NOTICE

All drawings located at the end of the document.

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan Background Document

A Working Group consisting of:

- **City of Broomfield**
- **City of Arvada**
- **City of Westminster**
- **City of Northglenn**
- **City of Thornton**
- **Colorado Department of Public Health and the Environment**
- **Department of Energy, Rocky Flats Field Office**
- **U.S. Environmental Protection Agency, Region VIII**
- **The Kaiser-Hill Team**

June 30, 1997

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INTEGRATED MONITORING PLAN

Rev. 1
June 1997

Responsible Organization: Environmental Management & Compliance

Effective Date:

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Reviewed for
Classification/UNCI:

By George H. Setlock

Date 12/17/97 U/NU

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List of Acronyms, Abbreviations, and Measurements

µ	Micro-
µCi	MicroCuries
µg	Microgram
µmho	Micromhos
AA	Atomic Absorption
Ag	Silver
ALARA	As Low as Reasonably Achievable
ALF	Action Level Framework
Am	Americium
AoI	Analyte of Interest
APCD	Air Pollution Control Division
APEN	Air Pollution Emission Notice
APO	Analytical Projects Organization
AQM	Air Quality Management
As	Arsenic
ASI	Advanced Sciences, Inc.
Ba	Barium
Be	Beryllium
BMP	Best Management Practices
BNA	Base-neutral acid extractable organics
BOD	Biological Oxygen Demand

C	Celsius
CAA	Clean Air Act
CAQCC	Colorado Air Quality Control Commission
CAS	Chemical Abstracts Service
CBOD	Carbonaceous Biological Oxygen Demand
CCR	*Code of Colorado Regulations*
Cd	Cadmium
CDPHE	Colorado Department of Public Health and Environment
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response Compensation and Liability Act
cf	Cubic Foot
CFR	*Code of Federal Regulation*
cfs	Cubic Feet Per Second
Ci	Curie(s)
CLP	Contract Laboratory Program
cm	Centimeter
cm^2	Square Centimeter
Co.	County
COD	Chemical Oxygen Demand
ComRad	Community Radiation
COPC	Contaminants of Potential Concern
Cr	Chromium
CRS	*Colorado Revised Statutes*

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CWA	Clean Water Act
CWQCC	Colorado Water Quality Control Commission
CY	Calendar Year
D&D	Decontamination and Decommissioning
DEFT	Decision Error Feasibility Trial
DIS	Drain Identification Study
DNAPL	Dense Nonaqueous Phase Liquid
DOE	Department of Energy
DQO	Data Quality Objective
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
F	Fahrenheit
ft	Foot
ft^3	Cubic foot
Fe	Iron
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facility Compliance Agreement
FID	Flame Ionization Detector
FO	Field Operations
FY	Fiscal Year
g	Gram
gal	Gallon

GC/MS	Gas Chromatography/Mass Spectroscopy
GIS	Geographic Information System
GPMPP	Groundwater Protection and Monitoring Program Plan
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
GT	Geotechnical
GW	Groundwater
GWAP	Groundwater Assessment Plan
H-3	Tritium
HEPA	High-Efficiency Particulate Air (filter)
Hg	Mercury
hr	Hour
HRR	Historic Release Report
HSL	Hazardous Substances List
HSU	Hydrostratigraphic Unit
IA	Industrial Area
IAG	Interagency Agreement
ICP	Inductively Coupled Plasma
IDLH	Imminent Danger to Life and Health
IDM	Investigation-Derived Waste
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measure/Interim Remedial Action
IMP	*Integrated Monitoring Plan*
ITS	Interceptor Trench System

IWS	Internal Waste Stream
Kaiser-Hill	Kaiser-Hill Company, L.L.C.
KSC	Salinity and Conductivity
L	Liter
LEL	Lower Explosive Level
LHSU	Lower Hydrostratigraphic Unit
LTL	Lower Tolerance Level
m	Meter
m^3	Cubic Meters
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
mg	Milligram
min	Minute
ml	Milliliter
mm	Millimeter
Mn	Manganese
mrem	Millirem
msl	Mean Sea Level
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
NO_2	Nitrite

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NO_3	Nitrate
NOx	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NSQ	Not Sufficient Quantity
NVSS	Non-volatile Suspended Solid
OLF	Old Landfill
OP	Operating Procedure
OU	Operable Unit
P	Phosphorous
PAC	Personnel Access Control
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
Pb	Lead
PCB	Polychlorinated Biphenyl
PCE	Perchloroethylene
PCOC	Potential Contaminants Of Concern
PCi	PicoCurie
PID	Photoionization Detector
PM_{10}	Particulate Matter (less than 10 micrometers)
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
POP	Pond Operating Plan
POTW	Publicly Owned Treatment Works
ppm	Parts per Million

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ppt	Precipitation
Pu	Plutonium
PU&D	Property Utilization and Disposal
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPD	Quality Assurance Program Description
QAPP	Quality Assurance Program Plan
QC	Quality Control
QCO	Quality Control Objectives
RAAMP	Radioactive Ambient Air Monitoring Program
RadNESHAP	National Emissions Standards for Emissions of Radionuclides Other than Radon from DOE Facilities (40 CFR, Part 61, Subpart H, Appendix B)
RCD	Radiation Control Division
RCRA	Resource Conservation and Recovery Act
RFCA	*Rocky Flats Compliance Agreement*
RFEDS	Rocky Flats Environmental Data Base System
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office
RFI	RCRA Facility Investigation
RI/FS	Remedial Investigation/Feasibility Study
RMRS	Rocky Mountain Remediation Services, L.L.C.
SCMP	Site-wide Commitments Management Program
sec	Second

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SEP	Solar Evaporation Pond
SID	South Interceptor Ditch
Site	Rocky Flats Environmental Technology Site
SOP	Standard Operating Procedure
SPCC/BMP	Spill Prevention, Control, and Countermeasures/Best Management Practices Plan
SSC	Species of Special Concern
SVOC	Semivolatile Organic Compound
SWMU	Solid Waste Management Unit
T&E	Threatened and Endangered (Species)
TBD	To Be Determined
TCA	Trichloroethane
TCE	Trichloroethylene
TDS	Total Dissolved Solids
temp	Temperature
TOC	Total Organic Carbon
tpy	Tons Per Year
TRAC	Terrain Responsive Atmospheric Code
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
U	Uranium
UHSU	Upper Hydrostratigraphic Unit
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey

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UTL	Upper Tolerance Level
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WER	Well Evaluation Report
WET	Whole Effluent Toxicity
WWTP	Wastewater Treatment Plant
WY	Water Year
yr	Year
YSI	Yellow Springs Instruments

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Introduction

June 30, 1997
Rev. 1

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1.0 INTRODUCTION

Soon after Kaiser-Hill Company, L.L.C. (Kaiser-Hill) became the Integrating Management Contractor at the Rocky Flats Environmental Technology Site (RFETS or the Site), Kaiser-Hill undertook a structured, comprehensive, reevaluation of all environmental monitoring programs. The objective of this effort was to develop specifications for monitoring utilizing the U.S. Environmental Protection Agency's (EPA's) established data quality objectives (DQO) process. The process involved the Department of Energy (DOE), EPA and Colorado Department of Public Health and Environment (CDPHE) (state) regulators, the cities of Broomfield and Westminster, and the Kaiser-Hill team. The effort was intended to identify any unnecessary monitoring and existing weaknesses in the monitoring programs, and to ensure protective and compliant programs. Using the consensus specifications (DQOs), an optimal data collection design was determined. This approach demonstrates compliance with the myriad of federal and state regulations and DOE Orders, and supports the decisions that must be made to protect human health and the environment with an acceptable degree of certainty. The monitoring programs of the regulators and cities were included and also modified to develop an integrated, multi-party Site monitoring program. The development and maintenance of this integrated program became a requirement of the *Rocky Flats Cleanup Agreement* (RFCA) issued on July 19, 1996[1]. This *Integrated Monitoring Plan* (IMP) is a result of the process described above.

The DQO process is a structured decision-making process that requires the identification of and agreement on decisions for which data are required, and results in the full set of specifications needed to develop a protective and compliant monitoring program (i.e., qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support decision making). The formal DQO process is documented in EPA QA/G-4 (1993)(1) and EPA/540/G-93/071 (1993)(2). In September 1994, the DOE institutionalized the DQO process for environmental data collection activities. This was implemented to balance the DOE's environmental sampling and analysis costs with the need for sound environmental data that address regulatory requirements and stakeholder concerns. Specific steps in the DQO process include:

[1] RFCA Part 21 Sections 267 and 268 state; "In consultation with CDPHE and EPA, DOE shall establish an IMP that effectively collects and reports the data required to ensure the protection of human health and the environment consistent with the Preamble, compliance with this Agreement, laws and regulation, and the effective management of RFETS's resources. The IMP will be jointly evaluated for adequacy on an annual basis, based on previous monitoring results, changed conditions, planned activities and public input. Changes to the IMP will be made with the approval of EPA and CEPHE. Disagreements regarding any modifications to the IMP will be subject to the dispute resolution process described in Subpart 15B or E, as appropriate.

"All Parties shall make available to each other and the public results of sampling, tests, or other data with respect to the implementation of this Agreement as specified in the IMP or appropriate sampling and analysis plan. If quality assurance is not completed within the time frames specified in the IMP or appropriate sampling and analysis plan, raw data or results shall be submitted upon the request of EPA or CDPHE. In addition, quality assured data or results shall be submitted as soon as they become available."

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- Identify and define problem(s) to be solved;
- Identify decision(s) to be made relative to the problem;
- Identify inputs to the decision (data needed to make decision);
- Define study boundaries/scope of problem and decision;
- Develop decision rule(s) [IF/THEN action statement(s)];
- Specify limits on decision errors (acceptable types and degrees of uncertainty); and
- Develop and optimize design for obtaining data.

The goal of using this approach was to reevaluate the basis and focus of existing programs, increase the defensibility of Site monitoring, and incorporate regulatory changes (e.g., water quality standards and cleanup levels) associated with RFCA. The RFCA requirements have been incorporated into the DQOs.

Implementation of the DQO process forces data suppliers and data users to consider the following questions:

- What decision has to be made?
- What type and quality of data are required to support the decision?
- Why are new data needed for the decision?
- How will new data be used to make the decision?

DOE and Kaiser-Hill recognized that the Site could no longer have separate, non-integrated sampling and analysis activities performed by various entities at the Site (e.g., Environmental Restoration and Environmental Protection), or between the Site, the cities, the state, and EPA Region VIII. DOE and Kaiser-Hill also realized that they should not work alone; therefore, an integrated monitoring working group was formed with representatives from EPA, the state, and the cities of Broomfield, Northglenn, and Westminster (see Table 1-1) to develop consensus on what data were needed, and how data would be used, and to develop sampling and analysis plans based on these specifications. The responsibility for data generation was then spread across these entities in a logical way. In developing the requirements for an integrated monitoring plan, the decisions and multimedia data requirements associated with Resource Conservation and Recovery Act (RCRA), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Clean Air Act (CAA), Clean Water Act (CWA), Colorado Water Quality Control Commission (CWQCC) standards, natural resource management regulations, Site-specific cleanup agreements (e.g., the *Industrial Area Interim Measures/Interim Remedial Action Decision Document*), and several DOE Orders were considered. After data requirements to support each of the desired decisions were identified, data collection was streamlined by looking for opportunities to use measurements for more than one decision.

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Table 1-1
Participants in the RFETS *Integrated Monitoring Plan* Development Process

Organization	Person	Surface Water	Ground-water	Air	Ecology
DOE, RFFO	K. Brakken				X
	J. Dion			X	
	P. Halder	X	X		
	R. McCallister			X	X
	S. Slaten	X	X	X	X
	J. Stover	X			X
DOE Contractor	J. Marks	X	X	X	X
Kaiser-Hill	E. Brovsky	X	X	X	X
	G. Kelly	X	X	X	X
	S. Nesta		X		X
	R. Nininger			X	
	G. Setlock	X	X		
	L. Woods				X
RMRS	M. Buddy	X			
	L. Dunston	X			
	S. Evans	X	X		X
	R. Fiehweg	X			
	C. Hoffman	X			
	J. Krause				X
	S. Singer		X		
	J. Starr	X			
	G. Wetherbee	X			
Radian Corporation	R. Crocker			X	
	G. Euler			X	
USGS	K. Lull	X			
	M. Smith	X			
EPA	W. Fraser	X			
	G. Kleeman		X		X
	M. Reed	X			
	C. Reynolds			X	
	S. Whitmore			X	
CDPHE	J. Bruch	X			
	R. Fox			X	
	T. Harrison	X		X	
	J. Love	X	X	X	X
	S. Marek	X			

Table 1-1 (continued)

Organization	Person	Surface Water	Ground-water	Air	Ecology
CDPHE	E Pottorff		X		
Colorado Dept. of Wildlife	D. Weber				X
Broomfield	H. Mahan	X			
	K. Schnoor	X			
Northglenn	K. Scott	X			
Westminster	S. Bernia	X			
	T. Settle	X			
RFCAB/CSM	S. Jovic	X	X		
Neptune & Co. Associates	D. Michael	X	X	X	X
	D. Neptune	X	X	X	X
PNNL	D. Gilbert	X	X	X	X

Notes:
CDPHE = Colorado Department of Public Health and Environment
DOE = Department of Energy
EPA = U.S. Environmental Protection Agency
Kaiser-Hill = Kaiser-Hill Company, L.L.C.
PNNL = Pacific Northwest National Laboratories
RFCAB/CSM = Rocky Flats Citizens Advisory Board/Colorado School of Mines
RMRS = Rocky Mountain Remediation Services, L.L.C.
USGS = United States Geological Survey

To accomplish the work associated with developing an integrated monitoring plan, four medium-specific DQO working groups (i.e., surface water, groundwater, air, and ecological resources) were established. Each group met regularly to work through the DQO process for each decision that required monitoring data. In addition, all four groups met together to discuss data needs across media, share progress, ensure consistency, and identify problems. DQO facilitators and statisticians, sponsored in part by DOE Headquarters, assisted the integrated monitoring working group in developing the DQOs, evaluating the adequacy of existing designs, and developing new sampling and analysis plans. The results of these efforts represent a multi-party consensus agreement and are documented below by environmental media. Integration was achieved between monitoring entities, regulatory programs, and environmental media. Interactions between media are discussed in Section 6.0 of this IMP.

This document covers all the environmental monitoring conducted by DOE and the Kaiser-Hill team, as well as monitoring conducted by CDPHE and the cities where interface and integration opportunities exist. There is other monitoring conducted by CDPHE and the cities that is related to the Site, but this monitoring did not present integration opportunities (e.g., monitoring of area reservoirs conducted by the cities and spot checks conducted by CDPHE).

Soil monitoring is not discussed in this document. Soil monitoring is conducted as it relates to specific environmental restoration (ER) and decontamination and decommissioning (D&D).

Integration of Site-wide and project-specific monitoring will occur during the planning of all major new activities, such as ER and D&D projects. Kaiser-Hill will review all major project plans and evaluate the need for specific environmental monitoring, based on potential release characteristics (e.g., constituents and concentrations), potential impacts [e.g., adherence to regulatory standards, RFCA, and as low as reasonably achievable (ALARA) principles], and existing Site-wide, multi-media monitoring. Consideration will be given to data needs before, during, and after a proposed activity. Monitoring before a project would assist in defining baseline conditions, characterizing relationships between media, assessing potential impacts to multiple media, and developing designs and controls to eliminate or mitigate impacts. Monitoring during and after a project would assist in determining the effectiveness and performance of designs and controls to eliminate or mitigate impacts. If additional monitoring was deemed necessary, Kaiser-Hill would work with project personnel to develop appropriate, media-specific DQOs and monitoring specifications. Project-specific DQOs will address protection of project personnel, collocated workers, off-Site populations, and the environment, and will complement Site-wide monitoring DQOs. Project-specific monitoring plans will be included in separate field sampling plans and/or health and safety plans, and therefore, will be available for review by the regulatory agencies and other stakeholders. Integration of Site-wide and project-specific monitoring could also be the subject of future meetings of the integrated monitoring working group.

A key component of the DQO process and the RFETS IMP is data evaluation. To be successful, both Site-wide and project-specific monitoring data will need to be continuously evaluated to support the DQO decision rules. Decision rules could address baseline definition, relationships between various media, performance and compliance demonstration, and identification of unplanned conditions and trends. Actions based on data evaluation are specified by the decision rules. Actions also may involve modification of DQOs and monitoring specifications. For example, additional data may be required to adequately characterize observed conditions and potential impacts (e.g., exceedance of RFCA Tier I and Tier II groundwater action levels), and in some cases, to properly scope a proposed activity (e.g., ER and D&D projects, or changes to existing water management schemes). Data evaluation is discussed in the media-specific sections that follow and in RFETS environmental program plans.

Data reporting and data exchange were considered during the development of the IMP. The data exchange mechanism, which was formalized as a RFCA requirement (Section 207), will provide Site-wide and project-specific monitoring data to all appropriate monitoring entities and regulatory agencies and will allow these groups to evaluate data needs associated with proposed activities (e.g., baseline characterization, design, and performance monitoring). Work is progressing on defining the data management tools needed for data exchange and interpretation. All entities are involved to ensure that the proper information is conveyed in a timely manner.

The plan presented herein should be considered dynamic. The monitoring programs will evolve as further progress is made on Site remediation and closure, as new remediation and closure efforts are planned and initiated that require performance monitoring, as the regulatory setting changes, and as new data become available to improve the statistical design. Such changes will be made by the multi-party working group and documented in updates to this plan. Routine meetings of the working group will be held, and resulting changes will be presented to other stakeholders, including the RFETS Citizens Advisory Board. Additional work that should be performed is presented below.

- Evaluate detection limits, quality control (QC) specifications, and other aspects not fully specified at this time;
- Finalize process to develop and evaluate monitoring DQOs and plans for new activities, such as ER and D&D projects, including integration of Site-wide and project-specific monitoring;
- Continue to identify integration opportunities between media (see Table 6-1);
- Finalize DQOs for Buffer Zone flow monitoring;
- Develop monitoring DQOs for controlled detention mode of pond operations;
- Continue to evaluate groundwater data regarding Tier I and II exceedances, and modify sampling and analysis accordingly (data review, additional sampling and analysis, and modeling as appropriate). For example:
  - Nitrate plume at solar ponds,
  - Walnut Creek wells,
  - Wells north of B771/B779 Complex, and
  - Volatile organic compound plume at Property Utilization and Disposal (PU&D) yard;
- Negotiate changes in National Emission Standards for Emissions of Radionuclides Other Than Radon from DOE Facilities (Rad NESHAP) monitoring in light of facility D&D (i.e., use of ambient monitoring to demonstrate compliance with NESHAP standards);
- Solicit broader stakeholder input (e.g., present plan and modifications to interested stakeholder groups);
- Convene integrated monitoring working group routinely (e.g., semiannually); and Complete development of mechanism to exchange data among monitoring entities and with other stakeholders.

1.1 References

1. EPA QA/G4, *Guidance for Planning for Data Collection in Support of Environmental Decision Making Using the Data Quality Objective Process.* U.S. Environmental Protection Agency, October 1993.

2. EPA/540/G-93/071, *Data Quality Objectives Process for Superfund.* U.S. Environmental Protection Agency, September 1993.

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Surface Water Monitoring

June 30, 1997
Rev. 1

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2.0 SURFACE WATER

2.1 Introduction

This chapter of the Integrated Monitoring Plan (IMP) is written so that it can be used in two different documents, as needed. The Site-wide plan may be in draft or under negotiation at times when Rocky Mountain Remediation Services, L.L.C. (RMRS) must demonstrate and document management control of their work. Thus, two separate documents are occasionally required, but the two documents must have the identical negotiated text. This plan has been written to accommodate this need.

2.1.1 Summary of Monitoring Objectives

This document describes surface water monitoring objectives implemented for fiscal year 1997 (FY97). The monitoring described herein integrates all surface water monitoring across the Rocky Flats Environmental Technology Site (RFETS or the Site) (see Figure 2-1), including much of the Site monitoring performed by the cities and the state.

The Data Quality Objective (DQO) process was used to determine necessary and sufficient monitoring requirements. The process yielded over 20 data-driven decisions. Some decisions need a higher priority than others, and some need greater confidence than others. The DQO process has produced descriptions that expose the strengths and weaknesses of each data-driven decision, and the value of the data (resources required) in making each decision. Management decisions often must be made on the basis of incomplete information. The individual DQO sections of this document help management to establish funding priorities for surface water monitoring objectives.

Surface water monitoring objectives have been organized in a roughly upstream-to-downstream direction, beginning with process discharges within the Industrial Area and ending at the drinking water reservoirs downstream, as depicted in Figure 2-1. These monitoring objectives are summarized in the following paragraphs and are discussed in detail in the remainder of this section.

Monitoring objectives that do not fit into the upstream-to-downstream sequence are discussed in Site-Wide Monitoring Objectives, Section 2.2, some of which do not fit in that sequence. For example, safe operation of the dams is dependent on some monitoring to avoid breaching a dam. This monitoring objective is placed first (see Section 2.2.1), in recognition of its unique importance in avoiding imminent danger to life and health (IDLH). Another monitoring objective is monitoring to locate a new source of contamination detected by other monitoring, which is covered in Section 2.3.1.

Location of a new contaminant source could take place anywhere in the area shown in Figure 2-1; therefore, it does not fall into the upstream-to-downstream order. In addition, some monitoring needs simply cannot be known in advance and are discussed in Section 2.2.3. Furthermore, some monitoring may be performed at various locations to evaluate alternatives for

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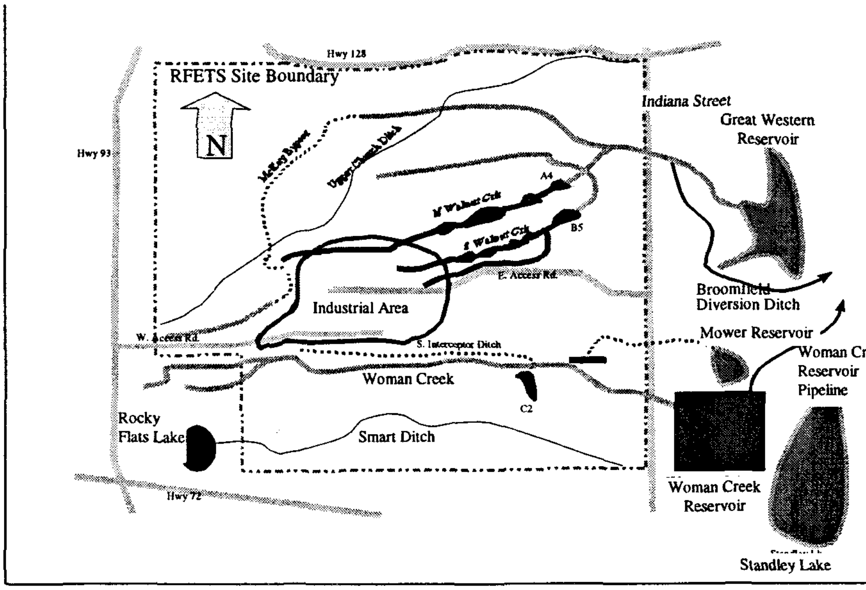
Figure 2-1
Conceptual Sketch of Site Surface Water



surface water management, such as controlled detention[1] pond management, discharge of the Interceptor Trench System (ITS[2]) effluent into Walnut Creek, or re-routing of wastewater treatment plant (WWTP) effluent. This type of monitoring is discussed in Section 2.4.

In the first of the upstream-to-downstream monitoring objectives, RFCA and the Industrial Area Interim Measures/Interim Remedial Action (IM/IRA) Decision Document require the Site to identify and correct significant accidental or undetected releases of contaminants from *within the Industrial Area.* In order to decide whether a significant release has occurred, the Site must monitor Industrial Area runoff for significant increases in contaminants (see Section 2.3.1). Immediately outside the buildings of the Industrial Area, the Site must often decide whether incidental waters (see Section 2.3.2) that accumulate in berms, utility pits, etc, must be treated, or whether they can be discharged directly to the environment or to the sanitary system. (Still within the Industrial Area [usually], individual high-risk projects will sometimes need performance monitoring (Section 2.3.3) to detect a spill or release of contaminants specifically from that project).

Section 2.4 deals with discharges from the Industrial Area to the ponds. The Rocky Flats Cleanup Agreement (RFCA) specifies monitoring for the upstream reaches of Site drainages (above the ponds) and specifies action levels for contaminants. This Stream Segment 5 monitoring is addressed in Section 2.4.1. Internal waste streams are discussed in Section 2.4.2.

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[1] Controlled detention is a strategy for Site pond operations that would allow continuous discharge of water from the terminal ponds under carefully controlled conditions.

[2] System designed to capture a contaminated subsurface plume on the north slope of the Solar Pond Area of the Industrial Area.

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To develop the National Pollutant Discharge Elimination System (NPDES) permit application, the Site must monitor the internal waste streams of some processes within facilities to establish what the Site might reasonably expect to see in discharges from these processes (see Section 2.4.2). Returning to the generally downstream sequence of the plan, the Site is routinely required to determine whether some internal waste streams (Section 2.4.3) may be discharged from the Industrial Area to the WWTP. Some monitoring must also be performed on the influent from the wastewater collection system (Section 2.4.4) to the WWTP. In addition, NPDES monitoring must be performed on the WWTP discharge to the ponds.

Water leaving the Site must also be monitored. Ponds are monitored prior to discharge (Section 2.5.1.1). The Site must monitor specific point-source discharges as specified by the NPDES permit (Section 2.5.2). The Site must also monitor to protect state stream standards in Segment 4 (Section 2.5.3), as specified in the RFCA. In addition, there are RFCA points of compliance (POC) that are monitored at the Site boundary and Indiana Street (Section 2.5.4).

The state of Colorado and downstream communities are concerned that the water quality in downstream reservoirs might be degraded by Site discharges. Section 2.6 addresses off-Site monitoring needs. These data are used to make decisions regarding use of the water for drinking and irrigation and for compensatory actions such as providing alternate water sources and reservoirs.

Section 6.0 of this IMP addresses the interfaces between surface water and other media: soil, groundwater, air, and ecology. For example, groundwater and soil could conceivably contaminate surface water, and surface water could contaminate habitats of endangered species. These monitoring requirements are addressed in different locations in the Surface Water Monitoring Management Plan (1).

2.1.2 Geologic and Hydrologic Setting

This section is included *only* as an introduction to the Site for the lay public not already familiar with the Site. This section contains no monitoring requirements or other commitments or agreements between the parties. This section contains no material that affects the interpretation of the rest of the document.

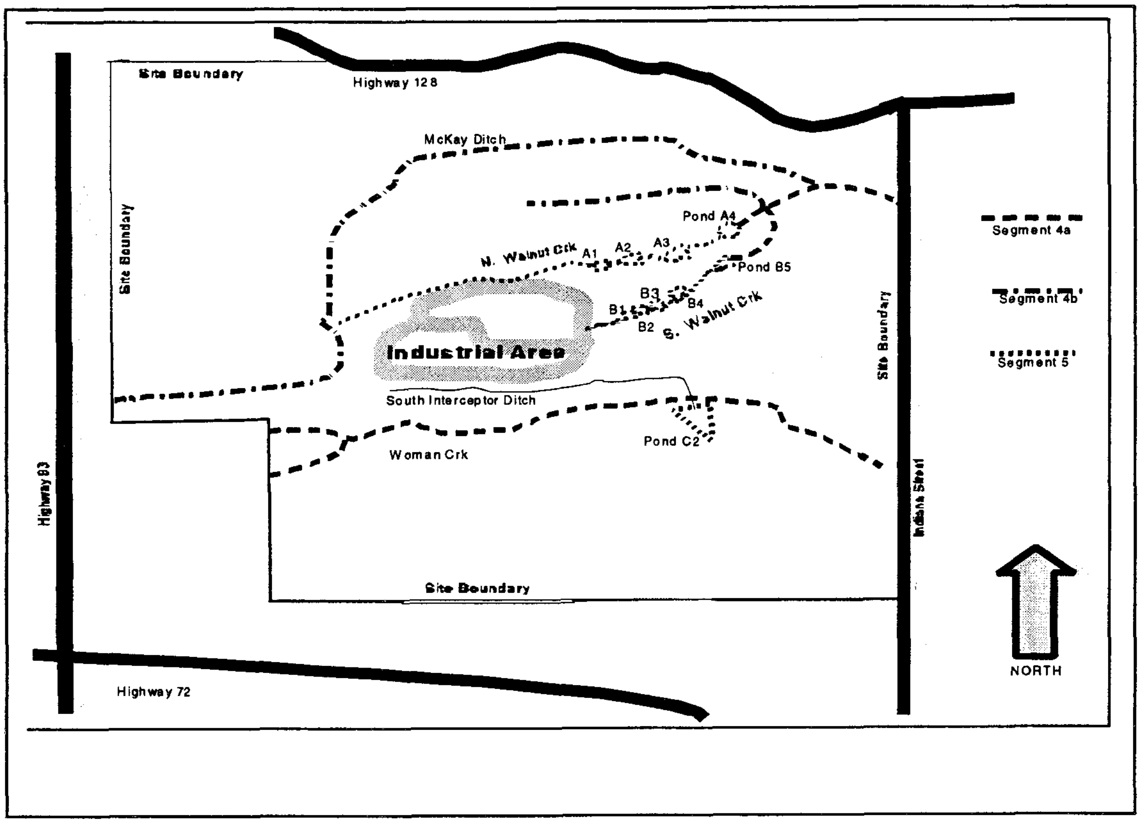
Geographically, the Site surface waters are bounded:

- Upstream by the West Interceptor Ditch (McKay Bypass);
- On the south, by the South Interceptor Ditch (SID) or by Woman Creek, subject to discussion and context;
- On the north by the landfill drainage; and
- On the downstream end by Great Western Reservoir and Standley Lake or by Stream Segment 1 of Big Dry Creek, subject to discussion and context.

These features are shown in Figures 2-1 and 2-2. A detailed discussion of Site geology and hydrology is presented in Section 3.0 of this IMP (1).

The stream drainages leading off Site are Walnut Creek, Woman Creek, and Rock Creek. The figures illustrate the first two drainages and their tributaries. North Walnut Creek and South Walnut Creek flow through the A and B series ponds, respectively. The Colorado Water Quality Control Commission (CWQCC) has designated the portion of these drainages from Ponds A4 and B5 to Indiana Street as Stream Segment 4b. Tributaries to the A and B terminal ponds, and Pond C2 itself, are designated as Stream Segment 5. The South Interceptor Ditch and Ponds A1, A2, B1, and B2 have not been designated as waters of the state. These stream segment designations are best illustrated in Figure 2-2.

Figure 2-2
Sketch of Stream Segments 4a, 4b, and 5



2.1.3 Assumptions

The Surface Water IMP Team had to make some assumptions in order to limit the monitoring program to address reasonable concerns. The alternative was to monitor for all possible Site conditions, contaminants, and practices, which would have been an extremely inefficient use of tax dollars. The Team's planning assumptions are presented below. These assumptions may not continue to be true in the future in all cases, and this document does not constitute agreement between the parties that these assumptions will be maintained. However, if an assumption becomes invalid during the effective period of this plan, then some of the monitoring that was

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excluded on the basis of that assumption should be reconsidered and possibly implemented in future years.

- Deviation from these assumptions requires prior approval of the U.S. Environmental Protection Agency (EPA), Colorado Department of Public Health and Environment (CDPHE), and the Department of Energy (DOE), as required in RFCA Part 23, paragraph 267.

- This plan is to be fully implemented during FY97.

- Monitoring objectives specified herein will be implemented by the parties, subject to funding constraints and priorities, as specified in RFCA Part 11, Subpart A.

- Terminal ponds will continue to be operated in a batch mode throughout FY97 until agreed on by all parties.

- The ITS will not be discharged into the Walnut Creek drainage without prior treatment unless a change is agreed to by RFCA Parties. Direct discharge of ITS effluents would require modification and reapproval of this plan.

- This plan incorporates all surface water monitoring of Site discharges to surface water and contaminant impacts down to and including Broomfield and Westminster water supplies. Monitoring and decisions by the Site, the state, and the cities are included.

- Decisions regarding Imminent Danger to Life and Health (IDLH) are deserving of special attention and will be segregated from decisions regarding potential very low health risks to ensure that no confusion will arise regarding the priority of IDLH decisions over low-risk water quality decisions.

- The parties agree that continuous monitoring probes will be used as indicators that may suggest a need for additional monitoring or mitigating action. The parties agree that compliance and enforcement issues will be resolved on the basis of standard analytical procedures specified by the applicable regulation or agreement, e.g., NPDES, RFCA, or CERCLA. The parties agree that continuous monitoring field probes should NOT be used to determine compliance or serve as a basis for enforcement action, unless the applicable regulation specifies such a probe as the enforceable analytical method for a particular measurement.

- For purposes of computation in regulatory reporting, the sample date for a multi-day sample will be the date that the sample was started. Although this will give the impression that multi-week samples are being reported months late, this convention is consistent with all other Site data.

- Termination for Cause: Completion of a flow-proportional composite sample is determined by several factors that are evaluated by the sampling team. These include, but are not limited to, the required sample volume for analysis (normally ≥ four liters), weather conditions, work schedules, sample preservation, potential loss of data, regulatory reporting schedules, and other concerns.

- Not Sufficient Quantity (NSQ): If sample accumulation is terminated for cause, and sample volume is inadequate for routine lab analyses, then no analyses are required, and the sample will not be used in the computation of a 30-day moving average. For example, routine lab analysis for Pu, Am, and tritium requires four liters. Therefore, samples of less than four liters may be discarded and not used in the computation and evaluation of compliance parameters, but must be reported. This requirement may be referred to as the NSQ requirement regarding insufficient quantity of sample.

- 30-day moving averages will be computed twice each month and reported within 5 working days of the 15th day and the last day of the month (the reporting dates) for samples completed during the 30-day period preceding the reporting date.

- Where there is no significant flow, there may be no samples completed within a 30-day period. However, flow-proportional monitoring will continue during dry periods, even though flows may be so low that it may take longer than 30 days to fill the sample carboy.

- If no samples are taken during a 30-day interval, then no sample result will be available for use in the computation of a 30-day moving average, and no such average will be reported for that period.

- All samples taken for RFCA monitoring under this plan must be reported, even if they are not analyzed, and the reason for not analyzing (e.g., NSQ) must be reported.

- All monitoring data acquired under the same procedural controls as used for RFCA monitoring are actionable[3] under RFCA and applicable regulations, even though it may not have been specifically identified as an analyte of interest (AoI) in Tables A-26 and A-27 in Appendix A to this section.

- All areas of the Site are linked by the flow of water within and above the ground surface in an upstream-to-downstream direction. Contaminants monitored in one area may have originated in an upstream area.

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[3] The term "enforceable" has been reserved for Segment 4 Standards, as opposed to Segment 5 Action Levels. The term "actionable" is intended here to include enforcement actions, actions taken in response to action level exceedances, and any other action required under RFCA in response to monitoring data.

- All of the areas are driven by the underlying CWQCC standards and the Colorado Water Quality Control Act.

- Each monitoring objective that requires comparison to baseline assumes that establishment of baseline will be performed before decisions are made on the basis of the data. Each monitoring objective that specifies decisions based on statistical tests assumes that variability of data will be established before decisions are made on the basis of the data.

2.1.4 Outstanding Issues

- A new NPDES permit is expected to be issued by EPA Region 8 in calendar year 1997 (CY97). This new permit will move Clean Water Act (CWA) Points of Evaluation and POC from the Site ponds to the outfalls of Buildings 995 and 374. This plan will have to be modified accordingly after the permit is issued.

- The Site plans to implement a controlled detention mode of pond operations (vs. a batch discharge mode) in the future, per Site closure plans.

- The Site would like to discharge Pond B5 directly through the existing outlet works and standpipe of Pond B5 in quasi-batch mode rather than discharging Pond B5 through Pond A4. This would avoid the costs of pumping water from Pond B5 to Pond A4. This Site goal does not yet have the support of all parties to this monitoring plan. One major concern would be that quasi-batch mode and grab samples do not monitor all of the effluent discharged because WWTP effluent continues to enter Pond B5 after the samples are taken and until the discharge is completed.

- The Site may seek to discharge WWTP effluent via a pipeline to Pond A3.

- The Site may seek permission from EPA to bypass the B-series ponds and discharge WWTP effluent below Pond B5 after monitoring in compliance with the applicable NPDES permit requirements. If discharge below Pond B5 is implemented, the Site would also monitor this discharge for radionuclides at the outfall into Segment 4. This Site goal does not yet have the support of all parties to this monitoring plan. One major concern would be that direct discharge of the WWTP effluent after only NPDES monitoring would not detect and prevent the possibility of a short spike of radionuclide contaminant release via the WWTP.

2.1.5 Quality Assurance

Sampling and analysis of Site surface water is controlled by Standard Operating Procedures, the RMRS Quality Assurance Program Plan, the Site Quality Assurance Manual, and the Analytical Services Division Statement of Work for Analytical Measurement. The Statement of Work for Analytical Measurement presents the approved analytical methods, hold times, detection limits and lab data reporting protocol. Sample sizes (number of independent samples analyzed) for

FY97 were determined by the NPDES permit in some cases and by desired confidence intervals, subject to funding limitations, in other cases. For additional details, such as requirements for blanks and duplicate samples, refer to the following plans and procedures.

- *Site Quality Assurance Manual, Rocky Flats Plant.* Rocky Flats Environmental Technology Site, Golden, Colorado, 1996.

- *Quality Assurance Program Plan. Manual No. 95-QAPP-001, Rev. 0, 10/4/95.* Rocky Mountain Remediation Services, L.L.C., Golden, Colorado, 1995.

- *EMD Operating Procedures Volume I, Field Operations, Manual No. 5-21000-OPS-FO.* EG&G Rocky Flats, Inc., Rocky Flats Plant, Golden, Colorado, 1992.

- *EMD Operating Procedures Volume IV, Surface Water, Manual No. 5-21000-OPS-SW.* EG&G Rocky Flats, Inc., Rocky Flats Plant, Golden, Colorado, 1992.

2.1.6 Reporting

Data specified in the surface water monitoring objectives are used in decision making. Many of the data are not routinely reported other than to the decision-maker(s) for a particular decision. Such data remain available in the Rocky Flats Environmental Data Base System (RFEDS) for subsequent queries (secondary data usage is quite common). Some typical examples of data usage are described below. (This is not a complete list).

- IDLH data are used to determine when valves and flood gates should be opened and closed. Some of these data may be reported verbally to the DOE, Rocky Flats Field Office (RFFO) and regulators during the decision-making process, but no formal report of pond levels, valve positions, and piezometer readings is produced as a regulatory report.

- If data helped to locate a new contaminant source, then the source and data would be reported internally for appropriate management action. Any external reporting would be dependant on the applicable regulations for that contaminant and source location.

- *Ad hoc* monitoring requested by on-Site parties is reported to the requestor.

- The results of monitoring for correlation of plutonium (Pu) with particulates could be published in a letter report, at the discretion of the Site.

- The New Source Detection monitoring would be reported internally to initiate action if a new contaminant source were detected, but no public or regulatory report would be routinely produced.

- The disposition of internal waste streams and incidental waters is based on data-driven decisions. The data are recorded and reported to the decision maker, but no regulatory or public report is produced.

There are a few routine reports prepared for surface water data. Current reports are:

- NPDES monitoring data are reported in a Discharge Monitoring Report each month to the EPA.

- The state routinely reports predischarge and community-assurance monitoring results to the Site and cities.

- Exceedance of RFCA standards and action levels must be reported to both EPA and CDPHE.
- Many of the surface water data are summarized and reported at the Quarterly Information Exchange Meetings.

2.2 Site-wide Monitoring Objectives

The monitoring objectives in this IMP are presented in an upstream-to-downstream order. This section deals with monitoring objectives that cannot be ordered in that way. This section also deals with cross-cutting monitoring objectives such as: safe operation of the dams (Section 2.2.1), location of spills wherever they may occur (Section 2.2.2), special request monitoring (Section 2.2.3), and the use of operational indicators for Pu to design and implement pond operations (Section 2.2.4). None of this monitoring is confined to a single geographical area of the Site. Section 2.3 addresses monitoring from the buildings downstream to the reservoirs.

2.2.1 IDLH Decision Monitoring

This IDLH section uses the term "action level" in reference to dam operations. This is an entirely different usage unrelated to the RFCA Action Levels discussed elsewhere in this document.

Failure of an earthen dam would present an IDLH. Safety and health professionals often refer to such conditions as IDLH conditions. The Site has several ponds formed by dams that can hold a limited amount of water safely. Water may be discharged from these ponds through the outlet works or by pumping. Water does not normally overtop the dams, which are all of earthen construction and would be damaged and could fail under those conditions. Heavy rain or snow melt can challenge the capacity of the ponds faster than the ponds can be monitored and discharged.

Problem Statement:

If water levels rise above safety limits that preserve dam integrity, then ponds must be discharged to prevent overflow or breaching[4]. The risk to the public and environment is far greater from a dam breach than from the low levels of contaminants that might be found in pond waters.

Problem Scope:

The actual decision process for controlling water flow through the ponds and conducting pond and dam monitoring activities is too complex to be treated in this document. Detailed information can be found in the *Pond Operations Plan* (POP) (2), and the *Emergency Response Plan for Failure of Dams A-4, B-5, or C-2 (3).* The following *generalized decisions* must be made on a continuous basis for Pond A4. Similar decisions are made for Ponds A3, B5, and C2. A series of simultaneous equations are solved via an expert system framework to consider actions associated with modeled action levels.

Inputs:

The decision factors include safe pond capacity, actual pond elevation, current and projected flow rates into and out of the ponds, and several indicators of dam integrity, such as piezometer readings, inclinometer readings, cracks or sloughs of embankment material.

- Pond inflow rates into Ponds A4, B5, and C2 must be continuously monitored (daily to hourly)[5].

- Pond elevation must be monitored continuously (daily to hourly) for all three terminal ponds.

- Piezometers in dams estimate amount of water in dam structure.

- Daily to hourly visual inspections of dam integrity.

- Daily to hourly telemetry data on the two dams that have inclinometers.

- Results of a model that rates the above inputs to determine whether to release water from a dam despite water quality. (Note: The *Pond Operations Plan* (2) details the decision tree that describes this logic).

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[4] Maximum discharge rate for earthen dams is one foot per day to achieve drawdown without inducing sloughing of the saturated sides of the dam.

[5] Critical measurements, such as pond inflow rates and elevations, require hourly monitoring capability, even though daily monitoring may be adequate for a portion of the year. During FY 1996 (FY96), hourly monitoring was actually used for 85 days during the year.

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- Discharge rates (pumped or through outlets).
- Weather prediction (affects the weighting factors in model).
- Biannual dam inspections.
- Annual Federal Energy Regulatory Commission (FERC) inspection.
- Crest monument movement monitoring (required by CCR for dams).
- Inclinometer monitoring (required by CCR for dams).

Boundaries:

Spatial: Flow in streams immediately upgradient to Ponds A3, A4, B5, C2, and the Landfill Pond is used in decision making. Each individual dam and the water in each pond is included in decision making. The only dams that are normally operated to contain or release water off Site are A4, B5, and C2 in the North Walnut Creek, South Walnut Creek, and Woman Creek drainages, respectively. (Woman Creek normally flows around Pond C-2, through an artificial diversion. However, Pond C-2 is directly in the natural drainage of Woman Creek and does receive water from Woman Creek during flood conditions.) Pond A3 may also be included in this list of terminal ponds under some conditions, such as during construction activities in Pond A4.

Temporal: Daily or more frequent dam piezometer data, hourly in-flow data, hourly to daily pond level data—all by telemetry. Most decisions are made Monday through Friday on a daily basis; however, during a crisis situation, hourly decisions may be made seven days a week.

Decision Statement:

IF Water quality analytical results meet all applicable standards to protect downstream water users, and dam is at pond operations Action Level 3 or less (determined by piezometer readings [water level in ground], dam inspections, pool level, and inflow data)

THEN The Site will discharge water from the pond.

IF A pond reaches Action Level 4 (i.e., exceeds its safe capacity based on data including piezometer readings, dam inspections, pool level, and inflow data)

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THEN	The Site will release water (without waiting for analytical results) from the pond at one foot per day and notify the Colorado State Engineer and other specified agencies.
IF	A pond reaches Action Level 5 [spillway overflow occurring or overtopping expected and/or breaching possible based on data including piezometer and inclinometer (measures the change in a slope, providing early warning of a potential dam failure) readings, dam inspections, pool level, inflow data]
THEN	The Site will release water (without waiting for analytical results) from the pond at two feet per day. Notifications to Colorado State Engineer and other agencies are required.
IF	Routine or emergency dam inspections, inclinometer readings, piezometer readings, and/or other monitoring activities reveal changed conditions affecting the structural integrity of a dam
THEN	The Site will notify the Colorado State Engineer and other agencies, as required by the *Code of Colorado Regulations* (CCR) (2 CCR 402-1, Rules 14 and 15) and *Colorado Revised Statutes* (CRS) (CRS 37-87-102 through 115), and develop alternatives, as necessary and appropriate, to correct the identified problem.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The Surface Water IMP Team believes that the frequency and type of monitoring specified is appropriate to identify any structural problems in a timely manner consistent with standard industry practices and applicable regulations.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - This monitoring does not lend itself to a statistical sampling design.

Monitoring Requirements:

Monitoring requirements currently being implemented to safely operate the dams are presented in Table 2-1.

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Table 2-1
Monitoring Requirements (Number of Samples/Analyses) for Safe Operation of Dams

Types Monitored	Pond											
	A1	A2	A3	A4	B1	B2	B3	B4	B5	C1	C2	Landfill
Inflow rate (telemetry measurement)	—	—	9/day	9/day	—	—	—	—	9/day	—	9/day	—
Inflow rate (field measurement)	1/week	1/week	1/day	1/day	1/week	1/week	—	—	1/day	—	1/day	1/week
Discharge rate (telemetry measurement)	—	—	9/day	9/day	—	—	—	—	9/day	—	9/day	—
Discharge rate (field measurement during discharge)	4/day	4/day	12/day	12/day	4/day	4/day	—	—	12/day	—	12/day	4/day
Pond elevation (telemetry measurement)	—	—	9/day	9/day	—	—	—	—	9/day	—	9/day	—
Pond elevation (field measurement)	1/week	1/week	3/week	3/week	1/week	1/week	—	—	3/week	—	3/week	1/week
Piezometers (telemetry measurement)	—	—	3/day	3/day	—	—	—	—	3/day	—	3/day	—
Piezometers (field measurement)	—	—	1/week	1/week	1/week	—	1/week	—	1/week	—	1/week	1/week
Routine dam inspection	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week
Biannual detailed dam inspection	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year
Annual FERC and DOE dam inspection	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year
Inclinometer (field measurement)	—	—	—	4/year	—	—	—	—	4/year	—	4/year	—
Crest monument movement (field measurement)	—	—	—	4/year	—	—	—	—	4/year	—	4/year	—
Use computer model to predict pond filling and/or discharge events (using data from telemetry and field measurement)	1/week	1/week	1/day	1/day	1/week	1/week	—	—	1/day	—	1/day	1/week

Notes:

Where nine measurements per day are indicated, this is the estimated average of critical measurements that are actually required. This varies from daily to hourly, and the hourly capability is required for 50-100 days per year.

— = Not applicable
DOE = Department of Energy
FERC = Federal Energy Regulatory Commission

2.2.2 Source Location Decision Monitoring

As used in this section a "source" is a contaminant source. The term "new source" as used in this section means any source that has not yet been located, halted, mitigated, quantified, or corrected. The parties intend that this decision rule will initiate appropriate action, even though a source may exist prior to the implementation of this IMP.[6]

Problem Statement:

> When new contaminant sources are detected by surface water monitoring within the Industrial Area, Points of Evaluation, or in the downstream reservoirs, additional monitoring will be required to identify[7] the source and evaluate for corrective action

[6] A decision rule under the DQO process links Site environmental data with operational and regulatory decisions.
[7] Note that the term "identify" is used here to mean "locate." Characterization is also implied.

pursuant to the RFCA Action Level Framework (ALF). The source location monitoring objective is to locate the source of contamination when a new source of contamination is detected.[8]

Inputs:

Only the contaminant of current concern that has caused the exceedance, or related indicators. The decision inputs are entirely dependent on the other decision rule under which the source was detected.

Boundaries:

Spatial: Anywhere within the Site surface water drainage area (especially within the Industrial Area) that a new contaminant source or exceedance is detected and outside of a facility. For example, if monitoring (just outside the Industrial Area) for new source detection suggests a new source within the Industrial Area, then portable sampling equipment may be installed within the Industrial Area, to locate the source. And if monitoring for compliance in Segment 4 suggests a new source, then monitoring to identify the source may begin in Segment 5.

Temporal: Source location monitoring should begin within 30 days of source detection and continue until the source is identified and evaluated or is no longer detected.

Decision Statement:

IF A new contaminant source is identified by any monitoring

THEN The Site will take appropriate and immediate action to halt or mitigate, locate and quantify the source, and implement corrective action pursuant to the RFCA ALF.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - This decision rule is only invoked when new sources are detected under other decision rules. Comprehensive monitoring for *detection* of new sources is an issue for other decision rules. Comprehensiveness and representativeness may be developed for specific instances of source location actions.

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[8] The various monitoring objectives might "detect" a new source through an increase in baseline or exceedance of an action level, standard, permit limitation, etc., depending on the decision rule under which the potential new source was detected.

- Acceptable Decision Error Rates for Statistical Sampling Design:

  — A generally applicable statistical sampling design has not been used.

Monitoring Requirements:

For planning purposes, it is assumed that exceedance of the Segment 5 Action Level for Pu will occur at all three Action Level monitoring locations, and that analyses for Pu and total suspended solids (TSS) will be performed to locate the sources contributing to any of the exceedances.

Table 2-2
Estimated Number of Annual Plutonium and Total Suspended Solids Samples

	SW093	SW027	GS10	Total
Plutonium	25	10	15	50
Total Suspended Solids	25	10	15	50
Flow	Continuous	Continuous	Continuous	—

2.2.3 *Ad Hoc* Monitoring

Problem Statement:

The Site often monitors surface waters on an *ad hoc* basis for a variety of reasons. This monitoring may or may not be used in decision-making processes, but it has been frequently requested by DOE, RFFO, cities, agencies, and the WWTP in the past. The Surface Water IMP Team anticipates that the DOE, RFFO will continue to request such *ad hoc* monitoring in the future, regardless of whether funding is allocated for that purpose. Some examples of events that would trigger *ad hoc* monitoring include:

- Major precipitation events that disrupt pond monitoring and discharge schedules.
- Community assurance monitoring at the request of downstream cities and the DOE, RFFO.
- Unanticipated changes in regulatory permits, agreements, or funding.
- Anticipated but unfunded changes in permits or agreements.
- Construction projects.
- Spill events.

The monitoring estimates in Table 2-3 are based on fiscal years 1995-1996 (FY95-96) actual monitoring, with spring 1995 sampling taken at 70% of actual to correct for the unusually high monitoring requirements during April, May, and June of 1995. Analytes listed are typical of current and past monitoring, but actual monitoring for future periods will certainly differ from this estimate.

Table 2-3
Example of Possible Annual *Ad Hoc* Monitoring Requirements
(Number of Samples/Analyses)

Analyses	995 Sand Filter Effluent	995 Influent	Pond					Walnut Creek at Indiana	Woman Creek at Indiana	Total
			A3	A4	B5	C1	C2			
Acute toxicity	—	—	2	—	—	—	—	—	—	2
Am-241	—	—	—	8	8	52	5	16	5	94
CBOD5	—	104	—	—	—	—	—	—	—	104
Fecal coliform	10	—	—	—	—	—	—	—	—	10
Gross alpha/beta	—	—	—	60	56	52	35	80	35	318
HSL metals	—	—	—	4	4	—	2	4	2	16
AA-Ag, As, Cd, Hg, Pb	—	—	—	4	4	—	2	4	2	16
NVSS	—	—	—	2	—	—	—	—	—	2
Pu-238	—	—	—	—	—	52	—	8	—	60
Pu-239/240	—	—	—	8	8	52	5	16	5	94
Tritium (H-3)	—	—	—	56	56	52	35	56	35	290
TSS	—	108	—	56	56	—	35	56	35	346
U-isotopic	—	—	—	8	8	52	5	16	5	94
Total samples for FY97	**10**	**212**	**2**	**206**	**200**	**312**	**124**	**256**	**124**	**1446**

Notes:
AA = Atomic absorption
Ag = Silver
Am = Americium
As = Arsenic
CBOD5 = 5-day carbonaceous biological oxygen demand
Cd = Cadmium
FY = Fiscal year
Hg = Mercury
HSL = Hazardous Substance List
NVSS = Non-volatile suspended solids
Pb = Lead
Pu = Plutonium
TSS = Total suspended solids
U = Uranium

2.2.4 Monitoring for Correlation of Plutonium with TSS[9]

Problem Statement:

This monitoring objective is intended to establish the relationship of Pu concentrations with several indicator parameters, such as TSS, turbidity, or flow rate.

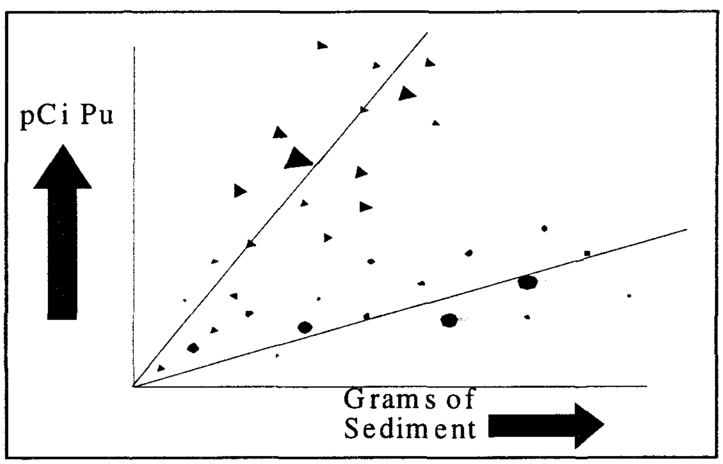
[9] Note: This section on the relationship of Pu with suspended particulates is *not complete*. The material in this section has been retained for future use, but several fundamental issues must be resolved, and a major rewrite will almost certainly be required before monitoring should begin. Consensus on this section may be difficult to achieve due to the concerns surrounding controlled detention. However, all members of the Surface Water IMP Team have agreed that decisions regarding controlled detention should be well-informed decisions based on monitoring data such as is identified in this section.

The Site intends to move toward controlled detention operation of the ponds in FY98. The controlled detention design basis indicator for Pu will be at first TSS, which historical stormwater data have shown to be strongly correlated with Pu activity (4) at several locations. This correlation was a primary assumption in the design basis for the controlled detention *Pond Operations Plan*[10]. To test these hypotheses, samples must be analyzed during FY97 for Pu and TSS at those monitoring locations to be used operationally for controlled detention discharge of the ponds in FY98 and later. This analysis will quantify the correlation between Pu and TSS.

The design basis for controlled detention is that Pu can be estimated as a function of TSS. Under controlled detention, the operational indicator might be turbidity, flow, or other indicators that can be monitored in real time. This section also addresses the correlation of Pu with other parameters that can be monitored in real time for operational decision making. TSS requires time for a laboratory analysis, so although it may provide a satisfactory design basis, it cannot be used as an operational indicator.

This section specifies data needed to develop deterministic regression models for estimating Pu concentrations in Segment 4 on the basis of TSS or turbidity data from Segment 5 and from within the Industrial Area. This section will also provide data for models that could estimate the magnitude of Pu contaminant sources within the Industrial Area on the basis of data from Segments 4 and 5. With respect to surface water, research indicates a relationship may exist between the amount of Pu activity and the amount of TSS in the water. Radionuclides, including Pu, tend to associate with particulate materials. When small mineral particles are carried in surface water runoff, radionuclides attached to the particles are transported as well. Therefore, measuring the amount of TSS in runoff from a specific drainage area can provide a characteristic ratio of Pu to TSS for that basin and insight into the amount of Pu activity being transported in the water.

Figure 2-3
Plot of Suspended Plutonium vs. Total Suspended Solids



[10] Pu is transported primarily on particulates in stormwater.

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If an initial correlation between Pu activity and TSS is determined for a drainage basin, it would prove useful for monitoring future cleanup and containment of Pu within that area. For example, removing a source of Pu-contaminated sediments from a watershed would result in less transport of Pu from the basin, and, barring the creation of new sources of suspended sediments, the Pu activity associated with TSS would have been lowered.

Therefore, a decrease in the ratio of Pu activity to TSS would be indicative of the effectiveness of the source removal. In contrast, an increased ratio might indicate a new source of Pu.

Data from this monitoring would also support a secondary data use of performance monitoring of decontamination and decommissioning (D&D) activities.

Inputs:

To evaluate the correlation between TSS, turbidity, and flow vs. Pu, monitoring at any three stations would suffice, but six stations should be monitored in case some do not correlate well during FY97. Because Pu is already monitored at terminal pond outfalls and at Indiana Street, flow and turbidity must be monitored at these five stations. One more station (the sixth) should be selected for monitoring TSS.

To evaluate the predictive capability of the real-time flow and turbidity parameters, the Site must monitor these parameters at locations most likely to be predictive and far enough upstream to provide at least two hours of warning before an exceedance could occur in Segment 4. These stations include GS12, GS10, GS22, SW093, SW091, and SW027.

Air temperature, snow depth, and precipitation should be monitored at several locations, including GS10, SW093, and SW027. Cloud cover should also be monitored.

Boundaries:

Spatial: Data may be acquired as far upstream as Segment 5 or even within the Industrial Area to predict Pu as far downstream as the reservoirs.

Temporal: None.

Decision Statement:

IF The correlation between total Pu activity and TSS exceeds 0.80 at three or more monitoring location pairs[11] for a period of six months or more, including peak spring runoff events and base flow, (4) (See reference).

[11] Monitoring location pairs: We may, theoretically, monitor for TSS at GS10 (east edge of Industrial Area) in order to predict Pu activity monitored at GS08 (below Pond B5). In this case, GS10 and GS08 would be a monitoring location pair.

THEN	The parties to this document will acknowledge and accept this relationship (not necessarily the specific values) between Pu and TSS as a design basis for operation of the ponds, and the Site may then attempt to establish the specific numerical values needed to design protective pond operations and structures. An identical decision may be made for a relationship between Pu activity and turbidity, or a combination of TSS and turbidity, or other indicators. Note that use of the relationship between Pu and suspended particulates as a design basis for pond operations would not necessarily preclude real-time monitoring, short-term storage and screening, alternative routing of pond water, or other protective engineering features.
IF	The Site can demonstrate mathematically that a regression model of discharged Pu as a function of turbidity and/or flow and/or another real-time parameter[12] would provide at least four hours of warning before discharged Pu would exceed the applicable RFCA standard so that outlet works could be closed or so that the effluent could be redirected
AND IF	A controlled detention terminal pond can be isolated from the WWTP and ITS
THEN	The parties to this document will actively support a full one-year trial of controlled detention for that terminal pond, subject to approval of the operational plan, after Great Western Reservoir ceases to be used as a drinking water supply.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - In order to provide a representative estimate of variability during FY97, it will be sufficient to monitor each event at event monitoring stations and monitor at least 10 samples taken over the full range of flow conditions, for each of the flow-proportional stations.
  - Monitoring at the Segment 5 and the new source detection stations (Section 2.3.1) would represent the main drainage basins for which correlations are needed.
  - Monitoring for the ratio of Pu to TSS or turbidity at each of the event monitoring stations (SW022 and SW091) during every event would provide adequate confidence that significant events are sampled and representative at those locations. Each of the flow-proportional stations must monitor for turbidity continuously due to the method (continuous probe). Monitoring for TSS at the flow-proportional stations should be performed only when Pu monitoring is performed and should provide at

[12] Precipitation and snow melting conditions may also provide an acceptable model.

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least 10 data pairs for FY97. The data set should include samples taken over the full range of flow conditions.

- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — Design of a sampling plan would require some knowledge of the variability, which is not yet available. Samples taken during FY97 will provide this variability information so that a statistical sampling design may be implemented late in FY97 or during FY98.
  - — Acceptable decision error rate for the decision to accept the correlation between TSS and Pu as a design basis: r $\geq$ 0.8 for three or more locations.

Monitoring Requirements:

The requirements shown in Table 2-4 are partially redundant with other decision rule monitoring requirements, but are specified here to retain the independence and separability of the monitoring requirements for each decision rule. Optimizing to reduce redundancy of the integrated monitoring program is shown in the Integrated Monitoring Table (Table B-29 in Appendix B to this section).

Table 2-4
Monitoring Requirements (Number of Samples/Analyses) to Evaluate the Relationship of Plutonium with Indicators

Station	Pu	TSS	Turbidity	Flow	Ppt	Temp
	Number of Measurements	Number of Measurements	Frequency of Measurements	Frequency of Measurements	Frequency of Measurements	Frequency of Measurements
Into the Ponds - Monitoring Indicators in Segment 5 for Pu in Segment 4						
SW093	10	10	15 min	15 min	2 hr	15 min
SW027	10	10	15 min	15 min	2 hr	15 min
GS10	10	10	15 min	15 min	2 hr	15 min
SW022	8	8	15 min	15 min	—	—
GS12	5	5	15 min	15 min	—	—
Leaving the Ponds - Monitoring Pu in Segment 4, and correlation with indicators						
GS11	9	9	15 min	15 min	—	—
GS08	3	3	15 min	15 min	—	—
GS31	1	1	15 min	15 min	—	—
Indiana Street - Monitoring Pu, and correlation with indicators						
GS01	1	1	15 min	15 min	—	—
GS03	12	12	15 min	15 min	—	—
TBD	5	5	15 min	15 min	—	—

Notes:

— = Not applicable
hr = hour
min = minute
Ppt = precipitation
Pu = Plutonium
TBD = To be determined
temp = temperature
TSS = Total suspended solids

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2.3 Industrial Area

This section includes the monitoring objectives for decisions regarding the Industrial Area[13]. Some of the monitoring performed to make these decisions is actually performed outside the Industrial Area. For example, to detect a new source of contamination within the Industrial Area, the Site actually monitors surface water just after it flows out of the Industrial Area.

This Industrial Area monitoring section also addresses monitoring of incidental waters and performance monitoring. Incidental waters are often accumulations of rain or snow melt in utility pits and bermed areas. Performance monitoring is project-specific or facility-specific monitoring that is required under a specific work plan to monitor for contaminant releases inside or immediately outside a facility. Performance monitoring checks for specific contaminants that are of special concern, for example, during D&D of a facility.

2.3.1 New Source Detection Monitoring

Problem Statement:

The new source detection monitoring objective provides comprehensive coverage of the entire Industrial Area but is not specifically focused on individual actions within the Industrial Area. Performance monitoring of specific activities within the Industrial Area (or elsewhere) may be carried out under the performance monitoring objective. This new source detection activity monitors the performance of all remedial activities within the Industrial Area with respect to their impact on surface waters. However, it does not necessarily identify and locate a specific source within the Industrial Area[14]. This monitoring objective provides for monitoring of all main drainages from the Industrial Area into the three main channels of Stream Segment 5[15].

This new source detection monitoring is one of many different spill response actions, but spill response is not the primary focus of this new source detection monitoring objective. Sampling and analysis of spills is addressed in other Site planning documents, such as the *Spill Prevention, Control, and Countermeasures/ Best Management Practice Plan* (SPCC/BMP)(5).

Inputs:

This decision requires contaminant concentration data from surface water samples. Required data inputs are listed in Sections 2.3.1.3 and 2.3.1.4. Analyses are performed for each of the contaminants in order to establish a baseline. After a baseline has been

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[13] In the surface water monitoring objectives, the term "Industrial Area" is intended to include the 903 Pad. Runoff from the 903 Pad flows through the same monitoring station (SW027) that monitors the southern portion of the Industrial Area.

[14] Location of a specific source would be performed under the source location monitoring objective in Section 2.2.2.

[15] The Site also desires early detection of smaller releases within the Industrial Area, by monitoring closer to the anticipated sources during D&D activities. This will be achieved through the performance monitoring decision (see Section 2.3.3).

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established, evaluations will be performed as required by the decision rules. The basis for selecting these contaminants is described below.

- Pu, uranium (U), and americium (Am) are primary contaminants of concern to regulators and the public.
- Turbidity, pH, nitrate (NO_3), and conductivity are analyses performed routinely because they are inexpensive and can be used as real-time indicators to provide or negate reasonable cause to analyze for other specific contaminants:
- Turbidity may indicate increased contaminant loads in general and increased Pu specifically. (Pu in surface water is generally bound to particulates).
- pH can be used to detect an acid or caustic spill. For example, plutonium nitrate might be detected using a real-time pH probe.
- Nitrate can also be used in real time to detect chemical spills that include plutonium nitrate.
- Conductivity can be used to corroborate a pH reading and to detect salt solution spills or metals.
- Precipitation data are used to determine whether a flow event is rain/snow runoff or a spill.
- Water flow rate is needed to identify an event; to control the sampling time, rate, and amount; and to evaluate the magnitude of the spill or contaminant source.
- Small changes to base flow not attributable to rain or snow melt may indicate a spill (Figure 2-4).

The following AoIs identified in Table 2-5 are *not* indicators and are *not* required inputs to this decision rule. However, at the discretion of the Site, the Site may perform additional monitoring at the same locations for the following contaminants.

- Chromium: Chromium (Cr) is of concern to stakeholders and regulators due to the Site's 1988 chromic acid incident. Chromic acid might be indicated by pH or conductivity probes.
- Spills: Significant changes in base flow (possible spill), pH, or conductivity might initiate analysis for chromium or other contaminants at the discretion of the Site. (The method of spill detection depicted in Table 2-5 is not reliable and is not the primary method of spill detection for the Site.)

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Figure 2-4
Hypothetical Difference in Hydrographs for Runoff vs. Spill

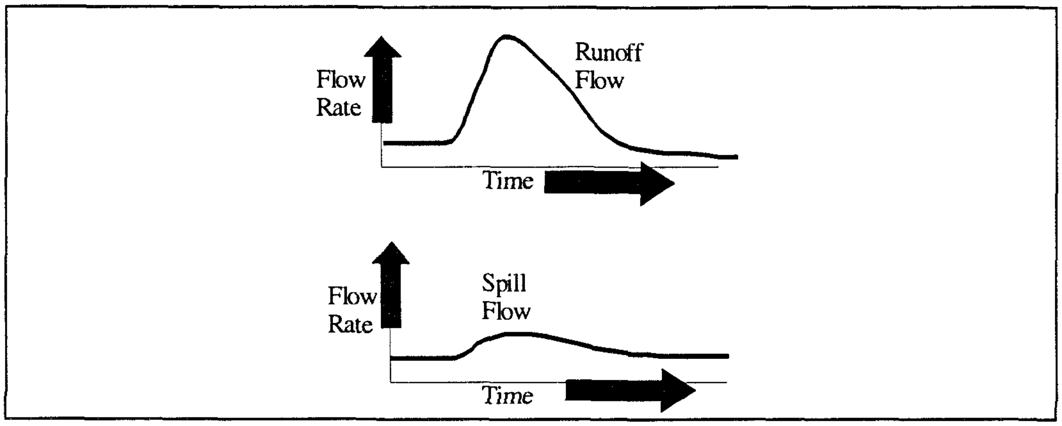

Table 2-5
Screening for New Source Detection
AoIs vs. Indicator Parameters

	Routinely Monitored Parameters							
	Monitored AoIs			**Indicator Parameters for AoIs**				
AoIs	**Pu**	**U**	**Am**	**Turbidity**	**pH**	**Conductivity**	**NO_3**	**Flow Rate and Precipitation**
Plutonium	X			X			X	X
Uranium		X						X
Americium			X	X				X
Turbidity				X				X
pH					X		X	X
Conductivity						X		X
Nitrate						X	X	X
Chromium					X	X	X	X
Beryllium						X		X
Silver						X		X
Cadmium						X	X	X

Notes:

Am = Americium
AoI = Analytes of interest
NO_3 = Nitrate
Pu = Plutonium
U = Uranium

- Beryllium (Be), Cr, silver (Ag), and cadmium (Cd) are included in Table 2-5 for reasons related to their toxicity specified in Table A-27 in Appendix A.

- Volatile Organic Analyses (VOAs) cannot be monitored effectively in turbulent runoff far from the source (Industrial Area), except perhaps in some extreme condition. This IMP depends on performance monitoring to detect VOAs in surface water close to the source.

Boundaries:

Spatial: This decision is limited to the Industrial Area, as represented by surface water monitoring stations SW022, SW091, SW093, SW027, and GS10[16]. This monitoring focuses on runoff into the three main drainage areas leaving the Industrial Area (see Figure 2-2). SW022 waters are normally monitored at GS10, so there is some redundancy in this set of monitoring stations. SW022 has been included at the request of the EPA to provide increased sensitivity for its drainage area. SW022 would also be used in the location of any new source detected.

Temporal: *For SW022 and SW091*, decisions are event-specific, focused on the time period during which the first flush conditions prevail; specifically, the time period during the rising limb of the hydrograph after any storm event resulting in sufficient flow rate [>1 cubic feet per second (cfs)][17] and volume [>1000 gallons (gal)] that persists for an adequate length of time for a sample [in a 15 liter (L) carboy] to be collected that represents the first flush (presumed worst case). Seasonal adjustments are applied to define the conditions that represent first flush. Professional judgement will be used to select the most representative sample for each month from each station for analysis, when a sample is available for that month at that station. This monitoring pushes the limits of the sampling equipment, and detection within a month is an appropriate goal.

For SW093, GS10, and SW027, the information will be flow-proportional data as used for monitoring Segment 5 Action Level compliance. These stations have base flow, whereas the other two stations do not.

Other: Only surface water runoff from the Industrial Area is included, (i.e., base flow, storm flow, and spills to surface water). Spills are only included in this new source detection monitoring as a secondary monitoring objective

[16] Subdrainage monitoring stations within the Industrial Area are used for performance monitoring and *source location* but are excluded from the planned monitoring for this new source *detection* decision rule.
[17] Note that specific boundary conditions are not procedural, legal, quality assurance (QA), or policy requirements. They serve only to clarify the objective so that a decision rule can be articulated. The flow rate and volume given in the text are only examples and may never actually be used in the field. These parameters vary greatly, depending on the season and the character of runoff events common during that season (e.g., snow melt or thunder shower).

Table 2-6
Monitoring Requirements (Number of Samples/Analyses) for New Source Detection

Monitoring Station	SW093	SW091	GS10	SW027	SW022
Analytical					
Total Pu-239/240	12/year[a]	12/year	12/year[a]	12/year[a]	12/year
Total Am-241	12/year[a]	12/year	12/year[a]	12/year[a]	12/year
Total U Isotopes	12/year[a]	12/year	12/year[a]	12/year[a]	12/year
Water Quality Probe					
pH	15-min	15-min	15-min	15-min	15-min
KSC	15-min	15-min	15-min	15-min	15-min
Turbidity	15-min	15-min	15-min	15-min	15-min
Nitrate	15-min	15-min	15-min	15-min	15-min
Flow	15-min	15-min	15-min	15-min	15-min
Precipitation	No gauge	5-min record	No gauge	No gauge	15-min
New Equipment					
1 YSI Model 6000	X	X	X	X	X
Supplies					
1 YSI Calibration Kit	X	X	X	X	X
7 and 10 buffers	X	X	X	X	X
Conductivity standard	X	X	X	X	X
Formazin standards	X	X	X	X	X
Nitrate standards	X	X	X	X	X
Labor Hours					
RMRS	125	100	125	110	110
Purchased Services					
ASI Subcontract	Sample Handling	Sample Handling	Sample Handling	Sample Handling	Sample Handling

Notes:

[a]Only SW091 and SW022 will be monitored for the rising limb of the hydrograph, as originally specified for this decision rule. Stations SW093, SW027, and GS10 are the Segment 5 Action Level monitoring stations. At these Segment 5 stations, new source detection will be performed by statistically testing the flow-proportional samples instead of the rising limb. The same test criterion will be used, except that flow-proportional samples will be tested against flow-proportional variability, which will be much less than rising limb variability.

Analytical and Water Quality Probe rows are derived from the columns of Table 2-5.

Am = Americium
ASI = Advanced Sciences Incorporated
KSC = Salinity and conductivity
min = minute
PU = Plutonium
RMRS = Rocky Mountain Remediation Services, L.L.C.
U = Uranium
YSI = Yellow Springs Instruments

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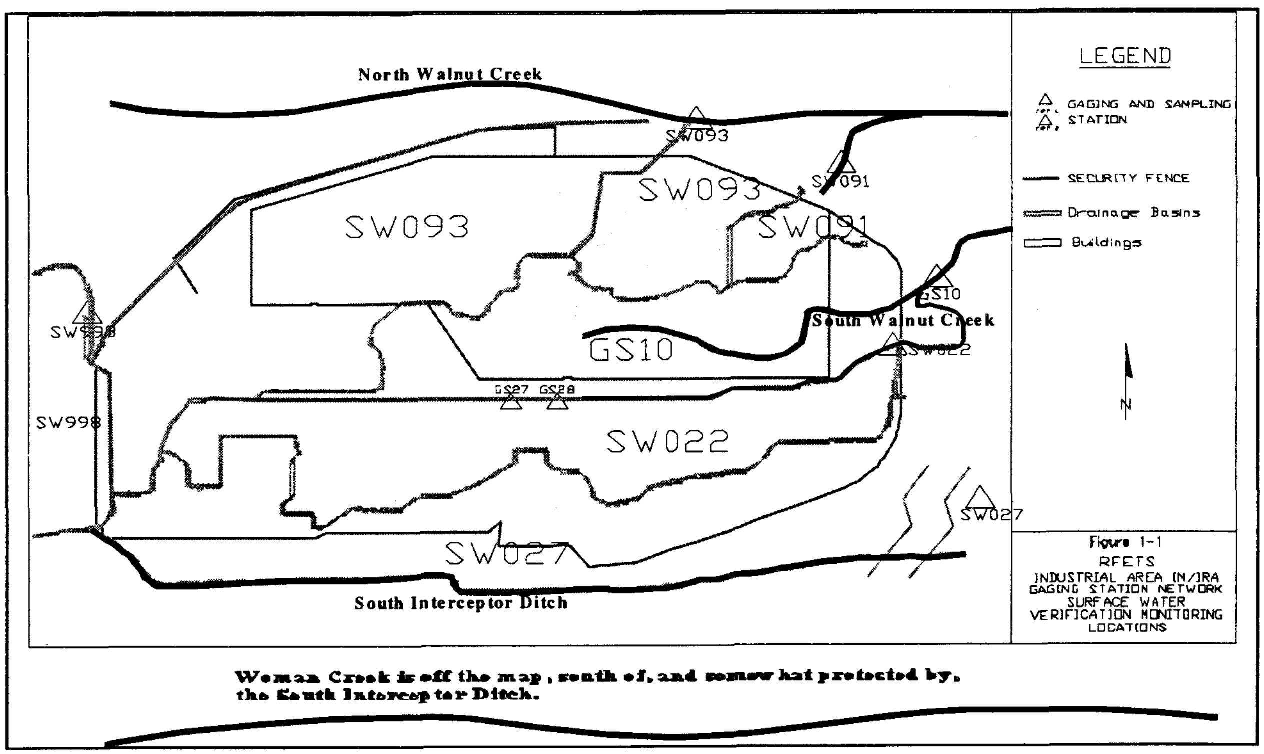
if a flow rate greater than the 95% upper tolerance limit (UTL)[18] for base flow is detected, and cannot be attributed to precipitation, snow melt, or other previously monitored discharge (see Figure 2-5). However, other management controls (e.g., SPCC/BMP) address monitoring of spills as a primary objective.

Monitoring will be performed for the parameters specified at the top of each column of Table 2-5. The first three columns are AoIs monitored directly. Although these three columns and rows have a different relationship than the others, they have been included so that all monitored parameters are shown on the same table. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes in lieu of analyzing for the AoIs identified at the left of each row. If a spike is detected in any one of these indicator parameters, then there is reasonable cause to suspect the presence of the analyte of interest identified at the left end of the row in which an "X" appears. For example, if the nitrate probe detects a high nitrate concentration, then the Site would have reasonable cause to suspect the presence of plutonium nitrate, extreme pH, cadmium

Figure 2-5
Main Drainages from Industrial Area and the Monitoring Stations for Each



[18] UTL is a specified upper confidence limit on a specified upper percentile of a distribution of single values. An UTL includes most of the values for a population.

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nitrate, and, of course, high nitrate, all of which are AoIs for Segment 5. If there were reasonable cause to suspect the presence of these analytes of interest, then the Site would perform additional analytical procedures specific for the analytes of interest.

Decision Statement:

Screening for reasonable cause to suspect a new source:

IF — The mean concentration of any of the screening indicator variables in Table 2-5 exceeds the 95% UTL of baseline for that variable

THEN — The Site will evaluate the need for further action under RFCA ALF, such as source evaluation and control. Evaluations will address persistence, trends, and risk of Action Level exceedances.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The Site desires detection through sampling of runoff events within a month of a significant new contaminant release.[19] This is achieved through sampling all major drainages from the Industrial Area during high flow and analyzing approximately one sample per station per month. The Site must monitor runoff events at four locations (SW093, SW091, GS10, SW027) to provide an acceptable level of confidence that significant events will be observed. These locations are shown in Figure 2-4.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - Baseline is defined by an average value for the parameter of interest over all monitored precipitation events for a single baseline year, at the discretion of the DOE, RFFO. A single measured value is accepted as representing a contaminant of interest. If a single measured value exceeds the 95% UTL of baseline, that will provide adequate confidence of new source detection and invoke the action(s) specified by the decision rule.

Monitoring Requirements:

Table 2-6 presents detailed monitoring requirements for this decision rule. Analytical and Water Quality Probe rows are derived from the columns of Table 2-5.

[19] Runoff events may be more than a month apart. The intent here is to detect a release to the environment from within the Industrial Area that is being flushed out of the Industrial Area by a runoff event within a few weeks.

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2.3.2 Incidental Waters Monitoring

Problem Statement:

Incidental water is precipitation, surface water, groundwater, utility water, process water, or wastewater collecting in one or more of the following areas:

- Excavation sites, pits, or trenches;
- Secondary containments or berms;
- Valve vaults;
- Electrical vaults;
- Stream pits and other utility pits;
- Utility manholes;
- Other natural or manmade depressions that must be dewatered; or
- Discharges from a fire suppression system that has been breached within a radiological buffer area or a contamination area.

For example, every precipitation event leaves rainwater in some utility pits and secondary containments. Disposition of such waters depends on the contaminants present, if any. For example, oil, radioactive, and hazardous substances may require management (e.g., treatment, storage, or disposal) under appropriate regulations, rather than by direct discharge. This incidental waters monitoring objective provides for the routine data-driven decisions on whether to allow discharge of these incidental waters into the environment. The Site must determine how to manage incidental waters (i.e., whether or not to discharge to the environment[20]).

This decision includes only incidental (not routine) accumulations of water (not waste). Discharges of water containing oil, radioactive, and hazardous constituents above the established control limit is prohibited. This monitoring objective does not include decisions regarding appropriate treatment of contaminated waters or solutions for which discharge authorization is denied. This monitoring objective does not require laboratory analyses of snow melt, rain water, groundwater, or potable water, unless there is reasonable cause to suspect contamination.

This program manages incidental water discharges of greater than 50 gallons if such discharges have not previously been identified to the NPDES permitting agency (currently EPA) for discharge to the sanitary system. Discharges identified in a permit application that has already been submitted to the EPA may be discharged as specified in the permit application without the aid of this program. Waters that are denied discharge authorization under this decision rule may be considered for discharge to the WWTP, Building 374, or Building 891 under the internal waste stream decision rule elsewhere in this plan, or they may be managed under other applicable regulations.

[20] The environment, in these cases, includes storm drainages, surface waters, and the surface of the ground.

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Inputs:

The Site incidental waters program requires only field screening observations and measurements, unless there is reasonable cause to expect the presence of oil, or hazardous or radioactive substances. The field screening initial assessment may be made without laboratory analysis on the basis of the screening criteria in Table 2-7.

Table 2-7
Incidental Waters Screening Criteria

Observation Parameter	Criterion
An estimate of volume	50 gallons
Process knowledge of the immediate vicinity	Professional judgement
Field pH using pH paper or similar indicator	pH 6 to 9
Appearance	Visible sheen or color
Field nitrate using probe, colorimetry, or similar indicator	10 mg/L
Field conductivity probe	700 µmho/cm^2

Notes:

µmho	=	micromhos	L	=	liter
cm^2	=	square centimeter	mg	=	milligram

Additional testing is performed only if process knowledge, screening observations, or measurements are positive. In the absence of reasonable cause to suspect contaminants, the water may be discharged to the environment.

Boundaries:

Spatial: This decision is restricted to accumulations of water within the Industrial Area and within the Site Buffer Zone, where such waters may accumulate in containment structures and be contaminated to levels unacceptable for discharge.

Temporal: Incidental waters are more common in rainy seasons, but incidental accumulations of potable water may occur during any part of the year. Although the frequency of occurrence varies seasonally, there are no formal temporal boundaries for the decision.

Decision Statement:

IF Incidental waters appear to be potable water or rain water accumulations that are collected in areas that have no potential for contamination and initial screening tests are negative. Areas with the potential for contamination include individual hazardous substance sites, material storage or handling areas, and high traffic areas

THEN Incidental waters may be discharged to the environment at the discretion of the Surface Water Program manager [21].

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

  — The Incidental Waters Program is well established, and there is low probability that accumulations of incidental waters would go unreported and unevaluated before being pumped and discharged to the environment.

- Acceptable Decision Error Rates for Statistical Sampling Design:

  — Recall that these accumulations of water in berms and utility pits are nearly always from rain, snow melt, groundwater, or potable water. If process knowledge and screening fail to provide reasonable cause to suspect the presence of oil, or hazardous or radioactive substances, then further analyses are not justified, and the discharge is authorized. A single measurement or observation will be adequate, if performed at all. Therefore, a statistical sampling design is not applicable to this decision rule.

Monitoring Requirements:

Monitoring of incidental waters will require field observation and screening of approximately 15 incidental water accumulations per month during FY97. For each instance, screening is required. No additional monitoring will be performed under this monitoring objective. If additional monitoring is performed, it will be at the direction and expense of the responsible facility or project manager. Estimated monitoring requirements for this monitoring objective are presented in Table 2-8.

Table 2-8
Estimated Field Test Monitoring Requirements
(Number of Samples/Analyses) for Incidental Waters

Parameter	Justification	Measurements per Year FY97
pH	NPDES permit and stream standards restrict pH of plant discharges. Lab analysis of pH performed only if pH paper field test is inconclusive.	180

[21] Incidental waters may also be discharged to the WWTP, with approval of the WWTP manager. However, the decision logic for these DQOs is that incidental waters become internal waste streams if they fail to qualify for discharge to the environment. Logically, there are three possible outcomes for the incidental water: the water may be discharged to the environment, or the water must be subjected to the internal waste stream decision, or the responsible organization may elect to employ other treatment, storage, or disposal options. Therefore, the formal decision for incidental waters addresses only the discharge to the environment. The decision to discharge to the WWTP is handled as the internal waste stream decision elsewhere in this document; and the decision to manage under other regulations is out of scope for this document.

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Nitrate as N	Stream standards and NPDES permit have restrictive nitrate limitations that are problematic for the Site.	180
Conductivity	NPDES permit and stream standards restrict metals. Least expensive analysis for the AoI will be used. (May include other species).	180

Notes:

AoI = Analyte of interest
FY97 = Fiscal year 1997
N = Nitrogen
NPDES = National Pollutant Discharge Elimination System

2.3.3 Performance Monitoring

Problem Statement:

This section addresses monitoring the performance of specific actions[22] on Site for the release of contaminants to the environment. Project-specific performance monitoring may be specified in the project plan through the review and approval process for individual project plans when the project poses a specific concern over risk of contaminant release for specific contaminants, especially for those contaminants that would not otherwise be adequately monitored by other monitoring objectives within this IMP. Each performance monitoring objective will target specific contaminants of greatest concern for the specific action being monitored. For example, performance monitoring for specific analytes may be needed for:

- Specific D&D Actions: The review and approval process for a D&D action may identify the need for performance monitoring specific to that action.

- Specific Remedial Actions: There are monitoring requirements associated with specific Operable Unit (OU) activities. The existing consolidated treatment plant for OU1 and OU2 has a surface water discharge. Performance monitoring specific to this discharge is specified in the work plans.

- Transition Actions: DOE, RFFO has proposed changes in the operation of the ITS. Specific performance monitoring may be needed in light of this change if other monitoring in this IMP fails to provide adequate assurance of protecting the environment and public health.

- Best Management Practices (BMPs) for the Control of Plutonium Transport in Surface Water Runoff: When a BMP (barrier, trap, filter, etc.) is installed to control a potential source of Pu-contaminated runoff, the Site would like to determine the effectiveness of the BMP so that resources may be allocated where they are most effective.

[22] This is project-specific, versus the global monitoring (new source detection) of the Industrial Area discussed in Section 2.3.1.

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Performance monitoring of activities within the Industrial Area is achieved, in general, through the new source detection and Segment 5 monitoring. Therefore, no general requirements for additional performance monitoring will be specified in this section.

Project-specific performance monitoring stations must be portable to monitor specific high-risk Site activities, such as D&D of a particular building. These mobile stations will be placed upstream from the routine monitoring stations, closer to specific Site activities to monitor for releases of contaminants specific to that activity.

Inputs:

- The decision input indicators must be specified in the project plan. For example, for Pu source control BMP monitoring, a baseline might be established by collecting runoff data that are representative of a drainage basin prior to implementing the BMPs.

- Monitoring could continue during and beyond the time when the BMP is installed.

- The before and after data for Pu and TSS would be compared under the decision rule to establish the effectiveness of the BMPs.

Boundaries:

Spatial: Anywhere within the Site surface water drainage area (especially within the Industrial Area), downstream from a BMP, remediation, or high-risk activity.

Temporal: Baseline monitoring should begin 18 months prior to the start of the project to be monitored, and end about 3 months after the project concludes, to ensure that storm runoff will have adequate opportunity to carry the contaminant to the monitoring station.

Decision Statement:

Decision rules must be specified for individual projects. A project-specific indicator might be a single monitoring result, a 30-day average for a specific analyte, or an indicator for the analyte of concern. Example decision rules are shown below.

IF The project-specific indicator is greater than the 95% UTL

THEN The Site will evaluate the specific activity to improve performance.

IF The project-specific indicator is less than the 95% lower tolerance level (LTL)

THEN The Site will conclude that the project has reduced environmental releases of the specific contaminant.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — The specific project plan must specify an adequate monitoring method.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — The specific project plan must specify the decision criteria. Examples are shown in the decision rule section, above.

Monitoring Requirements:

Monitoring requirements would be specific to the project. Pu source control BMPs might require monitoring for Pu concentration or TSS.

2.4 Industrial Area Discharges To Ponds

This section addresses monitoring of surface water before it arrives in the terminal ponds (i.e., surface waters running off of the Industrial Area, discharges from the WWTP, and Segment 5 waters upstream of the terminal ponds). These discharges are the major transport pathways available for contaminants leaving the Industrial Area. Ongoing activities and remediation tasks at the Site could create new contaminant source areas within and around the Industrial Area and could thus degrade downstream surface water quality. For example, a D&D or remediation project could result in the release of contaminants to soils near the facility, which could be transported via runoff into Site drainages, and eventually off Site.

The Site must monitor runoff to detect significant spills or leaks from ongoing activities such as remediation, D&D, construction, and continuing operations. Merely monitoring the terminal pond discharges is not adequate to protect water quality above the terminal ponds (in compliance with RFCA requirements), or to detect contaminant runoff from significant new sources within the Industrial Area.

2.4.1 Stream Segment 5 Monitoring

Problem Statement:

This problem statement deals with monitoring Segment 5 for compliance with RFCA Action Levels. RFCA provides specific criteria for virtually every possible contaminant for the main stream channels of Segment 5. In Table A-26 (presented at the end of this section in Appendix A), the DQO team identified a subset of those contaminants that are of sufficient interest to warrant monitoring. Figure 2-2 illustrates the stream segments, and Figure 2-4 shows the monitoring points used for various decisions.

Responses to exceedances in Segment 5 are different than the responses associated with contaminated runoff before it reaches Segment 5 or after it enters Segment 4. Industrial Area runoff upgradient of Segment 5 is monitored to detect new contaminant sources within the Industrial Area. Downstream, Segment 4 is monitored for compliance to protect designated uses, the ecology, and the public health. This subsection of the document deals with monitoring Segment 5 for compliance with RFCA action levels.

Historical data indicate that several regulated contaminants may exceed their RFCA action level criteria for Segment 5. Such exceedances will require the development of a mitigation plan. The initial response to these exceedances might be to invoke the source location decision rule, and take action upstream of Segment 5 to protect Segment 5 from contaminant sources that caused such exceedances.

Inputs:

The necessary decision inputs are those analytes specified as the Segment 5 AoIs per Table A-26 (see Appendix A to this section), as sampled at the designated monitoring points for Stream Segment 5 (see spatial boundaries below).

Boundaries:

Spatial: This segment includes the terminal ponds, and the main stream channels of North and South Walnut Creek, Pond C2, and the SID. Monitoring will be performed for Stream Segment 5 only as represented by SW093, SW027, and GS10.

Temporal: 30-day or 1-day moving averages, as specified in RFCA[23] and implemented by the ALF or DQO working groups involving consensus of all parties to RFCA.

Decision Statement:

IF The appropriate summary statistic[24] for any AoI[25] in the main stream channels of Stream Segment 5, as monitored at the designated monitoring stations[26], exceeds the appropriate RFCA action level

THEN The Site must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[27] if appropriate[28].

[23] Moving averages are to be calculated on whatever data are available, which may range from N=0 to more nearly ideal sample sizes computed on the basis of variability and confidence levels, unaffected by budgetary constraints. Where N=0, the average is not available. Where N=1, the average is the value for that single sample.
[24] Appropriate summary statistics, such as 30-day moving average or 1 calendar day average, are specified for individual contaminants in RFCA.
[25] AoIs are specified in Table A-26 in Appendix A to this section.
[26] Monitoring stations for Segment 5 are designated in the boundary conditions for this rule, and in Figure 2-4.
[27] Mitigating action may include, but not be limited to, the following examples: 1) Immediate action to halt a discharge or contain a spill; or 2) Use of the source location decision rule to seek out and mitigate upstream contaminant sources.

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Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

  — The flow-proportional monitoring method ensures that significant events will be sampled. This method involves taking a fixed volume [e.g., 60 milliliters (ml) or 1 L] into the sample carboy (15 L) as each Nth volume of flow [e.g., 500 L or 73,000 cubic feet(ft^3)] passes the monitoring point. Approximately 250 grab samples can be composited in the sample carboy.

- Acceptable Decision Error Rates for Statistical Sampling Design:

  — Variability is not known for flow-proportional monitoring. Therefore, decision error rates cannot be estimated. Sampling design was based, instead, on flow and professional judgement.
  — The decision error types and consequences for Segment 5 are presented in Table 2-9.

The Pacific Northwest National Laboratory (PNNL) statisticians evaluated designs based on the decision error limitations shown in Table 2-9, but historical data were inadequate to determine the number of samples needed to meet these decision error limitations[29]. Therefore, the statistical design team recommended a pilot study or alternatively that the initial design be based on flow. This design should be reevaluated (vs. Table 2-9) after flow-proportional data become available.

Table 2-9
Decision Error Types and Consequences in Segment 5

Error Type	Consequences
Failure to determine that an exceedance has occurred.	If the true average concentrations of analytes of interest are above RFCA Action Levels, but data fail to detect this, the Site may not be compliant with RFCA.
Incorrect determination that an exceedance has occurred.	The Site would be required to provide notification, planning, a schedule, and response action that consumes limited resources when no exceedance had actually occurred, and the response would not be justifiable.

The decision error limitations shown in Table 2-10 were not used to design and specify the FY97 monitoring requirements. They are retained here, however, for use in future

[28] RFCA may actually specify consequences for an exceedance of any action level (not just those for AoIs) at any location within the segment (not just at the consensus monitoring points). This decision rule presents the consensus decision rule that drives our monitoring activities. It is an implementation, rather than a reiteration, of RFCA.
[29] Actually, the statisticians were able to provide sample sizes based on historical data variability, but these sample sizes were impractically large due to the high variability in historical sampling methods (storm flow samples taken from the rising limb of the hydrograph). Because the FY97 monitoring will use, in part, the flow-proportional method (with much lower variability expected) sample sizes based on historical variability would be inappropriate.

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sampling designs when variability becomes known for the flow-proportional sampling method. Note that the decision error limitations shown in Table 2-10 are based on the assumption that failure to detect an exceedance is more important than falsely reporting an exceedance when no exceedance has occurred. The DQO team discussed this issue, but consensus was not achieved. When flow-proportional data become available and the sampling design is reevaluated, this issue will be resolved.

Table 2-10
Proposed Decision Error Limit Design Constraints for Segment 5 Monitoring

"Assumed-True" Parameter Value	Correct Decision	Acceptable Probability of Making an Incorrect Decision
0.1 x action level	Does not exceed action level	0.05
0.5 x action level	Does not exceed action level	0.10
0.5 to 1 x action level	Does not exceed action level	Gray region: No probability specified
2 x action level	Exceeds action level	0.05
4 x action level	Exceeds action level	0.01

Note:
This table is retained for future use, but was not used for FY97 decision rules.

Monitoring Requirements:

The recommended monitoring design for the DOE, RFFO is to take samples for FY97, as specified in Table 2-11, and analyze each sample for the Segment 5 AoIs specified in Table A-27 (presented at the end of this section in Appendix A), attempting to take no less than one sample per quarter, and no more than four sequential carboy samples per month from each of the three monitoring points for each month. The ideal sampling rate is one 15-L sample carboy for each 500,000 gallons of stream flow, and each 15-L sample carboy should comprise no less than 50 flow-paced grab samples.

Table 2-11 presents the number of samples per month recommended by statisticians at PNNL. There are both practical and statistical advantages to this sample allocation design. Averaging a larger number of samples is more expensive, but it protects the Site from regulatory action in response to a spurious non-representative monitoring result.

There are secondary advantages to this monitoring plan. Larger sample sizes allow estimates of variability that can be used to refine the monitoring plan over time. The monitoring program specified here is a technically defensible approach that represents a compromise between a statistical design, a design based on professional judgement, and a design based on budgetary constraints. This design will generate data that are representative of actual contaminant levels and loads.

This design is consistent with the intent of the 30-day running average specified in RFCA but allows some flexibility. Where there is no significant flow or contaminant load, there may be no samples completed within a 30-day period, and where the flows, loads, and variability are higher, sample size is also higher. Note that flow-proportional monitoring

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Table 2-11
Monitoring Requirements (Number of Samples/Analyses) for Segment 5

Month	SW093	GS10	SW027
	Number of Samples		
October	3	3	0
November	4	3	0
December	2	1	1
January	2	1	0
February	2	2	0
March	4	4	1
April	4	4	4
May	4	4	4
June	4	4	4
July	2	3	0
August	2	2	0
September	3	3	1
FY97 Total	**36**	**34**	**15**

Notes: Total samples for all 3 stations = 85
FY = Fiscal year

will continue during dry periods, even though flows may be so low that it takes more than 30 days to fill the sample carboy.

Alternative Minimum Required Monitoring:

Although one sample per month would be adequate to demonstrate the Site's compliance status to EPA or CDPHE, there is significant chance of declaring a false exceedance associated with smaller sample sizes. However, if budgets and priorities make the possibility of regulatory action preferable to the expense of the recommended sample sizes, then the Site may elect to gather samples as specified in Table 2-10, but analyze only one composite of those independent and sequential samples per month per station; then perform additional analyses only if an exceedance is suggested in the composite, and only if the historical mean for that AoI is below the Action Level at that monitoring station.

Several planning assumptions were adopted to estimate the minimum monitoring requirements for this high risk approach:

- Only one exceedance will be established for a single AoI at all three monitoring stations in Segment 5, and the mitigation plan in response to that exceedance will establish increased work scope, but no additional monitoring.
- Based on statistical evaluation, only Pu will exceed its action level. Thus, in the first month, Pu would incur one analysis from each station. No verification analyses would be performed because the historical average is greater than the

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action level. Therefore, the exceedance does not cause a change in the number of analyses during the first month.

- After the initial exceedance, only one sample per station per month would be taken.

- This one sample would be a composite that does not exceed a new criterion established by the mitigation plan.

The resulting projection of absolute minimum analytical requirements for Segment 5 is detailed in Table 2-11[30].

Other Constraints:

This sampling is flow-proportional sampling, not event sampling. For example, 250 ml samples may be taken every 500,000 gallons of flow throughout the reporting period.

Moving averages are to be calculated for the preceding period, verified by additional analyses at the discretion of the monitoring organization, and formally reported to the DOE, RFFO within 30 days of gaining knowledge that an exceedance *may* have occurred (i.e., within 30 days of receiving a high analytical result). This 30-day period allows time for verification analyses after the monitoring organization gains knowledge that an exceedance *may* have occurred before formal notification to DOE, RFFO of an actual exceedance is required. RFCA requires that DOE, RFFO inform regulators within 15 days of DOE, RFFO gaining knowledge (not just a suspicion) that an exceedance (verified) has (actually) occurred. During this 45-day period between first suspicion and formal notification to regulators, the DOE, RFFO may initiate discretionary mitigating action. The delay interval will prevent undue public alarm when the initial high result is not confirmed by subsequent monitoring. Informal communications between the parties are intended during the delay interval.

2.4.2 Internal Waste Stream Characterization for Permit Application

Both of the next two sections deal with internal waste streams (IWS) but have very different decision rules and monitoring requirements. These IWS monitoring objectives address two of the most conceptually complex surface water decisions to be made. These are decisions regarding disposition of contaminated waste streams produced on Site. Some can be discharged to the sanitary system, some must be treated under the Resource Conservation and Recovery Act (RCRA), some require treatment for radionuclides under DOE Orders, and some require management by still other regulations. These related issues, neither of which is monitoring required by the RFCA, are introduced below:

[30] Note that this approach is contrary to the approach negotiated by the DOE, RFFO and approved during development of the IMP. This approach would incur significant risk of exceedances and regulatory response actions. Although Segment 5 may not be subject to penalties for exceedances, there would be increased risk of failure to notify, plan, schedule, and implement mitigating actions due to the much larger number of exceedances resulting from natural variability of single sample preparations and analytical results (rather than averages), combined with reduced resources and a smaller work force.

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Table 2-12
Estimated Minimum Segment 5 Action Level Monitoring Requirements
(Number of Samples/Analyses)

Analyses	Sampling Protocol
Plutonium	3(1+11) = 36
Uranium	3 x 12 = 36
Americium	3 x 12 = 36
Beryllium	3 x 12 = 36
Chromium	3 x 12 = 36
Silver	3 x 12 = 36
Cadmium	3 x 12 = 36
Hardness	3 x 12 = 36
pH	Continuous
Conductivity	Continuous
Turbidity	Continuous
Nitrate	Continuous
Flow	Continuous

- The first main NPDES issue is that the Site must maintain strict compliance with NPDES permit conditions. This compliance requirement drives two distinct monitoring activities:

  — The Site must monitor permitted discharges as specified in the permit, and report as specified in the permit. This issue of NPDES compliance monitoring is covered below.

  — The Site must manage discharges to the WWTP for two reasons that are combined operationally under the “authorization to discharge” process:

    1) The Site must ensure that the operational capabilities of the WWTP are not exceeded, resulting in a permit violation for the WWTP effluent. This activity is covered in Section 2.4.3.
    2) The Site must ensure that waste streams discharged to the WWTP are compliant with the NPDES permit, RCRA, DOE Orders, and other regulations. This activity is also covered in Section 2.4.3.

- The second main NPDES issue is that of working with regulators toward well-informed decisions regarding permit conditions for the next NPDES permit or permit modification. (This is an ongoing process, so there is always a “next” permit or permit modification.) The Site provides input to the decision process through preparation and maintenance of the NPDES permit application. This second monitoring issue is covered in this section.

The quantity and complexity of this activity will increase during D&D and implementation of the 10-Year Plan. As the Site population decreases, the quantity of aqueous waste streams may decrease. But as the mission changes, process streams will undergo significant changes that must be reflected in the permit application. New challenging waste streams will arise more frequently as buildings are deactivated and drained of their fluid contents and as other facilities modify their operations accordingly.

Problem Statement:

This section addresses the monitoring required for the NPDES permit application.

Determining appropriate permit conditions is, in part, a data-driven process. The Site provides the data, and the regulators make the decisions. Data for these decisions are provided in the NPDES permit application. Data used in the permit application include detailed information about process streams within buildings in the Industrial Area, upstream of the discharge points. The nature of all Site processes and a detailed characterization of certain[31] discharges must be included in the permit application. These characterizations must include flow rates, constituents, and concentrations. Routine and continuous discharges are typically monitored and may become reflected in the NPDES permit.

Problem Scope:

The permit application identifies all managed and incidental waste streams that discharge to surface water. Sanitary discharges and process waste streams from all Site buildings, and discharges from Building 374, the WWTP, and the terminal ponds are waste streams included within the scope of this section.

There are two specific objectives covered in this section. First, the Site must keep the permit application current. This will require that the Site characterize new waste streams for disclosure in the permit application. The second objective is to determine whether reporting of cooling towers should be included as a permit requirement.
The following are excluded from the scope of this section:

- Process or sanitary discharges of any quantity (internal waste streams) are subject to evaluation under Section 2.4.3.

- Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.2 of this document. Stormwater runoff monitoring is excluded from this section, and is covered in Section 2.2.4 of this document.

[31] The CWA regulations require specific information about waste streams that arise from categorical processes identified at 40 CFR 400-500.

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Inputs:

- The following items are included in the permit application, as needed:

  — Complete NPDES application.
  — Update notifications that have been presented to the regulator.
  — Current drawings for each facility.
  — Descriptions of liquid discharges from each facility.
  — Current available characterization for each discharge.

Boundaries:

Spatial: The Industrial Area. All facilities and all storm water drainages from the Industrial Area are included.

Temporal: This section has no temporal boundaries; it deals only with present and future discharges. The permit application requires resubmission every five years.

The actual data-driven decision is made by the regulator. That is the decision whether to establish a permit condition, limitation, or requirement in response to a specific contaminant concentration in a specific discharge stream described in the permit application. With adequate and favorable data, as for the cooling towers, a permit condition may be negotiated

Decision Statement:

IF Any facility on Site discharges wastes to surface water directly or indirectly through a treatment facility

THEN The discharge must be characterized and must be reflected in the permit application.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

  — Site processes for review, notification, and approval of facility modifications are not fully implemented in some cases. Therefore, facility inspections are needed to provide complete identification and full disclosure of discharges. A planned approach to thorough inspection of facilities and processes should be used to provide completeness for the permit application.

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- Acceptable Decision Error Rates for Statistical Sampling Design:

  — Regulatory emphasis is on full disclosure rather than on accuracy. A rigorous statistical treatment is inappropriate for this decision because typically only one analysis will be performed. Therefore, sampling variability will not be evaluated and will not drive additional sampling to achieve some desired confidence level. Analytical results are required to be representative of typical conditions in discharged waste streams, but failure to report a discharge carries a greater risk than flawed characterization. Therefore, completeness is more important than the rigor of a statistically designed sampling protocol, except in those cases where the Site elects to negotiate a specific issue and requires project-specific monitoring data to negotiate that issue. Such monitoring is not addressed in this plan, except for the monitoring to negotiate the cooling tower reporting requirement.

Monitoring Requirements:

Monitoring requirements to maintain the NPDES permit application during FY97 are presented in Table 2-13.

Table 2-13
Monitoring Requirements (Number of Samples/Analyses) for Maintaining NPDES Permit Application

	Number of Samples in FY97 to Characterize Building 865 and One Other New Waste Stream Not Yet Specified	Number of Samples in FY97 to Monitor 4 Cooling Towers to Characterize and Establish Variability
HSL metals	2	48
Semivolatiles	2	--
Pu, U, Am	2	--
pH	2	48
Conductivity	2	48
BOD	2	--
TSS	2	48
Total phosphate	2	--
NO_3/NO_2	2	--
Ammonia	2	--

Notes:

-- = Not applicable
Am = Americium
BOD = Biological oxygen demand
FY = Fiscal year
HSL = Hazardous Substance List
NO_2 = Nitrite
NO_3 = Nitrate
NPDES = National Pollutant Discharge Elimination System
Pu = Plutonium
TSS = Total suspended solids
U = Uranium

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2.4.3 Monitoring Discharges to the WWTP

Problem Statement:

This section addresses the monitoring required for granting authorization to discharge a waste stream to the WWTP. The Site must make frequent decisions regarding disposition of waste streams. Non-routine incidental process discharges must be evaluated prior to discharge into the WWTP. NPDES, RCRA, and other regulations prohibit discharge of some hazardous, toxic, radioactive, and otherwise regulated materials to the WWTP.

Problem Scope:

This section covers non-routine process or sanitary discharges.

Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.2 of this document. Stormwater runoff monitoring is excluded from this section and is covered in Section 2.2.4 of this document.

If waste streams may not be discharged to the WWTP, then they might need to be evaluated for treatment, storage, or disposal under appropriate regulations such as RCRA, CERCLA, or DOE Orders prior to discharge. However, monitoring for treatment decisions is outside the scope of this environmental monitoring plan.

There are five sets of criteria against which monitoring may be required to verify compliance, depending on process knowledge.

- NPDES regulations prohibit certain hazardous substances from being discharged to surface water. Table A-24 (see Appendix A to this section) shows a list of NPDES hazardous substances that must be considered (but not necessarily analyzed) during the characterization of each internal waste stream. Sampling required to characterize each discharge is subject to process knowledge available and is limited to those analytes reasonably expected to be present.

- WWTP operational capabilities limit the loading of many substances and the values of some physical parameters, such as pH, in the WWTP influent stream. Table A-25 (see Appendix A to this section) specifies these limitations.

- RCRA hazardous wastes are also prohibited from being discharged to surface waters, and discharge to the WWTP is regulated. RCRA regulations for listed, characteristic, and derived hazardous wastes are included in this document by reference only.

- Oil in WWTP influent streams is limited to 100 milligrams (mg)/L unless a greater loading is specifically authorized by the WWTP manager.

- Radionuclides discharged to the WWTP are limited to loadings that will not result in exceedance of Segment 4 stream standards under RFCA. As low as reasonably achievably (ALARA) also applies to discharges of radionuclides.

Inputs:

Process knowledge is the most valuable indicator. Process knowledge might include the source of the waste stream, current location, and historic precedent. Screening inputs are shown in Table 2-14. Additional inputs (i.e., more specific or more sensitive analyses and tests) are occasionally needed but are less predictable and would be funded by the responsible organization. Therefore, these are not included in the estimated monitoring requirements shown in Table 2-15.

Table 2-14
Internal Waste Stream Screening Tests

- Process knowledge
  - Location
  - Source
  - History
- Visible sheen
- Color
- Clarity
- Volume
- Field Conductivity
- pH (paper)

Table 2-15
Monitoring Requirements (Number of Samples/Analyses) for Authorization to Discharge

Number of FY95 Requests for Authorization to Discharge	**116**
Approved	105
Denied	11
Number of FY96 Requests for Authorization to Discharge	**88**
Approved	74
Denied	14

Note:
FY = Fiscal year

Boundaries:

Spatial: All facilities within the Industrial Area are included.

Temporal: This section has no temporal boundaries, except that it deals only with present and future discharges.

Other: All liquids for which a facility requests authorization to discharge to the WWTP. Examples include chemical solutions, condensate, foundation drainage, incidental waters that are not acceptable for discharge to the environment, and new process discharges.

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Decision Statement:

The ideal decision rule is stated below.

IF	A waste stream for which a facility has requested authorization to discharge to the WWTP fails to qualify under any applicable regulatory criterion
THEN	Do not authorize discharge to the WWTP.

This ideal rule requires the decision maker to be virtually omniscient. Some finite, practical, and protective monitoring must be implemented to approach the ideal. The practical decision rules used to implement this monitoring objective are presented below.

IF	Process knowledge and the standard screening protocol shown in Table 2-14 offer no reasonable cause to suspect prohibited contaminants in a waste stream for which authorization to discharge has been requested
THEN	The Site will grant authorization to discharge to the WWTP, subject to approval of the WWTP manager.
IF	Screening results[32] or process knowledge indicate that contaminants would prohibit the discharge under any applicable regulation
THEN	The Site will either:

- Deny the request to discharge; or
- Perform more specific analyses and evaluate the estimated contaminant load to the WWTP and estimated contaminant concentrations discharged to the main stream channels of waters of the state after passing through the WWTP or ponds, then discharge at a controlled and compliant rate.

IF	More specific or more sensitive analyses indicate that the incidental waters would not cause a violation of applicable regulations
THEN	The Site will authorize discharge to the WWTP with the approval of the WWTP manager.

The responsible organization may elect to perform additional analyses at their expense, to resolve concerns raised by process knowledge or screening tests.

[32] Screening results may be single values or averaged values at the discretion of the surface water manager or WWTP manager.

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Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative and Acceptable Decision Error Rates for Statistical Sampling Design:

  — A single sample will typically be appropriate, and a statistical sampling design will not be needed.

Monitoring Requirements:

The Surface Water IMP Team estimates that there will be approximately 60 requests for authorization to discharge during FY97. Each will be screened as specified in Table 2-13. The number of requests for authorization to discharge internal waste streams has decreased substantially over the past year. This is due to grouping several similar waste streams (e.g., barrels) into single requests for administrative efficiency.

2.4.4 WWTP Collection System Monitoring

There are several different reasons for monitoring the WWTP collection system:

- To determine percent removals across the treatment plant and therefore be able to predict compliance or noncompliance with NPDES permit effluent limitations;
- To monitor explosive levels at the headworks for worker safety;
- To monitor for corrosive substances that may impact the treatment units;
- To determine if influent concentrations and loads are trending up or down; and
- To monitor within the collection system to establish pollutant loads attributable to specific industrial internal waste streams (such as the laundry water at the Site).

WWTP operators need to know what is entering the treatment plant as well as knowing from where it is coming. Ideally, an extensive monitoring plan should be in place throughout the collection system and at the headworks to effectively operate the plant.

At this time, collection system monitoring is minimal and consists of real-time monitoring for pH, conductivity, and lower explosive limit (LEL) at two locations (i.e., in the equalization basins and at the headworks to the plant). Some manual pH readings are also taken by plant personnel at the headworks. As D&D proceeds and buildings with drains to the WWTP are impacted, the need to expand the collection system monitoring will be evaluated.

The pH and conductivity monitoring are indicators for corrosivity and spills. LEL readings are for protecting worker safety and have a different decision rule.

Section 2.4.4 needs to be more extensive in future revisions of this IMP. The section is intended to remain undeveloped and only partially implemented during FY97. It will be completed in the future. The content of this section is retained in this document only to preserve some of the

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thought and discussion of the Surface Water IMP Team for future use. The text in this section is not intended to be complete but is intended to be correct.

Inputs:

The following indicators should be considered: pH, conductivity, LEL, and monitoring for radionuclides.

Boundaries:

Spatial:	All collection system lines influent to the WWTP up to but not including lines inside the buildings inside the Industrial Area.
Temporal:	This is real-time operational monitoring.

Decision Statement:

Proposed decision rules to be developed for FY98 are presented below. These are not intended to apply during FY97.

IF	pH or conductivity monitoring shows uncharacteristic changes over past results
THEN	The chief operator will be notified and will determine whether the influent should be rerouted to the flow equalization basin not currently in use while the problem is investigated.
IF	The LEL is exceeded (see Table A-25)
THEN	Emergency procedures will be activated.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - To be determined.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - To be determined.

Monitoring Requirements:

To be determined.

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2.4.5 Monitoring NPDES Discharges to Ponds

This section has been reserved for decisions regarding NPDES-permitted discharges upstream of the terminal ponds. NPDES-permitted discharges in and below the ponds are discussed in Section 2.5.2. This separation was imposed to retain the upstream-to-downstream continuity of this document. However, the explanatory text is identical at both locations: this monitoring is prescriptively required under the NPDES permit. Therefore, the monitoring requirements have been maintained in the same table (Table 2-16).

The only NPDES-permitted discharge anticipated throughout FY97 that is upstream of the ponds is the WWTP (Building 995) outfall. All other NPDES monitoring takes place in ponds or in water discharging from the ponds.

2.5 Water Leaving the Site

This section covers all surface water monitoring in streams leaving the eastern Site boundary (Indiana Street). This water is in Stream Segment 4. This water is first monitored prior to discharge from the terminal ponds. There are also some terminal pond monitoring requirements from the current NPDES permit. Monitoring for RFCA compliance in Stream Segment 4 takes place at the downstream end of Woman and Walnut Creeks, near Indiana Street. Additional monitoring at Indiana Street has been identified by the working group and is described at the end of this section.

2.5.1 Predischarge Monitoring

Problem Statement:

As the Site moves into its accelerated cleanup, there is a possibility that new or increased levels of pollutants will be introduced into the pond systems from activities in the Industrial Area. The other monitoring objectives are focused on specific analytes and indicators of greatest concern. Flow-proportional monitoring of those parameters is comprehensive. However, some unusual contaminant could be overlooked by the other monitoring objectives. It is important, therefore, to include a comprehensive analysis at some point, even when the historical data show no previous exceedances. The single sample predischarge monitoring is the least expensive method for including a comprehensive analytical suite in this IMP.

Under normal batch operations, nearly all water produced at the Site (including surface runoff, treated effluents, and various process waste streams) is directed to one of three terminal ponds. The terminal ponds serve as the last control[33] point for the water before it leaves the Site.

For these reasons, predischarge monitoring is needed for a full range of constituents, including radionuclides, inorganics, and organics. Samples should represent the water to

[33] The Site's control over impounded water is quite limited. There are no treatment options readily available, and the detention time is limited by the capacity of the pond and the rate of influx from precipitation and other sources.

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be discharged (i.e., grab samples should be depth integrated, and addition of water to the discharge should be minimized after the grab sample is taken). If the state believes that the first sample is not representative of the discharge, the state may request, and the Site will provide, one additional predischarge sample if the discharge has not yet begun, or a during-discharge sample if the discharge is not yet complete. However, because of dam safety, the Site has sole discretion to determine the schedule for discharges, independent of any action the state may take with regard to predischarge monitoring. If the predischarge monitoring suggests an exceedance of a contaminant that is also monitored by flow-proportional methods, the parties recognize that the flow-proportional methods would be more representative of the discharge compliance status.

It is the intention of the parties that the Site will perform the sample collection and that CDPHE will perform the analysis and reporting functions for predischarge monitoring.

Inputs:

It is estimated that a total of 8-10 predischarge samples will be taken over a year's time from the ponds in the Walnut Creek drainage and one sample per year is expected to be taken from Pond C2 in the Woman Creek drainage. CDPHE will analyze the samples for an extensive list of constituents, including inorganics, metals, volatile organics, semivolatile organics, radiologic parameters, herbicides, and pesticides. The final list will be detailed in CDPHE's annual monitoring plan.

Boundaries:

Spatial: The spatial boundary consists of Ponds A4, B5, and C2, or any other pond functioning as a terminal pond (e.g., Pond A3 during construction in Pond A4).

Temporal: Samples are intended to be taken far enough in advance of the discharge so that isolation, containment, treatment, flow-proportional compliance monitoring, or other actions can be taken to mitigate an exceedance, but near enough to the time of discharge that the sample is representative of the discharge. It is the intent of all parties that sampling will be performed so that results are known prior to discharge.

Decision Statement:

IF Predischarge monitoring results suggest apparent exceedances of the applicable stream standards

THEN

- CDPHE may notify the Site of additional AoIs for that discharge;

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- The Site would then perform flow-proportional monitoring for the additional AoI(s) during the discharge, as part of the Segment 4 compliance monitoring (see Section 2.5.3); and

- The Site may evaluate other water management options, including but not limited to treatment, storage, or disposal, rather than immediate discharge.

It should be noted that the results of predischarge monitoring can only indicate an *apparent* exceedance because:

- The water sampled is impounded and not discharged at the time (the predischarge sampling protocol applies to water being discharged); and

- The single grab predischarge sample does not necessarily reflect the quality associated with a 30-day average, against which nearly all standards are measured.

If an apparent exceedance is reported, DOE, RFFO has the responsibility to decide management alternatives. It is the intent of the Parties that predischarge monitoring is not enforceable under RFCA, but it will be performed as a prudent management practice that all Parties endorse.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - Predischarge monitoring is a routine practice. It is unlikely that a discharge would occur without predischarge monitoring.

- Acceptable Decision Error Rates for Statistical Sampling Design:
  - The parties intend that only one sample will be taken. No statistical sampling design is needed.

Monitoring Requirements:

Monitoring analyses to be performed by the state are shown in Table 2-16.

2.5.2 Monitoring NPDES Discharges from Ponds

Discharges from the terminal ponds and certain other point sources on Site are regulated by the NPDES permit, the NPDES Federal Facility Compliance Agreement (FFCA), and subsequent modifying correspondence. The basic function of the NPDES permit point-source monitoring is to verify that industrial point-source discharges from the Site are protective of waters of the

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Table 2-16
Predischarge Monitoring Requirements (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Volatile organic analyses (502.2)	0.8
Semivolatiles (525.2)	0.8
Hazardous Substance List metals (total)	0.8
Hazardous Substance List metals (dissolved)	0.8
Total dissolved solids	0.8
Total suspended solids	0.8
Nitrate/Nitrogen dioxide	0.8
Nitrogen dioxide	0.8
Total phosphorous	0.8
Ammonia	0.8
Hardness	0.8
Chloride	0.8
Sulfate	0.8
Sulfide	0.8
Gross alpha	0.8
Gross beta	0.8
Plutonium/uranium/americium	0.8
Tritium	0.8
pH	0.8
Dissolved oxygen	0.8
Conductivity	0.8
Totals	**16.8**

United States. The emphasis here is on industrial point sources. In the current permit, the monitoring points include discharges from some ponds and from the WWTP[34].

Problem Statement:

The Site must maintain compliance with NPDES permit conditions, i.e., the Site must monitor and report as specified in the permit. The related problem of working with the regulators toward well-informed permit conditions is addressed in Section 2.4.2.

[34] The draft NPDES permit is out of scope for this FY97 DQO document. The current permit does not address stormwater monitoring, so if a new permit is issued, then additional monitoring may be required. However, some stormwater monitoring is addressed in Section 2.2.4 of this plan. The draft NPDES permit includes point-source monitoring only at the WWTP and Building 374, and stormwater monitoring.

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Problem Scope:

This Section 2.5.2 addresses only the base monitoring of each NPDES-regulated point-source discharge. This section does not address stormwater monitoring[35].

Inputs:

There are no decisions or decision inputs for the Site with regard to NPDES point-source monitoring.

Boundaries:

Spatial: Monitoring is performed at point-source discharges from outfalls specified in the permit, FFCA, and modifying correspondence.

Temporal: Monitoring is performed at a wide variety of intervals and events, as specified in the permit, as modified.

Decision Statement:

The Site does not make decisions with respect to the NPDES permit monitoring, but the Site must monitor and report as specified in the permit. The regulators may make compliance decisions on the basis of the data. The monitoring results may also be used in operational decision making as a secondary data usage.

Acceptable Decision Errors:

For the Site, decision error is not applicable to the design of NPDES point-source monitoring because the permit is prescriptive. The number of samples may vary with conditions, but there is no latitude to design monitoring on the basis of acceptable decision errors[36].

Monitoring Requirements:

Monitoring requirements for the existing NPDES permit will be amended when the new Site NPDES permit becomes effective.

[35] Stormwater monitoring is partially addressed in Section 2.3.1, in the context of performance for reasons other than compliance with the NPDES stormwater permit. The stormwater permit requirements are not expected to become applicable during FY97.

[36] Note that the *regulator* may use statistical design methods and acceptable decision errors to design the permit monitoring requirements, conditions, and limitations.

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2.5.3 Segment 4 Compliance Monitoring

RFCA provides specific standards for Walnut and Woman Creeks below the terminal ponds (Segment 4). These criteria and the responses to them are different than the criteria and actions associated with Segment 5. This section deals only with monitoring discharges from the terminal ponds into Segment 4 and the additional points of compliance for Segment 4 at Indiana Street.

With the completion of the Woman Creek Reservoir, located just east of Indiana Street and operated by the city of Westminster, all Woman Creek flows will be detained in cells of the new reservoir until the water quality has been assured by monitoring of Site discharges via Woman Creek at Indiana Street. Reservoir water will then be pumped from Woman Creek Reservoir into the Walnut Creek drainage below Great Western Reservoir.

In the past, the majority of natural flow in Woman Creek was diverted to Mower Reservoir and did not exit the property via Woman Creek. This will no longer be the case, and all but base flows in Woman Creek[37] will leave the Site via Woman Creek and enter the Woman Creek Reservoir. Base flows are still diverted into Mower Ditch. In the past, Pond C2 (located off channel in the Woman Creek drainage) was tested and pumped directly from Woman Creek into the Walnut Creek drainage on Site. Now the Site plans to discharge Pond C2 directly into Woman Creek, and downstream to the Woman Creek Reservoir. These changes represent new flow configurations for Woman Creek for which water quality data are not yet available.

Pond C2 effluent is a permitted outfall under the existing NPDES permit, treated elsewhere in this document (see Section 2.5.2). CDPHE requires under the 1989 Agreement in Principle (AIP) (7) that Pond C2 effluent meet, *inter alia*, the stream standards for Pu, Am, and tritium before the discharge enters the main stream channel of Woman Creek. Note that the main stream channel carries other water that is not currently monitored upstream of Pond C2 and is not monitored as Pond C2 discharge because the main stream channel travels around Pond C2. Upper Woman Creek, above Pond C2, could become contaminated via groundwater or sediments in surface runoff, and the same potential for contamination exists between Pond C2 and the Site boundary at Indiana Street (see Figure 2-1).

There is concern that meeting standards for radiologic parameters in Pond C2 discharge does not adequately demonstrate that all water leaving the Site via Woman Creek and entering the Woman Creek Reservoir is meeting the radiologic standards. Other Woman Creek water (combined with Pond C2 or flowing in the absence of any Pond C2 water) will enter the Woman Creek Reservoir. This is the basis for setting an additional RFCA POC for Woman Creek at Indiana Street for those radiologic contaminants that could be directly attributable to the Site (i.e., not naturally occurring). These contaminants would be Pu, Am, and tritium.

A similar point of compliance will be established at Walnut Creek and Indiana Street. Although the Walnut Creek drainage is not undergoing operational changes like those in Woman Creek, it is theoretically possible that contaminated overland runoff or landfill drainage may enter Walnut Creek below the terminal pond monitoring points, yet upstream of Indiana Street.

[37] Base flow for Woman Creek is approximately 15 gal per minute.

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Inputs:

- RFCA AoIs, as sampled for Stream Segment 4 terminal pond discharges (see Table A-27 in Appendix A to this section).
- Total Pu, Am, and tritium at Indiana Street POC.
- Flow.
- Source(s) of the water sampled.
- Was sample taken during pond discharge?
- Was Woman Creek base flow occurring concurrent with the discharge?
- Was flow from No Name Gulch added to the Walnut Creek flow?

Sample type:

Flow-proportional composite.

Frequency:

- Flow-proportional monitoring[38] is maintained at all times for all five stations in Segment 4, even though no samples are anticipated from terminal pond stations except during planned pond discharges.

Ponds are discharged approximately once per year for Pond C2 and 10 times per year for the Walnut Creek drainage. Therefore, terminal ponds would require at least 11 samples and optimally 33 samples during FY97. The Indiana Street stations would generate the same number of samples during discharges, plus additional samples from storm and base flow between discharges: approximately 6 for Walnut Creek and 3 for Woman Creek, assuming no flow for 6-9 months out of the year.

Boundaries:

Spatial: Stream Segment 4 only, as represented by samples taken from the terminal pond discharges at GS11, GS08, and GS31, and the Indiana Street monitoring stations (GS01 and GS03). Table 2-17 shows the associations between monitoring locations and station designators.

Temporal: Samples taken during discharge from terminal ponds, or as specified in RFCA and the NPDES permit.

[38] Note: Sample compositing will be planned, at the discretion of the DOE, RFFO, to yield at least one sample per 500,000 gallons of flow, no more than three samples per 30-day interval at any station, and no more than three samples per discharge.

Table 2-17
Monitoring Station Designators for Segment 4

Pond A4	GS11
Pond B5	GS08
Pond C2	GS31
Walnut Creek at Indiana Street	GS03
Woman Creek at Indiana Street	GS01

Decision Statement:

IF — The 30-day running average for any AoI in Stream Segment 4, as represented by samples from the specified RFCA points of compliance (i.e., terminal pond discharges and Indiana Street) exceeds the appropriate RFCA standard

THEN — The Site must:

- — Notify EPA, CDPHE, and either Broomfield or Westminster, whichever is affected;
- — Submit a plan and schedule to evaluate for source location, and implement mitigating action if appropriate; and
- — The Site may receive a notice of violation.

Note that for the Indiana Street POCs, the only compliance monitoring to be performed is for Pu, Am, and tritium activity as measured at GS01 or GS03[39].

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

  — The Site will attempt to gather at least one sample representative of each pond discharge event, and multiple sequential samples may be taken. Flow-proportional monitoring will be maintained at all times but may not be effective during dry periods when evaporative losses would invalidate the data, or when samples are inadequate for analysis due to a variety of operational problems.

[39] GS01 and GS03 are the POC monitoring stations for Woman Creek at Indiana Street, and Walnut Creek at Indiana Street, respectively.

- Acceptable Decision Error Rates for Statistical Sampling Design:

  The decision error types and consequences for Segment 4 are presented in Table 2-18.

Table 2-18
Decision Error Types and Consequences in Segment 4

Error Type	Consequences
Failure to determine that an exceedance has occurred.	Potential for downstream water quality impacts.
Incorrect determination that an exceedance has occurred.	The Site would be required to provide notification, planning, a schedule, and response action that consumes limited resources when no exceedance has actually occurred, and the response would not be technically justifiable. The Site may also be subject to inappropriate fines or penalties or other regulatory action.

Note:
RFCA = *Rocky Flats Cleanup Agreement*

CDPHE and EPA representatives on the DQO team favored a simple decision rule that would be easier to explain to a concerned public. This led to a decision rule that placed equal emphasis on false alarms and failures to detect exceedances. The statistical design team recommended that the initial design be based on flow, and that this design should be reevaluated after flow-proportional data become available.

Monitoring Requirements:

Table 2-19 presents monitoring requirements for Segment 4. The overall strategy is to sample each discharge with three consecutive flow-proportional samples. This plan assumes nine discharges per year from Pond A4, three discharges from Pond B5[40], and one discharge from Pond C2. There is no storm or base flow immediately below the dams. At Walnut Creek and Indiana Street, the Site plans to take three samples during each of the nine discharges from Pond A4, three samples from each of the three discharges from Pond B5, and one sample of storm and base flow during the period between discharges. At Woman Creek and Indiana Street, the Site plans to take three samples during one discharge per year and a flow-proportional number of samples for storm and base flow for each of the 12 months of the year. Note that the analyte lists for the terminal pond discharges are different than the analyte lists for the Indiana Street POCs.

[40] Discharges from Pond B5 are a planning assumption to allow for emergency discharge due to precipitation events, possible delay of Pond A4 outlet works upgrades, etc.

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Table 2-19
POC Monitoring Requirements
(Number of Samples/Analyses) for Segment 4

Period	Pond A4	Pond B5	Pond C2	Walnut Creek at Indiana Street	Woman Creek at Indiana Street	Total Number of Samples
During Discharge	3X9=27	3X3=9	3	(3x9)+(3x3)= 27 + 9 = 36	3	78
Storm and Base Flow						
January	--	--	--	1	1	2
February	--	--	--	1	2	3
March	--	--	--	1	3	4
April	--	--	--	1	3	4
May	--	--	--	1	3	4
June	--	--	--	1	3	4
July	--	--	--	1	0	1
August	--	--	--	1	0	1
September	--	--	--	1	1	2
October	--	--	--	1	0	1
November	--	--	--	1	0	1
December	--	--	--	1	1	2
FY97 Totals	--	--	--	**48**	**20**	**103**

Note:
-- = Not applicable FY = Fiscal year

2.5.4 Non-POC Monitoring at Indiana Street

There are several reasons to monitor for certain possible contaminants and nutrients in the water leaving the Site in both drainages. The actions to be taken on the basis of this monitoring are variable and may not be known until the monitoring results are available. The state has proposed

to conduct this monitoring as a prudent management action, and it is the intent of the RFCA parties that no enforcement action will be taken on the basis of this monitoring.
Problem Statement:

> The CWQCC is moving toward waste load allocations for all segments of the Big Dry Creek drainage. Nutrient loadings generated by the Site are carried off Site via Walnut Creek, which either can bypass the Great Western Reservoir or be directed into the reservoir. Water bypassing the reservoir enters Segment 1 of Big Dry Creek, which then flows into the South Platte River. The Broomfield water replacement project will result in changes to the quantity and quality of water that could enter Great Western Reservoir.

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For these reasons, it will be necessary to monitor nutrient loads leaving the Site under all three of these conditions:

- Water leaving the Site via Walnut Creek is 100% Site discharge (either originates as surface water on Site or is used and potentially contaminated by the Site before discharge from terminal ponds).
- Water leaving the Site via Walnut Creek is 100% natural stream flows that originate off Site (no pond discharge included).
- Water leaving the Site via Walnut Creek is a mixture of Site discharge and natural stream flow.

A secondary use of the data would be to determine nitrate concentrations with respect to the proposed introduction of the ITS water into the drainage. No decision rule has been specified for this usage.

With the changes in flow configuration in the Woman Creek drainage, there is a need to monitor to determine new ambient levels for various analytes at monitoring station GS01. The results of these analyses will be used to determine what changes in water quality, if any, have occurred as a result of the new flow configuration.

Inputs:

- Un-ionized ammonia analyses on samples from Walnut Creek at Indiana Street.
- Flow from gauging stations GS01 and GS03.
- Analytes (analyzed by CDPHE) (see Table 2-20 for complete list). Note that pH and temperature are needed to calculate un-ionized ammonia, and that the parties intend to drop monitoring for Be, Cd, Ag, and Cr in the FY98 monitoring plan, unless FY97 monitoring results provide reasonable cause for concern. (Nutrient analysis samples are grab samples.)
- The source(s) of water at this location during any sampling event must be identified.

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Table 2-20
Non-POC Monitoring Requirements
(Number of Samples/Analyses) at Indiana Street

Total ammonia	21
Nitrite	21
Nitrate	21
Total phosphate as P	21
Orthophosphate	21
Be, Cd, Ag, Cr	21
Isotopic uranium	21
pH	Continuous 15 min intervals
Temperature	Continuous 15 min intervals
Conductivity	Continuous 15 min intervals
Flow	Continuous 15 min intervals

Notes:
Five samples at each of the three flow mixtures in Walnut Creek, plus one Woman Creek sample during Pond C2 discharge and five samples when Pond C2 is not discharging: (5 x 3) + 1 + 5) = 21. CDPHE will take their own grab samples independently for all nutrients, four metals, and U.

Ag = Silver
Be = Beryllium
Cd = Cadmium
CDPHE = Colorado Department of Public Health and Environment
Cr = Chromium
min = minute
P = Phosphorous
POC = Point of compliance
U = Uranium

- Frequency:
  - Walnut Creek:
    - Five per year for 100% Site effluent
    - Five per year for mixed effluent and natural stream flow
    - Five per year for 100% natural stream flow
  - Woman Creek
    - Five per year not during Pond C2 discharge
    - One per year during Pond C2 discharge

Boundaries:

Spatial: Stream Segment 4, as represented by samples taken from Walnut Creek at Indiana Street and Woman Creek at Indiana Street.

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Temporal: At different times, the water flowing off Site has differing composition of Site and natural stream flow. Samples will be scheduled so as to be representative of this variable composition.

Decision Statement:

IF Concentrations or loadings of specified contaminants in Woman Creek exceed their 95% UTLs

THEN CDPHE will notify the Site and cities, and the Site may propose a change in ambient standards.

No formal action has been identified as being dependent on nutrient monitoring of Walnut Creek at Indiana Street. The data may or may not be used in determining a waste load allocation for the Site sometime after FY97.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - — No special measures are needed, beyond standard operating procedures.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - — To be decided after variability is determined through FY97 monitoring.

Monitoring Requirements:

One objective of FY97 nutrient load monitoring will be to establish the variability of the data so that FY98 monitoring can be statistically designed. Three samples would be the absolute minimum required to estimate variability. Five samples for each parameter are planned. This monitoring is presented in Table 2-20.

2.6 Off Site: Community Water Supply Management

Contaminants generated by operations at the Site may have migrated off Site and impacted the downstream reservoirs. In addition, D&D activities at the Site may increase the risk of environmental contaminant release. The potential for the public to be exposed to contaminants originating from the Site that can impact the communities' water supply engenders public concern. Government officials in the downstream communities must respond to this public concern with adequate and timely monitoring data.

The ultimate decision regarding the management of community water resources rests with the affected community; however, monitoring data generated by other entities, such as CDPHE and the Site, are used to assess potential impacts, demonstrate acceptable water quality, and allay consumer concerns. These data are critical inputs for operational decisions. For example, the Site surface water monitoring data were used to show that water quality in uncontrolled storm

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flow entering Great Western Reservoir in 1995 did not exceed the CWQCC standards when averaged over the appropriate period. These data were used to allay public concern and were also used in the decision to resume production at Broomfield's water treatment facility rather than continue to purchase Denver water.

2.6.1 Monitoring Uncharacterized Discharges

This monitoring would normally be required only if the Site discharges uncharacterized water.

Problem Statement:

If surface water of unknown quality (unmonitored) leaves the Site, it is necessary to demonstrate that the water quality is acceptable to the downstream users. Examples of unmonitored water include:

- Unmonitored storm flow that exceeds the capacity of Broomfield's diversion and enters Great Western Reservoir instead of being diverted around the reservoir.
- Discharges wherein a significant precipitation event occurs subsequent to the predischarge monitoring so that a significant fraction of the total discharge is uncharacterized.
- Emergency discharges due to dam instability issues that are incompletely characterized.

Inputs:

- Flow monitoring locations:
  - Pond A4: North Walnut Creek,
  - Pond C2,
  - Pond B5: South Walnut Creek,
  - Woman Creek at Indiana Street,
  - Walnut Creek at Indiana Street, and
  - McKay Ditch.
- Flow from these stations is needed to evaluate:
  - The potential for Walnut Creek to exceed the capacity of Broomfield's diversion ditch (estimated at 40 cfs), and spill over into Great Western Reservoir, and
  - The Site contribution to the total flow leaving the Site in either drainage.

After the release event, water quality data may be evaluated in combination with flow data to estimate the total impact. Note that the flow data will already be available from monitoring performed under the POC and RFCA compliance decision rules.

Water Quality:

Analytes are shown in Table 2-21.

Note: Constituents appearing on the "Short List" represent a minimum analyte list for all unplanned releases or discharges. Some or all of the constituents on the "Long List" may be necessary depending on the nature of the event, the source of the release, and the receiving water. The composition of either list may change depending on activities at the Site at the time of the event. Samples should be taken, but not necessarily analyzed, for all possibilities.

Table 2-21
Off-normal Discharge Monitoring Inputs

Constituent Group	Short List	Long List
Radionuclides	Pu, gross alpha/beta (rapid turnaround indicator)	Gross alpha/beta, Pu, Am, U (isotopic), tritium
Physical properties and general water quality measurements	pH, temperature, turbidity or TSS, conductivity or TDS	pH, temperature, turbidity or TSS, conductivity or TDS, hardness, alkalinity, fluoride, chloride, sulfate
Nutrients	Nitrate + nitrite	Nitrate, nitrite, ammonia (total and un-ionized), orthophosphate, total phosphorus
Organics	None	VOCs (EPA 524.2)
Metals	None	**Total:** All metals having stream standards. **Dissolved:** Fe, Mn, Cr, Cd, Be

Notes:

Am	=	Americium	Mn	=	Manganese
Be	=	Beryllium	Pu	=	Plutonium
Cd	=	Cadmium	TDS	=	Total dissolved solids
Cr	=	Chromium	TSS	=	Total suspended solids
EPA	=	U.S. Environmental Protection Agency	U	=	Uranium
Fe	=	Iron	VOC	=	Volatile Organic compound

Action Levels:

Action levels would be the applicable CWQCC standard for the potentially impacted downstream segment (1,2,3, or 4a/b).

Locations:

Specific locations are event-driven, but may include:

- Walnut Creek at Indiana Street;

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- Woman Creek at Indiana Street; or
- Great Western Reservoir (only necessary if release of surface water enters Great Western Reservoir).

Frequency:

Event driven; only when uncharacterized waters or waters unacceptable for their intended use are discharged off Site.

Sample Type:

Walnut Creek:	Flow-proportional composite during the event.
Great Western Reservoir:	The sample will consist of location composite comprising samples collected along a transect between the mouth of Walnut Creek and the outlet structure 48 hours after the event. (Sampling method to be determined based on acceptable decision errors.)
Treated water:	Single grab sample of clearwell effluent 48 hours after the event.

Boundaries:

Spatial: Geographically, the decision is bounded by the Walnut and Woman Creek basins, from the western Site boundary to the main stem of Big Dry Creek. However, the downstream communities are primarily concerned about the negative impact (of contaminants leaving the Site) on downstream reservoirs and water supplies. The monitoring locations of interest are:

- Woman Creek at Indiana Street;
- Walnut Creek at Indiana Street;
- Great Western Reservoir;
- Woman Creek Reservoir;
- Mower Reservoir; and
- Broomfield's Water Treatment Plant.

Temporal: None.

Other: For this decision, monitoring would only be required when water of unknown quality leaves the Site. Under routine operations wherein surface water is impounded in the terminal ponds, isolated, and analyzed prior to discharge, and the ponds remain isolated between the pre-discharge sample and the completion of the discharge, additional downstream sampling is not necessary to characterize the quality of water leaving the Site. When water is under the full management control of the Site and dam safety is not threatened, this monitoring is not needed. This monitoring is needed only when the Site's management control over discharged water is at its lowest. The monitoring equipment should be designed with this lack of management control as a design basis.

Decision Statement:

IF Surface water of unknown or unacceptable quality leaves the Site

THEN The affected community will take appropriate protective measures until analytical data show that water quality is acceptable for the intended use.

For example, in the event of a contaminant release to Woman Creek Reservoir, Westminster might refrain from discharging water downstream until water quality has been analyzed and determined to be acceptable.

Acceptable Decision Errors:

If needed, this monitoring will be performed as single grab samples, location composites, or time composites at the discretion of the city of Broomfield. Statistically-based sample sizes will not be used for development of this FY97 monitoring plan.

Monitoring Requirements:

For planning purposes, no uncharacterized discharges are projected for FY97. If such a discharge does occur and this monitoring is needed, then the number and type of samples would be determined on a case-by-case basis.

2.6.2 Community Assurance Monitoring

RFETS' past mission as a nuclear weapons production facility, the nature of the contaminants, the history of releases and accidents, and the geographic and hydrologic relationship of the Site to the neighboring municipalities have made it necessary for the communities to reassure residents that their environment is safe. The level of concern fluctuates with activities at the Site but may be expected to continue as long as environmental contamination and special nuclear materials are present at the Site. Citizens' fears are more effectively addressed by data gathered within the community, near homes, schools, and parks than by institutional controls, modeling, and on-Site monitoring. The minimal community monitoring needed to provide this assurance is relatively inexpensive and demonstrates a community commitment on the part of DOE, RFFO. This community monitoring and Site monitoring are discussed at the Quarterly State Exchange Meetings. The DOE, RFFO has also sponsored a Dose Reconstruction Study for the Site.

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The Radiation Control Division of CDPHE supports the cities of Broomfield and Westminster by collecting quarterly samples of finished drinking water and analyzing for tritium, Pu, Am, and U. This monitoring was requested by the cities for the purpose of confirming and validating measurements made by the Site and the cities themselves. These measurements, in combination with analyses of raw water, also serve to assess treatment effectiveness, quantify loading to the treatment systems, and provide a baseline of low-level dose data for the residents of the communities. These data may be used in dose reconstruction activities.

Problem Statement:

Adequate and timely information regarding the impact of the Site on the neighboring environment is needed so that the communities can respond to citizens' concerns, and the Site can foster a credible public image. Inadequate monitoring results in poor public relations, impaired trust, increased public resistance to proposed activities at the Site, *and increased mandatory monitoring*. The necessity for repeated public meetings and clean-up delays due to negative public comment may increase costs of operating the Site.

Inputs:

Sample Locations:

- Representative samples of the influent to the community treatment plant demonstrate that only trace quantities of industrial and fallout contaminants are present in the water before treatment.
  - Raw water influent from Great Western Reservoir.
  - Treated water effluent from the Great Western Reservoir water treatment facility.
  - Broomfield Service Area of Broomfield's distribution system.
  - Denver Service Area of Broomfield's distribution system.

Sample Type:

- Quarterly composite of daily grab samples for WWTP influent and effluent.
- Six-month composite of weekly grab samples for the two service areas of the distribution systems.

Sampling Methods:

- Due to composite sampling requirements, community personnel are responsible for sample collection and compositing. A protocol acceptable to all parties will be developed and documented.

Analytical Methods:

- Analytical methodology must be adequate to provide detection limits comparable to those reported by CDPHE since 1992; approximately 0.003 picoCuries (pCi)/L for treated water, and 0.006 pCi/L for raw water.

Boundaries:

Spatial: Limited to downstream water supply storage reservoirs and water in community water treatment and distribution systems.

Temporal: Monitoring to meet this objective is only necessary on occasions of unusual public concern. However, the monitoring data needed at these times must be from an ongoing program so that current and historical data are readily available.

Other: This monitoring is limited to radionuclide contamination in the public water supply that is potentially attributable to the Site.

Decision Statement:

IF Monitoring of community water supply and distribution systems demonstrates an exceedance of the historical baseline

THEN The CDPHE will notify representatives of the affected community.

The response to a significant change in contaminant levels would be a different decision. The monitoring objectives described in previous sections are designed to prevent increased concentrations in the community drinking water systems. These community assurance monitoring data are used to address routine inquiries and to respond to occasions of unusual public concern. The data have been needed in the past and should be considered in future planning.

Acceptable Decision Errors:

Sufficient sampling and analysis must be performed to provide credible assurance that community water quality is adequately monitored and understood. A high level of confidence that the monitoring meets the desired objective is necessary. Because the type of monitoring involved is inconsistent with multiple samples, the required certainty must be achieved through appropriate sampling procedures, adequate sample volumes, laboratory quality control, and good analysis validation protocols.

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Frequency:

Analysis frequency is typically limited to intervals less than or equal to six months, therefore, semi-annual analysis is the minimum accepted frequency. The total number of samples for Broomfield would be 12[41].

Analyte list:

Pu-239/240
Am-241
U, isotopic (at least U-233/234:U-238 ratio)
Tritium

Monitoring Requirements:

Monitoring requirements for this section are presented in Table 2-22.

Table 2-22
Monitoring Requirements (Number of Samples/Analyses)
for Community Water Supply

	Analyses for FY 97			
Analyte	**WWTP Influent**	**WWTP Effluent**	**Distribution System**	**Total FY97**
Pu-239/240	4	4	4	12
Am-241	4	4	4	12
U, isotopic[42]	4	4	4	12
Tritium	4	4	4	12

Notes:

Am	=	Americium
FY	=	Fiscal year
Pu	=	Plutonium
U	=	Uranium
WWTP	=	Wastewater treatment plant

[41] The other communities may have different needs.
[42] Total U and U-233/234:U-238 ratio, as a minimum.

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2.7 References

1. *Background Geochemical Characterization Report.* EG&G Rocky Flats, Inc., Golden, Colorado, September 30, 1992 .

2. *Pond Operations Plan: Revision 2, RF/ER-96-0014.UN, PADC-96-00358*, Kaiser-Hill Company, L.L.C. and Rocky Mountain Remediation Services, L.L.C., September 1996.

3. *Emergency Response Plan for Failure of Dams A-4, B-5, or C-2, 1-A25-5500-06.08.* EG&G Rocky Flats, Inc., Golden, Colorado, June 1995.

4. Gilbert, R.O., *Statistical Methods for Environmental Pollution Monitoring*, Van Nostrand Reinhold, New York, New York, 1987.

5. *Spill Prevention Control Countermeasures/Best Management Practices Plan.* EG&G, 1992.

6. *Event-Related Surface Water Monitoring Report, RFETS: Water Year 1993.* EG&G Rocky Flats, Inc., Golden, Colorado, September 1994.

7. *Agreement in Principle Between U.S. Department of Energy and State of Colorado.* 28 June 1989.

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Table A-24
40 CFR 122 Appendix D Analytes for Internal Waste Stream Characterization

Table I-Conventional Pollutants

Total suspended solids (TSS)	pH
Total dissolved solids (TDS)	Total Kjeldahl nitrogen
Chemical oxygen demand (COD)	Nitrate plus nitrite
5-day biological oxygen demand (BOD5)	Dissolved phosphorus
Oil and grease	Total ammonia plus organic nitrogen
Fecal coliform	Total phosphorus
Fecal streptococcus	

Table II-Organic Toxic Pollutants in Each of Four Fractions in Analysis by Gas Chromatography/Mass Spectroscopy (GS/MS)

Volatiles

1V acrolein	12V dichlorobromomethane	23V 1,1,2,2-tetrachloroethane
2V acrylonitrile	14V 1,1-dichloroethane	24V tetrachloroethylene
3V benzene	15V 1,2-dichloroethane	25V toluene
5V bromoform	16V 1,1-dichloroethylene	26V 1,2-trans-dichloroethylene
6V carbon tetrachloride	17V 1,2-dichloropropane	27V 1,1,1-trichloroethane
7V chlorobenzene	18V 1,3-dichloropropylene	28V 1,1,2-trichloroethane
8V chlorodibromomethane	19V ethylbenzene	29V trichloroethylene
9V chloroethane	20V methyl bromide	31V vinyl chloride
10V 2-chloroethylvinyl ether	21V methyl chloride	
11V chloroform	22V methylene chloride	

Table III-Other Toxic Pollutants (Metals and Cyanide) and Total Phenols

Antimony, Total	Chromium, Total	Nickel, Total	Zinc, Total
Arsenic, Total	Copper, Total	Phenols, Total	Cyanide, Total
Beryllium, Total	Lead, Total	Silver, Total	Selenium, Total
Cadmium, Total	Mercury, Total	Thallium, Total	

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Table IV-Conventional and Nonconventional Pollutants Required To Be Tested by Existing Dischargers if Expected to be Present

Bromide	Nitrogen, Total Organic	Surfactants	Molybdenum, Total
Chlorine, Total	Oil and Grease	Aluminum, Total	Manganese, Total
Residual	Phosphorus, Total	Barium, Total	Tin, Total
Color	Radioactivity	Boron, Total	Titanium, Total
Fecal Coliform	Sulfate	Cobalt, Total	
Fluoride	Sulfide	Iron, Total	
Nitrate-Nitrite	Sulfite	Magnesium, Total	

Table V-Toxic Pollutants and Hazardous Substances Required To Be Identified by Existing Dischargers if Expected To Be Present

Toxic Pollutants

Asbestos

Hazardous Substances

Acetaldehyde	Disulfoton	Phosgene
Allyl alcohol	Diuron	Propargite
Allyl chloride	Epichlorohydrin	Propylene oxide
Amyl acetate	Ethion	Pyrethrins
Aniline	Ethylene diamine	Quinoline
Benzonitrile	Ethylene dibromide	Resorcinol
Benzyl chloride	Formaldehyde	Strontium
Butyl acetate	Furfural	Strychnine
Butylamine	Guthion	Styrene
Captan	Isoprene	2,4,5-T (2,4,5-Trichlorophenoxy acetic acid)
Carbaryl	Isopropanolamine	TDE (Tetrachlorodiphenylethane)
Carbofuran	Dodecylbenzenesulfonate	2,4,5-TP [2-(2,4,5-Trichlorophenoxy) propanoic acid]
Carbon disulfide	Kelthane	Trichlorofan
Chlorpyrifos	Kepone	Triethanolamine dodecylbenzenesulfonate
Coumaphos	Malathion	Triethylamine
Cresol	Mercaptodimethur	Trimethylamine
Crotonaldehyde	Methoxychlor	Uranium

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Hazardous Substances (Continued)

Cyclohexane	Methyl mercaptan	Vanadium
2,4-D (2,4-Dichlorophenoxy acetic acid)	Methyl methacrylate	Vinyl acetate
Diazinon	Methyl parathion	Xylene
Dicamba	Mevinphos	Xylenol
Dichlobenil	Mexacarbate	Zirconium
Dichlone	Monoethyl amine	
2,2-Dichloropropionic acid	Monomethyl amine	
Dichlorvos	Naled	
Diethyl amine	Napthenic acid	
Dimethyl amine	Nitrotoluene	
Dintrobenzene	Parathion	
Diquat	Phenolsulfanate	

Notes:
CFR = Code of Federal Regulations

Table A-25
Operational Limitations on Influent to WWTP

No person shall discharge or cause to be discharged to the sanitary sewer any stormwater, surface water, groundwater, roof runoff, subsurface drainage, cooling water, air conditioning wastewater, or any other domestic, commercial or industrial wastewater not meeting the following limitations:

1 Must have an instantaneous pH value in the range of five (5.0) to ten (10.0) standard units.

2 Must not contain any solid, viscous or liquid wastes which allow or may cause obstruction to the flow in a collection line or otherwise interfere with the proper operation of the WWTP. Prohibited materials include all solid objects, material, refuse, and debris not normally contained in sewage.

3 Must not contain explosive mixtures consisting of liquids, solids, or gases which by reason of their nature or quantity are, or may be, sufficient either alone or by interaction with other substances to cause fire or explosion or be injurious in any way to the operation of the WWTP. At no time shall two (2) successive readings on an explosion hazard meter at the point of discharge into the wastewater system be more than five percent (5%), nor may any single reading be over ten percent (10%) of the lower explosive limit (LEL) of the meter. Prohibited materials include, but are not limited to: gasoline, kerosene, naphtha, benzene, toluene, xylene, ethers, alcohols, ketones, aldehydes, peroxides, chlorates, perchlorates, bromates, carbides, hydrides and sulfides.

4 Must not contain any flammable substance with a flashpoint lower than 186 degrees F.

5 Must have a temperature between 32 degrees to 150 degrees F.

6 Must not contain grease or oil or other substance that will solidify or become viscous between 32 degrees and 150 degrees F.

7 Must not contain improperly shredded garbage that has not been ground or comminuted to such a degree that all particles will be carried freely in suspension under flow conditions normally prevailing in the wastewater system to which the user is connected At all times, no particle shall be greater than one-half inch (½) in any direction.

8 Must not contain gases or vapors either free or occluded in concentrations toxic or dangerous to humans or animals.

9 Must not contain any pollutant, including oxygen demanding pollutants (BOD5, etc.) released at a rate and/or concentration which has a reasonable potential, in the opinion of the WWTP manager, to adversely affect the WWTP (inhibition, pass-through, sludge contamination, or endangerment of the WWTP operators).

10 Must not contain any toxic or irritating substance which will create conditions hazardous to public health and safety.

11 Must not contain in excess of 100 ppm of any grease or oil or any oily substance from petroleum or mineral origin, or both, including but not limited to: a) cooling or quenching oils; b) lubrication oil; c) cutting oils; and d) non-saponifiable oils.

12	Must not contain toxic or poisonous solids, liquids or gases in sufficient quantity, either singly or by interaction with other wastes, to injure or interfere with any sewage treatment process, to create any hazard in the receiving waters of the WWTP or to contaminate the sludge of any wastewater treatment process.
13	Must not cause the temperature of the treatment plant to exceed 40 degrees C (104 degrees F).
14	Must not contain organic toxic pollutants, introduce by the intentional or accidental dumping of solvents, used in operations involving degreasing, surface preparation, tank washing, paint thinning, paint equipment cleaning or any other process.
15	Must not contain any hazardous waste, either listed or characteristic.
16	Numerical guidelines. See Allowable Concentrations worksheet.

Notes:

C	=	Celsius
F	=	Fahrenheit
LEL	=	Lower explosive limit
ppm	=	parts per million
WWTP	=	Wastewater treatment plant

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Table A-26
RFCA Analytes of Interest for Segment 5

RFCA Attachment 5, Table 1 specifies additional limitations beyond those specified here, and all RFCA Table 1 contaminant limitations are applicable. But most of those contaminant limitations are not exceeded and pose hypothetical health risks well below a 10^{-6} criterion, and are not a threat to the environment. Those contaminants do not need to be monitored. The analytes of interest (AoIs) specified here are the analytes for which monitoring funds will actually be requested.

Assumptions:

These AoIs were developed and agreement achieved on the basis of the assumptions below. These assumptions allow all parties to agree that funding and resources should be focused on this relatively short list of contaminants for which there is reasonable cause to expect exceedances of RFCA standards and action levels.

- Discharges into Segment 4 will be from batch operations as currently conducted.
- Monitoring for Segments 4 and 5 RFCA compliance will be flow-proportional.
- Predischarge sampling by the state will be comprehensive.
- Cost effective analytical methods used to monitor the AoIs will also yield information about other potential, but unanticipated, contaminants.
- The Site will perform tritium monitoring in Segment 4, at the Indiana Street points of compliance.
- Any of the parties may, from time to time, identify additional AoIs for cause, for a specific discharge event. If the parties agree, additional contaminants may be added to the ongoing AoIs specified here.

Table A-26
(continued)

Segment 5 Analytes Of Interest

The signatory parties to this plan agree that the AoIs for Segment 5 main stream channel monitoring stations are those listed below.

Radionuclides:	Pu	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA Action Levels.
	U	Known renal toxicity. Present on Site. Past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Am	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
Metals:	Be	Known to cause berylliosis in susceptible individuals when exposed by inhalation. May also cause contact dermatitis. Present on Site. Will be monitored as an indicator of releases from process and waste storage areas.
	Cr	Physiological and dermal toxicity. High level of regulatory concern due, in part to the chromic acid incident of 1989. Low levels can cause significant ecological damage.
	Ag	Highly toxic to fish at low levels if chronic. State of Colorado has temporarily removed its stream standard for silver, while under study. The study has been completed, and the standard will be reinstated at the next triennial review of South Platte stream standards, if not before. Used on Site only for photographic development. Routinely accepted by POTWs as municipal waste, but discharge is regulated. May be removed from this list later, if data do not support concern.

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Table A-26
(continued)

Metals (Continued)	Cd	Highly toxic to fish at low levels if chronic. Known human carcinogen (prostate cancer) and depletes physiologic calcium. Used on Site in plating processes. Monitoring data for the Interceptor Trench System (ITS) and the proposed discharge of untreated ITS waters into Walnut Creek provide reasonable cause to expect future releases in excess of RFCA Action Levels.
	Hardness	Required to evaluate metals analyses, due to its effect on solubility of these metals.
Real Time Monitoring of Physical and Indicator Parameters: These parameters provide real time alarms for a wide variety of regulated contaminants, and are also a required component of monitoring for AoIs. They require no laboratory analyses, and are the Site's most cost effective defensive monitoring.	pH	Toxicity to humans and ecology. Regulatory concern due to chromic acid incident. Real time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or plutonium nitrate) or failure of treatment systems.
	Conductivity	Conductivity is an indicator of total dissolved solids, metals, anions, and pH. Real time monitoring of conductivity is an inexpensive indicator of overall water quality.
	Turbidity	Turbidity is a general indicator of elevated contaminant levels, and may be correlated with Pu.
	NO_3	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. ITS discharges are often high in nitrate, and may challenge RFCA action levels.
	Flow	Required to detect flow events, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.

Notes:

VOAs, Fe, and Mn are specifically excluded from this list. The parties recognize that VOAs will not be effectively monitored at these monitoring stations, and defer to the decision rules that drive monitoring closer to the sources of VOA contamination.

AoI = Analytes of interest
Ag = Silver
Am = Americium
Be = Beryllium

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Table A-26
(continued)

Cd	=	Cadmium
Cr	=	Chromium
Fe	=	Iron
ITS	=	Interceptor Trench System
Mn	=	Manganese
NO_3	=	Nitrate
POTW	=	Publically owned treatment works
Pu	=	Plutonium
RFCA	=	Rocky Flats Cleanup Agreement
U	=	Uranium
VOA	=	Volatile organic analysis

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Table A-27
RFCA AoLs for Segment 4

Segment 4 Analytes Of Interest

This extremely focused list of AoIs was developed and agreed upon based on the following assumptions:

- The Site will perform Segment 5 monitoring for the AoIs described in Table A-26.
- The State will perform comprehensive monitoring, including tritium, for the predischarge samples.

	Terminal Pond Discharge Monitoring POCs	
Radionuclides:	Pu	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	U	Known renal toxicity. Present on Site. Past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Am	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
Real Time Monitoring of Physical and Indicator Parameters: These parameters provide real time alarms for a wide variety of regulated contaminants, and are also a required component of monitoring for AoIs. They require no laboratory analyses, and are the Site's most cost effective defensive monitoring.	pH	Toxicity to humans and ecology. Regulatory concern due to chromic acid incident. Real time monitoring is inexpensive and effective method of detecting acid spills such as (chromic acid or plutonium nitrate) or failure of treatment systems.
	Conductivity	Conductivity is an indicator of total dissolved solids, metals, anions, and pH. Real time monitoring of conductivity is an inexpensive indicator of overall water quality.
	Turbidity	Turbidity is a general indicator of elevated contaminant levels, and may be correlated with Pu.
	NO_3	Past releases near RFCA stream standards and action levels upstream of ponds provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels. ITS discharges are often high in nitrate, and may challenge RFCA action levels.

Table A-27
(continued)

	Terminal Pond Discharge Monitoring POCs	
Real Time Monitoring of Physical and Indicator Parameters (continued)	Flow	Required to detect flow events, evaluate contaminant loads, and plan pond operations and discharges. Affects nearly every decision rule, and is the most commonly discussed attribute of Site surface waters.
Indiana Street Monitoring POCs		
Radionuclides:	Pu	High level of public concern. Known carcinogen. Known past releases (within the past 8 years) have exceeded RFCA stream standards and action levels. This provides reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	Am	Known carcinogen. Present on Site. Known past exceedances provide reasonable cause to expect future releases in excess of RFCA stream standards and action levels.
	U	Uranium at Indiana Street cannot be attributed to the Site, due to natural source contributions in the environment.
	Tritium	Tritium is an AoI for the cities, due to the past release of tritium (1973).
Real Time Monitoring:	--	Indiana Street is not a point of compliance for the real-time monitoring parameters.

Note:
Non-POC monitoring specified in Table 2-21 is not reflected in this table, because the parties intend that Indiana Street. not be a POC for the parameters.

--	=	Not applicable
AoI	=	Analytes of interest
Am	=	Americium
ITS	=	Interceptor Trench System
NO_3	=	Nitrate
POC	=	Point of compliance
Pu	=	Plutonium
RFCA	=	Rocky Flats Cleanup Agreement
VOA	=	Volatile organic analysis
U	=	Uranium

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This appendix contains summary tables of all Site surface water monitoring performed by federal, state, and local agencies during FY96 and FY97. A separate table is presented for each year.

Table B-28
FY96 Integrated Surface Water Monitoring Table

A comprehensive estimate of all environmental monitoring laboratory analyses performed in FY96 is presented on the following insert pages. U.S. Geological Survey flow monitoring is included. Real-time monitoring of the dams is not included.

Notes for each column of the FY96 table are presented below, in the same order (top-to-bottom) as columns (left-to-right).

Analyte Column	Contaminants of Potential Concern
995 Effluent NPDES/FFCA	Parameters two per week. Total Cr is one per week. WET frequency is quarterly. Field parameters collected daily.
995 Effluent CDPHE Sample	Collected quarterly.
995 Effluent Operational	Best Management Practice
995 Influent Operational	Best Management Practice
B3 NPDES	Parameters one per week. Field parameters collected daily.
A3 Discharge	Assumes Pond A3 discharges six times per year at two weeks per discharge. NO_3/NO_2 and field parameters required daily at discharge.
A3 Predischarge	Internal Best Management Practice. Assumes six predischarge samples per year.
A4 Discharge NPDES	Assumes Pond A4 discharges seven times per year. Total Cr frequency is monthly at discharge. WET frequency is quarterly when discharge occurs per FFCA. NVSS collected only if outlet works used.
A4 Predischarge / Transfer Splits	Site collects samples for CDPHE who analyzes for discharge water quality. Site may split if required by DOE, RFFO or if circumstances warrant.
A4 Predischarge	Assumes eight predischarge samples per year on average.
A4 Discharge	Assumes eight discharges per year on average. Short metals list—As, Ba, Cr, and Hg only.
GS11	Continuous stream recorder and DCP are assumed to function 365 days per year. No precipitation data collected.
B5 CDPHE	Quarterly.
B5 Discharge/Tx NPDES	Assumes pond transfer 16 times per year. Total Cr collected at monthly discharge or transfer. WET required quarterly during discharge only per FFCA. If direct discharge NVSS required daily.
C1 5400	Best Management Practice. Composite sample collected weekly.

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Table B-28
(continued)

Analyte Column:	Contaminants of Potential Concern
SW029 USGS	Continuous stream recorder and DCP are assumed to function 365 days per year. Precipitation data collected for about 15 storms per year.
C2 Split	Site collects samples for CDPHE who analyzed for discharge water quality. Site may split if required by DOE, RFFO (recommended). One pre-discharge split per year.
C2 CDPHE Predischarge	Assumes one discharge per year.
C2 CDPHE	Collected monthly when no discharge.
C2 CDPHE Discharge	Assumes one discharge per year. Short metals list - As, Ba, Cr, and Hg only.
C2 NPDES Discharge	Assumes one discharge per year. Total Cr frequency is monthly at discharge. WET required quarterly during discharge only per FFCA. NVSS not listed as outlet works not used in over four years. If outlet works used NVSS is required daily during discharge.
Ponds A2 and LFP	Recommend one sample per pond per year as needed for transfer to off-Site discharging pond (Pond A3 to Pond A4).
New Landfill Pond	Sampled quarterly if flow at request of Broomfield and Jefferson County. TOC and Oil and Grease sampled only if sheen observed. Metals are ICP only.
Walnut & Indiana St. CDPHE	During low flow—one per year; during high flow—two per year. Collected during periods without Pond A4 discharge.
Walnut & Indiana St. CDPHE	Collected concurrently with Pond A4 discharge only. Assumes eight discharges per year on average.
Walnut & Indiana St. Broomfield	Composite sample collected approximately weekly during flow. Assume flow for 25 weeks per year. Organics collected at pond discharge (eight per year).
GS03 USGS	Samples collected during one low flow event and two other events during WY 96. Continuous stream recorder and DCP are assumed to function 365 days per year. Precipitation data for about 15 storms per year assumed.
Walnut Diversion	Composite sample collected approximately weekly during flow at outfall of Walnut Creek diversion below Great Western Reservoir. Assume flow for 25 weeks per year.
Mower	Collected two per year during high flow.
Woman	Collected two per year during high flow.
Finished Westminster	Quarterly.
Raw Westminster	Quarterly.
Standley CDPHE	Collected quarterly. BNA's collected one per year pre-runoff.
Standley Westminster	Sampled at five depths. Frequency varies by depth—monthly, bimonthly and triannually.

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Table B-28
(continued)

Analyte Column:	Contaminants of Potential Concern
Woman Westminster	Sampled once per month when flowing and twice per month during spring runoff. Assumes flow 6 months per year.
Mower Westminster	Sampled once per month when flowing and twice per month during spring runoff. Assumes flow 6 months per year.
Finished Westminster	Weekly and monthly
Raw Westminster	Weekly and monthly.
Carolyn's Well	Quarterly.
Finished Broomfield CDPHE	Quarterly.
Raw Broomfield CDPHE	Quarterly.
Finished Broomfield Broomfield	Composite sample collected weekly. Assume 52 weeks per year.
Denver Service Area	Grab sample collected weekly from Denver of distribution system. Assume 52 weeks per year.
Broomfield Service Area	Grab sample collected weekly from Broomfield of distribution system. Assume 52 weeks per year.
Church Ditch	Grab samples collected weekly at headgate on Clear Creek. Assume 30 weeks per year.
Dry Creek Valley Broomfield	Composite samples collected weekly at raw water pump station. Assumes 30 weeks per year.
Great Western-Broomfield	Composite samples collected weekly from influent from Great Western Reservoir. Assume 52 weeks per year.
Great Western-CDPHE	Collected quarterly. BNA collected one per year prior to runoff.
USGS Stream Monitoring	Stations include GS09, GS10, GS11, GS16, SW027, SW093, SW118, SW998. Continuous stream recorder and DCP assumed to function 365 days per year. Precipitation events collect at GS10 and SW998 only. Precipitation data collected for about 15 storms.
SW134	Sample collected during only one event per year. Continuous stream recorder and DCP assumed to function 365 days per year. No precipitation data collected.
Transition verification stations Tier I	Ten stations collected once per month.
Transition verification stations Tier II	Four stations collected once per month. COPCs collected are determined by transition activities in specific area.

Table B-28
(continued)

Notes:

As	=	Arsenic
Ba	=	Barium
CDPHE	=	Colorado Department of Public Health and Environment
COPC	=	Contaminants of potential concern
Cr	=	Chromium
DCP	=	Base-neutral acid extractable organics
DOE, RFFO	=	Department of Energy, Rocky Flats Field Office
FFCA	=	Federal Facility Compliance Agreement
Hg	=	Mercury
ICP	=	Inductively Coupled Plasma
NO_2	=	Nitrite
NO_3	=	Nitrate
NPDES	=	National Pollutant Discharge Elimination System
NVSS	=	Non-volatile suspended solids
TOC	=	Total organic carbon
USGS	=	U.S. Geological Survey
WET	=	Whole Effluent Toxicity
WY	=	Water year

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Groundwater Monitoring

June 30, 1997
Rev. 1

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3.0 GROUNDWATER MONITORING

3.1 Introduction

This section of the Integrated Monitoring Plan (IMP) describes the groundwater monitoring requirements for Rocky Flats Environmental Technology Site (RFETS or the Site) as outlined in the Rocky Flats Cleanup Agreement (RFCA) (1), and how they will be implemented at the Site. All RFETS groundwater monitoring is performed by Site organizations because groundwater contaminant plumes occur within the Site boundaries. Therefore, this IMP covers all groundwater monitoring activities. After a brief history of the monitoring program, this section outlines the goals for groundwater monitoring, and describes quality assurance/quality control (QA/QC) components and monitoring components. To evaluate groundwater monitoring needs, one must know the RFCA action levels for groundwater, Site history and areas of contamination, the physical and hydrologic setting of the Site, the effect of contaminated areas on groundwater, and the nature of the groundwater contaminant plumes. This information is presented in Appendices A, B, C, and D to this Groundwater Monitoring section, respectively. Appendix E lists the wells that will be monitored for water quality or for groundwater flow.

3.1.1 Purpose of the Integrated Monitoring Plan for Groundwater

In the past, two plans have been required at the Site to comply with Department of Energy (DOE) Order 5400.1 (2), a Groundwater Protection Management Program Plan, and a Groundwater Monitoring Plan. These two plans have historically been combined into one document, the Groundwater Protection and Monitoring Program Plan (GPMPP) (3), which defines and describes the groundwater protection and monitoring programs at the Site. In addition, an assessment groundwater monitoring plan was required under the Resource Conservation and Recovery Act (RCRA) for the interim status units on Site. This plan is called the Groundwater Assessment Plan (GWAP) (4). Other monitoring plans have been developed to address groundwater monitoring requirements as outgrowths of various Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Measure/Interim Remedial Action (IM/IRA) decision documents. This portion of the IMP will serve as the Groundwater Monitoring Plan for the Site, and it will replace the requirements found in the group of plans named above. It will also revise the requirements of the routine groundwater monitoring portion of the Industrial Area IM/IRA decision document (5) and the French Drain IM/IRA Plan (6).

3.1.2 Brief History of Groundwater Monitoring Activities

The historic growth of the groundwater monitoring network at the Site reflects the increasing DOE, regulatory, and public emphasis on identifying areas of groundwater contamination and preventing contaminant releases to the environment. The first three monitoring wells were installed in 1954 in the Solar Ponds area. A total of 1,055 wells and piezometers were installed at the Site from 1971 to present. Plate 1 shows all the wells that have been installed at the Site since 1974.

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Wells in the groundwater monitoring network were sampled annually until 1974, twice a year until 1980, and three times a year during 1981. From 1982 to 1995, designated monitoring wells were sampled quarterly. Beginning in 1995, designated wells were sampled either quarterly or semiannually, depending on regulatory requirements. The wells to be sampled are determined by the types of wells (e.g., RCRA), and the areas being monitored. Currently, wells are sampled on a semiannual basis. The groundwater monitoring program has supported the following compliance programs at the Site:

- RCRA programs;
- CERCLA programs;
- The Background Groundwater Characterization Program (completed in 1993);
- The Boundary Well Monitoring Program;
- Groundwater Protection (DOE Order 5400.1);
- French Drain IM/IRA Performance Monitoring Program;
- Industrial Area IM/IRA Monitoring Program;
- New Sanitary Landfill Permit Monitoring Program; and
- Special activities that support hydrogeologic projects, including aquifer testing and hydrogeological characterization.

Groundwater has been monitored for radionuclides since the first wells were installed in 1954; other chemical analytes were added in 1974, 1979, 1981, 1985, and 1994. Beginning in 1985, the wells were sampled and analyzed for volatile organic compounds (VOCs), metals, and major anions. Limited analyses for pesticides have also been performed. Results of groundwater analyses from 1986 to present are compiled in the Rocky Flats Environmental Data Base System (RFEDS).

In 1993, the large number of wells that were being monitored as an outgrowth of the various remedial investigations at the Site prompted the Well Evaluation Project. The Well Evaluation Report (WER) (7) reduced the monitoring network from 460 wells to 350 wells, but retained those wells in or near contaminant plumes.

In 1995, the Well Evaluation Project updated plume maps and again evaluated the monitoring network. On the basis of new plume configurations, the number of wells monitored was reduced from 350 wells to 150 wells, and the sample frequency and analyte list were amended.

3.1.3 Current Status of the Groundwater Program

In July 1996, the RFCA was approved (1). RFCA replaces the Interagency Agreement (IAG) as the environmental cleanup agreement for the Site. RFCA outlines the goals, objectives, and strategies that will lead to the Site cleanup and closure mission objectives. Supporting activities

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will reduce, eliminate, or mitigate existing environmental liabilities while maintaining the Site in a safe condition. The Action Level Framework (ALF) portion of RFCA contains specific requirements for monitoring and reporting, and it sets action levels for contaminant concentrations in groundwater and in other media (see Appendix B to this section). The IMP is required under RFCA to further define the monitoring programs for the Site.

Defining the groundwater monitoring involved reevaluating the monitoring system to ensure that it was protective of the environment, compliant with all applicable regulations and agreements, and aligned with the new Site mission. A data quality objective (DQO) process was used to determine the function of each well in the network and the decisions supported by information from each well. DOE, Rocky Flats Field Office (RFFO), the Colorado Department of Public Health and the Environment (CDPHE), and the U.S. Environmental Protection Agency (EPA) stakeholders were directly involved in all decisions about the monitoring network. Results of this evaluation are presented starting in Section 3.2.

3.1.4 Groundwater Interactions with Surface Water

There is considerable interchange between surface water and groundwater at Rocky Flats. Interchange occurs along stream channels, ponds, ditches, and lakes by way of natural hillside and channel seepage and artificial flow control structures, such as foundation drains and dams, that interrupt the natural flow of water. Streams nearest to the Industrial Area are more likely to be contaminated by groundwater discharges and, thus, have traditionally been the focus of most groundwater monitoring.

As shown in Figure 3-1, three ephemeral streams drain the Site. The streams are Rock Creek, Walnut Creek (consisting of two tributaries, "No Name Gulch," and South Walnut Creek), and Woman Creek. Groundwater is discharged from the Rocky Flats Alluvium and other surficial deposits through surface seeps and subsurface flow that, in turn, recharge stream flow and the stream valley groundwater system. Segments of streams have been shown to either gain or lose water as groundwater is discharged to or stream water is discharged from the stream channel. Gaining reaches of streams are more likely to be contaminated by groundwater discharges.

3.2 Groundwater Program Objectives

The objectives of the Site groundwater program are to 1) protect surface water quality, 2) ensure compliance with regulations, 3) minimize the chances of further degradation of the Upper Hydrostratigraphic Unit (UHSU), and 4) support the design and selection of remedial measures and assess the effect of any future remedial actions. Development of the IMP and subsequent updates are the responsibility of the Environmental Restoration Department of Rocky Mountain Remediation Services, L.L.C. (RMRS/ER) under the direction the Kaiser-Hill Company, L.L.C. (Kaiser-Hill) and the DOE, RFFO. RMRS/ER directs and implements the Groundwater Monitoring Program. The Site management structure is shown in Figure 3-2.

3.3 Monitoring Objectives

The Site Groundwater Monitoring Program will be integrated with ongoing activities designed to protect surface water from contamination by groundwater. The Groundwater Program will do the following:

- Identify groundwater containing contaminants;
- Identify and control contaminant sources;
- Identify contaminant pathways;
- Monitor contaminant concentrations;
- Monitor remediation and Decontamination and Decommissioning (D&D) actions;
- Protect groundwater from new sources of contamination; and
- Evaluate the effects of groundwater contaminants on surface water.

3.3.1 Identification of Potential Contaminants

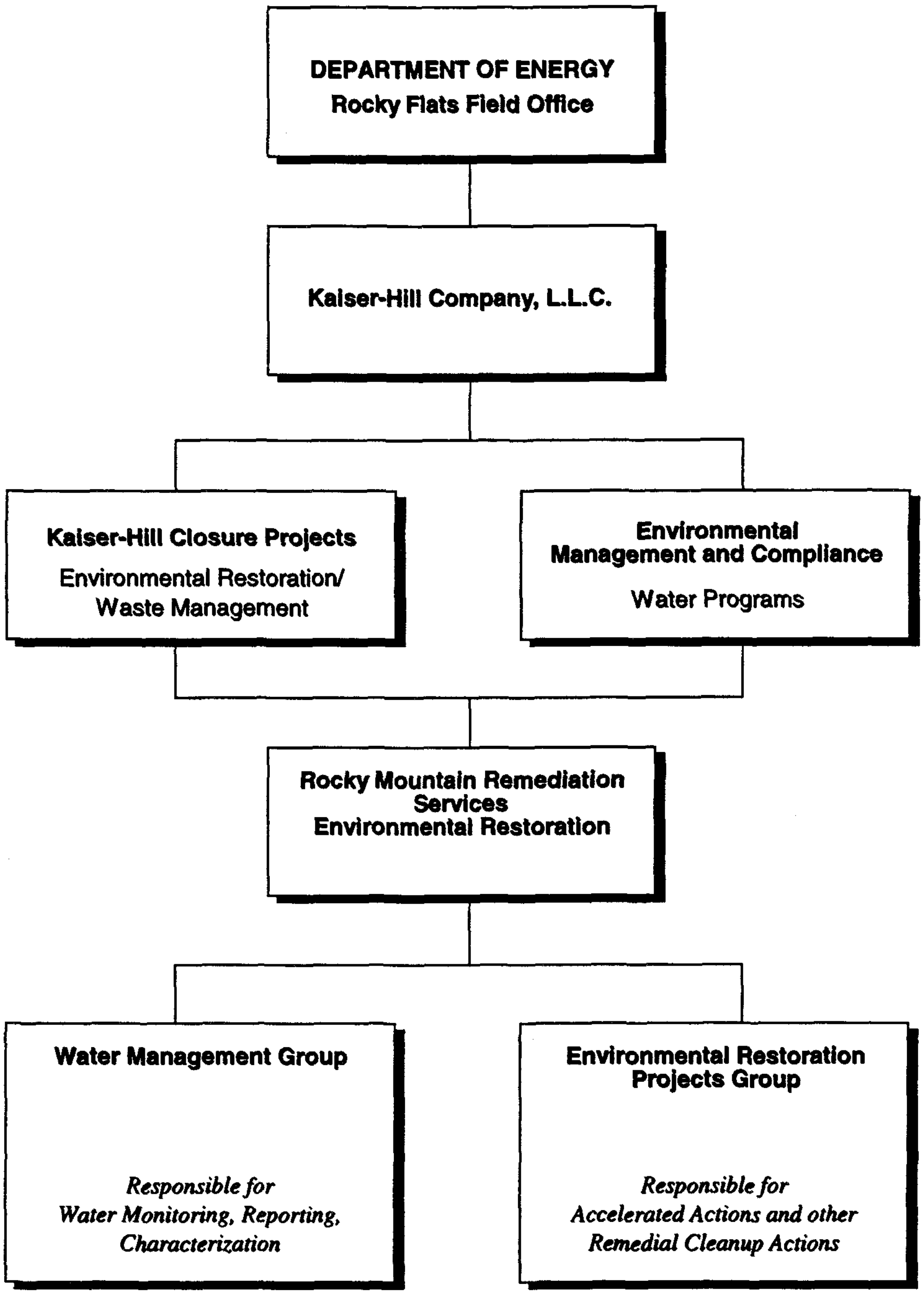
A chemical inventory system has operated since 1986. The current real-time Chemical Tracking System, which identifies chemicals used on Site that are potential contaminants, has been in operation since 1990. It fulfills RCRA requirements to track the disposition of hazardous chemicals. The Waste Programs Organization at the Site manages this tracking system.

In addition, the Historic Release Report (HRR) (8) was compiled to originally document spills and other releases of potentially hazardous chemicals at the Site. This report is updated annually and is maintained by the RMRS/ER Department.

3.3.2 Identification and Control of Contaminant Sources

Site area sources contaminated with hazardous substances are identified as Individual Hazardous Substance Site (IHSSs) and have been characterized under the Remedial Investigation/Feasibility Study (RI/FS) process. The IHSS ER Ranking Project is required under RFCA to determine the relative risk associated with contaminant sources and assign a priority for remediation. Those IHSSs that have contributed to groundwater contamination have been identified and put into the priority list for remediation. The HRR will document any new sources of contamination and will assign an IHSS number to a significant release.

Figure 3-2
Organizational Responsibilities for Groundwater



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3.3.2.1 Current Contaminated Areas

The remedial investigations at Operable Units (OUs) (a grouping of IHSSs) have provided adequate data for determining potential contamination sources for much of the Site. The Industrial Area OU has not been characterized as thoroughly as other OUs, but initial soil screening results helped to characterize sources in this area.

Table A-1 lists the IHSSs at the Site. Information about the effect of contaminated areas on groundwater is described in Appendix D to this section. Table D-1 lists the potential contaminants of concern (PCOC) in groundwater and in other media, based on risk assessment criteria in the OUs that have been characterized. The remedial investigations at OUs, combined with Site-wide groundwater characterization activities, have identified a number of groundwater contaminant plumes that emanate from contaminant sources. These plumes are described in Appendix D to this section. The dominant category of hazardous contaminants in groundwater are VOCs. Where feasible, general plume maps have been developed to show the extent of contamination in UHSU groundwater. Plate 3 shows the composite plumes of VOCs and the Solar Ponds nitrate plume. Analyte suites have been developed for wells that reflect the major contaminants of concern.

In areas where groundwater will be monitored during D&D activities, building-specific potential PCOCs will be developed. The RFCA Action Level Framework requires performance monitoring of remedial actions. Analyte suites will be developed for these wells based on knowledge of the contaminants of concern at the remediation site (1).

Remediation activities protect groundwater by minimizing further migration of potential contaminants and by cleaning contaminated areas. Data are gathered to identify the extent of contamination and the rate of contaminant migration, and to develop a plan for appropriate remedial actions. Data generated by the Groundwater Monitoring Program support the goals of identifying and remediating existing contaminated areas, detecting new contamination caused by D&D or other activities, and preventing contamination of surface water.

3.3.2.2 Hazardous Waste Management Areas

Hazardous or mixed waste management areas at the Site are generally operated in compliance with the RCRA requirements applicable to each area. These are further described in the Spill Prevention, Control, and Countermeasures/Best Management Practices (SPCC/BMP) Plan (9) and the RCRA Part B Permit. The RCRA waste management functions at the Site are the responsibility of Waste Programs.

3.3.2.3 Storage Tanks

The more than 2,000 storage tanks at the Site include underground storage tanks, production or process waste tanks, chemical feed tanks, and fuel oil tanks. Most production and process waste tanks are considered to have secondary containment because they are located inside buildings or have systems that contain spills. Some of the chemical feed and fuel oil tanks also have spill containment systems; these tanks are considered low risk for spills to the ground and thus unlikely to contaminate groundwater.

Further characterization and spill controls for non-waste storage tanks will be achieved with the implementation of the Tank Management Plan which was developed as a result of the 1989 chromic acid incident (10). The tank management project employs formal design, testing, and inspection standards to evaluate tanks and prevent environmental contamination. This Tank Management Plan complies with *Title 40 of the Code of Federal Regulations* (CFR) Parts 280, 281, and 282, where applicable (11). The Waste Programs Organization at the Site maintains and controls the tanks.

3.3.2.4 Process Waste System

The process waste system comprises process waste lines and valve vaults. Groundwater is protected from these systems by 1) inspection of single-contained lines, which are only in accessible locations, 2) development of secondary-containment systems for lines that are not as accessible, and 3) continuous monitoring of leak detectors.

3.3.2.5 Building Drains

The Drain Identification Study (DIS) at OU8 (12) identifies all those buildings with floor and footing drains located in areas containing potentially hazardous substances, and characterizes whether they lead to sanitary or process waste treatment facilities. Floor and footing drains are considered potential contaminant pathways since a large spill could enter the drains and be transported to the surface-water control system. Should this happen, the spill would be retained, sampled, treated, and released in compliance with permit conditions. Final completion of all DIS tasks, including corrective actions, was completed in August 1996. The Technical Memorandum No. 1 Data Compilation, Rocky Flats Plant, 700 area (OU8) (12) compiles locations and specifications on foundation drains, storm sewers, and sanitary sewers. This information may help define how the drain systems could affect groundwater and surface-water flow and migration.

3.3.2.6 Other Potential Contamination Sources

Underground buildings, building operations, and building sumps are also potential sources of contamination. The effect of these sources on groundwater will be further investigated as part of the RMRS/ER program and integrated with D&D activities.

3.3.3 Identification of Potential Contaminant Pathways

To assess the direction and magnitude of contaminant movement, both natural and man-made groundwater migration pathways must be known. The Site groundwater flow regime is determined from water level measurements at monitoring wells. This information can be used to help estimate recharge and discharge rates, and it can be incorporated into water table maps and groundwater flow models that help predict the path along which contaminants migrate.

3.3.4 Identification of Contaminant Concentrations

Routine chemical analysis of groundwater identifies both the contaminants present and the concentration of contaminants with respect to Site action levels or standards. Background concentrations have been established for most inorganic compounds present in groundwater at the Site. These Site-specific background levels are used to help determine concentrations that are anomalous with respect to natural levels. Increases in contaminant concentrations with time may indicate that contaminants are migrating from sources that could affect surface water.

3.3.5 Monitoring of Remedial Actions

The majority of the Site remedial investigation and characterization activities have been completed. Based on these remedial investigations, some interim remedial actions have already been completed, such as the groundwater treatment systems that have been built at the former OU4 and the former OU1. Performance monitoring of groundwater is required for those remedial activities where groundwater has been impacted.

The Interceptor Trench System (ITS) was installed on the hillside north of the Solar Ponds to decrease groundwater migration towards Walnut Creek and to collect groundwater contaminated with high concentrations of radionuclides and nitrate. The water collected in the ITS is pumped to the Building 374 Treatment Plant for processing. Groundwater is not currently monitored immediately downgradient of the ITS, but the Walnut Creek drainage below the ITS is monitored to detect contaminants that are not collected by the system.

The OU1 French Drain System was installed on the 881 Hillside to collect groundwater migrating towards Woman Creek. In addition, groundwater is intercepted in a collection well located near the French Drain and transferred to the Building 891 Treatment Plant nearby. Water that enters the drain is also pumped to the Building 891 Treatment Plant for processing. Groundwater is monitored downgradient of the French Drain system to detect any leakage of potentially contaminated groundwater toward Woman Creek.

Additional remedial activities are planned, as accelerated actions, to excavate and remove hazardous waste sources and to set up additional treatment systems for groundwater. The ALF addendum to RFCA requires performance monitoring of groundwater affected by remedial cleanup activities. It is anticipated that performance monitoring decisions will be made on a case-by-case basis but will follow a general decision rule that is described in a later section.

3.3.6 Protection from New Contaminant Sources

Future plans for the Site involve decommissioning of Site production systems, building demolition, and excavation and removal or capping of source areas. The IM/IRA for the

Industrial Area (5) proposed a framework for monitoring the effects of building D&D on air, surface water, and groundwater quality. Groundwater will be monitored before, during, and immediately after any operation that could potentially degrade groundwater quality. This monitoring will determine the Site-specific ambient groundwater conditions and immediately detect any release of contaminants to groundwater. Construction activities are also assessed to ensure that groundwater quality is not compromised. Groundwater protection will be considered in future D&D work plans to supplement existing programs for water collected and contained in the building footing drains, basements, valve vaults, and sumps in the Industrial Area . The goal is to monitor the Industrial Area perimeter and promptly detect any contaminant releases, primarily during D&D activities.

Additional sources of Site groundwater contamination may be identified by evaluating data from the groundwater monitoring network at the Site. Evaluation of these data may identify new areas with elevated contaminant concentrations.

3.3.7 Evaluation of Groundwater Contaminant Impacts on Surface Water

In the event that monitoring shows that a groundwater contaminant plume may reach and impact surface water, evaluations will be made to assess this impact. An activity plan will be prepared to identify the specific DQOs necessary for the proper collection and interpretation of information, such that an impact assessment can be made. Once a determination of impact to surface water has been made, a remedial action priority will be assigned.

3.4 Groundwater Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support decision making. At the programmatic level, DQOs are established to ensure that a project has been logically defined and planned, and that project scope will support the eventual decisions required. At the operational level, quality control objectives (QCOs) are established to insure that data generated by the project will withstand scientific and legal scrutiny, and that the data will be gathered or developed using procedures appropriate for the intended use of the data.

3.4.1 Programmatic Data Quality Objectives

The DQO process was applied to the Site groundwater program at both a programmatic and decision-specific level. At the programmatic level, the DQO process was used to qualitatively evaluate the overall need for, and purpose of, groundwater monitoring. This effort established that groundwater data are needed to comply with applicable regulations, agreements, permits, and to prevent unacceptable risks to public health and the environment through impacts to surface waters of the state. The information required to satisfy these requirements results from regular sampling of wells and surface locations selected to meet the above criteria. These data will be used to detect and document concentrations above limits established by regulations, agreements, permits, or risk-based analysis; to support planning, implementation, and assessment of

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removals, remedial actions, and D&D projects; to support modeling and evaluations; and to meet commitments to issue periodic monitoring reports to regulators. Sampling locations and frequency have been negotiated with regulators; locations were chosen to detect migration of known contaminant plumes along pathways and across boundaries. Analytical results need to be of high quality, owing to the many uses of the data — modeling, risk assessment, performance assessment, and compliance. These programmatic statements establish the general need for a groundwater monitoring program and outline program elements that need to be included.

3.4.2 Data Quality Objectives for Program Elements

The second DQO effort developed individual monitoring program decision elements. DQOs were approached on a medium-specific basis, although the goal was to integrate monitoring requirements for all media (e.g., surface water, ecology, air). Groundwater monitoring DQOs were developed for each component of the program and problem statements were established. These problem statements were then refined into a decision statement that specified corrective actions for that problem. Then data were identified and methods of analysis outlined to support the decision. Boundaries and scope are defined to clarify the spatial and temporal focus of the required monitoring information and exclude nonessential aspects of the problem. A decision rule was specified to document how data will be summarized to draw a conclusion upon which a decision will be based.

The groundwater monitoring network was defined with the Site-wide components described below.

- Plume Definition Wells: Wells that are within known contaminant plumes and are above Tier II Action Levels, but are below the Tier I Action Levels established in the ALF. These wells will be monitored to determine whether concentrations of contaminants are increasing, and, if a Tier I Action Level is exceeded, will be reported as a Tier I exceedance and be prioritized for remedial action.

- Plume Extent Wells: Wells at the edges of known groundwater contaminant plumes along pathways to surface water. A subset of these wells is listed in the ALF as Tier II Wells. The wells are monitored for increases in concentrations that would exceed Tier II Action Levels stated in the ALF, and they indicate movement that may result in contamination of surface water.

- Drainage Wells: Monitoring wells located in stream drainages downgradient of contaminant plumes. If contamination reaches these wells, and action levels are exceeded, they fall under the same requirements as plume extent wells.

- Boundary Monitoring Wells: Wells used to monitor the quality of groundwater leaving the eastern Site boundary.

In addition to this general groundwater monitoring scheme, specific requirements support regulatory directives. The following special categories are included as groundwater program elements:

- D&D Monitoring Wells: Wells used to monitor releases to groundwater from D&D activities on specific buildings. This requirement is specified in the IM/IRA for the Industrial Area (5).

- Performance Monitoring Wells: Wells used to monitor the effect of a remedial treatment or source removal action. Performance monitoring of source remediation is specifically required in the RFCA ALF for groundwater. The French Drain Performance Monitoring Wells are included in this category and are specified in the French Drain IM/IRA Plan (6).

- RCRA Compliance Wells: Wells used in upgradient and downgradient monitoring of RCRA interim status units. This requirement is specified under 6 *Code of Colorado Regulations* (CCR) 1007-3. Wells monitored at the new landfill would be specified under 6 CCR 1007-2. Future retrievable storage facilities would also fall under the RCRA monitoring category.

The ALF also lists specific analytes and the associated action level or standard for groundwater and surface water. Groundwater currently needs to meet domestic, agricultural, and surface water protection standards. There is general concensus that with institutional controls in place, the domestic and agricultural use classifications can be removed. For purposes of DQO development, the RFCA requirements for groundwater are assumed to support the surface water protection classification, and all DQO decisions will reflect this. Each component of the groundwater program can be considered a decision element, and decision statements have been created for each component.

3.4.2.1 Plume Definition Wells

Problem Statement:

Are contaminants within groundwater plumes increasing in concentration with time or reaching Tier I Action Levels with the potential to impact surface water?

Problem Scope:

Plume definition wells lie within the currently known groundwater contaminant plumes and are located appropriately to monitor groundwater pathways that could affect surface water. Plume definition wells are designated based on knowledge of existing groundwater contaminant plumes and particle flow models that simulate groundwater pathways. It is possible that some plume definition wells have historically exceeded Tier I Action Levels. For these wells, only new exceedances of Tier I Action Levels involving

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compounds that have concentrations greater than historic levels will cause the well to be reprioritized for remedial action.

Inputs:

- RFCA Tier I Action Levels.
- Background mean + 2 standard deviations.
- Historic baseline for contaminants.
- Selected analyte suites based on historic data (see Appendix E to this section).
- Historic data trends for contaminants.
- Field parameters.
- Water levels.

Boundaries:

Spatial: Wells are located in areas known to be contaminated above the Tier II Action Level. Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF Measured concentrations in well exceed Tier I Action Levels and background mean plus 2 standard deviations

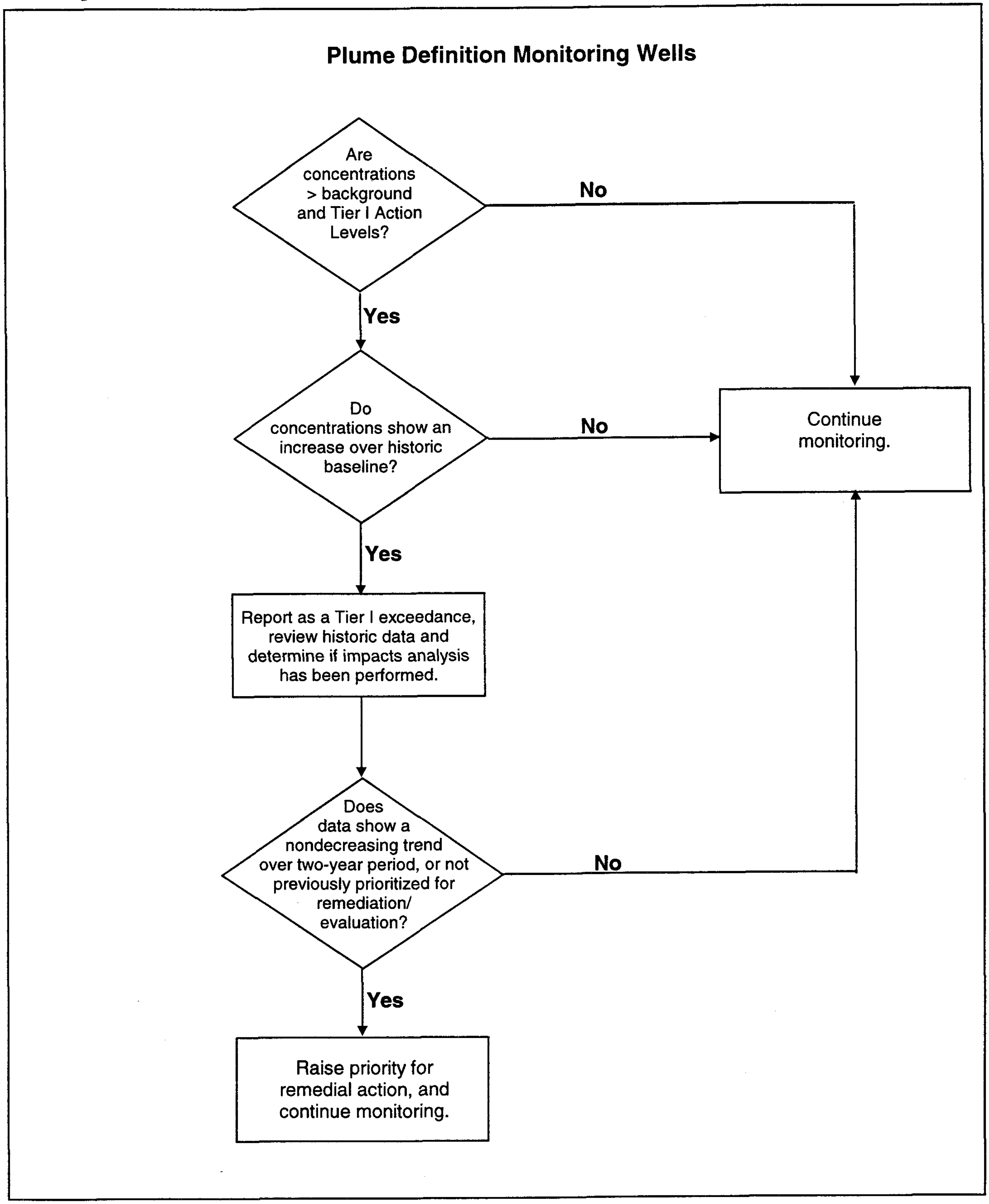
THEN Report as a Tier I exceedance and review historic data for well to determine if it has been prioritized for remediation/evaluation based on potential impact to surface water.

IF Data show a nondecreasing or increasing trend over a two-year period, or well has not been previously prioritized for remediation

THEN Update priority for remediation/evaluation

ELSE Continue monitoring.

Logic:


Plume Definition Monitoring Wells
Are concentrations > background and Tier I Action Levels?
No
Yes
Do concentrations show an increase over historic baseline?
No
Continue monitoring.
Yes
Report as a Tier I exceedance, review historic data and determine if impacts analysis has been performed.
Does data show a nondecreasing trend over two-year period, or not previously prioritized for remediation/ evaluation?
No
Yes
Raise priority for remedial action, and continue monitoring.

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3.4.2.2 Plume Extent Monitoring Wells

Problem Statement:

Have concentrations in wells exceeded Tier II Action Levels?

Problem Scope:

Plume extent monitoring is conducted to detect potential impact to surface water from known or suspected groundwater contamination plumes. Some of these wells are specifically listed as Tier II wells in the RFCA ALF for groundwater. If groundwater exceeds Tier II Action Levels, an evaluation is required to determine if remedial or management action is necessary to prevent surface water from exceeding standards. It is possible that some plume extent wells have historically exceeded Tier II Action Levels. For these wells, only new compounds with exceedances of Tier II Action Levels or involving compounds that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

- RFCA Tier II Action Levels.
- Background mean + 2 standard deviations.
- Historic baseline for contaminants.
- Selected analyte suites based on historic data (see Appendix E to this section).
- Historic data trends for contaminants.
- Field parameters.
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made on an annual basis.

Decision Statement:

IF Sample results show detections in a well that exceed Tier II action levels and background mean + 2 standard deviations

THEN Report as a Tier II exceedance, review historic data for well, and determine if evaluation of impact to surface water has been done.

IF Historic data confirm the exceedance and impact evaluation has not been done

THEN Notify appropriate parties and evaluate impacts to surface water.

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IF	Historic exceedances have not been documented or concentrations for a known contaminant are greater than the mean + 2 standard deviations with respect to the historic data set for that well
THEN	Initiate monthly sampling for three months.
IF	Monthly sampling confirms the exceedance
THEN	Notify appropriate parties and determine whether a remedial or management action is necessary
ELSE	Continue monitoring.

3.4.2.3 Drainage Monitoring Wells

Problem Statement:

Do contaminants that have reached surface water in groundwater exceed action levels, and are they migrating downgradient in valley fill alluvium?

Problem Scope:

In some areas, groundwater contamination from multiple sources has migrated to surface water drainages. Drainage wells monitor groundwater in valley fill alluvium downstream of areas where contaminant plumes may have reached surface water stream drainages. Any contaminants detected in stream drainages are assumed to have affected surface water and to have the potential to migrate off Site. It is possible that some drainage wells have historically exceeded Tier II Action Levels. For these wells, only new compounds with exceedances of Tier II Action Levels or involving compounds that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

- RFCA Tier II Action Levels.
- Background mean + 2 standard deviations.
- Historic baseline for contaminants.
- Selected analyte suites based on historic data (see Appendix E to this section).
- Historic data trends for contaminants.
- Field parameters.
- Water levels.

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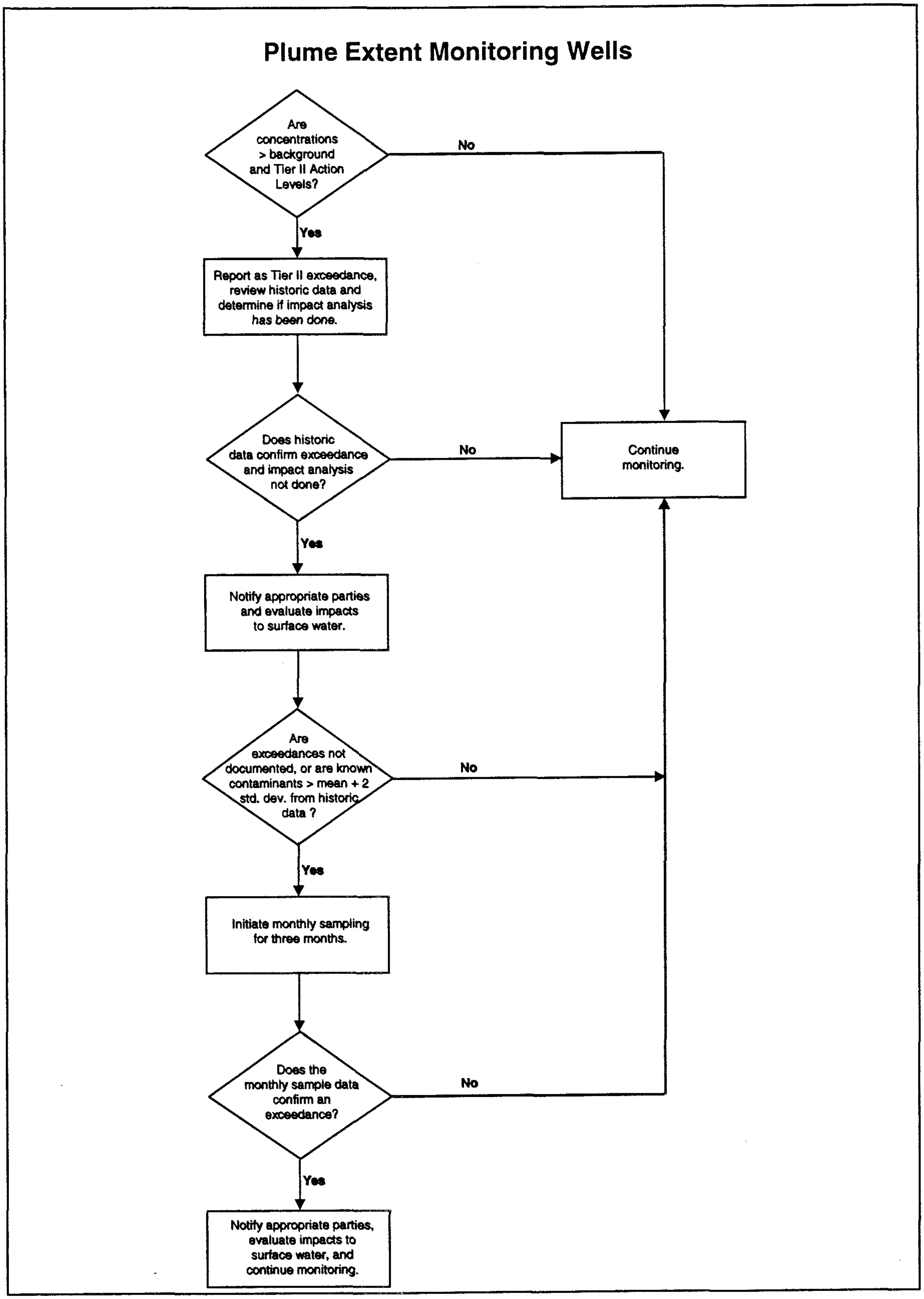
Logic:


Plume Extent Monitoring Wells
Are concentrations > background and Tier II Action Levels?
No
Yes
Report as Tier II exceedance, review historic data and determine if impact analysis has been done.
Does historic data confirm exceedance and impact analysis not done?
No
Continue monitoring.
Yes
Notify appropriate parties and evaluate impacts to surface water.
Are exceedances not documented, or are known contaminants > mean + 2 std. dev. from historic data ?
No
Yes
Initiate monthly sampling for three months.
Does the monthly sample data confirm an exceedance?
No
Yes
Notify appropriate parties, evaluate impacts to surface water, and continue monitoring.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF	Sample results show detections in a well that exceed Tier II Action Levels and background mean + 2 standard deviations
THEN	Report as a Tier II exceedance, review historic data for well, and determine if evaluation of impact to surface water has been done.
IF	Historic data confirm the exceedance and impact evaluation has not been done
THEN	Notify appropriate parties and evaluate impacts to surface water.
IF	Historic exceedances have not been documented or concentrations for a known contaminant are greater than the mean + 2 standard deviations with respect to the historic data set for that well
THEN	Initiate monthly sampling for three months.
IF	Monthly sampling confirms the exceedance
THEN	Notify appropriate parties and evaluate impacts to surface water.
ELSE	Continue monitoring.

3.4.2.4 Boundary Monitoring Wells

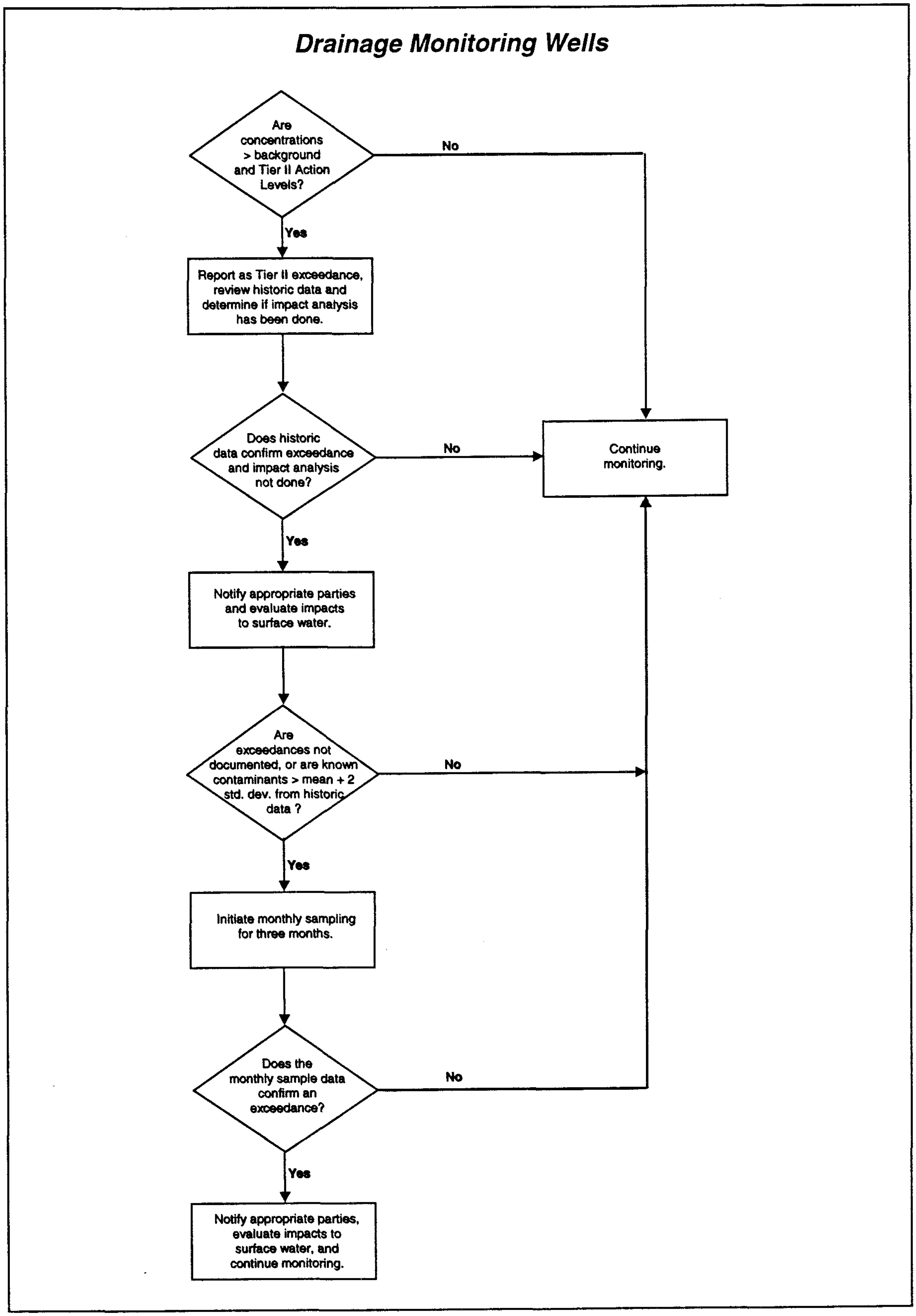
Problem Statement:

Do contaminants in groundwater exceed groundwater action levels, and do they migrate off Site?

Problem Scope:

Boundary wells monitor groundwater at the downstream boundary of the Site. Any contaminants detected in boundary wells that are above background and also above action levels are assumed to have impacted surface water and to have migrated off Site. Historically, the Site has monitored wells at the Indiana Street boundary to provide the surrounding cities with added certainty that there are no contaminants in alluvial groundwater leaving the Site. It is possible that some boundary wells historically

Logic:


Drainage Monitoring Wells
Are concentrations > background and Tier II Action Levels?
No
Yes
Report as Tier II exceedance, review historic data and determine if impact analysis has been done.
Does historic data confirm exceedance and impact analysis not done?
No
Continue monitoring.
Yes
Notify appropriate parties and evaluate impacts to surface water.
Are exceedances not documented, or are known contaminants > mean + 2 std. dev. from historic data ?
No
Yes
Initiate monthly sampling for three months.
Does the monthly sample data confirm an exceedance?
No
Yes
Notify appropriate parties, evaluate impacts to surface water, and continue monitoring.

exceeded Tier II Action Levels. For these wells, only new compounds that exceed Tier II Action Levels or that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

- RFCA Tier II Action Levels.
- Background mean + 2 standard deviations.
- Historic baseline for contaminants.
- Selected analyte suites based on historic data (see Appendix E to this section).
- Historic data trends for contaminants.
- Field parameters.
- Water levels.

Boundaries:

Spatial: Alluvial groundwater in the drainages at the Indiana Street boundary. Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF Sample results show detections in a well that exceed Tier II Action Levels and background mean + 2 standard deviations,

THEN Report as a Tier II exceedance, review historic data for well, and determine if evaluation of impact to surface water has been done.

IF Historic data confirms the exceedance and impact evaluation has not been done.

THEN Notify appropriate parties and evaluate impacts to surface water.

IF Historic exceedances have not been documented or concentrations for a known contaminant are greater than the background mean + 2 standard deviations with respect to the historic data set for that well,

THEN Initiate monthly sampling for three months.

IF Monthly sampling confirms the exceedance,

THEN Notify appropriate parties and evaluate impacts to surface water.

ELSE Continue monitoring.

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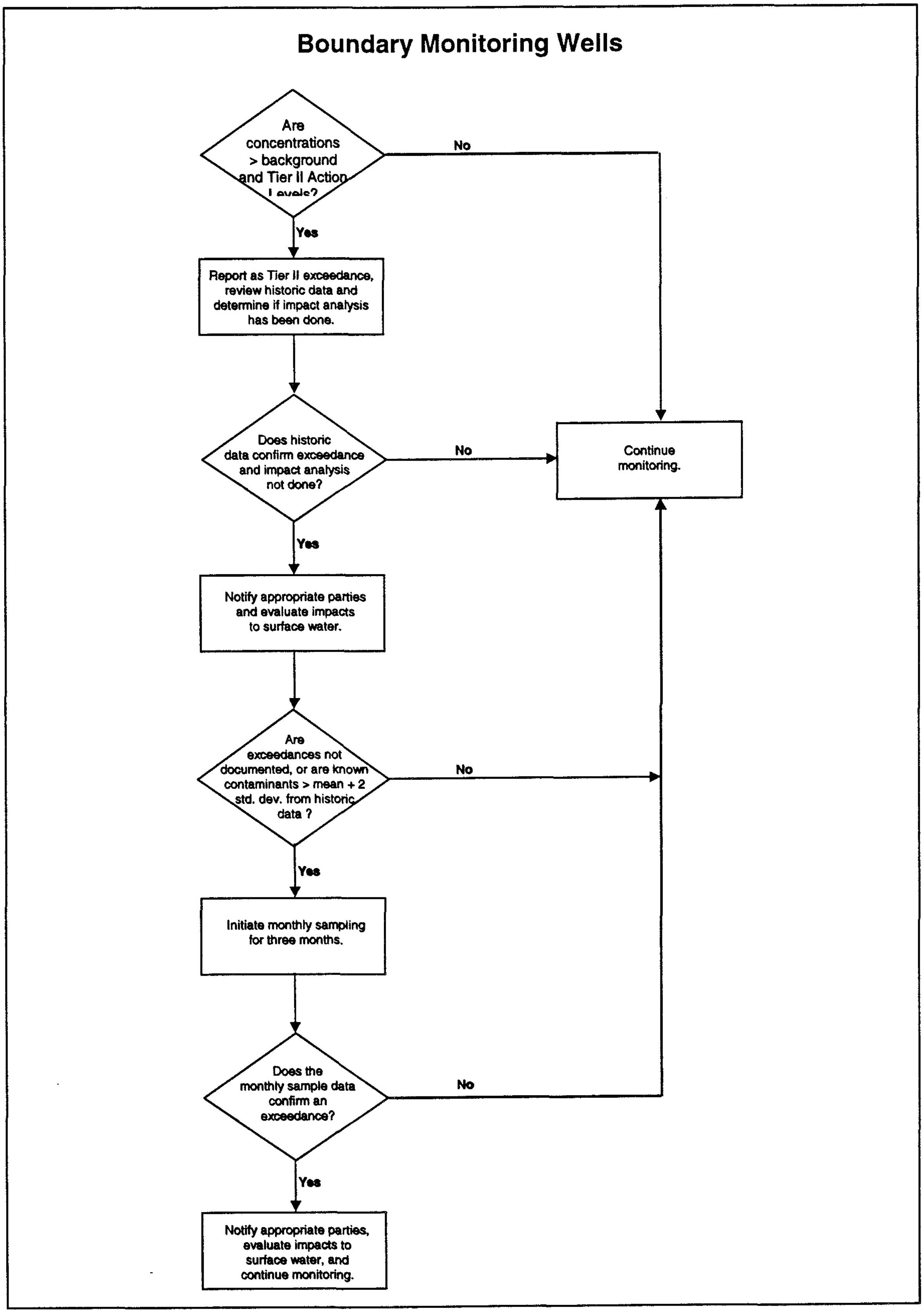
Boundary Monitoring Wells
Are concentrations > background and Tier II Action Levels?
No
Yes
Report as Tier II exceedance, review historic data and determine if impact analysis has been done.
Does historic data confirm exceedance and impact analysis not done?
No
Continue monitoring.
Yes
Notify appropriate parties and evaluate impacts to surface water.
Are exceedances not documented, or are known contaminants > mean + 2 std. dev. from historic data ?
No
Yes
Initiate monthly sampling for three months.
Does the monthly sample data confirm an exceedance?
No
Yes
Notify appropriate parties, evaluate impacts to surface water, and continue monitoring.

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3.4.2.5 Building–Specific D&D Monitoring Wells

Problem Statement:

Have building-specific D&D activities degraded groundwater in a way that can impact surface water?

Problem Scope:

Building-specific D&D activities involve three major steps: deactivation of building processes, demolition of building structures, and remediation of building foundations and surroundings. The IM/IRA for the Industrial Area outlines monitoring activities to insure that building-specific D&D actions do not inadvertently degrade surface water through a groundwater transport pathway. The proposed monitoring will provide the data needed to determine if precautions or actions taken during D&D adequately prevent migration of contaminants to groundwater.

Inputs:

- Building-specific PCOCs (to be determined).
- Baseline mean + 2 standard deviations.
- Field parameters (to be determined).
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF Existing information from a proposed D&D activity indicates a potential threat to surface water through a groundwater pathway

THEN Establish a pre-D&D baseline using wells located upgradient and downgradient of buildings.

IF Exceedances are detected greater than the mean + 2 standard deviations above baseline

THEN Inform appropriate parties and evaluate the problem

ELSE Continue monitoring.

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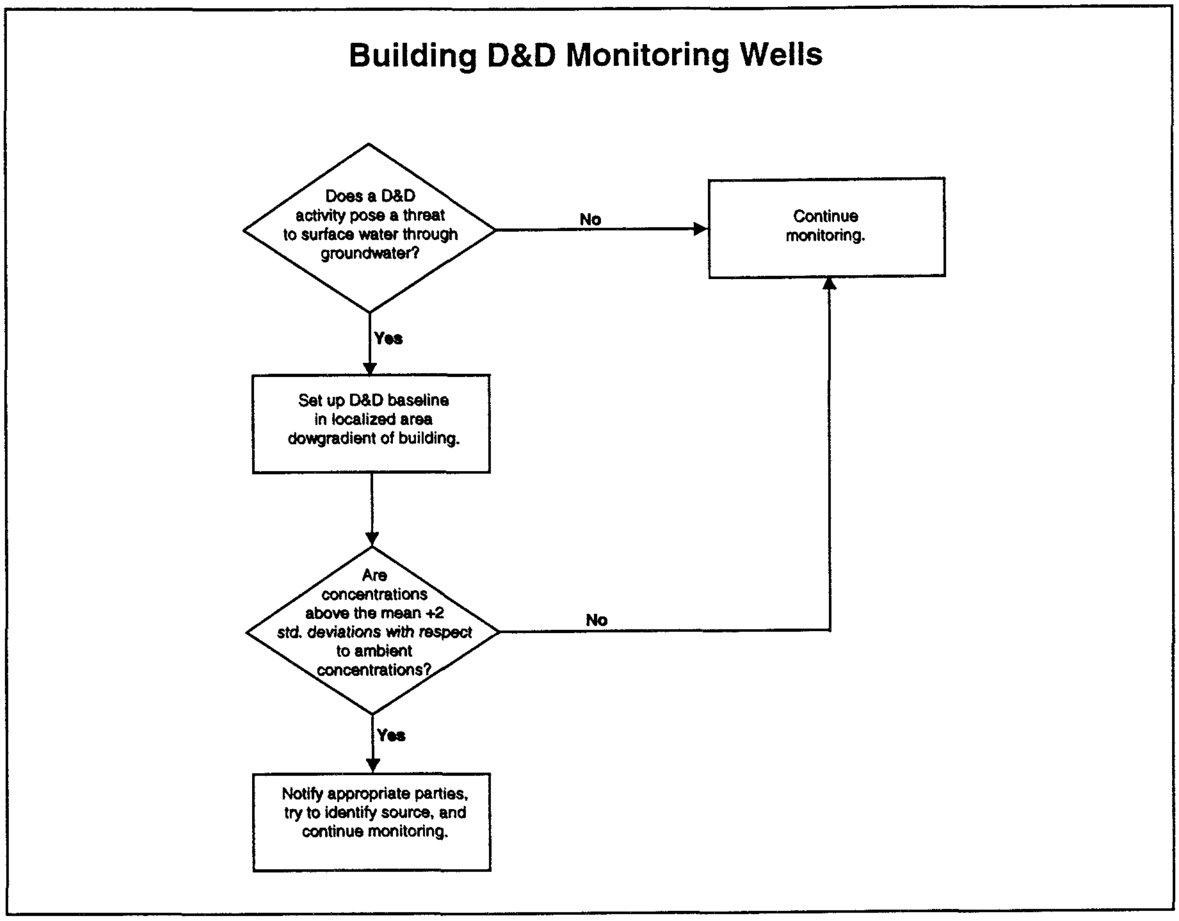
Logic:



3.4.2.6 Performance Monitoring Wells

Problem Statement:

Have remedial actions improved or further impacted groundwater?

Problem Scope:

Performance monitoring assesses the effectiveness of remedial activities such as contaminant source removals or treatment systems that are installed to clean groundwater plumes. In general, source removals are monitored by comparing current values to values that existed before the remedial action. RFCA requires performance monitoring of all groundwater and appropriate soil remediation actions. Specific activities will be determined on a case-by-case basis and will be established in decision documents for those projects where it is required. Details will be determined by the groundwater work group in conjunction with project managers and incorporated into the IMP.

Inputs:

- Source-specific PCOCs (to be determined) .
- Field parameters (to be determined).
- Water levels.

Boundaries:

Spatial:	Decisions will be made on a well-by-well basis. Wells will be placed downgradient from sources undergoing remediation.
Temporal:	Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF	Existing data or information from a remedial activity suggest potential impact through groundwater pathways to surface water
THEN	Establish monitoring points and initiate sample collection.
IF	Monitoring detects that the concentration of contaminants increases with time
THEN	Inform appropriate parties and initiate evaluation to assess the extent of the problem
ELSE	Continue monitoring until contaminant levels are reduced to acceptable levels.

3.4.2.7 RCRA Monitoring Wells

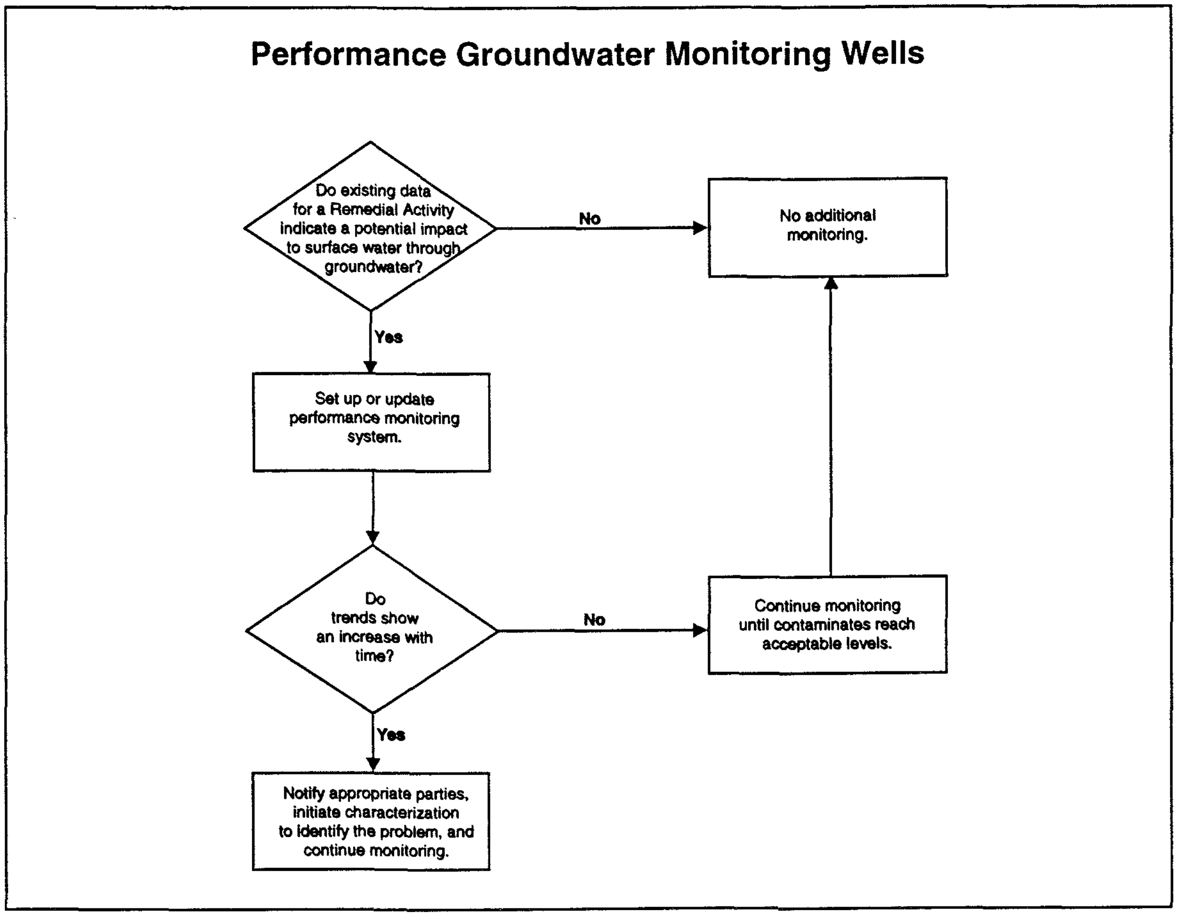
Problem Statement:

Have concentrations of contaminants in downgradient monitoring wells exceeded the mean concentrations in upgradient monitoring wells at RCRA units?

Problem Scope:

RCRA monitoring is conducted to detect potential excursions of contamination that are below the point of compliance established for RCRA units on Site. RCRA units are considered to be any units that are regulated under 6 CCR 1007-2 solid waste requirements, such as the Existing Landfill and the New Sanitary Landfill, and any future waste repositories.

Logic:



Inputs:

- Unit-specific PCOCs.
- Field parameters.
- Water levels.

Boundaries:

Spatial: Decisions will be made based on pooled results of upgradient wells and on a well head basis in downgradient wells.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF Mean concentrations in any downgradient well exceeds the mean concentration in upgradient wells

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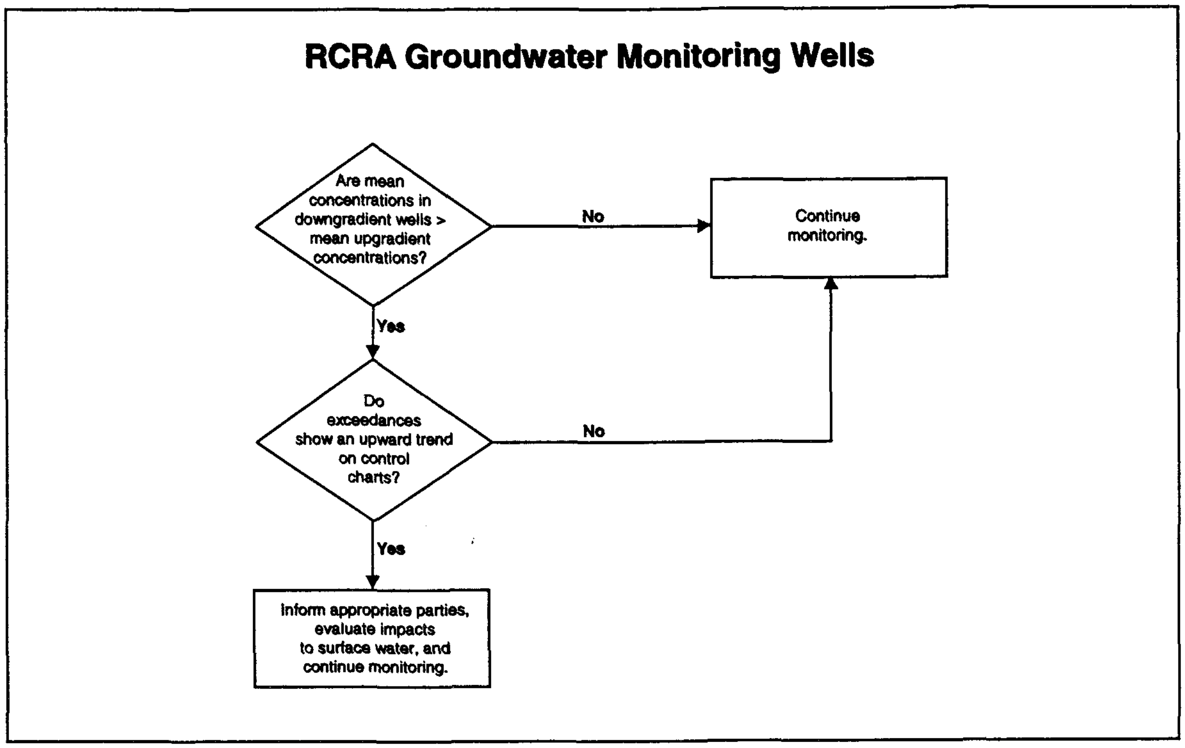
Logic:



AND	Concentrations at any downgradient well increase with time
THEN	Report to appropriate agencies and investigate possible causes
ELSE	Continue monitoring.

3.4.3 Data Quality Objectives for Monitoring Groundwater Flow

Groundwater quantity and the magnitude and direction of groundwater flow are necessary to assess the effects of Site operations on surface water quality and to design effective remedial actions (if such are needed). Compiling water level information from wells supports the following analyses:

- Assessment of the impact of contaminant plumes on surface water quality through the creation of potentiometric surfaces from which horizontal hydraulic gradient and flow path can be derived;
- Development of groundwater flow and transport models to assess the effect of groundwater contamination on surface water in the event that an action level is exceeded;

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- Evaluation of impacts to downgradient habitat and endangered species caused by changes to groundwater quantity and associated fluvial systems as a result of Site remediation activities.
- Estimation of direction and rate of plume migration and the volumes of contaminated groundwater for use in treatment feasibility scenarios.

3.4.3.1 Site-wide Flow Monitoring

Problem Statement:

Do Site remediation activities that adversely affect the quantity, velocity, and direction of Site-wide groundwater flow also adversely affect downgradient habitats, or surface water quality and quantity?

Problem Scope:

The three flow-monitoring components described below will provide groundwater flow information on a well-by-well basis. To fully evaluate the Site regional groundwater flow regime, monitoring must be spatially distributed to define a potentiometric surface so that maps of this surface can be produced. These potentiometric surface maps can then be used to determine groundwater volume and the velocity and direction of groundwater flow. Water level will be measured more frequently on the perimeter of the Industrial Area where flow information is critical. Wells in areas where groundwater flow is believed to be relatively slow will be monitored at least semiannually. This semiannual flow data will be collected during high recharge and low recharge periods of the year (generally spring and fall).

Inputs:

- Water level measurements.
- Frequency of action level sampling.
- Historic water level data.
- Meteorological data.

Boundaries:

Spatial: Decisions will be made on a regional basis.

Temporal: Data will be reviewed annually and decisions will be made on an annual basis.

Decision Statement:

IF Groundwater elevations show significant changes in an area with time

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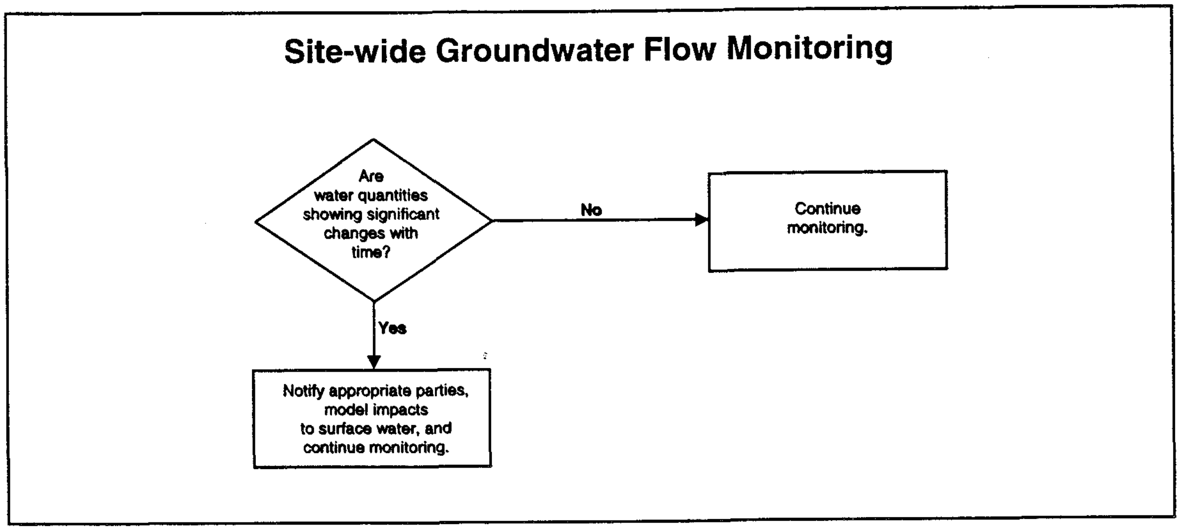
THEN Notify appropriate parties and evaluate impacts to surface water quality and quantity

ELSE Continue taking measurements.

Logic:



The Site-wide groundwater flow monitoring program has three components. Each component provides information that supports the programmatic goals. The three components are as follows:

- Water Quality Flow Monitoring, which supports interpretation of water quality data in determining impacts to surface water;
- Industrial Area Flow Monitoring, which supports interpretation of changes to the groundwater flow regime leaving the Industrial Area to surface water resulting from remediation activities; and
- Background Flow Monitoring, which supports interpretation of changes in the contribution of groundwater to surface water resulting from Site remediation activities by monitoring natural and off-Site impacts.

3.4.3.2 Water Quality Flow Monitoring

Problem Statement:

Do changes in the water level and gradient of groundwater affect surface water quality and flow regime?

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Problem Scope:

The alluvial water table responds to seasonal and event-related changes in recharge. Interpretations of the fate and transport of contaminants depend on knowledge of the hydraulic gradient and saturated thickness of the aquifer. The frequency of water level measurements should be sufficient to establish useable hydrographs so that the effects of water table fluctuations can be correlated with water quality data. Because water quality sampling frequency is increased when action levels are exceeded, water level frequency should be increased to match the sampling frequency.

Inputs:

Water level measurements.

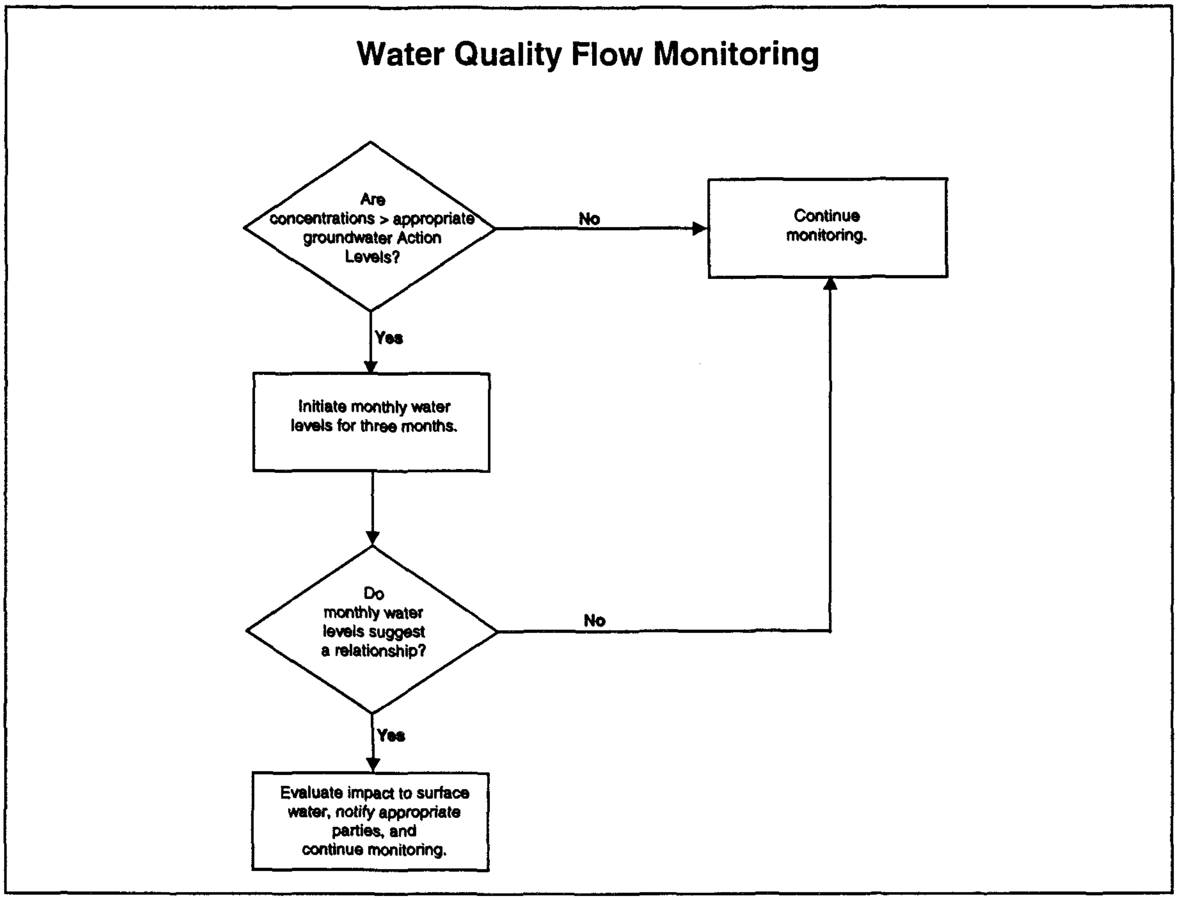
Boundaries:

Spatial:	Decisions will be made on a well head basis.
Temporal:	Data will be reviewed quarterly and decisions will be made annually.

Decision Statement:

IF	Action levels have been exceeded in the well,
THEN	Adjust water level frequency to mirror water quality sampling frequency,
AND	Evaluate impacts to determine whether a remedial or management action is necessary.
ELSE	Continue water level measurement at regular frequency.

Logic:



3.4.3.3 Industrial Area Flow Monitoring

Problem Statement:

Do remedial activities affect the groundwater flow regime surrounding the Industrial Area, and what impact to these changes have on surface water quality and quantity?

Problem Scope:

The alluvial water table responds to both seasonal and event-related changes in recharge. To understand how remediation activities affect contaminant migration, surface water quality and quantity, and wetlands, the hydraulic gradient and saturated thickness of the aquifer must be known. Because source wells in the Industrial Area are now monitored less frequently, the level of resolution of groundwater flow is too low to predict the effect of Site activities on groundwater migration. The frequency of measurements should be increased to a level sufficient to track the effects of remedial actions in the Industiral Area.

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Inputs:

- Water level measurements.
- Historic water level data.

Boundaries:

Spatial: Decisions will be made on a well head basis, but high resolution maps are also needed involving all Industrial Area wells that are monitored.

Temporal: Data will be reviewed quarterly and decisions will be made annually.

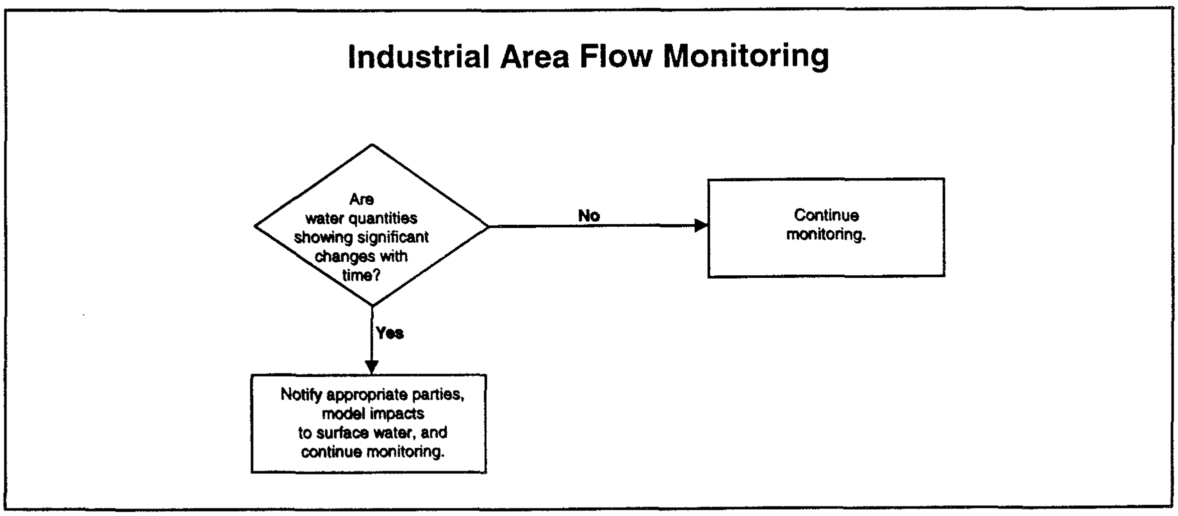
Decision Statement:

IF Groundwater levels show significant change with time

THEN Notify appropriate parties and model effects on surface water quality and quantity using background water level data as appropriate

ELSE Continue taking measurements.

Logic:



3.4.3.4 Background Groundwater Flow Monitoring

Problem Statement:

Are effects on surface water due to Site activities or natural climatic processes?

Problem Scope:

Background quantity, velocity, and direction of groundwater flow must be measured so that the effects of natural climatic or off-Site variations can be filtered out of the evaluations of the effects of Site actions on groundwater.

Inputs:

- Water level measurements.
- Event monitoring water level measurements.
- Meteorological data.

Boundaries:

Spatial: Decisions will be made on an individual well basis.

Temporal: *Data will be reviewed quarterly and decisions will be made annually.*

Decision Statement:

IF Site-wide groundwater elevations show significant changes with time that might cause significant impact surface water quantity

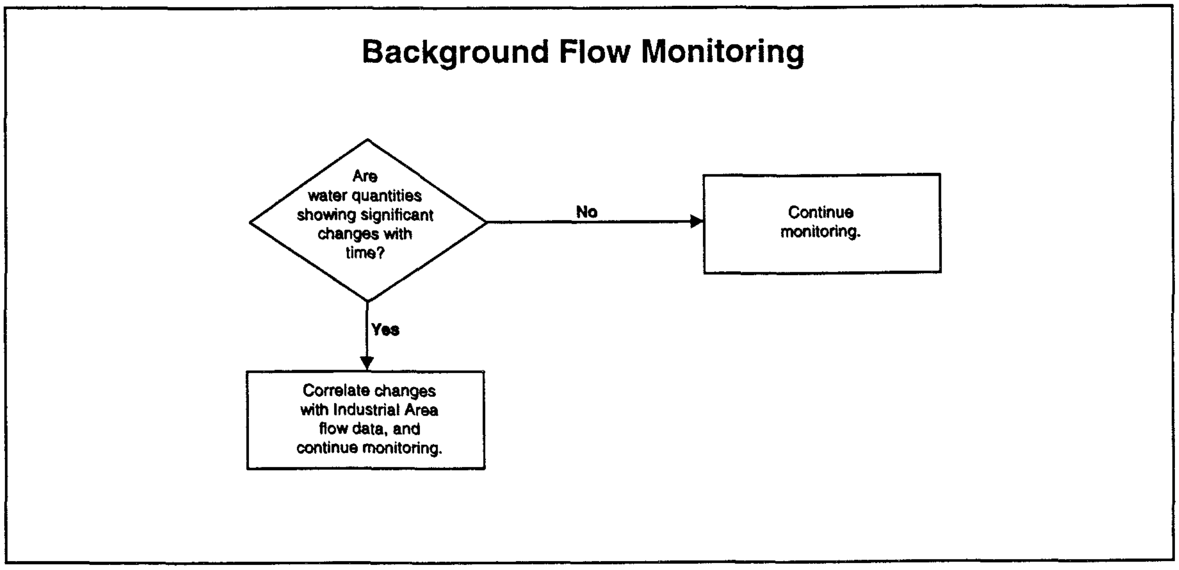
THEN Evaluate changes in groundwater flow measurements with respect to background flow

ELSE Continue monitoring.

3.4.4 Monitoring Frequencies to Meet DQOs

Hydrogeologic interpretation of the sampling media and statistical treatment of existing data sets determine the sample frequency required to meet the DQOs. Sampling frequency should reflect both the velocity that groundwater is moving through the aquifer and professional judgement. Aquifer tests conducted on wells at the Site have provided general estimates of flow velocity in geologic formations.

Logic:



Appendix C to this section gives relative hydraulic conductivities for groundwater in the various geologic units on Site. Groundwater flow in the Rocky Flats Alluvium and colluvium, which are the dominant components of the UHSU, averages 100 to 200 feet per year. Given these rates, a sampling frequency of twice a year would be able to detect a 50- to 100-foot excursion of contaminants. Because most monitoring wells are located 500 to 1,000 feet from major drainages, detection at this frequency would provide adequate time to evaluate and remediate a moving contaminant plume.

The historic variability of groundwater monitoring data can be used to help determine whether a particular sample represents actual changes in the concentration of contaminants. The EPA's Decision Error Feasibility Trials (DEFT) Program can be used to evaluate the expected performance of various sample frequencies based on DQO constraints, assuming that the decision will be based on a comparison of a mean value to an action level. Using two kinds of data (historical data for several wells to obtain estimates of variability, and preliminary limits on decision errors developed during the DQO process) suggests that two to four samples per year adequately determine exceedances of the RFCA action levels. These preliminary investigations, therefore, support the biannual sampling scheme that is proposed.

3.5 Quality Control Objectives for Collection/Evaluation of Groundwater Data

DOE Order 5400.1 (General Environmental Protection Program) requires that a QA program be developed consistent with DOE Order 5700.6C (Quality Assurance). The program must cover all environmental activities and describe the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. General requirements for the Groundwater Monitoring Program activities are covered under the

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RMRS Quality Assurance Program Description (QAPD) and associated operating procedures (OPs).

The Site management structure showing organizational responsibilities is illustrated in Figure 3-2. The organization has been structured to maintain quality for the duration of the program. Conformance to the applicable plan, operating procedures, and established requirements will be verified by personnel not directly responsible for performing the work. Issues identified during implementation of the plan will be tracked and closed out through the Site-wide Commitments Management Program (SCMP). Data (operating procedure forms, logbooks, analytical results, and other quality related information as deemed) will be managed in accordance to the Environmental Restoration Management Administrative Procedure RM-06.02, which governs records capture and transmittal, as described in the RFEDS data management plan. Work-controlling documents are controlled per Operating Procedure ERM Administrative Procedure 2-G01-ER-ADM-06.01 which governs document control.

The RMRS QAPD requires quality control for the collection and analysis of environmental samples. The major requirements include the following:

- Developing DQOs;
- Collecting and analyzing samples according to approved procedures; and
- Reducing and reporting data in a controlled manner.

Data quality objectives, sampling design and analysis, and ultimate conclusions about groundwater at the Site are based on judgmental sampling (13) and consensus decision making (among, for example, RMRS, Kaiser-Hill, DOE, RFFO, CDPHE, and EPA Region 8). DQOs, conclusions, and decisions are documented through reports, memos, and meeting minutes.

The following documents provide guidance to quality assurance at the Site:

- *The Data Quality Objectives Process* (14); EPA QA/G-4.
- *Data Quality Objectives for Remedial Response Activities Development Process* (15); EPA/540/G-87/003.
- *Guidance for Data Useability in Risk Assessment* (16); EPA/540/G-90/008.
- *Rocky Flats Plant Data Management Plan for Environmental Restoration Management Program* (17); RFP/ER-MP-93-006.
- *Evaluation of Environmental Restoration Management Data for Usability in Final Reports* (18); 2-G32-ER-ADM-08.02 *Rev. 0.*

For nonroutine groundwater investigation activities, the types of data, level of detail, and the data quality needed are determined by the DQOs specified for each data collection activity. OU- or

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IHSS-specific remedial investigations require DQOs with the primary goal of risk assessment and remediation. OU- and IHSS-specific DQOs are established in the work plan or in quality assurance addenda for that project.

For those data collection activities where project-specific DQOs are not developed, general groundwater DQO guidance is as follows:

- For precision, field duplicates will be collected at a rate of 5% (one in 20 samples), with a relative percent difference not to exceed 30%.
- For accuracy, the analytical method and detection or quantitation limits used for each groundwater analyte will be those specified in the Analytical Services Division, Statement of Work for Analytical Measurement (19), or provided with the instruments in the case of field measurements. Justification for deviation from the project-specific plan must be provided, along with a determination of whether the actual number of samples collected will be adequate for the end use. Laboratory analyses will be independently validated at 25% of the sample population, unless otherwise specified.
- For representativeness, the actual sample types and quantities collected are compared with those planned for the project. Justification for deviation from the project plan must be provided, as must a determination that the actual number of samples collected will be adequate for the end use.
- For completeness, 90% of the groundwater samples and associated quality control samples planned for the groundwater monitoring program must be collected.
- Field quality control samples will be collected at the rate of 5% (one in 20 samples) for equipment rinsates and preservation blanks, and will be compared to the real sample using EPA's 5%/10% criterion. Ambient-condition blanks are important when groundwater is sampled in areas close to possible sources of volatile organic contamination, such as areas with gasoline engines operating.

3.5.1 Field Data Collection

Quality control objectives for the collection of field parameters and representative samples of groundwater are established to ensure that data are of sufficient quality to support the decisions identified in the previous section.

The quality control objectives for field data collection are the following:

- Sampled water represents formation water;
- Sampling techniques do not introduce contaminants to samples or wells;
- All sampling techniques are standardized to ensure reproducibility and comparability of results; and

- Water elevations are measured precisely enough to detect minor fluctuations in the water table.

3.5.1.1 Representative Samples

All sampling devices are designed to collect representative samples that reflect actual formation conditions. Well productivity is also a factor since some alluvial and bedrock formations at the Site produce so little water that they dewater while purging. Recharge water becomes aerated while cascading along the inner wall of the well casing, which may alter the chemistry of the collected water. Therefore, specific recharge volumes and sampling times have been established that produce samples most closely representing formation conditions.

In addition, micropurging will be used in wells where there is sufficient sample volume to use a dedicated bladder pump. Micropurging collects the sample at a slow enough rate so that turbulence is reduced and limited drawdown is maintained in the well. Use of the dedicated pump also limits the aeration of the sample before it is placed in the sample bottle.

3.5.1.2 Minimization of Contamination During Sampling

Operating procedures are written to ensure that proper techniques are used to collect samples. The groundwater series of OPs describes sampling techniques that minimize operator-induced contamination. All downwell sampling equipment is made of inert materials. Techniques for the use and decontamination of this equipment ensure a high level of sample integrity and minimize the potential for cross-contamination of samples or contamination of any well with foreign materials. One rinsate sample is collected for every 20 wells sampled. These analyses are routinely checked to ensure that sample equipment does not cross-contaminate wells.

3.5.1.3 Standardization of Sampling Techniques

Standardization of sampling methodology is ensured by Site standard OPs. These OPs ensure consistency and standardization of sample collection, data entry, field parameter measurements, sample packaging and shipping, and equipment decontamination. Procedures are updated regularly to reflect any changes to the methodology of sample collection, and distribution of procedures is controlled to ensure that work is performed to the most current version of the procedure.

The RMRS/ER OPs (20, 21, 22) that are required to perform the groundwater monitoring tasks have been approved by CDPHE and EPA. Adherence to the directions set forth in these OPs for field operations (FO), groundwater (GW), and geotechnical (GT) activities should produce data that are representative of groundwater quality, comparable from well to well, and reproducible for any given well at the Site.

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The collection of groundwater from a new location involves the planning, permitting, and installation of an engineered well. OPs are used at the Site for siting, installing, and sampling wells containing groundwater (20, 21, 22). The applicable OPs are partitioned into three groups (A, B, and C) (Table 3-1) and generally arranged in order of performance. Several of the OPs will be followed more than once (e.g., transmittal of field QA records following completion of a documentable field technical procedure).

All field sampling crews are trained in the techniques described in the OPs, and standardized equipment is used during the sampling events. This uniformity of sampling crews eliminates sampling variability, and samples collected during any quarter can be compared without concern about field inconsistencies.

Adherence to procedures is ensured by both self-assessment audits by project management and formalized audits by the Site Health, Safety, and Quality Organization.

One field duplicate sample is collected for every 20 wells sampled. Field duplicates are used to assess the consistency of sample collection techniques.

3.5.2 Accuracy of Water Level Measurement

Water elevations are taken in accordance with OP GW.1, Water Level Measurements (21). Water level measurements are taken by each member of the sampling crew and compared. In addition, total depth of the well is measured to determine whether sediment has collected in the bottom of the well. Wells that contain large amounts of sediment are targeted for redevelopment. Event-related water level measurements may be collected with a continuous data electronic logging device.

3.5.3 Laboratory Analysis

Standardization of laboratory analysis is established through the Analytical Services Division Statement of Work for Analytical Measurement, which presents the approved analytical methods, holding times, detection limits, and reporting procedures for laboratories performing analytical work (19). Standardization of analytical results allows information generated from different laboratories to be used interchangeably for decision making.

General chemistry samples are typically sent to laboratories approved by the EPA Contract Laboratory Program (CLP). Radiochemistry samples are sent to labs that are licensed to analyze for radionuclides. Groundwater samples are analyzed at prequalified analytical laboratories both on and off the Site. The QA/QC for any non-CLP and non-radiochemistry samples parallels CLP protocol to include continuous equipment calibrations and method blanks for every one in ten samples. The CLP-type analysis is outlined in Section 2.4 of the Analytical Services Division Statement of Work for Analytical Measurement (19). The Analytical Projects Organization

Table 3-1
Operating Procedures for Planning, Installing and Sampling a Groundwater Monitoring Well

A. Planning

OP No.	Procedure
GT.6	Monitoring Well and Piezometer Installation
GT.18	Surface Geophysical Surveys
GT.10	Borehole Clearing
FO.16	Field Radiological Measurements
GT.24	Approval Process for Construction Activities on or Near Individual Hazardous Substance Sites

B. Installation

OP No.	Procedure
FO.4	Heavy Equipment Decontamination
FO.12	Decontamination Facility Operations
FO.11	Field Communications
GW.5	Field Measurement of Groundwater
GT.2	Drilling and Sampling Using Hollow-Stem Auger Techniques
GT.4	Rotary Drilling and Rock Coring
FO.14	Field Data Management
FO.7	Handling of Decontamination Water and Wash Water
FO.6	Handling of Personal Protective Equipment
GT.3	Isolating Bedrock from Alluvium with Grouted Surface Casing
GT.6	Monitoring Well and Piezometer Installation
GW.2	Well Development
FO.8	Handling of Drilling Fluids and Cuttings
FO.10	Receiving, Labeling, and Handling Environmental Materials Containers
FO.23	Management of Soil and Sediment Investigative Derived Material (IDM)
FO.2	Transmittal of Field Quality Assurance Records
GT.1	Logging Alluvial and Bedrock Material
GT.11	Plugging and Abandonment of Wells
GT.15	Geopysical Borehole Logging
GT.39	Push Subsurface Soil Sampling

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Table 3-1

(continued)

C. Sampling

OP No.	Procedure
FO.15	Photoionization Detectors (PIDs) and Flame Ionization Detectors (FIDs)
GW.1	Water Level Measurements in Wells and Piezometers
GW.6	Groundwater Sampling
FO.5	Handling of Purge and Development Water
FO.3	General Equipment Decontamination
FO.13	Containerizing, Preserving, Handling, and Shipping of Soil and Water Samples
FO.25	Shipping Limited Quantities of Radioactive Materials in Samples

(APO) audits laboratories that analyze the Site groundwater samples. The RFEDS ensures that data are complete and accurate as they are archived into the database by performing automated error checks of the electronic laboratory deliverables. One hundred percent of all analytical data currently undergo a verification review by Analytical Services. At a minimum, 25% of the analytical data produced receives an independent laboratory validation by a subcontractor. This percentage may be reduced in the future to a statistically significant percentage, upon approval of the regulatory agencies.

3.5.4 Data Management

All field data and laboratory analyses performed for groundwater monitoring are maintained in the RFEDS. This is a relational database that holds all groundwater, surface water, soil, and borehole data collected on Site. All data analysis and reporting are done with data extracted from RFEDS.

RFEDS uses Oracle® software for data management and retrieval. It compiles water quality data, field parameter data, sample tracking data, and water level data for groundwater, surface water, boreholes, soils, and sediment samples. Field parameter data (sample location, sample date, pH, turbidity, conductivity, and temperature) are included as are groundwater level measurements and chemical information (Chemical Abstracts Service [CAS] registry numbers, analytical results, and detection limits). Specific procedures for verification of database information received from subcontractors, or input directly into RFEDS, have been developed and are being implemented. These procedures provide QA documentation that ensures that all available data have been incorporated and entered or uploaded properly into RFEDS. Data integrity is maintained with standard OPs and standardized error checking routines used when loading data into RFEDS. Other procedures are being developed for database system security and software change control.

The field data gathered on Site is entered through the DATACAP field data entry system. This system is a data entry module that is compatible with the RFEDS database, and can be used in remote field locations by field personnel. Data entered into DATACAP is verified and signed off by the subcontractor before it is delivered to the main RFEDS database.

Spatial information for groundwater is located in the RMRS/ER geographic information system (GIS) system. This system uses ARC/INFO® software to store and present locational data for well locations, potentiometric surfaces, plume configurations, topographic contours, and Site facilities.

All well and borehole log information is maintained in the Geoscience Group's Logger Database. The Logger database has graphic logs of all boreholes and wells on Site, and displays well construction details and geologic information. Subsurface geologic correlations are displayed using Earth Vision® Software.

3.5.5 Groundwater Assessment and Reporting

Part of the data assessment process is to establish that data are of the requisite precision, accuracy, representativeness, comparability, and completeness (PARCC parameters) to give accurate evaluations for decision making (data usability). Definitions of the PARCC parameters and further information on the establishment of project-specific DQOs are found in the preceding sections.

3.6 Description of the Groundwater Monitoring Program Resulting from the DQO Process

Groundwater monitoring is an essential function of surface water protection at the Site, since the majority of groundwater becomes surface water within the Site boundaries. The overall objective is to identify contaminated groundwater and associated pathways to surface water, and protect those resources from further or potential damage. The goal is to assess the quality and quantity of groundwater resources in the vicinity of the Site to enable proper management of those resources.

Elements of the program include measurement of hazardous constituent concentrations in groundwater, determination of the gradient and direction of groundwater flow, and assessment of the nature and extent of any contaminant plumes in the UHSU within the Site boundaries. The monitoring network is designed to monitor areas of known or suspected groundwater contamination based on composite groundwater plume information and OU-specific source characterization activities. Composite plume maps are presented in Plate 3.

The monitoring well network should undergo constant evaluation to determine the most effective approach to monitoring groundwater at the Site. This evaluation should take into account current regulations and agreements, but, more important, it should integrate new data and technical information on the nature and extent of Site contamination.

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The proposed monitoring program comprises the following monitoring components:

- A network of 89 wells sampled on a semiannual basis;
- Monthly measurement of water elevations at 77 wells;
- Quarterly measurement of water elevations at 59 wells;
- Semiannual measurement of water elevations at 157 wells;
- Real-time measurement of water elevations in 25 wells;
- A program plan for updating and proposing changes to the groundwater monitoring program;
- Annual evaluation and reporting to the appropriate regulatory and community agencies;
- Quarterly reporting of groundwater data that exceed action levels;
- A groundwater modeling capability;
- A well control program;
- A well abandonment, replacement, and maintenance program; and
- Other special projects pertinent to groundwater assessment.

The groundwater monitoring network at the Site comprises the following seven categories of monitoring wells:

- Plume definition;
- Plume extent;
- Drainage;
- Boundary;
- Performance;
- D&D; and
- RCRA.

Well categories and wells of the groundwater monitoring network are described in Appendix E of this section (Well List).

3.6.1 Groundwater Monitoring Network

The current DQO evaluation process has prompted a review of the groundwater monitoring program and the determination of specific decisions for each well that is monitored. The general premise is that each well should provide data for a decision or action that is prompted when set criteria are met. At present, groundwater monitoring data are acted on only when they exceed specified action levels for analytes listed in the RFCA ALF document. The list of regulated analytes in RFCA is extensive. Historic data have been used to determine which contaminants are of major concern in Site groundwater. Table D-1 summarizes the chemicals of concern associated with the various groundwater plumes described in Appendix D of this section. The analyte suites tested for in water from current monitoring wells include the identified chemicals of concern.

The RFCA analyte lists for groundwater use concentration levels that may differ from the Site-specific levels used in the past. Major contaminants of concern were determined after reviews of historic groundwater data. The inorganic and radionuclide data for each well were initially screened against background concentrations using the 99/99 Upper Tolerance Limits reported in the Background Characterization Report (23). The data were then screened against the action levels in the ALF and exceedances were noted for each well. Table D-1 shows the results of this data screening and was used to determine the analyte suite for the wells in the program. The wells were then associated with the IHSS or plume source area where the groundwater contamination originated. Areas were delineated based on the known plumes and potential area of influence for those plumes. Area-specific monitoring suites were then derived. Appendix E to this section contains the analyte suites that will be collected for each well.

3.6.2 Sampling and Analysis

The operational groundwater sampling network will contain 89 wells, the majority of which will monitor the extent of various contaminant plumes. Appendix E lists the wells in the monitoring program along with their well classification. Appendix E also lists the sampling frequency for wells in the program. A semiannual schedule of sampling and analysis of water quality in Site wells has been chosen to generate data representative of the various groundwater conditions and to ensure compliance with applicable groundwater regulations. The frequency of sampling wells used for other purposes (such as performance monitoring and D&D monitoring) will be derived from compliance documents, agreements, or controlled work plans.

A data collection schedule will be adopted for the sampling network. This will ensure that samples for any particular well are collected as closely as possible to semiannual intervals. The schedule is used as a guide (except as required by specific regulations) and may be modified as needed to account for unplanned changes that occur during the sampling quarter.

The following are guidelines for the collection of groundwater samples:

- Filtered samples will be collected for metals analyses and uranium isotopes; unfiltered samples will be collected for organics analyses, water quality, and all other radionuclides.

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- Well-site field parameters measured are temperature, pH, specific conductance, turbidity, and alkalinity. Total dissolved solids will be measured as a laboratory parameter.
- If limited groundwater sample volumes prevent analysis of the entire analyte list, the analyses will be performed in the following order in accordance with RMRS/ER OP GW.6 Groundwater Sampling (20):

1. CLP Method 524.2 VOCs;
2. Semivolatile organic compounds (SVOCs);
3. Pesticides/polychlorinated biphenyls (PCBs);
4. Nitrate/nitrite, as nitrogen;
5. Radiation screen;
6. Metals—TAL, with cesium, lithium, strontium, tin, molybdenum, and silica;
7. Specific metals—list of metals specific to a given well;
8. Uranium-233/234, -235, -238;
9. Strontium-89/90;
10. Plutonium-239/240, americium-241;
11. Major anions (chloride, fluoride, sulfate, carbonate/bicarbonate); and
12. Tritium.

This order in which analyses are to be performed may be altered to fit specific characterization or statistical needs or work plan specifications.

3.6.3 Measurement of Groundwater Elevations

Preparation of water elevation maps and hydrographs addresses both a regulatory requirement and a technical need to know groundwater flow directions and gradients accurately. The measurement of groundwater elevations has been designed to produce data that are as representative of current conditions as possible. These water level measurements are collected within 10 working days of the period designated for measurement, so that the data are as temporally related as possible.

Based on the DQO for each activity, Appendix E lists the frequency of water level measurement proposed for the components of the Site-wide Groundwater Flow Monitoring Program.

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3.6.4 Groundwater Reporting

Groundwater activities will be reported throughout the life of the Site monitoring program. Reports will be transmitted to EPA and CDPHE as the responsible parties listed in the DQO decision statements in Section 3.4.2, after review and approval by DOE.

The following basic reporting vehicles are required for the groundwater program based on the integration of past regulatory requirements with the RFCA ALF.

3.6.4.1 Annual Report

An annual assessment of groundwater conditions is required in the DQO decisions in this document, the Industrial Area IM/IRA, and in the regulations governing RCRA interim status units and municipal landfills (6 CCR 1007 - 2 & 3). Therefore, this report will incorporate the data elements that were historically reported in the RCRA Annual Groundwater Report, Well Evaluation Reports, and IM/IRA reports. This annual report will replace these latter reports and will be the primary compliance report for groundwater monitoring. This integrated report will contain the following elements:

- A general description of the various monitoring program elements, including any new monitoring or sampling activities.
- Interpretation of the geochemical data generated from the year's sampling with respect to action levels and trends that may show contaminant movement. Where documented exceedances exist, the report will evaluate the need for further actions and propose those activities.
- Interpretation of the Site groundwater flow-through analysis of water level data collected by use of hydrographs, potentiometric surface maps, and modeling, where appropriate.
- Recommendations for improvements to the monitoring program that may include changes in the well network, analytes collected, and sampling frequency.

In general, reports on potential exceedances for wells will use the following methodology:

Plume Definition Wells:

- Data will first be compared with Tier I Action Levels for groundwater. If an action level has been exceeded for any analyte that has an action level, data will then be compared with background values using the mean + 2 standard deviations established in the 1993 Background Characterization Report (23).

- If both the action level and background levels have been exceeded for an analyte that has not had consistant historic exceedances, an evaluation will be proposed.

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Remediation and/or management decisions will be made based on the results of the evaluation.

- If a particular contaminant has been detected consistently above the Tier I Action Level in historic data, then the result will be plotted against historic data set for that analyte and that well. If the analytical results show an increasing trend in concentration over a two-year period with respect to the historic data set, then an evaluation will be proposed and remedial priority established.

For purposes of data analysis the historic data set is defined as the data generated for a particular well from the years 1991-1995. If a well does not have this data set, or is a newer well, the historic data set will be all data generated for the well until a five-year data set is reached.

Plume Extent, Tier II, Drainage, and Boundary Wells:

- Data will be compared with Tier II Action Levels for groundwater. If an action level has been exceeded for an analyte, data will then be compared with background values using the mean + 2 standard deviations, established in the 1993 Background Characterization Report (23).

- If both the action level and background level have been exceeded by an analyte that has not had consistent historic exceedances, monthly sampling will be performed per RFCA. An evaluation will be proposed to determine the impact to surface water. Remediation and/or management decisions will be made based on the results of the evaluation.

- If a particular analyte has been detected consistently above the Tier II Action Level and background in historic data, a check will be made to see if an evaluation of impact to surface water has been performed. If no evaluation has been performed, an evaluation will be proposed. If an evaluation has been performed, then future monitoring results will be tested against a historic data set of values for that analyte and that well. If the result is higher than the background mean + 2 standard deviations with respect to the historic data set, then another evaluation will be proposed to assess impacts to surface water.

Building D&D Monitoring Wells:

- Performance wells may be existing monitoring wells or special wells installed to detect any unplanned excursion of contaminants during a building D&D activity. Where there is a groundwater concern, a baseline should be established for water quality before D&D activities begin. The baseline should be established one year prior to the D&D action. After the baseline is established, any exceedances above the baseline mean + 2 standard deviations will be reported. Trend plots may be used to track concentrations where exceedances are determined. The results of building specific decisions may also be addressed in the Industrial Area IM/IRA annual report.

Performance Monitoring Wells:

- Performance wells may be existing monitoring wells or special wells installed to measure the effectiveness of a source removal or plume treatment system. In each case, it is assumed that the wells that will be used already exceed Tier I or Tier II Action Levels. Therefore, the trend in concentration with time is the best measure of performance. Trend plots will be constructed to track whether contaminant concentrations change with time. A performance monitoring activity may also be described in separate closure documents for that source area.

RCRA Monitoring Wells:

- The reporting of monitoring wells used for a permitted RCRA facility are prescribed in the state and federal regulations. Reporting will follow the requirements of these regulations and associated guidance documents. The results of unit-specific monitoring requirements may also be addressed in specific annual reports. An example of this is the annual report for the Existing Landfill.

The annual report will provide the results of monitoring on a calendar year basis. The annual report will be submitted to the DOE at the end of the fiscal year in which the calendar year ended. This date is typically September 30. DOE will review and transmit the report to the regulatory agencies by November 15.

3.6.4.2 RFCA Quarterly Reporting

Quarterly reporting of groundwater analyses is currently required for 1) RCRA interim status units, 2) the boundary wells under the Agreement in Principal, and 3) the French Drain Monitoring Wells under the IM/IRA for the French Drain, and an RFCA ALF document.

The RFCA quarterly report for groundwater will replace all previous quarterly reports and integrate all the various reporting elements into a standardized evaluation, using the action levels as a means of assessing results. The report will summarize the data collected and any exceedances of standards that have occurred using the methods outlined in the previous section. Because semiannual sampling is proposed, the quarterly reports will present only those data that have been analyzed and uploaded into RFEDS in time for the report. The report for any calendar quarter will be compiled 60 working days after the end of the quarter to allow time for laboratory analysis, data upload, and evaluation. The reports will be issued and presented at the next Quarterly Information Exchange Meeting following the 60-day compilation period. Summary results from the data evaluation will be submitted to DOE, EPA, and CDPHE one week prior to the Quarterly Information Exchange Meeting.

3.6.5 Evaluation of Groundwater Impacts To Surface Water

Many of the DQO decisions for groundwater monitoring require that the effect of potential groundwater contamination on surface water be evaluated. In many cases, when groundwater action levels are exceeded, confirmatory samples will be taken. If analyses of follow-up samples confirm an exceedance, or if historic data indicate an impact to surface water that has not been evaluated, an evaluation will be performed. In general, the evaluation phase will result in a focused data quality objective that will determine two things: The type of data that needs to be collected, and the methodology for determining the nature and extent of contamination and its effect on surface water. The following are possible components of an evaluation of surface water impact:

- Definition of degree of contaminants through additional sampling of soil, groundwater, surface water, or seeps;
- Definition of areal extent of the contaminant pathway through additional well or borehole installations;
- Establishment of discharge, flow velocity, and direction for groundwater or surface water;
- Determination of concentration loadings and mass flux of contaminants to the stream; and
- Estimation of the effects of seasonal variations, discharges, or removal of groundwater collection systems.

It is understood that each evaluation will have a unique DQO that will consider such factors as relative impact, priority, and risk to the public. This approach will insure that the available budget will be allocated to sites with the highest potential for contamination. Once a significant impact to surface water has been established, the findings will be used to establish or update priorities for remediation. At that point, the investigation will be promulgated as an accelerated action or an IM/IRA. Where action levels have been exceeded, the ALF section in RFCA that deals with Tier II wells requires modeling of impacts to surface water through mass balancing and flux calculations. It is assumed that these predictive components of the evaluation will be weighed against actual field data in setting the priority for remediation.

3.6.6 Groundwater Flow Modeling

Computer modeling of the groundwater system at the Site is a valuable tool for characterizing the groundwater flow regime and determining the fate of potential contaminants introduced into the groundwater system. The primary purpose of groundwater modeling is to integrate geologic, hydrogeologic, and geochemical characterization data into numerical representations of the groundwater system. These models provide predictive capabilities that can be used to analyze and design a groundwater monitoring network, and to evaluate how groundwater affects surface water.

This plan proposes that the current groundwater flow model and supporting software and graphic coverages should be maintained and updated; they are used in problem-solving and tracking how Site closure activities affect the environment. The activity would update and maintain the input grids and coverages for modeling so that real-time simulations can be run when potential impacts to the environment are discovered. Numeric modeling will be used if it is established that the project merits a numeric solution. This will be decided during the DQO development phase of the evaluation.

An annual status report for the maintenance and update of the groundwater flow model, including the results of any modeling performed, will be incorporated into the RFCA Annual Report.

3.6.7 Well Control Program

The Well Control Program is currently a Site Level 1 administrative procedure for new well and piezometer installations (24). The procedure is implemented through the RMRS/ER Groundwater Group. The Well Control Program ensures that proper recording and tracking of all well installation activities on Site are done, and serves as a necessary approval process for the installation of wells. The program will support the following activities:

- Assigning well location codes to eliminate misidentification of wells or use of redundant well names.
- Maintaining a database with summary well information to be used for evaluation of the functions of new wells, and preparing and obtaining well permits as required by 2 CCR 402-2 regulations (25). The instructions and form are available in the EMD OP GT.6 1994 revision (20).
- Maintaining a database of well construction information and geologic log information that must be submitted with the permit applications.
- Submitting to the State Engineer's Office permits for wells that are installed or abandoned.
- Maintaining the Site geologic core repository for use in correlation of geologic strata and interpretation of hydrogeologic properties.
- Through an approval process before well construction, insuring that wells are installed following applicable procedures and with appropriate knowledge of geologic and Site conditions.

3.6.8 Well Abandonment and Replacement

In certain cases, the usefulness of a groundwater monitoring well is exceeded by its potential liability. Such wells should be considered for abandonment or, in certain cases, replacement. Abandoning a well eliminates it from the monitoring network in such a manner that the well will

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not remain a conduit for groundwater or contaminant migration. Installation and monitoring procedures have been established to minimize the need for abandonments. However, well abandonment is a necessary component of the Groundwater Monitoring Program. Damaged wells must also be abandoned.

This IMP proposes that proper abandonment of wells be required under the following circumstances:

- When the potential for cross-contamination from the well exists;
- When the well is poorly constructed or of unknown construction;
- When the well is in the way of proposed construction or demolition activities; and
- When the well has been damaged.

A report describing the results of the Well Abandonment and Replacement Program including well installations, abandonments and replacements will be included as a section in the RFCA Annual Report.

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APPENDIX A

Site Description and Environmental History

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A.1 Site Description

Rocky Flats Environmental Technology Site (RFETS or the Site) is located 16 miles northwest of Denver in Jefferson County, Colorado, and is situated within a 50-mile radius of 2.1 million people. The Site encompasses approximately 6,550 acres of federally-owned land (Figure A-1). Ownership, however, does not include surface and subsurface minerals or water rights. The Site is a U.S. government-owned and contractor-operated facility. Site construction was initiated in 1951 and operations began in 1952 (1).

RFETS was part of the nationwide nuclear weapons research, development, and production complex governed by its original mission. The plant produced metal components for nuclear weapons from plutonium (Pu), uranium (U), beryllium (Be), and stainless steel. Other production activities included chemical recovery and purification of recyclable transuranic radionuclides, metal fabrication and assembly, and related quality control functions. The plant conducted research and development programs in metallurgy, machining, nondestructive testing, coatings, remote engineering, chemistry, and physics. Parts manufactured at the Site were shipped off Site for final assembly.

Major plant structures, including all production buildings, are located within a 400-acre Industrial Area (Figure A-2), with a 6,150-acre Buffer Zone that surrounds the IA. Industrial activity immediately adjoining the Site includes present and/or prior coal and clay mining, petroleum recovery, natural classified-aggregate quarrying, and fabricated-aggregate mining. Other activities include cattle ranching and wind energy research. Several irrigation ditches intersect the Site, transmitting water for downstream agricultural, industrial, and municipal purposes. Three ephemeral streams drain the Site and flow eastward.

The Site operations have generated solid and liquid nonhazardous, hazardous, radioactive, and mixed (hazardous and radioactive) waste streams. These wastes have been handled and disposed of in a variety of ways. Solid nonhazardous and nonradioactive wastes are disposed of at the on-Site landfill. Hazardous and mixed radioactive wastes are present on Site and recycled, stored on Site, or shipped off Site for recycling, treatment, or disposal.

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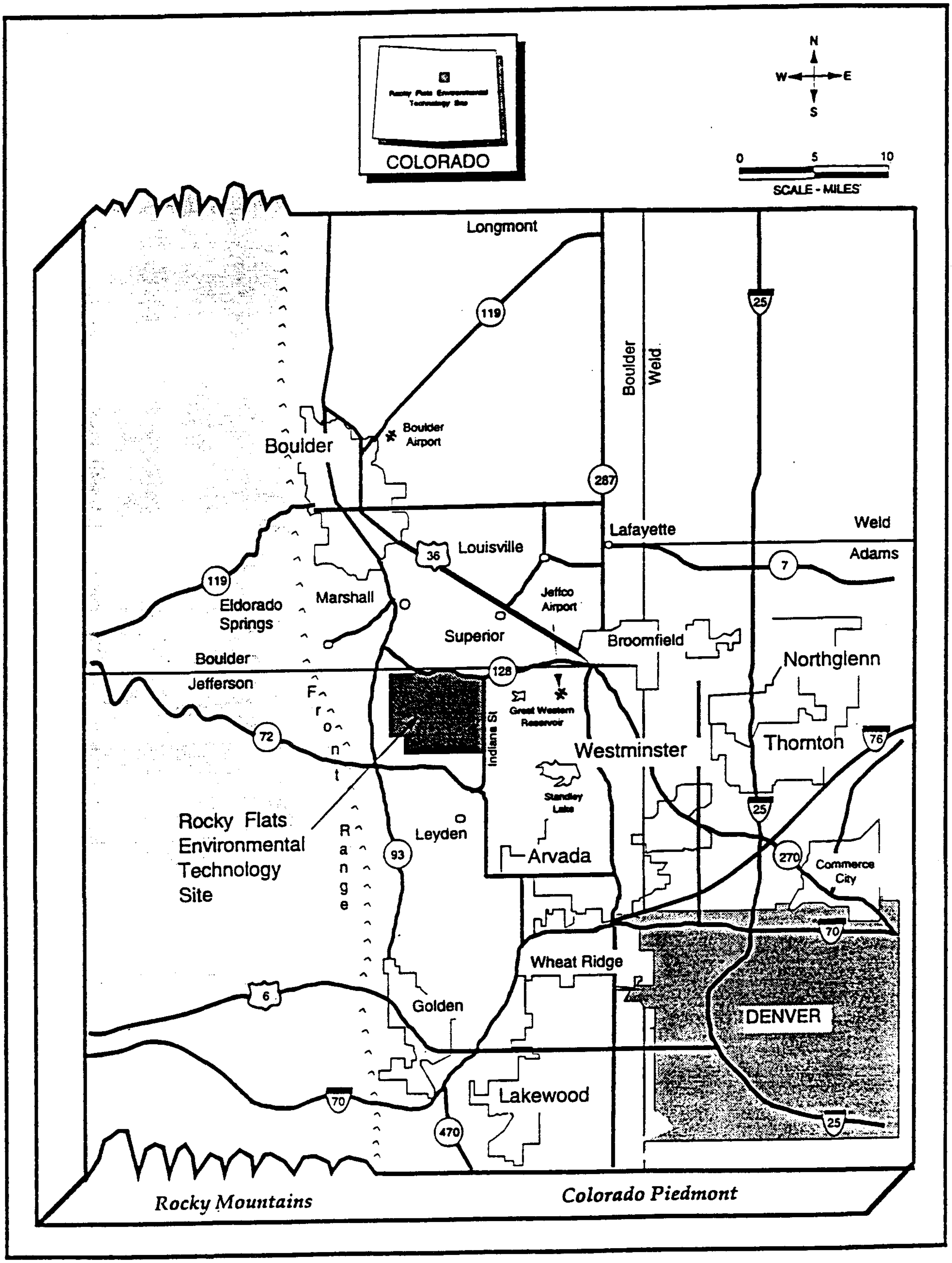
Figure A-1
General Location Map



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A.2 Environmental History

Processing and fabrication of weapons-related components began at the Site in 1952. At that time, environmental protection measures were established that seemed consistent with prudent environmental management. However, some activities resulted in the environmental contamination of portions of the Site. Efforts to document the extent of Site contamination are in progress, in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the Rocky Flats Cleanup Agreement (RFCA) (2), a cooperative agreement between the Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE). In addition, an Historical Release Report (HRR) (1) has been developed that documents knowledge gained to date about contamination arising from past practices. The HRR is updated annually to document any changes in status for known spills and contaminant sources.

A.2.1 Definition and Description of Contaminated Sites

Section 3004(u) of the RCRA requires that all Solid Waste Management Units (SWMUs) be identified. This became applicable to the Site with the signing of the Compliance Agreement between the state of Colorado and DOE, on July 31, 1986 (3). The exact definition of SWMUs had not been formalized. Therefore, the Site used guidance from the state of Colorado and the EPA Region 8 office (4). The state of Colorado and EPA required the identification of all areas where releases to the environment may have occurred, including hazardous waste and nonhazardous waste. Also included were single-release areas and locations where long-term management of waste may have occurred.

The SWMUs were initially identified in the Comprehensive Environmental Assessment and Response Program (CEARP) Phase I: Installation Assessment (5). The SWMUs consisted of inactive waste disposal sites, accidentally contaminated sites, and sites found to pose potential environmental concern due to past or current waste management practices. Inspections were conducted on each site. The first identification of SWMUs [now titled Individual Hazardous Substance Sites (IHSSs)], consistent with the guidance provided by the state of Colorado, was presented as an appendix to the November 1986, RCRA, Part B Permit Application (6).

The SWMUs at the Site were renamed as IHSSs in the Interagency Agreement (IAG), which became the compliance document for Site cleanup under RCRA and CERCLA (7). The term IHSS is specific to the Site and is defined in the IAG (Section 3.2.8) as ". . . locations associated with a release or threat of release of hazardous substances which may cause harm to human health and/or the environment ...".

Once the IHSSs were identified, they were grouped into Operable Units (OUs). The IHSSs were grouped based on cleanup priorities, waste type, and geographic setting into 16 OUs, as defined in the IAG. Under RFCA, the OUs have since been consolidated to eliminate redundant paperwork and to streamline the CERCLA remediation process.

Table A-1 lists IHSSs for each OU. Figure A-3 shows the IHSSs and their locations relative to the original 15 OUs located within the Site. Investigations of off-Site contamination beyond the Site boundary were investigated under OU3, which encloses 38 square miles and is not shown on Figure A-3.

These IHSSs have been investigated according to schedules presented in the IAG (7).

The IHSS list is updated as new IHSSs are identified in the HRR (1). Each IHSS is considered a potential source of environmental contamination and, therefore, a potential source of contamination to groundwater.

Table A-1
Individual Hazardous Substance Sites

IHSS NO.	PAC NO.	PAC NAME
101*	000-101	Solar Ponds
102	800-102	Oil Sludge Pit
103	800-103	Chemical Burial
104	800-104	Liquid Dumping
105.1	800-105.1	Westernmost Out-of-service Fuel Tanks
105.2	800-105.2	Easternmost Out-of-service Fuel Tanks
106	800-106	Outfall
107	800-107	Hillside Oil Leak
108	900-108	Trench T-1
109	900-109	Trench T-2
110	NE-110	Trench T-3
111.1	NE-111.1	Trench T-4
111.2	NE-111.2	Trench T-5
111.3	NE-111.3	Trench T-6
111.4	NE-111.4	Trench T-7
111.5	NE-111.5	Trench T-8
111.6	NE-111.6	Trench T-9
111.7	NE-111.7	Trench T-10
111.8	NE-111.8	Trench T-11
112	900-112	903 Pad
113	900-113	Mound Area
114*	NW-114	Present Landfill
115	SW-115	Original Landfill
116.1	400-116.1	West Loading Dock, Building 447 (IAG Name: West Loading Dock Area)
116.2	400-116.2	South Loading Dock, Building 444 (IAG Name: South Loading Dock Area)
117.1	500-117.1	North Site Chemical Storage
117.2	500-117.2	Middle Site Chemical Storage
117.3	600-117.3	South Site Chemical Storage
118.1	700-118.1	West of Building 730 Solvent Spill
118.2	700-118.2	South End of Building 776 Solvent Spill
119.1	900-119.1	West Scrap Metal Storage Area (IAG-Name: West Area Solvent Spill)
119.2	900-119.2	East Scrap Metal Storage Area (IAG-Name: East Area Solvent Spill)
120.1	600-120.1	Fiberglassing Area North of Building 664
120.2	600-120.2	Fiberglassing Area West of Building 664

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Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
121*	000-121	Original Process Waste Lines
122*	400-122	Underground Concrete Tanks
123.1*	700-123.1	Valve Vault 7
123.2	700-123.2	Valve Vault West of Building 707
124.1*	700-124.1	30,000 Gallon Tank (Tank #68)
124.2*	700-124.2	14,000 Gallon Tank (Tank #66)
124.3*	700-124.3	14,000 Gallon Tank (Tank #67)
125*	700-125	Holding Tank (Tank #66)
126.1	700-126.1	Westernmost Out-of-service Waste Tank
126.2	700-126.2	Easternmost Out-of-service Waste Tank
127	700-127	Low-level Radioactive Waste Leak
128	300-128	Oil Burn Pit No. 1
129*	400-129	Oil Leak
130	900-130	Radioactive Site - 800 Area Site No. 1
131	700-131	Radioactive Site - 700 Area Site No. 1
132*	700-132	Radioactive Site - 700 Area Site No. 4
133.1	SW-133.1	Ash Pit I-1
133.2	SW-133.2	Ash Pit I-2
133.3	SW-133.3	Ash Pit I-3
133.4	SW-133.4	Ash Pit I-4
133.5	SW-133.5	Incinerator
133.6	SW-133.6	Concrete Wash Pad
134	300-134 & 300-134.2	Metal Disposal Site North Area (IAG Name: Lithium Metal Destruction Site) & Reactive Metal Destruction Site South Area
135	300-135	Cooling Tower Blowdown
136.1	400-136.1	Cooling Tower Pond West of Building 444 (IAG Name: Cooling Tower Pond Northeast Corner of Building 460)
136.2	400-136.2	Cooling Tower Blowdown Building 444 (IAG Name: Cooling Tower Pond West of Building 460)
137	700-137	Cooling Tower Blowdown Buildings 712 and 713 (IAG Name: Cooling Tower Blowdown Building 774)
138	700-138	Cooling Tower Blowdown Building 779
139.1	700-139.1	Hydroxide Tank Area Spill
139.2	700-139.2	Hydrofluoric Acid Tanks Spill
140	900-140	Hazardous Disposal Area (IAG Name: Reactive Metal Destruction Site)

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Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
141	900-141	Sludge Dispersal
142.1	NE-142.1	A-1 Pond
142.10	SE-142.10	C-1 Pond
142.11	SE-142.11	C-2 Pond
142.12	NE-142.12	Flume Pond (IAG Name: A-5 Pond)
142.2	NE-142.2	A-2 Pond
142.3	NE-142.3	A-3 Pond
142.4	NE-142.4	A-4 Pond
142.5	NE-142.5	B-1 Pond
142.6	NE-142.6	B-2 Pond
142.7	NE-142.7	B-3 Pond
142.8	NE-142.8	B-4 Pond
142.9	NE-142.9	B-5 Pond
143	700-143	Old Outfall - Building 771 (IAG Name: Old Outfall)
144	700-144	Sewer Line Overflow (IAG Name: Sewer Line Break)
145	800-145	Sanitary Waste Line Leak
146.1	700-146.1	7,500 Gallon Tank (31)
146.2	700-146.2	7,500 Gallon Tank (32)
146.3	700-146.3	7,500 Gallon Tank (34W)
146.4	700-146.4	7,500 Gallon Tank (34E)
146.5	700-146.5	7,500 Gallon Tank (30)
146.6	700-146.6	7,500 Gallon Tank (33)
147.1	700-147.1	Process Waste Line Leaks (IAG Name: Maas) Area
147.2	800-147.2	Building 881 Conversion Activity Contamination (IAG: Name: Owen Area)
148	100-148	Waste Spills
149	700-149	Effluent Pipe
150.1	700-150.1	Radioactive Site West of Building 771 (IAG: Name: Radioactive Leak North of Building 771)
150.2	700-150.2	Radioactive Site West of Building 771 (IAG Name: Radioactive Leak West of Building 771)
150.3	700-150.3	Radioactive Site Between Buildings 771 & 774 (IAG Name: Radioactive Leak Between Buildings 771 & 774)
150.4	700-150.4	Radioactive Site Northwest of Building 750 (IAG Name: Radioactive Leak East of Building 750)

Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
150.5	700-150.5	Radioactive Site West of Building 707 (IAG Name: Radioactive Leak West of Building 707)
150.6	700-150.6	Radioactive Site South of Building 779 (IAG Name: Radioactive Leak South of Building 779)
150.7	700-150.7	Radioactive Site South of Building 776 (IAG Name: Radioactive Leak South of Building 776)
150.8	700-150.8	Radioactive Site Northeast of Building 779 (IAG Name: Radioactive Leak Northeast of Building 779)
151	300-151	Fuel Oil Leak
152	600-152	Fuel Oil Tank
153	900-153	Oil Burn Pit No. 2
154	900-154	Pallet Burn Site
155	900-155	903 Lip Area
156.1	300-156.1	Building 334 Parking Lot
156.2	NE-156.2	Soil Dump Area
157.1	400-157.1	Radioactive Site North Area
157.2	400-157.2	Radioactive Site South Area
158	500-158	Radioactive Site - Building 551
159	500-159	Radioactive Site - Building 559
160	600-160	Radioactive Site Building 444 Parking Lot
161	600-161	Radioactive Site West of Building 664
162	000-162	Radioactive Site - 700 Area Site No. 2
163.1	700-163.1	Radioactive Site 700 Area Site No. 3 Wash Area
163.2	700-163.2	Radioactive Site 700 Area Site No. 3 Buried Slab
164.1	600-164.1	Radioactive Site 800 Area Site No. 2 Concrete Slab
164.2	800-164.2	Radioactive Site 800 Area Site No. 2 Building 886 Spills
164.3	800-164.3	Radioactive Site 800 Area Site No. 2 Building 889 Storage Pad
165	900-165	Triangle Area
166.1	NE-166.1	Trench A
166.2	NE-166.2	Trench B
166.3	NE-166.3	Trench C
167.1	NE-167.1	Spray Field: North Area
167.2	NE-167.2	Spray Field: Pond Area (Center Area)
167.3	NE-167.3	Spray Field: South Area
168*	SW-168	West Spray Field

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Table A-1
(continued)

IHSS NO.	PAC NO.	PAC NAME
169	500-169	Waste Drum Peroxide Burial
170*	NW-170	PU&D Storage yard - Waste Spills
171	300-171	Solvent Burning Ground
172	000-172	Central Avenue Waste Spill
173	900-173	South Dock - Building 991 (IAG Name: Radioactive Site - 900 Area)
174*	NW-174	PU&D Container Storage Facilities (2)
175*	900-175	S&W Building 980 Contractor Storage Facility
176*	900-176	S&W Contractor Storage Yard
177*	800-177	Building 885 Drum Storage Area
178*	800-178	Building 881 Drum Storage Area
179*	800-179	Building 865 Drum Storage Area
180*	800-180	Building 883 Drum Storage Area
181*	300-181	Building 334 Cargo Container Area
182*	400-182	Building 444/453 Drum Storage Area
183	900-183	Gas Detoxification Area
184	900-184	Building 991 Steam Cleaning Area
185	700-185	Solvent Spill
186*	300-186	Valve Vault 12
187	400-187	Sulfuric Acid Spill (IAG Name: Acid Leaks (2))
188	300-188	Acid Leak
189	600-189	Multiple Acid Spills 218 Tanks (IAG Name: Multiple Acid Spills)
190	000-190	Caustic Leak
191	400-191	Hydrogen Peroxide Spill
192	000-192	Antifreeze Discharge
193	400-193	Steam Condensate Leak
194	700-194	Steam Condensate Leak
195	NW-195	Nickel Carbonyl Disposal
196	100-196	Water Treatment Plant Backwash Pond
197	500-197	Scrap Metal Sites
203*	NW-203	Inactive Hazardous Waste Storage Area
204*	400-204	Original Uranium Chip Rowster
205*	400-205	Building 460 Sump No. 3 Acid Side
206*	300-206	Inactive D-836 Hazardous Waste Tank
207*	400-207	Inactive 444 Acid Dumpster
208*	400-208	Inactive 444/447 Waste Storage Area
209	SE-209	Surface Disturbance Southeast of Building 881

IHSS NO.	PAC NO.	PAC NAME
210*	900-210	Unit 16, Building 980 Cargo Container
211*	800-211	Building 881 Drum Storage Unit 26
212*	300-212	Building 371 Drum Storage Unit 53
213*	900-213	Unit 15, 904 Pad Pondcrete Storage
214*	700-214	750 Pad Pondcrete and Saltcrete Storage, Unit 25
215*	700-215	Tank T-40, Unit 55.13
216.1	NE-216.1	Easy Spray Fields - North Area
216.2	NE-216.2	East Spray Fields - Center Area
216.3	NE-216.3	East Spray Fields - South Area
217*	800-217	Building 881, CN Bench Scale Treatment, Unit 32

Notes:

"*" indicates IHSSs that are RCRA units per the Interagency Agreement that was signed in 1991. IHSS 198 was deleted in 1990.

199	=	Contamination of the Land Surface
200	=	Great Western Reservoir
201	=	Standley Lake Reservoir
202	=	Mower Reservoir
IAG	=	Interagency Agreement
PAC	=	Personnel Access Conrol
PU&D	=	Property Utilization and Disposal

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A.3 References

1. *Final Historical Release Report for the Rocky Flats Plant*, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June 1992.

2. "Final Rocky Flats Cleanup Agreement", U.S. Department of Energy - Colorado Department of Health and Environment-U.S. Environmental Protection Agency, July 1996.

3. "In the Matter of Department of Energy, RFP, Golden, Colorado." Compliance Agreement signed by the U.S. E.P.A. and the U.S. Department of Energy, July 31, 1986.

4. Letter to James R. Nicks, US DOE RFP, From Robert L. Duprey, Director of EPA Waste Management Division and Kenneth Waesche, Director of Colorado Department of Health Waste Management Division. Environmental Protection Agency (EPA), 1985.

5. *Comprehensive Environmental Assessment and Response Program (CEARP) Phase 1: Installation Assessment.* Department of Energy, 1985

6. RCRA Part B Permit Application. Rockwell International, 1986.

7. State of Colorado, U.S. Environmental Protection Agency, and U.S. Department of Energy, Rocky Flats Interagency Agreement: Federal Facility Agreement and Consent Order, CERCLA-VIII-91-03, RCRA (3008(h))-VIII-91-07, State of Colorado Docket #91-01-22-01, January 22, 1991.

APPENDIX B Action Level Framework for Groundwater

Analyte	CAS No.	Tier 1- 100 x MCLs (mg/L)	Tier 2- MCLs (mg/L)
Acenaphthene (V)	83-32-9	2.19E+02	2.19E+00
Acetone (V)	67-64-1	3.65E+02	3.65E+00
Aldrin	309-00-2	5.00E-04	5.00E-06
Aluminum	7429-90-5	1.06E+04	1.06E+02
Anthracene (V)	120-12-7	1.10E+03	1.10E+01
Antimony	7440-36-0	6.00E-01	6.00E-03
Aroclor-1016	12674-11-2	5.00E-02	5.00E-04
Aroclor-1221	11104-28-2	5.00E-02	5.00E-04
Aroclor-1232	11141-16-5	5.00E-02	5.00E-04
Aroclor-1242	53469-21-9	5.00E-02	5.00E-04
Aroclor-1248	12672-29-6	5.00E-02	5.00E-04
Aroclor-1254	11097-69-1	5.00E-02	5.00E-04
Aroclor-1260	11096-82-5	5.00E-02	5.00E-04
Arsenic	7440-38-2	5.00E+00	5.00E-02
Barium	7440-39-3	2.00E+02	2.00E+00
Benzene (V)	71-43-2	5.00E-01	5.00E-03
alpha-BHC	319-84-6	1.35E-03	1.35E-05
beta-BHC	319-85-7	4.72E-03	4.72E-05
gamma-BHC (Lindane)	58-89-9	2.00E-02	2.00E-04
Benzo(a)anthracene	56-55-3	1.16E-02	1.16E-04
Benzo(a)pyrene	50-32-8	2.00E-02	2.00E-04
Benzo(b)fluoranthene	205-99-2	1.16E-02	1.16E-04
Benzo(k)fluoranthene	207-08-9	1.16E-01	1.16E-03
Benzoic Acid	65-85-0	1.46E+04	1.46E+02
Benzyl Alcohol	100-51-6	1.10E+03	1.10E+01
Beryllium	7440-41-7	4.00E-01	4.00E-03
bis(2-Chloroethyl)ether (V)	111-44-4	1.63E-03	1.63E-05
bis(2-Chloroisopropyl)ether (V)	108-60-1	4.22E-02	4.22E-04
bis(2-Ethylhexyl)phthalate	117-81-7	6.00E-01	6.00E-03
Bromodichloromethane (V)	75-27-4	1.00E+01	1.00E-01
Bromoform (V)	75-25-2	1.00E+01	1.00E-01
Bromomethane (V)	74-83-9	1.09E+00	1.09E-02
2-Butanone (V)	78-93-3	2.47E+02	2.47E+00
Butylbenzylphthalate	85-68-7	7.30E+02	7.30E+00
Cadmium	7440-43-9	5.00E-01	5.00E-03
Carbon disulfide (V)	75-15-0	2.76E+00	2.76E-02
Carbon tetrachloride (V)	56-23-5	5.00E-01	5.00E-03
alpha-Chlordane	5103-71-9	2.00E-01	2.00E-03
beta-Chlordane	5103-74-2	2.00E-01	2.00E-03
gamma-Chlordane	5103-74-2	2.00E-01	2.00E-03
4-Chloroaniline	106-47-8	1.46E+01	1.46E-01
Chlorobenzene (V)	108-90-7	1.00E+01	1.00E-01
Chloroethane (V)	75-00-3	2.78E+03	2.78E+01
Chloroform (V)	67-66-3	1.00E+01	1.00E-01
Chloromethane (V)	74-87-3	2.32E-01	2.32E-03
2-Chloronaphthalene (V)	91-58-7	2.92E+02	2.92E+00
2-Chlorophenol (V)	95-57-8	1.83E+01	1.83E-01
Chromium	7440-47-3	1.00E+01	1.00E-01
Chrysene	218-01-9	1.16E+00	1.16E-02
Cobalt	7440-48-4	2.19E+02	2.19E+00

APPENDIX B Action Level Framework for Groundwater

Analyte	CAS No.	Tier 1- 100 x MCLs (mg/L)	Tier 2- MCLs (mg/L)
Copper	7440-50-8	1.30E+02	1.30E+00
Cyanide	57-12-5	2.00E+01	2.00E-01
4,4-DDD	72-54-8	*3.54E-02*	*3.54E-04*
4,4-DDE	72-55-9	*2.50E-02*	*2.50E-04*
4,4-DDT	50-29-3	*2.50E-02*	*2.50E-04*
Dalapon	75-99-0	2.00E+01	2.00E-01
Dibenz(a,h)anthracene	53-70-3	*1.16E-03*	*1.16E-05*
Dibromochloromethane	124-48-1	*1.01E-01*	*1.01E-03*
1,2-Dibromo-3-chloropropane	96-12-8	2.00E-02	2.00E-04
Di-n-butylphthalate	84-74-0	*3.65E+02*	*3.65E+00*
2,4-D	94-75-7	7.00E+00	7.00E-02
1,2-Dichlorobenzene (V)	95-50-1	6.00E+01	6.00E-01
1,3-Dichlorobenzene (V)	541-73-1	6.00E+01	6.00E-01
1,4-Dichlorobenzene (V)	106-46-7	7.50E+00	7.50E-02
3,3-Dichlorobenzidine	91-94-1	*1.89E-02*	*1.89E-04*
1,1-Dichloroethane (V)	107-06-2	*1.01E+02*	*1.01E+00*
1,2-Dichloroethane (V)	107-06-2	5.00E-01	5.00E-03
1,1-Dichloroethene (V)	540-59-0	7.00E-01	7.00E-03
1,2-Dichloroethene (total)(V)	540-59-0	7.00E+00	7.00E-02
2,4-Dichlorophenol	120-83-2	*1.10E+01*	*1.10E-01*
1,2-Dichloropropane (V)	78-87-5	5.00E-01	5.00E-03
cis-1,3-Dichloropropene (V)	1006-01-5	*1.27E-02*	*1.27E-04*
trans-1,3-Dichloropropene (V)	10061-02-6	*1.27E-02*	*1.27E-04*
Dieldrin	60-57-1	*5.31E-04*	*5.31E-06*
Diethylphthalate	84-66-2	*2.92E+03*	*2.92E+01*
2,4-Dimethylphenol (V)	105-67-9	*7.30E+01*	*7.30E-01*
Dimethylphthalate	131-11-3	*3.65E+04*	*3.65E+02*
2,4-Dinitrophenol	51-28-5	*7.30E+00*	*7.30E-02*
2,4-Dinitrotoluene	121-14-2	*7.30E+00*	*7.30E-02*
2,6-Dinitrotoluene	606-20-2	*1.25E-02*	*1.25E-04*
Di-n-octylphthalate	117-84-0	*7.30E+01*	*7.30E-01*
Endos[illegible]	[illegible]	*2.19E+01*	*2.19E-01*
Endosulfan II	33213-65-9	*2.19E+01*	*2.19E-01*
Endosulfan sulfate	1031-07-8	*2.19E+01*	*2.19E-01*
Endosulfan (technical)	115-29-7	*2.19E+01*	*2.19E-01*
Endrin (technical)	72-26-8	2.00E-01	2.00E-03
Ethylbenzene (V)	100-41-4	7.00E+01	7.00E-01
Fluoranthene	206-44-0	*1.46E+02*	*1.46E+00*
Fluorene (V)	86-73-7	*1.46E+02*	*1.46E+00*
Fluoride	16984-48-8	4.00E+02	4.00E+00
Glyphosate	1071-83-6	7.00E+01	7.00E-01
Heptachlor	76-44-8	4.00E-02	4.00E-04
Heptachlor epoxide	1024-57-3	2.00E-02	2.00E-04
Hexachlorobenzene	118-74-1	1.00E-01	1.00E-03
Hexachlorobutadiene	87-68-3	*1.09E-01*	*1.09E-03*
Hexachlorocyclopentadiene	77-47-4	5.00E+00	5.00E-02
Hexachloroethane	67-72-1	*6.07E-01*	*6.07E-03*
Indeno(1,2,3-cd)pyrene	193-39-5	*1.16E-02*	*1.16E-04*
Isophorone	78-59-1	*8.95E+00*	*8.95E-02*
Lithium	7439-93-2	*7.30E+01*	*7.30E-01*

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APPENDIX B Action Level Framework for Groundwater

Analyte	CAS No.	Tier 1- 100 x MCLs (mg/L)	Tier 2- MCLs (mg/L)
Manganese	7439-96-5	***1.83E+01***	***1.83E-01***
Mercury	7439-97-6	2.00E-01	2.00E-03
Methoxychlor	72-43-5	4.00E+00	4.00E-02
Methylene chloride (V)	75-09-2	5.00E-01	5.00E-03
4-Methyl-2-pentanone (V)	108-10-1	***2.03E+01***	***2.03E-01***
2-Methylphenol	95-48-7	***1.83E+02***	***1.83E+00***
Molybdenum	7439-98-7	***1.83E+01***	***1.83E-01***
Naphthalene (V)	91-20-3	***1.46E+02***	***1.46E+00***
Nickel	7440-02-0	1.00E+01	1.00E-01
Nitrate (MCL as N)	1-005	1.00E+03	1.00E+01
Nitrite (MCL as N)	1-005	1.00E+02	1.00E+00
Nitrobenzene (V)	98-95-3	***4.20E-01***	***4.20E-03***
n-Nitrosodiphenylamine (V)	86-30-6	***1.73E+00***	***1.73E-02***
n-Nitrosodipropylamine	621-64-7	***1.21E-03***	***1.21E-05***
Pentachlorophenol	87-86-5	1.00E-01	1.00E-03
Phenol	108-95-2	***2.19E+03***	***2.19E+01***
Pyrene	129-00-0	***1.10E+02***	***1.10E+00***
Selenium	7782-49-2	5.00E+00	5.00E-02
Silver	7440-22-4	***1.83E+01***	***1.83E-01***
Strontium	7440-24-6	***2.19E+03***	***2.19E+01***
Styrene (V)	100-42-5	1.00E+01	1.00E-01
Sulfate	14808-79-8	5.00E+04*	5.00E+02*
1,1,2,2-Tetrachloroethane (V)	79-34-5	***8.95E-03***	***8.95E-05***
Tetrachloroethene (V)	127-18-4	5.00E-01	5.00E-03
Thallium	7440-28-0	2.00E-01	2.00E-03
Tin	7440-31-5	***2.19E+03***	***2.19E+01***
Toluene (V)	108-88-3	1.00E+02	1.00E+00
Toxaphene	8001-35-2	3.00E-01	3.00E-03
1,2,4-Trichlorobenzene (V)	120-82-1	7.00E+00	7.00E-02
1,1,1-Trichloroethane (V)	71-55-6	2.00E+01	2.00E-01
1,1,2-Trichloroethane (V)	79-00-5	5.00E-01	5.00E-03
Trichloroethene (V)	79-01-6	5.00E-01	5.00E-03
2,4,5-Trichlorophenol	95-95-4	5.00E+00	5.00E-02
2,4,6-Trichlorophenol	88-06-2	***7.73E-01***	***7.73E-03***
Vanadium	7440-62-2	***2.56E+01***	***2.56E-01***
Vinyl acetate	108-05-4	***3.65E+03***	***3.65E+01***
Vinyl chloride (V)	75-01-4	2.00E-01	2.00E-03
Xylene (total)(V)	1330-20-7	1.00E+03	1.00E+01
Zinc	7440-66-6	***1.10E+03***	***1.10E+01***

Analytes without an MCL value list the corresponding residential ground water ingestion Preliminary Programmatic Remediation Goal (PPRG) which is shown in bold italics.

Analytes without an MCL or a PPRG value are not listed.

(V) = Volatile chemicals

* Based on proposed MCL

APPENDIX B Action Level Framework for Groundwater

Analyte	CAS No.	Tier 1- 100 x MCLs (pCi/L)	Tier 2- MCLs (pCi/L)
RADIOLOGIC PARAMETERS:			
Americium-241	14596-10-2	1.45E+01	1.45E-01
Cesium-137+D	10045-97-3	1.51E+02	1.51E+00
Plutonium-239	10-12-8	1.51E+01	1.51E-01
Plutonium-240	10-12-8	1.51E+01	1.51E-01
Radium-226+D	13982-63-3	2.00E+03*	2.00E+01*
Radium-228+D	15262-20-1	2.00E+03*	2.00E+01*
Strontium-89	11-10-9	4.62E+02	4.62E+00
Strontium-90+D	11-10-9	8.52E+01	8.52E-01
Tritium	10028-17-8	6.66E+04	6.66E+02
Uranium-233+D	11-08-5	2.98E+02	2.98E+00
Uranium-234	11-08-5	1.07E+02	1.07E+00
Uranium-235+D	15117-96-1	1.01E+02	1.01E+00
Uranium-238+D	7440-61-1	7.68E+01	7.68E-01

D = Daughters

* Based on proposed MCL

APPENDIX C

Physical And Hydrologic Setting

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C.1 Geology

C.1.1 Introduction

Rocky Flats Environmental Technology Site (RFETS or the Site) is situated approximately two to six miles east of the Front Range of Colorado (Figure A-1) on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (1). The geologic history of the Rocky Mountain region of Colorado (which includes the Site area) has been summarized by Haun and Kent (1965)(2). The elevation at the Site is approximately 6,000 feet above mean sea level (msl). The Industrial Area (main facility area) of the Site is located on alluvial-covered pediment. The upper surface of the alluvium slopes easterly one to two degrees. Most of the surrounding area in the Buffer Zone is more prominently dissected with intermittent streams. These small, eastward flowing streams include Rock Creek, Walnut Creek, Woman Creek, and several surface water diversion ditches (see Section 3.1.4 of this report, Figure 3-1).

The following major geologic and hydrologic parameters influence groundwater flow at the Site (3):

- Topography controls the surface waters of the upslope drainage basin that, in part, recharges groundwater and the three principal streams draining the Site. The majority of shallow groundwater is intercepted by these drainages.

- The lithology and permeability of the unconsolidated surficial deposits permit meteoric waters to recharge the water table. The water table is contained in alluvium and weathered bedrock.

- Paleotopography of the bedrock pediment, which is less permeable than the overlying unconsolidated surficial deposits, serves to focus groundwater movement along bedrock "lows."

- Paleoweathering of shallow bedrock materials has enhanced the permeability of the upper 10 to 60 feet relative to unweathered bedrock.

- The permeability of bedrock units, composed primarily of claystone with lesser amounts of siltstone and sandstone, is generally several orders of magnitude less than for unconsolidated surficial deposits. The 600+ feet of unweathered bedrock between the shallow groundwater flow system and deep regional Laramie-Fox Hills aquifer provides an effective barrier to vertical groundwater and contaminant movement.

C.1.2 Stratigraphy

The stratigraphic sequence that underlies the Site extends from the crystalline Precambrian gneiss, schist, and granitoids at 3,000 feet below msl to the unconsolidated Quaternary deposits

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at surface approximately 6,000 feet above msl. Based upon aerial photographic interpretation, field geologic mapping, coal and aggregate mine development, petroleum exploration in the vicinity, and numerous borehole investigations, a substantial amount of lithologic information has been gained about the Site. The generalized lithologic section in the Rocky Flats area is shown in Figure C-1.

Bedrock formations from the uppermost Cretaceous Pierre, Fox Hills, Laramie, and Arapahoe Formations are present and exposed at the surface and beneath the Site. The Quaternary Rocky Flats Alluvium, and to a limited extent Verdos Alluvium, unconformably overlie the Cretaceous Arapahoe and Laramie Formations in the central portion of the Site. The unconsolidated surficial deposits, combined with the weathered portion of subcropping bedrock formations, form the sequence of rocks which have the greatest importance regarding groundwater flow and contaminant transport at the Site.

C.1.2.1 Pediment-Covering Alluviums

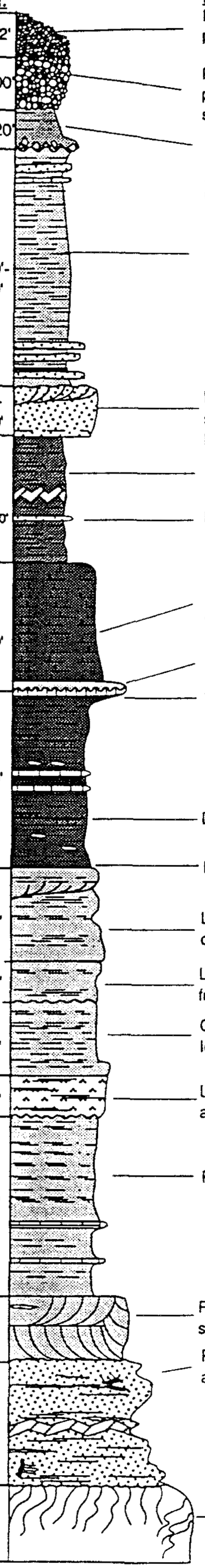
Several Quaternary alluvial formation pediment covers have been identified in the vicinity of the Site by Scott (1975)(4). The Rocky Flats Alluvium is an unconsolidated deposit derived from quartzites and granites of the Coal Creek Canyon provenance west of the Site. The deposit diminishes from west to east with thicknesses ranging from approximately 100 feet to less than one foot. In the central portion of the Site, the deposit is approximately 15 to 25 feet thick. The Rocky Flats Alluvium is a heterogeneous deposit dominantly composed of angular to subrounded, poorly-sorted, coarse, bouldery-gravel with a clay and sand matrix. Clay, silt, and sand lenses as well as varying amounts of caliche are also present. Exposures of Rocky Flats Alluvium in the aggregate quarries north and west of the Site exhibit some large scale cross-stratification. Depositional processes include fluvial and debris-flow transport (5) infilling paleotopographic lows but leaving a widespread surface of erosion with extremely low relief.

C.1.2.2 Other Surficial Deposits

In addition to the pediment-forming alluvial deposits, younger Quaternary units consisting of colluvium, landslide alluvium, and valley fill alluvium mantle the hillslopes and valley bottoms below the pediment surface. Colluvial deposits are derived from Arapahoe and Laramie Formations and older alluvial deposits. This unit consists of sheetwash, soil creep, and landslide materials in a total thickness of 3 to 16 feet (5). These deposits locally flank the Rocky Flats Alluvium and generally extend to lower parts of the slopes along the principal drainages.

Landslide deposits more commonly flank the Rocky Flats Alluvium. They are often bounded by headwall scarps and lobate toes at the downslope margins. Seeps issuing from the base of the Rocky Flats Alluvium contribute to landslide colluvium generation. The landslide units include earth flows, slumps, and debris flows in a thickness estimated between 10 to 33 feet (5).

Exposure	Age	Formation	Th.	Description
Formations exposed at RFETS	Quaternary	Verdos Alluvium	0'-12'	Reddish brown matrix, moderately sorted, sandy pebble gravel and pebbly, silty sand
Formations exposed at RFETS	Quaternary	Rocky Flats Alluvium	0'-100'	Reddish brown to yellowish brown matrix, grayish-orange to dark gray, poorly sorted, angular to subrounded, cobbles, coarse gravels, coarse sands and gravelly clays; varying amounts of caliche; aggregate source
Formations exposed at RFETS	Upper Cretaceous	Arapahoe Fm.	0'-120'	Gray to yellowish orange clay stone, sandy clay stone, and clayey sandstone, medium to coarse sandstone and chert pebble conglomerate locally at base; aquifer east of RFETS
Formations exposed at RFETS	Upper Cretaceous	Laramie Formation	600'-800'	Gray, fine- to medium-grained sandstone and clay stones; thin coal beds mined in lower part and locally uraniferous; ironstone nodule; aquifer east of RFETS
Formations exposed at RFETS	Upper Cretaceous	Fox Hills Sandstone	90'-140'	Light olive gray to yellowish brown fine- to medium-grained cross-bedded sandstone, and laminated silty sandstone and shale at base; aquifer east of RFETS
Formations in subsurface or exposed west of RFETS	Upper Cretaceous	Pierre Shale	± 7500'	Dark gray, silty bentonitic shale and few thin, silty sandstones; Hygiene Sandstone Member in lower part
Formations in subsurface or exposed west of RFETS	Upper Cretaceous	Niobrara Formation	350'	Olive gray to dusky yellow, very calcareous shale, thin bentonite, gypsum, and fossiliferous limestone beds; Light gray, dense, fossiliferous limestone; Yellowish gray, sandy fossiliferous limestone
Formations in subsurface or exposed west of RFETS	Upper Cretaceous	Benton Shale	450'	Dark gray shale with bentonite streaks, thin limestones in middle part; Dark gray to black, brittle silty shale
Formations in subsurface or exposed west of RFETS	Lower Cretaceous	Dakota Group: South Platte Formation	250'	Light gray, fine- to medium-grained cross-bedded sandstone, dark gray clay stone in middle part;mined for uranium ore; major oil reservoir
Formations in subsurface or exposed west of RFETS	Lower Cretaceous	Dakota Group: Lytle Formation	100'	Light gray to tan, fine- to coarse-grained, locally conglomeratic sandstone, frequent red and green siltstone interbeds
Formations in subsurface or exposed west of RFETS	Jurassic	Morrison Formation	250'	Gray to greenish-gray to red shale and siltstone, thin limestones in middle part; lenticular sandstones in upper and lower part; locally uraniferous
Formations in subsurface or exposed west of RFETS	Jurassic	Ralston Creek Formation	110'	Light gray siltstone and light red, silty shale; calcareous; chert nodules and beds
Formations in subsurface or exposed west of RFETS	Triassic / Permian	Lykins Formation	450'	Red siltstone and clay stone with two laminated limestones in lower part
Formations in subsurface or exposed west of RFETS	Permian	Lyons Sandstone	150'	Pinkish-gray, fine- to medium-grained, cross-bedded sandstone; conglomeratic lenses frequent
Formations in subsurface or exposed west of RFETS	Pennsylvanian	Fountain Formation	800'	Red, fine- to coarse-grained sandstone and conglomerate, arkosic, thin, lenticular red siltstones frequent throughout
Formations in subsurface or exposed west of RFETS	Pre-cambrian	Precambrian X ~1.7 byr.		Gneiss, schist, and small granitic intrusions; mined for uranium ore



Modified from LeRoy and Weimer (1971); USGS OFR-94-162 (1994); Nelson-Moore, et al.(1978); and Pearl (1980)

Rocky Flats Environmental Technology Site

Generalized Stratigraphic Column for the Rocky Flats Area

1996 IMP

August 1994 | Figure C-1

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M\ES\Fig 4-02 Stratigraphy/ S.M. Stoller

C.1.2.3 Arapahoe Formation

The Arapahoe Formation is composed of claystones and silty claystones with some lenticular sandstones. In the Geologic Characterization Report for the U.S. DOE Rocky Flats Plant (6), the Arapahoe Formation was interpreted to be 150 feet thick in the central area and to contain five sandstones named Sandstones 1 through 5. The thickest and most widespread, uppermost sandstone was defined as the No. 1 Sandstone which was interpreted to be deposited in a fluvial environment. The more recent Site-wide mapping program (7) determined that the overall Arapahoe Formation is generally less than 25 feet thick in the Site area. The No. 1 Sandstone (6) was correlated to the basal Arapahoe Sandstone. Lower bedrock sandstones (i.e., Sandstones 2 through 5) in the 1991 Geologic Characterization Report were redefined as lenticular Laramie sandstones as they are texturally distinct from the No. 1 Sandstone by virtue of their high silt and clay content. These lower sandstones have limited hydrologic significance and are currently identified as part of the upper Laramie Formation.

The No. 1 Sandstone, which is currently defined as the basal Arapahoe Sandstone, is of concern as a potential contamination pathway, especially where it subcrops beneath the alluvial/bedrock unconformity. The other sandstones pose a limited threat as potential contamination pathways since they are lenticular and discontinuous.

C.1.2.4 Laramie and Fox Hills Sandstone Formations

The Laramie Formation is approximately 600 to 800 feet thick and is composed of a lower sandstone/claystone/coal interval and an upper, thicker claystone interval. The permeable lower sandstones and coals of the Laramie, combined with the permeable sandstones of the Fox Hills, constitute a regional aquifer system known as the Laramie-Fox Hills aquifer. This aquifer system is an important water source in the South Platte River Basin (8), and is the sole water supply for some residents in the Rocky Flats area. The Fox Hills Formation is primarily a fine-grained sandstone with an approximate thickness of between 75 to 125 feet with thin siltstone and claystone interbeds. The Fox Hills Formation outcrops and subcrops along a narrow, north-south trending pattern in the extreme western part of the Site upgradient from known sources of contamination.

C.1.2.5 Pierre Formation

The Pierre Formation is a 7,500-foot thick, dark gray, silty bentonitic shale that acts as a lower confining layer for the Laramie-Fox Hills aquifer in the Denver Basin. This thick marine shale unit subcrops only in the extreme western part of the Site.

C.1.3 Geologic Structure

The Site is located along the western margin of the Denver Basin, an asymmetric basin with a steeply east-dipping western flank and a gentle eastern flank. The interpretation of the subsurface structure is generalized in the east-west geological cross section of the Site area presented in Figure C-2. A monoclinal fold limb exposed west of the Site is the most significant surficial structural feature in the Site area. Along the west limb of the fold, an angular unconformity exists between the Upper Cretaceous bedrock and the base of the Quaternary Rocky Flats Alluvium.

No active faults have been identified at the Site. Several high angle bedrock faults have been inferred to exist in the Industrial Area of the Site based on various stratigraphic and borehole correlation criteria. These faults appear to have only a limited hydrologic significance with regard to vertical groundwater movement and contaminant transport (9).

C.2 Hydrogeology

C.2.1 Introduction

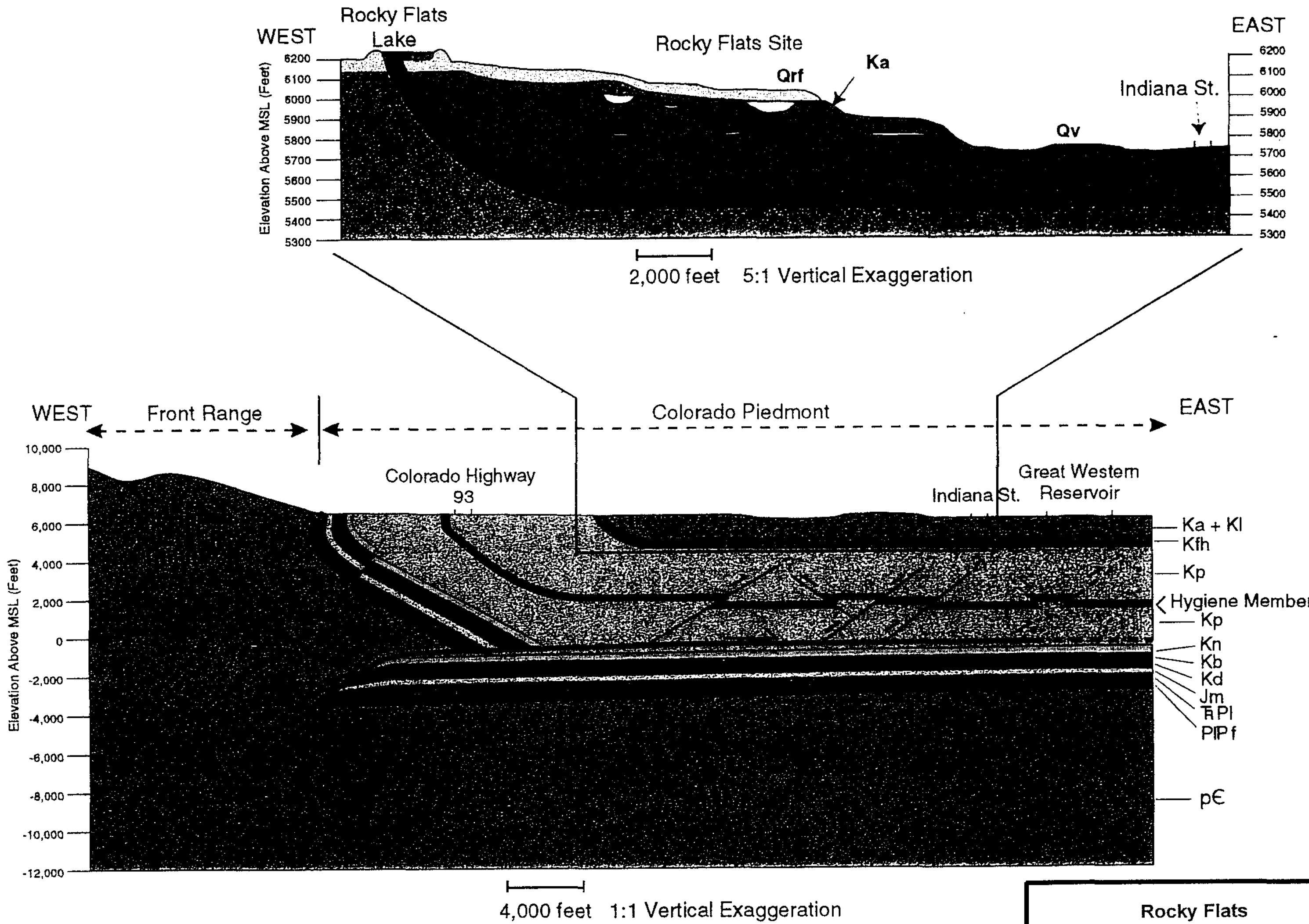
This section presents the basic concepts about the hydrogeologic conditions at the Site that affect groundwater monitoring and protection. Characterization of the hydrogeologic setting is based on the currently accepted conceptual geologic and hydrogeologic models described in the Sitewide Geoscience Characterization Study (10, 5, 11). These conceptual geologic and hydrogeologic models are used to predict the direction and rate of groundwater flow, identify potential pathways for contaminant migration, and determine the extent of contaminant plumes given varying physical, chemical, and biological factors.

C.2.2 Definition of the Uppermost Aquifer for the Site

The term "aquifer" as defined by *Title 40 of the Code of Federal Regulations* (CFR) Section 260.10 is a "geologic formation, group of formations, or a part of a formation that is capable of yielding a significant amount of water to a well or spring." An "uppermost aquifer" is defined as "the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's boundary." Geologic materials with similar hydrologic properties comprise a hydrostratigraphic unit (HSU) (12). For purposes of this report, the uppermost aquifer or upper hydrostratigraphic unit (UHSU) consists of the unconfined saturated zone, in which unconsolidated and consolidated groundwater-bearing strata are in hydraulic communication. The UHSU consists of the following geologic units: Rocky Flats Alluvium, valley-fill alluvium, colluvium, landslide deposits, weathered Arapahoe and Laramie Formation bedrock, and all sandstones within the Arapahoe and upper Laramie Formations in hydraulic communication with the overlying unconsolidated surficial deposits. The UHSU is considered to be equivalent to the uppermost aquifer at the Site.

Geologic Units

- Qv — Verdos Alluvium
- Qrf — Rocky Flats Alluvium
- Ka — Arapahoe Formation
- Kl — Laramie Formation
- Kfh — Fox Hills Sandstone
- Kp — Pierre Shale/Hygiene Member
- Kn — Niobrara Formation
- Kb — Benton Shale
- Kd — Dakota Group
- Jm — Morrison Formation
- TrPl — Lykins Formation
- PIPf — Lyons & Fountain Formations
- p€ — Undivided Igneous & Metamorphic Units



Structural interpretation from EG&G, 1993a.

Rocky Flats Environmental Technology Site

Generalized Geologic Cross Section of the Front Range and the Rocky Flats Area

Geologic Characterization Report

March 1995

Figure C-2

G95\ES\2801\Cross Section.ill

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Beneath the surficial materials and the consolidated sandstones of the UHSU are the geologic units of the lower hydrostratigraphic unit (LHSU). The LHSU consists of the consolidated, unweathered bedrock zone of the Arapahoe and upper Laramie Formations not in hydraulic communication with the overlying UHSU. The Arapahoe and upper Laramie Formations comprising the geologic units of the LHSU consist of lesser amounts of sandstone and greater amounts of adjacent claystones. Because of the low permeability of the claystones, they behave as aquitards restricting hydraulic communication with the UHSU. The lower Laramie and Fox Hills Formations comprise a stratigraphically lower and third hydrostratigraphic unit beneath the Site.

Groundwaters of the three hydrostratigraphic units are hydraulically separated beneath the IA of the Site. They do converge, however, and are in mutual contact immediately upgradient near the western margin of the Site due to monoclinal folding and erosional proximity. Initially, background geochemical characterization of the UHSU and LHSU revealed the units as having statistically different groundwater chemistry concurring with the delineation of separate hydrostratigraphic units (13). This concept is presently being qualified. In addition, possible communication of the hydrostratigraphic units along other geologic structures is currently being assessed. More detailed differentiation of the LHSU will be achieved as new hydrogeologic and geochemical data are generated from Site investigations currently proposed or in progress.

C.2.3 Groundwater Occurrence and Distribution

The Site is located in a regional groundwater recharge area (6). Groundwater recharge occurs from the infiltration of incident precipitation and as base flow near the upgradient area of the Site drainage basin which extends west to Coal Creek. Groundwater recharge occurs from the infiltration of precipitation and from stream, ditch, and pond seepage. Much of the groundwater which discharges from the UHSU to streams and seeps evaporates as it is being discharged. Limited investigation of the former Operable Unit (OU) 2 area during the period of July through October 1993 indicated that the precipitation component of recharge was lost to evapotranspiration demands (14).

In the western part of the Site, where the thickness of the Rocky Flats Alluvium reaches 100 feet, the depth to the water table is 50 to 70 feet below the surface. The depth to water generally becomes shallower from west to east as the alluvial material thins and the confining claystones approach the ground surface. At the head of stream drainages and valley sides, seeps are common at the base of the Rocky Flats Alluvium where it is in contact with claystones of the Arapahoe/Laramie Formations, and where Arapahoe Formation sandstone crops out. In general, the unconsolidated surficial materials are thicker in the western, higher elevations at the Site. Accordingly, the saturated thickness of these materials also thins eastward. The potentiometric surface of groundwater in unconsolidated surficial deposits has been mapped and is shown on Plate 2. The period illustrated represents the time of year when static water levels are highest. Extensive areas of unsaturated and seasonally unsaturated alluvium and colluvium are indicated east and northeast of the IA.

Groundwater in the Arapahoe Formation sandstone units which subcrop beneath the alluvial material is not confined when in contact with the surficial materials. In this setting, a hydraulic connection exists between the bedrock sandstone and the alluvial material allowing the bedrock groundwater to exist under unconfined conditions as part of the UHSU. The subcropping Arapahoe Formation No. 1 Sandstone located in the eastern portion of the IA and in the area between South Walnut Creek and Woman Creek is part of the UHSU (6). The upper discontinuous sandstones of the Laramie Formation also subcrop beneath alluvium and colluvium, but in limited areas in the valleys and along valley slopes. Groundwater in the lenticular sandstone units of the Laramie Formation occurs under confined conditions over scattered areas of the Site.

Groundwater levels in UHSU wells fluctuate in response to seasonal recharge events. Approximately 15% of the groundwater monitoring wells commonly are dry during at least one of the quarterly sampling events. Of the remaining wells, approximately half cannot yield sufficient water volume (4.5 gallons) specified for laboratory samples. Sampling crews must return later after wells have recovered and obtain additional sample volumes.

C.2.4 Groundwater Flow

The shallow groundwater flow regime at the Site is illustrated by the configuration of potentiometric contours in Plate 2. This map indicates that groundwater flow is largely controlled by the topography of the bedrock surface. Groundwater in the ridge tops generally flows toward the east-northeast. In areas where the ridge tops are dissected by east-northeast trending streams drainages, groundwater flows to the north or south toward the bottom of the valleys. In the valley bottoms, groundwater flows to the east, generally following the course of the stream. Shallow groundwater flow is primarily lateral due to the low permeability of the underlying claystone bedrock.

A potential for vertical groundwater flow, although limited by the low permeability of bedrock claystones, is indicated by the presence of strong downward vertical hydraulic gradients between the UHSU and underlying bedrock units. This situation implies a condition of poor hydraulic communication. For example, vertical gradients on the order of 0.79 to 1.05 feet per foot (ft/ft) have been calculated between colluvial and bedrock sandstones at OU1. The vertical groundwater flux through claystones is assumed to be small, on the order of 10^{-10} to 10^{-7} centimeters per second (cm/sec), based on calculations provided (9). Fracturing, where evident, is most abundant in the weathered bedrock zone, but is observed to decrease with depth in unweathered bedrock. Preferential vertical groundwater flow and contaminant transport along fractures or fault zones do not appear to represent a viable pathway for contaminant migration based on an assessment of available data (9).

C.2.5 Hydraulic Conductivity

The UHSU at the Site has a relatively low to moderate hydraulic conductivity that typically yields small amounts of water to groundwater monitoring wells. The UHSU exhibits a wide-range of hydraulic conductivities because of the diverse nature of the individual geologic units that comprise this unit. Summary statistics for UHSU hydraulic conductivities [(11) Table G-2] indicate a range of 5.0 x 10^{-2}cm/sec [3.0 x 10^{4} feet per year (ft/yr)] to 3 x 10^{-8}cm/sec (9.3 x 10^{-1}ft/yr). Listed in order of decreasing geometric mean hydraulic conductivity, the relative ranking of individual units of the UHSU is presented as follows: valley-fill alluvium (2.5 x 10^{-3}cm/sec); Arapahoe No. 1 sandstone (7.9 x 10^{-4} cm/sec); Rocky Flats Alluvium (2.1 x 10^{-4} cm/sec); colluvium (9.3 x 10^{-5} cm/sec); weathered Laramie Formation sandstones (3.9 x 10^{-5} cm/sec); and weathered Laramie Formation claystones (8.8 x 10^{-7} cm/sec). Hydraulic conductivities for LHSU materials are generally the lowest measured at the Site with geometric mean values for individual lithologic groups ranging from 1.6 x 10^{-7} to 5.8 x 10^{-7} cm/sec [(11), Table G-2]. The low permeability and 600+ foot thickness of the upper Laramie Formation claystones act as an effective aquitard that restricts downward vertical groundwater flow and contaminant transport to the Laramie-Fox Hills aquifer (9).

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APPENDIX D
Site Impacts To Groundwater

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D.1 Impact of Individual Hazardous Substance Sites on the Quality of Groundwater

The characterization and assessment of Individual Hazardous Substance Sites (IHSSs) and their potential to impact groundwater and surface water has historically been conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation/feasibility study (RI/FS) programs for individual Operable Units (OUs). In 1995, the decision was made to take a Site-wide approach to the evaluation and remediation of the Rocky Flats Environmental Technology Site (RFETS or the Site). Of the original 16 OUs, there are only 7 OUs remaining: the Buffer Zone OU; the Industrial Area OU; and OUs 1, 3, 5, 6, and 7. However, groundwater issues will be investigated on a Site-wide basis.

The general conclusions reached with respect to groundwater contamination are that the hydrogeologic setting of a specific area directly affects the movement and quality of groundwater. Chemicals at some of the Site IHSSs have impacted groundwater quality. To characterize this impact, groundwater quality data have been compiled to identify hazardous constituents, determine their concentrations and rate of migration, and delineate the horizontal and vertical extent of potential contaminant plumes. The migration of contaminants can be highly influenced by engineered structures such as buildings, dams, slurry walls, diversion drains, pipelines, and diversion flumes that affect natural, near-surface water movement at the Site.

Because so much of the information dealing with individual IHSSs and contaminant sources is referenced in documents pertaining to the OUs, a short description and references pertinent to the OU where plumes exist is provided in this section. Summaries of groundwater analytical data for determination of historic chemicals of concern is presented in Table D-1.

D.2 Groundwater Contaminant Plumes

Evaluation of geochemical data from groundwater wells sampled as part of the Site-wide monitoring program has delineated a number of areas of groundwater contamination. The most widespread contamination is that of volatile organic compounds (VOCs). Plate 3 shows the distribution of VOC contamination in the upper hydrostatigraphic unit (UHSU). Plume definition is inexact; however, because of limitations in well coverage, variability of hydrostratigraphic conditions, and local variations in groundwater transport velocity. Published plume maps for individual constituents can be found in the 1993 Well Evaluation Report (1), the annual RCRA groundwater reports (2, 3, 4, 5), and in individual OU RI/Resource Conservation and Recovery Act (RCRA) feasibility investigation (RFI) reports.

The VOC contaminant plumes in groundwater at the Site have the most potential to impact surface water or to migrate off Site. These plumes have been defined on the basis of exceedances above the maximum contaminant levels (MCL) for individual constituents. To delineate areas of highly contaminated groundwater, the groundwater action levels of 100 times the MCLs were compared against all groundwater data for the most common VOCs in groundwater. The

Table D-1
Chemicals of Concern for Groundwater

Potential Chemicals Of Concern	Groundwater Contaminant Plumes									
	X = Chemicals > Tier I Levels, X = Chemicals > Tier II Levels, x = Minor Detections > Tier II Levels									
	881 Hillside	903 Pad	Mound	E. Trenches	Solar Ponds	Carbon Tet	Ind. Area	Old LF	PU&D	Present LF
Metals/Indicator Parameters:										
Aluminum	x	x		X	x	x	X	x	X	
Antimony	X	X	X	X	X	X	X	x	x	X
Arsenic						X	x			x
Barium		x		X		x	X	x	x	X
Beryllium	x	X	x	X		X	X	X	X	x
Cadmium	x	X	x	X	X	x	x	x	X	x
Chromium	X	X	x	X		X	X	X	X	X
Cobalt					X					
Copper	x			x			x		x	x
Cyanide				x						
Fluoride	x	x			X	x	x	x	x	x
Lithium				x	X	x				
Manganese	X	X	X	X	X		X	X	X	X
Mercury										
Molybdenum	x	x								x
Nickel	X	X	x	X	X	X	X	X		X
Nitrate	X	X		X	X		X	x		X
Selenium	X				X		x			x
Silver									x	x
Strontium										
Sulphate	X	X			X					X
Vanadium	x	X		X		X	X	x	X	
Zinc					x					
Radionuclides:										
Americium-241	x	X	x	X	X	X	X			x
Cesium 137		x		x	x	x				
Plutonium-239/240		X	x	X	X	X	X	x	x	X
Strontium 89/90	X		X		X		x	x		x
Tritium					X					X
Uranium-233/234		x			X					
Uranium-235	X	x			X					
Uranium-238		X			X		X	X		

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exceedances were plotted and are shown on Plate 3. The most probable sources were identified using the results of recent field sampling programs and process knowledge (6). A flow diagram (6) describes the method used to locate the contaminant plumes and corresponding sources, and to determine which areas should be targeted for remedial action. Other contaminants also will be addressed where there is an impact to surface water exceeding action levels.

There are six groundwater contaminant plumes identified where contaminant concentrations exceed 100 times the MCLs. These groundwater contaminant plumes include: 1) IHSS 119.1 Plume, 2) Mound Plume, 3) 903 Pad and Ryan's Pit Plume, 4) Carbon Tetrachloride Plume, 5) East Trenches Plume, and 6) Industrial Area Plume. In addition, there are three plumes with contaminant concentrations that do not exceed 100 times the MCLs, but that have the potential to impact surface water. These plumes are the Existing (Present) Landfill, Solar Ponds, and the Property Utilization and Disposal (PU&D) Yard Plumes (6).

D.2.1 Groundwater Contamination at 881 Hillside (OU1)

The 881 Hillside is located in the south-central portion of the Site on the north slope of Woman Creek as shown on Figure A-3. Figure D-1 presents detail of the IHSSs for OU1. The area was selected as a high priority site because of the elevated concentrations of VOCs detected in the alluvial groundwater, the relatively permeable soils, and the proximity to Woman Creek. The *Final Phase III RFI/RI Work Plan Revision 1, Rocky Flats Plant 881 Hillside Area OU1* (7), outlines the activities that were required to identify the extent of contamination.

D.2.1.1 Individual Hazardous Substance Site 119.1 Plume

The drum storage area (IHSS 119.1) within OU1 is the site of historic releases of chlorinated VOCs to the environment. These releases have resulted in the contamination of shallow alluvial groundwater (i.e., the UHSU) and have formed a small, relatively stable contaminant plume extending down the 881 Hillside. Trichloroethylene (TCE), perchloroethylene (PCE), and 1,1,1 trichloroethane (TCA) are the most common organic contaminants at 881 Hillside.

In 1992, a French Drain was installed to intercept contaminated groundwater perceived to be flowing down the 881 Hillside. The French Drain is excavated as deep as 28 feet into bedrock and intercepts UHSU groundwater flowing in paleotopographic depressions. A three-foot diameter recovery well located within the source area also was installed to recover water containing high levels of dissolved VOCs.

The French Drain is still in operation and is collecting relatively uncontaminated groundwater for treatment at the Building 891 Treatment Plant. The plume is upgradient of the French Drain and does not appear to be migrating. The area immediately downgradient of the French Drain is unsaturated, indicating that the French Drain has dewatered much of the area. A small seep

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located south of IHSS 119.1 and downgradient of the French Drain along Woman Creek was sampled once. This sample contained a trace amount of VOCs. However, it is not clear if the VOC concentrations in the seep water are related to the contaminant plume.

Groundwater in the unweathered bedrock at 881 Hillside did not appear to be impacted by contaminants transported by the alluvial groundwater system.

Information on groundwater quality for the French Drain is documented in quarterly reports which have been produced as required in the French Drain interim measures/interim remediation action (IM/IRA) (8). Additional information on 881 Hillside is reported in the *OU1 Phase III RFI/RI Work Plan Revision 1* (7) and in the *OU1 Final Phase III RFI/RI* (9).

D.2.2 Groundwater Contamination Associated with the Former OU2

IHSSs grouped within the former OU2 are shown in Figure A-3. Figure D-2 presents detail of the IHSSs for OU2. The 903 Pad is located in the southeast corner of the Site south of the inner east gate. The Mound is located north of Central Avenue at the southeast corner of the Protected Area. The East Trenches straddle the East Access Road, east of the inner east gate.

The 903 Pad and the Mound were historically used for the storage and burial, respectively, of radioactively contaminated wastes. Radioactively contaminated sludge and other materials were buried in the trenches (10). The 903 Pad and Ryan's Pit Plume, the Mound Plume, and the East Trenches Plume are part of a large composite plume on the east side of the Site. Even though these contaminant plumes overlap, differing sources and flow paths make it effective to treat these parts of the large plume individually.

D.2.2.1 Mound Plume

The Mound site groundwater contaminant plume is poorly defined, but it is suspected to extend northward from the former location of the Mound where drums were buried to a point of discharge along South Walnut Creek, upstream of the Site Sewage Treatment Plant. Depending on the season, there may be many unsaturated areas within the plume. Dense nonaqueous phase liquid (DNAPLs) in the Mound area are suspected to be the source of the groundwater contamination and the potential exists for contaminant concentrations to increase over time. There is a possibility that Trench 1 could contribute to this plume; however, evidence indicates that the Mound site is the primary source.

Contaminated groundwater from the plume contains vinyl chloride, tetrachloroethene, and trichloroethene. The contaminant plume is discharging through surface and subsurface seepage into South Walnut Creek. The contaminated groundwater discharges at a rate of 0.5 gallons per minute (gal/min) or less at seep SW059, where it is collected and stored, then later treated at the Building 891 Treatment Plant.

D.2.2.2 The 903 Pad and Ryan's Pit Plume

This contaminant plume has two, closely spaced sources: 1) VOCs associated with drums formerly stored at the 903 Storage Area, where the contents of the drums leaked into the subsurface and groundwater, and 2) Ryan's Pit where VOCs were disposed of in a trench. The contaminated groundwater flows southward from these two source areas, toward the South Interceptor Ditch and Woman Creek. The groundwater is contaminated with carbon tetrachloride, tetrachloroethene, trichloroethene, and other VOCs. The highest concentrations of VOCs in groundwater are near the 903 Pad and Ryan's Pit sources, although isolated areas of high concentration have been observed within the plume away from these sources. Pure-phase tetrachloroethene and motor fuel constituents were found during the excavation of Ryan's Pit. Pure-phase DNAPLs are also suspected to exist underneath the 903 Pad.

Groundwater flow paths in alluvial materials in the 903 Pad and Ryan's Pit area are relatively well defined by contact seeps with the underlying bedrock materials and by numerous wells. However, groundwater flow through the hillside colluvium and bedrock is poorly understood. Areas of unsaturated colluvium are fairly common and prediction of local flow paths is difficult. Depending on the season, there may be many unsaturated areas within the plume. Discharge of contaminated groundwater has not been observed from the colluvium or weathered bedrock portion of this plume.

Contaminated groundwater containing tetrachloroethene and trichloroethene may eventually enter the South Interceptor Ditch and Woman Creek surface water pathways if no actions are taken to manage this plume. Discharge of contaminated groundwater into Woman Creek would pose a potential risk to the environment. Collection and treatment of contaminated groundwater from the 903 Pad and Ryan's Pit Plume will reduce the risk to the environment posed by uncontrolled releases to surface water.

D.2.2.3 East Trenches Plume

A large plume of contaminated groundwater is located in the East Trenches area. The principal sources are IHSS 110 (Trench 3) and 111.1 (Trench 4), with a minor contribution from the VOCs in the 903 Pad area. The trenches were used to bury sewage sludge from the Sewage Treatment Plant, but also contain DNAPLs, crushed drums, and other miscellaneous waste. Contaminated groundwater occurs within the UHSU, in the alluvium, and in the bedrock sandstone that is in hydraulic connection with the alluvium. The major contaminants are carbon tetrachloride, tetrachloroethene, and trichloroethene, as well as other VOCs.

The downgradient boundary of the contaminant plume is located at a spring-and-seep complex on the south bank of South Walnut Creek above Ponds B1 and B2 where the bedrock sandstone subcrops. Concentrations of VOCs above 100 times the MCLs have been detected by a recent sampling program conducted at the seep complex. There are potential ecological impacts because water from the contaminant plume containing tetrachloroethene and trichloroethene has

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reached South Walnut Creek. If concentrations in the seep complex increase over time, a greater contaminant mass may reach surface water.

A lobe of this contaminant plume also extends to the east of the East Trenches area in the alluvium, but has not reached surface water. Uncontaminated alluvial groundwater discharges downgradient of this lobe as seeps in an unnamed tributary drainage to South Walnut Creek. This groundwater will continue to be monitored.

Additional background information on groundwater quality for OU2 is reported in *the Phase II RI/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound, East Trenches Areas OU2* (11) and in the *Final Phase II RFI/RI OU2 Report* (12).

D.2.3 Solar Evaporation Ponds Groundwater Contamination (OU4)

The Solar Evaporation Ponds (SEPs)(IHSS 101) are located in the northeast section of the Protected Area as shown in Figure A-3. Figure D-3 presents details of the IHSS for OU4. The groundwater flow beneath the SEPs originates southwest of the Industrial Area and diverges flowing toward unsaturated areas above Walnut Creek and South Walnut Creek as shown on Plate 2.

The five ponds at IHSS 101 were used to temporarily store and treat various process aqueous wastes by evaporation. This included waste streams with low-level radioactivity, nitrates, acids, and sewage effluent. The configuration of these ponds has changed several times since they were initially installed in 1953. Previous hydrologic investigations of the SEP area indicated that the groundwater had been impacted by leakage from the ponds.

D.2.3.1 Solar Ponds Plume

Because contaminants were detected downgradient of the SEPs, a RCRA Assessment Groundwater Monitoring Program was instituted. Table D-1 lists contaminants detected in downgradient wells as reported in the annual RCRA groundwater monitoring reports (2, 3, 13, 4, 5). Groundwater monitoring data from UHSU wells indicate that nitrate contamination from the SEPs has migrated downgradient of the Interceptor Trench System (ITS) in unconsolidated surficial deposits and weathered bedrock.

The released nitrates have contaminated UHSU groundwater and have formed a plume that extends northward from the SEPs to the North Walnut Creek drainage above Pond A-1 (see Plate 3). A small lobe of this nitrate plume extends to the southwest for a short distance. This contaminant plume contains nitrates at concentrations above 100 times the MCLs. Nitrate concentrations within the plume are decreasing with time, but still exist at high levels. The analytical data indicate that the maximum concentrations of all the contaminants occurred in the immediate area of the SEPs with concentrations declining rapidly downgradient.

In response to nitrate/nitrite contamination detected in Walnut Creek, a series of trenches and sumps were installed north of the SEPs from 1971 to 1974. The trenches and sumps were replaced by a more extensive interceptor drainage system in the early 1980s. The purpose of this ITS was to collect surface water and shallow groundwater immediately downgradient of the SEP area. Water collected by the ITS was originally transferred back to one of the SEPs (14); but now, the ITS water is pumped to the Building 374 treatment system. The ITS was replumbed in 1993 to increase its effectiveness. The ITS captures approximately 2.7 million gal of water per year but is not entirely effective in preventing nitrate contamination from impacting the North Walnut Creek drainage (15).

Drainage of liquids and removal of sludge were completed at SEPs 207-A, 207-B North, 207-B Central, and 207-B South in 1994. The remaining pond, 207-C, has been drained and sludge has been removed to on-Site storage tanks.

The *Annual RCRA Groundwater Monitoring Reports for Regulated Units at the Site* contain available analytical data for the SEPs (2) (3) (1) (4) (5). Data are available for the second quarter 1988 through 1995. Additional information can be found in the *Draft IM/IRA Decision Document for OU4 Solar Evaporation Ponds* (15) and the *OU4 Solar Evaporation Ponds Phase II Groundwater Investigation Final Field Program Report* (16).

D.2.4 Industrial Area Groundwater Contamination

The Industrial Area has not received the same level of characterization as other portions of the Site. This is because the OUs associated with the Industrial Area had not completed RFI/RI investigations before the decision was made to integrate all remedial activities at the Site. Prior to the elimination of the OU-based investigations, OUs 8, 9, 10, 12, 13, and 14 were combined for purposes of remedial investigation. Preliminary surface soil investigations had been completed prior to cessation of activities on the Industrial Area OUs but no groundwater investigation had been started. However, two groundwater plumes have been generally defined; the Carbon Tetrachloride Plume and the Industrial Area Plume.

D.2.4.1 Carbon Tetrachloride Plume

Preliminary borehole drilling around tanks T9 and T10 in the former OU8 uncovered carbon tetrachloride free product that is associated with the Carbon Tetrachloride Plume. The carbon tetrachloride spill (IHSS 118.1) is located due north of Building 776 and east of Building 730. There are several documented past releases of carbon tetrachloride at this site. This area also overlaps other IHSSs [i.e., 121-T9, 121-T10, 131, and 144(N)]. Different spills are associated with these IHSSs.

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IHSS 118.1 is the site where a 5,000-gal, underground steel storage tank for carbon tetrachloride and associated piping were formerly located. Numerous reported spills have occurred before 1970, some between 100 to 200 gal, as documented in the Historical Release Report (10). The tank ultimately failed in June 1981 and subsequently was removed along with a limited amount of soil surrounding the tank. The numerous releases of carbon tetrachloride from IHSS 118.1 have contaminated surrounding soils and formed a contaminant plume in UHSU groundwater which extends from the vicinity of the former tank location eastward to the SEPs. The plume may eventually reach the Walnut Creek drainage.

D.2.4.2 Industrial Area Plume

The IM/IRA for the Industrial Area (17) compiled groundwater and surface water data for use in designing a monitoring program for decontamination and decommissioning (D&D) activities. From these data, a groundwater plume composed of VOCs was discovered in groundwater in the Builings 300 and 400 areas that later was defined as the Industrial Area Plume (see Plate 3). The Industrial Area Plume is suspected to be a coalesced plume of contaminated groundwater containing trichloroethene thought to emanate from IHSSs 117.1, 117.2, 157.1, 158, 171 and 182; tetrachloroethene thought to emanate from IHSSs 117.1, 117.2, 158, 157.1, 160, and 171; and carbon tetrachloride thought to emanate from IHSSs 117.1, 117.2, and 158.

Currently, the Industrial Area Plume does not appear to be migrating rapidly downgradient, and there are no known surface water impacts. However, groundwater pathways exist to both Woman Creek and to Walnut Creek. Groundwater recharge in the Industrial Area caused by water losses from sewers and water-supply pipelines may be substantial. Reduction of recharge from these sources could significantly reduce the potential for contaminant migration in the subsurface.

Treatment of contaminated groundwater within the Industrial Area does not appear to be necessary to protect surface water because the plume appears to have limited potential for migration. However, ongoing monitoring and evaluation of the groundwater through the monitoring program will continue and will detect any possible movement or expansion of the plume. Groundwater remedial actions may become necessary if the contaminant plumes expand and migrate significantly, thereby becoming a threat to surface water.

Further investigation of the plume or plumes in the Industrial Area has been suspended until D&D activities have been completed on buildings in the Industrial Area. Wells in the Industrial Area will be monitored for the known contaminants detected in the Industrial Area Plume.

D.2.5 Groundwater Contamination at the Existing Landfill (OU7)

The Existing (Present) Landfill began operation in 1968 with the closure of the Original Landfill (now IHSS 115). The Existing Landfill is located in the Buffer Zone north of the Protected Area as shown on Figure A-3. Figure D-4 presents detail of the IHSSs included in OU7. The local recharging groundwater flow direction is from the west-southwest toward the Existing Landfill, then is focused toward the Landfill Pond and the portion of the Walnut Creek drainage designated as "No Name Gulch" as shown on Plate 2.

In addition to typical sanitary landfill wastes, limited quantities of hazardous wastes were disposed of in the landfill, particularly in the early years of operation between 1968 and 1970. In September 1973, tritium was detected in leachate draining from the landfill. In response, a sampling program was initiated to determine the location of the tritium source and interim response measures were also undertaken to control the generation and migration of landfill leachate. Interim response measures included the construction of two ponds of which the East Landfill Pond remains, and a subsurface leachate collection system and a subsurface intercept/slurry wall system for diverting upgradient groundwater.

Evaluation of groundwater quality data (13) specifically within the Existing Landfill revealed elevated radionuclide activities and high concentrations of VOCs, metals, and inorganic constituents. The Existing Landfill has been under a RCRA Alternate Groundwater Monitoring Program. Table D-1 lists the chemicals detected in the Existing Landfill based on data generated from the groundwater monitoring program. Aluminum, manganese, zinc, 2-methylnaphthalene, naphthalene, benzene, and possibly methylene chloride are present in leachate below the current landfill, with average values exceeding action levels. Organic contaminant plumes exist in groundwater south and west of the current landfill pond, including a portion of OU7. Groundwater in downgradient wells below the landfill pond show elevated concentrations of nitrate, sulfate, chloride, lithium, barium, strontium, magnesium, and uranium with respect to upgradient wells (5).

D.2.5.1 PU&D Yard Plume

In 1993, newly installed upgradient wells at the PSL detected significant concentrations of VOCs in the alluvial groundwater. This data and data from wells on the south side of the PSL suggest that a VOC plume exists upgradient of the PSL and has migrated eastward (see Plate 3). The suspected source of the contamination is the PU&D yard located west of the landfill. Activities are being planned to evaluate the source of this plume.

Additional information on water quality at the PSL can be found in the *Annual RCRA Groundwater Monitoring Reports For Regulated Units* (2) (3) (1) (4) (5), *Technical Memorandum - Final Work Plan for OU7* (18) and *Draft IM/IRA Decision Document for OU7 Present Landfill* (19).

D.2.6 Old Landfill (OU5)

The Old Landfill (OLF) is geographically located along the north side of Woman Creek and is designated as IHSS 115. The OLF was investigated as part of the OU5 RFI/RI project (20). Figure A-3 shows the IHSSs covered in OU5.

Elevated concentrations of a few metals, water quality parameters, radionuclides and VOCs were encountered in wells monitoring the Old Landfill (see Table D-1). TCE and TCA were the only volatile organics encountered. Though contamination from the OLF is at low levels, and a downgradient contaminant plume has not been defined, the proximity of the IHSS to Woman Creek has made it a priority for monitoring.

D.3 References

1. *Well Evaluation Report Final.* EG&G Rocky Flats, Inc., Golden, Colorado, April 1994.

2. *1991 Annual RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant.* EG&G Rocky Flats, Inc., Golden, Colorado, March 1992.

3. *1992 Annual RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant.* EG&G Rocky Flats, Inc., Golden, Colorado, March 1993.

4. *1994 Annual RCRA Report for Regulated Units at the Rocky Flats Environmental Technology Site.* EG&G Rocky Flats, Inc., Golden, Colorado, March 1995.

5. *1995 Annual RCRA Report for Regulated Units at Rocky Flats Environmental Technology Site.* Rocky Mountain Remediation Services, L.L.C.,/Kaiser-Hill Company, L.L.C., February 1996.

6. *Groundwater Conceptual Plan for the Rocky Flats Technology Site*, Final Revised. Rocky Mountain Remediation Services, L.L.C., March 1996.

7. *Final Phase III RFI/RI Work Plan Revision 1 for 881 Hillside Operable Unit 1.* EG&G Rocky Flats, Inc., Golden, Colorado, March 1991.

8. *Interim Measure/Interim Remedial Action French Drain Performance Monitoring Plan.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June 1992.

9. *Final Phase III RFI/RI, Rocky Flats Plant, 881 Hillside Area, Operable Unit No. 1.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June 1994.

10. *Final Historical Release Report for the Rocky Flats Plant.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June 1992.

11. *Phase II RI/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound, East Trenches Areas OU2.* Rockwell International, 1989.

12. *Final Phase II RFI/RI Report 903 Pad, Mound, and East Trenches Area Operable Unit No. 2.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, October 1995.

13. *1993 Annual RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant.* EG&G Rocky Flats, Inc., Golden, Colorado, February 1994.

14. *Solar Pond Interceptor Trench System Groundwater Management Study, Rocky Flats Plant: Task 7 of the Zero-Offsite Water-Discharge Study.* Advanced Sciences, Inc., January 15, 1991.

15. *OU4 Solar Evaporation Ponds, Interim Measure/Interim Remedial Action, Environmental Assessment Decision Document, Part IV, Recommended Interim Measure/Interim Remedial Alternative and Part V, Post-Closure Monitoring and Assessment Plan Rev.: Draft Proposed.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, May 1994.

16. *OU4 Solar Evaporation Ponds Phase II Groundwater Investigation Final Field Program Report.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, February 1996.

17. *Final Interim Measures/Interim Remedial Action Decision Document for the Rocky Flats Industrial Area.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, March 1994.

18. *Technical Memorandum, Final Work Plan, Operable Unit No.7.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, September 1994.

19. *Phase I IM/IRA Decision Document and Closure Plan for Operable Unit 7 Present Landfill, Revised Draft.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, March 1996.

20. *Final Phase I RFI/RI Report, Woman Creek Drainage, Operable Unit 5.* U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, April 1996.

AF. _.NDIX E
PROPOSED MONITORING WELLS

WELL NO	FREQUENCY		PLUME\AREA	DRIVERS	FORMATION	DECISION\PURPOSE
6486	Semiannual	D	881 Hillside	RFCA	AL	Drainage well monitoring the Woman Cr. drainage downgradient of the 881 Hillside Plume
5587	Semiannual	D	881 Hillside	RFCA	AL	Drainage well monitoring the Woman Cr. drainage south of the 881 Hillside Plume
5387	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881Hillside Plume
4887	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881 Hillside Plume
4787	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881 Hillside Plume
38591	Semiannual	D	881 Hillside	RFCA	AL	Drainage well in Woman Cr. Drainage below 881 Hillside Plume
35691	Semiannual	PM	881 Hillside	RFCA	AL	Performance Monitoring for 881 Footing Drain Sump
11092	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10992	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10792	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10692	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10592	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
0487	Semiannual	PD	881 Hillside	RFCA	AL	Plume Definition well for the 881 Hillside Plume
6586	Semiannual	D	903 Pad	RFCA	AL	Drainage well monitoring the No. side Woman Cr. below 903Pad/Ryans Pit Plume
6386	Semiannual	PD	903 Pad	RFCA	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
6286	Semiannual	PD	903 Pad	RFCA	BD/USHU	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
3087	Semiannual	PD	903 Pad	RFCA	BD	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
2987	Semiannual	PD	903 Pad	RFCA	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
23196	Semiannual	PE	903 Pad	RFCA	AL	Plume Extent well monitoring the southward migration of the Ryans Pit/903 Pad Plume
23096	Semiannual	PE	903 Pad	RFCA	AL	Plume Extent well monitoring the southern migration of the Ryans- OU2 VOA Plume
22996	Semiannual	DD	Bldg 886	RFCA, IM/IRA for IA	AL	Building D&D well monitoring potential rad contamination near 886 lab
41691	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in the Walnut Cr. Drainage at the Indiana Street Boundary
41591	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in small drainage near east access gate
10394	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in the Woman Cr. Drainage at the Indiana Street Boundary
10294	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - in drainage below Pond D-2 in the southeast corner of the Site
06491	Semiannual	B	Boundary	RFCA, AIP	BD/UHSU	Boundary Well - in small drainage east of the Site at Indiana St.
0386	Semiannual	B	Boundary	RFCA, AIP	BD/UHSU	Boundary Well - in small drainage north of the east access gate
P219189	Semiannual	PD	Carbon Tet	RFCA, RCRA	AL	Plume Definition well for VOC contamination comming from Carbon Tet Plume
P209389	Semiannual	PD	Carbon Tet	RFCA, RCRA	BD	Plume Definition well in the Carbon Tet Plume
P209289	Semiannual	PD	Carbon Tet	RFCA, RCRA	AL	Plume Definition well in the Carbon Tet Plume
23296	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the northern migration of the East Trenches Area Plume
10194	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the southern migration of the East Trenches Plume
06091	Semiannual	PE	East Trenches	RFCA	AL/BD	Plume Extent well monitoring the northeast migration of the East Trenches Plume
05091	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume
04991	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume
04591	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the southward migration of the East Trenches Plume
04091	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the northward migration of the East Trenches Plume
03991	Semiannual	PE	East Trenches	RFCA	AL	Plume Definition well monitoring the East Trenches Plume
10994	Semiannual	PE	IA\Old Landfill	RFCA	AL	Plume Extent IA VOA Plume\Old Landfill Plume near Woman Cr.
7086	Semiannual	PE	IA\Old Landfill	RFCA	AL	Plume Extent well monitoring IA Plume and Old Landfill Plume pathway in Woman Cr.
P416889	Semiannual	PD	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Definition of IA Plume south of Bldg. 664 along pathway to Woman Cr.
P416789	Semiannual	PD	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Definition of IA Plume south of 400 area along pathway to Woman Cr.
P416689	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor southern migration of IA Plume south of Bldg. 440
P314289	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor the southern migration of IA Plume near Bldg. 850
P313589	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor the eastward migration of IA Plume near Bldg. 881
P114389	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well to monitor extent of PU&D yard plume pathway to Walnut Cr.
6186	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring easward migration of IA Plume
43392	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well monitoring southward migration of IA Plume
22896	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northward migration of IA VOA Plume
22796	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northward migration of Carbon Tet Plume
22696	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the westward migration of the Carbon Tet Plume
22596	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northern migration of the IA Plume
2186	Semiannual	PE	Ind. Area	RFCA	BD/UHSU	Plume Extent well monitoring the northern migration of the 'IA Plume

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1986	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well monitoring the northern migration of the IA PLume
B206989	Semiannual	RCRA	Landfill	RFCA, RCRA	BD/UHSU	RCRA\Plume Extent well monitoring downgradient of Landfill Plume
77392	Semiannual	PD	Landfill	RFCA, RCRA	AL	Plume Definition well monitoring the eastward migration of the PU&D Yard Plume
52994	Semiannual	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
52894	Semiannual	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
4087	Semiannual	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
3786	Semiannual	D	Mound	RFCA	AL	Drainage Well - below Pond B-4 in South Walnut Creek Drainage
75992	Semiannual	PE	Mound	RFCA	AL	Plume Extent well monitoring So. Walnut Cr. Drainage below Mound Site Plume
08091	Semiannual	PE	Mound\E. Trench	RFCA	AL	Plume Extent well monitoring the southern migration of Mound and East Trenches Plumes
New Well	Semiannual	PE	Old Landfill	RFCA	AL	Plume Extent well monitoring the Old Landfill Plume
New Well	Semiannual	PE	PU&D	RFCA	AL	Plume Extent well monitoring the PU&D Yard Plume
New Well	Semiannual	PE	PU&D	RFCA	AL	Plume Extent well monitoring the PU&D Yard Plume
New Well	Semiannual	PD	Solar Ponds	RFCA	AL	Plume Definition well monitoring the southern migration of the Solar Ponds Plume
70493	Semiannual	RCRA	PU&D	RFCA, RCRA	BD/UHSU	RCRA upgradient/Plume Definition well monitoring the edge of the PU&D Yard Plume
70393	Semiannual	RCRA	PU&D	RFCA, RCRA	AL	RCRA upgradient /Plume Definition well monitoring the edge of the PU&D Yard Plume
70193	Semiannual	RCRA	PU&D	RFCA, RCRA	BD/UHSU	RCRA upgradient/Plume Extent well monitoring the PU&D Yard Plume
5887	Semiannual	RCRA	PU&D	RFCA, RCRA	AL	RCRA upgradient/ Plume Extent Well monioring the PU&D Yard Plume - LF
76992	Semiannual	PE	PU&D\Landfill	RFCA, RCRA	AL	Plume Extent well monitoring the eastward migration of the PU&D Yard/Landfill Plume
6687	Semiannual	PD	PU&D\Landfill	RFCA, RCRA	AL	Plume Definition well monitoring the Landfill/PU&D yard Plume
P219489	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
P218389	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
B208289	Semiannual	PE	Solar Ponds	RFCA	BD/UHSU	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume
3386	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the southern migration of the SEP Nitrate and Carbon Tet Plumes
1786	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Definition well monitoring the migration of the SEP Nitrate and Carbon Tet Plumes
1386	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Definition well monitoring the migration of the SEP Nitrate and Carbon Tet Plumes
B208789	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume
CDPHE\EPA Well Requests						
07391	Semiannual	PM	903 Pad	RFCA	AL\BD	Performance Monitoring well monitoring effects of remediation downgradient of Ryans Pit
00491	Semiannual	PD	903 Pad	RFCA	BD\UHSU	Plume Definition well monitoring the 903 Pad VOC Plume
11891	Semiannual	PM	East Trenches	RFCA	BD\UHSU	Performance Montoring well monitoring effects of remediation downgradient of Trench T-3
3687	Semiannual	PM	East Trenches	RFCA	BD\USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
12691	Semiannual	PM	East Trenches	RFCA	BD\USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
05691	Semiannual	PM	East Trenches	RFCA	AL	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
P209489	Semiannual	PD	Solar Ponds	RFCA	BD\UHSU	Plume Definition well for the Carbon Tet. Plume
3586	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well tracking migration of Solar Ponds nitrate Plume
05391	Semiannual	PD	East Trenches	RFCA	AL	Plume Definition well monitoring eastward concentration of VOCs from the East Trenches Plume
12191	Semiannual	PM	East Tranches	RFCA	BD\UHSU	Performance Monitoring at edge of T3 soil excavation

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APPENDIX E
PROPOSED MONITORING WELLS

WELLNO	FREQUENCY	PLUME\AREA	VOC Suite	METALS Suite	TRITIUM	PU/AM	SR 89/90	URANIUM	NITRATE	FLUORIDE	SULPHATE			
6486	Semiannual	881 Hillside	X	X				X	X		X			
5587	Semiannual	881 Hillside	X	X				X	X		X			
5387	Semiannual	881 Hillside	X	X				X	X		X			
4887	Semiannual	881 Hillside	X	X				X	X		X			
4787	Semiannual	881 Hillside	X	X				X	X		X			
38591	Semiannual	881 Hillside	X	X				X	X		X			
35691	Semiannual	881 Hillside	X	X				X	X		X			
11092	Semiannual	881 Hillside	X	X				X	X		X			
10992	Semiannual	881 Hillside	X	X				X	X		X			
10792	Semiannual	881 Hillside	X	X				X	X		X			
10692	Semiannual	881 Hillside	X	X				X	X		X			
10592	Semiannual	881 Hillside	X	X				X	X		X			
0487	Semiannual	881 Hillside	X	X				X	X		X			
6586	Semiannual	903 Pad	X	X		X		X	X					
6386	Semiannual	903 Pad	X	X		X		X	X					
6286	Semiannual	903 Pad	X	X		X		X	X					
3087	Semiannual	903 Pad	X	X		X		X	X					
2987	Semiannual	903 Pad	X	X		X		X	X					
23196	Semiannual	903 Pad	X	X		X		X	X					
23096	Semiannual	903 Pad	X	X		X		X	X					
22996	Semiannual	Bldg 886	X			X	X	X						
41691	Semiannual	Boundary	X		X	X		X	X	X	X			
41591	Semiannual	Boundary	X		X	X		X	X	X	X			
10394	Semiannual	Boundary	X		X	X		X	X	X	X			
10294	Semiannual	Boundary	X		X	X		X	X	X	X			
06491	Semiannual	Boundary	X		X	X		X	X	X	X			
0386	Semiannual	Boundary	X		X	X		X	X	X	X			
P219189	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X			
P209389	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X			
P209289	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X			
23296	Semiannual	East Trenches	X	X		X		X	X					
10194	Semiannual	East Trenches	X	X		X		X	X					
06091	Semiannual	East Trenches	X	X		X		X	X					
05091	Semiannual	East Trenches	X	X		X		X	X					
04991	Semiannual	East Trenches	X	X		X		X	X					
04591	Semiannual	East Trenches	X	X		X		X	X					
04091	Semiannual	East Trenches	X	X		X		X	X					
03991	Semiannual	East Trenches	X	X		X		X	X					
10994	Semiannual	IA\Old Landfill	X	X			X	X	X		X			
7086	Semiannual	IA\Old Landfill	X	X			X	X	X		X			
P416889	Semiannual	Ind. Area	X	X										
P416789	Semiannual	Ind. Area	X	X										
P416689	Semiannual	Ind. Area	X	X										
P314289	Semiannual	Ind. Area	X	X										
P313589	Semiannual	Ind. Area	X	X										
P114389	Semiannual	Ind. Area	X	X										

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APPENDIX E
PROPOSED MONITORING WELLS

WELLNO	FREQUENCY	PLUME\AREA	VOC Suite	METALS Suite	TRITIUM	PU/AM	SR 89/90	URANIUM	NITRATE	FLUORIDE	SULPHATE			
6186	Semiannual	Ind. Area	X	X										
43392	Semiannual	Ind. Area	X	X										
22896	Semiannual	Ind. Area	X	X										
22796	Semiannual	Ind. Area	X	X										
22696	Semiannual	Ind. Area	X	X										
22596	Semiannual	Ind. Area	X	X										
2186	Semiannual	Ind. Area	X	X										
1986	Semiannual	Ind. Area	X	X										
B206989	Semiannual	Landfill	X	X	X			X	X	X	X			
77392	Semiannual	Landfill	X	X	X			X	X	X	X			
52994	Semiannual	Landfill	X	X	X			X	X	X	X			
52894	Semiannual	Landfill	X	X	X			X	X	X	X			
4087	Semiannual	Landfill	X	X	X			X	X	X	X			
3786	Semiannual	Mound	X			X	X	X						
75992	Semiannual	Mound	X	X		X	X	X	X					
08091	Semiannual	Mound\E. Trench	X	X		X	X	X	X					
New Well	Semiannual	Old Landfill	X	X	X		X	X	X	X	X			
New Well	Semiannual	PU&D	X	X	X			X	X	X	X			
New Well	Semiannual	PU&D	X	X	X			X	X	X	X			
New Well	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
70493	Semiannual	PU&D	X	X	X			X	X	X	X			
70393	Semiannual	PU&D	X	X	X			X	X	X	X			
70193	Semiannual	PU&D	X	X	X			X	X	X	X			
5887	Semiannual	PU&D	X	X	X			X	X	X	X			
76992	Semiannual	PU&D\Landfill	X	X	X			X	X	X	X			
6687	Semiannual	PU&D\Landfill	X	X	X			X	X	X	X			
P219489	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
P218389	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
B208289	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
3386	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
1786	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
1386	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X			
B208789	Semiannual	Solar Ponds	X	X	X	X		X	X	X	X			
CDPHE\EPA Well Requests														
07391	Semiannual	903 Pad	X	X		X		X	X					
00491	Semiannual	903 Pad	X	X		X		X	X					
11891	Semiannual	East Trenches	X	X		X		X	X					
3687	Semiannual	East Trenches	X	X		X		X	X					
12691	Semiannual	East Trenches	X	X		X		X	X					
05691	Semiannual	East Trenches	X	X		X		X	X					
P209489	Semiannual	Solar Ponds	X	X	X	X		X	X	X	X			
3586	Semiannual	Solar Ponds	X	X	X	X		X	X	X	X			
05391	Semiannual	East Trenches	X	X		X		X	X					
12191	Semiannual	East Trenches	X	X		X		X	X					
Wells Removed From List														
31791	Semiannual	881 Hillside	X	X				X	X		X			

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Appendix E Water Level Monitoring Wells

	SITE-WIDE[1]		
WELL Alluvium	WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
0186		12	
1086		730	
1386	12		
1786	12		
1886		2	
1986	12		
2286		12	
2486		2	
2686		2	
2986		2	
3386	12		
3586	12		
3686		2190	
3786	12		
3986		12	
4186		730	
4286		12	
4386		12	
4486		2	
4786			730
5586			730
5686			12
6186	4		
6386	4		
6486	12		
6586	12		
6686		12	
6786			2
6886		2190	
7086	4		
0187		730	
0487	12		
1087		2	
1587		12	
1987		2	
2187		2	
2487		2	
2687		2	
2987	4		
3287		2	
3387		2	
4087	12		
4387		2	
4787	4		
4887	4		
5287		12	
5387	4		
5587	12		

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WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
5887	4		
6087		2	
6687	4		
7187		2	
B400389			12
B200589			730
B200889			12
B102289			2
B102389			2
B402689			12
P207689		2	
P207889		2	
B208089		12	
B208789	4		
P209289	4		
P209789		2	
B210489		2190	
B410589			12
B410689			2
B410789		2	
B110889		2	
B110989			12
B111189			12
B411289			12
P313489		2	
P313589	12		
P213689		730	
P414189		2	
P314289	12		
P114389	12		
P114489		2	
P114689		2	
P114789		2	
P114889		730	
P114989		2	
P115089		12	
P115489		730	
P115589		2	
P115689		2	
P215789		2	
P415889		730	
P415989		2	
P416089		12	
P416189		2	
P416289		2	
P416389		2	
P416489		12	
P416589		730	
P416689	12		

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Appendix E Water Level Monitoring Wells

	SITE-WIDE[1]		
WELL	WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
P416789	12		
P416889	12		
P317989		2	
P218089		2	
P218289		2	
P218389	12		
P219189	12		
P119389		730	
P219489	4		
P320089		2	
0190			12
0290			12
0390			12
0990			12
1190			12
1290			2
1390			2
1490			12
00191		2	
00491	4		
00891		730	
01291		2	
01391		12	
03191		2	
03991	4		
04091	4		
04191		2	
04591	4		
04991	4		
05091	4		
05291		2	
05391	4	2	
05691	4		
06191		2	
06991		2	
07291		12	
07391	4		
08091	4		
13091		2	
13391		2	
13491		2	
13591		2	
20291		12	
20691		730	
34791		2	
35691	4		
37191		2	
37591		730	
37691		2	

WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
37791		2	
38591	4		
41091		12	
41591	12		
41691	12		
10592	4		
10692	4		
10992	4		
11092	4		
43392	4		
46292			2
46492		2	
75292		12	
75992	4		
76792		2	
76992	4		
77392	4		
77492		730	
00293			12
05193		12	
05293		730	
44893		12	
45793		2	
46293		730	
58793		2	
59493		2	
59893		2	
60693		2	
61293		2	
62593			12
62693			12
62893		2	
70393	4		
70693		2	
10194	4		
10294	4		
10394	4		
10594		2	
10694		2	
10794		2190	
10994		2	
11294			12
11494			12
11594			12
50494			2
50694		2	
51094			2
51194		2	
51294		12	

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WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
51494			730
51594			12
52894	4		
52994	4		
56994		2	
57094		2	
59594		2	
60294		2	
60994		2	
68294		2	
60195		12	
60295		2	
60395		2	
60695		2	
60795		2	
61295		2	
61495		2	
61595		2	
61695		2	
62395			12
63395		2	
63495		2	
63795			12
63895			12
64595			12
20196			2
20296			2
20396			2
20496			2
20596			2
20696			12
20796			2
22596	12		
22696	4		
22796	4		
22896	4		
22996	12		
23096	4		
23196	4		
23296	4		
P419689		2	
00491		2	
06091	12		
07391		2	
31791	4		
10894		2	
Bedrock			
0386	12		
2186	4		

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Appendix E   Water Level Monitoring Wells

WELL	SITE-WIDE[1] WATER QUALITY	INDUSTRIAL AREA	BACKGROUND
6286	4		
3087	4		
3687	730		
B206989	4		
B208289	4		
P209389	4		
P209489	4		
P114589		2	
P416989		2	
03791		730	
06291		12	
06491	4		
11891	4		
12191	4		
12691	4		
10792	4		
70193	4		
70493	4		
	1266	20884	3262

Note:
Numbers in columns denote measurement frequency per year

THIS TARGET SHEET REPRESENTS AN OVER-SIZED MAP / PLATE FOR THIS DOCUMENT

Integrated Monitoring Plan Background Document, June 30, 1997

Plate 1:

Groundwater Flow Monitoring Well Location Map

Map ID: 97-0028

December 15, 1997

CERCLA Administrative Record document, B2 - A - 000303

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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THIS TARGET SHEET REPRESENTS AN OVER-SIZED MAP / PLATE FOR THIS DOCUMENT

Integrated Monitoring Plan Background Document, June 30. 1997

Plate 2:

Potentiometric Surface Of Unconsolidated Surficial Deposits

Second Quarter , 1993

Map ID: 97-0034

June 3, 1997

CERCLA Administrative Record document, BZ - A - 000303

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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THIS TARGET SHEET REPRESENTS AN OVER-SIZED MAP / PLATE FOR THIS DOCUMENT

Integrated Monitoring Plan Background Document, June 30, 1997

Plate 2:

Regulatory Required Groundwater Monitoring Wells Selected VOC & Nitrate Plumes (Nitrate Standard and 100 X Standard VOC MCL and 100 X MCL)

Map ID: 97-0001

December 15, 1997

CERCLA Administrative Record document, BZ - A - 000363

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Air Monitoring

June 30, 1997
Rev. 1

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4.0 AIR QUALITY

4.1 Introduction

Regulatory activities encompassed by federal and state regulations pursuant to the Clean Air Act (CAA) and its amendments are managed and directed at the Rocky Flats Environmental Technology Site (RFETS or Site) by the Air Quality Management (AQM) within Kaiser-Hill Company's (Kaiser-Hill) Compliance and Performance Assurance organization. This group is responsible for developing the compliance scope and reporting and recordkeeping strategies that the project organizations on Site use to maintain compliance with all applicable air quality regulations and Department of Energy (DOE) Orders. Within that framework, AQM operates a monitoring program that supports both compliance demonstration and emergency response needs at the Site.

Monitoring of radioactive emissions from building process vents support both DOE Order requirements and National Emission Standards for Emissions of Radionuclides Other Than Radon from DOE Facilities (Rad NESHAP) monitoring and reporting requirements. Ambient monitoring of radionuclides on the Site and in the communities immediately adjacent to the Site also satisfy DOE Order requirements and is anticipated to be used in the near future to satisfy Rad NESHAP reporting requirements. Ambient monitoring is performed by AQM and by the Colorado Department of Public Health and Environment (CDPHE), both on Site and at the perimeter. Off-Site monitoring is performed by AQM. Meteorological monitoring supports both the Rad NESHAP reporting requirements and emergency response requirements under the DOE Orders.

Effluent monitoring also supports as low as reasonably achievable (ALARA) principals. These DOE principals provide a conceptual radiation exposure guideline intended to encourage radiation protection practices that exceed those of any prescribed standard. The basis for this concept is the acknowledgment that low exposure dose-effect relationships may exist that cannot be measured or demonstrated scientifically. Effluent monitoring is used to verify the efficacy of radiation control mechanisms that are used in the areas containing and handling significant quantities of radionuclide materials. Levels of emissions that cause no concern from a regulatorily significant environmental perspective are sufficient to trigger a proactive investigative response under the ALARA concept.

Meteorological monitoring is conducted on Site by use of a 61-meter (m) tower instrumented at three levels (10, 25, and 60 m). It is designed to provide support for routine monitoring and assessments, and emergency response. A redundant, instrumented, 10 m tower is located near the primary tower to provide backup data support. Meteorological data are currently used for air quality monitoring support, atmospheric dispersion modeling, hydrological studies, construction management, and safety investigation.

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In cooperation with the surrounding communities, DOE has implemented a five-station Community Radiation (ComRad) Program. Independently operated monitoring stations were installed in 1992 in the communities of Arvada, Westminster, Broomfield and Northglenn. Ambient concentrations of plutonium (Pu) are collected continuously using monitoring protocols comparable to those at the Site. Analytical support for sample analysis is provided by U.S. Environmental Protection Agency (EPA) Region 7 laboratories in Las Vegas. Although not a compliance-driven monitoring program, DOE supports this independent evaluation of its potential emissions as a gesture of public assurance in the Site's safe operation.

Air quality monitoring programs provide compliance and support data to other Site functional organizations. Effluent data supports Nuclear Safety evaluation of the building safety envelope. Ambient data can be used in the Human Health Risk Assessment evaluations of Operable Unit closure and to validate effluent modeling results. Emergency response operations and their associated modeling efforts (Terrain Response Atmospheric Code) make major use of the 61 m meteorological tower.

4.1.1 Air Monitoring Scope

The AQM organization provides programmatic support to Site operations, specifically directed toward compliance with all state and federal laws originating from the CAA and its amendments, regulations, and DOE Orders related to air quality impacts on the environment due to Site operations. The scope of this support includes the characterization of both airborne materials and the meteorology responsible for their transport and dispersion. Criteria for success include completeness of the permitting and surveillance activities, no violations of air quality regulations, adequate quality assurance/quality control (QA/QC) of the measurement activities, well-characterized data sets, and full reporting of required information to state and federal regulatory authorities. Within this program, monitoring activities play a major role in characterizing the emissions from the Site.

Air quality monitoring programs do not include sampling conducted to support Industrial Hygiene or radiation worker safety programs; however, these activities are being examined to determine ways that the information gathered during environmental restoration work can be used to evaluate the adequacy of existing air monitoring and its analysis schedule.

Regulatory drivers pertinent to air monitoring programs include:

- Effluent Monitoring:
  - *Title 40 of the Code of Federal Regulations (CFR) Part 61, Subparts A and H, and Appendix B (Rad NESHAPs),*
  - Regulation No. 8, Part A, Section III A-C, "State of Colorado Emission Standards for Beryllium," Colorado Air Quality Control Commission, and

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  - DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy.

- Ambient Monitoring:

  - DOE Order 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy (Ch 1.10), and
  - 40 CFR 61, Subpart H (ambient proposed for alternative compliance demonstration methodology for former point sources transition to fugitive sources); and

- Meteorological Monitoring:

  - 40 CFR 61, Subpart H (meteorology parameters used as input parameters to compliance dispersion modeling),
  - DOE Order 5400.1-IV; 2.4, *General Environmental Protection Program*, U.S. Department of Energy, and
  - DOE Order 5500.3A, *Emergency Planning and Preparedness for Operational Emergencies*, U.S. Department of Energy.

4.1.2 Environmental Protection Goal

The goal of the air quality programs is to provide a means to assess the impact of Site operations on the air quality on and around the Site and thereby protect the public and the environment. These programs integrate into a Site-wide Environmental Protection Program by providing monitoring, compliance, and permitting projects that quantify and/or characterize the air pathway impact on public receptors.

4.1.3 Monitoring Objectives

Air quality monitoring objectives provide assessment support for Site operations, either directly, as is the case with the effluent program, or indirectly, as with ambient monitoring and meteorological monitoring. Data from ambient monitoring are also used to validate projections made by dispersion modeling and may soon be used as direct confirmation of low emissions for demonstrating compliance under Rad NESHAP requirements. In addition, ambient data from the Radioactive Ambient Air Monitoring Program (RAAMP) are used to confirm controls are operating within Nuclear Safety's ALARA limits, under the DOE directive that strives to keep dose to all receptors as low as reasonably possible by maintaining administrative and mechanical controls on all potential radiological sources.

At routine (weekly or monthly) intervals, particulate material samples from a continuous effluent sampling system are removed from each exhaust system identified as having a potential to emit significant quantities of radioisotopes. Each of these 47-millimeter (mm) filters is radiometrically analyzed for long-lived alpha emitters. The concentration of long-lived alpha emitters is indicative of effluent quality and overall performance of the high-efficiency particulate air (HEPA) filtration system. If the total long-lived alpha concentration for an effluent sample exceeds the RFETS action level of 0.02×10^{-12} microCuries per milliliter (µCi/ml), a follow-up investigation is conducted to determine the cause and to evaluate the need for corrective action.

Historically, at the end of each month, individual samples from each exhaust system were composited into larger samples by location. Beginning in fiscal year 1996 (FY96), samples from minor (insignificant) emission locations have been collected monthly and composited on an annual basis. Filters from significant sources [having the potential to contribute more than 0.1 millirem (mrem) per year (yr) effective dose equivalent (EDE), uncontrolled, to any member of the public] are analyzed on a monthly basis. Radionuclides are extracted from these filter composites and subjected to radiochemical separation and alpha spectral analysis, which quantifies specific alpha-emitting radionuclides. Analyses are performed for specific isotopes of Pu, uranium (U), and americium (Am). Tritium (H-3) samples are collected twice weekly at six locations. Detection limits are established to ensure that these radionuclides are detected in concentrations well under 10% of the regulatory standard for that radionuclide, using Appendix E guidelines from 40 CFR 61.

The RAAMP monitors airborne dispersion of radioactive materials from the Site into the surrounding environment. Thirty-five samplers comprise the RAAMP network. Twelve of these existing samplers will be included in a proposal to satisfy future regulatory compliance demonstration requirements under the CAA using environmental measurements; the others are used for backup should there be accidental releases from the Site or for determining local impacts from remediation projects. Samplers operate continuously at a volumetric flow rate of approximately 40 cubic feet per minute (ft^3/min), collecting air particulates on two collection surfaces. Coarse and fine particulates are collected on separate substrates and can be analyzed independently. Samples are routinely analyzed for selected isotopes of Pu, U, and Am.

4.2 Rad NESHAP Compliance Monitoring

The Site must demonstrate compliance with the Rad NESHAP air emission and dose standards. To demonstrate compliance, the following critical inputs must be evaluated.

Inputs:

- Monitored concentrations of Pu-239/240, Am -241, U-233/234, U–238, and H-3 from applicable emission sources.

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- Site-specific meteorology for the year that the monitored data are reported.
- Resuspension coefficient for soils.
- Documentation of emissions potential from all unmonitored Site activities having potential to emit radionuclides.
- Verification of low emissions for sources not subject to continuous monitoring requirements.

Boundaries:

Spatial:	All areas hosting activities on the Site that could impact off-Site populations. Current effluent sampling (stack sampling) is occurring at 52 locations within buildings located throughout the Industrial Area. RAAMP samplers sited with a density that would typically allow capturing a plume that has a duration of two hours or more (35 locations).
Temporal:	Annual dose estimates. Quarterly estimates of emissions reported to public. Monthly data from significant emission points to generate 12-month rolling average. Weekly or monthly alpha-activity screening analyses.

Decision Statement:

IF	The estimated radiological dose to any member of the public is greater than 10 mrem/yr due to Site operations
THEN	The Site is out of compliance.

Point sources (significant sources) that have an estimated uncontrolled (without HEPA filtration) potential to result in an EDE to any member of the public greater than 0.1 mrem/yr require continuous effluent monitoring for radionuclides. Current data from this monitoring yield estimated doses that are three orders of magnitude below the regulatory standard at the Site boundary.

IF	The Site cannot use standard prescribed monitoring methods to characterize the emissions from a regulated emission source
THEN	The Site must obtain approval for an alternative methodology from the regulatory agency having primacy.

The use of ambient monitoring is being proposed as a plausible alternative sampling method to document dose to potential public receptors and demonstrate compliance.

Monitoring Requirements:

A continuous effluent monitoring system must be installed and/or activated for analytes identified in above inputs. For point sources (significant sources) that have an estimated uncontrolled potential to result in a dose to any member of the public greater than 0.1 mrem/yr (significant sources), the continuous monitoring system samples are analyzed monthly. Other ducts or vents yielding potential doses that are less than 0.1 mrem/yr (insignificant sources) are presently continuously sampled; these sample filters are collected monthly and analyzed as an annual composite sample from each location. The on-Site laboratory defines detection limit as: "The smallest amount of sample activity using a given measurement process that will yield a net count for which there is confidence at a pre-determined level that activity is present." Table 4-1 shows typical minimum detectable activity (MDA) or detection limits for various effluent analyses performed by the lab. These values are based on the average sample volume, typical detector efficiency, detector background, count time, and chemical recovery efficiency. MDA values calculated for individual analyses may vary depending on actual sample volume, chemical recovery, and analytical blank variability.

Table 4-1
Detection Limits (MDA) for Effluent Air Samples (Typical)

Parameter	Minimum Detectable Activity (per sample)	Approximate Sample Volume	MDA
Pu-239/240	1.6×10^{-7} µCi	7,340 m^3 [a]	0.02×10^{-15} µCi/ml
U-234	4.6×10^{-7} µCi	7,340 m^3 [a]	0.06×10^{-15} µCi/ml
U-238	3.4×10^{-7} µCi	7,340 m^3 [a]	0.05×10^{-15} µCi/ml
Am-241	1.0×10^{-7} µCi	7,340 m^3 [a]	0.01×10^{-15} µCi/ml
Tritium (H-3)	2.1×10^{-7} µCi	1.4 m^3	1.53×10^{-12} µCi/ml

Notes:
[a] Volume analyzed is usually an aliquoted fraction of the total volume collected.

µCi	=	microCuries	ml	=	milliliters
Am	=	Americium	MDA	=	Minimum Detectable Activity
Ci	=	Curies	Pu	=	Plutonium
m^3	=	cubic meters	U	=	Uranium

With approval from EPA Region 8 and CDPHE, ambient monitoring will also satisfy the regulatory requirements to demonstrate compliance with the 10 mrem/yr dose standard. Samples from selected ambient sites that can be demonstrated by dispersion modeling to

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have a reasonable probability of capturing the highest potential ambient concentrations due to source emissions will be collected and analyzed on a monthly basis. Analytes will include Pu-239/240, U-234 and -238, and Am-241. Table 4-2 gives the typical analytical detection limits (MDA) expected for the ambient sampling network

Table 4-2
Detection Limits (MDA) for Ambient Air Samplers (Typical)

Parameter	Minimum Detectable Activity	Approximate Sample Volume	MDA
Pu-239/240	9.4×10^{-8} µCi	48,937 m^3	1.9×10^{-18} Ci/m3
U-233/234	2.6×10^{-7} µCi	48,937 m^3	5.3×10^{-18} Ci/m3
U-238	2.8×10^{-7} µCi	48,937 m^3	5.7×10^{-18} Ci/m3
Am-241	4.3×10^{-8} µCi	48,937 m^3	8.8×10^{-18} Ci/m3

Notes:
Based on Monthly Composites

µCi	=	microCuries	ml	=	milliliters
Am	=	Americium	MDA	=	Minimum Detectable Activity
Ci	=	Curies	Pu	=	Plutonium
m^3	=	cubic meters	U	=	Uranium

4.3 Meteorological Monitoring

Continuous meteorological monitoring is conducted in the north-west Buffer Zone at a 61-m tower, instrumented at three levels (10, 25, and 61 m). Data are collected for wind speed, wind direction, temperature, relative humidity (dew point), solar radiation, and a calculated sigma-theta (used to determine Pasquill-Gifford stability classes). Data are used as inputs for all air quality and emergency response dispersion modeling. Data are also used as inputs to CERCLA risk assessment calculations and hydrogeological assessments.

4.3.1 Data Use for Rad NESHAP

Data are used as Site-specific meteorological inputs to the Rad NESHAP compliance modeling. Inputs to the modeling calculations require annual averaged meteorological data. Continuous monitoring is required in order to collect representative annual values.

4.3.2 Data Use for Emergency Preparedness

Data also provide real-time input to the Site-specific emergency response model (Terrain Responsive Atmospheric Code [TRAC]). Fifteen-minute averaged data are required to calculate the real-time movement of a pollutant plume as it disperses from the location of an accident. Five CDPHE-owned meteorological towers can also provide support to Site emergency response modeling. These towers are located along the perimeter of the Buffer Zone and are in the process of being integrated into the TRAC model under a program separate from Air Quality Management.

4.3.3 Data Use for Other Compliance Modeling

Data are basic inputs into various regulatory models used at the Site. Air Quality Management uses screening and predictive models to assess emissions impacts on the public and the environment. Exceedance of calculated thresholds may require implementation of pollution control measures and/or monitoring requirements.

4.3.4 Meteorological Monitoring Specifications

The following data quality specifications are common to all three of the above data needs. Inputs to the meteorology decisions include:

Inputs:

- Site-specific wind speed, wind direction, temperature, and relative humidity.
- Site-specific rainfall data.
- Atmospheric stability class calculations.
- Solar radiation data.

Boundaries:

Spatial: Representative air flow patterns impacting the Site.
A minimum of 10 m above ground level.

Temporal: Continuous data, averaged every 15 minutes.
Hourly averaged data, calculated from the 15-minute averages.
Annual averages and frequency distributions.

Decision Statement:

IF Regulatory compliance, emergency response, or risk assessment modeling is performed at RFETS

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THEN Standard, consistent, Site-specific meteorological summaries shall be used to ensure consistent model results.

Monitoring Requirements:

Operate meteorological monitoring station with a 95% or better data capture to provide data inputs in support of Site-required modeling programs. Operation shall follow guidance detailed in the Site Meteorological Monitoring Project Plan.

4.4 CDPHE Air Quality Control Division Ambient Air Monitoring

4.4.1 Non-Radiological Ambient Air Quality Monitoring

Pollutants regulated under the CAA National Ambient Air Quality Standards (NAAQS) are monitored along the Site perimeter by the CDPHE Air Pollution Control Division (APCD). Ambient sampling for beryllium (Be) is also performed by CDPHE to verify compliance with Colorado Air Quality Control Commission Regulation No. 8.

4.4.1.1 Ambient Nitrogen Dioxide (NO_2) and Particulate Monitoring

Inputs:

- Ambient particulate and NO_2 concentrations.
- Meteorological data, especially wind direction.

Boundaries:

Spatial: Property boundaries. Data must characterize concentrations as air enters the Site and leaves the Site. These concentrations continually change with wind direction.

Temporal: Continuous NO_2 measurements. No specified time increments for determining difference but averaging time for NO_2 standard is annual.

Particulates. Every sixth day, a 24-hour sample is collected and used to generate a quarterly estimate. Averaging times for PM_{10} standards are 24 hours and annual.

Decision Statement:

IF A perimeter monitor detects an exceedance of an ambient NO_2 [0.053 parts per million (ppm)] or fine particulate (PM_{10}) [50 micrograms per

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cubic meter ($\mu g/m^3$) annual and 150 $\mu g/m^3$ 24-hour] standard, and the difference in concentrations of PM_{10} or NO_2 at upwind monitors and downwind monitors indicates that the Site may be a primary contributor to the exceedance

THEN The Site's operating permit may be reopened and potentially revised to mitigate the exceedance.

4.4.1.2 Beryllium

Inputs:

Emission source assessment data, Air Pollutant Emission Notices (APENs).
Stack test data.

Boundaries:

Spatial: Emission points (stacks) of applicable sources.

Temporal: Twenty-four-hour sampling average.

Decision Statement:

IF Be emissions from sources subject to CAQCC Regulation No. 8 (40 CFR 61, Subpart C) exceed 10 grams per 24-hour period

THEN CDPHE may take enforcement action.

Inputs:

Ambient Be sampling data.
Meteorological data.

Boundaries:

Spatial: Site fenceline.

Temporal: Samples are composited for quarterly decisions.

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Decision Statement:

IF Ambient Be concentrations due to sources subject to CAQCC Regulation No. 8 (40 CFR 61, Subpart C) exceed 0.01 μg/m^3 averaged over a 30-day period

THEN CDPHE may take action to identify the source.

4.4.2 CDPHE Radiation Control Division Radiological Ambient Air Quality Monitoring

CDPHE's Radiation Control Division (RCD) has monitored radioactive emissions from the Site since 1969. The primary purpose for this sampling has been to provide an independent assessment of public exposure to radioactive material released from the Site. RCD's monitoring program has provided validation of sampling methods used by Site organizations; confirmation of Site measurements of Pu in air; and, on occasion, helped identify errors made by Site monitoring personnel. The data are compared to Derived Concentration Guides for nonoccupationally exposed persons. Historically, the desirability of an independent monitoring program outweighed concerns about costs, partly due to public mistrust of monitoring performed by DOE contractors.

Currently, concerns about releases during accidents or off-normal situations continue to arise and may increase as cleanup progresses. Emergency response plans for the Site include provisions for sampling environmental media after a plume dissipates. The continuous air samplers operated by RCD allow the state to begin fulfilling this obligation immediately after a release and would ultimately provide more accurate exposure assessments than output from TRAC or other models. Routine analyses of these samples provide baseline data for comparison to known or suspected releases.

In the future, data from RCD air samplers will support APCD in its evaluation of Site compliance with NESHAP requirements, especially around the 903 Pad and at the Site boundary, as well as providing documentation for ALARA decisions, which may arise during cleanup.

Inputs:

Adequate historical and baseline data and defensible estimates of normal variation; adequate QA/QC measures on laboratory analyses. Analytes include gross alpha/gross beta on weekly samples, and Pu and Am on quarterly composites. To fully satisfy NESHAP requirements, U would have to be added to the quarterly list, should these samples be used to supplement DOE's Site measurements.

Boundaries:

Spatial: RCD currently samples air at 13 locations, 9 surrounding the industrial area and 4 near the plant boundary. Most of these sample total suspended particulates (TSP) but some locations have collocated PM_{10} samplers. Precipitation is collected at three locations and analyzed for tritium.

Temporal: Individual samples are collected continuously for one week. Fractions of 13 samples are composited and analyzed as quarterly samples, corresponding to calendar quarters.

Decision Statement:

IF Any measurement of radionuclides in the air exceeds the normal variation seen in historical and baseline measurements

THEN A series of actions may be taken.

These actions include, but are not limited to, re-analysis of composite samples for verification; analysis of individual samples included in the composite; a request for analysis of comparable samples from the nearest DOE ambient samplers, ComRad Program samplers, and/or APCD samplers; a request for investigation or explanation of elevated results from DOE or its contractor; a calculation of public dose and/or risk; and a presentation of analysis and investigation results to CDPHE management, and in public forums, as requested.

IF The student's T-test or other appropriate test to determine if the latest data point exceeds the seasonally adjusted historical range indicates exceedance of the normal range

THEN Investigate cause; otherwise trend analysis.

Limits On Decision Errors:

Since Pu and Am have historically constituted a small fraction of the measured gross alpha concentration, extremely high concentrations of these nuclides would be required to result in an elevated gross alpha result. Such a sample would also be difficult to detect when composited with 12 samples in the "normal" range. Therefore narrow limits on what is defined as the normal range and a fairly high chance of a false positive result will be necessary to identify any unplanned short-term release. In the absence of real or

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suspected exceedences, trend analysis should be sensitive to small, upward shifts in concentration, especially in the case of boundary samplers.

4.5 Project-specific Monitoring

Environmental restoration programs require air quality assessments to evaluate potential emissions from remedial action projects. Project-specific monitoring may result, based on both risk assessment and CAA air quality screening. Project-specific ambient monitoring may also be triggered by soil screening measurements performed for radiation worker protection.

4.5.1 Interim Measures/Interim Remedial Action (IM/IRA) Ambient Volatile Organic Compound Monitoring

The Site's remediation and deactivation operations within the Industrial Area (the central portion of the Site that includes most Site buildings and historical radionuclide processing areas) may potentially emit significant concentrations of volatile organic compounds (VOCs). The Final Interim Measures/Interim Remedial Action Decision Document for the Rocky Flats Industrial Area recommended ambient VOC monitoring where appropriate to document the impacts and results of cleanup operations on the environment. However, additional ambient sampling for VOCs is not required. Emission calculations and risk assessments will be the primary decision tools used to determine the need to implement source controls.

Inputs:

- Environmental Restoration Residential Screening Level values.
- Rocky Flats VOC baseline data for 34 Rocky Flats Target Compounds.
- Assessment of building or emission source Remediation Plans for emission potential evaluation.
- Current meteorological data applicable to the source under evaluation.

Boundaries:

Spatial: Industrial Area perimeter fenceline.
Building or source perimeter.

Temporal: 24-hour sample averaging time (typical).
3-8 hour sample averaging time (short-term event).
Annual mean VOC data.

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Decision Statement:

IF	The highest annual baseline mean VOC concentration at any station exceeds residential screening levels
THEN	Evaluate risk to determine need for source control.

4.5.2 Interim Measures/Interim Remedial Action Ambient Radiological Monitoring

Ambient monitoring to document releases of radiological particulates that may impact the public or environment supports remediation or D&D of nonpoint sources. Air quality data provide verification of proper source control and model results.

Inputs:

- Building emissions inventory or list of potential contaminants of concern.
- Site-specific meteorology.
- Building or operation project plan and project schedule.

Boundaries:

Spatial:	Perimeter of source being evaluated or monitored.
	Upwind and downwind sampling locations. Two sites would be a minimum, five are typical to ensure representative sample capture relative to wind direction.
Temporal:	Continuous sampling during periods of potential high emissions, for multiple days. Continuous sampling is needed to capture sufficient sample for analysis.

Decision Statement:

IF	Remediation projects with the potential to emit radionuclide particulates in concentrations that exceed risk assessment thresholds or Site action limits are performed
THEN	Emissions to off-Site receptors will be documented by continuous ambient monitoring.

Monitoring Requirement:

For Industrial Area or Buffer Zone monitoring, specific RAAMP samplers must be activated as necessary to gather representative data. The actual number of samplers and their locations must be determined based on the location and extent of the source area. The periods and frequency of sampler operation would be determined by the project activities, action levels established for the projects, and duration of remedial activities that have the potential to emit radionuclide materials.

4.5.3 Particle Size-Distribution Monitoring

A particle-sizing head separates airborne particulate material into seven size fractions. Size distribution of ambient particles is of concern because smaller particles are retained more efficiently in the lungs. If a large fraction of the airborne Pu at the Site is attached to the smaller particles, then the radiation dose from inhalation of radioactive contaminants will be higher than would be expected from an activity distribution that is more soil-like in airborne distribution. Similarly, if the majority of the Pu in air at the Site is attached to the larger particles, then the radiation dose from inhalation will be less than would be estimated from a soil-like distribution. Both DOE and CDPHE have conducted particle size-distribution studies at the E-1 monitoring platform.

Inputs:

Pu and Am concentrations stratified by particle size, together with health physics data appropriate for the specific particle size ranges.

Boundaries:

Spatial: Data collection from the E-1 platform is complete. Data are currently being gathered at the E-2 platform. Funding permitting, similar data may be gathered at the D-13 ground level sampler in the future.

Temporal: In order to make a reasonable estimate of the range of concentrations in each size category, samples were collected at E-1 for three years and analyzed as quarterly composites. Since concentrations at the E-2 and E-3 platforms are lower, definitive quantitative assessments may not be possible for those data.

Decision Statement:

No specific decision is associated with the particle size study. Results will be used to estimate dose conversion factors for chronic exposure to Site emissions during normal operations, such as could be done during a dose reconstruction calculation. Particle size distributions for use in emergency planning and response activities are being estimated by plant personnel as part of a separate study.

IF	Results of the size-distribution study are well quantified and statistically valid
THEN	The results will be made available for future quantitative and qualitative assessments of dose impacts from the Site.

Limits On Decision Rule:

Not necessary. RCD typically calculates 95% confidence intervals on all measurements. Statistically based estimates of the minimum number of samples needed to estimate the range of concentrations with 95% confidence and 80% power need to be developed.

4.6 Outstanding Issues

4.6.1 Radiological NESHAP Ambient Monitoring

Approval for the use of ambient monitoring to demonstrate compliance with 40 CFR 61, Subpart H and Appendix B is currently being negotiated by DOE and Kaiser-Hill with EPA and CDPHE. Ambient monitoring is being proposed to ensure that the dose from all contributing sources of radionuclides is adequately quantified during the period when buildings have been deactivated, yet still have the potential to emit significant quantities of radionuclides. While deactivated, the buildings will be configured in a passive mode, without either ventilation or heat, and their effluent ducts will be sealed to the outside. These buildings will become fugitive sources of radionuclide emissions since they will no longer have well-defined and well-characterized ventilation pathways to the atmosphere.

4.6.2 Radiological NESHAP Regulatory Authority

Since regulatory primacy has not yet been transferred from EPA Region 8 to CDPHE, discussions on alternate monitoring protocols include both agencies.

4.6.3 Beryllium Effluent Stack Sampling

A review of future planned Be foundary operations may reveal a need to conduct effluent sampling for Be, such activities being subject to CDPHE Regulation No. 8. Emissions to the atmosphere are not allowed to exceed 10 grams of Be over a 24-hour period.

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

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5.0 ECOLOGICAL MONITORING

5.1 Introduction

Ecological monitoring at Rocky Flats Environmental Technology Site (RFETS or the Site) has historically focused on characterization of the ecological components within the Buffer Zone and compliance with a variety of regulatory drivers [e.g., the Endangered Species Act, the Fish and Wildlife Coordination Act, the Bald Eagle Protection Act, the Migratory Bird Treaty Act, wetlands regulations, weed control acts, the National Environmental Policy Act (NEPA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)]. The monitoring requirements presented here were established through implementation of the data quality objective (DQO) process and represent a program that emphasizes natural resource conservation, habitat management, and regulatory compliance.

Since the Ecological Monitoring Program deals with a large and dynamic natural system, where established endpoints (i.e., discharge permit limitations) do not exist, a qualitative, rather than a statistical, approach was adopted. The program, therefore, focuses on collection of data necessary to ensure regulatory compliance and to assess the success or failure of the Department of Energy's (DOE's) resource conservation and habitat management efforts. These conservation and management efforts are aimed at achieving a set of management goals consistent with DOE's demonstrated desire to practice ecosystem management (1) and resource conservation (2) on its properties.

These policies provide part of the basis for developing a set of environmental management goals and associated monitoring requirements that support ecological management decision making as part of the Integrated Monitoring Plan (IMP).

This chapter describes the technical and regulatory basis for the approach to ecological monitoring at the Site.

5.2 Ecological Conservation and Management Goals and Objectives

5.2.1 Goals

In general, the goals include conservation of currently viable ecosystems, detection and management of problems or undesirable impacts to the Buffer Zone before they become severe, protection of unique and ecologically valuable natural resources in the Buffer Zone, protection of any special-concern species (threatened, endangered, candidate, proposed, state-listed, or other sensitive species), and compliance with applicable wildlife and natural resource protection regulations. The goals are consistent with regulatory compliance and the DOE Buffer Zone Policy.

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Specific conservation and management goals for the major identified vegetation communities and one species of particular interest are presented in Table 5-1.

Table 5-1
Conservation and Management Goals

Vegetation Community	Management Goal
Xeric Tallgrass Prairie	Maintain current quantity (area) and quality of the vegetation community, and maintain the current populations of bird and mammal species characteristic of xeric tallgrass prairie.
Tall Upland Shrubland	Maintain current quantity (area) and quality of the vegetation community, maintain the current populations of bird and mammal species characteristic of tall upland (seep) shrubland, and maintain current population numbers and extent of Preble's meadow jumping mice within the habitat.
Great Plains Riparian Woodland Complex	Maintain current quantity (area) and quality of the vegetation community, maintain the current populations of bird and mammal species characteristic of the riparian woodland complex, and maintain current population numbers and extent of Preble's meadow jumping mice within the habitat.
High Quality Wetlands	Maintain current quantity (area) and quality of the vegetation community, and maintain the current populations of bird and mammal species characteristic of the largest contiguous high quality wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Wetlands Complexes).
Mesic Mixed Grassland	Maintain current contiguous extent of mesic mixed grassland for heavily and frequently used wildlife areas, and maintain the current populations of bird and mammal species characteristic of this vegetation community.
Species of Particular Interest	
Preble's Meadow Jumping Mouse Populations	Maintain the current quantity (area) and quality of Preble's meadow jumping mouse habitat and protect all extant populations of Preble's meadow jumping mice.

5.2.2 Objectives

There are two primary objectives for ecological monitoring:

- Determine if the Site is meeting ecological conservation and management goals; and
- Determine if the Site is complying with regulatory requirements.

5.3 Descriptions of Vegetation Communities and the Preble's Meadow Jumping Mouse Populations

Vegetation communities at the Site provide specific habitats for associated wildlife, rare plants, and unusual plant associations.

5.3.1 Xeric Tallgrass Prairie

The xeric mixed grassland unit selected for specific monitoring at the Site is the xeric tallgrass prairie. Identification of this vegetation community at the Site is based on the presence of big bluestem, little bluestem, prairie dropseed (*Sporobolus heterolepis*), Indian-grass (*Sorghastrum nuntans*), and/or switchgrass (*Panicum virgatum*). In general, only big bluestem and little bluestem occur very commonly or abundantly at Rocky Flats. These five species are considered to be tall grass prairie relicts. When they are found in the xeric mixed grassland community with a combined cover of approximately 10% or more, the community is classified as xeric tallgrass prairie. The soil under the xeric tallgrass prairie is visibly cobbly on the surface and considered to be a sandy clay loam. This vegetation community covers the high, rocky pediment on the western one-third of the Site. The xeric tallgrass prairie vegetation community was selected at the Site for special conservation efforts due to its nationwide rarity.

The xeric needle-and-thread grass prairie, which is the other unit of xeric mixed grassland at the Site, is also considered rare, but it is not large enough to justify special management efforts. Xeric needle-and-thread grass prairie is differentiated from xeric tallgrass prairie by a greater cover of needle-and-thread grass and New Mexico feather grass (*Stipa neomexicana*), and very little cover of the big bluestem and little bluestem or other tallgrass species. Generally the soils are not as visibly cobbly as in the xeric tallgrass prairie and have a higher visible component of caliche at the soil surface. This vegetation community occupies the tops of many of the eastern-most ridges of the Site.

5.3.2 Mesic Mixed Grassland

Mesic mixed grassland is characterized by western wheatgrass (*Agropyron smithii*) and blue grama grass (*Bouteloua gracilis*). Other common species include green needlegrass (*Stipa viridula*), Canada bluegrass (*Poa compressa*), and Kentucky bluegrass (*Poa pratensis*). The

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mesic grassland has a more solid turf appearance in contrast to the bunchgrass appearance of the xeric mixed grasslands. Soils are clay loams and do not have the cobbly surficial appearance typical of xeric mixed grassland soils. Most hillsides at the Site are considered mesic mixed grassland habitat.

The quality of these grasslands varies considerably across the Site. The mesic mixed grassland on the western side of the Site has been and continues to be significantly degraded by diffuse knapweed (*Centaurea diffusa*). Mesic mixed grassland on the eastern portion of the Site has been degraded by weed species such as Japanese brome (*Bromus japonicus*), alyssum (*Alyssum minus*), and musk thistle (*Carduus nutans*) more than those on the western edge of the Site. For classification purposes, if western wheatgrass and blue grama grass form an understory beneath non-native species, then the grassland is classified as mesic mixed grassland.

Mesic mixed grasslands comprise one of the largest contiguous vegetation communities at the Site. In addition to its essential role as a foraging habitat, the size and isolation of the vegetation community often makes it very important to some wildlife species,. A wide variety of grasslands birds breed and forage in this habitat. Small mammals are abundant and diverse and provide a suitable prey base for a variety of avian and mammalian predators. Many of the species supported by this vegetation community are rare or special-concern.

5.3.3 High Quality Wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Complexes)

The high quality wetlands selected for monitoring and specific conservation efforts are those Site wetlands with the largest contiguous areas and the most complex plant associations. The Rock Creek wetlands are a large, seep-fed wetland complex extending approximately one mile from the foot of the eastern-most seep-fed wetlands to the western-most short marsh areas.

The Antelope Springs/Apple Orchard Wetland Complex encompasses the predominantly wet meadow, short marsh, and tall marsh habitat mosaic of upper Woman Creek Drainage Basin. These are also seep-fed wetlands that depend on groundwater discharge for their continued existence.

Predominant vegetation in these wetlands includes cattails (*Typha sp.*) and bulrush (*Scirpus sp.*) in tall marsh community; Nebraska sedge (*Carex nebraskensis*) and Baltic rush (*Juncus balticus*) in short marsh habitat; and prairie cordgrass (*Spartina pectinata*), redtop (*Agrostis stolonifera*), showy milkweed (*Asclepias speciosa*), and Missouri iris (*Iris missouriensis*) in the wet meadow habitat.

These wetlands support a variety of terrestrial and aquatic organisms. Portions of these wetlands have been designated as prime Ute Ladies'-tresses (*Spiranthes diluvialis*) habitat (a federally listed threatened plant that may occur at the Site). Other parts support sensitive amphibian

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species and waterfowl. Many predatory mammals and bird species are dependent on these areas as hunting and foraging grounds due to their high prey species productivity.

5.3.4 Tall Upland Shrubland

The tall upland (seep) shrubland is comprised of stands of hawthorn (*Crataegus erythropoda*), chokecherry (*Prunus virginiana*), and occasionally wild plum (*Prunus americana*). Tall upland shrubland is found primarily on north-facing slopes above seeps, wetlands, and streams in the northern portion of the Site in the Rock Creek drainage. Small units also occur in other drainages of the Site. This vegetation community may be unique, having had no other units identified outside the general Rocky Flats vicinity, and is an important one to the resident mule deer population. Mule deer are highly reliant on tall upland shrubland for fawning cover, winter thermal cover and browse, and summer shade and isolation cover. A number of rare bird species (e.g., bluegray gnatcatchers and ashthroated flycatchers) occupy this community as well. Some units of tall upland shrubland also provide habitat for the rare Preble's meadow jumping mouse.

5.3.5 Great Plains Riparian Woodland Complex

Riparian areas are well known for the diversity of plant and animal species they support. The riparian woodland complex at the Site is a combination of two vegetation community classifications: riparian woodland and riparian shrubland. Riparian woodlands are found primarily along the drainage bottoms on Site. Due to the mosaic of trees and shrubs in the riparian areas, a contiguous mixture of both trees and shrubs is considered as the riparian woodland complex. This complex is characterized by stands of plains cottonwood (*Populus deltoides*), peach leaf willow (*Salix amygdaloides*), Siberian elm (*Ulmus pumila*), and silver poplar (*Populus albus*). Shrub species include chokecherry *(Prunus virginiana)*, snowberry (*Symphoricarpos occidentalis.*), coyote willow (*Salix exigua*), leadplant (*Amorpha fruticosa*), and others.

Riparian woodland complex is an important habitat for a different songbird association than the grasslands and shares some species with the tall upland shrubland. Several of the bird species that use the riparian woodland complex as foraging and nesting cover are rare species (e.g., blue grosbeaks). This vegetation community is also seasonally important to the resident mule deer herd as shelter, forage source, and fawning grounds. Large cottonwood trees imbedded within this unit provide nesting habitat for several raptor species, including great horned owls, red-tailed hawks, Swainson's hawks (a Colorado "at-risk" species), and American kestrels. Riparian woodland complex supports the greatest number of Preble's meadow jumping mice at the Site and is considered typical habitat for this species. The majority of monitoring, protection, and management of Preble's meadow jumping mouse habitat will occur in this community.

5.3.6 Preble's Meadow Jumping Mouse Populations

Preble's meadow jumping mouse (*Zapus hudsonius preblei*) is of particular concern at the Site because it is a rare subspecies of meadow jumping mouse found in parts of Colorado and Wyoming and is a Colorado species of special concern. The special interest in preserving this species resulted in a petition to list the species, which is under consideration by the U.S. Fish and Wildlife Service (USFWS) for listing as a threatened or endangered species. The USFWS final response to the listing petition is still pending. The USFWS has discussed a habitat conservation plan for the Site with DOE, Rocky Flats Field Office (RFFO), and ongoing Preble's meadow jumping mouse studies are being conducted to gather data in anticipation of such an agreement.

Preble's meadow jumping mice have been recorded in all major drainages of the Site: Rock Creek, Walnut Creek, Woman Creek, and the Smart Ditch drainages. Native plant communities in these areas provide a suitable habitat for this small mammal. Jumping mice at Rocky Flats are restricted to riparian areas and pond margins, apparently requiring multi-strata vegetation with abundant herbaceous cover. Preble's meadow jumping mouse populations at the Site are frequently found in association with coyote willow. Recent studies have produced a better understanding of population centers of the species, and studies over the past several years have also provided data to help estimate numbers of individuals within each population unit.

5.4 Monitoring DQOs by Vegetation Community

DQOs were developed for monitoring in five important vegetation communities in support of the following key decision:

- Given baseline information, determine whether to reevaluate current management practices to achieve specific vegetation community management goals.

Results from the monitoring of these communities will facilitate the conservation and management of these resources, as well as associated wildlife, rare plants, and unusual plant associations.

5.4.1 Xeric Tallgrass Prairie Vegetation Community

Inputs:

- Extant area of xeric tallgrass prairie.
- Baseline estimates of plant, bird, and mammal species richness.
- Baseline estimates of bird and mammal presence or absence.
- Annual estimates of plant, bird, and mammal species richness.

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- Annual weed mapping and photo surveys.
- Annual assessment of endpoints for the vegetation community and wildlife populations.
- Anticipated or estimated impact area of any proposed project.
- Identification of any plant or wildlife species populations of interest.
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic xeric tallgrass prairie within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of xeric tallgrass prairie from the baseline amount.
- New weed species are reported for the vegetation communities.
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the community.
- Weed control assessment monitoring indicates low effectiveness of a treatment option.
- A decline in the plant, bird, or mammal species richness or densities.
- Loss or major population decline of any of the predominant plant, bird, or mammal species from the vegetation community.
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species.

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- Significant change in any of the assessment endpoints.

THEN Evaluate options to achieve the stated goals.

5.4.2 Tall Upland Shrubland Community

Inputs:

- Extant area of tall upland (seep) shrubland.
- Baseline estimates of plant, bird, and mammal species richness.
- Baseline estimates of bird and mammal presence or absence.
- Annual estimates of plant, bird, and mammal species richness.
- Annual weed mapping and photo surveys.
- Annual assessment endpoints for the vegetation community and wildlife populations.
- Anticipated or estimated impact area of any proposed project.
- Identification of any plant or wildlife species populations of interest.
- Weed control assessment monitoring, as applicable.
- Biennial estimates of characteristic plant species area, density, height, and canopy cover within known Preble's meadow jumping mouse population areas. One-half the known population areas will be monitored on each alternate year.
- Baseline estimates of the known Preble's meadow jumping mouse population size estimates.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic tall upland shrubland community within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of tall upland shrubland vegetation community from the baseline amount.
- New weed species are reported for the vegetation community.
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community.
- Weed control assessment monitoring indicates low effectiveness of a treatment option.
- A decline in the plant, bird, or mammal species richness or densities.
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community.
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species.
- Significant change in any of the assessment endpoints.
- Structural measurements for any characteristic plant species (e.g., area, density, height, and canopy cover) within a known Preble's meadow jumping mouse population area decreases substantially from baseline.
- The area of known Preble's meadow jumping mouse habitat within the unit decreases substantially from baseline.
- Any known permanent population of Preble's meadow jumping mouse within the habitat unit decreases substantially from baseline.

THEN Evaluate options to achieve the stated goals.

5.4.3 Great Plains Riparian Woodland Complex

Inputs:

- Extant area of riparian woodland complex.
- Baseline estimates of plant, bird, and mammal species richness.
- Baseline estimates of bird and mammal presence or absence.
- Annual estimates of plant, bird, and mammal species richness.
- Annual weed mapping and photo surveys.
- Annual assessment endpoints for the vegetation community and wildlife populations.
- Anticipated or estimated impact area of any proposed project.
- Identification of any plant or wildlife species populations of interest.
- Weed control assessment monitoring, as applicable.
- Biennial estimates of characteristic plant species area, density, height, and canopy cover within known Preble's meadow jumping mouse population areas. One-half the known population areas will be monitored on each alternate year.
- Baseline estimates of the known Preble's meadow jumping mouse population size estimates.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic Great Plains riparian woodland complex community within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

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- A measured or anticipated loss of riparian woodland complex vegetation community from the baseline amount.
- New weed species are reported for the vegetation community.
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community.
- Weed control assessment monitoring indicates low effectiveness of a treatment option.
- A decline in the plant, bird, or mammal species richness or densities.
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community.
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species.
- Significant change in any of the assessment endpoints.
- Structural measurements for any characteristic plant species (e.g., area, density, height, and canopy cover) within a known Preble's meadow jumping mouse population area decrease substantially from baseline.
- The area of known Preble's meadow jumping mouse habitat within the unit decreases substantially from baseline.
- Any known permanent population of Preble's meadow jumping mouse within the habitat unit decreases substantially from baseline.

THEN Evaluate options to achieve the stated goals.

5.4.4 High Quality Wetlands

Inputs:

- Extant wetlands based on 1994 U.S. Army Corps of Engineers wetland map and study (restricted to Buffer Zone only).

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- Extent of wetlands will be evaluated every five years, with the next evaluation to be done in the year 2000 (to be done by U.S. Army Corps of Engineers).
- Baseline estimates of plant, bird, and mammal species richness.
- Baseline estimates of bird and mammal presence or absence.
- Annual estimates of plant, bird, and mammal species richness.
- Annual weed mapping and photo surveys.
- Annual assessment endpoints for the vegetation community and wildlife populations.
- Anticipated or estimated impact area of any proposed project.
- Identification of any plant or wildlife species populations of interest.
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Rock Creek and Antelope Springs/Apple Orchard Springs wetland complexes.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occur:

- Extant high quality wetlands decreases visibly from baseline.
- A measured or anticipated loss of high quality wetlands from the baseline amount.
- New weed species are reported for the vegetation community.
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community.
- Weed control assessment monitoring indicates low effectiveness of a treatment option.

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- A decline in the plant, bird, or mammal species richness or densities.

- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community.

- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species.

- Significant change in any of the assessment endpoints.

THEN Evaluate actions to achieve the stated goals.

5.4.5 Mesic Mixed Grassland Vegetation Community

Inputs:

- Baseline map of mesic mixed grasslands.
- Areas and positions of high and elevated use by wildlife as shown in *1995 Annual Wildlife Survey Report.*
- Baseline estimates of bird and mammal species richness.
- Baseline estimates of bird and mammal presence or absence.
- Annual estimates of bird and mammal species richness.
- Annual weed mapping and photo surveys.
- Anticipated or estimated impact area of any proposed project.
- Identification of any plant or wildlife species populations of interest.
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic mesic mixed grasslands within RFETS and its Buffer Zone.

Temporal: Yearly decisions from 1997 forward regarding species richness of characteristic plants, cover of noxious weed species, and bird or mammal species numbers.

Decision Statement:

IF One or more of the following occur:

- A measured or anticipated loss of mesic mixed grassland vegetation community from the baseline amount.
- New weed species are reported for the vegetation community.
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community.
- Weed control assessment monitoring indicates low effectiveness of a treatment option.
- A decline in the plant, bird, or mammal species richness or densities.
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community.
- Loss or major decline of any population of an identified plant species of interest, or any plant or animal special-concern species.
- Significant change in any of the assessment endpoints.

THEN Evaluate actions to achieve the stated goals.

5.5 Design for Integrated Ecological Monitoring

5.5.1 Decision Errors

Limits on decision errors were stated by the planning team as follows:

- Reasonable expectation that monitoring will detect any change of interest listed above.

- Reasonable expectation that monitoring will not incorrectly indicate that one or more changes occurred, triggering an unnecessary evaluation of management actions.

- Reasonable expectation that monitoring will detect the presence of special-concern species and any impacts to such species.

- Reasonable expectation that compliance with applicable regulations can be achieved.

Decision errors and their consequences are presented in Table 5-2.

Table 5-2
Decision Errors and Their Consequences

Decision Error	Consequences
Fail to detect one or more changes of interest that would lead to an evaluation of management actions. (This error type is of greater concern.)	Vegetation community management approaches (e.g., weed management, limited access, limitation of disturbance) go unchanged, with possible loss of habitat (or species) that could otherwise be conserved or protected.
Incorrectly decide one or more changes occurred, triggering an unnecessary evaluation of management actions.	Unnecessary expenditure of time and money to reevaluate vegetation community management plans that are actually working.

5.5.2 Statement of Need

The Site requires an Ecological Monitoring program that will provide data that can be used in management and conservation decisions during the Site cleanup over the next decade. In addition to data required for management and conservation decisions, the Site must remain in compliance with all applicable wildlife and wetland protective regulations. To meet this need, the proposed Site ecological program will monitor key variables over time in each of five vegetation communities. The data collected will be used to make discrete, but ongoing, determinations regarding changes in those key variables. These determinations will drive decisions regarding ecological protection and compliance decisions.

5.5.3 Monitoring Design

The design of the Ecological Monitoring program follows the development of decision rules regarding conservation and regulatory compliance at the Site. These decision rules specify the measurement and evaluation of analytical parameters for five vegetation communities and for Preble's meadow jumping mouse populations on the Site. They also specify the criteria that will help ensure regulatory compliance. These criteria, if detected for any of the variables, will trigger a reevaluation of ecological conservation actions or reevaluation of the Site project designs. These decision rules are formulated such that each can independently trigger an action. This is important since it will be fundamental to the way that evaluations are structured. Evaluations are structured to parallel the independence of decision rules.

The Ecological Monitoring program is designed to collect representative data from all sensitive and important vegetation communities at the Site to provide an integrated basis for decisions on vegetation community conservation and management, special-concern species protection, wetlands protection, and mitigation for all Site actions. The continuous data collection in representative vegetation communities across the entire Site allows ecologists to track trends in wildlife and plant populations seasonally and annually. Comparisons from year to year allow ecologists to detect changes, identify potential causes, and plan corrective strategies for changes due to Site activities rather than natural fluctuations. Availability of comprehensive data for each vegetation community type at the Site greatly aids compliance and protection evaluations and decision making for specific projects, and avoids the need for many expensive, one-time-only Site-specific studies. Ecologists are able to use data from comparable vegetation community units and extrapolate those data to similar units that may not have been monitored specifically to evaluate the potential presence of plant and animal species populations. With this knowledge available, ecologists can make more cost-effective evaluations of ecological concerns and compliance and protection decisions.

The five vegetation communities to be monitored to provide the inputs discussed above were identified on the basis of data collected and analyzed from 1991 to 1995. These baseline data were evaluated to define the communities at the Site. The most important or sensitive vegetation communities were selected for conservation monitoring. Vegetation communities were described in Section 5.3.

Key parameters to be measured and used in comparisons are presented in Table 5-3 and include:

- Species richness of plants in the vegetation community;
- Species richness of birds in the vegetation community;
- Species richness of mammals in the vegetation community;
- Presence of noxious weeds;
- Changes in vegetation communities; and
- Preble's meadow jumping mouse populations and associated habitat characteristics in appropriate habitat.

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Table 5-3
Parameters to be Measured vs. Vegetation Community

Vegetation Community	Measure			
	Preble's Mouse Populations and Habitat Characteristics	Noxious Weeds	Changes in Vegetation Communities	Species Richness (Plant and/or Animal)
Xeric tallgrass prairie		X	X	X
Riparian wood-land complex	X[a]	X	X	X
High quality wetlands		X	X	X
Tall upland shrubland	X[a]	X	X	X
Mesic mixed grassland		X	X	X
All other habitats		X	X	

Notes:
[a] These parameters will be measured where known Preble's meadow jumping mouse populations occur.

5.5.3.1 Vegetation Communities

To summarize, there are three separate parameters that will be evaluated. These parameters are wildlife and plant species richness, presence of noxious weeds, and changes in vegetation communities.

Species richness. Historically, the Site personnel have made a number of qualitative measurements of species richness. These measurements should continue. Changes in any of them, when quantified against the decision rule for species richness, should trigger further investigation, including an examination of field notes to offer potential explanations.

Baseline measurements for species richness in all vegetation communities will be determined using data gathered from the Buffer Zone in the years 1993 through 1996. Species richness surveys will be performed in all listed vegetation communities annually. Data collection will be performed in spring and summer, broken into two distinct data collection periods to ensure that spring ephemerals are recorded, as well as plants that mature late in the growing season.

Noxious Weeds. Monitoring will be performed to track the success of weed control strategies. Weed species and desirable plant species cover will be characterized in a treatment area prior to

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treatment. After an appropriate time period for the particular treatment option used, weed species and desirable species cover will again be assessed. Management strategies for weeds, including undesirable consequences of certain treatments, can thus be tracked, and strategies can be revised based on real-time results. Weed mapping performed in 1997 will establish baselines for these measurements. This portion of the program will be a component of the integrated weed control program for the Site.

Changes in Vegetative Communities. Photographic survey plots will be permanently established at vantage points adjacent to all vegetation communities to be monitored. The camera lens used for the photographs will be a standard size for all records made. Photographs will be taken from these survey points in summer and winter seasons in woody communities and annually in grasslands. Seasonal and annual comparisons of these photographs will be used to determine what type and amount of change has occurred within these vegetation communities over time. Should visible loss occur to a vegetation community, management and protection strategies will be reevaluated.

Acreage is to be calculated for each vegetation community following completion of vegetation mapping in 1996. This vegetation map will serve as the 1996 baseline map against which changes will be compared. Weed mapping and comparisons will be performed annually, or more frequently as determined by current conditions.

5.5.3.2 Preble's Meadow Jumping Mouse

Preble's meadow jumping mouse populations in selected population centers will be measured annually. Population estimates will be determined through trapping in known or potential Preble's meadow jumping mouse population areas. Trapping will occur only during the May through September activity period of this hibernator. Habitat characteristics will be monitored by measuring plant species coverage (area), density, height, and canopy cover. This will be done for each major vegetative canopy strata within the habitat. Baseline conditions will be established on the basis of all monitoring through 1996.

5.5.3.3 Mammals and Birds

The measurements to be made on birds and mammals are species richness and relative abundance. These parameters, as with plant species richness, can only be assessed annually from continuous sampling due to the seasonality of species.

Resident birds and mammals, including special-concern species, and uncommon and rare birds and mammals will be counted on line transects. The numbers counted will be determined by the dimension and number of the transects, not by the total population at large on the Site. The number of transects will be determined based on available vegetation communities at the discretion of the ecologists on Site. Since decision rules require that an apparent change in bird and mammal species richness or presence triggers reevaluation of conservation and management actions, a minimum sampling effort will be undertaken to count representative species at the Site in any given year. Monthly surveys will attempt to record representative species expected to occur in each vegetation community for the current season. Baseline was established in the *1995 Annual Wildlife Survey Report.*

Bird species analysis. Bird species richness will be measured monthly and assessed within each vegetation community for the seasons and the entire year.

Mammal species analysis. As with bird species richness, mammal species richness will be measured monthly within each vegetation community and assessed for seasons and the entire year.

5.6 Regulatory Compliance Monitoring DQOs

In addition to ecological conservation and habitat protection, specific decisions on threatened and endangered (T&E) species, state species of special concern (SSC), and migratory birds and wetlands must be considered. The initial decision to be made is whether a proposed project has potential to impact T&E and SSC species, migratory birds, or wetlands. Such projects may require mitigation actions before they are allowed to move forward. Much of the data to support these decisions will come from the data collected from monitoring each vegetation community as discussed above. This monitoring, however, does not focus on specific areas that may be affected by the footprint of a proposed project. Therefore, additional data needs may arise to support project-specific decisions in accordance with the regulatory requirements as they occur. The discussion that follows is applicable to each of the regulatory drivers. Therefore, specific data requirements and a design for sampling and analysis are not included.

Specific management goals to be supported by these efforts are:

- Protect T&E and SSC species at the Site and comply with applicable state and federal T&E species protection regulations and policies;
- Protect migratory birds at the Site and comply with applicable state and federal migratory bird protection requirements; and
- Protect Site wetlands and comply with applicable state and federal wetland protection requirements.

5.6.1 Threatened, Endangered, and Special-concern Species

Inputs:

- Seasonal presence/absence, location, and abundance of T&E or SSC species in any area of potential impact by a proposed project.
- Seasonal timing of a proposed project.
- Presence of habitat considered suitable for T&E species.
- Biology of T&E or other species of concern (food habits, home range, habitat preference, nesting habits, etc.).
- Information about the anticipated impacts of the proposed project.

Boundaries:

Spatial:	The area potentially affected by any Site project.
Temporal:	The time frame in which a proposed project could occur. Locations of alternative project sites. Jurisdictional policies and propriety.

Decision Statement:

IF	Any T&E or SSC species, population, individual or habitat may be affected by a proposed project
THEN	Notify project personnel and suggest alternatives for modifying the project.
IF	The project cannot be altered to achieve a "no effect" determination for the T&E species
THEN	Advise DOE, RFFO to conduct a Section 7 consultation with the U.S. Fish and Wildlife Service.
IF	The determination is made to proceed with the proposed project by altering it
THEN	Provide assistance to design the project to comply with regulatory requirements.

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The performance of biological assessments for T&E species is not within the scope of this plan; therefore, additional required methods are not discussed here.

Limits on Decision Errors:

The decision will be based on a qualitative study of the area of potential impact, as well as existing information about the potentially impacted area or similar habitat to that which will be affected. It should be noted that any impact to any individual is of concern, not just impact to a population. Care will be taken to identify any potential impact to T&E species.

5.6.2 Migratory Birds

Inputs:

- Seasonal presence, relative abundance and location of migratory birds or their nests in areas potentially impacted by Site projects.
- Location and seasonal timing of proposed projects that might affect migratory birds.
- Biology of potentially affected migratory bird species (food habits, home range, habitat preference, nesting habits, etc.).

Boundaries:

Spatial: The area potentially affected by Site projects.
Specific areas where migratory birds or nest locations overlap the footprint of specific proposed activity (as opposed to the area potentially affected by all possible projects).
Locations of alternative project sites.
Jurisdictional policies and propriety.

Temporal: The time frame potentially affected by Site projects.
Specific time frames where migratory birds or nest locations overlap the footprint of a specific proposed activity (as opposed to the area potentially affected by all possible projects).

Decision Statement:

IF Migratory birds, their nests, fledglings, or eggs are present in a location that may be affected by a proposed project

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THEN Notify project personnel and determine whether the project can be altered to avoid impacts.

IF Removal is required

THEN Obtain removal permits from the USFWS and adhere to any permit limitations.

Limits on Decision Errors:

Decisions will be based on a qualitative study of the area of potential impact as well as existing information on the potentially impacted habitat. Care will be taken to identify and avoid any potential impact to migratory bird species.

5.6.3 Wetlands

Inputs:

- Presence and location of wetlands on the Site (based on 1994 U.S. Army Corps of Engineers wetland report and field verification) (3).
- Presence and location of wetlands not mapped by the U.S. Army Corps of Engineers.
- Determination of jurisdictional wetlands presence based on U.S. Army Corps of Engineers wetland delineation manual (4).
- Location, timing, and description of proposed projects that potentially impact wetlands.
- Jurisdictional policies and propriety.

Boundaries:

Spatial: The area of any Site project.
Specific areas where wetlands overlap the footprint of proposed activities.
Locations of alternative project sites.

Temporal: The time frame of any Site project.

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Decision Statement:

IF	Any wetland may be affected by a proposed project
THEN	Advise project personnel, and seek to redesign the project to avoid wetland impacts.
IF	The project cannot be redesigned to avoid impacts
THEN	Proceed with a wetland delineation in accordance with U.S. Army Corps of Engineers wetland delineation guidelines (4).
IF	The delineation indicates that the wetlands is jurisdictional
THEN	Advise DOE of the need to consult with the U.S. Army Corps of Engineers and the EPA to determine the need for and amount of mitigation wetland acreage that will be required for the project.

Limits on Decision Errors:

Decisions will be based on qualitative evaluation of the area of potential impact for wetlands and jurisdictional determination of wetlands present. Wetlands determination will be governed by performance of a wetlands delineation in accordance with the U.S. Army Corps of Engineers wetlands delineation manual (4). Care will be taken to identify and avoid any potential impact to wetlands. The results of any wetland investigations will be conducted to err on the side of protection.

5.7 References

1. *Ecosystem Management: Federal Agency Activities.* Congressional Research Service, Library of Congress, Washington, DC., 1994. 124p.

2. *Policy 9-19: Erosion Control and Vegetation Stabilization, Revision 0.* U.S. Department of Energy, Golden, CO, January 4, 1994.

3. *Rocky Flats Plant Wetlands Mapping and Resource Study.* Prepared for the U.S. Department of Energy, Golden, Colorado. Prepared by the U.S. Army Corps of Engineers, Omaha District, December 1994.

4. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands.* Army Corps of Engineers, Environmental Protection Agency, U.S. Fish and Wildlife Service, and Soil Conservation Service. An Interagency Cooperative Publication, January 1989.

Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

Interactions Between Media

June 30, 1997
Rev. 1

773

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6.0 INTERACTIONS BETWEEN MEDIA

6.1 Overview

Some monitoring is performed to characterize interactions between the various environmental media. Possible interactions are presented in Table 6-1, which represents a conceptual model of integrated monitoring at Rocky Flats Environmental Technology Site (RFETS or the Site). Some significant interactions that require decision making and data are presented below.

Table 6-1
Interactions Between Media, Significance at RFETS, and Monitoring to Evaluate Interactions

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Surface Water to Ecology	Potentially significant; surface water flow and contamination could impact local ecology. However, the local ecology has remained healthy during a variety of climatic and flow conditions.	Data from existing Site-wide surface water monitoring may be used to assess potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes and assess general ecological health. In addition, project-specific evaluations are conducted to assess potential impacts.
Surface Water to Groundwater	Not significant; groundwater recharge from surface water is not significant.	No monitoring is necessary to characterize or assess groundwater impacts.
Surface Water to Air	Not significant; surface water quality will not significantly impact air quality (i.e., cause exceedances of air quality standards).	Any significant impacts on air or water quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Surface Water to Soil	Potentially significant; water in drainages and ponds will not significantly increase contaminant concentrations in soil; however, runoff could spread contaminants on surface soils and increase sediment concentrations.	Soil monitoring is conducted to determine the impacts of surface water runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Groundwater to Surface Water	Significant; most of the Site groundwater flows into Site surface water drainages.	Existing surface water monitoring will detect any impacts from groundwater. Data from Site-wide groundwater monitoring (Site-wide and project-specific) is also used to assess and predict potential surface water impacts.

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Table 6-1
(continued)

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Groundwater to Ecology	Potentially significant; contaminated groundwater could indirectly impact ecological resources, as well as reduce groundwater flow.	Data from existing Site-wide groundwater monitoring may be used to assess and predict potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes.
Groundwater to Air	Not significant; groundwater will not directly affect air quality.	Existing air quality monitoring will detect air quality degradation, and existing groundwater monitoring will detect groundwater contamination that could impact surface water quality.
Groundwater to Soil	Not significant; groundwater contaminants appear in surface water but are not likely to contaminate surface soils.	Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Air to Soil	Potentially significant; point source and fugitive emission sources could deposit contaminants on soil.	Soil monitoring is conducted to determine the impacts of air emissions and disposition and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project monitoring.
Air to Ecology	Potentially significant; point source and fugitive emissions could deposit contaminants on ecological resources.	The ecological monitoring program is designed to detect ecological changes. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Air to Surface Water	Potentially significant; point source and fugitive emission sources could degrade surface water quality.	Surface water monitoring (Site-wide and project-specific) will detect increases in contaminant concentrations. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific air monitoring.

Table 6-1
(continued)

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Air to Groundwater	Not significant; contaminants in air will not directly impact groundwater quality.	Groundwater monitoring will track groundwater contamination, and air quality monitoring (Site-wide and project-specific) will detect degradation of air quality that could impact other media.
Soil to Surface Water	Significant; contaminants in soils are transported to surface water via runoff and surface water quality is degraded.	Site-wide and project-specific surface water monitoring will detect increases in contaminant concentrations. Soil monitoring is also conducted to determine the impacts of runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Ecology	Could be significant; contaminated soils could adversely impact local ecology.	The ecological monitoring program is designed to detect ecological changes. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Air	Significant; contaminants in surface soil are resuspended and air quality is affected.	Any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific monitoring. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Groundwater	Significant; contaminants migrate from surface and subsurface soils to groundwater via percolation.	The existing groundwater well network is designed to detect increases in contaminant concentrations in groundwater. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.

Notes:
CDPHE = Colorado Department of Public Health and Environment
DOE = Department of Energy
RFETS = Rocky Flats Environmental Technology Site

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6.2 Water and Ecological Health

As indicated in Table 6-1, there are interactions between surface water, groundwater, and the flora and fauna of the Site. Concerns have been expressed that changes in flow into and out of the Site could impact significant habitat and species of concern both on Site and downstream (e.g., the Prebles meadow jumping mouse on Site, and whooping cranes in Nebraska). For example, aggregate mining activities west of the Site may alter surface water flowing onto the Site and could impact species of concern on Site and downstream. The Department of Energy, Rocky Flats Field Office (DOE, RFFO) could be held responsible for these impacts. Also, Site closure activities (e.g., closure of the Building 995 wastewater treatment plant and modification of the Interceptor Trench System) could significantly alter drainage and flow patterns. In fact, water is one of the key abiotic components structuring some of the significant habitats. Should the availability or quality of water be affected by upgradient off-Site activities or upgradient on-Site activities, significant habitats could be adversely affected.

The integrated monitoring working group, therefore, decided to collect some watershed-level information on water availability in the Buffer Zone. Current flow monitoring in the Buffer Zone is shown in Table 6-2. The data are collected at five-minute intervals, downloaded, and compiled monthly. However, data quality objectives (DQOs) for this monitoring have not yet been developed, and data evaluation to assess ecological impacts has not yet been initiated. Site-specific relationships between water availability and ecological health are not known; therefore, it is not known what type of data are actually required. Additional data, currently uncollected, could be required (e.g., accurate information on purchased water, data on exfiltration and infiltration of underground pipes, and data on alluvial flow through the Buffer Zone habitats of concern).

The following preliminary decision rules have been proposed:

Preliminary Secondary Data Uses Could Include:

- Determining the impact of mining on Rock Creek water quality and availability;
- Interpreting potential causes of declines in any of the valued habitats on Site;
- Supporting water management planning;
- Evaluating cumulative impacts of all actions (on and off Site);
- Validating any predicted impacts of the selected alternative to downstream resources; and
- Supporting the Site's biological assessment and USFWS's biological opinion.

Table 6-2
Buffer Zone Flow Monitoring Stations

Station Identifiers	Locations	Monitoring in Addition to Flow
	Boundary Stations	
GS01	Woman/Indiana	RFCA and possible nutrient load monitoring
GS02	Mower/Indiana	
GS03	Walnut/Indiana	RFCA and possible nutrient load monitoring
GS04	Rock Creek at Highway 128	
GS05	North Woman Creek at west boundary	
GS06	South Woman Creek at west boundary	
SW134	Rock Creek at west boundary (Gravel Pit)	
GS16	Antelope Springs	
	Interior Stations	
GS10	Upper South Walnut Creek	RFCA Segment 5 and IA IM/IRA by RMRS in FY96
GS11	A4 discharge	NPDES
GS09	B4 discharge	
SW029	C1 discharge	To be discontinued
SW998	Runoff from T130 trailer complex into Walnut Creek	IA IM/IRA
SW118	Above Portal 3, north side of road	
SW027	SID upstream of Pond C2	RFCA Segment 5 and IA IM/IRA by RMRS in FY96
SW093	Walnut Creek below Portal 3	RFCA Segment 5 and IA IM/IRA by RMRS in FY96

Notes:
- IA = Industrial Area
- IM/IRA = Interim Measures/Interim Remedial Action
- NPDES = National Pollutant Discharge Elimination System
- RFCA = Rocky Flats Cleanup Agreement
- RMRS = Rocky Mountain Remediation Services, L.L.C.
- SID = South Interceptor Ditch

Inputs:

- Drainage flow.
- Water level measurements.
- Stream gain or loss.

Preliminary Boundaries Include:

Spatial:	All surface waters entering and leaving the Site in the Rock Creek, Walnut, and Woman Creek drainages.
Temporal:	Seasonal and yearly determinations of total water availability and basic water quality.

Preliminary Decision Statement:

IF	The seasonal average or yearly average water availability or quality entering Rock Creek, Walnut Creek, or Women Creek drainages diminishes below baseline due to off-Site activities
THEN	The Site will notify Jefferson County and the U.S. Fish and Wildlife Service (USFWS) to determine what actions, if any, should be taken to restore availability and/or quality to historical levels.
IF	Activities occurring within Site boundaries result in a depletion of the seasonal or yearly average natural flow greater than the historic baseline, or at rates that are determined to have a negative impact on downstream habitats or individual species
THEN	The Site will determine what management actions should be taken to ameliorate this problem.
IF	Significant changes to alluvial groundwater availability in a wetlands habitat are determined
THEN	Notify parties of potential impacts to the wetlands habitat and continue groundwater and ecological monitoring.
IF	A proposed action could adversely affect a listed species or its critical habitat
THEN	The Site will enter into formal consultation with the USFWS.

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Preliminary Acceptable Decision Errors Include:

- Confidence that significant events are physically sampled and representative:
  - Flow will be continually monitored; therefore, as long as the flow meters are working, all events will be sampled. Seasonal grab samples will be taken to evaluate basic water chemistry. An effort will be made to gather a sample representative of conditions during the season.
- Acceptable decision error rates for statistical sampling design:
  - The function of this monitoring is to provide a watershed-level measure of water availability and quality to serve as an early warning that habitats reliant on these waters may be adversely impacted if depletion continues. The Site is more concerned with failing to detect a decrease in water availability or quality over historical levels than mistakenly determining that a decrease has occurred. The precise change over time that is of concern has not been established because the water requirements of the habitats are not fully understood. Therefore, no attempt has been made to establish quantitative limits on decision errors or to generate a statistical design.
  - The integrated monitoring working group will continue to address water and ecology monitoring integration. The group needs to determine how to effectively use the Buffer Zone flow data or eliminate that monitoring altogether. The group also needs to determine if it would be cost-effective to collect additional data and how those data could be used to assess impacts on ecological health.

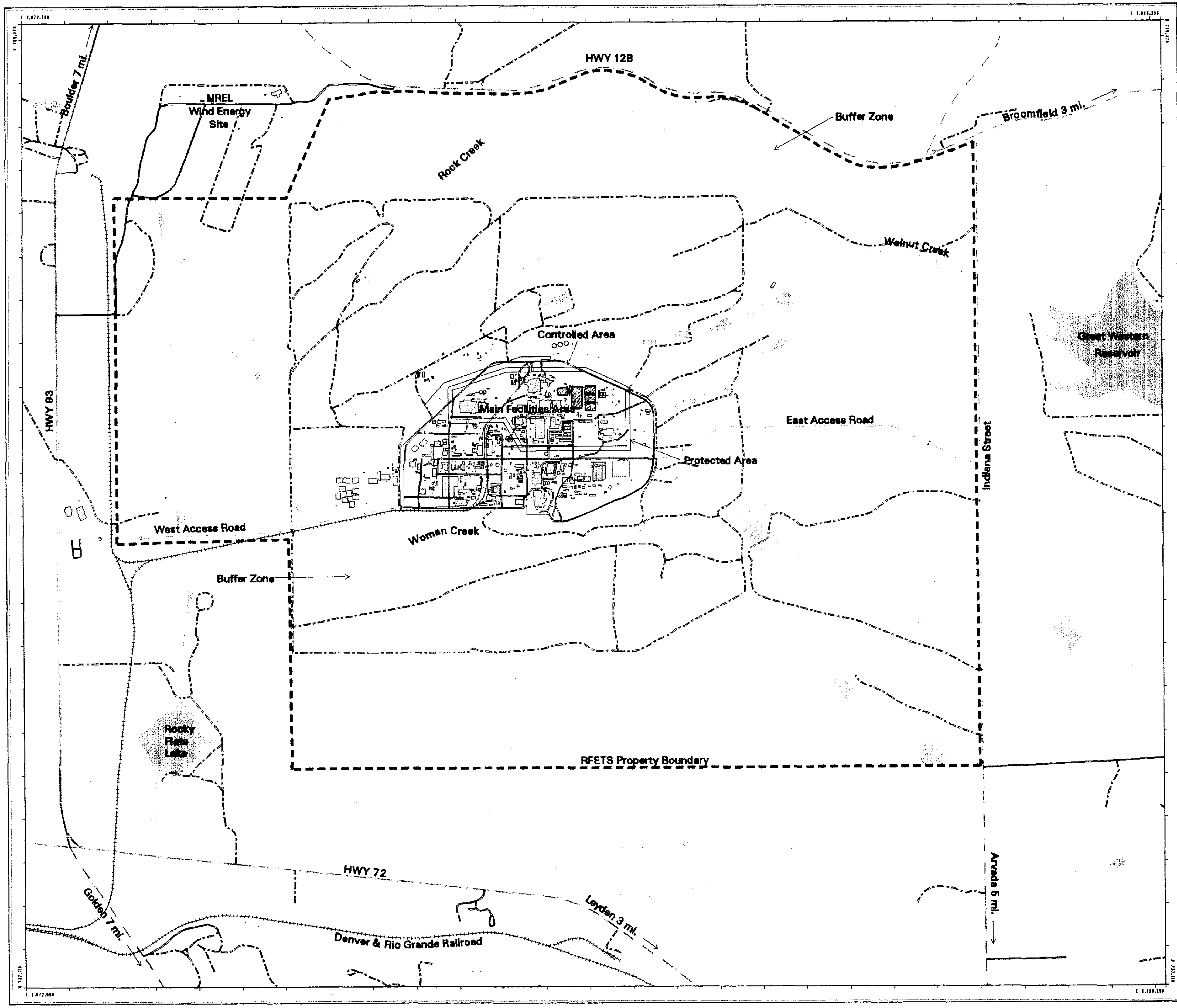

Figure 1-2

Rocky Flats Environmental Technology Site Map

EXPLANATION

Standard Map Features

- Buildings
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Heavy duty paved roads
- Medium duty paved roads
- Light duty paved roads
- Dirt roads
- Railroads

DATA SOURCE: Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 28720
1 inch represents approximately 2393 feet

700 0 1400 2800 ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

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MAP ID: 97-0063

September 29, 1997

(7)

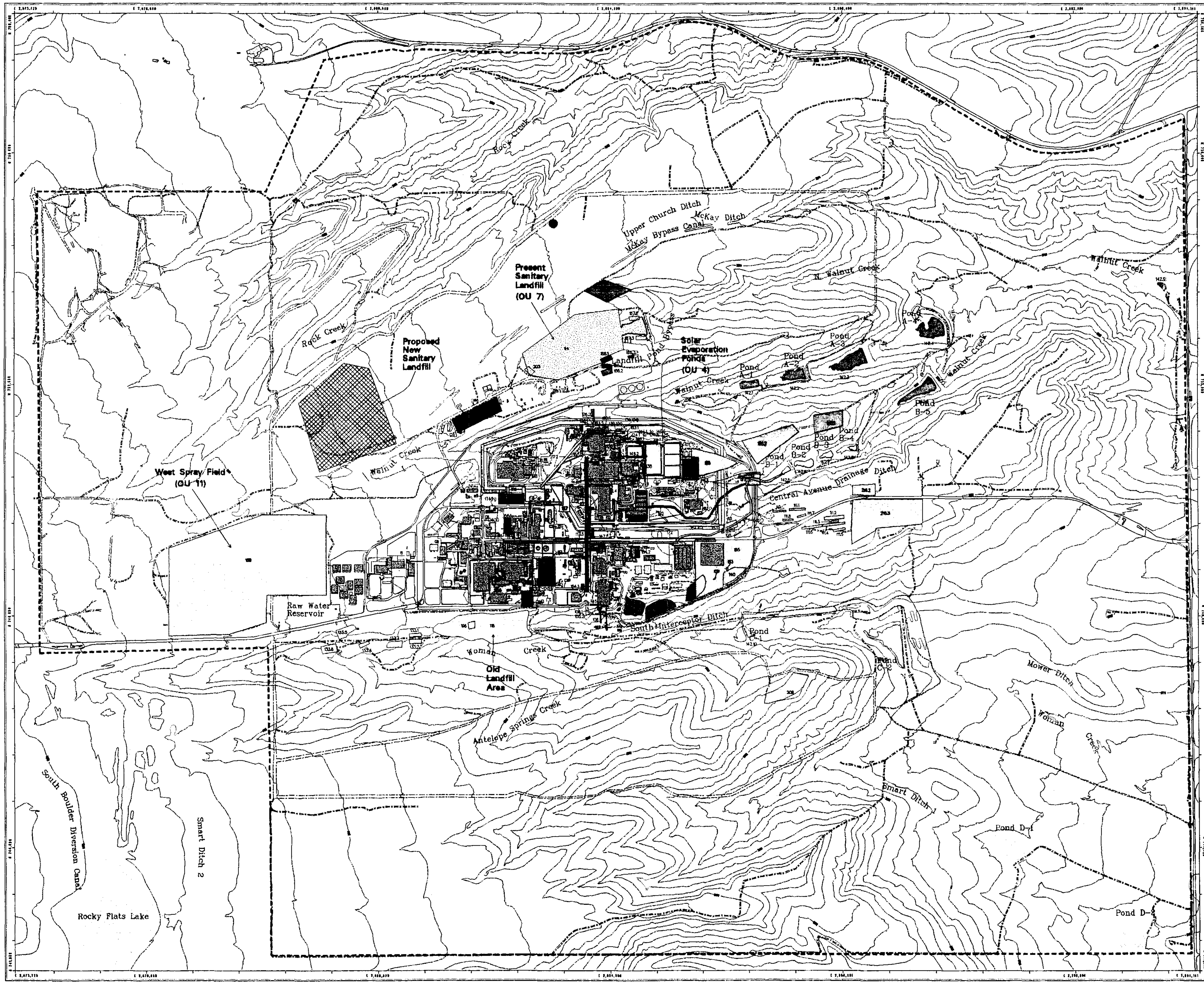

Figure A-3

Individual Hazardous Substance Sites by Operable Unit

EXPLANATION

- Operable Unit 1
- Operable Unit 2
- Operable Unit 4
- Operable Unit 5
- Operable Unit 6
- Operable Unit 7
- Operable Unit 8
- Operable Unit 9
- Operable Unit 10
- Operable Unit 11
- Operable Unit 12
- Operable Unit 13
- Operable Unit 14
- Operable Unit 15
- Operable Unit 16

Standard Map Features

- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - date unknown

Scale = 1 : 21390
1 inch represents approximately 1778 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
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MAP ID: 97-0068

March 05, 1997

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174

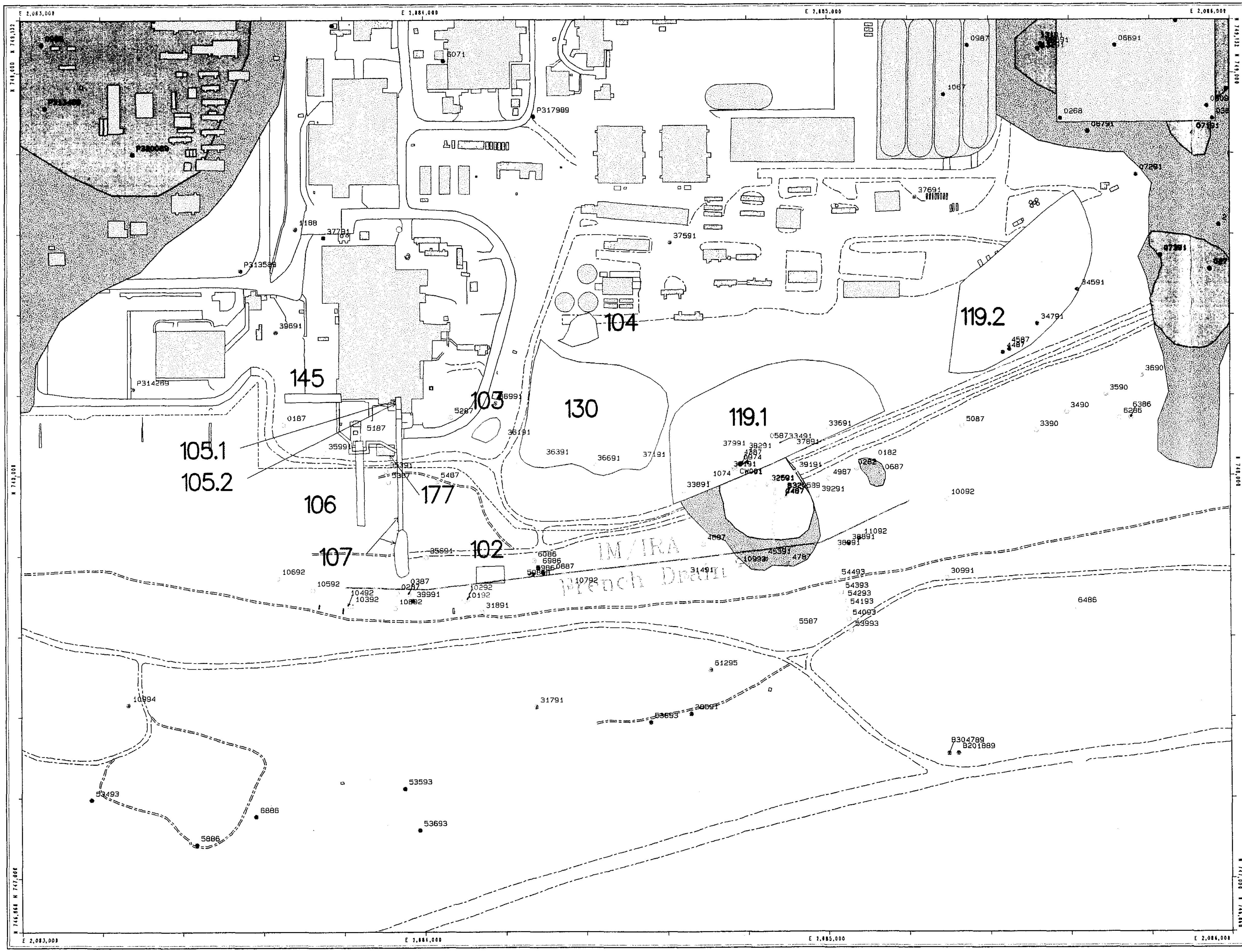

Figure D-1

Individual Hazardous Substance Sites of OU 1, 881 Hillside Area

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr. EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

Scale = 1 : 2920
1 inch represents approximately 243 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0063

May 12, 1997

201

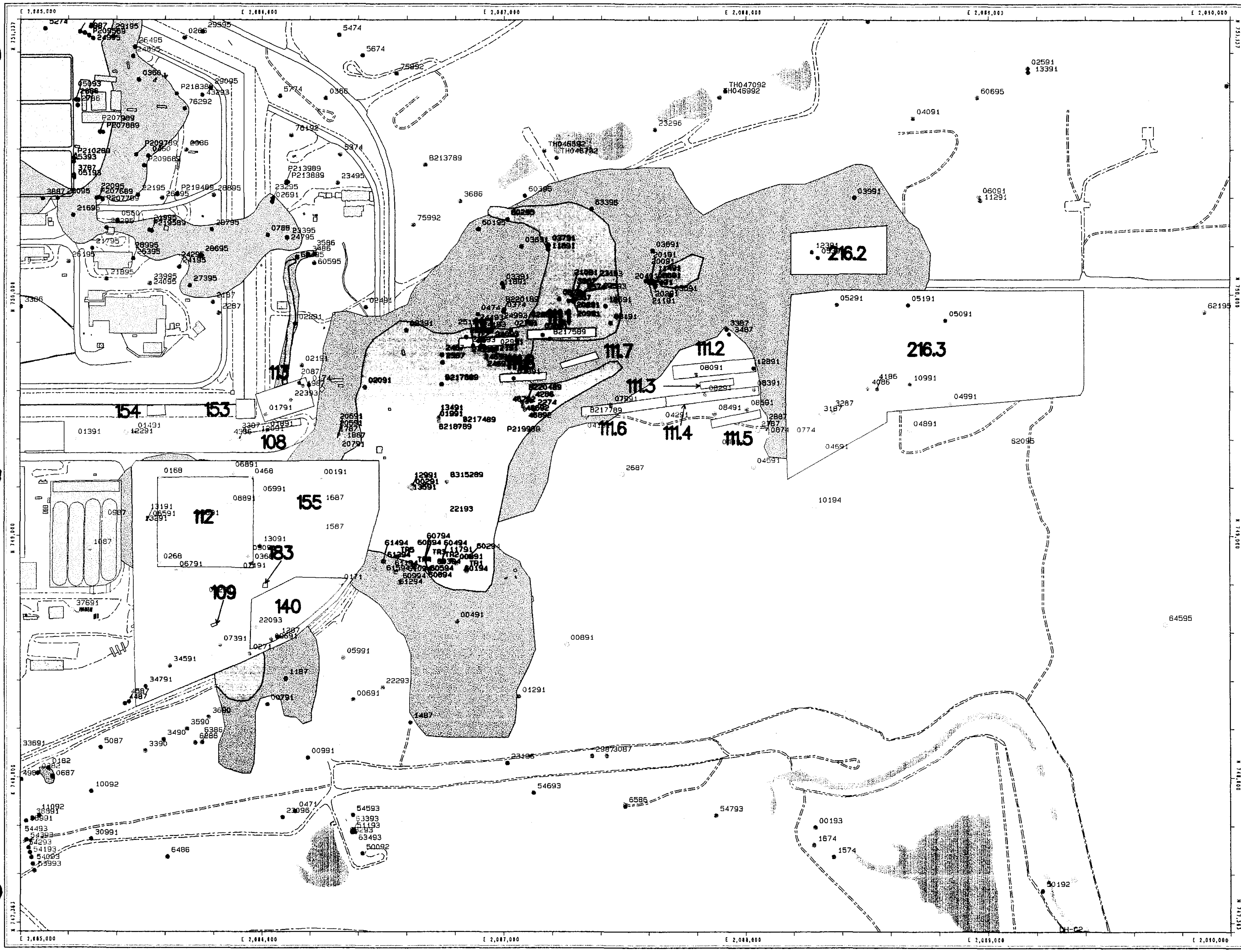

Figure D-2

Individual Hazardous Substance Sites of OU 2, 903 Pad, Mound, East Trenches

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

Scale = 1 : 4870
1 inch represents approximately 406 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0063

May 12, 1997

203

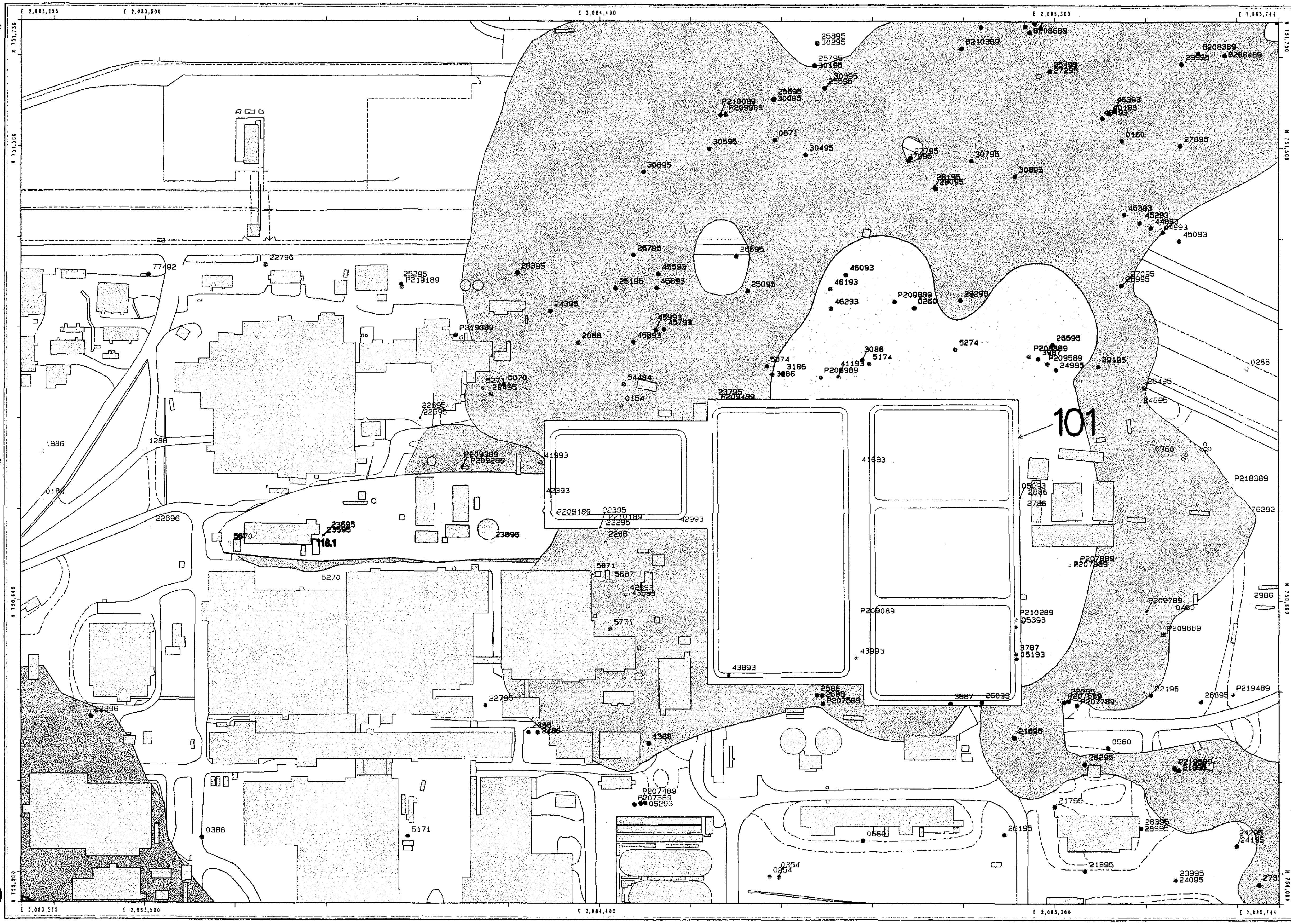

Figure D-3

Individual Hazardous Substance Sites of OU 4, Solar Evaporation Ponds and IHSS 118.1

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE: Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991. Hydrology provided by USGS - (date unknown)

Scale = 1 : 2420
1 inch represents approximately 202 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0063

May 12, 1997

206

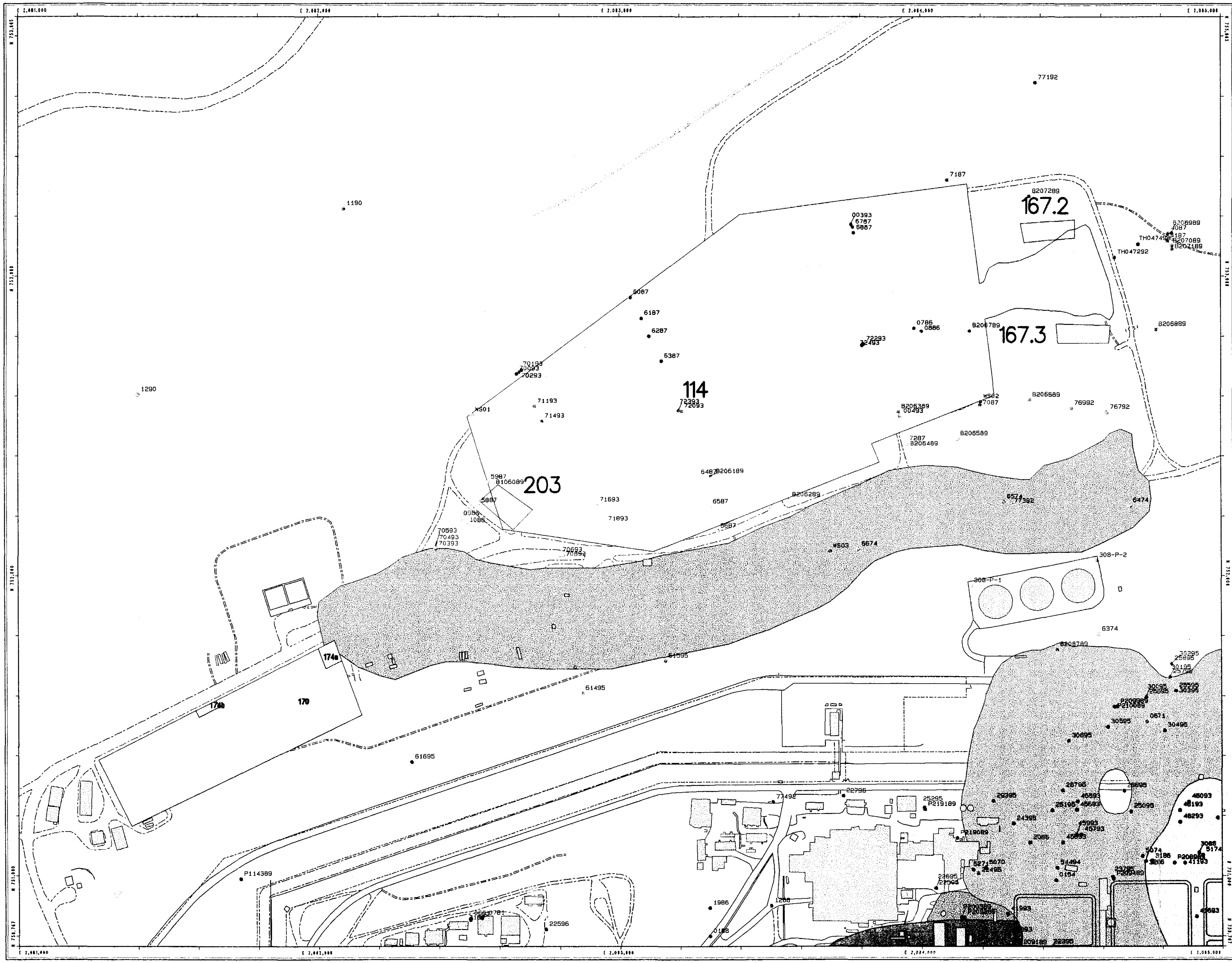

Figure D-4

Individual Hazardous Substance Sites of OU 7, Present Sanitary Landfill and IHSSs 170, 174a & 174b

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

Scale = 1 : 3830
1 inch represents approximately 319 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0063

May 12, 1997

210

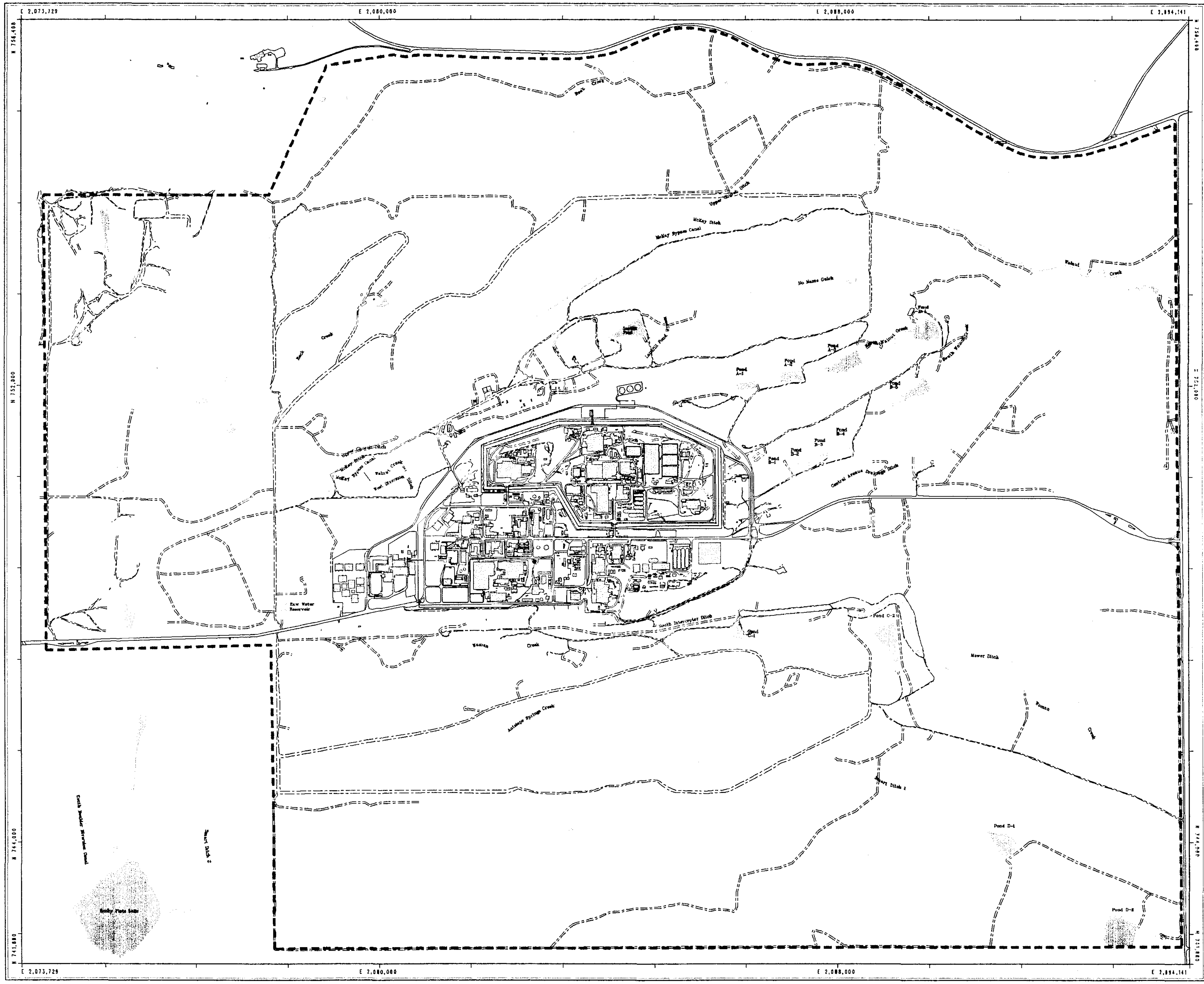

Figure 3-1

Detention Ponds, Ditches, Effluent Watercourses, and Creeks at RFETS

EXPLANATION

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by facilities (ngs), EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

N

Scale = 1 : 21330
1 inch represents approximately 1778 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 97-0063

March 06, 1997

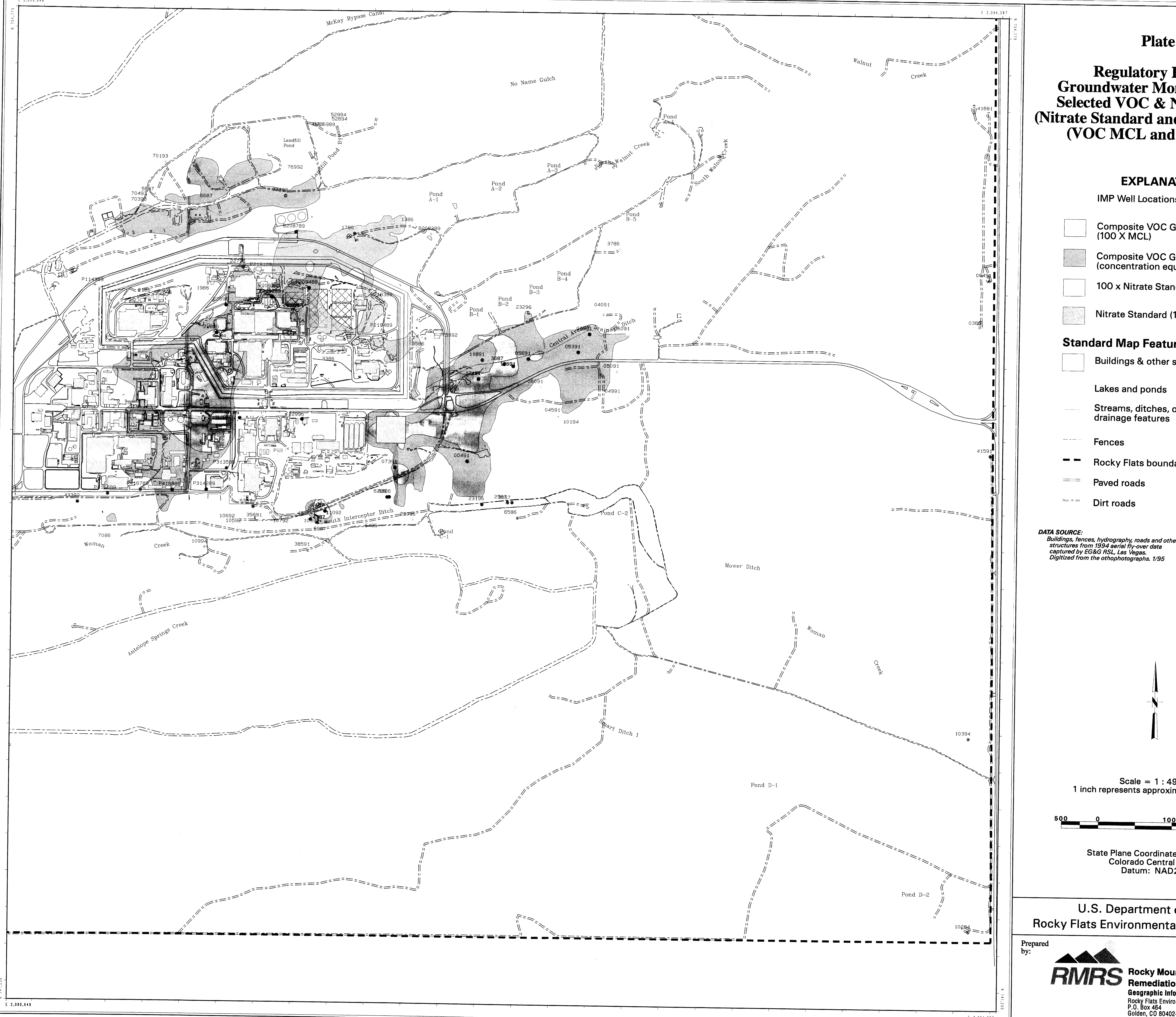

Plate 3

Regulatory Required Groundwater Monitoring Wells Selected VOC & Nitrate Plumes (Nitrate Standard and 100 x Standard) (VOC MCL and 100 x MCL)

EXPLANATION

IMP Well Locations

- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)
- 100 x Nitrate Standard (1000 mg/l)
- Nitrate Standard (10 mg/l)

Standard Map Features

- Buildings & other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the othophotographs. 1/95

Scale = 1 : 4960
1 inch represents approximately 413 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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MAP ID: 97-0001

December 15, 1997

Plate 2

Potentiometric Surface of Unconsolidated Surficial Deposits Second Quarter, 1993

EXPLANATION

- Groundwater Monitoring Well
- Water Level Contour
- Dashed where inferred
- Intermediate Water Level Contour
- Dashed where inferred
- Approximate extent of Unsaturated Area
- Area without Groundwater Elevation Data
- Perennial Seep
- Ephemeral Seep
- Extent of Rocky Flats Alluvium

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Contours (20' Intervals)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, roads, and fences provided by Facilities Engr., EG&G Rocky Flats, Inc. - 1991.
Hydrology provided by USGS - (date unknown)

This map may not identify all seep locations and all unsaturated areas

See 1995 Hydrogeologic Characterization Report

Scale = 1 : 7200
1 inch represents 600 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

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MAP ID: 97-0034

June 03, 1997

Plate 1

Groundwater Flow Monitoring Well Location Map

EXPLANATION

IMP Well Type

- Water Quality Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- Non-IMP

Monitoring Well Completion Zone

- Bedrock
- Alluvium
- Alluvium/Bedrock

Other Well Types Completion Zone

- Bedrock
- Alluvium
- Alluvium/Bedrock

Other

- Extent of Rocky Flats Alluvium

Standard Map Features

- Buildings & other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contours (20' Intervals)
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the othophotographs. 1/95

Scale = 1 : 6120
1 inch represents 510 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy

Rocky Flats Environmental Technology Site

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