NOTICE

All drawings located at the end of the document.

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INTEGRATED MONITORING PLAN FY 2003

SUMMARY DOCUMENT

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ACRONYMS AND ABBREVIATIONS

ALF	Action Levels and Standards Framework
AoI	Analyte of Interest
AQM	Air Quality Management
BDCWA	Big Dry Creek Watershed Association
BMP	Best Management Practice
CAA	Clean Air Act
CDPHE	Colorado Department of Public Health and Environment
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWA	Clean Water Act
D&D	Decontamination and Decommissioning
DOE	Department of Energy
DRCOG	Denver Regional Council of Governments
DQO	Data Quality Objective
EPA	U.S. Environmental Protection Agency
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
IMP	*Integrated Monitoring Plan*
NESHAP	National Emission Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
POC	Point of Compliance
POE	Point of Evaluation
QA/QC	Quality Assurance/Quality Control
RAAMP	Radioactive Ambient Air Monitoring Program
RCRA	Resource Conservation and Recovery Act
RFCA	*Rocky Flats Cleanup Agreement*
RFETS	Rocky Flats Environmental Technology Site
Site	Rocky Flats Environmental Technology Site
T&E	Threatened and Endangered (Species)
TSS	Total Suspended Solids
WARP	Well Abandonment and Replacement Program
WWTP	Wastewater Treatment Plant
yr	year

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1 INTRODUCTION

Environmental monitoring programs at the Rocky Flats Environmental Technology Site (RFETS or Site) continue to evolve in response to new regulatory requirements and accelerated Site closure activities. Various monitoring programs have amassed data on soils, surface water, groundwater, air, and different ecological systems. The *Rocky Flats Cleanup Agreement* (RFCA) (DOE, 1996) requires the U.S. Department of Energy (DOE), in consultation with the Colorado Department of Public Health and Environment (CDPHE), and the U.S. Environmental Protection Agency (EPA), to establish an integrated monitoring program that effectively collects and reports the data required to ensure the protection of human health and the environment. The program is consistent with the RFCA Preamble, and complies with RFCA, laws and regulations, and effective management of RFETS resources.

This Fiscal Year (FY) 2003 *Integrated Monitoring Plan* (IMP) identifies the routine monitoring programs for surface water, groundwater, air, and ecology, designed to minimize the duplication of efforts among DOE, CDPHE, the cities of Broomfield and Westminster, and associated data management systems.

The IMP details RFETS monitoring activities performed for legal, contractual, and operational purposes. It restates the agreed-upon types of monitoring, monitoring locations, sampling frequencies, and purposes of the monitoring. Much of the monitoring discussed in this document is performed to satisfy specific regulatory requirements that are not due to the RFCA agreement. Where this is the case, such monitoring requirements are not subject to enforcement pursuant to RFCA, but may be subject to enforcement in accordance with the initiating legal requirements. In addition, RFETS monitoring programs encompass Best Management Practices (BMPs) that are not required by RFCA or other federal and state laws and regulations. The BMPs are incorporated into the IMP, but may be dependent on the availability of federal funding in accordance with RFCA, Paragraph 249.

In developing the IMP, RFETS personnel met with a working group of representatives from EPA, the State of Colorado, and the cities of Westminster, Northglenn, Thornton, Arvada, and Broomfield to develop consensus on the types of data to be gathered and their eventual uses as portrayed in the data quality objectives (DQOs) described in this IMP. The program is designed to provide data that meet the DQOs needed to support operational and regulatory decision making, and to address the requirements of the following statutes, regulations, permits and agreements:

- Resource Conservation and Recovery Act (RCRA);
- Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA);
- Clean Air Act (CAA);
- Clean Water Act (CWA);

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- National Pollutant Discharge Elimination Systems (NPDES) Permit and amendments;
- Colorado Hazardous Waste Acts
- Standards promulgated by the Colorado Water Quality Control Commission;
- RFCA;
- Regulations governing natural resource (ecological) management;
- RFETS-specific monitoring and cleanup agreements; and
- DOE Orders and technical guidance.

1.1 Integrated Monitoring Plan

This document, the FY2003 IMP, is a revision of the FY2002 IMP (Kaiser-Hill, 2002a) and the FY2002 *IMP Background Document* (Kaiser-Hill, 2002b), which describes the activities being conducted at RFETS under the IMP to satisfy RFCA and other regulatory requirements and interests. The FY2003 *IMP Background Document* provides detailed discussions of the decision-making process that has resulted in numerous monitoring efforts at RFETS. This FY2003 IMP lists the monitoring programs to which DOE and the other regulatory agencies are committed. The FY2003 *IMP Background Document* provides additional information about the DQO decision process and the regulatory framework that drives many of the monitoring decisions at RFETS. The FY2003 *IMP Background Document* is not subject to enforcement under RFCA.

This FY2003 IMP lists the ongoing environmental monitoring activities that DOE, CDPHE, EPA, and other stakeholders have supported during the numerous working group meetings used to formulate monitoring-based decisions. It provides an overview of the requirements for these activities and the intended uses of the data that result. Monitoring is performed in four primary areas—surface water, groundwater, air, and ecological systems. Specific RFETS activities may involve soil monitoring, although RFETS-wide soil monitoring was discontinued in 1994 after many years of characterizing transuranic-contaminant distributions across RFETS. Interactions among these media have been recognized and discussed in some detail. The data collected can be used to support investigations into these interactions to the extent that the interactive effects are themselves measurable.

Each of the four major monitoring programs is discussed below. Soils are also considered. Soils and soil monitoring, as well as a discussion of the interactions between the media, are discussed below. Soil data relate to other media in various ways and continue to be important to the other programs, to future projects and project planning, and ultimately to Site closure. A discussion of RFETS soil monitoring is included in Section 6, and interactions between media are included in Section 7 of the *IMP Background Document.*

1.2 Data Quality Objectives

Representatives of DOE, Rocky Flats Field Office (RFFO), Kaiser-Hill, and the various federal, State of Colorado, and local stakeholder groups together developed a set of

DQOs to ensure that environmental monitoring data would satisfy the requirements of the regulations listed above and would aid in detection of conditions that could lead to unacceptable risks to public health and the environment. The data will be used to: (1) model contaminant movement and identify contaminant concentrations that exceed pre-established limits; (2) support planning, implementation, and assessment of remedial and Decontamination and Decommissioning (D&D) activities; (3) address regulatory reporting requirements and commitments; and (4) monitor various ecological systems at RFETS.

Therefore, the data need to meet or exceed quality requirements to ensure accuracy in modeling, risk assessment, performance assessment, and compliance. The data must be of sufficient quality to withstand scientific and legal scrutiny, and must be gathered using appropriate procedures for their intended use in making decisions for RFETS activities. Each environmental monitoring program includes a set of data usability requirements and procedures to ensure that high-quality data are produced.

1.3 Quality Assurance

The quality of the RFETS environmental monitoring data is ensured through careful planning and design of monitoring programs and implementation of work control procedures that address sampling, analysis and data management activities. Presented in this document are statements of the major decisions that need to be made based on monitoring data, how the data will be applied in decision making, and the approaches used to obtain the data. Procedures cover monitoring activities, including sampling, analysis and data management, and consist of approved, controlled documentation. Monitoring procedures are referenced in the various environmental program plans, which are contained in the RFETS Environmental Management Program Manual (MAN-080-EMPM, 9/98).

RFETS environmental program and analytical services managers have a significant role in controlling the quality of environmental monitoring data. They are responsible for designing adequate environmental monitoring programs, collecting environmental samples and field data of high quality, properly submitting samples, ensuring data are managed per procedures, and interpreting and reporting monitoring results.

Minimum requirements for laboratory quality assurance/quality control (QA/QC) programs have been promulgated. These requirements ensure that each laboratory generating data has procedures for assuring that the precision, accuracy, completeness, and representativeness of data generated are known and documented.

Additionally, analytical data are subject to data assessment (quality assurance evaluation of analytical chemistry data). Assessments cover monitoring activities, including sampling and analysis. Subcontracted laboratories are routinely audited and participate in inter-laboratory cross-check programs. Assessments are conducted pursuant to the RFETS *Site Integrated Oversight Manual* (1-MAN-013-SIOM), in compliance with DOE Order 414.1 and the Kaiser-Hill Team Quality Assurance program. Assessment findings are tracked and corrected pursuant to the *Site Corrective Action Requirements Manual* (1-

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MAN-012-SCARM) and the Kaiser Hill Corrective Action Process (3-X31-CAP-001). The *IMP Background Document* details the overall QA/QC requirements, including field duplicate and blank samples, analytical detection limits, and standards for accuracy and completeness.

2 SURFACE WATER

2.1 Introduction

The surface water monitoring program at RFETS addresses the requirements of statutes, regulations, orders, and agreements, and supports many decision-making processes. Surface water monitoring (summarized in Table 1) encompasses five areas:

- RFETS-wide water quality;
- Quality of waters within the Industrial Area;
- Quality of discharges from the Industrial Area;
- Quality of water leaving RFETS; and
- Off-site water quality.

Protocols for sampling and analysis of surface water, as well as QA/QC requirements, are defined in several documents. Refer to Section 2.1.5 of the *IMP Background Document* for details.

RFETS maintains surface water data in the Rocky Flats Soils and Water Database (formerly the Rocky Flats Environmental Database System). The data can be retrieved and reported in many formats for specific purposes. Many of the data generated are not specifically reported in RFETS documentation, but are provided to requestors or decision makers as needed. However, regularly generated reports include:

- NPDES permit compliance reports including monthly and annual preparation and delivery of the Discharge Monitoring Report to EPA Region VIII.
- Pre-discharge and community assurance monitoring results gathered by the State, and reported routinely to RFETS and nearby cities.
- Reportable RFCA monitoring results (those above of RFCA standards and action levels) reported to EPA and CDPHE.
- The bulk of the surface water data collected are summarized and reported at Quarterly Information Exchange Meetings, which have been held since 1972.

Table 1 Surface Water Monitoring Matrix

Type of Monitoring	Locations	Sampling Frequency	Sampling Performed By	Purpose
SITE-WIDE				
Dam Operations - Imminent Danger to Life and Health	Detention ponds	Various regular intervals	Site personnel	Assess need for discharges from ponds to ensure dam integrity
Streamflow	8 stream locations	Continuous when flowing	Site personnel	Determine streamflow upgradient of Ponds A3, A4, B5, and C2. Determine outflow from Ponds A3, A4, B5, and C2
Pond Elevations	4 pond locations	Daily (hourly if needed)	Site personnel	Monitor amount of water detained in Ponds A3, A4, B5, and C2
Piezometers	Dams at Ponds A3, A4, B1, B3, B4, B5, and C2, Landfill	Continuous	Site personnel	Monitor level of saturated zone in detention structures
Dam Integrity Inspections	12 dams	Various	Site, DOE, and Federal Energy Regulatory Commission (FERC) personnel	Assess physical integrity of earthen dams
Ad Hoc	Varies	As needed[1]	Site personnel	Address need for special monitoring
New Contaminant Sources	Varies	As needed[1]	Site personnel	Identify sources of new contamination detected by the surface water monitoring program
Plutonium Correlation	Point of compliance (POC), plus 5 additional locations	As needed[1]	Site personnel	Correlate plutonium concentrations to levels of more easily measurable parameters
INDUSTRIAL AREA				
New Source Detection	5 locations	As needed[1]	Site personnel	Detect changes in Analyte of Interest (AoI) concentrations or water quality parameters that might indicate new contamination

Type of Monitoring	Locations	Sampling Frequency	Sampling Performed By	Purpose
Incidental Waters	Varies	As needed[1] (100-200 events/yr on average)	Site personnel	Determine acceptable disposal method
Performance Monitoring (Source Location)	Varies	As needed[1], generally from 18 months before project start-up to 3 months after completion	Site personnel	Establish baseline conditions and monitor effects of RFETS activities on water quality
INDUSTRIAL AREA DISCHARGES TO PONDS				
Stream Segment 5	4 Action Levels and Standards Framework (ALF) locations	Varies[1] (total approx. 85 samples)	Site personnel	Monitor compliance with RFCA action levels
Internal Waste Streams	Discharges from buildings, Wastewater Treatment Plant (WWTP), terminal ponds, and cooling towers, plus any new discharges	Various intervals, depending on location	Site personnel (EPA Region VIII conducts annual NPDES permit inspections)	Confirm NPDES permit compliance
Discharges to WWTP	New waste streams	As needed[1]	Site personnel	Consider for discharge to WWTP
WWTP Collection System	2 locations in collection system	Regular intervals specified in *IMP Background Document*	Site WWTP personnel	Check for signs of corrosivity and monitor Lower Explosive Limits
WWTP Radiological Monitoring	WWTP influent collection lines and effluent	Influent monthly, effluent monthly	Site personnel	Monitor impact of cleanup activities on WWTP and determine removal efficiency
NPDES-Permitted Discharges	WWTP outfall and terminal pond discharges	Specified in NPDES Permit	Site personnel	Demonstrate permit compliance and provide data for permit updates

Type of Monitoring	Locations	Sampling Frequency	Sampling Performed By	Purpose
WATER LEAVING THE SITE				
Predischarge	Ponds A4, B5, and C2	About 8-10 events/yr (1 event/yr at C2)	Site personnel (CDPHE analyzes samples)	Determine quality of water to be discharged from terminal ponds
Terminal Ponds	3 terminal ponds	Frequency specified in *IMP Background Document*	Site personnel	Verify that industrial discharges do not endanger waters of the U.S.
Segment 4	5 locations	About 3 samples for each of 8-10 discharge events, plus 1-3 samples per month between discharges[1]	Site personnel	POC monitoring
Non-POC at Indiana St.	Walnut Creek & Woman Creek Drainages	Total of 21 samples annually	CDPHE	Assess effects of flow changes on nutrient loads in water leaving RFETS
OFF SITE				
Uncharacterized Discharges	5 primary locations, but could vary with circumstances of discharge	As needed[1]	Site personnel	Assess impact of uncharacterized discharges on community water supply facilities
Community Assurance	4 points in Westminster and Broomfield water treatment process streams	Weekly, with samples composited semiannually or annually	Westminster and Broomfield municipal employees	Notify municipalities in the event of water quality exceedances; provide data for dose reconstruction studies

[1] Sampling frequency is determined based on project plans. (Refer to *IMP Background Document* for more information.)

2.2 Site-Wide Water Quality

This section deals with surface water monitoring objectives that are not confined to a particular part of RFETS. Site-wide monitoring includes:

- Monitoring the dams that form the RFETS detention ponds (dams lie within a defined area, but monitoring is performed to ensure their safety);
- Locating the source of contamination detected by the monitoring objectives described in subsequent sections of the IMP;
- Specific monitoring activities in response to requests (i.e., *ad hoc* monitoring);
- Monitoring to establish a correlation between plutonium concentrations and levels of indicator parameters; and
- Monitoring performed for operational reasons and BMPs, but not enforceable under RFCA or other federal and state laws and regulations.

The Site-wide monitoring is described below.

2.2.1 MONITORING DAM OPERATIONS

The RFETS detention ponds (Figure 1) are formed by earthen dams, which are designed for stormwater detention. Once water quality is determined to meet downstream standards, water is routinely discharged from the ponds as water levels rise. Although water rarely rises to the elevation of emergency spillways, there is a risk that the dams could fail or sustain damage.

RFETS uses data from the monitoring activities listed below, along with water quality data from the ponds, within a specific decision-making process (see *IMP Background Document*, Section 2.2.1, and ancillary documents cited therein) to determine if, and when, water should be released from the ponds. RFETS performs the following monitoring activities:

- Measure streamflow upgradient of Ponds A3, A4, B5, and C2;
- Measure outflow from Ponds A3, A4, B5, and C2;
- Monitor pond elevations continuously in Pond A-3, Landfill Pond, and Terminal Ponds A4, B5, and C2. Daily monitoring is adequate for normal operations; hourly monitoring is invoked as established by procedure (e.g., in response to storms) to ensure dam safety;
- Monitor piezometers installed in the dams to track the level of the saturated zone in the earthen detention structures;
- Evaluate dam integrity through visual inspections at appropriate frequencies as determined by procedure;
- Perform routine integrity inspections on dams on the 12 ponds at appropriate frequencies, as determined by the *Pond Operations Plan* (Kaiser-Hill, 1996), and perform a detailed internal inspection biannually. FERC and DOE personnel conduct an annual external inspection of the dams;

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- Monitor spatial position of the terminal dam crest monuments to detect movement, if any, as required by the Colorado State Engineer's dam safety regulations;
- Monitor the inclinometers and evaluate dam crest movements quarterly to identify any movement of dam structure; and
- Annually exercise the valves in the outlet works of the terminal dams to ensure operability, as directed by the Office of the State Engineer.

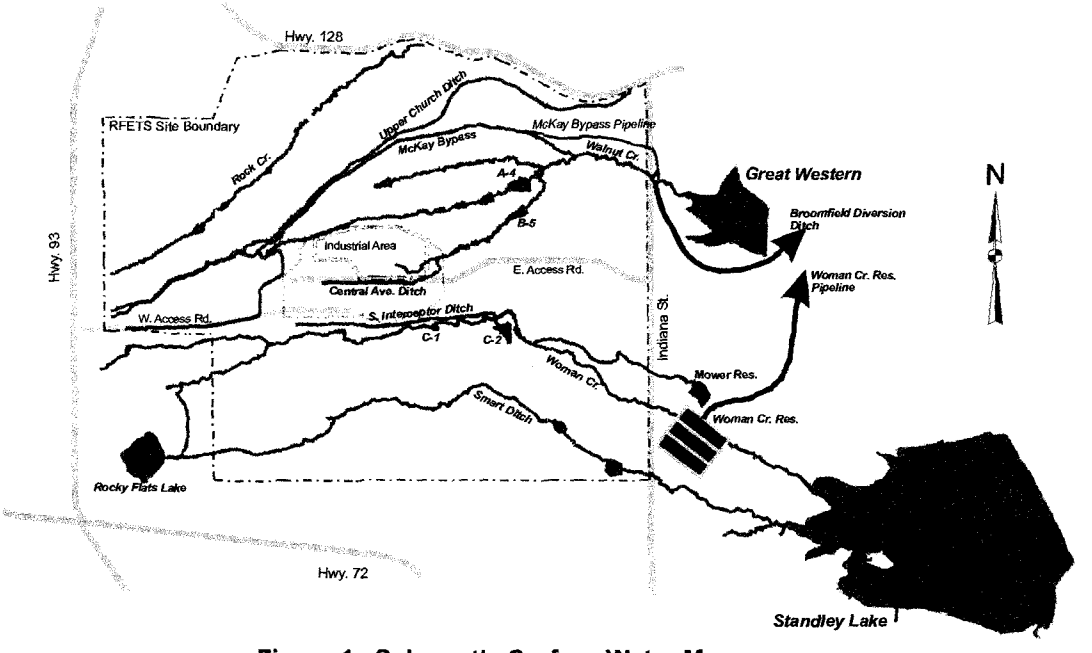

Figure 1. Schematic Surface Water Map

Data are entered into a spreadsheet model to assess the need for discharge, based on the *Pond Operations Plan*. Meteorological data are also used in the model, along with inflow and discharge rates as applicable.

2.2.2 LOCATING NEW CONTAMINANT SOURCES

If new contamination is indicated by surface water monitoring, New Source Detection stations, Point of Evaluation (POE) stations, or Point of Compliance (POC) stations, RFETS may use portable sampling equipment to help further isolate the source. This monitoring may cross the boundaries of other surface water monitoring objectives. For instance, if contaminants are detected outside the Industrial Area, portable sampling equipment may be deployed inside the Industrial Area to locate the source of the contaminants (see *IMP Background Document*, Section 2.2.2).

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2.2.3 AD HOC MONITORING

Ad hoc monitoring is designed to address specific identified data needs. The data needs arise in response to circumstances that are not addressed by the routine monitoring program. *Ad hoc* monitoring falls into one of two categories:

- *Required*—Statutory, regulatory, permit, or other requirements that monitoring must be done to obtain analytical data; and
- *Discretionary*—Where analytical data could help with further decision making, or a need for additional data is otherwise strongly indicated.

Ad hoc monitoring may be conducted in response to events such as unusual precipitation volumes, community concerns, changes in permit or regulatory requirements, construction projects, operations, or spills.

2.2.4 INDICATOR PARAMETER MONITORING FOR ANALYTICAL WATER QUALITY ASSESSMENT

RFETS continues to study whether a correlation can establish relationships between analytical measurements of constituents, such as actinides or metals and selected indicator parameters (i.e., total suspended solids (TSS), turbidity precipitation, and flow rate).

Plutonium concentrations are already being monitored at the terminal pond outfalls and at the Indiana Street RFCA POCs. RFETS also monitors TSS concentrations when possible for samples collected at the locations covered by the other decision rules in this section. To evaluate the relationship between turbidity and analytical constituents, turbidity is monitored at the locations where required by the other applicable decision rules. To evaluate the relationship between precipitation and analytical constituents, precipitation is currently monitored at ten locations across RFETS.

RFETS is continuing to evaluate the data to study the correlation between actinide and metals concentrations, and levels of selected indicator parameters. Based on this analysis, this monitoring objective may be modified in the future to further define observed correlations. Although correlation can be demonstrated under some conditions, the results have not shown a reliable quantitative correlation across the Site sufficient to allow indicator parameters to be substituted for the primary measurements. The indicator parameters prove useful as an investigative tool to assist in understanding source-related environmental conditions.

2.3 Water Quality Within the Industrial Area

RFETS monitors water within the Industrial Area to detect new sources of contamination, assess the performance of facilities or project elements (e.g., during closure of a facility) in preventing releases of specific constituents, and assess the quality of incidental rainwater or snowmelt that may accumulate in utility pits and bermed areas. Indications of a contaminant release would trigger reporting and decision-making for response and remediation. RFETS conducts the following activities under this portion of the surface water monitoring program:

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- Project-specific performance monitoring;
- Managing incidental waters;
- Monitoring the sanitary system including:
- Characterizing internal wastewater streams for NPDES Permit compliance;
- Monitoring discharges to the WWTP; and
- Monitoring total flow, potentially dangerous or damaging waste streams, and radiological activity of influent to the WWTP;
- WWTP influent monitoring; and
- WWTP collection system monitoring.

2.3.1 INCIDENTAL WATER

At RFETS, about 120 occurrences of incidental water per year (yr) require monitoring. Water that accumulates in utility pits, berms, footing drains, sumps, and excavation sites, or that is released within buildings or onto the ground, is evaluated using field screening observations and measurements, coupled with the process knowledge of RFETS personnel. Additional analysis is required if the circumstances or field observations provide cause to suspect the presence of oil or hazardous or radioactive constituents.

The program for monitoring incidental water provides for routine, data-driven decision making on whether to allow discharge of these waters into the environment without treatment. When evaluating incidental water, field personnel estimate the volume of water present, note its appearance (especially its color or presence of a visible sheen), and field test its pH, nitrate level, and conductivity. In conjunction with knowledge of the processes occurring in the immediate vicinity, these data guide the process of deciding how to dispose of the incidental water. Water that cannot be discharged to the environment may be considered for discharge to the WWTP (under internal wastewater stream rules) or may be managed under other applicable regulations.

2.3.2 SANITARY SYSTEM MONITORING

Sanitary collection system monitoring may provide D&D project managers and WWTP operators information about collection system conditions within the Industrial Area contributing to the WWTP flow. Current and prospective monitoring systems provide quantitative information about the relative contribution of the two main branches of the sanitary collection system, and qualitative information about the content of flows through the headworks of the WWTP. Sanitary system monitoring is conducted to:

- Determine percent removals across the treatment plant and, therefore, be able to predict compliance or noncompliance with NPDES Permit effluent limitations;
- Assess explosive levels at the headworks for worker safety;
- Identify corrosive substances that may impact the treatment units;
- Determine if trends in influent concentrations and loads are fluctuating up or down;

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- Establish pollutant loads attributable to specific internal waste streams; and
- Establish baseline conditions for the flows from the Protected Area (PA) and non-PA areas.

Five distinct monitoring objectives have been identified for sanitary system monitoring. Separate decision rules have been developed for each of these objectives and are detailed in the IMP Background Document. Each of the five objectives are discussed in the following sections.

2.3.2.1 Characterization of Internal Wastewater Streams to Meet Permit Requirements

The first monitoring objective is to characterize routine internal waste streams to meet NPDES Permit requirements (see *IMP Background Document,* Section 2.3.2.1 - Internal Waste Stream Characterization to Meet Permit Requirements). Data on internal waste streams are used to make decisions regarding the disposition of contaminated wastewater produced on RFETS. Monitoring is needed to determine when wastewater requires treatment versus when it can be discharged to the WWTP. The data are used to determine whether discharges to the WWTP are compatible with the activated sludge, exceed the facility's ability to handle it, and comply with the NPDES Permit.

The NPDES Permit also covers discharges to surface water (including the WWTP outflow). RFETS personnel use monitoring data to maintain the permit and to negotiate periodic permit renewals. Both permit maintenance and renewal may require modifying specific conditions, particularly as closure activities accelerate. The permit specifies the managed and incidental discharges to be monitored, including sanitary discharges and process wastewater streams from buildings and discharges from the WWTP. New wastewater streams must be characterized and monitored as well. RFETS personnel must fully disclose wastewater streams to EPA Region VIII, which conducts annual NPDES Permit inspections to enforce this disclosure requirement.

2.3.2.2 Monitoring Discharges to the WWTP

This monitoring objective is separate from the non-routine objective, for which a distinct decision rule has been developed (see *IMP Background Document* Section 2.3.2.2 - Monitoring Discharges to the WWTP). New wastewater streams generated at RFETS must be evaluated to determine how best to dispose of them. Most, but not all, wastewater can be discharged to the WWTP under the terms of the NPDES Permit. Wastewater that is not sent to the WWTP must be disposed of according to applicable requirements. RFETS personnel screen wastewater streams for visible sheen, color, clarity, volume, field conductivity, and pH. However, the most important factor in determining the means of disposal is knowledge of the specific process that produces the wastewater. This information is considered in making decisions regarding disposal of wastewater streams.

2.3.2.3 Monitoring the WWTP Collection System

Monitoring of the WWTP influent flows include collection system flow monitoring, protective monitoring, and radiological influent monitoring. WWTP personnel regularly

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check the WWTP collection system for pH, conductivity, and Lower Explosive Limits at two locations, and take manual pH readings at the headworks. This monitoring ensures that the WWTP effectively processes wastewaters that change as closure activity increases. The WWTP monitoring objectives and decision rules are described in the *IMP Background Document,* Section 2.3.2.3 - WWTP Collection System Protective Monitoring, Section 2.3.2.4 - WWTP Collection System Flow Monitoring, and Section 2.3.2.5 - WWTP Radiological Monitoring.

2.3.2.4 WWTP Collection System Flow Monitoring

Flow information for the sanitary collection system consists of influent records for the WWTP. The flow record will be used to establish annual baseline conditions and assist in further data assessment needs for flows from the PA and non-PA areas, as currently modified. Changes from the established baseline flow may be attributable to normal collection system conditions, such as infiltration and inflow, or abnormal conditions, such as increased flows from areas undergoing D&D. A preliminary sanitary collection system flow baseline was initiated during FY2001, and flow data are reported on a calendar year basis to EPA and CDPHE in an annual report required by the NPDES Permit.

2.3.2.5 WWTP Radiological and Metals Monitoring

This objective includes the monitoring of radiological and selected metals parameters at the influent to the WWTP, for the purpose of tracking pollutant loads entering the WWTP collection system. Radiological and metal loads at the WWTP should be decreasing, since RFETS has systematically tried to eliminate possible connections between waste streams containing radionuclides and the collection system. During FY2002, radiological and metals influent monitoring was conducted monthly, using 24-hour composite samples that were analyzed by the CDPHE.

2.3.3 PERFORMANCE MONITORING IN SURFACE WATER

Performance monitoring may be specific to individual projects (e.g., D&D, remedial activities, transition actions, or BMPs for transport and fate of plutonium in surface water runoff) within the Industrial Area. While performance monitoring may be conducted at any location on RFETS, most monitoring occurs within the Industrial Area. In general, project-specific monitoring targets 18 months of data prior to project startup to establish baseline conditions, and continues for three months after project completion. RFETS is conducting performance monitoring at Buildings 771/774, 776/777, 886, the Solar Ponds, and for Environmental Restoration (ER) projects at the 903 Pad.

2.3.4 MONITORING NPDES DISCHARGES TO PONDS

The NPDES permit program controls the release of pollutants into the waters of the United States, and requires routine monitoring of point source discharges and reporting of results. The first RFETS NPDES Permit was issued by EPA in 1974. The current permit was renewed in 2000. Monitoring for NPDES compliance is prescriptively required by EPA, and is not covered by the IMP process or detailed in this document.

Renewed Permit:

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The renewed RFETS permit identifies one monitoring point for control of discharges, the WWTP (Building 995) effluent. The NPDES/Federal Facility Compliance Agreement was terminated by the renewal of the permit. Modifications included the elimination of discharge points except for the WWTP discharge point. The other previously permitted discharge locations will be regulated under CERCLA via the RFCA. Additional expanded scope includes requirements for plans and procedures for operations of influent/effluent storage tanks, influent monitoring at WWTP, internal wastestream reporting, stormwater monitoring, stormwater pollution prevention plan, and WWTP influent real-time radiological monitoring feasibility study. New stormwater monitoring provisions result from new regulations promulgated since the 1984 permit renewal. Refer to the permit for specific monitoring requirements.

2.4 Industrial Area Discharges To Ponds

Industrial Area discharges to the ponds include surface water runoff, discharges from the WWTP, and waters in Segment 5 that include the stream channels and interior ponds. Under this portion of the surface water monitoring program, RFETS monitors:

- Segment 5 water quality; and
- NPDES-regulated discharges to the ponds.

2.4.1 NEW SOURCE DETECTION

RFETS collects surface water samples at stations SW022, SW091, SW093, SW027, and GS10, which are located in the upper reaches of the three main drainages through which runoff leaves the Industrial Area. Analyte of Interest (AoIs) include plutonium, uranium, and americium isotopes; water quality parameters, including turbidity, pH, nitrate, and conductivity (measured every 15 minutes); and precipitation data (measured continuously at SW022) and flow rate (measured continuously). Additional AoIs also may be identified.

The "indicator parameters," those that can be and are monitored continuously, provide a qualitative early warning of potential contaminant releases without the long turnaround time or cost of more frequent sample analyses for the specific contaminants. For example, plutonium and americium concentrations may be correlated with TSS (which correlates with turbidity), and plutonium may be correlated with nitrate concentrations. Additionally, levels of chromium, beryllium, silver, and cadmium may correlate with conductivity readings. If a continuously monitored parameter provides cause for concern about a particular contaminant, samples may be collected and analyzed for that contaminant. It should be noted that none of the monitoring to date clearly demonstrates the correlations suggested here.

2.4.2 STREAM SEGMENT 5

RFETS monitors Segment 5 water quality at four RFCA POE monitoring locations (as represented by stations SW093, SW027, GS10, and 995 POE) for compliance with RFCA action levels. Reportable values require development of a source evaluation plan and source evaluation.

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The RFCA Action Levels and Standards Framework (ALF) provides criteria for identified contaminants. A subset of these contaminants is monitored under this portion of the program (see Table A-26 in the *IMP Background Document*). RFETS collects samples (one to four per month depending on flows) from each station for an estimated total of 85 samples during the year (see Table 2-14 in the *IMP Background Document*). The number of samples collected from each station is determined using historical flow data. Approximately 15 liters (L) of water are collected for each 500,000 gallons of stream flow to a maximum of four per month, and each 15-L sample composite is designed to contain about 50 flow-paced grab samples.

Collecting only one sample per month and analyzing only for the AoIs listed above would be sufficient to comply with RFCA requirements. However, the higher number of samples reduces the chance of recording a false exceedance or of missing a short-duration contaminant surge. Sampling frequency may be adjusted to accommodate changing data needs.

2.5 Water Leaving the Site

Water leaves the Site in Stream Segment 4 at Indiana Street. Three monitoring objectives have been established to assess Segment 4 water quality:

- Predischarge monitoring;
- RFCA POC monitoring of Segment 4; and
- Additional, non-point of compliance (non-POC) monitoring.

2.5.1 PREDISCHARGE MONITORING

Before water is discharged from the Terminal Ponds, it must be evaluated for a range of constituents to ensure that unexpected contaminants have not been introduced. Therefore, RFETS collects predischarge samples eight to ten times per year from the Walnut Creek Drainage at Ponds A4 (North Walnut Creek) and B5 (South Walnut Creek), once per year from the Woman Creek Drainage at Pond C2, and as needed from another pond temporarily functioning as a terminal pond. RFETS and CDPHE analyze the samples for an extensive list of constituents, including inorganic compounds, metals, and radiologic parameters (see Tables 2-16a and 2-16b in the *IMP Background Document* for analyte list and sampling targets). Sampling and analyses are conducted far enough in advance of a planned discharge to allow action to be taken if exceedances are noted, but near enough to the time of discharge to be representative of the discharge composition.

2.5.2 SEGMENT 4 COMPLIANCE MONITORING

RFETS performs monitoring at five RFCA POC stations in Segment 4 (GS11, GS08, GS31, GS03, and GS01). POC monitoring is concerned primarily with concentrations of plutonium, americium, and tritium, although additional analytes are monitored in a subset of samples. About three samples are collected during each pond discharge event (about 8 to 10 discharge events per yr; see Table 2-19 in the *IMP Background Document* for POC monitoring targets), and flow-proportional sampling is conducted between discharges when flow rates are sufficient to obtain required water sample volumes.

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2.5.3 CDPHE MONITORING AT INDIANA STREET

Various off-Site reservoir construction and water diversion projects will cause changes in the surface water flow regime. The CDPHE conducts additional monitoring to assess the effects of these flow changes on nutrient loads in water leaving RFETS. CDPHE collects samples quarterly from Walnut Creek to assess the composition of the water when it consists of either:

- 100% RFETS effluent;
- Mixed effluent and natural stream flow; and
- 100% natural stream flow.

In addition to these samples, CDPHE collects an annual sample from Woman Creek during a Pond C2 discharge. Samples are analyzed for a variety of parameters, including water quality and selected metals.

2.6 Off-Site Monitoring to Support Community Water Supply Management

RFETS and CDPHE personnel provide monitoring data to nearby communities for their use. Procedures are in place to monitor uncharacterized discharges from RFETS and to provide data that address public concerns regarding water quality.

2.6.1 MONITORING UNCHARACTERIZED DISCHARGES

Monitoring of uncharacterized discharges would normally be required only if monitoring, specified under the previous decision rules, is not performed in accordance with the sampling and analysis protocols (e.g., POC monitoring at Indiana Street) or if flow leaving RFETS exceeds the capacity of the downstream ditch or reservoirs.

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

- Unmonitored storm flow exceeding the capacity of Broomfield's diversion ditch that enters Great Western Reservoir; and
- Downstream water that may have been impacted by unmonitored effluent from RFETS.

2.6.2 COMMUNITY ASSURANCE MONITORING

Several factors have made it necessary for the communities to reassure residents that their environment is safe. These factors include the Site's 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 RFETS to the neighboring municipalities. Adequate and timely information regarding the impact of RFETS is necessary. The level of concern fluctuates with activities at RFETS, but may be expected to continue as long as environmental contamination and special nuclear materials are present at RFETS.

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Since the completion of the Standley Lake Protection Project and the Great Western Reservoir Replacement Project, which were designed to protect potable water supplies, routine monitoring of the municipal treatment and distribution systems is no longer warranted. However, Great Western Reservoir is still used as an irrigation supply. Therefore, during FY2003, community assurance monitoring continues at Great Western Reservoir as specified in Section 2.6.2 of the *IMP Background Document.*

2.7 Watershed Integration

Geographically, the RFETS lies at the head of the Big Dry Creek Basin; functionally, every effort has been made to isolate RFETS from the rest of the watershed. Historical strategies on the part of RFETS and the downstream communities have focused on limiting, to the maximum extent possible, the natural flow of surface water from RFETS. Examples include past spray irrigation practices, the "Zero Discharge" goal, and the continuing detention of treated sanitary effluent and stormwater pending demonstration of acceptable water quality. Although these water management practices have been necessary to protect and reassure the downstream communities, they negatively impact the ecology of the basin and are inconsistent with the ultimate vision for the Site, as outlined in RFCA. As RFETS moves toward closure, the focus must evolve toward integrating the headwaters of Big Dry Creek with the rest of the watershed.

To accomplish this objective, RFETS must extend its water management strategy beyond Indiana Street, and participate with other stakeholders in identifying and implementing appropriate water quality and use goals for the basin. During 1996, DOE and its contractors progressed toward this goal by actively participating in a consensus group with the objective of achieving agreement on as many issues as possible prior to a standard-setting hearing before the Colorado Water Quality Control Commission (CWQCC). The group included representatives from the RFETS, regulatory agencies and surrounding communities, but the focus was limited to water quality issues impacting wastewater dischargers.

More recently, RFETS personnel helped to establish the Big Dry Creek Watershed Association (BDCWA). The BDCWA began as an extension of the original consensus group, but has evolved to include any entities or individuals interested in water-related issues within the basin. In addition to the original four dischargers (i.e., RFETS, Broomfield, Westminster, and Northglenn), participants include representatives of agriculture, parks, recreation, open space, and a variety of government agencies. The BDCWA has been recognized by Denver Region Council of Governments (DRCOG) as a district watershed in the Regional Clean Water Plan. The goals of the BDCWA include public education, monitoring activities, and protection of water quality, aquatic life and habitat.

The DOE has recognized the effectiveness of this approach by becoming a party to a formal agreement to participate, with the cities, in supporting monitoring activities within the basin. The agreement states that such support may consist of monetary contributions or in-kind services, but shall be equitably distributed among the parties. Monitoring

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decisions are made jointly by the group, with input from regulators and planning agencies including EPA, the Water Quality Control Division, and DRCOG. The immediate use of the data is to characterize the watershed, and to identify and quantify sources of impairment. Ultimately, water quality and biological data will be used to support water-quality standards, native species protection, and basin-wide planning activities. A coordinated effort to obtain accurate information about existing conditions and relative impacts is beneficial and cost effective for stakeholders.

2.8 Project-Specific Monitoring

Project specific performance monitoring must be detailed in a project plan through the review and approval process when the project poses a concern for a specific contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives downstream. Each performance monitoring location will target the contaminants of greatest concern, as identified by the implementing organization, for the specific action. Performance monitoring for specific analytes as specified in Section 2.3.3 may be needed for D&D actions, remedial actions, transition actions, and BMPs for the control of plutonium transport in surface water runoff.

Project specific performance monitoring stations must be sited to monitor specific high-risk Site activities, such as D&D activities. These project specific stations will be placed upstream from the routine monitoring stations (assuming more than one source area could be contributing to the routine location), to ensure the monitor will be quantitative for releases of AoI. Data types must be specified in the project plan, and analyte suites and sample collection protocols are project specific. The schedule for performance monitoring will vary with individual projects. However, the initiation will begin far enough in advance of project initiation that a statistically defensible baseline can be established. Monitoring will continue during the project activities at a rate that allows the project managers and monitoring staff to make timely changes in activities that may be impacting the water channel. The frequency will be specified in the project's Sampling and Analysis Plan. After project completion, monitoring will continue long enough to identify residual impacts to surface water quality that may be attributable to the project activities.

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3 GROUNDWATER

Most of the groundwater at RFETS is hydraulically connected to surface water. The groundwater monitoring program is designed to accomplish the following:

- Detect and identify contaminants in groundwater and monitor their concentrations;
- Identify contaminant sources and monitor remediation efforts;
- Delineate contaminant pathways;
- Assess the effects of RFETS remediation and closure activities;
- Protect groundwater from new sources of contamination; and
- Evaluate the effects of contaminated groundwater on surface water.

3.1 Groundwater Monitoring Focus

Several contaminant plumes have been identified in RFETS groundwater (see Plate 3 in the *IMP Background Document*). The main AoI are volatile organic compounds. Possible sources of contaminants that could affect groundwater include storage tanks, the process waste system, drains, sumps, historical storage areas, and spills. The monitoring scope is designed to be conducted before, during, and after operations that may affect groundwater quality.

RFETS personnel determine the concentrations of groundwater AoIs and compare them to established background levels, as well as to RFETS action levels or standards. Exceedances of these criteria are evaluated to determine whether the data demonstrate an ongoing trend. The presence or absence of discernible trends is factored into the decision-making process (see Section 3.4.2 of the *IMP Background Document*) to assess the need for new remediation efforts or changes in ongoing activities.

Water level measurements are incorporated into water elevation maps and hydrographs to define groundwater gradients and flow rates. Both the program for measuring water levels, and the sampling and analysis program provide temporally related data for use in direct comparisons from year to year.

3.2 Groundwater Monitoring Program

The groundwater monitoring program includes the following components (see *IMP Background Document,* Appendix E):

- Sampling of monitoring wells;
- Measurement of water-table elevations;
- Data management, interpretation and reporting;
- Groundwater impact evaluations; and
- Well control, abandonment and replacement.

Table 2 lists the frequency and number of wells for samples and water levels.

Table 2 Groundwater Monitoring Matrix

Type of Monitoring	Locations	Sampling Frequency	Purpose
Sample for determination of analyte concentrations	186 wells & footing drains	Semi-annual	Monitor analyte concentrations in groundwater
Sample for determination of analyte concentrations	16 wells	Quarterly	Monitor analyte concentrations in groundwater
Water-level measurement	51 wells	Monthly	Characterize groundwater flow regime
Water-level measurement	195 wells	Quarterly	Characterize groundwater flow regime
Water-level measurement	78 wells	Semi-annual	Characterize groundwater flow regime
Water-level measurement	33 wells	Real-time	Characterize groundwater flow regime

3.2.1 WELL LOCATIONS

Groundwater sampling wells have been installed along known or suspected pathways between contaminated areas and outlets to surface water. The majority of the wells are located around the perimeter of the Industrial Area, the former Operable Unit 2 (OU2), and the existing landfill. Additional wells are located within RFETS drainages, because stream flow is ephemeral. Boundary wells are maintained at the downgradient (eastern) RFETS boundary to confirm that contaminants are not migrating off-Site. On-Site monitoring wells fall into eight categories:

- Plume definition - 22 wells
- Boundary - 6 wells
- Plume extent - 41 wells
- Performance - 33 wells
- Drainage - 5 wells
- Building D&D - 74 wells
- RCRA (covers monitoring of permitted waste storage units) - 8 wells
- Plume degradation - 13 wells

3.2.2 GROUNDWATER SAMPLING AND ANALYSIS

Field crews measure groundwater temperature, pH, conductivity, turbidity, and alkalinity, and submit a sample to a laboratory for measurement of total dissolved solids. The crews collect filtered samples for determination of metals concentrations and uranium isotopes, and also collect unfiltered samples for organic compound analyses, water quality determination, and measurement of other radionuclides. AoI vary among wells, depending on

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the constituents in the plume being monitored. The scopes of work for the analytical laboratories contain complete target analyte lists.

The groundwater flow regime at RFETS limits sample volumes from some wells. If sample volume precludes determination of the entire analyte suite for a particular well, the analyses are performed in the following order of priority:

- Volatile organic compounds—Contract Laboratory Program SW846, Method 8260;
- Semi-volatile organic compounds;
- Pesticides and polychlorinated biphenyls;
- Nitrate/nitrite, as nitrogen;
- Metals;
- Specific metals for a particular well;
- Uranium-233/234, -235, -238;
- Strontium-89/90;
- Plutonium-239/240 and americium-241;
- Major anions (chloride, fluoride, sulfate, carbonate/bicarbonate); and
- Tritium.

3.3 Groundwater Data Disposition

3.3.1 DATABASES

RFETS personnel enter field data and analytical data into the Rocky Flats Soil and Water Database. Data integrity is maintained through the use of standard data entry operating procedures and by running error-checking routines when loading data.

Data can be extracted for various uses, including use of the geographic information system to map constituent distribution, and use of various analytical models to assess groundwater movement and constituent migration.

3.3.2 REPORTING

Groundwater monitoring activities are reported through the following vehicles:

- **RFCA Annual Groundwater Report:** The *RFCA Annual Groundwater Report* summarizes the data from the quarterly reports and provides assessment of the data gathered throughout the year. Based on these assessments, changes or improvements to the RFCA groundwater monitoring program are proposed. The *RFCA Annual Groundwater Report* replaced various previously required reports and serves as the primary compliance report. The *RFCA Annual Groundwater Report* is a calendar year report and is available in the designated RFETS reading rooms.
- **RFCA Quarterly Reporting:** Quarterly reporting presents data gathered during the reporting period, provides notification of any exceedances of RFCA groundwater action levels, and lists required actions for exceedances.

These reports replace all historic, quarterly reporting, integrating the elements of each regulatory driver into a single reporting vehicle. Quarterly reports are presented at the Quarterly Information Exchange Meetings, which are held off-Site and are open to the public.

- **IMP:** The IMP, reviewed annually, is the vehicle for documenting required groundwater monitoring program elements and is updated when necessary.

3.4 Groundwater Evaluations

Many of the DQO decisions for groundwater monitoring require the effect of potential groundwater contamination on surface water to 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. The evaluation phase will result in a focused DQO that will determine three things: (1) the type of data to be collected, (2) the methodology for determining the nature and extent of contamination, and (3) the effect on surface water.

3.5 Well Abandonment and Replacement Program

Section 3.6.7 of the *IMP Background Document* describes the Well Abandonment and Replacement Program (WARP), which specifies the approval process for well installation and ensures proper recording and registration of well installation activities. RFETS personnel maintain a database of well locations, construction, permitting, and other relevant information. They also maintain a core repository for use in hydrological and geological characterization.

Well abandonment is considered if: (1) the wells are damaged or poorly constructed; (2) construction details are unknown; (3) the wells present a potential for cross contamination with other wells or the aquifer; or (4) the wells are no longer needed. Activities conducted under the WARP are reported in the *RFCA Annual Report.*

3.6 Performance Monitoring

Project-specific remediation and D&D activities may require groundwater performance monitoring. This monitoring is intended to verify and evaluate the effectiveness of remedial actions in mitigating contamination of surface water through the groundwater pathway. Three categories of wells have been defined to satisfy performance monitoring requirements. The categories include performance monitoring for soil remedial actions, D&D monitoring for buildings, and plume degradation monitoring where the remedial decision may involve monitored natural attenuation. In cases where monitoring is not currently performed, or when there is a need for additional information not provided by existing monitoring near the planned activity, analyte suites will be developed based on knowledge of historic chemical use and AoIs. Initially, a full sample suite will be collected to characterize the well for AoIs. D&D monitoring activities may involve other potential contamination pathways such as underbuilding contamination, building footing drains, and building sumps. Disposition of these potential sources will be handled as part of building decommissioning, and will be integrated with ER program activities. Monitoring decisions will be made on an individual well basis prior to D&D activities.

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Wells will be placed downgradient from potential contaminant sources. Upgradient wells may be required if existing data are not available. Sampling protocols will be established for individual projects and sampling will begin prior to D&D activities to establish baselines. Monitoring will continue throughout the project, and for a period after project completion, to observe the results of the remediation effort. The duration of the monitoring will be determined per guidelines outlined in the *IMP Background Document.*

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4 AIR QUALITY

4.1 Purpose and Programs

Air monitoring activities at RFETS (listed in Table 3) assist in both protecting and informing the public, and in protecting the environment by detecting and trending the impacts of RFETS operations on air quality at and near RFETS. Monitoring characterizes airborne radionuclide materials that may be introduced and identifies the associated meteorological conditions that influence the transport and dispersion of the airborne materials. Data are used to plan, implement, and assess the effects of on-Site activities including operations, construction, and closure activities, and to maintain emergency preparedness and demonstrate compliance with relevant regulations.

The Air Quality Management (AQM) group within Kaiser-Hill's Environmental Systems and Stewardship (ESS) organization determines the scope of RFETS air monitoring and reporting activities required to maintain compliance with air quality regulations and DOE Orders. In addition, CDPHE conducts oversight monitoring through a grant from DOE.

4.1.1 AMBIENT AIR MONITORING

Ambient monitoring of radionuclides on RFETS, at the perimeter and at several locations in the community is performed by ESS. CDPHE monitors radioactive and non-radioactive pollutants on and around RFETS. Ambient monitoring in the communities immediately adjacent to RFETS has been supported further by DOE through the ComRad program. ComRad stations, which monitor airborne plutonium concentration, are operated independently through a grant to the Rocky Flats Citizen's Advisory Board managed by an oversight panel representing local governments.

4.1.2 EFFLUENT AIR MONITORING

Air emissions (effluent) from RFETS facilities that have potential to contain significant quantities of radioactive materials are monitored continuously in accordance with state and federal regulatory requirements and agreements, and are used to verify the effectiveness of radiation control mechanisms. These emissions data may be used as part of the evaluation process to keep radioactive emissions as low as reasonably achievable.

4.1.3 METEOROLOGICAL MONITORING

Instruments continuously monitor meteorological conditions at RFETS to generate data for use in air dispersion models that estimate the transport of airborne emissions. RFETS personnel use model predictions to evaluate operations and closure projects, and to support emergency preparedness requirements.

Table 3 Air Monitoring Matrix

Type of Monitoring	Analyte	Locations	Performed By	Sampling Frequency	Purpose
Routine ambient air	Radio-particulate	38 Radioactive Ambient Air Monitoring Program (RAAMP) samplers[1]	RFETS AQM	Continuous (monthly filter exchange; monthly analyses of 14 perimeter samples)[1]	Detect and characterize Site-related airborne radiological emissions and demonstrate compliance with state and federal regulations
CDPHE monitoring	Radio-particulate, alpha/beta activity	11 on-Site continuous samplers and 6 close-in samplers (around selected projects)	CDPHE	Continuous	Detect and characterize Site-related radiological airborne emissions
Effluent from Industrial Area facilities	Radio-particulate	19 exhaust outlets	RFETS AQM	Continuous (weekly filter changes with monthly compositing and analysis)	Verify effectiveness of radiation control mechanisms and provide secondary compliance data
Meteorology		1 tower with instruments at 1.5, 10, 25, and 60 meters	RFETS AQM	Continuous	Monitor meteorological conditions for use in air quality modeling and for inputs to emergency response models
Meteorology		Five 10-meter towers at Site perimeter	CDPHE	Continuous	Provide data as needed for emergency response modeling
Performance	Radio-particulate	Selected subsets of existing RAAMP locations	RFETS AQM	Continuous during demolition projects; weekly filter exchange, followed by gross alpha/beta counting and/or gamma spectroscopy; isotopic analyses as required	Assess radiological impacts of decommissioning and ER projects against environmental standards
Performance	Beryllium	Six portable air samplers	RFETS AQM	During active demolition only; filter exchange and analysis determined on a project-specific basis	Assess beryllium impacts of selected decommissioning and ER projects against environmental benchmarks

[1] Performance monitoring for radionuclides uses designated subsets of the 38 RAAMP samplers, with weekly filter exchanges.

4.1.4 PERFORMANCE MONITORING

Ambient monitoring for radionuclides and beryllium around selected building demolition and environmental restoration projects is performed by ESS. This monitoring effort

characterizes the potential short-term impacts of emissions from such projects on ambient air quality and receptors closer to the projects than the RFETS perimeter. This scope differs from routine ambient monitoring because of shorter sampling periods, increased sampling frequency, closer proximity to potential source locations, and in one case, a different AoI (i.e., beryllium). Additionally, while no regulatory standards apply specifically to this scope, the ambient concentration limits identified in the standards are used as guidance to establish action levels (regulatory compliance for radionuclides is determined using the routine ambient samplers at the RFETS perimeter; no beryllium standards currently apply to RFETS).

4.2 Site Air Monitoring Scope

Most ambient air monitoring and effluent monitoring performed at RFETS is done to satisfy the requirements of Title 40 of the *Code of Federal Regulations*, Part 61, Subpart H, *National Emission Standards for Emissions of Radionuclides Other Than Radon from Department of Energy (DOE) Facilities* (Rad NESHAP) and DOE Orders. CDPHE and the ComRad Monitoring Program provide additional, independent air monitoring.

4.2.1 AMBIENT AIR

The RAAMP collects ambient radioparticulate air data. The RAAMP network comprises 38 size-partitioning, high-volume ambient air samplers. Fourteen of the 38 samplers are used to demonstrate compliance with Rad NESHAP. Remaining samplers can be used for emission confirmation purposes should there be an accidental release from RFETS. Designated subsets of the RAAMP network are also used to determine localized impacts from D&D and ER projects, as described below.

The RAAMP samplers run continuously, collecting airborne particles on pairs of sampler substrate that segregate smaller inhalable particles from larger, more easily deposited airborne particulate matter. Filters and impactor substrates are routinely collected and submitted for analysis for specific isotopes of plutonium, uranium, and americium. The *IMP Background Document* details specific sampling intervals and analytical detection limits.

The CDPHE also operates air samplers within RFETS and at the perimeter of RFETS. The CDPHE-operated monitoring network serves to independently measure RFETS air quality conditions and public exposure to radioactive releases.

4.2.2 EFFLUENT AIR

Air emissions exhausted from buildings that could contain radioactive materials in sufficient quantity to have the potential to contribute at least 0.1 millirem (mrem) per year effective dose equivalent (EDE), uncontrolled, to any member of the public (significant sources) are monitored by continuous effluent sampling systems. Filters from these systems are changed weekly and composited for analysis for selected plutonium, americium, and uranium isotopes. Historically, more than 50 locations within the Industrial Area were monitored; currently, 19 building release points are continuously sampled. Sources having low emission potential (insignificant sources) are not monitored unless building operational requirements dictate that continuous sampling be

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performed. Radioparticulate emissions from insignificant sources that are not monitored using effluent samplers will be accounted for through the ambient monitoring network. Sampling for tritium in effluent air, once conducted at one or more locations at RFETS, has been discontinued following the removal of waste materials having substantial emissions potential for tritium.

4.2.3 METEOROLOGICAL CONDITIONS

A 61-meter tower is operated in the northwest part of the Buffer Zone by ESS, with monitoring instruments at 1.5, 10, 25, and 60 meters above the ground. Instruments measure horizontal and vertical wind speeds, horizontal wind direction, temperature, relative humidity (dew point), solar radiation, precipitation, and information used to calculate atmospheric stability class. CDPHE operates five 10-meter meteorological towers, located around the RFETS perimeter, that can provide data to support Site emergency response modeling.

4.3 Performance Monitoring - Air

When a decommissioning project or ER project is planned that has the estimated potential to release radionuclides in sufficient amounts to contribute a 0.1 mrem dose to the most impacted public receptor, existing on-Site ambient air samplers are used to provide performance monitoring for radionuclides. Sampler substrates from selected RAAMP samplers that surround the affected project are exchanged weekly instead of monthly. Filters are screened through gross alpha/beta counting and/or gamma spectroscopy, and the results compared to predefined action levels. If necessary, results of the screening may be used by project personnel to adjust schedule or project controls to ensure Site-wide compliance with state and federal regulatory requirements and to confirm the effectiveness of as-low-as-reasonably-achievable (ALARA) principles. The filters and impactor substrates may also be analyzed for selected plutonium, americium, and uranium isotopes.

The CDPHE may conduct independent performance monitoring for radionuclides during selected demolition and remediation projects. Filters will be collected and analyzed for gross alpha activity. If necessary, results of the screening may be used by project personnel to adjust schedule or project controls to ensure Site-wide compliance with state and federal regulatory requirements, and to confirm the effectiveness of ALARA principles. The filters may also be analyzed for selected plutonium, americium, and uranium isotopes. These monitoring efforts shall include, but are not limited to, the 903 Pad remediation and Building 865 demolition.

For beryllium monitoring purposes, a subject project will be ringed with six portable ambient air samplers that operate during periods of active demolition or remediation. Filters will be exchanged and shipped to off-Site laboratories for a total beryllium analysis, at a frequency set on a project-by-project basis. Results of beryllium analyses will be compared to ambient concentration benchmarks defined in the beryllium NESHAP. Although building demolitions are not subject sources pursuant to the beryllium NESHAP, the ambient air concentration standard listed therein was developed

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to be protective of human health and the environment, and therefore provides a reasonable basis for evaluating project monitoring results.

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5 ECOLOGY

The Buffer Zone around the Industrial Area at RFETS is one of only a few areas along Colorado's Front Range that has remained largely undisturbed by encroaching development. The Buffer Zone contains several unique assemblages of animals and vegetation, and the ecological monitoring activities described in this section have been designed by DOE and its contractors to protect these valuable natural resources. Five major vegetation communities have been identified at RFETS:

- Xeric Tallgrass Prairie;
- Tall Upland Shrubland;
- Great Plains Riparian Woodland Complex;
- High Quality Wetlands; and
- Mesic Mixed Grassland.

Ecological monitoring is designed to protect wildlife in the Buffer Zone, including special-concern species (i.e., threatened, endangered, candidate, proposed, state-listed, or other sensitive species). The Preble's meadow jumping mouse (Preble's mouse) is of particular concern because it was listed as a threatened species on May 13, 1998.

5.1 Monitoring Objectives

The Ecological Monitoring Program (summarized in Table 4) is designed to provide data that can be used in management and conservation decision-making during RFETS cleanup activities that will occur over the next several years. Data also demonstrate compliance with applicable natural resource protective regulations.

RFETS ecologists monitor key variables in the five vegetation communities and other habitats, and changes in any of these variables would trigger ecological protection and compliance decision making. Comparisons of monitoring data over time enable ecologists to detect changes, identify potential causes, and plan corrective actions for changes that result from RFETS activities, rather than from natural fluctuations.

Table 4 Ecological Monitoring Matrix

Basis for Monitoring	Number of Locations	Sampling Frequency	Purpose of Monitoring
Manage and conserve significant species numbers and richness; comply with Endangered Species Act, other federal acts, and Colorado wildlife protection statutes.	One Site-wide Survey (follows passable Buffer Zone roads.)	12 times per yr	Track changes in numbers, richness, and area use of significant wildlife species at RFETS.
Monitor and conserve viable Preble's mouse populations in appropriate habitat, and monitor and conserve current coverage of characteristic Preble's mouse habitat. Comply with Endangered Species Act and Colorado wildlife protection statutes.	About four locations per yr, based on previous years results	1 time per yr (800 trap-nights per location per yr)	Monitor presence of Preble's mouse at RFETS

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Monitor noxious weeds at RFETS; comply with weed control regulations.	Variable by yr	In flowering season and as available for observation	Evaluate effectiveness of weed control actions, and aid in out-year planning for weed controls at RFETS
Monitor for the presence, or potential presence, of special-concern, threatened, or endangered plant and wildlife species and wetlands; comply with federal, state, and local protection and conservation regulations.	Variable by yr	As required	Ensure compliance of projects with applicable ecological regulations and protect rare, threatened, and endangered species from harm

5.2 Scope of Monitoring

RFETS ecologists conduct several types of monitoring in the five vegetation communities, as well as conduct some activities specific to one or more communities. The following activities are common to the five vegetation communities:

- Define the extant area of the community.
- Provide baseline estimates of the presence of birds and mammals, and estimate the baseline species richness of plant, bird, and mammal populations (plant species richness baseline will be determined from 1993–96 or 1997 data, as applicable; the bird and mammal baseline was established in the *1996 Annual Wildlife Survey Report* (Kaiser-Hill, 1997a).
- Identify rare or imperiled plant or animal species.
- Conduct weed mapping and photo surveys.
- Monitor the presence of noxious weeds and the effects of weed control efforts.
- Anticipate impacts from proposed RFETS projects, and estimate the potential area affected.
- Perform monitoring of selected revegetated areas after remediation activities.

Ecologists also monitor the presence of noxious weeds and changes in plant community characteristics in areas not included within the five vegetation communities defined above.

5.2.1 PREBLE'S MEADOW JUMPING MOUSE

Populations of Preble's mouse have been identified in the four major drainages of the Site. The U.S. Fish and Wildlife Service published a proposed rule to designate critical habitat for the Preble's mouse on July 17, 2002. The proposed rule includes designating the Site as a critical habitat unit. The proposal includes a definition for critical habitat areas that is different than the Preble's mouse protection area currently defined by the Site. If the proposal is adopted, the Site's Preble's mouse protection plan will need revision to align the critical habitat definition with the current Preble's mouse protection area delineation.

Current Preble's mouse monitoring activities are described in the following paragraph.

Preble's mouse populations and habitat have been monitored over time (using monitoring through 1996 as a baseline). Monitoring concentrates on determining the presence or absence of the species; quantitative population measurements are not appropriate because of its rarity. Ecologists monitor the known population areas on a rotating basis, depending on results from the previous field season. Ecologists trap only during May through September because the mouse hibernates over the winter months.

5.2.2 WETLANDS

In addition to the activities listed above, the U.S. Army Corps of Engineers and the EPA conduct periodic wetland characterizations. The EPA is the lead agency on wetlands for CERCLA project activities impacting wetlands. The U.S. Army Corps of Engineers is the lead agency on wetlands for non-CERCLA project activities. The last characterization was completed in 1994. A comprehensive plan (Kaiser-Hill, 1997b) to manage and protect RFETS wetlands was issued in 1997, detailing the methods and procedures that will be used to identify wetlands and minimize impacts from closure and remediation projects.

5.2.3 PROJECT-SPECIFIC MONITORING

Proposed RFETS projects will be evaluated in terms of potential effects on threatened and endangered (T&E) species, species of special concern (SSC), migratory birds and wetlands. Much of the data for such evaluations will come from the monitoring activities listed above, but additional data needs may be identified to assess the impact of such projects in specific areas. Project-specific data needs may include:

- Seasonal presence or absence of affected species, and the seasonal timing of the proposed project;
- Presence of habitat considered suitable for T&E and SSC species; and
- Biological characteristics of species of concern (e.g., feeding and nesting habits, home range, habitat preference), and potential effects of the proposed project.

Proposed projects will also be evaluated in terms of their impacts to migratory birds and RFETS wetlands. Wetlands include both those areas mapped by the U.S. Army Corps of Engineers and those areas not included on the map.

Table 5 lists several potential 2003 projects that may impact wetlands or Preble's mouse habitat.

Table 5. Potential 2003 Projects at RFETS with Potential to Impact Wetlands or Preble's Mouse Habitat.

Project	Status of Project	Summary of Monitoring Requirements
Original Landfill	Scheduled 2003	Pending
Present Landfill	Scheduled 2003	Pending
Ash Pits	Scheduled 2003	Pending

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East Firing Range	Scheduled 2003	Pending
903 Pad and Lip Area	Scheduled 2003	Pending
Temporary Flume Project in Woman Creek	Scheduled 2003	Pending
B-5 Pond Pipeline Removal	Scheduled 2003	None
Buffer Zone Powerline Removal Project	Scheduled 2003	Pending
Well Abandonment and Removal Program	Scheduled 2003	None
C-1 Pond Breach	Scheduled 2003	Pending
General IA Revegetation	Ongoing	Pending

Certain project activities may require a biological assessment or biological opinion, or a wetland mitigation plan. These plans may include monitoring activities for specified objectives over time. The DQOs for each activity will be indicated in the project-specific biological assessment or opinion or mitigation plan. Future annual updates to this section are anticipated to include a project summary of the projects listed in Table 5, the DQOs, and the current status of projects.

5.3 Outside Factors Affecting RFETS Ecology

The ecological resources at RFETS are influenced not only by Site activities but also by issues and activities that occur off-Site. Outside factors that may affect ecological resources at RFETS include, for example, noxious weeds, chronic wasting disease, West Nile virus, plague, and other zoonoses. These and other factors often affect the surrounding region, which must be considered when evaluating the ecology of the Site.

For example, the Colorado Division of Wildlife is killing and testing a portion of the existing deer population for chronic wasting disease in late FY2002. If test results show that chronic wasting disease exists, the entire population may have to be destroyed.

Activities on adjacent properties may also impact Site vegetative communities and habitats. The Site borders lands used for various activities, including grazing, mining, and open space. While the Site continues to implement a comprehensive integrated ecological management program, the Site is influenced by the activities on neighboring lands that are beyond the control Site personnel. Wind blown materials from adjacent mining activities, prairie dogs, and noxious weeds can readily cross property lines.

5.4 Data Management

Ecological data was historically stored in two databases, the Ecological Monitoring Program Database and the Sitewide Ecological Database. Because extracting data for specific purposes requires a high degree of system-specific knowledge, the two databases were combined. The new database, the Site Ecological Database, allows for multi-user access (with security restrictions) for Site personnel.

5.5 Reporting

An *Ecological Resource Management Plan for the Rocky Flats Environmental Technology Site* (Kaiser-Hill, 1997c) is in place, setting forth the management actions that will be required to preserve valuable RFETS ecological resources. RFETS ecologists will update or modify this plan as required by variations in Site conditions, available technology, or changing regulations.

The Ecological Monitoring Program issues an annual ecology report for the Site. The Vegetation Management Plan is issued annually to document planned weed control and other management efforts for the year.

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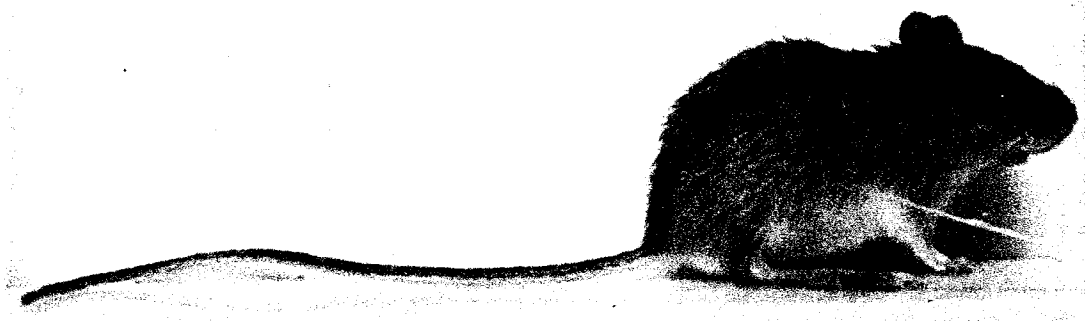

Integrated Monitoring Plan

FY2003

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ACRONYMS AND ABBREVIATIONS

μ	Micro-
μg	Microgram
μmho	Micromhos
Ag	Silver
ALARA	As Low as Reasonably Achievable
ALF	Action Levels and Standards Framework
Am	Americium
AoI	Analyte of Interest
APCD	Air Pollution Control Division
AQM	Air Quality Management
As	Arsenic
Ba	Barium
Be	Beryllium
BMP	Best Management Practice
CAA	Clean Air Act
CAPARS	Computer Assisted Protective Action Recommendations System
CAQCC	Colorado Air Quality Control Commission
CAS	Chemical Abstracts Service
CCR	*Code of Colorado Regulations*
Cd	Cadmium
CDPHE	Colorado Department of Public Health and Environment
CDOW	Colorado Wildlife Commission?/Colorado Department of Wildlife
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cf	Cubic Foot
CFR	*Code of Federal Regulations*
cfs	Cubic Feet Per Second
CLP	Contract Laboratory Program
cm	Centimeter
cm^2	Square Centimeter
cm^3	Cubic Centimeter
ComRad	Community Radiation
Cr	Chromium
CRS	*Colorado Revised Statutes*
Cu	Copper
CWA	Clean Water Act
CWQCC	Colorado Water Quality Control Commission

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CY	Calendar Year
D&D	Decontamination and Decommissioning
DMR	Discharge Monitoring Report
DOE	Department of Energy
DQO	Data Quality Objective
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
ESS	Environmental Systems and Stewardship
Fe	Iron
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facility Compliance Agreement
ft	Feet
ft^3	Cubic Foot
FY	Fiscal Year
g	Gram
GIS	Geographic Information System
GPMPP	*Groundwater Protection and Monitoring Program Plan*
GW	Groundwater
GWAP	*Groundwater Assessment Plan*
H-3	Tritium
HEPA	High-Efficiency Particulate Air (filter)
Hg	Mercury
hr	Hour
HRR	Historic Release Report
HSU	Hydrostratigraphic Unit
IA	Industrial Area
IAG	Interagency Agreement
ICP	Inductively Coupled Plasma
IDLH	Imminent Danger to Life and Health
IHSS	Individual Hazardous Substance Site
IM/IRA	Interim Measures/Interim Remedial Actions
IMP	*Integrated Monitoring Plan*
ITS	Interceptor Trench System
IWS	Internal Waste Streams
Kaiser-Hill	Kaiser-Hill Company, L.L.C.
L	Liter
LARS	Laboratory and Radiation Services

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LEL	Lower Explosive Limit
LHSU	Lower Hydrostratigraphic Unit
LTL	Lower Tolerance Level
m	Meter
m3	Cubic Meters
MDA	Minimum Detectable Activity
mg	Milligram
Mgal	Million Gallons
min	Minute
ml	Milliliter
mm	Millimeter
Mn	Manganese
mrem	Millirem
N	Nitrogen
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	Nickel
NO2	Nitrogen Dioxide, Nitrite
NO3	Nitrate
Non-PA	Non-Protected Area
NPDES	National Pollutant Discharge Elimination System
NSD	New Source Detection
NSQ	Non-Sufficient Quantity
OP	Operating Procedure
OU	Operable Unit
P	Phosphorous
PAM	Proposed Action Memorandum
PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
Pb	Lead
PCB	Polychlorinated Biphenyl
pCi	Picocuries
PM_{10}	Particulate Matter (less than 10 micrometers)
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
POE	Point of Evaluation
POP	Pond Operations Plan
ppm	Parts Per Million
Pu	Plutonium

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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
RAAMP	Radioactive Ambient Air Monitoring Program
Rad NESHAP	*National Emissions Standards for Emissions of Radionuclides Other than Radon from DOE Facilities* (40 CFR, 61, Subpart H)
RCRA	Resource Conservation and Recovery Act
RFCA	*Rocky Flats Cleanup Agreement*
RFETS	Rocky Flats Environmental Technology Site
RFFO	Rocky Flats Field Office
RI/FS	Remedial Investigation/Feasibility Study
RMRS	Rocky Mountain Remediation Services, L.L.C.
SCMP	Site-Wide Commitments Management Program
Se	Selenium
sec	Second
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
SSC	Species of Special Concern
STP	Sewage Treatment Plant
SW	Surface Water
SWD	Site Soil and Water Database
T&E	Threatened and Endangered (Species)
TAL	Target Analyte List
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
U	Uranium
UHSU	Upper Hydrostratigraphic Unit
USFWS	U.S. Fish and Wildlife Service
UTL	Upper Tolerance Level

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VOC	Volatile Organic Compound
WARP	Well Abandonment and Replacement Program
WER	Well Evaluation Report
WWTP	Wastewater Treatment Plant
yr	Year
Zn	Zinc

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1.0 INTRODUCTION

The *Integrated Monitoring Plan* (IMP) has been revised for fiscal year 2003 in accordance with the *Rocky Flats Cleanup Agreement* (RFCA) (DOE, 1996) requirements. The revisions focus on improving integrated monitoring for closure projects, and providing up-to-date documentation that reflects the most current technical approaches within the routine environmental monitoring programs. The revisions are the result of ongoing working group discussions, and are based on identified needs that were not previously addressed, or are based on changes in monitoring scope dictated by changes in the Rocky Flats Environmental Technology Site (RFETS or Site) operations or new technical capabilities. This document, called the *IMP Background Document*, provides supporting background information for the IMP, and reflects minor technical changes in most sections that address current and expected RFETS activities.

Integration of RFETS-wide and project-specific monitoring occurs during the planning of new major activities, such as environmental restoration (ER) and decontamination and decommissioning (D&D) projects. Kaiser-Hill Company, L.L.C. (Kaiser-Hill) will review 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, the RFCA, and as low as reasonably achievable [ALARA] principles), and existing RFETS-wide, multi-media monitoring. Consideration will be given to data needs before, during, and after a proposed activity. Pre-project monitoring is used to establish baseline conditions, characterize relationships between media, assess potential impacts to multiple media, and develop designs and controls to eliminate or mitigate impacts. Monitoring during and after a project helps to determine the effectiveness and performance of designs and controls to eliminate or mitigate impacts. If additional monitoring is deemed necessary, Kaiser-Hill will work with project personnel to develop appropriate, media-specific data quality objectives (DQO) and monitoring specifications. Project-specific DQOs will be developed as part of the decision document or the IMP, as appropriate. The project-specific DQOs will address protection of project personnel, collocated workers, off-Site populations, and the environment, and will generally complement RFETS-wide monitoring DQOs. Project work plans will include, as appropriate, project-specific monitoring plans, sampling and analysis plans, and health and safety plans, and will be available for review by the regulatory agencies and other stakeholders.

A key component of the DQO process and the IMP is data evaluation. To be successful, both RFETS-wide and project-specific monitoring data 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 following media-specific sections 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 (Part 23, Section 266-270),

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will provide RFETS-wide and project-specific monitoring data to appropriate monitoring entities and regulatory agencies and will allow these groups to evaluate data needs associated with proposed activities (e.g., baseline characterization, sampling program design, and performance monitoring). Work is progressing on defining the data management tools and reports 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 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. Periodic meetings of the working group will be held, and resulting changes will be presented to other stakeholders.

Background

Soon after Kaiser-Hill became the Integrating Management Contractor at the RFETS, Kaiser-Hill undertook a structured, comprehensive, reevaluation of environmental monitoring programs. The objective was to develop monitoring specifications using the U.S. Environmental Protection Agency's (EPA) established DQO process. The process involved the EPA, U.S. Department of Energy (DOE), Colorado Department of Public Health and Environment (CDPHE), the cities of Broomfield, Northglenn, Arvada, and Westminster, and the Kaiser-Hill team. The reevaluation identified unnecessary monitoring, areas for improvement in the monitoring programs, and efforts to ensure protective and compliant programs. Using the consensus specifications or DQOs, an optimal data collection design was determined. This approach demonstrates compliance with the myriad 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 monitoring program. The development and maintenance of this integrated program became a requirement of the RFCA issued on July 19, 1996[1]. The IMP is a result of this process.

The DQO process is a structured decision-making process that requires the identification of and agreement on decisions for which data are required. This process results in the specifications needed to develop a protective and compliant monitoring program. Specifications include qualitative and quantitative statements that include the type, quality, and quantity of the data

[1] RFCA Part 21 Paragraphs 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 CDPHE. Disagreements regarding 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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required to support decision making. The formal DQO process is documented in two EPA documents (EPA, 1993a; EPA, 1993b). In September 1994, DOE institutionalized the DQO process for environmental data collection activities. The process was implemented to balance 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:

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

The goal of using this approach was to reevaluate the basis and focus of existing programs, increase the defensibility of 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 RFETS could no longer have separate, non-integrated sampling and analysis activities performed by various entities at RFETS (e.g., Environmental Restoration, D&D projects, and Environmental Media Management), or between the RFETS, the cities, CDPHE, 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 DOE, Kaiser-Hill team, EPA, CDPHE, and the cities of Broomfield, Northglenn, Arvada, and Westminster. The group worked to develop consensus on what data were needed, how data would be used, and, based on these specifications, what sampling and analysis plans would be needed. 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 the RFCA, 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, RFETS-specific cleanup agreements, and 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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Four DQO working groups (i.e., surface water, groundwater, air, and ecological resources) were tasked with developing an integrated monitoring plan. Each group met regularly to work through the DQO process for each decision that required monitoring data. In addition, the 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 in this document by environmental media. Integration was achieved between monitoring entities, regulatory programs, and environmental media. Interactions between media are discussed in Section 7.0 of this *IMP Background Document*.

This document covers 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. Other monitoring conducted by CDPHE and the cities may be related to RFETS, but does not present integration opportunities (e.g., monitoring of area reservoirs conducted by the cities; spot checks conducted by CDPHE).

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2.0 SURFACE WATER MONITORING

In accordance with the Preamble to RFCA, RFETS operates a robust surface water monitoring system to provide information for cleaning up RFETS, to assure public safety, and to keep the public informed. This chapter of the *IMP Background Document* describes the surface water monitoring objectives implemented to achieve this goal for fiscal year (FY) 2003.

2.1 INTRODUCTION

Surface water is defined here as water flowing above ground in natural or manmade channels, water detained in RFETS detention ponds, water detained in other natural or manmade depressions which require dewatering, or water processed through the RFETS sanitary system. Surface water may originate as rainfall, surface water flowing from upgradient sources, water purchased from the Denver Water Board (DWB) for domestic use at RFETS, or groundwater discharge to the surface via seeps or footing drain discharge.

2.1.1 SUMMARY OF MONITORING OBJECTIVES

This chapter describes surface water monitoring objectives to be implemented for FY03. The monitoring described herein integrates surface water monitoring activities across RFETS (see Figure 2-1), which are performed under RFCA, including much of RFETS monitoring performed by the cities and the state.

The DQO process was used to determine decisions of necessary and sufficient monitoring requirements. The process yielded over 20 data driven decisions requiring various levels of priority and confidence.

Location-specific sample collection protocols are discussed in the following surface water monitoring sections. For decision rules requiring composite sampling, the protocols are specified in the related section on data types and frequency. Composite sample types include 1) continuous flow-paced, 2) storm-event, rising limb of the hydrograph, or 3) storm-event of the entire direct-runoff event. Continuous flow-paced composite samples are collected during all flow conditions. The automated samplers are programmed to collect a grab sample after each specified volume of stream discharge is measured by the flow meter during all flow conditions. This differs from storm-event sampling, in which samplers are programmed to collect grab samples whenever direct runoff conditions are detected. Storm-event sampling can use either flow- or time-pacing to collect grab samples during just the rising limb 'first flush' or the entire runoff event.

In this document, surface water monitoring objectives (or "decision rules" under the DQO process) are organized in a roughly upstream-to-downstream order, beginning with discharges within the Industrial Area (IA) and ending at the drinking water reservoirs downstream. This order is depicted in Figure 2-2. These monitoring objectives are summarized in the following paragraphs and are discussed in detail in the remainder of this section.

To begin, monitoring objectives that do not fit into the upstream-to-downstream sequence are discussed in Section 2.2 as Site-Wide Monitoring Objectives. The first of these objectives is monitoring to ensure safe operation of the RFETS detention pond dams. Safety monitoring to avoid dam breaching is discussed first (Section 2.2.1), in recognition of its unique importance to

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avoiding imminent danger to life and health (IDLH). Another monitoring objective, Source-Location monitoring, designed to locate a source of contamination detected by other monitoring objectives, is also covered under Site-Wide Monitoring Objectives in Section 2.2.2. Because Source Location of a contaminant source could occur anywhere in the area shown in Figure 2-2, it does not fall into the upstream-to-downstream order. Furthermore, some Site-wide monitoring needs simply cannot be known in advance. These are discussed as *Ad Hoc* monitoring (Section 2.2.3). Finally, monitoring may be performed to evaluate water management alternatives and fate and transport of constituents. Specifically, in this document, this refers to Indicator Parameter Monitoring for Analytical Water-Quality Data Assessment, as discussed in Section 2.2.4.

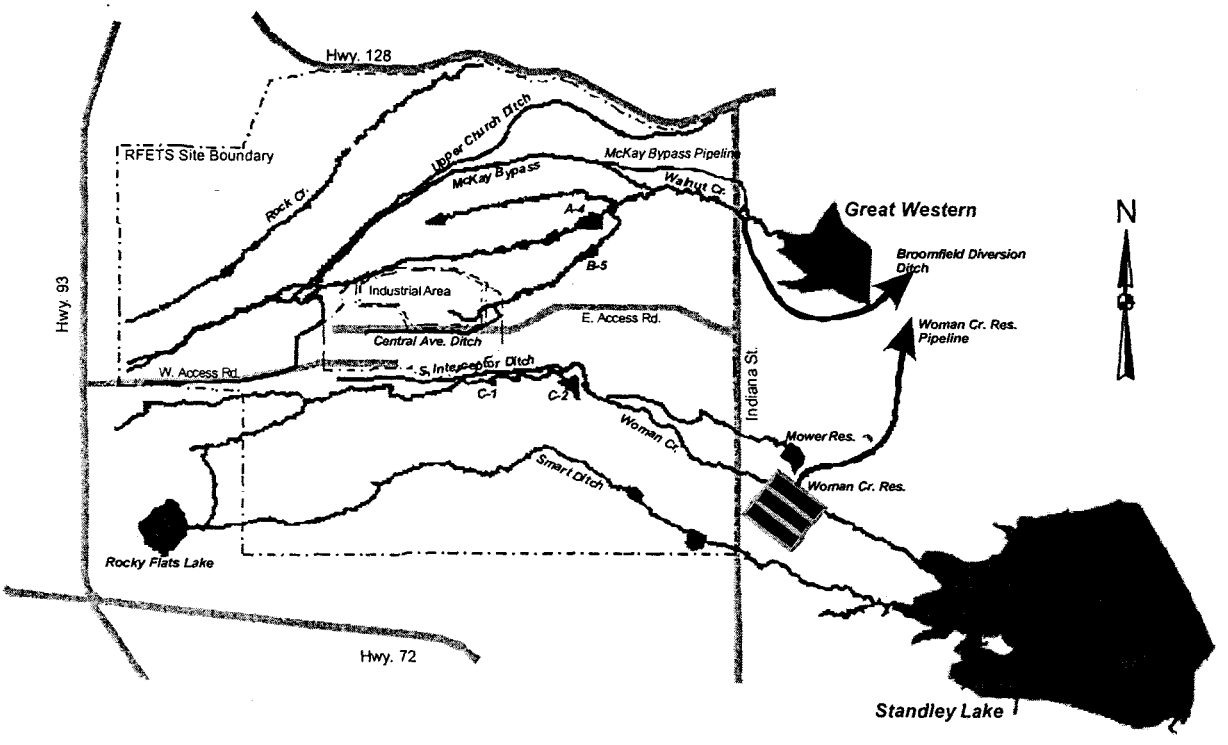

Figure 2-1. Conceptual Sketch of Major Site Surface Water Features

The first group of upstream-to-downstream monitoring objectives is IA monitoring. RFCA requires RFETS to characterize significant surface water releases within the IA. Immediately outside of the IA buildings, management must often decide whether incidental waters (see Section 2.3.1) 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. Routine and non-routine discharges to the sanitary system are monitored as discussed in Section 2.3.2. Internal wastestreams are discussed in Section 2.3.2.1. To develop the National Pollutant Discharge Elimination System (NPDES) permit application, RFETS monitored the internal wastestreams of some processes within facilities to establish what might reasonably be expected in discharges from these processes. Site management is also routinely required to determine whether some

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internal wastestreams may be discharged from the IA to the Wastewater Treatment Plant (WWTP). NPDES monitoring must be performed on the WWTP discharge under the conditions of the current permit. The NPDES permit no longer requires monitoring of ponds in the buffer zone area.

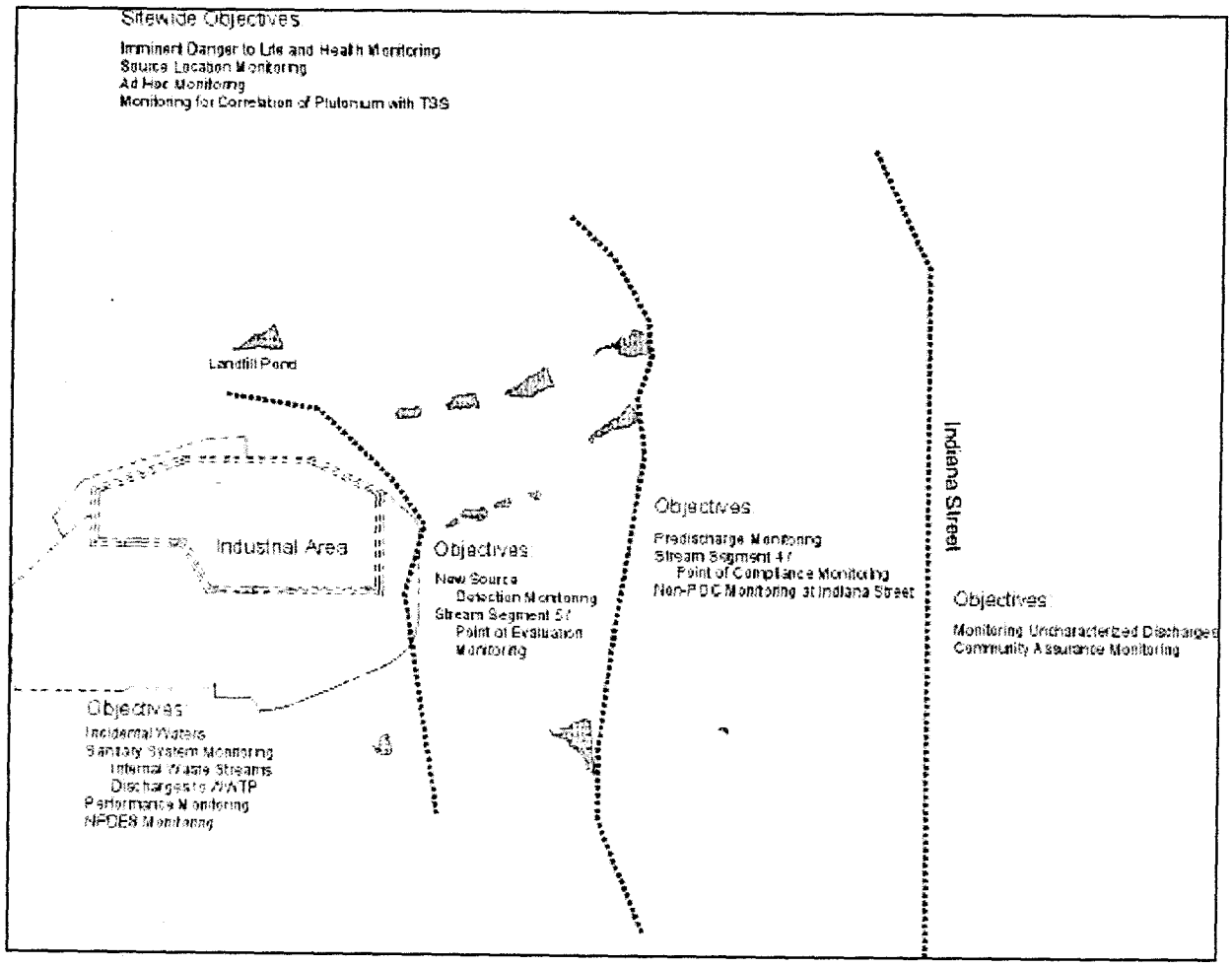

Figure 2-2. Conceptual Model of Site Monitoring Objectives

Individual high-risk projects (generally located within the IA) will sometimes warrant Performance Monitoring (Section 2.3.3) to detect a spill or release of contaminants specifically from that project. RFETS must also monitor specific point-source discharges specified by the NPDES permit (Section 2.3.4).

The next group of upstream-to-downstream monitoring objectives (Section 2.4) deals with discharges from the IA to the ponds. RFCA requires RFETS to identify and correct significant accidental or previously undetected releases of contaminants from the IA to the ponds (surface water leaving the IA and entering Stream Segment 5). To decide whether a significant release of contaminants has occurred, RFETS performs New Source Detection (NSD) monitoring of IA runoff for statistically significant increases in contaminants (see Section 2.4.1). Additionally, the RFCA specifies monitoring for the upstream reaches of RFETS drainages (above the ponds) and

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specifies action levels for contaminants (Action Level Framework). This Stream Segment 5/Point of Evaluation (POE) monitoring is addressed in Section 2.4.2.

Continuing downstream to the next group of monitoring objectives, terminal detention pond discharges and surface water leaving RFETS are monitored. Pre-discharge monitoring of terminal ponds occurs prior to controlled discharges (Section 2.5.1). RFETS also monitors at Points of Compliance (POCs) below the terminal ponds to demonstrate that RFETS discharges meet state stream standards in Segment 4 (Section 2.5.2), as specified in RFCA. Further, there are RFCA POCs on Walnut and Woman Creeks that are monitored at the RFETS boundary at Indiana Street (Section 2.5.2).

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

Section 7.0 of this document addresses the improved interfaces between surface water and other media: soil, groundwater, air, and ecology. For example, contaminants in groundwater and soil could conceivably contaminate surface water, and surface water could subsequently adversely affect habitats of endangered species. Monitoring objectives to evaluate the interaction between the media are addressed in Groundwater Monitoring, Section 3.0.

2.1.2 GEOLOGIC AND HYDROLOGIC SETTING

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

Geographically, RFETS surface waters are bounded:

- upstream by the West Diversion Ditch (McKay Bypass);
- on the south, by the South Interceptor Ditch (SID) or by Woman Creek, subject to discussion and context;
- by the landfill drainage on the north; 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 Figure 2-1 and Figure 2-2. A detailed discussion of RFETS geology and hydrology is presented in Appendix C of this *IMP Background Document.*

The stream drainages leading off-Site, from north to south, are Rock Creek, Walnut Creek, and Woman Creek. The figures illustrate the latter two drainages and their tributaries. North Walnut Creek flows through the A-Series ponds, and South Walnut Creek flows through the B-Series ponds. The CWQCC has designated the portion of these drainages from Ponds A-4 and B-5 to Indiana Street as Stream Segment 4b. Tributaries to the A- and B-Series terminal ponds, and Pond C-2 itself, are designated as Stream Segment 5. The South Interceptor Ditch and Ponds A-

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1, A-2, B-1, and B-2 have not been designated as waters of the state. These stream segment designations are illustrated in Figure 2-3.

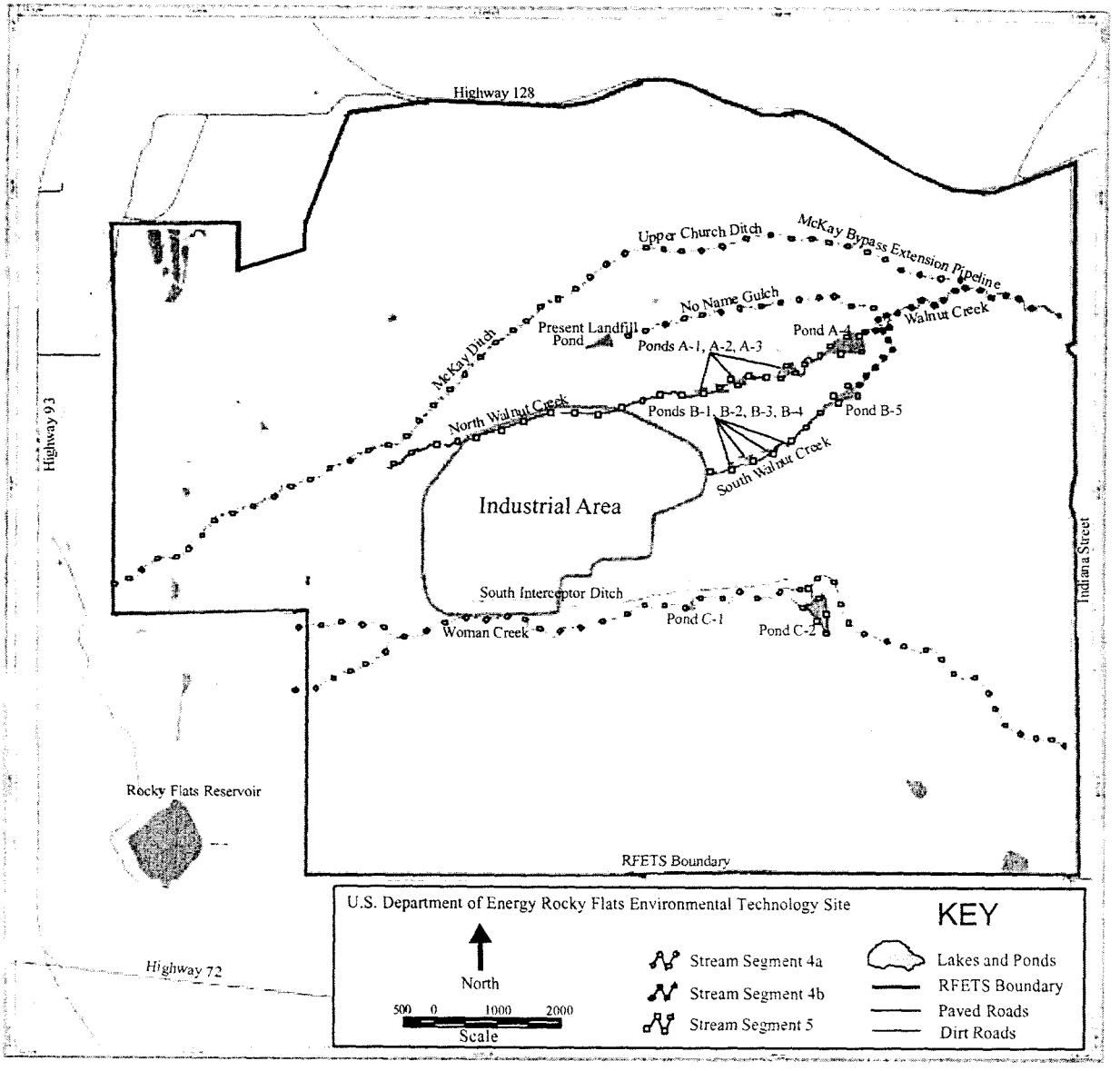

Figure 2-3 Sketch of Stream Segments 4a, 4b, and 5

2.1.3 ASSUMPTIONS

The Surface Water IMP Working Group made several assumptions in order to focus the monitoring program on practical concerns. These assumptions acknowledge that monitoring for all possible Site conditions, contaminants, and practices, would be an inefficient use of limited resources. The Working Group's planning assumptions are presented below. These assumptions may not continue to always be true, and this document does not constitute agreement between the parties that these assumptions will be maintained. However, if an assumption becomes

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invalid during the effective period of this plan, then some of the monitoring that was 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 EPA, CDPHE, and the DOE, as required in RFCA Part 23, paragraph 267.
- Monitoring objectives specified herein will be implemented by the parties, subject to funding constraints and priorities, as specified in RFCA Part 11, Subpart A.
- This plan incorporates surface water monitoring of RFETS discharges to surface water, and contaminant impacts down to and including Broomfield and Westminster water supplies. Monitoring and decisions by RFETS, the State, and the cities are included.
- Decisions regarding IDLH are deserving of special attention and will be segregated from decisions regarding likely low-risk health concerns to ensure that confusion will not arise regarding the priority of IDLH decisions over strictly water-quality decisions.
- The parties agree that continuous water-quality monitoring probes will be used as indicators that may suggest a need for additional monitoring, mitigating action, or management decision. 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 composite 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 other RFETS data.
- Termination for Cause: Successful completion of a flow-paced 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 ≥ about 4 liters (L); see NSQ discussion), equipment failures, off-normal conditions (e.g., emergencies and drills, severe weather, other force majeure), or health and safety concerns.
- Non-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 plutonium (Pu) and americium (Am) require 4.12 L.[3] Therefore, samples of less than 4.12 L 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.
- NSQ sample volume size has been discussed at several previous forums. As of the FY03 revision, the minimum sample volume needed to meet the minimum detectable activity

[3] Four liters are required for the Pu and Am analysis, with 0.12 required for a rad screen at new locations or locations that have not been recently characterized. For characterized locations, 4L would be required to analyze for Pu and Am.

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(MDA) for Pu and Am remains 4.12 L. If, during FY03, the subcontracted labs suggest that a modified sample volume could provide an acceptable MDA, a change in the NSQ volume may be warranted. Changes in the NSQ sample volume would be discussed in an IMP working group.

- The 30-day moving averages will be computed twice each month, within five working days of the 15th day and the last day of the month, for sample results received between these dates and reported per the RFCA.
- Where there is no significant flow, there may be no composite samples completed within a 30-day period. However, flow-paced sampling will continue during dry periods, even though flows may be so low that it may take longer than 30 days to fill the composite sample container.
- If no samples are taken during a 30-day interval due to a no-flow condition, 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.
- 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 also be reported.
- Monitoring data acquired under the same procedural controls as used for RFCA monitoring are actionable[4] under RFCA and applicable regulations, even though it may not have been specifically identified as an analyte of interest (AoI) in Tables V and VI in Appendix F.
- Many areas of RFETS 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.
- These monitoring objectives are based on requirements set forth in the CWA and Colorado Water Quality Control Act.
- Each monitoring objective that requires comparison to a baseline presupposes that the establishment of a baseline will be performed before decisions are made based on 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

- RFETS operators, as in past years, continue to request changing the pond operations protocol from batch discharge to controlled detention for off-Site release of surface waters. It is likely that this issue will be addressed at closure or post-closure.
- Terminal ponds will continue to be operated in a batch mode to the extent practicable throughout FY03.
- A detailed summary of ongoing IA D&D monitoring is not part of the IMP or the *IMP Background Document*. Detailed monitoring requirements and reporting for D&D

[4] 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.

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monitoring will be included in the project plans. This information will be reported in an annual summary to accompany the IMP and the *IMP Background Document*. This summary will include a review of performance monitoring.

2.1.5 QUALITY ASSURANCE

Sampling and analysis of surface water is controlled by the following Standard Operating Procedures (SOPs): the RMRS *Quality Assurance Program Plan for the Automated Surface Water Monitoring,* the *Site Quality Assurance Manual*, and Analytical Services' *Statement of Work for Analytical Measurements, General Laboratory Requirements.* The *Statement of Work for Analytical Measurements, General Laboratory Requirements* presents the approved analytical methods, sample hold times, analyte detection limits, and laboratory data reporting protocol. Sample sizes (number of independent samples analyzed) for FY02 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.

- *Statement of Work for Analytical Measurements, General Laboratory Requirements, Module GR01-B.3* (Kaiser-Hill, 1999).
- *Site Quality Assurance Program Procedures Manual (Kaiser-Hill, 2001a)*
- *Quality Assurance Program Plan for the Automated Surface Water Monitoring Program* RF/RMRS-2000-013, Rev. 0 (RMRS, 2000c).

2.1.6 REPORTING

Data specified in the surface water monitoring objectives are used in decision making. Many of the data may not be routinely reported to parties other than to the decision maker for a particular decision. These data are managed in the RFETS Soil and Water Database (SWD) or other RFETS databases for subsequent queries (secondary data usage is quite common). Some typical (though non-inclusive) examples of data usage are described below.

- IDLH data are used to make management and operational decisions; for example, 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 separate or special regulatory report.
- If data helped to locate a new contaminant source, then the source and data would be reported for appropriate management action.
- *Ad hoc* monitoring requested by RFETS parties is reported to the requestor.
- The NSD monitoring would be reported internally to initiate evaluation if a new contaminant source were detected, but no public or regulatory report would be routinely produced.
- Data collected for RFCA POE and POC monitoring locations are used to calculate 30-day moving averages for the AoIs. If the 30-day calculated results exceed the applicable reporting threshold (action level or standard), the formal notification is made to the RFCA parties pursuant to Attachment 5 of RFCA.

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- The disposition of internal wastestreams and incidental waters is based on data-driven decisions. The data are recorded and reported to the decision maker, with an annual summary of routine internal wastestreams provided to the EPA.

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

- NPDES monitoring data are reported in a *Discharge Monitoring Report* (DMR) each month to EPA;
- CDPHE routinely reports pre-discharge and community-assurance monitoring results to RFETS and cities;
- Many of the surface water data are summarized and reported at the Quarterly Information Exchange Meetings; and
- An annual Automated Surface Water Monitoring Report.

2.1.7 SURFACE WATER INTERACTIONS WITH GROUNDWATER

Significant interactions occur between surface water and groundwater systems at RFETS. Groundwater within the alluvium and other permeable sediments receive natural surface water recharge from streambeds, ponds, ditches, and lakes (i.e., where the unconfined aquifer lies below the surface water). Concurrently, surface water receives groundwater discharge from nature seeps and man-made structures that intercept the groundwater systems.

The surface water performance monitoring assessment and implementation template has been refined to better plan monitoring for D&D and remediation projects. As in the past, assessments will be conducted two years prior to the planned start of building demolition. Due to the dynamic nature of RFETS cleanup, initiation of performance monitoring two years prior to an activity is rarely achieved. However, additional samples are often collected at an increased rate to establish baseline prior to initiation of project activities. It is a goal that, during FY03, similar surface water/groundwater templates will be developed to better plan for those projects where surface water/groundwater interactions are expected. The refined templates for surface water are detailed in Section 2.3.3 Performance Monitoring.

2.2 SITE-WIDE MONITORING OBJECTIVES

The monitoring objectives in this IMP are generally presented in an upstream-to-downstream order. This section addresses monitoring objectives that cannot be ordered in that way. This section also addresses cross-cutting monitoring objectives such as safe operation of the dams (Section 2.2.1), location of contaminant sources, wherever they may occur (Section 2.2.2), special request (*ad hoc*) monitoring (Section 2.2.3), and the use of indicator parameters to evaluate constituent fate and transport and to design water management options (Section 2.2.4). None of this monitoring is confined to a single geographical area of RFETS. Figure 2-4 shows the locations of specific monitoring locations referenced under each objective. In the interest of fiscal and operational efficiency, many of these locations collect data to support multiple monitoring objectives. The location codes in Figure 2-4 are those used in the RFETS SWD.

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2.2.1 IMMINENT DANGER TO LIFE AND HEALTH DECISION MONITORING

This Imminent Danger to Life and Health (IDLH) section uses the term "action level" in reference to dam operations. This is an entirely different usage unrelated to the RFCA Action Levels and Standards Framework (ALF) discussed elsewhere in this document.

RFETS has a network of detention ponds with earthen dams (Figure 2-4). Failure of an earthen dam would present an IDLH condition as defined by safety and health professionals. In general, RFETS detention ponds 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 would likely be damaged and could fail under such conditions. Heavy rain or snowmelt runoff can challenge the capacity of the ponds faster than the ponds can be pre-discharge monitored and subsequently batch discharged.

Problem Statement:

If water levels rise above safety limits that preserve dam integrity, then ponds must be discharged to prevent overflow or breaching.[5] The risk to the public and environment is far greater from a dam breach than from the normally low levels of contaminants that might be found in pond waters.

Problem Scope:

The actual decision process for managing pond operations 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) (Kaiser-Hill and RMRS, 1996), and the *Action Level Response Plan for Dams A-4, B-5, or C-2* (RMRS, 1998). The following general decisions must be made on a continuous basis for Ponds A-3, A-4, B-5, and C-2. A series of simultaneous equations are solved via an expert system framework to consider actions associated with modeled action levels.

Information Types and Frequency:

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, and cracks or sloughs of embankment material. The information needs are as follows:

- Pond inflow rates into Ponds A-3, A-4, B-5, and C-2 (must be continuously monitored for daily to hourly averages with instantaneous measurement capability);[6]
- Pond elevations for Ponds A-3, A-4, B-5, C-2, and the Landfill pond (must be continuously monitored for daily to hourly averages with instantaneous measurement capability);
- Measurements from piezometers within dams (as an indication of water pore pressure in dam structures);

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

[6] 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. For example, during FY96, hourly monitoring was actually used for 85 days during the year.

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- Daily to hourly visual inspections of dam integrity;
- Results from the expert system that rates the above inputs to determine whether to release water from a dam despite water-quality [Note: *Pond Operations Plan* (Kaiser-Hill and RMRS, 1996) details decision tree that describes this logic];
- Pond discharge (outflow) rates from Ponds A-3, A-4, B-5, and C-2 (pumped or through outlets; daily to hourly averages with instantaneous measurement capability);
- Weather prediction (affects the weighting factors in the expert system);
- Biannual dam inspections;
- Annual Federal Energy Regulatory Commission (FERC) inspections;
- Crest monument movement monitoring [required by *Code of Colorado Regulations* (CCR) for dams]; and,
- Inclinometer monitoring (required by CCR for dams).

Boundaries:

Spatial: Inflows to and outflows from Ponds A-3, A-4, B-5, and C-2 are used in decision making. Each individual dam and the water volumes in each pond are included in decision making. Only terminal ponds (A-4, B-5, and C-2 in the North Walnut Creek, South Walnut Creek, and Woman Creek drainages, respectively) are normally operated to release water off-Site. (Woman Creek normally flows around Pond C-2, through an artificial diversion. However, Pond C-2 is directly discharged in the natural drainage of Woman Creek and may receive overflow from Woman Creek during extreme flood conditions.)

Temporal: Information is collected at varying intervals based on the pond conditions and rate of change of the specific parameter. Daily or more frequent dam piezometer data, hourly inflow and outflow data, and hourly to daily pond level data are all transmitted 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. RFETS also maintains instantaneous measurement capability for all telemetry data that can be accessed both on- and off-Site.

Decision Statements:

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

THEN RFETS 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	RFETS will release water (without waiting for pre-discharge analytical results; however, applicable POC monitoring will occur from the pond at a draw-down rate of 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 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	RFETS will release water (without waiting for pre-discharge analytical results; however, applicable POC monitoring will occur) from the pond at a draw-down rate greater than one foot per day. Notifications to Colorado State Engineer and other agencies are required.
IF	Routine or emergency dam inspections, inclinometer readings, piezometer readings, or other monitoring activities reveal changed conditions affecting the structural integrity of a dam—
THEN	RFETS will notify the Colorado State Engineer and other agencies, as required by the 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 Working Group determines the frequency and type of monitoring specified as 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:

  — Does not apply.

Monitoring Requirements:

Monitoring requirements determined to safely operate the dams are presented in Table 2-1.

2.2.2 SOURCE LOCATION MONITORING

As used in this section a "source" is a contaminant source. The term "new source" as used in this section means a source suggested by monitoring 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.[7]

[7] A decision rule under the DQO process links RFETS environmental data with operational and regulatory decisions.

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

Data Types Monitored	A1	A2	A3	A4	B1	B2	B3	B4	B5	C1	C2	Landfill
Inflow rate (telemetry measurement)	–	–	24/day [SW093]	24/day [GS12]	–	–	–	–	24/day [GS10 / 995POE]	–	24/day [SW027]	–
Inflow rate (field measurement)	1/week	1/week	1/day	1/day	1/week	1/week	–	–	1/day	–	1/day	–
Discharge rate (telemetry measurement)	–	–	24/day [GS12]	24/day [GS11]	–	–	–	–	24/day [GS08]	–	24/day [GS31]	–
Discharge rate (field measurement during discharge)	4/day	4/day	4/day	4/day	4/day	4/day	–	–	4/day	–	4/day	4/day
Pond elevation (telemetry measurement)	–	–	24/day	24/day	–	–	–	–	24/day	–	24/day	24/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	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 of computer expert system to predict pond filling and discharge events (using data from	1/week	1/week	1/week	1/ week	1/week	1/week	–	–	1/ week	–	1/ week	1/week

telemetry and field measurement)												

Notes: Where nine measurements per day are indicated, this is the estimated average of critical measurements that are actually targeted. This varies from daily to hourly, and the hourly capability is required for 50-100 days per year. Instantaneous measurement capability is also desired for telemetry data.

Specific automated gauging station locations are, for example, shown as: [GS12]

– = Not applicable

Problem Statement:

When new contaminant sources are detected by surface water monitoring within the IA, NSD locations, POEs, POCs, or in downstream reservoirs, additional monitoring may be required to identify[8] the source and evaluate for mitigating action pursuant to the RFCA ALF. The Source Location Monitoring objective is used to locate the source of contamination when a new source of contamination is detected[9].

Information Types and Frequency:

Analyte suites under this decision rule are determined based on the contaminant of current concern that has initiated the source location activities, or related indicators. The information types are entirely dependent on the results of other monitoring objectives under which the source was detected. The analyte suites are limited to parameters that will aid in the identification and evaluation of a contaminant source.

Boundaries:

Spatial: Source location monitoring may be implemented anywhere within the RFETS surface water drainage area (especially within the IA) where a new contaminant source is detected. The distribution of monitoring points is determined by the details of the specific source evaluation to determine source location and to efficiently use resources. For example, if NSD monitoring (just outside the IA) suggests a new source within the IA, then monitoring equipment may be installed within the IA to locate the source. 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 as soon as practical after source detection and continue until the source is identified and evaluated or is no longer detected. The number of samples will be based on the status of the source evaluation, taking into account, but not limited to, weather conditions, water availability, and process knowledge.

Decision Statement:

IF A new contaminant source is identified by a monitoring objective—

THEN RFETS will locate and quantify the source, take appropriate and immediate action to halt or mitigate, and implement mitigating action pursuant to the RFCA.

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 monitoring objectives. Comprehensive monitoring for detection of new sources is an

[8] Note that the term "identify" is used here to mean "locate." Characterization is also implied.

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

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issue for other monitoring objectives. Comprehensiveness and representativeness may be developed for specific instances of source location actions.

- Acceptable Decision Error Rates for Statistical Sampling Design:
  - A generally applicable statistical sampling design has not been used.

Monitoring Requirements:

The need for source location monitoring stations is dependent on the results of monitoring under other objectives. Therefore, it is impossible to estimate the exact monitoring targets under the Source Location Monitoring objective for each year. For FY03, eleven monitoring locations will collect data to support the source location objective. Although the majority of these locations were installed for the Performance Monitoring objective, the data from these locations will be used in support of ongoing source evaluation activities for POE GS10.

For planning purposes, Table 2-2 contains estimated analyses supporting continuing source evaluations that would be performed at multiple source location stations, in an attempt to locate and characterize the sources contributing to the exceedances.

Table 2-2 Estimated FY03 Annual Number of Samples and Parameter Collection Frequency for Source Location Monitoring

Gauging Station: Location Description	Pu, Am	TSS	Total Target Samples/Year
GS27: Small drainage north of B883	12	12	12
GS28: Ditch NW of B865; supports 800 Area D&D	12	12	12
GS38: Central Ave. Ditch on SE corner of Central Ave. and 8th Street	12	12	12
GS39: Ditch N of 904 Pad; also supports 903 Pad remediation	12	12	12
GS40: Drainage Outfall E of 750 Pad; also supports 700 Area D&D activities	12	12	12
GS43: Ditch draining B886 Area; supports B886 D&D	12	12	12
GS50: Ditch SE of Solar Ponds; supports Solar Ponds remediation activity	12	12	12
GS57: Ditch NE of 400 Area; supports 400 Area D&D	12	12	12
GS60: Confluence of ditches NE of B664 area and Conex yard	12	12	12
SW021: Outfall of culvert under former PSZ draining B991 Area	12	12	12
SW022: East end of Central Avenue Ditch at Inner Fence	12	12	12

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2.2.3 AD HOC MONITORING

RFETS and agencies monitor 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, building managers, and the WWTP in the past. The Surface Water IMP Working Group anticipates that these parties will continue to request such *ad hoc* monitoring in the future, regardless of whether funding is allocated for that purpose.

This monitoring will not always require sample analyses. In some cases, only flow measurement will be needed. Some examples that may warrant *ad hoc* monitoring include:

- Major precipitation events that disrupt routine pond pre-discharge monitoring and discharge schedules;
- Special projects (e.g., Actinide Migration Evaluation, Site-Wide Water Balance);
- Special studies by the agencies (e.g., CDPHE's *Uranium Inductively Coupled Plasma/Mass Spectroscopy (ICP/MS) Study*, CDPHE's nitrate loading study for Walnut Creek);
- Community assurance monitoring at the request of downstream cities and the DOE;
- Unanticipated changes in regulatory permits, agreements, or funding;
- Anticipated but unfunded changes in permits or agreements;
- Construction projects;
- Spill events; or
- Operational monitoring (i.e. footing drains, septic lift stations).

The anticipated automated monitoring locations for FY03 are presented in Table 2-3. Actual FY02 *Ad Hoc* monitoring will depend on the status of new and ongoing projects in FY03.

Table 2-3 Anticipated FY03 *Automated Ad Hoc* Monitoring Locations

ID Code	Location	Primary Flow Measurement Device	Telemetry	Notes
B371BAS	Building 371 basement footing drain	11.4° V-Notch Weir	Yes	Flow data collection to confirm proper operation of footing drain systems; funded by Safe Sites
B371SUBBAS	Building 371 sub-basement footing drain	11.4° V-Notch Weir	Yes	Flow data collection to confirm proper operation of footing drain systems; funded by Safe Sites
GS33	No Name Gulch at confluence with Walnut Cr.	9.5" Parshall flume	Yes	Flow data collection for Site Water Balance
GS35	McKay Ditch at confluence with	36" contracted rectangular	Yes	Flow data collection for Site Water

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ID Code	Location	Primary Flow Measurement Device	Telemetry	Notes
	Walnut Cr.	thin-plate weir		Balance
GS41	Sub-drainage SW of GS03; drains to Walnut Creek	0.5' H Flume	Yes	Flow data collection for Site Water Balance
GS45	Upper Church Ditch west of Site fenceline	9.5" Parshall Flume	No	Flow data collection for Site Water Balance
GS46	McKay Ditch west of Site fenceline	9.5" Parshall Flume	No	Flow data collection for Site Water Balance
SW009	McKay Bypass Canal upstream of confluence with West Diversion Ditch	1' Parshall Flume	No	Flow data collection for Site Water Balance

2.2.3.1 CDPHE's Special Uranium ICP/MS Study

This surface water *ad hoc* sampling is intended to augment CDPHE's special uranium (U) ICP/MS study of groundwater at RFETS. Details of the surface water monitoring component were first described in a CDPHE Quality Assurance Project Plan (QAPP) that was distributed to the IMP working group during a May 2000 meeting. The purpose of the study, DQOs, and decision rules specified in the QAPP are restated below:

Problem Statement:

Groundwater at the RFETS has been contaminated with man-made isotopes of U. There is also natural U in the groundwater. In an effort to better discern those areas where man-made contamination is present versus those areas where only natural U exists, and to further evaluate the HR-ICP/MS method of analysis, a special groundwater study is underway. A separate CDPHE document describes that study - the *Quality Assurance Project Plan for the determination of Isotopic Uranium in Groundwater at RFETS using HR-ICP/MS (High Resolution Inductively Coupled Plasma Mass Spectroscopy)* (hereinafter referred to as the *Groundwater QAPP*) (CDPHE, 1999).

It is generally accepted that groundwater surfaces upgradient of RFETS boundaries. However, the distribution of flow accretion along the stream profiles is not well understood. In order to gain a more detailed understanding of this interaction and provide additional information that can be used to identify areas where either man-made U contributes significantly to the measured activity, a limited number of surface water stations will also be sampled.

The information gained from these surface water stations will:

- identify locations where primarily natural U is present in the stream,
- allow a comparison between groundwater and surface water quality for U isotopes,

- assist in delineating groundwater flow patterns,
- help identify specific sources of man-made U,
- assist in the assessment of the potential impacts from alterations of either surface or sub-surface flows,
- assist in the assessment of future conditions as groundwater moves downgradient,
- help refine surface water monitoring plans, and
- test the utility of the HR - ICP/MS method of analysis for surface water.

Information Types and Frequency:

U analysis by HR-ICP/MS is the only analyte for this study. Sampling will be done on the same schedule as sampling for the groundwater study – preferably quarterly, or as funding sources allow.

Boundaries:

Spatial: Sampling will be done at eight stations:

- GS01 - Woman Creek at Indiana
- GS03 – Walnut Creek at Indiana
- GS04 - Rock Creek at Highway 128
- SW118 - North Walnut Creek (upstream of Solar Ponds Nitrate Plume)
- GS13 - North Walnut Creek above A-Series Bypass
- GS05 - North Fork of Woman Creek at West Fence Line
- GS17 - Woman Creek above Pond C1
- GS10 - South Walnut Creek above B-Series Bypass

Temporal: Quarterly, or as frequently as funding sources allow,

Decision Statement:

IF Sample results indicate non-natural U,

THEN Evaluate potential sources of non-natural U, and whether loading from that source may change over time.

Decision Errors and Decision Error Management

For the surface water study, false negative decision errors occur when the null hypothesis (H_0) (that only natural U is present in surface waters), is not rejected, and the surface water is actually contaminated with enriched/depleted U. False positive decision errors occur when the null hypothesis (H_0) is rejected, and the surface water is not contaminated with enriched/depleted U. For this project, the consequence of false negative decision error is not detecting a source of enriched/depleted U that may in the future pose unacceptable risks to public health. The consequences of false positive error would likely be the wasted costs of looking for a source of enriched or depleted U that may not exist.

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Further discussion of decision errors is provided in the *Quality Assurance Project Plan for Surface Water Sampling for ICP/MS Uranium Special Study* (CDPHE, 2000) and by reference, in the *Groundwater QAPP* (CDPHE, 1999).

Monitoring Requirements:

Grab samples will be collected. Detailed procedures are described in *Quality Assurance Project Plan for Surface Water Sampling for ICP/MS Uranium Special Study* (CDPHE, 2000).

2.2.3.2 CDPHE's Nitrate Loading Analysis for Walnut Creek

RFETS currently uses continuously recording water quality probes to conduct real-time monitoring of physical and indicator parameters (of which nitrate is one). These parameters provide real-time alarms for a wide variety of regulated contaminants, and are also a required component of the monitoring for AoIs. They require no laboratory analyses, and are RFETS's most cost effective defensive monitoring tool.

However, RFETS investigations revealed that the water quality probe nitrate measurements are subject to interference from common surface water constituents including chloride and natural organic matter. Although field calibrations are conducted to correct chronic drift, the accuracy of individual measurements is still compromised by short-term drift problems. Considering these factors, nitrate probe measurements were deemed unusable for the purposes of assessing nitrate loads when the effectiveness of the Solar Ponds Plume remediation system was being evaluated.

In order to ensure that accurate nitrate data is being collected, for the purposes described below, and unless the monitoring planned by RFETS is modified to satisfy its requirements, CDPHE will perform the following monitoring.

Problem Statement

There are two main sources of nitrate in the Walnut Creek drainage - the Solar Ponds Plume, and the Sewage Treatment Plant (STP). The Solar Ponds Plume appears to be moving primarily to the north, towards North Walnut Creek, but there is a small southern lobe that may be moving towards South Walnut Creek.

A groundwater interception and treatment system has been installed in the North Walnut Creek drainage, but may not be as effective as originally planned. Nitrate monitoring at GS13, and in Pond A3 are being conducted by RFETS in order to assess the treatment system's performance.

No remediation system is in place or is planned for the South Walnut Creek drainage.

While CDPHE has already performed a short-term assessment of nitrate concentrations throughout the North and South Walnut Creek drainages, it is possible that the loading from the Solar Ponds Plume - to either the North or South Walnut Creek drainages - could change over time. Also, the STP may be operated in different ways in order to reduce ammonia concentrations - potentially increasing nitrate concentrations, or there may be changes in the amount of water flowing into the STP over time.

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As a result of these types of potential changes in the hydrologic system, it will be necessary to perform some nitrate and ammonia monitoring in addition to the performance monitoring being done at GS13[10] and Pond A3.

Information Types and Frequency

Nitrate and ammonia are the only analytes for this study. Sampling will be done on a quarterly basis.

Boundaries:

Spatial: Sampling will be done at the following stations in the Walnut Creek Drainages:

North Walnut Creek

- SW118
- SW093
- GS13
- Pond A-4 – (grab sample from pond event is not concurrent with discharge, else grab sample from discharge if event is concurrent with discharge)

South Walnut Creek

- GS10
- Pond B-5 – (grab sample from pond event is not concurrent with discharge, else grab sample from discharge if event is concurrent with discharge)
- Building 995, Effluent of Waste Water Treatment Plant

Walnut Creek at Indiana Street

- GS03

Temporal: Quarterly sampling.

Decision Statement:

IF	No upward trend or high variability is detected,
THEN	Monitoring will continue on a quarterly basis.
ELSE	Monitoring frequency may be changed.

Monitoring Requirements:

Grab samples will be collected. Detailed procedures are described in *Quality Assurance Project Plan for Nitrate and Ammonia Special Studies at the Rocky Flats Environmental Technology Site* (CDPHE, 1999a).

[10] In order to accurately assess the loading going to the stream, continuous flow monitoring could be established at GS13.

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2.2.4 INDICATOR PARAMETER MONITORING FOR ASSESSMENT OF ANALYTICAL WATER QUALITY DATA

This objective provides for the collection of general water quality and quantity information to be used for various data assessments. Specifically, this objective outlines the current uses of parameters such as TSS, turbidity, and flow rate.

Problem Statement:

This monitoring objective is intended to collect indicator parameter data used to assess analytical measurements of constituents such as radionuclides and metals. The targeted indicator parameters include TSS, turbidity, precipitation, and flow rate. The collection of these data will also support evaluation of erosion control measures, design of final Site land configuration options, design of water management options, investigations into actinide transport, assessment of statistically significant changes in water quality, and management decision making.

Information Types and Frequency:

To evaluate analytical constituents[11] in conjunction with TSS, TSS would ideally be analyzed for all samples collected at the locations covered by the other decision rules in this surface water section. However, sampling protocols (continuous flow-paced) often result in composite samples that are collected over periods exceeding the seven-day hold time for TSS analyses. Therefore, TSS cannot be analyzed for all composite samples but will be analyzed when possible.

To evaluate analytical constituents in conjunction with turbidity, turbidity will be monitored at the locations where required by the other applicable decision rules. These locations include POEs (GS10, SW093, and SW027) and terminal pond POCs (GS08, GS11, and GS31). Each of these stations is equipped with a real-time, water-quality probe to continuously monitor turbidity.

To evaluate analytical constituents in conjunction with precipitation, precipitation is currently monitored at twelve locations across RFETS. The location of precipitation gages allows for the calculation of areal precipitation for any drainage area tributary to each monitoring location. Each of these stations is equipped with a continuously recording precipitation gage.

To evaluate analytical constituents in conjunction with flow rate, flow is currently monitored at virtually all monitoring locations at RFETS. Each of these locations is equipped with a continuously-recording flow-measurement device. Some locations do not collect flow data due to specific water routing configuration limitations. However, flow could be estimated for these locations through the use of flow from comparable locations, runoff coefficients, and sub-drainage area.

This decision rule does not limit the data uses to those given above. Evaluations may be determined for any data combinations as required. For example, assessments using flow and precipitation, turbidity and TSS, or precipitation and TSS, may be useful depending on the specific data evaluation.

[11] The term 'analytical constituents' is used here to refer to constituents measured for samples collected as defined by the other decision rules defined in this section.

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Boundaries:

Spatial: Data may be acquired at any monitoring location either on- or off-Site.

Temporal: No known constraints.

Selected Data Uses:

Table 2-4 outlines the anticipated or past data uses associated with this decision rule. This list provides examples of data uses; future data uses may be developed as needs arise.

Table 2-4 Selected Data Uses of Indicator Parameter Monitoring for Analytical Water-Quality Assessment

Data Use	Targeted Parameters	Description
Rainfall-Runoff Relationships	Precipitation, flow rate, flow volume	Determination of hydrologic characteristics for specific drainage areas
Evaluation of TSS with Turbidity	TSS, turbidity	Use of turbidity measurements to predict TSS concentrations
Evaluation of TSS and Turbidity with Flow Rate	TSS, turbidity, flow rate	Use of flow rate measurements to predict TSS concentrations and turbidity
Assessment of Actinide Measurements	Actinides, TSS, turbidity, flow rate	Determine if cause of unusual actinide measurement is likely due to RFETS activity (i.e. D&D work) or extreme hydrologic conditions
Assessment of Closure Activities	Actinides, TSS, turbidity, flow rate	Determine effects of closure activities on water quality and drainage characteristics
Erosion Modeling	TSS, flow rate, actinides	Model design, calibration, and verification
Water Balance Modeling	Flow rate, flow volume	Model design, calibration, and verification
BMP Assessment	TSS, turbidity, flow rate	Determine effectiveness of various erosion control measures
Land Configuration Design	Flow rate, flow volume, TSS	Design land configuration options: determine flow routing, size hydraulic components, assess sedimentation rates, design maintenance and operation protocols
Long-Term Stewardship	Flow rate, flow volume, TSS, turbidity	Assess post-closure conditions

Monitoring Requirements:

The targets shown in Table 2-5 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.

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Table 2-5 Annual Monitoring Targets (Number of Samples/Analyses) for Indicator Parameter Monitoring for Analytical Water-Quality Assessment

Monitoring Location	Analytical Analyses	TSS Analyses	Turbidity Measurement Frequency	Flow Measurement Frequency
All Locations	As Required by Other Decision Rules	For all samples when meeting 7-day TSS hold-time requirement	NA	15 min
POEs	As Required by Other Decision Rules	For all samples when meeting 7-day TSS hold-time requirement	15 min	15 min
Terminal Pond POCs	As Required by Other Decision Rules	For all samples when meeting 7-day TSS hold-time requirement	15 min	15 min

Notes:
The data collection shown above includes current parameters. Additional parameters may be added or deleted as needs arise.

2.3 INDUSTRIAL AREA MONITORING OBJECTIVES

This section includes the monitoring objectives for decisions regarding the IA.[12] Some of the monitoring performed to make these decisions is actually performed outside the IA. For example, to detect a new source of contamination within the IA, RFETS monitors surface water just after it flows out of the IA.

This IA Monitoring Section also addresses monitoring of incidental waters and the sanitary sewer system. Immediately outside the buildings of the IA, RFETS must often decide whether incidental waters (see Section 2.3.1) that accumulate in berms, utility pits, etc., can be discharged directly to the environment, or whether they must be treated. Discharges to the sanitary sewer system are monitored as discussed in Section 2.3.2. Internal wastestreams are discussed in Section 2.3.2.1. To report current information as required by the NPDES permit, RFETS must characterize all routine internal wastestreams to establish what else might reasonably occur in discharges from these processes. Additionally, RFETS routinely determines whether non-routine internal wastestreams (Section 2.3.2.2) may be discharged from the IA to the WWTP. In addition, NPDES monitoring must be performed on the WWTP discharge to the ponds.

[12] In the surface water monitoring objectives, the term "Industrial Area" is intended to include the 903 Pad. Runoff from the 903 Pad flows through monitoring stations SW022 or SW027.

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2.3.1 INCIDENTAL WATERS MONITORING

Problem Statement:

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

- Excavation sites, pits, or trenches;
- Secondary containments or berms;
- Valve vaults;
- Electrical vaults;
- Steam 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, many precipitation events leave rainwater in utility pits and secondary containment. Disposition of such waters depends on the contaminants present, if any, that may have been picked up from the surroundings or containment structures. Waters containing oil, radioactive constituents, 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. RFETS must determine how to manage incidental waters (i.e., whether or not to discharge to the environment[13]).

This decision includes incidental, not routine, accumulations of water (not waste). Discharges of water containing oil, radioactive constituents, and hazardous substances above the established control limits are prohibited. This monitoring objective does not include decisions regarding appropriate treatment of contaminated waters for which authorization to discharge to the environment 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.

Waters that are denied discharge authorization under this decision rule may be considered for discharge to the WWTP under the internal wastestream decision rule elsewhere in this plan, or they may be managed using other treatment, storage, or disposal options.

Data Types and Frequency:

The Site incidental waters program uses field screening observations and measurements, and chemical analyses for known or suspected constituents in order to determine the appropriateness of discharge to the environment. The field screening initial assessment is made on the basis of the screening criteria in Table 2-6.

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

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Table 2-6 Incidental Waters Screening Criteria

Observation Parameter	Criterion
Process knowledge of the immediate vicinity	Professional judgement
Field pH using pH paper or similar indicator	pH 6.5 to 9
Appearance	No visible sheen or discoloration
Field nitrate using probe or colorimetry	10 mg/L
Field conductivity probe	700 μmho/cm^2

Additional testing is performed when known or suspected contaminants exist, including tests for gross alpha/beta, volatile organic compounds (VOC), and metals.

Boundaries:

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

Temporal: Incidental waters are more common in rainy seasons, but may occur during any part of the year. Although the frequency of occurrence varies seasonally, there are no formal monitoring frequencies 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 (i.e., not individual hazardous substance sites, material storage or handling areas, and high traffic areas) and initial screening tests or chemical analyses are negative—

THEN Incidental waters may be discharged to the environment at the discretion of the Surface Water Operations program manager. [14]

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:

[14] 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 wastestreams 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, subjected to the internal wastestream 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 wastestream decision elsewhere in this document; and the decision to manage under other regulations is out of scope for this document.

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— These accumulations of water in berms and utility pits are nearly always from rain, snow melt, groundwater, or potable water. If process knowledge, screening, and chemical analyses fail to indicate the presence of oil, or hazardous or radioactive substances, then 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, and additional chemical analyses of an estimated twenty incidental water accumulations per month during FY02. For each instance, screening is required, with additional chemical analyses necessary when known or suspected contaminants exist. For planning purposes, estimated monitoring targets for this monitoring objective are presented in Table 2-7.

Table 2-7 Actual/Estimated Field Test Monitoring Targets (Number of Samples/Analyses) for Incidental Waters

Parameter	Justification	Measurements per Yr FY03 (Actual/estimated)
pH	NPDES Permit and stream standards restrict pH of plant discharges.	145
Nitrate as N	NPDES Permit and stream standards have restrictive nitrate limitations.	145
Conductivity	Indicator parameter for metals. NPDES permit and stream standards restrict metals.	145
Gross alpha/beta	BMP to restrict radionuclides in SW discharges.	145
VOC	NPDES Permit and stream standards restrict VOCs in SW discharges.	25
Inorganic metals	NPDES Permit and stream standards restrict metals in SW discharges.	50

2.3.2 SANITARY SYSTEM MONITORING

Sanitary collection system monitoring may provide RFETS D&D project managers and WWTP operators information about collection system condition within the IA as specific areas contributing to the WWTP flow. Current and prospective monitoring systems provide information about the relative contribution of the two main branches of the sanitary collection system and qualitative information about the content of flows through the headworks of the WWTP. Sanitary system monitoring is conducted to:

- Determine percent removals across the treatment plant and therefore be able to predict compliance or noncompliance with NPDES permit effluent limitations;
- Monitor explosive levels at the headworks for worker safety;

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- Monitor for corrosive substances that may impact the treatment units;
- Determine if influent concentrations and loads are trending up or down; and
- Monitor within the collection system to establish pollutant loads attributable to specific industrial internal wastestreams (e.g., laundry water at RFETS).

Five distinct monitoring requirements have been identified for sanitary system monitoring. Separate decision rules have been developed for each of these requirements. The first monitoring requirement is to characterize routine internal wastestreams to meet NPDES permit requirements. This requirement is distinct from the second monitoring requirement that is for non-routine internal wastestreams, for which separate decision rules have been developed. The final three requirements were identified for monitoring of the WWTP influent flows. These include WWTP protective monitoring, collection system flow monitoring, and WWTP radiological influent monitoring. The requirements and unique decision rules are described in the following subsections.

2.3.2.1 Internal Wastestream Characterization to Meet Permit Requirements

Both of the next two sections deal with internal wastestreams (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 wastestreams produced at RFETS. Some can be discharged to the sanitary system, some must be treated under 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:

- RFETS must maintain strict compliance with NPDES Permit conditions. This compliance requirement drives two distinct monitoring activities:

  RFETS 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.

  RFETS must manage discharges to the WWTP for two reasons that are combined operationally under the "authorization to discharge" process. First, RFETS 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 2.3.2.2. Second, RFETS must ensure that wastestreams discharged to the WWTP are compliant with the NPDES Permit, DOE Orders, and other regulations. This activity is also covered in Section 2.3.2.2.

  An additional 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). 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 *Rocky Flats Closure Project Management Plan*. As the RFETS population decreases, the quantity of aqueous wastestreams may decrease. New challenging wastestreams will arise more frequently as buildings are deactivated and drained of their fluid contents, and as other facilities modify their operations accordingly.

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Problem Statement:

Determining appropriate permit conditions is, in part, a data-driven process. RFETS 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 wastestreams emanating from buildings in the IA and discharged to the collection system. The nature of RFETS wastestreams and a detailed characterization of certain[15] discharges must be included in the permit application. These characterizations must include flow rates, constituents, and concentrations. Routine discharges are most likely to be monitored and may be incorporated in the NPDES Permit.

Problem Scope:

The permit application has been supplemented with information about most internal wastestreams and incidental waters that discharge to surface water. Sanitary discharges and wastestreams from RFETS buildings, discharges from Building 374 (B374), the WWTP, and the terminal ponds are potential monitoring targets included within the scope of this section.

The main objective covered in this section is that the current NPDES permit (October 2000) requires an annual report of all routine internal wastestreams discharged to the WWTP. This will require that RFETS characterize new routine wastestreams for inclusion in the report. The following are excluded from the scope of this section:

- Sanitary discharges of any quantity (internal wastestreams) are subject to evaluation under Section 2.3.2.2.
- Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.1 of this document. Stormwater runoff monitoring is excluded from this section.

Data Types and Frequency:

The following items are included in the annual report, as needed:

— Complete NPDES Permit application,

— The building or source of the IWS,

— The estimated annual volume,

— A description of the wastestream, including any analytical data that may be available.

— Current available characterization for each discharge.

Boundaries:

Spatial: The data collected for this monitoring objective is limited to the IA. All facilities and storm water drainages from the IA are included.

Temporal: This section has no temporal boundaries; it deals only with present and future discharges. The permit requires an annual report of all routine IWS discharges.

[15] The Clean Water Act (CWA) regulations require specific information about wastestreams that arise from categorical processes identified in 40 CFR 400-500. None exist at RFETS.

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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 annual report.

Decision Statement:

IF	A RFETS facility discharges wastes indirectly through a treatment facility—
THEN	The discharge must be characterized, approved, and must be reflected in the annual report.

Acceptable Decision Errors:

Confidence that Significant Events are Physically Sampled and Representative:

— RFETS processes for review, notification, and approval of facility modifications are not fully implemented in some cases. Often, facility inspections are needed to provide complete identification and full disclosure of discharges. A planned approach to thoroughly inspect facilities and processes should be used to provide completeness for the request for authorization to discharge.

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 wastestreams, 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 RFETS elects to negotiate a specific issue and requires project-specific monitoring data to negotiate that issue. Such monitoring is not addressed in this plan.

Monitoring Requirements:

For planning purposes, three new routine wastestreams are estimated to require characterization during FY03 in order to demonstrate IWS compatibility with the WWTP.

2.3.2.2 Monitoring Discharges to the WWTP

This section addresses the monitoring for granting authorization to discharge a wastestream to the WWTP. The Site must make frequent decisions regarding disposition of wastestreams. Non-routine 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.

This section covers non-routine sanitary discharges. Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.2.1 of this document. Storm-water runoff monitoring is excluded from this section.

If a wastestream cannot be discharged to the WWTP, then it may need to be evaluated for treatment, storage, or disposal under appropriate regulations such as RCRA, CERCLA, or DOE

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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. Tables I, II, and III (see Appendix F) show NPDES hazardous substances that must be considered (but not necessarily analyzed) during the characterization of each non-routine internal wastestream. 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 IV (see Appendix F) specifies these limitations.
- RCRA hazardous wastes are also prohibited from being discharged to WWTP. 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. ALARA also applies to discharges of radionuclides.

Data Types and Frequency:

Process knowledge is the most valuable indicator. Process knowledge might include the source of the wastestream, current location, and historic precedent. Screening inputs are shown in Table 2-8. Additional chemical analyses are performed when process knowledge and screening results are insufficient to adequately characterize a wastestream.

Table 2-8 Internal Wastestream Screening Tests

• Process Knowledge	• Clarity
– Location	• Volume
– Source	• Field Conductivity
– History	• pH
• Visible Sheen	• MSDS
• Color	

Facilities within the IA are included under this monitoring objective. This monitoring objective has no temporal boundaries, except that it deals only with present and future discharges. All liquids for which a facility requests authorization to discharge to the WWTP are included under

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this objective. Examples include chemical solutions, condensate, foundation drainage, and some incidental waters that are not acceptable for discharge to the environment.

Decision Statement:

The ideal decision rule is stated below.

IF	A wastestream 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 2-8 offer no reasonable cause to suspect prohibited contaminants in a wastestream for which authorization to discharge has been requested—
THEN	RFETS will grant authorization to discharge to the WWTP, subject to approval of the WWTP manager.
IF	Screening results[16] or process knowledge indicate that contaminants would prohibit the discharge under any applicable regulation—
THEN	RFETS 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.
IF	More specific or more sensitive analyses indicate that the wastestream would not cause a violation of applicable regulations—
THEN	RFETS 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.

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:

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

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The Surface Water Operations Group estimates that there will be about 40 requests for authorization to discharge during FY03. Each will be screened as specified in Table 2-8. Wastestreams with similar characteristics (i.e., acids or bases) may be grouped into single requests for administrative efficiency.

2.3.2.3 WWTP Collection System Protective Monitoring

At this time, collection system protective monitoring is minimal and consists of real-time monitoring for pH, conductivity, and Lower Explosive Limit (LEL) at three locations, in the two main collection lines and at the headworks to the plant. Some direct pH readings are also taken by plant personnel at the influent tanks. 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 separate decision rule.

Data Types and Frequencies:

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

Boundaries:

Spatial: Collection system lines influent to the WWTP up to but not including lines inside the buildings inside the IA.

Temporal: This is real-time operational monitoring.

Decision Statement:

The decision rules for FY02 are presented below.

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 an influent storage basin not currently in use while the problem is investigated.

IF The LEL is exceeded (see Table IV, Appendix F)—

THEN Emergency procedures will be activated.

Acceptable Decision Errors:

Confidence that Significant Events are Physically Sampled and Representative:

Error discussion is not applicable. The decision rule covers response to emergency signals, all of which are considered without error.

Acceptable Decision Error Rates for Statistical Sampling Design:

Not applicable. See above.

Monitoring Requirements:

The instrumentation is operated full time, and therefore monitoring is continuous.

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2.3.2.4 WWTP Collection System Flow Monitoring

Flow information for RFETS sanitary collection system is currently limited to influent records for the WWTP. The initial scope of collection system monitoring was intended to provide RFETS collection system flow information by installing continuous recording flow monitoring equipment at Building 990 on the two main collection system lines. The flow record was examined in an attempt to establish annual baseline conditions for the flows from the protected area (PA) and non-PA areas[17]. It was thought that changes from the established baseline flow may be attributable to normal collection system conditions such as infiltration and inflow, or abnormal conditions, such as increased flows from areas undergoing D&D. No modifications were made to the flow measuring equipment at Building 990. Ultrasonic transducers monitor water levels behind plywood weirs and transmit a signal to the control room of Building 995. Due to the inaccuracies of the weir construction, flow data at Building 990 have never met quality objectives. However, totalizer readings have been recorded and used as a general indication of the comparative flows from the two parts of the collection systems. For purposes of the IMP, these data constitute the baseline.

Problem Statement:

The sanitary collection system consists of two components, one serving the Protected Area and one serving all areas outside of the Protected Area (PA and non-PA, respectively). Flows from the two areas remain segregated until they combine into a single transmission line that bypasses the equalization basins located at Building 990. Influent to the WWTP (Building 995) is monitored for pH, conductivity, and LEL on a continuous basis. These parameters are also monitored at Building 990 on both the PA and non-PA systems. The Building 990 locations have continuously recording flow monitoring devices.

Data Types and Frequencies:

Equipment installed at Building 990 measures daily total flows from the PA and non-PA collection systems. These inputs can be combined with currently recorded pH, conductivity, LEL levels, and precipitation and other existing continuous monitoring programs.

Boundaries:

Spatial: The areas described in the problem statement and scope are areas at RFETS served by the existing sanitary collection system.

Decision Statement:

IF A baseline for flow does not exist—

THEN Access the usability of the baseline and identify future data resolution needs.

After assessment of the collection system flow baseline:

IF Flow in the PA or non-PA collection lines deviate from the baseline influent flows—

[17] The PA (fenced area) has been reconfigured to include only B371/374. However, the collection system has not been changed, and sanitary flows designated to be from the PA in this and other text are from the modified PA and previous PA area.

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THEN Identify the source of abnormal flows and evaluate the impact on the sanitary collection system.

Monitoring Requirements:

Continuous flow monitoring of the sanitary collection system in the main transmission lines from the PA and non-PA areas into Building 990.

2.3.2.5 CDPHE WWTP Influent Radiological and Metals Monitoring

This section also includes the monitoring of radiological parameters and metals at the influent to the WWTP for the purpose of tracking pollutant loads and concentrations coming through the WWTP collection system.

Problem Statement:

With the onset of D&D activities and remedial actions, the possibility of introducing contamination into the WWTP exists. Monitoring is one way to detect whether there is an impact by an unknown source to the WWTP as a result of clean up activities.

Also, with the eventual decommissioning of the WWTP, it will be important to know the quality of the water that may remain flowing through the sewer collection system as a result of inflow and infiltration, even after all domestic sewer contributions have been eliminated.

Data Types and Frequencies:

Influent WWTP monitoring will be done at the headworks to the treatment system, using the composite sampler located downstream of the equalization basins. Monitoring will be done on a monthly basis.

The monitoring will include the following suite of radiological parameters: isotopic Pu, Am, U, plus alpha and beta activity. Analyses will also be performed for these metals: silver (Ag), copper (Cu), manganese (Mn), nickel (Ni), selenium (Se) (dissolved), and arsenic (As), beryllium (Be), cadmium (Cd), chromium (Cr), iron (Fe), lithium (Li) (total). Influent flow is also a required input in order to determine the loading into the treatment plant.

Also, in order to 1) assess the effect of equalization basins upon influent quality, 2) ensure that collection system quality is accurately characterized, and 3) more precisely identify the location of sources of contaminants, quarterly monitoring will be done at a location upstream of the equalization basins at the same time that samples are collected from the composite sampler located below the equalization basins.

Preferably, this will be done at the terminus of the separate North and South Interceptors, just before they join. If this is not practical, then monitoring will be done at a location that can be accessed either above the equalization basins, or immediately after the flow enters the equalization basins. At this time, a location with acceptable access with respect to Site health and safety practices has not yet been identified.

Boundaries:

Spatial: Collection system lines influent to the WWTP.

Temporal: Present and future influent to the WWTP.

Decision Statement:

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IF	A baseline for parameters measured in the influent does not exist—
THEN	Establish a baseline

After developing an influent baseline:

IF	Influent loading or concentrations for any constituents show a significant increase over the established baseline—
THEN	An evaluation will be conducted to determine potential cause.
AND	
IF	Influent concentrations for a radiological constituent are above stream standards —
THEN	Plans will be developed for eliminating the flow in the collection system
OR	Plans will be developed for treating the flow in the collection system.

With respect to ensuring that samples taken fom the composite sampler located below the equalization basins accurately reflect collection system quality:

IF	After at least four quarters results are reviewed, a result for a sample collected above the equalization basin is either greater than twice the result or less than one-half the result for the paired sample collected below the basins,
THEN	Additional review of the data will be conducted in order to determine whether or not continuous sampling needs to be done above the equalization basins.

Acceptable Decision Errors:

Short-term "slug" discharges of contaminants will likely not be detected with either the composite sampling or grab sampling that is proposed. But, changes in more continuous contaminant contributions – such as those from groundwater sources, should be apparent in the data record. The monthly monitoring frequency at the composite sampler should provide an assessment for various hydrologic conditions and allow a reasonably quick response to significant changes.

With respect to the comparison of pre-equalization basin concentrations against post-equalization basin concentrations, the quarterly sampling frequency and decision rules should detect a major difference between the two concentrations.

Monitoring Requirements:

On a monthly frequency, RFETS will collect a 24-hour composite sample at the headworks to the WWTP, at a time representative of full operation of the complex (not on weekends). The volume of flow associated with the 24-hour composite needs to be provided by RFETS and made available to CDPHE. CDPHE will pick up the composite sample from RFETS and will perform the analyses and calculate the loadings

On a quarterly frequency, on the same day that the composite sample is obtained from the headworks to the WWTP, a grab sample will be obtained from either both the North and South

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Interceptors, or from another location located above the equalization basins or immediately after entering the equalization basins.

2.3.3 PERFORMANCE MONITORING

RFETS is developing an integrated approach for evaluating and implementing surface water and groundwater project-specific performance monitoring (see Section 2.1.7 for discussion). Under this approach, integrated project reviews are to be initiated two years prior to the planned start of D&D and remediation projects. This approach emphasizes those projects where contamination sources (i.e., soils, equipment, and building materials) are most likely to impact surface water.

The purpose of project-specific performance monitoring is to improve monitoring network resolution to isolate the potential impacts of individual projects. The process of screening candidate projects starts with a review of closure schedules to determine the relative priority of major D&D and remediation projects. RSOPs, environmental checklists, and project plans are reviewed to determine whether project managers have considered project-specific performance monitoring. For those projects that pose a particular concern to surface water (e.g., D&D of radiologic buildings), legacy environmental monitoring data are reviewed, surface water flow pathways are evaluated, and project managers are interviewed to identify and quantify specific concerns. For projects warranting independent performance monitoring, field walk-downs are conducted to delineate sub-drainage basin configuration and identify the location of new performance monitoring stations. In some cases, drainage configuration (natural or man-made) in the vicinity of a project makes it impossible to isolate runoff from a particular project area. In these cases, drainage modifications may be required. The overall goal is to implement performance monitoring 18 months prior project startup to enable development of a water-quality baseline for evaluating project impacts on surface water.

The decision process for screening projects to determine surface water performance needs is detailed in Figure 2-5.

2.3.3.1 Performance Monitoring Template

The performance monitoring decision process flowchart (Figure 2-5) is an effective tool for screening performance monitoring candidates and assisting in the initial selection of performance monitoring locations. However, it does not address other detailed elements of designing and implementing a monitoring project. Monitoring schedules must be developed, analytes of concern must be identified, sampling protocols must be designed, data evaluation methods must be selected, and an action response or notification process must be defined. In an effort to formalize the performance monitoring process, a template (see Figure 2-6) has been developed to address all aspects of the performance monitoring decision. The template guides the performance monitoring process from start to end including: 1) selecting projects to monitor, 2) locating monitoring locations, 3) scheduling monitoring activities, 4) identifying the contaminants of concern (e.g., AoI), 5) selecting data collection protocols, 6) determining the most effective method of evaluating data, and 7) setting up a reporting protocol. Documentation produced by this process serves as both specifications (e.g., DQOs, monitoring requirements) and records for performance monitoring decisions.

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2.3.3.2 Performance Monitoring Implementation Options[18]

Two distinct monitoring options have been identified for implementation of performance monitoring. Whether the "Minimal" or "Enhanced" option is selected depends on the primary monitoring objective. The minimal monitoring option seeks only to identify location specific changes in water quality. The enhanced monitoring option also allows for the determination of the specific impact of a particular project at a downstream POE or POC.

Minimal Monitoring Option: Determine Changes in Water Quality at Specific Location

This option would involve installation of automated samplers only. No attempt would be made to install flow control structures to allow for flow measurement. Automated samplers would collect time-paced composite samples that would be analyzed for the location-specific AoIs. Analytical results would be statistically compared against a baseline determined from previous data points or some other baseline relative to the POE action levels (e.g. a multiple of the action level) to determine project performance. This option involves minimal construction, equipment, and analytical cost. However, data collected through this option would not be directly applicable to POE or POC source evaluations.

Enhanced Monitoring Option: Determine Changes in Water Quality at Specific Location with Applicability to RFCA POE/POC Source Evaluations

This option would involve installation of automated samplers and flow control structures to allow for flow measurement. Automated samplers would collect flow-paced composite samples (as for POEs and POCs) that would be analyzed for the location-specific analytes of interest. Analytical results would be statistically compared against a baseline determined from previous data points or some other baseline relative to the POE action levels (e.g., a multiple of the action level) to determine project performance. This option may involve significant construction and equipment cost depending on location. However, data collected through this option would be directly applicable to POE and POC source evaluations. Determination of constituent loads and correlation/trend evaluation would aid in POE/POC source evaluations.

[18] Many of the data evaluation items for Option 2 do not correspond directly to the intent of the Performance Monitoring decision rule as currently defined, but are items that fall under the Source Evaluation decision rule that can result from enhanced Performance Monitoring.

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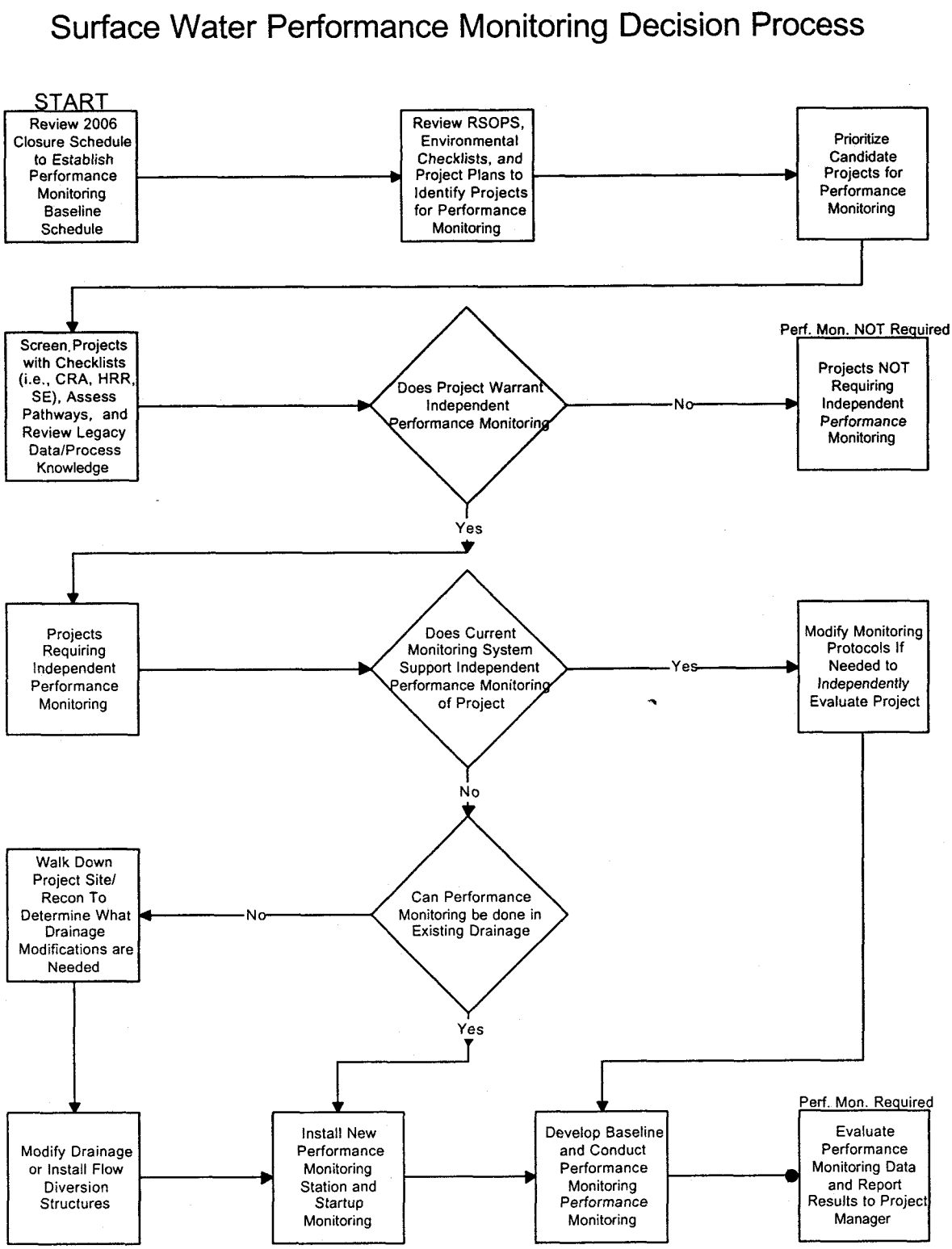

Figure 2-5. Surface Water Performance Monitoring Decision Process

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Surface Water Performance Monitoring Template

Which Projects?

Identify Projects for Performance Monitoring

Identify projects (i.e., building [or cluster] D&D and remediation actions) for independent performance monitoring. Select those projects that pose a significant risk to surface-water quality and that can not be adequately monitored by the existing monitoring stations.

→ *Projects*

Where?

Locate Performance Monitoring Outfalls

Locate monitoring outfalls based on suitability for independent monitoring. Consider whether a location will collect the desired flow, uniquely represent a potential contaminant source, or interfer with project activities.

→ *Locations*

When do we Start?

Schedule Monitoring Activities

Start monitoring at least 18 months in advance decontamination & decommissioning activities as indicated by the current Site Closure schedule. Target sampler pacing to collect 10-15 samples under various hydrologic conditions to develop a water quality baseline.

→ *Schedules*

What Analytes?

Identify the Analytes of Interest

Determine the list of contaminants of concern to identify analytes of interest. Base selection on process knowledge, historical release reports, legacy data reviews, and reconnaissance sampling if necessary.

→ *Analytes*

How do we Monitor?

Select Sampling Protocols

Select a sampling methodology that will confidently detect changes in water quality. Select minimal or enhanced monitoirng option. Develop an adaptable monitoring protocol to allow for changes as a water quality baseline is developed.

→ *Protocols*

How do Evaluate Data?

Select Data Analyses Methodologies

Select a data analyses methodology that will confidently detect changes in water quality. The methodology must be flexible to allow for changes as a water quality baseline is developed.

→ *Methods*

How do we Notify?

Establish Special Reporting/Action Response Protocols

Performance monitoring results are published in the RFETS Quarterly Environmental Monitoring Report. Special reporting and notification requirements should be determined in consultation with the project manager and specified in the project plans.

→ *Reports*

Figure 2-6. Template for Surface Water Performance Monitoring

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2.3.3.3 Integrated Approach

The selection of surface water performance monitoring locations will be determined in conjunction with the planned configuration of the groundwater monitoring network. A draft integrated surface water/groundwater performance monitoring sampling and analysis plan will be prepared for the project manager for inclusion when preparing the Project Management Plan. Data analysis and evaluation techniques will be recommended by water monitoring personnel. Reporting and notification protocols will be jointly determined between the D&D project manager and water monitoring personnel as needed to ensure the protection of downstream water quality.

Problem Statement:

This section addresses monitoring the performance of specific activities[19] on-Site for the release of contaminants to the environment. In general, performance monitoring of activities within the IA is achieved through the NSD and POE monitoring (see Sections 2.4.1 and 2.4.2 for details). Project-specific performance monitoring requirements (if necessary) will be detailed in a project plan as determined by the review and approval process for those projects that pose a concern for a specific contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives downstream. The performance monitoring protocols are also detailed annually in the Automated Surface Water Monitoring Work Plan. For example, performance monitoring for specific projects may be needed for:

- Building D&D Activities: The review and approval process for a D&D action may identify the need for performance monitoring specific to that action.
- Remedial Actions: Specific monitoring requirements may be identified for specific ER activities. For example, performance monitoring for RFETS's operating groundwater plume treatment systems is specified in the related work plans (i.e., *Final Mound Site Plume Decision Document, Final Proposed Action Memorandum for the East Trenches Plume, Final Solar Ponds Plume Decision Document*).
- Other Closure Activities: Specific performance monitoring may be needed for certain activities if other monitoring described in this IMP fails to provide adequate assurance of protecting the environment and public health.
- Off Normal Conditions: Monitoring of remedies intended to control contaminant transport in surface water runoff may be required. For example, when a BMP (barrier, trap, filter, or other watershed improvement) is installed to control a potential source of Pu-contaminated runoff, RFETS would like to determine the BMP effectiveness so that resources may be allocated where they are most effective.

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

[19] This is project specific versus the global monitoring (NSD and POE) of the IA discussed in Sections 2.4.1 and 2.4.2.

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Boundaries:

Spatial: Performance monitoring can occur anywhere within RFETS surface water drainage areas (especially within the IA), downstream from a best management practice (BMP) area, remediation, or high-risk activity.

Temporal: Generally, monitoring is initiated with enough time prior to project activities such that 10 - 15 samples over varying flow rates can be collected (preferably 18 months prior to project initiation[20]). Results from these samples are used to establish a baseline for the sub-drainage. Monitoring continues during the activity attempting to collect one sample per month. After project completion, monitoring continues long enough to determine any beneficial impacts to surface water quality.

Data Types and Frequency:

The types of data to be collected must be specified in the project plan. Analyte suites are generally determined by the analytes of concern associated with a specific activity or location. Generally, automated samples are flow-paced composites collected continuously during all flow conditions. However, protocols may be modified depending on the specific conditions for a monitoring location or drainage basin. For example, a location with substantial groundwater seepage or a periodic footing drain discharge may warrant monitoring of those flows. Regardless, the sampling protocols are designed to accurately characterize existing flows and confidently monitor for changes during the project activities.

With the administrative transfer of OU2 monitoring to the IMP to facilitate closeout of OU2 IM/IRA activities, quarterly grab samples are collected and analyzed as specified in the OU2 closure document. Reporting for these locations will be included in the quarterly report and no longer be reported in the Consolidated Water Treatment Facility report.

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% upper tolerance level (UTL) of baseline—

THEN RFETS will evaluate the specific activity to improve performance. Evaluations will address persistence, trends, and risk of action level exceedances at POEs.

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

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

[20] Due to the dynamic nature of Site cleanup, initiation of performance monitoring 18 months prior to an activity is rarely achieved. However, additional samples are often collected at an increased rate to establish baseline prior to initiation of project activities.

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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 details will be specific to the project. The anticipated performance monitoring locations to be operated during FY03 are presented in Table 2-10. Analyte suites and sample collection protocols are project-specific and are contained in the individual project plans for automated locations. This same detailed information can be found in the annual *RFETS Automated Surface Water Monitoring Work Plan* which can be obtained from Site Document Control. The actual performance monitoring for FY03 will depend on RFETS closure activities and schedules.

Table 2-10 Anticipated FY03 Performance Monitoring Locations

Location Code	Location Description	Project	Supporting Documentation
GS21 (to be re-installed)	Culvert SE of B664	B664 D&D activities	Automated SW Monitoring Work Plan
GS22	Outfall to South Interceptor Ditch draining 400 area	400 Area D&D Activities	Automated SW Monitoring Work Plan
GS27	Small ditch NW of B884	D&D of B889; Watershed Improvements evaluation; also serves as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS28	Small ditch NW of B865	B883 and B865 D&D activities; Also serves as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS32	Corrugated metal pipe (1.5 ft) north of Solar Ponds in PA draining B779 area	D&D of B779, B777, Solar ponds	Automated SW Monitoring Work Plan
GS39	Corrugated metal pipe (1.0 ft) north of 904 Pad draining 903/904 Pads and Contractor Yard areas	Remediation activities for 903 Pad; Also serves as Source Location monitoring station	Automated SW Monitoring Work Plan

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Location Code	Location Description	Project	Supporting Documentation
		for GS10 Source Evaluation	
GS40	Outfall E of 10th St. E of 750 Pad	700 Area D&D activities; Also serves as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS42	Drainage E of 903 Pad	903 Pad Remediation	Automated SW Monitoring Work Plan; Project Plan for Surface water Performance Monitoring of the 903 Pad and Lip Area
GS43	Small ditch NE of B886	D&D of B886; Also serves as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS44	Corrugated metal pipe between T771F and T771L	D&D of B771/774	Automated SW Monitoring Work Plan
GS49	Drainage ditch NW of B566	D&D of B566 and B776	Automated SW Monitoring Work Plan
GS50	Drainage ditch N of B990	Solar Ponds Remediation; Also serves as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS51	Drainage S of 903 Pad	903 Pad Remediation	Automated SW Monitoring Work Plan; Project Plan for Surface water Performance Monitoring of the 903 Pad and Lip Area
GS52	Drainage swale SSE of 903 Pad	903 Pad Remediation	Automated SW Monitoring Work Plan; Project Plan for Surface water Performance Monitoring of the 903 Pad and Lip Area
GS53	Drainage swale SE of 903 Pad	903 Pad Remediation	Automated SW Monitoring Work Plan; Project Plan for Surface water Performance Monitoring of the 903 Pad and Lip Area
GS54	Drainage swale ESE of	903 Pad Remediation	Automated SW

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Location Code	Location Description	Project	Supporting Documentation
	903 Pad		Monitoring Work Plan; Project Plan for Surface water Performance Monitoring of the 903 Pad and Lip Area
GS55	Outfall to SID draining B881 Area	B881 and B883 D&D activities	Automated SW Monitoring Work Plan
GS56	No name Gulch below Landfill Pond	Present Landfill closure activities	Automated SW Monitoring Work Plan
GS57	Ditch NE of B444 Area	B444 and 400 Area D&D activities; also serves as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS59	Woman Creek 900 feet upstream of Antelope Springs Cr. confluence	Old Landfill closure activities	Automated SW Monitoring Work Plan
GS60; to be installed	Confluence of ditches NE of B664 area and Conex yard	B664 D&D activities; will also serve as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
GS61; to be installed	Ditch NW of B559	B559 D&D activities	Automated SW Monitoring Work Plan
GS62; to be installed	To be determined; drainage area S of B371	B371/374 D&D activities	Automated SW Monitoring Work Plan
GS63; to be installed	Ditch N of B371 along former PA Perimeter Road	B371/374 D&D activities	Automated SW Monitoring Work Plan
SW021; to be installed	Outlet of culvert under former PSZ E of B991	B991 D&D activities; will also serve as Source Location monitoring station for GS10 Source Evaluation	Automated SW Monitoring Work Plan
SW036	South Interceptor Ditch downstream of Old Landfill	Old Landfill closure activities	Automated SW Monitoring Work Plan
SW055	Ditch along dirt road S of 903 Pad at Inner Security Fence	903 Pad Remediation	Automated SW Monitoring Work Plan; Project Plan for Surface water Performance Monitoring of the 903

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Location Code	Location Description	Project	Supporting Documentation
			Pad and Lip Area
SW061[a]	S. Walnut Creek upstream of B995	OU2 Closure	Final Surface Water Interim Measures/Interim Remedial Action Plan/ Environmental Assessment and Decision Document, S. Walnut Creek Basin
SW119	Drainage ditch N of Solar Ponds along PA perimeter road	Solar Ponds closure activities	Automated SW Monitoring Work Plan
SW120	Drainage ditch N of Solar Ponds along PA perimeter road	D&D of B771/774; Solar Ponds closure activities	Automated SW Monitoring Work Plan
SW132[a]	S. Walnut Creek, outfall of culvert draining 700 and 900 Areas, south of B995	OU2 Closure	Final Surface Water IM/IRA Plan/ Environmental Assessment and Decision Document, S. Walnut Creek Basin

[a] The inclusion of SW061 and SW132 monitoring in the IMP completes the OU2 IM/IRA administrative transfer of former OU2 monitoring.

2.3.3.4 CDPHE Performance Monitoring for Mound and East Trenches Plume Treatment Systems

Problem Statement:

The Mound and East Trenches groundwater contamination plumes contain VOCs. The concentrations of some metals appear elevated in these plume areas.

Groundwater collection and treatment systems have been installed, and the treatment appears to be effective. However, it is possible that some contaminated groundwater either was already downgradient of the collection systems before they were installed, or, that some groundwater may be bypassing the collection trenches. There is no instream monitoring specified in the Decision Documents for these systems that can either verify or disprove this. In order to insure that stream standards are being attained, monitoring for VOCs and selected metals will be done in South Walnut Creek in the immediate vicinity of the location where the groundwater contamination plumes may be intersecting the stream.

Information Types & Frequencies:

Monitoring will be done for VOCs and metals on a quarterly basis. The VOC testing will be done such that all VOCs known to exist within the plumes will be included in the analyses. Metals monitoring will be done using a list of metals that CDPHE will uniformly test for at all locations where metals are monitored. Analyses will be performed for these metals: Ag, Cu, Mn, Ni, Se (dissolved), and As, Be, Cd, Cr, Fe, Li (total). Also, in order to obtain at least a minimal

assessment of hardness – which is required for metals standards calculations, hardness will also be monitored at this location.

Boundaries:

Spatial: South Walnut Creek in the immediate vicinity of the location where the groundwater contamination plumes may be intersecting the stream.

Temporal: Until it has been demonstrated that instream VOC and metals concentrations are below stream *standards over a period of at least three years.*

Decision Statement:

IF: VOC concentrations or metals concentrations exceed stream standards

THEN: The monitoring frequency and number of sampling locations may be increased

ELSE: VOC monitoring will be discontinued after a period of three years, and metals concentrations will be reviewed using the following Decision Rule.

IF: Metals concentrations are lower than stream standards, but significantly higher than the concentrations found at other locations on RFETS

THEN: Further investigation of instream concentrations and the cause for the unusually high concentrations will be considered

ELSE: Metals monitoring may be discontinued after a period of three years.

Acceptable Decision Errors

The contaminant sources being investigated are groundwater plumes. If the plumes intersect the stream, a variation in instream concentrations will likely be due to seasonal hydrologic conditions. Therefore, the quarterly sampling should be sufficient to assess the full range of instream concentrations.

Monitoring Requirements:

Grab samples will be collected on a quarterly basis. The precise monitoring location still needs to be identified, but will be in the vicinity of Ponds B-3 or B-4 on South Walnut Creek. The intention is to obtain samples from the stream, so that there would be no opportunity for volatilization in the ponds. But, it may not be possible to access the stream in this area. If that is the case, samples will be collected from either Pond B-3 or B-4, again depending upon access considerations.

2.3.3.5 CDPHE Performance Monitoring for the Solar Pond Plume Treatment System

Problem Statement:

The Solar Ponds groundwater contamination plume contains high levels of nitrates and U, and lower concentrations of several other metals. Groundwater collection and treatment systems have been installed, and the treatment appears to be effective. However, it is possible that some contaminated groundwater either was already downgradient of the collection system before it was installed, or, that some groundwater may be bypassing the collection trench.

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While RFETS monitors instream nitrate and U concentrations, CDPHE will perform instream monitoring for metals. This data will be used in order to insure that stream standards are being attained.

Information Types & Frequencies:

Monitoring will be done for metals on a quarterly basis. Analyses will also be performed for these metals: Ag, Cu, Mn, Ni, Se (dissolved), and As, Be, Cd, Cr, Fe, Li (total). Also, in order to obtain at least a minimal assessment of hardness – which is required for metals standards calculations, hardness will also be monitored at this location.

Boundaries:

Spatial: North Walnut Creek in the immediate vicinity of the location where the Solar Ponds Plume may be intersecting the stream.

Temporal: Until it has been demonstrated that metals standards are being attained and that the metals concentrations at the most downgradient portion of the Solar Ponds Plume (which may be at the intersection with the collection trench) are declining.

Decision Statement:

IF: Metals concentrations exceed stream standards

THEN: The monitoring frequency and number of sampling locations may be increased

ELSE: Metals monitoring will be continued until it has been demonstrated that metals concentrations at the most downgradient portion of the Solar Ponds Plume (which may be at the intersection with the collection trench) are declining.

Acceptable Decision Errors

The contaminant source being investigated is a groundwater plume. If the plume is intersecting the stream, any variation in instream concentrations will likely be due to seasonal hydrologic conditions. Therefore, quarterly sampling should be sufficient to assess the full range of instream concentrations.

Monitoring Requirements:

Grab samples will be collected on a quarterly basis at monitoring location GS-13.

2.3.4 NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM PERMIT MONITORING

The NPDES permit program controls the release of pollutants into the waters of the United States, and requires routine monitoring of point source discharges and reporting of results. The Site's first NPDES permit was issued by EPA in 1974. The current permit was originally reissued by EPA in 1984, expired in 1989, administratively extended, and again renewed in 2000. Monitoring for NPDES compliance is prescriptively required by EPA, and is not covered by the IMP process or detailed in this document. Please refer to the current permit for specific monitoring requirements.

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Renewed Permit:

The renewal permit for RFETS identifies one monitoring point for control of discharges, the WWTP (B995) effluent. The NPDES/Federal Facility Compliance Act (FFCA) was terminated by issuance of the 2000 permit renewal. Modifications included the elimination of discharge points except for the WWTP discharge point. The other previously permitted discharge locations will be regulated under CERCLA via the RFCA. Additional expanded scope includes plans and procedures for operations of influent/effluent storage tanks, influent monitoring at WWTP, internal wastestream monitoring, stormwater monitoring, stormwater pollution prevention plan, and WWTP influent real-time radiological monitoring feasibility study. The renewed stormwater monitoring provisions result from new regulations promulgated since the 1984 permit renewal.

2.4 MONITORING OBJECTIVES FOR 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 IA to Segment 5 waters upstream of the terminal ponds). These discharges are the major transport pathways available for contaminants leaving the IA. Ongoing activities and remediation tasks at RFETS could create new contaminant source areas within and around the IA 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 possibly off-Site.

RFETS 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 acute changes in contaminant runoff from significant new sources within the IA.

2.4.1 NEW SOURCE DETECTION MONITORING

The NSD Monitoring objective provides comprehensive coverage of the entire IA but is not specifically focused on individual actions within the IA. Performance monitoring of specific activities within the IA (or elsewhere) may be carried out under the Performance Monitoring objective. This NSD objective monitors the performance of all remedial activities within the IA with respect to their impact on surface waters. However, it does not necessarily identify and locate a specific source within the IA.[21] This monitoring objective provides for monitoring of all main drainages from the IA into the three main channels of Stream Segment 5.[22]

This NSD monitoring is one of many possible spill response actions, but spill response is not the primary focus of the NSD Monitoring objective. Sampling and analysis of spills is addressed in

[21] Location of a specific source would be performed under the Source Location Monitoring objective in Section 2.2.2.

[22] RFETS also desires early detection of smaller releases within the IA, by monitoring closer to the anticipated sources during D&D activities. This will be achieved through the Performance Monitoring objective (see Section 2.3.3).

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other Site planning documents, such as the *Spill Prevention, Control, and Countermeasures Plan* (21000-SPCC) (RMRS, 1999).

Data Types and Frequency:

This decision requires contaminant concentration data from surface water samples taken at permanent monitoring locations located on the five main surface water pathways to RFETS detention ponds. Analyses are performed for each of the contaminants and parameters listed below in order to establish a baseline. After a baseline has been established, evaluations will be performed as required by the decision rules. The basis for selecting these analytes of concern and indicator parameters is described below.

- Isotopic Pu, U, and Am are primary analytes of concern.
- Turbidity, pH, nitrate (NO3), and conductivity are measurements performed continuously because they are inexpensive per measurement and can be used as real-time indicators to provide or negate reasonable cause to analyze for other specific contaminants.[23]
- Turbidity may indicate increased contaminant loads in general and increased Pu and Am specifically (Pu and Am in surface water are generally bound to particulates).
- pH can be used to detect an acid or caustic spill.
- NO_3 may be useful in detection of chemical spills that include plutonium nitrate.
- Conductivity can be used to corroborate a pH reading and to detect salt solution spills or metal spills such as Cr, Be, Ag, or Cd.
- Precipitation can be used to determine whether a flow event is rain/snow runoff or a spill. Precipitation data is collected at twelve locations across RFETS. Effective precipitation for a given monitoring location drainage can be calculated.
- Water flow rate is needed to identify an event, trigger an automatic sampler, control the flow-paced sampling, and evaluate the magnitude of the spill or contaminant source (mass loading).
- Small changes to baseflow not attributable to rain or snowmelt or an unusual runoff hydrograph shape may indicate a spill.

This monitoring objective is limited to information collected at the IA boundary, as represented by surface water monitoring stations SW022, SW091, SW093, SW027, and GS10[24] (see Figure 2-4). This monitoring focuses on runoff from the three main drainages leaving the IA: North Walnut Creek, South Walnut Creek, and the South Interceptor Ditch/Pond C-2 drainage (see Figures 2-3 and 2-4). Normally, SW022 waters are subsequently monitored at GS10, so there is some redundancy in this pair 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 to determine the location of any new source detected at GS10.

[23] Due to the intermittent flows at SW022 and SW091, real-time parameter monitoring is not feasible.

[24] Subdrainage monitoring stations within the IA are used for performance monitoring and source location but are excluded from the planned monitoring for this NSD decision rule.

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For SW091, sampling is event-specific, focused on the time period during which the first flush conditions prevail; specifically, the time period during the rising limb of a direct runoff hydrograph after a storm event. The automatic sampler is triggered when direct runoff is detected at the location [for example, >0.1 cubic feet per second (cfs); location specific].[25] The sample is analyzed when the runoff volume (for example, >25,000 gallons) is sufficient such that a flow-paced composite sample of sufficient volume (in a 15-L container) is representative of the first flush (presumed water-quality worst case). Seasonal adjustments are applied to define the conditions that represent first flush and direct runoff. Professional judgement will be used to select a representative sample for each month for analysis, when a sample is available for that month at that station. Samples are selected to provide analytical results for rising limbs with varying flow rates and runoff characteristics. This monitoring pushes the limits of the sampling equipment, and collection of one representative sample per month is an appropriate goal.

For SW093, GS10, and SW027, the information used in the NSD objective will be the same data as collected from the continuous flow paced sampling used for monitoring Segment 5 action levels (see Section 2.4.2). These POE stations have baseflow, whereas the other two stations do not. Sampling protocols for SW022 are also continuous flow-paced with the data being specifically collected in support of the NSD decision rule.

Only surface water runoff from the IA is included, (i.e., baseflow, stormwater runoff flow, and spills to surface water). Spills are only included in this NSD monitoring as a secondary monitoring objective if an increase in flow rate is detected and cannot be attributed to precipitation, snow melt, or other previously monitored discharge. However, other management controls (e.g., SPCC/BMP) address monitoring of spills as a primary objective. These locations also provide confirmation that containment measures for spills or accidental discharges have been effective through monitoring of the real-time indicator parameters and subsequent analyses of collected samples.

Indicator monitoring will be performed for the parameters specified at the top of each column of Table 2-11. The first three columns are AoIs monitored directly through sample laboratory analysis. Although these three columns and rows have a different relationship than the others, they have been included so that monitored parameters are shown on the same table. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes (per measurement) in lieu of analyzing for the AoIs identified at the left of each row. If a significant increase is detected in any one of these indicator parameters, then there is reasonable cause to suspect the presence of the AoI 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 RFETS would have reasonable cause to suspect the presence of plutonium nitrate, extreme pH, cadmium 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 AoIs, then RFETS could perform additional analytical procedures specifically for the AoI.

[25] 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). The parameters are selected such that representative samples can be collected on the rising limb for varying flow rates, runoff conditions, and seasons.

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Table 2-11 Screening for New Source Detection AoIs vs. Indicator Parameters

AoIs	Routinely Monitored Parameters					
	Monitored AoI	Indicator Parameters for AoI				
		Turbidity	pH	Conductivity	NO_3	Flow Rate and Precipitation
Pu	X	X			X	X
U	X					X
Am	X	X				X
Turbidity	X	X				X
pH			X		X	X
Conductivity				X		X
NO_3				X	X	X
Cr			X	X	X	X
Be				X		X
Ag				X		X
Cd				X	X	X

Decision Statement:

Screening for reasonable cause to suspect a new source:

IF The mean concentration of any of the screening indicator variables in Table 2-11 exceeds the 95% UTL of baseline for that variable—

THEN RFETS 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 at POEs.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

— RFETS desires detection through sampling of runoff events within a month of a significant new contaminant release.[26] This is achieved through sampling all major drainages from the IA during high flow and analyzing approximately one sample per station per month. The Site must monitor runoff events at four locations (SW093, SW091, GS10, and SW027) to provide an acceptable level of confidence that significant events will be observed. Monitoring at SW022 is not required for the desired confidence.

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

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- 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, it will provide adequate confidence of new source detection and invoke the actions specified by the decision rule.

Monitoring Requirements:

Table 2-12 presents detailed monitoring requirements for this decision rule. Analytical and real-time, water-quality probe indicator monitored parameters are in Table 2-11.

Table 2-12 Monitoring Requirements (Number of Samples) for New Source Detection

Parameter	Monitoring Station				
	SW093	SW091	GS10	SW027	SW022
Sample Analyses					
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
Real-Time, Water-Quality Probe Indicator Parameters					
pH	15-min	NA	15-min	15-min	NA
Specific Conductivity	15-min	NA	15-min	15-min	NA
Turbidity	15-min	NA	15-min	15-min	NA
Nitrate	15-min	NA	15-min	15-min	NA
Flow	15-min	15-min	15-min	15-min	15-min
Precipitation	Site-wide locations				

[a] Only SW091 will be monitored for the rising limb of the hydrograph, as originally specified for this decision rule. Starting in FY00, sample protocols at station SW022 were converted to flow paced for load calculation purposes in support of the GS10 source evaluation effort. Stations SW093, SW027, and GS10 are the Segment 5 action level (POE) monitoring stations. At these Segment 5 stations, NSD will be performed by statistically testing the flow-paced sample results. The same test criterion will be used, except that flow-paced samples will be tested against flow-paced variability. These locations will collect more than the target 12 samples for the NSD objective. All results collected at these locations under the POE objectives will be used in the NSD objective.

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2.4.2 STREAM SEGMENT 5/POINT OF EVALUATION MONITORING

This monitoring objective deals with POE monitoring of Segment 5 for adherence with RFCA action levels. RFCA provides specific criteria for virtually every possible contaminant for the main stream channels of Segment 5. In Table V (see Appendix F), the DQO team identified a subset of those contaminants that are of sufficient interest to warrant monitoring. Figure 2-3 illustrates the stream segments, and Figure 2-4 shows the monitoring points used for various decisions.

Responses to exceedances at POEs are different than those associated with contaminated runoff before it reaches Segment 5 or after it enters Segment 4. IA monitoring upgradient of Segment 5 is designed to detect new contaminant sources within the IA. Downstream, Segment 4 is monitored at POCs to determine compliance with RFCA standards. This subsection of the document deals with POE monitoring of Segment 5 for compliance with RFCA action levels.

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

Data Types and Frequency:

The necessary decision inputs are those analytes specified as the Segment 5 AoIs per Table V (see Appendix F), as sampled at the POEs for Stream Segment 5. Segment 5 includes the terminal ponds (A-4 and B-5), and the main stream channels of North and South Walnut Creek, Pond C-2, and the SID. Monitoring will be performed for Stream Segment 5 only as represented by POEs SW093, GS10, SW027, and 995POE (see Figure 2-4).

Sampling for AoIs at POEs is performed by collecting continuous flow-paced composite samples. Indicator parameters are measured using real-time, water-quality probes. These AoIs are evaluated using 30-day moving averages, as specified in RFCA[27] and implemented by the ALF or DQO working groups involving consensus of all parties to RFCA. Pu, Am, U, Be, Cr, dissolved Ag, and dissolved Cd are evaluated using volume-weighted 30-day moving averages at these POEs.[28]

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 of action levels may have occurred (i.e., within 30

[27] 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.

[28] The 30-day average for a particular day is calculated as a volume-weighted average of a "window" of time containing the previous 30-days which had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place at the end of that day). Therefore, there are 365 (366 in a leap year) 30-day moving averages for a location which flows all year. At locations that monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

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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.

Decision Statement:

IF The appropriate summary statistic[29] for any AoI[30] in the main stream channels of Stream Segment 5, as monitored at the designated POEs,[31] exceeds the appropriate RFCA action level—

THEN RFETS must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[32] if appropriate.[33]

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

— The flow-paced monitoring method ensures that significant events will be sampled. This method involves collecting a fixed volume grab sample [e.g., 200 milliliters (ml) or 1 L] into the composite sample container (e.g., 15 - 22 L) as each Nth volume of streamflow [e.g., 500 L or 73,000 ft^3] passes the monitoring point. Approximately 75 to 110 grab samples can be composited in the composite sample container with sufficient grab-sample volume repeatability.

- Acceptable Decision Error Rates for Statistical Sampling Design:

— Variability is not known for flow-paced monitoring. Therefore, decision error rates cannot be estimated. Sampling design was based, instead, on historical flow and professional judgement.

The decision error types and consequences for Segment 5 are presented in Table 2-13.

Statisticians from the Pacific Northwest National Laboratory (PNNL) evaluated sampling protocol designs based on the decision error limitations shown in Table 2-13, but historical data were inadequate to determine the number of samples needed to meet these decision error

[29] Appropriate action levels and standards for volume-weighted, 30-day moving averages, are specified for individual contaminants in RFCA.
[30] AoIs are specified in Table V in Appendix F.
[31] POE monitoring stations for Segment 5 are designated in Figure 2-4.
[32] 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.
[33] 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.

Table 2-13 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 AoIs are above RFCA action levels but data fail to detect this, RFETS may not be compliant with RFCA.
Incorrect determination that an exceedance has occurred.	RFETS 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.

limitations.[34] 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 2-13) after flow-paced data become available.

The decision error limitations shown in Table 2-14 were not used to design and specify the FY02 monitoring targets. They are retained here, however, for use in future sampling designs when variability becomes known for the flow-paced sampling method. Note that the decision error limitations shown in Table 2-14 are based on the assumption that failure to detect an exceedance is more important than falsely reporting an exceedance when no exceedance has occurred.

Table 2-14 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 that Table 2-14 is retained for future use, but was not used for FY03 decision rules. DQO team discussed this issue, but consensus was not achieved. When flow-paced data become available and the sampling design is reevaluated, this issue will be resolved.

Monitoring Targets:

[34] Actually, the statisticians were able to provide sample sizes based on historical data variability, but these sample sizes were impracticably large due to the high variability in historical sampling methods (storm flow samples taken from the rising limb of the hydrograph). Because the monitoring at POEs will use, in part, the flow-paced method (with much lower variability expected) sample sizes based on historical variability would be inappropriate.

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The recommended monitoring design for RFETS is to take samples for FY03, as specified in Table 2-15, and analyze each sample for the Segment 5 AoIs specified in Table V of Appendix F, attempting to take no less than one sample per quarter and no more than four sequential samples per month from each of the four monitoring points for each month. The ideal sampling rate is one 15-L composite sample for each 500,000 gallons of streamflow, and each 15-L composite sample should comprise about 50 flow-paced grab samples.

For the 995POE, total composite sample collection was designed to be comparable to that of both GS10 and SW093. The 995POE is targeted to collect 36 composite samples per year. However, in consideration of the low variability of water quality from the WWTP, groups of three composite samples will be combined for analysis. Aliquots will be held from each of the three composite sample for subsequent analysis should action levels be exceeded.

Table 2-15 presents the FY03 revised number of samples per month for Segment 5 POEs. The original recommendations from statisticians at PNNL were updated using recent flow data to collect more representative numbers of samples each month. There are both practical and statistical advantages to this sample allocation design. Averaging a larger number of samples is more expensive, but it protects RFETS from regulatory action in response to a spurious non-representative monitoring result.

There are secondary advantages to this monitoring plan. A larger number of samples allows for 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 moving average specified in RFCA but allows some flexibility. Where there is no significant flow, there may be no samples completed within a 30-day period, and where the flows, loads, and variability are expected to be higher, sample numbers are also higher. Note that flow-paced monitoring will continue during dry periods, even though flows may be so low that it takes more than 30 days to fill the composite sample container.

Alternative Minimum Required Monitoring:

Although one sample per month would be adequate to demonstrate RFETS's compliance status to EPA or CDPHE, there is a 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 RFETS may elect to gather samples as specified in Table 2-15 but analyze only one composite of those independent and sequential samples per month per station. Additional analyses could then be performed only if an exceedance is suggested in the composite and 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:

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Table 2-15 Monitoring Targets (Annual Number of Composite Samples) for Segment 5 POEs

Month	Number of Samples			
	SW093	GS10	SW027	995POE
October	3	3	1	3
November	3	2	0	3
December	2	1	0	3
January	2	1	1	2
February	2	2	0	2
March	3	3	1	3
April	4	4	4	4
May	4	4	4	4
June	3	3	2	3
July	3	4	1	3
August	4	4	2	3
September	3	3	1	3
Annual Total	36	34	17	36
Note: Total samples for all four stations = 123				

- Only one exceedance will be established for a single AoI at all three POEs 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 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, POEs SW093, GS10, and SW027, are detailed in Table 2-16.[35] For the 995 POE, the analytical targets are detailed in Table 2-17.

[35] 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

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Table 2-16 Estimated Minimum Segment 5 Action Level Monitoring Requirements for POE GS10, SW093, and SW027

Analyses	Sampling Protocol
Pu	3(1+11) = 36
U	3 x 12 = 36
Am	3 x 12 = 36
Be	3 x 12 = 36
Cr	3 x 12 = 36
Ag	3 x 12 = 36
Cd	3 x 12 = 36
Hardness	3 x 12 = 36
pH	Continuous
Conductivity	Continuous
Turbidity	Continuous
Nitrate	Continuous
Flow	Continuous

Table 2-17 Analytical Targets for 995 POE

Analyses	Sampling Protocol
Pu	36 ÷ 3 = 12
Am	36 ÷ 3 = 12
U	36 ÷ 3 = 12
Tritium	36 ÷ 3 = 12

During FY03, the Site plans to replace the existing flumes at two POE locations, GS10 and SW093. The flumes have been installed for many years and are showing signs of deterioration. Based on the relative importance of the locations to the overall Site monitoring goals, these flumes warrant replacement.

Although these locations continue to collect flow data of acceptable accuracy, concerns over continued deterioration and increased maintenance have initiated a project to replace these flumes. The construction phase of this project is scheduled to take place during the first quarter of FY03. During construction, the equipment at the existing locations will be temporarily removed and flows will be diverted around the area through pumping or temporary ditches. Due

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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to the importance of the uninterrupted operation of POEs to demonstrate Site compliance with RFCA water-quality action levels and standards, temporary monitoring points will be established downstream of the construction areas to demonstrate protection of surface water quality. The following sections outline the location-specific flume replacement and the temporary monitoring protocols.

For GS10:

The existing Parshall flume will be replaced with a single 3-foot H flume. This flume was chosen based on expected flow rates to be measured, the ability to pass debris, and a wide range of accurate flow measurement. The new flume will be capable of accurately measuring flows from nearly zero to 31 cfs. Although 31 cfs is below many of the historically estimated peak flow rates, the reduction of impervious surfaces as the Site moves toward closure will result in smaller peak flow rates. Consultation with the Site Water Balance modeling team has confirmed this assumption.

To facilitate the collection of samples to be used for comparison with the applicable RFCA action levels during construction, the Site has established a temporary monitoring location on South Walnut Creek at the diversion structure for the B-1 Bypass (30 feet downstream of GS10; state plane 2086770, 750326). This location has been given the identifier GS10T. Although no flow control structure will be installed, the Site is currently collecting stage data to be correlated with the flow data collected at the existing GS10 flume. A rating will be established for the dual diversion-structure head gates such that flow measurements can be continuously calculated from stage measurements at the diversion. The GS10T flow meter will be programmed with the rating in order to control the automatic sampler to collect continuous flow-paced composite samples. These samples will be collected using the identical protocols established for POE GS10. Although analytical results from this location will be uploaded to the SWD with the identifier GS10T, these results will be used to calculate the applicable 30-day moving average values for POE GS10. Reporting of data collected at GS10T will be noted as appropriate. Once construction is complete, the equipment will be re-installed at GS10. The intent is to maintain *uninterrupted* and *representative* surface water monitoring during all phases of construction.

For SW093:

The existing weir/flume will be replaced with a single 3-foot H flume. This flume was chosen based on expected flow rates to be measured, the ability to pass debris, and a wide range of accurate flow measurement. The new flume will be capable of accurately measuring flows from nearly zero to 31 cfs. Although 31 cfs is below many of the historically estimated peak flow rates, the reduction of impervious surfaces as the Site moves toward closure will result in smaller peak flow rates. Consultation with the Site Water Balance modeling team has confirmed this assumption.

To facilitate the collection of samples to be used for comparison with the applicable RFCA action levels during construction, the Site has established a temporary monitoring location on North Walnut Creek 165 feet downstream of SW093 (state plane 2085176, 751788). This location has been given the identifier GS10T. Although no flow control structure will be installed, the Site is currently collecting stage data to be correlated with the flow data collected at the existing SW093 weir/flume. A rating will be established for the creek channel such that flow measurements can be continuously calculated from stage measurements at the channel center. The SW093T flow meter will be programmed with the rating in order to control the automatic

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sampler to collect continuous flow-paced composite samples. These samples will be collected using the identical protocols established for POE SW093. Although analytical results from this location will be uploaded to the SWD with the identifier SW093T, these results will be used to calculate the applicable 30-day moving average values for POE SW093. Reporting of data collected at SW093T will be noted, as appropriate. Once construction is complete, the equipment will be re-installed at SW093. The intent is to maintain *uninterrupted* and *representative* surface water monitoring during all phases of construction.

2.5 MONITORING OBJECTIVES FOR TERMINAL DETENTION POND DISCHARGES AND WATER LEAVING RFETS

This section covers all surface water monitoring in streams leaving the eastern Site boundary (Indiana Street). This water is designated as Stream Segment 4a and/or 4b. This water is first monitored prior to discharge from the terminal ponds. Monitoring for RFCA compliance in Stream Segment 4 takes place at the terminal pond outfalls, and in both Woman and Walnut Creeks, near Indiana Street (RFCA POCs). Additional non-POC monitoring at Indiana Street has been identified by the working group and is described at the end of this section.

2.5.1 PRE-DISCHARGE MONITORING

Problem Statement:

Pond pre-discharge monitoring over the last three years has revealed only two instances of a parameter, iron and gross beta activity, exceeding stream standards. In those cases, follow-up sampling with either additional grab samples or at downstream continuous monitoring stations has shown that the quality of the pond release as a whole was well within acceptable quality limits.

In almost all cases, the pond sampling has shown levels of the parameters monitored to be well below a level of concern.

While RFETS will be undergoing massive D&D operations—which could theoretically affect the pond waters—each individual D&D project will have its own controls aimed at preventing contamination of surface waters, and monitoring intended to verify that no contamination has occurred. As a result, there is no reason to expect an exceedance of stream standards within the ponds.

Still, because of the level of public concern about radionuclides, and the potentially extensive and costly consequences of releasing high levels of radionuclides in a pond discharge, "rush" sampling for radionuclides will be continued

However, because tritium has not been detected in surface waters on or off RFETS for many years, and there is no known existing source of tritium, tritium will be removed from the monitoring done by CDPHE. With respect to U, there are no known sources above the ponds that could suddenly increase in concentration or load. Therefore, U will also be eliminated from pond pre-discharge monitoring.

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Samples should represent the water to be discharged (i.e., grab samples should be depth integrated where applicable, 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 RFETS will provide, one additional pre-discharge 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, RFETS has sole discretion to determine the schedule for discharges, independent of an action the State may take with regard to pre-discharge monitoring. If the pre-discharge monitoring suggests an exceedance of a contaminant that is also monitored by flow-paced methods, the parties recognize that the flow-paced methods would be more representative of the discharge compliance status.

It was the initial intention of the parties that, for pre-discharge monitoring, RFETS would perform the sample collection and CDPHE would perform the laboratory analysis and reporting functions of the completed analytical data. During FY03, RFETS will collect and provide analytical data for selected radionuclides and organic constituents as the State laboratory is sometimes unable to complete these analyses in the timeframe necessary for optimum pond discharge operations.

Data Types and Frequency:

A total of about 8-10 pre-discharge samples will be taken annually from the ponds in the Walnut Creek drainage. One sample per year is expected to be taken from Pond C-2 in the Woman Creek drainage. CDPHE will analyze the samples for gross alpha and gross beta activity, Am, Pu, total U, selected metals, and selected water quality parameters. This pre-discharge monitoring is limited to Ponds A-4, B-5, and C-2, or other pond functioning as a terminal pond (e.g., Pond A-3 during construction in Pond A-4). Samples are intended to be taken far enough in advance of the discharge so that isolation, containment, flow-paced compliance monitoring (at the terminal pond outfall POCs), 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 Pre-discharge monitoring results suggest apparent exceedances of the applicable stream standards—

THEN CDPHE may notify RFETS of additional AoIs for that discharge.

- RFETS would then perform flow-paced POC monitoring for the additional AoI(s) during the discharge, as part of the Segment 4 compliance monitoring (see Section 2.5.2); and
- RFETS 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 pre-discharge monitoring can only indicate an *apparent* exceedance because:

- The water sampled is impounded and not discharged at the time of sampling (the pre-discharge sampling protocol applies to water to be discharged); and

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- The single grab pre-discharge sample does not necessarily reflect the quality associated with a 30-day moving average, against which most 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 pre-discharge monitoring is not enforceable under RFCA, but it will be performed as a prudent management practice that the parties endorse.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

— Pre-discharge monitoring is a routine practice. It is unlikely that a discharge would occur without pre-discharge 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 Targets:

Monitoring analyses to be performed by RFETS are shown in Table 2-18. RFETS selected EPA Method 624 for volatile organic analysis (VOAs) based technical evaluation of available VOA methods. This evaluation concluded that the Method 624 is sufficient, both with respect to the range of compounds that can be detected, and the accuracy of the method.

Table 2-18 Pre-discharge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Volatile organic analyses (EPA Method 624)	0.8
Isotopic Pu/U/Am	0.8

Monitoring analyses to be performed by CDPHE are shown in Table 2-19.

Table 2-19 Pre-Discharge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analysis per Month
Gross alpha	0.8
Gross beta	0.8
Pu/Am	0.8
Total U	0.8
Selected metals	0.8
Selected water quality parameters	0.8
Note: Numbers of analyses are based on historical pond discharge operations.	

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2.5.2 STREAM SEGMENT 4/POINT OF 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. Terminal pond discharges will be monitored by POCs GS11, GS08, and GS31. Walnut Creek will be monitored at Indiana Street by POC GS03. Woman Creek will be monitored at Indiana Street by POC GS01. These locations are shown on Figure 2-4.

With the completion of the Woman Creek Reservoir, located just east of Indiana Street and operated by the city of Westminster, Woman Creek flows are detained in cells of the reservoir until the water quality has been assured by monitoring of RFETS discharges via Woman Creek at Indiana Street (at GS01). Reservoir water is then pumped from Woman Creek Reservoir into the Walnut Creek drainage below Great Western Reservoir.

In the past, most natural flows in Woman Creek were diverted to Mower Reservoir and did not exit RFETS via Woman Creek. This is no longer the case; the Mower Ditch headgates were upgraded, and water in Woman Creek will leave RFETS via Woman Creek (at GS01) and enter the Woman Creek Reservoir. In the past, Pond C-2 (located off channel in the Woman Creek drainage) was sampled and then pumped to the off-Site Broomfield Diversion Ditch. Currently, RFETS pump discharges Pond C-2 directly into Woman Creek (at GS31), which then flows to the Woman Creek Reservoir.

There is concern that meeting standards for radiological parameters in Pond C-2 discharge does not adequately demonstrate that water leaving RFETS via Woman Creek and entering the Woman Creek Reservoir is meeting the radiological standards. Other Woman Creek water (combined with Pond C-2 or flowing in the absence of any Pond C-2 water) will enter the Woman Creek Reservoir. This is the basis for setting an additional RFCA POC for Woman Creek at Indiana Street (GS01) for those radiological contaminants that could be directly attributable to RFETS (i.e., not naturally occurring).

A similar point of compliance, GS03, was established at Walnut Creek and Indiana Street. Although the Walnut Creek drainage is not undergoing operational changes like those in Woman Creek, it is possible that contaminated overland runoff or landfill drainage may enter Walnut Creek below the terminal pond monitoring points (GS11 and GS08), yet upstream of Indiana Street.

Data Types and Frequency:

- RFCA AoIs, as sampled for Stream Segment 4 terminal pond discharges (see Table VI in Appendix F).
- Isotopic Pu, Am, and tritium at Indiana Street POCs. Pu, Am, and total U at terminal pond POCs.
- Source of the water sampled. Monitoring at Indiana Street POCs GS01 and GS03 calls for samples to be segregated based on water origin (natural creek flows or terminal pond discharges commingled with natural flows).

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- Samples collected will be continuous flow-paced composites.
- Flow-paced monitoring is maintained at all times for the five POCs in Segment 4, even though no samples are anticipated from terminal pond stations except during planned pond discharges.

The original terminal pond sampling protocols developed through the DQO process (three samples per batch discharge) were initially designed assuming that only Pond A-4 would discharge to Walnut Creek.[36] During FY99, Pond B-5 began routine direct batch discharges to Walnut Creek. Therefore, sampling protocols were modified such that the number of continuous flow-paced composite samples to be collected annually for discharge from either Pond A-4 or Pond B-5 would be comparable to the original sampling protocols. For fiscal years 1993 through 1997, the total combined discharge volume for Pond A-4 and Pond B-5 was 687 million gallons (Mgals) in 43 discharge batches, or 16 Mgals per discharge on average. Targeting three composite samples per discharge gives one composite sample per 5.3 Mgals of discharge volume. This modification will preserve the originally targeted sampling frequencies (based on discharge volume) while maintaining effective cost controls (based on total sample costs). For annual planning purposes, six samples will be collected from Pond A-4, and 19 from Pond B-5, resulting in the collection of the targeted 25 composite samples (see Table 2-20).

Table 2-20 POC Monitoring Station Designators for Segment 4

Pond A-4	GS11
Pond B-5	GS08
Pond C-2	GS31
Walnut Creek at Indiana Street	GS03
Woman Creek at Indiana Street	GS01

However, this sample planning is dependent on the routing for the WWTP effluent. Future changes in the management of Walnut Creek water could result is sampling protocol modifications while preserving the initial intent of the DQO process. For Pond C-2 discharges, three composite samples will be collected per discharge, regardless of volume.

The Indiana Street stations collect the same number of samples during discharges, plus additional samples from storm runoff and baseflow between discharges. GS01 will collect three samples for the one expected Pond C-2 discharge, and storm runoff and baseflow samples based on average annual volumes. During storm runoff and baseflow, the target is one sample per 500,000 gallons, with a maximum of four samples during any one month (see Table 2-20). GS03 will collect the targeted 25 samples during Pond A-4 and Pond B-5 discharges (GS03 will collect the same number of composite samples as the terminal pond POCs for each discharge). During storm runoff and baseflow periods between discharges, GS03 will target two samples every 15 days. The goal is to have at least two analytical results for any 30-day period for

[36] When terminal pond POC sampling protocols were initially developed, only Pond A-4 discharged to Walnut Creek. All B-5 water (except during IDLH emergencies) was pump transferred to Pond A-4 for subsequent batch discharge.

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averaging purposes. RFETS reserves the right to combine samples of the same flow pacing to save resources, as long as two sample results are available for any 30-day period. This sample frequency increase from original targets for GS03 is a result of sampling protocol changes due to the occurrences of NSQ samples.

POC monitoring will be confined to 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 2-20 shows the associations between monitoring locations and station designators.

Decision Statement:

IF — The volume-weighted 30-day moving average[37] for any AoI in Stream Segment 4, as represented by samples from the specified RFCA POCs (i.e., terminal pond discharges and Indiana Street) exceeds the appropriate RFCA standard—

THEN — RFCA requires that DOE, RFFO inform regulators within 15 days of DOE, RFFO gaining knowledge that an exceedance (verified) has occurred:

- 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
- RFETS 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.[38]

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

— RFETS 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.

- Acceptable Decision Error Rates for Statistical Sampling Design:

[37] The 30-day average for a particular day is calculated as a volume-weighted average of a "window" of time containing the previous 30-days that had flow. Each day has its own discharge volume (measured at the location with a flow meter) and activity (from the sample carboy in place at the end of that day). Therefore, there are 365 30-day moving averages for a location that flows all year. At locations that monitor pond discharges or have intermittent flows, 30-day averages are reported as averages of the previous 30 days of greater than zero flow. For days where no activity is available, either due to failed laboratory analysis or NSQ for analysis, no 30-day average is reported.

[38] The POC monitoring station for Woman Creek is GS01 at Indiana Street, and the station for Walnut Creek is GS03 at Indiana Street.

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The decision error types and consequences for Segment 4 are presented in Table 2-21. 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-paced data become available.

Table 2-21 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.	RFETS would 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. RFETS may also be subject to inappropriate fines, penalties, or other regulatory action.

Monitoring Targets:

Table 2-22 presents monitoring targets for Segment 4 POCs. The overall strategy is to sample each discharge as stated in the *Data Types and Frequency* text above. This plan assumes six samples per year from Pond A-4, 19 samples from Pond B-5, and 3 samples from Pond C-2. There is no storm or base flow immediately below the dams. At Walnut Creek and Indiana Street (GS03), RFETS assumes that 25 samples will be collected annually during discharges from Ponds A-4 and B-5, and multiple samples of storm runoff and baseflow during the periods between discharges (approximately 30 samples). RFETS will attempt to schedule discharges from Ponds A-4 and B-5 concurrently. Therefore, about 8-10 discharge cycles per year will occur in Walnut Creek. At Woman Creek and Indiana Street (GS01), RFETS plans to take three samples during one Pond C-2 discharge per year, and a volume-based number of samples each month for storm runoff and baseflow periods. The increase in storm runoff and base flow samples at GS01 over the initial FY97 targets is due to the new routing of Mower Ditch water to Woman Creek Reservoir and the corresponding increase in volume to be monitored. Note that the analyte lists for the terminal pond discharges are different than the analyte lists for the Indiana Street POCs.

Table 2-22 POC Monitoring Targets (Number of Samples/Analyses) for Segment 4 POCs

Time Period	Pond A-4	Pond B-5	Pond C-2	Walnut Creek at Indiana Street	Woman Creek at Indiana Street	Total Number of Samples
During Discharge	6	19	3	25	3	56
Storm and Base Flow						

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Time Period	Pond A-4	Pond B-5	Pond C-2	Walnut Creek at Indiana Street	Woman Creek at Indiana Street	Total Number of Samples
October	NA	NA	NA	3	1	4
November	NA	NA	NA	3	1	4
December	NA	NA	NA	3	2	5
January	NA	NA	NA	3	2	5
February	NA	NA	NA	2	2	4
March	NA	NA	NA	3	3	6
April	NA	NA	NA	2	4	6
May	NA	NA	NA	2	4	6
June	NA	NA	NA	2	4	6
July	NA	NA	NA	3	1	4
August	NA	NA	NA	2	1	3
September	NA	NA	NA	2	0	2
FY Totals	6	19	3	55	28	111

During FY03, the Site plans to replace the existing flume at one POC location, GS03. This flume has been installed for many years are showing signs of deterioration. Based on the locations relative importance to the overall Site monitoring goals, the flume warrants replacement. The flume at GS01 is in good condition as it was installed in 1998 and will not be replaced. The flumes at GS08, GS11, and GS31 are in good repair as well and will not be replaced.

Although this location continue to collect flow data of acceptable accuracy, concerns over continued deterioration and increased maintenance have initiated a project to replace these flumes. The construction phase of this project is scheduled to take place during the first quarter of FY03. During construction, the equipment at the existing location will be temporarily removed and flows will be diverted around the area through pumping or temporary ditches. Due to the importance of the uninterrupted operation of POCs to demonstrate Site compliance with RFCA water-quality action levels and standards, a temporary monitoring point will be established downstream of the construction areas to demonstrate protection of surface water quality. The following sections outline the location-specific flume replacement and the temporary monitoring protocols.

The existing Parshall flumes will be replaced with a single three-foot HL flume. This flume was chosen based on expected flow rates to be measured, the ability to pass debris, and a wide range of accurate flow measurement. The new flume will be capable of accurately measuring flows from nearly zero to 60 cfs.

To facilitate the collection of samples to be used to demonstrate Site compliance with the applicable RFCA standards during construction, the Site has established a temporary monitoring location on Walnut Creek 30 feet upstream of the culvert under Indiana Street (320 feet downstream of GS03, state plane 2093906, 753489). This location has been given the identifier

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GS03T. Although no flow control structure will be installed, the Site is currently collecting water-level (stage) data to be correlated with the flow data collected at the existing GS03 flumes. A stage-discharge relationship (rating) will be established for the culvert such that flow measurements can be continuously calculated from stage measurements at the culvert. The GS03T flow meter will be programmed with the rating in order to control the automatic sampler to collect continuous flow-paced composite samples. These samples will be collected using the identical protocols established for POC GS03. Although analytical results from this location will be uploaded to the Site's Soil Water Database (SWD) with the identifier GS03T, these results will be used to calculate the applicable 30-day moving average values for POC GS03. Reporting of data collected at GS03T will be noted, as appropriate. Once construction is complete, the equipment will be re-installed at GS03. The intent is to maintain *uninterrupted* and *representative* surface water monitoring during all phases of construction.

2.5.3 NON-POC MONITORING AT INDIANA STREET

Problem Statement:

The State of Colorado has proposed to conduct this non-POC 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. Metals monitoring of flows coming from the IA is done by RFETS at POE's that are located above the ponds located on both Walnut Creek and Woman Creek. This monitoring, in combination with D&D project-specific monitoring, should detect significant changes in loadings of metals to surface waters from the IA. In addition to this monitoring, CDPHE will be monitoring metals in North and South Walnut Creek below the Solar Ponds, Mound and East Trenches Plumes to assess loadings from these only other known potential sources of metals above the A, B, and C series ponds.

Still, the ponds themselves have likely accumulated sediments containing some metals. As RFETS progresses through closure, the hydrology of the stream/pond system is likely to change, with a gradual reduction in domestic water supply and wastewater effluent. The effect of both reduced flows (domestic water supply leakage and wastewater effluent) and reduced nutrient loading into the B-series ponds upon stream/pond chemistry is unknown.

Therefore, the monitoring described in this section will be done in order to ensure metal concentrations leaving RFETS meet stream standards, and to provide an assessment of nutrients and physical parameters that might help explain any observed changes in metal concentrations over time.

Since the primary focus of this monitoring is to obtain an assessment of chemistry changes within the ponds, only pond releases will be monitored. And, as a practical matter, flows other than pond releases are only significant as a result of direct precipitation runoff, which will be difficult to accurately assess with only the grab sampling provided by CDPHE.

Data Types and Frequency:

The complete list of analytes analyzed by CDPHE is given in Table 2-23. The real-time parameters will be collected by RFETS. Note that pH and temperature are needed to calculate un-ionized ammonia. The sources of water at these locations during a sampling event must be identified.

Grab sample collection frequency will be as follows:

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- Walnut Creek: Quarterly
- Woman Creek: Yearly

Non-POC monitoring is limited to Stream Segment 4, as represented by samples taken from Walnut Creek at Indiana Street and Woman Creek at Indiana Street

Decision Statement:

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

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

Table 2-23 Non-POC Monitoring Requirements (Number of Samples/Analyses) at Indiana Street

Analyte	Number of Samples
Total ammonia	5
Nitrate/Nitrite	5
Total phosphate as P	5
Orthophosphate	5
Ag, Cu, Mn, Ni, Se (dissolved)	5
As, Be, Cd, Cr, Fe, Li (total)	5
Total Hardness, as $CaCO_3$	5
pH	Continuous 15 min intervals
Temperature	Continuous 15 min intervals
Conductivity	Continuous 15 min intervals
Flow	Continuous 15 min intervals

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 RFETS in the future.

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:

If hydrologic changes affect pond chemistry, the historic distribution of analyte concentrations may longer exist. The quarterly sampling for Walnut Creek should provide an adequate representation of the full range of concentrations likely to be in the waters flowing off-Site. However, continuous composite sampling would improve the reliability of the monitoring. For Woman Creek, a sample will be collected every time the pond discharges.

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Monitoring Targets:

Quarterly sampling will be done in Walnut Creek, and annual sampling will be done in Woman Creek – corresponding to the projected once a year discharge from Pond C-2.

2.6 OFF-SITE MONITORING OBJECTIVES: COMMUNITY WATER SUPPLY MANAGEMENT

Contaminants generated by operations at RFETS may have migrated off-Site and impacted the downstream reservoirs. In addition, D&D activities at RFETS may increase the risk of environmental contaminant release. The potential for the public to be exposed to contaminants originating from RFETS that can impact the community water supplies 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 RFETS, are used to assess potential impacts, demonstrate acceptable water quality, and allay consumer concerns. These data are critical inputs for operational decisions.

2.6.1 MONITORING UNCHARACTERIZED DISCHARGES

This monitoring would normally be required only if monitoring specified under the previous decision rules is not performed in accordance with the sampling and analysis protocols (e.g., Segment 5 POE or Segment 4 POC monitoring at Indiana Street), or if flow leaving RFETS exceeds the capacity of the downstream ditches or reservoirs.

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

- Flow that has the potential to exceed the capacity of the Walnut Creek Diversion Ditch and enter Great Western Reservoir instead of being diverted around the reservoir; and
- Water quality in downstream waters that may have been impacted by unmonitored effluent from RFETS.

Data Types and Frequency:

- Flow at the following monitoring locations:

— Pond A-4, North Walnut Creek, GS11,

— Pond C-2, GS31,

— Pond B-5, South Walnut Creek, GS08,

— Woman Creek at Indiana Street, GS01,

— Walnut Creek at Indiana Street, GS03, and

Flow from these stations is needed to evaluate:

— The potential for Walnut Creek to exceed the capacity of the Walnut Creek Diversion Ditch (estimated at 40 cfs) and spill over into Great Western Reservoir, and

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— The relative contribution of various sources (ponds, storm drainages) to the total flow leaving RFETS.

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 other decision rules, assuming flow channel capacities are not exceeded.

- Water quality as follows:
  - — Analytes are shown in Table 2-24.

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 RFETS at the time of the event. Samples should be taken, but not necessarily analyzed, for all possibilities.

- Action levels:
  - — Action levels would be the applicable CWQCC standard for the potentially impacted downstream segment (Segments 4a/b and 5).
- Sampling locations:

Specific locations are event-driven, but may include:

— Walnut Creek at Indiana Street, GS03,

— Woman Creek at Indiana Street, GS01, or

— Great Western Reservoir (only necessary, if release of surface water enters Great Western Reservoir).

- Sampling frequency:
  - — Event driven; only when uncharacterized water leaves RFETS.
- Sample type:

— Walnut and Woman Creeks at Indiana Street: If flow-paced composite sampling as specified under POC monitoring cannot be conducted, then grab samples will be collected as soon as the event is detected and at least daily thereafter until continuous monitoring is reestablished or the event terminates. If time-paced samples are available from Broomfield's monitoring station at GS03, these samples may be used to characterize water quality leaving RFETS.

— Reservoirs: Representative reservoir sampling will be conducted in accordance with the event and as agreed by the impacted parties. At a minimum, a surface composite sample, consisting of grab samples collected at various points in the reservoir, and a depth composite sample will be collected 48 hours after the event.

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Table 2-24 Off-Normal Discharge Monitoring Inputs

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

Geographically, this monitoring objective 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 RFETS on downstream reservoirs and water supplies; thus the monitoring locations of interest are:

- Woman Creek at Indiana Street, GS01;
- Walnut Creek at Indiana Street, GS03;
- Great Western Reservoir;
- Woman Creek Reservoir

For this decision, monitoring would only be required when water of unknown quality leaves RFETS. Under routine operations wherein surface water is under full management control of RFETS, dam safety is not threatened, and POC monitoring is conducted as specified under Section 2.5.2, this monitoring is not needed.

Decision Statement:

IF Surface water of unknown or unacceptable quality leaves RFETS

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:

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Because this monitoring is event-driven, decisions regarding necessary and sufficient monitoring must be based on the nature of the event. Samples may be single grab samples, location composites, or time composites. Statistically-based sample sizes will not be used for development of this FY03 monitoring plan.

Monitoring Targets:

For planning purposes, no uncharacterized discharges are projected for FY03. 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 RFETS 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 RFETS but may be expected to continue as long as environmental contamination and special nuclear materials are present at RFETS. Citizen concerns are more effectively addressed by a routine monitoring program to measure the analytes of concern at the locations of concern, than by institutional controls, modeling, and on-Site monitoring. Adequate and timely information regarding RFETS impact on the neighboring environment is needed so that the communities can respond to citizen concerns and RFETS can foster a credible public image. Inadequate monitoring results in poor public relations, impaired trust, increased public resistance to proposed activities at RFETS, *and increased mandatory monitoring.* The necessity for repeated public meetings and clean-up delays due to negative public comment may increase the cost of operating RFETS.

Data Types and Frequency:

- Sampling locations:
  - Since the completion of the Standley Lake Protection Project and the Great Western Reservoir Replacement Project, which were designed to protect the potable water supplies, routine monitoring of the municipal treatment and distribution systems is no longer warranted. However, Great Western Reservoir is still used as an irrigation supply, and the fact that the reservoir is considered to be unsuitable for potable use raises questions on the part of irrigation customers. Ongoing assessment is needed to address these questions.
  - For FY03, Great Western Reservoir is the only sampling location needed.
- Sample types:
  - Quarterly depth-integrated composite samples are adequate to characterize the contaminant concentration in Great Western Reservoir.
- Sampling methods:
  - City personnel routinely conduct sampling in Great Western Reservoir and will collect the necessary samples for this objective as part of Broomfield's sampling program.

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- Analytical methods:

  — Analytical methodology must provide detection limits adequate to assess changes in water quality and permit an acceptable comparison with steam standards. For Great Western Reservoir, the acceptable detection limit for Pu/Am is approximately 0.006 pCi/l.

- Analyte list:

  This monitoring is limited to radionuclide contamination that is potentially attributable to RFETS.

— Pu-239/240,

— Am-241,

— U, isotopic (at least U-233/234:U-238), and

— Tritium.

The total number of samples needed for this monitoring objective would be four samples per year for FY03. The hydrologic regime for the Great Western Reservoir will change over time as city irrigation and reuse projects are implemented. Sampling locations, types, and frequencies will be re-evaluated to reflect these changes.

Decision Statement:

IF	The potential for public exposure to contaminants attributable to RFETS causes reasonable concern in the neighboring communities—
THEN	Monitoring to quantify contaminant concentrations and provide the necessary information must be performed.

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.

Monitoring Targets:

Monitoring requirements for this section are presented in Table 2-25.

Table 2-25 Monitoring Targets (Number of Samples/Analyses) for Community Assurance Monitoring

Analyte	Analyses for FY03	
	Great Western Reservoir (Analyses per year)	Total
Pu-239/240	4	4
Am-241	4	4
Isotopic U[a]	4	4
Tritium	4	4

[a] Total U and U-233/234; U-238 ratio, as a minimum.

2.7 WATERSHED INTEGRATION

Geographically, the RFETS lies at the head of the Big Dry Creek Basin; functionally, every effort has been made to isolate RFETS from the rest of the watershed. Historical strategies on the part of both RFETS and the downstream communities have focused on limiting, to the maximum extent possible, the natural flow of surface water from RFETS. Examples include past spray irrigation practices, the "Zero Discharge" goal, and the continuing detention of treated sanitary effluent and stormwater pending demonstration of acceptable water quality. Although these water management practices have been necessary to protect and reassure the downstream communities, they impact the ecology downstream and are inconsistent with the ultimate vision for RFETS, as outlined in RFCA. As Rocky Flats moves toward closure, the focus must evolve toward integrating the headwaters of Big Dry Creek with the rest of the watershed.

To accomplish this objective, RFETS must use the watershed approach and extend it's water management strategy beyond Indiana Street, and participate with other stakeholders in identifying and implementing appropriate water quality and use goals for the basin. During 1996, DOE and it's contractors progressed toward this goal by actively participating in a consensus group with the objective of achieving agreement on as many issues as possible prior to a standard-setting hearing before the CWQCC. The group included representatives from the RFETS, regulatory agencies and surrounding communities, but limited its focus to water quality issues impacting wastewater dischargers.

More recently, RFETS personnel helped to establish the Big Dry Creek Watershed Association (BDCWA), which began as an extension of the original consensus group, but has evolved to include any entities or individuals interested in water-related issues within the basin. In addition to the original four dischargers, participants include representatives of agriculture, parks, recreation, open space, and a variety of government agencies. The BDCWA has been recognized by the Denver Region Council of Governments (DRCOG) as a district watershed in the Regional Clean Water Plan. The goals of the association include public education, basin-wide planning, monitoring activities, and protection of water quality, aquatic life and habitat.

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The DOE has recognized the effectiveness of this approach by becoming a party to a formal agreement to participate, with the cities, in supporting monitoring activities within the basin. The agreement states that such support may consist of monetary contributions or in-kind services, but shall be equitably distributed among the parties. Monitoring decisions are made jointly by the group, with input from regulators and planning agencies including EPA, the Water Quality Control District (WQCD), and DRCOG. The parties will work with the U.S. Fish and Wildlife Services (USFWS) and the BDCWA to determine an appropriate aquatic monitoring program. The immediate use of the data is to characterize the watershed, and to identify and quantify sources of impairment. Ultimately, water quality and biological data will be used to support water quality standards, native species protection, and basin-wide planning activities. A coordinated effort to obtain accurate information about existing conditions and relative impacts is beneficial and cost effective for stakeholders.

A Cooperative Agreement between DOE and the City of Westminster was signed in 2000 to continue the watershed group's administrative tasks and biological monitoring on Walnut Creek below RFETS and Big Dry Creek. The project period of the Cooperative Agreement is from 10/1/00 through 12/31/06. In 2001, DOE contracted with a firm to conduct biological monitoring on-Site. Information from RFETS monitoring activities will be provided to the BDCWA for incorporation into their databases. The data will also be shared with the USFWS to assist with their management of Rock Creek Reserve.

To provide consistency in sample collection in the Big Dry Creek watershed, a single contractor has been retained to collect the estimated samples detailed in Table 2-26.

Table 2-26 Anticipated Monitoring Requirements for Watershed Integration

Constituent	Frequency	Total Number of Samples FY02
Habitat Assessment	Annual	1
Flow	Concurrent with biological sampling	2
Fish population	Annual	2
Invertebrate population	Semi-annual, summer and fall	2
Water Quality	As needed	None projected

Data Types and Frequency:

The type of data needed and frequency of collection may vary as the watershed characterization progresses, and by agreement among the Stakeholders, but will include habitat assessment and biological sampling. Water quality data collection downstream of the RFETS boundary is not currently funded by RFETS, but if analysis of the biological data identifies a need for additional water quality information, the necessary analyses may be included in future revisions of this document.

- Sampling Locations

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Three various sites along Walnut Creek, from RFETS eastern boundary at Indiana Street to the confluence with the mainstream of Big Dry Creek.

- Sampling and Analytical Methods

  The sampling, analysis, and data interpretation protocols must be consistent with those selected for the downstream sites monitored by the cities.

- Analyte List

  - Fish population
  - Macro-invertebrate population
  - Habitat assessment
  - Flow
  - Water quality, if needed (constituents based on drivers).

Decision Statement:

IF	Impairments to Big Dry Creek are identified,
AND	RFETS activities are suspected to have adverse impact on water quality or habitat,
THEN	RFETS may be required to address these impacts through more stringent NPDES permit limitations, flow controls, habitat protection or restoration requirements, or other regulatory controls.

If the relative impact of factors, such as stormwater, WWTP discharges, agriculture, irrigation deliveries and diversions, and urbanization, has not been adequately characterized, RFETS may face large expenditures for capital improvements, environmental mitigation, and litigation that will not result in a significant improvement to the stream.

Acceptable Decision Errors:

For biological sampling, the sampling and analysis protocols have been designed to allow an assessment of certainty.

Monitoring Targets:

Anticipated monitoring requirements for this objective are listed in Table 2-26.

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3. GROUNDWATER MONITORING

3.1 INTRODUCTION

This section of the IMP describes the groundwater monitoring requirements for RFETS as outlined in the RFCA, and how the requirements will be implemented at RFETS. Groundwater monitoring is performed by RFETS organizations because groundwater contaminant plumes occur within the RFETS boundaries. Therefore, the IMP covers 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, an understanding of the historic and contemporary groundwater conditions must be achieved. This information is presented in Appendices A through E. Appendix A provides a description of RFETS and environmental history, including areas of contamination. Appendix B gives the Action Level Framework for groundwater, Appendix C gives the physical and hydrologic setting, Appendix D identifies groundwater contaminant plumes, and Appendix E lists the wells that will be monitored for water quality or water level.

3.1.1 PURPOSE OF THE INTEGRATED MONITORING PLAN FOR GROUNDWATER

In the past, two plans have been required at the RFETS to comply with DOE Order 5400.1 (DOE, 1988), the *Groundwater Protection Management Program Plan* and *Groundwater Monitoring Plan*. These two plans have historically been combined into one document, the *Groundwater Protection and Monitoring Program Plan* (GPMPP) (EG&G, 1993a), which defines and describes the groundwater protection and monitoring programs at RFETS. In addition, an assessment groundwater monitoring plan was required under RCRA for interim status units called the *Final Groundwater Assessment Plan* (GWAP) (DOE, 1993). Other monitoring plans have been developed to address groundwater monitoring requirements as outgrowths of various CERCLA IM/IRA decision documents. This portion of the IMP will serve as the Groundwater Monitoring Plan for RFETS, and will replace the requirements found in the above-listed plans.

3.1.2 BRIEF HISTORY OF GROUNDWATER MONITORING ACTIVITIES

The historic growth of the groundwater monitoring network at RFETS 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 1,356 wells and piezometers have been installed at RFETS from 1971 to present. Plate 1 shows the wells that have been installed at RFETS since 1974.

Wells in the groundwater monitoring network were sampled annually until 1974, twice a year between 1974 and 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 area being monitored. Currently, wells are sampled on a semiannual basis. The groundwater monitoring program has supported the following compliance programs at RFETS:

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- 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 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 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 RFETS SWD.

In 1993, the large number of wells that were being monitored as an outgrowth of the various remedial investigations at RFETS prompted the Well Evaluation Project. The *Well Evaluation Report* (WER) (EG&G, 1994) resulted in the reduction of 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 reevaluated the monitoring network. On the basis of new plume configurations, the number of monitored wells 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, RFCA was approved. RFCA replaces the Interagency Agreement (IAG) as the environmental cleanup agreement for the RFETS. RFCA outlines the goals, objectives, and strategies that will lead to cleanup and closure mission objectives. Supporting activities will reduce, eliminate, or mitigate existing environmental liabilities while maintaining RFETS in a safe condition. The ALF portion of RFCA contains specific requirements for monitoring and reporting, and sets action levels for contaminant concentrations in groundwater and in other media (see Appendix B). The IMP is required under RFCA to further define the monitoring programs for RFETS.

The groundwater monitoring program reevaluated the monitoring system to ensure that it was protective of the environment, compliant with applicable regulations and agreements, and aligned with the new RFETS mission. A DQO process was used to determine the function of each well in the network and the decisions supported by information from each well. The DOE RFFO, CDPHE, EPA, and various other stakeholder entities were directly involved in decisions concerning the monitoring network. Results of this evaluation are found in the following sections.

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3.2 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 IA are more likely to be contaminated by groundwater discharges and, thus, have traditionally been the focus of most groundwater monitoring.

As shown in Figure 2-1, three ephemeral streams drain RFETS. The streams are Rock Creek, Walnut Creek (consisting of three tributaries—No Name Gulch, Walnut Creek, 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.

Groundwater can also be transported to surface water directly through the numerous building sumps and footing drains that have been constructed to restrict groundwater infiltration into buildings and building basements. Some of these structures drain by gravity while others are pumped to the surface. The Water Programs Group will collect information on footing drain outfalls and will incorporate this information into future monitoring plans to assure that these pathways are adequately monitored to determine whether they result in contaminated surface water.

The RFETS sanitary sewer system may be a significant collector of groundwater through inflow to pipes via breaks in seals and piping. This water co-mingles with sanitary sewer water and reaches the STP, where it is treated and discharged to surface water at Pond B3. This influent groundwater may be an issue once the STP is decommissioned, and is no longer treating effluent from the sanitary sewers.

Other possible pathways for groundwater to reach surface water are through the various utility, sewer, and miscellaneous corridors that run through the IA. These utility corridors are often deep trenches which have been backfilled with permeable materials, thus creating a preferential pathway for groundwater. Evaluation of these corridors may be necessary if there is proof that significant contaminated groundwater could migrate down these pathways to surface water.

3.3 GROUNDWATER MONITORING PROGRAM OBJECTIVES

The objectives of the RFETS groundwater program are: 1) protect surface water quality, 2) demonstrate 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 future remedial actions. Development of the IMP and subsequent updates are the responsibility of the Environmental Media Management Program of Kaiser-Hill Company, L.L.C. (Kaiser-Hill) and DOE, RFFO. Kaiser-Hill directs and implements the Groundwater Monitoring Program. The management structure is shown in Figure 3-1.

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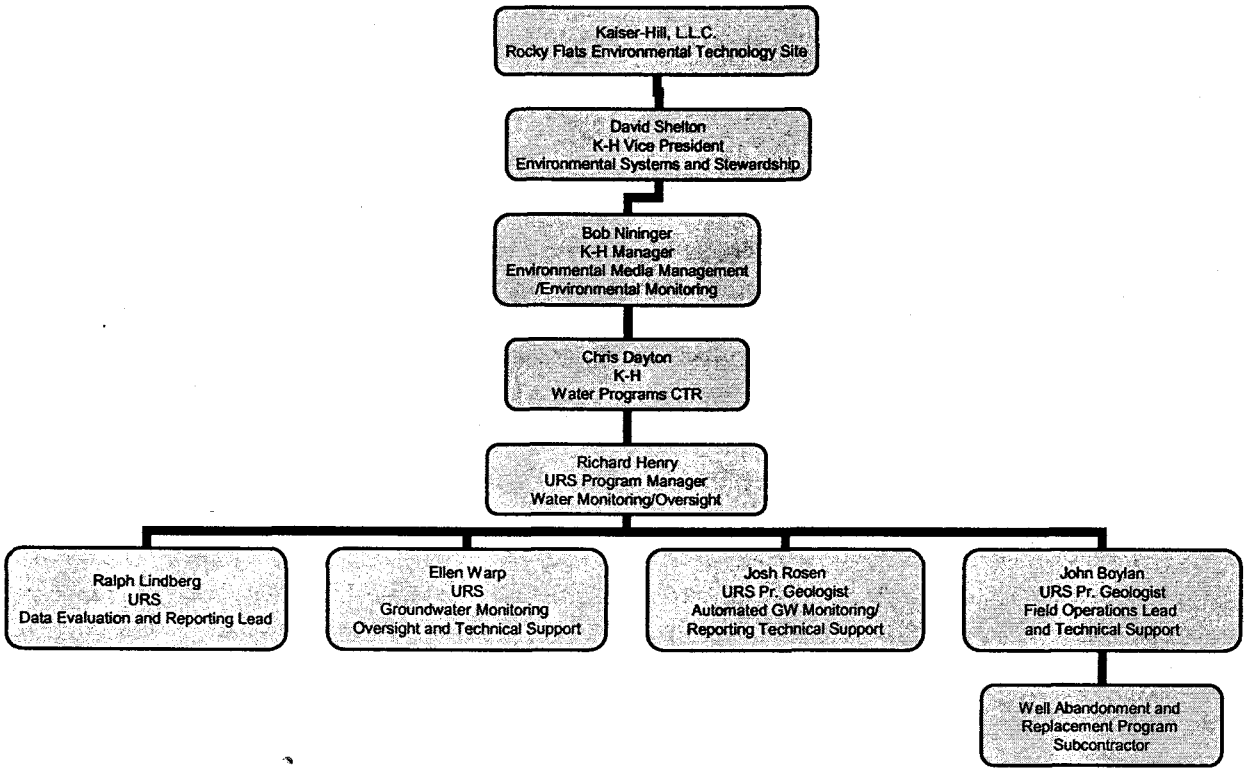

Figure 3-1. Groundwater Organization

The Groundwater Monitoring Program is integrated with ongoing activities designed to protect surface water from contamination by groundwater. The Groundwater Monitoring Program will:

- Identify contaminated groundwater and new sources of contamination;
- Identify and control contaminant sources;
- Identify contaminant pathways;
- Monitor and trend contaminant concentrations;
- Monitor remediation and D&D actions;
- Monitor groundwater flow for use in water balance and other groundwater modeling activities; and
- Evaluate the effects of groundwater contaminants on surface water.

3.3.1 IDENTIFICATION OF CONTAMINATED GROUNDWATER

The identification of contaminated groundwater at RFETS has resulted from previous investigations dealing with the characterization of former Operable Units (OUs) and facilities at

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RFETS. Wells installed during the Remedial Investigation/Feasibility Study (RI/FS) discovered groundwater contamination near Individual Hazardous Substance Site (IHSS) source areas, and historic groundwater characterization activities also contributed to knowledge on the extent of groundwater plumes. In addition, analyses of building sumps and drains and incidental waters generated during construction activities, also provide information on locations of groundwater contamination.

Groundwater contaminant concentration maps have been generated for most of the contaminants of interest at RFETS, and are published in the Annual RFCA Groundwater Reports. Groundwater plumes have been identified where contamination is spatially extensive. The delineation and refinement of groundwater plume extents is ongoing as part of the Groundwater Evaluation Project scope.

3.3.2 IDENTIFICATION AND CONTROL OF CONTAMINANT SOURCES

Potential sources of groundwater contamination are tracked in various ways at RFETS. A chemical inventory system has operated since 1986. The current real-time chemical tracking system, which identifies chemicals that may be potential contaminants, has been in operation since 1990. The system fulfills RCRA requirements to track the disposition of hazardous chemicals. The Waste Programs Organization at RFETS manages this tracking system.

In addition, the *Historic Release Report* (HRR) was compiled to originally document spills and other releases of potentially hazardous chemicals at RFETS (DOE, 1992a). This report is updated annually and maintained by the Environmental Restoration Program. The HRR will document new sources of contamination and assign an IHSS number to a significant release.

Area sources contaminated with hazardous substances are identified as IHSSs and have been characterized under the 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. Currently, the ER Ranking is no longer the sole source for identifying the remedial action sequence. The RFCA Parties recognize that future remedial actions will be addressed based on opportunity and D&D schedules. This opportunistic approach evaluates the accessibility of an area and what, if any, potential future impacts exist due to other remedial actions in the area. The opportunistic approach is balanced against the ER Ranking; any time it is determined that an IHSS is impacting human health or the environment, such that immediate action is warranted, then action will be taken as soon as possible.

3.3.2.1 Current Contaminated Areas

The remedial investigations at former OUs (a grouping of IHSSs) have provided adequate data for determining potential contamination sources for much of RFETS. The former 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 RFETS. Information about the effect of contaminated areas on groundwater is described in Appendix D in previous versions of the IMP, and in the RFCA Annual Groundwater Reports. The remedial investigations at former OUs, combined with groundwater characterization activities, have identified a number of groundwater contaminant plumes that emanate from contaminant sources. These plumes are described in Appendix D of

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previous versions of the IMP and more recent investigations have been incorporated into the RFCA Annual Groundwater Reports. The dominant category of hazardous contaminants in groundwater is 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 for the major analytes of concern have been developed for monitoring wells.

Building-specific potential analytes of concern will be developed in areas where groundwater will be monitored during D&D activities. The RFCA ALF requires performance monitoring of remedial actions. Analyte suites will be developed for these wells based on knowledge of the analytes of concern at the remediation site (DOE, 1996). However, a full sample suite will initially be collected for these wells as a check on potential analytes of concern.

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 RFETS are generally operated in compliance with RCRA requirements. These are further described in the *Spill Prevention, Control, and Countermeasures/Best Management Practices (SPCC/BMP) Plan* and the RCRA Part B Permit (EG&G, 1992a). The RCRA waste management functions at RFETS are the responsibility of Waste Programs.

3.3.2.3 Storage Tanks

There are currently over 2,000 storage tanks at RFETS. These 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 to be low risk for spills, and are thus unlikely to contaminate groundwater.

Further characterization and spill control for non-waste storage tanks is achieved through implementation of the Tank Management Plan, which was developed as a result of a 1989 chromic acid incident (EG&G, 1990). The plan employs formal design, testing, and inspection standards to evaluate tanks and prevent environmental contamination. The plan complies with Title 40 of the *Code of Federal Regulations* (CFR) Parts 280, 281, and 282, where applicable. The Waste Programs Organization at RFETS maintains and controls the tanks.

3.3.2.4 Process Waste System

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

RFETS also has old and abandoned process waste lines that could impact groundwater and surface water. The Environmental Restoration Program plans to characterize process waste lines during RFETS closure. A groundwater evaluation will be performed if significant contaminant leaks are detected during characterization.

3.3.2.5 Building Drains and Sumps

Numerous buildings on RFETS contain sumps and footing drains which can collect groundwater along with building water. Sumps and floor and footing drains are considered potential contaminant pathways since a chemical spill or contaminated groundwater could enter the drains and be transported to the surface water control system. Monitoring of selected footing drains and sump outfalls has been included as part of D&D groundwater monitoring. As buildings are identified for D&D, a review of the footing drain systems is done, and where appropriate, monitoring is performed. The Drain Identification Study at OU8 identifies buildings with floor and footing drains located in areas containing potentially hazardous substances (DOE, 1994a). It also establishes whether the drains lead to sanitary or process waste treatment facilities. The *Technical Memorandum No. 1 Data Compilation, Rocky Flats Plant, 700 Area (OU8)* compiles locations and specifications on foundation drains, storm sewers, and sanitary sewers in the Protected Area (DOE, 1994a). 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

In addition to the known IHSSs, groundwater contaminant plumes, and contaminated building areas, there are other potential areas of concern. These are areas where possible underbuilding contamination has occurred, or where there are areas of possible soil contamination outside of buildings. If significant contamination is found in these areas, the Environmental Restoration Program will remediate the area. The effect of these sources on groundwater and surface water will be investigated as part of the Groundwater Monitoring Program, and integrated with D&D and ER 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 RFETS 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 may migrate. In addition, the groundwater level data is necessary for determining contaminant flux to surface water, water balance, and groundwater saturated thickness.

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 RFETS action levels or standards. Background concentrations have been established for most inorganic compounds present in the groundwater at RFETS. These background levels are used to help determine concentrations that are irregular with respect to natural levels. Increases in contaminant concentrations over time may indicate that contaminants are migrating from sources and could eventually affect surface water.

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3.3.5 MONITORING OF REMEDIAL ACTIONS

RFCA requires that groundwater performance monitoring be conducted during and after certain soil remediation activities. Performance monitoring has been implemented for major soil removal actions such as T1, T3/T4, Ryan's Pit and the Mound Site. Performance monitoring has also been implemented for the groundwater treatment systems that have been built at the former OU1, OU2 and OU4. The groundwater treatment systems are described in the following paragraphs.

The Solar Ponds Passive Treatment System was installed on the hillside north of the Solar Ponds to collect groundwater from the Solar Ponds Plume. The plume contains high concentrations of U and nitrate derived from the Solar Evaporation Ponds, which historically stored and evaporated radioactive and hazardous liquid wastes. The Solar Ponds were drained, and sludge removal was completed in 1995. To de-water the hillside, six interceptor trenches were installed in 1971. The original six trenches were abandoned in place and the Interceptor Trench System (ITS) was installed in 1981. Installation of the 1,100-foot long collection system and a passive treatment cell containing iron and wood chips was completed in September 1999. The water collected is treated in the passive treatment system to remove these contaminants and the water is released to Walnut Creek. Groundwater is not currently monitored immediately downgradient of the Treatment System, but the Walnut Creek drainage below the ITS is monitored to detect contaminants that may not be collected by the system. Performance monitoring requirements are documented in the *Final Solar Ponds Decision Document* (DOE 1999a).

The OU1 French Drain System was installed in 1992 on the 881 Hillside to collect VOC-contaminated groundwater that was migrating from IHSS 119.1 towards Woman Creek. In addition, groundwater was intercepted in a collection well located near the French Drain and transferred to the Building 891 Treatment Plant. Water that enters the drain was also pumped to the Building 891 Treatment Plant for processing. In 2000, the French Drain was decommissioned so that water collected in the system is no longer treated. The water in the system has been consistently below groundwater action levels and is now released to the SID.

Groundwater is still monitored downgradient of the IHSS 119.1 to detect migration of potentially contaminated groundwater toward Woman Creek. The collection well is no longer treated, but will continue to be monitored. Original performance monitoring requirements are documented in the *Interim Measure/Interim Remedial Action French Drain Performance Monitoring Plan* (DOE, 1992). Current performance monitoring requirements are documented in the OU1 CAD/ROD modification.

At the former OU2, two passive treatment systems have been built to treat groundwater contaminated with VOCs. The Mound Treatment System was built to collect and treat contaminated groundwater from the Mound Site (IHSS 113) and the East Trenches Passive Treatment System was built to collect and treat groundwater from the East Trenches Sources (IHSSs 110 – 111.8).

The Mound Site Plume Treatment System is a 230-foot below-grade impermeable-barrier collection system with two treatment cells that was installed in 1998. The system was designed to collect contaminated groundwater derived from the Mound Site and treat it to fall within the parameters of the Groundwater Action Level Framework Tier 2 level concentrations defined in the RFCA. The effectiveness and feasibility of using this type of system on other contaminated groundwater plumes was demonstrated by this project. The Mound Site Plume Treatment

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System employs innovative technology for the collection and treatment of contaminated groundwater containing chlorinated organic contamination and low levels of radionuclides. The performance monitoring requirements are defined in the *Final Mound Site Plume Decision Document* (DOE 1997).

The East Trenches Plume Treatment System collects and treats the contaminated groundwater from Trench 3 and Trench 4 to the Groundwater Action Level Framework Tier 2 level concentrations defined in the RFCA. The sources for the contaminated groundwater plume were remediated in 1996 as an accelerated action. Installation of the 1,200-foot long collection system along with the two reactive iron treatment cells was completed in September 1999. Performance monitoring requirements are described in the *Final Proposed Action Memorandum for the East Trenches Plume* (DOE 1999).

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. Monitoring decisions and specific monitoring requirements related to these projects are documented in decision documents associated with the individual projects, and will not be found in the IMP.

3.3.6 PROTECTION FROM NEW CONTAMINANT SOURCES

Future plans for RFETS involve decommissioning of production systems, building demolition, and excavation and removal or capping of source areas. Groundwater will be monitored before, during, and immediately after an operation that could potentially degrade groundwater quality. This will determine the site-specific ambient groundwater conditions and detect release of contaminants. 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 IA.

Additional sources of groundwater contamination may be identified by evaluating data from the groundwater monitoring network at RFETS. 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 by the Environmental Restoration Program.

3.3.8 GROUNDWATER DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support the decision making process. At the programmatic level, DQOs are

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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 are established to ensure 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. The DQO process employed is generally derived from EPA guidance documents (e.g., EPA, 1987, 1990 and 1994) but has been used primarily as a decision support tool as opposed to a sample optimization tool.

3.3.9 PROGRAMMATIC DATA QUALITY OBJECTIVES

The DQO process was applied to the groundwater program at 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 are used to detect and document contaminant concentrations above limits established by regulations, agreements, permits, or risk-based analysis; to support planning, implementation, and assessment of 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 specified, documented quality, owing to the many uses of the data for 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.

3.3.10 DATA QUALITY OBJECTIVES FOR PROGRAM ELEMENTS

The second DQO effort developed individual monitoring program decision elements. DQOs were approached on a media-specific basis, although the goal was to integrate monitoring requirements for groundwater, surface water, air and ecology. 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. The data were then 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 following components:

- 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. If a Tier I Action Level is exceeded, it will be reported and 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

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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 RFETS 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 potential releases to groundwater from D&D activities on specific buildings.
- Performance Monitoring Wells: Wells used to monitor both the short-term and long-term effects of a remedial treatment or source removal action. Performance monitoring of source remediation is specifically required in the RFCA ALF for groundwater.
- RCRA Compliance Wells: Wells used in upgradient and downgradient monitoring of RCRA interim status units. This requirement is specified under 6 CCR 1007-3. Wells monitored at the present landfill would be specified under 6 CCR 1007-2.
- Plume Degradation Wells: Wells used to assess whether natural chemical breakdown processes are an effective alternative to groundwater remediation. This monitoring well category supports remedial and no-further-action alternatives analyses through the collection of data used in determining whether natural attenuation is occurring.

RFETS groundwater has a surface water protection use-classification and must be managed to be protective of surface water quality. The ALF lists specific analytes and associated groundwater action levels. DQO decisions will reflect the RFCA requirement to support the surface water protection classification. Each component of the groundwater program can be considered a decision element; decision statements have been created for each component.

3.3.10.1 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 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. Some plume definition wells may have historically exceeded Tier I Action Levels. For these wells, only new exceedances of Tier I Action Levels involving compounds that have concentrations greater than historic levels will cause the well to be reprioritized for remedial action.

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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);
- Historic data trends for contaminants;
- Field parameters; and
- 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:	Wells will be sampled and data will be reviewed *and reported* quarterly, and decisions will be made annually.

Decision Statement:

IF	Measured concentrations in well exceed Tier I Action Levels and background mean +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 an 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.

Figure 3-2 presents a flowchart for plume definition monitoring wells.

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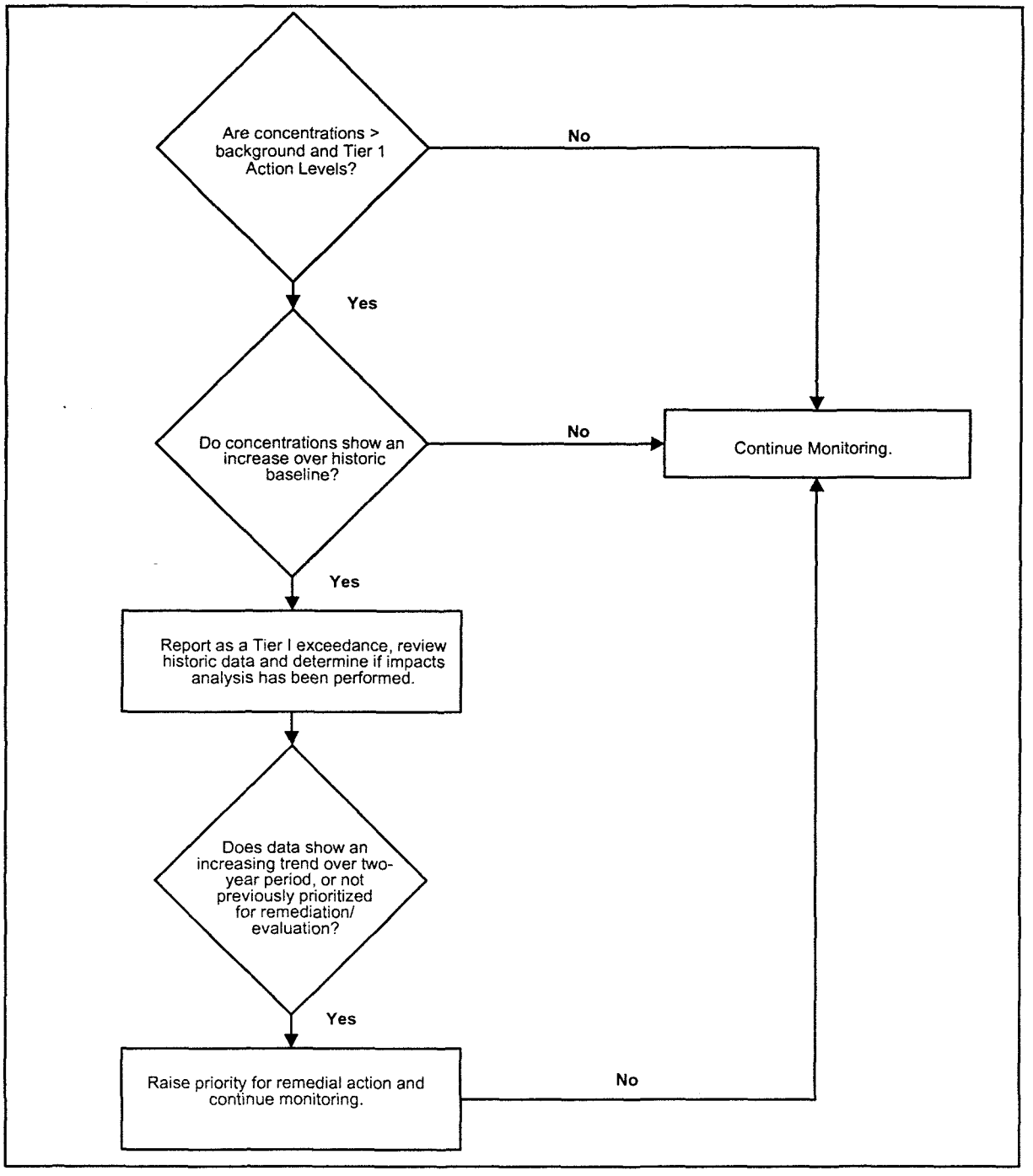

Figure 3-2. Plume Definition Monitoring Wells Flowchart

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3.3.10.2 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. 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);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

Spatial:	Decisions will be made on an individual well basis. UHSU wells will be installed at the distal end of known contaminant plumes.
Temporal:	Data will be reviewed and reported 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 the 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 ER and RFCA 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—

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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 on routine schedule.

Figure 3-3 presents a flowchart for plume extent definition monitoring wells.

3.3.10.3 Drainage Monitoring Wells

Problem Statement:

Do groundwater contaminants that have reached surface water exceed action levels, and are the contaminants 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. Contaminants detected in stream drainages are assumed to have affected surface water and to have the potential to migrate off RFETS. 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 2 standard deviations 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);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

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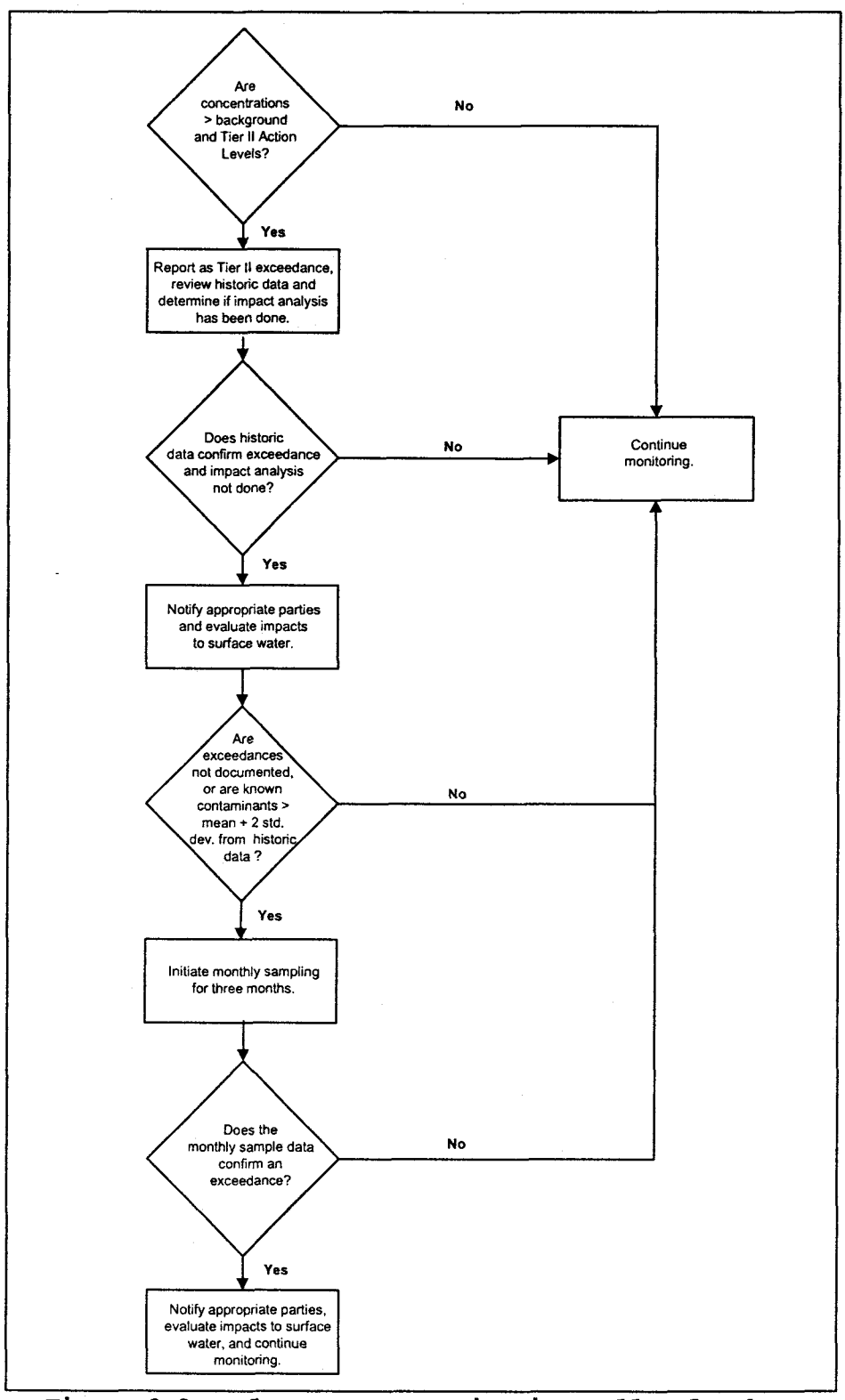

Figure 3-3. Plume Extent Monitoring Wells Flowchart

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Boundaries:

Spatial: Decisions will be made on an individual well basis. *Wells are installed to monitor UHSU groundwater in the drainages.*

Temporal: Data will be reviewed *and reported* 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 on routine schedule.

Figure 3-4 presents a flowchart for drainage monitoring wells.

3.3.10.4 Boundary Monitoring Wells

Problem Statement:

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

Problem Scope:

Boundary wells monitor groundwater at the downstream boundary of RFETS. 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 RFETS. Historically, RFETS 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 RFETS. It is possible that some boundary wells historically 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.

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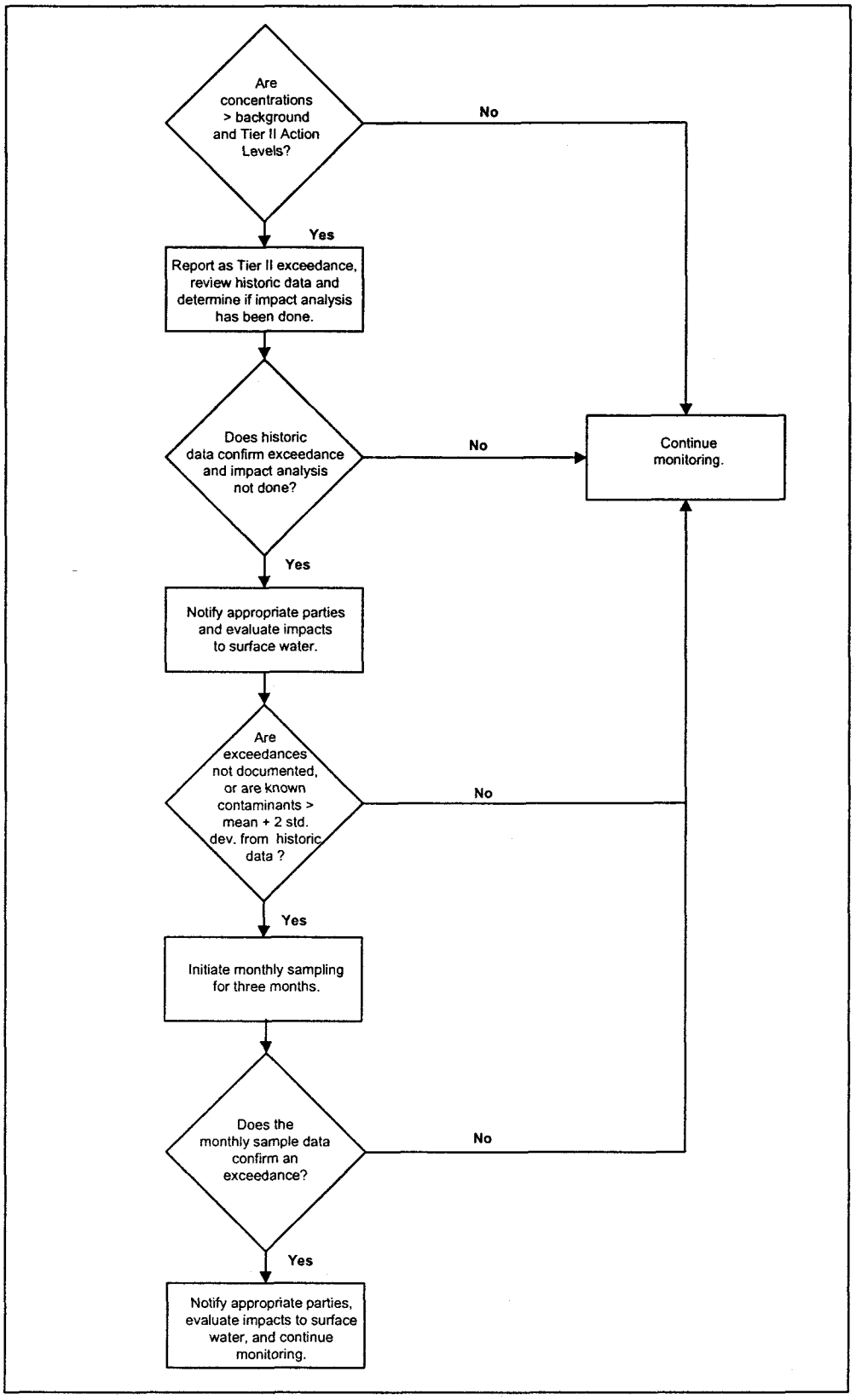

Figure 3-4. Drainage Monitoring Wells Flowchart

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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);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

Spatial:	*UHSU* groundwater in the drainages at the Indiana Street boundary. Decisions will be made on an individual well basis.
Temporal:	Wells will be sampled, and data will be reviewed *and reported* 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 on routine schedule.

Figure 3-5 presents a flowchart for boundary monitoring wells.

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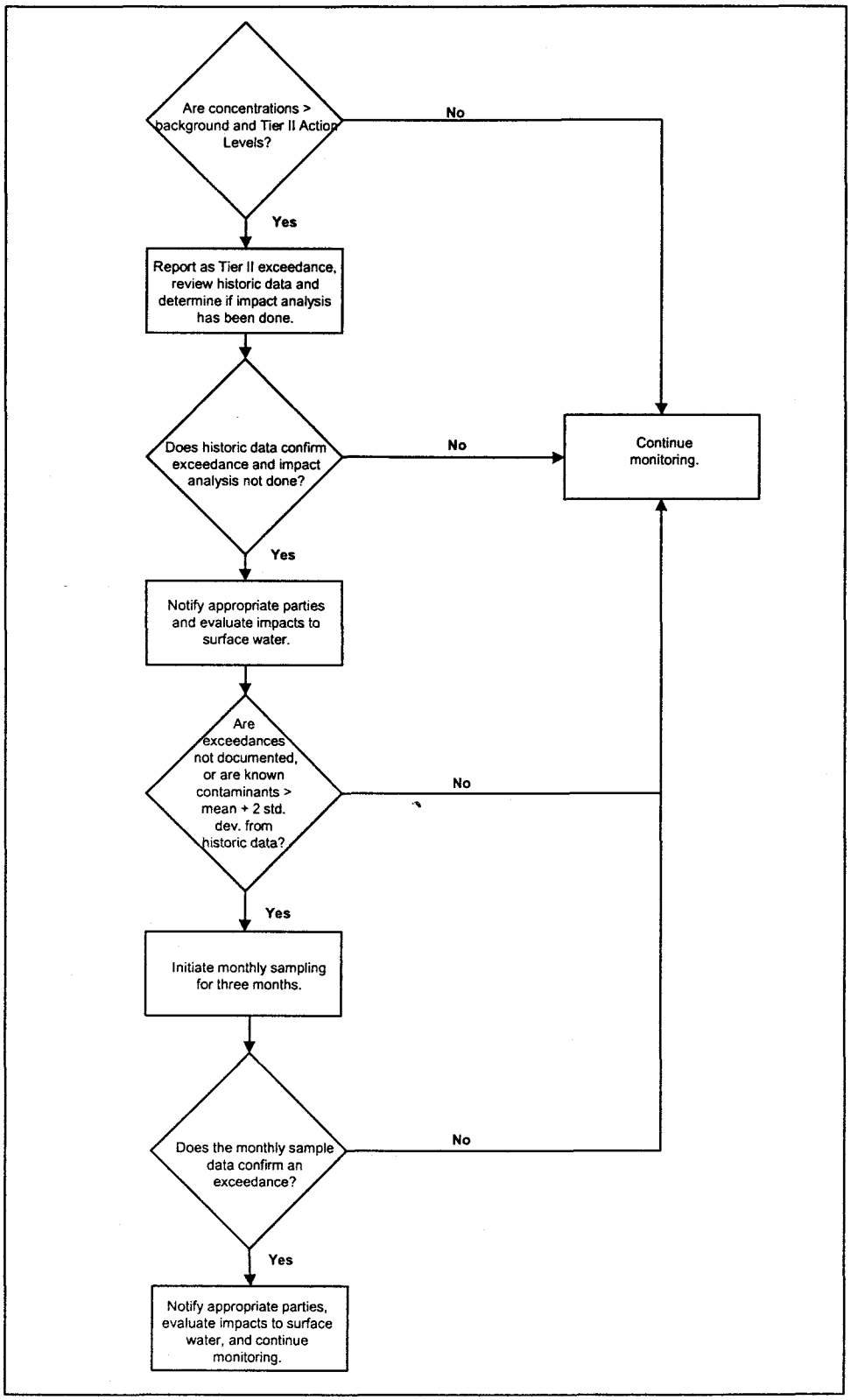

Figure 3-5. Boundary Monitoring Wells Flowchart

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3.3.10.5 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:

The acronym D&D is a general term that refers to the decontamination and decommissioning of buildings at RFETS. Included in this phase are building-specific D&D activities that post date a required deactivation, and may include surveillance/ maintenance, decontamination, dismantlement, and ultimately, demolition. This IMP outlines monitoring activities to ensure 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. D&D monitoring will begin two years (or four sample events) before building demolition and continue for five years after demolition, sampled on a semiannual frequency. Monitoring results will be reviewed prior to termination of D&D monitoring for a building to assure that the project has met its intended goals.

Inputs:

- Building-specific AoIs (to be determined and documented in project-specific documents);
- Baseline mean + 2 standard deviations;
- Field parameters (to be determined); and
- Water levels.

Boundaries:

Spatial: Decisions will be made on an individual well basis. Wells are located in areas that could be contaminated from a specific building. Upgradient wells may be installed to distinguish contamination from other sources. In some cases foundation drain outfalls will also be monitored.

Temporal: Wells and drains will be sampled and data will be reviewed and reported quarterly; 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—

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THEN Inform appropriate parties and evaluate the problem,

ELSE Continue monitoring.

Figure 3-6 presents a flowchart for building D&D monitoring wells.

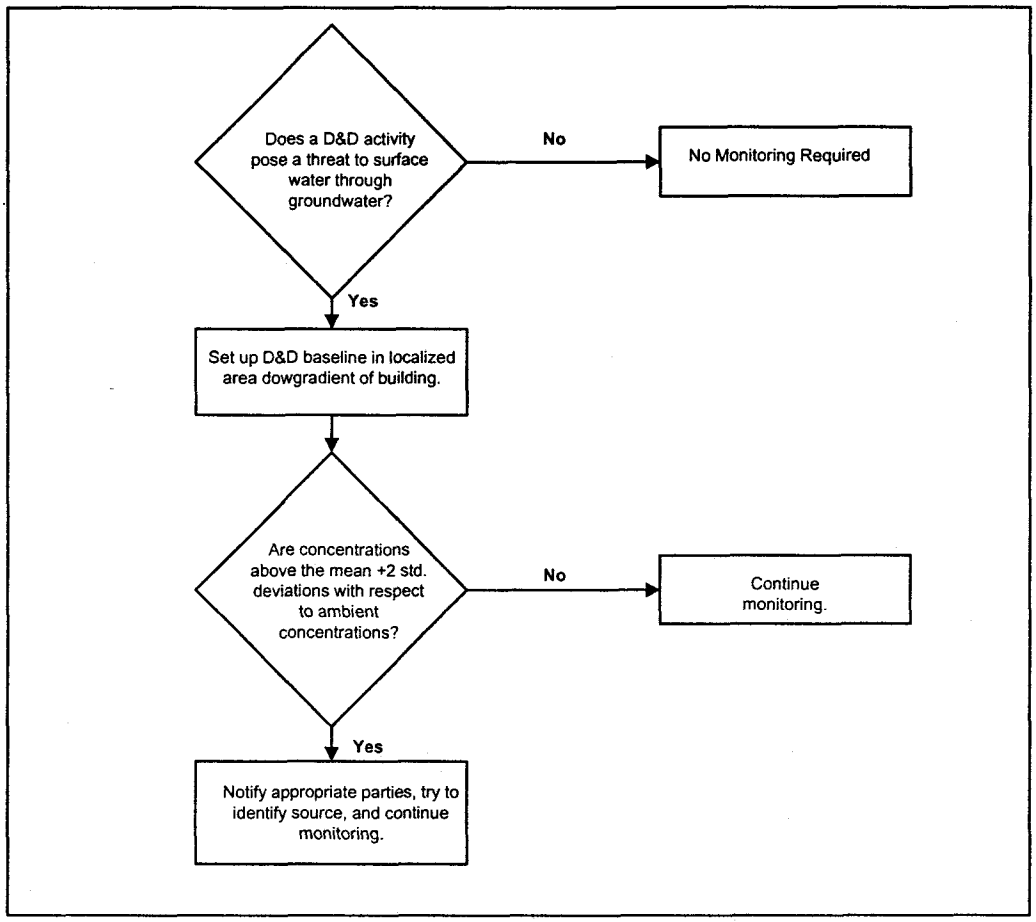

Figure 3-6. Building D&D Monitoring Wells Flowchart

3.3.10.6 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 groundwater and appropriate soil remediation actions. Specific activities will be

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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 decision *documents.*

Inputs:

- Source-specific AoIs (to be determined and documented in project-specific documents);
- Field parameters (to be determined); and
- Water levels.

Boundaries:

Spatial: Decisions will be made on a well-by-well basis. Wells will be placed downgradient from sources undergoing remediation.

Temporal: Wells will be sampled, and data will be reviewed *and reported* 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 detected at acceptable levels.

Figure 3-7 presents a flowchart for performance groundwater monitoring wells.

3.3.10.7 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 RFETS. RCRA units are considered to be units that are regulated under 6 CCR 1007-2 solid waste requirements, such as the Present Landfill. Attachment 10 of the RFCA will be followed in determining points of compliance and alternate concentration limits affecting these units.

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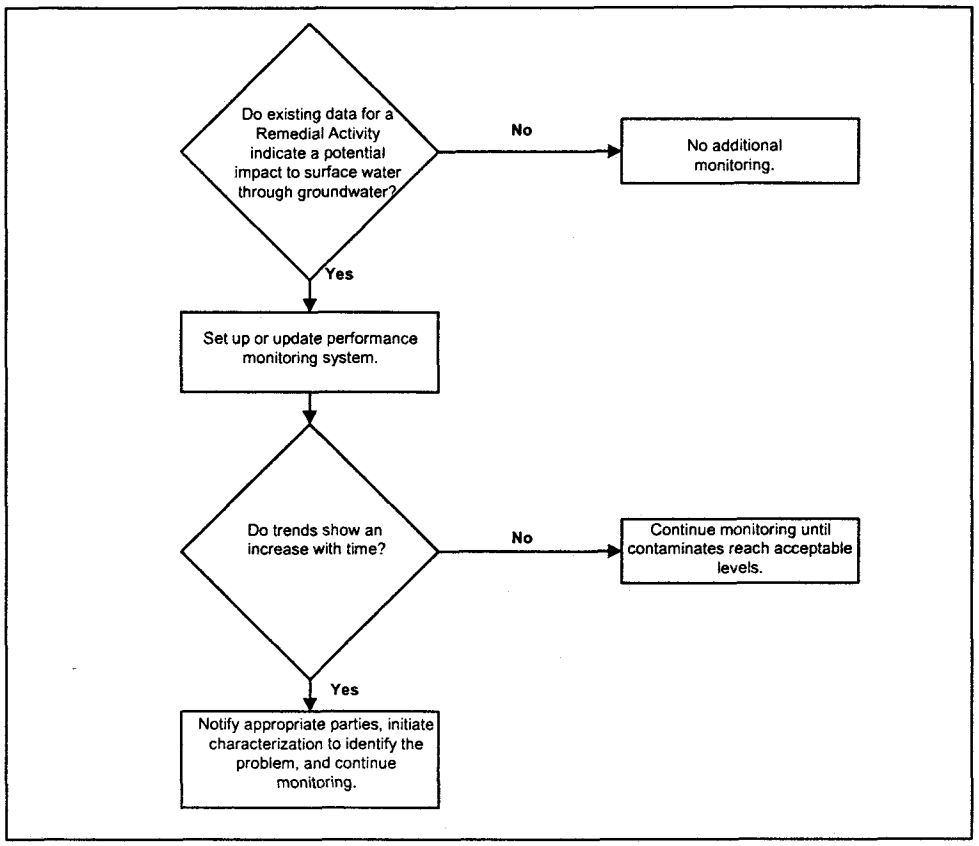

Figure 3-7. Performance Groundwater Monitoring Wells Flowchart

Inputs:

- Unit-specific AoIs;
- Field parameters; and
- Water levels.

Boundaries:

Spatial: Decisions will be made based on pooled results of upgradient wells and on an individual well basis in downgradient wells. If there is insufficient data to do downgradient comparisons on a per well basis then a pooled dataset will be used.

Temporal: Data will be reviewed and upgradient/downgradient comparisons made annually. However, because downgradient wells are in a drainage, they will also be evaluated and reported as drainage wells quarterly.

Decision Statement:

IF Mean concentrations in a downgradient well exceed the mean concentration in upgradient wells by greater than two standard deviations of the data set,

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

Figure 3-8 presents a flowchart for RCRA groundwater monitoring wells.

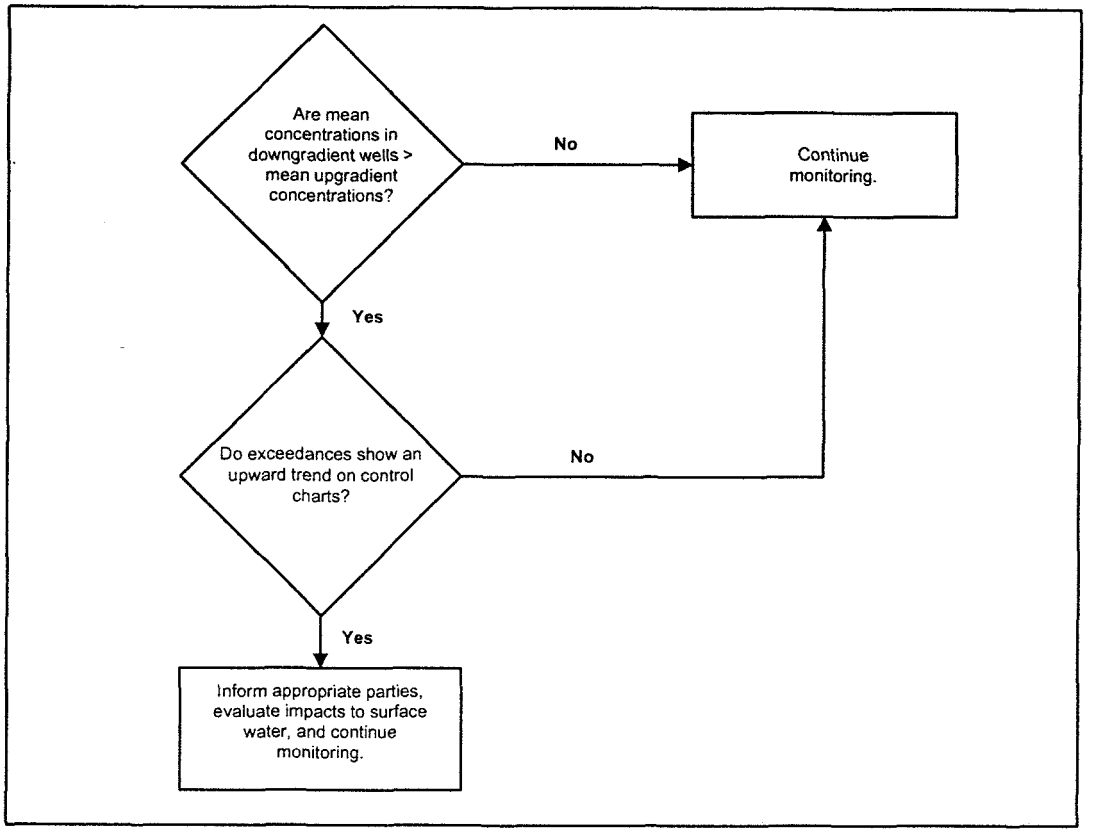

Figure 3-8. RCRA Groundwater Monitoring Wells Flowchart

3.3.10.8 Plume Degradation Monitoring Wells

Problem Statement:

Do natural processes acting on contaminants in groundwater affect the impact to surface water and therefore influence the priority and method of remediation?

Problem Scope:

The natural breakdown of contaminants in groundwater may be a significant factor influencing the nature and extent of contaminant migration. Plumes (and their potential sources) that have been evaluated under the IMP evaluation criteria, and show evidence of degradation, may need additional characterization or monitoring to establish degradation characteristics. Based on these characteristics, the type of natural attenuation

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(e.g., biological degradation, chemical degradation, adsorption, volatilization, dispersion) may be established. Degradation monitoring includes the placement and sampling of wells for use in decision making (with respect to the methodology of source and plume remediation), and will aid in assessing remediation priorities. For biodegradation to occur, there must be a favorable chemical environment in the aquifer. Wiedemeier et al (1996) have developed a simple system for determining whether biodegradation is occurring, based on applying numeric scores to the chemical parameters discussed in this report. The criteria used are summarized in Table 3-1. A score of 0 to 5 points suggests inadequate evidence of biodegradation, 6 to 14 suggests limited evidence of biodegradation, 15 to 20 shows adequate evidence, and scores above 20 show strong evidence of biodegradation.

Table 3-1. Checklist for Determination of Biodegradation

Analyte	Concentration in most contaminated zone	Significance	Points
Oxygen	< 0.5 mg/L	Tolerated at this concentration	3
Oxygen	> 1.0 mg/L	Prohibits reductive dechlorination	-3
Nitrate	< 1.0 mg/L	Competes with reductive pathway at higher concentrations	2
Ferrous Iron	> 1.0 mg/L	Reductive pathway possible	3
Sulfate	< 20 mg/L	Competes with reductive pathway at higher concentrations	2
Sulfide	> 1.0 mg/L	Reductive pathway possible	3
Methane	> 0.1 mg/L	Ultimate reductive daughter product	2
Redox	< 50 mV	Reductive pathway possible	1
Redox	< -100 mV	Reductive pathway more possible	2
DOC	> 20 mg/L	Carbon and energy source - drives dechlorination	2
Temperature	> 20 degrees C	Biochemical process accelerated	1
Carbon Dioxide	> 2x background	Ultimate oxidative daughter product	1
Alkalinity	> 2x background	Results from interaction of CO2 in aquifer	1
Chloride	> 2x background	Daughter product of organic chlorine	2
Hydrogen	> 2 nM	Reductive pathway possible	3
Chloroform	Present	Daughter product of carbon tetrachloride	2
Methylene Chloride	Present	Daughter product of chloroform	2
Chloromethane	Present	Daughter product of methylene chloride	2

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Inputs:

- Project-specific field and laboratory parameters. These parameters must allow for the conclusive determination of the presence of biodegradation. Typical parameters include:

Chloride	Nitrate	Sulfide
Dissolved Oxygen	pH	Total Organic Carbon
Ferrous Iron	Redox	
Methane	Sulfate	

- Concentration and speciation of project-specific contaminants in the source groundwater with respect to time;
- Concentration and speciation of project specific contaminants in downgradient groundwater with respect to time;
- Concentration and speciation of background water quality in upgradient groundwater with respect to time (if necessary);
- Determination of score for establishing whether biodegradation is present;
- Water levels to establish gradient and saturated thickness;
- Trend analysis; and
- Mass flow rate analysis.

Boundaries:

Spatial: Wells are located in areas thought to be contaminated from a specific source. Upgradient wells may be installed to distinguish contamination from other sources.

Temporal: Wells will be sampled, and data will be reviewed annually to determine if sufficient data have been collected to support remedial decision making. Upon collection of sufficient data an evaluation will be performed to establish inputs to the remedial conceptual model.

Decision Statement:

IF Data evaluation concludes that sufficient data have been collected to characterize the nature and extent of the contaminant plume

AND Evaluation concludes that natural processes have decreased potential contaminant impact to surface water—

THEN Determine course of action using decision analysis phase in IMP plume management template to reevaluate the priority and methodology for remediation, and discontinue monitoring,

ELSE Reestablish data needs and re-scope monitoring activities.

Figure 3-9 presents a flowchart for plume degradation monitoring wells.

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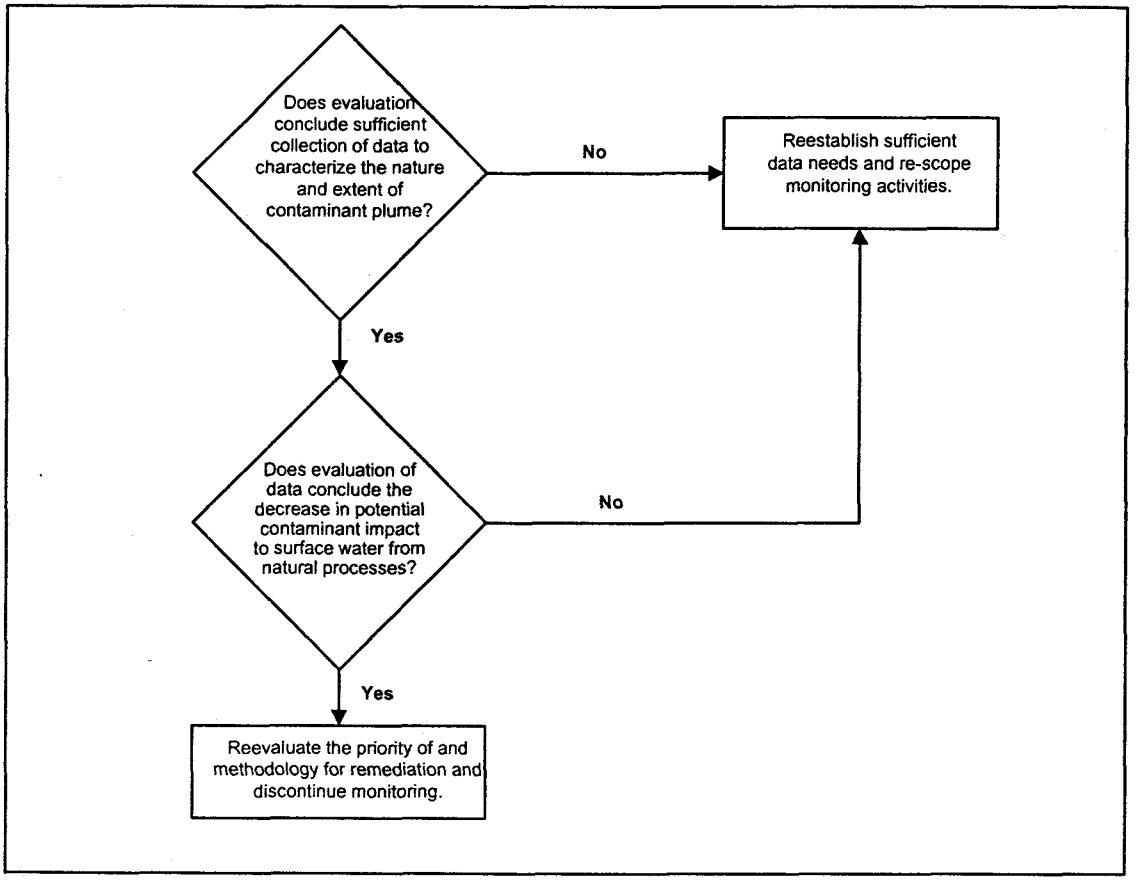

Figure 3-9. Plume Degradation Monitoring Wells Flowchart

3.3.11 DATA QUALITY OBJECTIVES FOR MONITORING GROUNDWATER FLOW

Groundwater quantity, and the magnitude and direction of groundwater flow, are necessary to assess the effects of RFETS 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;
- Evaluation of impacts to downgradient habitat and endangered species caused by changes to groundwater quantity and associated fluvial systems as a result of RFETS remediation activities; and
- Estimation of direction and rate of plume migration and the volumes of contaminated groundwater for use in treatment feasibility scenarios.

3.3.11.1 Site-Wide Flow Monitoring

Problem Statement:

Do 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 RFETS 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 IA 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; and
- Meteorological data.

Boundaries:

Spatial:	Decisions will be made on a Site-regional basis.
Temporal:	Wells will be measured, data will be reviewed, and decisions will be made annually.

Decision Statement:

IF	Groundwater elevations show significant changes in an area with time—
THEN	Notify appropriate parties and evaluate impacts to surface water quality and quantity,
ELSE	Continue taking measurements.

Figure 3-10 presents a flowchart for Site-wide groundwater flow monitoring.

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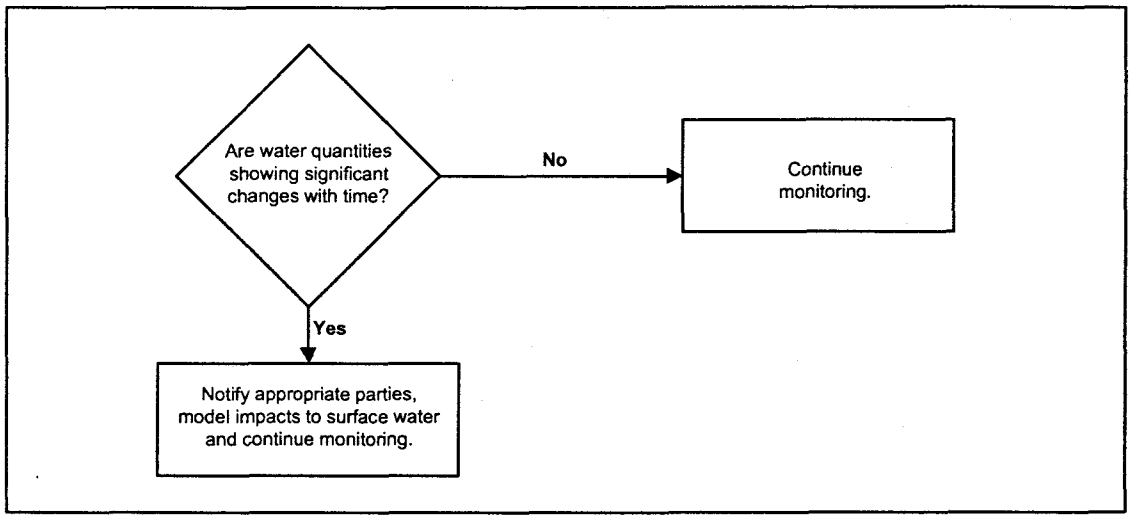

Figure 3-10. Site-Wide Groundwater Flow Monitoring Flowchart

The groundwater flow monitoring program has three components. Each component provides information supporting the programmatic goals as follows:

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

3.3.11.2 Water Quality Flow Monitoring

Problem Statement:

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

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:

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Spatial: Decisions will be made on a wellhead basis.

Temporal: Wells will be measured and 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 measurement 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.

Figure 3-11 presents a flowchart of water quality flow monitoring.

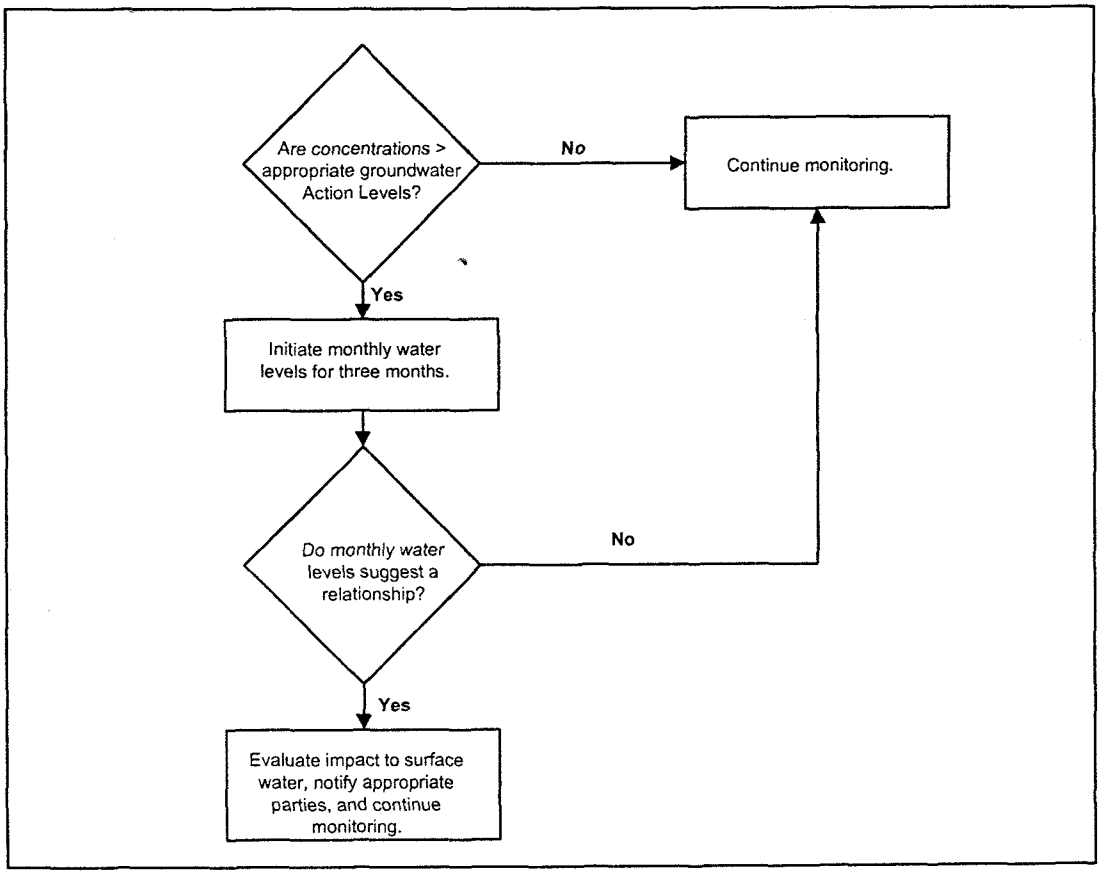

Figure 3-11. Water Quality Flow Monitoring Flowchart

3.3.11.3 Industrial Area Flow Monitoring

Problem Statement:

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Do remedial activities affect the groundwater flow regime surrounding the IA, and what impact do 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 IA are now monitored less frequently, the level of resolution of groundwater flow is too low to predict the effect of RFETS activities on groundwater migration. The frequency of measurements should be increased to a level sufficient to track the effects of remedial actions in the IA.

Inputs:

- Water level measurements; and
- Historic water level data.

Boundaries:

Spatial:	Decisions will be made on a well head basis, but high resolution maps are also needed involving IA wells that are monitored.
Temporal:	Wells will be measured and 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.

Figure 3-12 presents a flowchart of industrial area flow monitoring.

3.3.11.4 Background Groundwater Flow Monitoring

Problem Statement:

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

Problem Scope:

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

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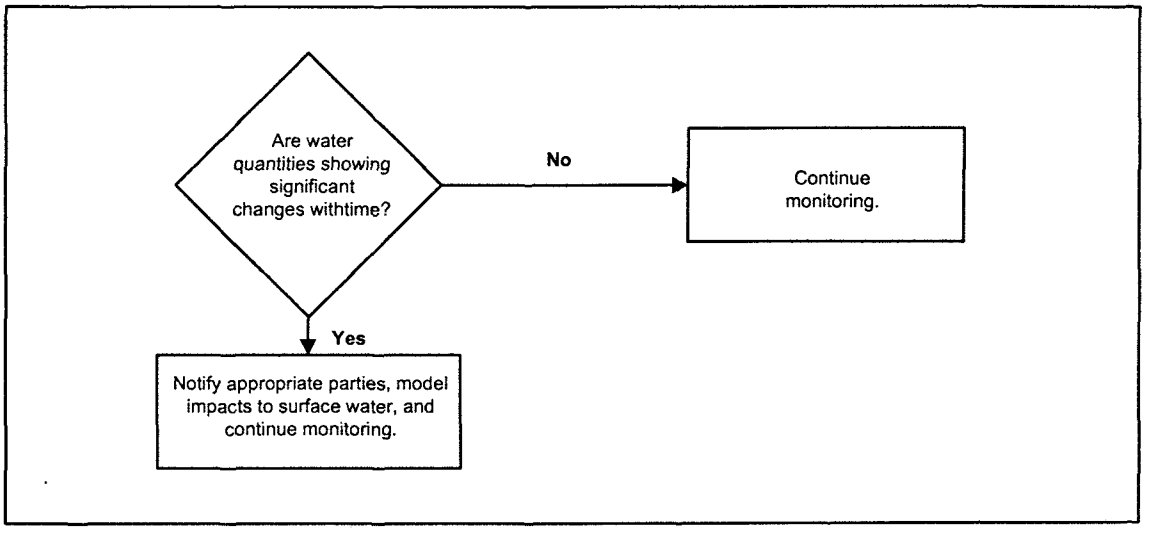

Figure 3-12. Industrial Area Flow Monitoring Flowchart

Inputs:

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

Boundaries:

Spatial:	Decisions will be made on an individual well basis.
Temporal:	Wells will be measured and data will be reviewed quarterly, and decisions will be made annually.

Decision Statement:

IF	Site-wide groundwater elevations show significant changes with time that may cause significant impact on surface water quantity—
THEN	Evaluate changes in groundwater flow measurements with respect to background flow,
ELSE	Continue monitoring.

Figure 3-13 presents a flowchart of background flow monitoring.

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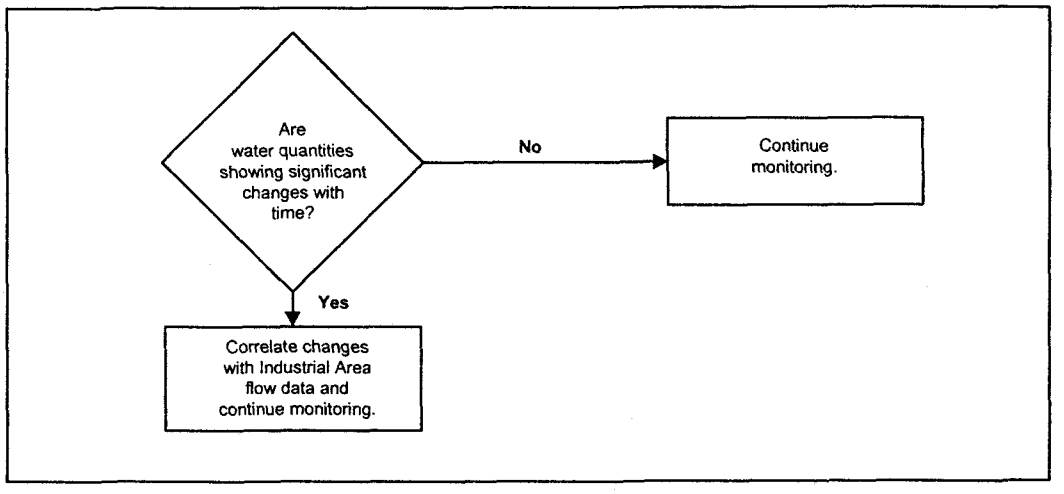

Figure 3-13. Background Flow Monitoring Flowchart

3.3.12 GROUNDWATER EVALUATION PROJECTS

In addition to the groundwater monitoring activities covered under the decision rules described in the previous section, there are special projects that may be implemented as part of the groundwater evaluation requirements under this IMP and RFCA. These projects are typically of limited duration, and assess exceedances of action levels in current wells or areas with historic exceedances. Evaluation projects may also attempt to refine methodologies of sample collection, data analysis, or characterization to improve the program in general. The following projects are currently in some stage of implementation. Each project is implemented under a project-specific sampling and analysis plan.

3.3.12.1 Monitoring of Building 111 for PCB Migration

An EPA letter discussed the in-filling of the Building 111 basement with concrete debris containing trace amounts of PCBs. The letter acknowledged that modeling scenarios run by RFETS showed that no significant migration of PCBs would occur in groundwater. However, the letter requested that groundwater monitoring be done to confirm these conclusions. An evaluation will be done on where to install a monitoring well to verify that PCBs will not emanate from this structure.

3.3.12.2 Industrial Area VOC Plume Evaluation

This project was initiated in FY01 to investigate possible source areas that feed the Industrial Area VOC Plume. These sources have not been well documented, and additional wells would shed light on whether the IA plume is one large plume or whether it is a collection of smaller plumes. Fourteen wells were installed during early 2002 and were sampled in the second quarter of 2002. The results of the project can be found in the *2001 RFCA Annual Groundwater Report.* Additional information is contained in the *Final Sampling and Analysis Plan for Groundwater Monitoring of the Industrial Area Plume.*

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3.3.12.3 ICP/MS Uranium Sampling Project

The ICP/MS U sampling project is conducted jointly with CDPHE to try to differentiate between exceedances of groundwater action levels for U *caused by RFETS activities* and exceedances *caused by naturally-occurring U.* In 2002, thirty four additional wells were sampled, and the results incorporated in the *2001 RFCA Annual Groundwater Monitoring Report.* Additional samples may be collected in 2003, depending upon CDPHE funding. Further information can be found in the *2000 and 2001 RFCA Annual Groundwater Monitoring Reports.*

3.3.12.4 Natural Attenuation of the PU&D Yard VOC Plume

This project investigates the natural attenuation of the PU&D Yard Plume as an alternative to possible groundwater remediation and treatment. In 2000, wells were installed downgradient of the known plume to assess the possible pathway of the plume towards surface water. Once the dominant pathway was identified, wells were selected for collection of natural attenuation parameters. In 2001, the PU&D source was treated with a hydrogen release compound to determine the effects of the compound on enhancing the breakdown of VOCs. Two wells were installed to monitor changes in VOC concentrations, and were monitored from January 2001 through October 2001. The results of the monitoring for both the plume and the source treatment can be found in the 2001 RFCA Annual Groundwater Report and the Annual Plume (see the *Technical Memorandum, Groundwater Monitoring of the PU&D Yard VOC Plume* and the *Draft Final Sampling and Analysis Plan for the Natural Attenuation of the PU&D Yard VOC Plume).*

3.3.12.5 Re-interpretation of the Site VOC and Nitrate Plume Map

In 2002, the methodology for defining the groundwater plumes at RFETS was examined. The issue revolved around using data from wells that was temporally different to construct the plume maps found in the *Annual Groundwater Monitoring Report.* The reason for the temporal difference is that only a fraction of the wells at RFETS are actively sampled, which means that data used from other wells was collected at some time in the past. The current attempt to resolve the issue is to show the historic plume configuration from 1997, which represents a period before major D&D and remediation activities were initiated. This configuration used 1991-1997 averaged data. The updated plume map uses 1998-2002 averaged data. Both configurations are displayed on the map to help identify areas where improved knowledge of nature and extent of the plume has occurred. The updated plume map is shown in the *2001 RFCA Annual Groundwater Monitoring Report.*

3.4 QUALITY CONTROL OBJECTIVES FOR COLLECTION/EVALUATION OF GROUNDWATER DATA

DOE Order 5400.1 *General Environmental Protection Program* (DOE 1988) requires that a quality assurance (QA) program be developed consistent with DOE Order 414.1, *Quality Assurance.* The program must cover 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 *Quality Assurance Program Plan for the Groundwater Monitoring Program* (QAPPGW) (RMRS, 2000a) and associated operating procedures (OP). Non-routine evaluations and special sampling projects will be governed by project-specific work plans.

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The RFETS management structure showing organizational responsibilities is illustrated in Figure 3-1. The organization has been structured to maintain quality for the duration of the program. Conformance to the applicable plans, operating procedures, and established QA 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). The QAPPGW generally covers quality control (QC) for the following components of the groundwater program:

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

3.4.1 FIELD DATA COLLECTION

QC 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 QC objectives for field data collection are the following:

- Sampled water is representative of 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.

The QAPPGW lists operating procedures that are developed and maintained to ensure that quality samples are collected for use in environmental decision making.

3.4.2 DATA MANAGEMENT

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

SWD 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 SWD, have been developed and are being implemented. These procedures provide QA documentation, which ensures that available data have been incorporated and entered or uploaded properly into SWD. Data integrity is maintained with standard OPs and standardized error checking routines used when loading data into SWD. Other procedures are being developed for database system security and software change control.

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The RFETS field data is entered through the DATACAP field data entry system. This system is a data entry module that is compatible with the SWD 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 SWD database.

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

All well and borehole log information is maintained in the Water Programs Group's Equis Log Database. The Equis Log Database has graphic logs of boreholes and wells on RFETS, and displays well construction details and geologic information. Subsurface geologic correlations are displayed using Earth Vision® Software.

3.4.3 GROUNDWATER DATA QUALITY ASSESSMENT

Part of the data assessment process is to establish adequate 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 QAPPGW (RMRS, 2000a) and in Site Procedure RF/RMRS-98-200 (RMRS, 1998).

3.5 DESCRIPTION OF THE GROUNDWATER MONITORING PROGRAM RESULTING FROM THE DQO PROCESS

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

The proposed monitoring program comprises the following monitoring components:

- A network of 186 wells and some footing drains sampled on a semiannual basis;
- A network of 16 wells and seeps sampled quarterly;
- Monthly measurement of water elevations at 51 wells;

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- Quarterly measurement of water elevations at 195 wells;
- Semiannual measurement of water elevations at 78 wells;
- Real-time measurement of water elevations in 33 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 includes the following seven categories of monitoring wells:

- Plume definition - 22 wells
- Plume extent - 41 wells
- Drainage - 5 wells
- Boundary - 6 wells
- Performance - 33 wells
- D&D - 74 wells
- RCRA - 8 wells
- Plume degradation - 13 wells

There are only six wells that will be removed from the monitoring network in FY03. Well 18399 is near IHSS 118.1 and was left in the IMP by mistake. It had been removed from the program two years ago because it was redundant to another well being monitored there.

Wells 10592, 10692 and 10792 were performance monitoring wells for the 881 French Drain. Now that the french drain has been decommissioned, there is no further need to monitor these wells.

Well P209489 was abandoned in preparation for the decommissioning of the Solar Ponds. New well 79202 was installed in the same general area and will monitor this area in the future.

Well 2186 was monitored to look for the northern extent of the IA plume. The northern extent has now been better defined and it is apparent that the plume does not reach the area monitored by this well.

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

3.5.1 GROUNDWATER MONITORING NETWORK

The DQO evaluation process has been used to design the groundwater monitoring program and determine the 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

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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 and Site knowledge have been used to determine which contaminants are of major interest in RFETS groundwater. The analyte suites tested for in water from current monitoring wells include the identified analytes of concern.

The RFCA analyte lists for groundwater use concentration levels that may differ from the Site-specific levels used in the past. Major analytes of interest 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* (EG&G, 1993b). The data were then screened against the action levels in the ALF and exceedances were noted for each well. 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 contains the analyte suites that will be collected for each well.

3.5.2 GROUNDWATER SAMPLING AND ANALYSIS

The operational groundwater sampling network will contain 205 wells and other sampling locations, 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 RFETS 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 a 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:

- For bailed wells, filtered samples will be collected for metals analyses and U isotopes; unfiltered samples will be collected for organics analyses, water quality, and other radionuclides. For micropurged wells, samples will not be filtered.
- Well-site field parameters measured are temperature, pH, specific conductance, turbidity, and alkalinity. Total dissolved solids (TDS) will be measured as either a laboratory parameter or a field parameter.
- If limited groundwater sample volumes prevent analysis of the target analyte list, the analyses will be performed in the following order in accordance with RMRS/OPS-PRO.113, *Groundwater Sampling* (RMRS, 2000). The listing outlines the methods and sample collection hierarchy for groundwater samples. The analytes collected at each well are unique and are shown in Appendix E-2. In some cases, other special analytes are collected from wells as requested in project specific Sampling and Analysis Plans.

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1. VOCs— Contract Laboratory Program SW846, Method 8260;
2. Semi-volatile organic compounds;
3. Pesticides and polychlorinated biphenyls (PCBs);
4. Nitrate/nitrite, as nitrogen;
5. Metals;
6. Specific metals for a given well;
7. Uranium-238, -235 and -233/234;
8. Strontium-89/90;
9. Plutonium-239/240, americium-241;
10. Major anions (chloride, fluoride, sulfate, carbonate/bicarbonate); and
11. Tritium.

- Note that there is a change to the analysis methodology for groundwater samples. VOCs are now being run under EPA SW846, Method 8260 as opposed to previous Method 524.2. This was an administrative change made because the QC procedures for Method 8260 were more rigorous while retaining the same analyte list and detection limits.

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

3.5.3 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 ten 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.

3.5.4 GROUNDWATER REPORTING

Groundwater activities will be reported throughout the life of the monitoring program. The communication to responsible parties, as outlined in the DQO decision statements in Section 3.4.2 will be accomplished at various levels of formality depending upon the nature of the activity.

Monitoring information from individual projects will be communicated to project personnel when the results pose an impact to project activities or affect general cleanup strategies. In addition, monitoring information is also collected in the Soil Water Database which can be accessed by RFETS personnel who want information for specific monitoring locations.

The RFCA Quarterly Groundwater Compliance Reports contain a summary of groundwater monitoring data collected in a calendar quarter at RFETS. The data will be presented at public quarterly information exchange meetings and officially transmitted to EPA and CDPHE by

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DOE. These reports will also be posted on the RFETS 'EDDIE' webpage which is accessible by RFETS personnel.

The RFCA Annual Groundwater Compliance Report will be reviewed and approved by DOE, who will transmit copies to EPA and CDPHE. Highlights from the Annual Report may be presented at the public Quarterly Water Workgroup Meetings. This report will also be posted on the RFETS 'EDDIE' webpage.

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

3.5.4.1 RFCA Annual Groundwater Report

An annual assessment of groundwater conditions is required in the DQO decisions in this document. 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 *RFCA Annual Groundwater Report* will replace these prior 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 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 RFETS 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 an 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* (EG&G, 1993a).
- If both the action level and background levels have been exceeded for an analyte that has not had consistent historic exceedances, an evaluation will be proposed. Remediation and 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.

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- 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 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* (EG&G, 1993a).
- 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 management decisions will be made based on the results of the evaluation.
- If a particular analyte has been consistently detected above the Tier II Action Level and historic data background, a check will be made to see if surface water impacts have been evaluated. 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 an 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:

- D&D monitoring wells may be existing monitoring wells or special wells installed to detect unplanned excursions of contaminants during or after a building D&D activity. Where there is a groundwater concern, a baseline should be established for water quality before major demolition activities begin. The baseline should be established two years prior to the D&D action and should be composed of a minimum of four sample events. After the baseline is established, deviations above the baseline mean + 2 standard deviations will be reported. Trend plots may be used to track concentrations where deviations are encountered.

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 used will 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:

- Reporting of well monitoring for a permitted RCRA facility is 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.

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The annual report will provide the results of monitoring on a calendar year basis. To date, *RFCA Annual Groundwater Monitoring Reports* (Kaiser-Hill, 1997, 1998 1999, 2000, 2001) have been produced for calendar years 1996 through 2000. 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 *Annual Report* to the regulatory agencies by November 15.

3.5.4.2 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 a RFCA ALF document.

The RFCA quarterly report for groundwater will replace previous quarterly reports and integrate 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 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 SWD in time for the report. The report for a 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.

3.5.5 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 DQO that will determine the type of data that need to be collected, and the methodology for determining the nature and extent of contamination and its effect on surface water. The plume management strategy and performance/D&D monitoring strategy is outlined in the following subsections.

3.5.5.1 General Strategy for Groundwater Plume Management and Remediation

The existence of groundwater contaminant plumes (e.g., VOC, radionuclide, nitrate) at RFETS has been well documented. The *Groundwater Conceptual Plan for the Rocky Flats Environmental Technology Site* (RMRS, 1996) presented a summary of the known information on individual groundwater plumes and possible remedial actions. For purposes of implementing the IMP, the following template serves as a unifying policy for plume management and decision making for groundwater plumes under the IMP and aids in the integration of groundwater functions into closure planning at RFETS.

The plume management strategy for RFETS will consist of the following components.

Detection:

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The detection of groundwater contamination that could impact surface water at RFETS is supported through the current water monitoring programs at RFETS as well as through historic data from past investigations and information on past contaminant spills. The surface and groundwater monitoring programs have been established to detect the migration of contaminants into water that could move off Site. The monitoring programs are dynamic and may be changed to accommodate new insights into contaminant migration. The maintenance of historic data in the Soil Water Database and the HRR (DOE, 1992a) help provide information on potential groundwater contamination problems.

The IMP gives DQOs that establish the methods of detection and the actions that will follow.

Evaluation:

Many of the DQO decisions for groundwater monitoring require that an evaluation be performed to assess impacts to surface water caused by potential groundwater contamination. In many cases, the evaluation is predicated on the confirmatory sampling that follows an exceedance of groundwater action levels. If follow up sampling confirms an exceedance, or if historic data have indicated an impact to surface water that has not been evaluated, an evaluation will be performed. In general, the evaluation phase will involve a focused DQO which will determine the type of data that will need to be collected and the methodology for determining the nature and extent of contamination and its impact on surface water. The following are possible components of an evaluation of surface water impact:

- Definition of extent 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 and/or surface water;
- Determination of concentration loadings and mass flux of contaminants to the stream; and
- Estimation of impacts due to 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 ensure that the available budget will be allocated to areas with the highest potential for contamination. Once a significant impact to surface water has been established, the findings will be provided to the RFETS organization responsible for remediation. This organization will establish or update priorities for remediation. At that point, the scope will be promulgated as an accelerated action, Proposed Action Memorandum (PAM), or an IM/IRA. The ALF section in RFCA that deals with Tier II wells requires modeling of impacts to surface water through mass balancing and flux calculations, where action levels have been exceeded. It is assumed that these predictive components of the evaluation will be weighed against actual field data in setting the priority for remediation.

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Remedial Decision Validation:

Additional groundwater monitoring may be required to validate the efficacy of a remedial action or the no-action alternative. Performance monitoring will consider both the short term and the long term protection of surface water. A DQO process will be employed to establish a performance monitoring system. Decisions will require involvement of the groundwater workgroup during key phases of the evaluation, and the actions will be implemented through the IMP process. The Quarterly and Annual RFCA Groundwater Reports will track the long term results of the monitoring activities and recommend changes if necessary.

3.5.5.2 General Strategy for Performance and D&D Monitoring

This section addresses monitoring specific on-Site remedial activities for the release of contaminants to the environment. In general, performance monitoring relates to a soil remedial action or a groundwater treatment remedy. D&D monitoring relates to the removal of a contaminated building or group of structures. Project-specific performance monitoring, if necessary, will be detailed in a decision document or project plan through the review and approval process when the project poses a concern for a specific contaminant release, especially for a contaminant that may not be adequately monitored by other monitoring objectives. Each performance or D&D monitoring location will target the contaminants of greatest concern for the specific action being monitored. For example, performance monitoring for specific analytes may be needed for:

Building D&D Activities: The review process for a D&D action may identify the need for monitoring specific to that action.

Remedial Actions: There are monitoring requirements associated with specific ER activities. For example, performance monitoring for RFETS operating groundwater plume treatment systems is specified in the related decision documents (i.e., *Final Mound Site Plume Decision Document, Final Proposed Action Memorandum for the East Trenches Plume, Final Solar Ponds Plume Decision Document).*

RFETS is developing an integrated approach for evaluating and implementing surface water and groundwater project specific performance monitoring. Under this approach, integrated project reviews are to be initiated 24 months prior to the planned start of D&D and remediation projects. This approach emphasizes those projects where contaminant sources (i.e., IHSSs, buildings, building sumps, and footing drains) are most likely to impact surface water. The integrated approach incorporates the steps already established by the decision process that has evolved since the start of RFCA.

To further improve monitoring network resolution and isolate discrete projects, a process was developed for screening D&D and remediation projects. The process starts with a review of RFETS closure schedules to determine the relative order of major D&D and remediation projects. The building classification is also reviewed to determine whether it is classified as a Type 2 or 3 building, as these are buildings that would be potential targets for D&D monitoring. A document review is then performed to determine which buildings have had significant processes and associated spills or leaks to pose a threat to surface water quality. The Historical Release Reports, ChemRisk reports, and legacy environmental monitoring data are reviewed, groundwater and surface water flow pathways evaluated, and project managers interviewed to

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identify and quantify specific concerns. For projects needing D&D or performance monitoring, a combination of historic data review and field walk-downs are conducted to further delineate monitoring locations. In some cases, existing monitoring stations can be used to achieve the performance or D&D monitoring goals. The overall goal is to implement performance and D&D monitoring for 24 months prior to project startup to enable development of a water-quality baseline for evaluating potential project impacts on surface water.

To further refine the performance and D&D monitoring review and implementation process, the following strategy was developed to determining if additional monitoring is needed.

- Which project do we monitor? (Specifies those buildings (or building clusters) and remediation projects that need independent performance/D&D monitoring).
- Where do we monitor these projects? (Specifies the existing or proposed monitoring locations needed to adequately observe project impacts).
- When do we monitor these projects? (Specifies monitoring to begin ~24 months prior to project initiation; target to collect 4 samples for initial baseline determination).
- What do we monitor for? (Specifies that analyte suites are determined by the analytes of interest associated with a specific project).
- How do we monitor? (Specifies flexible design of sample collection method intended to confidently monitor for changes in water quality).
- How do we recognize a problem? (Increasing trend for performance monitoring or Mean + 2 STD DEV above building D&D baseline).
- Who do we report to and what actions are taken? Specifies that RFETS will evaluate specific project to improve performance if evaluation shows change in water quality.

The template starts with these fundamental questions and poses a series of detailed questions to guide the process for evaluating candidate projects, assessing specific performance monitoring needs (i.e., where, when and what), communicating these requirements to the project manager and assisting in the determination of sampling and analysis requirements for inclusion in the project plan, and implementation for performance monitoring/reporting process.

Template for Performance/D&D Monitoring:

I. Monitoring Location Selection

A. Selection of Projects (Buildings/Actions) to be Monitored

Consider project-specific risks to surface water

- Scope of activities
- History of project area or building

Consider project duration

- Sufficient time to collect adequate data for evaluation purposes
- When will monitoring begin and end based on project schedule? Consider relative risks

B. Selection of Project Groundwater Locations to be Monitored

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Identify groundwater pathways for project

- Locate footing drains, if applicable
- Determine groundwater flow direction
- Determine if there is a groundwater plume associated with IHSS

Determine IHSS/building specific locations of potential contamination

- Is there a basement or sub-basement?
- Are there areas of an IHSS that are more contaminated?
- Will monitoring equipment interfere with project activities?
- Does the specific building or IHSS pose a significant risk to surface water? What is the level of effort to implement monitoring? Does the risk warrant the effort to implement monitoring?
- Can monitoring at existing sample locations serve as an alternative?

II. Data Requirements

A. Installation Requirements

Consider depth of wells with respect to potential contaminant pathways

B. Analytes of Interest

Consider history of project area or building

Consider scope of project

C. Water Level Measurements

Frequency of Measurement?

C. Sampling Frequency

How many samples month/year?

D. Field Data Collection

Consider Field Parameters Required

III. Data Evaluation

A. Determine Changes in Water Quality at Specific Location with Applicability to Specific Building/IHSS Sources

Statistically compare new data points against old data points

- Upgradient/downgradient/Control Charting/Baseline Comparison; consider persistence

  a) IF new data point is not significantly different than old data points incorporating additional corresponding information; THEN continue monitoring

  b) IF new data point is significantly different than old data points incorporating additional corresponding information; THEN initiate notification/action process

- Does the specific event pose a significant risk to surface water at POEs and POCs?

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B. Notification Process

Schedule/time table

To be determined

Hierarchy/personnel involved

- Building or Project Managers will be notified first
- DOE will be notified next
- Regulatory Agencies will be notified next

Notification items

- Nature of anomalous event
- Constituents involved
- Suspected source where constituents may have originated
- Other?

C. Action Determination

Determine potential impact to surface water

- Estimate direction and magnitude of contaminant to reach surface water; incorporate consideration of hydrologic conditions and indicator parameters.
- Track progress of plume using groundwater and/or surface water locations
- Estimate contaminant fluxes and loads if necessary

Verify activity/location responsible

- Based on event characteristics
- Based on suspected area where constituents may have originated

Determine potential mitigating actions

- Based on identified activity/location responsible
- Based on event characteristics, constituent
- What is the level of effort to implement mitigating actions?
- Does the risk to surface water warrant the mitigating action?
- Would the mitigating actions result in unacceptable delays to other higher priority risk reduction activities?

This template will be applied in an integrated fashion where groundwater contamination is of concern, (e.g., if building foundation drain is identified as a potential source of groundwater contamination). In this case, the appropriate recommendations will be made to the building or project to include a performance monitoring specification in the project plan. The selection of appropriate monitoring locations for flow measurement and sampling will be determined in conjunction with the planned configuration of the groundwater monitoring network. The

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integrated groundwater performance monitoring/D&D monitoring design package, in the form of a proposed sampling and analysis plan or project plan, will be delivered to the D&D project manager for review. Data analysis and evaluation techniques will be in accordance with the IMP. Monitoring results will be reported in RFCA groundwater compliance reports and data will be accessible in SWD and the EDDIE webpage. Individual project notification will occur when monitoring results could impact project activities.

3.5.6 GROUNDWATER FLOW MODELING

Computer modeling of the groundwater system at RFETS 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.

The Site has recently completed a Site water balance using the MIKE/SHE coupled groundwater/surface water modeling software. This model has been used to run water balance scenarios for the Site and is now being used for other purposes, including contaminant transport. This plan proposes that this current groundwater flow model, supporting software, and graphic coverages be maintained and updated and used in problem-solving and tracking how closure activities affect the environment.

3.5.7 WELL CONTROL PROGRAM

The Well Control Program is currently a RFETS procedure for new well and piezometer installations (RMRS, 1999b). The procedure is implemented through the Water Programs Group. The Well Control Program ensures that proper recording and tracking of well installation activities on RFETS 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. The instructions and form are available in RFETS Procedure PRO-1059-WELL-118 (RMRS, 2000b).
- Maintaining a database of well construction information and geologic log information that must be submitted with the permit applications.
- Submitting permits for wells that are installed or abandoned to the State Engineer's Office.
- Maintaining the RFETS geologic core repository for use in correlation of geologic strata and interpretation of hydrogeologic properties.
- Through an approval process before well construction, ensuring that wells are installed following applicable procedures and with appropriate knowledge of geologic and RFETS conditions.

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3.5.8 WELL ABANDONMENT AND REPLACEMENT (WARP)

Beginning in FY02, wells that are considered no longer necessary for groundwater monitoring purposes will be abandoned. Abandoning a well eliminates it from the monitoring network in such a manner that the well will not remain a conduit for groundwater or contaminant migration. WARP will replace damaged or poorly constructed wells useful to the monitoring network and abandon others. The project will continue through FY05 and will result in the removal of about 1,000 wells. In tandem with this activity will be evaluations of the groundwater monitoring network to insure that the wells necessary for compliance are retained.

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 damaged;
- When the well is in the way of proposed construction or demolition activities; and
- When the well has no identified purpose for future monitoring.

The General description of WARP activities can be found *in The Well Abandonment and Replacement Program Work Plan*. Specific information, including wells to be abandoned or replaced and schedules, is presented in various work plan addenda to this document. A report describing the results of the WARP, including well installations, abandonment, and replacement, will be included as a section in the RFCA Annual Reports.

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4.0 AIR MONITORING

4.1 INTRODUCTION

The Air Quality Management (AQM) group within Kaiser-Hill's Environmental Systems and Stewardship (ESS) organization provides oversight for regulatory activities encompassed by federal and state regulations established pursuant to the Clean Air Act (CAA) and its amendments. AQM develops compliance, reporting, and record keeping strategies that organizations at RFETS use to maintain compliance with applicable air quality regulations and Department of Energy (DOE) Orders. Within that framework, AQM operates effluent, ambient, and meteorological monitoring programs that support both compliance demonstration and emergency response needs at RFETS. Additional air monitoring is performed by the Colorado Department of Public Health and Environment (CDPHE) or coordinated by DOE.

The goal of the air quality program is to provide a means to assess the impact of RFETS operations on air quality at and near the RFETS, and thereby protect the public and the environment. These monitoring programs contribute to the RFETS environmental protection program by providing measurements that can be used to quantify and characterize the effects of Site activities on air quality.

4.1.1 AIR MONITORING OBJECTIVES AND REGULATORY DRIVERS

The air monitoring program at RFETS fulfills multiple objectives. In many cases, those objectives are mandated by CAA regulations or by DOE Orders. Regulatory drivers pertinent to air monitoring programs include:

- Ambient Monitoring:
  - Title 40 CFR Part 61, Subpart A "General Provisions," Subpart H "National Emission Standards for the Emissions of Radionuclides Other Than Radon From DOE Facilities" (Rad-NESHAP) and Appendix B [NOTE: ambient monitoring is performed as an alternative compliance demonstration method];
  - Colorado Air Quality Control Commission (CAQCC) Regulation No. 8, Part A, Subpart A, "General Provisions" and Subpart H, "National Emission Standards for Emissions of Radionuclides Other Than Radon From Department of Energy Facilities;" and
  - DOE Orders 5400.1, *General Environmental Protection Program*, and 5400.5, *Radiation Protection of the Public and the Environment*, U.S. Department of Energy.
- Effluent Monitoring:
  - 40 CFR 61, Subparts A and H; and
  - DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy.

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- Meteorological Monitoring:
  - 40 CFR 61, Subpart H and CAQCC Regulation No. 8, Part A, Subpart H (meteorological observables used as input to dispersion modeling, if necessary);
  - DOE Order 5400.1-IV; 2.4, *General Environmental Protection Program*, U.S. Department of Energy;
  - DOE Order 5500.3A, *Emergency Planning and Preparedness for Operational Emergencies,* U.S. Department of Energy; and
  - DOE Order 414.1A, *Quality Assurance,* U.S. Department of Energy.

Air monitoring is performed to comply with regulatory requirements and to support the assessment of RFETS operations, either directly, as is the case with the effluent monitoring program, or indirectly, as with ambient and meteorological monitoring. For example, while monitoring of radioactive emissions from building process vents fulfills monitoring and reporting requirements of both DOE Orders and Rad-NESHAP regulations, these effluent data also support Nuclear Safety evaluations of the building safety envelope.

Effluent monitoring also supports ALARA principles. These DOE principles provide a conceptual radiation exposure guideline intended to encourage radiation protection practices that are more protective than those of a 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 an environmental regulatory perspective are sufficient to trigger a proactive investigative response under the ALARA concept.

Ambient monitoring of radionuclides on RFETS and at the perimeter is performed by AQM and by CDPHE. Ambient monitoring in the communities immediately adjacent to RFETS is supported by DOE, as explained below.

Ambient monitoring satisfies DOE Order requirements and has been given approval for use in satisfying Rad-NESHAP compliance demonstration requirements. Ambient data can be used in human health risk assessment evaluations of Operable Unit closure. Data from ambient monitoring are also used to validate projections made by dispersion modeling. In addition, ambient data from the Radioactive Ambient Air Monitoring Program (RAAMP) are used to confirm that controls are operating within Nuclear Safety's ALARA limits, under the DOE directive that strives to keep doses to receptors as low as reasonably possible by maintaining administrative and physical controls on potential sources of radiological exposure.

On-Site meteorological monitoring supports both the Rad-NESHAP reporting requirements and emergency response requirements under the DOE Orders. Meteorological data are currently used for air quality monitoring support, atmospheric dispersion modeling, hydrologic studies, construction management, and safety investigations. Emergency response operations and their associated modeling efforts make use of the RFETS meteorological data.

In cooperation with the surrounding communities, DOE has implemented a four-station Community Radiation (ComRad) Monitoring Program. In 1992, independently operated monitoring stations were installed in the communities of Arvada, Westminster, Broomfield, and

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Northglenn. Ambient concentrations of Pu, meteorological data, and gamma radiation data are collected continuously using monitoring protocols comparable to those at RFETS. Sample analysis is performed at Paragon Analytics, Inc., laboratories in Fort Collins, Colorado. Although not a compliance-driven program, DOE supports this independent monitoring through grants as a gesture of public good will.

4.1.2 RFETS AIR MONITORING SCOPE

The ESS group provides programmatic support to RFETS operations to assure compliance with state and federal laws and regulations, and DOE Orders related to the air impacts of RFETS operations. The scope of this support includes the characterization of selected airborne materials and the meteorology responsible for their transport and dispersion, with monitoring activities playing a major role in this characterization. Criteria for success include completeness of permitting and surveillance activities, compliance with air quality regulations, adequate QA/QC of the measurement activities, well-characterized data sets, and full reporting of required information to state and federal regulatory authorities. ESS air quality monitoring programs do not include sampling conducted to support industrial hygiene or radiation worker safety programs.

4.1.2.1 Ambient Air Monitoring

The RAAMP monitors airborne dispersion of radioactive materials from RFETS into the surrounding environment. Thirty-eight samplers are deployed in the RAAMP network. Fourteen of these samplers, located around the Site perimeter, are used to satisfy Rad-NESHAP compliance demonstration requirements using environmental measurements; the others are used to characterize resuspension from non-point sources, and to identify exposure and plume path should there be an accidental release from RFETS.

Samplers operate continuously at a volumetric flow rate of approximately 40 cubic feet per minute (ft^3/min) (1.13 cubic meters per minute [m^3/min]), collecting airborne particles on two collection surfaces. Coarse, non-inhalable particles (larger than about 10 micrometers aerodynamic equivalent diameter) are collected on an oiled impactor surface; fine, inhalable particles (smaller than 10 micrometers) are collected on glass fiber filters. The paired, size-partitioned samples are analyzed independently to quantify differences in radioparticulate partitioning between inhalable and non-inhalable airborne particles.

Collection substrates are exchanged monthly for RAAMP samplers that are not assigned to performance monitoring (see below). Substrates from the compliance demonstration samplers are subjected to digestion, radiochemical separation, and alpha spectral analysis, which quantifies specific alpha-emitting radioisotopes. Analyses are performed for specific isotopes of Pu, U, and Am. Sample substrates from RAAMP monitors employed as performance monitors are exchanged and analyzed as described in Section 4.5, *Performance Monitoring*. Samples from the remaining RAAMP monitors are archived for the remainder of the closure project.

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4.1.2.2 Effluent Air Monitoring

At weekly intervals, particle samples from continuous effluent sampling systems are removed from 19 building exhaust systems identified as having a potential to emit radioisotopes to the environment above a regulatory level of significance. Significant emission points are those with the potential (uncontrolled) to release radioactive materials in sufficient quantity to contribute 0.1 millirem (mrem) or more per year effective dose equivalent (EDE) to a member of the public. These samples, collected on 47-millimeter (mm) filters, are 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.

Weekly effluent sample filters from significant sources are composited into monthly samples for each emission point and analyzed for specific isotopes of Pu, U, and Am. Detection limits are established to ensure that these radionuclides can be detected at concentrations that would yield a dose to a member of the public equal to 10% of the regulatory standard, using Appendix E guidelines from 40 CFR 61.

Radioparticulate emissions from insignificant sources, which are not monitored using effluent samplers, are accounted for using the ambient monitoring network.

4.1.2.3 Meteorological Monitoring

Meteorological monitoring is conducted on RFETS by use of a 61-meter (m) tower instrumented at four levels (1.5m, 10m, 25m, and 60m). The tower is instrumented to collect meteorological data for modeling, and to provide support for routine monitoring and assessments and emergency response.

4.2 RADIOLOGICAL NESHAP COMPLIANCE MONITORING

RFETS must demonstrate compliance with the Rad-NESHAP air emission monitoring requirements and dose standards. This demonstration is accomplished using ambient monitoring by the RAAMP network. Effluent monitoring of significant sources can provide a secondary means of demonstrating compliance through release modeling. Since tritium is a gas and is not captured by the RAAMP network, the dose contribution from tritium is evaluated through inventory tracking and release modeling (the dose potential from incidental RFETS tritium sources is not sufficient to require environmental monitoring under the Rad-NESHAP).

4.2.1 AMBIENT RADIOLOGICAL NESHAP COMPLIANCE MONITORING

In accordance with the RFETS closure mission, buildings are being decommissioned then demolished. In the normal course of the decommissioning process, equipment removal and structural demolition will be carried out with the existing ventilation systems disrupted or dismantled at some point in the process. A lack of directed flow from the potentially-contaminated areas would preclude normal effluent monitoring in these buildings. Such buildings will become non-point (diffuse) sources of airborne radionuclides. Building effluent sampling therefore ceases to be an effective means of radionuclide monitoring and ambient air monitoring becomes essential.

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Decision Statement:

IF RFETS cannot use standard prescribed monitoring methods to characterize the emissions from a regulated emission source (i.e., effluent monitoring), as would be the case during decommissioning and demolition of a source building—

THEN RFETS must obtain approval for an alternative methodology from the regulatory agency having primacy.

The use of ambient monitoring has been approved by EPA Region VIII and CDPHE as an alternative sampling method to document dose to potential public receptors and demonstrate compliance with the 10 mrem/yr dose standard. This methodology allows for direct measurement of radionuclide concentrations in air at RFETS boundary.

Inputs:

- Monitored concentrations of Pu-239/240, Am-241, U-233/234, U-235, and U-238 at fourteen compliance RAAMP samplers;
- Modeled dose from tritium release, based on tritium inventory tracking; and
- Quality assurance of monitoring data.

Boundaries:

Spatial: RAAMP samplers sited with a density that will capture a plume that has a duration of two hours or more (14 locations around RFETS perimeter).

Temporal: Rolling 12-month average dose, as calculated using:.

Monthly calculations of ambient air concentrations;

Monthly isotopic and field data from RAAMP sampler filter analyses; and

Annual tritium release data from tritium inventory tracking.

Decision Statement:

IF The measured radiological dose to a member of the public is greater than 10 mrem/yr EDE due to RFETS operations—

THEN RFETS is out of compliance.

Current ambient monitoring data from the RAAMP network indicate that the EDE to a member of the public is less than three percent of the 10 mrem/yr EDE standard.

Detection limit may be defined 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 gives the required minimum detection limits (MDL) for the ambient sampling network.

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Table 4-1 Minimum Detection Limits for Ambient Air Samplers

Parameter	Required MDA (per individual filter) (pCi)	Approximate Sample Volume (m^3)	MDA (pCi/m^3)
Pu-239/240	0.14	48,937	2.86×10^{-6}
U-233/234	0.59	48,937	1.20×10^{-5}
U-235	0.59	48,937	1.20×10^{-5}
U-238	0.59	48,937	1.20×10^{-5}
Am-241	0.18	48,937	3.68×10^{-6}

4.2.2 EFFLUENT AIR COMPLIANCE MONITORING

If necessary, compliance may be demonstrated using effluent monitoring and dispersion modeling. To accomplish this, the following critical inputs must be evaluated:

Inputs:

- Monitored concentrations of Pu-239/240, Am-241, U-233/234, U-235, and U-238 from applicable emission sources;
- Site-specific meteorology for the year that the monitored data are reported;
- Resuspension coefficient for soils;
- Documentation of emissions potential from unmonitored RFETS activities having potential to emit radionuclides;
- Verification of low emissions for sources not subject to continuous monitoring requirements; and
- Quality assurance of monitored data.

Boundaries:

Spatial: Areas hosting activities on RFETS that could impact off-Site populations.

Current effluent sampling, occurring at 19 building release points located throughout the IA.

Temporal: Rolling 12-month dose estimates, as calculated using:

Monthly calculation of effluent air concentrations;

Monthly isotopic and field data from significant emission points; and

Annual tritium release data from tritium inventory tracking.

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Decision Statement:

IF The estimated radiological dose to a member of the public is greater than 10 mrem/yr due to RFETS operations—

THEN RFETS is out of compliance.

RFETS continues to perform continuous effluent monitoring for significant sources not engaged in active decommissioning. The most recent dispersion model predictions using data from this monitoring yield estimated doses that are three orders of magnitude below the regulatory standard at RFETS boundary.

Monitoring Requirements:

A continuous effluent monitoring system must be installed and activated for analytes identified in above inputs for significant sources. Sample filters from significant source effluent monitoring systems are analyzed monthly.

Detection limit may be defined 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 4-2 shows the MDA or detection limits for various effluent analyses that are required of the off-Site laboratories that perform the analyses (on a per sample basis). MDA values calculated for individual analyses may vary depending on actual sample volume, chemical recovery, and analytical blank variability.

Table 4-2 Minimum Detection Limits for Effluent Air Samples

Parameter	Required MDA (per sample) (pCi)	Approximate Sample Volume (m^3)	MDA (pCi/m^3)
Pu-239/240	0.14	7,340	1.91×10^{-5}
U-234	0.59	7,340	8.04×10^{-5}
U-235	0.59	7,340	8.04×10^{-5}
U-238	0.59	7,340	8.04×10^{-5}
Am-241	0.18	7,340	2.45×10^{-5}

4.3 METEOROLOGICAL MONITORING

Continuous meteorological monitoring is conducted in the northwest Buffer Zone using a 61-m tower, instrumented at four levels (1.5, 10, 25, and 61 m). Data are collected for wind speed, wind direction, temperature, relative humidity (dew point), solar radiation, precipitation, and a calculated sigma-theta (used to determine Pasquill-Gifford stability classes). Data are used as inputs for air quality and emergency response dispersion modeling. Data are also used as inputs to CERCLA risk assessment calculations and hydrological assessments.

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4.3.1 DATA USE FOR RADIOLOGICAL NESHAP

Collected meteorological data are used as RFETS-specific inputs to the Rad-NESHAP compliance modeling, when required. Inputs to the modeling calculations require annually averaged meteorological data. Continuous monitoring is required to collect representative annual values.

4.3.2 DATA USE FOR EMERGENCY PREPAREDNESS

Data also provide real-time input to the RFETS emergency response model (Computer Assisted Protective Action Recommendations System [CAPARS], formerly called the Terrain Responsive Atmospheric Code). Fifteen-minute averaged data are used to calculate the real-time movement of a pollutant plume as it disperses from the location of an accident. Five CDPHE-operated meteorological towers, as well as other nearby meteorological stations, also provide support to RFETS emergency response modeling.

4.3.3 DATA USE FOR OTHER COMPLIANCE MODELING

Meteorological data are basic inputs into various regulatory and research models used at RFETS. AQM 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 or monitoring requirements. Modeling has also been performed to support the Actinide Migration Evaluation, with meteorological data feeding into both the erosion modeling and air dispersion/deposition modeling efforts.

4.3.4 METEOROLOGICAL MONITORING SPECIFICATIONS

The following data quality specifications are common to 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; and
- Solar radiation data.

Boundaries:

Spatial:	Representative air flow patterns impacting RFETS.
	A minimum of 10 m above ground level.
Temporal:	Continuous data, averaged every 15 minutes.
	Hourly averaged data, calculated from the 15-minute averages.
	Annually averaged data and frequency distributions.

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Decision Statement:

IF	Regulatory compliance, emergency response, or risk assessment modeling is performed at RFETS—
THEN	Standard, consistent, RFETS-specific meteorological summaries shall be used to ensure most representative model results.

Monitoring Requirements:

Operate meteorological monitoring station with a 90% or better data capture to provide data inputs in support of RFETS-required modeling programs (EPA, 1987).

4.4 CDPHE AMBIENT AIR MONITORING

CDPHE's Laboratory and Radiation Services Division (LARS) has monitored radioactive emissions from RFETS since 1969. The primary purpose for this sampling has been to provide an independent assessment of public exposure to radioactive material released from RFETS. The LARS monitoring program has provided validation of sampling methods used by RFETS organizations, confirmation of RFETS measurements of Pu in air, and, on occasion, helped identify errors made by RFETS monitoring personnel. The data are compared to Derived Concentration Guides for non-occupationally 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.

4.4.1 CDPHE MONITORING

Concerns about releases during accidents or abnormal situations continue to arise and may increase as cleanup progresses. Emergency response plans for RFETS include provisions for sampling environmental media after a plume dissipates. The continuous air samplers operated by LARS allow the CDPHE to begin fulfilling this obligation immediately after a release and would ultimately provide more accurate exposure assessments than output from CAPARS or other models. Routine analyses of these samples provide baseline data for comparison to known or suspected releases.

Data from LARS air samplers support the Air Pollution Control Division (APCD) in its evaluation of RFETS compliance with NESHAP requirements, as well as providing documentation for ALARA decisions that 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 U, Pu and Am on quarterly composites of selected samplers.
- Statistical analysis of weekly gross alpha data collected since January 1999 demonstrates that values exceeding 0.012 pCi/m^3 are extremely rare. This value has been selected as the activity level that will trigger additional analyses or other actions.

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Boundaries:

Spatial: LARS currently samples air at 11 locations: three east of the IA, three in the Buffer Zone, and five near RFETS boundary. Total suspended particulates (TSP) are sampled at all locations. Samples are analyzed for long lived gross alpha/gross beta.

Am, Pu and U are analyzed at perimeter locations and at the two ground level samplers nearest the IA (D-1 and D-3.)

Temporal: Individual samples are collected continuously for one week. Fractions of 13 weekly samples from selected locations are composited and analyzed as quarterly samples, corresponding to calendar quarters.

Decision Statement:

IF The latest gross alpha data point exceeds 0.012 pCi/m^3

THEN Expedite analysis of that weeks' sample for Pu, Am and U.

IF A measurement of Pu, Am or U 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 the sample for verification; analysis of other samples collected during the week in question; a request for analysis of comparable samples from the nearest DOE ambient samplers and ComRad Program samplers; a request for investigation or explanation of elevated results from DOE or its contractor; a calculation of public dose or risk; and a presentation of analysis and investigation results to CDPHE management and public forums, as requested.

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 a unplanned short-term release. In the absence of real or suspected exceedances, trend analysis should be sensitive to small, upward shifts in concentration, especially in the case of boundary samplers.

CDPHE detection limits are calculated at the 95% confidence level. While no specific detection limit is required, Table 4-3 summarizes typical detection limits for LARS samples, assuming 100% chemical recovery.

Table 4-3 Detection Limits for CDPHE Air Samples

Parameter	Approximate Sample Volume (m^3)	MDA (pCi/m^3)
Gross alpha activity	300 per week, 30 per day	0.003 weekly, 0.02 daily
Gross beta activity	300 per week, 30 per day	0.004 weekly, 0.03 daily
U-234, U-235, U-238	3,400	5.0×10^{-5}
Pu-239/240	3,400	1.0×10^{-6}
Am-241	3,400	1.0×10^{-6}

4.4.2 CDPHE SPECIAL PROJECT MONITORING – 903 PAD REMEDIATION

To provide an independent assessment of potential public exposure to radioactive material released during environmental restoration activities, CDPHE proposes to conduct ambient air monitoring using existing routine monitoring locations in close proximity to the 903 Pad Area. The CDPHE program could be expanded in the future should Site or CDPHE air monitoring data exhibit out of the norm or inconsistent values.

Problem Statement:

The 903 pad area contains elevated levels of Pu and Am in near surface soil. During remediation efforts involving excavation of the asphalt cover and removal of soil up to about 18-inches beneath the asphalt cover, the potential exists for a release of nuclides (Pu and Am). Remediation activities are slated to be conducted within the confines of a weather enclosure, which will also provide additional measures for controlling potential release of particulates. Kaiser-Hill (K-H) has developed a Performance Monitoring program to ensure that any significant release can be detected and quantified. CDPHE (LARS) will collect independent samples to supplement the K-H data and verify that concentrations in the vicinity of projects are consistent with Rad-NESHAP and ALARA compliance attainment.

Data Types and Frequencies:

Ambient air monitoring will be conducted for mass, gross alpha and gross beta collected on TSP filters, weekly from three routine monitoring locations. These locations include:

- D3, E1, and E2 - Currently sampled as part of the overall LARS Radiological Ambient Air Quality Monitoring Program (LARS) described previously in the IMP. With respect to the 903 Pad project area - E1 is located to the north-northeast, D3 is located to the southeast, and E2 is located further to the east.

These locations provide coverage in the prevailing downwind area in closer proximity to the 903 Pad remediation project than the Site-selected locations [see *Performance Monitoring for Radionuclides: 903 Pad Remediation Project (IHSS 112 & 155)*, K-H, May 2002].

In addition to the weekly samples, quarterly samples for isotopic nuclides (Pu, Am, and U) are currently collected from D1 and D3, and would be supplemented as necessary based on sample results.

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Should site data indicate potential concerns, then CDPHE/LARS may expand the program to include, at a minimum, the following locations:

- D4 – Requires reactivation from historical sample events. D4 is located to the south-southeast.
- D15 (Temporary Location) – To be established to the west-northwest, co-located with the Site's S-119 sampler.

Boundaries:

Spatial: CDPHE - LARS collects samples from three routine monitoring locations surrounding the 903 Pad remediation project for mass, gross alpha and gross beta (weekly) and from at least one location for isotopic parameters (quarterly).

Temporal: Individual samples are collected continuously for one week through the life of the project. The 903 Pad ER project is currently projected to commence in October 2002 and be conducted through March 2003 (six months). Samples will initially be analyzed under an expedited turnaround (four days), with a change to regular turnaround if data sets from the Site and LARS exhibit consistency.

Decision Statement:

IF A measurement of gross alpha activity in air exceeds 0.012 pCi/m3,

THEN Request data of comparable samples from the nearest DOE ambient samplers;

AND Conduct analysis of samples for isotopic parameters (Pu, Am, and U);

AND Meet with project personnel to reassess project parameters and implement mitigative measures to reduce future releases.

IF A measurement from the workspace air monitoring conducted by the RISS Radiological Engineering group exceeds acceptable concentrations or exhibits the potential for a release from the workspace,

THEN Collect filters for expedited gross alpha and gross beta analyses, and proceed with the assessment process above.

Limits on Decision Errors:

As 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. 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 suspected exceedances, trend analysis should be sensitive to small, upward shifts in concentration.

Monitoring Requirements:

The program is established based on the Special Project Monitoring contained in the 2001 IMP. The existing LARS network of samplers will be utilized. Samples will be collected on filters weekly for gross alpha, gross beta and TSP analysis from locations E1, D3, and E2. In addition

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quarterly filter samples will be analyzed for isotopic analysis (Pu, Am, and U) from existing stations D1 and D3 (no additional frequency). Analysis for gross alpha/gross beta will initially be expedited (4-5 day turnaround), then if the samples correspond well with the site collected samples, normal turnaround will be conducted unless site data indicates the potential of a release from the workspace.

Should sample results indicate out of norm results, as necessary, more frequent isotopic analysis (monthly) may be collected from select locations.

4.4.3 CDPHE SPECIAL PROJECT MONITORING – BUILDING 865 DEMOLITION

To provide an independent assessment and verification of the competency of the decontamination process for Building 865 and the potential worker and public exposure to radioactive material that may be released during the Building 865 demolition activities, CDPHE proposes to conduct site-specific ambient air monitoring using monitoring locations in close proximity to Building 865. This project is motivated by the desire, expressed to the regulators by various stakeholders, for close-in building specific monitoring of radioactive material in air during the demolition of historically contaminated buildings. This monitoring is to be performed in addition to the normal Site-wide monitoring to be conducted during the demolition of Building 865.

Problem Statement:

Building 865 is a large concrete building known to have been used for work with radioactive material, consisting of mostly enriched and depleted uranium. Building 865 contains known radiological contamination. The radiological contamination associated with Building 865 is expected to be removed to free-release levels prior to demolition, unless material within Building 865 to be contained and treated as radiological waste is expressly identified prior to demolition (as was the case for Building 886 demolition). This air monitoring effort is intended to demonstrate that the decontamination of Building 865 has been successful in preventing excessive releases of radiological contamination by detecting and quantifying possible releases of radioactive material from Building 865 during demolition.

Demolition is expected to take place over four weeks, and removal of building rubble is expected to occur over the following two weeks. Air monitoring is proposed to begin approximately one week before demolition and continue for one week after the removal of building rubble is complete. The radiological air monitoring samplers are expected to be collocated with beryllium performance monitoring samplers.

Data Types and Frequencies:

Ambient air monitoring will be conducted for mass, gross alpha and gross beta collected on TSP filters, daily from six monitoring locations. These locations will be determined at a later date, and will be based on prevailing wind directions and location availability.

Boundaries:

Spatial: Six sample locations in an approximately circular array around Building 865. All samplers should be no less than 50 meters and no more than 200 meters from the nearest exterior wall of Building 865.

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Temporal: Sample collection should begin one week prior to building demolition and continue for one week after demolition activity is complete. Samples will be collected daily on days worked. Samples will be collected from about one hour prior to the commencement of work to about one hour after work ends. Total daily sample duration will be variable, depending on the work schedule of the demolition contractor. All samples will be aged for at least 96 hours in order to allow decay of radon progeny.

Decision Statement:

IF Any measurement of gross alpha activity in the air exceeds 0.05 pCi/m3 (after 96 hours),

THEN Conduct analysis of samples for isotopic parameters (Pu, Am, and U);

AND Meet with project personnel to reassess project parameters and implement mitigative measures to reduce future releases.

Limits on Decision Errors:

As Pu, Am and U have historically constituted a small fraction of the measured gross alpha concentration, extremely high concentrations of these nuclides would be required to cause an elevated gross alpha result. 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 suspected exceedances, trend analysis should be sensitive to small, upward shifts in concentration.

Detection limits will be consistent with those in Table 4-3. Results will be reported in pCi/m^3.

Monitoring Requirements:

The program is established based on the Special Project Monitoring contained in the 2001 IMP. Samples will be collected on filters daily for gross alpha, gross beta and TSP analysis from six locations. In addition, filter samples will be analyzed for isotopic analysis (Pu, Am, and U) from those stations with gross levels exceeding 0.05 pCi/m3 after 96 hours.

4.5 PERFORMANCE MONITORING

Planning of decommissioning and ER programs includes air quality assessments to evaluate potential emissions. As a result of these assessments, additional air quality monitoring may be performed during the project due to either risk assessment or CAA air quality screening results.

4.5.1 PERFORMANCE MONITORING – RADIONUCLIDES IN AIR

As outlined in project-specific operations plans or in RFCA standard operating protocols, when a decommissioning or remediation project has the potential to release radionuclides in sufficient concentrations to contribute a 0.1 mrem annual dose to the most impacted public receptor, performance monitoring for radionuclides (PM-Rad) will be implemented. The existing RAAMP sampling network will provide the framework for this performance monitoring program. During execution of those portions of decommissioning and remediation projects that have a significant potential to release fugitive air emissions, the routine RAAMP air compliance

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sampling program is to be supplemented by more frequent sampling using selected RAAMP network samplers located in the immediate vicinity of the projects. The current schedule shows that several demolition and remediation projects may be conducted during the same time period. This will result in area-wide PM-Rad being conducted, possibly in conjunction with multiple RFETS demolition and remediation projects.

When warranted (as detailed above), area-wide PM-Rad plans will be prepared for incorporation into project plans. Performance monitoring for radionuclides will be conducted for decommissioning and remediation activities within the IA and for remediation activities in contaminated areas of the Buffer Zone, as needed. Specific RAAMP samplers surrounding each area will be activated to gather representative data. Filters will be collected weekly and screened for long-lived alpha contamination and/or gamma emissions. Results of the radiation screening will be available about four workdays after submitting filters to the laboratory. The results will be used to calculate the airborne concentration in units of activity per volume of air drawn through the filter (pCi/m^3), and then compared to two predefined action levels based on the expected isotopic composition of materials to be disturbed. Action Level 1 will correspond to a 1.0 mrem dose at the sampler location, and action level 2 will correspond to a 5.0 mrem dose, with dose calculated as if the measured concentration were constant for a two week exposure period. The two-week exposure assumption is based on a one week PM-Rad sampling period followed by a one week period to allow analysis (actual analytical turnaround is expected to be four working days, as stated above).

Air sampling and atmospheric modeling results indicate that airborne concentrations of radionuclides decrease by a factor between approximately 10 and 1000 over the distance between the IA and the Site boundary due to atmospheric dispersion. In other words, a two week concentration measured at an IA air sampler may be expected to decrease by a factor of at least 10 before reaching the Site boundary (e.g., 1 mrem in the IA yields <0.1 mrem at the fenceline). Therefore, adoption of the two-week exposure scenario described above as the basis for calculating the 1 mrem and 5 mrem action level-equivalent concentrations is protective of public receptors and helps ensure compliance with the Rad-NESHAP. For radionuclide concentrations below Action Level 1, PM-Rad will continue with weekly filters being screened for radioactivity. If Action Level 1 is exceeded, affected weekly filters will be submitted for isotopic analysis on an expedited schedule and ESS personnel will meet with project personnel to evaluate the project for unexpected conditions and to determine what additional sample collection and analysis may be warranted. If Action Level 2 is exceeded, an evaluation of the project for unexpected conditions will be undertaken to determine what additional analysis may be warranted. RFETS environmental personnel will contact project personnel within six hours of receiving results if Action Level 2 is exceeded, and will meet with project personnel to reassess project parameters and evaluate mitigative measures to reduce future emissions. Mitigative measures may include additional dust control efforts, modifications to demolition techniques, reevaluation of work response to environmental conditions (e.g., high wind), and cessation of work. When sample isotopic results exceeding Action Level 2 also indicate that a 10 mrem dose to the most impacted public receptor could occur, project operations will cease until appropriate controls are in place.

The results of expedited isotopic analyses will be available approximately two weeks following initial activity screens. The isotopic data will quantify the various U, Pu, and Am isotopic concentrations on the filters to a greater degree of accuracy than is possible using alpha

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screening techniques. Also, if warranted due to known upset conditions, sample changes can be accelerated at other RAAMP samplers or additional expedited isotopic analyses can be requested.

Inputs:

- Types and quantities of potential analytes of concern that may be emitted by each project;
- Project and process descriptions and schedules; and
- Screened concentrations of airborne radioactivity at PM-Rad samplers.

Boundaries:

Spatial: Perimeter of IA and contaminated areas of the Buffer Zone. Upwind and downwind sampling locations. Typically, 10 sampling locations would be used to ensure representative sample capture relative to wind direction around a given Site area.

Temporal: Continuous sampling during periods of potential high emissions. Continuous sampling is needed to capture sufficient sample volume for analysis.

Decision Statements:

IF Calculated potential radionuclide emissions from planned decommissioning or remediation projects exceed a 0.1 mrem/yr dose at the most impacted public receptor, or exceed other RFETS action limits—

THEN Radionuclide concentrations at PM-Rad samplers will be screened and documented, and for concentrations that exceed specified action levels, project activities will be evaluated for unexpected conditions that may require implementation of more stringent emission controls or other mitigative measures.

IF Alpha activity in a PM-Rad sample exceeds Action Level 1 (1 mrem equivalent concentration)—

THEN The sample will be submitted for expedited isotopic analysis and ESS personnel will meet with project personnel to evaluate the project for unexpected conditions and to determine what additional sample collection and analysis may be warranted.

IF Alpha activity in a PM-Rad sample exceeds Action Level 2 (5 mrem equivalent concentration)—

THEN The sample will be submitted for expedited isotopic analysis and ESS personnel will meet with project personnel to reassess project parameters and evaluate potential mitigative measures to reduce future emissions. [NOTE: if isotopic results from a PM-Rad sample indicate a 10 mrem dose to the most impacted public receptor could occur, project operations will cease until appropriate controls are in place]

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Monitoring Requirement:

For IA and Buffer Zone PM-Rad sampling, selected RAAMP samplers have been designated as necessary to gather representative data. Projects within the IA will be performance monitored using the 10-sampler IA PM-Rad network (samplers S-103, -104, -106, -114, -116, -119, -121, -123, -205, and -212). 903 Pad and lip area remediation will be monitored using a separate but partially-overlapping 10-sampler PM-Rad network (samplers S-102, -103, -104, -106, -110, -112, -211, -212, -213, and -216). The period and frequency of PM-Rad operations will be determined by the duration of demolition and remedial activities that have the potential to emit significant quantities of radionuclide materials, but will generally include one-week sample periods to ensure that sample detection limits may be met for the action levels described above.

4.5.2 PERFORMANCE MONITORING – BERYLLIUM IN AIR

When a decommissioning or remediation project involves a facility with a history of significant beryllium operations (i.e., Buildings 444/447, 865, and 883), performance monitoring for beryllium (PM-Be) will be implemented. Six portable, high-volume ambient air samplers will constitute the infrastructure for the PM-Be program. These samplers will be arrayed around subject sources as close as is reasonable, in a manner that optimizes the probability of capturing a plume in the event of a beryllium release.

If warranted, PM-Be plans will be prepared for incorporation into project decision documents. Beryllium monitoring will be conducted for demolition and remediation activities of Buildings 444/447, 865, and 883. Filters will be collected and submitted for total beryllium analysis on a schedule established for each project on a case-by-case basis and documented in a Beryllium Monitoring Implementation Plan (BMIP) associated with each project plan. Typically, PM-Be samples will be exchanged daily until insignificant beryllium emissions have been demonstrated, at which point sampling intervals of up to three days per sample may be assumed. Analytical results will be used to calculate the airborne concentration in units of micrograms per volume of air drawn through the filter ($\mu g/m^3$), and then compared to three predefined action levels.

Action Level 1 corresponds to a 0.01 $\mu g/m^3$ average air concentration (30-day average), which is consistent with benchmark concentrations established in the Be-NESHAP and is therefore protective of human health and the environment. Action Level 2 corresponds to a 0.03 $\mu g/m^3$ concentration measured in a single sampling event (i.e., on one filter), which would indicate a short-term event that may compromise the 30-day benchmark concentration. Action Level 3 corresponds to a 0.1 $\mu g/m^3$ concentration measured in a single sampling event, which would indicate that half of the allowable ambient concentration for RFETS worker exposure (0.2 $\mu g/m^3$) had been present near the activity.

For beryllium concentrations below Action Level 1, performance monitoring will continue and results will be reported to project management on a routine schedule. If concentrations between Action Levels 1 and 2 are measured, ESS personnel will communicate results to project personnel within 12 hours of receiving results. ESS personnel will recommend an evaluation of the project for unexpected conditions to determine what additional analysis may be warranted. If Action Level 2 is exceeded, an evaluation of the project for unexpected conditions to determine what additional analysis may be warranted will be undertaken. RFETS environmental personnel will contact project personnel within six hours of calculating results if Action Level 2 is exceeded, and will meet with project personnel to reassess project parameters and evaluate

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potential mitigative measures to reduce future emissions. If concentrations exceeding Action Level 3 are detected, environmental personnel will communicate results to project management within two hours of calculating results and will meet to reassess project parameters and propose potential mitigative measures to reduce future emissions.

Inputs:

- Types and quantities of potential analytes of concern that may be emitted by each project;
- Project and process descriptions and schedules; and
- Concentrations of airborne beryllium at PM-Be samplers.

Boundaries:

Spatial: As close as reasonable to the subject source project, generally within 100 meters of project perimeter.

Upwind and downwind sampling locations.

Six sampling locations will be used to ensure representative sample capture relative to wind direction.

Temporal: Sampling during periods of active demolition.

Decision Statements:

IF Beryllium concentration in ambient air around a decommissioning or remediation projects exceeds action level 1 (0.01 $\mu g/m^3$ on a 30-day average basis, calculated individually for each sampling location) —

THEN Project activities will be evaluated for unexpected conditions that may require implementation of more stringent emission controls or other mitigative measures.

IF Beryllium concentration in ambient air around a decommissioning or remediation projects exceeds action level 2 (0.03 $\mu g/m^3$ based on a single sample) —

THEN ESS personnel will communicate results to project personnel within six hours of receiving results and will recommend an evaluation of the project for unexpected conditions to determine what additional analysis may be warranted.

IF Beryllium concentration in ambient air around a decommissioning or remediation projects exceeds action level 3 (0.1 $\mu g/m^3$ based on a single sample) —

THEN ESS personnel will communicate results to project personnel within two hours of receiving results and will meet with project personnel to reassess project parameters and evaluate potential mitigative measures to reduce future emissions.

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Monitoring Requirement:

For PM-Be monitoring, portable beryllium samplers must be arrayed as necessary to gather representative data. The locations of samplers must be determined based on the location and the extent of the source area, potential interference from other projects or buildings, and meteorological data. The period and frequency of sampler operation will be determined by the project activities, the action levels established through the IMP, and duration of demolition and remedial activities that have the potential to emit significant quantities of beryllium-contaminated materials.

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5.0 ECOLOGICAL MONITORING

5.1 INTRODUCTION

This chapter describes the technical and regulatory basis for the approach to ecological monitoring at RFETS. The Ecological Monitoring Program instituted at RFETS has historically focused on characterizing ecological components in the Buffer Zone, and compliance with laws and regulations (e.g., the Endangered Species Act, the Migratory Bird Treaty Act, wetlands regulations, weed control acts). The monitoring requirements presented here were established through the 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 (e.g., permit discharge limits) do not exist, a qualitative rather than quantitative approach was adopted. The program focuses on the collection of data necessary to ensure regulatory compliance, and to assess the success or failure of DOE's natural resource conservation and habitat management efforts. These efforts are intended to comply with DOE's demonstrated desire to practice natural resource conservation (DOE, 1994b) and ecosystem management (Congressional Research Service, 1994) on its properties.

These efforts also provide part of the basis for ongoing refinement of natural resource conservation and habitat management goals. Monitoring requirements that support ecological management decision making needed to achieve these goals are an essential component of the IMP.

5.2 NATURAL RESOURCE CONSERVATION AND HABITAT MANAGEMENT GOALS

Ecological conservation and management goals include the protection of currently viable ecosystems, unique and ecologically valuable natural resources, and special-concern species (threatened, endangered, candidate, proposed, state-listed, or other sensitive species), and compliance with wildlife and natural resource protection regulations. Early detection and management of problems or undesirable impacts to the Buffer Zone before they become severe is extremely important.

Specific conservation and management goals for the major identified vegetation communities and one species of particular interest, the Preble's meadow jumping mouse (Preble's mouse) are presented in Table 5-1.

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Table 5-1 Conservation and Management Goals

Vegetation Community	Goal
Xeric Tallgrass Prairie	Maintain the current quantity (area) and quality of the vegetation community, and maintain the populations of bird and mammal species characteristic of xeric tallgrass prairie.
Tall Upland Shrubland	Maintain the quantity and quality of the vegetation community, maintain the populations of bird and mammal species characteristic of tall upland (seep) shrubland, and maintain population numbers and extent of Preble's mice within the habitat.
Great Plains Riparian Woodland Complex	Maintain the quantity and quality of the vegetation community, maintain populations of bird and mammal species characteristic of the riparian woodland complex, and maintain the population numbers and extent of Preble's mice within the habitat.
High Quality Wetlands	Maintain the quantity and quality of the vegetation community, and maintain the populations of bird and mammal species characteristic of the largest contiguous high quality wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Wetland complexes).
Mesic Mixed Grassland	Maintain the contiguous extent of mesic mixed grassland for heavily and frequently used wildlife areas, and maintain the populations of bird and mammal species characteristic of this vegetation community.
Aquatic Community	**Goal**
Aquatic Community	Maintain the quality of aquatic communities at RFETS, including macro-invertebrate and vertebrate species characteristic of the community.
Species of Particular Interest	**Goal**
Preble's Mouse Populations	Maintain the quantity and quality of Preble's mouse habitat, and protect extant populations of the Preble's mouse.
Regulatory Compliance	**Goal**
T&E and SSC	Protect T&E and SSC species at RFETS, and comply with applicable state and federal T&E species protection regulations and policies.
Migratory Birds	Protect migratory birds at RFETS, and comply with applicable state and federal migratory bird protection requirements.
Wetlands	Protect RFETS wetlands, and comply with applicable state and federal wetland protection requirements.

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5.3 DESCRIPTIONS OF VEGETATION COMMUNITIES, AQUATIC ECOSYSTEMS, AND PREBLE'S MOUSE POPULATIONS

Vegetation communities at RFETS provide specific habitats for associated wildlife, rare plants, and unusual plant associations. These communities include the xeric tallgrass prairie, mesic mixed grassland, high quality wetlands, tall upland shrubland, and the Great Plains riparian woodland complex. The aquatic ecosystem at RFETS consists of ephemeral and intermittent streams, old stock ponds, and several water management impoundments. The Preble's mouse is of particular concern because it is a federally listed threatened species, which provides special protection for the species under the Endangered Species Act.

5.3.1 XERIC TALLGRASS PRAIRIE

There are two types of xeric mixed grassland units at RFETS, the xeric tallgrass prairie and the xeric needle-and-thread grass prairie. At RFETS, the xeric tallgrass prairie is monitored. Identification of this vegetation community is based on the presence of big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), prairie dropseed (*Sporobolus heterolepis*), Indian-grass (*Sorghastrum nuntans*), and switchgrass (*Panicum virgatum*). These five species are considered to be tall grass prairie relicts. Of these species, only big bluestem and little bluestem are abundant at RFETS. When the five species cover about 10% or more of a xeric mixed grassland community, the community is classified as xeric tallgrass prairie.

The soil in a xeric tallgrass prairie is visibly cobbly on the surface, and is considered to be a sandy clay loam. This vegetation community covers the high, rocky pediment on the western one-third of RFETS. The xeric tallgrass prairie was selected for special conservation efforts due to its nationwide rarity.

The other type of xeric mixed grassland, the xeric needle-and-thread grass prairie, is also considered rare, but is not large enough to justify special management efforts at RFETS. Xeric needle-and-thread grass prairie is differentiated from xeric tallgrass prairie by a greater cover of needle-and-thread grass (*Stipa comata*) and New Mexico feather grass (*Stipa neomexicana*) than of big bluestem and little bluestem or other tallgrass species.

The soils in which xeric needle-and-thread grass prairie are found are not as cobbly as those 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 RFETS.

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 mesic grassland has a more solid turf appearance in contrast to the bunchgrass appearance of the xeric mixed grasslands. Surficial soils are clay loams that do not have the cobbly appearance typical of xeric mixed grassland soils. Most hillsides at RFETS are considered mesic mixed grassland habitat.

The quality of these grasslands varies considerably across RFETS. The mesic mixed grassland on the western side of RFETS has been, and continues to be, significantly degraded by diffuse knapweed (*Centaurea diffusa*), although this problem has been greatly improved through recent

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weed control efforts. Mesic mixed grassland on the eastern portion of RFETS has been degraded by non-native species such as Japanese brome (*Bromus japonicus*), alyssum (*Alyssum minus*), and musk thistle (*Carduus nutans*). For classification purposes, a grassland is designated as mesic mixed grassland if western wheatgrass and blue grama grass form an understory beneath non-native species, regardless of dominance by non-native species.

Mesic mixed grasslands comprise one of the largest contiguous vegetation communities at RFETS. In addition to its essential role as a foraging habitat, the size and isolation of the mesic mixed grassland often makes it very important to some wildlife species. A wide variety of grassland 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 of special concern.

5.3.3 HIGH QUALITY WETLANDS

The high quality wetlands selected for monitoring and specific conservation efforts are the RFETS wetlands with the largest contiguous areas and the most complex plant associations. These wetlands are the Rock Creek and Antelope Springs/Apple Orchard Springs Complexes.

The Rock Creek wetlands are a large, seep-fed wetland complex extending about one mile from the foot of the easternmost 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 RFETS). Other portions support sensitive amphibian 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 Rock Creek drainage in the northern portion of RFETS, but small units occur across RFETS. This vegetation community may be unique, because no similar units have been identified outside the general RFETS vicinity. It is important habitat for 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 chestnut-sided warblers) occupy this community as well. Some units of tall upland shrubland also provide habitat for the rare Preble's 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 RFETS is a combination of two vegetation community classifications: riparian woodland and riparian shrubland, which form a complex mosaic habitat along the drainage bottoms on RFETS. Due to its contiguous mixture of both trees and shrubs, the riparian areas are described as a complex. The woodland component of the complex is characterized by stands of plains cottonwood (*Populus deltoides*), peach leaf willow (*Salix amygdaloides*), Siberian elm (*Ulmus pumila*), and silver poplar (*Populus albus*). The shrubland component of the complex includes chokecherry *(Prunus virginiana)*, snowberry (*Symphoricarpos occidentalis.*), coyote willow (*Salix exigua*), leadplant (*Amorpha fruticosa*), and other shrubs.

The 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 using the riparian woodland complex as foraging and nesting cover are rare species (e.g., blue grosbeak). Like the tall upland shrubland community, 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. The riparian woodland complex supports the greatest number of Preble's mice at RFETS and is considered typical habitat for this species. The majority of monitoring, protection, and management of Preble's mouse habitat will occur in this community.

5.3.6 AQUATIC COMMUNITY

The aquatic ecosystem at RFETS consists of a network of ephemeral and intermittent streams, and several scattered old stock ponds. In the Walnut Creek and Woman Creek drainages, there are several water management impoundments that retain large bodies of water. Numerous seep springs feed streams at RFETS and provide limited wetland habitat. Other than the outflow of the seeps, and the water in the existing ponds and larger pools, very little permanent water exists at RFETS.

During 1991-1992, the *Operable Unit 1 Ecological Evaluation* (DOE, 1992b) and the *Baseline Characterization* (DOE, 1992c) studies conducted sampling to characterize the aquatic community at RFETS. This effort included widespread benthic invertebrate sampling across RFETS, and limited fish sampling in ponds and some streams. The Colorado Division of Wildlife (CDOW) listed five species of small fish native to the South Platte River drainage as State endangered (the northern redbelly dace, southern redbelly dace, plains minnow, suckermouth minnow, and lake chub), and two as threatened (the brassy minnow and common shiner) (CDOW, 1998).

In light of these potential listings, and the prior recommendation in the *1996 Annual Wildlife Survey Report* (Kaiser-Hill, 1997a) that fish sampling be added to the Natural Resource Compliance and Protection Program's ecological monitoring effort, Kaiser-Hill authorized the addition of this study to the ecology program (Kaiser-Hill, 1997b). This additional sampling initially focused on streams, and then sampled ponds on alternate years. This was discontinued in 2001.

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While fish sampling of the aquatic community attempted to quantify populations through relative abundance sampling, aquatic sampling in RFETS's upper headwater streams did not provide sufficient numbers to estimate stream populations. Due to the ephemeral nature of these streams, the amount of viable habitat is extremely limited, and few fish have been captured except in ponds and pools. To sample macroinvertebrate and fish populations and assess the physical habitat parameters of the aquatic communities, DOE has employed an aquatic contractor. The contractor, who work is independent of the IMP, will conduct aquatic sampling at RFETS in accordance with protocols established by the Big Dry Creek Watershed Association (BDCWA) and various requesting agencies. These data will be collected, analyzed, and shared with various requesting agencies.

5.3.7 PREBLE'S MOUSE HABITAT AND POPULATIONS

The Preble's mouse (*Zapus hudsonius preblei*) is a species of particular concern at RFETS because it is listed as threatened by the USFWS. This listing provides special protection for the species under the Endangered Species Act, and actions must be evaluated for potential impact to the mouse.

Preble's mice have been recorded in the major drainages of RFETS: 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. Preble's mouse populations are found in association with the riparian zone and seep wetlands, and apparently prefer multi-strata vegetation with abundant herbaceous cover. The vegetation communities that provide Preble's mouse habitat include the Great Plains riparian woodland complex, tall upland shrubland, wetlands adjacent to these communities, and some of the upland grasslands surrounding these areas. 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.

5.3.8 INDUSTRIAL AREA REVEGETATION/RESTORATION

As the Industrial Area at RFETS comes down during remediation operations, restoration and revegetation of the land may be conducted to return the area to a more native state. Should a revegetation/restoration plan be developed, the ecology section of the IMP should be re-evaluated to incorporate new ecological monitoring requirements or data quality objectives.

5.3.9 OUTSIDE FACTORS AFFECTING RFETS ECOLOGY

The ecological resources at RFETS are influenced not only by Site activities but also by activities that occur off-Site. Outside factors that have potential to affect ecological resources at RFETS include, but are not limited to, chronic wasting disease (CWD), west Nile virus, plague, and other zoonoses. These and other factors often affect wildlife regionally, and therefore must be considered when evaluating the ecology of the Site.

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5.4 VEGETATION COMMUNITY AND AQUATIC ECOSYSTEM MONITORING DQOS

DQOs were developed for monitoring in five important vegetation communities and the aquatic ecosystem. Monitoring the vegetation communities facilitates the management and conservation of vegetation communities, associated wildlife, rare plants, and unusual plant associations. The results of the monitoring can precipitate a reevaluation of management practices to better achieve specific vegetation community management goals.

Based on defined inputs and boundaries for each vegetation community, a decision statement is developed. The decision statement lists monitored occurrences (e.g., a decline in native plant densities), and provides a corrective action for that problem. Sections 5.4.1 to 5.4.5 list the five vegetation communities; Section 5.4.6 identifies the aquatic ecosystem.

5.4.1 XERIC TALLGRASS PRAIRIE VEGETATION COMMUNITY

Inputs:

- Existing area of xeric tallgrass prairie;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial:	Current RFETS geographic boundaries.
	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 or photo surveys indicate weed species are spreading or increasing in the community;
	Weed control assessment monitoring indicates low effectiveness of a treatment option;
	Significant change in an assessment endpoint–
THEN	Evaluate options to achieve the stated goals.

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5.4.2 TALL UPLAND SHRUBLAND COMMUNITY

Inputs:

- Existing 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 weed mapping and photo surveys;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest;
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.

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 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;

Significant change in an assessment endpoint;

The area of known Preble's mouse habitat within the unit decreases substantially from baseline; or

A known permanent population of Preble's mouse within the habitat unit cannot be verified—

THEN Evaluate options to achieve the stated goals.

5.4.3 GREAT PLAINS RIPARIAN WOODLAND COMPLEX

Inputs:

- Existing area of riparian woodland complex;
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;

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- Annual weed mapping and photo surveys;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest;
- Weed control assessment monitoring, as applicable;

Boundaries:

Spatial: Current RFETS geographic boundaries.

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:

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 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;

Significant change in an assessment endpoint;

The area of known Preble's mouse habitat within the unit decreases substantially from baseline; or

Any known permanent population of Preble's mouse within the habitat unit cannot be verified —

THEN Evaluate options to achieve the stated goals.

5.4.4 HIGH QUALITY WETLANDS

Inputs:

- Existing wetlands based on 1994 U.S. Army Corps of Engineers (USCOE) wetland map and study (restricted to Buffer Zone only);
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

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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:

Existing high quality wetlands decrease 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 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;

Significant change in an assessment endpoint—

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* (Kaiser-Hill, 1996);
- Baseline estimates of bird and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Annual weed mapping and photo surveys;
- Anticipated or estimated impact area of a proposed project;
- Identification of plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.

Characteristic mesic mixed grasslands within RFETS and the Buffer Zone.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occur:

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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 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 bird or mammal species richness or densities;

Loss or major decline of a predominant plant, bird, or mammal species from the vegetation community;

Loss or major decline of a population of an identified plant species of interest, or plant or animal special-concern species; or

Significant change in an assessment endpoint—

THEN Evaluate actions to achieve the stated goals.

5.4.6 AQUATIC COMMUNITY

Inputs:

- Macroinvertebrate richness, abundance, and diversity;
- Habitat assessments of physical parameters of aquatic community at RFETS.

Boundaries:

Spatial: Current RFETS geographic boundaries.

Temporal: Annual decisions

Decision Statement:

IF One of the following occurs:

A change is observed in macroinvertebrate richness, abundance, or diversity;

Habitat assessments indicate changes in the physical parameters of the aquatic communities at RFETS have occurred

A fish kill is observed;

A loss of fish species richness is observed; or

Abnormalities in the macroinvertebrate or vertebrate organisms are observed—

THEN Evaluate actions to achieve the stated goals.

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5.4.7 RIPARIAN VEGETATION

Long-term changes in the riparian vegetation that result from changes in water flow regimes after cleanup and closure of RFETS are beyond the scope of the 2003 ecological monitoring program. Because these changes will occur over decades, it will be at the discretion of the USFWS to institute a monitoring program to monitor these changes after RFETS becomes a National Wildlife Refuge.

5.5 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), migratory birds, and wetlands must be considered. The initial decision to be made is whether a proposed project has a potential impact to T&E and SSC species, migratory birds, or wetlands. Such projects may require mitigation actions before they are allowed to move forward. Baseline data, previously collected at the Site, are used for decision making. Project-specific decisions with regulatory implications may require the collection of additional data. The discussion that follows is applicable to each of the regulatory drivers. Note that specific data requirements and a design for sampling and analysis are not included in the discussion.

Specific management goals to be supported by these efforts are:

- Protect T&E and SSC species at RFETS and comply with applicable state and federal T&E species protection regulations and policies;
- Protect migratory birds at RFETS and comply with applicable state and federal migratory bird protection requirements; and
- Protect RFETS wetlands and comply with applicable state and federal wetland protection requirements.

5.5.1 THREATENED, ENDANGERED, AND SPECIAL-CONCERN SPECIES

Inputs:

- Seasonal presence and absence, location, and abundance of T&E or SSC species in an 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 (e.g., food habits, home range, habitat preference, nesting habits); and
- Information about the anticipated impacts of the proposed project.

Boundaries:

Spatial:	The area potentially affected by a project.
Temporal:	The time frame in which a proposed project could occur.
	Locations of alternative project sites.

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Jurisdictional policies and propriety.

Decision Statement:

IF	A 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 USFWS.
IF	The determination is made to proceed with the proposed project by altering it—
THEN	Provide assistance with the design of the project for regulatory compliance requirements.
IF	Additional information is required to make a decision-
THEN	Develop project specific sampling and analysis plans to provide the necessary information.

Note that additional required methods are not discussed here because the performance of biological assessments for T&E species is not within the scope of this plan.

5.5.2 MIGRATORY BIRDS

Inputs:

- Seasonal presence, relative abundance and location of migratory birds or their nests in areas potentially impacted by RFETS projects;
- Location and seasonal timing of proposed projects that may affect migratory birds; and
- Biology of potentially affected migratory bird species (e.g., food and nesting habits, home range, habitat preference).

Boundaries:

Spatial:	The area potentially affected by RFETS projects.
	Specific areas where migratory birds or nest locations overlap the footprint of specific proposed activities (as opposed to the area potentially affected by possible projects).
	Locations of alternative project sites.
	Jurisdictional policies and propriety.
Temporal:	The time frame potentially affected by RFETS projects.

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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 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—
THEN	Notify project personnel and determine whether the project can be altered to avoid impacts.
IF	Removal is required—
THEN	Comply with substantive requirements of MBTA from the USFWS and adhere to permit limitations.
IF	Additional information is required to make a decision-
THEN	Develop project specific sampling and analysis plans to provide the necessary information.

5.5.3 WETLANDS

Inputs:

- Presence and location of wetlands on RFETS (based on 1994 USCOE wetland report and field verification) (USCOE, 1994);
- Presence and location of wetlands not mapped by the USCOE;
- Determination of jurisdictional wetlands presence based on USCOE wetland delineation manual (USCOE, 1987);
- Location, timing, and description of proposed projects that potentially impact wetlands; and
- Jurisdictional policies and propriety.

Boundaries:

Spatial:	The area of a project.
	Areas where wetlands overlap the footprint of proposed activities.
	Locations of alternative project sites.
Temporal:	The time frame of a project.

Decision Statement:

IF	A wetland may be affected by a proposed project—
THEN	Advise project personnel and seek to redesign the project to avoid wetland impacts.

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IF	The project cannot be redesigned to avoid impacts—
THEN	Proceed with a wetland delineation in accordance with USCOE of Engineers wetland delineation guidelines (USCOE, 1987).
IF	The delineation indicates that the wetland is jurisdictional—
THEN	Advise DOE of the need to consult with the USCOE and EPA to determine the need for and amount of mitigation wetland acreage that will be required for the project.
IF	Additional information is required to make a decision-
THEN	Develop project specific sampling and analysis plans to provide the necessary information.

5.6 DESIGN FOR INTEGRATED ECOLOGICAL MONITORING

An Ecological Monitoring Program is needed to provide data that can be used in natural resource conservation and habitat management decisions during the cleanup of RFETS. In addition to data required for conservation and management decisions, RFETS must remain in compliance with applicable wildlife and wetland protective regulations. To meet this need, the proposed Ecological Monitoring Program will monitor key variables over time in each of the 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.

5.6.1 DECISION ERRORS

Limits on decision errors were stated by the planning team as follows:

- Reasonable expectation that monitoring will detect a 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 impacts to such species; and
- Reasonable expectation that compliance with applicable regulations can be achieved.
- 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 which will be affected. It should be noted that an impact to an individual, or population, is of concern. Care will be taken to identify potential impacts to T&E species.
- 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 potential impacts to migratory bird species.
- Decisions will be based on qualitative evaluation of the area of potential impact for wetlands and jurisdictional determination of wetlands present. Wetland determination will be governed by performance of a wetland delineation, in accordance with the USCOE wetland delineation manual (USCOE, 1989). Care will be taken to identify, and avoid, potential

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impacts to wetlands. Wetland investigations will be conducted to err on the side of protection.

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 or aquatic community management approaches (e.g., weed management, limited access, limitation of disturbances) go unchanged, with the 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.

5.6.2 MONITORING DESIGN

The design of the Ecological Monitoring Program follows the development of decision rules regarding conservation and regulatory compliance at RFETS. The decision rules specify the measurement and evaluation of analytical parameters for five vegetation communities and for Preble's mouse populations. The decision rules 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 RFETS project designs. The decision rules can each independently trigger an action. This is important, since it will be fundamental to the way evaluations are structured. Evaluations are structured to parallel the independence of decision rules.

The Ecological Monitoring program collected representative data from RFETS vegetation communities, in order to provide an integrated basis for decisions on vegetation community conservation and management, special-concern species protection, wetlands protection, and mitigation efforts. Availability of comprehensive data for each vegetation community type greatly aids compliance and protection evaluations, and decision making for specific projects. 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, ecologists can make more cost-effective protection decisions and evaluations of ecological concerns and compliance.

The five vegetation communities to be monitored were identified on the basis of data collected and analyzed from 1991 to 1995. These baseline data were evaluated to define the communities at RFETS. The most important, or sensitive, vegetation communities were selected for conservation monitoring. Vegetation communities are described in Section 5.3.

Key parameters measured and used in comparisons are presented in Table 5-3. These include:

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- 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;
- Preble's mouse populations and associated habitat characteristics in appropriate habitat; and
- Aquatic community macroinvertebrate and habitat assessments.

Table 5-3 Parameters to be Measured vs. Vegetation Community

Vegetation Community	Preble's Mouse Populations and Habitat	Noxious Weeds	Changes in Vegetation Communities
Xeric tallgrass prairie		X	X
Riparian woodland complex	X	X	X
High quality wetlands		X	X
Tall upland shrubland	X	X	X
Mesic mixed grassland		X	X
All other habitats		X	X

5.6.2.1 Vegetation Communities

Two parameters will be evaluated in the vegetation communities—noxious weeds and plant community change.

Noxious Weed – Monitoring will be performed to track the success of weed control strategies at selected locations. Pre-and post-treatment monitoring will be utilized when feasible to evaluate the effectiveness of weed control effects on target and non-target species. Management strategies for weed controls can thus be tracked, and strategies revised based on real-time results. Weed mapping performed in 1997 will establish baselines for the measurements. This portion of the program will be a component of the RFETS integrated weed control program.

Changes in Vegetative Communities – Qualitative and quantitative monitoring is conducted in selected communities to evaluate change. Quantitative monitoring examines changes in species richness, species cover, and species frequency. Qualitative monitoring includes community-wide species richness surveys, general observations, and weed mapping. Additionally, photographic survey plots will be permanently established at vantage points adjacent to monitored vegetation communities, and photographs will be taken every two years from these survey points during the summer. The camera lens used for the photographs will be a standard

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size. Comparisons of the photographs will be used to determine the type and amount of change that has occurred within the vegetation communities. Should visible loss occur to a vegetation community, management and protection strategies will be reevaluated.

Acreage was calculated for each vegetation community following the completion of vegetation mapping in 1996. This serves as the baseline map from which changes will be compared. Weed mapping and comparisons will be performed annually (or more frequently depending on current conditions).

5.6.2.2 Preble's Mouse

Preble's mouse populations in selected population centers will be monitored annually. Trapping will only occur during the May through September activity period of this hibernator.

5.6.2.3 Mammals and Birds

Species richness and abundance measurements will be made on birds and mammals.

Surveys will be conducted at least annually to evaluate wildlife populations at the Site.

6.0 SOIL MONITORING

6.1 INTRODUCTION

6.1.1 CONTAMINANT HISTORY

Since nuclear materials were first processed at RFETS, the potential for dispersing contaminants into the atmosphere and onto the soils within the IA and throughout the Buffer Zone has existed due to the inherent hazards associated with handling and processing nuclear materials. Three events at RFETS contributed widespread, observable radionuclide contamination of soils: the 1957 fire in Building 771, the 1969 fire in Building 776 and, most significantly, the release of contaminated cutting fluids into soils on the 903 Pad in the 1960s. The latter event culminated in the dispersion of measurable quantities of radionuclides (mostly Pu and Am isotopes) into the eastern Buffer Zone and off-Site areas previously identified as OU2 and OU3, respectively.

Soil "hot spots," regions of localized radionuclide contamination, are found in the IA and in some parts of the Buffer Zone. These hot spots are a result of spills, burial of contaminated drums and debris (such burial was standard operating disposal practice in the 50s and 60s), and runoff from other contaminated source areas.

Process buildings are also potential sources of contamination. However, high-efficiency particulate air (HEPA) filtration on the effluent stacks and vents of process buildings has controlled these potential emissions to the extent that this source of contamination is not considered a major contributor to surface soil contamination on and around RFETS during routine operating conditions.

In addition, sediments in process-water ponds (primarily the Solar Evaporation Ponds) and surface water detention ponds (A, B, and C Series Ponds; used primarily for detention of stormwater runoff from the IA and treated sanitary waste effluent) are contaminated with radionuclides to varying degrees. These ponds hold contaminated sediments and are a potential source of contamination to subsurface soils and stream beds downstream of the ponds.

6.1.2 EXISTING SOIL CONTAMINANT INFORMATION

The history of spills and contaminant dispersion events at RFETS is most accessible in the report commissioned by the CDPHE entitled *Rocky Flats History - Rocky Flats Toxicologic Review and Dose Reconstruction Task 3/4 Report* (ChemRisk, 1992). Background soil contamination at RFETS is primarily attributable to global fallout from atmospheric testing of nuclear weapons.

In addition, a rich database exists from which to determine the contaminant dispersion profiles at and around RFETS. Surveys to determine the extent of contamination in surface soils were performed extensively in the 1970s and 1980s, and routine monitoring of surface soils was performed from 1972-1977 and 1984-1994 with limited sampling from 1978 to 1983. While such data cannot identify areas of contamination, the results provide a good perspective on contaminants that were dispersed through larger airborne events. Limitations in survey data are related to specific hot-spots of contamination, which may exist due to burials and localized spills of contaminated materials. Many such locally contaminated areas have also been characterized

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during the environmental investigations of the early 90s. A discussion of soil sampling methods is discussed in *Rocky Flats Plant Final Environmental Monitoring Plan* (EG&G, 1992).

The routine survey data reveal dispersed on-Site Pu 239 contaminant concentrations which range (averaging data from each location over the period of 1984 to 1994) from 11 picrocuries per gram (pCi/g) down to 0.06 pCi/g (near background level) with highest concentrations found east and east-southeast of the 903 Pad. Fence-line concentrations in the surface soil range from 5 pCi/g down to 0.24 pCi/g along the Indiana Street perimeter, again with the higher concentrations to the east and east-southeast of the 903 Pad. Along the west, north and south perimeter fences, near-background concentrations are generally observed. Soil sampling results are presented in *Rocky Flats Plant Final Environmental Monitoring Plan* (EG&G, 1992).

6.2 SITE-WIDE SOIL MONITORING

Inherent to the issue of contaminant dispersion in the environment are several questions:

- Are the contaminants continuing to be dispersed such that the environment is being further degraded?
- Are the contaminants that are present in the environment being redistributed in some manner that is important to the environment or public health?
- What level of environmental damage has resulted?
- Is the environment recovering from the original insult?

These questions can generally be answered only on a media-specific basis; the DQOs for monitoring to determine environmental impact depend on the sensitivity of the medium being measured and the purpose of the investigation. For example, a regulatory threshold to which soil emissions contribute, such as an air dose to the public or surface water concentration, may be quite different than the threshold for measurable impact on an animal species through ingestion from plant uptake. For this reason, soil investigations have more recently been focused on project-specific potential to impact regulatory standards.

As noted earlier, a routine RFETS-wide soil monitoring program was conducted for many years, with sampling performed by both CDPHE and RFETS personnel. The 11 years of data reviewed in the *1994 Annual Site Environmental Report* (Kaiser-Hill, 1995) do not indicate changes or trends in soil contaminant levels that would be attributable to redistribution of the contaminants over the multiple-year time-scale. Should significant releases, or other events (or project requirements) at RFETS suggest a need to recharacterize the generalized distribution of contaminants, routine soil monitoring could be revisited.

6.3 PROJECT-SPECIFIC SOIL CHARACTERIZATION SAMPLING

In addition to the general characterization of contamination in the environment, RFETS frequently has requirements to characterize the immediate area around project activities that will disturb potentially contaminated soils. Requirements for such project-specific sampling are generally defined at the time the project is being planned, and will follow guidelines specified in the soil disturbance permitting procedures (1-B37-HSP-12.08, Excavation and Trenching and 1-F20-ER-EMR-EM.001, Environmental Approval Process for Construction/Excavation Activities) and soil sampling procedure (4-F99-ENV-OPS-FO.20), or in other less generic

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project plans. Many soil samples were collected in the early 1990s to characterize the contaminant dispersion around suspected burial and spill areas. These site characterization samples were used, along with the routine data, to generate a detailed contaminant dispersion map, featuring isopleths that present the contaminant dispersion profiles around the IA. Figure 6-1 is an example of these isopleths, showing Pu concentrations in this example. As with the routine samples, the general trend is for the highest concentrations to be found near and to the east and east-southeast of the 903 Pad with isolated hotspots located near other historical release areas.

Under the RFCA, this kind of sampling is defined through the project PAM or IM/IRA, and the Field Implementation Plan or the Sampling and Analysis Plan. The contents of such plans include results of searches of historical records, identification of sampling locations and results from pre-project surveys, and specifications for sampling of soils in the project area.

6.4 SOURCE IDENTIFICATION SAMPLING

Under RFCA, it may become appropriate to further investigate the soils in the vicinity of a surface water exceedance point or stream in order to characterize the nature of the potential contaminant sources in that area. These investigations will have spatial extent determined primarily by assuming the probable reach of contaminants that could influence the exceedance point. These investigations will otherwise be similar to the methods used to characterize soils around some project-specific activity. Soil and sediment samples are managed under Procedure 4-F99-ENV-OPS-FO.23.

6.5 OUTSTANDING ISSUES—ACTINIDE MIGRATION STUDY

Questions remain regarding the immediate and long-term potential for contaminated soils to disperse from RFETS. These questions are being evaluated in a long-term study that is investigating actinide migration pathways and characteristics. These Actinide Migration Studies may result in the identification of additional soil data needed to facilitate the investigation. Such data needs, while not expected to result in a routine soil monitoring program, may result in short-term, more project-specific soil sampling. In the long term, the results of the study may point to long-range monitoring strategies for determining the efficacy of clean-up activities or to other parameters that must be characterized more routinely.

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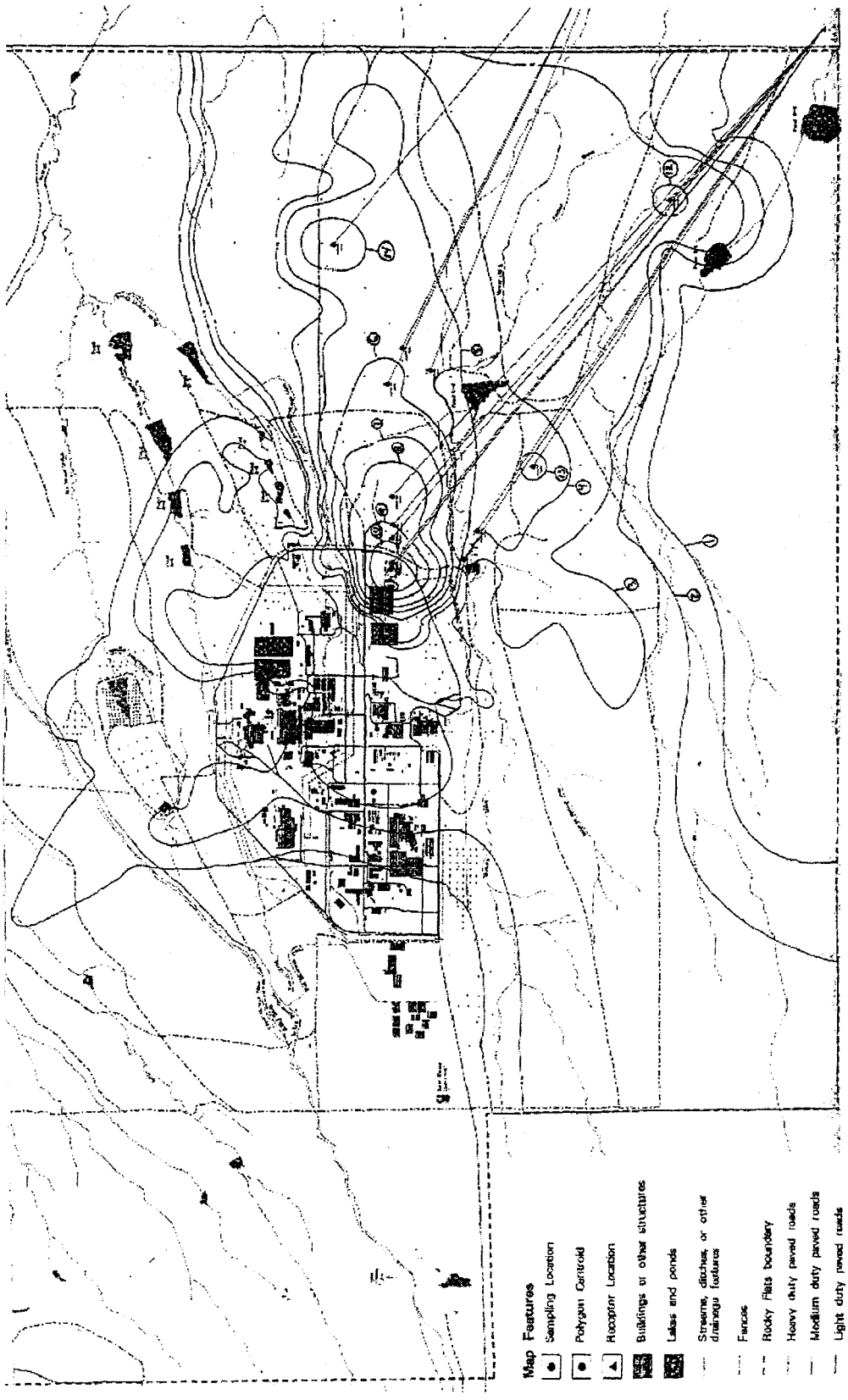

Figure 6-1
Example Soil Isopleth Map -
Pu-239/240 Concentrations of Surface Soil Samples

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7.0 INTERACTIONS BETWEEN MEDIA

7.1 OVERVIEW

Some monitoring is performed to characterize interactions between the various environmental media. Possible interactions are presented in Table 7-1, which represents a conceptual model of integrated monitoring at RFETS. Some significant interactions that require decision making and data are presented below.

Table 7-1 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. Published RFETS research indicates that this is not a major pathway for actinides.	Data from existing RFETS-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	Potentially significant. Contaminants that are typically insoluble (such as Pu and Am) are not prone to move from surface water to groundwater. However, more soluble contaminants (such as U) are transported from surface water to groundwater.	Paired surface water and groundwater data sets must be analyzed to assess where and for what constituents the surface water to groundwater pathway is significant. Additional aseptic well samples, where special precautions are taken to prevent sample contamination from surface soils, may be required for groundwater actinide analysis.
Surface Water to Air	Not significant; surface water quality will not significantly impact air quality (i.e., cause exceedances of air quality standards).	Significant impacts on air or water quality will be detected by existing DOE, CDPHE, and project-specific monitoring.

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Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
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 RFETS groundwater flows into RFETS surface water drainages.	Existing surface water monitoring may detect impacts from a limited suite of groundwater contaminants. Data from groundwater monitoring (RFETS-wide and project-specific) is also used to assess and predict potential surface water impacts.
Groundwater to Ecology	Potentially significant; contaminated groundwater could indirectly impact ecological resources, as well as reduce groundwater flow.	Data from existing RFETS-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 the disposition and extent of soil removal before, during, and after individual remediation projects.

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Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
		Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded. Also, 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, 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, significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific air monitoring.
Air to Groundwater	Not significant; contaminants in air will not directly impact groundwater quality.	Groundwater monitoring will track groundwater contamination, and Site-wide and project-specific air monitoring will detect degraded 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 runoff impacts and 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.

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Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
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.	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.

7.2 WATER AND ECOLOGICAL HEALTH

As indicated in Table 7-1, there are interactions between surface water, groundwater, and plants and animals at RFETS. There are concerns that changes in water flow into and out of RFETS could impact significant habitat and species of concern located both on-Site and downstream from RFETS (e.g., the Preble's mouse at RFETS and whooping cranes in Nebraska). For example, aggregate mining activities at the west end of RFETS may alter surface water flowing onto RFETS and could impact species of concern on-Site and downstream. In fact, water is one of the key abiotic components impacting some of the significant habitats.

Site-specific relationships between water availability and ecological health, and groundwater and surface water interactions are not currently well understood. One of the primary goals of the ongoing Site Water Balance activity is to improve the understanding of interactions. The Site Water Balance will develop a hydrologic design basis for RFETS closure activities. The objectives of the Site Water Balance are to provide RFETS with a management tool to:

1. Evaluate how water hydrology is likely to change from present to final configuration;
2. Predict surface water impacts from groundwater for present and final configuration;

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3. Provide data to support decisions for final IA configuration to protect surface water quality (cap and cover design and land recontouring);
4. Provide information for the comprehensive risk assessment and the Final CAD/ROD; and
5. Provide information to guide the development of the wetlands conversion project.

7.3 BUFFER ZONE HYDROLOGIC MONITORING

Starting in FY03, the Site has reached agreement with the stakeholders and DOE to discontinue sampling at several of the locations given in Table 7-2. Sampling at POCs GS01 and GS03, as required by RFCA, will continue unchanged. Flow and precipitation will continue to be measured at all locations. The Site has determined that the water quality information for the BZ hydrologic locations will not be required for decision-making as the Site moves toward closure. However, minimal sample collection at GS01, GS03, and GS04 will be retained and is detailed below. The termination of BZ sampling at selected locations will provide sampling equipment and resources available for use at performance monitoring locations slated for installation in FY03.

As indicated in Table 7-1, there are interactions between surface water, air, groundwater, and the plants and animals of RFETS.[39] As discussed in Section 7.2, flow changes into and out of RFETS could impact habitat and species of concern both onsite and downstream. RFETS closure activities (e.g., closure of Building 995, the wastewater treatment plant, and modification of the Interceptor Trench System) could also significantly alter drainage and flow patterns. Should the availability of water be affected by upgradient off-Site activities or upgradient on-Site activities, significant habitats could be adversely affected.

In consideration of these potential impacts, watershed-level information—regarding water availability in the Buffer Zone—has been collected for the past four years. These data now constitute a baseline for RFETS, and therefore the monitoring program for FY03 has been reduced. For selected locations, such as GS01, GS03, and GS04, monitoring for selenium has been retained, as selenium may be an element of interest for EPA and CDPHE with respect to watershed impacts. At location SW134, monitoring for selected nutrients and TSS has been retained to assist in determining possible impacts from mining operations in the drainage. Current flow monitoring in the Buffer Zone, in addition to that performed under RFCA, is shown in Table 7-2. The flow data are collected at 15-minute intervals, downloaded, and compiled monthly. However, 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 yet known. Therefore, additional data, currently not collected, could be required (e.g., accurate information on purchased water, data on exfiltration and infiltration of underground pipes, additional water quality parameters, and data on alluvial flow through the Buffer Zone habitats of concern).

[39] This table taken directly from the IMP.

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Table 7-2 Buffer Zone Hydrologic Monitoring Locations

Station Identifiers	Locations	Monitoring in Addition to Flow
GS01	Woman Creek/Indiana Street	RFCA, selenium, precipitation
GS02	Mower Reservoir/Indiana Street	
GS03	Walnut Creek/Indiana Street	RFCA, selenium, precipitation
GS04	Rock Creek at Highway 128	Selenium, precipitation
GS05	North Woman Creek at west boundary	Precipitation
GS06	South Woman Creek at west boundary	
SW134	Rock Creek at west boundary (Gravel Pit)	Selected nutrients, TSS
GS16	Antelope Springs	Precipitation
SW118	North Access Road	Precipitation

7.3.1 DATA TYPES, FREQUENCY, AND COLLECTION PROTOCOLS

Buffer Zone hydrologic flow monitoring (see Figure 7-1, Table 7-3) will be performed only as represented by GS01-GS06, GS16, SW118, and SW134.

Table 7-3 Buffer Zone Hydrologic Field Data Collection: Parameters and Frequency

Station	Parameter	
	Discharge	Precipitation
GS01	15-min continuous	5-min continuous
GS02	15-min continuous	NA
GS03	15-min continuous	5-min continuous
GS04	15-min continuous	5-min continuous
GS05	15-min continuous	5-min continuous
GS06	15-min continuous	NA
GS16	15-min continuous	5-min continuous
SW118	15-min continuous	5-min continuous
SW134	15-min continuous	NA

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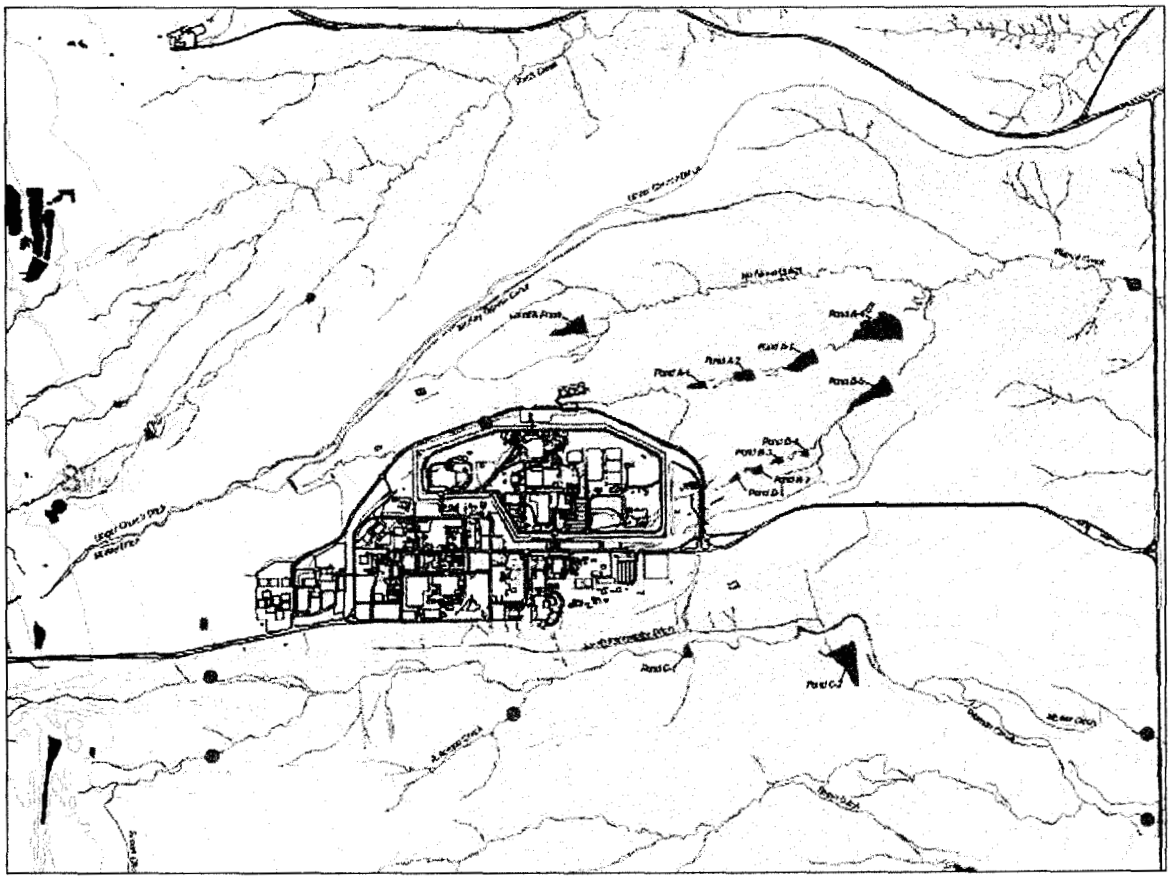

Figure 7-1 Map Showing Buffer Zone Hydrologic Monitoring Locations

7.3.2 DATA ANALYSIS

Although no routine data evaluations are required, the following preliminary decision rules have been proposed:

IF The seasonal average or yearly average water availability or quality entering Rock Creek, Walnut Creek, or Woman Creek drainages diminishes below baseline due to off-Site activities,

THEN RFETS will notify Jefferson County and USFWS to determine what actions, if any, should be taken to restore availability or quality to historical levels.

IF Activities occurring within RFETS 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,

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THEN RFETS 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 RFETS will consult with the USFWS.

Secondary data uses could include:

- Determining the impact of mining on Rock Creek water availability;
- Interpreting potential causes of declines in the valued habitats onsite;
- Supporting water management planning;
- Evaluating cumulative impacts of actions (on- and off-Site);
- Validating any predicted impacts of the selected alternative to downstream resources; and
- Supporting RFETS's biological assessment and the USFWS biological opinion.

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APPENDIX A

Site Description and Environmental History

A.1 Site Description

RFETS 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 about 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 (DOE, 1992a).

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 Pu, U, 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 RFETS 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). A 6,150-acre Buffer Zone that surrounds the Industrial Area. Industrial activity immediately adjoining RFETS includes present and 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 RFETS, transmitting water for downstream agricultural, industrial, and municipal purposes. Three ephemeral streams drain the Site and flow eastward.

RFETS operations have generated solid and liquid non-hazardous, hazardous, radioactive, and mixed (hazardous and radioactive) waste streams. These wastes have been handled and disposed of in a variety of ways. Solid non-hazardous and non-radioactive wastes are disposed of at the 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.

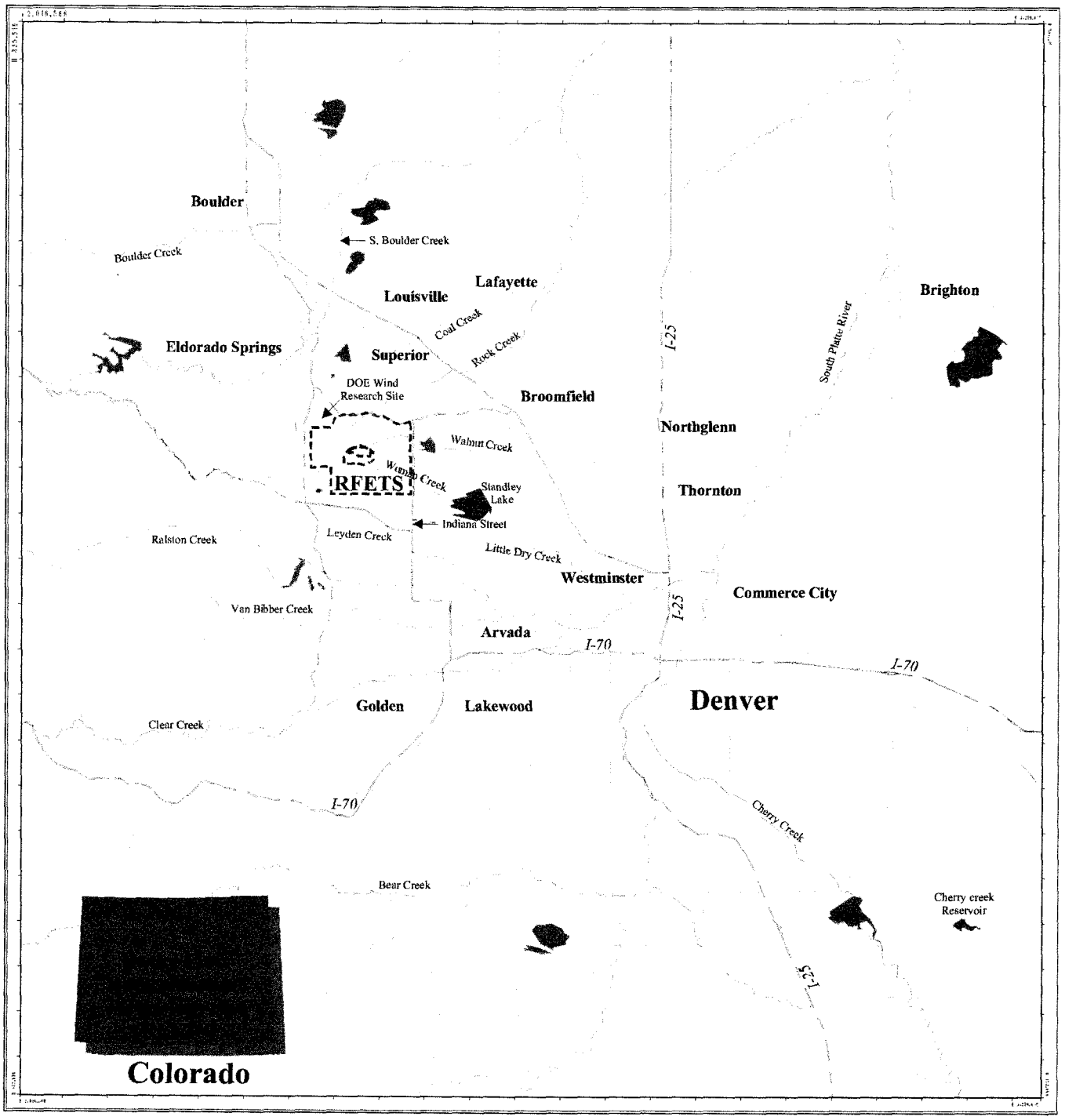

Figure A-1
General Location Map

CH2M HILL

CH2M Hill
Geographic Information Systems Group
Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

5,000' 0' 10,000' 20,000'
Scale in Feet

/projects/fy2003\03-0386\location_map.cdr

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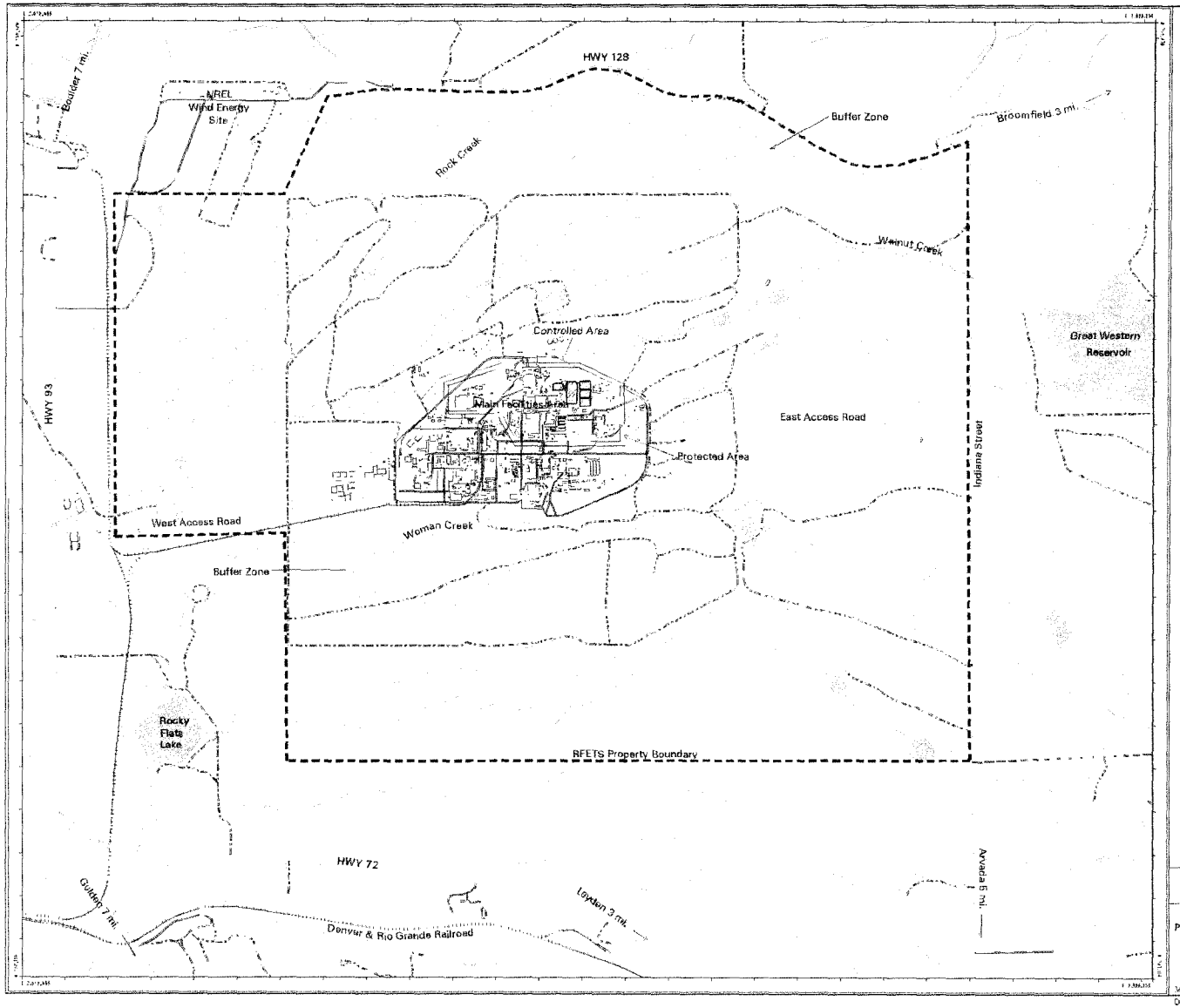

Figure A-2

Rocky Flats Environmental Technology Site Map

EXPLANATION

Standard Map Features

- Buildings
- Solar Evaporation Ponds (SEP)
- 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 AERIAL PHOTOGRAPHS: Buildings, fences, hydrographic, roads were also digitized from 1994, aerially-acquired by EG&G RFS, Las Vegas. Digitized on the Photogrammetric 1:85

Scale = 1 : 28720
1 inch represents approximately 2393 feet

700 0 1400 2800ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept 303-966-7707

Prepared by: CARGILL

Prepared for: KAISER-HILL

Map ID: 03-0186 April 23, 2003

Original map contents are preserved. Logo and date have changed.

NT_Svr W:\Projects\fy2003\03-0386\sitemap\fy03.cdr

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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 RFETS. Efforts to document the extent of contamination are in progress, in accordance with RCRA, CERCLA, and RFCA (DOE et al, 1996), a cooperative agreement between DOE, EPA, and CDPHE. In addition, an HRR (DOE, 1992a) 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.

Definition and Description of Contaminated Sites

Section 3004(u) of RCRA requires that SWMUs be identified. This became applicable to RFETS with the signing of the Compliance Agreement between the State of Colorado and DOE, on July 31, 1986 (State of Colorado, 1986). The exact definition of SWMUs had not been formalized. Therefore, RFETS used guidance from the State of Colorado and EPA Region VIII (EPA, 1985). The State of Colorado and EPA required the identification of 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* (DOE, 1985). 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 called 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 (Rockwell, 1986).

The SWMUs at the Site were renamed as IHSSs in the IAG, which became the compliance document for RFETS cleanup under RCRA and CERCLA (State of Colorado, 1991). The term IHSS is specific to RFETS 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 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 RFETS 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 (State of Colorado, 1991).

The IHSS list is updated as new IHSSs are identified in the HRR (DOE, 1992a). Each IHSS is considered a potential source of environmental contamination and, therefore, a potential source of contamination to groundwater.

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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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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)

IHSS NO.	PAC NO.	PAC NAME

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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)
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

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IHSS NO.	PAC NO.	PAC NAME
		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
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

IHSS NO.	PAC NO.	PAC NAME
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
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

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IHSS NO.	PAC NO.	PAC NAME

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

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APPENDIX B

Action Level Framework for Groundwater

APPENDIX B
Action Levels Framework for Groundwater

Analyte	CAS Reference Number	Tier I [a] (mg/L)	Tier II (mg/L)	Basis [b]	PQLs [c] (mg/L)
Acenaphthene	83-32-9	2.19E+02	2.19E-00	[2]	1.00E-02
Acetone	67-64-1	3.65E+02	3.65E-00	[2]	
Aldrin	309-00-2	5.01E-04	5.01E-06	[2]	1.00E-04
Aluminum	7429-90-5	3.65E+03	3.65E+01	[2]	
Ammonium (as Ammonia)	7664-41-7	3.54E+03	3.54E+01	[2]	
Anthracene	120-12-7	1.10E+03	1.10E+01	[2]	1.00E-02
Antimony	7440-36-0	6.00E-01	6.00E-03	[1]	1.00E-02
Aroclor-1016	12674-11-2	5.00E-02	5.00E-04	[1]	1.00E-03
Aroclor-1221	11104-28-2	5.00E-02	5.00E-04	[1]	1.00E-03
Aroclor-1232	11141-16-5	5.00E-02	5.00E-04	[1]	1.00E-03
Aroclor-1242	53469-21-9	5.00E-02	5.00E-04	[1]	1.00E-03
Aroclor-1248	12672-29-6	5.00E-02	5.00E-04	[1]	1.00E-03
Aroclor-1254	11097-69-1	5.00E-02	5.00E-04	[1]	1.00E-03
Aroclor-1260	11096-82-5	5.00E-02	5.00E-04	[1]	1.00E-03
Arsenic	7440-38-2	5.00E-00	5.00E-02	[1]	
Barium	7440-39-3	2.00E+02	2.00E-00	[1]	
Benzene	71-43-2	5.00E-01	5.00E-03	[1]	1.00E-03
alpha-BHC	319-84-6	1.35E-03	1.35E-05	[2]	5.00E-05
beta-BHC	319-85-7	4.73E-03	4.73E-05	[2]	5.00E-05
gamma-BHC [Lindane]	58-89-9	2.00E-02	2.00E-04	[1]	5.00E-05
Benzo(a)anthracene	56-55-3	1.17E-02	1.17E-04	[2]	1.00E-02
Benzo(a)pyrene	50-32-8	2.00E-02	2.00E-04	[1]	2.00E-04
Benzo(b)fluoranthene	205-99-2	1.17E-02	1.17E-04	[2]	1.00E-02
Benzo(k)fluoranthene	207-08-9	1.17E-01	1.17E-03	[2]	1.00E-02
Benzoic Acid	65-85-0	1.46E+04	1.46E+02	[2]	
Benzyl Alcohol	100-51-6	1.10E+03	1.10E+01	[2]	
Beryllium	7440-41-7	4.00E-01	4.00E-03	[1]	5.00E-03
Bromodichloromethane	75-27-4	1.00E+01	1.00E-01	[1]	1.00E-03
Bromoform [Tribromomethane]	75-25-2	1.00E+01	1.00E-01	[1]	1.00E-03
Bromomethane [Methyl bromide]	74-83-9	5.11E-00	5.11E-02	[2]	1.00E-03
2-Butanone [Methylethyl ketone]	78-93-3	2.19E+03	2.19E+01	[2]	
Butylbenzylphthalate	85-68-7	7.30E+02	7.30E-00	[2]	1.00E-02
Cadmium	7440-43-9	5.00E-01	5.00E-03	[1]	5.00E-03
Carbon disulfide	75-15-0	3.65E+02	3.65E-00	[2]	
Carbon tetrachloride	56-23-5	5.00E-01	5.00E-03	[1]	1.00E-03
alpha-Chlordane	5103-71-9	2.00E-01	2.00E-03	[1]	1.00E-03
beta-Chlordane	5103-74-2	2.00E-01	2.00E-03	[1]	1.00E-03
gamma-Chlordane	12789-03-6	2.00E-01	2.00E-03	[1]	1.00E-03
4-Chloroaniline	106-47-8	1.46E+01	1.46E-01	[2]	
Chlorobenzene	108-90-7	1.00E+01	1.00E-01	[1]	5.00E-03
Chloroethane	75-00-3	2.94E-00	2.94E-02	[2]	
bis(2-Chloroethyl)ether	111-44-4	7.74E-03	7.74E-05	[2]	1.00E-02
Chloroform	67-66-3	1.00E+01	1.00E-01	[1]	1.00E-03

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[Trichloromethane]					
bis(2-Chloroisopropyl)ether	39638-32-9	1.22E-01	1.22E-03	[2]	1.00E-02
Chloromethane [Methyl chloride]	74-87-3	6.55E-01	6.55E-03	[2]	1.00E-03
2-Chloronaphthalene	91-58-7	2.92E+02	2.92E-00	[2]	
2-Chlorophenol	95-57-8	1.83E+01	1.83E-01	[2]	5.00E-02
Chromium (total)	7440-47-3	1.00E+01	1.00E-01	[1]	
Chrysene	218-01-9	1.17E-00	1.17E-02	[2]	1.00E-02
Cobalt	7440-48-4	2.19E+02	2.19E-00	[1]	
Copper	7440-50-8	1.30E+02	1.30E-00	[3]	
Cyanide	57-12-5	2.00E+01	2.00E-01	[1]	
4,4-DDD	72-54-8	3.55E-02	3.55E-04	[2]	1.00E-04
4,4-DDE	72-55-9	2.50E-02	2.50E-04	[2]	1.00E-04
4,4-DDT	50-29-3	2.50E-02	2.50E-04	[2]	1.00E-04
Dalapon	75-99-0	2.00E+01	2.00E-01	[1]	1.30E-02
Dibenzo(a,h)anthracene	53-70-3	1.17E-03	1.17E-05	[2]	1.00E-02
Dibenzofuran	132-64-9	1.46E+01	1.46E-01	[2]	
Dibromochloromethane	124-48-1	1.01E-01	1.01E-03	[2]	1.00E-03
1,2-Dibromo-3-chloropropane	96-12-8	2.00E-02	2.00E-04	[1]	1.00E-03
Di-n-butylphthalate	84-74-2	3.65E+02	3.65E-00	[2]	1.00E-02
1,2-Dichlorobenzene	95-50-1	6.00E+01	6.00E-01	[1]	1.00E-02
1,3-Dichlorobenzene	541-73-1	6.00E+01	6.00E-01	[1]	1.00E-02
1,4-Dichlorobenzene	106-46-7	7.50E-00	7.50E-02	[1]	1.00E-02
3,3-Dichlorobenzidine	91-94-1	1.89E-02	1.89E-04	[2]	1.00E-02
1,1-Dichloroethane	75-34-3	3.65E+02	3.65E-00	[2]	1.00E-03
1,2-Dichloroethane	107-06-2	5.00E-01	5.00E-03	[1]	1.00E-03
1,1-Dichloroethene	75-35-4	7.00E-01	7.00E-03	[1]	1.00E-03
1,2-Dichloroethene (total)	75-35-4	7.00E-00	7.00E-02	[1]	5.00E-03
2,4-Dichlorophenol	120-83-2	1.10E+01	1.10E-01	[2]	5.00E-02
2,4-Dichlorophenoxyacetic acid (2,4-D)	94-75-7	7.00E-00	7.00E-02	[1]	1.00E-03
1,2-Dichloropropane	78-87-5	5.00E-01	5.00E-03	[1]	1.00E-03
cis-1,3-Dichloropropene	10061-01-5	4.73E-02	4.73E-04	[2]	1.00E-03
trans-1,3-Dichloropropene	10061-02-6	4.73E-02	4.73E-04	[2]	1.00E-03
Dieldrin	60-57-1	5.32E-04	5.32E-06	[2]	1.00E-04
Diethylphthalate	84-66-2	2.92E+03	2.92E+01	[2]	1.00E-02
2,4-Dimethylphenol	105-67-9	7.30E+01	7.30E-01	[2]	5.00E-02
Dimethylphthalate	131-11-3	3.65E+04	3.65E+02	[2]	1.00E-02
4,6-Dinitro-2-methylphenol	534-52-1	3.65E-01	3.65E-03	[2]	
2,4-Dinitrophenol	51-28-5	7.30E-00	7.30E-02	[2]	5.00E-02
2,4-Dinitrotoluene	121-14-2	1.25E-02	1.25E-04	[2]	1.00E-02
2,6-Dinitrotoluene	606-20-2	1.25E-02	1.25E-04	[2]	1.00E-02
Di-n-octylphthalate	117-84-0	7.30E+01	7.30E-01	[2]	
Endosulfan I	959-98-8	2.19E+01	2.19E-01	[2]	1.00E-04
Endosulfan II	33213-65-9	2.19E+01	2.19E-01	[2]	1.00E-04
Endosulfan sulfate	1031-07-8	2.19E+01	2.19E-01	[2]	1.00E-04
Endosulfan (technical)	115-29-7	2.19E+01	2.19E-01	[2]	1.00E-04
Endrin (technical)	72-20-8	2.00E-01	2.00E-03	[1]	1.00E-04

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Ethylbenzene	100-41-4	7.00E+01	7.00E-01	[1]	1.00E-02
bis(2-Ethylhexyl)phthalate	117-81-7	6.00E-01	6.00E-03	[1]	1.00E-02
Fluoranthene	206-44-0	1.46E+02	1.46E-00	[2]	1.00E-02
Fluorene	86-73-7	1.46E+02	1.46E-00	[2]	1.00E-02
Fluoride	7782-41-4	4.00E+02	4.00E-00	[1]	
Glyphosate	1071-83-6	7.00E+01	7.00E-01	[1]	6.00E-02
Heptachlor	76-44-8	4.00E-02	4.00E-04	[1]	5.00E-05
Heptachlor epoxide	1024-57-3	2.00E-02	2.00E-04	[1]	5.00E-05
Hexachlorobenzene	118-74-1	1.00E-01	1.00E-03	[1]	1.00E-02
Hexachlorobutadiene	87-68-3	1.09E-01	1.09E-03	[2]	1.00E-02
Hexachlorocyclopentadiene	77-47-4	5.00E-00	5.00E-02	[1]	1.00E-02
Hexachloroethane	67-72-1	6.08E-01	6.08E-03	[2]	1.00E-02
Indeno(1,2,3-cd)pyrene	193-39-5	1.17E-02	1.17E-04	[2]	1.00E-02
Isophorone	78-59-1	8.96E-00	8.96E-02	[2]	1.00E-02
Lead (dissolved)	7439-96-5	1.50E-00	1.50E-02	[3]	1.00E-02
Lithium	7439-93-2	7.30E+01	7.30E-01	[2]	
Manganese	7439-96-5	1.72E+02	1.72E-00	[2]	
Mercury	7439-97-6	2.00E-01	2.00E-03	[1]	1.00E-03
Methoxychlor	72-43-5	4.00E-00	4.00E-02	[1]	5.00E-04
Methylene chloride [Dichloromethane]	75-09-2	5.00E-01	5.00E-03	[1]	1.00E-03
2-Methylnaphthalene	91-57-6	1.46E+02	1.46E-00	[2]	
4-Methyl-2-pentanone	108-10-1	2.92E+02	2.92E-00	[2]	
2-Methylphenol	95-48-7	1.83E+02	1.83E-00	[2]	
4-Methylphenol	106-44-5	1.83E+01	1.83E-01	[2]	
Molybdenum	7439-98-7	1.83E+01	1.83E-01	[2]	
Naphthalene	91-20-3	1.46E+02	1.46E-00	[2]	1.00E-02
Nickel	7440-02-0	1.40E+01	1.40E-01	[1]	
Nitrate (MCL as N)	14797-55-8	1.00E+03	1.00E+01	[1]	
Nitrite (MCL as N)	14797-65-0	1.00E+02	1.00E-00	[1]	
2-Nitroaniline	88-74-4	2.19E-01	2.19E-03	[2]	
Nitrobenzene	98-95-3	1.83E-00	1.83E-02	[2]	1.00E-02
4-Nitrophenol	100-02-7	2.92E+01	2.92E-01	[2]	
n-Nitrosodiphenylamine	86-30-6	1.74E-00	1.74E-02	[2]	1.00E-02
n-Nitrosodipropylamine	621-64-7	1.22E-03	1.22E-05	[2]	1.00E-02
Pentachlorophenol	87-86-5	1.00E-01	1.00E-03	[1]	5.00E-02
Phenol	108-95-2	2.19E+03	2.19E+01	[2]	5.00E-02
Pyrene	129-00-0	1.10E+02	1.10E-00	[2]	1.00E-02
Selenium	7782-49-2	5.00E-00	5.00E-02	[1]	1.00E-02
Silver	7440-22-4	1.83E+01	1.83E-01	[2]	5.00E-03
Strontium	7440-24-6	2.19E+03	2.19E+01	[2]	
Styrene	100-42-5	1.00E+01	1.00E-01	[1]	5.00E-03
Sulfate	14808-79-8	5.00E+04	5.00E+02	[4]	
1,1,2,2-Tetrachloroethane	79-34-5	4.26E-02	4.26E-04	[2]	1.00E-03
Tetrachloroethene	127-18-4	5.00E-01	5.00E-03	[1]	1.00E-03
Thallium	7440-28-0	2.00E-01	2.00E-03	[1]	1.20E-02
Tin	7440-31-5	2.19E+03	2.19E+01	[2]	
Toluene	108-88-3	1.00E+02	1.00E-00	[1]	5.00E-03
Toxaphene	8001-35-2	3.00E-01	3.00E-03	[1]	3.00E-03
1,2,4-Trichlorobenzene	120-82-1	7.00E-00	7.00E-02	[1]	1.00E-02
1,1,1-Trichloroethane	71-55-6	2.00E+01	2.00E-01	[1]	5.00E-03

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1,1,2-Trichloroethane	79-00-5	5.00E-01	5.00E-03	[1]	1.00E-03
Trichloroethene	79-01-6	5.00E-01	5.00E-03	[1]	1.00E-03
2,4,5-Trichlorophenol	95-95-4	5.00E-00	5.00E-02	[1]	
2,4,6-Trichlorophenol	88-06-2	7.74E-01	7.74E-03	[2]	5.00E-02
Vanadium	7440-62-2	2.56E+01	2.56E-01	[2]	
Vinyl acetate	108-05-4	3.65E+03	3.65E+01	[2]	
Vinyl chloride	75-01-4	2.00E-01	2.00E-03	[1]	2.00E-03
Xylene (total)	1330-20-7	1.00E+03	1.00E+01	[1]	5.00E-03
Zinc	7440-66-6	1.10E+03	1.10E+01	[2]	

Notes:

[a] Tier I action levels are 100 times the corresponding Tier II value.
[b] Basis for Tier II action level:
[1] Maximum Concentration Level (MCL)
[2] Residential groundwater ingestion Programmatic Preliminary Remediation Goal (PPRG)
[3] EPA Action Level based on the Lead and Copper Rule (40 CFR 141.2)
[4] Proposed MCL
[c] If the practical quantitation level (PQL) for a pollutant is higher (less stringent) than an action level, "less than" the PQL will be used as the compliance threshold. These less stringent PQLs are shaded.

The scientific notation used in this table indicates the power of ten by which the two-decimal-place number is multiplied (e.g., 2.52E-02 = 2.52 X 10^{-2} = .0252).

Radionuclide Analytes	CAS Reference Number	Tier I [a] (pCi/L)	Tier II [b] (pCi/L)	PQL (pCi/L)
Americium-241	14596-10-2	14.5	0.145	
Cesium-137+D	10045-97-3	151	1.51	
Plutonium-239/240	10-12-8	15.1	0.151	
Radium-226/228+D		2000 [c]	20 [c]	
Strontium-89/90	11-10-9	85.2	0.852	
Tritium	10028-17-8	66600	666	
Uranium-233/234	11-08-5	106	1.06	
Uranium-235	15117-96-1	101	1.01	
Uranium-238	7440-61-1	76.8	0.768	

Notes:

[a] Tier I action levels are 100 times the corresponding Tier II value.
[b] Tier II action levels for radionuclides are the corresponding residential ground water ingestion
Preliminary Programmatic Remediation Goals (PPRGs) except for radium isotopes which are proposed MCLs.
[c] This value applies to the sum of the two radium isotopes.

D = Daughters (Indicates that cancer risk estimates for these radionuclides include the contributions from their short-lived decay products, assuming secular equilibrium with the principal nuclide in the environment. Sample analyses for these radionuclides will not include any activity contribution from daughter products.)

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APPENDIX C

Physical and Hydrologic Setting

C.1 Geology

C.1.1 Introduction

RFETS is situated about 2 to 6 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 (Spencer, 1961). The geologic history of the Rocky Mountain region of Colorado (which includes RFETS) has been summarized by Haun and Kent (1965). The Site's elevation is about 6,000 feet above mean sea level (msl). The Industrial Area (main facility area) of RFETS 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, Figure 3-1).

The following major geologic and hydrologic parameters influence groundwater flow at RFETS (EG&G, 1995a):

- Topography controls the surface waters of the upslope drainage basin that, in part, recharges groundwater and the three principal streams draining RFETS. 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 RFETS extends from the crystalline Precambrian gneiss, schist, and granitoids at 3,000 feet below msl to the unconsolidated Quaternary deposits at surface approximately 6,000 feet above msl. Based upon aerial photographic interpretation,

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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 RFETS. The generalized lithologic section in the RFETS 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 RFETS. 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 RFETS. 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 RFETS.

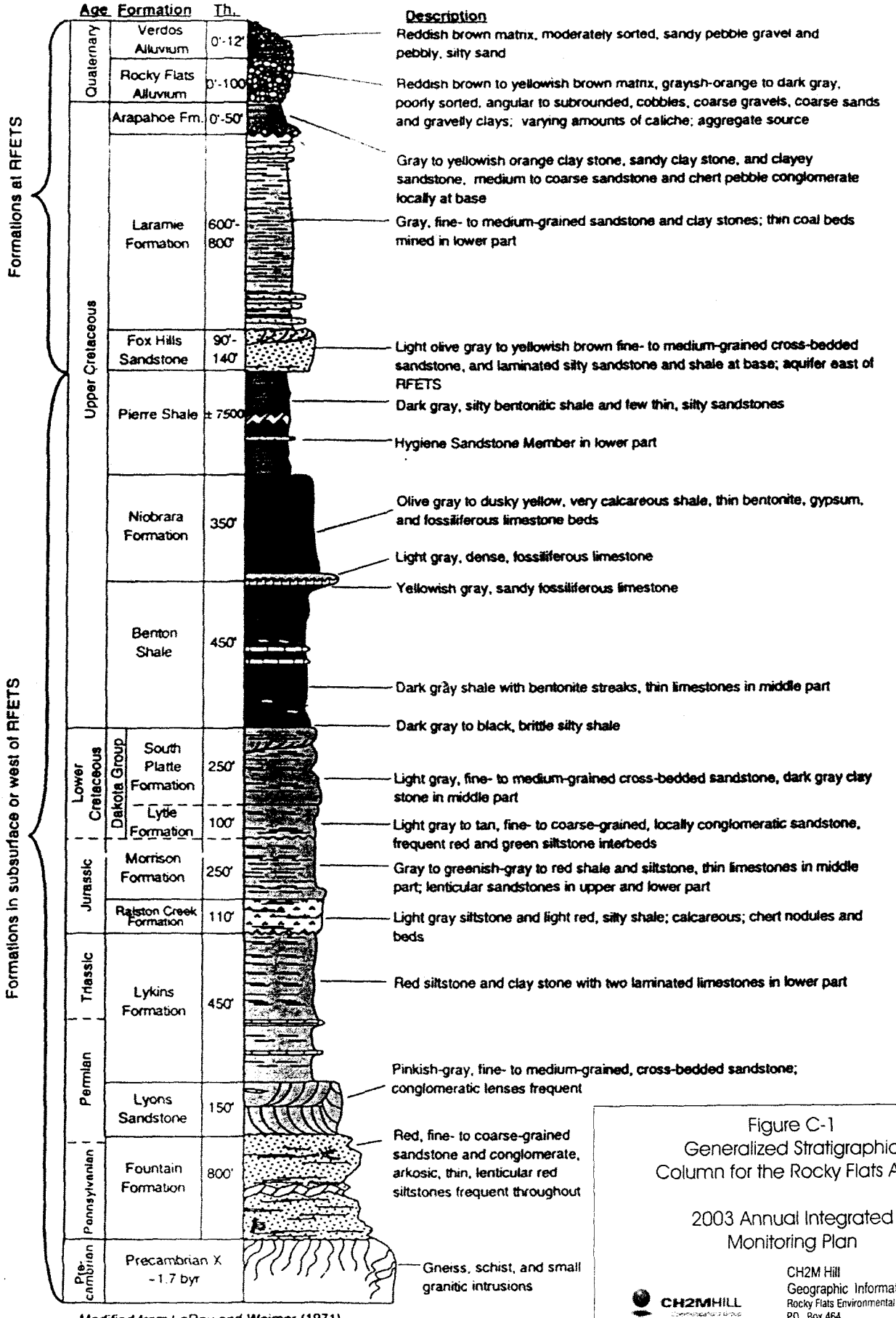
C.1.2.1 Pediment-Covering Alluviums

Several Quaternary alluvial formation pediment covers have been identified in the vicinity of RFETS by Scott (1975). The Rocky Flats Alluvium is an unconsolidated deposit derived from quartzites and granites of the Coal Creek Canyon provenance west of RFETS. The deposit diminishes from west to east with thicknesses ranging from about 100 feet to less than one foot. In the central portion of RFETS, the deposit is about 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 RFETS exhibit some large scale cross-stratification. Depositional processes include fluvial and debris-flow transport infilling paleotopographic lows, but leaving a widespread surface of erosion with extremely low relief (Shroba, 1994).

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 (Shroba, 1994). 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 (Shroba, 1994).



Modified from LeRoy and Weimer (1971)

Figure C-1
Generalized Stratigraphic Column for the Rocky Flats Area

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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 DOE (EG&G, 1991a), 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 RFETS-wide mapping program (EG&G, 1992d) determined that the overall Arapahoe Formation is generally less than 25 feet thick in the area. The No. 1 Sandstone (EG&G, 1991a) 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 about 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 (Pearl, 1980), and is the sole water supply for some residents in the RFETS area. The Fox Hills Formation is primarily a fine-grained sandstone that is about 75 to 125 feet thick 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 RFETS 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 RFETS.

C.1.3 Geologic Structure

RFETS 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 area as presented in Figure C-2. A monoclinal fold limb exposed west of RFETS is the most significant

surficial structural feature. 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 RFETS. Several high angle bedrock faults have been inferred to exist in the Industrial Area, 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 (DOE, 1996).

C.2 Hydrogeology

C.2.1 Introduction

This section presents the basic concepts about the hydrogeologic conditions 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 (EG&G, 1995b; Shroba, 1994; EG&G, 1995c). 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 RFETS Aquifer

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) (Fetter, 1988). For purposes of this report, the uppermost aquifer or 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 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 RFETS.

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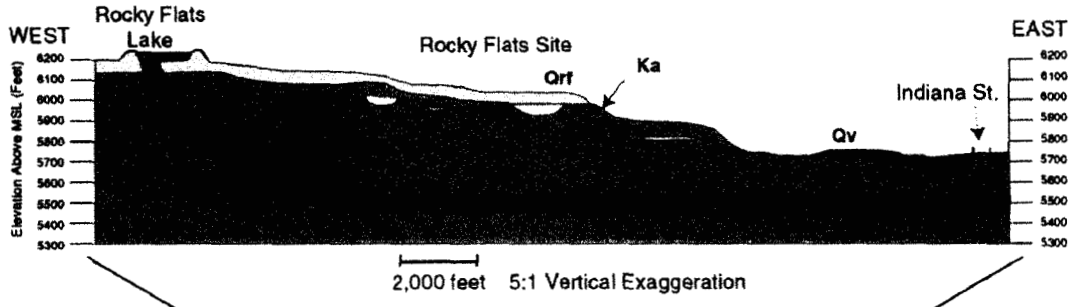
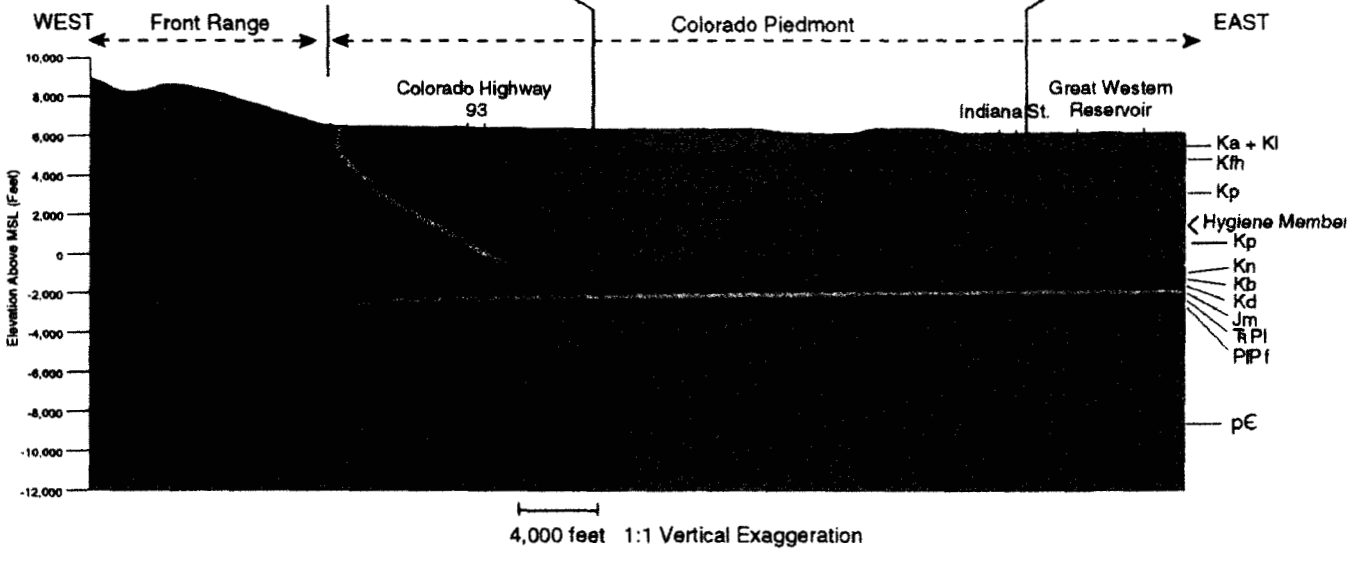
Geologic Units

- Qv — Verdos Alluvium
- 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.

Figure C-2
Generalized Geologic Cross Section of the Front Range and the Rocky Flats Area

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Rocky Flats Environmental Technology Site
P.O. Box 464
Golden, CO 80402-0464

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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 RFETS.

Groundwaters of the three hydrostratigraphic units are hydraulically separated beneath the Industrial Area. They do converge, however, and are in mutual contact immediately upgradient near the western margin of RFETS 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 (EG&G, 1993d). 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

RFETS is located in a regional groundwater recharge area (EG&G, 1991a). 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 that 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 (EG&G, 1993d).

In the western part of RFETS, 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 RFETS. 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 Industrial Area.

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 Industrial Area and in the area between South Walnut Creek and Woman Creek is part of the UHSU (EG&G, 1991a). 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 RFETS.

Groundwater levels in UHSU wells fluctuate in response to seasonal recharge events. About 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 RFETS 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 stream 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 (DOE, 1996). 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 (DOE, 1996).

C.2.5 Hydraulic Conductivity

The UHSU at RFETS 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 [(EG&G, 1995c) Table G-2] indicate a range of 5.0×10^{-2} cm/sec [3.0×10^{4} feet per year (ft/yr)] to 3×10^{-8} cm/sec (9.3×10^{-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 (2.5×10^{-3} cm/sec); Arapahoe No. 1 sandstone (7.9×10^{-4} cm/sec); Rocky Flats Alluvium (2.1×10^{-4} cm/sec); colluvium (9.3×10^{-5} cm/sec); weathered Laramie Formation sandstones (3.9×10^{-5} cm/sec); and weathered Laramie Formation claystones (8.8×10^{-7} cm/sec). Hydraulic conductivities for LHSU materials are generally the lowest measured at RFETS, with geometric mean values for individual lithologic groups ranging from 1.6×10^{-7} to 5.8×10^{-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 (DOE, 1996).

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APPENDIX D

Site Impacts to Groundwater

D.1 Impact of Individual Hazardous Substance Sites on the Quality of Groundwater

The characterization and assessment of IHSSs and their potential to impact groundwater and surface water has historically been conducted under the CERCLA RI/FS programs for individual OUs. In 1995, the decision was made to take a Site-wide approach to the evaluation and remediation of RFETS. Of the original 16 OUs, there are only seven 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 conclusion regarding groundwater contamination is that the hydrogeologic setting of a specific area directly affects the movement and quality of groundwater. Chemicals at some of the 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 RFETS.

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 Analytes of Interest 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 VOCs. Plate 3 shows the distribution of VOC contamination in the UHSU. However, because of limitations in well coverage, variability of hydrostratigraphic conditions, and local variations in groundwater transport velocity, plume definition is inexact. Published plume maps for individual constituents can be found in the 1993 *Well Evaluation Report* (EG&G, 1994), the annual RCRA groundwater reports (EG&G, 1992c, 1993c, 1995; RMRS, 1996a), and in individual OU RI/RCRA feasibility investigation reports.

The VOC contaminant plumes in groundwater at RFETS 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 MCLs for individual constituents. To delineate areas of highly contaminated groundwater, the groundwater action levels of 100 times the MCLs were compared against groundwater data for the most common VOCs in groundwater. The exceedances were plotted and are shown on Plate 3.

TABLE D-1
Analytes of Interest

Groundwater Contaminant Plumes										
Potential Analytes of Interest	**X** = Chemicals>Tier I Levels, X = Chemicals>Tier II Levels, x = Minor Detections>Tier II Levels									
	881 Hillside	903 Pad	Mound	East Trenches	Solar Ponds	Carbon Tet	Ind. Area	Old Landfill	PU&D	Present Landfill
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
Tritium					X					X
Uranium-233/234		x			**X**					
Uranium-235	X	x			X					
Uranium-238		X			X		X	**X**		
Organic Compounds:										
1,1,1-Trichloroethane									X	
1,1,2-Trichloroethane	X	x	x				X			

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1,1-Dichloroethane							**X**	x		
1,1-Dichloroethene	**X**	**X**	x	X		X	**X**	x	X	X
1,2-Dichloroethane			x							
1,2-Dichloroethene	X	X	x				X			
1,2-Dichloropropane			x							
2,6-Dinitrotoluene	x									X
4-Methyl-2-Pentanone										X
Acenaphthene										
Acetone		x		x						
Alpha-BHC	x									
Aroclor-1232										x
Aroclor-1242										x
Benzene		**X**	x	X		x	x			X
Benzo(a) anthracene							x			
Benzo(a)pyrene							x			
Benzo(b) fluoranthene							x			
Bromomethane		X								
bis(2-Ethylhexyl) phthalate	x	X		X	x		X	X	X	X
Beta-BHC	x									
Carbon Disulfide					x					
Carbon Tetrachloride	**X**	**X**	X	**X**	X	**X**	**X**		X	X
Clorobenzene		x				x				
Chloroform		**X**	x	X		X	x			
Chloromethane		**X**	X				X			
cis-1,3-Dichloropropene		x	X			X	x			
Dibromochloro-methane		x	X							
Fluoranthene										
Hexachloro-butadiene		**X**	x	x						
Hexachloro-ethane		X								
Methylene Chloride	X	**X**	X	**X**	X	**X**	X	x		X
Pyrene										
Tetrachloro-ethene	**X**	**X**	**X**	**X**		**X**	**X**	X	X	X
Toluene										
trans-1,3-Dichloropropene		x	X	x						
Trichloroethene	**X**	**X**	**X**	**X**	X	**X**	**X**	X	X	X
Vinyl Chloride		X	X	x		x	X		X	X

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The most probable sources were identified using the results of recent field sampling programs and process knowledge (RMRS, 1996). A flow diagram 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 (RMRS, 1996).

D.2.1 Groundwater Contamination at 881 Hillside (OU1)

The 881 Hillside is located in the south-central portion of RFETS 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* (EG&G, 1991) outlines the activities that were required to identify the extent of contamination.

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. TCE, PCE, and TCA are the most common organic contaminants at the 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 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.

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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 that have been produced as required in the French drain interim measures/interim remediation action (IM/IRA) (DOE, 1992). Additional information on 881 Hillside is reported in the *OU1 Phase III RFI/RI Work Plan Revision 1* (EG&G, 1991) and in the *OU1 Final Phase III RFI/RI* (DOE, 1994).

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 details of the IHSSs for OU2. The 903 Pad is located in the southeast corner of RFETS, 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 (DOE, 1992a). The 903 Pad and Ryan's Pit Plume, Mound Plume, and East Trenches Plume are part of a large composite plume on the east side of RFETS. 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. 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. Although Trench 1 could contribute to this plume, evidence indicates that the Mound site is the primary source.

Contaminated groundwater from the plume contains vinyl chloride, PCE, and TCE. 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 or less at seep SW059, where it is collected and stored, and later treated at Building 891.

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D.2.2.2 903 Pad and Ryan's Pit Plume

This contaminant plume has two, closely spaced sources: VOCs associated with drums formerly stored at the 903 Storage Area, where the contents of the drums leaked into the subsurface and groundwater, and 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, PCE, TCE, 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 PCE 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 PCE and TCE 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, PCE, and TCE, 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 PCE and TCE has reached South Walnut Creek. If concentrations in the seep complex increase over time, a greater contaminant mass may reach surface water.

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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* (Rockwell, 1989) and in the *Final Phase II RFI/RI OU2 Report* (DOE, 1995).

D.2.3 Solar Evaporation Ponds Groundwater Contamination (OU4)

The 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.

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 (EG&G, 1992c, 1993c, 1994b, 1995; RMRS, 1996a). Groundwater monitoring data from UHSU wells indicate that nitrate contamination from the SEPs has migrated downgradient of the 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 A1 (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.

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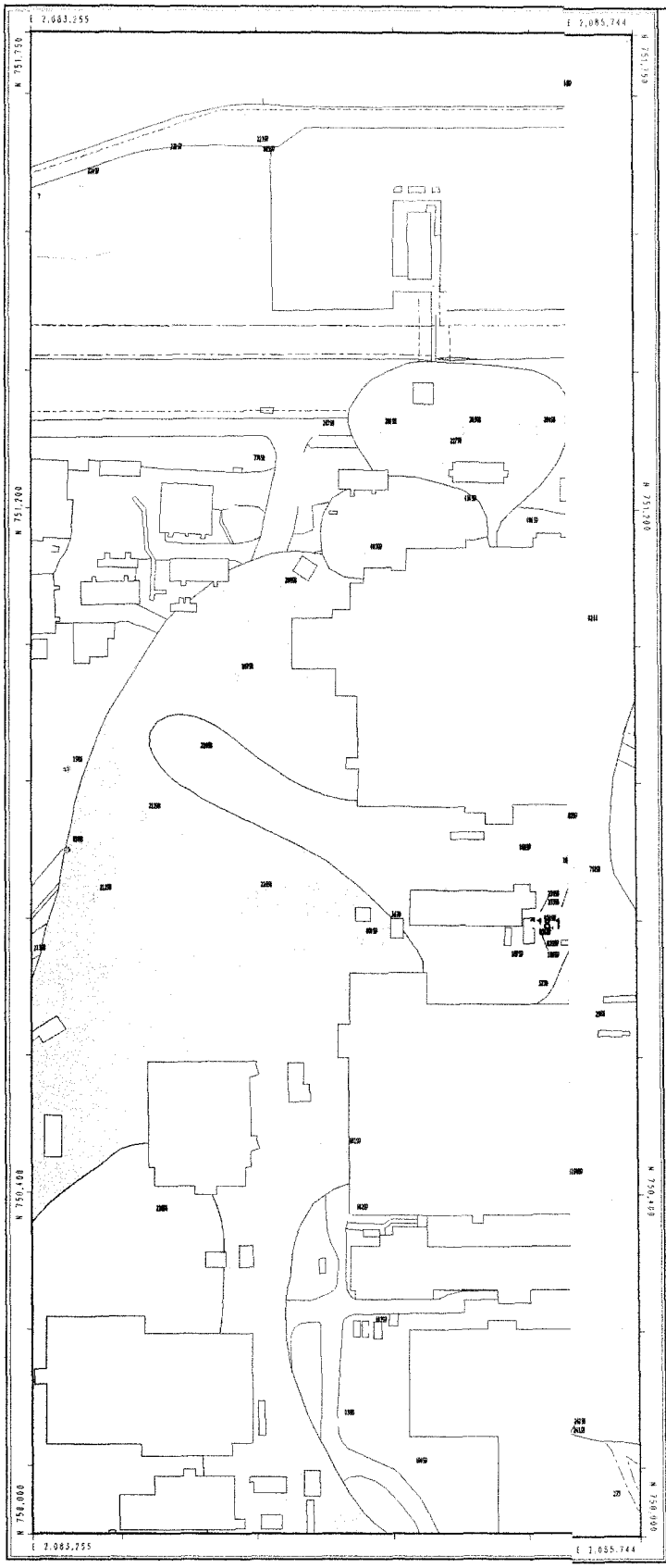

Figure D-3

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

Scale = 1 : 2500
1 inch represents approximately 208 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: CH2MHILL

Prepared for: KAISER•HILL COMPANY

Map ID: 03-0386

April 23, 2003

NT_Svr w:/projects/fy99/99-0372/ou4a_nt.aml

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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 trench system (ITS) 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 (Advanced Sciences, 1991); 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 about 2.7 million gallons of water per year, but is not entirely effective in preventing nitrate contamination from impacting the North Walnut Creek drainage (DOE, 1994e).

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 (EG&G, 1992c, 1993c, 1994, 1995). 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* (EPA, 1994b) and the *OU4 Solar Evaporation Ponds Phase II Groundwater Investigation Final Field Program Report* (DOE, 1996a).

D.2.4 Industrial Area Groundwater Contamination

The Industrial Area has not received the same level of characterization as other portions of RFETS. This is because the OUs associated with the Industrial Area had not completed RFI/RI investigations before the decision was made to integrate remedial activities at RFETS. 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-gallon, 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 gallon, as documented in the Historical Release Report (DOE, 1992a). 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 (DOE, 1994) 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 Buildings 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 TCE thought to emanate from IHSSs 117.1, 117.2, 157.1, 158, 171 and 182; PCE 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 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.

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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 (EG&G, 1994) 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 (RMRS, 1996a).

PU&D Yard Plume

In 1993, newly installed upgradient wells at the Process Simulation Laboratory (PSL) detected significant concentrations of VOCs in the alluvial groundwater. These 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* (EG&G, 1992c, 1993c, 1994, 1995; RMRS, 1996a), *Technical Memorandum - Final Work Plan for OU7* (DOE, 1994e) and *Draft IM\IRA Decision Document for OU7 Present Landfill* (DOE, 1996b).

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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 (DOE, 1996c). 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 OLF (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.

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APPENDIX E

Proposed Monitoring Wells

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Table E-1
Proposed Monitoring Wells

WELL NO	FREQUENCY	CLASS	PLUME/AREA	FORMATION	PURPOSE
00100	Semiannual	DD/PD	Bldg 779	AL/BD	D&D Monitoring for Bldg 779/Plume Definition well monitoring upgradient of Solar Pond Plume
00191	Semiannual	PM	903 Pad/Lip Area	AL	Performance Monitoring downgradient for 903 Pad/Lip Area
00197	Semiannual	PE	Old Landfill	AL	Plume Extent well monitoring the Industrial Area Plume
00200	Semiannual	DD	Bldg 707	AL/BD	D&D Monitoring for Bldg 707
00297	Semiannual	PD	Solar Ponds	AL	Plume Definition well monitoring the southern migration of the Solar Ponds Plume
00300	Semiannual	DD	Bldg 707	AL/BD	D&D Monitoring for Bldg 707
00397	Semiannual	PE	PU&D	AL	Plume Extent well monitoring the PU&D Yard Plume
00400	Semiannual	DD	Bldg 776/777	AL/BD	D&D Monitoring for Bldg 776/777 Complex
00491	Semiannual	PD	903 Pad	BD/UHSU	Plume Definition well monitoring the 903 Pad VOC Plume
00500	Semiannual	DD/PD	Bldg 776/777	AL/BD	D&D Monitoring for Bldg 776/777 Complex/Plume Definition well upgradient of Solar Pond Plume
00597	Semiannual	PD	PU&D/Pres.Landfill	AL	Plume Definition well monitoring the Landfill/PU&D yard Plume
00600	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Bldg 776/777 Complex
00700	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Bldg 776/777 Complex
00797	Semiannual	PM	881 Hillside	AL	Performance Monitoring for 881 Footing Drain Sump
00897	Semiannual	PM	Mound	BD/UHSU	Performance Monitoring on the Mound Source remediation
00997	Semiannual	D	NA	AL	Drainage well below Pond B-4 in South Walnut Creek Drainage
01097	Semiannual	PA	PU&D/Pres.Landfill	AL	Plume Degradation well monitoring upgradient of the Landfill/PU&D Yard Plume
01497	Semiannual	PA	PU&D	AL	Plume Degradation well monitoring the PU&D Yard Plume
01697	Semiannual	PE	PU&D	AL	Plume Extent well monitoring the PU&D Yard Plume
02097	Semiannual	PA	PU&D/Pres.Landfill	AL	Plume Degradation well monitoring the Landfill/PU&D Yard Plume
02291	Semiannual	PM	Mound	BD/UHSU	Performance Monitoring on the Mound Source remediation
02397	Semiannual	DD	Bldg 779	AL	D&D monitoring upgradient of Bldg 779
02497	Semiannual	DD	Bldg 779	AL	D&D monitoring downgradient of Bldg 779
02500	Semiannual	DD/PD	B779/Solar Ponds	AL/BD	D&D monitoring downgradient of Bldg 779/Plume Definition well monitoring upgradient of Solar Pond Plume
0386	Semiannual	B	Boundary	BD/UHSU	Boundary Well - in small drainage north of the east access gate
03991	Semiannual	PD	East Trenches	AL	Plume Definition well monitoring the East Trenches Plume
04091	Semiannual	PE	East Trenches	AL	Plume Extent well monitoring the northward migration of the East Trenches Plume
04591	Semiannual	PE	East Trenches	AL	Plume Extent well monitoring the southward migration of the East Trenches Plume
0487	Semiannual	PD	881 Hillside	AL	Plume Definition well for the 881 Hillside Plume
04991	Semiannual	PE	East Trenches	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume
05091	Semiannual	PE	East Trenches	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume
05391	Semiannual	PD	East Trenches	AL	Plume Definition well monitoring eastward concentration of VOCs from the East Trenches Plume
05691	Semiannual	PM	East Trenches	AL	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
06091	Semiannual	PE	East Trenches	AL/BD	Plume Extent well monitoring the northeast migration of the East Trenches Plume
06491	Semiannual	B	Boundary	BD/UHSU	Boundary Well - in small drainage east of the Site at Indiana St.
07291	Semiannual	PM	903 Pad/Lip Area	AL	Performance Monitoring sidegradient to downgradient of 903 Pad/Lip Area
07391	Semiannual	PM/PA	903 Pad/Ryans Pit	AL/BD	Performance Monitoring/Plume Degradation well monitoring effects of remediation of Ryans Pit
08091	Semiannual	PE	Mound/E. Trench	AL	Plume Extent well monitoring the southern migration of Mound and East Trenches Plumes
0987	Semiannual	PA	903 Pad/Ryans Pit	BD/UHSU	Plume Degradation well monitoring upgradient of the 903 Pad/Ryan's Pit Plume
1187	Semiannual	PA	903 Pad/Ryans Pit	BD/UHSU	Plume Degradation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
1386	Quarterly	PE/PM	Drainage/Solar Ponds	AL	Performance Monitoring - SEP Treatment System, Plume Extent Monitoring for Solar Ponds Plume
1786	Quarterly	PE/PM	Solar Ponds	AL	Performance Monitoring - SEP Treatment System, Plume Extent Monitoring for Solar Ponds Plume
1986	Semiannual	PE	Industrial Area	AL	Plume Extent well monitoring the northern migration of the IA Plume
3386	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the southern migration of the SEP Nitrate and Carbon Tet Plumes
3586	Semiannual	PE/PM	Mound	AL	Plume Extent well tracking migration of Solar Ponds nitrate Plume
3687	Semiannual	PM	East Trenches	BD/UHSU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
4087	Quarterly	RCRA	Landfill	AL	RCRA/Plume Extent well monitoring downgradient of Present Landfill
4386	Semiannual	PM	903 Pad/Lip Area	AL	Performance Monitoring sidegradient to downgradient for the 903 Pad/Lip Area
4787	Semiannual	PE	881 Hillside	AL	Plume Extent south of the 881 Hillside Plume
4887	Semiannual	PE	881 Hillside	AL	Plume Extent south of the 881 Hillside Plume
5187	Semiannual	DD	Bldg 881	AL	D & D Monitoring for Bldg 881
5387	Semiannual	PE	881 Hillside	AL	Plume Extent south of the 881 Hillside Plume
5587	Semiannual	D	NA	AL	Drainage well monitoring the Woman Cr. drainage south of the 881 Hillside Plume
5887	Quarterly	RCRA	PU&D	AL	RCRA upgradient/ Plume Extent well monitoring the PU&D Yard Plume and Present Landfill
6186	Semiannual	PE	Industrial Area	AL	Plume Extent well monitoring eastward migration of IA Plume
6286	Semiannual	PD	903 Pad	BD/USHU	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
6386	Semiannual	PD	903 Pad	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
6486	Semiannual	D	NA	AL	Drainage well monitoring the Woman Creek drainage downgradient of the 881 Hillside Plume
6586	Semiannual	D	NA	AL	Drainage well monitoring the N side of Woman Creek below 903 Pad/Ryans Pit Plume
7086	Semiannual	PE	IA/Old Landfill	AL	Plume Extent well monitoring IA Plume and Old Landfill Plume pathway in Woman Cr.
10098	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Bldg 123
10194	Semiannual	PE	East Trenches	AL	Plume Extent well monitoring the southern migration of the East Trenches Plume
10198	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Bldg 123
10294	Semiannual	B	Boundary	AL	Boundary Well - in drainage below Pond D-2 in the southeast corner of the Site
10298	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Bldg 123
10394	Semiannual	B	Boundary	AL	Boundary Well - in the Woman Cr. Drainage at the Indiana Street Boundary
10398	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Bldg 123
10498	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Bldg 123
10598	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Bldg 123
10992	Semiannual	PM	881 Hillside	AL	Performance Monitoring for the French Drain
10994	Semiannual	PE	IA/Old Landfill	AL	Plume Extent IA VOA Plume/Old Landfill Plume near Woman Creek
11092	Semiannual	PM	881 Hillside	AL	Performance Monitoring for the French Drain
11791	Semiannual	PA	903 Pad/Ryan's Pit	AL/BD	Plume Degradation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume

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Table E-1
Proposed Monitoring Wells

WELL NO	FREQUENCY	CLASS	PLUME/AREA	FORMATION	PURPOSE
11891	Semiannual	PM	East Trenches	BD/UHSU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-3
12191	Semiannual	PM	East Trenches	BD/UHSU	Performance Monitoring at edge of T3 soil excavation
12691	Semiannual	PM	East Trenches	BD/UHSU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
15599	Semiannual	PM	Mound	AL	Performance Monitoring for the Mound groundwater treatment system
15699	Semiannual	PM	Mound	AL/BD	Performance Monitoring for the Mound groundwater treatment system
15799	Semiannual	PM	Mound	AL	Performance Monitoring for the Mound groundwater treatment system
18199	Semiannual	PA/DD	IHSS 118.1/B771	AL/BD	Plume Degradation well monitoring the IHSS 118.1 plume and D&D monitoring for Bldg 771 Complex
18399	Semiannual	PD	IHSS 118.1	AL/BD	Plume Definition well monitoring the IHSS 118.1 plume
18499	Semiannual	PA	IHSS 118.1	AL	Plume Degradation well monitoring the IHSS 118.1 plume
18799	Semiannual	PA	IHSS 118.1	AL/BD	Plume Degradation well monitoring the IHSS 118.1 plume
20902	Semiannual	DD	Bldg 771	BD/UHSU	D & D Monitoring for Bldg 771 Complex
21002	Semiannual	PE	IHSS 118.1	AL/BD	Plume Extent well monitoring the IHSS 118.1 plume
22596	Semiannual	PE	Industrial Area	AL	Plume Extent well monitoring the northern migration of the IA Plume
22696	Semiannual	PE	Industrial Area	AL	Plume Extent well monitoring the westward migration of the Carbon Tet Plume
22796	Semiannual	PE	Industrial Area	AL	Plume Extent well monitoring the northward migration of Carbon Tet Plume
22896	Semiannual	PD	Industrial Area	AL	Plume Definition well monitoring the northward extent of the Tier I part of IA VOA Plume
22996	Semiannual	DD	Bldg 886	AL	D & D Monitoring for Bldg 886
23096	Semiannual	PE	903 Pad	AL	Plume Extent well monitoring the southern migration of the Ryan's Pit Plume - OU2 VOA Plume
23296	Semiannual	PE/PM	East Trenches	AL	Plume Extent/Performance Monitoring well monitoring the East Trenches Treatment System
30100	Semiannual	PE	PU&D	AL	Plume Extent well monitoring the PU&D Yard Plume
30900	Semiannual	PA	PU&D	AL	Plume Degradation well monitoring the PU&D Yard Plume
33502	Semiannual	PD	Industrial Area	AL	Plume Definition well monitoring buried drainage south of B371, north of B335
37101	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37201	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37301	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37402	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37501	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37601	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37701	Semiannual	DD	Bldg 371/374	AL/BD	D & D Monitoring for Bldg 371/374 Complex
37791	Semiannual	DD	Bldg 881	AL	D & D Monitoring for Bldg 881
38591	Semiannual	D	NA	AL	Drainage well in Woman Creek drainage below 881 Hillside
39691	Semiannual	DD	Bldg 881	AL/BD	D & D Monitoring for Bldg 881
40099	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
40199	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
40299	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
40399	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
40499	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
40599	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
40699	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
40799	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
40899	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
40999	Semiannual	DD	Bldg 886/865	AL/BD	D & D Monitoring for Bldgs 886 and 865
41099	Semiannual	DD	Bldg 886	AL/BD	D & D Monitoring for Bldg 886
41102	Semiannual	DD	Bldg 886	AL/BD	D & D Monitoring for Bldg 886
41299	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
41499	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
41591	Semiannual	B	Boundary	AL	Boundary Well - in small drainage near east access gate
41599	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
41691	Semiannual	B	Boundary	AL	Boundary Well - in the Walnut Cr. Drainage at the Indiana Street Boundary
43392	Semiannual	PE	Industrial Area	AL	Plume Extent well monitoring southward migration of IA Plume
50099	Semiannual	PM	903 Pad/Lip Area	AL/BD	Performance Monitoring downgradient of 903 Pad/Lip area
52894	Quarterly	RCRA	Pres. Landfill	AL	RCRA/Plume Extent well monitoring downgradient of Present Landfill
52994	Quarterly	RCRA	Pres. Landfill	AL	RCRA/Plume Extent well monitoring downgradient of Present Landfill
55901	Semiannual	DD	Bldg 559	AL/BD	D & D Monitoring for Bldg 559
56001	Semiannual	DD	Bldg 559	AL/BD	D & D Monitoring for Bldg 559
56101	Semiannual	DD	Bldg 559	AL/BD	D & D Monitoring for Bldg 559
56201	Semiannual	DD	Bldg 559	AL/BD	D & D Monitoring for Bldg 559
56301	Semiannual	DD	Bldg 559	AL/BD	D & D Monitoring for Bldg 559
60299	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Bldg 776/777 Complex
60499	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Bldg 707
60599	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Bldg 707
60699	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Bldg 707
61099	Semiannual	DD	Bldg 883	AL/BD	D & D Monitoring for Bldg 883
61199	Semiannual	DD	Bldg 883	AL/BD	D & D Monitoring for Bldg 883
61499	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Bldg 707
70099	Quarterly	PM	Solar Ponds	AL/BD	Performance Monitoring of groundwater treatment system below Solar Ponds
70193	Quarterly	RCRA	PU&D	BD/UHSU	RCRA upgradient/Plume Extent well monitoring the PU&D Yard Plume
70299	Quarterly	PM	Solar Ponds	AL/BD	Performance Monitoring of groundwater treatment system below Solar Ponds
70393	Quarterly	RCRA	PU&D	AL	RCRA upgradient/Plume Definition well monitoring the edge of the PU&D Yard Plume
70493	Quarterly	RCRA	PU&D	BD/UHSU	RCRA upgradient/Plume Definition well monitoring the edge of the PU&D Yard Plume
70693	Semiannual	PA	PU&D/Pres. Landfill	AL	Plume Degradation well monitoring the Landfill/PU&D Yard Plume
75992	Semiannual	PE	Mound/E. Trench	AL	Plume Extent well monitoring So. Walnut Cr. Drainage below Mound Site Plume
76992	Semiannual	PE	PU&D/Pres. Landfill	AL	Plume Extent well monitoring the eastward migration of the PU&D Yard/Landfill Plume

Table E-1
Proposed Monitoring Wells

WELL NO	FREQUENCY	CLASS	PLUME/AREA	FORMATION	PURPOSE
77392	Semiannual	PD	Pres. Landfill	AL	Plume Definition well monitoring the eastward migration of the PU&D Yard Plume
79102	Semiannual	PD	Solar Ponds	BD/UHSU	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
79202	Semiannual	PD	Solar Ponds	BD/UHSU	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
79302	Semiannual	PD	Solar Ponds	BD/UHSU	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
79402	Semiannual	PD	Solar Ponds	AL/BD	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
79502	Semiannual	PD	Solar Ponds	AL/BD	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
83101	Semiannual	DD	Bldg 883/881	AL/BD	D & D Monitoring for Bldgs 883 and 881
83201	Semiannual	DD	Bldg 883	AL/BD	D & D Monitoring for Bldg 883
86501	Semiannual	DD	Bldg 865	AL/BD	D & D Monitoring for Bldg 865
86601	Semiannual	DD	Bldg 865	AL/BD	D & D Monitoring for Bldg 865
86701	Semiannual	DD	Bldg 865	AL/BD	D & D Monitoring for Bldg 865
88101	Semiannual	DD	Bldg 881	AL/BD	D & D Monitoring for Bldg 881
90099	Semiannual	PA	903 Pad/Ryan's Pit	AL/BD	Plume Degradation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90199	Semiannual	PE	903 Pad/Ryan's Pit	AL/BD	Plume Extent well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90299	Semiannual	PE	903 Pad/Ryan's Pit	AL/BD	Plume Extent well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90399	Semiannual	PA	903 Pad/Ryan's Pit	AL/BD	Plume Degradation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90402	Semiannual	PM	903 Pad/Lip Area	AL/BD	Performance Monitoring downgradient of 903 Pad/Lip area
90502	Semiannual	PM	903 Pad/Lip Area	AL/BD	Performance Monitoring upgradient of 903 Pad/Lip area
95099	Semiannual	PM	East Trenches	AL	Performance Monitoring of groundwater treatment system below East Trenches
95199	Semiannual	PM	East Trenches	AL	Performance Monitoring of groundwater treatment system below East Trenches
95299	Semiannual	PM	East Trenches	AL/BD	Performance Monitoring of groundwater treatment system below East Trenches
99101	Semiannual	DD	Bldg 991	AL/BD	D & D Monitoring for Bldg 991
99201	Semiannual	DD	Bldg 991	AL/BD	D & D Monitoring for Bldg 991
99301	Semiannual	DD	Bldg 991	AL/BD	D & D Monitoring for Bldg 991
99401	Semiannual	DD	Bldg 991	BD/UHSU	D & D Monitoring for Bldg 991
B206989	Quarterly	RCRA	Pres. Landfill	BD/UHSU	RCRA/Plume Extent well monitoring downgradient of Present Landfill
B208289	Semiannual	PE	Solar Ponds	BD/UHSU	Plume Extent well monitoring the northeast migration of the SEP Nitrate Plume
B208789	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the northeast migration of the SEP Nitrate Plume
P114389	Semiannual	PE	Industrial Area	AL	Plume Extent well to monitor extent of Industrial Area plume pathway to Walnut Creek
P209289	Semiannual	PD	Carbon Tet	AL	Plume Definition well in the Carbon Tet Plume
P209389	Semiannual	PD	Carbon Tet	BD	Plume Definition well in the Carbon Tet Plume
P207989	Semiannual	PD	Solar Ponds	BD/UHSU	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
P218089	Semiannual	DD	Bldg 707	AL	D & D Monitoring for Bldg 707
P218389	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
P208989	Semiannual	PD	Solar Ponds	BD/UHSU	Plume Definition well monitoring downgradient of Solar Evaporation Ponds
P219089	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Bldg 771 Complex
P219189	Semiannual	PD	Carbon Tet	AL	Plume Definition well in the Carbon Tet Plume
P219489	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
P313589	Semiannual	PE	Industrial Area	AL	Plume Extent to monitor the eastward migration of IA Plume near Bldg 881
P314289	Semiannual	PE	Industrial Area	AL	Plume Extent to monitor the southern migration of IA Plume near Bldg 850
P317989	Semiannual	DD	Bldg 865	AL	D & D Monitoring for Bldg 865
P416689	Semiannual	PE	Industrial Area	AL	Plume Extent to monitor southern migration of IA Plume south of Bldg. 440
P416789	Semiannual	PD	Industrial Area	AL	Plume Definition of IA Plume south of 400 area along pathway to Woman Creek
P416889	Semiannual	PD	Industrial Area	AL	Plume Definition of IA Plume south of Bldg 664 along pathway to Woman Creek
P419689	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Bldg 444 Complex
891COLWEL	Quarterly	PM	881 Hillside	AL	Performance Monitoring of groundwater in collection well on 881 Hillside
ETP ef	Semiannual	PM	East Trenches	NA	Performance Monitoring of groundwater treatment system below East Trenches
ETP in	Semiannual	PM	East Trenches	NA	Performance Monitoring of groundwater treatment system below East Trenches
R1-0	Semiannual	PM	Mound	NA	Performance Monitoring of groundwater treatment system below Mound
R2-E	Semiannual	PM	Mound	NA	Performance Monitoring of groundwater treatment system below Mound
371-Basement	Semiannual	DD	Bldg 371/374	NA	D & D Monitoring for Bldg 371/374 Complex at foundation drain outfall
371-SubBasement	Semiannual	DD	Bldg 371/374	NA	D & D Monitoring for Bldg 371/374 Complex at foundation drain outfall
FD-559/561	Semiannual	DD	Bldg 559	NA	D & D Monitoring for Bldg 559 at foundation drain access point
FD-707-4	Semiannual	DD	Bldg 707	NA	D&D Monitoring for Bldg 707 at foundation drain access point
771FDOut#2	Semiannual	DD	Bldg 771	NA	D&D Monitoring for Bldg 771 at foundation drain outfall
BS-865-2	Semiannual	DD	Bldg 865	NA	D & D Monitoring for Bldg 865 at foundation drain access point
SW099	Quarterly	PM	Pres.Landfill	PM	Performance Monitoring of groundwater intercept system below Present Landfill
SW100	Quarterly	PM	Pres.Landfill	PM	Performance Monitoring of groundwater intercept system below Present Landfill
SW13494	Quarterly	PM/DD	Bldg 881	NA	Performance Monitoring in footing drain below Bldg 881/D&D monitoring for Bldg 881

Table E-2
Analyte Suite

Well Number	Frequency	Plume/Area	Drivers	VOC Suite	Metals Suite	Tritium	PU/AM	SR 89/90	Uranium	Nitrate	Fluoride	Sulfate	Cyanide	Cesium-137	Chloride	Sulfide	TOC	Methane	Ethene	Water Quality Suite	SVOC	Np-237	TPH	PCB
00100	Semiannual	Bldg 779		X	X		X		X	X														
00191	Semiannual	903 Pad/Lip Area		X	X		X		X	X												X		
00197	Semiannual	Old Landfill	RFCA	X	X	X		X	X	X	X	X												
00200	Semiannual	Bldg 707		X	X		X		X													X		
00297	Semiannual	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
00300	Semiannual	Bldg 707		X	X		X		X													X		
00397	Semiannual	PU&D	RFCA	X	X	X			X	X	X	X												
00400	Semiannual	Bldg 776/777		X	X	X	X		X	X														
00491	Semiannual	903 Pad		X	X		X		X	X		X												
00500	Semiannual	Bldg 776/777/Solar Ponds		X	X	X	X		X	X												X		
00597	Semiannual	PU&D/Landfill	RFCA	X	X	X			X	X	X	X												
00600	Semiannual	Bldg 776/777		X	X	X	X		X	X														
00700	Semiannual	Bldg 776/777		X	X	X	X		X	X														
00797	Semiannual	881 Hillside	RFCA	X	X				X	X		X												
00897	Semiannual	Mound		X	X		X		X	X														
00997	Semiannual	Drainage	RFCA	X	X		X	X	X															
01097	Semiannual	PU&D		X						X		X			X	X	X		X					
01497	Semiannual	PU&D		X						X		X			X	X	X		X					
01697	Semiannual	PU&D	RFCA	X	X	X			X	X	X	X												
02097	Semiannual	PU&D		X						X		X			X	X	X		X					
02291	Semiannual	Mound		X	X		X		X	X														
02397	Semiannual	Bldg 779		X	X		X		X	X														
02497	Semiannual	Bldg 779	RFCA	X	X		X		X	X														
02500	Semiannual	Bldg 779/Solar Ponds		X	X	X	X		X	X												X		
0386	Semiannual	Boundary	RFCA, AIP	X	X	X	X		X	X	X	X												
03991	Semiannual	East Trenches	RFCA	X	X		X		X	X														
04091	Semiannual	East Trenches	RFCA	X	X		X		X	X														
04591	Semiannual	East Trenches	RFCA	X	X		X		X	X														
0487	Semiannual	881 Hillside	RFCA	X	X				X	X		X												
04991	Semiannual	East Trenches	RFCA	X	X		X		X	X														
05091	Semiannual	East Trenches	RFCA	X	X		X		X	X														
05391	Semiannual	East Trenches		X	X		X		X	X														
05691	Semiannual	East Trenches		X	X		X		X	X														
06091	Semiannual	East Trenches	RFCA	X	X		X		X	X														
06491	Semiannual	Boundary	RFCA, AIP	X	X	X	X		X	X	X	X												
07291	Semiannual	903 Pad/Lip Area		X	X		X		X	X												X		
07391	Semiannual	903 Pad/Ryan's Pit		X	X		X		X	X		X			X	X	X	X	X					
08091	Semiannual	Mound/E. Trench	RFCA	X	X		X	X	X	X														
0987	Semiannual	903 Pad/Ryan's Pit		X						X		X			X	X	X	X	X					
1187	Semiannual	903 Pad/Ryan's Pit		X						X		X			X	X	X	X	X					
1386	Quarterly**	Drainage/Solar Ponds	RFCA, RCRA	X	X	X	X	X	X+X (D&T)	X	X	X												
1786	Quarterly**	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X+X (D&T)	X	X	X												
1986	Semiannual	Ind. Area	RFCA	X	X		X		X	X														
3386	Semiannual	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
3586	Semiannual	Mound		X	X		X		X	X														
3687	Semiannual	East Trenches		X	X		X		X	X														
4087	Quarterly	Pres. Landfill	RFCA, RCRA	X	X	X			X	X	X	X												
4386	Semiannual	903 Pad/Lip Area		X	X		X		X	X												X		
4787	Semiannual	881 Hillside	RFCA	X	X				X	X		X												
4887	Semiannual	881 Hillside	RFCA	X	X				X	X		X												
5187	Semiannual	Bldg 881		X	X		X		X	X														X*
5387	Semiannual	881 Hillside	RFCA	X	X				X	X		X												
5587	Semiannual	Drainage	RFCA	X	X			X	X	X		X												
5887	Quarterly	PU&D	RFCA, RCRA	X	X	X			X	X	X	X												
6186	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
6286	Semiannual	903 Pad	RFCA	X	X		X		X	X		X												
6386	Semiannual	903 Pad	RFCA	X	X		X		X	X		X												
6486	Semiannual	Drainage	RFCA	X	X			X	X	X		X												
6586	Semiannual	Drainage	RFCA	X	X		X		X	X														
7086	Semiannual	IA/Old Landfill	RFCA	X	X			X	X	X		X												
10098	Semiannual	Bldg. 123		X	X		X		X	X			X	X										
10194	Semiannual	East Trenches	RFCA	X	X		X		X	X														
10198	Semiannual	Bldg. 123		X	X		X		X	X			X	X										
10294	Semiannual	Boundary	RFCA, AIP	X	X	X	X		X	X	X	X												
10298	Semiannual	Bldg. 123		X	X		X		X	X			X	X										
10394	Semiannual	Boundary	RFCA, AIP	X	X	X	X	X	X	X	X	X												
10398	Semiannual	Bldg. 123		X	X		X		X	X			X	X										
10498	Semiannual	Bldg. 123		X	X		X		X	X			X	X										
10598	Semiannual	Bldg. 123		X	X		X		X	X			X	X										
10992	Semiannual	881 Hillside	RFCA, IM/IRA -FD	X	X				X	X		X												
10994	Semiannual	IA/Old Landfill	RFCA	X	X			X	X	X		X												
11092	Semiannual	881 Hillside	RFCA, IM/IRA -FD	X	X				X	X		X												
11791	Semiannual	903 Pad/Ryan's Pit		X						X		X			X	X	X	X	X					
11891	Semiannual	East Trenches		X	X		X		X	X														
12191	Semiannual	East Trenches	East Trenches	X	X		X		X	X														
12691	Semiannual	East Trenches		X	X		X		X	X														
15598	Semiannual	Mound		X			X		X															
15699	Semiannual	Mound		X			X		X															

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Table E-2
Analyte Suite

Well Number	Frequency	Plume/Area	Drivers	VOC Suite	Metals Suite	Tritium	PU/AM	SR 89/90	Uranium	Nitrate	Fluoride	Sulfate	Cyanide	Cesium-137	Chloride	Sulfide	TOC	Methane	Ethene	Water Quality Suite	SVOC	Np-237	TPH	PCB
15799	Semiannual	Mound		X			X		X															
18199	Semiannual	IHSS 118.1/Bldg 771		X	X	X	X		X	X		X			X	X	X	X				X		
18399	Semiannual	IHSS 118.1		X						X		X			X	X	X	X						
18499	Semiannual	IHSS 118.1		X						X		X			X	X	X	X						
18799	Semiannual	IHSS 118.1		X						X		X			X	X	X	X						
20902	Semiannual	Bldg 771		X	X	X	X		X	X												X		
21002	Semiannual	IHSS 118.1		X						X		X			X	X	X	X						
22596	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
22696	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
22796	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
22896	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
22996	Semiannual	Bldg 886	RFCA, IM/IRA for IA	X	X		X		X	X														
23096	Semiannual	903 Pad	RFCA	X	X		X		X	X		X												
23296	Semiannual	East Trenches	RFCA	X	X		X		X	X														
30100	Semiannual	PU&D		X	X	X			X	X	X	X												
30900	Semiannual	PU&D		X						X		X			X	X	X		X					
33502	Semiannual	Ind. Area		X	X		X		X	X		X			X	X	X	X	X		X		X	
37101	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37201	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37301	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37402	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37501	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37601	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37701	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
37791	Semiannual	Bldg 881		X	X		X		X	X														X*
38591	Semiannual	Drainage	RFCA	X	X			X	X	X		X												
39891	Semiannual	Bldg 881		X	X		X		X	X														X*
40099	Semiannual	Bldg 444		X	X	X			X	X			X											
40199	Semiannual	Bldg 444		X	X	X			X	X			X											
40299	Semiannual	Bldg 444		X	X	X			X	X			X											
40399	Semiannual	Bldg 444		X	X	X			X	X			X											
40499	Semiannual	Bldg 444		X	X	X			X	X			X											
40599	Semiannual	Bldg 771		X	X	X	X		X	X												X		
40699	Semiannual	Bldg 771		X	X	X	X		X	X												X		
40799	Semiannual	Bldg 771		X	X	X	X		X	X												X		
40899	Semiannual	Bldg 771		X	X	X	X		X	X												X		
40999	Semiannual	Bldg 865/886		X	X		X		X	X														
41099	Semiannual	Bldg 886		X	X		X		X	X														
41102	Semiannual	Bldg 886		X	X		X		X	X														
41299	Semiannual	Bldg 444		X	X	X			X	X			X											
41499	Semiannual	Bldg 771		X	X	X	X		X	X												X		
41591	Semiannual	Boundary	RFCA, AIP	X	X	X	X		X	X	X	X												
41599	Semiannual	Bldg 771		X	X	X	X		X	X												X		
41691	Semiannual	Boundary	RFCA, AIP	X	X	X	X	X	X	X	X	X												
43392	Semiannual	Ind. Area	RFCA	X	X		X		X	X														
50099	Semiannual	903 Pad/Up Area		X	X		X		X	X												X		
52894	Quarterly	Landfill	RFCA, RCRA	X	X	X			X	X	X	X												
52994	Quarterly	Landfill	RFCA, RCRA	X	X	X			X	X	X	X												
55901	Semiannual	Bldg 559		X	X		X		X	X														X*
56001	Semiannual	Bldg 559		X	X		X		X	X														X*
56101	Semiannual	Bldg 559		X	X		X		X	X														X*
56201	Semiannual	Bldg 559		X	X		X		X	X														X*
56301	Semiannual	Bldg 559		X	X		X		X	X														X*
60299	Semiannual	Bldg 776/777		X	X	X	X		X	X														
60499	Semiannual	Bldg 707		X	X		X		X													X		
60599	Semiannual	Bldg 707		X	X		X		X													X		
60699	Semiannual	Bldg 707		X	X		X		X													X		
61099	Semiannual	Bldg 883		X	X				X	X													X*	X*
61199	Semiannual	Bldg 883		X	X				X	X													X*	X*
61499	Semiannual	Bldg 707		X	X		X		X													X		
70099	Quarterly	Solar Ponds							X (T)	X														
70193	Quarterly	PU&D	RFCA, RCRA	X	X	X			X	X	X	X												
70299	Quarterly	Solar Ponds							X (T)	X														
70393	Quarterly	PU&D	RFCA, RCRA	X	X	X			X	X	X	X												
70493	Quarterly	PU&D	RFCA, RCRA	X	X	X			X	X	X	X												
70693	Semiannual	PU&D/Landfill		X						X		X			X	X	X		X					
75992	Semiannual	Mound/E. Trench	RFCA	X	X		X	X	X	X														
76992	Semiannual	PU&D/Landfill	RFCA, RCRA	X	X	X			X	X	X	X												
77392	Semiannual	Landfill	RFCA	X	X	X			X	X	X	X												
79102	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
79202	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
79302	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
79402	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
79502	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
83101	Semiannual	Bldg 883/881		X	X		X		X	X													X*	X*
83201	Semiannual	Bldg 883		X	X				X	X													X*	X*
86501	Semiannual	Bldg 865		X	X				X	X														
86601	Semiannual	Bldg 865		X	X				X	X														

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Table E-2
Analyte Suite

Well Number	Frequency	Plume/Area	Drivers	VOC Suite	Metals Suite	Tritium	PU/AM	SR 89/90	Uranium	Nitrate	Fluoride	Sulfate	Cyanide	Cesium-137	Chloride	Sulfide	TOC	Methane	Ethene	Water Quality Suite	SVOC	Np-237	TPH	PCB
86701	Semiannual	Bldg 865		X	X				X	X														
88101	Semiannual	Bldg 881		X	X		X		X	X														X*
90099	Semiannual	903 Pad/Ryan's Pit		X						X		X			X	X	X	X	X					
90199	Semiannual	903 Pad/Ryan's Pit		X	X		X		X	X		X												
90299	Semiannual	903 Pad/Ryan's Pit		X	X		X		X	X		X												
90399	Semiannual	903 Pad/Ryan's Pit		X	X		X		X	X		X			X	X	X	X	X					
90402	Semiannual	903 Pad/Lip Area		X	X		X		X	X												X		
90502	Semiannual	903 Pad/Lip Area		X	X		X		X	X												X		
95099	Semiannual	East Trenches	RFCA	X																				
95199	Semiannual	East Trenches	RFCA	X																				
95299	Semiannual	East Trenches	RFCA	X																				
99101	Semiannual	Bldg 991		X	X		X		X	X													X*	
99201	Semiannual	Bldg 991		X	X		X		X	X													X*	
99301	Semiannual	Bldg 991		X	X		X		X	X													X*	
99401	Semiannual	Bldg 991		X	X		X		X	X													X*	
B206989	Quarterly	Landfill	RFCA, RCRA	X	X	X			X	X	X	X												
P207989	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
B208289	Semiannual	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
B208789	Semiannual	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
P208989	Semiannual	Solar Ponds		X	X	X	X		X	X												X		
P114389	Semiannual	Ind. Area	RFCA	X	X		X		X	X														
P209289	Semiannual	Carbon Tet	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
P209389	Semiannual	Carbon Tet	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
P218089	Semiannual	Bldg 707		X	X		X		X													X		
P218389	Semiannual	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
P219089	Semiannual	Bldg 771		X	X	X	X		X	X												X		
P219189	Semiannual	Carbon Tet	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
P219489	Semiannual	Solar Ponds	RFCA, RCRA	X	X	X	X	X	X	X	X	X												
P313589	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
P314289	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
P317989	Semiannual	Bldg 865		X	X				X	X														
P416689	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
P416789	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
P416889	Semiannual	Ind. Area	RFCA, IM/IRA for IA	X	X		X		X	X														
P419689	Semiannual	Bldg 444		X	X	X			X	X			X											
891COLWEL	Quarterly	881 Hillside		X	X				X															
ETP ef	Semiannual	East Trenches		X	X (T)							X			X									
ETP in	Semiannual	East Trenches		X	X (T)							X			X									
R1-0	Semiannual	Mound		X	X (T)		X		X (T)			X			X					X				
R2-E	Semiannual	Mound		X	X (T)		X		X (T)			X			X					X				
371 Basement	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
371 SubBasement	Semiannual	Bldg 371/374		X	X		X		X	X													X*	
FD-559/561	Semiannual	Bldg 559		X	X		X		X	X														X*
FD-707-4	Semiannual	Bldg 707		X	X		X		X													X		
771FDOut#2	Semiannual	Bldg 771		X	X	X	X		X	X												X		
BS-865-2	Semiannual	Bldg 865		X	X				X	X														
SW099	Quarterly	Landfill		X																				
SW100	Quarterly	Landfill		X																				
SW13494	Quarterly***	Bldg 881		X	X		X		X	X														X*

Notes:
- * If not detected in samples from first sampling round, discontinued from analytical suite.
- ** Full IMP suite semiannually, reduced Solar Ponds Plume suite in remaining quarters.
- *** IMP suite quarterly, with additional Bldg 881 samples semiannually.
- (D), (T) Field filtered, unfiltered, respectively.

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
0186		730	
0386	12		
1086		730	
1386	4		
1786	4		
1886		2	
1986	12		
2286		12	
2686		2	
2986		2	
3386	730		
3586	4		
3686		2190	
3986		730	
4286		12	
4386	12		
4786			730
5586			730
5686			12
6186	4		
6286	4		
6386	4		
6486	12		
6586	12		
6686		12	
6786			2
6886		2190	
7086	4		
0187		730	
0487	12		
0987	4		
1087		2	
1187		4	
1487		730	
1987		2	
2187		2	
2487		2	
2687		2	
3287		2	
3387		2	
3687	4		
4087	12		
4287		730	
4387		2	
4787	4		
4887	4		
5187	4		
5287		12	

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
5387	4		
5587	12		
5887	4		
6087		2	
7187		2	
B400389			12
B200589			730
B200889			730
B402689			12
B206989	4		
P207689		2	
P207889		2	
P207989	4		
B208089		12	
B208289	4		
B208789	4		
P208989	4		
P209289	4		
P209389	4		
P209789		2	
P209889		730	
B210489		2190	
B110889		2	
B110989			12
P313489		2	
P313589	12		
P213689		730	
P414189		730	
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	

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
P416689	12		
P416789	12		
P416889	12		
P317989	4		
P218089	4		
P218289		2	
P218389	12		
P219089	4		
P219189	12		
P119389		730	
P219489	4		
P419689	4		
P320089		2	
0190			12
0290			12
0390			12
0990			12
1190			730
1290			2
1390			2
1490			12
00191	4		
00491	4		
01291		2	
01391		12	
02291	4		
03191		2	
03791		730	
03991	4		
04091	4		
04191		2	
04591	4		
04991	4		
05091	4		
05191		730	
05291		2	
05391	4		
05691	4		
06091	12		
06191		2	
06291		12	
06491	4		
07291	4		
07391	4		
08091	4		
11791	4		
11891	4		
12191	4		

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
12691	4		
13391		2	
13491		2	
13591		2	
20291		12	
20691		730	
20991		730	
34791		2	
37191		2	
37591		730	
37691		2	
37791	4		
38591	4		
39691	4		
41091		12	
41591	12		
41691	12		
10992	4		
11092	4		
43392	4		
46492		2	
75292		12	
75992	4		
76792		2	
76992	4		
77392	4		
77492		730	
00293			12
05293		730	
45793		2	
58793		2	
59493		2	
59893		2	
60693		2	
61293		2	
62593			12
62693			12
62893		2	
70193	4		
70393	4		
70493	4		
70693	4		
10194	4		
10294	4		
10394	4		
10594		2	
10694		2	
10794		2190	

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
10894		2	
10994	4		
11294			12
11494			730
11594			12
51094			2
51494			730
52894	4		
52994	4		
56994		2	
57094		2	
59594		2	
60294		2	
60994		2	
60195		4	
60395		2	
60695		2	
60795		2	
61295		2	
61495		2	
61595		2	
61695		2	
62395			12
63395		4	
63495		2	
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		
23296	4		
00197	4		
00297	4		
00397	4		
00697	4		
00597	4		
00797	4		
00897	4		
00997	12		
01097	4		

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
01497	4		
01697	4		
02097		4	
02197	4		
02397	4		
02497	4		
10098	4		
10198	4		
10298	4		
10398	4		
10498	4		
10598	4		
21498		4	
21698		4	
21898		4	
22098		4	
15199		4	
15299		4	
15399		4	
15499		4	
15599	4		
15699	4		
15799	4		
16199	4		
16299	4		
16399	4		
16499	4		
16599	4		
18199	4		
18399	4		
18499	4		
18799	4		
40099	4		
40199	4		
40299	4		
40399	4		
40499	4		
40599	4		
40699	4		
40799	4		
40899	4		
40999	4		
41099	4		
41199	4		
41299	4		
41499	4		
41599	4		
50099	4		

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
60299	4		
60499	4		
60599	4		
60699	4		
61099	4		
61199	4		
61299		4	
61499	4		
70099	4		
70299	4		
70799		4	
70899		4	
70999		4	
71099		4	
90099	4		
90199	4		
90299	4		
90399	4		
95099	4		
95199	4		
95299	4		
95699		4	
95799		4	
95899		4	
00100	4		
00200	4		
00300	4		
00400	4		
00500	4		
00600	4		
00700	4		
02500	4		
30100	4		
30900	4		
33502	4		
37101	4		
37201	4		
37301	4		
37501	4		
37601	4		
37701	4		
55901	4		
56001	4		
56101	4		
56201	4		
56301	4		
83101	4		
83201	4		

300

Table E-3
Site-Wide Water Level Monitoring Wells

Well	Water Quality	Industrial Area	Background
Alluvium and UHSU Bedrock			
86501	4		
86601	4		
86701	4		
88101	4		
99101	4		
99201	4		
99301	4		
99401	4		
20902	4		
21002	4		
33502	4		
37402	4		
41102	4		
44202		2	
71102		12	
71202		12	
79102	4		
79202	4		
79302	4		
79402	4		
79502	4		
33502	4		
90402	4		
90502	4		

Note: All LHSU Wells cancelled on 2003 IMP
Numbers in columns denote measurement frequency per year

APPENDIX F

Surface Water

NPDES Permit Application Testing Requirements

Tables I, II, and III provide examples of conventional and non-conventional pollutants and toxic pollutants that must be specifically identified in NPDES permit applications. Certain of these parameters must be analyzed for if expected to be present, and others must be analyzed for based on the type of industry applying for a permit. Pollutants identified in the application process, according to 40 CFR 122 Appendix D, may be incorporated into the discharge permit. As such, Appendix D to 40 CFR 122 is incorporated by reference and is not replicated here in order to direct the reader to the current version of the Code of Federal Regulations.

The applicability of the parameters listed in Appendix D is established in the regulations, specifically 40 CFR 122.21. The Site has completed an application for a National Pollutant Discharge Elimination System (NPDES) permit in accordance with the requirements in this section. Information is gathered on an ongoing basis regarding materials used at RFETS, especially those identified in this appendix. That information is incorporated in the permit application as required.

Table IV provides guidance on the general prohibitions for influent to the Wastewater Treatment Plant.

Table F-1 Examples of Conventional Pollutants

Total suspended solids (TSS)	pH
Total dissolved solids (TDS)	Total Kjeldahl nitrogen
Chemical oxygen demand (COD)	Nitrate plus nitrite
Biochemical Oxygen Demand, 5 day test (CBOD5)	Dissolved phosphorus
Oil and grease	Total ammonia plus organic nitrogen
Fecal coliform	Total phosphorus
Fecal streptococcus	

Table F-2 Examples of Toxic Pollutants (Metals and Cyanide) and Total Phenols

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

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Table F-3 Examples of Conventional and Non-conventional Pollutants which may be Required to be Tested by Existing Discharges if Expected to be Present

Bromide	Chlorine, total
Chlorine, residual	Color
Fecal coliform	Fluoride
Nitrate-nitrite	Nitrogen, total organic
Oil and grease	Phosphorus, total
Radioactivity	Sulfate
Sulfide	Sulfite
Surfactants	Aluminum, total
Barium, total	Boron, total
Cobalt, total	Iron, total
Magnesium, total	Molybdenum, total
Manganese, total	Tin, total
Titanium, total	

Table F-4 - General Prohibitions 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 6.5 to 9.0 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 Waste Water Treatment Plant (WWTP). Prohibited materials include solid objects, materials, 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 operations of the WWTP. At no time shall two successive readings on an explosion hazard meter at the point of discharge into the wastewater system by more than five percent, nor may any single reading be over ten percent 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, hydrids, and sulfides.
4. Must not contain any flammable substance with a flash point lower than 186 degrees Fahrenheit.
5. Must not have a temperature between 32 degrees to 150 degrees Fahrenheit.
6. Must not contain grease or oil or other substance that will solidify or become viscous between 32 degrees and 150 degrees Fahrenheit.
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

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in the wastewater system to which the user is connected. At all times, no particle shall be greater than one-half inch 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 (e.g., CBOD5) released at a rate or concentration that 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 parts per million of any grease or oil or any oil 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 the wastewater treatment process.
13. Must not cause the temperature of the treatment plant to exceed 40 degrees Celsius (104 degrees Fahrenheit)
14. Must not contain organic toxic pollutants, introduced 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 a listed or characteristic hazardous waste.
Refer to Section 2.3.2.2 Monitoring Discharges to the WWTP for additional information.

RFCA Analytes of Interest for Segment 5 and Segment 4

The analytes of interest (AoI) for Segment 5 listed in Table V are those analytes agreed upon with the stakeholder and the regulators during the development of the original IMP. Monitoring for these analytes is conducted at Points of Evaluation (POE) locations GS10, SW093, and SW027, and are the analytes for which monitoring funds have been requested. Attachment 5, Table 1 of RFCA specifies additional analytes beyond those specified here, and all of contaminant limitations listed are applicable. Most of those contaminants limitations are not measured above the standards or action levels and pose hypothetical health risks well below a 10^{-6} criterion. These are not a threat to the environment and are not included in routine monitoring.

The AoIs for Segment 4 listed in Table VI are those analytes agreed upon with the stakeholder and the regulators during the development of the original IMP. These analytes are monitored for at Points of Compliance (POC) locations GS01, GS03, GS08, GS11, and GS31, and are the analytes for which monitoring funds have been requested. Attachment 5, Table 1 of RFCA specifies additional analytes beyond those specified here, and all of contaminant limitations listed are applicable. Most of those contaminants limitations are not measured above the standards or action levels and pose hypothetical health risks well below a 10^{-6} criterion. These are not a threat to the environment and are

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not included in routine monitoring. Refer to Table VI for specific analytes at specific locations.

AoIs for Segment 5 and Segment 4 were developed and agreement achieved on the basis of the following assumptions. These assumptions allowed all parties to agree that funding and resources should be focused on a relatively short list of contaminants for which there is reasonable cause to expect measurements above the RFCA standards and actions levels.

- Discharges into Segment 4 will be from batch operations as currently conducted
- Sampling for RFCA compliance in Segments 4 and 5 will be flow-proportional
- Pre-discharge sampling by CDPHE will be comprehensive
- Cost effective analytical methods used to monitored the AoIs may also yield information about other potential, but unanticipated contaminants
- The Site will perform tritium monitoring in Segment 4 at the Indiana Street POC
- 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.

The real time monitoring of physical and indicator parameters included in the table provide some general indication of a wide variety of contaminants and are a required component of monitoring for AoIs. As this monitoring requires no laboratory analyses, it is the Site's most cost effective defensive monitoring.

Table F-5 - Segment 5 Analytes of Interest

Parameter	Rational for Inclusion as AoI
Plutonium 239, 240	High level of public concern. Known carcinogen. Known past releases have measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Uranium 233, 234, 235, and 238	Known renal toxicity; present on Site. Known past releases have measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Americium 241	Known carcinogen; present on Site. Known past releases have measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Tritium (at 995 POE)	Added per agreement of RFCA parties.

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Beryllium, total	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.
Chromium, total	Physiological and dermal toxicity. High level of regulatory concern, due in part to a 1989 chromic acid incident. Low levels can cause significant ecological damage.
Silver, dissolved	Highly toxic to fish at low levels. Used on Site only for photographic development, which has since been discontinued. Routinely accepted by POTWs as municipal waste, but discharge is regulated. May be removed from list later if data do not support concern.
Cadmium, dissolved	Highly toxic to fish at low levels with chronic exposure. Known human carcinogen and depletes physiologic calcium. Formerly used on Site in electroplating operations.
Hardness	Required to evaluate dissolved metals analyses due to its effect on solubility of these metals.
pH	Toxicity to humans and ecology. Real-time monitoring is inexpensive and effective method of detecting acid spills (such as chromic acid or plutonium nitrate) or failure of treatment system.
Conductivity	Conductivity is indicator of TDS, metals, cations, anions, and pH. Real-time monitoring is an inexpensive indicator of overall water quality.
Turbidity	Turbidity is general indicator of elevated contaminant levels.
Nitrate	The Solar Ponds Plume has elevated levels of nitrate in groundwater. Current remediation effort does not remove all nitrate from groundwater that recharges into N. Walnut Creek.
Flow	Required to detect flow events (precipitation, spills, discharges), evaluate, contaminant loads, and plan pond operations and discharges. Affects most decision rules and is the most commonly discussed attribute of

	Site surface waters.
Other notes	Volatile organic compounds (VOA), iron, and manganese are specifically excluded from the list. The parties recognize that VOAs will not be effectively monitored at these locations, and defer to the decision rules that drive monitoring closer to the sources of VOA contamination.

Table F-6 – Segment 4 Analytes of Interest

Parameter	Rational for inclusion as AoI
For Locations GS08, GS11, and GS31 (terminal pond discharges)	
Plutonium 239, 240	High level of public concern. Known carcinogen. Known past releases have measurements above the RFCA stream standards and action levels upstream of the terminal ponds provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Uranium 233, 234, 235, and 238	Known renal toxicity; present on Site. Known past releases have measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Americium 241	Known carcinogen; present on Site. Known past releases have measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases which may be above RFCA action levels.
pH	Toxicity to humans and ecology. Real-time monitoring is inexpensive and effective method of detecting acid spills (such as chromic acid or plutonium nitrate) or failure of treatment system.
Conductivity	Conductivity is indicator of total dissolved solids, metals, cations, anions, and pH. Real-time monitoring is inexpensive indicator of overall water quality.
Turbidity	Turbidity is general indicator of elevated contaminant levels.
Nitrate	Solar Ponds Plume impacts in Segment 5 may also be seen in the terminal ponds. Nitrates from the

	WWTP effluent may also be see in terminal ponds.
Flow	Required to detect flow events (precipitation, spills, discharges), evaluate, contaminant loads, and plan pond operations and discharges. Affects most decision rules and is the most commonly discussed attribute of Site surface waters.
For locations GS01 and GS03 (Indiana Street)	
Plutonium 239, 240	High level of public concern. Known carcinogen. Known past releases have measurements above the RFCA stream standards and action levels upstream of the terminal ponds provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Americium 241	Known carcinogen; present on Site. Known past releases have measurements above the RFCA stream standards and action levels provides reasonable cause to monitor for future releases which may be above RFCA action levels.
Tritium	Tritium is an AoI for the cities of Broomfield and Westminster due to the 1973 release of tritium from the Site.
Other notes	Indiana Street is not a POC for real-time monitoring parameters. Non-POC monitoring specified in Table 2/22 is not reflected in this table, as the parties did not intend Indiana Street be a POC for the parameters listed in that table.

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PLATE 1A

Groundwater Monitoring Report: IMP Monitoring Well RFETS Location Map

PLATE 1B

Groundwater Monitoring Report: IMP Monitoring Well IA Location Map

PLATE 2

Groundwater Monitoring Report: Potentiometric Surface of Permeable Units of the UHSU 2nd Quarter

PLATE 3

Groundwater Monitoring Report: VOCs Composite and Nitrate Plumes Map

Figure 2-4
Automated Surface Water Monitoring Locations and Precipitation Gages for Fiscal Year 2003

EXPLANATION

Precipitation Gage

Monitoring Location Objective*

- Buffer Zone Hydrologic
- New Source Detection
- Point of Compliance
- Point of Evaluation
- Source Location
- Ad Hoc
- Performance
- IDLH**

Standard Map Features

- Buildings and other structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Topographic Contour (20-Foot)
- Paved roads

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial flyovers data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Topographic contours were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was captured by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at ~ 10 meter resolution. DEM post-processing performed by MK, Winter 1997.

NOTES:

Scale = 1 : 17870
1 inch represents approximately 1488 feet

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: CH2MHILL

Prepared for: KAISER•HILL COMPANY

Map ID: 03-0386 April 21, 2003

Original map contents are preserved. Logo and date have changed.

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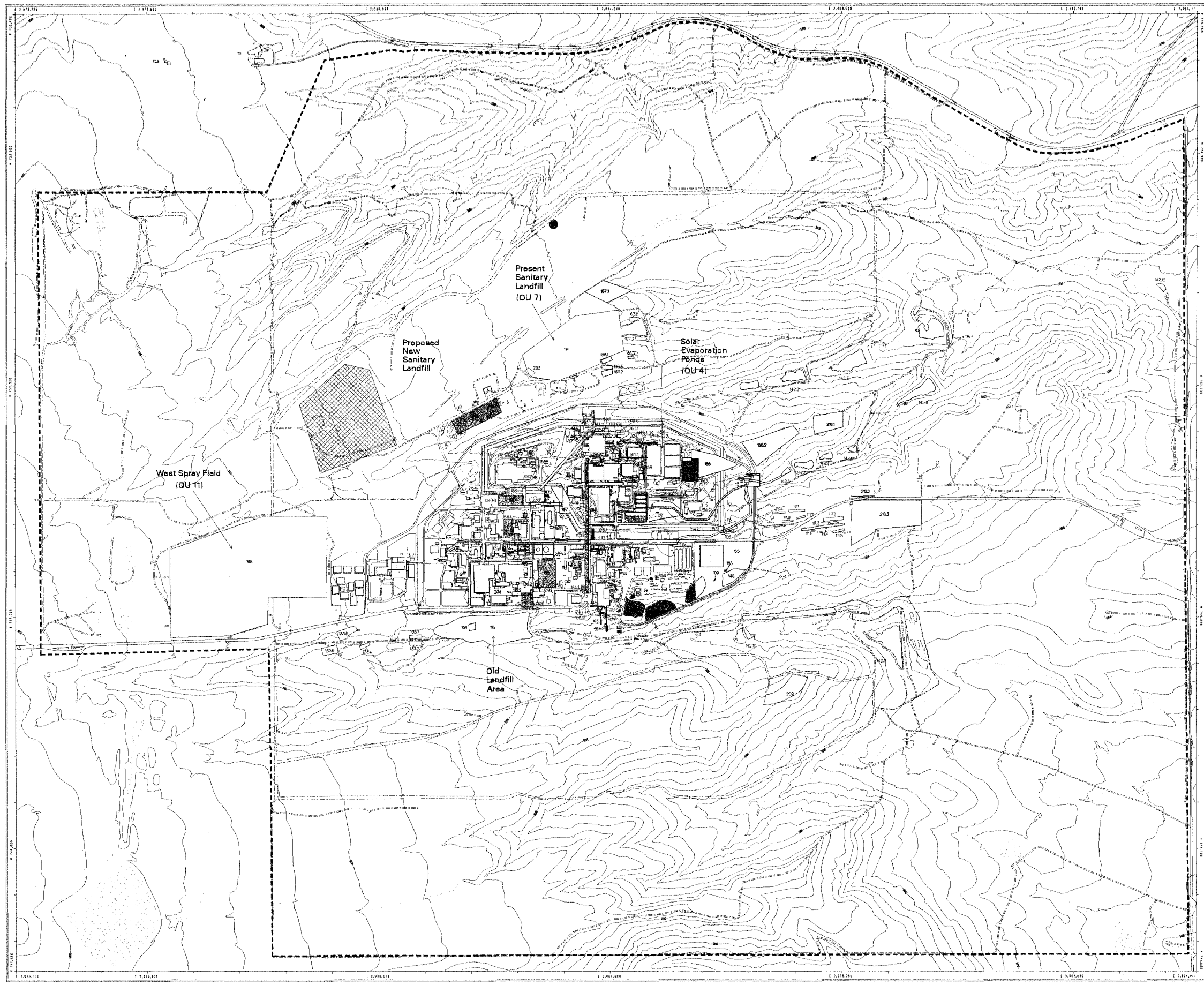

Figure A-3

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 BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95

Scale = 1 : 21330
1 inch represents approximately 1778 feet

State Plane Coordinate Projection
Colorado Central Zone
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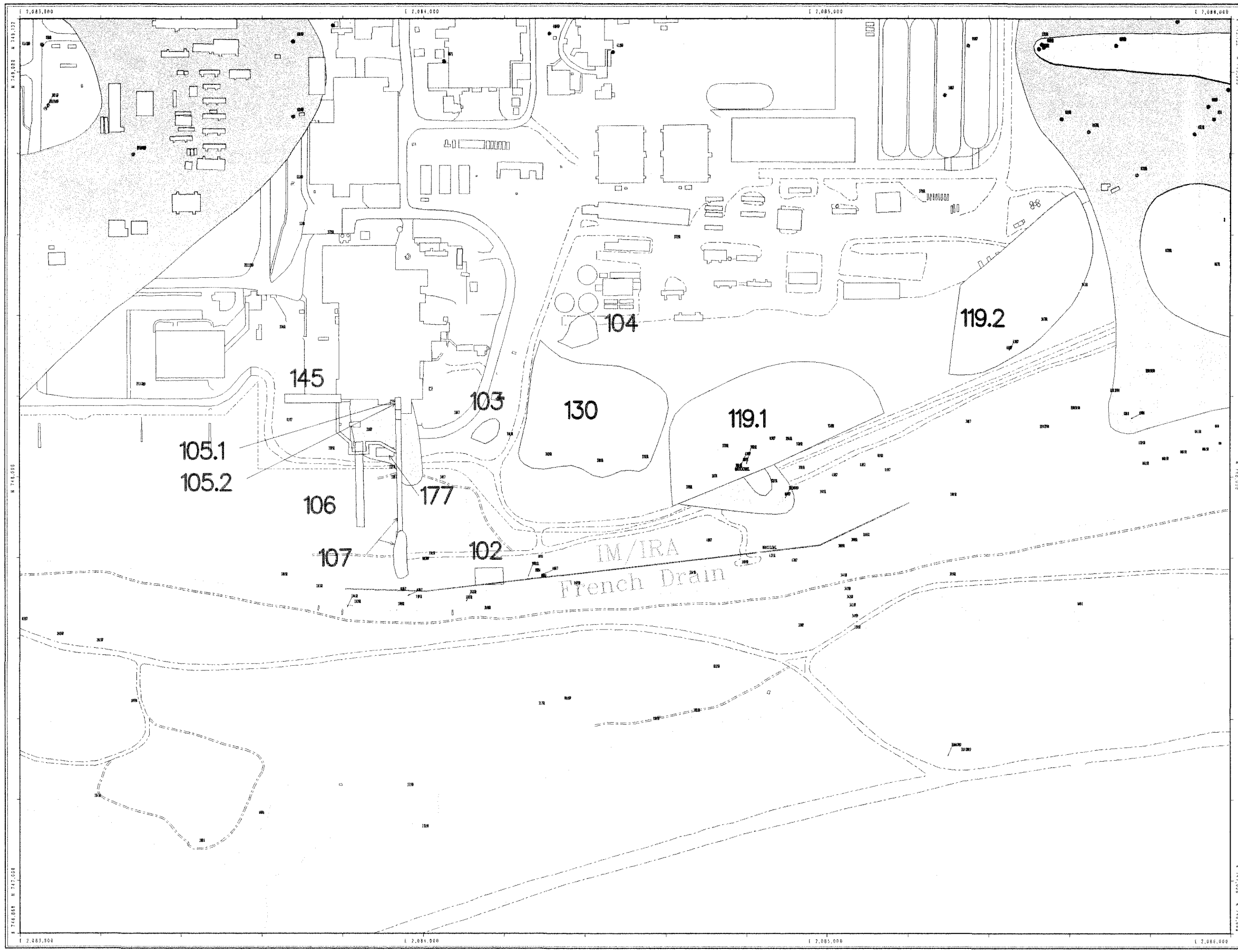

Figure D-1

Individual Hazardous Substance Site of OU 1, 881 Hillside Area

Health and Safety Plan for the Groundwater Monitoring Profram PRO-1574-GMPHASP

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 BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95

Scale = 1 : 3010
1 inch represents approximately 251 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared by: CH2MHILL

Prepared for: KAISER•HILL COMPANY

Map ID: 03-0386

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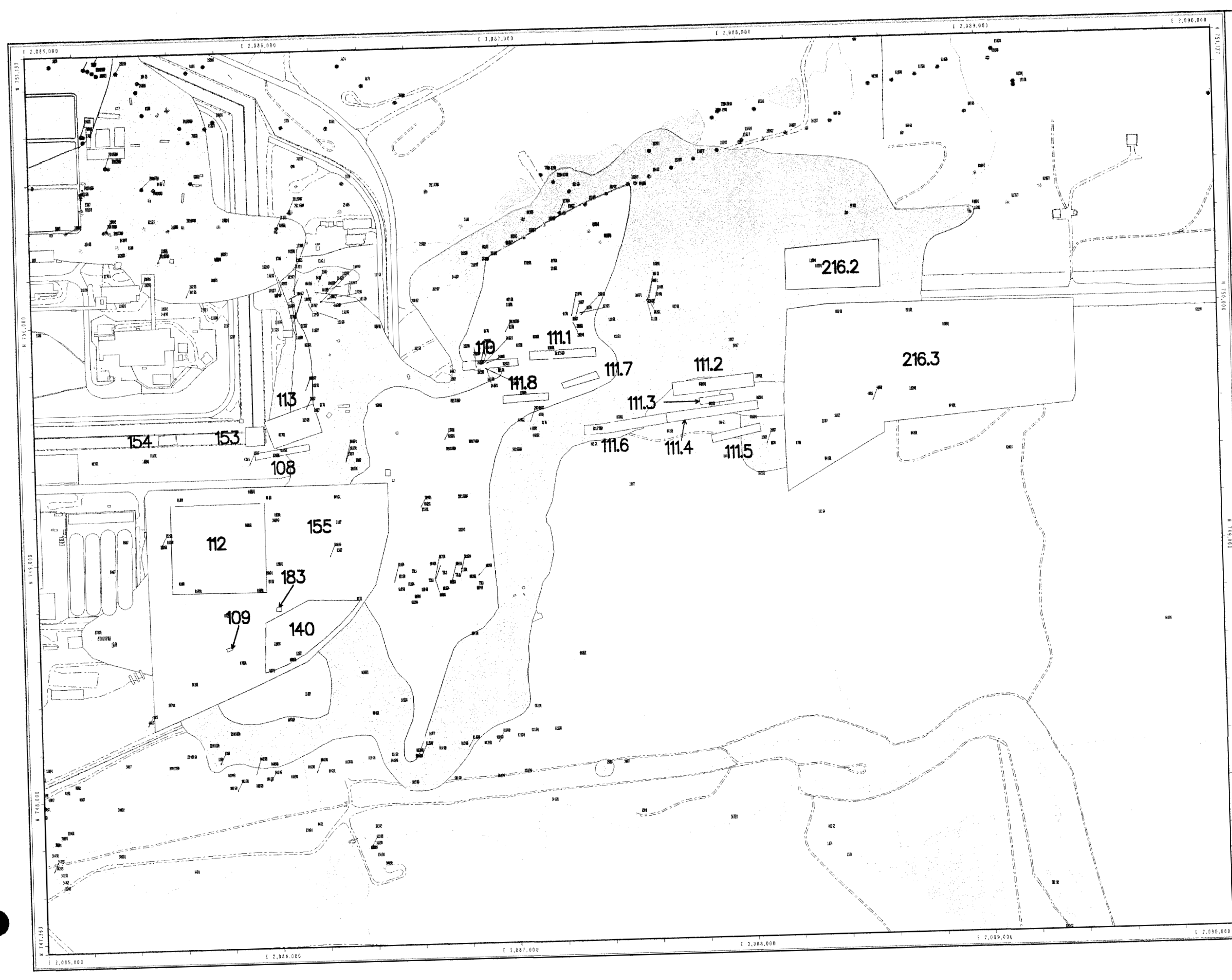

Figure D-2

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 and other barriers
- Rocky Flats boundary
- Paved roads
- Dirt roads

Scale = 1 : 4870
1 inch represents approximately 406 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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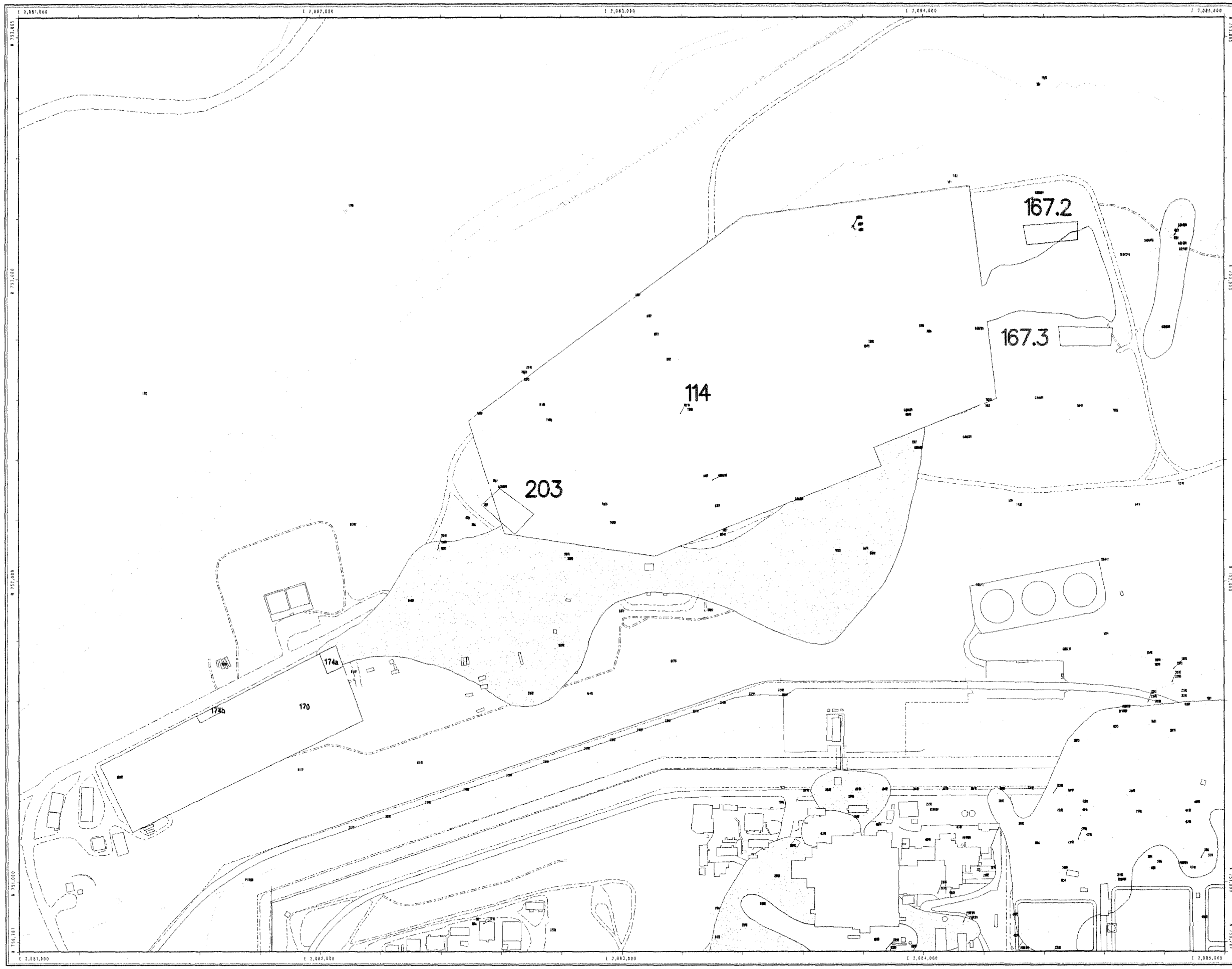

Figure D-4

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 BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 3830
1 inch represents approximately 319 feet

100 0 200 400ft

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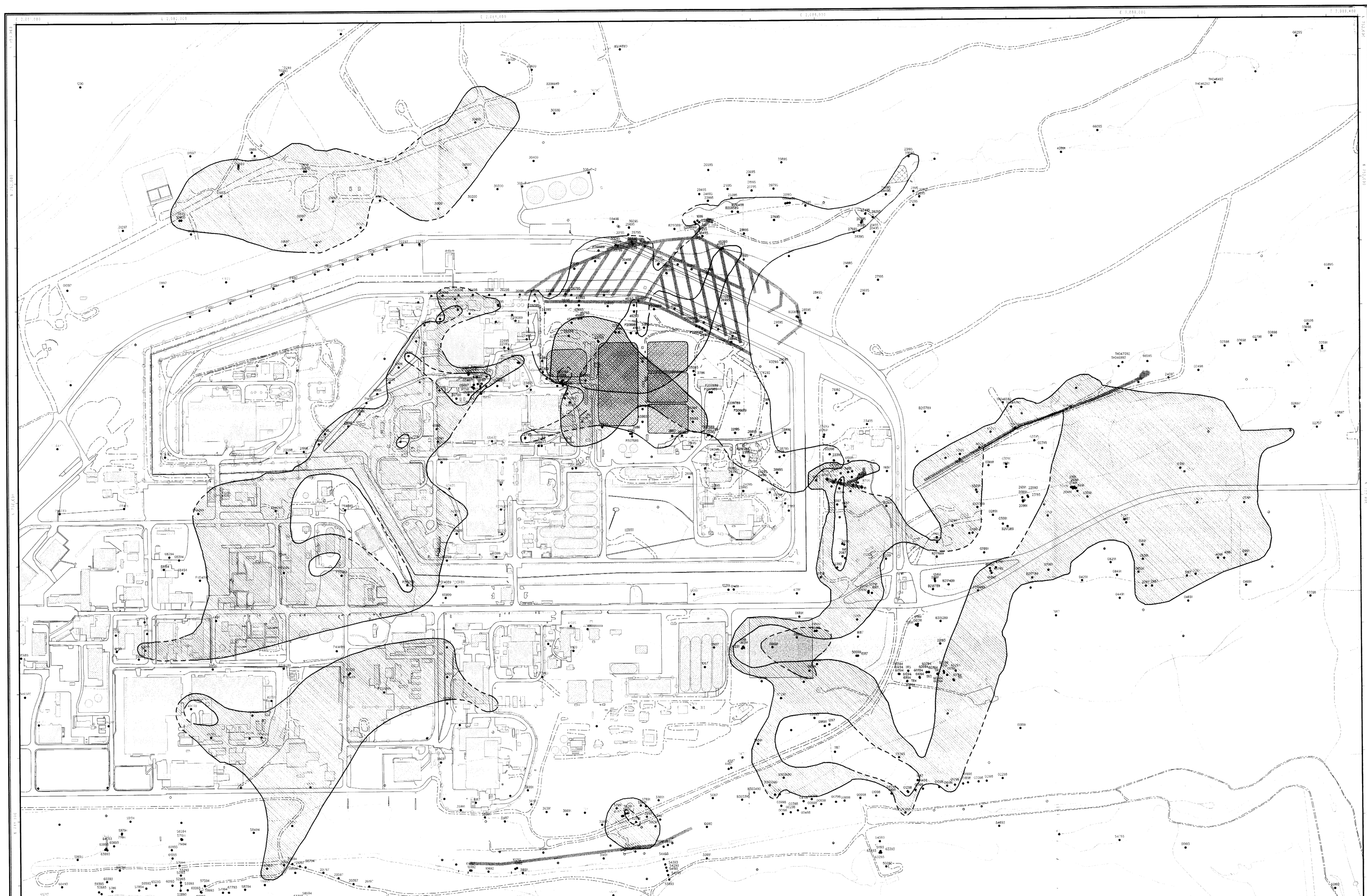

Plate 3
VOCs Composite & Nitrate Plumes Map

2002 Annual Integrated Monitoring Plan

IMP Well Type

- Water Quality Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- D&D Monitoring
- Non-IMP
- Collection Trenchs

Composite Plume Key

- 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 and other structures
- Demolished buildings and Other Structures
- Solar Evaporation Ponds (SEPs)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contour (20-Foot)
- Paved roads
- Dirt roads

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Scale = 1 : 2870
1 inch represents approximately 239 feet

200 0 400 800ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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GIS Dept. 303-966-7707

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CH2MHILL
Communications Group

Prepared for:

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May 01, 2003

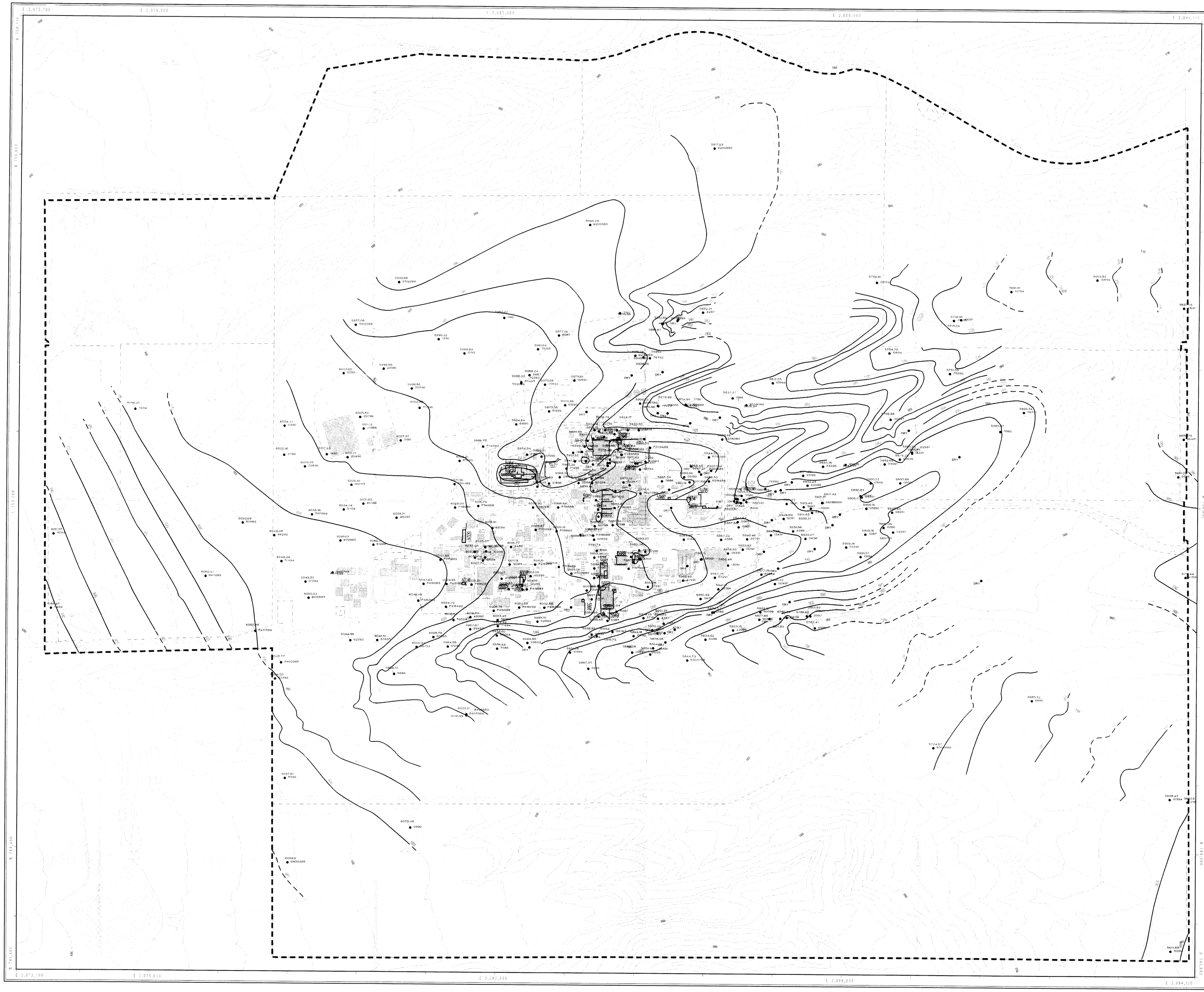

Plate 2

Potentiometric Surface of Permeable Units of the UHSU Second Quarter 2000

2002 Annual Integrated Monitoring Plan

- Groundwater Monitoring Well
- Water Level Contour (20′ Interval)
- Dashed where inferred
- Foundation Drain
- Approximate current extent of Unsaturated Alluvium
- Area without Groundwater Elevation Data

Standard Map Features

- Buildings & other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Topographic Contours (20′ Intervals)
- Roads
- Rocky Flats Boundary

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

Scale = 1 : 7200
1 inch represents 600 feet

500 0 1000 2000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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May 01, 2003

SW-A-004805 pg 313

Plate 1b

IMP Monitoring Well IA Location Map

2002 Annual Integrated Monitoring Plan

IMP Well Type

- Water Quality/Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- Non-IMP
- 2000 Wells (color denotes IMP well type)

Standard Map Features

- Buildings
- Demolished buildings and Other Structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contours (20' Intervals)
- Roads
- Rocky Flats Boundary

DATA SOURCE BASE FEATURES:
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Scale = 1 : 3630
1 inch represents approximately 303 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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SW-A-004805 Pg 312

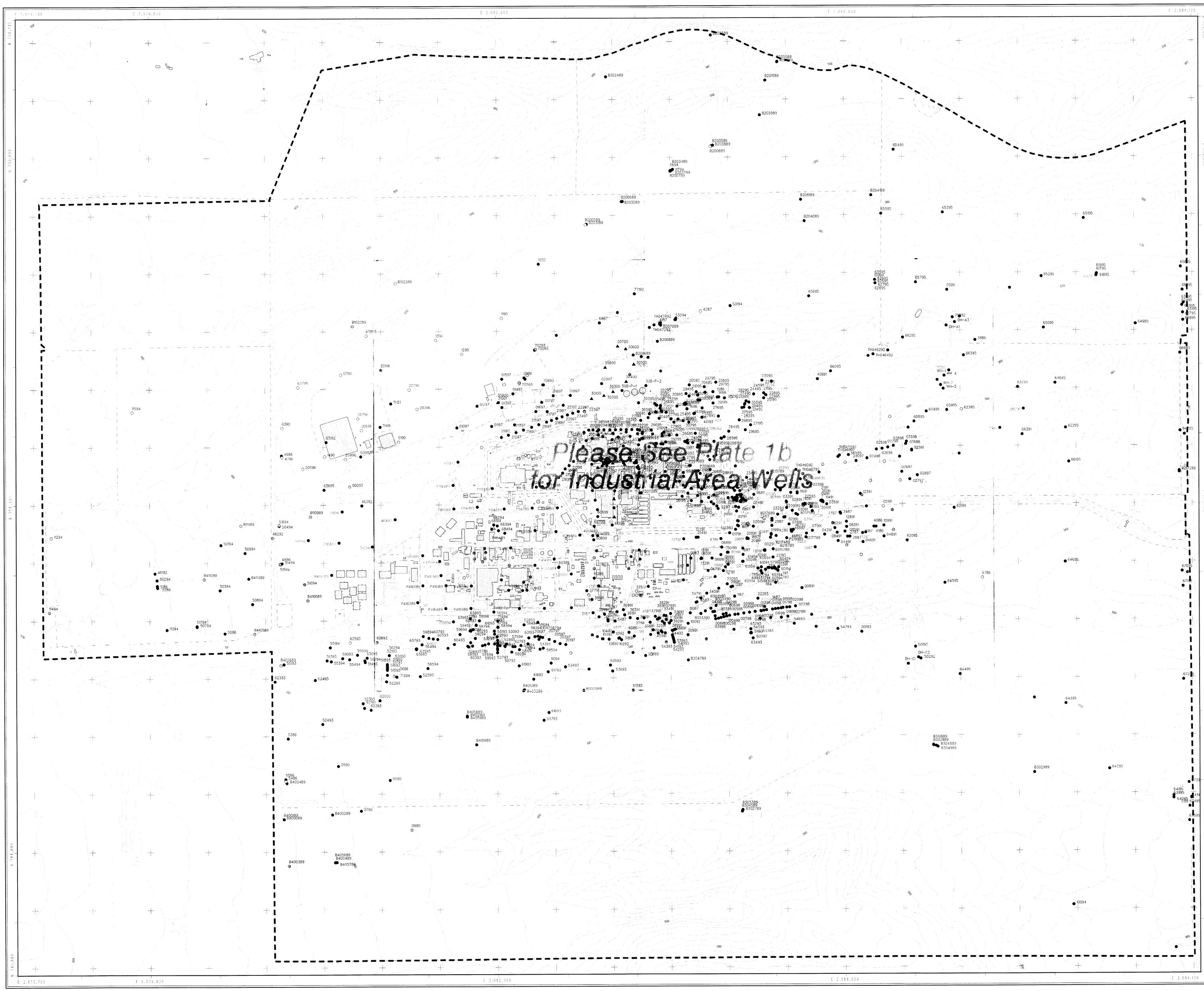

Plate 1a

IMP Monitoring Well RFETS Location Map

2002 Annual Integrated Monitoring Plan

IMP Well Type

- Water Quality/Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- Non-IMP
- 2000 Wells (color denotes IMP well type)

Standard Map Features

- Buildings
- Demolished Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contours (20' Intervals)
- Roads
- Rocky Flats Boundary

DATA SOURCE BASE FEATURES:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas. Digitized from the orthophotographs. 1/95

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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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Prepared by: CH2MHILL Communications Group

Prepared for: KAISER•HILL COMPANY

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