FY 2001 Integrated Monitoring Plan

Rocky Flats Environmental Technology Site

Summary Document

November 2000

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan

FY2001

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ACRONYMS AND ABBREVIATIONS

AoI	Analyte of Interest
ALF	Action Levels and Standards Framework
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
CLP	Contract Laboratory Program
ComRad	Community Radiation Program
COCs	Contaminants of Concern
Cr	Creek
CWA	Clean Water Act
CWQCC	Colorado Water Quality Control Commission
D&D	Decontamination and Decommissioning
DMR	Discharge Monitoring Report
DOE	Department of Energy
DOE, RFFO	Department of Energy, Rocky Flats Field Office
DQO	Data Quality Objective
DRCOG	Denver Region Council of Governments
EcMPD	Ecological Monitoring Program Database
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
GIS	Geographic Information System
IDLH	Imminent Danger to Life and Health
IMP	*Integrated Monitoring Plan*
Kaiser-Hill	Kaiser-Hill Company, L.L.C.
L	Liter
LEL	Lower Explosive Limit
m	Meter
NPDES	National Pollutant Discharge Elimination System
NSD	New Source Detection
OP	Operating Procedure
OU2	Operable Unit 2
PA	Protected Area
PCB	Polychlorinated Biphenyl
POC	Point of Compliance
POE	Point of Evaluation
POps	*Pond Operations Plan*

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QA/QC	Quality Assurance/Quality Control
RAAMP	Radioactive Ambient Air Monitoring Program
Rad NESHAP	National Emission Standards for Hazardous Air Pollutants—Radionuclides
RCRA	Resource Conservation and Recovery Act (Colorado Hazardous Waste Act)
RFCA	*Rocky Flats Cleanup Agreement*
RFEDS	Rocky Flats Environmental Data Base System
RFETS	Rocky Flats Environmental Technology Site
SED	Sitewide Ecological Database
Site	Rocky Flats Environmental Technology Site
SSC	Species of Special Concern
SWD	Site Soil and Water Database (formerly RFEDS)
T&E	Threatened and Endangered (species)
TAL	Target Analyte List
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
VOC	Volatile Organic Compound
WARP	Well Abandonment and Replacement Program
WQCD	Water Quality Control Division
WWTP	Wastewater Treatment Plant
yr	Year

1.0 INTRODUCTION

Environmental monitoring programs at the Rocky Flats Environmental Technology Site (RFETS or the 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 et al., 1996) requires 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's resources.

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

This IMP details the Site 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 and 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, the Site's 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 Integrated Monitoring Program, Site 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 including the data quality objectives, or 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 regulations, Permits and Agreements:

- The Resource Conservation and Recovery Act (RCRA);
- The Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA);
- The Clean Air Act (CAA);
- The Clean Water Act (CWA);
- National Pollutant Discharge Elimination Systems (NPDES) Permit;
- Standards promulgated by the Colorado Water Quality Control Commission;
- Rocky Flats Cleanup Agreement (RFCA);
- The body of regulations governing natural resource (ecological) management;
- Site-specific monitoring and cleanup agreements; and
- DOE Orders and technical guidance.

1.1 Integrated Monitoring Plan

~~This~~ For Fiscal Year (FY) FY2001 2 IMP is a revision of the FY2000 1 IMP and the FY2000 1 *IMP Background Document* (Kaiser-Hill, ~~1998~~ 2000) which describe the activities being conducted at the Site under the Integrated Monitoring Program to satisfy RFCA and other regulatory requirements and interests. The FY2001 2 *IMP Background Document*, provides detailed discussions of the decision-making process that has resulted in numerous monitoring efforts at the Site. This IMP lists the monitoring programs to which DOE and the other regulatory agencies are committed. The *IMP Background Document* provides additional information on the DQO decision process and the regulatory framework that drives many of the monitoring decisions at the Site. The *IMP Background Document* is not subject to enforcement under RFCA.

Both the IMP and the *IMP Background Document* will continue to change with time. One significant change in monitoring in FY2001 is the inclusion of the surface water special source investigation of RFCA Point of Evaluation (POE) GS10 subdrainage. Since the inception of RFCA monitoring in FY97, reportable values for americium and plutonium have been observed every spring at monitoring location GS10. This annual reoccurrence prompted the Site to conduct a special source investigation of the GS10

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subdrainage. Field sampling for this source investigation was completed during FY2000 and sample analysis, interpretation of results and report preparation will be completed during FY2001.

This 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 Site activities may involve soil monitoring. Site-wide soil monitoring was discontinued in 1994, after many years of characterizing transuranic-contaminant distributions across the Site. 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. In addition, a fifth medium, soil, and its related monitoring is discussed. Soil data relate to all of the other media in some way and continue to be important to the other programs, to future projects and project planning, and ultimately to Site closure. A discussion of soil monitoring at the Site is included in Section 6 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 Data Quality Objectives (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 Site remedial and D&D activities; (3) address regulatory reporting requirements and commitments; and (4) monitor various ecological systems at the Site. 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 they must be gathered using procedures that are appropriate for their intended use in making decisions for Site 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 major decisions that need to be made based on monitoring data, how

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the data will be applied in decision making, and the approaches used to obtain the data. Procedures cover all monitoring activities, including sampling, analysis and data management, and consists 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).

Site 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 all 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 all 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. All assessment findings are tracked and corrected pursuant to the Site Corrective Action Requirements Manual (1-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.

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2.0 SURFACE WATER

2.1 Introduction

The surface water monitoring program at the Site 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:

- Site-wide water quality;
- Quality of waters within the Industrial Area;
- Quality of discharges from the Industrial Area;
- Quality of water leaving the Site; 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.

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

- National Pollutant Discharge Elimination System (NPDES) permit compliance reports including monthly and annual preparation and delivery of the Discharge Monitoring Report (DMR) to EPA Region VIII.

- Pre-discharge and community assurance monitoring results gathered by the State and reported routinely to the Site 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

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Table 1
Surface Water Monitoring Matrix

Type of Monitoring	Locations	Sampling Frequency	Sampling Performed By	Purpose
SITE-WIDE				
Dam Operations (IDLH)	All detention ponds	Various regular intervals	Site personnel	Assess need for discharges from ponds to ensure dam integrity
Streamflow	7 stream locations	Continuous when flowing	Site personnel	Determine streamflow upgradient of Ponds A3, A4, B5, and C2. Determine outflow from Ponds 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 personnel, FERC, and DOE	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 source(s) of any new contamination detected by the surface water monitoring program
Plutonium Correlation	POCs, 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	As needed[1]	Site personnel	Detect changes in AoI concentrations or water quality parameters that might indicate new contamination
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 Site activities on water quality

Table 1 (Continued)
Surface Water Monitoring Matrix

Type of Monitoring	Locations	Sampling Frequency	Sampling Performed By	Purpose
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	Non-process non-domestic wastewaters discharging to sanitary collection system	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	WWTP (Site) personnel	Check for signs of corrosivity and monitor LEL
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	Specified in NPDES permit	Site personnel	Demonstrate permit compliance and provide data for permit updates
WATER LEAVING THE SITE				
Predischarge	Ponds A4, B5, and C2	Approximately 8–10 events/yr (1 per 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	Approximately 3 samples for each of 8–10 discharge events, plus 1–3 samples per month between discharges[1]	Site personnel	RFCA point of compliance (POC) monitoring
Non-POC at Indiana St.	Walnut Cr. & Woman Cr. Drainages	Total of 21 samples annually	CDPHE	Assess effects of flow changes on nutrient loads in water leaving the site

Table 1 (Continued)
Surface Water Monitoring Matrix

Type of Monitoring	Locations	Sampling Frequency	Sampling Performed By	Purpose
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	Great Western Reservoir	Quarterly	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.)

Notes:

ALF = Action Levels and Standards Framework
AoI = Analyte of Interest
CDPHE = Colorado Department of Public Health and Environment
Cr = Creek
DOE = Department of Energy
EPA = U.S. Environmental Protection Agency
FERC = Federal Energy Regulatory Commission
IDLH = Imminent Danger to Life and Health
IMP = *Integrated Monitoring Plan*
LEL = Lower Explosive Limit
NPDES = National Pollutant Discharge Elimination System
POC = Point of Compliance
POps = *Pond Operations Plan*
RFCA = *Rocky Flats Cleanup Agreement*
WWTP = Wastewater Treatment Plant

2.2 Site-Wide Water Quality

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

- Monitoring the dams that form the Site detention ponds (dams lie within a defined area, but monitoring is performed to ensure their effectiveness);
- Locating the source of any 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 Site 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 levels rise. Although water rarely rises to the elevation of emergency spillways, there is a risk that the dams could fail or sustain damage.

The Site 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. The Site performs the following monitoring activities:

- Measure streamflow upgradient of Ponds A3, A4, B5, and C2;
- Measure outflow from Ponds 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;

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- 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 all 12 ponds at appropriate frequencies as determined by *Pond Operations Plan* (POP) (Kaiser-Hill et al., 1996), and perform a detailed internal inspection biannually. Federal Energy Regulatory Commission (FERC) and DOE inspect dams externally on an annual basis;

- Monitor spatial position of the crest monument 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

- Exercise the valves in the outlet works of the terminal dams to ensure operability, as directed by the Office of the State Engineer.

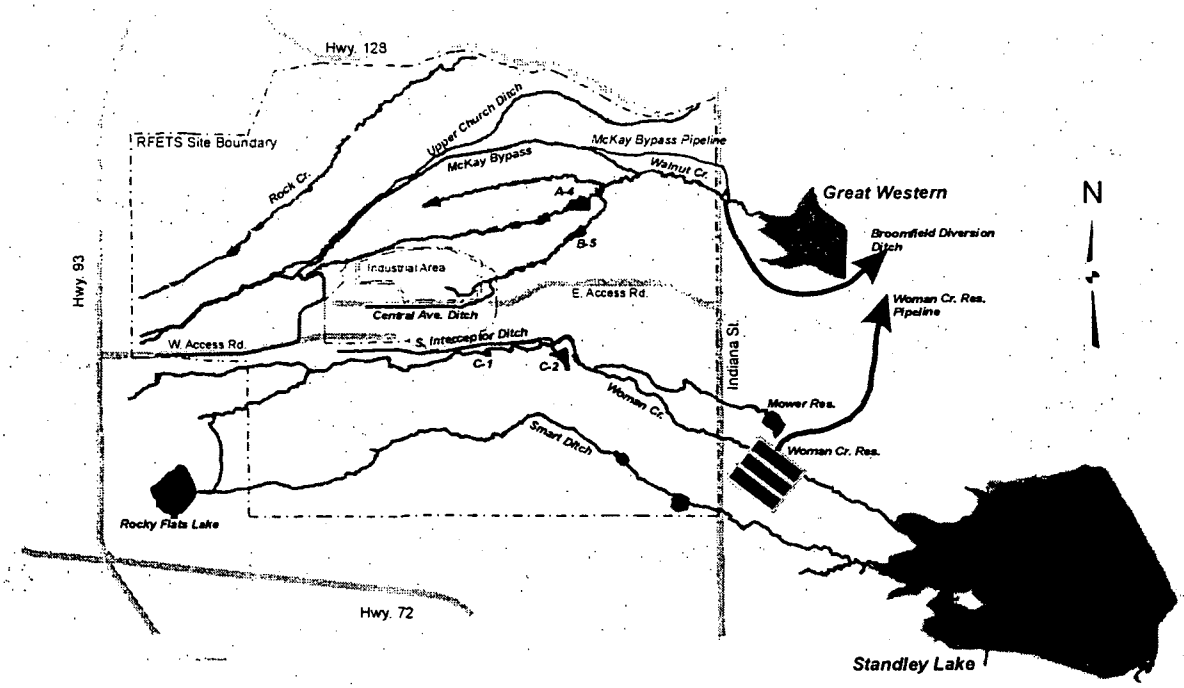

Figure 1. Schematic Surface Water Map

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.

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2.2.2 Locating New Contaminant Sources

If new contamination is indicated by surface water monitoring, New Source Detection (NSD), POE, or Point of Compliance (POC) stations, the Site 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 (see *IMP Background Document*, Section 2.2.2).

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 Monitoring for Correlation of Plutonium with Indicator Parameters

The Site continues to study whether a correlation can be established between plutonium concentrations and levels of indicator parameters that can be measured frequently, or even continuously, at much less expense than radiochemically analyzing samples for plutonium. For instance, total suspended solid (TSS) concentrations may provide an indication of plutonium concentrations, because plutonium and other radionuclides tend to be adsorbed by particulate matter in surface water. Although measuring TSS requires a laboratory analysis, the lag time between sample collection and data delivery is considerably shorter than for a radiochemical analysis. Turbidity, which can be measured continuously, may also correlate with plutonium concentrations. If so, continuous turbidity measurements would provide an early indication of potential rising plutonium concentrations, improving the protection of public health and the environment. The technical hurdle in this effort remains the issue of sensitivity: identifying reliable correlations at very low concentrations challenges the available analytical methods.

Plutonium concentrations are already being monitored at the terminal pond outfalls and at the Indiana Street RFCA POCs. The Site also monitors TSS concentrations when possible at these five stations. In addition, the Site monitors, when possible, TSS and turbidity at stations SW022, GS10, SW093, SW091, and SW027, which are located

sufficiently upstream in Segment 5 that they would provide at least two hours warning before exceedances could occur in Segment 4. The Site also monitors precipitation at several locations.

The Site will evaluate the data from this monitoring objective to study the correlation between plutonium concentrations and levels of indicator parameters. Based on this analysis, this monitoring objective may be modified in the future to further define any correlations observed.

2.3 Water Quality Within the Industrial Area

The Site 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/or remediation. The Site conducts the following activities under this portion of the surface water monitoring program:

- Project-specific performance monitoring;
- Management of incidental waters;
- Sanitary system monitoring including:
  - Characterize internal wastewater streams for NPDES permit compliance;
  - Monitoring discharges to the Wastewater Treatment Plant (WWTP); and
  - Monitor total flow, potentially dangerous or damaging waste streams, and radiological activity of influent to the WWTP;
- WWTP influent monitoring; and
- WWTP collection system monitoring.

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2.3.1 Incidental Water

Approximately 100–200 occurrences per year of incidental water at the Site 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 Site personnel. Additional analysis is required if the circumstances or field observations provide cause to suspect the presence of oil or hazardous/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 the Site Decontamination and Decommissioning (D&D) project managers and WWTP operators information about collection system condition within the Industrial Area 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;
- 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;
- Establish pollutant loads attributable to specific industrial internal waste streams (such as the laundry water at the Site); and
- Establish baseline conditions for the flows from the Protected Area (PA) and non-PA areas.

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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 wastewater streams are used to make decisions regarding the disposition of contaminated waste water produced on the Site. 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 Site's NPDES permit.

The existing NPDES Permit also covers all discharges to surface water (including the WWTP outflow). Site 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 Site closure activities accelerate. The renewed NPDES Permit specifies all managed and incidental discharges to be monitored, including all sanitary discharges and process wastewater streams from Site buildings, along with discharges from the WWTP. Any new wastewater streams must be characterized and monitored as well. Site personnel must fully disclose all wastewater streams to EPA Region VIII, which conducts annual NPDES Permit inspections of the Site to enforce this disclosure requirement.

2.3.2.2 Monitoring Discharges to the WWTP

This monitoring objective is distinct 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). Any new wastewater streams generated on the Site must be evaluated to determine how best to dispose of them. Most can be discharged to the WWTP under the terms of the NPDES Permit, but some cannot. The latter must be disposed of in accordance with applicable requirements. Site personnel screen all 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 check the WWTP collection system at two locations for pH, conductivity, and lower explosive limit (LEL). They also take manual pH readings at the headworks. Conductivity and pH are indicators of corrosivity, which could damage the treatment equipment, and LEL readings are taken to ensure worker safety, collection system flow monitoring and influent radiological activity. This monitoring ensures that the plant effectively processes wastewaters that change as Site 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, respectively.

2.3.2.4 WWTP Collection System Flow Monitoring

Flow information for the Site's sanitary collection system is currently limited to influent records for the WWTP. The initial scope of collection system monitoring is intended to provide Site collection system flow information by installing continuous recording flow monitoring equipment at B990 on the two main collection system lines. The flow record will be used to establish annual baseline conditions for the flows from the PA and non-PA areas. 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 sanitary collection system flow baseline will be developed during FY01.

2.3.2.5 WWTP Radiological Monitoring

This objective includes the monitoring of radiological parameters at the influent to the WWTP for the purpose of tracking pollutant loads coming through the WWTP collection system. The assumption is that radiologic loads to the WWTP should be decreasing, since the Site has systematically tried to eliminate any possible connections between waste streams containing radionuclides and the collection system. During FY00, radiological influent monitoring was conducted monthly using 24 hour composite sample and analyzed by the state.

2.3.3 Performance Monitoring

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.[1] In general, project-specific monitoring targets 18

[1] Although performance monitoring may be conducted at any location on the Site, the majority occurs within the Industrial Area.

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months of data prior to project startup to establish baseline conditions, and continues for three months after project completion. The Site is conducting performance monitoring at Buildings, 701, 771/774, 776/777, 779, 886, and Solar Ponds and for ER for 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 Site's first NPDES Permit was issued by EPA in 1974. The current Permit was originally reissued by EPA in 1984, expired in 1989, and administratively extended, and again renewed again in 2000. All 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.

Renewed Permit:

The renewed Permit for the Site identifies one monitoring point for control of discharges, the WWTP (Building 995) effluent. The NPDES/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 Permit stormwater monitoring provisions result from new regulations promulgated since the 1984 Permit renewal.

2.4 Industrial Area Discharges To Ponds

Industrial Area discharges to the ponds include surface water runoff, discharges from the wastewater treatment plant (WWTP), and waters in Segment 5 which include the stream channels and interior ponds. Under this portion of the surface water monitoring program, the Site monitors:

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

2.4.1 New Source Detection

The Site 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

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runoff leaves the Industrial Area. Analytes 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 are generally 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.

2.4.2 Stream Segment 5

The Site 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.

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*). The Site 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 approximately 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. Four 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, the Site 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 any other ponds temporarily functioning as a terminal pond. The Site and CDPHE analyze the samples for an extensive list of constituents, including inorganic compounds, metals, volatile and semi-volatile organic compounds, radiologic parameters, herbicides, and pesticides (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

The Site 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. Approximately three samples are collected during each pond discharge event (approximately 8 to 10 discharge events per year, 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.

2.5.3 Non-POC 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 the Site. CDPHE collects samples periodically from Walnut Creek to assess the composition of the water when it consists of:

- 100% Site effluent (five samples);
- Mixed effluent and natural stream flow (five samples); and
- 100% natural stream flow (five samples).

In addition to these 15 samples, CDPHE collects 5 samples from Woman Creek during times when Pond C2 is not discharging and one sample during Pond C2 discharge. All 21 samples are analyzed for total ammonia, nitrite, nitrate, phosphate, orthophosphate, uranium isotopes, beryllium, cadmium, silver, and chromium. In the future, the latter four metals may be deleted from the analyte suite, depending on initial water quality results.

2.6 Off-Site Monitoring to Support Community Water Supply Management

Site and CDPHE personnel provide monitoring data to nearby communities for their use. Procedures are in place to monitor uncharacterized discharges from the Site 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 and POE monitoring at Indiana Street) or if flow leaving the Site exceeds the capacity of the downstream ditch or reservoirs.

If surface water of unknown quality (unmonitored) leaves the Site, 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 the Site.

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 RFETS past mission as a nuclear weapons production facility, the nature of the contaminants, the history of releases and accidents, and the geographic and hydrologic relationship of the Site to the neighboring municipalities. Adequate and timely information regarding the impact of the Site is necessary. The level of concern fluctuates with activities at the Site, but may be expected to continue as long as environmental contamination and special nuclear materials are present at the Site.

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Since the completion of the Standley Lake Protection Project and the Great Western Reservoir Replacement Project, both of 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, and the fact that the reservoir is considered to be unsuitable for potable use raises questions on the part of irrigation customers. Therefore, during FY01, 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 the Site from the rest of the watershed. Historical strategies on the part of both the Site and the downstream communities have focused on limiting, to the maximum extent possible, the natural flow of surface water from the Site. 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 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, the Site 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 its focus was limited to water quality issues impacting wastewater dischargers.

More recently, Site 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 (e.g. RFETS, Broomfield, Westminster, and Northglenn), participants include representatives of agriculture, parks, recreation, open space, and a variety of government agencies. The BDCWA has bee recognized by Denver Region Council of Governments (DRCOG) as a district watershed in the Regional Clean Water Plan. The goals the Association 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

decisions are made jointly by the group, with input from regulators and planning agencies including EPA, the Water Quality Control Division (WQCD) and DRCOG. The immediate use of the data is to characterize the watershed and to identify and quantify any 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 all 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 contaminants of concern. 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 any residual impacts to surface water quality that may be attributable to the project activities.

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3.0 GROUNDWATER

3.1 Purpose

Most of the groundwater at the Site 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 Site remediation and closure activities;
- Protect groundwater from new sources of contamination; and
- Evaluate any effects of contaminated groundwater on surface water.

3.2 Monitoring Focus

Several contaminant plumes have been identified in Site groundwater (see Appendix D and Plate 3 in the *IMP Background Document*). The main contaminants of concern (COCs) are volatile organic compounds (VOCs), which originated from the Site's historical use and chemical storage during its years of producing nuclear weapons components. Possible sources of contaminants that could affect groundwater include storage tanks, the process wastewater system, drains, sumps, historical storage areas, and spills. The monitoring scope is designed to be conducted before, during, and after Site operations that may affect groundwater quality.

Site personnel determine the concentrations of groundwater AoIs and compare them to established background levels, as well as to Site 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 Site 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.

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3.3 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 evaluations; and
- Well control, abandonment and replacement.

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

Table 2
Groundwater Monitoring Matrix

Type of Monitoring	Locations	Sampling Frequency	Purpose
Sample for determination of analyte concentrations	148 wells	Semi-annual	Monitor analyte concentrations in groundwater
Sample for determination of analyte concentrations	28 wells	Quarterly	Monitor analyte concentrations in groundwater
Water-level measurement	73 wells	Monthly	Characterize groundwater flow regime
Water-level measurement	147 wells	Quarterly	Characterize groundwater flow regime
Water-level measurement	85 wells	Semi-annual	Characterize groundwater flow regime
Water-level measurement	33 wells	Real-time	Characterize groundwater flow regime

3.3.1 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 the Site drainages, because stream flow is ephemeral. Boundary wells are maintained at the downgradient (eastern) Site boundary to confirm that contaminants are not migrating off Site. On-Site wells fall into eight categories:

- Plume definition;
- Boundary;
- Plume extent;
- Performance;
- Drainage;
- Closure activities;
- RCRA (covers monitoring of permitted waste storage units); and
- Plume degradation.

3.3.2 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 (TDS). They collect filtered samples for determination of metals concentrations and uranium isotopes. They also collect unfiltered samples for organic compound analyses, water quality determination, and measurement of all other radionuclides. Analytes of concern vary among wells, depending on the particular constituents in the plume being monitored. The scopes of work for the analytical laboratories contain complete target analyte lists (TALs).

The groundwater flow regime at the Site 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:

- VOCs [Contract Laboratory Program (CLP) Method 524.2];
- Semi-volatile organic compounds;
- Pesticides and polychlorinated biphenyls (PCBs);
- Nitrate/nitrite, as nitrogen;
- Metals (TAL, plus cesium, lithium, strontium, tin, molybdenum, and silica);
- Any specific metals for a particular well (see TALs);
- Uranium-233/234, -235, -238;
- Strontium-89/90;
- Plutonium-239/240 and americium-241;
- Major anions (chloride, fluoride, sulfate, carbonate/bicarbonate); and
- Tritium.

3.4 Data Disposition

3.4.1 Databases

Site personnel enter all field data and analytical data into the SWD. Data integrity is maintained through the use of standard data entry operating procedures (Ops) and by running error-checking routines when loading data.

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

3.4.2 Reporting

Groundwater monitoring activities are reported through the following vehicles:

- **RFCA Annual Groundwater Report**: Quarterly reporting at the Quarterly Information Exchange Meeting presents data gathered during the reporting period, provides notification of any exceedances of RFCA groundwater action levels, and lists required actions for exceedances. These quarterly reports are used to create the RFCA

Annual Report. The Annual Groundwater Report replaced various previously required reports and serves as the primary compliance report.

- **RFCA Quarterly Reporting**: These data replace all previous, quarterly reporting, integrating the elements of each regulatory driver into a single reporting vehicle. Quarterly reporting at the Quarterly Information Exchange Meeting summarizes data gathered during the reporting period and also provides exceedance notification of RFCA groundwater quality standards.

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

3.5 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 data quality objective 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) it's effect on surface water.

3.6 Well Abandonment and Replacement Program (WARP)

Section 3.6.7 of the *IMP Background Document* describes the WARP, which specifies the approval process for well installation and ensures proper recording and registration of all well installation activities. Site personnel maintain a database of all 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) they are damaged or poorly constructed; (2) construction details are unknown; (3) they present a potential for cross contamination of other wells or the aquifer; or (4) they are no longer needed. Activities conducted under the WARP are reported in the RFCA Annual Report.

3.7 Project-Specific Monitoring

Project-specific remediation and building D&D activities may require groundwater monitoring. 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

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activity, building specific potential contaminants of concern (PCOC) will be identified. Analyte suites will be developed based on knowledge of historic use and contaminants of concern. Initially, a full sample suite will be collected to characterize the well for PCOCs. D&D activities may involve other potential contamination sources such as underbuilding contamination, building pipelines, and building sumps. These potential sources, and their effects on groundwater, will be investigated as part of the Environmental Restoration (ER) program and integrated with D&D activities. Monitoring decisions will be made on an individual-well basis prior to D&D activities. Wells will be placed downgradient from potential contaminant sources. Upgradient wells may be required if existing data is 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 the guidelines outlined in the IMP background document.

4.0 AIR QUALITY

4.1 Purpose and Programs

Air monitoring activities on the Site (Table 3) assist in both protecting and informing the public, and in protecting the environment by detecting and trending the impacts of Site operations on air quality at and near the Site. Monitoring characterizes any 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; 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 Site air monitoring and reporting activities required to maintain compliance with applicable 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 the Site, at the perimeter, and at several locations in the community is performed by ESS. CDPHE monitors both radioactive and non-radioactive pollutants on, and around, the Site. Ambient monitoring in the communities immediately adjacent to the Site has been supported further by DOE through the ComRad program. The purpose of these monitoring efforts is to characterize any Site-related airborne emissions. The ComRad stations, which monitor airborne plutonium concentrations, are operated independently through a grant to the Citizen's Advisory Board.

4.1.2 Effluent Monitoring

Air emissions (effluent) from Site facilities that 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. Some facilities with lower potential to emit radionuclides are monitored periodically to satisfy specific building operational requirements. 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 the Site to generate data for use in air dispersion models that predict the transport of airborne emissions. Site

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personnel use model predictions to evaluate Site operations and closure projects, and to support emergency preparedness requirements.

Table 3
Air Monitoring Matrix

Type of Monitoring	Locations	Sampling Performed By	Sampling Frequency	Purpose
Ambient air	37 RAAMP samplers	Site personnel (AQM)	Continuous (monthly filter exchange; monthly analyses of perimeter samples)	Detect and characterize Site-related airborne rad emissions and demonstrate compliance with state and federal regulatory compliance
CDPHE Monitoring	13 continuous samplers on-Site, 5 samplers every 6 days at Perimeter	CDPHE	Continuous, or every 6 days	Detect and characterize Site-related rad and non-rad airborne emissions
Effluent from Industrial Area facilities	21 exhaust outlets	Site personnel (AQM)	Continuous (weekly filter changes with monthly compositing of most locations; monthly filter changes with annual compositing at remaining locations)	Verify effectiveness of radiation control mechanisms and provide secondary compliance data
Meteorology	1 tower with instruments at ground level and at 10, 25, and 60 m; 1 backup tower with instruments at 10 m	Site personnel (AQM)	Continuous	Monitor meteorological conditions for use in air quality modeling and for inputs to emergency response models
	5 towers at Site perimeter	CDPHE	Continuous	Provide data as needed for emergency response modeling
Special Project	Selected subset of existing ambient air monitoring locations	Site personnel (AQM)	Continuous; weekly filter exchange and gross alpha/beta counting; isotopic analyses as required	Assess impacts of D&D and ER projects

Notes:

m = Meter
AQM = Air Quality Management
rad = radioactive
D&D = Decontamination & Decommissioning
CDPHE = Colorado Department of Public Health and Environment
ER = Environmental Restoration

4.2 Site Air Monitoring Scope

The majority of ambient air monitoring and effluent monitoring is performed at the Site to satisfy 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 program perform additional, independent air monitoring.

4.2.1 Ambient Air

The Radioactive Ambient Air Monitoring Program (RAAMP) collects ambient radioparticulate air data. The RAAMP network comprises 37 size-partitioning, high-volume ambient air samplers. Fourteen of the 37 samplers are used to satisfy regulatory compliance demonstration requirements under the CAA Rad-NESHAP provisions. One sampler is used to monitor the ambient air east of the 903 Pad. The others are used for backup should there be accidental releases from the Site or for determining localized impacts from D&D and ER projects. The samplers run continuously, collecting airborne particles on pairs of sampler substrates that segregate small inhalable particles from larger, 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 on Site and at the perimeter. The two state operated monitoring networks serve as independent measures of Site air quality conditions and public exposure to radioactive releases. CDPHE also monitors additional analytes, including beryllium, nitrogen dioxide, and non-radiologic pollutants regulated under the National Ambient Air Quality Standards, but not necessarily originating from Site sources.

4.2.2 Effluent Air

Exhaust air emissions from Site buildings that contain radioactive materials in sufficient quantity that they have the potential to contribute at least 0.1 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. Sources having low emission potential ("insignificant sources") are not monitored unless building operational requirements dictate that continuous sampling be performed. Any radioparticulate emissions from insignificant sources that are not monitored using effluent samplers will be accounted for through the ambient monitoring network. Historically, more than 50 locations within the Industrial Area were monitored; currently, 21 building release points are continuously sampled. Tritium sampling, once conducted at one or more locations on the Site, has been discontinued, following the removal of waste materials having significant emissions potential for tritium.

4.2.3 Meteorological Conditions

A 61-meter (m) tower is located in the northwest part of the Buffer Zone, with monitoring instruments at ground level and at 10, 25, and 60 m above the ground. A separate 10-m tower nearby provides backup data of most parameters. Instruments measure wind speed and direction, temperature, and relative humidity (dew point), solar radiation, precipitation, and information used to calculate atmospheric stability class. CDPHE operates five 10-m meteorological towers located around the Site perimeter that can provide data to support Site emergency response modeling.

4.3 Special Project Monitoring

Whenever a D&D or ER project is planned that has a significant potential to release radionuclides, existing on-Site ambient air samplers are used to provide project-specific monitoring. Selected sampler substrates in the Industrial Area are exchanged weekly instead of monthly. Filters are screened through an expedited gross alpha/beta count and the results compared to predefined action levels specific to the Industrial Area and each sampler. 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 as-low-as-reasonably-achievable (ALARA) principles. The filters and impactor substrates may be analyzed for selected plutonium, americium, and uranium isotopes as required.

Additional investigation is ongoing to determine the availability and feasibility of other sampling techniques that might provide sampling results more quickly without compromising the ability to detect concentrations of concern for public exposure.

5.0 ECOLOGY

The Buffer Zone around the Industrial Area at the Site 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 the Site:

- 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 any special-concern species (i.e., threatened, endangered, candidate, proposed, state-listed, or other sensitive species). The Preble's meadow jumping 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 Site cleanup activities that will occur over the next decade. Data also demonstrate compliance with applicable natural resource protective regulations.

Site 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 Site 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 migratory bird species numbers and richness; comply with Migratory Bird Treaty Act.	20 Transects	15 times per year	Track changes in numbers and richness of migratory birds at the Site
Manage and conserve significant wildlife species and bird species numbers and richness; comply with Endangered Species Act, other federal acts, and Colorado wildlife protection statutes.	16 Transects	12 times per year	Track changes in numbers, richness, and habitat dependence of significant wildlife species (including birds) at the Site
Manage and conserve significant species numbers and richness; comply with Endangered Species Act, other federal acts, and Colorado wildlife protection statutes.	1 Sitewide Survey (Follows all passable Buffer Zone roads.)	12 times per year	Track changes in numbers, richness, and area use of significant wildlife species at the Site
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.	Approximately 4 locations per year based on previous year's results	2 times per year (800 trap-nights per location per year)	Monitor presence, relative populations, and habitat dependence of Preble's mouse at the Site
Monitor and conserve unique and rare vegetation communities and develop management strategies for their protection and enhancement.	44 Management Units	2 times per year	Track changes in numbers and richness of plant species, health of plant communities, and changes in areal extent of high-value vegetation communities
Monitor the noxious weeds at the Site; comply with weed control regulations.	Variable by year	2 times per year	Evaluate effectiveness of, and aid in out year planning for, weed control actions at the Site
Monitor the effectiveness of controlled burning as a management tool for conservation and enhancement of high-value vegetation communities.	Variable by year	2 times per year	Evaluate effectiveness of, and aid in outyear planning for, controlled burning actions at the Site
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 year	As required	Ensure compliance of projects with applicable ecological regulations and protect rare, threatened, and endangered species from harm
Monitor and conserve fish species presence in streams and ponds; comply with the Endangered Species act, other Federal acts. and Colorado Fish Protection statutes	Variable by year	Once annually	Track continued presence of fish species at the Site

5.2 Scope of Monitoring

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

- 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, and bird and mammal baseline was established in the *1996 Annual Wildlife Survey Report* (Kaiser-Hill, 1997b).
- Identify rare or imperiled plant or animal species.
- Make annual estimates of plant, bird, and mammal species richness. (Plant data are collected in the spring and summer to ensure that spring ephemerals and late-maturing plants are recorded, and bird and mammal species richness is measured monthly).
- Conduct weed mapping and photo surveys. (Photo surveys are conducted in both summer and winter in woody communities and annually in grasslands).
-
- Monitor the presence of noxious weeds and the effects of weed control efforts.
- Anticipate impacts from proposed Site projects, and estimate the potential area affected.

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.

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5.2.1 Preble's Meadow Jumping Mouse

Populations of Preble's meadow jumping mouse have been identified within areas of tall upland shrubland and Great Plains riparian woodland. Monitoring activities in these areas include:

- Monitoring Preble's mouse populations (using all monitoring through 1996 as a baseline) and habitat over time. Monitoring concentrates on determining the presence or absence of the species; quantitative population measurements are not appropriate because of its rarity. Monitoring data provide a basis for tracking ratios of males to females and adults to juveniles, enabling population viability to be confirmed. Ecologists monitor the known population areas on a rotating basis, depending on results from the previous field season. They 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 determines the extent of wetlands at the Site every five years. It is expected that they will conduct the next wetlands evaluation after the year 2000. A comprehensive plan (Kaiser-Hill, 1997c) to manage and protect Site wetlands was issued in 1997, detailing the methods and procedures that will be used to identify wetlands and minimize impacts to them from Site closure and remediation projects.

5.2.3 Project-Specific Monitoring

Proposed Site projects will be evaluated in terms of potential effects on threatened and endangered (T&E) species, species of special concern (SSC), and 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 (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 Site wetlands. (Wetlands include both those mapped by the U.S. Army Corps of Engineers and those not included on the map.)

5.3 Data Disposition

Ecological data was historically stored in two databases [the Ecological Monitoring Program Database (EcMPD) and the Sitewide Ecological Database (SED)]. 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) and ease of use with minimal training.

5.4 Reporting

A comprehensive ecological management plan (Kaiser-Hill, 1997e) is in place, setting forth the management actions that will be required to preserve the valuable ecological resources present at the Site. Site ecologists will update or modify this plan as required by variations in Site conditions, available technology, or changing regulations.

The Ecological Monitoring Program issues the following reports annually:

- Wildlife survey report (including a monitoring on the Preble's meadow jumping mouse): and
- Site vegetation report.

The Vegetation Management Plan is issued annually to document planned weed control and other management efforts for the year.

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6.0 INTERACTIONS AMONG MEDIA

Interactions can be identified between groundwater and surface water, between air and soils, and among all of these media and ecological conditions both on-Site and potentially at off-Site locations (see Table 7-1 of the *IMP Background Document*). Also, activities upgradient from the Site (e.g., aggregate mining to the west) can influence environmental conditions on the Site and downgradient from it. The monitoring described in the previous sections provides information from which correlations among media can be identified and their effects characterized. For example, surface water quality will be influenced by groundwater perturbations, at least near their interface, and the interaction can be characterized.

Chemical and physical soil characteristics can influence air, surface water and groundwater quality. While soils are not monitored routinely as part to the Integrated Monitoring Program, many of the interactions are relatively well understood and others are being characterized through special Actinide Migration Evaluations currently in progress through Site funding. In particular, these studies will assist in understanding the importance of soil transport and the influence of water and air on transport relative to the ultimate fate of radioactive contaminants known to exist in the surficial soils at the Site. This study may point to additional monitoring needed to take the Site to a safe, environmentally sound closure.

Significant habitat effects could accrue from upgradient off-Site activities, as well as on-Site projects, and variations in water supply could affect on-Site and downgradient off-Site habitats. Therefore, to gather data beyond those generated by the monitoring programs described previously, Site personnel collect watershed-level information to assess water availability in the Buffer Zone. Instruments continuously monitor flow at 15 Site locations, and personnel collect seasonal grab samples from seven of those locations for chemical analysis to assess compliance with various regulations (see Table 6-2 in the *IMP Background Document*). In FY99, aquatics sampling on the Site was performed for the first time in a number of years. The resulting data, and other water quality data, is being analyzed in concert with data being collected off-Site by other stakeholders. These data will supplement understanding of downgradient influences due to Site and upgradient impacts on water quality.

The IMP working group will continue to meet periodically to discuss new data needs to address our understanding of the interactions among media, especially relating water quality and quantity to the ecological condition of the Site.

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FY 2001 Integrated Monitoring Plan

Rocky Flats Environmental Technology Site

Background Document

November 2000

A working group consisting of:

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

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ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

INTEGRATED MONITORING PLAN

November 2000

Responsible Organization: Environmental Management & Compliance

Effective Date:
November 2000

Periodic Review Frequency: 1 year from the effective date

Reviewed for
Classification/UCNI:

By _____

Date _____

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List of Acronyms, Abbreviations, and Measurements

µ	Micro-
µCi	Microcuries
µg	Microgram
µmho	Micromhos
AA	Atomic Absorption
Ag	Silver
ALARA	As Low as Reasonably Achievable
ALF	Action Levels and Standards Framework
Am	Americium
AoI	Analyte of Interest
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AQM	Air Quality Management
As	Arsenic
ASI	Advanced Sciences, Inc.
Ba	Barium
Be	Beryllium
BMP	Best Management Practice
BOD	Biological Oxygen Demand
C	Celsius
CAA	Clean Air Act

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CAB	Citizens Advisory Board
CAPARS	Computer Assisted Protective Action Recommendations System
CAQCC	Colorado Air Quality Control Commission
CAS	Chemical Abstracts Service
CBOD	Carbonaceous Biological Oxygen Demand
CCR	*Code of Colorado Regulations*
Cd	Cadmium
CDPHE	Colorado Department of Public Health and Environment
CEARP	Comprehensive Environmental Assessment and Response Program
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cf	Cubic Foot
CFR	*Code of Federal Regulations*
cfs	Cubic Feet Per Second
Ci	Curie(s)
CLP	Contract Laboratory Program
cm	Centimeter
cm^2	Square Centimeter
cm^3	Cubic Centimeter
Co.	County
COD	Chemical Oxygen Demand
ComRad	Community Radiation
Cr	Chromium

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CRS	*Colorado Revised Statutes*
Cu	Copper
CWA	Clean Water Act
CWQCC	Colorado Water Quality Control Commission
CY	Calendar Year
D&D	Decontamination and Decommissioning
DEFT	Decision Error Feasibility Trial
DIS	Drain Identification Study
DMR	Discharge Monitoring Report
DNAPL	Dense Nonaqueous Phase Liquid
DOE	Department of Energy
DQO	Data Quality Objective
ECO	Environmental Compliance and Operations
EDE	Effective Dose Equivalent
EPA	U.S. Environmental Protection Agency
ER	Environmental Restoration
F	Fahrenheit
ft	Feet
ft^3	Cubic Foot
Fe	Iron
FERC	Federal Energy Regulatory Commission
FFCA	Federal Facility Compliance Agreement

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FID	Flame Ionization Detector
FIP	Field Implementation Plan
FO	Field Operations
FY	Fiscal Year
g	Gram
gal	Gallon
GC/MS	Gas Chromatography/Mass Spectroscopy
GIS	Geographic Information System
GPMPP	*Groundwater Protection and Monitoring Program Plan*
GRRASP	General Radiochemistry and Routine Analytical Services Protocol
GT	Geotechnical
GW	Groundwater
GWAP	*Groundwater Assessment Plan*
H-3	Tritium
HEPA	High-Efficiency Particulate Air (filter)
Hg	Mercury
hr	Hour
HRR	Historic Release Report
HSL	Hazardous Substances List
HSU	Hydrostratigraphic Unit
IAG	Interagency Agreement
ICP	Inductively Coupled Plasma

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ICRP	International Commission on Radiation Protection
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
LEL	Lower Explosive Limit
LHSU	Lower Hydrostratigraphic Unit
LTL	Lower Tolerance Level
m	Meter
m^3	Cubic Meters
MCL	Maximum Contaminant Level
MDA	Minimum Detectable Activity
mg	Milligram
Mgal	Thousand Gallons
min	Minute
ml	Milliliter
mm	Millimeter

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Mn	Manganese
mrem	Millirem
msl	Mean Sea Level
N	Nitrogen
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NESHAP	National Emission Standards for Hazardous Air Pollutants
Ni	Nickel
NO_2	Nitrogen Dioxide, Nitrite
NO_3	Nitrate
Non-PA	Non-Protected Area
NPDES	National Pollutant Discharge Elimination System
NSD	New Source Detection
NSQ	Non-Sufficient Quantity
NVSS	Nonvolatile Suspended Solids
OLF	Old Landfill
OP	Operating Procedure
OU	Operable Unit
P	Phosphorous
PA	Protected Area
PAC	Personnel Access Control
PAM	Proposed Action Memorandum

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PARCC	Precision, Accuracy, Representativeness, Comparability, and Completeness
Pb	Lead
PCB	Polychlorinated Biphenyl
PCE	Perchloroethylene
PCOC	Potential Contaminants of Concern
pCi	Picocuries
PID	Photoionization Detector
PM_{10}	Particulate Matter (less than 10 micrometers)
PNNL	Pacific Northwest National Laboratory
POC	Point of Compliance
POE	Point of Evaluation
POps	Pond Operations Plan
POTW	Publicly Owned Treatment Works
ppm	Parts per Million
PPRG	Preliminary Programmatic Remediation Goal
PSL	Process Simulation Laboratory
Pu	Plutonium
PU&D	Property Utilization and Disposal
QA	Quality Assurance
QA/QC	Quality Assurance/Quality Control
QAPD	Quality Assurance Program Description
QAPP	Quality Assurance Program Plan

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QC	Quality Control
QCO	Quality Control Objective
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.
SAP	Sampling and Analysis Plan
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
SVOC	Semivolatile Organic Compound
SW	Surface Water

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SWD	Site Soil and Water Database
SWMU	Solid Waste Management Unit
SWWG	Surface Water Working Group
TAL	Target Analyte List
T&E	Threatened and Endangered (Species)
TCA	Trichloroethane
TCE	Trichloroethylene
TDS	Total Dissolved Solids
TOC	Total Organic Carbon
tpy	Tons Per Year
TRAC	Terrain Responsive Atmospheric Code
TSP	Total Suspended Particulates
TSS	Total Suspended Solids
U	Uranium
UHSU	Upper Hydrostratigraphic Unit
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
UTL	Upper Tolerance Level
VOA	Volatile Organic Analysis
VOC	Volatile Organic Compound
WARP	Well Abandonment and Replacement Program
WER	Well Evaluation Report

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WET	Whole Effluent Toxicity
WM&T	Water Management and Treatment
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 2001 in accordance with the Rocky Flats Cleanup Agreement (RFCA) requirements. These revisions have again focused on developing better integrated monitoring related to the execution of closure projects, and on providing up-to-date documentation reflecting the most current technical approaches within the routine environmental monitoring programs. These revisions are the result of ongoing working group discussions based on needs that have been identified but not previously addressed, or based on changes in monitoring scope dictated by changes in Site operations or new technical capabilities. Similar to the previous year, minor technical changes were made mostly in the surface water and groundwater monitoring programs. These changes are seen in the form of newly implemented monitoring locations, elimination of source location monitoring stations that have fulfilled their purpose, and implementation of a monitoring study to assist in understanding the contributions of the tributary drainages to RFCA POE GS-10 to the elevated concentrations observed there. The document also reflects better integration of surface water and groundwater resources to support the D&D projects. In the air monitoring program a more integrated approach to performance monitoring of D&D projects is defined, one that provides more comprehensive monitoring of the immediate impacts around the entire Industrial Area. The air monitoring changes also reflect the implementation of a fully deployed ambient monitoring network for demonstration of compliance with Rad-NESHAPs requirements.

Integration of Site-wide and project-specific monitoring occurs during the planning of all major new activities, such as ER and D&D projects. Kaiser-Hill Company, L.L.C. (Kaiser-Hill) will review all major project plans and evaluate the need for specific environmental monitoring, based on potential release characteristics (e.g., constituents and concentrations), potential impacts [e.g., adherence to regulatory standards, the Rocky Flats Cleanup Agreement (RFCA), and as low as reasonably achievable (ALARA) principles], and existing Site-wide, multi-media monitoring. Consideration will be given to data needs before, during, and after a proposed activity. 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 assists in determining the effectiveness and performance of designs and controls to eliminate or mitigate impacts. If additional monitoring is deemed necessary, Kaiser-Hill works with project personnel to develop appropriate, media-specific DQOs and monitoring specifications. Project-specific DQOs, developed as part of the decision document or the IMP, when appropriate, will address protection of project personnel, collocated workers, off-Site populations, and the environment, and generally complement Site-wide monitoring DQOs. As projects are planned, project-specific monitoring plans will be included in project plans or as separate sampling and analysis plans and/or health and safety plans, and, therefore, will be available for review by the regulatory agencies and other stakeholders.

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

Data reporting and data exchange were considered during the development of the IMP. The data exchange mechanism, which was formalized as a RFCA requirement (Section 207), will provide Site-wide and project-specific monitoring data to all appropriate monitoring entities and regulatory agencies and will allow these groups to evaluate data needs associated with proposed activities (e.g., baseline characterization, 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 Site remediation and closure, as new remediation and closure efforts are planned and initiated that require performance monitoring, as the regulatory setting changes, and as new data become available to improve the statistical design. Such changes will be made by the multi-party working group and documented in updates to this plan. Periodic meetings of the working group will be held, and resulting changes will be presented to other stakeholders. Additional work that should be performed is presented below.

- D&D monitoring of Buildings 371/374, 559 and 881,
- Volatile organic compound plume at Property Utilization and Disposal (PU&D) yard,
- Industrial Area volatile organic plume evaluation,
- GS10 Source Evaluation - automated synoptic surface water and sediment sampling to investigate spatial trends in water-quality and sediment contamination in the sub-drainage areas tributary to the RFCA POE GS10 monitoring location,

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— Surface water performance monitoring for B771/774, B777, B779, B886, B889, OU2 Closure, and ER projects for 903 Pad, and

— *Ad Hoc* monitoring by CDPHE – special uranium ICP/MS study and nitrate loading analysis for Walnut Creek;

1.1 Background

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

The DQO process is a structured decision-making process that requires the identification of and agreement on decisions for which data are required. This results in the full set of specifications needed to develop a protective and compliant monitoring program (i.e.,

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

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

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qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support decision making). The formal DQO process is documented in two EPA documents (EPA, 1993a; EPA, 1993b). In September 1994, DOE institutionalized the DQO process for environmental data collection activities. This was implemented to balance DOE's environmental sampling and analysis costs with the need for sound environmental data that address regulatory requirements and stakeholder's concerns. Specific steps in the DQO process include:

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

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

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

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

DOE and Kaiser-Hill recognized that the Site could no longer have separate, non-integrated sampling and analysis activities performed by various entities at the Site (e.g., Environmental Restoration, D&D projects, and Environmental Media Management), or between the Site, 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, K-H Team, EPA, CDPHE, and the cities of Broomfield, Northglenn, Arvada, and Westminster to develop consensus on what data were needed and how data would be used, and to develop sampling and analysis plans based on these specifications. The responsibility for data generation was then

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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 Rocky Flats Cleanup Agreement (RFCA), Resource Conservation and Recovery Act (RCRA); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Clean Air Act (CAA); the Clean Water Act (CWA); the Colorado Water Quality Control Commission (CWQCC) standards; natural resource management regulations, Site-specific cleanup agreements (e.g., the *Industrial Area Interim Measures/Interim Remedial Action Decision Document*), and several DOE Orders. 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.

Four, environmental media-specific, DQO working groups (i.e., surface water, groundwater, air, and ecological resources) were established to accomplish the work associated 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, all four groups met together to discuss data needs across media, share progress, ensure consistency, and identify problems. DQO facilitators and statisticians, sponsored in part by DOE Headquarters, assisted the integrated monitoring working group in developing the DQOs, evaluating the adequacy of existing designs, and developing new sampling and analysis plans. The results of these efforts represent a multi-party consensus agreement and are documented 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 all the environmental monitoring conducted by DOE and the Kaiser-Hill team, as well as monitoring conducted by CDPHE and the cities where interface and integration opportunities exist. Other monitoring conducted by CDPHE and the cities is related to the Site, but does not present integration opportunities (e.g., monitoring of area reservoirs conducted by the cities and spot checks conducted by CDPHE).

1.2 References

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

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

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

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2.0 Surface Water Monitoring

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2.0 SURFACE WATER MONITORING

2.1 Introduction

In accordance with the objectives stated in the Preamble to the Rocky Flats Cleanup Agreement (RFCA), the Rocky Flats Environmental Technology Site (RFETS or the Site) operates a robust surface water monitoring system to provide information for cleaning up the Site, to assure public safety, and to keep the public informed. This chapter of the Integrated Monitoring Plan (IMP) Background Document describes the specific surface water monitoring objectives implemented to achieve this goal for fiscal year 2001 (FY01).

Surface water is defined here as water flowing above ground in natural or manmade channels, water detained in Site detention ponds or other natural or manmade depressions which require dewatering, or water processed through the Site sanitary system. Site surface water may originate as rainfall on-site, surface water from up-gradient sources, water purchased from the Denver Water Board (DWB) for domestic use on-site, 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 FY01. The monitoring described herein integrates all surface water monitoring activities across the Site (see Figure 2-1), which are performed under RFCA, including much of the Site monitoring performed by the cities and the state.

The Data Quality Objective (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, the entire direct-runoff event. Continuous flow paced composite samples are collected during all flow conditions. The samplers are paced to collect a grab sample after a specified volume of stream discharge is measured by the flow meter. This differs from storm event sampling in which samplers are paced to collect grab samples whenever direct runoff conditions are detected. Storm-event sampling can use either flow or time pacing to collect grab samples just the rising-limb 'first flush' or the entire runoff event.

In this document, surface water monitoring objectives (a.k.a. "decision rules" under the DQO process) are organized in a roughly upstream-to-downstream order, beginning with process discharges within the Industrial Area (IA) and ending at the drinking water reservoirs

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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 dams. Safety monitoring to avoid dam breaching is discussed first (Section 2.2.1), in recognition of its unique importance to 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 take place anywhere in the area shown in Figure 2-2, it does not fall into the upstream-to-downstream order. Furthermore, some 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 management alternatives such as controlled detention[1] pond management. Specifically, in this document, this refers to monitoring for correlation of Plutonium to TSS in surface water, as discussed in Section 2.2.4.

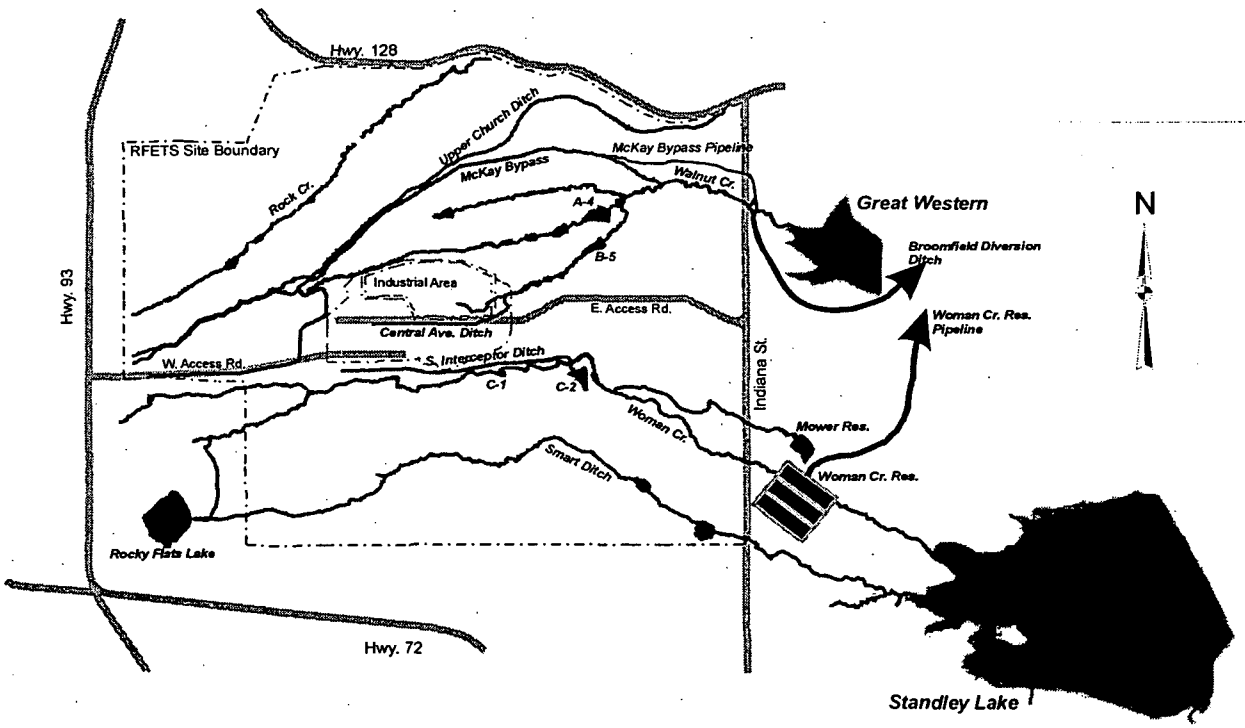

Figure 2-1. Conceptual Sketch of Major Site Surface Water Features.

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

The first of the upstream-to-downstream monitoring objectives is Industrial Area Monitoring. RFCA and the Industrial Area Interim Measures/Interim Remedial Action (IM/IRA) Decision Document (DOE 1994) require the Site to characterize significant surface-water releases within the Industrial Area. Immediately outside the buildings of the IA, the Site 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. Discharges to the sanitary system, both routine and non-routine, are also 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, the Site monitored the internal wastestreams of some processes within facilities to establish what the Site might reasonably expect to see in discharges from these processes. Additionally, the Site is routinely required to determine whether some internal wastestreams (Section 2.3.2.1) may be discharged from the IA to the WWTP. In addition, NPDES monitoring must be performed on the WWTP discharge to the ponds under the conditions of the current permit. The new NPDES permit will no longer require monitoring of any ponds in the buffer zone area.

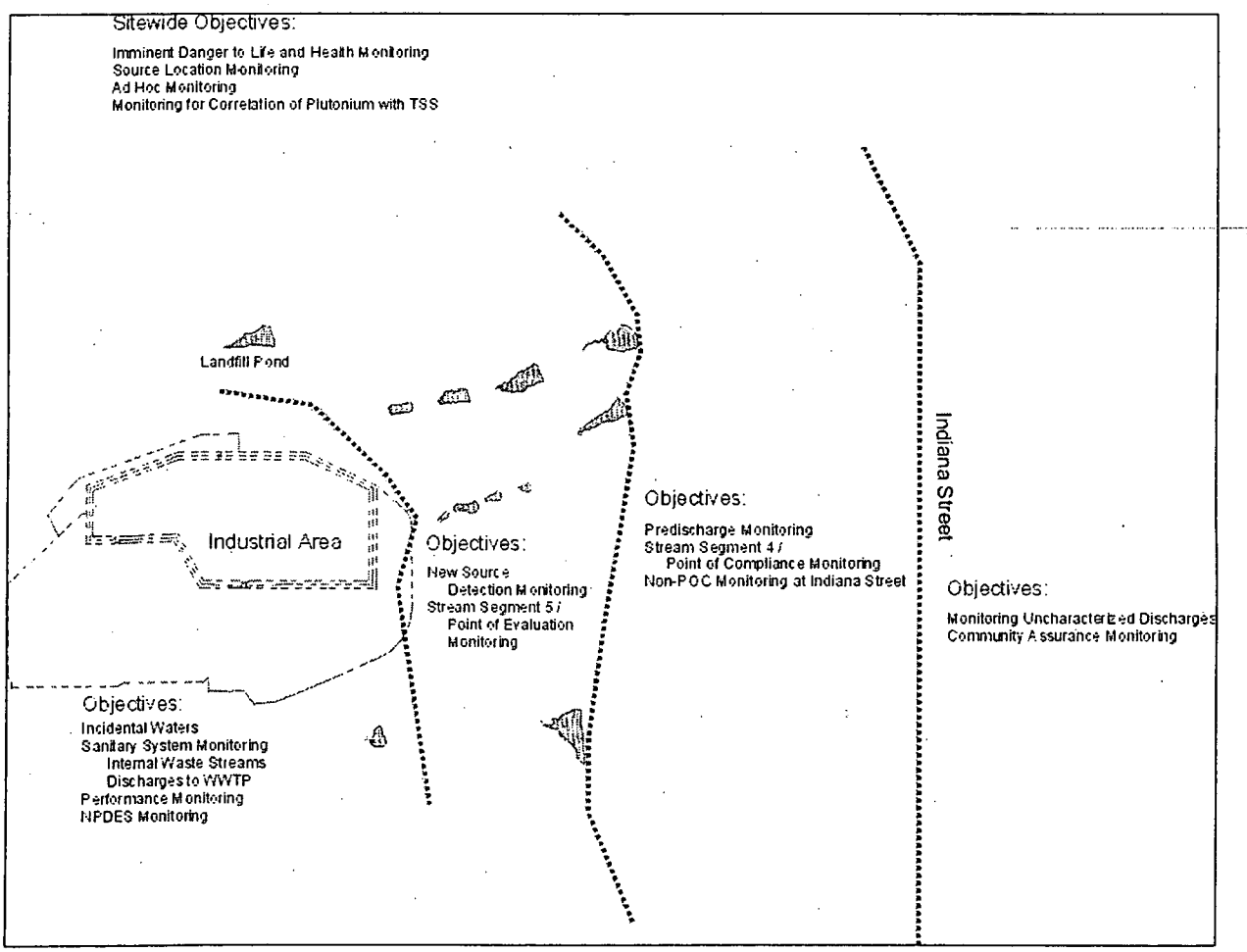

Figure 2-2. Conceptual Model of Site Monitoring Objectives.

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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. The Site must also monitor specific point-source discharges as specified by the NPDES permit (Section 2.3.4).

The next of the upstream-to-downstream monitoring objectives (Section 2.4) deals with discharges from the IA to the ponds. RFCA and the Industrial Area Interim Measures/Interim Remedial Action (IM/IRA) Decision Document require the Site to identify and correct significant accidental or undetected releases of contaminants from the IA to the Site Detention ponds (surface water leaving the IA and entering Segment 5). To decide whether a significant release of contaminants has occurred, the Site performs New Source Detection (NSD) monitoring of IA runoff for significant increases in contaminants (see Section 2.4.1). Additionally, the RFCA specifies monitoring for the upstream reaches of Site drainages (above the ponds) and 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 with the monitoring objectives, terminal detention pond discharges and surface water leaving the Site are monitored. Pre-discharge monitoring of terminal Ponds occurs prior to controlled discharges (Section 2.5.1). The Site also monitors at Points of Compliance (POCs) below the terminal ponds to demonstrate that the Site discharge meets 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 Site boundary and Indiana Street (Section 2.5.2).

The State of Colorado and downstream communities are concerned that the water quality in downstream reservoirs might be degraded by Site discharges. Section 2.6 addresses off-Site monitoring 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 *IMP Background 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 the Groundwater Monitoring Section 3.0.

2.1.2 Geologic and Hydrologic Setting

This section is included only as an introduction to the Site for members of the public not already familiar with the Site. 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, the Site surface waters are bounded:

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

These features are shown in Figure 2-1 and Figure 2-2. A detailed discussion of Site geology and hydrology is presented in Appendix C to Section 3 of this *IMP Background Document.*

The stream drainages leading off-Site are Walnut Creek, Woman Creek, and Rock Creek. The figures illustrate the first two drainages and their tributaries. North Walnut Creek and South Walnut Creek flow through the A- and B- series ponds, respectively. The Colorado Water Quality Control Commission (CWQCC) has designated the portion of these drainages from Ponds A-4 and B-5 to Indiana Street as Stream Segment (Segment) 4b. Tributaries to the A and B terminal ponds, and Pond C-2 itself, are designated as Stream Segment (Segment) 5. The South Interceptor Ditch and Ponds A-1, A-2, B-1, and B-2 have not been designated as waters of the state. These stream segment designations are best illustrated in Figure 2-3.

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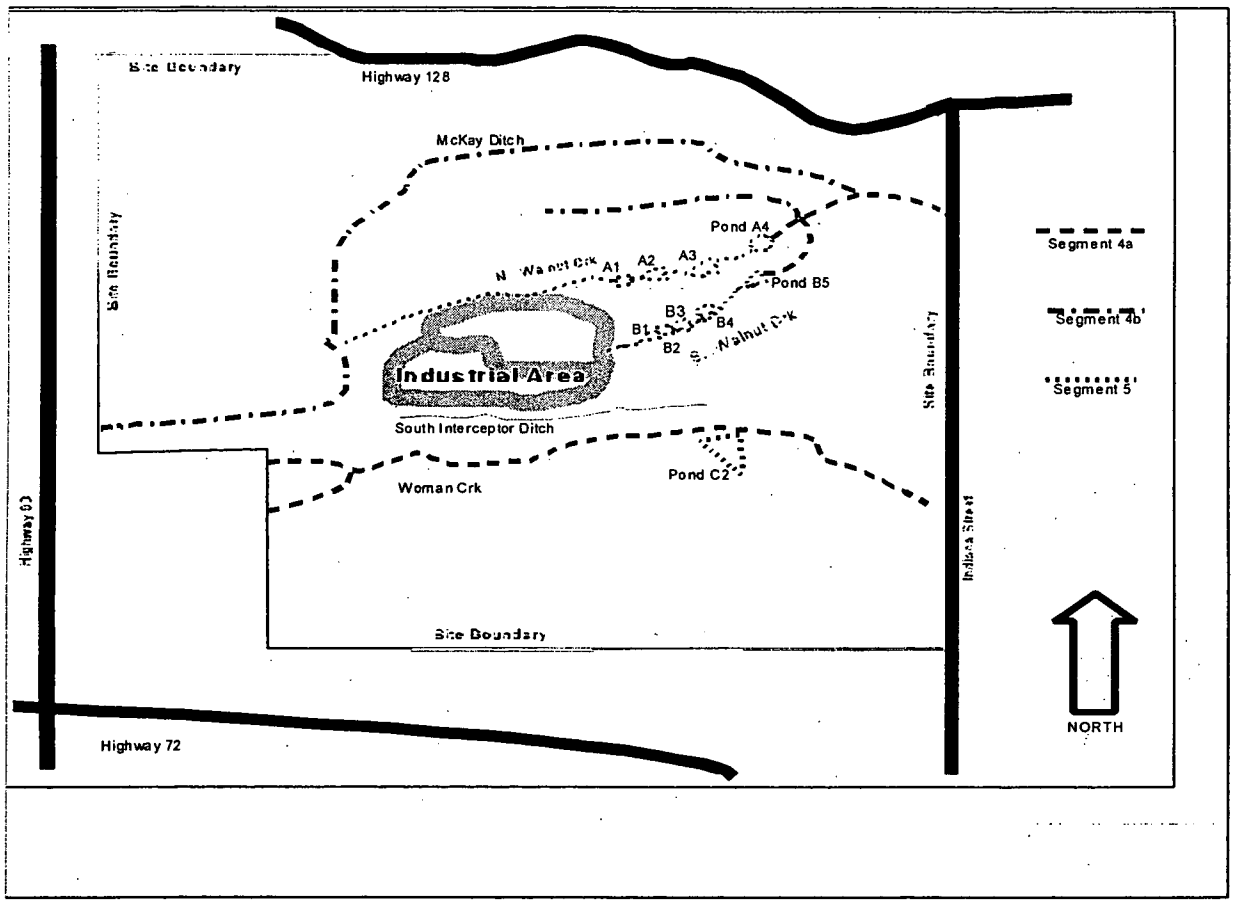
Figure 2-3. Sketch of Stream Segments 4a, 4b, and 5



2.1.3 Assumptions

The Surface Water IMP Working Group made some 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 be true in the future in all cases, and this document does not constitute agreement between the parties that these assumptions will be maintained. However, if an assumption becomes invalid during the effective period of this plan, then some of the monitoring that was excluded on the basis of that assumption should be reconsidered and possibly implemented in future years.

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

- 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 all surface water monitoring of Site discharges to surface water and contaminant impacts down to and including Broomfield and Westminster water supplies. Monitoring and decisions by the Site, the State of Colorado, 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 no confusion will 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, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), or RFCA. 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 all other Site 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 ≥ 4 liters (L), see NSQ discussion], equipment failures, off-normal conditions (e.g., Site 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)

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and americium (Am) require 4.12L.[2] Therefore, samples of less than 4.12L 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.

- At the time of the FY01 revision, the NSQ sample volume size was being reevaluated. If the evaluation results suggest a change in the NSQ volume is warranted, such change will be proposed to the IMP working group for further consideration. Any changes in the NSQ sample volume would require consensus of the RFCA parties.

- The 30-day moving averages will be computed twice each month within 5 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 ALF.

- Where there is no significant flow, there may be no 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 sample carboy.

- 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.

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

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

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

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[2] Four (4) liters is 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.

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

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- These monitoring objectives are based on requirements set forth in federal and state regulations, with authority derived, respectively, from the federal Clean Water Act and the Colorado Water Quality Control Act.

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

2.1.4 Outstanding Issues

- The Site operators request to change pond operations protocol from batch discharge to controlled detention for off-Site release of surface waters and related impacts on monitoring are also unresolved. This will be addressed in the Site's Water Management Closure Plan that is scheduled for completion during FY02.

- Terminal ponds will continue to be operated in a batch mode to the extent practicable throughout FY01.

- A detailed summary of ongoing Industrial Area decontamination and decommissioning (D&D) monitoring is not part of the IMP or the *IMP Background Document*. Detailed monitoring requirements and reporting this for D&D monitoring will be included in the related project plans. This information could be reported in an annual summary to accompany the IMP and the *IMP Background Document*. This summary should include a review of performance monitoring and any monitoring of routine sanitary wastestreams.

2.1.5 Quality Assurance

Sampling and analysis of Site surface water is controlled by Standard Operating Procedures, 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, hold times, detection limits, and laboratory data reporting protocol. Sample sizes (number of independent samples analyzed) for FY01 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.

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- *Statement of Work for Analytical Measurements, General Laboratory Requirements, Module GR01-B.3.* Kaiser-Hill Company, L.L.C., Golden, Colorado, March 18, 1999.

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

- *Quality Assurance Program Plan for the Automated Surface Water Monitoring Program RF/RMRS-2000-013, Rev.0 March 2000.* Rocky Mountain Remediation Services, L.L.C., Golden, Colorado, 1995.

2.1.6 Reporting

Data specified in the surface-water monitoring objectives are used in decision making. Many of the data are not routinely reported to parties other than to the decision maker(s) for a particular decision. These data are managed in the Site Soil and Water Database (SWD) or other Site 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 on-Site parties is reported to the requestor.

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

- 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 Point of Evaluation and Point of Compliance monitoring locations are used to calculate 30-day moving averages for Analytes of Interest. If the 30-day calculated results exceed the applicable reporting threshold (ALF or Standards), the formal notification is made to the RFCA parties pursuant to Attachment 5 of RFCA.

- 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 the Site and cities;
- Many of the surface water data are summarized and reported at the Quarterly Information Exchange Meetings;
- A FY00 Automated Surface-Water Monitoring Report is planned to be completed during FY01.

2.1.7 Surface Water Interactions with Groundwater

Significant interactions occur between surface water and groundwater systems at Rocky Flats. Groundwater within the Rocky Flats 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 ground water discharge from nature seeps and man-made structures that intercept the ground water systems.

Of particular concern from the surface water monitoring prospective are streams nearest to the Industrial Area (IA) that are more likely to receive contaminated groundwater discharges either from natural or man-made sources. Artificial ground water flow control structures in the IA (i.e., building sumps and foundation drains) that interrupt the natural flow of groundwater can and do provide a direct pathways for contaminated groundwater to surface water systems. In the past, surface water and groundwater D&D performance monitoring and remediation project reviews were conducted independently with minimal information exchange. With the startup of most building D&D and remediation projects looming in the next few years, the need for an integrated surface water/groundwater monitoring program is essential.

Starting in FY01, a surface water/groundwater performance monitoring assessment and implementation template will be developed for D&D and remediation projects. Assessments will be conducted in parallel 2 years prior to the planned start of building demolition. Emphasis will be placed on those projects where surface water/groundwater interactions are expected. This new approach is detailed in section 2.3.3 Performance Monitoring.

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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 operational indicators of Pu levels to describe actinide transport and to design and implement pond operations (Section 2.2.4). None of this monitoring is confined to a single geographical area of the Site. 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 Site's Soil and Water Database (SWD).

2.2.1 Imminent Danger to Life and Health (IDLH) Decision Monitoring

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

The Site has a network of detention ponds with earthen dams (Figure 2-4). Failure of an earthen dam would present an Imminent Danger to Life and Health. Safety and health professionals often refer to such conditions as Imminently Dangerous to Life and Health conditions. The Site has several ponds formed by dams that can hold a limited amount of water safely. Water may be discharged from these ponds through the outlet works or by pumping. Water does not normally overtop the dams, which are all of earthen construction and would be damaged and could fail under those conditions. Heavy rain or snowmelt runoff can challenge the capacity of the ponds faster than the ponds can be pre-discharge monitored and subsequently batch discharged.

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Problem Statement:

If water levels rise above safety limits that preserve dam integrity, then ponds must be discharged to prevent overflow or breaching.[4] The risk to the public and environment is far greater from a dam breach than from the 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 et al., 1996), and the Action Level Response Plan for Dams A-4, B-5, or C-2 (RMRS, 1995). The following *general decisions* must be made on a continuous basis for Pond A-4.

Similar decisions are made for Ponds A-3, 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)[5]
- Pond elevation for Ponds A-3, A-4, B-5, and C-2 (must be continuously monitored for daily to hourly averages with instantaneous measurement capability)
- Measurements from piezometers in dams (indication of water pore pressure in dam structures)
- Daily to hourly visual inspections of dam integrity

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

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

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- 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 et al., 1996) details decision tree that describes this logic]
- Pond discharge rates (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) inspection
- Crest monument movement monitoring [required by *Code of Colorado Regulations* (CCR) for dams]
- Inclinometer monitoring (required by CCR for dams)

Boundaries:

Spatial: Inflows to and outflows from Ponds A-3, A-4, B-5, and C-2 is 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. The Site also maintains instantaneous measurement capability for all telemetry data.

Decision Statements:

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

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THEN	The Site will discharge water from the pond.
IF	A pond reaches Action Level 4 (i.e., exceeds its safe capacity based on data including piezometer readings, dam inspections, pool level, and inflow data)—
THEN	The Site will release water (without waiting for analytical results) 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 and/or breaching possible based on data including piezometer and inclinometer (measures the change in a slope, providing early warning of a potential dam failure) readings, dam inspections, pool level, inflow data]—
THEN	The Site will release water (without waiting for analytical results) from the pond at 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, and/or other monitoring activities reveal changed conditions affecting the structural integrity of a dam—
THEN	The Site will notify the Colorado State Engineer and other agencies, as required by the 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.

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

Data Types Monitored	POND											
	A1	A2	A3	A4	B1	B2	B3	B4	B5	C1	C2	Landfill
Inflow rate (telemetry measurement)	—	—	9/day [SW093]	9/day [GS12]	—	—	—	—	9/day [GS09]	—	9/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)	—	—	9/day [GS12]	9/day [GS11]	—	—	—	—	9/day [GS08]	—	9/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)	—	—	9/day	9/day	—	—	—	—	9/day	—	9/day	—
Pond elevation (field measurement)	1/week	1/week	3/week	3/week	1/week	1/week	—	—	3/week	—	3/week	1/week
Piezometers (telemetry measurement)	—	—	3/day	3/day	—	—	—	—	3/day	—	3/day	—
Piezometers (field measurement)	—	—	1/week	1/week	1/week	—	1/week	—	1/week	—	1/week	1/week
Routine dam inspection	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week	1/week
Biannual detailed dam inspection	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year	2/year
Annual FERC and DOE dam inspection	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year	1/year
Inclinometer (field measurement)	—	—	—	4/year	—	—	—	—	4/year	—	4/year	—
Crest monument movement (field measurement)	—	—	—	4/year	—	—	—	—	4/year	—	4/year	—
Use of computer expert system to predict pond filling and/or discharge events (using data from telemetry and field measurement)	1/week	1/week	1/week	1/ week	1/week	1/week	—	—	1/ week	—	1/ week	1/week

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.

— = Not applicable

DOE = Department of Energy

FERC = Federal Energy Regulatory Commission

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

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 any 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.[6]

Problem Statement:

When new contaminant sources are detected by surface-water monitoring within the Industrial Area, at NSD locations, at POEs, at POCs, or in the downstream reservoirs, additional monitoring may be required to identify[7] 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[8].

Information Types and Frequency:

Analyte suites under this decision rule are determined based on the contaminant of current concern that has caused the exceedance, 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 Site surface-water drainage area (especially within the Industrial Area) where a new contaminant source or exceedance is detected. The distribution of monitoring points is determined by the details of the specific source evaluation to determine source location and to efficiently utilize resources. For example, if monitoring (just outside the Industrial Area) for NSD suggests a new source within the Industrial Area, then portable monitoring equipment may be installed within the Industrial Area to locate the source. And, if monitoring for compliance in Segment 4 suggests a new source, then monitoring to identify the source may begin in Segment 5.

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

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

[8] 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.

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 any monitoring objective—

THEN The Site will take appropriate and immediate action to halt or mitigate, locate and quantify the source, 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 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. As of third quarter FY00, 18 monitoring stations were collecting data to support source location. These stations were established to investigate Pu and Am water quality exceedances detected at GS03, GS10, and SW093 during FY97; at GS10 and SW027 during FY98, at GS10 and SW093 during FY99, and again at GS10 during in FY00 .

Three (3) source location stations tributary to GS03 (i.e., GS33, GS34, GS35) that were established for the Walnut Creek source evaluation and one (1) source location monitoring station tributary to SW093 (i.e., SW118) upgraded to collect continuous flow-paced samples for the SW093 source evaluation are no longer needed and will be discontinued in FY01.

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

Table 2-2 Estimated FY01 Annual Number of Samples and Parameter Collection Frequency for Source Location Monitoring

Gauging Station : Location Description	Pu, Am	TSS	Total Samples/Year
GS27 Small drainage north of B883	12	12	12
GS38: Central Ave. Ditch NW of Building 889	12	12	12
GS39: Ditch N of 904 Pad; also supports 903 Pad remediation	12	12	12
GS40: Drainage Outfall E of Tenth St. S of Building 997; also supports 700 Area D&D activities	12	12	12
GS43 Ditch draining B886 Area	12	12	12
SW022 East end of Central Avenue Ditch at Inner Fence	12	12	12
SW120: Drainage Ditch N of Solar Ponds inside PA along perimeter road; also supports B771/774 D&D	12	12	12

2.2.2.1 GS10 SPECIAL SOURCE INVESTIGATION

Since the inception of RFCA monitoring in FY97, reportable values for Am and Pu have been observed every spring at monitoring location GS10. This annual reoccurrence prompted the Site to conduct a special source investigation of the GS10 subdrainage. Results of this investigation will also fulfill Site requirements to conduct a source investigation in

response to the spring FY00 reportable GS10 event. Details of the investigation are documented in the *Sampling and Analysis Plan for Automated Synoptic Surface- Water and Sediment Sampling for the GS10 Source Investigation.* To summarize, a network of automated synoptic surface water samplers will facilitate detection of spatial water-quality trend. The samplers will be activated sequentially downstream in response to the first flush storm water through the GS10 subdrainage. Similarly, the investigation plan calls for the collection of 46 sediment samples to evaluate spatial sediment trends for the subdrainage areas tributary to POE GS10. Table 2-3 lists the automated surface water monitoring stations that will be used in the study.

Table 2-3 Automated Synoptic Surface Water Sampling Locations

Location Code	Location Description (see sampling and analysis plan)	Rationale
GS10	POE on S. Walnut Creek just upstream from the B-1 Bypass	The continuous flow-paced samples collected under RFCA will be analyzed for additional parameters (see sampling and analysis plan) in support of the data evaluation for the synoptic sampling. No changes will be made to existing sample collection protocols.
SW023	Co-located with GS10 on S. Walnut Creek just upstream from the B-1 Bypass	This location will collect samples representative of all surface water from the GS10 drainage. Samples collected at GS10 are continuous flow-paced, and therefore cannot be compared directly to the event samples to be collected at the upstream locations. Approximate Drainage Area: 168 acres
SW132	At end of corrugated metal pipe draining area east of 750 Pad and west of B991; includes western portion of B991 and any unknown inflows to this pipe from area around B991	At a manmade structure providing a singular outfall to a specific sub-drainage; Approximate Drainage Area:33.1 acres
SW021	Outfall of culvert draining area inside PA downstream from 750 Pad	At a manmade structure providing a singular outfall to a specific sub-drainage; specifically areas nearest the Solar Ponds and B991; Approximate Drainage Area: 20.1 acres
SW060	Outfall of corrugated metal	At a manmade structure providing a singular outfall to a specific sub-drainage; Approximate Drainage Area: 25.7 acres

	pipe draining areas east and south of PSZ; includes areas east of B551	
SW022	Eastern end of Central Avenue Ditch before diversion to S. Walnut Creek	At a manmade structure providing a singular outfall to a specific sub-drainage; specifically areas nearest the 903 Pad; Approximate Drainage Area: 77.9 acres
SW100100	Upstream end of corrugated metal pipe leading to SW132	On a stream just before entering a manmade structure providing a singular outfall to a specific sub-drainage; specifically areas between the 750 Pad and B991; Approximate Drainage Area: 31.1 acres

The GS10 special investigation samples should be analyzed, analytical results interpreted, and a report prepared during the first half of FY01.

2.2.3 *Ad Hoc* Monitoring

The Site and agencies do 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 the DOE, RFFO 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 alarms 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 (i.e., Actinide Migration Evaluation [AME], Site-Wide Water Balance;
- Special studies by the agencies (i.e., CDPHE's Uranium ICP/MS Study and CDPHE's nitrate loading study for Walnut Creek;
- Community assurance monitoring at the request of downstream cities and the DOE, RFFO;
- Unanticipated changes in regulatory permits, agreements, or funding;
- Anticipated but unfunded changes in permits or agreements;
- Construction projects;
- Spill events; or

- Operational monitoring (i.e. footing drains, septic lift stations).

The monitoring locations for FY00 presented in Table 2-3 for reference. Actual FY01 Ad Hoc monitoring will depend on the status of new and ongoing projects in FY01.

Table 2-4 FY00 *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	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	Data collection to confirm proper operation of footing drain systems; funded by Safe Sites
GS22	Outfall from 400 Area at SID	1.5' H Flume	No	Data collection for Site Water Balance
GS41	Sub-drainage SW of GS03; drains to Walnut Creek	0.5' H Flume	Yes	Data collection for Actinide Migration Evaluation; partially funded by EPA
GS42	Sub-drainage N of SW027; drains to SID	3" Parshall Flume	Yes	Data collection for Actinide Migration Evaluation; partially funded by EPA
GS45	Upper Church Ditch west of Site fenceline	9.5" Parshall Flume	No	Data collection for Site Water Balance
GS46	McKay Ditch west of Site fenceline	9.5" Parshall Flume	No	Data collection for Site Water Balance
GS47	West Diversion Ditch north of Site Perimeter Road	Area-Velocity flow meter in ditch of known geometry	No	Data collection for Site Water Balance
GS48	McKay Bypass Canal north of Landfill Pond	Area-Velocity flow meter in ditch of known geometry	No	Data collection for Site Water Balance
SW009	McKay Bypass Canal upstream of confluence with West Diversion Ditch	1' Parshall Flume	No	Data collection for Site Water Balance

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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 ICP/MS study of groundwater at Rocky Flats. 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 uranium. There is also natural uranium in the groundwater. In an effort to better discern those areas where man-made contamination is present versus those areas where only natural uranium 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 - "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)", July 23, 1999 (hereinafter referred to as the "Groundwater QAPP").

It is generally accepted that groundwater at the site surfaces up-gradient of the Site boundaries. But, 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 uranium 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 uranium is present in the stream,
- allow a comparison between groundwater and surface water quality for uranium isotopes,
- assist in delineating groundwater flow patterns,
- help identify specific sources of man-made uranium,
- 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.

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Information Types and Frequency

Uranium 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 - quarterly. CDPHE originally planned to collect samples during the fourth quarter of FY00; since the groundwater study has progressed in advance of the surface water study, the total number of surface water samples will be reduced, with sampling only occurring as long as the duration of the groundwater study.

Boundaries:

Spatial: Sampling will be done at nine stations:

- INFL_N- Sewage Treatment Plant Influent - North Interceptor
- INFL_S - Sewage Treatment Plant Influent – South Interceptor
- GS01 - Woman Creek at Indiana
- GS04 - Rock Creek at Highway 128
- SW118 - North Walnut Creek (upstream of Solar Ponds Nitrate Plume)
- GS13 - North Walnut Creek Above Pond A3
- GS05 - North Woman Creek at West Buffer Zone
- GS17 - Woman Creek above Pond C1
- GS10 - South Walnut Creek above B-Series bypass

Temporal: Quarterly surface water sampling will be done through the duration of the groundwater study.

Decision Statement:

IF sample results indicate non-natural uranium,

THEN evaluate potential sources of non-natural uranium, 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 uranium is present in surface waters), is not

rejected, and the surface water is actually contaminated with enriched/depleted uranium. False positive decision errors occur when the null hypothesis (H_0) is rejected, and the surface water is not contaminated with enriched/depleted uranium. For this project, the consequences of false negative decision error is not detecting a source of enriched/depleted uranium 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/depleted uranium that may not exist.

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

2.2.3.2 CDPHE's Nitrate Loading Analysis for Walnut Creek

The Site 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 the Site's most cost effective defensive monitoring tool.

However, Site 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 insure that accurate nitrate data is being collected, for the purposes described below, please add the following section, unless the monitoring planned by RFETS is modified to satisfy its requirements.

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Problem Statement

There are two main sources of nitrate in the Walnut Creek drainage - the Solar Ponds Plume, and the Sewage Treatment Plant. 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 the Site 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 to STP over time.

As a result of these types of potential changes in the hydrologic system, it will be necessary to perform some nitrate monitoring in addition to the performance monitoring being done at GS13[9] and Pond A3.

Information Types and Frequency

Nitrate is the only analyte 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 (may be covered by SPP Decision Document - not sure)

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

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- Pond A4 – (grab sample from pond event is not concurrent with discharge, else grab sample from discharge if event is concurrent with discharge)
- Pond A3

South Walnut Creek

- GS10
- Pond B3
- GS08

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, November 1999.

2.2.4 Monitoring for Correlation of Plutonium with TSS[10]

The Site intends to move toward controlled detention operation of the ponds at some time in the future. The initial controlled detention design basis indicator for Pu will be total suspended solids (TSS), which historical storm-water data have shown to be correlated with

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

Pu activity (Gilbert, 1987) at several locations. This correlation was a primary assumption in the design basis for the controlled detention *Pond Operations Plan*[11] (Kaiser-Hill et al., 1996). To test these hypotheses, it is desired that samples be analyzed for Pu and TSS at selected monitoring locations planned for use during future controlled detention discharge from the ponds. This analysis may quantify the correlation between Pu and TSS.

Problem Statement:

This monitoring objective is intended to establish the relationship of Pu concentrations with several indicator parameters, such as TSS, turbidity, or flow rate. The determination of relationships between Pu and indicator parameters will support future pond operations, investigations into actinide transport, and management decision making.

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

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

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

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

of the source removal. In contrast, an increased ratio might indicate a new source of Pu.

Data from this monitoring would also support evaluations of the impact of D&D and watershed improvement activities.

Information Types and Frequency:

To evaluate the correlation between TSS, turbidity, and flow with Pu, monitoring at any three stations would suffice, but six stations should be monitored in case some do not correlate well. Since Pu is already monitored at terminal pond outfalls (POCs) and at the Industrial Area boundary (POE and NSD locations), flow, TSS, and turbidity[12] (turbidity monitored real-time) will also be monitored at these eight stations where feasible.

To evaluate the predictive capability of the real-time flow and turbidity parameters, the Site must monitor these parameters at locations most likely to be predictive and far enough upstream to provide at least 2 hours of warning before an exceedance could occur in Segment 4 (at a POC). These stations include POEs GS10, SW093, and SW027. Each of these stations will be equipped with real-time, water-quality probes to continuously monitor turbidity.

Ideally, TSS would be analyzed for all samples collected at the above locations. However, sampling protocols for these stations (detailed in Sections 2.4.1, 2.4.2, and 2.5.2) often result in composite samples that are collected over periods exceeding the 7-day hold time for TSS analyses. Therefore, TSS cannot be analyzed for all composite samples but will be analyzed when possible. For reference, NSD locations collect composite samples during singular runoff events, while POCs and POEs collect composite samples continuously during all flows.

Boundaries:

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

Temporal: No known constraints.

Decision Statement:

[12] Due to intermittent flows at locations SW022 and SW091, real-time turbidity measurement is not feasible.

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IF The correlation between total Pu activity and TSS exceeds 0.80 at three or more monitoring location pairs[13] for a period of six months or more, including peak spring runoff events and base flow, (Gilbert, 1987) (see reference)—

THEN Knowledge of this correlation is shared with the Actinide Migration Evaluation Team for further investigation. The Actinide Migration Evaluation Team will work with the RFCA monitoring team to determine whether the relationship between Pu and TSS is significant enough to be used as a design basis for operation of the ponds, and the Site may then attempt to establish the specific numerical values needed to design protective pond operations and structures. Results of these studies will be presented to stakeholders for consideration as a basis for operations.

An identical decision may be made for a relationship between Pu activity and turbidity, or a combination of TSS and turbidity, or other indicators. Note that use of the relationship between Pu and suspended particulates as a design basis for pond operations would not necessarily preclude real-time monitoring, short-term storage and screening, alternative routing of pond water, or other protective engineering features.

IF The Site can demonstrate mathematically that a regression model of discharged Pu as a function of turbidity and/or flow and/or another real-time parameter[14] would provide at least 4 hours of warning before discharged Pu would exceed the applicable RFCA standard so that outlet works could be closed or so that the effluent could be redirected,

AND IF A controlled detention terminal pond can be isolated from the WWTP and ITS—

THEN The parties to this document will actively support a full one-year trial of controlled detention for that terminal pond, subject to approval of the operational plan.

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:

[13] Monitoring location pairs: Theoretically, monitoring for TSS at GS10 (east edge of Industrial Area) may predict Pu activity monitored at GS08 (below Pond B-5). In this case, GS10 and GS08 would be a monitoring location pair.

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

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— In order to provide a representative estimate of variability during FY01, it will be sufficient to monitor approximately one event per month at event monitoring stations (NSDs) and monitor a target of 20 samples taken over the full range of flow conditions, for each of the flow-paced stations (POEs and POCs). Monitoring at the POE and the NSD stations would represent the main drainage basins for which correlations are needed.

— Each of the stations must continuously monitor for turbidity due to the method (continuous probe). Monitoring for Pu and TSS at each of the event monitoring stations (SW022 and SW091) during every sampled event would provide adequate confidence that significant events are sampled and representative at those locations. Monitoring for TSS at the flow-paced stations (GS10, SW093, and SW027) should be performed only when Pu monitoring is performed and should provide at least 20 data pairs for FY01. The data set should include samples taken over the full range of flow conditions.

- *Acceptable Decision Error Rates for Statistical Sampling Design:*

— Design of a sampling plan would require some knowledge of the variability, which is not yet available. Samples taken during FY01 will provide more of this variability information so that a statistical sampling design may be implemented when possible.

— Acceptable decision error rate for the decision to accept the correlation between TSS and Pu as a design basis: $r^2 \geq 0.8$ for three or more locations.

Monitoring Requirements:

The requirements shown in Table 2-4 are partially redundant with other decision rule monitoring requirements, but are specified here to retain the independence and separability of the monitoring requirements for each decision rule.

Precipitation is currently measured in 5- and/or 15- minute intervals at nine locations around the Site. The effective precipitation for any monitoring location drainage basin can be calculated from these data.

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Table 2-5 Annual Monitoring Targets (Number of Samples/Analyses) to Evaluate the Relationship of Plutonium with Indicator Parameters

Monitoring Location	Pu Analyses	TSS Analyses	Turbidity Measurement Frequency	Flow Measurement Frequency
Into the Ponds - Monitoring Indicators in Segment 5 for Pu in Segment 4				
SW093	10	10	15 min	15 min
SW027	10	10	15 min	15 min
GS10	10	10	15 min	15 min
SW022	12	12		15 min
SW091	12	12		15 min
Leaving the Ponds - Monitoring Pu in Segment 4, and correlation with Indicators				
GS11	10	10	15 min	15 min
GS08	10	10	15 min	15 min
GS31	3	3	15 min	15 min

Notes:
min = Minute
Pu = Plutonium
TSS = Total suspended solids

2.3 Industrial Area Monitoring Objectives

This section includes the monitoring objectives for decisions regarding the Industrial Area.[15] Some of the monitoring performed to make these decisions is actually performed outside the Industrial Area. For example, to detect a new source of contamination within the Industrial Area, the Site actually monitors surface water just after it flows out of the Industrial Area.

This Industrial Area Monitoring section also addresses monitoring of incidental waters, the sanitary sewer system, and performance monitoring. Immediately outside the buildings of the Industrial Area, the Site 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 maintain current information in the NPDES permit application, the Site must characterize all routine internal wastestreams to establish what else might reasonably occur in discharges

[15] 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 and SW027.

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from these processes. Additionally, the Site routinely determines whether non-routine internal wastestreams (Section 2.3.2.2) may be discharged from the Industrial Area to the WWTP. In addition, NPDES monitoring must be performed on the WWTP discharge to the ponds.

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 some utility pits and secondary containments. 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. The Site must determine how to manage incidental waters (i.e., whether or not to discharge to the environment[16]).

This decision includes only 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,

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

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 2-5.

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 to 9
Appearance	Visible sheen or color
Field nitrate using probe, colorimetry, or similar indicator	10 mg/L
Field conductivity probe	700 μmho/cm^2

Notes:

μmho= Micromhos
cm^2= Square centimeter
L= Liter
mg= Milligram

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

Boundaries:

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

Temporal: Incidental waters are more common in rainy seasons, but 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. [17]

[17] 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 (*continued on next page*)

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:
  - 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 10 incidental water accumulations per month during FY01. 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 2-6.

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

Parameter	Justification	Measurements per Year FY00/FY01
pH	NPDES permit and stream standards restrict pH of plant discharges.	120
Nitrate as N	NPDES permit and stream standards have restrictive nitrate limitations.	120
Conductivity	Indicator parameter for metals. NPDES permit and stream standards restrict metals.	120
Gross alpha/beta	BMP to restrict radionuclides in SW discharges.	100
VOCs	NPDES permit and stream standards restrict VOCs in SW discharges.	40
Inorganic metals	NPDES permit and stream standards restrict metals in SW discharges.	10

Notes:

BMP= Best Management Practice
FY00/FY01= Fiscal years 2000 and 2001
N= Nitrogen
NPDES= National Pollutant Discharge Elimination System
VOCs= Volatile organic compounds
SW= Surface water

2.3.2 Sanitary System Monitoring

Sanitary collection system monitoring may provide the Site D&D project managers and WWTP operators information about collection system condition within the Industrial Area 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;
- Monitor for corrosive substances that may impact the treatment units;

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- 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 the Site).

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 collection system flow monitoring, WWTP protective 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 on Site. Some can be discharged to the sanitary system, some must be treated under the Resource Conservation and Recovery Act (RCRA), some require treatment for radionuclides under DOE Orders, and some require management by still other regulations. These related issues, neither of which is monitoring required by the RFCA, are introduced below:

- The first main NPDES issue is that the Site must maintain strict compliance with NPDES permit conditions. This compliance requirement drives two distinct monitoring activities:
  - The Site must monitor permitted discharges as specified in the permit and report as specified in the permit. This issue of NPDES compliance monitoring is covered below.
  - The Site must manage discharges to the WWTP for two reasons that are combined operationally under the "authorization to discharge" process:
    1. The Site must ensure that the operational capabilities of the WWTP are not exceeded, resulting in a permit violation for the WWTP effluent. This activity is covered in Section 2.3.2.2.
    2. The Site 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.

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

The quantity and complexity of this activity will increase during D&D and implementation of the Rocky Flats Closure Project Management Plan. As the Site population decreases, the quantity of aqueous wastestreams may decrease. But as the mission changes, wastestreams will undergo significant changes that must be reflected in the Permit application. 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.

Problem Statement:

Determining appropriate Permit conditions is, in part, a data-driven process. The Site provides the data, and the regulators make the decisions. Data for these decisions are provided in the NPDES Permit application. Data used in the Permit application include detailed information about wastestreams emanating from buildings in the Industrial Area and discharged to the collection system. The nature of all Site wastestreams and a detailed characterization of certain[18] 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 all Site buildings, discharges from Building 374, 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 Site must keep the Permit application current. This will require that the Site characterize new routine wastestreams for disclosure in the Permit application. 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.

[18] The Clean Water Act (CWA) regulations require specific information about wastestreams that arise from categorical processes identified in 40 CFR 400-500.

- Incidental waters (which do not contain oil, or hazardous or radioactive substances) are covered in Section 2.3.1 of this document. Storm-water runoff monitoring is excluded from this section.

Data Types and Frequency:

- The following items are included in the Permit application, as needed:
  - Complete NPDES application,
  - Update notifications that have been presented to the permitting agency,
  - Current drawings for each facility,
  - Descriptions of discharges from the facility to waters of the United States, and
  - Current available characterization for each discharge.

Boundaries:

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

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

The actual data-driven decision is made by the regulator. That is the decision whether to establish a Permit condition, limitation, or requirement in response to a specific contaminant concentration in a specific discharge stream described in the Permit application.

Decision Statement:

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

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

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - Site processes for review, notification, and approval of facility modifications are not fully implemented in some cases. 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 Permit application.
- 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 the Site elects to negotiate a specific issue and requires project-specific monitoring data to negotiate that issue. Such monitoring is not addressed in this plan.

Monitoring Requirements:

For planning purposes, it is estimated that three (3) new routine wastestreams will require characterization during FY01 in order to maintain the NPDES Permit application.

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 2.3.1 of this document. Storm-water runoff monitoring is excluded from this section.

If wastestreams may not be discharged to the WWTP, then they may need to be evaluated for treatment, storage, or disposal under appropriate regulations such as RCRA, CERCLA, or

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DOE Orders prior to discharge. However, monitoring for treatment decisions is outside the scope of this environmental monitoring plan.

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

- NPDES regulations prohibit certain hazardous substances from being discharged to surface water. Table A-24 (see Appendix A to this section) shows a list of NPDES hazardous substances that must be considered (but not necessarily analyzed) during the characterization of each internal 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 A-25 (see Appendix A to this section) specifies these limitations.
- RCRA hazardous wastes are also prohibited from being discharged to surface waters, and discharge to the WWTP is regulated. RCRA regulations for listed, characteristic, and derived hazardous wastes are included in this document by reference only.
- Oil in WWTP influent streams is limited to 100 milligrams (mg)/L unless a greater loading is specifically authorized by the WWTP manager.
- Radionuclides discharged to the WWTP are limited to loadings that will not result in exceedance of Segment 4 stream standards under RFCA. As low as reasonably achievable (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 2-7. 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
  - — Location
  - — Source
  - — History
- Visible Sheen
- Color
- Clarity
- Volume
- Field Conductivity
- pH

Table 2-9 Requests (Number of Samples/Analyses) for Authorization to Discharge

Requests	Total	Approved	Denied
Number of Requests for FY99	32	31	1
Number of Requests for FY00 (through June)	40	35	5

Notes:
FY = Fiscal year
Numbers shown are examples for planning purposes in future years

All facilities within the Industrial Area 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 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 2-7 offer no reasonable cause to suspect prohibited contaminants in a wastestream for which authorization to discharge has been requested—

THEN The Site will grant authorization to discharge to the WWTP, subject to approval of the WWTP manager.

IF Screening results[19] or process knowledge indicate that contaminants would prohibit the discharge under any applicable regulation—

THEN The Site will either:

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

IF More specific or more sensitive analyses indicate that the wastestream would not cause a violation of applicable regulations—

THEN The Site will authorize discharge to the WWTP with the approval of the WWTP manager.

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

Acceptable Decision Errors:

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

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

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

Monitoring Requirements:

The Surface Water Operations Group estimates that there will be approximately 40 requests for authorization to discharge during FY01. Each will be screened as specified in Table 2-7. 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 two locations, in the equalization basins and at the headworks to the plant. Some direct pH readings are also taken by plant personnel at the headworks. As D&D proceeds and buildings with drains to the WWTP are impacted, the need to expand the collection system monitoring will be evaluated.

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

Data Types and Frequencies:

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

Boundaries:

Spatial: All collection system lines influent to the WWTP up to but not including lines inside the buildings inside the Industrial Area.

Temporal: This is real-time operational monitoring.

Decision Statement:

The decision rules for FY01 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 the flow equalization basin not currently in use while the problem is investigated.

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IF The LEL is exceeded (see Table A-25)—

THEN Emergency procedures will be activated.

Acceptable Decision Errors:

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

Monitoring Requirements:

To be determined.

2.3.2.4 WWTP Collection System Flow Monitoring

Flow information for the Site's sanitary collection system is currently limited to influent records for the WWTP. The initial scope of collection system monitoring is intended to provide Site collection system flow information by installing continuous recording flow monitoring equipment at (Building 990) on the two main collection system lines. The flow record will be used to establish annual baseline conditions for the flows from the protected area (PA) and non-PA areas. 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.

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 enter the equalization basins located at B990. Influent to the WWTP (B995) is monitored for pH, conductivity, and LEL on a continuous basis. These parameters are also monitored at B990 on both the PA and non-PA systems. The B990 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.

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Boundaries:

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

Decision Statement:

IF A baseline for flow does not exist—

THEN Develop a baseline and correlate its relationship with ground water levels and precipitation.

After developing a collection system flow baseline:

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

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 B990.

2.3.2.5 WWTP Radiological Monitoring

This section also includes the monitoring of radiological parameters at the influent to the WWTP for the purpose of tracking pollutant loads coming through the WWTP collection system. The assumption is that these radiologic loads to the WWTP should be decreasing, since the Site has systematically tried to eliminate any possible connections between wastestreams containing radionuclides and the 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.

Data Types and Frequencies:

Influent WWTP monitoring will include the suite of radiological parameters: isotopic Pu, Am, total U, tritium, plus alpha and beta activity. Influent flow is also a required input in order to determine the loading into the treatment plant. Effluent WWTP monitoring includes the suite of radiological parameters: isotopic Pu, Am, total U, tritium, plus alpha and beta activity.

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Boundaries:

Spatial: All collection system lines influent to the WWTP and WWTP effluent.

Temporal: Present and future influent and effluent to the WWTP.

Decision Statement:

IF A baseline for influent radiological levels does not exist—

THEN Establish a baseline with initial loading data for WWTP radiological influent monitoring.

After developing a influent radiological baseline:

IF Influent loading for any radiological constituents show a significant increase over the established baseline—

THEN An evaluation will be conducted to determine potential cause.

The WWTP radiological effluent monitoring data will be compared with influent data to evaluate WWTP removal efficiency.

Monitoring Requirements:

For the FY01 IMP, the Site collected 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 the Site and made available to CDPHE. CDPHE will pick up the composite sample from the Site and will perform the analyses and calculate the loadings. For FY01 CDPHE has projected to report on influent quality once per month. Additionally, for FY01 CDPHE also collected a quarterly sample from the effluent of the WWTP. This sample was composited in the same manner as the sample from the headworks. CDPHE analyzes for several constituents including isotopic Pu and Am, total U and metals.

The Site collects an 8-hour composite sample of WWTP effluent once a month. The sample is analyzed for isotopic Pu, Am, U, and tritium. Alpha and beta screens are performed twice monthly.

Sampling protocol and data quality objectives for WWTP monitoring are specified in the related sampling and analysis plan.

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2.3.3 Performance Monitoring

The Site 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 2 year prior to the planned start of D&D and remediation projects. This approach emphasizes those projects groundwater contamination where natural and man-made groundwater sources contamination (i.e., plumes, building sumps and footing drains) are most likely to impact surface water.

The purpose of project specific performance monitoring is to improve monitoring network resolution and to isolate impacts of individual projects. The process of screening performance monitoring candidate projects that has evolved since the start of RFCA monitoring is depicted in the performance monitoring decision process flowchart. (see Figure 2-4). The process starts with a review of Site closure schedules to determine the relative order of major D&D and remediation projects by sub-drainages. RSOPs, environmental checklists, and project plans are reviewed to determine whether project managers had considered project specific performance monitoring. For those projects that posed a particular concern to surface water (i.e., D&D of rad 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 needing independent performance monitoring, a combination of field walk-downs are conducted to further delineate drainage basin configuration and aid in the placement of new performance monitoring stations. In some cases, topographic impediments (nature and/or man-made) in vicinity of a project make it impossible to isolate runoff from a particular project site. In these cases, drainage modifications are recommended. 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 is for screening projects to determine surface water performance needs is detailed in Figure 2-5.

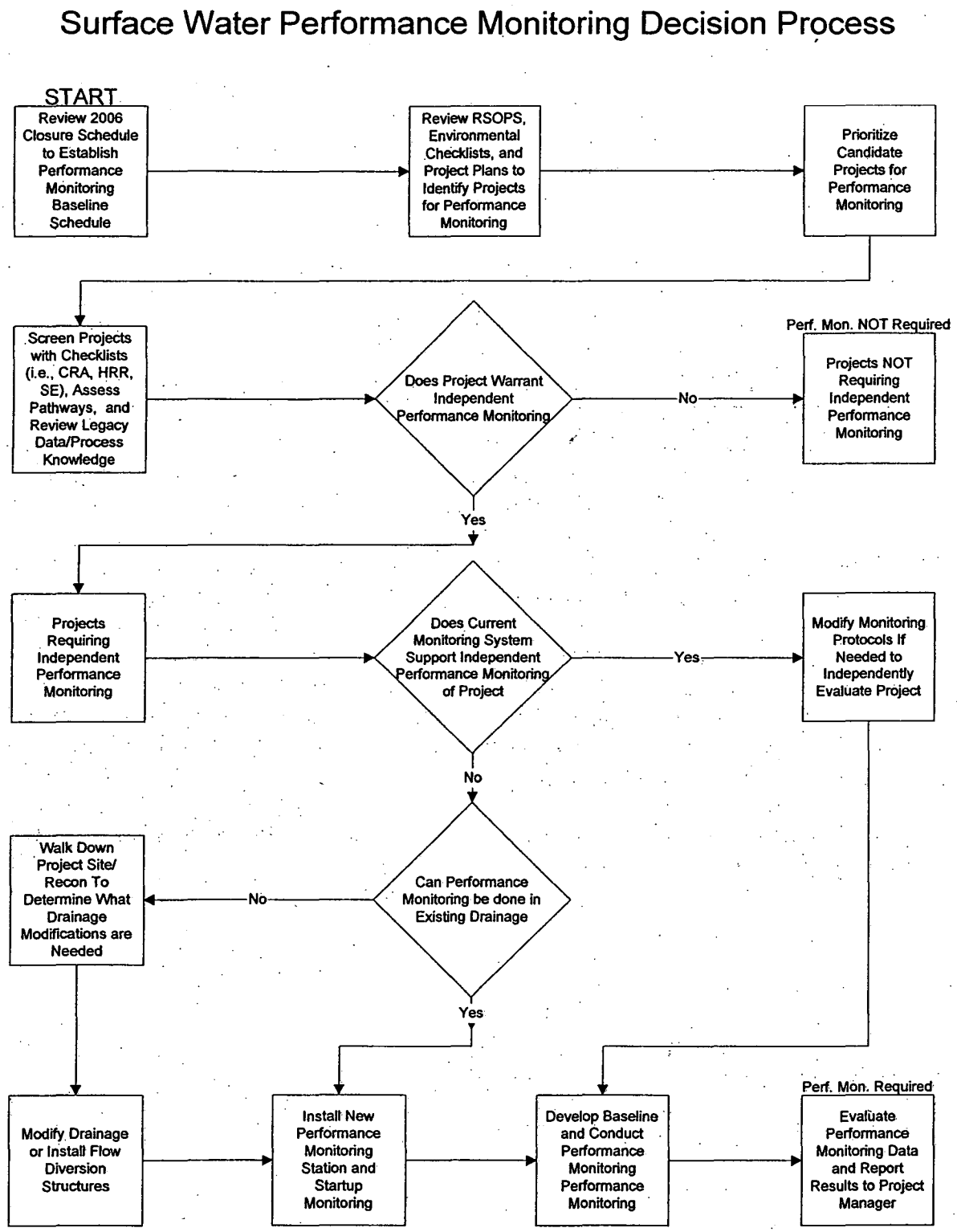

Figure 2-5. Surface Water Performance Monitoring Decision Process

2.3.3.1 Performance Monitoring Template

The surface water performance monitoring decision process flowchart 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 fundamental elements of designing and implementing a monitoring project. Monitoring schedules must be developed, contaminants of concern must be identified, sampling protocols must be selected, data analyses methods selected, and an action response and/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 outfalls, 3) scheduling monitoring activities, 4) identifying the contaminants of concern (i.e., analytes of interest), 5) selecting sampling methods, 6) determining the most effective method(s) of evaluating data, and 7) setting up a reporting protocol. Documentation produced by this process serves as both specifications (i.e., DQOs, monitoring requirements) and record for performance monitoring decisions.

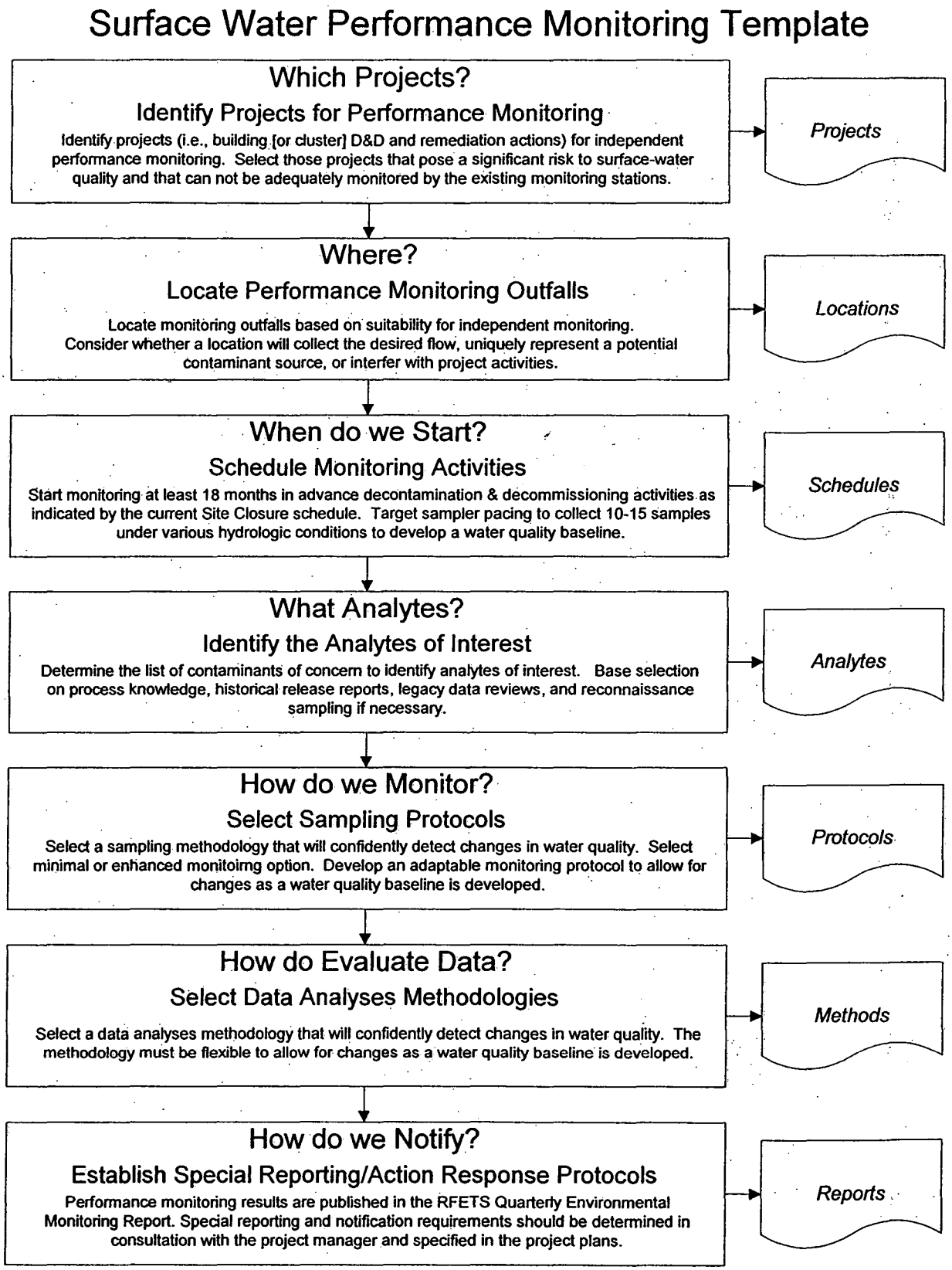

Figure 2-6. Template for Surface Water Performance Monitoring

2.3.3.2 Performance Monitoring Implementation Options[20]

One of two distinct monitoring options exist for implementation of performance monitoring (see Figure 2-6, How Do We Monitor?). Whether Minimum or Enhance option is selected depends on the primary monitoring objective. Option one, the minimal monitoring option seeks to identify project specific impacts. Option two, the enhanced monitoring option seeks to determine the specific impact of a particular project at a downstream POE.

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 provide 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 source evaluation(s).

Enhanced Monitoring Option: Determine Changes in Water Quality at Specific Location with Applicability to RFCA POE Source Evaluation(s)

This option would involve installation of automated samplers and flow control structures to provide flow measurement. Automated samplers would collect flow-paced composite samples (as for POEs) 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 source evaluation(s). Determination of constituent loads and correlation/trend evaluation would aid in POE source evaluation(s).

2.3.3.3 Integrated Approach

The selection of surface water performance monitoring will be determined in conjunction with the planned configuration of the groundwater monitoring network. A draft integrated

[20] 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 'spin-out' of enhanced Performance Monitoring

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surface water/groundwater performance monitoring network design and sampling and analysis plan will be prepared for the project manager to include for inclusion when preparing the Project Management Plan. Data analysis and evaluation techniques will be recommended by water monitoring. Reporting and notification protocols will be jointly determined between the D&D project manager and water monitoring as needed to ensure the protection of downstream water quality.

Problem Statement:

This section addresses monitoring the performance of specific activities[21] on-Site for the release of contaminants to the environment. In general, performance monitoring of activities within the Industrial Area is achieved through the NSD and POE monitoring (see Sections 2.4.1 and 2.4.2 for details). Project-specific performance monitoring, (if necessary) requirements 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. Each performance 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 and approval process for a D&D action may identify the need for performance monitoring specific to that action.
- Remedial Actions: There are monitoring requirements associated with specific environmental restoration activities. For example, performance monitoring for the Site'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 in light of this change if other monitoring in this IMP fails to provide adequate assurance of protecting the environment and public health.
- Off Normal Conditions: Monitoring of remedies intended to control plutonium transport in surface water runoff: For example, when a BMP (barrier, trap, filter, or other watershed improvement) is installed to control a potential source of Pu-contaminated runoff, the Site would like to determine the effectiveness of the BMP so that resources may be allocated where they are most effective.

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

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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-basin for releases of contaminants specific to the activity in the sub-basin.

Boundaries:

Spatial: Performance monitoring can occur anywhere within the Site surface-water drainage areas (especially within the Industrial Area), downstream from a BMP, 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[22]). Results from these samples are used to establish a baseline for the sub-basin. 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 constituents of concern associated with a specific activity or location. Generally, automated samples are flow-paced composites of 15 grabs taken on the rising limb of a runoff event. 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 (see Table 2-9) 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:

[22] 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.

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	The Site will evaluate the specific activity to improve performance.
IF	The project-specific indicator is less than the 95% lower tolerance level (LTL)—
THEN	The Site will conclude that the project has reduced environmental releases of the specific contaminant.

Acceptable Decision Errors:

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

Monitoring Requirements:

Monitoring details will be specific to the project. The performance monitoring locations operated during FY00 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 information can be found in the RFETS Automated Surface-Water Monitoring FY00 Work Plan (RF/RMRS-00-341) which can be obtained from Site Document Control. The performance monitoring for FY01 will depend on Site closure activities and schedules.

Table 2-10 FY00 Performance Monitoring Locations

Location Code	Location Description	Project	Supporting Documentation
GS27	Small ditch NW of B884	D&D of B889; Watershed Improvements 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	ER projects for 903 Pad	Automated SW Monitoring Work Plan
GS40	Outfall E of Tenth St. E of 750 Pad	700 Area D&D activities	Automated SW Monitoring Work Plan
GS43	Small ditch NE of B886	D&D of B886	Automated SW Monitoring Work Plan
GS44	A 4.1 acre subdrainage located west of the B771/774 complex between T771F and T771L	D&D of B771/774	Automated SW Monitoring Work Plan
SW061[23]	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
SW120	Drainage ditch N of Solar Ponds along PA perimeter road	D&D of B771/774	Automated SW Monitoring Work Plan
SW132	S. Walnut Creek, outfall of culvert draining 700 and 900 Areas, south of B995	OU2 Closure	Final Surface Water Interim Measures/Interim Remedial Action Plan/ Environmental Assessment and Decision Document, S. Walnut Creek Basin

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

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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, and administratively extended, and again renewed again in 2000. All 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.

Renewed Permit:

> The renewed permit for the Site identifies one monitoring point for control of discharges, the WWTP (Building 995) effluent. The NPDES/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 Permit 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 Industrial Area to Segment 5 waters upstream of the terminal ponds). These discharges are the major transport pathways available for contaminants leaving the Industrial Area. Ongoing activities and remediation tasks at the Site could create new contaminant source areas within and around the Industrial Area and could thus degrade downstream surface-water quality. For example, a D&D or remediation project could result in the release of contaminants to soils near the facility, which could be transported via runoff into Site drainages, and possibly off-Site.

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

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2.4.1 New Source Detection Monitoring

The NSD Monitoring objective provides comprehensive coverage of the entire Industrial Area but is not specifically focused on individual actions within the Industrial Area. Performance monitoring of specific activities within the Industrial Area (or elsewhere) may be carried out under the Performance Monitoring objective. This NSD objective monitors the performance of all remedial activities within the Industrial Area with respect to their impact on surface waters. However, it does not necessarily identify and locate a specific source within the Industrial Area.[24] This monitoring objective provides for monitoring of all main drainages from the Industrial Area into the three main channels of Stream Segment 5.[25]

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 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 the Site 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 contaminants of concern and indicator parameters is described below.

- Isotopic Pu, U, and Am are primary contaminants of concern.
- Turbidity, pH, nitrate (NO_3), 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.[26]
- Turbidity may indicate increased contaminant loads in general and increased Pu specifically. (Pu in surface water is generally bound to particulates.)
- pH can be used to detect an acid or caustic spill.

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

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

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

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- Nitrate 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 chromium (Cr), beryllium (Be), silver (Ag), or cadmium (Cd).
- Precipitation can be used to determine whether a flow event is rain/snow runoff or a spill. Precipitation data is collected at nine locations across the Site. 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 Industrial Area boundary, as represented by surface-water monitoring stations SW022, SW091, SW093, SW027, and GS10[27] (see Figure 2-4). This monitoring focuses on runoff from the three main drainage areas leaving the Industrial Area: North Walnut Creek, South Walnut Creek, and the South Interceptor Ditch/Pond C-2 drainage (see Figure 2-3 and Figure 2-4). Normally, SW022 waters are subsequently monitored at GS10, so there is some redundancy in this set of monitoring stations. SW022 has been included at the request of the EPA to provide increased sensitivity for its drainage area. SW022 would also be used to determine the location of any new source detected at GS10.

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 any storm event. Automatic samplers are triggered when direct runoff is detected at the location [for example, >0.1 cubic feet per second (cfs); location specific].[28] The sample is analyzed when the runoff volume [for example, >25,000 gallons (gal)] is sufficient such that a flow-paced composite sample (in a 15-L container) can be collected that represents the first flush (presumed water-

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

[28] 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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represent first flush and direct runoff. Professional judgement will be used to select the most representative sample for each month from each station for analysis, when a sample is available for that month at that station. 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 a 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 were modified to continuous flow-paced from storm-event starting in FY00.

Only surface-water runoff from the Industrial Area 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 analytical measurements. Although these three columns and rows have a different relationship than the others, they have been included so that all monitored parameters are shown on the same table. The remaining columns are indicator parameters that are monitored with inexpensive real-time probes in lieu of analyzing for the AoIs identified at the left of each row. If a 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 the Site 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 the Site could perform additional analytical procedures specific for the AoI.

Decision Statement:

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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 The Site will evaluate the need for further action under RFCA ALF, such as source evaluation and control. Evaluations will address persistence, trends, and risk of action level exceedances at POEs.

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

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

Notes:

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

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The Site desires detection through sampling of runoff events within a month of a significant new contaminant release.[29] This is achieved through sampling all major drainages from the Industrial Area during high flow and analyzing approximately one sample per station per month. The Site must monitor runoff events at four locations (SW093, SW091, GS10, 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.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - Baseline is defined by an average value for the parameter of interest over all monitored precipitation events for a single baseline year, at the discretion of the DOE, RFFO. A single measured value is accepted as representing a contaminant of interest. If a single measured value exceeds the 95% UTL of baseline, that will provide adequate confidence of new source detection and invoke the action(s) specified by the decision rule.

Monitoring Requirements:

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

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

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

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	15-min	15-min		
Specific Conductivity	15-min	15-min	15-min		
Turbidity	15-min	15-min	15-min		
Nitrate	15-min	15-min	15-min		
Flow	15-min	15-min	15-min	15-min	15-min
Precipitation	Site-wide locations				

Notes:

[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 objective will be used in the NSD objective.

Am = Americium
Pu = Plutonium
U = Uranium
min = minute

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 A-26 (presented at the end of this section in Appendix A), the DQO team identified a subset of those contaminants that are of sufficient interest to warrant monitoring. Figure 2-3 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. Industrial Area monitoring upgradient of Segment 5 is designed to detect new contaminant sources within the Industrial Area. 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. 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 A-26 (see Appendix A to this section), 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 and SW027 (see Figure 2-4) and the new 995POE (established by the recent RFCA Attachment 5 ALF modification in coordination with implementation of the new NPDES permit).

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 and indicator parameters are evaluated using 30-day or 1-day moving averages, as specified in RFCA[30] 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

[30] 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.

averages at these POEs.[31] Indicator parameters pH and nitrate are evaluated as one-day arithmetic averages (averaging of pH takes into consideration the logarithmic characteristics of pH measurement).

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

Decision Statement:

IF	The appropriate summary statistic[32] for any AoI[33] in the main stream channels of Stream Segment 5, as monitored at the designated POEs,[34] exceeds the appropriate RFCA action level—
THEN	The Site must notify EPA and CDPHE, evaluate for source location, and implement mitigating action[35] if appropriate.[36]

[31] 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.

[32] Appropriate action levels and standards for volume-weighted, 30-day moving averages or 1 calendar-day arithmetic averages, are specified for individual contaminants in RFCA.

[33] AoIs are specified in Table A-26 in Appendix A to this section.

[34] POE monitoring stations for Segment 5 are designated in Figure 2-4.

[35] 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.

[36] 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.

- Confidence that Significant Events are Physically Sampled and Representative:
  - The flow-paced monitoring method ensures that significant events will be sampled. This method involves taking a fixed volume [e.g., 200 milliliters (ml) or 1 L] into the composite sample carboy (e.g., 15 - 22 L) as each Nth volume of flow [e.g., 500 L or 73,000 cubic feet(ft^3)] passes the monitoring point. Approximately 75 to 110 grab samples can be composited in the sample carboy 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 limitations.[37] 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.

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, the Site may not be compliant with RFCA.
Incorrect determination that an exceedance has occurred.	The Site would be required to provide notification, planning, a schedule, and response action that consumes limited resources when no exceedance had actually occurred, and the response would not be justifiable.

The decision error limitations shown in Table 2-14 were not used to design and specify the FY01 monitoring targets. They are retained here, however, for use in future sampling designs

[37] 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 FY01 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.

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. The 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.

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: This table is retained for future use, but was not used for FY01 decision rules.

Monitoring Targets:

The recommended monitoring design for the Site is to take samples for FY01, as specified in Table 2-15, and analyze each sample for the Segment 5 AoIs specified in Table A-26, attempting to take no less than one sample per quarter and no more than four sequential carboy samples per month from each of the four monitoring points for each month. The ideal sampling rate is one 15-L sample carboy for each 500,000 gallons of stream flow, and each 15-L sample carboy should comprise approximately 50 flow-paced grab samples.

For the 995 POE, total composite sample collection was designed to be comparable to that of both GS10 and SW093. The 995 POE 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. Alloquates will be held from each composite sample for subsequent analysis should action levels be exceeded.

Table 2-15 presents the FY01 revised number of samples per month for Segment 5 POEs. The original recommendations from statisticians at PNNL were updated using 4 years of RFCA flow data to collect more representative samples each month. There

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are both practical and statistical advantages to this sample allocation design. Averaging a larger number of samples is more expensive, but it protects the Site from regulatory action in response to a spurious non-representative monitoring result.

There are secondary advantages to this monitoring plan. 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 carboy.

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

	SW093	GS10	SW027	995POE
Month	**Number of Samples**			
October	2	3	0	3
November	3	2	0	3
December	2	1	1	3
January	2	1	0	2
February	2	2	0	2
March	4	3	1	3
April	4	4	4	4
May	4	4	4	4
June	4	4	4	3
July	3	3	0	3
August	4	4	1	3
September	2	3	1	3
Annual Total	36	34	16	36

Note: Total samples for all 4 stations = 98

Alternative Minimum Required Monitoring:

Although one sample per month would be adequate to demonstrate the Site's compliance status to EPA or CDPHE, there is 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 the Site 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, and then perform additional analyses 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.

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

- Only one exceedance will be established for a single AoI at all three 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 2-16a.[38] For the 995 POE, the analytical targets are detailed in Table 2-16b.

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

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

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

Table 2-16b Analytical Targets for 995 POE

Analyses	Sampling Protocol
Plutonium	36 ÷ 3 = 12
Americium	36 ÷ 3 = 12
Uranium	36 ÷ 3 = 12
Tritium	36 ÷ 3 = 12

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2.5 Monitoring Objectives for Terminal Detention Pond Discharge and Water Leaving the Site

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

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

Under normal batch pond operations, nearly all water produced at the Site (including surface water runoff, treated effluents, and various approved process wastestreams) is detained in one of three terminal ponds. The terminal ponds serve as the last control[39] point for the water before it leaves the Site.

For these reasons, pre-discharge monitoring is needed for a full range of constituents, including radionuclides, inorganics, organics and selected water quality parameters. 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 of Colorado believes that the first sample is not representative of the discharge, the State may request, and the Site 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, the Site has sole discretion to determine the schedule for discharges, independent of any 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.

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

It was the initial intention of the parties that for pre-discharge monitoring the Site would perform the sample collection and that CDPHE would perform the laboratory analysis and reporting functions of the completed analytical data to the Site. During FY00/01, the Site will collect and provided analytical data for selected radionuclides and organic constituents as the States laboratory is sometimes unable to complete these analyses in the timeframe necessary for optimum pond discharge operations.

For FY00/FY01, EPA VOA method 624 has been selected for pre-discharge samples collected and analyzed by the Site. This method was chosen as it includes all the organic compounds that will be required for the new NPDES permit as well as those organic compounds that were used in large quantities during the production years at the Site.

Data Types and Frequency:

It is estimated that a total of 8-10 pre-discharge samples will be taken annually from the ponds in the Walnut Creek drainage and one sample per year is expected to be taken from Pond C-2 in the Woman Creek drainage. CDPHE will analyze the samples for an extensive list of constituents, including inorganics, metals, volatile organics, semi-volatile organics, radiologic parameters, herbicides, and pesticides. The final list will be detailed in CDPHE's annual monitoring plan.

This pre-discharge monitoring is limited to Ponds A-4, B-5, and C-2, or any 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 the Site of additional AoIs for that discharge.

- The Site 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

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

It should be noted that the results of 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
- The single grab pre-discharge sample does not necessarily reflect the quality associated with a 30-day moving average, against which nearly all standards are measured.

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

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - 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 2-17a. The Site selected EPA Method 624 for 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 2-17a Pre-discharge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Volatile organic analyses (EPA Method 624)	0.8
Isotopic plutonium/uranium/americium	0.8

Monitoring analyses to be performed by CDPHE are shown in Table 2-17b.

Table 2-17b Pre-Discharge Monitoring Targets (Number of Samples/Analyses)

Analytical Parameter	Average Analyses per Month
Volatile organic analyses (502.2 or equivalent)	0.8
Chlorinated herbicide analyses (515.1 or equivalent)	0.8
Semi-volatiles (525.2 or equivalent)	0.8
Selected Hazardous Substance List metals (total/total recoverable)	0.8
Selected Hazardous Substance List metals (dissolved)	0.8
Total dissolved solids	0.8
Total suspended solids	0.8
Nitrate/Nitrite as N	0.8
Nitrite as N	0.8

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Table 2-17b (continued)

Analytical Parameter	Average Analyses per Month
Total phosphate	0.8
Orthophosphate	0.8
Ammonia	0.8
Sulfide	0.8
Gross alpha	0.8
Gross beta	0.8
Plutonium/uranium/americium	0.8
Tritium	0.8
PH	0.8
Dissolved oxygen	0.8
Conductivity	0.8
Totals	16.0

Note: Numbers of analyses are based on historical pond discharge operations.

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, all Woman Creek flows are detained in cells of the reservoir until the water-quality has been assured by monitoring of Site discharges via Woman Creek at Indiana Street (at GS01). Reservoir water will then be pumped from Woman Creek Reservoir into the Walnut Creek drainage below Great Western Reservoir.

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In the past, the majority of natural flow in Woman Creek was diverted to Mower Reservoir and did not exit the Site via Woman Creek. This is no longer the case; the Mower Ditch headgates were upgraded, and all flows in Woman Creek will leave the Site 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 pre-discharge sampled and subsequently pumped to the Broomfield Diversion Ditch off-Site. Currently, the Site 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 radiologic parameters in Pond C-2 discharge does not adequately demonstrate that all water leaving the Site via Woman Creek and entering the Woman Creek Reservoir is meeting the radiologic standards. Other Woman Creek water (combined with Pond 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 radiologic contaminants that could be directly attributable to the Site (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 A-27 in Appendix A to this section).
- Isotopic Pu, Am, and tritium at Indiana Street POCs.
- Source(s) 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).
- Samples collected will be continuous flow-paced composites.
- Flow-paced monitoring is maintained at all times for all five POCs in Segment 4, even though no samples are anticipated from terminal pond stations except during planned pond discharges.

Terminal pond discharges currently occur approximately once per year for Pond C-2 and nine times per year for Ponds A-4 and B-5. Since the DQO process targeted 3 samples per discharge, terminal pond POCs currently target 30 composite samples to be collected annually.

Terminal pond sampling protocols (3 samples per batch discharge) were initially designed assuming that only Pond A-4 would discharge to Walnut Creek.[40] During FY00, 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, 9 samples will be collected from Pond A-4, and 18 from Pond B-5, resulting in the collection of the targeted 27 composite samples (see Table 2-20). However, this sample planning is dependent on the routing for the WWTP effluent. Any 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 three samples during any one month (see Table 2-20). GS03 will collect the targeted 27 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 2 samples every 15 days. The goal is to have at least two analytical results for any 30-day period for averaging purposes. The Site 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 2-18 shows the associations between monitoring locations and station designators.

[40] 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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Table 2-18 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

Decision Statement:

IF The volume-weighted 30-day moving average[41] 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
- The Site may receive a notice of violation.

Note that for the Indiana Street POCs, the only compliance monitoring to be performed is for Pu, Am, and tritium activity as measured at GS01 or GS03.[42]

[41] 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.

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

Acceptable Decision Errors:

- Confidence that Significant Events are Physically Sampled and Representative:
  - The Site will attempt to gather at least one sample representative of each pond discharge event, and multiple sequential samples may be taken. Flow-proportional monitoring will be maintained at all times but may not be effective during dry periods when evaporative losses would invalidate the data, or when samples are inadequate for analysis due to a variety of operational problems.
- Acceptable Decision Error Rates for Statistical Sampling Design:
  - The decision error types and consequences for Segment 4 are presented in Table 2-19.

Table 2-19 Decision Error Types and Consequences in Segment 4

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

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.

Monitoring Targets:

Table 2-20 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 8 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), the Site assumes that 27 samples will be

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collected annually during discharges from Ponds A-4 and B-5, and 2-4 samples of storm runoff and baseflow during the periods between discharges (approximately 31 samples). The Site will attempt to schedule discharges from Ponds A-4 and B-5 concurrently. Therefore, approximately 10 discharge cycles per year will occur in Walnut Creek. At Woman Creek and Indiana Street (GS01), the Site 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.

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Table 2-20 POC Monitoring Targets (Number of Samples/Analyses) for Segment 4 POCs

Time Period	Pond			Walnut Creek at Indiana Street	Woman Creek at Indiana Street	Total Number of Samples
	A-4	B-5	C-2			
During Discharge	9	18	3	27	3	60
Storm and Base Flow						
October	--	--	--	3	1	4
November	--	--	--	3	2	5
December	--	--	--	3	2	5
January	--	--	--	3	2	5
February	--	--	--	2	2	4
March	--	--	--	3	3	6
April	--	--	--	2	4	5
May	--	--	--	1	4	4
June	--	--	--	2	3	5
July	--	--	--	4	1	6
August	--	--	--	2	1	4
September	--	--	--	3	0	3
FY Totals	9	18	3	59	28	116

Note: -- = Not applicable FY = Fiscal year

2.5.3 Non-POC Monitoring at Indiana Street

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. There are several reasons to monitor for certain possible contaminants and nutrients in the water leaving the Site in both drainages. The

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actions to be taken on the basis of this monitoring are variable and may not be known until the monitoring results are available.

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

- Water leaving the Site via Walnut Creek that is 100% Site pond discharge (either originates as surface water on Site or is used and potentially contaminated by the Site before discharge from terminal ponds);
- Water leaving the Site via Walnut Creek is 100% stream flow and does not include pond discharge; and
- Water leaving the Site via Walnut Creek that is a mixture of Site discharge and stream flows.

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

Data Types and Frequency:

The complete list of analytes (analyzed by CDPHE) is given in Table 2-21. The real-time parameters will be collected by the Site. Note that pH and temperature are needed to calculate un-ionized ammonia, and that the parties intend to drop monitoring for Be, Cd, Ag, and Cr in the future, unless FY00/FY01 monitoring results provide reasonable cause for concern. Nutrient analysis samples are grab samples. Un-ionized ammonia analyses are for samples from Walnut Creek at Indiana Street.

The source(s) of water at these locations during any sampling event must be identified.

Sample collection frequency will be as follows:

- Walnut Creek:
  - Five per year for 100% Site effluent (pond discharges),
  - Five per year for mixed effluent and natural stream flow, and

- — Five per year for 100% natural stream flow.

- Woman Creek:
  - — Five per year not during Pond C-2 discharge, and
  - — One per year during Pond C-2 discharge.

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 (GS03 and GS01, respectively).

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

Table 2-21 Non-POC Monitoring Requirements (Number of Samples/Analyses) at Indiana Street

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

Notes:
Five samples at each of the three flow mixtures in Walnut Creek, plus one Woman Creek sample during Pond C-2 discharge and five samples when Pond C-2 is not discharging: (5 x 3) + 1 + 5 = 21. CDPHE will take their own grab samples independently for all nutrients, four metals, and U.

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

Decision Statement:

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

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

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

  — To be decided after variability is determined through FY01 monitoring.

Monitoring Targets:

One objective of FY00 nutrient load monitoring was to establish the variability of the data so that FY01 monitoring can be statistically designed. Three samples would be the absolute minimum required to estimate variability. Five samples for each parameter are planned. This monitoring is presented in Table 2-21.

2.6 Off-Site Monitoring Objectives: Community Water Supply Management

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

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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 4 POE or Segment 5 POC monitoring at Indiana Street, or if flow leaving the Site exceeds the capacity of the downstream ditches or reservoirs.

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

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
  - McKay Ditch (flow monitoring to continue in FY01 at former source location monitoring station GS35).

  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 cubic feet per second (cfs)] and spill over into Great Western Reservoir, and
  - The relative contribution of various sources (ponds, storm drainages) to the total flow leaving the Site.

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.

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- Water quality as follows:
  - Analytes are shown in Table 2-22.
  - Note: Constituents appearing on the "Short List" represent a minimum analyte list for all unplanned releases or discharges. Some or all of the constituents on the "Long List" may be necessary depending on the nature of the event, the source of the release, and the receiving water. The composition of either list may change depending on activities at the Site at the time of the event. Samples should be taken, but not necessarily analyzed, for all possibilities.

Table 2-22 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, turbidity, TSS, conductivity or TDS	pH, temperature, turbidity, TSS, conductivity, TDS, hardness, alkalinity, fluoride, chloride, sulfate
Nutrients	Nitrate + nitrite	Nitrate, nitrite, ammonia (total and un-ionized), orthophosphate, total phosphorus
Organics	None	VOCs (EPA 524.2 or 502.2)
Metals	None	All metals having stream standards (As, Be, Cd, Cr, Cu, Fe, Pb, Mn, Hg, Ni, Se, Ag, Zn)

Notes:

Ag = Silver
Am = Americium
As = Arsenic
Be = Beryllium
Cd = Cadmium
Cr = Chromium
Cu = Copper
Fe = Iron
Hg = Mercury
Mn = Manganese
Ni = Nickel
Pb = Lead
Pu = Plutonium
Se = Selenium
TDS = Total dissolved solids
TSS = Total Suspended solids
U = Uranium
VOC = Volatile Organic Compound
Zn = Zinc
Zn = Zinc

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- 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 the Site.
- 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 the Site.
  - 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.

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 the Site 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; and
- Mower Reservoir.

For this decision, monitoring would only be required when water of unknown quality leaves the Site. Under routine operations wherein surface water is under full management control of the Site, 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 the Site

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

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

Acceptable Decision Errors:

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 FY01 monitoring plan.

Monitoring Targets:

For planning purposes, no uncharacterized discharges are projected for FY01. If such a discharge does occur and this monitoring is needed, then the number and type of samples would be determined on a case-by-case basis.

2.6.2 Community Assurance Monitoring

RFETS' past mission as a nuclear weapons production facility, the nature of the contaminants, the history of releases and accidents, and the geographic and hydrologic relationship of the Site to the neighboring municipalities have made it necessary for the communities to reassure residents that their environment is safe. The level of concern fluctuates with activities at the Site but may be expected to continue as long as environmental contamination and special nuclear materials are present at the Site. Citizens' concerns are more effectively addressed by a routine monitoring program to measure the contaminants of concern at the locations of concern, than by institutional controls, modeling, and on-Site monitoring. The minimal community monitoring needed to provide this assurance is relatively inexpensive and demonstrates a community commitment on the part of DOE, RFFO. This community monitoring and Site monitoring are discussed at the Quarterly

Information Exchange Meetings. The DOE, RFFO has also sponsored a dose reconstruction study for the Site.

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

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 question.
  - For FY01, 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.
  - A sampling protocol acceptable to all parties will be developed and documented.
- Analytical methods:
  - Analytical methodology must be adequate to provide detection limits comparable to those reported by CDPHE since 1992—approximately 0.003 picocuries (pCi)/L for treated water and 0.006 pCi/L for raw water.

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- Analyte list:

  This monitoring is limited to radionuclide contamination that is potentially attributable to the Site.

  — 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 FY01. The hydrologic regime for the Great Western Reservoir will change over time as the cities' irrigation and reuse projects are implemented. Sampling locations, types, and frequencies will be reevaluated to reflect these changes.

Decision Statement:

IF The potential for public exposure to contaminants attributable to the Site 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 2-23.

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Table 2-23 Monitoring Targets (Number of Samples/Analyses) for Community Assurance Monitoring

Analyte	Analyses for FY00/FY01	
	Great Western Reservoir (Analyses per year)	Total
Pu-239/240	4	8
Am-241	4	8
U, isotopic[43]	4	8
Tritium	4	8

Notes:

Am = Americium
FY = Fiscal year
Pu = Plutonium
U = Uranium

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 the Site from the rest of the watershed. Historical strategies on the part of both the Site and the downstream communities have focused on limiting, to the maximum extent possible, the natural flow of surface water from the Site. 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 the Site, 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, the Site 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 it's focus to water quality issues impacting wastewater dischargers.

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

More recently, Site 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 DRCOG as a district watershed in the Regional Clean Water Plan. The goals the Association 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 decisions are made jointly by the group, with input from regulators and planning agencies including EPA, the WQCD and DRCOG. The Parties will work with the U.S. Fish and Wildlife Services 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 any 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 all Stakeholders.

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 Site boundary is not currently funded by the Site, 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

  Various (6) sites along Walnut Creek, from the eastern Site 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

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- 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	The Site 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 have not been adequately characterized, the Site 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 2-24.

Table 2-24 Anticipated Monitoring Requirements for Watershed Integration

Constituent	Frequency	Total Number of Samples FY99-00
Habitat Assessment	Annual	1
Flow	Concurrent with biological sampling	2
Fish population	Semi-annual, spring and fall	2
Invertebrate population	Semi-annual, spring and fall	2
Water Quality	As needed	None projected

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3.0 GROUNDWATER MONITORING

3.1 Introduction

This section of the *Integrated Monitoring Plan* (IMP) describes the groundwater monitoring requirements for Rocky Flats Environmental Technology Site (RFETS or the Site) as outlined in the *Rocky Flats Cleanup Agreement* (RFCA), and how they will be implemented at the Site [Department of Energy (DOE et al.), 1996]. All RFETS groundwater monitoring is performed by Site organizations because groundwater contaminant plumes occur within the Site boundaries. Therefore, this IMP covers all groundwater monitoring activities. After a brief history of the monitoring program, this section outlines the goals for groundwater monitoring and describes quality assurance/quality control (QA/QC) components and monitoring components. To evaluate groundwater monitoring needs, one must know the RFCA action levels for groundwater, Site history and areas of contamination, the physical and hydrologic setting of the Site, the effect of contaminated areas on groundwater, and the nature of the groundwater contaminant plumes. This information is presented in Appendices A, B, C, and D to this Groundwater Monitoring section, respectively. Appendix E lists the wells that will be monitored for water quality or for groundwater flow.

3.1.1 Purpose of the Integrated Monitoring Plan for Groundwater

In the past, two plans have been required at the Site to comply with DOE Order 5400.1, a "Groundwater Protection Management Program Plan," and a "Groundwater Monitoring Plan." (DOE, 1988) 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 the Site. In addition, an assessment groundwater monitoring plan was required under the Resource Conservation and Recovery Act (RCRA) for the interim status units on Site. This plan is called the *Final Groundwater Assessment Plan* (GWAP) (DOE, 1993). Other monitoring plans have been developed to address groundwater monitoring requirements as outgrowths of various Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) Interim Measure/Interim Remedial Action (IM/IRA) decision documents. This portion of the IMP will serve as the Groundwater Monitoring Plan for the Site, and it will replace the requirements found in the group of plans named above. It will also revise the requirements of the routine groundwater monitoring portion of the Industrial Area IM/IRA decision document (DOE, 1994) and the French Drain IM/IRA plan (DOE, 1992).

3.1.2 Brief History of Groundwater Monitoring Activities

The historic growth of the groundwater monitoring network at the Site reflects the increasing DOE, regulatory, and public emphasis on identifying areas of groundwater contamination and preventing contaminant releases to the environment. The first three monitoring wells were

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installed in 1954 in the Solar Ponds area. A total of 1,284 wells and piezometers were installed at the Site from 1971 to present. Plate 1 shows the wells that have been installed at the Site since 1974.

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

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

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

In 1993, the large number of wells that were being monitored as an outgrowth of the various remedial investigations at the Site prompted the Well Evaluation Project. The *Well Evaluation Report* (WER) (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.

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

3.1.3 Current Status of the Groundwater Program

In July 1996, the RFCA was approved (DOE, 1996). RFCA replaces the Interagency Agreement (IAG) as the environmental cleanup agreement for the Site. RFCA outlines the goals, objectives, and strategies that will lead to the Site cleanup and closure mission objectives. Supporting activities will reduce, eliminate, or mitigate existing environmental liabilities while maintaining the Site in a safe condition. The Action Levels and Standards Framework (ALF) portion of RFCA contains specific requirements for monitoring and reporting, and it sets action levels for contaminant concentrations in groundwater and in other media (see Appendix B to this section). The IMP is required under RFCA to further define the monitoring programs for the Site.

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

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

As shown in Figure 3-1, three ephemeral streams drain the Site. The streams are Rock Creek, Walnut Creek (consisting of 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.

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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 sanitary sewer system on Site 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 Sewage Treatment Plant (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 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 Industrial Area. 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 Program Objectives

The objectives of the Site 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 any 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 the DOE, RFFO. Kaiser-Hill directs and implements the Groundwater Monitoring Program. The Site management structure is shown in Figure 3-2.

The Site Groundwater Monitoring Program will be 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;

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- Monitor and trend contaminant concentrations;
- Monitor remediation and decontamination and decommissioning (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 the Site. Wells installed during the Remedial Investigation/Feasibility Study (RI/FS) discovered groundwater contamination near 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 are on-going and is 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 used on-Site that may be potential contaminants, has been in operation since 1990. It fulfills RCRA requirements to track the disposition of hazardous chemicals. The Waste Programs Organization at the Site manages this tracking system.

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

Site area sources contaminated with hazardous substances are identified as Individual Hazardous Substance Sites (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

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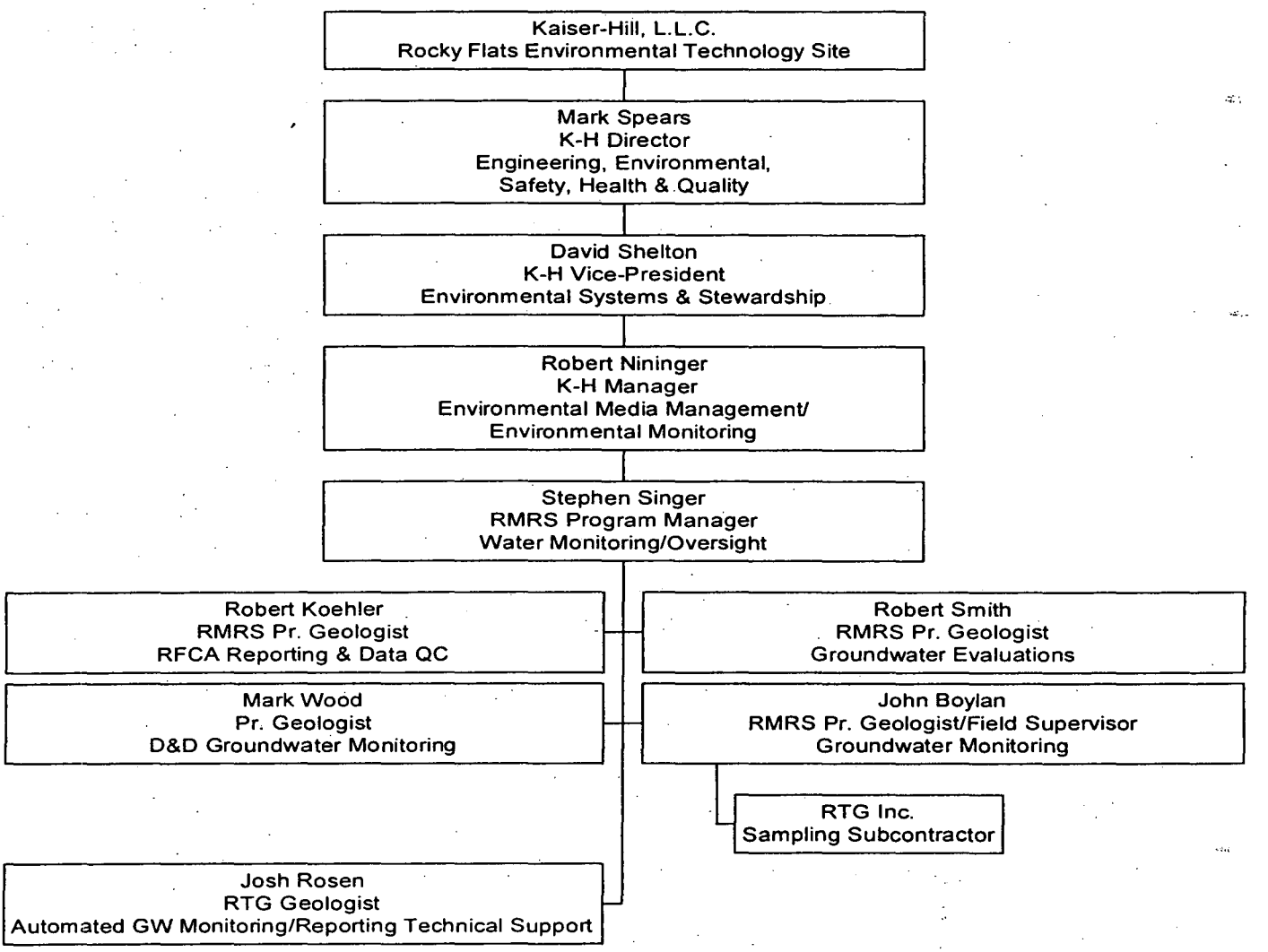
contaminant sources and assign a priority for remediation. Those IHSSs that have contributed to groundwater contamination have been identified and put into the priority list for remediation.

Figure 3-2
Groundwater Organization



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

Building-specific potential PCOCs 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 contaminants of concern at the remediation site (DOE, 1996). However, a full sample suite will initially be collected for these wells as a check on known PCOCs.

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

3.3.2.2 Hazardous Waste Management Areas

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

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3.3.2.3 Storage Tanks

There are currently over 2,000 storage tanks on-Site. 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; they are considered low risk for spills to the ground and thus unlikely to contaminate groundwater.

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

3.3.2.4 Process Waste System

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

The Site also has old and abandoned process waste lines that could cause potential impacts to groundwater and surface water. The Environmental Restoration Program has plans to characterize process waste lines during Site closure. A groundwater evaluation would be performed if significant contaminant leaks are detected during characterization,.

3.3.2.5 Building Drains and Sumps

Numerous buildings on Site contain sumps and footing drains which can collect groundwater along with other 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 drain and sump outfalls has been tied to the scope for 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 (DIS) 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

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sewers in the Protected Area (PA), (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, the Site has identified other potential areas of concern. These include locations where possible underbuilding contamination has occurred, or areas of possible soil contamination outside of buildings. Should significant contamination be 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 Site groundwater flow regime is determined from water level measurements at monitoring wells. This information can be used to help estimate recharge and discharge rates, and it can be incorporated into water table maps and groundwater flow models that help predict the path along which contaminants 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 Site action levels or standards. Background concentrations have been established for most inorganic compounds present in groundwater at the Site. These Site-specific background levels are used to help determine concentrations that are irregular, with respect to natural levels. Increases in contaminant concentrations with time may indicate that contaminants are migrating from sources that could affect surface water.

3.3.5 Monitoring of Remedial Actions

Performance monitoring is required under RFCA for groundwater during and following certain soil remediation activities. Performance monitoring has been implemented for major soil removal actions such as T3/T4, Ryan's Pit and the Mound source. 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 as follows:

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 uranium and nitrate derived from the Solar Evaporation Ponds, which historically stored and

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evaporated radioactive and hazardous liquid wastes. The Solar Ponds were drained, and sludge removal was completed in 1995. To dewater 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 then 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 (RMRS 1999a).

The OU1 French Drain System was installed in 1992 on the 881 Hillside to collect groundwater, contaminated with VOCs, that was migrating from IHSS 119.1 towards Woman Creek. In addition, groundwater is intercepted in a collection well located near the French Drain and transferred to the Building 891 Treatment Plant. Water that enters the drain is also pumped to the Building 891 Treatment Plant for processing. Groundwater is monitored downgradient of the French Drain system to detect any leakage of potentially contaminated groundwater toward Woman Creek. Performance monitoring requirements are documented in the *Interim Measure/Interim Remedial Action French Drain Performance Monitoring Plan*,(DOE, 1992).

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 source (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-long, 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 Rocky Flats Cleanup Agreement (RFCA), (DOE, 1996). 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 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*. (RMRS 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 (DOE, 1996). 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* (RMRS 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 the Site involve decommissioning of Site production systems, building demolition, and excavation and removal or capping of source areas. The IM/IRA for the Industrial Area (DOE, 1994) proposed a framework for monitoring the effects of building D&D on air, surface water, and groundwater quality. Groundwater will be monitored before, during, and immediately after any operation that could potentially degrade groundwater quality. This will determine the Site-specific ambient groundwater conditions and detect any 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 Industrial Area.

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

3.3.7 Evaluation of Groundwater Contaminant Impacts on Surface Water

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

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3.4 Groundwater Data Quality Objectives

DQOs are qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support decision making. At the programmatic level, DQOs are established to ensure that a project has been logically defined and planned, and that project scope will support the eventual decisions required. At the operational level, quality control objectives (QCOs) are established to 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 utilized primarily as a decision support tool as opposed to a sample optimization tool.

3.4.1 Programmatic Data Quality Objectives

The DQO process was applied to the Site groundwater program at both a programmatic and decision-specific level. At the programmatic level, the DQO process was used to qualitatively evaluate the overall need for, and purpose of, groundwater monitoring. This effort established that groundwater data are needed to comply with applicable regulations, agreements, permits, and to prevent unacceptable risks to public health and the environment through impacts to surface waters of the state. The information required to satisfy these requirements results from regular sampling of wells and surface locations selected to meet the above criteria. These data are used to detect and document 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 modeling, risk assessment, performance assessment, and compliance. These programmatic statements establish the general need for a groundwater monitoring program and outline program elements that need to be included.

3.4.2 Data Quality Objectives for Program Elements

The second DQO effort developed individual monitoring program decision elements. DQOs were approached on a medium-specific basis, although the goal was to integrate monitoring requirements for all media (e.g., surface water, ecology, air). Groundwater monitoring DQOs were developed for each component of the program and problem statements were established. These problem statements were then refined into a decision statement that specified corrective actions for that problem. 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 Site-wide components described below:

- Plume Definition Wells: Wells that are within known contaminant plumes and are above Tier II Action Levels, but are below the Tier I Action Levels established in the ALF. These wells will be monitored to determine whether concentrations of contaminants are increasing. 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 wells are monitored for increases in concentrations that would exceed Tier II Action Levels stated in the ALF, and they indicate movement that may result in contamination of surface water.

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

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

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

- D&D Monitoring Wells: Wells used to monitor releases to groundwater from D&D activities on specific buildings. This requirement is specified in the IM/IRA for the Industrial Area (DOE, 1994).

- 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. The French drain performance monitoring wells are included in this category and are specified in the French Drain IM/IRA plan (DOE, 1992).

- RCRA Compliance Wells: Wells used in upgradient and downgradient monitoring of RCRA interim status units. This requirement is specified under 6 *Code of Colorado Regulations* (CCR) 1007-3. Wells monitored at the new

landfill would be specified under 6 CCR 1007-2. Future retrievable storage facilities would also fall under the RCRA monitoring category.

- Plume Degradation Wells: Wells used to assess whether natural attenuation is 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.

On-Site 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 the associated groundwater action levels. All 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.

3.4.2.1 Plume Definition Wells

Problem Statement:

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

Problem Scope:

Plume definition wells lie within the currently known groundwater contaminant plumes and are located appropriately to monitor groundwater pathways that could affect surface water. Plume definition wells are designated based on knowledge of existing groundwater contaminant plumes and particle flow models that simulate groundwater pathways. It is possible that some plume definition wells have historically exceeded Tier I Action Levels. For these wells, only new exceedances of Tier I Action Levels involving compounds that have concentrations greater than historic levels will cause the well to be reprioritized for remedial action.

Inputs:

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

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- 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.

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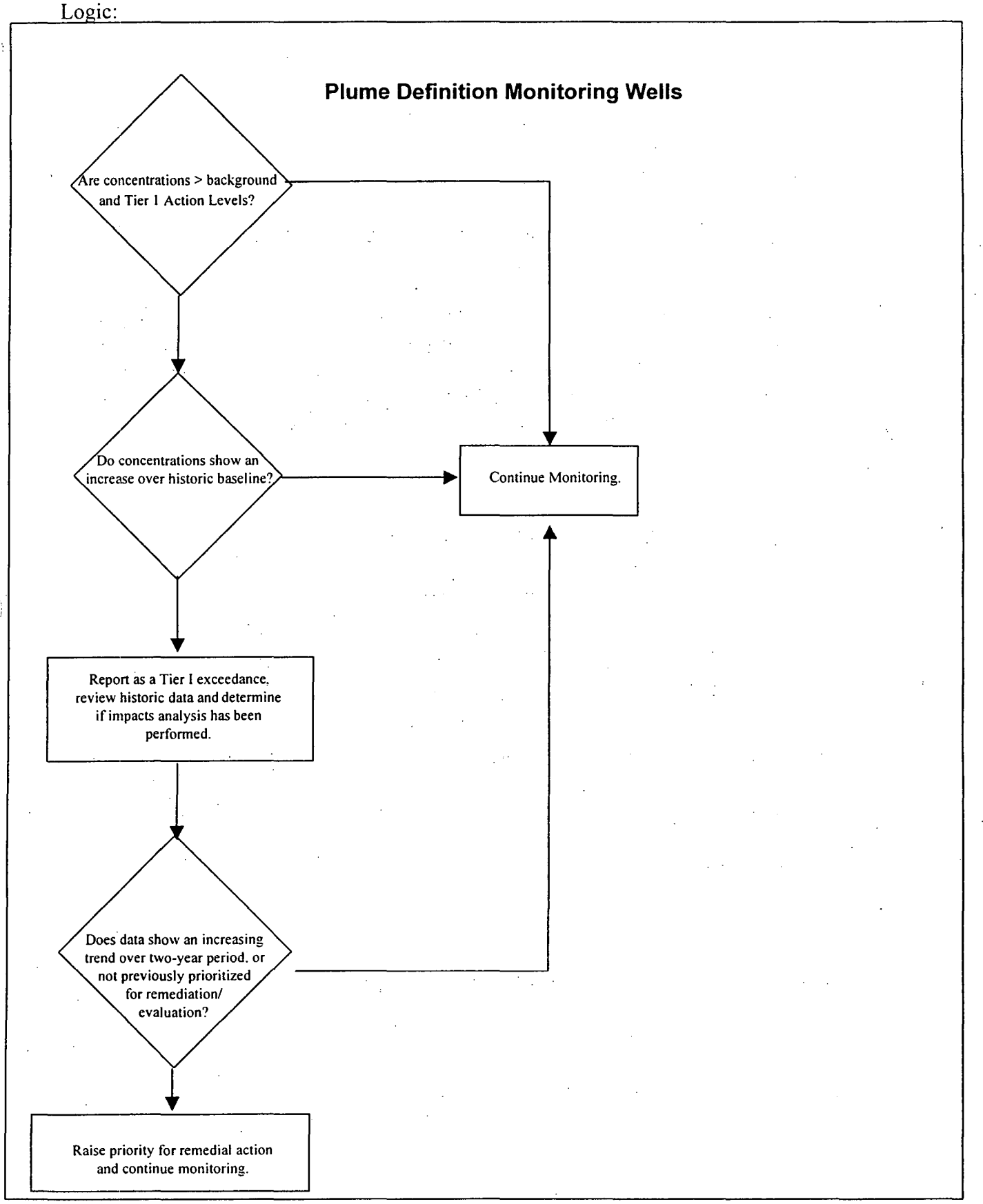
Logic:


Plume Definition Monitoring Wells
Are concentrations > background and Tier 1 Action Levels?
Do concentrations show an increase over historic baseline?
Continue Monitoring.
Report as a Tier I exceedance, review historic data and determine if impacts analysis has been performed.
Does data show an increasing trend over two-year period, or not previously prioritized for remediation/ evaluation?
Raise priority for remedial action and continue monitoring.

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3.4.2.2 Plume Extent Monitoring Wells

Problem Statement:

Have concentrations in wells exceeded Tier II Action Levels?

Problem Scope:

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

Inputs:

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

Boundaries:

Spatial: Decisions will be made on an individual well basis. *Upper* Hydrostratigraphic Unit 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.

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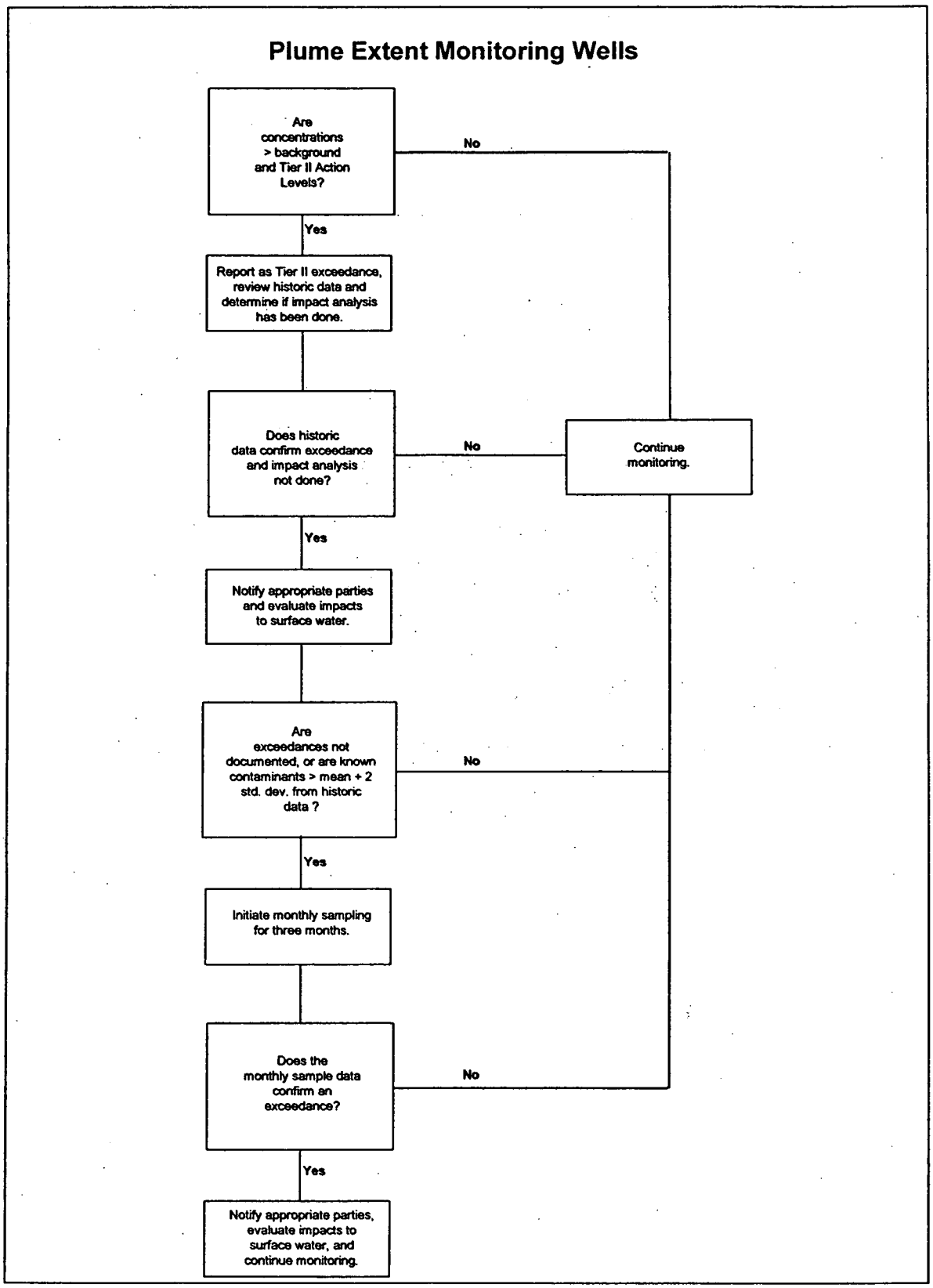
Decision Statement:

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—
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.

Logic:


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

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3.4.2.3 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. Any contaminants detected in stream drainages are assumed to have affected surface water and to have the potential to migrate off Site. It is possible that some drainage wells have historically exceeded Tier II Action Levels. For these wells, only new compounds with exceedances of Tier II Action Levels or involving compounds that have concentrations 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 to this section);
- Historic data trends for contaminants;
- Field parameters; and
- Water levels.

Boundaries:

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

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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.

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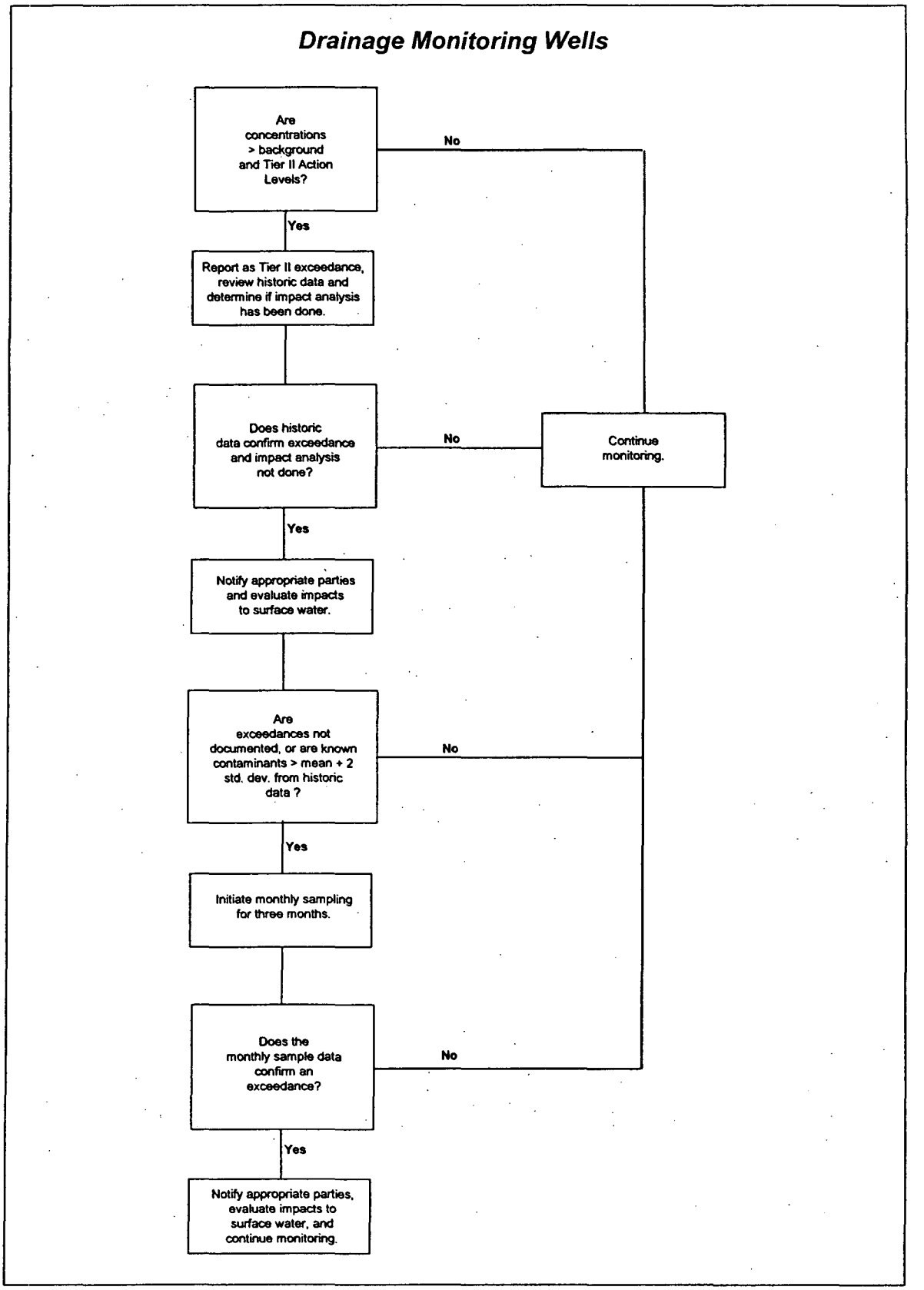
Logic:


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

203

3.4.2.4 Boundary Monitoring Wells

Problem Statement:

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

Problem Scope:

Boundary wells monitor groundwater at the downstream boundary of the Site. Any contaminants detected in boundary wells that are above background and also above action levels are assumed to have impacted surface water and to have migrated off Site. Historically, the Site has monitored wells at the Indiana Street boundary to provide the surrounding cities with added certainty that there are no contaminants in alluvial groundwater leaving the Site. It is possible that some boundary wells historically exceeded Tier II Action Levels. For these wells, only new compounds that exceed Tier II Action Levels or that have concentrations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

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

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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.

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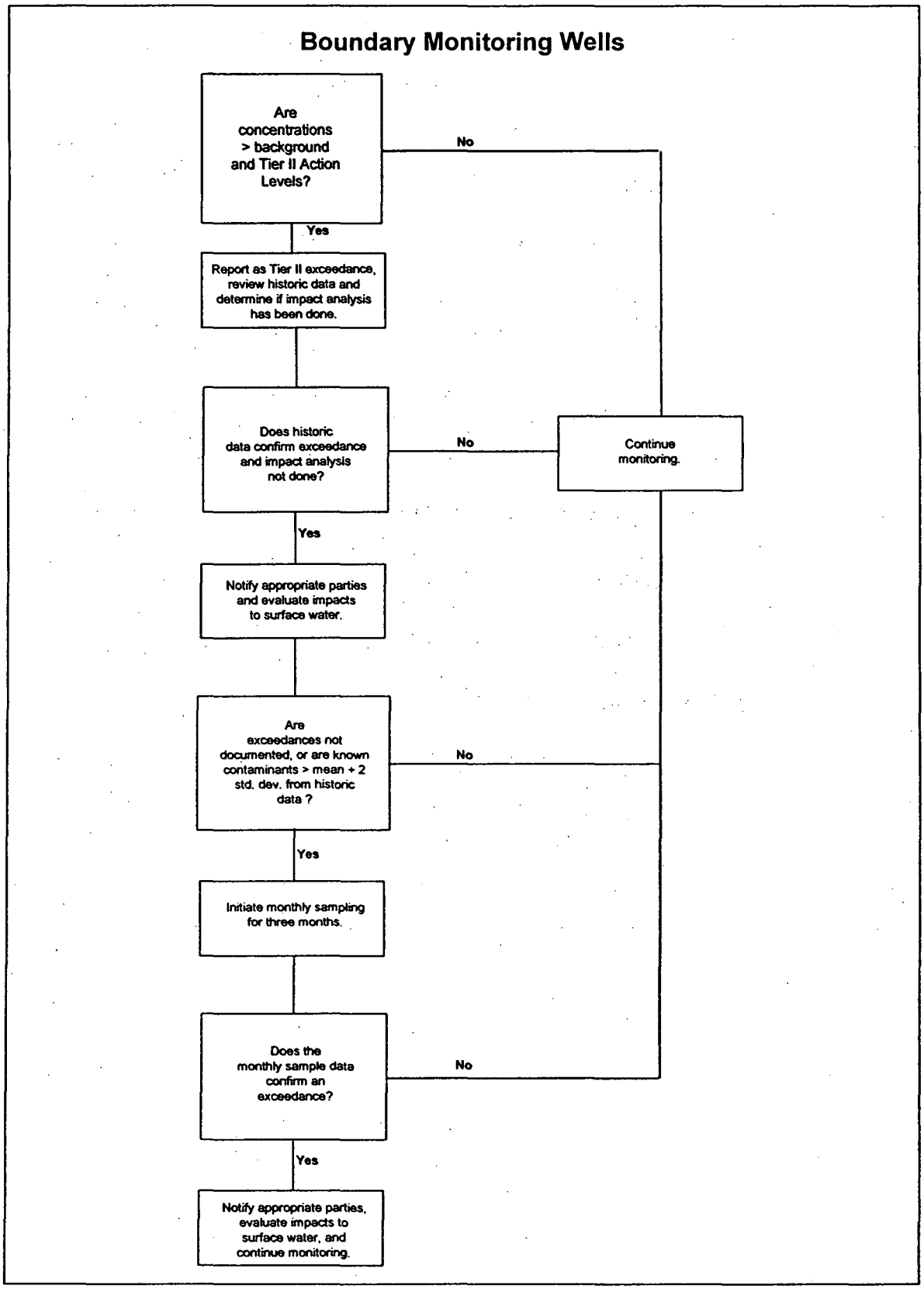
Logic:


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

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3.4.2.5 Building–Specific D&D Monitoring Wells

Problem Statement:

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

Problem Scope:

Building-specific D&D activities involve three major steps: deactivation of building processes, demolition of building structures, and remediation of building foundations and surroundings. The IM/IRA for the Industrial Area (U.S. DOE, 1994) 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 at least one year 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 PCOCs (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.

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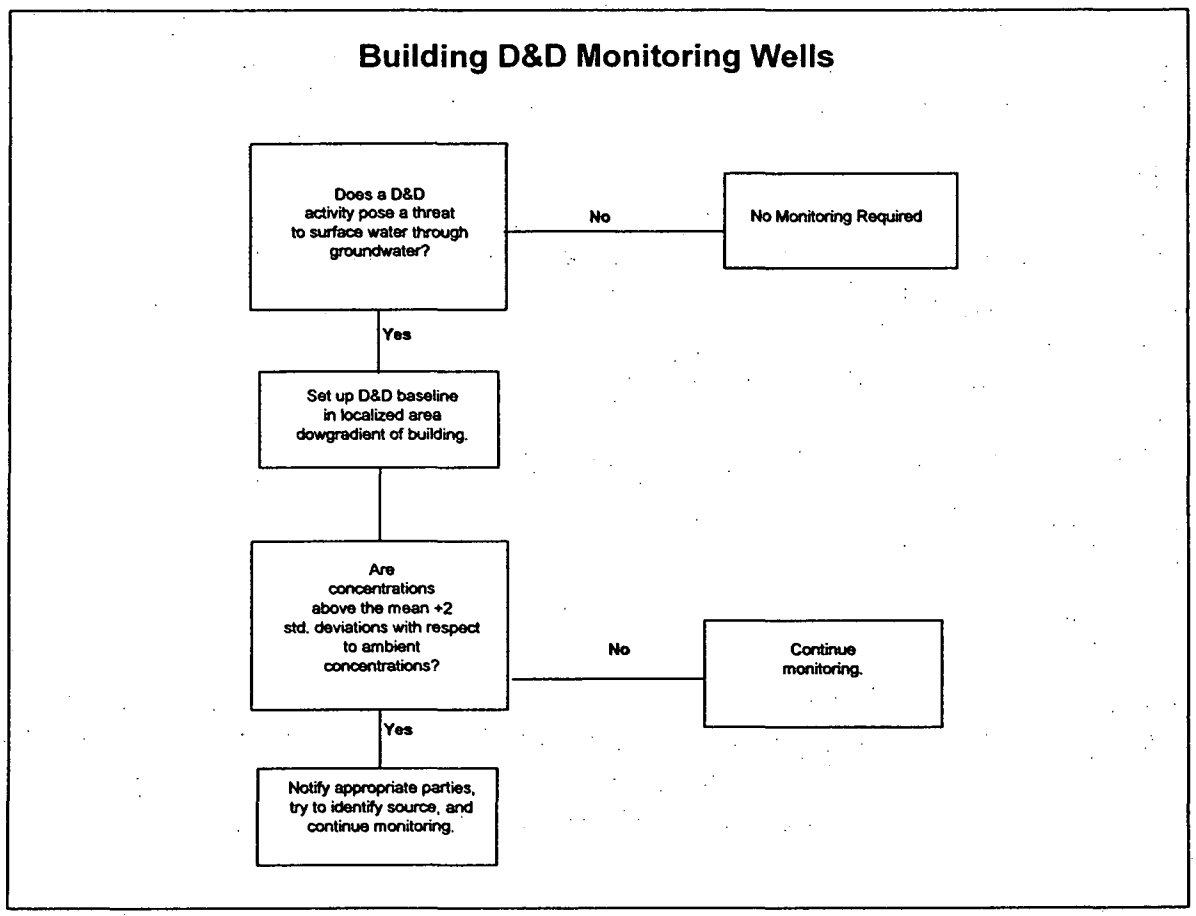
Decision Statement:

IF	Existing information from a proposed D&D activity indicates a potential threat to surface water through a groundwater pathway—
THEN	Establish a pre-D&D baseline using wells located upgradient and downgradient of buildings.
IF	Exceedances are detected greater than the mean + 2 standard deviations above baseline—
THEN	Inform appropriate parties and evaluate the problem,
ELSE	Continue monitoring.

Logic:



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3.4.2.6 Performance Monitoring Wells

Problem Statement

Have remedial actions improved or further impacted groundwater?

Problem Scope:

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

Inputs:

- Source-specific PCOCs (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.

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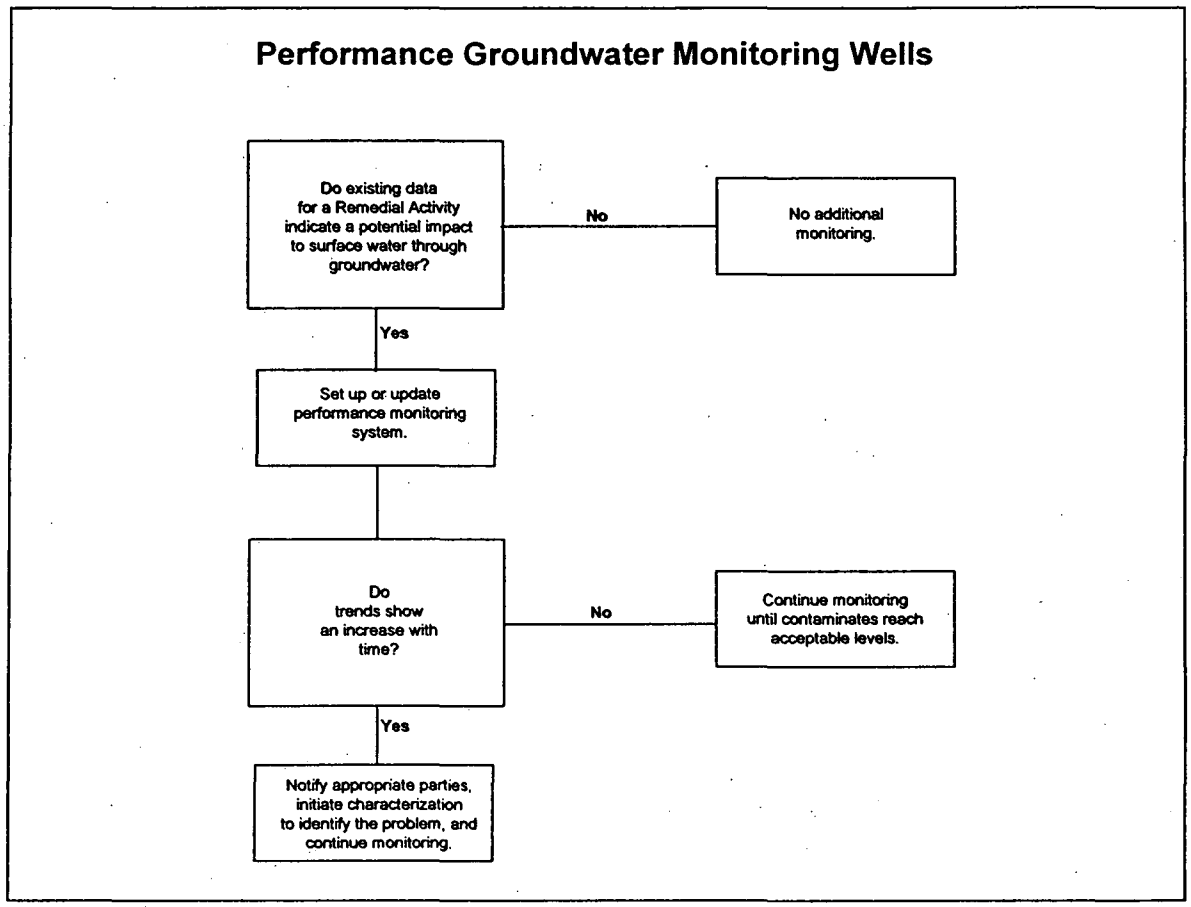
IF Monitoring detects that the concentration of contaminants increases with time—

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.

Logic:



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3.4.2.7 RCRA Monitoring Wells

Problem Statement:

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

Problem Scope:

RCRA monitoring is conducted to detect potential excursions of contamination that are below the point of compliance established for RCRA units on Site. RCRA units are considered to be any units that are regulated under 6 CCR 1007-2 solid waste requirements, such as the Existing Landfill and the New Sanitary Landfill, and any future waste repositories. Attachment 10 of the RFCA will be followed in determining points of compliance and alternate concentration limits affecting these units.

Inputs:

- Unit-specific PCOCs;
- 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.

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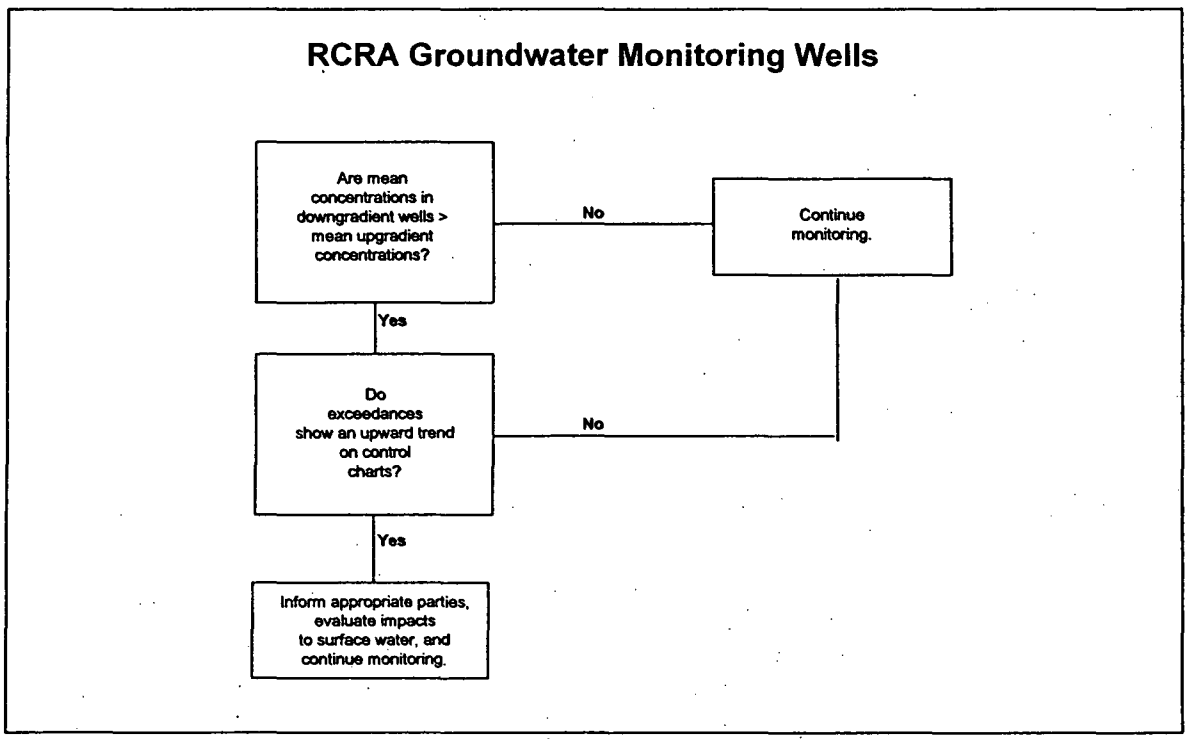
Decision Statement:

IF	Mean concentrations in any downgradient well exceed the mean concentration in upgradient wells by greater than two standard deviations of the data set,
AND	Concentrations at any downgradient well increase with time—
THEN	Report to appropriate agencies and investigate possible causes,
ELSE	Continue monitoring.

Logic:



3.4.2.8 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 attenuation 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 natural attenuation, may need additional characterization or monitoring to establish attenuation characteristics. Based on these characteristics the type of natural attenuation that may be occurring, (i.e., biologic or chemical degradation, adsorption, volatilization, dispersion, etc.). Degradation monitoring would involve 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 the priority for remediation. For biodegradation to occur there must be a favorable chemical environment in the aquifer for the metabolic reactions to take place. Wiedemeier et al (1996) have developed a simple system for determining whether biodegradation is occurring at a site based on applying 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 is suggestive of inadequate evidence of biodegradation. A score of 6 to 14 suggests limited evidence of biodegradation, a score of 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
	< -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 with 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
			Score

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

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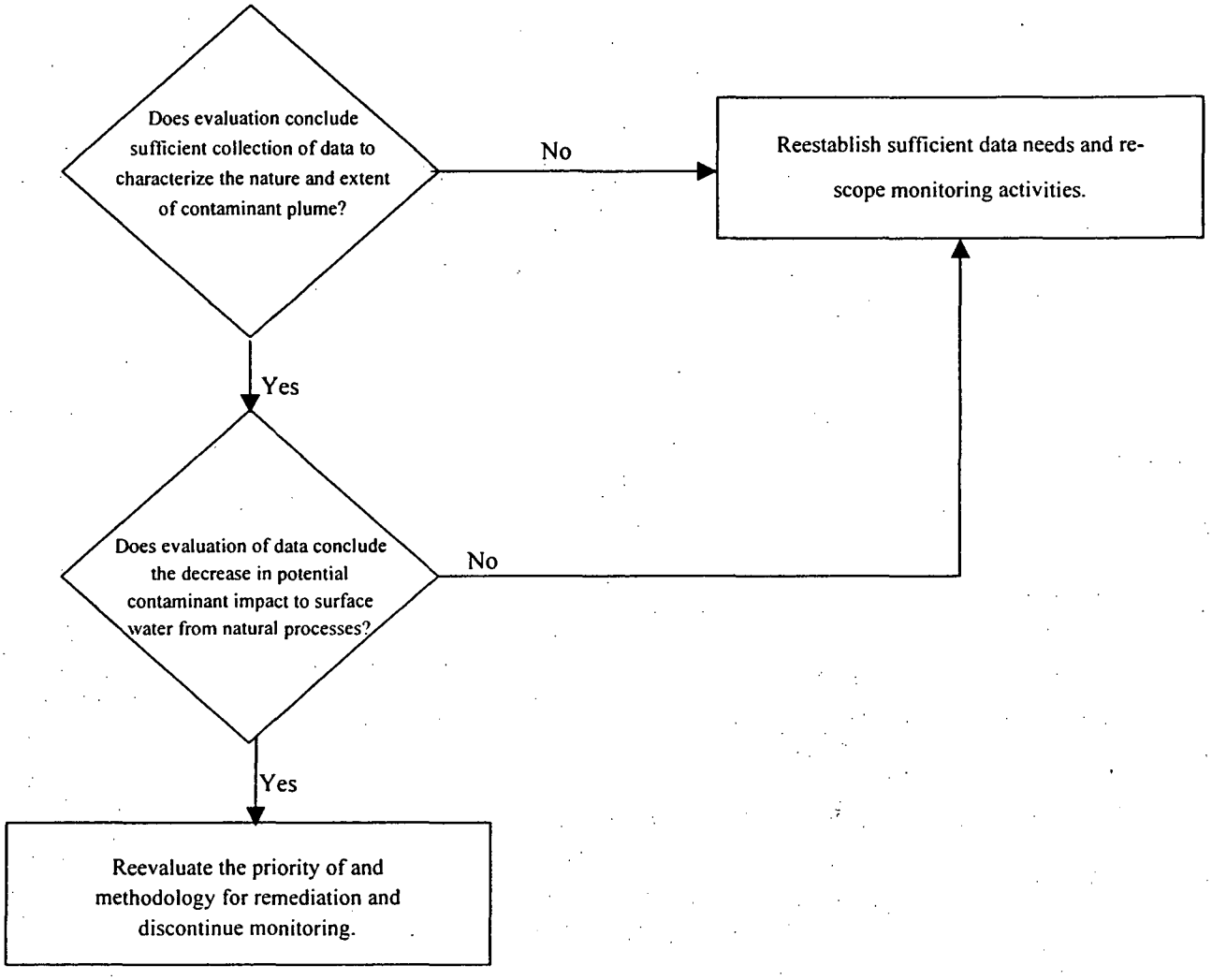
AND Evaluation concludes that natural processes have decreased potential contaminant impact to surface water—

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

Logic:

PLUME DEGRADATION MONITORING WELLS



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3.4.3 Data Quality Objectives for Monitoring Groundwater Flow

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

- Assessment of the impact of contaminant plumes on surface water quality through the creation of potentiometric surfaces from which horizontal hydraulic gradient and flow path can be derived;
- Development of groundwater flow and transport models to assess the effect of groundwater contamination on surface water in the event that an action level is exceeded;
- Evaluation of impacts to downgradient habitat and endangered species caused by changes to groundwater quantity and associated fluvial systems as a result of Site remediation activities; and
- Estimation of direction and rate of plume migration and the volumes of contaminated groundwater for use in treatment feasibility scenarios.

3.4.3.1 Site-Wide Flow Monitoring

Problem Statement:

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

Problem Scope:

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

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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.

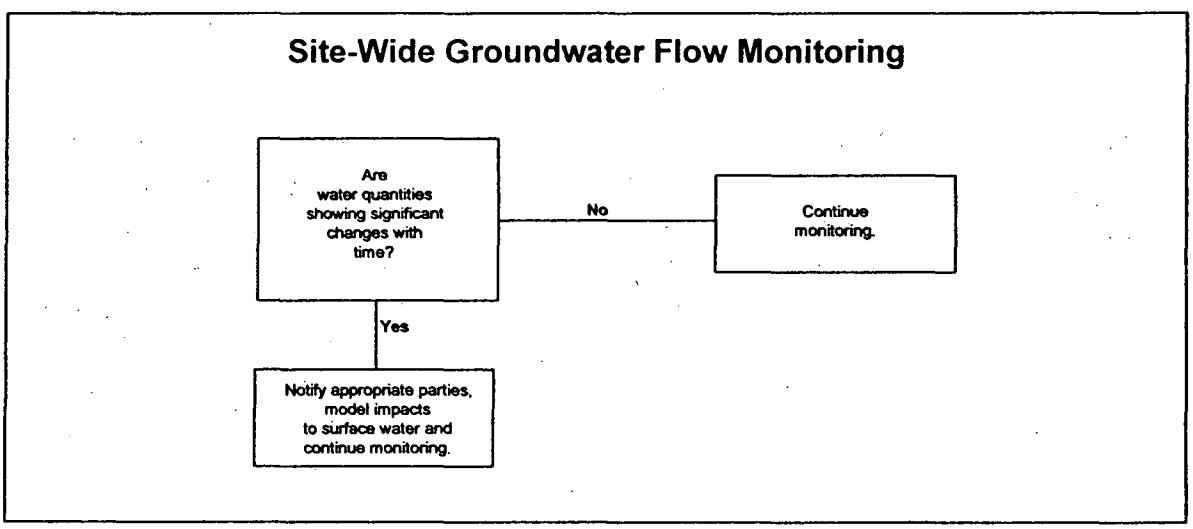
Decision Statement:

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.

Logic:



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The Site-wide groundwater flow monitoring program has three components. Each component provides information supporting the programmatic goals. They are 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 Industrial Area to surface water resulting from remediation activities.

- Background Flow Monitoring- supports interpretation of changes in the contribution of groundwater to surface water resulting from Site remediation activities by monitoring natural and off-Site impacts.

3.4.3.2 Water Quality Flow Monitoring

Problem Statement:

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

Problem Scope:

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

Inputs:

Water level measurements.

Boundaries:

Spatial: Decisions will be made on a well-head basis.

Temporal: Wells will be measured and data will be reviewed quarterly, and decisions will be made annually.

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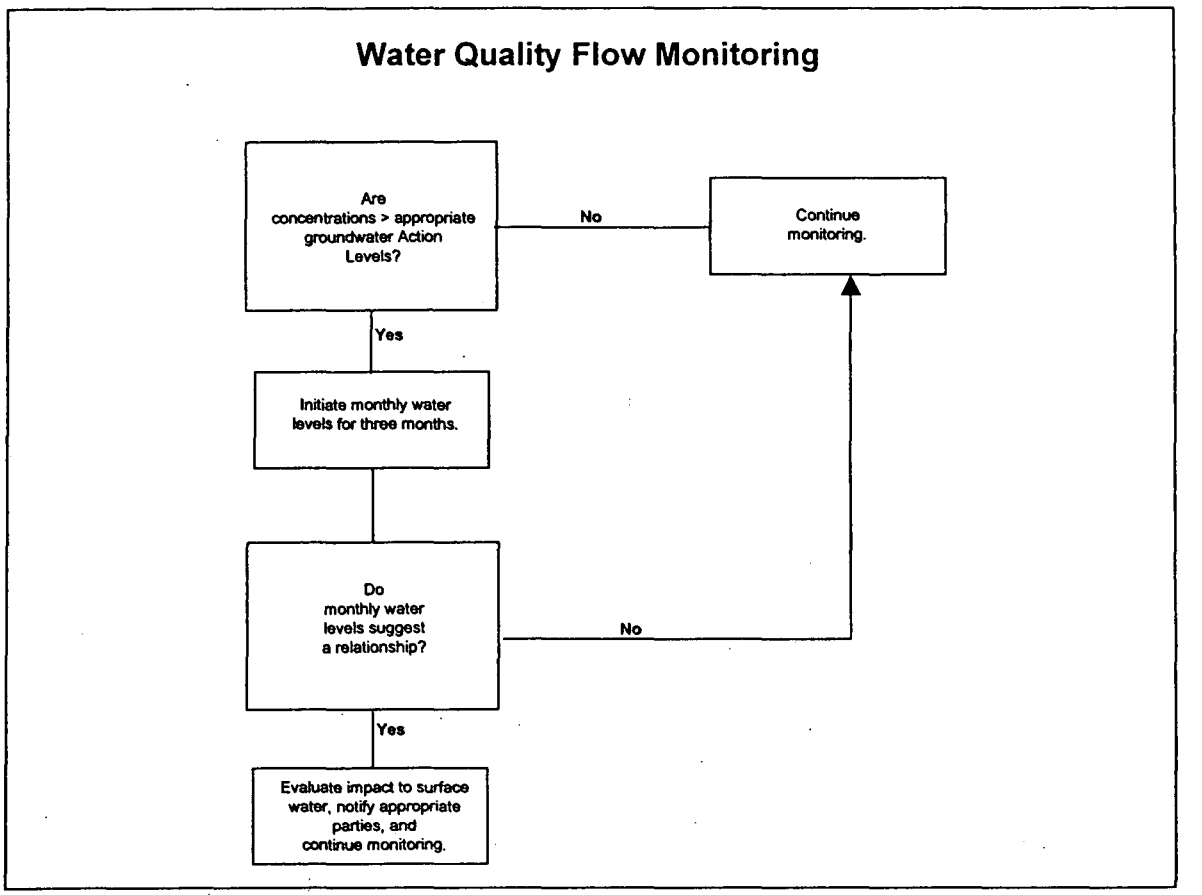
Decision Statement:

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.

Logic:



3.4.3.3 Industrial Area Flow Monitoring

Problem Statement:

Do remedial activities affect the groundwater flow regime surrounding the Industrial Area, and what impact 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 Industrial Area are now monitored less frequently, the level of resolution of groundwater flow is too low to predict the effect of Site activities on groundwater migration. The frequency of measurements should be

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increased to a level sufficient to track the effects of remedial actions in the Industrial Area.

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 all Industrial Area wells that are monitored.

Temporal: Wells will be measured and data will be reviewed quarterly, and decisions will be made annually.

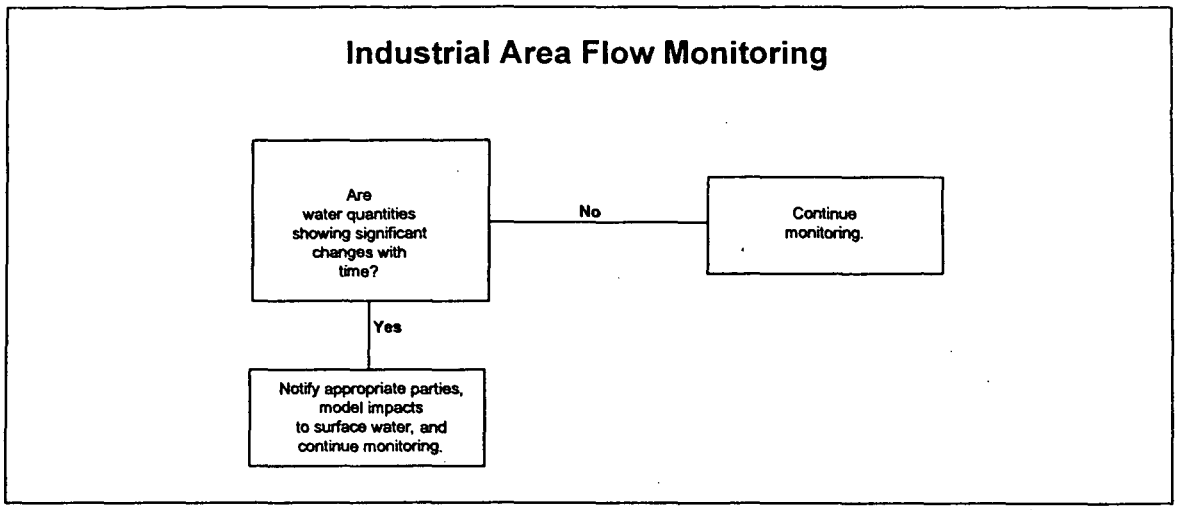
Decision Statement:

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.

Logic:


Industrial Area Flow Monitoring
Are water quantities showing significant changes with time?
No
Continue monitoring.
Yes
Notify appropriate parties, model impacts to surface water, and continue monitoring.

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3.4.3.4 Background Groundwater Flow Monitoring

Problem Statement:

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

Problem Scope:

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

Inputs:

- Water level measurements;
- Event monitoring water level measurements; 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.

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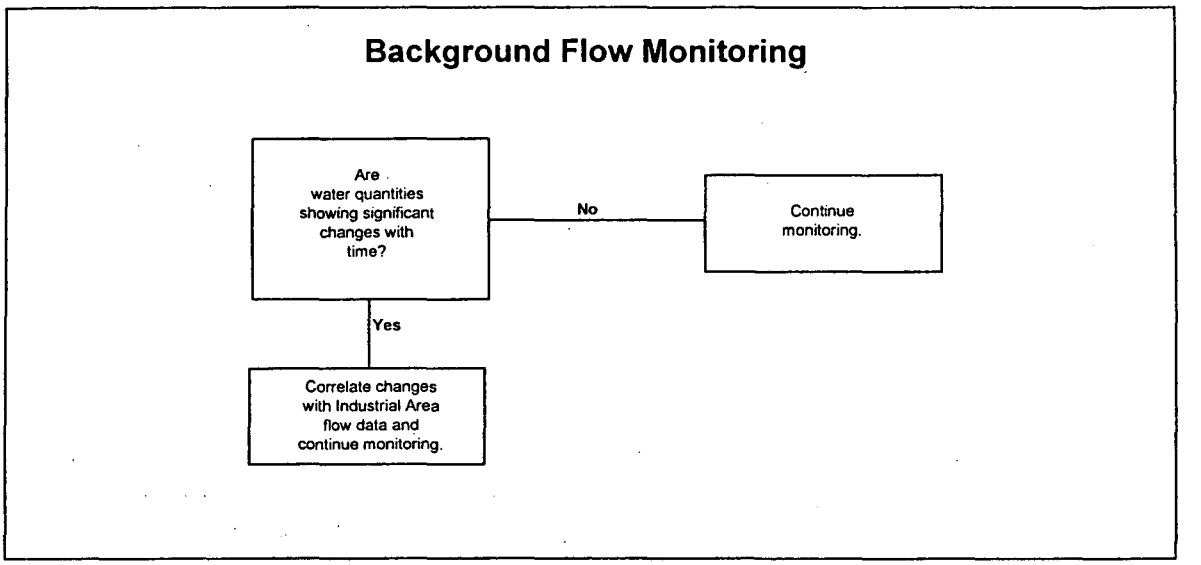
Logic:



3.4.4 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 either current wells or for 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 of these projects is implemented under its own project-specific sampling and analysis plan.

3.4.4.1 Aseptic Monitoring of Select Wells Containing Actinides

This project is being conducted in support of the Actinide Migration Project, and involves the twinning of four existing wells that had historic exceedances of Action Levels for Plutonium and Americium. The project was initiated in FY99 with the purpose of proving that Pu and Am had accidentally been introduced into the well bore from overlying surface soil. Additional information is contained in the *Sampling and Analysis Plan for Groundwater Investigations Involving Actinide Drilling-Artifact Contamination, the Industrial Area VOC Plume East Boundary and Solar Ponds Well Installation.*

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3.4.4.2 East Industrial Area VOC Plume Evaluation

This project was initiated in FY99 to investigate the eastern extent of the Industrial Area VOC Plume. It was hypothesized that a major north-south utility corridor may be restricting the eastward migration of the plume. Wells were installed at approximately 100 foot intervals to the east of the utility corridor and sampled for VOCs. Additional information is contained in the *Sampling and Analysis Plan for Groundwater Investigations Involving Actinide Drilling-Artifact Contamination, the Industrial Area VOC Plume East Boundary and Solar Ponds Well Installation.*

3.4.4.3 ICP/MS Uranium Sampling Project

The ICP/MS Uranium sampling project was conducted jointly with CDPHE to attempt to differentiate between uranium exceedances of Action Levels in groundwater that were caused by Site activities, as opposed to those caused by natural uranium in the environment. Forty–eight wells were sampled four times during the fall of 1999 and spring of 2000. Additional information can be found in the *Statement of Work for Los Alamos National Laboratory to Determine the Isotopic Uranium in Groundwater at RFETS Using High Resolution Inductively Coupled Plasma Spectroscopy/Mass Spectrometry.*

3.4.4.4 Natural Attenuation of the PU&D Yard VOC Plume

This project will investigate the natural attenuation of the PU&D Yard Plume as an alternative to possible groundwater remediation and treatment. Wells will be installed downgradient of the known plume to assess the possible pathway of the plume towards surface water. Once the dominant pathway is identified, wells will be selected for collection of natural attenuation parameters. Additional information can be found in the *Technical Memorandum; Monitored Natural Attenuation of the PU&D Yard VOC Plume, Final Draft* and *Sampling and Analysis Plan for Groundwater Monitoring at the Property Utilization and Disposal (PU&D) Yard.*

3.5 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 all environmental activities and describe the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. General requirements for the Groundwater Monitoring Program activities are covered under the RMRS Quality Assurance Program Plan for the Groundwater Monitoring Program (QAPPGW) (RMRS, 2000a) and associated operating procedures (OPs).

Non-routine evaluations and special sampling projects will be governed by project specific work plans.

The Site management structure showing organizational responsibilities is illustrated in Figure 3-2. The organization has been structured to maintain quality for the duration of the program. Conformance to the applicable 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.

3.5.1 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 the operating procedures that are developed and maintained to insure that quality samples are collected for use in environmental decision making.

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3.5.2 Data Management

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

SWD uses Oracle® (registered trademark of Oracle Company) 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 all 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.

The field data gathered on-Site is entered through the Analytical Services Toolkit (AST) field data entry system. This system is a data entry module that is compatible with the SWD database. Data entered into AST 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® (registered trademark of ESRI) software to store and present locational data for well locations, potentiometric surfaces, plume configurations, topographic contours, and Site facilities.

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

3.5.3 Groundwater Assessment and Reporting

Part of the data assessment process is to establish that the data are of the requisite precision, accuracy, representativeness, comparability, and completeness (PARCC parameters) to give accurate evaluations for decision making (data usability). Definitions of the PARCC parameters and further information on the establishment of project-specific DQOs are found in the QAPPGW (RMRS, 2000a) and in Site Procedure RF/RMRS –98-200 (RMRS, 1998).

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

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

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

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

The proposed monitoring program comprises the following monitoring components:

- A network of 148 wells sampled on a semiannual basis;
- A network of 28 wells and seeps sampled quarterly;
- Monthly measurement of water elevations at 73 wells;
- Quarterly measurement of water elevations at 147 wells;
- Semiannual measurement of water elevations at 85 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;

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- Quarterly reporting of groundwater data that exceed action levels;
- A groundwater modeling capability;
- A well control program;
- A well abandonment, replacement, and maintenance program; and
- Other special projects pertinent to groundwater assessment.

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

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

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

3.6.1 Groundwater Monitoring Network

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

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in Appendix D of this section. The analyte suites tested for in water from current monitoring wells include the identified chemicals of concern.

The RFCA analyte lists for groundwater use concentration levels that may differ from the Site-specific levels used in the past. Major contaminants of concern were determined after reviews of historic groundwater data. The inorganic and radionuclide data for each well were initially screened against background concentrations using the 99/99 Upper Tolerance Limits reported in the Background Characterization Report (EG&G, 1993b). The data were then screened against the action levels in the ALF and exceedances were noted for each well. Table D-1 shows the results of this data screening and was used to determine the analyte suite for the wells in the program. The wells were then associated with the IHSS or plume source area where the groundwater contamination originated. Areas were delineated based on the known plumes and potential area of influence for those plumes. Area-specific monitoring suites were then derived. Appendix E to this section contains the analyte suites that will be collected for each well.

3.6.2 Sampling and Analysis

The operational groundwater sampling network will contain 176 wells, the majority of which will monitor the extent of various contaminant plumes. Appendix E lists the wells in the monitoring program along with their well classification. Appendix E also lists the sampling frequency for wells in the program. A semiannual schedule of sampling and analysis of water quality in Site wells has been chosen to generate data representative of the various groundwater conditions and to ensure compliance with applicable groundwater regulations. The frequency of sampling wells used for other purposes (such as performance monitoring and D&D monitoring) will be derived from compliance documents, agreements, or controlled work plans.

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

The following are guidelines for the collection of groundwater samples:

- For bailed wells, filtered samples will be collected for metals analyses and uranium isotopes; unfiltered samples will be collected for organics analyses, water quality, and all other radionuclides. For micropurged wells, samples will not be filtered.

- Well-site field parameters measured are temperature, pH, specific conductance, turbidity, and alkalinity. Total dissolved solids will be measured as either a laboratory parameter or a field parameter.

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- If limited groundwater sample volumes prevent analysis of the entire analyte list, the analyses will be performed in the following order in accordance with RMRS/OPS-PRO.113 Groundwater Sampling (RMRS, 2000):

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

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

3.6.3 Measurement of Groundwater Elevations

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

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

3.6.4 Groundwater Reporting

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

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

3.6.4.1 Annual Report

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

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

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

Plume Definition Wells:

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

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

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

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

Plume Extent, 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/or management decisions will be made based on the results of the evaluation.

- If a particular analyte has been detected consistently above the Tier II Action Level and background in historic data, a check will be made to see if an evaluation of impact to surface water has been performed. If no evaluation has been performed, an evaluation will be proposed. If an evaluation has been performed, then future monitoring results will be tested against 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:

- Performance wells may be existing monitoring wells or special wells installed to detect any unplanned excursion of contaminants during a building D&D activity. Where there is a groundwater concern, a baseline should be established for water

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quality before D&D 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, any exceedances above the baseline mean + 2 standard deviations will be reported. Trend plots may be used to track concentrations where exceedances are determined. The results of building specific decisions may also be addressed in the Industrial Area IM/IRA annual report.

Performance Monitoring Wells:

- Performance wells may be existing monitoring wells or special wells installed to measure the effectiveness of a source removal or plume treatment system. In each case, it is assumed that the wells 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:

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

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

3.6.4.2 RFCA Quarterly Reporting

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

The RFCA quarterly report for groundwater will replace all previous quarterly reports and integrate all the various reporting elements into a standardized evaluation, using the action levels as a means of assessing results. The report will summarize the data collected and any exceedances of standards that have occurred using the methods outlined in the previous section. Because semiannual sampling is proposed, the quarterly reports will present only those data that have been analyzed and uploaded into SWD in time for the report. The report for any calendar

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quarter will be compiled 60 working days after the end of the quarter to allow time for laboratory analysis, data upload, and evaluation. The reports will be issued and presented at the next Quarterly Information Exchange Meeting following the 60-day compilation period. Summary results from the data evaluation will be submitted to DOE, EPA, and CDPHE one week prior to the Quarterly Information Exchange Meeting.

3.6.5 Evaluation of Groundwater Impacts To Surface Water

Many of the DQO decisions for groundwater monitoring require that the effect of potential groundwater contamination on surface water be evaluated. In many cases, when groundwater action levels are exceeded, confirmatory samples will be taken. If analyses of follow-up samples confirm an exceedance, or if historic data indicate an impact to surface water that has not been evaluated, an evaluation will be performed. In general, the evaluation phase will result in a focused data quality objective that will determine two things: (1) the type of data that need to be collected, and the methodology for determining the nature and (2) extent of contamination and its effect on surface water. The Plume Management Template and Performance/D&D Monitoring templates will be outlined in the following subsections.

3.6.5.1 General Strategy for Groundwater Plume Management and Remediation

The existence of groundwater contaminant plumes (e.g., volatile organic, 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. The plume management template below outlines the process for decision making for the management and remediation of plumes at the Site. This 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 the Site.

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

Detection:

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.

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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 spawn a focused data quality objective 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/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 used to 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 Decisions:

Once impact to surface water has been quantified, and the need for a remedial decision has been determined, the project scope will be promulgated as an accelerated action, PAM, or an IM/IRA. An alternatives analysis will be used to assess the remediation options. This analysis will consider such factors as risk reduction, remediation method, impact on the ecology, cost and performance. Once the remedial decisions have been reached, additional information may be needed to aid the design and construction of a remedial system. A DQO process will be employed to establish the data that need to be collected to aid in the construction of the remedial system. The remedial system may consist of a groundwater treatment system, source removal action or both. Alternatively, the decision alternatives analysis may propose an evaluation of natural attenuation of the contaminant plume, or that no remedial action be performed due to physical or technological impracticality, or adverse impact to the environment.

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.

3.6.5.2 General Strategy for Performance and D&D Monitoring

This section addresses monitoring the performance of specific remedial activities on-Site 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/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 and approval process for a D&D action may identify the need for performance monitoring specific to that action.

Remedial Actions: There are monitoring requirements associated with specific environmental restoration activities. For example, performance monitoring for the Site's operating groundwater plume treatment systems is specified in the related decision documents (i.e., Final Mound Site

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Plume Decision Document, Final Proposed Action Memorandum for the East Trenches Plume, Final Solar Ponds Plume Decision Document).

The Site 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 two years 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 started with a review of Site closure schedules to determine the relative order of major D&D and remediation projects. RSOPS, environmental checklists, and project plans were reviewed to determine whether project managers had considered project specific performance monitoring. For those projects that posed a particular concern to surface water (i.e., D&D of rad buildings), legacy environmental monitoring data were reviewed, groundwater and surface water flow pathways evaluated, and projects managers interviewed to 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 could be used to achieve the performance/D&D monitoring goals. The overall goal is to implement performance/D&D monitoring 24 months prior to project startup to enable development of a water-quality baseline for evaluating potential project impacts on surface water.

In an attempt to further refine the performance/D&D monitoring review and implementation process, a template was developed that sets out a logic for determination of the need for additional monitoring. decision.

- 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 constituents of concern 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).

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- Who do we report to and what actions are taken? Specifies that Site 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

i. Consider project-specific risks to surface water

- Scope of activities
- History of project area or building

ii. Consider project duration

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

B. Selection of Project Groundwater Locations to be Monitored

i. Identify all groundwater pathways for project

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

ii. 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?

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- 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

i. Installation Requirements

- Consider depth of wells with respect to potential contaminant pathways

ii. Analytes of Interest

- Consider history of project area or building
- Consider scope of project

iii. Water Level Measurements

- Frequency of Measurement?

iv. Sampling Frequency

- How many samples month/year?

v. 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 Source(s)

i. 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**

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

B. Notification Process

i. Schedule/time table

- To be determined

ii. Hierarchy/personnel involved

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

iii. Notification items

- Nature of anomalous event
- Constituents involved
- Suspected source where constituents may have originated
- Other?

C. Action Determination

i. 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

ii. Verify activity/location responsible

- Based on event characteristics
- Based on suspected area where constituents may have originated

iii. 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 POEs and POCs warrant the mitigating action? Would the mitigating actions result in unacceptable delays to other higher priority risk reduction activities?

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Applying this template in an integrated fashion where groundwater contamination is of concern, (i.e., if building foundation drain is identified as a potential source of groundwater contamination), then 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 integrated surface water/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 Integrated Monitoring Plan. Reporting and notification protocols will be jointly determined between the D&D project manager and water monitoring as needed to ensure the protection of downstream water quality.

3.6.6 Groundwater Flow Modeling

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

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

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

3.6.7 Well Control Program

The Well Control Program is currently a Site 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 all well installation activities on

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Site are done, and serves as a necessary approval process for the installation of wells. The program will support the following activities:

- Assigning well location codes to eliminate misidentification of wells or use of redundant well names.
- Maintaining a database with summary well information to be used for evaluation of the functions of new wells, and preparing and obtaining well permits as required by 2 CCR 402-2 regulations. The instructions and form are available in the Site 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 Site 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 Site conditions.

3.6.8 Well Abandonment and Replacement

In certain cases, the usefulness of a groundwater monitoring well is exceeded by its potential liability. Such wells should be considered for abandonment or, in certain cases, replacement. Abandoning a well eliminates it from the monitoring network in such a manner that the well will not remain a conduit for groundwater or contaminant migration. Installation and monitoring procedures have been established to minimize the need for abandonments. However, well abandonment is a necessary component of the Groundwater Monitoring Program. Damaged wells must also be abandoned.

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

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

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- When the well has been damaged.

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

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APPENDIX A

Site Description and Environmental History

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Site Description and Environmental History

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A.1 Site Description

Rocky Flats Environmental Technology Site (RFETS or the Site) is located 16 miles northwest of Denver in Jefferson County, Colorado, and is situated within a 50-mile radius of 2.1 million people. The Site encompasses approximately 6,550 acres of federally-owned land (Figure A-1). Ownership, however, does not include surface and subsurface minerals or water rights. The Site is a U.S. government-owned and contractor-operated facility. Site construction was initiated in 1951 and operations began in 1952 (DOE, 1992).

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

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

The Site operations have generated solid and liquid 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.

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A.2 Environmental History

Processing and fabrication of weapons-related components began at the Site in 1952. At that time, environmental protection measures were established that seemed consistent with prudent environmental management. However, some activities resulted in the environmental contamination of portions of the Site. Efforts to document the extent of Site contamination are in progress, in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the *Rocky Flats Cleanup Agreement* (RFCA) (DOE et al, 1996), a cooperative agreement between the Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE). In addition, an Historical Release Report (HRR) (DOE, 1992) has been developed that documents knowledge gained to date about contamination arising from past practices. The HRR is updated annually to document any changes in status for known spills and contaminant sources.

A.2.1 Definition and Description of Contaminated Sites

Section 3004(u) of the RCRA requires that all Solid Waste Management Units (SWMUs) be identified. This became applicable to the Site with the signing of the Compliance Agreement between the State of Colorado and DOE, on July 31, 1986 (State of Colorado, 1986). The exact definition of SWMUs had not been formalized. Therefore, the Site used guidance from the State of Colorado and EPA Region VIII (EPA, 1985). The State of Colorado and EPA required the identification of all areas where releases to the environment may have occurred, including hazardous waste and nonhazardous waste. Also included were single-release areas and locations where long-term management of waste may have occurred.

The SWMUs were initially identified in the *Comprehensive Environmental Assessment and Response Program (CEARP) Phase I: Installation Assessment* (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 titled Individual Hazardous Substance Sites (IHSSs)], consistent with the guidance provided by the State of Colorado, was presented as an appendix to the November 1986, RCRA, Part B Permit Application (Rockwell, 1986).

The SWMUs at the Site were renamed as IHSSs in the Interagency Agreement (IAG), which became the compliance document for Site cleanup under RCRA and CERCLA (State of Colorado, 1991). The term IHSS is specific to the Site and is defined in the IAG (Section 3.2.8) as ". . . locations associated with a release or threat of release of hazardous substances which may cause harm to human health and/or the environment ...".

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

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

These IHSSs have been investigated according to schedules presented in the IAG (State of Colorado, 1991).

The IHSS list is updated as new IHSSs are identified in the HRR (DOE, 1992). Each IHSS is considered a potential source of environmental contamination and, therefore, a potential source of contamination to groundwater.

Table A-1
Individual Hazardous Substance Sites

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

Table A-1
(continued)

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

Table A-1
(continued)

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

Table A-1
(continued)

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

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Table A-1
(continued)

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

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

Notes:

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

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

A.3 References

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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 [Trichloromethane]	67-66-3	1.00E+01	1.00E-01	[1]	1.00E-03
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

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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
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

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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
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)

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[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).

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APPENDIX B

Action Level Framework for Groundwater

Analyte	CAS Reference Number	Tier I [a] (pCi/L)	Tier II [b] (pCi/L)	PQL (pCi/L)
RADIONUCLIDES:				
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

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APPENDIX C

Physical And Hydrologic Setting

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C.1 Geology

C.1.1 Introduction

Rocky Flats Environmental Technology Site (RFETS or the Site) is situated approximately 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 the Site area) has been summarized by Haun and Kent (1965). The elevation at the Site is approximately 6,000 feet above mean sea level (msl). The Industrial Area (main facility area) of the Site is located on alluvial-covered pediment. The upper surface of the alluvium slopes easterly one to two degrees. Most of the surrounding area in the Buffer Zone is more prominently dissected with intermittent streams. These small, eastward flowing streams include Rock Creek, Walnut Creek, Woman Creek, and several surface water diversion ditches (see Section 3.1.4 of this report, Figure 3-1).

The following major geologic and hydrologic parameters influence groundwater flow at the Site (EG&G, 1995a):

- Topography controls the surface waters of the upslope drainage basin that, in part, recharges groundwater and the three principal streams draining the Site. The majority of shallow groundwater is intercepted by these drainages.
- The lithology and permeability of the unconsolidated surficial deposits permit meteoric waters to recharge the water table. The water table is contained in alluvium and weathered bedrock.
- Paleotopography of the bedrock pediment, which is less permeable than the overlying unconsolidated surficial deposits, serves to focus groundwater movement along bedrock "lows."
- Paleoweathering of shallow bedrock materials has enhanced the permeability of the upper 10 to 60 feet relative to unweathered bedrock.
- The permeability of bedrock units, composed primarily of claystone with lesser amounts of siltstone and sandstone, is generally several orders of magnitude less than for unconsolidated surficial deposits. The 600+ feet of unweathered bedrock between the shallow groundwater flow system and deep regional Laramie-Fox Hills aquifer provides an effective barrier to vertical groundwater and contaminant movement.

C.1.2 Stratigraphy

The stratigraphic sequence that underlies the Site extends from the crystalline Precambrian gneiss, schist, and granitoids at 3,000 feet below msl to the unconsolidated Quaternary deposits 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 the Site. The generalized lithologic section in the Rocky Flats area is shown in Figure C-1.

Bedrock formations from the uppermost Cretaceous Pierre, Fox Hills, Laramie, and Arapahoe Formations are present and exposed at the surface and beneath the Site. The Quaternary Rocky Flats Alluvium, and to a limited extent Verdos Alluvium, unconformably overlie the Cretaceous Arapahoe and Laramie Formations in the central portion of the Site. The unconsolidated surficial deposits, combined with the weathered portion of subcropping bedrock formations, form the sequence of rocks which have the greatest importance regarding groundwater flow and contaminant transport at the Site.

C.1.2.1 Pediment-Covering Alluviums

Several Quaternary alluvial formation pediment covers have been identified in the vicinity of the Site by Scott (1975). The Rocky Flats Alluvium is an unconsolidated deposit derived from quartzites and granites of the Coal Creek Canyon provenance west of the Site. The deposit diminishes from west to east with thicknesses ranging from approximately 100 feet to less than 1 foot. In the central portion of the Site, the deposit is approximately 15 to 25 feet thick. The Rocky Flats Alluvium is a heterogeneous deposit dominantly composed of angular to subrounded, poorly-sorted, coarse, bouldery-gravel with a clay and sand matrix. Clay, silt, and sand lenses as well as varying amounts of caliche are also present. Exposures of Rocky Flats Alluvium in the aggregate quarries north and west of the Site exhibit some large scale cross-stratification. Depositional processes include fluvial and debris-flow transport (Shroba, 1994) infilling paleotopographic lows but leaving a widespread surface of erosion with extremely low relief.

C.1.2.2 Other Surficial Deposits

In addition to the pediment-forming alluvial deposits, younger Quaternary units consisting of colluvium, landslide alluvium, and valley fill alluvium mantle the hillslopes and valley bottoms below the pediment surface. Colluvial deposits are derived from Arapahoe and Laramie Formations and older alluvial deposits. This unit consists of sheetwash, soil creep, and landslide materials in a total thickness of 3 to 16 feet (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).

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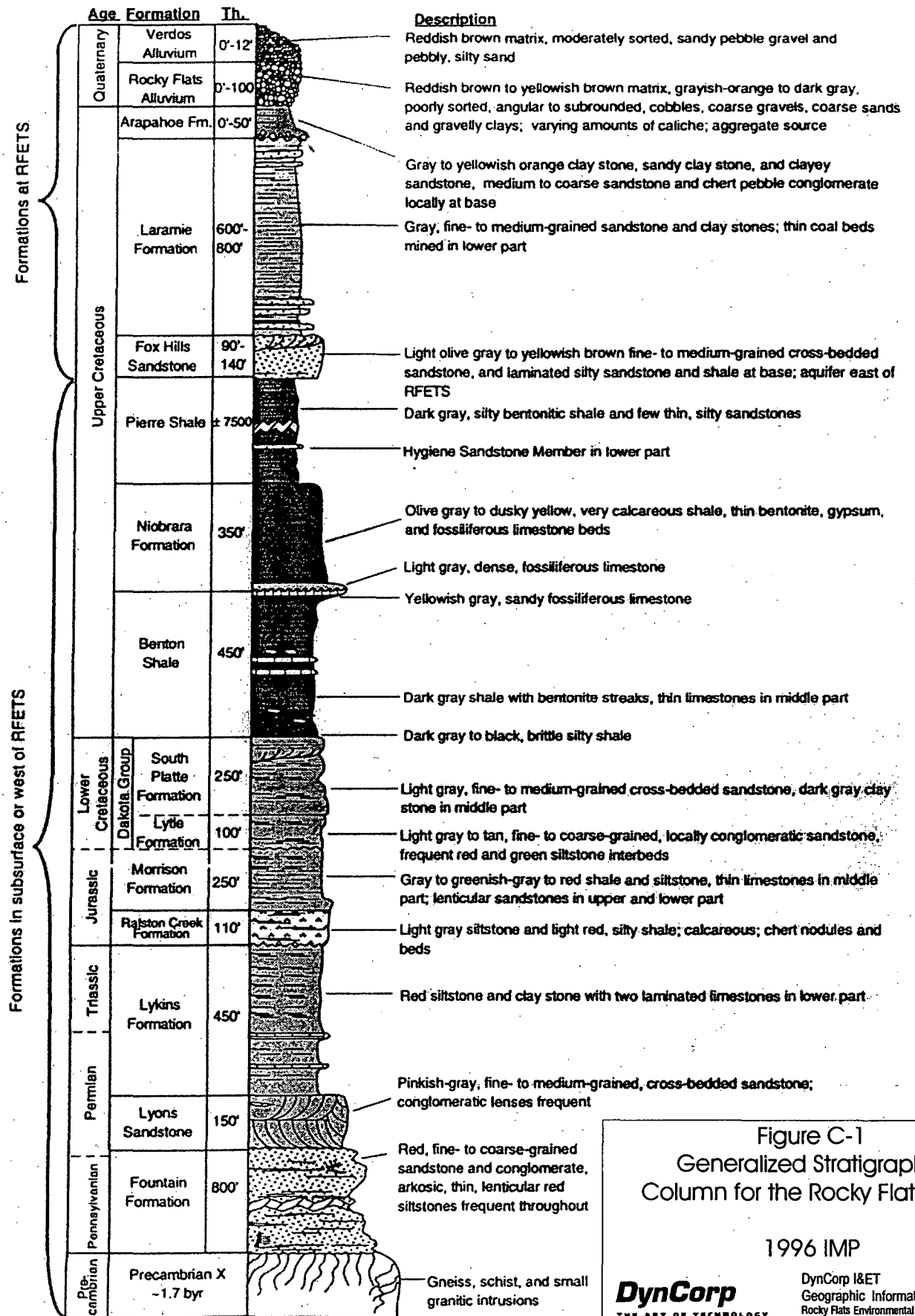

Modified from LeRoy and Weimer (1971)

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 the U.S. DOE Rocky Flats Plant (EG&G, 1991), the Arapahoe Formation was interpreted to be 150 feet thick in the central area and to contain five sandstones named Sandstones 1 through 5. The thickest and most widespread, uppermost sandstone was defined as the No. 1 Sandstone which was interpreted to be deposited in a fluvial environment. The more recent Site-wide mapping program (EG&G, 1992) determined that the overall Arapahoe Formation is generally less than 25 feet thick in the Site area. The No. 1 Sandstone (EG&G, 1991) was correlated to the basal Arapahoe Sandstone. Lower bedrock sandstones (i.e., Sandstones 2 through 5) in the 1991 Geologic Characterization Report were redefined as lenticular Laramie sandstones as they are texturally distinct from the No. 1 Sandstone by virtue of their high silt and clay content. These lower sandstones have limited hydrologic significance and are currently identified as part of the upper Laramie Formation.

The No. 1 Sandstone, which is currently defined as the basal Arapahoe Sandstone, is of concern as a potential contamination pathway, especially where it subcrops beneath the alluvial/bedrock unconformity. The other sandstones pose a limited threat as potential contamination pathways since they are lenticular and discontinuous.

C.1.2.4 Laramie and Fox Hills Sandstone Formations

The Laramie Formation is approximately 600 to 800 feet thick and is composed of a lower sandstone/claystone/coal interval and an upper, thicker claystone interval. The permeable lower sandstones and coals of the Laramie, combined with the permeable sandstones of the Fox Hills, constitute a regional aquifer system known as the Laramie-Fox Hills aquifer. This aquifer system is an important water source in the South Platte River Basin (Pearl, 1980), and is the sole water supply for some residents in the Rocky Flats area. The Fox Hills Formation is primarily a fine-grained sandstone with an approximate thickness of between 75 to 125 feet with thin siltstone and claystone interbeds. The Fox Hills Formation outcrops and subcrops along a narrow, north-south trending pattern in the extreme western part of the Site upgradient from known sources of contamination.

C.1.2.5 Pierre Formation

The Pierre Formation is a 7,500-foot thick, dark gray, silty bentonitic shale that acts as a lower confining layer for the Laramie-Fox Hills aquifer in the Denver Basin. This thick marine shale unit subcrops only in the extreme western part of the Site.

C.1.3 Geologic Structure

The Site is located along the western margin of the Denver Basin, an asymmetric basin with a steeply east-dipping western flank and a gentle eastern flank. The interpretation of the

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subsurface structure is generalized in the east-west geological cross section of the Site area presented in Figure C-2. A monoclinal fold limb exposed west of the Site is the most significant surficial structural feature in the Site area. Along the west limb of the fold, an angular unconformity exists between the Upper Cretaceous bedrock and the base of the Quaternary Rocky Flats Alluvium.

No active faults have been identified at the Site. Several high angle bedrock faults have been inferred to exist in the Industrial Area of the Site based on various stratigraphic and borehole correlation criteria. These faults appear to have only a limited hydrologic significance with regard to vertical groundwater movement and contaminant transport (DOE, 1996).

C.2 Hydrogeology

C.2.1 Introduction

This section presents the basic concepts about the hydrogeologic conditions at the Site that affect groundwater monitoring and protection. Characterization of the hydrogeologic setting is based on the currently accepted conceptual geologic and hydrogeologic models described in the Sitewide Geoscience Characterization Study (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 Aquifer for the Site

The term "aquifer" as defined by Title 40 of the *Code of Federal Regulations (*CFR) Section 260.10 is a "geologic formation, group of formations, or a part of a formation that is capable of yielding a significant amount of water to a well or spring." An "uppermost aquifer" is defined as "the geologic formation nearest the natural ground surface that is an aquifer, as well as lower aquifers that are hydraulically interconnected with this aquifer within the facility's boundary." Geologic materials with similar hydrologic properties comprise a hydrostratigraphic unit (HSU) (Fetter, 1988). For purposes of this report, the uppermost aquifer or upper hydrostratigraphic unit (UHSU) consists of the unconfined saturated zone, in which unconsolidated and consolidated groundwater-bearing strata are in hydraulic communication. The UHSU consists of the following geologic units: Rocky Flats Alluvium, valley-fill alluvium, colluvium, landslide deposits, weathered Arapahoe and Laramie Formation bedrock, and all sandstones within the Arapahoe and upper Laramie Formations in hydraulic communication with the overlying unconsolidated surficial deposits. The UHSU is considered to be equivalent to the uppermost aquifer at the Site.

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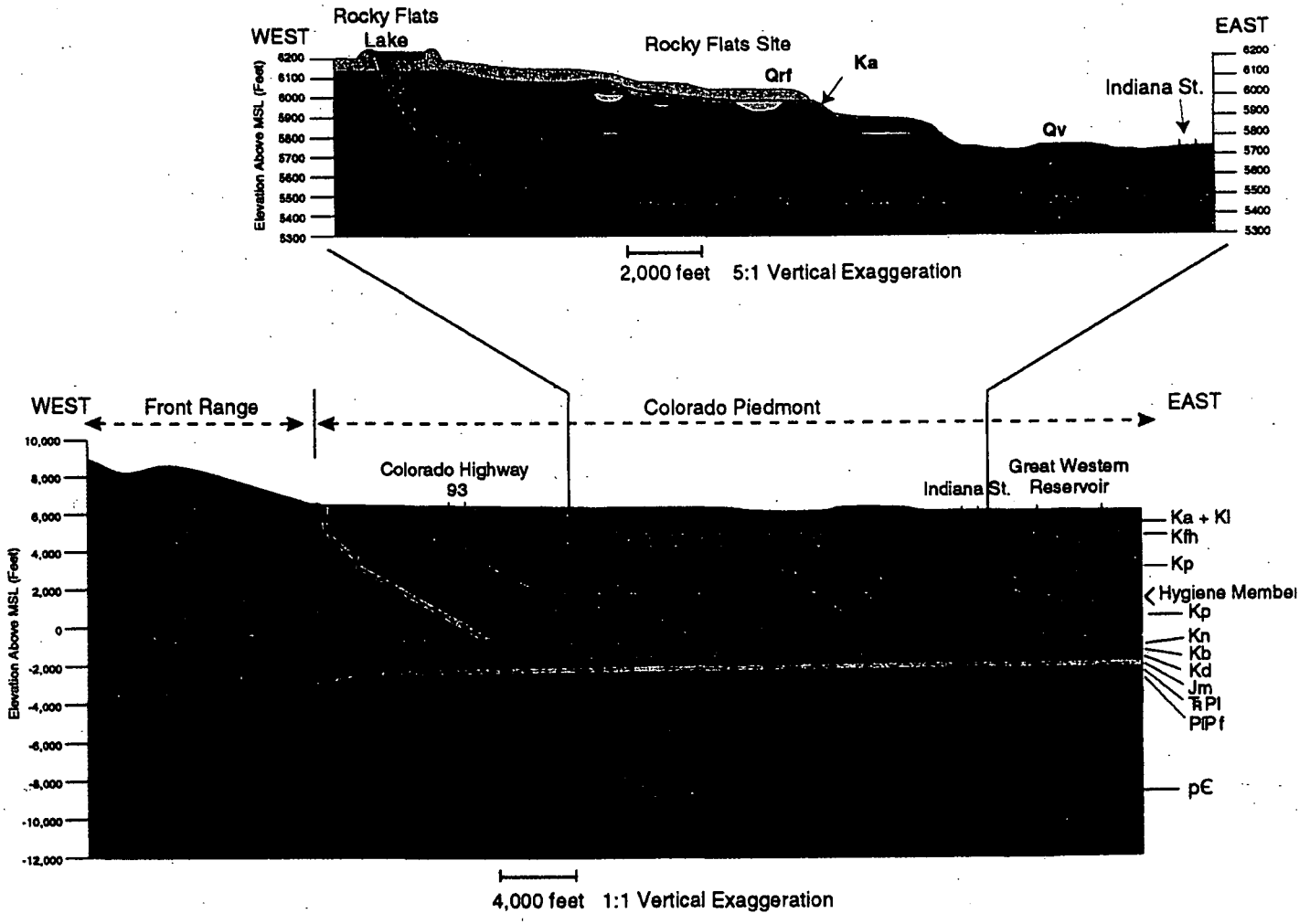
Geologic Units

- Qv — Verdos Alluvium
- Qrf — Rocky Flats Alluvium
- Ka — Arapahoe Formation
- Kl — Laramie Formation
- Kfh — Fox Hills Sandstone
- Kp — Pierre Shale/Hygiene Member
- Kn — Niobrara Formation
- Kb — Benton Shale
- Kd — Dakota Group
- Jm — Morrison Formation
- TrPl — Lykins Formation
- PIPf — Lyons & Fountain Formations
- pЄ — 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

Geologic Characterization Report

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Beneath the surficial materials and the consolidated sandstones of the UHSU are the geologic units of the lower hydrostratigraphic unit (LHSU). The LHSU consists of the consolidated, unweathered bedrock zone of the Arapahoe and upper Laramie Formations not in hydraulic communication with the overlying UHSU. The Arapahoe and upper Laramie Formations comprising the geologic units of the LHSU consist of lesser amounts of sandstone and greater amounts of adjacent claystones. Because of the low permeability of the claystones, they behave as aquitards restricting hydraulic communication with the UHSU. The lower Laramie and Fox Hills Formations comprise a stratigraphically lower and third hydrostratigraphic unit beneath the Site.

Groundwaters of the three hydrostratigraphic units are hydraulically separated beneath the Industrial Area of the Site. They do converge, however, and are in mutual contact immediately upgradient near the western margin of the Site due to monoclinal folding and erosional proximity. Initially, background geochemical characterization of the UHSU and LHSU revealed the units as having statistically different groundwater chemistry concurring with the delineation of separate hydrostratigraphic units (EG&G, 1993a). This concept is presently being qualified. In addition, possible communication of the hydrostratigraphic units along other geologic structures is currently being assessed. More detailed differentiation of the LHSU will be achieved as new hydrogeologic and geochemical data are generated from Site investigations currently proposed or in progress.

C.2.3 Groundwater Occurrence and Distribution

The Site is located in a regional groundwater recharge area (EG&G, 1991). 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, 1993b).

In the western part of the Site, where the thickness of the Rocky Flats Alluvium reaches 100 feet, the depth to the water table is 50 to 70 feet below the surface. The depth to water generally becomes shallower from west to east as the alluvial material thins and the confining claystones approach the ground surface. At the head of stream drainages and valley sides, seeps are common at the base of the Rocky Flats Alluvium where it is in contact with claystones of the Arapahoe/Laramie Formations, and where Arapahoe Formation sandstone crops out. In general, the unconsolidated surficial materials are thicker in the western, higher elevations at the Site. Accordingly, the saturated thickness of these materials also thins eastward. The potentiometric surface of groundwater in unconsolidated surficial deposits has been mapped and is shown on Plate 2. The period illustrated represents the time of year when static water levels are highest. Extensive areas of unsaturated and seasonally unsaturated alluvium and colluvium are indicated east and northeast of the Industrial Area.

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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, 1991). The upper discontinuous sandstones of the Laramie Formation also subcrop beneath alluvium and colluvium, but in limited areas in the valleys and along valley slopes. Groundwater in the lenticular sandstone units of the Laramie Formation occurs under confined conditions over scattered areas of the Site.

Groundwater levels in UHSU wells fluctuate in response to seasonal recharge events. Approximately 15% of the groundwater monitoring wells commonly are dry during at least one of the quarterly sampling events. Of the remaining wells, approximately half cannot yield sufficient water volume (4.5 gallons) specified for laboratory samples. Sampling crews must return later after wells have recovered and obtain additional sample volumes.

C.2.4 Groundwater Flow

The shallow groundwater flow regime at the Site is illustrated by the configuration of potentiometric contours in Plate 2. This map indicates that groundwater flow is largely controlled by the topography of the bedrock surface. Groundwater in the ridge tops generally flows toward the east-northeast. In areas where the ridge tops are dissected by east-northeast trending 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 the Site has a relatively low to moderate hydraulic conductivity that typically yields small amounts of water to groundwater monitoring wells. The UHSU exhibits a wide range of hydraulic conductivities because of the diverse nature of the individual geologic units

that comprise this unit. Summary statistics for UHSU hydraulic conductivities [(EG&G, 1995c) Table G-2] indicate a range of 5.0 x 10^{-2}cm/sec [3.0 x 10^{4} feet per year (ft/yr)] to 3 x 10^{-8}cm/sec (9.3 x 10^{-1}ft/yr). Listed in order of decreasing geometric mean hydraulic conductivity, the relative ranking of individual units of the UHSU is presented as follows: valley-fill alluvium (2.5 x 10^{-3}cm/sec); Arapahoe No. 1 sandstone (7.9 x 10^{-4} cm/sec); Rocky Flats Alluvium (2.1 x 10^{-4} cm/sec); colluvium (9.3 x 10^{-5} cm/sec); weathered Laramie Formation sandstones (3.9 x 10^{-5} cm/sec); and weathered Laramie Formation claystones (8.8 x 10^{-7} cm/sec). Hydraulic conductivities for LHSU materials are generally the lowest measured at the Site with geometric mean values for individual lithologic groups ranging from 1.6 x 10^{-7} to 5.8 x 10^{-7} cm/sec [(11), Table G-2]. The low permeability and 600+ foot thickness of the upper Laramie Formation claystones act as an effective aquitard that restricts downward vertical groundwater flow and contaminant transport to the Laramie-Fox Hills aquifer (DOE, 1996).

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APPENDIX D

Site Impacts to Groundwater

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Site Impacts to Groundwater

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D.1 Impact of Individual Hazardous Substance Sites on the Quality of Groundwater

The characterization and assessment of Individual Hazardous Substance Sites (IHSSs) and their potential to impact groundwater and surface water has historically been conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) remedial investigation/feasibility study (RI/FS) programs for individual Operable Units (OUs). In 1995, the decision was made to take a Site-wide approach to the evaluation and remediation of the Rocky Flats Environmental Technology Site (RFETS or the Site). Of the original 16 OUs, there are only 7 OUs remaining: the Buffer Zone OU; the Industrial Area OU; and OUs 1, 3, 5, 6, and 7. However, groundwater issues will be investigated on a Site-wide basis.

The general conclusions reached with respect to groundwater contamination are that the hydrogeologic setting of a specific area directly affects the movement and quality of groundwater. Chemicals at some of the Site IHSSs have impacted groundwater quality. To characterize this impact, groundwater quality data have been compiled to identify hazardous constituents, determine their concentrations and rate of migration, and delineate the horizontal and vertical extent of potential contaminant plumes. The migration of contaminants can be highly influenced by engineered structures such as buildings, dams, slurry walls, diversion drains, pipelines, and diversion flumes that affect natural, near-surface water movement at the Site.

Because so much of the information dealing with individual IHSSs and contaminant sources is referenced in documents pertaining to the OUs, a short description and references pertinent to the OU where plumes exist is provided in this section. Summaries of groundwater analytical data for determination of historic chemicals of concern is presented in Table D-1.

D.2 Groundwater Contaminant Plumes

Evaluation of geochemical data from groundwater wells sampled as part of the Site-wide monitoring program has delineated a number of areas of groundwater contamination. The most widespread contamination is that of volatile organic compounds (VOCs). Plate 3 shows the distribution of VOC contamination in the upper hydrostatigraphic unit (UHSU). Plume definition is inexact; however, because of limitations in well coverage, variability of hydrostratigraphic conditions, and local variations in groundwater transport velocity. Published plume maps for individual constituents can be found in the 1993 *Well Evaluation Report* (EG&G, 1994a), the annual RCRA groundwater reports [EG&G, 1992, 1993, 1995; Rocky Mountain Remediation Services (RMRS), 1996a], and in individual OU RI/Resource Conservation and Recovery Act (RCRA) feasibility investigation (RFI) reports.

The VOC contaminant plumes in groundwater at the Site have the most potential to impact surface water or to migrate off Site. These plumes have been defined on the basis of exceedances above the maximum contaminant levels (MCL) for individual constituents. To delineate areas of highly contaminated groundwater, the groundwater action levels of 100 times the MCLs were compared against all groundwater data for the most common VOCs in groundwater. The exceedances were plotted and are shown on Plate 3.

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The most probable sources were identified using the results of recent field sampling programs and process knowledge (RMRS, 1996b). A flow diagram (RMRS, 1996b) 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, 1996b).

D.2.1 Groundwater Contamination at 881 Hillside (OU1)

The 881 Hillside is located in the south-central portion of the Site on the north slope of Woman Creek as shown on Figure A-3. Figure D-1 presents detail of the IHSSs for OU1. The area was selected as a high priority site because of the elevated concentrations of VOCs detected in the alluvial groundwater, the relatively permeable soils, and the proximity to Woman Creek. The *Final Phase III RFI/RI Work Plan Revision 1, Rocky Flats Plant 881 Hillside Area OU1* (EG&G, 1991), outlines the activities that were required to identify the extent of contamination.

D.2.1.1 Individual Hazardous Substance Site 119.1 Plume

The drum storage area (IHSS 119.1) within OU1 is the site of historic releases of chlorinated VOCs to the environment. These releases have resulted in the contamination of shallow alluvial groundwater (i.e., the UHSU) and have formed a small, relatively stable contaminant plume extending down the 881 Hillside. Trichloroethylene (TCE), perchloroethylene (PCE), and 1,1,1 trichloroethane (TCA) are the most common organic contaminants at 881 Hillside.

In 1992, a French drain was installed to intercept contaminated groundwater perceived to be flowing down the 881 Hillside. The French drain is excavated as deep as 28 feet into bedrock and intercepts UHSU groundwater flowing in paleotopographic depressions. A three-foot diameter recovery well located within the source area also was installed to recover water containing high levels of dissolved VOCs.

The French drain is still in operation and is collecting relatively uncontaminated groundwater for treatment at the Building 891 Treatment Plant. The plume is upgradient of the French drain and does not appear to be migrating. The area immediately downgradient of the French drain is unsaturated, indicating that the French drain has dewatered much of the area. A small seep 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, 1992a). 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, 1994a).

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 the Site south of the inner east gate. The Mound is located north of Central Avenue at the southeast corner of the Protected Area. The East Trenches straddle the East Access Road, east of the inner east gate.

The 903 Pad and the Mound were historically used for the storage and burial, respectively, of radioactively contaminated wastes. Radioactively contaminated sludge and other materials were buried in the trenches (DOE, 1992b). 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 the Site. Even though these contaminant plumes overlap, differing sources and flow paths make it effective to treat these parts of the large plume individually.

D.2.2.1 Mound Plume

The Mound site groundwater contaminant plume is poorly defined, but it is suspected to extend northward from the former location of the Mound where drums were buried to a point of discharge along South Walnut Creek, upstream of the Site Sewage Treatment Plant. Depending on the season, there may be many unsaturated areas within the plume. Dense nonaqueous phase liquids (DNAPLs) in the Mound area are suspected to be the source of the groundwater contamination and the potential exists for contaminant concentrations to increase over time. There is a possibility that Trench 1 could contribute to this plume; however, evidence indicates that the Mound site is the primary source.

Contaminated groundwater from the plume contains vinyl chloride, tetrachloroethene, and trichloroethene. The contaminant plume is discharging through surface and subsurface seepage into South Walnut Creek. The contaminated groundwater discharges at a rate of 0.5 gallons per minute (gal/min) or less at seep SW059, where it is collected and stored, then later treated at the Building 891 Treatment Plant

D.2.2.2 903 Pad and Ryan's Pit Plume

This contaminant plume has two, closely spaced sources: 1) VOCs associated with drums formerly stored at the 903 Storage Area, where the contents of the drums leaked into the subsurface and groundwater, and 2) Ryan's Pit where VOCs were disposed of in a trench. The contaminated groundwater flows southward from these two source areas, toward the South Interceptor Ditch and Woman Creek. The groundwater is contaminated with carbon tetrachloride, tetrachloroethene, trichloroethene, and other VOCs. The highest concentrations of VOCs in groundwater are near the 903 Pad and Ryan's Pit sources, although isolated areas of high concentration have been observed within the plume away from these sources. Pure-phase tetrachloroethene and motor fuel constituents were found during the excavation of Ryan's Pit. Pure-phase DNAPLs are also suspected to exist underneath the 903 Pad.

Groundwater flow paths in alluvial materials in the 903 Pad and Ryan's Pit area are relatively well defined by contact seeps with the underlying bedrock materials and by numerous wells. However, groundwater flow through the hillside colluvium and bedrock is poorly understood. Areas of unsaturated colluvium are fairly common and prediction of local flow paths is difficult. Depending on the season, there may be many unsaturated areas within the plume. Discharge of contaminated groundwater has not been observed from the colluvium or weathered bedrock portion of this plume.

Contaminated groundwater containing tetrachloroethene and trichloroethene may eventually enter the South Interceptor Ditch and Woman Creek surface water pathways if no actions are taken to manage this plume. Discharge of contaminated groundwater into Woman Creek would pose a potential risk to the environment. Collection and treatment of contaminated groundwater from the 903 Pad and Ryan's Pit Plume will reduce the risk to the environment posed by uncontrolled releases to surface water.

D.2.2.3 East Trenches Plume

A large plume of contaminated groundwater is located in the East Trenches area. The principal sources are IHSS 110 (Trench 3) and 111.1 (Trench 4), with a minor contribution from the VOCs in the 903 Pad area. The trenches were used to bury sewage sludge from the Sewage Treatment Plant, but also contain DNAPLs, crushed drums, and other miscellaneous waste. Contaminated groundwater occurs within the UHSU, in the alluvium, and in the bedrock sandstone that is in hydraulic connection with the alluvium. The major contaminants are carbon tetrachloride, tetrachloroethene, and trichloroethene, as well as other VOCs.

The downgradient boundary of the contaminant plume is located at a spring-and-seep complex on the south bank of South Walnut Creek above Ponds B1 and B2 where the bedrock sandstone subcrops. Concentrations of VOCs above 100 times the MCLs have been detected by a recent sampling program conducted at the seep complex. There are potential ecological impacts because water from the contaminant plume containing tetrachloroethene and trichloroethene has reached South Walnut Creek. If concentrations in the seep complex increase over time, a greater contaminant mass may reach surface water.

A lobe of this contaminant plume also extends to the east of the East Trenches area in the alluvium, but has not reached surface water. Uncontaminated alluvial groundwater discharges downgradient of this lobe as seeps in an unnamed tributary drainage to South Walnut Creek. This groundwater will continue to be monitored.

Additional background information on groundwater quality for OU2 is reported in *the Phase II RI/FS Work Plan, Rocky Flats Plant, 903 Pad, Mound, East Trenches Areas OU2* (Rockwell, 1989) and in the *Final Phase II RFI/RI OU2 Report* (DOE, 1995).

D.2.3 Solar Evaporation Ponds Groundwater Contamination (OU4)

The Solar Evaporation Ponds (SEPs)(IHSS 101) are located in the northeast section of the Protected Area as shown in Figure A-3. Figure D-3 presents details of the IHSS for OU4. The groundwater flow beneath the SEPs originates southwest of the Industrial Area and diverges flowing toward unsaturated areas above Walnut Creek and South Walnut Creek as shown on Plate 2.

The five ponds at IHSS 101 were used to temporarily store and treat various process aqueous wastes by evaporation. This included waste streams with low-level radioactivity, nitrates, acids, and sewage effluent. The configuration of these ponds has changed several times since they were initially installed in 1953. Previous hydrologic investigations of the SEP area indicated that the groundwater had been impacted by leakage from the ponds.

D.2.3.1 Solar Ponds Plume

Because contaminants were detected downgradient of the SEPs, a RCRA Assessment Groundwater Monitoring Program was instituted. Table D-1 lists contaminants detected in downgradient wells as reported in the annual RCRA groundwater monitoring reports (EG&G, 1992, 1993, 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.

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 approximately 2.7 million gal of water per year but is not entirely effective in preventing nitrate contamination from impacting the North Walnut Creek drainage (DOE, 1994b)

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, 1992, 1993, 1994a, 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 the Site. This is because the OUs associated with the Industrial Area had not completed RFI/RI investigations before the decision was made to integrate all remedial activities at the Site. Prior to the elimination of the OU-based investigations, OUs 8, 9, 10, 12, 13, and 14 were combined for purposes of remedial investigation. Preliminary surface soil investigations had been completed prior to cessation of activities on the Industrial Area OUs but no groundwater investigation had been started. However, two groundwater plumes have been generally defined; the Carbon Tetrachloride Plume and the Industrial Area Plume.

D.2.4.1 Carbon Tetrachloride Plume

Preliminary borehole drilling around tanks T9 and T10 in the former OU8 uncovered carbon tetrachloride free product that is associated with the Carbon Tetrachloride Plume. The carbon tetrachloride spill (IHSS 118.1) is located due north of Building 776 and east of Building 730. There are several documented past releases of carbon tetrachloride at this site. This area also overlaps other IHSSs [i.e., 121-T9, 121-T10, 131, and 144(N)]. Different spills are associated with these IHSSs.

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IHSS 118.1 is the site where a 5,000-gal, underground steel storage tank for carbon tetrachloride and associated piping were formerly located. Numerous reported spills have occurred before 1970, some between 100 to 200 gal, as documented in the Historical Release Report (DOE, 1992b). 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, 1994c) 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 trichloroethene thought to emanate from IHSSs 117.1, 117.2, 157.1, 158, 171 and 182; tetrachloroethene thought to emanate from IHSSs 117.1, 117.2, 158, 157.1, 160, and 171; and carbon tetrachloride thought to emanate from IHSSs 117.1, 117.2, and 158.

Currently, the Industrial Area Plume does not appear to be migrating rapidly downgradient, and there are no known surface water impacts. However, groundwater pathways exist to both Woman Creek and to Walnut Creek. Groundwater recharge in the Industrial Area caused by water losses from sewers and water-supply pipelines may be substantial. Reduction of recharge from these sources could significantly reduce the potential for contaminant migration in the subsurface.

Treatment of contaminated groundwater within the Industrial Area does not appear to be necessary to protect surface water because the plume appears to have limited potential for migration. However, ongoing monitoring and evaluation of the groundwater through the monitoring program will continue and will detect any possible movement or expansion of the plume. Groundwater remedial actions may become necessary if the contaminant plumes expand and migrate significantly, thereby becoming a threat to surface water.

Further investigation of the plume or plumes in the Industrial Area has been suspended until D&D activities have been completed on buildings in the Industrial Area. Wells in the Industrial Area will be monitored for the known contaminants detected in the Industrial Area Plume.

D.2.5 Groundwater Contamination at the Existing Landfill (OU7)

The Existing (Present) Landfill began operation in 1968 with the closure of the Original Landfill (now IHSS 115). The Existing Landfill is located in the Buffer Zone north of the Protected Area as shown on Figure A-3. Figure D-4 presents detail of the IHSSs included in OU7. The local recharging groundwater flow direction is from the west-southwest toward the Existing Landfill, then is focused toward the Landfill Pond and the portion of the Walnut Creek drainage designated as "No Name Gulch" as shown on Plate 2.

In addition to typical sanitary landfill wastes, limited quantities of hazardous wastes were disposed of in the landfill, particularly in the early years of operation between 1968 and 1970. In September 1973, tritium was detected in leachate draining from the landfill. In response, a sampling program was initiated to determine the location of the tritium source and interim response measures were also undertaken to control the generation and migration of landfill leachate. Interim response measures included the construction of two ponds, of which the East Landfill Pond remains, and a subsurface leachate collection system and a subsurface intercept/slurry wall system for diverting upgradient groundwater.

Evaluation of groundwater quality data (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).

D.2.5.1 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, 1992, 1993, 1994a, 1995; RMRS, 1996a), *Technical Memorandum - Final Work Plan for OU7* (DOE, 1994d) 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

Water Quality and Water Level Monitoring Wells

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APPENDIX E

Water Quality and Water Level Monitoring Wells

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APPENDIX E-1 Proposed Monitoring Wells

WELL NO	FREQUENCY	CLASS	PLUME/AREA	FORMATION	PURPOSE
00100	Semiannual	DD	Bldg 779	AL/BD	D & D Monitoring for Building 779 D&D
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 Building 707 D&D
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 Building 707 D&D
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 Building 776/777 Complex D&D
00491	Semiannual	PD	903 Pad	BD/UHSU	Plume Definition well monitoring the 903 Pad VOC Plume
00500	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Building 776/777 Complex D&D
00597	Semiannual	PD	PU&D/Landfill	AL	Plume Definition well monitoring the Landfill/PU&D yard Plume
00600	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Building 776/777 Complex D&D
00700	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Building 776/777 Complex D&D
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
02197	Semiannual	PE	PU&D	AL	Plume Extent well monitoring the 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	Bldg 779	AL/BD	D&D monitoring downgradient of Bldg. 779
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

APPENDIX E-1 Proposed Monitoring Wells (cont.)

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.
07391	Semiannual	PM	903 Pad	AL/BD	Performance Monitoring well monitoring effects of remediation downgradient of Ryans Pit
08091	Semiannual	PE	Mound/E. Trench	AL	Plume Extent well monitoring the southern migration of Mound and East Trenches Plumes
1386	Semiannual	PE/PM	Drainage/Solar Ponds	AL	Performance Monitoring - SEP Treatment System, Plume Extent Monitoring for Solar Ponds Plume
1786	Semiannual	PE/PM	Solar Ponds	AL	Performance Monitoring - SEP Treatment System, Plume Extent Monitoring for Solar Ponds Plume
1986	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring the northern migration of the IA PLume
2186	Semiannual	PE	Ind. Area	BD/UHSU	Plume Extent well monitoring the northern migration of the 'IA Plume
2987**	Semiannual	PD	903 Pad	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
3087	Semiannual	PD	903 Pad	BD	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit 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/USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
4087	Quarterly	RCRA	Landfill	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
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
5387	Semiannual	PE	881 Hillside	AL	Plume Extent south of the 881Hillside 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 monioring the PU&D Yard Plume - LF
6186	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring easward migration of IA Plume

APPENDIX E-1 Proposed Monitoring Wells (cont.)

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 Cr. drainage downgradient of the 881 Hillside Plume
6586	Semiannual	D	NA	AL	Drainage well monitoring the No. side Woman Cr. below 903Pad/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 Building 123 D&D
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 Building 123 D&D
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 Building 123 D&D
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 Building 123 D&D
10498	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Building 123 D&D
10592	Semiannual	PM	881 Hillside	AL	Performance Monitoring for the French Drain
10598	Semiannual	DD	Bldg. 123	AL	D & D Monitoring for Building 123 D&D
10692	Semiannual	PM	881 Hillside	AL	Performance Monitoring for the French Drain
10792	Semiannual	PM	881 Hillside	AL	Performance Monitoring for the French Drain
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 Cr.
11092	Semiannual	PM	881 Hillside	AL	Performance Monitoring for the French Drain
11891	Semiannual	PM	East Trenches	BD/UHSU	Performance Montoring well monitoring effects of remediation downgradient of Trench T-3
12191	Semiannual	PM	East Tranches	BD/UHSU	Performance Monitoring at edge of T3 soil excavation
12691	Semiannual	PM	East Trenches	BD/USHU	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	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	Plume Degredation well monitoring the IHSS 118.1 plume and Building D&D well monitoring Building 771

APPENDIX E-1 Proposed Monitoring Wells (cont.)

18299	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
18399	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
18499	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
18599	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
18699	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
18799	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
18899	Semiannual	PA	IHSS 118.1	AL	Plume Degredation well monitoring the IHSS 118.1 plume
20998	Semiannual	DD	Bldg 771	AL	D & D Monitoring for Building 771 Complex D&D
22596	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring the northern migration of the IA Plume
22696	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring the westward migration of the Carbon Tet Plume
22796	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring the northward migration of Carbon Tet Plume
22896	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring the northward migration of IA VOA Plume
22996	Semiannual	DD	Bldg 886	AL	Building D&D well monitoring potential rad contamination near 886 lab
23096	Semiannual	PE	903 Pad	AL	Plume Extent well monitoring the southern migration of the Ryans- OU2 VOA Plume
23196	Semiannual	PE	903 Pad	AL	Plume Extent well monitoring the southward migration of the Ryans Pit/903 Pad Plume
23296	Semiannual	PE/PM	East Trenches	AL	Plume Extent/Performance Monitoring well monitoring the East Trenches Treatment System
38591	Semiannual	D	NA	AL	Drainage well in Woman Cr. Drainage below 881 Hillside Plume
40099	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
40199	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
40299	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
40399	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
40499	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
40599	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
40699	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
40799	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
40899	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
40999	Semiannual	DD	Bldg 865/886	AL/BD	D & D Monitoring for Buildings 865 and 886 D&D
41099	Semiannual	DD	Bldg 886	AL/BD	Building D&D well monitoring potential rad contamination near 886 lab
41199	Semiannual	DD	Bldg 886	AL/BD	Building D&D well monitoring potential rad contamination near 886 lab
41299	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
41499	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
41591	Semiannual	B	Boundary	AL	Boundary Well - in small drainage near east access gate

APPENDIX E-1 Proposed Monitoring Wells (cont.)

41599	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
41691	Semiannual	B	Boundary	AL	Boundary Well - in the Walnut Cr. Drainage at the Indiana Street Boundary
43392	Semiannual	PE	Ind. Area	AL	Plume Extent well monitoring southward migration of IA Plume
52894	Quarterly	RCRA	Landfill	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
52994	Quarterly	RCRA	Landfill	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
60299	Semiannual	DD	Bldg 776/777	AL/BD	D & D Monitoring for Building 776/777 Complex D&D
60499	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Building 707 D&D
60599	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Building 707 D&D
61099	Semiannual	DD	Bldg 883	AL/BD	D & D Monitoring for Building 883 D&D
61199	Semiannual	DD	Bldg 883	AL/BD	D & D Monitoring for Building 883 D&D
61499	Semiannual	DD	Bldg 707	AL/BD	D & D Monitoring for Building 707 D&D
70099	Semiannual	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	Semiannual	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
75992	Semiannual	PE	Mound/E. Trench	AL	Plume Extent well monitoring So. Walnut Cr. Drainage below Mound Site Plume
76992	Semiannual	PE	PU&D/Landfill	AL	Plume Extent well monitoring the eastward migration of the PU&D Yard/Landfill Plume
77392	Semiannual	PD	Landfill	AL	Plume Definition well monitoring the eastward migration of the PU&D Yard Plume
90099	Semiannual	PA	903 Pad/Ryans Pit	AL/BD	Plume Degredation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90199	Semiannual	PA	903 Pad/Ryans Pit	AL/BD	Plume Degredation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90299	Semiannual	PA	903 Pad/Ryans Pit	AL/BD	Plume Degredation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
90399	Semiannual	PA	903 Pad/Ryans Pit	AL/BD	Plume Degredation well monitoring the southern migration of the 903 Pad/Ryan's Pit Plume
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

APPENDIX E-1 Proposed Monitoring Wells (cont.)

95299	Semiannual	PM	East Trenches	AL/BD	Performance Monitoring of groundwater treatment system below East Trenches
891COL WEL	Quarterly	PM	881 Hillside	AL	Performance Monitoring of groundwater in collection well on 881 Hillside
B206989	Quarterly	RCRA	Landfill	BD/UHSU	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
B208289	Semiannual	PE	Solar Ponds	BD/UHSU	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume
B208789	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume
P114389	Semiannual	PE	Ind. Area	AL	Plume Extent well to monitor extent of Industrial Area plume pathway to Walnut Cr.
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
P209489	Semiannual	PD	Solar Ponds	BD/UHSU	Plume Definition well for the Carbon Tet. Plume
P218089	Semiannual	DD	Bldg 707	AL	D & D Monitoring for Building 707 D&D
P218389	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
P219089	Semiannual	DD	Bldg 771	AL/BD	D & D Monitoring for Building 771 Complex D&D
P219189	Semiannual	PD	Carbon Tet	AL	Plume Definition well for VOC contamination comming from Carbon Tet Plume
P219489	Semiannual	PE	Solar Ponds	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
P313589	Semiannual	PE	Ind. Area	AL	Plume Extent to monitor the eastward migration of IA Plume near Bldg. 881
P314289	Semiannual	PE	Ind. Area	AL	Plume Extent to monitor the southern migration of IA Plume near Bldg. 850
P317989	Semiannual	DD	Bldg 865/886	AL	D & D Monitoring for Buildings 865 and 886 D&D
P416689	Semiannual	PE	Ind. Area	AL	Plume Extent to monitor southern migration of IA Plume south of Bldg. 440
P416789	Semiannual	PD	Ind. Area	AL	Plume Definition of IA Plume south of 400 area along pathway to Woman Cr.
P416889	Semiannual	PD	Ind. Area	AL	Plume Definition of IA Plume south of Bldg. 664 along pathway to Woman Cr.
P419689	Semiannual	DD	Bldg 444	AL/BD	D & D Monitoring for Building 444 Complex D&D
SW13494	Quarterly	PM	881 Hillside	NA	Performance Monitoring of groundwater in footing drain seep below Bldg. 881
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
ETP in	Semiannual	PM	East Trenches	NA	Performance Monitoring of groundwater treatment system below East Trenches

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APPENDIX E-1 Proposed Monitoring Wells (cont.)

ETP ef	Semiannual	PM	East Trenches	NA	Performance Monitoring of groundwater treatment system below East Trenches
SW099	Quarterly	PM	Landfill	PM	Performance Monitoring of groundwater intercept system below Present Landfill
SW100	Quarterly	PM	Landfill	PM	Performance Monitoring of groundwater intercept system below Present Landfill

18199 Micropurge well

** Well needs to be replaced

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APPENDIX E-2 Proposed Monitoring Wells and Chemicals to be Monitored

WELLNO	FREQUENCY	PLUME/AREA	VOC Suite	METALS Suite	TRITIUM	PU/AM	SR 89/90	URANIUM	NITRATE	FLUORIDE	SULPHATE	TDS	CYANIDE	CESIUM-137	CHLORIDE	SULFIDE	TOC	METHANE	ANIONS Suite	GASES Suite	Np-237	PCBs	TPH	GROSS a/b
00100	Semiannual	Bldg 779	X	X		X		X	X			X												
00197	Semiannual	Old Landfill	X	X	X		X	X	X	X	X	X												
00200	Semiannual	Bldg 707	X	X		X		X				X									X	X*	X*	
00297	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
00300	Semiannual	Bldg 707	X	X		X		X				X									X	X*	X*	
00397	Semiannual	PU&D	X	X	X			X	X	X	X	X												
00400	Semiannual	Bldg 776/777	X	X	X	X		X	X			X											X*	
00491	Semiannual	903 Pad	X	X		X		X	X		X	X												
00500	Semiannual	Bldg 776/777	X	X	X	X		X	X			X											X*	
00597	Semiannual	PU&D/Landfill	X	X	X			X	X	X	X	X												
00600	Semiannual	Bldg 776/777	X	X	X	X		X	X			X											X*	
00700	Semiannual	Bldg 776/777	X	X	X	X		X	X			X											X*	
00797	Semiannual	881 Hillside	X	X				X	X		X	X												
00897	Semiannual	Mound	X	X		X		X	X			X												
00997	Semiannual	Drainage	X	X		X	X	X				X												
02197	Semiannual	PU&D	X	X	X			X	X	X	X	X												
02291	Semiannual	Mound	X	X		X		X	X			X												
02397	Semiannual	Bldg 779	X	X		X		X	X			X												
02497	Semiannual	Bldg 779	X	X		X		X	X			X												
02500	Semiannual	Bldg 779	X	X		X		X	X			X												
0386	Semiannual	Boundary	X	X	X	X		X	X	X	X	X												
03991	Semiannual	East Trenches	X	X		X		X	X			X												
04091	Semiannual	East Trenches	X	X		X		X	X			X												
04591	Semiannual	East Trenches	X	X		X		X	X			X												
0487	Semiannual	881 Hillside	X	X				X	X		X	X												
04991	Semiannual	East Trenches	X	X		X		X	X			X												

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APPENDIX E-2 Proposed Monitoring Wells and Chemicals to be Monitored (cont.)

05091	Semiannual	East Trenches	X	X		X		X	X			X												
05391	Semiannual	East Trenches	X	X		X		X	X			X												
05691	Semiannual	East Trenches	X	X		X		X	X			X												
06091	Semiannual	East Trenches	X	X		X		X	X			X												
06491	Semiannual	Boundary	X	X	X	X		X	X	X	X	X												
07391	Semiannual	903 Pad	X	X		X		X	X		X	X												
08091	Semiannual	Mound/E. Trench	X	X		X	X	X	X			X												
1386	Semiannual	Drainage/Solar Ponds	X	X	X	X	X	X+X (D&T)	X	X	X	X												
1786	Semiannual	Solar Ponds	X	X	X	X	X	X+X (D&T)	X	X	X	X												
1986	Semiannual	Ind. Area	X	X		X		X	X			X												
2186	Semiannual	Ind. Area	X	X		X		X	X			X												
2987**	Semiannual	903 Pad	X	X		X		X	X		X	X												
3087	Semiannual	903 Pad	X	X		X		X	X		X	X												
3386	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
3586	Semiannual	Mound	X	X		X		X	X			X												
3687	Semiannual	East Trenches	X	X		X		X	X			X												
4087	Quarterly	Landfill	X	X	X			X	X	X	X	X												
4787	Semiannual	881 Hillside	X	X				X	X		X	X												
4887	Semiannual	881 Hillside	X	X				X	X		X	X												
5387	Semiannual	881 Hillside	X	X				X	X		X	X												
5587	Semiannual	Drainage	X	X			X	X	X		X	X												
5887	Quarterly	PU&D	X	X	X			X	X	X	X	X												
6186	Semiannual	Ind. Area	X	X		X		X	X			X												
6286	Semiannual	903 Pad	X	X		X		X	X		X	X												
6386	Semiannual	903 Pad	X	X		X		X	X		X	X												
6486	Semiannual	Drainage	X	X			X	X	X		X	X												
6586	Semiannual	Drainage	X	X		X		X	X			X												
7086	Semiannual	IA/Old Landfill	X	X			X	X	X		X	X												
10098	Semiannual	Bldg. 123	X	X		X		X	X			X	X	X										
10194	Semiannual	East Trenches	X	X		X		X	X			X												

APPENDIX E-2 Proposed Monitoring Wells and Chemicals to be Monitored (cont.)

10198	Semiannual	Bldg. 123	X	X		X		X	X			X	X	X										
10294	Semiannual	Boundary	X	X	X	X		X	X	X	X	X												
10298	Semiannual	Bldg. 123	X	X		X		X	X			X	X	X										
10394	Semiannual	Boundary	X	X	X	X	X	X	X	X	X	X												
10398	Semiannual	Bldg. 123	X	X		X		X	X			X	X	X										
10498	Semiannual	Bldg. 123	X	X		X		X	X			X	X	X										
10592	Semiannual	881 Hillside	X	X				X	X		X	X												
10598	Semiannual	Bldg. 123	X	X		X		X	X			X	X	X										
10692	Semiannual	881 Hillside	X	X				X	X		X	X												
10792	Semiannual	881 Hillside	X	X				X	X		X	X												
10992	Semiannual	881 Hillside	X	X				X	X		X	X												
10994	Semiannual	IA/Old Landfill	X	X			X	X	X		X	X												
11092	Semiannual	881 Hillside	X	X				X	X		X	X												
11891	Semiannual	East Trenches	X	X		X		X	X			X												
12191	Semiannual	East Trenches	X	X		X		X	X			X												
12691	Semiannual	East Trenches	X	X		X		X	X			X												
15599	Semiannual	Mound	X			X		X				X												
15699	Semiannual	Mound	X			X		X				X												
15799	Semiannual	Mound	X			X		X				X												
18199	Semiannual	IHSS 118.1/Bldg 771		X	X	X		X	X*		X	X			X	X	X	X			X*	X*		
18299	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
18399	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
18499	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
18599	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
18699	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
18799	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
18899	Semiannual	IHSS 118.1	X						X*		X	X			X	X	X	X						
20998	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		

APPENDIX E-2 Proposed Monitoring Wells and Chemicals to be Monitored (cont.)

22596	Semiannual	Ind. Area	X	X		X		X	X			X												
22696	Semiannual	Ind. Area	X	X		X		X	X			X												
22796	Semiannual	Ind. Area	X	X		X		X	X			X												
22896	Semiannual	Ind. Area	X	X		X		X	X			X												
22996	Semiannual	Bldg 886	X	X		X		X	X			X												
23096	Semiannual	903 Pad	X	X		X		X	X		X	X												
23196	Semiannual	903 Pad	X	X		X		X	X		X	X												
23296	Semiannual	East Trenches	X (Q& Semi)	X		X		X	X			X												
38591	Semiannual	Drainage	X	X			X	X	X		X	X												
40099	Semiannual	Bldg 444	X	X	X			X	X			X	X											
40199	Semiannual	Bldg 444	X	X	X			X	X			X	X											
40299	Semiannual	Bldg 444	X	X	X			X	X			X	X											
40399	Semiannual	Bldg 444	X	X	X			X	X			X	X											
40499	Semiannual	Bldg 444	X	X	X			X	X			X	X											
40599	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
40699	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
40799	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
40899	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
40999	Semiannual	Bldg 865/886	X	X		X		X	X			X												
41099	Semiannual	Bldg 886	X	X		X		X	X			X												
41199	Semiannual	Bldg 886	X	X		X		X	X			X												
41299	Semiannual	Bldg 444	X	X	X			X	X			X	X											
41499	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
41591	Semiannual	Boundary	X	X	X	X		X	X	X	X	X												
41599	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
41691	Semiannual	Boundary	X	X	X	X	X	X	X	X	X	X												
43392	Semiannual	Ind. Area	X	X		X		X	X			X												
52894	Quarterly	Landfill	X	X	X			X	X	X	X	X												
52994	Quarterly	Landfill	X	X	X			X	X	X	X	X												
60299	Semiannual	Bldg 776/777	X	X	X	X		X	X			X											X*	
60499	Semiannual	Bldg 707	X	X		X		X				X									X	X*	X*	
60599	Semiannual	Bldg 707	X	X		X		X				X									X	X*	X*	
61099	Semiannual	Bldg 883	X	X				X	X			X										X*	X*	
61199	Semiannual	Bldg 883	X	X				X	X			X										X*	X*	
61499	Semiannual	Bldg 707	X	X		X		X				X									X	X*	X*	
70099	Quarterly	Solar Ponds						X (T)	X			X												
70193	Quarterly	PU&D	X	X	X			X	X	X	X	X												
70299	Quarterly	Solar Ponds						X (T)	X			X												
70393	Quarterly	PU&D	X	X	X			X	X	X	X	X												

APPENDIX E-2 Proposed Monitoring Wells and Chemicals to be Monitored (cont.)

70493	Quarterly	PU&D	X	X	X			X	X	X	X	X												
75992	Semiannual	Mound/E. Trench	X	X		X	X	X	X			X												
76992	Semiannual	PU&D/Landfill	X	X	X			X	X	X	X	X												
77392	Semiannual	Landfill	X	X	X			X	X	X	X	X												
90099	Semiannual	903 Pad/Ryan's Pit										X												
90199	Semiannual	903 Pad/Ryan's Pit										X												
90299	Semiannual	903 Pad/Ryan's Pit										X												
90399	Semiannual	903 Pad/Ryan's Pit										X												
95099	Semiannual	East Trenches	X									X												
95199	Semiannual	East Trenches	X									X												
95299	Semiannual	East Trenches	X									X												
891COLWEL	Quarterly	881 Hillside	X	X				X				X												
B206989	Quarterly	Landfill	X	X	X			X	X	X	X	X												
B208289	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
B208789	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
P114389	Semiannual	Ind. Area	X	X		X		X	X			X												
P209289	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X	X												
P209389	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X	X												
P209489	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
P218089	Semiannual	Bldg 707	X	X		X		X				X									X	X*	X*	
P218389	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
P219089	Semiannual	Bldg 771	X	X	X	X		X	X			X									X*	X*		
P219189	Semiannual	Carbon Tet	X	X	X	X	X	X	X	X	X	X												
P219489	Semiannual	Solar Ponds	X	X	X	X	X	X	X	X	X	X												
P313589	Semiannual	Ind. Area	X	X		X		X	X			X												

APPENDIX E-2 Proposed Monitoring Wells and Chemicals to be Monitored (cont.)

P314289	Semiannual	Ind. Area	X	X		X		X	X			X													
P317989	Semiannual	Bldg 865/886	X	X		X		X	X			X													
P416689	Semiannual	Ind. Area	X	X		X		X	X			X													
P416789	Semiannual	Ind. Area	X	X		X		X	X			X													
P416889	Semiannual	Ind. Area	X	X		X		X	X			X													
P419689	Semiannual	Bldg 444	X	X	X			X	X			X	X												
SW13494	Quarterly	881 Hillside	X	X				X				X													
R1-0	Semiannual	Mound	X	X (T)		X		X (T)			X				X				X	X				X
R2-E	Semiannual	Mound	X	X (T)		X		X (T)			X				X				X	X				X
ETP in	Semiannual	East Trenches	X	X (T)							X				X									
ETP ef	Semiannual	East Trenches	X	X (T)							X				X									
SW099	Quarterly	Landfill	X									X												
SW100	Quarterly	Landfill	X									X												

NOTES

B444/771/886 SAP says after 1st round, "selected wells" will be sampled per IMP (allowing us to trim the list of wells)

18199 - Micropurge wel

D, T - Dissolved, Total

* - Can be omitted once a complete round is collected and results indicate no contamination with these species (may never happen for all B771 wells); new D&D SAP says can be omitted "after first sampling round" (does not rule out omitting them if wells are dry)

** - Well needs to be replaced;

APPENDIX E-3 Water Level Monitoring Wells

(Including Water Balance Project wells)

SITE-WIDE[1]

Well Alluvium	Water Quality	Industrial Area	Background
0186		730	
1086		730	
1386	12		
1786	12		
1886		2	
1986	12		
2286		12	
2486		2	
2686		2	
2986		2	
3386	12		
3586	4		
3686		2190	
3986		730	
4286		12	
4386		12	
4486		2	
5686			12
6186	4		
6386	4		
6486	12		
6586	12		
6686		12	
6786			2
6886		2190	
7086	4		
0187		730	
0487	12		
1087		2	
1487		730	
1587		730	
1987		2	
2187		2	
2487		2	
2687		2	
2987	4		
3287		2	
3387		2	
4087	12		
4287		730	
4387		2	
4787	4		
4887	4		
5287		12	
5387	4		
5587	12		

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
5887	4		
6087		2	
7187		2	
B400389			12
B200589			730
B200889			730
B102289			2
B102389			2
B402689			12
P207689		2	
P207889		2	
B208089		12	
B208789	4		
P209289	4		
P209789		2	
P209889		730	
B210489		2190	
B410589			12
B410689			2
B410789		2	
B110889		2	
B110989			12
B111189			12
B411289			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	

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
P416489		12	
P416589		730	
P416689	12		
P416789	12		
P416889	12		
P317989		4	
P218089		4	
P218289		2	
P218389	12		
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		2	
00491	4		
01291		2	
01391		12	
03191		2	
03991	4		
04091	4		
04191		2	
04591	4		
04991	4		
05091	4		
5191		730	
05291		2	
05391	4		
05691	4		
06091	12		
06191		2	
06991		2	
07291		12	
07391	4		
08091	4		
13091		2	
13391		2	
13491		2	

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
13591		2	
20291		12	
34791		2	
37191		2	
37591		730	
37691		2	
37791		2	
38591	4		
41091		12	
41591	12		
41691	12		
10592	4		
10692	4		
10992	4		
11092	4		
43392	4		
46292			2
46492		2	
75292		12	
75992	4		
76792		2	
76992	4		
77392	4		
77492		730	
00293			12
05193		12	
5293		730	
45793		2	
58793		2	
59493		2	
59893		2	
60693		2	
61293		2	
62593			12
62693			12
62893		2	
70393	4		
70693		2	
10194	4		
10294	4		
10394	4		
10594		2	
10694		2	
10794		2190	
10894		2	
10994	4		

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
11294			12
11494			730
11594			12
50494			2
50694		2	
51094			2
51194		2	
51294		12	
51494			730
51594			12
52894	4		
52994	4		
56994		2	
57094		2	
59594		2	
60294		2	
60994		2	
60695		2	
60795		2	
61295		2	
61495		2	
61595		2	
61695		2	
62395			12
63395		2	
63495		2	
63795			12
63895			12
20196			2
20296			2
20396			2
20496			2
20596			2
20696			12
20796			2
22596	12		
22696	4		
22796	4		
22896	4		
22996	12		
23096	4		
23196	4		
23296	2		
00197	4		
00297	4		
00397	4		

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
00697	4		
00597	4		
00797	4		
00897	4		
00997	12		
02197	4		
02297	4		
02397	4		
02497	4		
10098	12		
10198	4		
10298	4		
10398	4		
10498	4		
10598	4		
20998		4	
15199	2		
15299	2		
15399	2		
15499	2		
15599	4		
15699	4		
15799	4		
16199	2		
16299	2		
16399	2		
16499	2		
16599	2		
18199	4		
18299	4		
18399	4		
18499	4		
18599	4		
18699	4		
18799	4		
18899	4		
40099		4	
40199		4	
40299		4	
40399		4	
40499		4	
40599		4	
40699		4	
40799		4	
40899		4	
40999		4	

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
41099		4	
41199		4	
41299		4	
41499		4	
41599		4	
60299		4	
60499		4	
60599		4	
61099		4	
61199		4	
61499		4	
70099	12		
70299	12		
70799	12		
70899	12		
70999	12		
71099	12		
90099	4		
90199	4		
90299	4		
90399	4		
95099	4		
95199	4		
95299	4		
95699	2		
95799	2		
95899	2		
00100		4	
00200		4	
00400		4	
00500		4	
00600		4	
00700		4	
00900		4	
01000		4	
01100		4	
01200		4	
01300		4	
01400		4	
01600		4	
01700		4	
01800		4	
02100		4	
02200		4	

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APPENDIX E-3 Water Level Monitoring Wells (Cont.)

(Including Water Balance Project wells)

SITE-WIDE1

Well Alluvium	Water Quality	Industrial Area	Background
		BEDROCK	
0386	12		
2186	4		
6286	4		
3087	4		
3687	4		
B206989	4		
B208289	4		
P209389	4		
P209489	4		
P416989		2	
3791		730	
02291	4		
06291		12	
06491	4		
11891	4		
12191	4		
12691	4		
10792	4		
20991		730	
70193	4		
70493	4		
Totals:	**668**	**25204**	**5404**

Note:

Numbers in columns denote measurement frequency per year.

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

4.0 Air Monitoring

November 2000

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4.0 AIR MONITORING

4.1 Introduction

The Air Quality Management (AQM) group within Kaiser-Hill Company's (Kaiser-Hill) 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 at the Rocky Flats Environmental Technology Site (RFETS or Site).. AQM develops compliance, reporting, and recordkeeping strategies that organizations on Site 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 the Site. Additional air monitoring is performed by the Colorado Department of Public Health and Environment (CDPHE) or coordinated by DOE.

The goal of the Site air quality program is to provide a means to assess the impact of Site operations on air quality on and around the Site, and thereby protect the public and the environment. These monitoring programs contribute to the Site-wide environmental protection program by providing data that can be used to quantify and/or characterize the air pathway impact on public receptors.

4.1.1 Air Monitoring Objectives and Regulatory Drivers

Air monitoring programs, on and around the Site, fulfill 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 of the *Code of Federal Regulations (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 performed as 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.

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- Effluent Monitoring:

  — 40 CFR 61, Subparts A and H;
  — CAQCC Regulation No. 8, Part A, Subpart A, , Subpart C, "National Emission Standard for Beryllium," and Subpart H,; and
  — DOE Order 5400.1, *General Environmental Protection Program*, U.S. Department of Energy

- Meteorological Monitoring:

  — 40 CFR 61, Subpart H and CAQCC Regulation No. 8, Part A, Subpart H (meteorological observables used as input to compliance dispersion modeling),
  — 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,* US Department of Energy.

Air monitoring is performed to comply with regulatory requirements and to support the assessment of Site 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 as-low-as-reasonably-achievable (ALARA) principles. These DOE principles provide a conceptual radiation exposure guideline intended to encourage radiation protection practices that are more protective than those of any prescribed standard. The basis for this concept is the acknowledgment that low exposure dose-effect relationships may exist that cannot be measured or demonstrated scientifically. Effluent monitoring is used to verify the efficacy of radiation control mechanisms that are used in the areas containing and handling significant quantities of radionuclide materials. Levels of emissions that cause no concern from an environmental regulatory perspective are sufficient to trigger a proactive investigative response under the ALARA concept.

Ambient monitoring of radionuclides on the Site and at the perimeter is performed by AQM and by CDPHE. Ambient monitoring in the communities immediately adjacent to the Site 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

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ambient monitoring are also used to validate projections made by dispersion modeling. In addition, ambient data from the Site's 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 dose to all receptors as low as reasonably possible by maintaining administrative and physical controls on all potential sources of radiological exposure. Ongoing discussions with stakeholders may lead to enhanced monitoring during some phases of building demolition for some select facilities.

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 on-Site meteorological data.

In cooperation with the surrounding communities, DOE has implemented a five-station Community Radiation (ComRad) Monitoring Program. Independently operated monitoring stations were installed in 1992 in the communities of Arvada, Westminster, Broomfield, and Northglenn. Ambient concentrations of plutonium (Pu), meteorological data, and gamma radiation data are collected continuously using monitoring protocols comparable to those at the Site. Although not a compliance-driven monitoring program, DOE supports this independent evaluation of its potential emissions through grants as a gesture of public assurance of the Site's safe operation.

4.1.2 Site Air Monitoring Scope

The AQM group provides programmatic support to Site operations to assure compliance with all state and federal laws and regulations originating from the CAA and its amendments, and DOE Orders related to the air impacts of Site 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, no violations of air quality regulations, adequate quality assurance/quality control (QA/QC) of the measurement activities, well-characterized data sets, and full reporting of required information to state and federal regulatory authorities. AQM's air quality monitoring programs do not include sampling conducted to support industrial hygiene or radiation worker safety programs, nor is such monitoring covered in this IMP.

4.1.2.1 Ambient Monitoring

The RAAMP monitors airborne dispersion of radioactive materials from the Site into the surrounding environment. Thirty-seven samplers comprise the RAAMP network. Fourteen of these samplers have been included in the perimeter network used to satisfy compliance

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demonstration requirements under the CAA 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 the Site.

Samplers operate continuously at a volumetric flow rate of approximately 40 cubic feet per minute (ft^3/min), collecting airborne particles on two collection surfaces. Coarse particles (larger than about 10 micrometers aerodynamic equivalent diameter) are collected on an oiled impactor surface; fine 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 all RAAMP samplers that are not assigned to special project monitoring (see below). Samples from the compliance demonstration samplers are analyzed monthly for long-lived alpha emitters and subjected to radiochemical separation and alpha spectral analysis, which quantifies specific alpha-emitting radioisotopes. Analyses are performed for specific isotopes of plutonium (Pu), uranium (U), and americium (Am). Samples from a RAAMP sampler located adjacent to the most significant area source on the Site, the 903 Pad, are also analyzed monthly. Sample substrates from RAAMP monitors employed as special project monitors are exchanged and analyzed as described in section 4.5, *Special Project Monitoring*. Samples from the remaining RAAMP monitors are archived for two years against the possibility of analysis.

4.1.2.2 Effluent Monitoring

At weekly intervals, particulate samples from continuous effluent sampling systems are removed from 16 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 any 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.

Effluent sample filters from significant sources are composited monthly for each emission point and analyzed for specific isotopes Pu, U, and Am. In addition, tritium (H-3) samples are collected three times weekly at one location. Detection limits are established to ensure that these radionuclides can be detected at concentrations that would yield a dose to any member of the public equal to 10% of the regulatory standard, using Appendix E guidelines from 40 CFR 61.

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Additionally, samples from continuous effluent sampling systems are collected monthly from six building exhaust systems that have been determined to be insignificant sources (sources having a potential to emit of less than 0.1 mrem/year EDE). These filters are analyzed for long-lived alpha emitters and then composited for annual isotopic analyses. This monitoring effort is not regulatorily required but continues to support specific operational requirements in these buildings. Any radioparticulate emissions from insignificant sources which are not monitored using effluent samplers will be accounted for through the ambient monitoring network.

4.1.2.3 Meteorological Monitoring

Meteorological monitoring is conducted on Site by use of a 61-meter (m) tower instrumented at four levels (ground level and 10, 25, and 60 m). It is designed to provide support for routine monitoring and assessments, and emergency response. A redundant tower, instrumented at 10 m, is located near the primary tower to provide backup data support.

4.2 Rad NESHAP Compliance Monitoring

The Site 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 provides a secondary means of demonstrating compliance through release modeling. The dose contribution from tritium is still evaluated through effluent monitoring and release modeling, since tritium is a gas and is not captured by the RAAMP network.

4.2.1 Ambient Rad-NESHAP Compliance Monitoring

In accordance with the Site closure mission, buildings are being deactivated and decommissioned (D&D), then demolished. In the normal course of the D&D 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 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.

IF The Site 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 The Site must obtain approval for an alternative methodology from the regulatory agency having primacy.

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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/year dose standard. This methodology allows for direct measurement of radionuclide concentrations in air at the Site 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 effluent monitoring; and
- Quality assurance of all 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 Site perimeter).

Temporal: Rolling 12-month average dose calculations.
Monthly calculations of ambient air concentrations.
Monthly isotopic data from RAAMP sampler filter analyses.
Quarterly presentation of concentration and potential dose data.
Weekly alpha-activity screening analyses from effluent sources.
Tritium concentration data from tritium effluent monitoring.
Weekly alpha-activity screening analyses of special project monitors, when in use.

Decision Statement:

IF The measured radiological dose to any member of the public is greater than 10 mrem/yr EDE due to Site operations—

THEN The Site is out of compliance.

Current ambient monitoring data from the RAAMP network indicate that the EDE to any member of the public is less than three percent of the 10 mrem/year EDE standard.

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Table 4-1 gives the required analytical detection limits (MDA) for the ambient sampling network.

Table 4-1
Detection Limits (MDA) for Ambient Air Samplers

Parameter	Required Minimum Detectable Activity (per individual filter) (pCi)	Approximate Sample Volume (m3)	MDA (pCi/m3)
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}

Notes:
There are two separate filter substrates per sample.

4.2.2 Effluent Compliance Monitoring

If necessary, compliance may be demonstrated using effluent monitoring. To accomplish this, the following critical inputs must be evaluated:

Inputs:

- Monitored concentrations of Pu-239/240, Am-241, U-233/234, U-235, U-238, and H-3 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 all unmonitored Site activities having potential to emit radionuclides;
- Verification of low emissions for sources not subject to continuous monitoring requirements; and
- Quality assurance of all monitored data.

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Boundaries:

Spatial: All areas hosting activities on the Site that could impact off-Site populations.
Current effluent sampling, occurring at 21 building release points located throughout the Industrial Area.
RAAMP samplers sited with a density that would typically capture a plume that has duration of two hours or more (37 locations).

Temporal: Rolling 12-month dose estimates.
Quarterly estimates of emissions reported to public.
Monthly isotopic data from significant emission points.
Tritium concentration data from tritium effluent monitoring.
Weekly alpha-activity screening analyses from effluent sources.

Decision Statement:

IF The estimated radiological dose to any member of the public is greater than 10 mrem/yr due to Site operations—

THEN The Site is out of compliance.
The Site continues to perform continuous effluent monitoring for all significant sources. Current dispersion model predictions using data from this monitoring yield estimated doses that are three orders of magnitude below the regulatory standard at the Site boundary.

Monitoring Requirements:

A continuous effluent monitoring system must be installed and/or activated for analytes identified in above inputs for significant sources. Sample filters from significant source effluent monitoring systems are analyzed monthly. Sample filters from insignificant sources are collected monthly and analyzed as an annual composite.

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 minimum detectable activity (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
Detection Limits (MDA) for Effluent Air Samples

Parameter	Required Minimum Detectable Activity (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}
Tritium (H-3)	27	1.81	14.9

Notes:

pCi = Picocuries
Am = Americium
Pu = Plutonium
m^3 = Cubic meters
MDA = Minimum Detectable Activity
U = Uranium

4.3 Meteorological Monitoring

Continuous meteorological monitoring is conducted in the northwest Buffer Zone using a 61-m tower, instrumented at four levels (ground and 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 hydrogeological assessments.

4.3.1 Data Use for Rad NESHAP

Collected meteorological data are used as Site-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 Site-specific emergency response model (Computer Assisted Protective Action Recommendations System [CAPARS], formerly the Terrain Responsive Atmospheric Code [TRAC]). Fifteen-minute averaged data are used to calculate

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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 Site 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 the Site. 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 and/or monitoring requirements. Modeling is also being performed to support the Actinide Migration Study, 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 all three of the above data needs. Inputs to the meteorology decisions include:

Inputs:

- Site-specific wind speed, wind direction, temperature, and relative humidity;
- Site-specific rainfall data;
- Atmospheric stability class calculations; and
- Solar radiation data.

Boundaries:

Spatial: Representative air flow patterns impacting the Site.
A minimum of 10 m above ground level.

Temporal: Continuous data, averaged every 15 minutes.
Hourly averaged data, calculated from the 15-minute averages.
Annually averaged data and frequency distributions.

Decision Statement:

IF Regulatory compliance, emergency response, or risk assessment modeling is performed at RFETS—

THEN Standard, consistent, Site-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 Site-required modeling programs (EPA 1987).

4.4 CDPHE Air Monitoring

4.4.1 Air Pollution Control Division (APCD) Non-Radiological Ambient Air Quality Monitoring

Pollutants regulated under the CAA National Ambient Air Quality Standards (NAAQS) are monitored along the Site perimeter by the CDPHE Air Pollution Control Division (APCD). Ambient sampling for beryllium (Be) is also performed by CDPHE to verify compliance with CAQCC Regulation No. 8.

4.4.1.1 Ambient Nitrogen Dioxide (NO2) and Particulate Monitoring

Inputs:

- Ambient particulate and NO_2 concentrations; and
- Meteorological data, especially wind direction.

Boundaries:

Spatial: Property boundaries. Data characterizes concentrations as air enters the Site and leaves the Site. These concentrations continually change with wind direction.

Temporal: Continuous NO_2 measurements. No specified time increment for determining difference but averaging time for NO_2 standard is annual.

Particulates. Every sixth day, a 24-hour sample is collected and used to generate a quarterly estimate. Averaging times for PM_{10} standards are 24 hours and annual.

Decision Statement:

IF A perimeter monitor detects an exceedance of an ambient NO_2 [0.053 parts per million (ppm)] or fine particulate (PM_{10}) [50 micrograms per

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cubic meter ($\mu g/m^3$) annual and 150 $\mu g/m^3$ 24-hour] standard, and the difference in concentrations of PM_{10} or NO_2 at upwind monitors and downwind monitors indicates that the Site may be a primary contributor to the exceedance—

THEN The Site's operating permit may be reopened and potentially revised to mitigate the exceedance.

4.4.1.2 Beryllium Monitoring

Inputs:

- Emission source assessment data, Air Pollutant Emission Notices (APENs); and
- Stack test data.

Boundaries:

Spatial: Emission points (stacks) of applicable sources.

Temporal: 24-hour sampling average.

Decision Statement:

IF Be emissions from sources subject to CAQCC Regulation No. 8 (40 CFR 61, Subpart C) exceed 10 grams per 24-hour period—

THEN CDPHE may take enforcement action.

Inputs:

- Ambient Be sampling data; and
- Meteorological data.

Boundaries:

Spatial: Site fenceline.

Temporal: Samples are composited for quarterly decisions.

Decision Statement:

IF	Ambient Be concentrations due to sources subject to CAQCC Regulation No. 8 (40 CFR 61, Subpart C) exceed 0.01 $\mu g/m^3$ averaged over a 30-day period—
THEN	CDPHE may take action to identify the source.

4.4.2 Laboratory and Radiation Services Division (LARS) Radiological Ambient Air Quality Monitoring

CDPHE's Laboratory and Radiation Services Division (LARS) has monitored radioactive emissions from the Site since 1969. The primary purpose for this sampling has been to provide an independent assessment of public exposure to radioactive material released from the Site. LARS's monitoring program has provided validation of sampling methods used by Site organizations; confirmation of Site measurements of Pu in air; and, on occasion, helped identify errors made by Site monitoring personnel. The data are compared to Derived Concentration Guides for 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.

Currently, concerns about releases during accidents or off-normal situations continue to arise and may increase as cleanup progresses. Emergency response plans for the Site include provisions for sampling environmental media after a plume dissipates. The continuous air samplers operated by LARS allow the state 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 APCD in its evaluation of Site compliance with NESHAP requirements, as well as providing documentation for ALARA decisions, which may arise during cleanup.

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4.4.2.1 Radiological Ambient Air Quality Monitoring

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 perimeter samplers.

Boundaries:

Spatial: LARS currently samples air at 12 locations: four east of the Industrial Area, four in the Buffer Zone, and four near the Site boundary. Total suspended particulates (TSP) are sampled at all locations. One location from each category has a collocated PM_{10} sampler.

Temporal: Individual samples are collected continuously for one week. Fractions of 13 samples are composited and analyzed as quarterly samples, corresponding to calendar quarters.

Decision Statement:

IF Any measurement of radionuclides in the air exceeds the normal variation seen in historical and baseline measurements—

THEN A series of actions may be taken.

These actions include, but are not limited to, re-analysis of composite samples for verification; analysis of individual samples included in the composite; a request for analysis of comparable samples from the nearest DOE ambient samplers, ComRad Program samplers, and/or APCD samplers; a request for investigation or explanation of elevated results from DOE or its contractor; a calculation of public dose and/or risk; and a presentation of analysis and investigation results to CDPHE management, and in public forums, as requested.

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IF The student's T-test or other appropriate test to determine if the latest data point exceeds the seasonally adjusted historical range indicates exceedance of the normal range—

THEN Investigate cause; otherwise trend analysis.

Limits On Decision Errors:

Since Pu and Am have historically constituted a small fraction of the measured gross alpha concentration, extremely high concentrations of these nuclides would be required to result in an elevated gross alpha result. Such a sample would also be difficult to detect when composited with 12 samples in the "normal" range. Therefore, narrow limits on what is defined as the normal range and a fairly high chance of a false positive result will be necessary to identify any unplanned short-term release. In the absence of real or 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 APCD and 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)
APCD Pu-239/240	1,500	4.0×10^{-6}
APCD Am-241	1,500	4.0×10^{-6}
LARS Pu-239/240	3,400	1.0×10^{-6}
LARS Am-241	3,400	1.0×10^{-6}

Notes:

PCi= Picocuries
m^3= Cubic meters
Pu= Plutonium
Am= Americium
MDA= Minimum Detectable Activity
U= Uranium

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4.4.2.2 Precipitation Sampling

LARS collects samples of precipitation at four locations, one east of the Industrial Area, one near the 903 Pad lip area, one at the Site boundary on Indiana Street, and one at the CDPHE laboratory building in east Denver. All samples are analyzed for tritium. When sufficient sample volume is collected, they are analyzed for gross alpha/beta, Pu-239/240, and Am-241. It is recognized that the Site vicinity rarely gets enough precipitation for either atmospheric washout or deposition to have significant environmental effects, but these data are collected against the possibility that environmental modeling attains a level of sophistication where such inputs could be useful.

Inputs:

- Location;
- Sample volume
- Meteorological data
- Sample concentration of Am, Pu, gross alpha, and gross beta.

Boundaries:

Spatial: Sample locations are given above.

Temporal: All precipitation in a calendar quarter is collected and composited. Results correspond to a given quarter.

Decision Statement:

IF Any measurement of radionuclides in precipitation exceeds the normal variation seen in historical and baseline measurements—

THEN A series of actions may be taken. These include, but are not limited to, re-analysis of the samples for verification; analysis of individual ambient air filters from the same quarter; a request for analysis of comparable filters from the nearest DOE, ComRad, or APCD program samplers; a request for investigation of the results

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from DOE or its contractor; and a request for CDPHE and DOE modeling efforts to examine the environmental effects of such deposition.

Limit on Decision Errors:

All measurements are reported at the 95% confidence level. It is recognized that historically, there has been an inverse relationship between sample concentration and sample volume.

4.4.2.3 Particle Size Distribution Monitoring

A cascade impactor is used to separate airborne particulate material into seven size fractions. The size distribution of airborne particles is of concern because the size of the particles to which contaminants are attached is a determinant of the degree of hazard they pose; generally, smaller particles are inhaled more deeply and retained in the respiratory system for a longer period of time than larger particles. Both DOE and CDPHE have conducted particle size-distribution studies. The CDPHE studies are more recent and have been performed at the edge of the Industrial Area (just east of the east security fence), in the Buffer Zone, and at the Site perimeter on Indiana Street.

Inputs:

- Pu and Am concentrations, suspended particulate material concentrations, Pu/Am ratio and U-234/U-238 ratio, all by particle size, together with International Commission on Radiation Protection (ICRP) data relating to inhalation and retention of particulate material by particle size.

Boundaries:

Spatial: Data collection from the E-1 (east of security fence) is complete, unless additional information is needed. Data collection from the E-2 platform (east Buffer Zone) is also complete. Data collection from E-3 platform (Indiana Street) will be completed in December 1998. Similar data from the D-13 ground level sampler (directly below the E-1 sampler) is still needed.

Temporal: Samples were collected at the E-1 platform for three years; the quantity of data is now probably sufficient to make conclusions about the variability in the particle size distribution (relative amounts in each

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size fraction) with respect to changes of season and the passage of time. Since the concentrations of airborne contaminants from Rocky Flats are generally lower at the E-2 and E-3 platforms, the uncertainty associated with those measurements may be too great to draw precise or reliable conclusions.

Decision Statements:

IF Results of the size-distribution studies are well quantified and statistically valid—

THEN The results will be made available for future quantitative and qualitative assessments of dose impacts from the Site.

Discussion:

If there is no seasonal variation, annual variation, or variation with distance from the source in the particle size distributions, the estimates of hazards (e.g., radiation dose) from airborne particulate material will be mostly straightforward and the overall precision and certainty of conclusions will be high. If the mean particle size (or more broadly, the particle size distribution) is approximately the same as assumptions that have been made about particle size, then decisions that have been made by CDPHE in the past about the health effects of Rocky Flats and for emergency planning have been reasonably conservative, but not excessively so. Similarly, if the mean particle size (or more broadly, the particle size distribution) is approximately the same as what has been measured in the past by the Site, then reconciliation of the data sets, and the conclusions that have been drawn in the past, will be straightforward. If consensus can be gained as to the reliability and utility of the data set, the results will provide a useful tool for reconstruction of estimates of hazards from the past, for estimating the health-related impacts of remediation and other future decisions, and for emergency planning.

Limits On Decision Rule:

Not necessary. LARS typically calculates 95% confidence intervals on all radiometric measurements, and plans to place 95% confidence intervals on estimates drawn from the data. Other statistics will accompany the data set to allow future estimations to be made at whatever confidence level is selected. Data precision in measurements is as high as current environmental survey techniques are likely to allow.

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4.5 Special Project Monitoring

Deactivation and decommissioning (D&D) and environmental restoration (ER) programs require air quality assessments to evaluate potential emissions from planned remedial action projects. As a result of these assessments, air quality monitoring may be performed during the project due to either risk assessment or CAA air quality screening results. Project-specific ambient monitoring may also be triggered by soil screening measurements performed for radiation worker protection.

4.5.1 Special Project Ambient Air Radiological Monitoring

As outlined in project-specific operations plans or in Site-wide RFCA standard operating protocols, whenever a D&D or remediation project has a significant potential to release radionuclides, enhanced radiological ambient air monitoring will be implemented. The existing RAAMP sampling network will provide the framework for this enhanced 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 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 will be conducted during the same time period. This will result in area-wide enhanced radiological air monitoring being conducted, possibly in conjunction with multiple Site demolition and remediation projects.

If warranted, area-wide enhanced air monitoring plans will be prepared for incorporation into project decision documents. Enhanced radiological ambient air monitoring will be conducted for D&D and remediation activities within the Industrial Area (IA) and for remediation activities in contaminated areas of the Buffer Zone, as needed. Specific RAAMP samplers in and around each area will be activated to gather representative data. Filters will be collected weekly and screened for long-lived alpha contamination. Results of the alpha screening will be available approximately 3 workdays following submittal of 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/year off-Site dose rate, and action level 2 will correspond to a 5.0 mrem/year off-Site dose rate, calculated as if emissions were to continue at those levels for the entire year.

For radionuclide emissions corresponding to concentration level 1 or less, enhanced monitoring will continue, with weekly filters being screened for alpha contamination. If concentration level 1 is exceeded, weekly filters from the area-specific samplers will be submitted for isotopic analysis on an expedited schedule, and Air Quality Management personnel will meet with project personnel to evaluate the project(s) for possibly unexpected

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conditions and to determine what additional sample collection and analysis is warranted. If concentration level 2 is exceeded, weekly filters from the area-specific samplers will be submitted for isotopic analysis on an expedited schedule, and Air Quality Management personnel will meet with project personnel to reassess project parameters and implement mitigative measures to reduce future emissions. The results of expedited isotopic analyses will be available approximately two weeks following filter gross alpha screens. The isotopic data will quantify the various uranium, plutonium, and americium isotopic concentrations on the filters. Also, if warranted due to known upset conditions, sample changes can be accelerated at other RAAMP samplers and/or additional expedited isotopic analyses can be requested.

Inputs:

- Types and quantities of potential contaminants of concern that may be emitted by each project.
- Site-specific meteorological data; and
- Project and process descriptions and schedules.

Boundaries:

Spatial: Perimeter of IA and contaminated areas of the Buffer Zone.

Upwind and downwind sampling locations. Up to 10 sampling locations could be utilized to ensure representative sample capture relative to wind direction.

Temporal: Continuous sampling during periods of potential high emissions for multiple days. Continuous sampling is needed to capture sufficient sample volume for analysis.

Decision Statement:

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 Site action limits—

THEN Radionuclide concentrations at area-specific RAAMP samplers will be tracked 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.

Monitoring Requirement:

For IA and Buffer Zone area-wide enhanced radionuclide air monitoring, area-specific RAAMP samplers must be activated as necessary to gather representative data. The actual number of samplers and their locations must be determined based on the location and the extent of the source area. The period and frequency of sampler operation will be determined by the project activities, action levels established for the projects, and duration of demolition and remedial activities that have the potential to emit significant quantities of radionuclide materials.

4.6 References

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Rocky Flats Environmental Technology Site

Integrated Monitoring Plan
Background Document

5.0 Ecological Monitoring

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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 the Site. Ecological monitoring at Rocky Flats Environmental Technology Site (RFETS or the Site) has historically focused on characterization of the ecological components within the Buffer Zone and compliance with a variety of regulatory drivers [e.g., the Endangered Species Act, the Fish and Wildlife Coordination Act, the Bald Eagle Protection Act, the Migratory Bird Treaty Act, wetlands regulations, weed control acts, the National Environmental Policy Act (NEPA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)]. The monitoring requirements presented here were established through implementation of the data quality objective (DQO) process and represent a program that emphasizes natural resource conservation, habitat management, and regulatory compliance.

Since the Ecological Monitoring Program deals with a large and dynamic natural system, where established endpoints (i.e., discharge permit limitations) do not exist, a qualitative, rather than a statistical, approach was adopted. The program, therefore, focuses on collection of data necessary to ensure regulatory compliance and to assess the success or failure of the U.S. Department of Energy's (DOE's) resource conservation and habitat management efforts. These conservation and management efforts are aimed at achieving a set of management goals consistent with DOE's demonstrated desire to practice ecosystem management (Congressional Research Service, 1994) and resource conservation (DOE, 1994) on its properties.

These policies provide part of the basis for developing a set of environmental management goals and associated monitoring requirements that support ecological management decision making as part of the *Integrated Monitoring Plan* (IMP).

5.2 Ecological Conservation and Management Goals and Objectives

5.2.1 Goals

Ecological conservation and management goals include the protection of currently viable ecosystems, unique and ecologically valuable natural resources, and any special-concern species (threatened, endangered, candidate, proposed, state-listed, or other sensitive species), as well as compliance with applicable wildlife and natural resource protection regulations. Additionally, early detection and management of problems or undesirable impacts to the Buffer Zone before they become severe is extremely important.

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Specific conservation and management goals for the major identified vegetation communities and one species of particular interest are presented in Table 5-1.

Table 5-1
Conservation and Management Goals

Vegetation Community	Management Goal
Xeric Tallgrass Prairie	Maintain current quantity (area) and quality of the vegetation community, and maintain the current populations of bird and mammal species characteristic of xeric tallgrass prairie.
Tall Upland Shrubland	Maintain current quantity (area) and quality of the vegetation Community, maintain the current populations of bird and mammal Species characteristic of tall upland (seep) shrubland, and maintain current population numbers and extent of Preble's meadow jumping mice within the habitat.
Great Plains Riparian Woodland Complex	Maintain current quantity (area) and quality of the vegetation Community, maintain the current populations of bird and mammal Species characteristic of the riparian woodland complex, and maintain current population numbers and extent of Preble's meadow jumping mice within the habitat.
High Quality Wetlands	Maintain current quantity (area) and quality of the vegetation Community, and maintain the current populations of bird and mammal species characteristic of the largest contiguous high quality wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Wetlands Complexes).
Mesic Mixed Grassland	Maintain current contiguous extent of mesic mixed grassland for Heavily and frequently used wildlife areas, and maintain the current populations of bird and mammal species characteristic of this Vegetation community.
Aquatic Community	Maintain current populations of aquatic organisms including invertebrate and vertebrate species characteristic of the stream and pond environment at the Site.
Species of Particular Interest	
Preble's Meadow Jumping Mouse Populations	Maintain the current quantity (area) and quality of Preble's meadow jumping mouse habitat and protect all extant populations of Preble's meadow jumping mice.

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5.2.2 Objectives

The two primary objectives for the ecological monitoring are to determine if the Site is:

- Meeting ecological conservation and management goals; and
- Complying with regulatory requirements.

5.3 Descriptions of Vegetation Communities and the Preble's Meadow Jumping Mouse Populations

Vegetation communities at the Site provide specific habitats for associated wildlife, rare plants, and unusual plant associations. These communities include the xeric tallgrass prairie, mesic mixed grassland, high quality wetlands, tall upland shrubland and the Great Plains riparian woodland complex.

5.3.1 Xeric Tallgrass Prairie

The xeric mixed grassland unit selected for specific monitoring at the Site is the xeric tallgrass prairie. Identification of this vegetation community at the Site is based on the presence of big bluestem (*Andropogon gerardii*), little bluestem (*Andropogon scoparius*), prairie dropseed (*Sporobolus heterolepis*), Indian-grass (*Sorghastrum nuntans*), and/or switchgrass (*Panicum virgatum*). These five species are considered to be tall grass prairie relicts. When they are found in the xeric mixed grassland community with a combined cover of approximately 10% or more, the community is classified as xeric tallgrass prairie. Of these species, only big bluestem and little bluestem are abundant at Rocky Flats.

The soil under the xeric tallgrass prairie is visibly cobbly on the surface and considered to be a sandy clay loam. This vegetation community covers the high, rocky pediment on the western one-third of the Site. The xeric tallgrass prairie vegetation community was selected at the Site for special conservation efforts due to its nationwide rarity.

The xeric needle-and-thread grass prairie, the other unit of xeric mixed grassland at the Site, is also considered rare. This unit is not large enough to justify special management efforts. Xeric needle-and-thread grass prairie is differentiated from xeric tallgrass prairie by a greater cover of needle-and-thread grass (*Stipa comata*) and New Mexico feather grass (*Stipa neomexicana*), than that 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

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soil surface. This vegetation community occupies the tops of many of the eastern-most ridges of the Site.

5.3.2 Mesic Mixed Grassland

Mesic mixed grassland is characterized by western wheatgrass (*Agropyron smithii*) and blue grama grass (*Bouteloua gracilis*). Other common species include green needlegrass (*Stipa viridula*), Canada bluegrass (*Poa compressa*), and Kentucky bluegrass (*Poa pratensis*). The mesic grassland has a more solid turf appearance in contrast to the bunchgrass appearance of the xeric mixed grasslands. Soils are clay loams and do not have the cobbly surficial appearance typical of xeric mixed grassland soils. Most hillsides at the Site are considered mesic mixed grassland habitat.

The quality of these grasslands varies considerably across the Site. The mesic mixed grassland on the western side of the Site has been, and continues to be, significantly degraded by diffuse knapweed (*Centaurea diffusa*), although this problem has been greatly improved through recent weed control efforts. Mesic mixed grassland on the eastern portion of the Site has been degraded by non-native species such as Japanese brome (*Bromus japonicus*), alyssum (*Alyssum minus*), and musk thistle (*Carduus nutans*) more than the same community on the western edge of the Site. 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 the Site. In addition to its essential role as a foraging habitat, the size and isolation of the vegetation community often makes it very important to some wildlife species. A wide variety of grasslands birds breed and forage in this habitat. Small mammals are abundant and diverse and provide a suitable prey base for a variety of avian and mammalian predators. Many of the species supported by this vegetation community are rare or of special concern.

5.3.3 High Quality Wetlands (Rock Creek and Antelope Springs/Apple Orchard Springs Complexes)

The high quality wetlands selected for monitoring and specific conservation efforts are those Site wetlands with the largest contiguous areas and the most complex plant associations. The Rock Creek wetlands are a large, seep-fed wetland complex extending approximately one mile from the foot of the eastern-most seep-fed wetlands to the western-most short marsh areas.

The Antelope Springs/Apple Orchard Wetland Complex encompasses the predominantly wet meadow, short marsh, and tall marsh habitat mosaic of upper Woman Creek

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Drainage Basin. These are also seep-fed wetlands that depend on groundwater discharge for their continued existence.

Predominant vegetation in these wetlands includes cattails (*Typha sp.*) and bulrush (*Scirpus sp.*) in tall marsh community; Nebraska sedge (*Carex nebraskensis*) and Baltic rush (*Juncus balticus*) in short marsh habitat; and prairie cordgrass (*Spartina pectinata*), redtop (*Agrostis stolonifera*), showy milkweed (*Asclepias speciosa*), and Missouri iris (*Iris missouriensis*) in the wet meadow habitat.

These wetlands support a variety of terrestrial and aquatic organisms. Portions of these wetlands have been designated as prime Ute Ladies'-tresses (*Spiranthes diluvialis*) habitat (a federally listed threatened plant that may occur at the Site). Other parts support sensitive amphibian 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 the Site, but small units occur across the Site. This vegetation community may be unique, because no other similar units have been identified outside the general Rocky Flats 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 meadow jumping mouse.

5.3.5 Great Plains Riparian Woodland Complex

Riparian areas are well known for the diversity of plant and animal species they support. The riparian woodland complex at the Site is a combination of two vegetation community classifications: riparian woodland and riparian shrubland, which form a complex mosaic habitat along the drainage bottoms on Site. Due to its contiguous mixture of both trees and shrubs is 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 others.

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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 grosbeaks). 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 meadow jumping mice at the Site and is considered typical habitat for this species. The majority of monitoring, protection, and management of Preble's meadow jumping mouse habitat will occur in this community.

5.3.6 Aquatic Community

The aquatic ecosystem at the Site consists of a network of ephemeral and intermittent streams across the Site, with some old stock ponds scattered across the Site. In the Walnut Creek and Woman Creek drainages, there are several water management impoundments that retain large, permanent ponds of water. Additionally, numerous seep springs feed streams at the Site and provide limited wetland habitat themselves. Other than the outflow of the seeps, and the water in the existing ponds and larger pools, very little permanent water exists at the Site.

During 1991-1992, the Operable Unit 1 Ecological Evaluation (DOE 1992a) and the Baseline Characterization (DOE, 1992b) studies conducted sampling to characterize the aquatic community at the Site. This effort included widespread benthic invertebrate sampling across the Site, and limited fish sampling in ponds and some streams. No fish inventory had been made since then. The Colorado Wildlife Commission (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, with ponds to be sampled on alternate years.

While sampling of the aquatic community attempted to quantify populations through relative abundance sampling, it should be understood that aquatic sampling in the Site's upper headwaters streams did not provide sufficient numbers to estimate stream

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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. Because serious damage may occur to the habitat if an attempt is made to sample 100% of the individuals located in such limited habitat, more intensive sampling is considered inadvisable. After the 2000 field season, fish sampling will be discontinued except under special circumstances.

5.3.7 Preble's Meadow Jumping Mouse Habitat and Populations

The Preble's meadow jumping mouse (*Zapus hudsonius preblei*) is a species of particular concern at the Site because it is listed as threatened by the U.S. Fish and Wildlife Service (USFWS). This listing provides special protection for the species under the Endangered Species Act, and Site actions must be evaluated for potential to impact the mouse.

Preble's meadow jumping mice (also referred to as Preble's mice) have been recorded in all major drainages of the Site: Rock Creek, Walnut Creek, Woman Creek, and the Smart Ditch drainages. Native plant communities in these areas provide a suitable habitat for this small mammal. Jumping mice at Rocky Flats are restricted to riparian areas and pond margins, apparently requiring multi-strata vegetation with abundant herbaceous cover. Preble's meadow jumping mouse populations at the Site are found in association with the riparian zone and seep wetlands across the Site. 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.

5.4 Monitoring DQOs by Vegetation Community

DQOs were developed for monitoring in five important vegetation communities in support of the following key decision:

- Given baseline information, determine whether to reevaluate current management practices to achieve specific vegetation community management goals.

Results from the monitoring of these communities will facilitate the conservation and management of these resources, as well as associated wildlife, rare plants, and unusual plant associations.

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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;
- Estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;
- Assessment of endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic xeric tallgrass prairie within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of xeric tallgrass prairie from the baseline amount;
- New weed species are reported for the vegetation communities;
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the community;

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- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major population decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species; and/or
- Significant change in any of the assessment endpoints–

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;
- Estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;
- Assessment endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest;
- Weed control assessment monitoring, as applicable;

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic tall upland shrubland community within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of tall upland shrubland vegetation community from the baseline amount;
- New weed species are reported for the vegetation community;

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- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species;
- Significant change in any of the assessment endpoints;
- Structural measurements for any characteristic plant species (e.g., area, density, height, and canopy cover) within a known Preble's meadow jumping mouse population area decreases substantially from baseline;
- The area of known Preble's meadow jumping mouse habitat within the unit decreases substantially from baseline; and/or
- Any known permanent population of Preble's meadow jumping 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;
- Estimates of plant, bird, and mammal species richness;

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- Annual weed mapping and photo surveys;
- Assessment endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest;
- Weed control assessment monitoring, as applicable;

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic Great Plains riparian woodland complex community within RFETS.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occurs:

- A measured or anticipated loss of riparian woodland complex vegetation community from the baseline amount;
- New weed species are reported for the vegetation community;
- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;

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- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species;
- Significant change in any of the assessment endpoints;
- Structural measurements for any characteristic plant species (e.g., area, density, height, and canopy cover) within a known Preble's meadow jumping mouse population area decrease substantially from baseline;
- The area of known Preble's meadow jumping mouse habitat within the unit decreases substantially from baseline; and/or
- Any known permanent population of Preble's meadow jumping 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 wetland map and study (restricted to Buffer Zone only);
- Extent of wetlands will be evaluated every five years, with the next evaluation to be done in the year 2000 (to be done by U.S. Army Corps of Engineers);
- Baseline estimates of plant, bird, and mammal species richness;
- Baseline estimates of bird and mammal presence or absence;
- Estimates of plant, bird, and mammal species richness;
- Annual weed mapping and photo surveys;
- Assessment endpoints for the vegetation community and wildlife populations;
- Anticipated or estimated impact area of any proposed project;

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- Identification of any plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Rock Creek and Antelope Springs/Apple Orchard Springs wetland complexes.

Temporal: Yearly decisions from 1997 forward.

Decision Statement:

IF One or more of the following occur:

- 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 and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the plant, bird, or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest or any plant or animal special-concern species; and/or
- Significant change in any of the assessment endpoints—

THEN Evaluate actions to achieve the stated goals.

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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;
- Estimates of bird and mammal species richness;
- Annual weed mapping and photo surveys;
- Anticipated or estimated impact area of any proposed project;
- Identification of any plant or wildlife species populations of interest; and
- Weed control assessment monitoring, as applicable.

Boundaries:

Spatial: Current RFETS geographic boundaries.
All characteristic mesic mixed grasslands within RFETS and its Buffer Zone.

Temporal: Yearly decisions from 1997 forward regarding species richness of characteristic plants, cover of noxious weed species, and bird or mammal species numbers.

Decision Statement:

IF One or more of the following occur:

- A measured or anticipated loss of mesic mixed grassland vegetation community from the baseline amount;
- New weed species are reported for the vegetation community;

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- Weed mapping and/or photo surveys indicate weed species are spreading or increasing in the vegetation community;
- Weed control assessment monitoring indicates low effectiveness of a treatment option;
- A decline in the bird or mammal species richness or densities;
- Loss or major decline of any of the predominant plant, bird, or mammal species from the vegetation community;
- Loss or major decline of any population of an identified plant species of interest, or any plant or animal special-concern species; and/or
- Significant change in any of the assessment endpoints—

THEN Evaluate actions to achieve the stated goals.

5.4.6 Aquatic Community

Decision Statement:

IF One of the following occurs:

- A fish kill is observed;
- A decline in fish species richness is observed; or
- Abnormalities in fish are observed—

THEN Evaluate actions to achieve the stated goals.

5.5 Design for Integrated Ecological Monitoring

5.5.1 Decision Errors

Limits on decision errors were stated by the planning team as follows:

- Reasonable expectation that monitoring will detect any change of interest listed above;

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- Reasonable expectation that monitoring will not incorrectly indicate that one or more changes occurred, triggering an unnecessary evaluation of management actions;

- Reasonable expectation that monitoring will detect the presence of special-concern species and any impacts to such species; and

- Reasonable expectation that compliance with applicable regulations can be achieved.

Decision errors and their consequences are presented in Table 5-2.

Table 5-2
Decision Errors and Their Consequences

Decision Error	Consequences
Fail to detect one or more changes of interest that would lead to an evaluation of management actions. (This error type is of greater concern.)	Vegetation 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.

5.5.2 Statement of Need

The Site requires an Ecological Monitoring program that will provide data that can be used in management and conservation decisions during the Site cleanup over the next decade. In addition to data required for management and conservation decisions, the Site must remain in compliance with all applicable wildlife and wetland protective regulations. To meet this need, the proposed Site ecological program will monitor key variables over time in each of five vegetation communities. The data collected will be used to make discrete, but ongoing, determinations regarding changes in those key variables. These determinations will drive decisions regarding ecological protection and compliance decisions.

5.5.3 Monitoring Design

The design of the Ecological Monitoring program follows the development of decision rules regarding conservation and regulatory compliance at the Site. These decision rules

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specify the measurement and evaluation of analytical parameters for five vegetation communities and for Preble's meadow jumping mouse populations at the Site. They also specify the criteria that will help ensure regulatory compliance. These criteria, if detected for any of the variables, will trigger a reevaluation of ecological conservation actions or Site project designs. These decision rules are formulated such that each can independently trigger an action. This is important, since it will be fundamental to the way evaluations are structured. Evaluations are structured to parallel the independence of decision rules.

The Ecological Monitoring program is designed to collect representative data from all sensitive and important vegetation communities at the Site to provide an integrated basis for decisions on vegetation community conservation and management, special-concern species protection, wetlands protection, and mitigation for all Site actions. The continuous data collection in representative vegetation communities across the entire Site allows ecologists to track trends in wildlife and selected plant communities seasonally and annually. Comparisons over time allow ecologists to detect changes, identify potential causes, and plan corrective strategies for changes due to Site activities rather than natural fluctuations. Availability of comprehensive data for each vegetation community type at the Site greatly aids compliance and protection evaluations and decision making for specific projects, and avoids the need for many expensive, one-time-only Site-specific studies. Ecologists are able to use data from comparable vegetation community units and extrapolate those data to similar units that may not have been monitored specifically to evaluate the potential presence of plant and animal species populations. With this knowledge, ecologists can make more cost-effective evaluations of ecological concerns and compliance and protection decisions.

The five vegetation communities to be monitored to provide the inputs discussed above were identified on the basis of data collected and analyzed from 1991 to 1995. These baseline data were evaluated to define the communities at the Site. The most important, or sensitive, vegetation communities were selected for conservation monitoring. Vegetation communities are described in Section 5.3.

Key parameters measured and used in comparisons are presented in Table 5-3. These include:

- Species richness of plants in the vegetation community;
- Species richness of birds in the vegetation community;
- Species richness of mammals in the vegetation community;
- Presence of noxious weeds;

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- Changes in vegetation communities; and

- Preble's meadow jumping mouse populations and associated habitat characteristics in appropriate habitat.

Table 5-3
Parameters to be Measured vs. Vegetation Community

Vegetation Community	Measure			
	Preble's Mouse Populations and Habitat Characteristics	Noxious Weeds	Changes in Vegetation Communities	Species Richness (Plant and/or Animal)
Xeric tallgrass prairie		X	X	X
Riparian wood-land complex	X[a]	X	X	X
High quality wetlands		X	X	X
Tall upland shrubland	X[a]	X	X	X
Mesic mixed grassland		X	X	X
All other habitats		X	X	
Aquatic community				X (Fish kills)

Note:
[a] These parameters will be measured where known Preble's meadow jumping mouse populations occur.

5.5.3.1 Vegetation Communities

To summarize, three separate parameters will be evaluated. These parameters are wildlife and plant species richness, presence of noxious weeds, and changes in vegetation communities.

Species richness – Historically, Site personnel have made a number of qualitative measurements of species richness; these measurements will continue. Changes in any of them, when quantified against the decision rule for species richness, should trigger further investigation, including an examination of field notes to offer potential explanations.

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Baseline measurements for species richness in vegetation communities will be determined using data gathered from the Buffer Zone in the years 1993 through 1996 (except the high-value vegetation communities which were baselined in 1997). Species richness surveys will be performed in vegetation communities on a rotating schedule. Data collection will be performed in spring and summer, broken into two distinct data collection periods to ensure that spring ephemerals are recorded, as well as plants that mature late in the growing season.

Noxious Weed – Monitoring will be performed to track the success of weed control strategies at selected locations. Prior to treatment, weed and desirable plant species cover will be characterized in a treatment area. After an appropriate time period for the particular treatment option used, weed and desirable species cover will again be assessed. Management strategies for weeds, including undesirable consequences of certain treatments, can thus be tracked, and strategies will be revised based on real-time results. Weed mapping performed in 1997 will establish baselines for these measurements. This portion of the program will be a component of the integrated weed control program for the Site.

Changes in Vegetative Communities –Changes in Vegetative Communities - Qualitative and quantitative monitoring is conducted in selected communities to evaluate change. Quanitative 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 all monitored vegetation communities . The camera lens used for the photographs will be a standard size for all records made. Photographs will be taken every two years from these survey points in summer and winter seasons for woody communities ; late summer for grasslands. Comparisons of these photographs will be used to determine the type and amount of change that has occurred within these vegetation communities over time. Should visible loss occur to a vegetation community, management and protection strategies will be reevaluated.

Acreage was calculated for each vegetation community following 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 (more frequently depending on current conditions).

5.5.3.2 Preble's Meadow Jumping Mouse

Preble's meadow jumping mouse populations in selected population centers will be monitored annually. Trapping will only occur during the May through September activity period of this hibernator. Habitat characteristics will be monitored by measuring plant species coverage (area), density, height, and canopy cover until each major drainage

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has been thoroughly characterized. This will be done for each major vegetative canopy strata within the habitat. Baseline conditions will be established on the basis of all monitoring through 1996.

5.5.3.3 Mammals and Birds

Species richness and relative abundance measurements will be made on birds and mammals. These parameters can only be assessed annually, after continuous sampling, due to the seasonality of species.

Resident birds and mammals, including special-concern species, uncommon and rare bird and mammal species, will be counted on line transects. The numbers counted will be determined by the dimension and number of the transects, not by the total population at large on the Site. The number of transects will be determined based on available vegetation communities at the discretion of the ecologists on Site. Since decision rules require that an apparent change in bird and mammal species richness, or presence, triggers reevaluation of conservation and management actions, a minimum sampling effort will be undertaken to count representative species at the Site in any given year. Monthly surveys will attempt to record representative species expected to occur in each vegetation community for the current season. Baseline figures were established in the *1995 Annual Wildlife Survey Report* (Kaiser-Hill, 1996).

Bird species analysis – Bird species richness will be measured monthly and assessed within each vegetation community for the seasons and the entire year.

Mammal species analysis – As with bird species richness, mammal species richness will be measured monthly within each vegetation community and assessed for seasons and the entire year.

5.6 Regulatory Compliance Monitoring DQOs

In addition to ecological conservation and habitat protection, specific decisions on threatened and endangered (T&E) species, state species of special concern (SSC), and migratory birds and wetlands must be considered. The initial decision to be made is whether a proposed project has potential to impact T&E and SSC species, migratory birds, or wetlands. Such projects may require mitigation actions before they are allowed to move forward. Much of the data to support these decisions will come from the monitoring of each vegetation community as discussed above. However, this monitoring does not focus on specific areas that may be affected by the footprints of proposed projects. Therefore, additional data needs may arise to support project-specific decisions in accordance with the regulatory requirements as they occur. The discussion that follows is applicable to each of the regulatory drivers. Specific data requirements and a design for sampling and analysis are not included.

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Specific management goals to be supported by these efforts are:

- Protect T&E and SSC species at the Site and comply with applicable state and federal T&E species protection regulations and policies;
- Protect migratory birds at the Site and comply with applicable state and federal migratory bird protection requirements; and
- Protect Site wetlands and comply with applicable state and federal wetland protection requirements.

5.6.1 Threatened, Endangered, and Special-Concern Species

Inputs:

- Seasonal presence/absence, location, and abundance of T&E or SSC species in any area of potential impact by a proposed project;
- Seasonal timing of a proposed project;
- Presence of habitat considered suitable for T&E species;
- Biology of T&E or other species of concern (food habits, home range, habitat preference, nesting habits, etc.); and
- Information about the anticipated impacts of the proposed project.

Boundaries:

Spatial: The area potentially affected by any Site project.

Temporal: The time frame in which a proposed project could occur.
Locations of alternative project sites.
Jurisdictional policies and propriety.

Decision Statement:

IF Any T&E or SSC species, population, individual or habitat may be affected by a proposed project—

THEN Notify project personnel and suggest alternatives for modifying the project.

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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.

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.

Limits on Decision Errors:

The decision will be based on a qualitative study of the area of potential impact, as well as existing information about the potentially impacted area or similar habitat which will be affected. It should be noted that an impact to any *individual*, or *population*, is of concern. Care will be taken to identify any potential impact to T&E species.

5.6.2 Migratory Birds

Inputs:

- Seasonal presence, relative abundance and location of migratory birds or their nests in areas potentially impacted by Site projects;
- Location and seasonal timing of proposed projects that may affect migratory birds; and
- Biology of potentially affected migratory bird species (food and nesting habits, home range, habitat preference, etc.).

Boundaries:

Spatial: The area potentially affected by Site projects.
Specific areas where migratory birds or nest locations overlap the footprint of specific proposed activity (as opposed to the area potentially affected by all possible projects).
Locations of alternative project sites.

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Jurisdictional policies and propriety.

Temporal: The time frame potentially affected by Site projects. Specific time frames where migratory birds, or nest locations, overlap the footprint of a specific proposed activity (as opposed to the area potentially affected by all possible projects).

Decision Statement:

IF Migratory birds, their nests, fledglings, or eggs are present in a location that may be affected by a proposed project—

THEN Notify project personnel and determine whether the project can be altered to avoid impacts.

IF Removal is required—

THEN Obtain removal permits from the USFWS and adhere to any permit limitations.

Limits on Decision Errors:

Decisions will be based on a qualitative study of the area of potential impact as well as existing information on the potentially impacted habitat. Care will be taken to identify and avoid any potential impact to migratory bird species.

5.6.3 Wetlands

Inputs:

- Presence and location of wetlands on the Site (based on 1994 U.S. Army Corps of Engineers wetland report and field verification) (U.S. Army Corps of Engineers, 1994);
- Presence and location of wetlands not mapped by the U.S. Army Corps of Engineers;
- Determination of jurisdictional wetlands presence based on U.S. Army Corps of Engineers wetland delineation manual (U.S. Army Corps of Engineers, 1989);
- Location, timing, and description of proposed projects that potentially impact wetlands; and

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- Jurisdictional policies and propriety.

Boundaries:

Spatial: The area of any Site project.
Specific areas where wetlands overlap the footprint of proposed activities.
Locations of alternative project sites.

Temporal: The time frame of any Site project.

Decision Statement:

IF Any wetland may be affected by a proposed project—

THEN Advise project personnel and seek to redesign the project to avoid wetland impacts.

IF The project cannot be redesigned to avoid impacts—

THEN Proceed with a wetland delineation in accordance with U.S. Army Corps of Engineers wetland delineation guidelines (U.S. Army Corps of Engineers, 1989).

IF The delineation indicates that the wetland is jurisdictional—

THEN Advise DOE of the need to consult with the U.S. Army Corps of Engineers and EPA to determine the need for and amount of mitigation wetland acreage that will be required for the project.

Limits on Decision Errors:

Decisions will be based on qualitative evaluation of the area of potential impact for wetlands and jurisdictional determination of wetlands present. Wetland determination will be governed by performance of a wetland delineation, in accordance with the U.S. Army Corps of Engineers wetland delineation manual (U.S. Army Corps of Engineers, 1989). Care will be taken to identify, and avoid, any potential impact to wetlands. The results of any wetland investigations will be conducted to err on the side of protection.

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5.7 References

Colorado Division of Wildlife, 1998. News Release: *Commission Makes Changes to Threatened and Endangered List*. Denver, Colorado, May 8.

Congressional Research Service, 1994. *Ecosystem Management: Federal Agency Activities*, Library of Congress, Washington, DC., 124p.

Kaiser-Hill Company, L.L.C., 1996. *1995 Annual Wildlife Survey Report. Natural Resource Compliance and Protection Program.* Prepared by PTI Environmental Services. Rocky Flats Environmental Technology Site, Golden, Colorado, April.

Kaiser-Hill Company, L.L.C., 1997a. *1996 Annual Wildlife Survey Report. Natural Resource Compliance and Protection Program.* Prepared by PTI Environmental Services. Rocky Flats Environmental Technology Site, Golden, Colorado, March.

Kaiser-Hill Company, L.L.C., 1997b. *Ecological Resource Management Plan for the Rocky Flats Environmental Technology Site*. Prepared by PTI Environmental Services. Rocky Flats Environmental Technology Site, Golden, Colorado, March.

U.S. Army Corps of Engineers, Environmental Protection Agency, U.S. Fish and Wildlife Service, and Soil Conservation Service, 1989. *Federal Manual for Identifying and Delineating Jurisdictional Wetlands.* An Interagency Cooperative Publication, January.

U.S. Army Corps of Engineers, 1994. *Rocky Flats Plant Wetlands Mapping and Resource Study*. Prepared for the U.S. Department of Energy, Golden, Colorado, Omaha District, December.

U.S. Department of Energy, 1992a. *Draft Phase III FRI/RI Report, Appendix E, Environmental Evaluation, Rocky Flats Plant 881 Hillside Area, Operable Unit 1,* Rocky Flats Plant, Golden, Colorado, October.

U.S. Department of Energy, 1992b. *Baseline Biological Characterization of the Terrestrial and Aquatic Habitats at the Rocky Flats Plant*, Rocky Flats Plant, Golden, Colorado, September.

U.S. Department of Energy, 1994. *Policy 9-19: Erosion Control and Vegetation Stabilization, Revision 0*, Golden, Colorado, January 4.

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6.0 Soil Monitoring

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6.0 SOIL MONITORING

6.1 Introduction

6.1.1 Contaminant History

Since nuclear materials were first processed at the Rocky Flats Environmental Technology Site (RFETS or the Site), the potential for dispersing contaminants into the atmosphere and onto the soils within the Industrial Area and throughout the Buffer Zone has existed due to the inherent hazards associated with handling and processing nuclear materials. Three events at the Site 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 plutonium (Pu) and americium (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 Industrial Area 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 the Site 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 Industrial Area 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 the Site is most accessible in the report commissioned by the Colorado Department of Public Health and Environment (CDPHE) entitled Rocky Flats History - Rocky Flats Toxicologic Review and Dose Reconstruction Task 3/4 Report (ChemRisk, 1992). Background soil contamination at the Site is primarily attributable to global fallout from atmospheric testing of nuclear weapons.

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In addition, a rich database exists from which to determine the contaminant dispersion profiles at and around Rocky Flats. 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 all 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 during the environmental investigations of the early 90s. A discussion of soil sampling methods is discussed in Rocky Flats Plant Final Environmental Monitoring Plan, 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, 1992 (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 data quality objectives (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.

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As noted earlier, a routine Site-wide soil monitoring program was conducted for many years at the Site, with sampling performed by both CDPHE and Site personnel. The 11 years of data reviewed in the 1994 Annual Site Environmental Report (Kaiser-Hill, 1995) do not indicate any 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 the Site 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, the Site 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 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 Industrial Area. 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 Rocky Flats Cleanup Agreement (RFCA) (DOE et al., 1996), this kind of sampling is defined through the project Proposed Action Memorandum (PAM) or an Interim Measure/Interim Remedial Action (IM/IRA) Plan, and the Field Implementation Plan (FIP) or Sampling and Analysis Plan (SAP). 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.

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6.5 Outstanding Issues—Actinide Migration Study

Questions remain regarding the immediate and long-term potential for contaminated soils to disperse from the Site. 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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6.6 References

ChemRisk, 1992, *Rocky Flats History - Rocky Flats Toxicologic Review and Dose Reconstruction Task 3/4 Report* commissioned by the Colorado Department of Public Health and Environment.

EG&G, 1992. *Rocky Flats Plant Final Environmental Monitoring Plan.* Golden, Colorado.

Kaiser-Hill Company, L.L.C., 1995. *1994 Annual Site Environmental Report.* Golden, Colorado.

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

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7.0 Interaction Between Media

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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 Rocky Flats Environmental Technology Site (RFETS or the Site). 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.	Data from existing Site-wide surface water monitoring may be used to assess potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes and assess general ecological health. In addition, project-specific evaluations are conducted to assess potential impacts.
Surface Water to Groundwater	Not significant; groundwater recharge from surface water is not significant.	No monitoring is necessary to characterize or assess groundwater impacts.
Surface Water to Air	Not significant; surface water quality will not significantly impact air quality (i.e., cause exceedances of air quality standards).	Any significant impacts on air or water quality will be detected by existing DOE, CDPHE, and project-specific monitoring.
Surface Water to Soil	Potentially significant; water in drainages and ponds will not significantly increase contaminant concentrations in soil; however, runoff could spread contaminants on surface soils and increase sediment concentrations.	Soil monitoring is conducted to determine the impacts of surface water runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.

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Table 7-1
(continued)

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Groundwater to Surface Water	Significant; most of the Site groundwater flows into Site surface water drainages.	Existing surface water monitoring may detect impacts from a limited suite of groundwater contaminants. Starting in FY01, an integrated groundwater/surface water monitoring approach is being developed for performance monitoring of D&D and remediation projects. Data from Site-wide groundwater monitoring (Site-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 Site-wide groundwater monitoring may be used to assess and predict potential ecological impacts. The ecological monitoring program is also designed to detect ecological changes.
Groundwater to Air	Not significant; groundwater will not directly affect air quality.	Existing air quality monitoring will detect air quality degradation, and existing groundwater monitoring will detect groundwater contamination that could impact surface water quality.
Groundwater to Soil	Not significant; groundwater contaminants appear in surface water but are not likely to contaminate surface soils.	Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Air to Soil	Potentially significant; point source and fugitive emission sources could deposit contaminants on soil.	Soil monitoring is conducted to determine the impacts of air emissions and disposition and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project monitoring.
Air to Ecology	Potentially significant; point source and fugitive emissions could deposit contaminants on ecological resources.	The ecological monitoring program is designed to detect ecological changes. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific monitoring.

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Table 7-1
(continued)

Interactions Between Media	Significance at RFETS	Monitoring to Evaluate Interactions
Air to Surface Water	Potentially significant; point source and fugitive emission sources could degrade surface water quality.	Surface water monitoring (Site-wide and project-specific) will detect increases in contaminant concentrations. Also, any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific air monitoring.
Air to Groundwater	Not significant; contaminants in air will not directly impact groundwater quality.	Groundwater monitoring will track groundwater contamination, and air quality monitoring (Site-wide and project-specific) will detect degradation of air quality that could impact other media.
Soil to Surface Water	Significant; contaminants in soils are transported to surface water via runoff and surface water quality is degraded.	Site-wide and project-specific surface water monitoring will detect increases in contaminant concentrations. Soil monitoring is also conducted to determine the impacts of runoff and the extent of required soil removal before, during, and after individual remediation projects. Results of the actinide migration studies will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Ecology	Could be significant; contaminated soils could adversely impact local ecology.	The ecological monitoring program is designed to detect ecological changes. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.
Soil to Air	Significant; contaminants in surface soil are resuspended and air quality is affected.	Any significant impacts on air quality will be detected by existing DOE, CDPHE, and project-specific monitoring. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.

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Table 7-1
(continued)

Soil to Groundwater	Significant; contaminants migrate from surface and subsurface soils to groundwater via percolation.	The existing groundwater well network is designed to detect increases in contaminant concentrations in groundwater. Results of the actinide migration studies also will be used to determine whether existing soil monitoring needs to be modified or expanded.

Notes:
CDPHE = Colorado Department of Public Health and Environment
DOE = Department of Energy
RFETS = Rocky Flats Environmental Technology Site

7.2 Water and Ecological Health

As indicated in Table 7-1, there are interactions between surface water, groundwater, and the flora and fauna of the Site. Concerns have been expressed that changes in flow into and out of the Site could impact significant habitat and species of concern both on Site and downstream (e.g., the Preble's meadow jumping mouse on Site, and whooping cranes in Nebraska). For example, aggregate mining activities at the west-end of the Site may alter surface water flowing onto the Site and could impact species of concern on Site and downstream. In fact, water is one of the key abiotic components structuring some of the significant habitats. The Department of Energy, Rocky Flats Field Office (DOE, RFFO) could be held responsible for these impacts.

Site-specific relationships between water availability and ecological health and the interactions better 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 between media. The Site Water balance activity 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 the site-wide water hydrology is likely to change from present to final site configuration,
2) predict surface water impacts from groundwater for present and final site configuration,
3) provide data to support decisions for final Industrial Area configuration to protect surface water quality (cap and cover design and land recontouring);
4) provide information for the Interim Final CAD/ROD, the comprehensive risk assessment, and the Final CAD/ROD; and
5) provide information to guide the development of the wetlands conversion project.

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The following preliminary decision rules have been proposed:

Preliminary Secondary Data Uses Could Include:

- Determining the impact of mining on Rock Creek water quality and availability;
- Interpreting potential causes of declines in any of the valued habitats on Site;
- Supporting water management planning and Water Right issues;
- Evaluating cumulative impacts of all actions (on and off Site);
- Validating any predicted impacts of a selected alternative on downstream resources; and
- Supporting Site biological assessments and U.S. Fish and Wildlife Service (USFWS) biological opinions.

Table 7-2
Buffer Zone Flow Monitoring Stations

Station Identifiers	Locations	Monitoring in Addition to Flow
GS01	Woman Creek/Indiana Street	RFCA and possible nutrient load monitoring; precipitation
GS02	Mower Reservoir/Indiana Street	
GS03	Walnut Creek/Indiana Street	RFCA and possible nutrient load monitoring; precipitation
GS04	Rock Creek at Highway 128	Precipitation
GS05	North Woman Creek at west boundary	Precipitation
GS06	South Woman Creek at west boundary	--
SW134	Rock Creek at west boundary (Gravel Pit)	(4 samples per year quarterly)
GS16	Antelope Springs	
SW118	Above Portal 3, north side of road	RFCA Source Location

Notes:

IA = Industrial Area
IM/IRA = Interim Measures/Interim Remedial Action
NPDES = National Pollutant Discharge Elimination System
RFCA = *Rocky Flats Cleanup Agreement* (DOE et al., 1996)
RMRS = Rocky Mountain Remediation Services, L.L.C.
SID = South Interceptor Ditch

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Inputs:

- Drainage flow;
- Water level measurements; and
- Stream gain or loss.

Preliminary Boundaries Include:

Spatial: All surface waters entering and leaving the Site in the Rock Creek, Walnut, and Woman Creek drainages.

Temporal: Seasonal and yearly determinations of total water availability and basic water quality.

Preliminary Decision Statement:

IF The seasonal average or yearly average water availability or quality entering Rock Creek, Walnut Creek, or Women Creek drainages diminishes below baseline due to off-Site activities—

THEN The Site will notify Jefferson County and the USFWS to determine what actions, if any, should be taken to restore availability and/or quality to historical levels.

IF Activities occurring within Site boundaries result in a depletion of the seasonal or yearly average natural flow greater than the historic baseline, or at rates that are determined to have a negative impact on downstream habitats or individual species—

THEN The Site will determine what management actions should be taken to ameliorate this problem.

IF Significant changes to alluvial groundwater availability in a wetlands habitat are determined—

THEN Notify parties of potential impacts to the wetlands habitat and continue groundwater and ecological monitoring.

IF A proposed action could adversely affect a listed species or its critical habitat—

THEN The Site will enter into formal consultation with the USFWS.

Preliminary Acceptable Decision Errors Include:

- Confidence that Significant Events are Physically Sampled and Representative:

  — Flow will be continually monitored; seasonal composite samples will be taken to evaluate basic water chemistry. An effort will be made to gather a sample representative of conditions during the season.

- Acceptable Decision Error Rates for Statistical Sampling Design:

  — The function of this monitoring is to provide a watershed-level measure of water availability and quality to serve as an early warning that habitats reliant on these waters may be adversely impacted if changes continue. The Site is more concerned with failing to detect a decrease in water availability or quality over historical levels than mistakenly determining that a decrease has occurred. The precise change over time that is of concern has not been established because the water requirements of the habitats are not fully understood. Therefore, no attempt has been made to establish quantitative limits on decision errors or to generate a statistical design.

  — The integrated monitoring working group will continue to address water and ecology monitoring integration. The group needs to determine how to effectively use the Buffer Zone flow data or eliminate that monitoring altogether. The group also needs to determine if it would be cost-effective to collect additional data and how those data could be used to assess impacts on ecological health.

7.3 References

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

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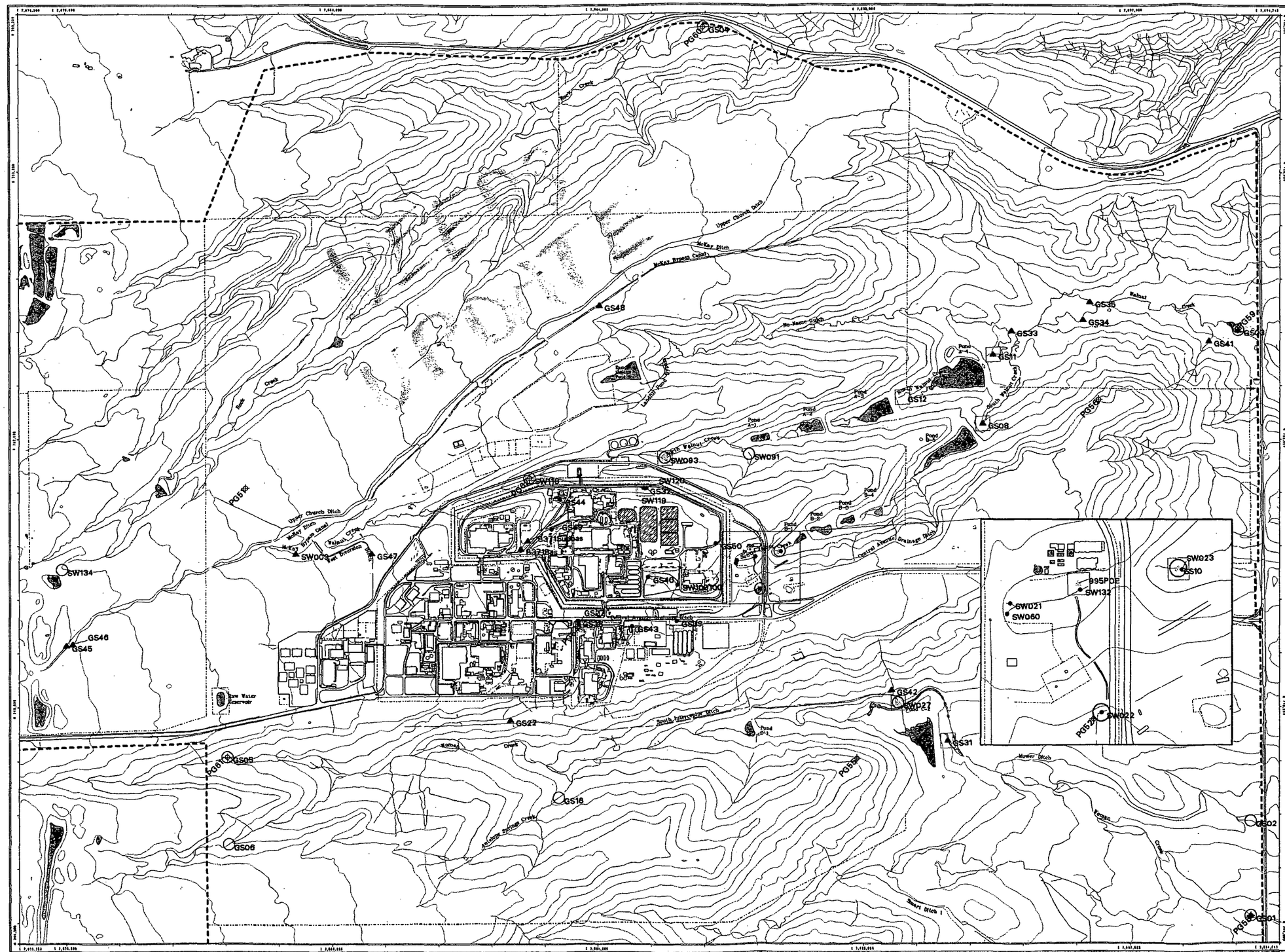


Figure 2-4
Automated Surface Water Monitoring Locations and Precipitation Gages for Fiscal Year 2001

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 (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Rocky Flats boundary
- Paved 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. 1/35
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudson (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.

NOTE:
* The monitoring objective(s) performed at each location are detailed in the Surface Water Section of the Site Integrated Monitoring Plan.

** IDLH (Immediate Danger to Life & Health) refers to the monitoring objective for safe operation of the Site detention ponds.

Scale = 1 : 17870
1 inch represents approximately 1489 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: DynCorp — THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL COMPANY

MAP ID: IN-0227

November 30, 2000

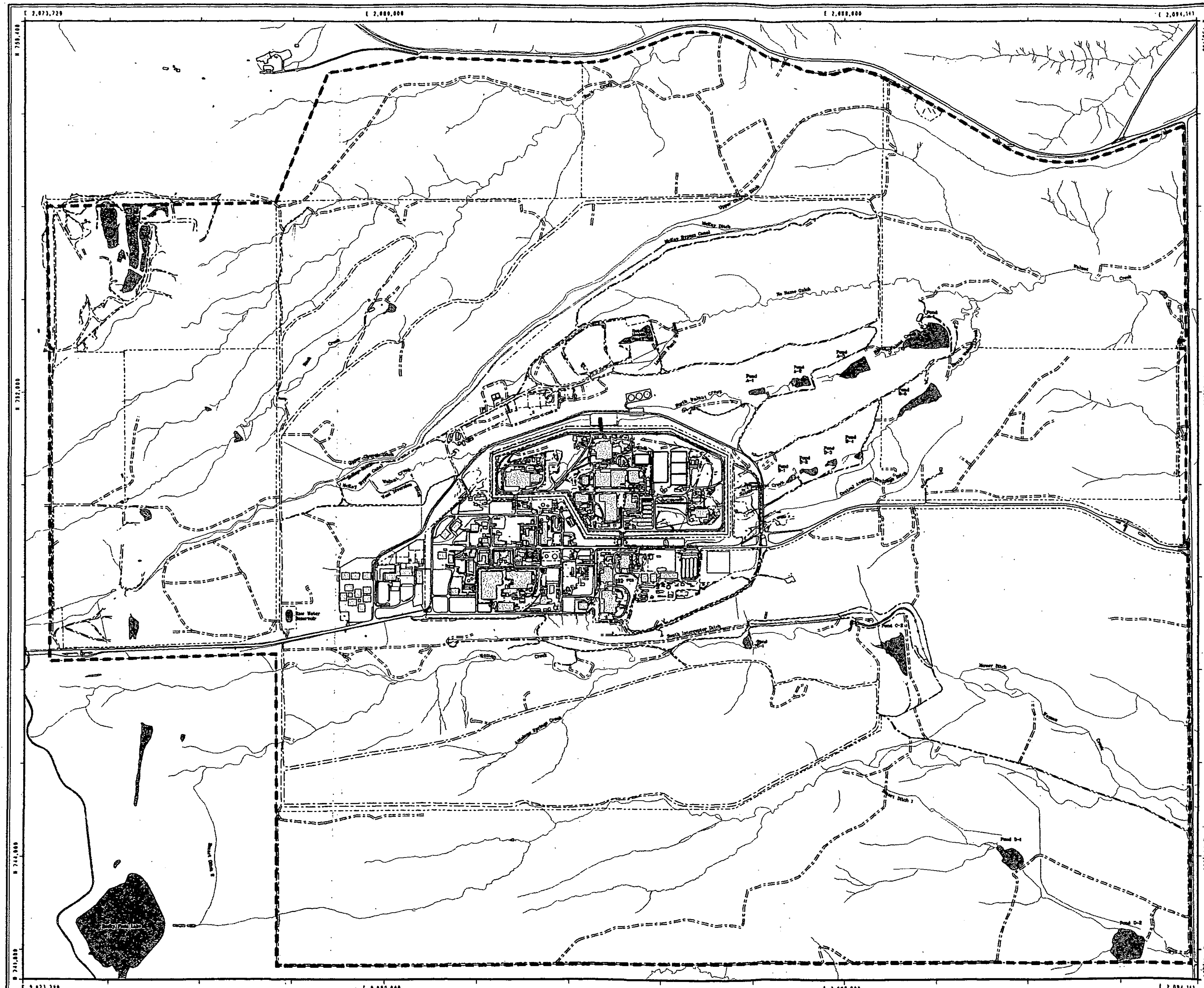
Original map contents are preserved. Logo and date have changed.

NT_Svr w:/projects/fy2001/01-0023/auto-sw-loc-b-imp.aml

92

Figure 3-1

Detention Ponds, Ditches, Effluent Watercourses, and Creeks at RFETS



EXPLANATION

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- 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

500 0 1000 2000 Ft

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:
DynCorp
THE ART OF TECHNOLOGY

Prepared for:
KAISER-HILL COMPANY

MAP ID: 97-0063
November 27, 2000

Original map contents are preserved. Logo and date have changed.

NT_Svr w:/projects/fy97/97-0063/surf-features99.aml

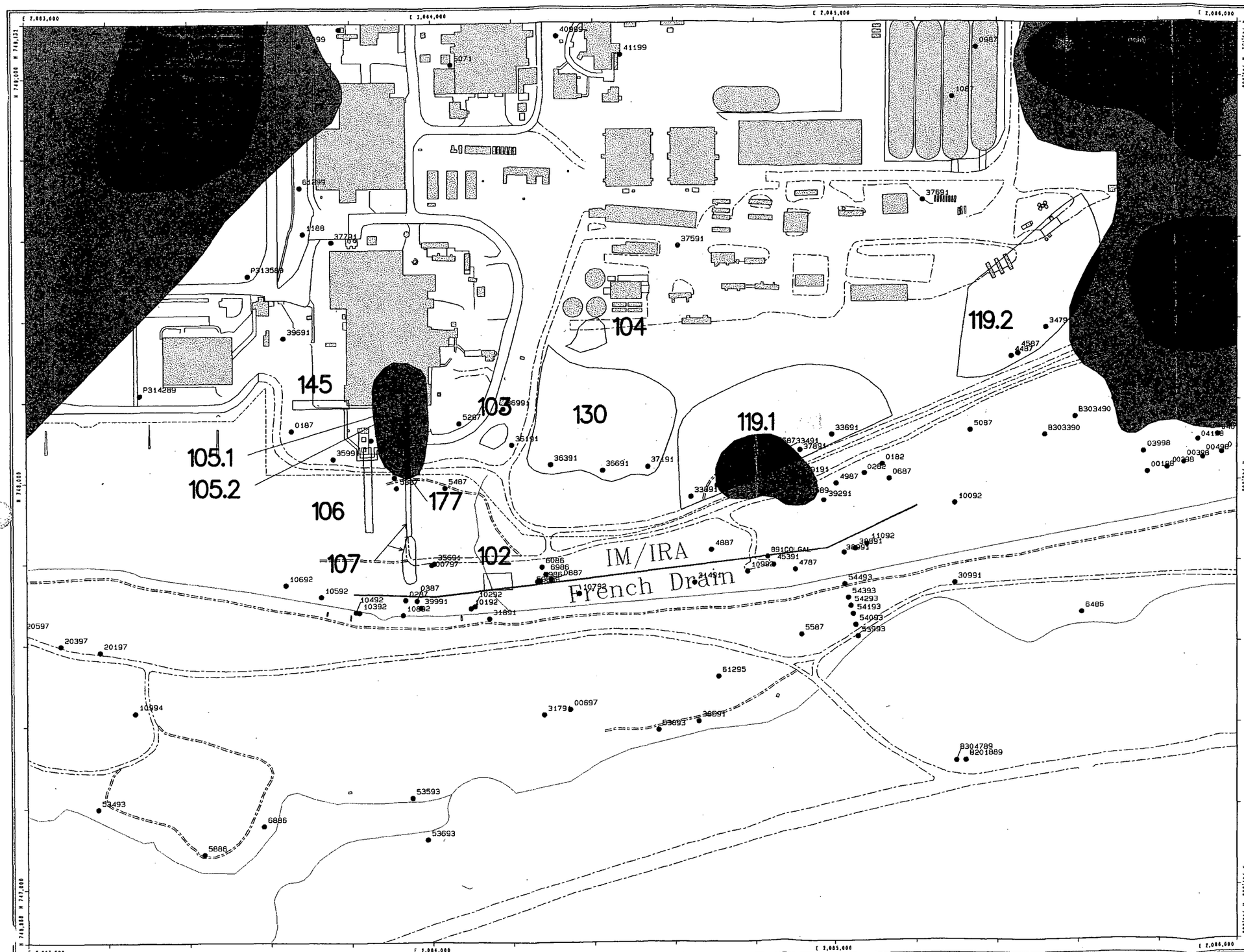


Figure D-1

Individual Hazardous Substance Sites of OU 1, 881 Hillside Area

EXPLANATION

- Groundwater Monitoring Well Locations
- Individual Hazardous Substance Sites
- Composite VOC Groundwater Plume (100 X MCL)
- Composite VOC Groundwater Plume (concentration equal to MCL)

Standard Map Features

- Buildings
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences
- Rocky Flats boundary
- Paved roads
- Dirt roads

DATA SOURCE 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. V95

Scale = 1 : 2920
1 inch represents approximately 243 feet

100 0 200 400ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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Prepared by: DynCorp — THE ART OF TECHNOLOGY

Prepared for: KAISER-HILL COMPANY

MAP ID: 99-0372

November 28, 2000

NT_Svr w:/projects/fy99/99-0372/ou1a_nt.aml

283

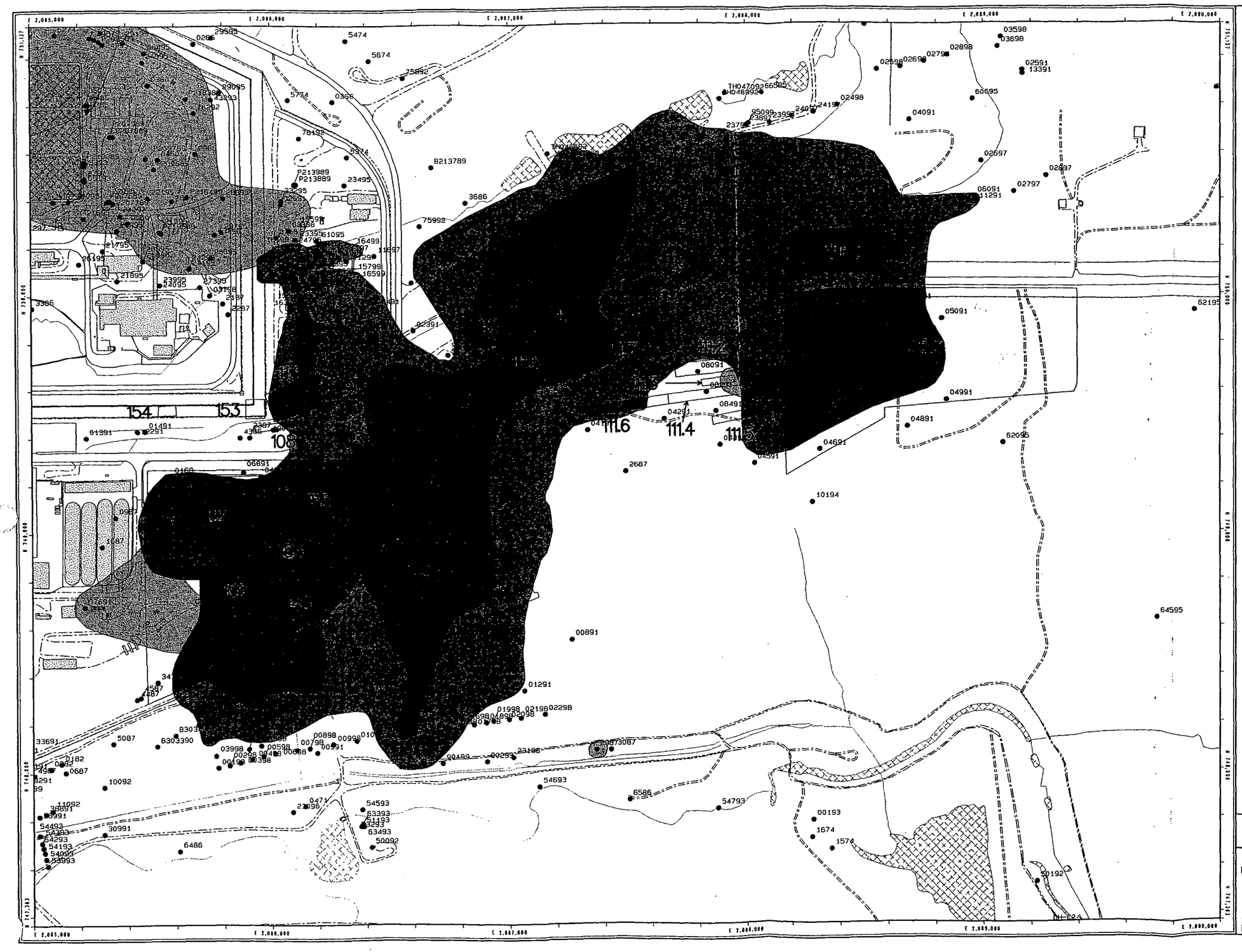

Figure D-2

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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Rocky Flats Environmental Technology Site

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Prepared for: KAISER-HILL COMPANY

MAP ID: 99-0372

November 28, 2000

NT_Svr w:/projects/fy99/99-0372/ou2e_nt.aml

286

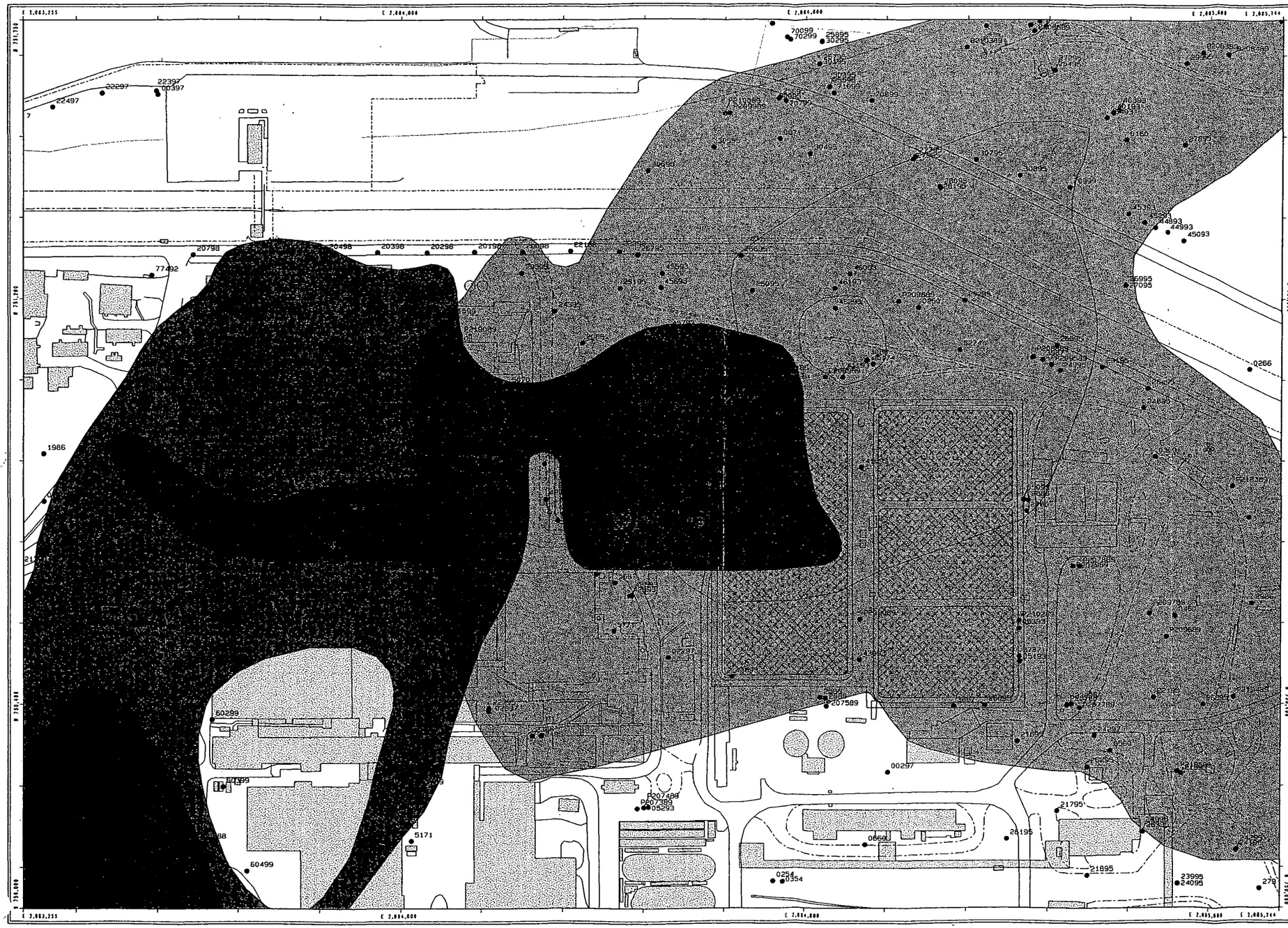

Figure D-3

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

N

Scale = 1 : 2500
1 inch represents approximately 208 feet

50 0 100 200ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 99-0372

November 28, 2000

NT_Svr w:/projects/fy99/99-0372/ou4a_nt.aml

284

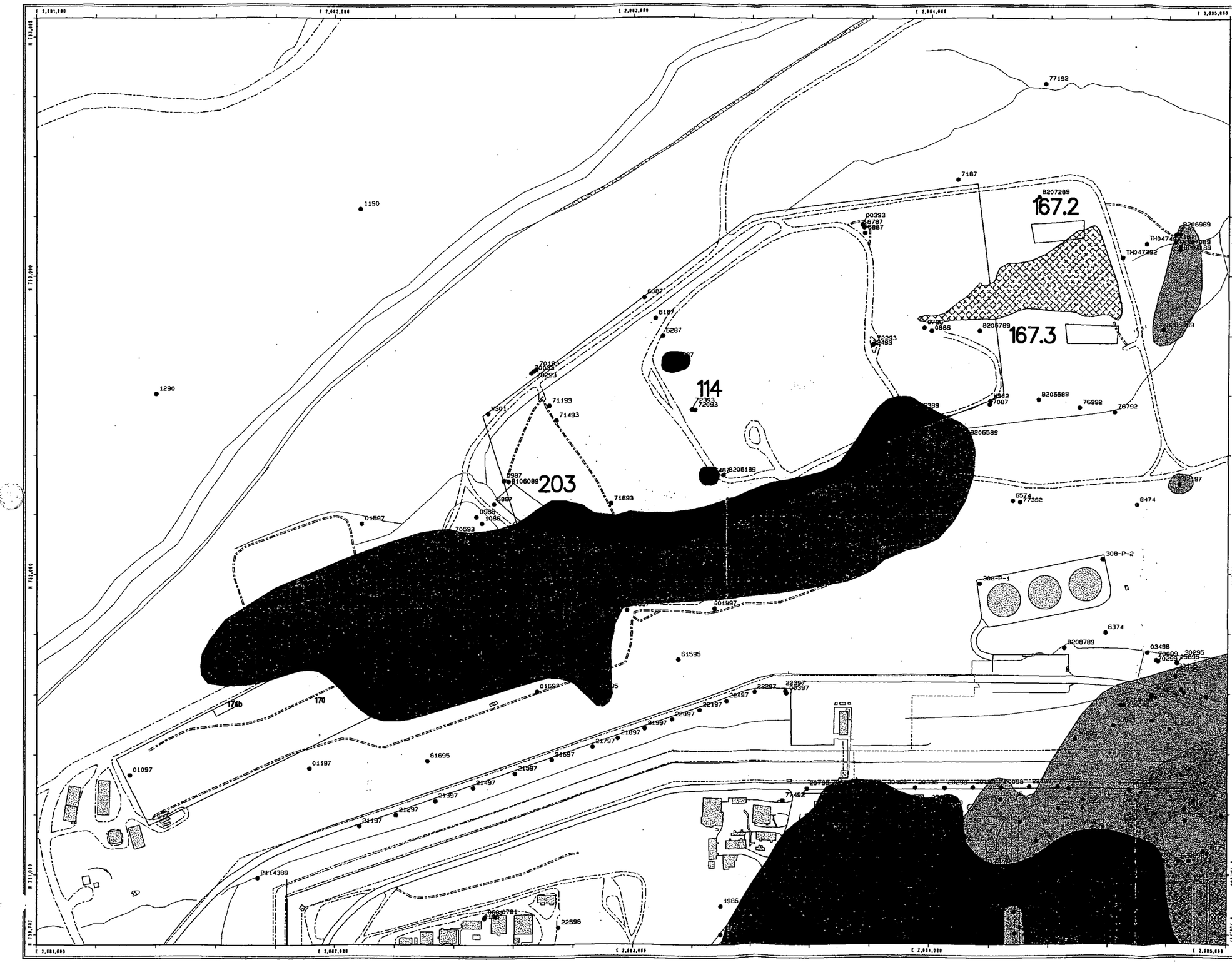

Figure D-4

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

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: 99-0372

November 28, 2000

NT_Svr w:/projects/fy99/99-0372/ou7a_nt.aml

290

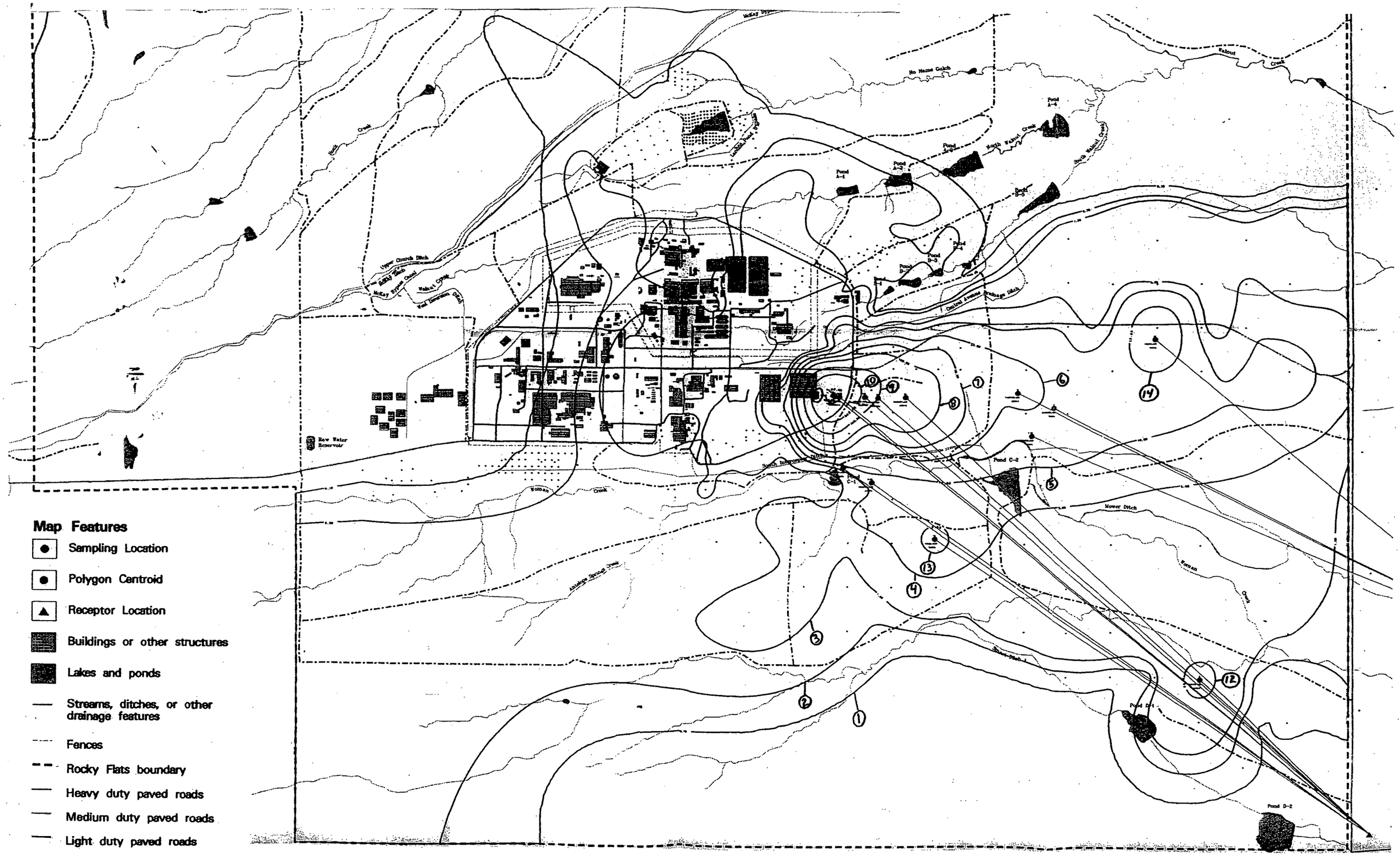

Figure 6-1
Example Soil Isopleth Map -
Pu-239/240 Concentrations of Surface Soil Samples

380

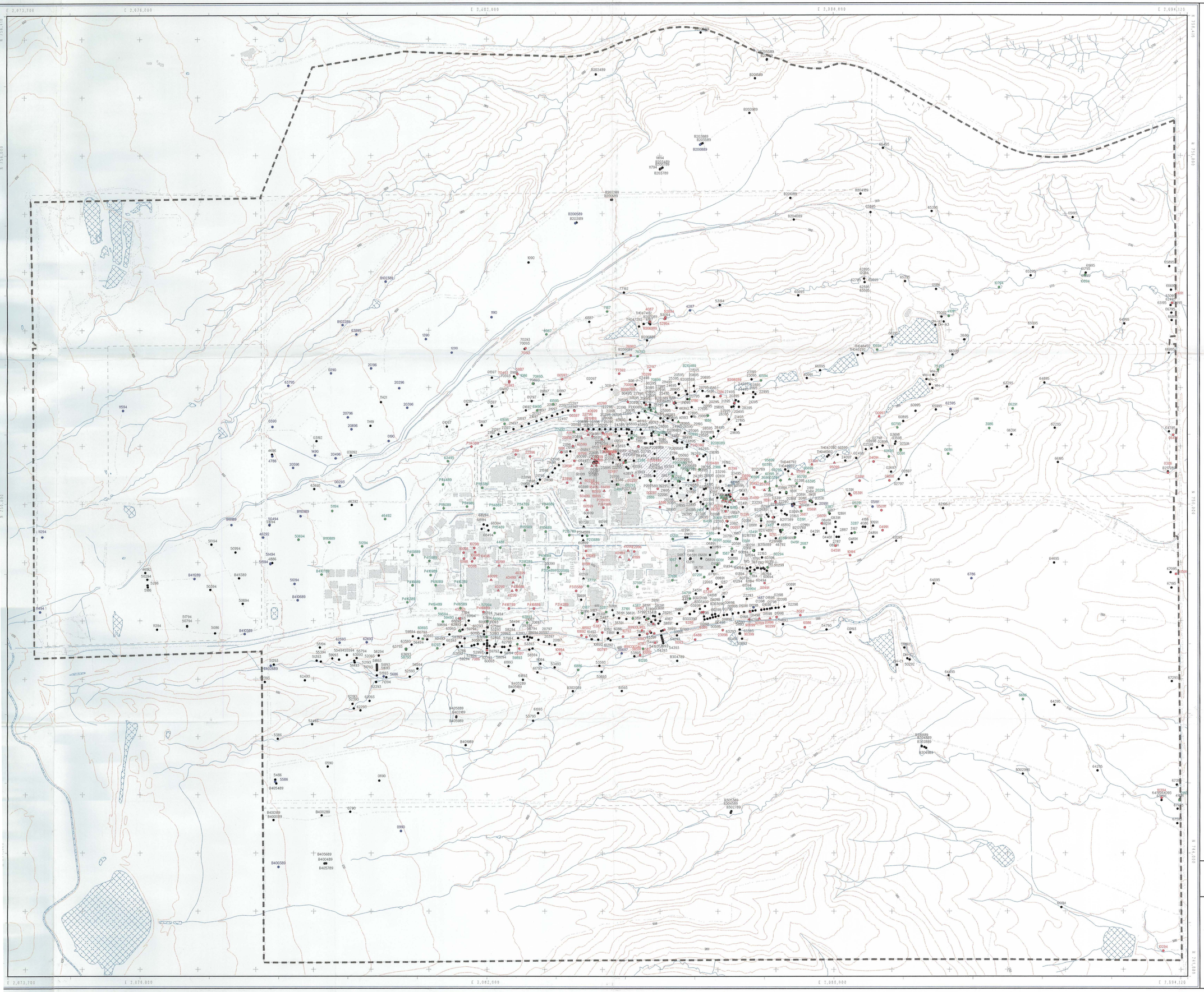

Plate 1
IMP Monitoring Well Location Map

1999 Annual RFCA Groundwater Monitoring Report

IMP Well Type

- Water Quality/Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- Non-IMP
- 1999 Wells (color denotes IMP well type)

Standard Map Features

- 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

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER•HILL COMPANY

MAP ID: fy2k/rfca-rpt

December 04, 2000

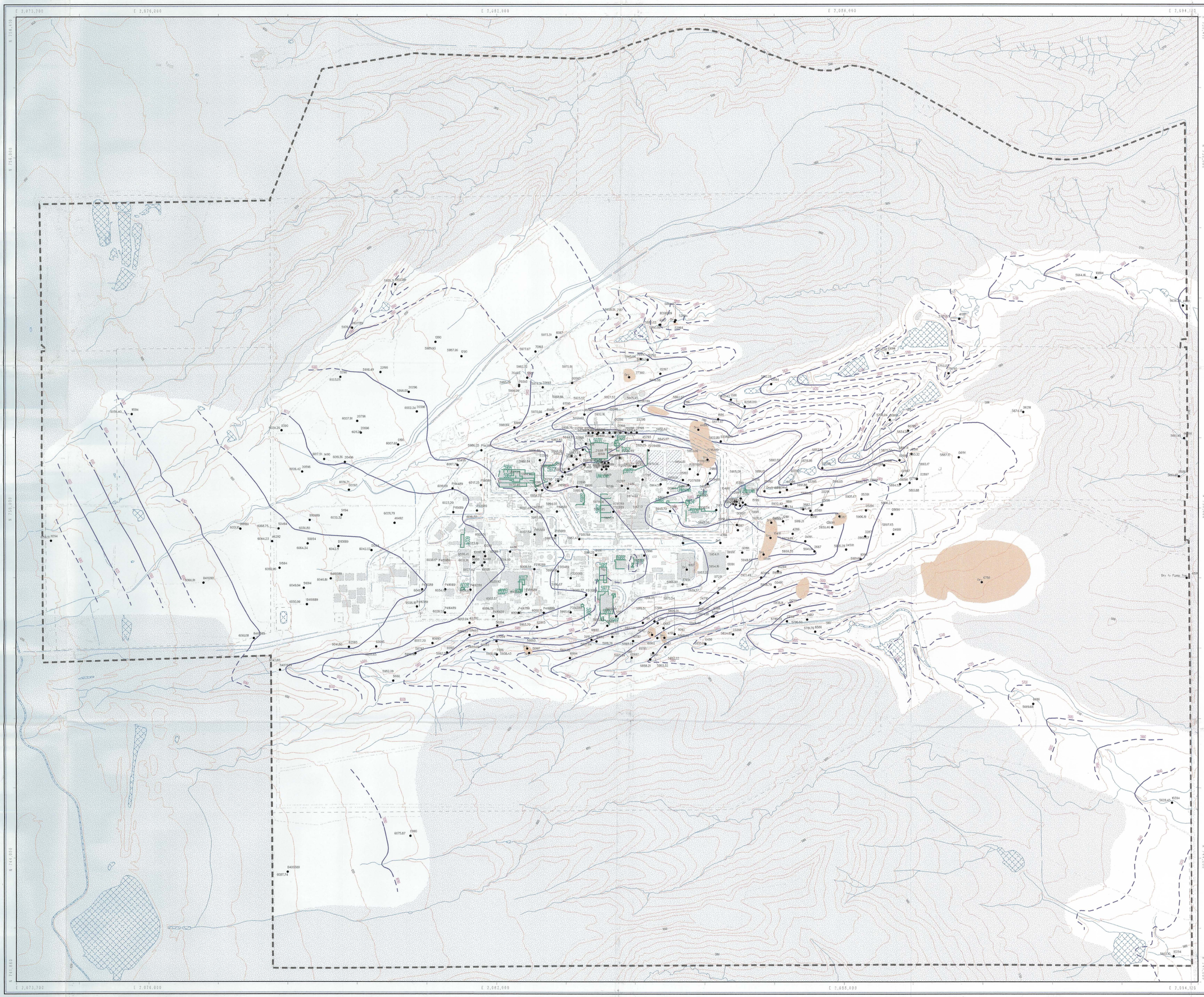

Plate 2

Potentiometric Surface of Permeable Units of the UHSU Second Quarter 1999

1999 Annual RFCA Groundwater Monitoring Report

- Groundwater Monitoring Well
- Water Level Contour
- Dashed where inferred
- Foundation Drain
- Approximate extent of Unsaturated Area
- 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
- 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

U.S. Department of Energy
Rocky Flats Environmental Technology Site

GIS Dept. 303-966-7707

Prepared by: DynCorp THE ART OF TECHNOLOGY

Prepared for: KAISER•HILL COMPANY

MAP ID: fy2k/rfca-rpt/pot maps

December 04, 2000

SW-A-004740 Pg 518

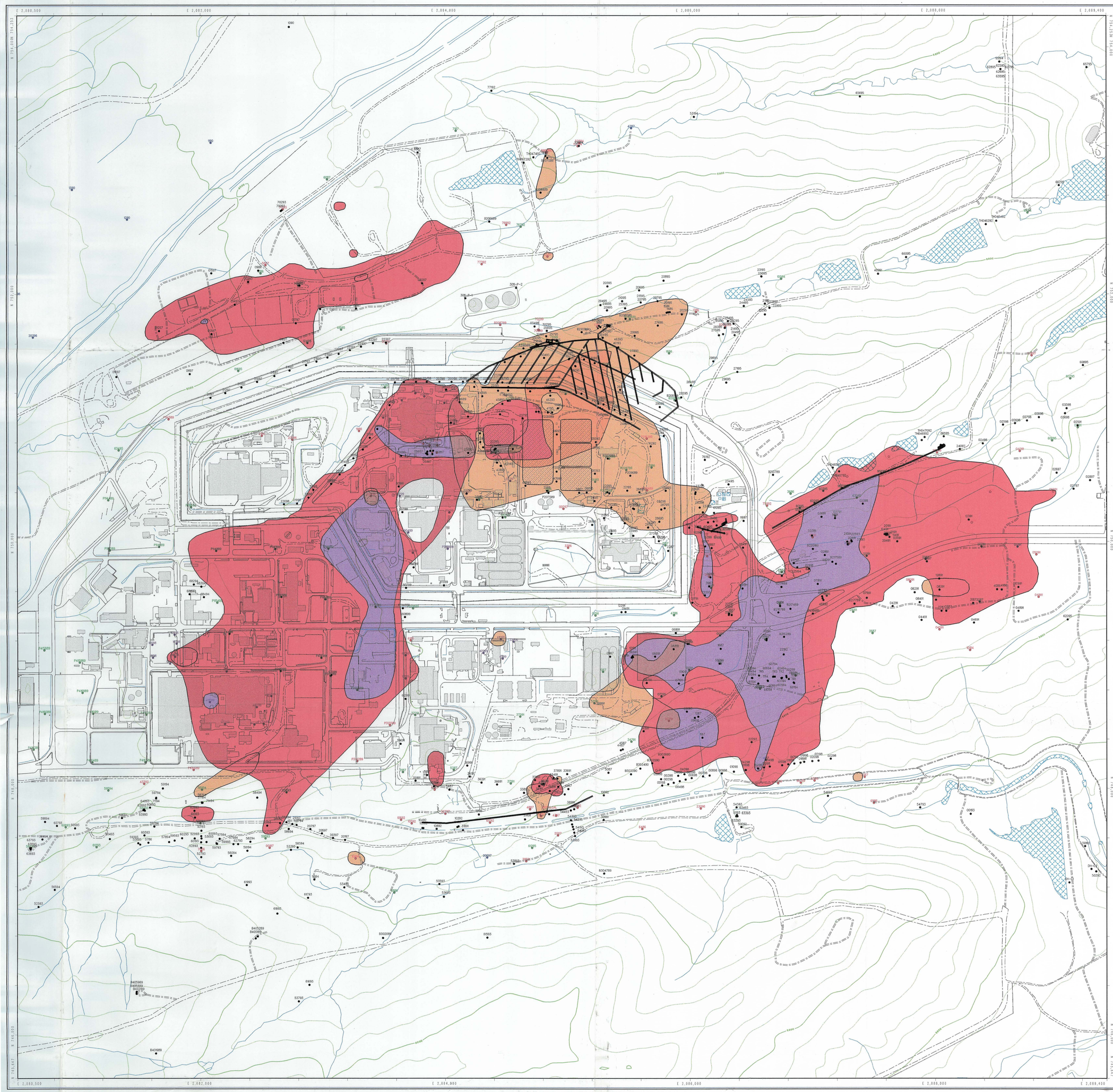

Plate 3
VOCs Composite & Nitrate Plumes Map

1999 Annual RFCA Groundwater Monitoring Report

IMP Well Type

- Water Quality Flow Monitoring
- Industrial Area Flow Monitoring
- Background Flow Monitoring
- D&D Monitoring
- Non-IMP
- 1999 Wells
- 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
- Solar Evaporation Ponds (SEP)
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

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Scale = 1 : 3200
1 inch represents approximately 267 feet

250 0 500 1000ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

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MAP ID: FY2K/RFCA-RPT/VOC_PLUME

November 28, 2000

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