3. GROUNDWATER MONITORING

3.1 INTRODUCTION

This section of the IMP describes the groundwater monitoring requirements for RFETS as outlined in the RFCA, and how the requirements will be implemented at RFETS. Groundwater monitoring is performed by RFETS organizations because groundwater contaminant plumes occur within the RFETS boundaries. Therefore, the IMP covers groundwater monitoring activities. After a brief history of the monitoring program, this section outlines the goals for groundwater monitoring, and describes quality assurance/quality control (QA/QC) components and monitoring components. To evaluate groundwater monitoring needs, an understanding of the historic and contemporary groundwater conditions must be achieved. This information is presented in Appendices A, through E. Appendix A provides a description of RFETS and environmental history, including areas of contamination. Appendix B gives the Action Levels Framework for groundwater, Appendix C gives the physical and hydrologic setting, Appendix D identifies groundwater contaminant plumes, and Appendix E lists the wells that will be monitored for water quality or water level.

3.1.1 PURPOSE OF THE INTEGRATED MONITORING PLAN FOR GROUNDWATER

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

3.1.2 BRIEF HISTORY OF GROUNDWATER MONITORING ACTIVITIES

The historic growth of the groundwater monitoring network at RFETS reflects the increasing DOE, regulatory, and public emphasis on identifying areas of groundwater contamination and preventing contaminant releases to the environment. The first three monitoring wells were installed in 1954 in the Solar Ponds area. A total of 1,356 wells and piezometers have been installed at RFETS from 1971 to present. Plate 1 shows the wells that have been installed at RFETS since 1974.

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

Currently, wells are sampled on a semiannual basis. The groundwater monitoring program has supported the following compliance programs at RFETS:

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

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

In 1993, the large number of wells that were being monitored as an outgrowth of the various remedial investigations at RFETS prompted the Well Evaluation Project. The *Well Evaluation Report* (WER) (EG&G, 1994) resulted in the reduction of the monitoring network from 460 wells to 350 wells, but retained those wells in or near contaminant plumes.

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

3.1.3 CURRENT STATUS OF THE GROUNDWATER PROGRAM

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

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

concerning the monitoring network. Results of this evaluation are found in the following sections.

3.2 GROUNDWATER INTERACTIONS WITH SURFACE WATER

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

As shown in Figure 2-1, three ephemeral streams drain RFETS. The streams are Rock Creek, Walnut Creek (consisting of three tributaries—No Name Gulch, Walnut Creek, and South Walnut Creek), and Woman Creek. Groundwater is discharged from the Rocky Flats Alluvium and other surficial deposits through surface seeps and subsurface flow that, in turn, recharge stream flow and the stream valley groundwater system. Segments of streams have been shown to either gain or lose water as groundwater is discharged to or stream water is discharged from the stream channel. Gaining reaches of streams are more likely to be contaminated by groundwater discharges.

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

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

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

3.3 GROUNDWATER MONITORING PROGRAM OBJECTIVES

The objectives of the RFETS groundwater program are: 1) protect surface water quality, 2) demonstrate compliance with regulations, 3) minimize the chances of further degradation of the Upper Hydrostratigraphic Unit (UHSU), and 4) support the design and selection of remedial measures and assess the effect of future remedial actions. Development of the IMP and subsequent updates are the responsibility of the Environmental Media Management Program of

Kaiser-Hill Company, L.L.C. (Kaiser-Hill) and DOE, RFFO. Kaiser-Hill directs and implements the Groundwater Monitoring Program. The management structure is shown in Figure 3-1.

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

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

3.3.1 IDENTIFICATION OF CONTAMINATED GROUNDWATER

The identification of contaminated groundwater at RFETS has resulted from previous investigations dealing with the characterization of former Operable Units (OUs) and facilities at RFETS. Wells installed during the Remedial Investigation/Feasibility Study (RI/FS) discovered groundwater contamination near Individual Hazardous Substance Site (IHSS) source areas, and historic groundwater characterization activities also contributed to knowledge on the extent of groundwater plumes. In addition, analyses of building sumps and drains and incidental waters generated during construction activities, also provide information on locations of groundwater contamination.

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

3.3.2 IDENTIFICATION AND CONTROL OF CONTAMINANT SOURCES

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

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

Area sources contaminated with hazardous substances are identified as IHSSs and have been characterized under the RI/FS process. The IHSS ER Ranking Project is required under RFCA

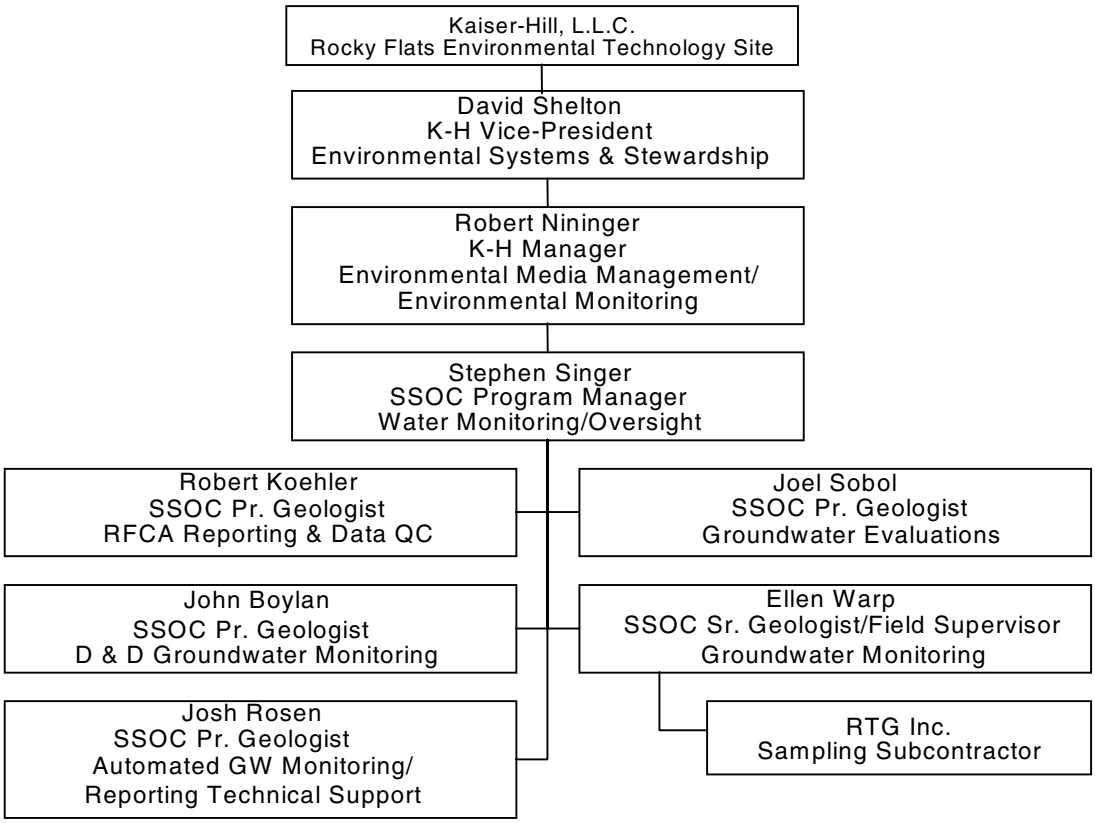

Figure 3-1. Groundwater Organization

to determine the relative risk associated with contaminant sources and assign a priority for remediation. Those IHSSs that have contributed to groundwater contamination have been identified and put into the priority list for remediation. Currently, the ER Ranking is no longer the sole source for identifying the remedial action sequence. The RFCA Parties recognize that future remedial actions will be addressed based on opportunity and D&D schedules. This opportunistic approach evaluates the accessibility of an area and what, if any, potential future impacts exist due to other remedial actions in the area. The opportunistic approach is balanced against the ER Ranking; any time it is determined that an IHSS is impacting human health or the environment, such that immediate action is warranted, then action will be taken as soon as possible.

3.3.2.1 Current Contaminated Areas

The remedial investigations at former OUs (a grouping of IHSSs) have provided adequate data for determining potential contamination sources for much of RFETS. The former Industrial Area

OU has not been characterized as thoroughly as other OUs, but initial soil screening results helped to characterize sources in this area.

Table A-1 lists the IHSSs at RFETS. Information about the effect of contaminated areas on groundwater is described in Appendix D. Table D-1 lists the potential analytes of interest (AoI) 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 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 is VOCs. Where feasible, general plume maps have been developed to show the extent of contamination in UHSU groundwater. Plate 3 shows the composite plumes of VOCs and the Solar Ponds nitrate plume. Analyte suites for the major analytes of concern have been developed for monitoring wells.

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

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

3.3.2.2 Hazardous Waste Management Areas

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

3.3.2.3 Storage Tanks

There are currently over 2,000 storage tanks at RFETS. These include underground storage tanks, production or process waste tanks, chemical feed tanks, and fuel oil tanks. Most production and process waste tanks are considered to have secondary containment because they are located inside buildings or have systems that contain spills. Some of the chemical feed and fuel oil tanks also have spill containment systems. These tanks are considered to be low risk for spills, and are thus unlikely to contaminate groundwater.

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

3.3.2.4 Process Waste System

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

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

3.3.2.5 Building Drains and Sumps

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

3.3.2.6 Other Potential Contamination Sources

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

3.3.3 IDENTIFICATION OF POTENTIAL CONTAMINANT PATHWAYS

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

3.3.4 IDENTIFICATION OF CONTAMINANT CONCENTRATIONS

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

3.3.5 MONITORING OF REMEDIAL ACTIONS

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

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

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

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

At the former OU2, two passive treatment systems have been built to treat groundwater contaminated with VOCs. The Mound Treatment System was built to collect and treat

contaminated groundwater from the Mound Site (IHSS 113) and the East Trenches Passive Treatment System was built to collect and treat groundwater from the East Trenches Sources (IHSSs 110 – 111.8).

The Mound Site Plume Treatment System is a 230-foot below-grade impermeable-barrier collection system with two treatment cells that was installed in 1998. The system was designed to collect contaminated groundwater derived from the Mound Site and treat it to fall within the parameters of the Groundwater Action Level Framework Tier 2 level concentrations defined in the RFCA. The effectiveness and feasibility of using this type of system on other contaminated groundwater plumes was demonstrated by this project. The Mound Site Plume Treatment System employs innovative technology for the collection and treatment of contaminated groundwater containing chlorinated organic contamination and low levels of radionuclides. The performance monitoring requirements are defined in the *Final Mound Site Plume Decision Document* (DOE 1997).

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

Additional remedial activities are planned, as accelerated actions, to excavate and remove hazardous waste sources and to set up additional treatment systems for groundwater. The ALF addendum to RFCA requires performance monitoring of groundwater affected by remedial cleanup activities. It is anticipated that performance monitoring decisions will be made on a case-by-case basis but will follow a general decision rule that is described in a later section. Monitoring decisions and specific monitoring requirements related to these projects are documented in decision documents associated with the individual projects, and will not be found in the IMP.

3.3.6 PROTECTION FROM NEW CONTAMINANT SOURCES

Future plans for RFETS involve decommissioning of production systems, building demolition, and excavation and removal or capping of source areas. Groundwater will be monitored before, during, and immediately after an operation that could potentially degrade groundwater quality. This will determine the site-specific ambient groundwater conditions and detect release of contaminants. Construction activities are also assessed to ensure that groundwater quality is not compromised. Groundwater protection will be considered in future D&D work plans to supplement existing programs for water collected and contained in the building footing drains, basements, valve vaults, and sumps in the IA.

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

3.3.7 EVALUATION OF GROUNDWATER CONTAMINANT IMPACTS ON SURFACE WATER

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

3.3.8 GROUNDWATER DATA QUALITY OBJECTIVES

DQOs are qualitative and quantitative statements that specify the type, quality, and quantity of the data required to support 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 are established to ensure that data generated by the project will withstand scientific and legal scrutiny, and that the data will be gathered or developed using procedures appropriate for the intended use of the data. The DQO process employed is generally derived from EPA guidance documents (e.g., EPA, 1987, 1990 and 1994) but has been used primarily as a decision support tool as opposed to a sample optimization tool.

3.3.9 PROGRAMMATIC DATA QUALITY OBJECTIVES

The DQO process was applied to the groundwater program at a programmatic and decision-specific level. At the programmatic level, the DQO process was used to qualitatively evaluate the overall need for, and purpose of, groundwater monitoring. This effort established that groundwater data are needed to comply with applicable regulations, agreements, permits, and to prevent unacceptable risks to public health and the environment through impacts to surface waters of the state. The information required to satisfy these requirements results from regular sampling of wells and surface locations selected to meet the above criteria. These data are used to detect and document contaminant concentrations above limits established by regulations, agreements, permits, or risk-based analysis; to support planning, implementation, and assessment of removals, remedial actions, and D&D projects; to support modeling and evaluations; and to meet commitments to issue periodic monitoring reports to regulators. Sampling locations and frequency have been negotiated with regulators. Locations were chosen to detect migration of known contaminant plumes along pathways and across boundaries. Analytical results need to be of specified, documented quality, owing to the many uses of the data for modeling, risk assessment, performance assessment, and compliance. These programmatic statements establish the general need for a groundwater monitoring program and outline program elements that need to be included.

3.3.10 DATA QUALITY OBJECTIVES FOR PROGRAM ELEMENTS

The second DQO effort developed individual monitoring program decision elements. DQOs were approached on a media-specific basis, although the goal was to integrate monitoring requirements for groundwater, surface water, air and ecology. Groundwater monitoring DQOs were developed for each component of the program and problem statements were established.

These problem statements were then refined into a decision statement that specified corrective actions for that problem. The data were then identified and methods of analysis outlined to support the decision. Boundaries and scope are defined to clarify the spatial and temporal focus of the required monitoring information and exclude nonessential aspects of the problem. A decision rule was specified to document how data will be summarized to draw a conclusion upon which a decision will be based.

The groundwater monitoring network was defined with the following components:

- Plume Definition Wells: Wells that are within known contaminant plumes and are above Tier II Action Levels, but are below the Tier I Action Levels established in the ALF. These wells will be monitored to determine whether concentrations of contaminants are increasing. If a Tier I Action Level is exceeded, it will be reported and prioritized for remedial action.
- Plume Extent Wells: Wells at the edges of known groundwater contaminant plumes along pathways to surface water. A subset of these wells is listed in the ALF as Tier II Wells. The wells are monitored for increases in concentrations that would exceed Tier II Action Levels stated in the ALF, and they indicate movement that may result in contamination of surface water.
- Drainage Wells: Monitoring wells located in stream drainages downgradient of contaminant plumes. If contamination reaches these wells, and action levels are exceeded, they fall under the same requirements as plume extent wells.
- Boundary Monitoring Wells: Wells used to monitor the quality of groundwater leaving the eastern RFETS boundary.

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

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

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

3.3.10.1 Plume Definition Wells

Problem Statement:

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

Problem Scope:

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

Inputs:

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

Boundaries:

Spatial:	Wells are located in areas known to be contaminated above the Tier II Action Level. Decisions will be made on an individual well basis.
Temporal:	Wells will be sampled and data will be reviewed *and reported* quarterly, and decisions will be made annually.

Decision Statement:

IF	Measured concentrations in well exceed Tier I Action Levels and background mean +2 standard deviations—
THEN	Report as a Tier I exceedance and review historic data for well to determine if it has been prioritized for remediation/evaluation based on potential impact to surface water.
IF	Data show an increasing trend over a two-year period, or well has not been previously prioritized for remediation—
THEN	Update priority for remediation/evaluation,
ELSE	Continue monitoring.

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

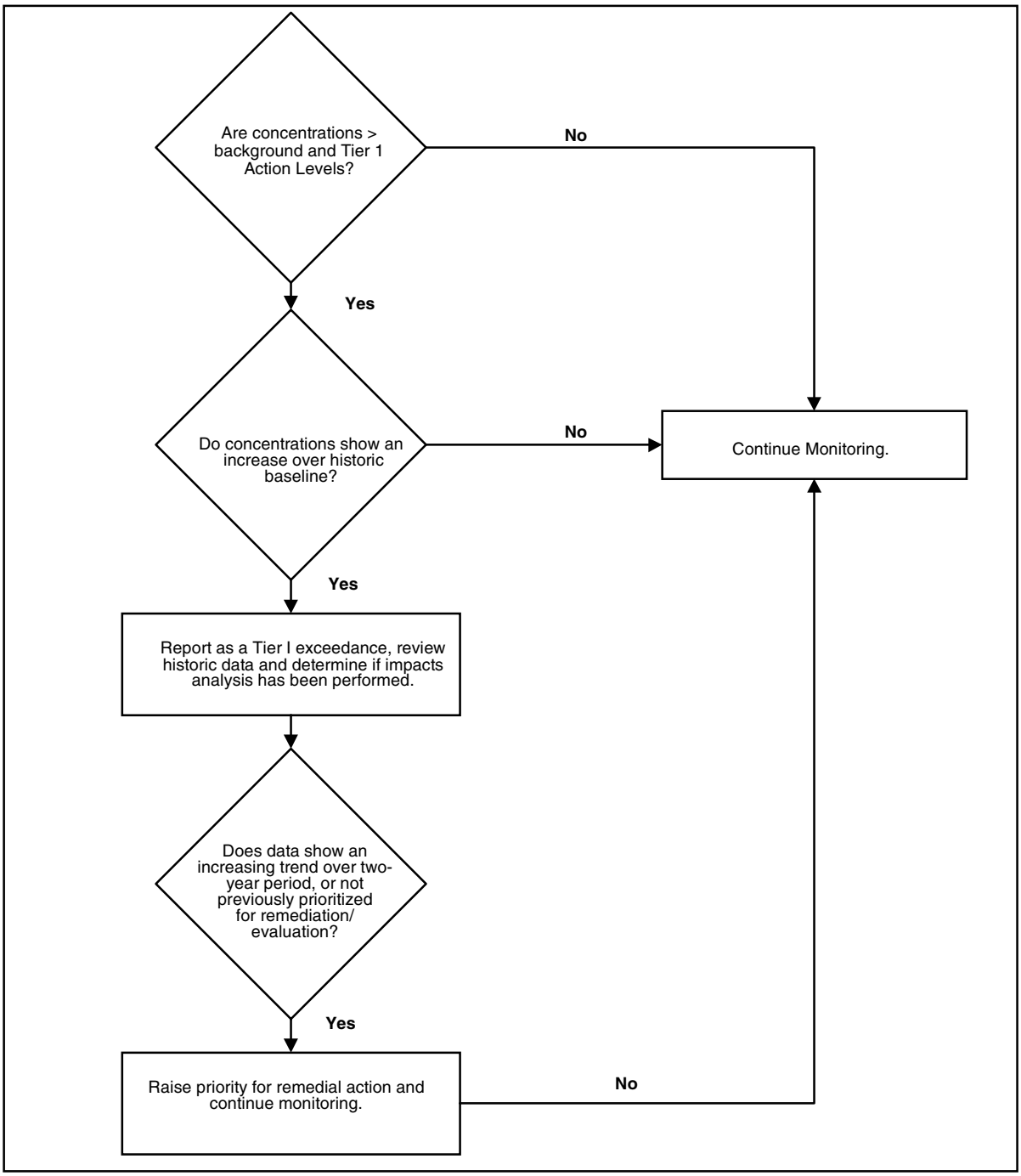

Figure 3-2. Plume Definition Monitoring Wells Flowchart

3.3.10.2 Plume Extent Monitoring Wells

Problem Statement:

Have concentrations in wells exceeded Tier II Action Levels?

Problem Scope:

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

Inputs:

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

Boundaries:

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

Decision Statement:

IF	Sample results show detections in a well that exceed Tier II Action Levels and background mean + 2 standard deviations—
THEN	Report as a Tier II exceedance, review historic data for the well, and determine if evaluation of impact to surface water has been done.
IF	Historic data confirm the exceedance, and impact evaluation has not been done—
THEN	Notify appropriate ER and RFCA parties and evaluate impacts to surface water.

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

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

3.3.10.3 Drainage Monitoring Wells

Problem Statement:

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

Problem Scope:

In some areas, groundwater contamination from multiple sources has migrated to surface water drainages. Drainage wells monitor groundwater in valley fill alluvium downstream of areas where contaminant plumes may have reached surface water stream drainages. Contaminants detected in stream drainages are assumed to have affected surface water and to have the potential to migrate off RFETS. It is possible that some drainage wells have historically exceeded Tier II Action Levels. For these wells, only new compounds with exceedances of Tier II Action Levels or involving compounds that have concentrations 2 standard deviations greater than historic levels will be sampled on a monthly basis as required by RFCA.

Inputs:

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

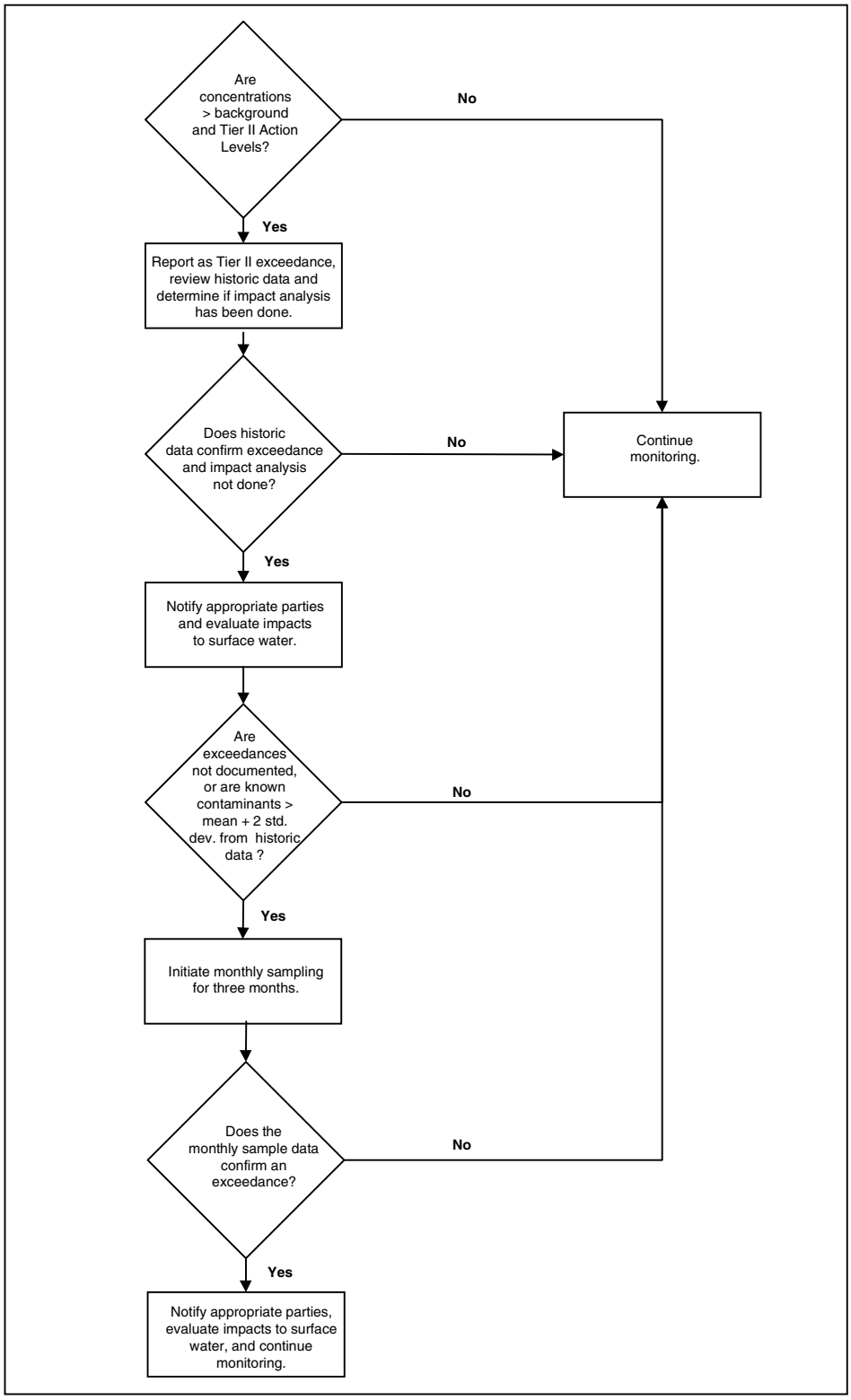

Figure 3-3. Plume Extent Monitoring Wells Flowchart

Boundaries:

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

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

Decision Statement:

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

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

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

THEN Notify appropriate parties and evaluate impacts to surface water.

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

THEN Initiate monthly sampling for three months.

IF Monthly sampling confirms the exceedance—

THEN Notify appropriate parties and evaluate impacts to surface water,

ELSE Continue monitoring on routine schedule.

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

3.3.10.4 Boundary Monitoring Wells

Problem Statement:

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

Problem Scope:

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

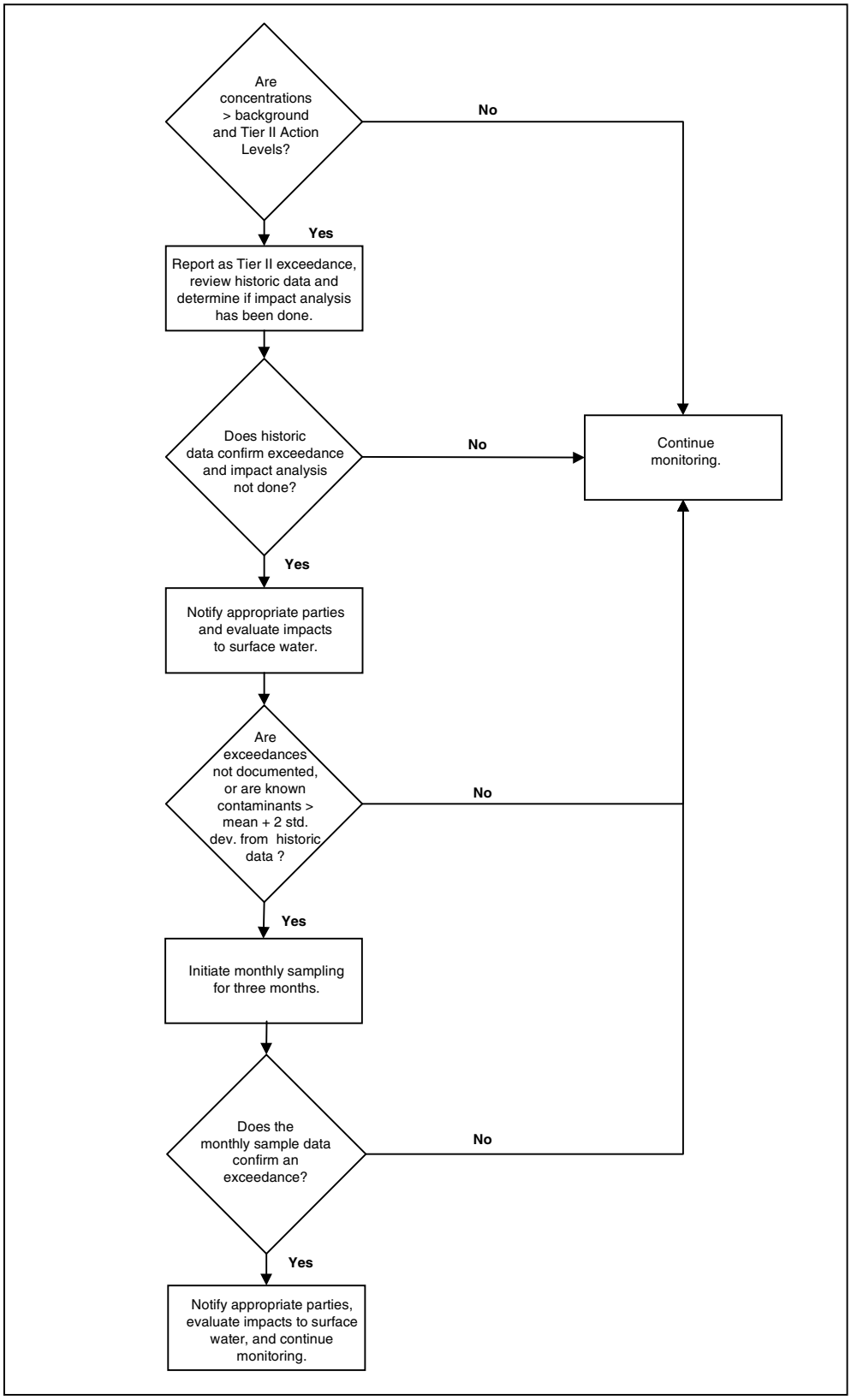

Figure 3-4. Drainage Monitoring Wells Flowchart

Inputs:

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

Boundaries:

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

Decision Statement:

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

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

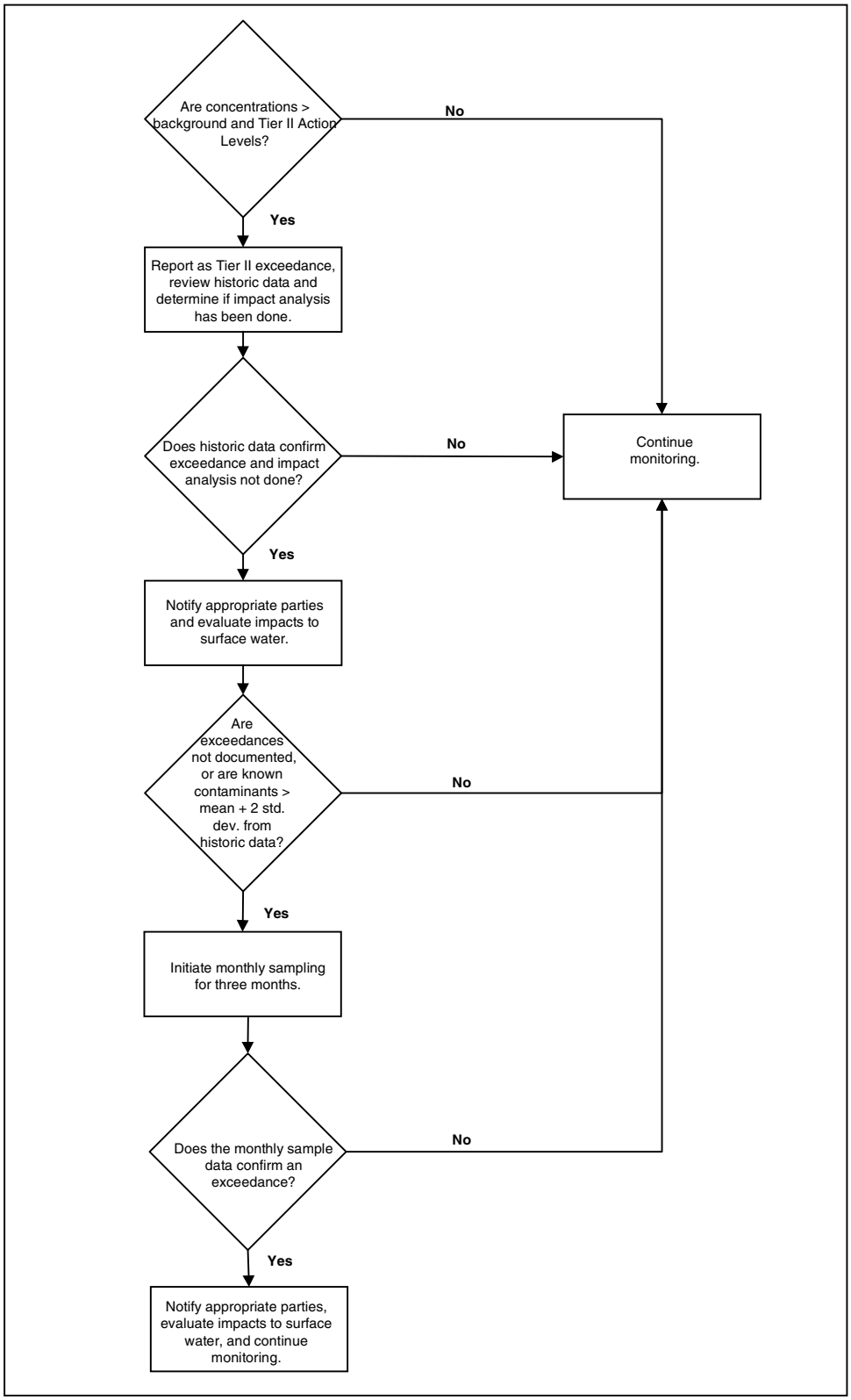

Figure 3-5. Boundary Monitoring Wells Flowchart

3.3.10.5 Building-Specific D&D Monitoring Wells

Problem Statement:

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

Problem Scope:

The acronym D&D is a general term that refers to the decontamination and decommissioning of buildings at RFETS. Included in this phase are building-specific D&D activities that post date a required deactivation, and may include surveillance/ maintenance, decontamination, dismantlement, and ultimately, demolition. This IMP outlines monitoring activities to ensure that building-specific D&D actions do not inadvertently degrade surface water through a groundwater transport pathway. The proposed monitoring will provide the data needed to determine if precautions or actions taken during D&D adequately prevent migration of contaminants to groundwater. D&D monitoring will begin two years (or four sample events) before building demolition and continue for five years after demolition, sampled on a semiannual frequency. Monitoring results will be reviewed prior to termination of D&D monitoring for a building to assure that the project has met its intended goals.

Inputs:

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

Boundaries:

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

Temporal: Wells and drains will be sampled and data will be reviewed and reported quarterly; decisions will be made annually.

Decision Statement:

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

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

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

THEN Inform appropriate parties and evaluate the problem,

ELSE Continue monitoring.

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

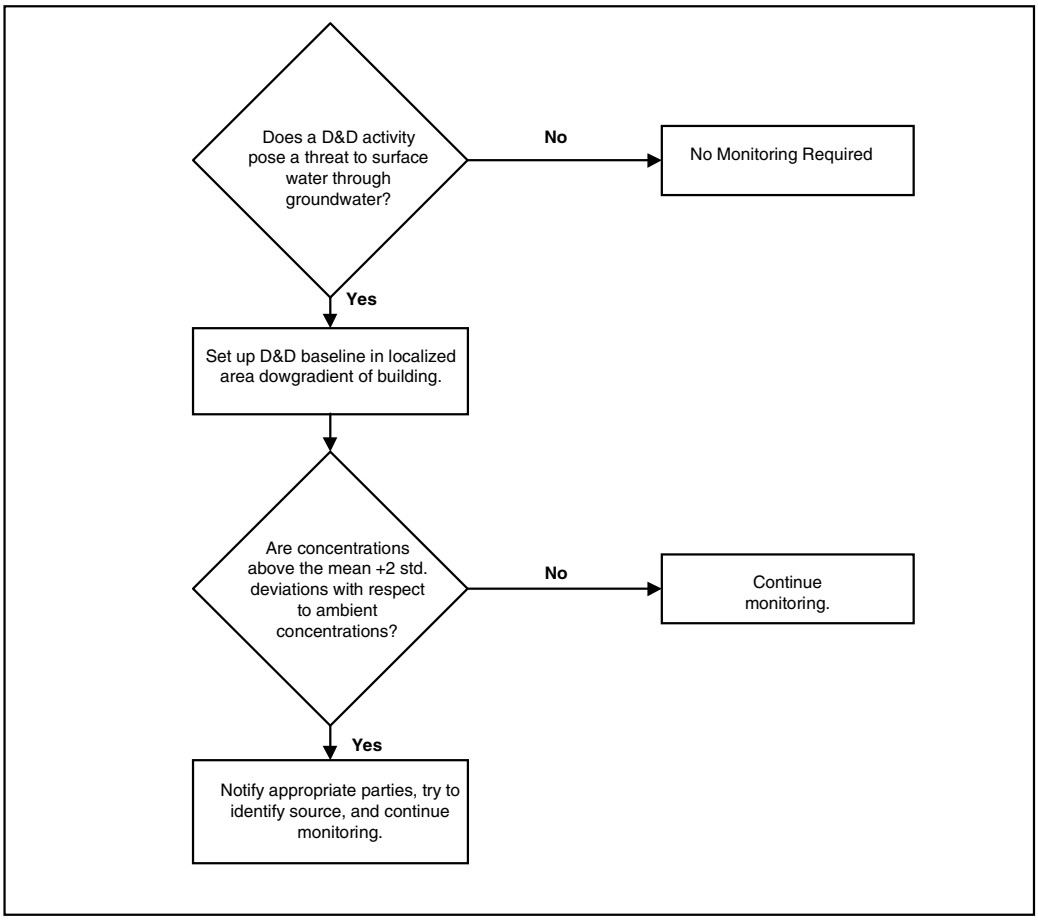

Figure 3-6. Building D&D Monitoring Wells Flowchart

3.3.10.6 Performance Monitoring Wells

Problem Statement

Have remedial actions improved or further impacted groundwater?

Problem Scope:

Performance monitoring assesses the effectiveness of remedial activities such as contaminant source removals or treatment systems that are installed to clean groundwater plumes. In general, source removals are monitored by comparing current values to values that existed before the remedial action. RFCA requires performance monitoring

of groundwater and appropriate soil remediation actions. Specific activities will be determined on a case-by-case basis and will be established in decision documents for those projects where it is required. Details will be determined by the groundwater work group in conjunction with project managers and incorporated into the decision *documents.*

Inputs:

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

Boundaries:

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

Decision Statement:

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

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

3.3.10.7 RCRA Monitoring Wells

Problem Statement:

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

Problem Scope:

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

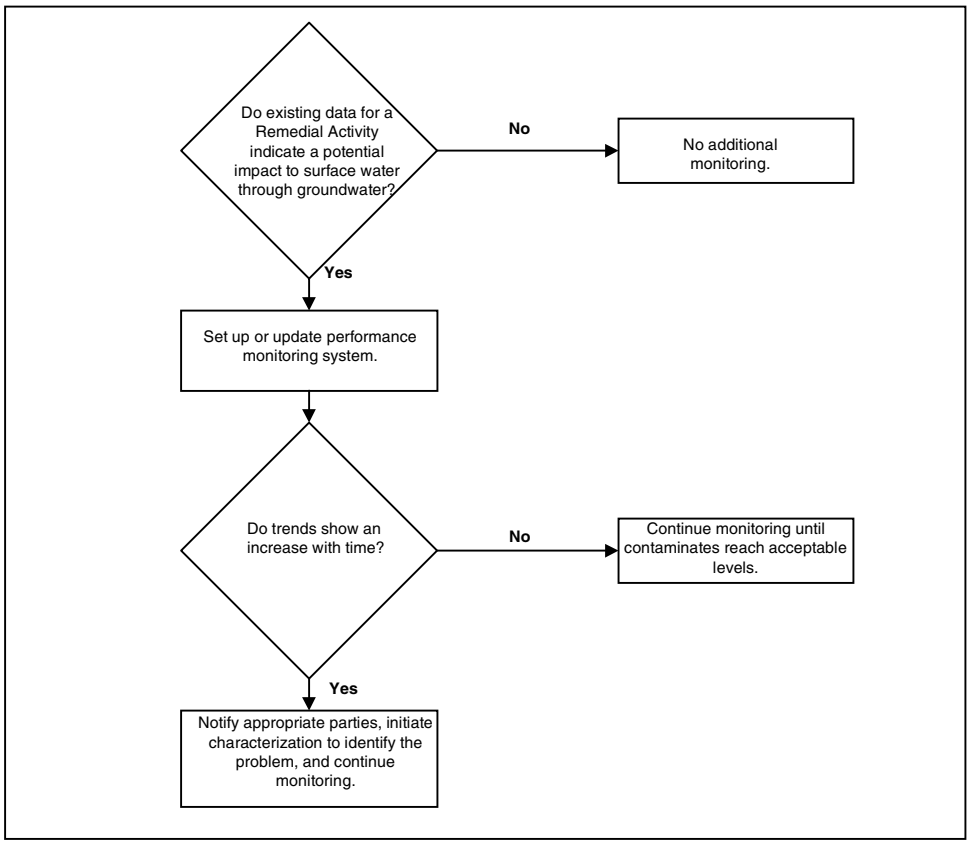

Figure 3-7. Performance Groundwater Monitoring Wells Flowchart

Inputs:

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

Boundaries:

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

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

Decision Statement:

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

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

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

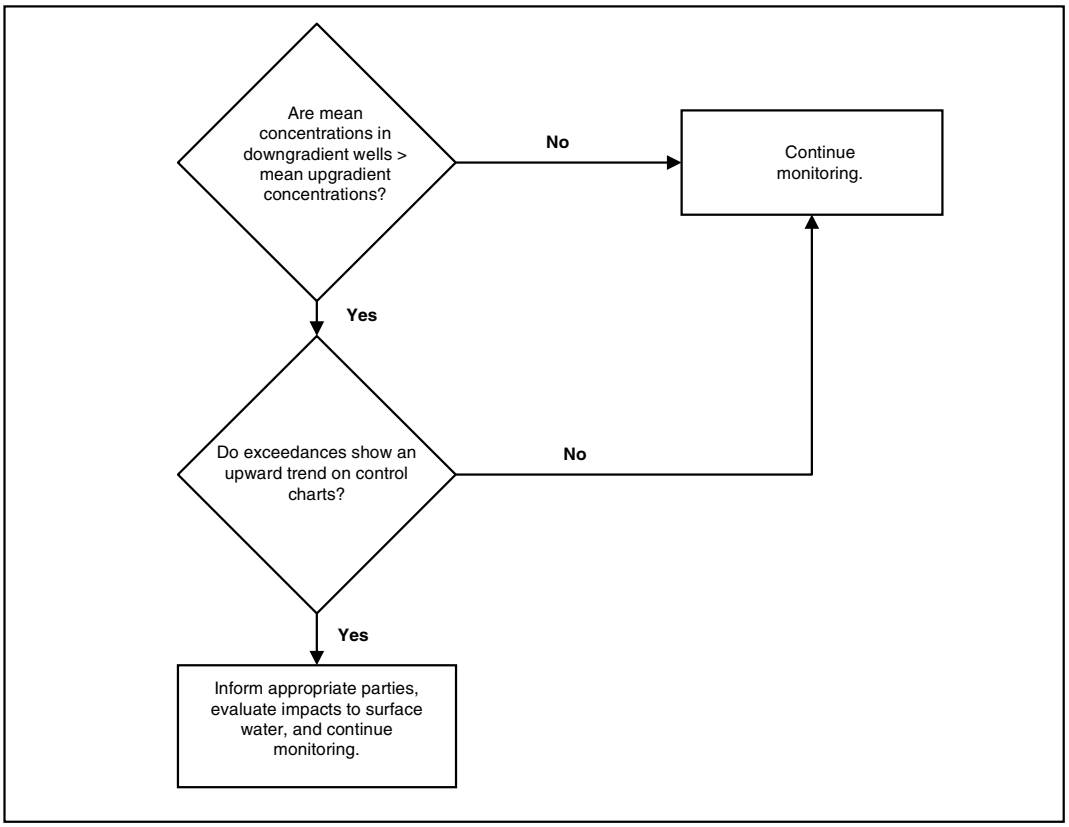

Figure 3-8. RCRA Groundwater Monitoring Wells Flowchart

3.3.10.8 Plume Degradation Monitoring Wells

Problem Statement:

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

Problem Scope:

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

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

Table 3-1. Checklist for Determination of Biodegradation

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

Inputs:

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

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

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

Boundaries:

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

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

Decision Statement:

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

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

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

ELSE Reestablish data needs and re-scope monitoring activities.

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

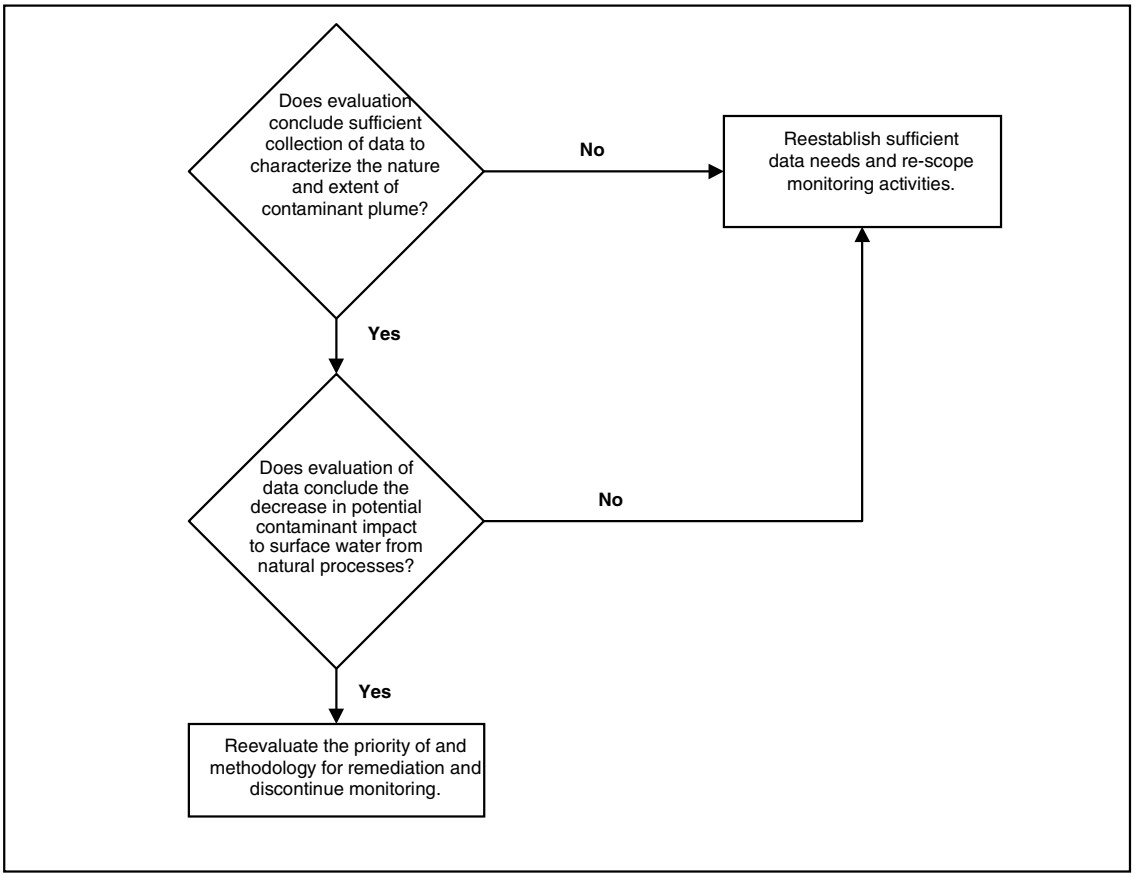

Figure 3-9. Plume Degradation Monitoring Wells Flowchart

3.3.11 DATA QUALITY OBJECTIVES FOR MONITORING GROUNDWATER FLOW

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

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

3.3.11.1 Site-Wide Flow Monitoring

Problem Statement:

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

Problem Scope:

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

Inputs:

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

Boundaries:

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

Decision Statement:

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

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

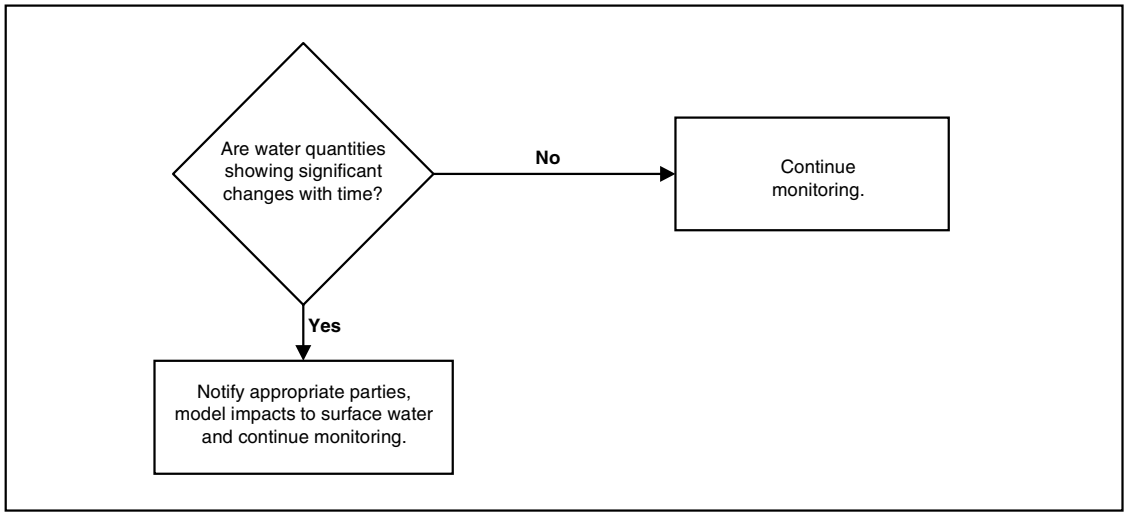

Figure 3-10. Site-Wide Groundwater Flow Monitoring Flowchart

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

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

3.3.11.2 Water Quality Flow Monitoring

Problem Statement:

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

Problem Scope:

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

Inputs:

- Water level measurements.

Boundaries:

Spatial: Decisions will be made on a wellhead basis.

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

Decision Statement:

IF Action levels have been exceeded in the well—

THEN Adjust water level measurement frequency to mirror water quality sampling frequency

AND Evaluate impacts to determine whether a remedial or management action is necessary,

ELSE Continue water level measurement at regular frequency.

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

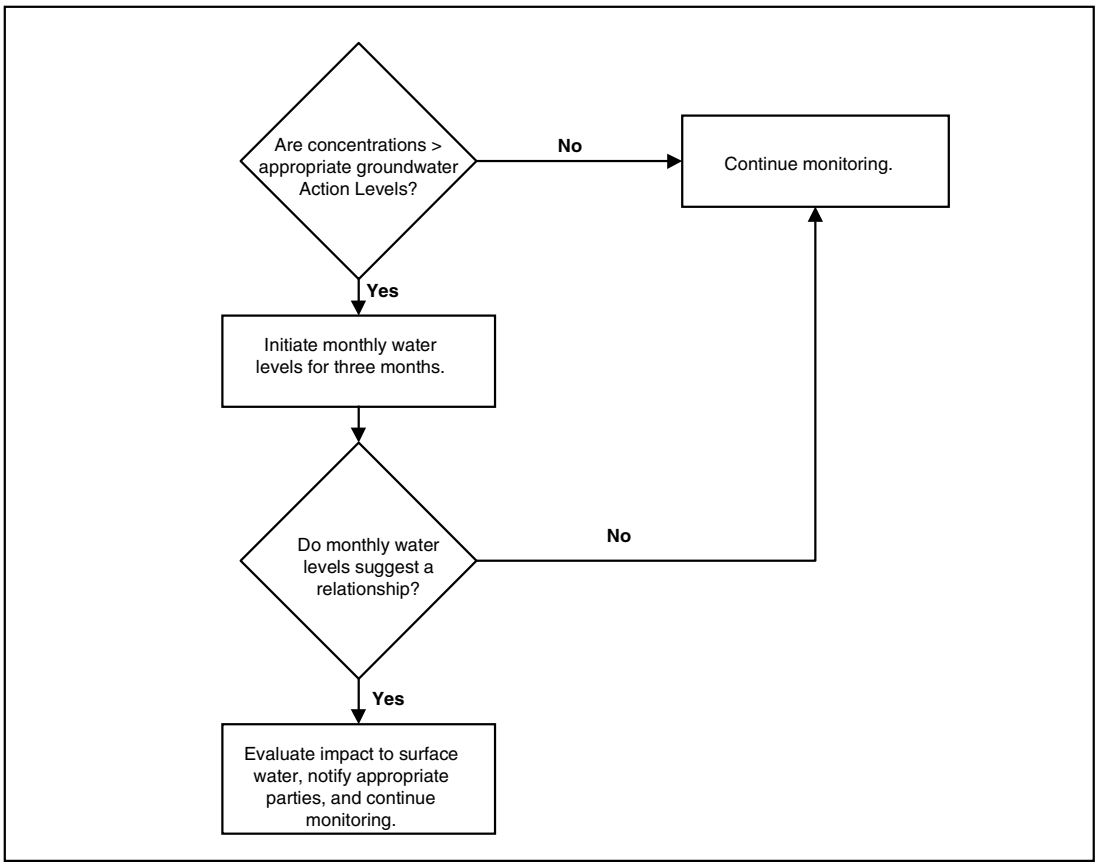

Figure 3-11. Water Quality Flow Monitoring Flowchart

3.3.11.3 Industrial Area Flow Monitoring

Problem Statement:

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

Problem Scope:

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

Inputs:

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

Boundaries:

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

Decision Statement:

IF	Groundwater levels show significant change with time—
THEN	Notify appropriate parties and model effects on surface water quality and quantity using background water level data as appropriate,
ELSE	Continue taking measurements.

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

3.3.11.4 Background Groundwater Flow Monitoring

Problem Statement:

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

Problem Scope:

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

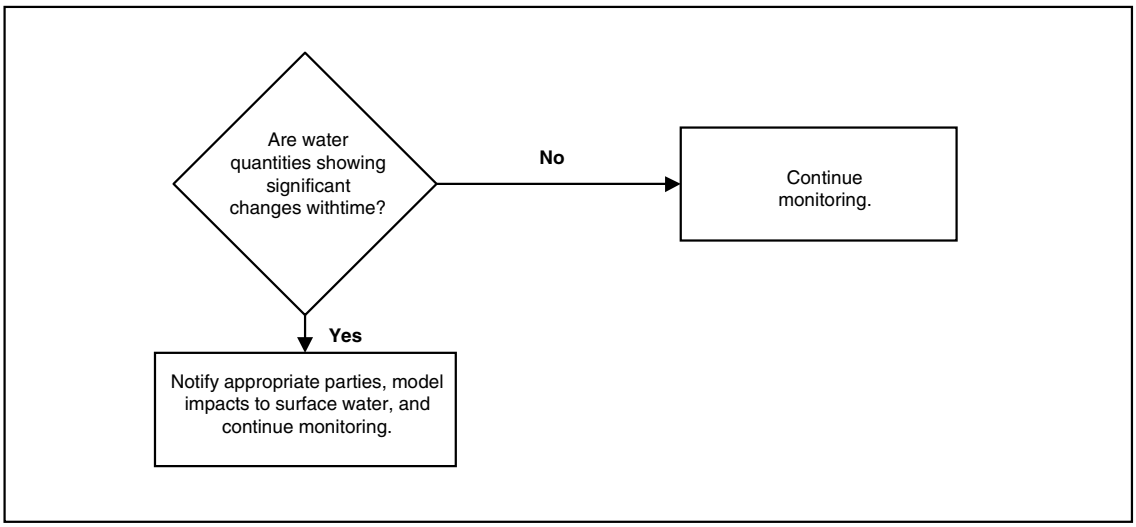

Figure 3-12. Industrial Area Flow Monitoring Flowchart

Inputs:

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

Boundaries:

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

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

Decision Statement:

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

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

ELSE Continue monitoring.

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

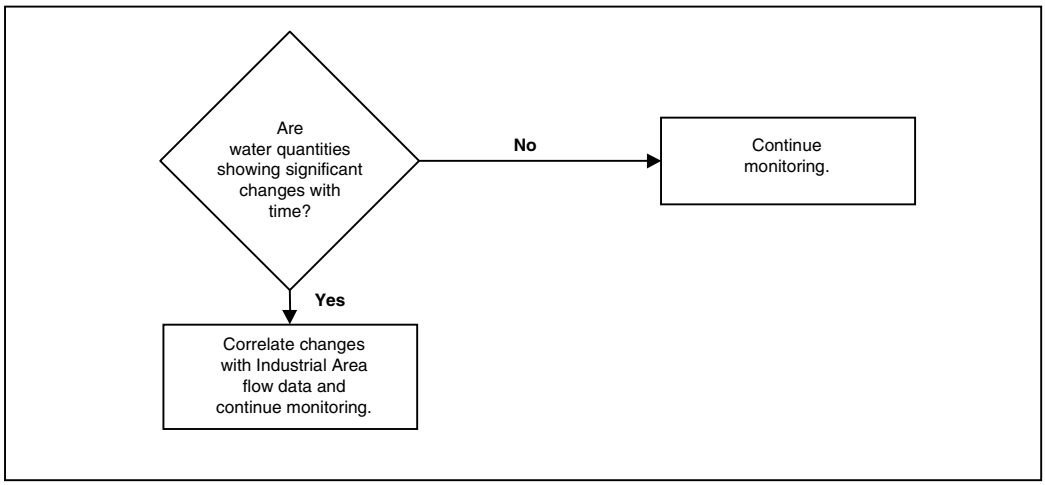

Figure 3-13. Background Flow Monitoring Flowchart

3.3.12 GROUNDWATER EVALUATION PROJECTS

In addition to the groundwater monitoring activities covered under the decision rules described in the previous section, there are special projects that may be implemented as part of the groundwater evaluation requirements under this IMP and RFCA. These projects are typically of limited duration, and assess exceedance 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.

3.3.12.1 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 Pu and Am. 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. Evaluation of sampling results is continuing in FY02. 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.*

3.3.12.2 Industrial Area VOC Plume Evaluation

This project was initiated in FY01 to investigate the possible source areas that feed the Industrial Area VOC Plume. These sources have not been well documented and additional wells may shed light on whether the IA plume is one large plume or whether it is a collection of smaller plumes. Thirteen wells are proposed. Additional information is contained in the *Final Sampling and Analysis Plan for Groundwater Monitoring of the Industrial Area Plume.*

3.3.12.3 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 RFETS 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 samples may be collected in 2002 depending upon CDPHE funding. 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.*

3.3.12.4 Natural Attenuation of the PU&D Yard VOC Plume

This project investigates the natural attenuation of the PU&D Yard Plume as an alternative to possible groundwater remediation and treatment. Wells were installed downgradient of the known plume to assess the possible pathway of the plume towards surface water. Once the dominant pathway was identified, wells were selected for collection of natural attenuation parameters (see the *Technical Memorandum, Groundwater Monitoring of the PU&D Yard VOC Plume* and *Draft Final Sampling and Analysis Plan for the Natural Attenuation of the PU&D Yard VOC Plume).*

3.3.12.5 Natural Attenuation of the Ryan's Pit/903 Pad VOC plume

In 1999, a project was initiated to determine whether natural attenuation was occurring for the Ryan's Pit/903 Pad VOC plume. This plume extends southward from the 903 Pad and Ryan's Pit IHSSs towards the Woman Creek drainage. Four additional wells were installed to determine the pathway for contaminated groundwater. These new wells as well as a downgradient seep were sampled. In 2000 and 2001, additional natural attenuation parameters were collected from wells in the area to determine whether biodegradation of contaminants was occurring (see the *Sampling and Analysis Plan for Groundwater Monitoring at the 903 Pad/Ryan's Pit Plume*).

3.4 QUALITY CONTROL OBJECTIVES FOR COLLECTION/EVALUATION OF GROUNDWATER DATA

DOE Order 5400.1 *General Environmental Protection Program* (DOE 1988) requires that a quality assurance (QA) program be developed consistent with DOE Order 414.1, *Quality Assurance*. The program must cover environmental activities and describe the requirements, methods, and responsibilities of environmental management, staff, contractors, and vendors for achieving and ensuring quality. General requirements for the Groundwater Monitoring Program activities are covered under the *Quality Assurance Program Plan for the Groundwater Monitoring Program* (QAPPGW) (RMRS, 2000a) and associated operating procedures (OP). Non-routine evaluations and special sampling projects will be governed by project-specific work plans.

The RFETS management structure showing organizational responsibilities is illustrated in Figure 3-1. The organization has been structured to maintain quality for the duration of the program. Conformance to the applicable plans, operating procedures, and established QA requirements will be verified by personnel not directly responsible for performing the work. Issues identified

during implementation of the plan will be tracked and closed out through the Site-wide Commitments Management Program (SCMP). The QAPPGW generally covers quality control (QC) for the following components of the groundwater program:

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

3.4.1 FIELD DATA COLLECTION

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

The QC objectives for field data collection are the following:

- Sampled water is representative of formation water;
- Sampling techniques do not introduce contaminants to samples or wells;
- All sampling techniques are standardized to ensure reproducibility and comparability of results; and
- Water elevations are measured precisely enough to detect minor fluctuations in the water table.

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

3.4.2 DATA MANAGEMENT

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

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

The RFETS field data is entered through the DATACAP field data entry system. This system is a data entry module that is compatible with the SWD database, and can be used in remote field

locations by field personnel. Data entered into DATACAP is verified and signed off by the subcontractor before it is delivered to the main SWD database.

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

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

3.4.3 GROUNDWATER DATA QUALITY ASSESSMENT

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

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

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

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

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

The proposed monitoring program comprises the following monitoring components:

- A network of 180 wells and some footing drains sampled on a semiannual basis;
- A network of 16 wells and seeps sampled quarterly;
- Monthly measurement of water elevations at 66 wells;
- Quarterly measurement of water elevations at 180 wells;

- Semiannual measurement of water elevations at 84 wells;
- Real-time measurement of water elevations in 34 wells;
- A program plan for updating and proposing changes to the groundwater monitoring program;
- Annual evaluation and reporting to the appropriate regulatory and community agencies;
- Quarterly reporting of groundwater data that exceed action levels;
- A groundwater modeling capability;
- A well control program;
- A well abandonment, replacement, and maintenance program; and
- Other special projects pertinent to groundwater assessment.

The groundwater monitoring network includes the following seven categories of monitoring wells:

- Plume definition - 16 wells
- Plume extent - 42 wells
- Drainage - 5 wells
- Boundary - 6 wells
- Performance - 30 wells
- D&D - 76 wells
- RCRA - 8 wells
- Plume degradation - 13 wells

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

3.5.1 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 interest in RFETS groundwater. Table D-1 summarizes the analytes of interest associated with the various groundwater plumes described in Appendix D. The analyte suites tested for in water from current monitoring wells include the identified analytes of concern.

The RFCA analyte lists for groundwater use concentration levels that may differ from the Site-specific levels used in the past. Major analytes of interest were determined after reviews of historic groundwater data. The inorganic and radionuclide data for each well were initially screened against background concentrations using the 99/99 Upper Tolerance Limits reported in

the *Background Characterization Report* (EG&G, 1993b). The data were then screened against the action levels in the ALF and exceedances were noted for each well. 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 contains the analyte suites that will be collected for each well.

3.5.2 GROUNDWATER SAMPLING AND ANALYSIS

The operational groundwater sampling network will contain 196 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 RFETS wells has been chosen to generate data representative of the various groundwater conditions and to ensure compliance with applicable groundwater regulations. The frequency of sampling wells used for other purposes (such as performance monitoring and D&D monitoring) will be derived from compliance documents, agreements, or controlled work plans.

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

The following are guidelines for the collection of groundwater samples:

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

    1. VOCs— Contract Laboratory Program SW846, Method 8260;
    2. Semi-volatile organic compounds;
    3. Pesticides and polychlorinated biphenyls (PCBs);
    4. Nitrate/nitrite, as nitrogen;
    5. Metals;
    6. Specific metals for a given well;
    7. Uranium-238, -235 and -233/234;

8. Strontium-89/90;
9. Plutonium-239/240, americium-241;
10. Major anions (chloride, fluoride, sulfate, carbonate/bicarbonate); and
11. Tritium.

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

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

3.5.3 MEASUREMENT OF GROUNDWATER ELEVATIONS

Preparation of water elevation maps and hydrographs addresses both a regulatory requirement and a technical need to know groundwater flow directions and gradients accurately. The measurement of groundwater elevations has been designed to produce data that are as representative of current conditions as possible. These water level measurements are collected within 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.

3.5.4 GROUNDWATER REPORTING

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

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

The RFCA Quarterly Groundwater Compliance Reports contain a summary of groundwater monitoring data collected in a calendar quarter at RFETS. The data will be presented at public quarterly information exchange meetings and officially transmitted to EPA and CDPHE by DOE. These reports will also be posted on the RFETS 'EDDIE' webpage which is accessible by RFETS personnel.

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

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

3.5.4.1 RFCA Annual Groundwater Report

An annual assessment of groundwater conditions is required in the DQO decisions in this document. Therefore, this report will incorporate the data elements that were historically reported in the *RCRA Annual Groundwater Report*, Well Evaluation reports, and IM/IRA reports. This *RFCA Annual Groundwater Report* will replace these prior reports and will be the primary compliance report for groundwater monitoring. This integrated report will contain the following elements:

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

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

Plume Definition Wells:

- Data will first be compared with Tier I Action Levels for groundwater. If an action level has been exceeded for an analyte that has an action level, data will then be compared with background values using the mean + 2 standard deviations established in the *1993 Background Characterization Report* (EG&G, 1993a).
- If both the action level and background levels have been exceeded for an analyte that has not had consistent historic exceedances, an evaluation will be proposed. Remediation and management decisions will be made based on the results of the evaluation.
- If a particular contaminant has been detected consistently above the Tier I Action Level in historic data, then the result will be plotted against historic data set for that analyte and that well. If the analytical results show an increasing trend in concentration over a two-year period with respect to the historic data set, then an evaluation will be proposed and remedial priority established.
- For purposes of data analysis the historic data set is defined as the data generated for a particular well from the years 1991-1995. If a well does not have this data set, or is a newer well, the historic data set will be data generated for the well until a five-year data set is reached.

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

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

- If both the action level and background level have been exceeded by an analyte that has not had consistent historic exceedances, monthly sampling will be performed per RFCA. An evaluation will be proposed to determine the impact to surface water. Remediation and management decisions will be made based on the results of the evaluation.
- If a particular analyte has been consistently detected above the Tier II Action Level and historic data background, a check will be made to see if surface water impacts have been evaluated. If no evaluation has been performed, an evaluation will be proposed. If an evaluation has been performed, then future monitoring results will be tested against an historic data set of values for that analyte and that well. If the result is higher than the background mean + 2 standard deviations with respect to the historic data set, then another evaluation will be proposed to assess impacts to surface water.

Building D&D Monitoring Wells:

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

Performance Monitoring Wells:

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

RCRA Monitoring Wells:

- Reporting of well monitoring for a permitted RCRA facility is prescribed in the State and Federal Regulations. Reporting will follow the requirements of these regulations and associated guidance documents. The results of unit-specific monitoring requirements may also be addressed in specific annual reports. An example of this is the annual report for the Existing Landfill.

The annual report will provide the results of monitoring on a calendar year basis. To date, *RFCA Annual Groundwater Monitoring Reports* (Kaiser-Hill, 1997, 1998 1999, 2000, 2001) have been produced for calender years 1996 through 2000. The *Annual Report* will be submitted to the DOE at the end of the fiscal year in which the calendar year ended. This date is typically September 30. DOE will review and transmit the *Annual Report* to the regulatory agencies by November 15.

3.5.4.2 RFCA Quarterly Reporting

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

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

3.5.5 EVALUATION OF GROUNDWATER IMPACTS TO SURFACE WATER

Many of the DQO decisions for groundwater monitoring require that the effect of potential groundwater contamination on surface water be evaluated. In many cases, when groundwater action levels are exceeded, confirmatory samples will be taken. If analyses of follow-up samples confirm an exceedance, or if historic data indicate an impact to surface water that has not been evaluated, an evaluation will be performed. In general, the evaluation phase will result in a focused DQO that will determine the type of data that need to be collected, and the methodology for determining the nature and extent of contamination and its effect on surface water. The plume management strategy and performance/D&D monitoring strategy will be outlined in the following subsections.

3.5.5.1 General Strategy for Groundwater Plume Management and Remediation

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

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

Detection:

> The detection of groundwater contamination that could impact surface water at RFETS is supported through the current water monitoring programs at RFETS as well as through historic data from past investigations and information on past contaminant spills. The surface and groundwater monitoring programs have been established to detect the migration of contaminants into water that could move off Site. The monitoring programs are dynamic and may be changed to accommodate new insights into contaminant

migration. The maintenance of historic data in the Soil Water Database and the HRR (DOE, 1992a) help provide information on potential groundwater contamination problems.

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

Evaluation:

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

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

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

Remedial Decision Validation:

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

3.5.5.2 General Strategy for Performance and D&D Monitoring

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

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

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

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

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

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

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

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

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

Template for Performance/D&D Monitoring:

I. Monitoring Location Selection

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

Consider project-specific risks to surface water

- Scope of activities
- History of project area or building

Consider project duration

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

B. Selection of Project Groundwater Locations to be Monitored

Identify groundwater pathways for project

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

Determine IHSS/building specific locations of potential contamination

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

II. Data Requirements

A. Installation Requirements

Consider depth of wells with respect to potential contaminant pathways

B. Analytes of Interest

Consider history of project area or building

Consider scope of project

C. Water Level Measurements

Frequency of Measurement?

C. Sampling Frequency

How many samples month/year?

D. Field Data Collection

Consider Field Parameters Required

III. Data Evaluation

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

Statistically compare new data points against old data points

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

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

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

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

B. Notification Process

Schedule/time table

To be determined

Hierarchy/personnel involved

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

Notification items

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

C. Action Determination

Determine potential impact to surface water

- Estimate direction and magnitude of contaminant to reach surface water; incorporate consideration of hydrologic conditions and indicator parameters.
- Track progress of plume using groundwater and/or surface water locations
- Estimate contaminant fluxes and loads if necessary

Verify activity/location responsible

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

Determine potential mitigating actions

- Based on identified activity/location responsible
- Based on event characteristics, constituent
- What is the level of effort to implement mitigating actions?
- Does the risk to surface water warrant the mitigating action?
- Would the mitigating actions result in unacceptable delays to other higher priority risk reduction activities?

This template will be applied in an integrated fashion where groundwater contamination is of concern, (e.g., if building foundation drain is identified as a potential source of groundwater contamination). In this case, the appropriate recommendations will be made to the building or project to include a performance monitoring specification in the project plan. The selection of appropriate monitoring locations for flow measurement and sampling will be determined in conjunction with the planned configuration of the groundwater monitoring network. The

integrated groundwater performance monitoring/D&D monitoring design package, in the form of a proposed sampling and analysis plan or project plan, will be delivered to the D&D project manager for review. Data analysis and evaluation techniques will be in accordance with the IMP. Monitoring results will be reported in RFCA groundwater compliance reports and data will be accessible in SWD and the EDDIE webpage. Individual project notification will occur when monitoring results could impact project activities.

3.5.6 GROUNDWATER FLOW MODELING

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

This plan proposes that the current groundwater flow model, supporting software, and graphic coverage should be maintained and updated; they are used in problem-solving and tracking how closure activities affect the environment. The activity would update and maintain the input grids and coverage 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. The decision will be made 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 modeling, will be incorporated into the *RFCA Annual Report*.

3.5.7 WELL CONTROL PROGRAM

The Well Control Program is currently a RFETS procedure for new well and piezometer installations (RMRS, 1999b). The procedure is implemented through the Water Programs Group. The Well Control Program ensures that proper recording and tracking of well installation activities on RFETS are done, and serves as a necessary approval process for the installation of wells. The program will support the following activities:

- Assigning well location codes to eliminate misidentification of wells or use of redundant well names.
- Maintaining a database with summary well information to be used for evaluation of the functions of new wells, and preparing and obtaining well permits as required by 2 CCR 402-2 regulations. The instructions and form are available in RFETS Procedure PRO-1059-WELL-118 (RMRS, 2000b).
- Maintaining a database of well construction information and geologic log information that must be submitted with the permit applications.
- Submitting permits for wells that are installed or abandoned to the State Engineer's Office.
- Maintaining the RFETS geologic core repository for use in correlation of geologic strata and interpretation of hydrogeologic properties.

- Through an approval process before well construction, ensuring that wells are installed following applicable procedures and with appropriate knowledge of geologic and RFETS conditions.

3.5.8 WELL ABANDONMENT AND REPLACEMENT (WARP)

Beginning in FY02 wells that are considered no longer necessary for groundwater monitoring purposes will be abandoned. Abandoning a well eliminates it from the monitoring network in such a manner that the well will not remain a conduit for groundwater or contaminant migration. WARP will replace damaged or poorly constructed wells useful to the monitoring network and abandon others. The project will continue through FY05 and will result in the removal of about 1,000 wells. In tandem with this activity will be evaluations of the groundwater monitoring network to insure that the wells necessary for compliance are retained.

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

- When the potential for cross-contamination from the well exists;
- When the well is poorly constructed or damaged;
- When the well is in the way of proposed construction or demolition activities; and
- When the well has no identified purpose for future monitoring.

A report describing the results of WARP, including well installations, abandonment and replacement, will be included as a section in the RFCA Annual Report.