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Conceptual Plan for the Management and Remediation of Groundwater at the Rocky Flats Environmental Technology Site

FINAL

Conceptual Plan for the Management and Remediation of Groundwater at the Rocky Flats Environmental Technology Site

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Environmental Restoration/Waste Management

Sitewide Actions

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Revision 1

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EXECUTIVE SUMMARY

A sitewide conceptual plan has been developed to address groundwater issues at the Rocky Flats Environmental Technology Site (RFETS). The groundwater conceptual plan is directly related to the cleanup of contaminated soil and the protection of surface water quality. Proposed remedial actions will be protective of surface water quality.

Addressing groundwater on a sitewide basis will allow for effective coordination of groundwater activities, a consistent approach to addressing groundwater contamination, and establishment of consistent remediation goals. Overall, the programmatic goals are to protect human health and the environment (i.e., on and offsite), and to limit potential contamination of surface water and groundwater.

The goal of the Groundwater Conceptual Plan is to provide a strategy consistent with the Vision and the Action-Level Framework for surface water, groundwater, and soils, to identify and describe the salient groundwater plumes, rank the groundwater plumes in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995), and propose the next steps. The Vision is a strategic series of steps that describes cleanup, consolidation, closure, and reuse of the site.

Domestic use of groundwater at RFETS will be prevented through institutional controls. Since no human exposure to groundwater is foreseen, action levels for groundwater must be protective of surface water standards and quality as well as the ecological resources.

The volatile organic compound (VOC) groundwater plumes at RFETS have been defined on the basis of exceedances above the maximum contaminant level (MCL) for individual constituents. To delineate areas of highly contaminated groundwater, the proposed groundwater action levels of 100 x MCLs were compared against all groundwater data for the most common VOCs in groundwater and the exceedances were plotted.

There are six groundwater contaminant plume areas identified where groundwater contamination exceeds 100 x MCLs. In addition, groundwater contaminant plumes with concentrations that do not exceed 100 x MCLs, but have the potential to impact surface water are discussed as a seventh plume area. These groundwater contaminant plumes areas are: (1) Individual Hazardous Substance Site (IHSS) 119.1 Groundwater Contaminant Plume, (2) Mound Site Groundwater Contaminant Plume, (3) 903 Pad and Ryan's Pit Plume, (4) IHSS 118.1 Plume, (5) East Trenches Area Plume, (6) IA Plume, and (7) Landfill and Solar Ponds Groundwater Contaminant Plumes.

The groundwater plumes were ranked in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995). The plume ranking in this document will be incorporated into the previously developed IHSS ranking.

Proposed conceptual actions will result from applying the action levels for groundwater remediation within the framework of the Vision. Further analysis will determine optimal locations, treatment methodologies, and cost-effective project sequencing. Alternatives analyses for proposed remedial action of the plumes will be presented as an Interim Measure/Interim Remedial Action (IM/IRA) decision document or Proposed Action Memorandum (PAM).

1.0 INTRODUCTION

The Groundwater Conceptual Plan has been developed as a joint effort between the Department of Energy Rocky Flats Field Office (DOE/RFFO), Kaiser-Hill, L. L. C. (KH), Rocky Mountain Remediation Services, L. L. C. (RMRS), the Environmental Protection Agency (EPA), Region VIII, and the Colorado Department of Public Health and Environment (CDPHE). This groundwater plan incorporates the draft Rocky Flats Conceptual Vision (dated November 8, 1995 [Appendix B]), and technical guidance from the Groundwater Strategy Working Group and the Action Levels and Standards Working Group.

1.1 VISION AND ACCELERATED SITE ACTION PLAN (ASAP)

The Rocky Flats Conceptual Vision identifies the proposed future site conditions for different areas at the Rocky Flats Environmental Technology Site (RFETS). The Vision recognizes that RFETS cannot be returned to a pristine condition and defines four final site conditions. These conditions include (1) capped areas underlain by long-term waste management facilities or contaminated materials closed in-place, (2) an industrial area (IA), (3) an inner buffer zone and windblown plutonium area managed as restricted open space, and (4) an unrestricted outer buffer zone that will be managed as open space, but which could be used for any purpose.

A comprehensive action plan (i.e., ASAP) is being formulated to describe how to implement the Vision in compliance with the Rocky Flats Compliance Agreement (RFCA). This Groundwater Conceptual Plan will help define the requirements for ASAP, and will describe the groundwater management and actions necessary to attain the Vision.

The groundwater plan conceptually describes how groundwater will be remediated and managed to protect surface-water quality and the ecology. Groundwater management and cleanup will focus on protecting surface-water quality, since there will be no consumptive use of onsite groundwater. This prohibition against using onsite groundwater will aid in maintaining hydraulic gradients (i.e., vertical and horizontal) to minimize contaminant migration. Nevertheless, groundwater quality in the outer buffer zone will be protective for all uses.

1.2 PURPOSE OF THE GROUNDWATER CONCEPTUAL PLAN

Groundwater at RFETS is present in the subsurface throughout the site. In the past, each Operable Unit (OU) investigated groundwater within its boundaries without addressing influences from upgradient sources. However, groundwater is not limited by OU or Individual Hazardous Substance Site (IHSS) boundaries. Several sources may contribute to a single groundwater

plume, and groundwater plumes may cross several units and contribute to surface-water contamination at some distance from the source location. Therefore, a sitewide technical and regulatory strategy has been developed to address groundwater issues at RFETS.

The Groundwater Conceptual Plan addresses groundwater on a sitewide basis to allow for effective coordination of groundwater activities, a consistent approach to addressing groundwater contamination, and establishment of consistent remediation goals. Development of a sitewide groundwater strategy also means that groundwater remediation can be performed independent of source remediation. As there is no exposure pathway to humans, the programmatic goals are to protect surface water and the environment, and limit potential contaminant migration (to the extent possible).

The specific goals of this Conceptual Plan are to:

1) Provide a groundwater strategy consistent with the Vision and the Action-Level Framework;

2) Identify and describe the principal contaminated groundwater plumes;

3) Rank the contaminated groundwater plumes for the purpose of establishing the priority for remedial actions in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995); and

4) Provide an initial planning basis for funding and implementation of groundwater remediation.

To meet these goals, the strategy proposes source removal, where feasible; provides for source control, where necessary; and provides for the treatment of dissolved-phase plumes, where necessary. The strategy includes an evaluation whereby some areas of contaminated groundwater may remain in place if the goals of the strategy can be met without active intervention. Downgradient wells will continue to be monitored to ensure that the goals of the strategy are met.

1.3 DOCUMENT ORGANIZATION

The strategy for groundwater restoration is presented in five sections: (1) Section 1.0 provides an introduction, describes the goals and purpose of the groundwater strategy, and presents the organization of the report; (2) Section 2.0 provides a summary background on groundwater at

RFETS; (3) Section 3.0 presents the cleanup standards and approach developed by the Standards Working Group for surface water, groundwater, surface soil, and subsurface soil and describes the monitoring associated with groundwater restoration and plume management; (4) Section 4.0 describes the various groundwater contaminant plumes present at RFETS and provides an overview of the potential remediation techniques that may be used; and (5) Section 5.0 summarizes the next steps and presents the conclusions.

This document also contains three appendices: (1) Appendix A is a list of acronyms used in this text, (2) Appendix B contains the text of the draft Conceptual Vision for RFETS, used as the basis for the groundwater strategy; and (3) Appendix C contains the draft Action-Level Framework for Surface Water, Groundwater, and Soils developed by the Standards Working Group.

Figure 1-1 is a location reference map showing the central portion of RFETS. The principal areas discussed in the text are indicated by annotations.

2.0 GROUNDWATER AT RFETS

The physical setting is important to understanding the nature of groundwater flow and contaminant transport at RFETS. Detailed studies of the hydrogeology are presented in the "Hydrogeologic Characterization Report for the Rocky Flats" (EG&G, 1995a). Detailed studies of the geology are presented in the companion document, "Geologic Characterization Report of the Rocky Flats Environmental Technology Site." (EG&G, 1995b). Plume configurations used in the Strategy were derived from the 1995 Well Evaluation Project.

Shallow groundwater flow can be described as occurring through two distinct layers, each exhibiting common hydrologic characteristics allowing for grouping into two hydrostratigraphic units. These units are generally referred to as the (1) upper hydrostratigraphic unit (UHSU) and (2) lower hydrostratigraphic unit (LHSU).

The UHSU is the predominant water-bearing unit of concern at RFETS. It consists of sandy and gravely soils mixed with clay (i.e., alluvium, colluvium, and artificial fill) as well as weathered bedrock and minor bedrock sandstones hydraulically connected to the alluvium. The LHSU consists of unweathered claystone, with some interbedded siltstones and sandstones. There is a significant difference in each units' ability to allow groundwater flow. For example, the typical hydraulic conductivity values for the Rocky Flats Alluvium are about 2×10^{-4} centimeters per second (cm/sec), while the unweathered Laramie claystones exhibit hydraulic conductivity values of 3×10^{-7} cm/sec, similar to that required for a landfill liner (EG&G, 1995a). However, neither the UHSU nor the LHSU has sufficient transmissivity or saturated thickness to be developed as a water source for residential use, although some isolated (i.e., UHSU) bedrock sandstones in OU 2 and valley-fill alluvial materials in Walnut Creek near Indiana Street could provide sufficient water to support limited household-use.

The spread of contamination in groundwater at RFETS is limited by hydrogeologic conditions. Generally, groundwater flows slowly at RFETS. The speed of groundwater moving through the Rocky Flats Alluvium in the East Trenches Area is estimated to be about 50 feet per year. Because natural processes inhibit or retard the transport of contaminants in groundwater, the speeds at which chlorinated solvents are transported at this location are estimated to range between 2.5 and 25 feet per year.

The LHSU provides natural vertical containment for the impacted UHSU groundwater. Directly underlying the IA, low permeability claystones of the LHSU form a barrier no less than 500 feet in thickness, effectively preventing contamination from migrating downward to the Laramie/Fox

Hills aquifer (See Figure 2-1). By comparison, the average Resource Conservation and Recovery Act (RCRA) landfill is lined with two to four feet of similar material. As a result of these stratigraphic relationships, all contaminated groundwater emerges as surface water before leaving the site. In addition, there is no known hydraulic connection between domestic wells located offsite and impacted groundwater at Rocky Flats. Horizontal spread of the plumes is mitigated by the low hydraulic conductivity, lack of continuous permeable beds, limited zones of saturation, and high contaminant retardation factors characteristic of the clay-rich units comprising the UHSU. High contaminant retardation in clayey soils is caused by the small pores inhibiting the passage of the contaminants as well as the process of adsorption onto the aquifer materials.

Groundwater in the UHSU preferentially flows along pre-existing channels cut into the bedrock (See Figure 2-2). These channels are known to occur in the IA, Solar Ponds, 881 Hillside, 903 Pad, and East Trenches Areas. Other hydrogeologic controls for groundwater flow and contaminant transport are hydraulic gradient, distribution of subcropping sandstones and claystones, and topography. In addition, groundwater in the IA may preferentially flow along buried sewer lines and process-waste lines. Groundwater in the surficial deposits of the UHSU generally flows to the east, following bedrock and surface topography and discharges to surface drainages where surficial deposits are intersected by drainages. These drainages are the main groundwater pathways offsite. The surface-water flow onsite is controlled by artificial impoundments in these drainages.

The available hydrogeologic and isotopic data suggest that faults are not significant conduits for downward vertical groundwater flow to deep aquifers. Evidence of limited hydraulic communication between UHSU and LHSU groundwater was found to exist in some wells, but these occurrences do not present a consistent pattern with known fault locations. Isolated fractures in unfaulted bedrock, as opposed to fault zone fractures, are the most likely mode of transport for UHSU groundwater to reach unweathered bedrock. Due to the thickness and lithology of the LHSU, it is likely that fault zones become more impermeable with depth, thus reducing the potential for any shallow groundwater flow to the Laramie/Fox Hills aquifer.

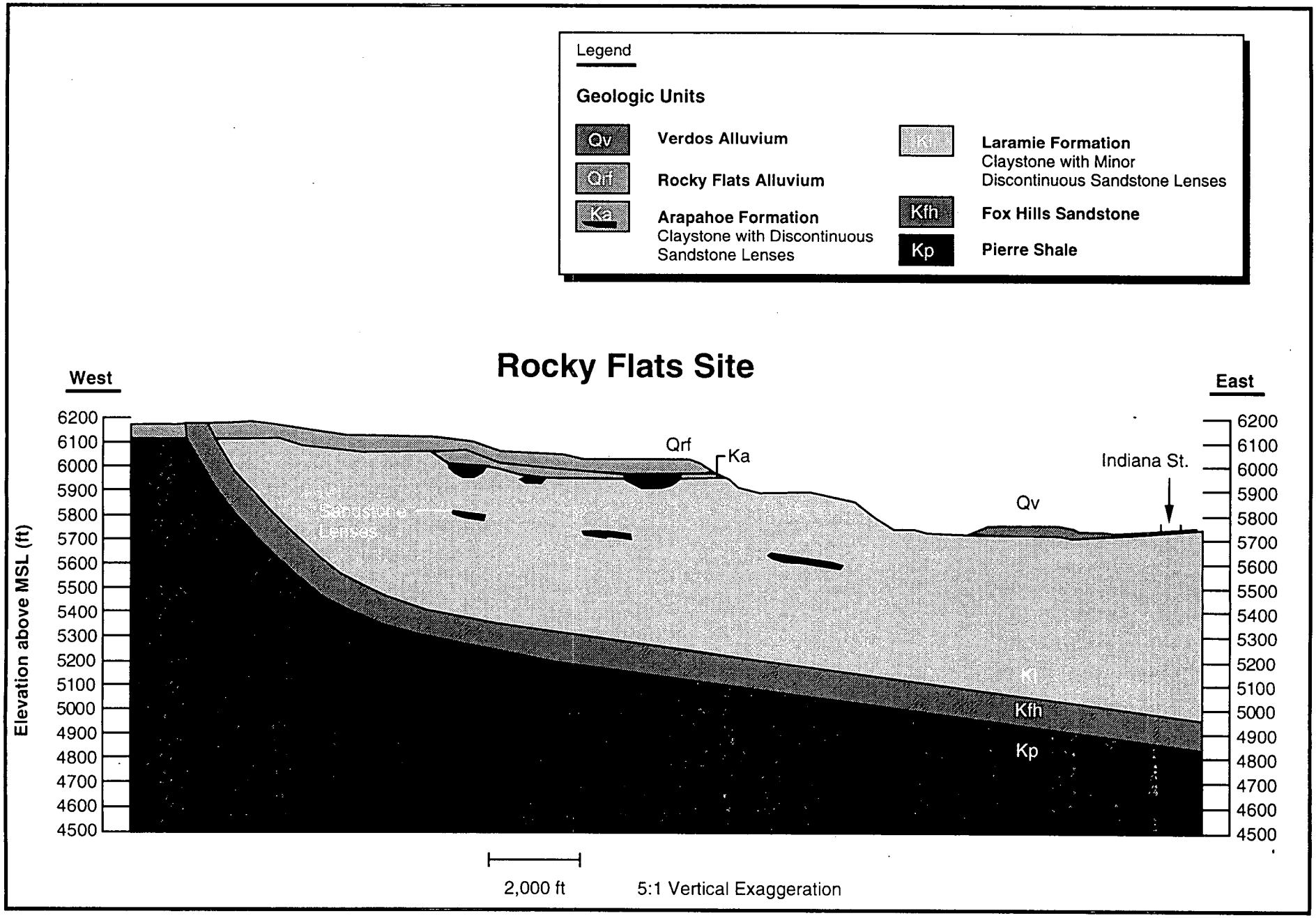
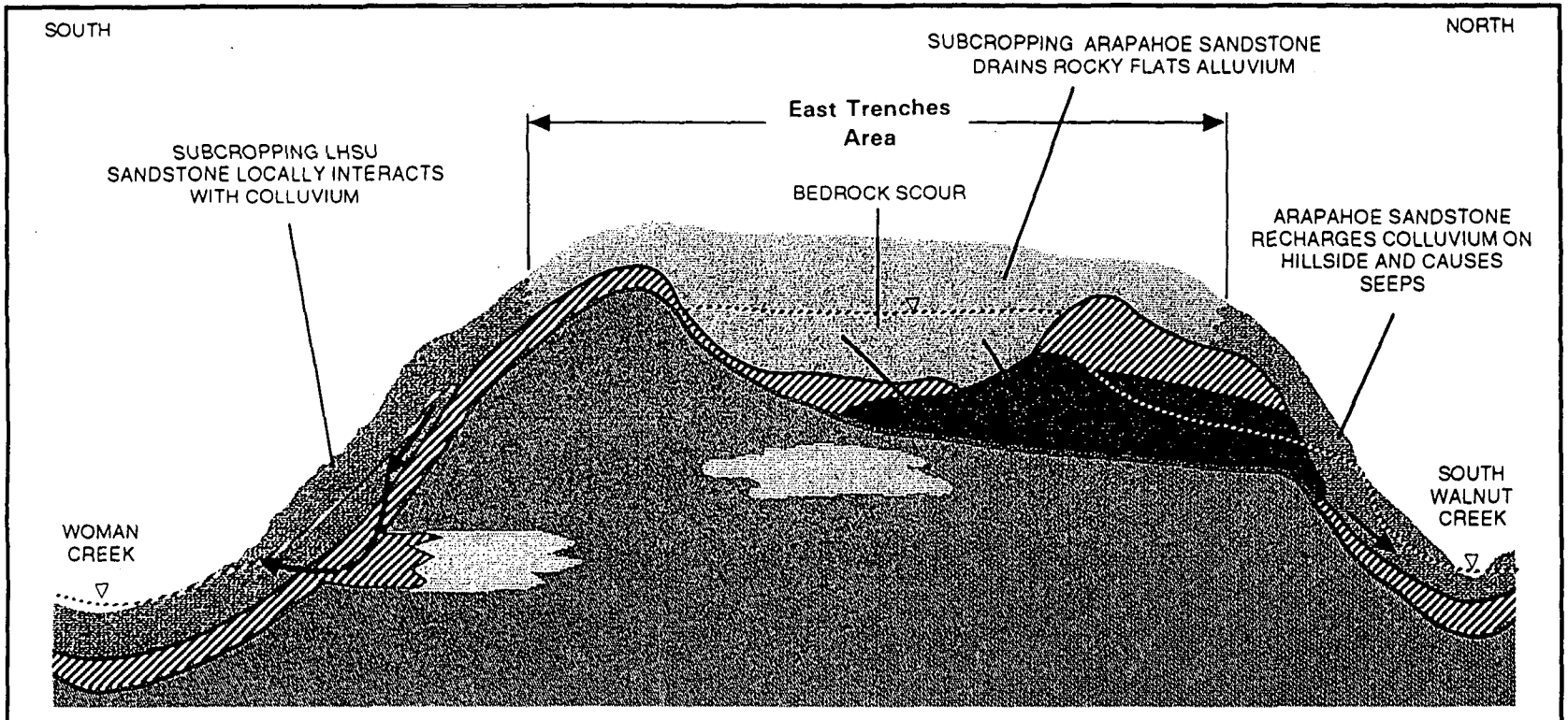


Figure 2-1 Generalized Geologic Cross-Section of the Rocky Flats Area



EXPLANATION

- (Qrf) ROCKY FLATS ALLUVIUM
- (Qc) COLLUVIUM
- UNWEATHERED CLAYSTONE/ SILTSTONE BEDROCK
- WEATHERED BEDROCK
- WEATHERED ARAPAHOE #1 SANDSTONE BEDROCK
- LHSU UNWEATHERED SANDSTONE BEDROCK
- GROUND WATER FLOW DIRECTION
- CONCEPTUAL UHSU/LHSU BOUNDARY
- WATER TABLE

Schematic Cross Section of Hydrostatigraphy at East Trenches Area

April 1995 | **Figure 2-2**

g95\ES\hydrodoc\hydrostat cross-sectn cdw

3.0 ACTION LEVELS AND CLEANUP STANDARDS/GOALS

The Vision is the basis for the standards and action levels developed by the Working Group. The draft Conceptual Vision for RFETS places the greatest emphasis on protecting the quality of surface water and minimizing the migration of contaminants offsite through a surface-water pathway. Protection of surface water is the primary driver for the cleanup and stabilization of contaminated subsurface soil and groundwater at RFETS. Surface water, groundwater, and soil cleanup are interrelated, and the Groundwater Strategy Working Group considered all three media in developing a sitewide strategy for RFETS.

The result of the Action Levels and Standards Working Group, Action-Level Framework for Surface Water, Groundwater, and Soils (February 5, 1996) is attached as Appendix C. The parties have not reached agreement on all of the text in this document. The following sections summarize the approaches delineated in the draft Action-Levels document for monitoring and remediation of surface water, groundwater, and subsurface soils as these apply to groundwater.

3.1 SURFACE WATER

Groundwater will be managed to protect surface water. During active remediation, surface-water standards and surface-water management will be different than those applied after remediation. The design of systems should include meeting action levels and cleanup standards upon completion of the remediation plans.

3.2 GROUNDWATER

As stated in the draft Conceptual Vision, domestic use of groundwater at RFETS will be prevented through institutional controls. Because no other human exposure to groundwater is foreseen by the Vision, groundwater action levels are not based on human consumption or direct contact. Instead, action levels for groundwater have been selected to be protective of surface-water quality and ecological resources. This framework for groundwater action levels is based on the conclusion that all contaminated groundwater emerges as surface water before leaving the site.

3.2.1 Action Levels

The action levels and standards working group has defined the action levels based on federal drinking water standards' Maximum Contaminant Levels (MCLs) (see Appendix C). MCLs are well established and accepted values which also have been used to guide cleanup at other contaminated sites. Where an MCL for a particular contaminant is lacking, the residential

ingestion-based PPRG value will apply. A two-tier approach to groundwater remediation and monitoring is presented in the following paragraphs.

Tier-I

Action levels were developed to drive near-source remediations in areas where groundwater contamination exceeds 100 x MCL levels for organic contaminants. These action levels are designed to identify groundwater contaminant sources that present a higher potential risk to surface water and that should be addressed through an accelerated action. If Tier-I action levels are exceeded, an evaluation is required to determine if remedial or management action is necessary to prevent more highly contaminated (i.e., contaminant concentrations exceeding 100 x MCLs) groundwater from reaching surface water (the evaluation process is described in Section 4.1). If action is necessary, the type and location of the action will be delineated and implemented as an accelerated action. Additional groundwater that does not exceed the Tier-I action levels may also need to be remediated or managed to protect surface-water quality or ecological resources. The plume areas to be remediated and the cleanup levels or management techniques used will be determined on a case-by-case basis. Wells that yield groundwater that is contaminated with VOC concentrations exceeding 100 x MCLs are considered Tier-I wells.

Tier-II

The VOC action levels for surface-water protection were developed to prevent contaminated groundwater from reaching surface water, by triggering groundwater management actions when necessary. Tier-II wells are located down gradient of existing plumes to detect the spread of contamination from these plumes. If concentrations in a Tier-II well exceed MCLs during a regular sampling event, monthly sampling of that well will be required. Three consecutive monthly samples showing contaminant concentrations greater than groundwater action level will require a groundwater remedial action. These actions will be determined on a case-by-case basis and will be designed to treat, contain, manage, or mitigate the contaminant plume. Such actions will be incorporated into the Environmental Priority List and will be given weight according to measured or modeled impacts to surface water.

A detailed discussion of where Tier-II action levels will be measured is found in Section 3.2 of Appendix C. Table 3-1 presents a list of three new wells and a subset of existing groundwater monitoring wells that are designated as Tier-II monitoring locations. Figure 3-1 shows the location of Tier II monitoring wells relative to the composite VOC plumes defined by constituent concentrations greater than the MCLs. Additional Tier-II monitoring wells may be installed, if

necessary. The following paragraph reflects the recommend option made by the Working Group regarding Tier-II wells triggering action (see Section 3.3 of Appendix C).

The existing proposed Tier II wells are currently in the groundwater monitoring network. The new Tier II monitoring wells will be added to the groundwater monitoring network upon completion of well installation and development activities. The results of groundwater sampling and analysis will be integrated with concurrent surface water data for the purpose of evaluating potential impacts to surface water.

Table 3-1 Tier-II Groundwater Monitoring Wells for VOCs

Location Code	Comments
6586	
New Well	Upstream of 6586
New Well	Between B-2 and B-3
75992	
06091	
New Well	Near C-1 (Downgradient of Ryan's Pit)
10194	
1986	
10994	
P314289	
P313589	
7086	
10992	
1786	
1386	
10692	
4087	
B206989	

Groundwater Monitoring

The groundwater monitoring network will continue to operate as recently modified by the Groundwater Monitoring Working Group, unless subsequent changes are agreed to by all parties. Analyte suites, sampling frequency, and specific monitoring locations will be evaluated annually to adjust to changing hydrogeologic conditions such as plume migration and increased understanding of contaminant distributions. All groundwater monitoring data, as well as changes in hydrogeologic conditions and any exceedance of groundwater action levels, will be reported quarterly and summarized annually to all parties.

All long term monitoring requirements for the Site, including those wells that are identified in the groundwater strategy, will be incorporated into the Groundwater Monitoring and Assessment Plan (GMAP). This document will incorporate two pre-existing plans: (1) the Groundwater Protection and Monitoring Program Plan (GPMPP) (DOE, 1993) and (2) the Groundwater Assessment Plan (GWAP) (DOE, 1992a).

The GMAP will list the wells with their appropriate regulatory driver, the sampling frequency, and analyte suite as well as describe data evaluation and reporting methodologies. The GMAP will also reference other implementation plans and decision documents from which the requirements are derived. The GMAP will be updated regularly as programmatic changes occur.
If quarterly reporting shows that previously uncontaminated wells are contaminated above groundwater action levels, the sampling frequency will be increased to monthly. Three consecutive monthly samples showing exceedances will trigger an evaluation to determine if a remedial or management action is necessary.

All groundwater remedies, as well as some soil remedies, will require groundwater performance monitoring. The amount, frequency, and location of any performance monitoring will be based on the type of remedy implemented and will be determined on a case-by-case basis within decision documents

3.3 SUBSURFACE SOILS

Action levels for volatile organic compounds (VOCs) in subsurface soils were developed to be protective of groundwater in order to protect surface water. Metals and radionuclides were not included because they are not generally mobile in groundwater. However, it is recognized that locally, metals and radionuclides are present in groundwater at concentrations or activities exceeding background levels. Where these metal and radionuclide exceedances coincide with VOC contaminant plumes, the selected remedy will address all contaminants of concern. The remaining isolated exceedances of metals and radionuclides will be evaluated with respect to possible impact to surface water and will be reported upon in the Annual RCRA Groundwater Monitoring Report that will be expanded to include a Sitewide as well as a regulated unit analysis. A working group will be established to set action levels for metals and radionuclides.

The level of VOC soil contamination protective of groundwater was determined using a soil/water partitioning equation and a calculated dilution factor (EPA, 1994). The partitioning equation used chemical-specific parameters and site-specific subsurface media characteristics to determine the equilibrium partitioning of a given contaminant between the soil and groundwater. The dilution factor accounts for dilution up to the edge of the source location. Using this approach, subsurface soil contaminant levels that would be protective of groundwater to 100 x MCLs were calculated (see Appendix C).

4.0 GROUNDWATER CONTAMINANT PLUMES AND REMEDIATION

4.1 IDENTIFICATION

The VOC groundwater contaminant plumes at RFETS have been defined on the basis of exceedances above the MCL for individual constituents (see Figure 3-1). To delineate areas of highly contaminated groundwater, the proposed groundwater action levels of 100 x MCLs were compared against all groundwater data for the most common VOCs in groundwater. The exceedances were plotted and are shown on Figure 4-1. The most probable sources were identified using the results of recent field sampling programs and process knowledge. The flow diagram (see Figure 4-2) describes the method used to locate groundwater contaminant plumes and the corresponding sources, and to determine which areas should be targeted for remedial action.

There are six groundwater contaminant plume areas identified where groundwater contamination exceeds 100 x the MCLs. In addition, groundwater contaminant plumes with concentrations that do not exceed 100 x MCLs, but are of interest because of proximity to surface water are discussed as a seventh plume area. Contaminated groundwater flows slowly at RFETS, and it appears that the extent of these plumes is not rapidly changing. These groundwater contaminant plumes areas are: (1) IHSS 119.1 Groundwater Contaminant Plume, (2) Mound Site Groundwater Contaminant Plume, (3) 903 Pad and Ryan's Pit Plume, (4) IHSS 118.1 Plume, (5) East Trenches Area Plume, (6) IA Plume, and (7) Landfill and Solar Ponds Groundwater Contaminant Plumes.

The 903 Pad and Ryan's Pit plume, the Mound, and the East Trenches plumes are part of a large composite groundwater contaminant plume on the east side of the plant. Even though these component plumes overlap, differing sources and flow paths make it effective to treat these parts of the large plume individually.

4.2 GROUNDWATER REMEDIATION

4.2.1 Remediation Alternatives

The goal of this strategy is to manage and/or remediate groundwater to be protective of surface water. The proposed remediation of contaminated groundwater plumes involves source removal or source containment, with treatment or management of the contaminated groundwater to minimize impacts on surface water. The conceptual remedies for each groundwater contaminant plume were developed by assessing the available technologies, and proposing a cost effective, readily available technology.

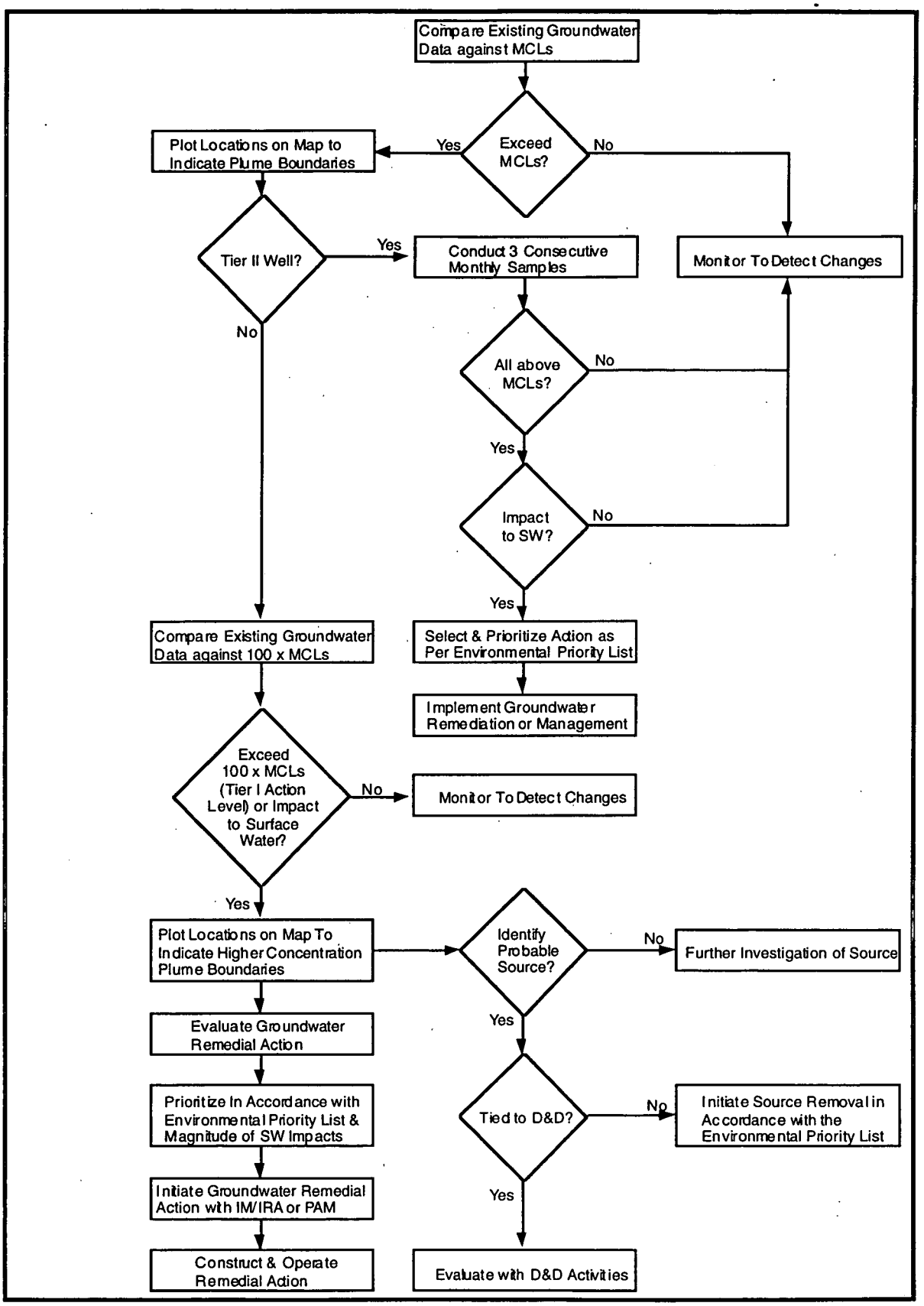


Figure 4-2 Flow Diagram

Active and passive remedial actions were initially considered. Active treatment actions such as pump and treat are well known and accepted, but often have high operation and maintenance costs, can have a negative impact on wetlands, may consume groundwater, have limited application in clayey aquifers, and are relatively inefficient for dense nonaqueous phase liquid (DNAPL) remediation. Passive treatment actions include passive collection of groundwater with *ex situ* treatment, and *in situ* collection and treatment. These systems may have higher capitol costs, but have lower operation and maintenance costs, low energy consumption, no water consumption, and reduced equipment requirements.

The pump and treat methodology is commonly used and accepted. EPA has identified the pump and treat methodology as one of the most common methods for groundwater remediation, but recognizes that pump and treat methods may require decades of potentially expensive operations to achieve cleanup levels (EPA, 1992). A preliminary analysis was performed on the potential effectiveness at RFETS. The analysis concluded that pump and treat would not be an effective treatment for most RFETS contaminated groundwater plumes based on the following:

- Neither the UHSU nor the LHSU are capable of producing significant quantities of water as each has a relatively large clay content.

- Aquifer tests conducted at RFETS show that, for the most part, aquifer yields are low, ranging from .000006 gpm to 12 gpm, with an average of 0.3 gpm (EG&G, 1995a).

- Factors limiting water production within the UHSU include relatively thin saturated thicknesses and the presence of broad areas that become unsaturated during the fall and early winter (EG&G, 1995a).

- Surficial deposits (UHSU) at RFETS have hydraulic conductivities in the 10^{-3} to 10^{-4} cm/sec range. Weathered and unweathered claystone bedrock (LHSU) have hydraulic conductivities in the 10^{-7} cm/sec range. The valley fill alluvium is the most permeable unit, but no contaminant sources are known to be present in this unit.

- Due to the relatively low permeability of the geologic units at RFETS, cones of depression induced by groundwater removal would typically have very steep gradients requiring a large number of closely spaced wells to effectively implement pump and treat remediation.

- The present widespread distribution of seeps and springs (EG&G, 1995a) may be reduced by the upgradient extraction of groundwater.

- Most of the RFETS groundwater contaminant plumes have suspected sources consisting of dense nonaqueous phase liquids (DNAPLs) which are difficult to remediate by using pump and treat methods because:

  - DNAPLs have low dissolution rates in water and are denser than water, tending to sink to the bottom of the unit.

  - The high clay content tends to adsorb DNAPL, making it difficult to impossible to remove.

  - Pump and treat remediation leaves residual DNAPL which will continue to act as a source, further releasing dissolved contaminants to the groundwater system.

DNAPL contamination is difficult and time consuming to treat, whether by active or passive remediation methods. Residual DNAPL will generally remain, and will continue to release contamination into groundwater. When properly placed, a passive collection system near the distal ends of plumes will effectively capture the DNAPL contaminated groundwater, but a contaminated plume will be left upgradient to naturally attenuate. The contaminants in the plume will degrade with time, and upgradient water will flush the source material toward the collection system.

Remedial actions were selected to be effective, inexpensive to install and operate, and require minimal plant infrastructure support. For these and the preceding reasons, passive treatment actions were the preferred proposed remedial actions.

Passive systems proposed for the contaminated groundwater plumes at RFETS include:

- *In situ* passive collection and treatment system such as a funnel and gate where contaminated groundwater is funneled into a reactive barrier. Treated water is released back into the groundwater flow system downgradient of the barrier. These systems have been used effectively at other sites.

- Collection of groundwater from springs, seeps, and/or shallow drains, then pumping the collected water to an existing treatment facility (i.e., Building 891).

- Collection of groundwater from springs, seeps, and/or shallow drains, then using gravity to feed the collected water through a nearby, *ex situ* treatment system which uses granulated activated carbon, or reactive iron, or similar treatment options.

The passive treatment methods proposed in this plan could use any of these methods.

All proposed remedial actions are conceptual in nature. No engineering feasibility analyses were performed and the proposed remedial actions were not evaluated with regard to changing site conditions over time. Before implementation of any remedy, an evaluation will be done to determine the most appropriate, effective, implementable, and cost-effective remedy for each contaminated groundwater plume. The result of these evaluations will be presented as part of ASAP or in a planning or implementation document such as an Interim Measure/Interim Remedial Action (IM/IRA) or Proposed Action Memorandum (PAM) along with the data used to make the decision. It is possible that, as a result of these evaluations, different remedial actions will be selected for some of the groundwater contaminant plumes.

Assumptions

The proposed conceptual groundwater remedial actions were developed using the following assumptions:

- RFETS groundwater will not be used for domestic or other consumptive purposes, and there are no pathways for contaminated groundwater to directly impact human receptors.

- Groundwater will be managed or remediated to protect surface water and to minimize potential ecological impacts due to entering the surface water system.

- Source removals or containment of subsurface soil sources will be designed to prevent groundwater contaminant concentrations greater than 100 x MCLs.

- Remediation and plume management will preserve wetlands where possible, and will be implemented using cost-effective methodologies.

- Passive groundwater treatment or containment is the preferred remedial action.

- Performance monitoring will be conducted for all treatment systems to verify the effectiveness of the treatment.

- The remediation and management decisions described herein are based on the existing data set for groundwater contaminant plumes, as well as on known technologies that are believed to be applicable.

- For this plan, the proposed remedial actions are assumed to be passive treatment or containment devices. Passive treatment systems will be sited downgradient from the sources and coincident with the 100 x MCL boundary within the plume, or where otherwise practicable and feasible. The actual remedial actions and location of these actions will be decided on a case-by-case basis and detailed in a IM/IRA or PAM before implementation.

- An alternatives analysis for any proposed remedial action will be presented as part of ASAP or as an IM/IRA decision document or PAM.

- All remedial actions will be consistent with the proposed end-state of the Site.

4.2.2 IHSS 119.1 GROUNDWATER CONTAMINANT PLUME

The IHSS 119.1 drum storage area within OU 1 is the site of historic releases of chlorinated VOCs to the environment. These solvents have resulted in the contamination of shallow alluvial groundwater (UHSU) and have formed a small, relatively stable contaminant plume extending down the 881 Hillside. In 1992, a French Drain was installed to intercept contaminated groundwater perceived to be flowing down the 881 Hillside. A three-foot-diameter recovery well, located within the source area, was also installed to recover water containing higher levels of dissolved VOCs.

The French Drain is in operation and is collecting relatively uncontaminated groundwater for treatment at the Building 891 Treatment Plant. The plume is upgradient of the French Drain and does not appear to be migrating. The area immediately downgradient of the French Drain is unsaturated indicating that the French Drain has dewatered much of the area. A small seep located south of IHSS 119.1 and downgradient of the French Drain along Woman Creek was sampled once. This sample contained a trace amount of VOCs. However, it is not clear if this seep is related to the contaminant plume.

The final remedy planned for OU 1 is to excavate those soils containing solvent concentrations greater than the Tier-I action levels. Excavating the source will also remove much of the groundwater contaminated above 100 x MCLs. After demonstration that this proposed remedy has been effective, and that the source and much of the resulting contaminated groundwater has been removed, the French Drain and recovery well would be removed from operation.

This remedial action will be protective of surface water, and should reduce any potential long-term stress to environmental receptors of contaminants that may reach Woman Creek.

4.2.3 MOUND SITE GROUNDWATER CONTAMINANT PLUME

The Mound groundwater contaminant plume is poorly defined but it is suspected to migrate northward from the old Mound Site and discharge to South Walnut Creek upstream of the sewage treatment plant. DNAPLs in the Mound area are suspected to be the source of the groundwater contamination and the potential exists for these concentrations to increase over time. There is a possibility that Trench T-1 could contribute to this plume, however, evidence indicates the Mound Site is the primary source.

Contaminated groundwater from the plume contains vinyl chloride, tetrachloroethene, and trichloroethene. The contaminant plume is discharging through surface and subsurface seepage into South Walnut Creek. The contaminant plume discharges at a rate of .5 gallons per minute or less at seep SW059 where it is collected and stored, then later treated at the Building 891 Treatment Facility.

Remediation of the Mound Site contaminated groundwater plume will consist of excavating sources exceeding Tier-I action level for soil cleanup criteria for VOCs. Trench T-1 will also be removed using the same criteria. The remedial action proposed for the groundwater with concentrations of VOCs in excess of 100 x MCLs is to collect the plume front before impacting South Walnut Creek by making improvements to the existing seep collection system at SW059. The contaminated water could then be treated by a system installed along the south bank of South Walnut Creek.

Containment and treatment of the Mound site groundwater contaminant plume will result in a reduction of risk to the environment posed by uncontrolled releases of contaminated groundwater to surface water.

4.2.4 THE 903 PAD AND RYAN'S PIT GROUNDWATER CONTAMINANT PLUME

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

Contaminated groundwater occurs in the UHSU in alluvium, colluvium and weathered, low-permeability bedrock where it forms a complex plume, or plume group. Depending on the season, there may be many unsaturated areas within the plume. Groundwater flow paths in alluvial materials are relatively well-defined by contact seeps with the underlying bedrock materials and by numerous wells. However, groundwater flow through the hillside colluvium and bedrock is poorly understood. Areas of unsaturated colluvium are fairly common and prediction of local flow paths is difficult. Discharge of contaminated groundwater has not been observed from the colluvium or weathered bedrock portion of this plume.

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

The proposed remedy is to remove contaminant sources exceeding the applicable RFETS soil cleanup criteria for VOCs from the 903 Pad area. Removal of the subsurface soils in the Ryan's Pit area has already been completed. Further groundwater remediation is proposed as a plume capture and treatment system proposed to be installed at or near the MCL plume boundary which appears to be close to the 100 x MCL isopleth. Monitoring of treated groundwater and groundwater downgradient of the collection facilities for plume constituents would be conducted to ensure system performance. Active groundwater collection systems are not considered feasible for this area because of low hydraulic conductivities, limited saturated thicknesses, limited area extent of saturated zones, and complex interaction of groundwater between colluvial and bedrock units.

4.2.5 118.1 GROUNDWATER CONTAMINANT PLUME

IHSS 118.1 is located due north of Building 776 and east of Building 730. There are documented past releases of chlorinated solvents (i.e., carbon tetrachloride) at this site. The area where IHSS 118.1 is located also includes overlap from other IHSSs (i.e., 121-T9, 121-T10, 131, and 144[N]). Different spills and occurrences are associated with these IHSSs.

IHSS 118.1 is the site where a 5,000 gallon underground steel storage tank and associated piping were formerly located. Numerous reported spills have occurred, some between 100 to 200 gallons, before 1970, as documented in the Historical Release Report. The tank ultimately failed in June of 1981 and was subsequently removed, along with a limited amount of soil surrounding the tank. The carbon tetrachloride released from IHSS 118.1 has contaminated surrounding soils and the UHSU groundwater.

These releases have formed a contaminated groundwater plume, which may eventually reach the North Walnut Creek drainage. During the recent field sampling program, four soil borings were installed near the IHSS 118.1. Two soil borings intercepted 6 to 8 inches of free phase carbon tetrachloride at a depth of approximately 25 to 27 feet. Significant soil contamination was also discovered in soil samples of several borings.

The are two potential remedial actions for IHSS 118.1 groundwater contaminant plume: (1) source removal by using shallow recovery wells to remove as much of the free phase carbon tetrachloride as possible, and (2) removal of the soils, adjacent tanks, and associated piping. In addition, the potential remedial action includes the installation of a containment wall around the area at approximately the 100 x MCL boundary, and capping the area with a soil vegetative cover and/or regrading to limit recharge and contaminant leaching.

4.2.6 GROUNDWATER CONTAMINANT PLUMES IN THE EAST TRENCHES AREA

A large groundwater contaminant plume is located in the East Trenches area. The sources are IHSS 110 (Trench T-3) and 111.1 (Trench T-4) with a minor upgradient contribution from the VOCs in the 903 Pad area. The trenches were used to bury sewage sludge from the sewage treatment plant, but also contain crushed drums and DNAPLs. Contaminated groundwater occurs within the UHSU, in the alluvium and in the Number 1 Sandstone in hydraulic connection with the alluvium. The major contaminants are carbon tetrachloride, tetrachloroethene, and trichloroethene as well as other VOCs.

The downgradient boundary of the groundwater contaminant plume is located at a spring and seep complex on the south bank of South Walnut Creek, above Ponds B-1 and B-2 where the Number 1 Sandstone subcrops. Concentrations of VOCs above 100 x MCLs have been detected by a recent sampling program conducted at the seep complex.

A lobe of this groundwater contaminant plume extends to the east of the trench area in the alluvium. This lobe of the contaminant plume does not reach surface water. Uncontaminated alluvial groundwater discharges downgradient to this lobe as seeps in an unnamed tributary drainage to South Walnut Creek. This lobe will continue to be monitored.

The preliminary remedial action is to perform source remediation, if feasible, for Trenches T-3 and T-4 to remove subsurface soils that exceed the applicable RFETS soil cleanup criteria for the Tier-I action level for VOCs. This action is scheduled to occur in FY96. The potential groundwater remediation proposed is to install a plume capture system near South Walnut Creek and possibly to use passive technologies to treat the contaminated groundwater.

It may be possible to implement pump and treat groundwater near the East Trenches where the No. 1 Sandstone is contaminated. However, a large number of closely spaced wells will be required to effectively pump and treat groundwater due to the low conductivities and the resulting steep cones of depression. DNAPL contamination could easily remain after treatment. For these reasons, and the associated higher costs for this methodology, pump and treat was not considered as the proposed remediation treatment in this area.

There are potential ecological impacts since water from the contaminant plume containing tetrachloroethene and trichloroethene has reached South Walnut Creek. If concentrations in these seeps increase over time, a greater contaminant mass may reach surface water. Capture and treatment of the contaminant plume in the East Trenches area will reduce risk to the environment posed by contaminant migration to the surface water system.

4.2.7 IA GROUNDWATER CONTAMINANT PLUME

The IA contains a coalesced plume of contaminated groundwater containing trichloroethene thought to emanate from IHSSs 117.1, 117.2, 157.1, 158, and 171; tetrachloroethene thought to emanate from IHSSs 117.1, 117.2, 158, 157.1, 160, and 171; and carbon tetrachloride thought to emanate from IHSSs 117.1, 117.2, and 158. This coalesced plume southwest of Building 559, is outside of the fenced portion of the protected area (PA) and extends downgradient towards the central portion of the PA.

Currently, the groundwater contaminant plume does not appear to be moving, and there are no known or potential surface water impacts. Proposed remedial actions include removal of soils containing contamination above the Tier-I action level where feasible, and installation of a soil vegetative cover to limit natural recharge and contaminant leaching, with continued monitoring of the groundwater contaminant plumes. Groundwater recharge in the IA caused by water losses from sewers and water supply pipelines, as estimated from water budget studies from surface water monitoring activities, is between 7 and 26 million gallons per year. Reduction of recharge from these sources could significantly reduce the potential for contaminant migration in the subsurface.

Other alternatives under consideration for remedial actions include diverting groundwater flow upgradient of the IA, and collecting contaminated groundwater within the IA by linking footing drains on selected buildings with new sections of horizontal drains connected to the existing treatment facility in Building 891. Preliminary calculations indicate that only 15 percent of the present recharge (precipitation plus groundwater influx) to the IA could be diverted by an upgradient barrier. Preliminary calculations also indicate that an upgradient barrier would divert only 3.6 gallons per minute of groundwater flux from entering the IA.

Treatment of contaminated groundwater within the IA does not appear to be necessary to protect surface water, as the plume appears to have limited potential for migration. However, ongoing monitoring and evaluation of the groundwater through the monitoring program will continue, and will detect if movement or expansion of the plume is occurring. Groundwater remedial actions may become necessary if the contaminant plumes increase significantly and become a threat to surface water.

4.2.8 ADDITIONAL PLUMES

The Landfill and Solar Ponds groundwater contaminant plumes do not contain VOCs in groundwater with concentrations above 100 x MCLs. However, these plumes are of interest as these are associated with RCRA units. The setting and status of these plumes is discussed below.

Landfill Plume

Groundwater contaminant plumes are located south and west of the current landfill pond, including a portion of OU 7. Aluminum, manganese, zinc, 2-methylnaphthalene, naphthalene, benzene, and possibly methylene chloride are present downgradient of the current landfill, with average values exceeding MCLs. Contaminants above MCLs may reach surface water if some remedial action is not taken.

An interim remedial action currently under construction will include the installation of a gravity flow system designed to collect the contaminated groundwater and leachate flowing from the landfill for treatment. This system will consist of cement vaults collecting the contaminated water through a gravity-driven system. Treatment will include a settling basin, bag filter to remove additional suspended solids, and granular activated carbon to remove organic chemical constituents. Modifications to this design may be required if long-term treatment is determined to be necessary. Contaminated water will be treated to comply with established cleanup levels. This treatment should effectively mitigate the potential ecological risk from the contaminants of concern.

Solar Ponds Nitrate Groundwater Contaminant Plume

The Solar Ponds area has historically released nitrates to the environment. The released nitrates have contaminated UHSU groundwater which forms a plume that extends northward from the Solar Ponds to the Walnut Creek drainage above Pond A-1. A small lobe of this nitrate plume extends to the southwest for a short distance. This contaminant plume contains nitrates at concentrations above 100 x MCLs. Nitrate concentrations within the plume are decreasing with time, but still exist at high levels. The Interceptor Trench System (ITS) was installed to intercept contaminants and capture the nitrate plume and was recently replumbed to increase its effectiveness. The ITS captures 2.7 million gallons of water per year, but is not entirely effective in preventing nitrate contamination from impacting the North Walnut Creek drainage.

Proposed remedial actions for the groundwater nitrate plume, if required, will be developed at a later date based on final cleanup standards and site-specific hydrogeologic conditions. No source removal is planned for nitrate-containing media. However, a soil-vegetative cover is being considered which would reduce the groundwater recharge and the flow through the nitrate contaminated soils.

Recent negotiations may make it possible to change the stream classification downgradient of the nitrate plume from drinking water to agricultural, recreational, and protective of aquatic life. There is some possibility that this surface water will be used for irrigation. If the drinking water classification is lifted, then the nitrate concentrations seen in the surface water as a result of the nitrate plume are acceptable for all of the remaining uses, and could be of benefit to irrigation uses.

4.3 PLUME RANKING

When a source or contaminant plume is identified above action levels and determined to be a candidate for remedial actions, a prioritization process is used to determine the sequence in which remediation will occur. A methodology was developed by CDPHE, EPA, KH, and RMRS staff to rank the known environmental risks at RFETS. This methodology is outlined in the "Environmental Restoration Ranking" (September 1995). Sites are ranked according to 1) a factor related to concentrations of contaminants present in soil, subsurface soil, and groundwater; 2) a factor characterizing the mobility of the contaminants, and the proximity to surface water; and 3) the potential for further release factor which quantifies the possibility that source material will continue to be released into the environment. The resulting prioritized list is used to determine the general order to implement remedial actions, it is not a specific sequence of remediation.

The groundwater contaminant plumes described in this document were ranked using this methodology except the mobility factor was replaced by a factor estimating the impact of the groundwater contaminant plume on surface water. The three factors and how they were applied to obtain the plume ranking are:

1) **Score Ratio**: Concentrations of VOCs in groundwater from 1990 on were compared to the proposed action levels of 100 x MCLs. The maximum ratio for each analyte within the contaminant plume was tabulated, and a total score for each groundwater plume was calculated by summing the maximum ratios. As in the original ranking, to minimize the impact of high levels of contaminants on the overall rankings, Table 4-1 was used to convert these summed values to a Score Ratio for each contaminant plume.

2) **Impact to Surface Water**: A rating of 1 to 3 was assigned to each plume based on the evaluation of whether a groundwater contaminant plume was impacting surface water (a rating of 3), had the potential to impact surface water (a rating of 2), or did not pose a threat to surface water at this time (a rating of 1). As all plumes are relatively slow moving, the velocity of the groundwater was not a factor.

3) **Potential for Further Release**: The potential for contaminants to continue to migrate into groundwater (i.e. is an uncontained source present?). A rating of 1 to 3 is assigned based on whether there is probably no uncontained source present (a rating of 1), high contaminant concentration present is soil (a rating of 2), and probable free product present (a rating of 3).

The results of the plume ranking is shown in Table 4-2. When the ER Priority List is regenerated using the action levels and standards currently under negotiation, the groundwater contamination plume rankings will be incorporated. The rankings generated for the groundwater contaminant plumes have been compared to the existing ER Priority List to estimate where these actions might be ranked.

Table 4-1 Conversion Table for Scores

Total Groundwater Score	100 x MCL Score
> 501	10
251 – 500	9
101 – 250	8
76 – 100	7
51 – 75	6
31 – 50	5
21 – 30	4
11 – 20	3
6 – 10	2
1 – 5	1

The following is an example showing how these factors were used to generate the ranking for the 903 Pad groundwater contaminant plume. Concentrations of VOCs in groundwater in the 903 Pad and Ryan's Pit plume were identified and compared to the appropriate 100 x MCL value. The maximum ratios for each contaminant that exceeded 100 x MCL were summed, which equaled a value of 603. Using Table 4-1, this value equated with a Ratio Score of 10.

Next, the mobility of the contaminants was evaluated. Because the contaminants are VOCs, and the area is near surface water, the maximum value of 3 was used. The potential for further release was believed to be high and a factor of 3 was assigned based on the belief that there is free product underneath the 903 Pad which is still being released into the groundwater. Finally, the impact to surface water from this groundwater contaminant plume was evaluated. Because the contaminant plume is close to surface water, this was rated as a 3.

Multiplying the Ratio Score of 10 times the impact to a surface water factor of 3, and the potential for further release of 3, generated a ranking score of 90.

Table 4-2 Plume Ranking

Rank	Plume Location	Total Plume Groundwater Location Score	Ratio Score	Impacts to Surface Water Multiplier	Potential for Further Release Multiplier	Total Priority Score	Relative ER Priority List Rank
1	903 Pad/Ryan's Pit Plume	603.4	10	3	3	90	1
2	East Trenches Plume	256.8	9	3	3	81	4
3	Mound Plume	187.9	8	3	2	48	7
4	IHSS 118.1	53.2	6	2	3	36	11
5	IHSS 119.1 Plume (OU1)	87.9	7	2	1	14	13
6	Solar Ponds Nitrate Plume	16.7	3	1	1	3	33
7	South IA Plume	11.9	3	1	1	3	33
8	Landfill Plume (IHSS 114)	—	—	—	—	—	*

Note:

*No ranking value shown because the contaminant concentrations did not approach 100 x MCL (evaluated under RCRA).

5.0 CONCLUSIONS AND NEXT STEPS

The specific goals of the Groundwater Strategic Plan are to provide a strategy consistent with the Vision and the Action-Level Framework for surface water, groundwater, and soils, to identify and describe the salient groundwater plumes, rank the groundwater plumes in accordance with the method outlined in the "Environmental Restoration Ranking" (RMRS, 1995), and provide an initial planning basis for work package development and funding.

To meet these goals, the strategy proposes source removal, where possible, provides for source control, where necessary, and provides for the treatment of dissolve phase plumes, where necessary. The strategy includes an evaluation allowing some areas of contaminated groundwater to remain in place where the goals of the strategy can be met without active intervention.

Action levels for groundwater must be protective of surface water standards and quality as well as the ecological resources. As stated in the draft Conceptual Vision, domestic use of groundwater at RFETS will be prevented through institutional controls. Since no other human exposure to groundwater is foreseen by the Vision, groundwater action levels are not based on human health protection. The protectiveness of surface water will be achieved by applying MCLs as groundwater action levels. A two-tier approach to groundwater remediation and monitoring is being proposed.

The previously ranked IHSSs and the ranking of groundwater plumes presented in Section 4.1 provide the basis for establishing the priority and sequence of remedial actions. However, a schedule for implementing groundwater remediation will be dependent on factors such as funding, data sufficiency, resource availability, and the integration with other remedial and site activities. The emphasis of the proposed near-future groundwater remedial actions will be on the removal of source material outside of the IA.

Installation of the three new Tier II groundwater monitoring wells is necessary to provide a means to determine if the plumes are advancing towards surface water. These wells are intended to provide an early warning that remedial actions may be required under the Action Level Framework described in Section 3.0.

The unknown extent of the chlorinated solvent plumes associated with the PU&D yard (IHSS 170, 174a, and 174b) is a major data gap. Because the nature of the southern boundary of these plumes is undetermined, the potential impact to surface water can not be evaluated. A limited investigation of the hillslope hydrology including the installation of new groundwater monitoring wells near North Walnut Creek is recommended.

Before each remedial action can begin, certain pre-construction activities must be completed. These activities include, but are not limited to, additional investigations to determine the optimal location of the remedial device, analysis of alternatives, and engineering design. The success of any given groundwater remedial device will be dependent on having an adequate understanding of the local hydrogeology and pathways. Costs for these additional subsurface investigations can be minimized by using site-owned Geoprobe equipment as an alternative to employing conventional hollow-stem auger techniques.

The following proposed conceptual actions would be the direct result of applying the action levels for groundwater remediation within the framework of the Vision:

- Contaminated soils in OU 1 (IHSS 119.1) above action levels would be excavated, thereby removing material above the Tier-I Action Level. Since the source of groundwater contamination would be removed, the use of the French Drain system and recovery well eventually would no longer be necessary. Monitoring will demonstrate the effectiveness of the remedy.

- In the area of the 903 Pad and Ryan's Pit plume, the Mound plume and the East Trenches plume, sources exceeding Tier-I Action Levels will be removed to the extent practical. Contaminated groundwater will be collected by systems installed on the hillsides. Groundwater would be directed to a treatment system. The capture structures would be located approximately at the 100 x MCL boundary on the down gradient side of the plume where surface water is determined to be potentially at risk.

- Known areas of carbon tetrachloride sources would be evaluated for potential excavation near IHSS 118.1 where feasible. An impermeable barrier may be installed to contain the portion of the chlorinated solvent plume that exceeds the 100 x MCL contaminant concentration in groundwater

- A gravity flow treatment system will be installed to treat leachate and contaminated groundwater flowing from the present Landfill. However, the current system is designed as an interim measure. Modifications may be required for long term use.

- A soil vegetative cover and regrading would be used where necessary to limit natural recharge caused by precipitation from leaching of contaminants in the unsaturated zone. This approach is predicted to reduce the movement of groundwater through the IA and thereby reduce the mobility of the plumes. Subsurface sources of groundwater

contamination would be removed where practical. At the end of the D&D/remediation phase, the plant water supply and sanitary sewer will be shut off. This will eliminate a major source of groundwater recharge for the IA and should greatly reduce the mobility of plumes originating from the IA.

Further analysis is required to determine optional intercept locations, actual treatment methodologies and cost-effective project sequencing.

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STAFF WORKING DRAFT
of the
VISION
for the
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

February 9, 1996

I. INTRODUCTION

As a former contributor to our nation's defense, the Rocky Flats Environmental Technology Site (Site) has become one of the larger nuclear industrial facilities undergoing planned closure and cleanup. The Site now faces new demands and challenges.

The people of Colorado believe that the Site will one day be an asset rather than a liability in maintaining our quality of life. Through a strategic and well-defined series of steps – a "Vision" – that includes aggressive cleanup, consolidation, closure and reuse, the Site will become such an asset. This Vision represents a new model for cleanup, for partnerships with the regulatory agencies and the private sector, and for enhanced community involvement to achieve our collective goals for the Site.

The Site, constructed in 1953 along what was then a sparsely populated area of the foothills of metropolitan Denver, now sits in the midst of growing communities. Over 2 million people now live within 50 miles of the Site. The Site exists directly upstream of water supplies that serve four municipalities and over 400,000 people.

Our Vision is a Site that poses no unacceptable risk to the citizens of Colorado or to the Site's workers from either contamination or an accident. Our goal is to achieve cleanup and closure of the Site in a safe and environmentally protective manner that is consistent with the values of the community, achievable within budgetary and technological limitations, and fiscally responsible. This will be accomplished in an accelerated fashion to achieve cleanup and closure in the shortest possible time. The Vision is intended to provide a single, coherent course of action for the Site and its regulatory agencies.

The Vision provides a roadmap for the common course of action for the Site with the recognition that technology, budget and community preferences will continue to change. Our Vision recognizes that cleanup of the Site may continue beyond what is described herein. Nothing in this Vision is meant to preclude further cleanup if technological, budgetary and community and political circumstances allow.

A. Organization of the Vision

The Vision is composed of specific Vision elements. Each element is discussed within two site conditions: the Near-Term Site Condition and the Intermediate Site Condition. The Vision also describes a third site condition, the Long-Term Site Condition. For the Near-Term and Intermediate Site Conditions, the Vision describes generally how the Site's materials, facilities and

environmental resources will be addressed, what environmental conditions will be attained, and what the Site will look like. A discussion of the Vision elements occurs in Section III below.

B. Relationship to the Rocky Flats Cleanup Agreement

The Rocky Flats Cleanup Agreement (RFCA) is the legal document that describes the relationship between the Agencies (the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency (EPA), and the Colorado Department of Public Health and Environment (CDPHE)) during cleanup. The RFCA will facilitate the accomplishment of the Vision and will ensure the effective and efficient cleanup of the Site. The Vision sets the goals for cleanup and closure activities, and the RFCA (along with other documents, orders and regulatory requirements) defines how the DOE and the regulators will oversee specific activities at the Site to accomplish the Vision.

C. Community Involvement

Community preferences and public involvement will continue to help shape the direction and the future of the Site. Regular meetings with elected officials and the public will continue. The alignment of the cleanup and closure activities with the Vision will be reviewed on a frequent basis. As the budget for the Site is variable, all interested organizations and individuals will be kept apprised of budget issues and how these issues may affect cleanup and closure goals and priorities. The opportunities for public participation in decisions regarding the Site will include the continuation of organized stakeholder activities as well as greater opportunities for formal and informal interaction.

D. Description of Wastes and Materials

The following description of terms used in this Vision is provided for information. These are not scientific definitions.

1. Plutonium

Plutonium is found in the form of metals, oxides, solutions and residues. These materials are currently in storage or will be recovered in the future.

2. Special Nuclear Material

Special nuclear material is plutonium, plutonium-uranium combinations, and highly enriched uranium. All of the Site's estimated 14.2 tons of plutonium is included within the broad definition of special nuclear material. Although special nuclear material and plutonium largely overlap, the terms are listed separately throughout this Vision to address all forms of special nuclear material and to specifically identify the goals and policies for plutonium.

3. Transuranic Waste

Transuranic waste is a radioactive waste contaminated with elements heavier than uranium (such as plutonium and americium) in concentrations above 100 nanocuries per gram. Transuranic waste is both process waste from past production activities as well as waste generated from building decontamination. Typical transuranic waste at the Site is similar to low-level waste but with generally higher levels of radioactivity. For the purposes of this Vision, transuranic waste is both transuranic waste and transuranic-mixed waste, which is transuranic waste that contains hazardous waste.

4. Low-Level Waste

Low-level waste is a radioactive waste that is not high-level waste, spent nuclear fuel, by-product material, or transuranic waste (although it may contain small amounts of transuranic elements). At the Site, it exists in many forms such as rags, paper, plastic, glassware, filters, soils and some building rubble.

5. Low-Level Mixed Waste

Low-level mixed waste is low-level waste that contains hazardous waste.

II. The Vision Site Conditions

The Vision elements in Section III below are discussed within the context of a Near-Term and an Intermediate Site Condition. In addition, a Long-Term Site Condition is identified and described.

1. Near-term Site Condition

The Near-Term Site Condition is the time period during which the following activities will be completed: consolidation, stabilization and safe storage of plutonium, other special nuclear material and transuranic wastes; storage in a retrievable and monitored manner, disposal, and some removal of low-level, low-level mixed and other wastes; and nearly all cleanup activities. It is the intent of the Agencies to accelerate Site activities to substantially achieve and complete risk reduction and cleanup during this period of time. Completion of activities in this period is anticipated to take about 8 to 15 years.

2. Intermediate Site Condition

The Intermediate Site Condition is the period of time during which all plutonium, other special nuclear material, and transuranic wastes will be removed from the Site. By the end of this period, none of these materials, nor the buildings that contained them, will remain. Also by the end of this period, all low-level, low-level mixed, hazardous, and solid wastes will have been shipped off-site, disposed, or stored in a retrievable and monitored manner to protect public health and the environment. Any remaining cleanup will be completed. Activities occurring in this period are

anticipated to be completed about 12 to 20-25 years from now.

3. Long-Term Site Condition

The Long-Term Site Condition follows the Intermediate Site Condition and continues through the indefinite future. Additional cleanup and removal activities may be conducted in this time period as funding, technology and political opportunities allow. While recognizing that some members of the public prefer cleanup to background levels, the Agencies are unable to commit to this goal. The Agencies will continue to explore new technologies to make further cleanup possible. Nothing in this Vision precludes the goal of further cleanup or waste removal. Activities beyond the Intermediate Site Condition are unknown, and perhaps unknowable, and are therefore not described below.

III. VISION ELEMENTS

The Vision is organized by the following elements. Each element includes a broad Vision Summary, followed by more specific statements for each element in the Near-Term and Intermediate Site Conditions.

1. Disposition of Plutonium, Other Special Nuclear Material and Transuranic Wastes

Vision Summary: **DOE will stabilize, consolidate, and temporarily store plutonium, other special nuclear material and transuranic wastes on-site for removal; ultimate removal of plutonium is targeted for no later than 2015.**

a. Near-Term Site Condition. DOE will stabilize, consolidate, and store plutonium, other special nuclear material, and transuranic wastes on-site in a safe and cost-effective manner. Plutonium is targeted for removal from the Site as soon as possible, beginning no later than 2010 and completed by 2015. No additional plutonium or other special nuclear material will be transferred onto the Site.

Other special nuclear material will be shipped off-site as soon as possible.

Transuranic waste will be shipped to the Waste Isolation Pilot Plant (WIPP) as soon as this facility is available to accept waste from the Site. DOE, EPA and the State of Colorado are committed to aggressively pursuing the early opening of WIPP and making it available to accept wastes from the Site as soon as possible. If WIPP is not opened, does not have sufficient capacity to accept all of the Site's transuranic waste, or is otherwise not available, another off-site facility will be identified.

b. Intermediate Site Condition. Plutonium and other special nuclear material are targeted for removal from the Site by 2015. By the end of the Intermediate Site

Condition, all transuranic waste will have been removed from the Site.

2. On-Site and Off-Site Waste Management

There are substantial risks and costs in removing wastes now stored on-site and those wastes that will be generated during plutonium stabilization, cleanup and building decommissioning. DOE, together with the regulators and with appropriate public participation, will determine which wastes are stored, disposed or removed through an ongoing process consistent with this Vision.

Vision Summary: **Waste management activities for low-level, low-level mixed, hazardous, and solid wastes will include a combination of on-site treatment, storage in a retrievable and monitored manner, disposal, and off-site removal.**

a. Near-Term Site Condition. Initially, controlling the sources of contamination will take priority over off-site waste shipments to maximize risk reduction. Off-site shipments of waste will occur based on risk, technology, facility availability, and cost. DOE, EPA and CDPHE will actively seek off-site facilities to accept the Site's waste.

During this period, most active environmental cleanup will be completed. Cleanup will include the treatment, consolidation, and management of contaminated soil, water and material. Decisions regarding storage or disposal of contaminated soil and building debris will be made during this period. Other low-level and low-level mixed wastes generated during cleanup that remains on-site will be stored in a retrievable and monitored manner, will be environmentally safe, and will be in compliance with legal requirements. Decisions on the specific degree of retrievability and monitorability will be based on the following factors: risk, legal requirements, waste type, technology, cost effectiveness, and community concerns. For any stored waste that remains on-site, storage facilities will be designed to provide safe storage or disposal.

Existing and any future on-site landfills will be closed in compliance with legal requirements. The landfills will be capped using a low-profile contour, designed to blend in with the natural topography of the Site.

b. Intermediate Site Condition. Waste materials that are to be removed will have been shipped off-site. Any necessary follow-up cleanup related to the former storage sites will have been completed. By the end of this period, decisions will have been made regarding stored material for its continued storage, treatment or disposal.

3. Water Quality

Vision Summary: **At the completion of cleanup activities, all surface water on-site and all surface and groundwater leaving the Site will be of acceptable quality for all uses.**

a. Near-Term Site Condition. The Agencies are committed to reliable controls and monitoring to protect water quality during cleanup activities, storage of special nuclear material and wastes, and storm events. Contaminants and contamination sources that pose an unacceptable risk will be removed, controlled, or stabilized.

Protection of all surface water uses will be a basis for making interim soil and groundwater cleanup and management decisions. Actions will be designed to prevent adverse impacts to ecological resources and groundwater consistent with the Action Levels and Standards Framework Attachment to the RFCA.

Surface water leaving the Site will continue to be diverted around Standley Lake and the Great Western Reservoir. The quality of surface water leaving the Site during cleanup activities will meet standards for aquatic life, recreation, and agricultural classifications, but not for domestic (drinking water) use. On-site groundwater will not be used for any purpose unrelated to Site cleanup activities. Surface water standards for plutonium and americium during cleanup activities will be based on a conservative risk-based approach. Proposed changes to state water quality standards will be presented to the Colorado Water Quality Control Commission for approval.

Water quality management plans will be developed with the participation and involvement of municipalities and counties whose water supplies are potentially affected by the Site.

b. Intermediate Site Condition. By the time cleanup activities are completed, all on-site surface water and all surface water and groundwater leaving the Site will be of acceptable quality for all uses including domestic water supply. Groundwater quality in the Outer Buffer Zone and off-site will support all uses. On-site groundwater will not be used for any purpose unrelated to Site cleanup activities. Reliable monitoring and controls to protect water quality during storage of plutonium, other special nuclear material and wastes, and during storm events, will continue. To assure the above described water quality, long-term operation and maintenance of waste management and cleanup facilities will continue.

4. Cleanup Guidelines

Vision Summary: **Cleanup activities will be conducted in a manner that will:**

- **reduce risk;**
- **be cost-effective;**
- **protect public health;**
- **protect reasonably foreseeable land and water uses;**
- **prevent adverse impacts to ecological resources, surface water and groundwater; and**
- **be consistent with a streamlined regulatory approach.**

a. Near-Term Site Condition. Cleanup will include treatment, consolidation, and management of contaminated soil, water and materials in a manner that protects public health, reduces the impact to the natural environment, and minimizes the generation of new wastes. Environmental cleanup will be accomplished to protect and support open space uses in the Inner and Outer Buffer Zones and limited industrial uses as noted in the Future Site Use Working Group (FSUWG) report. In the vicinity of buildings converted to non-DOE use, cleanup will be to industrial use levels in the Industrial Area. See also the discussion in the Land Use section below.

b. Intermediate Site Condition. After off-site disposition of plutonium, other special nuclear material and transuranic wastes, the cleanup of the buildings that contained these materials, and of any residual waste from their shipment or storage, will be completed. Appropriate monitoring, operation and maintenance of any remaining treatment, storage, or disposal facilities will continue.

5. Land Use

Vision Summary: **Cleanup decisions and activities are based on open space and limited industrial uses; the particular land use recommendations of the Future Site Use Working Group (FSUWG)[1] are not precluded; specific future land uses and post-cleanup designations will be developed in consultation with local governments.**

a. Near-Term Site Condition. The Inner and Outer Buffer Zones will be managed, and cleaned as necessary, to accommodate open space uses. During this period, access to the Inner and Outer Buffer Zones will remain controlled consistent with cleanup efforts and the need for a safety and security zone around plutonium, other special nuclear material and transuranic wastes on-site. A part of the Industrial

[1] That Group's recommendations are presented in its June 1995 Report.

Area will be reserved for waste treatment, storage, or disposal facilities.

During cleanup, non-DOE activities (such as economic conversion) may take place in areas other than the Inner and Outer Buffer Zones, provided they do not adversely impact cleanup and closure work and do not require a DOE subsidy. Particular open space and industrial uses as recommended by the FSUWG are not precluded. These uses will be developed in consultation with local governments. See the FSUWG Report for additional detail regarding recommended land uses during and after cleanup.

b. Intermediate Site Condition. At the beginning of this period, access to the Inner and Outer Buffer Zones will continue to be controlled consistent with the safety and security needs of plutonium, other special nuclear material and transuranic wastes. After plutonium, other special nuclear material and transuranic wastes are removed, DOE will work with local governments to determine the optimal use of the Inner and Outer Buffer Zones. Any access controls and/or institutional controls that are necessary or appropriate for public health, environmental protection, ongoing monitoring and operation and maintenance activities, will continue.

6. Environmental Monitoring

Vision Summary: **Environmental monitoring will be maintained for as long as necessary.**

a. Near-Term Site Condition. A robust environmental monitoring system will be maintained to provide information for cleaning up the Site, to assure public safety, and to keep the public informed. The system will maximize the available resources of the Agencies and municipalities and will minimize duplicative efforts. The system will include both routine (baseline and regular) and non-routine (to respond to events or worst case) monitoring.

b. Intermediate Site Condition. After plutonium, other special nuclear material and transuranic wastes are gone, the monitoring system will continue to address remaining waste management facilities and water quality needs. This monitoring system will remain in place indefinitely.

7. **Building Disposition**

Vision Summary: **All contaminated buildings will be decontaminated as required for future use or demolition; unneeded buildings will be demolished.**

a. Near-Term Site Condition. All contaminated buildings will be decontaminated as required for future use or demolition. Building demolition or reuse will take place after plutonium, other special nuclear material, transuranic waste, and radioactive hot-spots have been removed. In most cases, contaminated systems (such as gloveboxes, duct-work and piping) will be decontaminated and removed prior to demolition. In a few instances, contaminated systems will be decontaminated and demolished along with the building.

Radioactive material removed from buildings will be either processed and added to the Site's plutonium inventory, packaged as transuranic waste for eventual removal, or handled as low-level or low-level mixed waste and stored in a retrievable and monitored manner. Uncontaminated or decontaminated buildings will be demolished or made available to the private sector for other economic uses in consultation with local officials, provided that these uses do not adversely impact cleanup and closure activities and do not require DOE subsidies. Building debris will be disposed of as follows: clean rubble will be recycled, stored or removed, or disposed on-site; contaminated rubble will be stored on-site in a retrievable and monitored manner.

b. Intermediate Site Condition. By the end of this period, the remaining buildings that were used for plutonium, other special nuclear material, and transuranic waste storage will have been demolished. Also by the end of this period, decisions will have been made regarding material that have been stored in a retrievable and monitored manner for its continued treatment, storage or disposal.

8. **Mortgage Reduction**

Vision Summary: **Plutonium, other special nuclear material and transuranic wastes will be safely consolidated into the smallest number of buildings to reduce operating costs and shrink the security perimeter; contaminated and non-contaminated buildings will be decommissioned and either demolished or turned over for other non-DOE uses.**

a. Near-Term Site Condition. DOE will stabilize and consolidate plutonium, other special nuclear material and transuranic wastes to achieve safer and less expensive storage while awaiting removal of these materials. The contaminated buildings from which these materials were removed will be decontaminated and closed. The

Site will also close or convert to non-DOE uses non-contaminated buildings as expeditiously as possible. Utility and other Site infrastructure will be substantially reduced during this period. As operating costs are reduced through building shut-downs, every effort will be made to return the cost savings to the Site to fund cleanup and closure activities.

b. Intermediate Site Condition. During this period, the secured area will be further reduced and eventually removed. Operating costs will be minimized. By the end of this period, plutonium, other special nuclear material and transuranic wastes will have been removed from the Site and the related buildings will have been decontaminated and either demolished or converted to non-DOE uses. Closure of non-contaminated buildings will be completed by the end of this period. Also by the end of this period, existing Site infrastructure will be essentially eliminated, except for monitoring, and operation and maintenance of any remaining waste storage or disposal facilities.

Appendix C

Rocky Flats Environmental Technology Site

Action Levels and Standards Framework for Surface Water, Ground Water, and Soils

Rocky Flats Environmental Technology Site

Action Levels and Standards Framework for Surface Water, Ground Water, and Soils

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Tables

1.0 General Background

1.1 Goal of Action Levels and Standards Framework

On October 10 and 11, 1995, a "Workout Session" was convened between DOE, EPA, CDPHE, DNFSB, and Kaiser-Hill to resolve, or develop a path to resolve, all outstanding issues associated with the new Rocky Flats Cleanup Agreement (RFCA). Several of the significant Workout Session outcomes included agreement on a proposed conceptual vision for RFETS and agreement that the environmental cleanup of the site will now be implemented through an integrated and streamlined regulatory approach. The Draft Vision proposed the approximate areal extent of four future land uses. These include capped areas underlain by either waste disposal cells or contaminated materials closed in-place, an industrial area, an inner buffer zone managed as open space, and an uncontaminated outer buffer zone that, while it would be managed as open space, actually could be available for any use. EPA will be the lead regulatory agency over the buffer zone, and CDPHE will be the lead regulatory agency over the industrial area. The CDPHE and EPA roles are clarified in the RFCA.

As a result of the 1995 Workout Session, a working group consisting of DOE, EPA, CDPHE, and Kaiser-Hill teams was formed to develop a consensus proposal for the appropriate cleanup standards that should apply to RFETS. This Action Levels and Standards Framework presents the final product of the working group. It has been developed in a manner generally consistent with the Draft Vision. In some cases, the working group found it necessary to more precisely define aspects of the Draft Vision so that applicability of action levels and required mitigating actions could be completely defined. The goal of the Action Levels and Standards Framework is to:

a. provide a basis for future decision-making,
b. define the common expectations of all parties, and
c. incorporate land- and water-use controls into site cleanup.

This document describes the parties' commitments and recommendations for both action levels and standards. Action levels are numeric levels that, when exceeded, trigger an evaluation, remedial action, and/or management action. Action levels will not necessarily be the same as cleanup levels which must be achieved for a remedial action to be complete. A standard is an enforceable narrative and/or numeric restriction established by regulation and applied so as to protect one or more existing or potential future uses. Within this framework, standards are associated with surface water use classifications and applied at points of compliance. Standards are not being directly applied to ground water or soils. Closure performance standards apply to RCRA units and are explained in the RFCA.

Protection of all surface water uses with respect to Vision fulfillment (the Intermediate and Long-Term Site condition) will be a basis for making interim soil and ground water remediation and management decisions. Actions will be designed to prevent adverse impacts to ecological

resources and ground water consistent with the Action Levels and Standards Framework. Because the Action Levels and Standards Framework does not address the inherent value of ground water, any residual effects on ground water not addressed through this framework will be addressed under a Natural Resources Damage Assessment (NRDA).

1.2 Programmatic Assumptions

The working group developed this framework using the following inter-related programmatic or site-wide assumptions:

1. The framework must be consistent with the Draft Vision.
2. Implementation of the framework must protect human health and the environment.
3. Implementation of the framework must protect surface water uses and quality.

1.3 Action Prioritization and Implementation

Remedial decisions will be supportive of Intermediate and Long-Term Site conditions. Actions required as a result of exceedances of the standards or action levels described in this document will be taken in accordance with the Draft Vision and be prioritized on the Risk Ranking. The Risk Ranking will, in turn, be considered in the Budget and Work Planning Process (RFCA, Part 15). These interim remedial decisions may be implemented by means of an accelerated action (PAM or IM/IRA) or addressed as necessary in the ROD for the affected area. Actions will be developed in an integrated manner with other actions being taken and will be consistent with best management practices.

1.4 Outside Factors

Several factors outside the control of the Working Group. Foremost among these factors is the Water Quality Control Commission (WQCC). The WQCC determines water quality standards throughout Colorado. The consensus position presented herein recommends several changes to existing use designations and standards for water at RFETS. There is no guarantee that the WQCC will make the changes this document recommends.

Another factor that could affect the positions presented in this document is public response to the Revised Vision, the RFCA, and this framework. Specifically, the response of the local municipalities including Westminster, Broomfield, Thornton, and Northglenn, will be extremely important in finalizing these recommendations for standards and action levels.

2.0 SURFACE WATER

2.1 Some of the surface water quality standards and action levels proposed in this section differ from the existing state water quality standards. It will be necessary, therefore, to petition the the Water Quality Control Commission (WQCC) for these changes. Petitions must provide sufficient rationale and justification to document that all uses consistent with the Draft Vision will be protected, and will be supported by all parties. Once these changes to the water quality standards have been made, EPA will issue a new NPDES permit within six months of WQCC action. Local municipalities will be involved and consulted in surface water decisions.

Surface water exists in the Vision-defined Areas 2, 3 and 4, as well as immediately off-site (see map in Draft Vision). The standards, action levels and points of compliance presented below are based on the following refinement of the Vision-delineated areas (this assumes current pond water-transfer configurations):

A. Area 2 (inner buffer zone) will include all surface water down to, and including, the terminal ponds (Ponds A-4 and B-5) in Walnut Creek. For Woman Creek, only Pond C-2 is in Area 2. Therefore, the surface water in Area 2 is consistent with Segment 5 of Big Dry Creek.

B. Areas 3 and 4 (outer buffer zone) will include the streams from the terminal ponds to the plant boundary in Walnut Creek and all of Woman Creek except Pond C-2. The surface water in Areas 3 and 4 is part of Segment 4 of Big Dry Creek.

2.2 Numeric Levels During Active Remediation (Near-Term Site Condition)
During the period of active remediation, the Table 1 values will apply as standards in Segment 4 of Big Dry Creek and Table 1 values as action levels in Segment 5.

A. Non-radionuclides

1. The numeric values that will apply throughout both stream segments are based on surface water use classifications consistent with the uses described in the Vision:

   Water Supply
   Aquatic Life - Warm 2
   Recreation 2
   Agricultural

2. Numeric values will be derived from the following:

   a) Metals - the lower of either the Aquatic Life values listed in Table III of the Basic Standards and Methodologies for Surface Water or the Segment Specific Water Quality standards apply.

   b) Inorganics - Segment-Specific Water Quality standards apply, except for nitrate which will equal 100 mg/L.

c) Organic Chemicals:

1 - In Segment 4, water quality standards will apply in accordance with the use classifications identified in 2.2.A.1 above.

2 - In Segment 5, the organic chemical MCLs will apply (Table 1). Therefore, the underlying Segment 5 organic standards will not apply during the period of active remediation.

3. Temporary modifications to the numeric values during active remediation may be developed through subsequent working group efforts.

a) The basis for proposing the temporary modifications may include one or more of the following:

1 - A determination of ambient conditions in a manner similar to the existing Segment 5 temporary modifications;

2 - A mass-balance equation that calculates maximum influent concentrations in Segment 5 that will be protective of numeric values at Segment 4 points of compliance without allowing treatment within waters of the State;

3 - Some other methodology agreed to by all parties.

b) These temporary modifications should be developed together with other stakeholders (i.e., the local municipalities that are impacted by surface water from the Site).

B. Radionuclides

1. Numeric values for plutonium and americium are risk-based (10^{-6} increased carcinogenic risks to human health from direct exposure including consumption).
2. The numeric values are:

   0.15 pCi/L for plutonium

   0.15 pCi/L for americium
3. If necessary, higher event-related and/or seasonal (limited duration) action levels for each drainage will be developed through subsequent working group efforts based on existing baseflow and event data. The Working Group will develop a process to actuate these higher numeric values.
4. Numeric values for other radionuclides will be the site-specific standards found in Table 2 of 5 CCR 1002-8, §3.8.0. The parties will re-examine these values based upon conditions in the basins and will propose alternative values if appropriate.

C. Points of Compliance/Action Level Measuring Points

1. In Segment 4, points of compliance will be placed at the existing sampling locations for the outfalls of the terminal ponds (Ponds A-4, B-5, and C-2) in both Walnut Creek and Woman Creek. Since all of Woman Creek is

within Segment 4 and because of the complex water transfer configurations, additional points of compliance may need to be established by the parties.

2. In Segment 5, exceedance of action levels will be measured in the ponds and upstream in the main stream channel at existing gaging/sampling stations or at additional sampling sites in the main stream channel as necessary.

3. Compliance will be measured using a 30-day moving average for those contaminants for which this is appropriate. When necessary to protect a particular use, acute and chronic levels will be measured differently as described in current sampling and analysis plans.

2.3 Standards After Active Remediation (Intermediate and Long-Term Site Condition)

When the Intermediate Site Condition is achieved following completion of active remediation, the surface water must be of sufficient quality to support any surface water use classification in both Segments 4 and 5. Any temporary modifications will be removed. Points of compliance will be at the outfalls of the terminal ponds. However, all final remedies must be designed to protect surface water for any use as measured at the nearest and/or most directly impacted surface water in Segments 4 and 5. Interim remedies will be consistent with this as a goal. If the terminal ponds are removed, new monitoring and compliance points will be designated and will consider groundwater in stream alluvium.

2.4 Action Determinations

A. When contaminant concentrations exceed the Table ___ standards at a point of compliance, source evaluation and mitigating action will be required. Specific remedial actions will be determined on a case-by-case basis, but must be designed such that surface water will meet applicable surface water standards at the points of compliance.

B. During active remediation, when contaminant concentrations in Segment 5 exceed the Table ___ action levels, source evaluation will be required. If mitigating action is appropriate, the specific action will be determined on a case-by-case basis, but will be designed such that surface water will continue to meet applicable surface water standards at the points of compliance.

[The Action Levels and Standards Working Group needs input from the LQAT on enforceability of the Action Levels and Standards Framework.]

2.5 Surface Water Monitoring

A. Surface water monitoring will continue as currently established unless subsequent changes are agreed to by all parties.

B. All parties will receive quarterly surface water monitoring reports which will highlight any exceedances of surface water standards or action levels and any significant changes to surface water flow conditions.

3.0 GROUND WATER

3.1 Action levels for ground water must be protective of surface water standards and quality as well as the ecologic resources. As stated in the Draft Vision, domestic use of ground water at RFETS will be prevented through institutional controls. Since no other human exposure to on-site ground water is foreseen, ground water action levels are only based on surface water protection. This framework for ground water action levels assumes that all contaminated ground water emerges to surface water before leaving the site.

3.2 Action Levels: The strategy for ground water is intended to prevent contamination of surface water. This protectiveness can be achieved by applying Maximum Contaminant Levels (MCLs) as ground water action levels. Where an MCL for a particular contaminant is lacking, the residental ingestion-based PPRG value will apply.

A. Tier I - Near-Source Action Levels for Accelerated Actions:

1. Action levels = 100 x MCLs (see Table 2).
2. Applies in areas of high ground water contaminant concentrations.
3. Designed to identify high concentration ground water "sources" that should be addressed through an accelerated action.

B. Tier II - Surface Water Protection Action Levels:

1. Action levels = MCLs (see Table 2).
2. Designed to prevent surface water from exceeding surface water standards/action levels by triggering ground water management actions when necessary.
3. Situations where ground water is contaminating or could contaminate surface water at levels above surface water standards/action levels will trigger a Tier II action.
4. Tier II Action Levels are to be measured in designated wells:
   a) Tier II wells have been selected by all parties from the existing monitoring network where practical. New wells have been proposed where apparent gaps exist. Designated Tier II wells are listed in Table 3.
   b) Tier II wells are either currently uncontaminated or contaminated at levels less than MCLs. In general, Tier II wells are located between the downgradient edge of each plume and the surface water towards which the plume is most directly migrating.
   c) If the proposed new wells are shown to be contaminated or if additional plume information dictates, new or alternate wells will need to be chosen.

3.3 Action Determinations

A. Tier I

1. If Tier 1 action levels are exceeded, an evaluation is required to determine if remedial or management action is necessary to prevent surface water from exceeding standards. If this evaluation determines that action is necessary, the type and location of the action will be delineated and implemented as an accelerated action. This evaluation may include a trend analysis based on existing data. Accelerated action priority will be given to plumes showing no significant decreasing trend in ground water contaminant concentrations over 2 years.
2. Additional ground water that does not exceed the Tier I action levels may still need to be remediated or managed through accelerated actions or RODs to protect surface water quality or ecological resources and/or prevent action level exceedances at Tier II wells (e.g., lower-level, but fast-moving contamination). The plume areas to be remediated and the cleanup levels or management techniques utilized will be determined on a case-by-case basis.

B. Tier II

1. If concentrations in a Tier II well exceed MCLs during a regular sampling event, monthly sampling in that well will be required. Three consecutive monthly samples showing contaminant concentrations greater than MCLs will trigger an evaluation. This will require a ground water remedial action, if modelling, which considers mass balancing and flux calculations and multiple source contributions, predicts that surface water **action levels** will be exceeded in surface water. These actions will be determined on a case-by-case basis and will be designed to treat, contain, manage, or mitigate the contaminant plume. Such actions will be incorporated into the Environmental Priority List in which they will be given weight according to measured or predicted impacts to surface water.
2. Ground water contaminated at levels above ground water action levels currently exists at several locations. Each of these situations will be addressed according to appropriate decision documents.
   [Nonconsensus exists as to how nitrates should be managed.]

C. Other Considerations

1. Efficient, cost-effective, and feasible actions that are taken to remediate or manage contaminated ground water may not necessarily be taken at the leading edge of plumes, but rather at a location within the plume. Factors contributing to this situation could include technical impracticability at the plume edge, topographic or ecologic problems at the plume edge, etc. This situation may result in a portion of a plume that will not be remediated or managed. This plume portion may cause exceedance of MCLs at Tier II wells or exceedance of surface water standards/action levels. When an up-

gradient ground water action is taken that results in this situation, DOE and its subcontractor may request relief from the ground water and/or surface water standards. CDPHE and EPA will evaluate the request and may grant temporary relief or alternate concentration limits for a specific area. Soil or subsurface soil source removals will not be considered as the sole justification for alternate concentration limits. In addition, alternate concentration limits will be determined such that surface water use classifications are not jeopardized and surface water quality does not exceed standards at points of compliance.

2. Ground water plumes that can be shown to be stationary and do not therefore present a risk to surface water, regardless of their contaminant levels, will not require remediation or management. They will require continued monitoring to demonstrate that they remain stationary.

3.4 Ground Water Monitoring Network

A. The ground water monitoring network will continue to operate as recently modified unless subsequent changes are agreed to by all parties. Analyte suites, sampling frequency, and specific monitoring locations will be evaluated annually to adjust to changing hydrologic conditions including plume migration.

B. All groundwater monitoring data as well as changes in hydrologic conditions and exceedances of groundwater standards will be reported quarterly and summarized annually to all parties.

C. If quarterly reporting shows that previously uncontaminated wells are contaminated above ground water standards, the sampling frequency will be increased to monthly. Three consecutive monthly samples showing exceedances will trigger an evaluation to determine if a remedial or management action is necessary.

D. All ground water plumes that exceed ground water standards must continue to be monitored until the need for institutional controls is mitigated.

E. All ground water remedies, as well as some soil remedies, will require ground water performance monitoring. The amount, frequency, and location of any performance monitoring will be based on the type of remedy implemented and will be determined on a case-by-case basis within decision documents.

3.5 Ground Water Classifications

A. Three classifications currently apply to ground water at RFETS:
   1. Domestic Use Quality
   2. Agricultural Use Quality
   3. Surface Water Protection

B. Because the Draft Vision restricts ground water use in all areas of the Site, the domestic use and agricultural use classifications can be removed. Surface water protection standards for ground water are understood to be the applicable surface water standards.

4.0 SUBSURFACE SOIL

4.1 Subsurface soil is defined as soils deeper than six inches below the ground surface. Action levels for subsurface soil are protective of:

A. human exposure appropriate for uses described in the Draft Vision document,
B. surface water standards via ground water transport, and
C. ecological resources.

4.2 Action Levels: The subsurface soil action levels have been calculated using a two-tier approach.

A. Tier I:

1. All subsurface soils capable of leaching volatile organic compounds to groundwater at concentrations greater than or equal to 100 x MCLs. Where an MCL for a particular contaminant is lacking, the residental ingestion-based PPRG value will apply.
2. Contaminant-specific Tier I action levels have been determined using a soil/water partitioning equation and a dilution factor from EPA's Draft Soil Screening Guidance (1994). These derived values and the parameters used to derive them are listed in Table 4. The subsurface media characteristics for these calculations are based on site-specific data or conservative values where representative site values cannot be determined. Where subsurface characteristics in a particular area within RFETS differ significantly from those chosen as representative of the entire site, those alternate values should be used.

B. Tier II:

Additional subsurface soil may need to be remediated or managed to protect surface water quality via ground water transport or ecological resources. Subsurface soil presenting unacceptable ecological risks (HI≥1) identified using the approved methodology will be evaluated for remediation or management.

4.3 Action Determinations

A. Tier I: When contaminant levels in subsurface soil exceed Tier I action levels, subsurface soil source removals will be triggered. These removals will be accomplished through accelerated actions.

B. Tier II: When an action is necessary to protect surface water or ecological resources, a process to identify, evaluate, and implement efficient, cost-effective, and feasible remediation or management actions will be triggered.

1. Actions will be developed in an integrated manner with other actions being taken.
2. Actions will be consistent with best management practices.
3. Actions may be accomplished by means of an interim or final action.
4. Remediation and/or management actions will be implemented to protect ecological resources where those actions can be implemented without damaging other ecological resources.

These efforts to minimize vertical and horizontal migration of contaminants will reduce long-term costs and protect surface water and ecological resources.

C. Appropriate remedial or management actions will be determined through this evaluation process on a case-by-case basis, and may include the removal, treatment, disposal, or in-place stabilization of contaminated subsurface soils.

D. Single geographically isolated data points of subsurface soil contamination above the Tier I or Tier II action levels will be evaluated for potential source magnitude. These single points will not necessarily trigger a source removal, remedial, or management action, depending on the source evaluation.

5.0 SURFACE SOIL

5.1 Surface soil will be defined as the upper six inches of soil. Action levels for surface soil are protective of:

A. human exposure appropriate for uses specified in the Draft Vision document,
B. surface water quality via runoff, and
C. ecological resources.

5.2 Action Levels: The surface soil action levels have been calculated using a two-tier approach based on protection of appropriate human exposure.

A. Tier I:

1. Action levels for non-radionuclides are human-health risk-based (carcinogenic risk equal to 10^{-4}) for the appropriate land-use receptor. Table 5 presents the calculated action levels for these exposure scenarios:

a) Industrial Area (Area 1 of Draft Vision): Action levels are based on Office Worker exposure as defined in the finalized PPRG document.
b) Inner Buffer Zone (Area 2 of Draft Vision): Action levels are based on Open Space Recreational User exposure as defined in the finalized PPRG document.

2. Action levels for radionuclides will be the more conservative of:

a) Radiation dose limit of 15 mrem per year for the appropriate land use receptor, or
b) Human-health risk (carcinogenic risk equal to 10^{-4}) to the appropriate land-use receptor as described in Section 5.2.A.1 above. The calculated values associated with these exposure scenarios are listed in Table 5.

B. Tier II:

1. Action levels for radionuclides and non-radionuclides are human-health risk-based (carcinogenic risk of 10^{-6} and/or a hazard index of 1) for the appropriate land-use receptor. Table 5 presents the calculated action levels for these exposure scenarios:

a) Industrial Area (Area 1 of Draft Vision): Action levels are based on Office Worker exposure as defined in the finalized PPRG document.
b) Inner Buffer Zone (Area 2 of Draft Vision): Action levels are based on Open Space Recreational User exposure as defined in the finalized PPRG document.

2. Additional surface soil may need to be remediated or managed to protect surface water quality via runoff or ecological resources. The amount of soil and the protective remediation levels and/or management technique will be determined on a case-by-case basis. Subsurface soil presenting unacceptable ecological risks (a hazard index greater than or equal to 1) identified using the approved methodology will be evaluated for remediation or management.

5.3 Action Determinations:

A. Tier I: When contaminant levels in surface soil exceed Tier I action levels a process to identify, evaluate and implement efficient, cost-effective, and feasible remediation or management actions will be triggered. Appropriate remedial or management actions will be determined through this process on a case-by-case basis, and may include the removal, treatment, disposal, or in-place stabilization of contaminated surface soils.

B. Tier II: When contaminant levels in surface soil exceed Tier II action levels, they will be managed. Management may include, but is not limited to, "hotspot" removal, capping, or designating land uses that preclude unacceptable exposure. In addition, if aggregate risks at any source area exceed 10E-4, remedial action will be required.

1. Actions will be developed in an integrated manner with other actions being taken.
2. Actions will be consistent with best management practices.
3. Actions may be accomplished by means of an interim or final action.
4. Remediation and/or management actions will be implemented to protect ecological resources where those actions can be implemented without damaging other ecological resources.

ACTION LEVELS AND STANDARDS FRAMEWORK: SUMMARY TABLES

SURFACE WATER - During Active Remediation (Near-Term Site Condition)

Surface Water		Action Levels		Action	Point of Eval.	Standards		Action	Point of Compliance
	Segment 4					Non-Rads: -Rec 2 -Agricultural -Aquatic Life Warm 2 -Water Supply (nitrate = 100 ppm)	Rads: -Pu = 0.15 pCi/l -Am = 0.15 pCi/l -All other rads: existing stds	Notification, source eval, mitigation if appro., ~~fines and penalties if appro.~~	Terminal Pond Outfalls
	Segment 5	Non-Rads: organics = MCLs inorganics/metals = -Rec 2 -Agricultural -Aquatic Life Warm 2 -Water Supply (nitrate = 100 ppm)	Rads: -Pu = 0.15 pCi/l -Am = 0.15 pCi/l -All other rads: existing stds	Notification, source eval, mitigation if appro.	Within ponds and in main stream channels, at existing monitoring stations				

SURFACE WATER - After Active Remediation (Intermediate and Long-Term Site Condition)

Surface Water		Action Levels (1)		Action	Point of Eval.	Standards (2)		Action	Point of Compliance
	Segment 4					Non-Rads: -Rec 2 -Agricultural -Aquatic Life Warm 2 -Water Supply	Rads: -Pu = 0.15 pCi/l -Am = 0.15 pCi/l -All other rads: existing stds	Notification, source eval, mitigation if appro., ~~fines and penalties if appro.~~	Terminal Pond Outfalls unless ponds gone; if ponds gone, TBD
	Segment 5					Non-Rads: -Rec 2 -Agricultural -Aquatic Life Warm 2 -Water Supply	Rads: -Pu = 0.15 pCi/l -Am = 0.15 pCi/l -All other rads: existing stds	Notification, source eval, mitigation if appro., ~~fines and penalties if~~ appro.	Terminal Pond Outfalls unless ponds gone; if ponds gone, TBD

(1) After active remediation, the concept of action levels in surface water no longer be necessary. All action levels will either be discontinued (MCLs) and/or convert to enforceable standards.

(2) Standards for Segment 4 and Segment 5 become identical when the period of active remediation is concluded.

OTHER MEDIA - During Active Remediation (Near-Term Site Condition)

Other Media	Tier I				Tier II			
	Action Level	Action	Cleanup Level	Point of Compliance	Action Level	Action	Cleanup Level	Point of Measurement
Ground Water	100 X MCLs[1] and protection of surf wtr and eco resources	Remedial or management action (accelerated)	Protective of surf wtr and eco resources	None; applies across RFETS	MCL[1]	Plume evaluation, plume mgmt if necessary	Protection of surf wtr and eco resources	In designated Tier II gnd wtr monitoring wells
Subsurface Soil	Protective of 100 X MCLs[1] in ground water	Source removal (accelerated)	Protective of 100 X MCLs[1] in ground water	None; applies across RFETS	Protection of surf wtr and eco resources.	Source eval, remediation/mgmt if appro.	Protection of surf wtr and eco resources.	Actual or predicted exceedances in surface water of surface water action levels or standards.
Surface Soil	10^{-4} carcinogenic risk for use scenarios OR 15 mrem/yr dose	Remediation (accelerated)	Protective of human health for use scenarios	None; applies across RFETS	10^{-4} carcinogenic risk and protection of surf wtr and eco resources.	Source eval, remediation/mgmt if appro.	Protection of human health, surf wtr, and eco resources	Human health: none; applies across RFETS. surf wtr: actual or predicted exceedances in surf wtr of surf wtr action levels or standards.

(1) For chemicals w/out an MCL, domestic use 10-6 "Programmatic Preliminary Remediation Goals" (PPRGs) will be used. The reason for this is that the PPRG is the closest to MCL derivation.

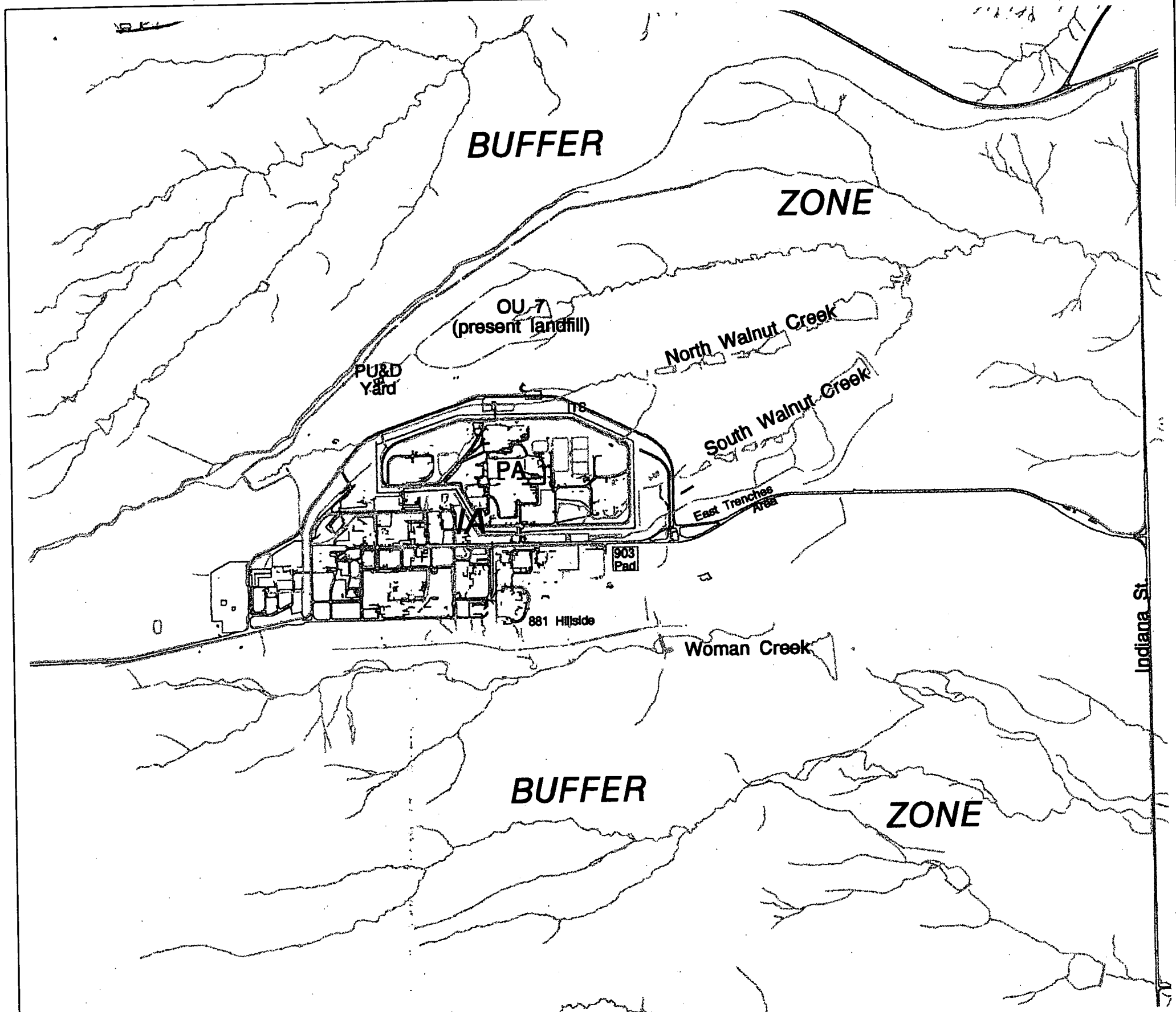
OTHER MEDIA - After Active Remediation (Intermediate and Long-Term Site Condition)

The Action Level and Standards Framework will continue in effect until the need for land and water use control is mitigated. When the Intermediate Site Condition is achieved, on-going monitoring and maintenance of RFETS will continue. Should monitoring identify some off-normal contaminant migration event, decisions about any necessary remediation will be made consistent with the Action Levels and Standards Framework.

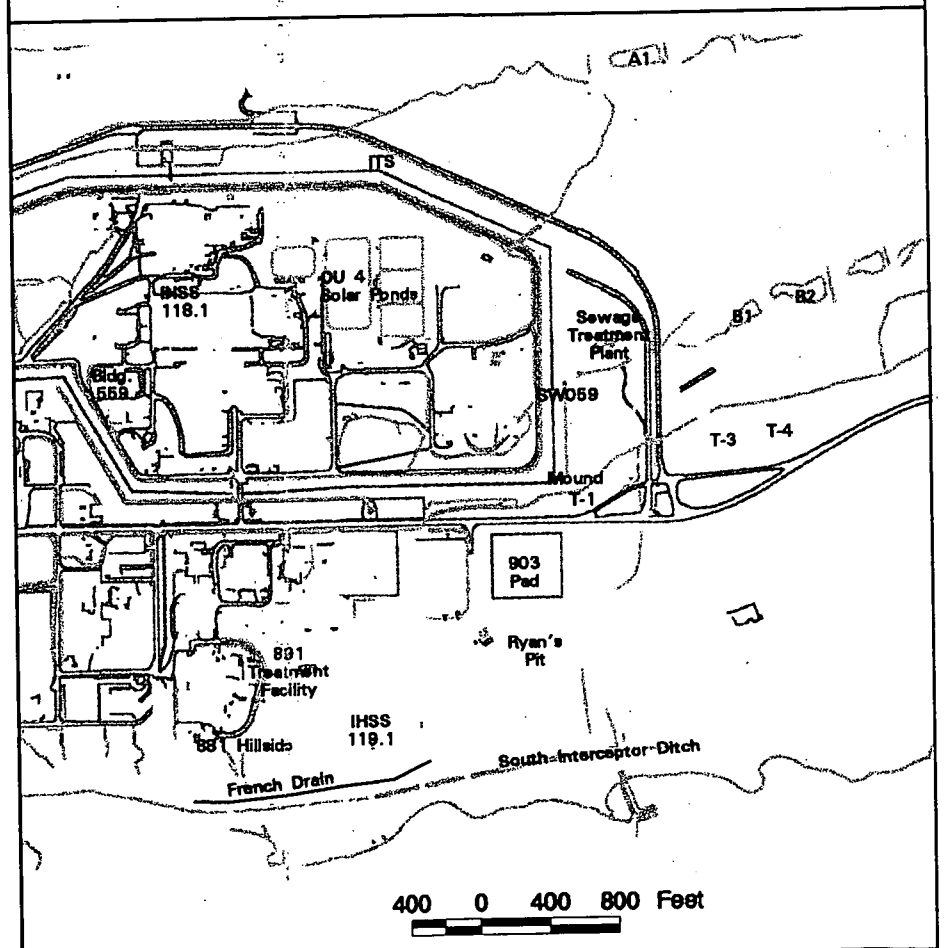
Location Reference Map

Location of areas of interest refered to in text.

Figure 1-1



Detailed View of Industrial Area



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Tier II Well Location Map with Composite Plume Extent for Concentrations > MCLs

Contamination extent boundaries represent groundwater sampling results for TCE, PCE, CCl4, and VC.

LEGEND

- 06091 Tier II Well
- Surficial Unit Groundwater Contour
- Groundwater Flow Direction
- OU 7 Remediation Installation
- Well With Contam. > 100 X MCLs
- UHSU Wells
- Buildings
- Suspected VOA Source
- Pavement
- Surface Drainage
- Concentrations > MCLs

N

470 0 470 940 Feet

Figure 3-1

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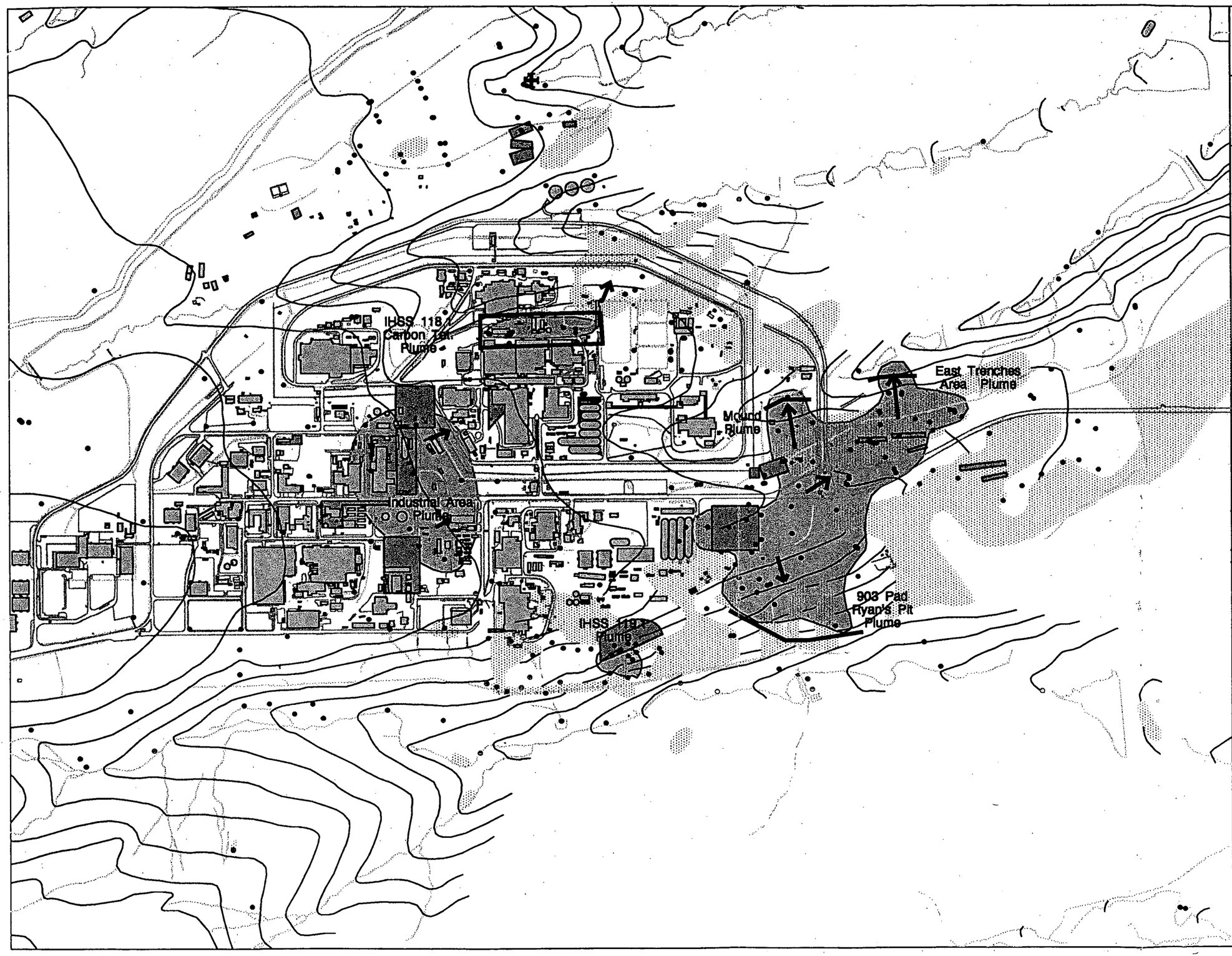

Potential Remedial Actions with Composite Plume Extent for Concentrations > 100 x MCLs

Contamination extent boundaries represent groundwater sampling results for TCE, PCE, CCl4, and VC.

LEGEND

- Surficial Unit Groundwater Contour
- Groundwater Flow Direction
- OU 7 Remediation Installation

Remediation Installations

- Containment Wall
- Plume Intercept Location
- Well With Contam. > 100 X MCLs
- UHSU Wells
- Buildings
- Suspected VOA Source
- Pavement
- Surface Drainage
- Unsaturated Surficial Materials
- Concentrations > 100 X MCLs

N

400 0 400 800 Feet

Figure 4-1

February 12, 1996