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FINAL

1996 ANNUAL ROCKY FLATS CLEANUP AGREEMENT (RFCA)

GROUNDWATER MONITORING REPORT

for

Rocky Flats Environmental Technology Site

November 18, 1997

VOLUME I OF II

This Binder includes Volume I and Volume II.
Volume II is presented in electronic format at the end of this Binder.

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RMRS
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. . . protecting the environment

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EXECUTIVE SUMMARY

This Report, which is required annually according to the Rocky Flats Cleanup Agreement (RFCA, 1996. Section 5 Attachment), summarizes the groundwater monitoring activities and results at the Rocky Flats Environmental Technology Site (RFETS) for calendar year (CY) 1996.

Section 1 will serve as a brief introduction to the report, and will summarize the Site environmental history and the hydrogeologic setting. Section 2 will discuss the groundwater quality data collected in CY96 and will contain updated plume maps for radionuclides and nitrate. Section 3 will present some baseline hydrogeologic data for the recently defined RFCA groundwater monitoring network. Section 4 will discuss the evaluation activities that are in process for exceedances reported in this report. Section 5 gives a brief summary of other activities at RFETS in CY96 that involved groundwater.

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1.0 INTRODUCTION

This Annual Groundwater Monitoring Report summarizes the groundwater monitoring activities and results at RFETS for CY96, as required in the Rocky Flats Cleanup Agreement (RFCA, 1996), and outlined in the Integrated Monitoring Plan (IMP) (K-H, 1997). Section 1 will serve as a brief introduction to the report. Section 2 discusses the groundwater quality data collected in CY96 and contains updated plume maps for radionuclides. Section 3 presents some baseline hydrogeologic data for the new recently defined RFCA groundwater monitoring network. Section 4 discusses the evaluation activities that are in process for exceedances reported in this document. Section 5 gives a brief summary of other activities at RFETS in CY96 that involve groundwater.

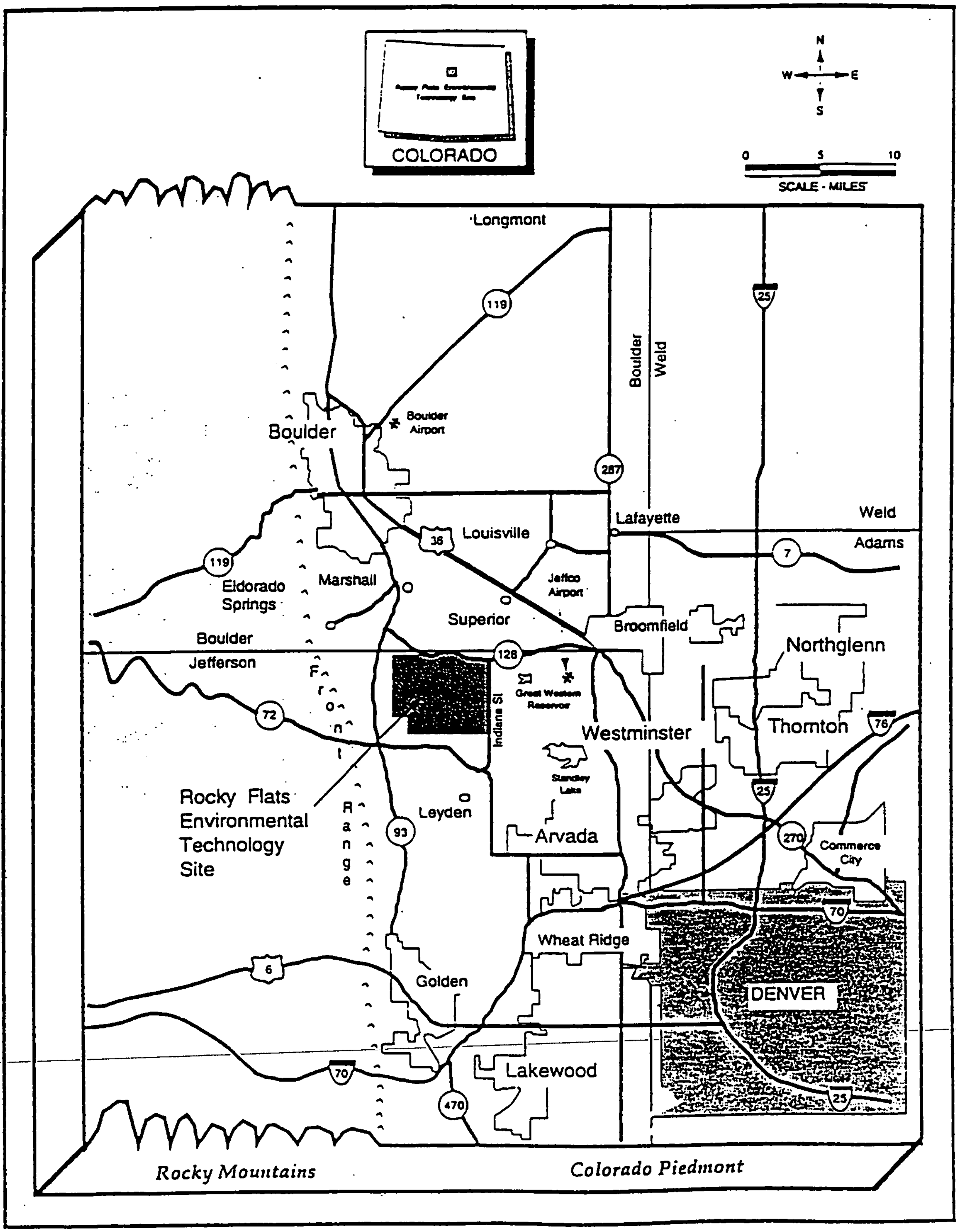
1.1 SITE DESCRIPTION

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

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

Major plant structures, including all production buildings, are located within a 400-acre Industrial Area (IA) of the Site (Figure 1-2), with a 6,150-acre Buffer Zone that surrounds the Industrial Area. Industrial activity immediately adjoining the Site includes present and/or prior coal and clay mining, petroleum recovery, natural classified-aggregate quarrying, and fabricated-aggregate mining. Other activities include cattle ranching and wind energy research. Several irrigation ditches intersect the Site, transmitting water for downstream agricultural, industrial, and municipal purposes. Three ephemeral streams drain the Site and flow eastward (see Figure 1-2).

FIGURE 1-1. General Location Map.



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1.2 GEOLOGY AND HYDROGEOLOGY

1.2.1 Introduction

The Site is situated approximately two miles east of the Front Range of Colorado (Figure 1-1), on the western margin of the Colorado Piedmont section of the Great Plains Physiographic Province (Spencer, 1961). The geologic history of the Rocky Mountain region which includes the Site area of Colorado has been summarized by Haun and Kent (1965). The elevation at the Site is approximately 6,000 feet above mean sea level (MSL). The Industrial Area of the Site is located on alluvial-covered pediment. The upper surface of the alluvium slopes easterly 1 to 2 degrees. Most of the surrounding area in the Buffer Zone is more prominently dissected with intermittent streams. These small, eastward flowing streams include Rock Creek, Walnut Creek, Woman Creek, and several surface water diversion ditches.

1.2.2 Stratigraphy

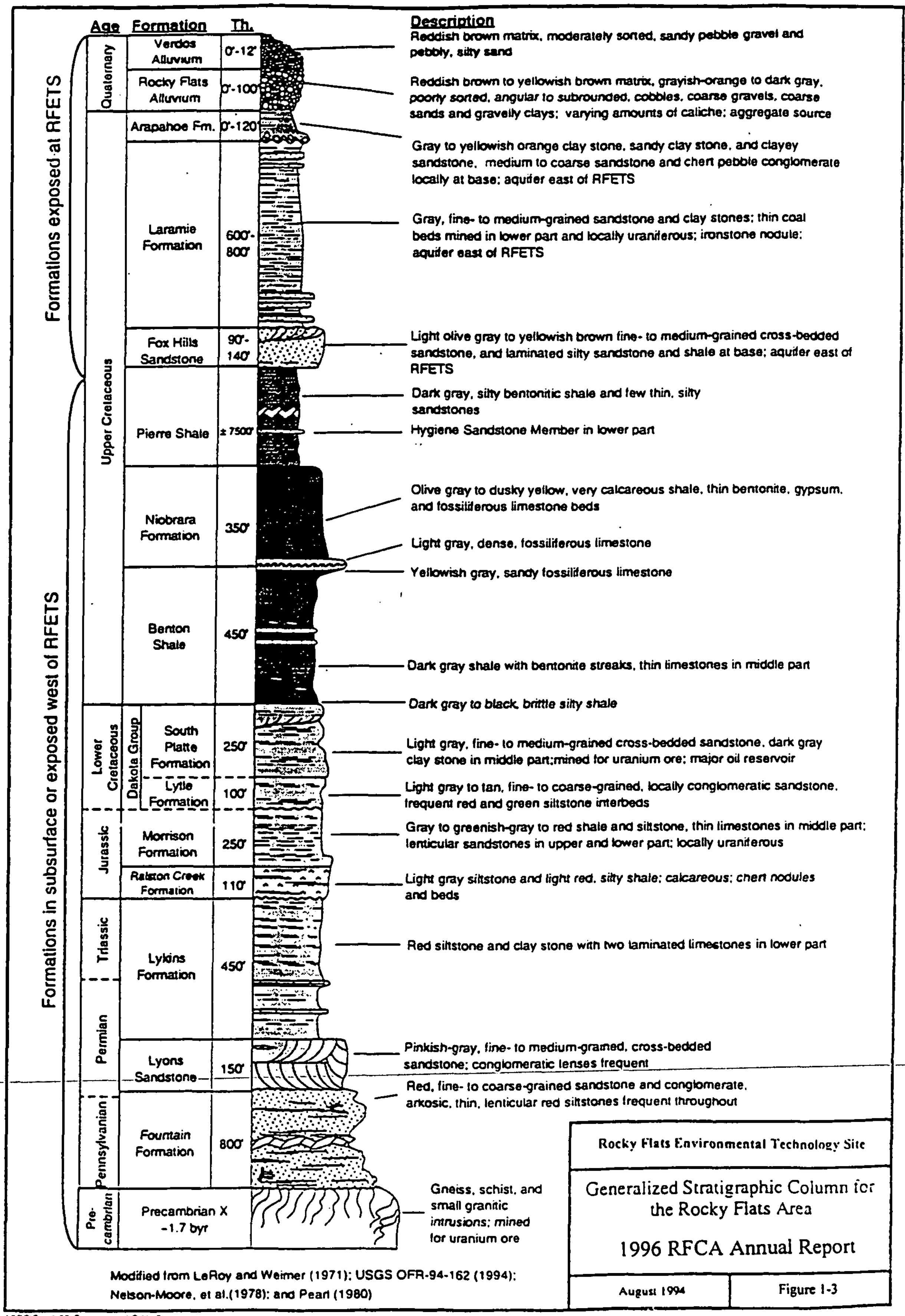
The stratigraphic sequence that underlies the Site extends from the crystalline Precambrian gneiss, schist, and granitoids at 3,000 feet below MSL to the unconsolidated Quaternary deposits at surface approximately 6,000 feet above MSL. Based upon aerial photographic interpretation, field geologic mapping, coal and aggregate mine development, petroleum exploration in the vicinity, and numerous borehole investigations, a substantial amount of lithologic information has been gained about the Site. The generalized lithologic section in the Rocky Flats area is shown in Figure 1-3.

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

1.2.2.1 Pediment-Covering Alluviums

Several Quaternary alluvial formation pediment covers have been identified in the vicinity of the Site by Scott (1975). The Rocky Flats Alluvium is an unconsolidated deposit derived from quartzites and granites of the Coal Creek Canyon provenance west of the Site. The deposit diminishes from west to east with thicknesses ranging from approximately 100 feet to less than one foot. In the central portion of the Site, the deposit is approximately 15 to 25 feet thick. The Rocky Flats Alluvium is a heterogeneous deposit dominantly composed of angular to subrounded, poorly-sorted, coarse, bouldery-gravel with a clay and sand matrix. Clay, silt, and sand lenses as well as varying amounts of caliche are also present.

FIGURE 1-3. Generalized Stratigraphic Column for the Rocky Flats Area



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M\ESVFig 4-02 Stratigraphy/ S.M. Stoner

Exposures of Rocky Flats Alluvium in the aggregate quarries north and west of the Site exhibit some large scale cross-stratification. Depositional processes include fluvial and debris-flow transport (Shroba and Carrara, 1994) infilling paleotopographic lows but leaving a widespread surface of erosion with extremely low relief.

1.2.2.2 Other Surficial Deposits

In addition to the pediment-forming alluvial deposits, younger Quaternary units consisting of colluvium, landslide alluvium, and valley fill alluvium mantle the hillslopes and valley bottoms below the pediment surface. Colluvial deposits are derived from Arapahoe and Laramie Formations and older alluvial deposits. This unit consists of sheetwash, soil creep, and landslide materials in a total thickness of 3 to 16 feet (Shroba and Carrara, 1994). These deposits locally flank the Rocky Flats Alluvium and generally extend to lower parts of the slopes along the principal drainages.

Landslide deposits more commonly flank the Rocky Flats Alluvium. They are often bounded by headwall scarps and lobate toes at the downslope margins. Seeps issuing from the base of the Rocky Flats Alluvium contribute to landslide colluvium generation. The landslide units include earth flows, slumps, and debris flows in a thickness estimated between 10 to 33 feet (Shroba and Carrara, 1994).

Valley-fill alluvial deposits, present in the bottoms of modern stream channels, flood plains, and terraces, are composed of clay, silt, sand, and gravel. They are commonly less than 10 feet thick but can be tens of feet thick. Usually these deposits contain more sand than the Rocky Flats Alluvium and are better sorted.

1.2.2.3 Arapahoe Formation

The Arapahoe Formation is composed of claystones and silty claystones with lenticular sandstones in the basal portion of the Formation. The Arapahoe Formation is generally less than 25 feet thick in the Site area, occurring as erosional remnants of fine grained sandstone above the Laramie Formation at various locations on Site (EG&G, 1995b). This basal Arapahoe Formation sandstone, which is currently defined as the No. 1 Sandstone on Site, is of concern as a potential contamination pathway, especially where it subcrops beneath the alluvial/bedrock unconformity.

1.2.2.4 Laramie and Fox Hills Sandstone Formations

The Laramie Formation is approximately 600 to 800 feet thick and is composed of a lower sandstone/claystone/coal interval and an upper, thick claystone interval. Within the upper claystone interval, thin, lenticular sandstone lenses (i.e., Sandstones 2 through 5 in the 1991 Geologic Characterization Report (EG&G, 1991a)) occur. The discontinuous nature of these sandstone lenses

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coupled with the large claystone layer that encloses them, mitigates their potential for transmitting groundwater contamination in both a horizontal and vertical direction.

The Fox Hills sandstone is primarily a fine-grained sandstone with an approximate thickness of between 75 to 125 feet with thin siltstone and claystone interbeds. The Fox Hills sandstone outcrops and subcrops along a narrow, north-south trending pattern in the extreme western part of the Site upgradient from known sources of contamination.

The permeable lower sandstones and coals of the Laramie, combined with the permeable sandstones of the Fox Hills, constitute a regional aquifer system known as the Laramie-Fox Hills aquifer. This aquifer system is an important water source in the South Platte River Basin (Pearl, 1980), and is the sole water supply for some residents in the Rocky Flats area. This aquifer lies approximately 500 to 600 feet below the Industrial Area and is protected from possible contamination by the intervening Laramie Formation claystones.

1.2.2.5 Pierre Formation

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

1.2.3 Geologic Structure

The Site is located along the western margin of the Denver Basin, an asymmetric basin with a steeply east-dipping western flank and a gentle eastern flank. The interpretation of the subsurface structure is generalized in the east-west geological cross section of the Site area presented in Figure 1-4. A monoclinal fold limb exposed west of the Site is the most significant surficial structural feature in the Site area. Along the west limb of the fold, an angular unconformity exists between the Upper Cretaceous bedrock and the base of the Quaternary Rocky Flats Alluvium.

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

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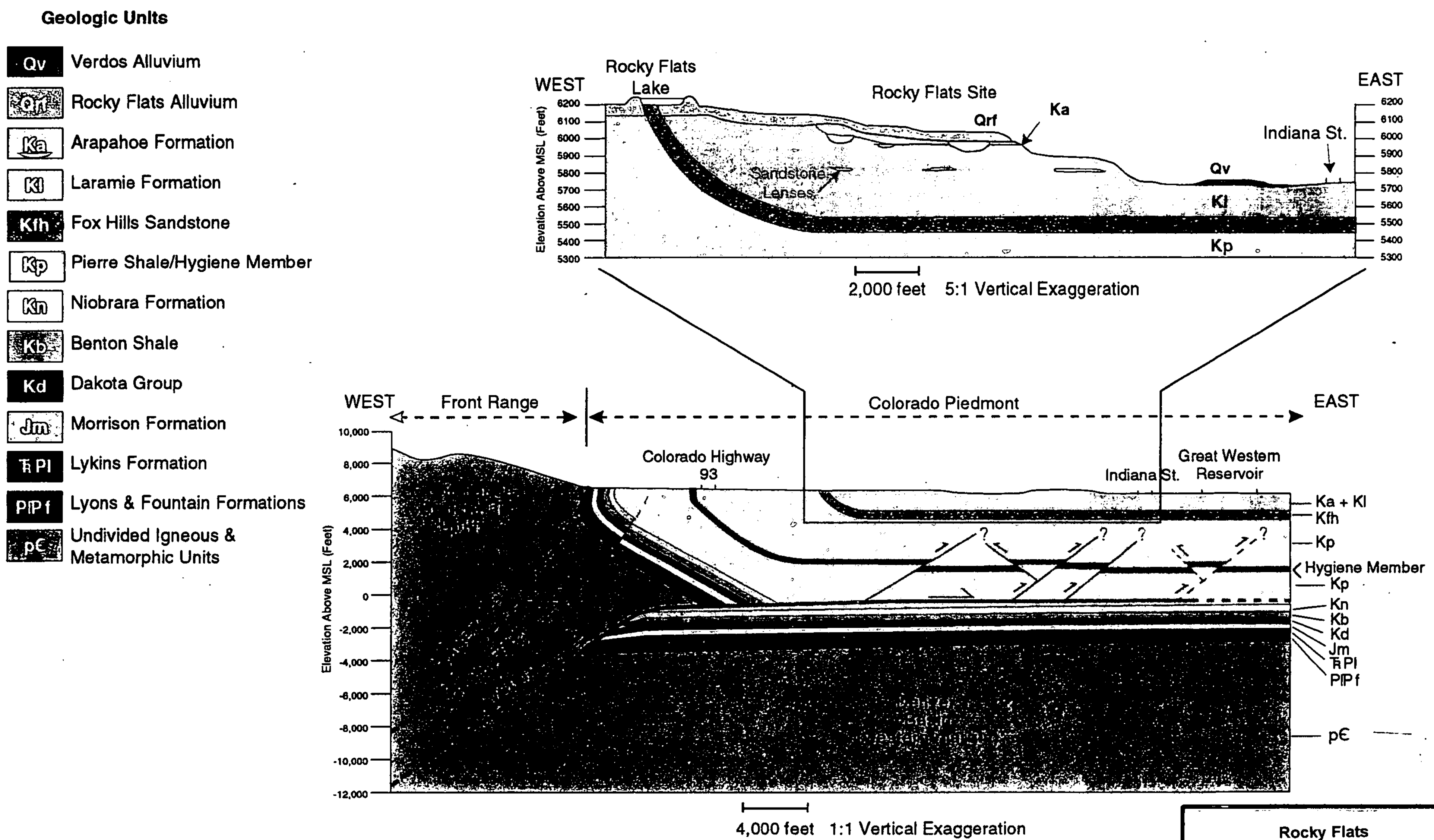

Structural interpretation from EG&G, 1993a.

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Rocky Flats Environmental Technology Site

Generalized Geologic Cross Section of the Front Range and the Rocky Flats Area

Geologic Characterization Report

March 1995

Figure 1-4

5ES\2801\Cross Section.ill

1.2.4 Hydrogeology

This section presents the basic concepts about the hydrogeologic conditions at the Site that affect groundwater monitoring and protection. Characterization of the hydrogeologic setting is based on the currently accepted conceptual geologic and hydrogeologic models described in the Sitewide Geoscience Characterization Study (EG&G, 1995a, 1995b, 1995d). These conceptual geologic and hydrogeologic models are used to predict the direction and rate of groundwater flow, identify potential pathways for contaminant migration, and determine the extent of contaminant plumes given varying physical, chemical, and biological factors.

1.2.4.1 Definition of the Uppermost Aquifer for the Site

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

Beneath the surficial materials and the consolidated sandstones of the UHSU are the geologic units of the lower hydrostratigraphic unit (LHSU). The LHSU consists of the consolidated, unweathered bedrock zone of the Arapahoe and upper Laramie Formations not in hydraulic communication with the overlying UHSU. The Arapahoe and upper Laramie Formations comprising the geologic units of the LHSU consist of lesser amounts of sandstone and greater amounts of adjacent claystones. Because of the low permeability of the claystones, they behave as aquitards restricting hydraulic communication with the UHSU. The lower Laramie and Fox Hills Sandstone Formations comprise a stratigraphically lower and third hydrostratigraphic unit beneath the Site. Groundwaters of the three hydrostratigraphic units are hydraulically separated beneath the IA of the Site. They do converge, however, and are in mutual contact immediately upgradient near the western margin of the Site due to monoclinal folding and erosional proximity. Initially, background geochemical characterization of the UHSU and LHSU revealed that

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these units have statistically different groundwater chemistry concluding with the delineation of separate hydrostratigraphic units (EG&G, 1993b). In addition, possible communication of the hydrostratigraphic units along other geologic structures is currently being assessed. More detailed differentiation of the LHSU will be achieved as new hydrogeologic and geochemical data are generated from Site investigations currently proposed or in progress.

1.2.4.2 Groundwater Occurrence and Distribution

The Site is located in a regional groundwater recharge area (EG&G, 1991a). Groundwater recharge occurs from the infiltration of incident precipitation and as base flow near the upgradient area of the Site drainage basin which extends west to Coal Creek. Groundwater recharge occurs from the infiltration of precipitation and from stream, ditch, and pond seepage. Much of the groundwater which discharges from the UHSU to streams and seeps evaporates as it is being discharged. Limited investigation of the former OU2 area during the period of July through October 1993 indicated that the precipitation component of recharge was lost to evapotranspiration demands (EG&G, 1993d).

In the western part of the Site, where the thickness of the Rocky Flats Alluvium reaches 100 feet, the depth to the water table is 50 to 70 feet below the surface. The depth to water generally becomes shallower from west to east as the alluvial material thins and the confining claystones approach the ground surface. At the head of stream drainages and valley sides, seeps are common at the base of the Rocky Flats Alluvium where it is in contact with claystones of the Arapahoe/Laramie Formations, and where the Arapahoe Formation sandstone crops out. In general, the unconsolidated surficial materials are thicker in the western, higher elevations at the Site. Accordingly, the saturated thickness of these materials also thins eastward. The potentiometric surface of groundwater in unconsolidated surficial deposits has been mapped and is shown on Plates 2 and 3. The periods illustrated represent the times of year when static water levels are highest. Extensive areas of unsaturated and seasonally unsaturated alluvium and colluvium are indicated east and northeast of the IA.

Groundwater in the Arapahoe Formation sandstone units, which subcrop beneath the alluvial material, is not confined when in contact with the surficial materials. In this setting, a hydraulic connection exists between the bedrock sandstone and the alluvial material allowing the bedrock groundwater to exist under unconfined conditions as part of the UHSU. The subcropping Arapahoe Formation No. 1 Sandstone located in the eastern portion of the IA and in the area between South Walnut Creek and Woman Creek is part of the UHSU (EG&G, 1991a). The upper discontinuous sandstones of the Laramie Formation also subcrop beneath alluvium and colluvium, but in limited areas in the valleys and along valley slopes.

Groundwater in the lenticular sandstone units of the Laramie Formation occurs under confined conditions over scattered areas of the Site.

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

1.2.4.3 Groundwater Flow

The shallow groundwater flow regime at the Site is illustrated by the configuration of potentiometric contours in Plates 2 and 3. These maps indicate that groundwater flow is largely controlled by the topography of the bedrock surface. Groundwater in the ridge tops generally flows toward the east-northeast. In areas where the ridge tops are dissected by east-northeast trending stream drainages, groundwater flows to the north or south toward the bottom of the valleys. In the valley bottoms, groundwater flows to the east, generally following the course of the stream. Shallow groundwater flow is primarily lateral due to the low permeability of the underlying claystone bedrock.

A potential for vertical groundwater flow, although limited by the low permeability of bedrock claystones, is indicated by the presence of strong downward vertical hydraulic gradients between the UHSU and underlying bedrock units. This situation implies a condition of poor hydraulic communication. For example, vertical gradients on the order of 0.79 to 1.05 ft/ft have been calculated between colluvial and bedrock sandstones. The vertical groundwater flux through claystones is assumed to be small, on the order of 10^{-10} to 10^{-7} cm/sec, based on calculations provided in RMRS (1996c). Fracturing, where evident, is most abundant in the weathered bedrock zone, but is observed to decrease with depth in unweathered bedrock. Preferential vertical groundwater flow and contaminant transport along fractures or fault zones do not appear to represent a viable pathway for contaminant migration based on an assessment of available data (RMRS, 1996c).

1.2.4.4 Hydraulic Conductivity

The UHSU at the Site has a relatively low to moderate hydraulic conductivity that typically yields small amounts of water to groundwater monitoring wells. The UHSU exhibits a wide-range of hydraulic conductivities because of the diverse nature of the individual geologic units that comprise this unit. Summary statistics for UHSU hydraulic conductivities (EG&G, 1995c, Table G-2) indicate a range of 5.0×10^{-2} cm/sec (3.0 x 104 feet per year [ft/yr]) to 3×10^{-8} cm/sec (9.3 x 10-1 ft/yr). Listed in order of

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decreasing geometric mean hydraulic conductivity, the relative ranking of individual units of the UHSU is presented as follows: valley-fill alluvium (2.5 x 10^{-3} cm/sec); Arapahoe No. 1 sandstone (7.9 x 10^{-4} cm/sec); Rocky Flats Alluvium (2.1 x 10^{-4} cm/sec); colluvium (9.3 x 10^{-5} cm/sec); weathered Laramie Formation sandstones (3.9 x 10^{-5} cm/sec); and weathered Laramie Formation claystones (8.8 x 10^{-7} cm/sec).

Hydraulic conductivities for LHSU materials are generally the lowest measured at the Site with geometric mean values for individual lithologic groups ranging from 1.6 x 10^{-7} to 5.8 x 10^{-7} cm/sec (EG&G, 1995c, Table G-2). The low permeability and 600+ foot thickness of the upper Laramie Formation claystones act as an effective aquitard that restricts downward vertical groundwater flow and contaminant transport to the Laramie-Fox Hills aquifer (RMRS, 1996c).

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

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

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

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

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

(5) The permeability of bedrock units, composed primarily of claystone with lesser amounts of siltstone and sandstone, is generally several orders of magnitude less than for unconsolidated surficial deposits. The 600+ feet of unweathered bedrock between the shallow groundwater flow system and deep regional Laramie-Fox Hills aquifer provides an effective barrier to vertical groundwater and contaminant movement.

1.3 ENVIRONMENTAL HISTORY

Processing and fabrication of weapons-related components began at the Site in 1952 and continued through 1981. During operation, environmental protection measures were established that seemed consistent with prudent environmental management. However, some activities resulted in the environmental contamination of portions of the Site. Efforts to document the extent of Site contamination are in progress, in accordance with the Resource Conservation and Recovery Act (RCRA), the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), and the RFCA, a cooperative agreement between U.S. Department of Energy (DOE), U.S. Environmental Protection Agency (EPA), and Colorado Department of Public Health and Environment (CDPHE). In addition, a historical release report (HRR) (DOE, 1992a) has been developed that documents knowledge gained to date about contamination arising from past practices. The HRR is updated annually to document any changes in status for known spills and contaminant sources.

Documented areas of soil contamination have been designated as Individual Hazardous Substance Sites (IHSSs). Many of these IHSSs have been characterized as part of the Remedial Investigation/Feasibility Study (RI/FS) process which was conducted under the Interagency Agreement (IAG, 1991) between DOE, CDPHE and EPA. Some of these IHSSs are currently scheduled for excavation and treatment as Accelerated Actions conducted by the Environmental Restoration Department.

1.3.1 Groundwater Contaminant Plumes

Groundwater investigations at the Site have determined that some IHSSs have contaminated groundwater. The most widespread contamination is that of volatile organic compounds (VOCs). Plate 12 shows the distribution of VOC contamination in the UHSU. Plume definition is inexact however, because of limitations in well coverage, variability of hydrostratigraphic conditions, and local variations in groundwater transport velocity. Published plume maps for individual constituents can be found in the 1993 Well Evaluation Report (EG&G, 1994b), the annual RCRA Groundwater reports (EG&G, 1992, 1993a, 1994a, 1995c; RMRS/KH, 1996) and in individual OU RI/RFI reports.

The VOC contaminant plumes in groundwater at RFETS have the most potential to impact surface water. These plumes have been defined on the basis of exceedances above the RFCA Tier II Action Level for individual constituents. To delineate areas of highly contaminated groundwater, the Tier I groundwater action levels of 100 x Tier II Action Level were compared against all groundwater data for the most common VOCs in groundwater. The exceedances were plotted and are shown on Plate 12. The most probable sources were identified using the results of recent field sampling programs and correlating this

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with our knowledge of Site processes (see RMRS, 1996b). A flow diagram (RMRS, 1996b) illustrates the method used to locate the contaminant plumes and corresponding sources, and to determine which areas should be evaluated for potential remedial action. Other contaminants will also be addressed where there is a potential impact to surface water exceeding action levels.

Six VOC groundwater contaminant plumes have been identified where contaminant concentrations exceed Tier I Action Levels (see Plate 12). These groundwater contaminant plumes include: (1) IHSS 119.1 Plume, (2) Mound Plume, (3) 903 Pad and Ryan's Pit Plume, (4) Carbon Tetrachloride Plume, (5) East Trenches Area Plume, and (6) Industrial Area Plume. In addition, there are two plumes with contaminant concentrations exceed Tier II Action Levels and have the potential to impact surface water. These plumes are the Present Landfill and the Property Utilization and Disposal (PU&D) Yard (RMRS, 1996b).

In addition to the VOC plumes, there are other constituents that exceed action levels in groundwater. This report will present updated plume maps for radionuclides (uranium and tritium) and nitrate. Evaluation of metals anomalies has been curtailed pending re-evaluation of background thresholds which will be done in FY98.

1.4 REGULATORY CHANGES AFFECTING THE GROUNDWATER MONITORING PROGRAM

1.4.1 Rocky Flats Cleanup Agreement

The RFCA was officially adopted on July 19, 1996. The RFCA replaces the IAG as the environmental cleanup agreement for RFETS. The RFCA outlines the goals, objectives, and strategies that will lead to the RFETS cleanup and closure mission objectives. The Action Level Framework (ALF) attachment to the RFCA contains specific requirements for environmental monitoring and reporting, and it sets Action Levels for contaminant concentrations in groundwater and in other media. The IMP is required under RFCA to further define the monitoring programs for the Site.

To align the groundwater monitoring program with the new RFETS mission and RFCA requirements, the monitoring network was evaluated in 1996. A data quality objective (DQO) process was used to determine the decisions that were necessary for groundwater and the function of each well in the network in supporting those decisions. DOE, CDPHE and EPA stakeholders were directly involved in decisions involving the monitoring network. Results of this evaluation are presented in the IMP discussed below.

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1.4.2 Integrated Monitoring Plan for Groundwater

The IMP outlines the goals for groundwater monitoring (and other environmental media), and describes the various components of the groundwater monitoring program. To evaluate groundwater monitoring needs, one must know the RFCA ALF for groundwater, the Site history and areas of contamination, the physical and hydrogeologic setting of the Site, the effect of contaminated areas on groundwater, and the nature of the groundwater contaminant plumes. This information is presented in Appendices A, B, C, and D of the groundwater section of the IMP, respectively. Appendix E of the groundwater section lists the wells that will be monitored for water quality or for groundwater flow.

In the past, two plans have been required at RFETS to comply with DOE Order 5400.1 (DOE, 1988, Page III-2), a Groundwater Protection & Management Program Plan and a Groundwater Monitoring Plan. These two plans have historically been combined into one document, the Groundwater Protection and Monitoring Program Plan (GPMPP) (EG&G, 1993c), which defines and describes the groundwater protection and monitoring programs at the Site. In addition, an assessment groundwater monitoring plan was required under the RCRA for the interim status units on Site. This Plan is called the Groundwater Assessment Plan (GWAP) (DOE, 1993b). Other monitoring plans have been developed to address groundwater monitoring requirements as outgrowths of various CERCLA Interim Measure/Interim Remedial Action (IM/IRA) decision documents. The IMP will serve as the Groundwater Monitoring Plan for the Site, and it will replace the requirements found in the group of plans named above. It will also revise the requirements of the routine groundwater monitoring portion of the IA IM/IRA decision document (DOE, 1994) and the French Drain IM/IRA Plan (DOE, 1992b).

The IMP will be finalized for public review in late 1997. Draft portions of the IMP have been reviewed by DOE, CDPHE and EPA.

1.4.3 Changes to the Groundwater Monitoring Program

With the implementation of the IMP for groundwater monitoring, a number of changes have been made to the program. In the beginning of CY96 the monitoring program consisted of a network of 150 wells. Half were monitored semiannually and half were monitored quarterly. Subsequent re-evaluation of the monitoring network using DQO decisions developed as part of IMP reduced the monitoring network to 89 wells sampled semiannually.

The groundwater monitoring network, as defined in the draft IMP (K-H, 1997), has seven categories of monitoring wells. Table 1-1 lists the wells in the current monitoring program. The decision rule

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TABLE 1-1. Monitoring Wells

WELL NO	FREQUENCY	IMP Well Class	PLUME\AREA	DRIVERS	FORMATION	DECISION\PURPOSE
6486	Semiannual	D	881 Hillside	RFCA	AL	Drainage well monitoring the Woman Cr. drainage downgradient of the 881 Hillside Plume
5587	Semiannual	D	881 Hillside	RFCA	AL	Drainage well monitoring the Woman Cr. drainage south of the 881 Hillside Plume
5387	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881Hillside Plume
4887	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881 Hillside Plume
4787	Semiannual	PE	881 Hillside	RFCA	AL	Plume Extent south of the 881 Hillside Plume
38591	Semiannual	D	881 Hillside	RFCA	AL	Drainage well in Woman Cr. Drainage below 881 Hillside Plume
35691	Semiannual	PM	881 Hillside	RFCA	AL	Performance Monitoring for 881 Footing Drain Sump
11092	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10992	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10792	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10692	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
10592	Semiannual	PM	881 Hillside	RFCA, IM/IRA -FD	AL	Performance Monitoring for the French Drain
0487	Semiannual	PD	881 Hillside	RFCA	AL	Plume Definition well for the 881 Hillside Plume
6586	Semiannual	D	903 Pad	RFCA	AL	Drainage well monitoring the No. side Woman Cr. below 903Pad/Ryans Pit Plume
6386	Semiannual	PD	903 Pad	RFCA	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
6286	Semiannual	PD	903 Pad	RFCA	BD/USHU	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
3087	Semiannual	PD	903 Pad	RFCA	BD	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
2987	Semiannual	PD	903 Pad	RFCA	AL	Plume Definition well monitoring pathway to Woman Cr. in the 903 Pad/Ryans Pit Plume
23196	Semiannual	PE	903 Pad	RFCA	AL	Plume Extent well monitoring the southward migration of the Ryans Pit/903 Pad Plume
23096	Semiannual	PE	903 Pad	RFCA	AL	Plume Extent well monitoring the southern migration of the Ryans- OU2 VOA Plume
22996	Semiannual	DD	Bldg 886	RFCA, IM/IRA for IA	AL	Building D&D well monitoring potential rad contamination near 886 lab
41691	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - In the Walnut Cr. Drainage at the Indiana Street Boundary
41591	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - In small drainage near east access gate
10394	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - In the Woman Cr. Drainage at the Indiana Street Boundary
10294	Semiannual	B	Boundary	RFCA, AIP	AL	Boundary Well - In drainage below Pond D-2 in the southeast corner of the Site
06491	Semiannual	B	Boundary	RFCA, AIP	BD/UHSU	Boundary Well - In small drainage east of the Site at Indiana St.
0386	Semiannual	B	Boundary	RFCA, AIP	BD/UHSU	Boundary Well - In small drainage north of the east access gate
P219189	Semiannual	PD	Carbon Tet	RFCA, RCRA	AL	Plume Definition well for VOC contamination comming from Carbon Tet Plume
P209389	Semiannual	PD	Carbon Tet	RFCA, RCRA	BD	Plume Definition well in the Carbon Tet Plume
P209289	Semiannual	PD	Carbon Tet	RFCA, RCRA	AL	Plume Definition well in the Carbon Tet Plume
23296	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the northern migration of the East Trenches Area Plume
10194	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the southern migration of the East Trenches Plume
06091	Semiannual	PE	East Trenches	RFCA	AL/BD	Plume Extent well monitoring the northeast migration of the East Trenches Plume
05091	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume
04991	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the eastward migration of the East Trenches Plume
04591	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the southward migration of the East Trenches Plume
04091	Semiannual	PE	East Trenches	RFCA	AL	Plume Extent well monitoring the northward migration of the East Trenches Plume
03991	Semiannual	PE	East Trenches	RFCA	AL	Plume Definition well monitoring the East Trenches Plume
10994	Semiannual	PE	IA\Old Landfill	RFCA	AL	Plume Extent IA VOA Plume\Old Landfill Plume near Woman Cr.
7086	Semiannual	PE	IA\Old Landfill	RFCA	AL	Plume Extent well monitoring IA Plume and Old Landfill Plume pathway in Woman Cr.
P416889	Semiannual	PD	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Definition of IA Plume south of Bldg. 664 along pathway to Woman Cr.
P416789	Semiannual	PD	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Definition of IA Plume south of 400 area along pathway to Woman Cr.
P416689	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor southern migration of IA Plume south of Bldg. 440
P314289	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor the southern migration of IA Plume near Bldg. 850
P313589	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent to monitor the eastward migration of IA Plume near Bldg. 881
P114389	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well to monitor extent of PU&D yard plume pathway to Walnut Cr.
6186	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring easward migration of IA Plume
43392	Semiannual	PE	Ind. Area	RFCA	AL	Plume Extent well monitoring southward migration of IA Plume
22896	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northward migration of IA VOA Plume
22796	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northward migration of Carbon Tet Plume
22696	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the westward migration of the Carbon Tet Plume

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TABLE 1-1. Monitoring Wells (cont'd)

WELL NO	FREQUENCY	IMP Well Class	PLUME\AREA	DRIVERS	FORMATION	DECISION\PURPOSE
22596	Semiannual	PE	Ind. Area	RFCA, IM/IRA for IA	AL	Plume Extent well monitoring the northern migration of the IA Plume
2186	Semiannual	PE	Ind. Area	RFCA	BD/UHSU	Plume Extent well monitoring the northern migration of the 'IA Plume
1986	Semiannual	PE.	Ind. Area	RFCA	AL	Plume Extent well monitoring the northern migration of the IA PLume
B206989	Semiannual	RCRA	Landfill	RFCA, RCRA	BD/UHSU	RCRA\Plume Extent well monitoring downgradient of Landfill Plume
77392	Semiannual	PD	Landfill	RFCA, RCRA	AL	Plume Definition well monitoring the eastward migration of the PU&D Yard Plume
52994	Semiannual	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
52894	Semiannual	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
4087	Semiannual	RCRA	Landfill	RFCA, RCRA	AL	RCRA/Plume Extent well monitoring downgradient of Landfill Plume
3786	Semiannual	D	Mound	RFCA	AL	Drainage Well - below Pond B-4 in South Walnut Creek Drainage
75992	Semiannual	PE	Mound	RFCA	AL	Plume Extent well monitoring So. Walnut Cr. Drainage below Mound Site Plume
08091	Semiannual	PE	Mound\E. Trench	RFCA	AL	Plume Extent well monitoring the southern migration of Mound and East Trenches Plumes
New Well	Semiannual	PE	Old Landfill	RFCA	AL	Plume Extent well monitoring the Old Landfill Plume
New Well	Semiannual	PE	PU&D	RFCA	AL	Plume Extent well monitoring the PU&D Yard Plume
New Well	Semiannual	PE	PU&D	RFCA	AL	Plume Extent well monitoring the PU&D Yard Plume
New Well	Semiannual	PD	Solar Ponds	RFCA	AL	Plume Definition well monitoring the southern migration of the Solar Ponds Plume
70493	Semiannual	RCRA	PU&D	RFCA, RCRA	BD/UHSU	RCRA upgradient/Plume Definition well monitoring the edge of the PU&D Yard Plume
70393	Semiannual	RCRA	PU&D	RFCA, RCRA	AL	RCRA upgradient /Plume Definition well monitoring the edge of the PU&D Yard Plume
70193	Semiannual	RCRA	PU&D	RFCA, RCRA	BD/UHSU	RCRA upgradient/Plume Extent well monitoring the PU&D Yard Plume
5887	Semiannual	RCRA	PU&D	RFCA, RCRA	AL	RCRA upgradient/ Plume Extent Well monioring the PU&D Yard Plume - LF
76992	Semiannual	PE	PU&D\Landfill	RFCA, RCRA	AL	Plume Extent well monitoring the eastward migration of the PU&D Yard/Landfill Plume
6887	Semiannual	PD	PU&D\Landfill	RFCA, RCRA	AL	Plume Definition well monitoring the Landfill/PU&D yard Plume
P219489	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
P218389	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northern migration of the SEP Nitrate Plume
B208289	Semiannual	PE	Solar Ponds	RFCA	BD/UHSU	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume
3386	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the southern migration of the SEP Nitrate and Carbon Tet Plumes
1786	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Definition well monitoring the migration of the SEP Nitrate and Carbon Tet Plumes
1386	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Definition well monitoring the migration of the SEP Nitrate and Carbon Tet Plumes
B206789	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well monitoring the northeast mitgration of the SEP Nitrate Plume
CDPHE\EPA Well Requests						
07391	Semiannual	PM	903 Pad	RFCA	AL\BD	Performance Monitoring well monitoring effects of remediation downgradient of Ryans Pit
00491	Semiannual	PD	903 Pad	RFCA	BD\UHSU	Plume Definition well monitoring the 903 Pad VOC Plume
11891	Semiannual	PM	East Trenches	RFCA	BD\UHSU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-3
3687	Semiannual	PM	East Trenches	RFCA	BD\USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
12691	Semiannual	PM	East Trenches	RFCA	BD\USHU	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
05691	Semiannual	PM	East Trenches	RFCA	AL	Performance Monitoring well monitoring effects of remediation downgradient of Trench T-4
P209489	Semiannual	PD	Solar Ponds	RFCA	BD\UHSU	Plume Definition well for the Carbon Tet. Plume
3586	Semiannual	PE	Solar Ponds	RFCA	AL	Plume Extent well tracking migration of Solar Ponds nitrate Plume
05391	Semiannual	PD	East Trenches	RFCA	AL	Plume Definition well monitoring eastward concentration of VOCs from the East Trenches Plume
12191	Semiannual	PM	East Tranches	RFCA	BD\UHSU	Performance Monitoring at edge of T3 soil excavation
Wells Removed From List						
31791	Semiannual	PE	881 Hillside	RFCA	AL/BD	Plume Extent well monitoring 881 Hillside

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sequence presented in the draft IMP was followed for determining Tier I and II exceedances. The well types and decision rules are defined below:

Boundary (B) Monitoring Wells: These wells monitor groundwater leaving the eastern Site boundary. A reportable exceedance occurs if a measured concentration exceeds a Tier II action level **and** the background Mean plus 2 Standard Deviations (M2SDs). When there are no previous historical data, **or** a value exceeds the M2SD of the historical concentration in the well when there have been historical exceedances of Tier II action levels, the required action is to initiate monthly sampling. If action levels are exceeded for three consecutive months, by the above criteria, then appropriate parties are notified and the possible impacts to surface water are evaluated.

D&D (DD) Monitoring Wells: These wells monitor for releases to groundwater from deactivation and decommissioning (D&D) activities. A reportable exceedance occurs when a measured concentration exceeds the M2SD of the established historical baseline concentration downgradient of the building(s). The required action is to inform appropriate parties and initiate an evaluation of the situation.

Plume Definition (PD) Monitoring Wells: These wells are located within known contaminant plumes and are above Tier II action levels, but are below the Tier I action levels established in the ALF. A reportable exceedance occurs when a measured concentration exceeds a Tier I action level, **and** the background M2SD, **and** the M2SD of the historical concentration in the well. The required action is to reclassify as a Tier I exceedance well and evaluate possible impacts to groundwater.

Plume Extent (PE) Monitoring Wells: These wells are located at the edges of known groundwater contaminant plumes, along pathways to surface water. These wells monitor for an increase in concentrations that may result in future impacts to surface water. A reportable exceedance occurs if a measured concentration exceeds a Tier II action level **and** the background M2SD. When there are no previous historical data, **or** a value exceeds the M2SD of the historical concentration in the well when there have been historical exceedances of Tier II action levels, the required action is to initiate monthly sampling. If action levels are exceeded for three consecutive months, by the above criteria, then appropriate parties are notified and the possible impacts to surface water are evaluated.

Drainage (D) Monitoring Wells: These wells are located in stream drainages, downgradient of contaminant plumes. They have the same programmatic requirements as PE wells under the IMP. A reportable exceedance occurs if a measured concentration exceeds a Tier II action level **and** the background M2SD. When there are no historical data, **or** a value exceeds the M2SD of the historical

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concentration in the well when there have been historical exceedances of Tier II action levels, the required action is to initiate monthly sampling. If action levels are exceeded for three consecutive months, by the above criteria, then appropriate parties are notified and the possible impacts to surface water are evaluated.

Performance Monitoring (PM) Wells: These wells monitor the effect of a remediation or source removal action, as required in the ALF. If an increasing trend in the concentration of a contaminant is noted, then the appropriate parties are notified and an evaluation of the situation is initiated.

RCRA Monitoring Wells: These wells monitor downgradient groundwater contaminant concentrations at RCRA units. If the mean concentration of a contaminant in a downgradient well exceeds the mean concentration in upgradient wells **and** concentrations at the well show an upward trend with time, a report will be made to appropriate agencies and an investigation will be initiated to investigate possible causes.

In addition to changes in the monitoring network, groundwater reporting has been integrated under the IMP. Four quarterly reports are produced annually documenting exceedances of RFCA Action Levels and changes in water quality for wells not monitored for Action Level exceedances. This RFCA Annual Groundwater Report is also required to summarize all actions taken for groundwater compliance within each calendar year.

For documented exceedances above Action levels and Site background in the designated monitoring wells in the program, an evaluation of impact to surface water is required. These evaluations are determined on a case by case basis depending on the data requirements necessary to do the impacts analysis. Section 4 of this report will provide a status on the current evaluations based on 1996 exceedances.

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2.0 DATA ANALYSIS

2.1 METHODS

Groundwater analytical data for calendar year 1996 were retrieved by a query of the Rocky Flats Environmental Database System (RFEDS) performed on May 28, 1997. Results for 71 of 85 RFCA wells were obtained. Fourteen wells having no results for 1996 were either dry or were added to the groundwater monitoring program as a result of changes made late in the year (see § 1.0). Seven of these wells were sampled successfully in the first quarter of 1997. Wells 08091 and P209289 were dry throughout 1996 and the first quarter of 1997. Table 2-1 summarizes sample collection activity, by quarter, for RFCA wells sampled in 1996.

Analytical results for groundwater were imported into an ACCESS database for analysis. Data with the Quality Control (QC) identifiers "REAL" (actual analysis), "DUP" (duplicate sample), and "RNS" (rinsate blank) were graphically examined for consistency. Duplications, mismatches, and laboratory QC data were excluded. Field QC samples were identified for use in the data quality assessment (§ 2.2).

Detections (results without a "U" qualifier) for analytes with Tier I and Tier II ALF criteria were matched with the background M2SD for inorganic analytes, including radionuclides. Three ratios used to identify exceedances were calculated for each detection; *result:* Tier I ALF, *result:* Tier II ALF; and for inorganics, *result:* background M2SD. Results for organic compounds exceeding Tier I or Tier II ALF were compared with location specific historic mean data (M2SD) for trend analysis. Background values were calculated from the Background Geochemical Characterization Report (DOE, 1993a) with the exception of americium-241, plutonium-239/240, uranium-233/234, uranium-235, and uranium-238. Background values for these radionuclides were taken from the draft Background Comparison for Radionuclides in Groundwater report (DOE, 1997a). Data used to calculate the historical M2SD for locations with analytes exceeding Tier II ALF criteria and produce trend plots were extracted directly from RFEDS.

2.2 GROUNDWATER DATA QUALITY ASSESSMENT

In this section, the quality of the analytical data is assessed in terms of five data-quality parameters: precision, accuracy, representativeness, completeness, and comparability (PARCC) (EPA, 1992). This section summarizes the types of data available to assess the PARCC parameters, presents the results of data-quality evaluations for each analyte type, and evaluates the overall quality of the groundwater monitoring data for the calendar year 1996.

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TABLE 2-1. Summary of Sampling for RFCA Groundwater Locations in 1996 (by Quarter)

Location	Metals				Radionuclides												VOCs				Water Quality Parameters							
					PU/AM				Tritium				Uranium								Sulfate				Nitrate/Nitrite			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
00491	X		X		X				X		X		X				X		X		X		X		X			
0386	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X		X	X	X	X	X	X	X	X	X	X
03991	X		X		X				X		X		X				X		X		X		X		X		X	
04091	X								X		X		X				X				X				X			
04591	X		X		X				X		X		X				X		X		X		X		X		X	
0487	X		X		X				X		X		X				X		X		X		X		X		X	
04991	X				X				X		X		X				X		X		X				X		X	
05091	X		X		X				X		X		X				X		X		X		X		X		X	
05391	X		X		X				X		X		X				X				X				X			
05691																												
06091	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X	X	X
06491	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X
07391	X		X		X				X		X		X				X		X		X		X		X		X	
08091																												
10194	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	
10294	X		X		X				X		X		X				X		X		X		X		X		X	
10394	X	X		X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X
10592	X		X						X	X	X		X				X	X	X				X			X	X	
10692	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X		X	X			X	X	
10792									X	X	X	X		X			X	X	X	X		X				X	X	X
10992			X							X	X	X	X	X			X	X		X		X				X		X
10994	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X		X	X	X		X	X	X		X
11092												X								X								X
11891																												
12191																												
12691	X		X		X				X		X		X				X		X		X		X		X		X	
1386	X	X		X	X	X		X	X	X	X	X	X	X	X	X		X	X	X	X	X	X	X	X	X	X	X
1786	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X			X	X	X	X	X	X	X	X	X	X
1986	X	X	X		X	X	X		X	X	X		X	X	X				X		X	X	X		X	X	X	
2186	X		X		X				X		X		X						X		X		X		X		X	
22596			X				X				X				X				X				X				X	
22696																												
22796			X				X				X				X				X				X				X	
22896			X				X				X				X				X				X				X	
22996			X	X			X	X			X	X			X	X			X	X			X	X			X	X
23096				X				X			X	X				X			X	X			X	X			X	X
23196																												
23296											X								X				X				X	
2987	X		X		X				X		X		X				X		X		X		X		X		X	
3087		X		X		X		X		X		X		X		X		X		X		X		X		X		X
3386																												
35691		X		X		X		X		X		X		X		X		X		X		X		X		X		X
3586																												
3687																												
3786										X		X		X				X		X		X				X		X

Q1 - First Quarter | Q2 - Second Quarter | Q3 - Third Quarter | Q4 - Fourth Quarter

TABLE 2-1 Summary of Sampling for RFCA Groundwater Locations in 1996 (by Quarter (cont'd)

Location	Metals				Radionuclides												VOCs				Water Quality Parameters							
					PU/AM				Tritium				Uranium								Sulfate				Nitrate/Nitrite			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
38591																												
4087		X				X				X	X			X				X	X			X				X	X	
41591	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X	
41691	X		X	X	X			X	X		X	X	X			X	X		X	X	X		X	X	X		X	X
43392			X	X	X	X		X	X	X	X	X	X	X		X	X		X	X		X	X	X		X	X	X
4787																												
4887		X								X				X				X				X				X		
52894		X								X				X				X				X				X		
52994																												
5387		X				X				X				X				X		X		X				X		
5587										X								X								X		
5887	X	X	X		X	X	X		X	X	X		X	X	X		X	X	X			X	X			X	X	
6186	X		X		X	X			X	X	X	X	X	X		X	X		X	X	X	X	X		X	X	X	X
6286		X		X		X		X		X		X		X		X		X		X		X		X		X		X
6386										X		X						X		X						X		X
6486		X				X				X				X				X				X				X		
6586		X	X	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X	X		X	X	X
6687	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X		X	X	X		X	X	X
70193	X	X	X	X	X	X		X	X	X	X	X	X	X		X	X	X	X	X	X	X	X		X	X	X	
70393	X	X	X		X	X			X	X	X		X	X			X		X		X	X	X		X	X	X	
70493		X		X		X		X		X		X		X		X		X		X		X		X		X		X
7086			X	X			X	X			X	X			X	X			X	X			X				X	
75992			X	X						X	X	X		X		X			X	X		X	X	X		X	X	X
76992																		X								X		
77392																												
B206989									X		X						X		X						X		X	
B208289										X								X		X						X		
B208789				X						X		X		X		X		X		X		X		X		X		X
P114389	X		X		X		X		X		X		X		X		X		X		X		X		X		X	
P209289																												
P209389	X		X		X	X	X		X	X	X		X	X	X		X		X		X	X	X		X	X	X	
P209489																												
P218389		X									X				X		X	X	X			X			X	X	X	
P219189										X							X	X	X								X	
P219489																	X	X	X						X	X	X	
P313589	X	X	X		X	X	X		X	X	X		X	X	X			X	X			X	X			X	X	
P314289										X	X							X	X							X	X	
P416689									X		X		X		X		X		X				X		X		X	
P416789											X				X				X				X				X	
P416889	X	X	X		X	X	X		X	X	X		X	X	X			X	X			X	X			X	X	

Q1 - First Quarter | Q2 - Second Quarter | Q3 - Third Quarter | Q4 - Fourth Quarter

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QC samples for all groundwater sampling (RFCA and non-RFCA wells) were included in the assessment Field duplicate and equipment rinsate sample data used to assess precision and representativeness were obtained from the RFEDS major analytical data tables. Percent recovery data for spiked samples were retrieved from the RFEDS validation/quality assurance table (VAL_QA) for all groups except radionuclides. Percent recovery data for radionuclides were hand-transcribed from laboratory sheets, as available, during report preparation.

Precision: Precision is a measure of the reproducibility of analytical results. Precision is expressed quantitatively by the relative percent difference (RPD) between duplicate field samples as defined by the following equation:

$$RPD = \frac{|(S-D)|}{(S+D)/2} \times 100$$

where:
S = first sample
D = duplicate sample

The RPD was not calculated for duplicate samples for which the analytical result for either member was qualified with a "U" or "B" ("B" excluded for metals only) by the laboratory. The data flag "U" indicates that the analyte was not present above the detection limit. The data flag "B" indicates that the value is larger than the instrument detection limit, but less than the method detection limit. Results in these categories have inherently poor reproducibility and are described qualitatively. Individual RPDs can be found in Appendix A, Table A-1. The QC criterion for RPDs is 20%. (EG&G, 1991a).

Accuracy: Accuracy is a measure of how closely an analytical result corresponds to the "true" concentration in a sample. Accuracy is expressed quantitatively by the percent recovery (%R) obtained from spiked samples as derived by the following equation:

$$\%R = \frac{(SSR-SR)}{SA} \times 100$$

where:
SSR = spiked sample result
SR = sample result
SA = spike added

Percent recoveries for individual samples are reported in the data set and are shown in Appendix A, Table A-2. The QC criterion for % R is adopted from EPA (1988a and 1988b) and is 75% to 125% for all analytes.

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Representativeness: The discussion of representativeness in this section is limited to an evaluation of whether analytical results for field samples are truly representative of environmental concentrations or whether they may have been influenced by the introduction of contamination during collection and handling. Other aspects of representativeness such as numbers of samples and spatial distribution are addressed in the IMP for groundwater monitoring.

Possible introduction of contamination is evaluated by examination of the analytical results for equipment rinsates (Appendix A, Table A-3). Equipment rinsates are used to assess the efficacy of the decontamination process and possible cross-contamination between environmental samples. They are samples of volatile free American Society of Testing and Materials (ASTM) Type II water that have been poured over or through decontaminated sampling equipment and subsequently handled in the same manner as environmental samples.

Although rinsates are used specifically as indicators of cross-contamination during decontamination of equipment, they are carried through the entire sampling, shipping, and laboratory process and are, consequently, also good indicators of possible introduced contamination during any of these steps.

Completeness: As of this report, data were not yet validated by a third party, or were not received. Thus, a determination of completeness based on validated samples cannot be performed. However, all samples specified in the groundwater IMP (K-H, 1997) were collected unless well disposition was prohibitive (i.e. dry or went dry during sampling). All groundwater analytical results for 1996 were retrieved from RFEDS in May, 1997. No additional 1996 analytical results are expected. Table 2-1 presents a summary of sample collection by quarter for 1996. Completeness will not be addressed with respect to individual analyte groups.

Comparability: Analytical methods and sampling techniques remained consistent for each analyte group over the sampling period. Laboratory analyses were performed according to standard CLP protocols and results should be comparable to data produced by similar methods. Therefore, it is unnecessary to discuss comparability in terms of individual analyte groups.

2.2.1 METALS

2.2.1.1 Precision

There were 429 records for duplicates from 21 samples in the data set for dissolved metals in 1996 (frequency = 1 in 20). There were 105 instances of detections in both samples of a REAL-DUP pair for which an RPD could be calculated. These included Ba, Se, Li, Mg, Mn, K, Si, Na, Ca, and Sr. Only one

RPD in 105 exceeded the 20% QC criterion. This occurred for selenium in the first quarter at location 12491. The calculated RPD for this pair was 21% (Appendix A, Table A-1). Overall precision for metals is very good.

2.2.1.2 Accuracy

There were 730 spike recovery records for dissolved metals (1 in 10). Recovery for calcium, sodium, silicon, potassium, and magnesium (148 records) were consistently reported as 0%. This is believed to be an artifact of laboratory reporting and an explanation is being sought. Of the remaining 582 records, one result for mercury at location 06491 fell below the QC criterion (70%). 12 results for cesium or selenium exceeded the QC criterion with values ranging from 126% to 150%. Nearly 98% of results were within the QC criterion indicating good overall accuracy for 1996 metals data.

2.2.1.3 Representativeness

There were 429 equipment rinsate records for metals in 1996 (1 in 20). All but six were "U" or "B" qualified. Results for non-RFCA location P207689 showed detectable levels of calcium, magnesium, and sodium during May, 1996 sampling and silicon for August, 1996 sampling. Consequently, results for real sample numbers GW05126TE and GW05227TE should be considered with care. Location 70093, a non-RFCA well, also contained detectable concentrations of lithium (3ug/l) during the Feb., 1996 sampling and silicon (111 ug/l) during the Aug., 1996 sampling. Results for associated real sample numbers GW03120GA and GW05277TE should also be used with care. The concentration for lithium detected in the rinsate sample was below RFCA action levels.

Over 98% of equipment rinsate results were below detection limits indicating that contamination of environmental samples from outside sources was not a significant concern for 1996.

2.2.2 RADIONUCLIDES

2.2.2.1 Precision

The data set for dissolved radionuclides contains 212 records for duplicate samples in 1996. Of these, there were 139 REAL/DUP pairs for which an RPD could be calculated. Seventy-six of these pairs (55%) had RPDs exceeding 20%. Fifteen pairs (11%) had RPDs exceeding 100% and three pairs (2%) had RPDs of 200%. Due to the inherently poor reproducibility of results at the very low concentrations typically found in RFETS groundwater, 20% is believed to be an unattainable QC criterion for radionuclides. RPDs of 100% or greater are not uncommon for data of this type, even under ideal field and laboratory conditions (DOE, 1993a). Individual pairs for all analytes significantly exceeded the 20% QC criterion.

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2.2.2.2 Accuracy

One hundred and eighteen laboratory control sample results were identified and transcribed from hard-copy laboratory sheets. Of these, 110 (93%) were within the 75-125% QC criterion indicating good overall accuracy for radionuclide analyses in 1996. Efforts are being made to ensure that these data are transmitted electronically to the database in the future.

2.2.2.3 Representativeness

There were 212 equipment rinsate records for radionuclides of which 187 (88%) were "J"(estimated) or "U" qualified indicating they are below detection limits. Three RFCA locations, 0386, 06091, and 12691, had radionuclide detections in one or more rinsate sample. For location 0386, Am-241 and Ra-228 were detected at low levels during fourth quarter sampling and Gross beta was detected during second quarter sampling. Am-241 was detected in one fourth quarter rinsate sample at location 06091 and Ra-228 was detected in one first quarter sample for well 12691.

Four non-RFCA wells, B210489, P115489, P207689, and P419689 also had detections in one or more rinsate sample. For location P207689, All analytes except Pu-239/40 were detected in the May, 1996 rinsate sample as were several metals. Therefore, results from associated real sample number GW05126TE should be considered unreliable. Detected analytes from locations B210489, P115489, and P419689 were at very low concentrations. (Appendix A, Table A-3).

2.2.3 VOLATILE ORGANIC COMPOUNDS

2.2.3.1 Precision

There were 1159 duplicate (DUP) records for organic compounds in 1996 groundwater (1 in 20), with over 92% reported as non-detects. Of the 30 pairs having detects for both the REAL and DUP sample, 17 were identical (RPD = 0%). RPDs for seven pairs exceeded the QC criterion of 20%. All pairs which exceeded the QC criterion had at least one result which was either "J" qualified or at the detection limit (1 ug/l). Values near the detection limit have inherently poor precision (DOE, 1993a). Based on the fraction of pairs with true detections exceeding QC criterion, precision is good for organic compounds.

2.2.3.2 Accuracy

There were 425 matrix spike and 399 matrix spike duplicate sample results for volatile organics in 1996. Spike analysis was performed for a subset of the analyte suite for volatile organic compounds and results represent only those analytes. All matrix spike duplicate samples had % recovery values between 85% and 120% (QC criterion is 75%-125%). One matrix spike sample had 126% recovery for ethylbenzene at

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location 10792. These results demonstrate very good overall accuracy for these compounds (Appendix A, Table A-2).

2.2.3.3 Representativeness

There were 1102 rinsate records for volatile organic compounds in 1996. 1084 of these (>98%) were "U" qualified non-detects. An additional 10 were "J" qualified (<1 ug/l). Of the eight detections, 6 were for common laboratory contaminant chloromethane (all <10 ug/l) and two were for naphthalene (both <2 ug/l). Thus, there is no indication of significant introduced organic contamination for the sampling period.

2.2.4 WATER QUALITY PARAMETERS

2.2.4.1 Precision

There were 126 duplicate sample records for water quality parameters in 1996. RPDs were calculated for 99 REAL/DUP pairs having detections for both samples. All but one RPD value were less than the QC criteria of 20%. Total dissolved solids for well 70093 had a calculated RPD of 30% for the fourth quarter, 1996. Based on the percentage of RPDs falling within the QC criterion, precision for water quality parameters is good.

2.2.4.2 Accuracy

There were 115 matrix spike sample results for water quality parameters in 1996. Analytes spiked included nitrate/nitrite, sulfate, and chloride. All % recovery results were within the QC criteria indicating very good accuracy for water quality parameters.

2.2.4.3 Representativeness

There were 126 rinsate records for water quality parameters. Of these, 118 (94%) were "U" or "B" qualified. Five of the eight detections were from May, 1996 sampling at location P207689. This sample was mentioned in previous sections as it also contained significant concentrations of metals and radionuclides. It is likely that this sample container was mislabeled as a rinsate sample. Additionally, total dissolved solids were detected twice for location 70093 and once for location P115489. Thus, there was little evidence of introduced contamination for water quality parameters and results can be considered representative.

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2.3 DATA SUMMARY FOR RFCA DESIGNATED WELLS SAMPLED IN 1996

Sixty-four RFCA-designated monitoring wells were sampled and had concentrations of one or more analytes above the Tier II action levels. All reported results greater than a Tier II action level are presented in Table 2-2 and are summarized in the following discussion. Twenty-one wells with no results above the Tier II action levels are noted in Table 2-3. Complete sampling results are given in Appendix Table B-1. Reportable exceedances of action levels and required actions are defined in Section 1 of this report. Results for all RFCA wells for metals radionuclides, organics, and water quality parameters that have concentrations above the Tier II action levels in any well are shown in box plots in Plates 4 through 7.

Historical trends for PM and D&D wells with analyte concentrations above Tier I or II action levels are shown in Figures 2-1 through 2-96. Historical trends are also shown for all wells with organic compound concentrations exceeding Tier II action levels, and for wells with any analyte concentrations exceeding Tier II action levels **and** background M2SD. Background values for inorganics are taken from the 1993 Background Geochemical Characterization Report (DOE, 1993a) and from the draft Background Comparison for Radionuclides in Groundwater (DOE, 1997a). Exceedances that occurred in the third and fourth quarter sampling programs have previously been reported in 1996 RFCA Quarterly Groundwater Monitoring Reports (RMRS, 1997b, 1997c).

2.3.1 TIER I EXCEEDANCES

There were two reportable Tier I exceedances found in 1996 (Table 2-2). The first, as reported in the 1996 Third Quarter RFCA Groundwater Monitoring Report (RMRS, 1997b), was at well 22896, installed in 1996, and first sampled on July 15. Trichloroethene (TCE) was determined to be present at 2100 µg/L. Methylene chloride and nitrate concentrations in this well were reported at levels slightly above Tier II action levels. This well was originally designated as a plume extent well. It has been reclassified as a plume definition well, because of the Tier I exceedance, which has been confirmed in monthly sampling during the first quarter of 1997 (RMRS, 1997d). TCE concentrations, including three confirmatory 1997 samples, are shown in Figure 2-83.

The second Tier I exceedance was in plume definition well 00491. Americium-241 was reported at 30 pCi/L for the February 1996 sampling. Figure 2-6 shows that activity-concentrations of americium-241 in this well have consistently been below 0.01pCi/L since 1991. A sample taken in the first quarter of 1997 (RMRS, 1997d) was also in the historical range. An evaluation of the data for this well confirms that the reported value is in error. No action is recommended based on this spurious value.

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TABLE 2-2. 1996 Groundwater Exceedances of Tier II Action Levels and Standards Framework Criteria (ALF) in RFCA-Designated Wells)

Well Class	Location	Sample Date	Analyte	Result	Units	Q	Tier II AL	Tier II Ratio	Background M2SD	BKGD ratio	Exceed BKGD?	Historic M2SD	Historic Ratio	Exceedance of BKGD and Historic M2SD	Reportable Exceedance
BOUNDARY	0386	29-Feb-96	SELENIUM	74.7	UG/L		50	1.5	43.7	1.71	YES	78.7	0.9	NO	YES
BOUNDARY	0386	12-Jun-96	SELENIUM	79.6	UG/L		50	1.6	43.7	1.82	YES	78.7	1.0	YES	YES
BOUNDARY	0386	24-Sep-96	SELENIUM	51.9	UG/L		50	1.0	43.7	1.19	YES	78.7	0.7	NO	YES
BOUNDARY	0386	25-Oct-96	THALLIUM	6.9	UG/L	B	2	3.5	4.90	1.41	YES	5.40	1.3	YES	YES
BOUNDARY	0386	25-Oct-96	U-234	11.2	PCI/L		1.07	10.5	60.7	0.18	NO				NO
BOUNDARY	0386	12-Jun-96	U-234	11.2	PCI/L		1.07	10.5	60.7	0.19	NO				NO
BOUNDARY	0386	29-Feb-96	U-234	13.3	PCI/L		1.07	12.5	60.7	0.22	NO				NO
BOUNDARY	0386	12-Jun-96	U-238	7.47	PCI/L		0.768	9.7	41.8	0.18	NO				NO
BOUNDARY	0386	25-Oct-96	U-238	7.97	PCI/L		0.768	10.4	41.8	0.19	NO				NO
BOUNDARY	0386	29-Feb-96	U-238	12.8	PCI/L		0.768	16.6	41.8	0.31	NO				NO
BOUNDARY	06491	11-Nov-96	THALLIUM	9.5	UG/L	B	2	4.8	4.90	1.94	YES	9.01	1.1	YES	YES
BOUNDARY	06491	19-Aug-96	THALLIUM	6	UG/L	B	2	3.0	4.90	1.22	YES	9.01	0.7	NO	YES
BOUNDARY	06491	08-Apr-96	U-234	15.3	PCI/L		1.07	14.3	60.7	0.25	NO				NO
BOUNDARY	06491	19-Aug-96	U-234	19.5	PCI/L		1.07	18.2	60.7	0.32	NO				NO
BOUNDARY	06491	26-Feb-96	U-234	21.1	PCI/L		1.07	19.7	60.7	0.35	NO				NO
BOUNDARY	06491	11-Nov-96	U-234	19.3	PCI/L		1.07	18.0	60.7	0.32	NO				NO
BOUNDARY	06491	08-Apr-96	U-238	9.9	PCI/L		0.768	12.9	41.8	0.24	NO				NO
BOUNDARY	06491	11-Nov-96	U-238	13.4	PCI/L		0.768	17.5	41.8	0.32	NO				NO
BOUNDARY	06491	19-Aug-96	U-238	14.6	PCI/L		0.768	19.1	41.8	0.35	NO				NO
BOUNDARY	06491	26-Feb-96	U-238	14.1	PCI/L		0.768	18.3	41.8	0.34	NO				NO
BOUNDARY	10294	17-Sep-96	MANGANESE	853	UG/L		183	4.7	162	5.25	YES	900	0.9	NO	YES
BOUNDARY	10294	17-Sep-96	SULFATE	606	UG/L		500	1.2	436	1.39	YES	1183	0.5	NO	YES
BOUNDARY	10294	26-Feb-96	SULFATE	618	UG/L		500	1.2	436	1.42	YES	1183	0.5	NO	YES
BOUNDARY	10294	26-Feb-96	U-234	24.7	PCI/L		1.07	23.1	60.7	0.41	NO				NO
BOUNDARY	10294	26-Feb-96	U-238	21.3	PCI/L		0.768	27.7	41.8	0.51	NO				NO
BOUNDARY	10394	08-Apr-96	U-234	6.52	PCI/L		1.07	6.1	60.7	0.11	NO				NO
BOUNDARY	10394	18-Nov-96	U-234	8.19	PCI/L		1.07	7.7	60.7	0.13	NO				NO
BOUNDARY	10394	28-Feb-96	U-234	6.72	PCI/L		1.07	6.3	60.7	0.11	NO				NO
BOUNDARY	10394	08-Apr-96	U-238	5.69	PCI/L		0.768	7.4	41.8	0.14	NO				NO
BOUNDARY	10394	28-Feb-96	U-238	4.93	PCI/L		0.768	6.4	41.8	0.12	NO				NO
BOUNDARY	10394	18-Nov-96	U-238	5.83	PCI/L		0.768	7.6	41.8	0.14	NO				NO
BOUNDARY	41591	30-Jul-96	THALLIUM	10.8	UG/L	*	2	5.4	4.90	2.20	YES	6.78	1.6	YES	YES
BOUNDARY	41591	25-Nov-96	U-234	8.97	PCI/L		1.07	8.4	60.7	0.15	NO				NO
BOUNDARY	41591	30-Jul-96	U-234	7.85	PCI/L		1.07	7.3	60.7	0.13	NO				NO
BOUNDARY	41591	29-Feb-96	U-234	8.57	PCI/L		1.07	8.0	60.7	0.14	NO				NO
BOUNDARY	41591	09-May-96	U-234	10.3	PCI/L		1.07	9.6	60.7	0.17	NO				NO
BOUNDARY	41591	09-May-96	U-238	7.88	PCI/L		0.768	10.3	41.8	0.19	NO				NO
BOUNDARY	41591	29-Feb-96	U-238	7.68	PCI/L		0.768	10.0	41.8	0.18	NO				NO
BOUNDARY	41591	25-Nov-96	U-238	7.62	PCI/L		0.768	9.9	41.8	0.18	NO				NO
BOUNDARY	41591	30-Jul-96	U-238	5.76	PCI/L		0.768	7.5	41.8	0.14	NO				NO
BOUNDARY	41691	14-Nov-96	MANGANESE	706	UG/L		183	3.9	162	4.36	YES	853	0.8	NO	YES
BOUNDARY	41691	19-Sep-96	MANGANESE	641	UG/L		183	3.5	162	3.95	YES	853	0.8	NO	YES
BOUNDARY	41691	14-Nov-96	U-234	1.18	PCI/L		1.07	1.1	60.7	0.02	NO				NO
BOUNDARY	41691	29-Feb-96	U-238	1.01	PCI/L		0.768	1.3	41.8	0.02	NO				NO
BOUNDARY	41691	14-Nov-96	U-238	1.29	PCI/L		0.768	1.7	41.8	0.03	NO				NO
D&D	22996	16-Aug-96	MANGANESE	227	UG/L		183	1.2	162	1.40	YES	ND			NO
D&D	22996	19-Nov-96	THALLIUM	7.8	UG/L	B	2	3.9	4.90	1.59	YES	ND			NO
D&D	22996	16-Aug-96	U-234	2.21	PCI/L		1.07	2.1	60.7	0.04	NO				NO
D&D	22996	19-Nov-96	U-234	2.33	PCI/L		1.07	2.2	60.7	0.04	NO				NO
D&D	22996	19-Nov-96	U-238	1.84	PCI/L		0.768	2.4	41.8	0.04	NO				NO
D&D	22996	16-Aug-96	U-238	2.02	PCI/L		0.768	2.6	41.8	0.05	NO				NO
DRAINAGE	3786	07-May-96	SULFATE	1170	UG/L		500	2.3	436	2.69	YES	1459	0.8	NO	YES
DRAINAGE	3786	07-May-96	U-234	35.8	PCI/L		1.07	33.4	60.7	0.59	NO				NO
DRAINAGE	3786	07-May-96	U-238	25.1	PCI/L		0.768	32.7	41.8	0.60	NO				NO
DRAINAGE	6486	24-Apr-96	NICKEL	105	UG/L		100	1.1	21.4	4.91	YES	62.0	1.7	YES	YES
DRAINAGE	6486	24-Apr-96	U-234	3.13	PCI/L		1.07	2.9	60.7	0.05	NO				NO
DRAINAGE	6486	24-Apr-96	U-238	2.38	PCI/L		0.768	3.1	41.8	0.06	NO				NO
DRAINAGE	6586	12-Nov-96	NICKEL	212	UG/L		100	2.1	21.4	9.92	YES	78.8	2.7	YES	YES
DRAINAGE	6586	12-Nov-96	THALLIUM	7.1	UG/L	B	2	3.6	4.90	1.45	YES	3.87	1.8	YES	YES
DRAINAGE	6586	18-Apr-96	U-234	4.20	PCI/L		1.07	3.9	60.7	0.07	NO				NO
DRAINAGE	6586	12-Nov-96	U-234	4.62	PCI/L		1.07	4.3	60.7	0.08	NO				NO
DRAINAGE	6586	19-Jul-96	U-234	3.05	PCI/L		1.07	2.9	60.7	0.05	NO				NO
DRAINAGE	6586	12-Nov-96	U-238	3.38	PCI/L		0.768	4.4	41.8	0.08	NO				NO
DRAINAGE	6586	18-Apr-96	U-238	4.00	PCI/L		0.768	5.2	41.8	0.10	NO				NO
DRAINAGE	6586	19-Jul-96	U-238	2.54	PCI/L		0.768	3.3	41.8	0.06	NO				NO
PERF MON	07391	11-Mar-96	1,1,1-TRICHLOROETHANE	350	UG/L	J	200	1.8				2725	0.1	NO	NO
PERF MON	07391	11-Mar-96	CHLOROFORM	1800	UG/L	J	100	18.0				4439	0.4	NO	NO
PERF MON	07391	24-Sep-96	CHLOROFORM	1600	UG/L	J	100	16.0				4439	0.4	NO	NO
PERF MON	07391	11-Mar-96	NITRATE/NITRITE	20.6	MG/L		10	2.1	4.66	4.42	YES	33.6	0.6	NO	NO
PERF MON	07391	24-Sep-96	NITRATE/NITRITE	17.3	MG/L		10	1.7	4.66	3.71	YES	33.6	0.5	NO	NO
PERF MON	07391	11-Mar-96	TETRACHLOROETHENE	1500	UG/L	J	5	300.0				3030	0.5	NO	NO
PERF MON	07391	24-Sep-96	TETRACHLOROETHENE	1400	UG/L	J	5	280.0				3030	0.5	NO	NO

TABLE 2-2 1996 Groundwater Exceedances of Tier II Action Levels and Standards Framework Criteria (ALF) in RFCA-Designated Wells (cont'd)

Well Class	Location	Sample Date	Analyte	Result	Units	Q	Tier II AL	Tier II Ratio	Background M2SD	BKGD ratio	Exceed BKGD?	Historic M2SD	Historic Ratio	Exceedance of BKGD and Historic M2SD	Reportable Exceedance
PERF MON	07391	24-Sep-96	THALLIUM	8.1	UG/L	B	2	4.1	4.90	1.65	YES	19.9	0.4	NO	NO
PERF MON	07391	24-Sep-96	TRICHLOROETHENE	100000	UG/L		5	20000.0				158351	0.6	NO	NO
PERF MON	07391	11-Mar-96	TRICHLOROETHENE	99000	UG/L		5	19800.0				158351	0.6	NO	NO
PERF MON	07391	11-Mar-96	U-234	16.4	PCI/L		1.07	15.4	60.7	0.27	NO				NO
PERF MON	07391	11-Mar-96	U-238	37.6	PCI/L		0.768	48.9	41.8	0.90	NO				NO
PERF MON	10592	06-Feb-96	SELENIUM	286	UG/L		50	5.7	43.7	6.54	YES	344	0.8	NO	NO
PERF MON	10592	26-Aug-96	SELENIUM	193	UG/L		50	3.9	43.7	4.41	YES	344	0.6	NO	NO
PERF MON	10592	06-Feb-96	U-234	12.9	PCI/L		1.07	12.1	60.7	0.21	NO				NO
PERF MON	10592	06-Feb-96	U-238	10.5	PCI/L		0.768	13.6	41.8	0.25	NO				NO
PERF MON	10692	17-Sep-96	THALLIUM	8.1	UG/L	B	2	4.1	4.90	1.65	YES	11.0	0.7	NO	NO
PERF MON	10692	26-Nov-96	THALLIUM	6.6	UG/L	B	2	3.3	4.90	1.35	YES	11.0	0.6	NO	NO
PERF MON	10692	26-Nov-96	U-234	13.9	PCI/L		1.07	13.0	60.7	0.23	NO				NO
PERF MON	10692	07-Feb-96	U-234	14.9	PCI/L		1.07	13.9	60.7	0.25	NO				NO
PERF MON	10692	10-Apr-96	U-234	18.6	PCI/L		1.07	17.4	60.7	0.31	NO				NO
PERF MON	10692	10-Apr-96	U-238	9.76	PCI/L		0.768	12.7	41.8	0.23	NO				NO
PERF MON	10692	07-Feb-96	U-238	10.7	PCI/L		0.768	13.9	41.8	0.26	NO				NO
PERF MON	10692	26-Nov-96	U-238	8.4	PCI/L		0.768	11.0	41.8	0.20	NO				NO
PERF MON	10792	16-Apr-96	U-234	1.80	PCI/L		1.07	1.7	60.7	0.03	NO				NO
PERF MON	10792	16-Apr-96	U-238	1.42	PCI/L		0.768	1.8	41.8	0.03	NO				NO
PERF MON	10992	19-Nov-96	NITRATE/NITRITE	26.2	MG/L		10	2.6	4.66	5.62	YES	37.2	0.7	NO	NO
PERF MON	10992	16-Apr-96	NITRATE/NITRITE	27.6	MG/L		10	2.8	4.66	5.92	YES	37.2	0.7	NO	NO
PERF MON	10992	04-Sep-96	SELENIUM	629	UG/L	N	50	12.6	43.7	14.39	YES	ND			NO
PERF MON	10992	16-Apr-96	U-234	7.58	PCI/L		1.07	7.1	60.7	0.12	NO				NO
PERF MON	10992	16-Jan-96	U-234	6.50	PCI/L		1.07	6.1	60.7	0.11	NO				NO
PERF MON	10992	16-Jan-96	U-238	4.54	PCI/L		0.768	5.9	41.8	0.11	NO				NO
PERF MON	10992	16-Apr-96	U-238	6.94	PCI/L		0.768	9.0	41.8	0.17	NO				NO
PERF MON	12691	18-Mar-96	CARBON TET.	590	UG/L		5	118.0				2969	0.2	NO	NO
PERF MON	12691	18-Sep-96	CARBON TET.	540	UG/L		5	108.0				2969	0.2	NO	NO
PERF MON	12691	18-Mar-96	HEXACHLOROBUTADIENE	2	UG/L	J	1.09	1.8				10.8	0.2	NO	NO
PERF MON	12691	18-Mar-96	METHYLENE CHLORIDE	14	UG/L	JB	5	2.8				584	0.0	NO	NO
PERF MON	12691	18-Sep-96	METHYLENE CHLORIDE	14	UG/L	J	5	2.8				584	0.0	NO	NO
PERF MON	12691	18-Sep-96	TETRACHLOROETHENE	100	UG/L		5	20.0				647	0.2	NO	NO
PERF MON	12691	18-Mar-96	TETRACHLOROETHENE	130	UG/L		5	26.0				647	0.2	NO	NO
PERF MON	12691	18-Sep-96	TRICHLOROETHENE	61	UG/L		5	12.2				362	0.2	NO	NO
PERF MON	12691	18-Mar-96	TRICHLOROETHENE	76	UG/L		5	15.2				362	0.2	NO	NO
PERF MON	12691	18-Mar-96	U-234	2.41	PCI/L		1.07	2.3	60.7	0.04	NO				NO
PERF MON	12691	18-Mar-96	U-238	2.23	PCI/L		0.768	2.9	41.8	0.05	NO				NO
PERF MON	35691	20-Jun-96	SELENIUM	58.7	UG/L	N	50	1.2	43.7	1.34	YES	20.6	2.8	YES	NO
PERF MON	35691	20-Jun-96	SULFATE	510	UG/L		500	1.0	436	1.17	YES	578	0.9	NO	YES
PERF MON	35691	13-Nov-96	SULFATE	532	UG/L		500	1.1	436	1.22	YES	578	0.9	NO	YES
PERF MON	35691	13-Nov-96	THALLIUM	10.4	UG/L		2	5.2	4.90	2.12	YES	4.15	2.5	YES	NO
PERF MON	35691	13-Nov-96	U-234	18.03	PCI/L		1.07	16.9	60.7	0.30	NO				NO
PERF MON	35691	20-Jun-96	U-234	22.49	PCI/L		1.07	21.0	60.7	0.37	NO				NO
PERF MON	35691	13-Nov-96	U-238	15.17	PCI/L		0.768	19.8	41.8	0.36	NO				NO
PERF MON	35691	20-Jun-96	U-238	15.26	PCI/L		0.768	19.9	41.8	0.37	NO				NO
PLUME DEF	00491	13-Feb-96	AM-241	30.01	PCI/L		0.145	207.0	0.04	833.61	YES	0.01	2500.8	YES	YES
PLUME DEF	00491	12-Sep-96	CARBON TET.	180	UG/L		5	36.0				545	0.3	NO	NO
PLUME DEF	00491	13-Feb-96	CARBON TET.	170	UG/L		5	34.0				545	0.3	NO	NO
PLUME DEF	00491	13-Feb-96	TETRACHLOROETHENE	25	UG/L		5	5.0				54.2	0.5	NO	NO
PLUME DEF	00491	12-Sep-96	TETRACHLOROETHENE	32	UG/L		5	6.4				54.2	0.6	NO	NO
PLUME DEF	00491	12-Sep-96	THALLIUM	5.9	UG/L	B	2	3.0	4.90	1.20	YES	3.00	2.0	YES	NO
PLUME DEF	00491	12-Sep-96	TRICHLOROETHENE	73	UG/L		5	14.6				153	0.5	NO	NO
PLUME DEF	00491	13-Feb-96	TRICHLOROETHENE	64	UG/L		5	12.8				153	0.4	NO	NO
PLUME DEF	00491	13-Feb-96	U-234	5.30	PCI/L		1.07	4.9	60.7	0.09	NO				NO
PLUME DEF	00491	13-Feb-96	U-238	3.43	PCI/L		0.768	4.5	41.8	0.08	NO				NO
PLUME DEF	0487	12-Feb-96	CARBON TET.	12	UG/L		5	2.4				1545	0.0	NO	NO
PLUME DEF	0487	16-Sep-96	METHYLENE CHLORIDE	9	UG/L	J	5	1.8				284	0.0	NO	NO
PLUME DEF	0487	16-Sep-96	NICKEL	101	UG/L		100	1.0	21.4	4.73	YES	217	0.5	NO	NO
PLUME DEF	0487	16-Sep-96	SELENIUM	130	UG/L		50	2.6	43.7	2.97	YES	700	0.2	NO	NO
PLUME DEF	0487	12-Feb-96	SELENIUM	260	UG/L		50	5.2	43.7	5.95	YES	700	0.4	NO	NO
PLUME DEF	0487	12-Feb-96	TETRACHLOROETHENE	8	UG/L		5	1.6				351	0.0	NO	NO
PLUME DEF	0487	16-Sep-96	THALLIUM	10.3	UG/L		2	5.2	4.9	2.10	YES	5.46	1.9	YES	NO
PLUME DEF	0487	16-Sep-96	TRICHLOROETHENE	100	UG/L		5	20.0				5686	0.0	NO	NO
PLUME DEF	0487	12-Feb-96	TRICHLOROETHENE	140	UG/L		5	28.0				5686	0.0	NO	NO
PLUME DEF	0487	12-Feb-96	U-234	12.9	PCI/L		1.07	12.0	60.7	0.21	NO				NO
PLUME DEF	0487	12-Feb-96	U-238	8.74	PCI/L		0.768	11.4	41.8	0.21	NO				NO
PLUME DEF	05391	20-Feb-96	CARBON TET.	10	UG/L		5	2.0				32.9	0.3	NO	NO
PLUME DEF	05391	20-Feb-96	U-234	1.18	PCI/L		1.07	1.1	60.7	0.02	NO				NO
PLUME DEF[3]	22896	15-Jul-96	METHYLENE CHLORIDE	24	UG/L	J	5	4.8				ND			YES[1]
PLUME DEF[3]	22896	15-Jul-96	NITRATE/NITRITE	12.1	MG/L		10	1.2	4.66	2.59	YES	ND			YES[2]
PLUME DEF[3]	22896	15-Jul-96	TRICHLOROETHENE	2100	UG/L		5	420.0				ND			YES[1]
PLUME DEF	2987	01-Mar-96	NICKEL	1220	UG/L		100	12.2	21.4	57.09	YES	1742	0.7	NO	NO

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TABLE 2-2 1996 Groundwater Exceedances of Tier II Action Levels and Standards Framework Criteria (ALF) in RFCA-Designated Wells (cont'd)

Well Class	Location	Sample Date	Analyte	Result	Units	Q	Tier II AL	Tier II Ratio	Back-ground M2SD	BKGD ratio	Exceed BKGD?	Historic M2SD	Historic Ratio	Exceedance of BKGD and Historic M2SD	Reportable Exceedance
PLUME DEF	2987	11-Sep-96	NICKEL	1870	UG/L		100	18.7	21.4	87.51	YES	1742	1.1	YES	NO
PLUME DEF	2987	01-Mar-96	SELENIUM	442	UG/L		50	8.8	43.7	10.11	YES	408	1.1	YES	NO
PLUME DEF	2987	11-Sep-96	SELENIUM	389	UG/L		50	7.8	43.7	8.90	YES	408	1.0	NO	NO
PLUME DEF	2987	01-Mar-96	SULFATE	600	UG/L		500	1.2	436	1.38	YES	688	0.9	NO	NO
PLUME DEF	2987	11-Sep-96	SULFATE	708	UG/L		500	1.4	436	1.62	YES	688	1.0	YES	NO
PLUME DEF	2987	01-Mar-96	U-234	2.12	PCI/L		1.07	2.0	60.7	0.03	NO				NO
PLUME DEF	3087	07-Nov-96	THALLIUM	9.8	UG/L	B	2	4.9	4.90	2.00	YES	3.40	2.9	YES	NO
PLUME DEF	6286	16-Apr-96	CARBON TET.	7	UG/L		5	1.4				9.76	0.7	NO	NO
PLUME DEF	6286	31-Oct-96	CARBON TET.	8	UG/L		5	1.6				9.76	0.8	NO	NO
PLUME DEF	6286	16-Apr-96	SELENIUM	89	UG/L	N	50	1.8	43.7	2.04	YES	66.0	1.3	YES	NO
PLUME DEF	6286	31-Oct-96	SELENIUM	64.6	UG/L		50	1.3	43.7	1.48	YES	66.0	1.0	NO	NO
PLUME DEF	6286	31-Oct-96	U-234	4.94	PCI/L		1.07	4.6	60.7	0.08	NO				NO
PLUME DEF	6286	16-Apr-96	U-234	3.44	PCI/L		1.07	3.2	60.7	0.06	NO				NO
PLUME DEF	6286	31-Oct-96	U-238	3.75	PCI/L		0.768	4.9	41.8	0.09	NO				NO
PLUME DEF	6286	16-Apr-96	U-238	4.10	PCI/L		0.768	5.3	41.8	0.10	NO				NO
PLUME DEF	6687	16-Jan-96	1,1-DICHLOROETHENE	8	UG/L		7	1.1				9.93	0.8	NO	NO
PLUME DEF	6687	13-Nov-96	1,1-DICHLOROETHENE	7	UG/L		7	1				9.93	0.7	NO	NO
PLUME DEF	6687	13-Nov-96	THALLIUM	7.2	UG/L	B	2	3.6	4.90	1.47	YES	4.41	1.6	YES	NO
PLUME DEF	6687	16-Jan-96	TRICHLOROETHENE	8	UG/L		5	1.6				18.7	0.4	NO	NO
PLUME DEF	6687	16-Apr-96	TRICHLOROETHENE	5	UG/L		5	1				18.7	0.3	NO	NO
PLUME DEF	6687	14-Aug-96	TRICHLOROETHENE	5	UG/L		5	1				18.7	0.3	NO	NO
PLUME DEF	6687	13-Nov-96	TRICHLOROETHENE	6	UG/L		5	1.2				18.7	0.3	NO	NO
PLUME DEF	P209389	11-Mar-96	1,1-DICHLOROETHENE	27	UG/L		7	3.9				88.5	0.3	NO	NO
PLUME DEF	P209389	24-Jul-96	1,1-DICHLOROETHENE	28	UG/L		7	4.0				88.5	0.3	NO	NO
PLUME DEF	P209389	24-Jul-96	CARBON TET.	5	UG/L		5	1				58.7	0.1	NO	NO
PLUME DEF	P219189	14-May-96	1,1-DICHLOROETHENE	21	UG/L		7	3.0				46.8	0.4	NO	NO
PLUME DEF	P219189	23-Jul-96	1,1-DICHLOROETHENE	23	UG/L		7	3.3				46.8	0.5	NO	NO
PLUME DEF	P219189	11-Mar-96	1,1-DICHLOROETHENE	11	UG/L		7	1.6				46.8	0.2	NO	NO
PLUME DEF	P219189	14-May-96	TRITIUM	777	PCI/L		666	1.2	613	1.27	YES	1229	0.6	NO	NO
PLUME DEF	P416789	13-Aug-96	U-234	3.52	PCI/L		1.07	3.3	60.7	0.06	NO				NO
PLUME DEF	P416789	13-Aug-96	U-238	1.90	PCI/L		0.768	2.5	41.8	0.05	NO				NO
PLUME DEF	P416889	13-Aug-96	TETRACHLOROETHENE	43	UG/L		5	8.6				77.7	0.6	NO	NO
PLUME DEF	P416889	06-Jun-96	TETRACHLOROETHENE	48	UG/L		5	9.6				77.7	0.6	NO	NO
PLUME DEF	P416889	13-Aug-96	THALLIUM	9.8	UG/L	B	2	4.9	4.90	2.00	YES	13.0	0.8	NO	NO
PLUME DEF	P416889	13-Aug-96	U-234	1.60	PCI/L		1.07	1.5	60.7	0.03	NO				NO
PLUME DEF	P416889	29-Jan-96	U-234	1.89	PCI/L		1.07	1.8	60.7	0.03	NO				NO
PLUME EXT	03991	21-Feb-96	CARBON TET.	18	UG/L		5	3.6				27.2	0.7	NO	NO
PLUME EXT	03991	12-Sep-96	CARBON TET.	14	UG/L		5	2.8				27.2	0.5	NO	NO
PLUME EXT	03991	21-Feb-96	U-234	13.2	PCI/L		1.07	12.3	60.7	0.22	NO				NO
PLUME EXT	03991	21-Feb-96	U-238	9.61	PCI/L		0.768	12.5	41.8	0.23	NO				NO
PLUME EXT	04091	13-Feb-96	U-234	2.33	PCI/L		1.07	2.2	60.7	0.04	NO				NO
PLUME EXT	04091	13-Feb-96	U-238	1.74	PCI/L		0.768	2.3	41.8	0.04	NO				NO
PLUME EXT	04591	11-Mar-96	U-234	2.73	PCI/L		1.07	2.6	60.7	0.04	NO				NO
PLUME EXT	04591	11-Mar-96	U-238	1.27	PCI/L		0.768	1.7	41.8	0.03	NO				NO
PLUME EXT	04991	12-Feb-96	U-234	6.82	PCI/L		1.07	6.4	60.7	0.11	NO				NO
PLUME EXT	04991	12-Feb-96	U-238	4.79	PCI/L		0.768	6.2	41.8	0.11	NO				NO
PLUME EXT	05091	17-Sep-96	THALLIUM	5.9	UG/L	B	2	3.0	4.90	1.20	YES	5.39	1.1	YES	YES
PLUME EXT	05091	19-Feb-96	U-234	3.99	PCI/L		1.07	3.7	60.7	0.07	NO				NO
PLUME EXT	05091	19-Feb-96	U-238	2.15	PCI/L		0.768	2.8	41.8	0.05	NO				NO
PLUME EXT	06091	14-Mar-96	CARBON TET.	5	UG/L		5	1				4.44	1.1	YES	YES
PLUME EXT	06091	16-Sep-96	CARBON TET.	5	UG/L		5	1				4.44	1.1	YES	YES[1]
PLUME EXT	06091	14-Nov-96	CARBON TET.	6	UG/L		5	1.2				4.44	1.4	YES	YES[2]
PLUME EXT	06091	14-Mar-96	U-234	3.48	PCI/L		1.07	3.2	60.7	0.06	NO				NO
PLUME EXT	06091	14-Nov-96	U-234	3.40	PCI/L		1.07	3.2	60.7	0.06	NO				NO
PLUME EXT	06091	18-Jun-96	U-234	3.61	PCI/L		1.07	3.4	60.7	0.06	NO				NO
PLUME EXT	06091	18-Jun-96	U-238	1.82	PCI/L		0.768	2.4	41.8	0.04	NO				NO
PLUME EXT	06091	14-Mar-96	U-238	1.49	PCI/L		0.768	1.9	41.8	0.04	NO				NO
PLUME EXT	06091	14-Nov-96	U-238	1.83	PCI/L		0.768	2.4	41.8	0.04	NO				NO
PLUME EXT	10194	26-Feb-96	U-234	2.07	PCI/L		1.07	1.9	60.7	0.03	NO				NO
PLUME EXT	10194	23-Jul-96	U-234	2.18	PCI/L		1.07	2.0	60.7	0.04	NO				NO
PLUME EXT	10194	25-Nov-96	U-234	2.81	PCI/L		1.07	2.6	60.7	0.05	NO				NO
PLUME EXT	10194	06-Jun-96	U-234	2.81	PCI/L		1.07	2.6	60.7	0.05	NO				NO
PLUME EXT	10194	06-Jun-96	U-238	1.314	PCI/L		0.768	1.7	41.8	0.03	NO				NO
PLUME EXT	10194	23-Jul-96	U-238	1.33	PCI/L		0.768	1.7	41.8	0.03	NO				NO
PLUME EXT	10194	25-Nov-96	U-238	1.05	PCI/L		0.768	1.4	41.8	0.03	NO				NO
PLUME EXT	10194	26-Feb-96	U-238	1.96	PCI/L		0.768	2.5	41.8	0.05	NO				NO
PLUME EXT	10994	19-Nov-96	NITRATE/NITRITE	15.9	MG/L		10	1.6	4.66	3.41	YES	23.7	0.7	NO	YES
PLUME EXT	10994	12-Mar-96	NITRATE/NITRITE	14	MG/L		10	1.4	4.66	3.00	YES	23.7	0.6	NO	YES
PLUME EXT	10994	06-Jun-96	SELENIUM	509	UG/L		50	10.2	43.7	11.64	YES	1097	0.5	NO	YES
PLUME EXT	10994	04-Sep-96	SELENIUM	624	UG/L	N	50	12.5	43.7	14.27	YES	1097	0.6	NO	YES
PLUME EXT	10994	12-Mar-96	SELENIUM	706	UG/L		50	14.1	43.7	16.15	YES	1097	0.6	NO	YES
PLUME EXT	10994	19-Nov-96	SELENIUM	717	UG/L	E	50	14.3	43.7	16.40	YES	1097	0.7	NO	YES

TABLE 2-2 1996 Groundwater Exceedances of Tier II Action Levels and Standards Framework Criteria (ALF) in RFCA-Designated Wells (cont'd)

Well Class	Location	Sample Date	Analyte	Result	Units	Q	Tier II AL	Tier II Ratio	Back-ground M2SD	BKGD ratio	Exceed BKGD?	Historic M2SD	Historic Ratio	Exceedance of BKGD and Historic M2SD	Reportable Exceedance
PLUME EXT	10994	19-Nov-96	THALLIUM	7.5	UG/L	B	2	3.8	4.90	1.53	YES	4.87	1.5	YES	YES
PLUME EXT	10994	06-Jun-96	U-234	8.62	PCI/L		1.07	8.1	60.7	0.14	NO				NO
PLUME EXT	10994	12-Mar-96	U-234	8.25	PCI/L		1.07	7.7	60.7	0.14	NO				NO
PLUME EXT	10994	19-Nov-96	U-234	6.41	PCI/L		1.07	6.0	60.7	0.11	NO				NO
PLUME EXT	10994	12-Mar-96	U-238	4.64	PCI/L		0.768	6.0	41.8	0.11	NO				NO
PLUME EXT	10994	19-Nov-96	U-238	4.57	PCI/L		0.768	6.0	41.8	0.11	NO				NO
PLUME EXT	10994	06-Jun-96	U-238	5.37	PCI/L		0.768	7.0	41.8	0.13	NO				NO
PLUME EXT	1386	19-Nov-96	NICKEL	321	UG/L		100	3.2	21.4	15.02	YES	309	1.0	YES	YES
PLUME EXT	1386	06-Jun-96	NICKEL	156	UG/L		100	1.6	21.4	7.30	YES	309	0.5	NO	YES
PLUME EXT	1386	06-Mar-96	NICKEL	249	UG/L		100	2.5	21.4	11.65	YES	309	0.8	NO	YES
PLUME EXT	1386	19-Nov-96	THALLIUM	4.7	UG/L	B	2	2.4	4.90	0.96	NO				NO
PLUME EXT	1386	06-Jun-96	U-234	9.25	PCI/L		1.07	8.6	60.7	0.15	NO				NO
PLUME EXT	1386	19-Nov-96	U-234	7.59	PCI/L		1.07	7.1	60.7	0.13	NO				NO
PLUME EXT	1386	23-Jul-96	U-234	7.59	PCI/L		1.07	7.1	60.7	0.12	NO				NO
PLUME EXT	1386	06-Mar-96	U-234	7.70	PCI/L		1.07	7.2	60.7	0.13	NO				NO
PLUME EXT	1386	06-Jun-96	U-238	7.52	PCI/L		0.768	9.8	41.8	0.18	NO				NO
PLUME EXT	1386	23-Jul-96	U-238	6.72	PCI/L		0.768	8.8	41.8	0.16	NO				NO
PLUME EXT	1386	06-Mar-96	U-238	6.42	PCI/L		0.768	8.4	41.8	0.15	NO				NO
PLUME EXT	1386	19-Nov-96	U-238	6.29	PCI/L		0.768	8.2	41.8	0.15	NO				NO
PLUME EXT	1786	18-Jul-96	NITRATE/NITRITE	611	MG/L		10	61.1	4.66	131.00	YES	689	0.9	NO	YES
PLUME EXT	1786	07-Mar-96	NITRATE/NITRITE	603	MG/L		10	60.3	4.66	129.29	YES	689	0.9	NO	YES
PLUME EXT	1786	10-Jun-96	NITRATE/NITRITE	588	MG/L		10	58.8	4.66	126.07	YES	689	0.9	NO	YES
PLUME EXT	1786	31-Oct-96	NITRATE/NITRITE	651	MG/L		10	65.1	4.66	139.58	YES	689	0.9	NO	YES
PLUME EXT	1786	18-Jul-96	SELENIUM	251	UG/L		50	5.0	43.7	5.74	YES	246	1.0	YES	YES
PLUME EXT	1786	31-Oct-96	SELENIUM	299	UG/L		50	6.0	43.7	6.84	YES	246	1.2	YES	YES
PLUME EXT	1786	10-Jun-96	SELENIUM	316	UG/L		50	6.3	43.7	7.23	YES	246	1.3	YES	YES
PLUME EXT	1786	07-Mar-96	SELENIUM	282	UG/L		50	5.6	43.7	6.45	YES	246	1.1	YES	YES
PLUME EXT	1786	18-Jul-96	THALLIUM	6.6	UG/L	B	2	3.3	4.90	1.35	YES	6.49	1.0	YES	YES
PLUME EXT	1786	31-Oct-96	TRITIUM	730	PCI/L		666	1.1	613	1.19	YES	1077	0.7	NO	YES
PLUME EXT	1786	18-Jul-96	U-234	32.9	PCI/L		1.07	30.7	60.7	0.54	NO				NO
PLUME EXT	1786	10-Jun-96	U-234	33.8	PCI/L		1.07	31.6	60.7	0.56	NO				NO
PLUME EXT	1786	31-Oct-96	U-234	37.8	PCI/L		1.07	35.3	60.7	0.62	NO				NO
PLUME EXT	1786	07-Mar-96	U-234	39.2	PCI/L		1.07	36.6	60.7	0.65	NO				NO
PLUME EXT	1786	31-Oct-96	U-235	1.37	PCI/L		1.01	1.4	1.79	0.77	NO				NO
PLUME EXT	1786	07-Mar-96	U-235	1.27	PCI/L		1.01	1.3	1.79	0.71	NO				NO
PLUME EXT	1786	10-Jun-96	U-238	23.81	PCI/L		0.768	31.0	41.8	0.57	NO				NO
PLUME EXT	1786	31-Oct-96	U-238	27.31	PCI/L		0.768	35.6	41.8	0.65	NO				NO
PLUME EXT	1786	07-Mar-96	U-238	27.93	PCI/L		0.768	36.4	41.8	0.67	NO				NO
PLUME EXT	1786	18-Jul-96	U-238	26.22	PCI/L		0.768	34.1	41.8	0.63	NO				NO
PLUME EXT	1986	08-Aug-96	MANGANESE	2730	UG/L		183	14.9	162	16.82	YES	3305	0.8	NO	YES
PLUME EXT	1986	04-Mar-96	U-234	3.51	PCI/L		1.07	3.3	60.7	0.06	NO				NO
PLUME EXT	1986	11-Jun-96	U-234	3.65	PCI/L		1.07	3.4	60.7	0.06	NO				NO
PLUME EXT	1986	08-Aug-96	U-234	3.54	PCI/L		1.07	3.3	60.7	0.06	NO				NO
PLUME EXT	1986	08-Aug-96	U-238	2.05	PCI/L		0.768	2.7	41.8	0.05	NO				NO
PLUME EXT	1986	04-Mar-96	U-238	2.10	PCI/L		0.768	2.7	41.8	0.05	NO				NO
PLUME EXT	1986	11-Jun-96	U-238	2.81	PCI/L		0.768	3.7	41.8	0.07	NO				NO
PLUME EXT	22596	15-Jul-96	MANGANESE	505	UG/L		183	2.8	162	3.11	YES	ND			YES[1]
PLUME EXT	22796	15-Jul-96	TRICHLOROETHENE	39	UG/L		5	7.8				ND			YES[1]
PLUME EXT	22796	15-Jul-96	U-234	3.28	PCI/L		1.07	3.1	60.7	0.05	NO				NO
PLUME EXT	22796	15-Jul-96	U-238	1.69	PCI/L		0.768	2.2	41.8	0.04	NO				NO
PLUME EXT	23096	18-Nov-96	THALLIUM	5.7	UG/L	B	2	2.9	4.90	1.16	YES	ND			YES
PLUME EXT	23096	18-Nov-96	U-234	1.34	PCI/L		1.07	1.3	60.7	0.02	NO				NO
PLUME EXT	23096	18-Nov-96	U-238	1.22	PCI/L		0.768	1.6	41.8	0.03	NO				NO
PLUME EXT	23296	28-Aug-96	CARBON TET.	6	UG/L	J	5	1.2				ND			YES[1]
PLUME EXT	23296	28-Aug-96	TETRACHLOROETHENE	18	UG/L		5	3.6				ND			YES[1]
PLUME EXT	23296	28-Aug-96	TRICHLOROETHENE	430	UG/L		5	86.0				ND			YES[1]
PLUME EXT	43392	12-Nov-96	THALLIUM	8	UG/L	B	2	4.0	4.90	1.63	YES	3.87	2.1	YES	YES
PLUME EXT	43392	28-Aug-96	THALLIUM	5.8	UG/L	B	2	2.9	4.90	1.18	YES	3.87	1.5	YES	YES
PLUME EXT	43392	12-Nov-96	U-234	1.17	PCI/L		1.07	1.1	60.7	0.02	NO				NO
PLUME EXT	4887	22-Apr-96	NICKEL	806	UG/L		100	8.1	21.4	37.72	YES	903	0.9	NO	YES
PLUME EXT	4887	22-Apr-96	SELENIUM	237	UG/L	N	50	4.7	43.7	5.42	YES	ID			YES
PLUME EXT	4887	22-Apr-96	U-234	6.49	PCI/L		1.07	6.1	60.7	0.11	NO				NO
PLUME EXT	4887	22-Apr-96	U-238	5.91	PCI/L		0.768	7.7	41.8	0.14	NO				NO
PLUME EXT	5387	16-Apr-96	U-234	13.4	PCI/L		1.07	12.6	60.7	0.22	NO				NO
PLUME EXT	5387	16-Apr-96	U-238	7.44	PCI/L		0.768	9.7	41.8	0.18	NO				NO
PLUME EXT	6186	22-May-96	U-234	2.28	PCI/L		1.07	2.1	60.7	0.04	NO				NO
PLUME EXT	6186	12-Nov-96	U-234	2.14	PCI/L		1.07	2.0	60.7	0.04	NO				NO
PLUME EXT	6186	10-Jan-96	U-234	1.98	PCI/L		1.07	1.8	60.7	0.03	NO				NO
PLUME EXT	6186	22-May-96	U-238	1.80	PCI/L		0.768	2.3	41.8	0.04	NO				NO
PLUME EXT	6186	12-Nov-96	U-238	2.03	PCI/L		0.768	2.6	41.8	0.05	NO				NO
PLUME EXT	6186	10-Jan-96	U-238	1.48	PCI/L		0.768	1.9	41.8	0.04	NO				NO
PLUME EXT	7086	18-Jul-96	MANGANESE	499	UG/L		183	2.7	162	3.07	YES	761	0.7	NO	YES

TABLE 2-2 1996 Groundwater Exceedances of Tier II Action Levels and Standards Framework Criteria (ALF) in RFCA-Designated Wells (cont'd)

Well Class	Location	Sample Date	Analyte	Result	Units	Q	Tier II AL	Tier II Ratio	Background M2SD	BKGD ratio	Exceed BKGD?	Historic M2SD	Historic Ratio	Exceedance of BKGD and Historic M2SD	Reportable Exceedance
PLUME EXT	7086	25-Nov-96	MANGANESE	332	UG/L		183	1.8	162	2.05	YES	781	0.4	NO	YES
PLUME EXT	7086	25-Nov-96	THALLIUM	6.4	UG/L	B	2	3.2	4.90	1.31	YES	3.77	1.7	YES	YES
PLUME EXT	7086	25-Nov-96	U-238	0.842	PCI/L		0.768	1.1	41.8	0.02	NO				NO
PLUME EXT	7086	18-Jul-96	U-238	0.904	PCI/L		0.768	1.2	41.8	0.02	NO				NO
PLUME EXT	75992	11-Nov-96	MANGANESE	282	UG/L		183	1.4	162	1.61	YES	ID			YES
PLUME EXT	75992	11-Nov-96	THALLIUM	7	UG/L	B	2	3.5	4.90	1.43	YES	ND			YES
PLUME EXT	75992	21-May-96	U-234	20.6	PCI/L		1.07	19.3	60.7	0.34	NO				NO
PLUME EXT	75992	11-Nov-96	U-234	8.48	PCI/L		1.07	7.9	60.7	0.14	NO				NO
PLUME EXT	75992	21-May-96	U-235	1.24	PCI/L		1.01	1.2	1.79	0.69	NO				NO
PLUME EXT	75992	11-Nov-96	U-238	6.87	PCI/L		0.768	8.9	41.8	0.16	NO				NO
PLUME EXT	75992	21-May-96	U-238	18.9	PCI/L		0.768	24.6	41.8	0.45	NO				NO
PLUME EXT	B208289	23-Apr-96	NITRATE/NITRITE	46.7	MG/L		10	4.7	4.66	10.01	YES	70.3	0.7	NO	YES
PLUME EXT	B208789	22-Oct-96	MANGANESE	348	UG/L		183	1.9	162	2.14	YES	ID			YES
PLUME EXT	B208789	22-Oct-96	THALLIUM	7.2	UG/L	B	2	3.6	4.90	1.47	YES	ID			YES
PLUME EXT	B208789	22-Oct-96	U-234	7.13	PCI/L		1.07	6.7	60.7	0.12	NO				NO
PLUME EXT	B208789	08-May-96	U-234	4.65	PCI/L		1.07	4.3	60.7	0.08	NO				NO
PLUME EXT	B208789	22-Oct-96	U-238	5.94	PCI/L		0.768	7.7	41.6	0.14	NO				NO
PLUME EXT	B208789	08-May-96	U-238	4.30	PCI/L		0.768	5.6	41.8	0.10	NO				NO
PLUME EXT	P114389	17-Jul-96	MANGANESE	416	UG/L		183	2.3	162	2.56	YES	682	0.6	NO	YES
PLUME EXT	P114389	17-Jul-96	U-234	3.33	PCI/L		1.07	3.1	60.7	0.05	NO				NO
PLUME EXT	P114389	29-Feb-96	U-234	3.54	PCI/L		1.07	3.3	60.7	0.06	NO				NO
PLUME EXT	P114389	29-Feb-96	U-238	2.08	PCI/L		0.768	2.7	41.8	0.05	NO				NO
PLUME EXT	P114389	17-Jul-96	U-238	2.46	PCI/L		0.768	3.2	41.8	0.06	NO				NO
PLUME EXT	P218389	20-Aug-96	NITRATE/NITRITE	17.7	MG/L		10	1.8	4.66	3.80	YES	33.0	0.5	NO	YES
PLUME EXT	P218389	14-May-96	NITRATE/NITRITE	14.9	MG/L		10	1.5	4.66	3.19	YES	33.0	0.5	NO	YES
PLUME EXT	P218389	19-Feb-96	NITRATE/NITRITE	25.6	MG/L		10	2.6	4.66	5.49	YES	33.0	0.8	NO	YES
PLUME EXT	P218389	20-Aug-96	U-234	6.01	PCI/L		1.07	5.6	60.7	0.10	NO				NO
PLUME EXT	P218389	20-Aug-96	U-238	5.59	PCI/L		0.768	7.3	41.8	0.13	NO				NO
PLUME EXT	P219489	08-May-96	NITRATE/NITRITE	36.3	MG/L		10	3.6	4.66	7.78	YES	51.6	0.7	NO	YES
PLUME EXT	P219489	19-Feb-96	NITRATE/NITRITE	37.9	MG/L		10	3.8	4.66	8.13	YES	51.6	0.7	NO	YES
PLUME EXT	P219489	30-Jul-96	NITRATE/NITRITE	38.7	MG/L		10	3.9	4.66	8.30	YES	51.6	0.8	NO	YES
PLUME EXT	P313589	29-Jan-96	NICKEL	156	UG/L		100	1.6	21.4	7.30	YES	254	0.6	NO	YES
PLUME EXT	P313589	18-Apr-96	NICKEL	104	UG/L		100	1.0	21.4	4.87	YES	254	0.4	NO	YES
PLUME EXT	P313589	17-Jul-96	NICKEL	138	UG/L		100	1.4	21.4	6.46	YES	254	0.5	NO	YES
PLUME EXT	P313589	29-Jan-96	U-234	2.67	PCI/L		1.07	2.5	60.7	0.04	NO				NO
PLUME EXT	P313589	17-Jul-96	U-234	2.46	PCI/L		1.07	2.3	60.7	0.04	NO				NO
PLUME EXT	P313589	18-Apr-96	U-234	2.56	PCI/L		1.07	2.4	60.7	0.04	NO				NO
PLUME EXT	P313589	29-Jan-96	U-238	2.37	PCI/L		0.768	3.1	41.8	0.06	NO				NO
PLUME EXT	P313589	17-Jul-96	U-238	1.68	PCI/L		0.768	2.2	41.8	0.04	NO				NO
PLUME EXT	P313589	18-Apr-96	U-238	1.18	PCI/L		0.768	1.5	41.8	0.03	NO				NO
PLUME EXT	P416689	19-Feb-96	U-234	5.27	PCI/L		1.07	4.9	60.7	0.09	NO				NO
PLUME EXT	P416689	17-Jul-96	U-234	3.67	PCI/L		1.07	3.4	60.7	0.06	NO				NO
PLUME EXT	P416689	19-Feb-96	U-238	1.19	PCI/L		0.768	1.5	41.8	0.03	NO				NO
PLUME EXT	P416689	17-Jul-96	U-238	1.85	PCI/L		0.768	2.4	41.8	0.04	NO				NO
RCRA	4087	26-Apr-96	U-234	17.3	PCI/L		1.07	16.2	60.7	0.29	NO				NO
RCRA	4087	26-Apr-96	U-238	12.6	PCI/L		0.768	16.5	41.8	0.30	NO				NO
RCRA	52894	23-Apr-96	U-234	11.4	PCI/L		1.07	10.6	60.7	0.19	NO				NO
RCRA	52894	23-Apr-96	U-238	8.36	PCI/L		0.768	10.9	41.8	0.20	NO				NO
RCRA	5887	15-Aug-96	THALLIUM	9	UG/L	B	2	4.5	4.90	1.84	YES	5.22	1.7	YES	NO
RCRA	70393	14-Mar-96	TETRACHLOROETHENE	5	UG/L		5	1				8.9	0.6	NO	NO
RCRA	70393	18-Sep-96	TETRACHLOROETHENE	5	UG/L		5	1				8.9	0.6	NO	NO
RCRA	70193	25-Nov-96	THALLIUM	4.7	UG/L	B	2	2.4	4.90	0.96	NO				NO
RCRA	70393	18-Sep-96	1,1-DICHLOROETHENE	12	UG/L		7	1.7				20.7	0.6	NO	NO
RCRA	70393	14-Mar-96	1,1-DICHLOROETHENE	12	UG/L		7	1.7				20.7	0.6	NO	NO
RCRA	70393	18-Sep-96	TRICHLOROETHENE	18	UG/L		5	3.6				36.3	0.5	NO	NO
RCRA	70393	14-Mar-96	TRICHLOROETHENE	20	UG/L		5	4.0				36.3	0.6	NO	NO
RCRA	70493	07-Nov-96	THALLIUM	5.7	UG/L	B	2	2.9	4.90	1.16	YES	6.01	0.9	NO	NO
RCRA	70493	07-Nov-96	U-234	1.12	PCI/L		1.07	1.0	60.7	0.02	NO				NO
RCRA	B206989	16-Jul-96	NITRATE/NITRITE	36.7	MG/L		10	3.7	4.66	7.87	YES	75.4	0.5	NO	NO
RCRA	B206989	22-Jan-96	NITRATE/NITRITE	46.2	MG/L		10	4.6	4.66	9.91	YES	75.4	0.6	NO	NO

1 Reported in 1996 Third Quarter RFCA Groundwater Monitoring Report (RMRS, 1997a).
2 Reported in 1996 Fourth Quarter RFCA Groundwater Monitoring Report (RMRS, 1997b).
3 This well has been reclassified from a plume extent well to a plume definition well.

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Table 2-3. RFCA-Designated Wells with No Analytes Above Tier II Action Levels

WELL CLASS	RFCA WELLS
DRAINAGE	5587
PERF MONITORING	11092
PLUME DEFINITION	6386
PLUME EXTENT	2186
PLUME EXTENT	76992
PLUME EXTENT	P314289
DRAINAGE*	38591
PERF MONITORING*	05691
PERF MONITORING*	11891
PERF MONITORING*	12191
PERF MONITORING*	3687
PLUME DEFINITION*	77392
PLUME DEFINITION*	P209289
PLUME DEFINITION*	P209489
PLUME EXTENT*	08091
PLUME EXTENT*	22696
PLUME EXTENT*	23196
PLUME EXTENT*	3386
PLUME EXTENT*	3586
PLUME EXTENT*	4787
RCRA*	52994

* Well was dry throughout 1996.

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2.3.2 TIER II EXCEEDANCES

Boundary Wells

Six RFCA designated boundary wells were sampled in 1996. No volatile organic compounds (VOCs) were found above the Tier II action levels. There were reported results of Uranium-233/234 and -238 (U-234 and U-238) above the Tier II action levels in all six wells. All uranium isotope analyses were well below the background benchmarks of 60.7 pCi/L for U-234 and 41.8 pCi/L for U-238. These are not reportable exceedances.

Manganese was above the Tier II action level and the background M2SD in wells 10294 and 41691. The reported levels were not above the historic M2SDs for the wells and no increasing concentrations were noted (Table 2-2 and Figures 2-17 and 2-19, respectively). No action is required.

Selenium concentrations were reported above the action level and the background M2SD in well 0386 on three sampling dates. These are reportable exceedances. The reported value was slightly above the historic M2SD for the well at the June 12 sampling (Table 2-2). The concentrations in this well do not appear to be increasing (Figure 2-39). It is recommended that semi-annual sampling of this well continue, pending reevaluation of the background benchmarks for metals.

Sulfate was detected in well 10294 above the Tier II action level and the background benchmark for two sampling events. This is a reportable exceedance. The reported level was not above the historic M2SDs for the well and an increasing concentration was not noted (Table 2-2 and Figure 2-48). It is recommended that semi-annual sampling of this well continue, pending reevaluation of the background benchmarks for metals.

Thallium reported above the Tier II action level and the background M2SD in wells 0386, 06491, and 4159 (Table 2-2). These are reportable exceedances. Concentrations were above the historic M2SD for each of the wells. Concentrations appear to be increasing in wells 0386 and 06491 (Figures 2-60 and 2-63). It is recommended that semi-annual sampling of this well continue, pending reevaluation of the background benchmarks for metals.

D&D Wells

One D&D well was sampled in 1996. Well 22996 was sampled in August and November (Table 2-2). The purpose of this well is to establish a historical baseline for the area to determine the effects of future D&D activities on groundwater. Manganese and thallium were above both Tier II action levels and the

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background benchmark. Uranium-234 and -238 were above the Tier II action levels, but below the background M2SD. No action is required.

Drainage Wells

Three drainage wells were sampled in 1996. Sulfate was reported above the Tier II action level and the background M2SD for one sample from well 3786, but below the historic M2SD for the well (Table 2-2). There is no indication of an increasing trend (Figure 2-51) for sulfate at this well. This is a reportable exceedance, however, it is recommended that semi-annual sampling of this well continue, pending reevaluation of the background benchmarks for metals.

Nickel was reported above the Tier II action level, the background M2SD and the historic M2SD for one sample each from wells 6486 and 6586 (Table 2-2). The Nickel concentration in well 6486 shows a slight upward trend over the last four samplings, with the April 1996 result being the first over the action level since 1987 (Figure 2-28). There is no indication of an increasing trend (Figure 2-29) in well 6586. The reported result for November 1996 appears to be an anomalously high reading. These are reportable exceedances.

Thallium was also reported above the Tier II action level, the background M2SD and the historic M2SD for one sample from well 6586 (Table 2-2). There is an indication of an increasing trend in thallium concentrations at this well over the last three samplings (Figure 2-73). This is a reportable exceedance.

There were reported results of Uranium-233/234 and -238 (U-234 and U-238) above the Tier II action levels in all three Drainage wells (Table 2-2). All uranium isotope analyses were well below the background benchmarks of 60.7 pCi/L for U-234 and 41.8 pCi/L for U-238. These are not reportable exceedances.

Performance Monitoring Wells

Six PM wells had analytes with concentrations exceeding Tier II concentration criteria (Table 2-2). PM wells monitor the effect of a remedial action or source removal on downgradient groundwater. Figures 2-1 through 2-96 are trend plots for all organics above Tier II action levels and inorganics above Tier II action levels II **and** the background benchmarks that were reported in samples from PM wells. Trends are summarized in Table 2-4. Only sulfate in well 35691 appears to show a clear upward trend, although the current concentration is below that reported in 1991 (Figure 2-50). Selenium and thallium both have what appear to be single anomalously high results in the current reporting period. Concentrations of these constituents will be further evaluated as more data become available.

TABLE 2-4. Performance Monitoring Well Summary of Organics Reported Above the RFCA Action Levels and Inorganics Above the RFCA Action Level and the Background M2SD.

WELL	ANALYTE	TREND	FIGURE
07391	1,1-Trichloroethane	No	2-1
07391	Chloroform	No	2-15
07391	Nitrate	No	2-31
07391	Tetrachloroethene	No	2-54
10592	Selenium	No	2-41
10692	Thallium	No	2-65
10992	Nitrate	No	2-32
10992	Selenium	ND[1]	NA[2]
12691	Carbon Tetrachloride	No	2-12
12691	Hexachlorobutadiene	No	2-16
12691	Methylene Chloride	No	2-23
12691	tetrachloroethene	No	2-55
12691	Trichloroethene	No	2-82
35691	Selenium	No	2-45
35691	Sulfate	Up	2-50
35691	Thallium	No	2-69

[1] ND indicates that data was not available to perform a trend analysis.
[2] NA Not applicable

Access Query for wells & Analyte w/ TII's

MANUAL
Look @ Trend plots & Add Fig #

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Plume Definition Wells

Twelve PD wells were sampled during 1996. PD wells are located in areas of known groundwater contamination and generally have one or more analytes above the Tier II action levels. Well 22896 has been reclassified from a plume extent well to a PD well based on sampling results during 1996 and confirmatory sampling in the first quarter of 1997 (RMRS, 1997d).

There were four reportable exceedances for PD wells during 1996 (Table 2-2).

Three of the reportable exceedances were in well 22896. In the first sampling of this well, methylene chloride and nitrate were found at concentrations above Tier II action levels and trichloroethene was above the Tier I action level (Table 2-2). These are considered reportable exceedances and were previously reported in a quarterly RFCA monitoring report (RMRS, 1997b). This well is located in the Industrial Area, and was installed in a location with groundwater VOC concentrations estimated to be below Tier II action levels for the purpose of monitoring the movement of groundwater VOC contamination above the Tier II action levels. The initial sampling of this well and later confirmatory sampling (RMRS, 1997d) has shown that the area of Tier I contamination has moved further to the north than originally estimated. The VOC plume map has been modified to reflect this new information (Plate 12).

Well 00491 was sampled in February of 1996. Americium-241 was reported at 30.01 pCi/L in the sample (Table 2-2). This is well above the Tier I action level. This well is located in the 903 Pad Lip area. Historically, this well has not had a reported activity-concentration above 0.01 pCi/L (Figure 2-6). Sampling in February, 1997 returned a reported result of 0.001 pCi/L, well within the historical range. It appears that the 30.01 pCi/L result is spurious. No action will be taken.

There were no other reportable exceedances for PD wells. Table 2-5 summarizes concentration trends in PD wells for organics above the Tier II action levels and for inorganics above both the Tier II action levels and the background M2SDs. Concentrations of carbon tetrachloride (Figure 2-7), tetrachloroethene (Figure 2-52), and trichloroethene in well 00491 (Figure 2-79), selenium in well 0487 (Figure 2-40), carbon tetrachloride in well 05391 (Figure 2-10), trichloroethene in well 66871 (Figure 2-84), and 1,1-dichloroethene in well P209389 (Figure 2-4) are decreasing. Concentrations of selenium, carbon tetrachloride, and 1,1-dichloroethene are increasing slightly in wells 2987, 6286, and 6687, respectively (Figures 2-44, 2-13, 2-2, respectively). Several wells had large jumps in reported concentrations of thallium. These may be laboratory artifacts and will be evaluated as new data becomes available.

TABLE 2-5 Plume Definition Well Summary of Organics Reported Above the RFCA Action Levels and Inorganics Above the RFCA Action Level and the Background M2SD.

WELL	ANALYTE	TREND	FIGURE
00491	Carbon Tetrachloride	Down	2-7
00491	Tetrachloroethene	Down	2-52
00491	Thallium	No	2-59
00491	Trichloroethene	Down	2-79
0487	Carbon Tetrachloride	No	2-9
0487	Methylene Chloride	No	2-22
0487	Nickel	No	2-24
0487	Selenium	Down	2-40
0487	Tetrachloroethene	No	2-53
0487	Thallium	No	2-61
0487	Trichloroethene	No	2-80
05391	Carbon Tetrachloride	Down	2-10
2987	Nickel	No	2-26
2987	Selenium	Up	2-44
2987	Sulfate	No	2-49
3087	Thallium	No	2-68
6286	Carbon Tetrachloride	Up	2-13
6286	Selenium	No	2-47
6687	1,1-Dichloroethene	Up	2-2
6687	Thallium	No	2-74
6687	Trichloroethene	Down	2-84
P209389	1,1-Dichloroethene	Down	2-4
P209389	Carbon Tetrachloride	No	2-14
P219189	1,1-Dichloroethene	No	2-5
P416889	Tetrachloroethene	No	2-58
P416889	Thallium	No	2-77

Same as Table 2-4 but for Plum Def.

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Plume Extent Wells

Twenty-six PE wells were sampled during 1996. There were reportable exceedances for 21 chemicals in 14 wells (Table 2-1). Most of these have been previously reported in the 1996 quarterly RFCA groundwater monitoring reports (RMRS, 1997b and 1997c). There were exceedances for three organic analytes. Carbon tetrachloride is slightly above the Tier II action levels at wells 06091 and 23296. Well 23296 also had concentrations of tetrachloroethene (18 μg/L) and trichloroethene (430 μg/L) above the Tier II criteria.

Well 06091, located to the northeast of trenches T-3 and T-4, has a carbon tetrachloride concentration above the Tier II action level of 5 ug/L. The concentration (6 ug/L) exceeds the historical M2SD for this well (Table 2-2) and the historical data indicate an upward trend consistent with a possible advancing plume front (Figure 2-11). Monthly sampling of this well was initiated in January, 1997. Results confirmed the presence of low concentrations of carbon tetrachloride (RMRS 1997c).

Well 23296 is located in the South Walnut Creek drainage. The well was installed in 1996 as a PE well. It had been estimated that the East Trenches Plume had not reached the drainage and the well was intended to detect increasing concentrations of plume contaminants as they began to approach the drainage. The results of the first sampling indicated that the plume had reached the drainage at concentrations above the Tier II criteria. The well was sampled monthly during the first quarter of 1997 to confirm the exceedances for carbon tetrachloride, tetrachloroethene, and trichloroethene reported in the third quarter of 1996 (RMRS, 1997b and 1997d). The concentrations in all three confirmatory samples were above the Tier II action levels. Concentrations of carbon tetrachloride appear to be increasing, while those of tetrachloroethene and trichloroethene are remaining level. One result for 1,2-dichloroethene was equal to the Tier II criteria (RMRS, 1997d).

Further investigations are proceeding in the areas around both well 06091 and well 23296. Results of this sampling effort should be available in the fall of 1997.

Inorganics in PE wells that exceeded the Tier II action levels included manganese in wells1986, 22596, 7086, 75992, B208789, and P114389; nickel in well 1386, selenium in well 1786; and thallium in wells 10994, 1786, 43392, and 7086 (Table 2-2). Well 22596 was first developed in 1996 and has no historical data associated with it. Monthly confirmatory sampling was performed on this well in the first quarter of 1997. Results varied from 197 μg/L to 1010 μg/L, all were above the Tier II action level. Nickel concentrations in well 1386 have been highly variable over then last four years (Figure 2-25) and do not exhibit a definite trend. Selenium concentrations in well 1786 appear to have increased in the last two years (Figure 2-43). All of the thallium results that exceeded the Tier II action levels were B qualified, meaning they were below the method detection limit. It is recommended that semi-annual sampling of this well continue, pending reevaluation of the background benchmarks for metals.

RCRA Wells

Seven RCRA wells, that are included in the RFCA monitoring plan, were sampled in 1996 (Table 2-2). Wells 4087 and 52894 had activity-concentrations of U-233/234 and U-238 above the Tier II action levels, but below the background benchmarks. There is no indication that uranium activities in well 4087 are rising (Figures 2-91 and 2-96). There is insufficient data to chart well 52894. Nitrate was above the Tier II action level in well B206989, but was below the historic M2SD. Nitrate concentrations are not increasing in this well (Figure 2-35). Thallium concentrations exceeded Tier II action levels and background in wells 5887 and 70493. There is no indication of increasing concentrations in either well, although results for 5887 are quite erratic (Figure 2-72).

Concentrations of organics above the Tier II criteria were reported in one RCRA well, 70393. Tetrachloroethene, trichloroethene, and 1,1-dichloroethene were above the action levels, but not the historic M2SDs. Figures 2-57, 2-85, and 2-3 show that concentrations of these analytes are not increasing in these wells.

2.4 DATA SUMMARY FOR NON-RFCA DESIGNATED WELLS SAMPLED IN 1996

Much of the sampling for 1996 was completed prior to approval of the new monitoring well list (CDPHE Nov. 1996 and EPA Nov. 1996) and the establishment of sampling frequencies. Therefore, 43 wells sampled in 1996 will not be sampled in future years. Non-RFCA groundwater monitoring locations are included in this section. These wells are no longer being sampled under the RFCA groundwater monitoring program at RFETS. Organic chemicals-of-concern and inorganics with results greater than background M2SDs are shown for non-RFCA groundwater monitoring locations in Table 2-6. Results for all non-RFCA wells for metal, radionuclides, organics, and water quality parameter chemicals of concern are shown in box plots in Plates 8 through 11. Complete sampling results are given in Appendix B, Table B-1.

Many of these non-RFCA wells are located in previously established source areas. During the DQO process the Groundwater Working Group decided to eliminate these wells from further monitoring activities because the sources had been well defined. Some of these wells may become performance monitoring wells if groundwater remediation activities occur on associated sources.

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TABLE 2-6. Chemicals of Concern in Non-RFCA Wells

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	00391	11-Mar-96	CARBON TETRACHLORIDE	600	UG/L		5	120.00		
NON-RFCA	00391	24-Sep-96	CARBON TETRACHLORIDE	640	UG/L		5	128.00		
NON-RFCA	00391	11-Mar-96	PU239/40	0.178	PCI/L		0.151	1.18	0.047	3.78
NON-RFCA	00391	11-Mar-96	TETRACHLOROETHENE	93	UG/L		5	18.60		
NON-RFCA	00391	24-Sep-96	TETRACHLOROETHENE	100	UG/L		5	20.00		
NON-RFCA	00391	24-Sep-96	THALLIUM	6.1	UG/L	B	2	3.05	4.9	1.24
NON-RFCA	00391	11-Mar-96	TRICHLOROETHENE	77	UG/L		5	15.40		
NON-RFCA	00391	24-Sep-96	TRICHLOROETHENE	79	UG/L		5	15.80		
NON-RFCA	00391	11-Mar-96	U-234	3.46	PCI/L		1.07	3.23	60.7	0.06
NON-RFCA	00391	11-Mar-96	U-238	1.69	PCI/L		0.768	2.20	41.8	0.04
NON-RFCA	01291	19-Feb-96	CARBON TETRACHLORIDE	15	UG/L		5	3.00		
NON-RFCA	01291	09-Sep-96	CARBON TETRACHLORIDE	7	UG/L		5	1.40		
NON-RFCA	01291	19-Feb-96	TRICHLOROETHENE	12	UG/L		5	2.40		
NON-RFCA	01291	09-Sep-96	TRICHLOROETHENE	8	UG/L		5	1.60		
NON-RFCA	01291	19-Feb-96	U-234	11.16	PCI/L		1.07	10.43	60.7	0.18
NON-RFCA	01291	19-Feb-96	U-238	8.816	PCI/L		0.768	11.48	41.8	0.21
NON-RFCA	02591	28-Feb-96	U-234	5.223	PCI/L		1.07	4.88	60.7	0.09
NON-RFCA	02591	28-Feb-96	U-238	2.325	PCI/L		0.768	3.03	41.8	0.06
NON-RFCA	03691	18-Mar-96	CARBON TETRACHLORIDE	260	UG/L		5	52.00		
NON-RFCA	03691	13-Sep-96	CARBON TETRACHLORIDE	310	UG/L		5	62.00		
NON-RFCA	03691	18-Mar-96	METHYLENE CHLORIDE	6	UG/L	JB	5	1.20		
NON-RFCA	03691	13-Sep-96	METHYLENE CHLORIDE	8	UG/L	J	5	1.60		
NON-RFCA	03691	18-Mar-96	TETRACHLOROETHENE	230	UG/L		5	46.00		
NON-RFCA	03691	13-Sep-96	TETRACHLOROETHENE	320	UG/L		5	64.00		
NON-RFCA	03691	18-Mar-96	TRICHLOROETHENE	34	UG/L		5	6.80		
NON-RFCA	03691	13-Sep-96	TRICHLOROETHENE	38	UG/L		5	7.60		
NON-RFCA	03691	18-Mar-96	U-234	2.74	PCI/L		1.07	2.56	60.7	0.05
NON-RFCA	03691	18-Mar-96	U-238	2.71	PCI/L		0.768	3.53	41.8	0.06
NON-RFCA	03791	19-Mar-96	CARBON TETRACHLORIDE	500	UG/L		5	100.00		
NON-RFCA	03791	12-Sep-96	CARBON TETRACHLORIDE	480	UG/L		5	96.00		
NON-RFCA	03791	19-Mar-96	METHYLENE CHLORIDE	14	UG/L	JB	5	2.80		
NON-RFCA	03791	12-Sep-96	METHYLENE CHLORIDE	37	UG/L		5	7.40		
NON-RFCA	03791	19-Mar-96	TETRACHLOROETHENE	250	UG/L		5	50.00		
NON-RFCA	10492	06-Feb-96	U-234	15.83	PCI/L		1.07	14.79	60.7	0.26
NON-RFCA	10492	10-Apr-96	U-234	16.81	PCI/L		1.07	15.71	60.7	0.28
NON-RFCA	10492	20-Nov-96	U-234	20.37	PCI/L		1.07	19.04	60.7	0.34
NON-RFCA	10492	06-Feb-96	U-238	10.85	PCI/L		0.768	14.13	41.8	0.26
NON-RFCA	10492	10-Apr-96	U-238	11.84	PCI/L		0.768	15.42	41.8	0.28
NON-RFCA	10492	20-Nov-96	U-238	14.56	PCI/L		0.768	18.96	41.8	0.35
NON-RFCA	03791	12-Sep-96	TETRACHLOROETHENE	300	UG/L		5	60.00		
NON-RFCA	03791	19-Mar-96	TRICHLOROETHENE	66	UG/L		5	13.20		
NON-RFCA	10991	01-Mar-96	U-234	2.548	PCI/L		1.07	2.38	60.7	0.04
NON-RFCA	10991	01-Mar-96	U-238	1.285	PCI/L		0.768	1.67	41.8	0.03
NON-RFCA	03791	12-Sep-96	TRICHLOROETHENE	62	UG/L		5	12.40		
NON-RFCA	10492	06-Feb-96	SELENIUM	789	UG/L		50	15.78	43.72	18.05
NON-RFCA	10492	10-Apr-96	SELENIUM	854	UG/L		50	17.08	43.72	19.53
NON-RFCA	10492	28-Aug-96	SELENIUM	791	UG/L		50	15.82	43.72	18.09
NON-RFCA	10492	20-Nov-96	SELENIUM	809	UG/L	E	50	16.18	43.72	18.50
NON-RFCA	10492	20-Nov-96	THALLIUM	7.6	UG/L	B	2	3.80	4.9	1.55
NON-RFCA	10594	14-Feb-96	SULFATE	631	MG/L		500	1.26	435.598	1.45
NON-RFCA	10594	09-Sep-96	SULFATE	933	MG/L		500	1.87	435.598	2.14
NON-RFCA	10794	18-Jul-96	THALLIUM	8.6	UG/L	B	2	4.30	4.9	1.76
NON-RFCA	10894	24-Oct-96	THALLIUM	8.6	UG/L	B	2	4.30	4.9	1.76
NON-RFCA	1187	05-Mar-96	U-234	7.209	PCI/L		1.07	6.74	60.7	0.12
NON-RFCA	1187	05-Mar-96	U-238	4.961	PCI/L		0.768	6.46	41.8	0.12
NON-RFCA	10991	01-Mar-96	TETRACHLOROETHENE	6	UG/L		5	1.20		
NON-RFCA	12094	01-Mar-96	U-234	8.232	PCI/L		1.07	7.69	60.7	0.14
NON-RFCA	12094	01-Mar-96	U-238	5.909	PCI/L		0.768	7.69	41.8	0.14
NON-RFCA	10991	13-Sep-96	TETRACHLOROETHENE	5	UG/L		5	1.00		
NON-RFCA	11691	10-Sep-96	CARBON TETRACHLORIDE	440	UG/L		5	88.00		
NON-RFCA	12491	13-Mar-96	U-234	2.615	PCI/L		1.07	2.44	60.7	0.04
NON-RFCA	12491	13-Mar-96	U-238	0.7941	PCI/L		0.768	1.03	41.8	0.02
NON-RFCA	11691	10-Sep-96	METHYLENE CHLORIDE	12	UG/L	J	5	2.40		
NON-RFCA	11691	10-Sep-96	TETRACHLOROETHENE	490	UG/L		5	98.00		
NON-RFCA	11691	10-Sep-96	TRICHLOROETHENE	88	UG/L		5	17.60		
NON-RFCA	1187	10-Sep-96	CARBON TETRACHLORIDE	370	UG/L		5	74.00		
NON-RFCA	1487	06-Mar-96	U-234	5.749	PCI/L		1.07	5.37	60.7	0.09
NON-RFCA	1487	30-Jul-96	U-234	4.563	PCI/L		1.07	4.26	60.7	0.08
NON-RFCA	1487	06-Mar-96	U-238	3.719	PCI/L		0.768	4.84	41.8	0.09
NON-RFCA	1487	30-Jul-96	U-238	2.972	PCI/L		0.768	3.87	41.8	0.07
NON-RFCA	1187	10-Sep-96	METHYLENE CHLORIDE	65	UG/L	J	5	13.00		

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TABLE 2-6 Chemicals of Concern in Non-RFCA Wells (cont'd)

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	1187	10-Sep-96	NICKEL	404	UG/L		100	4.04	21.37	18.91
NON-RFCA	1187	10-Sep-96	TETRACHLOROETHENE	59	UG/L	J	5	11.80		
NON-RFCA	1187	10-Sep-96	THALLIUM	6.8	UG/L	B	2	3.40	4.9	1.39
NON-RFCA	1586	10-Jan-96	U-234	20.29	PCI/L		1.07	18.96	60.7	0.33
NON-RFCA	1586	24-Apr-96	U-234	26.19	PCI/L		1.07	24.48	60.7	0.43
NON-RFCA	1586	08-Nov-96	U-234	20.81	PCI/L		1.07	19.45	60.7	0.34
NON-RFCA	1586	10-Jan-96	U-235	1.106	PCI/L		1.01	1.10	1.79	0.62
NON-RFCA	1586	10-Jan-96	U-238	17.08	PCI/L		0.768	22.24	41.8	0.41
NON-RFCA	1586	24-Apr-96	U-238	21.67	PCI/L		0.768	28.22	41.8	0.52
NON-RFCA	1586	08-Nov-96	U-238	16.11	PCI/L		0.768	20.98	41.8	0.39
NON-RFCA	1187	10-Sep-96	TRICHLOROETHENE	4400	UG/L		5	880.00		
NON-RFCA	12094	16-Sep-96	THALLIUM	7.2	UG/L	B	2	3.60	4.9	1.47
NON-RFCA	12491	13-Mar-96	CARBON TETRACHLORIDE	5	UG/L		5	1.00		
NON-RFCA	12491	18-Sep-96	THALLIUM	5.9	UG/L	B	2	2.95	4.9	1.20
NON-RFCA	2586	15-May-96	U-234	2.854	PCI/L		1.07	2.67	60.7	0.05
NON-RFCA	2586	10-Dec-96	U-234	2.411	PCI/L		1.07	2.25	60.7	0.04
NON-RFCA	2586	15-May-96	U-238	0.8456	PCI/L		0.768	1.10	41.8	0.02
NON-RFCA	1487	30-Jul-96	CARBON TETRACHLORIDE	460	UG/L		5	92.00		
NON-RFCA	31791	12-Apr-96	U-234	18.61	PCI/L		1.07	17.39	60.7	0.31
NON-RFCA	31791	22-Oct-96	U-234	33.9	PCI/L		1.07	31.68	60.7	0.56
NON-RFCA	31791	22-Oct-96	U-235	1.052	PCI/L		1.01	1.04	1.79	0.59
NON-RFCA	31791	12-Apr-96	U-238	11.74	PCI/L		0.768	15.29	41.8	0.28
NON-RFCA	31791	22-Oct-96	U-238	24.59	PCI/L		0.768	32.02	41.8	0.59
NON-RFCA	1487	30-Jul-96	TETRACHLOROETHENE	8	UG/L	J	5	1.60		
NON-RFCA	53194	17-Apr-96	U-234	10.7	PCI/L		1.07	10.00	60.7	0.18
NON-RFCA	53194	12-Nov-96	U-234	12.13	PCI/L		1.07	11.34	60.7	0.20
NON-RFCA	53194	17-Apr-96	U-238	6.698	PCI/L		0.768	8.72	41.8	0.16
NON-RFCA	53194	12-Nov-96	U-238	9.593	PCI/L		0.768	12.49	41.8	0.23
NON-RFCA	59393	08-Nov-96	U-234	7.112	PCI/L		1.07	6.65	60.7	0.12
NON-RFCA	59393	08-Nov-96	U-238	6.032	PCI/L		0.768	7.85	41.8	0.14
NON-RFCA	1487	30-Jul-96	THALLIUM	6	UG/L	B*	2	3.00	4.9	1.22
NON-RFCA	1487	30-Jul-96	TRICHLOROETHENE	190	UG/L		5	38.00		
NON-RFCA	1586	10-Jan-96	NITRATE/NITRITE	52.5	MG/L		10	5.25	4.664	11.26
NON-RFCA	1586	24-Apr-96	NITRATE/NITRITE	46.3	MG/L		10	4.63	4.664	9.93
NON-RFCA	1586	08-Nov-96	NITRATE/NITRITE	65.5	MG/L		10	6.55	4.664	14.04
NON-RFCA	76292	11-Mar-96	U-234	1.887	PCI/L		1.07	1.76	60.7	0.03
NON-RFCA	76292	22-May-96	U-234	1.576	PCI/L		1.07	1.47	60.7	0.03
NON-RFCA	76292	19-Aug-96	U-234	1.611	PCI/L		1.07	1.51	60.7	0.03
NON-RFCA	76292	20-Dec-96	U-234	1.523	PCI/L		1.07	1.42	60.7	0.03
NON-RFCA	76292	11-Mar-96	U-238	1.424	PCI/L		0.768	1.85	41.8	0.03
NON-RFCA	76292	22-May-96	U-238	1.46	PCI/L		0.768	1.90	41.8	0.03
NON-RFCA	76292	19-Aug-96	U-238	1.118	PCI/L		0.768	1.46	41.8	0.03
NON-RFCA	76292	20-Dec-96	U-238	1.761	PCI/L		0.768	2.29	41.8	0.04
NON-RFCA	1586	08-Nov-96	THALLIUM	7.9	UG/L	B	2	3.95	4.9	1.61
NON-RFCA	B202589	09-May-96	U-234	1.432	PCI/L		1.07	1.34	60.7	0.02
NON-RFCA	B202589	28-Oct-96	U-234	1.08	PCI/L		1.07	1.01	60.7	0.02
NON-RFCA	B202589	09-May-96	U-238	1.259	PCI/L		0.768	1.64	41.8	0.03
NON-RFCA	B202589	28-Oct-96	U-238	0.985	PCI/L		0.768	1.28	41.8	0.02
NON-RFCA	B208189	22-Jan-96	U-234	11.56	PCI/L		1.07	10.80	60.7	0.19
NON-RFCA	B208189	23-Apr-96	U-234	7.286	PCI/L		1.07	6.81	60.7	0.12
NON-RFCA	B208189	20-Nov-96	U-234	12.18	PCI/L		1.07	11.38	60.7	0.20
NON-RFCA	B208189	22-Jan-96	U-238	6.096	PCI/L		0.768	7.94	41.8	0.15
NON-RFCA	B208189	23-Apr-96	U-238	4.985	PCI/L		0.768	6.49	41.8	0.12
NON-RFCA	B208189	20-Nov-96	U-238	8.207	PCI/L		0.768	10.69	41.8	0.20
NON-RFCA	2586	10-Dec-96	CADMIUM	5	UG/L		5	1.00	4.25	1.18
NON-RFCA	2586	15-May-96	SULFATE	1100	MG/L		500	2.20	435.598	2.53
NON-RFCA	2586	10-Dec-96	SULFATE	1080	MG/L		500	2.16	435.598	2.48
NON-RFCA	2586	10-Dec-96	THALLIUM	7.1	UG/L	B	2	3.55	4.9	1.45
NON-RFCA	2686	05-Mar-96	NITRATE/NITRITE	60.1	MG/L		10	6.01	4.664	12.89
NON-RFCA	B208589	18-Apr-96	U-234	29.58	PCI/L		1.07	27.64	60.7	0.49
NON-RFCA	B208589	30-Oct-96	U-234	33.79	PCI/L		1.07	31.58	60.7	0.56
NON-RFCA	B208589	18-Apr-96	U-238	22.35	PCI/L		0.768	29.10	41.8	0.53
NON-RFCA	B208589	30-Oct-96	U-238	28	PCI/L		0.768	36.46	41.8	0.67
NON-RFCA	2686	14-May-96	NITRATE/NITRITE	47.8	MG/L		10	4.78	4.664	10.25
NON-RFCA	2686	23-Jul-96	NITRATE/NITRITE	48.7	MG/L		10	4.87	4.664	10.44
NON-RFCA	2686	14-May-96	SELENIUM	65.9	UG/L	N	50	1.32	43.72	1.51
NON-RFCA	2686	23-Jul-96	TRICHLOROETHENE	5	UG/L		5	1.00		
NON-RFCA	31791	22-Oct-96	THALLIUM	9.9	UG/L	B	2	4.95	4.9	2.02
NON-RFCA	53194	12-Nov-96	THALLIUM	5.9	UG/L	B	2	2.95	4.9	1.20
NON-RFCA	5686	28-Oct-96	THALLIUM	5.6	UG/L	B	2	2.80	4.9	1.14
NON-RFCA	70693	10-Sep-96	THALLIUM	6.1	UG/L	B	2	3.05	4.9	1.24

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TABLE 2-6 Chemicals of Concern in Non-RFCA Wells (cont'd)

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	75292	22-Apr-96	SULFATE	511	MG/L		500	1.02	435.598	1.17
NON-RFCA	B208689	22-Jan-96	U-235	1.192	PCI/L		1.01	1.18	1.79	0.67
NON-RFCA	75292	24-Oct-96	THALLIUM	11.1	UG/L		2	5.55	4.9	2.27
NON-RFCA	76292	11-Mar-96	NITRATE/NITRITE	24.9	MG/L		10	2.49	4.664	5.34
NON-RFCA	76292	22-May-96	NITRATE/NITRITE	24.4	MG/L		10	2.44	4.664	5.23
NON-RFCA	76292	19-Aug-96	NITRATE/NITRITE	23.8	MG/L		10	2.38	4.664	5.10
NON-RFCA	76292	20-Dec-96	NITRATE/NITRITE	22.1	MG/L		10	2.21	4.664	4.74
NON-RFCA	B202589	28-Oct-96	THALLIUM	5.1	UG/L	B	2	2.55	4.9	1.04
NON-RFCA	B208589	18-Apr-96	NITRATE/NITRITE	245	MG/L		10	24.50	4.664	52.53
NON-RFCA	B210389	23-Jan-96	U-234	55.65	PCI/L		1.07	52.01	60.7	0.92
NON-RFCA	B210389	23-Jan-96	U-235	1.014	PCI/L		1.01	1.00	1.79	0.57
NON-RFCA	B210389	23-Jan-96	U-238	30.61	PCI/L		0.768	39.88	41.8	0.73
NON-RFCA	P207389	05-Mar-96	U-234	3.124	PCI/L		1.07	2.92	60.7	0.05
NON-RFCA	P207389	21-May-96	U-234	3.645	PCI/L		1.07	3.41	60.7	0.06
NON-RFCA	P207389	22-Aug-96	U-234	2.517	PCI/L		1.07	2.35	60.7	0.04
NON-RFCA	P207389	10-Dec-96	U-234	3.359	PCI/L		1.07	3.14	60.7	0.06
NON-RFCA	P207389	05-Mar-96	U-238	2.265	PCI/L		0.768	2.95	41.8	0.05
NON-RFCA	P207389	21-May-96	U-238	2.619	PCI/L		0.768	3.41	41.8	0.06
NON-RFCA	P207389	22-Aug-96	U-238	1.621	PCI/L		0.768	2.11	41.8	0.04
NON-RFCA	P207389	10-Dec-96	U-238	2.074	PCI/L		0.768	2.70	41.8	0.05
NON-RFCA	B208589	30-Oct-96	NITRATE/NITRITE	373	MG/L		10	37.30	4.664	79.97
NON-RFCA	B208589	18-Apr-96	SELENIUM	302	UG/L	N	50	6.04	43.72	6.91
NON-RFCA	P207989	19-Feb-96	U-234	28.78	PCI/L		1.07	26.90	60.7	0.47
NON-RFCA	P207989	08-May-96	U-234	33.29	PCI/L		1.07	31.11	60.7	0.55
NON-RFCA	P207989	30-Jul-96	U-234	32.26	PCI/L		1.07	30.15	60.7	0.53
NON-RFCA	P207989	05-Dec-96	U-234	32.88	PCI/L		1.07	30.73	60.7	0.54
NON-RFCA	P207989	08-May-96	U-235	1.211	PCI/L		1.01	1.20	1.79	0.68
NON-RFCA	P207989	19-Feb-96	U-238	21.62	PCI/L		0.768	28.15	41.8	0.52
NON-RFCA	P207989	08-May-96	U-238	22.47	PCI/L		0.768	29.26	41.8	0.54
NON-RFCA	P207989	30-Jul-96	U-238	24.4	PCI/L		0.768	31.77	41.8	0.58
NON-RFCA	P207989	05-Dec-96	U-238	24.53	PCI/L		0.768	31.94	41.8	0.59
NON-RFCA	B208589	30-Oct-96	SELENIUM	99.4	UG/L		50	1.99	43.72	2.27
NON-RFCA	B208589	30-Oct-96	THALLIUM	5.2	UG/L	B	2	2.60	4.9	1.06
NON-RFCA	B208689	09-Apr-96	LITHIUM	825	UG/L		0.73	1.13	142.6	5.79
NON-RFCA	B208689	21-Nov-96	LITHIUM	1030	UG/L		0.73	1.41	142.6	7.22
NON-RFCA	B208689	22-Jan-96	SULFATE	2320	MG/L		500	4.64	435.598	5.33
NON-RFCA	B208689	21-Nov-96	SULFATE	2300	MG/L		500	4.60	435.598	5.28
NON-RFCA	B208689	21-Nov-96	THALLIUM	8.9	UG/L	B	2	4.45	4.9	1.82
NON-RFCA	B208689	22-Jan-96	U-234	63.5	PCI/L		1.07	59.34	60.7	1.05
NON-RFCA	B208689	09-Apr-96	U-234	68.6	PCI/L		1.07	64.11	60.7	1.13
NON-RFCA	B208689	23-Jul-96	U-234	85.6	PCI/L		1.07	80.04	60.7	1.41
NON-RFCA	B208689	21-Nov-96	U-234	66.0	PCI/L		1.07	61.64	60.7	1.09
NON-RFCA	B208689	09-Apr-96	U-235	1.95	PCI/L		1.01	1.93	1.79	1.09
NON-RFCA	B208689	23-Jul-96	U-235	2.15	PCI/L		1.01	2.13	1.79	1.20
NON-RFCA	B208689	21-Nov-96	U-235	1.94	PCI/L		1.01	1.92	1.79	1.08
NON-RFCA	B208689	22-Jan-96	U-238	42.3	PCI/L		0.768	55.13	41.8	1.01
NON-RFCA	B208689	09-Apr-96	U-238	42.6	PCI/L		0.768	55.47	41.8	1.02
NON-RFCA	B208689	23-Jul-96	U-238	57.4	PCI/L		0.768	74.73	41.8	1.37
NON-RFCA	B208689	21-Nov-96	U-238	43.1	PCI/L		0.768	56.13	41.8	1.03
NON-RFCA	B210489	24-May-96	NITRATE/NITRITE	424	MG/L		10	42.40	4.664	90.91
NON-RFCA	B210489	24-Jul-96	NITRATE/NITRITE	339	MG/L		10	33.90	4.664	72.68
NON-RFCA	B210489	22-Nov-96	NITRATE/NITRITE	468	MG/L		10	46.80	4.664	100.34
NON-RFCA	B210489	19-Jan-96	SELENIUM	322	UG/L		50	6.44	43.72	7.37
NON-RFCA	B210489	24-Jul-96	SELENIUM	233	UG/L		50	4.66	43.72	5.33
NON-RFCA	B210489	22-Nov-96	SELENIUM	265	UG/L	E	50	5.30	43.72	6.06
NON-RFCA	B210489	24-Jul-96	THALLIUM	7.4	UG/L	B	2	3.70	4.9	1.51
NON-RFCA	B210489	22-Nov-96	THALLIUM	5	UG/L	B	2	2.50	4.9	1.02
NON-RFCA	P210089	24-Apr-96	U-234	3.224	PCI/L		1.07	3.01	60.7	0.05
NON-RFCA	P210089	22-Oct-96	U-234	4.088	PCI/L		1.07	3.82	60.7	0.07
NON-RFCA	P210089	24-Apr-96	U-238	2.159	PCI/L		0.768	2.81	41.8	0.05
NON-RFCA	P210089	22-Oct-96	U-238	2.468	PCI/L		0.768	3.21	41.8	0.06
NON-RFCA	P114589	13-Aug-96	THALLIUM	9.2	UG/L	B	2	4.60	4.9	1.88
NON-RFCA	P114689	15-May-96	1,1-DICHLOROETHENE	420	UG/L		0.007	60.00		
NON-RFCA	P114689	19-Jul-96	1,1-DICHLOROETHENE	340	UG/L		0.007	48.57		
NON-RFCA	P114689	25-Nov-96	1,1-DICHLOROETHENE	260	UG/L		0.007	37.14		
NON-RFCA	P114689	25-Nov-96	1,2,4-TRICHLOROBENZENE	79	UG/L		0.07	1.13		
NON-RFCA	P114689	15-May-96	CARBON TETRACHLORIDE	780	UG/L		5	156.00		
NON-RFCA	P114689	19-Jul-96	CARBON TETRACHLORIDE	620	UG/L		5	124.00		
NON-RFCA	P114689	25-Nov-96	CARBON TETRACHLORIDE	670	UG/L		5	134.00		
NON-RFCA	03791	19-Mar-96	U-234	2.171	PCI/L		1.07	2.03	60.7	0.04
NON-RFCA	03791	19-Mar-96	U-238	1.032	PCI/L		0.768	1.34	41.8	0.02

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TABLE 2-6 Chemicals of Concern in Non-RFCA Wells (cont'd)

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	05293	10-Dec-96	U-234	2.969	PCI/L		1.07	2.77	60.7	0.05
NON-RFCA	05293	10-Dec-96	U-238	2.2	PCI/L		0.768	2.86	41.8	0.05
NON-RFCA	06291	13-Feb-96	U-234	17.93	PCI/L		1.07	16.76	60.7	0.30
NON-RFCA	06291	13-Feb-96	U-238	7.614	PCI/L		0.768	9.91	41.8	0.18
NON-RFCA	P114689	15-May-96	METHYLENE CHLORIDE	16	UG/L	J	5	3.20		
NON-RFCA	P114689	15-May-96	TETRACHLOROETHENE	120	UG/L		5	24.00		
NON-RFCA	10594	14-Feb-96	U-234	32.38	PCI/L		1.07	30.26	60.7	0.53
NON-RFCA	10594	14-Feb-96	U-235	1.16	PCI/L		1.01	1.15	1.79	0.65
NON-RFCA	10594	14-Feb-96	U-238	24.34	PCI/L		0.768	31.69	41.8	0.58
NON-RFCA	10694	14-Feb-96	U-234	8.799	PCI/L		1.07	8.22	60.7	0.14
NON-RFCA	10694	14-Feb-96	U-238	5.715	PCI/L		0.768	7.44	41.8	0.14
NON-RFCA	P114689	19-Jul-96	TETRACHLOROETHENE	96	UG/L		5	19.20		
NON-RFCA	10794	14-Feb-96	U-234	2.335	PCI/L		1.07	2.18	60.7	0.04
NON-RFCA	10794	18-Jul-96	U-234	1.175	PCI/L		1.07	1.10	60.7	0.02
NON-RFCA	10794	14-Feb-96	U-238	2.738	PCI/L		0.768	3.57	41.8	0.07
NON-RFCA	10794	18-Jul-96	U-238	1.016	PCI/L		0.768	1.32	41.8	0.02
NON-RFCA	P114689	25-Nov-96	TETRACHLOROETHENE	83	UG/L		5	16.60		
NON-RFCA	10894	11-Jun-96	U-234	1.196	PCI/L		1.07	1.12	60.7	0.02
NON-RFCA	10894	24-Oct-96	U-234	2.08	PCI/L		1.07	1.94	60.7	0.03
NON-RFCA	10894	11-Jun-96	U-238	1.151	PCI/L		0.768	1.50	41.8	0.03
NON-RFCA	10894	24-Oct-96	U-238	2.179	PCI/L		0.768	2.84	41.8	0.05
NON-RFCA	13391	29-Feb-96	U-234	2.561	PCI/L		1.07	2.39	60.7	0.04
NON-RFCA	13391	29-Feb-96	U-238	1.058	PCI/L		0.768	1.38	41.8	0.03
NON-RFCA	P114689	19-Jul-96	THALLIUM	7.4	UG/L	B	2	3.70	4.9	1.51
NON-RFCA	P114689	25-Nov-96	THALLIUM	8.6	UG/L	B	2	4.30	4.9	1.76
NON-RFCA	P114689	15-May-96	TRICHLOROETHENE	47	UG/L		5	9.40		
NON-RFCA	P114689	19-Jul-96	TRICHLOROETHENE	40	UG/L		5	8.00		
NON-RFCA	P114689	25-Nov-96	TRICHLOROETHENE	27	UG/L		5	5.40		
NON-RFCA	2686	14-May-96	U-234	30.22	PCI/L		1.07	28.24	60.7	0.50
NON-RFCA	2686	23-Jul-96	U-234	40.67	PCI/L		1.07	38.01	60.7	0.67
NON-RFCA	2686	23-Jul-96	U-235	1.15	PCI/L		1.01	1.14	1.79	0.64
NON-RFCA	2686	14-May-96	U-238	20.55	PCI/L		0.768	26.76	41.8	0.49
NON-RFCA	2686	23-Jul-96	U-238	30.02	PCI/L		0.768	39.09	41.8	0.72
NON-RFCA	37791	10-Apr-96	U-234	12.8	PCI/L		1.07	11.96	60.7	0.21
NON-RFCA	37791	30-Oct-96	U-234	17.18	PCI/L		1.07	16.06	60.7	0.28
NON-RFCA	37791	10-Apr-96	U-238	11.28	PCI/L		0.768	14.69	41.8	0.27
NON-RFCA	37791	30-Oct-96	U-238	13.02	PCI/L		0.768	16.95	41.8	0.31
NON-RFCA	3986	07-Nov-96	THALLIUM	4.4	UG/L	B	2	2.20	4.9	0.90
NON-RFCA	3986	14-May-96	U-234	2.806	PCI/L		1.07	2.62	60.7	0.05
NON-RFCA	3986	07-Nov-96	U-234	3.038	PCI/L		1.07	2.84	60.7	0.05
NON-RFCA	3986	14-May-96	U-238	1.775	PCI/L		0.768	2.31	41.8	0.04
NON-RFCA	3986	07-Nov-96	U-238	2.35	PCI/L		0.768	3.06	41.8	0.06
NON-RFCA	41091	07-May-96	U-234	4.923	PCI/L		1.07	4.60	60.7	0.08
NON-RFCA	41091	07-May-96	U-238	3.058	PCI/L		0.768	3.98	41.8	0.07
NON-RFCA	P114789	20-Feb-96	TETRACHLOROETHENE	69	UG/L		5	13.80		
NON-RFCA	6886	30-Oct-96	U-234	1.513	PCI/L		1.07	1.41	60.7	0.02
NON-RFCA	6886	30-Oct-96	U-238	1.149	PCI/L		0.768	1.50	41.8	0.03
NON-RFCA	P114789	24-May-96	TETRACHLOROETHENE	70	UG/L		5	14.00		
NON-RFCA	P114789	17-Jul-96	TETRACHLOROETHENE	47	UG/L		5	9.40		
NON-RFCA	75292	22-Apr-96	U-234	18.5	PCI/L		1.07	17.29	60.7	0.30
NON-RFCA	75292	24-Oct-96	U-234	15.6	PCI/L		1.07	14.58	60.7	0.26
NON-RFCA	75292	22-Apr-96	U-238	12.74	PCI/L		0.768	16.59	41.8	0.30
NON-RFCA	75292	24-Oct-96	U-238	10.77	PCI/L		0.768	14.02	41.8	0.26
NON-RFCA	P114789	21-Nov-96	TETRACHLOROETHENE	34	UG/L		5	6.80		
NON-RFCA	P114789	17-Jul-96	THALLIUM	7.6	UG/L	B	2	3.80	4.9	1.55
NON-RFCA	P114889	29-May-96	CIS-1,2-DICHLOROETHENE	310	UG/L		70	4.43		
NON-RFCA	P114889	13-Aug-96	CIS-1,2-DICHLOROETHENE	320	UG/L		70	4.57		
NON-RFCA	P114889	20-Nov-96	CIS-1,2-DICHLOROETHENE	360	UG/L		70	5.14		
NON-RFCA	P114889	29-May-96	METHYLENE CHLORIDE	9	UG/L	JB	5	1.80		
NON-RFCA	P114889	29-May-96	TETRACHLOROETHENE	260	UG/L		5	52.00		
NON-RFCA	P114889	13-Aug-96	TETRACHLOROETHENE	220	UG/L		5	44.00		
NON-RFCA	B210489	19-Jan-96	U-234	27.99	PCI/L		1.07	26.16	60.7	0.46
NON-RFCA	B210489	24-May-96	U-234	25.6	PCI/L		1.07	23.93	60.7	0.42
NON-RFCA	B210489	24-Jul-96	U-234	25.54	PCI/L		1.07	23.87	60.7	0.42
NON-RFCA	B210489	22-Nov-96	U-234	29.33	PCI/L		1.07	27.41	60.7	0.48
NON-RFCA	B210489	19-Jan-96	U-238	21.83	PCI/L		0.768	28.42	41.8	0.52
NON-RFCA	B210489	24-May-96	U-238	19.52	PCI/L		0.768	25.42	41.8	0.47
NON-RFCA	B210489	24-Jul-96	U-238	18.17	PCI/L		0.768	23.66	41.8	0.43
NON-RFCA	B210489	22-Nov-96	U-238	23.16	PCI/L		0.768	30.16	41.8	0.55
NON-RFCA	P114889	20-Nov-96	TETRACHLOROETHENE	240	UG/L		5	48.00		
NON-RFCA	P114889	29-May-96	TRICHLOROETHENE	170	UG/L		5	34.00		

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TABLE 2-6 Chemicals of Concern in Non-RFCA Wells (cont'd)

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	P114889	13-Aug-96	TRICHLOROETHENE	160	UG/L		5	32.00		
NON-RFCA	P114889	20-Nov-96	TRICHLOROETHENE	170	UG/L		5	34.00		
NON-RFCA	P115489	18-Apr-96	NITRATE/NITRITE	10.2	MG/L		10	1.02	4.684	2.19
NON-RFCA	P114689	25-Nov-96	ANTIMONY	18.6	UG/L	B	0.006	3.10	39.54	0.47
NON-RFCA	P115489	16-Dec-96	THALLIUM	5.9	UG/L	B	2	2.95	4.9	1.20
NON-RFCA	P115589	15-Feb-96	1,1-DICHLOROETHENE	910	UG/L		7	130.00		
NON-RFCA	P115589	15-Aug-96	1,1-DICHLOROETHENE	850	UG/L		7	121.43		
NON-RFCA	P115589	10-Dec-96	1,1-DICHLOROETHENE	830	UG/L		7	118.57		
NON-RFCA	P115589	15-Feb-96	1,2-DICHLOROETHANE	57	UG/L		5	11.40		
NON-RFCA	P115589	15-Aug-96	1,2-DICHLOROETHANE	47	UG/L		5	9.40		
NON-RFCA	P115589	10-Dec-96	1,2-DICHLOROETHANE	51	UG/L		5	10.20		
NON-RFCA	P115589	15-Feb-96	CIS-1,2-DICHLOROETHENE	280	UG/L		70	4.00		
NON-RFCA	P115589	15-Aug-96	CIS-1,2-DICHLOROETHENE	280	UG/L		70	4.00		
NON-RFCA	P115589	10-Dec-96	CIS-1,2-DICHLOROETHENE	300	UG/L		70	4.29		
NON-RFCA	P115589	10-Dec-96	METHYLENE CHLORIDE	12	UG/L	J	5	2.40		
NON-RFCA	P115589	15-Feb-96	TETRACHLOROETHENE	430	UG/L		5	86.00		
NON-RFCA	P114689	11-Jan-96	U-234	1.374	PCI/L		1.07	1.28	60.7	0.02
NON-RFCA	P114689	15-May-96	U-234	1.817	PCI/L		1.07	1.70	60.7	0.03
NON-RFCA	P114689	25-Nov-96	U-234	1.288	PCI/L		1.07	1.20	60.7	0.02
NON-RFCA	P114689	15-May-96	U-238	1.106	PCI/L		0.768	1.44	41.8	0.03
NON-RFCA	P114689	19-Jul-96	U-238	1.018	PCI/L		0.768	1.33	41.8	0.02
NON-RFCA	P115589	15-Aug-96	TETRACHLOROETHENE	410	UG/L		5	82.00		
NON-RFCA	P115589	10-Dec-96	TETRACHLOROETHENE	400	UG/L		5	80.00		
NON-RFCA	P115589	10-Dec-96	THALLIUM	6.2	UG/L	B	2	3.10	4.9	1.27
NON-RFCA	P115589	15-Feb-96	TRICHLOROETHENE	120	UG/L		5	24.00		
NON-RFCA	P115589	15-Aug-96	TRICHLOROETHENE	110	UG/L		5	22.00		
NON-RFCA	P114789	21-Nov-96	THALLIUM	4.3	UG/L	B	2	2.15	4.9	0.88
NON-RFCA	P114789	20-Feb-96	U-234	1.371	PCI/L		1.07	1.28	60.7	0.02
NON-RFCA	P114789	21-Nov-96	U-234	1.268	PCI/L		1.07	1.18	60.7	0.02
NON-RFCA	P114789	24-May-96	U-238	0.8039	PCI/L		0.768	1.05	41.8	0.02
NON-RFCA	P114789	21-Nov-96	U-238	0.7869	PCI/L		0.768	1.02	41.8	0.02
NON-RFCA	P115589	10-Dec-96	TRICHLOROETHENE	110	UG/L		5	22.00		
NON-RFCA	P115689	24-Jan-96	1,1-DICHLOROETHENE	82	UG/L		7	11.71		
NON-RFCA	P115689	18-Jul-96	1,1-DICHLOROETHENE	58	UG/L		7	8.29		
NON-RFCA	P115689	22-Nov-96	1,1-DICHLOROETHENE	73	UG/L		7	10.43		
NON-RFCA	P115689	24-Jan-96	CIS-1,2-DICHLOROETHENE	200	UG/L		70	2.86		
NON-RFCA	P115689	18-Jul-96	CIS-1,2-DICHLOROETHENE	200	UG/L		70	2.86		
NON-RFCA	P115689	22-Nov-96	CIS-1,2-DICHLOROETHENE	220	UG/L		70	3.14		
NON-RFCA	P115689	18-Jul-96	MANGANESE	207	UG/L		183	1.13	162.33	1.28
NON-RFCA	P115689	22-Nov-96	MANGANESE	229	UG/L		183	1.25	162.33	1.41
NON-RFCA	P115689	24-Jan-96	TETRACHLOROETHENE	17	UG/L		5	3.40		
NON-RFCA	P115689	18-Jul-96	TETRACHLOROETHENE	17	UG/L		5	3.40		
NON-RFCA	P115689	22-Nov-96	TETRACHLOROETHENE	16	UG/L		5	3.20		
NON-RFCA	P115689	18-Jul-96	THALLIUM	7.2	UG/L	B	2	3.60	4.9	1.47
NON-RFCA	P115689	22-Nov-96	THALLIUM	8	UG/L	B	2	4.00	4.9	1.63
NON-RFCA	P115689	24-Jan-96	TRICHLOROETHENE	56	UG/L		5	11.20		
NON-RFCA	P115689	18-Jul-96	TRICHLOROETHENE	56	UG/L		5	11.20		
NON-RFCA	P115689	22-Nov-96	TRICHLOROETHENE	60	UG/L		5	12.00		
NON-RFCA	P115689	24-Jan-96	VINYL CHLORIDE	66	UG/L		2	33.00		
NON-RFCA	P115689	18-Jul-96	VINYL CHLORIDE	75	UG/L		2	37.50		
NON-RFCA	P115689	22-Nov-96	VINYL CHLORIDE	97	UG/L		2	48.50		
NON-RFCA	P207689	16-May-96	NITRATE/NITRITE	85.7	MG/L		10	8.57	4.684	18.37
NON-RFCA	P207689	08-Aug-96	NITRATE/NITRITE	21.7	MG/L		10	2.17	4.684	4.65
NON-RFCA	P207689	19-Dec-96	NITRATE/NITRITE	13.1	MG/L		10	1.31	4.684	2.81
NON-RFCA	P207689	16-May-96	SELENIUM	166	UG/L	N	50	3.32	43.72	3.80
NON-RFCA	P207689	16-May-96	SULFATE	521	MG/L		500	1.04	435.598	1.20
NON-RFCA	P207689	08-Aug-96	THALLIUM	6.2	UG/L	B	2	3.10	4.9	1.27
NON-RFCA	P207889	24-Jul-96	NITRATE/NITRITE	12.1	MG/L		10	1.21	4.684	2.59
NON-RFCA	P207889	21-May-96	SULFATE	705	MG/L		500	1.41	435.598	1.62
NON-RFCA	P207989	08-May-96	SELENIUM	52.8	UG/L	N	50	1.06	43.72	1.21
NON-RFCA	P115589	15-Feb-96	U-234	4.994	PCI/L		1.07	4.67	60.7	0.08
NON-RFCA	P115589	17-Jun-96	U-234	4.678	PCI/L		1.07	4.37	60.7	0.08
NON-RFCA	P115589	15-Aug-96	U-234	4.702	PCI/L		1.07	4.39	60.7	0.08
NON-RFCA	P115589	10-Dec-96	U-234	5.33	PCI/L		1.07	4.98	60.7	0.09
NON-RFCA	P115589	15-Feb-96	U-238	1.283	PCI/L		0.768	1.67	41.8	0.03
NON-RFCA	P115589	17-Jun-96	U-238	1.7	PCI/L		0.768	2.21	41.8	0.04
NON-RFCA	P115589	15-Aug-96	U-238	1.359	PCI/L		0.768	1.77	41.8	0.03
NON-RFCA	P115589	10-Dec-96	U-238	1.414	PCI/L		0.768	1.84	41.8	0.03
NON-RFCA	P207989	05-Dec-96	THALLIUM	6	UG/L	B	2	3.00	4.9	1.22
NON-RFCA	P209589	08-May-96	NITRATE/NITRITE	4740	MG/L		10	474.00	4.684	1016.30
NON-RFCA	P209589	20-Aug-96	NITRATE/NITRITE	2820	MG/L		10	282.00	4.684	561.75

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TABLE 2-6 Chemicals of Concern in Non-RFCA Wells (cont'd)

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	P209589	11-Mar-96	RA-228	20.3	PCI/L		20	1.01	3.16	6.41
NON-RFCA	P209589	08-May-96	RA-228	22.9	PCI/L		20	1.15	3.16	7.25
NON-RFCA	P209589	20-Aug-96	RA-228	20.2	PCI/L		20	1.01	3.16	6.39
NON-RFCA	P209589	10-Dec-96	RA-228	25.6	PCI/L		20	1.28	3.16	8.09
NON-RFCA	P209589	20-Aug-96	TRITIUM	10600	PCI/L		666	15.92	612.98	17.29
NON-RFCA	P209589	10-Dec-96	TRITIUM	11000	PCI/L		666	16.52	612.98	17.95
NON-RFCA	P209589	11-Mar-96	U-234	168.7	PCI/L		1.07	157.66	60.7	2.78
NON-RFCA	P209589	08-May-96	U-234	189.1	PCI/L		1.07	176.73	60.7	3.12
NON-RFCA	P209589	20-Aug-96	U-234	215.4	PCI/L		1.07	201.31	60.7	3.55
NON-RFCA	P209589	10-Dec-96	U-234	220.9	PCI/L		1.07	206.45	60.7	3.64
NON-RFCA	P209589	11-Mar-96	U-235	5.33	PCI/L		1.01	5.27	1.79	2.98
NON-RFCA	P209589	08-May-96	U-235	7.90	PCI/L		1.01	7.82	1.79	4.41
NON-RFCA	P209589	20-Aug-96	U-235	5.44	PCI/L		1.01	5.39	1.79	3.04
NON-RFCA	P115689	24-Jan-96	U-234	2.14	PCI/L		1.07	2.00	60.7	0.04
NON-RFCA	P115689	17-Jun-96	U-234	2.08	PCI/L		1.07	1.95	60.7	0.03
NON-RFCA	P115689	18-Jul-96	U-234	2.25	PCI/L		1.07	2.10	60.7	0.04
NON-RFCA	P115689	22-Nov-96	U-234	2.45	PCI/L		1.07	2.29	60.7	0.04
NON-RFCA	P115689	24-Jan-96	U-238	1.43	PCI/L		0.768	1.87	41.8	0.03
NON-RFCA	P115689	18-Jul-96	U-238	1.52	PCI/L		0.768	1.98	41.8	0.04
NON-RFCA	P115689	22-Nov-96	U-238	1.22	PCI/L		0.768	1.58	41.8	0.03
NON-RFCA	P209589	10-Dec-96	U-235	6.50	PCI/L		1.01	6.43	1.79	3.63
NON-RFCA	P209589	11-Mar-96	U-238	72.6	PCI/L		0.768	94.47	41.8	1.74
NON-RFCA	P209589	08-May-96	U-238	85.2	PCI/L		0.768	110.96	41.8	2.04
NON-RFCA	P209589	20-Aug-96	U-238	93.2	PCI/L		0.768	121.33	41.8	2.23
NON-RFCA	P209589	10-Dec-96	U-238	94.1	PCI/L		0.768	122.47	41.8	2.25
NON-RFCA	P209689	20-Aug-96	NITRATE/NITRITE	56.8	MG/L		10	5.68	4.684	12.18
NON-RFCA	P209789	21-Feb-96	NITRATE/NITRITE	140	MG/L		10	14.00	4.684	30.02
NON-RFCA	P209789	09-May-96	NITRATE/NITRITE	136	MG/L		10	13.60	4.684	29.16
NON-RFCA	P209789	20-Aug-96	NITRATE/NITRITE	92.1	MG/L		10	9.21	4.684	19.75
NON-RFCA	P207689	19-Dec-96	THALLIUM	4.6	UG/L	B	2	2.30	4.9	0.94
NON-RFCA	P207689	05-Mar-96	U-234	9.474	PCI/L		1.07	8.85	60.7	0.16
NON-RFCA	P207689	16-May-96	U-234	31.34	PCI/L		1.07	29.29	60.7	0.52
NON-RFCA	P207689	08-Aug-96	U-234	10.58	PCI/L		1.07	9.89	60.7	0.17
NON-RFCA	P207689	19-Dec-96	U-234	20.85	PCI/L		1.07	19.49	60.7	0.34
NON-RFCA	P207689	05-Mar-96	U-238	6.937	PCI/L		0.768	9.03	41.8	0.17
NON-RFCA	P207689	16-May-96	U-238	27.12	PCI/L		0.768	35.31	41.8	0.65
NON-RFCA	P207689	08-Aug-96	U-238	7.775	PCI/L		0.768	10.12	41.8	0.19
NON-RFCA	P207689	19-Dec-96	U-238	15.79	PCI/L		0.768	20.56	41.8	0.38
NON-RFCA	P209789	20-Dec-96	NITRATE/NITRITE	186	MG/L		10	18.60	4.684	39.88
NON-RFCA	P209789	21-Feb-96	TRITIUM	1715	PCI/L		666	2.58	612.98	2.80
NON-RFCA	P207889	21-May-96	U-234	14.26	PCI/L		1.07	13.33	60.7	0.23
NON-RFCA	P207889	21-May-96	U-238	12.56	PCI/L		0.768	16.35	41.8	0.30
NON-RFCA	P209789	09-May-96	TRITIUM	2089	PCI/L		666	3.14	612.98	3.41
NON-RFCA	P209789	20-Aug-96	TRITIUM	977	PCI/L		666	1.47	612.98	1.59
NON-RFCA	P209789	20-Dec-96	TRITIUM	2300	PCI/L		666	3.45	612.98	3.75
NON-RFCA	P209789	20-Dec-96	U-234	64.7	PCI/L		1.07	60.50	60.7	1.07
NON-RFCA	P209789	20-Dec-96	U-235	1.83	PCI/L		1.01	1.81	1.79	1.02
NON-RFCA	P210089	24-Apr-96	NITRATE/NITRITE	185	MG/L		10	18.50	4.684	39.67
NON-RFCA	P210089	22-Oct-96	NITRATE/NITRITE	195	MG/L		10	19.50	4.684	41.81
NON-RFCA	P210089	24-Apr-96	SELENIUM	1510	UG/L	N	50	30.20	43.72	34.54
NON-RFCA	P209789	21-Feb-96	U-234	24.93	PCI/L		1.07	23.30	60.7	0.41
NON-RFCA	P209789	09-May-96	U-234	48.78	PCI/L		1.07	45.59	60.7	0.80
NON-RFCA	P209789	20-Aug-96	U-234	32.87	PCI/L		1.07	30.72	60.7	0.54
NON-RFCA	P210089	24-Apr-96	SULFATE	743	MG/L		500	1.49	435.598	1.71
NON-RFCA	P209789	09-May-96	U-235	1.329	PCI/L		1.01	1.32	1.79	0.74
NON-RFCA	P209789	20-Aug-96	U-235	1.244	PCI/L		1.01	1.23	1.79	0.69
NON-RFCA	P210089	22-Oct-96	SULFATE	760	MG/L		500	1.52	435.598	1.74
NON-RFCA	P209789	21-Feb-96	U-238	12.74	PCI/L		0.768	16.59	41.8	0.30
NON-RFCA	P209789	09-May-96	U-238	19.85	PCI/L		0.768	25.85	41.8	0.47
NON-RFCA	P209789	20-Aug-96	U-238	12.91	PCI/L		0.768	16.81	41.8	0.31
NON-RFCA	P209789	20-Dec-96	U-238	26.12	PCI/L		0.768	34.01	41.8	0.62
NON-RFCA	P215789	28-Feb-96	1,1-DICHLOROETHENE	29	UG/L		7	4.14		
NON-RFCA	P215789	30-Jul-96	1,1-DICHLOROETHENE	43	UG/L		7	6.14		
NON-RFCA	P215789	28-Feb-96	METHYLENE CHLORIDE	25	UG/L		5	5.00		
NON-RFCA	P215789	28-Feb-96	NITRATE/NITRITE	10	MG/L		10	1.00	4.684	2.14
NON-RFCA	P215789	30-Jul-96	NITRATE/NITRITE	12.2	MG/L		10	1.22	4.684	2.62
NON-RFCA	P215789	28-Feb-96	TETRACHLOROETHENE	5	UG/L	J	5	1.00		
NON-RFCA	P215789	30-Jul-96	TETRACHLOROETHENE	6	UG/L	J	5	1.20		
NON-RFCA	P215789	28-Feb-96	TRICHLOROETHENE	680	UG/L		5	136.00		
NON-RFCA	P215789	30-Jul-96	TRICHLOROETHENE	740	UG/L		5	148.00		
NON-RFCA	P218289	28-Feb-96	TETRACHLOROETHENE	43	UG/L		5	8.60		

TABLE 2-6 Chemicals of Concern in Non-RFCA Wells (cont'd)

Well Class	Location	Sample Date	Chemical of Concern	Result	Units	Q	Tier 2 AL	Tier II Ratio	Background M2SD	Background Ratio
NON-RFCA	P218289	29-Jul-96	TETRACHLOROETHENE	23	UG/L		5	4.60		
NON-RFCA	P218289	28-Feb-96	TRICHLOROETHENE	10	UG/L		5	2.00		
NON-RFCA	P218289	29-Jul-96	TRICHLOROETHENE	6	UG/L		5	1.20		
NON-RFCA	P218289	28-Feb-96	U-234	2.012	PCI/L		1.07	1.88	60.7	0.03
NON-RFCA	P218289	29-Jul-96	U-234	1.544	PCI/L		1.07	1.44	60.7	0.03
NON-RFCA	P218289	28-Feb-96	VINYL CHLORIDE	4	UG/L		2	2.00		
NON-RFCA	P218289	29-Jul-96	VINYL CHLORIDE	3	UG/L		2	1.50		
NON-RFCA	P313489	26-Nov-96	ANTIMONY	18	UG/L	B	6	3.00	39.54	0.46
NON-RFCA	P313489	12-Mar-96	PU239/40	0.613	PCI/L		0.151	4.06	0.047	13.04
NON-RFCA	P313489	17-Jul-96	PU239/40	0.87	PCI/L		0.151	5.76	0.047	18.51
NON-RFCA	P313489	26-Nov-96	PU239/40	0.245	PCI/L		0.151	1.62	0.047	5.22
NON-RFCA	P313489	26-Nov-96	THALLIUM	6.2	UG/L	B	2	3.10	4.9	1.27
NON-RFCA	P313489	12-Mar-96	U-234	1.615	PCI/L		1.07	1.51	60.7	0.03
NON-RFCA	P313489	29-May-96	U-234	1.537	PCI/L		1.07	1.44	60.7	0.03
NON-RFCA	P313489	17-Jul-96	U-234	1.248	PCI/L		1.07	1.17	60.7	0.02
NON-RFCA	P313489	26-Nov-96	U-234	1.515	PCI/L		1.07	1.42	60.7	0.02
NON-RFCA	P313489	17-Jul-96	U-238	0.8145	PCI/L		0.768	1.06	41.8	0.02
NON-RFCA	P320089	24-Oct-96	ANTIMONY	37.4	UG/L	B	0.006	6.23	39.54	0.95
NON-RFCA	P320089	18-Jun-96	TETRACHLOROETHENE	770	UG/L		5	154.00		
NON-RFCA	P320089	24-Oct-96	TETRACHLOROETHENE	470	UG/L		5	94.00		
NON-RFCA	P320089	24-Oct-96	THALLIUM	8.9	UG/L	B	2	4.45	4.9	1.82
NON-RFCA	P320089	18-Jun-96	TRICHLOROETHENE	30	UG/L		5	6.00		
NON-RFCA	P320089	24-Oct-96	TRICHLOROETHENE	20	UG/L	J	5	4.00		
NON-RFCA	P320089	18-Jun-96	U-234	1.345	PCI/L		1.07	1.26	60.7	0.02
NON-RFCA	P320089	24-Oct-96	U-234	1.349	PCI/L		1.07	1.26	60.7	0.02
NON-RFCA	P320089	18-Jun-96	U-238	0.7706	PCI/L		0.768	1.00	41.8	0.02
NON-RFCA	P320089	24-Oct-96	U-238	0.9239	PCI/L		0.768	1.20	41.8	0.02
NON-RFCA	P416289	17-Jul-96	THALLIUM	8	UG/L	B	2	4.00	4.9	1.63
NON-RFCA	P416289	10-Dec-96	THALLIUM	4.6	UG/L	B	2	2.30	4.9	0.94
NON-RFCA	P416289	23-Jan-96	U-234	10.21	PCI/L		1.07	9.54	60.7	0.17
NON-RFCA	P416289	17-Jul-96	U-234	7.299	PCI/L		1.07	6.82	60.7	0.12
NON-RFCA	P416289	10-Dec-96	U-234	7.982	PCI/L		1.07	7.46	60.7	0.13
NON-RFCA	P416289	23-Jan-96	U-238	2.097	PCI/L		0.768	2.73	41.8	0.05
NON-RFCA	P416289	17-Jul-96	U-238	1.592	PCI/L		0.768	2.07	41.8	0.04
NON-RFCA	P416289	10-Dec-96	U-238	1.552	PCI/L		0.768	2.02	41.8	0.04
NON-RFCA	P416989	26-Nov-96	THALLIUM	5.6	UG/L	B	2	2.80	4.9	1.14
NON-RFCA	P419689	01-Mar-96	TETRACHLOROETHENE	17	UG/L		5	3.40		
NON-RFCA	P419689	23-Sep-96	TETRACHLOROETHENE	12	UG/L		5	2.40		

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2.5 DISCUSSION OF GROUNDWATER PLUMES

Plume maps have recently been updated for VOCs, nitrate, tritium, U-233/234, U-235, and U-238. Groundwater data extracted from RFEDS for the period 1991 through 1996 were used in this effort. The mean concentration of each analyte for each well from 1991 through 1995 was calculated and used to define the outlines for each plume. Final adjustments to the plume definitions were made using the latest 1996 data. The plumes, as drawn, are best estimates of the spatial distribution of concentrations of the chemicals of concern in groundwater. In the case of the uranium isotopes, an anthropogenic source is not necessarily implied (see discussion below).

2.5.1 Volatile Organic Chemical (VOC) Plume

The VOC plume map (Plate 12) has been updated from those published in the last three RFCA Quarterly Reports (RMRS, 1997b, 1997c, and 1997d) to reflect the 1996 data (Plate 12). There are four areas with significant updates. Data from well 23296 has shown that the East Trenches Plume has reached the South Walnut Creek drainage at concentrations approaching Tier I action levels. Geoprobe sampling is currently being conducted in the area surrounding well 23296 to better define the plume extent. The second change was made in the 881 Hillside area, around IHSS 119.1, to reflect sampling in 1996 (Plate 12), and geoprobe work performed in 1997 (RMRS, 1997e), that did not show any evidence of VOC concentrations in this area above Tier I action levels. The third change is in the IA plume. Data collected in 1996 indicates that both the Tier I and Tier II areas of the plume extend further north than previously thought. The fourth change is in the area of the PU&D Yard and the present Landfill. The area has been shown as having two distinct plumes, due to the groundwater intercept system surrounding the present Landfill. Data collected in 1996 from the sampling of well 6687 suggests that the PU&D Yard plume is in contact with the intercept system. Therefore, a single plume is shown on the map, although they are separated by the hydrologic barrier (Plate 12).

2.5.2 Nitrate Plume

The nitrate plume map has been updated slightly from those published in the last three RFCA Quarterly Reports (RMRS, 1997b, 1997c, and 1997d) to reflect the 1996 data. Plate 13 shows the estimated extent of the plume with the 1991 through 1995 well locations and average nitrate concentrations. Plate 14 shows the 1996 sampling locations and average nitrate concentrations for the year. The area with groundwater concentrations greater than 100 times the nitrate standard (1000 mg/L) has been expanded to the north to include well 0160, which has a historic mean of 1200 mg/L. The previously isolated areas near well B208289 and to the northeast of Pond A-1, represented as having concentrations greater than the 10 mg/L nitrate standard, have been connected to the rest of the plume. Both of these sampling locations are in the weathered bedrock. Well B208289 is a shallow well, screened in bedrock at a depth of 6 to 15.4 feet. The location to the northeast of pond A-1 was installed into shallow bedrock with a geoprobe. These locations are thought to be hydrologically connected to the rest of the plume.

2.5.3 Tritium Plume

Tritium plumes have been estimated using the 1991 through 1995 well averages and the 1996 results. Plate 15 shows the estimated extent of the tritium plume with the 1991 through 1995 well locations and average activity-concentrations. Plate 16 shows the 1996 tritium sampling locations and average activity-concentrations for the year. There are three areas with groundwater tritium activity-concentrations greater than the Tier II action levels. The largest area is within and to the north of the Solar Ponds. Two other smaller areas with tritium activities above the Tier II action level are located in the central Industrial Area, to the west of the Protected Area, and in the present Landfill. There are no known areas with tritium activities above the Tier I action level.

2.5.4 Uranium Isotope Plumes

Plumes for the uranium isotopes U-233/234, U-235, and U-238 have been estimated using the 1991 through 1995 well averages and the 1996 results. There are two plates for each isotope. The first shows the estimated spatial extent of the plumes with the 1991 through 1995 sampling locations and the average well activity-concentrations (Plates 17, 19, and 21). The second set of plates show the plumes with the 1996 average well activity-concentrations (Plates 18, 20, and 22). There are three isolated wells considered to be out of the zone of influence of the Industrial Area that have high activity-concentrations of the three uranium isotopes. Well B205589 is located near the north boundary of the Site and has been designated as a background well. The other two wells are located in the southeast corner of the Site in the Woman Creek drainage, below Pond D-2.

The maps for U-233/234 and U-238 look very similar (Plates 17 and 21). Areas with activity concentrations above the background M2SD (U-233/234=60.7 pCi/L and U-238=41.8 pCi/L) are in the Solar Ponds area and downgradient near North Walnut Creek. The other areas shown in tan are well groupings that have activity concentrations above 5 pCi/L for the isotopes. Wells in the three main branches of the Walnut Creek drainage system (No Name Gulch and North and South Walnut Creeks) consistently have activity-concentrations between 5 and 40 pCi/L for both U-233/234 and U-238. The surface water stream standard for total uranium isotope activity is 10 pCi/L. Although the levels in the drainages may not be due to Site activities (see discussion below), the activity-concentrations, when summed to estimate total activity, are above the stream standard and may be impacting surface water.

The U-235 maps (Plates 19 and 20) show areas with wells that have activity-concentrations above 0.5 pCi/L, due to the much lower levels of U-235. Areas with activity concentrations above the background M2SD (U-235=1.79 pCi/L) are in the Solar Ponds area and downgradient near North Walnut Creek.

It is uncertain at present whether the uranium isotopes in groundwater associated with the above plumes are naturally occurring or the result of Site activities. Two ratios have been used to distinguish between anthropogenic and natural uranium. The first is the atom ratio of U-238 to U-235, which in naturally occurring uranium is a constant of 137.8. This atom ratio can be used to separate the components of anthropogenic (i.e., enriched or depleted) uranium and naturally occurring uranium. The second is the U-234 to U-238 *activity* ratio that has also been used to distinguish between natural and anthropogenic uranium. Uranium-234 is a product of the U-238 decay chain and its abundance is determined by the abundance of U-238. The activity ratios of U-234 to U-238 are approximately 0.09 in depleted uranium, 1.06 in natural uranium, 5.74 in power-reactor fuel, higher for weapons-grade uranium (EG&G, 1988), and usually ranges from one to three (Hess et al., 1985) in natural waters.

Unfortunately, the alpha-spectroscopy method used for analysis of uranium isotopes at RFETS only estimates the U-235 activity and does not resolve between U-233 and U-234, which are reported together. Thermal ionization mass spectrometry (TIMS) can be used to measure precise amounts of U-234, -235, -236, and -238 in groundwater samples. The technique is more accurate than alpha-spectroscopy, and provides more certain isotopic ratios.

Tables 2-7 and 2-8 show atom and activity ratios in groundwater calculated for some locations with average activities above the background benchmark. U-238 to U-235 atom ratios for dissolved uranium from wells with levels above background in RFETS groundwater show a wide scatter. This may be due to the analytical method, as discussed above, or the lack of a systematic treatment of sampling and analytical error or real variability in isotopic ratios. The data shown in Table 2-8 showing the U-234 to U-238 ratios range from 0.42 to 2.20. Only two wells have very low activity ratios, Well 07391 located about 300 feet south of the 903 Pad and Well 61093 located near the Original Landfill. Once again the value of these ratios are limited and can not be used to decisively conclude what areas of groundwater on the Site have been impacted by uranium originating from Site activities.

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TABLE 2-7. Uranium Isotope Atom Ratios[1] for Filtered Groundwater Locations Above Background.

LOCATION	MEAN U-238 PCI/L	U-238 N NO. OF ATOMS	MEAN U-235 PCI/L	U-235 NO. OF ATOMS	U-238 N/U-235 RATIO
61093	39.2	3.85875E-08	0.991	1.53707E-10	251
07391	33.9	3.33991E-08	0.868	1.34657E-10	248
B305389	14.7	1.44181E-08	0.504	7.82187E-11	184
P208989	37.7	3.71190E-08	1.57	2.42728E-10	153
2689	76.9	7.57378E-08	3.33	5.16028E-10	147
B205589	84.3	8.30155E-08	3.66	5.66977E-10	146
B210389	49.9	4.91498E-08	2.19	3.39676E-10	145
4689	106	1.0395E-07	4.73	7.33482E-10	142
B208689	47.7	4.69755E-08	2.20	3.40830E-10	138
1786	28.5	2.80030E-08	1.32	2.05358E-10	136
P209889	28.9	2.84041E-08	1.35	2.10021E-10	135
P210289	41.2	4.05464E-08	1.94	3.00900E-10	135
B303089	115.	1.13203E-06	5.45	8.45311E-10	134
2886	95.6	9.41133E-08	4.59	7.11125E-10	132
B206589	20.5	2.01591E-08	1.01	1.56806E-10	129
06491	22.5	2.21041E-08	1.13	1.74724E-10	127
B208589	26.9	2.64863E-08	1.37	2.13163E-10	124
P209489	26.5	2.61065E-08	1.37	2.12107E-10	123
1586	15.4	1.51662E-08	0.833	1.29251E-10	117
35691	13.4	1.32088E-08	0.730	1.13213E-10	117
05393	66.4	6.54019E-08	3.64	5.64730E-10	116
37791	15.1	1.48754E-08	0.861	1.33486E-10	111
0586	23.4	2.30487E-08	1.35	2.08668E-10	111
10692	10.9	1.07735E-08	0.679	1.05238E-10	102
2187	18.8	1.84529E-08	1.17	1.81390E-10	101
B210489	21.7	2.13546E-08	1.36	2.10805E-10	101
05093	144	1.41856E-07	9.53	1.47793E-09	96.0
3086	63.9	6.29358E-08	4.31	6.68737E-10	94.1
2686	21.1	2.07350E-08	1.44	2.23832E-10	92.6
10294	31.0	3.04729E-08	2.20	3.40990E-10	89.4
01391	7.47	7.35223E-09	0.532	8.25874E-11	89.0
5287	23.4	2.29937E-08	1.73	2.68753E-09	85.6
37191	6.51	6.40846E-09	0.483	7.49102E-11	85.6
05193	90.4	8.89479E-08	10.5	1.63106E-09	54.5

1 Efurd et al. (1993) used the following equation to transform activities in pCi/L into atom ratios:

$$A = N / l$$

where: A = activity, N = number of atoms of the isotope, l = decay constant (0.693/half-life),
l for uranium-238 = 9.84375E-10, l for uranium-235 = 1.55103E-10

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TABLE 2-8. Uranium Isotope Activity Ratios for Filtered Groundwater Locations Above Background

LOCATION	MEAN U-233/234 PCI/L	MEAN U-238 PCI/L	U-234/U-238 RATIO
05193	198	90.4	2.20
0586	39.5	23.4	1.69
B206589	33.1	20.5	1.62
B210389	80.9	49.9	1.62
P208989	59.1	37.7	1.57
3086	98.2	63.9	1.54
05093	220	144	1.53
B208689	72.9	47.7	1.53
B305389	22.1	14.7	1.51
4689	158	106	1.50
2886	141	95.6	1.47
06491	32.5	22.5	1.45
B205589	121	84.3	1.43
2187	26.5	18.8	1.41
5287	32.7	23.4	1.40
P209889	40.0	28.9	1.39
10692	14.9	10.9	1.36
35691	18.0	13.4	1.34
37191	8.72	6.51	1.34
2686	28.0	21.1	1.33
1786	37.6	28.5	1.32
B208589	35.6	26.9	1.32
B210489	28.0	21.7	1.29
2689	95.1	76.9	1.24
05393	81.1	66.4	1.22
10294	37.3	31	1.21
P209489	31.8	26.5	1.20
P210289	49.3	41.2	1.20
1586	18.0	15.4	1.17
37791	17.7	15.1	1.17
B303089	135	115	1.17
01391	7.76	7.47	1.04
07391	16.0	33.9	0.47
61093	16.5	39.2	0.42

60

Plans are currently being made as part of the Actinide Evaluation Program to perform TIMS analysis on groundwater samples from both background wells and wells within the plume areas to determine if areas with naturally occurring uranium can be differentiated from areas with anthropogenic uranium. It is not currently known if the budget will be available to perform these analyses. However, this is an important step in potentially determining the origin of the uranium in groundwater at RFETS.

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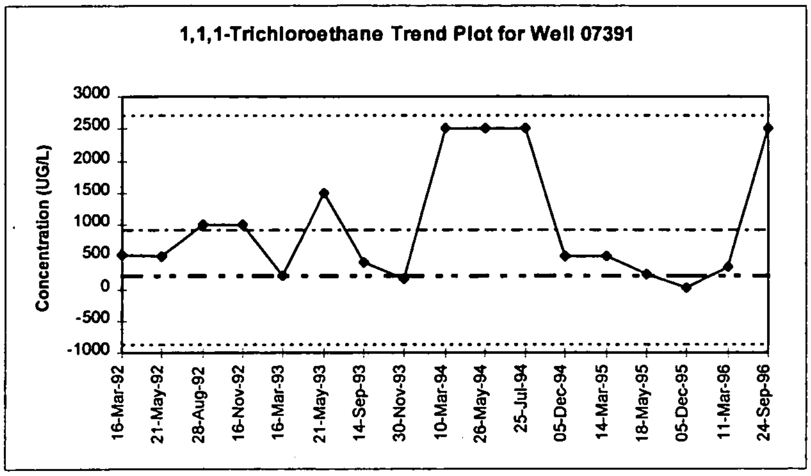
Excell

Figure 2
Trend Plots for Selected Analytes and Wells
1996 Groundwater

1



All 1,1,1-TCA data are "U" or "J" qualified except 16-MAR-92 and 30-NOV-93

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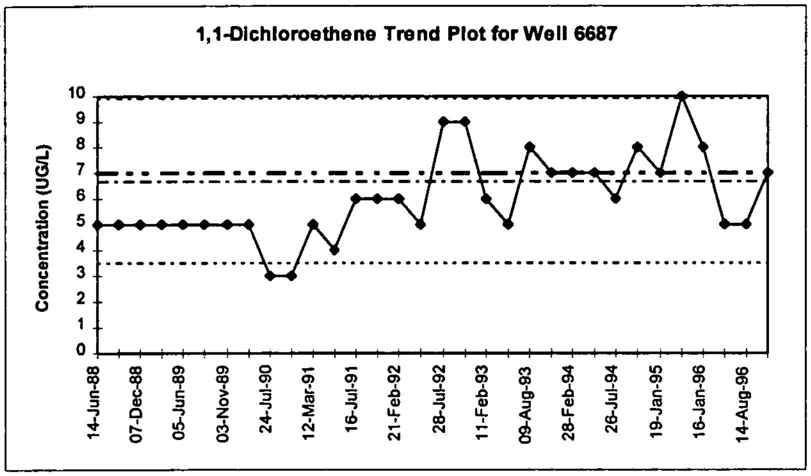

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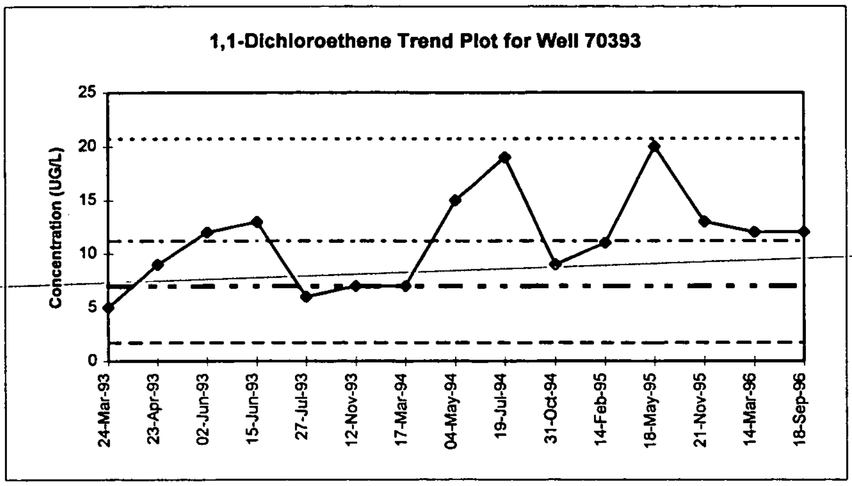
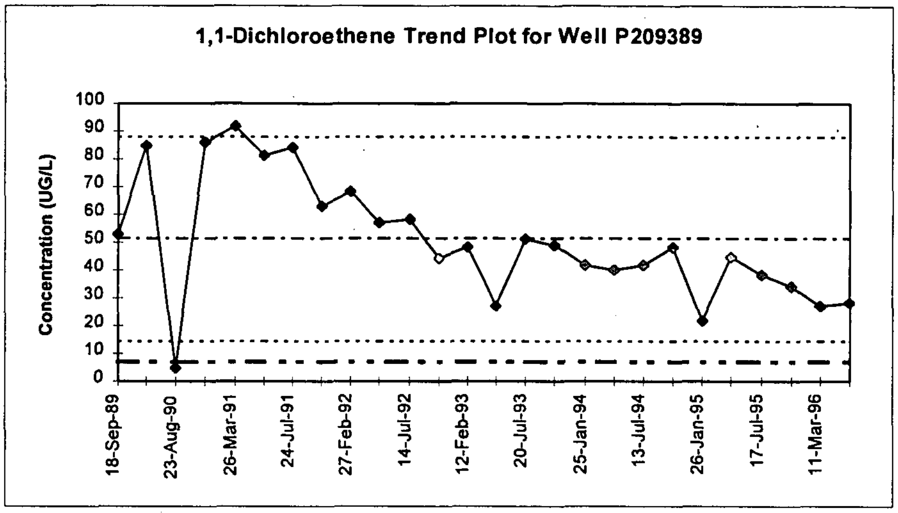


62 Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

4


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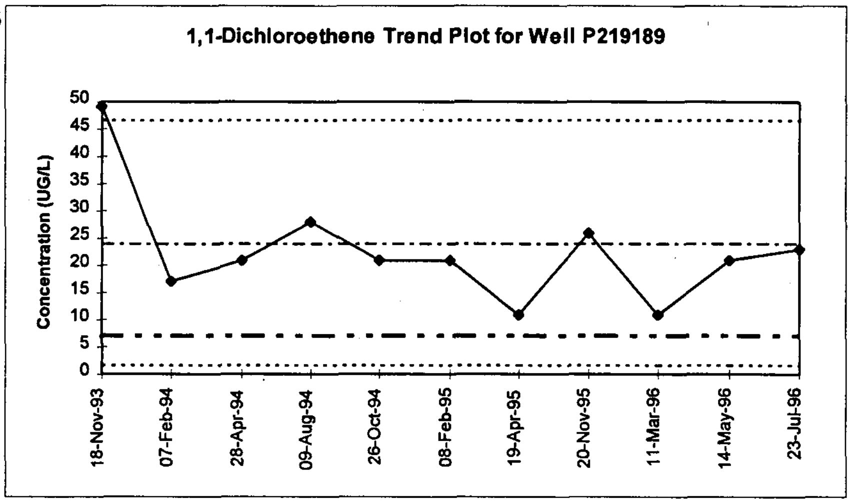

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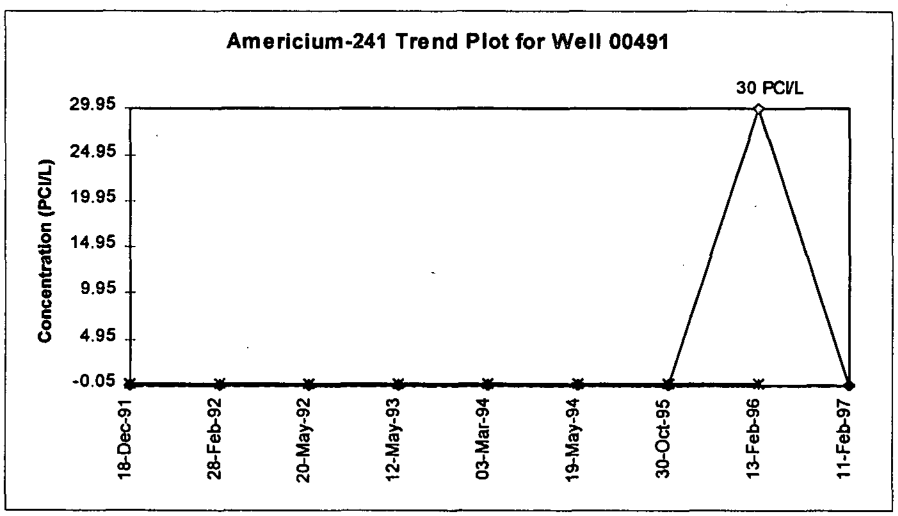

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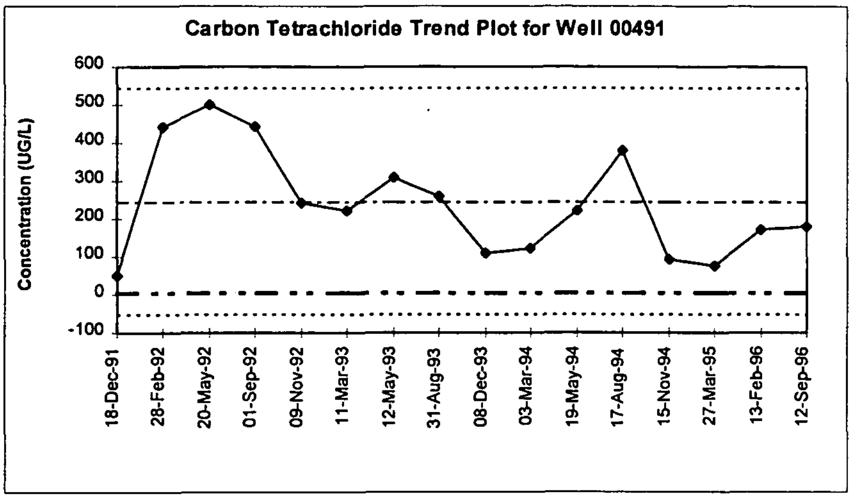
Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

7



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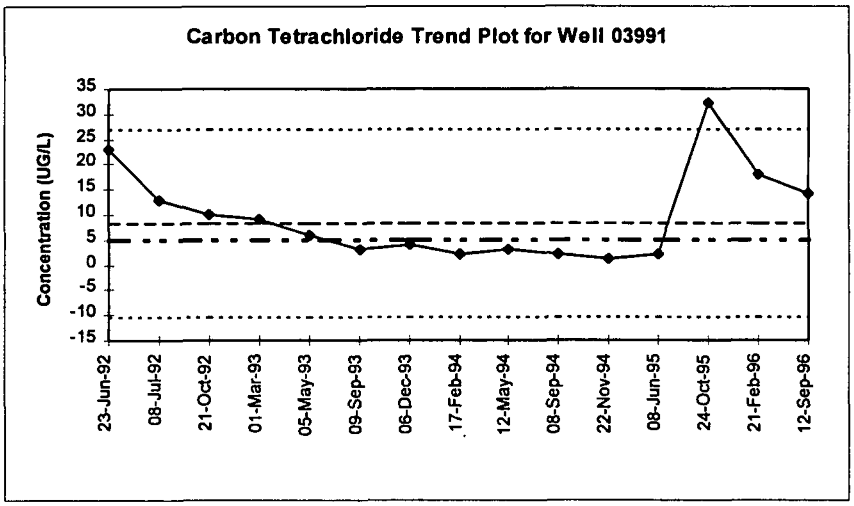

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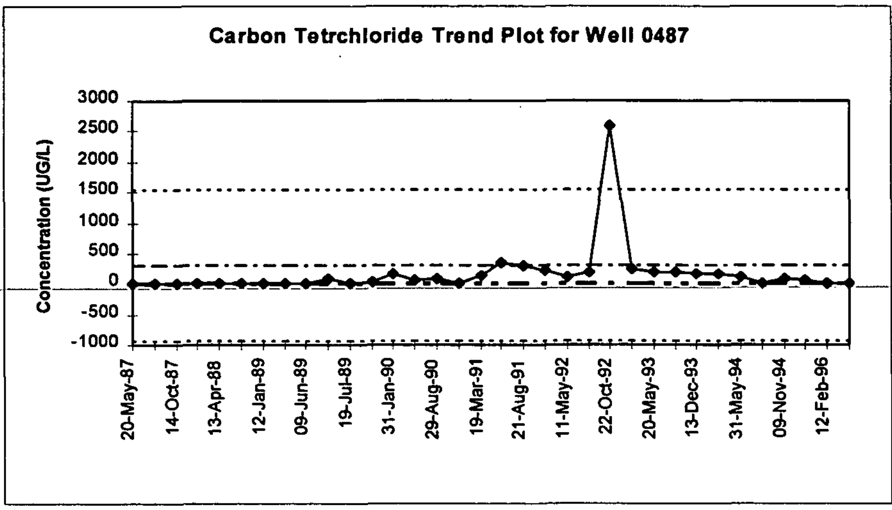

Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

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Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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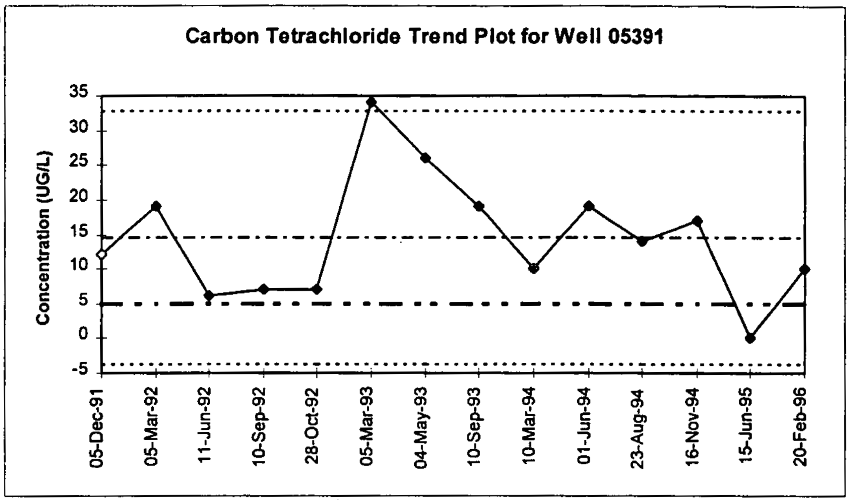

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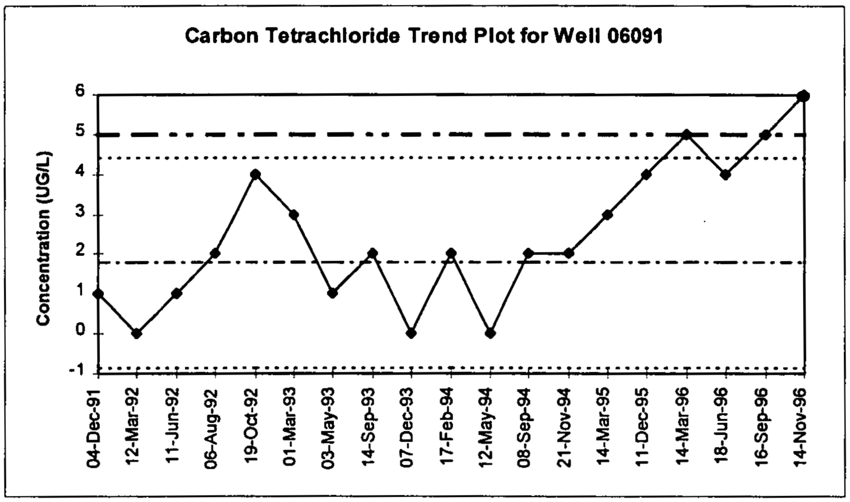

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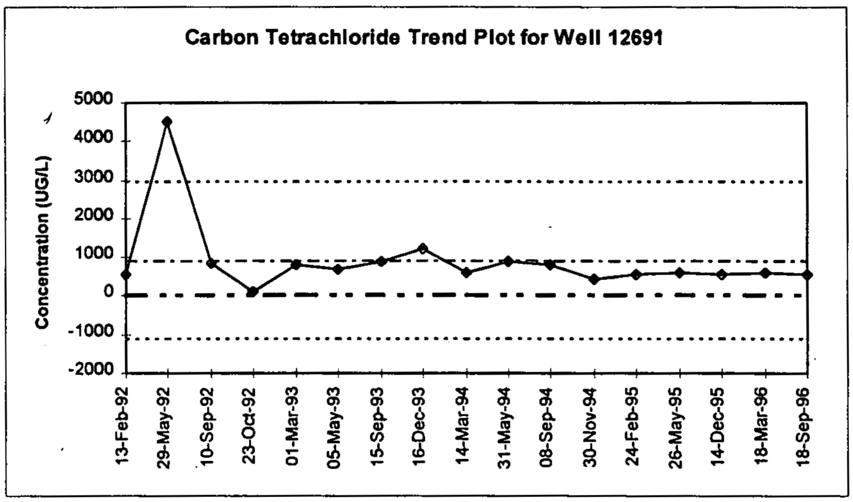
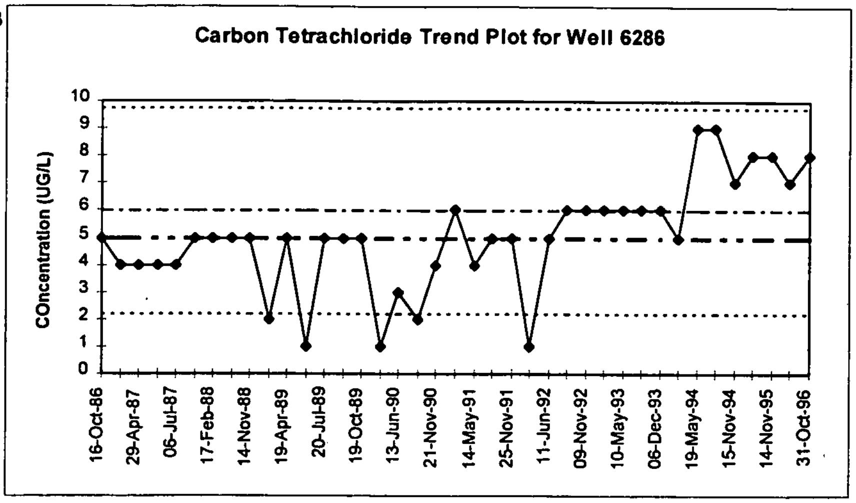


Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

13



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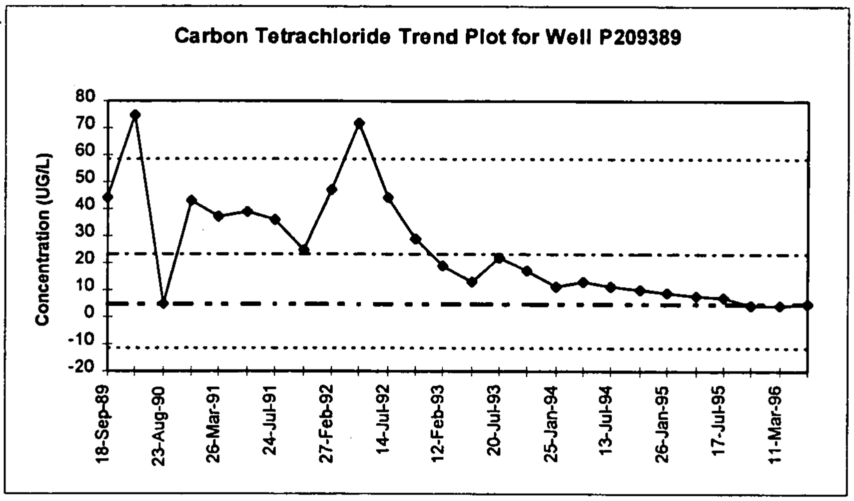

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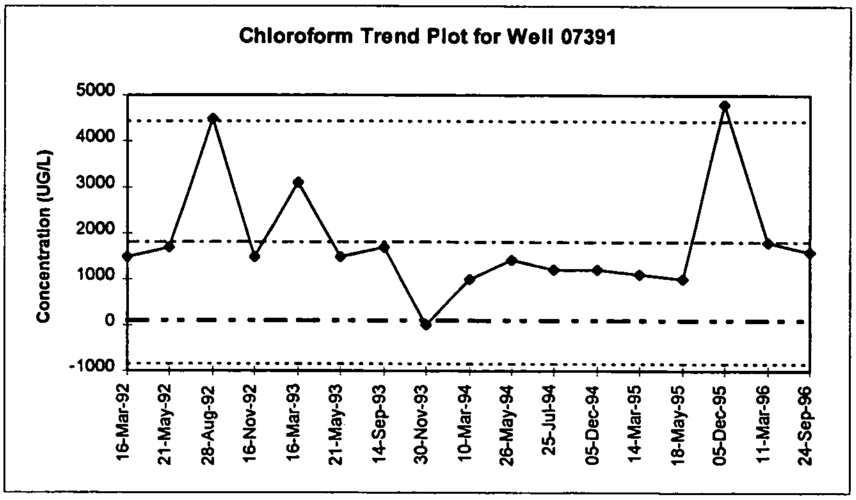
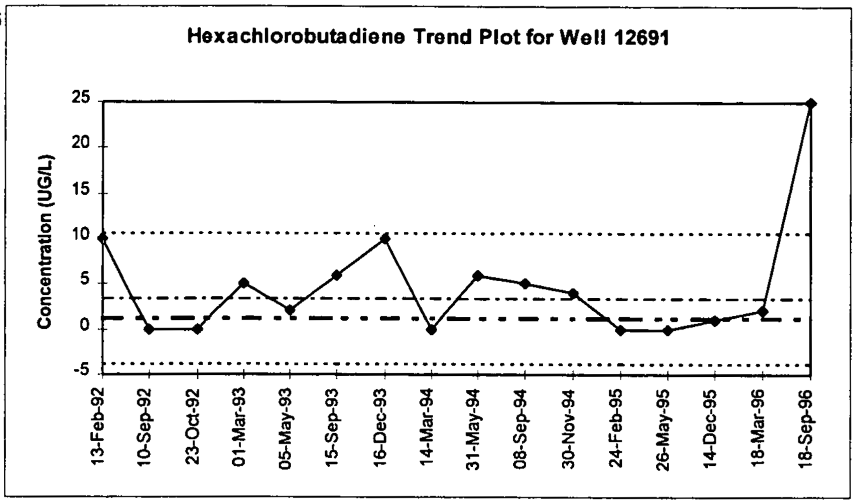


Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

66

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

16



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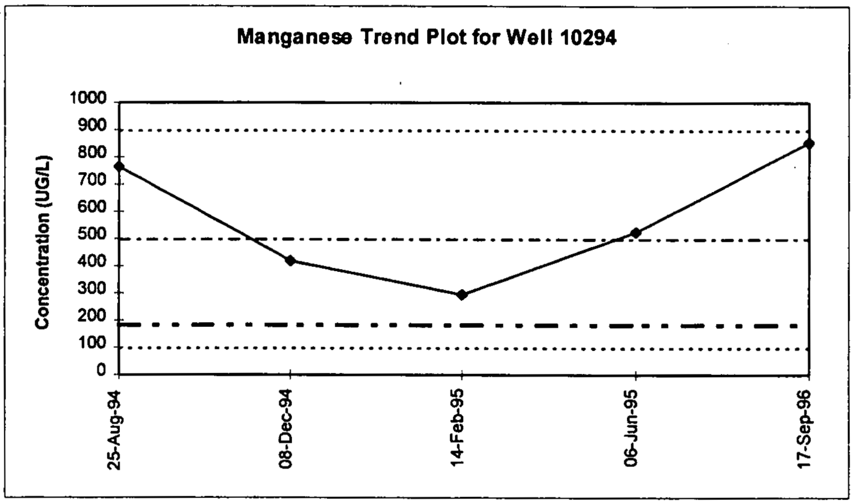

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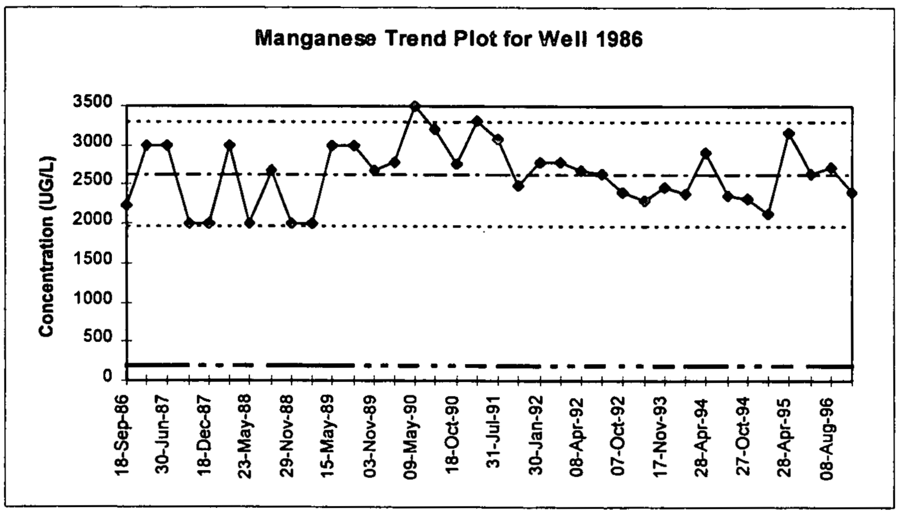
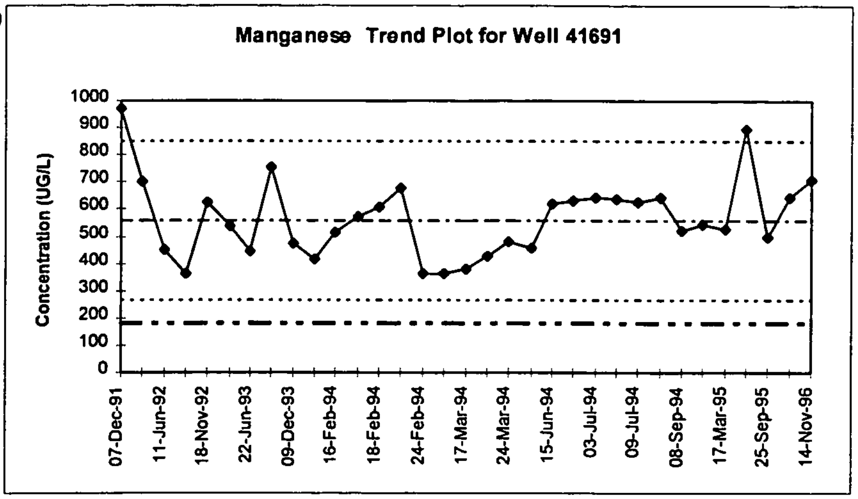


Heavy dashed line = Tier II action level
Light dashed lines = historic mean $\pm$ 2SD

67

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

19



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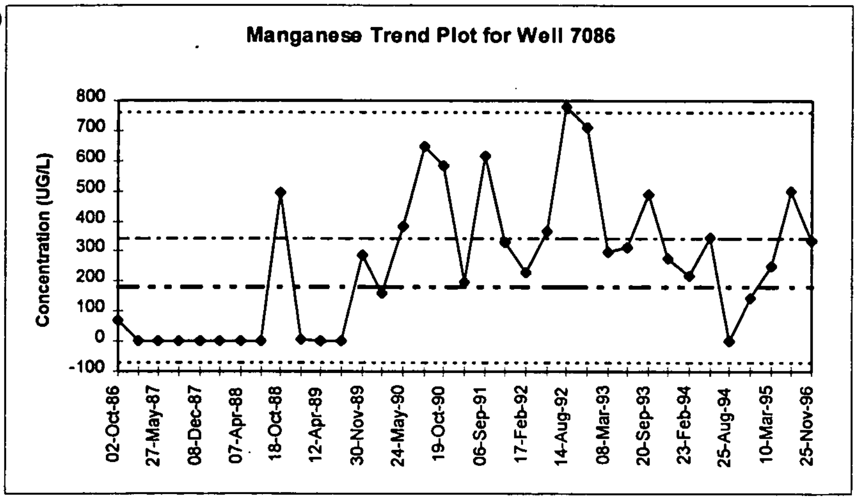

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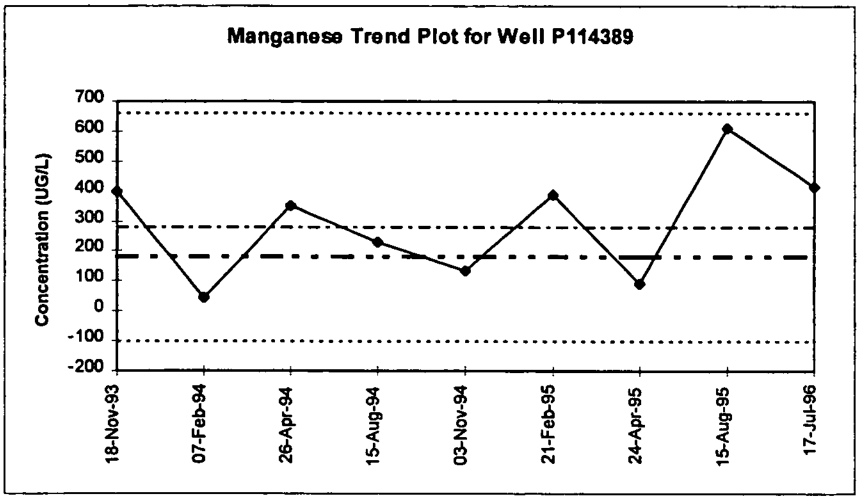

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Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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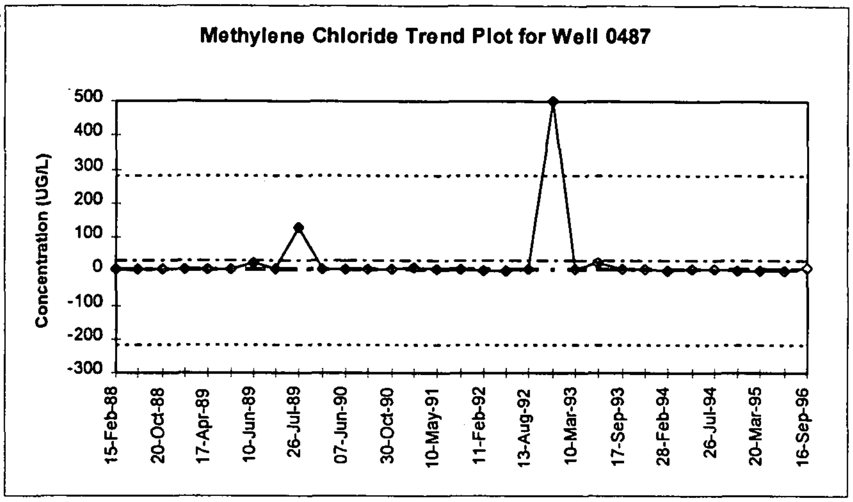

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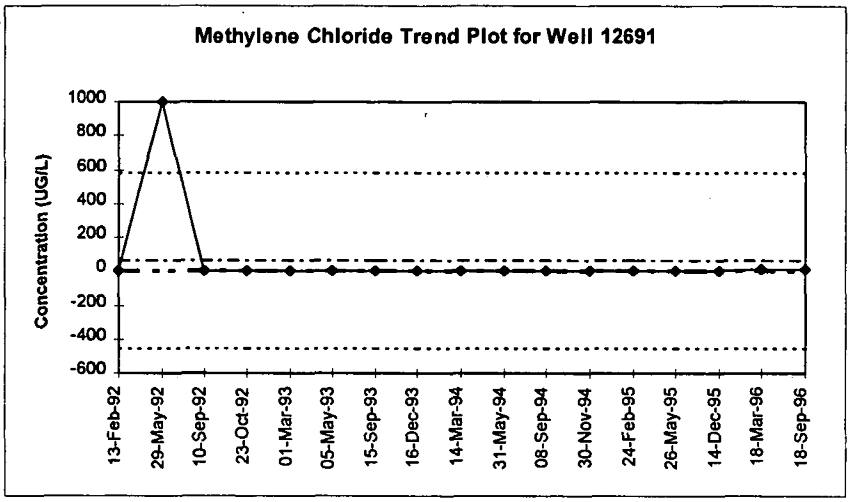

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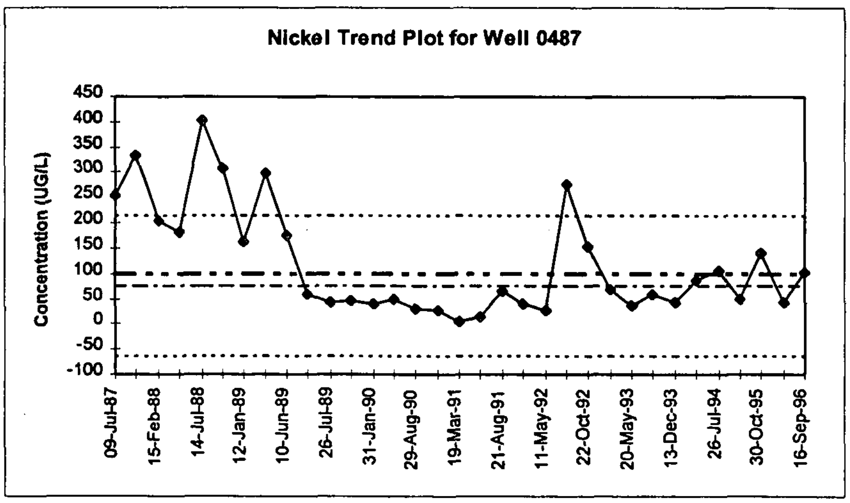

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Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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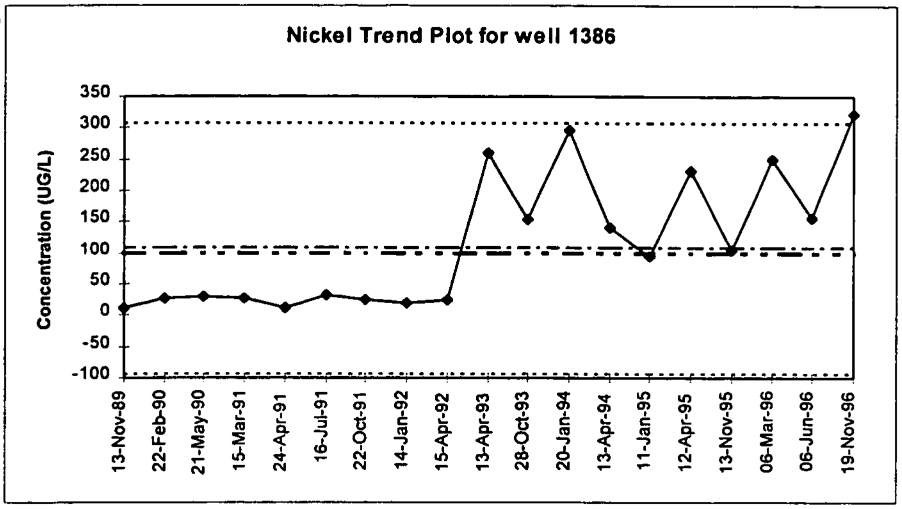

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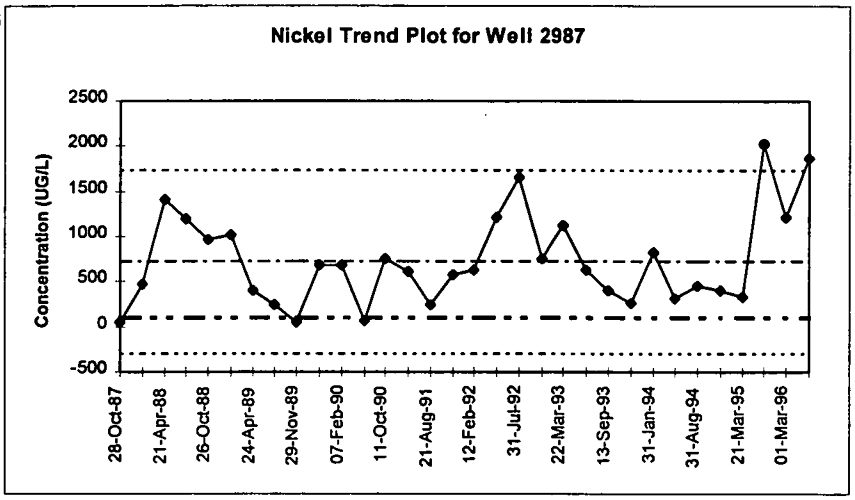

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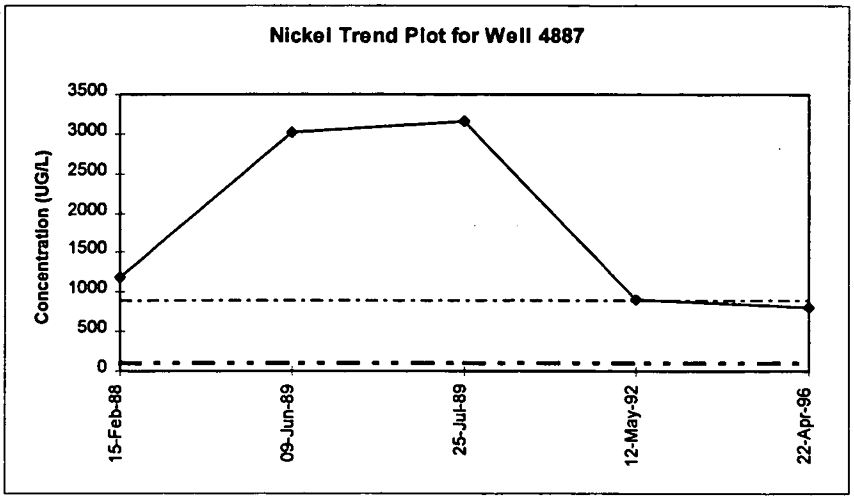

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Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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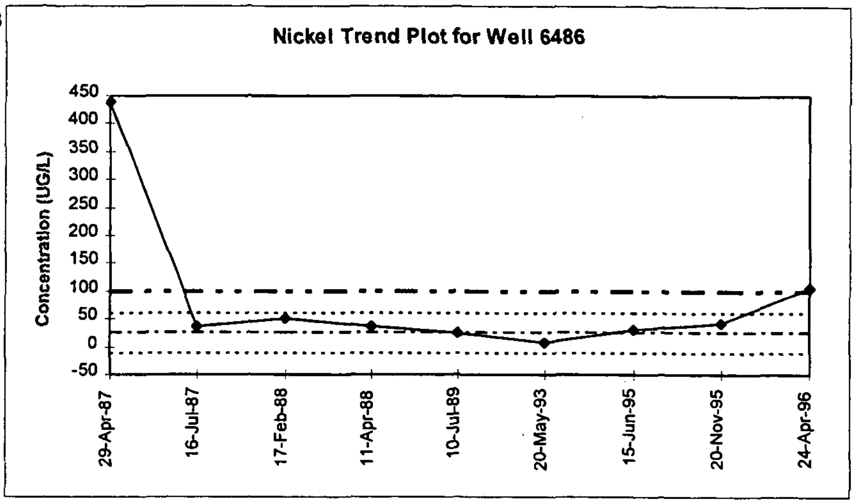

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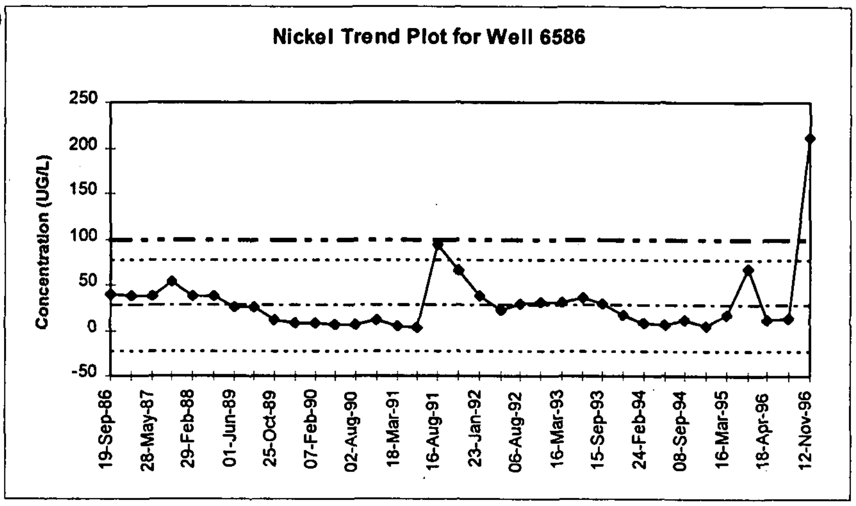

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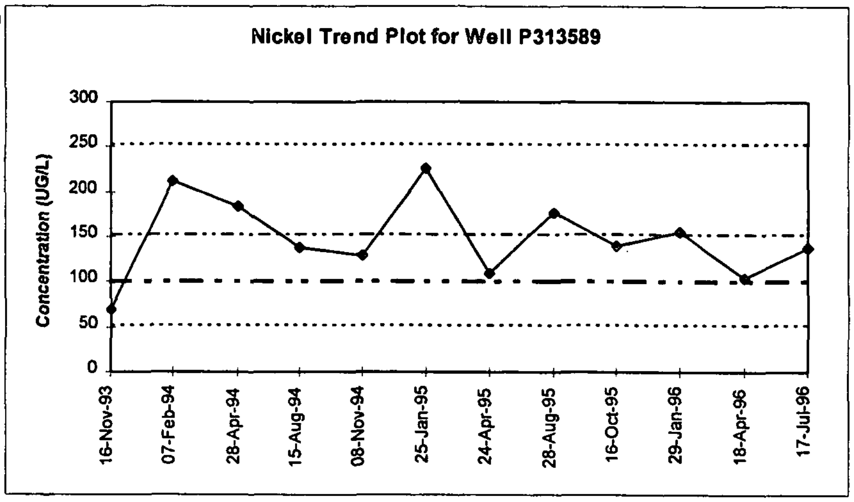
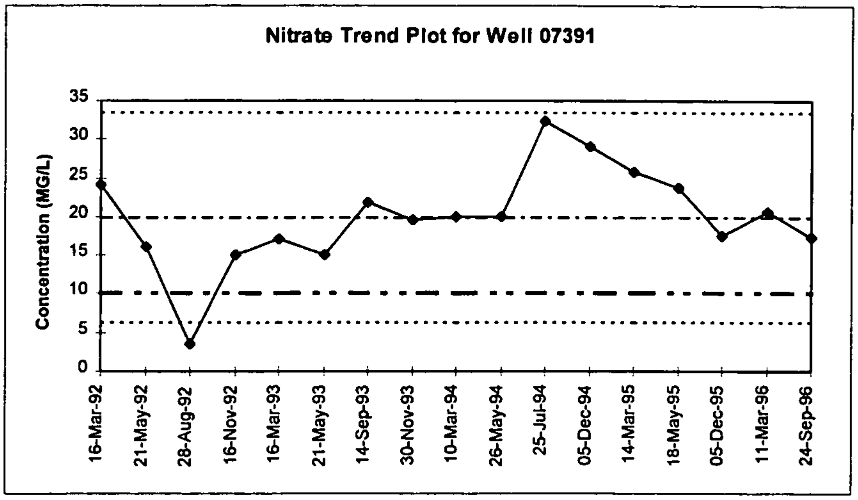


Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

71

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

31



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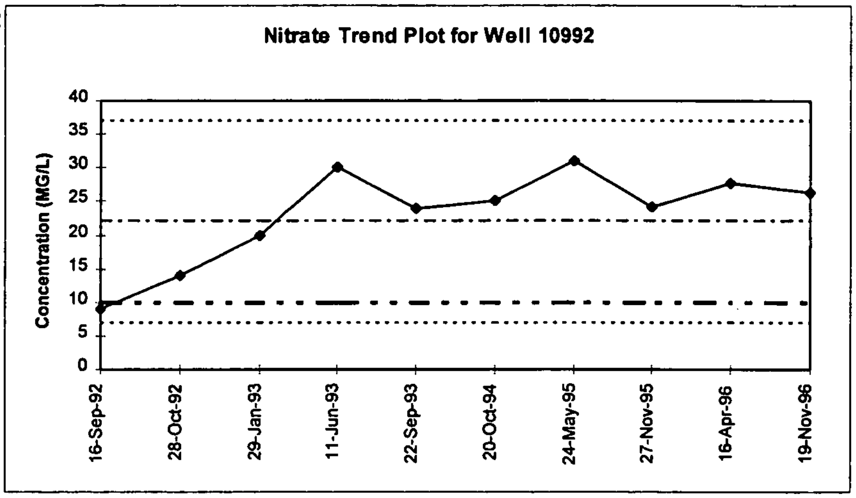

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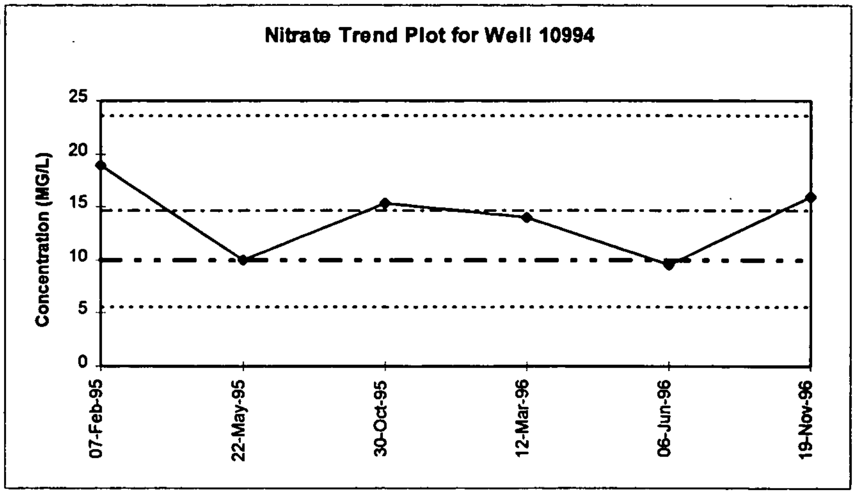

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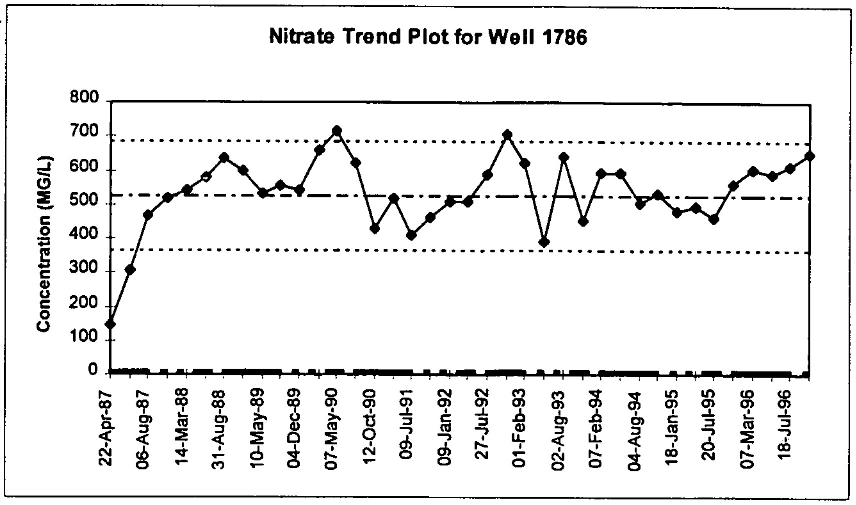
Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

34



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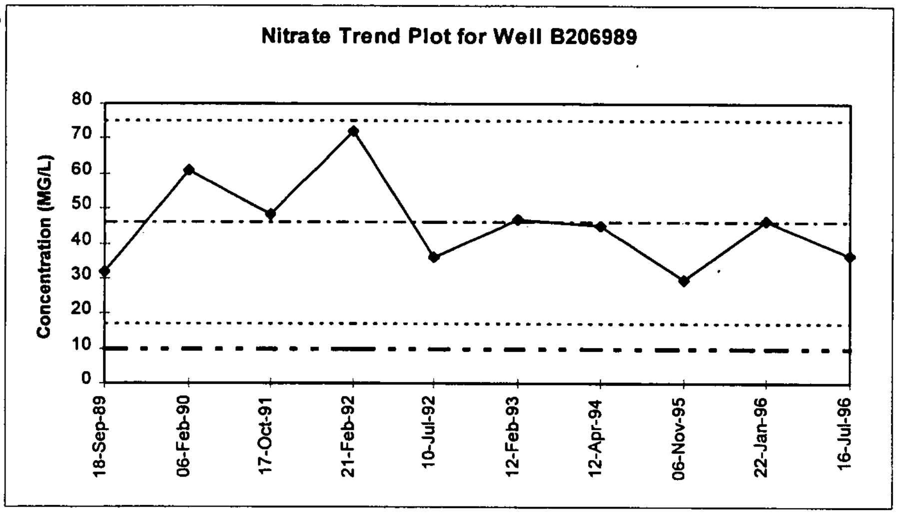

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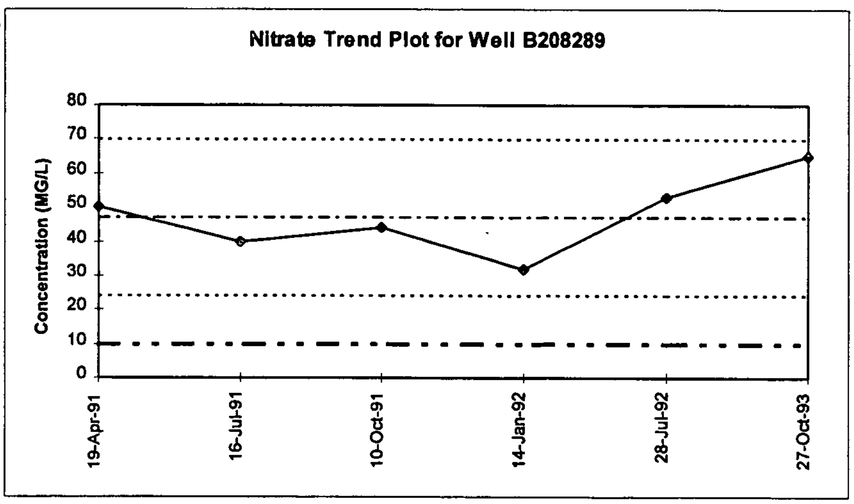
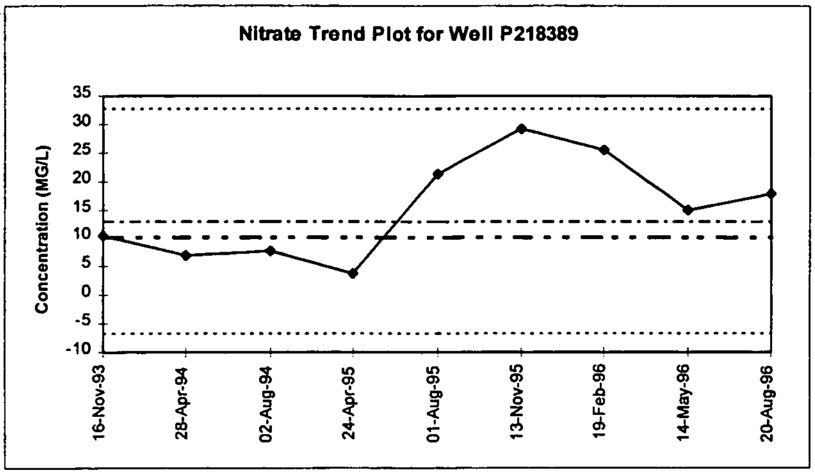


Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

73

Figure 2
Trend Plots for Selected Analytes and Wells
1996 Groundwater

37



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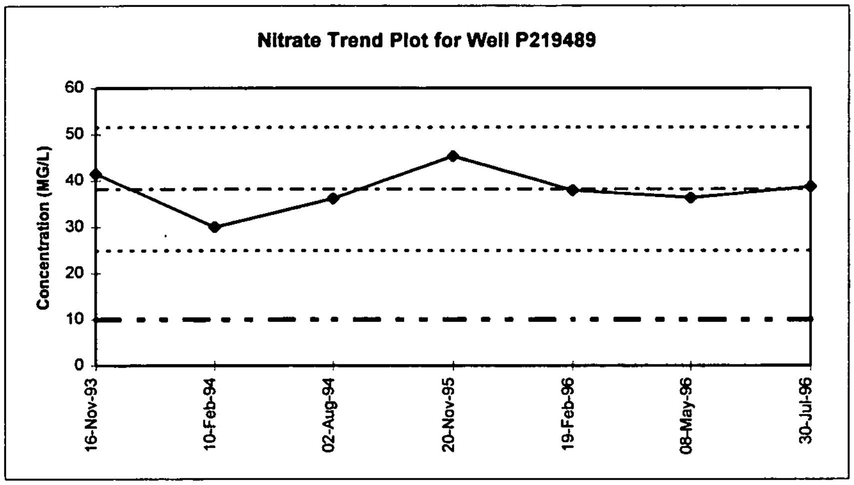

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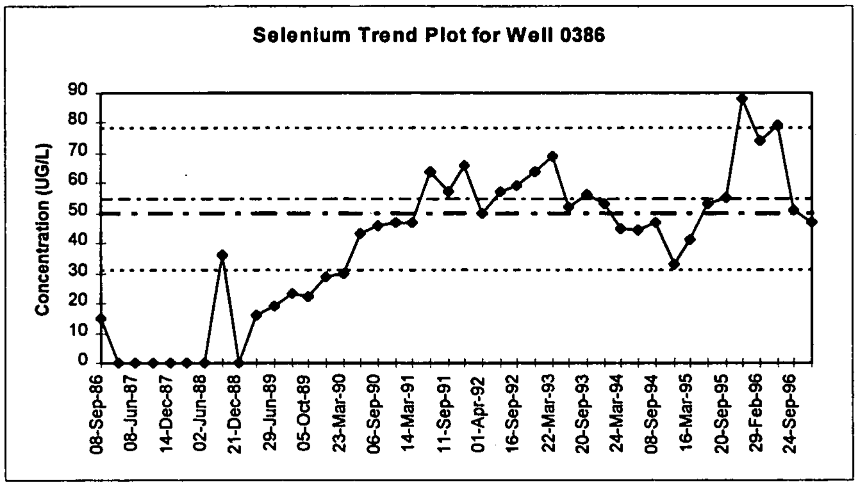

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Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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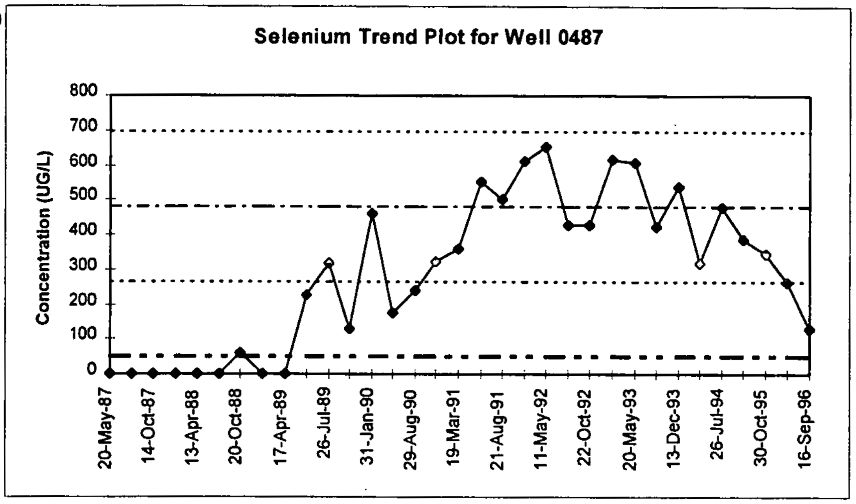

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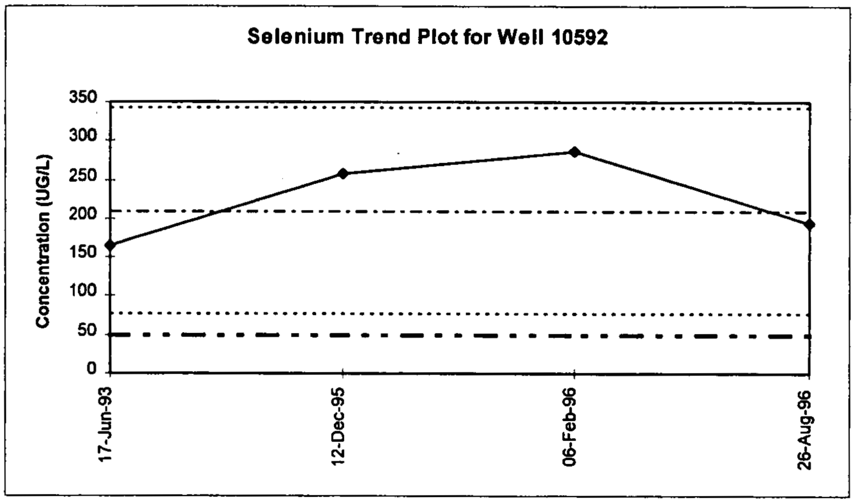

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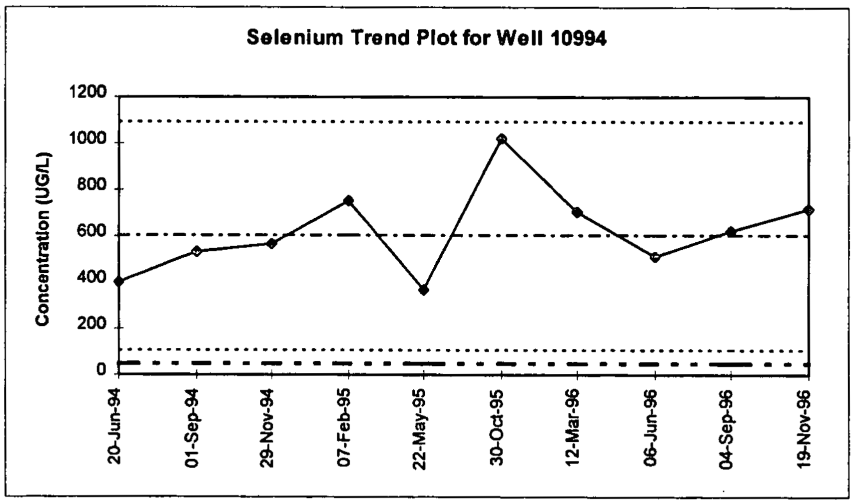

Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

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Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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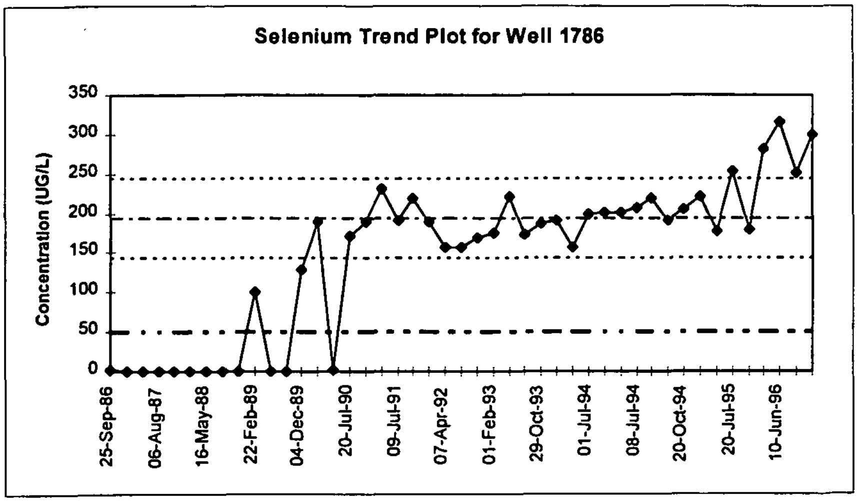

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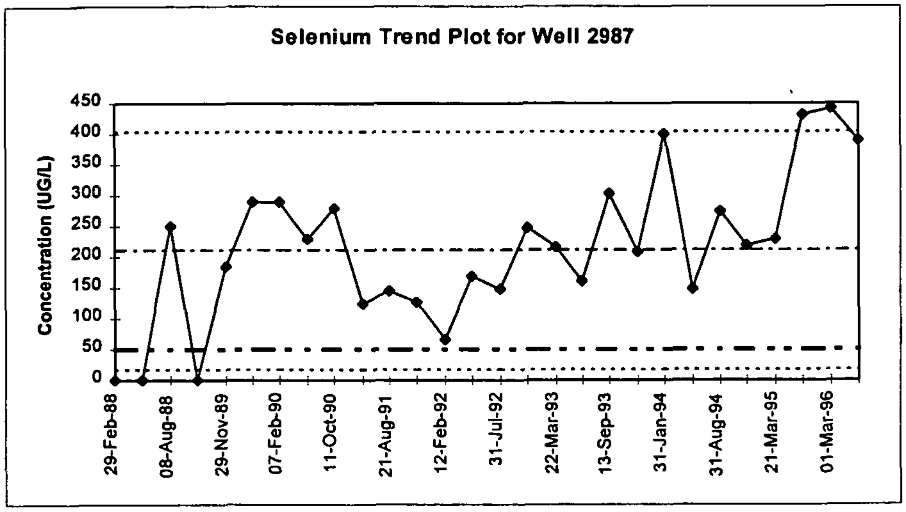

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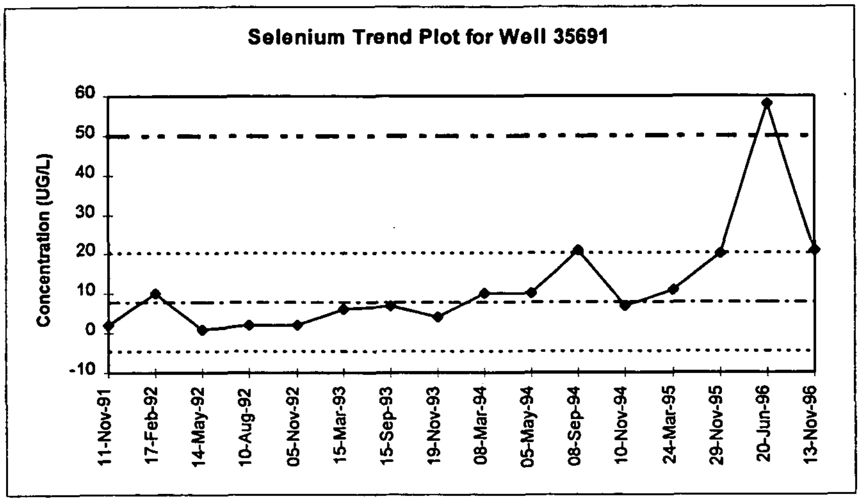

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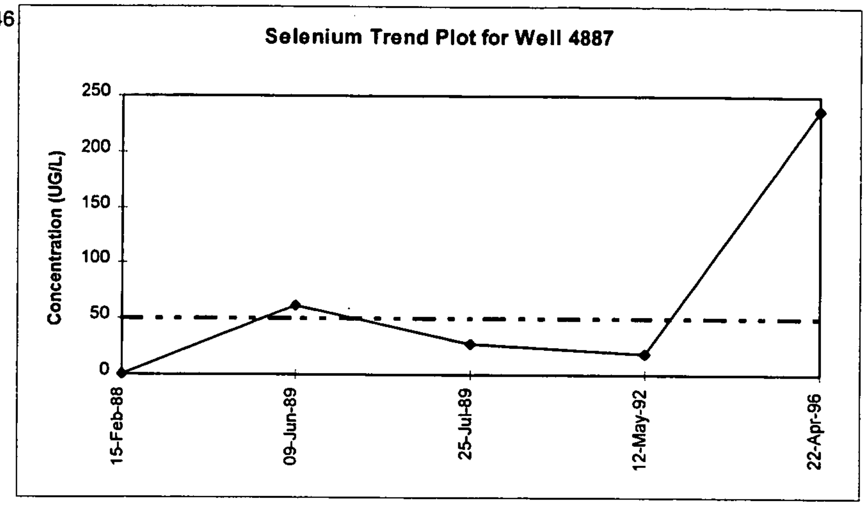
Heavy dashed line = Tier II action level
Light dashed lines = historic mean $\pm$ 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

46



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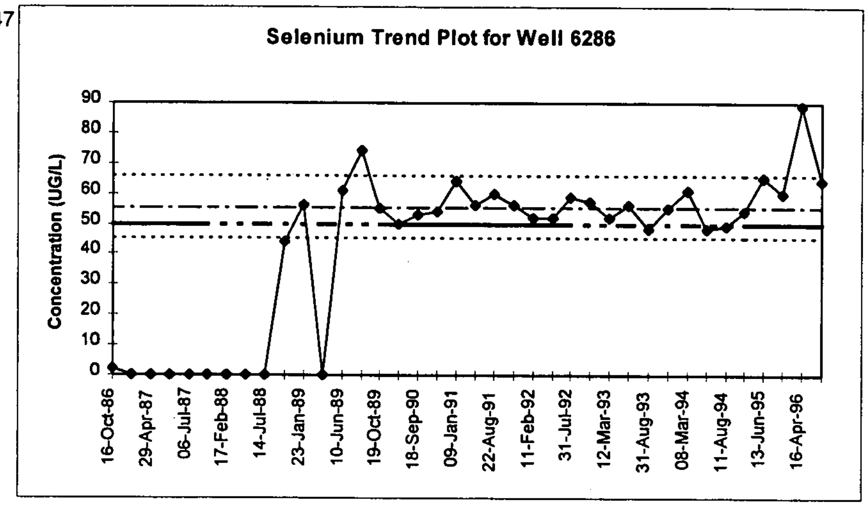

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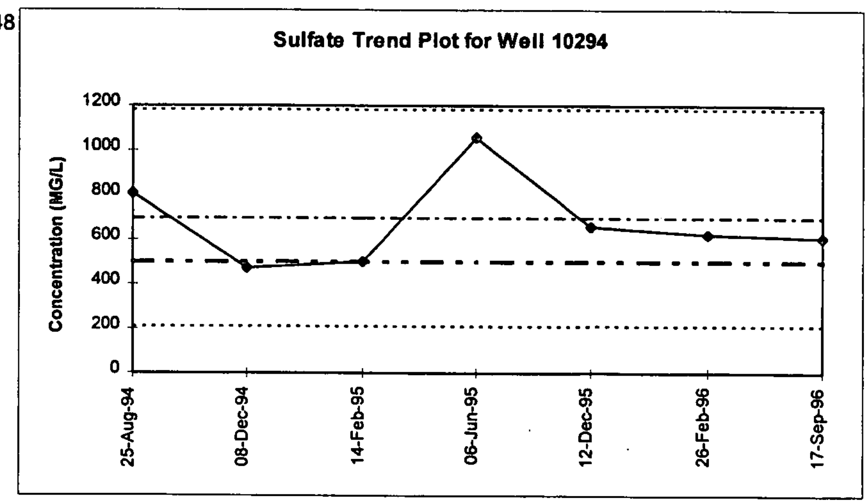

77

Heavy dashed line = Tier II action level
Light dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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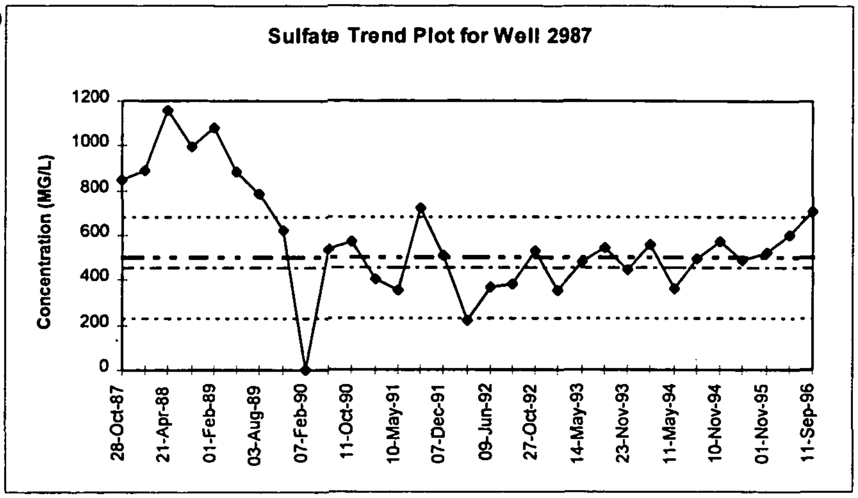

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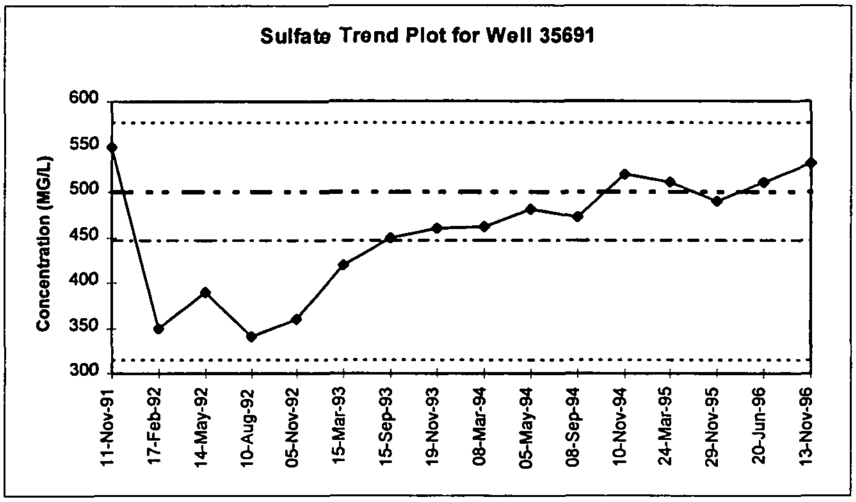

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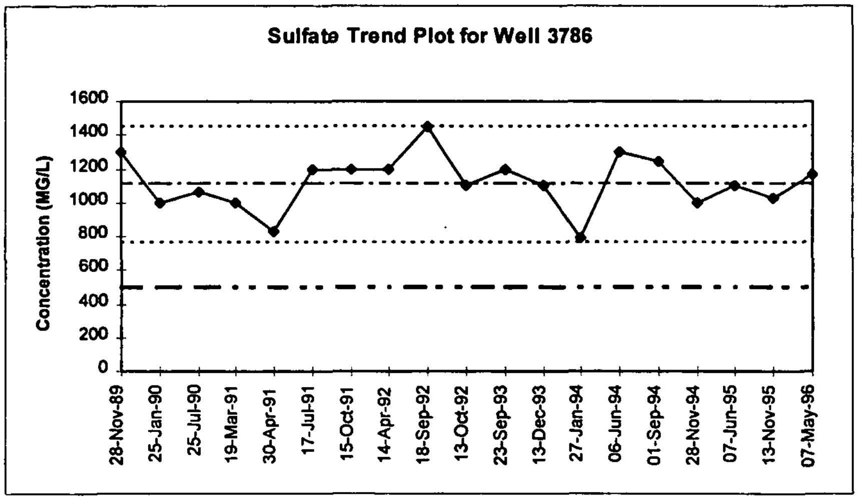

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Heavy dashed line = Tier II action level
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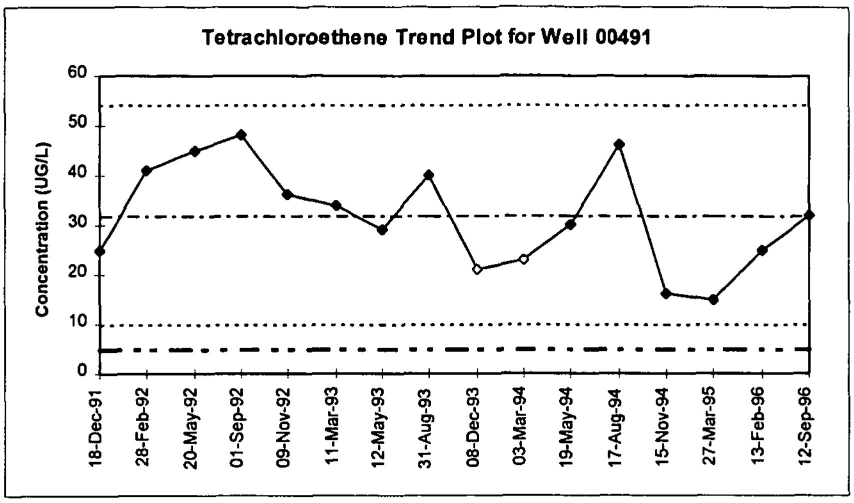
Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

52



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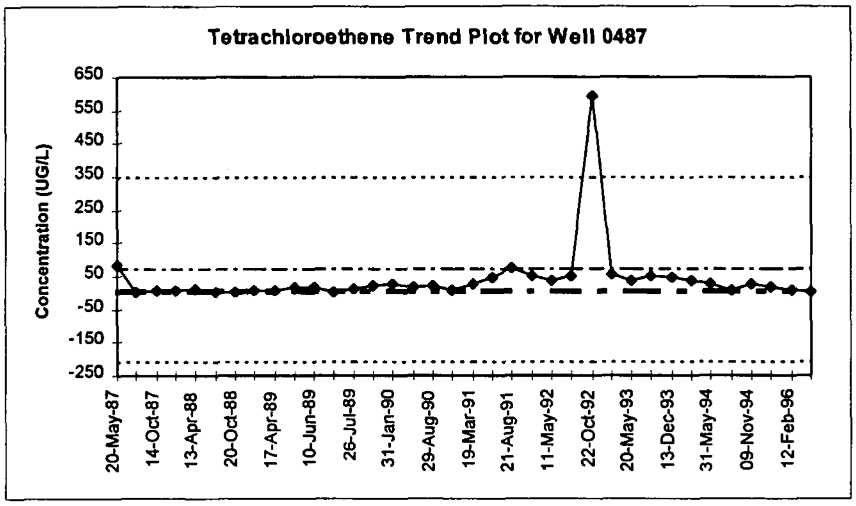

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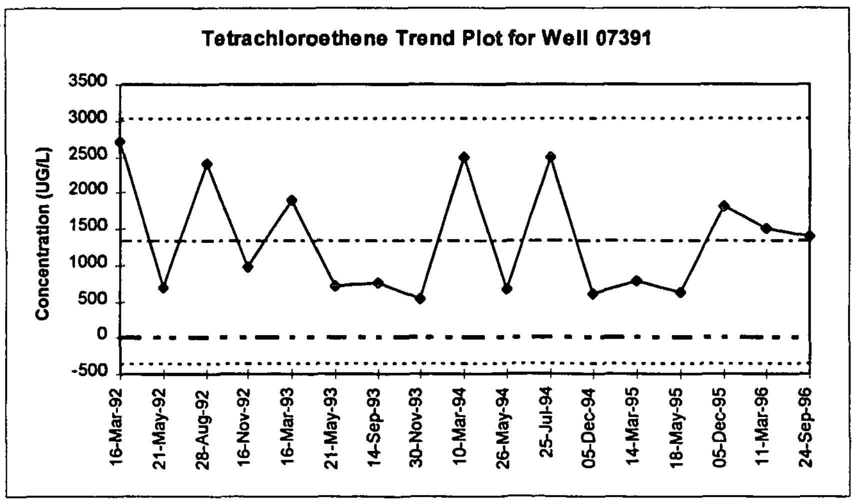

Heavy dashed line = Tiet II action level
Lighter dashed lines = historic mean ± 2SD

79

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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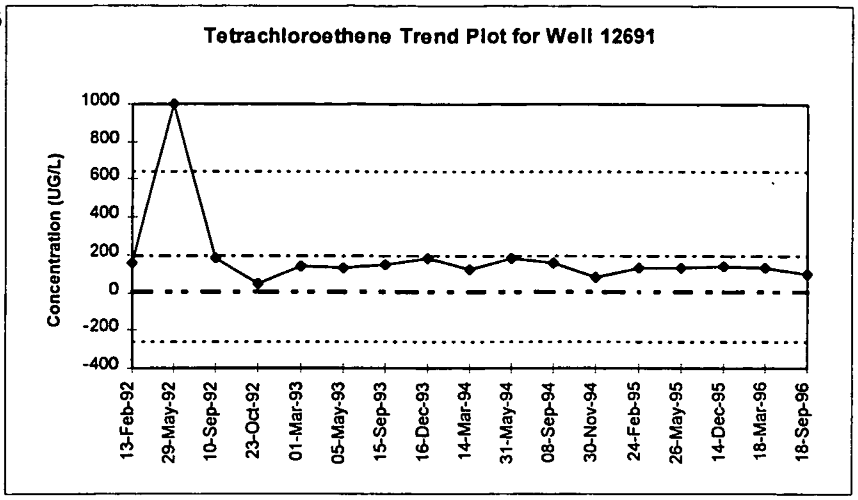

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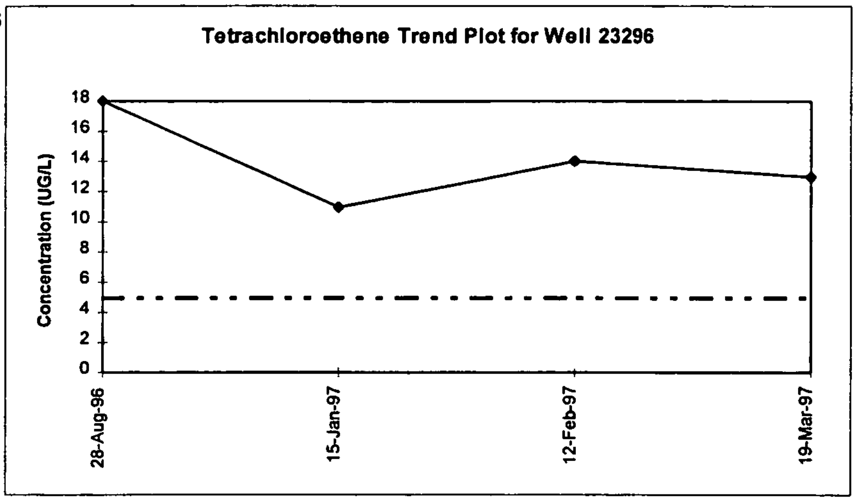

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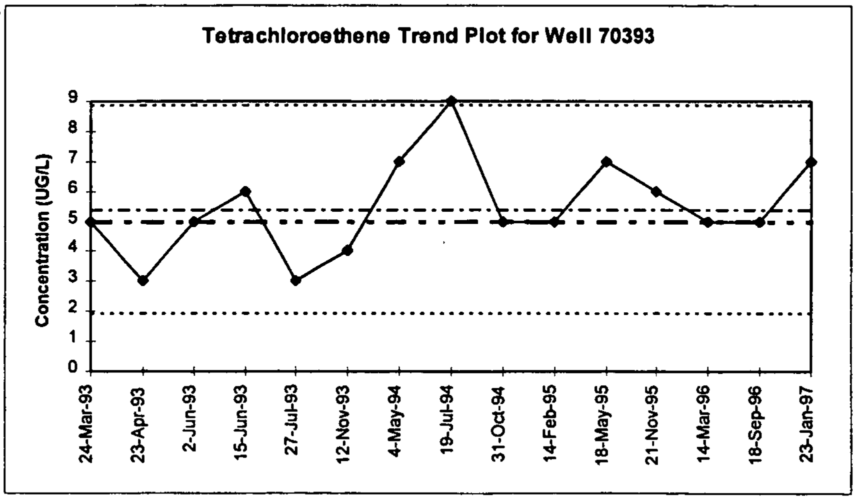

Heavy dashed line = Tiet II action level
Lighter dashed lines = historic mean ± 2SD

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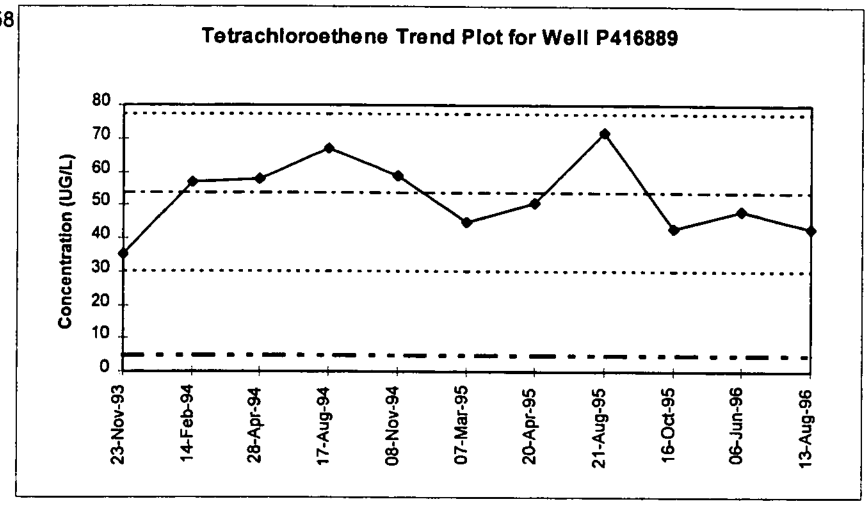
Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

58



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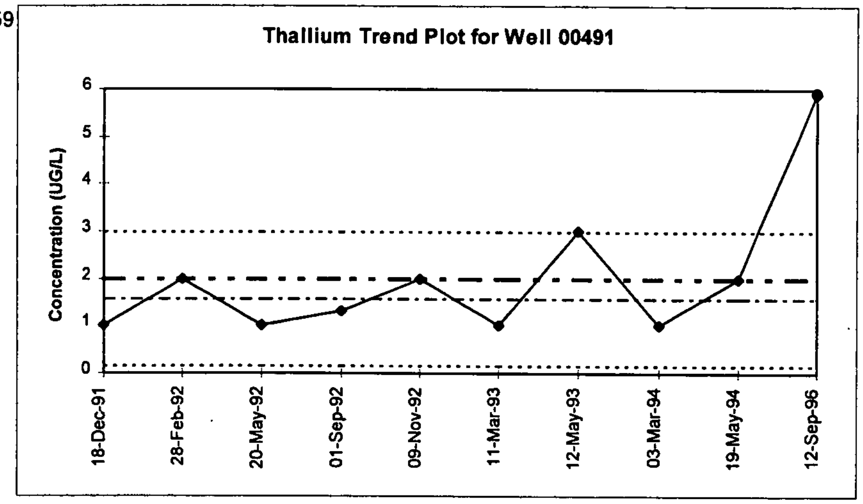

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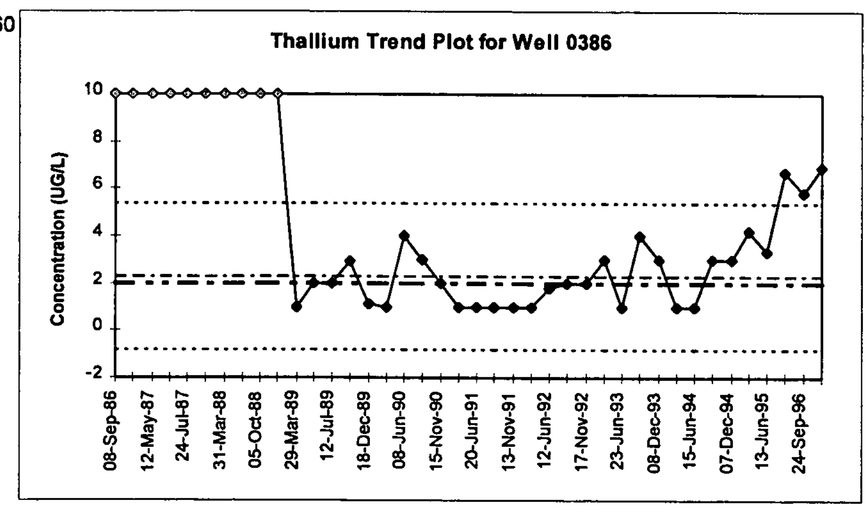
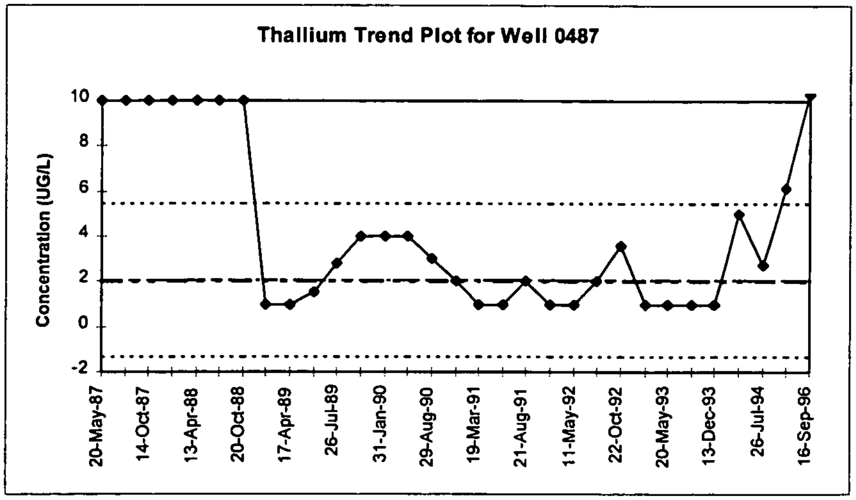


Heavy dashed line = Tiet II action level
Lighter dashed lines = historic mean ± 2SD

81

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

61


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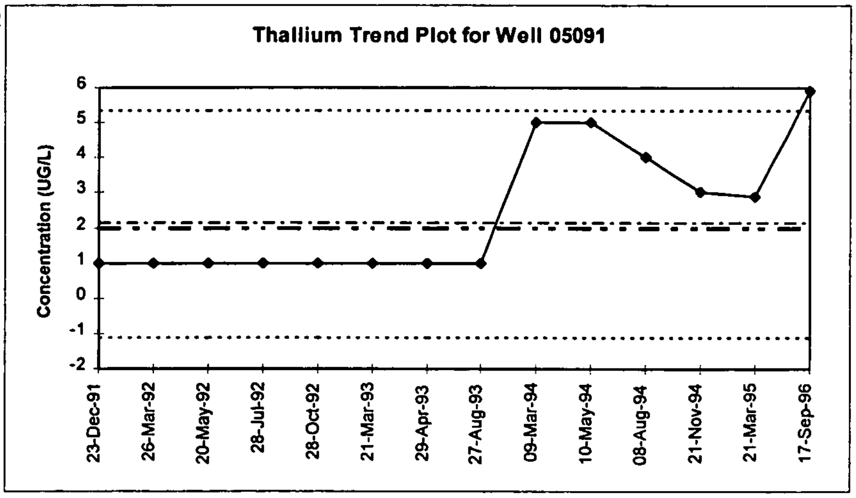

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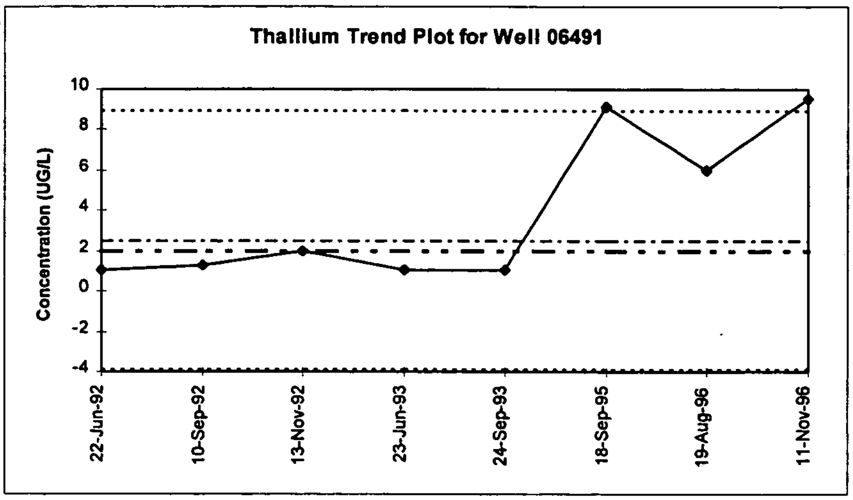

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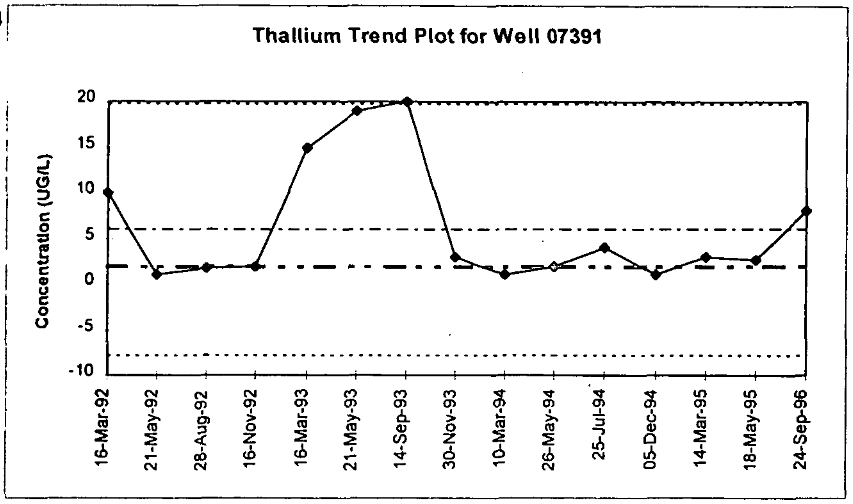
Heavy dashed line = Tiet II action level
Lighter dashed lines = historic mean ± 2SD

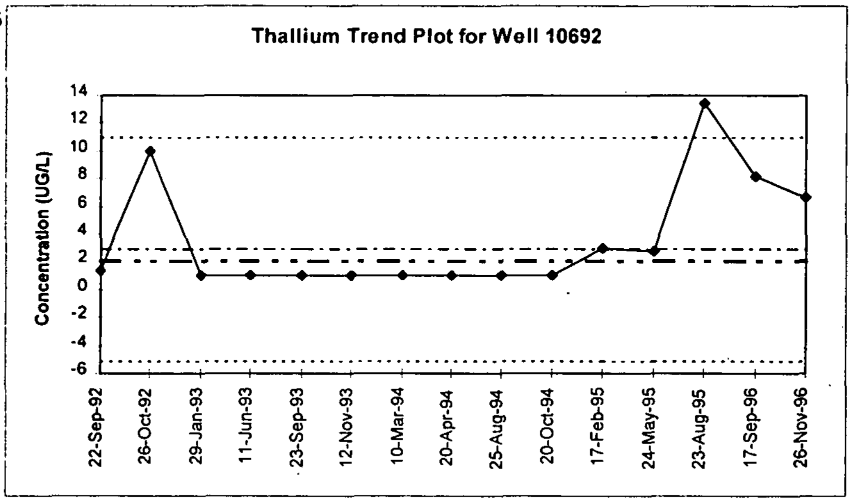
Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

64



Thallium Trend Plot for Well 07391

65



Thallium Trend Plot for Well 10692

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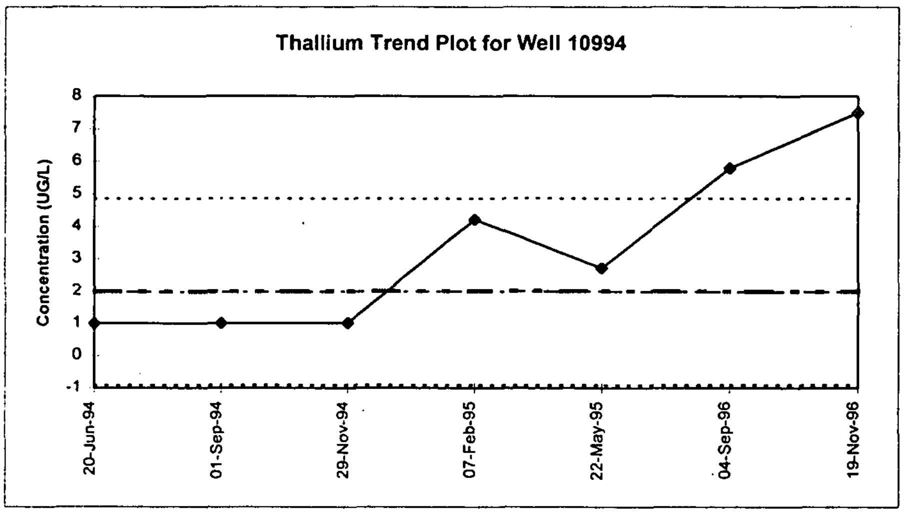

Thallium Trend Plot for Well 10994

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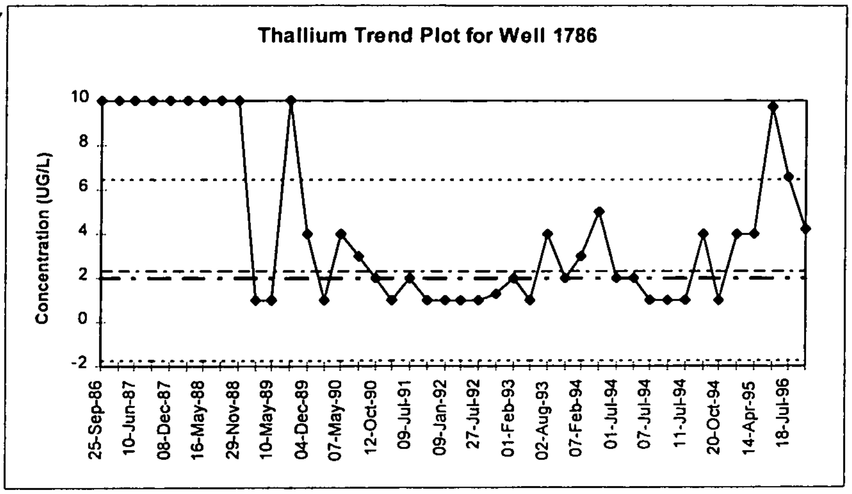
Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

67



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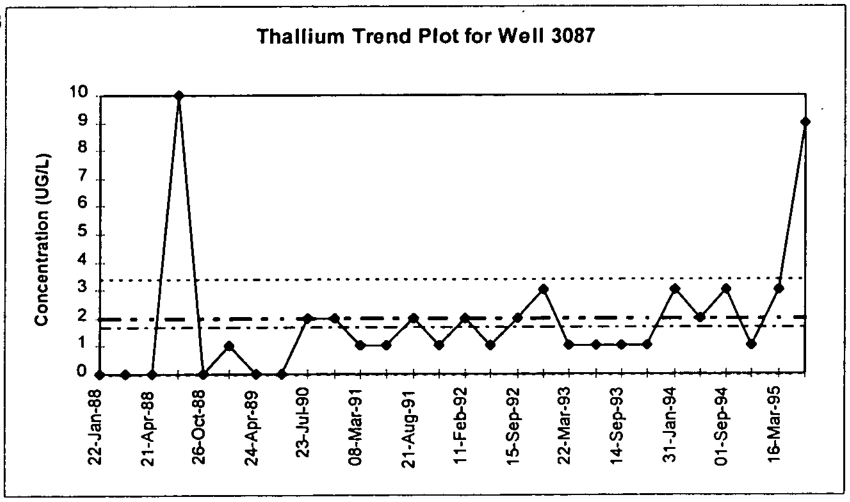

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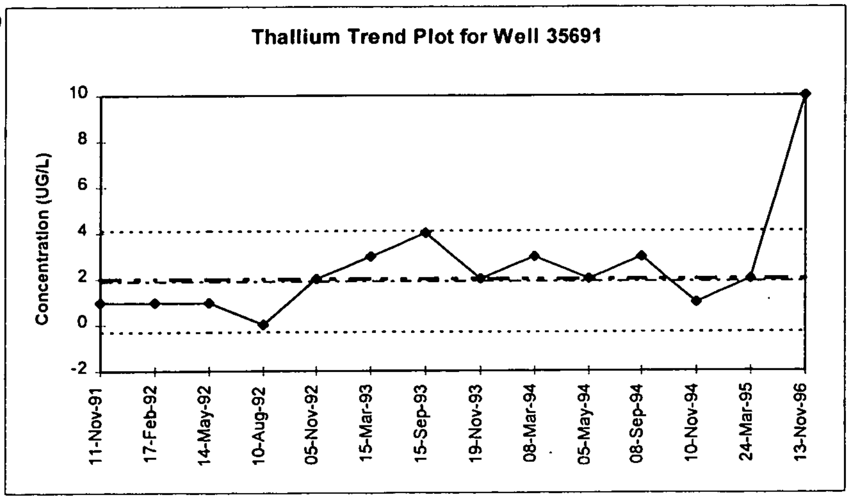

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Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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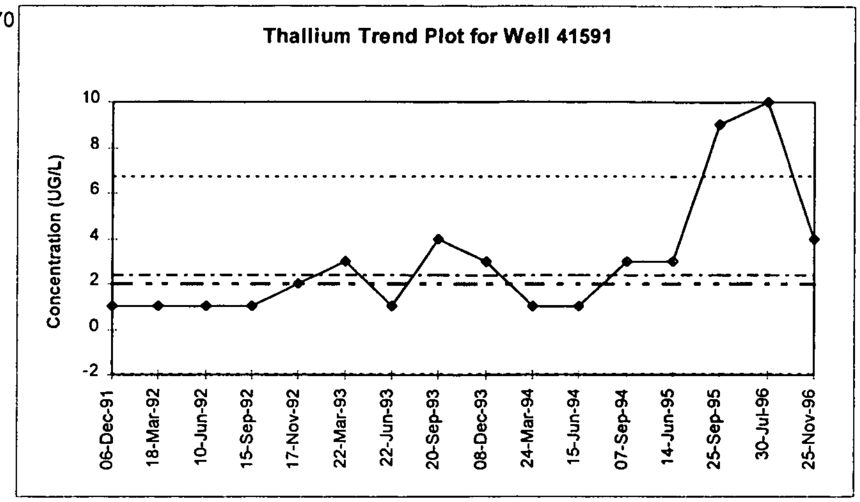

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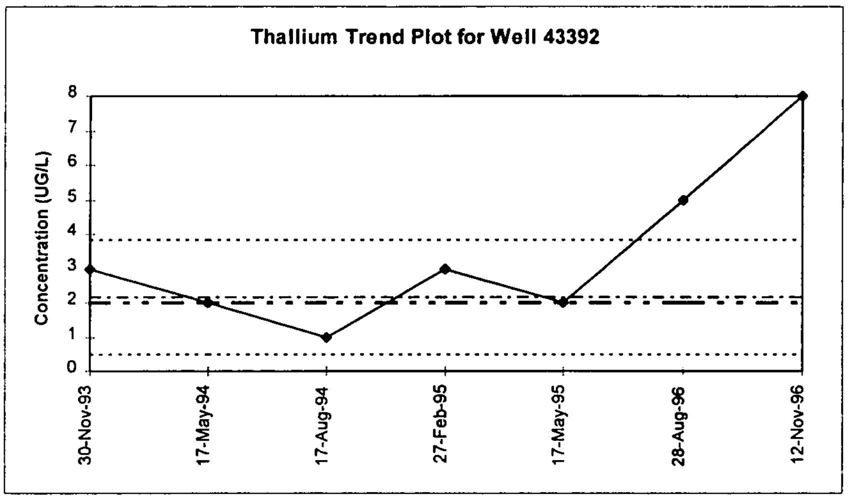

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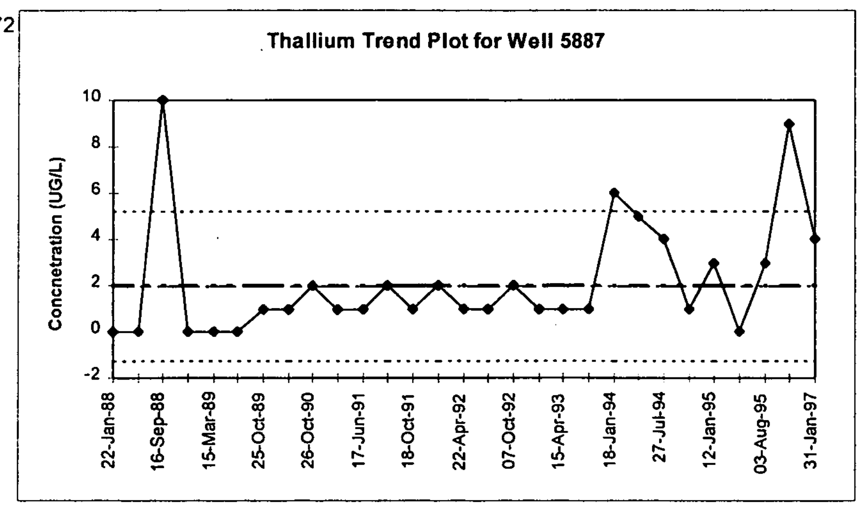
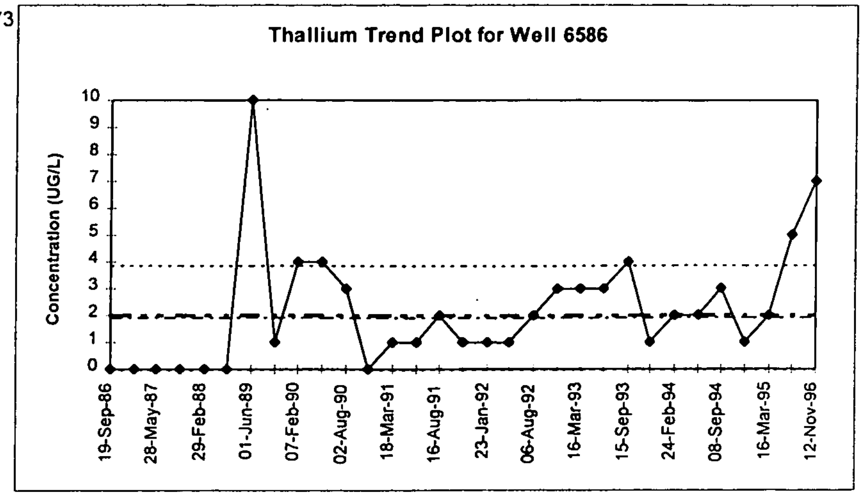


Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

73



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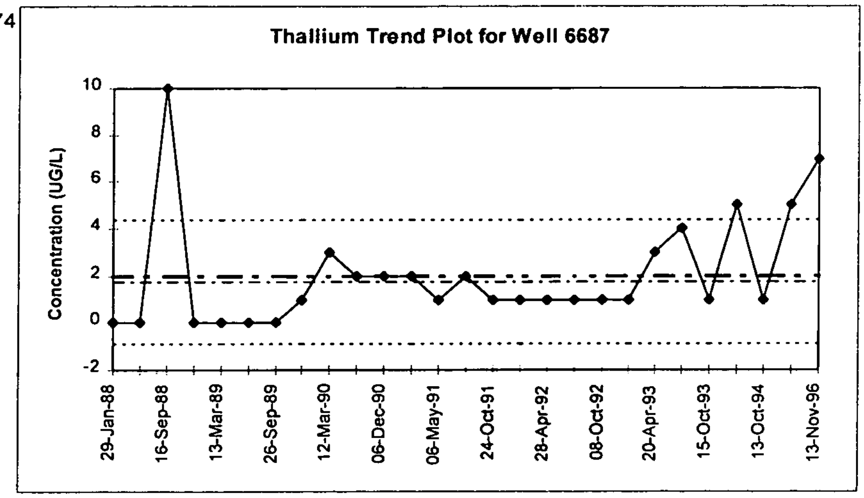

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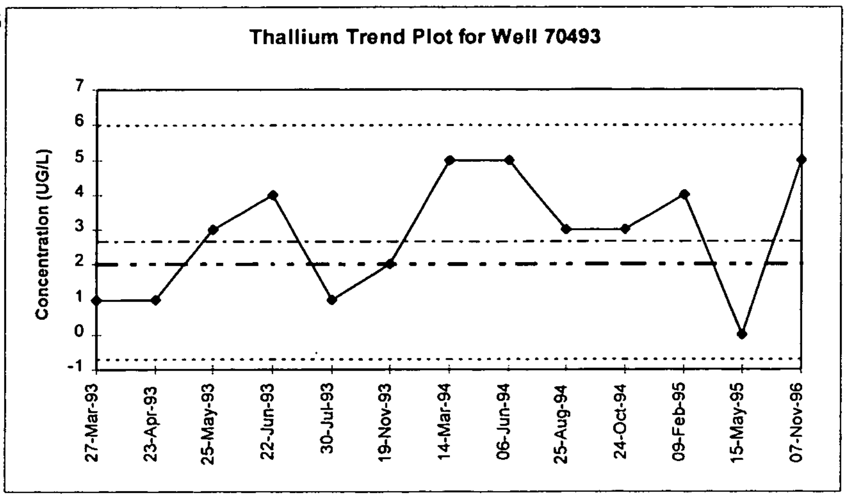

Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

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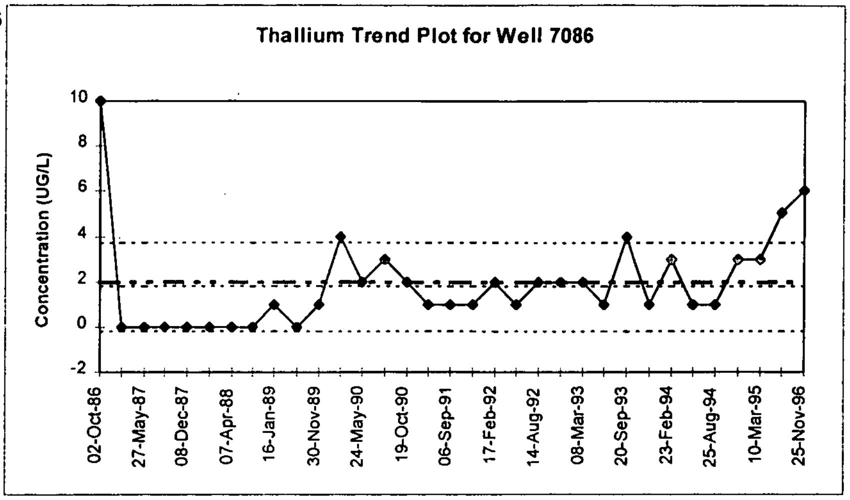
Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

76



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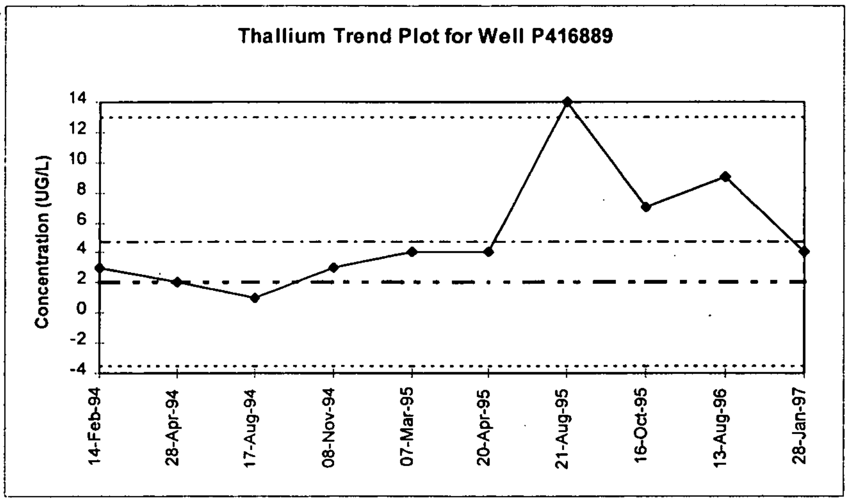

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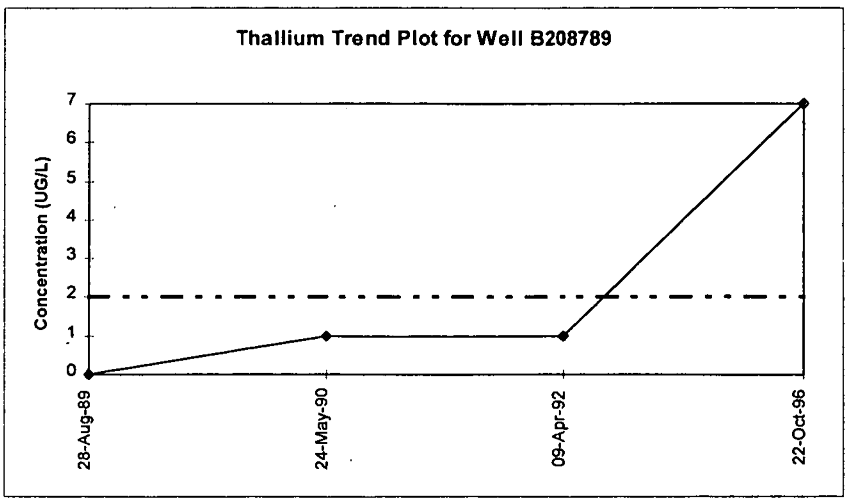

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Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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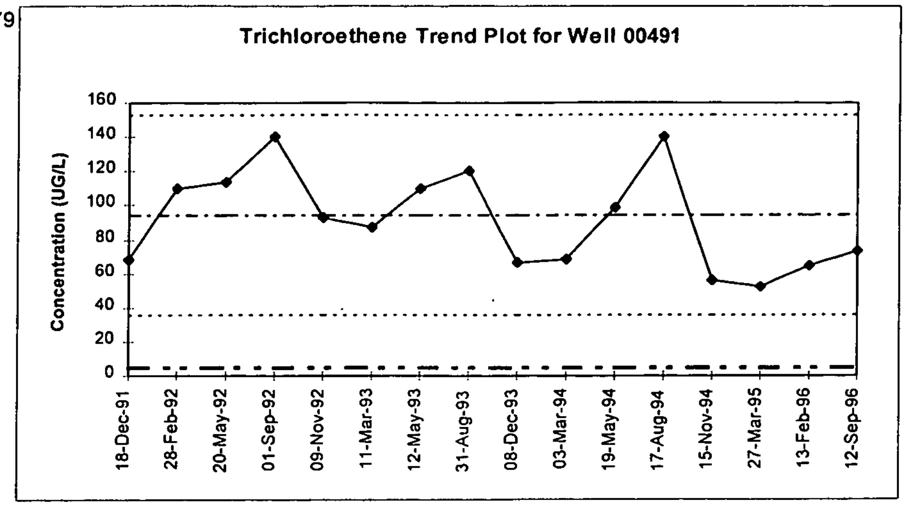

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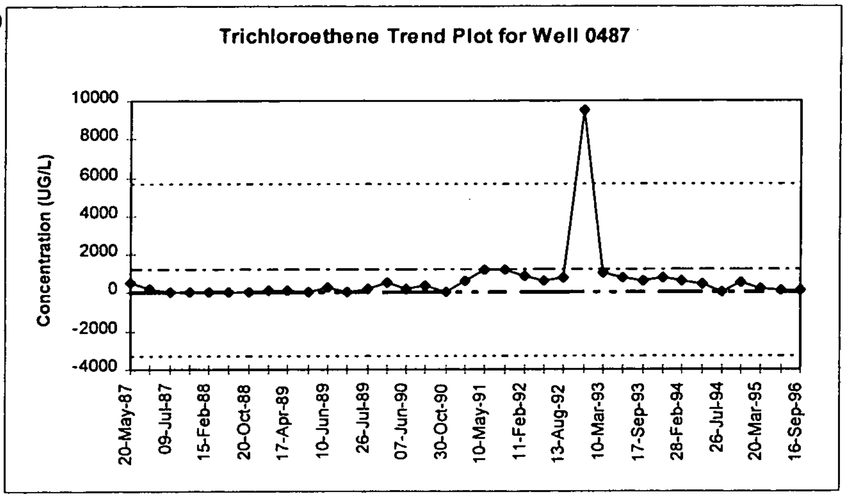

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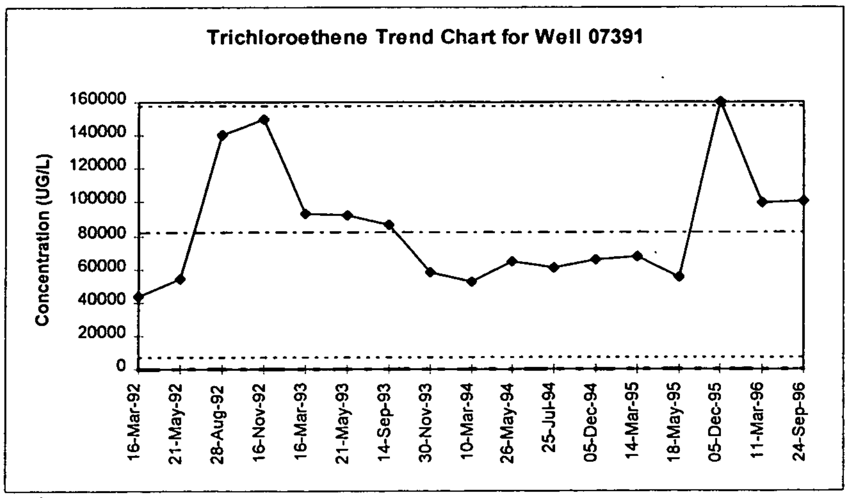

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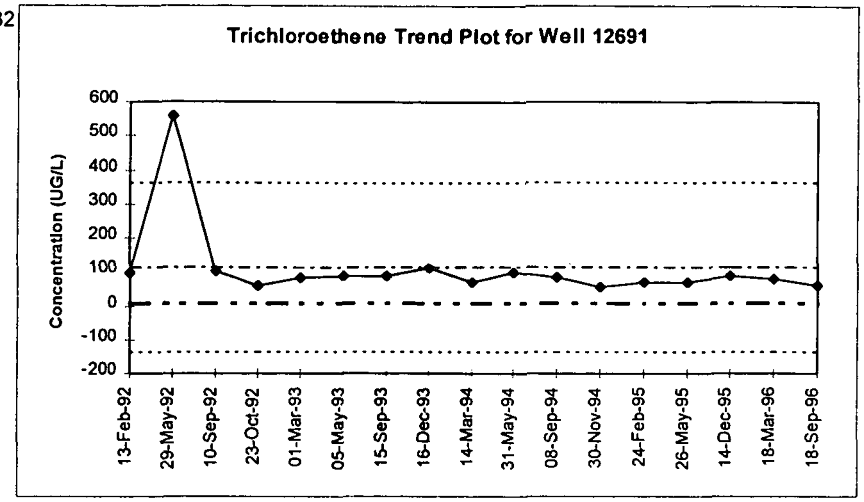
Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

82


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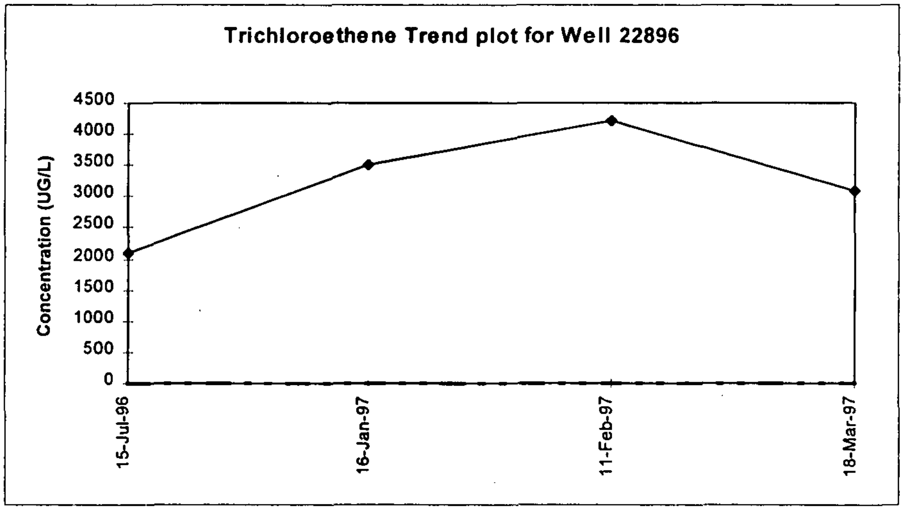

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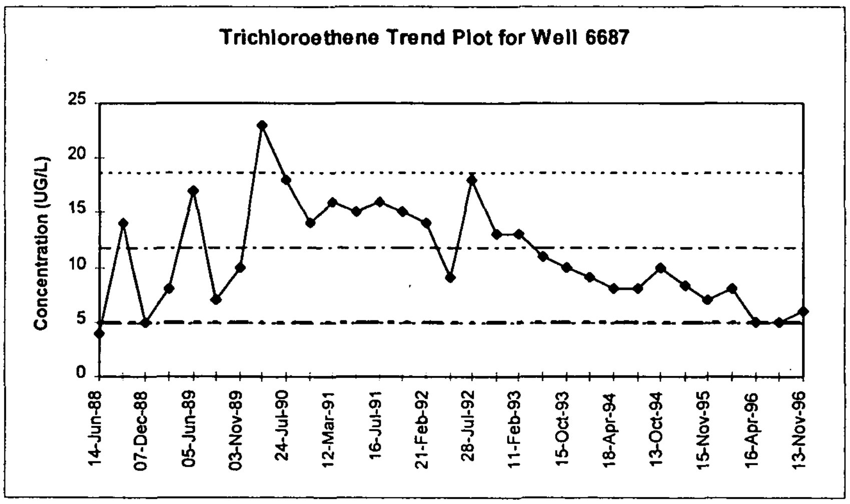

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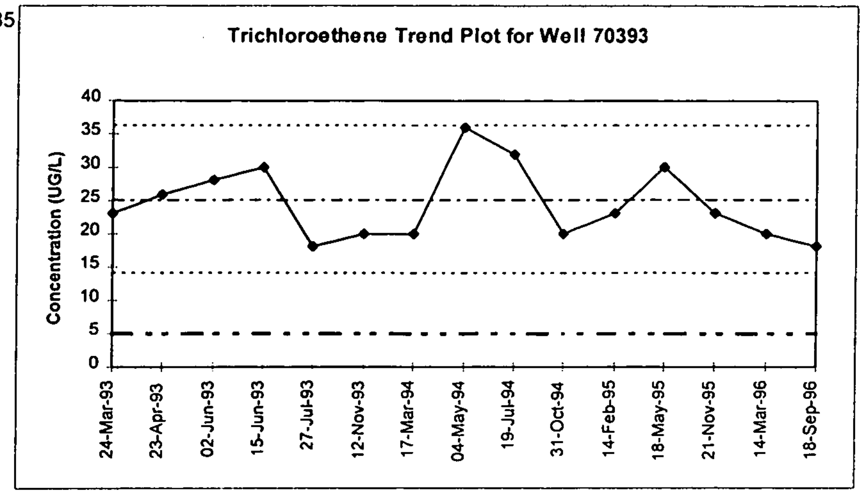
Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

85



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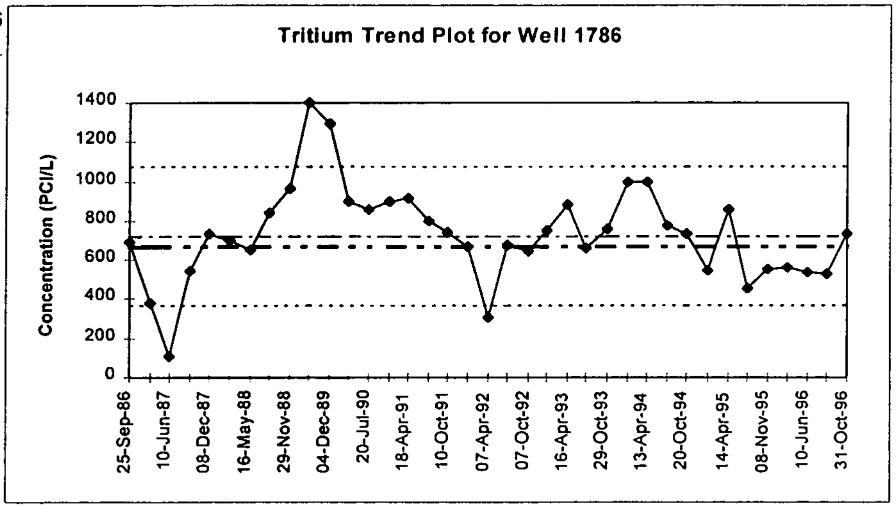

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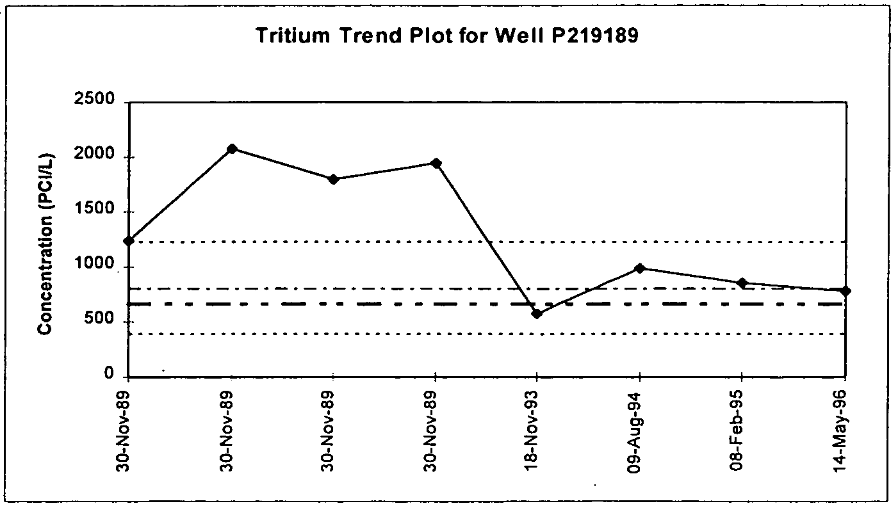
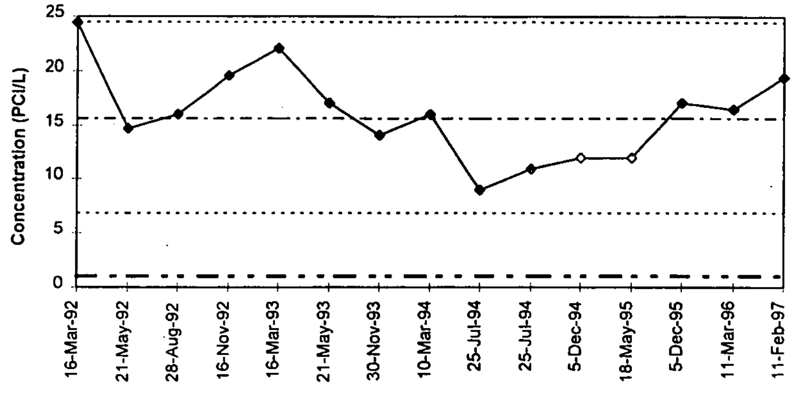


Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

88

Uranium-233/234 Trend Plot for Well 07391



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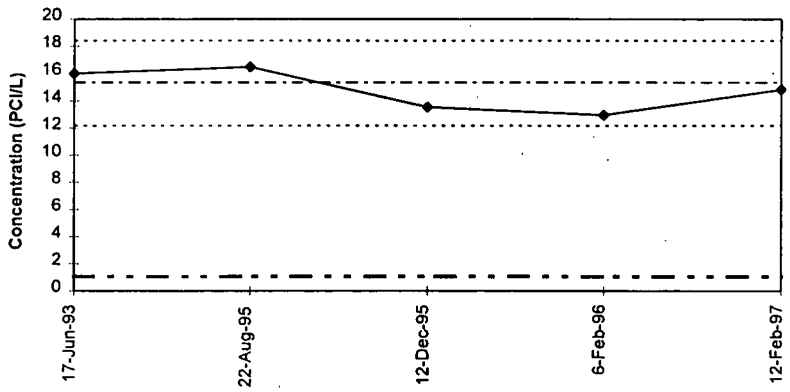
Uranium-233/234 Trend Plot for Well 10592



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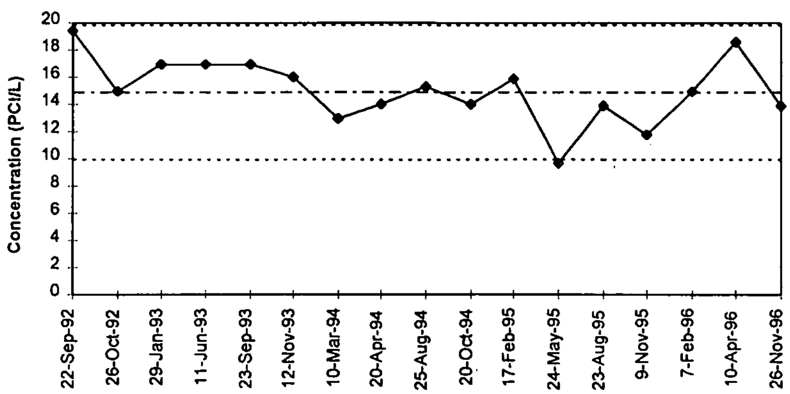
Uranium-233/234 Trend Plot for Well 10692



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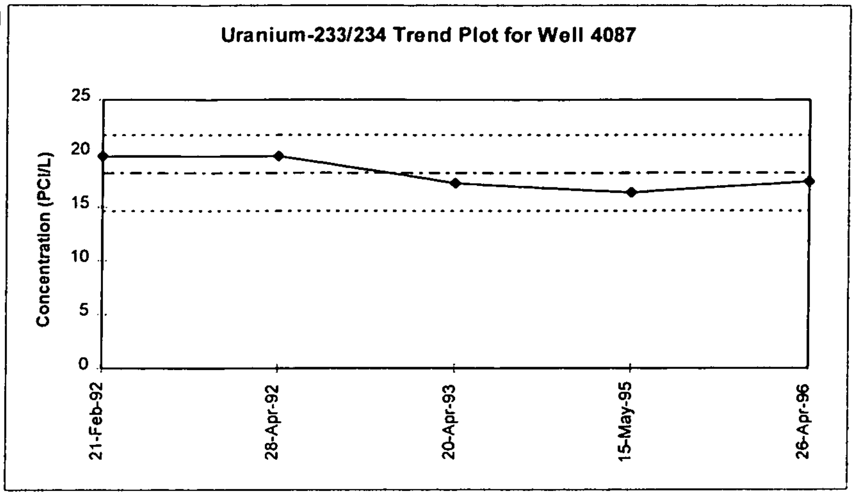
Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

91



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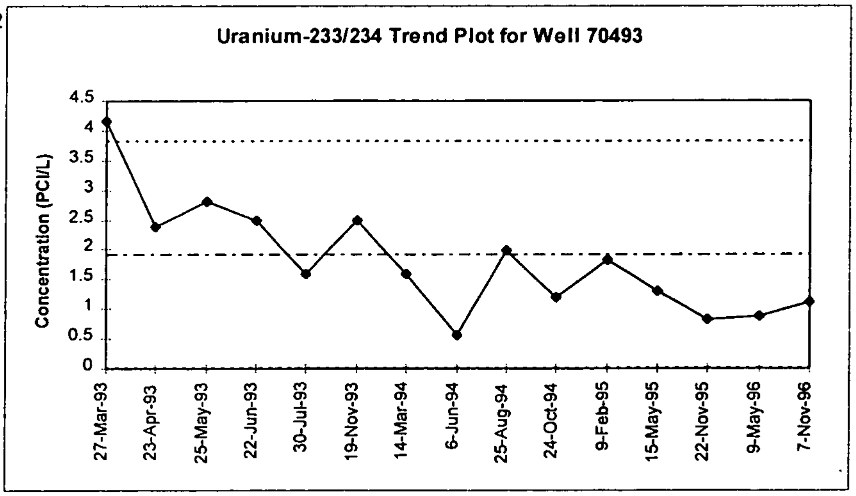

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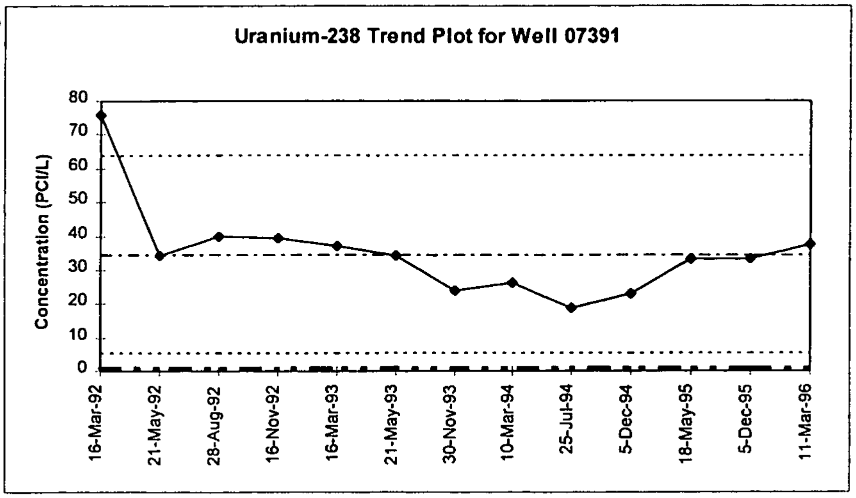

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Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

Figure 2 (cont.)
Trend Plots for Selected Analytes and Wells
1996 Groundwater

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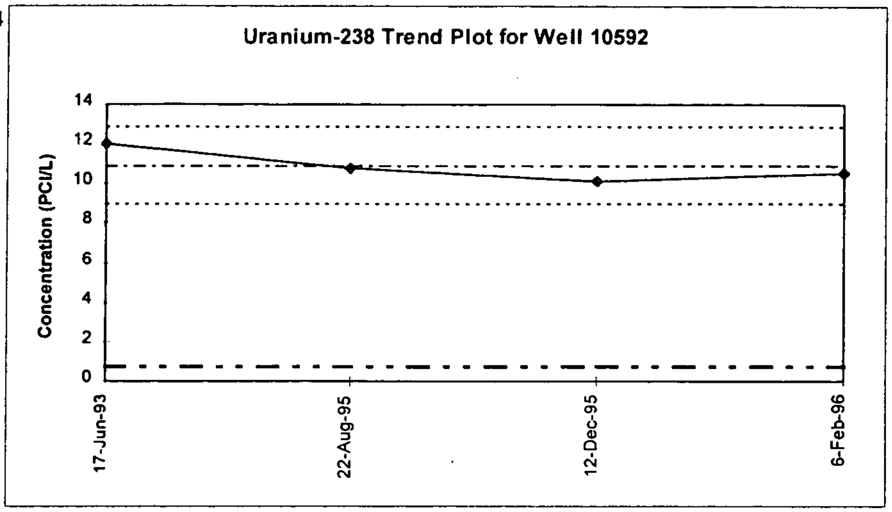

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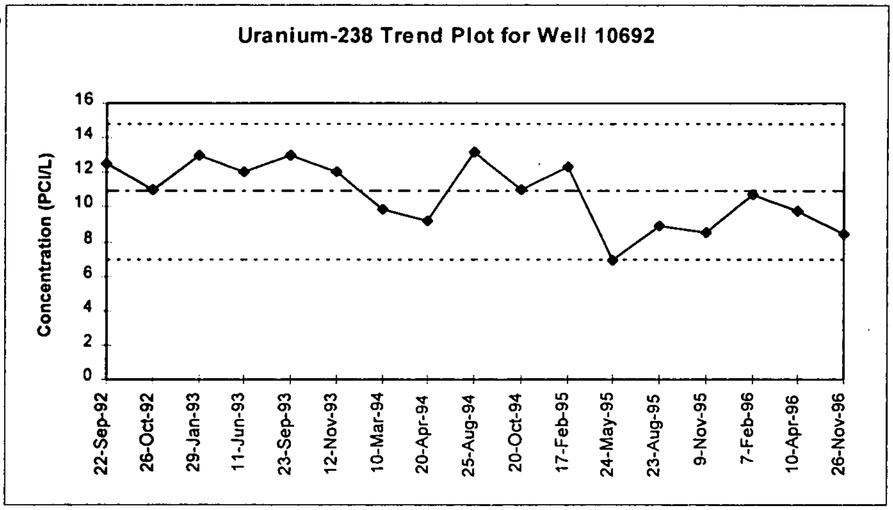

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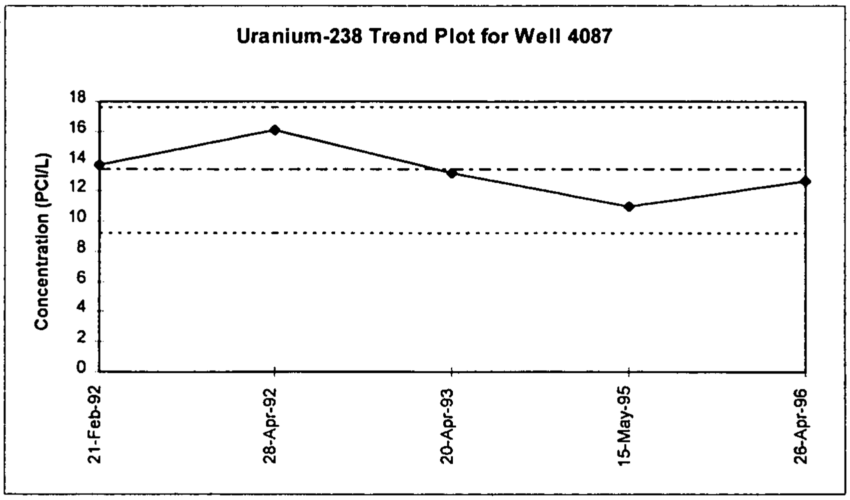

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Heavy dashed line = Tier II action level
Lighter dashed lines = historic mean ± 2SD

3.0 GROUNDWATER FLOW CONDITIONS DURING 1996

Groundwater level data collected throughout calendar year 1996 were reviewed to determine whether significant changes in flow direction, flow velocity, and quantity have occurred to the upper hydrostratigraphic unit groundwater system since 1995 and previous years. This review included evaluations of semiannual potentiometric surface maps, quarterly well pair velocity calculations, and selected well hydrographs. Discussion of the 1996 data compared to historical potentiometric surface maps, such as presented in EG&G (1995c), and historical water level trends presented in the individual well hydrographs is presented to provide a framework for identifying the type of potentiometric configurations, seasonal fluctuations and long-term trends typically associated with pre-1996 plant operations. The 1996 data set comprises a new sitewide baseline that will be used for assessing annual changes to the groundwater flow system during the remaining years of plant closure and post-closure monitoring.

3.1 POTENTIOMETRIC SURFACE MAPS

Groundwater potentiometric surface maps (Plates 2 and 3) were constructed from water level data collected during the second and fourth quarters of 1996 for the unconsolidated surficial deposits component of the UHSU. These maps provide information on groundwater flow direction and saturated extent that were used in the selection of well pairs for velocity calculations and definition of plume extent and movement. For map construction, it was assumed that well construction details, borehole logs, and depth-to-water measurements were accurate. When the measured depth to water was below the bottom of the well screen, the well was assumed to be dry.

Maps constructed for the UHSU were based entirely on data from wells screened in surficial deposits thought to be representative of regional shallow groundwater flow conditions. For this reason, wells completed in perched alluvial groundwater zones, such as wells 50494 and 51594 located west of the IA, were not utilized in map construction. Information on unsaturated areas from previous potentiometric surface maps, particularly the 1993 maps, were used in the construction of the second and fourth quarter 1996 maps. Shaded, non-contoured areas of the maps indicate areas where well coverage is absent.

In general, the configuration of the potentiometric surfaces for the second and fourth quarters 1996 closely matches the configurations depicted for earlier quarterly maps. Conceptual refinements were made in areas with new well coverage (i.e., IA IM/IRA wells) and at the west boundary of the Site where the Laramie-Fox Hills Sandstone subcrop forms a north-south oriented barrier to alluvial groundwater flow. In this area, it is also believed that the Laramie-Fox Hills Sandstone functions as a bedrock

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recharge sink for alluvial groundwater, hence the steeper hydraulic gradients shown between the Site west boundary and Laramie-Fox Hills Sandstone subcrop zone (delineated approximately by the alignment of gravel mine pits).

Plant operations have potentially impacted groundwater flow patterns in areas where potentiometric contours appear to deviate from topographic or bedrock topographic configurations. For example, a prominent and persistent eastward distention of the 6000 through 6040 foot contour lines in the west IA of the Site deviate significantly from the pattern expected from the surface topography. The coincidence of this broad, mound-like feature within an industrialized portion of the Site suggests that a greater amount of recharge is occurring in this area compared to similar background areas situated to the north and south. Likewise, the convergence of potentiometric contour lines near Buildings 371 and 881 suggest that foundation drains may have subtle local impacts on groundwater flow in the IA. Unsaturated areas shown on the 1996 maps were generally less extensive than drawn on the 1993 maps. This condition probably reflects the residual effects of the 1995 spring recharge event during which record high water levels were measured in many wells.

3.2 AVERAGE LINEAR FLOW VELOCITIES

Average linear groundwater flow velocities (seepage velocities) were calculated for 24 UHSU well pairs within the Industrial Area and perimeter based on flow direction considerations derived from the 1996 potentiometric surface maps. Table 3-1 presents the results of these calculations. The Darcy equation was used to calculate the seepage velocity (v):

$$v = \frac{K}{n}(dh / dl)$$

where:

K = hydraulic conductivity
n = effective porosity
dh/dl = hydraulic gradient

Values for hydraulic gradient were calculated from quarterly water level measurements made between well pairs located along a groundwater pathway. These well pairs were chosen on the basis of their perpendicular orientation to potentiometric contour lines. Hydraulic conductivity values used for velocity calculations were derived from the geometric mean values reported for the Rocky Flats Alluvium, colluvium, and Arapahoe Formation sandstone (No. 1 Sandstone) presented in Table G-2 of EG&G (1995c). For each well pair, the K value chosen for the calculation was based on the predominant

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TABLE 3-1. Average Linear Flow Velocities for the Industrial Area and Surrounding Areas.

WELL PAIR	AREA	1996 QTR	dh/dl	K (cm/sec)	n	v (cm/sec)	v (ft/yr)
P416289/P416689	Industrial Area	1	0.02873333	2.10E-04	0.1	6.034E-05	62.48
		2	0.03483333	2.10E-04	0.1	7.315E-05	75.75
		3	0.03343333	2.10E-04	0.1	7.021E-05	72.70
		4	0.03315	2.10E-04	0.1	6.9615E-05	72.09
P419689/P416889	Industrial Area	1	0.0062069	2.10E-04	0.1	1.30345E-05	13.50
		2	0.00772414	2.10E-04	0.1	1.62207E-05	16.80
		3	0.00765517	2.10E-04	0.1	1.60759E-05	16.65
		4	0.0088046	2.10E-04	0.1	1.84897E-05	19.15
P314289/10492	Industrial Area	1	0.08479279	9.33E-05	0.1	7.91117E-05	81.92
		2	0.08514414	9.33E-05	0.1	7.94395E-05	82.26
		3	0.08653153	9.33E-05	0.1	8.07339E-05	83.60
		4	0.08684685	9.33E-05	0.1	8.10281E-05	83.90
5387/35691	881 Hillside	1	0.1655	9.33E-05	0.1	0.000154412	159.89
		2	0.17395	9.33E-05	0.1	0.000162295	168.05
		3	0.1447	9.33E-05	0.1	0.000135005	139.80
		4	0.1529	9.33E-05	0.1	0.000142656	147.72
34791/6386	903 Pad	1	n/d	9.33E-05	0.1	n/d	n/d
		2	0.20312903	9.33E-05	0.1	0.000189519	196.24
		3	n/d	9.33E-05	0.1	n/d	n/d
		4	0.19996774	9.33E-05	0.1	0.00018657	193.19
07291/07391	903 Pad	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.08638095	2.10E-04	0.1	0.0001814	187.84
00491/23196	903 Pad	1	n/d	9.33E-05	0.1	n/d	n/d
		2	n/d	9.33E-05	0.1	n/d	n/d
		3	n/d	9.33E-05	0.1	n/d	n/d
		4	n/d	9.33E-05	0.1	n/d	n/d
04591/10194	903 Pad	1	0.00780328	2.10E-04	0.1	1.63869E-05	16.97
		2	0.01098361	2.10E-04	0.1	2.30656E-05	23.88
		3	0.01678689	2.10E-04	0.1	3.52525E-05	36.50
		4	0.01206557	2.10E-04	0.1	2.53377E-05	26.24
05291/05091	East Trenches	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.0232	2.10E-04	0.1	4.872E-05	50.45
05391/06091	East Trenches	1	0.01314685	2.10E-04	0.1	2.76084E-05	28.59
		2	0.01451748	2.10E-04	0.1	3.04867E-05	31.57
		3	0.0165035	2.10E-04	0.1	3.46573E-05	35.89
		4	0.016	2.10E-04	0.1	3.36E-05	34.79
4286/20291	East Trenches	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.02460993	2.10E-04	0.1	5.16809E-05	53.51

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TABLE 3-1 Average Linear Flow Velocities for the Industrial Area and Surrounding Areas (cont'd)

WELL PAIR	AREA	1996 QTR	dh/dl	K (cm/sec)	n	v (cm/sec)	v (ft/yr)
3687/60295	East Trenches	1	n/d	7.88E-04	0.1	n/d	n/d
		2	n/d	7.88E-04	0.1	n/d	n/d
		3	n/d	7.88E-04	0.1	n/d	n/d
		4	0.05298851	7.88E-04	0.1	0.000417549	432.37
00191/13491	903 Pad	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.02007273	2.10E-04	0.1	4.21527E-05	43.65
1987/3586	Mound	1	n/d	9.33E-05	0.1	n/d	n/d
		2	n/d	9.33E-05	0.1	n/d	n/d
		3	n/d	9.33E-05	0.1	n/d	n/d
		4	0.12234862	9.33E-05	0.1	0.000114151	118.20
05293/3386	Solar Pond	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.03624348	2.10E-04	0.1	7.61113E-05	78.81
P218389/B208089	Solar Pond	1	0.05235897	9.33E-05	0.1	4.88509E-05	50.58
		2	0.05971795	9.33E-05	0.1	5.57168E-05	57.69
		3	0.05420513	9.33E-05	0.1	5.05734E-05	52.37
		4	0.05364103	9.33E-05	0.1	5.00471E-05	51.82
2286/45793	Solar Pond	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.05783721	2.10E-04	0.1	0.000121458	125.77
1986/77492	Solar Pond	1	n/d	9.33E-05	0.1	n/d	n/d
		2	n/d	9.33E-05	0.1	n/d	n/d
		3	n/d	9.33E-05	0.1	n/d	n/d
		4	0.02295238	9.33E-05	0.1	2.14146E-05	22.17
P114689/22896	Industrial Area	1	n/a	2.10E-04	0.1	n/d	n/d
		2	n/a	2.10E-04	0.1	n/d	n/d
		3	n/a	2.10E-04	0.1	n/d	n/d
		4	n/a	2.10E-04	0.1	n/d	n/d
P215789/P218089	Industrial Area	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.01002632	2.10E-04	0.1	2.10553E-05	21.80
P313489/6186	Industrial Area	1	0.00979167	2.10E-04	0.1	2.05625E-05	21.29
		2	0.01406944	2.10E-04	0.1	2.95458E-05	30.59
		3	0.01375	2.10E-04	0.1	2.8875E-05	29.90
		4	0.01476389	2.10E-04	0.1	3.10042E-05	32.10
4486/P115689	Industrial Area	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.01890476	2.10E-04	0.1	3.97E-05	41.11

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TABLE 3-1 Average Linear Flow Velocities for the Industrial Area and Surrounding Areas (cont'd)

WELL PAIR	AREA	1996 QTR	dh/dl	K (cm/sec)	n	v (cm/sec)	v (ft/yr)
P415989/P115489	Industrial Area	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.01971545	2.10E-04	0.1	4.14024E-05	42.87
P115089/P119389	Industrial Area	1	n/d	2.10E-04	0.1	n/d	n/d
		2	n/d	2.10E-04	0.1	n/d	n/d
		3	n/d	2.10E-04	0.1	n/d	n/d
		4	0.03668	2.10E-04	0.1	7.7028E-05	79.76

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lithologic unit existing between the wells. In the absence of measured values of n, a conservative value of 0.1 is assumed based on its predominant usage in previous velocity calculations performed at the Site.

Groundwater flow velocities can be used as estimates of the migration rates for conservative (i.e., non-reactive) groundwater chemical constituents. Because they do not consider the effects of dispersion and chemical reactions (e.g., volatilization, biodegradation, dissolution/precipitation, and adsorption) on the concentrations of constituents along a flow path, seepage velocities approximate only the unattenuated rate of migration for dissolved constituents in groundwater. Attenuated, volatile, biodegradable, or redox-sensitive species will likely exhibit migration rates slower than the average linear velocity of groundwater flow.

Large-scale changes in the hydraulic gradient distribution caused by reconfiguration of the groundwater recharge and discharge regime during plant closure have the potential to impact groundwater flow directions and velocities which, in turn, can affect plume spreading and movement. Although actual linear flow velocities at any given well pair are not known with certainty, changes in relative flow velocities, combined with potentiometric mapping and hydrograph analysis, can provide some insight into plume dynamics and movement. Linear flow velocity calculations are sensitive only to the magnitude and direction of the hydraulic gradient, assuming that the assigned values of K and n are kept constant. Temporal analysis of relative linear flow velocities using 1996 as a baseline year is expected to compliment the other available assessment tools (potentiometric and water level change maps, hydrographs, plume extent maps, etc.) in monitoring plume migration toward surface water.

As shown in Table 3-1, the calculated groundwater flow velocities ranged from approximately 10 to over 400 feet per year. Linear flow velocities below 80 ft/yr tend to be associated with the Rocky Flats Alluvium while linear flow velocities above 80 ft/yr tend to be associated with hillslope areas. The high value of 432 ft/yr calculated for well pair 3687/60296 is associated with the Arapahoe Formation Sandstone, which discharges to the hillside above South Walnut Creek. These velocities are generally higher than reported in previous annual RCRA groundwater monitoring reports largely because sitewide mean K values were employed in the calculations instead of individual RCRA unit mean K's.

3.3 WELL HYDROGRAPHS AND WATER LEVEL CHANGE MAPS

Hydrograph plots for selected RFCA wells have been prepared to monitor changes in water table elevation with time. In addition to illustrating seasonal fluctuations in water table elevation, hydrographs are useful for evaluating long-term trends that might result from plant closure activities or natural causes,

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such as climate change. It is expected that a comparison of IA and surrounding area well hydrograph trends to background well trends will determine whether any of the observed trends are natural remediation—or plant-induced. Assuming that groundwater levels within the Site have reached a quasi-steady state condition since the cessation of production operations in 1989, it is conceivable that plant closure activities could cause local water levels to rise or fall, depending on the closure action. These changes in water level elevations will be evaluated in future years using annual and life-of-closure water level change maps that will be based on water levels collected during the 1996 baseline year.

Water levels measured during 1996 were, for the most part, observed to fluctuate within normal limits. Most wells, including recharge-sensitive wells such as 20691 and P416289 , exhibited only moderate recharge peaks during the spring season. In general, water levels were 1 to 2 feet higher at the beginning of 1996 compared to the end which reflects the decaying influence of record high water levels experienced in 1995. The sitewide scale of this trend, also observed in background wells, implies that climate is the dominant cause of water level changes in 1996.

In summary, groundwater flow conditions for 1996 appear to closely resemble flow conditions described for recent years. This situation is not unexpected because major plant closure activities have yet to be undertaken. The 1996 data set represents a baseline for future annual evaluations.

4.0 GROUNDWATER EVALUATIONS

This section discusses the technical evaluations being performed due to exceedances of RFCA groundwater Action Levels in 1996 as reported in Section 2. Evaluations of impact to surface water will be performed as required by the RFCA Action Level Framework for groundwater exceedances. Details with respect to the final location of sample points, data analysis and calculations will be presented upon completion of the field projects.

4.1 EAST TRENCHES PLUME - EXCEEDANCES IN WELL 23296 AND 06091

Well 23296 was installed in 1996 as part of the agreement on the Groundwater portion of the Action Level Framework document. The original sample result showed a trichloroethene (TCE) concentration of 430 ug/L, which is above Tier II action levels. The first monthly follow-up sample (300 ug/L) taken in January 1997 confirmed the magnitude of the exceedance. Well 23296 is a Plume Extent well and is located in the South Walnut Creek drainage between Pond B2 and Pond B3. Historic VOC data from the B series ponds shows that Pond B1 and Pond B2 have had infrequent detections of TCE, TCA, and carbon tetrachloride. The source of water in ponds B1 and B2 is mainly surface water runoff, with lesser amounts from groundwater flow. A seep adjacent to Pond B1 has had detections of TCA (280 ug/L), TCE (27 ug/L), and carbon tetrachloride (22 ug/L). Pond B3 is used as a short term storage pond for effluent from the Sewage Treatment Plant and has not been sampled for VOCs.

It is believed that the source of TCE in well 23296 is from the East Trenches plume, upgradient of the South Walnut Creek drainage in the former OU2. The extent of the East Trenches Plume is well known within the East Trenches area which is on the plateau above the drainage. However the groundwater pathways from the trenches to surface water are imperfectly known. Well 06091 monitors the northeast extension of the East Trenches VOC plume. VOC concentrations appear to be increasing with time in this well, and have reached the Tier II action level for TCE.

The initial phase of the evaluation will involve determination of groundwater pathways to surface water. This is because there are no downgradient groundwater wells installed north of the East Trenches plume in the Walnut Creek drainage. This phase will be accomplished through a series of temporary well points (15-20) installed on the south side of Walnut Creek parallel to the portion of the South Walnut Creek drainage where groundwater pathways to surface water are suspected. It is believed that the groundwater may travel through colluvial materials on the south hillside of Walnut Creek, or through the No. 1 sandstone bedrock. The well points will be installed through both the colluvium and No. 1 Sandstone and screened where the saturated zone exists. This activity is set to be initiated in September, 1997, and will

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be integrated with field investigation supporting the evaluation remediation needs. After field work has been completed, historic and new data collected from both surface water and groundwater will be used to evaluate mass loading of contaminants to the South Walnut Creek.

Well 06091 has shown detections of carbon tetrachloride at or below the Tier II Action Level. This well is at the far end of the bedrock low which directs the alluvial East Trenches plume towards the northeast. Because there are no wells immediately to the east of well 06091, two temporary wells will be installed to determine if concentrations above action levels have migrated farther east. A third temporary well will be installed north of well 06091 to determine if contaminants are migrating to the north toward South Walnut Creek This activity is also scheduled to be completed in September, 1997.

4.2 MOUND PLUME - EXCEEDANCES IN WELL 3586

Well 3586 has historically produced groundwater with concentrations of vinyl chloride exceeding Tier I action levels (200 ug/L). Concentrations have dropped below Tier I levels, but exceedances of Tier II action levels (2 ug/L) are still observed. The source for vinyl chloride is likely to be the Mound IHSS which has a documented plume that migrates to the SW059 seep. This seep has historically drained into South Walnut Creek and has concentrations of tetrachloroethene (PCE) and trichloroethene (TCE) above Tier II action levels.

Remediation work has already been done on the Mound plume to lessen the impact to surface water. The flow from SW059 is captured and the effluent is treated at the 891 treatment plant. Multiple excavations and source removals have been performed at the Mound Site, and removal of the remaining source was completed as an accelerated action. The plume extent was investigated in September, 1996 by installing 18 temporary wells along a transect that parallels the South Walnut Creek drainage (RMRS/KH, 1997). Fourteen additional temporary wells were installed in February, 1997 to further define the plume width and extent (RMRS/KH, 1997). These activities were specifically planned to aid the design of a groundwater collection and treatment system for the distal end of the plume. The Draft Mound Site Decision Document (RMRS/KH, 1997) describes the characterization activities that were performed for the Mound plume and tabulates the data collected from the temporary wells. Future activities on the Mound plume are on hold pending review of the draft Decision Document. Figure 4-1 shows the location of the temporary wells installed to characterize the Mound plume and associated Total VOC concentrations.

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4.3 SOLAR PONDS PLUME - EXCEEDANCES IN WELLS 1786, P219489 AND P208389

Well 1786 is in the North Walnut Creek drainage, and located downgradient of the Solar Ponds. The well has nitrate levels that exceed Tier I action levels. Historic data for nitrate from wells B208589 and B210489, which are also near the creek, are also above Tier I action levels. The nitrate concentration in well 1586 is above Tier II action levels. In 1995 a large number of small diameter piezometers were installed within the former OU4. These piezometers were sampled for nitrate and the results have been incorporated into the resulting nitrate plume map. Because of the extensive sample coverage, additional well installations are not necessary. The impact evaluation will involve the following activities:

- Focused stream sampling and flow measurements to determine the true concentration, duration and frequency of nitrate entering North Walnut Creek;
- Evaluation of historic surface water and groundwater data;
- Evaluation of alluvial and possible bedrock pathways to surface water;
- Evaluation of the nitrate plume to ascertain the flow volume and concentrations that could be entering North Walnut Creek; and
- Evaluation of the effects of turning off the Interceptor Trench System on the amount of flow and nitrate concentrations entering North Walnut Creek.

These activities will be budgeted and scheduled for completion in FY98 and will be tied to the FY99 milestone for the carbon tetrachloride source removal.

Wells P219489 and P218389 were installed as plume extent wells for possible VOC contamination that might be migrating east from the Solar Ponds. The southeast wells have historic nitrate concentrations above Tier II action level. Reclassification of these wells as plume definition wells would allow for future tracking of nitrate concentrations while maintaining a good spatial location for potential VOC migration. If this change is made there should be no evaluation activities required at this time.

4.4 PU&D YARD PLUME

In 1995 it was discovered that a VOC plume of relatively low concentration, but potentially large extent, was present west and south of IHSS 170 west of the Present Landfill. The source of this plume is expected to be IHSS 170, the former PU& D yard. Traces of this plume above Tier II action levels have

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been found in wells 70393, 6687 and 77392. A piezometer installed immediately upgradient of a seep on the hillslope south of the PU&D Yard near North Walnut Creek also has detections of VOCs. The longitudinal extent of the plume may be as much as three thousand feet. The dimensions of this plume are not well known due to sparse well coverage in the area. Well coverage is absent in the of North Walnut Creek drainage directly south of this plume.

There are two goals for the investigation of the PU&D area. One is to establish the source for the VOC plume. The other goal is to establish the extent of the VOC plume to both the east and to the south towards the North Walnut Creek drainage.

The suspected IHSS 170 source will be characterized by drilling in the most likely source area determined, based on historic knowledge and soil gas survey data collected as part of the OU10 investigation. This source characterization is scheduled to be completed by mid-September, 1997. The plume investigation will be conducted with three objectives. First, wells will be installed on all four sides of the PU& D yard to help establish the source location for the plume. Upgradient wells will be installed to confirm that contamination is not coming from sources other than the PU&D Yard. The eastern extent of the plume will be determined through drilling of temporary wells, which will be sampled for VOCs. Additional wells and piezometers will be installed to establish the width of the plume. A line of temporary well points will be installed along a line parallel to North Walnut Creek in the drainage south of the plume to establish groundwater pathways to surface water. If pathways exist, at least two permanent wells will be installed to monitor plume migration, and plume flux calculations will be performed. This activity is scheduled for August, 1997.

4.5 INDUSTRIAL AREA PLUME

4.5.1 Exceedance in Well P416889

Well P416889 is a plume definition well monitoring the IA Plume that is above Tier II action levels for tetrachlorothene. A large seep complex occurs to the south of this well in Woman Creek, and a piezometer installed just above one area of this seep shows concentration of TCE in the 20-30 ug/L range. Therefore, there is an indication of a potential pathway to surface water. At present, there is no drainage well in Woman Creek that would monitor this potential pathway downgradient of the IA plume. Historic data will be reviewed and some pre-existing temporary well points from the OU5 investigation will be sampled. In addition, a field investigation will be conducted to delineate surface water pathways using a line of temporary wells in areas not already covered by wells. If a pathway to surface water

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exists, a new monitoring well will be installed along the potential flow path to Woman Creek. This activity is currently scheduled for July, 1997.

4.5.2 Exceedance in Wells P219189 and 22796

Well P219189 is located north of Building 771, next to building 770 near the North Walnut Creek drainage. The well has historically produced groundwater with concentrations of 1,1, dichloroethene (1,1, DCE) that range from 20 to 50 ug/L. 1,1, DCE is the only volatile organic compound that exceeds action levels in this well, which distinguishes it from wells in the nearby carbon tetrachloride plume near IHSS 118.1.

Wells within the carbon tetrachloride plume are defined by concentrations of carbon tetrachloride and chloroform, in addition to 1,1 DCE (wells P209389 and P209489). Wells in the eastern portion of the plume contain carbon tetrachloride, chloroform and trichloroethene (Wells 2286 and P209189). The potential pathways for VOC contamination from this plume to reach North Walnut Creek are not well known due to the presence of many subsurface conduits and buildings with footing drains that collect groundwater. The Interceptor Trench System (ITS) has probably captured a portion of the carbon tetrachloride plume near the Solar Ponds. However, well 0671, which was located between the ITS and North Walnut Creek, had carbon tetrachloride, chloroform and trichlorethene above current Tier II action levels in the one sample that was taken prior to abandonment in 1992.

Well 22796 lies due north of Building 771 and next to Building T771A near the North Walnut Creek drainage. This well was installed in 1996 and has concentrations of trichloroethene above Tier II action levels. As with well P219189, the source of this contamination is not well known. Trichloroethene is a component of both the carbon tetrachloride plume and the IA plume. Well 22896, which is located near Building 566, has concentrations of TCE above Tier I action levels suggesting that the IA VOC plume continues farther north than originally thought.

There may also be local sources for the contamination seen in this area. IHSS 150.1 consists of the paved area north of Building 771 where drums containing plutonium residues were stored. There is no documentation on whether hazardous wastes were also stored in this area, but the former OU8 Data Summary Report (DOE, 1995c) documents a number of spills of radionuclide bearing material in this location. Up to 100 drums were stored in this area at various times during the life of the facility.

Because of the potential to impact the surface waters of North Walnut Creek the following evaluation activities are proposed:

- The groundwater pathways to surface water will be established through the installation of temporary wells where feasible. In addition, knowledge about subsurface conduits footing drains and outfalls in nearby buildings will be collected.

- Once sufficient field data exist to quantify the nature and extent of the groundwater contamination, plume flux calculations will be performed to gauge the impact of VOCs to North Walnut Creek.

These activities will be budgeted and scheduled for startup in FY98.

4.5.3 Exceedance in Well 22896

Well 22896 was installed to monitor the northeast edge of the IA VOC plume. The sample results from this well showed concentrations of trichloroethene above Tier I action levels and methylene chloride above Tier II action levels. Subsequent monthly sampling has confirmed the TCE exceedance but did not confirm the methylene chloride exceedance. The high concentrations of TCE in 22896 suggest that the portion of the IA plume with concentrations greater than Tier I levels extends farther to the northeast than previously known. The well is located at the southeast edge of a small stream channel that joins North Walnut Creek near PACS 2. Well 1986 which is located in the stream drainage has historically shown no detections of VOCs above action levels. Well 22696 located to the north of well 22796 also shows no VOC detections above action levels. The following evaluation is planned.

- Historic data will be evaluated to predict the location of pathways to surface water from the area around well 22896. Well 1986 will be evaluated to ensure that it is located and screened appropriately to detect potential contamination in the stream;

- Temporary wells will be installed to help locate saturated pathways to surface water; and

- If a significant pathway exists to surface water, and contamination is present, the mass flux of contaminants to the stream will be estimated.

This project will be budgeted and scheduled for startup in FY98.

4.6 OTHER GROUNDWATER EXCEEDANCES

4.6.1 Manganese Exceedances in Wells 22596, 1986, P114389 and 7086

Manganese concentrations above Tier II action levels have been detected in wells 22596, 1986 and P114389. These three wells are downgradient of the building 374 area. No building activities involving manganese are known. Manganese is also above Tier II action levels in well 7086 which is near the Old Landfill. The "Groundwater Geochemistry Report for the Rocky Flats Environmental Technology Site" completed in 1995 plots data on manganese along east-west transects at the Site. The transect through the Industrial Area shows highly variable manganese concentrations relative to transects in areas away from the Industrial Area.

Manganese has typically been eliminated from consideration as a contaminant of concern (COC) in the various operable unit RI/RFI evaluations based on process knowledge and professional judgement (e.g., OU1, OU2, OU5, OU6). The OU1 report did an extensive statistical evaluation of manganese.

4.6.2 Nickel in Well P313589:

Nickel has been evaluated in the OU2, OU5 and OU6 RI/RFI reports. The OU6 RI/RFI report did the most thorough evaluation on nickel, which was eliminated as a COC based on professional judgement.

4.6.3 Sulfate Exceedances in Wells 2987 and 10294:

Sulfate concentrations above Tier II action levels have been detected in wells 2987 and 10294. The "Groundwater Geochemistry Report for the Rocky Flats Environmental Technology Site" (EG&G, 1995b) plots data on Sulfate along east-west transects at the Site. Sulfate can be seen to increase in concentration from west to east along the two transects farthest away from the Industrial Area. We believe that this report documents increased sulfate concentration in the eastern portion of the Site as a natural process.

In 1997 the groundwater workgroup agreed to forego any active investigation of metals and sulfate exceedances until after new Site background thresholds had been established. This activity is scheduled for FY98.

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5.0 OTHER PROJECTS INVOLVING GROUNDWATER

The following groundwater activities were completed in CY96 either as support activities to the groundwater program or as support to other remediation activities. These activities are summarized in this report. Additional information can be found in the reports that are referenced in the text.

5.1 ASAP GROUNDWATER FLOW MODELING

The Accelerated Site Action Project (ASAP) was formulated to address the closure and future conditions of RFETS (DOE, 1996). Some of the future site conditions considered as part of the ASAP include placing engineered caps over selected areas of the site and shutting off the site infrastructure (water supply systems, sewers, etc.). Considerations for site closure are currently being addressed under the Focus On 2006 Plan (DOE, 1997b).

5.1.1 Purpose Of ASAP Modeling Project

The purpose for developing the ASAP groundwater model was to assess the impacts of future ASAP site conditions on the RFETS groundwater flow system. Future site conditions will likely involve constructing engineered caps over portions of the IA to reduce the infiltration of surface waters. In addition, many of the sub-surface piping systems in the IA may be deactivated or destroyed. These processes may alter the groundwater flow system by changing the rate, volume, and spatial distribution of groundwater recharge and discharge in the IA.

5.1.2 Precursor Site-Studies

To assist in developing the ASAP model, a series of research and review studies were performed. The goal of these studies was to provide information on several of the groundwater recharge and discharge processes at RFETS. This information could then be used to assist in the development and calibration of the ASAP groundwater model.

The first of these studies investigated groundwater recharge from the infiltration of precipitation (RMRS, 1996d). This study concentrated on areas covered by native materials (Rocky Flats Alluvium) and by native materials augmented with an improved soil cover to allow for a vegetated cap. Several sources of information including infiltration simulations using the Hydrologic Evaluation of Landfill Performance (HELP) model, hydrograph analysis, and previous groundwater modeling work were used in this investigation. The results from this study indicate that the HELP model may not consider all of the recharge mechanisms which may be operating at RFETS, and so may underestimate the amount of

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recharge. The study results estimate that recharge to the native materials should be on the order of one to two inches per year.

A second study summarized discharge rates from several subsurface drain systems at RFETS (RMRS, 1996e). This study was designed to provide estimates of groundwater fluxes in the subsurface based on discharge rates from building foundation drains and groundwater intercept systems. The study presents discharge data for foundation drains from buildings 444, 881, 865, 875 and 886. Additional discharge data are presented for the OU-1 French Drain and Solar Ponds Interceptor Trench System. The drain systems considered in this study account for an total groundwater flux of 3.4 million gallons per year.

The third study was a review concerning the natural discharge of groundwater (RMRS, 1996f). This study summarized groundwater discharge information for some of the seeps and springs at RFETS. The discharge data was available from a previous study in which discharge measurements from 206 seeps and springs were presented. Due to fiscal constraints, it was not possible to make discharge measurements for all seeps and springs at RFETS. The discharge rates that were determined varied from 72 to 28,000 gallons per day

The forth, and final, pre-modeling study developed a simple water mass balance for the IA at RFETS (RMRS, 1996g). It was primarily concerned with the transfer of water between the subsurface hydrogeologic system and the subsurface piping systems. The piping systems considered during this analysis included the: water supply, sanitary sewers, storm sewers, and foundation drains. One of the goals of this study was to determine if the water supply systems at RFETS are a significant source of recharge to the hydrogeologic system beneath the IA. This study indicates that, although there is significant recharge from the plant water supply system, there is also a large amount of discharge from the plant subsurface drain systems. This study concludes that there is an effective net loss of groundwater within the IA due to the plant subsurface piping systems.

5.1.3 Status of ASAP groundwater model

The ASAP groundwater model (RMRS, 1996h) was intended to be a tool to investigate the impacts of future site closure activities on groundwater at RFETS. The conceptualization and implementation of the model were developed with this goal in mind, so many of the important subsurface features that impact the groundwater system at RFETS, and which may change with the future site configuration, were included in the model.

The model was implemented using the USGS MODFLOW numerical groundwater modeling code. The current configuration of the model uses a single layer, with varying grid-spacing ranging from 75 to 300 feet. The single model layer is intended to represent the unconsolidated surficial materials present at RFETS. The model grid is centered over the RFETS IA and includes a substantial area around the main industrial complex.

As part of this modeling project, several of the main data input grids used in previous modeling activities were refined or updated. This was done in part to refine the data-grid spacing to that needed for the ASAP model, and also to include more recent information. These updated grids included the bedrock elevation grid used as the base of the model, and the Spring 1994 water table elevation grid which was used as the initial groundwater elevation for the model.

The current ASAP model includes the effects of stream-aquifer interactions, major building foundation drain systems, and groundwater interception systems (french drains). Net groundwater recharge is also included, although no distinction between natural and artificial recharge is made.

In its present state the groundwater flow model is calibrated to spring of 1994 conditions. The calibration data set consisted of water elevations from 239 wells. Currently, the model has only been preliminarily calibrated. To date, the only data set used to calibrate the model are the spring 1994 groundwater elevations. Some of the other data which might be used for model calibration, such as water discharge volumes from subsurface drains, have not been incorporated into the calibration data set.

Although steady-state simulations have been run, the preliminary calibration level of the current ASAP model precludes using it to simulate and assess future site conditions. Before simulating future conditions, further calibration work using the existing model would be necessary. The current model data sets provide a foundation and important resource for future modeling activities.

5.2 ACTINIDE MIGRATION PROJECT

The near-term projects to evaluate and mitigate actinide migration include: (1) finalization of the conceptual model for actinide migration for the Woman Creek and Walnut Creek drainages; (2) remediation of the 903 Pad and Lip area; and (3) evaluation of the Solar Ponds plume.

5.2.1 Woman Creek Drainage

The 903 Pad and Lip area is a source of windblown contamination. Initiation of potential remediation activities is scheduled for the 2000-2001 time frame, depending on the outcome of the current evaluation. The goals of the proposed actinide migration evaluation work for FY98 are to complete a draft Conceptual Model for actinide migration at RFETS, to quantify the rates of actinide transfer among media (surface and subsurface soil, groundwater, surface water, and air), and to evaluate transport rates

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on proposed remediation scenarios for the 903 Pad and Lip area under normal environmental conditions. The following activities will be performed to accomplish this:

- Laboratory studies on soils and sediments to determine actinide speciation, partition coefficients and mobility under various environmental conditions, soil erosion and air dispersion analyses, establishment of rates for each transport mechanism (leaching to groundwater, erosion, and air);
- A mass loading analysis to determine the maximum contribution of plutonium and americium to each drainage basin so as not to exceed stream standards; and
- The above data will be used to determine Site-specific cleanup levels under normal environmental conditions.

Actinide mobility distribution maps will be generated for normal and abnormal environmental conditions. The probability of meeting surface water standards by proposed remedial actions under varying environmental conditions will be determined.

5.2.2 Walnut Creek Drainage

The potential sources of actinides in the Walnut Creek Drainage are the Solar Ponds (U) and the IA (Pu, Am, and U).

Surface water in South Walnut Creek may need to be protected from contaminated groundwater originating from the Solar Ponds. The proposed RFCA milestone is to construct a plume containment system in FY99. To ensure attainment of this milestone, additional plume characterization will be conducted in FY98 to define the extent of the uranium and nitrate plumes originating from the Solar Ponds area. Groundwater analyses will be performed to evaluate, select, and design a preferred alternative for addressing the Solar Ponds plume.

The North and South Walnut Creek drainages will be further examined to define the sources of plutonium loading, and the Conceptual Model for actinide migration will be further refined.

5.3 INDUSTRIAL AREA IM/IRA ACTIVITIES IN CY96

In March 1997, the IA IM/IRA annual report was published (RMRS, 1997a) which documents groundwater and other monitoring data that were collected in support of the IA IM/IRA. This report covered the period from October, 1995 through September 1996. In addition, five new groundwater monitoring wells were installed in the IA to augment the monitoring of contaminants leaving the IA. These wells were some of the twelve wells originally proposed in the IM/IRA Implementation Plan for the Rocky Flats IA (DOE, 1995b). The other seven monitoring wells were not installed because of the change in criteria for monitoring as determined in the DQO process mentioned in Section 1. These additional wells would have been installed within the IA rather than on the perimeter, and would not have supported a decision as presented in the IMP. The wells that were installed are wells 22596, 22696, 22796, 22896 and 22996. Under the new well classification scheme, wells 22596, 22696, 22796 and 22896 are Plume Extent Wells located to detect northward migration of the IA Plume. Well 22996 is classified as a D&D well based on its use in monitoring the Decommissioning and Decontamination of Building 886. Section 2 discusses the sampling results for these wells. Well 22696 was technically dry during 1996 and no samples were collected. Figure 5-1 shows the location of these wells.

5.3.1 Building D&D Activities for FY97

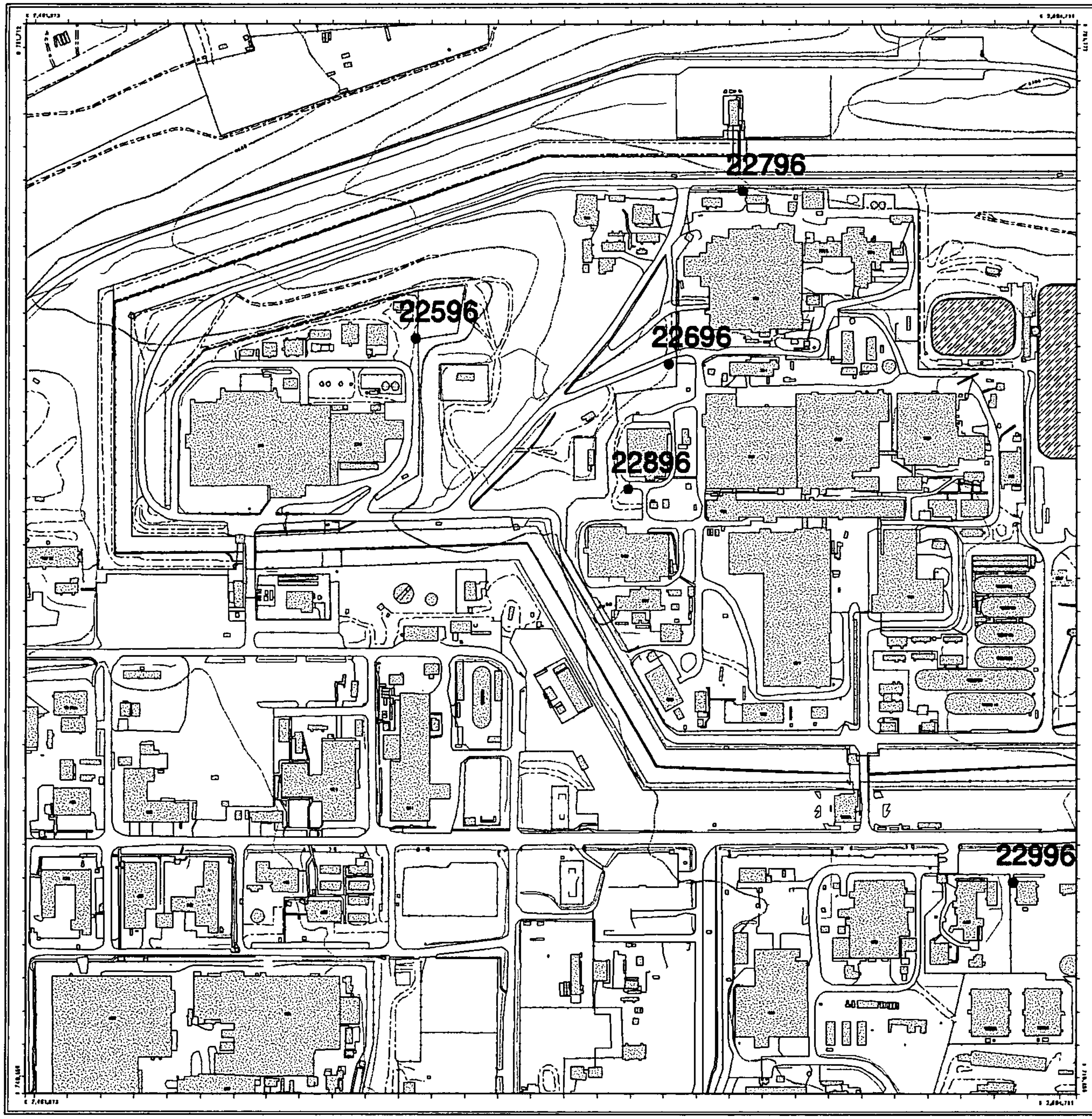
In compliance with the IA IM/IRA and the groundwater section of the IMP, groundwater monitoring must be performed on D&D activities that may impact surface water. Building 779 is slated for D&D within the next fiscal year. Building 779 was used as an R&D laboratory in which testing and experimentation on radionuclide and other materials was done. Though large volumes of radionuclides and hazardous substances were not resident at any given time, many different types of materials were used in the building. The IM/IRA requires the collection of pre-D&D groundwater quality data to establish a baseline for monitoring any effects due to D&D activities. The following activities are planned under the scope of the IM/IRA:

- Establishment of groundwater gradient and flowpath in the vicinity of Building 779;
- Installation of temporary monitoring wells with one upgradient well and up to three downgradient wells;
- Collection of groundwater samples for radionuclides, VOCs and metals; and
- Presentation of the sampling results in the IM/IRA annual report.

This project is scheduled and budgeted for completion in FY97.

5.4 FY96 WELL ABANDONMENT AND REPLACEMENT PROGRAM ACTIVITIES

The Well Abandonment and Replacement Program (WARP) is a maintenance program for the Groundwater Monitoring Program (GMP) at RFETS. Implementation of WARP achieves the general objective of ensuring the viability of groundwater monitoring wells and piezometers for the purpose of collecting representative samples of groundwater and other groundwater parameters. WARP provides a means to eliminate and selectively replace wells and piezometers where sample and water level readings are suspected of not being representative of subsurface conditions, or the elimination of wells that are no longer needed.



IA IM/IRA
Well Installation Program
Figure 5-1

EXPLANATION

- Tier II Monitoring Well

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs, 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours. The DEM data was capture by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at 10 (?) meter resolution. The DEM post-processing performed by MK, Winter 1997.

N

Scale = 1 : 5860
1 inch represents approximately 488 feet

100 0 200 400 Ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:
RMRS Rocky Mountain Remediation Services, L.L.C.

MAP ID: 97-0196 November 20, 1997

/gis2/projects/fy97/97-0196/lawell.aml

As stated in the FY96 WARP work plan (RMRS, 1996a), the specific objectives of FY96 WARP related to the GMP were to meet the following goals:

- abandon wells and piezometers located within or adjacent to IHSSs with known or suspected nonaqueous phase liquids (NAPLs) which were scheduled for 1996 removal actions using State of Colorado well abandonment and Site procedures.

- Install five wells at locations where water quality or piezometric data was needed for the Industrial Area groundwater monitoring program before initiation of building decommissioning and decontamination activities per the IM/IRA Work Plan (DOE, 1995b).

- Install three wells at locations where water quality or piezometric data was needed for the sitewide groundwater monitoring program (RMRS, 1996b).

5.4.1 Well Abandonments

A total of nine groundwater monitoring wells and soil vapor extraction piezometers were abandoned at RFETS during FY96 (Figures 5-2 and 5-3). The nine wells, piezometers, and conductor casings, identified in Figure 5-2 and Table 5-1, were used during a pilot soil vapor extraction project for Trench T-3 (IHSS 110). These nine wells were located within the excavation area of the trench, which was remediated by source removal under the Interagency Agreement. Four wells (24193, 24393, 24993, and 25093) with conductor casing were previously abandoned in-place during FY94 WARP, but required partial casing removal to allow for trench excavation activities. Five well casings (24093, 24293, 24493, 24593, and 24693) were obsolete alluvial piezometers used for vadose zone monitoring during soil vapor extraction testing.

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TABLE 5-1. Phase I Wells, IHSS 110, Trench T-3

WELL NO. (LOCATION CODE)	WELL PURPOSE	ABANDONMENT METHOD	CONDUCTOR CASING OR WELL CASING DIAMETER	CASING DEPTH (FEET)
24093	Piezometer	Overdrill	4 inch well	18
24193	Collection Well	Drill out grout inside conductor casing	12 in. conductor	15
24293	Piezometer	Overdrill	4 inch well	17
24393	Injection Well	Drill out grout inside conductor casing	12 in. conductor	17
24493	Piezometer	Overdrill	2 inch well	15.2
24593	Piezometer	Overdrill	2 inch well	14.2
24693	Piezometer	Overdrill	2 inch well	16.4
24993	Piezometer	Drill out grout inside conductor casing	8 in. conductor	17
25093	Piezometer	Drill out grout inside conductor casing	12 in. conductor	17.1

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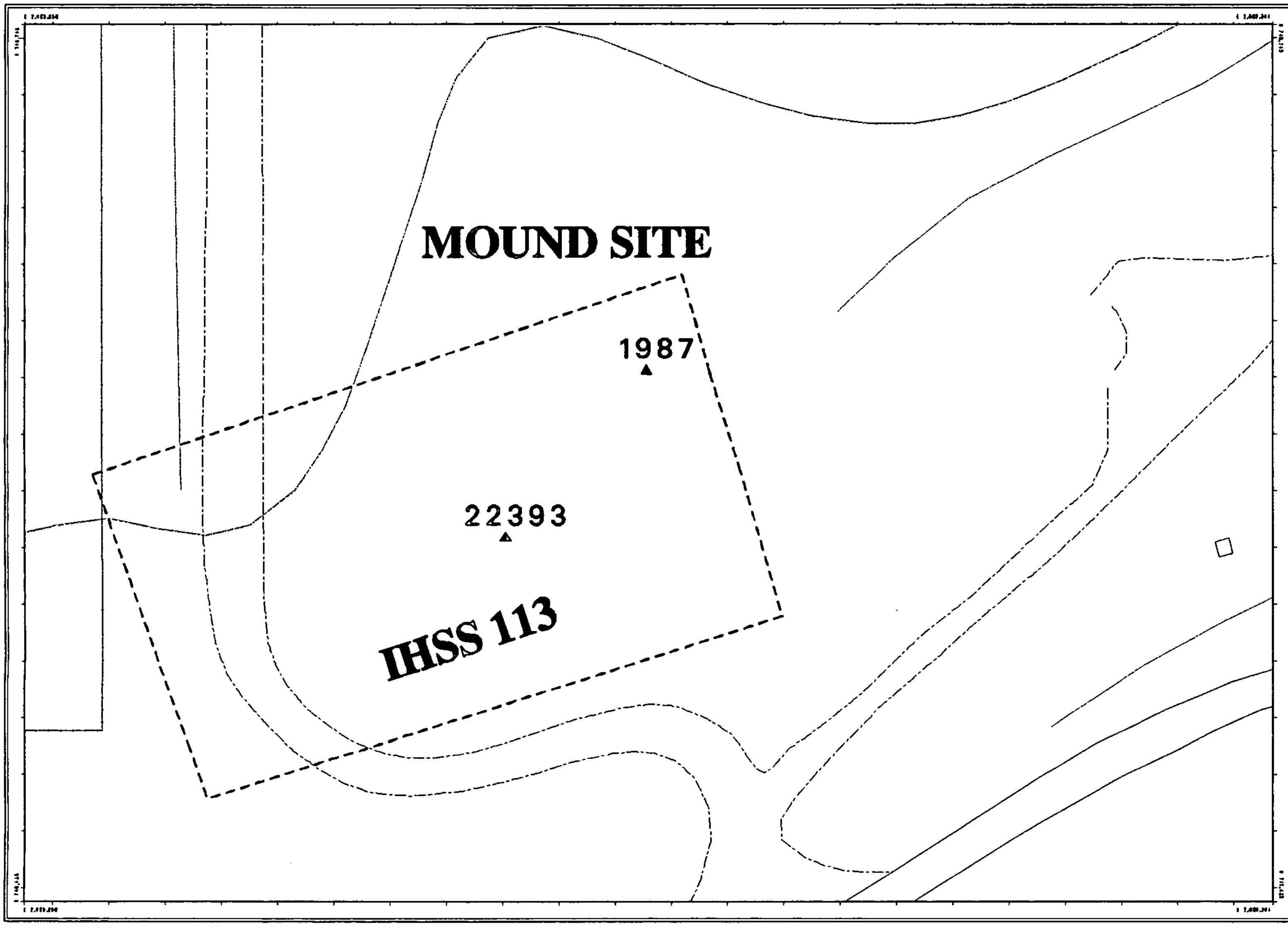

FY96 WARP
IHSS 113, Mound Site Well Abandonment Program
Figure 5-3

EXPLANATION

▲ Groundwater Well

Standard Map Features

- Buildings and other structures
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

N

Scale = 1 : 680
1 inch represents approximately 57 feet

15 0 30 60ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

RMRS Rocky Mountain Remediation Services, L.L.C.

MAP ID: 97-0196 November 20, 1997

/gis2/projects/fy97/97-0196/mound_r.aml

5.4.2 Well Installations

Eight groundwater monitoring wells were installed under FY96 WARP, including five wells in support of the IA IM/IRA (DOE, 1995b) and three wells in support of the RFETS Action Level Framework for Surface Water, Groundwater, and Soils (RMRS, 1996b); as referenced under the RFCA (RFCA, 1996). The IA IM/IRA well installation program has been discussed separately in Section 5.3 and will not be discussed further in this section.

The three Tier II wells (23096, 23196 and 23296) were located along Site surface water drainages for groundwater plume detection monitoring purposes. Well locations and other siting information are shown in Figure 5-4 and Table 5-2.

TABLE 5-2. Tier II Well Locations And Rationale

WELL NO.	LOCATION	SITING RATIONALE
23096	North of Pond C-1	Lack of potentiometric and water quality data for Tier II monitoring
23196	East of Pond C-1 along Woman Creek	Lack of potentiometric and water quality data for Tier II monitoring
23296	Between the dam footing of Pond B-2 and Pond B-3 along South Walnut Creek	Lack of potentiometric and water quality data for Tier II monitoring

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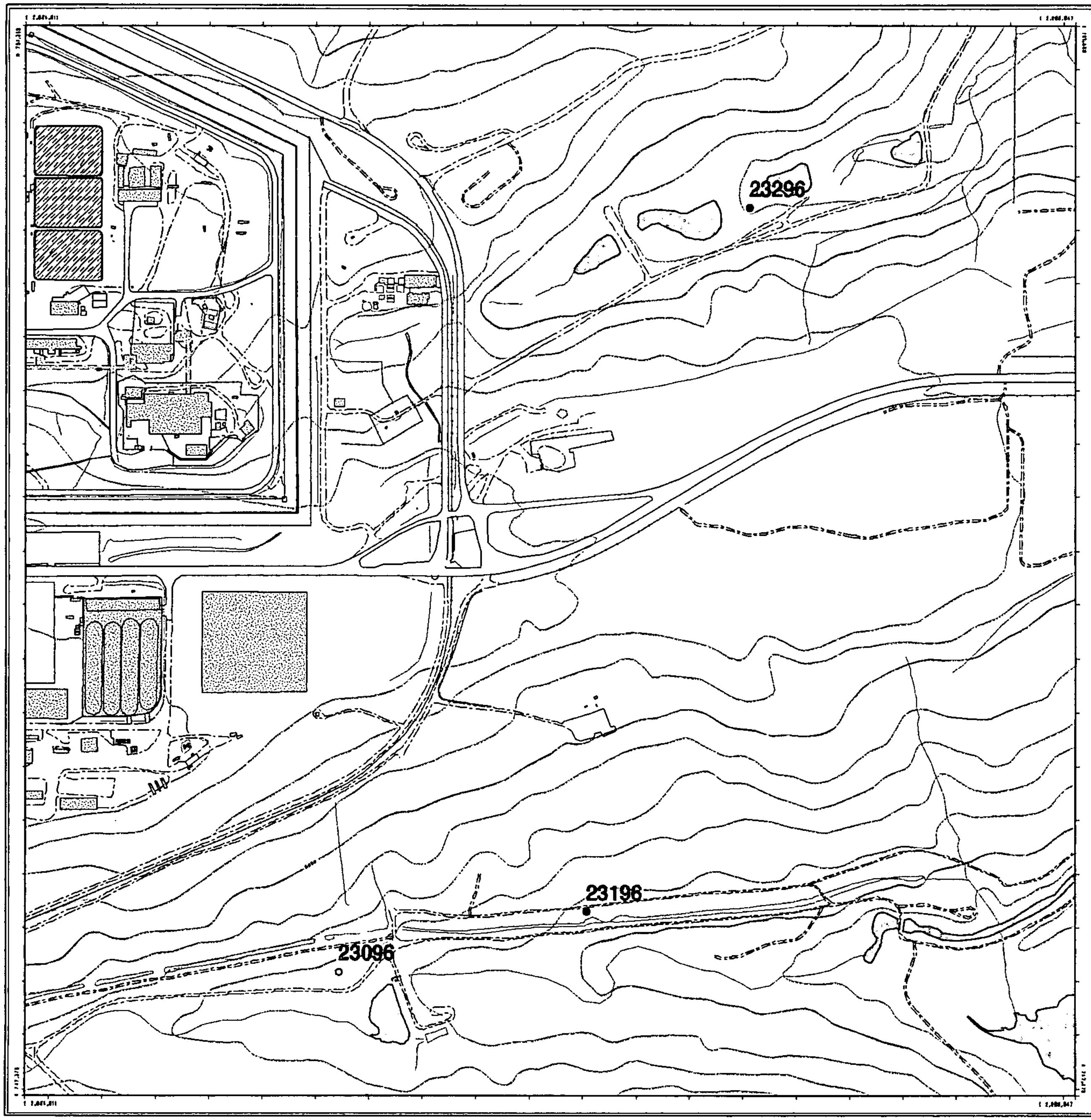

FY96 WARP
Tier II Monitoring Well Installation Program

Figure 5-4

EXPLANATION

- Tier II Monitoring Well

Standard Map Features

- Buildings and other structures
- Solar evaporation ponds
- Lakes and ponds
- Streams, ditches, or other drainage features
- Fences and other barriers
- Contour (20-Foot)
- Paved roads
- Dirt roads

DATA SOURCE:
Buildings, fences, hydrography, roads and other structures from 1994 aerial fly-over data captured by EG&G RSL, Las Vegas.
Digitized from the orthophotographs. 1/95
Topology (contours) were derived from digital elevation model (DEM) data by Morrison Knudsen (MK) using ESRI Arc TIN and LATTICE to process the DEM data to create 5-foot contours.
The DEM data was capture by the Remote Sensing Lab, Las Vegas, NV, 1994 Aerial Flyover at 10 (?) meter resolution.
The DEM post-processing performed by MK, Winter 1997.

Scale = 1 : 7250
1 inch represents approximately 604 feet

150 0 300 600 Ft

State Plane Coordinate Projection
Colorado Central Zone
Datum: NAD27

U.S. Department of Energy
Rocky Flats Environmental Technology Site

Prepared by:

RMRS Rocky Mountain Remediation Services, L.L.C.

MAP ID: 97-0196

November 20, 1997

/gis2/projects/fy97/97-0196/tierii.aml

underlying Laramie-Fox Hills Sandstone aquifer which subcrops west of the Industrial Area and plunges eastward beneath the plant. Vertical hydraulic conductivities for the confining layer materials are estimated to range from about 2.8 x 10^{-10} to 2.5 x 10^{-7} centimeters/second, or roughly three to seven orders of magnitude lower than for the overlying surficial deposits. Due to this contrast in hydraulic conductivity, groundwater is expected to move predominently laterally in the surficial deposits and vertically in the confining layer. Downward vertical hydraulic gradients observed in the confining layer indicate that shallow groundwater has the potential to recharge the Laramie-Fox Hills aquifer.

Faulting in the upper Laramie Formation has been documented regionally and recently has been documented at the Industrial Area. The influence of these fault zones on vertical groundwater flow is unknown; however, an observed trend of decreasing claystone permeabilities with depth is expected to result in a restrictive, rather than an enhanced, vertical groundwater flow regime. Fractures observed in bedrock core samples tend to be discontinuous, sub-horizontal to sub-vertical, and closed with depth. Trace concentrations of trichloroethene, tetrachloroethene, carbon tetrachloride, and chloroform found in some unweathered bedrock wells indicate that limited contaminant migration has occurred in the shallowest part of the confining layer beneath shallow groundwater plumes with high concentrations, although most detections are apparently related to laboratory or well cross contamination. Plutonium-239/240 was detected above background in three unweathered bedrock wells, but the available evidence indicates that these occurrences are attributable to cross contamination probably as a result of drilling through radionuclide contaminated soils.

Estimates of the vertical groundwater flow velocity through the confining layer indicate that groundwater movement is expected to be very slow. The calculated range of groundwater velocities, based on a potential range of vertical hydraulic conductivities, is 0.00054 to 0.468 feet/year, which translates to travel times to the Laramie-Fox Hills aquifer of 1,300 to 1.1 million years. Consideration of the hydrologic setting and declining hydraulic conductivity trend with depth suggests that the actual groundwater flow velocity will be near the low end of the range.

Analysis of the behavior of dense nonaqueous phase liquids indicated that a potential exists for entry of DNAPL into fractured bedrock. However, the threat of DNAPL migration to the Laramie-Fox Hills aquifer is rapidly mitigated by diffusive disappearance of DNAPL from fractures into the claystone matrix, which has a large contaminant mass storage capacity. Dissolved and sorbed volatile organic contaminants derived from DNAPLs therefore represent the principal concern for vertical contaminant migration to the deep aquifer.

All Tier II wells were completed in the upper hydrostratigraphic unit (UHSU) which consists of Rocky Flats Alluvium, valley fill alluvium, and some underlying weathered bedrock. As a preventative measure, the wells were double-cased to prevent potentially contaminated surface soil from entering the borehole, but were otherwise installed using conventional construction methods prescribed in OP, GT.06, Monitoring Wells and Piezometer Installation. Well construction materials consisted of 2-inch diameter, schedule 40 polyvinyl chloride (PVC) riser and factory cut well screen, 18 to 24-inch length of 16-inch surface conductor casing, and 6-inch diameter steel surface protective casing with locking cap and lock.

5.5 VERTICAL MIGRATION

In 1996, RMRS was tasked by Kaiser-Hill to evaluate the potential for shallow groundwater contaminants, particularly volatile organic compounds, to migrate vertically downward through a thick, laterally extensive confining layer and enter a deep regional artesian aquifer system known as the Laramie-Fox Hills Sandstone aquifer. The Laramie-Fox Hills Sandstone aquifer provides an important source of water for local and regional use and is the sole water supply for some residents in the Rocky Flats area. This evaluation produced a white paper entitled "*Analysis of Vertical Contaminant Migration Potential*" (RMRS, 1996c) that formed part of a comprehensive environmental initiative, known as the Accelerated Site Action Project (ASAP). A summary of the major issues and conclusions of this report are presented below.

Concerns related to contaminant migration and the long-term hydrologic integrity of this confining layer were raised regarding the presence of dense non-aqueous phase liquids (DNAPLs) in the groundwater at some waste disposal sites and the occurrence of secondary permeability (i.e., fractures and faults) in bedrock materials. The combination of these factors at other Superfund sites have led to persistent groundwater contamination problems that have proven to be difficult to remediate and, thus, represent a long term contaminant migration threat. In order to evaluate the potential significance of vertical groundwater contaminant transport at the Site, two individual hazardous substance sites (IHSSs 110 and 118.1) with evidence of chlorinated solvent releases were selected for analysis and discussion. The primary DNAPL and dissolved contaminants-of-concern identified at these sites are trichloroethene, tetrachloroethene, and carbon tetrachloride. Information from numerous site reports, unpublished site data, and recently published articles provided the basis for the analyses presented in the white paper.

The Site is underlain by a mantle of permeable Quaternary surficial geologic deposits deposited on a 600+ foot thick sequence of low permeability Cretaceous claystone and siltstone bedrock known as the upper Laramie Formation. The upper Laramie Formation functions as a confining layer for the

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Organic contaminants are expected to move much slower than the groundwater flow velocity in the confining layer due to the effects of sorption by high organic carbon and clay contents, dispersion and molecular diffusion, and possibly *in situ* abiotic transformation reactions. The most rapidly transported contaminant, trichloroethene, is predicted to travel for 17,000 to 15 million years before reaching the Laramie-Fox Hills aquifer, with the most likely case being on the order of a hundred thousand years or more. Assuming that natural contaminant degradation is a viable process, some contaminants with short environmental half lives, such as carbon tetrachloride, may fully degrade before reaching the aquifer. The results of simple one- and two-dimensional analytical modeling of contaminant transport indicate that dispersion will reduce contaminant concentrations at the confining layer/aquifer interface by 6 to 99 percent, depending on magnitude of the vertical flux. Under worst case conditions, the resulting contaminant concentrations derived from mass flux calculations in the Laramie-Fox Hills aquifer exceed regulatory limits; however, these calculations are exceedingly conservative and ignore some important basic factors. Using a more realistic set of assumptions, it is expected that, if contaminants should ever reach the aquifer, the concentrations will be below regulatory limits.

It was concluded from this review and analysis that the upper Laramie Formation confining beds have a sufficient amount of hydrologic and geochemical integrity to provide long-term protection of the Laramie-Fox Hills aquifer. Monitoring of vertical contaminant migration at potential bedrock source areas, rather than remediation, was recommended as the most prudent and cost effective option for protection of the Laramie-Fox Hills aquifer given the apparent robust geochemical nature of unweathered bedrock materials underlying the site.

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EG&G, 1993a. 1992 Annual RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant, Golden, Colorado, March.

EG&G, 1993b. Background Geochemical Characterization Report, Rocky Flats Plant, Golden, Colorado, September.

EG&G, 1993c. Groundwater Protection and Monitoring Program Plan for Rocky Flats Plant, Golden, Colorado, October.

EG&G, 1993d. Ground-Water Recharge Study, Final Interim Report Rocky Flats Plant, Golden, Colorado, October.

EG&G, 1994a. 1993 Annual RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant, February.

EG&G, 1994b. Well Evaluation Report Final, EG&G Rocky Flats, Inc., Golden, Colorado, April.

EG&G, 1995a. Groundwater Geochemistry Report For the Rocky Flats Environmental Technology Site, Sitewide Geoscience Characterization Study Vol III, January.

EG&G, 1995b. Geologic Characterization Report For the Rocky Flats Technology Site, Sitewide Geoscience Characterization Study, Vol I, March.

EG&G, 1995c. 1994 Annual RCRA Report for Regulated Units at the Rocky Flats Environmental Technology Site, March.

EG&G, 1995d. Hydrogeologic Characterization Report for the Rocky Flats Technology Site, Sitewide Geoscience Characterization Study Vol II. April.

EPA., 1988a. Laboratory Data Validation Functional Guidelines for Evaluating Organics Analysis. Prepared by EPA's Data Review Workgroup for EPA's Hazardous Site Evaluation Division. EPA, February, 1988.

EPA., 1988b. Laboratory Data Validation Functional Guidelines for Evaluating Inorganics Analysis. Prepared by EPA's Data Review Workgroup for EPA's Hazardous Site Evaluation Division. EPA, July, 1988.

EPA., 1992. Guidance for Data Useability in Risk Assessment, Final. EPA, 9285.7-09A.

EPA., 1996. Letter from Tim Rehder to Steven Slaten, RE: Monitoring Well List. November 14, 1996.

Fetter, G.W. Jr., 1988. Applied Hydrogeology, 2nd ed., Merrill Publishing Company, Columbus, Oh.

Haun, J.D. and H.C. Kent, 1965. Geologic History of the Rocky Mountain Region, Bull. of the American Association of Petroleum Geologists, v 49, no. 11, p. 1781-1800.

Hess, C.T. et al., 1985. The Occurance of Radioactivity in Public Water Supplies in the United States, Health Physics 48(5), 553-586.

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

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6.0 REFERENCES

CDPHE, 1996. Letter from Steve Tarlton to Steven W. Slaten. November 19, 1996.

DOE, 1988. DOE Order 5400.1, General Environmental Protection Program.

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

DOE, 1992b. Interim Measure/Interim Remedial Action French Drain Performance Monitoring Plan, U.S. Department of Energy, June.

DOE, 1993a. Background Geochemical Characterization Report. September 30, 1993.

DOE, 1993b. Final Ground Water Assessment Plan, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, February. 24.

DOE, 1994. Final Interim Measures/Interim Remedial Action Decision Document for the Rocky Flats Industrial Area, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, March.

DOE, 1995a. Interim Measure/Interim Remedial Action Implementation Plan for the Rocky Flats Environmental Technology Site, U.S. Department of Energy, Rocky Flats Environmental Technology Site, Golden, Colorado, June.

DOE, 1995b. Final Interim Measures/Interim Remedial Action Implementation Plan for the Rocky Flats Industrial Area, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado, June.

DOE, 1995c. Draft Data Summary 2, Operable Unit No. 8, 700 Area, U.S. Department of Energy, Rocky Flats Plant, Golden, Colorado , September.

DOE, 1996. Phase II Choices for Rocky Flats; Accelerated Site Action Project, February, 1996.

DOE, 1997a. Background Comparison for Radionuclides in Groundwater, Draft. January, 1997.

DOE, 1997b. Accelerating Cleanup: Focus on 2006, June, 1997.

Efurd, D.W., Rokop, D.J., Perrin, R.E., 1993. Characterization of Radioactivity in Surface-Waters and Sediments Collected at the Rocky Flats Facility, LANL Report LA-UR-93-4373, Los Alamos National Laboratory, Los Alamos, New Mexico, 54 pp.

EG&G, 1988. Health Physics Manual of Good Practices for Uranium Facilities, EG&G, NTIS DE88-013620.

EG&G, 1991a. Final Geologic Characterization Report for the U.S. D.O.E. Rocky Flats Plant.

EG&G, 1991b. Rocky Flats Plant Site-Wide Quality Assurance Project Plan for CERCLA RI/FS and RFI/CMS Activities. EG&G, May 7, 1991.

EG&G, 1992. 1991 Annual RCRA Groundwater Monitoring Report for Regulated Units at the Rocky Flats Plant, Golden, Colorado, March.

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Scott, G.R., 1975. Cenozoic Surfaces and Deposits in the Southern Rocky Mountains, In Cenozoic History of the Southern Rocky Mountains, Curtis, B.F., ed., Geological Society of America Memoir 144.

Shroba, R.R. and P.E. Carrara, 1994. Preliminary Surficial Geologic Map of the Rocky Flats Plant and Vicinity, Jefferson and Boulder Counties, Colorado, U.S. Geological Survey Open-file Report, OFR-94-162.

Spencer, F.D., 1961 Bedrock Geology of the Louisville Quadrangle, Colorado. USGS. Geological Quadrangle Map GQ-151, lat. 39 52' 30" to 40 long 105 07' 30" to 105 15' scale 1:24000, contour interval 10 feet.

K-H, 1997. Rocky Flats Environmental Technology Site Integrated Monitoring Plan (Draft), June.

Pearl, R.H., 1980. "Ground-Water Resources of Colorado"in: Colorado Geology, H.C. Kent and K.W. Porter eds.

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

RMRS, 1996a. Well Abandonment and Replacement Program Work Plan, RF/ER-96-0015, Environmental Restoration Program, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

RMRS, 1996b. Conceptual Plan for the Management and Remediation of Groundwater at the Rocky Flats Environmental Technology Site, RF/ER-95-0121, Rev. 2, Environmental Restoration Program, Rocky Flats Environmental Technology Site, Golden, Colorado, March.

RMRS, 1996c. White Paper - Analysis of Vertical Contaminant Migration Potential, Final Report, RF/ER-96-0040.UN, August 16, 1996.

RMRS, 1996d. Recommendation of Recharge Estimates for the Rocky Flats Alluvium - Preliminary Draft, April 15, 1996.

RMRS, 1996e. Rocky Flats Environmental Technology Site - Subsurface Drain Analysis in Support of the Accelerated Site Action Project For Site Closure, May 16, 1996.

RMRS, 1996f. Rocky Flats Environmental Technology Site - Seep and Spring Analysis in Support of the Accelerated Site Action Project For Site Closure - Draft, May 29, 1996.

RMRS, 1996g. Industrial Area Groundwater Mass Balance - Draft, July 18, 1996.

RMRS, 1996h. Status Report - Groundwater Flow Modeling at the Rocky Flats Environmental Technology Site, September 30, 1996.

RMRS, 1997a. Annual Report Interim Measures/Interim Remedial Action for the Industrial Area of the Rocky Flats Environmental Technology Site, March.

RMRS, 1997b. 1996 Third Quarter RFCA Groundwater Monitoring Report For Rocky Flats Environmental Technology Site. January, 1997.

RMRS, 1997c. 1996 Fourth Quarter RFCA Groundwater Monitoring Report For Rocky Flats Environmental Technology Site. June, 1997.

RMRS, 1997d. 1997 First Quarter RFCA Groundwater Monitoring Report For Rocky Flats Environmental Technology Site. August, 1997.

RMRS, 1997e. Final Post-Corrective Action Decision/Record of Decision Investigation Report for the 881 Hillside Area, IHSS 119.1, Revision 0, RF/RMRS-97-054.UN, September, 1997.

RMRS/KH, 1996. 1995 Annual RCRA Report for Regulated Units at Rocky Flats Environmental Technology Site, February.

RMRS/KH, 1997. Draft Mound Site Plume Decision Document, August.

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THIS TARGET SHEET REPRESENTS AN
OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 1:

Groundwater Flow Monitoring Well Location Map

Map ID: 97-0028

September 29, 1997

CERCLA Administrative Record Document, SW-A-004868

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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THIS TARGET SHEET REPRESENTS AN OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 2:

Potentiometric Surface of Unconsolidated Surficial Deposits Second Quarter 1996

Map ID: 97-0136

September 27, 1997

CERCLA Administrative Record Document, SW-A-004868

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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THIS TARGET SHEET REPRESENTS AN
OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 3:

Potentiometric Surface of Unconsolidated Surficial Deposits Fourth Quarter 1996

Map ID: 97-0136

September 27, 1997

CERCLA Administrative Record Document, SW-A-004868

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 4:

Radionuclides in Groundwater RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

CERCLA Administrative Record Document, SW-A-004868

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 5:

Dissolved Metals in Groundwater RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

CERCLA Administrative Record Document, SW-A-004868

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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THIS TARGET SHEET REPRESENTS AN
OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 6:

VOCs in Groundwater RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

CERCLA Administrative Record Document, SW-A-004868

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GOLDEN, COLORADO

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OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 7:

Water Quality in Groundwater RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

CERCLA Administrative Record Document, SW-A-004868

U.S. DEPARTEMENT OF ENERGY
ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

GOLDEN, COLORADO

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THIS TARGET SHEET REPRESENTS AN
OVER-SIZED MAP / PLATE FOR THIS DOCUMENT:
(Ref: RF/RMRS-97-087.UN)

1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 8:

Radionuclides in Groundwater Non RFCA Wells, 1996

Map ID: 97-0158

September 27, 1997

CERCLA Administrative Record Document, SW-A-004868

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 9:

Dissolved Metals in Groundwater Non RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 10:

VOCs in Groundwater Non RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 11:

Water Quality in Groundwater Non RFCA Wells, 1996

Map ID: 97-0158

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 12:

VOCs in Groundwater, 1996

Map ID: 97-0133

September 27, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 13:

Nitrate Concentration in Groundwater, 1991-1995 (Avg.)

Map ID: 97-0133

September 26, 1997

CERCLA Administrative Record Document, SW-A-004868

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 14:

Nitrate Concentration in Groundwater, 1996

Map ID: 97-0133

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 15:

Filtered Tritium in Groundwater, 1991-1995 (Avg.)

Map ID: 97-0133

September 29, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 16:

Filtered Tritium in Groundwater, 1996

Map ID: 97-0133

September 29, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate ~~16~~: 17

Filtered U233/234 in Groundwater, 1991-1995 (Avg.)

Map ID: 97-0133

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 18:

Filtered U233/234 in Groundwater, 1996

Map ID: Draft

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 19:

Filtered U235 in Groundwater, 1991-1995 (Avg.)

Map ID: 97-0133

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 20:

Filtered U235 in Groundwater, 1996

Map ID: Draft

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 21:

Filtered U238 in Groundwater, 1991-1995 (Avg.)

Map ID: 97-0133

September 26, 1997

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1996 Annual RFCA Groundwater Monitoring Report

November 18, 1997

Plate 22:

Filtered U238 in Groundwater, 1996

Map ID: Draft

September 26, 1997

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