Department of Energy
Office of Legacy Management

May 25, 2007

Mr. James A. Saric, Remedial Project Manager
United States Environmental Protection Agency
Region V-SRF-5J
77 West Jackson Boulevard
Chicago, Illinois 60604-3590

Mr. Thomas Schneider, Project Manager
Ohio Environmental Protection Agency
Southwest District Office
401 East Fifth Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

Subject: **Transmittal of the 2006 Site Environmental Report**

This letter transmits the Fernald Site Environmental Report for calendar year 2006 to the United States Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA). The enclosed report is submitted in order to meet the June 1, 2007 commitment date, which fulfills the annual reporting commitment identified in Attachment D of the Comprehensive Legacy Management and Institutional Controls Plan.

The 2006 Site Environmental Report documents the results of the environmental monitoring activities over the calendar year and highlights the Fernald site's progress to and completion of final remediation. Consistent with the reporting format outlined, this report consists of the following two components:

- Summary Report – Similar to previous annual site environmental reports, it includes background information about the Fernald site and associated remediation activities. It also provides a summary-level presentation of environmental data for groundwater, surface water and treated effluent, sediment, and air. This summary report also includes an exposure pathway dose assessment for 2006, and a natural resources update.

- Appendices A through D – The appendices present detailed environmental data for 2006, and primarily consist of graphs and tables. This detailed information supports the findings and data interpretations presented in the summary report. In addition, Appendix D provides the National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart H compliance report and supporting documentation.

The summary report is intended to serve the same audience as past annual reports and will be distributed to Fernald stakeholders. The appendices are intended to serve a more technical audience and will receive a more limited initial distribution.

The summary report and appendices will be available to all stakeholders through the Public Environmental Information Center, which is located at 10995 Hamilton-Cleves Highway Cincinnati, OH 45030; (513) 648-5051 (open Monday through Thursday, 9:00 a.m. to 4:00 p.m., or by appointment). The summary report will also be made available on the Department of Energy Office of Legacy Management's internet site (http://www.lm.doe.gov) under the Legacy Management Sites icon.

As in the past, comments on this report will be addressed through a comment response document and incorporated in future annual reports, as appropriate, rather than through a revision of this document. If you have any questions concerning this report, please call me at (513) 648-3148.

Sincerely,

Jane Powell

Jane Powell,
Fernald Site Manager
DOE-LM-20.1

Enclosures

cc w/enclosure:
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Administrative Records (Thru W. Sumner)

cc w/o enclosure:
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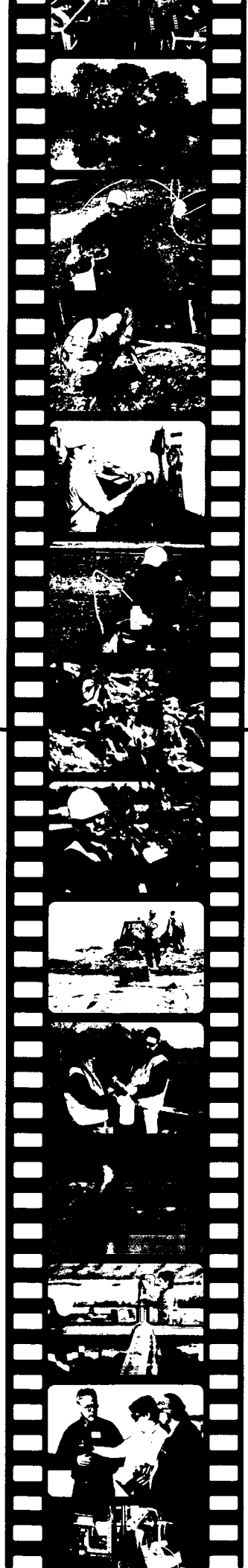

2006

Fernald
Site Environmental Report

U.S. Department of Energy
Office of Legacy Management
Contract DE-AC01-02GJ79491
Issued May 2007

Document 6740

DOE–LM/1461–2007

2006 Fernald Site Environmental Report

May 2007

Work Performed by S.M. Stoller Corporation under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management, Grand Junction, Colorado

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Appendix

Appendix A Supplemental Groundwater Information
Appendix B Supplemental Surface Water, Treated Effluent, and Sediment Information
Appendix C Supplemental Air Information
Appendix D 2006 National Emissions Standards for Hazardous Air Pollutants (NESHAP) Annual Report

Acronyms

ARARs	applicable or relevant and appropriate requirements
BCG	Biota Concentration Guides
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
ICRP	International Commission on Radiological Protection
IEMP	Integrated Environmental Monitoring Plan
NAS	National Academy of Science
NCRP	National Council on Radiation Protection
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
PCB	polychlorinated biphenyl
RAC	Risk Assessments Corporation
RCRA	Resource Conservation and Recovery Act
SARA	Superfund Amendment and Reauthorization Act of 1986
SER	site environmental report
TLD	thermoluminescent dosimeter
TTA	Transfer Tank Area
TSCA	Toxic Substance Control Act
USGS	United States Geologic Survey
WCS	Waste Control Specialists
WLM	working level month

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List of Measurement Abbreviations

cm	centimeter
ft	feet
ft^3/sec	cubic feet per second
m	meter
m^3	cubic meters
m^3/sec	cubic meters per second
yd^3	cubic yards
gpm	gallons per minute
kg	kilogram
km	kilometer
Lpm	liters per minute
µCi	microCuries
µg/m^3	micrograms per cubic meter
µg/kg	micrograms per kilogram
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mGy/day	milliGray per day
M gal	million gallons
M liters	million liters
mrem	millirem
mSv/yr	milliSievert per year
person-Sv	person-Sievert
pCi/m^3	picoCuries per cubic meter
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter
lb	pound

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Units (Abbreviations) and Conversion Table

Multiply	By	To Obtain	Multiply	By	To Obtain
inches (in)	2.54	centimeters (cm)	cm	0.3937	in
feet (ft)	0.3048	meters (m)	m	3.281	ft
miles (mi)	1.609	kilometers (km)	km	0.6214	mi
pounds (lb)	0.454	kilograms (kg)	kg	2.205	lb
tons	0.9072	metric tons	metric tons	1.102	tons
gallons	3.785	liters (L)	L	0.2642	gallons
square feet (ft^2)	0.0929	square meters (m^2)	m^2	10.76	ft^2
acres	0.4047	hectares	hectares	2.471	acre
cubic yards (yd^3)	0.7646	cubic meters (m^3)	m^3	1.308	yd^3
cubic feet (ft^3)	0.02832	cubic meters (m^3)	m^3	35.31	ft^3
picocuries (pCi)	10^{-12}	curies (Ci)	Ci	1012	pCi
pCi/L	10^{-6}	microcuries per liter (µCi/L)	µCi/L	106	pCi/L
millirem (mrem)	0.001	rem	rem	1000	mrem
mrem	0.01	milliSievert (mSv)	mSv	100	mrem
rem	0.01	Sievert (Sv)	Sv	100	rem
mSv	0.001	Sv	Sv	1000	mSv
person-rem	0.01	person-Sv	person-Sv	100	person-rem
rad	0.01	Gray (Gy)	Gy	100	rad
milliGray (mGy)	0.001	Gy	Gy	1000	mGy
milligrams per liter (mg/L)	1000	micrograms per liter (µg/L)	µg/L	0.001	mg/L
Fahrenheit (˚F)	(˚F - 32) x 5/9	Celsius (˚C)	˚C	(˚C x 9/5) + 32	˚F
For Natural Uranium in Water					
pCi/L	0.0015	mg/L	mg/L	675.7	pCi/L
pCi/L	1.48	µg/L	µg/L	0.6757	pCi/L
µg/L	0.6757	pCi/L	pCi/L	1.48	µg/L
For Natural Uranium in Soil					
pCi/g	1.48	µg/g	µg/g	0.6757	pCi/g
mg/kg	1	µg/g	µg/g	1	mg/kg

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Executive Summary

The *2006 Fernald Site Environmental Report* provides stakeholders with the results from the Fernald, Ohio, site's environmental monitoring programs for 2006; a summary of the U.S. Department of Energy's (DOE's) remedial activities conducted on site; and a summary of the Fernald site's compliance with the various environmental regulations, compliance agreements, and DOE policies that govern site activities. Information presented in this executive summary is discussed more fully within the body of this report and the supporting appendixes. This report has been prepared in accordance with DOE Order 5400.1, *General Environmental Protection Program* (DOE 1990), and the *Integrated Environmental Monitoring Plan* (IEMP), which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan*, (DOE 2006a). In January 2003, DOE Order 450.1 went into effect, superseding DOE Order 5400.1; however, it has been determined that the intent of this order is met through existing DOE Fernald contractual requirements.

During 2006, a wide range of environmental remediation activities occurred, including:

- Large scale excavation of contaminated soil and materials from the former production area (Operable Unit 5).
- Placement of contaminated soil and debris in the on-site disposal facility (Operable Unit 2).
- Decontamination and dismantlement of former production buildings and support facilities (Operable Unit 3).
- Transfer of material from Silos 1, 2, and 3 for treatment, packaging, and shipment to an off-site storage facility (Silo 1 and 2 material) and disposal facility (Silo 3 material) (Operable Unit 4).
- Installation of the last groundwater module needed to complete the aquifer remediation system.
- Extraction and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).

An important milestone was achieved in 2006 when Fluor Fernald, Inc., the prime contractor to the DOE's Office of Environmental Management at Fernald for the remediation of the Fernald site, declared the remediation complete on October 29, 2006. On November 17, 2006, DOE determined this declaration to be reasonable and subsequently accepted the project as complete on January 22, 2007. Achieving this completion milestone required that all remediation under the five operable units had been completed, with the exception of the final disposal of waste materials from Silos 1 and 2 and the groundwater remedy being conducted under Operable Unit 5.

The completion of the remediation of the Fernald site resulted in

- The demolition of 323 structures.
- The placement of 2.96 million in-place cubic yards (yd^3)(2.2 million cubic meters [m^3]) of contaminated debris and soil in the on-site disposal facility.
- The excavation of 2.1 million in-place yd^3 of contaminated soils and sediments.

- The rail shipment of 975,100 tons of waste pit material to Envirocare of Utah.
- The preparation and shipment by truck of 2,297 containers of Silo 3 material for disposal at Envirocare.
- The preparation and shipment by truck of 3,776 containers of material from Silo 1 and 2 for interim storage at Waste Control Specialists (WCS) in Texas.

DOE underwent a formal process to transfer responsibilities from the Office of Environmental Management to the Office of Legacy Management. This process ensured that physical features of the site were properly documented and the legal and regulatory environment within which site operations were conducted were understood to ensure DOE commitments and responsibilities continued to be met. This transfer process also supported budgetary and appropriation decisions to ensure the necessary funding was secured to perform operations and long-term surveillance and maintenance responsibilities.

The DOE's Office of Legacy Management and their Technical Assistance Contractor, S.M. Stoller Corporation, assumed full responsibility for operations at the Fernald site on November 17, 2006.

The following sections highlight the results of environmental monitoring activities conducted during 2006.

Liquid Pathway Highlights

Groundwater Pathway

The groundwater pathway at the Fernald site is routinely monitored to:

- Determine capture and restoration of the total uranium plume and non-uranium constituents, and evaluate water quality conditions in the aquifer that indicate a need to modify the design or the operation of restoration modules.
- Meet compliance based groundwater monitoring obligations.

During 2006, active restoration of the Great Miami Aquifer continued. At the end of 2006, all three required groundwater restoration modules were operating (i.e., South Field, South Plume, Waste Storage Area) and all required extraction wells were installed and operational. In addition, the infrastructure to pump and discharge clean groundwater to the storm sewer outfall ditch to facilitate the flushing of the aquifer was also operational.

Approximately 140 monitoring wells were sampled semiannually to determine water quality. Water elevations were measured quarterly in approximately 170 monitoring wells. The following highlights describe the key findings from the 2006 groundwater data:

- 2,027 million gallons (M gal) (7,672 million liters [M liters]) of water were pumped from the Great Miami Aquifer. As a result of these restoration activities, 673 pounds (lb) (305 kilograms [kg]) of uranium were removed from the aquifer.
- The results of the 2006 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the groundwater remedy for the aquifer restoration system is appropriate for capture of the plume.

- Pumping of the South Plume/South Plume Optimization Module continued to meet the objective of preventing further southward migration of the southern total uranium plume beyond the extraction wells.
- Leak detection monitoring at Cells 1 through 8 of the on-site disposal facility indicates that all of the individual cell liner systems are performing within the specifications outlined in the approved cell design.

Surface Water and Treated Effluent Pathway

Surface water and treated effluent are monitored to determine the effects of Fernald remediation activities on Paddys Run (an intermittent stream), the Great Miami River, and the underlying Great Miami Aquifer; and to meet compliance-based surface water and treated effluent monitoring obligations. In addition, the results from sediment sampling are discussed as a component of this primary exposure pathway.

In 2006, 16 surface water and treated effluent locations and two sediment locations were sampled at various frequencies. The following highlights describe the key findings from the 2006 surface water, treated effluent, and sediment monitoring programs:

- The uranium released to the Great Miami River through the treated effluent pathway was an estimated 476 lb (216 kg), which was below the limit of 600 lb (272 kg) per year. Uranium released through the uncontrolled runoff pathway was estimated at 89 lb (40 kg). Therefore, the total amount of uranium released through the treated effluent and uncontrolled surface water pathways during 2006 was estimated to be 565 lb (256 kg).
- No surface water or treated effluent analytical results from samples collected in 2006 exceeded the final remediation level (FRL) for total uranium, the site's primary contaminant. In addition, there were no FRL exceedances for any other constituent.
- Compliance sampling, consisting of sampling for non-radiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald site, is regulated under the state-administrated National Pollutant Discharge Elimination System (NPDES) program. The current permit became effective on July 1, 2003, and expires on June 30, 2008.
- Discharges were in compliance with effluent limits identified in the NPDES Permit more than 99 percent of the time during 2006.
- There were no FRL exceedances for any sediment result in 2006.

Air Pathway Highlights

The air pathway is routinely monitored to assess the impact of Fernald site emissions of radiological air particulates, radon, and direct radiation on the surrounding public and environment. In addition, the data are used to demonstrate compliance with various regulations and DOE Orders.

Radiological Air Particulate Monitoring

Data collected from the network of the air monitoring stations around the boundary of the Fernald site (including one background air monitoring station) showed the annual average

radionuclide concentrations were fewer than 1 percent of DOE-derived concentration guidelines contained in DOE Order 5400.5, *Radiation Protection of the Public and the Environment.*

The maximum effective dose equivalent at the boundary from 2006 airborne emissions (excluding radon) was estimated to be 0.17 millirem (mrem) above background per year and occurred at AMS-3 along the eastern boundary of the site. This represents 1.7 percent of the limit of 10 mrem per year established in National Emission Standards for Hazardous Air Pollutants, Subpart H.

Radon Monitoring

A network of approximately 30 continuous environmental radon monitors was used for determining compliance with the applicable limits during 2006. The annual average radon concentration recorded at the site's property boundary ranged from 0.2 picoCuries per liter (pCi/L) to 0.6 pCi/L (inclusive of background concentrations). The annual average background concentration measured in 2006 was 0.3 pCi/L. Property boundary results were well below the DOE radon standard of 3.0 pCi/L above background concentrations. In addition, the site's property boundary radon concentrations were below the proposed Title 10 *Code of Federal Regulations* (CFR) Part 834 limit of 0.5 pCi/L.

Long-term comparisons are also performed on average radon concentrations at western property boundary locations and background locations as a basis for comparison to the 0.5 pCi/L annual average limit. In 2006, a marginal difference in radon concentrations was observed between background and western property boundary monitoring locations. Additionally, there were no exceedances of the DOE limit of 100 pCi/L during 2006.

Direct Radiation Monitoring

Direct radiation measurements were continually collected at approximately 28 locations at the Fernald site and at background locations. The direct radiation levels observed in 2006 indicate that the highest measurements were obtained in the northeast quadrant of the site. This is reflective of the changing conditions at the Fernald site and is a result of decreasing radiation levels near the Silos Project (site's western boundary).

Estimated Dose for 2006

In 2006, the maximally exposed individual near the eastern boundary of the Fernald site could have hypothetically received a maximum dose of approximately 2.8 mrem. This estimate represents the maximum incremental dose above background attributable to the site and is exclusive of the dose received from radon. The contributions to this all-pathway dose for 2006 were 0.17 mrem from air inhalation dose and 2.8 mrem from direct radiation. This dose can be compared to the limit of 100 mrem above background for all pathways (exclusive of radon) that was established by the International Commission on Radiological Protection and adopted by DOE.

Natural Resources

Natural resources include the diversity of plant and animal life and their supporting habitats found in and around the Fernald site. During 2006, upon the completion of remediation, the required restoration activities including final grading and final plantings were completed. The following primary activities associated with natural resource monitoring and restoration occurred:

- Restoration construction activities were completed for the Former Production, Waste Pits, Silos, and Borrow Areas.
- Restoration was complete in "non-design" areas such as the former Storm Water Retention Basin and various construction support areas.
- Mortality counts for Paddys Run East, Paddys Run West, and a portion of the Borrow Area indicated a plant survival rate of greater than 80 percent.

There were no unexpected discoveries of cultural resources during 2006 remediation activities.

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1.0 Site Background

Abbreviated Timeline

1951	Construction of the Feed Materials Production Center began.
1952	Uranium production started.
1986	EPA and DOE signed the Federal Facilities Compliance Agreement, thus initiating the remedial investigation/feasibility study process.
1989	Uranium production was suspended. The Fernald site was placed on the National Priorities List, which is the list of CERCLA sites most in need of cleanup.
1990	As part of the Amended Consent Agreement, the site was divided into operable units for characterization and remedy determination.
1991	Uranium production formally ended. The site mission changed from uranium production to environmental remediation and site restoration.
1994	Decontamination and dismantling of the first building was completed under the Operable Unit 3 Interim Record of Decision.
1996	The last operable unit's record of decision was signed, signifying the end of the 10-year remedial investigation/feasibility study process. (The Operable Unit 4 Record of Decision was later re-opened.) Construction began in support of the Operable Unit 1 selected remedy. Soil remedial excavation began as part of the Operable Unit 5 selected remedy.
1997	Construction of Cell 1 of the on-site disposal facility took place, and the first waste placement began in December. Environmental monitoring and reporting were consolidated under the IEMP to align with remediation efforts.
1998	Operable Unit 2 remedial excavations began.
1999	Excavation of the waste pits was initiated under the Operable Unit 1 Record of Decision and the first rail shipment of waste material was transported to Envirocare of Utah, Inc.
2000	The Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions was signed by EPA, thus establishing a new selected remedy for Operable Unit 4.
2001	Cell 1 of the on-site disposal facility was capped. Remediation of the southern waste units was completed.
2002	The Silos 1 and 2 Radon Control System began operations and successfully reduced radon levels within the silos. The off-site transfer of nuclear product material was completed. Wastes were placed into cells 2 through 5 of the on-site disposal facility.
2003	All major Operable Unit 2 remedial actions were completed. In addition, approximately 412,000 cubic yards (yd^3) (315,015 cubic meters [m^3]) of waste were placed in cells 3 through 6 of the on-site disposal facility.
2004	Removal of Silo 1 and 2 wastes from the silos to the holding tank facility was initiated. Plans to reduce the size of the site's wastewater treatment infrastructure were approved and implemented. The last of Fernald's 10 uranium production complexes, plus an additional 35 structures and 73 trailers, were demolished. Also, all 8 cells of the on-site disposal facility were capped or received waste and approximately 513,000 yd^3 (392,240 m^3) were placed in cells 4 through 8.
2005	Removal of Silo 3 waste was initiated and the first shipment of waste arrived at Envirocare of Utah. Remedial actions for Operable Unit 1 were completed in June. The first shipment of Silos 1 and 2 waste arrived at WCS in Texas.
2006	Remediation of the Fernald site was completed on October 29, 2006, and the site was officially transferred into Legacy Management on November 17, 2006.

In 1951, the U.S. Atomic Energy Commission, predecessor agency to the U.S. Department of Energy (DOE), began building the Feed Materials Production Center on a 1,050-acre (425-hectare) tract of land outside the small farming community of Fernald, Ohio. The facility's mission was to produce "feed materials" in the form of purified uranium compounds and metal for use by other government facilities involved in the production of nuclear weapons for the nation's defense.

Uranium metal was produced at the Feed Materials Production Center from 1952 through 1989. During that time, more than 500 million pounds (lb) (227 million kilograms [kg]) of uranium metal products were delivered to other sites. Due to these production operations, releases to the surrounding environment occurred resulting in contamination of soil, surface water, sediment, and groundwater on and around the site.

In 1991, the mission of the site officially changed from uranium production to environmental cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), as amended. The site was renamed the Fernald Environmental Management Project in 1991. In 2003, the site name changed to the Fernald Closure Project to reflect the mission of the site as on a path to closure.

Fluor Fernald, Inc. was the contractor in charge of the remediation through completion of their scope of work on January 22, 2007, under the terms of a prime contract with DOE. S.M. Stoller

Corporation—Legacy Management's Technical Assistance Contractor—assumed responsibility for site activities, including the ongoing groundwater remedy, on November 17, 2006. Regulatory oversight is provided by Region V of the U.S. Environmental Protection Agency (EPA) and the Southwest District Office of the Ohio Environmental Protection Agency (OEPA).

In the 1980s, the goals of environmental monitoring activities were to assess the impact of production operations and monitor the environmental pathways through which residents of the local community might be exposed to contaminants from the site (exposure pathways). The environmental monitoring program provided comprehensive on- and off-property surveillance of contaminant levels in surface water, groundwater, air, and biota (produce). The goal was to measure the levels of contaminants associated with uranium production operations, and report this information to the regulatory agencies and stakeholders.

Exposure Pathways

An **exposure pathway** is a route that materials can travel between the point of release (a source) and the point of delivering a radiation or chemical dose (a receptor). At the Fernald site, two primary exposure pathways (liquid and air) have been identified. A primary pathway is one that may allow pollutants to directly reach the public or the environment. Therefore, the liquid and air pathways provide a basis for environmental sampling and information useful for evaluating potential dose to the public or the environment.

Secondary exposure pathways have been thoroughly evaluated under previous environmental monitoring programs. Secondary exposure pathways represent indirect routes pollutants may reach receptors. An example of a secondary pathway is produce. Through the food chain, one organism may accumulate a contaminant and then be consumed by humans or other animals. The contaminant travels through the air to the soil, where it is absorbed into produce through the roots and is consumed by humans or animals. An evaluation of past monitoring data has shown that secondary exposure pathways at the Fernald site are insignificant routes of exposure to off-site receptors. Therefore, the main focus of the IEMP monitoring program is on the primary exposure pathways.

Refer to Chapter 6 of this report for information pertaining to 2006 dose calculations from all pathways.

Since the conclusion of the site's uranium production and the completion of the CERCLA remedy selection process, the focus had been on the safe and efficient implementation of environmental remediation activities and facility decontamination and dismantling operations. In recognition of this shift in emphasis toward remedy implementation, the environmental monitoring program was revised in 1997 to align with the remediation activities planned for the Fernald site. The site's environmental monitoring program for 2006 is described in the *Integrated Environmental Monitoring Plan* (IEMP), Revision 4B, which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan (LMICP)* (DOE 2006c). The IEMP is reviewed annually for necessary changes and revised every five years. Now that remediation is complete, the emphasis will shift to ensure the continued protectiveness of the completed remedial actions as well as implementing the on-going groundwater remedy.

This *Fernald 2006 Site Environmental Report* summarizes the findings from the IEMP monitoring program and provides a status on the progress toward final site restoration. This report consists of the following:

Summary Report The summary report (Chapters 1 through 7) documents the results of environmental monitoring activities at the Fernald site in 2006. It includes a discussion of remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, sediment, air, and natural resources monitoring programs. It also summarizes the information contained in the appendixes.

Appendixes The detailed appendixes provide the 2006 environmental monitoring data for the various media, primarily in the form of graphs and tables. The National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 CFR 61 Subpart H) compliance report is also included. The appendixes are generally distributed only to the regulatory agencies. However, a complete copy of the appendixes is available at the Public Environmental Information Center, located at 10995 Hamilton-Cleves Highway (Delta Building) in Cincinnati, Ohio, and is open Monday through Thursday, 9:00 a.m. to 4:00 p.m.

CERCLA Remedial Process

The process of cleaning up sites under CERCLA consists of the following general phases:

Site Characterization – During this phase, contaminants are identified and quantified, and the potential impacts of those contaminants on human health are determined. This phase includes the remedial investigation and the baseline risk assessment.

Remedy Selection – During this phase, cleanup alternatives are developed and evaluated. Activities include the feasibility study and proposed plan. After public comments are received, a remedy is selected and documented in a Record of Decision.

Remedial Design and Remedial Action – This phase of the CERCLA process includes the detailed design and implementation of the remedy. The CERCLA process ends with certification and site closure.

A five-year review process is triggered by the onset of construction for the first operable unit remedial action that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Of all the operable units, the site preparation construction to support the Waste Pits Project under the Operable Unit 1 Record of Decision (DOE 1995b) was the first such action. This construction began on April 1, 1996. The First Five-Year Review Report for the site was submitted to and approved by the EPA in 2001. These reviews ensure that the remedy remains effective and continues to be protective of human health and the environment.

Site closure, relative to the completion of remediation, is defined in the contract between Fluor Fernald, Inc. and DOE as the physical completion of the scope of work required by the five Records of Decision with the exception of ground water remedy and final disposal of the Silo 1 and 2 stabilized material.

DOE's Office of Legacy Management assumed the long-term surveillance monitoring and maintenance of the Fernald site on November 17, 2006 in order to ensure continued protection of human health and the environment and continued operation of the ground water remedy. The Comprehensive Legacy Management and Institutional Controls Plan defines the activities to be conducted with respect to long-term stewardship at the Fernald site. The previously mentioned five-year review process will continue to provide stakeholders with information on the remedy performance as well as long-term stewardship information.

The rest of this introductory chapter provides:

- An overview of the current environmental remediation operations recently completed as well as ongoing remedy implementation.
- A description of environmental monitoring activities at the Fernald site.
- A description of the physical, ecological, and human characteristics of the area.

1.1 The Path to Site Closure

In 1986, the Fernald site began working through the CERCLA process to characterize the nature and extent of contamination at the site, establish risk-based cleanup standards, and select the appropriate remediation technologies to achieve those standards. To facilitate this process, the site was organized into five operable units in 1991. The purpose of the operable unit concept under CERCLA was to organize site components by their location or by the potential for similar technologies to be used for environmental remediation. The remedy selection process culminated in 1996 with the approval of the final Records of Decision for each of the five operable units. However, several of the Records of Decision (including those for Operable Units 1, 4, and 5) have subsequently been modified through issuance of Explanation of Significant Differences or Record of Decision Amendment documents. These documents were prepared, submitted for EPA and public review, and issued in accordance with CERCLA regulations.

Following approval of the initial records of decision, work began on the design and implementation of the operable unit remedies. In order to align site-wide responsibilities and regulatory obligations of each operable unit and to most efficiently execute remedial design and remedial action, the site established integrated project organizations in 1996. Realignment into project organizations reflected the actual work processes and operations necessary to complete remediation while meeting the requirements of the records of decision. Table 1–1 describes each operable unit and its associated remedy, and provides a crosswalk between each operable unit and the projects responsible for implementing each remedy. When a project is mentioned in this document, references to the applicable operable unit are included, as identified in the Table 1–1 description. It should be noted that several reorganizations have occurred during the past several years; therefore, Table 1–1 reflects a simplified project organization.

Table 1–1. Operable Unit Remedies and Associated Project Responsibilities

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
1	- Waste Pits 1-6 - Clearwell - Burn pit - Berms, liners, caps, and soil within the boundary	Record of Decision Approved: March 1995 Explanation of Significant Differences Approved: September 2002 Record of Decision Amendment Approved: November 2003 Remedial actions completed: June 2005 Excavation of materials with constituents of concern above final remediation levels (FRLs), waste processing and treatment by thermal drying (as necessary), off-site disposal at a permitted facility, and soil remediation/certification.	Waste Pits Project was responsible for rail upgrades; excavation of Operable Unit 1 waste units; pre-treatment of wastewater as necessary to meet Aquifer Restoration Project wastewater acceptance criteria; waste processing, drying, and loading; rail transport; and off-site disposal of all waste pit waste as well as any contaminated soil and debris that exceed the waste acceptance criteria for the on-site disposal facility. Remedial actions for Operable Unit 1 were completed in June 2005. From June 2005 through October 2006 the only project activity was continued rail shipping of soil and waste material from other site projects that exceeded the on-site disposal facility waste acceptance criteria. Environmental Closure, Soil, and Disposal Facility Project was responsible for the excavation and certification of contaminated soil beneath the waste pits, and at- and below-grade remediation facilities. The project was also responsible for field oversight of soil excavations, for reviewing and signing manifests for impacted material delivered to the on-site disposal facility for placement, and for rejecting any unacceptable shipments. Decontamination and Demolition Project was responsible for decontamination and dismantling of Operable Unit 1 remediation facilities. Aquifer Restoration/Wastewater Project was responsible for final treatment of contaminated runoff, perched water collected during waste pit excavation, and processing wastewater discharges.
2	- Solid waste landfill - Inactive flyash pile - Active flyash pile (now inactive) - North and south Lime Sludge Ponds - Other South Field areas - Berms, liners, and soil within the operable unit boundary	Record of Decision Approved: May 1995 Post-Record of Decision Fact Sheet Approved: April 1999 Remedial actions completed: June 2006 Excavation of all materials with constituents of concern above FRLs, treatment for size reduction and moisture control as required, on-site disposal in the on-site disposal facility, and off-site disposal of excavated material that exceeds the waste acceptance criteria for the on-site disposal facility.	Environmental Closure, Soil, and Disposal Facility Project was responsible for excavating and disposing of waste from all Operable Unit 2 subunits and certifying the footprints. This project was also responsible for the ongoing design, construction, maintenance, and closure of the on-site disposal facility that contain Operable Unit 2 subunit wastes and underlying Operable Unit 5 soil. This project was responsible for field oversight of soil excavations, for reviewing and signing manifests for impacted material delivered to the on-site disposal facility for placement, and for rejecting any unacceptable shipments. Decontamination and Demolition Project was responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the Fernald site. Aquifer Restoration/Wastewater Project was responsible for treating contaminated runoff and perched water collected during excavation of Operable Unit 2 subunit wastes. This project, now under S.M. Stoller, continues to be responsible for leachate and leak detection monitoring at the on-site disposal facility and for treating leachate from the on-site disposal facility.

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Table 1–1 (continued). Operable Unit Remedies and Associated Project Responsibilities

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
3	Former production area, associated facilities, and equipment (includes all above- and below-grade improvements) including but not limited to: - All structures, equipment, utilities, effluent lines, and K-65 transfer line - Wastewater treatment facilities - Fire training facilities - Coal Pile - Scrap metals piles - Drums, tanks, solid waste, waste product, feedstocks, and thorium	Record of Decision for Interim Remedial Action Approved: June 1994 Record of decision for Final remedial Action Approved: August 1996 Remedial actions completed: October 2006 Adoption of Operable Unit 3 Interim Record of Decision; alternatives to disposal through the unrestricted or restricted release of materials as economically feasible for recycling, reuse, or disposal; treatment of material for on- or off-site disposal; required off-site disposal for process residues, product materials, process-related metals, acid brick, concrete from specific locations, and any other material exceeding the on-site disposal facility waste acceptance criteria; and on-site disposal for material that meets the on-site disposal facility waste acceptance criteria.	Decontamination and Demolition Project was responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the Fernald site. Environmental Closure, Soil, and Disposal Facility Project was responsible for excavation and certification of soil beneath facilities and for removal of at- and below-grade structures. This project is also responsible for design, construction, and closure of the on-site disposal facility that will contain and Operable Unit 3 debris and underlying Operable Unit 5 soil. This organization was also responsible for field oversight of debris sizing, segregation of on-site disposal facility material categories and prohibited items; completing field tracking logs; completing manifests for material bound for the on-site disposal facility; and compiling final records of decontamination and dismantling debris placed in the on-site disposal facility. Aquifer Restoration/Wastewater Project was responsible for treating decontamination and other wastewater during decontamination and dismantling activities, and processing wastewater discharges.
4	- Silos 1 and 2 (containing K-65 residues; demolished in 2005) - Silo 3 (containing cold metal oxides; demolished in 2006) - Silo 4 (empty and never used; demolished in 2003) - Decant tank system - Berms and soil within the operable unit boundary	Record of Decision Approved: December 1994 Explanation of Significant Differences for Silo 3 Approved: March 1998 Record of Decision Amendment for Silos 1 and 2 Approved: July 2000 Record of Decision Amendment for Silo 3 Approved: September 2003 Explanation of Significant Differences for Silos 1 and 2 Approved: November 2003 Explanation of Significant Differences for Operable Unit 4 Approved: January 2005 Remedial actions for Silo 3 complete: April 2006 Remedial actions involving the completion of the shipment of stabilized Silo 1 & 2 material to a temporary storage facility in Texas was completed in May 2006 Removal of Silo 3 materials for treatment and Silos 1 and 2 residues and decant sump tank sludges with on-site stabilization of materials, residues, and sludges followed by off-site disposal. Excavation of silos area soils contaminated above the FRLs with on-site disposal for contaminated soils and debris that meet the on-site disposal facility waste acceptance criteria; and site restoration. Concrete from Silos 1 and 2, and contaminated soil and debris that exceed the on-site disposal facility waste acceptance criteria disposed of off-site.	Silos 1 and 2 Project was responsible for transfer of Silos 1 and 2 residues to temporary transfer tanks, treatment, and transport off-site for temporary storage. Silo 3 Project was responsible for Silo 3 content removal, treatment, and transport off-site. Environmental Closure, Soil, and Disposal Facility Project was responsible for certification, excavation, and disposition of contaminated soil beneath the silos and for removal of subsurface structures (i.e., sub-grade silo decant system). Decontamination and Demolition Project was responsible for decontamination and dismantling of all Operable Unit 4 silos and remediation facilities (storage, processing, and remediation) and associated above-ground piping. Aquifer Restoration/Wastewater Project was responsible for the ultimate treatment and discharge of excess wastewater generated from Advanced Waste Retrieval activities and Silo 1, 2, and 3 remediation activities.

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Table 1–1 (continued). Operable Unit Remedies and Associated Project Responsibilities

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
5	- Groundwater - Surface water and sediments - Soil not included in the definitions of Operable Units 1 through 4 - Flora and fauna	Record of Decision Approved: January 1996 Explanation of Significant Differences was approved in November 2001, formally adopting EPA's Safe Drinking Water Act Maximum Contaminant Level for uranium of 30 micrograms per liter (µg/L) as both the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River. Extraction of contaminated groundwater from the Great Miami Aquifer to meet FRLs at all affected areas of the aquifer. Treatment of contaminated groundwater, storm water, and wastewater to attain concentration and mass-based discharge limits and FRLs in the Great Miami River. Excavation of contaminated soil and sediment to meet FRLs. Excavation of contaminated soil containing perched water that presents an unacceptable threat through contaminant migration to the underlying aquifer. On-site disposal of contaminated soil and sediment that meet the on-site disposal facility waste acceptance criteria. Soil and sediment that exceed the waste acceptance criteria for the on-site disposal facility will be treated, when possible, to meet the on-site disposal facility waste acceptance criteria or will be disposed of at an off-site facility. Also includes site restoration, institutional controls, and post-remediation maintenance.	Aquifer Restoration/Wastewater Project under S.M. Stoller continues to be responsible for designing, installing, and operating the systems needed to restore groundwater in the Great Miami Aquifer. This project is responsible for groundwater monitoring in the Great Miami Aquifer; reporting on the progress of aquifer restoration; designing, constructing, and operating all treated effluent discharge systems; and treating and discharging contaminated groundwater, storm water, and remediation wastewater at the Fernald site. This project is also responsible for operation, maintenance, and monitoring of the on-site disposal facility leachate collection system and leak detection system. Environmental Closure, Soil, and Disposal Facility Project was responsible for certification of site-wide soil; excavation and disposition of contaminated soil, sediment, perched groundwater and at- and below-grade structures; and final site restoration. The project was responsible for design, construction, maintenance, and closure of the on-site disposal facility that contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. This project was also responsible for oversight of field excavations; segregating on-site disposal facility material categories and segregating prohibited items; completing field tracking logs; completing manifests for material bound for the on-site disposal facility; and compiling final records of soil and at- and below-grade debris placed in the on-site disposal facility. Decontamination and Demolition Project was responsible for decontamination and dismantling of all Operable Unit 5 remediation facilities through site closure.

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1.2 Environmental Monitoring Program

In the 1980s, an environmental monitoring program was initiated to assess the impact of past operations on the environment and monitor potential exposure pathways to the local community. Additionally, characterization activities were conducted at the Fernald site for nearly 10 years through the remedial investigation phase of the CERCLA process. The initial environmental evaluations performed during the remedial investigation/feasibility study process were used to select the final remedy for Operable Unit 5, which addressed contamination in soil, groundwater, surface water, sediment, air, and biota—in short, all environmental media and contaminant exposure pathways affected by past uranium production operations at the site. The selected remedy for Operable Unit 5 defined the site's final contaminant cleanup levels and established the extent of on- and off-property remedial actions necessary to provide permanent solutions to environmental concerns posed by the site.

The Operable Unit 5 remedy included plans for removing the contamination that might be released through these exposure pathways, and for monitoring these pathways to measure the site's continuing impact on the environment as remediation progresses. The characterization data used to develop the final remedy were also used to focus on and develop the environmental monitoring program documented in the IEMP.

The following describes the IEMP's key elements:

- The IEMP defines monitoring activities for environmental media, such as groundwater, surface water and treated effluent, sediment, air (including air particulate, radon, and direct radiation), and natural resources. In general, the primary exposure pathways (liquid and air) are monitored and the program focuses on assessing the collective effect of site-wide emissions on the surrounding environment.
- The IEMP establishes a data evaluation and decision-making process for each environmental medium. Through this process, environmental conditions at the site are continually evaluated. These evaluations sometimes affect decisions made about the implementation of remediation activities. For example, environmental data are routinely evaluated to identify any significant trends that may indicate the potential for an unacceptable future impact to the environment if action is not taken.
- Recognizing that the type and pace of activities will change over the life of the cleanup effort, the IEMP allows for program adjustments as the mission changes. At this time, the IEMP is reviewed annually and revised every five years to ensure that the monitoring program adequately addresses changing activities.
- The IEMP consolidates routine reporting of environmental data into a comprehensive annual report.

1.3 Characteristics of the Site and Surrounding Area

The natural setting of the Fernald site and nearby communities were important factors in selecting the final remedy, and remain important in the continual evaluation of the environmental monitoring program. Land use and demography, local geography, geology, surface hydrology, meteorology, and natural resources all impact monitoring activities and the implementation of the site remedy.

1.3.1 Land Use and Demography

Economic activities in the area rely heavily on the physical environment. Land in the area is used primarily for livestock, crop farming, and gravel pit excavation operations. There also is a private water utility approximately 2 miles (3.2 kilometers [km]) east of the Fernald site that pumps groundwater primarily for industrial use.

Downtown Cincinnati is approximately 18 miles (29 km) southeast of the Fernald site (Figure 1–1). The cities of Fairfield and Hamilton are 6 and 8 miles (10 and 13 km) to the east and northeast, respectively (Figure 1–2). Scattered residences and several villages including Fernald, New Baltimore, New Haven, Ross, and Shandon are located near the site. Based on the 2000 U.S. Census Bureau figures, there is an estimated population of 20,000 people within 5 miles (8 km) of the Fernald site and an estimated 2.8 million people within 50 miles (80 km).

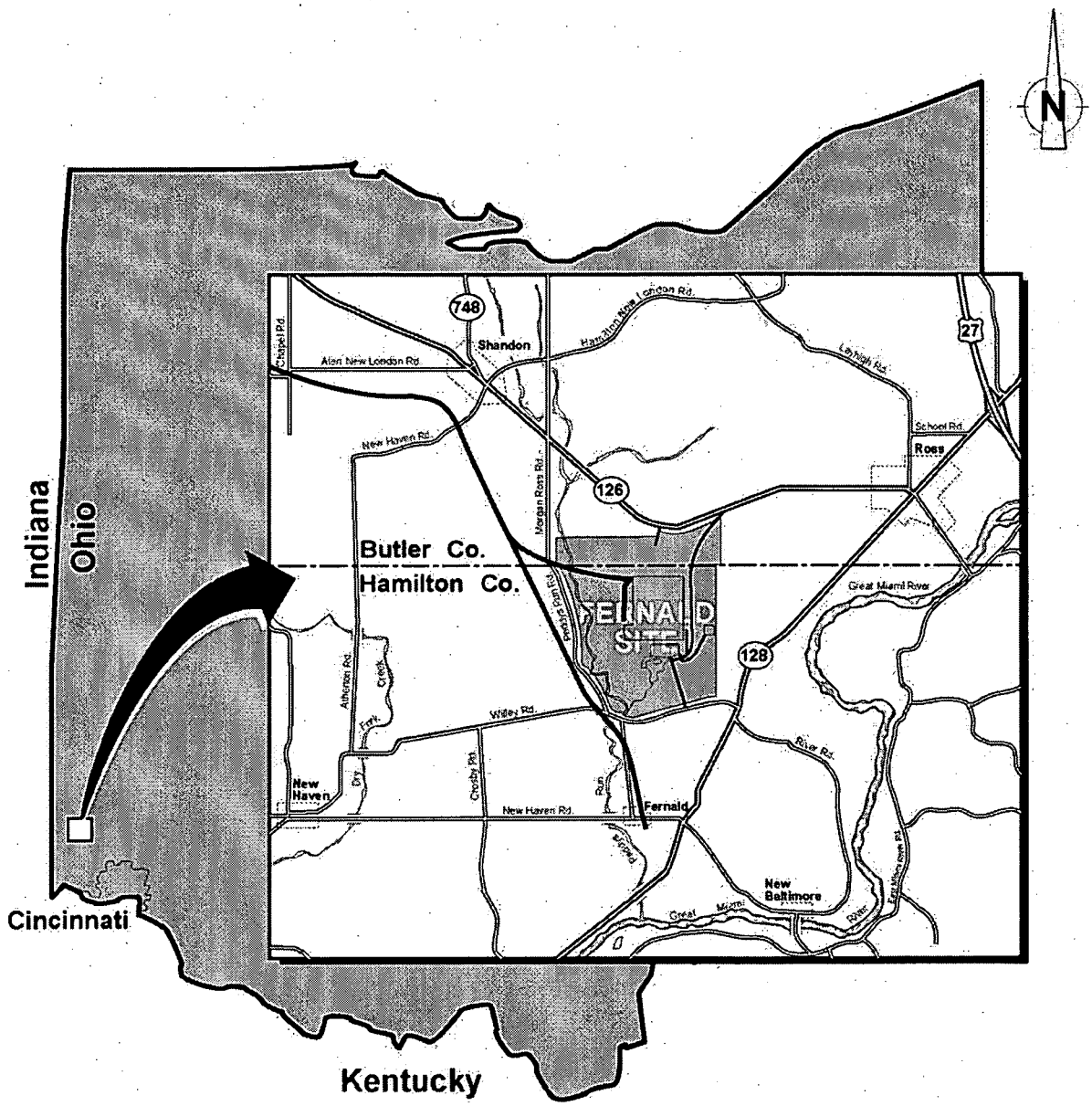
1.3.2 Geography

Figure 1–3 depicts the location of the major physical features of the site, such as the buildings and supporting infrastructure. The former production area and the on-site disposal facility (OSDF) dominate this view. The former production area occupies approximately 136 acres (55 hectares) in the center of the site. The Great Miami River cuts a terraced valley to the east of the site, while Paddys Run (an intermittent stream) flows from north to south along the site's western boundary. In general, the site lies on a terrace that slopes gently among vegetated bedrock outcroppings to the north, southeast, and southwest.

1.3.3 Geology

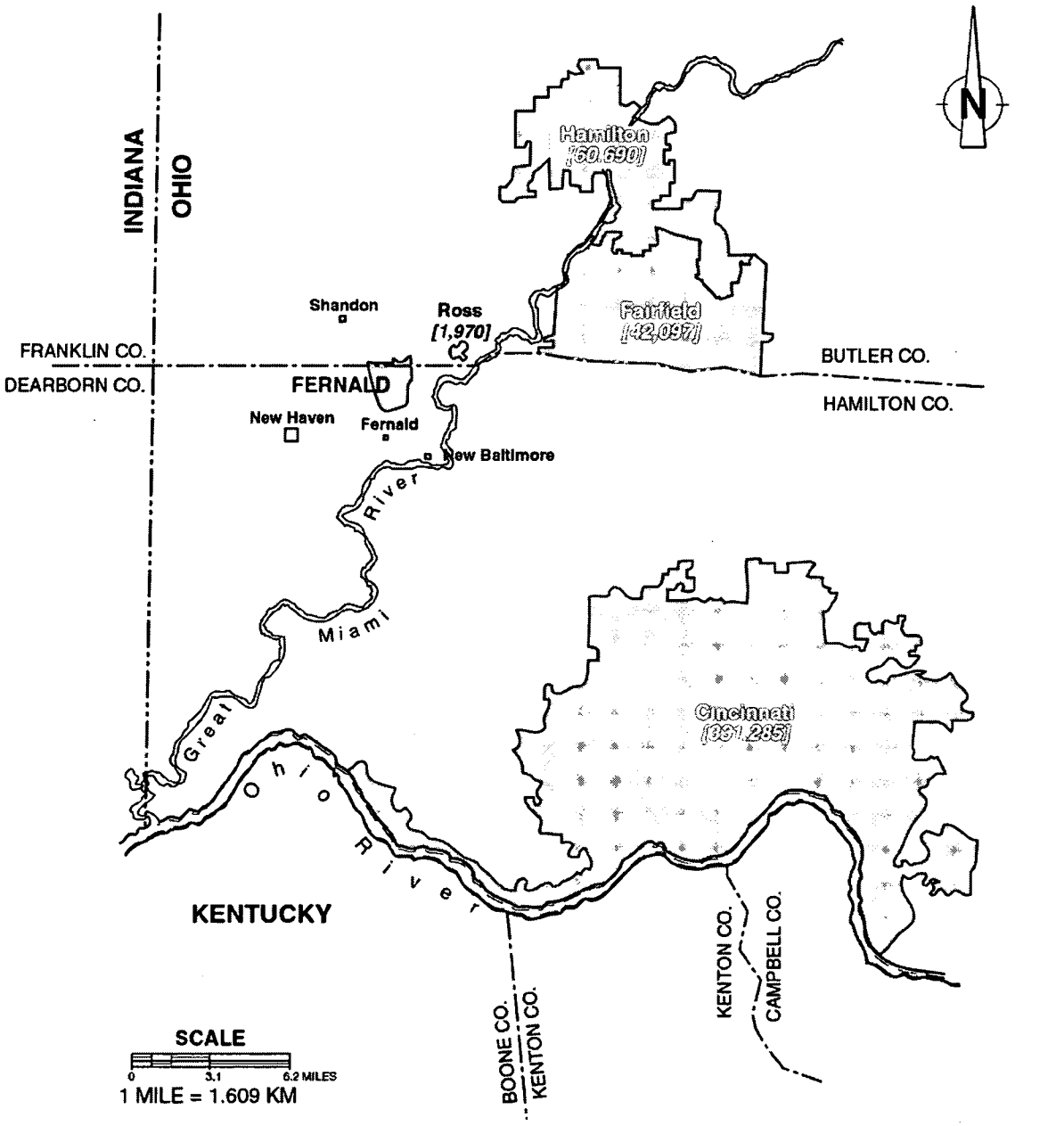
Bedrock in the area indicates that approximately 450 million years ago a shallow sea covered the Cincinnati area. Sediments that later became flat-lying shale with interbedded limestone were deposited in the shallow sea as evidenced by the abundance of marine fossils in the bedrock. In the more recent geologic past, the advance and retreat of three separate glaciers shaped the southwestern Ohio landscape. A large river drainage system south of the glaciers created river valleys up to 200 feet (ft) (61 meters [m]) deep, which were then filled with sand and gravel when the glaciers melted. These filled river valleys are called buried valleys.

The last glacier to reach the area left an impermeable mixture of clay and silt with minor amounts of sand and gravel deposited across the land surface, called glacial overburden. The site is situated on a layer of glacial overburden that overlies portions of a 2- to 3-mile-wide (3- to 5-km) buried valley. This valley, known as the New Haven Trough, makes up part of the Great Miami Aquifer. The impermeable shale and limestone bedrock that define the edges and bottom of the New Haven Trough confine the groundwater to the sand and gravel within the buried valley. Where present, the glacial overburden limits the downward movement of precipitation and surface water runoff into the underlying sand and gravel of the Great Miami Aquifer.



The Fernald site covers about 1,050 acres (425 hectares).

Figure 1–1. Fernald Site and Vicinity



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Populations (shown in brackets) are estimated from 2000 U.S. Census Bureau figures.

Figure 1–2. Major Communities in Southwestern Ohio

The Great Miami River and its tributaries have eroded considerable portions of the glacial overburden and exposed the underlying sand and gravel of the Great Miami Aquifer. Thus, in some areas, precipitation and surface water runoff can easily migrate into the underlying Great Miami Aquifer, permitting contaminants to be transported to the aquifer as well. Natural and man-made breaches of the glacial overburden were key pathways where contaminated water entered the aquifer, causing the groundwater plumes that are being addressed by aquifer restoration activities. Figure 1–4 provides a glimpse into the structure of subsurface deposits in the region along an east-west cross section through the site, and Figure 1–5 presents the regional groundwater flow patterns in the Great Miami Aquifer.

1.3.4 Surface Hydrology

The Fernald site is located in the Great Miami River drainage basin (Figure 1–6). Natural drainage from the site to the Great Miami River occurs primarily via Paddys Run. This intermittent stream begins losing flow to the underlying sand and gravel aquifer south of the former waste pit area. Paddys Run empties into the Great Miami River 1.5 miles (2.4 km) south of the site. The Great Miami River, 0.6 mile (1 km) east of the Fernald site, runs in a southerly direction and flows into the Ohio River about 24 miles (39 km) downstream of the site. The segment of the river between the Fernald site and the Ohio River is not used as a source of public drinking water.

The average flow volume for the Great Miami River in 2006 was 4,736 cubic feet per second (ft^3/sec) (134.1 cubic meters per second [m^3/sec]). This is based on daily measurements collected at the United States Geologic Survey (USGS) Hamilton stream gauge (USGS 3274000) approximately 10 river miles (16 river km) upstream of the site's effluent discharge.

1.3.5 Meteorology

Meteorological data were collected from the Fernald site until May 16, 2006 when the meteorological tower was taken out of service and demolished. Meteorological data are currently being collected from the Butler County Regional Airport because it the closest location that provides the most comprehensive meteorological data set. These data are used to evaluate site-specific climatic conditions. The environmental monitoring program uses atmospheric models to determine how airborne effluents are mixed and dispersed. These models are then used to assess the impact of operations on the surrounding environment, in accordance with DOE requirements. Airborne pollutants are subject to weather conditions. Wind speed and direction, precipitation, and atmospheric stability play a key role in predicting how pollutants are distributed in the environment and in interpreting environmental data.

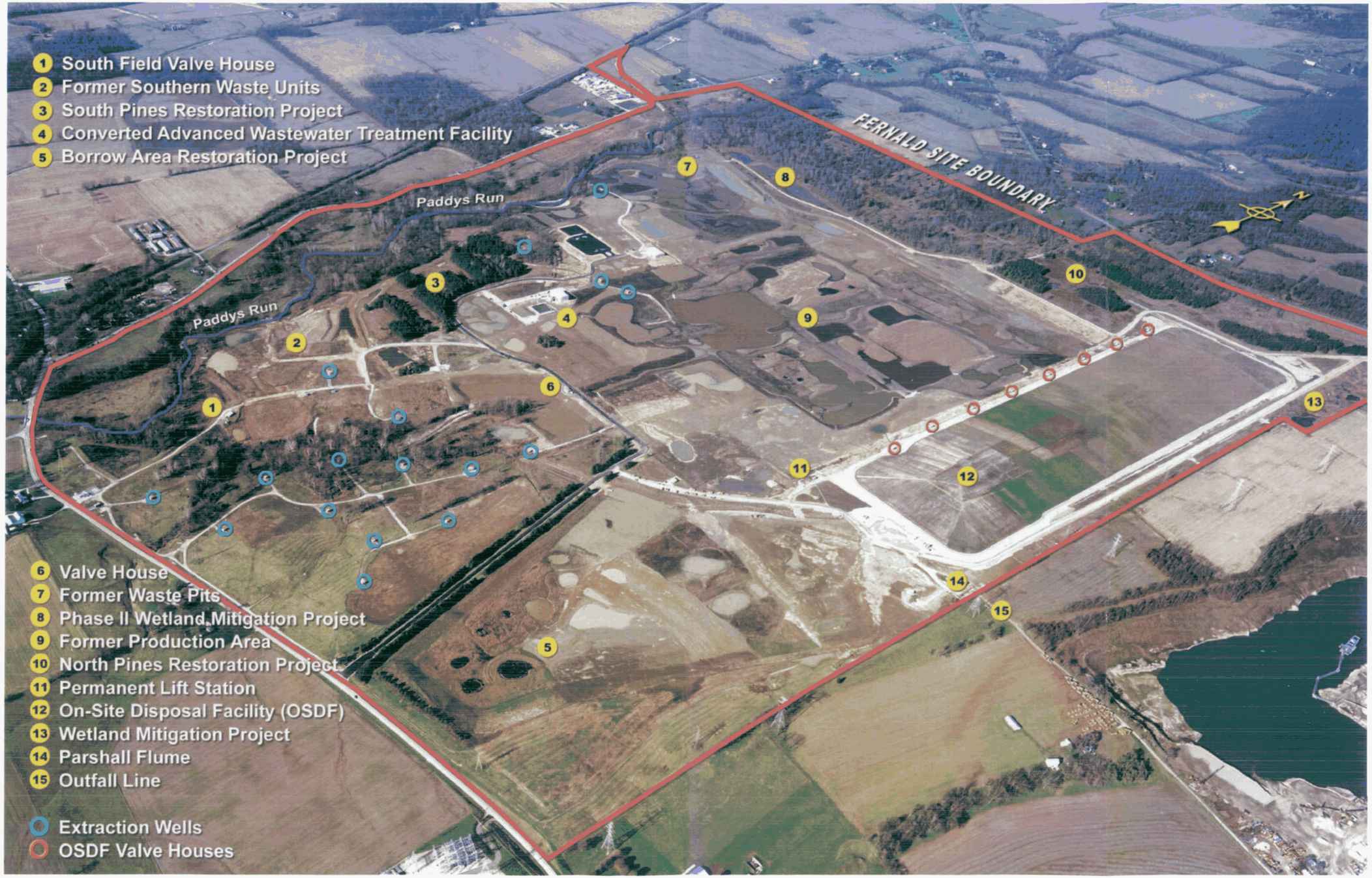

Figure 1–3. Fernald Site Perspective

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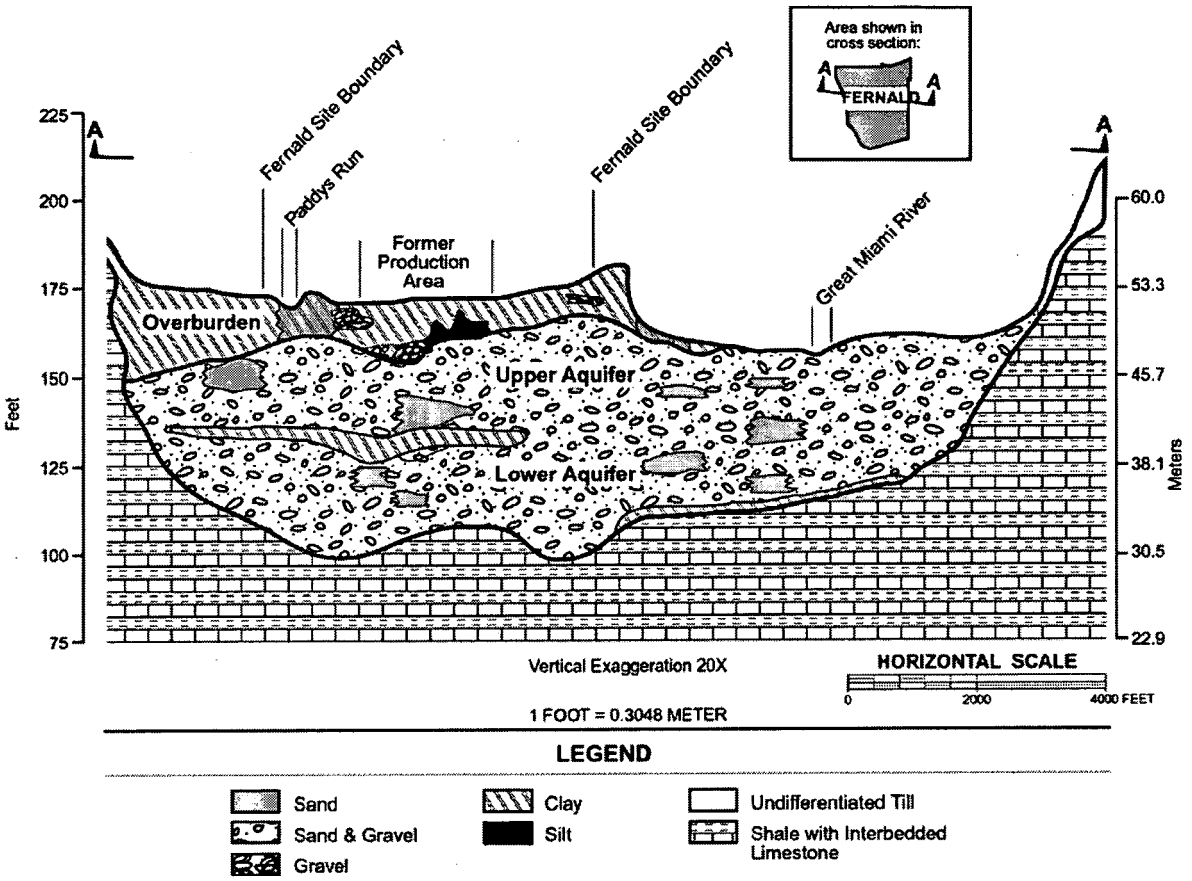

Figure 1–4. Cross Section of the New Haven Trough, Looking North

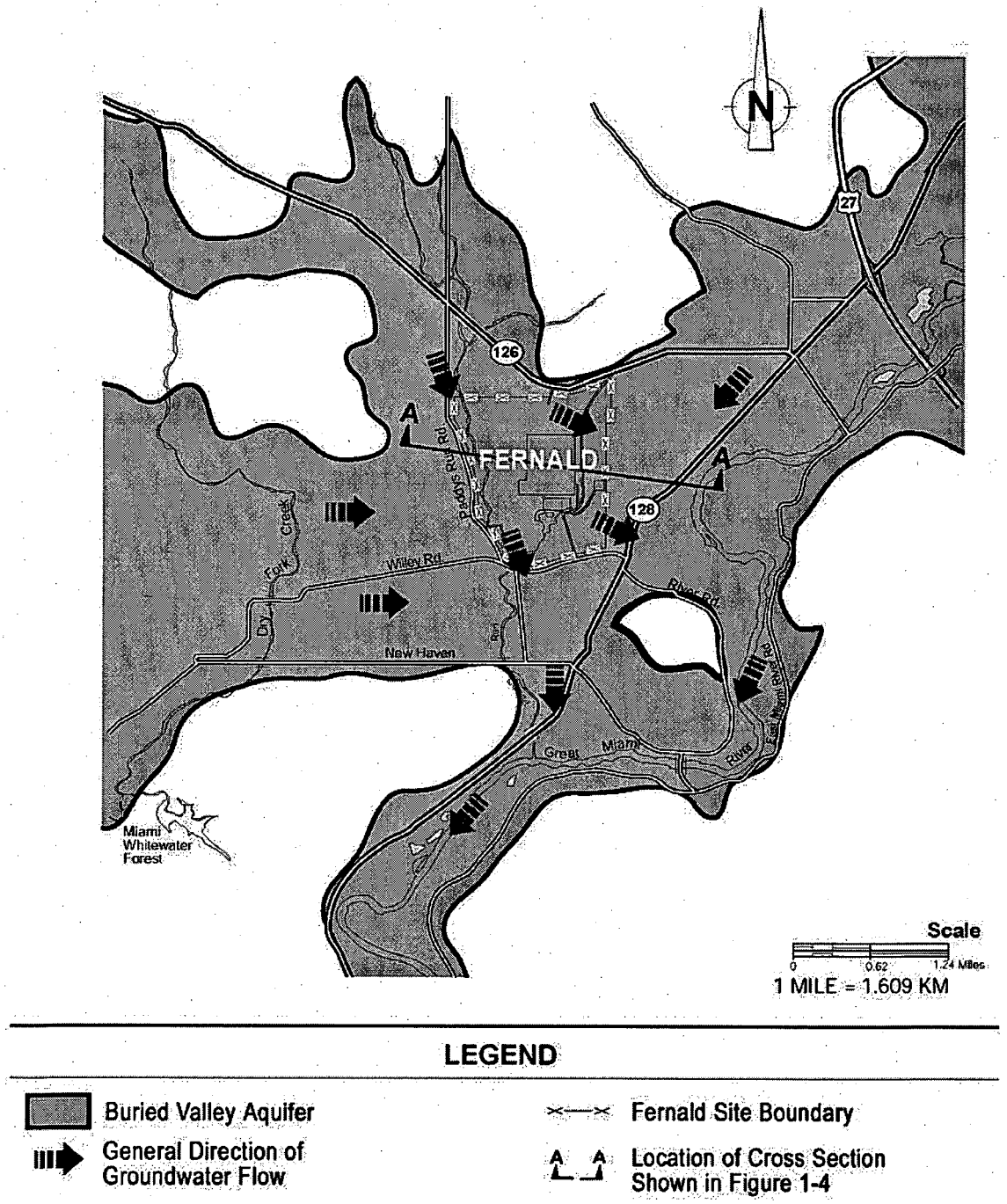

Figure 1–5. Regional Groundwater Flow in the Great Miami Aquifer

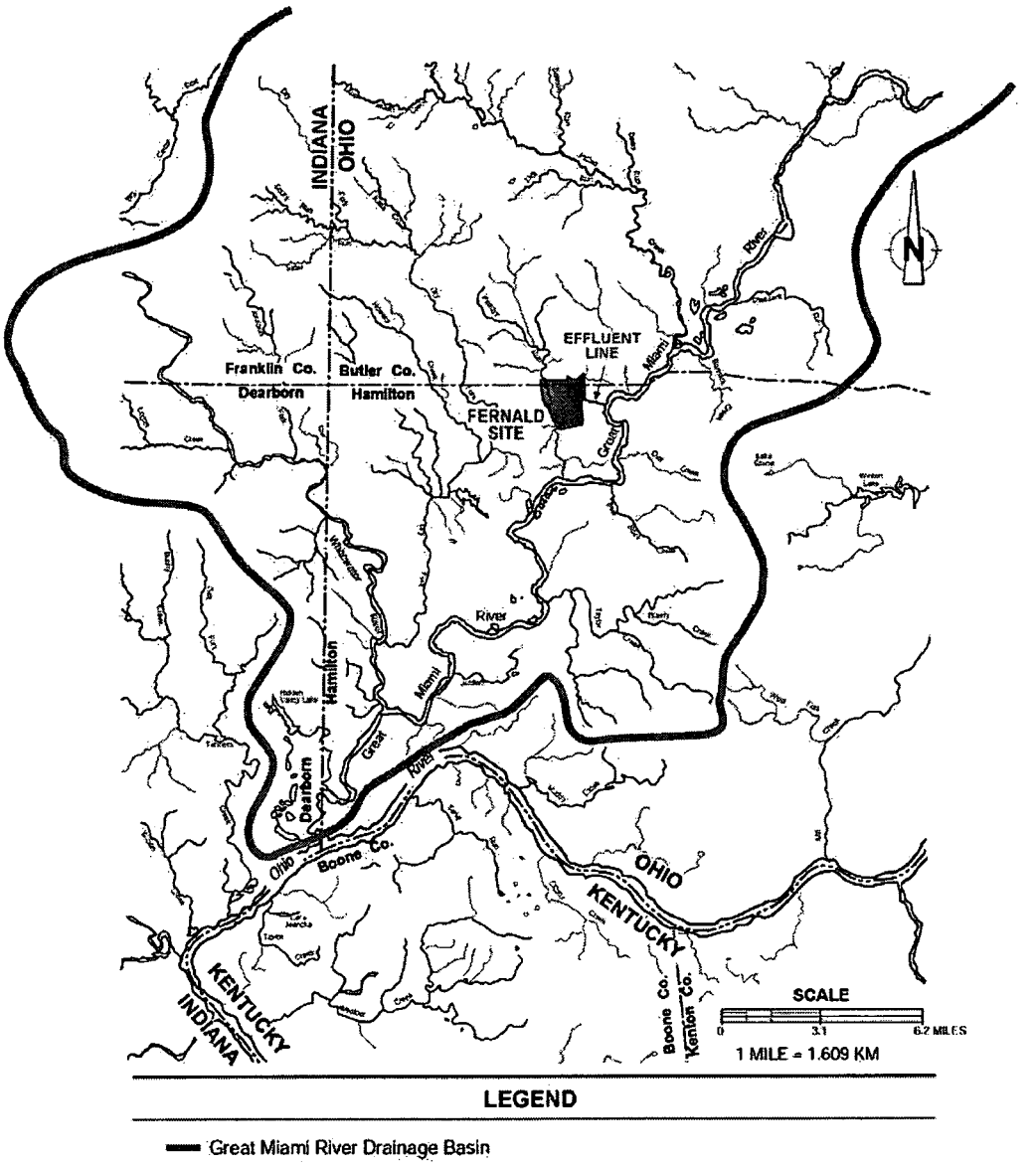

Figure 1–6. Great Miami River Drainage Basin

Figures 1–7 and 1–8 illustrate the average wind speed and general wind direction for 2006 measured at the 33-ft (10-m) and 197-ft (60-m) levels, respectively, in wind rose format. The prevailing winds were from the southwest 45 percent of the time at the 10-m height and 38 percent of the time from the 60-m height. Tables in Appendix C, Attachment C.4, present meteorological data for 2006, including wind direction and average speed.

In 2006, 42.2 inches (107.2 centimeters [cm]) of precipitation were measured at the Fernald site. This is slightly higher than the average annual precipitation of 41.18 inch (104.6 cm) for 1951 through 2005. Figure 1–9 shows the average precipitation recorded at the Fernald site for each year from 1994 through 2006 and the annual average precipitation for the Cincinnati area from 1951 through 2005. Figure 1–10 shows monthly precipitation at the site for 2006 compared to the Cincinnati area average monthly precipitation from 1951 through 2005.

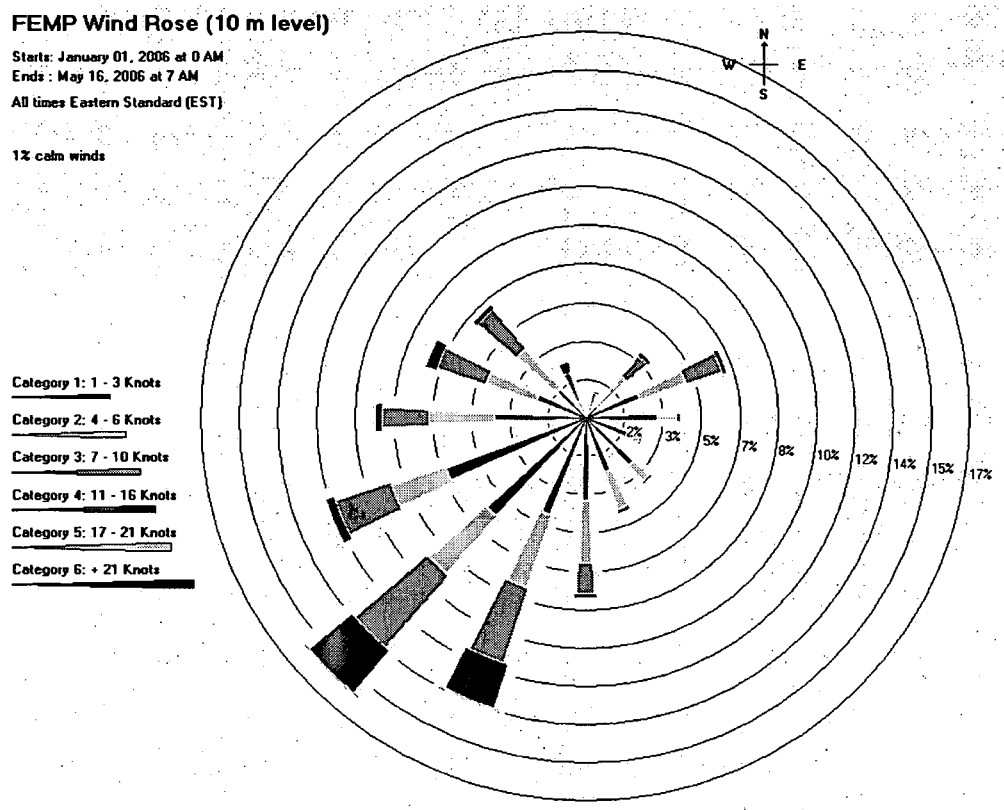

Figure 1–7. 2006 Wind Rose, 33-ft (10-m) Height

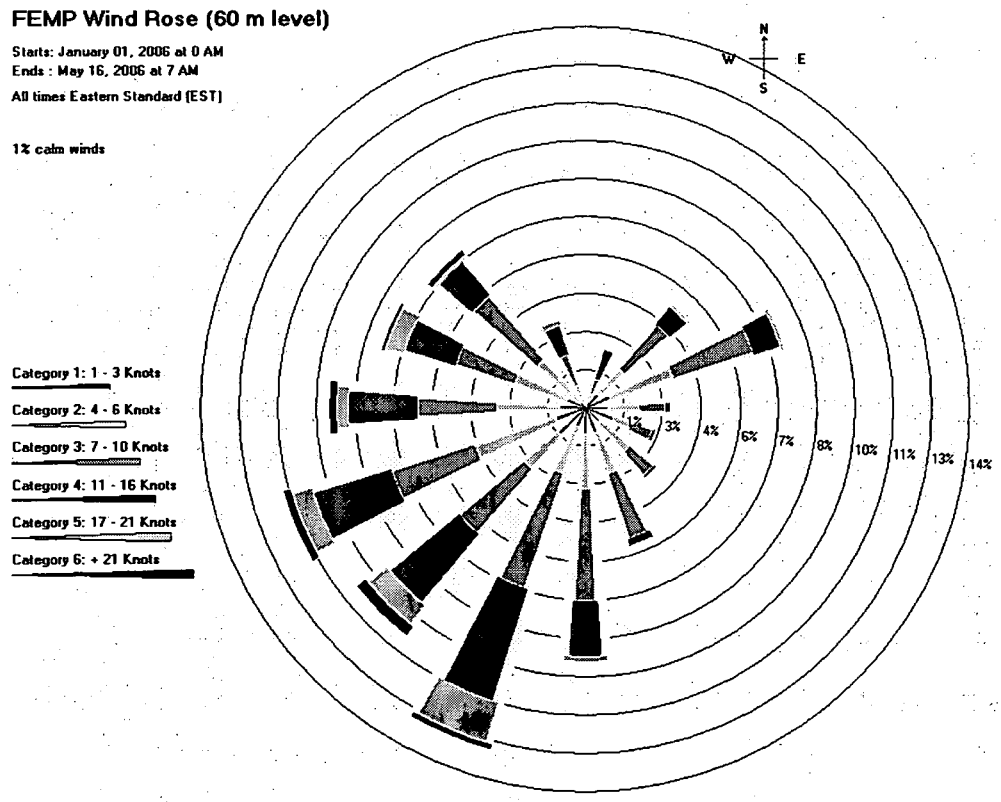

Figure 1–8. 2006 Wind Rose, 197-ft (60-m) Height

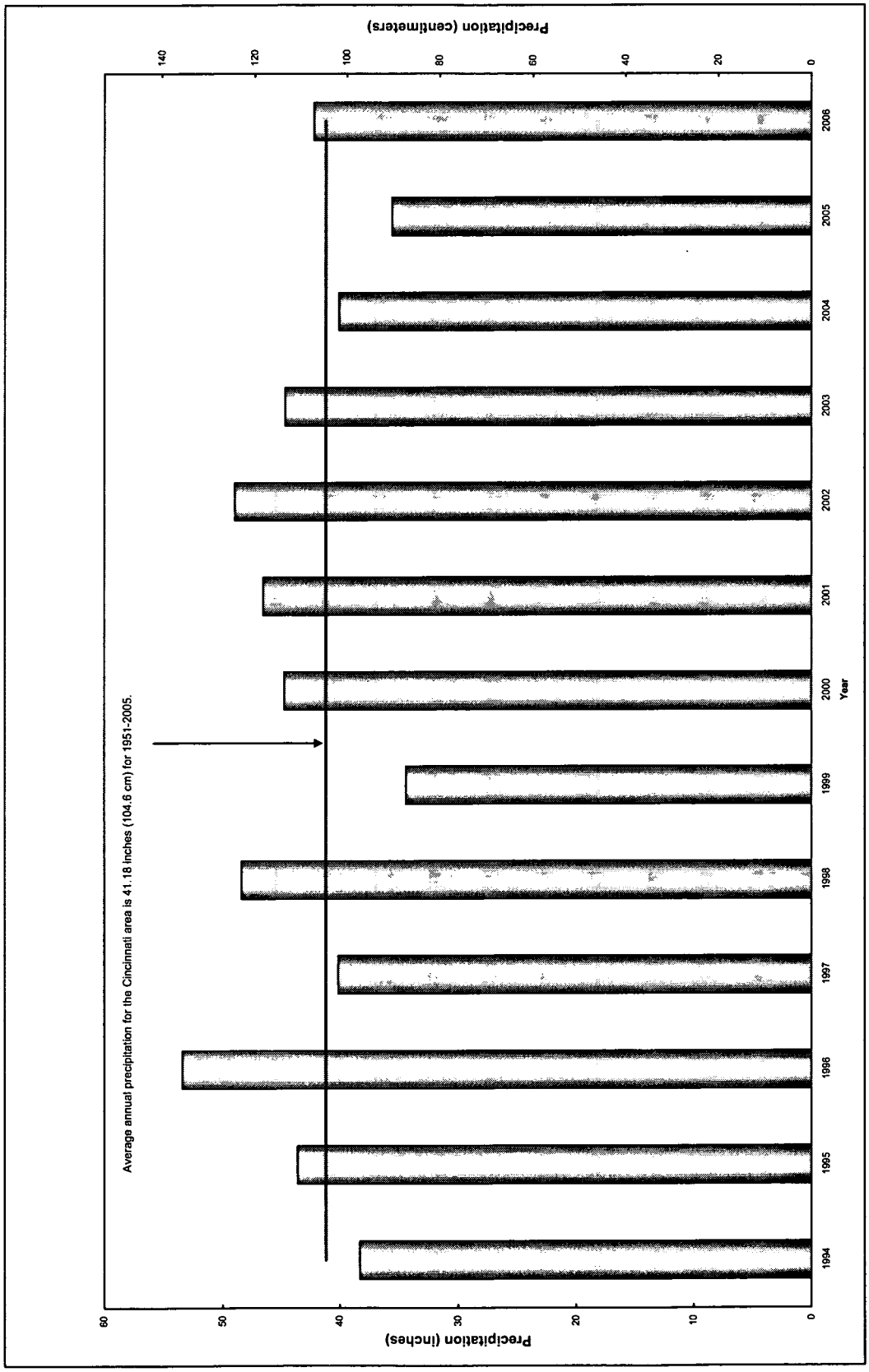

Figure 1–9. Average Annual Precipitation, 1994–2006

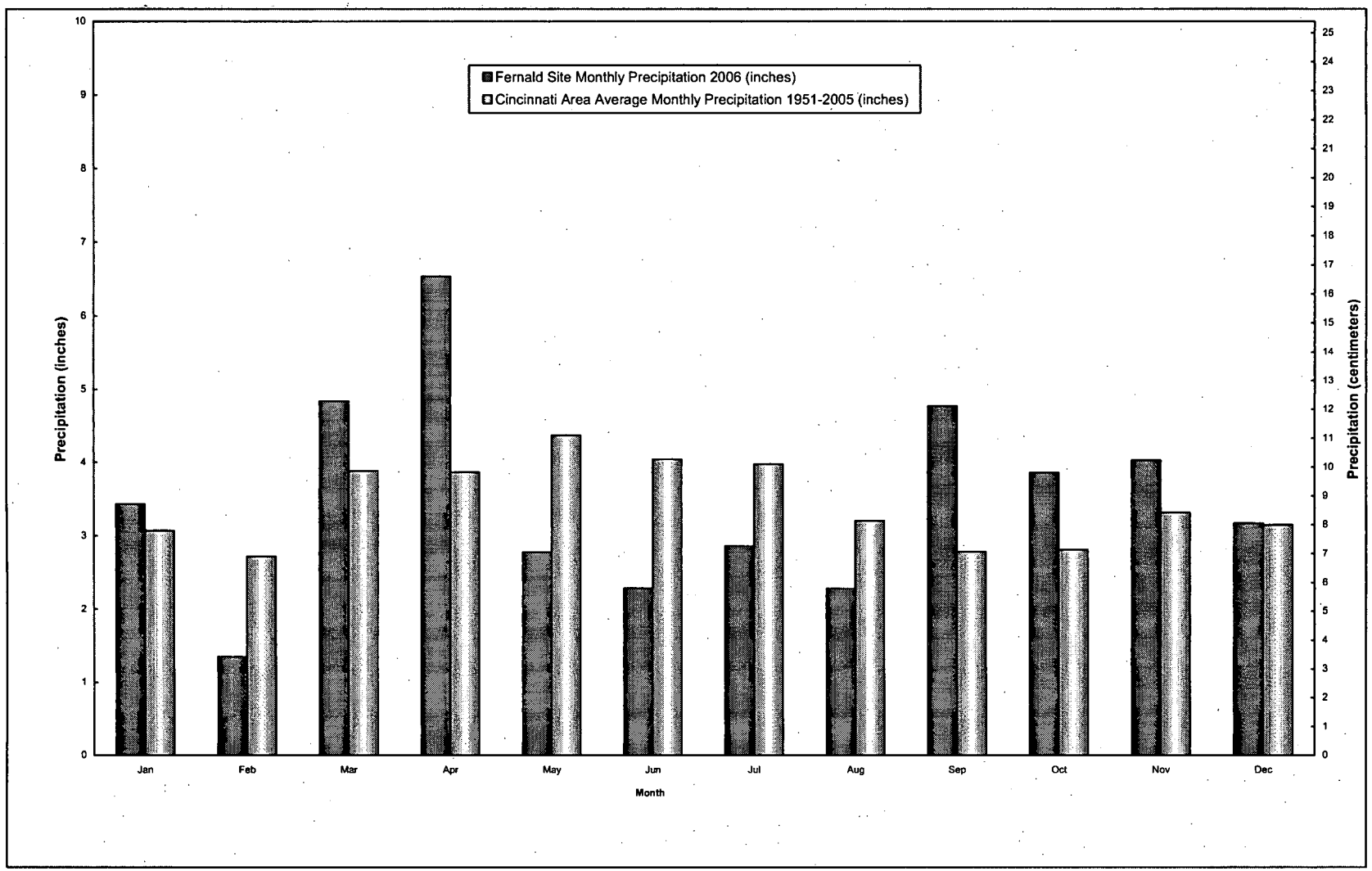

Figure 1–10. Monthly Precipitation for 2006 Compared to Average Monthly Precipitation for 1951–2005

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1.3.6 Natural Resources

Natural resources have important aesthetic, ecological, economic, educational, historical, recreational, and scientific value to the United States. Their protection will be an ongoing process at the Fernald site. Studies such as wildlife surveys (Facemire et al. 1990) and the Operable Unit 5 Ecological Risk Assessment (provided as Appendix B of the *Remedial Investigation Report for Operable Unit 5* [DOE 1995d]) show that terrestrial and aquatic flora and fauna at the site are diverse, healthy, and similar in abundance and species composition to those populations of surrounding ecological communities. Chapter 7 provides a discussion of the site's diverse ecological habitats and cultural resources.

End of current text

2.0 Remediation Status and Compliance Summary

This chapter provides a summary of CERCLA remediation activities in 2006 for each project, and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. CERCLA (the Superfund Act) is the primary driver for environmental remediation of the Fernald site.

The EPA and OEPA enforce the environmental laws, regulations, and legal agreements governing work at the Fernald site. The EPA develops, promulgates, and enforces environmental protection regulations and technology-based standards. EPA regional offices and state agencies enforce these regulations and standards by review of data collected at the Fernald site. Region V of the EPA has regulatory oversight of the CERCLA process at the Fernald site, with active participation from OEPA.

For some programs, such as those under the Resource Conservation and Recovery Act (RCRA) as amended, the Clean Air Act as amended (excluding NESHAP compliance), and the Clean Water Act as amended; EPA has authorized the State of Ohio to act as the primary enforcement authority. For these programs, Ohio promulgates state regulations that must be at least as stringent as federal requirements. Several legal agreements among DOE, EPA Region V, and OEPA identify site specific requirements for compliance with the regulations. To comply with these regulations, DOE Headquarters issues directives to its field and area offices and conducts audits to ensure compliance with all regulations.

2.1 CERCLA Remediation Status

The process for remediating sites under CERCLA consists of three phases: site characterization, remedy selection, and implementation. The first two phases at the Fernald site are complete, and the regulatory agencies have approved remedy selection documents (i.e., Records of Decision) for all operable units, as well as several amendments to these documents.

During 2006, the Fernald site was involved in the implementation phase of CERCLA remediation that included remedial design and remedial action (construction and implementation of the remedy). Remediation activities, documents, and schedules were specifically identified in each operable unit's remedial design and remedial action work plan.

In October 2006, remedial actions were completed for four of the five operable units. As of October 29, 2006, the only active remedy implementation efforts remaining involve the continuation of the groundwater remedy. A complete status of each of the remedial action projects are provided in subsequent sections of this chapter.

Each phase of the CERCLA remediation process requires documentation. The documents produced reflect the input of stakeholders who have helped form the remediation strategy at the Fernald site. Many documents that describe specific remediation activities were issued or approved in 2006. All cleanup related CERCLA documentation, including a copy of the Administrative Record, is available to the public at the Public Environmental Information Center, located at 10995 Hamilton Cleves Highway in Cincinnati, Ohio, and is open Monday through Thursday, 9:00 a.m. to 4:00 p.m. A copy of the Administrative Record is also located at EPA's Region V office in Chicago, Illinois. The progress made by each remedial project toward CERCLA cleanup is summarized later in this chapter.

The completion and closure of a National Priorities List (NPL) site encompasses several milestones, and specific documentation requirements for each milestone completed [OSWER Directive 9320.2-09A-P, *Close Out Procedures for National Priorities List Sites*, January 2000 (i.e., OSWER Directive)]. These milestones begin with remedial action completion and end with deletion from the NPL, and includes:

- Remedial action completion (Final or Interim Remedial Action Reports).
- Construction completions (Preliminary Closeout Report) – all construction activities are complete, immediate threats are addressed, and long-term threats are under control.
- Site completion (Final Closeout Report) – all site clean-up goals are met, all RODs are complete, institutional controls are in place, and the site is protective of human health and the environment.
- Site deletion from the National Priorities List (Notice of Intent to Delete).

Several documents were prepared by DOE in the summer and fall of 2006 documenting the completion of remedial actions. Final Remedial Action Reports were prepared for Operable Units 1 through 4 and provided to the regulatory agencies for approval. A Preliminary Closeout Report was prepared by EPA on December 21, 2006, and an Interim Remedial Action Report for Operable Unit 5 is planned to be provided to the agencies in the summer of 2007.

CERCLA also requires a five-year review process of remedial actions implemented under the signed Record of Decision for each operable unit. The purpose of a five-year review is to determine, through evaluation of performance of the selected remedy, whether the remedy at a site remains protective of human health and the environment. The first five-year review report for the Fernald site (DOE 2001b) was approved by the EPA in September 2001. The second five-year report was submitted in April 2006 (DOE 2006b).

Cleanup levels at the Fernald site for surface water, sediment, and groundwater were established in the *Final Record of Decision for Remedial Actions at Operable Unit 5* (DOE 1996). These final remediation levels (FRLs) were established for constituents of concern or for those constituents at the Fernald site determined, through risk assessment, to present potential risk to human health or the environment. Table 2–1 lists FRLs identified for constituents in groundwater, surface water, and sediment. FRLs represent the maximum allowable residual levels (the maximum concentrations that may remain in the environment following remediation). These levels drive excavation and clean up.

On November 30, 2001, the EPA approved an Explanation of Significant Differences document to the Operable Unit 5 Record of Decision. This document formally adopts the EPA's Safe Drinking Water Act Maximum Contaminant Level for uranium of 30 µg/L as the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River.

2.1.1 Waste Pits Project

The Waste Pits Project (Operable Unit 1) was responsible for the excavation, drying (as required), loading, and rail transport of the contents of waste pits 1 through 6, the burn pit, and the clearwell to Envirocare of Utah, Inc. (Envirocare). Sampling and analysis of the waste pit material, and the off-site disposal of contaminated soil and debris from other remedial projects

that exceed the waste acceptance criteria (physical, chemical, and radiological standards) for the on-site disposal facility, were part of this scope of work. The project was also responsible for collecting wastewater and storm water associated with Waste Pits Project activities and, as needed, pre-treating and discharging this remediation water to the converted advanced wastewater treatment facility. In addition, the project was responsible for implementing dust control measures and for implementing point source emission controls for dryer operations.

By the end of June 2005, the project was complete; specifically, all the waste and contaminated liners had been removed from the waste pits and shipped to Envirocare. Beginning in June 2005, the only project activity was continued rail shipping of soil and other material from other site projects that exceeded the on-site disposal facility waste acceptance criteria. This material was placed into soil pile 7 and two new soil piles, soil pile 8 and soil pile 9, and loaded from these same locations. Rail shipping activities ended in October 2006.

During 2006, 34 unit trains left the Fernald site carrying approximately 200,545 tons (181,936 metric tons) of material. From April 1999, when the first rail shipment left the Fernald site, through October 2006, 201 unit trains carrying approximately 1,267,919 tons (1,150,265 metric tons) of material were shipped to Envirocare for disposal.

A Final Remedial Action Report documenting the completion of Operable Unit 1 was prepared by DOE and approved by EPA and OEPA in August and September 2006, respectively.

Former Waste Pit Area After Remediation

Table 2–1. Final Remediation Levels for Groundwater, Surface Water, and Sediment

Constituent	FRL[a] Groundwater	Surface Water	Sediment
General Chemistry	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Cyanide	NA[b]	0.012	NA
Fluoride	4[c]	2.0	NA
Nitrate[d]	11	2,400	NA
Inorganics	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Antimony	0.0060	0.19	NA
Arsenic	0.050	0.049	94
Barium	2	100	NA
Beryllium	0.0040	0.0012	33
Boron	0.33	NA	NA
Cadmium	0.014	0.0098	71
Chromium VI[d]	0.022	0.010	3,000
Cobalt	0.17	NA	36,000
Copper	1.3	0.012	NA
Lead	0.015[c]	0.010	NA
Manganese	0.900	1.5	410
Mercury	0.0020	0.00020	NA
Molybdenum	0.10	1.5	NA
Nickel	0.10	0.17	NA
Selenium	0.050	0.0050	NA
Silver	0.050	0.0050	NA
Thallium	NA	NA	88
Vanadium	0.038	3.1	NA
Zinc	0.021	0.11	NA
Radionuclides	**(pCi/L)**	**(pCi/L)**	**(pCi/g)**
Cesium-137	NA	10	7.0
Neptunium-237	1.0	210	32
Lead-210	NA	11	390
Plutonium-238	NA	210	1,200
Plutonium-239/240	NA	200	1,100
Radium-226	20	38	2.9
Radium-228	20	47	4.8
Strontium-90	8.0	41	7,100
Technetium-99	94	150	200,000
Thorium-228	4.0	830	3.2
Thorium-230	15	3500	18,000
Thorium-232	1.2	270	1.6
	(µg/L)	(µg/L)	(mg/kg)
Total Uranium[e]	30[f]	530	210

Table 2-1. (Continued). Final Remediation Levels for Groundwater, Surface Water, and Sediment

Constituent	FRL[a] Groundwater	Surface Water	Sediment
Organics	**(µg/L)**	**(µg/L)**	**(µg/kg)**
Alpha-chlordane	2.0	0.31	NA
Aroclor-1254	0.20	0.20	670
Aroclor-1260	NA	0.20	670
Benzene	5.0	280	NA
Benzo(a)anthracene	NA	1.0	190,000
Benzo(a)pyrene	NA	1.0	19,000
Benzo(b)fluoranthene	NA	NA	190,000
Benzo(k)fluoranthene	NA	NA	1,900,000
Bis(2-chloroisopropyl)ether	5.0	280	NA
Bis(2-ethylhexyl)phthalate	6.0	8.4	5,000,000
Bromodichloromethane	100	240	NA
Bromoform	NA	NA	160,000
Bromomethane	2.1	1300	NA
Carbazole	11	NA	63,000
Carbon disulfide	5.5	NA	NA
Chloroethane	1.0	NA	NA
Chloroform	100	79	NA
Chrysene	NA	NA	19,000,000
Dibenzo(a,h)anthracene	NA	1.0	NA
3,3'-Dichlorobenzidene	NA	7.7	NA
1,1-Dichloroethane	280	NA	NA
1,1-Dichloroethene	7.0	15	NA
1,2-Dichloroethane	5.0	NA	NA
Dieldrin	NA	0.020	NA
Di-n-butylphthalate	NA	6,000	NA
Di-n-octylphthalate	NA	5.0	NA
Methylene chloride	5.0	430	NA
4-Methylphenol	29	2,200	NA
4-Methyl-2-pentanone	NA	NA	2,100,000
4-Nitrophenol	320	7,400,000	NA
N-nitrosodiphenylamine	NA	NA	260,000
Octachlorodibenzo-p-dioxin	0.0001	NA	NA
Phenanthrene	NA	NA	3
2,3,7,8-Tetrachlorodibenzo-p-dioxin	0.010	NA	NA
Tetrachloroethene	NA	45	NA
1,1,1-Trichloroethane	NA	1.0	NA
1,1,2-Trichloroethane	NA	230	NA
Trichloroethene	5.0	NA	NA
Vinyl Chloride	2.0	NA	NA

[a]From Record of Decision for Remedial Actions at Operable Unit 5, Tables 9-4 through 9-6, January 1996.
[b]NA = not applicable. No FRL was required for this constituent in this particular environmental media.
[c]The groundwater FRLs for fluoride and lead were changed from 0.89 milligrams per liter (mg/L) and 0.002 mg/L, respectively, to be consistent with the FRL selection process outlined in the Feasibility Study Report for Operable Unit 5 (DOE 1995a). The changes were documented in the Operable Unit 5 Record of Decision by change pages.
[d]Because of holding time considerations, nitrate/nitrite is analyzed for nitrate and total chromium is analyzed for hexavalent chromium. Total chromium and nitrate/nitrite provide a more conservative result.
[e]Uranium consists of several isotopes (uranium-234, 235, 236 and 238). This report interchangeably uses the terms uranium and total uranium, both defined as the sum of the various isotopic components.
[f]The total uranium groundwater FRL was changed to 30 µg/L in 2001 to reflect the EPA's adopted Safe Drinking Water Act Final Maximum Contamination Level for uranium.

2.1.2 Environmental Closure, Soil, and Disposal Facility Project

The Environmental Closure, Soil, and Disposal Facility Project, which included components of Operable Units 2 and 5, was responsible for characterizing the extent of contamination in the soil, soil sampling, and treatment of soil if necessary; certifying that the soil met the FRLs established in the Operable Units 2 and 5 Records of Decision, natural resource restoration, the design and certification activities associated with the on-site disposal facility, and waste acceptance operations associated with the placement of materials into the facility. The project was also responsible for construction activities associated with excavation of soil and debris, placement of soil and debris in the on-site disposal facility, and the construction of the on-site disposal facility liners and caps. The on-site disposal facility's leachate and leak detection monitoring and operation, maintenance, and monitoring of the leachate transmission system were part of the Environmental Closure scope, but are addressed under the Aquifer Restoration/Wastewater Project.

The Fernald site was divided into nine separate soil remediation areas based on land use history and known contamination levels (Figure 2–1). Area 9 includes off-site soil that was remediated and certified. In addition, portions of the site's stream corridors (including Paddys Run), along with other potentially contaminated corridors, required remediation and were considered unique areas. Other utility corridors and access roads were not included with the remediation areas; these will be addressed following completion of aquifer restoration.

Prior to soil remediation, real time scanning and soil sampling was performed to gather information related to the extent of surface and subsurface contamination and to identify the impacted materials that meet or exceed the waste acceptance criteria for the on-site disposal facility. Materials that could not be placed in the on-site disposal facility were stockpiled or containerized, monitored, and disposed off site. Engineering personnel used the analytical data and extent of contamination to design soil and debris excavations.

Volume Descriptions: Bank and In-place Soil/debris can be described as "bank" (in the ground before excavation) or "in-place" (placed and compacted in the on-site disposal facility). When soil is designed and estimated for excavation, the soil volume is calculated by length, width, and height. When the soil is placed in the on-site disposal facility, considerable compaction is achieved, which reduces the volume that is actually in-place at the on-site disposal facility.

The following soil remedial excavation activities took place in 2006:

- Area 1 Phase IV. Excavation of the decontamination facility.
- Area 5. Excavation of the 60-inch storm water line.
- Area 6 Former Production Area. The management and excavation of soil pile 8. Soil pile 8 was used to support the last off-site rail shipments.
- Area 6. Remedial excavations within the waste pit area and the former on-site disposal facility material transfer area and the management and excavation of soil piles 7 and 9. Soil pile 9, a lined stockpile area located in the southern footprint of the railcar loadout building, was used for the rail loadout of a small portion of material from the demolition of the silos in Area 7 for off-site disposal.
- Area 7. Remedial excavations within the footprints of Silos 1, 2, and 3 and their respective remediation areas. Excavation of the storm water retention basins.

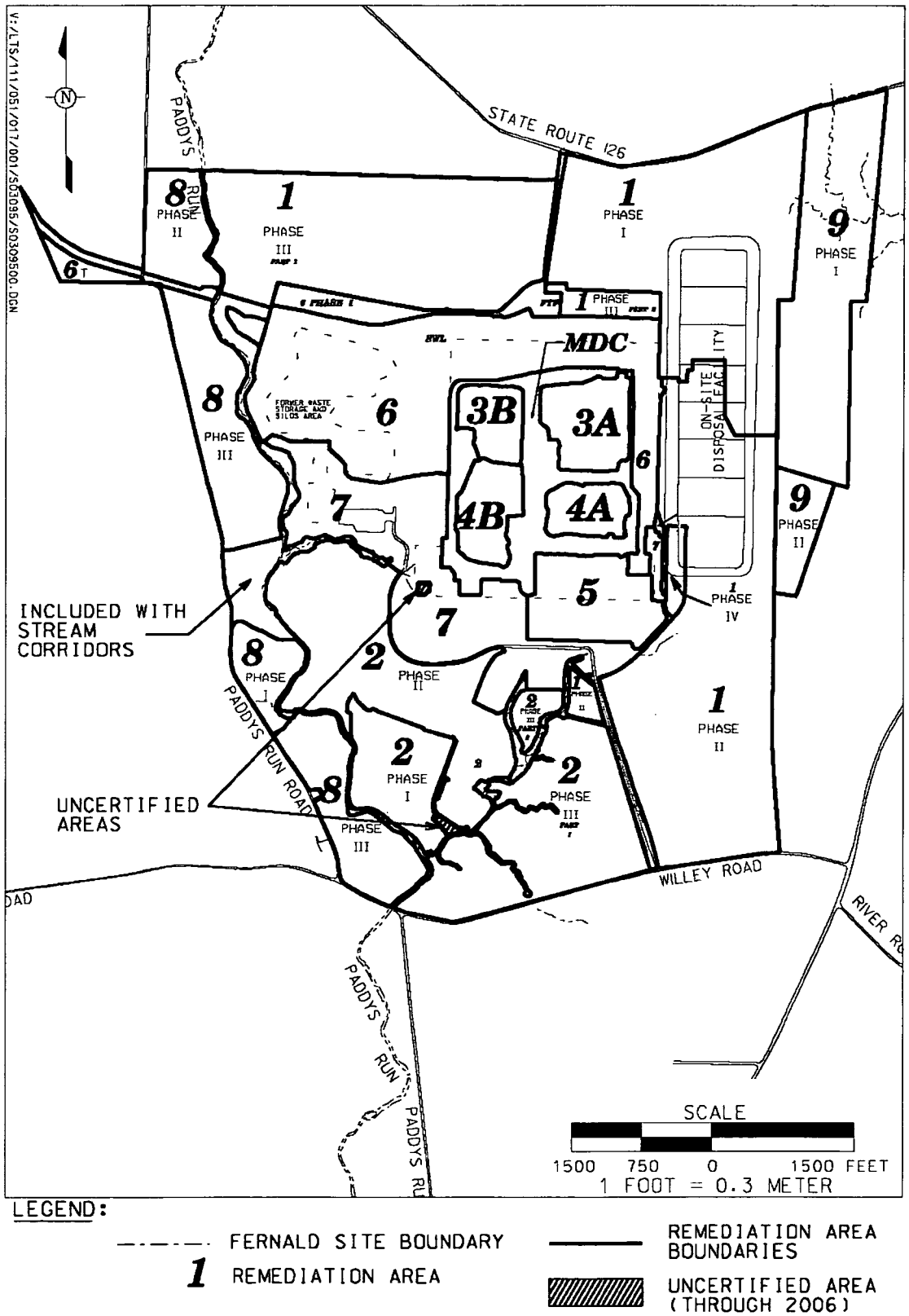

Figure 2–1. Site-Wide Soil Certified Areas

When contaminated soil and debris were excavated from each area, pre-certification real time scanning and certification sampling was performed to demonstrate that the residual levels of the constituents of concern for that area were below the Fernald site's soil FRLs. After statistical analyses for an area was reviewed and indicated that concentrations met certification requirements, a certification report was submitted to EPA and OEPA for review and approval.

At the end of 2006, all 55 required certification reports were submitted to the regulatory agencies for approval. Of these, 43 reports were approved by EPA and OEPA, four were approved by one agency or the other, and eight were pending review.

Figure 2–1 identifies all of the remediation areas for which the statistical analyses of the certification data supports the determination that the soil remediation goals have been attained. However, DOE does not consider a remediation area certified until EPA and OEPA approvals have been obtained. The following certification reports were prepared and submitted in 2006:

- Area 1 (Phase II), Dissolved Oxygen Building Area, Addendum, (October 2006)
- Area 1 (Phase IV), Decontamination Facility Area (October 2006)
- Area 2 (Phase II), Subarea 3 (January 2006)
- Area 2 (Phase II), Subareas 1, 2, and 4, Addendum, (July 2006)
- Area 2 (Phase III), Addendum, (October 2006)
- Area 4A, Addendum (September 2006)
- Area 4B, Part 1 (January 2006)
- Area 4B, Part 1, Addendum, (October 2006)
- Area 4B, Part 2 and Main Drainage Corridor (October 2006)
- Area 5, Administration Area and Parking Lots (October 2006)
- Area 6, Waste Pits 4, 5, and 6 (March 2006)
- Area 6, Waste Pits 1, 2, 3, Clearwell, and Burn Pit (July 2006)
- Area 6, Waste Pits General Area East (July 2006) and Addendum (October 2006)
- Area 6, Former Production Area and Main Drainage Corridor North (August 2006)
- Area 6, Former Production Area and Main Drainage Corridor North Addendum (Soil Pile 8) (October 2006)
- Area 6, Soil Pile 7 and Solid Waste Landfill (October 2006)
- Area 6E, (October 2006)
- Area 6, Waste Pits General Area West (October 2006)
- Area 6, Rail Yard and Rail Lines (October 2006)
- Area 7, Silos and Support Areas (October 2006)
- Area 7, Outside Areas (October 2006)
- Area 7, Miscellaneous Areas (October 2006)
- Area 7, Silo 3 Concrete (October 2006)

- Area 7, Silos 1 and 2 Remediation Facility and Temporary Transfer Area Concrete (October 2006)
- Area 7, Storm Water Retention Basins (October 2006)
- Paddys Run (October 2006)

After an area of the site was certified, natural resource restoration activities began. Chapter 7 discusses the specific natural resource restoration activities that took place in 2006.

During 2006, approximately 202,061 in-place cubic yards (yd^3) (154,496 cubic meters [m^3]) of waste (including excavated material, debris, etc.) were placed in cells 7 and 8 of the on-site disposal facility. The last waste placement into the on-site disposal facility occurred September 7, 2006, and the cap systems for cells 7 and 8 were completed in October 2006. A total of 2,956,221 in-place yd^3 (2,260,327 m^3) of contaminated soil and debris was placed in the on-site disposal facility over the life of placement operations. A discussion of the ongoing performance monitoring of the on-site disposal facility is provided in Chapter 3.

An Interim Remedial Action Report documenting the completion of soils remediation and completion of the on-site-disposal facility was prepared by DOE in October 2006. However, formal submission of this report (which also addresses the aquifer remediation) to EPA and OEPA will not occur until all soil certification reports have been approved. The final soil certification report approval and the subsequent Interim Remedial Action Report submittal is expected to occur in the summer of 2007.

On-Site Disposal Facility After Completion of all Caps

2.1.3 Decontamination and Demolition Project

The Decontamination and Demolition Project (Operable Unit 3) was responsible for decontaminating and dismantling the above-grade structures and facilities associated with production operations and remedial actions. This included decontamination of facilities; isolation of utilities; demolition of buildings, equipment, and other facilities; removal of uranium and other material from former processing equipment; and shipment of material and equipment off-site. The scope included the collection and proper management of associated decontamination wastewater.

During 2006, decontamination and demolition activities were completed at the following facilities:

- 16L Northwest 34.5 KV Feeder System
- 18Y AWWT Ozone Generation Building
- 18Z Sludge Mix Tank
- 22C/31B Truck Scale
- 23A Meteorological Tower
- 24D Railroad Inspection Pit
- 26D Domestic and Fire Water Booster Station
- 26E Domestic and Fire Water 400K Tank
- 26F Domestic and Fire Water Lift Station
- 28G Guard Post
- 28H Guard Post
- TS-09 Wise Fabrication Shop
- TS-13 Maintenance Shop
- G-001 Rail Tracks
- 35B Metal Oxide Storage Tank (Silo 3)
- 94A Silos Operations/Maintenance Building
- 94B Silos 1 and 2 Remediation Building
- 94C Silos 1 and 2 Transfer Tank Area
- 94D Silos 1 and 2 Carbon Bed Facility
- 94E Silos 1 and 2 Radon Control System
- 94G Silos 1 and 2 Electrical Building
- 94H Silo 3 Process Building
- 94J AWR Continuous Emissions Monitoring Building
- 94L Silos 1 and 2 Continuous Emissions Monitoring Building
- 94M Silo 3 Enclosure Building
- 94N Silo 3 Excavator Building
- 94P Silo 3 Cargo Container Building
- 94Q Silo 3 Electrical Equipment Building
- 94R Silos 1 and 2 High Pressure Pump/Breathing Air Utility Building
- 94S Silos Small Lab Building
- 94T Silos Test Stand
- 94X Silo 3 Continuous Emissions Monitoring Building
- 94Y Silos Maintenance Shop

Demolition of these structures completed the decontamination and decommissioning effort at the Fernald site. A total of 316 structures were decontaminated and decommissioned during the life of the Operable Unit 3 remedy.

A Final Remedial Action Report for Operable Unit 3 documenting the completion of the Operable Unit 3 Remedy was prepared by DOE and submitted to EPA and OEPA in December 2006.

Decontamination and Decommissioning of the Silos 1 and 2 Remediation Facility

2.1.4 Silos Projects

The Silos Project (Operable Unit 4) included Silos 1 and 2 (also known as the K-65 Silos), Silos 3 and 4, and several nearby structures. Silos 1 and 2 contained radium bearing residues from the processing of uranium ore and ore concentrates during the 1950s and were demolished in 2005 after completing retrieval of the residues. Silo 3 contained cold metal oxides generated from uranium recovery operations and was demolished in 2006. Silo 4 was never used and was demolished in 2004. The Silos Project remediation activities included the retrieval, processing, and off-site disposal of the residues stored in the silos, as well as decontamination and dismantling of the silo structures and associated facilities.

In 1997, DOE, EPA, and OEPA reached the decision to separate the remediation of Silo 3 material from the remediation of Silos 1 and 2 material and re-evaluate the treatment remedies for both materials. In addition, the Silos 1 and 2 Accelerated Waste Retrieval Project was initiated to provide control of radon in Silos 1 and 2 headspaces and treatment facilities, and safe storage of the material from Silos 1 and 2 during the interim period until treatment and disposal could be implemented. The following is a summary of each project's major activities during the year:

- Bulk processing in the Silos 1 and 2 Remediation Facility was completed March 19, 2006. A total of 3,776 containers of treated material from Silo 1 and 2 (including 80 containers produced through direct loadout in support of the safe shutdown of the facility) were

packaged and shipped to WCS for temporary storage, pending permanent disposal. The Radon Control System, which initiated operation on April 25, 2003 to remove radon from the headspaces in Silos 1 and 2, provided control of radon and particulate emissions from the silos waste retrieval system equipment, TTA tanks, and process vessels in the Silos 1 and 2 Remediation Facility until it was shut down on April 1, 2006.

- Pneumatic retrieval, conditioning, and packaging of Silo 3 material was initiated March 23, 2005. A total of 1,416 containers were filled via pneumatic retrieval through October 21, 2005, when mechanical retrieval was initiated. Retrieval and packaging of Silo 3 material was completed March 21, 2006. A total of 2,297 containers were filled (including 50 containers of material generated during safe shutdown of the facility) and transported to Envirocare for disposal.
- A Final Remedial Action Report for Operable Unit 4 documenting completion of Operable Unit 4 remedial actions was prepared by DOE and approved by EPA and OEPA in September and October 2006 respectively. (Documenting the final disposal of Silo 1 and 2 materials discussed above will be through an addendum to this report).

Stabilized Silo 1 and 2 Material in Transit to WCS in Texas

2.1.5 Aquifer Restoration/Wastewater Project

The Aquifer Restoration/Wastewater Project (Operable Unit 5) is responsible for the restoration of water quality in the affected portions of the Great Miami Aquifer and for addressing the Fernald site's water treatment needs. This includes the design, construction, operation, monitoring, and reporting in regard to the groundwater restoration and wastewater treatment systems at the Fernald site. This project is also responsible for managing the on-site disposal facility's leak detection monitoring program, and operation, maintenance, and monitoring of the leachate transmission system.

As an ongoing remedy, the Aquifer Restoration/Wastewater Project will continue to be responsible (during legacy management) for implementing the groundwater remedy, monitoring the performance of the on-site disposal facility, and operating the treatment systems necessary to meet uranium discharge limits stipulated in the Operable Unit 5 Record of Decision and National Pollutant Discharge Elimination System (NPDES) Permit. The DOE's Office of Legacy Management's Technical Assistance Contractor, S.M. Stoller, became responsible for the operation of all groundwater extraction systems, the on-site-disposal facility, and treatment systems on October 29, 2006; in advance of assuming responsibility for the entire site on November 17, 2006.

As required by the remediation contract between Fluor Fernald, Inc. and DOE, all necessary infrastructures were to be in place at the time of site closure. By October 2006 the converted advanced wastewater treatment system, the supporting backwash basin, all necessary groundwater extraction wells, and infrastructure to pump clean groundwater to the storm sewer outfall ditch for flushing purposes were all installed and operational.

In 2006, a total of 2,028 M gal (7,676 million liters [M liters]) of groundwater was extracted from the Great Miami Aquifer, and 673 lb (305 kg) of uranium were removed from the aquifer. Chapter 3 discusses groundwater monitoring.

The Converted Advanced Wastewater Treatment Facility (Backwash Basin in Foreground)

2.2 Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations as part of remediation of the Fernald site. These requirements are referred to as applicable or relevant and appropriate requirements (ARARs). ARARs that are pertinent to remediation of the Fernald site are specified in the Record of Decision for each operable unit. This section of the report highlights some of the major requirements related to environmental monitoring and waste management, and how the Fernald site complied with these requirements in 2006.

The regulations discussed in this section have been identified as ARARs within the Records of Decision. The Fernald site must comply with these regulations while site remediation under CERCLA is underway; compliance is enforced by EPA and OEPA. Some of these requirements include permits for controlled releases, which are also discussed in this section.

2.2.1 Resource Conservation and Recovery Act

Resource Conservation and Recovery Act (RCRA) as amended, regulates the treatment, storage, and disposal of hazardous waste and mixed waste that contains radioactive and hazardous waste components. Hazardous and mixed waste currently generated at the Fernald site results from such activities as CERCLA remedial actions and maintenance activities. These wastes are

regulated under RCRA and Ohio hazardous waste management regulations; therefore, the Fernald site must comply with legal requirements for managing hazardous and mixed wastes. OEPA has been authorized by EPA to enforce its hazardous waste management regulations in lieu of the federal RCRA program. In addition, hazardous waste management is subject to the 1988 Consent Decree, the 1993 Stipulated Amendment between the State of Ohio and DOE, and a series of Director's Final Findings and Orders issued by OEPA.

The Fernald site completed several administrative activities related to mixed waste storage and treatment during 2006, including:

- Submittal of the 2005 RCRA Annual Report (DOE 2006) that describes hazardous waste activities for 2005.
- Submittal of the *Fiscal Year 2005 Site Treatment Plan Annual Update* (DOE 2005b) as required in the 1992 Federal Facility Compliance Act, and implementing the Director's Findings and Orders issued by OEPA in October 1995. This submittal documented the completion of all required milestones associated with the Site Treatment Plan. DOE requested the Director's Findings and Orders be terminated as all actions had been completed. OEPA Division of Hazardous Waste Management concurred that all obligations under the Director's Findings and Orders had been met and terminated the Director's Findings and Orders on March 9, 2006.

On February 15, 2006, the Fernald site received a Notice of Violation from OEPA for missing inspection records for two hazardous waste storage lockers for four weeks during January 2005 and for missing inspection records for all storage lockers during the week of April 4, 2005. OEPA determined these missing records constituted a violation of Ohio Administrative Codes 3745 65 15 and 3745 66 74. However, OEPA took no further action nor was any further action required on the part of DOE.

2.2.1.1 RCRA Property Boundary Groundwater Monitoring

The Director's Findings and Orders, which were signed September 10, 1993, described an alternate monitoring system for RCRA groundwater monitoring. A revision of this document was approved on September 7, 2000, to align with the groundwater monitoring strategy identified in the IEMP. The Property Boundary Groundwater Monitoring program is discussed in Chapter 3.

2.2.1.2 RCRA Closures

The 1993 Stipulated Amendment to Consent Decree required that DOE identify all hazardous waste management units at the Fernald site. As a result, burners, incinerators, furnaces, stills, process equipment, tank units, dust collectors, and other potential waste containment units were evaluated in the early 1990s to determine if they were hazardous waste management units or solid waste management units. This evaluation was completed in 1994. In 1996, OEPA issued Director's Findings and Orders to integrate RCRA closure requirements with CERCLA response actions for the Fernald site hazardous waste management units.

In 2006, the Fernald site completed the remediation of five units:

- The tank farm sump
- The storage pad north of Plant 6
- The UNH tanks
- The drum storage area south of W-26
- The abandoned sump west of the Pilot Plant

In accordance with Section V.4 of the Director's Findings and Orders, DOE certified in the Operable Unit 1 Final Remedial Action Report that the waste pit material from two units within Operable Unit 1 (Waste Pits 4 and 5) were completely excavated and disposed. This certification acknowledged that formal closure of the units would not occur until the certification of the underlying soils. Soil Certification Report for waste pits 4 and 5 was approved in March 2006.

In addition, the physical and structural elements associated with 11 above-grade units, without underlying soil contamination, were certified to be removed in the Operable Unit 3 Final Remedial Action Reports.

2.2.1.3 Waste Management

With the completion of remediation, DOE also completed the disposition of the containerized waste inventory. The last shipment of hazardous waste occurred October 2, 2006, ending hazardous waste management activities. (A limited amount of waste may be generated during legacy management. It is anticipated this will consist only of non-contaminated sanitary waste and small quantities of low-level waste.) During 2006, a total of 11,207 lb (5,086 kg) of hazardous or low-level mixed waste was shipped off-site for disposition.

2.2.2 Clean Water Act

Under the Clean Water Act, as amended, the Fernald site is governed by NPDES regulations that require the control of discharges of non-radiological pollutants to waters of the State of Ohio. The NPDES Permit, issued by the State of Ohio, specifies discharge and sample locations, sampling and reporting schedules, and discharge limitations. The Fernald site submits monthly reports on NPDES activities to OEPA. The Fernald site's current NPDES Permit, Permit Number 1IO00004*GD, became effective on July 1, 2003. Chapter 4 discusses the surface water and treated effluent information in detail.

2.2.3 Clean Air Act

NESHAP Subpart H imposes a limit of 10 millirem (mrem) per year on the effective dose equivalent to the maximally exposed individual as a result of all air emissions (with the exception of radon) from the facility in a single year. For 2006, the Fernald site was in compliance with the NESHAP dose limit as determined by ambient air monitoring at the Fernald site's boundary. Appendix D contains the NESHAP Annual Report for 2006.

OEPA is authorized to enforce the State of Ohio's air standards for particulate matter at the Fernald site. Several remediation activities, including decontamination and dismantling, soil excavation, and on-site disposal facility construction and waste placement, may have resulted in

the generation of fugitive dust. Compliance is accomplished by implementing the Fugitive Dust Control Policy negotiated between DOE and OEPA in 1997. This policy is implemented in the *Best Available Technology Determination for Remedial Construction Activities on the Fernald Environmental Management Project* (DOE 1997b), the requirements of which are incorporated into each operable unit's remedial design and remedial action deliverables. The policy allows for visual observation of fugitive dust and implementation of dust control measures to determine compliance during remediation activities.

2.2.4 Superfund Amendments and Reauthorization Act of 1986

The Superfund Amendments and Reauthorization Act of 1986 (SARA) amended CERCLA and was enacted, in part, to clarify and expand CERCLA Superfund requirements. SARA Title III is also known as the Emergency Planning and Community Right to Know Act.

The SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report for 2006 was submitted to OEPA, to the local emergency planning committees of Hamilton and Butler Counties, and to the Crosby Township Fire Department prior to the March 1, 2007, deadline. This report lists the amounts and locations of hazardous chemicals and substances stored or used in amounts greater than the minimum reporting threshold (generally 10,000 lb [4,540 kg] for hazardous chemicals, and 500 lb [107 kg] for extremely hazardous substances) at any time during the previous year. For 2006, demolition of buildings and facilities and downsizing of the advanced wastewater treatment facility led to further reduction of the types and quantities of chemicals utilized and stored on-site. Several chemicals that were reported in previous years no longer exceeded reportable thresholds due to their use or disposition through transfers to other DOE sites, sales, or shipment off-site for treatment and disposal. The major chemicals that exceeded reportable thresholds were those associated with the site-wide excavation and demolition activities (such as diesel fuel), and those used in the waste treatment project for Silos 1 and 2 and the waste stabilization project for Silo 3. No new chemicals were above reportable thresholds.

Another SARA Title III report, the Section 313 Toxic Chemical Release Inventory Report (Form R), is required if the Fernald site exceeds an applicable threshold for any SARA 313 chemical. If required, the Toxic Chemical Release Inventory Report lists routine and accidental releases and information about the activities, uses, and waste for each reported toxic chemical. No chemicals have exceeded the threshold for several years. An evaluation to determine if any chemicals used at the Fernald site during 2006 exceeded reporting thresholds will be completed and will be reported, if required, to EPA and OEPA prior to the July 1, 2007, compliance date. It is anticipated again this year that no chemical will exceed a reporting threshold.

Also under SARA Title III, any off-site release meeting or exceeding a reportable quantity as defined by SARA Title III, Section 304, requires that immediate notifications be made to local emergency planning committees and the state emergency response commission. Notifications are also made to the National Response Center and other appropriate federal, state, and local regulatory entities. All releases occurring at the Fernald site are evaluated and documented to ensure that proper notifications are made in accordance with SARA, and under CERCLA Section 103, RCRA, the Toxic Substances Control Act, the Clean Air Act, the Clean Water Act, and Ohio environmental laws and regulations. Note that in 2006, there were no releases at the Fernald site that met the reporting criteria under CERCLA.

2.2.5 Other Environmental Regulations

The Fernald site is also required to comply with other environmental laws and regulations in addition to those described above. Table 2–2 summarizes compliance with each of these requirements for 2006.

2.2.6 Other Permits

Certain environmental laws are implemented through permits. The Fernald site's permit for discharging water under NPDES regulations is discussed in subsection 2.2.2, Clean Water Act. Permits to Install govern the installation (and to a lesser degree, the operation) of specific wastewater treatment and control devices. The last two facilities (Storm Water Retention Basins and Biosurge Lagoon) with effective Permits to Install have been removed from service (i.e., there is no longer any wastewater facilities with effective Permits to Install).

All air sources previously covered by air Permits to Operate or Install have either been eliminated or are being addressed through the CERCLA remediation process. Therefore, the Fernald site has withdrawn all active air Permits to Operate, and the site no longer has any air permits associated with its operations.

2.2.7 Pollution Prevention and Source Reduction

The Fernald site is actively involved in an effort to reduce solid, hazardous, radioactive, and mixed waste generation, and eliminate or minimize pollutants released to all environmental media. Various waste streams were recycled during 2006 including:

- 189 lb (86 kg) of nickel cadmium batteries.
- 2,283 gal (8,417 liters) of used oil.
- 631 fluorescent light tubes.

Table 2–2. Compliance With Other Environmental Regulations

Regulation and Purpose	Background Compliance Issues	2006 Compliance Activities
Toxic Substances Control Act (TSCA)		
Regulates the manufacturing, use, storage, and disposal of toxic materials, including polychlorinated biphenyl (PCB) and PCB items.	The last routine TSCA inspection of the FCP's program was conducted by EPA Region V on September 21, 1994. No violations of PCB regulations were identified during the inspection.	The last shipment of radiologically contaminated PCB liquids was shipped to the TSCA-permitted DOE incinerator in Oak Ridge, Tennessee.
Ohio Solid Waste Act		
Regulates infectious waste.	The Fernald site was registered with OEPA as a generator of infectious waste (generating more than 50 pounds [23 kg] per month) until December 6, 1999, when OEPA concurred with the Fernald site's qualification as a small quantity generator.	No infectious waste activities were required in 2006.
Federal Insecticide, Fungicide, and Rodenticide Act		
Regulates the registration, storage, labeling, and use of pesticides (such as insecticides, herbicides, and rodenticides).	The last inspection of the Federal Insecticide, Fungicide, and Rodenticide Act program conducted by EPA Region V on September 21, 1994 found the Fernald site to be in full compliance with the requirements mandated by Federal Insecticide, Fungicide, and Rodenticide Act.	Pesticide applications at the Fernald site were conducted according to federal and state regulatory requirements.
National Environmental Policy Act		
Requires the evaluation of environmental, socio-economic, and cultural impacts before any action, such as a construction or cleanup project, is initiated by a federal agency.	An environmental assessment for proposed final land use was issued for public review in 1998. It was prepared under DOE's guidelines for implementation of National Environmental Policy Act, 10 CFR 1021. The assessment requires consulting the public before any decisions on land use are made; it includes previous DOE commitments.	No National Environmental Policy Act activities were required in 2006.
Endangered Species Act		
Requires the protection of any threatened or endangered species found at the site as well as any critical habitat that is essential for the species' existence.	Ecological surveys conducted by Miami University and DOE, in consultation with the Ohio Department of Natural Resources, and the U.S. Fish and Wildlife Service, have established the following list of threatened and endangered species and their habitats existing on site: Cave salamander, state-listed endangered — marginal habitat, none found; Sloan's crayfish, state-listed threatened — found on northern sections of Paddys Run; Indiana brown bat, federally listed endangered — found in riparian areas along Paddys Run.	No endangered species surveys were conducted in 2006.

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Table 2–2 (Continued). Compliance With Other Environmental Regulations

Regulation and Purpose	Background Compliance Issues	2006 Compliance Activities
Floodplains/Wetlands Review Requirements		
DOE regulations require a floodplain/wetland assessment for DOE construction and improvement projects.	A wetlands delineation of the Fernald site, completed in 1992 and approved by the U.S. Army Corps of Engineers in August 1993, identified 36 acres (15 hectares) of freshwater wetland on the Fernald site property. Updated delineations are conducted approximately every five years.	No assessments were performed in 2006.
National Historic Preservation Act		
Establishes a program for the protection, maintenance, and stewardship of federal prehistoric and historic properties.	The Fernald site is located in an area of sensitive historic and prehistoric cultural resources that are eligible for or on the National Register of Historic Places. These cultural resources include historic structures, buildings, and bridges, plus Native American villages and campsites.	No cultural resource surveys were necessary in 2006. Monitoring for unexpected discoveries was conducted during site-wide field activities.
Native American Graves Protection and Repatriation Act		
Establishes a means for Native American Indians to request the return or "repatriation" of human remains and other cultural items. Federal agencies must return human remains, associated funerary objects, sacred objects, and objects of cultural patrimony to the Indian Nations or Tribes with cultural affiliation to the remains or material.	Native American Indian remains have been discovered during remediation activities at the Fernald site. Native American Indian remains and artifacts have been removed or left in place, with consultation from Native American Indian Nations, Tribes, and Groups.	No Native American remains were discovered or repatriated to Native American Indian Nations, Tribes, or Groups in 2006. As stated above, monitoring for unexpected discoveries was conducted during site-wide field activities.
Natural Resource Requirements Under CERCLA and Executive Order 12580		
Requires DOE to act as a Trustee (i.e., guardian) for natural resources at its federal facilities.	DOE and the other Trustees, which include the U.S. Department of the Interior, the U.S. Fish and Wildlife Service, OEPA, the Ohio Attorney General's Office, and EPA, meet regularly to discuss potential impact to natural resources and to coordinate Trustee activities. The Trustees also interact with the Fernald Citizens Advisory Board and Community Reuse Organization.	In 2006, the Trustees and DOE continued to pursue settlement of the 1986 Natural Resource injury claim at Fernald. While the components of restoration have been established through a 2001 Memorandum of Understanding (DOE 2001c) and restoration of the site continues, the Trustees and DOE continue to negotiate issues such as maintenance and monitoring at the Fernald site.

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The Fernald site's affirmative procurement program involves source reduction and the use of EPA designated materials to increase the market for recovered materials. In accordance with Executive Order 13101, Greening of the Government through Waste Prevention, Recycling, and Federal Acquisition, the Fernald site generates an annual report demonstrating compliance with this order.

As part of the *Annual Waste Reduction Report* under DOE Order 5400.1 (DOE 1990), the Fernald site routinely submits a summary report of waste generated and pollution prevention progress. However, due to transition activities toward the end of 2006, this report was not prepared. The annual waste reduction reporting will resume in December 2007.

2.2.8 Site Specific Regulatory Agreements

2.2.8.1 Federal Facility Compliance Agreement

In July 1986, DOE entered into a Federal Facility Compliance Agreement with EPA, which requires the Fernald site to:

- Maintain a sampling program for daily flow and total uranium at the South Plume extraction wells and report the results to the EPA, OEPA, and Ohio Department of Health. The sampling program conducted to address this requirement has also been modified over the years and is currently governed by an agreement reached with EPA and OEPA on May 1, 1996. These data are reported through IEMP reports (refer to Appendix A).
- Maintain a continuous sample collection program for radiological constituents at the treated effluent discharge points and report the results to EPA, OEPA, and the Ohio Department of Health. The sampling program to address this requirement has been modified over the years and is currently governed by an agreement reached with EPA and OEPA that became effective May 1, 1996. These data are reported through IEMP reports (refer to Appendix B).

2.2.8.2 Federal Facility Agreement, Control, and Abatement of Radon 222 Emissions

The Federal Facility Agreement between DOE and EPA, signed in November of 1991, ensures that DOE takes all necessary actions to control and abate radon 222 emissions at the Fernald site, under the authority of 40 CFR 61, Subpart Q. This agreement acknowledged that Silos 1 and 2 exceed the radon flux rate of 20 picoCuries per square meter per second. But it allowed the Fernald site to address this exceedance by implementing a removal action (installation of a bentonite cap in 1991) to take radon emissions from the silos to a level as low as reasonably achievable, and to attain the NESHAP Subpart Q standard upon completion of final remediation. Chapter 5 further discusses the results of the Radon Monitoring program for 2006.

2.2.9 Environmental Management Systems Requirement

DOE requires that sites develop and implement Environmental Management Systems as a means of systematically planning, implementing, evaluating, and improving processes and actions undertaken to achieve environmental goals. This requirement is specified in DOE Order 450.1, *Environmental Protection Program*, which directs that sites implement Environmental Management Systems by December 2005. As a CERCLA remediation site, the Fernald site has progressed through, or is in the process of implementing similar steps of investigation, risk

evaluation, remedy selection, planning, execution, and evaluation. During 2004, the Fernald site conducted a cross reference comparison of the elements of the Environmental Management Systems approach versus the systematic method of addressing environmental issues identified under the CERCLA driven approach. The comparison demonstrated that the substantive elements of Environmental Management Systems are satisfied through implementation of the CERCLA program at the Fernald site.

During legacy management under S.M. Stoller, Environmental Management Systems will be formally implemented through S.M. Stoller Manual STO 11, *Environmental Management Program Implementation Manual.*

2.3 Split Sampling Program

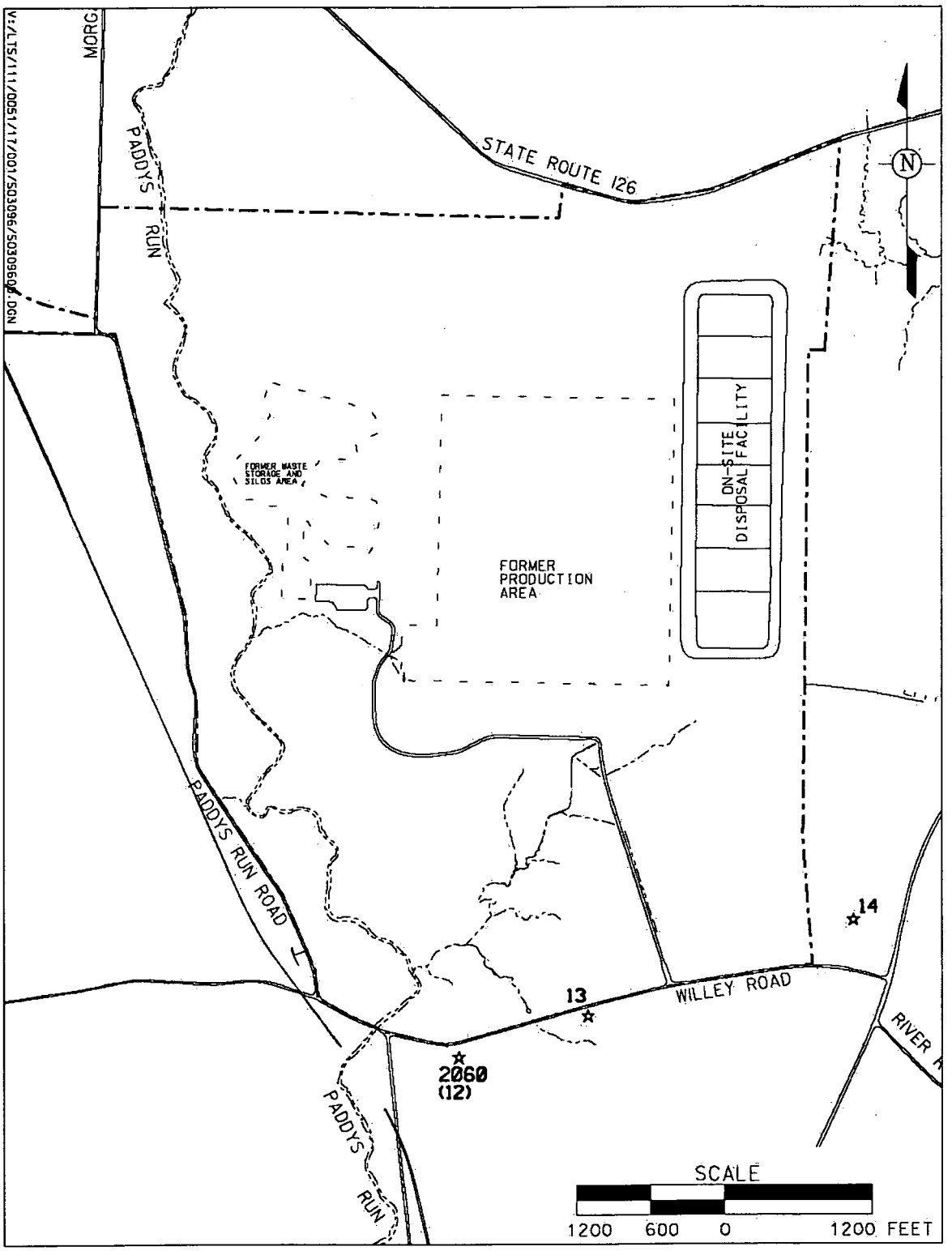
Since 1987, DOE has participated in the split sampling program with the state. Split samples are obtained when technicians alternately add portions of a sample to two individual sample containers. This collection method helps ensure that both samples are as identical as possible. The split samples are then submitted to two analytical laboratories; this allows for an independent comparison of data to ascertain laboratory analysis and field quality assurance. In addition to split sampling, OEPA performs independent sampling. Results are provided in OEPA's Annual Report to the Public on the Fernald site.

In 2006, DOE and OEPA cooperated in the split sampling program. Samples of groundwater were split (refer to split sample locations in Figure 2–2) and the results are provided in Table 2–3.

Table 2–3. 2006 DOE/OEPA Split Sampling Comparison

Media	Sample Location	Sample Date	Constituent	DOE Result	OEPA Result	FRL
Groundwater[a]				(µg/L)	(µg/L)	(µg/L)
	2060 (12)	April	Total Uranium	51.4	29.3	30
	2060 (12)	October	Total Uranium	71.2	96.3	30
	13	April	Total Uranium	16.6	9.2	30
	13	October	Total Uranium	15.6	16.8	30
	14	April	Total Uranium	4.33	3.71	30
	14	October	Total Uranium	3.4	3.88	30

[a]Refer to Figure 2-2 for groundwater split sample locations.



LEGEND:

FERNALD SITE BOUNDARY

☆ SAMPLE LOCATION

Figure 2–2. 2006 DOE and OEPA Groundwater Split Sample Locations

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Section 3

3.0 Groundwater Pathway

Results in Brief: 2006 Ground Water Pathway

Ground Water Remedy—In 2006 the Waste Storage Area Phase II Module began operating. This was the last module needed to complete the ground water remediation system.

Extraction well operations were impacted by site D&D and soil remediation activities in 2006. At times the ground water treatment system was shut down to accommodate these activities, resulting in the temporary reduction of aquifer remediation operations.

Eight Great Miami Aquifer monitoring wells were plugged and abandoned in an effort to facilitate site closure.

Since 1993
- 20,370 M gal (77,100 M liters) of water have been pumped from the Great Miami Aquifer.
- 1,936 M gal (7,328 M liters) of water have been re-injected into the Great Miami Aquifer.
  Note: Well-based re-injection ceased in 2004.
- 7,796 net pounds (3,539 kg) of uranium have been removed from the Great Miami Aquifer.

During 2006
- 2,028 M gal (7,676 M liters) of water were pumped from the Great Miami Aquifer
- 673 pounds (306 kg) of total uranium were removed from the Great Miami Aquifer.

Ground Water Monitoring Results—Uranium concentrations within the footprint of the maximum uranium plume continue to decrease in response to pumping. Uranium concentration data collected during the second half of 2006 indicate that the maximum total uranium plume at the end of 2006 was approximately 7 acres smaller than at the end of 2005. This decrease was realized along the west side of the uranium plume in both the South Field and off site in the South Plume.

On-site Disposal Facility Monitoring—Leak detection monitoring continued in 2006 for cells 1 through 8. During 2006, no constituents sampled to meet on-site disposal facility monitoring requirements in the Great Miami Aquifer exceeded ground water FRLs. However, two non-uranium constituents (manganese and zinc), which were sampled to meet IEMP requirements, exceeded ground water FRLs. Data collected from the cells indicate that the liner systems are performing well within the specifications outlined in the approved cell design.

This chapter provides background information on the nature and extent of groundwater contamination in the Great Miami Aquifer due to past operations at the Fernald site and summarizes:

- Aquifer restoration progress.
- Groundwater monitoring activities and results for 2006.

Restoration of the affected portions of the Great Miami Aquifer and continued protection of the groundwater pathway are primary considerations in the groundwater remediation strategy for the Fernald site. The groundwater pathway will continue to be monitored following remediation to ensure the protection of this primary exposure pathway.

3.1 Summary of the Nature and Extent of Groundwater Contamination

Ground Water Modeling at the Fernald Site

The Fernald site uses a computer model to make predictions about how the concentration/location of contaminants in the aquifer will change over time. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with field measurements obtained from ground water monitoring activities.

If ground water monitoring data indicate the need for operational changes to the ground water remedy, the ground water model is run to predict the effect those changes might have on the aquifer and the contaminants. If the predictions indicate the proposed changes would increase cleanup efficiency and reduce the cleanup time and cost, the operational changes are made and monitoring data are collected after the changes to verify whether model predictions were correct. If model predictions prove to be incorrect, modifications are made to the model to improve its predictive capabilities.

The nature and extent of groundwater contamination from operations at the Fernald site were investigated and the risk to human health and the environment from those contaminants was evaluated in the Operable Unit 5 Remedial Investigation Report. As documented in that report, the primary groundwater contaminant at the site is uranium.

Groundwater contamination resulted from infiltration of contaminated surface water through the bed of Paddys Run, the storm sewer outfall ditch, the Pilot Plant drainage ditch, and the waste storage area ditch (previously located between the Plant 1 Pad and Paddys Run). In these areas, the glacial overburden is eroded, creating a direct pathway between surface water and the sand and gravel of the aquifer. To a lesser degree, groundwater contamination also resulted where past excavations (such as the waste pits) removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination.

3.2 Selection and Design of the Groundwater Remedy

While a remedial investigation and feasibility study was in progress and a groundwater remedy was being selected, off-property contaminated groundwater was being pumped from the South Plume area by the South Plume Removal Action System (referred to as the South Plume Module). In 1993, this system was installed south of Willey Road and east of Paddys Run Road to stop the uranium plume in this area from migrating any farther to the south. Figure 3–1 shows South Plume Module extraction wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

After the nature and extent of groundwater contamination was defined in the Operable Unit 5 Remedial Investigation Report, various remediation technologies were evaluated in the Feasibility Study Report for Operable Unit 5. Remediation cost, efficiency, and various land-use scenarios were considered during the development of the preferred remedy for restoring the quality of the groundwater in the aquifer. The Operable Unit 5 Feasibility Study Report recommended a concentration-based, pump-and-treat remedy for the groundwater contaminated with uranium, consisting of 28 groundwater extraction wells located on and off property. Computer modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gallons per minute (gpm) (15,140 liters per minute [Lpm]) would remediate the aquifer within 27 years.

The recommended groundwater remedy was presented to EPA, OEPA, and stakeholders in the *Proposed Plan for Operable Unit 5* (DOE 1995c) as the Preferred Groundwater Remedy. Once the proposed plan was approved, the Operable Unit 5 Record of Decision was presented to stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision formally defines the selected groundwater remedy and establishes FRLs for all constituents of concern.

Re-injection at the Fernald Site

From 1998 to 2004, re-injection was an enhancement to the ground water remedy at the Fernald site, supplementing pump-and-treat operations. The term "well-based" refers to the injection of treated ground water through specially designed re-injection wells. Ground water pumped from the aquifer was treated to remove contaminants and then re-injected into the aquifer at strategic well locations. Because the treatment process was not 100 percent efficient, a small amount of uranium was re-injected into the aquifer with the treated water. The re-injected ground water increased the speed at which dissolved contaminants moved through the aquifer and were pulled by extraction wells, thereby decreasing the overall remediation time. Based on updated ground water modeling and the unfavorable results of a cost/benefit analysis, well-based re-injection was discontinued in 2004.

The Operable Unit 5 Record of Decision commits to an ongoing evaluation of innovative remediation technologies so that remedy performance can be improved as such technologies become available. As a result of this commitment, an enhanced groundwater remedy was presented in the Operable Unit 5 *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)* (DOE 1997a).

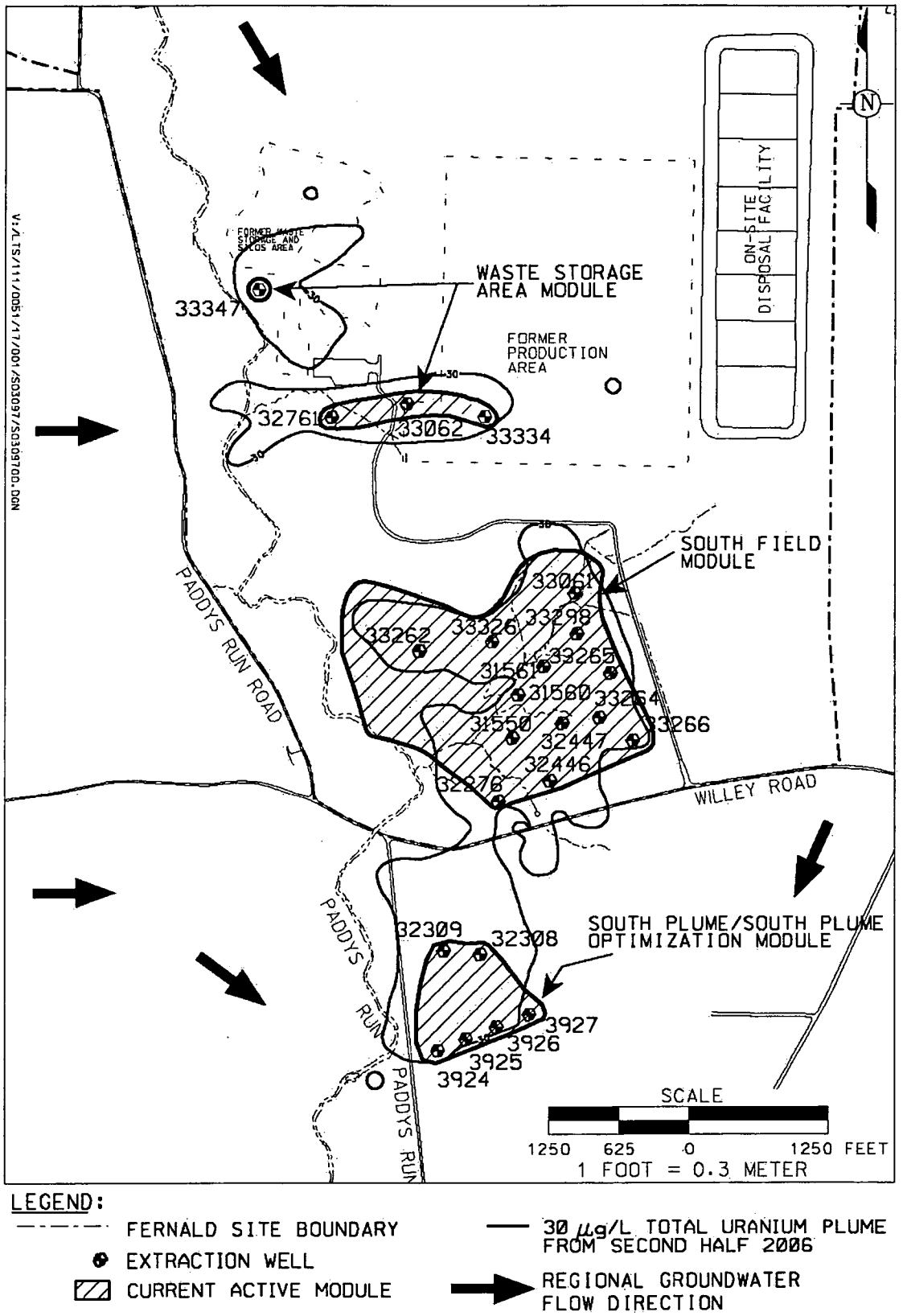

Figure 3–1. Extraction Wells Active in 2006

Groundwater modeling studies conducted in order to design the enhanced groundwater remedy suggested that, with the early installation of additional extraction wells and the use of re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy that relies on pump-and-treat and re-injection technology. The groundwater remedy included the use of well-based re-injection until September 2004.

Evolution of the enhanced groundwater remedy has been documented through a series of approved designs. These designs are: The *Operable Unit 5 Baseline Remedial Strategy Report,* Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a), *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001a), *Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module* (DOE 2002a), *Comprehensive Groundwater Strategy Report* (DOE 2003a), the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004), and the *Waste Storage Area Phase II Design Report* and Addendum (DOE 2005e).

The enhanced groundwater remedy commenced in 1998 with the start-up of the South Field (Phase I), the South Plume Optimization, and the Re-injection Demonstration Modules. It focuses primarily on the removal of uranium, but has also been designed to limit the further expansion of the plume, achieve removal of all targeted contaminants to concentrations below designated FRLs, and prevent undesirable groundwater drawdown impacts beyond the site's boundary. Start-up of the enhanced groundwater remedy included a year-long re-injection demonstration that was initiated in September 1998. Through the years, extraction and re-injection wells have been added to/removed from these initial restoration modules.

In 2001, the EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer in the waste storage and Plant 6 areas. Approval of this design initiated the installation of the next planned aquifer restoration module. The design specified three extraction wells in the waste storage area to address contamination in the Pilot Plant drainage ditch plume (Phase I) and two extraction wells to address the remaining contamination after the waste pits excavation was completed (Phase II). One of the three Phase I waste storage area wells was installed in 2000 to support an aquifer pumping test to help determine the restoration well field design. The remaining two Phase I wells were installed in the summer of 2001 after the design was approved by EPA and OEPA. All three wells became operational on May 8, 2002. One was abandoned in 2004 in order to facilitate site remediation work. A replacement well was installed and began operating in 2006.

The Design for Remediation of the Great Miami Aquifer in the waste storage and Plant 6 areas also provided data indicating that the uranium plume in the Plant 6 area was no longer present. It was believed that the uranium plume had dissipated to concentrations below the FRL as a result of the plant operations shutting down in the late 1980s, and the pumping of highly contaminated perched water as part of the Perched Water Removal Action No. 1 in the early 1990s. Because a uranium plume with concentrations above the groundwater FRL was no longer present in the Plant 6 area at the time of the design, a restoration module for the area was determined to be unnecessary. Groundwater monitoring continues in the Plant 6 area with one well in the area having sporadic total uranium FRL exceedances.

In 2002, the EPA and OEPA approved the next planned groundwater restoration design document, the Design for Remediation of the Great Miami Aquifer South Field (Phase II)

Module. The Phase II design presents an updated interpretation of the uranium plume in the South Field area along with recommendations on how to proceed with remediation in the area, based on the updated plume interpretation. Installation of Phase II components was initiated in 2002. The overall system (Phases I and II) is referred to as the South Field Module.

In 2003, groundwater remediation approaches were evaluated to determine the most cost-effective groundwater remedy infrastructure, including the wastewater treatment facility, to remain after site closure. An evaluation of alternatives was presented in the Comprehensive Groundwater Strategy Report. In October 2003, initial discussions were held with the regulators and the public concerning the various alternatives identified in the report. These discussions culminated in an identified path forward to work collaboratively with the Fernald Citizens Advisory Board, EPA, and OEPA to determine the most appropriate course of action for the ongoing aquifer restoration and water treatment activities at the Fernald site.

In 2004, a decision regarding the future aquifer restoration and wastewater treatment approach was made following regulatory and public input. In May, EPA and OEPA approved the decision to reduce the size of the advanced wastewater treatment facility; in June, they approved the decision to discontinue the use of well-based re-injection. Reducing the size of the advanced wastewater treatment facility provided the opportunity to dismantle and dispose of approximately 90 percent of the existing facility in the on-site disposal facility in time to meet the 2006 closure schedule. This resulted in a protective, more cost-effective, long-term water treatment facility to complete aquifer restoration. Well-based re-injection was discontinued based on groundwater modeling cleanup predictions presented in the *Comprehensive Groundwater Strategy Report* and the *Groundwater Remedy Evaluation and Field Verification Plan*. The updated modeling indicated that the aquifer restoration time frame would likely be extended beyond dates previously predicted due to refined modeling input. The updated modeling also indicated that continued use of the groundwater re-injection wells would shorten the aquifer remedy by approximately three years. Therefore, the benefit of continuing re-injection did not justify the cost. Well-based re-injection was discontinued in September 2004 to support construction of the converted advanced wastewater treatment facility. All re-injection wells remain in place as potential groundwater remedy performance monitoring locations.

In 2005, the *Waste Storage Area Phase II Design Report* was issued. Comments received from EPA and OEPA resulted in the issuance of an addendum to the report in December 2005. The design consisted of the installation of one more extraction well in the waste storage area, near the former silos area.

In 2005, an infiltration test was conducted in the storm sewer outfall ditch. The test consisted of gauging the flow into and out of the storm sewer outfall ditch with six Parshall flumes. This was done so that the overall infiltration rate along the storm sewer outfall ditch could be obtained. Findings from the test were included in the *Storm Sewer Outfall Ditch Infiltration Test Report* (DOE 2005d). The decision was made that natural storm water flow into the storm sewer outfall ditch will be supplemented with pumped clean groundwater.

The Fernald Groundwater Certification Plan was issued and approved by EPA in 2005. Ohio EPA approved Revision 2 of the plan in 2006. Revision 2 addressed comments that the Ohio EPA had on the 2005 submittal. The certification plan defines a programmatic strategy for certifying completion of the aquifer remedy. It was developed through a series of four technical information exchange meetings held in 2005 among DOE, EPA, and OEPA. The Fernald

Groundwater Certification Plan identifies that the IEMP will continue to be the plan that includes remedy performance monitoring requirements.

In 2006, the Waste Storage Area Phase II Module components became operational, marking completion of the groundwater remediation system design. Completion of the Waste Storage Area Phase II Module brings the total number of extraction wells in the Waste Storage Area to four.

On December 14, 2006 the site began pumping clean groundwater from three existing construction wells located on the east side of the Fernald site to the former storm sewer outfall ditch (SSOD). This water is being pumped as needed to maintain a flow of approximately 500 gpm (1,890 Lpm) into the former SSOD. Pumping will continue until the existing wells, pumps, or motors are no longer serviceable. At that time the operation will be suspended, pending a determination by DOE regarding the benefits to the aquifer remedy. Also, with the completion of site soil remediation, surface water runoff from the Former Production Area is being directed to the former SSOD.

Figure 3–1 shows the extraction well locations that were active in 2006. The operational information associated with these modules is presented in the following subsections.

3.3 Groundwater Monitoring Highlights for 2006

For this annual site report, groundwater monitoring results are discussed in terms of restoration and compliance monitoring.

The key elements of the Fernald site groundwater monitoring program design are described below.

- **Sampling** – Sample locations, frequency, and constituents were selected to address operational assessment, restoration assessment, and compliance requirements. Selected wells are monitored for up to 50 groundwater FRL constituents. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3–2 shows a typical groundwater monitoring well at the site, and Figure 3–3 identifies the relative placement depths of groundwater monitoring wells at the site.
- As part of the comprehensive groundwater monitoring program specified in the IEMP (Revision 4B), approximately 140 wells were monitored for water quality in 2006. Figures 3–4 and 3–5 identify the locations of the current water quality monitoring wells. In addition to water quality monitoring, approximately 180 wells were monitored quarterly for groundwater elevations to determine groundwater flow direction. Figure 3–6 depicts the routine water level (groundwater elevation) monitoring wells, including extraction wells, as specified in the IEMP (Revision 4B).
- **Data Evaluation** – The integrated data evaluation process involves review and analysis of the data collected from wells to determine capture and restoration of the uranium plume; capture and restoration of non-uranium FRL constituents; water quality conditions in the aquifer that indicate a need to modify the design and installation of restoration modules; and the impact of ongoing groundwater restoration on the Paddys Run Road Site plume (a separate contaminant plume unrelated to the Fernald site, resulting from industrial activities in the area located south of the Fernald site along Paddys Run Road).
- **Reporting** – All data are reported in the annual site environmental reports.

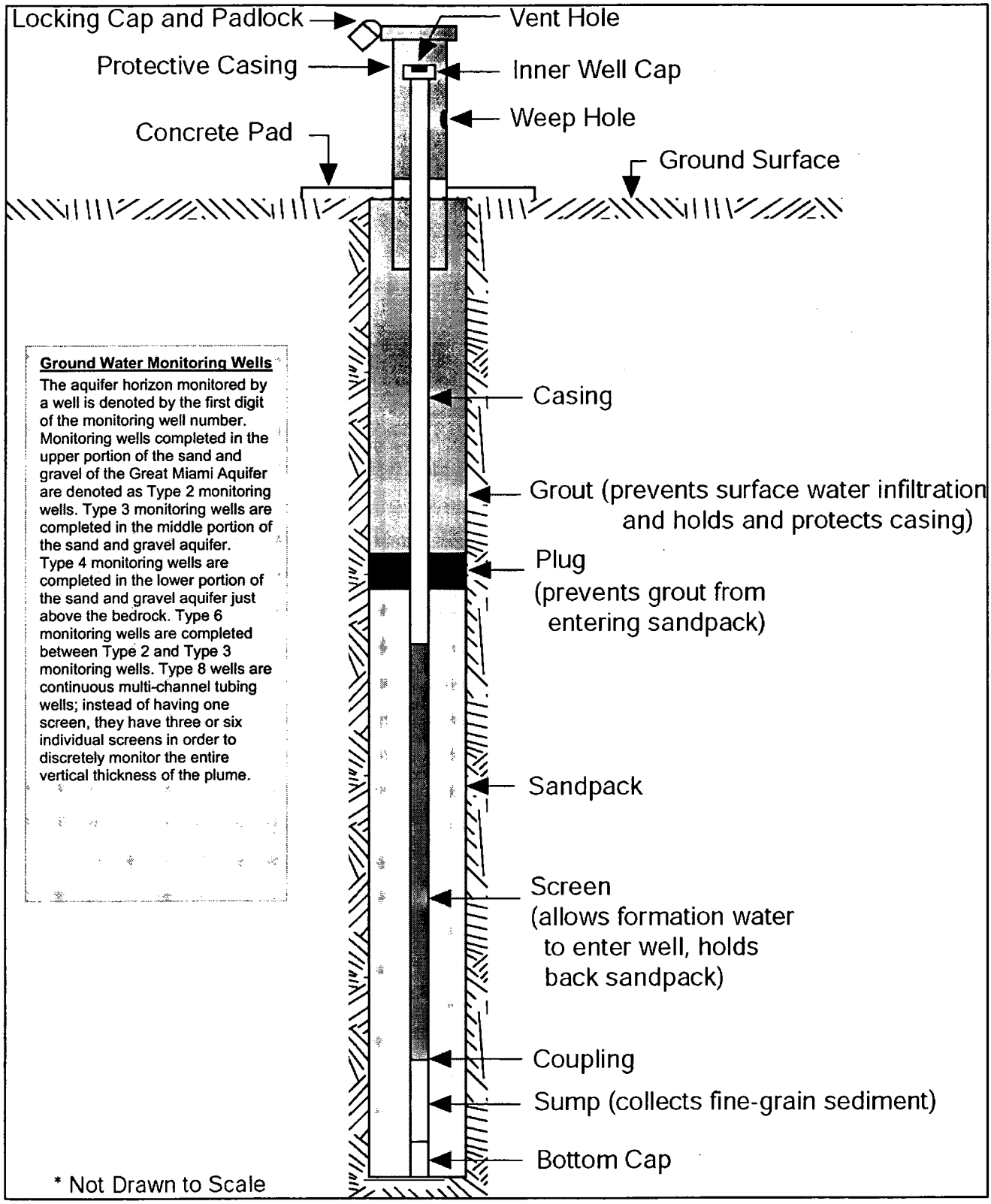

Figure 3–2. Diagram of a Typical Groundwater Monitoring Well

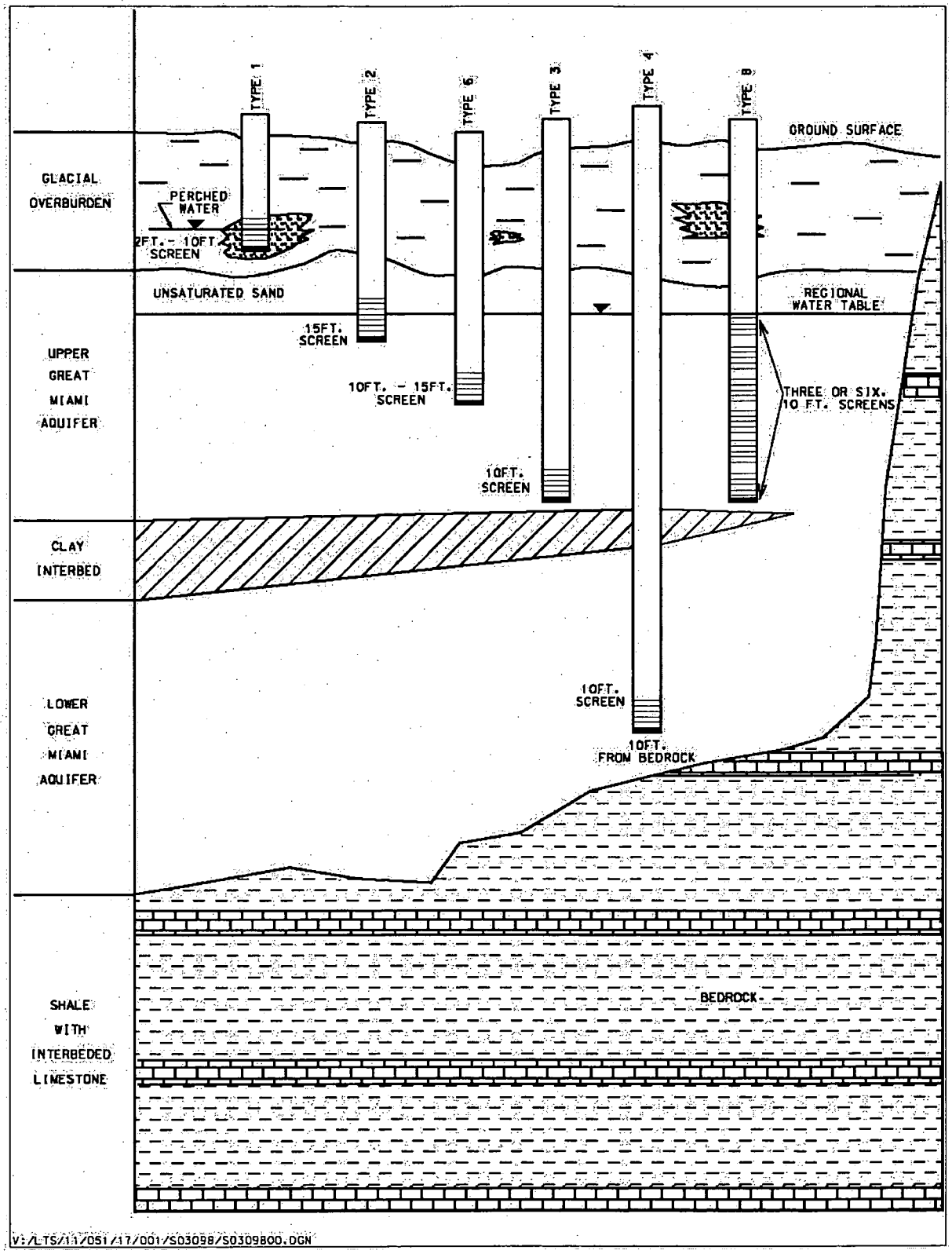

Figure 3–3. Monitoring Well Relative Depths and Screen Locations

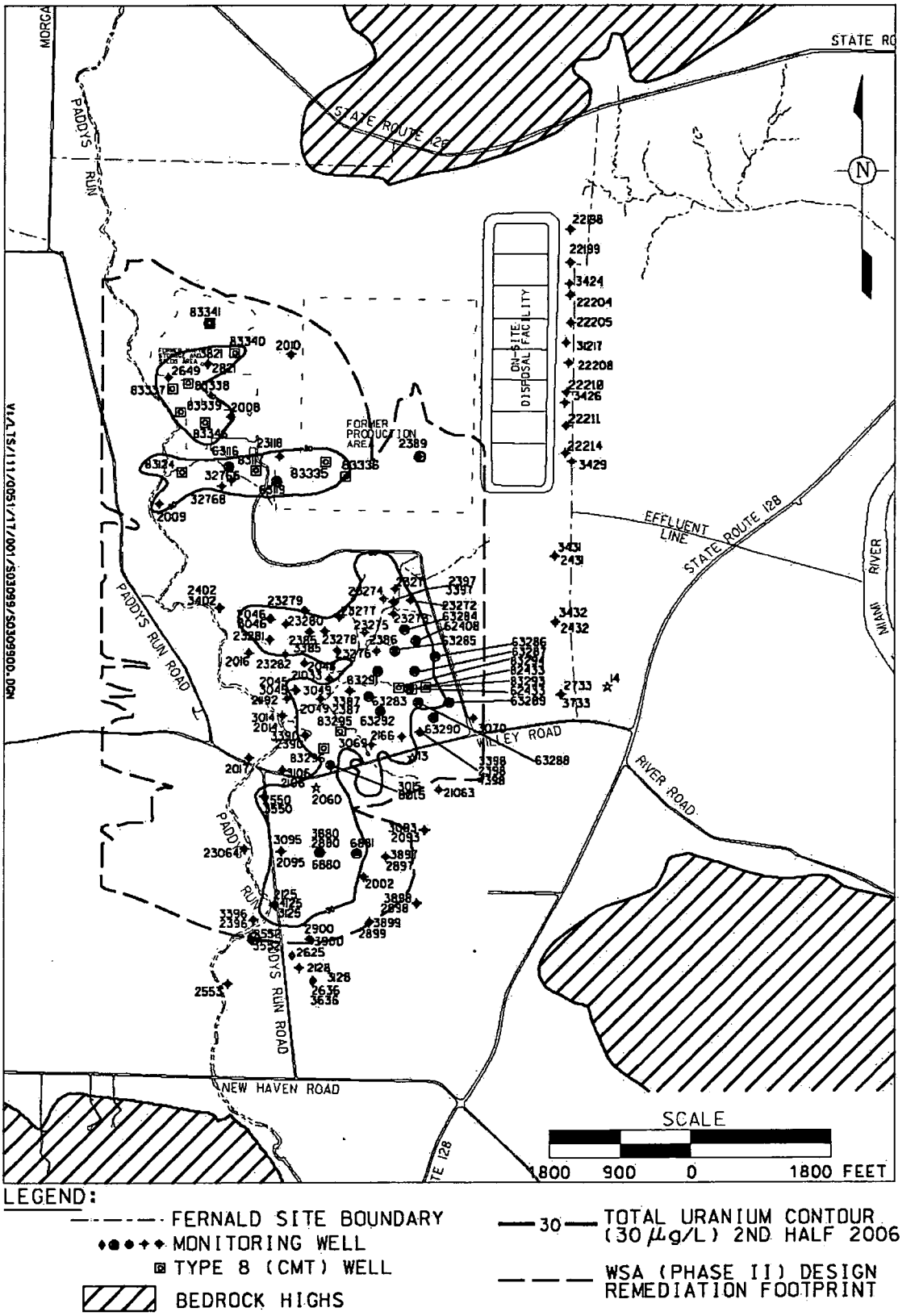

Figure 3–4. Locations for Semiannual Total Uranium Monitoring

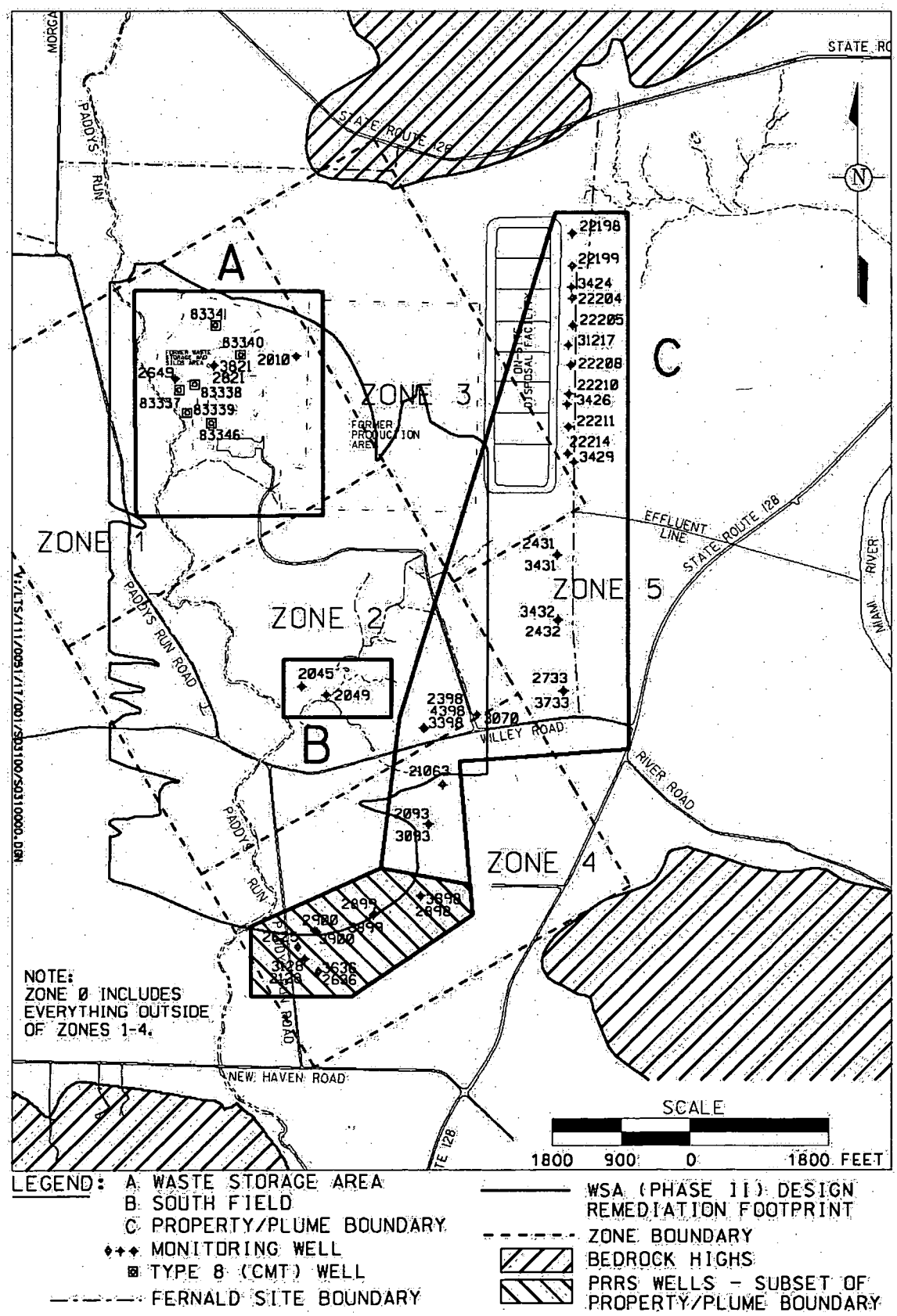

Figure 3–5. Locations for Semiannual Non-Uranium Monitoring

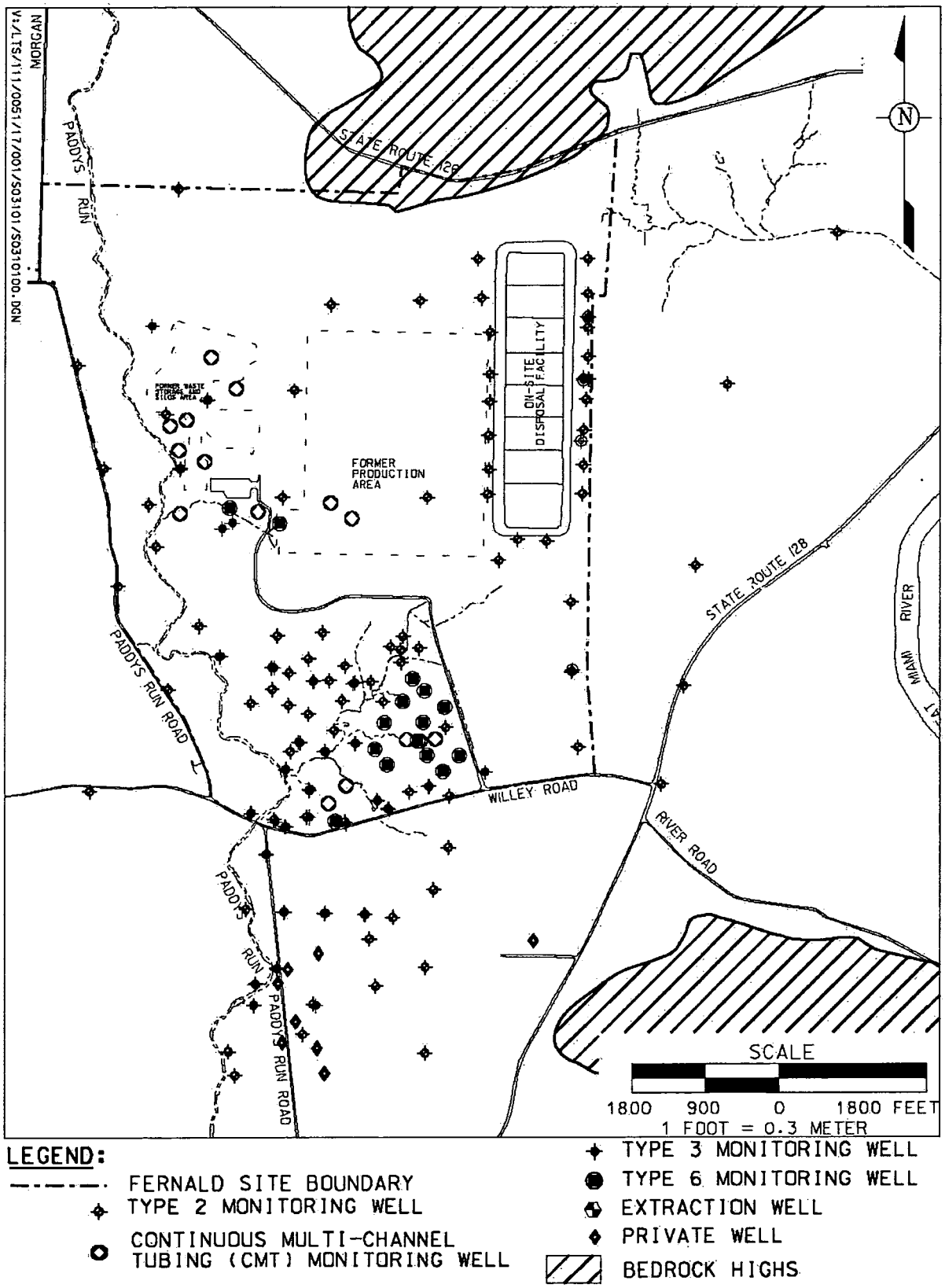

Figure 3–6. IEMP Groundwater Elevation Monitoring Wells

3.3.1 Restoration Monitoring

In general, restoration monitoring tracks the progress of the groundwater remedy and water quality conditions. All operational modules are evaluated during the year to determine the progress of aquifer remediation. Uranium concentration maps are developed from analytical data and compared with groundwater elevation maps depicting the location of capture zones.

More detailed information can be found in Appendix A. Subsections that follow identify the specific attachment of Appendix A where the detailed information can be found.

3.3.1.1 Operational Summary

Figure 3–1 shows the extraction well locations associated with the restoration modules operating in 2006. All wells currently planned for the groundwater remedy have been installed. Table 3–1 summarizes the pounds of uranium removed and the volume of groundwater pumped during 2006. Several operational disruptions were necessary during 2006 to facilitate site remediation. Additional details are provided in the module operational summaries in Sections 3.3.1.2 through 3.3.1.4. Figure 3–7 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 2006.

Since 1993:

- 20,370 M gal (77,100 M liters) of water have been pumped from the Great Miami Aquifer.
- 1,936 M gal (7,328 M liters) of treated water have been re-injected into the Great Miami Aquifer.
- 7,796 net lb (3,539 kg) of total uranium have been removed from the Great Miami Aquifer.

Appendix A, Attachment A.1, provides detailed operational information on each extraction and re-injection well. The following sections provide an overview of the individual modules.

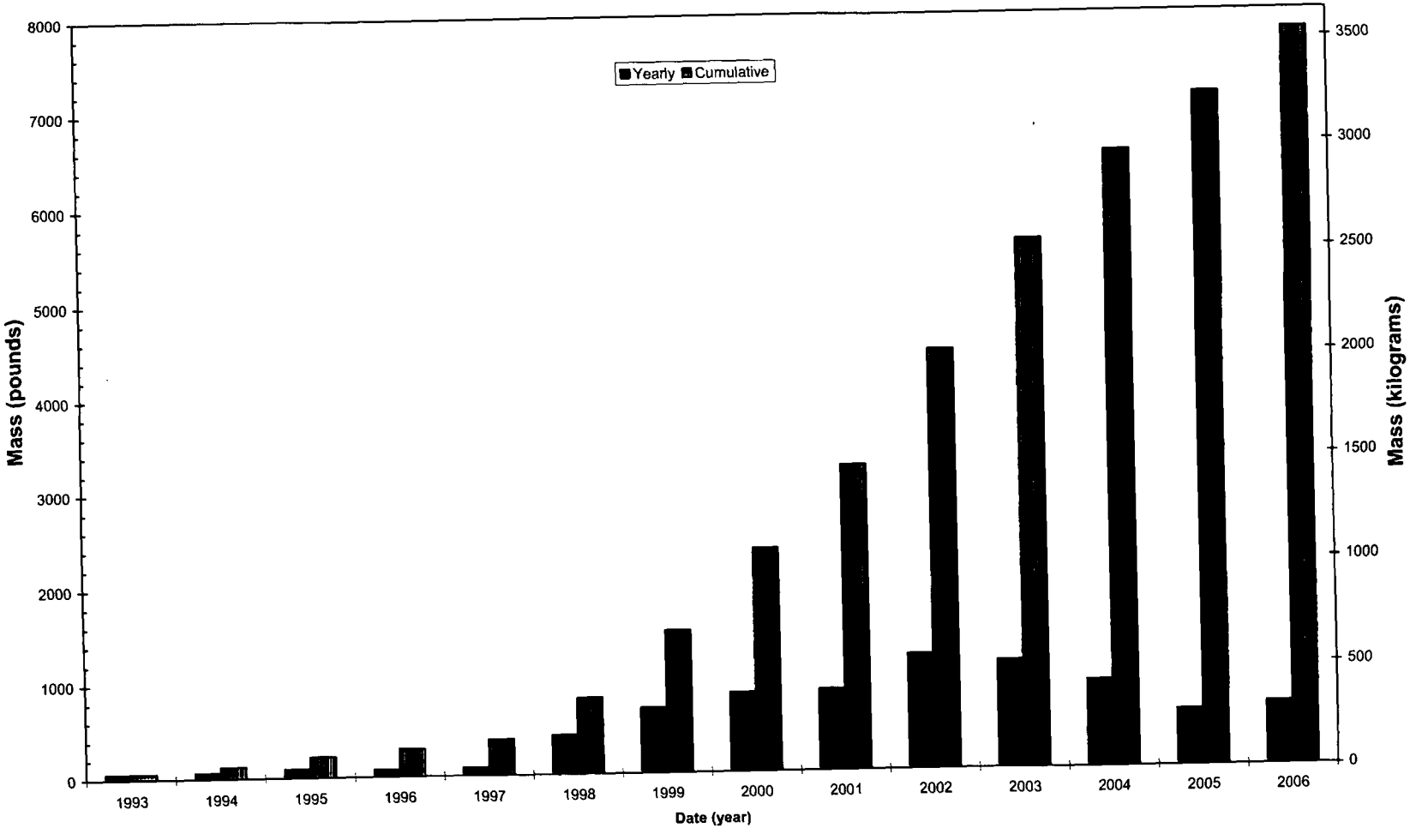

Figure 3–7. Net Pounds of Uranium Removed from the Great Miami Aquifer, 1993–2006

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Table 3–1. Groundwater Restoration Module Status for 2006

Modules & Restoration Wells	Target Pumping		Volume Pumped (Millions)		Uranium Removed	
	gpm	Lpm	gallons	liters	lbs	kg
South Plume	1,400	5,299	583	2,207	111	50
South Field Module: 31550, 31560, 31561, 31567[a], 32276, 32446, 32447, 33061, 33262, 33264, 33265, 33266, 33298, 33326[a]	2,575	9,746	1,105	4,182	424	193
Waste Storage Area Module[b]: 32761, 33062, 33334, 33347	1000	3,785	339	1,283	138	63
Aquifer Restoration System Total Pumped	4,975	18,830	2,027	7,672	673	306

[a]Extraction well 31567 began operating in July 1998. Extraction Well 33326 replaced this well in September 2005.
[b]Extraction wells 33334 and 33347 became operational in 2006

3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

The four extraction wells (3924, 3925, 3926, and 3927) of the South Plume Module began operating in August 1993. The two extraction wells (32308 and 32309) of the South Plume Optimization Module began operating in August 1998. Figure 3–8 illustrates the uranium plume capture observed for the South Plume/South Plume Optimization Module in the fourth quarter of 2006.

During 2006, 583 M gal (2,207 M liters) of groundwater and 111 lb (50 kg) of uranium were removed from the Great Miami Aquifer by the South Plume/South Plume Optimization Module. Based on analysis of the data collected in 2006, the module continues to meet its primary objectives as demonstrated by the following:

- Southward movement of the uranium plume beyond the southern most extraction wells has not been detected.
- Active remediation of the central portion of the off-property uranium plume continues to reduce plume concentration. Nearly the entire off-property uranium plume concentration is now below 100 µg/L. When pumping began in 1993, areas in the off-property uranium plume had concentrations over 300 µg/L.
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

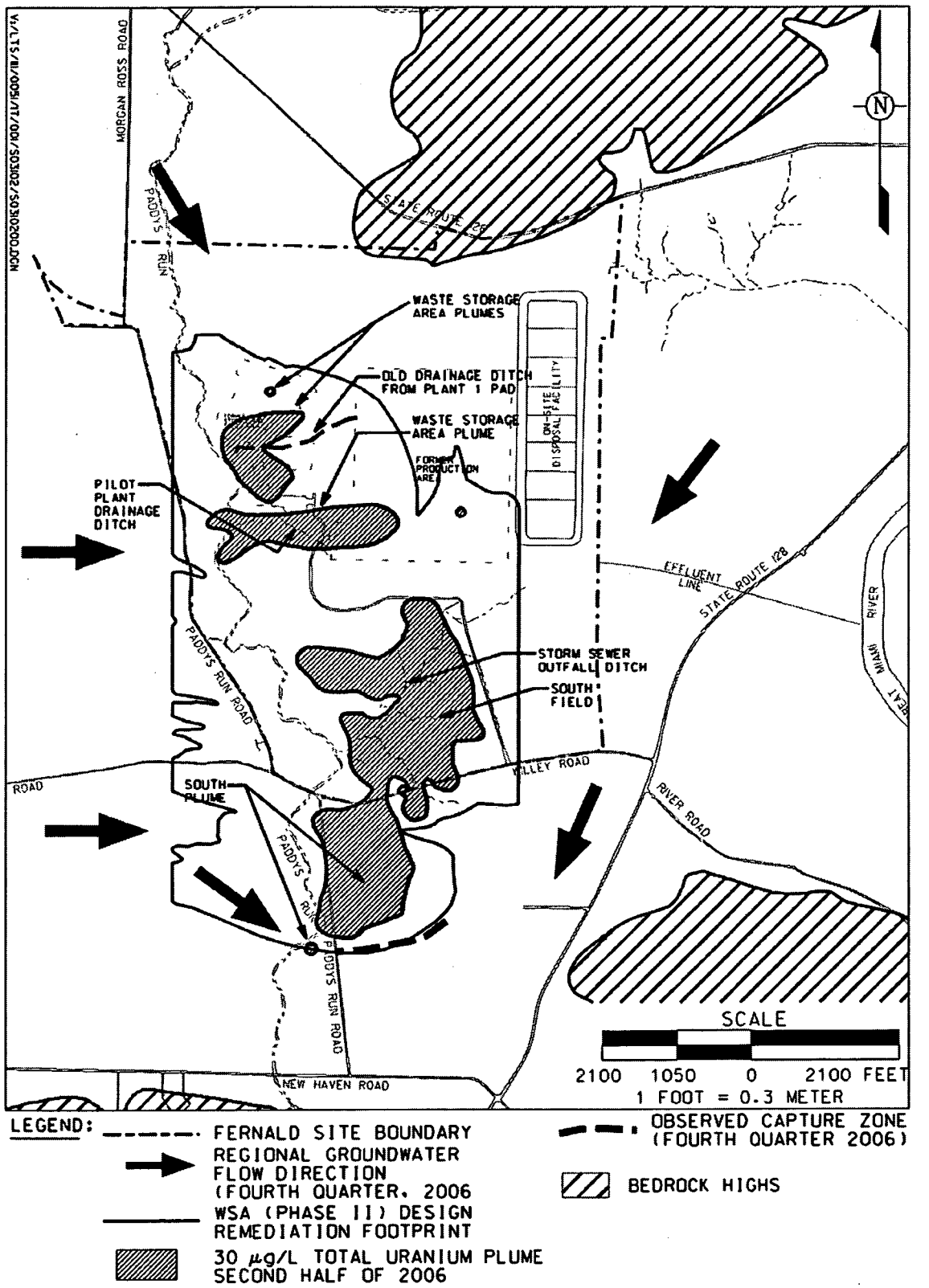


Figure 3–8. Total Uranium Plume in the Aquifer With Concentrations Greater than 30 µg/L at the End of 2006

3.3.1.3 South Field Module Operational Summary

The South Field Module was constructed in two phases. Phase I began operating in July 1998 and Phase II began operating in July 2003. During 2006, 13 extraction wells were operational.

The 10 original extraction wells installed under Phase I were 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276. Six of the original 10 wells have been shutdown (31564, 31565, 31566, 31563, 31562, and 31567).

- Extraction wells 31564 and 31565 were shut down in December 2001 and May 2001, respectively, to accommodate soil remedial activities.
- Extraction well 31566 was shut down in August 1998 and was replaced by extraction well 33262, which was installed as part of South Field (Phase II) Module.
- Extraction well 31563 was shut down in December 2002 and converted to a re-injection well that began operating in 2003.
- Extraction well 31562 was shut down in March 2003 and replaced by extraction well 33298.
- Extraction well 31567 was shut down in September of 2005 and replaced by extraction well 33326.

Three new extraction wells (32446, 32447, and 33061) were added to the South Field Module between 1998 and 2002. These new wells were installed in the eastern, downgradient portion of the South Field plume, at locations where total uranium concentrations were considerably above the FRL. Two of these three wells (32446 and 32447) were installed in late 1999 and began pumping in February 2000. The third extraction well (33061) was installed in 2001, and became operational in 2002.

Phase II components of the South Field Module are described in the Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module, which was issued in May 2002. The design provides an updated characterization of the uranium plume in the Great Miami Aquifer beneath the southern portion of the site and a modeled design for the South Field Module located in that area. All Phase II design components became operational in 2003. The components include:

- Four additional extraction wells, one in the Southern Waste Units area (extraction well 33262) and three along the eastern edge of the on-property portion of the southern uranium plume (extraction wells 33264, 33265, and 33266).
- One additional re-injection well in the Southern Waste Units area (re-injection well 33263).
- A converted extraction well (31563) that was converted into a re-injection well.
- An injection pond that is located in the western portion of the Southern Waste Units excavations.

South Field Module re-injection components were shut down in September 2004.

During 2006, 1,105 M gal (4,182 M liters) of groundwater and 424 lb (193 kg) of uranium were removed from the Great Miami Aquifer by the South Field Module.

3.3.1.4 Waste Storage Area (Phase I) Module Operational Summary

The Waste Storage Area Module became operational on May 8, 2002, nearly 17 months ahead of the October 1, 2003 start date established in the Operable Unit 5 Remedial Action Work Plan. The module consisted of three extraction wells (32761, 33062, and 33063). These three wells were installed to remediate a uranium plume in the Pilot Plant drainage ditch area, according to the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas. In July 2004, extraction well 33063 was plugged and abandoned to make way for surface excavation activities. Additionally, monitoring wells 83120, 83123, 63121, and 63122 were also plugged and abandoned in 2004 to make way for remedial excavation activities. The remaining two extraction wells in the Waste Storage Area Module were shut down at the end of September 2004 for preventive maintenance, and from October 2004 through March 2005 to facilitate construction of the converted advanced wastewater treatment facility. A replacement well for extraction well 33063 was installed in 2005 (extraction well 33334) and became operational June 29, 2006. Additional monitoring wells were installed in 2005 to replace those that were plugged and abandoned. The final extraction well in the waste storage area (extraction well 33347) was installed and become operational on October 5, 2006. During 2006, 339 M gal (1,283 M liters) and 138 lb (63 kg) of uranium were removed from the Great Miami Aquifer through the Waste Storage Area Module.

The Waste Storage Area (Phase II) Design remediation footprint illustrates how far a particle of water will travel in response to pumping over the time period modeled for the Waste Storage Area (Phase II) Design. It replaces the 10-year, uranium-based restoration footprint that was used in the 2005 SER.

3.3.1.5 Monitoring Results for Total Uranium

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant and it has impacted the largest area of the aquifer. Figure 3–8 shows general groundwater flow directions observed during the fourth quarter of 2006, and the interpretation of the uranium plume in the aquifer updated through the end of 2006. The shaded areas represent the interpreted size of the maximum uranium plume that is above the 30 µg/L groundwater FRL for total uranium. At the end of 2006, approximately 189 acres (76 hectares) of the Great Miami Aquifer were contaminated above the 30 µg/L groundwater FRL for total uranium. This represents a decrease of 7.1 acres from the size of the plume at the end of 2005. The decrease was realized along the western trailing edge of the uranium plume in the South Field and off property in the South Plume. Capture zones observed during the fourth quarter of 2006 for the active restoration modules are also identified in Figure 3–8. The man indicates that the South Plume is being captured by the existing system and that further movement of uranium to the south of the extraction wells is being prevented. Figure 3–8 also depicts the time-of-travel remediation footprint that was predicted by modeling the Waste Storage Area (Phase II) Remediation Design.

Geoprobe® (Direct-Push Sampling)
The Geoprobe, a hydraulically powered, direct-push sampling tool, is used at the Fernald site to obtain ground water samples at specific intervals without installing a permanent monitoring well. Direct-push means that the tool employs the weight of the vehicle it is mounted on and percussive force to push into the ground without drilling (or cutting) to displace soil in the tool's path. The Fernald site uses this technique to collect data on the progress of aquifer restoration and to determine the optimal location and depth of additional monitoring and extraction wells that may be installed in the future.

Waste Storage Area – In 2006 one new extraction well and six new groundwater monitoring wells were installed in the Waste Storage Area as part of the Waste Storage Area (Phase II) design. One new uranium FRL exceedance was measured in a new monitoring well that was installed off of the northeast corner of former waste pit 3. This new exceedance is mapped as a separate area of contamination in the Waste Storage Area; north of the larger plume. Figure 3–8 shows the new outline of the maximum uranium plume.

Plant 6 Area – Plans for a restoration module in the Plant 6 area were dropped in 2001 based on the outcome of the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Area. This design provided data that indicated that the total uranium plume in the Plant 6 area was no longer present. The EPA and OEPA concurred with this decision.

Subsequent to the decision not to install a remediation system of extraction wells at Plant 6, a thin layer of uranium contamination has been detected in the upper foot of the aquifer at monitoring well 2389. As discussed in past SERs, this thin layer of contamination is evident at monitoring well 2389 where sporadic uranium FRL exceedances have been detected since 2002. Monitoring in 2006 provides an update on the uranium exceedance in this well.

Monitoring well 2389 is the only groundwater monitoring well remaining in the area where Plant 6 was located. All other monitoring wells were plugged and abandoned as part of source removal activities. Monitoring well 2389 was the only monitoring well experiencing sporadic uranium FRL exceedances in the Plant 6 area. As reported in the 2005 SER, it appears that a thin layer of contamination is present in the upper 12 inches of the aquifer. In April 2006, an unfiltered sample and duplicate had a uranium concentration of 30.1 µg/L and 30.9 µg/L respectively. Other samples collected in 2006 from this well had uranium concentrations were below the groundwater FRL. It is expected that over time the uranium concentration at this monitoring well will decrease on its own. Monitoring will continue, and additional direct-push sampling will be conducted in this area when deemed appropriate.

South Field and South Plume Areas – Data collected in 2006 indicate that uranium concentrations continue to decrease in the South Field and South Plume areas in response to remediation activities. Additional direct-push sampling conducted in 2006 focused at re-defining the western edge of the uranium plume. This new data was used to reduce the size of the mapped maximum uranium plume in the South Field and South Plume by approximately 7 acres, compared to the size of the plume that was mapped for the second half of 2005.

Appendix A, Attachment A.2, provides individual monitoring well total uranium results and detailed uranium plume maps for 2006. Appendix A, Attachment A.3, provides quarterly groundwater elevation maps and capture zone interpretations, along with graphical displays of groundwater elevation data.

3.3.1.6 Monitoring Results for Non-Uranium Constituents

Although the groundwater remedy is primarily targeting remediation of the uranium plume, other FRL constituents contained within the uranium plume are also being monitored. Figure 3–9 identifies the locations of the wells that had non-uranium FRL exceedances. Table 3–2 shows the number of wells exceeding FRLs in 2006; the number of wells exceeding FRLs outside the Waste Storage Area (Phase II) remediation footprint; the groundwater FRLs; and the range of 2006 data inside or outside the Waste Storage Area (Phase II) remediation footprint.

Table 3–2. Non-Uranium Constituents With Results Above Final Remediation Levels During 2006

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the Waste Storage Area (Phase II) Remediation Footprint	Groundwater FRL	Range of 2005 Data Inside the Waste Storage Area (Phase II) Remediation Footprint[a]	Range of 2005 Data Outside the Waste Storage Area (Phase II) Remediation Footprint[a]
General Chemistry			(mg/L)	(mg/L)	(mg/L)
Nitrate/Nitrite	3	0	11b	11.6 to 47.5	NA
Inorganics					
Manganese	4	1	0.90	0.998 to 5.72	1.10 to 3.01
Molybdenum	1	0	0.10	0.404 to 0.687	NA
Zinc	1	1	0.021	NA	0.0228 to 0.0306
Volatile Organics			(µg/L)	(µg/L)	(µg/L)
Trichloroethene	1	0	5.0	68.6 to 82.2	NA
Radionuclides			(pCi/L)	(pCi/L)	(pCi/L)
Technetium-99	2	0	94	140 to 849	NA

[a]NA = not applicable
[b]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for nitrate/nitrite.

During 2006, non-uranium FRL exceedances were observed at 7 monitoring well locations as shown in Figure 3–9. A total of 6 non-uranium FRL constituents exceeded FRLs in monitoring wells in 2006.

The exceedance locations along the eastern Fernald site boundary are outside the Waste Storage Area (Phase II) remediation footprint. No plumes for the non-uranium above-FRL constituents at the locations outside the Waste Storage Area (Phase II) remediation footprint were identified in the extensive groundwater characterization efforts evaluated as part of the Remedial Investigation Report for Operable Unit 5.

The non-uranium constituents with FRL exceedances at the well locations outside the Waste Storage Area (Phase II) remediation footprint were further evaluated to determine whether they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment A.4. One of the exceedances in 2006 is classified as persistent (manganese at monitoring well 22204). In past years, exceedances identified as persistent became non-persistent in later years. Continued monitoring will occur to determine if additional actions are warranted beyond the current aquifer remedy design.

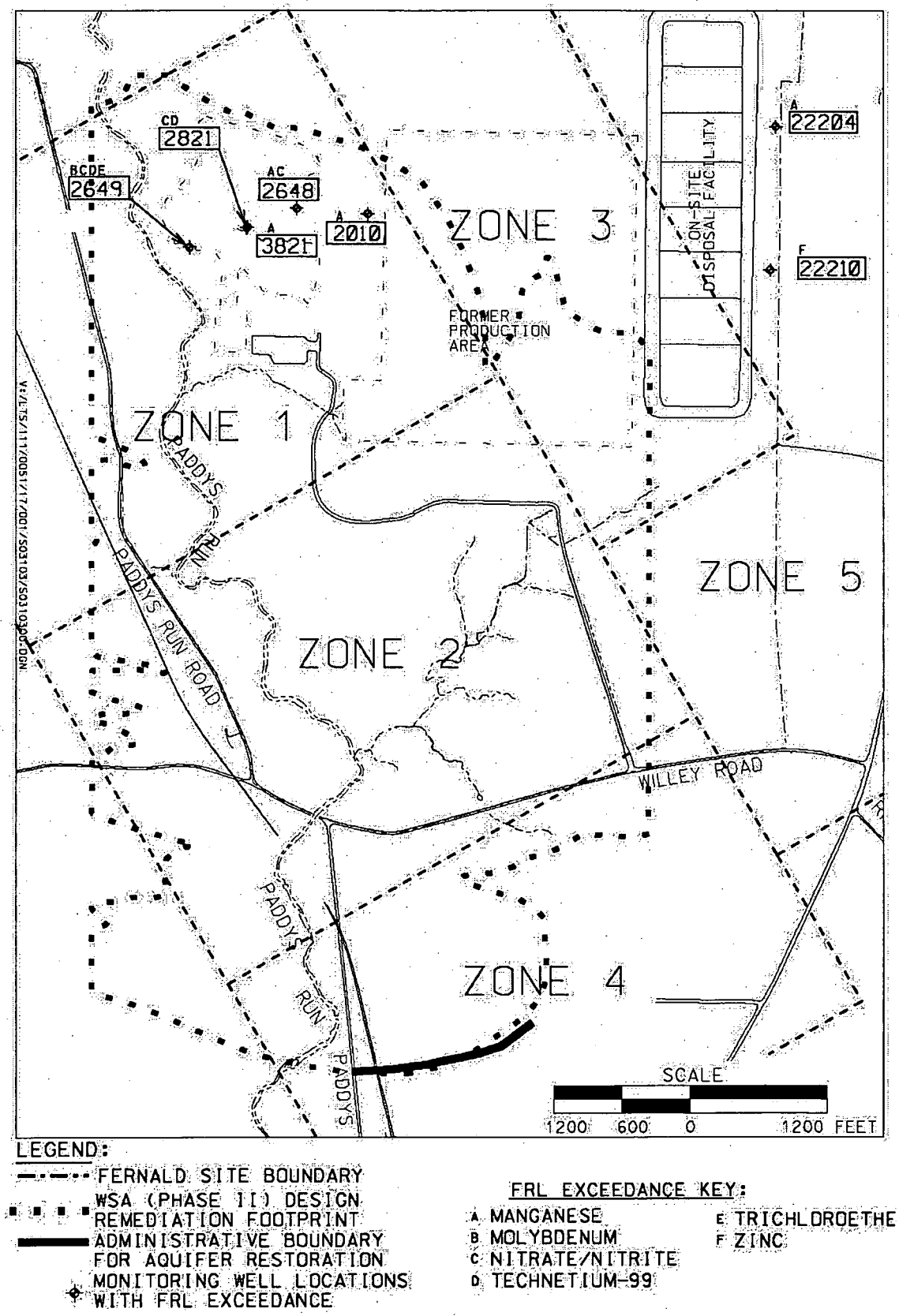


Figure 3–9. Non-Uranium Constituents With 2006 Results Above Final Remediation Levels

3.3.2 Other Monitoring Commitments

Two other groundwater monitoring activities are included in the IEMP: private well monitoring and property boundary monitoring.

As stated earlier, the groundwater data from these activities, along with the data from all other IEMP groundwater monitoring activities, are collectively evaluated for total uranium and, where necessary, non-uranium constituents of concern. The discussion that follows provides additional details on the two compliance monitoring activities.

The three private wells (monitoring wells 2060 [12], 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the uranium plume migration (for well locations, refer to Figure 2–2 in Chapter 2). It was at one of these private wells that off-property groundwater contamination was initially detected in 1981. Monitoring stopped at the other private wells in 1997 because a DOE-sponsored public water supply became available to Fernald site neighbors who were affected by off-property groundwater contamination.

The availability of the public water supply resulted in the discontinuation of monitoring at many private wells in off-property areas. Data from the three private wells sampled under the IEMP were incorporated into the uranium plume map shown in Figure 3–8.

During 2006, Property/Plume Boundary Monitoring was comprised of 36 monitoring wells located downgradient of the Fernald site, along the eastern and southern portions of the property boundary. Twenty-five wells were monitored along the eastern Fernald site boundary and slightly downgradient of the South Plume to determine if any contaminant excursions were occurring. Eleven Type 2 and Type 3 wells were sampled in the Paddys Run Road Site area to document the influence, or lack thereof, that pumping in the South Plume was having on the Paddys Run Road Site Plume. Data from the property/plume boundary wells were integrated with other groundwater data for 2006 and were incorporated into the uranium plume maps shown in Figure 3–8 and in Attachment A.2. Non-uranium data from these wells were included in Section 3.3.1.6.

As indicated in Chapter 2, the Director's Findings and Orders were issued by OEPA on September 7, 2000. These orders specify that the site's groundwater monitoring activities will be implemented in accordance with the IEMP. The revised language allows modification of the groundwater monitoring program as necessary, via the IEMP revision process (subject to OEPA approval), without issuance of a new Director's Order. As determined by OEPA, the IEMP will remain in effect following remediation.

3.4 On-site Disposal Facility Monitoring

Groundwater monitoring of the on-site disposal facility cells is conducted in the glacial till (perched water) and in the Great Miami Aquifer. Groundwater monitoring in support of the on-site disposal facility continued in 2006.

This monitoring program is designed to accomplish the following:

- Establish a baseline of groundwater conditions in the perched groundwater and the Great Miami Aquifer beneath each cell of the on-site disposal facility. The baseline data will be used to evaluate future changes in perched groundwater and Great Miami Aquifer groundwater quality to help determine if the changes are due to on-site disposal facility operations.

- Continue routine groundwater sampling following waste placement and cell capping as part of the comprehensive leak detection monitoring program for the on-site disposal facility. This information will be used to help verify the ongoing performance and integrity of the on-site disposal facility.

Table 3–3 summarizes the groundwater, leachate collection system, and leak detection system monitoring information associated with the on-site disposal facility. Table 3–3 provides information for cells 1 through 8 along with sample information and range of total uranium concentrations.

In 2006, monitoring continued for cells 1 through 8. During 2006, no constituents sampled to meet on-site disposal facility monitoring requirements exceeded groundwater FRLs. However, two non-uranium constituents (manganese and zinc), which are sampled to meet IEMP requirements, exceeded groundwater FRLs at monitoring well 22204 (manganese) and monitoring well 22210 (zinc), as identified in Section 3.3.1.6.

The final on-site disposal facility has a capacity of 2.96 million yd^3 (2.26 million m^3); a maximum height of approximately 65 ft (20 m); and covers an area of approximately 90 acres (36 hectares). It is located in the northeastern corner of the Fernald site. At the end of 2006, approximately 2.96 million in-place yd^3 (2.26 million m^3) of waste were placed in the on-site disposal facility, of which approximately 202,061 in-place yd^3 (154,487 m^3) of waste (including excavated material, debris, etc.) were placed in cells 7 and 8 of the on-site disposal facility. Cells 1 through 6 were 100 percent full and capped by the end of 2005. Cells 7 and 8 were filled to capacity and the final cover system construction was completed by October 2006.

Figure 3–10 identifies the on-site disposal facility footprint and monitoring well locations for cells 1 through 8. For additional information on the groundwater leak detection and leachate sampling results for the on-site disposal facility, refer to Appendix A, Attachment A.5.

Table 3–3. On-Site Disposal Facility Groundwater, Leachate, and Leak Detection System Monitoring Summary

Cell (Waste Placement Start Date)	Monitoring Location	Monitoring Zone	Date Sampling Started	Total Number of Samples	Range of Total Uranium Concentrations[a] (µg/L)
Cell 1 (December 1997)	12338C	Leachate Collection System	February 17, 1998	36	ND – 142
	12338D	Leak Detection System	February 18, 1998	33	1.5 – 23.2
	12338	Glacial Till	October 30, 1997	56	ND – 19
	22201	Great Miami Aquifer	March 31, 1997	51	ND – 8.33
	22198	Great Miami Aquifer	March 31, 1997	76	0.577 – 15.2
Cell 2 (November 1998)	12339C	Leachate Collection System	November 23, 1998	32	4.51 – 197
	12339D	Leak Detection System	December 14, 1998	20	4.08 – 22.3[b]
	12339	Glacial Till	June 29, 1998	55	ND – 9.13
	22200	Great Miami Aquifer	June 30, 1997	46	ND – 1.11
	22199	Great Miami Aquifer	June 25, 1997	53	ND– 12.1
Cell 3 (October 1999)	12340C	Leachate Collection System	October 13, 1999	29	9.27 – 83.7
	12340D	Leak Detection System	August 26, 2002	16	12.5 – 27.7[b]
	12340	Glacial Till	July 28, 1998	48	ND – 29.3
	22203	Great Miami Aquifer	August 24, 1998	44	ND – 7.92
	22204	Great Miami Aquifer	August 24, 1998	50	ND – 14.3
Cell 4 (November 2002)	12341C	Leachate Collection System	November 4, 2002	15	4.41 – 165
	12341D	Leak Detection System	November 4, 2002	16	5.74 – 21.3
	12341	Glacial Till	February 26, 2002	28	4.89 – 7.91
	22206	Great Miami Aquifer	November 6, 2001	32	ND – 5.78
	22205	Great Miami Aquifer	November 5, 2001	39	0.446 – 19.7
Cell 5 (November 2002)	12342C	Leachate Collection System	November 4, 2002	17	3.39 – 285
	12342D	Leak Detection System	November 4, 2002	15	2.93 – 24.4
	12342	Glacial Till	February 26, 2002	29	7.45 – 21.1
	22207	Great Miami Aquifer	November 6, 2001	32	ND – 4.48
	22208	Great Miami Aquifer	November 5, 2001	39	ND – 2.1
Cell 6 (November 2003)	12343C	Leachate Collection System	October 27, 2003	14	8.03 – 197
	12343D	Leak Detection System	October 27, 2003	13	3.1 – 29.5
	12343	Glacial Till	March 14, 2003	22	ND – 10.9
	22209	Great Miami Aquifer	December 16, 2002	27	ND – 2.43
	22210	Great Miami Aquifer	December 16, 2002	31	ND – 1.02
Cell 7 (September 2004)	12344C	Leachate Collection System	September 2, 2004	10	4.72 – 227
	12344D	Leak Detection System	September 2, 2004	9	12.2 – 33.7
	12344	Glacial Till	February 24, 2004	19	0.674 – 3.91
	22212	Great Miami Aquifer	January 21, 2004	20	ND – 4.46
	22211	Great Miami Aquifer	January 21, 2004	24	ND – 3.21
Cell 8 (December 2004)	12345C	Leachate Collection System	October 18, 2004	9	1.51 – 181
	12345D	Leak Detection System	October 18, 2004	8	9.38 – 30.1
	12345	Glacial Till	May 19, 2004	14	3.48 – 5.89
	22213	Great Miami Aquifer	March 31, 2004	19	ND – 0.421
	22214	Great Miami Aquifer	March 31, 2004	23	ND – 1.53
	22215	Great Miami Aquifer	August 22, 2005	9	ND – 0.625
	22216[c]	Great Miami Aquifer	August 22, 2005	4	ND – 0.1.65
	22217[c]	Great Miami Aquifer	August 16, 2006	3	1.3 – 8.1

[a]ND = not detectable
[b]Some data not considered representative of true leak detection system uranium concentrations in Cell 2 (December 14, 1998 through May 23, 2000 data set) due to malfunction in the Cell 2 leachate pipeline and the resulting mixing of individual flows. Additionally, it is suspected that some November 2004 samples (i.e., 12339C and 12339D, 12340C and 12340D) were switched. If data from these events were included above, the maximum total uranium concentrations would be 71 g/L for 12339D and 72.4 g/L for 12340D.
[c]Monitoring Location 22216 was plugged and abandoned in April 2006. Monitoring Location 22217 is its replacement

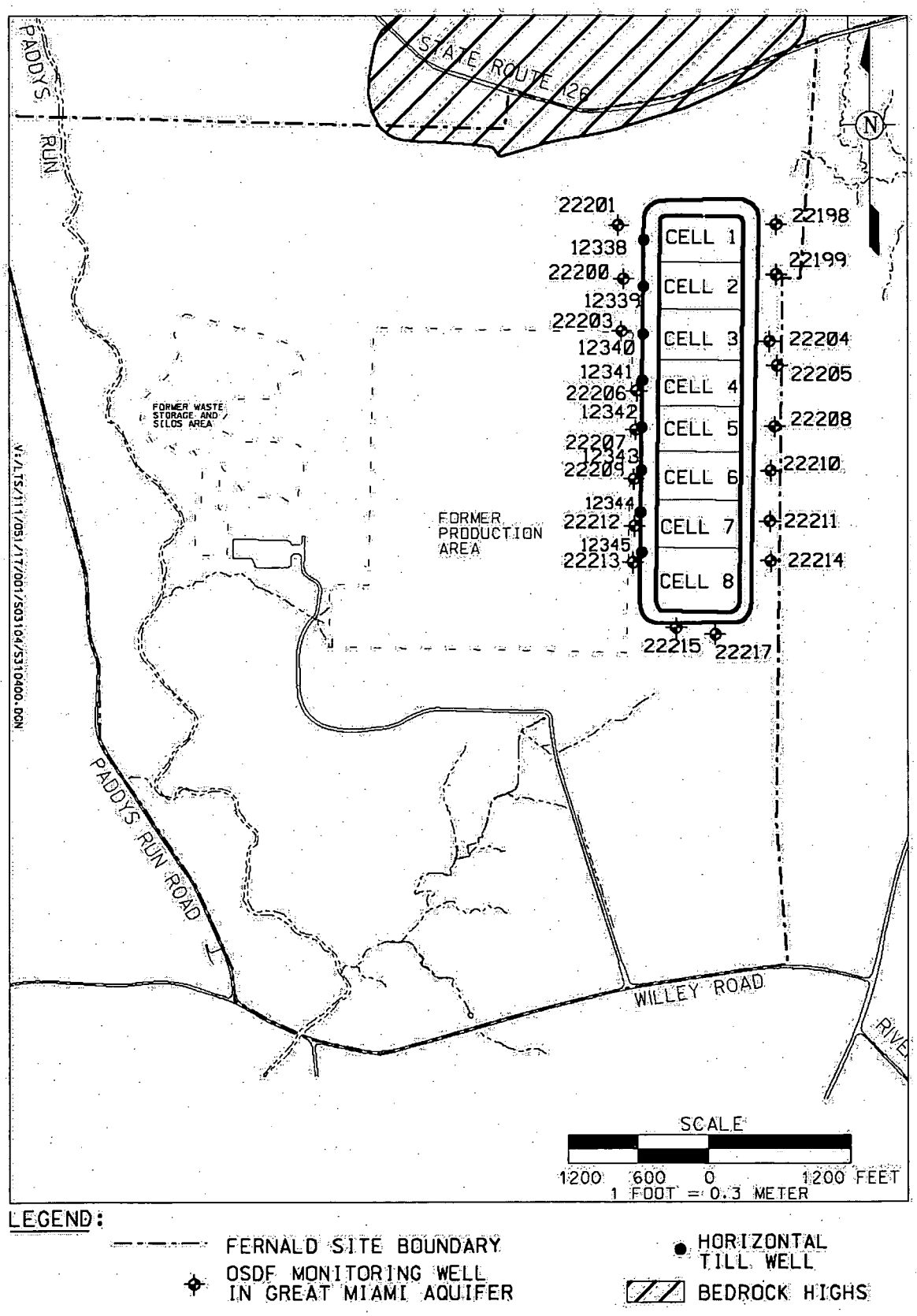


Figure 3–10. On-Site Disposal Facility Footprint and Monitoring Well Locations

4.0 Surface Water and Treated Effluent Pathway

Results in Brief: 2006 Surface Water and Treated Effluent Pathway

Surveillance Monitoring—No surface water or treated effluent analytical results from samples collected in 2006 exceeded the surface water FRL for total uranium, the primary site contaminant. There was one non-uranium FRL exceedance that can be attributable to the Fernald site.

Uranium Discharges—In 2006, 476 lb (216 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 89 lb (40 kg) of uranium were released to the environment through uncontrolled storm water runoff. The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 565 lb [257 kg]) increased 26 percent from the 2005 estimate.

Sediment—In 2006, there were no FRL exceedances for any sediment result. Certification against sediment FRLs was approved for the storm sewer outfall ditch.

This chapter presents the 2006 monitoring activities and results for surface water, treated effluent, and sediment to determine the effects of remediation activities on the surface water pathway.

In general, low levels of contaminants enter the surface water pathway at the Fernald site by two primary mechanisms: treated effluent that is monitored as it is discharged to the Great Miami River, and uncontrolled runoff entering the site's drainages from areas that had remediation activities occurring that now are certified and restored. Because these discharges have continued through remediation and legacy management, the surface water and sediment pathways will continue to be monitored. Effective use of the site's wastewater treatment capabilities and implementation of runoff and sediment controls minimizes the site's impact on the surface water pathway.

4.1 Summary of Surface Water and Treated Effluent Pathway

To assist in the understanding of this chapter, the following key definitions are provided:

- **Controlled runoff** is contaminated storm water that is collected and, under normal circumstances, treated and discharged to the Great Miami River as treated effluent.
- **Uncontrolled runoff** is storm water that is not collected for treatment, but enters the site's natural drainages.
- **Treated effluent** is water from numerous sources at the site, which is treated through the site's wastewater treatment facility, then discharged to the Great Miami River.
- **Surface water** is water that flows within natural drainage features.

The treated effluent pathway consists of flows discharged to the Great Miami River via the Parshall Flume (PF 4001). Discharges through this point are considered under the control of wastewater operations. During 2006 this effluent was comprised of the following sources:

- Storm water runoff collected from the former production area and the waste pit area.
- Treated and untreated groundwater from the South Plume, South Field, and Waste Storage Area Modules.
- Treated remediation wastewater, such as on-site disposal facility leachate and decontamination rinse water generated during building decontamination and dismantling activities.
- With the completion of remediation in October 2006, treated effluent is composed of only treated and untreated groundwater and leachate from the on-site disposal facility.

The volume and flow rate of uncontrolled runoff depends on the amount of precipitation within any given period of time. Figure 1–10 in Chapter 1 shows monthly precipitation totals for 2006. Figure 4–1 shows the site's natural drainage features. The site's natural surface water drainages include several tributaries to Paddys Run (e.g., Pilot Plant drainage ditch and storm sewer outfall ditch) as well as the northeast drainage that flows to the Great Miami River. The arrows on Figure 4–1 indicate the general flow direction of uncontrolled runoff that is determined from the topography. Uncontrolled runoff from the Fernald site leaves the property via two drainage pathways: Paddys Run and the northeast drainage.

4.2 Remediation Activities Affecting Surface Water Pathway

Major remediation activities in 2006 that affected (or had the potential to affect) the surface water pathway includes:

- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area.
- Waste hauling and placement activities associated with the on-site disposal facility.
- Soil excavation activities conducted by the Environmental Closure, Soil, and Disposal Facility Project (refer to Chapter 2).
- Activities associated with the Waste Pits Project remediation.
- Operational activities associated with the remediation projects for Silos 1, 2, and 3. This activity included the treatment and discharge of excess wastewater from operations and flush water generated during safe shut-down of these facilities.

During active remediation, engineered and administrative controls were used at the Fernald site to reduce the amount of sediment entering the surface water drainages during rainfall events. As water flows over soil, contaminants typically move with the water either by being adsorbed to the sediment eroded from the land surface or by being dissolved in the water itself. The chosen sediment control method varies by the contaminants expected during excavation, the topography of the area, and the size and duration of the excavation.

Engineered sediment controls implemented during remediation included the construction of sedimentation basins (lined or unlined), silt fences, check dams, and temporary seeding. Administrative controls included limiting the duration of open excavations and routinely inspecting each of the engineered controls used.

Now that remediation has been completed and the infrastructure to continue the groundwater remedy has been installed, the restored areas of the Fernald site will be the primary focus relative to uncontrolled runoff. Controls to mitigate sediment leaving the site will be primarily based on the vegetative and stabilization practices within the restored areas.

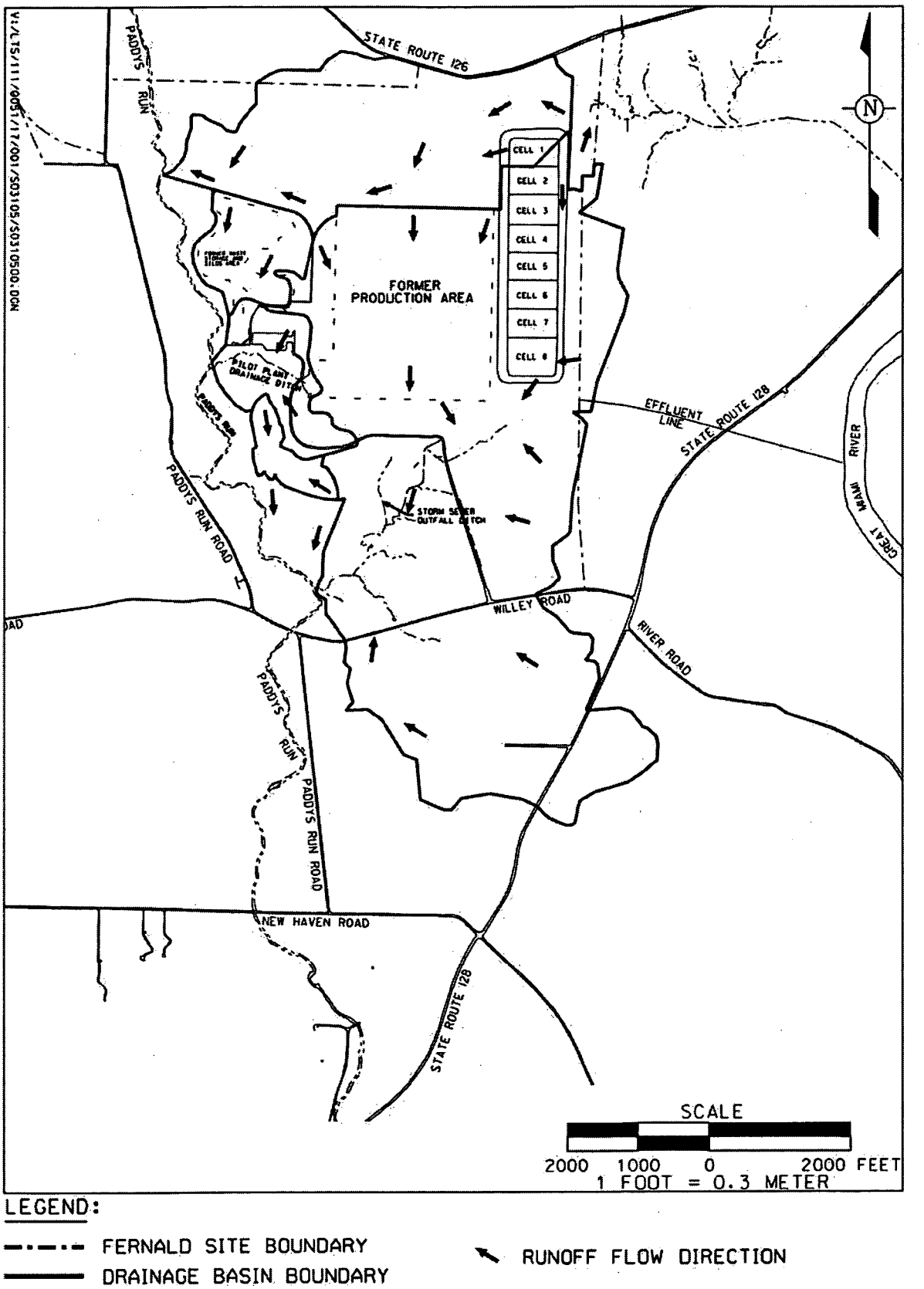


Figure 4–1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

4.3 Surface Water, Treated Effluent, and Sediment Monitoring Program for 2006

Surface water, treated effluent, and sediment are sampled to determine the effect of the Fernald site's remediation activities on the environment. Surface water is sampled at several locations in the site's drainages and analyzed for various radiological and non-radiological constituents. Treated effluent is sampled prior to discharge into the Great Miami River. Sediment is sampled for total uranium in the Great Miami River.

The key elements of the surface water and treated effluent program design are:

- **Sampling**—Sample locations, frequency, and constituents were selected to address the requirements of the NPDES Permit, Federal Facility Compliance Agreement (FFCA), and the Operable Unit 5 Record of Decision, and to provide a comprehensive assessment of surface water quality at key locations including two background locations (refer to Figures 4–2 and 4–3). Surface water is monitored for 17 FRL constituents.
- **Data Evaluation**—The integrated data evaluation process focuses on tracking and evaluating data compared with background and historical ranges, FRLs, and NPDES limits. This information is used to assess impacts on surface water due to site remediation activities affecting uncontrolled runoff or treated effluent. The assessment also includes identifying the potential for impacts from surface water to the groundwater in the underlying Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision-making by providing timely feedback to the remediation project organizations on the effectiveness of storm water runoff controls and treatment processes.
- **Reporting**—Surface water and treated effluent data are reported through the annual site environmental reports. Monthly discharge monitoring reports required by the NPDES Permit are submitted to OEPA.

The IEMP sediment monitoring program includes an annual sampling program with data reported through annual site environmental reports.

Data from samples collected under the IEMP are used to fulfill surveillance and compliance monitoring functions. Surveillance monitoring results of the IEMP surface water and treated effluent program are used to assess the collective effectiveness of site storm water controls and wastewater treatment processes in preventing unacceptable impacts to the surface water and groundwater pathways. Compliance monitoring includes sampling at storm water and treated effluent discharge points, and is conducted to comply with provisions in the NPDES Permit, the FFCA, and the Operable Unit 5 Record of Decision. The data are routinely evaluated to identify any unacceptable trends and to trigger corrective actions when needed to ensure protection of these critical environmental pathways. Figure 4–2 depicts IEMP/NPDES surface water and treated effluent sample locations; Figure 4–3 shows IEMP background sample locations.

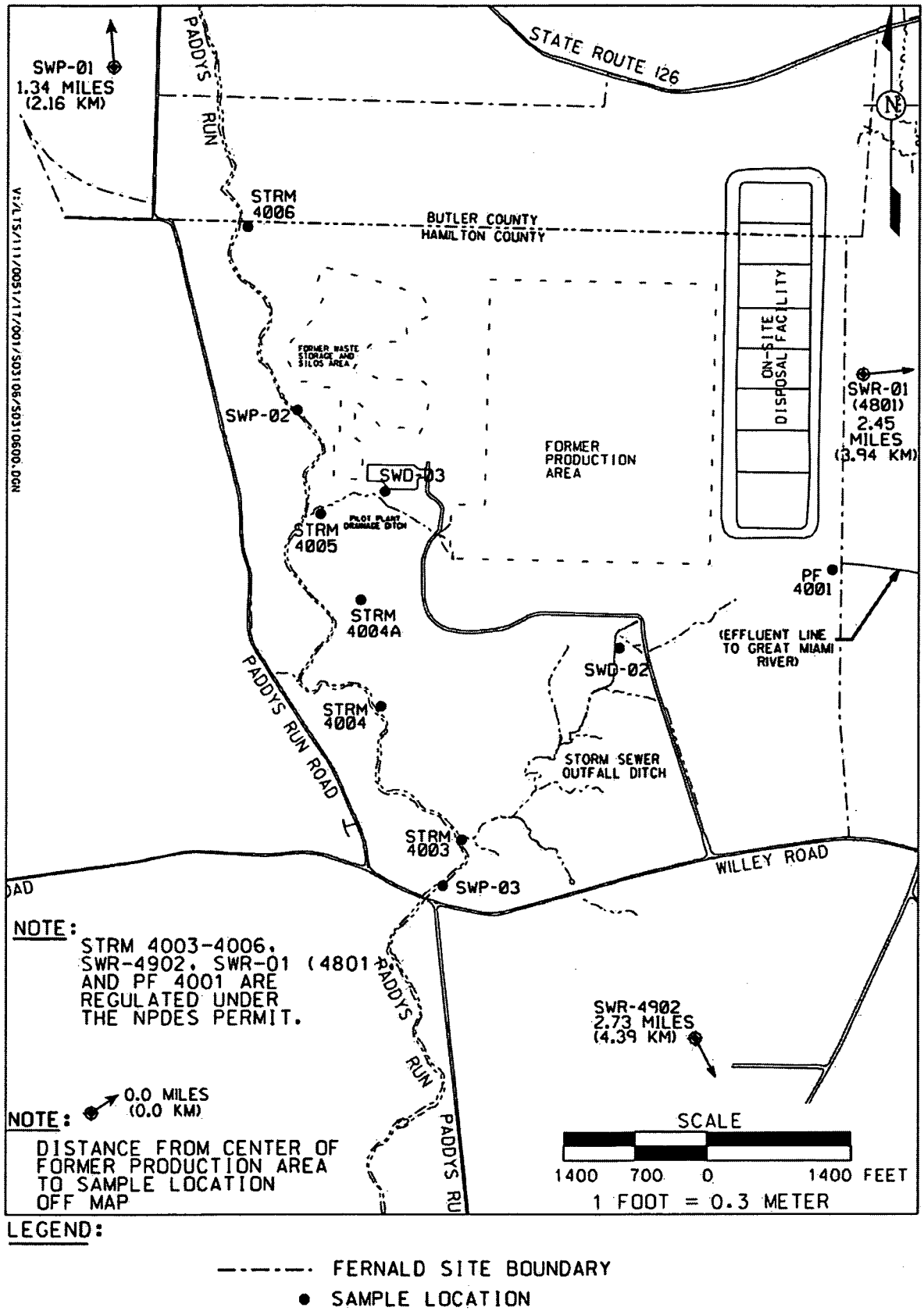
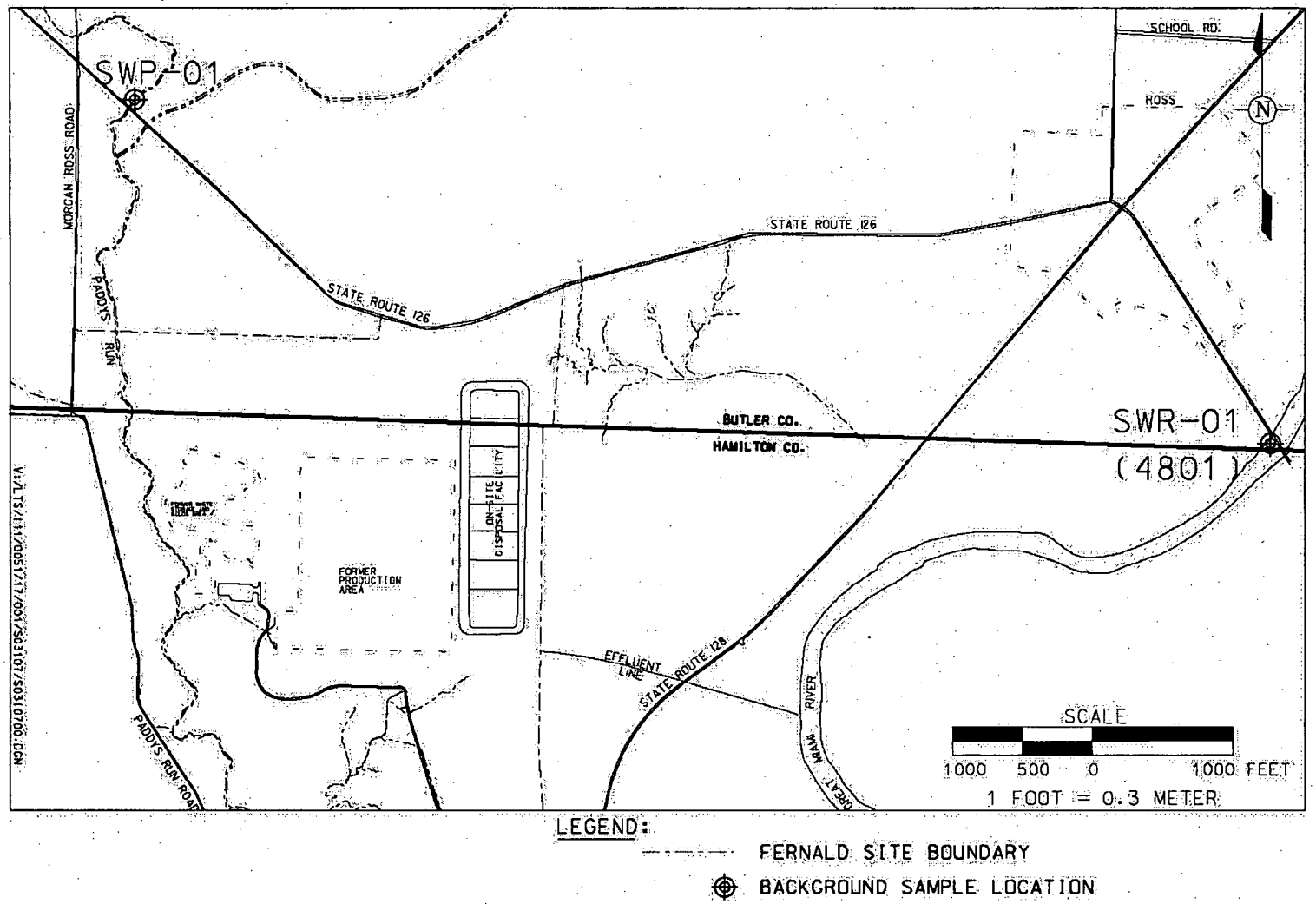


Figure 4–2. IEMP/NPDES Surface Water and Treated Effluent Sample Locations



LEGEND:

FERNALD SITE BOUNDARY

BACKGROUND SAMPLE LOCATION

Figure 4–3. IEMP Background Surface Water Sample Locations

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Treated effluent is discharged to the Great Miami River through the effluent line identified on Figure 4-1. Samples of the treated effluent are collected at the Parshall Flume (PF 4001). The resulting data are used to calculate the concentration of each FRL constituent after the effluent water mixes with the water in the Great Miami River.

4.3.1 Surveillance Monitoring

Data resulting from 2006 sampling efforts were evaluated to provide surveillance monitoring of remediation activities. This evaluation indicated that during 2006, there was one surface water FRL exceedance for copper (0.0129 mg/L) at sampling location SWD-03. The FRL for copper is 0.012 mg/L. There were no exceedances of the total uranium FRL (530 µg/L) in any of the surface water and treated effluent samples.

The following two key sample locations represent points where surface water or treated effluent leaves the site:

- Paddys Run at the Willey Road property boundary (sample location SWP-03).
- Parshall Flume (PF 4001) located at the entry point of the effluent line leading to the Great Miami River.

Evaluation of the data from these locations is especially important because they represent locations to which direct exposure to the public is possible. There were no exceedances of the surface water FRL during 2006 at these two locations.

The maximum total uranium concentration at SWP-03 during 2006 was 3.5 µg/L, well below the surface water total uranium FRL of 530 µg/L. Figure 4–4 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 2006. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986, following completion of the former Storm Water Retention Basin, which collected contaminated storm water from the former production area during the later years of operation and through active remediation until they were removed from service in February 2006.

Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point where treated effluent is sampled prior to discharge to the Great Miami River. Data collected from this location cannot directly be compared to the surface water FRL without considering the effect of the effluent waters mixing with the Great Miami River. This is done through the use of a mixing equation.

The maximum daily total uranium concentration at the Parshall Flume (PF 4001) in 2006 prior to discharge through the effluent line to the Great Miami River was 41.8 µg/L. After the water from the Parshall Flume (PF 4001) mixed with the water in the Great Miami River, the concentration would have been approximately 1 µg/L. Both concentrations, those from the Parshall Flume (PF 4001) and after mixing with the Great Miami River, were well below the surface water total uranium FRL of 530 µg/L. Contaminant concentrations observed at the Parshall Flume (PF 4001) in 2006 are discussed further in the Compliance Monitoring section.

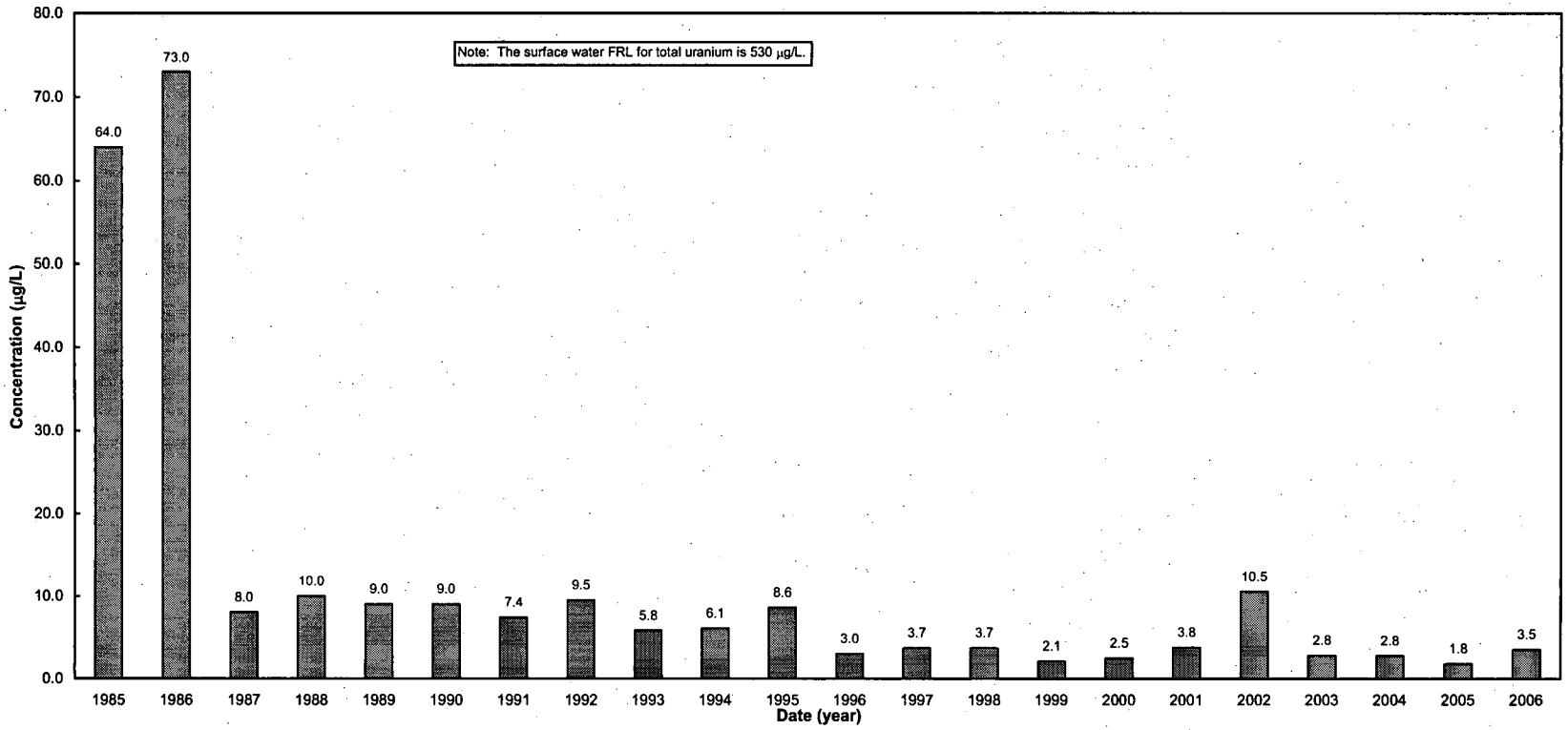

Figure 4–4. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985–2006

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Evaluation of surface water data is also performed in order to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. In areas where there is no glacial overburden, a direct pathway exists for contaminants to reach the aquifer. This contaminant pathway to the aquifer was considered in the design of the groundwater remedy. The groundwater remedy includes placing groundwater extraction wells downgradient of these areas where direct infiltration occurs in order to mitigate any potential cross-media impacts during surface remediation. To provide this assessment, sample locations were selected to evaluate contaminant concentrations in surface water just upstream of, or within, those areas where site drainages have eroded through the protective glacial overburden. This includes locations SWP-02, SWD-02, SWD-03, STRM 4005, and the Storm Water Retention Basin overflow (SWRB 4002O). Because the Storm Water Retention Basin has been removed from service and excavated, SWRB2O is no longer a monitored point.

During 2006, none of the five surface water locations evaluated had results that exceeded the total uranium groundwater FRL of 30 µg/L. Of the locations evaluated, only SWD-03 had results that exceeded the groundwater FRL for a constituent other than uranium. These groundwater FRL exceedances were for zinc from samples collected on March 9, 2006 (0.0438 mg/L), April 23, 2006 (0.0255 mg/L), and July 29, 2006 (0.0855 mg/L). The groundwater FRL for zinc is 0.021 mg/L. Additional details of the FRL exceedances are presented in Appendix B, Attachment B.1.

4.3.2 Compliance Monitoring

4.3.2.1 FFCA and Operable Unit 5 Record of Decision Compliance

The Fernald site is required to monitor treated effluent discharges at the Parshall Flume (PF 4001) for total uranium mass discharges and total uranium concentrations. This requirement is identified in the July 1986 FFCA and the Operable Unit 5 Record of Decision. The Operable Unit 5 Record of Decision requires treatment of effluent so that the mass of total uranium discharged to the Great Miami River through the Parshall Flume (PF 4001) does not exceed 600 lb (272 kg) per year. The Operable Unit 5 Record of Decision and subsequent approval of the Explanation of Significant Differences also require that the monthly average total uranium concentration in the effluent must be at or below 30 µg/L.

The Operable Unit 5 Record of Decision allowed the Fernald site to discharge water from the Storm Water Retention Basin directly to the Great Miami River during periods of heavy precipitation. This was allowed in order to reduce the possibility of an overflow condition for the Storm Water Retention Basin. To comply with the monthly average total uranium concentration limit during these types of bypasses, the Fernald site was allowed to deduct these uranium concentrations from the monthly average total uranium calculation at the Parshall Flume (PF 4001) for up to 10 significant precipitation bypass days per year. However, the mass of total uranium discharged during these 10 days per year was still considered in the total discharge mass in order to ensure the discharge limit of 600 lb (272 kg) per year was not exceeded.

In addition to significant precipitation-related bypasses, the site was also allowed to bypass water from the Storm Water Retention Basin during certain scheduled wastewater treatment plant maintenance activities provided they were pre-approved by the regulatory agencies. The total uranium concentration in the discharge related to maintenance activities was allowed to be

deducted from the monthly average calculation demonstrating compliance with the total uranium monthly average concentration limit. However, the mass of total uranium discharged during these maintenance bypasses is still considered in the total discharge mass to ensure the discharge limit of 600 lb (272 kg) per year was not exceeded.

As noted above, the Storm Water Retention Basins were removed from service in February 2006. No direct precipitation or maintenance related bypasses occurred from the Storm Water Retention Basins during 2006. However, there was one occasion where the direct discharge of storm water to the Great Miami River was required. From March 17 through March 21, 2006, storm water was discharged from a large excavation within Remediation Area 4B. This effort was required to mitigate against the potential loss of control of the water within the excavation and the possible recontamination of other adjacent certified areas. Approval for this bypass was obtained from the regulatory agencies.

Figure 4–5 shows that the cumulative mass of total uranium discharged to the Great Miami River during 2006 was 476.36 lb (216.27 kg), which is below the annual discharge limit of 600 lb (272 kg). Figure 4–6 shows that the total uranium monthly average concentration limit was met every month during 2006.

4.3.2.2 NPDES Permit Compliance

Compliance sampling, consisting of sampling for non-radiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald site, is regulated under the state-administrated NPDES program. The current permit became effective on July 1, 2003, and expires on June 30, 2008. The permit specifies discharge and sample requirements and discharge limits for several constituents. One non-compliance occurred in 2006 and was reported to OEPA pursuant to the terms of the NPDES Permit, as summarized in Table 4–1.

Table 4–1. Exceedances of the NPDES Permit During 2006

Date	Location	Parameter	Permit Limit	Actual Result	Possible Cause	Corrective Action
12/6	PF 4001	Oil & Grease	10.0 mg/L	13.5 mg/L	Introduction of oily sludge into the backwash basin during D&D activities	None. Continue to monitor and observe

4.3.3 Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4–5, 476.36 lb (216.27 kg) of uranium in treated effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 2006. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of uranium entering the environment. Figure 4–7 presents the pounds of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2006.

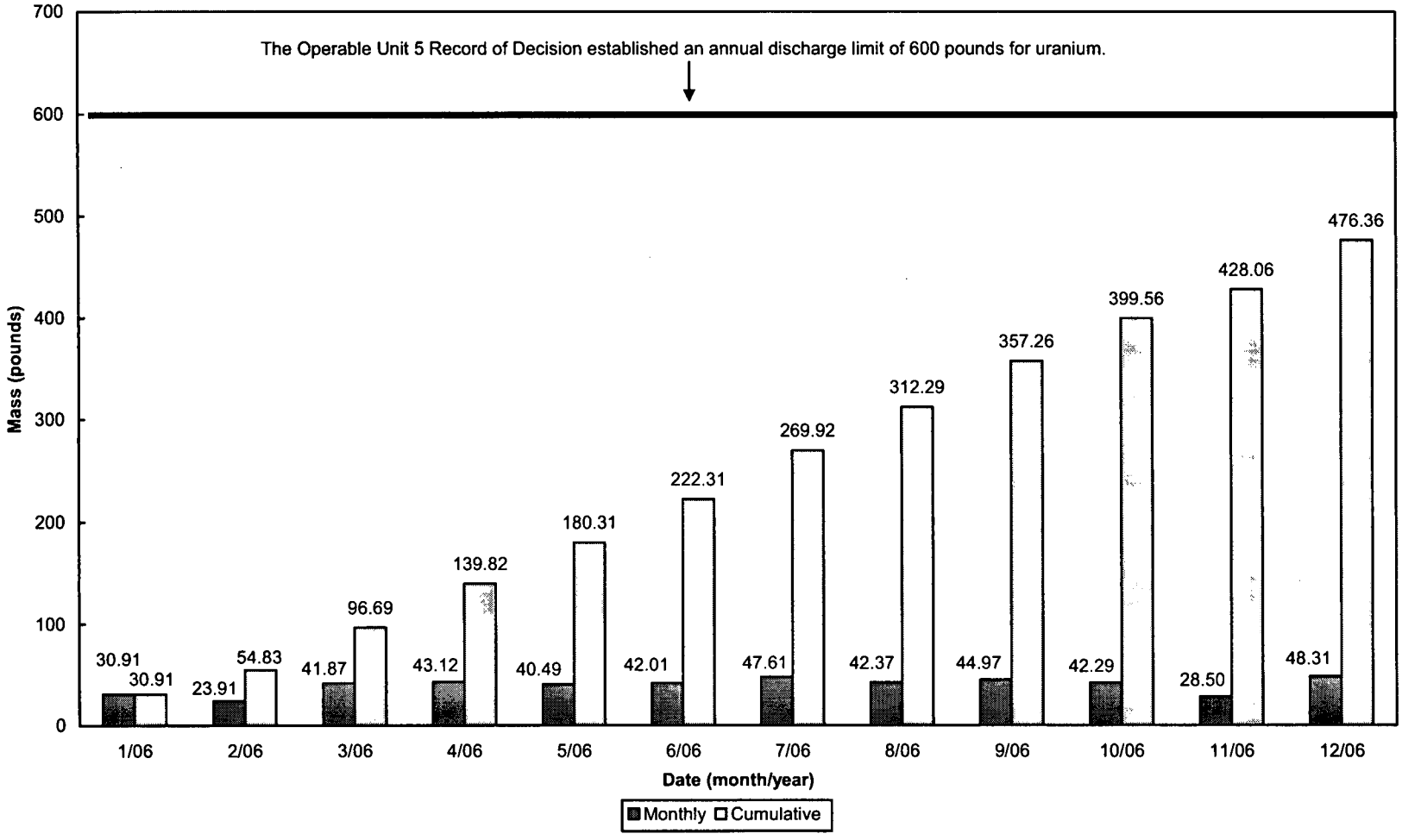

Figure 4–5. Pounds of Uranium Discharged to the Great Miami River Through the Parshall Flume (PF 4001) in 2006

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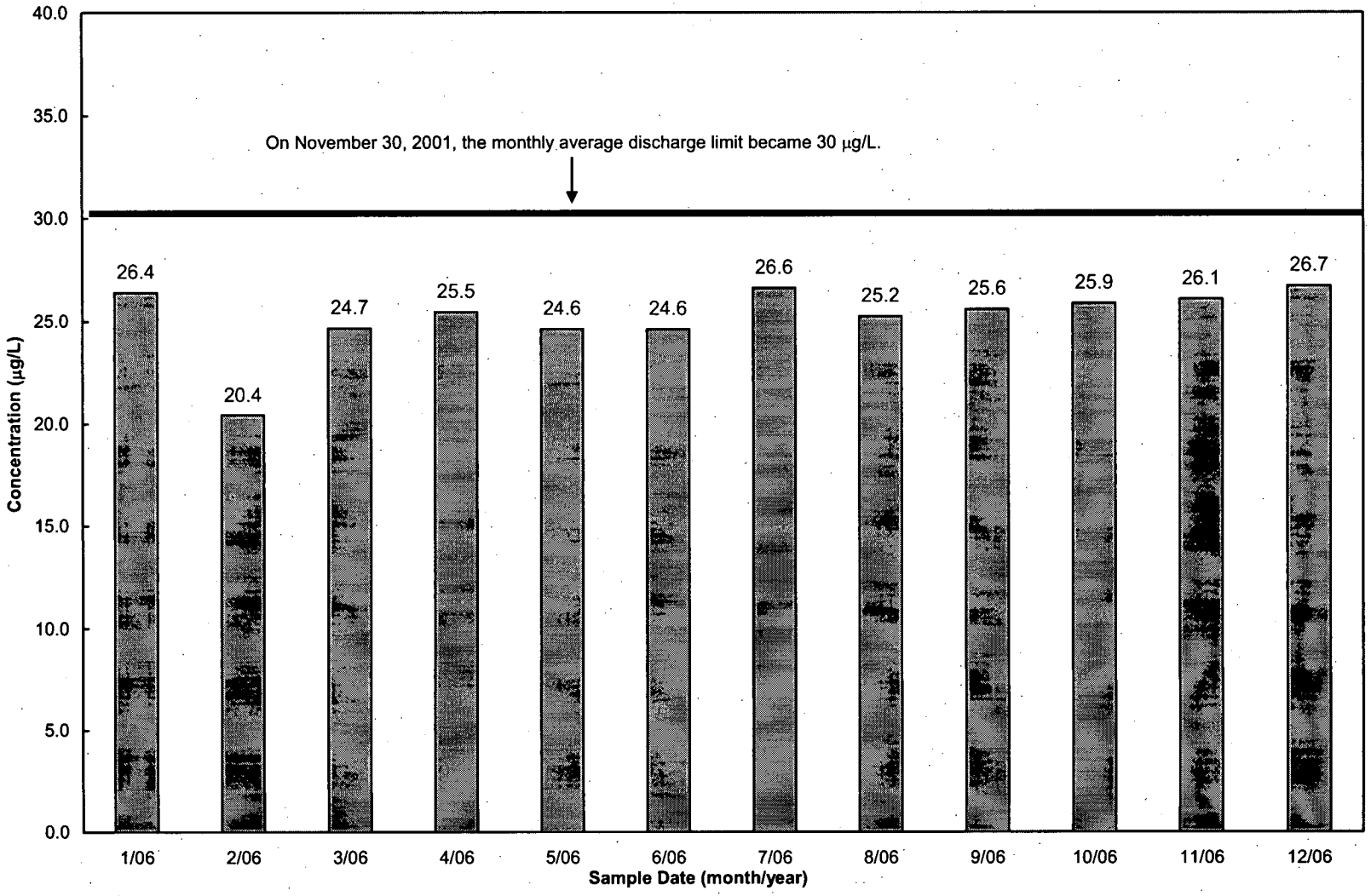

Figure 4–6. 2006 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River

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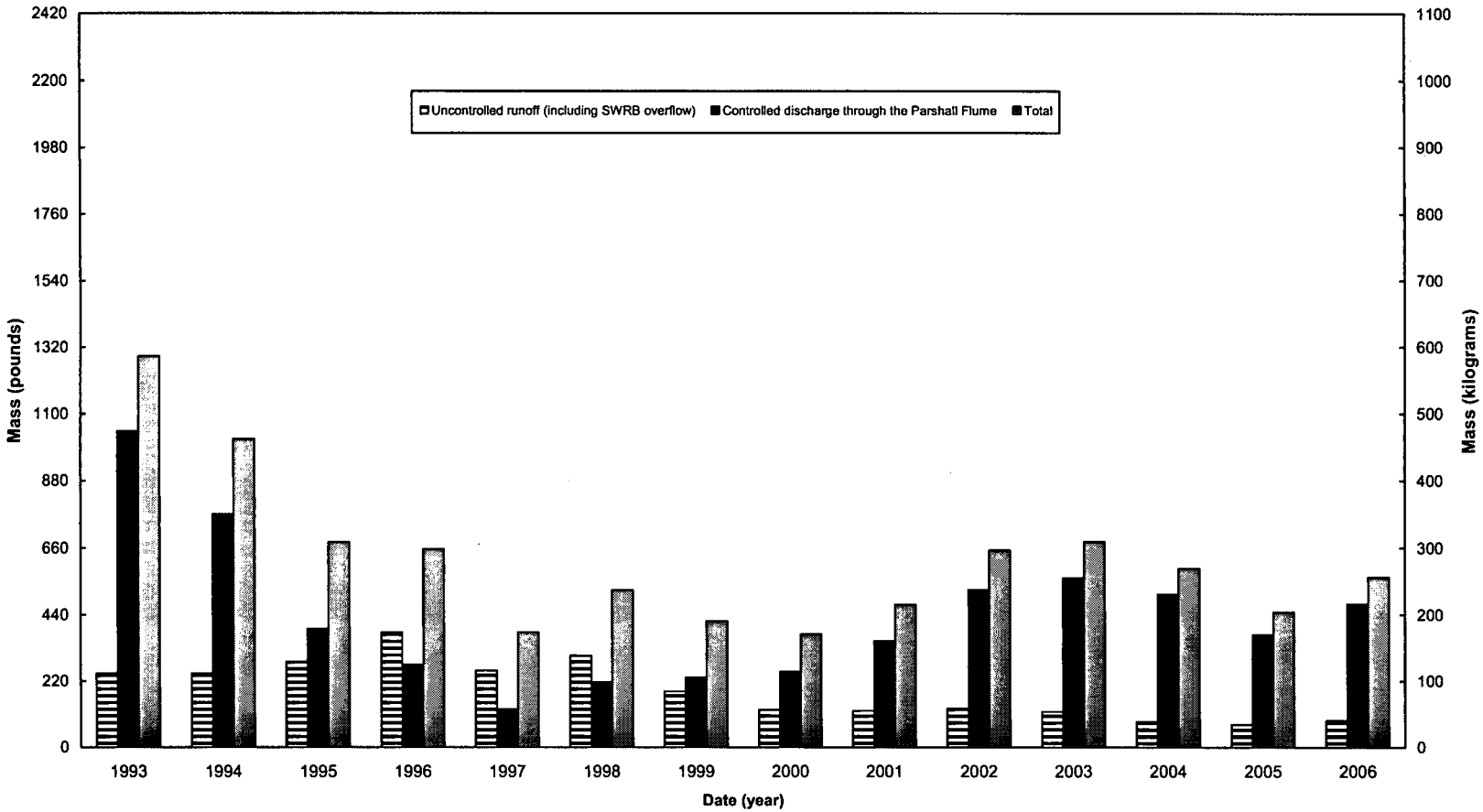

Figure 4–7. Uranium Discharged Via the Surface Water Pathway, 1993–2006

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A loading term is used to estimate the pounds of uranium discharged to Paddys Run via uncontrolled runoff. This loading term was recently revised and approved in August 2004 based on total uranium data, which reflect the decreasing total uranium concentrations measured at points discharging to Paddys Run. Total uranium concentrations measured in Paddys Run have been decreasing due to significant improvements in the capture of contaminated storm water and the progress and effectiveness of remediation activities. The loading term is 2.1 lb uranium per inch of rainfall, a decrease from the previous loading term of 2.6 lb of uranium per inch of rainfall.

During 2006, 42.2 inch (107.2 cm) of precipitation fell at the Fernald site; therefore, an estimated 88.62 lb (40.23 kg) of uranium entered the environment through uncontrolled runoff.

The estimated total amount of uranium discharged to the surface water pathway for the year, including controlled treated effluent discharges and uncontrolled runoff, was approximately 564.98 lb (256.50 kg).

4.4 Sediment Monitoring

Sediment is a secondary exposure pathway and is monitored annually to assess the impact of remediation activities on sediments deposited along surface water drainages. For the IEMP, sediment samples were collected at strategic locations in the Great Miami River (i.e., upgradient and downgradient of the effluent line). Sediment samples analyzed for total uranium were collected in October 2006 at two locations in the Great Miami River (refer to Figure 4–8). Table 4–2 presents the 2006 results, which show that all uranium results were below the sediment FRL (210 milligrams per kilometer [mg/kg]). Appendix B, Attachment B.2, contains additional details of the IEMP and certification sediment monitoring results.

Table 4–2. 2006 Summary Statistics for Sediment Monitoring Program

Radionuclide	Sediment FRL	No. of Samples	2006 Results Concentration (dryweight) mg/kg)
Great Miami River, North of the Effluent Line (G2)			
Total Uranium	210 mg/kg	1	0.739
Great Miami River, South of the Effluent Line (G4)			
Total Uranium	210 mg/kg	1	1.60

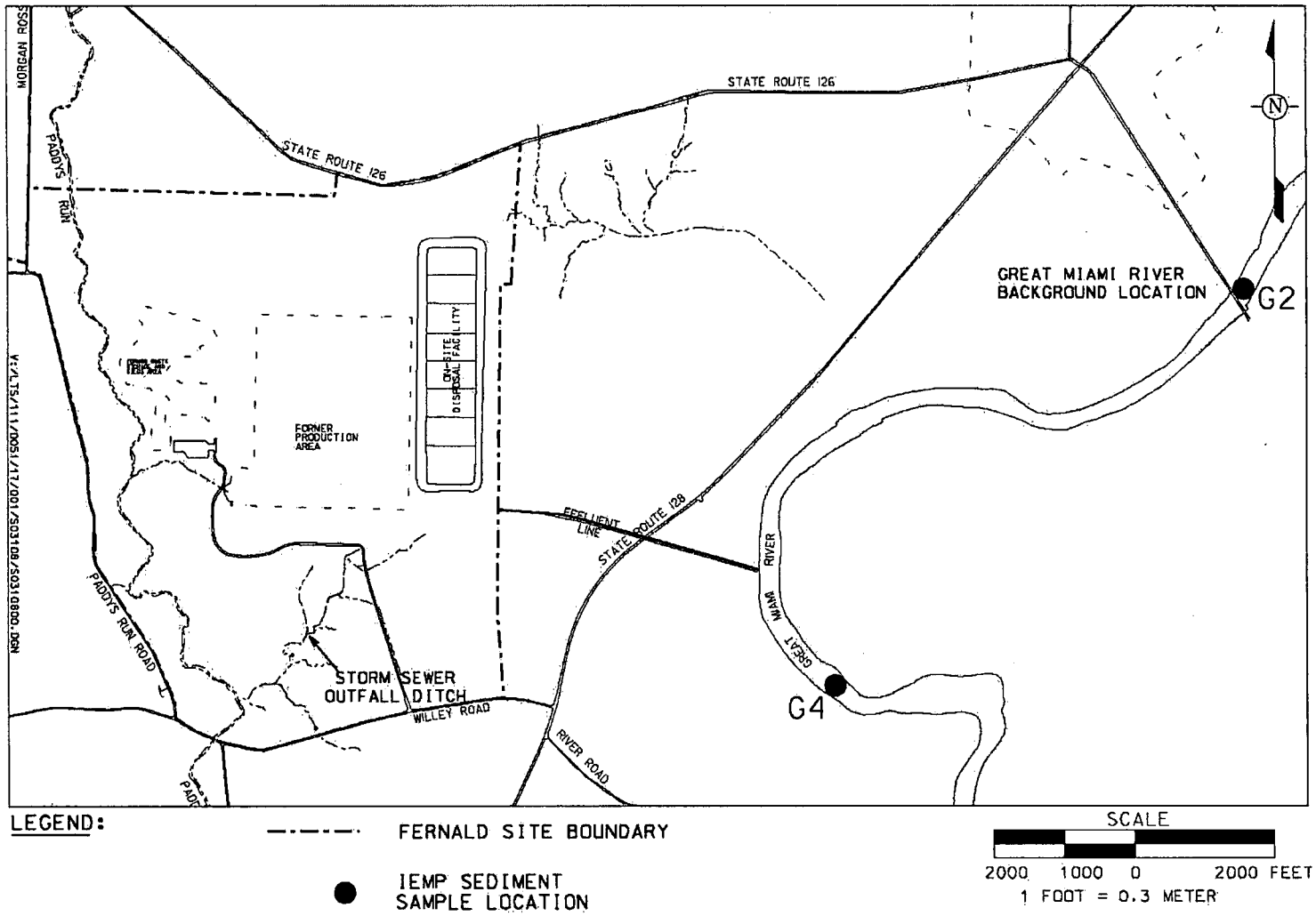

Figure 4–8. 2006 Sediment Sample Locations

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5.0 Air Pathway

This chapter describes the air pathway monitoring program used to track and evaluate airborne emissions from the Fernald site. It includes a discussion of radiological air particulates, radon, and direct radiation.

Results in Brief: 2006 Air Pathway

Radiological Air Particulates—Data collected from the site boundary air monitoring stations show that average concentrations for each radionuclide monitored were less than 1 percent of the corresponding DOE-derived concentration guide.

Radon—There were no exceedances of the 10 CFR 834 proposed standard (0.5 pCi/L annual average above background) at the site boundary and off-property locations. The maximum annual average concentration at the Fernald site boundary measured by continuous radon monitors was 0.4 pCi/L above background.

Direct Radiation—2006 direct radiation measurements at the site boundary were lower than those in 2005. This was attributed to the continuing operation of the Radon Control System and the removal of the remaining Silos 1, 2, and 3 materials from the site.

Air pathway monitoring focuses on airborne pollutants carried from the site as a particle or gas and how these pollutants are distributed in the environment. The physical form and chemical composition of pollutants influence their dispersal in the environment and the delivered radiation dose. For example, fine particles and gases remain suspended, while larger, heavier particles tend to settle and deposit on the ground. Chemical properties determine whether the pollutant will dissolve in water, be absorbed by plants and animals, or settle in sediment and soil.

The final year of soil remediation at the Fernald site was 2006. As the number of sources of airborne contamination decreased throughout 2006, so did the number of active air monitoring stations (AMS). AMS-4, 5, 7, 23, 25, and 28 were removed from service in April 2006; thorium monitor WPTH-2 was removed from service in August 2006; and AMS-9C, 22, 26, 27, and 29 were removed from service in December 2006. All air monitoring stations that were active in 2006 are shown in Figure 5–1.

By the end of October 2006, all major sources of airborne contamination were removed from the site or placed in the OSDF. However, air monitoring continues to ensure the continued protection of the public and the environment after the remediation process. The site's air monitoring approach (presented in the IEMP) provided an ongoing assessment of the collective emissions originating from remediation activities. The results of this assessment were used to provide feedback to remediation project organizations regarding the site-wide effectiveness of project-specific emission controls relative to DOE, EPA, and OEPA standards. In response to this feedback, project organizations modified or maintained emission controls.

5.1 Remediation Activities Affecting the Air Pathway

When the mission of the Fernald site changed from production to remediation, work activities also changed. This change in work scope altered the characteristics of sources that emit pollutants in the environment via the air pathway. During the production years, the primary emission sources were point sources (i.e., stacks and vents) from process facilities. During 2006, the dominant emission sources were associated with remediation activities in the form of fugitive emissions (i.e., excavation, hauling and processing of waste and contaminated soil, demolition of production facilities, and general construction activities supporting the remediation process), and the storage of radon-generating waste materials.

The following primary emission sources were active during 2006:

- Excavation of contaminated soil and debris (Operable Unit 5).
- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area (Operable Units 2, 3, and 5).
- Transportation and placement of contaminated material in the on-site disposal facility and interim storage at the on-site material transfer area (Operable Unit 2).
- Radon Control System waste retrieval, processing, and shipping operations (Operable Unit 4) for Silos 1, 2, and 3.

The following activities, which occurred in 2006, highlight the end of the major airborne emission sources:

- April–the last shipment of Silo 3 waste left Fernald for Envirocare in Clive, Utah. The concrete silo was demolished the same day.
- May–the last truck carrying treated waste from Silo 1 and 2 left Fernald for WCS in Texas.
- July–the Silo 1 and 2 Remediation Facility, TTA, and Radon Control System demolition was completed.
- September - last waste placement in the on-site disposal facility.

During site remediation, each project was responsible for designing and implementing engineered and administrative controls for fugitive emissions. DOE/EPA policy mandated that emissions be visually monitored and controls be implemented as necessary. The following types of controls were used to keep point source and fugitive emissions to a minimum:

- **Engineered Controls**–Typical engineered controls included physical barriers, wetting agents, filtration, fixatives, sealants, dust suppressants and control, and collection and treatment systems. Engineered designs helped reduce point source and fugitive emissions by using the best available technology. The selection of the best available technology for controlling project emissions was conducted during the design process and frequently included the evaluation of several treatment alternatives.
- **Administrative Controls** – Typical administrative controls included management and control procedures; record keeping; periodic assessments; and establishment of speed limits, control zones, and construction zones.

5.2 Air Monitoring Program Summary for 2006

The site's air monitoring program, as defined in the IEMP, consists of three distinct components:

- Radiological air particulate.
- Radon.
- Direct radiation.

Each component of the air monitoring program is designed to address a unique aspect of air pathway monitoring, and each has distinct sampling methodologies and analytical procedures. The key elements of the air monitoring program design are:

- **Sampling** – Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the Fernald site. Key considerations in the design of the sampling program included prevailing wind directions, location of potential sources of emissions, and the location of off-property receptors. The IEMP program includes monitoring radiological air particulates, radon, and direct radiation.
- **Data Evaluation** – The data evaluation process focuses on tracking and trending data against historical ranges and DOE, EPA, and OEPA standards. Each section in this chapter presents an evaluation of data and a comparison to applicable standards and guidelines.
- **Reporting** – All data are reported through the annual site environmental reports.

5.3 Radiological Air Particulate Sampling Results

As described in the IEMP, Revision 4B, a network of high-volume air particulate monitoring stations is used to measure the collective contributions from fugitive and point source particulate emissions from the site. Figure 5–1 provides the locations of the IEMP air monitoring stations in operation during 2006.

The sampling and analysis program for the site boundary and background locations consists of biweekly total uranium and total particulate analyses, monthly composites (eight times per year) for isotopic thorium analyses, and a quarterly composite sample. The quarterly composite sample is analyzed for the expected major contributors (i.e., radium, thorium, and uranium) to the radiological dose at the site's boundary. The thorium monitor (WPTH-2), which was removed from service in August 2006, included biweekly particulate and monthly isotopic thorium analyses. Analytical data from this program are used to assess the effectiveness of the emission control practices throughout the year and to ensure particulate emissions remain below health protective standards.

The radiological air particulate monitoring program is designed to demonstrate compliance with the following:

- NESHAP Subpart H requirements that stipulate radionuclide emissions (including radon) to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem/year above background levels. This dose is reported in the annual NESHAP Subpart H compliance report and is included in Appendix D.
- DOE Order 5400.5, *Radiation Protection of the Public and the Environment* (DOE 1993), guidelines for concentrations of radionuclides in air emissions. These guidelines, referred to as derived concentration guide values, are concentrations of radionuclides that, under conditions of continuous exposure for one year by one exposure mode (e.g., inhalation or ingestion), would result in a dose of 100 mrem to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

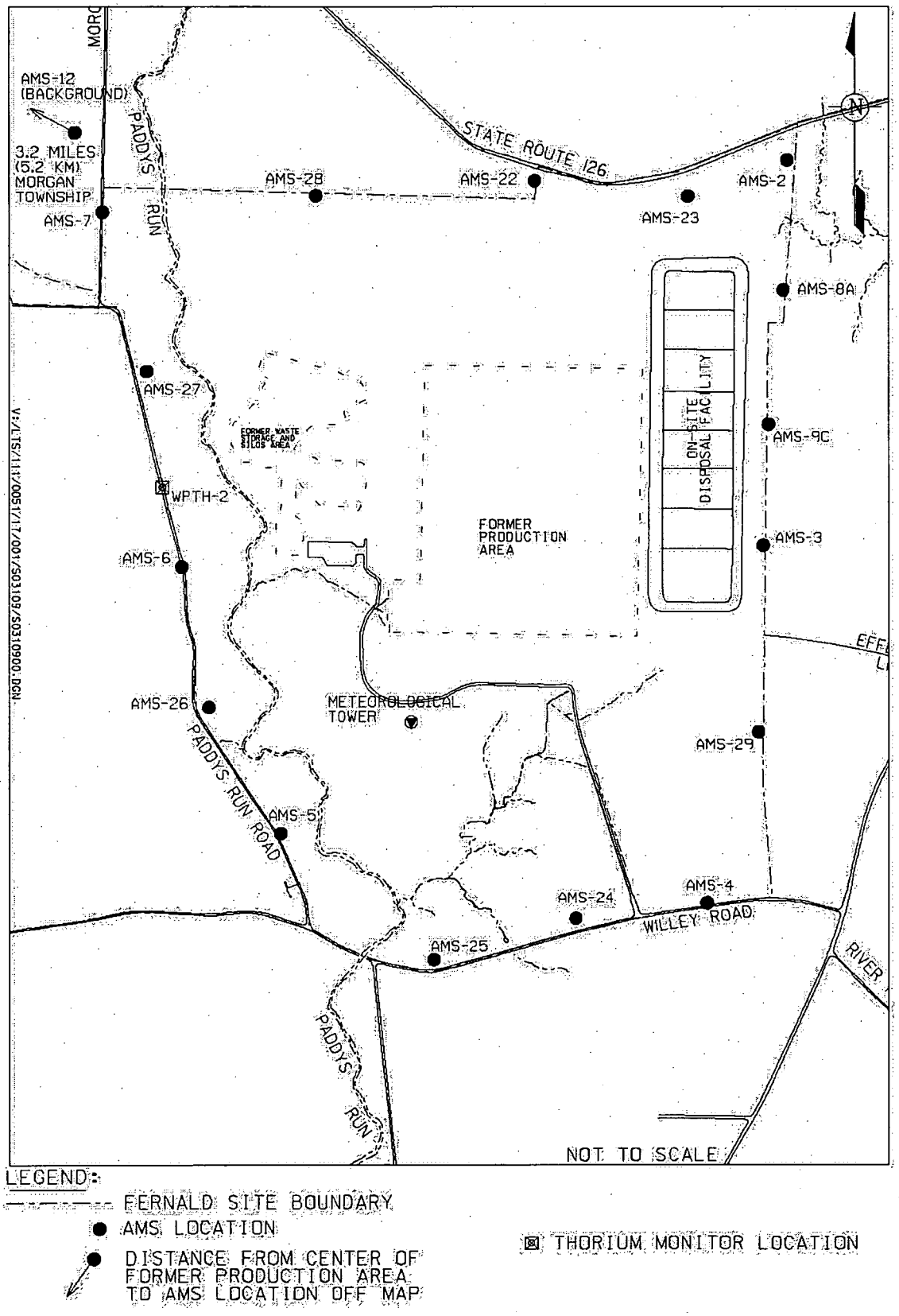

Figure 5–1. Radiological Air Monitoring Locations

Table 5–1 presents a summary of the minimum, maximum, and average concentrations for total uranium, thorium-230, and total particulate in 2006 and 2005 based on the biweekly and monthly sample results. For 2006, the annual average concentrations of total uranium at all boundary air monitoring stations ranged from 6.9×10^{-7} to 2.6×10^{-4} picoCuries per cubic meter (pCi/m^3), which is much less than 1 percent of the DOE derived concentration guide value (0.1 pCi/m^3). For comparison, the 2005 maximum total uranium concentration was 3.5×10^{-4} pCi/m^3.

Table 5–1. Summary of Biweekly Total Uranium, Total Particulate, and Monthly Thorium-230 Concentrations in Air

Location	2006 Total Uranium (pCi/m^3)	2005 Total Uranium (pCi/m^3)	2006 Total Particulate (µg/m^3)	2005 Total Particulate (µg/m^3)	2006 Thorium-230 (pCi/m^3)	2005 Thorium-230 (pCi/m^3)
Boundary Locations						
Minimum	6.9E-07	0.0E+00	0.0E+00	11	4.0E-08	0.0E+00
Maximum	2.6E-04	3.5E-04	110	110	3.0E-05	7.8E-05
Average	3.1E-05	5.1E-05	31	35	5.3E-06	1.8E-05
Background Location						
Minimum	7.8E-07	0.0E+00	14	11	0.0E+00	0.0E+00
Maximum	2.3E-05	2.3E-05	67	43	6.8E-06	1.1E-05
Average	1.1E-05	1.2E-05	25	26	2.0E-06	4.8E-06

Monthly thorium monitoring at the boundary provided timely feedback on engineered and administrative controls that were implemented to control fugitive emissions, primarily at the Silo 3 Project, which concluded activities in April 2006. The boundary concentrations of thorium-230 ranged from 4.0×10^{-8} to 3.0×10^{-5} pCi/m^3. For comparison, the 2005 maximum thorium-230 concentration at the site boundary was 7.8×10^{-5} pCi/m^3.

In addition to the total uranium and isotopic thorium analyses, total particulate measurements are also obtained from each filter every two weeks (Table 5–1). Total particulate concentrations at the boundary ranged from 11 to 110 micrograms per cubic meter (µg/m^3). There are no general or site-specific regulatory limits associated with total particulate measurements for use in the data evaluation process.

Total particulate, total uranium, and thorium-230 data were collectively evaluated to identify any increasing trends related to remediation activities. Figures 5–2 and 5–3 show total uranium and thorium-230 concentrations, respectively, at the boundary locations with the highest dose rate from airborne emissions in 2006 (AMS-3, AMS-9C, and AMS-29). Appendix C, Attachment C.1, provides graphical displays of the 2006 total uranium, thorium-230, and total particulate data.

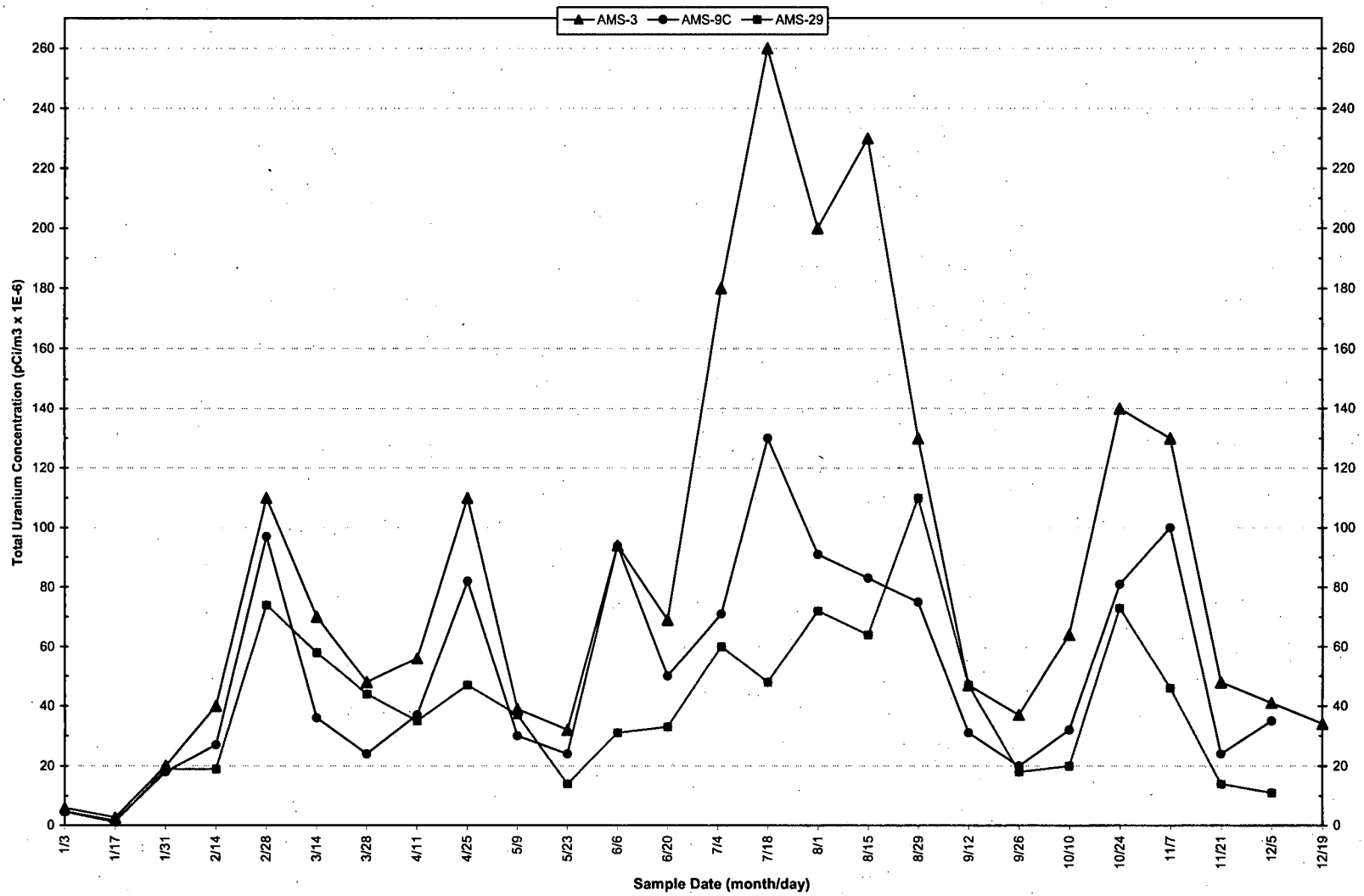

Figure 5–2. 2006 Total Uranium Concentrations in Air at Selected East Boundary Monitors (AMS-3, AMS-9C, and AMS-29)

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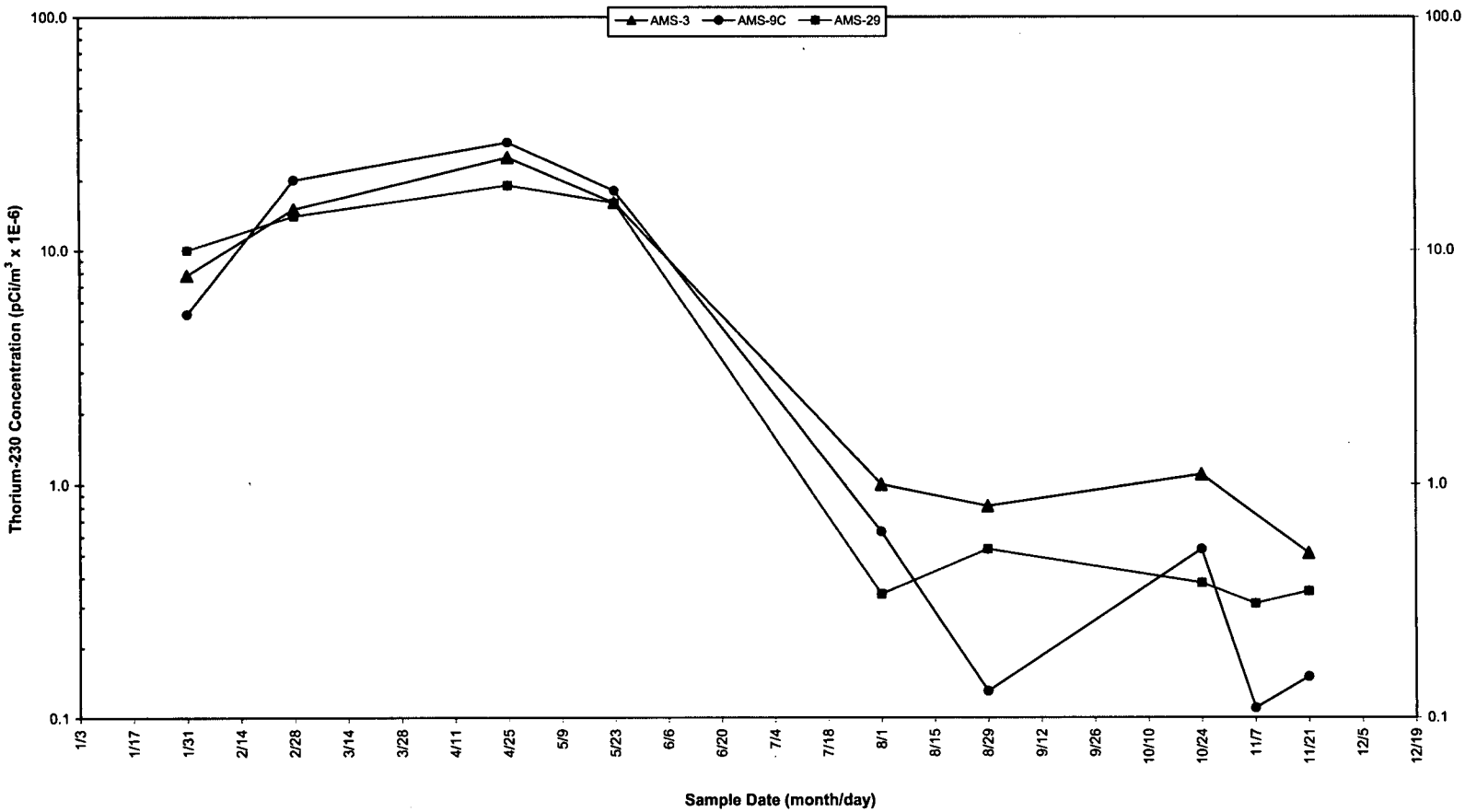

Figure 5–3. 2006 Thorium-230 Concentrations in Air at Selected East Boundary Monitors (AMS-3, AMS-9C, and AMS-29)

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In 2006, quarterly composite air filter samples were formed from the biweekly samples at each IEMP air monitoring station to determine the radiological air inhalation dose for NESHAP compliance. The samples were analyzed for isotopes of radium, thorium, and uranium, and the results were used to assess compliance with the NESHAP 10-mrem/year dose limit. The maximum dose associated with the 2006 quarterly composite results was 0.17 mrem/year (compared to the 10-mrem/year limit) and occurred at AMS-3. The composite results from the boundary monitors show that, on average, thorium isotopes contribute 57 percent of the dose from 2006 airborne emissions. Isotopes of uranium and radium account for 22 and 21 percent of the dose, respectively. The nine percent increase in the thorium isotopes emission relative to 2005 is an artifact of lower thorium background, resulting in less removal of the background thorium dose, and higher background corrected thorium results. Chapter 6 and Appendix D provide more detailed information on the dose associated with the composite results.

The annual average radionuclide concentrations at each air monitoring station, as determined from the quarterly composite results, were compared to the DOE-derived concentration guide values. At each monitoring station, the annual average radionuclide concentrations were below one percent of the corresponding DOE-derived concentration guide values.

The WPTH-2 boundary monitor was installed in late 1998 on the west property boundary to specifically monitor thorium emissions from the Waste Pits Project. Measured airborne concentrations of isotopic thorium were approximately three times higher than background concentrations in part due to lower thorium levels at the background monitor in 2006. Appendix C, Attachment C.1, provides graphical displays of the isotopic thorium data from the WPTH-2 monitor.

5.4 Radon Monitoring

Radon-222 (referred to in this section as radon) is a naturally occurring radioactive gas. It is produced by radioactive decay of radium-226, which can be found in varying concentrations in the earth's crust. Radon is also chemically inert and tends to diffuse from the earth's crust to the atmosphere. The concentration of radon in the environment is dynamic and exhibits daily, seasonal, and annual variability.

Many factors influence the concentration of radon in the environment, including the distribution of radium-226 in the ground, porosity of the soil, weather, etc. For instance, radon diffusion from the ground is minimized by the presence of precipitation and snow cover. Alternatively, elevated temperatures and the absence of precipitation can produce cracks in the ground and changes in porosity that increase the rate radon escapes.

Environmental radon concentrations are also influenced by atmospheric conditions. During periods of calm winds and temperature inversions (when the air near the earth's surface is cooler than the air above it), air is held near the earth's surface, minimizing the mixing of air. Consequently, radon's movement is limited vertically and concentrations tend to increase near the ground. A summary of meteorological data from 2006 is presented in Figures 1−7 through 1−10 in Chapter 1, and Appendix C, Attachment C.4.

Waste material generated at the Fernald site from uranium extraction processes performed decades ago contained radium-226, which produces radon. The waste material was contained in Silos 1, 2, and 3, TTA (Operable Unit 4 remediation), and the waste pit area (Operable Unit 1 remediation).

DOE Order 5400.5 provides guidelines for clean up of residual radioactive material, the management of resulting wastes and residues, the release of radiological property; and radiological protection requirements. Radon limits at interim storage facilities (such as at the Fernald site) are also defined under DOE Order 5400.5 and proposed 10 CFR 834 and must not exceed:

- 100 pCi/L at any given location and any given time.
- Annual average concentration of 30 pCi/L (above background) over the facility.
- Annual average concentration of 0.5 pCi/L (above background) at and beyond the Fernald site boundary.

Figure 5–4 illustrates the continuous radon monitoring network used in 2006 for determining compliance with the above limits. The continuous monitoring network provided frequent feedback to remediation projects, regulatory agencies, and stakeholders on trends in ambient radon concentrations, while providing sufficient radon monitoring to ensure compliance with DOE Order 5400.5 and proposed 10 CFR 834 requirements.

In general, monitoring locations were selected near radon-emitting sources, at the property boundary, and a background location. The Federal Facility Agreement identifies additional environmental radon monitoring locations and DOE guidance and EPA air monitor citing criteria were considered when selecting monitoring locations.

5.4.1 Continuous Radon Monitors

Continuous radon monitors use scintillation cells to evaluate environmental radon concentrations on an hourly average. Radon gas in ambient air diffuses into the scintillation cell through a foam barrier without the aid of a pump (this technique is called passive sampling). Inside the cell, radon decays into more radioactive material (progeny products), which gives off alpha particles. The alpha particles interact with the scintillation material inside the cell, producing light pulses that are amplified and counted. The number of light pulses counted is proportional to the radon concentration inside the cell.

Continuous monitors reveal variations in radon concentrations at different times during the day and at various locations on and off site. These monitors allow for the timely review of radon concentrations, to observe any significant variations from day to day and week to week that may occur. However, the location of potential monitoring sites is restricted by certain conditions, such as the availability of electricity.

Table 5–2 provides monthly average radon concentration data from the continuous radon monitors for 2006. The data are used to ensure the monthly trends will not lead to exceedances of DOE limits. In addition to the summary data presented here, Appendix C, Attachment C.2, provides graphical displays of monthly average radon concentrations from continuous radon monitors during 2006.

Results from the boundary monitoring locations indicate radon levels for 2006 were within historical ranges. The maximum annual average site boundary net radon concentration for 2006 was 0.4 pCi/L above background at PR-1, which is below the proposed 10 CFR 834 site boundary limit of 0.5 pCi/L above background. The annual average radon concentration at the background monitoring location was 0.3 pCi/L (refer to Table 5–2).

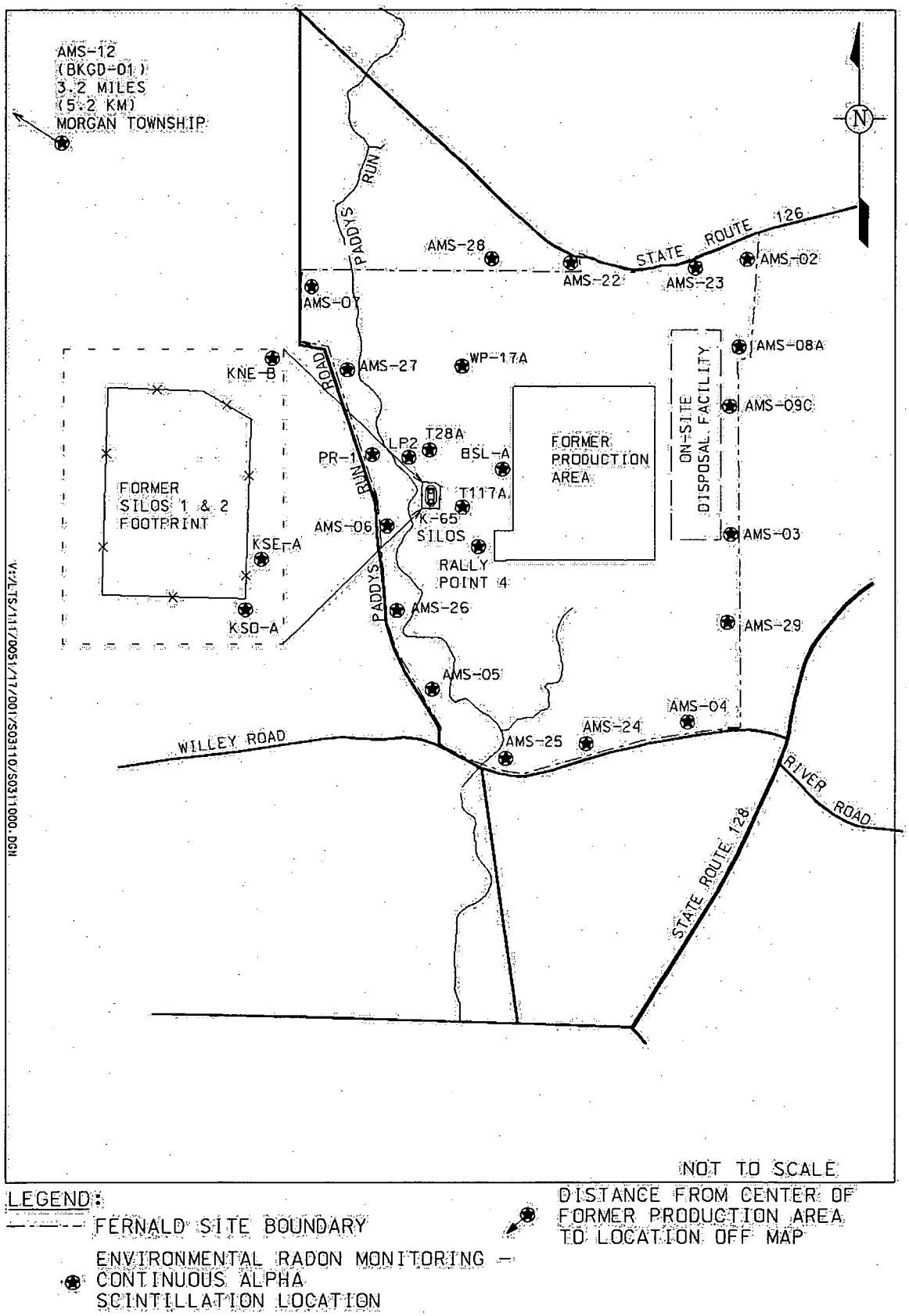


Figure 5–4. Radon Monitoring Locations

Table 5–2. Continuous Environmental Radon Monitoring Monthly Average Concentrations[a]

Location[b]	2006 Summary Results[c] (Instrument Background Corrected) (pCi/L)			2005 Summary Results[c] *(Instrument Background Corrected)* (pCi/L)		
	Min.	Max.	Avg.	Min.	Max.	Avg.
Boundary						
AMS-02	0.2	0.8	0.5	0.2	0.9	0.5
AMS-03	0.2	0.6	0.4	0.2	0.7	0.4
AMS-04[d]	0.2	0.3	0.3	0.1	0.6	0.4
AMS-05[d]	0.1	0.6	0.4	0.2	1.1	0.6
AMS-06	0.3	1.1	0.6	0.1	1.0	0.5
AMS-07[d]	0.3	0.5	0.4	0.2	1.1	0.6
AMS-08A	0.2	0.7	0.4	0.3	0.6	0.4
AMS-09C[d]	0.3	0.9	0.5	0.2	0.6	0.4
AMS-22[d]	0.2	0.5	0.3	0.2	0.5	0.3
AMS-23[d]	0.2	0.3	0.3	0.3	0.5	0.4
AMS-24	0.2	0.9	0.6	0.2	0.8	0.5
AMS-25[d]	0.4	0.6	0.5	0.3	0.8	0.6
AMS-26[d]	0.3	0.7	0.4	0.1	0.7	0.4
AMS-27[d]	0.5	0.9	0.6	0.2	1.0	0.5
AMS-28[d]	0.2	0.2	0.2	0.1	0.7	0.4
AMS-29[d]	0.2	0.6	0.4	0.3	0.6	0.4
Background						
AMS-12	0.1	0.5	0.3	0.2	0.6	0.4
On-Site						
KNE-B[d]	0.2	1.1	0.4	0.3	1.7	0.9
KSE-A[d]	0.3	1.3	0.5	0.2	1.5	0.8
KSO-A[d]	0.1	1.0	0.5	0.2	0.7	0.5
LP2[d]	0.1	1.2	0.4	0.1	0.6	0.3
PR-1[d]	0.3	2.2	0.7	0.2	1.3	0.6
Rally Point 4[d]	0.3	1.0	0.4	0.3	0.7	0.4
BSL-A[d]	0.3	1.3	0.5	0.1	0.6	0.3
T117-A[d]	0.4	1.1	0.5	0.3	0.8	0.5
T28-A[d]	0.3	1.3	0.6	0.3	0.9	0.6

[a]Monthly average radon concentrations are calculated from the daily average concentrations.
[b]Refer to Figure 5-4 for radon monitoring locations.
[c]Instrument background changes as monitors are replaced.
[d]Monitors were removed during 2006 based on the completion of activities (removal of Silos) and/or making way for demolition activities: AMS-04, 05, 07, 23, and 28 (April); KNE-B, KSE-A, KSO-A, LP2, PR-1, Rally Point 4, BSL-A, T117-A, T28-A (August); AMS-9C, 22, 26, 27, and 29 (November).

During the past 4 years, there were no exceedance events measured on-site related to the 100 pCi/L DOE limit, compared with 10 events recorded in 2002. The decrease in the exceedance events is attributable to the operation of the Radon Control System and the elimination of radon sources (i.e. silos waste material).

Long term comparisons have been performed on average radon concentrations recorded at the former K-65 Silos exclusion fence locations. Historical alpha track etch and continuous alpha scintillation detector data were used for this comparison (refer to Figure 5–5). The average concentrations adjacent to the former K-65 Silos remained below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

Long-term comparisons are also performed on average radon concentrations at western property boundary locations, which is closest to the radon source in the K-65 Silos project area, and background locations as a basis for comparison to the 0.5 pCi/L annual average limit. In 2006, there was no significant difference in radon concentrations between background and western property boundary monitoring locations (refer to Figure 5–6). The on-property monitoring locations also recorded radon levels well below the applicable DOE annual average above background limit (on-site) of 30 pCi/L.

5.5 Monitoring for Direct Radiation

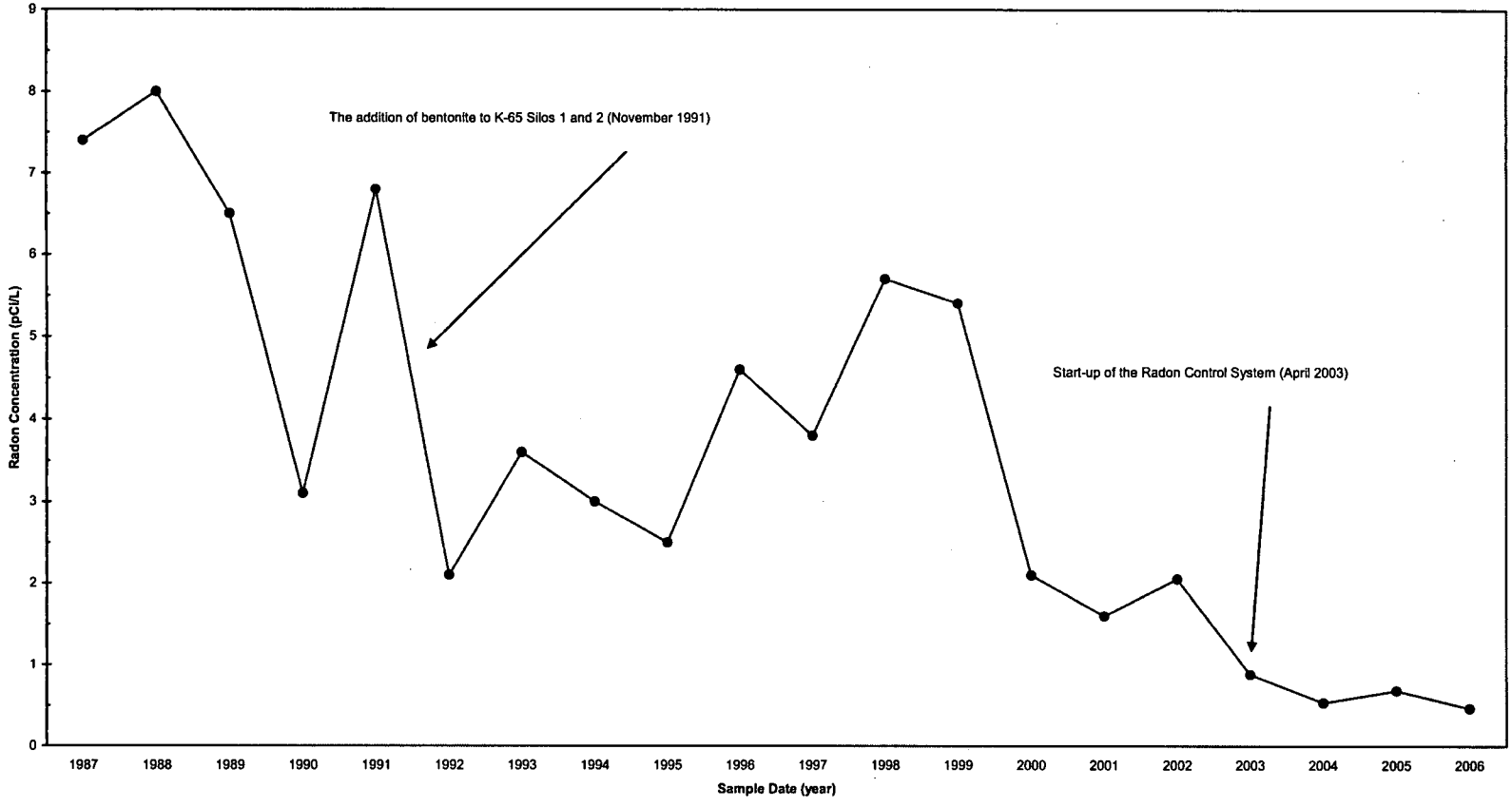
Direct radiation (e.g., x-rays, gamma rays, energetic beta particles, and neutrons) originates from sources such as cosmic radiation, naturally occurring radionuclides in soil and food, and radioactive materials at the Fernald site. The largest source of direct radiation was the silos waste materials. Gamma rays and x-rays are the dominant types of radiation that create a public exposure concern because they penetrate into the deep tissues of the body.

Direct radiation levels at and around the Fernald site were continuously measured with thermoluminescent dosimeters (TLDs) during 2006. TLDs absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions in a laboratory, the stored energy is released as light, measured, and correlated to the amount of direct radiation. Figure 5–7 identifies the TLD monitoring locations. These monitoring locations were selected based on the need to monitor the silos waste materials, the Fernald site boundary, and the background locations. Table 5–3 provides summary level information pertaining to direct radiation measurements for 2006 and 2005.

Table 5–3. Direct Radiation (Thermoluminescent Dosimeter) Measurement Summary

	Direct Radiation (mrem)	
TLD Location	**Summary of 2006 Results[ab]**	**Summary of 2005 Results**
Boundary		
Minimum	77	91
Maximum	84	110
On-Site		
Minimum	NA	85
Maximum	NA	781
Background		
Minimum	79	93
Maximum	79	104

[a] The minimum and maximum results presented for 2006 are based on those TLDs that remained in service through all four quarters of the year. None of the on-site TLDs remained in service through the entire year and only one background TLD remained in service through all four quarters. All of the TLD data for 2006 are presented in Appendix C.
[b]NA = not applicable



Note: The data from 1987 through 1996 are based on the alpha track-etch detectors and averaging locations corresponding to continuous radon monitors.
The data from 1997 through 2006 are based on the average radon concentration from continuous radon monitors at the former K-65 Silos exclusion fence.
The 2004 and 2005 averages include locations KNO and KSO data. The 2006 average includes location KSO data.
Also note that the annual average is below the applicable DOE Order 5400.5 radon limit of 30.0 pCi/L above background (on-site).

Figure 5–5. Annual Average Radon Concentrations at the Former K-65 Silos Exclusion Fence, 1987–2006

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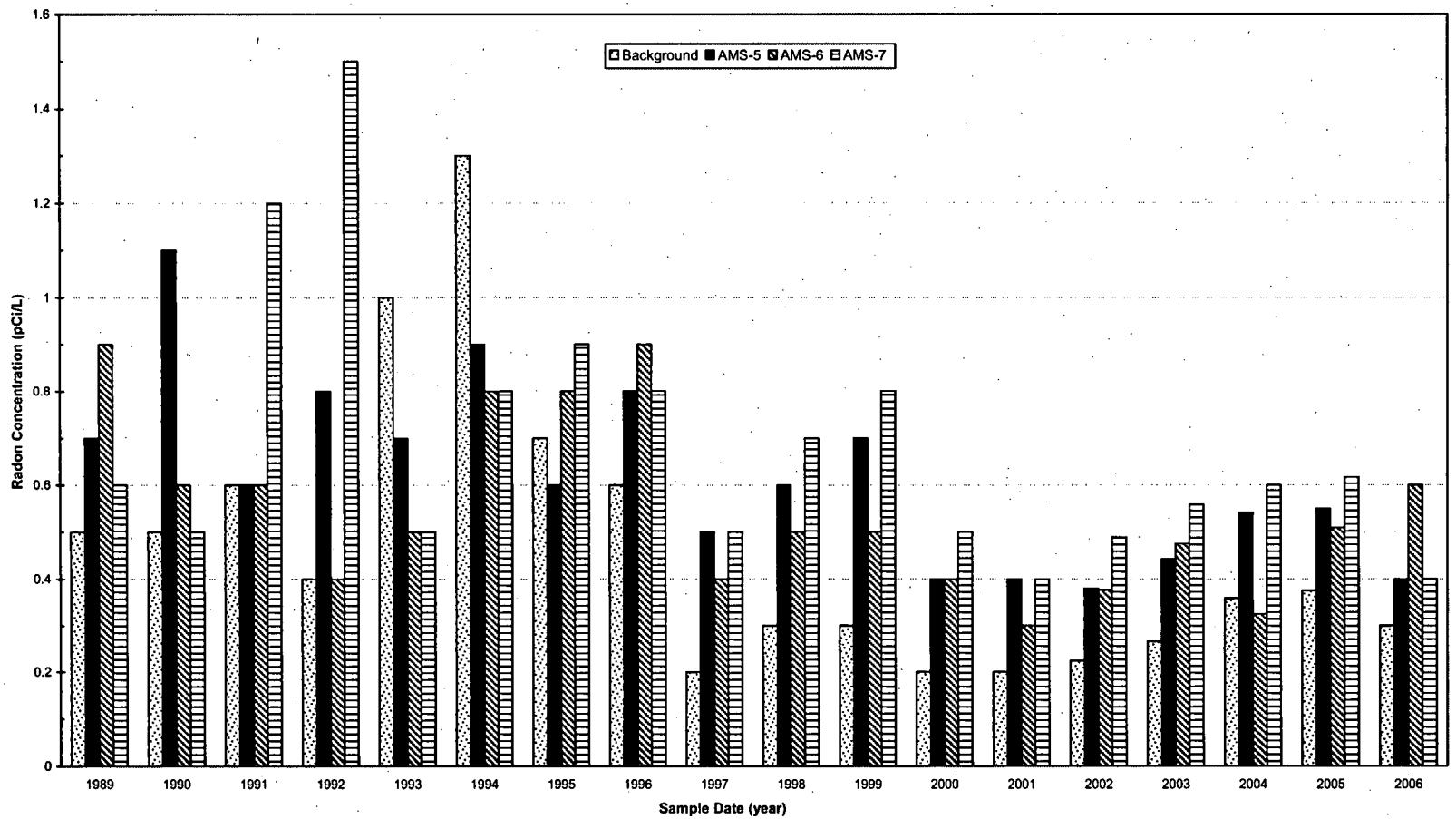

Note: The data from 1989 through 1996 are based on the alpha track-etch detectors, and the data from 1997 through 2006 are based on the continuous radon monitors. Also note that the background corrected annual average is below the applicable DOE Order 5400.5 radon limit of 0.5 pCi/L above background (property boundary).

Figure 5–6. Annual Average Radon Concentrations at Selected Radon Locations, 1989–2006

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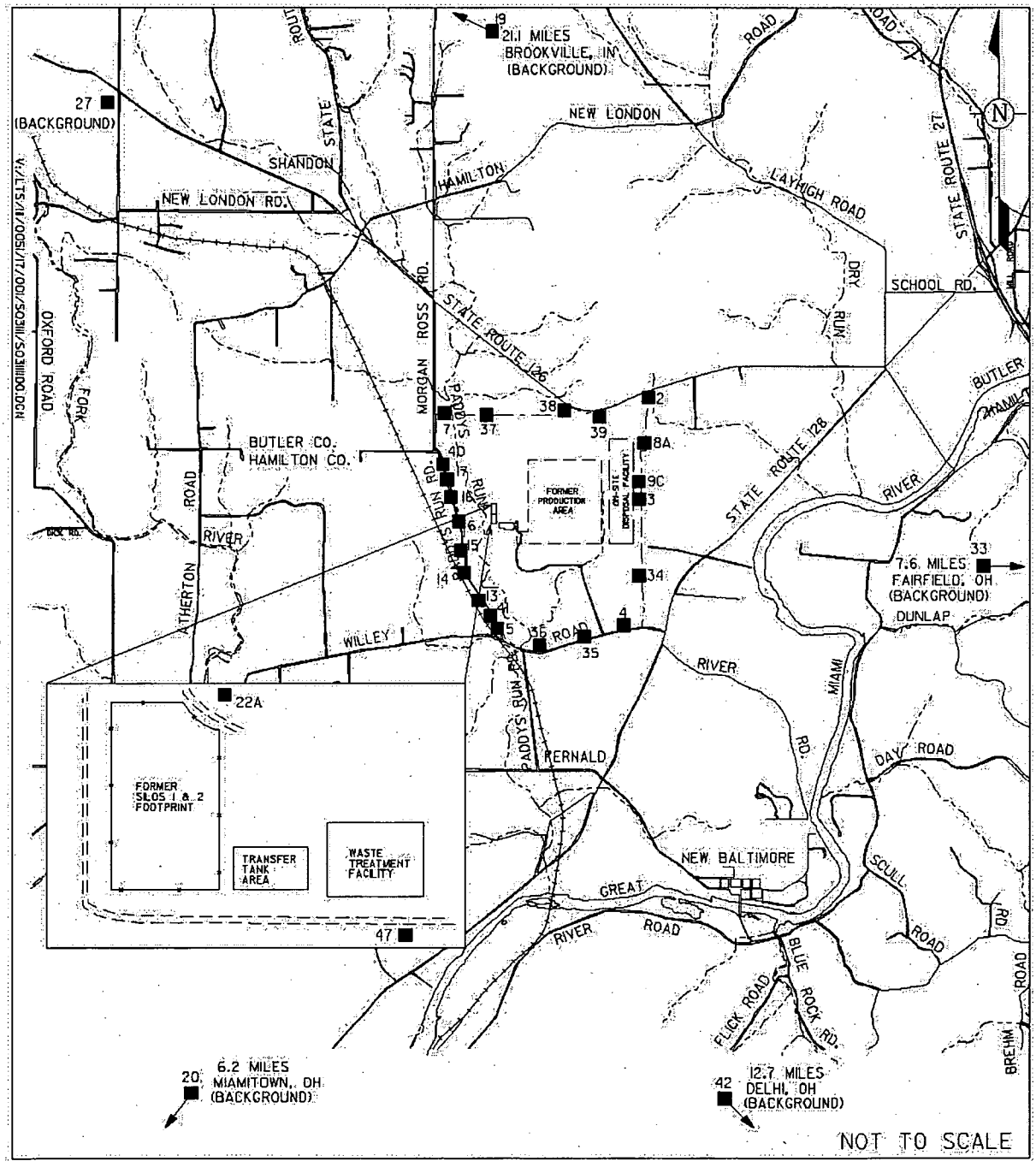
All monitoring results from TLDs for 2006 were within historical or expected ranges. During 2003, there was a significant decrease in the direct radiation levels, followed by a continuing decrease in 2004 (Figure 5–8). This was attributed to a reduction of the radon concentrations and associated decay products within the K-65 Silos' headspace. This reduction was accomplished through operations of the Radon Control System. A slight upward trend was noted at the end of 2004 and continued into 2005. This increase was most likely due to initiation of pumping operations to transfer K-65 Silo materials to the TTA, which subsided during the last half of 2005. Finally, the last shipment of material from Silos 1, 2, and 3 were shipped during the second quarter of 2006 and levels decreased.

During 2003, there was a significant decrease in background corrected direct radiation levels, particularly at TLD location 6, which is the closest location to the K-65 Silos. Between 2003 and 2006, direct radiation levels at TLD location 6 were essentially equivalent to background (Figure 5–9). These changes at the boundary are attributable to the reduction of radon concentrations by the operation of the Radon Control System and completion of the material transfer operations from the silos.

Historically, the maximum net radiation levels were measured at the site's western boundary; for 2005 and 2006, the maximum radiation level was monitored in the northeast quadrant of the site. This is reflective of changing conditions at the Fernald site and is a result of decreasing radiation levels near the Silos Project (site's western boundary). Chapter 6 provides more information on the dose associated with the direct radiation results. Detailed results of direct radiation measurements for 2005 and 2006 are provided in Appendix C, Attachment C.3.



LEGEND:

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO SAMPLE LOCATIONS OFF MAP

FERNALD SITE BOUNDARY

DIRECT RADIATION (TLD) MONITORING LOCATION

Figure 5–7. Direct Radiation (TLD) Monitoring Locations

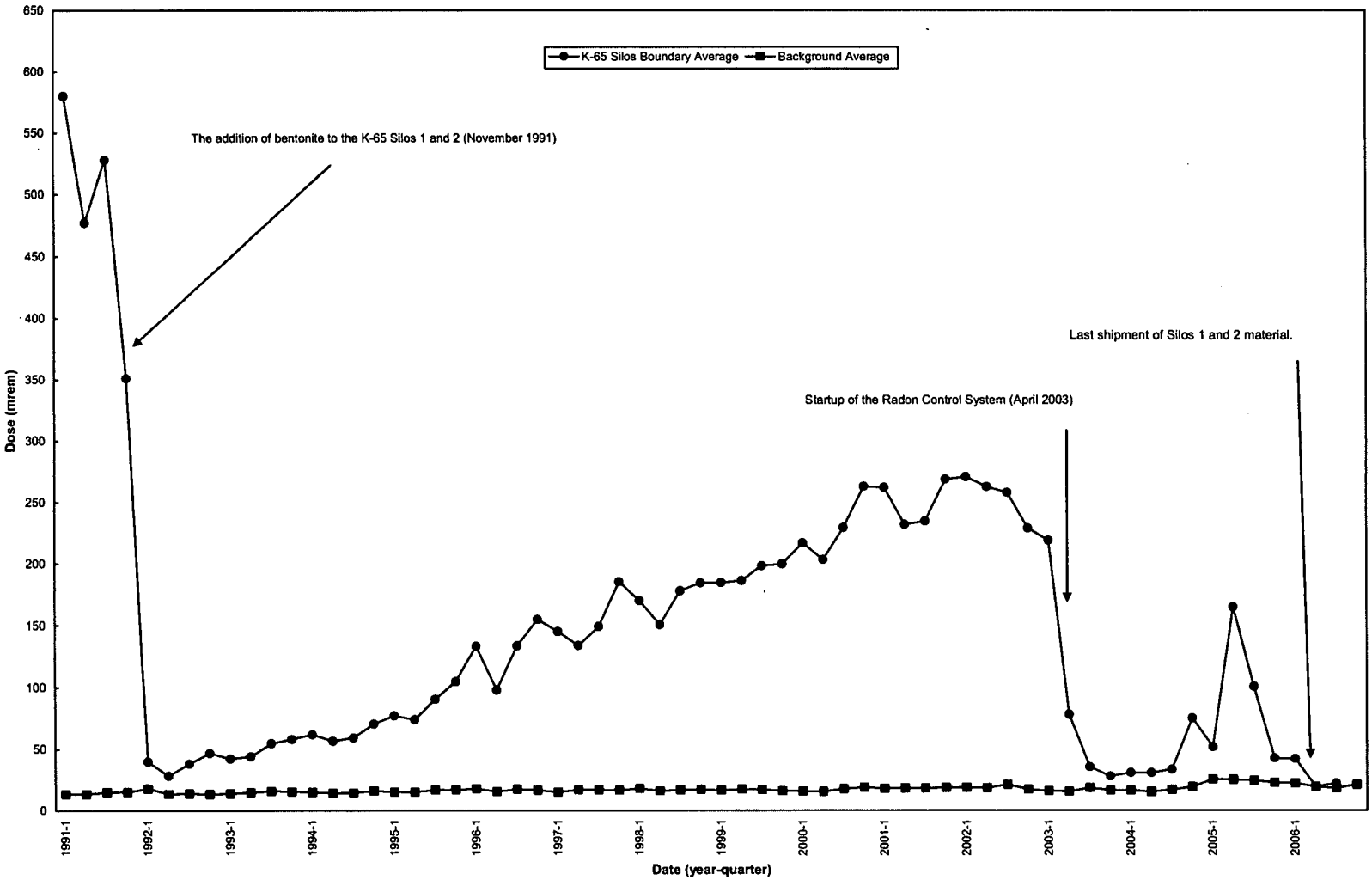


Figure 5–8. Direct Radiation (TLD) Measurements at Silos Boundary, 1991–2006 (Silos Boundary Average Versus Background Average)

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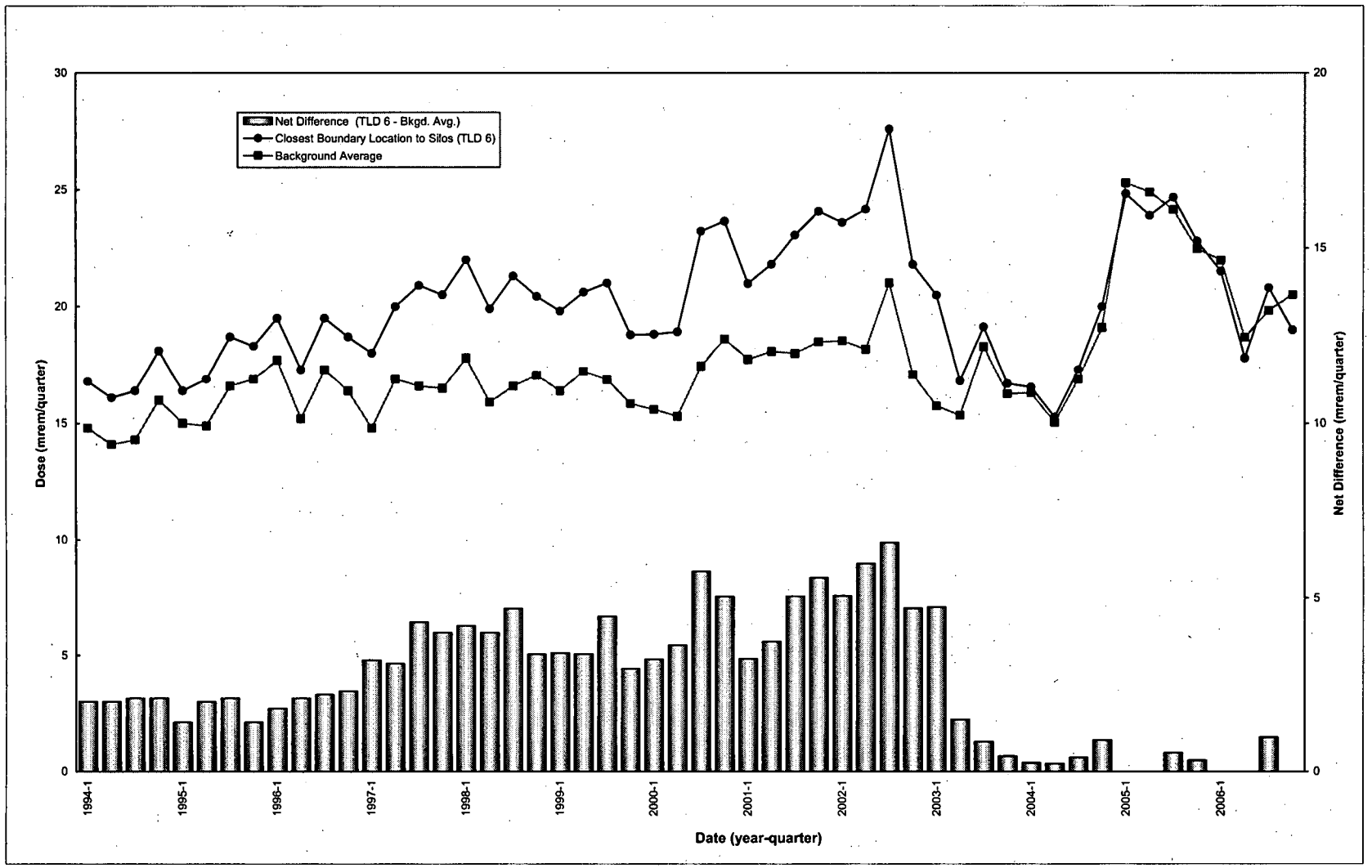

Figure 5–9. Quarterly Direct Radiation (TLD) Measurements, 1994–2006 (Location 6 Versus Background Average)

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6.0 Radiation Dose

Results in Brief: 2006 Estimated Doses

Airborne Emissions—The estimated maximum effective dose equivalent at the site boundary from 2006 airborne emissions (excluding radon) was 0.17 mrem/yr (0.0017 mSv/yr), which is 1.7 percent of the EPA NESHAP 10-mrem/yr dose limit.

Direct Radiation—The estimated 2006 effective dose equivalent at an off-site receptor location near the northeastern boundary of the site was 2.8 mrem/yr (0.028 mSv/yr). This is 2.8 percent of the 100-mrem/yr (1-mSv/yr) DOE limit.

Dose to the Maximally Exposed Individual—The dose to the maximally exposed individual for 2006 was estimated to be 2.8 mrem/yr (0.028 mSv/yr) at an off-site receptor location near the northeastern boundary of the site. This is 2.8 percent of the 100-mrem/yr (1-mSv/yr) DOE limit.

This chapter provides the estimated 2006 doses to the public, from air and direct radiation pathways and from remedial actions executed at the Fernald site. EPA NESHAP regulations require the Fernald site to demonstrate that the site's radionuclide airborne emissions are low enough to ensure that no one in the public receives an effective dose of 10 mrem/yr (0.1 milliSievert/year [mSv/yr]) or more. Moreover, to determine whether the Fernald site is in compliance with the DOE effective dose limit of 100 mrem/yr (1 mSv/yr) from all exposure pathways (excluding radon), estimates of dose due to direct radiation are combined with airborne emissions to estimate the total dose to the maximally exposed individual. This estimate reflects the incremental dose above background that is attributable to the site.

The DOE limits for radon and its decay products in air are provided in terms of concentrations rather than dose limits, and are addressed independently of the all-pathway dose limit. A concentration-based limit is used because dose calculations associated with radon and its decay products are highly sensitive to assumed exposure parameters, which are difficult to confirm with environmental measurements. However, dose estimates for radon have been included in response to public interest in radon exposures. A number of accepted calculations are presented to demonstrate the variation of radon doses as a function of each method of calculation. The radon dose estimates in this chapter can also be compared with radon dose estimates presented in previous annual site environmental reports and other radon dose studies, such as the study that resulted from the Fernald Dosimetry Reconstruction Project (Risk Assessments Corporation [RAC] 1996).

This chapter also provides an assessment of dose to aquatic organisms that may be affected by the site's effluent to nearby streams and rivers. An assessment of dose to biota (i.e., aquatic and terrestrial organisms) is one of the requirements of DOE Order 5400.5. By limiting the dose to aquatic organisms, DOE Order 5400.5 seeks to limit the severity and likelihood of off-site environmental impacts attributable to the cleanup and restoration efforts at the Fernald site. The dose assessment to biota is performed through the use of a computer model that estimates dose based on radionuclide concentrations in effluent discharged to the Great Miami River.

6.1 Estimated Dose from Airborne Emissions

The estimated dose from 2006 airborne emissions was calculated from annual average radionuclide concentrations measured at the 17 IEMP air particulate monitoring locations (1 background and 16 site boundary locations [refer to Figure 5–1 in Chapter 5 for the location of the air particulate monitoring locations]). The annual average background concentration was subtracted from the boundary concentrations in order to account for the natural occurrence of airborne radionuclides. Dose estimates were determined by converting the net annual average

radionuclide concentrations measured at each boundary monitoring location to doses using values listed in 40 CFR 61 (NESHAP) Subpart H, Appendix E, Table 2.

The maximum effective dose at the site boundary from 2006 airborne emissions was estimated to be 0.17 mrem/yr (0.0017 mSv/yr) and occurred at AMS-3 along the eastern boundary of the site. This dose estimate is based on the conservative assumption that a person remains outdoors at the AMS-3 location 24 hours a day for the entire year, the actual dose received by this receptor would be lower than 0.17 mrem/yr (0.0017 mSv/yr), because the nearest residence is located approximately 1,500 ft (460 m) downwind from AMS-3. The 2006 maximum site boundary dose is approximately one-third of the 2005 value (0.46 mrem/yr [0.0046 mSv/yr]). A lower value for 2006 reflects the completion of remedial actions (i.e., building demolition and soil excavation) and closure of the OSDF in October of 2006.

Figure 6–1 provides a comparison between the air-pathway doses at the background and maximum boundary locations with the annual NESHAP limit of 10 mrem/yr (0.1 mSv/yr). The background and maximum boundary doses shown on Figure 6–1 are due to the airborne concentration of radium, thorium, and uranium, and exclude contributions from radon (radon is excluded from the annual NESHAP limit of 10 mrem/yr [0.1 mSv/yr]). The maximum air-pathway dose of 0.17 mrem/yr (0.0017 mSv/yr) is in addition to the background dose of 0.08 mrem/yr (0.0008 mSv/yr), and represents 1.7 percent of the annual NESHAP limit. The estimated dose for each radionuclide at every boundary air monitor is provided in Appendix D.

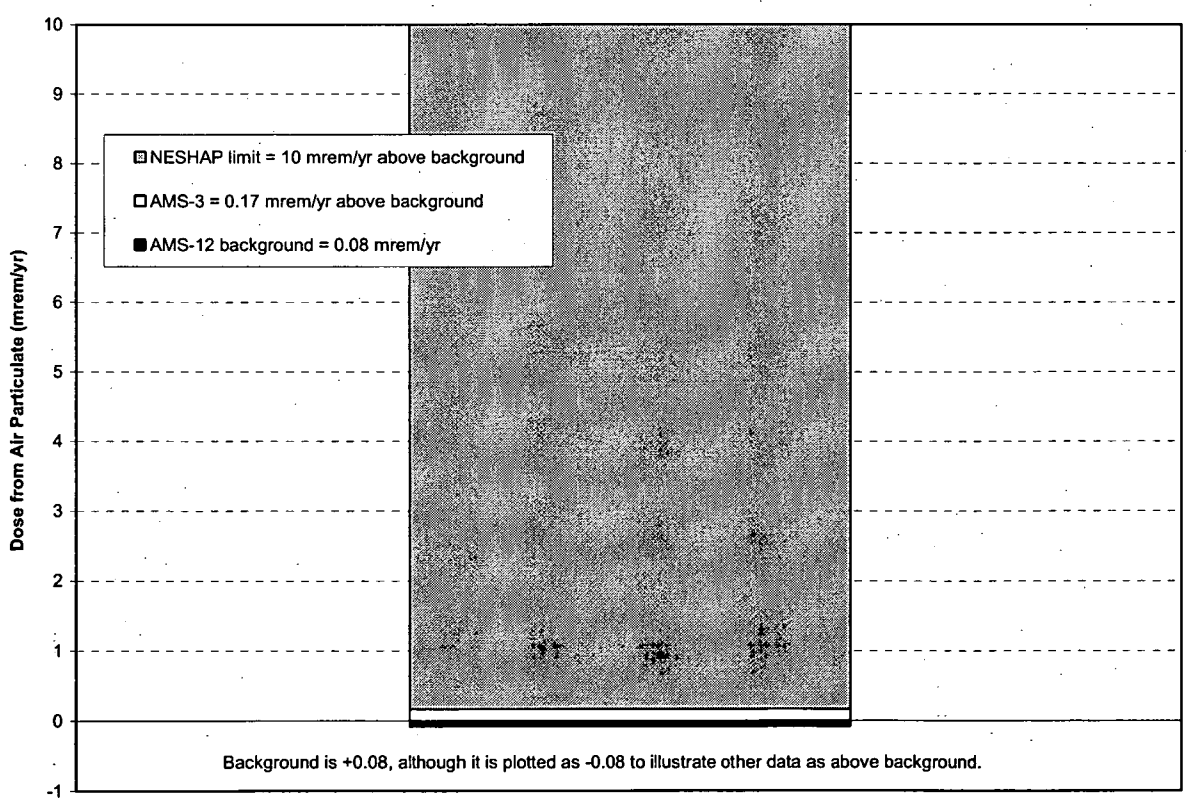

Figure 6–1. Comparison of 2006 Air-Pathway Doses and Allowable Limits

The collective effective dose from 2006 airborne emissions (excluding radon) to the population within 50 miles (80 km) of the Fernald site was estimated to be 0.49 person-rem (0.0049 person-Sievert [person-Sv]) for a population of 2.7 million. The collective effective population dose for all pathways (air and direct radiation) was estimated to be 0.52 person-rem (0.0052 person-Sv). The collective effective dose provides an aggregate measure of the impact of airborne emissions from the Fernald site to the population in the area. For comparison, background radiation from the sun and naturally occurring radionuclides in the earth and food products delivered an estimated collective effective dose of 300,000 person-rem (3,000 person-Sv) to the population within 50 miles of the Fernald site.

6.2 Direct Radiation Dose

Direct radiation dose is the result of gamma and x-ray radiation emitted from radionuclides stored or processed on-site. The largest source of direct radiation at the site was the waste materials stored in the silos. During radioactive decay of the silos waste materials, alpha particles, beta particles, gamma rays, and x-rays are emitted from the decaying nuclides. Direct radiation from the decay of radon progeny contributes a major fraction of the direct radiation from the silos waste materials.

The direct radiation dose for 2006 at the site boundary was estimated using the highest dose from the boundary monitoring locations and subtracting the background dose. This method provides a conservative estimate of direct radiation dose and measures the impact of radiation levels near the site boundary. From the data in Table 5–3, the maximum boundary measurement was 84 mrem/yr (0.84 mSv/yr) and occurred at TLD location 8. The average background dose from the one background TLD location was 79 mrem/yr (0.79 mSv/yr). It should be noted that during 2006, monitoring was discontinued after the third quarter at four of the five background locations. The difference in the TLD dose between location 8 and the background monitor (5 mrem/yr [0.05 mSv/yr]) is the estimated direct radiation dose for a hypothetical individual who stands at the boundary for one year, specifically at TLD location 8. In accordance with DOE Order 5400.5, which requires that realistic exposure conditions be used for conducting dose evaluations, an estimate of direct radiation dose was calculated for the residence nearest TLD location 8. This dose was estimated by using the net measurement at TLD location 8 and accounting for the distance between the boundary TLD location and the residence (approximately 5675 ft [1720 m]), which lowers the direct radiation dose to approximately 2.8 mrem/yr (0.028 mSv/yr). This estimate remains extremely conservative in that it assumes a person is present at this resident 24 hours per day for a full year, and it does not account for shielding provided by the structure of the house.

6.3 Total of Doses to Maximally Exposed Individual

The maximally exposed individual is the member of the public who receives the highest estimated effective dose based on the sum of the individual pathway doses. As shown in Table 6–1, the 2006 dose to the maximally exposed individual is the sum of the estimated doses from direct radiation and airborne emissions (excluding radon). The conservative assumptions used throughout the dose calculation process ensure that the dose to the maximally exposed individual is the maximum possible dose any member of the public could receive. The 2006 dose to the maximally exposed individual is estimated to be 2.8 mrem/yr (0.028 mSv/yr).

Table 6–1. Dose to Maximally Exposed Individual

Pathway	Dose Attributable to the Fernald Site	Applicable Limit
Direct radiation at AMS-8	2.8 mrem/yr	100 mrem/yr (total of all pathways)
Airborne emissions at AMS-8 (excluding radon)	0.037 mrem/yr	10 mrem/yr (air pathway)
Maximally exposed individual	2.8 mrem/yr	100 mrem/yr (total of all pathways)

The contributions to this all-pathway dose are:

- 2.8 mrem/yr (0.028 mSv/yr) from direct radiation to an off-site receptor, as measured at AMS-8, located near the northeastern boundary of the site.
- 0.037 mrem/yr (0.00037 mSv/yr) from air inhalation dose, as measured at AMS-8, to an off-site receptor located near the northeastern boundary of the site.

The estimate represents the incremental dose above background attributable to the Fernald site, exclusive of the dose received from radon. Figure 6–2 provides a comparison between the average background radiation dose at the background location (79 mrem/yr [0.79 mSv/yr]) and the all-pathway dose to the maximally exposed individual (2.8 mrem/yr [0.028 mSv/yr]). Figure 6–2 also provides a graphical comparison to the annual DOE all-pathway limit (100 mrem/yr [1 mSv/yr]).

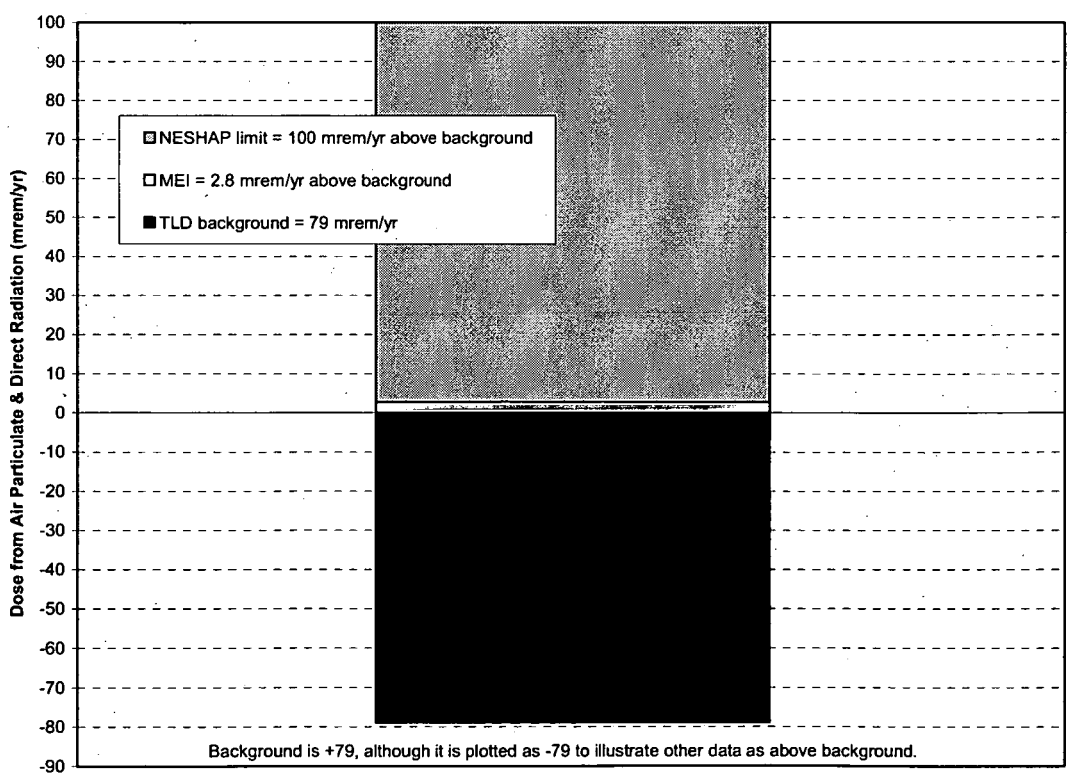

Figure 6–2. Comparison of 2006 All-Pathway Doses and Allowable Limits

6.4 Significance of Estimated Radiation Doses for 2006

One method of evaluating the significance of the estimated doses is to compare them with doses received from background radiation. Background radiation delivers an annual dose of approximately 100 mrem/yr (1 mSv/yr) from natural sources, excluding radon. For example, the dose received each year from cosmic and terrestrial background radiation contributes approximately 26 mrem/yr (0.26 mSv/yr) and 28 mrem/yr (0.28 mSv/yr), respectively. In addition, the background radiation dose will vary in different parts of the country. Living in the Cincinnati, Ohio area contributes an annual dose of approximately 110 mrem/yr (1.1 mSv/yr), whereas living in the Denver, Colorado area would contribute approximately 125 mrem/yr (1.25 mSv/yr) from background radiation (National Academy of Science [NAS] 1980, National Council on Radiation Protection and Measurements [NCRP] 1987). Comparing the maximally exposed individual dose to the background dose demonstrates that, even with the conservative estimates, the dose to the nearest resident from the Fernald site is much less than the natural background radiation dose. Although the estimated dose from the Fernald site will be received in addition to the background dose, this comparison provides a basis for evaluating the significance of the estimated doses.

Another method of determining the significance of the estimated doses is to compare them with dose limits developed to protect the public. The International Commission on Radiological Protection (ICRP) has recommended that members of the public receive fewer than 100 mrem/yr (1 mSv/yr) above background. As a result of this recommendation, DOE has incorporated 100 mrem/yr (1 mSv/yr) above background as the limit in DOE Order 5400.5. The sum of all estimated doses from site operations for 2006 (2.8 mrem/yr [0.028 mSv/yr]) is considerably below this limit.

6.5 Estimated Dose from Radon

Radon in the air decays to produce radioactive daughter products. Airborne daughter products attach to dust particles that may be inhaled and deposited within the lungs. As the daughter products decay, they emit electrostatically charged particles (alpha and beta particles) that may damage sensitive tissues of the lung. For exposures to radon and its daughters, the target organ for the radiation dose is the lung.

Radon dose estimate methodologies from the ICRP and the NCRP have been revised and updated over the years, with the net effect being a decrease in the estimated health damage (detriment) per unit of radiation exposure. The revisions were based on re-evaluations of studies that examine the detrimental health effects (e.g., epidemiological studies) on highly exposed worker populations (e.g., uranium miners). Therefore, radon dose estimates were generated for this report using the following four calculation methods:

- **Working Level-Month Determination**–Historically, exposure to radon and its daughters has been measured in the units of working levels, which is a measure of the activity of radon and its daughters in air. One working level is equivalent to an activity of 100 pCi/L of radon in 100 percent equilibrium with its daughters. An individual exposure is determined by multiplying the job-specific working level by the number of exposure hours and dividing this by 170 hours per month, yielding the exposure unit working level months (WLM). Working level months are provided in this annual report because this is the fundamental unit used by government agencies and private industries for all dose

conversion factors and coefficients associated with estimating a dose from radon and its daughters.

- **National Council on Radiation Protection and Measurements, Report 78 (NCRP 1984)**–This document, in part, provides equations for converting exposure from inhalation of radon daughter products to an equivalent lung dose. The calculation considers the whole lung as the target organ for the radiation exposure. A number of dose conversion factors and assumptions are used to equate the lung dose to a whole body radiation dose (i.e., effective dose equivalent). Equations from this report were used in previous annual site environmental reports and are presented here for direct comparison to estimates from previous years.
- **International Commission on Radiological Protection, Report 66 (ICRP 1994a) Tissue Weighting Factor Modification to NCRP Report 78 Equation**–This report introduced a specific tissue-weighting factor representing the localized radiation exposure from radon and its daughters to the bronchial epithelium (a specific region of the lung thought to be the source for lung cancer). Using the ICRP weighting factor in the NCRP equations from Report 78, results in a reduction of the effective dose by a factor of three. This calculation allows comparison to dose estimates provided in the Fernald Dosimetry Reconstruction Project, as performed by Risk Assessments Corporation under contract with the Centers for Disease Control.
- **ICRP Report 65 (ICRP 1994b)**–This report was released in 1994 and presents a methodology for calculating radon dose using detriment coefficients for estimating dose from exposure to radon and its daughters. The coefficients are based on epidemiological studies of the lung cancer rates among uranium miners, and the use of these coefficients results in a dose conversion factor of approximately 500 mrem per WLM.

Table 6–2 presents the 2006 radon dose estimates. Radon concentrations at the boundary and background locations, as well as DOE radon limits, are provided as the basis for the dose calculations. The estimated WLM exposures are given for each concentration value, assuming a radon daughter equilibrium concentration of 70 percent. Effective dose equivalents are calculated using the WLM results and the NCRP Report 78, ICRP Report 66, and ICRP Report 65 methods. All dose estimates are for a reference man of average body size and breathing rate who continuously breathes air at the site boundary while engaged in light, physical activity 24 hours a day for the entire year. The calculated dose to this maximally exposed reference man is very conservative, and the methodology of the ICRP Report 65 yields a dose of 50 mrem/yr (0.50 mSv/yr) above background.

As presented in Table 6–2, the maximum measured radon concentration and corresponding dose at the Fernald site boundary are below the limits associated with proposed 10 CFR 834 and DOE Order 5400.5. Although there are no regulatory limits for dose from radon and its daughters, the radon concentration limits proposed by 10 CFR 834 and DOE Order 5400.5 provide a benchmark for evaluating the estimated doses from radon at the Fernald site boundary. In 10 CFR 834, the annual average radon concentration limit at the facility boundary is 0.5 pCi/L above background. Using the ICRP 65 methodology, this concentration equates to an effective dose equivalent of 100 mrem/yr (1 mSv/yr). In DOE Order 5400.5, the annual average radon concentration limit at the site boundary is 3 pCi/L above background. Using the ICRP 65 methodology, this concentration equates to an effective does equivalent of 550 mrem/yr (5.5 mSv/yr).

Table 6–2. 2006 Radon Dose Estimate[a]

Location	Radon Concentration (pCi/L)[a,b]	Exposure in Working Level Months[b]	NCRP Report 78 Effective Dose Equivalent Equation (mrem)[b,c]	NCRP Report 78 Effective Dose Equivalent Equation (mrem)[b,d]	ICRP Report 65 Effective Dose Equivalent (mrem)[b,e]
Background	0.3	0.1	200	70	50
Fernald Site Boundary Nearest Receptor (net, above background)	ND	NA	NA	NA	NA
Maximum Boundary (net, above background)	0.3	0.1	200	70	50
10 CFR 834 Limit (net, above background)	0.5	0.2	400	140	100
DOE Order 5400.5 Limit (net, above background)	3.0	1.1	2,200	770	550

[a]Assuming the suggested environmental radon daughter equilibrium concentration of 70 percent.
[b]ND = non-detectable
NA = not applicable, because no net dose was measured at the nearest receptor
[c]NCRP report 78 suggests whole lung tissue weighting factor of 0.12.
[d]NCRP Report 78 calculation using the ICRP Report 66 bronchial epithelium weighting factor of 0.04.
[e]Using the dose conversion factor for the maximally exposed reference person.

6.6 Estimated Dose to Biota

DOE Order 5400.5 requires that populations of aquatic biota be protected at a dose limit of 1 rad/day (10 milliGray per day [mGy/day]). The DOE has issued a technical standard entitled, *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002b), and supporting software (RAD-BCG), for use in the evaluation and reporting of biota dose limits.

In general, the dose and compliance assessment process involves comparing radionuclide concentrations measured in surface water or sediment samples to established Biota Concentration Guides (BCGs). The BCGs are set so that biota exposed at the BCG level would not be expected to exceed the biota dose limit of 1 rad/day (10 mGy/day) during a calendar year. The measured radionuclide concentration in water or sediment is divided by the appropriate BCG value and, if the resulting fraction is less than 1.0, compliance with the biota dose limit is demonstrated for that nuclide. BCGs have been established for radionuclides that are relatively common constituents in past releases to the environment from DOE facilities. At facilities such as Fernald, where multiple contaminants (e.g., radium, thorium, and uranium) can be released, a "sum of the fractions" rule applies. The sum of the fractions means each radionuclide fraction (i.e., the measured concentration divided by the BCG for that nuclide) must be summed and the sum of all nuclide fractions must be less than 1.0.

For 2006, compliance with the dose limit to aquatic biota was determined by using the maximum concentrations of applicable radionuclides found in effluent discharged to the Great Miami River and Paddys Run (refer to Chapter 4), and mixing this with the low-flow volume from the Great Miami River to derive input concentrations to the RAD-BCG computer model. The results of this assessment indicate that the sum of the fractions for radium, strontium, technetium, thorium, and uranium isotopes is 0.062, which is well below the compliance threshold value of 1.0. Attachment C.5 provides additional information on the biota dose assessment.

End of current text

7.0 Natural Resources

This chapter provides background information on the natural resources associated with the Fernald site and summarizes the activities in 2006 relating to these resources. Included in this chapter is a discussion of the following:

- Threatened and endangered species.
- Impacted habitat areas.
- Ecological restoration activities.
- Cultural resources.

Much of the 1,050 acres (425 hectares) of the Fernald site property is undeveloped land that provides habitat for a variety of animals and plants. Wetlands, deciduous and riparian (stream side) woodlands, old fields, grasslands, and aquatic habitats are among the site's natural resources. Some of these areas provide habitat for state and federal endangered species. Cultural resources, such as prehistoric archaeological sites, can also be found at the Fernald site. Monitoring of these natural and cultural resources is addressed in the Natural Resource Monitoring Plan, which is included in the IEMP. The Natural Resource Monitoring Plan presents an approach for monitoring and reporting the status of several priority natural resources in order to remain in compliance with pertinent regulations and agreements.

7.1 Threatened and Endangered Species

Sloan's Crayfish - The state-listed threatened Sloan's crayfish (*Orconectes sloanii*) is found in southwest Ohio and southeast Indiana. It prefers streams with constant (though not necessarily fast) current flowing over rocky bottoms. A large, well-established population of Sloan's crayfish is found at the Fernald site in the northern reaches of Paddys Run.

Indiana Brown Bat - The federally listed endangered Indiana brown bat (*Myotis sodalis*) forms colonies in hollow trees and under loose tree bark along riparian (stream side) areas during the summer. Excellent habitat for the Indiana brown bat has been identified at the Fernald site along the wooded banks of the northern reaches of Paddys Run. The habitat provides an extensive mature canopy of older trees and water throughout the year. One Indiana brown bat was captured and released on the property in August 1999.

Running Buffalo Clover - The federally listed endangered running buffalo clover (*Trifolium stoloniferum*) is a member of the clover family whose flower resembles that of the common white clover. Its leaves, however, differ from white clover in that they are heart-shaped and a lighter shade of green. Running buffalo clover has not been identified at the Fernald site; however, because running buffalo clover is found nearby in the Miami Whitewater Forest, the potential exists for this species to become established at the site. The running buffalo clover prefers habitat with well-drained soil, filtered sunlight, limited competition from other plants, and periodic disturbances. Suitable habitat areas include partially shaded former grazed areas along Paddys Run and the storm sewer outfall ditch.

Spring Coral Root - The state-listed threatened spring coral root (*Corallorhiza wisteriana*) is a white and red orchid that blooms in April and May, and grows in partially shaded areas of forested wetlands and wooded ravines. This plant has not been identified at the Fernald site; however, suitable habitat exists in portions of the northern woodlot.

The Endangered Species Act requires the protection of any federally listed threatened or endangered species and any habitat critical for the species' existence. Several Ohio laws mandate the protection of state-listed endangered species as well. Since 1993 a number of surveys have been conducted to determine the presence of any threatened or endangered species at the Fernald site. As a result of these surveys, the federally endangered Indiana brown bat and the state-threatened Sloan's crayfish have been found at the Fernald site. In addition, suitable habitat exists at the Fernald site for the federally endangered running buffalo clover and the state-threatened spring coral root. Neither of these species has been found on the property, but their habitat ranges encompass the Fernald site. Figure 7–1 shows the habitats and potential habitats of these species. Based on provisions set forth in the IEMP, any threatened or endangered species habitat will be surveyed prior to any remediation or restoration activities. If threatened or endangered species are present, appropriate avoidance or mitigation efforts will be taken. No surveys were conducted during 2006.

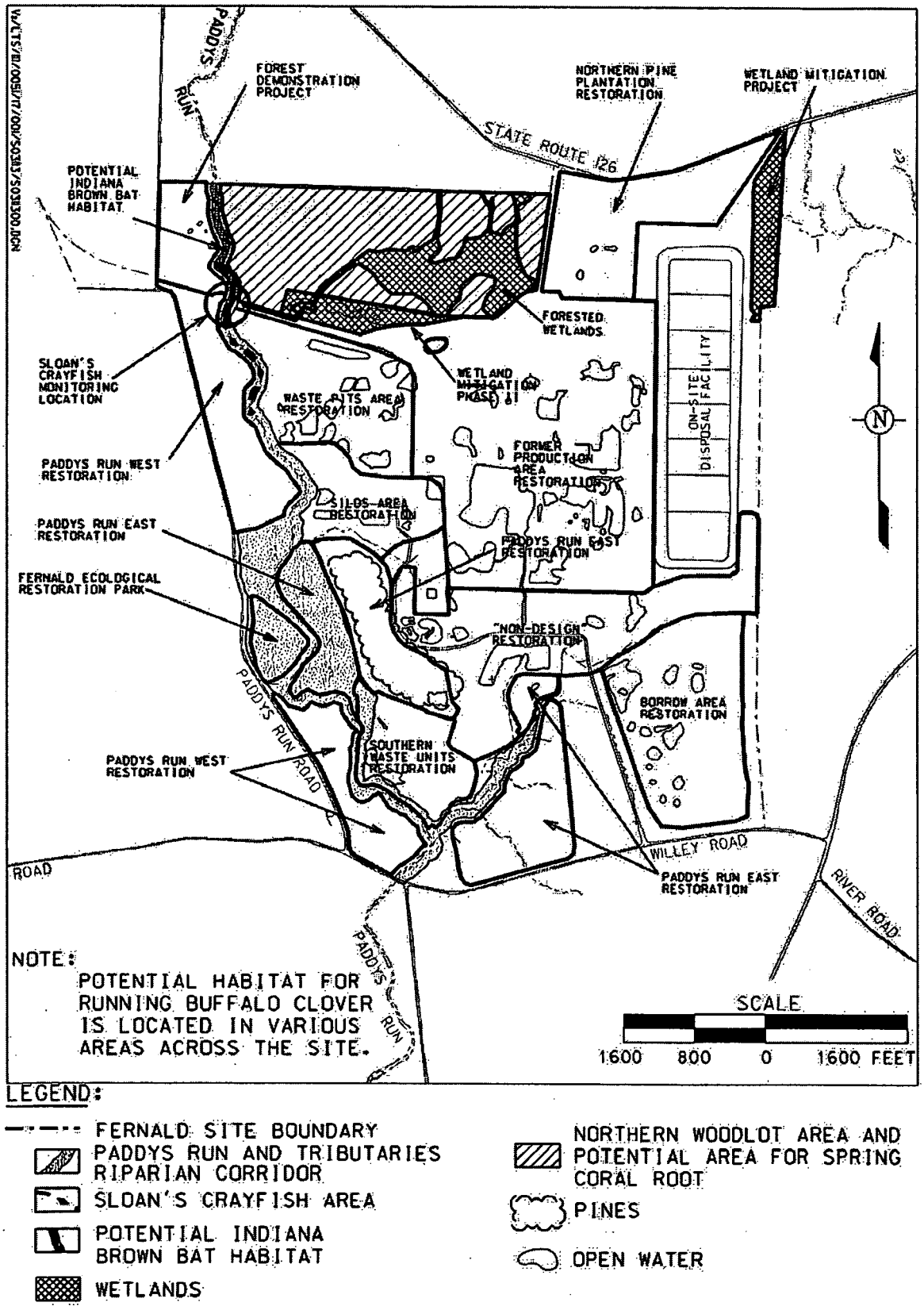

Figure 7–1. Priority Natural Resource Areas

7.1.1 Sloan's Crayfish Monitoring and Provisions for Protection

A Sloan's crayfish survey was conducted in August 2001 in order to determine if there were any impacts following debris removal near Paddys Run in Area 1, Phase III. The survey results from the 2001 sampling effort demonstrated that the Paddys Run Sloan's crayfish population was not impacted by the debris removal operation. A large number of Sloan's crayfish were observed downstream and upstream of the project area. Researchers did note a general decline in the ratio between Sloan's crayfish and *Orconectes rusticus*, which is a larger, more aggressive crayfish species that often competes with the Sloan's crayfish. Similar trends are observed statewide and are attributed to the aggressive nature of *Orconectes rusticus*.

Several more recent activities have taken place to ensure the protection of the Sloan's crayfish habitat at the Fernald site. Turbidity observations were conducted when construction activities had the potential to increase sediment loading into crayfish habitat. More recently, DOE and the regulatory agencies decided to keep the former train trestle in place rather than dismantle it. This decision was based in part on the potential for impacts to the Paddys Run Sloan's crayfish habitat that would result from demolishing the trestle. With site remediation complete, Sloan's crayfish habitat will continue to be protected as part of legacy management activities.

7.2 Impacted Habitat

DOE and the Natural Resource Trustees tentatively agreed that it would not be necessary to quantitatively assess habitat impacted through remediation because DOE will be conducting natural resource restoration on approximately 900 acres (364 hectares) of the Fernald site. A summary of the year's habitat impacts is presented here.

Approximately two acres of habitat was impacted in order to excavate contaminated soil from a wooded hillside north of the Fernald Ecological Restoration Park. In addition to the excavation footprint, an access road was constructed in order to haul material for final disposition. The road cut through approximately four acres of previously restored prairie, old field, and woodland habitat. The road also crossed Paddys Run at the Southern Waste Units restored area. All impacted areas were reseeded with native grasses and wildflowers. Erosion matting was used on slopes as appropriate. The stream crossing actually resulted in a beneficial reuse. It was converted into a "Newbury Riffle," which is a stream habitat-improvement structure that helps reduce erosion.

Clean concrete debris was reused in the Southern Waste Units to stabilize an eroding bank. The concrete was strategically placed to create habitat for a variety of amphibians and reptiles, including the state-endangered cave salamander (*Eurycea lucifuga*). In order to access the area during construction, about 0.5 acre of restored dry prairie was impacted. This area was reseeded, along with the soil placed over the concrete debris.

7.3 Ecological Restoration Activities

The completion of remedial activities in 2006 also marked the end of ecological restoration construction activities at the Fernald site. The Former Production Area, the Waste Pits Area, the Silos Area, and the Borrow Area were all completed. Additional "non-design" areas were also restored, including the Storm Water Retention Basin and various construction support areas. In

total, approximately 300 acres of remediated areas were graded, seeded, or planted in 2006. These efforts will result in the creation of 240 acres of prairie grassland, 20 acres of wetlands, and 40 acres of open water. The new site mission of long-term stewardship under Legacy Management will focus on establishment, management, and improvement of these restored areas.

Ecological restoration monitoring has been divided into two phases: the implementation phase and the functional phase. Implementation phase monitoring is conducted to ensure that restoration projects are completed as intended in their designs. This effort involves the mortality counts and herbaceous cover estimates that are conducted after a project is completed. Functional phase monitoring is more general and considers projects in terms of their contribution to the ecological community as a whole. This is accomplished by comparing projects to pre-remediation baseline conditions and to ideal reference sites. Mortality and herbaceous cover thresholds are described in the *2002 Consolidated Monitoring Report for Restored Areas at the Fernald Closure Project* (DOE 2003b).

In 2006, implementation monitoring was conducted for Paddys Run East and Paddys Run West, and was initiated for the Borrow Area. Mortality counts and herbaceous cover estimates were calculated across each of these projects. Overall plant survival was generally at or above 80 percent. The continued use of deer exclusion fencing has proven beneficial at the Fernald site. Water levels were also measured to monitor the performance of the newly constructed wetlands in the Phase II Wetland Mitigation Project and the Borrow Area. Pursuant to the Natural Resource Restoration Plan, functional monitoring efforts were completed in 2005, so no additional monitoring was conducted in 2006.

Common Arrowhead (Sagittaria latifolia) Grows in Many of the Restored Wetlands at the Fernald Site

7.4 Cultural Resources

The Fernald site and surrounding area are located in a region of rich soil and many sources of water, such as the Great Miami River. Because of its advantageous location, the area was settled repeatedly throughout prehistoric and historic time, resulting in richly diverse cultural resources. In summary, 148 prehistoric and 40 historic sites have been identified within 1.24 miles (2 km) of the Fernald site.

Several laws have been established to protect cultural resources during remedial activities at the Fernald site. The National Historic Preservation Act requires DOE to consider the effects of its actions on sites that are listed or eligible for listing on the National Register of Historic Places. The Native American Graves Protection and Repatriation Act requires that prehistoric human remains and associated artifacts be identified and returned to the appropriate Native American tribe.

To comply with these laws, DOE conducted archeological surveys prior to remediation activities in undeveloped areas of the Fernald site. Figure 7–2 shows the areas of the Fernald site that have been surveyed. These surveys have resulted in the identification of six sites that may be eligible for listing on the National Register of Historic Places. None of these sites were impacted by remediation activities and no additional surveys were required in 2006.

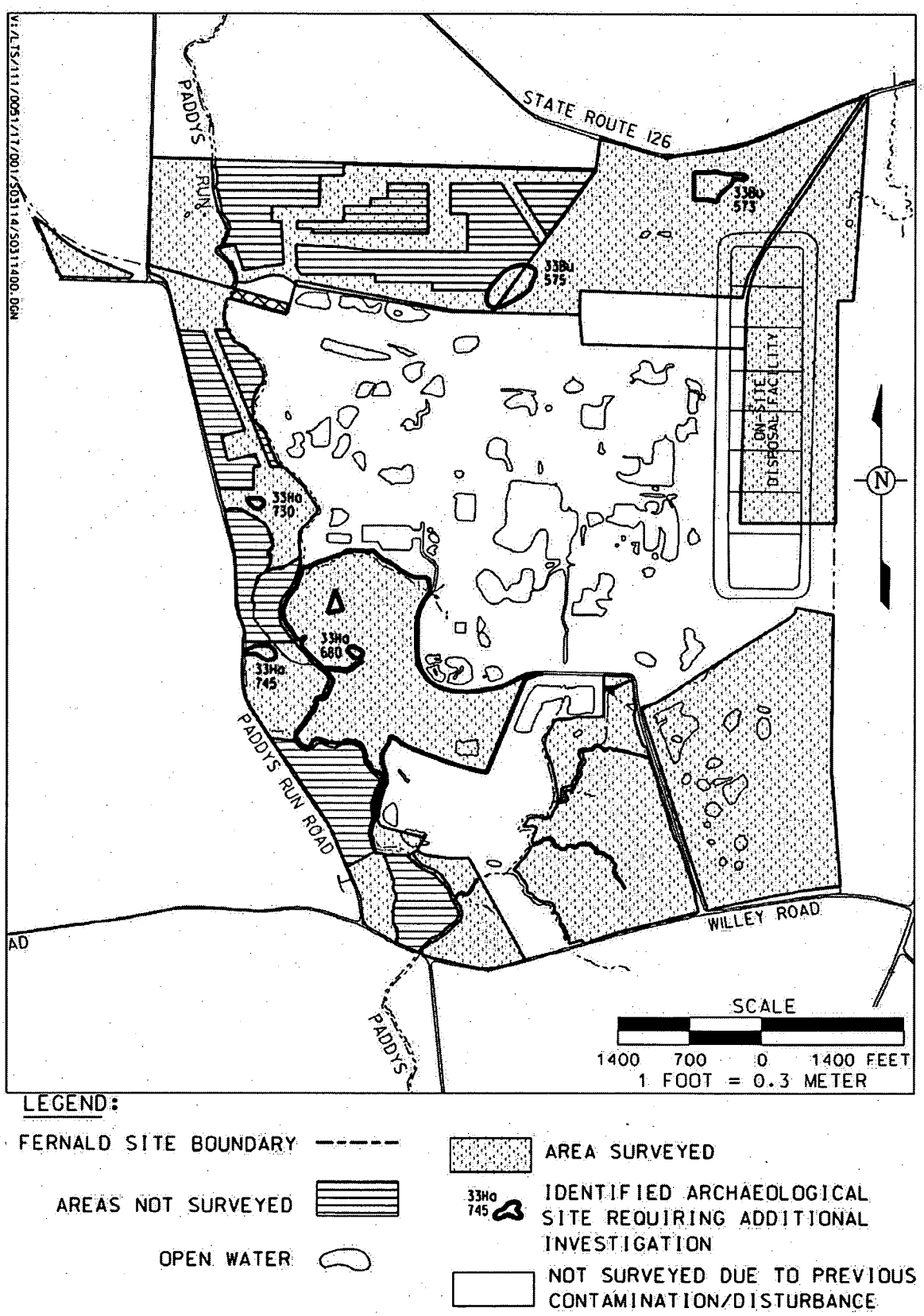

Figure 7–2. Cultural Resource Survey Areas

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9.0 Glossary

ALARA—An acronym for "as low as reasonably achievable." Used to describe an approach to radiation exposure and emissions control or management, whereby exposures and resulting doses to workers and the public are maintained as far below the specified limits as economic, technical, and practical considerations will permit.

Alpha Particle—Type of particulate radiation emitted from the nucleus of an atom. It consists of two protons and two neutrons. It does not travel long distances and loses its energy quickly.

Aquifer—A geologic formation, group of formations, or part of a formation that contains sufficient saturated permeable material to yield economical quantities of water to wells and springs.

ARARs—An acronym for "applicable or relevant and appropriate requirements." Requirements set forth in regulations that implement environmental and public health laws and must be attained or exceeded by a selected remedy unless a waiver is invoked. ARARs are divided into three categories: chemical-specific, location-specific, and action-specific, based on whether the requirement is triggered by the presence or emission of a chemical, by a vulnerable or protected location, or by a particular action.

Background Radiation—Particle or wave energy spontaneously released from atomic nuclei in the natural environment, including cosmic rays and such releases from naturally radioactive elements outside and inside the bodies of humans and animals, and fallout from nuclear weapons tests.

Beta Particle—Type of particulate radiation emitted from the nucleus of an atom that has a mass and charge equal in magnitude to that of the electron.

Bypass Events—A bypass event occurs when storm water is diverted around water treatment facilities and is directly discharged to the Great Miami River via the Fernald site effluent line. Bypass events can occur during sizeable precipitation or when water treatment facilities are down for maintenance. Bypassing treatment is only implemented when the site's storm water retention capacity is in danger of being exceeded.

Capture Zone—Estimated area that is being "captured" by the pumping of groundwater extraction wells. The definition of the capture zone is important in ensuring that the uranium plumes targeted for cleanup are being remediated.

Certification—The process by which a soil remediation area is certified as clean. Samples from the area are collected and analyzed, and then the contaminant levels are compared to the final remedial levels established in the Operable Unit 5 Record of Decision. Not all soil remediation areas at the Fernald site require excavation before certification is done.

Contaminant—A substance that when present in air, surface water, sediment, soil, or groundwater above naturally occurring (background) levels causes degradation of the media.

Controlled Runoff—Contaminated storm water requiring treatment; it is collected, treated, and eventually discharged to the Great Miami River as treated effluent.

Curie (Ci)—Unit of radioactivity that measures the rate of spontaneous, energy-emitting transformations in the nuclei of atoms.

Dose—Amount of radiation absorbed in tissue.

Ecological Receptor—A biological organism selected by ecological risk assessors to represent a target species most likely to be affected by site-related chemicals, especially through bioaccumulation. Such organisms may include terrestrial and aquatic species.

Effective Dose Equivalent—The sum of the products of the dose equivalent received by specified tissues of the body and tissue-specific weighting factor. This sum is a risk-equivalent value and can be used to estimate the risk of health effects to the exposed individual. The tissue-specific weighting factor represents the fraction of the total health risk resulting from uniform whole-body irradiation that would be contributed by that particular tissue. The effective dose equivalent includes the committed effective dose equivalent from internal deposition of radionuclides and the effective dose equivalent due to penetrating radiation from sources external to the body. Effective dose equivalent is expressed in units of rem or sievert.

Exposure Pathway—A route materials can travel between the point of release and the point of delivery of a radiation or chemical dose to a receptor organism.

Flyash—The ash remaining after burning coal in a boiler plant.

Gamma Ray—Type of electromagnetic radiation of discrete energy emitted during radioactive decay of many radioactive elements.

Glacial Overburden/Glacial Till—Silt, sand, gravel, and clay deposited by glacial action on top of the Great Miami Aquifer and surrounding bedrock highs.

Great Miami Aquifer—Sand and gravel deposited by the meltwaters of Pleistocene glaciers within the entrenched ancestral Ohio and Miami rivers. This is also called a buried channel or a sand and gravel aquifer.

Groundwater—Water in a saturated zone or stratum beneath the surface of land.

Head Works—Includes the various flow equalization basins or preliminary treatment units that serve as the central collection and distribution points to the wastewater treatment operations in the main facility.

Mixed Waste—Hazardous waste that has been contaminated with low-level radioactive materials.

Opacity—The amount of light that is blocked by particulates present in stack emissions.

Overpacking—The act of placing a deteriorating drum inside a new, larger drum to prevent further deterioration or the possible release of contaminants during storage.

Point Source—The single defined point (origin) of a release such as a stack, vent, or other discernable conveyance.

Radiation—The energy released as particles or waves when an atom's nucleus spontaneously loses or gains neutrons or protons. The three main types are alpha particles, beta particles, and gamma rays.

Radioactive Material—Refers to any material or combination of materials that spontaneously emits ionizing radiation.

Radionuclide—Refers to a radioactive nuclide. There are several hundred known radionuclides that are artificially produced and naturally occurring. Radionuclides are characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay processes.

Receptors—Individuals or organisms that are or can be impacted by contamination.

Remedial Action—The actual construction and implementation phase of a Superfund site cleanup that follows the remedy selection process and remedial design.

Remedial Investigation/Feasibility Study—The first major event in the remedial action process that serves to assess site conditions and evaluate alternatives to the extent necessary to select a remedy.

Removal Action—A short-term cleanup or removal of released hazardous substances from the environment. This occurs in the event of a release or the imminent threat of release of hazardous substances into the environment.

Roentgen Equivalent Man (Rem)—A special unit of dose equivalent that expresses the effective dose calculated for all radiation on a common scale; the absorbed dose in rads multiplied by certain modifying factors (e.g., quality factor); 100 rem = 1 sievert.

Sediment—The unconsolidated inorganic and organic material that is suspended in surface water and is either transported by the water or has settled out and become deposited in beds.

Source—A controlled source of radioactive material used to calibrate radiation detection equipment. Can also be used to refer to any source of contamination (e.g., a point source such as the stack on the waste pits stack, a source of radon such as the silos' headspace, etc.).

Surface Water—Water that is flowing within natural drainage features.

Treated Effluent—Water from numerous sources at the site that is treated through one of the site's wastewater treatment facilities and discharged to the Great Miami River.

Thermoluminescent Dosimeter—A device used to monitor the amount of radiation absorbed and stored within the thermoluminescent material.

Uncontrolled Runoff—Storm water that is not collected by the site for treatment, but enters the site's natural drainages.

Volatile Organic Compound—A hydrocarbon compound, except methane and ethane, with a vapor pressure equal to or greater than 0.1 millimeter of mercury.

Waste Acceptance Criteria—Disposal facilities specify the types and sizes of materials, acceptable levels of constituents, and other criteria for all material that will be disposed in that facility. These are known as waste acceptance criteria. Off-site disposal facilities (such as the Nevada Test Site) that dispose of Fernald waste have specific waste acceptance criteria. In addition, the on-site disposal facility had waste acceptance criteria that were approved by the regulatory agencies. The Waste Acceptance Organization was responsible for ensuring that all waste placed in the on-site disposal facility met all of the applicable criteria before waste placement.

Document 6740

DOE–LM/1461–2007

Fernald 2006 Site Environmental Report

2006 Environmental Summary (Appendixes A Through D)

May 2007

U.S. Department of Energy

Office of Legacy Management

Work Performed Under DOE Contract No. DE–AC01–02GJ79491
for the U.S. Department of Energy Office of Legacy Management.
Approved for public release; distribution is unlimited.

Appendix A

Supplemental Groundwater Information

Contents

Attachment A.1	Operational Assessment
Attachment A.2	Assessment of Total Uranium Results
Attachment A.3	Groundwater Elevations and Capture Assessment
Attachment A.4	Non-uranium FRL Results
Attachment A.5	On-site Disposal Facility Monitoring Results

End of current text

List of Acronyms

AMSL	above mean sea level
AWWT	advanced wastewater treatment facility
BRSR	Baseline Remedial Strategy Report
CAWWT	converted advanced wastewater treatment facility
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CMT	Continuous Multi-channel Tubing
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
ESD	Explanation of Significant Differences
EW	Extraction Well
FRL	final remediation level
GMA-D	Great Miami Aquifer downgradient
GMA-U	Great Miami Aquifer upgradient
GWLMP	Groundwater/Leak Detection and Leachate Monitoring Plan
HTW	horizontal till well
IAWWT	Interim Advanced Waste Water Treatment
IEMP	Integrated Environmental Monitoring Plan
IW	Re-injection Well
LCS	leachate collection system
LDS	leak detection system
OAC	Ohio Administrative Code
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
PCB	polychlorinated biphenyls
PRRS	Paddys Run Road Site
RCRA	Resource Conservation and Recovery Act
RW	Recovery Well
SCL	Shewhart control limit
UCL	upper confidence level
WRS	Wilcoxon Rank Sum

List of Measurement Abbreviations

ft	feet
gpad	gallons per acre per day
gpm	gallons per minute
lb	pound
m	meter
m^3	cubic meter
M gal	million gallons
mg/L	milligrams per liter
µg/L	micrograms per liter
NTU	nephelometric turbidity unit
pCi/L	picoCuries per liter
yd^3	cubic yards

End of current text

Appendix A presents additional groundwater data and analysis in support of Chapter 3 of this 2006 Site Environmental Report. This appendix consists of five attachments as follows:

- Attachment A.1 provides operational data for the South Field Module, the South Plume Module, and the Waste Storage Area Module for 2006.
- Attachment A.2 provides total uranium data (including summary statistics) and plume maps for the first and second halves of 2006.
- Attachment A.3 evaluates the capture zone by reviewing groundwater flow directions based on groundwater elevation data. It includes groundwater elevation maps from all four quarters of 2006 and hydrographs for specific wells.
- Attachment A.4 provides an analysis of the 2006 non-uranium final remediation level (FRL) exceedances both inside and outside the Waste Storage Area (Phase II) design remediation footprint.
- Attachment A.5 presents 2006 leak detection and leachate monitoring results associated with the On-site Disposal Facility Monitoring program.

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Attachment A.1

Attachment A.1

A.1.0 Operational Assessment

At the start of 2006 all extraction systems modules were operational. Figures A.1–1A and A.1–1B depict the locations of extraction and former reinjection wells and identify surrounding monitoring wells. Table A.1–1 provides summaries of gallons pumped, total uranium removed, and uranium removal indices for 2006 and for August 1993 through December 2006.

The operation assessment information in this attachment is organized into the following subsections:

- South Field Module (Section A.1.1)
- South Plume Module (Section A.1.2)
- Waste Storage Area Module (Section A.1.3)
- Total Uranium Data (Section A.1.4)
- Pumping Rates (Section A.1.5).

A.1.1 South Field Module

The South Field Module was built in two phases. Phase I began operating in July 1998 and Phase II began operating in July 2003. At the end of 2006, the South Field Module included 13 active extraction wells, six inactive extraction wells, two inactive reinjection wells, and one inactive Injection Pond.

- The 13 active extraction wells are Extraction Wells 31550 (EW-18), 31560 (EW-19), 31561 (EW-20), 33326 (EW-17a), 32276 (EW-22), 32446 (EW-24), 32447 (EW-23), 33061 (EW 25), 33262 (EW-15a), 33264 (EW-30), 33265 (EW-31), 33266 (EW-32), and 33298 (EW-21a).
- The six inactive extraction wells are Extraction Wells 31564 (EW-14), inactive since December 19, 2001; 31565 (EW-13), inactive since May 22, 2001; 31566 (EW-15), inactive since August 7, 1998; 31562 (EW-21), inactive since March 13, 2003 to facilitate installation of a replacement well; 31563 (EW-16), inactive since December 9, 2002 to facilitate conversion to a reinjection well as part of the South Field (Phase II) Project, and 31567 (EW-17) inactive since September 6, 2005 to facilitate installation of a replacement well.
- The two inactive reinjection wells are 31563 (IW 16), which was converted from Extraction Well 31563 (EW-16); and 33263 (IW 29). South Field Module wells are located near the Southern Waste Unit excavations and the storm sewer outfall ditch in the South Field area of the Fernald site, from Paddys Run to just west of the site's South Access Road.
- The inactive Injection Pond was located in the western portion of the southern waste unit excavations area.

The target combined pumping rate for the online South Field Module wells in 2006 was 2,575 gallons per minute (gpm). This target is consistent with pumping rates defined for the Waste Storage Area Phase II Model Design. Tables A.1–2 through A.1–14 provide individual extraction well performance data for the South Field Module extraction wells that were operational in 2006. The footnotes explain individual extraction well outages of greater than 24 hours. The combined performance data for the South Field Module are presented in Table A.1–1.

During 2006, 1,105.42 million gallons of groundwater were pumped by the active extraction wells in the South Field Module resulting in the removal of 423.693 pounds (lbs) of uranium from the Great Miami Aquifer. Since startup of the South Field Module in July 1998, the module has removed 8.583 billion gallons of water and 4,598.3 lbs of uranium from the Great Miami Aquifer.

A.1.2 South Plume Module

At the end of 2006, the South Plume Module included six active recovery wells and one inactive recovery well. The six active Recovery Wells are 3924 (RW 1), 3925 (RW 2), 3926 (RW 3), 3927 (RW 4), 32308 (RW 6), and 32309 (RW 7). Recovery Wells 32308 (RW 6) and 32309 (RW 7) were installed as the South Plume Optimization Module. The one inactive recovery well is 3928 (RW 5), inactive since September 11, 1994. These wells are located south of Willey Road and north of New Haven Road.

The target combined pumping rate for the South Plume Module in 2006 was 1,400 gpm. This target is consistent with the Waste Storage Area Phase II Model Design with the exception of RW-4. The pumping rate of RW-4 was set higher than what was defined in the Waste Storage Area Phase II Model Design to assure capture of a lobe of the uranium plume just south of Willey Road along the eastern side of the plume. Tables A.1–15 through A.1–20 provide individual extraction well performance data for the South Plume Module extraction wells that were operational in 2006. The footnotes explain individual extraction well outages of greater than 24 hours. The combined performance data for the South Plume Module are presented in Table A.1–1.

During 2006, 583.28 million gallons of groundwater were pumped by the six wells in the South Plume Module resulting in the removal of 110.92 lbs of uranium from the Great Miami Aquifer. Since startup of the South Plume Module in August 1993, the module has removed 9.992 billion gallons of groundwater and 2,122.91 lbs of uranium from the Great Miami Aquifer.

During 2006, the South Plume Module continued to meet the primary objectives of:

- Preventing further southward movement of the total uranium plume while capturing the main lobe of the South Plume without adversely affecting the Paddys Run Road Site (PRRS) plume (Extraction Wells 3924 [RW 1], 3925 [RW 2], 3926 [RW 3], and 3927 [RW 4]).
- Actively remediating the higher concentration region of the off property plume (Extraction Wells 32308 [RW 6] and 32309 [RW 7]).

Attachment A.3 presents additional details concerning capture, along with supporting data. In 2006, as in previous years, Paddys Run Road Site (PRRS) constituents of concern (arsenic, phosphorus, potassium, sodium, and volatile organic compounds) were monitored at 11 monitoring well locations immediately south of the South Plume Module to ensure that the operation of the system does not adversely impact the PRRS plume. The 11 wells monitored were 2128, 2625, 2636, 2898, 2899, 2900, 3128, 3636, 3898, 3899, and 3900 (refer to Figures A.1–1A).

Consistent with previous reporting, the Mann Kendall test for trend was run on PRRS data collected from these wells. As indicated in Table A.1–21, two wells monitored for PRRS constituents of concern had an "up, significant" trend for two constituents based on the Mann Kendall test for trend:

- Each year since 2001, Monitoring Wells 2898 and 2899 have had "up, significant" trends for potassium. Potassium concentration versus time plots for these wells are shown in Figures A.1–2 and A.1–3. As reported in Attachment A.3, the groundwater flow direction was from the northeast to southwest at Monitoring Wells 2898 and 2899. This indicates that the increasing potassium concentrations at these two locations were moving toward the PRRS plume, not away from it.

The monitoring activity for PRRS constituents of concern also included sampling for volatile organic compounds. These compounds are monitored because they were present in the PRRS plume, which is not of Fernald origin (ERM Midwest, Inc. 1994). No volatile organic compounds were detected in 2006.

A.1.3 Waste Storage Area Module

Phase-I of the Waste Storage Area Module became operational on May 8, 2002. The module consisted of three extraction wells: 32761 (EW-26), 33062 (EW-27), and 33063 (EW-28). Extraction Well 33063 (EW-28) was turned off in July 2004 and was plugged and abandoned to make way for surface remediation activities. Four groundwater monitoring wells surrounding EW-28 (63121, 63122, 83120, and 83123) were also plugged and abandoned. The two remaining extraction wells resumed operation in March 2005, after pumping was suspended for the duration of CAWWT Stage I construction. The target combined pumping rate was 700 gpm. The pumping rate of EW-27 was set higher than what was defined in the Waste Storage Area Phase II Model Design in order to compensate for the temporary loss of EW-28. On June 29, 2006 a replacement well for extraction well EW-28 (EW-28a, 33334) became operational. On October 5, 2006 a new extraction well became operational (EW-33a, 33347) as part of the Waste Storage Area Phase II Design. The target pumping rate for the Waste Storage Area Module following the start up of extraction well EW-33a was 1000 gpm. This target pumping rates is consistent with the Waste Storage Area Phase II Model Design. Tables A.1–22 through A.1–25 provide individual extraction well performance data for the Waste Storage Area Module wells. The combined performance data for the Waste Storage Area Module are presented in Table A.1–1.

During 2006, 339.25 million gallons of groundwater were pumped from extraction wells in the Waste Storage Area Module resulting in the removal of 137.890 lbs of uranium from the Great Miami Aquifer. Since startup of the Waste Storage Area Module in May 2002, 1.79 billion gallons of water and 1,151.27 lbs of uranium have been removed from the Great Miami Aquifer.

A.1.4 Total Uranium Data

Process control water samples are collected weekly from the extraction wells and analyzed for total uranium. The weekly total uranium concentrations are used to support the statistical trend analysis presented in Attachment A.2 and to determine if a well is routed to treatment or to bypass treatment. Figure A.1–4 provides a graph of the monthly gallons of groundwater extracted versus the monthly gallons of groundwater treated for 2006.

Uranium concentration data collected from the extraction wells are also being tracked graphically in order to predict when the extraction well-specific uranium concentrations will reach the groundwater remediation goal of 30 micrograms per liter (μg/L), and to help determine how long groundwater treatment will be necessary. This is done by plotting uranium concentrations over time and then fitting a regression line to the data set.

Figures A.1–5 through A.1–27 are uranium concentration versus time plots for each extraction well. Each graph displays three different data sets (operational data, 95 percent upper confidence level [UCL] of the operational data, and model predictions). Trend lines for the operational data set and the 95 percent UCL of the operational data set were fitted using the regression function found in Microsoft Excel software.

As pumping continues the uranium concentration of the pumped groundwater will decrease. The slope of a fitted regression curve through the uranium concentration data set collected at each extraction well provides a prediction of when pumping concentrations will decrease below 30 µg/L at each well. However, the slope of a fitted regression curve through the pumped uranium concentration data set is an insufficient statistical measure by itself because future measured concentrations could vary about the trend curve. EPA guidelines in General Methods for Remedial Operation Performance Evaluations (EPA 1992a) suggest that a 95 percent UCL of the measured uranium concentration data set can be used to help evaluate the uncertainty of the predicted data trend. From this perspective, the concentration trend of the measured data set presents a less conservative prediction of when pumping concentrations will decrease below 30 µg/L and the 95 percent UCL data trend presents a more conservative trend prediction (i.e., longer predicted cleanup times).

The graphs in Figures A.1–5 through A.1–27 indicate when the actual measured concentrations and the 95 percent UCL calculated concentrations will reach the 30 µg/L final remediation level (FRL) for total uranium. For example, the concentration trend of pumped water from Extraction Well 31550 (refer to Figure A.1–13) reaches 30 µg/L in approximately 2008 (trend for the measured data set) or approximately 2023 (trend for the 95 percent UCL data).

Figures A.1–5 through A.1–27 also show how modeled uranium concentration predictions relate to the measured and 95 percent UCL data trends. The VAM 3D groundwater model uranium concentration predictions are taken from modeling results for the Waste Storage Area (Phase-II) Design.

The Fernald groundwater model predicts the future average pounds of uranium that will be removed from the aquifer for each year of the modeled remedy. The average annual pounds of uranium actually removed from the aquifer are compared to the model predictions to assess remedy progress. Concentration regression equations based on measured concentration data collected at the extraction wells are also used to provide a prediction of the number of pounds of uranium that will be removed from the aquifer in future years. Regression equations based on uranium concentration data collected at extraction wells through December 31, 2006 are summarized in Table A.1–26.

At the end of December 2006, approximately 7,796 net lbs of uranium had been removed from the Great Miami Aquifer by the pump-and-treat remedy. Modeled performance metrics for the Waste Storage Area (Phase II) design are provided in Table A.1–27. Model predictions indicate that an additional 6,386 lbs of uranium will be removed from the Great Miami Aquifer by operating the system according to the Waste Storage Area (Phase II) Design through 2024. Performance metrics based on the measured uranium concentration data set collected at the extraction wells are provided in Table A.1–28. The concentration data set indicates that an additional 5,371 lbs of uranium will be removed from the Great Miami Aquifer based on regression analyses of the individual well data. Performance metrics based on the 95 percent UCL of the measured uranium

concentration data set are provided in Table A.1–29. The 95 percent UCL measured concentration data set indicates that an additional 15,896 lbs of uranium will be removed from the Great Miami Aquifer based on regression analyses of the individual well data. Figure A.1–28 illustrates the relationship between the results. The predictions are also summarized below.

	Data	Model	95% UCL
Net pounds of uranium extracted through December 2006	7796	7796	7796
Predicted pounds of U to be extracted between 07 and the end of the remedy	5371	6386	15896
Total predicted pounds of uranium to be removed	**13167**	**14182**	**23692**
Estimated Percent Complete (based on lbs of uranium to be removed)	**59.21**	**54.97**	**32.91**

Results indicate that as of January 1, 2007, the estimated percent complete for the aquifer remedy is approximately 59 percent (based on the uranium concentration data set) or 55 percent (based on the model predictions) equaling a difference of approximately 4 percent. The remedy is approximately 33 percent complete based on the 95 percent UCL data set. The regression trend predictions based on the measured concentration data are very close to the modeled predictions.

A.1.5 Pumping Rates

Daily pumping rate data for each extraction well are presented on the DOE Office of Legacy Management's website under the Fernald site (http://www.lm.doe.gov/land/sites/sites_map.htm); therefore, those data have not been repeated here. The footnotes in the well specific operational tables explain individual well outages of greater than 24 hours.

Target extraction well pumping rates for 2006 are provided in Table A.1–30. The target pumping rates shown in Table A.1–30 are consistent with rates defined by the Waste Storage Area Phase II Model Design with the exception of Extraction Well 3927 (RW 4) in the South Plume The target pumping rate for Extraction Well 3927 in the South Plume Module was set at 400 gpm in 2006 to ensure capture of the east side of the South Plume. In 2007, the target pumping rate for Extraction Well 3927 will be decreased to 200 gpm, to be in accordance with` the Waste Storage Area Phase II Design. As explained further in Attachment A.3, new particle path modeling indicates that east side of the South Plume is being captured under Waste Storage Area Phase II pumping schedules. The target pumping rate for Extraction Well 33062 (EW-27) in the waste storage area was increased to 400 gpm in the first half of 2006 in order to help compensate for the temporary loss of Extraction Well 33063 (EW-28). Extraction Well 33063 (EW-28) in the waste storage area was shut down in July 2004 to make way for soil remediation activities. A replacement well for Extraction Well 33063 (EW-28) became operational on June 29, 2006. As additional operational experience is gained, pumping rate changes may occur as efforts to maximize the effectiveness of each module are made.

Table A.1–1. Aquifer Restoration System Operational Summary Sheet

	Reporting Period					
	January 2006 through December 2006			August 1993 through December 2006		
	Gallons Pumped/ Re-injected (M gal)[a]	Total Uranium Removed/ Re-injected (lbs)	Uranium Removal Index[b] (lbs/M gal)	Gallons Pumped/ Re-injected (M gal)	Total Uranium Removed/ Re-injected (lbs)	Uranium Removal Index[b] (lbs/M gal)
South Field Module	1,105.422	423.693	0.38	8,582.618	4,598.330	0.54
Waste Storage Area Module	339.250	137.890	0.41	1,795.809	1,151.270	0.64
South Plume Module	583.282	110.918	0.19	9,991.944	2,122.908	0.21
Re-injection Module[c]	0	0	NA	1,936.478	76.27	NA
Aquifer Restoration Systems Totals						
Extraction Wells	2,027.953	672.502	0.33	20,370.070	7,872.509	0.39
(Re-injection Wells)	0	0	NA	(1,936.478)	(76.27)	NA
Net	2,027.953	672.502	NA	18,433.592	7,796.239	NA

[a]million gallons
[b]NA = not applicable
[c] Re-Injection module was shut down in September of 2004.

Table A.1–2. Extraction Well 31550 (EW-18) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 572.11 (top of well)
Northing Coordinate ('83) – 477,018.5
Easting Coordinate ('83) – 1,348,979.8

Hours in reporting period – 8760 | Hours pumped – 7484 | Target pumping rate – 100 gpm
Hours not pumped – 1276 | Operational percent – 85.43

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/Million Gallons Pumped)
1/06	21.6 [a]	0.963	39.4	0.33
2/06	88.0 [b]	3.548	47.4	0.40
3/06	105.4 [b]	4.703	41.9	0.35
4/06	111.2	4.803	39.3	0.33
5/06	93.7 [c]	4.184	42.4	0.35
6/06	104.2 [c]	4.501	45.9	0.38
7/06	98.8 [d]	4.410	44.4	0.37
8/06	96.9 [e]	4.324	42.7	0.36
9/06	107.8	4.657	40.7	0.34
10/06	97.0 [f]	4.330	42.0	0.35
11/06	79.8 [g]	3.448	42.6	0.36
12/06	98.4	4.391	42.1	0.35
Average	91.9	Total 48.261	Average 42.6	Average 0.36

[a] Well shut down from January 1 to January 29 for maintenance and to facilitate construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, and 27 to March 2 to facilitate construction tie-ins to the discharge header.
[c] Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line and CAWWT power outage.
[d] Downtime for well in July was due to chlorination.
[e] Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[f] Well shut down on October 20 and from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.

Table A.1–3. Extraction Well 31560 (EW-19) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 574.93 (top of well)
Northing Coordinate ('83) – 477,403.1
Easting Coordinate ('83) – 1,349,028.9

Hours in reporting period – 8760 | Hours pumped – 7786 | Target pumping rate –100 gpm
Hours not pumped – 974 | Operational percent – 88.88

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/Million Gallons Pumped)
1/06	63.8 [a]	2.847	43.7	0.36
2/06	85.0 [b]	3.425	40.5	0.34
3/06	104.7 [b]	4.672	36.5	0.30
4/06	106.9	4.619	36.3	0.30
5/06	92.2 [c]	4.116	36.8	0.31
6/06	103.2 [cd]	4.457	35.9	0.30
7/06	105.3 [d]	4.699	32.7	0.27
8/06	94.9 [e]	4.235	31.4	0.26
9/06	108.2	4.673	30.5	0.25
10/06	99.9 [f]	4.461	34.2	0.29
11/06	71.9 [g]	3.104	34.6	0.29
12/06	98.7 [h]	4.405	35.5	0.30
	Average 94.5	Total 49.714	Average 35.7	Average 0.30

[a] Well shut down January 5 to January 15 to reduce the uranium concentration at the Parshall Flume. Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, February 27 to March 2 facilitate construction tie-ins to the discharge header.
[c] Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[d] The flow meter failed on June 22. Daily flow was estimated through July 11 from the set point.
[e] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[f] Well shut down on October 20, and from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well shut down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.
[h] Wells shut down on December 12 and December 13 for check valve cleaning.

Table A.1–4. Extraction Well 31561 (EW-20) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 578.77 (top of well)
Northing Coordinate ('83) – 477,660.8
Easting Coordinate ('83) – 1,349,254.5

Hours in reporting period – 8760 Hours pumped – 5857 Target pumping rate – 100 gpm
Hours not pumped – 2903 Operational percent – 66.86

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration [a] (µg/L)	Uranium Removal Index [a] (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	63.7 [b]	2.846	30.6	0.25
2/06	88.1 [c]	3.551	29.7	0.25
3/06	102.3 [c]	4.567	28.8	0.24
4/06	8.3 [d]	0.358	28.8	0.24
5/06	0.0 [e]	0.0	NS	NS
6/06	30.4 [e]	1.313	25.0	0.21
7/06	102.7	4.583	31.8	0.27
8/06	97.8 [f]	4.367	30.3	0.25
9/06	91.4 [g]	3.949	31.5	0.26
10/06	97.6 [h]	4.357	33.6	0.28
11/06	80.6 [i]	3.480	33.1	0.28
12/06	98.9 [j]	4.416	32.2	0.27
	Average 71.8	Total 37.786	Average 30.5	Average 0.25

[a] NS = not sampled
[b] Well shut down from January 5 to January 15 to reduce the uranium concentration at the Parshall Flume. Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[c] Well shut down February 11, 17, and February 27 to March 2 to facilitate construction tie-ins to the discharge header.
[d] Well shut down April 3 to the end of the month for rehab and pump replacement.
[e] Well shut down from May 1 to June 22 for rehab and pump replacement.
[f] Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[g] Well shut down from September 15 to September 20 due to a power outage and re-start problems.
[h] Well shut down on October 19 for maintenance on IX 2B. Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[i] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.
[j] Wells shut down on December 12 and December 13 for check valve cleaning.

Table A.1–5. Extraction Well 31567 (EW-17) and 33326 (EW-17a) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 574.84 (top of well)
Northing Coordinate ('83) – 477,905.5
Easting Coordinate ('83) – 1,348,854.1

Hours in reporting period – 8760 | Hours pumped – 7524 | Target pumping rate – 175 gpm
Hours not pumped – 1237 | Operational percent – 85.88

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	120.5 [a]	5.378	31.2	0.26
2/06	166.7 [b]	6.722	38.1	0.32
3/06	201.9 [b]	9.014	31.1	0.26
4/06	208.8	9.021	31.9	0.27
5/06	159.7 [c]	7.128	30.9	0.26
6/06	166.8 [c]	7.204	30.8	0.26
7/06	149.9 [d]	6.692	34.1	0.28
8/06	121.0 [e]	5.400	27.7	0.23
9/06	99.1 [f]	4.281	26.8	0.22
10/06	129.6 [g]	5.784	27.2	0.23
11/06	100.4 [h]	4.336	28.5	0.24
12/06	114.0 [i]	5.090	28.5	0.24
Average	144.9	Total 76.050	Average 30.6	Average 0.26

[a] Well shut down January 5 to January15 to reduce the uranium concentration at the Parshall Flume. Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, and February 27 to March 2 to facilitate construction tie-ins to the discharge header.
[c] Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[d] All downtime for well in July was due to chlorination.
[e] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage
[f] Well shut down from September 9 to September 20 due to fluctuating flow rates.
[g] Well shut down on October 20 and from October 24 to October 27 due to a power outage at the Parshall Flume.
[h] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI.
[i] Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.

Table A.1–6. Extraction Well 32276 (EW-22) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 567.14 (top of well)
Northing Coordinate ('83) – 476,447.3
Easting Coordinate ('83) – 1,348,857.3

Hours in reporting period – 8760 Hours pumped – 7911 Target pumping rate – 300 gpm
Hours not pumped – 850 Operational percent – 90.30

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	264.2 [a]	11.794	50.1	0.42
2/06	230.5 [b]	9.293	58.2	0.49
3/06	261.8 [c]	11.687	50.1	0.42
4/06	273.3	11.806	53.9	0.45
5/06	259.3 [d]	11.573	56.4	0.47
6/06	288.3 [d]	12.455	55.2	0.46
7/06	305.6	13.643	55.3	0.46
8/06	288.8 [e]	12.894	53.0	0.44
9/06	325.8	14.075	47.8	0.40
10/06	292.5 [f]	13.057	48.5	0.40
11/06	230.3 [g]	9.948	48.9	0.41
12/06	304.7	13.600	46.8	0.39
	Average 277.1	Total 145.823	Average 52.0	Average 0.43

[a] Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header.
[d] Wells shut down on May 25 due to lightning. Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage
[f] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.

Table A.1–7. Extraction Well 32446 (EW-24) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 578.367 (top of well)
Northing Coordinate ('83) – 476,634.53
Easting Coordinate ('83) – 1,349,312.38

Hours in reporting period – 8760 Hours pumped – 6639.5 Target pumping rate – 300 gpm
Hours not pumped – 2120.5 Operational percent – 75.79

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration [a] (µg/L)	Uranium Removal Index [a] (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	0.0 [b]	0.000	NS	NS
2/06	0.0 [b]	0.000	NS	NS
3/06	291.3 [c]	13.005	50.1	0.42
4/06	302.6	13.074	52.0	0.43
5/06	239.6 [d]	10.695	52.7	0.44
6/06	264.0 [d]	11.404	50.7	0.42
7/06	230.3 [e]	10.279	47.8	0.40
8/06	215.9 [f]	9.638	47.2	0.39
9/06	237.6 [g]	10.265	49.5	0.41
10/06	196.0 [h]	8.748	48.3	0.40
11/06	176.1 [i]	7.607	50.5	0.42
12/06	228.5 [j]	10.201	47.5	0.40
	Average 198.5	Total 104.917	Average 49.6	Average 0.41

[a] NS = not sampled
[b] Well shut down in January and February waiting repairs to motor.
[c] Well shut down March 1 due to construction tie-ins to the discharge header.
[d] Well shut down on May 25 due to lightning. Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] All downtime for well in July was due to chlorination.
[f] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[g] Wells shut down on September 11 due to a lightning strike.
[h] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down October 22 due to fluctuating flows. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[i] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.
[j] Well down 14 hours per day starting on December 4 because communication antenna was down.

Table A.1–8. Extraction Well 32447 (EW-23) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 574.528 (top of well)
Northing Coordinate ('83) – 477,150.24
Easting Coordinate ('83) – 1,349,421.19

Hours in reporting period – 8760 Hours pumped – 6969 Target pumping rate – 300 gpm
Hours not pumped – 1791 Operational percent – 79.55

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	68.5 [a]	3.056	68.7	0.57
2/06	60.0 [b]	2.418	80.4	0.67
3/06	65.1 [c]	2.907	72.4	0.60
4/06	26.3 [d]	1.136	72.8	0.61
5/06	72.4 [e]	3.231	73.0	0.61
6/06	139.7 [e,f]	6.035	74.7	0.62
7/06	306.5	13.683	74.9	0.63
8/06	291.4 [g]	13.010	74.6	0.62
9/06	319.2	13.791	76.2	0.64
10/06	284.3 [h]	12.690	72.8	0.61
11/06	235.0 [i]	10.154	76.2	0.64
12/06	311.4	13.900	73.7	0.62
	Average 181.7	Total 98.012	Average 74.2	Average 0.62

[a] Well shut down January 23 to January 29 due to construction tie ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header. Well shut down March 13 to March 22 for mini-rehabilitation.
[d] Well shut down most of April due to a bad pressure sensor.
[e] Well shut down May 1 to May 10 for repair of the pressure sensor. Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[f] Well shut down on June 28 so a new pump could be installed.
[g] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[h] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[i] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.

Table A.1–9. Extraction Well 33061 (EW-25) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 575.56 (top of well)
Northing Coordinate ('83) – 478318.82
Easting Coordinate ('83) – 1349531.03

Hours in reporting period – 8760 | Hours pumped – 7817 | Target pumping rate – 100 gpm
Hours not pumped – 943 | Operational percent – 89.24

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	86.3 [a]	3.853	62.15	0.52
2/06	116.8 [b]	4.707	48.00	0.40
3/06	143.7 [c]	6.414	40.67	0.34
4/06	148.4	6.412	50.93	0.43
5/06	128.5 [d]	5.737	53.25	0.44
6/06	142.6 [d]	6.158	53.83	0.45
7/06	141.2	6.301	64.87	0.54
8/06	129.7 [e]	5.792	57.25	0.48
9/06	149.1	6.440	34.15	0.29
10/06	133.8 [f]	5.972	34.35	0.29
11/06	108.6 [g]	4.692	36.76	0.31
12/06	140.6	6.278	41.38	0.35
Average	131.0	Total 68.756	Average 48.1	Average 0.41

[a] Well shut down January 5 to January 15 to reduce the uranium concentration at the Parshall Flume. Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header.
[d] Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[f] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.

Table A.1–10. Extraction Well 33262 (EW-15a) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 568.368 (top of well)
Northing Coordinate ('83) – 477,799.912
Easting Coordinate ('83) – 1,348,149.97

Hours in reporting period – 8760 Hours pumped – 7866 Target pumping rate – 200 gpm
Hours not pumped – 894 Operational percent – 89.79

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	172.5 [a]	7.702	48.6	0.41
2/06	163.4 [b]	6.587	51.3	0.43
3/06	185.3 [c]	8.273	51.1	0.43
4/06	200.9	8.677	41.8	0.35
5/06	185.8 [d]	8.295	49.3	0.41
6/06	209.2 [d]	9.038	51.4	0.43
7/06	206.7	9.225	47.5	0.40
8/06	194.4 [e]	8.679	43.4	0.36
9/06	215.4	9.304	39.6	0.33
10/06	197.2 [f]	8.802	37.8	0.32
11/06	153.2 [g]	6.617	41.1	0.34
12/06	204.5	9.128	39.2	0.33
Average	190.7	Total 100.327	Average 45.2	Average 0.38

[a] Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header.
[d] Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] Well down August 8 to August10 for Well 33 tie-in and other maintenance. Well down from August 18 to August 19 for a site wide electrical outage.
[f] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.

Table A.1–11. Extraction Well 33264 (EW-30) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 573.818 (top of well)
Northing Coordinate ('83) – 477,200.945
Easting Coordinate ('83) – 1,349,751.49

Hours in reporting period – 8760 Hours pumped – 6707.5 Target pumping rate–200 gpm
Hours not pumped – 2052.5 Operational percent – 76.57

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	121.2 [a]	5.410	80.8	0.67
2/06	11.8 [b]	0.476	80.8	0.67
3/06	118.8 [b]	5.302	71.8	0.60
4/06	193.5 [c]	8.359	87.6	0.73
5/06	126.7 [c, d]	5.655	81.8	0.68
6/06	245.2 [d]	10.594	83.7	0.70
7/06	209.4	9.347	83.5	0.70
8/06	192.5 [e]	8.595	82.7	0.69
9/06	209.4	9.048	83.1	0.69
10/06	170.5 [f]	7.613	85.2	0.71
11/06	221.6 [g,h]	5.251	83.7	0.70
12/06	140.0	6.249	81.0	0.68
Average	155.1	Total 81.900	Average 82.1	Average 0.69

[a] Well shut down January 23 to January 29 due to construction tie in at CAWWT.
[b] Well shut down February 4 to March 2 for mini-rehab.
[c] Well shut down April 28 to May 10 for check valve replacement.
[d] Well shut down on May 25 due to lightning. Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[f] Well shut down on October 19 for maintenance on IX 2B. Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI.
[h] Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume. Wells shut down on November 28 for check valve preventive maintenance.

Table A.1–12. Extraction Well 33265 (EW-31) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 577.474 (top of well)
Northing Coordinate ('83) – 477,598.909
Easting Coordinate ('83) – 1,349,849.01

Hours in reporting period – 8760
Hours not pumped – 800.5
Hours pumped – 7959.5
Operational percent – 90.86
Target pumping rate – 300 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	201.5 [a]	8.995	49.3	0.41
2/06	174.3 [b]	7.029	25.3	0.21
3/06	201.3 [c]	8.985	21.3	0.18
4/06	216.5	9.354	22.0	0.18
5/06	183.3 [d]	8.183	22.6	0.19
6/06	214.2 [d]	9.251	22.3	0.19
7/06	292.6	13.064	21.1	0.18
8/06	287.2 [e]	12.818	20.8	0.17
9/06	317.2	13.704	19.6	0.16
10/06	291.5 [f]	13.012	18.7	0.16
11/06	222.9 [g]	9.630	20.2	0.17
12/06	289.8 [h]	12.937	18.4	0.15
	Average 241.0	Total 126.961	Average 23.4	Average 0.20

[a] Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header.
[d] Well shut down on May 25 due to lightning. Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] Well shut down from August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[f] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[g] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume.
[h] Well shut down on December 17 for maintenance.

Table A.1–13. Extraction Well 33266 (EW-32) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 579.625 (top of well)
Northing Coordinate ('83) – 476,997.576
Easting Coordinate ('83) – 1,350,046.97

Hours in reporting period – 8760 Hours pumped – 7663 Target pumping rate – 200 gpm
Hours not pumped – 1097 Operational percent – 87.48

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	92.5 [a]	4.127	19.7	0.16
2/06	154.7 [b]	6.239	20.2	0.17
3/06	198.2 [c]	8.850	17.2	0.14
4/06	199.2 [d]	8.607	17.5	0.15
5/06	165.5 [e]	7.386	17.4	0.15
6/06	185.9 [e]	8.031	16.8	0.14
7/06	173.9 [f]	7.764	15.7	0.13
8/06	156.3 [g]	6.978	17.4	0.15
9/06	167.2 [h]	7.225	13.5	0.11
10/06	147.7 [i]	6.595	12.8	0.11
11/06	117.6 [j]	5.079	13.7	0.11
12/06	134.3	5.994	11.9	0.10
	Average 157.8	Total 82.877	Average 16.1	Average 0.13

[a] Well shut down January 19 through the end of the month for a mini-rehab.
[b] Well shut down February 1 & 2 for a mini-rehabilitation. Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header.
[d] Well shut down April 26 to April 27 for maintenance.
[e] Well shut down on May 25 due to lightning. Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[f] All downtime for well in July was due to chlorination.
[g] Well shut down August 8 to August10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage. Well shut down from August 5 to August 6 due to a local power outage.
[h] Wells shut down on September 11 due to a lightning strike.
[i] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[j] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume. Wells shut down on November 28 for check valve preventive maintenance.

Table A.1–14. Extraction Well 33298 (EW-21a) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 576.21 (top of well)
Northing Coordinate ('83) – 477,953.1
Easting Coordinate ('83) – 1,349,499.9

Hours in reporting period – 8760 Hours pumped – 7508 Target pumping rate –200 gpm
Hours not pumped – 1253 Operational percent – 85.70

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	176.5 [a]	7.879	53.2	0.44
2/06	139.9 [b]	5.639	61.9	0.52
3/06	82.2 [c]	3.668	55.9	0.47
4/06	172.6 [d]	7.454	56.0	0.47
5/06	178.3 [e]	7.957	62.2	0.52
6/06	197.9 [e]	8.551	63.2	0.53
7/06	193.8	8.651	56.6	0.47
8/06	158.5 [f]	7.076	51.7	0.43
9/06	183.1	7.909	51.2	0.43
10/06	172.2 [g]	7.688	47.8	0.40
11/06	127.9 [h]	5.524	48.9	0.41
12/06	180.1	8.041	48.1	0.40
	Average 163.6	Total 86.036	Average 54.7	Average 0.46

[a] Well shut down January 23 to January 29 due to construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 1 due to construction tie-ins to the discharge header. Well shut down March 18 to the end of the month for a mini-rehab.
[d] Well shut down from April 1 to April 7 for mini-rehab.
[e] Well shut down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[f] Well shut down August 8 to August10 for Well 33 tie-in and other maintenance. Well shut down from August 18 to August 19 for a site wide electrical outage.
[g] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume.
[h] Well shut down on November 18 for a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communications with HMI. Well shut down from November 20 to November 21 due to a power outage at the Parshall Flume. Well shut down November 28 and November 29 for check valve PM.

Table A.1–15. Extraction Well 3924 (RW-1) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 533.51 (top of well)
Northing Coordinate ('83) – 474,219.7
Easting Coordinate ('83) – 1,348,314.3

Hours in reporting period – 8760 Hours pumped – 7895.5 Target pumping rate – 200 gpm
Hours not pumped – 864.5 Operational percent – 90.13

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	173.0 [a]	7.166	24.9	0.21
2/06	181.9 [b]	7.220	28.0	0.232
3/06	214.5	9.575	24.1	0.20
4/06	218.6	9.442	23.5	0.20
5/06	189.3 [c]	8.452	21.8	0.18
6/06	210.0 [c]	9.074	20.3	0.17
7/06	206.1 [d]	9.201	19.1	0.16
8/06	194.9 [e]	8.700	19.3	0.16
9/06	210.1	9.078	22.0	0.18
10/06	191.5 [f]	8.547	21.6	0.18
11/06	159.0 [g]	6.870	24.3	0.20
12/06	213.0 [h]	9.507	24.8	0.21
	Average 196.8	Total 102.830	Average 22.8	Average 0.19

[a] Well shut down from January 1 to January 3 for repairs. Well shut down from January 22 to January 23 to facilitate construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line, and CAWWT power outage.
[d] Well down from July 17 to July 19 due to an electrical outage caused by a hawk on the wires. Well flow totalizer was not working in July. Flow was estimated from set point.
[e] Well down from August 8 to August 10 to facilitate the tie-in of Well 33 and other maintenance. Well down from August 18 to August 19 due to a site wide electrical outage.
[f] Well down on October 20 due to a power outage at the Parshall flume. Well down from October 24 to October 27 due to a power outage at the Parshall flume.
[g] Well down November 8 due to a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communication with HMI. Well down November 20 due to a power outage at the Parshall Flume.
[h] Well down 14 hours/day starting on December 4 because communication antenna was down.

Table A.1-16. Extraction Well 3925 (RW-2) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 542.01 (top of well)
Northing Coordinate ('83) – 474,319.7
Easting Coordinate ('83) – 1,348,565.4

Hours in reporting period – 8760 Hours pumped – 6861.5 Target pumping rate – 200 gpm
Hours not pumped – 1898.5 Operational percent – 78.33

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	153.6 [a]	6.856	12.4	0.10
2/06	6.2 [b]	0.250	12.4	0.10
3/06	41.9 [c]	1.870	21.2	0.18
4/06	99.5 [d]	4.298	18.4	0.15
5/06	98.3 [e]	4.389	17.5	0.15
6/06	100.3 [e]	4.332	15.8	0.13
7/06	81.9 [f]	3.657	19.7	0.16
8/06	188.2 [g]	8.403	18.3	0.15
9/06	219.3	9.472	17.9	0.15
10/06	192.3 [h]	8.583	15.8	0.13
11/06	153.2 [i]	6.617	18.3	0.15
12/06	177.7 [j]	7.931	9.5	0.08
Average	126.0	Total 66.659	Average 16.4	Average 0.14

[a] Well shut down from January 28 to January 30 for repairs.
[b] Well shut down from February 3 through the end of the month for rehabilitation.
[c] Well down from March 1to March 16 for rehabilitation and pump replacement.
[d] Well down from April 18 to April 19 due to problems with the flow controller.
[e] Well down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line, and CAWWT power outage.
[f] Well down from July 17 to July 24 due to an electrical outage caused by a hawk on the wires. Well flow totalizer was not working in July. Flow was estimated from the set point.
[g] Well down from August 8 to August 10 to facilitate the tie-in of Well 33 and other maintenance. Well down from August 18 to August 19 due to a site wide electrical outage.
[h] Well down on October 20 due to a power outage at the Parshall flume. Well down from October 24 to October 27 due to a power outage at the Parshall flume.
[i] Well down November 8 due to a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communication with HMI. Well down November 20 due to a power outage at the Parshall Flume.
[j] Well down 14 hours/day starting on December 4 because communication antenna was down.

Table A.1–17. Extraction Well 3926 (RW-3) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 586.73 (top of well)
Northing Coordinate ('83) – 474,428.6
Easting Coordinate ('83) – 1,348,837.5

Hours in reporting period – 8760 Hours pumped – 7246 Target pumping rate – 200 gpm
Hours not pumped – 1514 Operational percent – 82.72

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	205.0	9.150	28.2	0.24
2/06	73.1 [a]	2.948	28.2	0.24
3/06	150.4 [b]	6.714	30.3	0.25
4/06	215.5	9.311	26.4	0.22
5/06	181.6 [c]	8.107	27.7	0.23
6/06	204.4 [c]	8.829	28.4	0.24
7/06	171.1 [d]	7.639	27.2	0.23
8/06	156.0 [e]	6.966	25.0	0.21
9/06	148.4	6.412	24.6	0.21
10/06	112.9 [f]	5.038	24.7	0.21
11/06	83.0 [g]	3.587	27.5	0.23
12/06	62.5 [h]	2.790	27.2	0.23
	Average 147.0	Total 77.490	Average 27.1	Average 0.23

[a] Well shut down from February 11 through the end of the month because it couldn't reach its set point.
[b] Well down from March 1to March 9 for maintenance.
[c] Well down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line, and CAWWT power outage.
[d] Well down from July 17 to July 19 due to an electrical outage caused by a hawk on the wires. Well flow totalizer was not working in July. Flow was estimated using the set point. Well down from July 22 to July 23 due to a power outage caused by a lightning strike.
[e] Well down from August 8 to August 10 to facilitate the tie-in of Well 33 and other maintenance. Well down from August 18 to August 19 due to a site wide electrical outage.
[f] Well down on October 20 due to a power outage at the Parshall flume. Well down from October 24 to October 27 due to a power outage at the Parshall flume.
[g] Well down November 8 due to a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communication with HMI. Well down November 20 due to a power outage at the Parshall Flume.
[h] Well down 14 hours/day starting on December 4 because communication antenna was down. Well down on December 24 due to fluctuating flow rate.

Table A.1–18. Extraction Well 3927 (RW-4) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 591.84 (top of well)
Northing Coordinate ('83) – 474,541.8
Easting Coordinate ('83) – 1,349,127.3

Hours in reporting period – 8760
Hours not pumped – 2166.5
Hours pumped – 6593.5
Operational percent – 75.27
Target pumping rate–400 gpm

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	230.6 [a]	10.294	2.2	0.02
2/06	350.9 [b]	14.147	3.2	0.03
3/06	405.0 [c]	18.078	2.5	0.02
4/06	127.7 [d]	5.518	3.0	0.03
5/06	304.1 [e]	13.576	2.9	0.02
6/06	417.9 [e]	18.053	3.0	0.03
7/06	366.8 [f]	16.373	2.8	0.02
8/06	347.6 [g]	15.518	2.8	0.02
9/06	380.9	16.453	2.9	0.02
10/06	216.9 [h]	9.683	2.5	0.02
11/06	15.6 [i]	0.675	2.6	0.02
12/06	369.9 [j]	16.511	2.7	0.02
Average	294.5	Total 154.878	Average 2.8	Average 0.02

[a] Well shut down from January 1 to January 5 for rehabilitation. Well shut down from January 22 to January 23 to facilitate construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well down March 1 to facilitate construction tie-ins to the discharge header.
[d] Well down from April 11 to the end of the month to repair a leaking pipe.
[e] Well down from May 1 to May 6 to repair a leaking pipe. Well down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line, and CAWWT power outage.
[f] Well down from July 17 to July 19 due to an electrical outage caused by a hawk on the wires. Well down from July 22 to July 23 due to a power outage caused by a lightning strike.
[g] Well down from August 8 to August 10 to facilitate the tie-in of Well 33 and other maintenance. Well down from August 18 to August 19 due to a site wide electrical outage.
[h] Well down most of October due to maintenance problems. Well down on October 20 due to a power outage at the Parshall flume. Well down October 22 through the end of the month due to a blown fuse.
[i] Well down November 8 due to a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communication with HMI. Well down November 20 due to a power outage at the Parshall Flume.
[j] Well down 14 hours/day starting on December 4 because communication antenna was down.

Table A.1–19. Extraction Well 32308 (RW-6) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 582.05 (top of casing)
Northing Coordinate ('83) – 475,078.83
Easting Coordinate ('83) – 1,348,693.9

Hours in reporting period – 8760 Hours pumped – 6793.5 Target pumping rate –200 gpm
Hours not pumped – 1966.5 Operational percent – 77.55

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	118.9 [a]	5.307	50.0	0.42
2/06	174.1 [b]	7.018	48.1	0.40
3/06	207.8	9.276	39.2	0.33
4/06	222.8	9.626	40.0	0.33
5/06	183.7 [c]	8.200	40.0	0.33
6/06	194.8 [c]	8.416	39.2	0.33
7/06	179.0 [d]	7.989	40.9	0.34
8/06	157.4 [e]	7.027	38.3	0.32
9/06	117.9 [f]	5.094	41.0	0.34
10/06	27.6 [g]	1.233	41.0	0.34
11/06	69.7 [h]	3.013	47.3	0.40
12/06	207.4 [i]	9.258	40.3	0.34
	Average 155.1	Total 81.459	Average 42.1	Average 0.35

[a] Well shut down from January 5 to January 15 to reduce uranium concentrations at the Parshall Flume. Well shut down from January 22 to January 23 to facilitate construction tie-ins at CAWWT.
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header.
[c] Well down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line, and CAWWT power outage.
[d] Well down from July 17 to July 19 due to an electrical outage caused by a hawk on the wires. Well down from July 22 to July 23 due to a power outage caused by a lightning strike.
[e] Well down from August 8 to August 10 to facilitate the tie-in of Well 33 and other maintenance. Well down from August 18 to August 19 due to a site wide electrical outage.
[f] Well down from September 11 to the end of the month due to a leak from the pitless adapter.
[g] Well shut down most of October due to a leak from the pitless adapter . Well down on October 20 due to a power outage at the Parshall flume. Well down from October 24 to October 27 due to a power outage at the Parshall flume.
[h] Well down November 8 due to a site wide power outage. Well down for 14 hours/day from November 9 to November 20 due to no power for offsite communication with HMI. Well down on November 15 to replace the pitless adapter. Well down November 20 due to a power outage at the Parshall Flume
[i] Well down 14 hours/day starting on December 4 because communication antenna was down

Table A.1–20. Extraction Well 32309 (RW-7) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 582.05 (top of casing)
Northing Coordinate ('83) – 475,109.60
Easting Coordinate ('83) – 1,348,366.34

Hours in reporting period – 8760 Hours pumped – 7655 Target pumping rate –200 gpm
Hours not pumped – 1105 Operational percent – 87.39

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	127.4 [a]	5.688	43.5	0.36
2/06	174.2 [b]	7.025	44.3	0.37
3/06	207.4 [c]	9.261	36.3	0.30
4/06	212.4	9.175	36.9	0.31
5/06	189.9 [d]	8.475	38.7	0.32
6/06	205.2 [d]	8.863	39.2	0.33
7/06	214.3 [e]	9.564	40.9	0.34
8/06	196.4 [f]	8.766	39.6	0.33
9/06	214.7	9.276	39.2	0.33
10/06	210.9 [g]	9.417	41.1	0.34
11/06	126.1 [h]	5.448	41.5	0.35
12/06	201.8 [i]	9.008	38.6	0.32
Average	190.1	Total 99.966	Average 40.0	Average 0.33

[a] Well shut down from January 5 to January 15 to reduce uranium concentrations at the Parshall Flume. Well shut down from January 22 to January 23 to facilitate construction tie-ins at CAWWT
[b] Well shut down February 11, 17, 27 & 28 to facilitate construction tie-ins to the discharge header
[c] Well down March 1 to facilitate construction tie-ins to the discharge header
[d] Well down from May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, removal of DO line, and CAWWT power outage
[e] Well down from July 17 to July 19 due to an electrical outage caused by a hawk on the wires
[f] Well down from August 8 to August 10 to facilitate the tie-in of Well 33 and other maintenance. Well down from August 18 to August 19 due to a site wide electrical outage
[g] Well down on October 20 due to a power outage at the Parshall flume. Well down from October 24 to October 27 due to a power outage at the Parshall flume
[h] Well down November 8 due to a site wide power outage. Well down for 14 hours/day starting November 9 due to no power for offsite communication with HMI. Well down November 20 to facilitate replacement of the pitless adapter in Well 6.
[i] Well down 14 hours/day starting on December 4 because communication antenna was down

Table A.1–21. Paddys Run Road Site Groundwater Summary Statistics and Trend Analysis

Constituent	Monitoring Well	Number of Samples[a,b,c]	Min.[a,b,c,d] (mg/L)	Max.[a,b,c,d] (mg/L)	Avg.[a,b,c,d] (mg/L)	SD[a,b,c,d] (mg/L)	Trend[a,b,c,d]
Arsenic	2128	228	0.000195	0.188	0.0118	0.0214	Down, Significant
	2625	205	0.00110	0.0595	0.0117	0.0090	Down, Significant
	2636	175	0.010	0.0939	0.0444	0.0188	No Significant Trend
	2898	45	0.000147	0.082	0.0038	0.0124	No Significant Trend
	2899	38	0.00032	0.0032	0.0012	0.0007	Down, Significant
	2900	227	0.00032	0.0609	0.0052	0.0063	Down, Significant
	3128	48	0.0004	0.234	0.0078	0.0336	Down, Significant
	3636	47	0.0005	0.014	0.0020	0.0022	No Significant Trend
	3898	45	0.0005	0.010	0.0026	0.0017	Up, Marginal
	3899	46	0.000147	0.010	0.0014	0.0015	No Significant Trend
	3900	46	0.000375	0.010	0.0022	0.0015	Down, Significant
Phosphorus	2128	54	0.025	16.2	1.63	2.6	Down, Significant
	2625	29	0.307	12.3	3.12	3.01	No Significant Trend
	2636	27	9.6	170	92.7	46.9	No Significant Trend
	2898	46	0.005	9.95	0.327	1.48	No Significant Trend
	2899	37	0.005	0.831	0.067	0.14	No Significant Trend
	2900	44	0.050	4.74	0.555	0.74	Down, Marginal
	3128	55	0.005	13	0.292	1.75	No Significant Trend
	3636	46	0.00955	1.1	0.082	0.162	No Significant Trend
	3898	44	0.00955	1.24	0.109	0.193	No Significant Trend
	3899	45	0.00955	0.83	0.107	0.165	No Significant Trend
	3900	46	0.005	1.38	0.107	0.267	No Significant Trend
Potassium	2128	46	0.83	18	3.69	3.73	No Significant Trend
	2625	30	0.64	9.49	3.33	2.02	No Significant Trend
	2636	27	8.51	218	77.0	53.2	Down, Significant
	2898	46	1.11	9.64	4.30	1.38	**Up, Significant**
	2899	38	1.36	8.85	3.97	1.12	**Up, Significant**
	2900	45	0.0095	6.0	2.04	1.17	No Significant Trend
	3128	48	1.085	3.7	2.08	0.66	Down, Significant
	3636	46	1.09	4.24	2.33	0.54	Down, Significant
	3898	45	0.61	3.93	2.34	0.55	Up, Marginal
	3899	46	0.875	3.22	2.43	0.37	No Significant Trend
	3900	46	0.975	3.19	1.77	0.44	Down, Significant
Sodium	2128	46	12.3	75.2	35.3	11.9	Down, Significant
	2625	30	16.5	50.7	33.0	7.6	Down, Significant
	2636	27	23	148	52.4	24.8	Down, Significant
	2898	46	4.95	29.2	17.7	3.8	Down, Significant
	2899	38	11.2	22.9	16.7	2.7	Down, Significant
	2900	45	0.0136	43.3	27.5	7.9	No Significant Trend
	3128	48	3.56	13.4	5.95	2.79	Down, Significant
	3636	46	3.14	13.0	6.37	2.95	Down, Significant
	3898	45	7.29	14.6	9.68	1.64	No significant Trend
	3899	46	6.24	12.1	8.73	1.27	No Significant Trend
	3900	46	3.13	10.8	5.17	1.92	Down, Significant

[a]The data are based on unfiltered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2006 groundwater data (unfiltered and filtered for 2001 through 2006).
[b]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples and the sample with the maximum concentration is used to determine the summary statistics (minimum, maximum, average, standard deviation, and Mann-Kendall test for trend).
[c]Rejected data qualified with either an R or Z were not included in this count or the summary statistics.
[d]Where concentrations are below the detection limit each result used in the summary statistics is set at half the detection limit.

Table A.1–22. Extraction Well 32761 (EW-26) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 570.88 (top of casing)
Northing Coordinate ('83) – 479892.36
Easting Coordinate ('83) – 1347364.02

Hours in reporting period – 8760 Hours pumped – 7172 Target pumping rate – 300 gpm
Hours not pumped – 1588 Operational percent – 81.87

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	64.0 [a]	2.858	52.0	0.43
2/06	247.0 [b]	9.957	68.2	0.57
3/06	259.9 [c]	11.601	57.2	0.48
4/06	287.1 [d]	12.403	56.7	0.47
5/06	254.8 [e]	11.374	55.5	0.46
6/06	313.8 [e]	13.557	52.6	0.44
7/06	329.3	14.699	46.1	0.38
8/06	288.1 [f]	12.863	44.7	0.37
9/06	320.9 [g]	13.862	39.7	0.33
10/06	291.4 [h]	13.008	43.2	0.36
11/06	184.0 [i]	7.950	47.3	0.39
12/06	285.9 [j]	12.764	44.2	0.37
	Average 260.5	Total 136.895	Average 50.6	Average 0.42

[a] Well shut down from January 1 to January 18 for pump and motor installation. Wells shut down from January 23 to January 29 to facilitate construction tie-ins at CAWWT
[b] Well shut down February 11, 17, 27, & 28 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 18 to March 21 to facilitate bypassing Area 4B water
[d] Well shut down April 20 for maintenance
[e] Well shut down May 23 to May 25 to connect Well 33 to the treatment header. Well shut down May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[f] Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down August 18 to August 19 for a site wide electrical outage
[g] Well shut down at September 15 due to a power outage
[h] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume
[i] Well shut down on November 8 due to a site wide power outage. Well shut down for 14 hours/day from November 9 to November 19 due to an offsite communication problem with the HMI. Well shut down on November 21 due to a power outage at the Parshall Flume
[j] Well shut down from December 4 to December 7 due to blown fuses in the power line

Table A.1–23. Extraction Well 33062 (EW-27) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 575.1 (top of casing)
Northing Coordinate ('83) – 480013.01
Easting Coordinate ('83) – 1348037.2

Hours in reporting period – 8760 Hours pumped – 7602 Target pumping rate–200 gpm
Hours not pumped – 1158 Operational percent – 86.78

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration (µg/L)	Uranium Removal Index (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	320.5 [a]	14.309	51.4	0.43
2/06	317.8 [b]	12.815	63.0	0.53
3/06	323.0 [c]	14.419	52.1	0.43
4/06	293.8	12.690	56.6	0.47
5/06	308.7 [d]	13.779	51.4	0.43
6/06	365.2 [d]	15.778	49.4	0.41
7/06	216.2	9.652	48.8	0.41
8/06	181.9 [e]	8.118	49.2	0.41
9/06	213.6 [f]	9.229	46.7	0.39
10/06	196.2 [g]	8.757	48.4	0.40
11/06	118.6 [h]	5.126	47.9	0.40
12/06	187.2 [i]	8.357	48.6	0.41
Average	253.6	Total 133.029	Average 51.14	Average 0.43

[a] Wells shut down from January 23 to January 29 to facilitate construction tie-ins at CAWWT
[b] Well shut down February 11, 17, 27, & 28 and March 1 to facilitate construction tie-ins to the discharge header.
[c] Well shut down March 18 to March 21 to facilitate bypassing Area 4B water
[d] Well shut down May 23 to May 25 to connect Well 33 to the treatment header. Well shut down May 28 to June 2 for SPIT safe shutdown, CAWWT compressor repairs, soils removal of DO line and CAWWT power outage.
[e] Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down August 18 to August 19 for a site wide electrical outage
[f] Well shut down at September 15 due to a power outage
[g] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume
[h] Well shut down on November 8 due to a site wide power outage. Well shut down for 14 hours/day from November 9 to November 19 due to an offsite communication problem with the HMI. Well shut down on November 21 due to a power outage at the Parshall Flume
[i] Well shut down from December 4 to December 7 due to blown fuses in the power line

Table A.1–24. Extraction Well 33334 (EW-28a) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 570.441 (top of casing)
Northing Coordinate ('83) – 479918.959
Easting Coordinate ('83) – 1348686.378

Hours in reporting period – 8760 | Hours pumped – 3738 | Target pumping rate–200 gpm
Hours not pumped – 5022 | Operational percent – 42.67

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration [a] (µg/L)	Uranium Removal Index [a] (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	0.0	0.000	NS	NS
2/06	0.0	0.000	NS	NS
3/06	0.0	0.000	NS	NS
4/06	0.0	0.000	NS	NS
5/06	0.0	0.000	NS	NS
6/06	11.9 [b]	0.516	45.0	0.38
7/06	197.5 [c]	8.818	45.0	0.38
8/06	177.9 [d]	7.939	38.2	0.32
9/06	226.5 [e]	9.784	28.8	0.24
10/06	192.7 [f]	8.603	28.0	0.23
11/06	124.9 [g]	5.395	27.5	0.23
12/06	188.3 [h]	8.406	22.8	0.19
Average	93.3	Total 49.461	Average 33.6	Average 0.28

[a] NS = not sampled
[b] Well began operating on June 29. The totalizer did not work. Daily flow was estimated using the set point.
[c] Well shut down July 1 due to access issues with radiation postings. Well shut down July 22 to July 23 due to a power outage
[d] Well shut down August 5 to August 6 due to a local power outage. Well shut down August 8 to August 10 for Well 33 tie-in and other maintenance. Well shut down August 18 to August 19 for a site wide electrical outage
[e] Well shut down at September 15 due to a power outage
[f] Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume
[g] Well shut down on November 8 due to a site wide power outage. Well shut down for 14 hours/day from November 9 to November 19 due to an offsite communication problem with the HMI. Well shut down on November 21 due to a power outage at the Parshall Flume
[h] Well shut down from December 4 to December 7 due to blown fuses in the power line

Table A.1–25. Extraction Well 33347 (EW-33a) Operational Summary Sheet for 2006

Reference Elevation (feet AMSL) – 574.86 (top of casing)
Northing Coordinate ('83) – 481031.762
Easting Coordinate ('83) – 1346715.817

Hours in reporting period – 8760 Hours pumped – 1032 Target pumping rate–300 gpm
Hours not pumped – 7728 Operational percent – 11.78

Monthly Measurements at Wellfield				
Month	Monthly Average Pumping Rate (gpm)	Million Gallons Pumped	Monthly Average Total Uranium Concentration [a] (µg/L)	Uranium Removal Index [a] (Pounds of Total Uranium Removed/ Million Gallons Pumped)
1/06	0.0	0.000	NS	NS
2/06	0.0	0.000	NS	NS
3/06	0.0	0.000	NS	NS
4/06	0.0	0.000	NS	NS
5/06	0.0	0.000	NS	NS
6/06	0.0	0.000	NS	NS
7/06	0.0	0.000	NS	NS
8/06	0.0	0.000	NS	NS
9/06	0.0	0.000	NS	NS
10/06	195 [b]	8.703	87.2	0.73
11/06	0.0 [c]	0.0	NS	NS
12/06	250 [d]	11.162	41.6	0.35
Average	222.5	Total 19.865	Average 64.4	Average 0.54

[a] NS = not sampled
[b] Well began operating on October 5. Well shut down on October 20 due to a power outage at the Parshall Flume. Well shut down from October 24 to October 27 due to a power outage at the Parshall Flume. Well shut down on October 28 because the flow controller was not controlling the flow rate
[c] Well shut down in November due to operational problems.
[d] Well shut down from December 4 to December 7 due to blown fuses in the power line

Table A.1–26. Regression Equations for Uranium Concentration Data Collected at Extraction Wells
Data Collected Through December 31, 2006

Well-ID	SED-ID	Data Trend	95% UCL	Function Type
RW-1	3924	$y = 3.12E+05e^{-2.0E-04x}$	$y = 9.70E+03e^{-1.0E-04x}$	Exponential Function
RW-2	3925	$y = -6.13E-03x + 2.56E+02$	$y = -6.13E-03x + 2.71E+02$	Linear
RW-3	3926	$y = -1.131E-09x^3 + 1.222E-04x^2 - 4.384x + 5.232E+04$	$y = -1.131E-09x^3 + 1.222E-04x^2 - 4.384x + 5.233E+04$	Polynomial
RW-4	3927	$y = 1.28E-34x^{7.49}$	$y = 4.09E-15x^{3.30}$	Power Function
RW-6	32308	$y = 2.66E+05e^{-2.26E-04x}$	$y = 2.57E+04e^{-1.53E-04x}$	Exponential Function
RW-7	32309	$y = 1.06E+06e^{-2.63E-04x}$	$y = 4.63E+04e^{-1.66E-04x}$	Exponential Function
EW-15a	33262	$y = 4.96E+82x^{-1.77E+01}$	$y = 9.12E+58x^{-1.24E+01}$	Power Function
EW-17a	33326	$y = 4.81E+03e^{-1.34E-04x}$	$y = 1.56E+03e^{-9.28E-05x}$	Exponential Function
EW-18	31550	$y = 4.15E+05e^{-2.41E-04x}$	$y = 2.06E+04e^{-1.45E-04x}$	Exponential Function
EW-19	31560	$y = 3.52E+09e^{-4.78E-04x}$	$y = 7.23E+05e^{-2.29E-04x}$	Exponential Function
EW-20	31561	$y = 1.08E+04e^{-1.48E-04x}$	$y = 2.67E+03e^{-1.01E-04x}$	Exponential Function
EW-21a	32398	$y = 3.64E+07e^{-3.49E-04x}$	$y = 2.17E+05e^{-1.96E-04x}$	Exponential Function
EW-22	32276	$y = 4.14E+10e^{-5.29E-04x}$	$y = 2.46E+06e^{-2.48E-04x}$	Exponential Function
EW-23	32447	$y = 2.18E+10e^{-5.04E-04x}$	$y = 8.23E+06e^{-2.78E-04x}$	Exponential Function
EW-24	32446	$y = 3.58E+06e^{-2.89E-04x}$	$y = 1.13E+05e^{-1.85E-04x}$	Exponential Function
EW-25	33061	$y = 9.90E+03e^{-1.40E-04x}$	$y = 2.22E+03e^{-9.19E-05x}$	Exponential Function
EW-30	33264	$y = 1.60E+11e^{-5.50E-04x}$	$y = 1.78E+08e^{-3.62E-04x}$	Exponential Function
EW-31	33265	$y = 1.23E+08e^{-4.00E-04x}$	$y = 5.24E+05e^{-2.46E-04x}$	Exponential Function
EW-32	33266	$y = 3.20E+12e^{-6.70E-04x}$	$y = 3.25E+08e^{-4.17E-04x}$	Exponential Function
EW-26	32761	$y = 2.38E+12e^{-6.34E-04x}$	$y = 9.92E+07e^{-3.54E-04x}$	Exponential Function
EW-27	33062	$y = 1.64E+15e^{-8.03E-04x}$	$y = 5.62E+08e^{-3.92E-04x}$	Exponential Function
EW-28a	33334	$y = 7.62E+18e^{-1.04E-03x}$	$y = 8.172E+08e^{-4.07E-04}$	Exponential Function
EW-33a	33347			

Table A.1–27. Modeled Performance Metrics
Based on the Waste Storage Area (Phase II) Design

	Predicted								
Year	Total Water Pumped (gpm)	Stormwater to Treatment (gpm)	Groundwater to Treatment (gpm)	Groundwater not Treated (gpm)	Concentration to Treatment (ug/L)	Concentration not Treated (ug/L)	Concentration Discharged to GMR (ug/L)	Annual Mass Discharged to GMR (pounds)	**Annual Uranium Extracted from GMA (pounds)**
2007	**4775**	**25**	**600**	**4175**	**171.8**	**28.1**	**25.8**	**542**	**925**
2008	**4775**	**25**	**300**	**4475**	**168.6**	**25.4**	**24.4**	**513**	**697**
2009	4775	0	0	4775	0	28.6	28.6	598	**586**
2010	4775	0	0	4775	0	24.6	24.6	516	**509**
2011	4775	0	0	4775	0	21.6	21.6	452	**450**
2012	4775	0	0	4775	0	19.3	19.3	403	**404**
2013	4775	0	0	4775	0	17.4	17.4	363	**366**
2014	4775	0	0	4775	0	15.8	15.8	330	**335**
2015	4775	0	0	4775	0	14.5	14.5	302	**307**
2016	4775	0	0	4775	0	13.5	13.5	264	**276**
2017	4775	0	0	4775	0	12.1	12.1	237	**247**
2018	4775	0	0	4775	0	11.0	11.0	216	**225**
2019	4775	0	0	4775	0	10.1	10.1	199	**208**
2020	4775	0	0	4775	0	9.4	9.4	184	**193**
2021	4775	0	0	4775	0	8.8	8.8	172	**180**
2022	4775	0	0	4775	0	8.2	8.2	161	**169**
2023	4775	0	0	4775	0	7.7	7.7	152	**159**
2024	4775	0	0	4775	0	7.3	7.3	143	**150**
Predicted Pounds of Uranium to be Extracted between 2007 and the End of the Remedy (2024)									**6386**
Pounds of Uranium Extracted Thru December 2006									**7796**
Total Predicted Pounds of Uranium to be Removed									**14182**

Assumptions: **Train 1 & 2 Effluent @ 10 ug/L**
Train 3 Effluent @ 15 ug/L

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Table A.1–28. Data Trend Performance Metrics
Based on Data Through December 31, 2006

	Predicted								
Year	Total Water Pumped (gpm)	Stormwater to Treatment (gpm)	Groundwater to Treatment (gpm)	Groundwater not Treated (gpm)	Concentration to Treatment (ug/L)	Concentration not Treated (ug/L)	Concentration Discharged to GMR (ug/L)	Annual Mass Discharged to GMR (pounds)	**Annual Uranium Extracted From GMA (pounds)**
2007	**4775**	**25**	**500**	**4275**	**66.0**	**30.3**	**28.1**	**590**	**761**
2008	4775	0	0	4775	0	28.9	28.9	605	**654**
2009	4775	0	0	4775	0	24.5	24.5	513	**560**
2010	4775	0	0	4775	0	21.3	21.3	446	**492**
2011	4775	0	0	4775	0	18.7	18.7	391	**435**
2012	4775	0	0	4775	0	16.4	16.4	343	**386**
2013	4775	0	0	4775	0	14.5	14.5	303	**345**
2014	4775	0	0	4775	0	12.8	12.8	268	**308**
2015	4775	0	0	4775	0	11.4	11.4	238	**276**
2016	4775	0	0	4775	0	10.1	10.1	198	**198**
2017	4775	0	0	4775	0	8.9	8.9	174	**174**
2018	4775	0	0	4775	0	7.8	7.8	153	**154**
2019	4775	0	0	4775	0	7.0	7.0	136	**136**
2020	4775	0	0	4775	0	6.2	6.2	121	**121**
2021	4775	0	0	4775	0	5.5	5.5	108	**108**
2022	4775	0	0	4775	0	5.0	5.0	97	**97**
2023	4775	0	0	4775	0	4.5	4.5	88	**87**
2024	4775	0	0	4775	0	4.0	4.0	79	**79**
Predicted Pounds of Uranium to be Extracted between 2007 and the End of the Remedy (2024)									**5371**
Pounds of Uranium Extracted Thru December 2006									**7796**
Total Predicted Pounds of Uranium to be Removed									**13167**

Assumptions: **Train 1 & 2 Effluent @ 10 ug/L**
Train 3 Effluent @ 15 ug/L

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Table A.1–29. UCL Trend Performance Metrics
Based on Data Through December 31, 2006

	Predicted								
Year	Total Water Pumped (gpm)	Stormwater to Treatment (gpm)	Groundwater to Treatment (gpm)	Groundwater not Treated (gpm)	Concentration to Treatment (ug/L)	Concentration not Treated (ug/L)	Concentration Discharged to GMR (ug/L)	Annual Mass Discharged to GMR (pounds)	Annual Uranium Extracted From GMA (pounds)
2007	**4775**	**25**	**1800**	**2975**	**128.0**	**53.7**	**37.8**	**827**	**1703**
2008	**4775**	**25**	**1800**	**2975**	**112.9**	**48.2**	**34.0**	**730**	**1547**
2009	**4775**	**25**	**1800**	**2975**	**99.8**	**42.9**	**30.4**	**640**	**1395**
2010	**4775**	**25**	**1800**	**2975**	**89.8**	**39.5**	**28.3**	**596**	**1278**
2011	**4775**	**25**	**1800**	**2975**	**81.3**	**36.6**	**26.5**	**558**	**1171**
2012	**4775**	**25**	**1700**	**3075**	**76.8**	**36.2**	**27.2**	**595**	**1075**
2013	**4775**	**25**	**1400**	**3375**	**70.8**	**34.1**	**27.0**	**567**	**988**
2014	**4775**	**25**	**1200**	**3575**	**66.9**	**32.5**	**26.8**	**563**	**909**
2015	**4775**	**25**	**800**	**3975**	**68.2**	**31.6**	**27.9**	**588**	**822**
2016	**4775**	**25**	**800**	**3975**	**65.2**	**34.0**	**29.7**	**585**	**775**
2017	**4775**	**25**	**800**	**3975**	**59.2**	**31.1**	**27.3**	**538**	**708**
2018	**4775**	**25**	**700**	**4075**	**56.1**	**30.7**	**27.6**	**581**	**646**
2019	**4775**	**25**	**400**	**4375**	**51.3**	**28.1**	**26.4**	**521**	**591**
2020	4775	0	0	4775	0	27.6	27.6	542	**541**
2021	4775	0	0	4775	0	25.4	25.4	497	**496**
2022	4775	0	0	4775	0	23.3	23.3	456	**455**
2023	4775	0	0	4775	0	21.4	21.4	419	**418**
2024	4775	0	0	4775	0	19.7	19.7	385	**376**
Predicted Pounds of Uranium to be Extracted between 2007 and the End of the Remedy									**15896**
Pounds of Uranium Extracted Thru December 2006									**7796**
Total Predicted Pounds of Uranium to be Removed									**23692**

Assumptions: Train 1 & 2 Effluent @ 10 ug/L
Train 3 Effluent @ 15 ug/L

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Table A.1–30. 2006 Extraction Well Target Pumping Rates

Module	Extraction Well	January 1 to December 31[a] (gpm)
South Plume	3924 (RW-1)	200
	3925 (RW-2)	200
	3926 (RW-3)	200
	3927 (RW-4)	400
	32308 (RW-6)	200
	32309 (RW-7)	200
Sub-Total		1400
Waste Storage Area	32761 (EW-26)	300
	33062 (EW-27)	200
	33334 (EW-28a)	200
	33347 (EW-33a)	300
Sub-Total		1000
South Field Extraction	31550 (EW-18)	100
	31560 (EW-19)	100
	31561 (EW-20)	100
	33298 (EW-21a)	200
	33326 (EW-17a)	175
	32276 (EW-22)	300
	32446 (EW-24)	300
	32447 (EW-23)	300
	33061 (EW-25)	100
	33264 (EW-30)	200
	33265 (EW-31)	300
	33266 (EW-32)	200
	33262 (EW-15a)	200
Sub-Total		2575
Total Pumping		4975

[a]The target pumping rates are from the Waste Storage Area Phase II Design with the following exception: The pumping rate of RW-4 in the South Plume was increased from 200 gpm to 400 gpm to assure capture of a lobe of uranium contamination extending south of Willey Road along the eastern side of the plume.

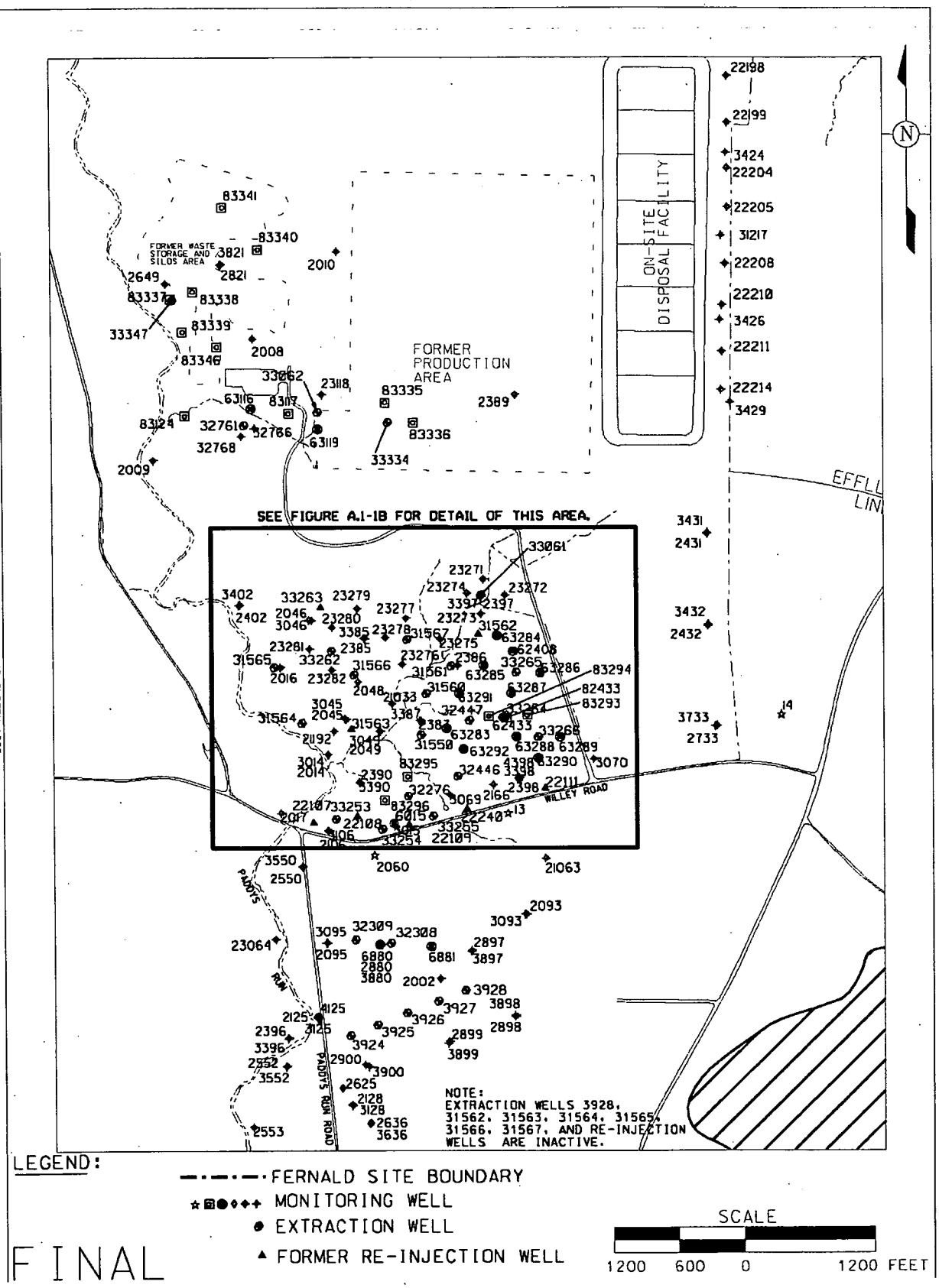

Figure A.1–1A. Well Locations for South Plume, South Field, Waste Storage Area, and Paddys Run Road Site Monitoring Activities

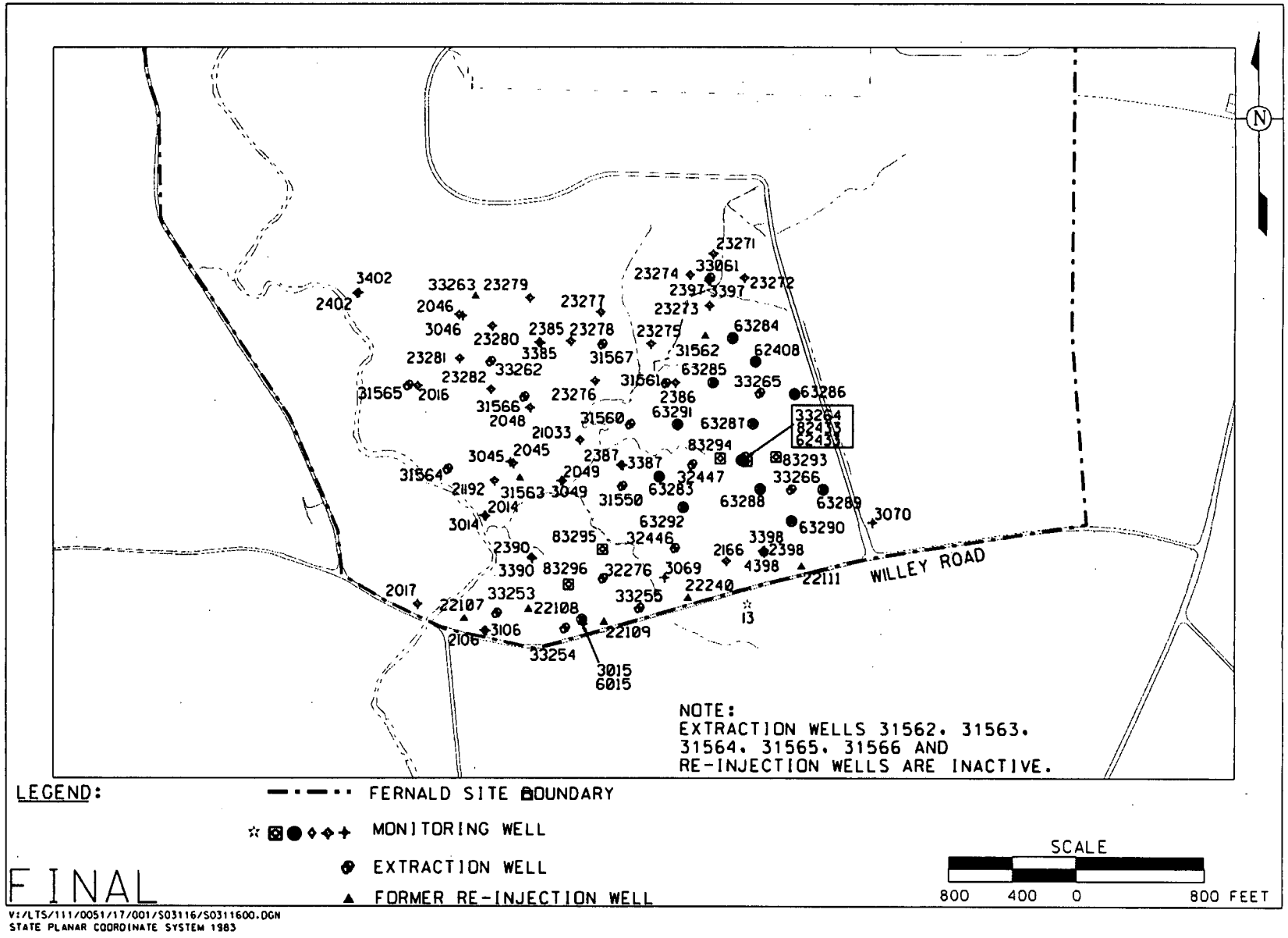

Figure A.1–1B. Well Locations for South Field

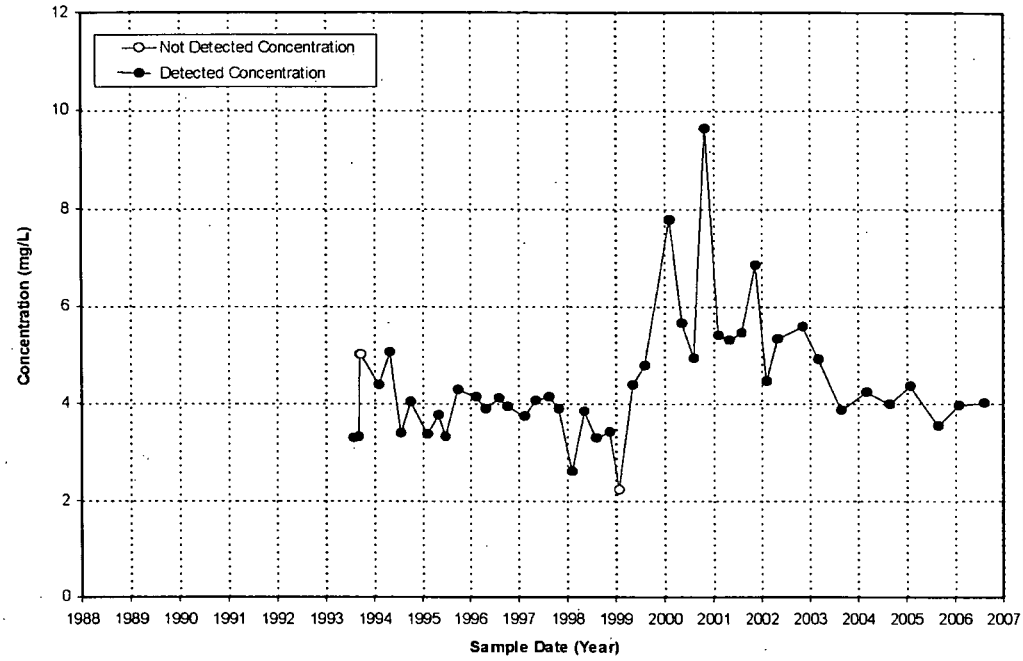

FIGURE A.1-2. POTASSIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2898

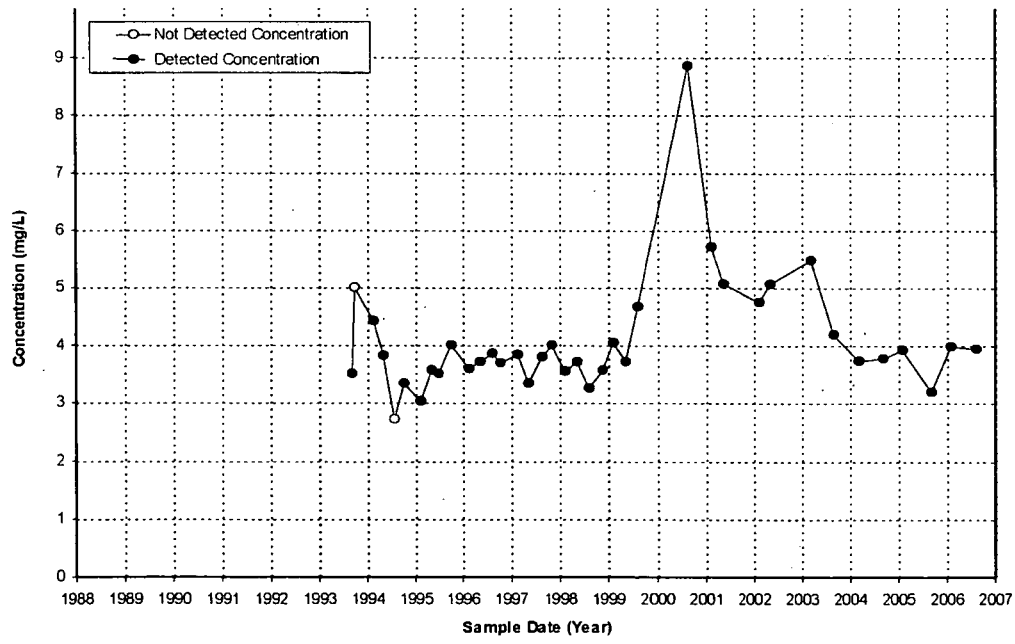

FIGURE A.1-3. POTASSIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2899

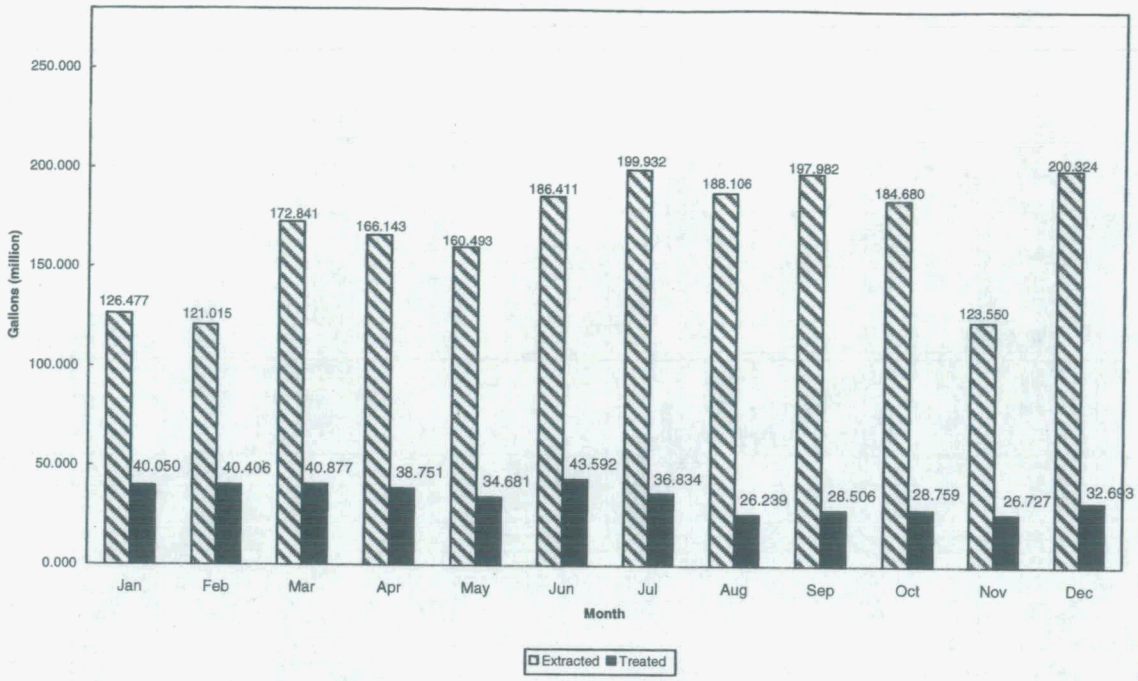

Figure A.1-4. Total Groundwater Extracted vs. Groundwater Treated for 2006

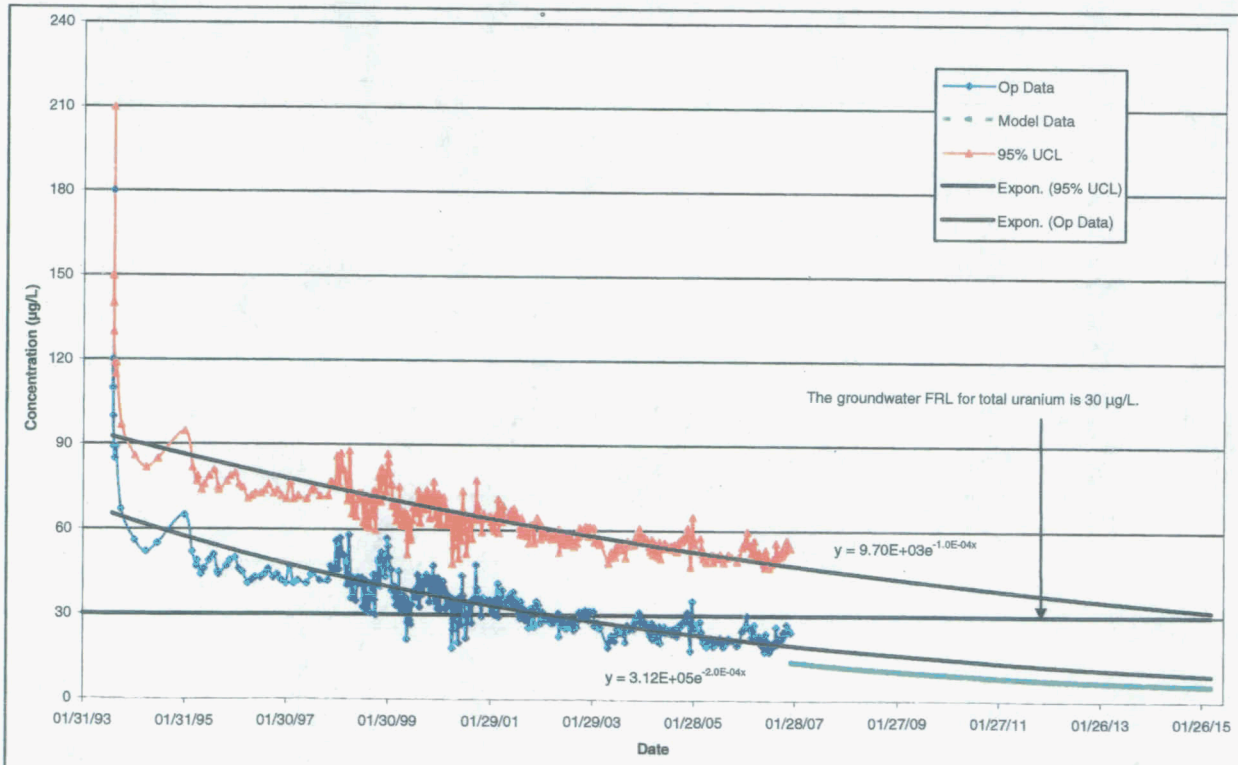

Figure A.1-5. Total Uranium Concentration vs. Time Plot for Extraction Well 3924 (RW-1) with Regression Analysis

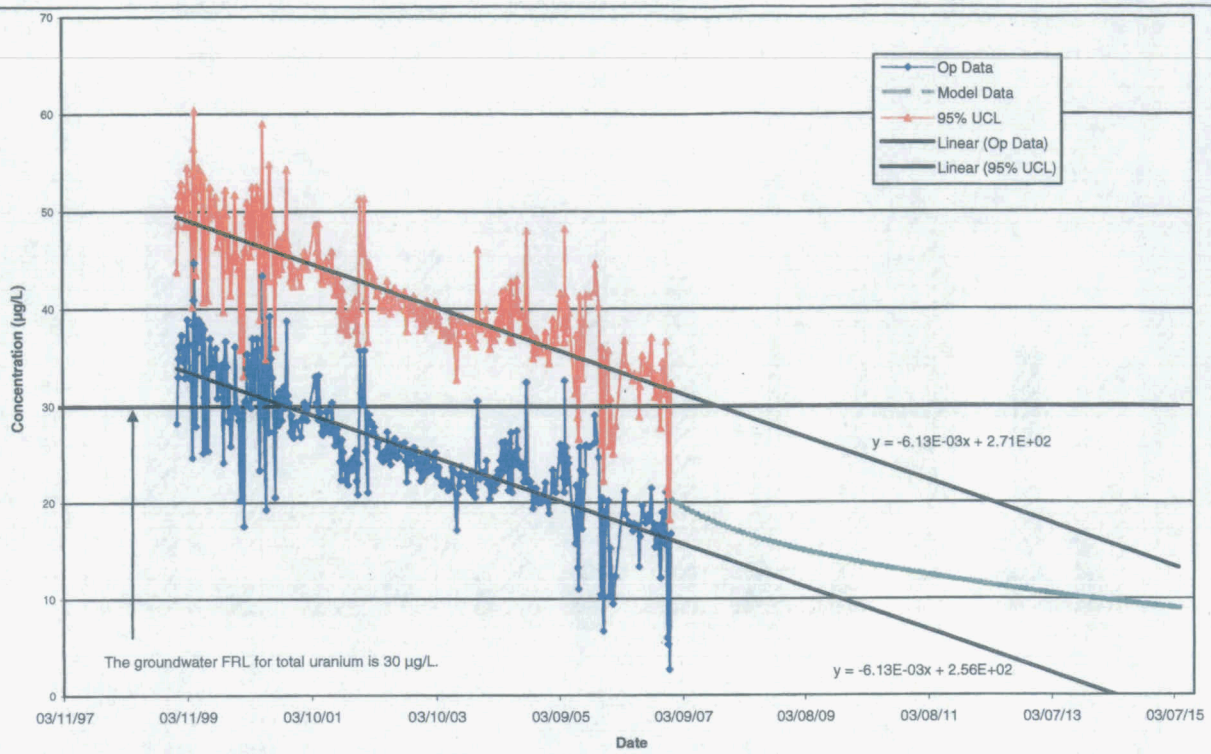

Figure A.1-6. Total Uranium Concentration vs. Time Plot for Extraction Well 3925 (RW-2) with Regression Analysis

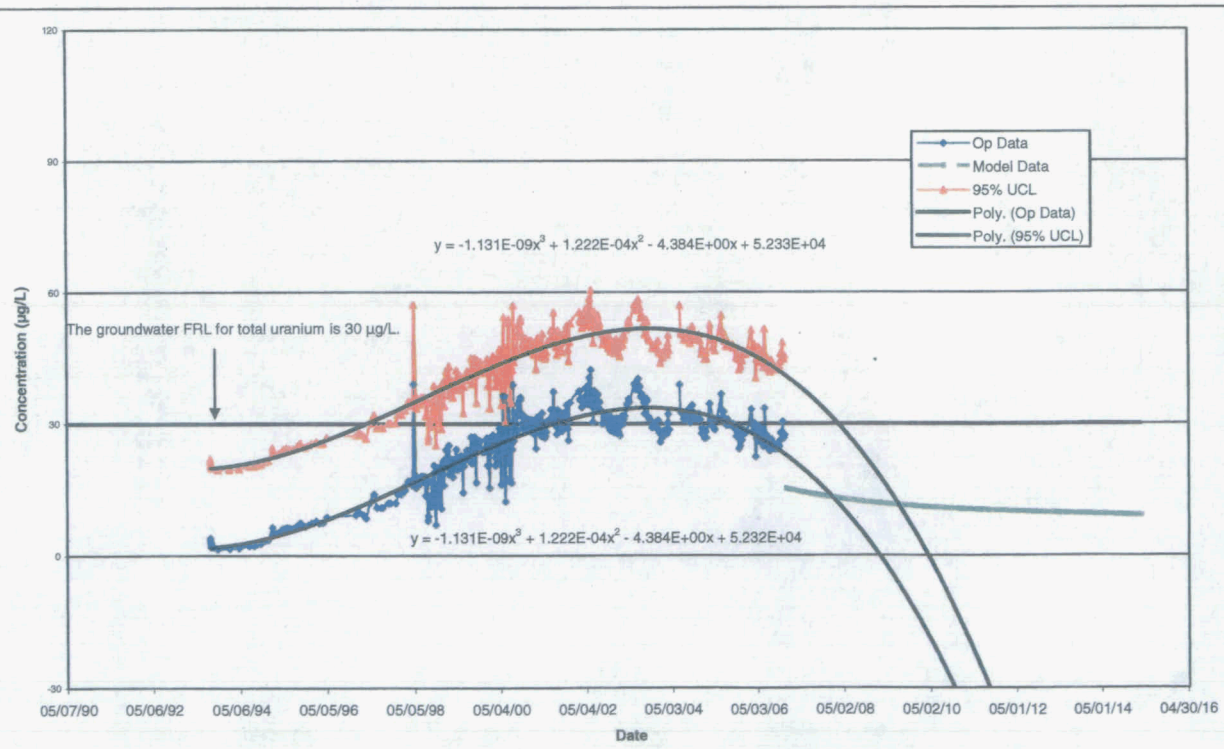

Figure A.1-7. Total Uranium Concentration vs. Time Plot for Extraction Well 3926 (RW-3) with Regression Analysis

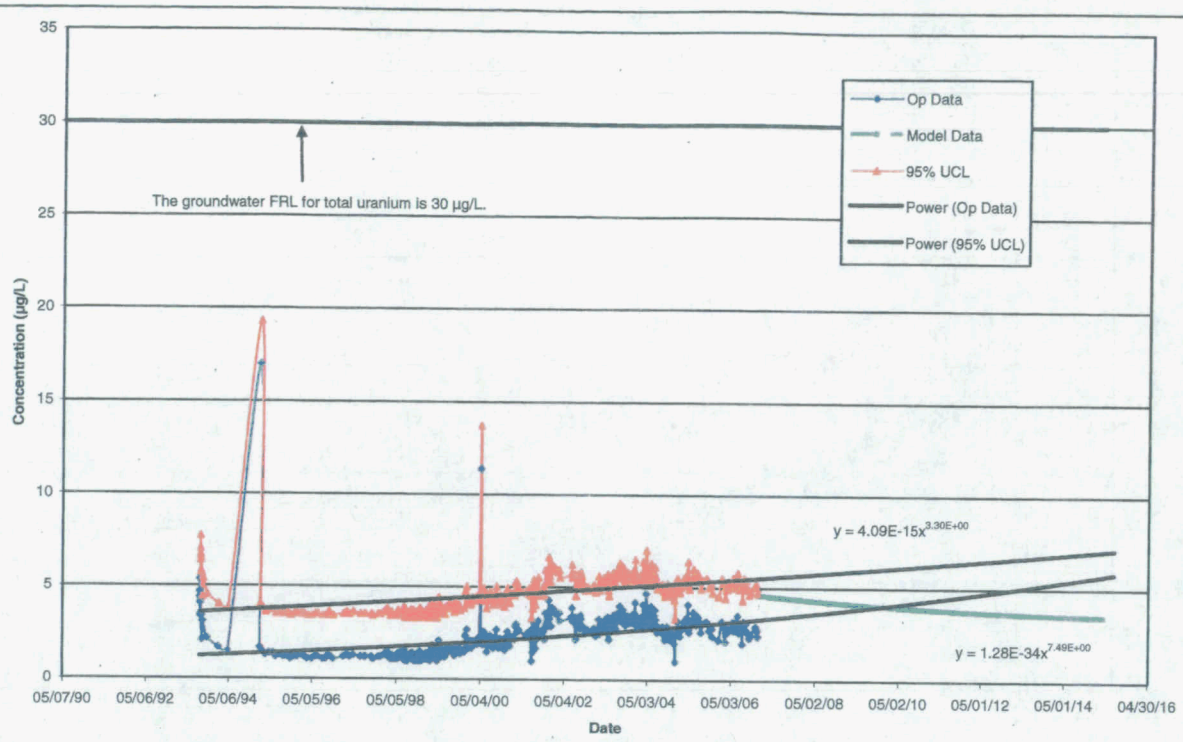

Figure A.1-8. Total Uranium Concentration vs. Time Plot for Extraction Well 3927 (RW-4) with Regression Analysis

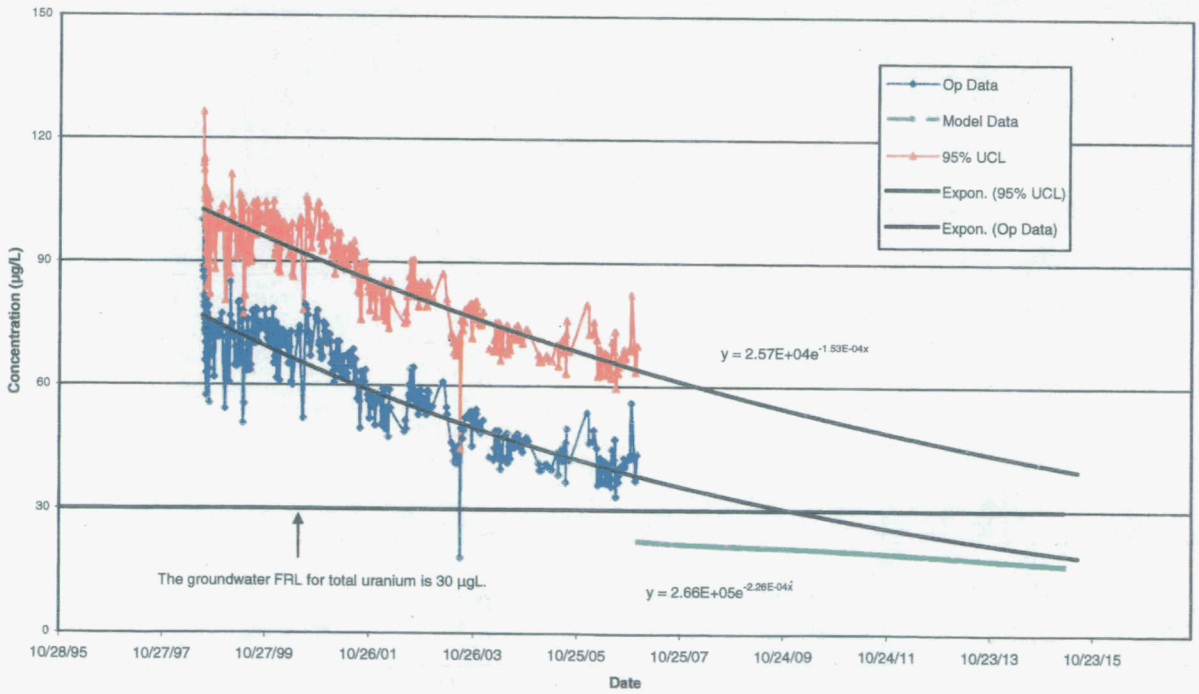

Figure A.1-9. Total Uranium Concentration vs. Time Plot for Extraction Well 32308 (RW-6) with Regression Analysis

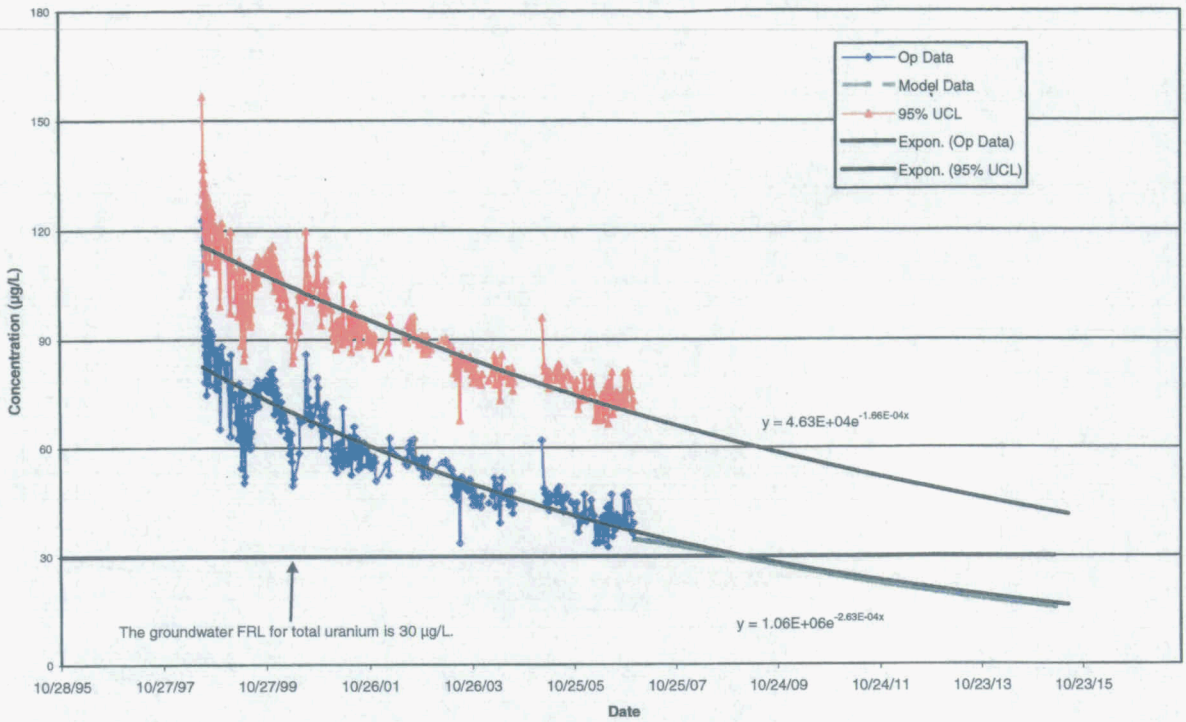

Figure A.1-10. Total Uranium Concentration vs. Time Plot for Extraction Well 32309 (RW-7) With Regression Analysis

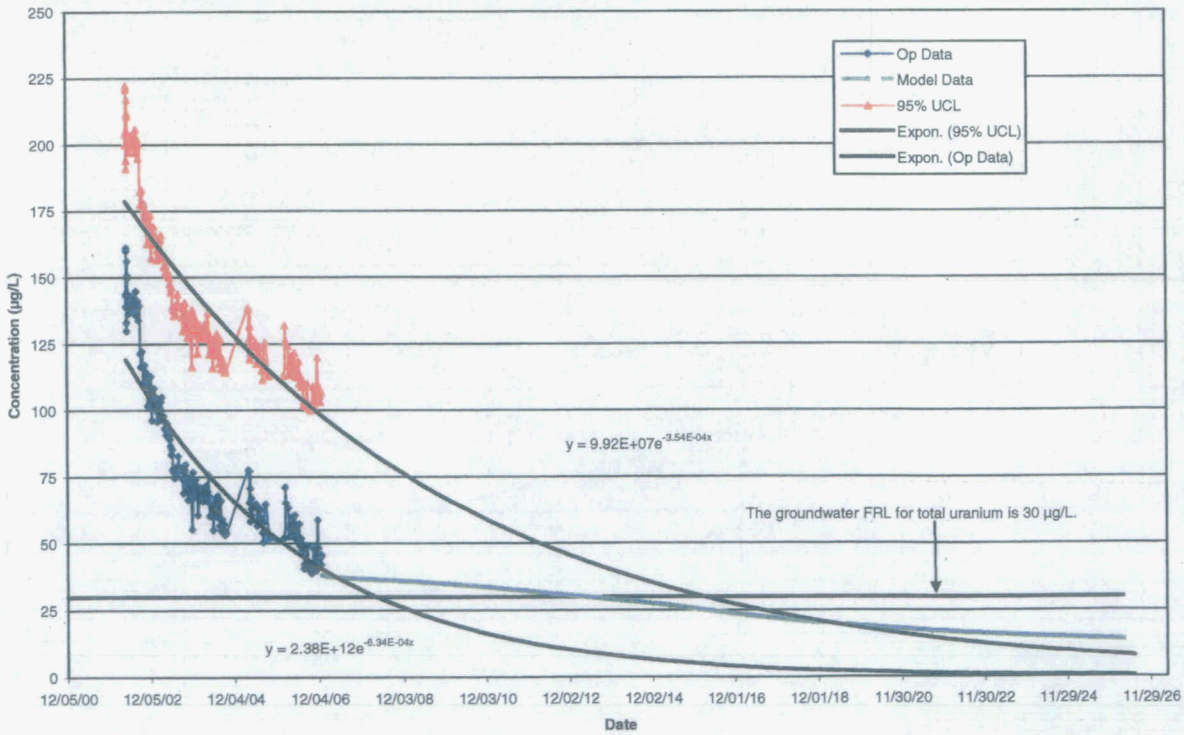

Figure A.1-11. Total Uranium Concentration vs. Time Plot for Extraction Well 32761 (EW-26) with Regression Analysis

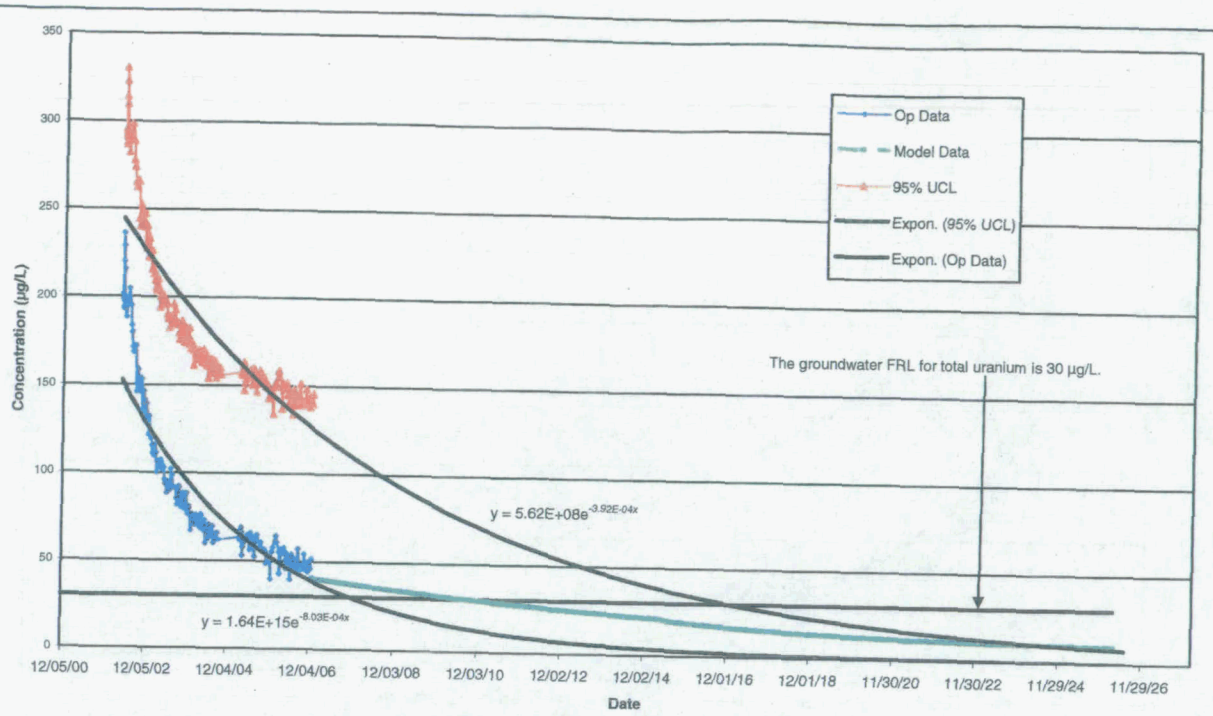

Figure A.1-12. Total Uranium Concentration vs. Time Plot for Extraction Well 33062 (EW-27) with Regression Analysis

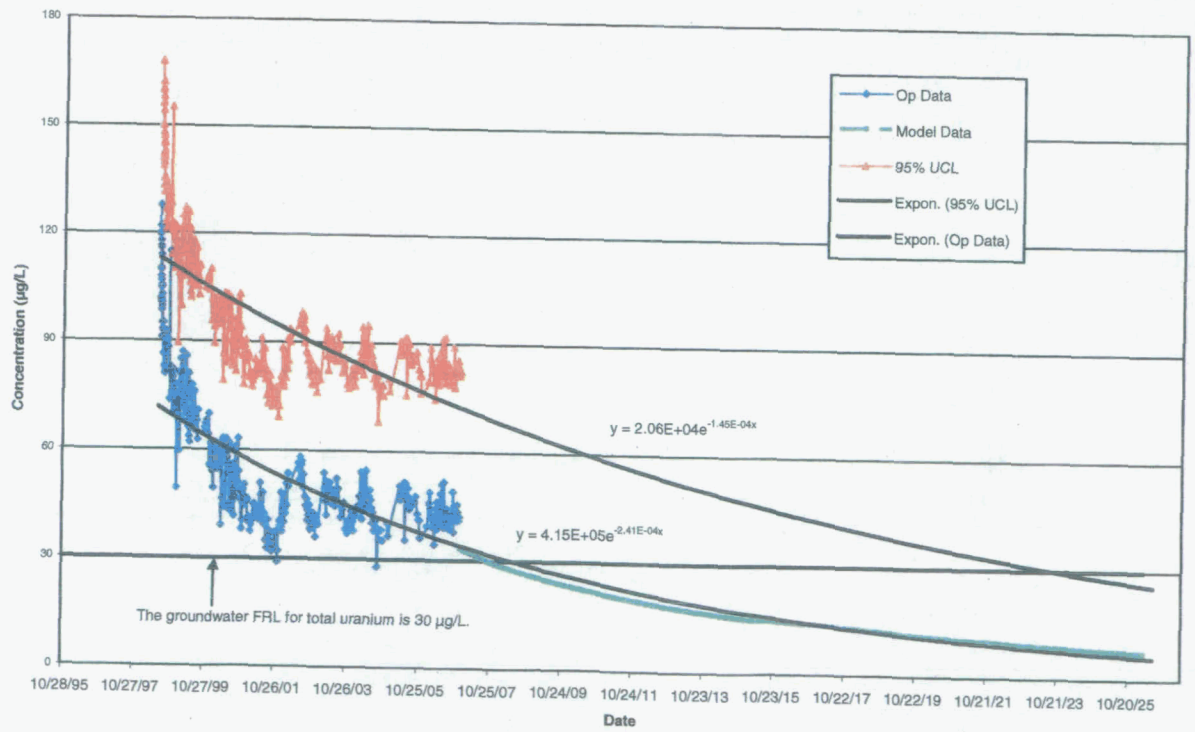

Figure A.1-13. Total Uranium Concentration vs. Time Plot for Extraction Well 31550 (EW-18) with Regression Analysis

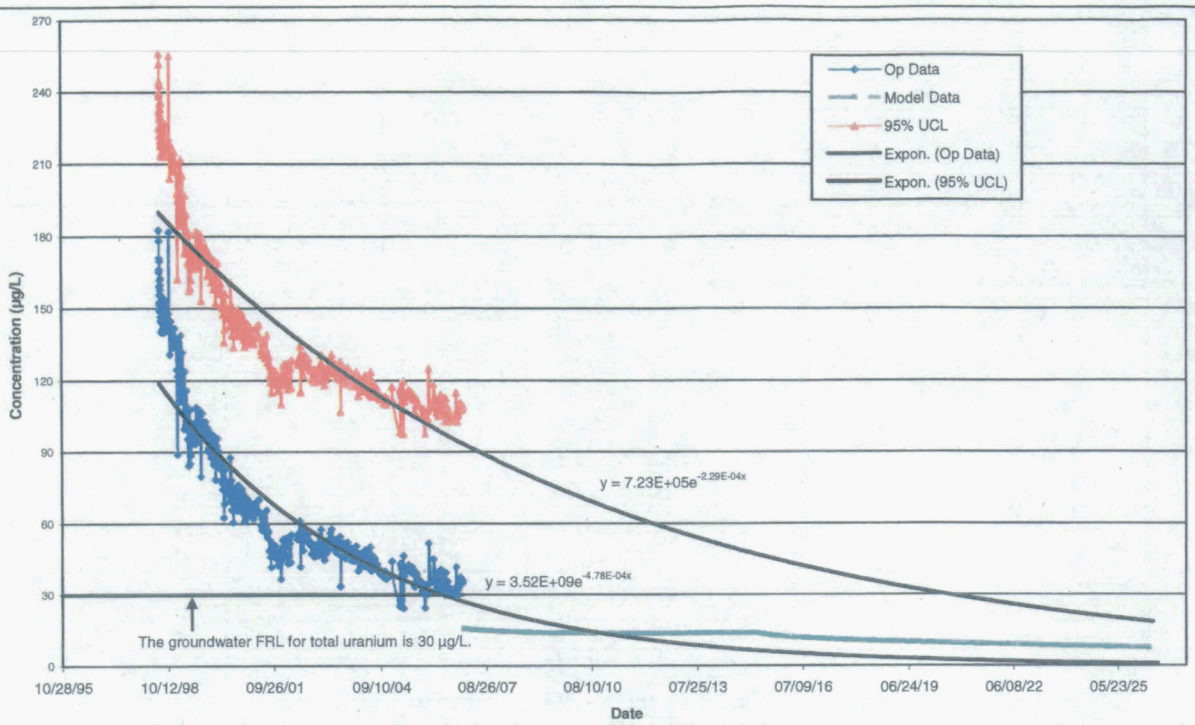

Figure A.1-14. Total Uranium Concentration vs. Time Plot for Extraction Well 31560 (EW-19) with Regression Analysis

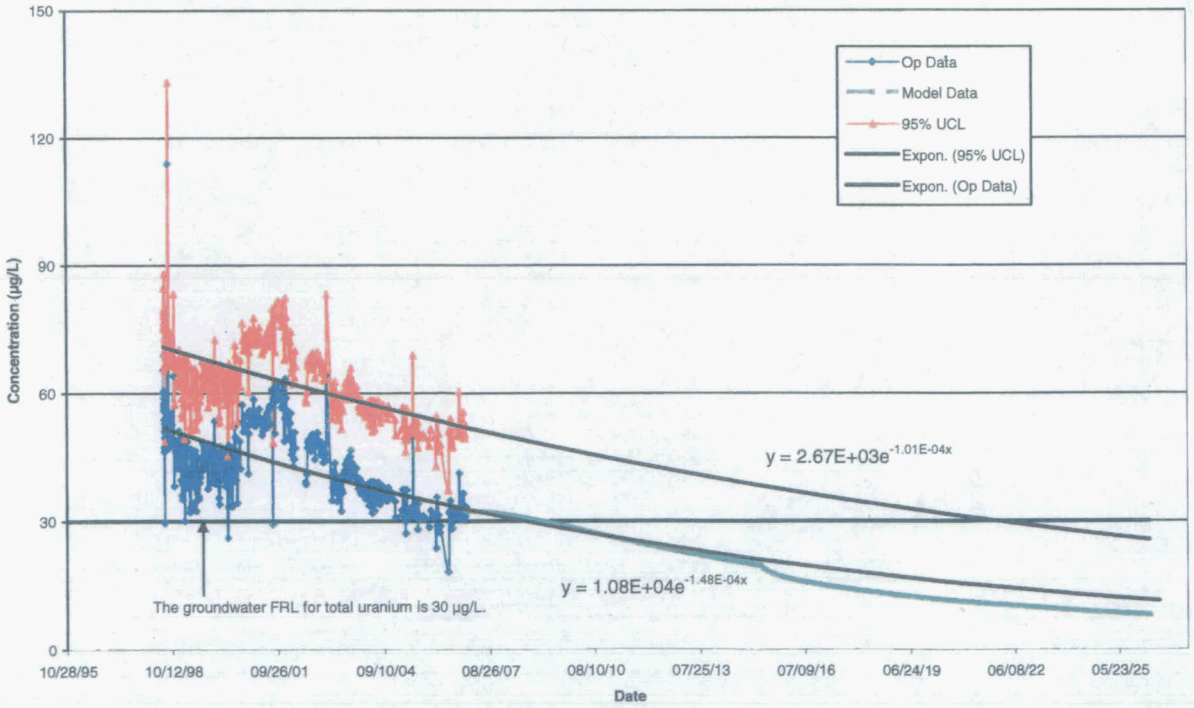

Figure A.1-15. Total Uranium Concentration vs. Time Plot for Extraction Well 31561 (EW-20) with Regression Analysis

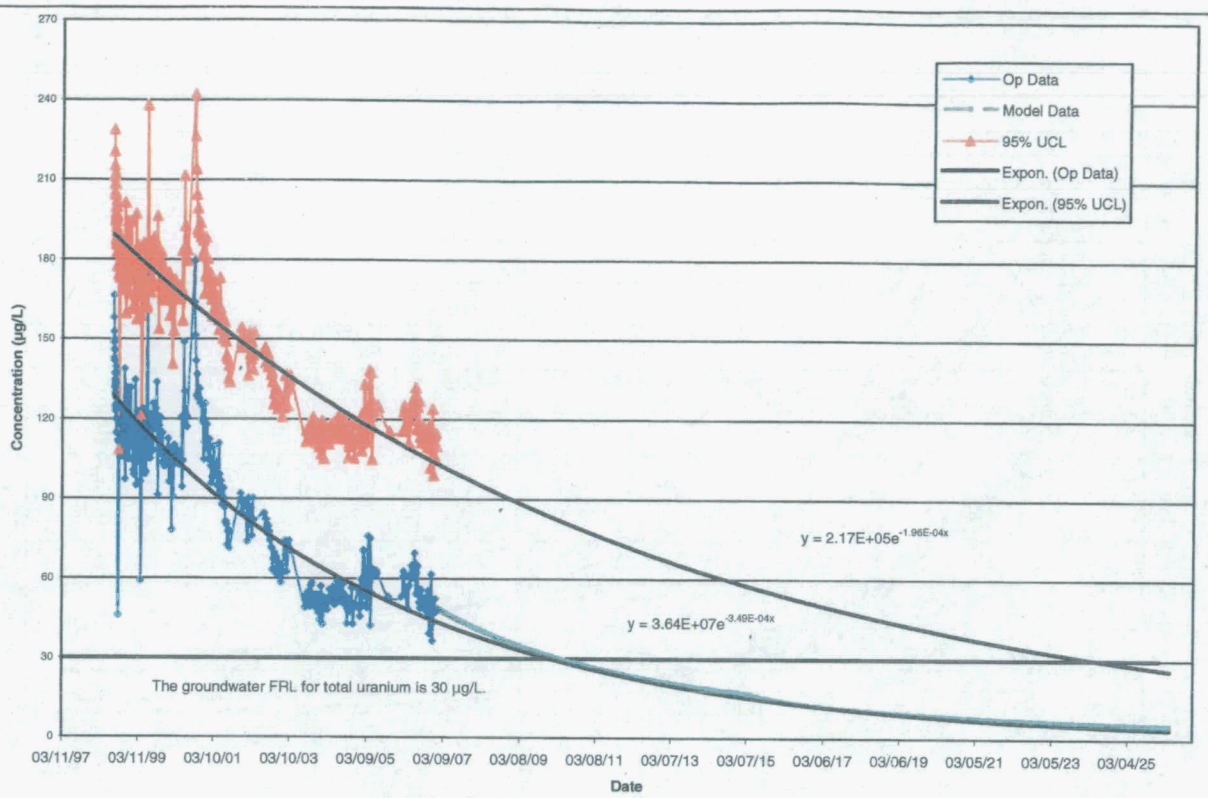

Figure A.1-16. Total Uranium Concentration vs. Time Plot for Extraction Well 31562 (EW-21) / 33298 (EW-21a) with Regression Analysis

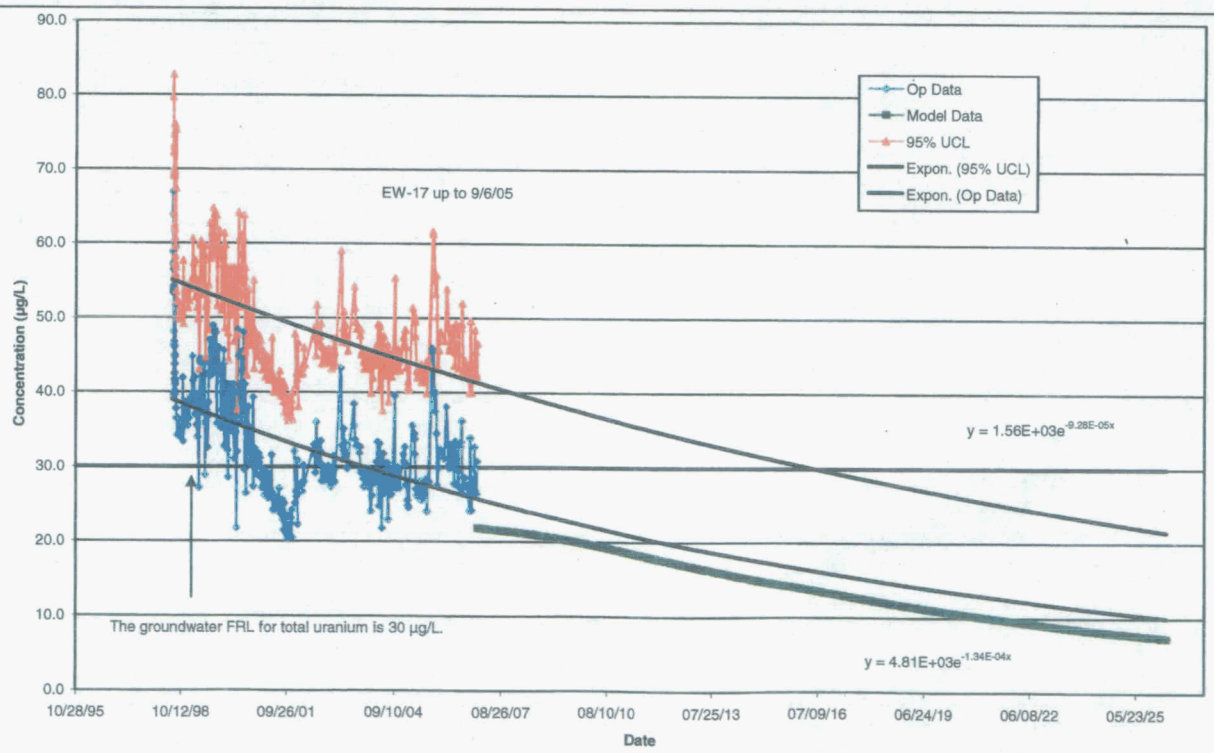

Figure A.1-17. Total Uranium Concentration vs. Time Plot for Extraction Well 31567 (EW-17)/ 33326 (EW-17a) with Regression Analysis

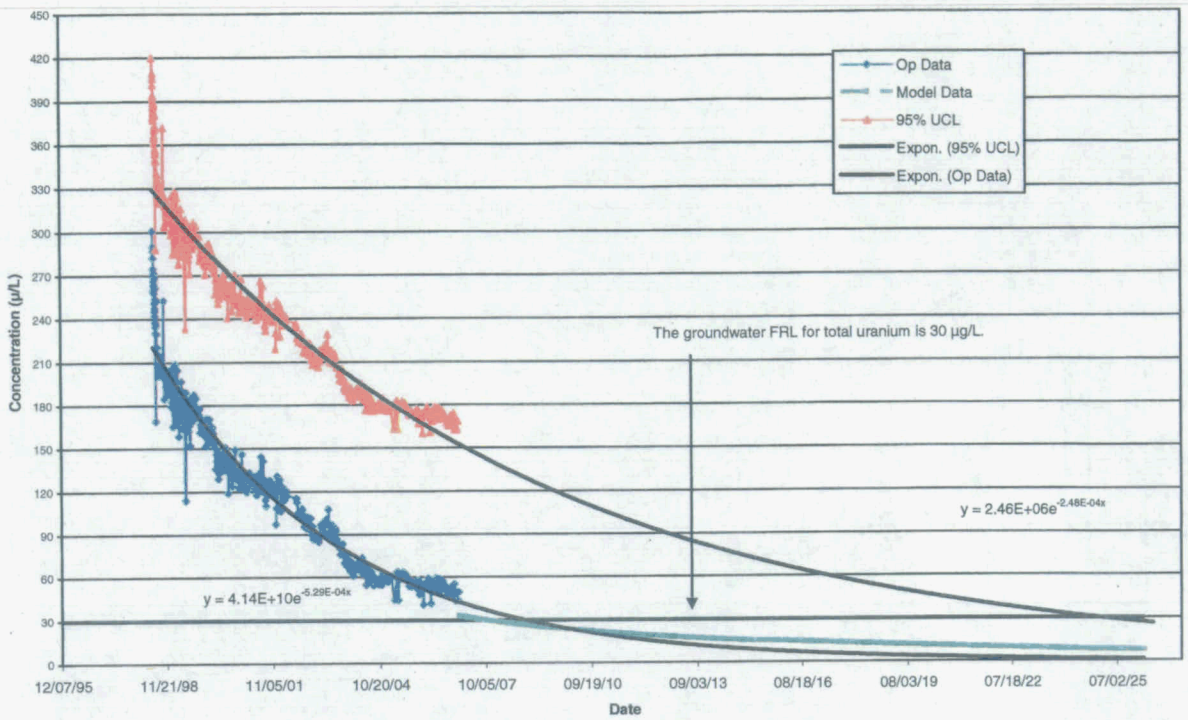

Figure A.1-18. Total Uranium Concentration vs. Time Plot for Extraction Well 32276 (EW-22) with Regression Analysis

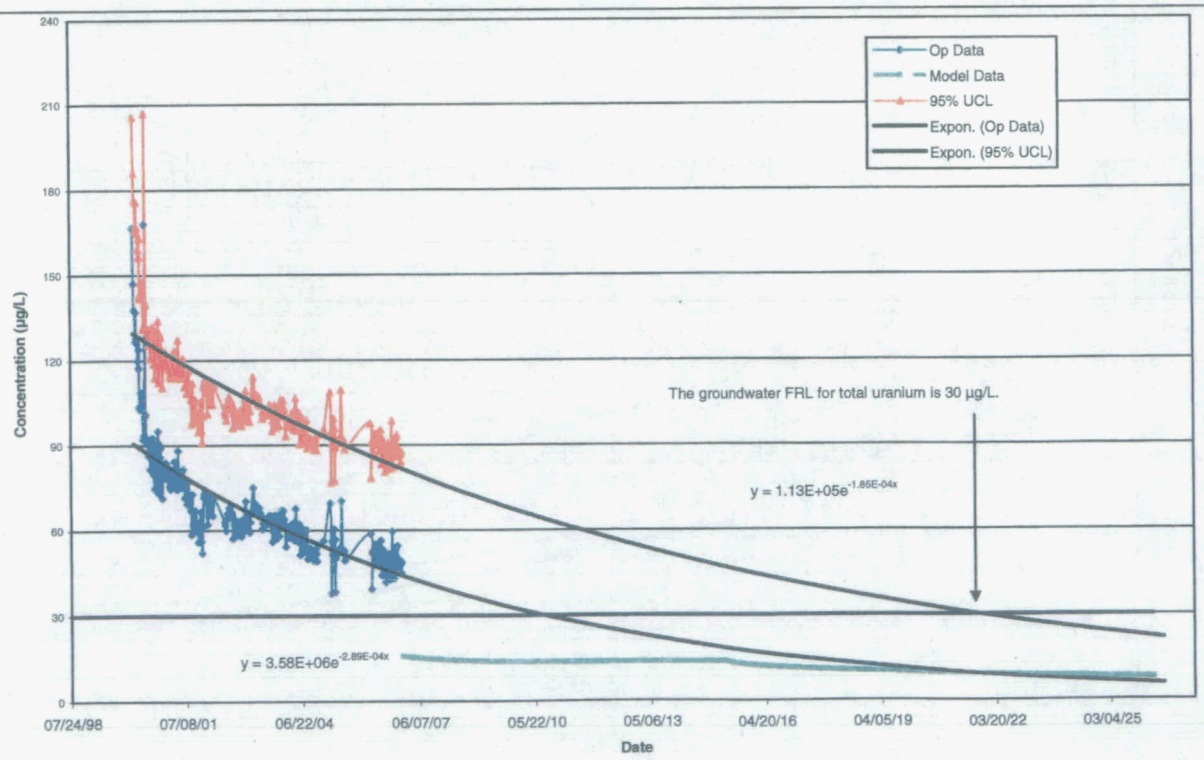

Figure A.1-19. Total Uranium Concentration vs. Time Plot for Extraction Well 32446 (EW-24) with Regression Analysis

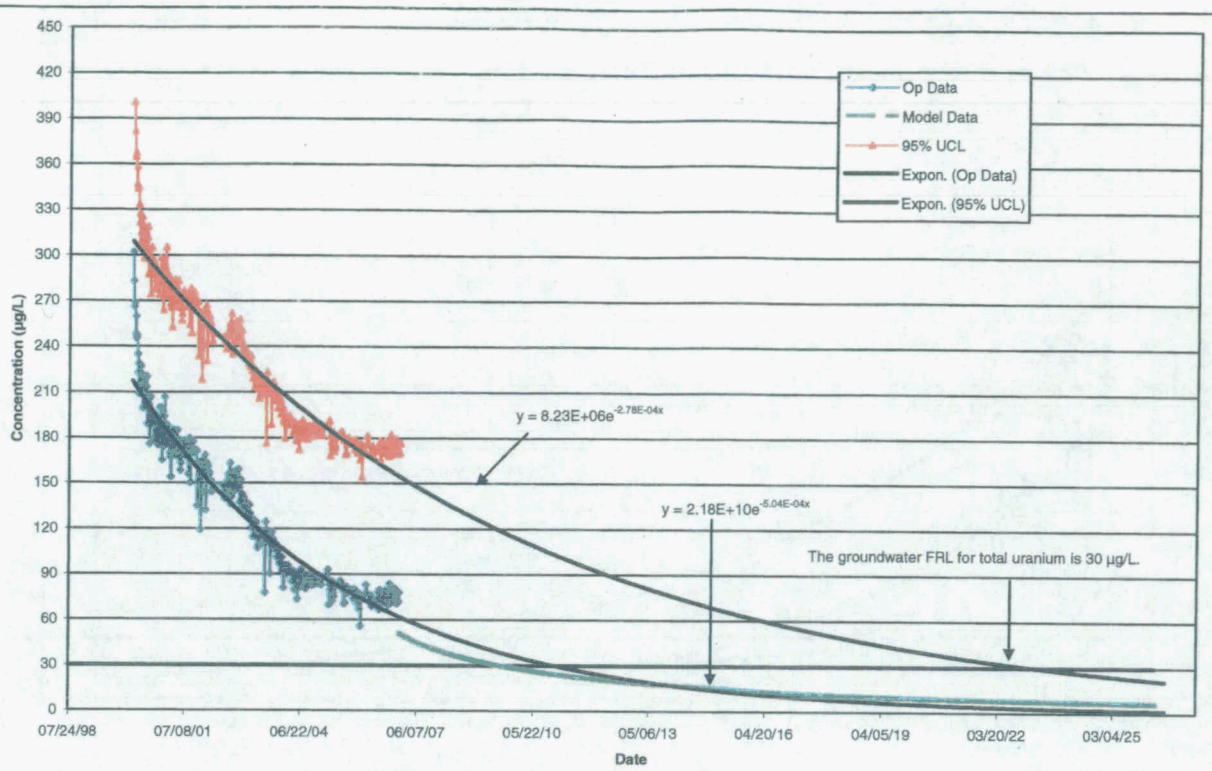

Figure A.1-20. Total Uranium Concentration vs. Time Plot for Extraction Well 32447 (EW-23) with Regression Analysis

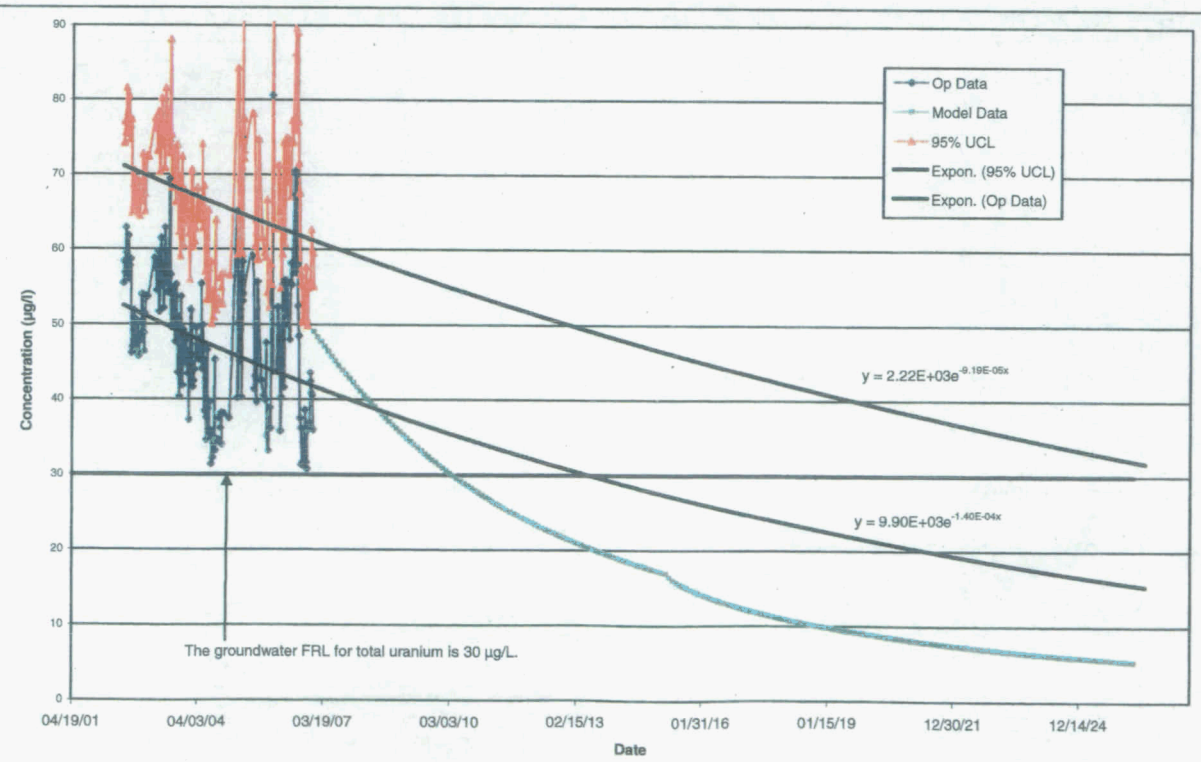

Figure A.1-21. Total Uranium Concentration vs. Time Plot for Extraction Well 33061 (EW-25) with Regression Analysis

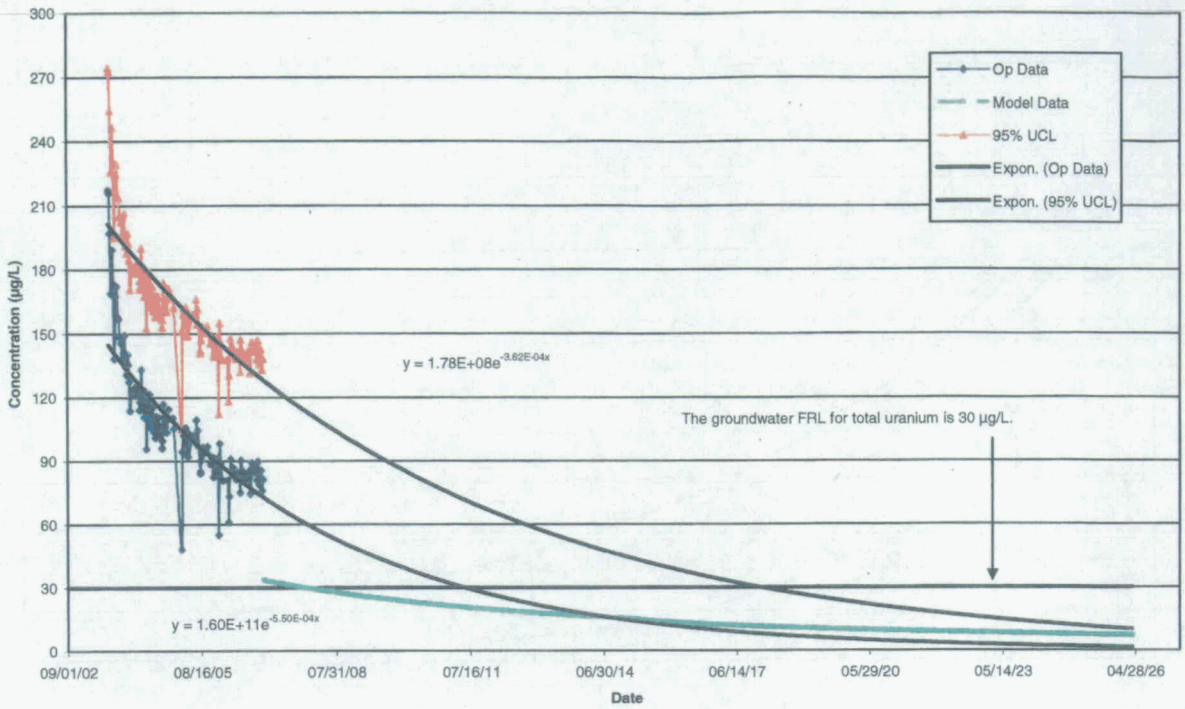

Figure A.1.22. Total Uranium Concentration vs. Time Plot for Extraction Well 33264 (EW-30) with Regression Analysis

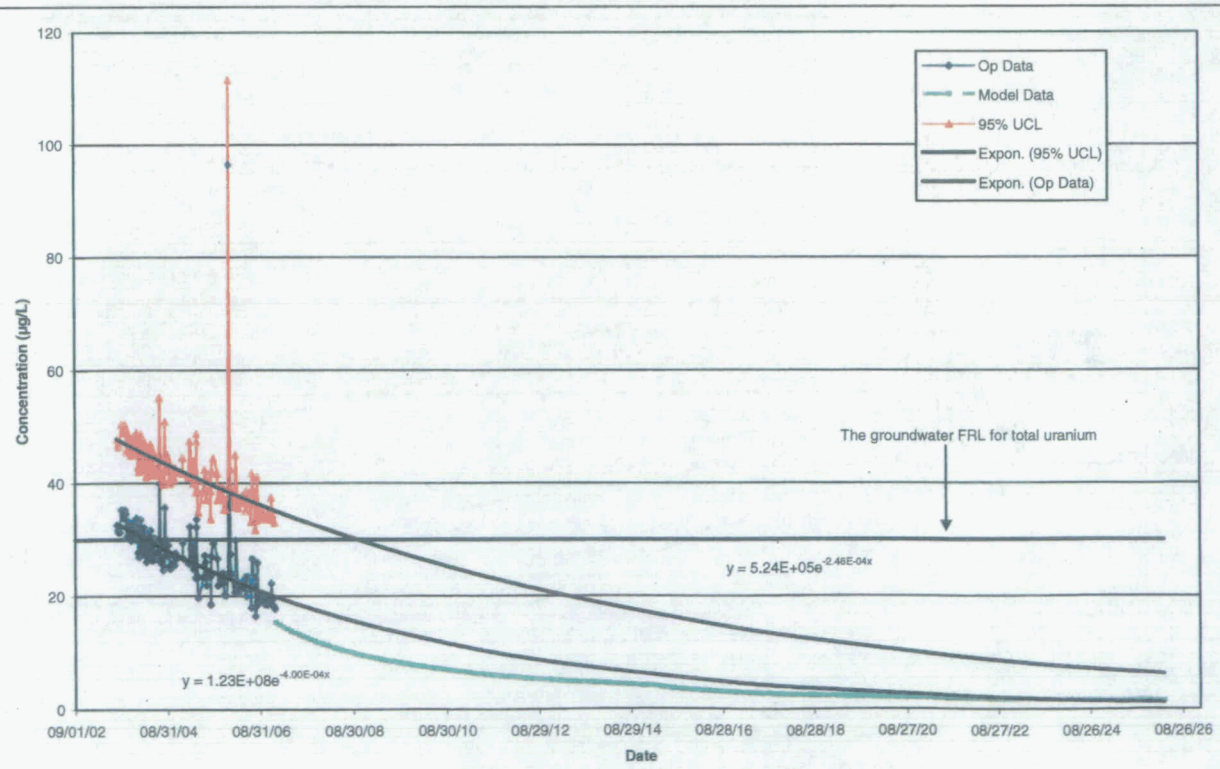

Figure A.1-23. Total Uranium Concentration vs. Time Plot for Extraction Well 33265 (EW-31) with Regression Analysis

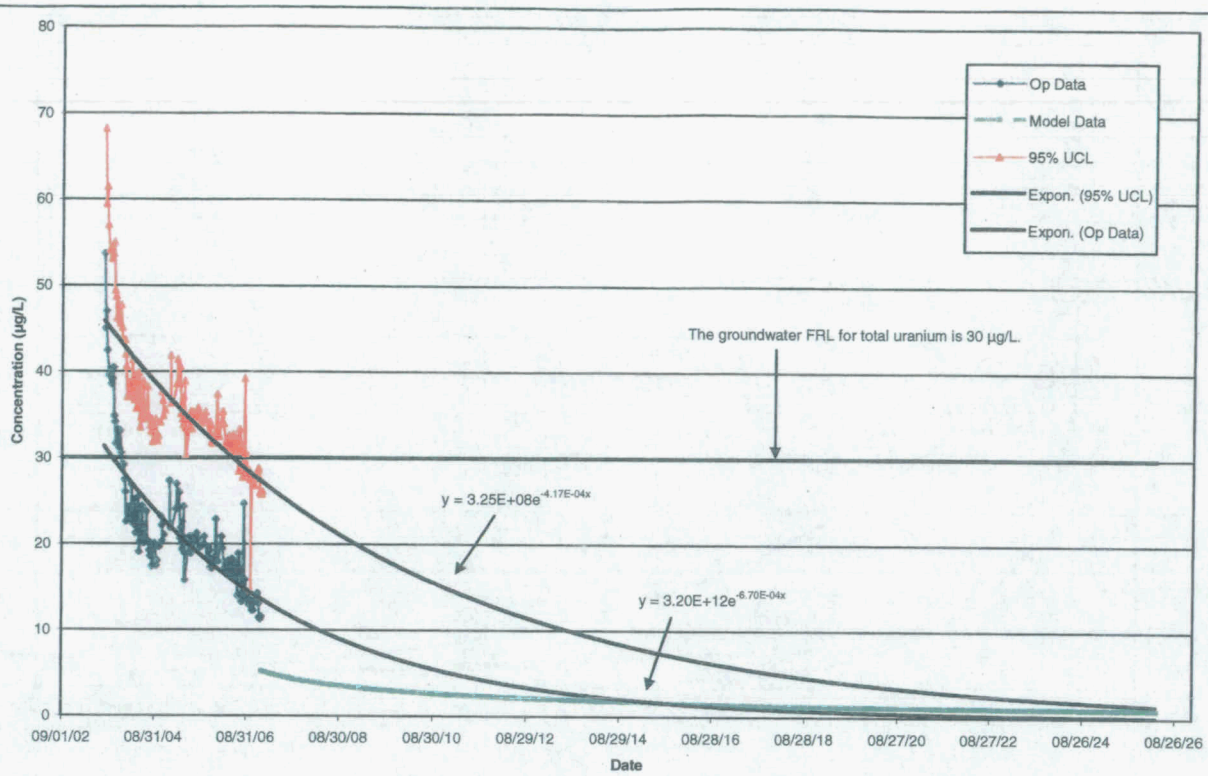

Figure A.1-24. Total Uranium Concentration vs. Time Plot for Extraction Well 33266 (EW-32) with Regression Analysis

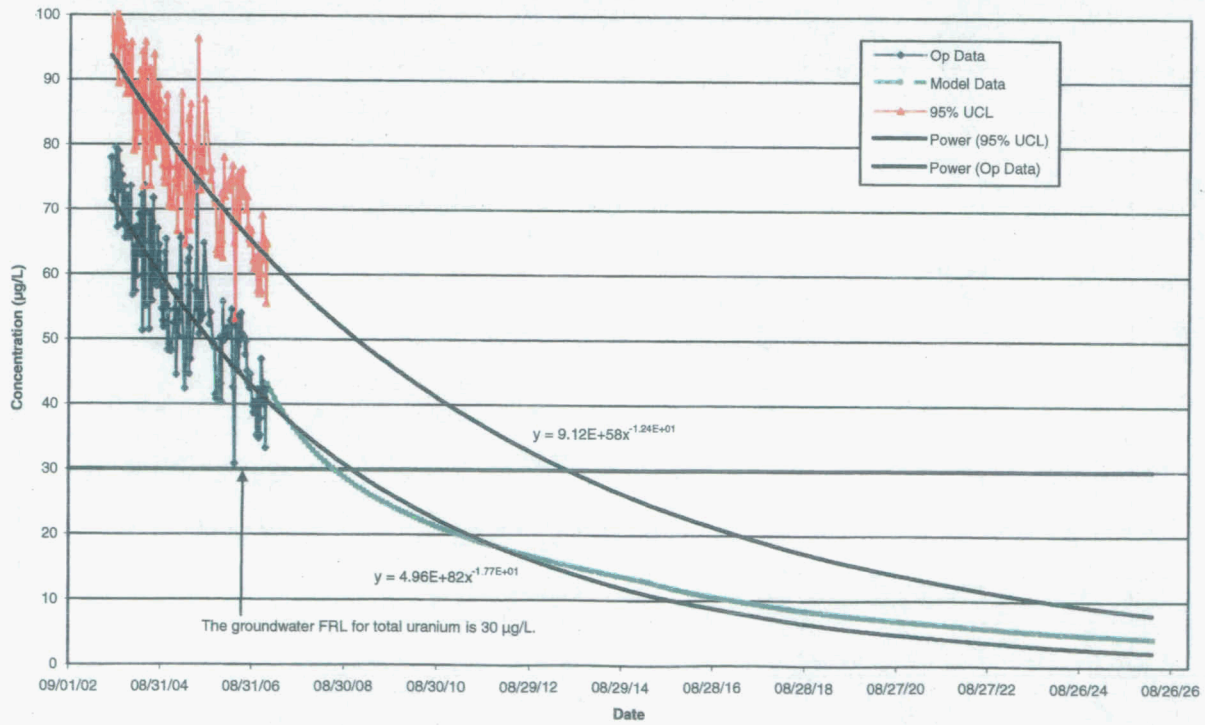

Figure A.1-25. Total Uranium Concentration vs. Time Plot for Extraction Well 33262 (EW-15a) with Regression Analysis

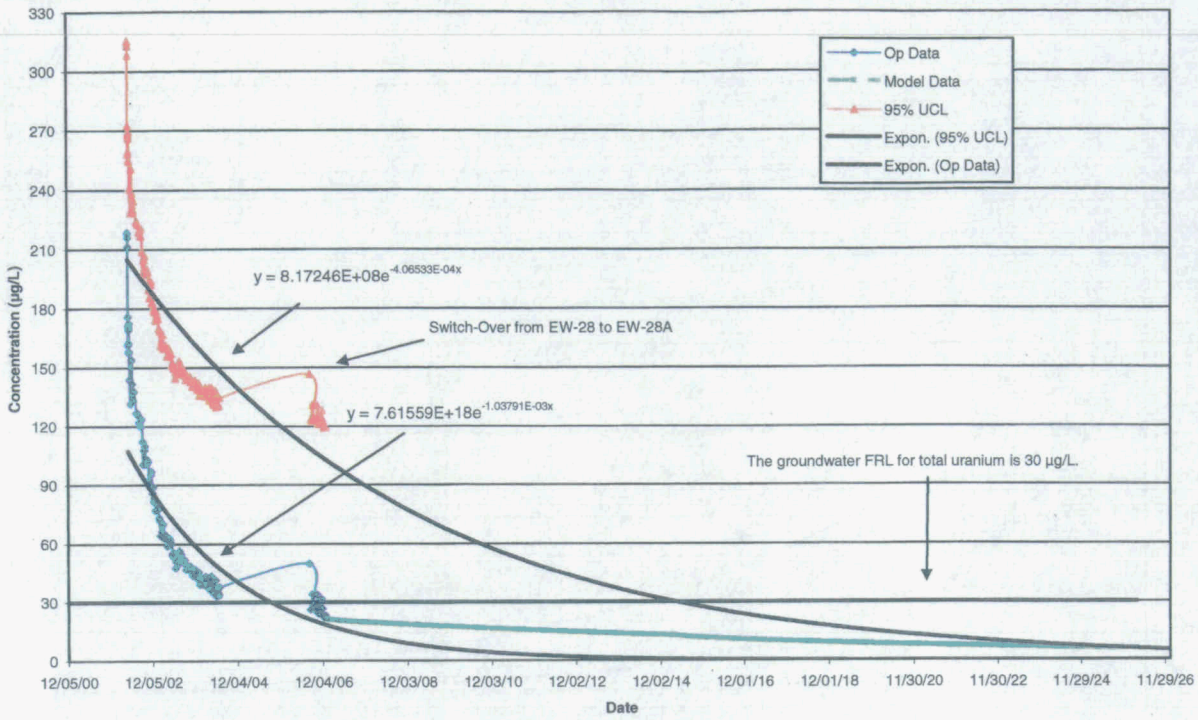

Figure A.1-26. Total Uranium Concentration vs. Time Plot for Extraction Well 33063 (EW-28) / 33334 (EW-28a) with Regression Analysis

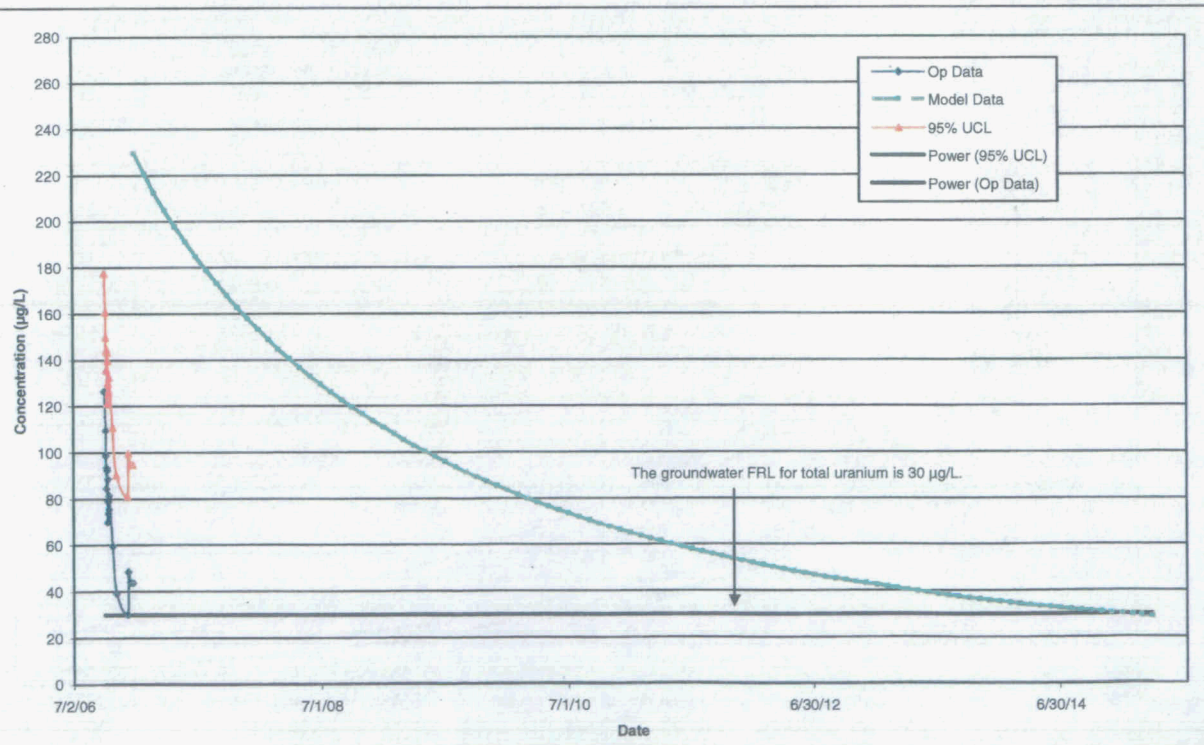

Figure A.1-27. Total Uranium Concentration vs. Time Plot for Extraction Well 33347 (EW-33a) with Regression Analysis

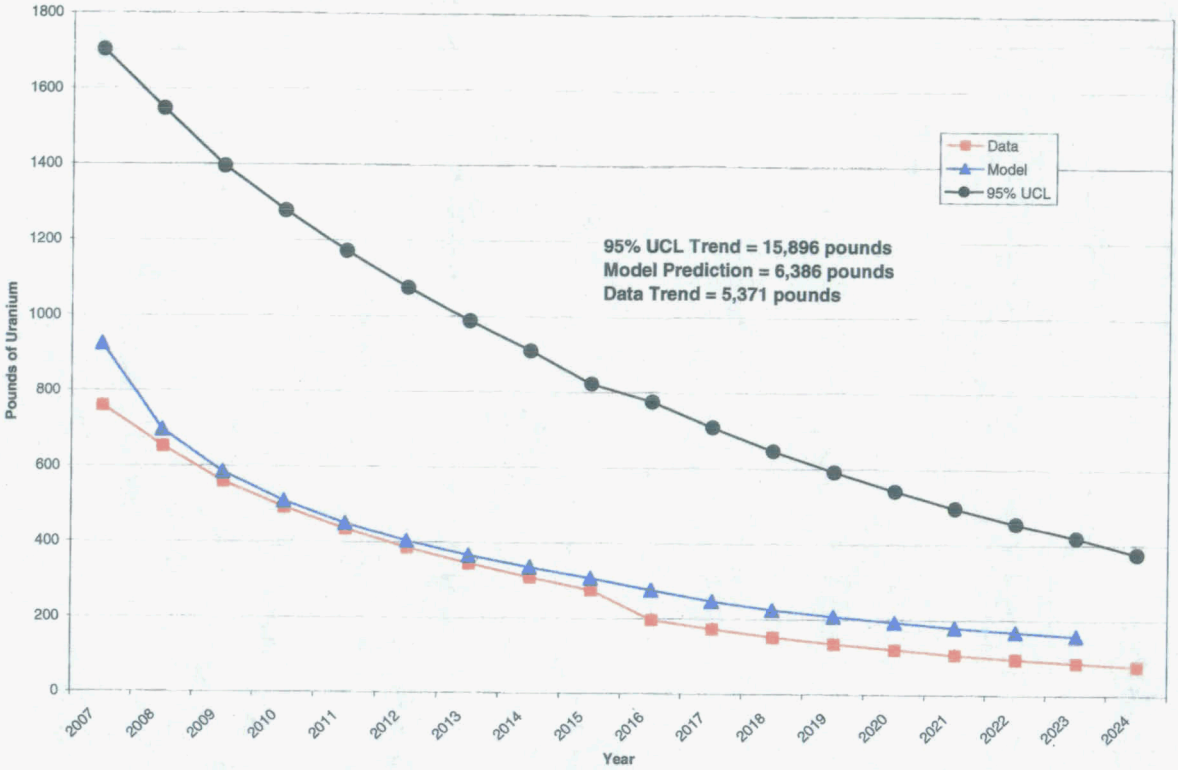

Figure-A.1-28. Estimate of Yearly Pounds of Uranium to be Removed from the Aquifer to Meet Cleanup Dates Predicted by the Groundwater Model
(Model Predictions versus Measured Concentrations, Data Current Through December 2006)

End of current text

Attachment A.2

Attachment A.2

A.2.0 Assessment of Total Uranium Results

This attachment discusses groundwater total uranium results for 2006 in context with results collected prior to 2006. Monitoring well locations associated with the IEMP are listed in Table A.2–1. Monitoring and extraction well locations associated with the IEMP are shown in Figure A.2–1. For integration purposes, the on site disposal facility monitoring well locations are also shown on Figure A.2–1 and Table A.2–1.

Figures A.2–2A, A.2–2B, A.2–2C; and A.2–3A, A.2–3B, A.2–3C show maximum total uranium plume maps for the first and second halves of 2006, respectively. The maps are posted in three parts to show all of the data in an 8½ by 11 inch format. The first part shows direct push (i.e., Geoprobe®) data, the second part shows monitoring well and extraction well data, and the third part shows a detailed expansion of monitoring well and extraction well data in the South Field. Data collected from the aquifer are used to progressively update the total uranium plume maps in the following manner:

- Total uranium concentration data are posted on a map with the contours from the previous map. The highest representative total uranium value at a monitoring well location is posted. The highest concentration associated with each direct push location is also posted.
- If a recently measured concentration from a well is greater than the previous concentration contour value at that location, then the plume is recontoured to honor the higher value.
- If the most recent concentration measurement from a well is less than the previous contoured for that location, then the new data are posted but the plume contours are not adjusted to honor the new data until confirmatory direct push sampling can be conducted.
- If direct push data are available and a complete vertical profile of an area indicates that concentrations have changed, then the map is recontoured to honor the new direct push data.

Table A.2–2 lists the monitoring wells where total uranium concentrations exceeded the 30 µg/L FRL during 2006. Included in the table are total uranium statistical summaries for each well including Mann Kendall trend analyses. Table A.2–3 provides total uranium statistical summaries for the extraction wells including Mann Kendall trend analyses. Figure A.2–4 illustrates the statistics presented in Table s A.2–2 and A.2–3 (e.g., where total uranium concentrations have, if any, an "up, significant," "down, significant," or a "no significant" trend). Figures A.2–5 through A.2–147 present total uranium concentration versus time plots for those wells listed in Table A.2–1, with the exception of wells 22217, 83337, 83338, 83339, 83340, 83341, and 83346. These wells were installed in 2007 and not enough data is available this year to produce meaningful plots. These plots also show the screen interval for Type 2 wells (if available) and water levels.

The topics listed below are deemed to be important based on a review of the total uranium data:

- Uranium plume changes in the waste storage area (Section A.2.1)
- Uranium plume changes in the Plant 6 area (Section A.2.2)
- Uranium plume changes in the South Field and off-property South Plume Areas (Section A.2.3)
- 2006 Plugging and abandonment activities (Section A.2.4)
- Flow Monitoring in the Storm Sewer Outfall Ditch (SSOD) (Section A.2.5)

A.2.1 Uranium Plume Changes in the Waste Storage Area

The maximum total uranium plume map for the Waste Storage Area did not change from the second half of 2005 to the first half of 2006. The maximum total uranium plume map for the first half of 2006 is presented in Figures A.2–2A, A.2–2B, and A.2–2C.

The maximum total uranium plume map for the Waste Storage Area did change from the first half of 2006 to the second half of 2006 based on a new uranium FRL exceedance being measured at Monitoring Well 83341. The maximum total uranium plume map for the second half of 2006 is presented in Figures A.2–3A, A.2–3B, and A.2–3C.

The following highlights for the Waste Storage Area are discussed below:

- Monitoring Well 83341- Uranium FRL exceedance
- Monitoring Well 2649 - Uranium fluctuations
- Monitoring Well 2008 - No uranium FRL exceedance in 2006
- Monitoring Well 2010 - Reporting of filtered uranium
- Direct Push Sampling

A.2.1.1 Monitoring Well 83341

This new Type-8 groundwater monitoring well, with three sampling channels, was installed in the waste storage area in 2006 to monitor the aquifer off the northeast corner of where waste pit 3 was previously located. The northeast corner of waste pit 3 was a low point in the pit so if the pit had leaked prior to source removal this would be a logical location. The new monitoring well was sampled for the first time in July of 2006. The upper-most sampling channel had an unfiltered uranium result of 33.4 µg/L and a filtered result of 37 ug/L. The largest uranium concentration measured below the 33.4 µg/L concentration was 9.3 ug/L. Therefore, a small uranium plume was positioned at Monitoring Well 83341 on the second half 2006 maximum total uranium plume map (Figure A.2–3A and Figure A.2–3B). Additional direct push sampling is needed to determine if this exceedance is connected to the larger plume located to the south. It is possible that this is a separate small plume, sourced from former waste pit 3. If this interpretation is correct, it is expected that the thin uranium exceedance at this location will dissipate rather quickly on its own now that the source excavation activities in the Waste Storage Area are complete. Particle path modeling indicates that Monitoring Well 83341 is located within the model predicted capture based on the Waste Storage Area (Phase II) Design. A map displaying particle paths for the Waste Storage Area (Phase II) Model Design is provided in Attachment A.3 (Figure A.3-5).

A.2.1.2 Monitoring Well 2649

In the 2005 SER, it was noted that the uranium concentration for the past two years fluctuated at Monitoring Well 2649. This fluctuation pattern was not observed in 2006. Monitoring Well 2649 is located at the southeast corner of where the clearwell was once located. Surface grading completed in 2006 near this well directs surface water runoff to an area close to the well where it is allowed to infiltrate into the ground and serve as a source of recharge to the aquifer. Increased recharge in this area in 2006 is evident by the highest water level being recorded at this well since 1998 (Figure A.2–41). As reported in the 2005 SER, the uranium concentration at

monitoring well 2649 was high during the first half of the year, and low during the second half of the year in both 2004 and 2005 (Figure A.2–41). During 2004 and 2005 the water level measured at well 2649 remained relatively steady. In the first half of 2006, the water level was up and uranium concentrations remained low. The decision was made not to sample this well during the second half of 2006 so as not to disturb freshly seeded ground surrounding the well. The fact that the uranium concentration measured in the first half of 2006 was low, indicates that the up-down pattern of the previous two years did not repeat in 2006. On October 5, 2006, a new Extraction Well (EW-33a) began pumping at a target pumping rate of 300 gpm in close proximity to Monitoring Well 2649. This new pumping should result in lower water levels in Monitoring Well 2649. The observed water level impact will be reported in the 2007 SER. It is anticipated that with the combined impact of completed source removal, new surface water infiltration, and new pumping, uranium concentrations measured in Monitoring Well 2649 will remain low.

A.2.1.3 Monitoring Well 2008

In the 2005 SER, it was reported that during 2004 a uranium FRL exceedance was reported at Monitoring Well 2008 for the first time. Monitoring well 2008 is located east of the former silos area and south of the former bio-surge lagoon. An exceedance was not measured in 2005 and an exceedance was not measured in 2006 (Figure A.2–8). The exceedance recorded in 2004 will continue to be honored on the maximum uranium plume maps until direct-push sampling is conducted to confirm that all depths at this location are below the groundwater uranium FRL.

A.2.1.4 Monitoring Well 2010

Monitoring Well 2010 is located east of the former waste storage area. In the Addendum to the Waste Storage Area (Phase II) Design Report (DOE 2005d) it was reported that bio-fouling is occurring at Monitoring Well 2010 and concentrating manganese around the well screen. Unfiltered water samples collected in 2006 yielded higher uranium concentrations than filtered samples did. Sampling results from January 18, 2006 were 93 ug/L uranium (unfiltered) and 8.63 ug/L uranium (filtered). Sampling results from December 6, 2006 were 119 ug/L (unfiltered) and 10 ug/L (filtered). Due to the suspected biofouling at this well, the filtered uranium results were posted on the maximum total uranium plume maps for 2006. Because this well shows such drastic differences between filtered and unfiltered samples, filtering of groundwater samples will continue at this location. The filtered results for 2006 are posted on Figure A.2-10.

A.2.1.5 Direct Push Sampling

In 2006, direct-push sampling was conducted at one location in the Waste Storage Area, Location 13351. As shown in Figure A.2–3A, this location is on the western edge of the Pilot Plant Drainage Ditch Plume, west of Paddys Run. Sampling results for total uranium indicate that the maximum uranium concentration at this location remains above 30 ug/L (i.e., 36.3 ug/L uranium at a depth of 20 to 30 feet below the water table, 492.32 feet amsl). Sampling results are provided in Table A.2–4.

A.2.2 Uranium Plume Changes in the Plant 6 Area

A thin layer of uranium contamination is present in the upper foot or so of the aquifer at Monitoring Well 2389. As discussed in past SERs, this thin layer of contamination is evident at

Monitoring Well 2389 where sporadic uranium FRL exceedances have been detected since 2002. Monitoring in 2006 provides an update on the uranium concentration FRL exceedance in this area.

Plans for a restoration module in the Plant 6 area were abandoned in 2001 based on the outcome of the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 area. This design provided data that indicated that the total uranium plume in the Plant 6 area was no longer present. The EPA and OEPA concurred with this decision.

Monitoring Well 2389 is the only groundwater monitoring well remaining in the area where Plant 6 was located. All other monitoring wells in the area were plugged and abandoned as part of source removal activities. As indicated in Figure A.2–28, sporadic uranium FRL exceedances have been detected since 2002 at Monitoring Well 2389. As reported in the 2005 SER, it appears that a thin layer of contamination is present in the upper foot or so of the aquifer. Prior to 2006, only unfiltered groundwater samples were collected from Well 2389. Beginning in 2006, both unfiltered and filtered groundwater samples were collected from this well. As expected, uranium concentrations of the filtered samples were slightly below the uranium concentrations of the unfiltered samples. In April of 2006 the unfiltered sample and duplicate had a uranium concentration of 30.1 ug/L and 30.9 ug/L, respectively. The filtered sample and duplicate had a uranium concentration of 21.6 ug/L and 21.3 ug/L, respectively. In October of 2006 an unfiltered sample and duplicate had a uranium concentration of 20.3 ug/L and 20.7 ug/L, respectively. The filtered sample and duplicate were 18.6 ug/L and 17.6 ug/L respectively. Filtered results for 2006 are posted on Figure A.2–27. It is expected that over time the uranium concentration at this location will decrease. Monitoring at this location will continue.

A.2.3 Uranium Plume Changes in the South Field and the Off-Property South Plume Areas

The maximum total uranium plume map for the South Field and South Plume did not change from the second half of 2005 to the first half of 2006. The maximum total uranium plume map for the first half of 2006 is presented in Figures A.2–2A, A.2–2B, and A.2–2C.

The maximum total uranium plume map for the South Field and South Plume did change from the first half to the second half of 2006, based on new uranium concentration data collected at direct-push sampling locations. The maximum total uranium plume map for the second half of 2006 is presented in Figures A.2–3A, A.2–3B, and A.2–3C.

The following highlights for the South Field and South Plume are discussed below:

- Direct-push data – Uranium Plume Updates
- Monitoring Well 2397 – Dry in second half of 2006
- Area around the former Inactive Fly Ash Pile

A.2.3.1 Direct Push Sampling

During 2006, direct-push sampling was conducted at ten locations (13355, 13356, 13358, 13359, 13235a, 13226b, 12367h, 12368h, 12372l, and 12373l) in the South Field and South Plume. The

ten locations are shown in Figure A.2–3A. Sampling results for each location, broken down by sampling depth, are provided in Tables A.2–5 through A.2–14.

Direct-push sampling in 2006 was focused at assessing the western edge of the uranium plume and evaluating changes to the plume along Willey Road. Direct-push sampling data collected at locations 13358, 12372l, 12368h, 3226b, 13235A, and 13359 indicate that the uranium concentrations along the western edge of the plume have decreased below 30 ug/L. This new profile data was used to re-map the western edge of the uranium plume. In the second half of 2005, the South Field and South Plume Uranium Plume covered a combined area of 145.9 acres. Direct-push data collected in 2006 were used to reduce the size of the mapped maximum uranium plume in the South Field and South Plume combined to an area equal to 138.8 acres, which is a reduction of 7.1 acres.

Each year seven locations along Willey Road (Locations 12367, 12368, 12369, 12370, 12371, 12372, and 12373) are re-sampled using direct-push sampling tools. These locations were originally sampled to track re-injection progress along Willey Road. Re-sampling the locations each year provides insight into how the remedy is progressing in this area now that re-injection is no longer taking place. This area is subject to pumping stresses from both the South Field Extraction wells to the north and South Plume Extraction Wells to the south placing the area in a stagnation zone. Re-injection (when it was occurring) helped to break up this stagnation zone.

Only four of these locations were sampled in 2006 (12367H, 12368H, 12372L, and 12373L). A decision was made to drop annual re-sampling at location 12371H because it is outside of the uranium plume. Sampling in 2006 was conducted in September and October. The two remaining locations not sampled in 2006 were sampled in 2007 (Locations 12369L in March 2007 and Location 12370H in January of 2007). Data from 2006 and 2007 were used to create two cross sections (Figure A.2–148 and Figure A.2–149). In addition to the water levels measured at the time of sampling (either 2006 or 2007), the water levels measured during the 2005 sampling event are also noted on the sections.

The thin units of the maximum uranium plumes that were detected in 2005 at Locations 12368 and 12372 were not detected in 2006. The thick maximum uranium plume detected in 2005 at Location 12373 was much reduced in thickness and concentration in 2006. As illustrated in the cross sections, water levels measured in 2006 and early 2007 were lower than the levels measured in 2005. As discussed below, it is possible that monitoring in 2006/2007 missed the thin layer of above FRL contamination that was detected in the aquifer at the water table in 2005.

Direct-Push Location 12373L exhibits the greatest uranium concentration change since 2005. In 2005, this location was sampled in July when seasonal water levels are high. The maximum uranium plume in 2005 was approximately 40 feet thick (515.298 feet amsl to 476.298 feet amsl) and the highest uranium concentration was 170.6 ug/L measured in a sample collected at an elevation of 515.3 feet amsl. In October of 2006 the water level was 512.5 feet amsl. The maximum uranium concentration measured was 32.1 ug/L at an elevation of 508 feet amsl. Given the potential that higher uranium concentrations were not measured in 2006 due to a lower water table, the maximum uranium plume was not re-mapped at this location to reflect the lower values measured in 2006. The maximum uranium plume map for the second half of 2006 continues to honor previous maximum uranium values at Location 12373L. The location will be re-sampled in the future.

Based on the discussion above concerning water levels at Location 12373L, an effort will be made to conduct as much future direct-push sampling as possible during the late spring and early summer when water levels are at there seasonal high.

A.2.3.2 Monitoring Well 2397

Monitoring Well 2397 is located in the northeast section of the South Field near Extraction Well 33061 (EW-25). Pumping in EW-25 began in 2002. As shown in Figure A.2–31, the base of the well screen is set at an elevation of approximately 513 feet amsl. In 2006 this monitoring well was dry. Pumping from EW-25 and seasonal water table fluctuations lowered the water level below the base of the screen.

A.2.3.3 Area Around the Former Inactive Fly Ash Pile

Groundwater monitoring results in 2006 indicate that uranium concentrations in the former Inactive Fly Ash Pile area are considerably lower than the mapped maximum uranium plume (i.e., Monitoring Well 2046 and Monitoring Well 23281, on Figure A.2–3B). The maximum uranium plume contours in this area are based on direct push sampling results that are approximately 6 years old. Additional direct-push sampling is being planned in 2007 to update the maximum uranium plume in this area.

A.2.4 2006 Plugging and Abandonment Activities

Eight groundwater-monitoring wells were plugged and abandoned in 2006 to facilitate site remediation activities or because they were no longer needed to track the performance of the groundwater remedy:

- Four in the South Plume Area (2127, 3127, 2557, 2554)
- One in the Waste Storage Area (2648)
- Three in the OSDF Area (22216, 2429, and 4446)

None of these monitoring wells were part of the current IEMP (Revision 5A).

A.2.5 Flow Monitoring in the Storm Sewer Outfall Ditch

A test was conducted in 2005 to gauge seasonal flow of water in the Storm Sewer Outfall Ditch (SSOD) and to determine if recharge to the Great Miami Aquifer through the SSOD at a rate of 500 gallons per minute was feasible (DOE 2005). As reported in the Groundwater Remedy Evaluation and field Verification Plan (DOE 2004), a modeled infiltration rate of 500 gpm in the SSOD decreased the predicted cleanup time by one year. The study concluded that the operation would not be cost effective. Subsequent discussions in 2006 with EPA and OEPA led to an agreement to continue the infiltration operation. The agreement was to pump clean groundwater into the SSOD to supplement natural storm water runoff in an attempt to accelerate remediation of the South Plume. Three existing construction water supply wells on the east side of the site will be utilized to deliver as much clean groundwater as is needed to maintain a flow of approximately 500 gpm into the SSOD.

As shown in Figure A.2–150, six Parshall flumes are installed in the SSOD. These flumes are used to measure flow into and out-of the SSOD. Water is supplied from a group of three water wells located on the east side of the site (42202, 42471, and 43309). Water pumped from the wells is discharged into a ditch that empties into the former OSDF Borrow Area Sediment Basin. Water from this basin is allowed to overflow into the mouth of the SSOD. Flume 6 is the first flume located down stream of the former OSDF Borrow Area Sediment Basin. Flumes 2, 3, 4, 5, and 6 all measure flows into the SSOD. Flume 1 is the most southern flume. It measures flow emptying out of the SSOD and into Paddys Run.

The six Parshall flumes in the SSOD were designed to be temporary installations to support the test conducted in 2005. The design allowed movement of the flumes during the testing period, if circumstances required. Engineering controls (i.e., anchoring the frames with metal stakes and sandbags incorporating bonding trenches into the wing-walled construction) were implemented to limit the potential of the flumes to develop leaks or dislodge during the test. Since these engineering controls worked well during the testing period, it was decided to continue using the flumes without design modifications for the longer term operation. As discussed below, the designs are not intended for long-term use.

Pumping of clean groundwater into the SSOD could not begin until December of 2006 because the water from the supply wells was needed for dust suppression to support site closure activities.

From January 1, 2006 through December 14, 2006, flow in the flumes was monitored to assess seasonal flow patterns. Operating the flumes over the course of a year involved a couple of challenges that were not faced during the initial test (i.e. freezing temperatures in the winter months and beavers constructing dams in the SSOD). Most of the beaver activity occurred immediately down gradient of Flume 6, but flow in the SSOD has not been disrupted enough to influence the hydraulic drop in Flume 6.

Two very heavy rain events occurred in 2006, one in March and one in April. From March 8 to March 12, approximately 4.62 inches of rain fell. From April 13 to April 21, approximately 4.2 inches of rain fell. The force of the flow in the SSOD created by this much precipitation in such a short period of time damaged the wing walls on Flume 1, allowing water to flow around and under the flume. Temporary repairs to the flume were made both times. A more permanent solution is being developed.

Figure A.2–151 illustrates the average monthly input to the SSOD versus the average monthly precipitation. Pumping into the SSOD began on December 14, 2006, using Well 43309. Based on the data presented in this graph, it is not necessary to pump water to the SSOD in the winter and early spring as natural flow is > 500 gpm. Therefore, DOE will reduce pumping from the construction wells during these months.

Figure A.2–152 illustrates the average monthly inflow, outflow, and precipitation. A concern is that the measured outflow rate exceeds the measured inflow rate in July and September through December resulting in a negative infiltration calculation (i.e., subtracting outflow from inflow). This indicates that unmeasured flow is entering the SSOD. The most likely location for this to occur is the ditch where Flume 4 is installed. The post closure configuration of the ditch, in which Flume 4 is installed, is too large for the size of the flume. The flow appears to be going under and around the flume.

The average pumping rate for December 14 – 31 was 334 gpm. The flow rate in Flume 6 gradually increased after December 14. It rose above 500 gpm on December 22. With the exception of December 30, it remained above 500 gpm for the rest of the month. On December 30, the average Flume 6 flow rate was 454 gpm (see Figure A.2–153).

Groundwater will continue to be pumped into the SSOD in 2007 and flow will continue to be monitored. Efforts are being made to implement more permanent repairs to Flume 1 and to improve monitoring of the ditch in which Flume 4 is installed, by either installing an additional larger flume at the mouth of the ditch or enlarging Flume 4. Once problems at Flume 1 and Flume 4 have been addressed, it is anticipated that a better infiltration calculation can be obtained.

Table A.2–1. List of IEMP Monitoring Wells

Well ID	Monitoring Activity
13	Total Uranium
14	Total Uranium
2002	Total Uranium
2008	Total Uranium
2009	Total Uranium
2010	Waste Storage Area
2014	Total Uranium
2016	Total Uranium
2017	Total Uranium
2045	South Field
2046	Total Uranium
2048	Total Uranium
2049	South Field
2060 (12)	Total Uranium
2093	Property/Plume Boundary for FRL Exceedances
2095	Total Uranium
2106	Total Uranium
2125	Total Uranium
2128	Property/Plume Boundary for Paddys Run Road Site
2166	Total Uranium
2385	Total Uranium
2386	Total Uranium
2387	Total Uranium
2389	Total Uranium
2390	Total Uranium
2396	Total Uranium
2397	Total Uranium
2398	Property/Plume Boundary for FRL Exceedances
2402	Total Uranium
2431	Property/Plume Boundary for FRL Exceedances
2432	Property/Plume Boundary for FRL Exceedances
2550	Total Uranium
2552	Total Uranium
2553	Total Uranium
2625	Property/Plume Boundary for Paddys Run Road Site
2636	Property/Plume Boundary for Paddys Run Road Site
2649	Waste Storage Area
2733	Property/Plume Boundary for FRL Exceedances
2821	Waste Storage Area
2880	Total Uranium
2897	Total Uranium
2898	Property/Plume Boundary for Paddys Run Road Site
2899	Property/Plume Boundary for Paddys Run Road Site
2900	Property/Plume Boundary for Paddys Run Road Site
3014	Total Uranium
3015	Total Uranium
3045	Total Uranium

Table A.2–1 (continued). List of IEMP Monitoring Wells

Well ID	Monitoring Activity
3046	Total Uranium
3049	Total Uranium
3069	Total Uranium
3070	Property/Plume Boundary for FRL Exceedances
3093	Property/Plume Boundary for FRL Exceedances
3095	Total Uranium
3106	Total Uranium
3125	Total Uranium
3128	Property/Plume Boundary for Paddys Run Road Site
3385	Total Uranium
3387	Total Uranium
3390	Total Uranium
3396	Total Uranium
3397	Total Uranium
3398	Property/Plume Boundary for FRL Exceedances
3402	Total Uranium
3424	Property/Plume Boundary for FRL Exceedances
3426	Property/Plume Boundary for FRL Exceedances
3429	Property/Plume Boundary for FRL Exceedances
3431	Property/Plume Boundary for FRL Exceedances
3432	Property/Plume Boundary for FRL Exceedances
3550	Total Uranium
3552	Total Uranium
3636	Property/Plume Boundary for Paddys Run Road Site
3733	Property/Plume Boundary for FRL Exceedances
3821	Waste Storage Area
3880	Total Uranium
3897	Total Uranium
3898	Property/Plume Boundary for Paddys Run Road Site
3899	Property/Plume Boundary for Paddys Run Road Site
3900	Property/Plume Boundary for Paddys Run Road Site
4125	Total Uranium
4398	Property/Plume Boundary for FRL Exceedances
6015	Total Uranium
6880	Total Uranium
6881	Total Uranium
21033	Total Uranium
21063	Property/Plume Boundary for FRL Exceedances
21192	Total Uranium
22198	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22199	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22200	OSDF[a]
22201	OSDF[a]
22203	OSDF[a]
22204	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22205	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22206	OSDF[a]

Table A.2–1 (continued). List of IEMP Monitoring Wells

Well ID	Monitoring Activity
22207	OSDF[a]
22208	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22209	OSDF[a]
22210	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22211	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22212	OSDF[a]
22213	OSDF[a]
22214	Property/Plume Boundary for FRL Exceedances and OSDF[a]
22215	OSDF[a]
22217	OSDF[a]
23064	Total Uranium
23118	Total Uranium
23271	Total Uranium
23272	Total Uranium
23273	Total Uranium
23274	Total Uranium
23275	Total Uranium
23276	Total Uranium
23277	Total Uranium
23278	Total Uranium
23279	Total Uranium
23280	Total Uranium
23281	Total Uranium
23282	Total Uranium
31217	Property/Plume Boundary for FRL Exceedances
32766	Total Uranium
32768	Total Uranium
62408	Total Uranium
62433	Total Uranium
63116	Total Uranium
63119	Total Uranium
63283	Total Uranium
63284	Total Uranium
63285	Total Uranium
63286	Total Uranium
63287	Total Uranium
63288	Total Uranium
63289	Total Uranium
63290	Total Uranium
63291	Total Uranium
63292	Total Uranium
82433	Total Uranium
83117	Total Uranium
83124	Total Uranium
83293	Total Uranium
83294	Total Uranium
83295	Total Uranium

Table A.2–1 (continued). List of IEMP Monitoring Wells

Well ID	Monitoring Activity
83296	Total Uranium
83335	Total Uranium
83336	Total Uranium
83337	Waste Storage Area
83338	Waste Storage Area
83339	Waste Storage Area
83340	Waste Storage Area
83341	Waste Storage Area
83346	Waste Storage Area

[a]OSDF total uranium graphs are included in this attachment and all of the OSDF data are discussed in Attachment A.5

Table A.2–2. Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium With 2006 Results Above Final Remediation Levels

Well	No. of Samples Since 1988[a,b,c]	Minimum[a,b,c,d] (µg/L)	Maximum[a,b,c,d,e] (µg/L)	Average[a,b,c,d,e,f] (µg/L)	Standard Deviation[a,b,c,d,e,f] (µg/L)	Trend[a,b,c,d,e,f,g]
2045	42	12.034	462	145.61	129.09	No Significant Trend
2046	40	20	907	218.88	246.27	Down, Marginal
2049	40	3	177.893	86.52	44.95	Down, Significant
2060	53	8.4	332	83.82	66.44	Down, Marginal
2095	52	27	208	115.59	42.50	Down, Significant
2166	41	28.3	95.1	60.38	15.35	Down, Significant
23271	10	49.1	144.3	98.41	28.71	No Significant Trend
23273	10	172	402	268.65	59.62	No Significant Trend
23274	10	141	348.3	231.85	62.25	Down, Significant
23275	9	119	168	138.69	14.80	Down, Marginal
23276	10	60.4	94	78.12	10.27	No Significant Trend
23278	10	89.4	201.4	133.66	40.42	Down, Significant
23280	10	67.3	700	247.12	183.80	No Significant Trend
23281	10	95.8	366.6	202.70	75.36	Down, Significant
2385	33	76.648	592.164	255.68	116.87	No Significant Trend
2386	33	6.67	43.431	21.15	8.49	No Significant Trend
2387	33	18.1	492	133.68	92.23	No Significant Trend
2390	32	39.5	163	86.6	26.4	Down, Significant
2397	25	212	737	397.87	129.72	Up, Marginal
2550	43	3.3	120	65.52	19	Down, Significant
3069	59	0.5	398.33	133.70	102.45	Down, Significant
3095	53	2.0	94	21.77	15.56	Down, Significant
32766	11	40.3	79.9	54.71	13.23	Down, Significant
62408	21	49.1	157	102.31	39.52	Down, Significant
62433	22	277	844.991	460.81	135.01	Down, Significant
63119	12	22.7	151	73.07	44.96	Down, Significant
63285	10	74.9	246	185.22	55.24	**Up, Significant**
63287	10	174	315.7	214.11	42.73	Down, Marginal
63288	10	41.3	267	124.95	79.49	Down, Marginal
63291	10	41.7	96.7	57.08	17	Down, Significant
6880	20	62.8	145	95.96	24.88	Down, Significant
82433_C2	7	55.8	214	138.24	64.94	Down, Marginal
82433_C3	13	164	506	305.77	126.71	Down, Significant
82433_C4	7	48	311	184.03	117.68	Down, Significant
82433_C5	7	2.66	85.4	44.91	32.13	No Significant Trend
83117_C1	12	655	1230	883.83	181.74	Up, Marginal
83117_C2	6	105	330	237.33	98.93	Down, Marginal
83117_C3	6	73.1	128	105.38	24.55	Down, Significant

Table A.2–2 (continued) Summary Statistics and Trend Analysis of Monitoring Wells for Total Uranium With 2006 Results Above Final Remediation Levels

Well	No. of Samples Since 1988[a,b,c]	Minimum[a,b,c,d] (µg/L)	Maximum[a,b,c,d,e] (µg/L)	Average[a,b,c,d,e,f] (µg/L)	Standard Deviation[a,b,c,d,e,f] (µg/L)	Trend[a,b,c,d,e,f,g]
83117_C4	6	71.3	99	80.62	9.88	Up, Marginal
83124_C1	12	185	1070	512.50	266.71	No Significant Trend
83124_C2	6	59	103	74.45	17.41	Down, Significant
83124_C4	6	25.4	41.2	33.03	7.68	No Significant Trend
83124_C5	6	24.4	58.7	48.47	12.45	No Significant Trend
83293_C3	6	3.8	62.7	41.75	20.01	No Significant Trend
83293_C4	10	30.1	115	60.05	24.58	Down, Significant
83294_C1	4	98.5	166	128.63	33.61	**Up, Significant**
83294_C2	8	256	575	394.85	109.41	Up, Marginal
83294_C3	8	330	538.8	436.61	79.93	Down, Significant
83294_C4	6	98.5	298.6	206.82	88.92	Down, Significant
83295_C2	8	92.3	178	142.24	30.98	**Up, Significant**
83295_C3	7	128	175	155	15.86	No Significant Trend
83295_C4	7	77.2	199.1	145.41	53.27	Down, Significant
83295_C5	6	78.9	155	104.65	29.71	Down, Marginal
83296_C2	9	41.1	117	71.98	24.94	Down, Significant
83296_C3	7	16.5	75	52.54	22.04	Down, Significant
83296_C4	6	23.6	62.7	43.43	15.09	No Significant Trend
83337_C1	4	371.8	1240	924.75	403.64	No Significant Trend
83337_C2	3	591	835.1	749.43	137.36	No Significant Trend
83337_C3	2	3.7	30.5	17.10	18.95	No Significant Trend
83338_C1	2	454.5	582	518.25	90.16	No Significant Trend
83338_C2	2	310.5	648	479.25	238.65	No Significant Trend
83338_C3	3	20.1	36.2	25.53	9.24	No Significant Trend
83341_C1	1	37	NA	NA	NA	NA
83346_C1	1	45.6	NA	NA	NA	NA
83346_C2	1	31.1	NA	NA	NA	NA

[a]Summary statistics and Mann-Kendall test for trend are primarily based on unfiltered samples with some filtered samples from the Operable Unit 5 remedial investigation/feasibility study data set (1988 through 1993) and 1994 through 2005 groundwater data.
[b]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[c]Rejected data qualified with either an R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[d]If the number of samples is greater than or equal to four, then all of the summary statistics and the Mann-Kendall test for trend are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum.
[e]NA = not applicable
[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[g]Mann-Kendall test for trend is performed using data from third quarter 1998 through 2006.

Table A.2–3. Summary Statistics and Trend Analysis of Extraction Wells for Total Uranium

Well	No. of Samples Since 1988[a,b]	Minimum[a,b,c] (µg/L)	Maximum[a,b,c] (µg/L)	Average[a,b,c] (µg/L)	Standard Deviation[a,b,c] (µg/L)	Trend[a,b,c]
South Plume Module (August 27, 1993 through December 31, 2006)						
3924	458	1.8	180	33.70	15.23	Down, Significant
3925	457	0.5	84	26.11	7.93	Down, Significant
3926	448	1.5	42.4	25.13	9.17	**Up, Significant**
3927	450	1	17	2.46	1.2	**Up, Significant**
South Plume Optimization Module (August 9, 1998 through December 31, 2006)						
32308	386	18.4	100.1	59.60	13.46	Down, Significant
32309	382	32.7	122.8	62.09	17.15	Down, Significant
South Field Module (July 13, 1998 through December 31, 2006)						
31550	398	28.1	127.9	55,07	19.98	Down, Significant
31560	423	24.4	182.8	70.30	37.34	Down, Significant
31561	398	18.1	114[d]	43.91	9.73	Down, Significant
32276	440	41.1	290.2	120.67	59.54	Down, Significant
32446	298	37.9	168.1	67.84	19.44	Down, Significant
32447	314	55.9	302.3	129.82	49.54	Down, Significant
33061	199	30.8	98.5	50.91	12.65	Down, Significant
33262	149	30.9	79.5	55.41	11.13	Down, Significant
33264	147	48.2	217.3	106.38	29.09	Down, Significant
33265	148	16.5	96.5	26.10	7.55	Down, Significant
33266	145	11.3	53.7	21.40	7.24	Down, Significant
33298	108	36.6	76.2	54.75	7.23	No Significant Trend
33326	55	24.2	45.9	31.07	4.42	Down, Significant
Waste Storage Area Module (May 8, 2002 through December 31, 2006)						
32761	192	38.9	161.2	79.68	30.88	Down, Significant
33062	200	40.1	236.4	90.67	47.72	Down, Significant
33334	18	22.6	50	29.26	7.47	Down, significant
33347	18	30.2	126.5	74.43	26.11	Down, significant

[a]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[b]Rejected data qualified with either an R or Z were not included in this count, the summary statistics, or Mann-Kendall test for trend.
[c]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[d]This result (sampled August 31, 1998) appears to be an outlier. It is suspected that the sample for this well was switched with the sample for Extraction Well 31562.

Table A.2–4. Geoprobe Location 13351

Easting '83:	**1346475**	Feet
Northing '83:	**480122.9**	Feet
Ground Elevation:	**550.32**	Feet AMSL
Depth to Water Table:	**33**	Feet bgs
Water Table Elevation:	**517.32**	Feet AMSL
Work Completed:	**10/31/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	512	38	0 feet - 10 feet	23.9	19.2	7.54	7.130	170	6.13
2	502.32	48	10 feet - 20 feet	23.3	16.6	7.66	0.809	566	5.91
3	502.32	48	10 feet - 20 feet	21.5	16.6	7.66	0.809	566	5.91
4	492.32	58	20-feet - 30 feet	36.3	12.1	7.43	0.692	91	5.04
5	482.32	68	30 feet - 40 feet	23.6	12.4	7.56	0.652	999	6.44
6	472.32	78	40 feet - 50 feet	19.9	12.7	7.58	0.621	824	6.58
Rinsate				< 1.0					

Max	19.2	7.66	7.130	999	6.58
Min	12.1	7.43	0.621	91	5.04
Range	7.1	0.23	6.509	908	1.54
Average	14.9	7.57	1.786	536	6.00

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

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Table A.2–5. Geoprobe Location 12367H

Easting '83:	**1347990**	Feet
Northing '83:	**476146**	Feet
Ground Elevation:	**536**	Feet AMSL
Depth to Water Table:	**23**	Feet bgs
Water Table Elevation:	**513**	Feet AMSL
Work Completed:	**10/16/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb 5-micron NTU	DO 5-micron mg/L
1	508	28	0 feet - 10 feet	8.9	12.9	7.02	0.677	511	4.08
2	498	38	10 feet - 20 feet	15.2	13.3	7.13	0.843	386	4.07
3	498	38	10 feet - 20 feet	15.0	13.3	7.13	0.843	386	4.07
4	488	48	20-feet - 30 feet	10.5	13.4	7.20	0.681	255	4.31
5	478	58	30 feet - 40 feet	7.1	13.0	7.30	0.677	434	4.33
Rinsate				< 1.0					

Max	13.4	7.30	0.843	511	4.33
Min	12.9	7.02	0.677	255	4.07
Range	0.5	0.28	0.166	256	0.26
Average	13.2	7.16	0.744	394	4.17

Table A.2–6. Geoprobe Location 12368H

Easting '83:	**1348470**	Feet
Northing '83:	**476172.4**	Feet
Ground Elevation:	**576.7**	Feet AMSL
Depth to Water Table:	**63**	Feet bgs
Water Table Elevation:	**513.7**	Feet AMSL
Work Completed:	**9/11/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	509	68	0 feet - 10 feet	25.4	17.4	7.44	0.728	NA[b]	5.29
2	498.7	78	10 feet - 20 feet	28.2	20.0	7.63	0.698	958	7.44
3	488.7	88	20 feet - 30 feet	11.6	17.4	7.80	0.603	489	6.29
4	488.7	88	20-feet - 30 feet	11.7	17.4	7.80	0.603	489	6.29
5	478.7	98	30 feet - 40 feet	15.2	19.0	7.80	0.660	999	6.92
6	468.7	108	40 feet - 50 feet	14.0	17.3	7.47	0.825	999	6.36
Rinsate				< 1.0					

Max	20.0	7.80	0.825	999	7.44
Min	17.3	7.44	0.603	489	5.29
Range	2.7	0.36	0.222	510	2.15
Average	18.1	7.66	0.686	787	6.43

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.
[b] Turbidity reading not taken.

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Table A.2–7. Geoprobe Location 12372L

Easting '83:	**1348559**	Feet
Northing '83:	**476215.8**	Feet
Ground Elevation:	**576.528**	Feet AMSL
Depth to Water Table:	**64**	Feet bgs
Water Table Elevation:	**512.528**	Feet AMSL
Work Completed:	**10/10/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	508	69	0 feet - 10 feet	21.8	16.7	7.23	0.951	379	5.91
2	497.528	79	10 feet - 20 feet	7.8	16.1	7.67	0.678	338	5.33
3	497.528	79	10 feet - 20 feet	7.9	16.1	7.67	0.678	338	5.33
4	487.528	89	20-feet - 30 feet	7.9	17.9	7.57	0.804	999	5.83
5	477.528	99	30 feet - 40 feet	8.7	16.3	7.69	0.637	798	5.52
Rinsate				< 1.0					

Max	17.9	7.69	0.951	999	5.91
Min	16.1	7.23	0.637	338	5.33
Range	1.8	0.46	0.314	661	0.58
Average	16.6	7.57	0.750	570	5.58

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

Table A.2–8. Geoprobe Location 12373L

Easting '83:	**1349024.582**	Feet
Northing '83:	**576240.519**	Feet
Ground Elevation:	**564.547**	Feet AMSL
Depth to Water Table:	**52**	Feet bgs
Water Table Elevation:	**512.547**	Feet AMSL
Work Completed:	**10/17/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	508	57	0 feet - 10 feet	32.1	17.1	7.47	0.727	137	6.04
2	497.547	67	10 feet - 20 feet	9.5	17.2	7.77	0.692	999	6.56
3	497.547	67	10 feet - 20 feet	11.4	17.2	7.77	0.692	999	6.56
4	487.547	77	20-feet - 30 feet	10.4	16.8	7.77	0.720	999	5.66
5	477.547	87	30 feet - 40 feet	6.4	16.8	7.65	0.728	999	5.54
6	467.547	97	40 feet - 50 feet	7.0	16.7	7.57	0.724	999	5.83
7	457.547	107	50 feet - 60 feet	9.4	16.6	7.45	0.722	999	5.76
Rinsate				< 1.0					

Max	17.2	7.77	0.728	999	6.56
Min	16.6	7.45	0.692	137	5.54
Range	0.6	0.32	0.036	862	1.02
Average	16.9	7.64	0.715	876	5.99

* Borehole moved approx. 30 feet north and 2 feet lower than posted coordinates.

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

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Table A.2–9. Geoprobe Location 13226B

Easting '83:	**1348198.48**	Feet
Northing '83:	**475958.18**	Feet
Ground Elevation:	**539.18**	Feet AMSL
Depth to Water Table:	**24**	Feet bgs
Water Table Elevation:	**515.18**	Feet AMSL
Work Completed:	**12/18/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	510	29	0 feet - 10 feet	29.7	12.8	6.80	1.030	527	6.12
2	500.18	39	10 feet - 20 feet	7.7	13.3	7.15	0.725	383	4.97
3	500.18	39	10 feet - 20 feet	8.0	13.3	7.15	0.725	383	4.97
4	490.18	49	20-feet - 30 feet	4.1	13.5	7.10	0.666	863	4.94
5	480.18	59	30 feet - 40 feet	5.1	12.9	7.04	0.688	648	4.99
6	470.18	69	40 feet - 50 feet	1.9	13.3	6.92	0.752	666	3.78
Rinsate				< 1.0					

Max	13.5	7.15	1.030	863	6.12
Min	12.8	6.80	0.666	383	3.78
Range	0.7	0.35	0.364	480	2.34
Average	13.2	7.03	0.764	578	4.96

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

Table A.2–10. Geoprobe Location 13235A

Easting '83:	**1348047.97**	Feet
Northing '83:	**475816.03**	Feet
Ground Elevation:	**536.2**	Feet AMSL
Depth to Water Table:	**21**	Feet bgs
Water Table Elevation:	**515.2**	Feet AMSL
Work Completed:	**12/19/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	510	26	0 feet - 10 feet	31.5	12.2	6.69	0.705	737	6.02
2	500.2	36	10 feet - 20 feet	9.8	11.6	6.95	0.668	695	5.55
3	500.2	36	10 feet - 20 feet	9.6	10.9	7.06	0.622	999	6.25
4	490.2	46	20-feet - 30 feet	7.2	10.9	7.06	0.622	999	6.25
5	480.2	56	30 feet - 40 feet	5.5	10.7	7.08	0.638	410	5.71
6	470.2	66	40 feet - 50 feet	3.1	10.5	7.20	0.612	423	5.21
Rinsate				< 1.0					

Max	12.2	7.20	0.705	999	6.25
Min	10.5	6.69	0.612	410	5.21
Range	1.7	0.51	0.093	589	1.04
Average	11.1	7.01	0.645	711	5.83

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

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Table A.2–11. Geoprobe Location 13355

Easting '83:	**1348975**	Feet
Northing '83:	**477354**	Feet
Ground Elevation:	**567.165**	Feet AMSL
Depth to Water Table:	**56**	Feet bgs
Water Table Elevation:	**511.165**	Feet AMSL
Work Completed:	**10/23/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	506	61	0 feet - 10 feet	79.3	8.9	7.37	0.966	325	7.74
2	496.165	71	10 feet - 20 feet	39.4	10.0	7.18	0.782	537	7.56
3	496.165	71	10 feet - 20 feet	39.1	10.0	7.18	0.782	537	7.56
4	486.165	81	20-feet - 30 feet	10.4	9.6	7.44	0.699	999	7.47
5	476.165	91	30 feet - 40 feet [b]						
6	466.165	101	40 feet - 50 feet	1.7	10.1	7.20	0.657	533	7.41
7	456.165	111	50 feet - 60 feet	< 1.0	9.9	7.24	0.658	625	6.37
Rinsate				< 1.0					

Max	10.1	7.44	0.966	999	7.74
Min	8.9	7.18	0.657	325	6.37
Range	1.2	0.26	0.309	674	1.37
Average	9.8	7.27	0.757	593	7.35

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.
[b] Sample from 30-40 feet not collected

Table A.2–12. Geoprobe Location 13356

Easting '83:	**1349685.76**	Feet
Northing '83:	**476445.76**	Feet
Ground Elevation:	**580.99**	Feet AMSL
Depth to Water Table:	**67**	Feet bgs
Water Table Elevation:	**513.99**	Feet AMSL
Work Completed:	**11/21/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	509	72	0 feet - 10 feet	30.7	12.5	7.43	0.821	247	5.53
2	498.99	82	10 feet - 20 feet	56.3	12.7	7.38	0.833	999	5.03
3	498.99	82	10 feet - 20 feet	45.6	12.7	7.38	0.833	999	5.03
4	488.99	92	20-feet - 30 feet	18.8	12.7	7.41	0.784	244	4.34
5	478.99	102	30 feet - 40 feet	5.8	13.1	7.28	0.774	999	5.55
6	468.99	112	40 feet - 50 feet	1.5	12.5	7.36	0.764	999	5.92
7	458.99	122	50 feet - 60 feet	1.6	13.6	7.42	0.758	999	5.10
Rinsate				< 1.0					

Max	13.6	7.43	0.833	999	5.92
Min	12.5	7.28	0.758	244	4.34
Range	1.1	0.15	0.075	755	1.58
Average	12.8	7.38	0.795	784	5.21

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

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Table A.2–13. Geoprobe Location 13358

Easting '83:	**1348216**	Feet
Northing '83:	**476772.8**	Feet
Ground Elevation:	**528.8**	Feet AMSL
Depth to Water Table:	**15**	Feet bgs
Water Table Elevation:	**513.8**	Feet AMSL
Work Completed:	**10/25/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	509	20	0 feet - 10 feet	9.0	14.9	7.48	1.080	999	5.29
2	498.8	30	10 feet - 20 feet	5.9	12.1	7.57	1.050	655	6.01
3	498.8	30	10 feet - 20 feet	5.9	12.1	7.57	1.050	655	6.01
4	488.8	40	20-feet - 30 feet	4.9	14.7	7.49	1.050	576	4.67
5	478.8	50	30 feet - 40 feet	3.2	12.6	7.40	0.840	479	4.85
6	468.8	60	40 feet - 50 feet	9.0	11.5	7.37	0.656	731	6.41
7	458.8	70	50 feet - 60 feet	9.6	13.3	7.33	0.666	929	6.33
Rinsate				1.5					

Max	14.9	7.57	1.080	999	6.41
Min	11.5	7.33	0.656	479	4.67
Range	3.4	0.24	0.424	520	1.74
Average	13.0	7.46	0.913	718	5.65

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

Table A.2–14. Geoprobe Location 13359

Easting '83:	**1347883**	Feet
Northing '83:	**475449**	Feet
Ground Elevation:	**532.62**	Feet AMSL
Depth to Water Table:	**18**	Feet bgs
Water Table Elevation:	**514.62**	Feet AMSL
Work Completed:	**12/14/2006**	

Sample Point	Elevation (ft amsl)	Depth Feet bgs	Sample Interval	Uranium Conc. (5 micron filtered) (µg/L)	Temp 5-micron Celcius	pH 5-micron SU	Cond 5-micron us/cm	Turb[a] 5-micron NTU	DO 5-micron mg/L
1	510	23	0 feet - 10 feet	17.2	12.1	7.35	0.708	109	6.55
2	499.62	33	10 feet - 20 feet	9.6	11.7	7.55	0.687	646	4.50
3	499.62	33	10 feet - 20 feet	9.4	11.7	7.55	0.687	646	4.50
4	489.62	43	20-feet - 30 feet	4.6	11.6	7.57	0.657	999	5.60
5	479.62	53	30 feet - 40 feet	5.4	11.3	7.60	0.591	673	4.44
6	469.62	63	40 feet - 50 feet	6.4	11.4	7.55	0.615	583	6.53
Rinsate				< 1.0					

Max	12.1	7.60	0.708	999	6.55
Min	11.3	7.35	0.591	109	4.44
Range	0.8	0.25	0.117	890	2.11
Average	11.6	7.53	0.658	609	5.35

[a] Turbidity reading of 999 NTU is the maximum possible for the meter used.

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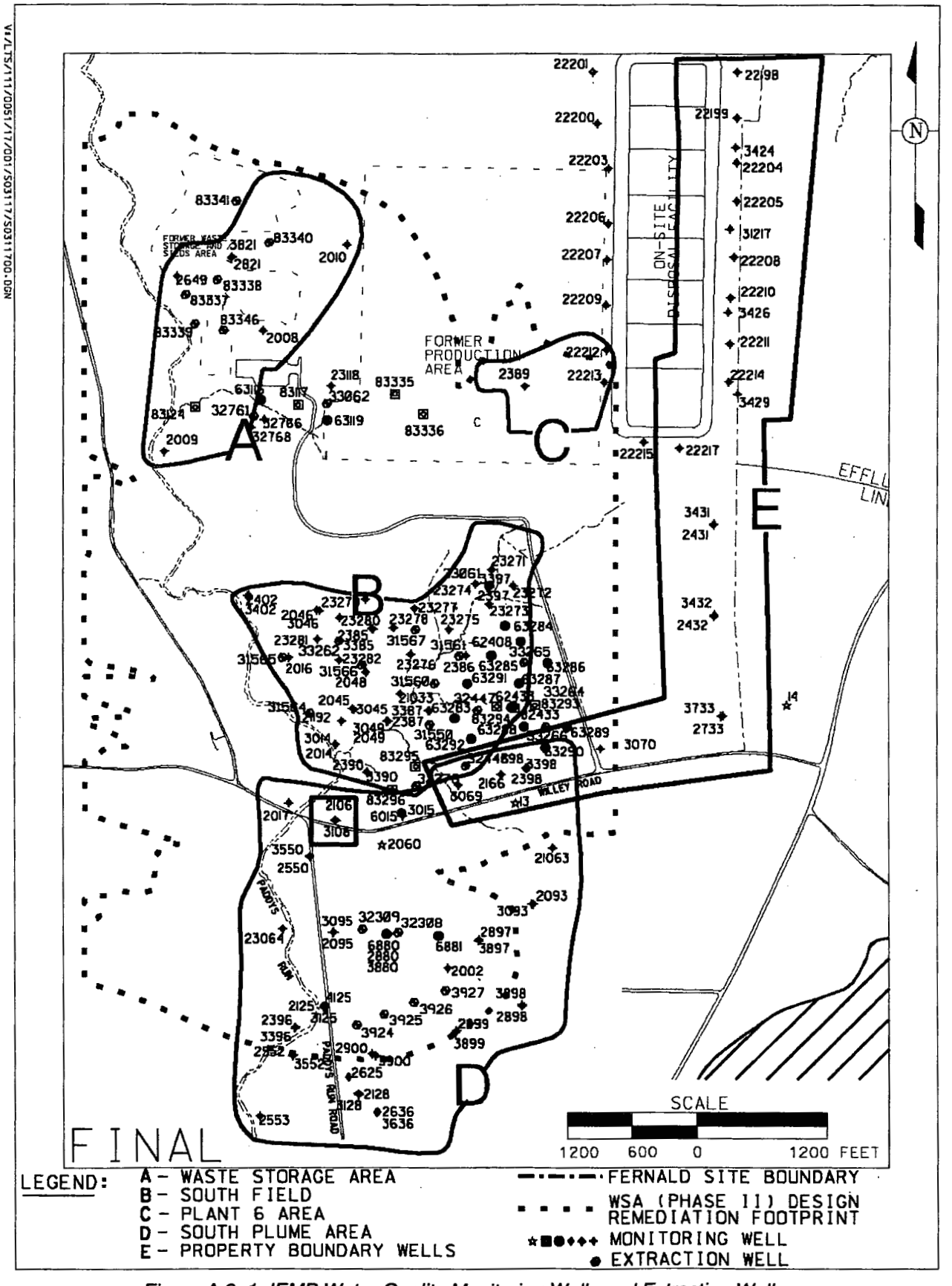

Figure A.2–1. IEMP Water Quality Monitoring Wells and Extraction Wells

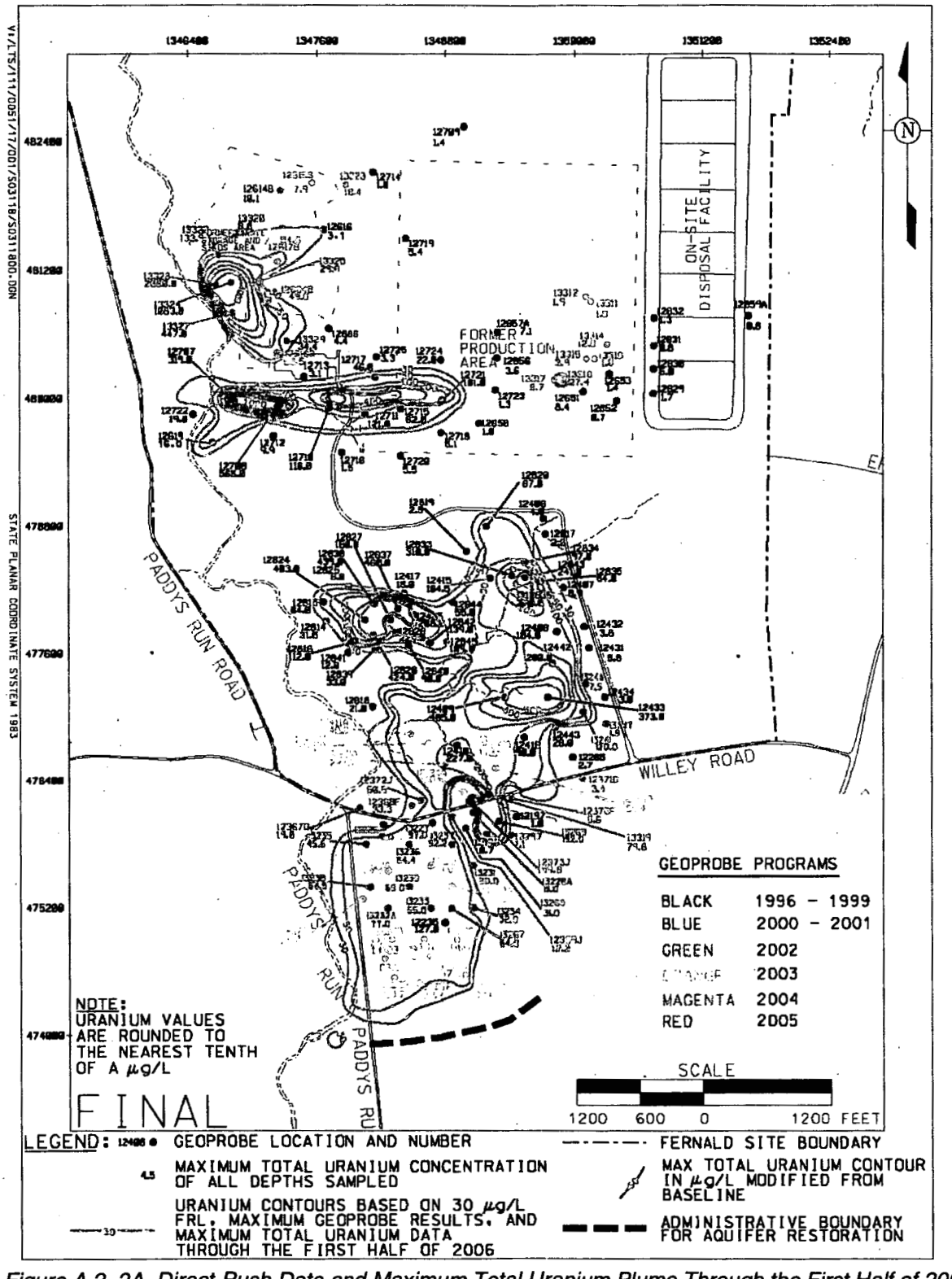

Figure A.2–2A. Direct-Push Data and Maximum Total Uranium Plume Through the First Half of 2006

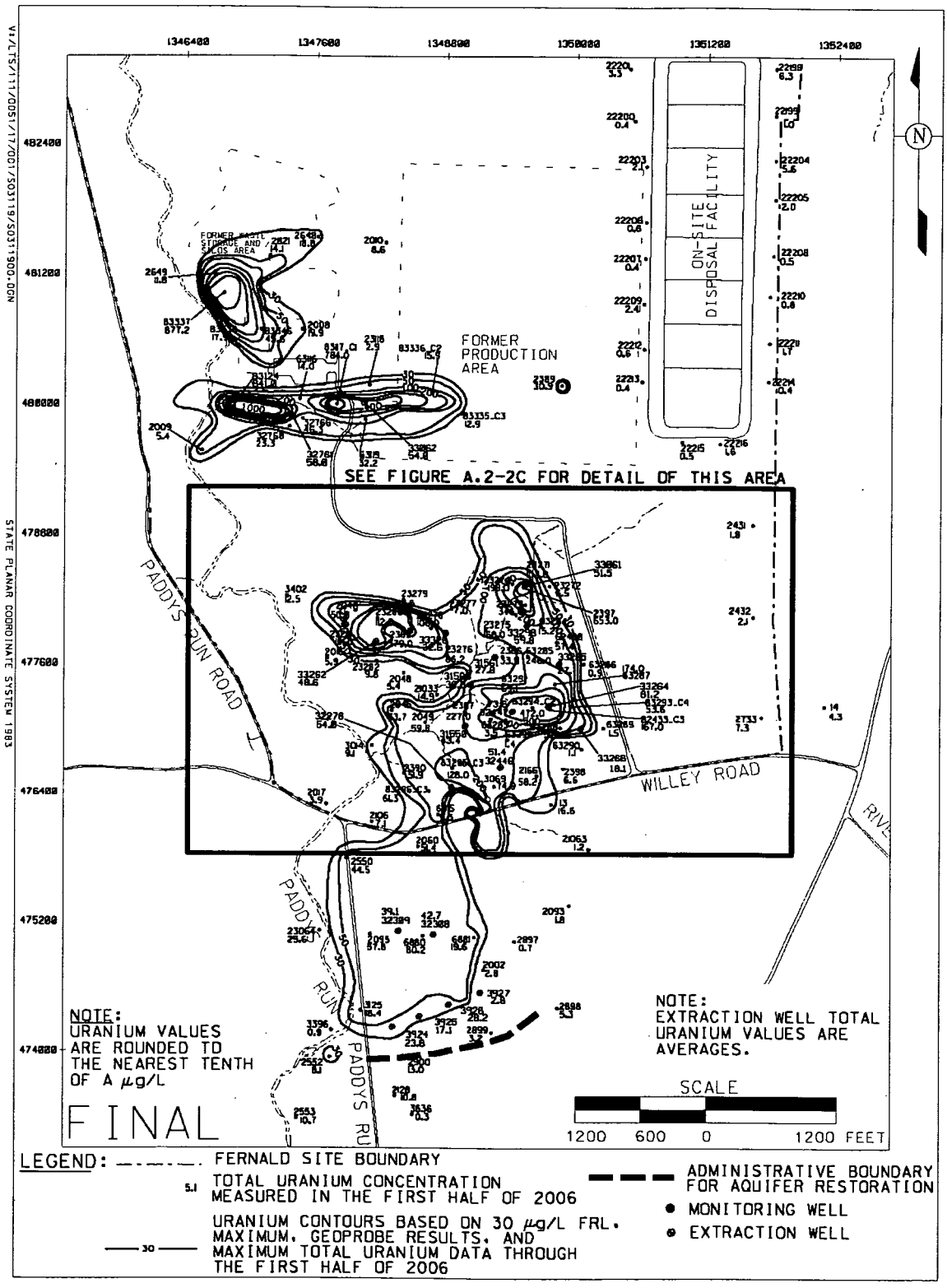

Figure A.2–2B. Monitoring Well Data and Maximum Total Uranium Plume Through the First Half of 2006

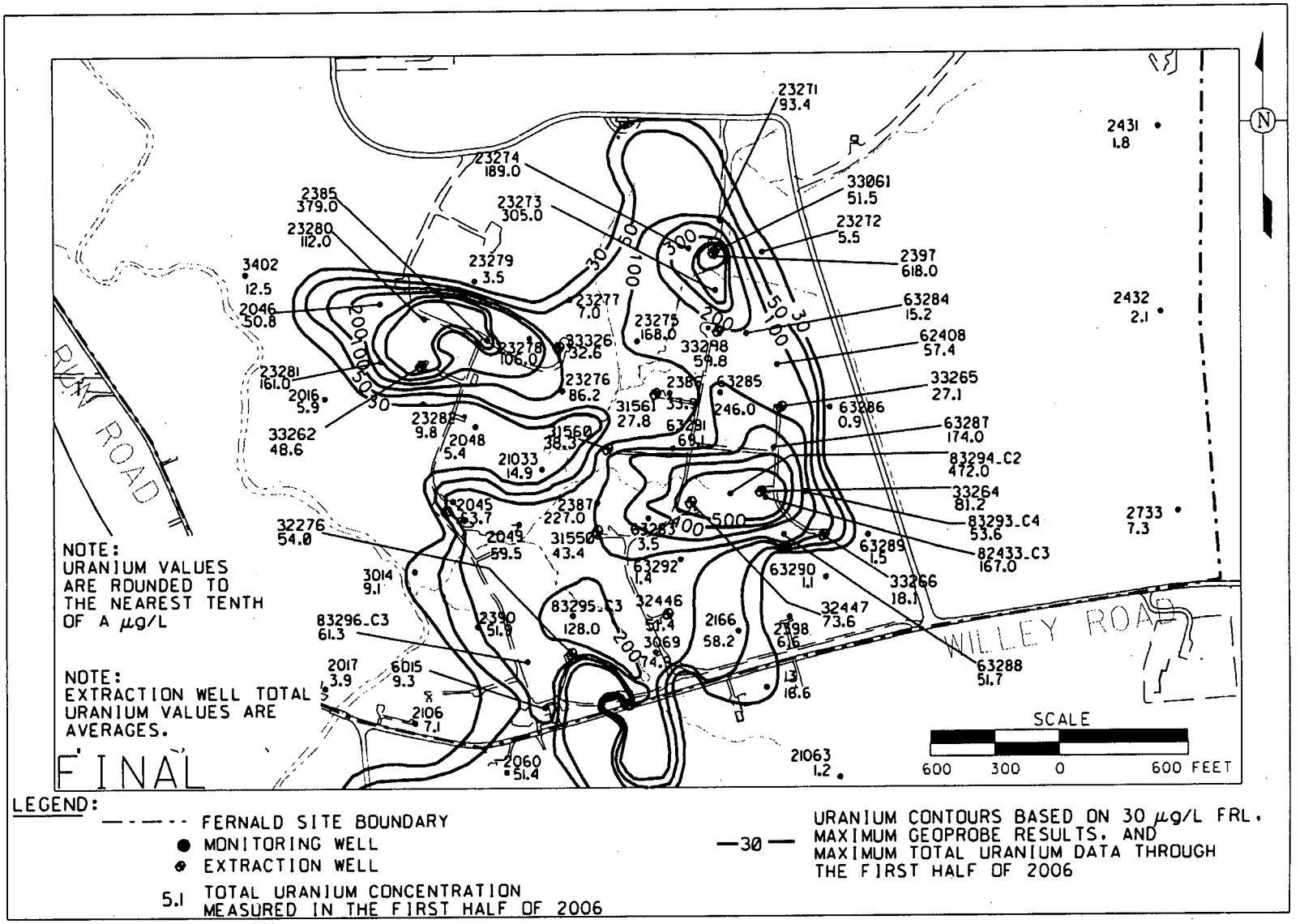

Figure A.2-2C. Monitoring Well Data and Maximum Total Uranium Plume South Field Through the First Half of 2006

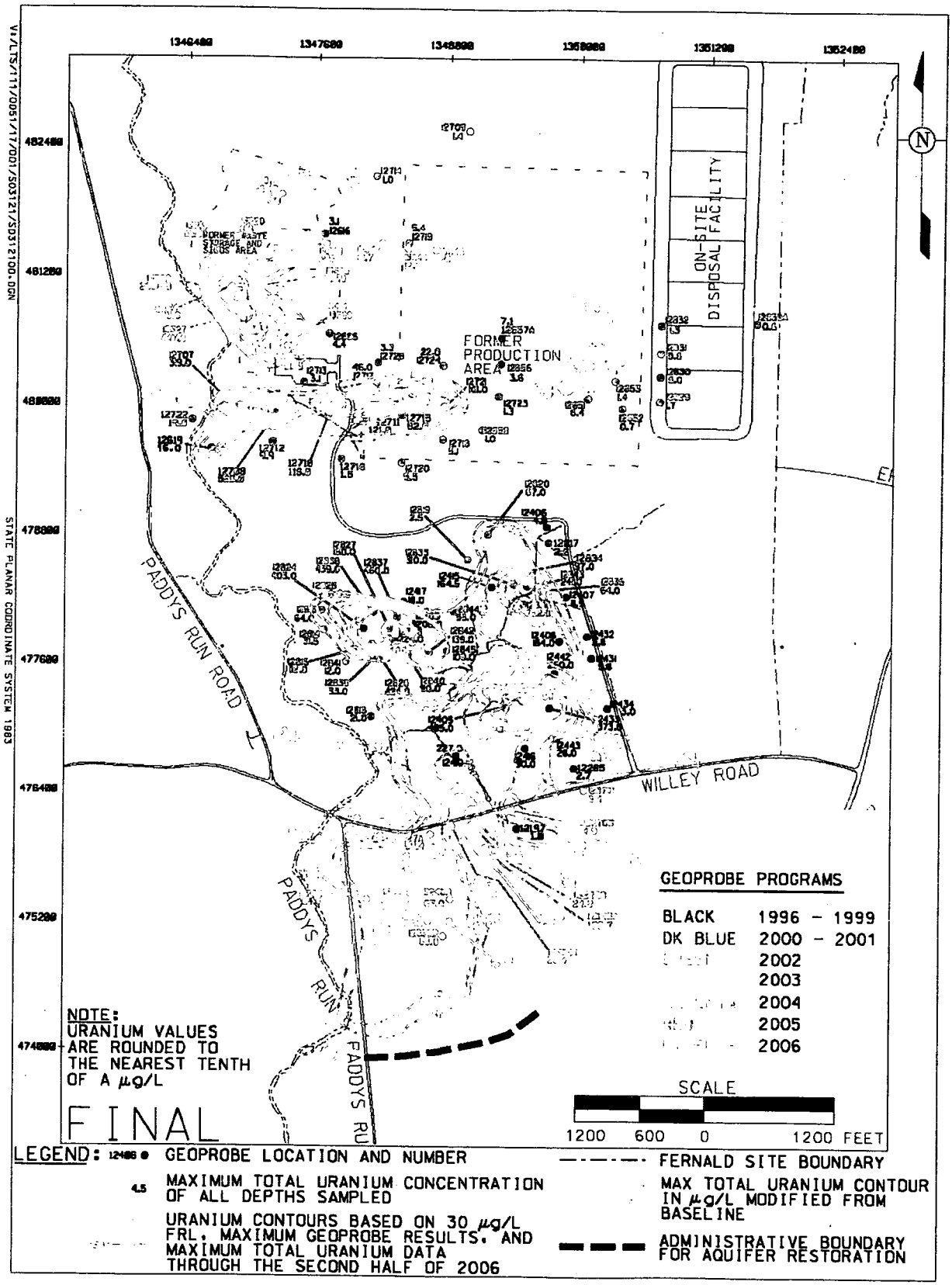

Figure A.2–3A. Direct-Push Data and Maximum Total Uranium Plume Through the Second Half of 2006

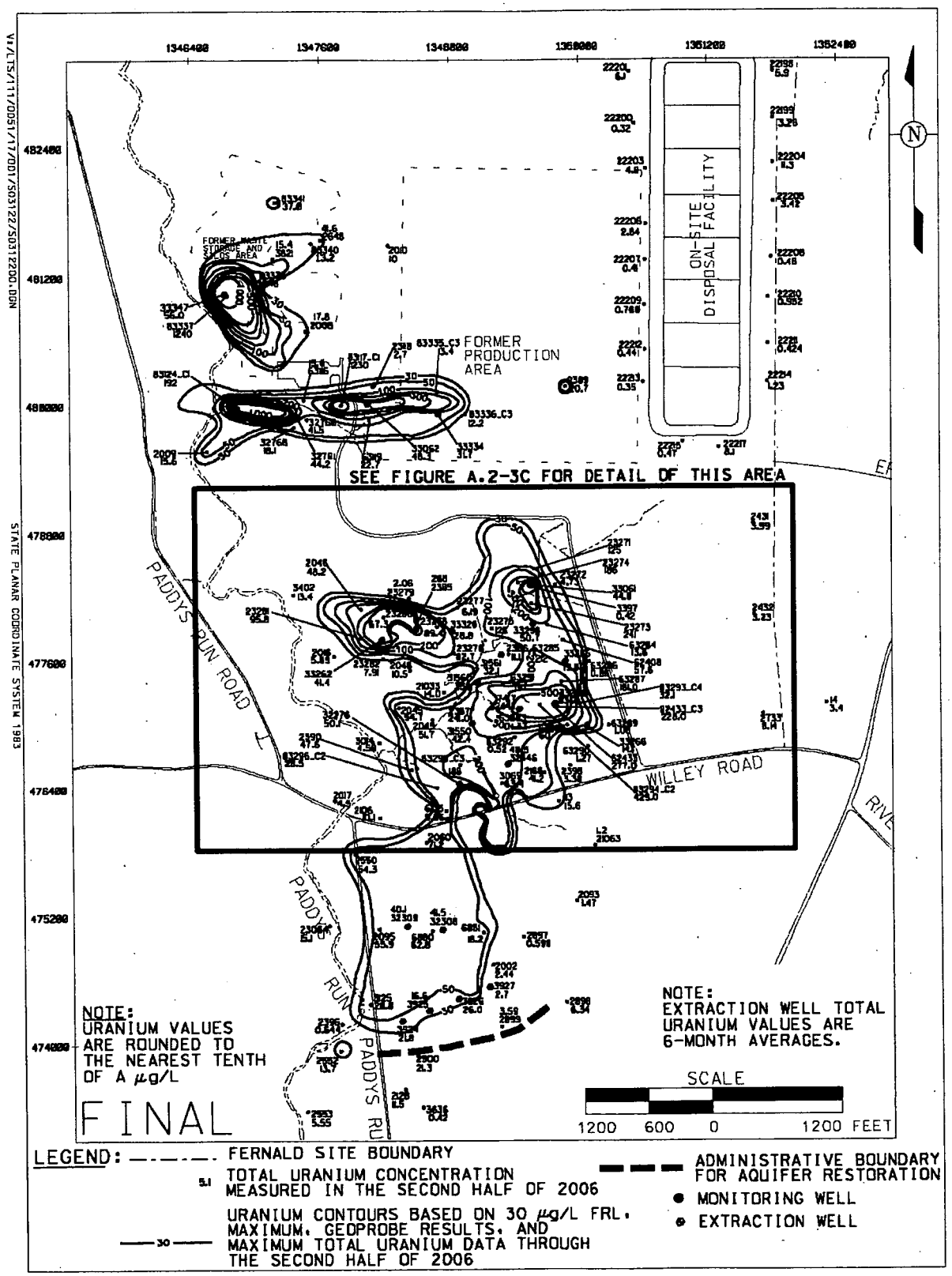

Figure A.2–3B. Monitoring Well Data and Maximum Total Uranium Plume Through the Second Half of 2006

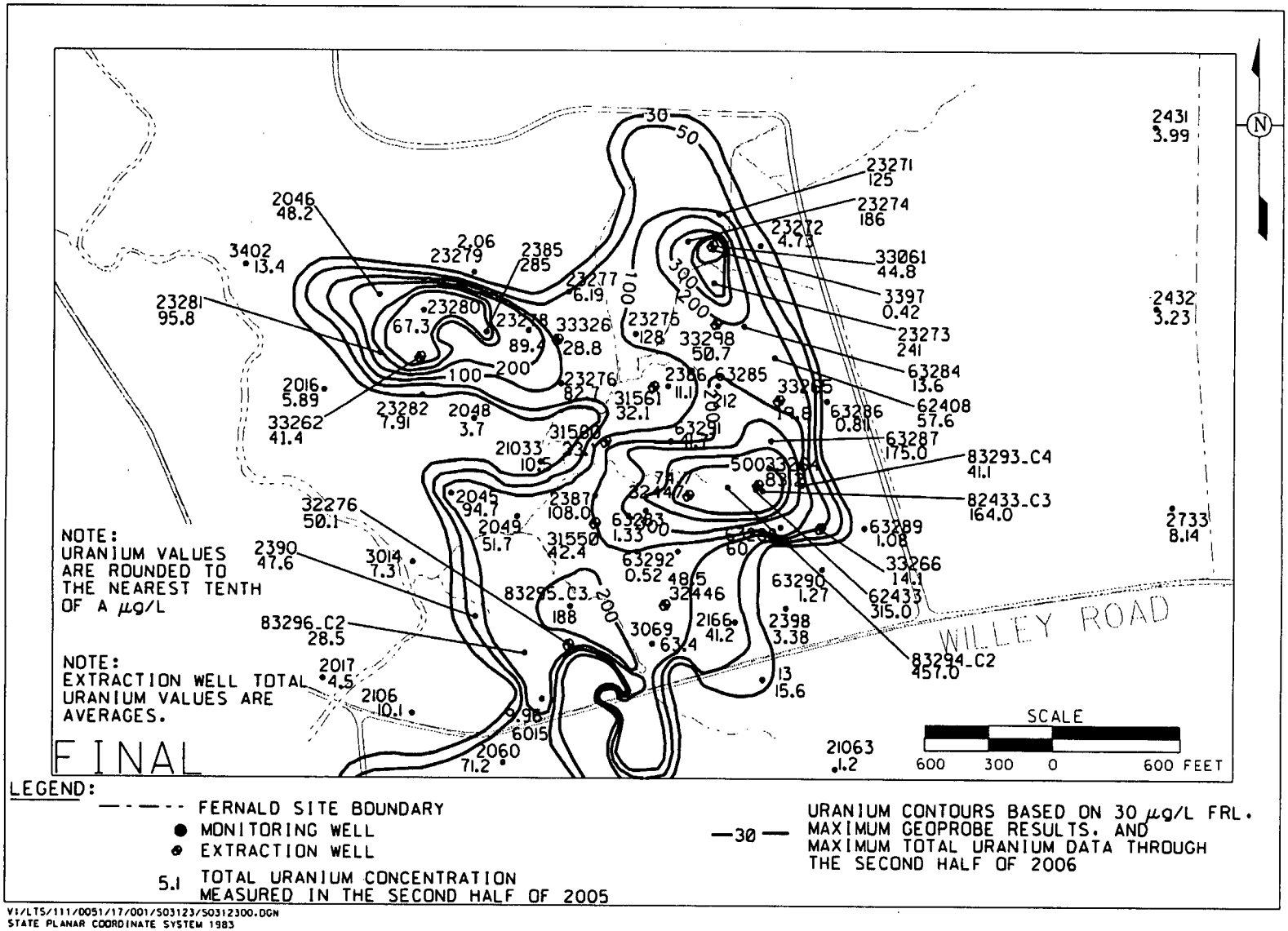

Figure A.2–3C. Monitoring Well Data and Maximum Total Uranium Plume Through the Second Half of 2006

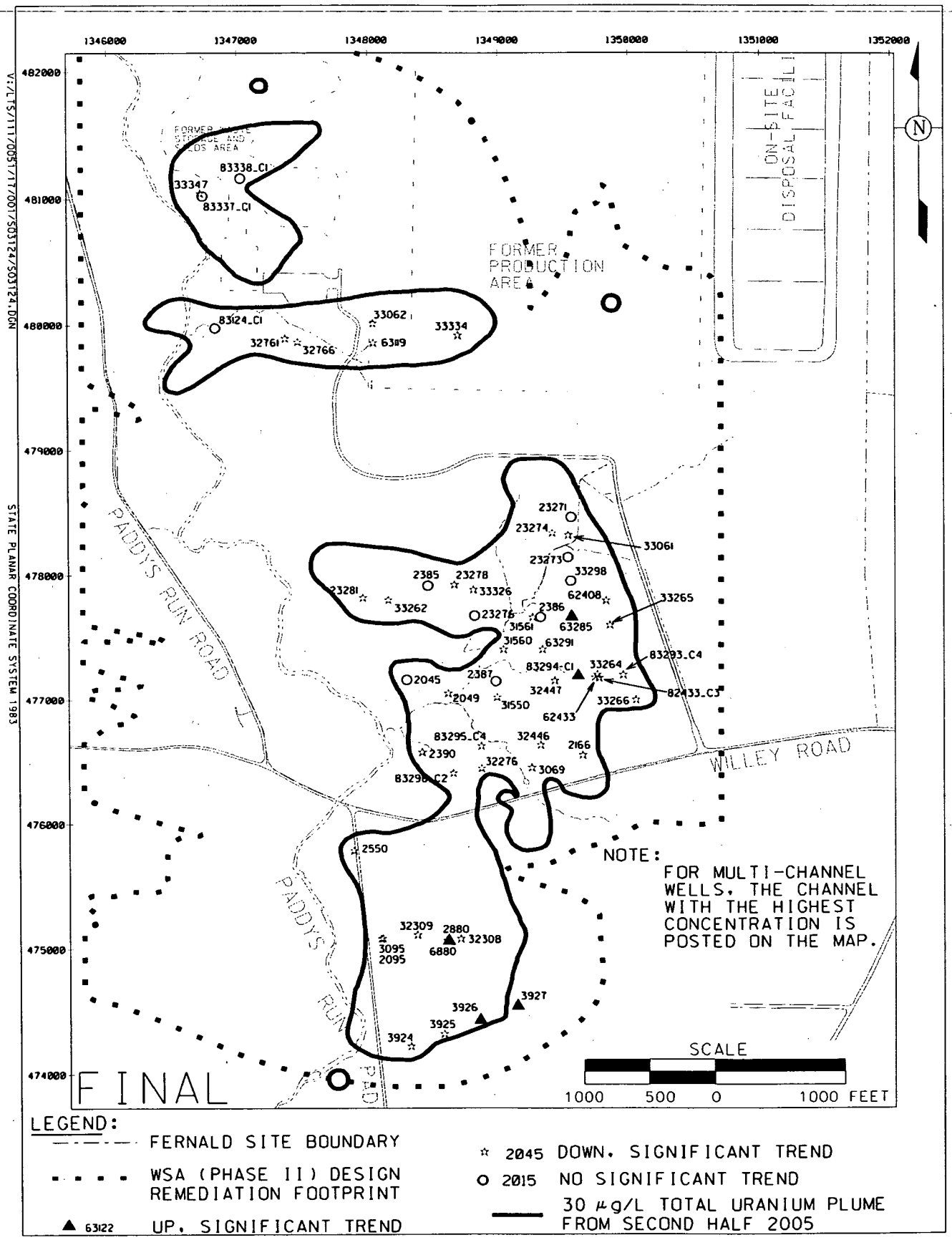

Figure A.2–4. Wells with 2006 FRL Exceedances for Total Uranium with Up, Down, or no Significant Trends

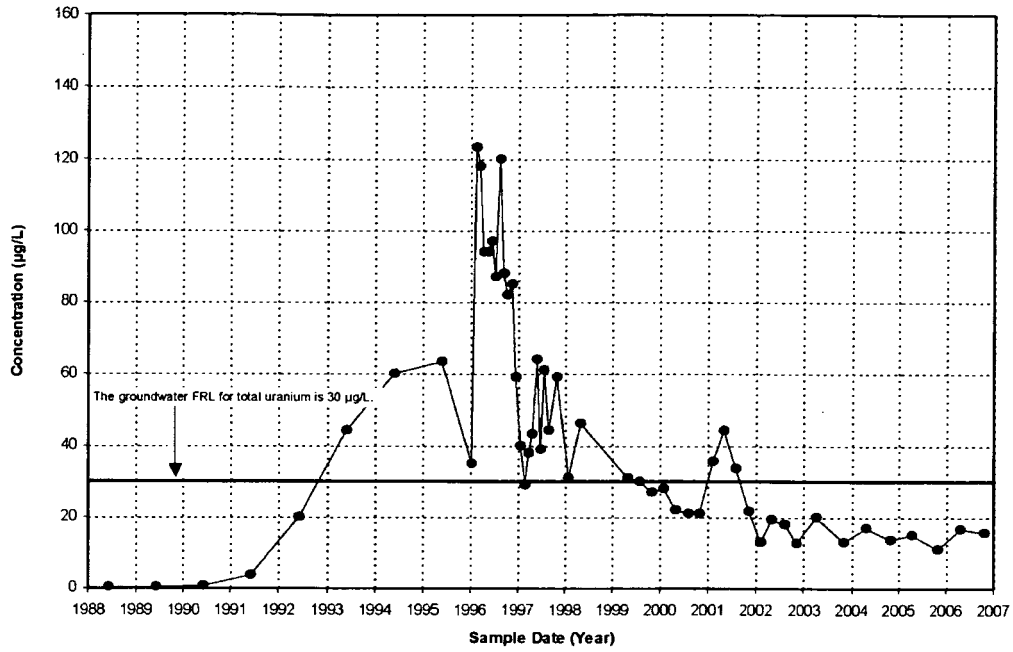

FIGURE A.2-5. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 13

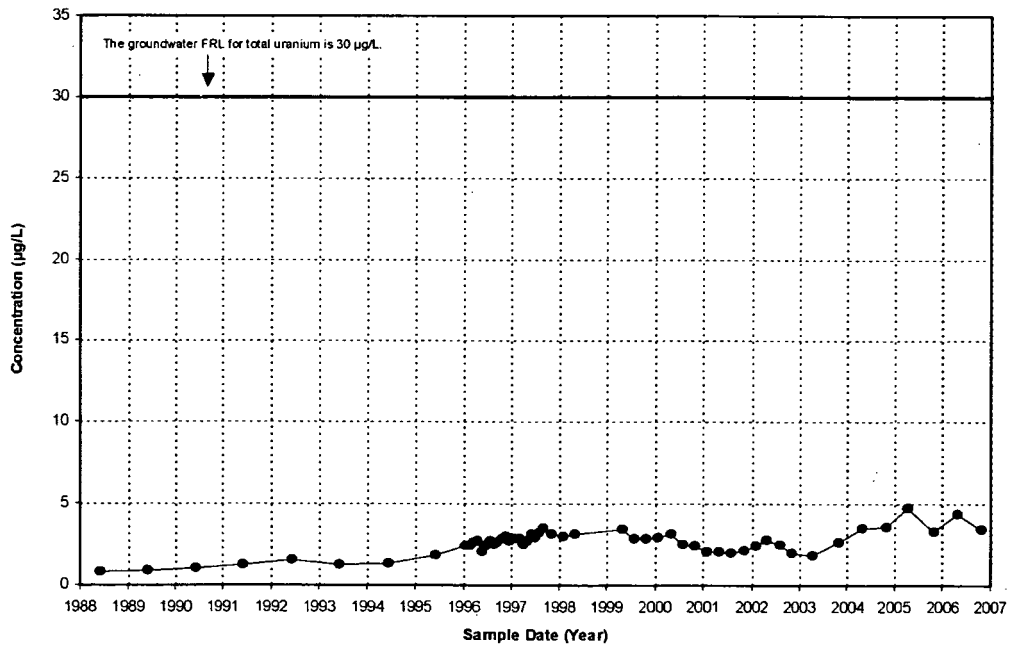

FIGURE A.2-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 14

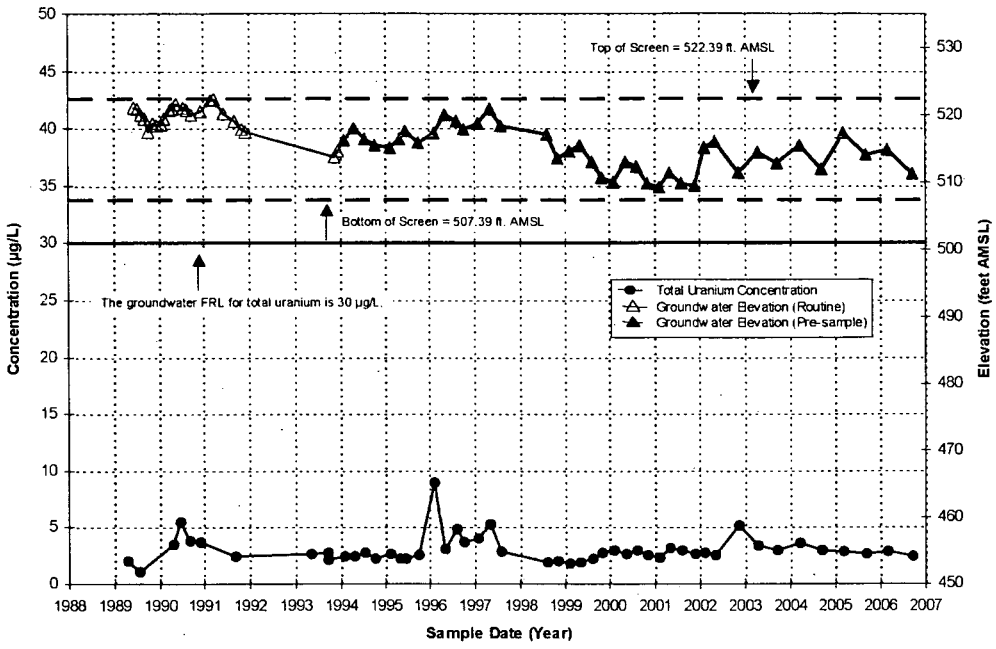

FIGURE A.2-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2002

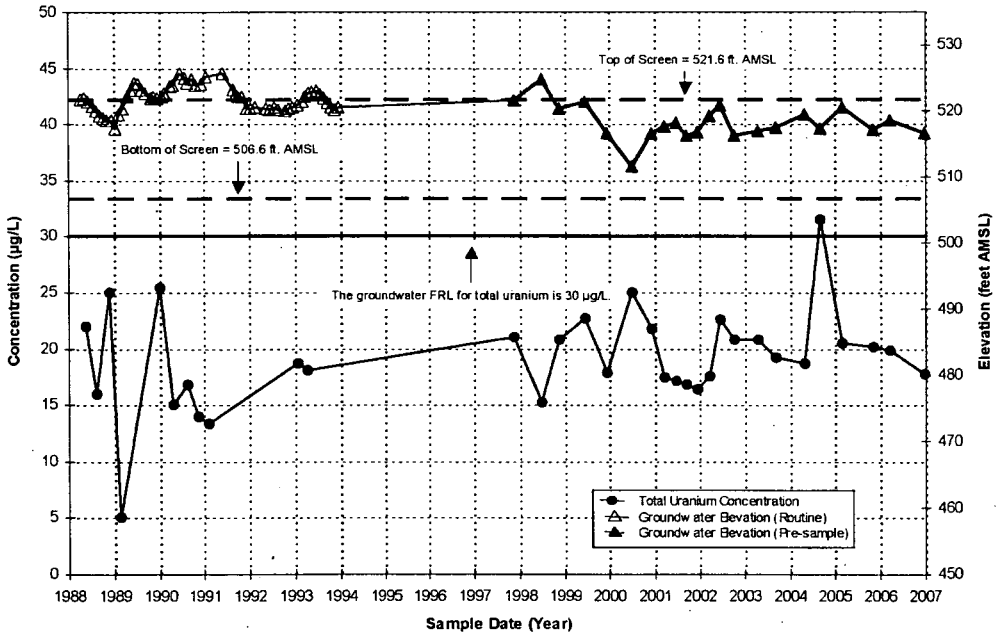

FIGURE A.2-8. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2008

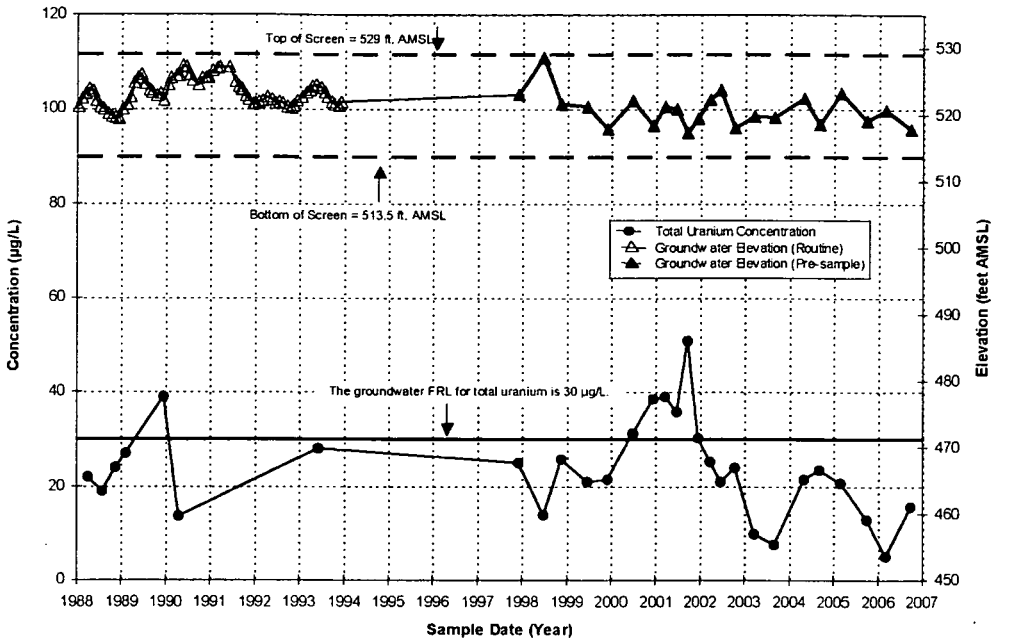

FIGURE A.2-9. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2009

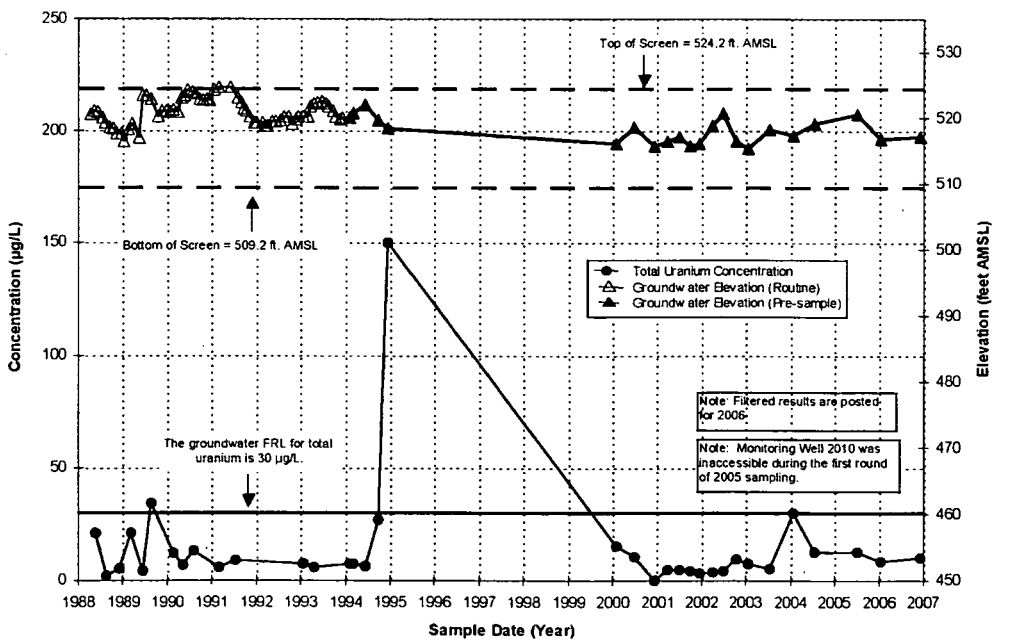

FIGURE A.2-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2010

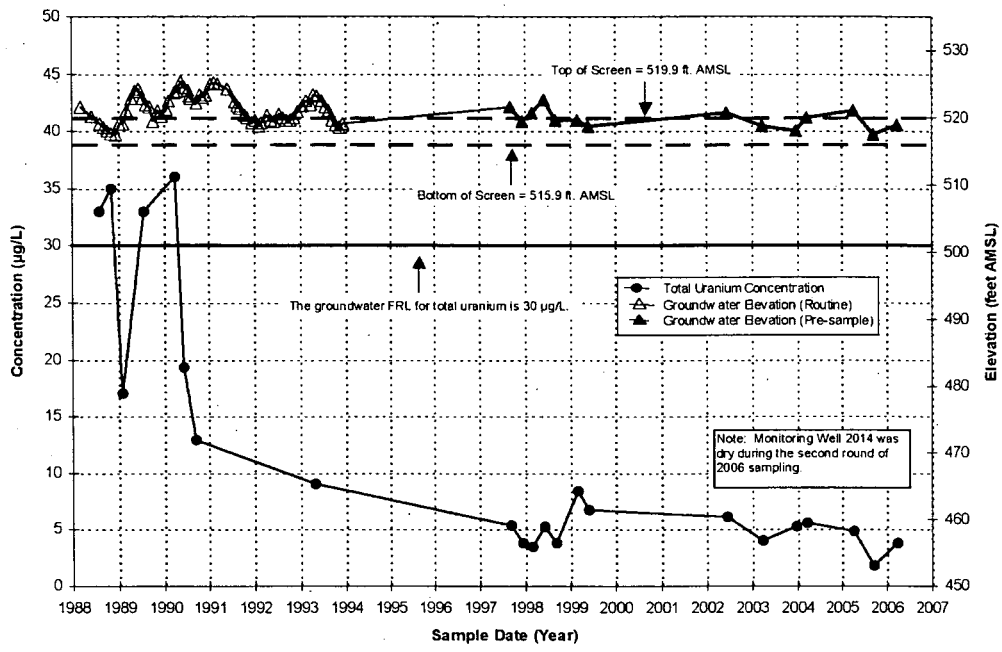

FIGURE A.2-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2014

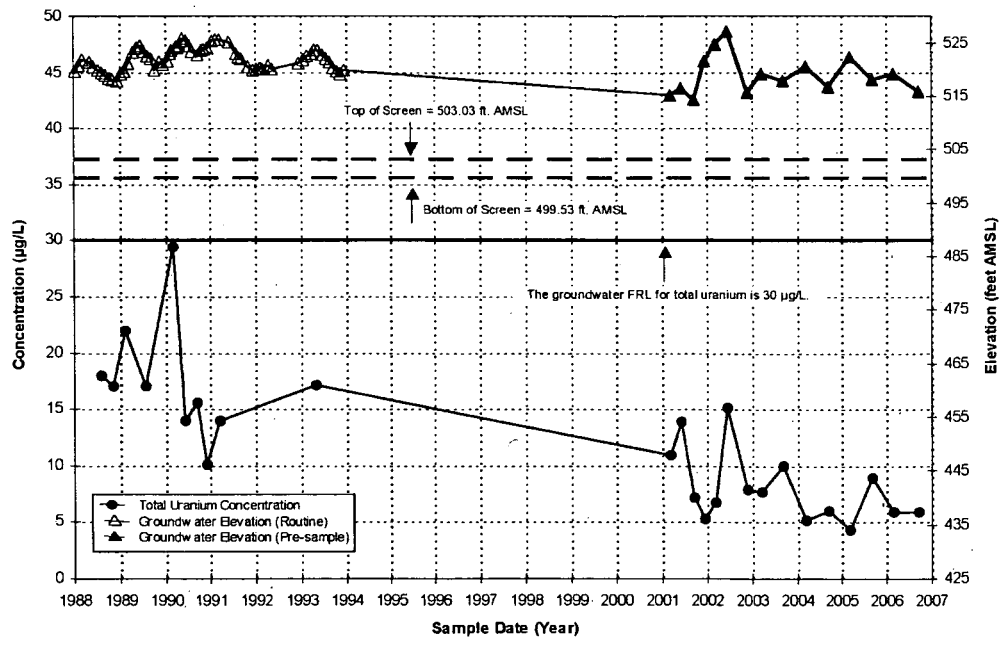

FIGURE A.2-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2016

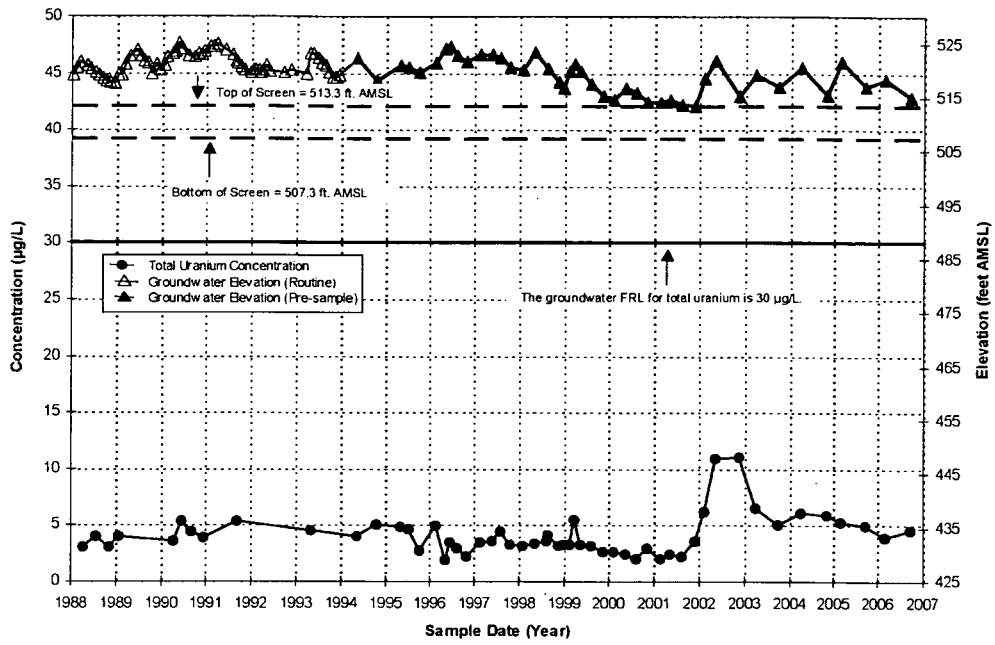

FIGURE A.2-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2017

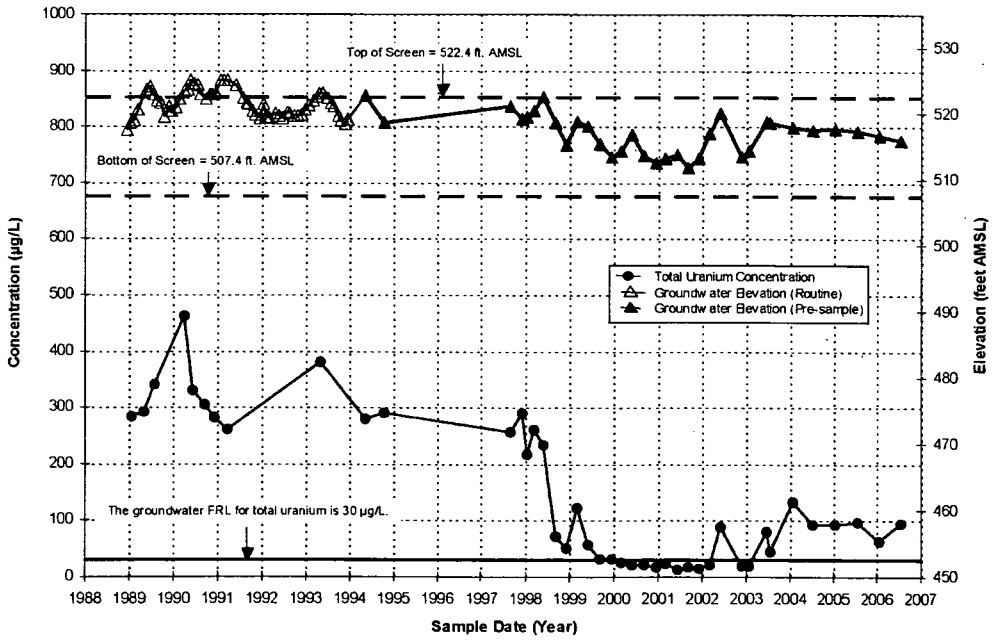

FIGURE A.2-14. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2045

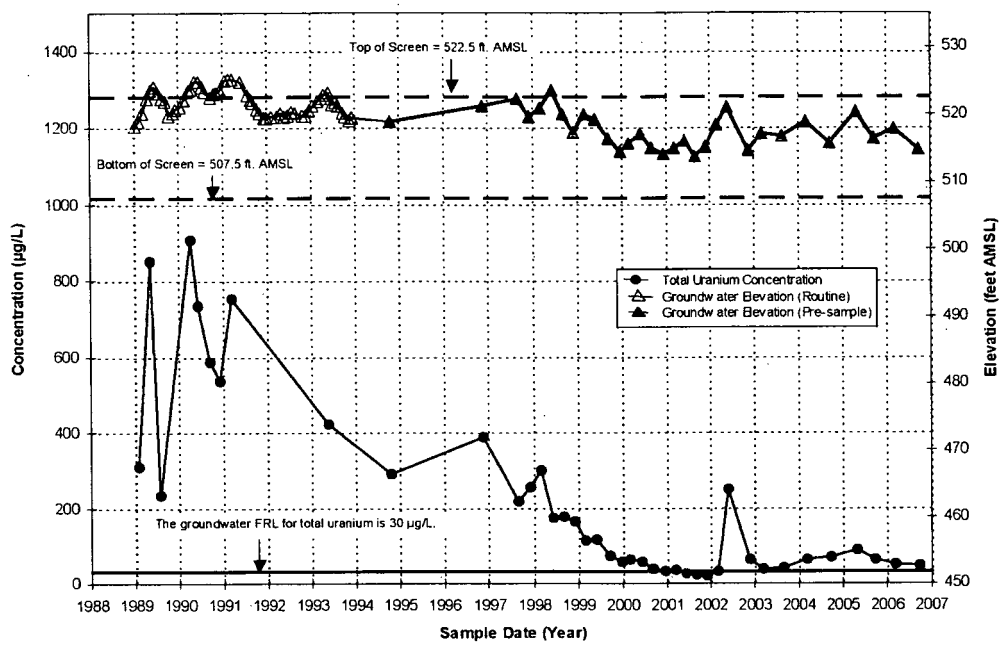

FIGURE A.2-15. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2046

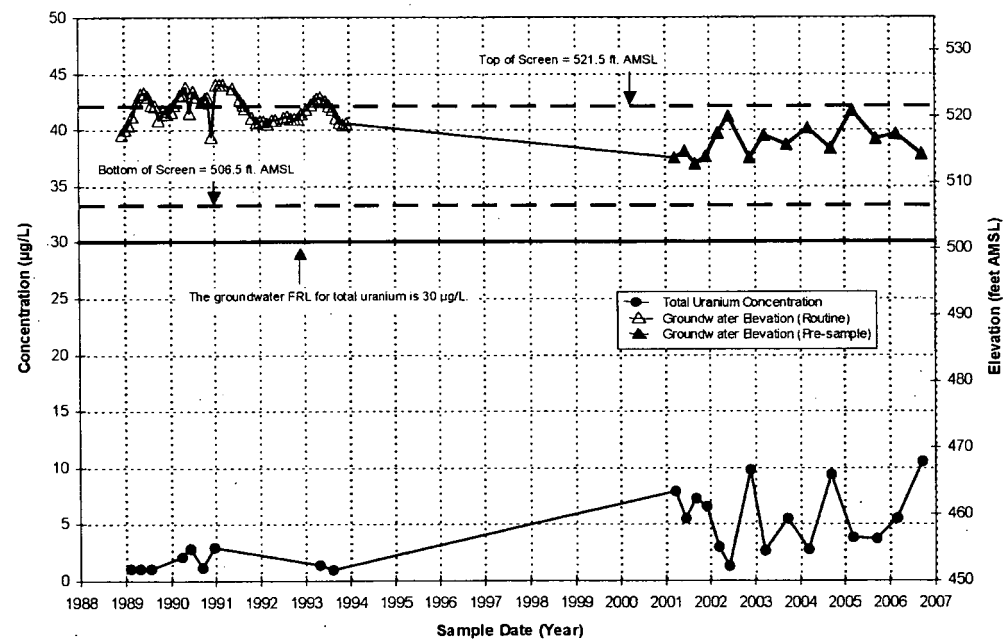

FIGURE A.2-16. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2048

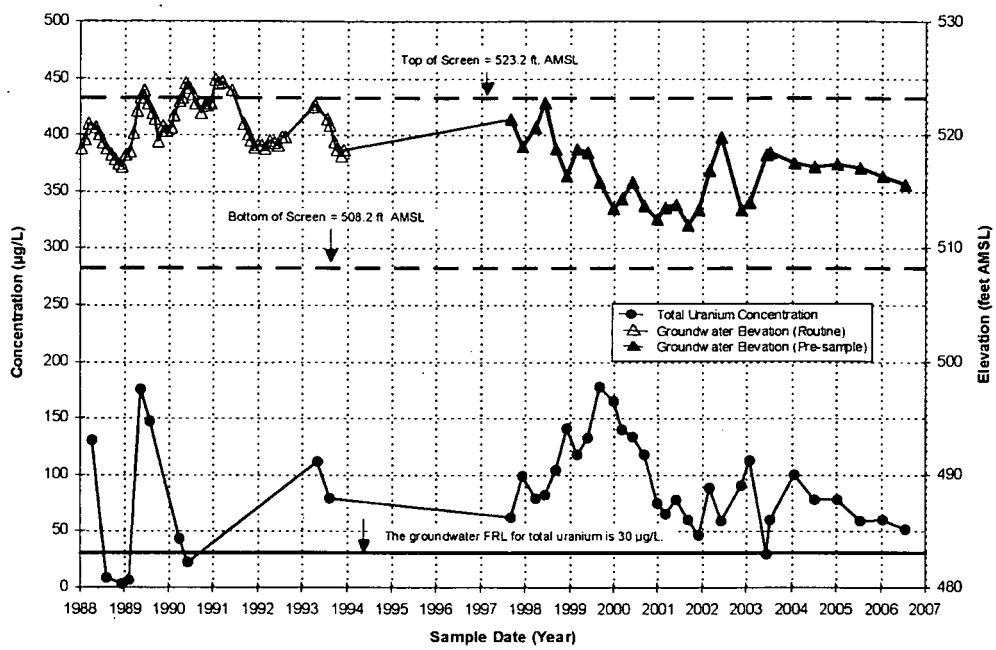

FIGURE A.2-17. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2049

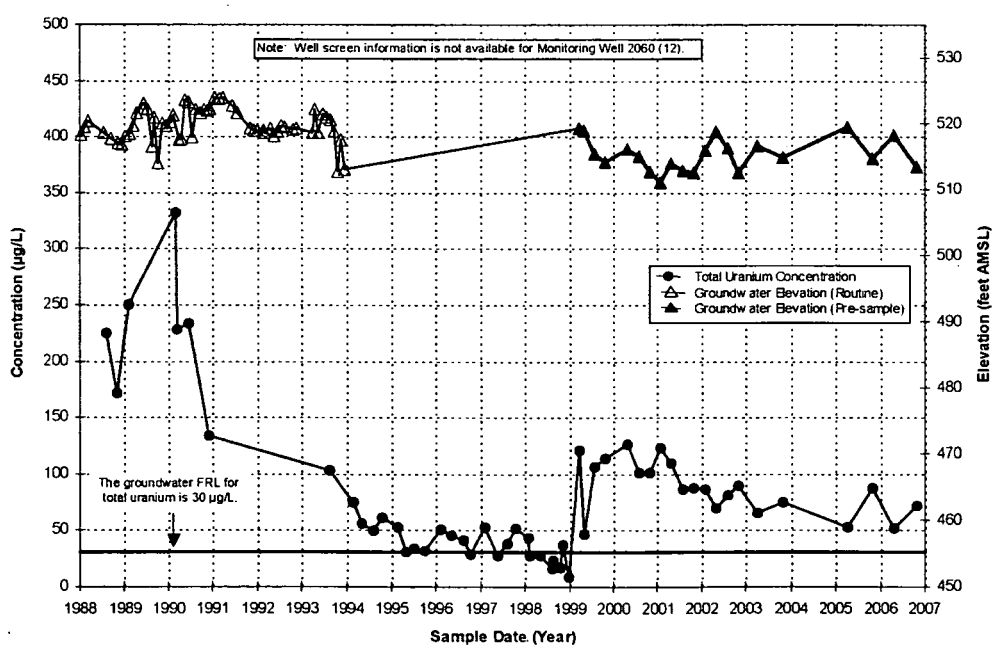

FIGURE A.2-18. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2060 (12)

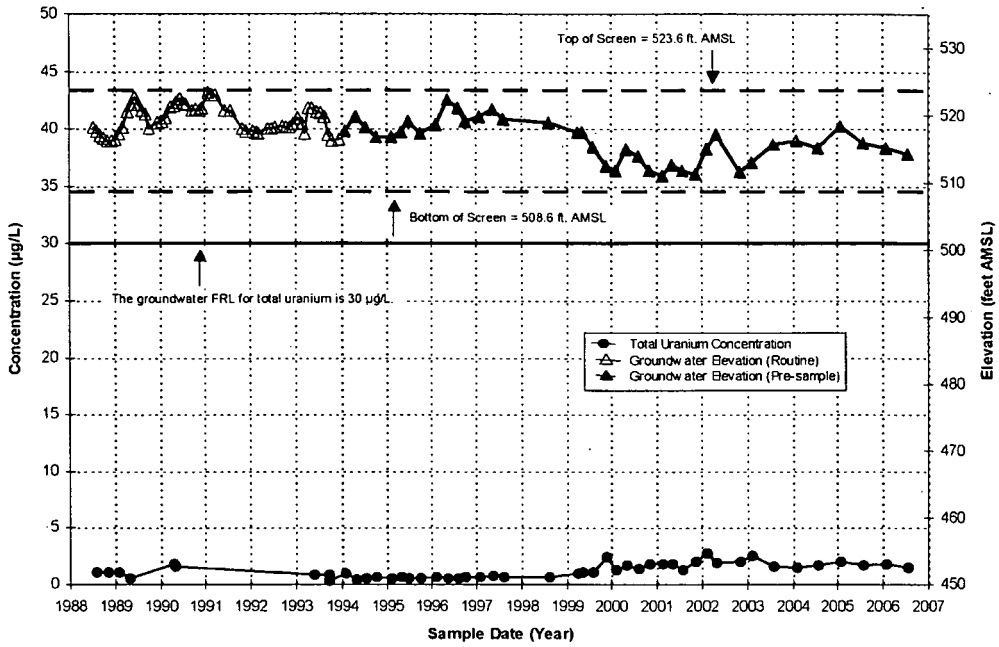

FIGURE A.2-19. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2093

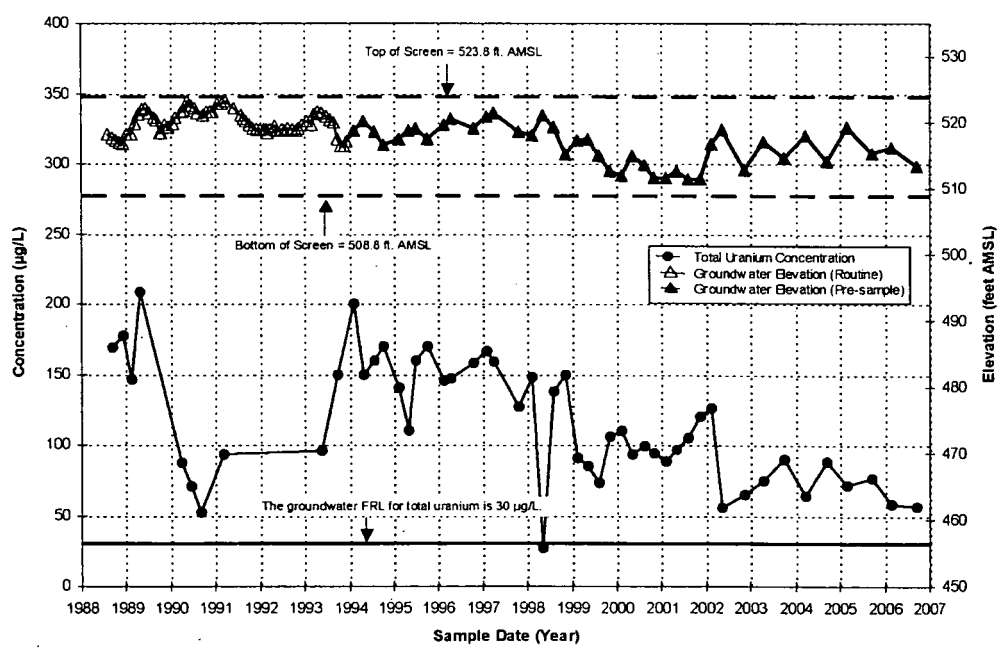

FIGURE A.2-20. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2095

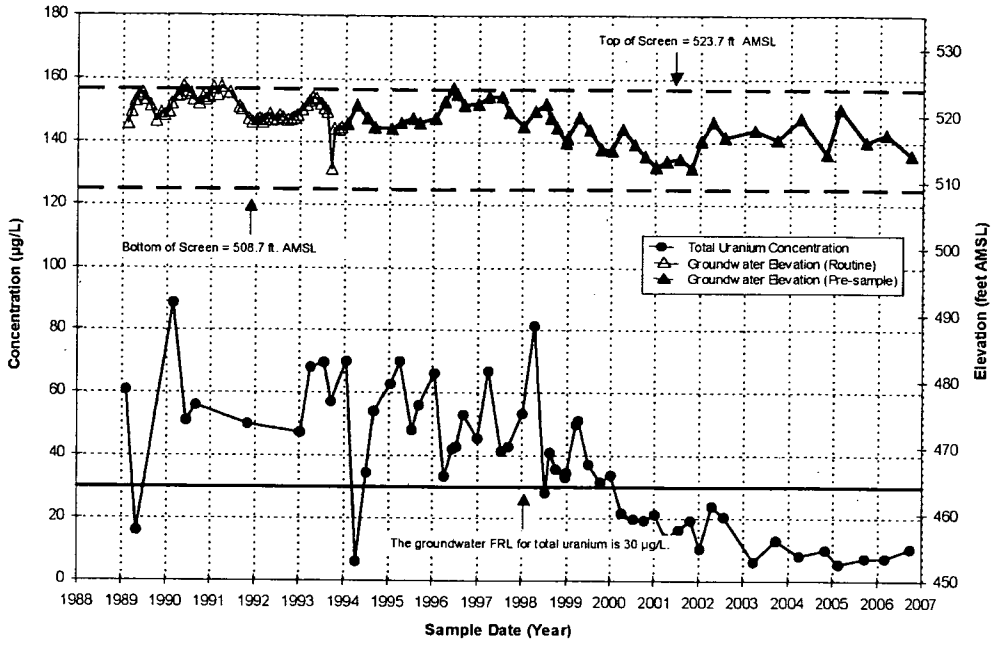

FIGURE A.2-21. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2106

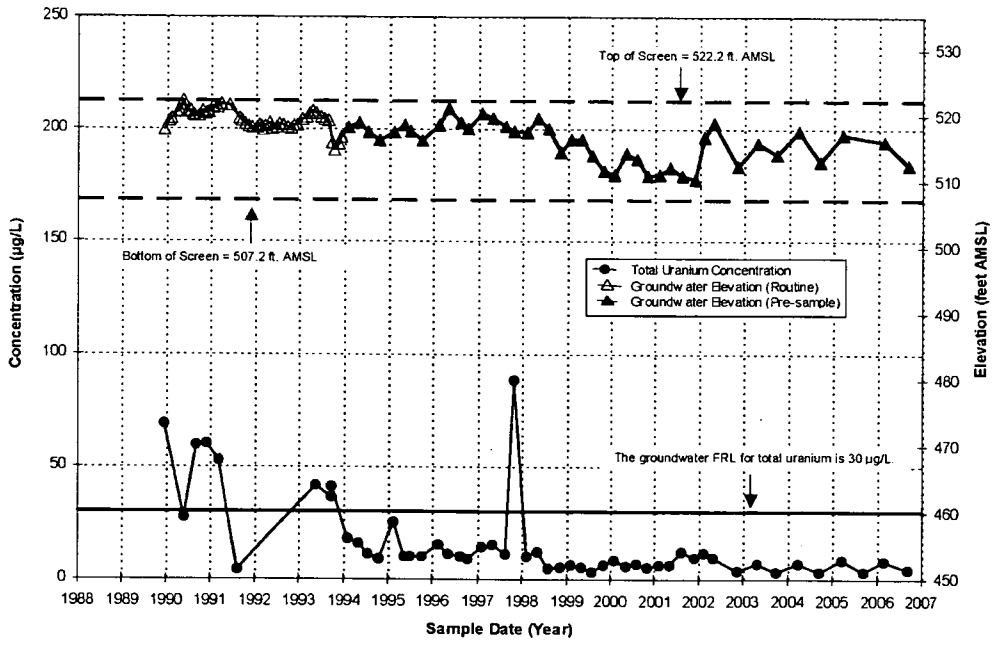

FIGURE A.2-22. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2125

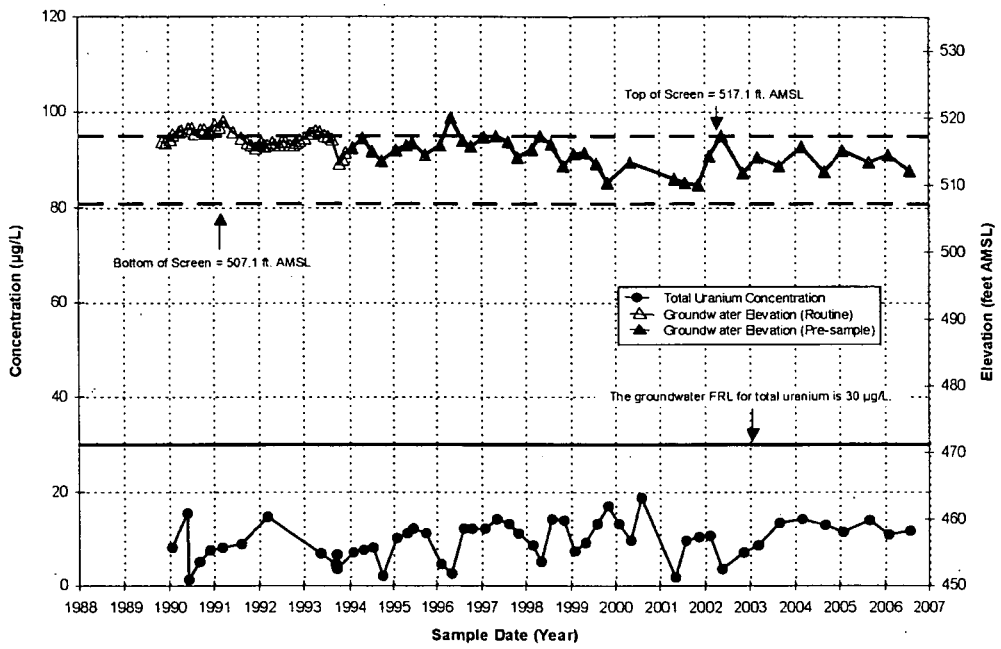

FIGURE A.2-23. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2128

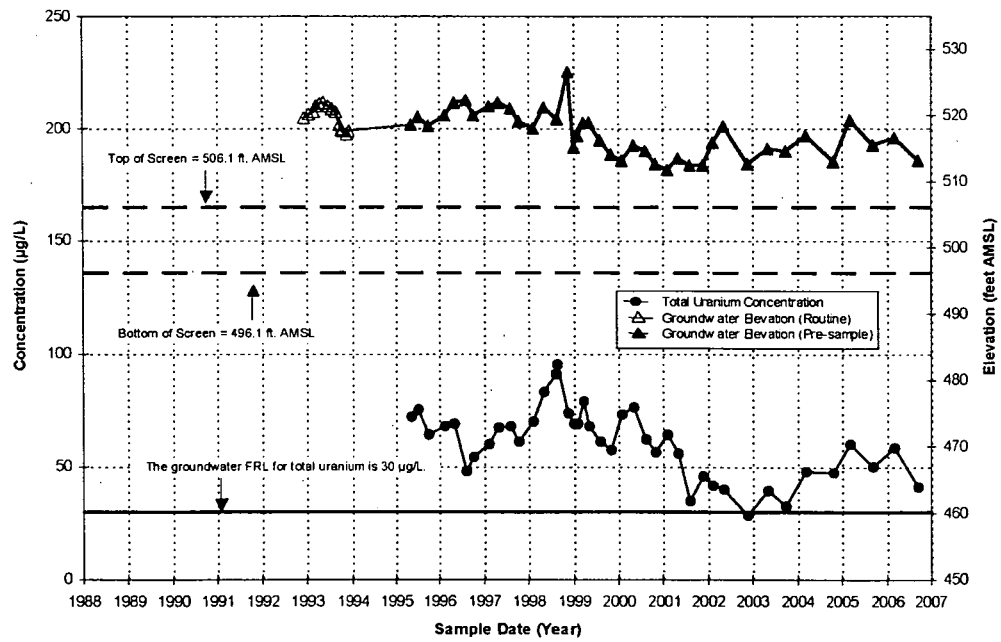

FIGURE A.2-24. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2166

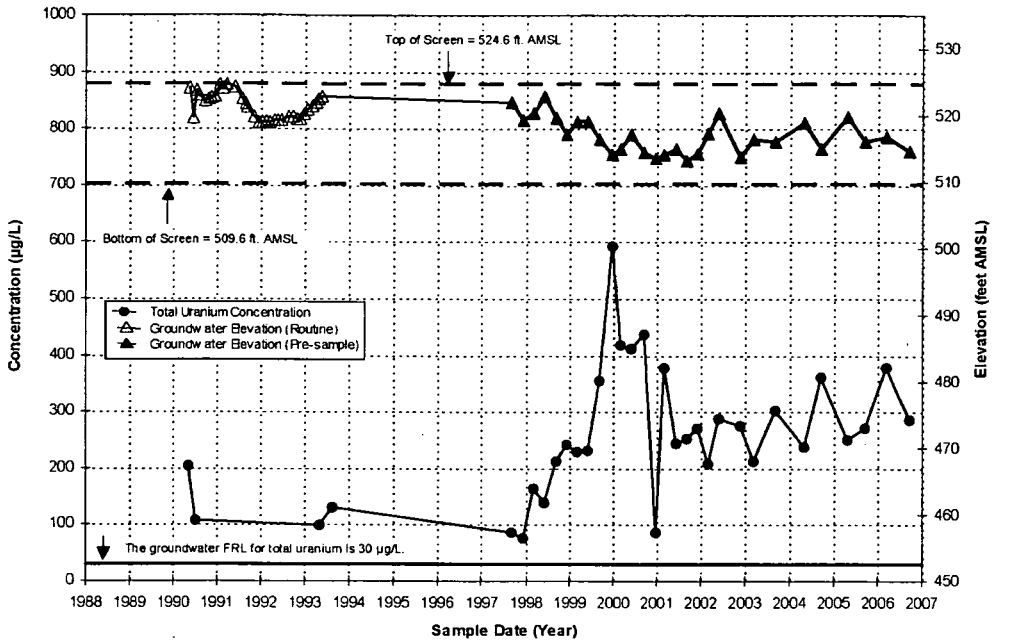

FIGURE A.2-25. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2385

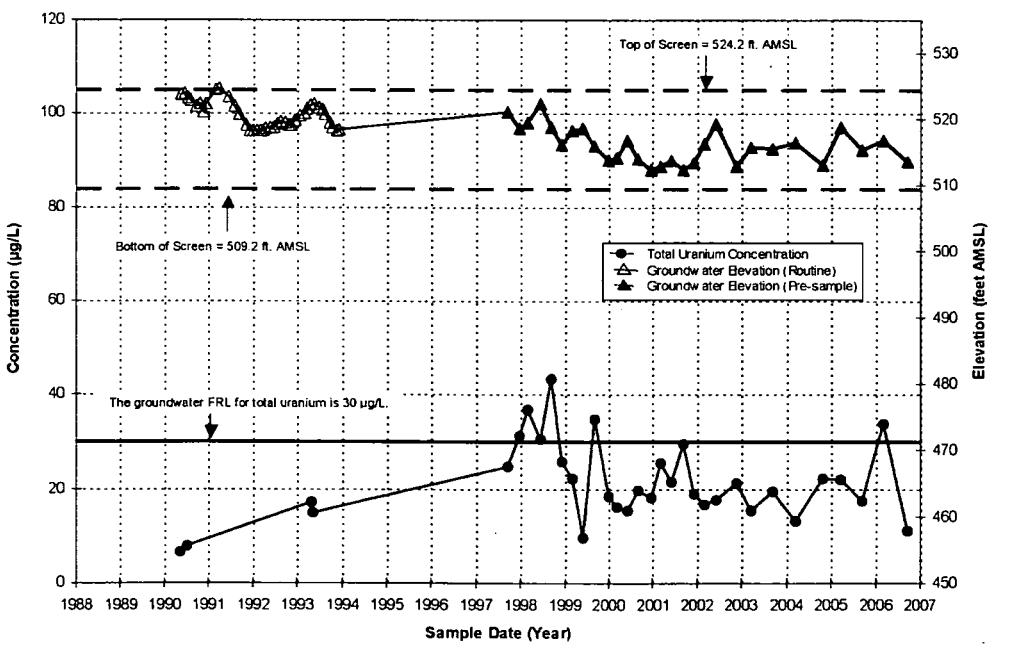

FIGURE A.2-26. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2386

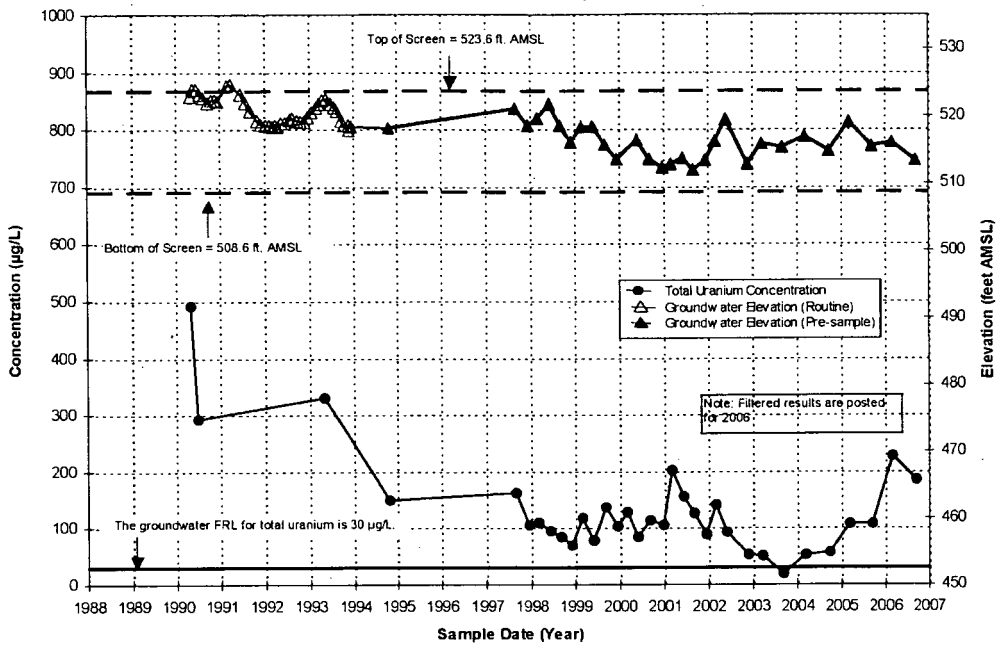

FIGURE A.2-27. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2387

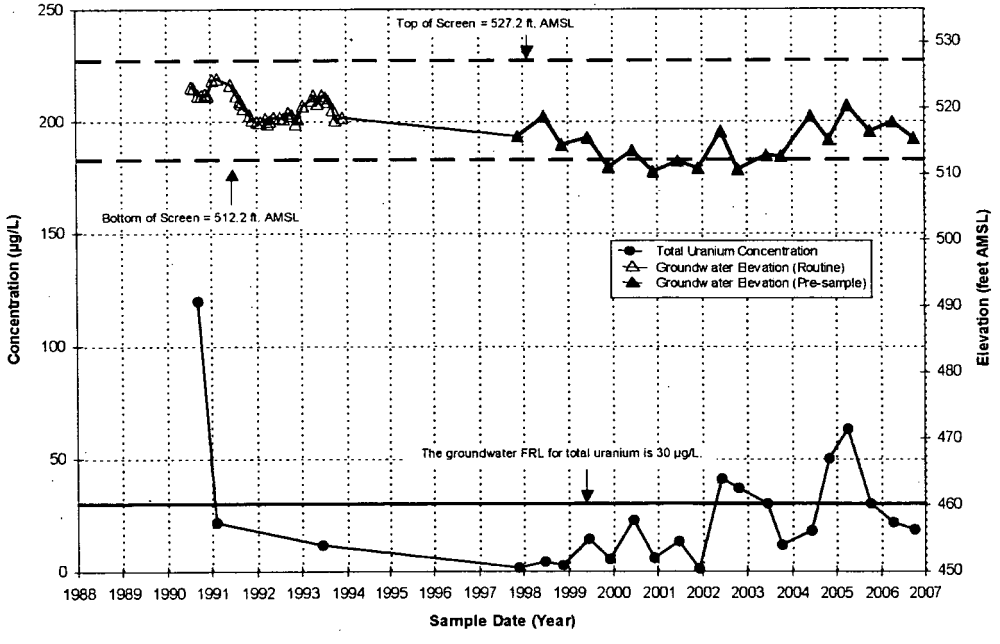

FIGURE A.2-28. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2389

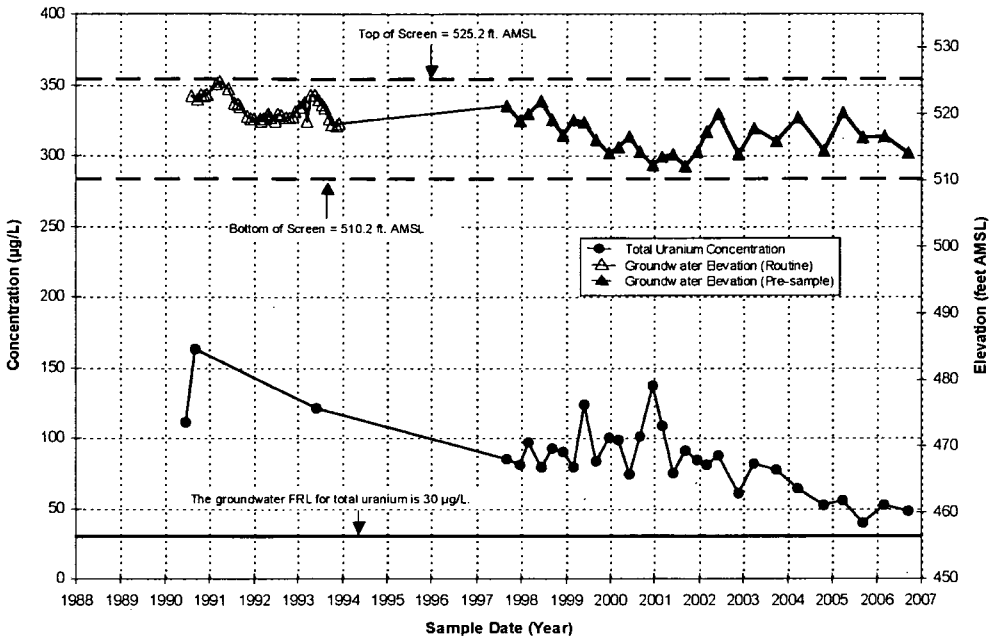

FIGURE A.2-29. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2390

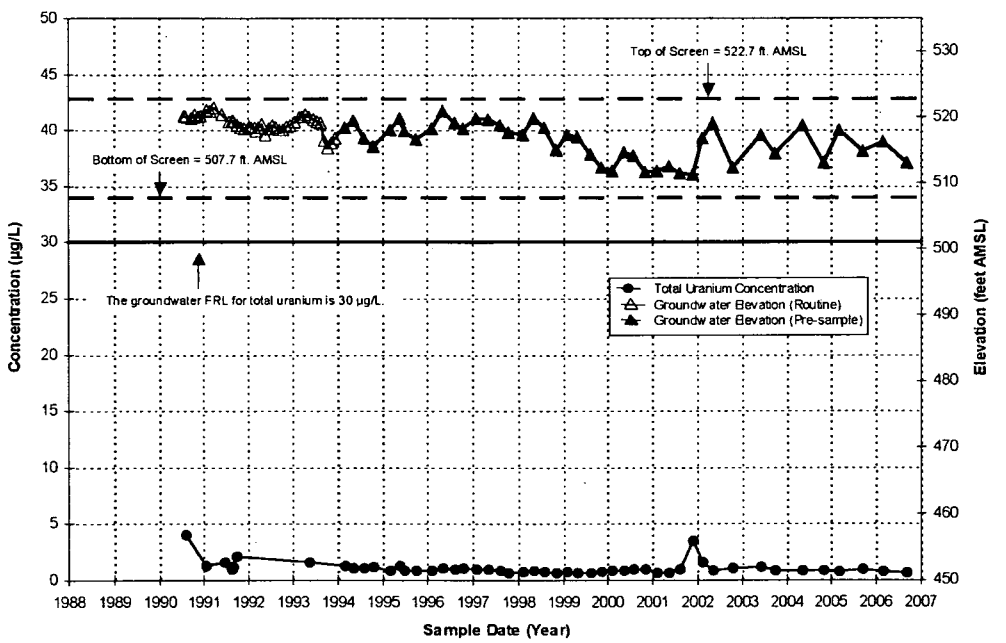

FIGURE A.2-30. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2396

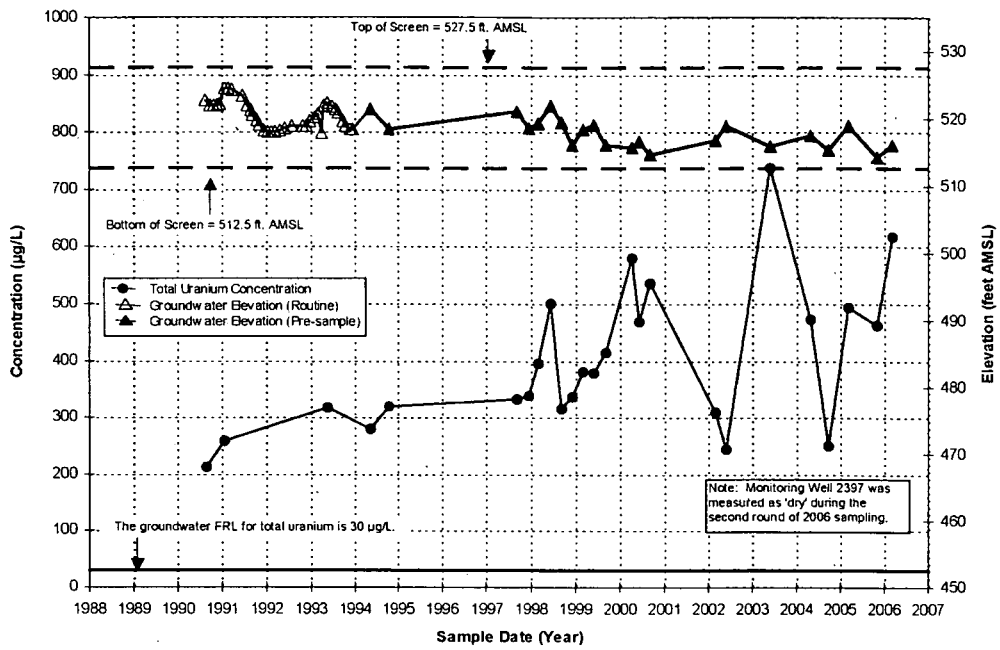

FIGURE A.2-31. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2397

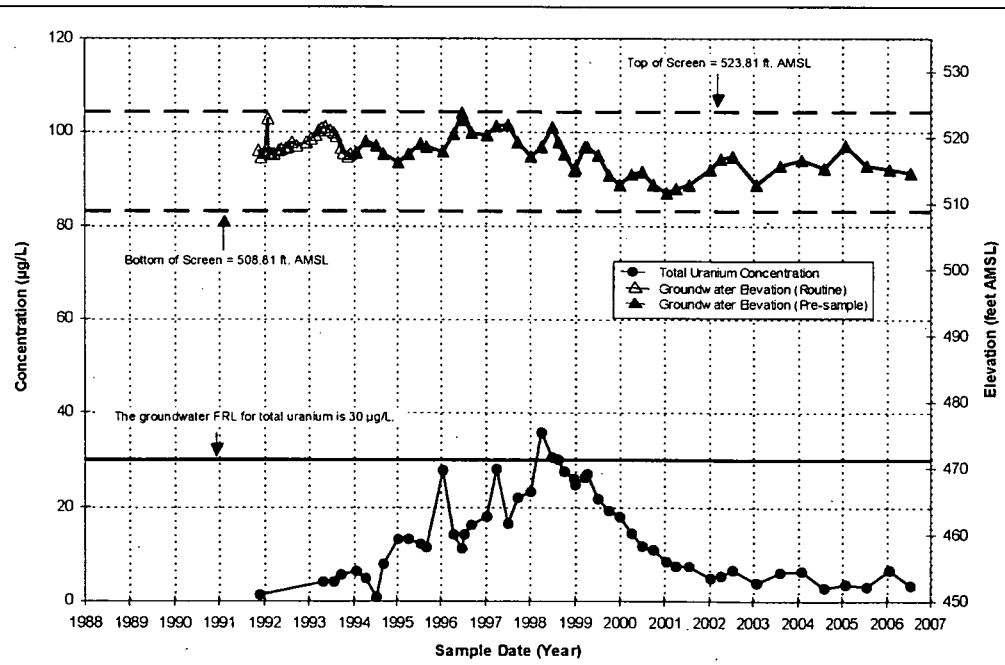

FIGURE A.2-32. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2398

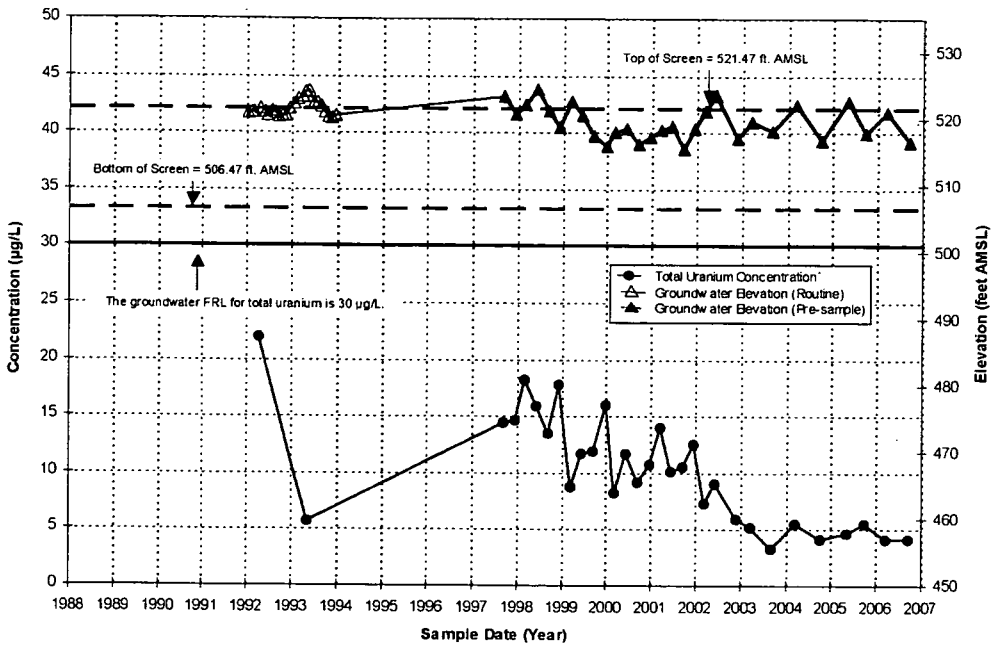

FIGURE A.2-33. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2402

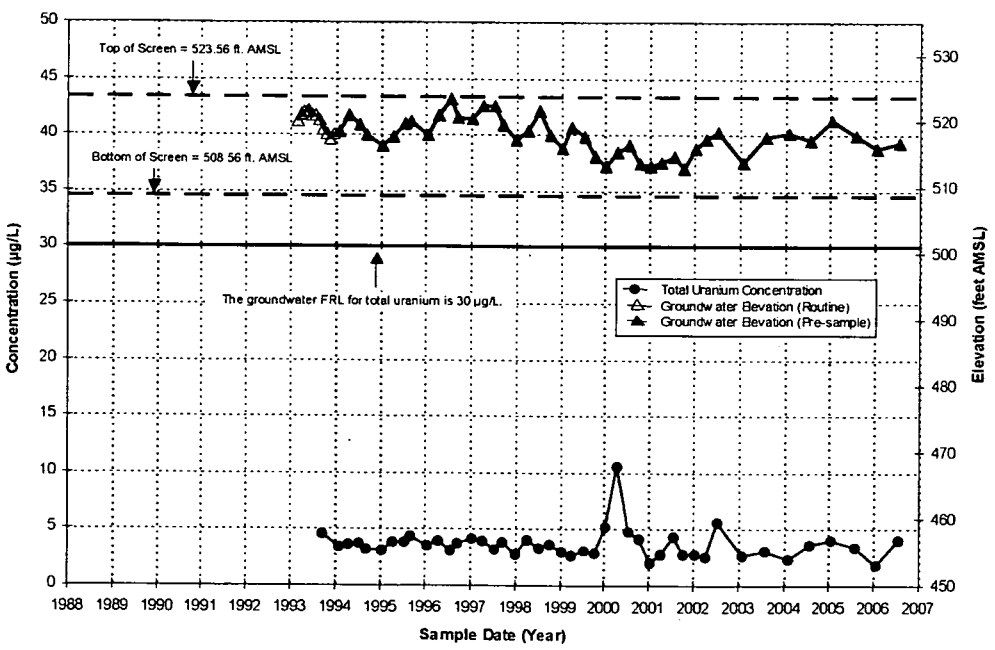

FIGURE A.2-34. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2431

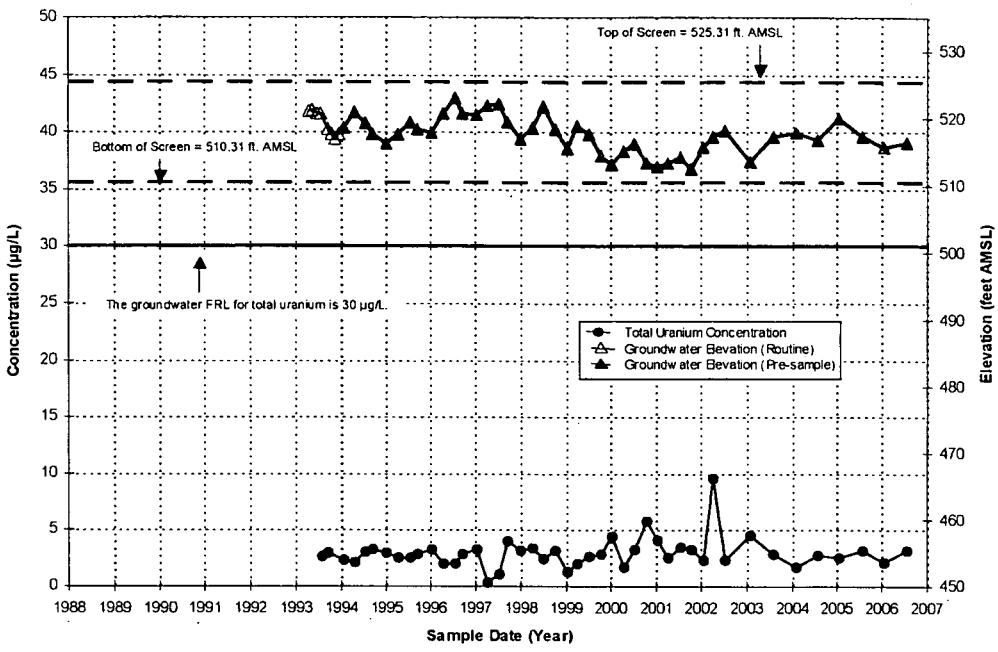

FIGURE A.2-35. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2432

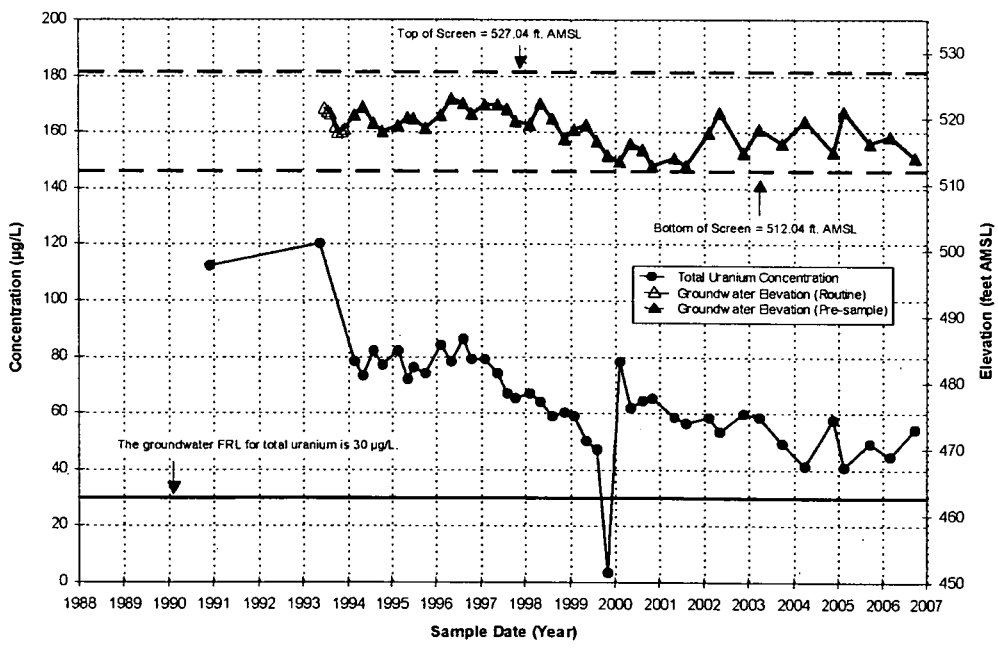

FIGURE A.2-36. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2550

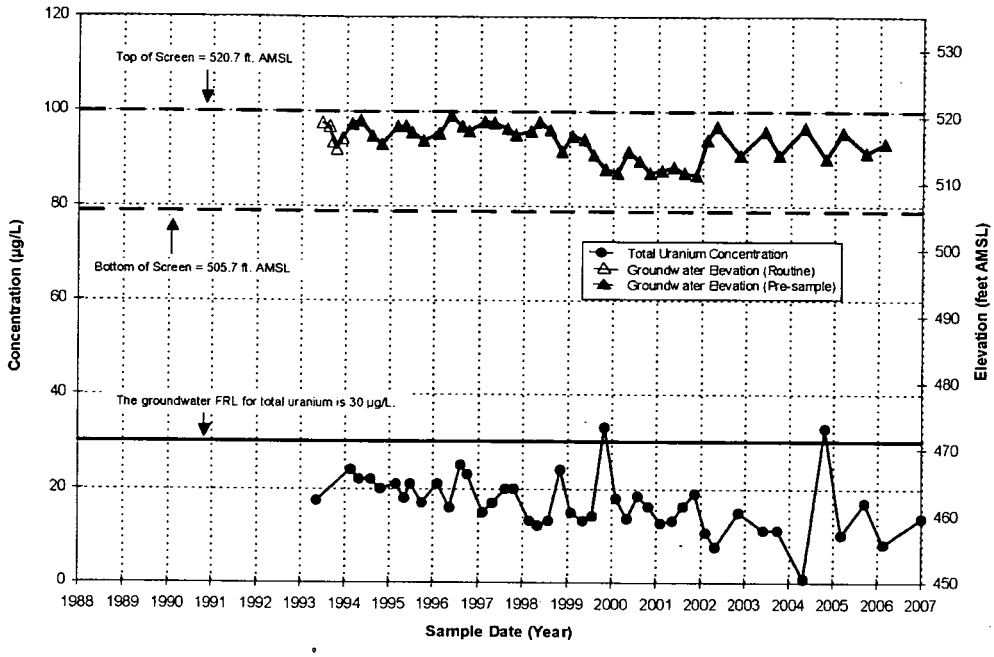

FIGURE A.2-37. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2552

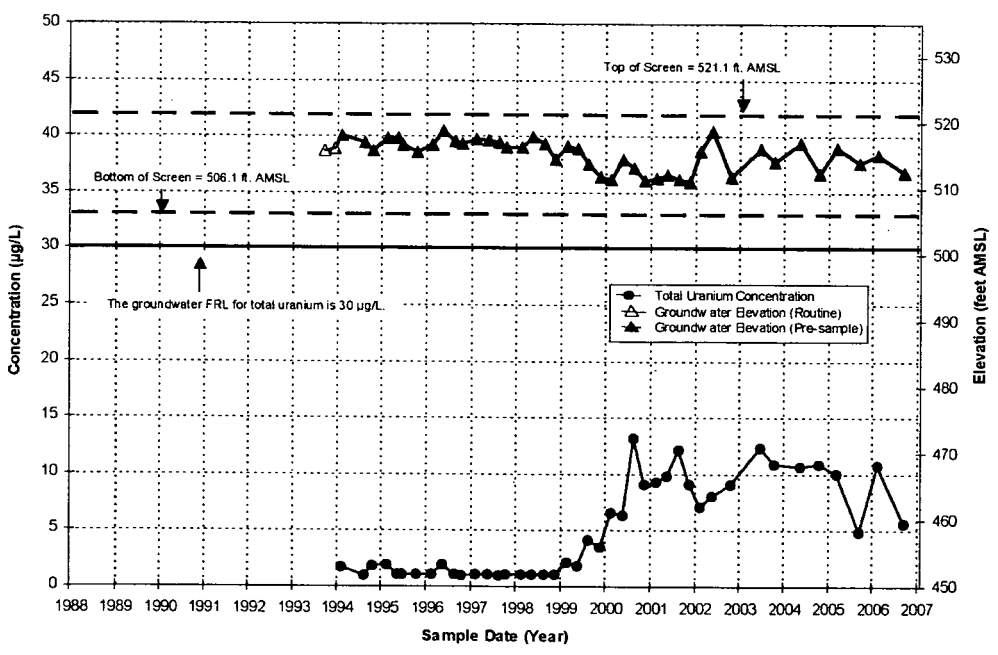

FIGURE A.2-38. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2553

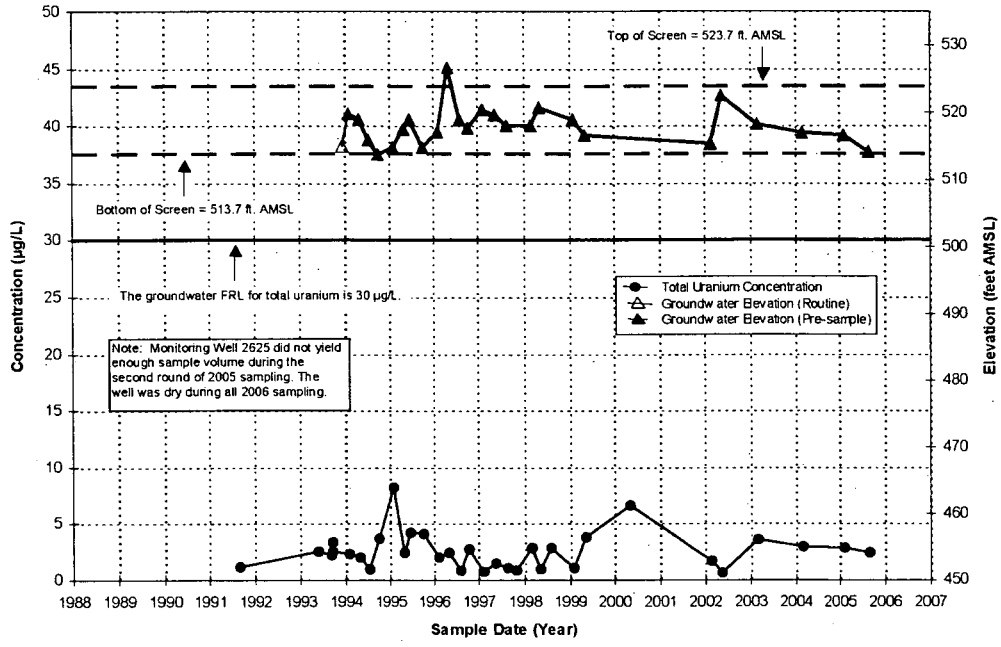

FIGURE A.2-39. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2625

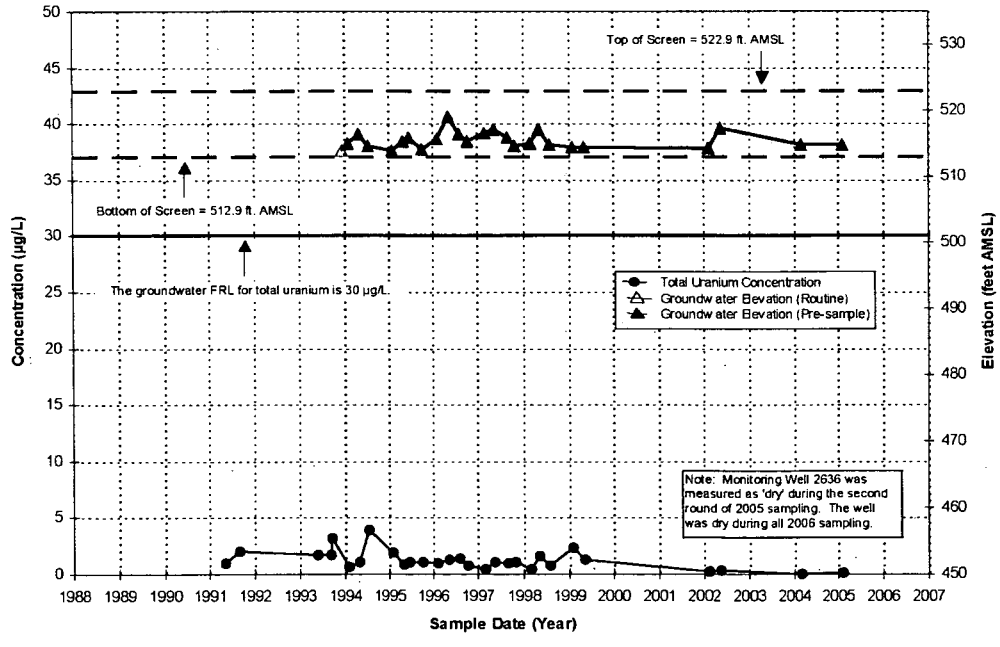

FIGURE A.2-40. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2636

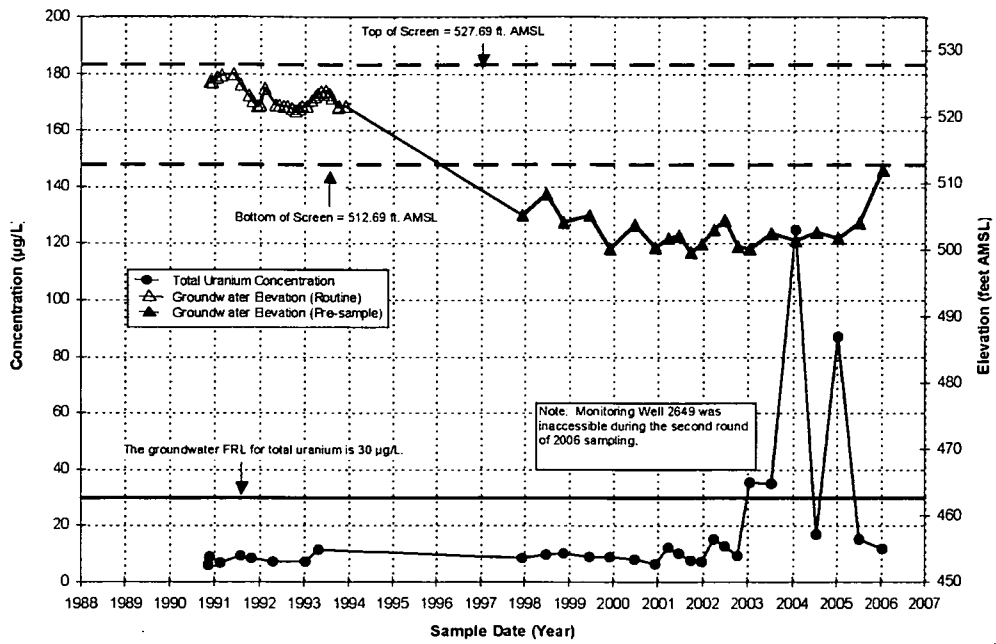

FIGURE A.2-41. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2649

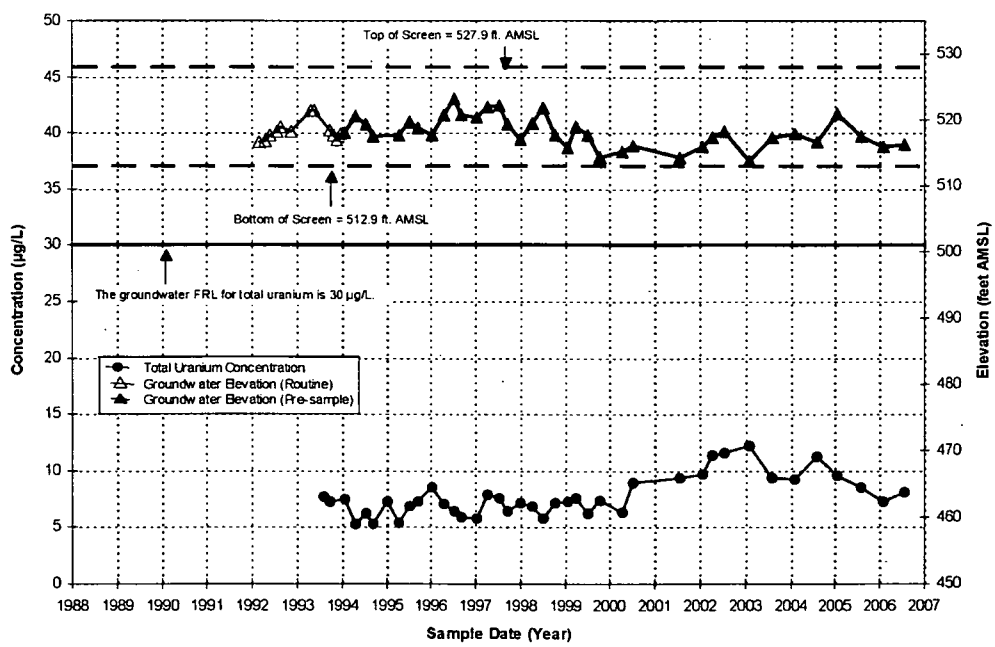

FIGURE A.2-42. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2733

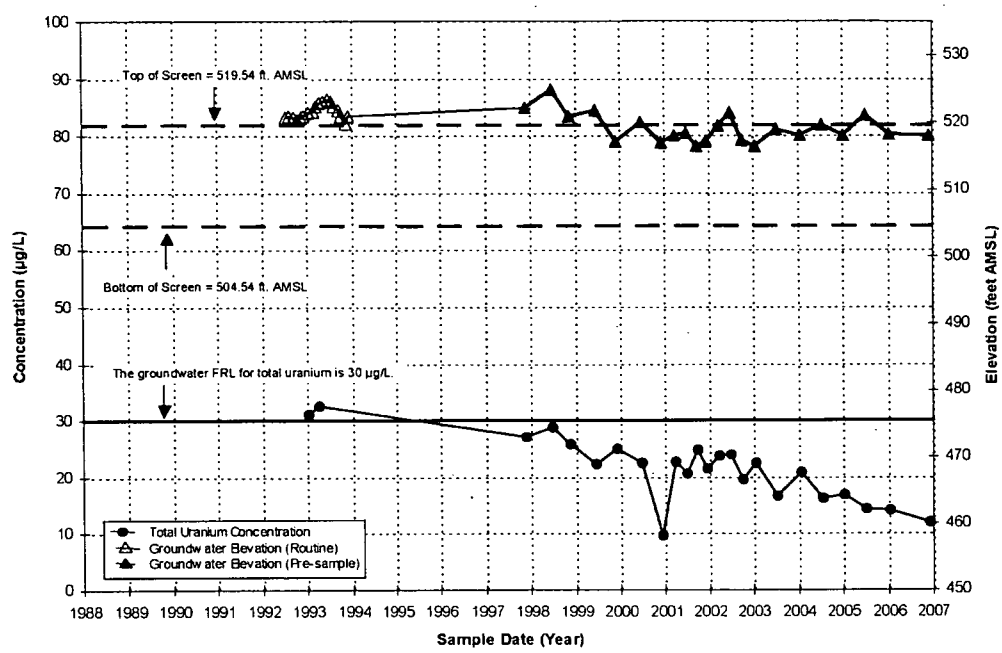

FIGURE A.2-43. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2821

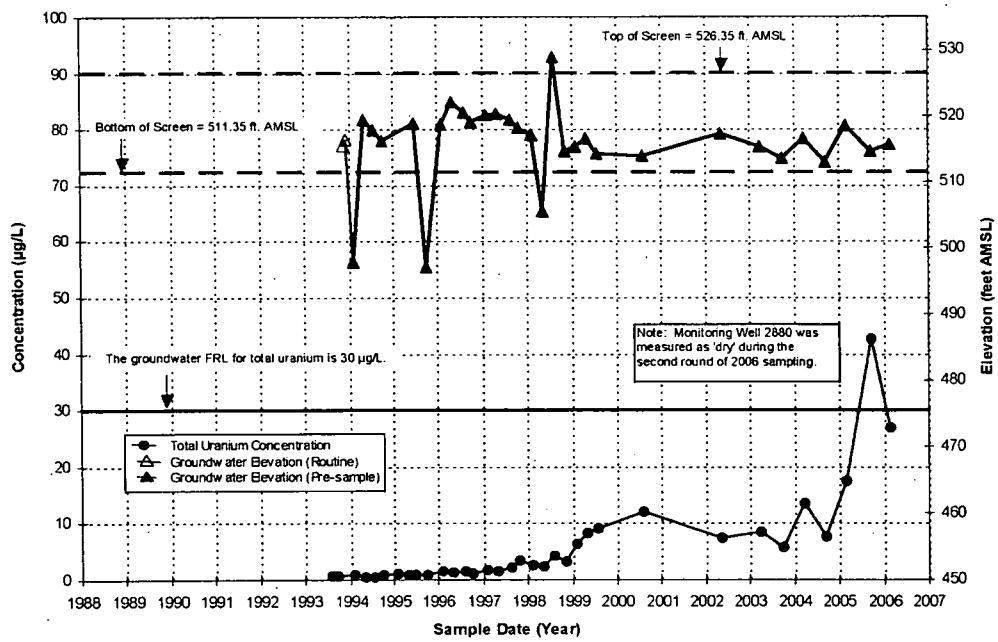

FIGURE A.2-44. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2880

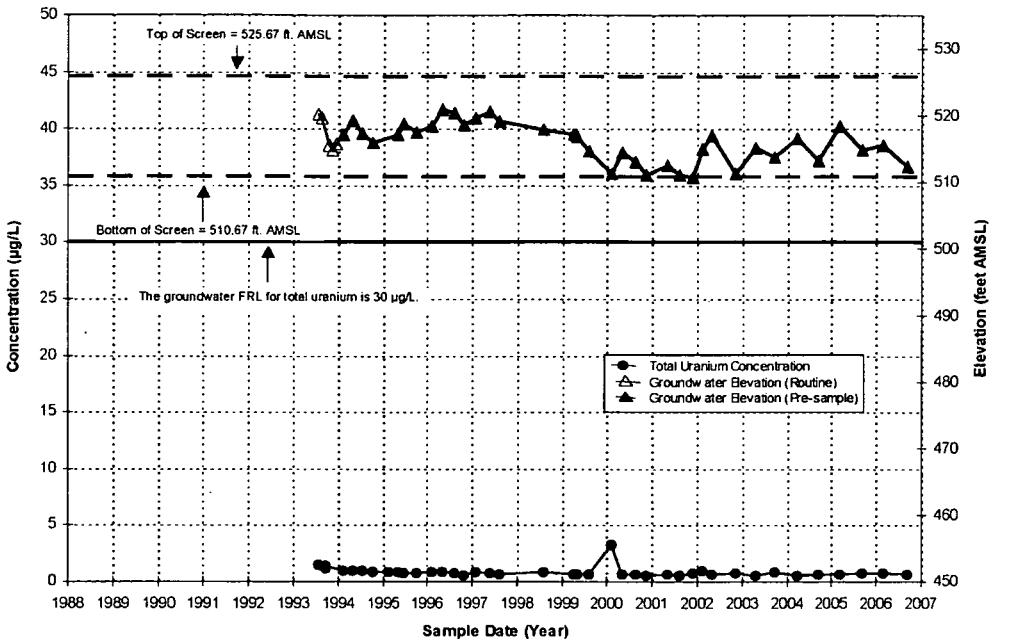

FIGURE A.2-45. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2897

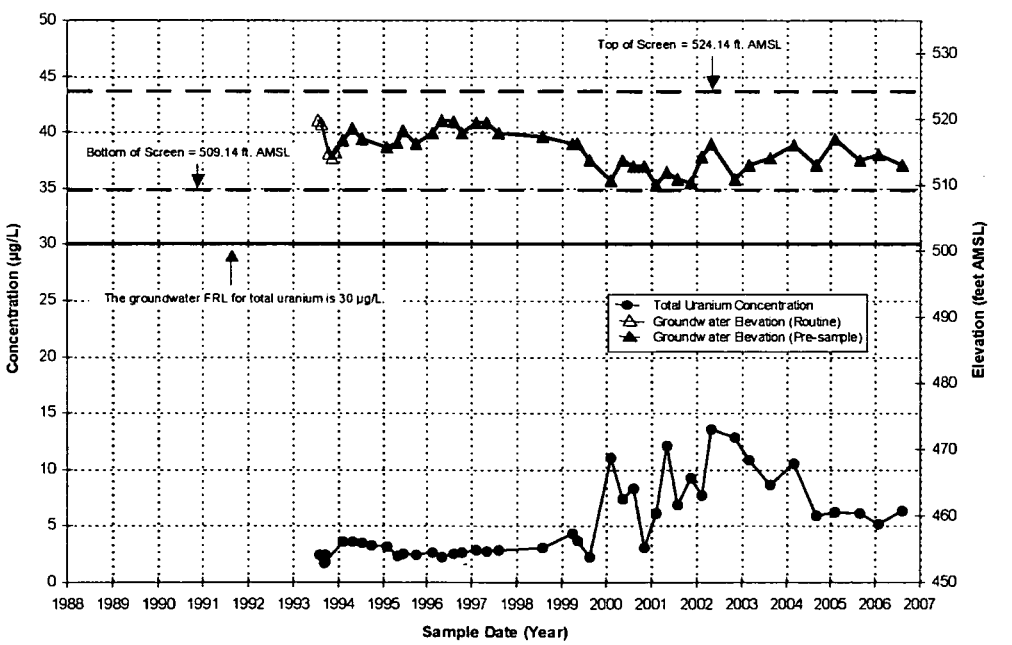

FIGURE A.2-46. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2898

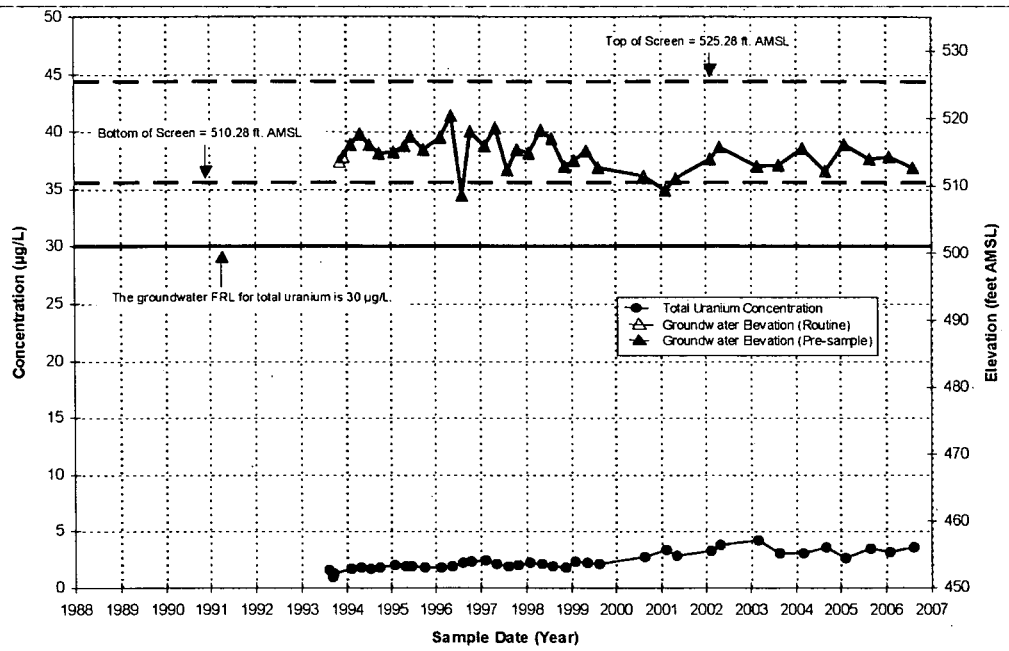

FIGURE A.2-47. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2899

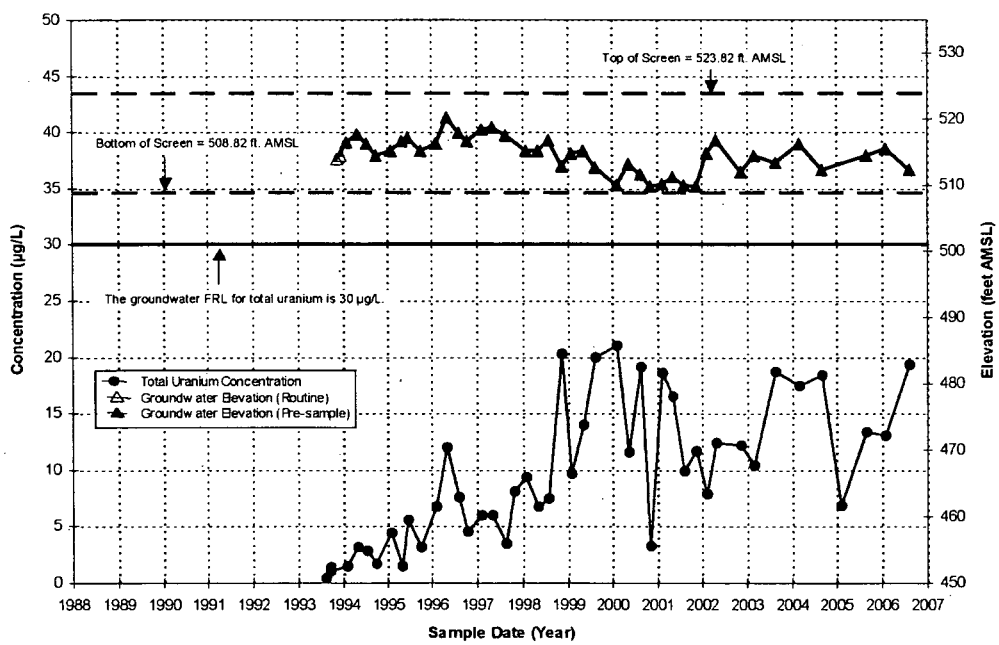

FIGURE A.2-48. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2900

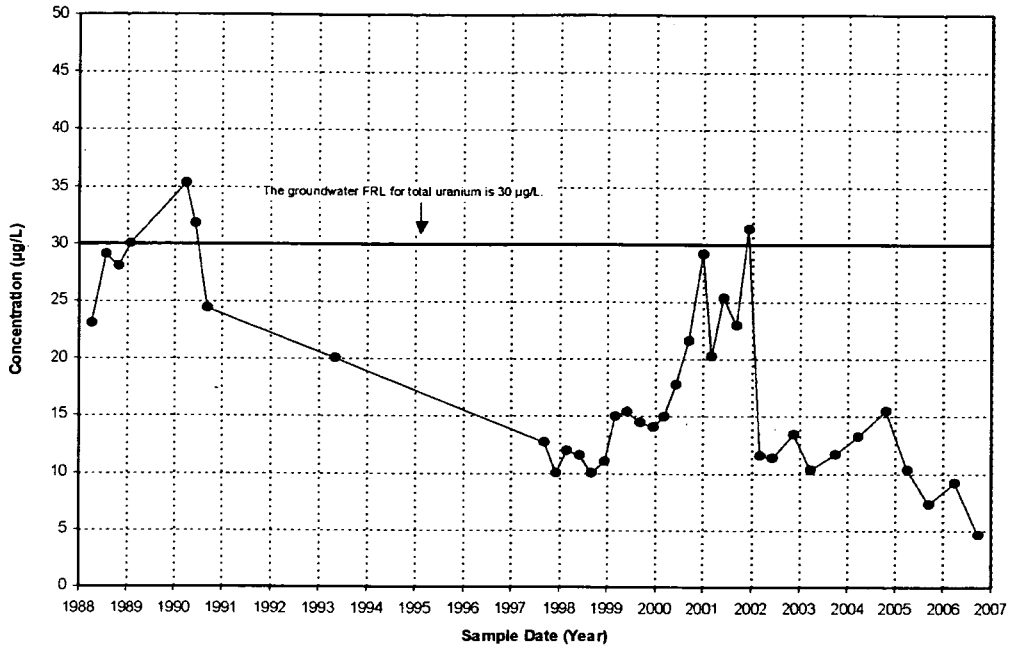

FIGURE A.2-49. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3014

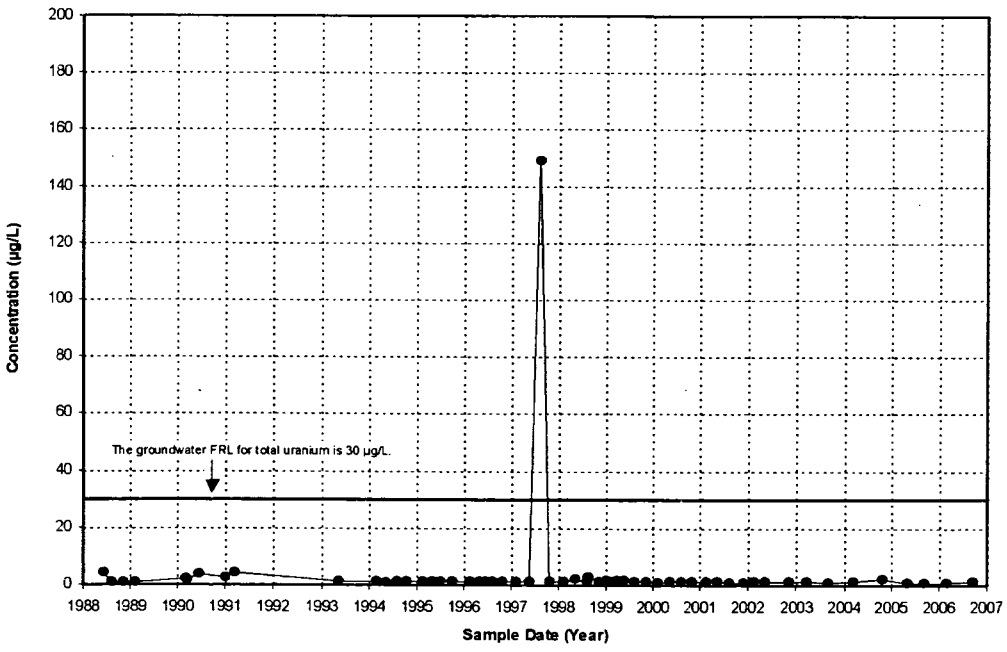

FIGURE A.2-50. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3015

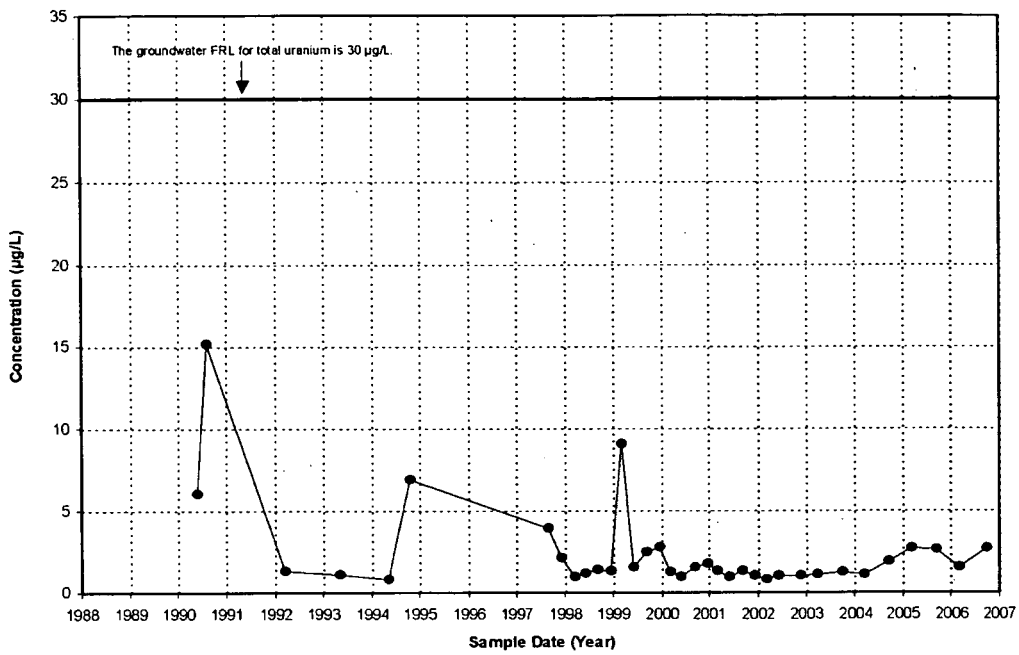

FIGURE A.2-51. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3045

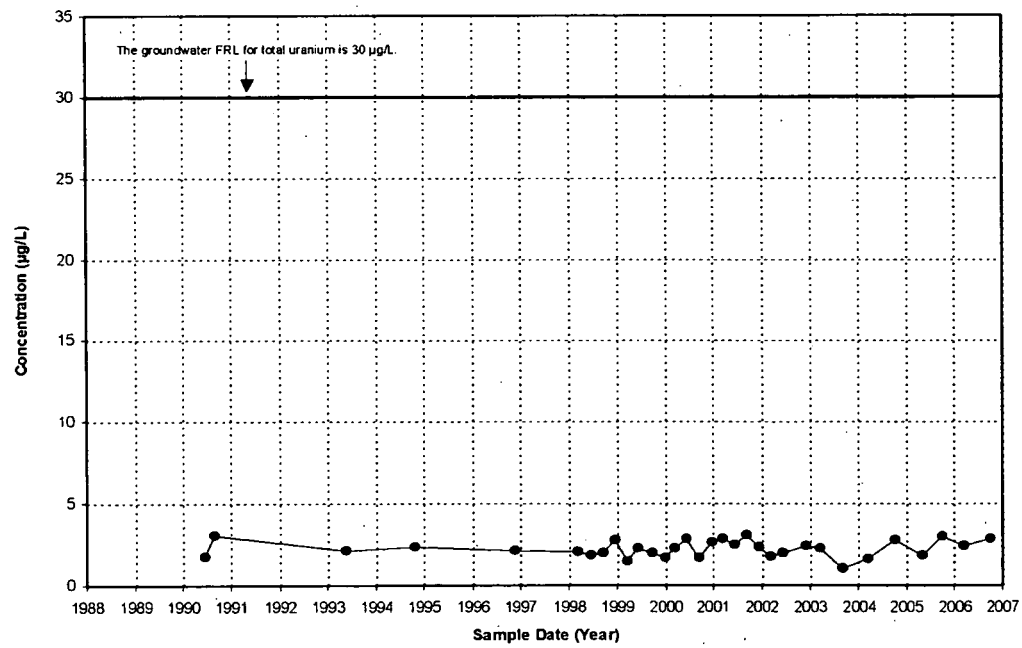

FIGURE A.2-52. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3046

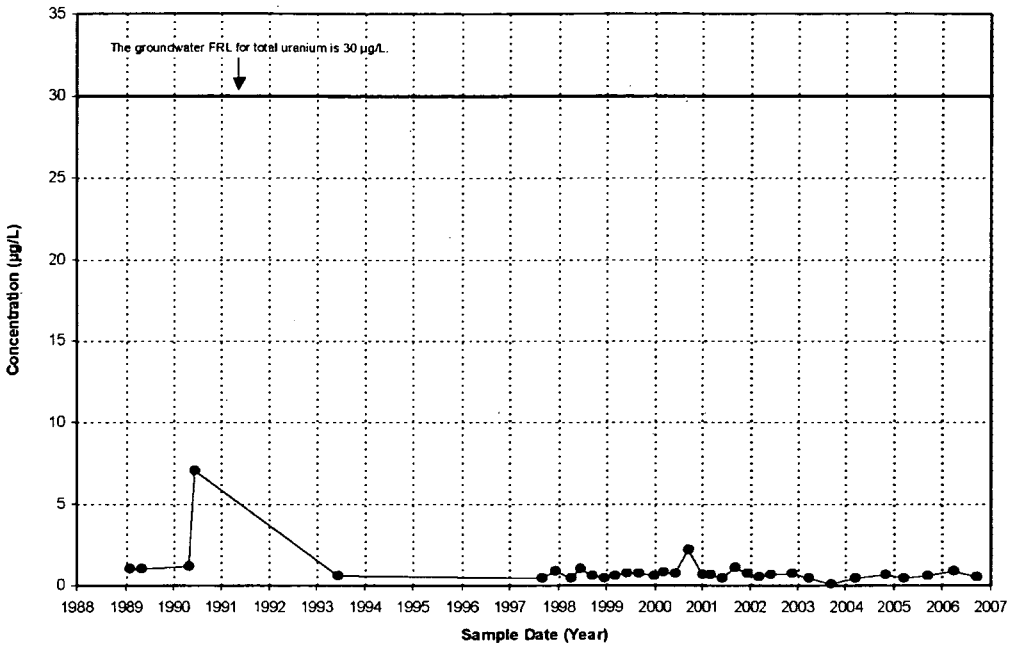

FIGURE A.2-53. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3049

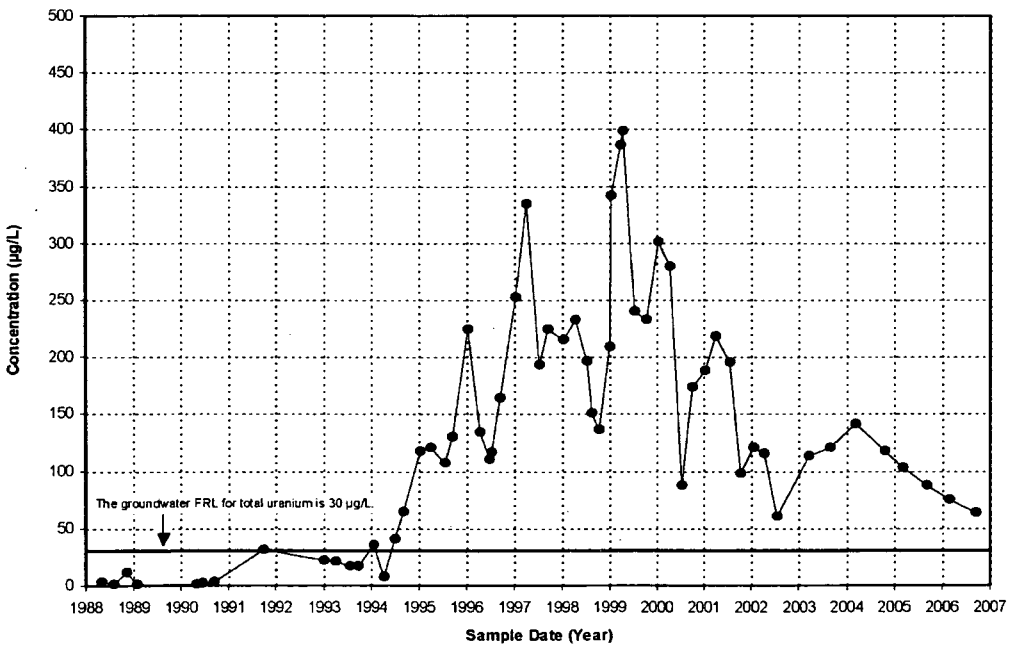

FIGURE A.2-54. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3069

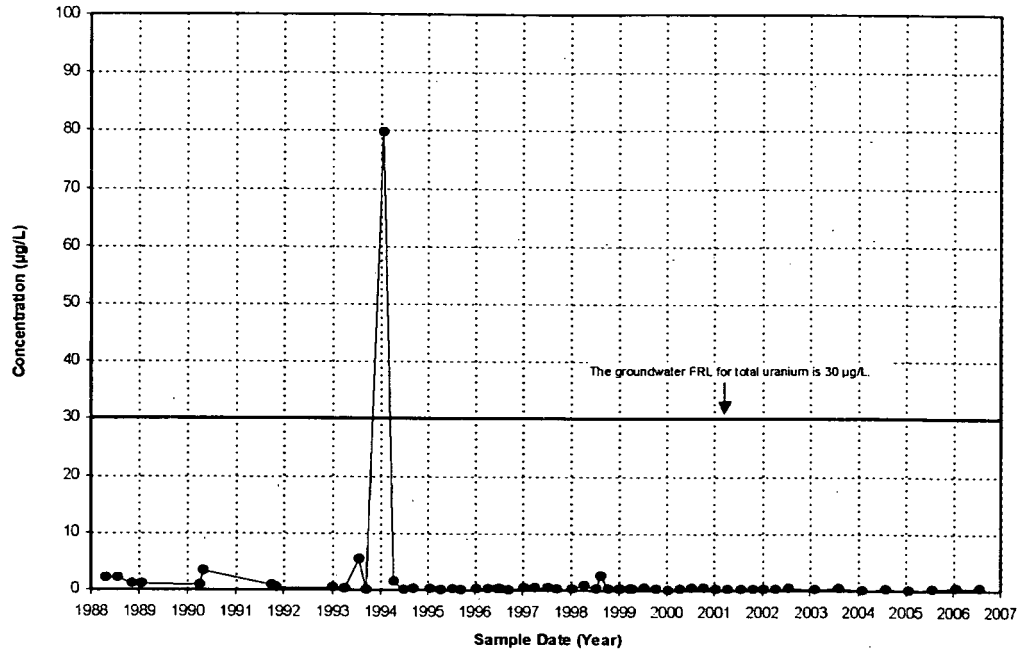

FIGURE A.2-55. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3070

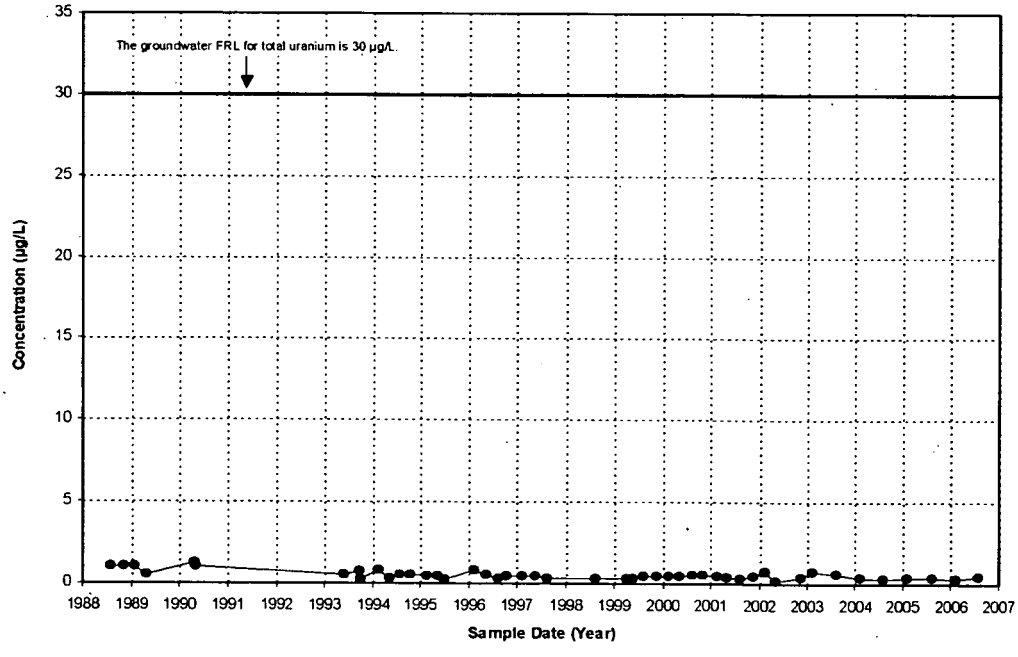

FIGURE A.2-56. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3093

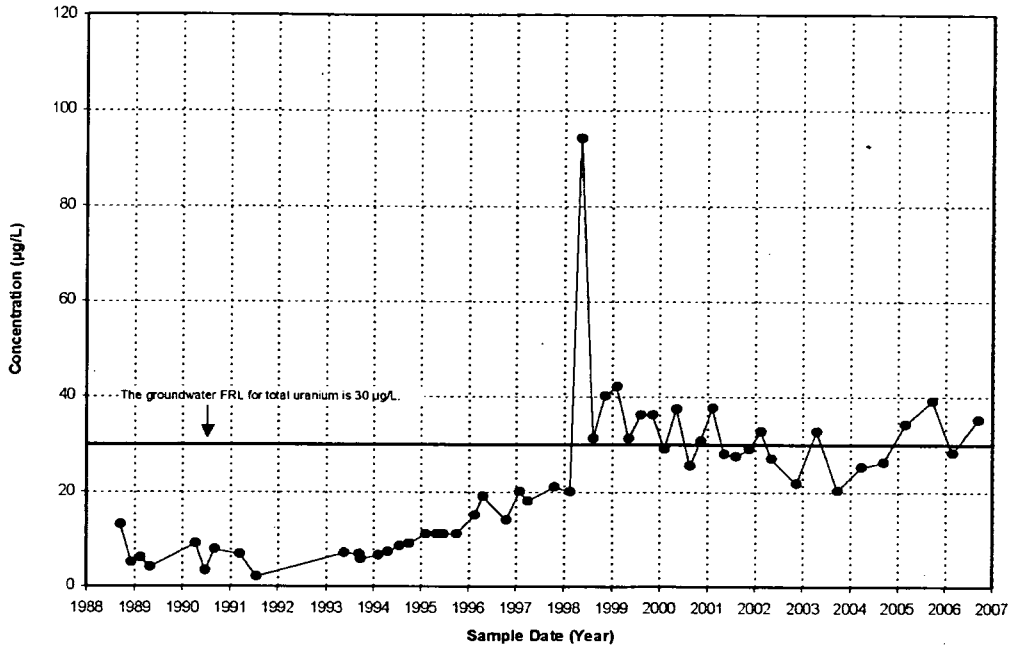

FIGURE A.2-57. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3095

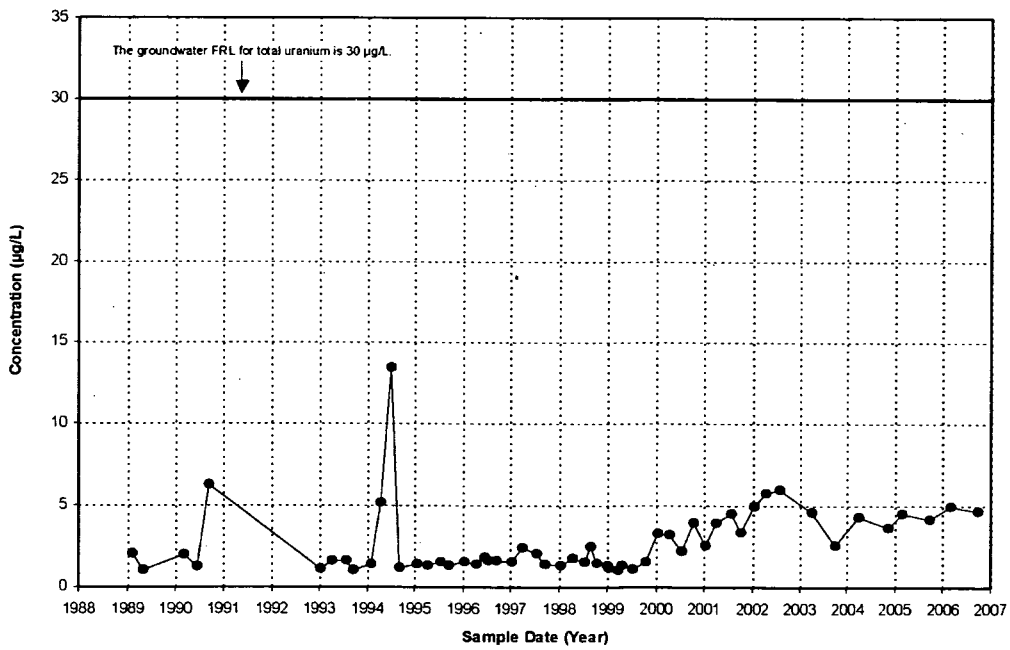

FIGURE A.2-58. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3106

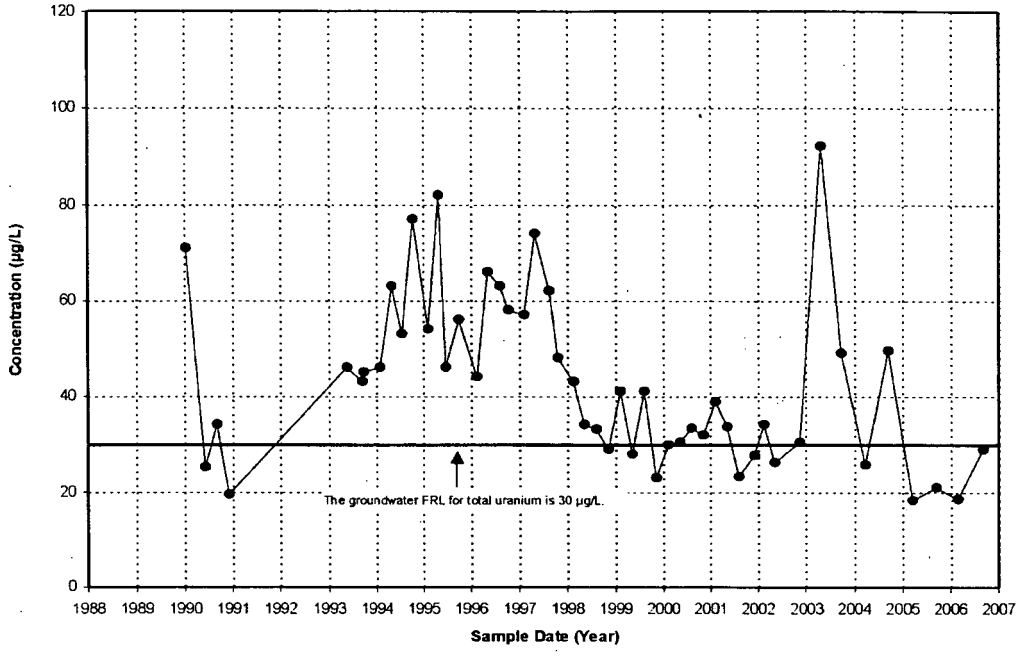

FIGURE A.2-59. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3125

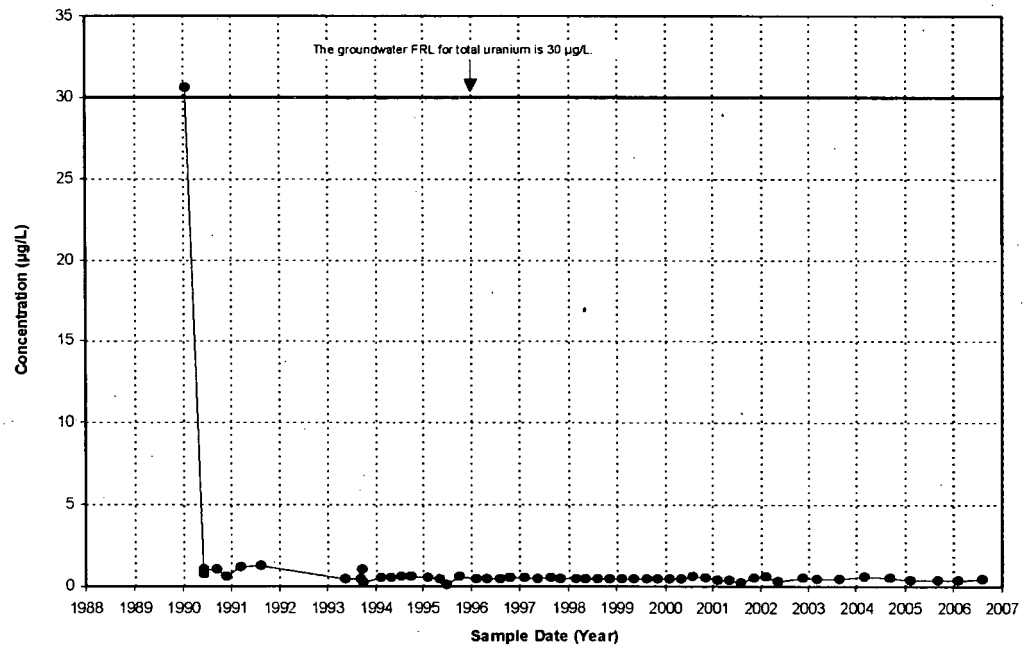

FIGURE A.2-60. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3128

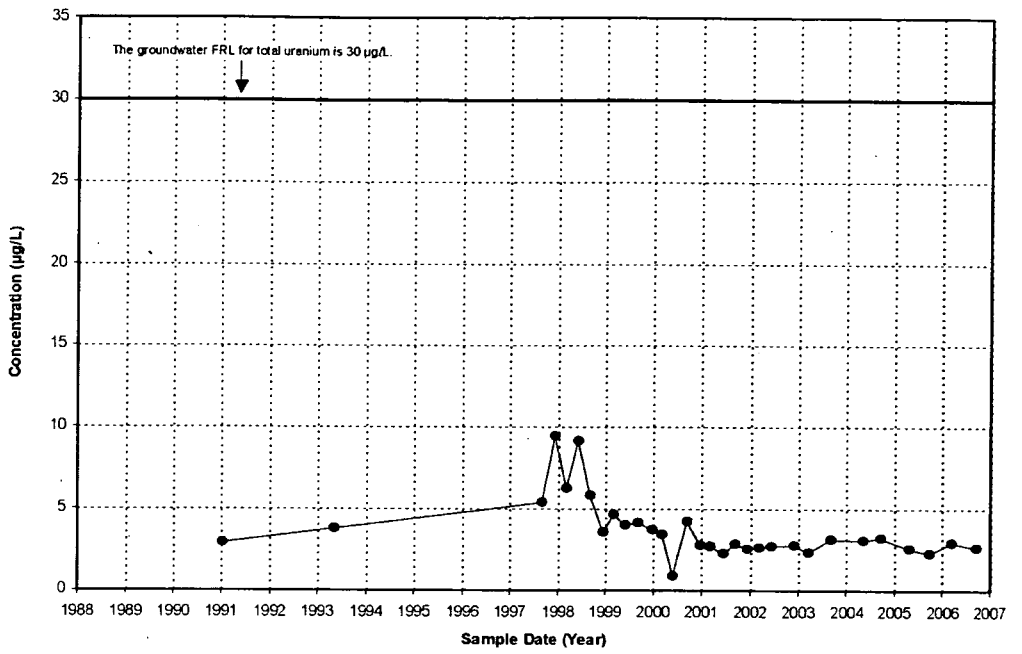

FIGURE A.2-61. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3385

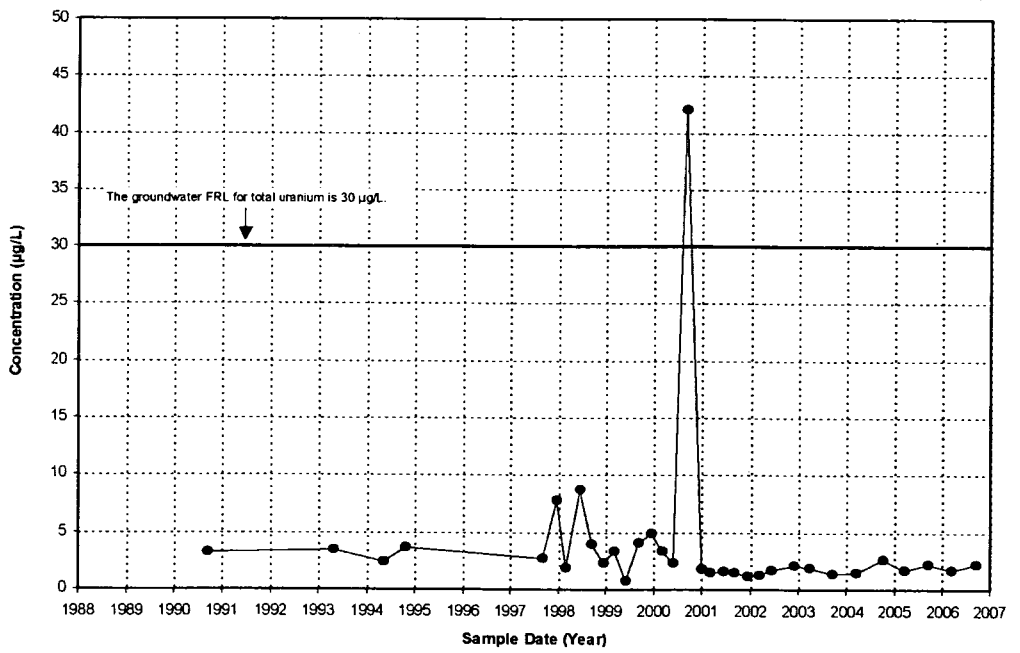

FIGURE A.2-62. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3387

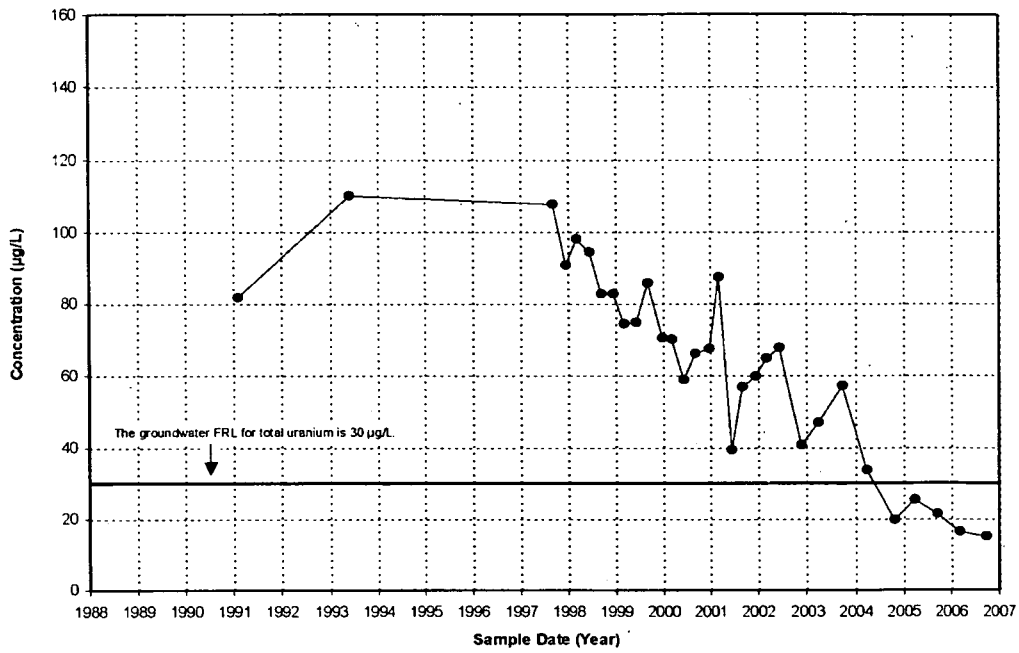

FIGURE A.2-63. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3390

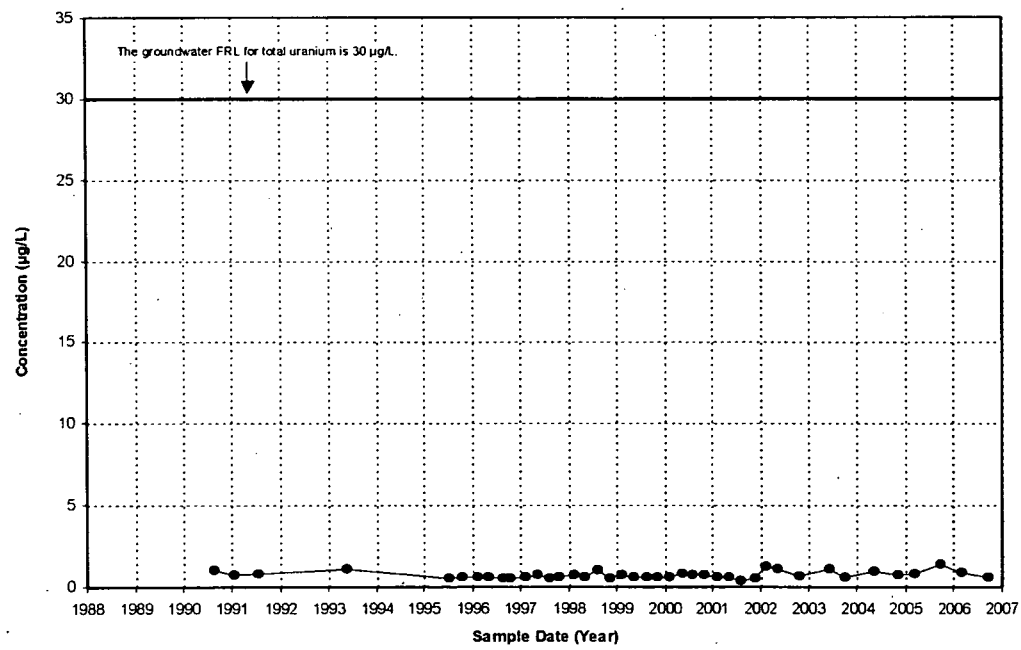

FIGURE A.2-64. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3396

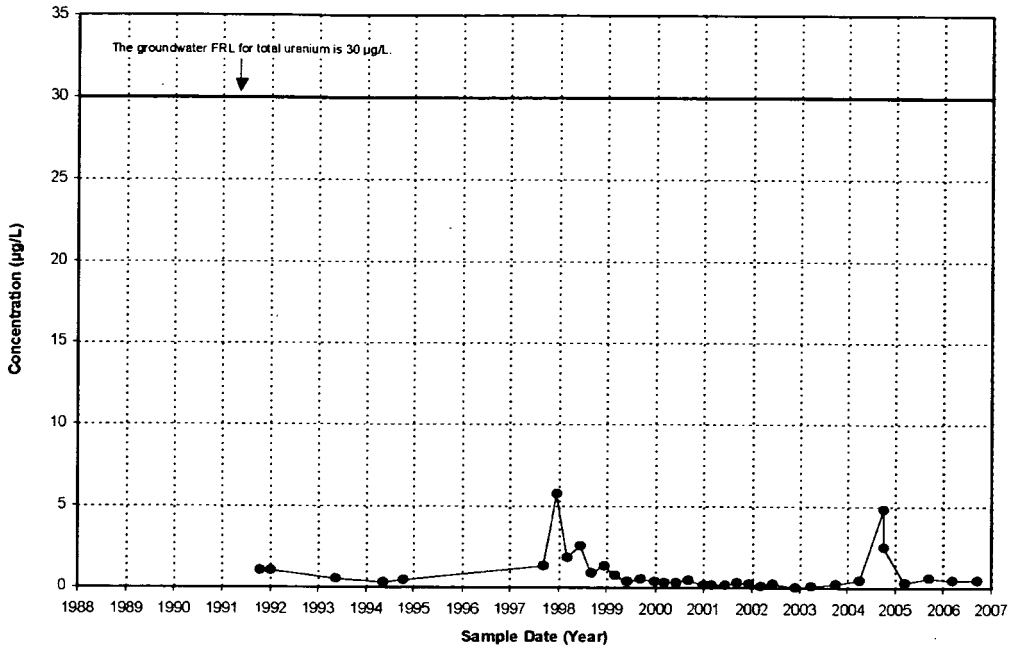

FIGURE A.2-65. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3397

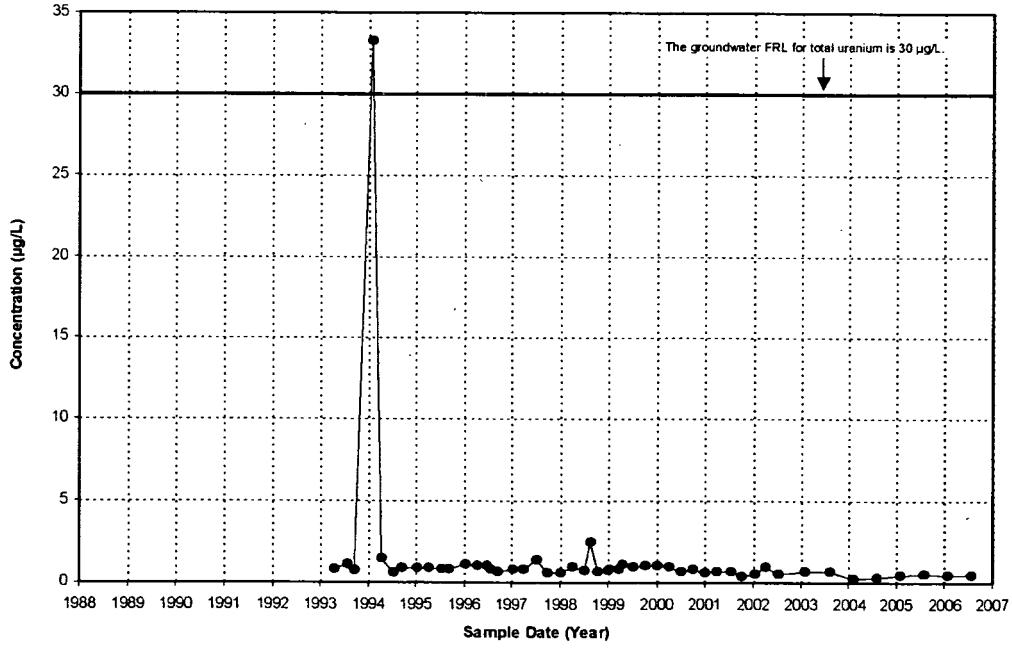

FIGURE A.2-66. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3398

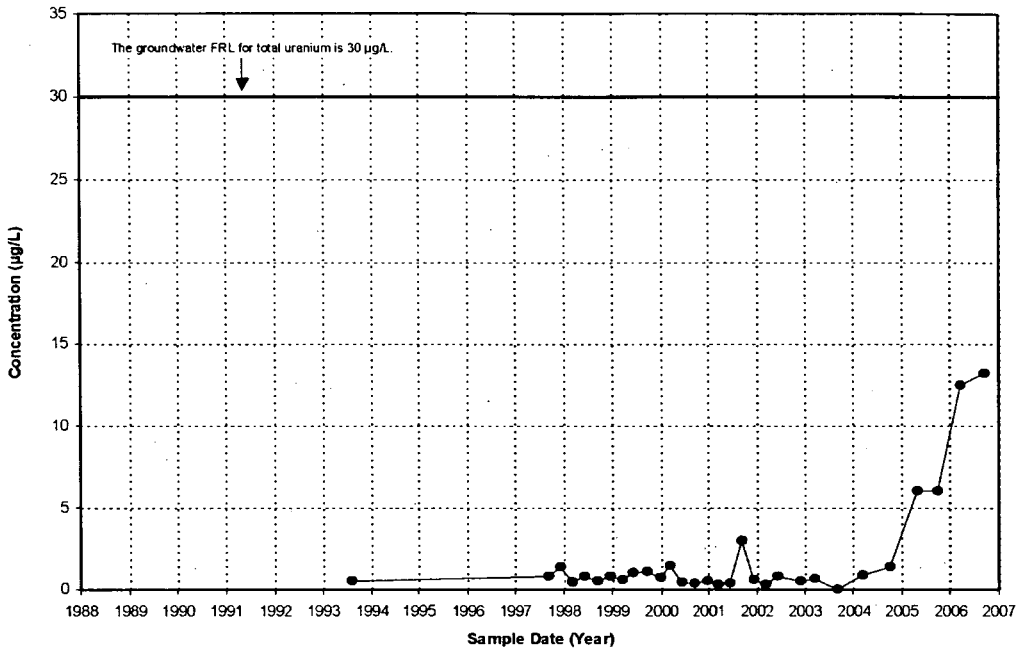

FIGURE A.2-67. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3402

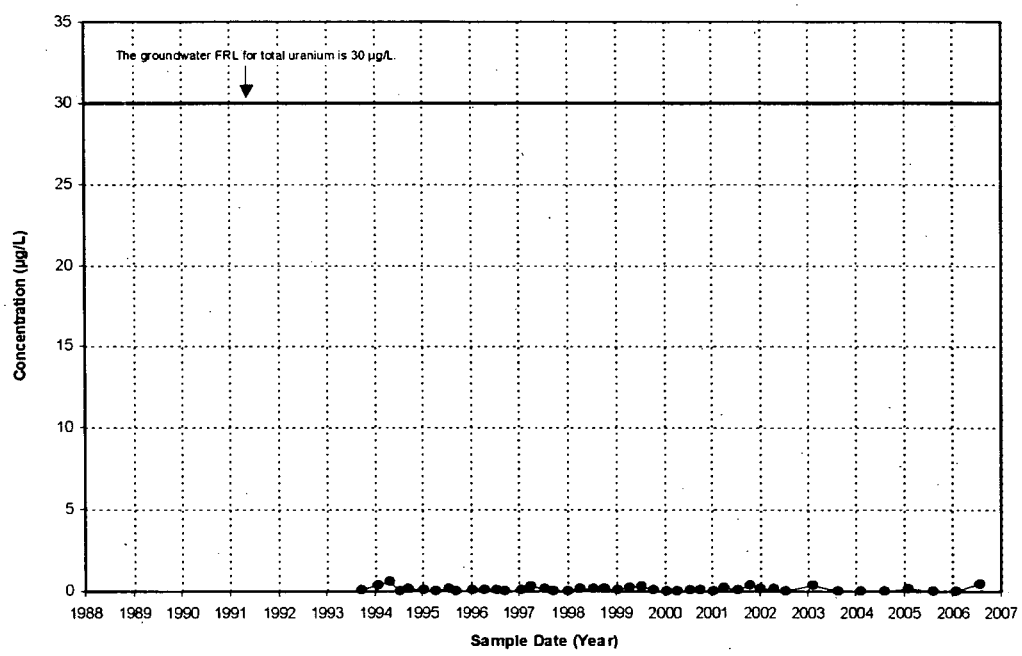

FIGURE A.2-68. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3424

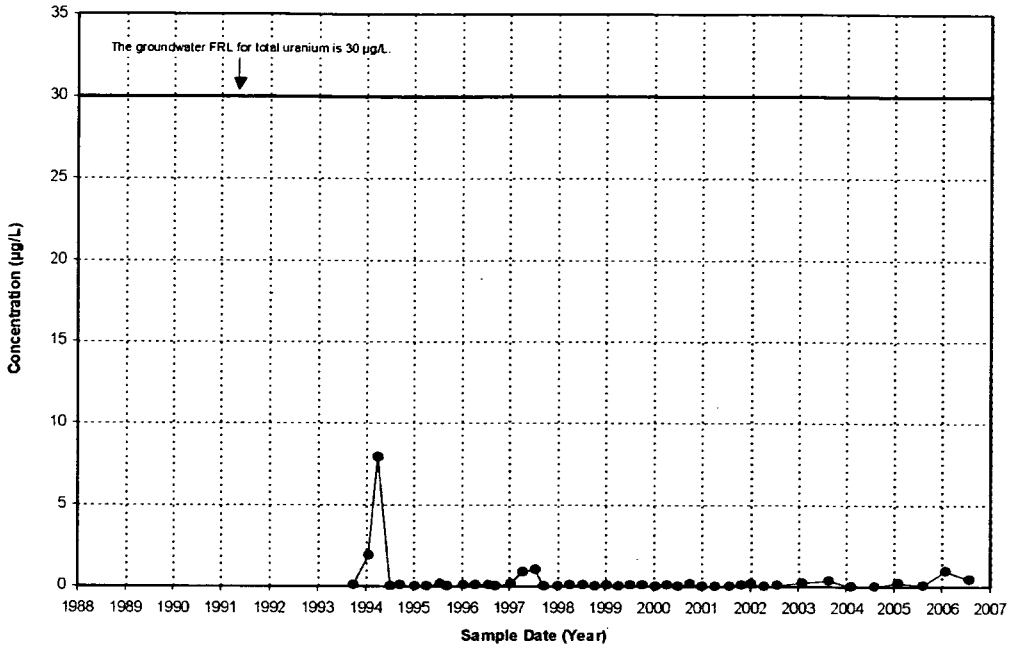

FIGURE A.2-69. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3426

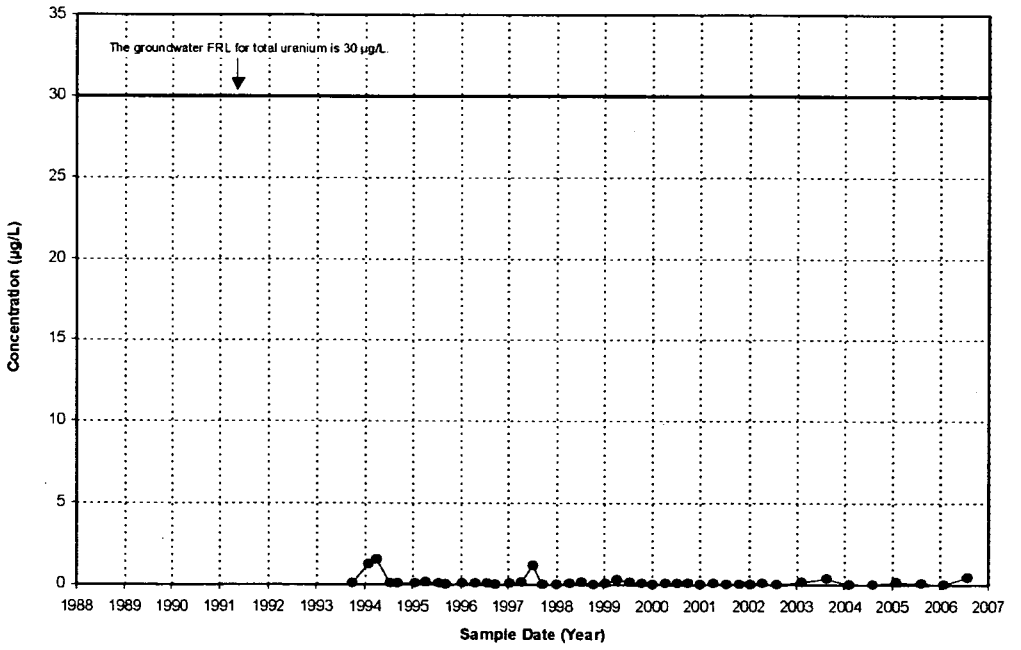

FIGURE A.2-70. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3429

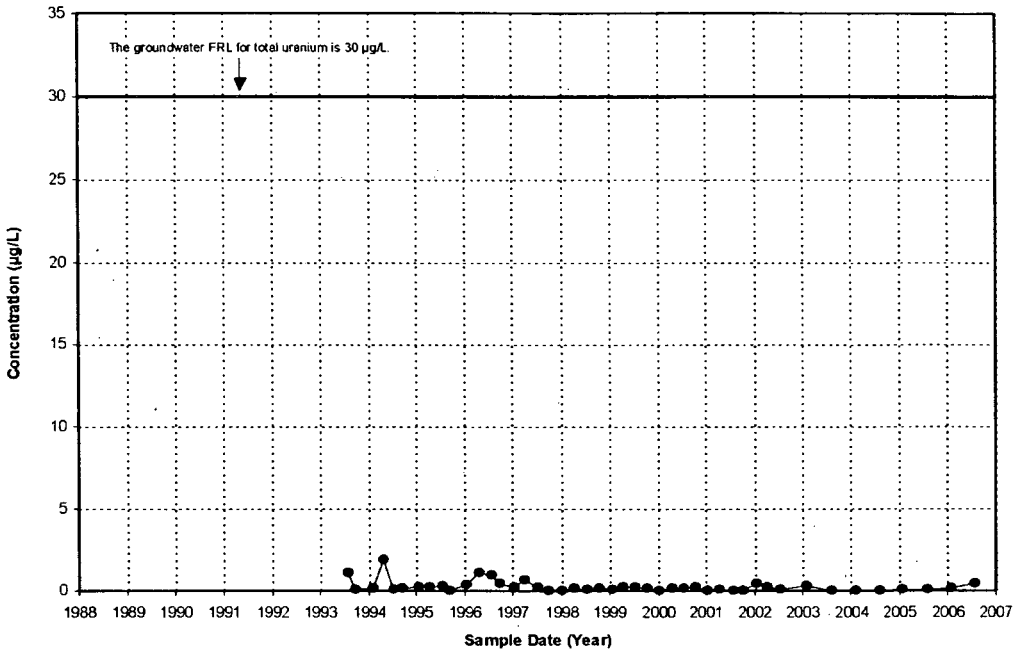

FIGURE A.2-71. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3431

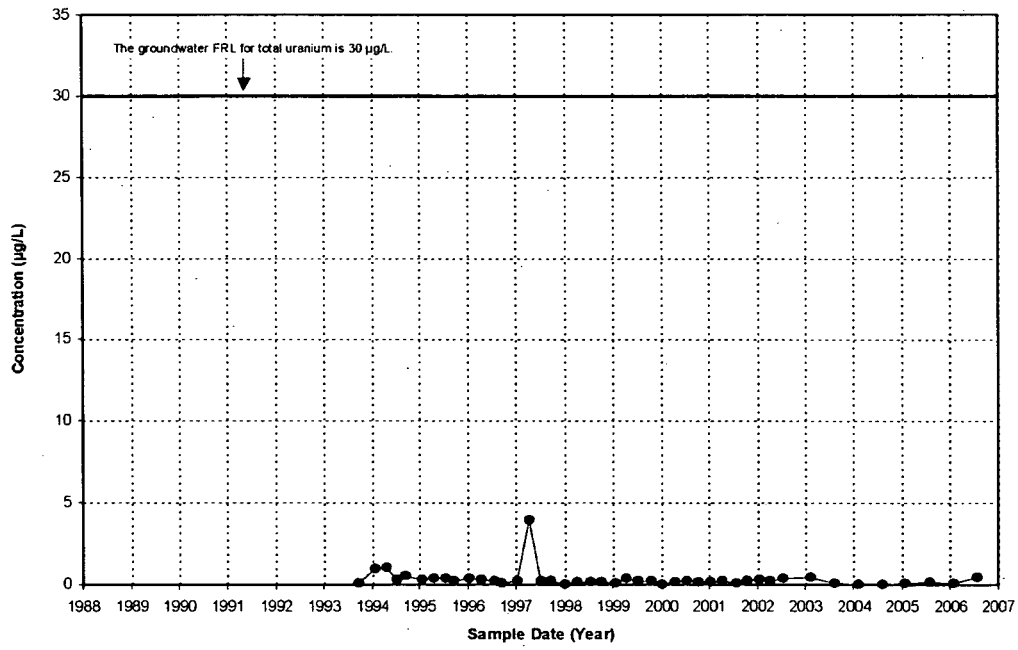

FIGURE A.2-72. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3432

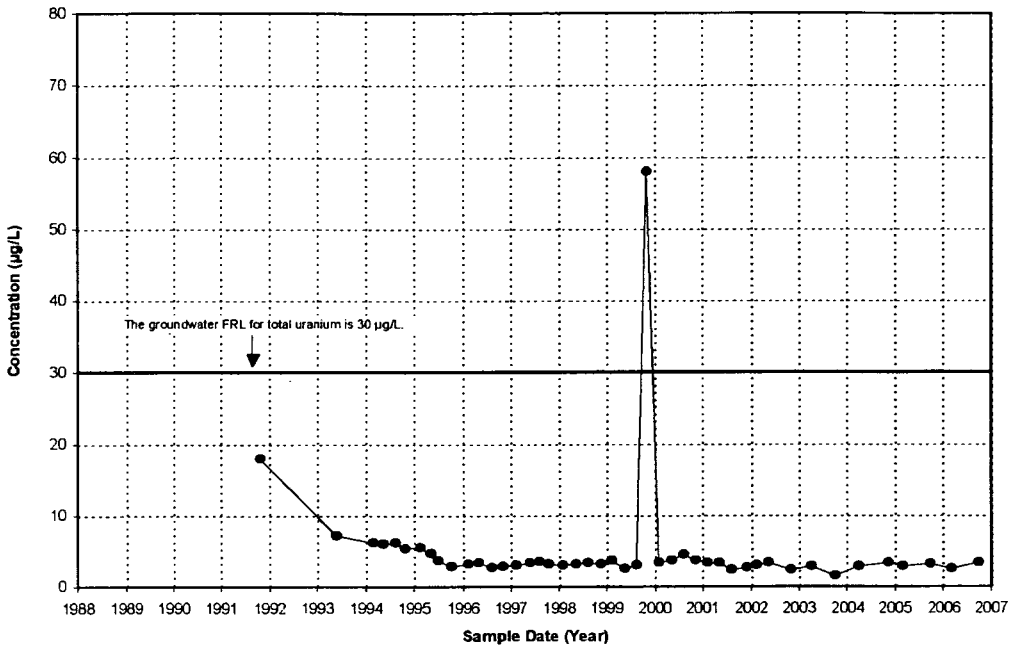

FIGURE A.2-73. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3550

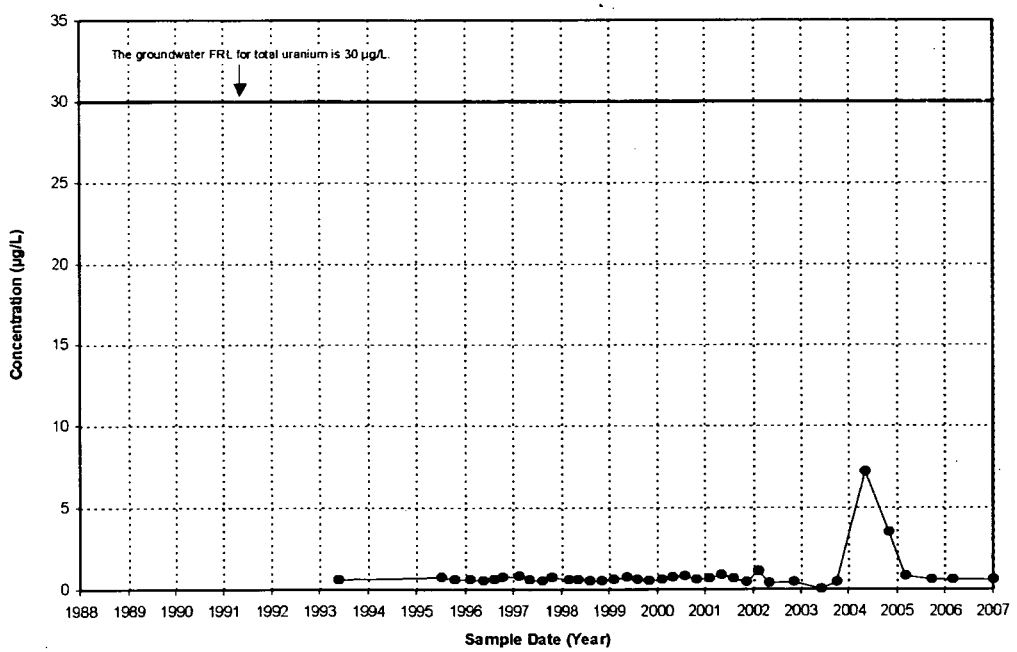

FIGURE A.2-74. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3552

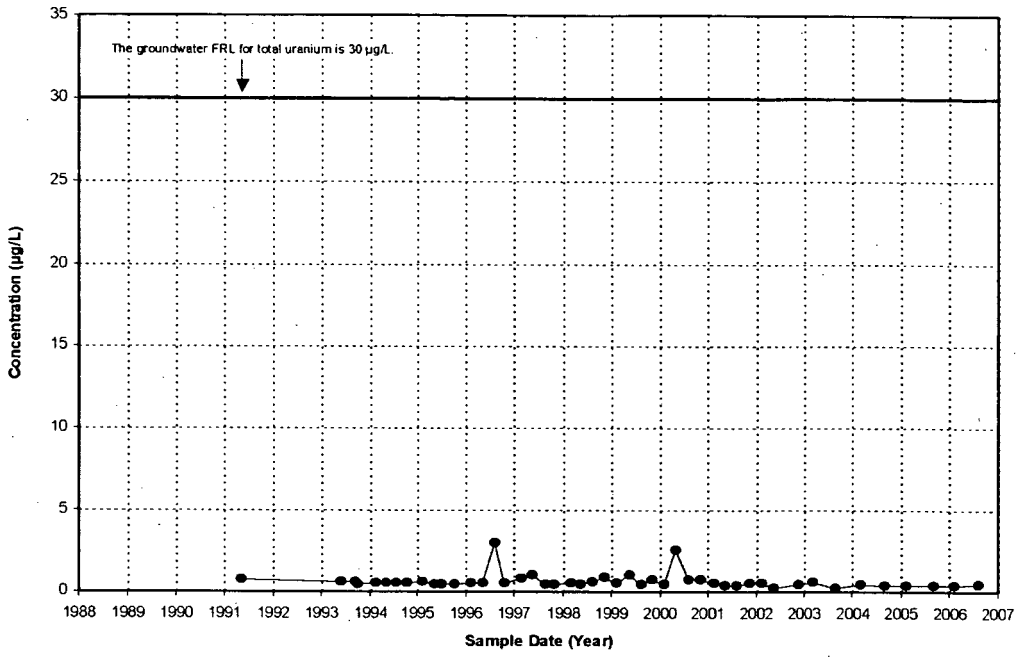

FIGURE A.2-75. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3636

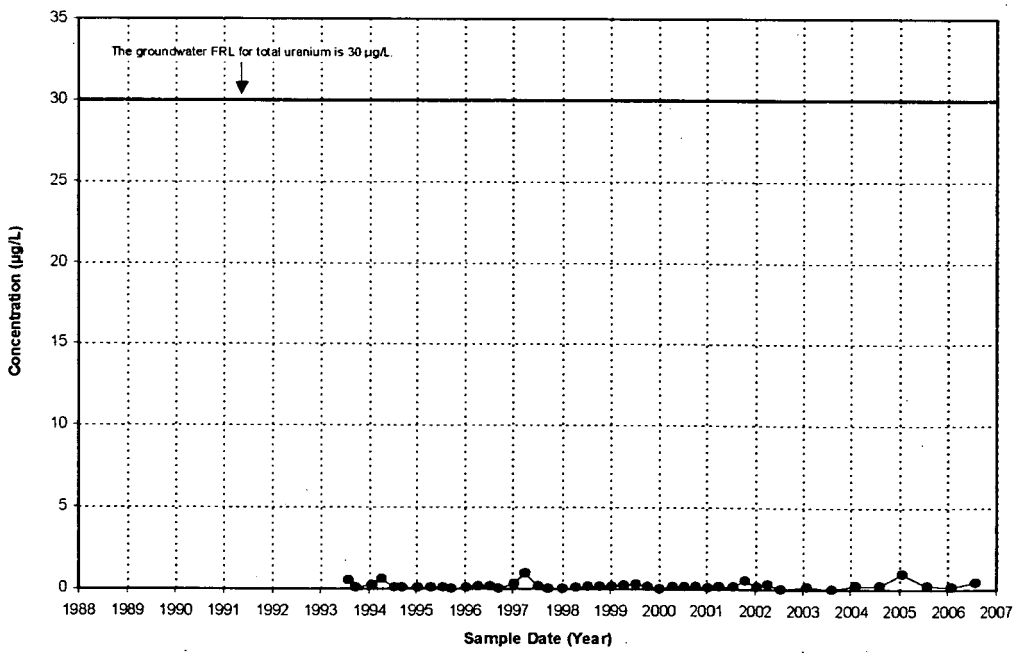

FIGURE A.2-76. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3733

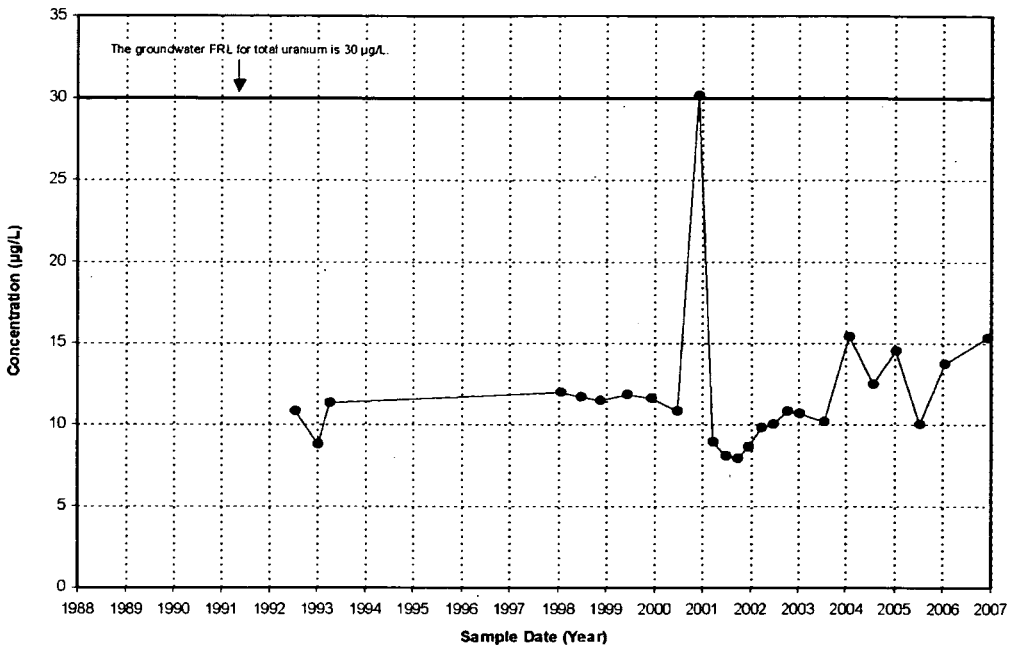

FIGURE A.2-77. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3821

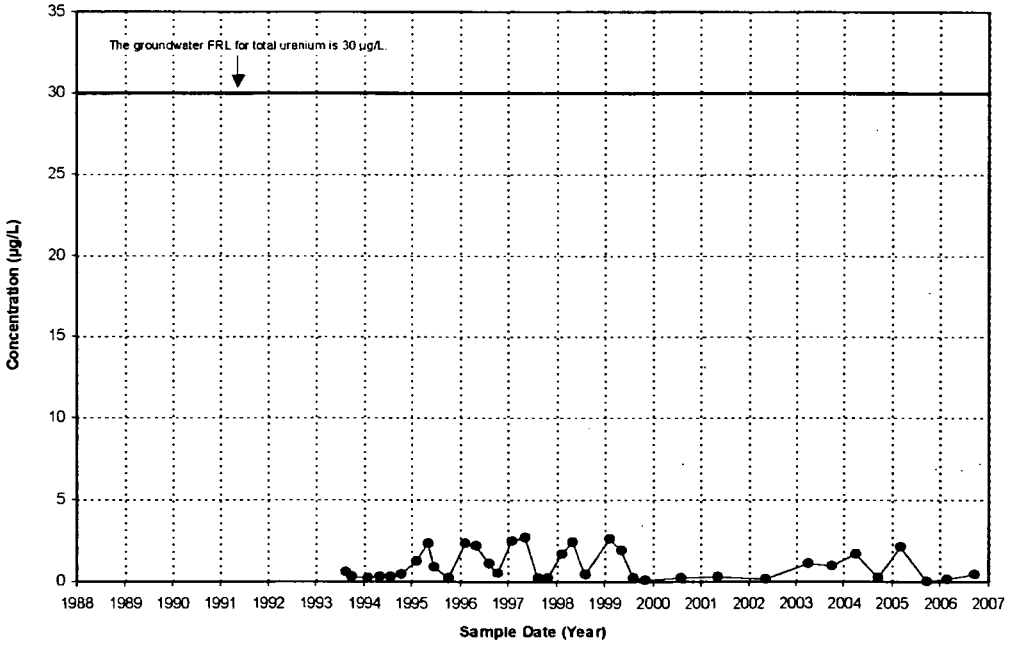

FIGURE A.2-78. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3880

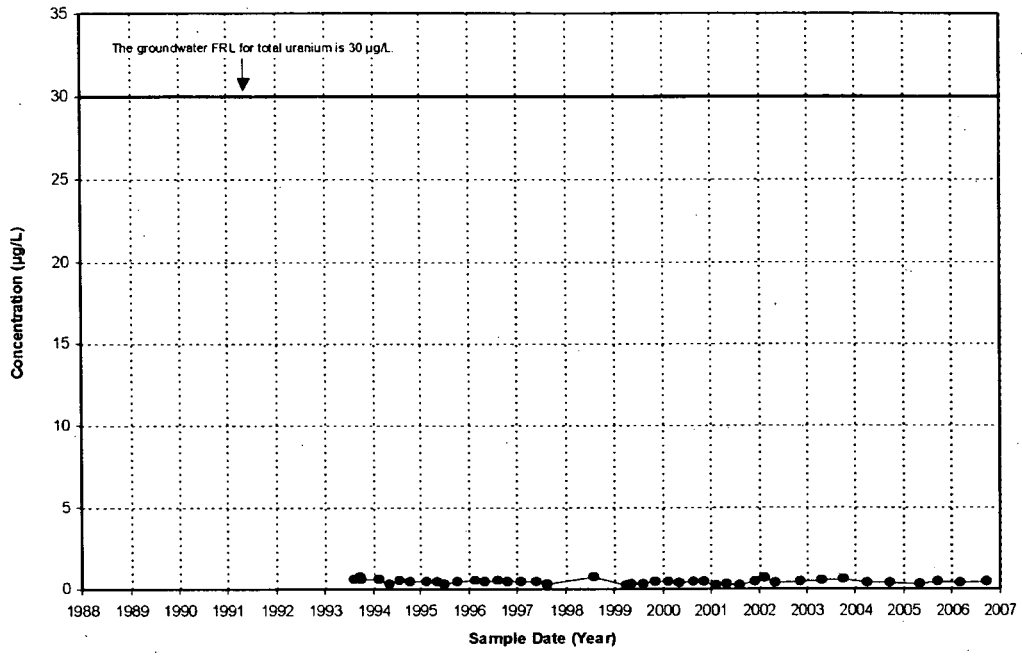

FIGURE A.2-79. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3897

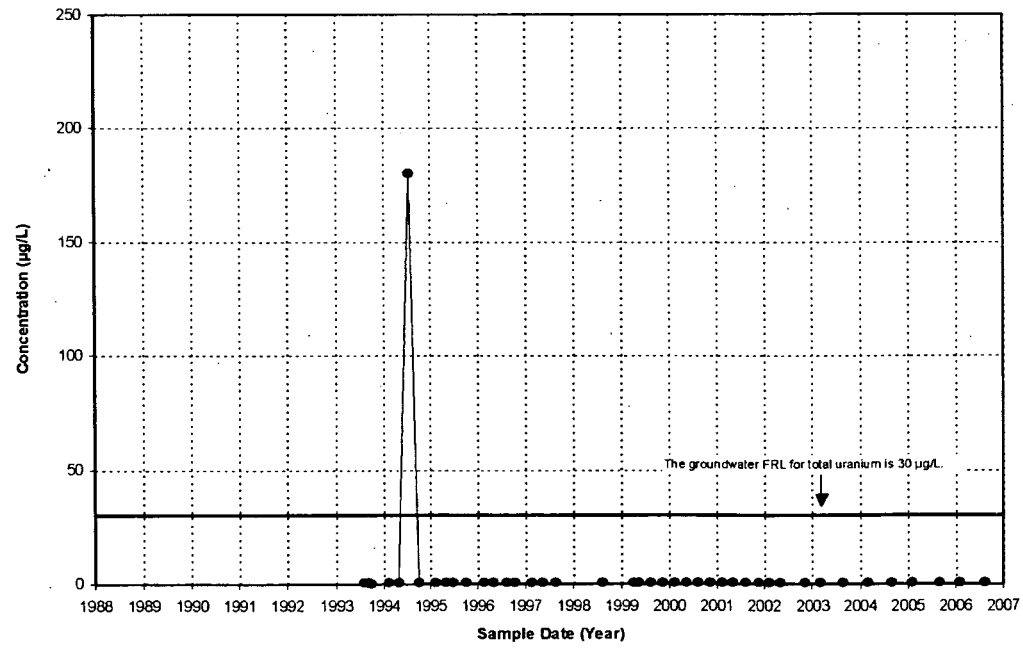

FIGURE A.2-80. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3898

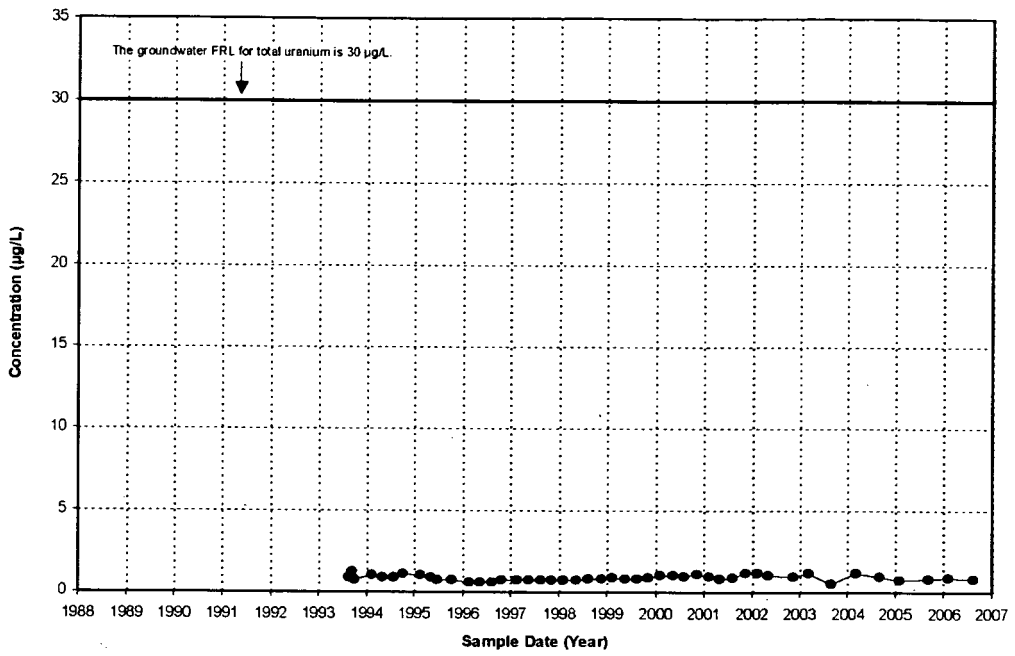

FIGURE A.2-81. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3899

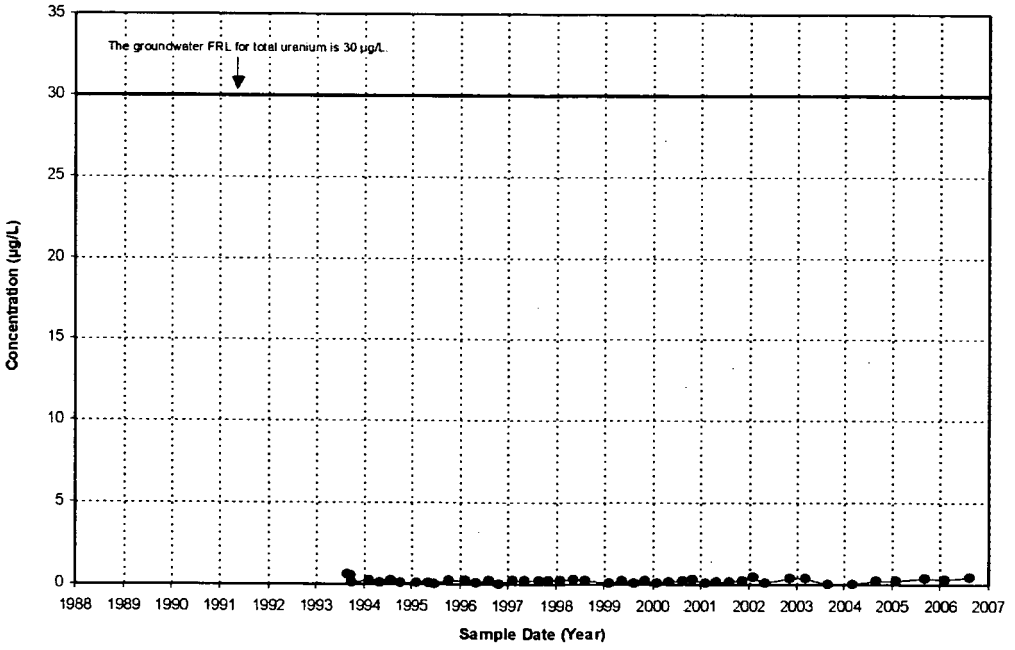

FIGURE A.2-82. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3900

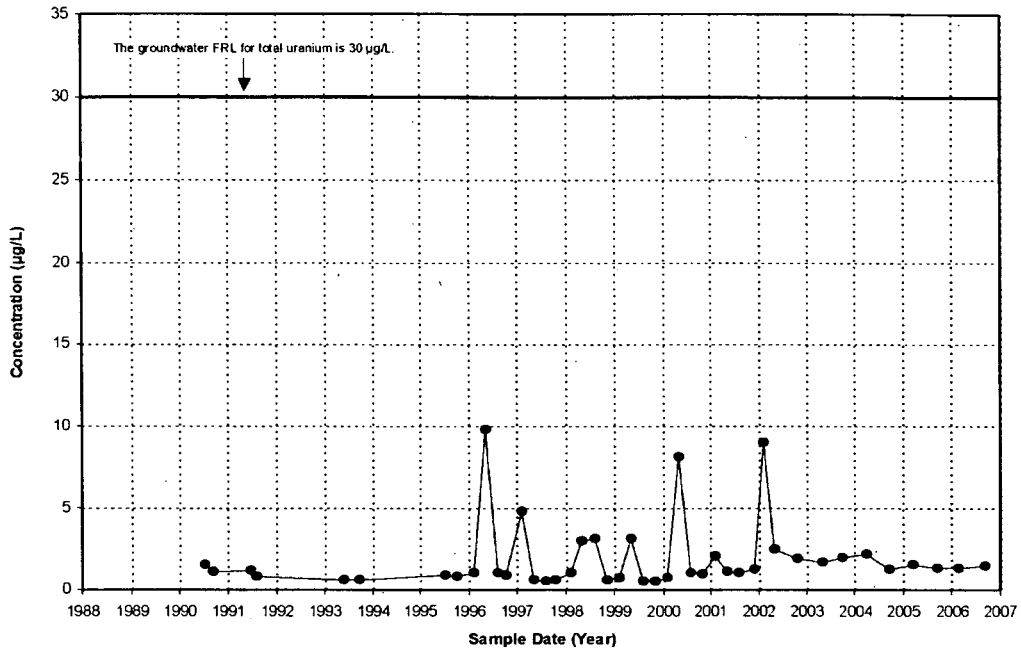

FIGURE A.2-83. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4125

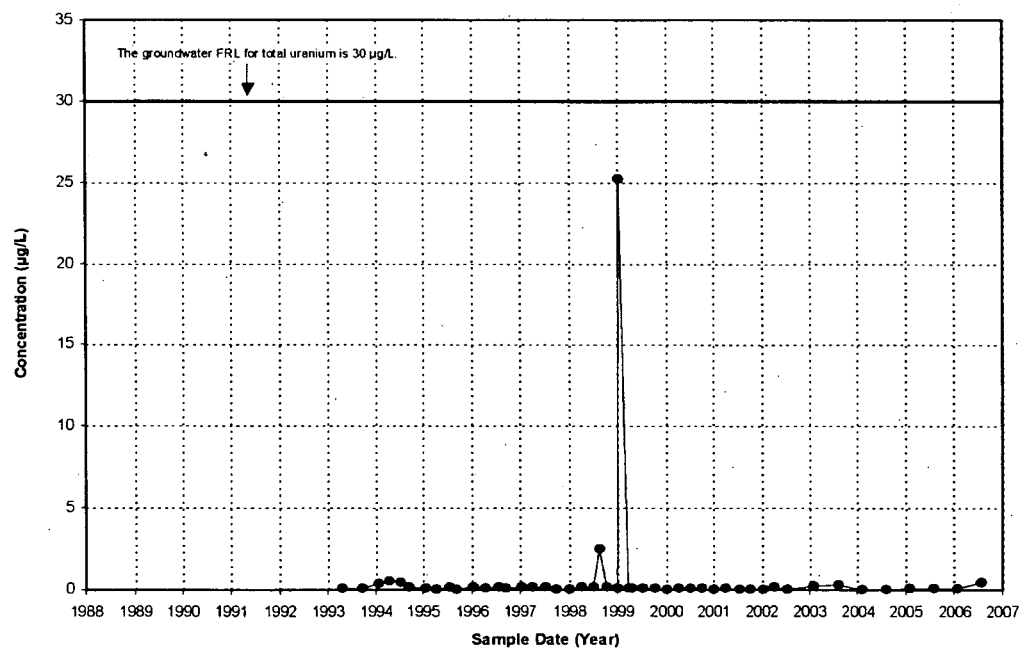

FIGURE A.2-84. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 4398

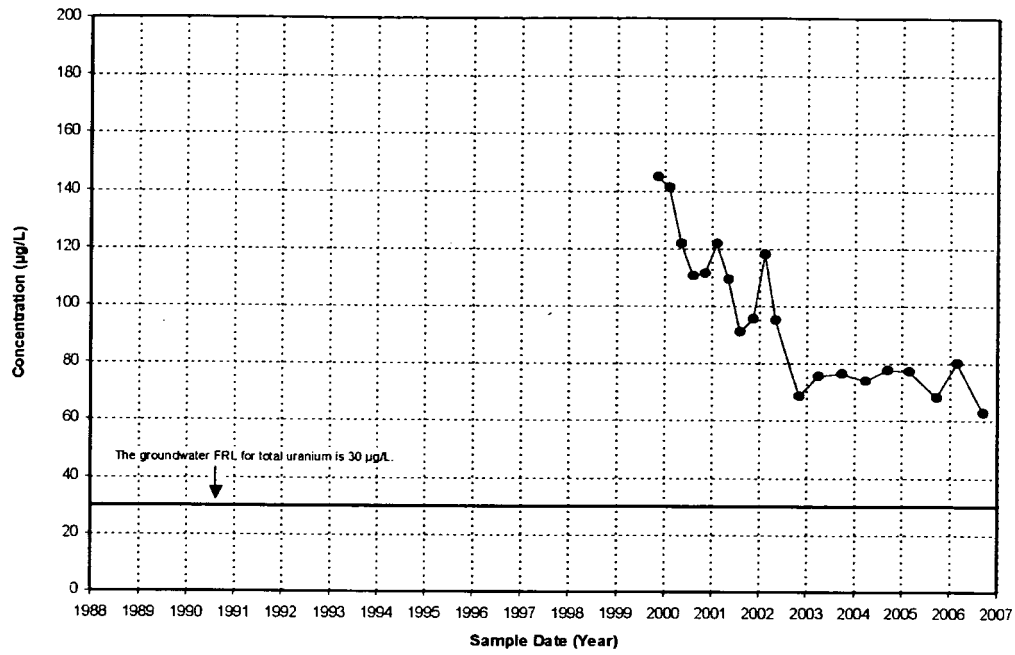

FIGURE A.2-85. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 6880

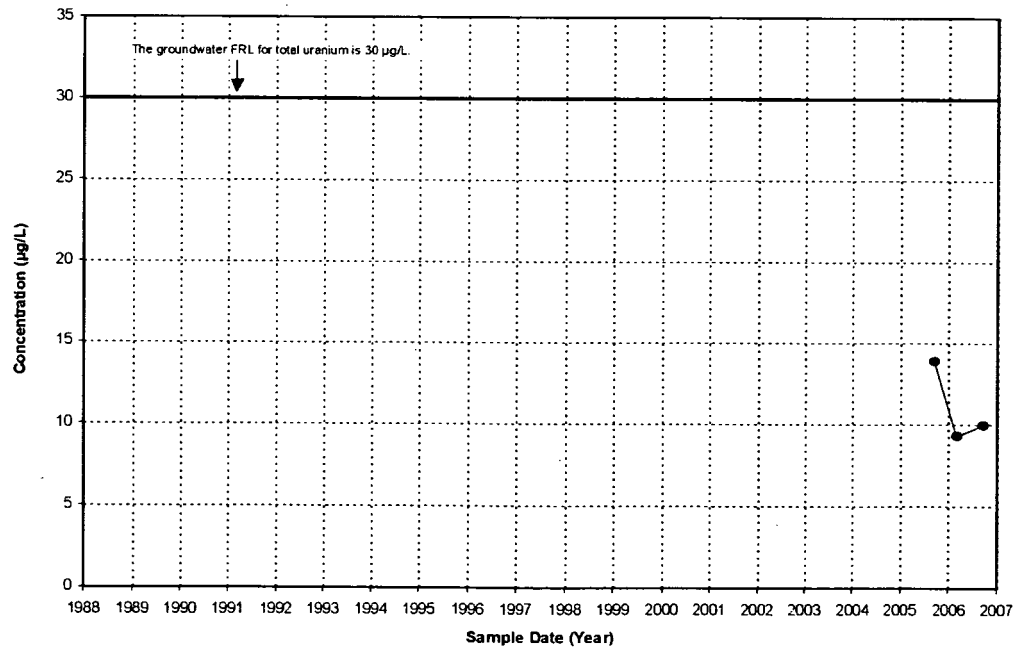

FIGURE A.2-86. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 6015

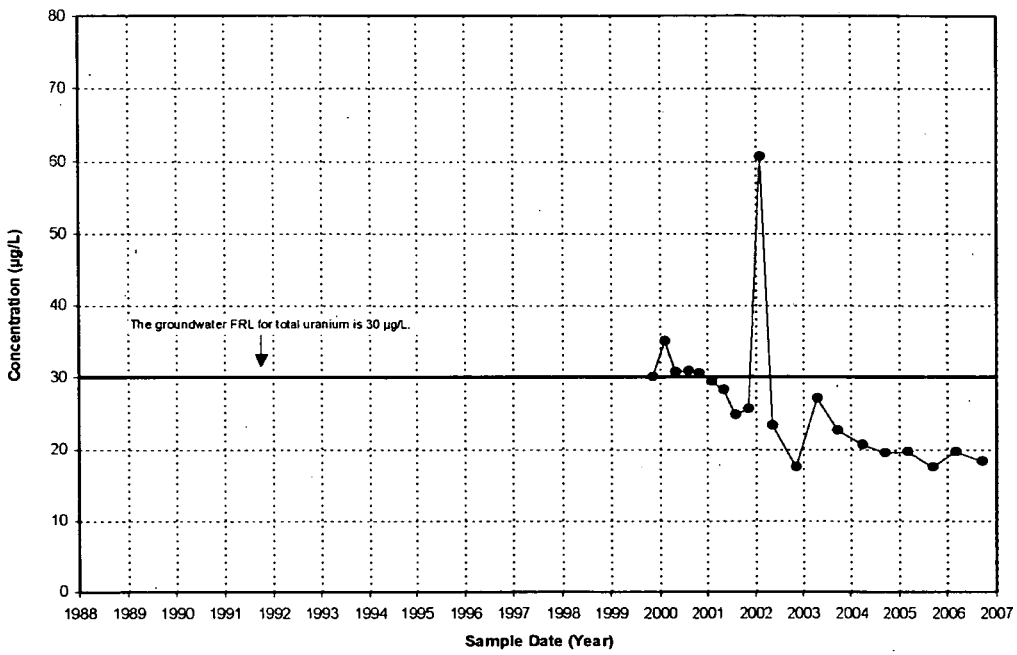

FIGURE A.2-87. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 6881

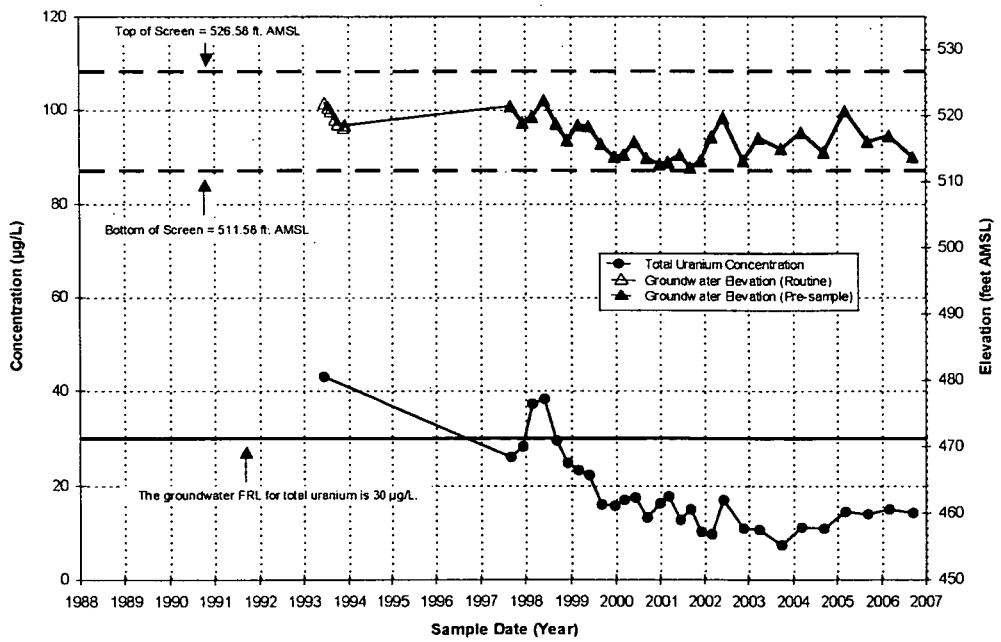

FIGURE A.2-88. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21033

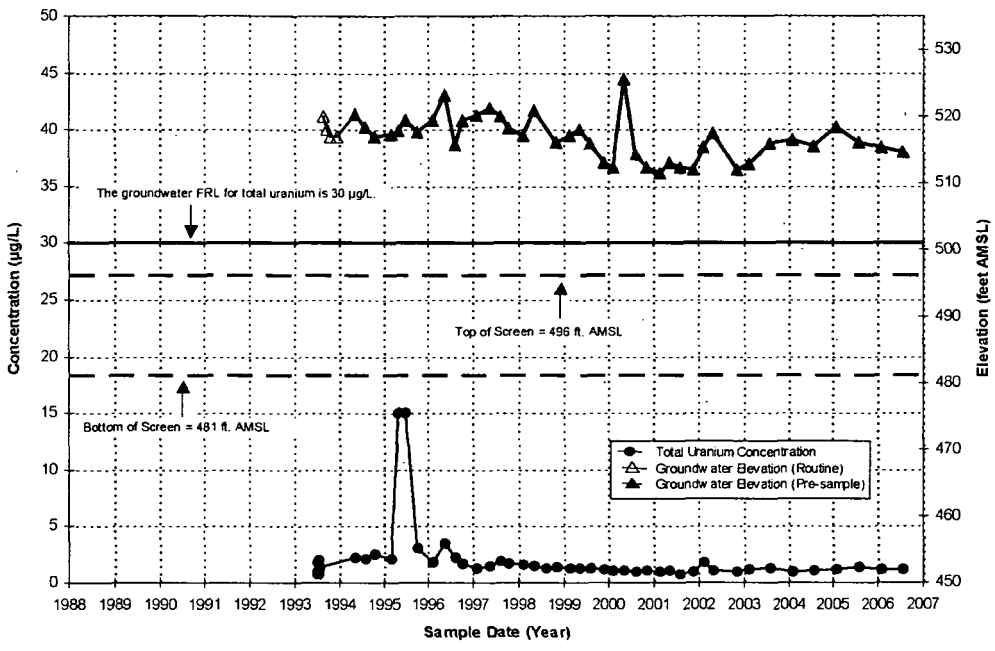

FIGURE A.2-89. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21063

1

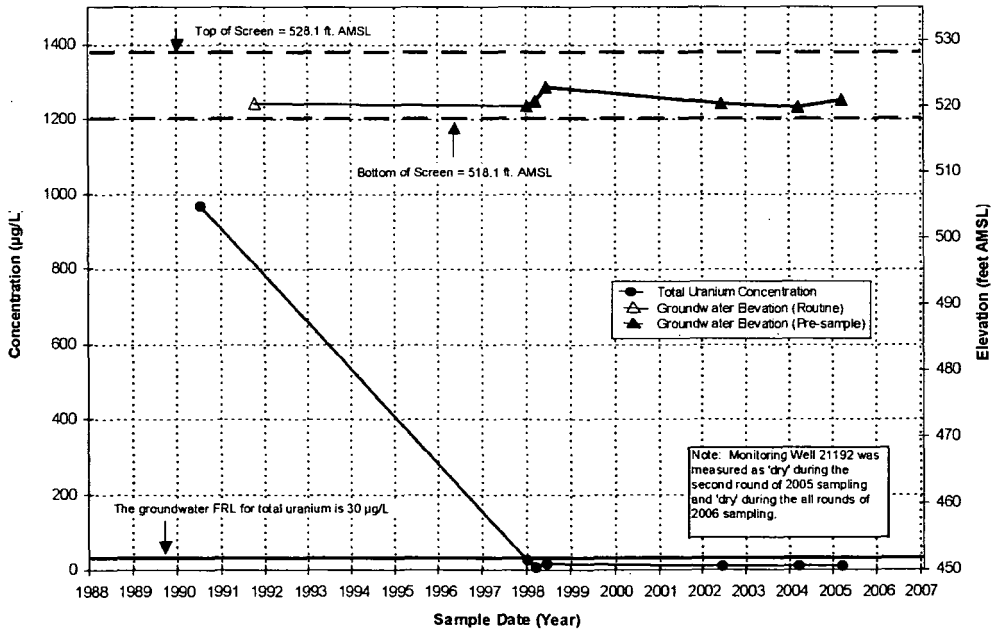

FIGURE A.2-90. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 21192

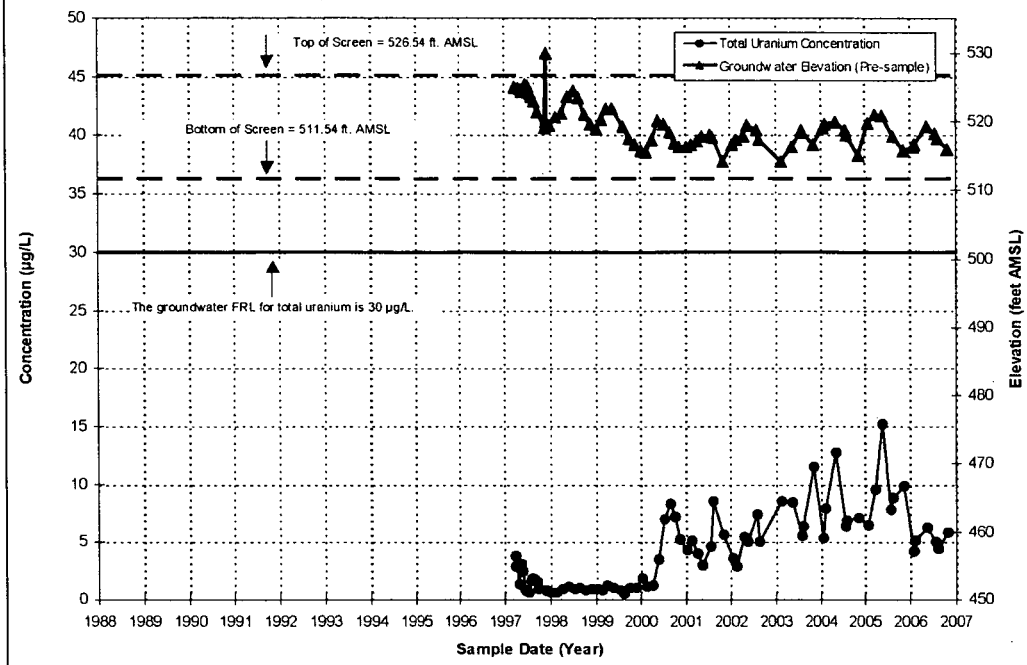

FIGURE A.2-91. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22198

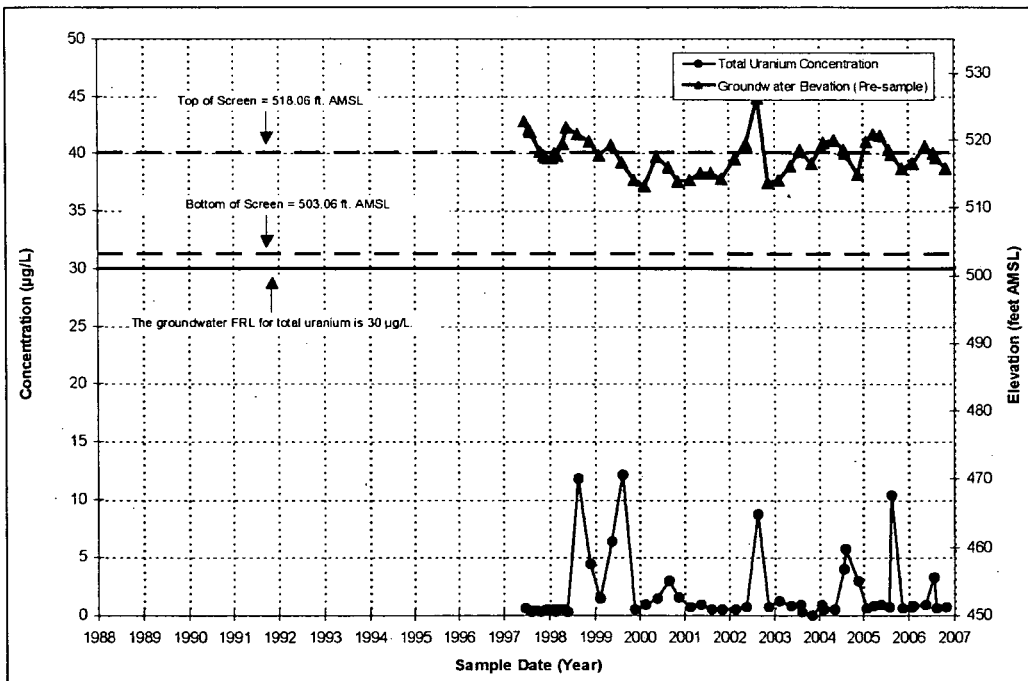

FIGURE A.2-92. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22199

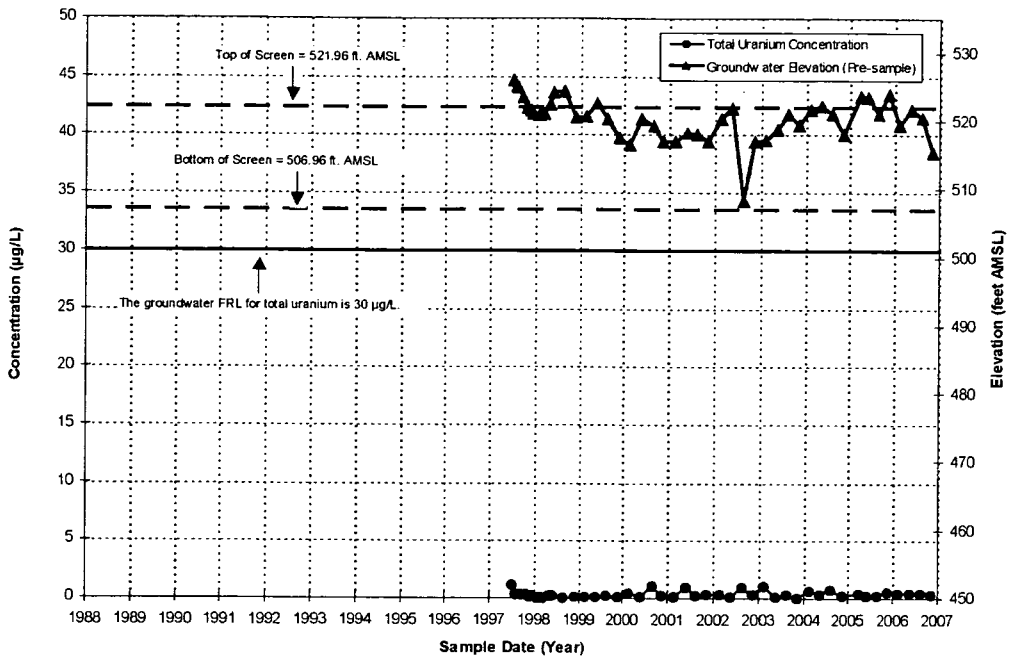

FIGURE A.2-93. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22200

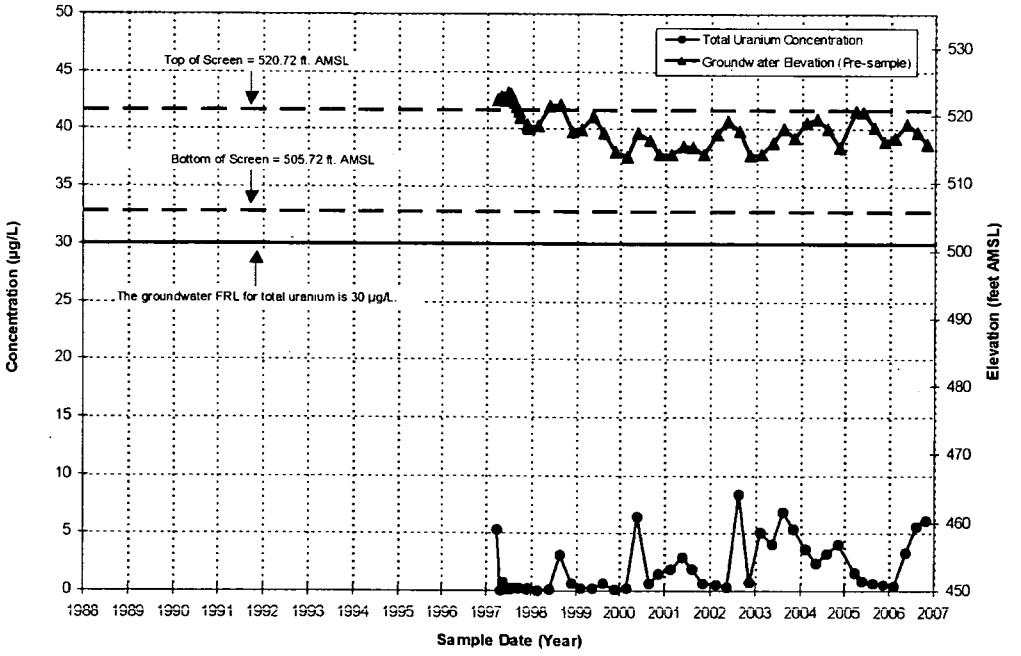

FIGURE A.2-94. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22201

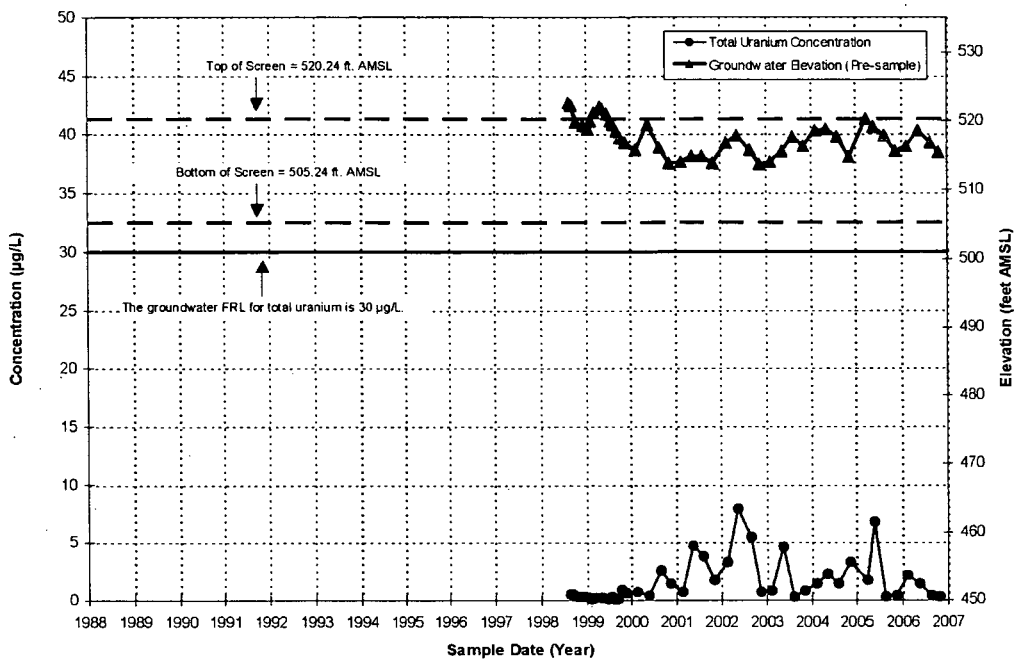

FIGURE A.2-95. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22203

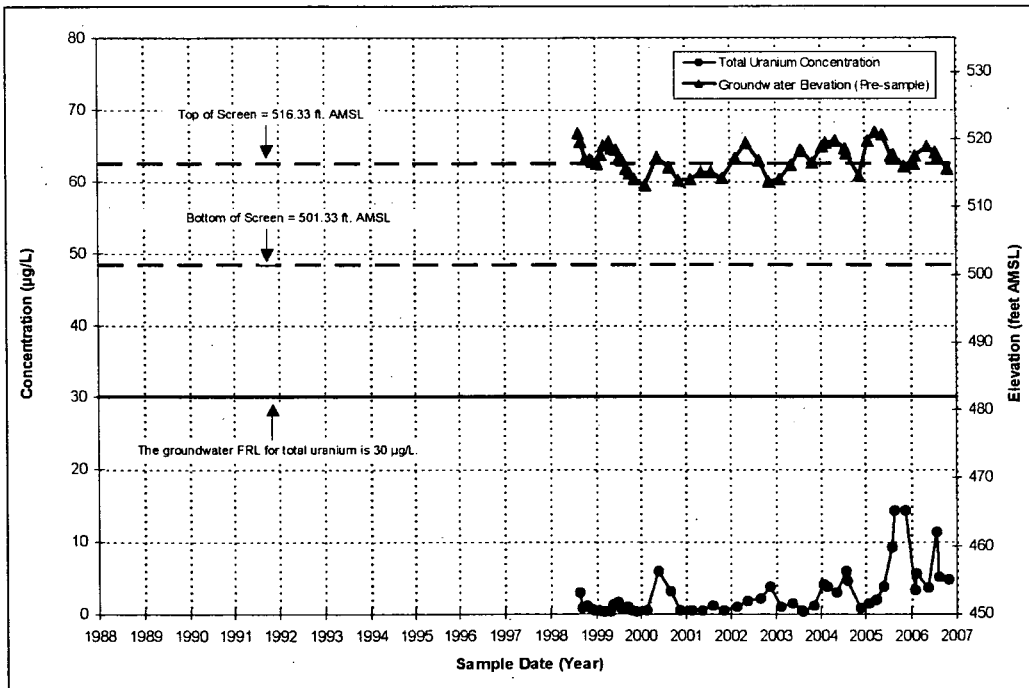

FIGURE A.2-96. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22204

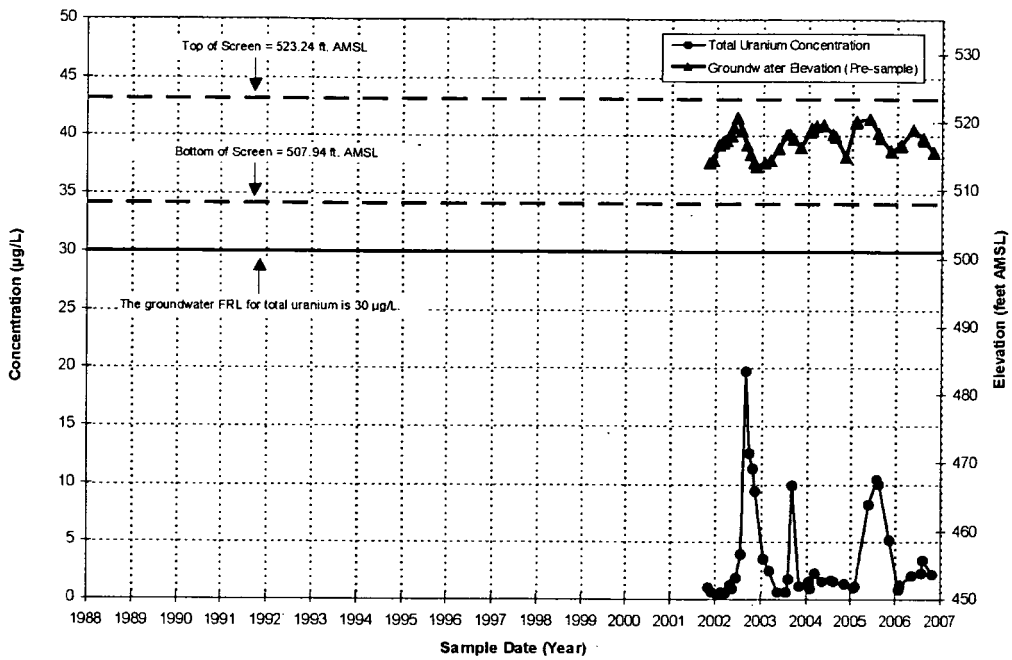

FIGURE A.2-97. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22205

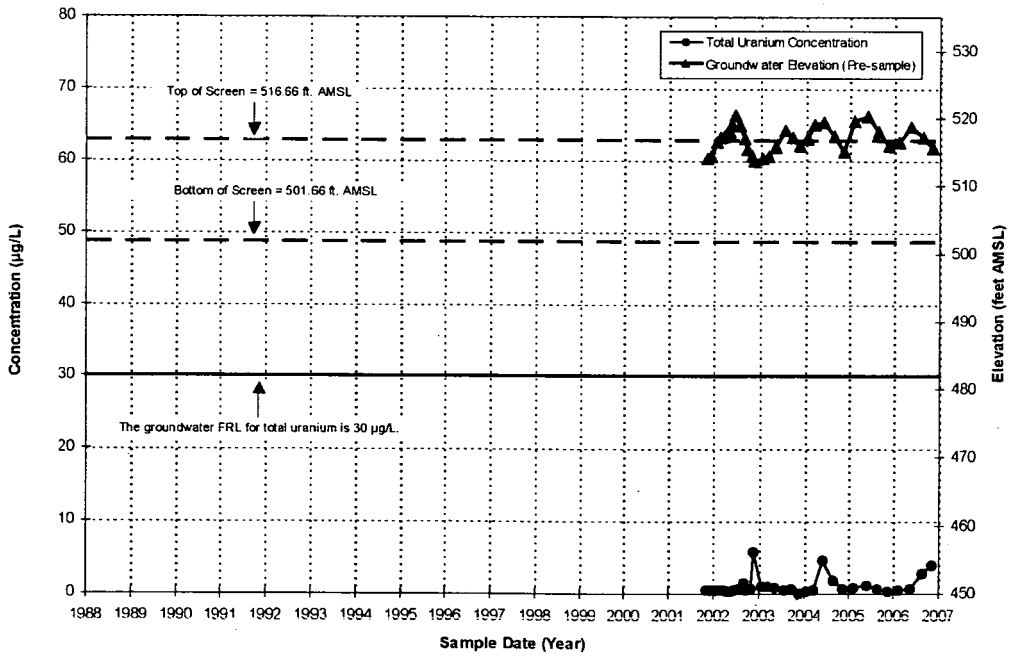

FIGURE A.2-98. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22206

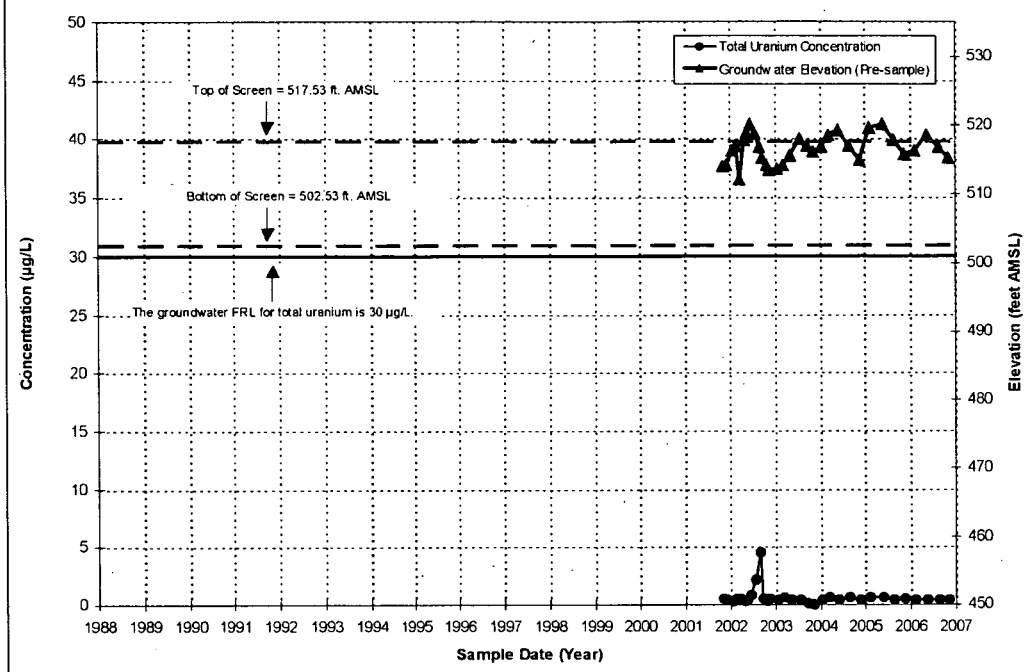

FIGURE A.2-99. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22207

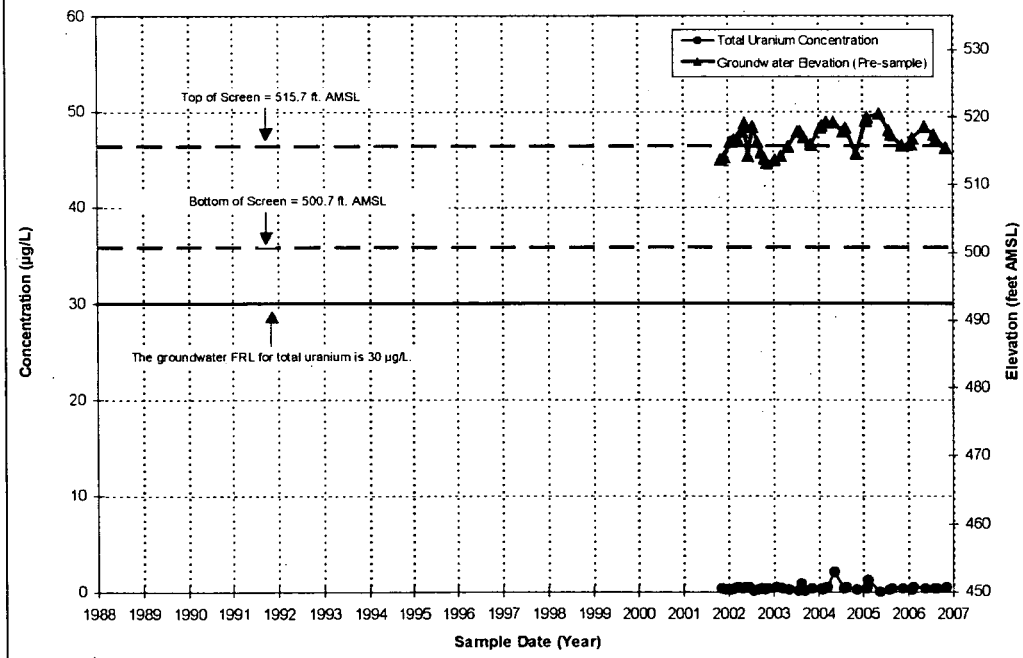

FIGURE A.2-100. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22208

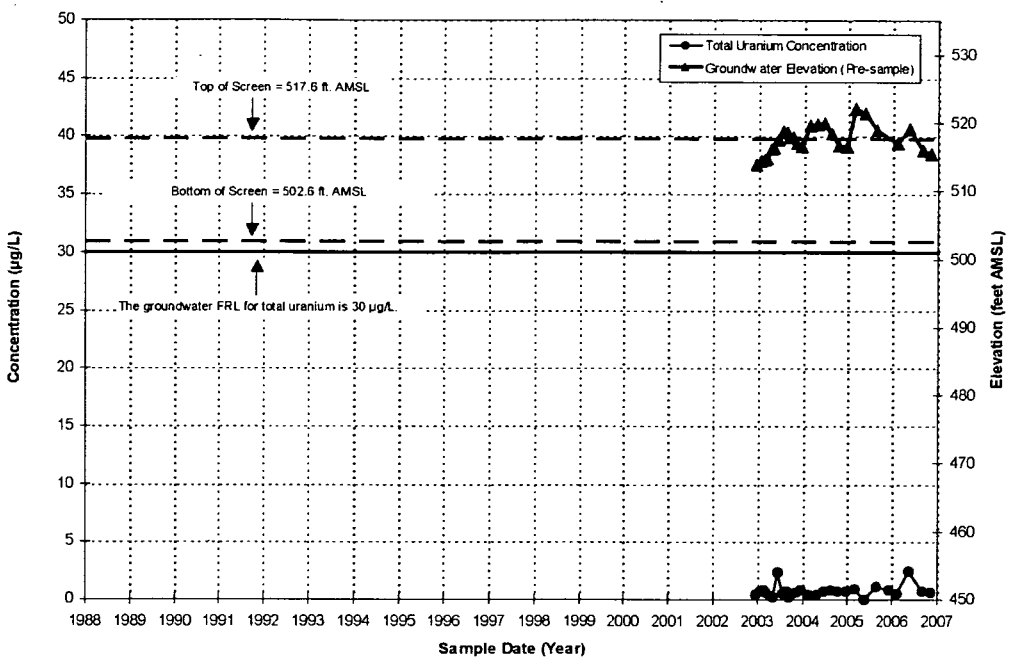

FIGURE A.2-101. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22209

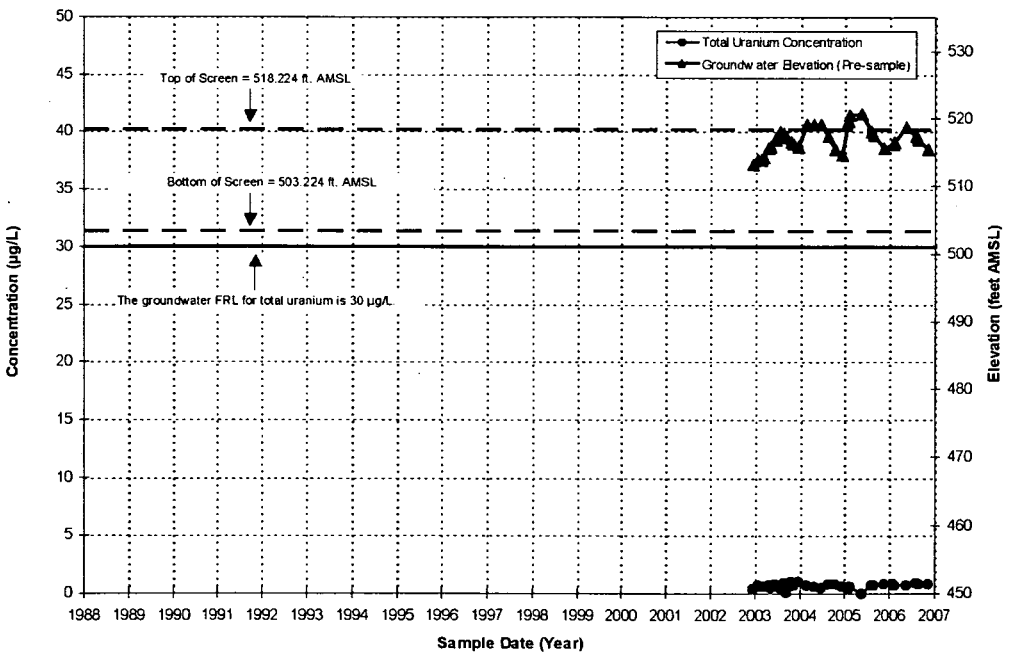

FIGURE A.2-102. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22210

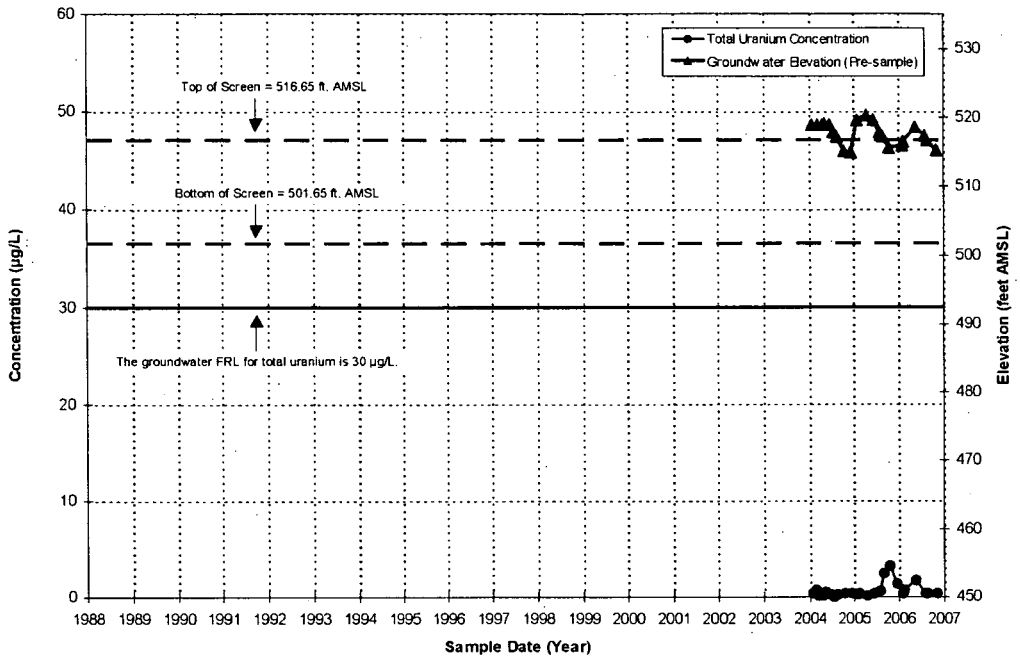

FIGURE A.2-103. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22211

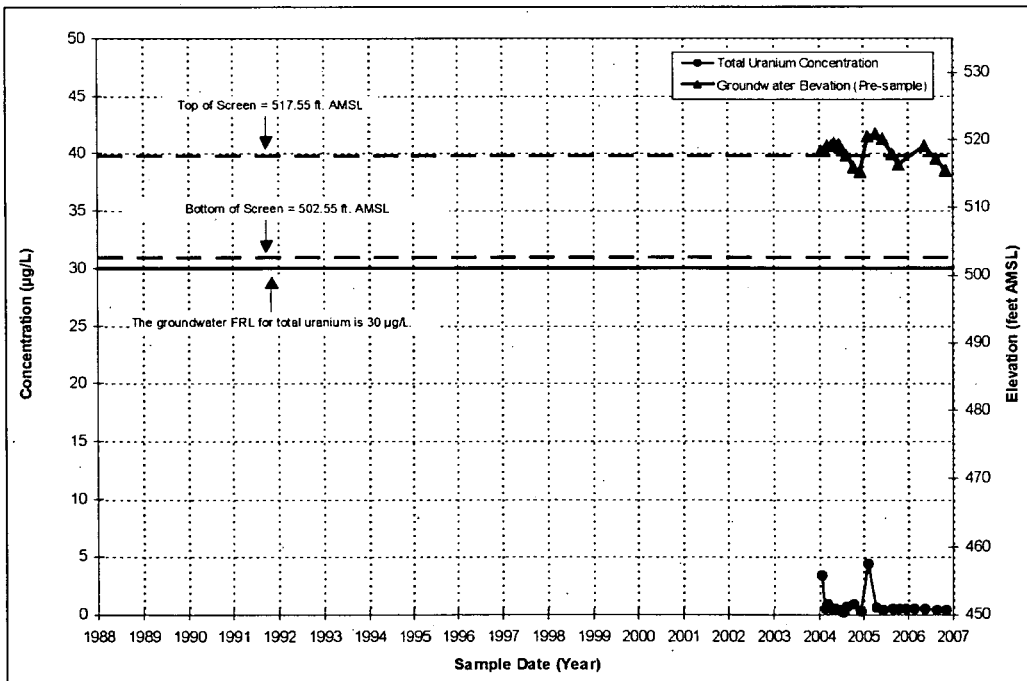

FIGURE A.2-104. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22212

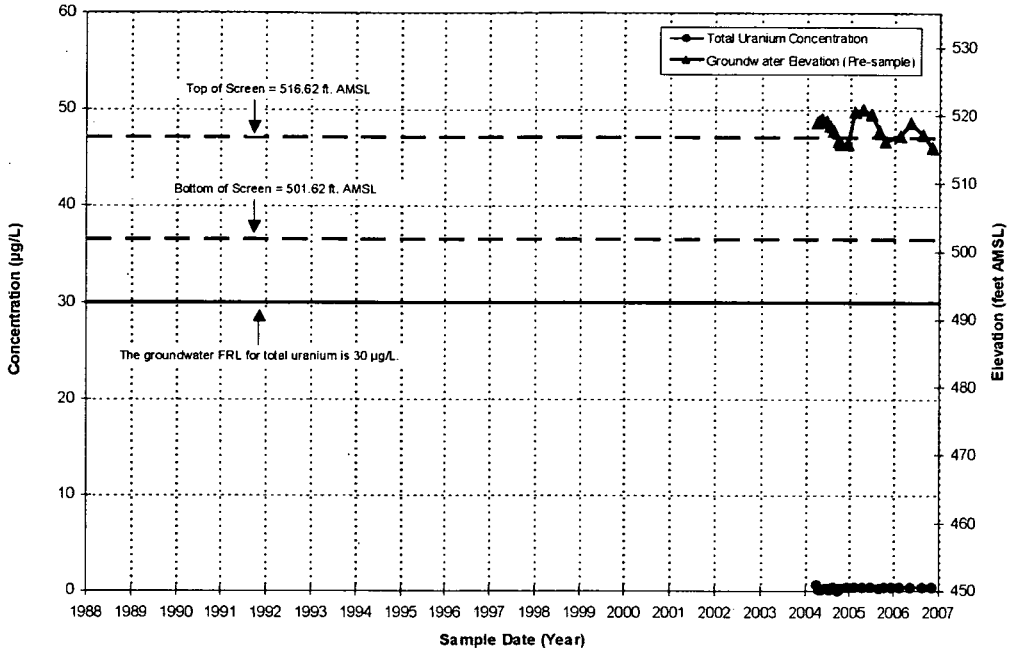

FIGURE A.2-105. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22213

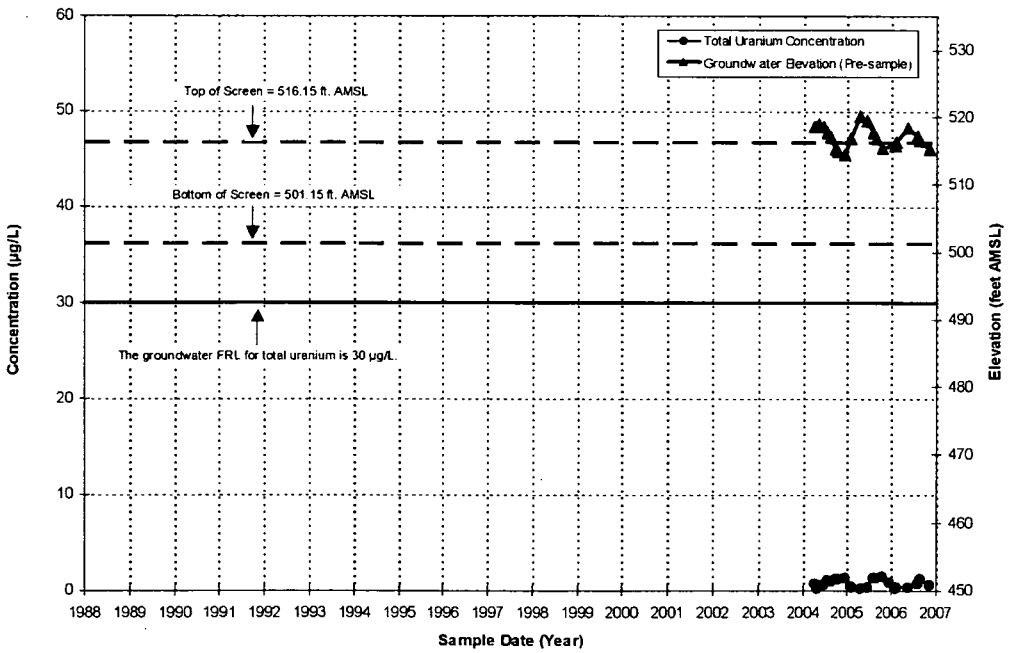

FIGURE A.2-106. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22214

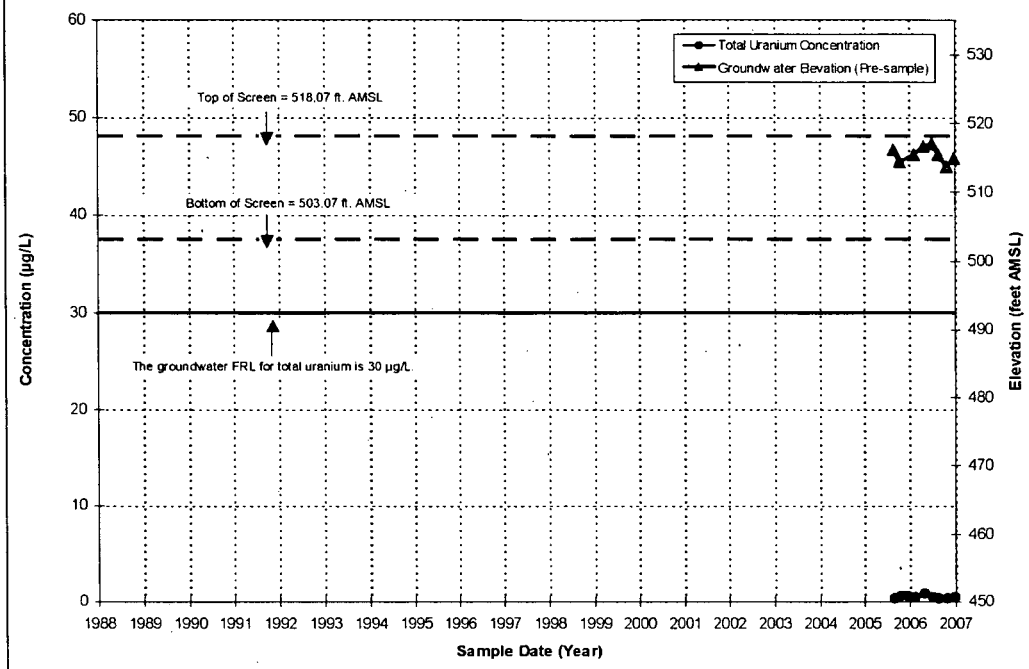

FIGURE A.2-107. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22215

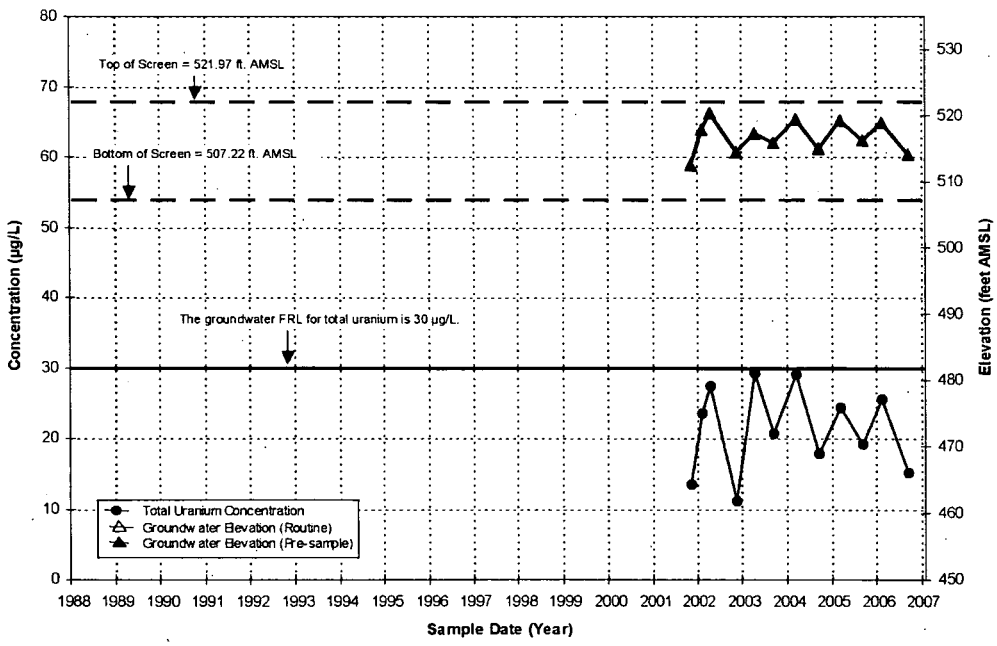

FIGURE A.2-108. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23064

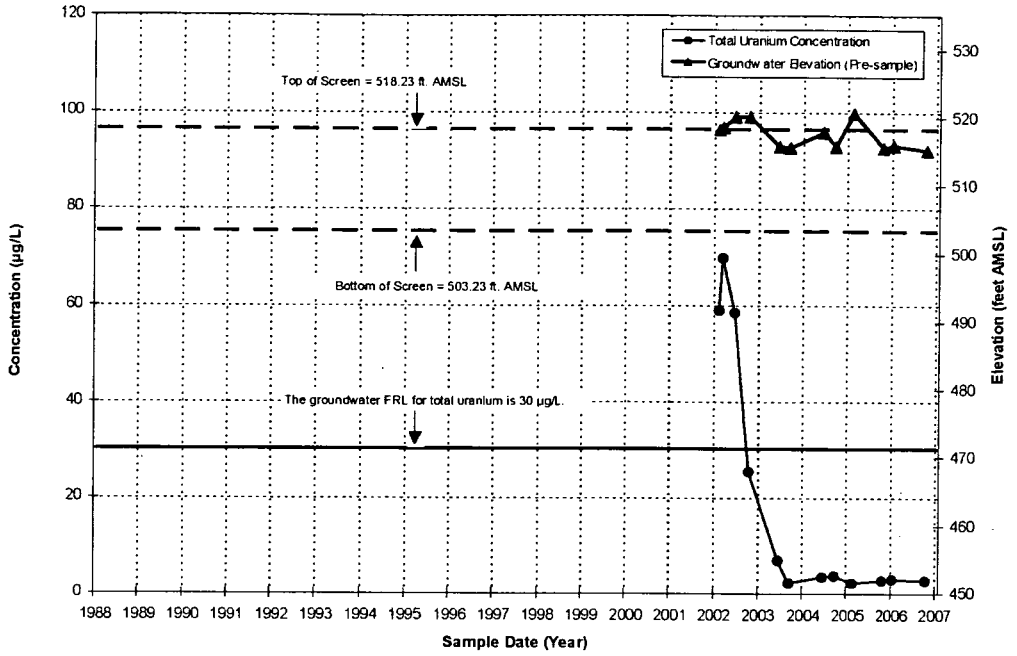

FIGURE A.2-109. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23118

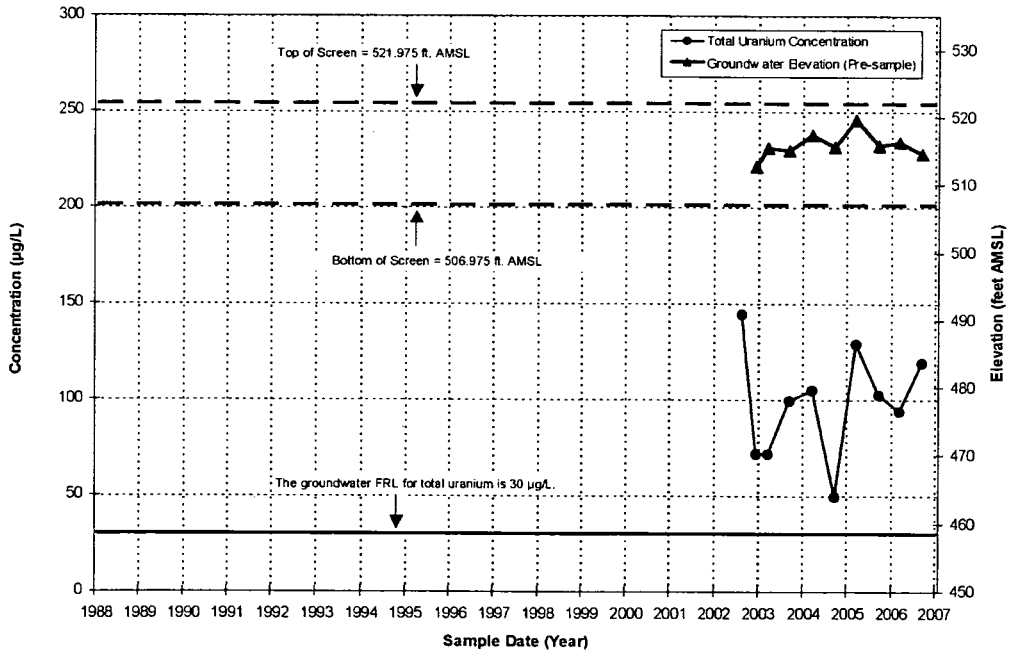

FIGURE A.2-110. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23271

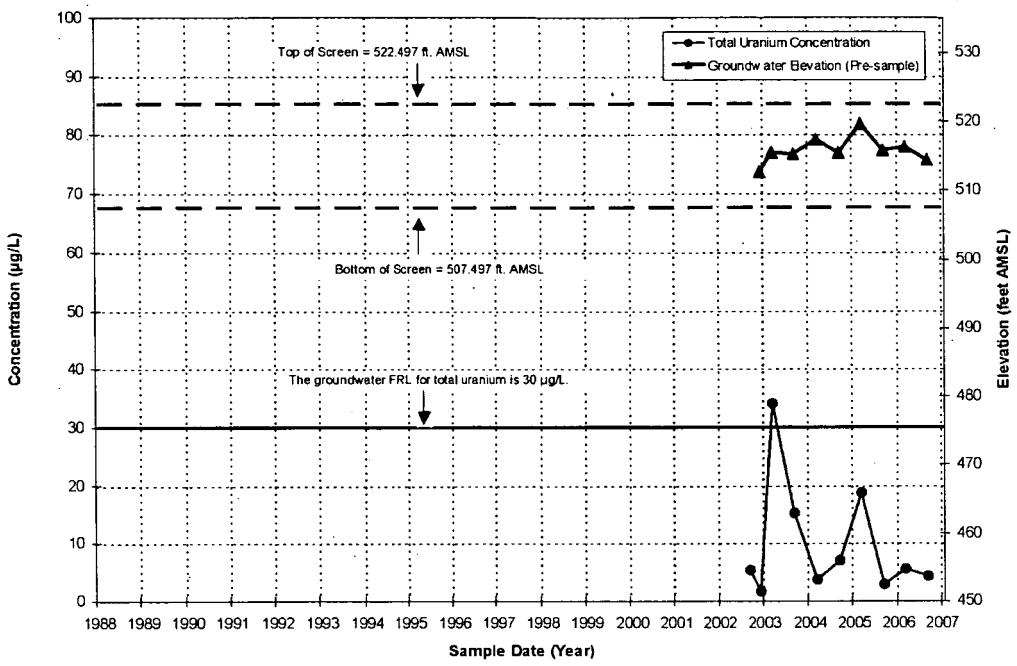

FIGURE A.2-111. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23272

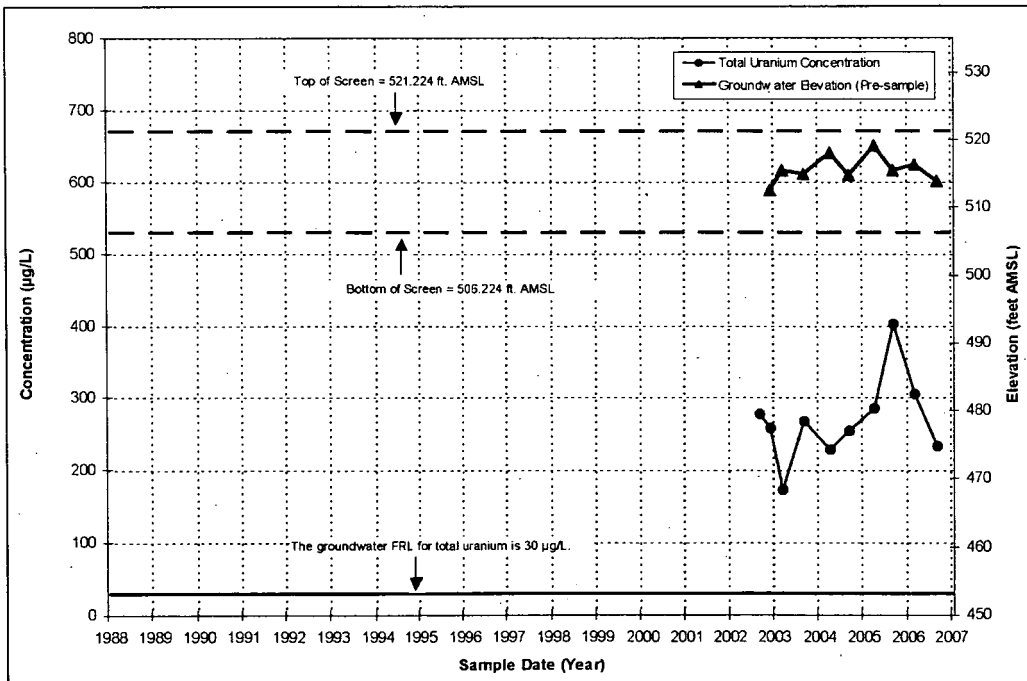

FIGURE A.2-112. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23273

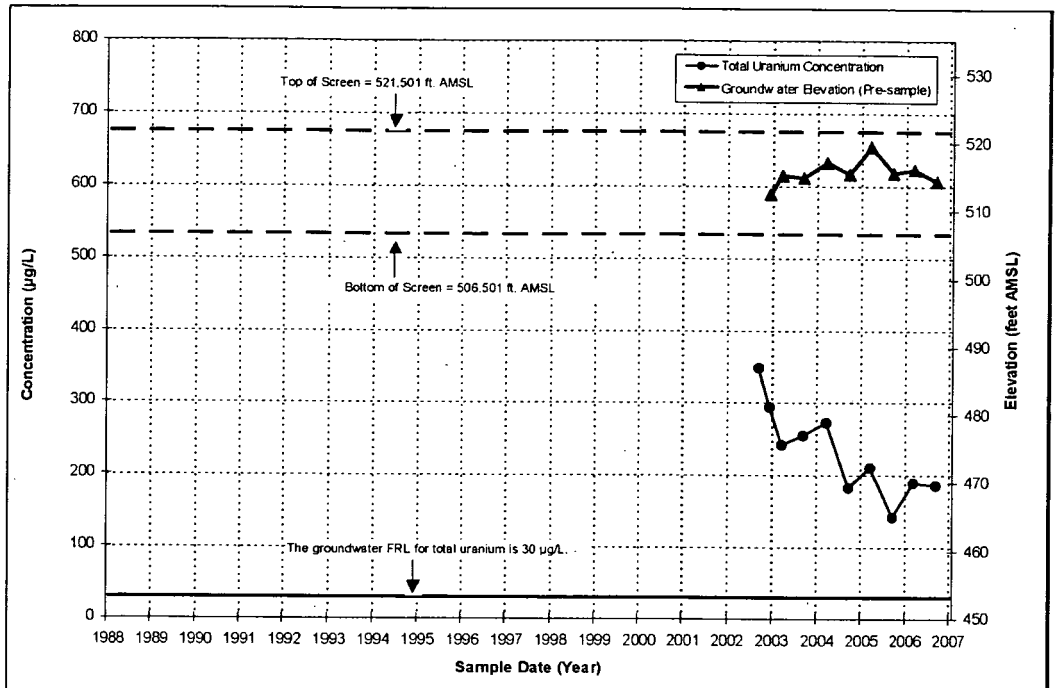

FIGURE A.2-113. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23274

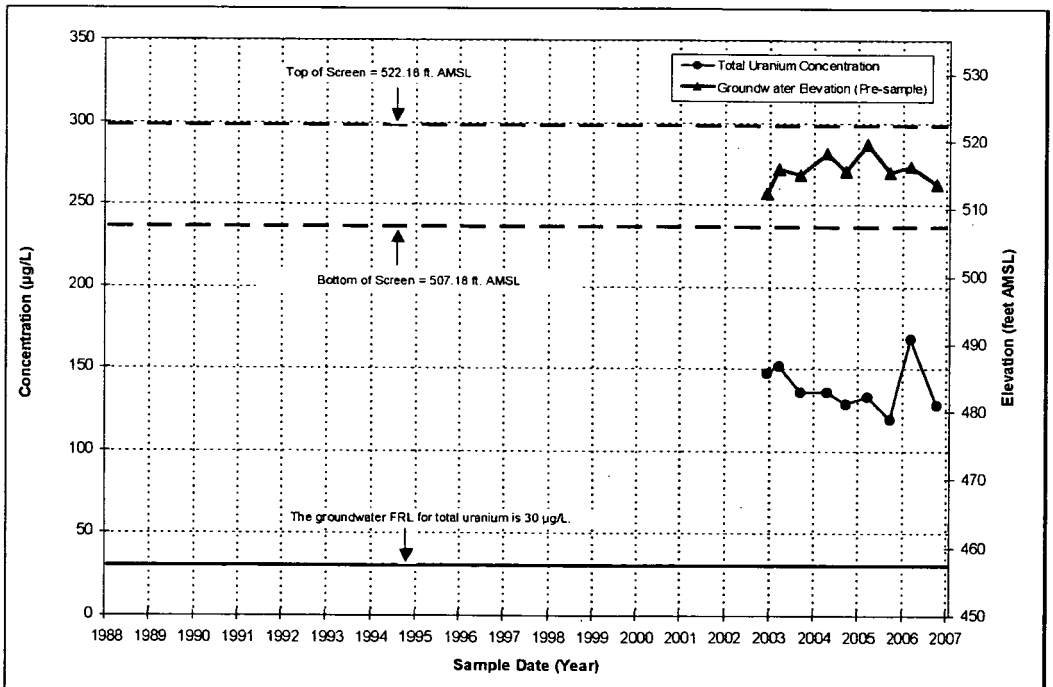

FIGURE A.2-114. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23275

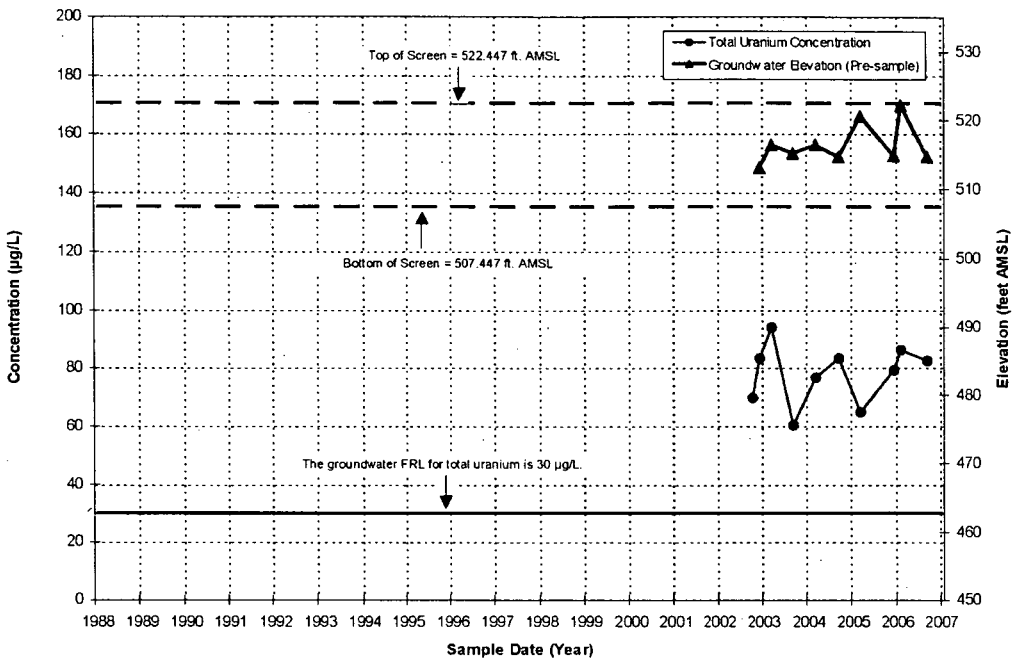

FIGURE A.2-115. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23276

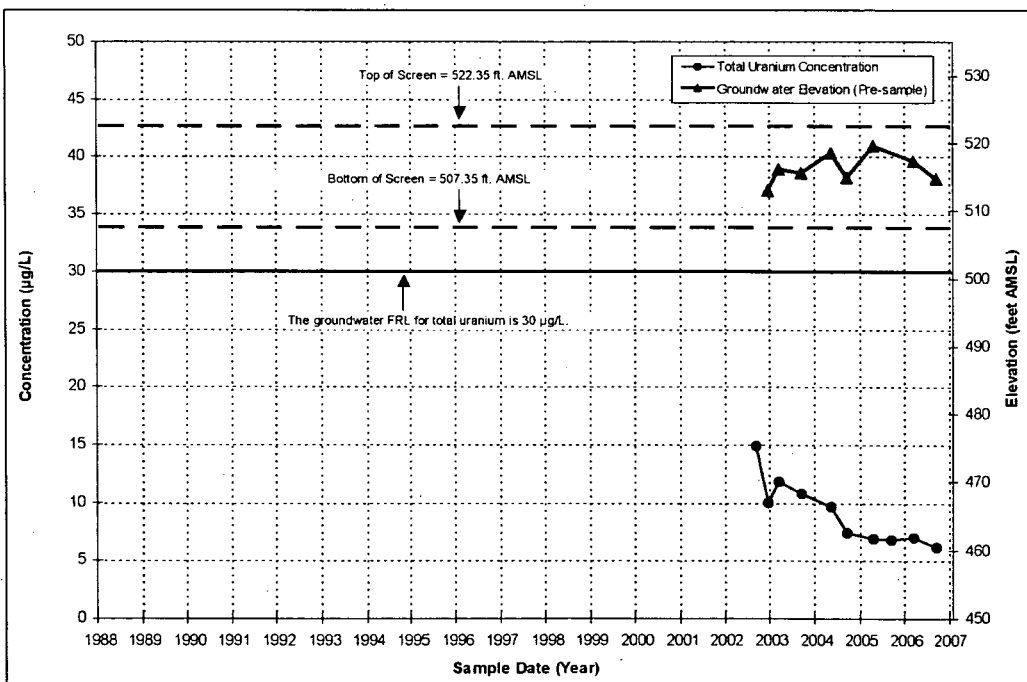

FIGURE A.2-116. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23277

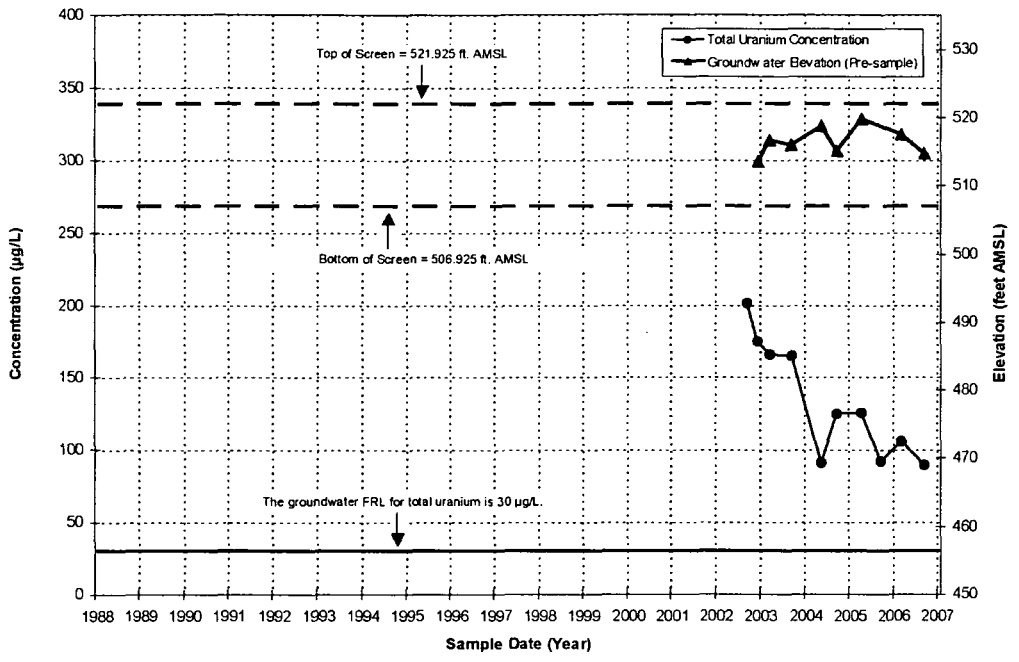

FIGURE A.2-117. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23278

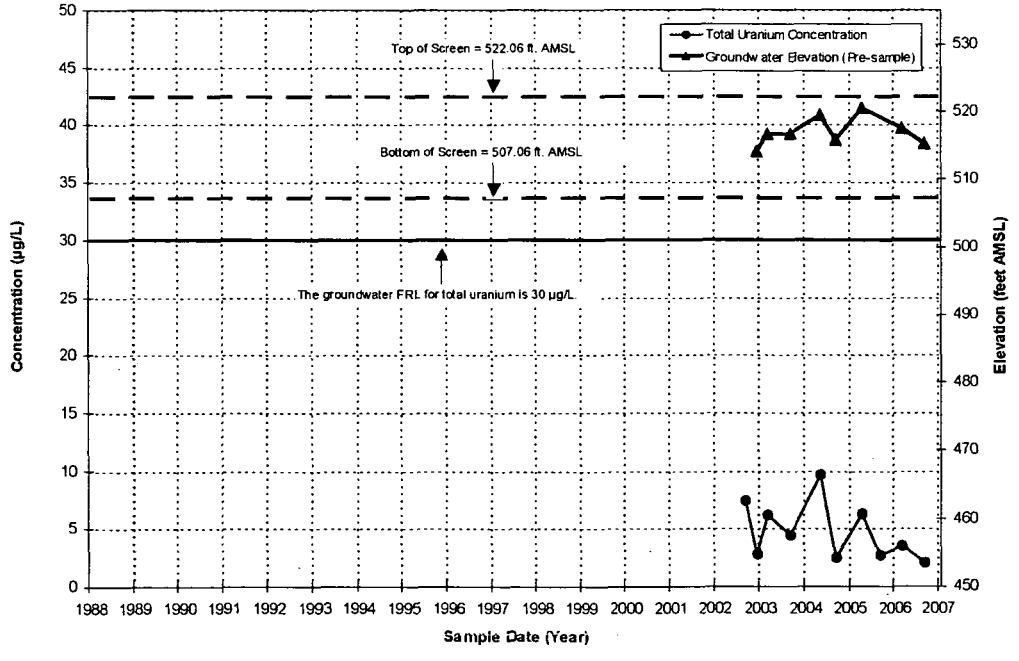

FIGURE A.2-118. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23279

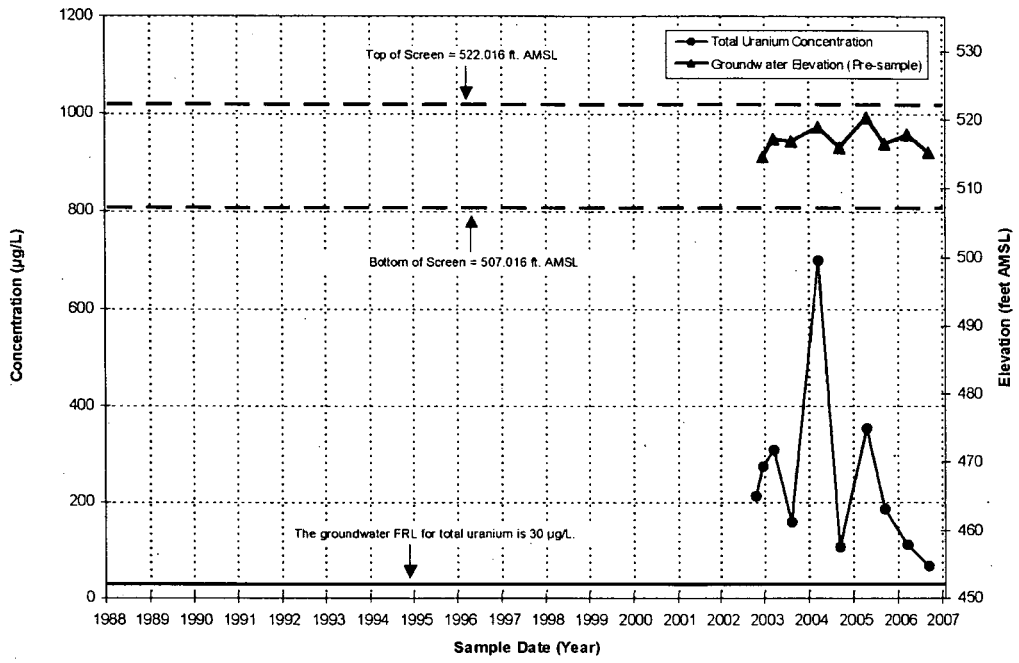

FIGURE A.2-119. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23280

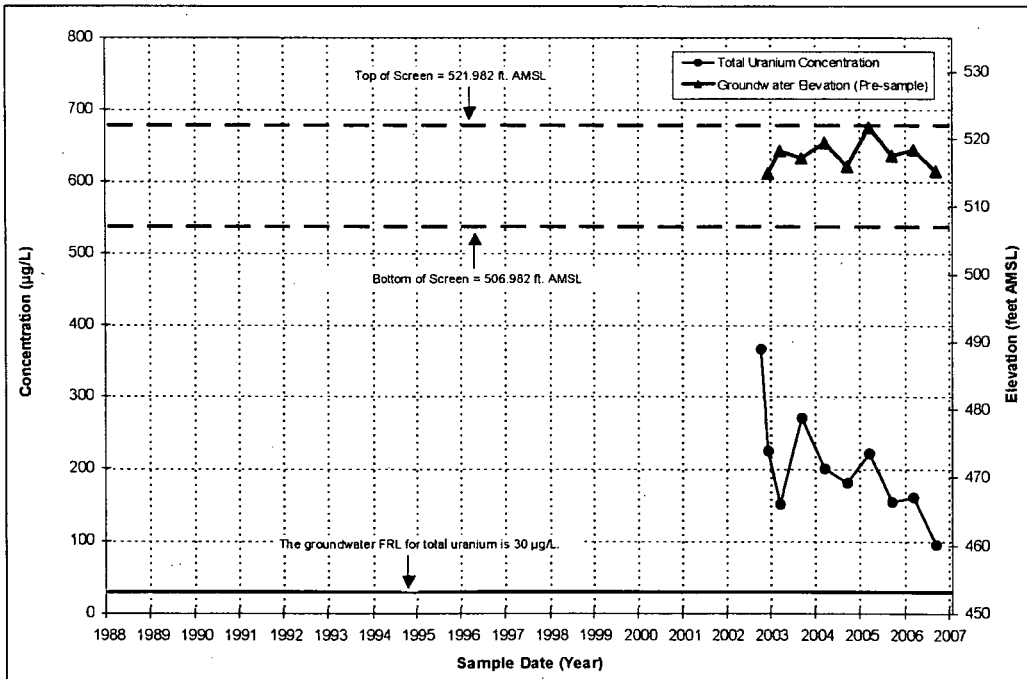

FIGURE A.2-120. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23281

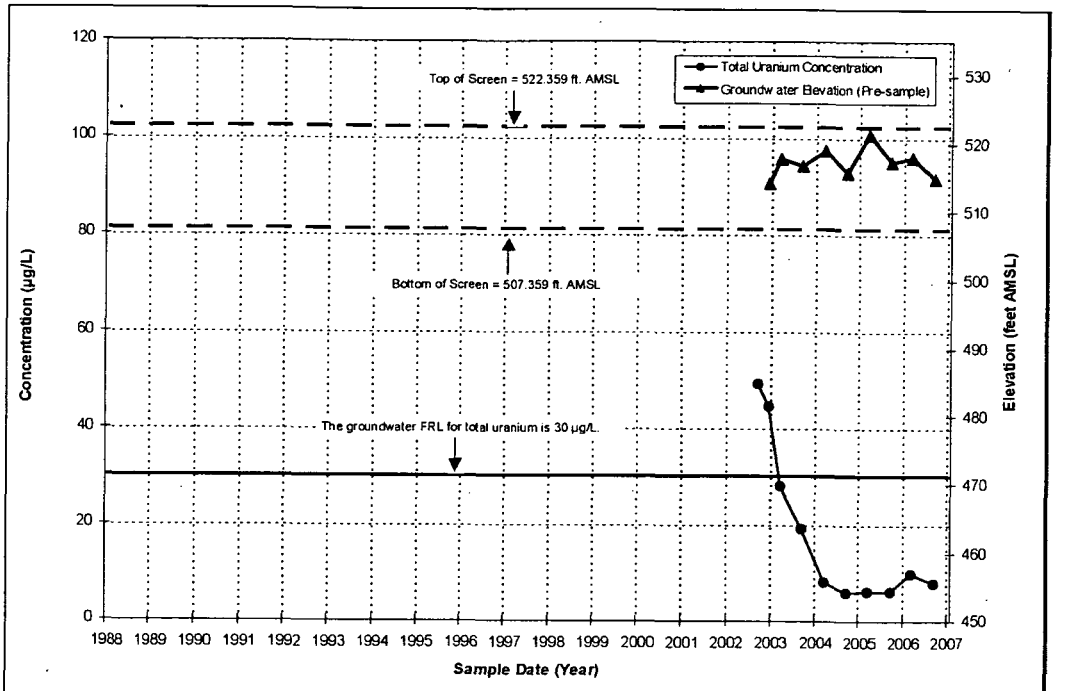

FIGURE A.2-121. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 23282

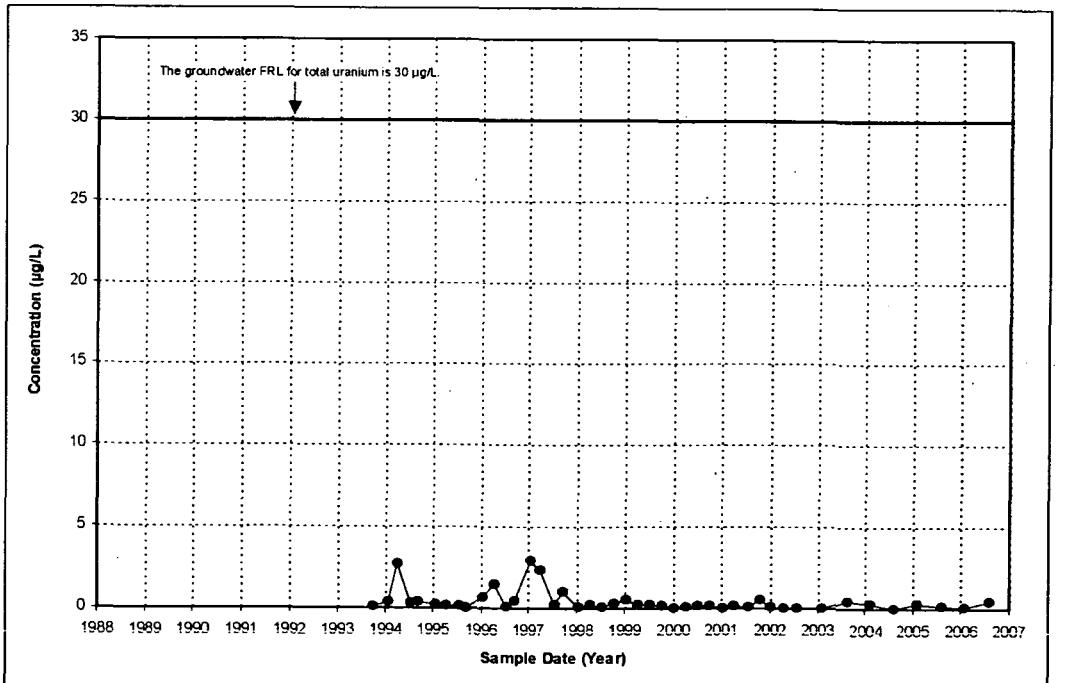

FIGURE A.2-122. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 31217

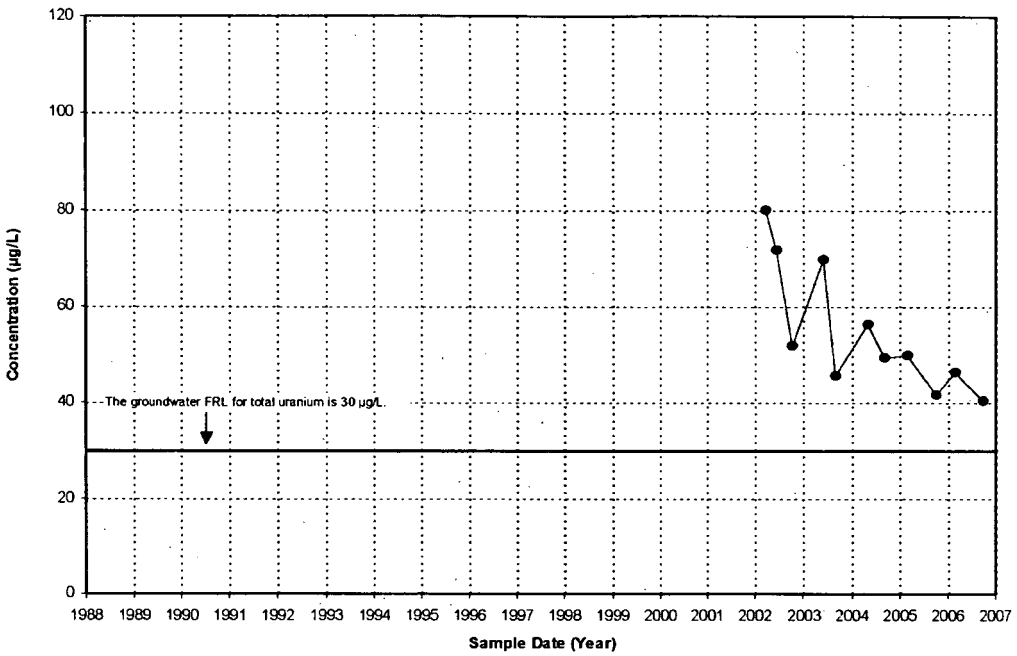

FIGURE A.2-123. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 32766

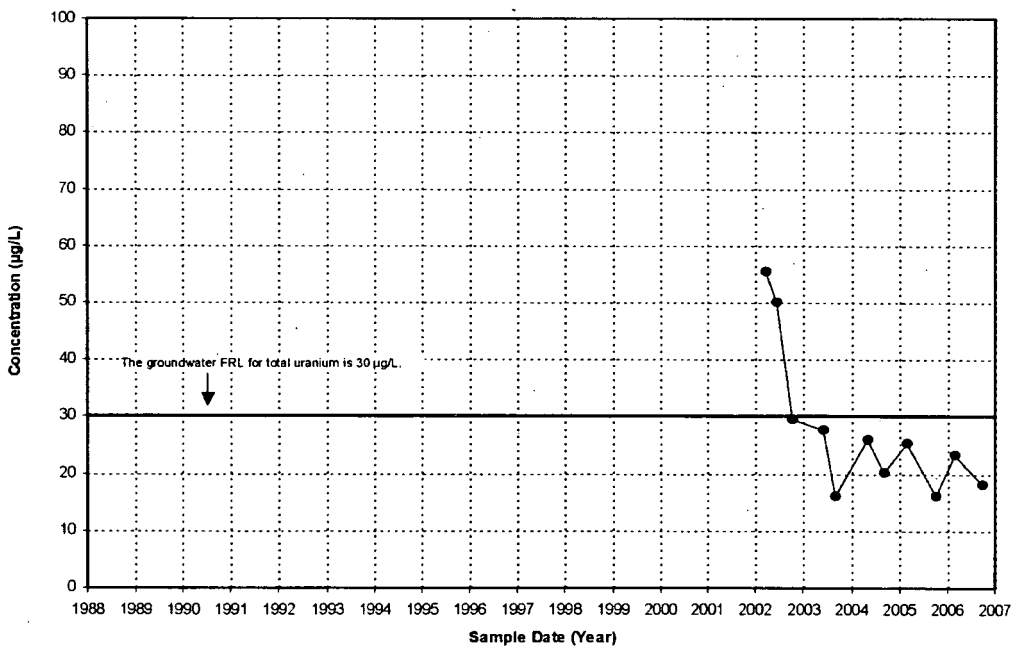

FIGURE A.2-124. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 32768

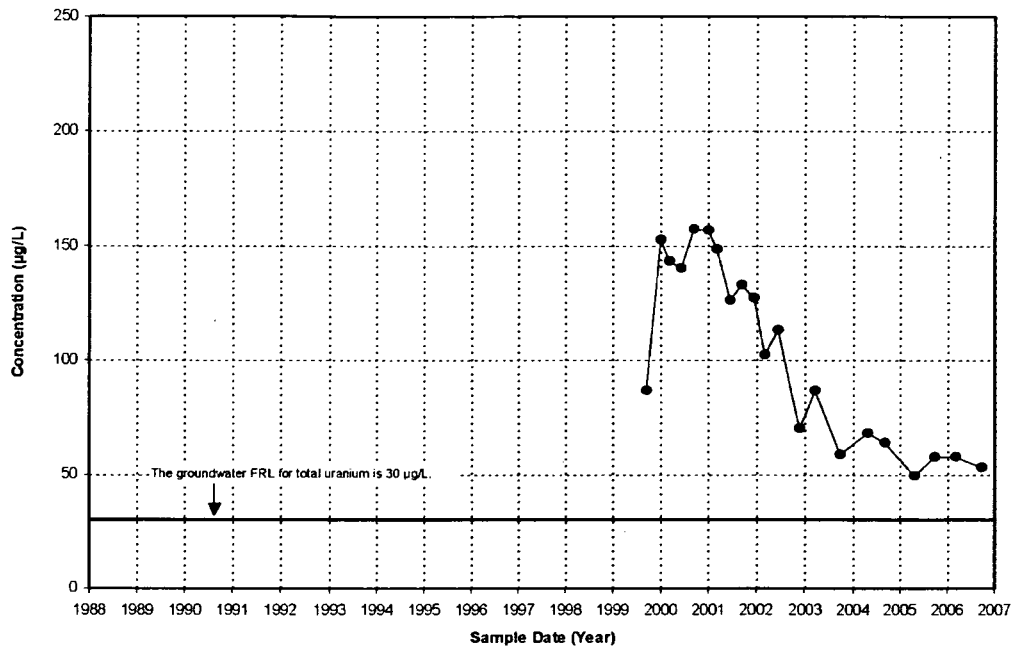

FIGURE A.2-125. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 62408

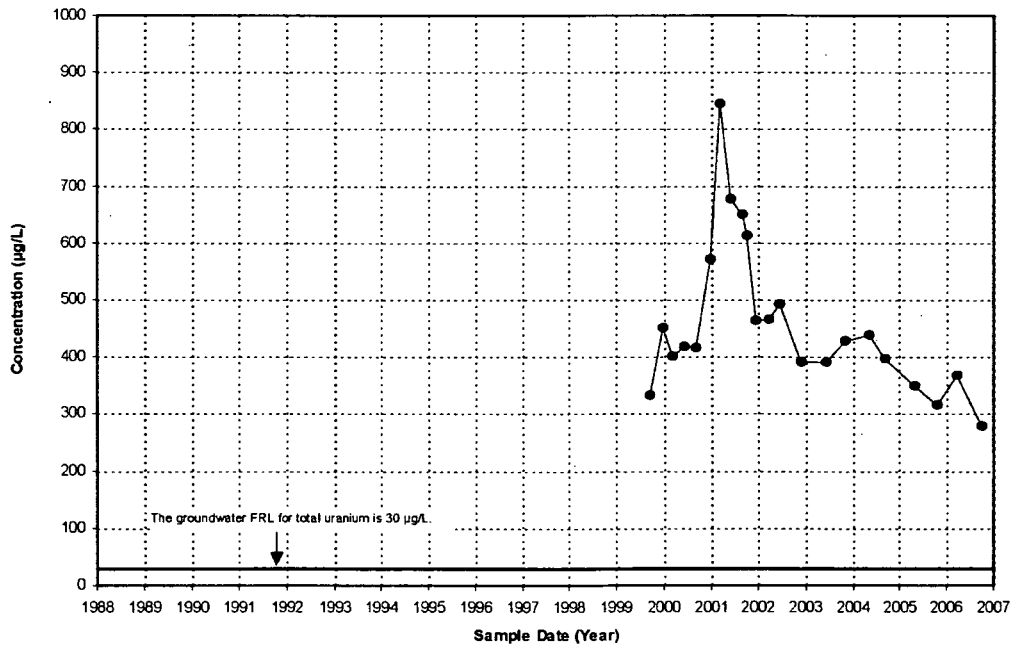

FIGURE A.2-126. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 62433

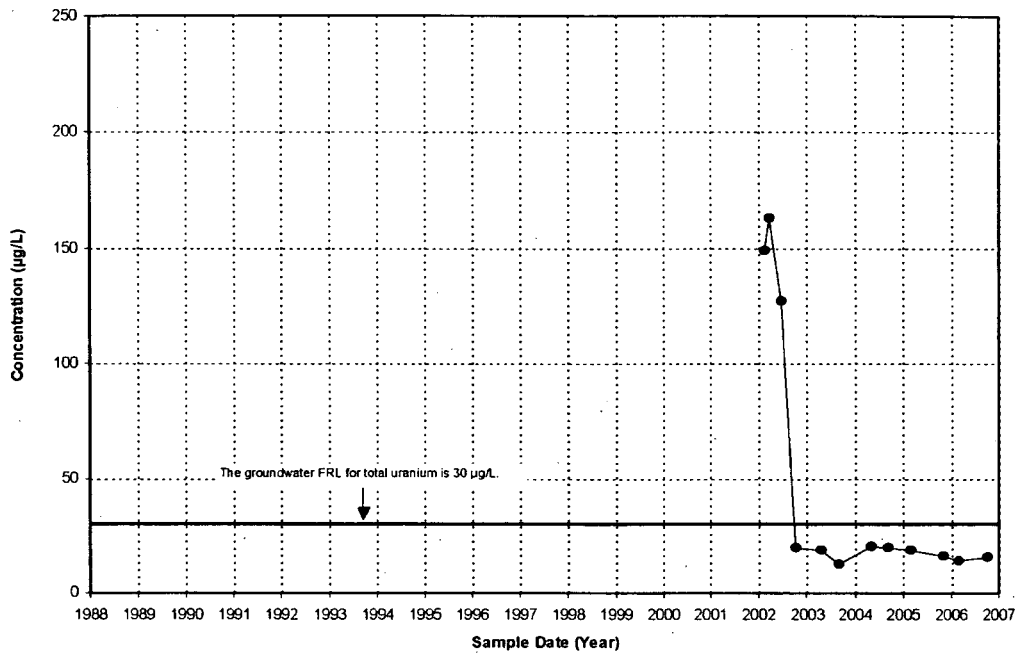

FIGURE A.2-127. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63116

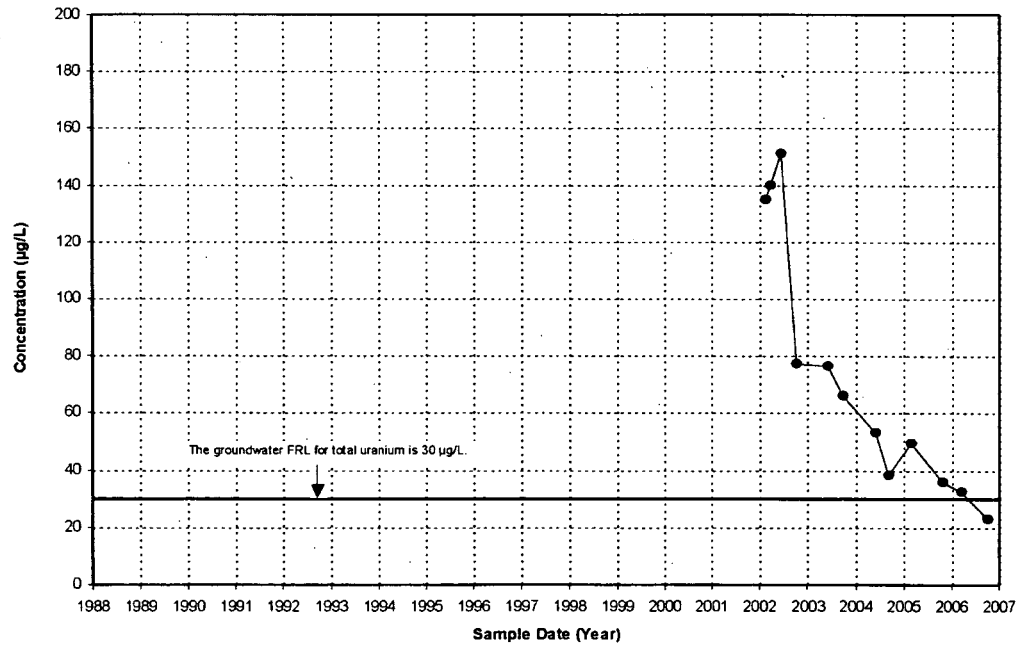

FIGURE A.2-128. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63119

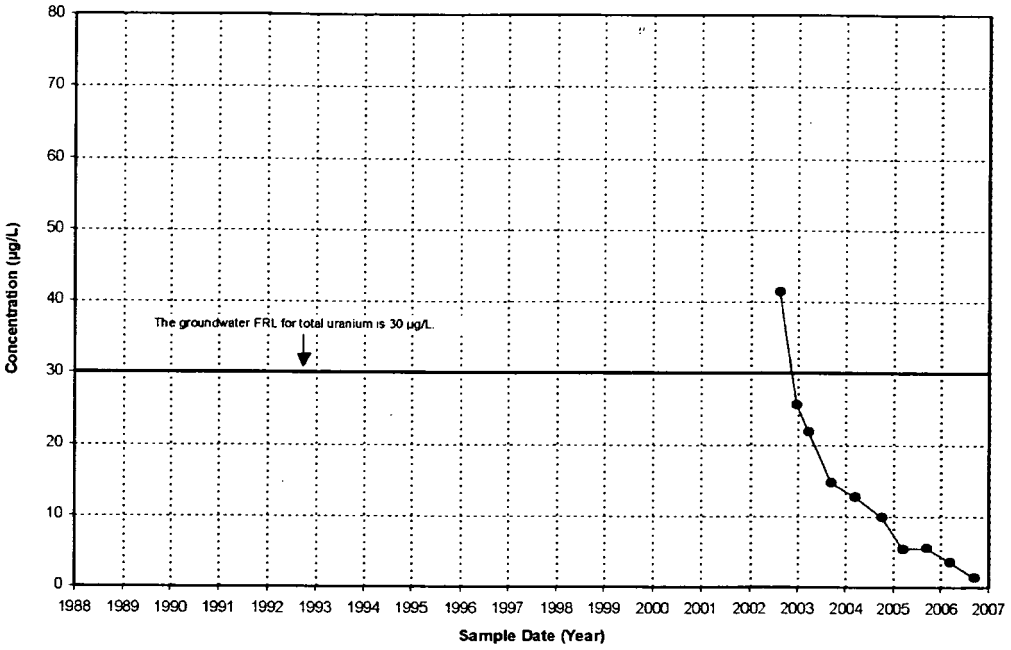

FIGURE A.2-129. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63283

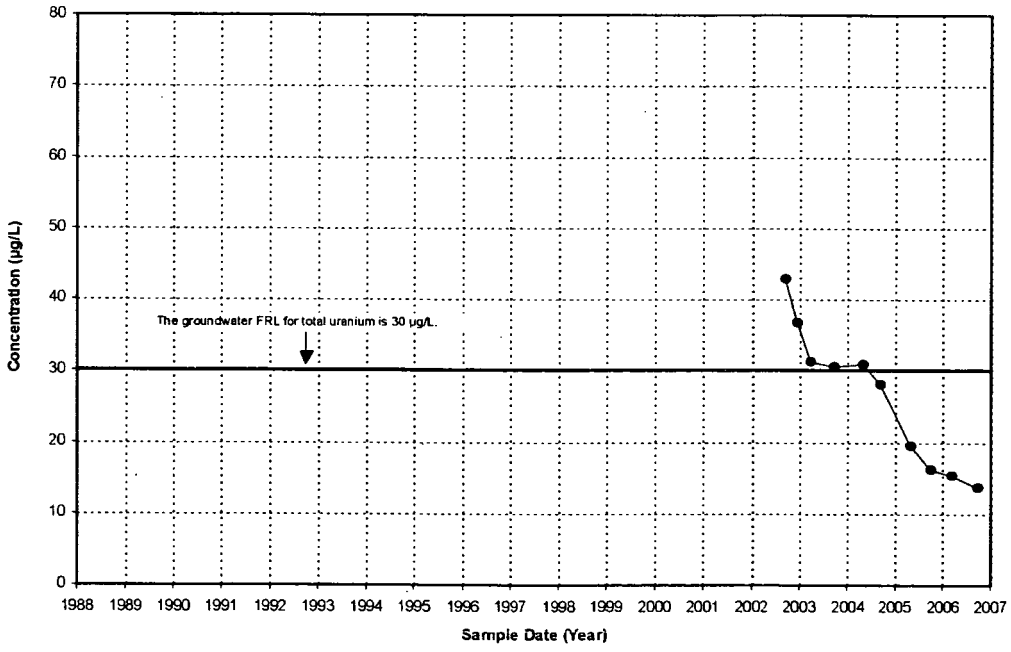

FIGURE A.2-130. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63284

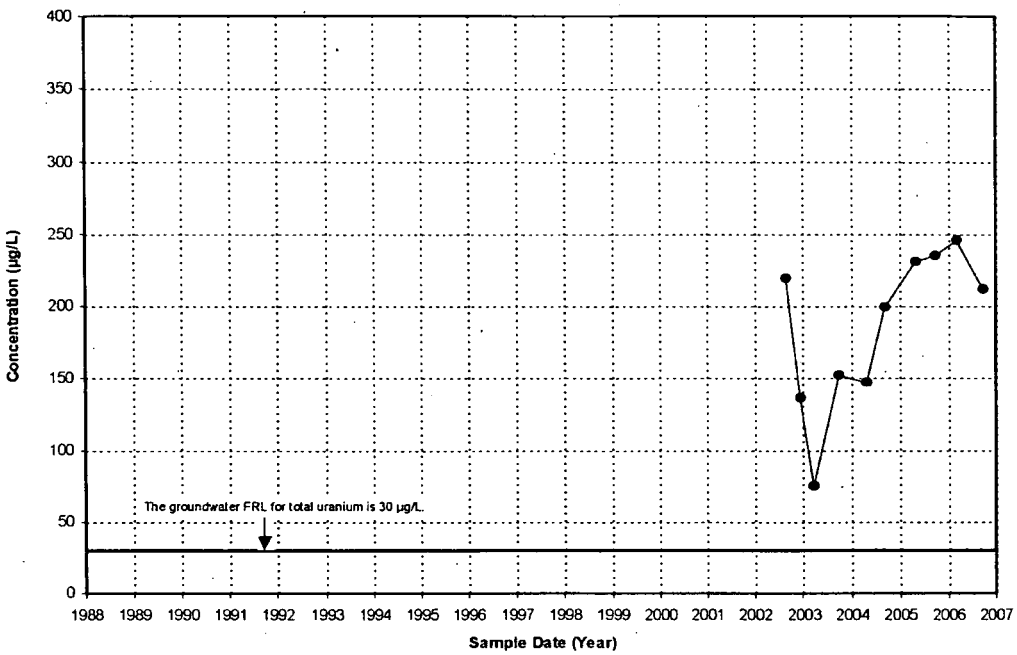

FIGURE A.2-131. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63285

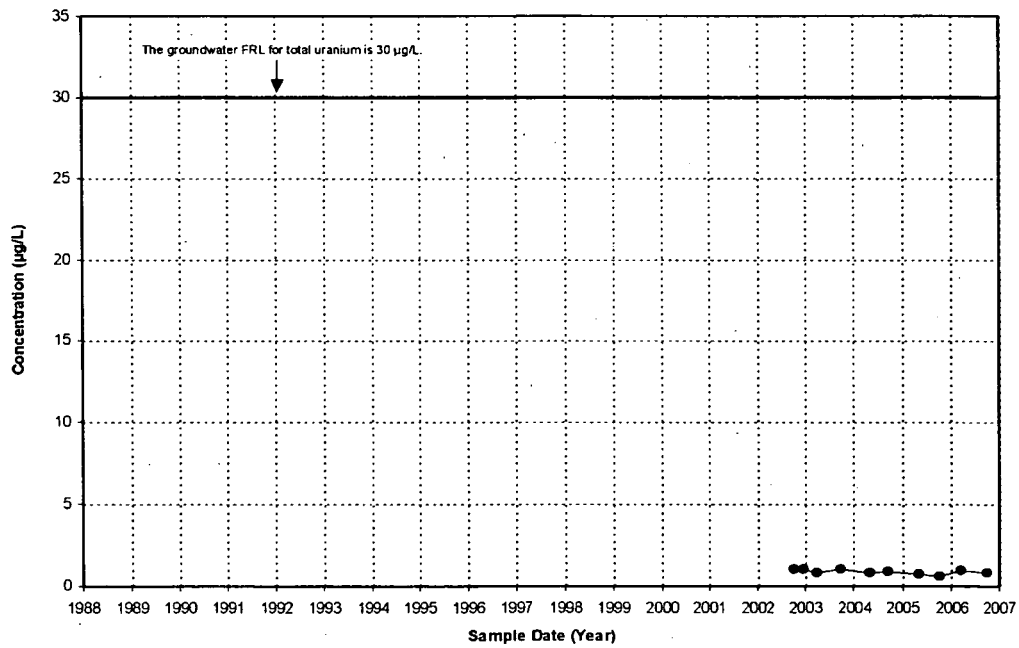

FIGURE A.2-132. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63286

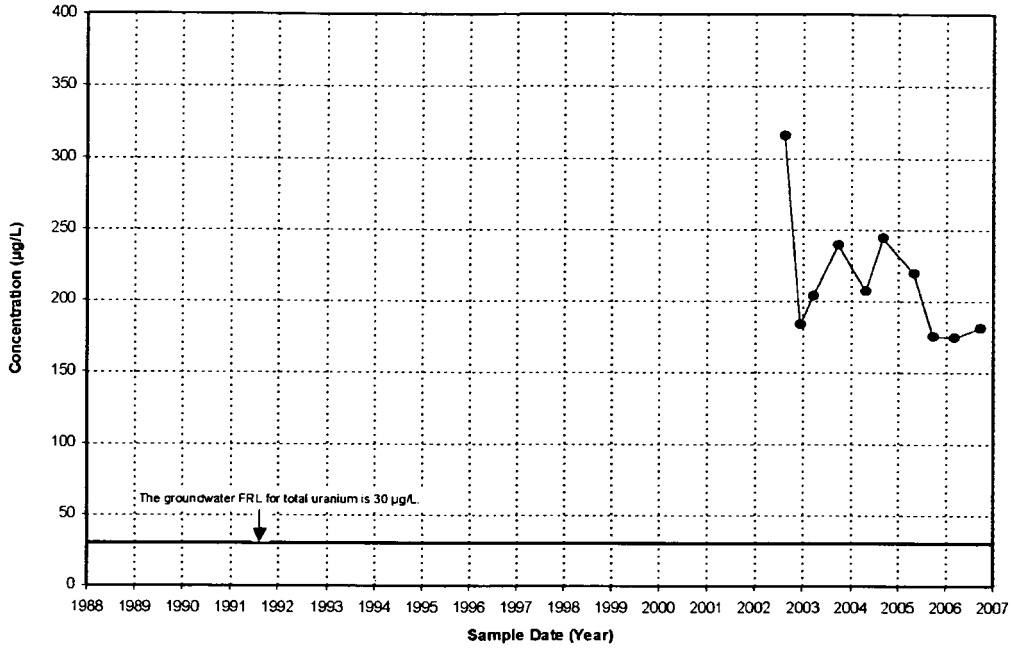

FIGURE A.2-133. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63287

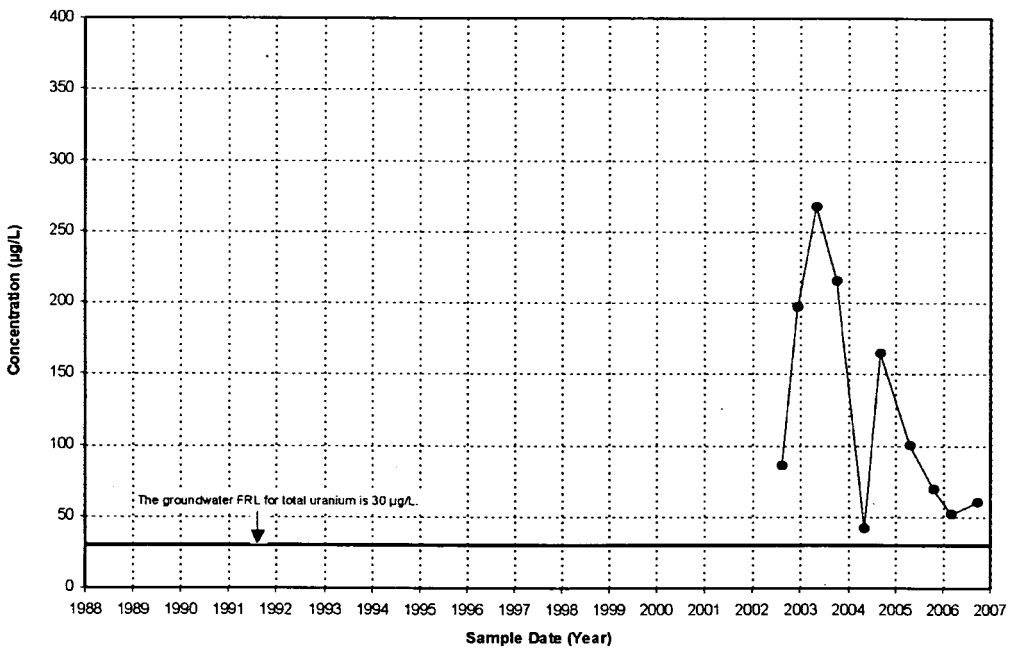

FIGURE A.2-134. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63288

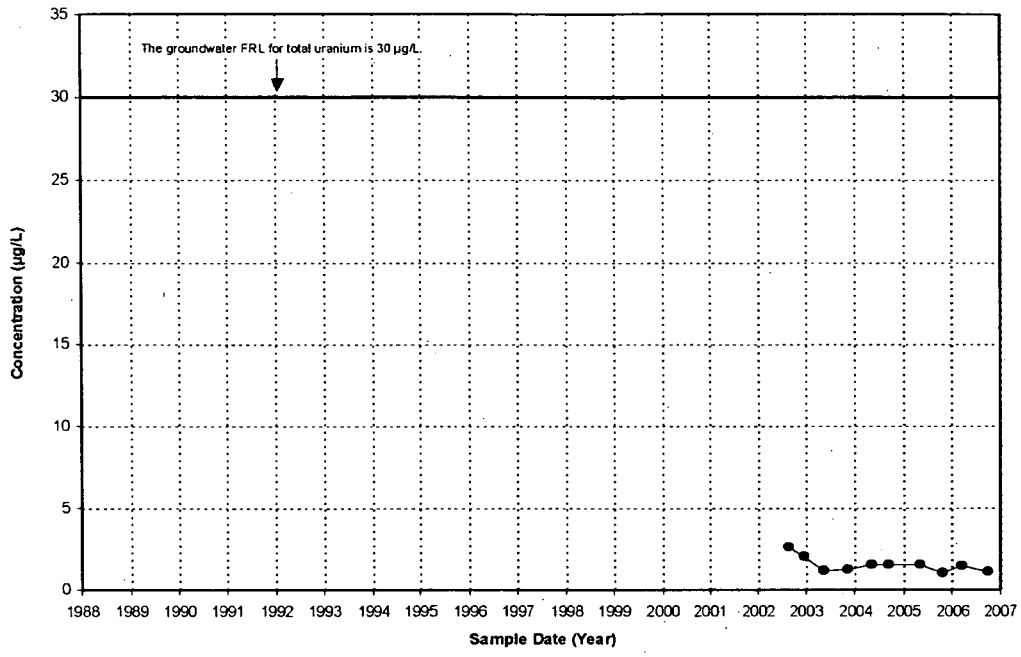

FIGURE A.2-135. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63289

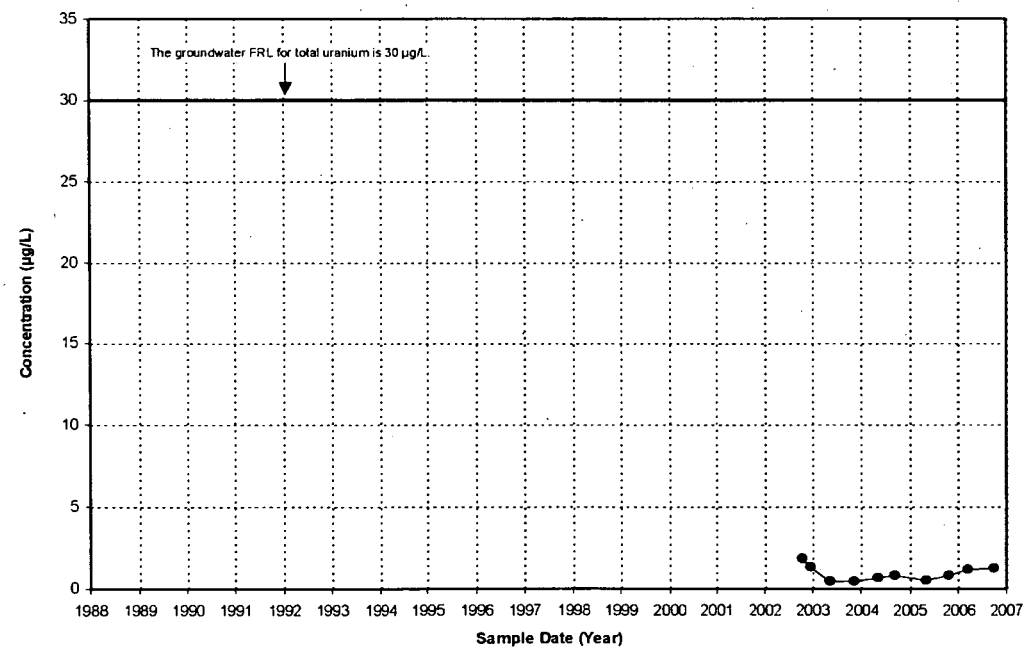

FIGURE A.2-136. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63290

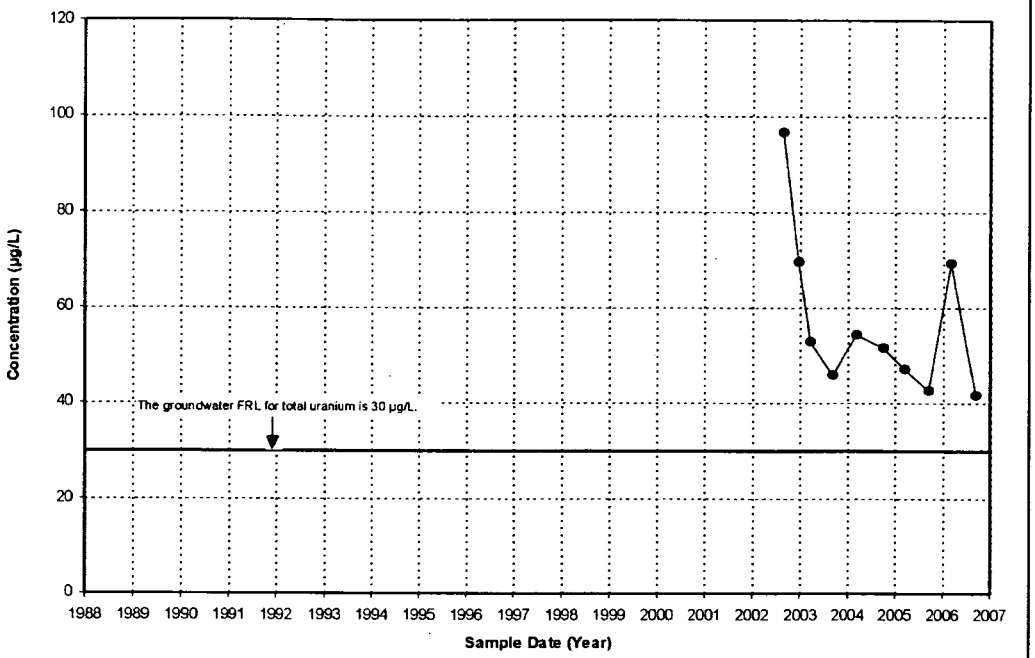

FIGURE A.2-137. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63291

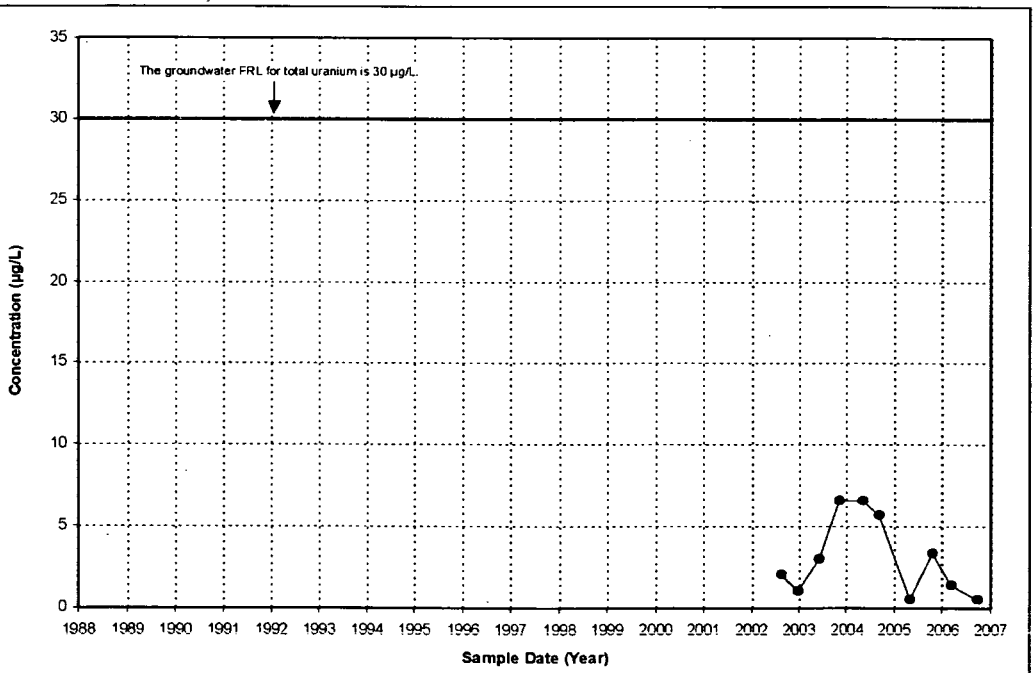

FIGURE A.2-138. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 63292

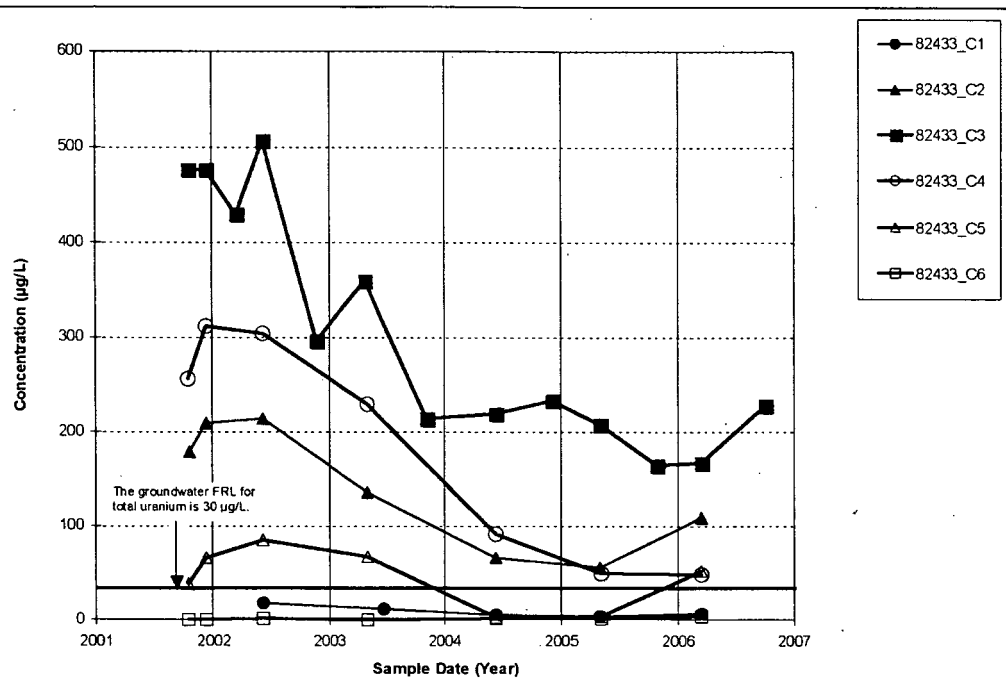

FIGURE A.2-139. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 82433

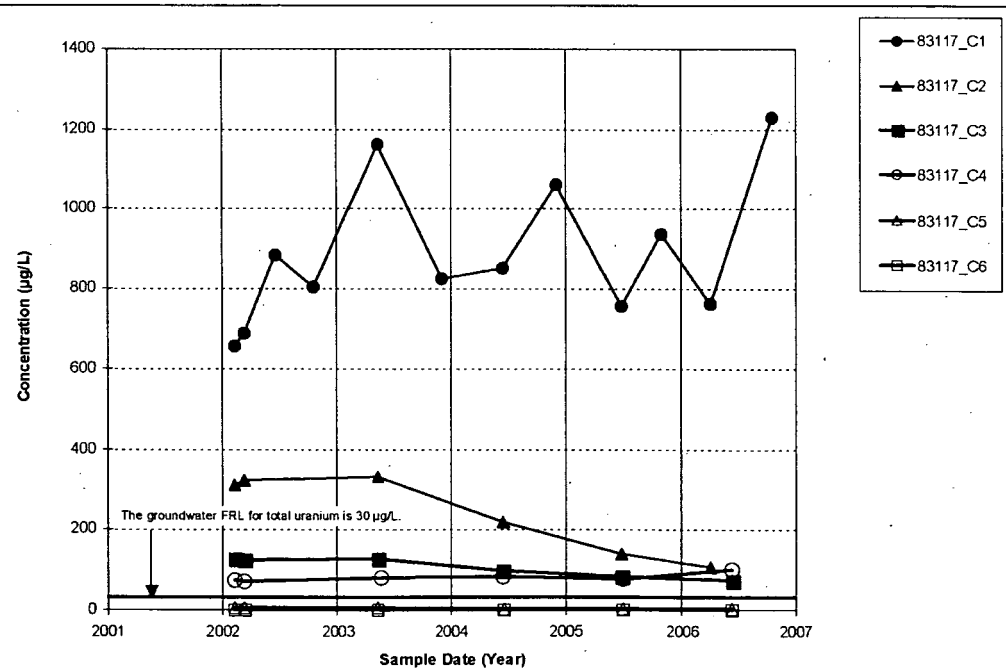

FIGURE A.2-140. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83117

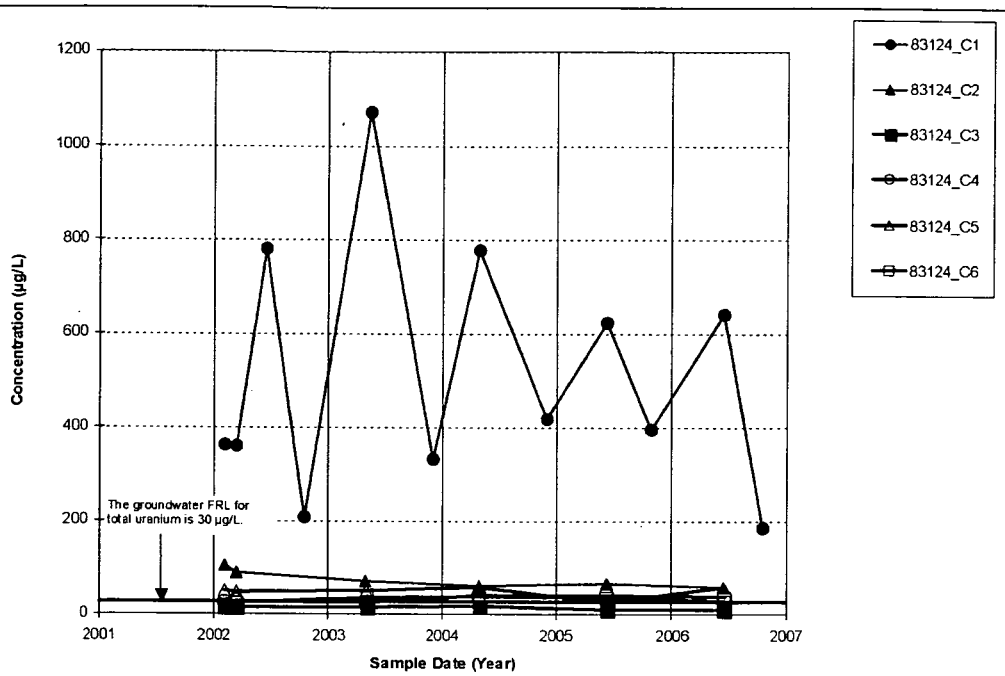

FIGURE A.2-141. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83124

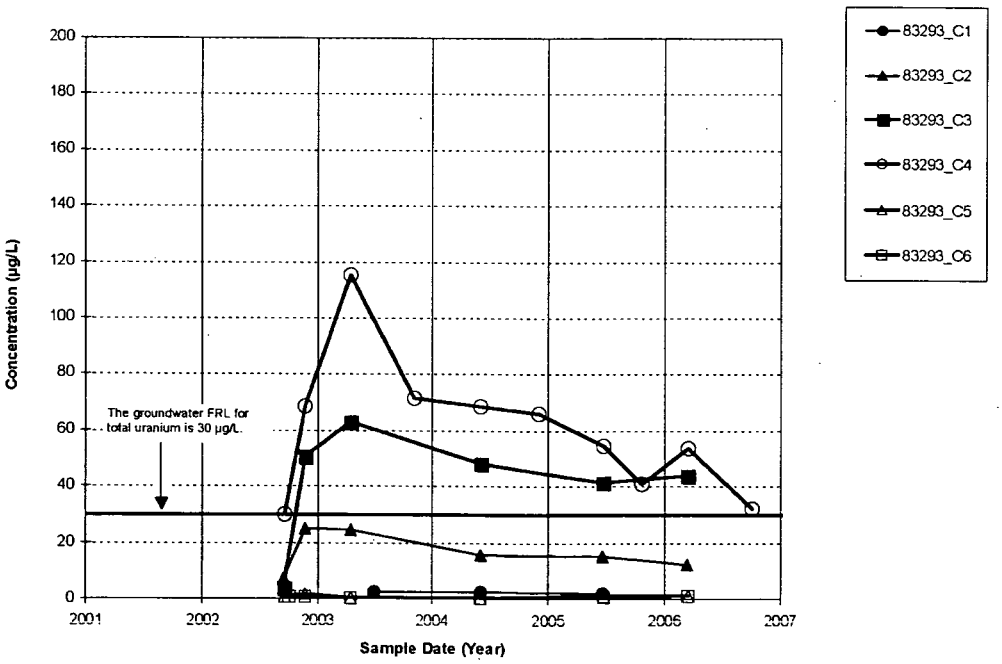

FIGURE A.2-142. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83293

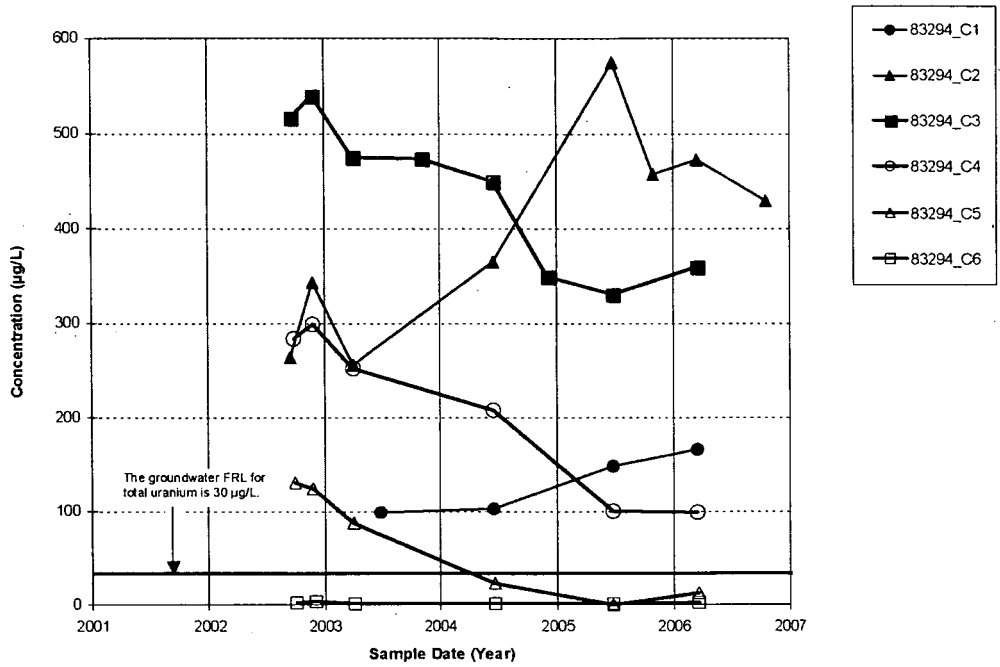

FIGURE A.2-143. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83294

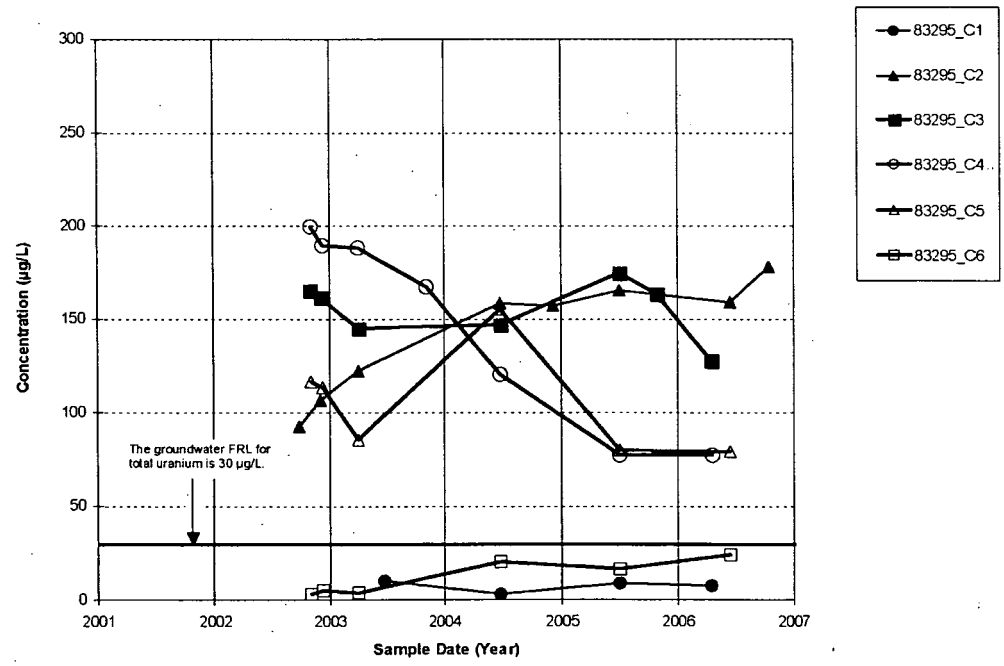

FIGURE A.2-144. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83295

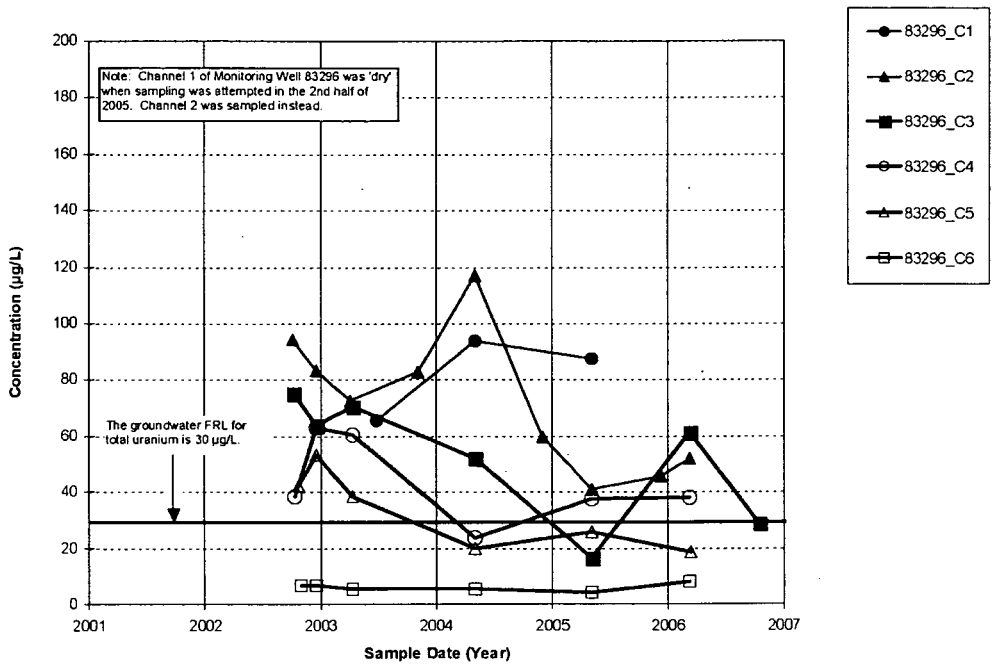

FIGURE A.2-145. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83296

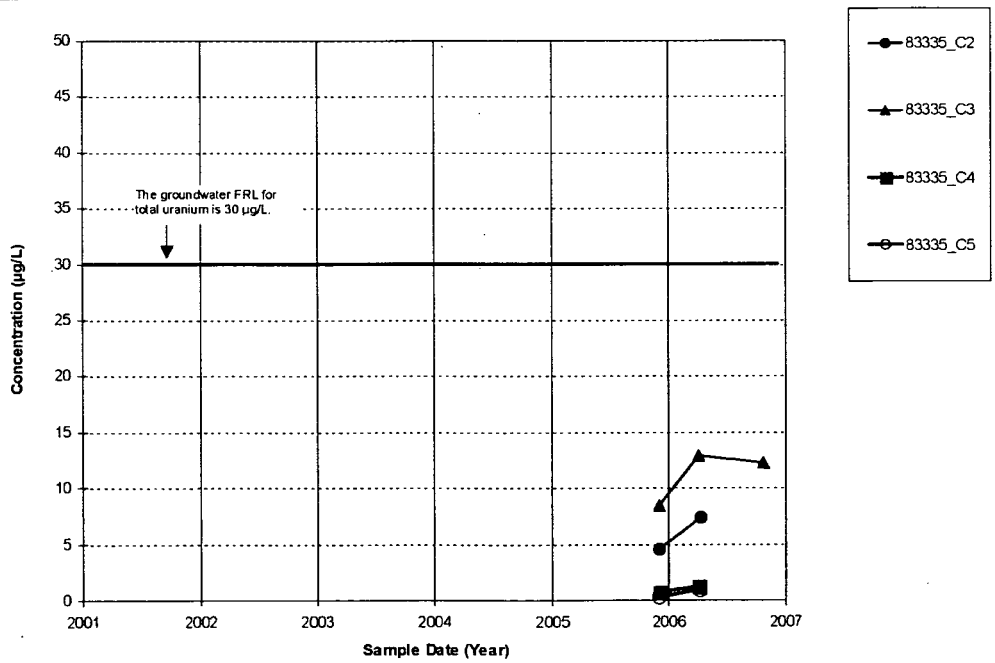

FIGURE A.2-146. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83335

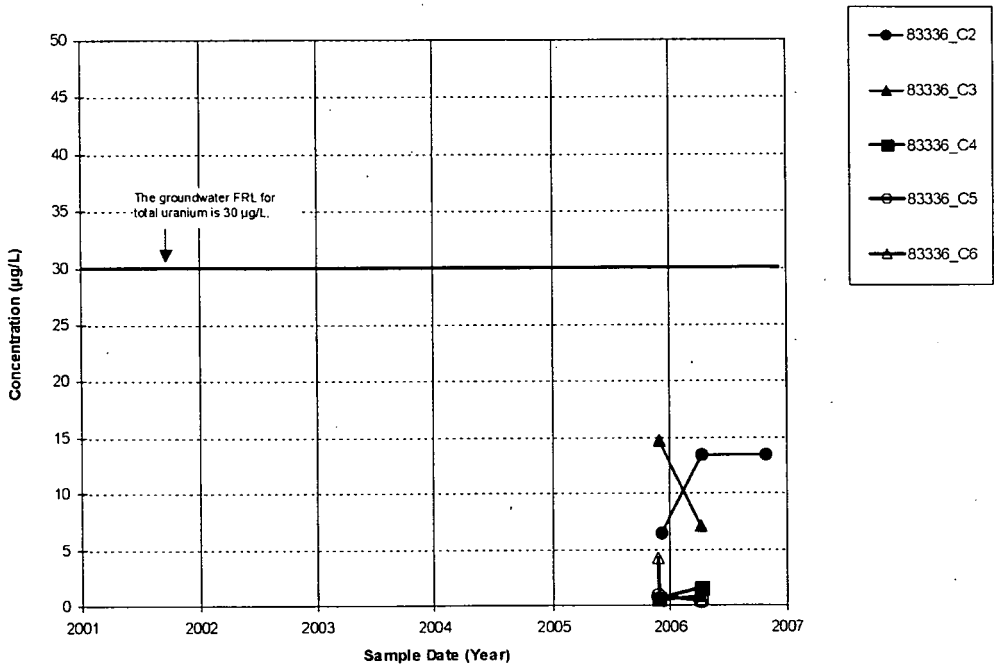

FIGURE A.2-147. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 83336

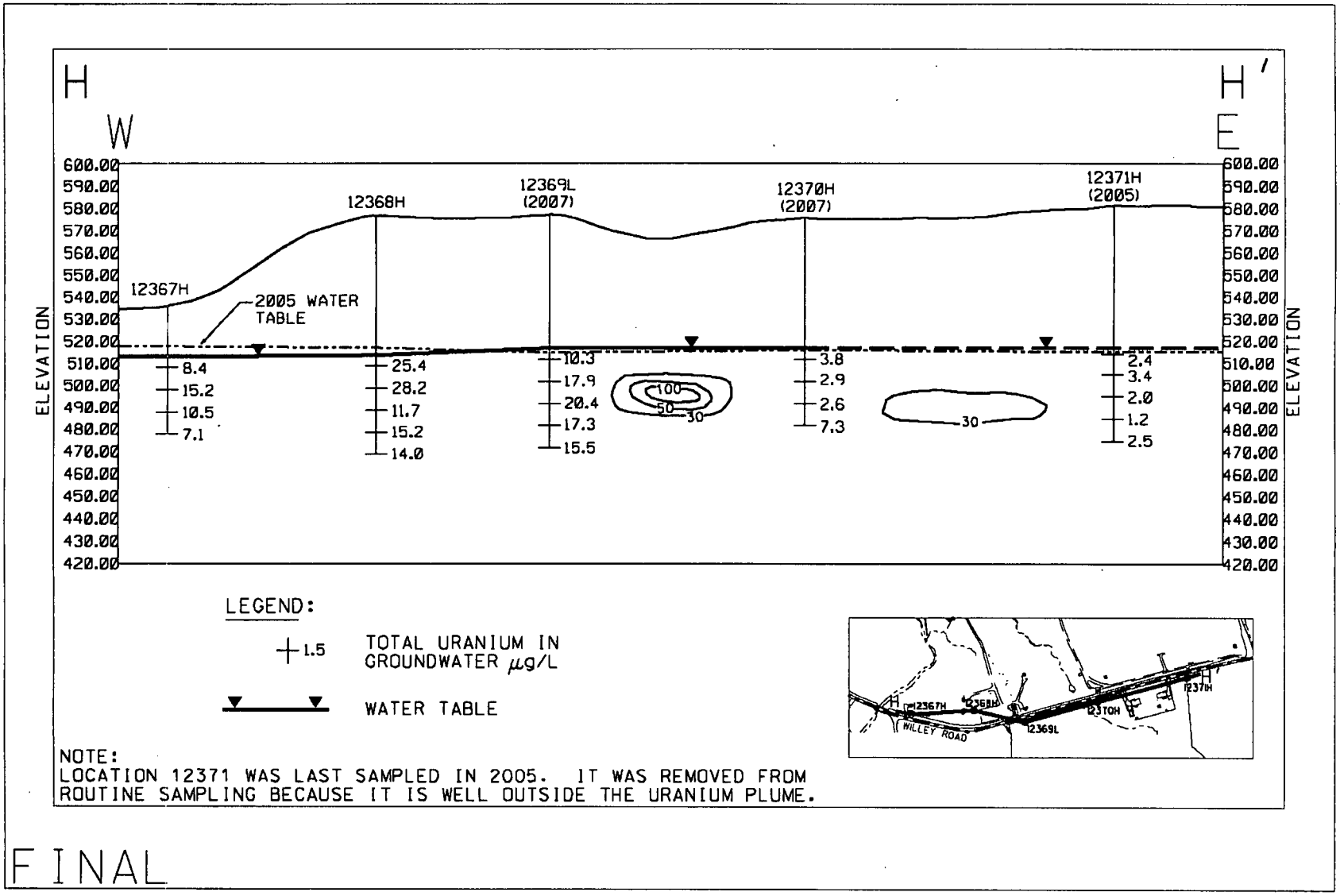

Figure A.2–148. Total Uranium in Ground Water (2006/2007) South of Former Re-Injection Wells

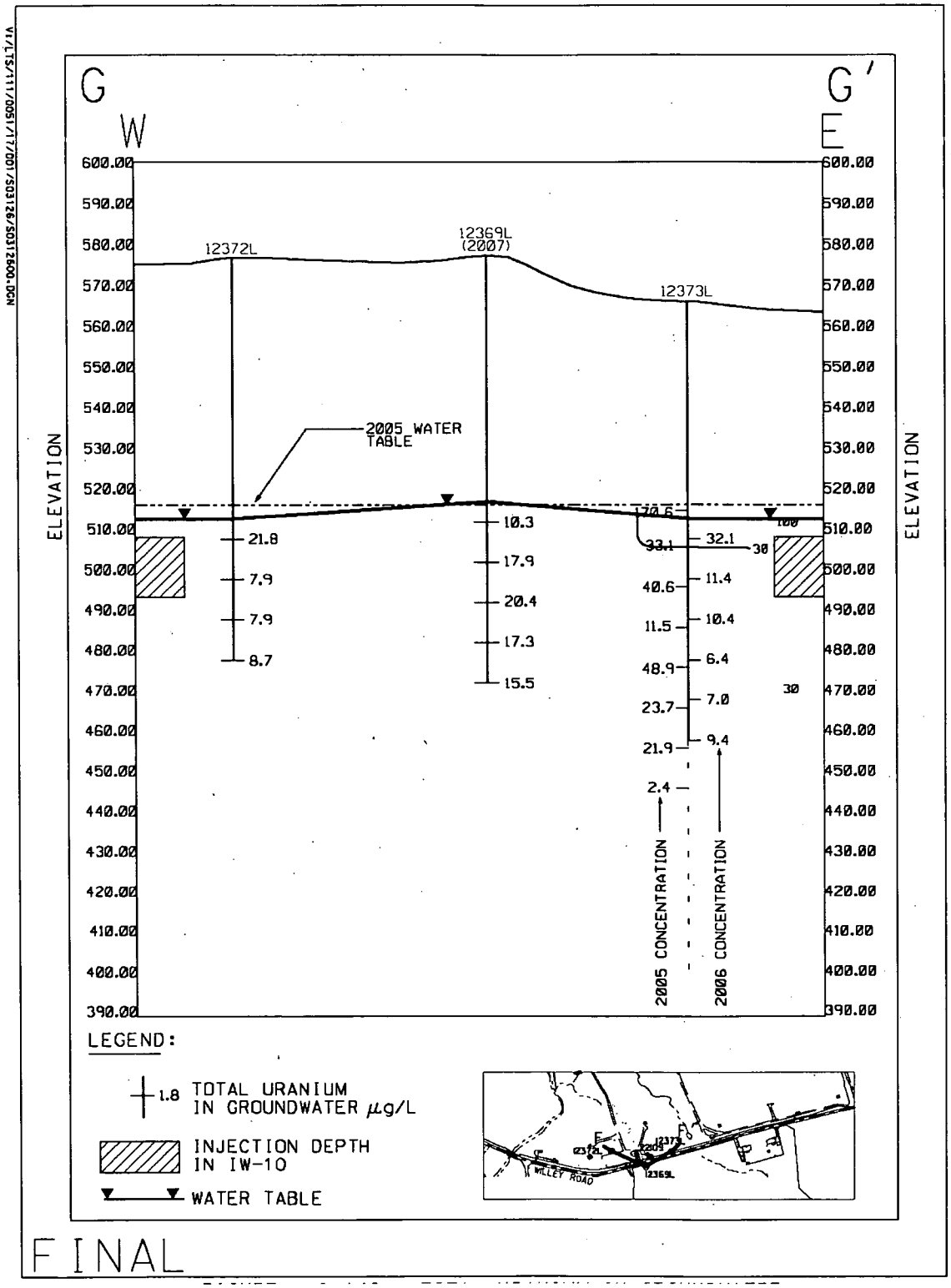

Figure A.2–149. Total Uranium in Ground Water (2006/2007) Next to and South of IW-10

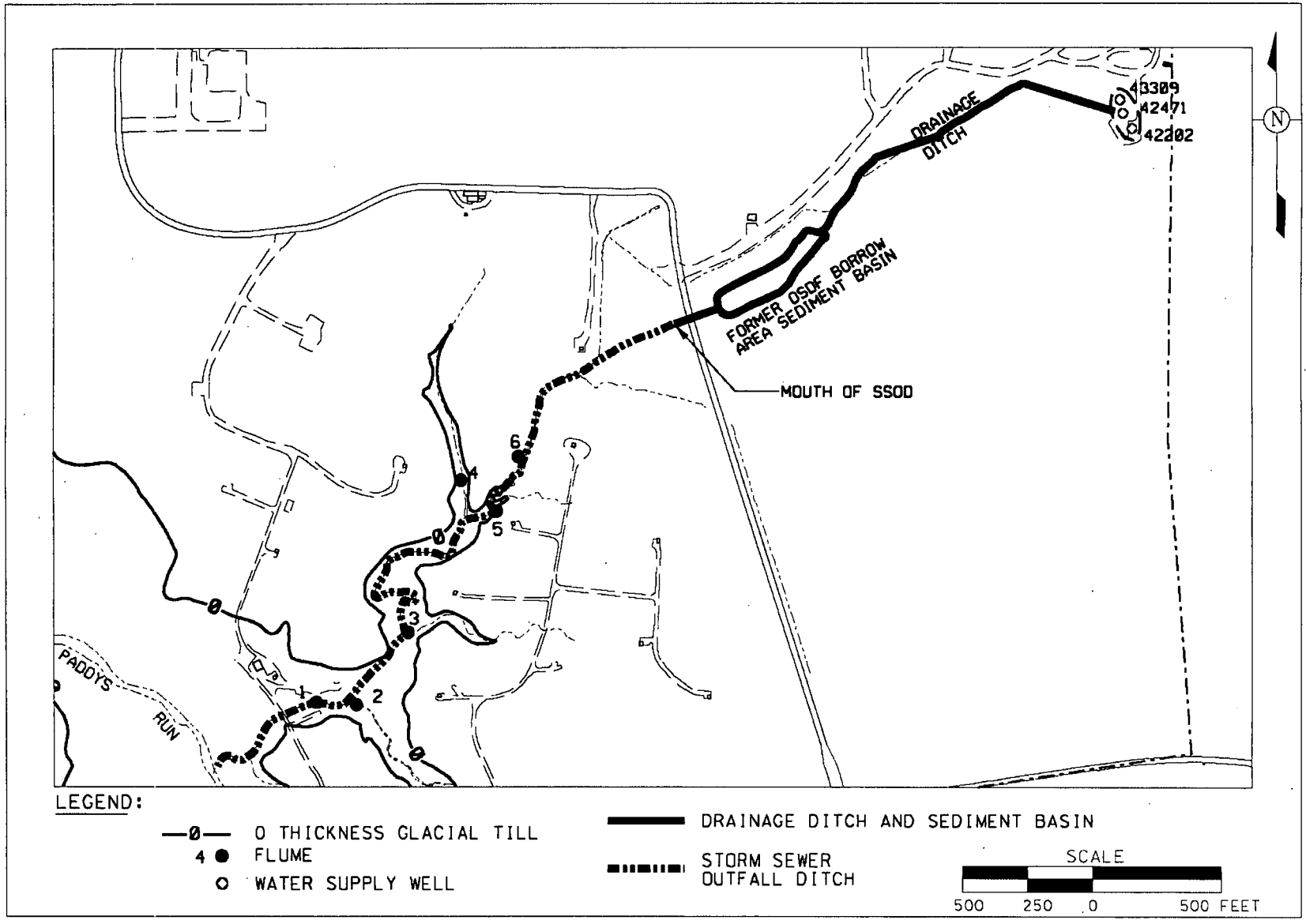

Figure A.2-150. SSOD Flumes and Water Supply Wells

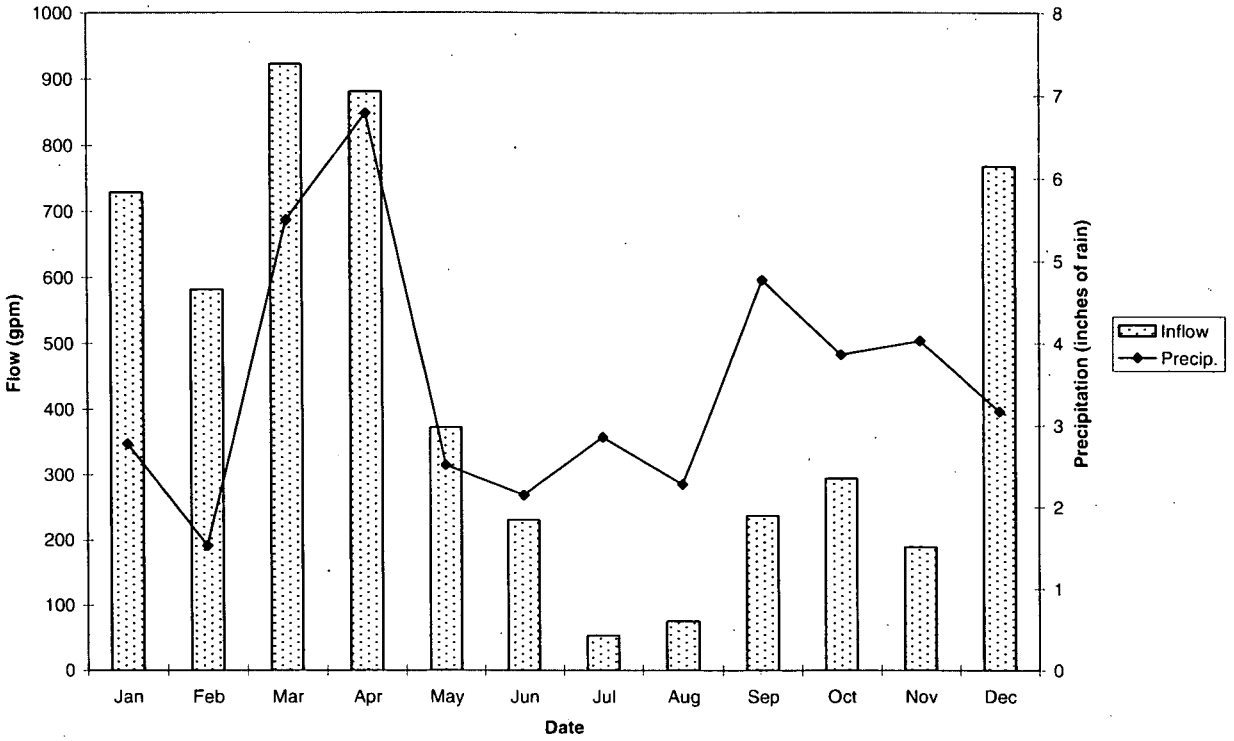

Figure A2-151
Average Monthly Input versus Average Monthly Precipitation

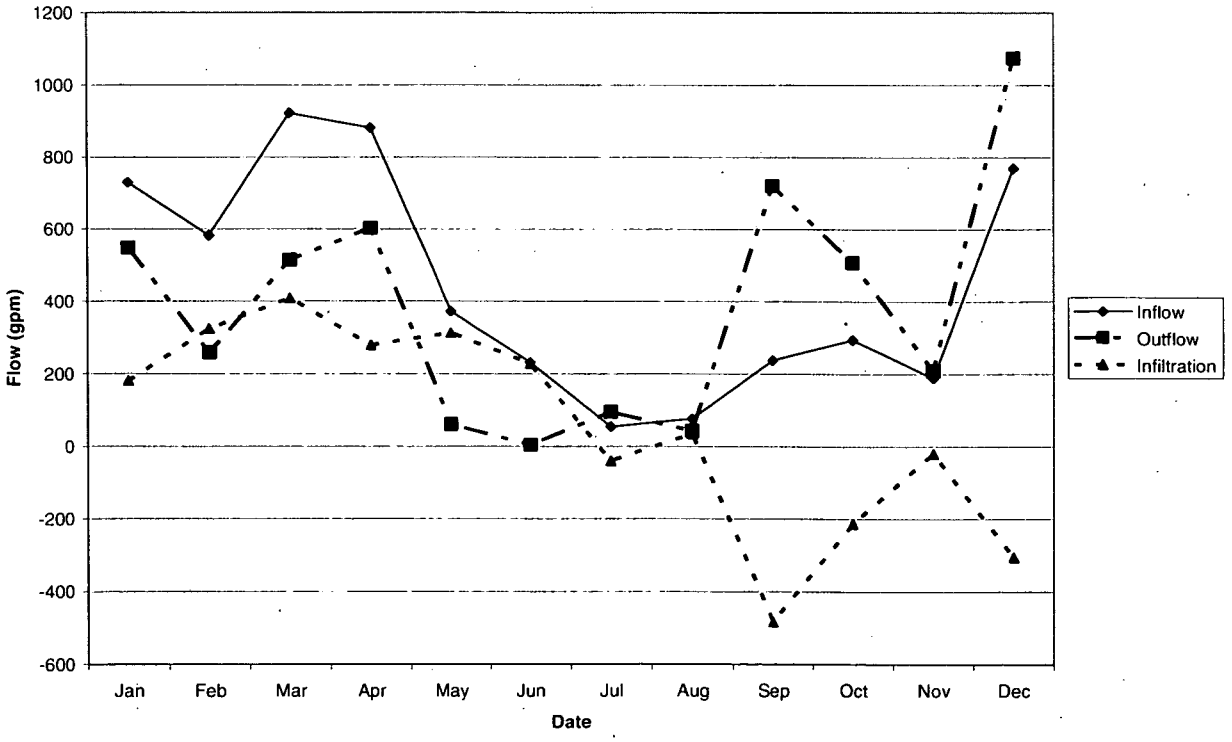

Figure A.2-152
Inflow, Outflow, and Infiltration versus Time

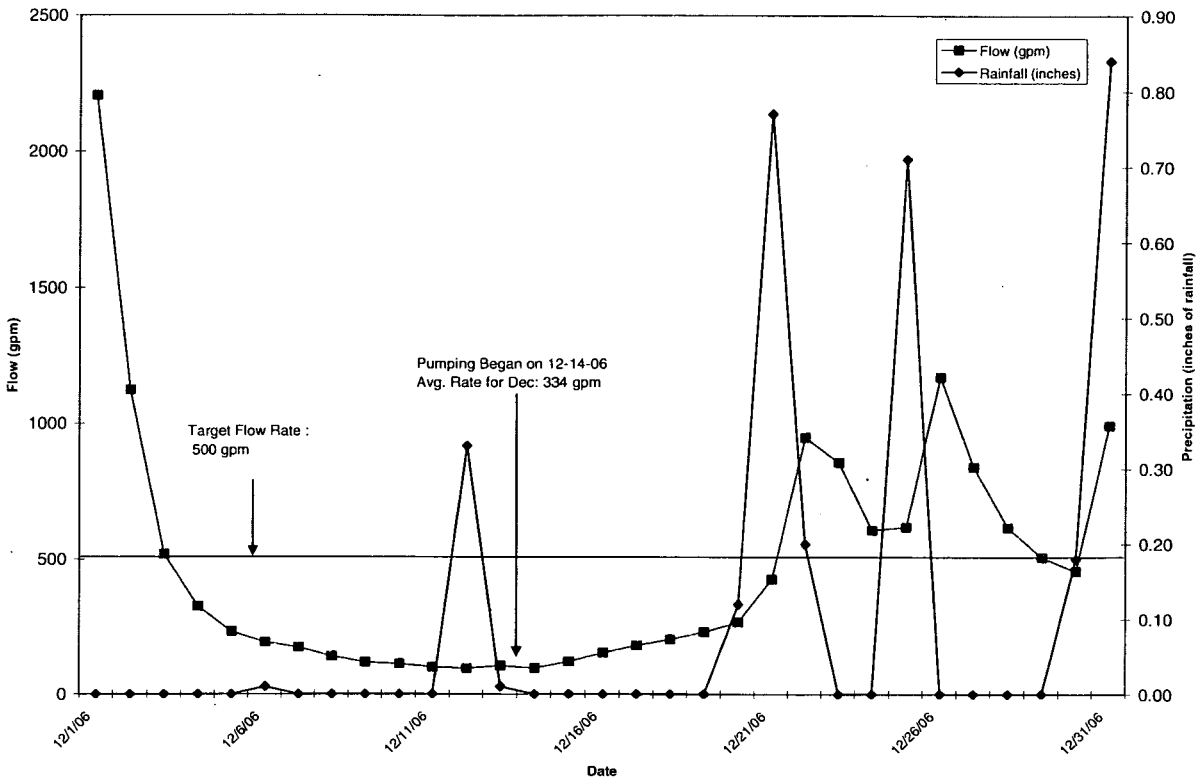

Figure A.2-153
Daily Flow in Flume 6 and Daily Precipitation in December 2006

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Attachment A.3

Attachment A.3

A.3.0 Groundwater Elevations and Capture Assessment

This attachment discusses groundwater elevation and capture assessment. Figures A.3–1 through A.3–4 present groundwater elevation maps for the four quarters of 2006. Each groundwater elevation map contains the following quarter specific information:

- Groundwater elevation data and resulting water table contours
- Interpreted capture zones and flow divides
- Bedrock highs
- Waste Storage Area (Phase II) Design particle track remediation footprint
- Extent of the maximum 30 µg/L total uranium plume
- Module specific pumping rates during the time period in which the groundwater elevation measurements were collected.

Water levels in 2006 were measured in the first and second quarter at 173 locations, as specified in the IEMP, Rev. 4B. Water levels were measured in the third and fourth quarters at 178 locations, as specified in the IEMP, Rev. 5A. Measurements were collected over a time period of 3 to 9 days, as noted below.

Quarter	Measurement Dates	Number of Days	Average Water Level
1	1/4/06 to 1/12/06	9	515.80 feet amsl
2	4/7/06 to 4/12/06	6	517.55 feet amsl
3	7/10/06 to 7/17/06	8	516.46 feet amsl
4	10/9/06 to 10/11/06	3	514.15 feet amsl

Fifteen monitoring wells were not measured at various times in 2006 either because the wells were dry, not accessible, or plugged and abandoned. A summary is provided below.

Well	First Quarter	Second Quarter	Third Quarter	Fourth Quarter
2014			Dry	Dry
2544				Dry
2552				Not Accessible
2625				Dry
2636			Dry	Dry
2648			Not Accessible	Not Accessible
2649		Not Accessible	Not Accessible	Not Accessible
3011	Not Accessible			
3552				Not Accessible
21192	Dry	Dry	Dry	Dry
22209			Not Accessible	
22212			Not Accessible	
22213			Not Accessible	
22216		Abandoned	Abandoned	Abandoned
23118			Not Accessible	

Water level assessments in 2006 were impacted by operational disruptions and pumping rate changes. Most of these disruptions/pumping rate changes resulted from site remediation activities. The number of wells pumping in each restoration module and the average pumping rate for each restoration module are indicated on the quarterly water level maps (i.e., Figures A.3–1 through A.3–4). Information on the figures indicates that extraction wells were sometimes turned off and on during the time period that water levels were collected in 2006. An example of this is water level measurements collected during the first quarter of 2006 from January 4 through January 12 (refer to Figure A.3–1). The number of extraction wells pumping in the South Field went from 11 to seven during this time period. This is noted on Figure A.3–1 by "11/7" for the South Field extraction operational status. The pumping rates on the figures are averages of the actual pumping rates during the measurement period. Operational disruptions and pumping rate changes impact water levels and are avoided as much as possible during measurement periods. The disruptions and pumping rate changes noted on the water level maps for 2006 are the ones that could not be avoided, due to the numerous remediation activities that took place in 2006.

During 2006 the water table in the measurement area fluctuated on average approximately 3.4 feet. The fluctuation range was approximately 2 feet to 7.1 feet depending on the location of the well being measured and its proximity to recharge areas. Six wells in 2006 had a measured water level variance over the course of the year of 5 feet or more (Well 2044 – 5 feet, Well 2107 – 5.6 feet, Well 3402 – 5.6 feet, Well 2402 – 5.6 feet, Well 2017 – 5.8 feet, and Well 23281 – 7.1 feet). All of these wells are located along the western half of the plume near recharge from Paddy's Run.

Uranium contamination bound to aquifer sediments in the unsaturated portions of the Great Miami Aquifer has been identified under some source areas. An annual exercise is being planned to shut down all extraction wells (with the exception of the four leading edge South Plume Recovery Wells) from June 15 to July 15 to allow water levels within the aquifer to rise. Based on evaluation of aquifer water levels collected since 1988, during June and July seasonal water levels are usually at their highest level. Shutting down the extraction wells during the same time period that seasonal water levels are high will maximize the saturation of as much aquifer sediment as possible.

The 2006 quarterly groundwater elevation maps shown in Figures A.3–1 through A.3–4 illustrate capture of the maximum total uranium plume by means of capture zones interpreted from quarterly water level measurements; predicted capture based on Waste Storage Area (Phase II) design particle track modeling; and contoured water table gradients.

It should be noted that the Waste Storage Area (Phase II) design remediation footprint used in this report was constructed using reverse, non retarded, particle path interpretations from the VAM 3D, Zoom Groundwater Model.

Figure A.3–5 shows the resulting particle tracks that were used to define the Waste Storage Area (Phase II) design remediation footprint. Model particles were seeded at each extraction well. The resulting particle tracks represent the individual path that each particle traveled over the time period of the Waste Storage Area (Phase II) design (2007 to 2023). The limits of most of the particle tracks are truncated because the particles reached the edge of the Zoom Groundwater Model domain.

Quarterly capture zone interpretations were added to the maps for each quarter in areas where the data indicated they were present (i.e., Waste Storage Area and South Plume).

Due to the discontinuance of re-injection along Willey Road, capture delineation between the South Field and South Plume could not be determined. In past years, re-injection along Willey Road created small areas of elevated water levels, which could be connected to illustrate the extent of the South Field capture. The groundwater flow divide between Paddys Run Outlet and the New Baltimore Outlet was not readily distinguishable in 2006.

The quarterly capture zone interpretations coupled with the Waste Storage Area (Phase II) particle track interpretations and contoured water table gradients indicate that the 30 μg/L total uranium plume was being captured in 2006.

Well cluster hydrographs are also provided in this attachment as a means to assess vertical groundwater gradients. The hydrographs depict groundwater elevations available from 1993 through 2006 from Type 2 and Type 3 wells in the same cluster. Hydrographs for the following monitoring well clusters appear in Figures A.3–6 through A.3–27: 014, 017, 045, 046, 049, 065, 069 (434), 095, 106, 125, 385, 387, 390, 396, 398, 402, 550, 552, 821, 880, 881, and 900. (Note: The last three digits of the monitoring wells identify the well clusters, e.g., cluster 552 consists of Monitoring Wells 2552 and 3552). Figure A.3–28 identifies the well cluster locations.

Analysis of these hydrographs for 2006 indicates that elevations in the Type 2 and Type 3 monitoring wells within the majority of the clusters are almost always identical for each measurement event. An occasional slight difference can be seen, but these differences do not appear to be indicative of vertical hydraulic gradients. Rather, they are attributed to measurement, transcription, or error during data collection and processing.

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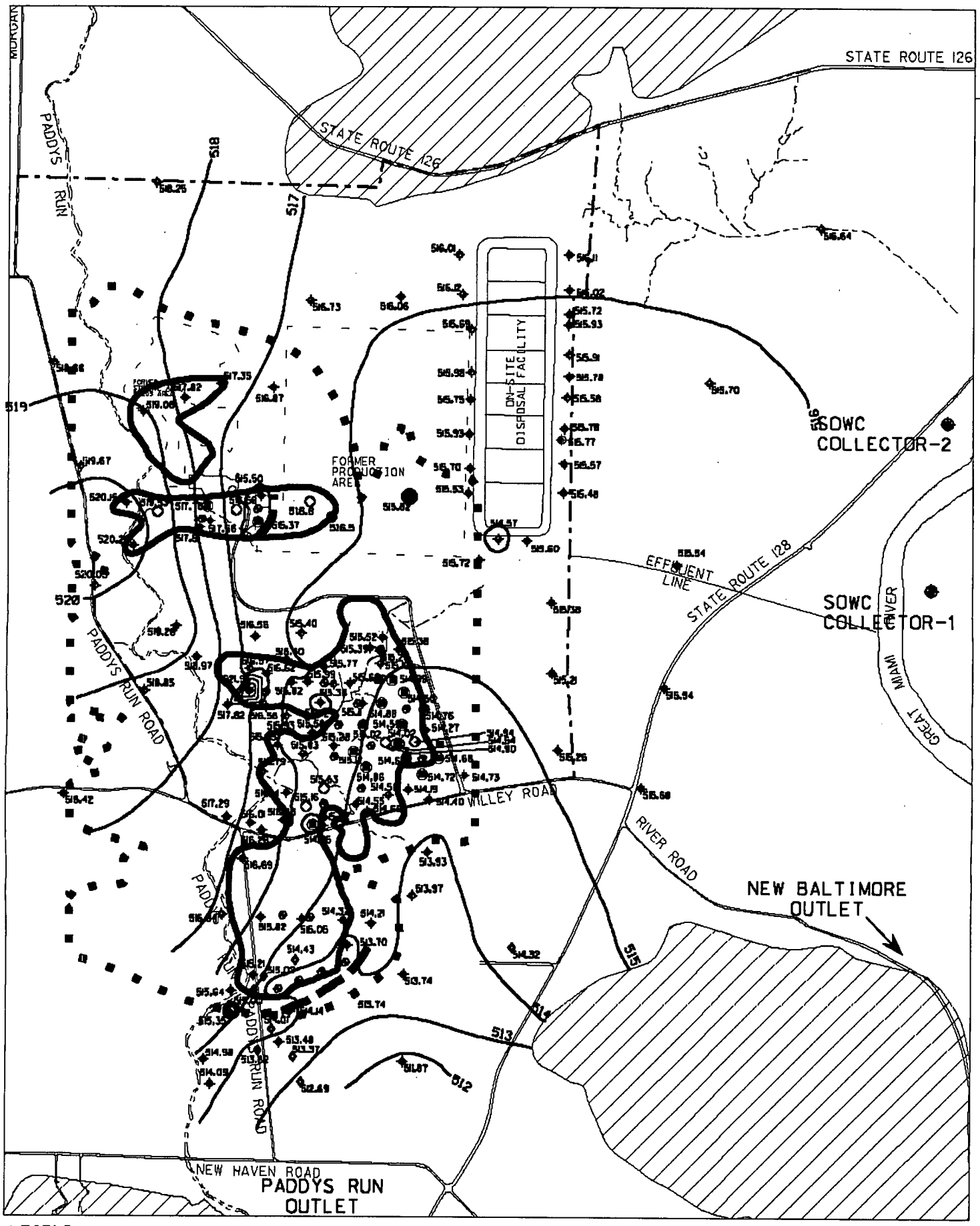

LEGEND:

- FERNALD SITE BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- BEDROCK HIGHS
- WSA (PHASE II) DESIGN REMEDIATION FOOTPRINT (DEFINED IN ATTACHMENT A.3)
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- EXTRACTION WELL
- EXTENT OF THE MAXIMUM TOTAL URANIUM 30 µg/L CONTOUR FROM BRSR, MODIFIED AS NEEDED THROUGH FIRST HALF 2006

JANUARY 4 THROUGH JANUARY 12, 2006 OPERATIONAL STATUS:	AVERAGE PUMPING RATES (gpm)
SOUTH PLUME: 5/4 WELLS	784
SOUTH FIELD EXTRACTION: 11/7 WELLS	1,378
WASTE STORAGE AREA: 1 WELL	412

SCALE
1300 650 0 1300 FEET

FINAL

Figure A.3–1. Routine Ground Water Elevation Map, First Quarter 2006 (January 4 through January 12, 2006)

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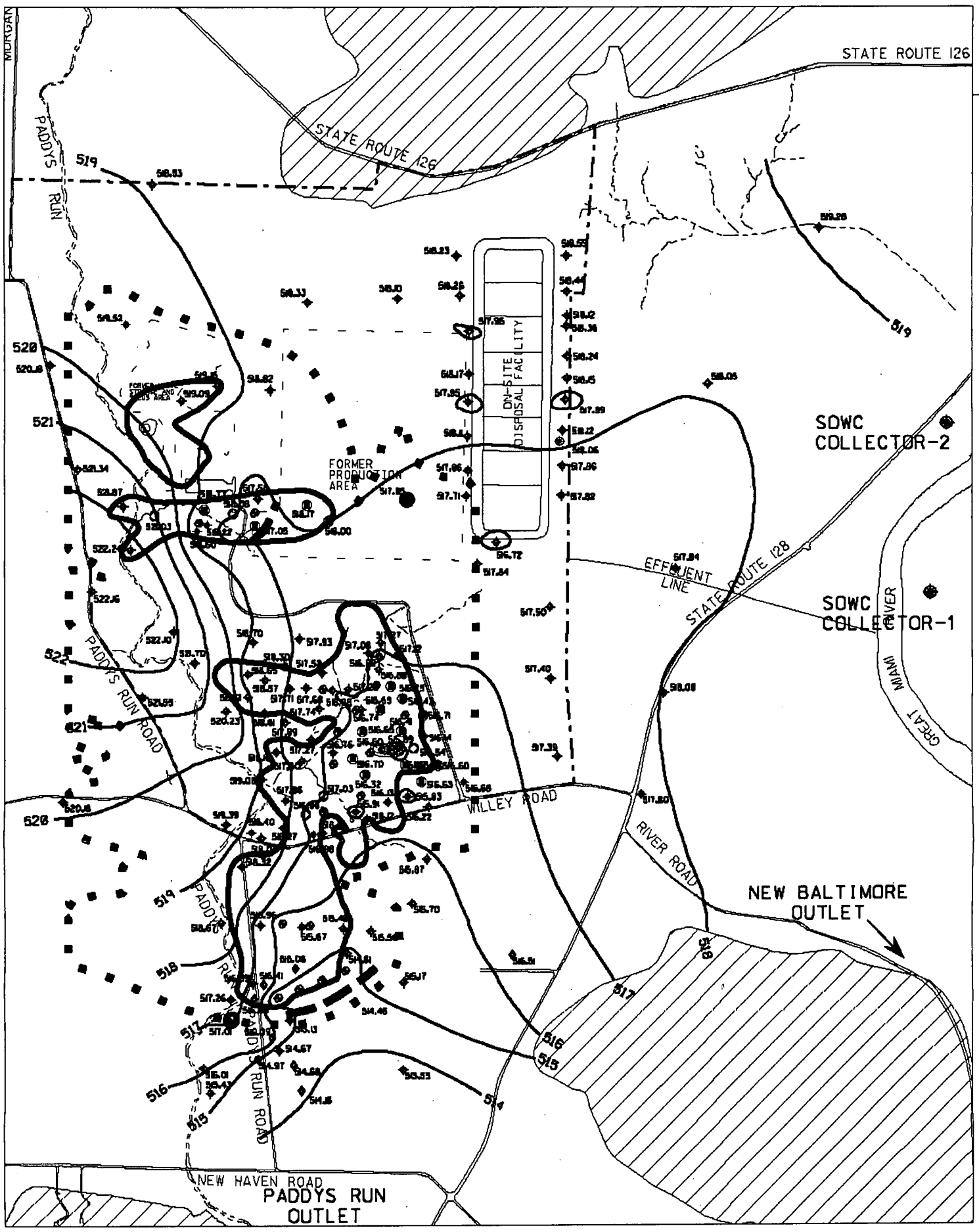


LEGEND:

- FERNALD SITE BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- BEDROCK HIGHS
- WSA (PHASE II) DESIGN REMEDIATION FOOTPRINT (DEFINED IN ATTACHMENT A.3)
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- EXTRACTION WELL
- EXTENT OF THE MAXIMUM TOTAL URANIUM 30 µg/L CONTOUR FROM BRSR. MODIFIED AS NEEDED THROUGH FIRST HALF 2006

APRIL 1 THROUGH APRIL 12, 2006 OPERATIONAL STATUS:	AVERAGE PUMPING RATES (gpm)
SOUTH PLUME: 6/5 WELLS	1,074
SOUTH FIELD EXTRACTION: 11 WELLS	2,336
WASTE STORAGE AREA: 2 WELLS	719

SCALE
1300 650 0 1300 FEET

FINAL

Figure A.3–2. Routine Ground Water Elevation Map, Second Quarter 2006 (April 1 through April 12, 2006)

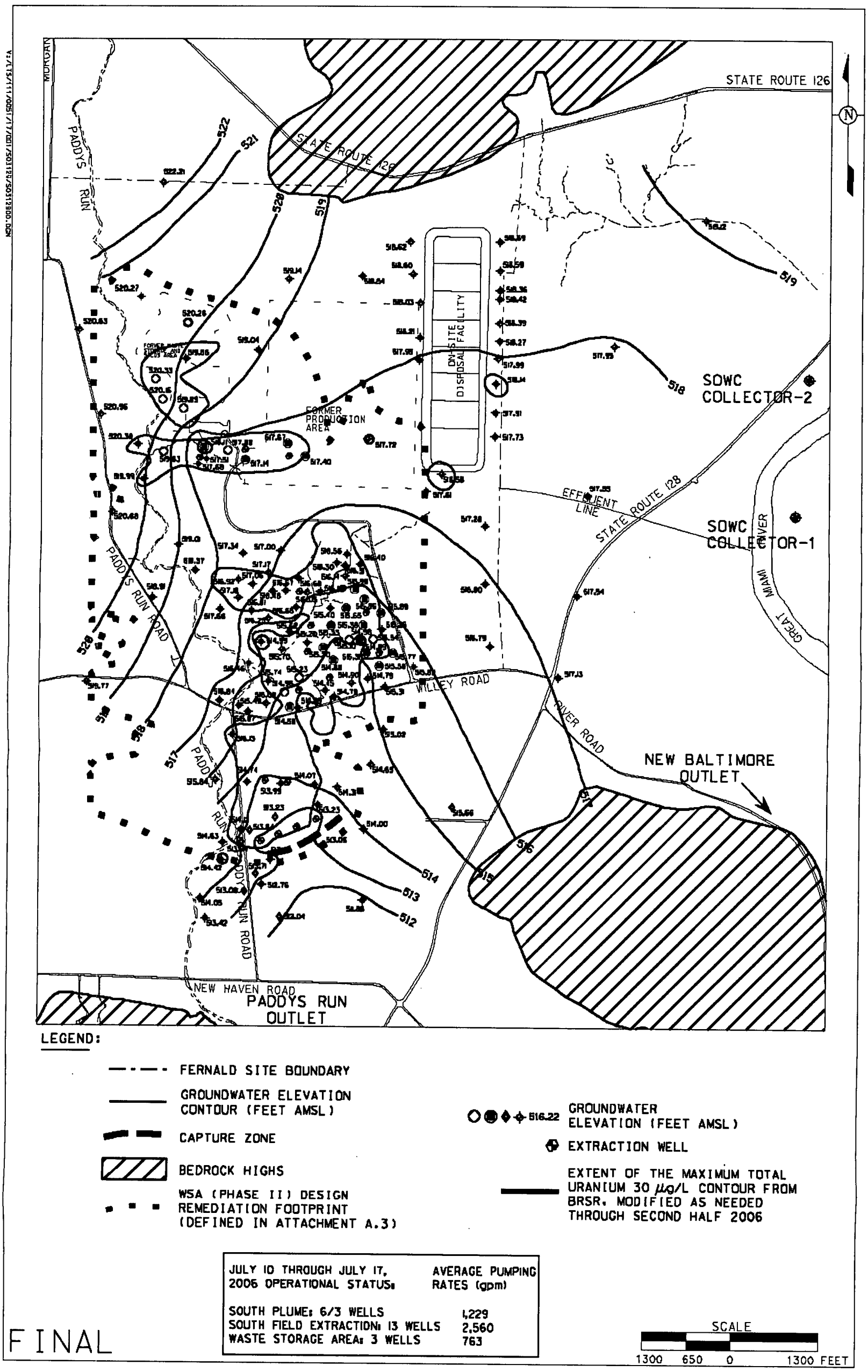
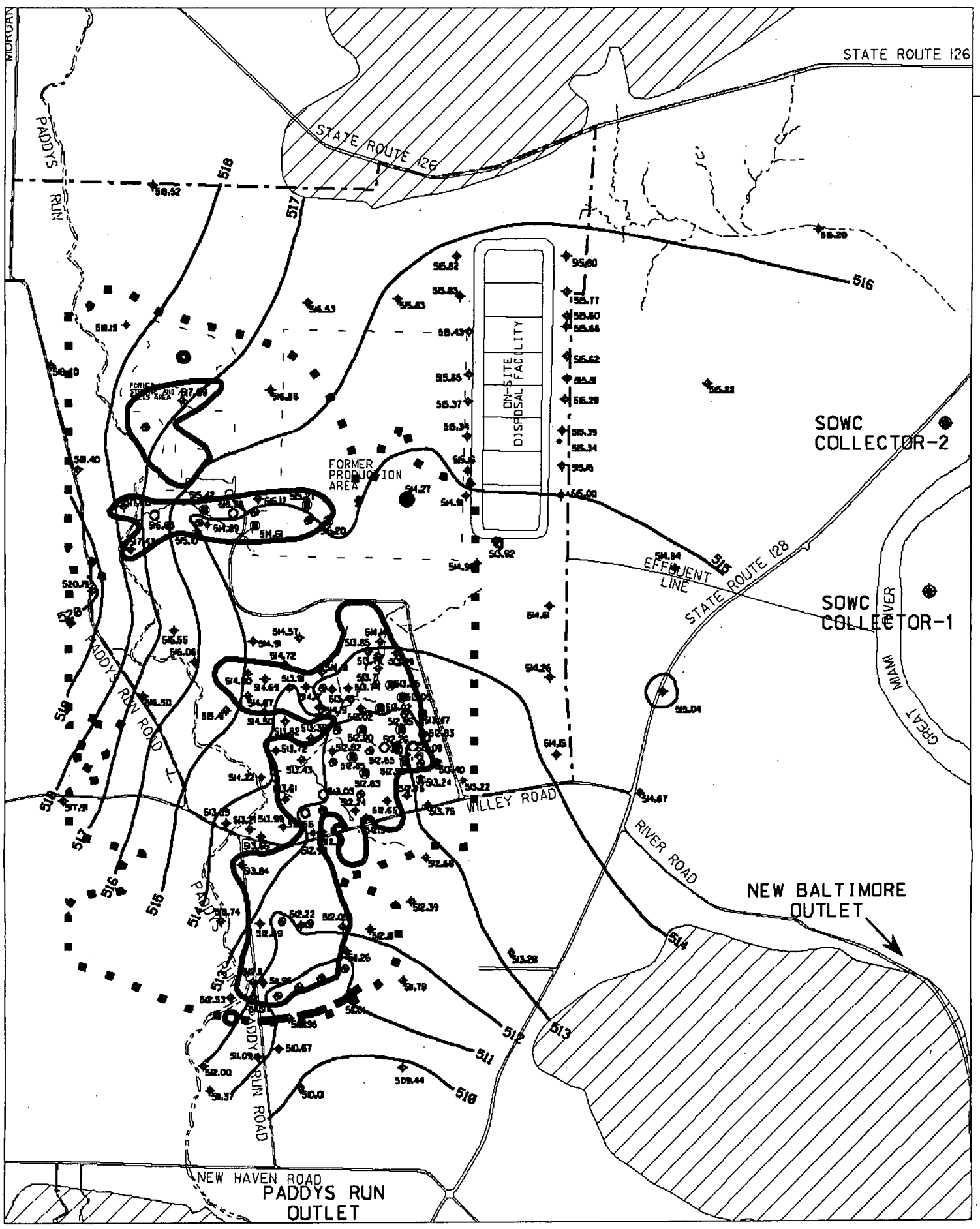


Figure A.3–3. Routine Ground Water Elevation Map, Third Quarter 2006 (July 10 through July 17, 2006)

Document 6740



LEGEND:

- FERNALD SITE BOUNDARY
- GROUNDWATER ELEVATION CONTOUR (FEET AMSL)
- CAPTURE ZONE
- BEDROCK HIGHS
- WSA (PHASE II) DESIGN REMEDIATION FOOTPRINT (DEFINED IN ATTACHMENT A.3)
- 516.22 GROUNDWATER ELEVATION (FEET AMSL)
- EXTRACTION WELL
- EXTENT OF THE MAXIMUM TOTAL URANIUM 30 µg/L CONTOUR FROM BRSR. MODIFIED AS NEEDED THROUGH SECOND HALF 2006

OCTOBER 9 THROUGH OCTOBER 11, 2006 OPERATIONAL STATUS:	AVERAGE PUMPING RATES (gpm)
SOUTH PLUME: 5 WELLS	1,119
SOUTH FIELD EXTRACTION: 13 WELLS	2,628
WASTE STORAGE AREA: 4 WELLS	1,105

SCALE
1300 650 0 1300 FEET

FINAL

Figure A.3–4. Routine Ground Water Elevation Map, Fourth Quarter 2006 (October 09 through October 11, 2006)

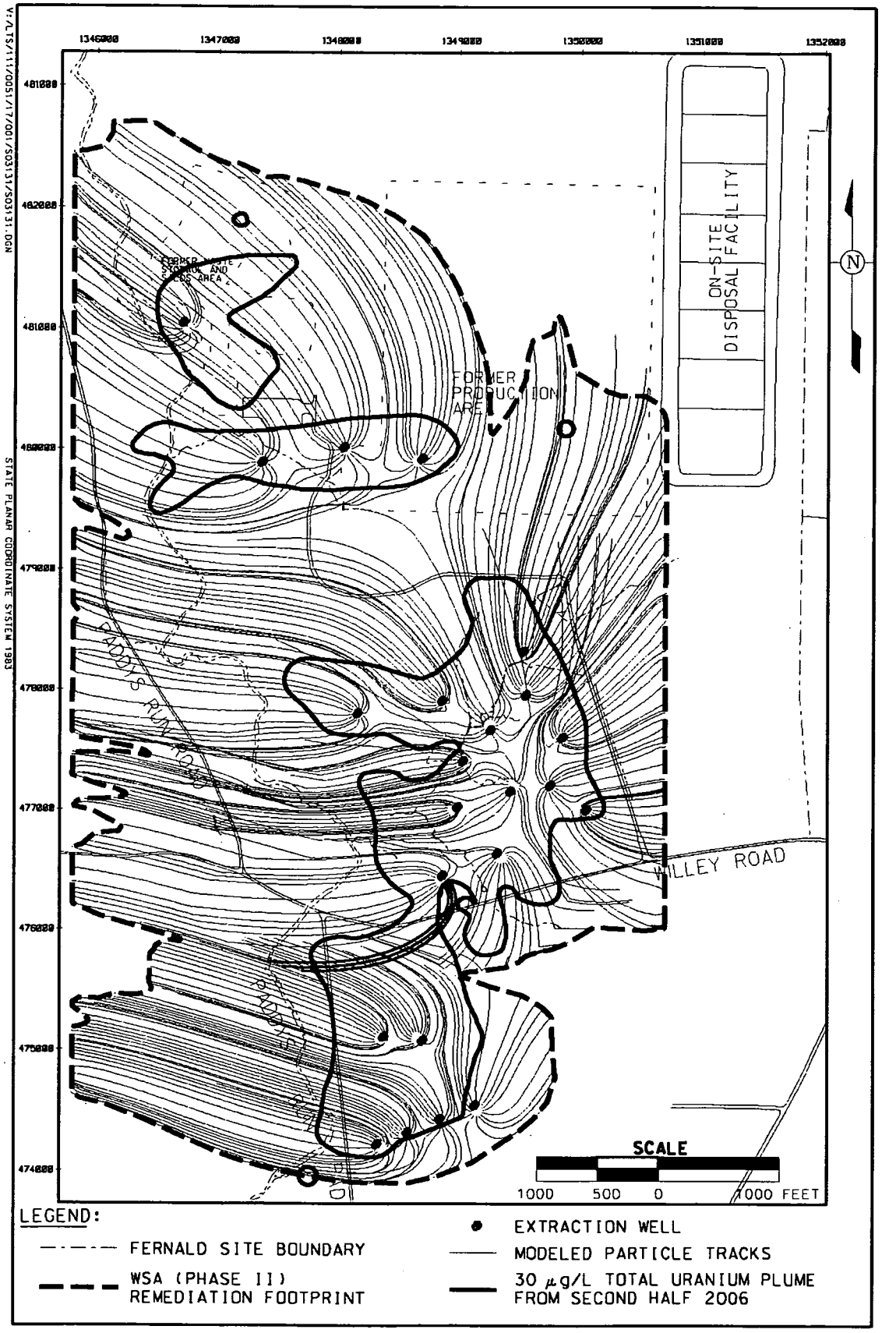


FIGURE A.3-5. WSA (PHASE-II) DESIGN REMEDIATION FOOTPRINT

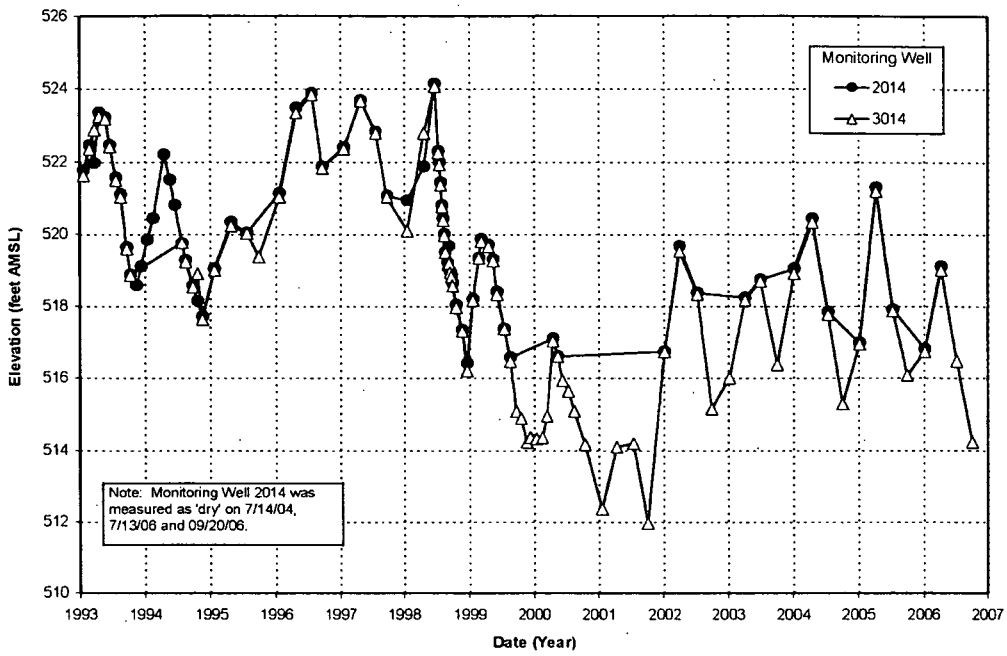


FIGURE A.3-6. HYDROGRAPH FOR WELL CLUSTER 014

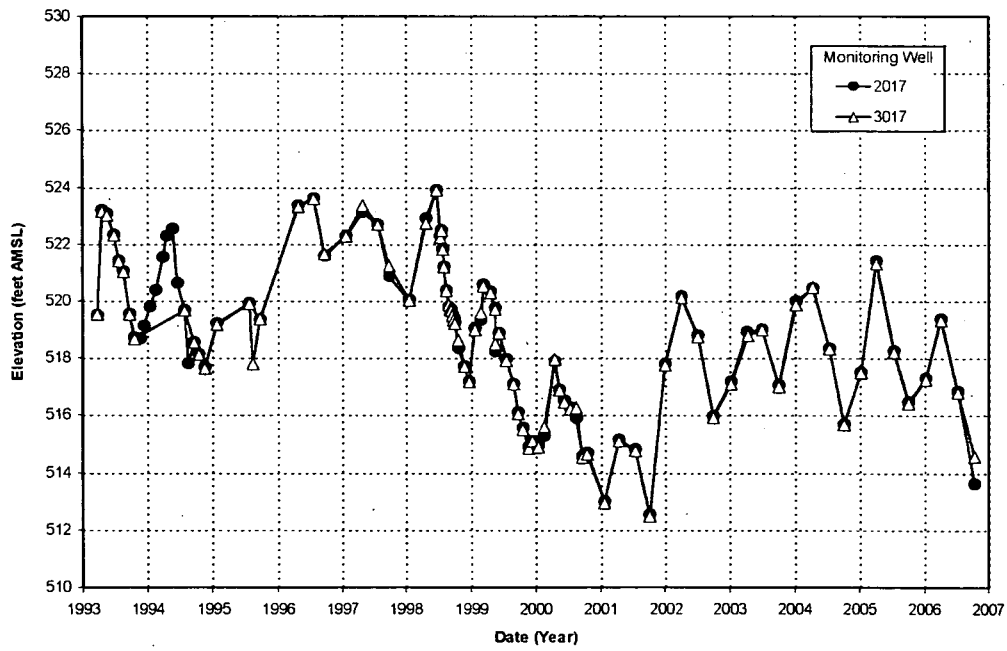


FIGURE A.3-7. HYDROGRAPH FOR WELL CLUSTER 017

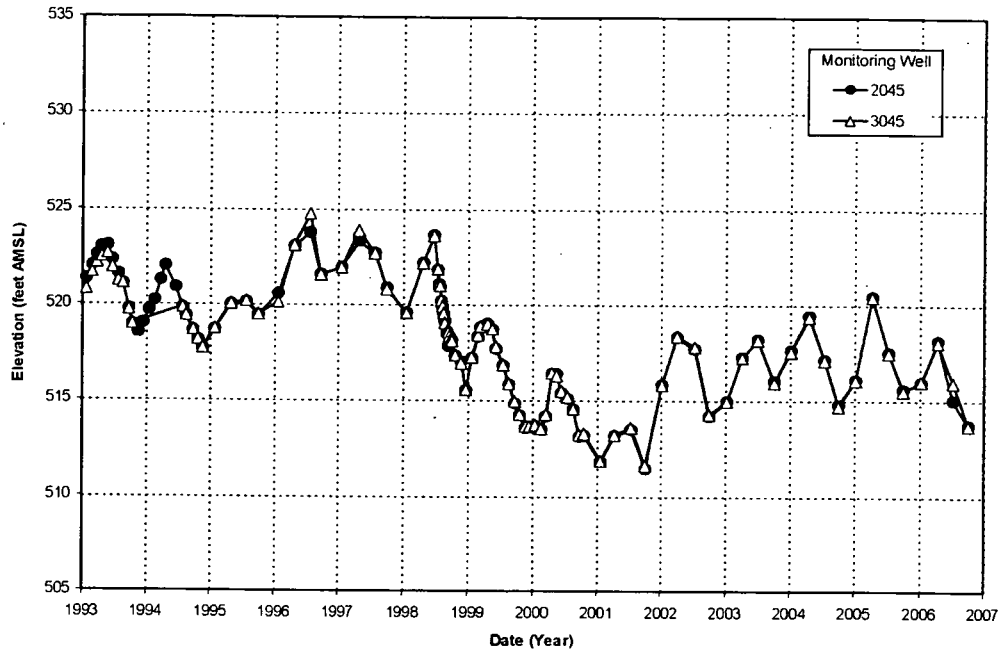


FIGURE A.3-8. HYDROGRAPH FOR WELL CLUSTER 045

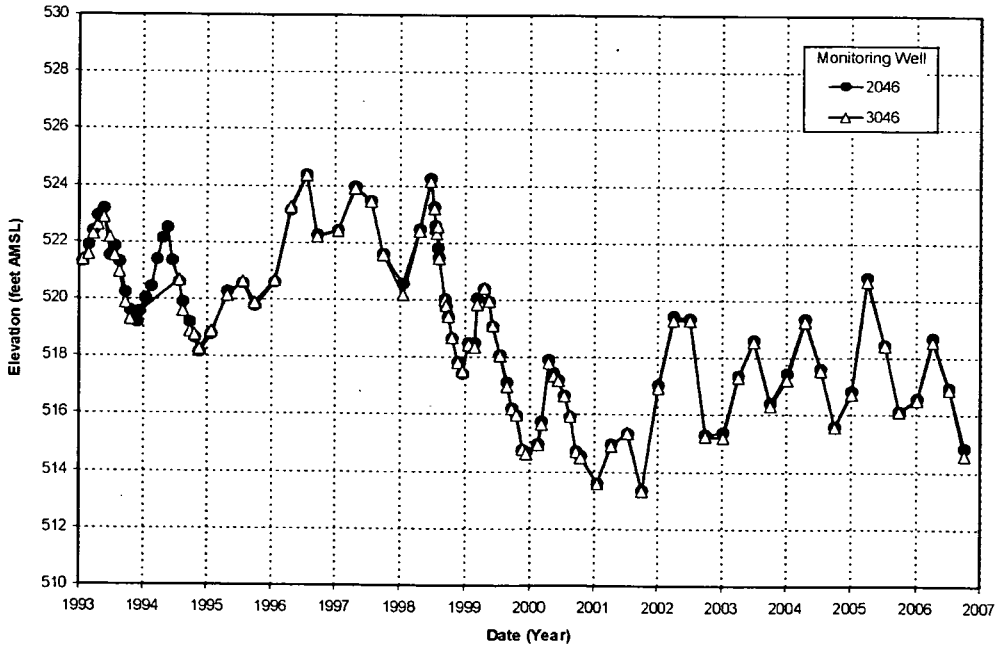


FIGURE A.3-9. HYDROGRAPH FOR WELL CLUSTER 046

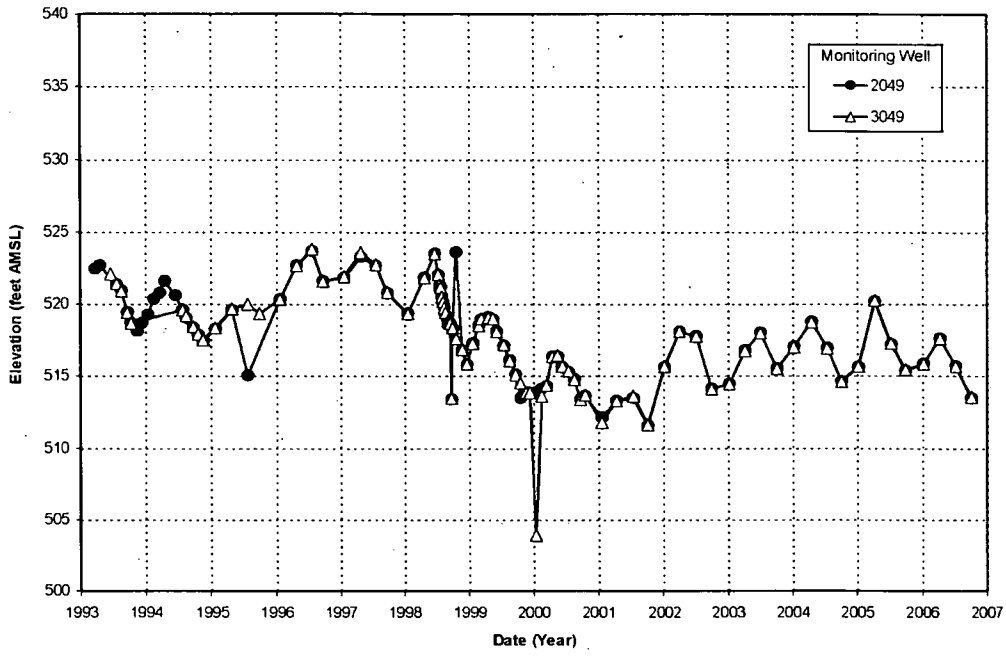


FIGURE A.3-10. HYDROGRAPH FOR WELL CLUSTER 049

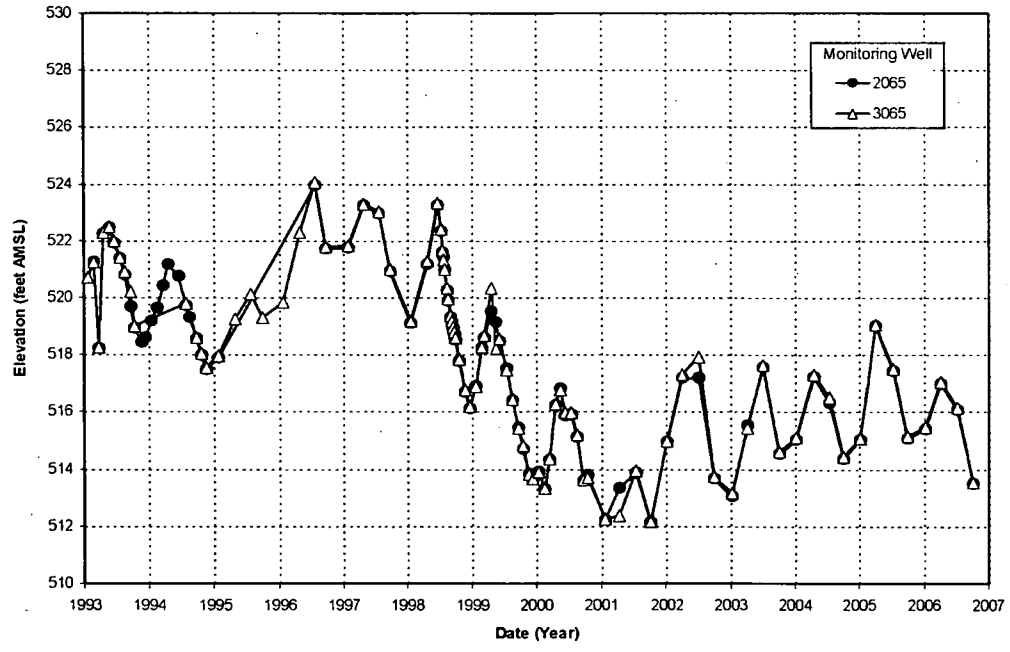


FIGURE A.3-11. HYDROGRAPH FOR WELL CLUSTER 065

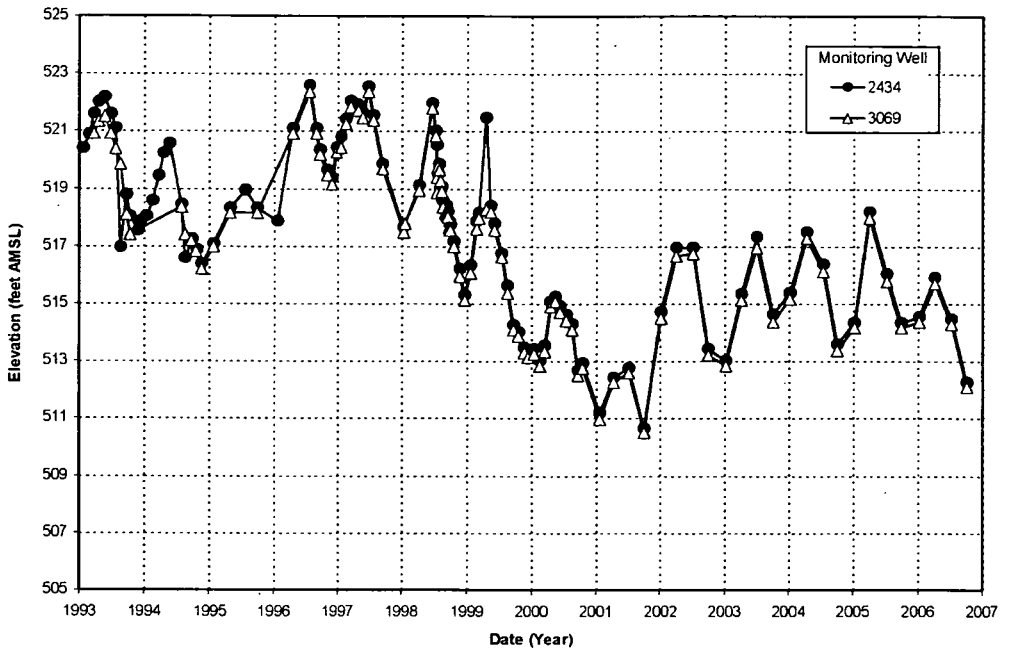


FIGURE A.3-12. HYDROGRAPH FOR WELLS 2434 AND 3069

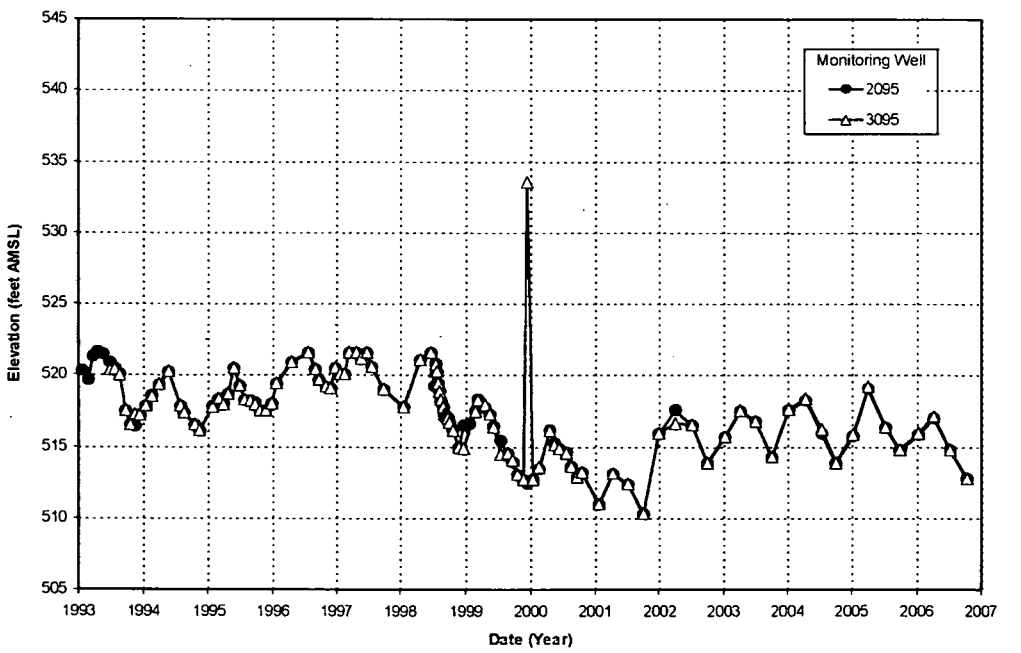


FIGURE A.3-13. HYDROGRAPH FOR WELL CLUSTER 095

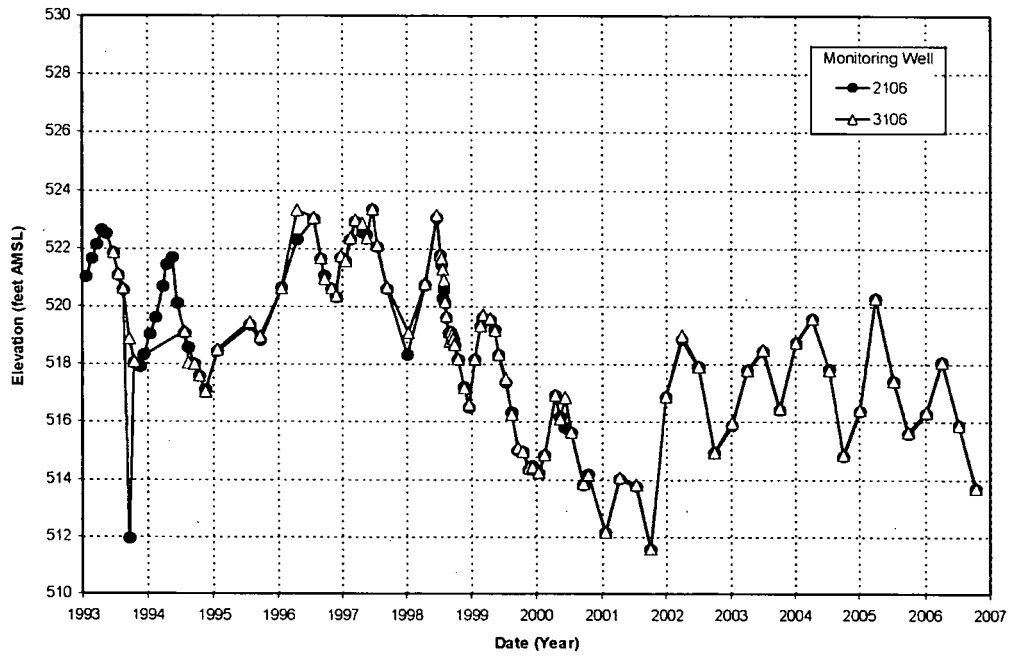


FIGURE A.3-14. HYDROGRAPH FOR WELL CLUSTER 106

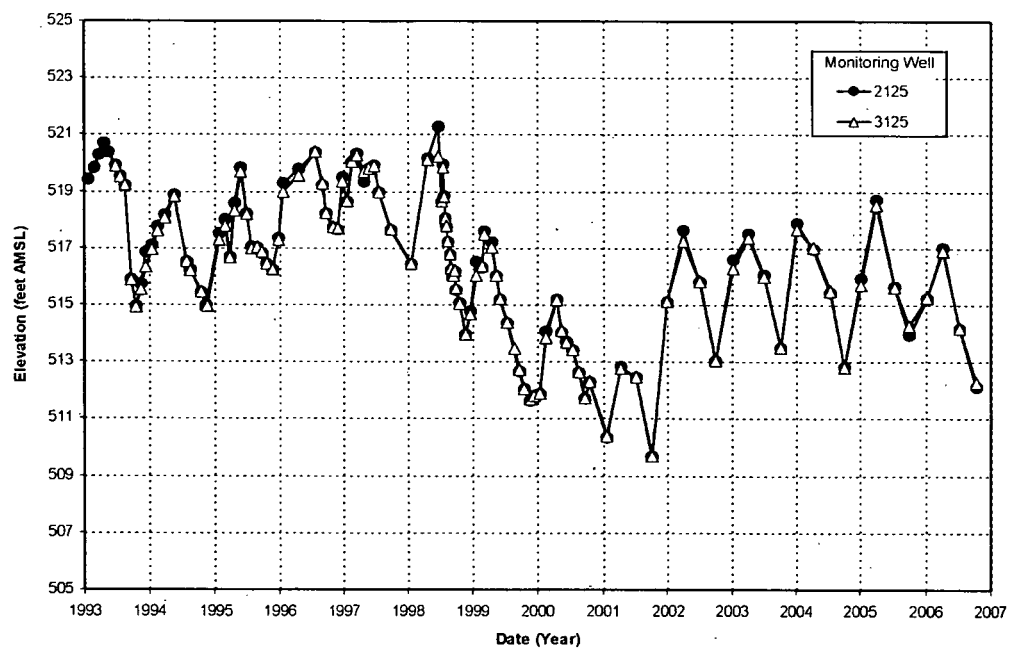


FIGURE A.3-15. HYDROGRAPH FOR WELL CLUSTER 125

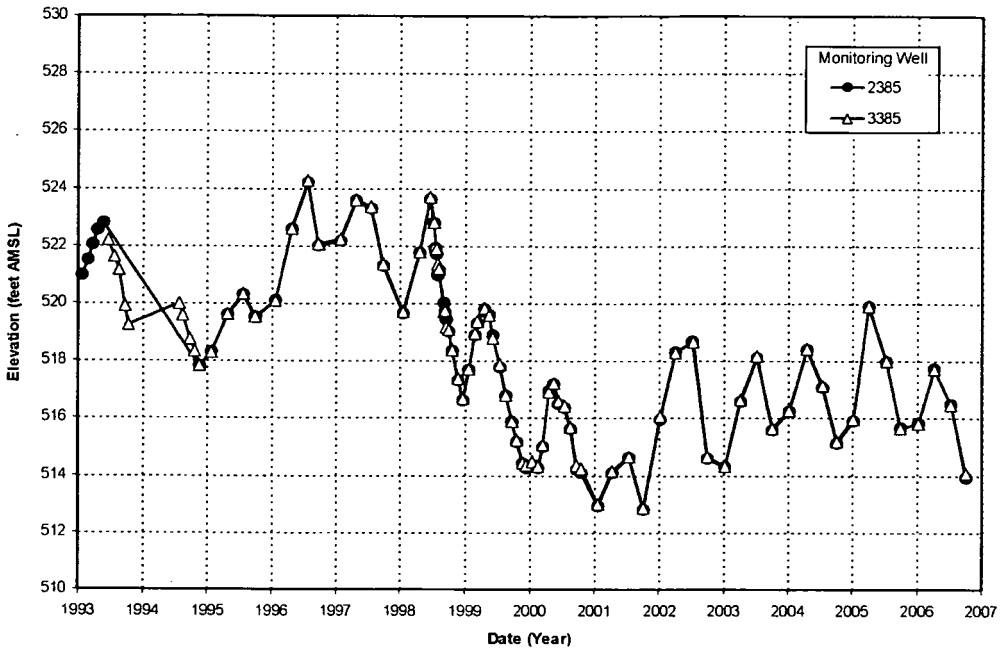


FIGURE A.3-16. HYDROGRAPH FOR WELL CLUSTER 385

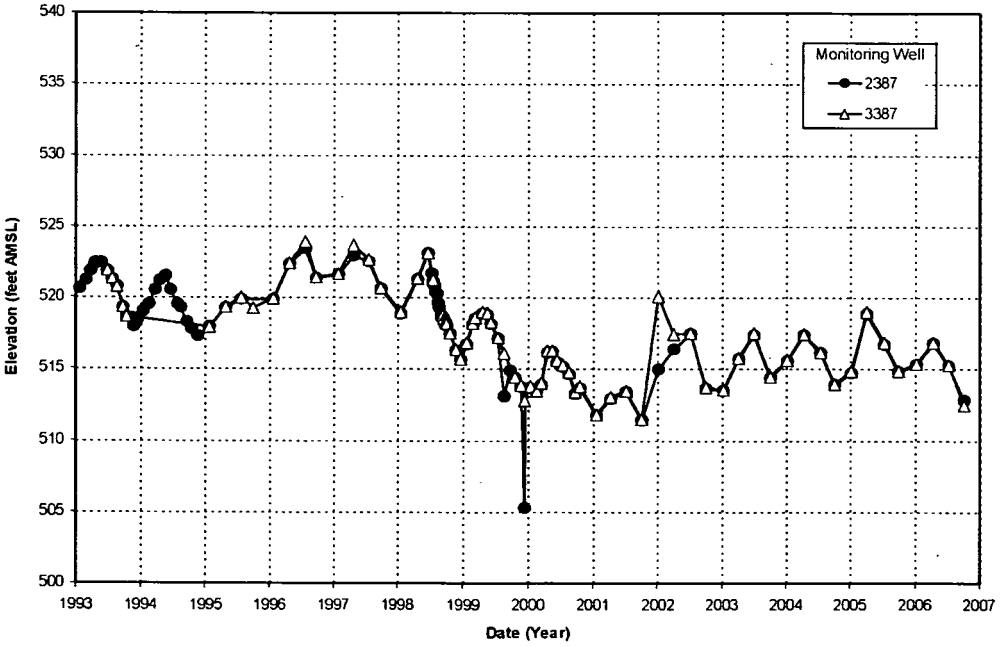


FIGURE A.3-17. HYDROGRAPH FOR WELL CLUSTER 387

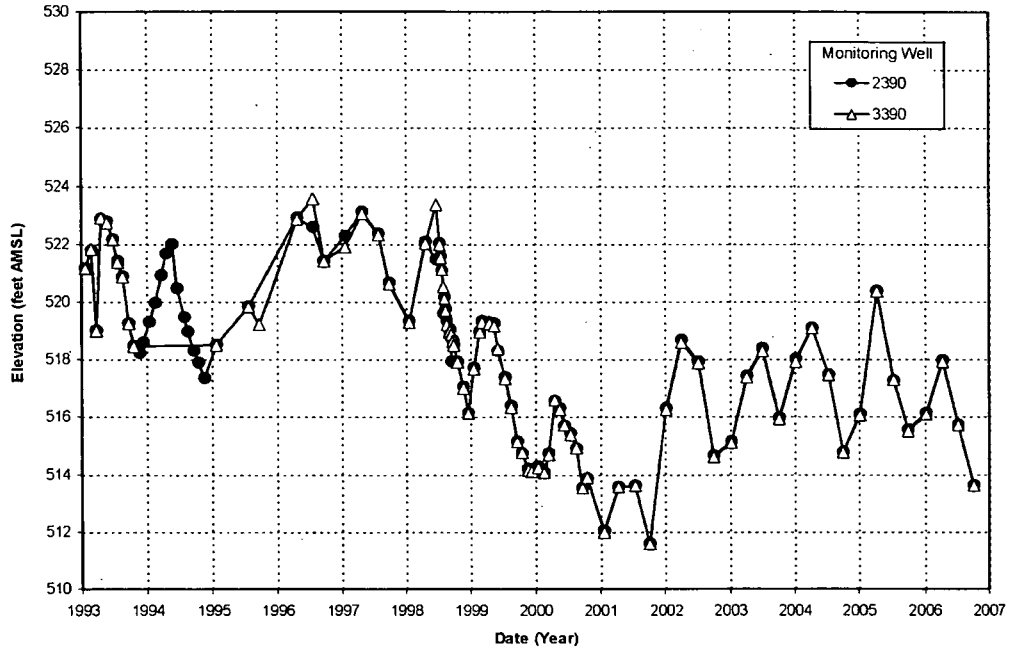


FIGURE A.3-18. HYDROGRAPH FOR WELL CLUSTER 390

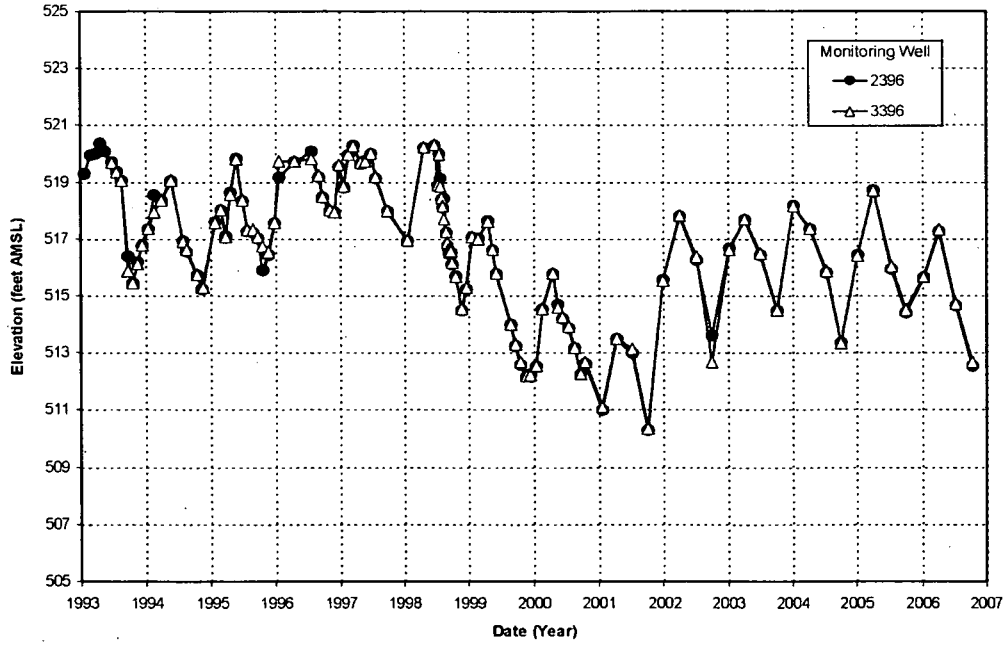


FIGURE A.3-19. HYDROGRAPH FOR WELL CLUSTER 396

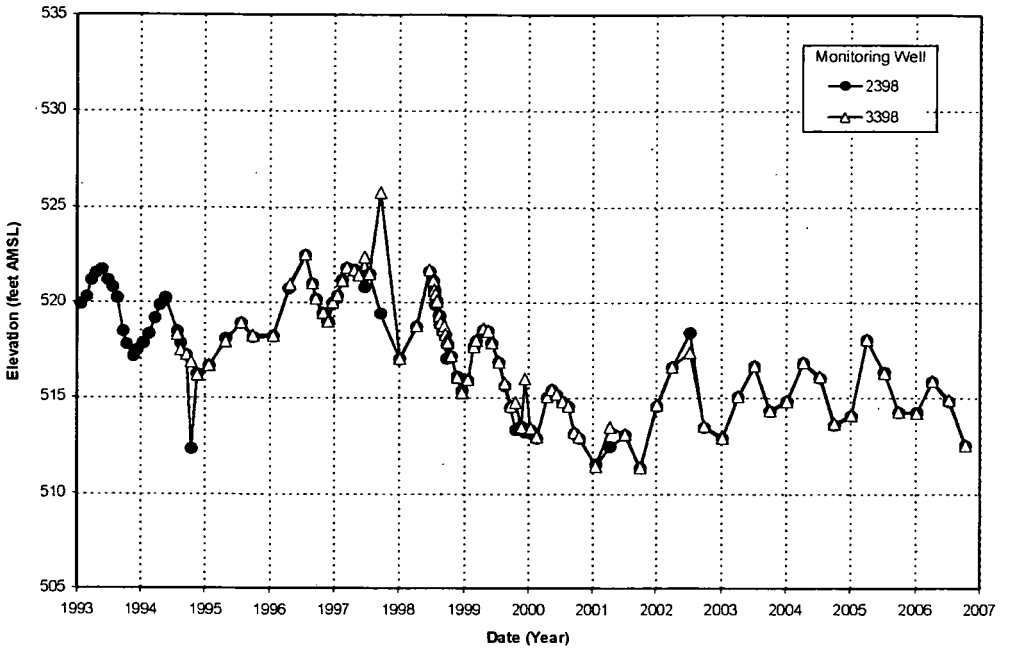


FIGURE A.3-20. HYDROGRAPH FOR WELL CLUSTER 398

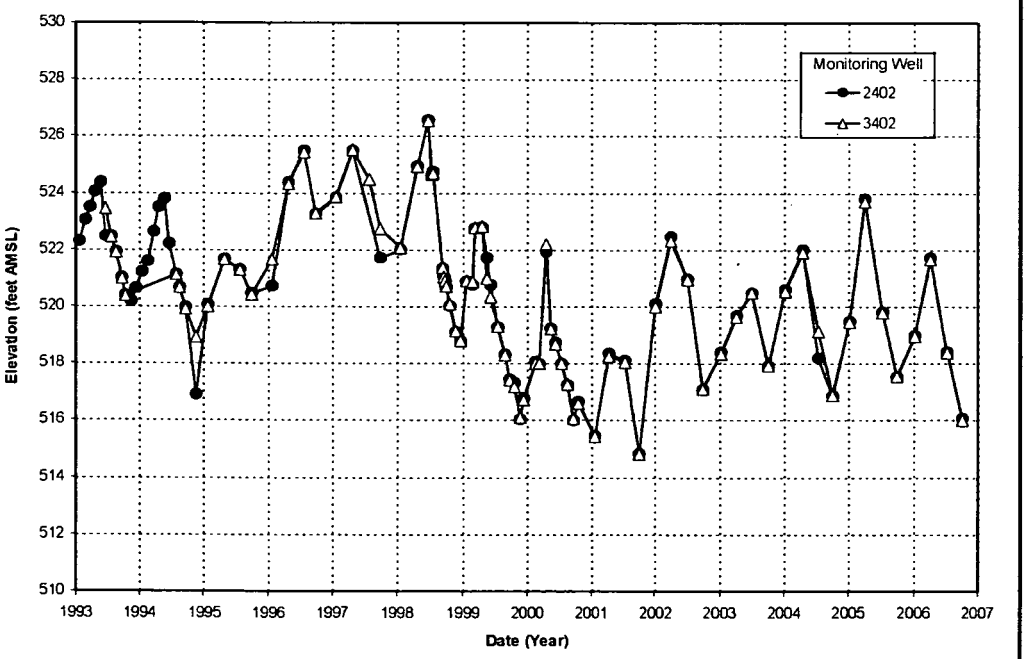


FIGURE A.3-21. HYDROGRAPH FOR WELL CLUSTER 402

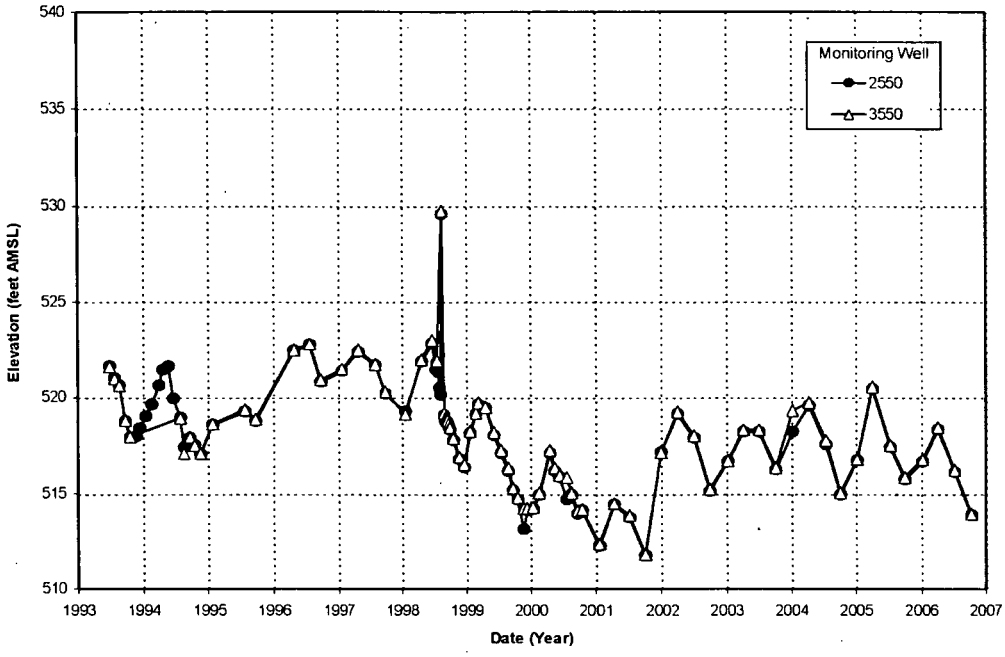


FIGURE A.3-22. HYDROGRAPH FOR WELL CLUSTER 550

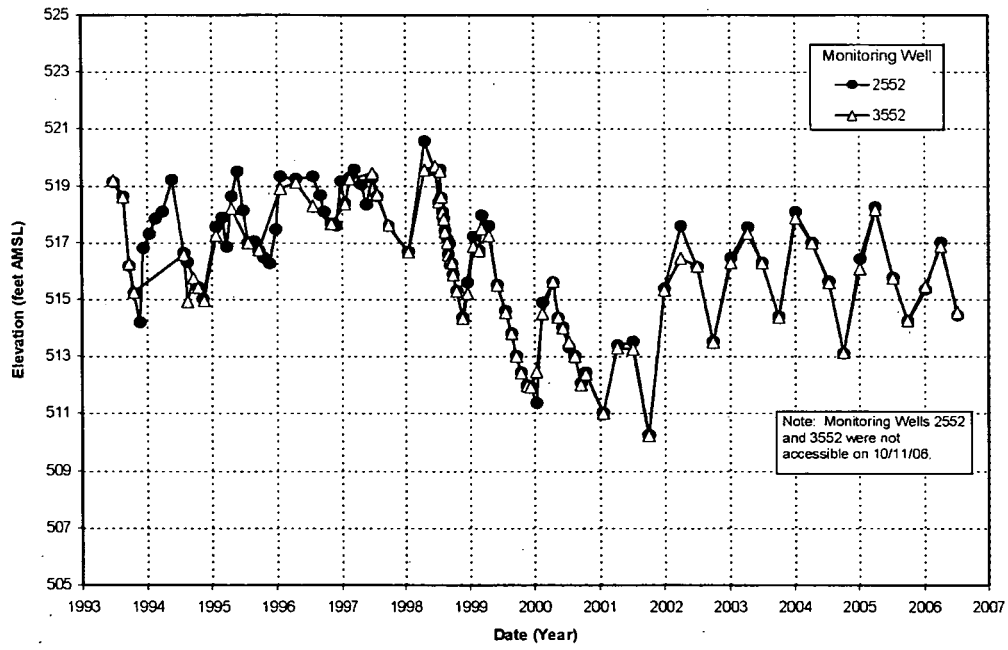


FIGURE A.3-23. HYDROGRAPH FOR WELL CLUSTER 552

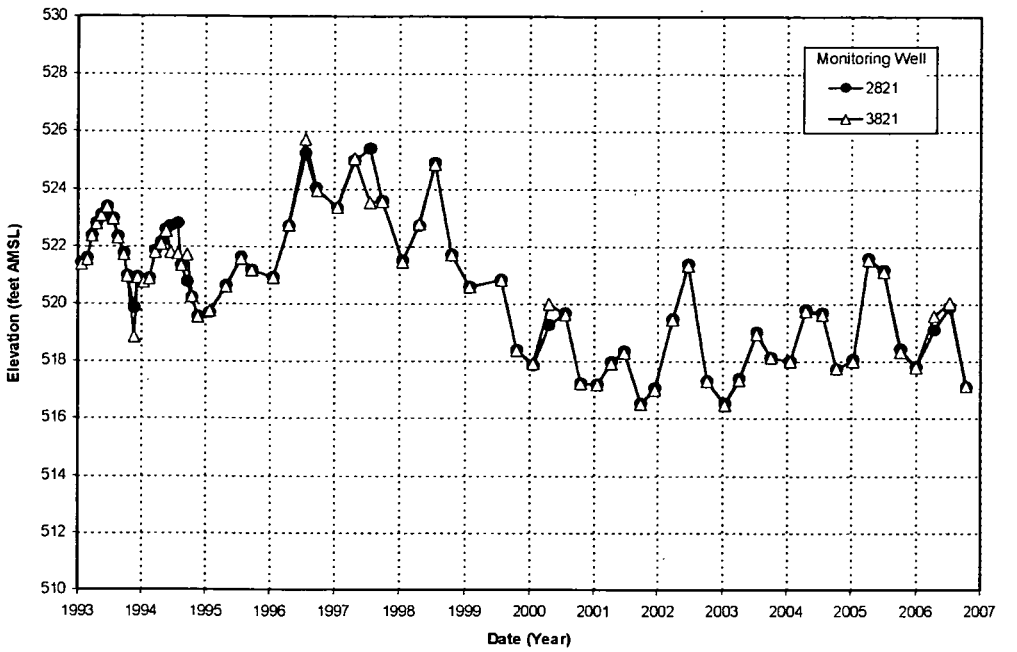


FIGURE A.3-24. HYDROGRAPH FOR WELL CLUSTER 821

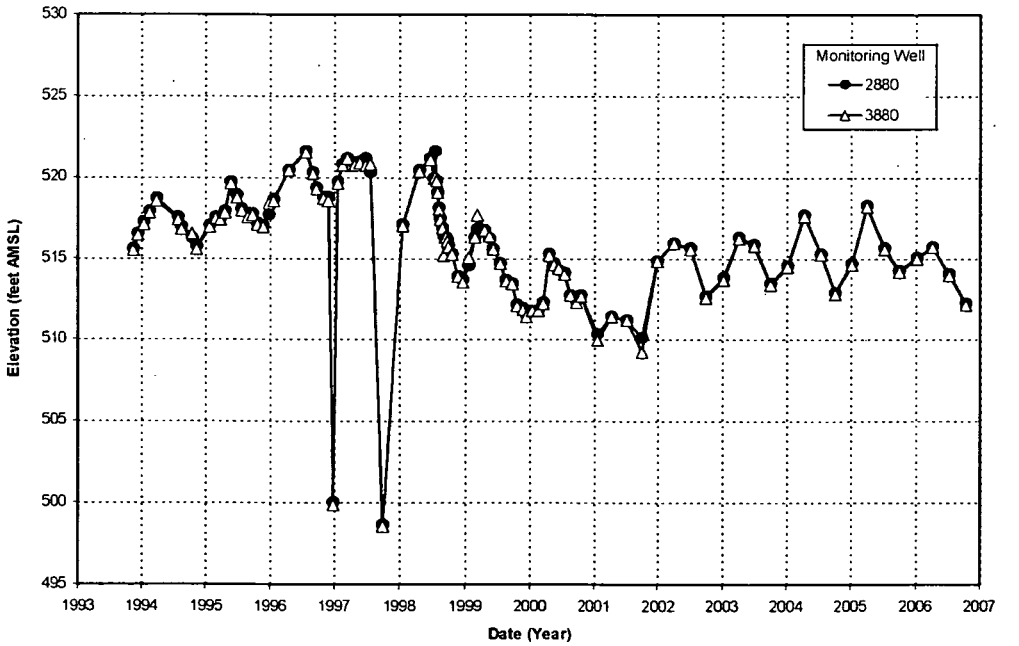


FIGURE A.3-25. HYDROGRAPH FOR WELL CLUSTER 880

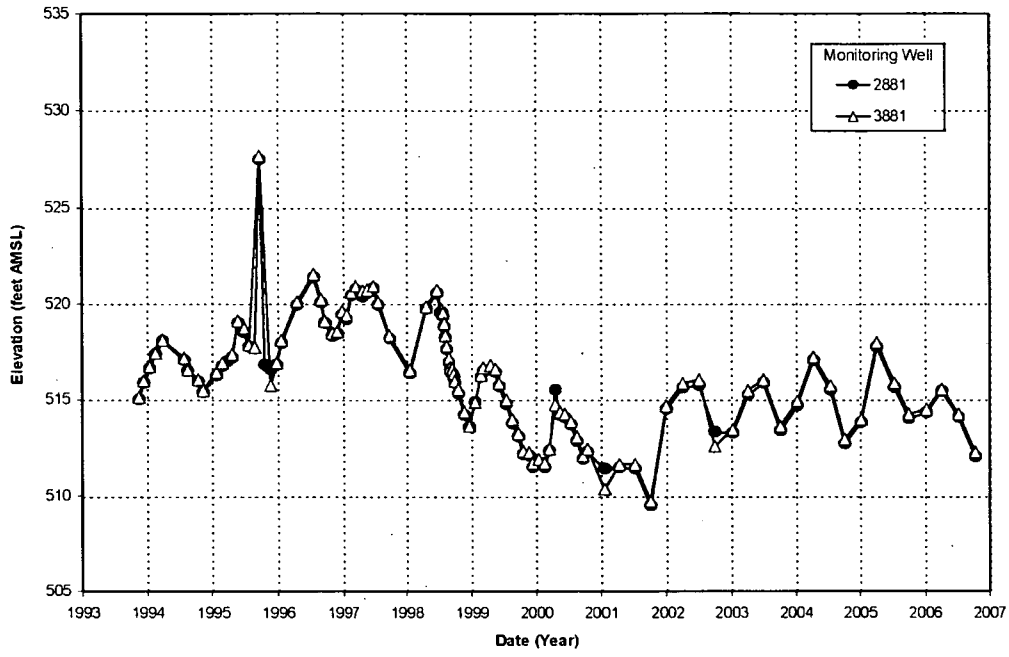


FIGURE A.3-26. HYDROGRAPH FOR WELL CLUSTER 881

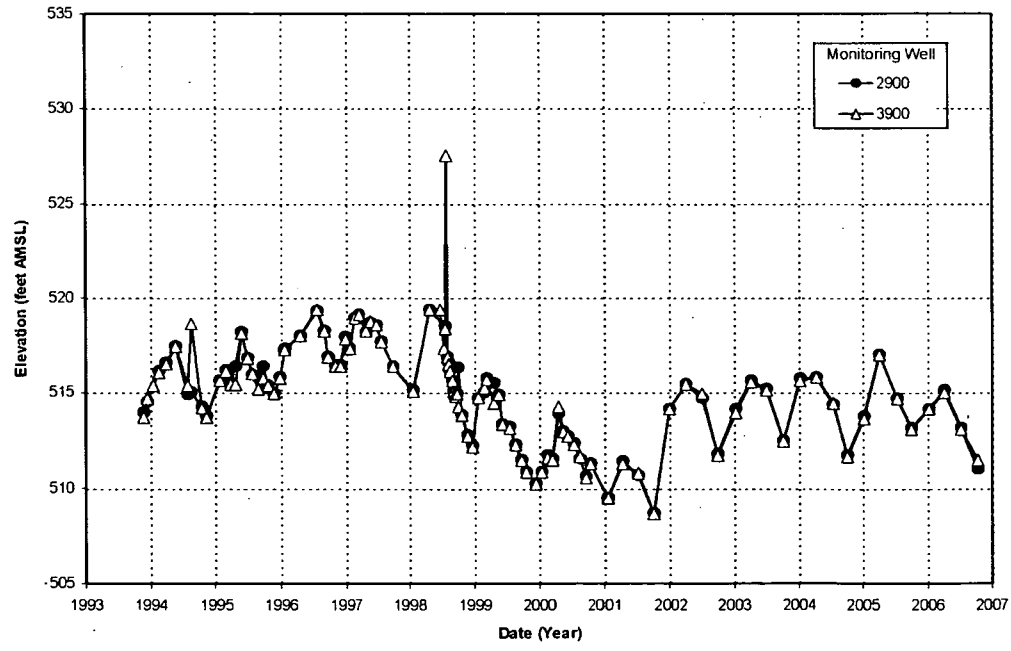


FIGURE A.3-27. HYDROGRAPH FOR WELL CLUSTER 900

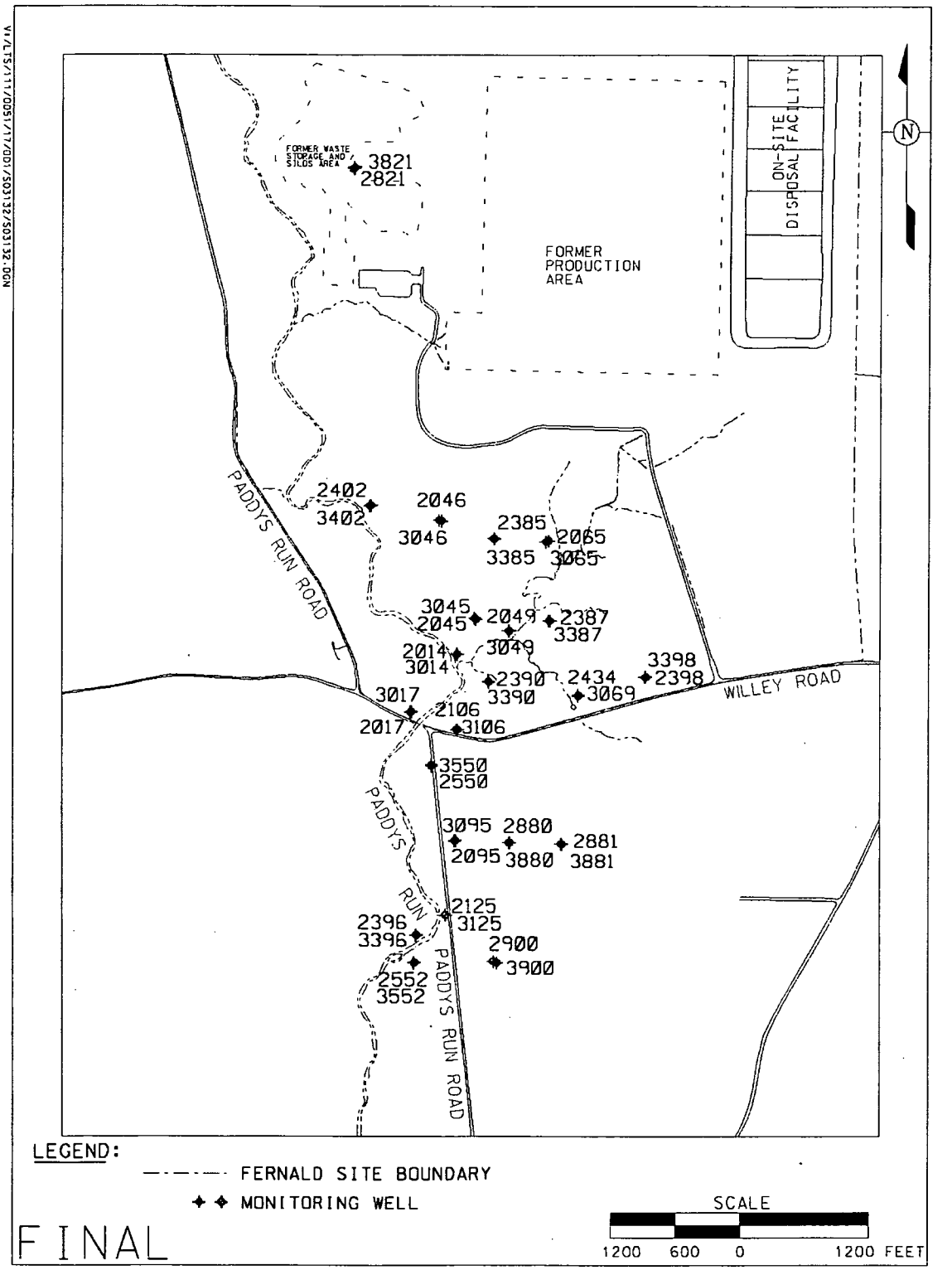


Figure A.3–28. Monitoring Well Locations for Well Cluster Hydrographs

End of current text

Attachment A.4

A.4.0 Non-Uranium FRL Results

This attachment evaluates non-uranium FRL results for 2006. The purpose of the evaluation is to:

- Identify 2006 non-uranium FRL exceedances and determine if monitoring locations should be added or removed based on exceedances (Section A.4.1)
- Determine the persistence of non-uranium FRL exceedances outside the Waste Storage Area (Phase II) design remediation footprint (Section A.4.2)
- Present conclusions (Section A.4.3).

A.4.1 Non-Uranium FRL Exceedances For 2006

Table A.4–1 identifies the summary statistics and trend analysis for the 2006 non-uranium FRL exceedances from monitoring wells both inside and outside the Waste Storage Area (Phase II) design. As indicated in Table A.4–1, six non-uranium FRL constituents had one or more FRL exceedances during 2006. Figure A.4–1 identifies the location of these FRL exceedances. Figure A.4–1 shows that the non-uranium FRL exceedances in 2006 for monitoring wells were located in the waste storage area, and along the eastern site boundary. Those in the waste storage area were within the Waste Storage Area (Phase II) design remediation footprint, while those along the eastern property boundary were located outside the Waste Storage Area (Phase II) design remediation footprint. Specific discussion regarding exceedances and persistence outside the footprint is provided in Section A.4.2. Further discussion regarding exceedances inside the footprint follows.

A revised groundwater monitoring approach was implemented in January 2003. In support of that change, a table was presented in the IEMP, Revision 3 (DOE 2003), which identified all non-uranium FRL exceedances from 1997 through 2002. In Table A.4-2 was revised to present all locations and constituents that are monitored and the location of all non-uranium exceedances for each year. Prior to 2003, only the locations where exceedances occurred were presented; but by showing all of the monitoring locations and constituents, it is possible to see the limited number of exceedances that actually occur with respect to the monitoring programs. Table A.4-2 has been updated to include the data from 2006.

The first column in Table A.4–2 lists the groundwater FRL constituents monitored in 2006. The second column identifies the wells monitored for each constituent. The third column identifies the associated aquifer zone monitored. The fourth column identifies the associated monitoring program for each well/constituent. The remaining columns show monitoring years divided into quarters through 2002 and into halves beginning in 2003, to reflect the semiannual sampling frequency. An X denotes the time period in which an exceedance occurred. Table A.4–2 also indicates whether exceedances occurred inside or outside of the footprint (shading indicates the well is located outside the footprint).

There were 13 non-uranium constituents monitored in 2006 and, as indicated above, six had exceedances. The following summarizes the 2006 non-uranium monitoring information:

Constituent	Monitoring Program	2006 Monitoring Summary
Antimony	Property/Plume Boundary for PRRS Constituents	No exceedances
Arsenic	Property/Plume Boundary for PRRS Constituents	No exceedances
Boron	South Field	No exceedances
Carbon Disulfide	Waste Storage Area	No exceedances
Fluoride	Property/Plume Boundary	No exceedances
Lead	Property/Plume Boundary	No exceedances
Manganese	Property/Plume Boundary, Waste Storage Area	Exceedances in three waste storage area wells and one well along the eastern site boundary
Molybdenum	Waste Storage Area	Exceedance in one waste storage area well
Nickel	Property/Plume Boundary	No exceedances
Nitrate/Nitrite	Waste Storage Area	Exceedances in three waste storage area wells
Technetium 99	Waste Storage Area	Exceedances in two waste storage area wells
Trichloroethene	Waste Storage Area	Exceedances in one waste storage area well
Zinc	Property/Plume Boundary	Exceedance in one well along the eastern site boundary

Wells with exceedances inside the footprint consist of Monitoring Wells 2649, 2821, 3821, 2648, and 2010, which are located in the waste storage area where active source remediation was taking place during 2006.

Table A.4–2 shows while a few of the exceedances were present one year, in subsequent years the concentration was once again below the associated groundwater FRL. Table A.4–2 illustrates that the monitoring approach is conservative in that there are very few exceedances with respect to the overall monitoring program, and that many wells continue to have no non-uranium exceedances. This table will be updated annually and determinations will be made through the annual report and IEMP revisions as to whether constituent monitoring frequencies can be reduced.

With the implementation of the streamlined monitoring approach in 2003, it is important to track the wells that are being plugged and abandoned. During 2006, it was necessary to plug and abandon Monitoring Well 2648 (which was sampled for non-uranium constituents) to support source removal excavation activities in the former waste storage area. If a well is plugged due to well integrity issues, this decision is documented through EPA and OEPA conference calls and through the annual letter to the Ohio Department of Natural Resources. Monitoring Well 2648 was located on the south east side of the former waste pit 4 and was plugged and abandoned on October 14, 2006. The monitoring well was replaced in the IEMP by Monitoring Well 83340.

A.4.2 Evaluation of 2006 Non-Uranium FRL Exceedances Outside the Waste Storage Area (Phase II) design Remediation Footprint

This section presents an evaluation of the persistence of non-uranium FRL exceedances outside the Waste Storage Area (Phase II) design remediation footprint.

A.4.2.1 Background

The Restoration Area Verification Sampling Program Summary Report (DOE 1998) states that any FRL exceedance detected at the property boundary during routine monitoring outside the 10 year uranium based restoration footprint (DOE 1997a) would also be evaluated for persistence. The evaluation would be performed using the same conservative data evaluation method approved in the Restoration Area Verification Sampling Program Project Specific Plan (DOE 1997c) to determine if a change in the aquifer restoration remedy is required. This evaluation was expanded beginning with the 2000 Site Environmental Report (DOE 2001) to include all non-uranium FRL exceedances detected outside of the 10 year uranium based restoration footprint not just those detected at the property boundary. In the 2003 report, the 10 year uranium based restoration footprint was replaced with a 10 year time-of-travel remediation footprint based on 2003 target pumping rates and using the VAM 3D Zoom Model. The footprint has since been updated to reflect capture during the time period modeled for the Waste Storage Area (Phase II) remediation design.

Analytical data from samples collected immediately following an FRL exceedance are evaluated to determine if the exceedance is persistent. In accordance with the approved Restoration Area Verification Sampling method, if two or more consecutive sampling events following an FRL exceedance indicate that the concentration in question has decreased below the groundwater FRL, then the exceedance is not considered persistent. If an FRL exceedance outside the Waste Storage Area (Phase II) design remediation footprint is determined to not be persistent, then no additional action is required above and beyond the routine groundwater monitoring specified in the IEMP, Revision 4. If an FRL exceedance is determined to be persistent, then the cause of the persistent exceedance must be identified and its effect on the aquifer remedy design assessed. Ultimately, the cause needs to be addressed either through a modification of the aquifer remedy or by other means, as applicable.

A.4.2.2 Evaluation and Discussion

Five possible persistent FRL exceedances were identified in 2005 requiring additional data collection in 2006. The exceedances were: antimony in Monitoring Well 2636; arsenic in Monitoring Well 2636, manganese in Monitoring Wells 22205; and zinc in Monitoring Wells 22210 and 3128. The non-uranium FRL exceedances for 2006 along with the possible persistent exceedances identified in 2005 are addressed below.

Figure A.4–1 and Table A.4–1 identify the 2006 non-uranium FRL exceedances outside the Waste Storage Area (Phase II) design remediation footprint. These wells are shaded in Table A.4–1. In 2006, two constituents had one or more FRL exceedance at two wells located outside the Waste Storage Area (Phase II) design remediation footprint:

- Manganese at Monitoring Well 22204
- Zinc at Monitoring Well 22210

Table A.4–3 is used as an evaluation tool to address the possible persistent FRL exceedances for those that occur outside the Waste Storage Area (Phase II) design remediation footprint. It includes the exceedances for 2006 listed in the bullets above, as well as those still being evaluated or deemed persistent from the 2005 Site Environmental Report (DOE 2005b). If two or

more sampling events immediately following an FRL exceedance indicate that the concentration decreased below the FRL, then the exceedance is identified as not persistent in Table A.4–3. As shown in Table A.4–3, an FRL exceedance was identified as being persistent in 2006 for manganese at Monitoring Well 22204.

The following is a summary of results presented in Table A.4–3:

- Additional data, to be collected in 2007, are necessary to determine the persistence of the following FRL exceedances:
  - Antimony at Monitoring Well 2636
  - Arsenic at Monitoring Well 2636
  - Zinc at Monitoring Well 22210
- The following FRL exceedances in 2005 were not persistent:
  - Manganese at Monitoring Well 22205
  - Zinc at Monitoring Well 3128.
- The FRL exceedance recorded for manganese at Monitoring Well 22204 in 2006 was persistent.
- The exceedance for manganese at Monitoring Well 22210 that was judged as persistent in 2005 was not persistent in 2006.

Figures A.4–2 through A.4–8 present individual concentration versus time graphs for all monitoring wells and constituents identified above.

The evaluation for persistence of non-uranium FRL exceedances in wells located outside the Waste Storage Area (Phase II) design remediation footprint in 2006 marks the tenth year that an evaluation has been conducted as part of the IEMP. In the past, exceedances identified as persistent became non persistent in later years. This year, an exceedance for manganese at Monitoring Well 22204 was identified again as persistent. Continued monitoring will determine if the exceedance remains persistent. At this time, no change to the aquifer remedy is planned to address the exceedance at this monitoring well.

Note that Monitoring Well 2636 had a persistent FRL exceedance for arsenic in 2004 and an exceedance for antimony in the first half of 2004. This well is often dry and cannot be sampled, as was the case for the second half of 2005 and all of 2006. Additional data is required to determine if the 2004 exceedances are still present/persistent. This well is located south of the administrative boundary in the Paddys Run Road Site contaminant plume area. The administrative boundary is located between the Fernald site uranium plume and the Paddys Run Road Site contaminant plume area. The Paddys Run Road Site consists of documented releases of inorganic constituents (including arsenic), volatile organic compounds, and semivolatile organic compounds. Groundwater monitoring is occurring south of the administrative boundary to assess the impact of pumping the South Plume extraction wells on the Paddys Run Road Site plumes.

A.4.3 Conclusions

From the information provided in this attachment, the following conclusions can be made:

- Groundwater exceedances will continue to be monitored to determine if monitoring frequencies can be reduced (Table A.4–2 will continue to be updated annually).
- Non-uranium FRL exceedances occurring in the waste storage area were taken into consideration for the Waste Storage Area (Phase II) Remediation Module Design.
- There was one persistent non-uranium FRL exceedance outside the Waste Storage Area (Phase II) design footprint identified in 2006: manganese at Monitoring Well 22204. A change in the design of the aquifer remedy to address the exceedance at this monitoring well is not required at this time.
- Additional data are needed to verify whether antimony, arsenic, and zinc FRL exceedances outside the Waste Storage Area (Phase II) design footprint are persistent.

Table A.4–1. Summary Statistics and Trend Analysis for Non-Uranium Constituents With 2006 Results Above Final Remediation Levels

Constituent (FRL)[a]	Monitoring Well	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2006[c,d]	Minimum[b,c,d,e,f]	Maximum[b,c,d,e,f]	Average[b,c,d,e,f]	Standard Deviation[b,c,d,e,f]	Trend[b,c,d,e,f,g]
Manganese (0.90 mg/L)	2010	10	9	2	0.600	6.14	3.19	2.08	Up, Marginal
	22204	8	6	2	0.418	3.01	1.33	0.78	Up, Marginal
	2648	13	9	1	0.347	4.08	1.59	1.14	Down, Significant
	3821	14	9	1	0.145	6.07	1.95	1.79	No Significant Trend
Molybdenum (0.10 mg/L)	2649	13	13	1	0.207	0.69	0.46	0.14	No Significant Trend
Nitrate/Nitrite (11 mg/L)[h]	2648	21	8	1	0.150	27.4	9.59	7.69	No Significant Trend
	2649	21	20	1	0.805	102	53.4	26.5	**Up, Significant**
	2821	22	5	2	1.38	30.9	8.63	7.48	**Up, Significant**
Zinc (0.021 mg/L)	22210	4	2	1	0.0077	0.0244	0.018	0.008	No Significant Trend
					(pCi/L)	(pCi/L)	(pCi/L)	(pCi/L)	
Technetium-99 (94 pCi/L)	2649	21	21	1	101	1350	611	398	No Significant Trend
	2821	22	10	2	0.253	651	143	186	**Up, Significant**
					(µg/L)	(µg/L)	(µg/L)	(µg/L)	
Trichloroethene (5.0 µg/L)	2649	13	12	1	0.50	120	65	27	No Significant Trend

Note: Shading indicates well is outside the Waste Storage Area (Phase-II) design remediation footprint.

[a]From Operable Unit 5 Record of Decision, Table 9-4.
[b]Based on samples from August 1997 through 2006.
[c]If more than one sample is collected per well per day (e.g., duplicate), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation) and Mann-Kendall test for trend.
[d]Rejected data qualified with either an R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e]If the number of samples is greater than or equal to four, then the Mann-Kendall test for trend and all of the summary statistics are reported. If the total number of samples is equal to three, then the minimum, maximum, and average are reported. If the total number of samples is equal to two, then the minimum and maximum are reported. If the total number of samples is equal to one, then the data point is reported as the minimum. NA = not applicable.
[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.
[g]Mann-Kendall test for trend is performed using data from third quarter 1998 through 2006.
[h]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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Table A.4–2. Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Antimony																																	
	2093	4	P/PB																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																								x						
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
	2398	2	P/PB																														
	2431	0	P/PB																								x						
	2432	0	P/PB																														
	2625	4	PRRS																														
	2636	4	PRRS																									x		x			
	2733	0	P/PB																														
	2898	4	PRRS																														
	2899	4	PRRS																														
	2900	4	PRRS																														
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																														
	3398	2	P/PB																														
	3424	0	P/PB																														
	3426	0	P/PB																														
	3429	0	P/PB																														
	3431	0	P/PB																														
	3432	0	P/PB																														
	3636	4	PRRS																														
	3733	0	P/PB																														
	3898	4	PRRS																														
	3899	4	PRRS																														
	3900	4	PRRS																														
	4398	2	P/PB																														

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Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Arsenic																																	
	2093	4	PRRS																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
	2398	2	P/PB																														
	2431	0	P/PB																														
	2432	0	P/PB																														
	2625	4	PRRS												x																		
	2636	4	PRRS		x	x				x	x											x						x					
	2733	0	P/PB																														
	2898	4	PRRS											x																			
	2899	4	PRRS																														
	2900	4	PRRS											x																			
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																														
	3398	2	P/PB																														
	3424	0	P/PB																														
	3426	0	P/PB																														
	3429	0	P/PB																														
	3431	0	P/PB																														
	3432	0	P/PB																														
	3636	4	PRRS																														
	3733	0	P/PB																														
	3898	4	PRRS																														
	3899	4	PRRS																														
	3900	4	PRRS																														
	4398	2	P/PB																														

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Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Benzene																																	
	2128	4	PRRS																														
	2625	4	PRRS																														
	2636	4	PRRS																														
	2898	4	PRRS																														
	2899	4	PRRS																														
	2900	4	PRRS																														
	3128	4	PRRS																														
	3636	4	PRRS																														
	3898	4	PRRS																														
	3899	4	PRRS																														
	3900	4	PRRS																														
Boron																																	
	2045	2	SF								x		x		x																		
	2049	2	SF	x	x			x	x	x	x	x	x	x	x		x								x								
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
Bromodichloromethane																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
Carbazole																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														

Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Carbon disulfide																																	
	2010	1	WSA																														
	2648	1	WSA																														
	2649	1	WSA						x																								
	2821	1	WSA																														
	3821	1	WSA										x																x				
Alpha-Chlordane																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
Bis(2-Chloroisopropyl)ether																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
1,1-Dichloroethene																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF										x																				
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
Fluoride																																	
	2093	4	P/PB																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														

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Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Fluoride (Contd)	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
	2398	2	P/PB																														
	2431	0	P/PB						x																								
	2432	0	P/PB																														
	2625	4	PRRS																														
	2636	4	PRRS																														
	2733	0	P/PB																														
	2898	4	PRRS																														
	2899	4	PRRS																														
	2900	4	PRRS																														
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																														
	3398	2	P/PB																														
	3424	0	P/PB																														
	3426	0	P/PB																														
	3429	0	P/PB																														
	3431	0	P/PB																														
	3432	0	P/PB																														
	3636	4	PRRS																														
	3733	0	P/PB																														
	3898	4	P/PB																														
	3899	4	P/PB																														
	3900	4	P/PB																														
	4398	2	P/PB																														
Lead																																	
	2093	4	P/PB																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														

Table A.4-2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Lead (Cont.)																																	
	2398	2	PRRS																														
	2431	0	PRRS											x																			
	2432	0	PRRS																														
	2625	4	PRRS																														
	2636	4	PRRS																														
	2733	0	PRRS																														
	2898	4	PRRS																														
	2899	4	PRRS																														
	2900	4	PRRS																														
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																														
	3398	2	P/PB																														
	3424	0	P/PB																														
	3426	0	P/PB																														
	3429	0	P/PB																														
	3431	0	P/PB																														
	3432	0	P/PB																														
	3636	4	PRRS																														
	3733	0	P/PB	x													x																
	3898	4	PRRS																														
	3899	4	PRRS																														
	3900	4	PRRS																														
	4398	2	P/PB																														
Manganese																																	
	2010	1	WSA													x				x						x	x	x	x		x	x	x
	2093	4	P/PB																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF																					x									
	22199	0	OSDF																														
	22204	0	OSDF																							x			x	x	x	x	x
	22205	0	OSDF																												x		
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														

Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Manganese (Cont.)	2398	2	P/PB																														
	2431	0	P/PB			x	x																										
	2432	0	P/PB														x			x	x		x			x							
	2625	4	PRRS																														
	2636	4	PRRS																														
	2648	1	WSA		x				x				x		x				x				x						x	x		x	
	2649	1	WSA																														
	2733	0	P/PB																														
	2821	1	WSA																														
	2898	4	PRRS																				x					x					
	2899	4	PRRS													x																	
	2900	4	PRRS													x																	
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																														
	3398	2	P/PB																														
	3424	0	P/PB																														
	3426	0	P/PB																														
	3429	0	P/PB																														
	3431	0	P/PB																														
	3432	0	P/PB																														
	3636	4	PRRS																														
	3733	0	P/PB																														
	3821	1	WSA										x		x				x				x			x	x	x			x	x	
	3898	4	PRRS																														
	3899	4	PRRS																														
	3900	4	PRRS																														
	4398	2	P/PB																														
Mercury																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														

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Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Molybdenum																																	
	2010	1	WSA																														
	2648	1	WSA																														
	2649	1	WSA	x					x				x		x				x				x			x	x	x	x	x	x	x	
	2821	1	WSA																														
	3821	1	WSA																														
Nickel																																	
	2093	4	P/PB																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF										x																				
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
	2398	2	P/PB	x		x	x	x	x			x	x																				
	2431	0	P/PB																														
	2432	0	P/PB																														
	2625	4	PRRS																														
	2636	4	PRRS																														
	2733	0	P/PB																														
	2898	4	PRRS																														
	2899	4	PRRS																														
	2900	4	PRRS																														
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																														
	3398	2	P/PB																														
	3424	0	P/PB																														
	3426	0	P/PB																														
	3429	0	P/PB																														
	3431	0	P/PB																														
	3432	0	P/PB																														
	3636	4	PRRS																														
	3733	0	P/PB																														

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Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Wella	Aquifer Zone	Projectb	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3c	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Nickel (Cont.)	**3898**	4	PRRS																														
	3899	4	PRRS																														
	3900	4	PRRS																														
	4398	2	P/PB							x				x																			
Nitrate/Nitrite																																	
	2010	1	WSA																														
	2648	1	WSA				x						x		x			x									x	x	x			x	
	2649	1	WSA		x		x		x		x		x		x		x	x	x	x	x	x	x		x	x	x	x	x		x	x	
	2821	1	WSA										x													x				x		x	x
	3821	1	WSA														x				x										x		
Technetium-99																																	
	2010	1	WSA																														
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
	2648	1	WSA										x					x	x							x							
	2649	1	WSA		x		x		x		x		x		x		x	x	x	x	x	x	x		x	x	x	x	x	x	x	x	
	2821	1	WSA										x												x	x	x	x	x	x	x	x	x
	3821	1	WSA																														
Trichloroethene																																	
	2010	1	WSA																														
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
	2648	1	WSA																														
	2649	1	WSA						x				x		x				x				x			x	x	x	x	x	x	x	
	2821	1	WSA																														
	3821	1	WSA																														

Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006	
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1	2
Vinyl Chloride																																	
	22198	0	OSDF																														
	22199	0	OSDF																														
	22204	0	OSDF																														
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																														
	22211	0	OSDF																														
	22214	0	OSDF																														
Zinc																																	
	2093	4	P/PB																														
	2128	4	PRRS																														
	21063	4	P/PB																														
	22198	0	OSDF																														
	22199	0	OSDF																							x							
	22204	0	OSDF																							x							
	22205	0	OSDF																														
	22208	0	OSDF																														
	22210	0	OSDF																											x		x	
	22211	0	OSDF																														
	22214	0	OSDF																														
	2398	2	P/PB				x																										
	2431	0	P/PB					x	x					x																			
	2432	0	P/PB							x				x			x																
	2625	4	PRRS																														
	2636	4	PRRS																														
	2733	0	P/PB								x																						
	2898	4	PRRS																														
	2899	4	PRRS																														
	2900	4	PRRS													x												x					
	3070	2	P/PB																														
	3093	4	P/PB																														
	31217	0	P/PB																														
	3128	4	PRRS																											x			

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Table A.4–2 (continued). Groundwater FRL Exceedances From 1997 Through 2006 Quarterly/Semiannually

Constituent	Well[a]	Aquifer Zone	Project[b]	1997		1998				1999				2000				2001				2002				2003		2004		2005		2006
				3[c]	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	1	2	1	2	1
Zinc (Cont.)																																
	3398	2	P/PB																													
	3424	0	P/PB																													
	3426	0	P/PB								x		x																			
	3429	0	P/PB							x	x																					
	3431	0	P/PB																			x										
	3432	0	P/PB																													
	3636	4	PRRS																													
	3733	0	P/PB																							x						
	3898	4	PRRS																													
	3899	4	PRRS																x													
	3900	4	PRRS																													
	4398	2	P/PB																													

Note: **Shading** indicates well is outside the Waste Storage Area (Phase-II) design remediation footprint.

[a]As defined in the IEMP, Rev. 3, all monitoring is now semiannual. Well numbers that are **bold** have historical FRL exceedances.
[b]WSA = Waste Storage Area
[c]Sampling for the IEMP was initiated in August 1997.

SF = South Field
P/PB = Property/Plume Boundary for FRL Exceedances
PRRS = Property/Plume Boundary for Paddys Run Road Site
OSDF = Property/Plume Boundary for on-site disposal facility

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Table A.4-3. Summary of Persistence Evaluation of Non-Uranium FRL Exceedances Outside the Waste Storage Area (Phase-II) Design Remediation Footprint

Constituent	Monitoring Well	Pertinent 2005 Results	2006 FRL Exceedance[a]		Evaluation Results for 2006	Figure No.
			1st Semiannual	2rd Semiannual		
Antimony	2636[b]	Additional Data Required Exceedance in the first half of 2004	NS	NS	Additional Data Required	A.4-2
Arsenic	2636[b]	Additional Data Required Persistent in 2004	NS	NS	Additional Data Required	A.4-3
Manganese	22204	Persistent	Yes	Yes	**Persistent**	A.4-4
	22205	Additional Data Required	No	No	Not Persistent	A.4-5
	22210[c]	Persistent	No	No	Not Persistent	A.4-6
Zinc	22210	Additional Data Required No exceedance in 2nd half of 2005	Yes	No	Additional Data Required	A.4-7
	3128	Additional Data Required	No	No	Not Persistent	A.4-8

[a]NS = not sampled
[b]This monitoring well is often dry and cannot be sampled. In the first quarter of 2002 it had an FRL exceedance for arsenic. In the second quarter of 2002 it did not have an FRL exceedance for arsenic. The well was dry from the third quarter of 2002 through 2003. In the first half of 2004, the well had another FRL exceedance for arsenic and a first-time-ever FRL exceedance for antimony. The well was dry in the second half of 2004, the second half of 2005, and all of 2006.
[c]Monitoring Well 22210 replaced Monitoring Well 2426 which was plugged and abandoned August 2, 2005.

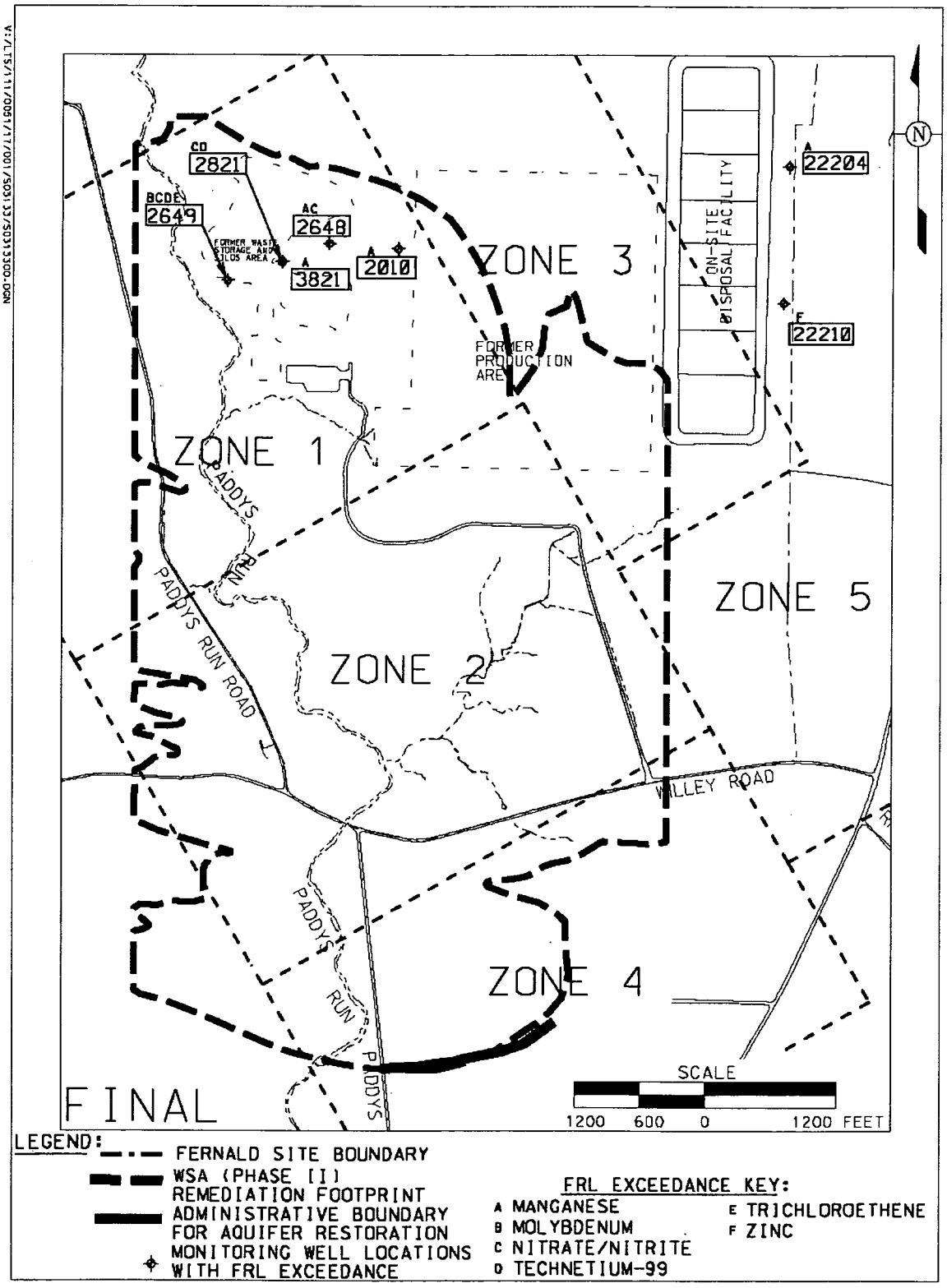

Figure A.4–1. Non-uranium Constituents with 2006 Results Above Final Remediation Levels

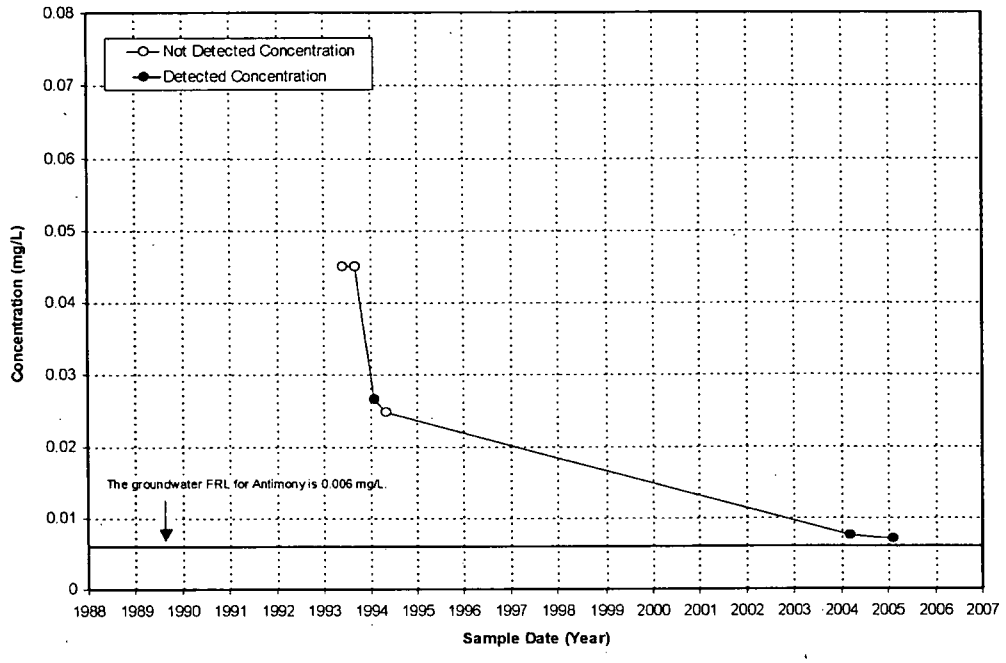

FIGURE A.4-2. ANTIMONY CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2636

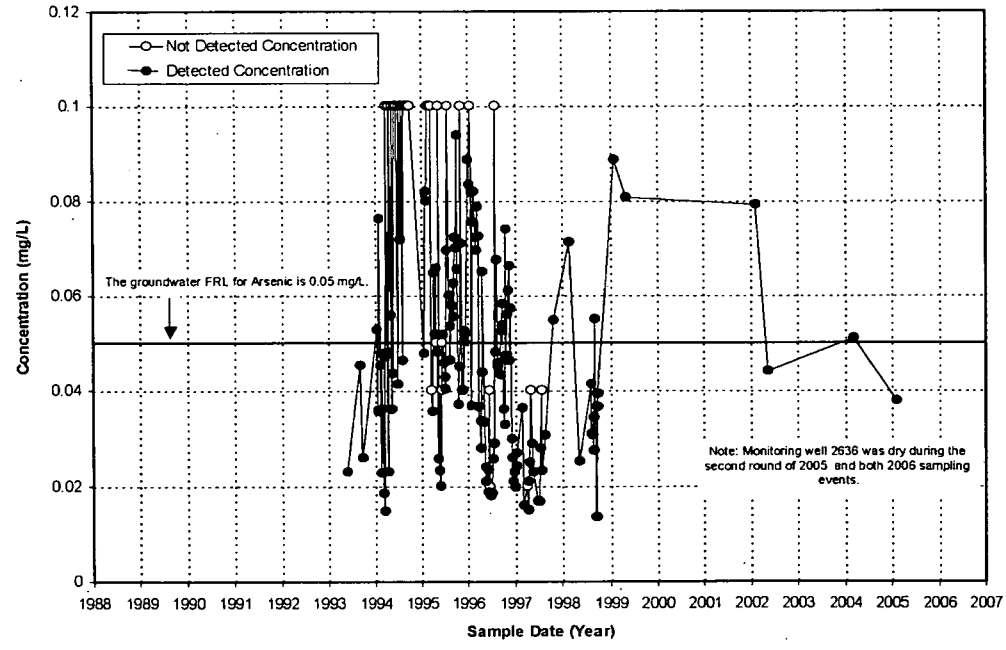

FIGURE A.4-3. ARSENIC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 2636

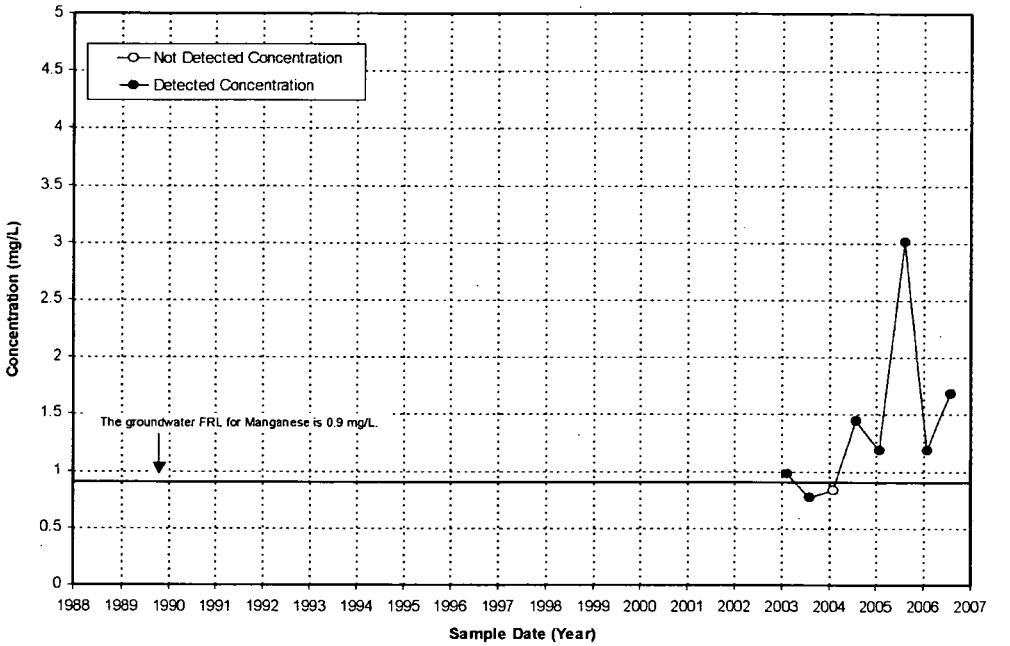

FIGURE A.4-4. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22204

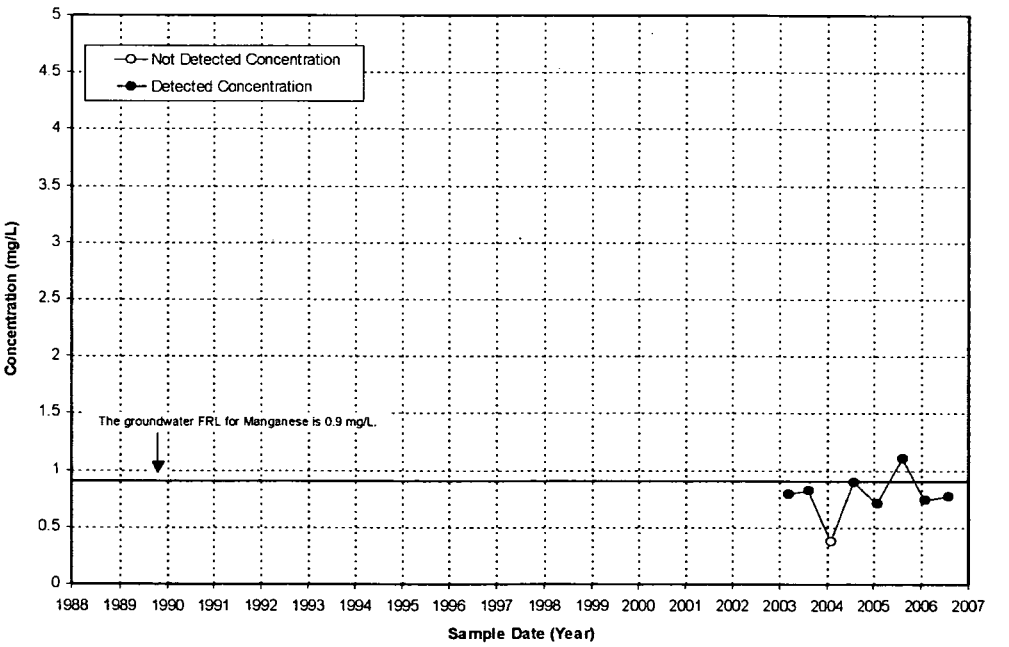

FIGURE A.4-5. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22205

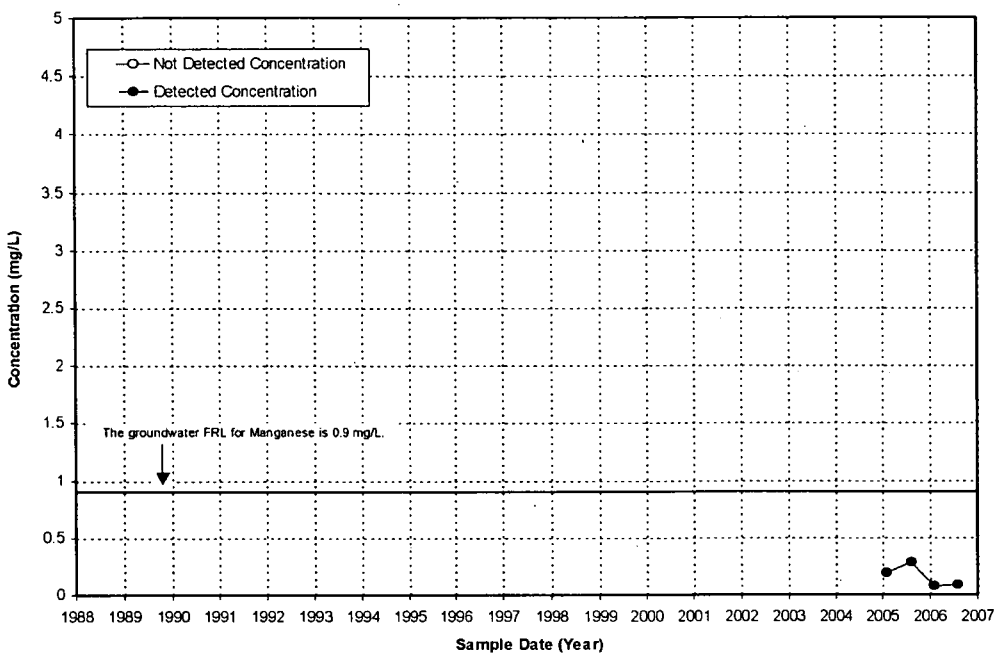

FIGURE A.4-6. MANGANESE CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22210

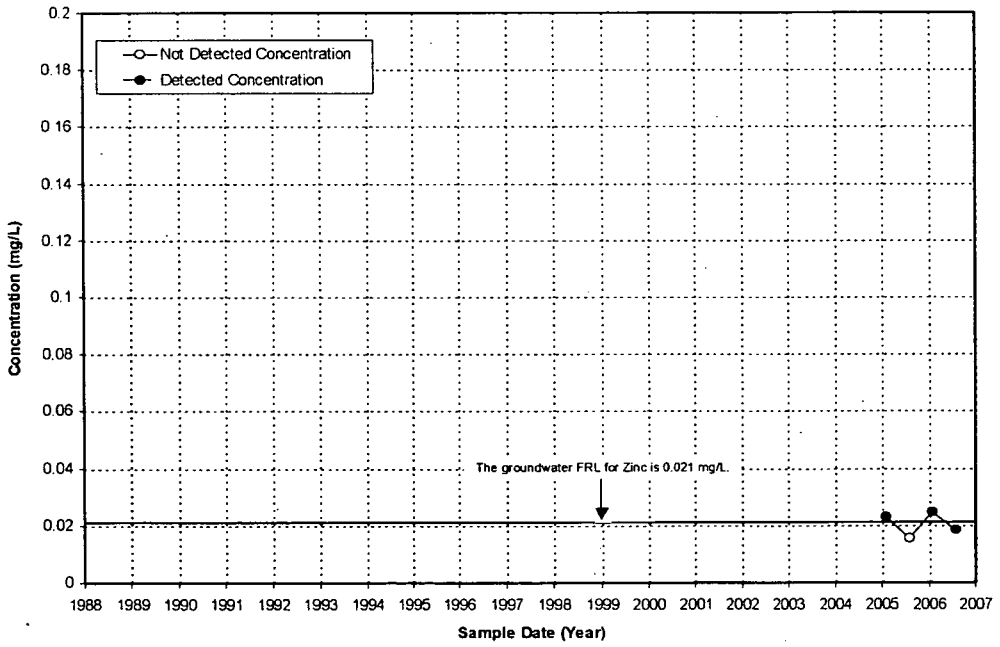

FIGURE A.4-7. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 22210

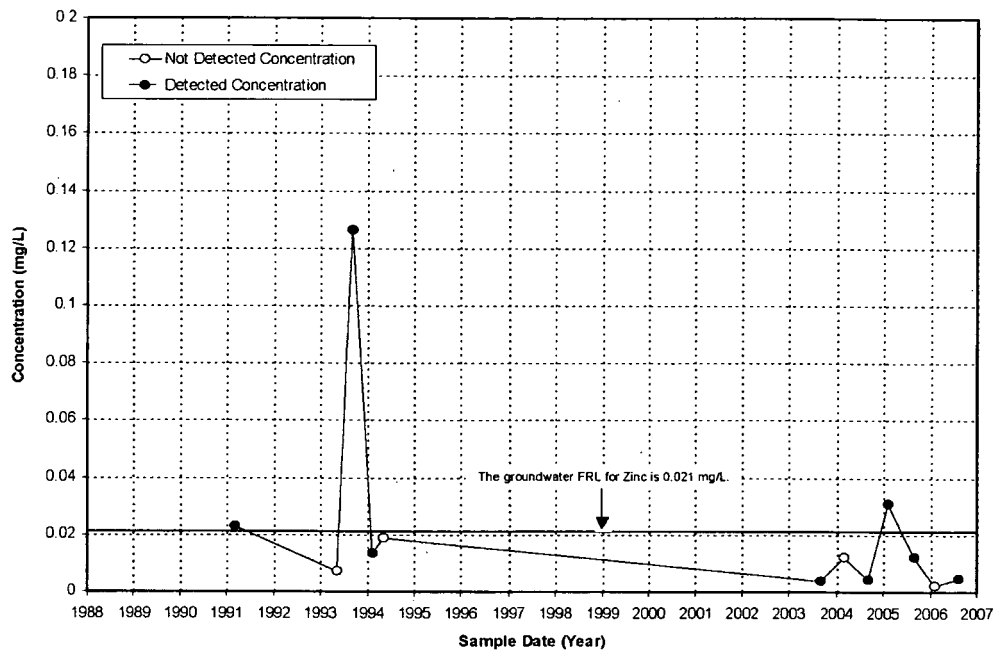

FIGURE A.4-8. ZINC CONCENTRATION VS. TIME PLOT FOR MONITORING WELL 3128

End of current text

Attachment A.5

A.5.0 On-Site Disposal Facility Monitoring Results

The on-site disposal facility (OSDF) monitoring program described in the OSDF Groundwater/Leak Detection and Leachate Monitoring Plan (GWLMP) (DOE 2006) fulfills two primary purposes: leak detection and leachate monitoring. This attachment provides the 2006 results for the leak detection monitoring program to meet regulatory requirements for groundwater detection monitoring in the Great Miami Aquifer and perched groundwater system and to provide leachate monitoring information.

Protection of the Great Miami Aquifer and the overlying perched groundwater system includes the following measures for each of the eight cells (refer to Figure A.5–1 for a cross section of the liner system):

- Leachate collection system (LCS)
- Leak detection system (LDS)
- Multi-layer composite liner system
- Multi-layer composite cap system.

The LCS consists of a gravel layer installed beneath the waste to collect rainwater that comes in contact with the waste during cell construction and additional moisture that drains from the waste following capping. The LDS is located beneath both the LCS and the primary geosynthetic liner system, and provides a mechanism for collecting and monitoring leakage from the OSDF prior to any releases to the environment. Both systems drain to the west and extend beyond the synthetic liner systems into valve houses, where leachate becomes accessible for monitoring.

Horizontal till wells (HTWs) are set beneath the compacted clay liner of each cell. These wells provide monitoring of the perched groundwater quality beneath the point where the LCS and LDS pipes exit the liner system. The Great Miami Aquifer is monitored via both an upgradient and a downgradient monitoring well for each cell. Figure A.5–2 identifies the well locations associated with the OSDF.

The final on-site disposal facility dimensions are: capacity of 2.96 million cubic yards (yd^3) (2.26 cubic meters [m^3]); maximum height of approximately 65 feet (ft) (20 meters [m]); and an estimated area coverage of 90 acres (36 hectares) of the northeastern area of the Fernald site. At the end of 2006, approximately 2.96 million in-place yd^3 (2.26 m^3) of waste were placed in the on-site disposal facility, of which in 2006 approximately 202,061 in-place yd^3 (154,487 m^3) of waste (including some excavated material, debris, etc.) were placed in Cells 7 and 8 of the on-site disposal facility. Cells 1 through 6 were 100 percent full and capped as of the end of January 2006. In 2006, Cell 7 was filled to its capacity (from 94 percent at the end of 2005) and the final cover system construction was completed by October 2006. In addition, Cell 8 was filled to its capacity (from 63 percent at the end of 2005) and the final cover system was completed by October 2006.

The 2006 OSDF leak detection and leachate monitoring information is organized in the following sections: Water Balance (Section A.5.1), Analytical (Section A.5.2), Additional OSDF Information (Section A.5.3), and Overall Performance and Recommendations (Section A.5.4). Subattachments are also included to provide cell-specific information:

- Cell 1 (Subattachment A.5.1)
- Cell 2 (Subattachment A.5.2)
- Cell 3 (Subattachment A.5.3)
- Cell 4 (Subattachment A.5.4)
- Cell 5 (Subattachment A.5.5)
- Cell 6 (Subattachment A.5.6)
- Cell 7 (Subattachment A.5.7)
- Cell 8 (Subattachment A.5.8).

Each subattachment includes figures, tables, and analytical information.

Table A.5–1 identifies specific dates for the following cell activities:

- Sample initiation for each monitoring horizon
- Waste placement initiation
- LDS volume measurement initiation
- Cap geomembrane layer completion
- Cap completion (through seeding).

A.5.1 Water Balance

This section provides the following information:

- Overall LCS volumes (A.5.1.1)
- LDS accumulation rates and volumes (A.5.1.2)
- Liner efficiencies (A.5.1.3)
- HTW water yields (A.5.1.4)
- Perched water level investigation (A.5.1.5)
- Great Miami Aquifer water levels versus total uranium (A.5.1.6).

A.5.1.1 Overall LCS Volumes

Leachate volumes were measured in 2006 at a meter located within the OSDF leachate conveyance system lift station located immediately south of the valve houses. Leachate was derived from precipitation and use of dust suppression water on the active cells. In addition to leachate from active cells, the volumes measured include water pumped from the LDS tanks from each cell. The LDS flows are subtracted from the total meter reading to obtain a

measurement that represents the collective leachate volume from all OSDF cells containing waste materials.

The volume of precipitation that fell on the active cells in 2006 was approximately 10.6 million gallons. As noted above, another source of water that generated leachate was the dust suppression water obtained from any of three OSDF construction wells. From January through the end of September 2006, a total of 25.9 million gallons were pumped from these wells for dust suppression, a portion of which was used as dust suppression water on Cells 7 and 8.

Leachate was collected from Cells 1 through 8 for the entire year. Leachate volumes have been measured in all cells since waste placement was initiated.

According to the data collected in 2006, approximately 7.6 million gallons of leachate were collected and pumped to the Storm Water Retention Basin and Backwash Basin for subsequent treatment at the Converted Advanced Wastewater Treatment Facility (CAWWT). This value represents about 20.8 percent of the precipitation and dust suppression water that fell on the active cells. The remainder of the precipitation/dust suppression water evaporated or was retained in the waste material.

Figure A.5–3 provides monthly LCS-to-Backwash Basin flow volumes (and previously LCS-to-Storm Water Retention Basin flow volumes). Precipitation amounts corresponding to each accumulation period are displayed to show the correlation between precipitation and the LCS accumulation rate. As presented in Figure A.5–3, leachate volumes fluctuated throughout the year but generally correlate to precipitation. These fluctuations were expected during the active waste placement period that occurred prior to final capping. The leachate volumes during this period primarily reflected the amount of precipitation that fell on the active cells and was subsequently collected in the LCS. As the cells were capped, the leachate volume from the capped cells are expected to stabilize and diminish over time as in Cells 1, 2, and 3.

The OSDF GWLMP identifies that trend analysis of the LCS flow monitoring measurements will be conducted for capped cells in order to provide an indication of changes in system performance. Figures in Subattachments A.5.1 through A.5.3 for Cells 1 through 3 show weekly and monthly LCS accumulation volumes for capped cells (e.g., Cells 1, 2, and 3). As identified above, the leachate volumes from Cells 1, 2, and 3 (i.e., the capped cells) have stabilized and diminished over time. Cells 4 and 5 were capped during 2005, and Cell 6 was capped in January 2006. These cells have similar trends to those observed in Cells 1 through 3. Subattachments A.5.4 through A.5.6 show weekly and monthly LCS accumulation volumes for Cells 4, 5, and 6, respectively.

A.5.1.2 LDS Accumulation Rates and Volumes

Quantitative measurement of the volumes accumulating in and pumped from the LDS was initiated according to the various dates in Table A.5–1. These measurements are taken from a pressure transducer installed in the primary containment vessel and attached to a data logger that measures and records water levels hourly. The water level data are downloaded weekly and converted into volumes based on the tank manufacturer's design specifications for the LCS and LDS tanks. These data are used to determine both accumulation rates (in gallons per acre per day [gpad]) and accumulation volumes (in gallons) for each cell's LDS.

In each cell-specific subattachment (Subattachments A.5.1 through A.5.8), weekly and monthly accumulation rates along with corresponding precipitation amounts are graphically displayed. Precipitation amounts corresponding to each accumulation period are used to determine whether a correlation exists between precipitation and the LDS accumulation rate. Based on a review of the figures, it does not appear that there is a strong correlation between precipitation and the cell LDS accumulation rates. This is not surprising as a geosynthetic liner and various amounts and types of material above the liner retard the movement of precipitation into the LDS. Figures are also provided in the cell-specific subattachments to show LDS monthly accumulation rates versus waste placement volume. Now that all waste cells have been capped and it has been documented through this and past SERs that there is not a strong correlation between precipitation and the Cell LDS accumulation rates it is no longer necessary to track LDS accumulation rates on a weekly basis. With next year's SER, DOE recommends going to reporting of only monthly LDS accumulation rates.

The OSDF GWLMP states that trend analysis of the LDS flow monitoring measurements will be conducted for capped cells to provide an indication of changes in system performance. Weekly and monthly accumulation volumes are shown for capped Cells 1 through 6 in Subattachments A.5.1 through A.5.6.

Additionally, the OSDF Final Design Calculation Package (DOE 1997b) concludes that an initial response leakage rate for individual cells should be 20 gallons per acre per day (gpad). The 2006 maximum LDS accumulation rates and the percent of the initial response leakage rate for each cell is as follows:

- Cell 1 – 0.07 gpad (0.4 percent)
- Cell 2 – 0.09 gpad (0.5 percent)
- Cell 3 – 0.59 gpad (3.0 percent)
- Cell 4 – 2.61 gpad (13.1 percent)
- Cell 5 – 9.47 gpad (47.4 percent)
- Cell 6 – 10.16 gpad (50.8 percent)
- Cell 7 – 13.08 gpad (65.4 percent)
- Cell 8 – 9.85 gpad (49.3 percent).

These rates indicate that the liner systems for the cells that are capped (Cells 1 through 8) are performing well within the specifications outlined in the approved cell design. Note that Cells 4 and 5 were capped during 2005 (April and August, respectively), Cell 6 was capped in January 2006, Cell 7 and Cell 8 were capped in October 2006. Over time, with the capping and closure of the cells, the water yield from each cell's LDS is expected to diminish (refer to individual cell subattachments). The volume of water removed from each cell's LDS will continue to be closely tracked to determine if the primary liner systems continue to perform as expected.

A.5.1.3 Liner Efficiencies

Cell-specific apparent liner hydraulic efficiencies can be calculated via the following equation:

$$[1-(Vol_{LDS}/Vol_{LCS})] \times 100$$

Apparent liner hydraulic efficiency is a measure of how a cell's liner is performing, and the above equation considers *all* the LDS volume to be leakage through the primary liner, which is a conservative measure. In the EPA report of the 1995 Workshop on Geosynthetic Clay Liners, Appendix F (EPA 1996), several sources of flow from leak detection layers are identified. These sources include:

- Top liner leakage
- Construction water and compression water
- Consolidation water
- Water from groundwater infiltration.

Monthly liner efficiencies were consistently greater than 99 percent for Cell 1, 96 percent for Cell 2 and Cell 3, 83 percent for Cell 4, 73 percent for Cell 5 and 78 percent for Cell 6. Monthly liner efficiencies (in percentages) are provided for capped Cells 1 through 6 in Subattachments A.5.1 through A.5.6. Data for cells 7 and 8 are not available for 2006.

A.5.1.4 HTW Water Yields

HTW water yields are being reviewed to determine if trends exist in perched water purge volumes. Average monthly water yields from the HTWs ranged from 141 gallons below Cell 6 to 1,088 gallons below Cell 1. The Cell 3 HTW water yield, which had been trending upward from 2001 through 2005, showed a reduction in average monthly yield of 54 gallons. The HTW water yields will continue to be tracked and factored into the OSDF leak detection evaluation, where appropriate. The water-yield graphs, provided in each cell's subattachment, are updated with purge volume data collected prior to each sampling event.

A.5.1.5 Perched Water Level Investigation

The purpose of this monitoring was to determine whether the perched water levels beneath the cells were high enough to come in contact with the secondary liner of the cells. The water levels were measured and stored electronically on an hourly basis and were reviewed monthly. HTW water level monitoring was initiated in February 2002 for Cells 1 through 3; in March 2002 for Cells 4 and 5; in October 2003 for Cell 6; in January 2005 for Cell 7; and in August 2005 for Cell 8. Specific graphs for Cells 1 through 8 are provided in Subattachments A.5.1 through A.5.8. In addition to the HTW water level monitoring, five Type 1 wells (13249, 13250, 13251, 13252, and 13261) were installed around Cell 1 in the spring of 2002 to evaluate perched water levels around the cell with respect to those found in the HTW for Cell 1 (Well 12338). Monitoring of these wells ceased in 2005 after approval EPA and OEPA.

Based on the HTW water level monitoring and known water level gradients, it appears in past years that perched water levels may have been high enough at certain times of the year to come in contact with portions of the liners beneath Cells 1 and 5. This information is important to the

OSDF leak detection program because it indicates that perched water may be a source for flow into the LDS layer. The perched water levels in the vicinity of Cells 1 through 5, and their implications for contributing fluid to the LDS, have been discussed periodically with EPA and OEPA during the weekly conference calls, site visits, and meetings. Note that during 2005, Cell 1 water levels were not high enough to come in contact with the liners (i.e., primary or secondary); however, Cell 5 water levels were high enough to come into contact with its secondary liner. Data indicate that perched water levels in the area of Cells 6 through 8 are not high enough to be directly in contact with their associated liners.

Sufficient data has been gathered to conclude that perched water could be a source for flow into the LDS layer of Cells 1 through 5. Water level information will continue to be collected prior to sampling HTWs; however, the electronic downloads were discontinued during 2005 after approval from EPA and OEPA. Note that the pressure transducers/dataloggers were removed from the wells in early 2006.

A.5.1.6 Great Miami Aquifer Water Levels Versus Total Uranium

Time plots of total uranium versus water level are prepared for the Great Miami Aquifer wells for Cells 1 through 8 and are provided in the cell-specific subattachments. It is important to review these plots with respect to the overall OSDF data evaluation process. In general, as groundwater elevations increase, uranium concentrations increase; and as groundwater elevations decrease, the uranium concentrations decrease. Groundwater elevations around the OSDF are typically about 520 ft above mean sea level (AMSL), and total uranium concentrations remain below the total uranium groundwater FRL of 30 µg/L, with concentrations typically less than 10 µg/L.

A.5.2 Analytical

This section provides the following information:

- Data presentations and evaluations (Section A.5.2.1)
- Parameter modification criteria (Section A.5.2.2).

Detailed text for each cell is also provided in the cell-specific subattachments.

A.5.2.1 Data Presentations and Evaluations

At this time, the number of samples collected from each OSDF cell determines how the data are presented. The OSDF GWLMP states that, based on the current understanding of pre-existing levels of contaminants in the OSDF subsurface, the Fernald site is electing to perform up to 12 rounds of initial baseline sampling for both the perched system and the Great Miami Aquifer for all initial site-specific leak detection monitoring parameters.

Sufficient samples have been collected to evaluate initial baseline conditions in Cells 1 through 7, and monitoring in these cells is utilizing a refined baseline list of constituents. Concentration plots are prepared and provided for these cells. Since sufficient samples have not been collected to evaluate baseline conditions in Cell 8, concentration plots are not provided in this report for Cell 8. Instead a data summary table is provided.

The following subsections describe specifics pertaining to the different types of data presentations:

- Summary tables (Section A.5.2.1.1)
- Concentration plots (Section A.5.2.1.2).

A.5.2.1.1 Summary Tables

Summary tables are used to evaluate initial baseline conditions and to also summarize analytical data prior to evaluating initial baseline conditions. A summary table is presented for Cell 8 in Subattachment A.5.8. This summary table includes overall sample numbers, number of detections, and sample ranges. Trend analysis prior to establishment of baseline is only required for the LCS and LDS per the OSDF GWLMP; however, it is provided for all horizons, where possible. It should be noted that the same seven constituents detected in Cells 1 through 7 have also been detected in Cell 8 (i.e., total organic carbon, total organic halogens, boron, mercury, technetium-99, sulfate, and total uranium).

A.5.2.1.2 Concentration Plots

There have been at least 12 samples collected from the HTWs and Great Miami Aquifer wells for Cells 1 through 7. Therefore, concentration plots are provided for these cells in Subattachments A.5.1 through A.5.7.

In previous SERs control charts have also been provided for informational purposes only. Technically though, it does not make sense to continue providing control charts until it has been determined that constituent-specific steady state conditions have been established. A common ion study is underway to address the steady state issue. Data collection for the common ion study is scheduled to be completed in 2007. Once it has been demonstrated that steady state conditions have been established, control charts will once again be provided in the SERs.

Summary statistics tables for Cells 1 through 7 are provided in each cell-specific subattachment. Each table summarizes, for constituents detected greater than 25 percent of the time the: average, distribution type, trend, presence of serial correlation, and outliers. The information provided in each table is based on a standardized sampling frequency, which is quarterly for all cells. Information in each table is also included on the concentration plots provided in the cell-specific subattachments. Note that minimum and maximum results provided on concentration plots are based on the non-standardized data (i.e., all results provided on the charts with the exception of pre-purge HTW results). Averages and trends presented on concentration plots are based on the standardized frequency data sets (e.g., quarterly) so that concentrations are weighted appropriately for trend analysis and to account for outlier removal. Outliers have been removed from cell-specific concentration plots.

Concentration plots (for those constituents detected more than 25 percent of the time) for each cell are provided on two plots: one showing the LCS, LDS, and HTW; and one showing the HTW and Great Miami Aquifer wells. The HTW is provided on both plots to serve as a reference horizon.

With respect to trend analysis, it is not unexpected that concentrations in any one or a number of horizons might be trending upward. Upward trends are not necessarily indicative of a leak, but possibly an indication of the changes in the environment surrounding the system. For example, the LCS concentrations could reflect more concentrated water as the leachate ages and infiltration into the capped cells decreases. Also, there is the pre-existing contamination in the Great Miami Aquifer, which could cause upward trends in concentrations as well. It is important to look at the overall LCS and LDS flow trends and concentration levels to evaluate the integrity of all components in the system.

For Cells 1 through 7, four of the 16 original leak detection indicator parameters (i.e., total organic carbon, total organic halogens, boron, and total uranium) were detected more than 25 percent of the time. In 2003, sulfate was added to the leak detection indicator parameter list due to its high mobility and the presence of a sulfate source in the crushed stone placed in the LCS and LDS layers. Sulfate was also detected more than 25 percent of the time.

A.5.2.2 Parameter Modification Criteria

As identified in the OSDF GWLMP, it is anticipated that during the data collection process, recommended refinements to the monitoring lists will be made periodically. The following subsections describe the current considerations for future additions and deletions to the parameter lists.

A.5.2.2.1 Eliminating Monitoring Parameters

An indicator parameter (sampled at least eight times) will be eliminated from the long-term leak detection monitoring program if it is not detected more than 25 percent of the time during the initial baseline period in the LCS, LDS, HTW, and GMA wells. This approach will be implemented on a cell-by-cell basis. Based on this approach, to date four constituents (total organic carbon, total organic halogens, boron, and total uranium) have been identified for long-term leak detection monitoring at Cells 1 through 7. The reduction in monitoring for Cells 1, 2, and 3 was approved through the Cells 1, 2, and 3 Technical Memorandum. The reduction in monitoring for Cells 4, 5, and 6 was approved through the 2004 Site Environmental Report. The reduction in monitoring for Cell 7 was approved through the 2005 Environmental Report.

A.5.2.2.2 Adding Monitoring Parameters

Based on the analytical results for the annual grab sample of leachate collected from the LCS for the Appendix I and polychlorinated biphenyl (PCB) parameters specified in the Ohio Administrative Code (OAC) 3745-27-10 and 19, detected constituents are evaluated to determine whether the initial site specific indicator parameters list is sufficient for leak detection purposes. Results of the evaluations are reported in the annual site environmental reports in accordance with the OAC 3745-27-19(M) reporting requirement.

Most of the Appendix I constituents have already been detected in perched groundwater at the Fernald site and were considered when selecting the initial site specific leak detection indicator parameters. It is expected that these constituents will also be detected in future OSDF leachate samples. Although constituents that are not part of the initial site specific indicator parameter list

for leak detection may be detected in the annual grab samples; it is not anticipated that the concentrations will be high enough to warrant revision of the initial site specific leak detection parameter list. Therefore, constituents detected in the annual OSDF LCS samples will not be added to the initial site specific leak detection indicator parameters list until the detections have been confirmed and criteria discussed below have been met.

The need to add a new initial site specific parameter will be considered when its detected concentration in the annual OSDF LCS samples are higher than the concentrations that exist currently in the contaminated media underlying the facility (i.e., above the range of Fernald site perched water concentrations as defined in the Remedial Investigation Report for Operable Unit 5 [DOE 1995]). A constituent will be added if: (1) the concentrations observed in the annual sample are much higher than the perched water concentrations at the Fernald site; and (2) routine analysis of the constituent can significantly enhance early detection capability. Additionally, concentrations will be compared to perched water and Great Miami Aquifer background values and the Great Miami Aquifer FRL values. Comparisons will be provided through the annual site environmental reports.

The refined baseline monitoring list currently consists of uranium, boron, total organic carbon (TOC), total organic halogens (TOX) sulfate, and the common ion constituents. The common ion constituents are being monitored temporarily to support a common ion study. Continued sampling for common ion constituents will be decided based upon the results of the study. Based on comments received on the 2006 SER, DOE and Geotrans over the course of 2006 have discussed ideas to develop a more systematic approach to determine how an annual LCS monitoring parameter will be added to the site specific monitoring list. The resulting selection approach is presented in the attached flow charts (FiguresA.5–4A and A.5–4B). The selection approach calls for any Appendix I or PCB constituent that has been sampled for eight times and has a 25 percent detection rate to be considered a "potential" site specific monitoring constituent. Incorporation to the site specific monitoring list would only be done if it can be demonstrated that adding the constituent would significantly enhance the early detection capability of the monitoring program.

Adding a constituent to the site specific monitoring list will be based on a statistical test to determine if there is a significant difference between the potential site-specific parameter concentration and either the pre-design or background data sets that are specific to the Fernald site. Statistical tests proposed include a T-test, Wilcoxen Rank Sum and Quantile Test, and Poisson Prediction Limits Test. Use of a specific test depends upon dataset conditions presented in Figure A.5–4B. It is possible that some Appendix I or PCB constituents that have no site-specific pre-design or background data will meet the eight sample, and >25 percent detect criteria. If this occurs, inclusion of the constituents on the site specific monitoring list will need to be considered on a case-by-case basis to determine if adding the constituent would significantly enhance the early detection capability of the monitoring program.

Potential site specific leak detection monitoring constituents are identified in the cell specific subattachments of this report. Once it has been documented that EPA/OEPA agrees with the proposed evaluation approach presented in Figures A.5–4A and A.5–4B, DOE will assess the potential leak detection monitoring constituents that are identified in the cell specific subattachments of this report. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

A.5.2.2.3 Confirmatory Sampling

As recommended in the Cells 1, 2, and 3 Technical Memorandum, when cell monitoring is refined (i.e., changed to those constituents detected more than 25 percent of the time during initial baseline sampling), annual samples collected from the LCS and LDS will be analyzed for all site-specific leak detection indicator constituents. If a site-specific constituent (not on the refined list) is detected in either the LCS or LDS, then confirmatory sampling for that constituent will consist of three consecutive sample events from the horizon in which it was detected. Depending on the magnitude and/or persistence of the constituent detected in the LCS or LDS, sampling for the detected constituent in the next lower horizon may occur. If the constituent is detected in the next lower horizon, then confirmatory sampling will again be conducted for three consecutive sampling events to determine if the sampling needs to progress to the next horizon.

Confirmatory Sampling for 1,1-dichloroethene in the LCS and LDS of Cell 3

In 2006 confirmatory sampling took place for 1,1-dichloroethene in the LCS and LDS of Cell 3. On May 16, 2005, a concentration of 9.2 µg/L was detected in the Cell 3 LCS. The groundwater FRL is 7 µg/L. Confirmatory sampling began in the fourth quarter of 2005. Results are as follows.

- Nov 28, 2005 13 µg /L
- Feb 20, 2006 3.2 µg /L
- May 23, 2006 12 µg /L
- Aug 25, 2006 2.1 µg /L
- Nov 1, 2006 2.5 µg /L
- Feb 20, 2007 0.737 µg/L

The annual Cell 3 LDS result from May 30, 2006 was a non-detect. Based on LCS results though, it was decided to conduct confirmatory sampling in the LDS. Results are as follows:

- Aug 25, 2006 Non-detect
- Nov 1, 2006 Non-detect
- Feb 20, 2007 Non-detect

Confirmatory sampling at the Cell 3 LCS for 1,1-dichloroethene will continue in 2007 until the constituent is evaluated using the site specific parameter selection approach presented in Figures A.5–4A and A.5–4B. Confirmatory sampling at Cell 3 LDS for 1,1-dichloroethene will be discontinued.

A.5.3 Additional OSDF Information

The following information on the common ion study, construction material, leach tests, and cell cap inspections has been included in this report to assist with the overall leak detection evaluation.

A.5.3.1 Common-Ion Study

At the March 8, 2005, TIE meeting, it was agreed upon by DOE, EPA, and OEPA that common ion monitoring would be conducted for eight rounds in the LCS, LDS, and horizontal till wells for each cell. Common ions, which are being sampled and analyzed, include: calcium, iron, magnesium, manganese, phosphorous, potassium, silicon, sodium, alkalinity, chloride, fluoride, nitrate/nitrite, and oxidation reduction potential. This monitoring was initiated in May 2005. It is anticipated that the 8 rounds of sampling will be completed for the majority of the locations in August 2007. Once the 8 rounds of common ion data have been collected, sampling for common ion constituents will stop. A decision concerning the resumption of common ion monitoring activities will be determined based upon the results of the common ion study.

A.5.3.2 Construction Information and Leach Tests

As indicated in the 2004 Site Environmental Report, crushed limestone with dolomite was used in the construction of the OSDF for the LCS, LDS, and cap drainage layers. This rock is primarily composed of carbonate, calcium, and magnesium, but contains minor and trace quantities of almost every constituent that is present in seawater, including sulfate and boron. When the rock was crushed to prepare the size fraction dictated by the construction specification, a large surface area of fresh rock became available to react with the water that eventually contacts the stone. The composition of the leachate generated when water contacts the crushed stone was determined with leach tests performed in 2005. Results of the leach tests will be evaluated along with the results of the common ion monitoring discussed above.

A.5.3.3 Cell Cap Inspections

OSDF cell cap inspections are conducted on a quarterly basis. The inspection team typically includes representatives from Tetra Tech, Inc. (supporting the EPA); OEPA; Ohio Department of Health; S.M. Stoller Corporation; and the DOE Office of Legacy Management. During OSDF construction, a cell cap was included in the quarterly inspection once it was seeded and vegetation was becoming established. Issues identified during inspections typically include small erosion rills, rocks that surface as top soil settles, animal burrows and digging, small areas that require reseeding, and the presence of woody vegetation and thistle. The issues are addressed as follows:

- Erosion rills are repaired if they exceed 3 inches wide by 6 inches deep.
- Rocks that surface are removed, especially if they will interfere with mowing activities or may be a source location for erosion.
- Animal burrows and digging holes are filled in and reseeded, if necessary.
- Areas that require reseeding are seeded and covered with jute matting to help prevent erosion of the seed.
- Woody vegetation is removed and herbicide is applied to the noxious weeds.

Following each inspection, a report is generated for DOE that documents that the inspection was conducted and any findings that were reported. In 2006, inspections were conducted in February, June, September, and December.

A.5.4 Overall Performance and Recommendations

Based on the information provided in the previous subsections and in the following cell-specific subattachments, during 2006 the liners for Cells 1 through 8 all appear to be performing within the specifications detailed in the OSDF design documents. Over time, with the capping and closure of the cells, the water yield from each cell's LDS is expected to diminish. The volume of water removed from each cell's LDS will continue to be closely tracked to determine if the primary liner systems continue to perform as expected.

A.5.4.1 Parameter Modification Recommendation Summary

No modifications are recommended at this time.

Future parameter modifications will be made, as necessary, according to the criteria defined in the OSDF GWLMP and based on information collected for the common ion sampling.

Table A.5–1. OSDF Initiation and Completion Dates

Cell	Sample Initiation per Horizon[a]	Waste Placement Initiation	LDS Volume Measurement Initiation[b]	Cap Geomembrane Layer Completion[c]	Cap Completion[d]
1	LCS: February 17, 1998 LDS: February 18, 1998 HTW: October 30, 1997 GMA-U: March 31, 1997 GMA-D: March 31, 1997	December 23, 1997	May 1999	August 17, 2001	December 20, 2001
2	LCS: November 23, 1998 LDS: December 14, 1998 HTW: June 29, 1998 GMA-U: June 30, 1997 GMA-D: June 25, 1997	November 12, 1998	May 1999	July 17, 2003	November 12, 2003
3	LCS: October 13, 1999 LDS: August 26, 2002 HTW: July 28, 1998 GMA-U: August 24, 1998 GMA-D: August 24 1998	October 26, 1999	October 1999	July 16, 2004	September 20, 2004
4	LCS: November 4, 2002 LDS: November 4, 2002 HTW: February 26, 2002 GMA-U: November 6, 2001 GMA-D: November 5, 2001	November 08, 2002	November 2002	December 18, 2004	April 29, 2005
5	LCS: November 4, 2002 LDS: November 4, 2002 HTW: February 26, 2002 GMA-U: November 6, 2001 GMA-D: November 5, 2001	November 19, 2002	November 2002	June 22, 2005	August 29, 2005
6	LCS: October 27, 2003 LDS: October 27, 2003 HTW: March 14, 2003 GMA-U: November 16, 2002 GMA-D: December 16, 2002	November 18, 2003	January 2004	October 28, 2005	January 12, 2006

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Table A.5–1 (continued). OSDF Initiation and Completion Dates

Cell	Sample Initiation per Horizon[a]	Waste Placement Initiation	LDS Volume Measurement Initiation[b]	Cap Geomembrane Layer Completion[c]	Cap Completion[d]
7	LCS: September 2, 2004 LDS: September 2, 2004 HTW: February 24, 2004 GMA-U: January 21, 2004 GMA-D: January 21, 2004	September 9, 2004	September 2004	July 2006	October 25, 2006
8	LCS: October 18, 2004 LDS: October 18, 2004 HTW: May 19, 2004 GMA-U: March 31, 2004 GMA-D: March 31, 2004 GMA-SW: August 22, 2005 GMA-SE: August 22, 2005	December 2, 2004	December 2004	September 24, 2006	October 25, 2006

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; GMA-D = downgradient Great Miami Aquifer; GMASW = southwest Great Miami Aquifer; and GMA-SE = southeast Great Miami Aquifer
[b]Prior to 1999, overall LDS volumes were measured. From 1999 on, LDS volumes were measured by cell.
[c]The cap geomembrane layer is made of high density polyethylene.
[d]Cap completion includes seeding.

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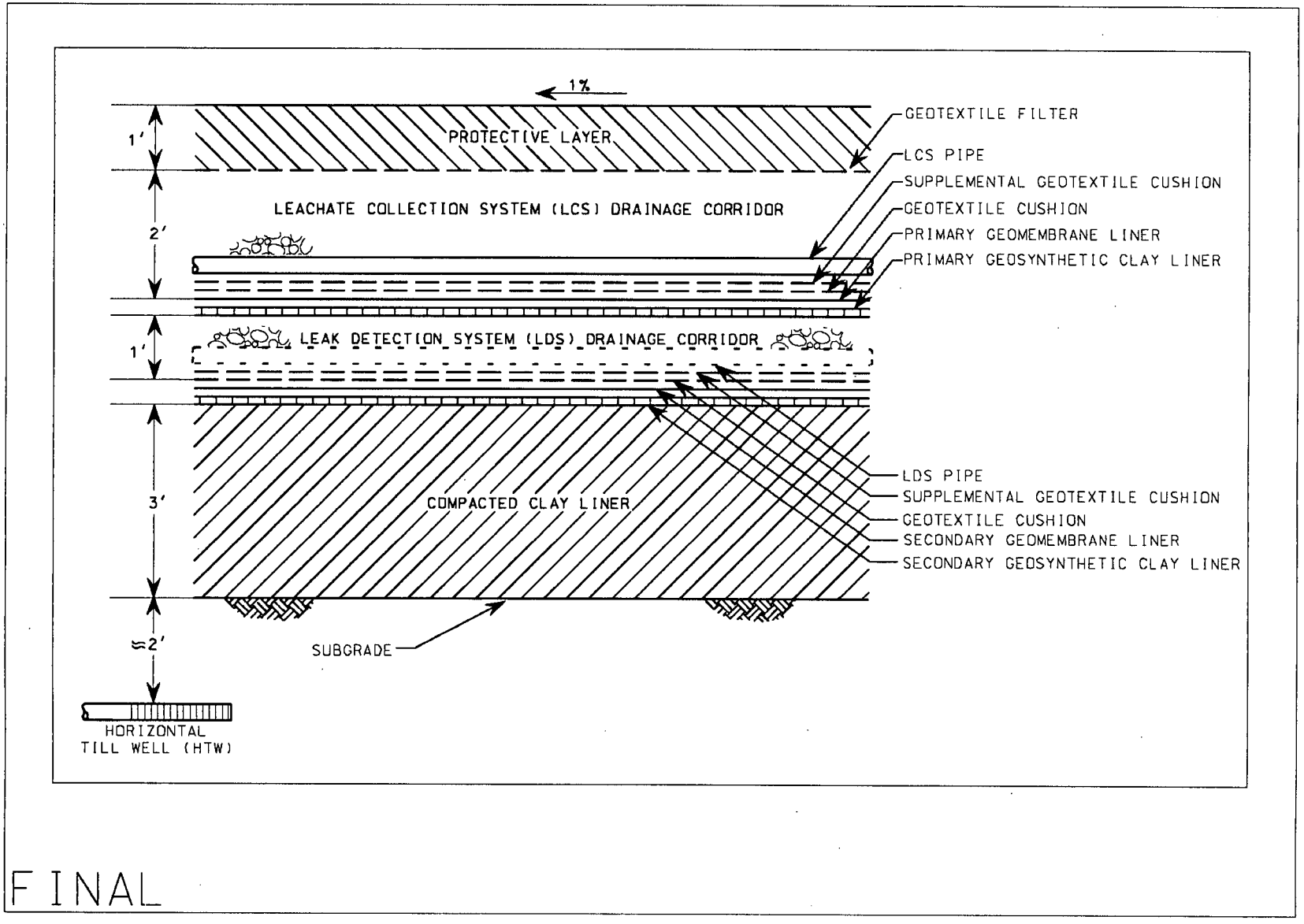

Figure A.5–1. On-Site Disposal Facility Liner System with HTW at the Drainage Corridor

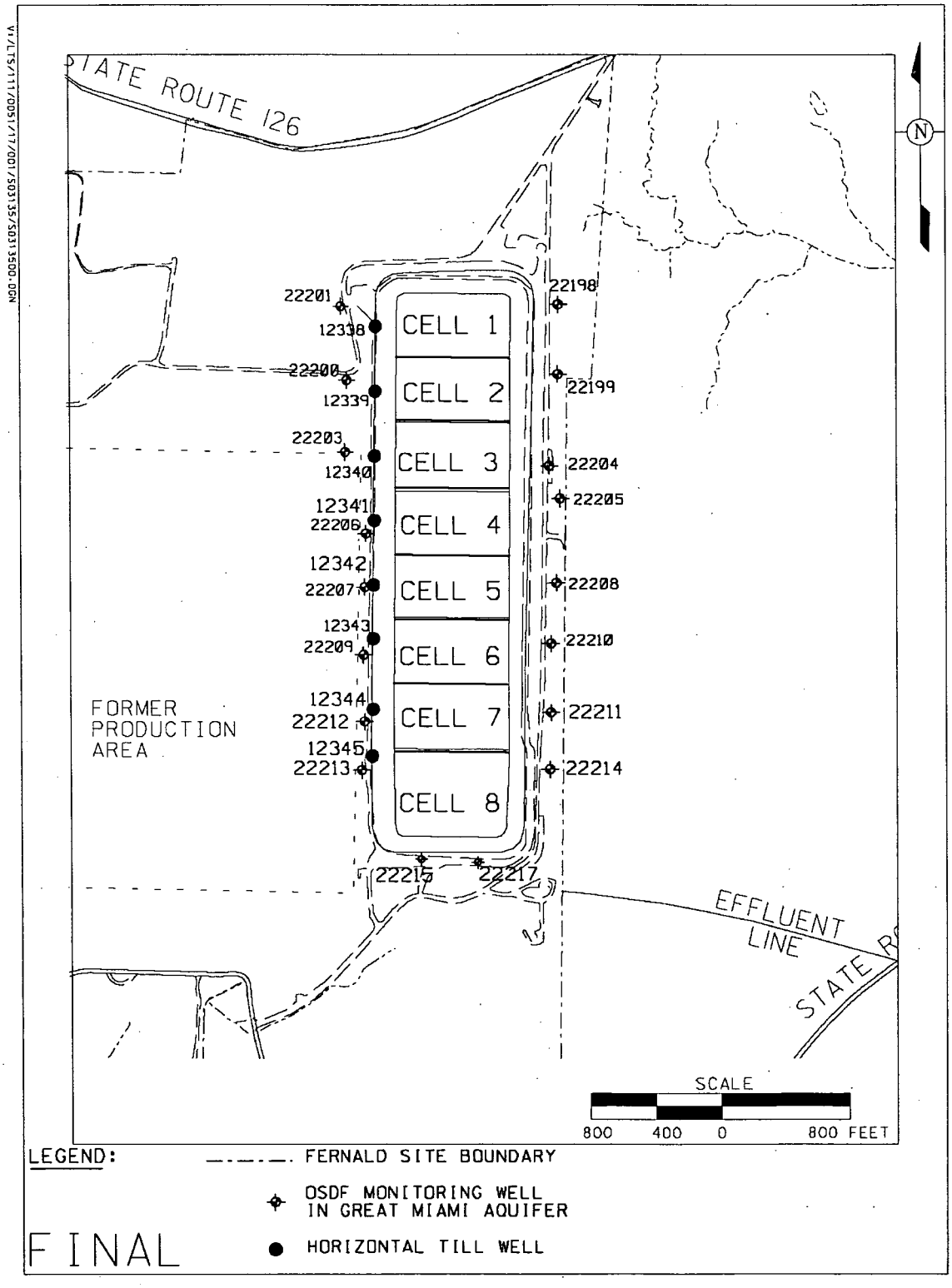

Figure A.5–2. On-Site Disposal Facility Footprint and Monitoring Well Locations

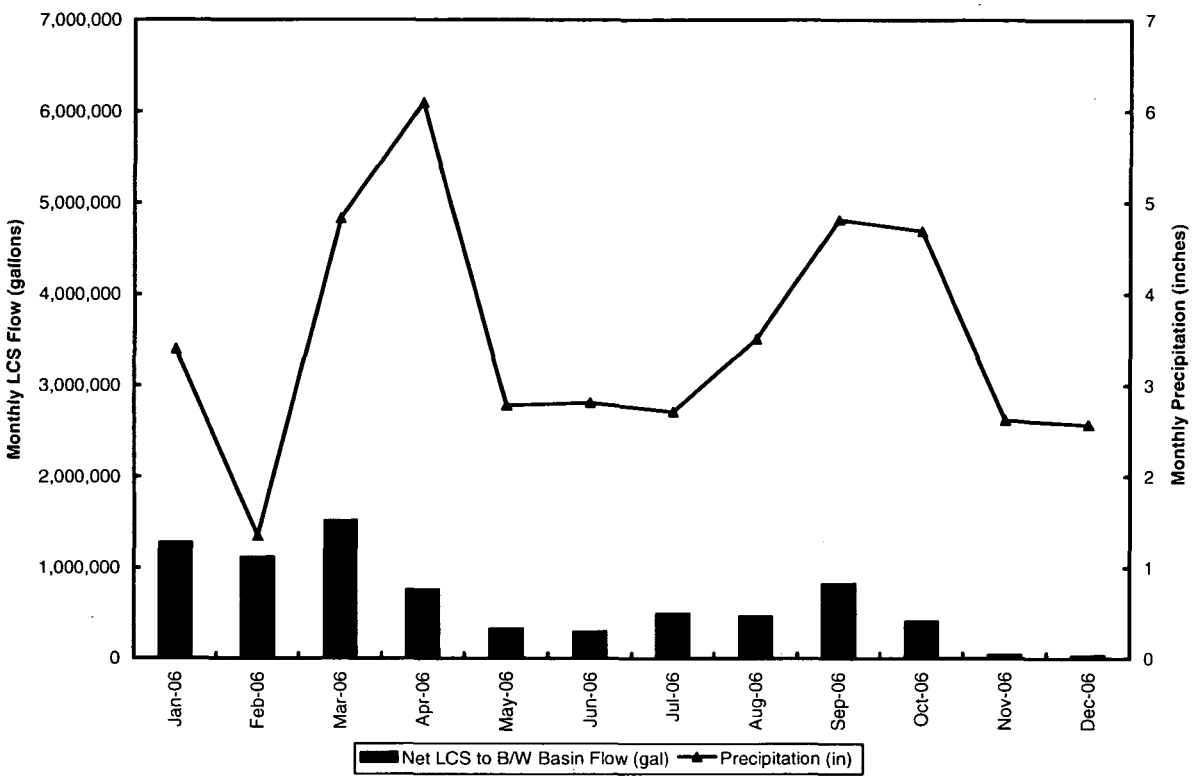

FIGURE A.5-3. OSDF LCS to Backwash Basin Flow and Precipitation

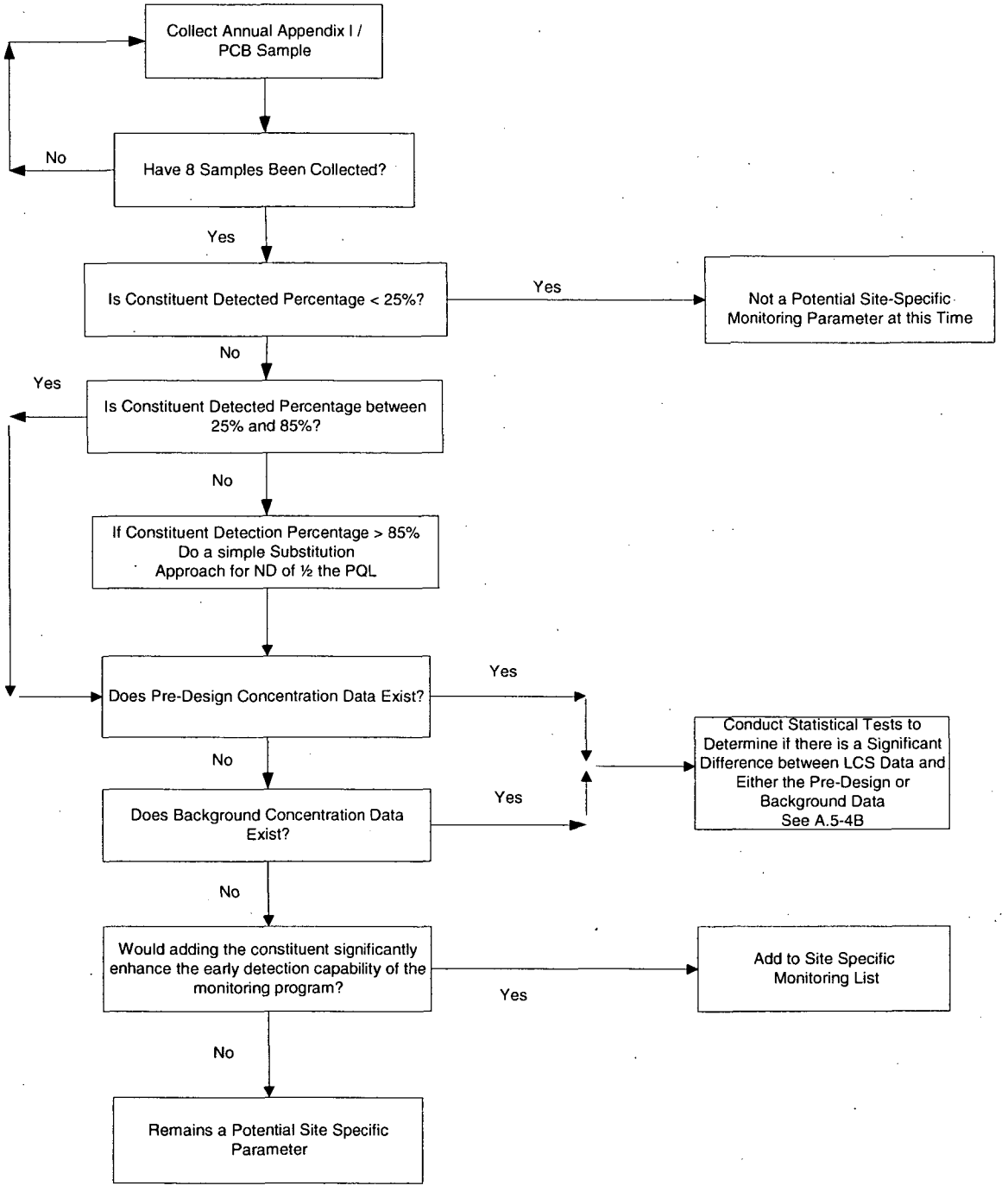

Figure A.5–4A. OSDF Site-Specific Leachate Monitoring Parameter Selection Approach

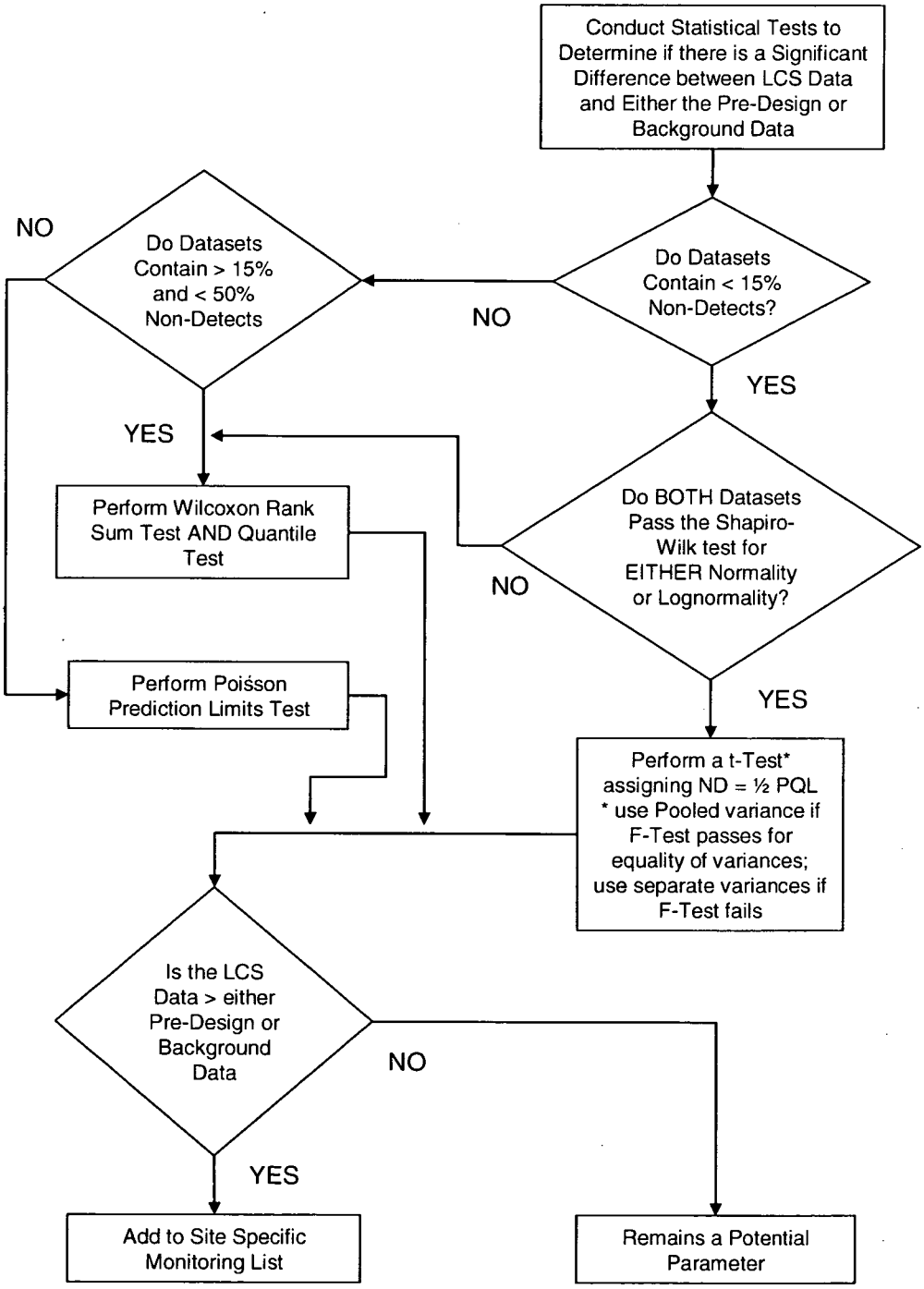

Figure A.5-4B (continued). OSDF Site Specific Leachate Monitoring Parameter Selection Approach

End of current text

Subattachment A.5.1

Cell 1

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.1–1 and A.5.1–2)
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.1–3 and A.5.1–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.1–5 and A.5.1–6)
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.1–7)
- Monthly liner efficiencies (refer to Table A.5.1–1)
- HTW Water Yield (refer to Figure A.5.1–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.1–9 and A.5.1–10)
- Summary statistics for refined baseline constituents (refer to Section A.5.1.1 and Table A.5.1–2)
- Concentration plots for refined baseline constituents (refer to Section A.5.1.1 and Figures A.5.1–11A through A.5.1–15B)
- Annual LCS monitoring results (refer to Section A.5.1.2 and Table A.5.1–3)
- Annual LDS monitoring results (refer to Section A.5.1.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. In 2006, all samples were collected for Cell 1 monitoring horizons with the exception of the LDS which was dry in the third and fourth quarters.

A.5.1.1 Refined Baseline Monitoring Results

Refined baseline constituents are those constituents that have been sampled for at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also included in Table 2–3 are common ion constituents. A summary statistics table (refer to Table A.5.1–2), and concentration plots (Figures A.5.1–11A through A.5.1–15B) are provided for the five baseline constituents of Cell 1. For Cell 1, these five constituents are total uranium, boron, total organic carbon, total organic halogens, and sulfate. Note that with the addition of data since 2005, total organic halogens concentrations are now detected less than 25 percent of the time in Well 22198.

A.5.1.2 LCS Monitoring Results

Ohio Solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 1 LCS took place in May.

Table A.5.1–3 summarizes the annual LCS sampling results for Cell 1, along with data collected in previous years.

Of the non-refined baseline site specific constituents that have been sampled for at least eight times, 19 have been detected at least 25 percent of the time. Ten of these 19 constituents are common ion constituents (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, potassium, silicon, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 1 will be determined based upon results of the common ion study.

The remaining nine constituents (considered to be "*potential*" site-specific leak detection monitoring constituents for Cell 1) are: ammonia, arsenic, barium, cobalt, copper, nickel, selenium, TDS, and zinc. These potential Cell 1 site specific leak detection monitoring constituents will be assessed using the approach presented in Figure A.5–4A and A.5–4B, once final approval of the approach has been obtained from the EPA and OEPA. The assessment will be used to determine what potential constituent (if any) will be added to the Cell 1 site specific leak detection monitoring constituent list. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

Mercury and technetium-99 are both site specific leak detection parameters; however, they are not on the refined baseline list for Cell 1. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.1–3, mercury and technetium-99 have been detected in the Cell 1 LCS, but these detections occurred prior to the establishment of the refined baseline for Cell 1. Therefore, confirmatory sampling for mercury and technetium-99 in the Cell 1 LCS is not required.

A.5.1.3 LDS Monitoring Results

Each year the LDS of Cell 1 is sampled for site-specific baseline parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. In 2006, annual sampling of the Cell-1 LDS took place in May.

Of the non-refined baseline constituents that have been sampled at least eight times in the Cell 8 LDS, none of the constituents have been detected at least 25 percent of the time.

Table A.5.1-1. Cell 1 – 2006 Monthly Liner Efficiencies

Month	Cell 1 Apparent Liner Efficiency (%)
January	100.00
February	99.55
March	99.64
April	99.67
May	99.56
June	100.00
July	100.00
August	100.00
September	100.00
October	100.00
November	99.88
December	99.60

Table A.5.1–2. Summary Statistics for Cell 1

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]		
Total Uranium (µg/L)	LCS	12338C	34	34	100%	69.7	Lognormal	None	Detected	0 U (1Q-99)	8.75 (Q3-03)	
	LDS	12338D	32	32	100%	12.0	Lognormal	None	Detected	1.5 (Q1-98)		
	HTW	12338	30	32	94%	3.95	Lognormal	Upward	Detected	0.608 (Q2-05)		
	GMA-U	22201	36	39	92%	1.42	Undefined	Upward	Detected	0 U (Q1-98)		
	GMA-D	22198	39	39	100%	5.22	Undefined	Upward	Detected			
Boron (mg/L)	LCS	12338C	32	33	97%	1.37	Lognormal	None	Not Detected	0.0642 (Q1-98)	0.128 (Q2-98)	0.337 (Q3-98)
	LDS	12338D	31	31	100%	0.238	Lognormal	None	Not Detected	0.002 U (Q3-00)	0.0296 (Q1-98)	
	HTW	12338	30	33	91%	0.175	Undefined	Upward	Detected			
	GMA-U	22201	38	40	95%	0.101	Normal	None	Detected			
	GMA-D	22198	36	39	92%	0.0608	Undefined	Upward	Marg. Detect			
Total Organic Carbon (mg/L)	LCS	12338C	32	32	100%	25.9	Lognormal	None	Detected	1.7 U (Q2-99)	1.8 U (Q1-99)	123 (Q2-98)
	LDS	12338D	27	31	87%	6.13	Normal	None	Marg. Detect	80.9 (Q2-98)	15.7 (Q1-00)	
	HTW	12338	17	29	59%	1.56	Lognormal	None	Detected	4.25 (Q1-04)	7.24 (Q1-00)	3.21 (Q3-99)
	GMA-U	22201	27	39	69%	2.67	Undefined	Downward	Detected	59.7 (Q2-98)		
	GMA-D	22198	20	38	53%	1.37	Undefined	Downward	Not Detected	52.5 (Q2-98)		
Total Organic Halogens (mg/L)	LCS	12338C	30	33	91%	0.205	Undefined	Upward	Detected	1.52 (Q3-02)		
	LDS	12338D	24	33	73%	0.0463	Lognormal	Marg. Up.	Marg. Detect			
	HTW	12338	14	33	42%	0.0090	Undefined	None	Marg. Detect			
	GMA-U	22201	12	39	31%	0.0125	Undefined	Downward	Detected	0.308 (Q2-00)		
	GMA-D	22198	8	39	21%	0.0111	Undefined	Downward	Detected			
Sulfate (mg/L)	LCS	12338C	21	21	100%	1070	Lognormal	Upward	Not Detected			
	LDS	12338D	14	14	100%	1500	Normal	Upward	Detected			
	HTW	12338	16	16	100%	776	Lognormal	None	Marg. Detect			
	GMA-U	22201	16	16	100%	405	Lognormal	Marg. Down.	Detected			
	GMA-D	22198	16	16	100%	287	Lognormal	Marg. Down.	Not Detected			

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.

Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

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Table A.5.1–3. Cell 1 and LCS Sample Summary Information

PARAMETER (UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
4-Nitroaniline (ug/L)	22	1	4.5%	1.01	-	-	-	-	-	-	3 ug/L[h]
Alkalinity as CaCO3 (mg/L)	14	14	100.0%	274	658	480	-	422 mg/L (9)	430 mg/L (8)	-	10 mg/L
Ammonia (mg/L)	9	6	66.7%	0.03	4.5	1.2	-	4.2 mg/L (1)	4.34 mg/L (1)	220 mg/L (0)	0.1 mg/L
Arsenic (mg/L)	9	4	44.4%	0.0038	0.0786	0.0248	0.05 mg/L (1)	0.029 mg/L (1)	0.019 mg/L (1)	0.191 mg/L (0)	0.02 mg/L
Barium (mg/L)	9	9	100.0%	0.0434	0.205	0.082	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Beryllium (mg/L)	9	2	22.2%	0.0000674	0.00012	-	0.004 mg/L (0)	-	-	0.0343 mg/L (0)	0.001 mg/L
Cadmium (mg/L)	9	2	22.2%	0.00033	0.00084	-	0.014 mg/L (0)	0.014 mg/L (0)	-	0.05 mg/L (0)	0.002 mg/L
Calcium (mg/L)	14	14	100.0%	377	1500	620	-	159 mg/L (14)	172 mg/L (14)	1800 mg/L (0)	5 mg/L
Chloride (mg/L)	14	14	100.0%	21.8	40.9	35.1	-	7.3 mg/L (14)	45 mg/L (0)	6300 mg/L (0)	5 mg/L
Chromium (mg/L)	9	2	22.2%	0.0012	0.0016	-	0.022 mg/L (0)	0.021 mg/L (0)	0.0046 mg/L (0)	0.818 mg/L (0)	0.005 mg/L
Cobalt (mg/L)	9	8	88.9%	0.0033	0.0575	0.0205	0.17 mg/L (0)	0.0086 mg/L (5)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	9	9	100.0%	0.00094	0.0157	0.0083	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	7	100.0%	0.173	0.26	0.21	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	14	14	100.0%	0.475	101	14	-	5.72 mg/L (7)	6.35 mg/L (7)	21.3 mg/L (2)	0.1 mg/L
Lead (mg/L)	9	1	11.1%	0.00066	-	-	0.015 mg/L (0)	0.022 mg/L (0)	0.0016 mg/L (0)	0.0114 mg/L (0)	0.008 mg/L
Magnesium (mg/L)	14	14	100.0%	71.4	319	159	-	38.5 mg/L (13)	50.7 mg/L (13)	690 mg/L (0)	5 mg/L
Manganese (mg/L)	14	14	100.0%	0.0104	7.7	2.2	0.9 mg/L (9)	0.9 mg/L (9)	0.21 mg/L (13)	35 mg/L (0)	0.09 mg/L
Mercury (mg/L)	22	2	9.1%	0.00000024	0.00047	-	0.002 mg/L (0)	-	-	0.0018 mg/L (0)	0.0002 mg/L
Nickel (mg/L)	9	9	100.0%	0.0119	0.0535	0.0330	0.1 mg/L (0)	0.0514 mg/L (1)	0.0072 mg/L (9)	0.981 mg/L (0)	0.02 mg/L
Nitrate/Nitrite (mg/L)	24	13	54.2%	0.00793	7	1.9	11[g] mg/L (0)	11 mg/L (0)	0.29 mg/L (8)	2670 mg/L (0)	1.1 mg/L
Phosphorus (mg/L)	7	4	57.1%	0.0873	0.19	0.13	-	-	-	-	0.1 mg/L
Potassium (mg/L)	14	14	100.0%	10.8	25.9	17.2	-	1.96 mg/L (14)	17.2 mg/L (6)	12400 mg/L (0)	5 mg/L
Selenium (mg/L)	9	3	33.3%	0.0048	0.017	0.0097	0.05 mg/L (0)	0.00075 mg/L (3)	-	0.0494 mg/L (0)	0.005 mg/L
Silicon (mg/L)	7	7	100.0%	5.09	7.39	6.11	-	-	-	15 mg/L (0)	0.015 mg/L
Silver (mg/L)	9	1	11.1%	0.00014	-	-	0.05 mg/L (0)	0.0117 mg/L (0)	0.0031 mg/L (0)	0.264 mg/L (0)	0.005 mg/L
Sodium (mg/L)	14	14	100.0%	11.7	29.3	16.1	-	47.1 mg/L (0)	50 mg/L (0)	1300 mg/L (0)	5 mg/L
Technetium-99 (pCi/L)	22	5	22.7%	10.1	18.3	12.7	94 pCi/L (0)	22 pCi/L (0)	30 pCi/L (0)	6130 pCi/L (0)	10 pCi/L
Thallium (mg/L)	9	1	11.1%	0.00756	-	-	-	-	-	0.0028 mg/L (1)	0.02 mg/L
Total Dissolved Solids (mg/L)	18	18	100.0%	1940	2660	2310	-	-	-	-	10 mg/L
Zinc (mg/L)	9	6	66.7%	0.0162	0.575	0.130	0.021 mg/L (4)	0.02 mg/L (4)	0.35 mg/L (1)	1.78 mg/L (0)	0.015 mg/L

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information.
[b]Rejected data qualified with an R or Z were not included.
[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.
[d]From Operable Unit 5 Record of Decision, Table 9-4.
[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.
[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.
[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.
[h]Detection Limit of 4-Nitroaniline is sometimes less than the value, depending on the laboratory doing the analysis.

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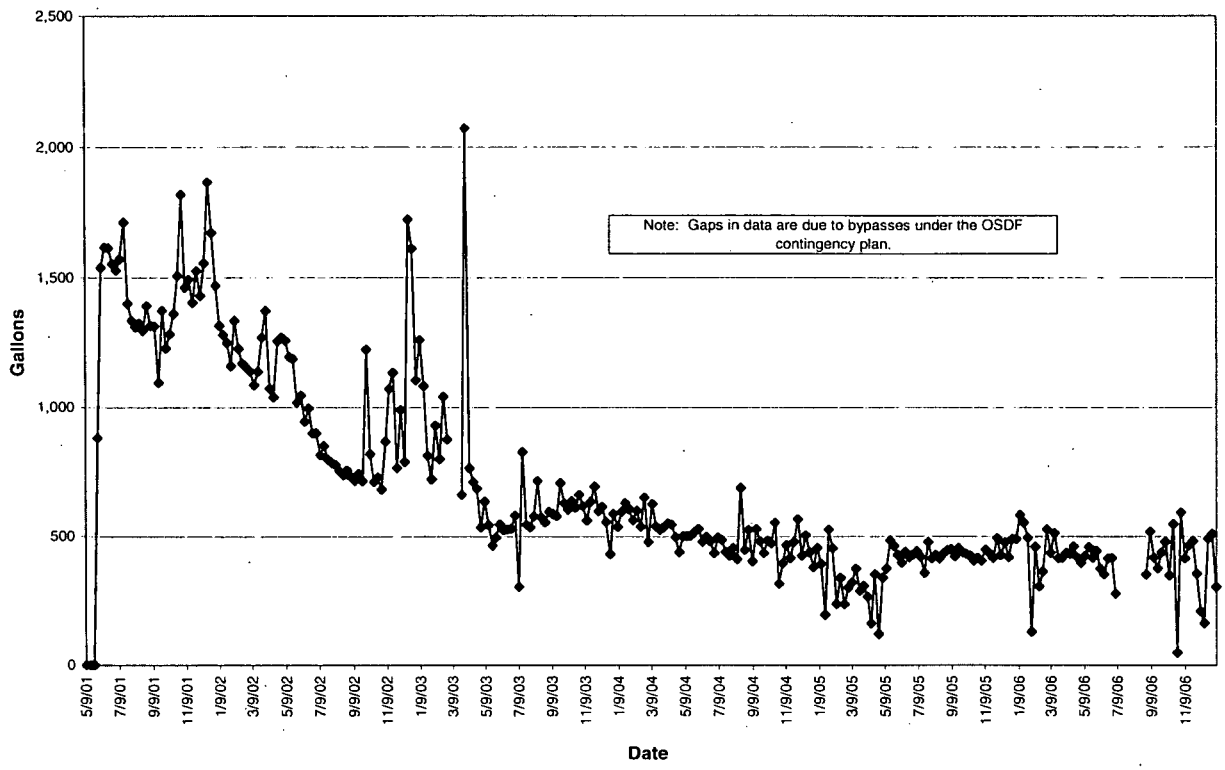


FIGURE A.5.1-1. Weekly Accumulation Volumes for Cell 1 LCS

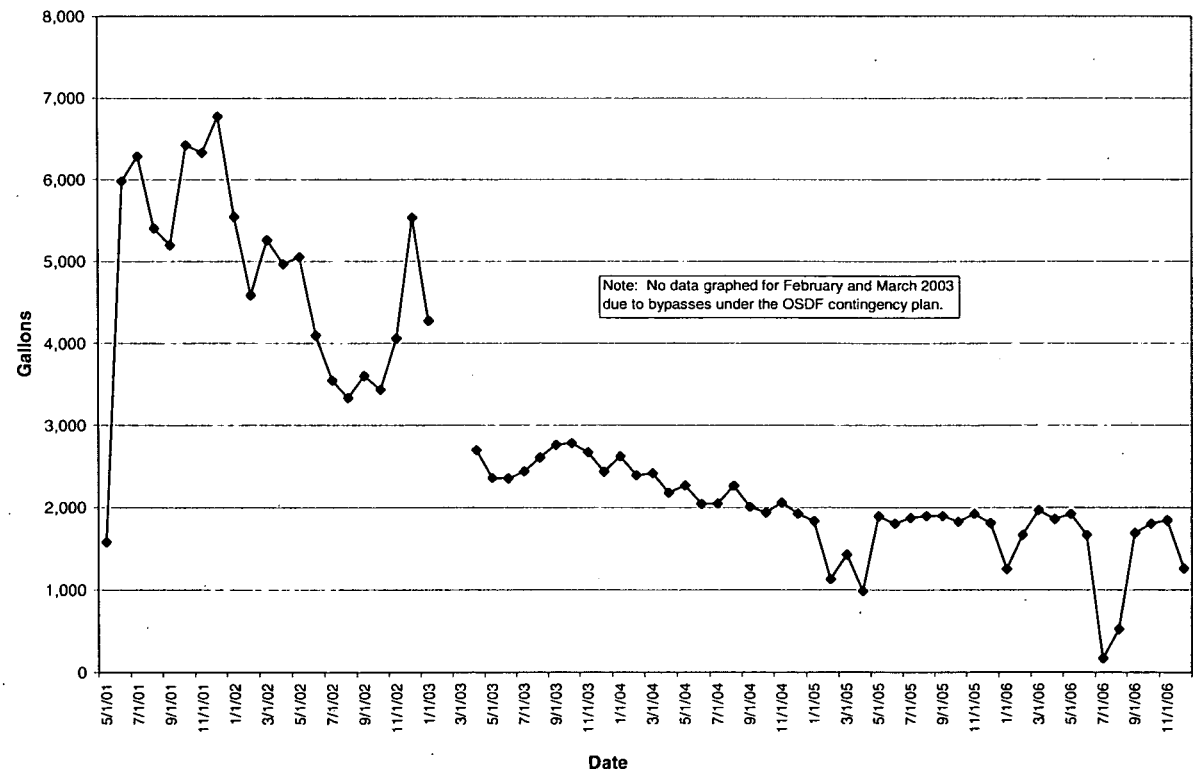


FIGURE A.5.1-2. Monthly Accumulation Volumes for Cell 1 LCS

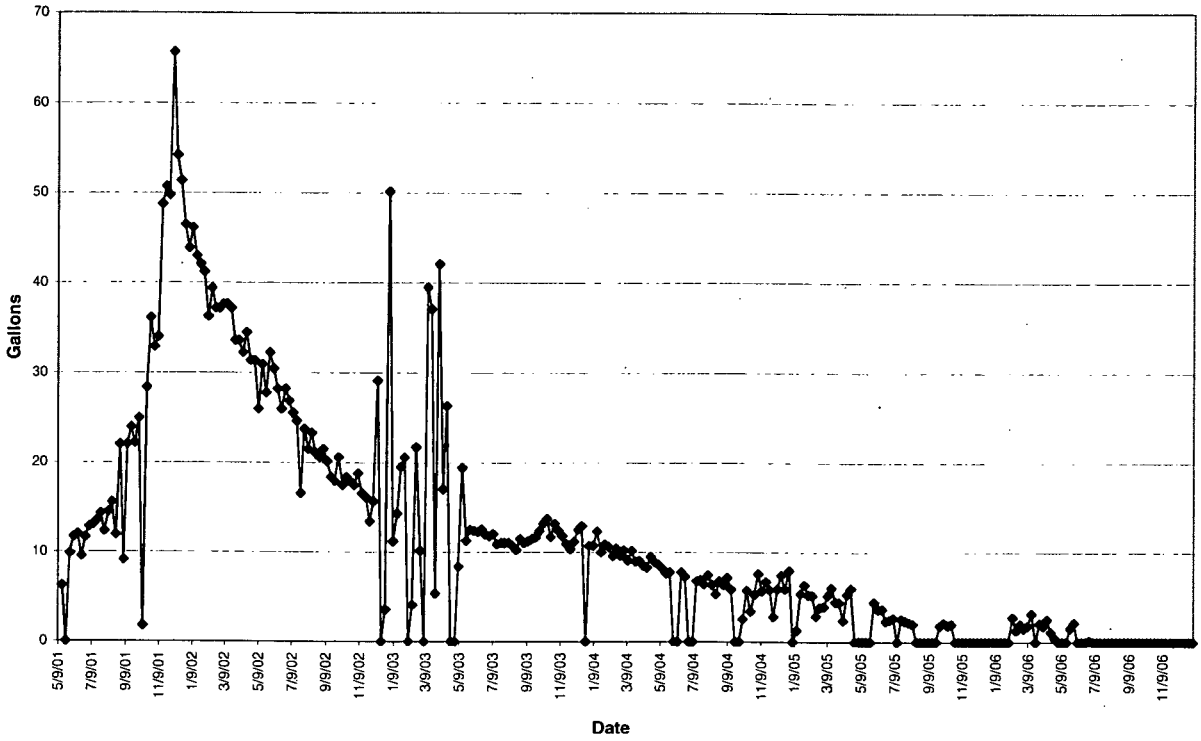


FIGURE A.5.1-3. Weekly Accumulation Volumes for Cell 1 LDS

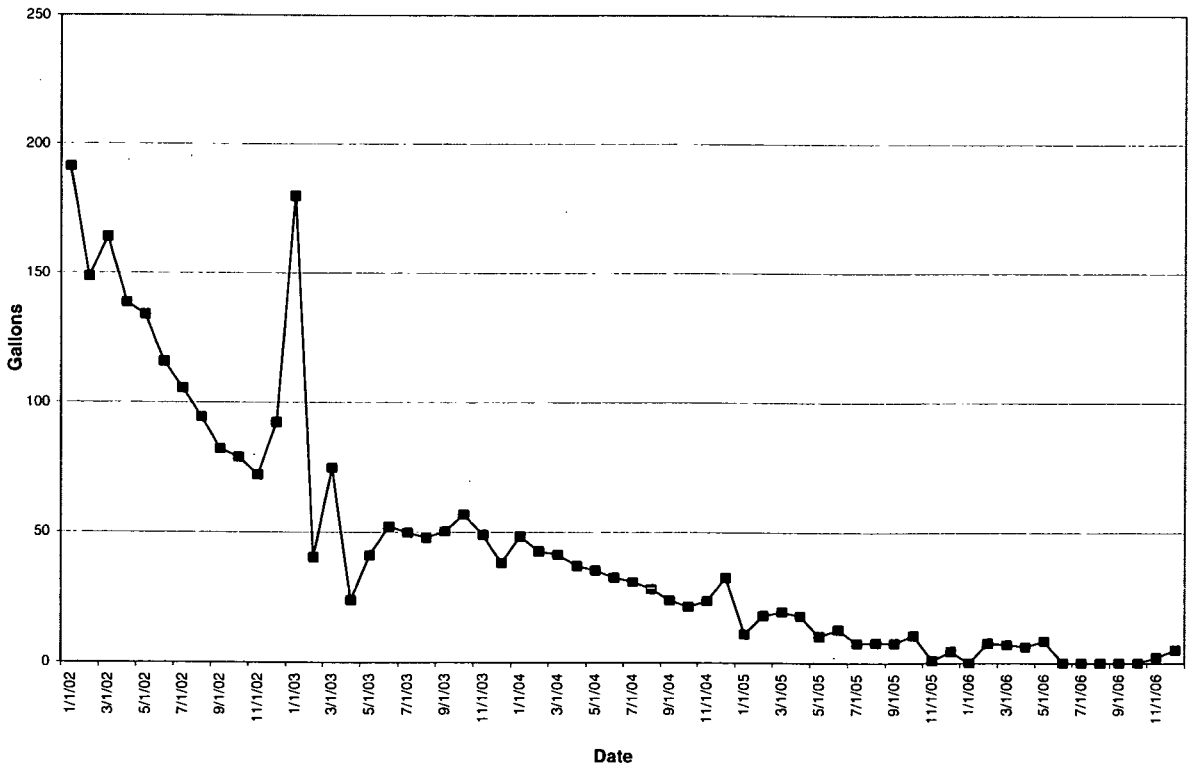


FIGURE A.5.1-4. Monthly Accumulation Volumes for Cell 1 LDS

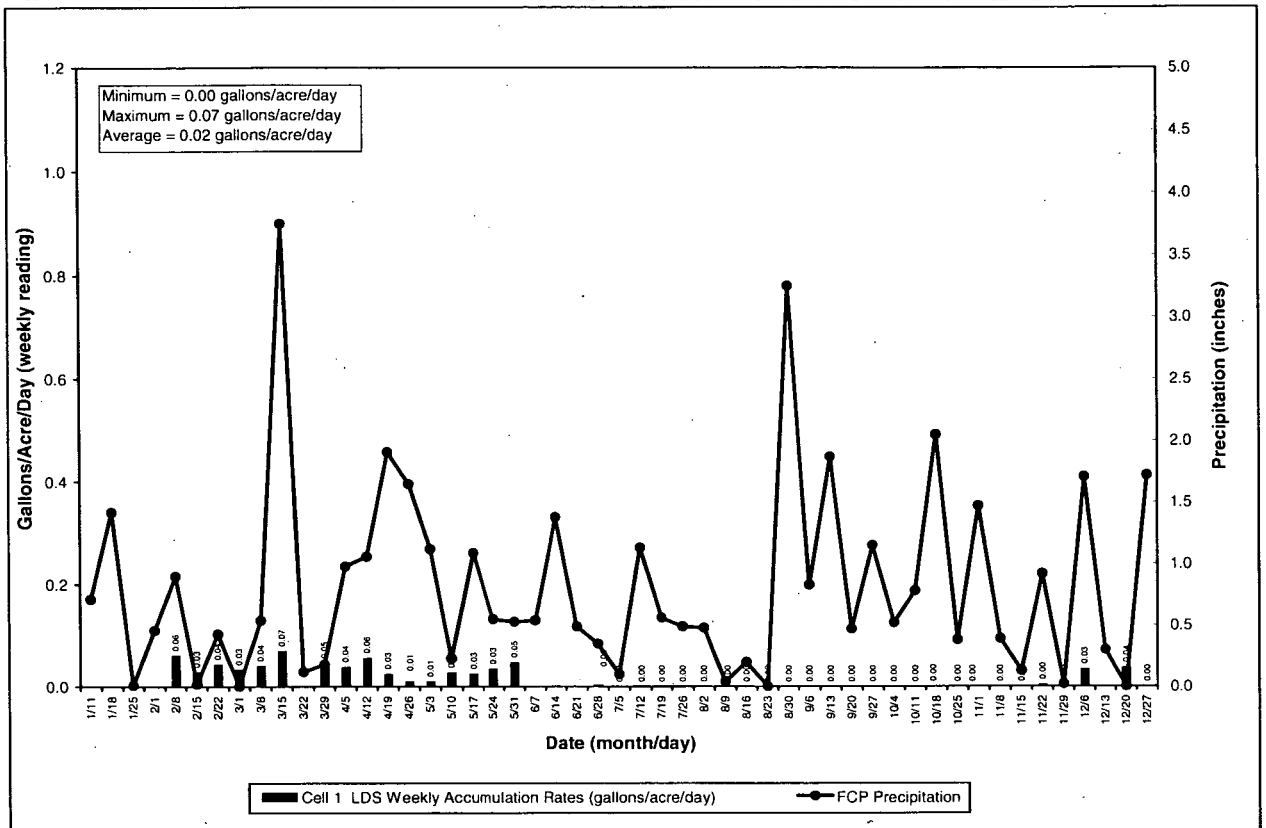


FIGURE A.5.1-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 1

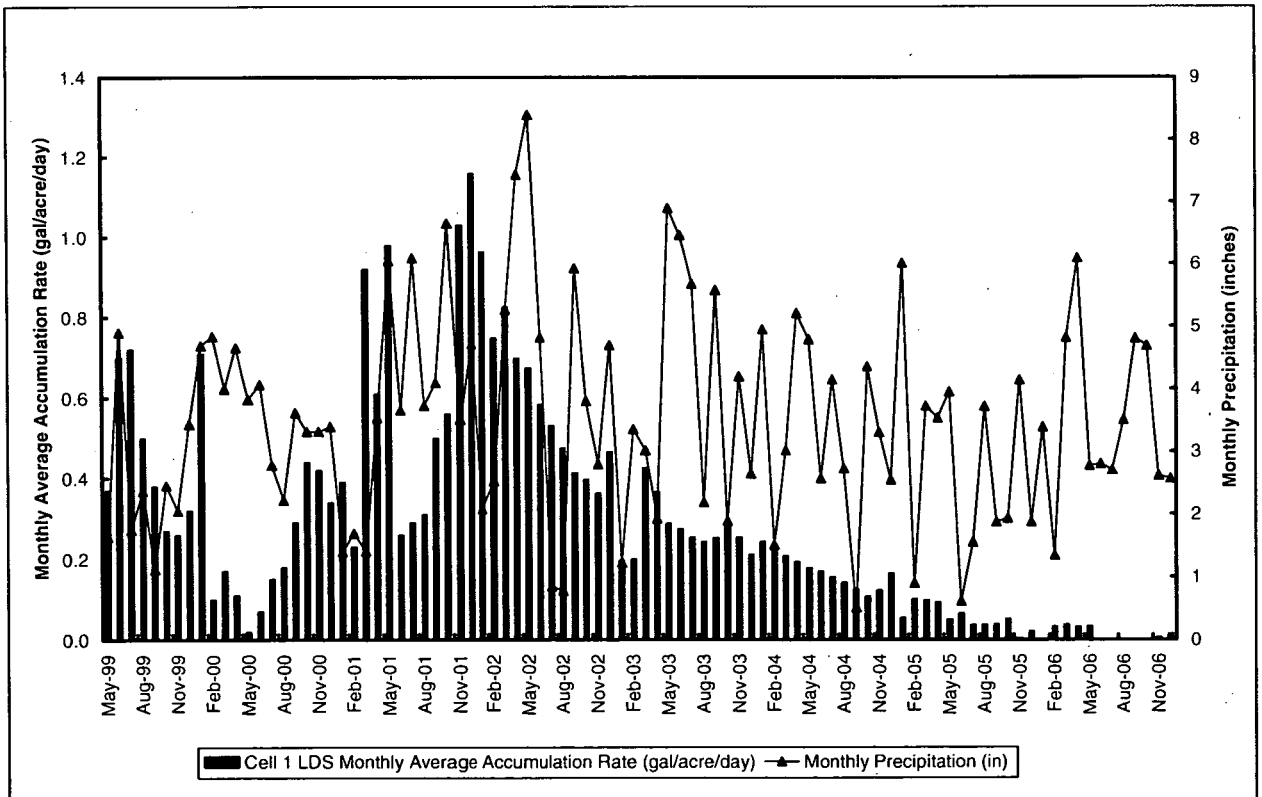


FIGURE A.5.1-6. OSDF Cell 1 LDS Monthly Average Accumulation Rates and Monthly Precipitation

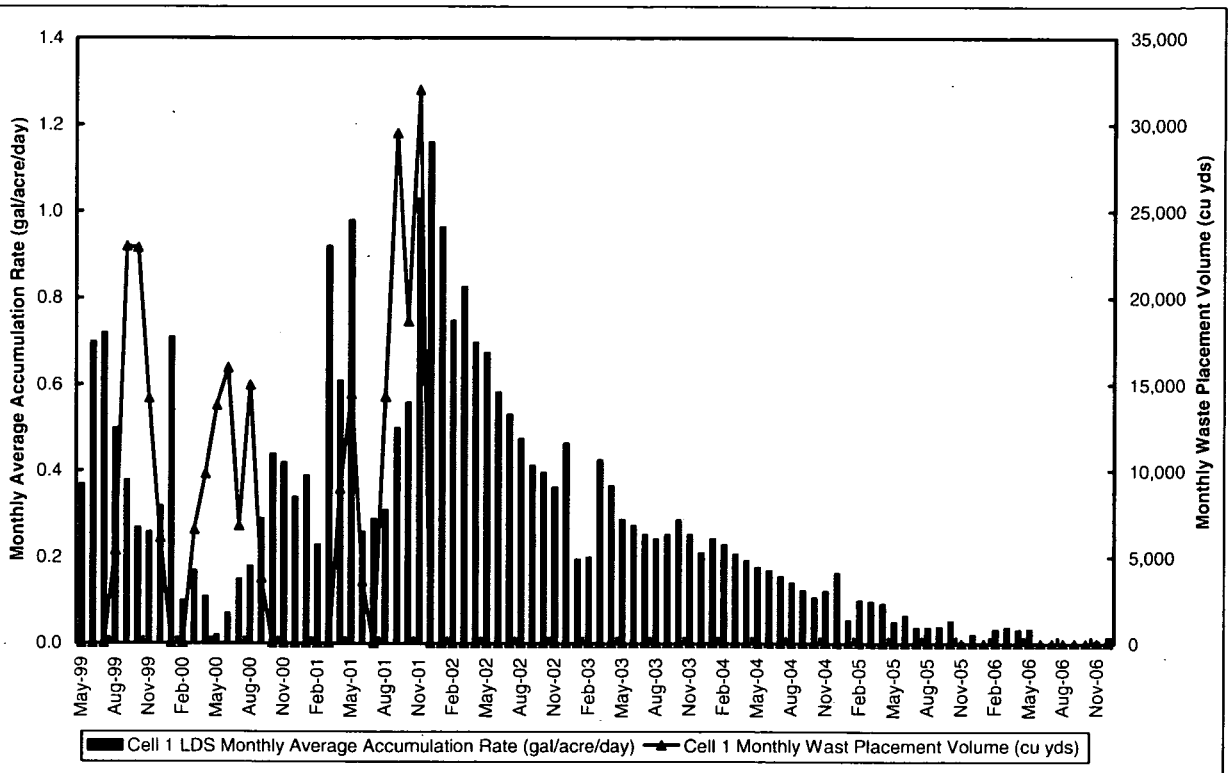
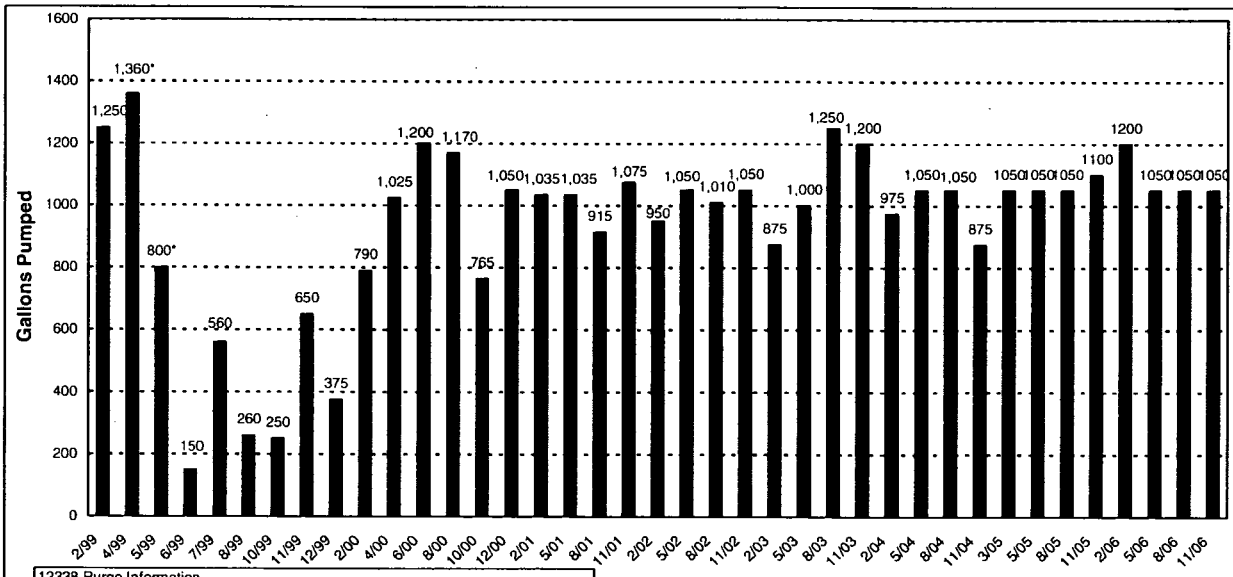


FIGURE A.5.1-7. OSDF Cell 1 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12338 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	5655	n=9	628
2000:	6000	n=6	1000
2001:	4060	n=4	1015
2002:	4060	n=4	1015
2003:	4325	n=4	1081
2004:	3950	n=4	988
2005:	4250	n=4	1063
2006:	4350	n=4	1088
Overall:			940

*More than one purge of the well was completed during these months to help evaluate well yield.

FIGURE A.5.1-8. OSDF Horizontal Till Well 12338 (Cell 1) Water Yield

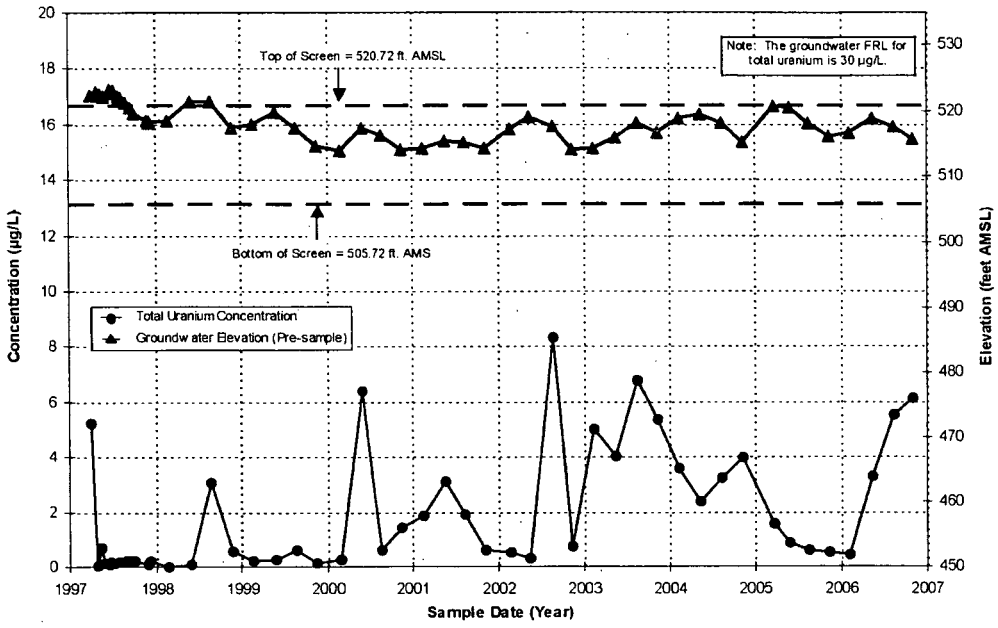


Figure A.5.1-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 1 Upgradient Monitoring Well 22201

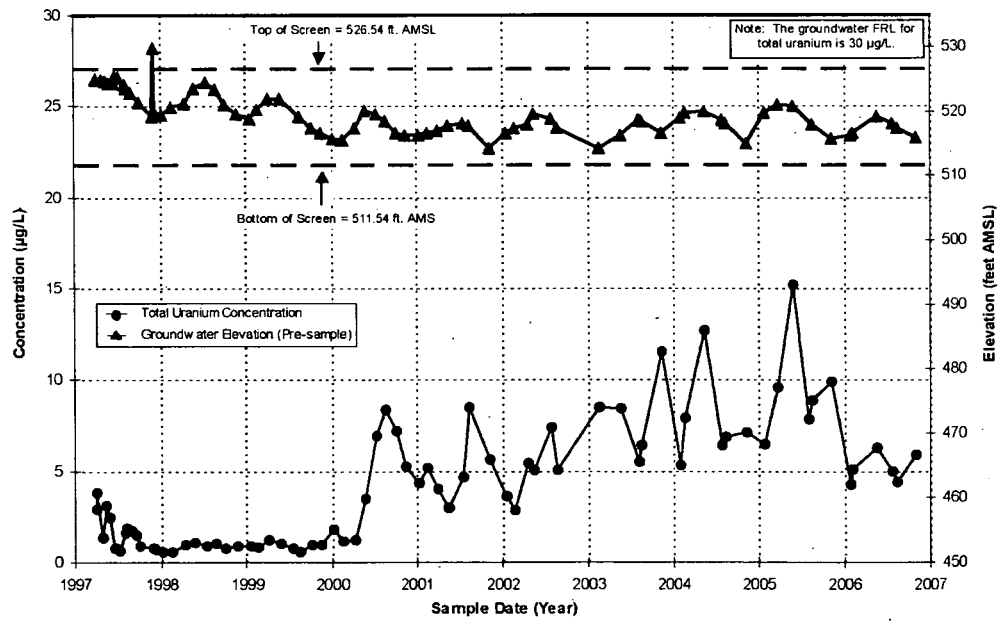


Figure A.5.1-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 1 Downgradient Monitoring Well 22198

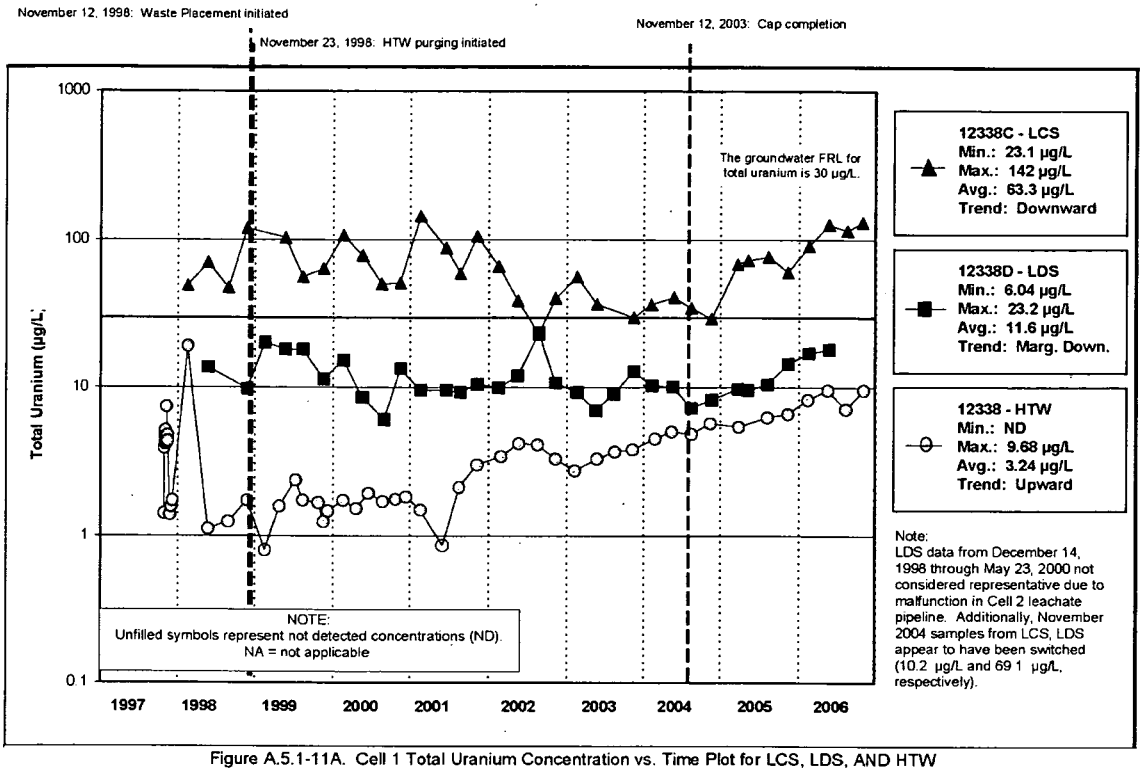


Figure A.5.1-11A. Cell 1 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

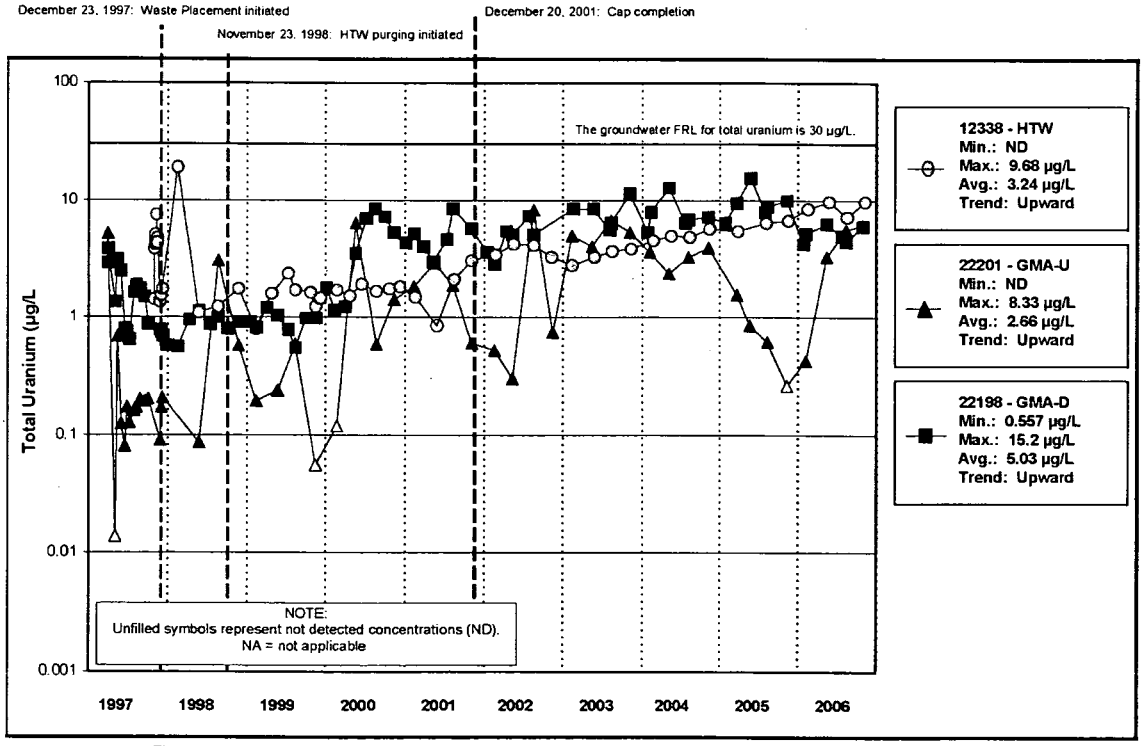


Figure A.5.1-11B. Cell 1 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

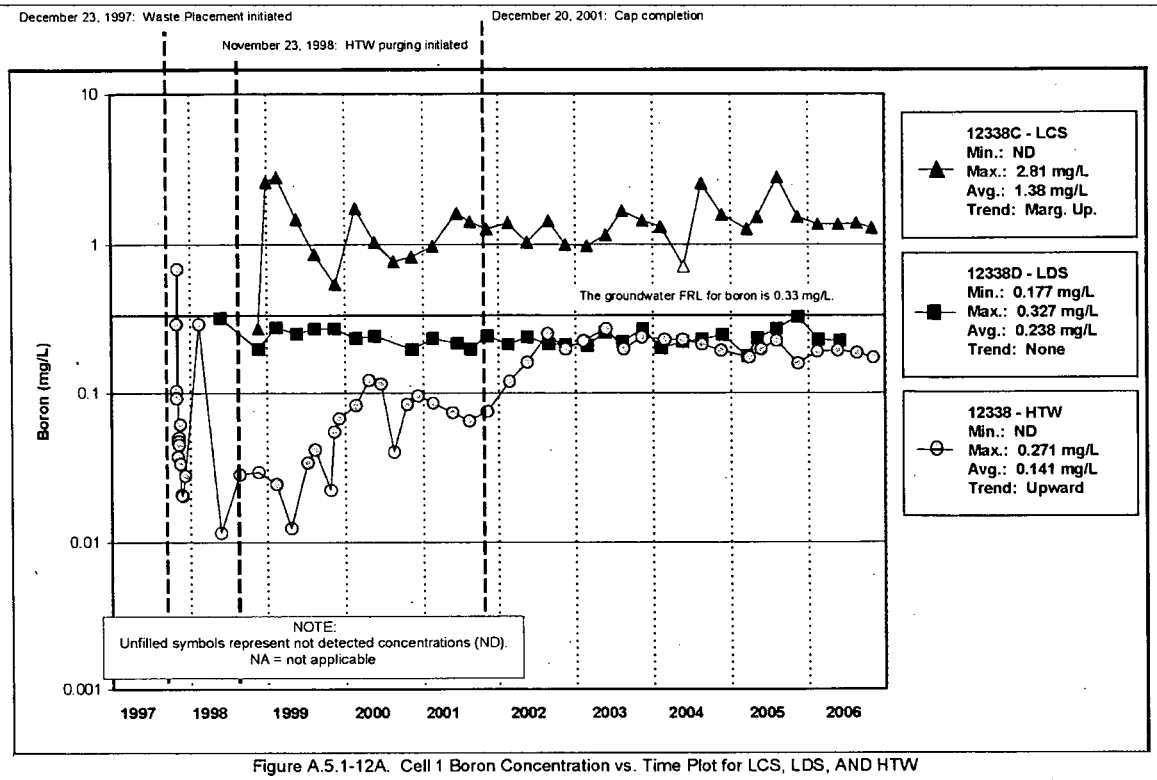


Figure A.5.1-12A. Cell 1 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

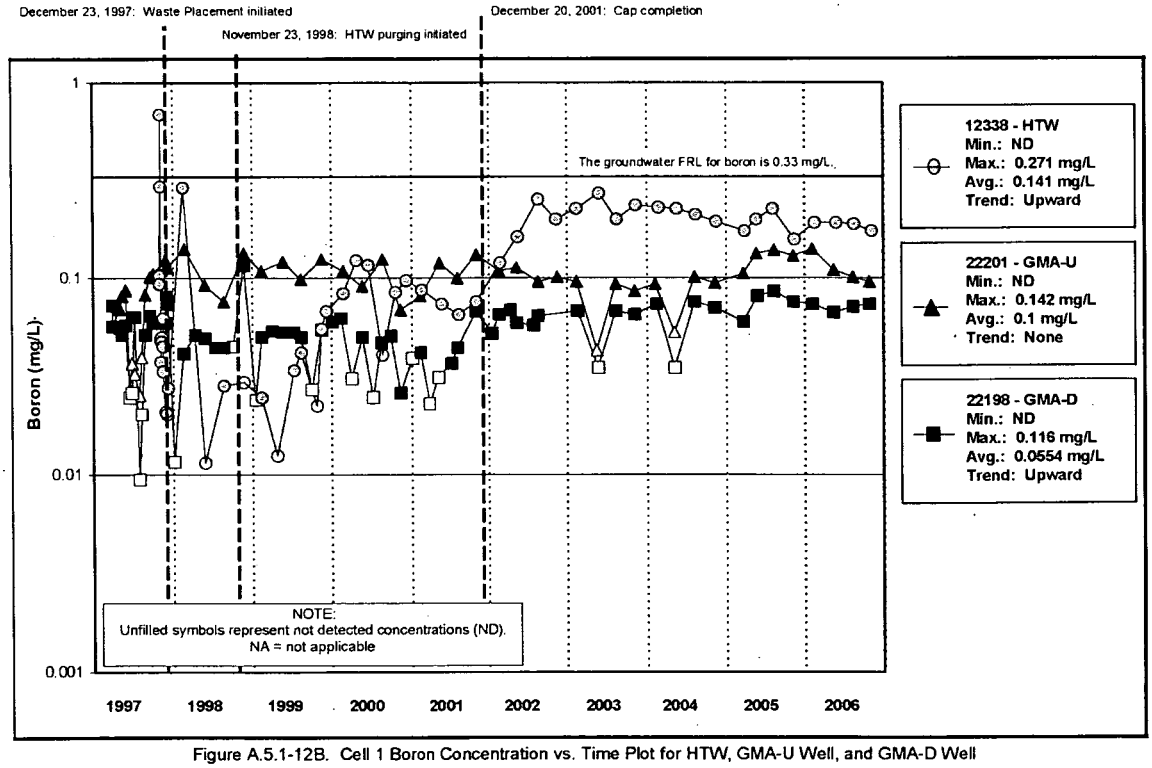


Figure A.5.1-12B. Cell 1 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

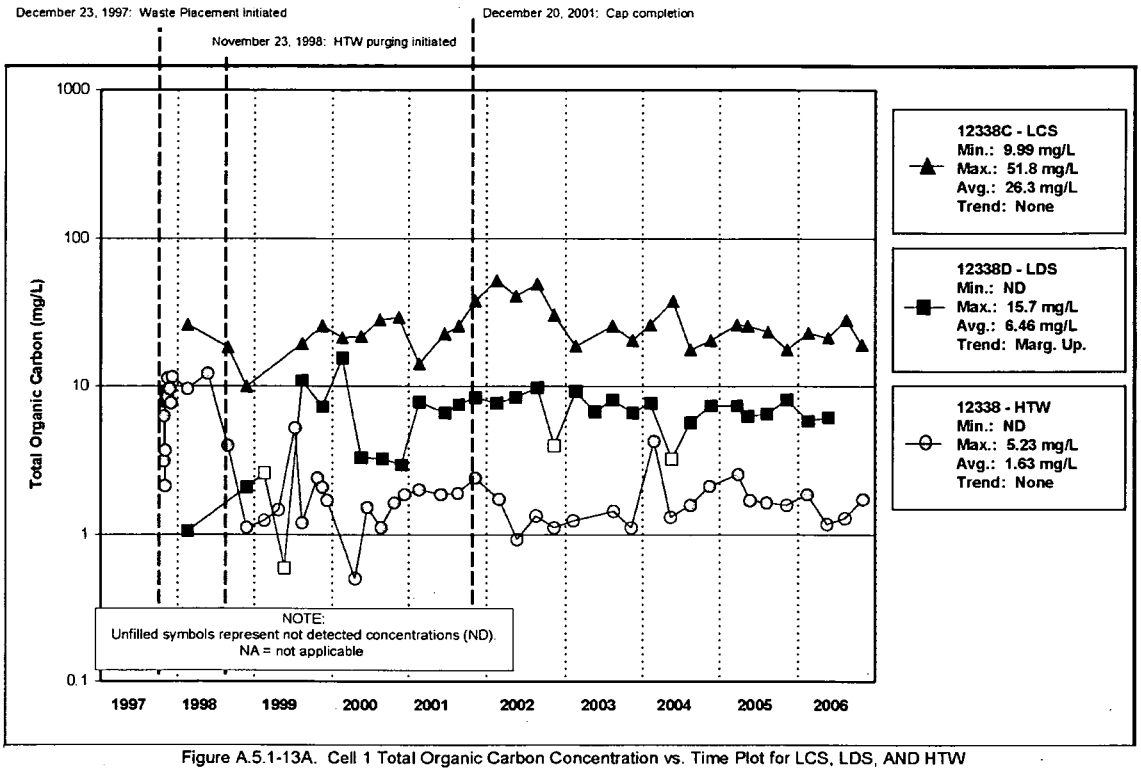


Figure A.5.1-13A. Cell 1 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

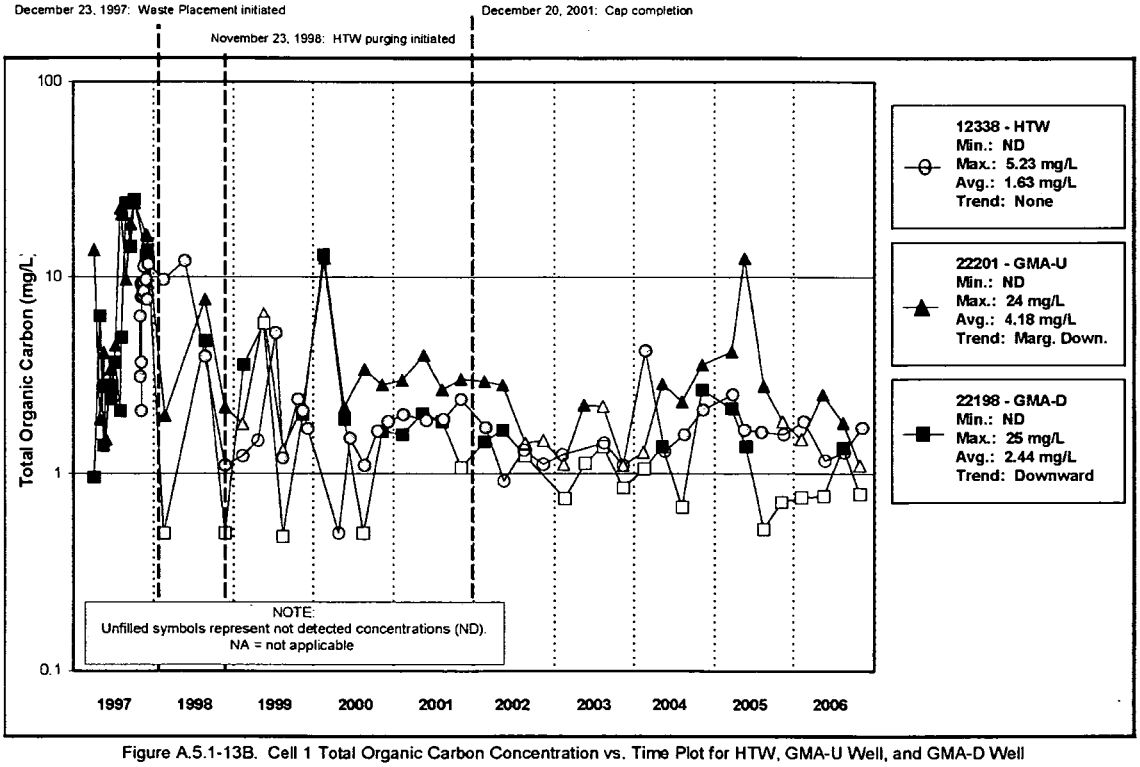


Figure A.5.1-13B. Cell 1 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

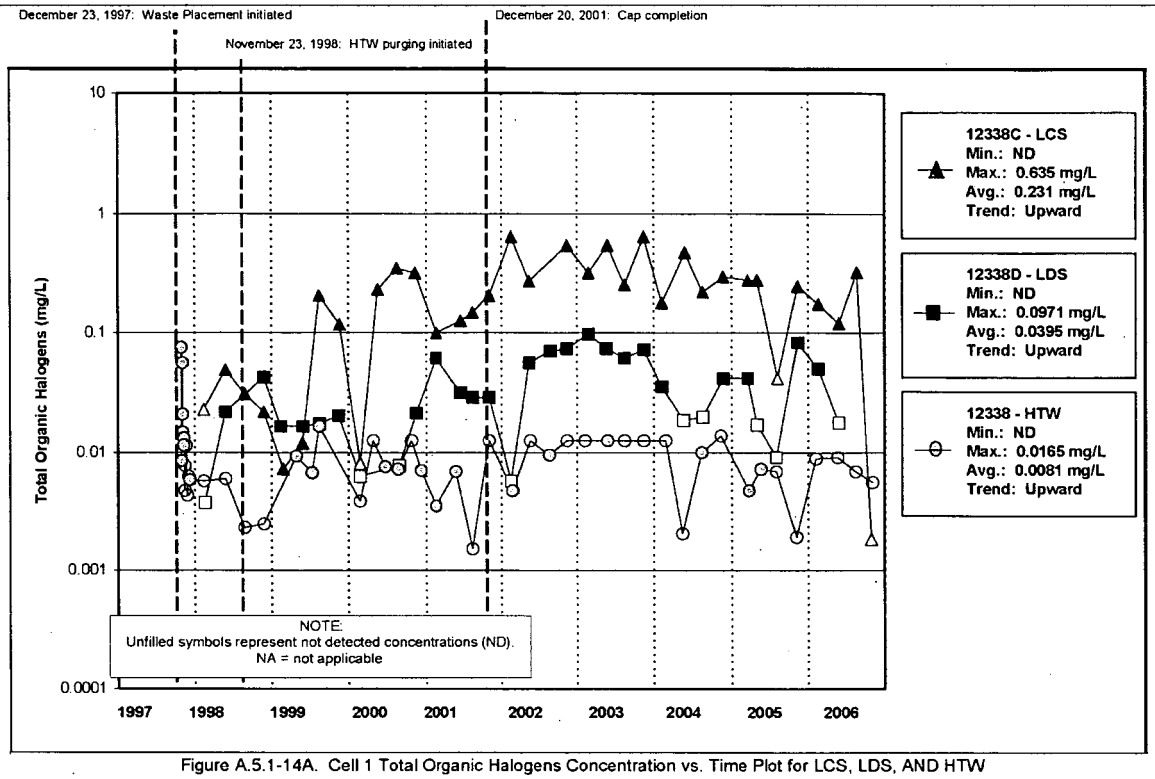


Figure A.5.1-14A. Cell 1 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

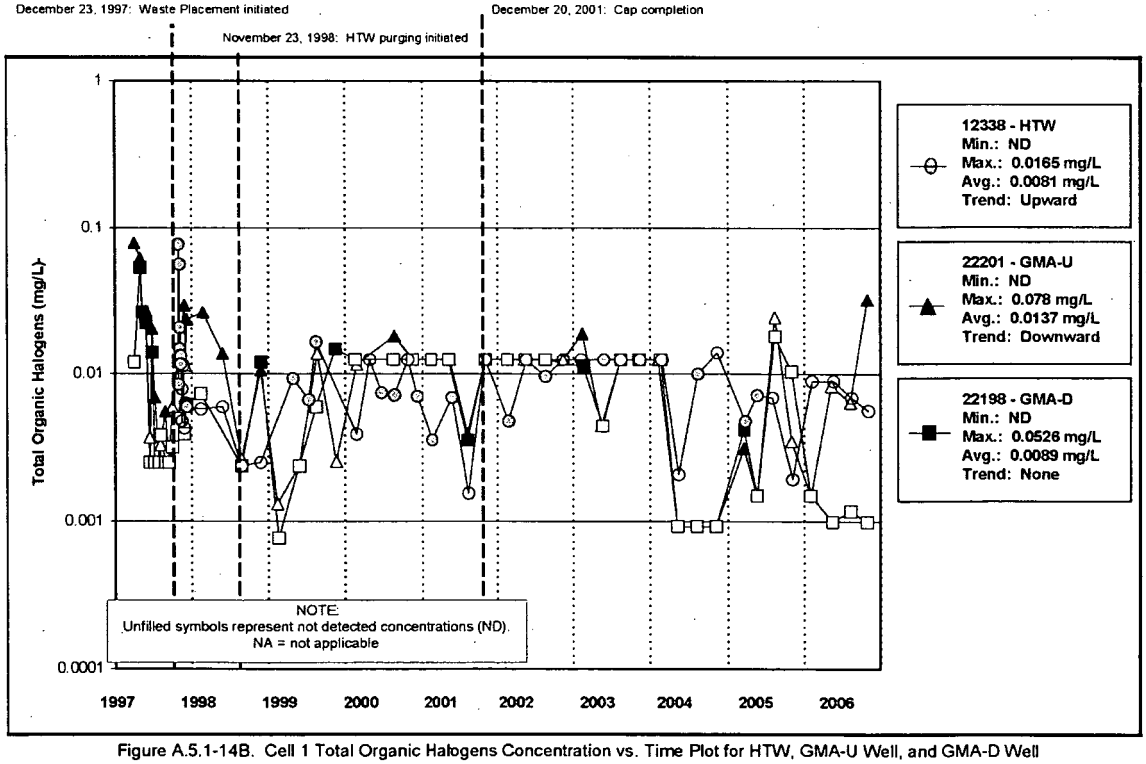


Figure A.5.1-14B. Cell 1 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

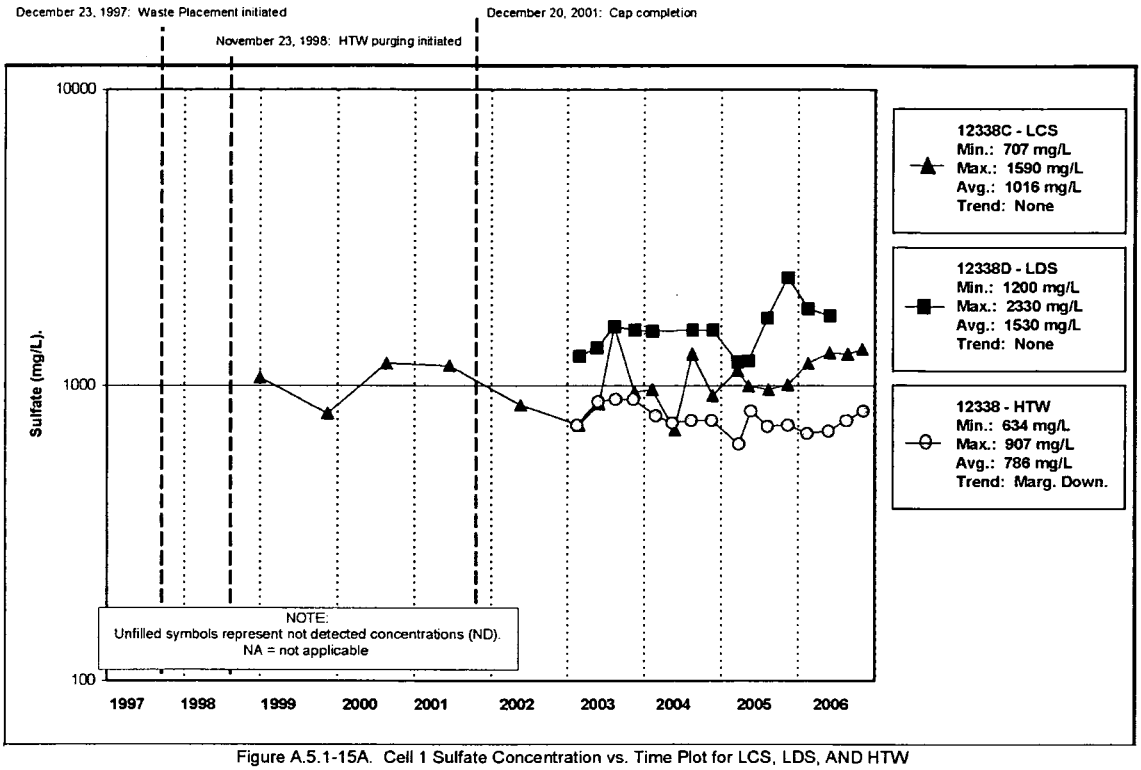


Figure A.5.1-15A. Cell 1 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

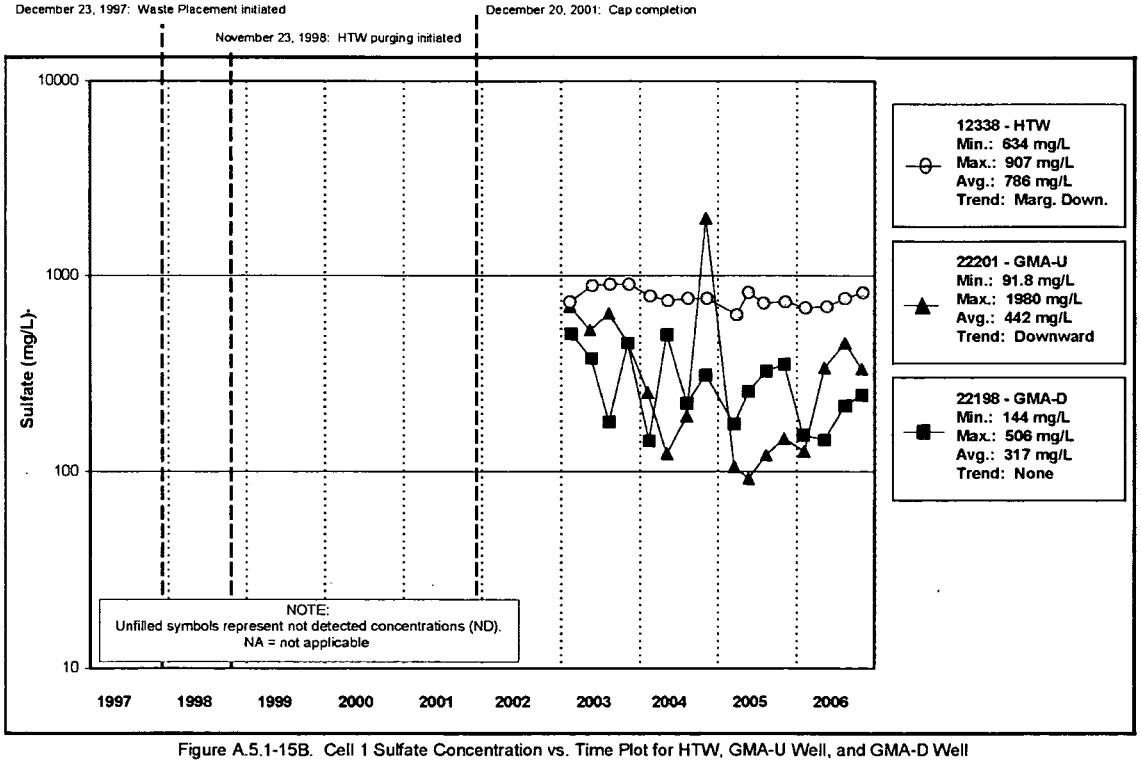


Figure A.5.1-15B. Cell 1 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

End of current text

Subattachment A.5.2

Cell 2

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.2–1 and A.5.2–2)
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.2–3 and A.5.2–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.2–5 and A.5.2–6)
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.2–7)
- Monthly liner efficiencies (refer to Table A.5.2–1)
- HTW Water Yield (refer to Figure A.5.2–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.2–9 and A.5.2–10)
- Summary statistics for refined baseline constituents (refer to Section A.5.2.1 and Table A.5.2–2)
- Concentration plots for refined baseline constituents (refer to Section A.5.2.1 and Figures A.5.2–11A through A.5.2–15B)
- Annual LCS monitoring results (refer to Section A.5.2.2 and Table A.5.2–3)
- Annual LDS monitoring results (refer to Section A.5.2.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. In 2006, the Cell 2 LDS was dry during all four sampling quarters. All samples were collected from the other Cell 2 monitoring horizons.

A.5.2.1 Refined Baseline Monitoring Results

Refined baseline constituents are those constituents that have been sampled for at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also included in Table 2–3 are common ion constituents. A summary statistics table for Cell 2 (Table A.5.2–2) and concentration plots (Figures A.5.2–11A through A.5.2–15B) are provided for the five refined baseline constituents of Cell 2. For Cell 2, these five constituents are: total uranium, boron, total organic carbon, total organic halogens, and sulfate. Note, with incorporation of 2006 sampling results, total organic halogens now has less than 25 percent detects in the GMA wells.

A.5.2.2 LCS Monitoring Results

Ohio Solid Waste Regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 2 LCS took place in May.

Table A.5.2–3 summarizes the annual LCS sampling results for Cell 2, along with data collected in previous years.

Of the non-refined site specific baseline constituents that have been sampled at least 8 times in Cell 2, 21 have been detected at least 25 percent of the time. Twelve of the 21 constituents are common ion constituents (alkalinity, calcium, chloride, fluoride, iron, magnesium, manganese, nitrate/nitrite, phosphorous, potassium, silicon, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 2 will be determined based upon the results of the common ion study.

The remaining nine constituents (considered to be "*potential*" site specific leak detection monitoring constituents for Cell 2) are: ammonia, barium, chromium, cobalt, copper, nickel, selenium, TDS, and zinc). These potential Cell 2 site specific leak detection monitoring constituents will be assessed using the approach presented in Figures A.5–4A and A.5–4B, once final approval of the approach has been obtained from EPA and OEPA. The assessment will be used to determine what potential constituent (if any) will be added to the Cell 2 site specific leak detection monitoring constituent list. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

Technetium-99 is a site specific leak detection parameter; however, it is not on the refined baseline list for Cell 2. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.2–3, technetium-99 has been detected in the Cell 2 LCS, but this detection occurred prior to the establishment of the refined baseline for Cell 2. Therefore, confirmatory sampling for technetium-99 in the Cell 2 LCS is not required.

A.5.2.3 LDS Monitoring Results

Each year the LDS of each cell is sampled for site-specific baseline parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. In 2006, annual sampling of the Cell-2 LDS was scheduled for May. In May the LDS was dry. Two other attempts were made in 2006 to sample the LDS for Table 2–1 constituents (August and November). The LDS was dry both times.

Table A.5.2-1. Cell 2 – 2006 Monthly Liner Efficiencies

Month	Cell 2 Apparent Liner Efficiency (%)
January	100.00
February	100.00
March	100.00
April	100.00
May	100.00
June	100.00
July	96.57
August	97.92
September	99.91
October	100.00
November	100.00
December	100.00

Table A.5.2–2. Summary Statistics for Cell 2

Note: The data used in this table has been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]			
Total Uranium (µg/L)	LCS	12339C	31	31	100%	54.7	Lognormal	Upward	Detected	4.51 (Q3-99)			
	LDS	12339D	23	23	100%	14.5	Normal	None	Detected	71 (Q4-98)	50.37 (Q1-99)	41.5 (Q2-99)	
	HTW	12339	32	33	97%	5.77	Undefined	Upward	Detected				
	GMA-U	22200	23	37	62%	0.33	Lognormal	None	Not Detected	0 U (Q1-98)	0 U (Q4-03)		
	GMA-D	22199	37	39	95%	0.74	Undefined	None	Detected				
Boron (mg/L)	LCS	12339C	33	33	100%	1.69	Undefined	Upward	Detected				
	LDS	12339D	19	19	100%	0.380	Normal	None	Not Detected	0.841 (Q2-99)	0.865 (Q2-04)	0.904 (Q4-98)	2.22 (Q1-99)
	HTW	12339	31	33	94%	0.069	Lognormal	Upward	Detected				
	GMA-U	22200	28	39	72%	0.0446	Normal	None	Not Detected				
	GMA-D	22199	31	39	79%	0.0417	Normal	Upward	Detected				
Total Organic Carbon (mg/L)	LCS	12339C	22	32	69%	2.6	Lognormal	Upward	Not Detected				
	LDS	12339D	17	25	68%	3.40	Lognormal	Downward	Detected	26.1 (Q3-99)			
	HTW	12339	18	30	60%	1.61	Lognormal	None	Not Detected	11.1 (Q1-00)			
	GMA-U	22200	23	34	68%	1.78	Lognormal	Downward	Not Detected				
	GMA-D	22199	19	35	54%	1.52	Lognormal	Downward	Not Detected	9.68 (Q1-00)	10.5 (Q4-97)	16.5 (Q3-97)	48.1 (Q2-98)
Total Organic Halogens (mg/L)	LCS	12339C	10	33	30%	0.013	Undefined	None	Detected				
	LDS	12339D	8	27	30%	0.0123	Undefined	Marg. Down.	Marg. Detect	0.138 U (Q2-00)			
	HTW	12339	21	33	64%	0.0229	Normal	Downward	Not Detected				
	GMA-U	22200	9	37	24%	0.0073	Undefined	Marg. Down.	Detected	0.124 (Q4-98)	0.177 (Q2-00)		
	GMA-D	22199	9	39	23%	0.0093	Undefined	Downward	Detected				
Sulfate (mg/L)	LCS	12339C	21	21	100%	1350	Undefined	None	Detected				
	LDS	12339D	8	8	100%	2910	Normal	Upward	Insuff. Data	8110 (Q4-05)			
	HTW	12339	16	16	100%	684	Normal	Downward	Detected				
	GMA-U	22200	16	16	100%	240	Normal	Marg. Up.	Not Detected				
	GMA-D	22199	16	16	100%	234	Lognormal	None	Not Detected				

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.

Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

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Table A.5.2–3. Cell 2 Annual LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
Alkalinity as CaCO3 (mg/L)	14	14	100.0%	60.5	683	428	-	422 mg/L (8)	430 mg/L (8)	-	10 mg/L
Ammonia (mg/L)	9	3	33.3%	0.109	0.2	0.14	-	4.2 mg/L (0)	4.34 mg/L (0)	220 mg/L (0)	0.1 mg/L
Antimony (mg/L)	9	1	11.1%	0.00053	-	-	0.006 mg/L (0)	-	-	0.0987 mg/L (0)	0.005 mg/L
Arsenic (mg/L)	9	2	22.2%	0.00091	0.14	-	0.05 mg/L (1)	0.029 mg/L (1)	0.019 mg/L (1)	0.191 mg/L (0)	0.02 mg/L
Barium (mg/L)	9	9	100.0%	0.0367	0.228	0.078	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Cadmium (mg/L)	9	2	22.2%	0.000091	0.00041	-	0.014 mg/L (0)	0.014 mg/L (0)	-	0.05 mg/L (0)	0.002 mg/L
Calcium (mg/L)	15	15	100.0%	165	984	537	-	159 mg/L (14)	172 mg/L (13)	1800 mg/L (0)	5 mg/L
Chloride (mg/L)	14	14	100.0%	3.95	41.2	14.5	-	7.3 mg/L (11)	45 mg/L (0)	6300 mg/L (0)	5 mg/L
Chromium (mg/L)	9	3	33.3%	0.0009	0.0047	0.0027	0.022 mg/L (0)	0.021 mg/L (0)	0.0046 mg/L (1)	0.818 mg/L (0)	0.005 mg/L
Cobalt (mg/L)	9	5	55.6%	0.000283	0.17	0.039	0.17 mg/L (1)	0.0086 mg/L (3)	-	0.0888 mg/L (1)	0.034 mg/L
Copper (mg/L)	9	8	88.9%	0.00093	0.017	0.0067	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	7	100.0%	0.092	0.245	0.166	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	15	14	93.3%	0.088	213	38	-	5.72 mg/L (8)	6.35 mg/L (8)	21.3 mg/L (4)	0.1 mg/L
Lead (mg/L)	9	1	11.1%	0.0046	-	-	0.015 mg/L (0)	0.022 mg/L (0)	0.0016 mg/L (1)	0.0114 mg/L (0)	0.008 mg/L
Magnesium (mg/L)	15	15	100.0%	32.4	375	178	-	38.5 mg/L (12)	50.7 mg/L (11)	690 mg/L (0)	5 mg/L
Manganese (mg/L)	15	13	86.7%	0.0106	12.7	4.8	0.9 mg/L (9)	0.9 mg/L (9)	0.21 mg/L (9)	35 mg/L (0)	0.09 mg/L
Nickel (mg/L)	9	9	100.0%	0.00495	0.133	0.037	0.1 mg/L (1)	0.0514 mg/L (3)	0.0072 mg/L (7)	0.981 mg/L (0)	0.02 mg/L
Nitrate/Nitrite (mg/L)	23	15	65.2%	0.0439	3.58	1.64	11 mg/L[g] (0)	11 mg/L (0)	0.29 mg/L (13)	2670 mg/L (0)	1.1 mg/L
Phosphorus (mg/L)	8	5	62.5%	0.0361	0.438	0.190	-	-	-	-	0.1 mg/L
Potassium (mg/L)	15	15	100.0%	3.93	22.6	16.8	-	1.96 mg/L (14)	17.2 mg/L (9)	12400 mg/L (0)	5 mg/L
Selenium (mg/L)	9	6	66.7%	0.00417	0.0422	0.0150	0.05 mg/L (0)	0.00075 mg/L (6)	-	0.0494 mg/L (0)	0.005 mg/L
Silicon (mg/L)	8	8	100.0%	8.42	17.1	11.8	-	-	-	15 mg/L (2)	0.015 mg/L
Sodium (mg/L)	15	15	100.0%	3.32	26.7	15.1	-	47.1 mg/L (0)	50 mg/L (0)	1300 mg/L (0)	5 mg/L
Technetium-99 (pCi/L)	19	1	5.3%	21.25	-	-	94 pCi/L (0)	22 pCi/L (0)	30 pCi/L (0)	6130 pCi/L (0)	10 pCi/L
Thallium (mg/L)	9	2	22.2%	0.00057	0.0107	-	-	-	-	0.0028 mg/L (1)	0.02 mg/L
Total Dissolved Solids (mg/L)	18	18	100.0%	557	2840	1680	-	-	-	-	10 mg/L
Trichlorofluoromethane (ug/L)	9	1	11.1%	0.27	-	-	-	-	-	-	1 ug/L
Vanadium (mg/L)	9	2	22.2%	0.00158	0.0068	-	0.038 mg/L (0)	0.012 mg/L (0)	0.005 mg/L (1)	0.299 mg/L (0)	0.02 mg/L
Zinc (mg/L)	9	3	33.3%	0.016	0.178	0.073	0.021 mg/L (2)	0.02 mg/L (2)	0.35 mg/L (0)	1.78 mg/L (0)	0.015 mg/L

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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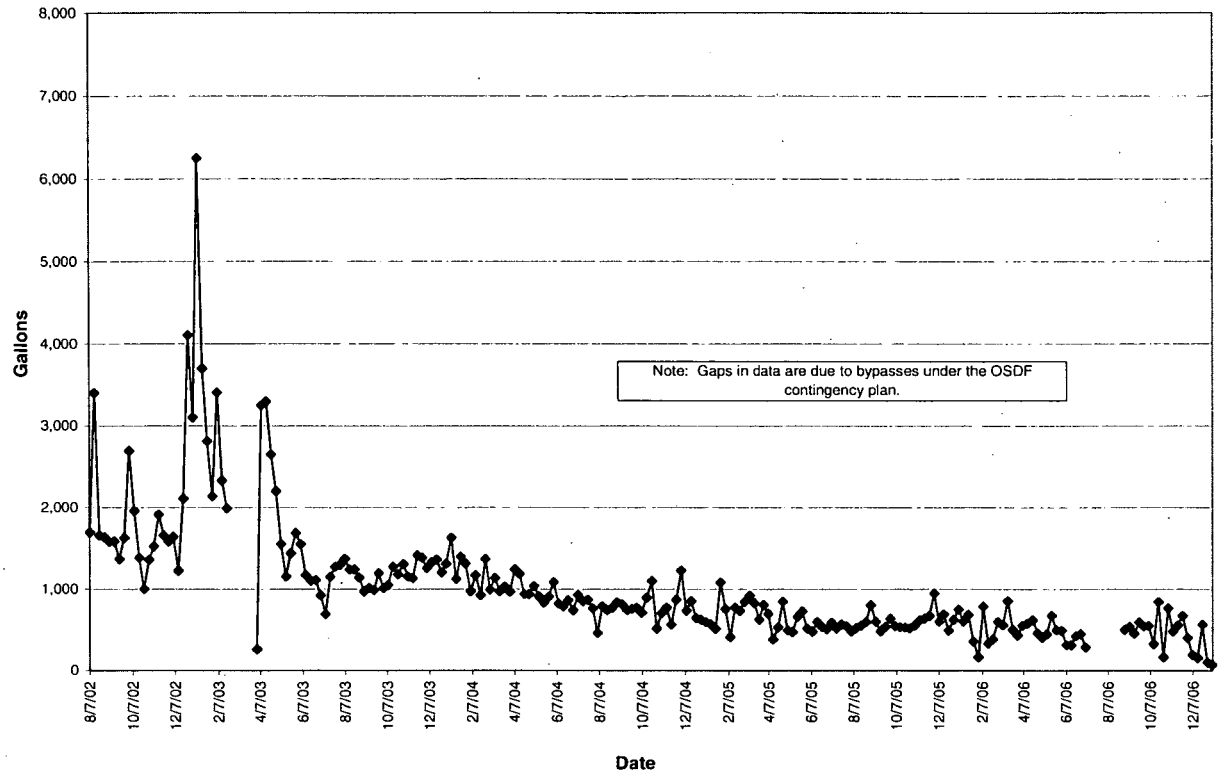


FIGURE A.5.2-1. Weekly Accumulation Volumes for Cell 2 LCS

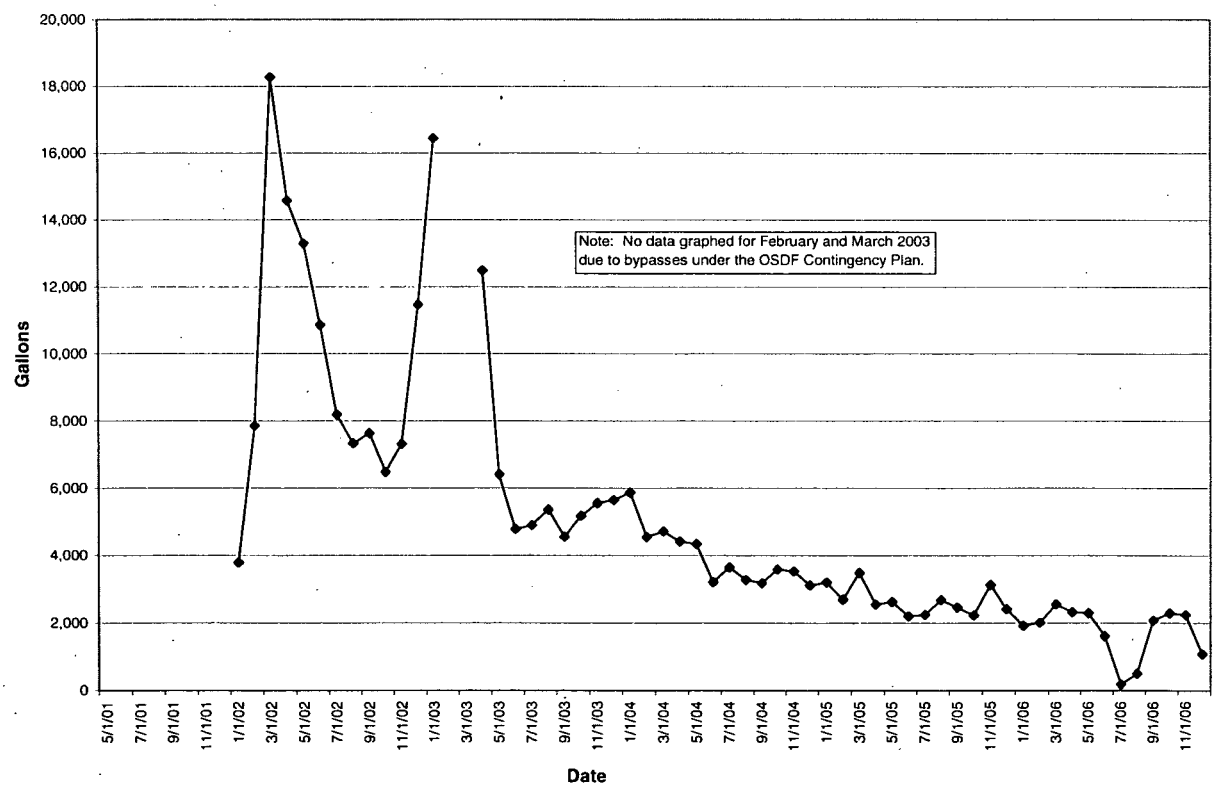


FIGURE A.5.2-2. Monthly Accumulation Volumes for Cell 2 LCS

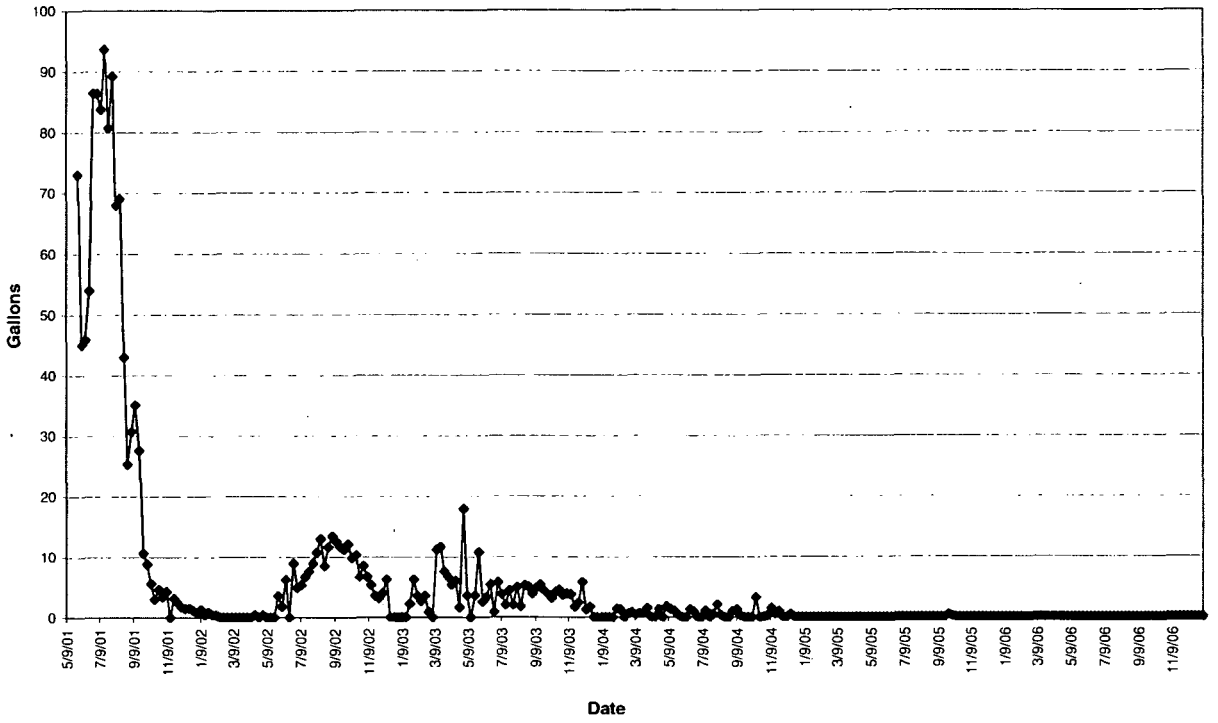


FIGURE A.5.2-3. Weekly Accumulation Volumes for Cell 2 LDS

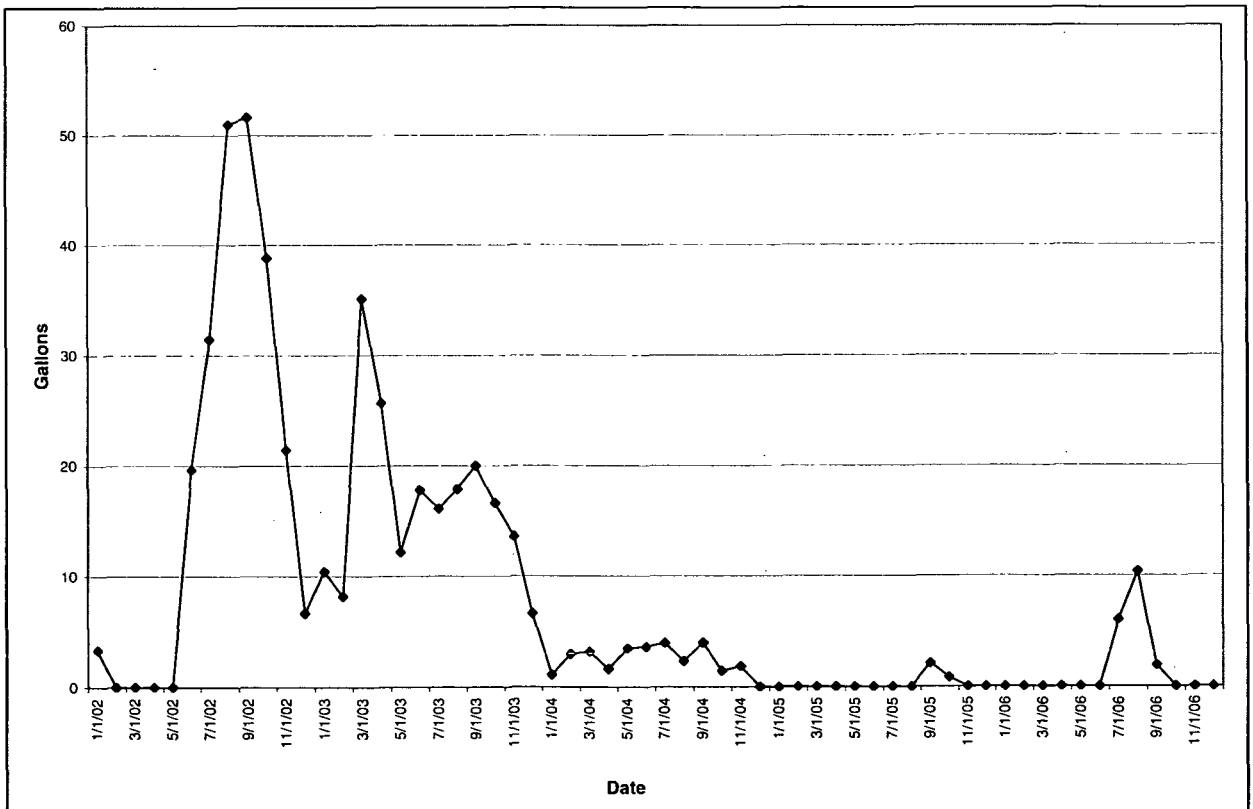


FIGURE A.5.2-4. Monthly Accumulation Volumes for Cell 2 LDS

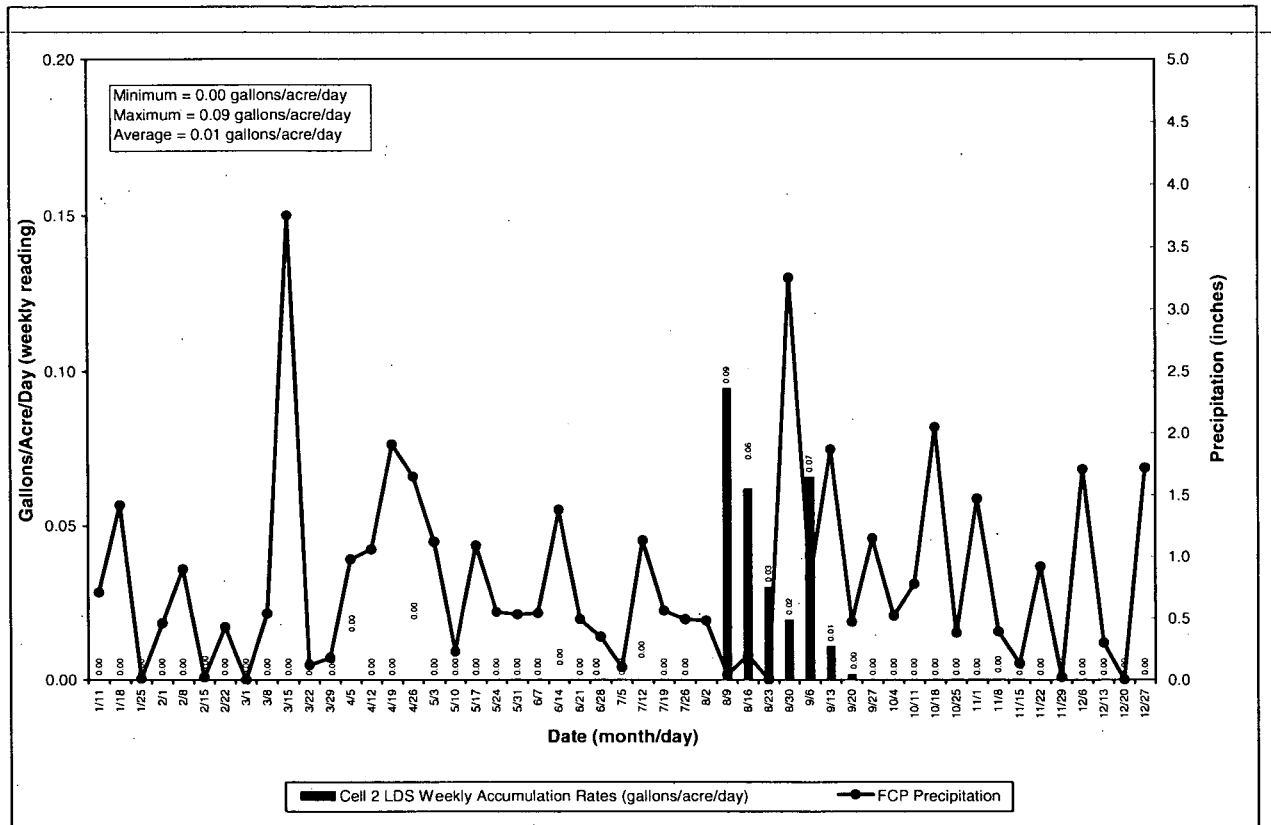


FIGURE A.5.2-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 2

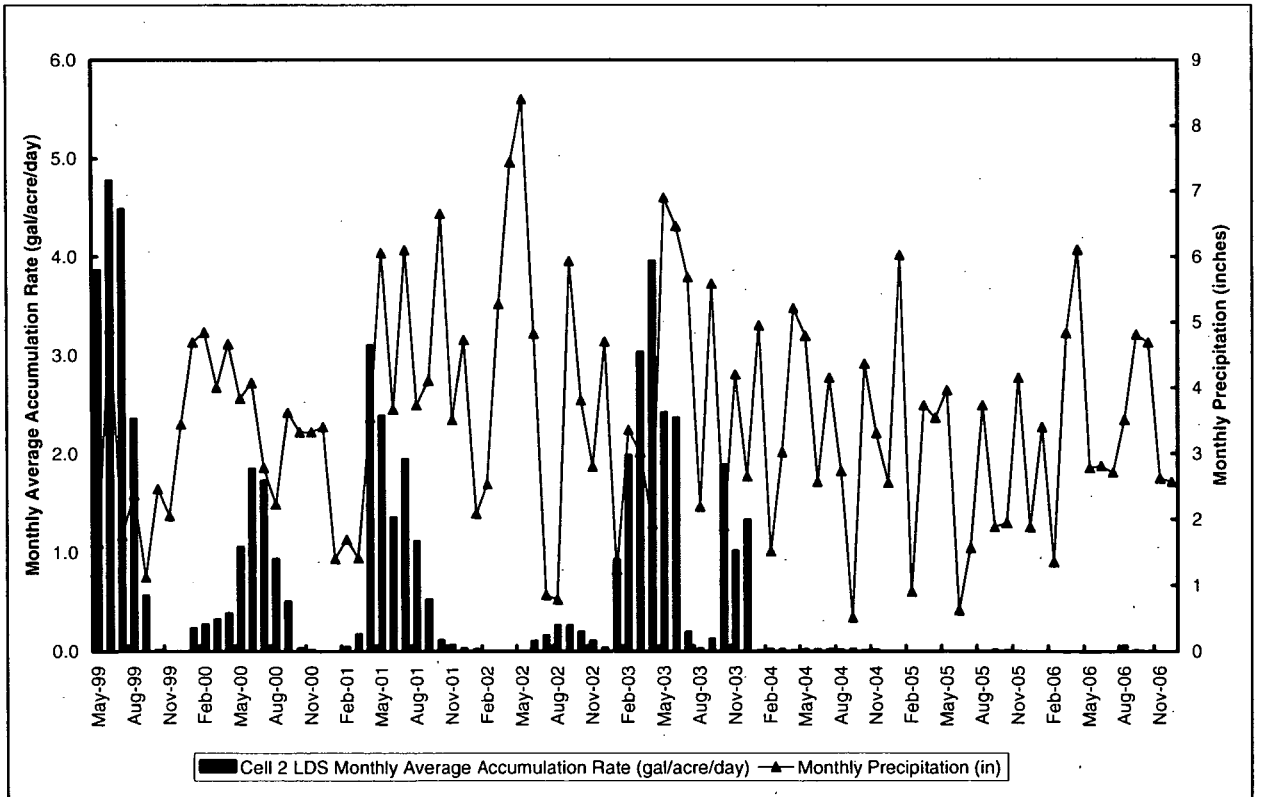


FIGURE A.5.2-6. OSDF Cell 2 LDS Monthly Average Accumulation Rates and Monthly Precipitation

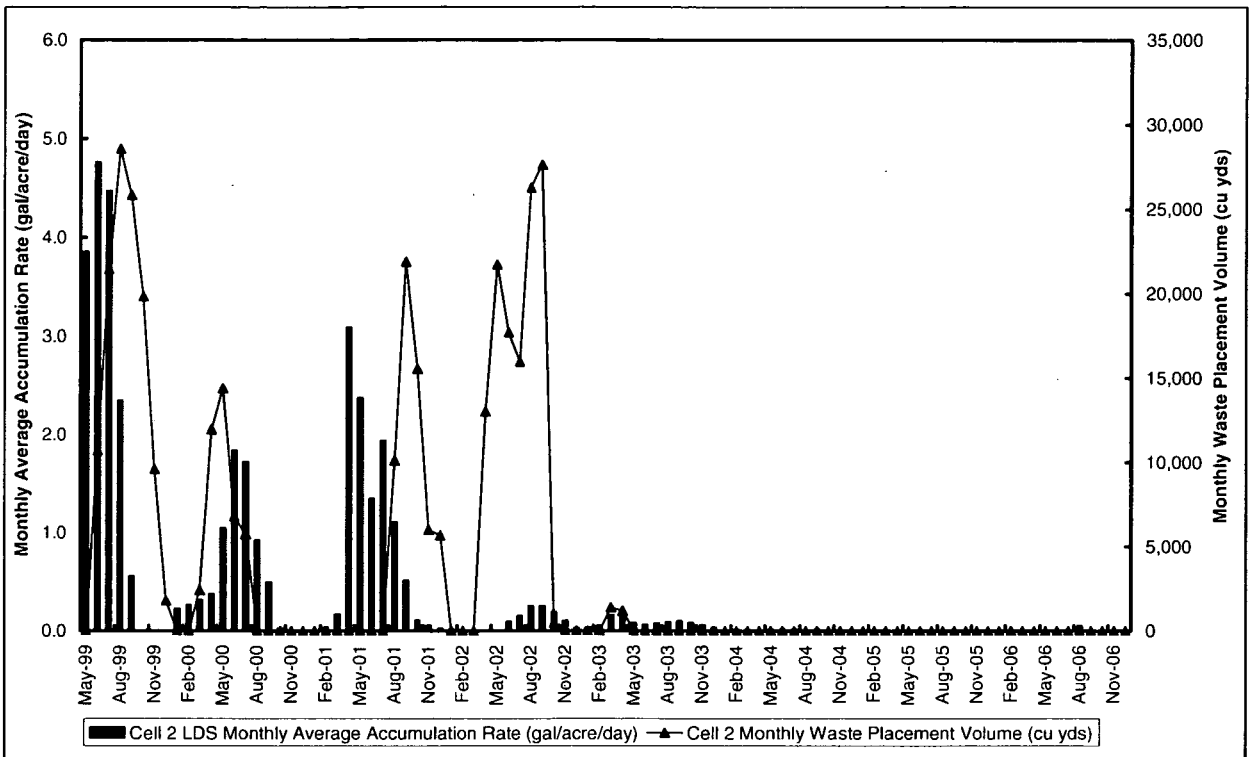
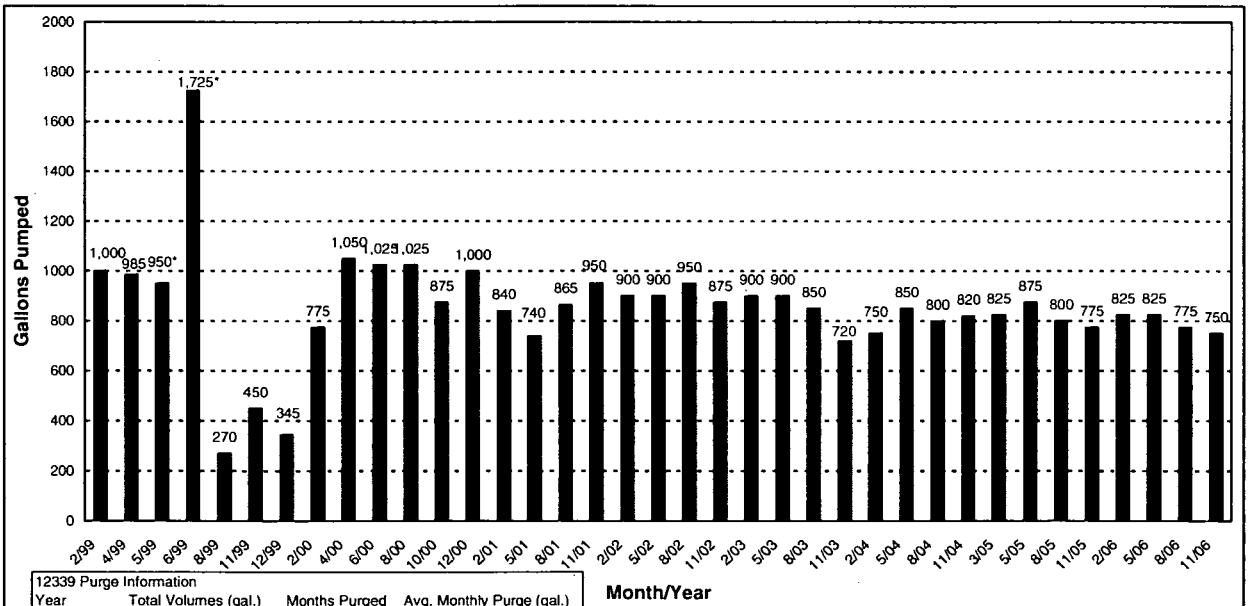


FIGURE A.5.2-7. OSDF Cell 2 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12339 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	5725	n=7	818
2000:	5750	n=6	958
2001:	3395	n=4	849
2002:	3625	n=4	906
2003:	3370	n=4	843
2004:	3220	n=4	805
2005:	3275	n=4	819
2006:	3175	n=4	794
Overall:			852

*More than one purge of the well was completed during these months to help evaluate well yield.

FIGURE A.5.2-8. OSDF Horizontal Till Well 12339 (Cell 2) Water Yield

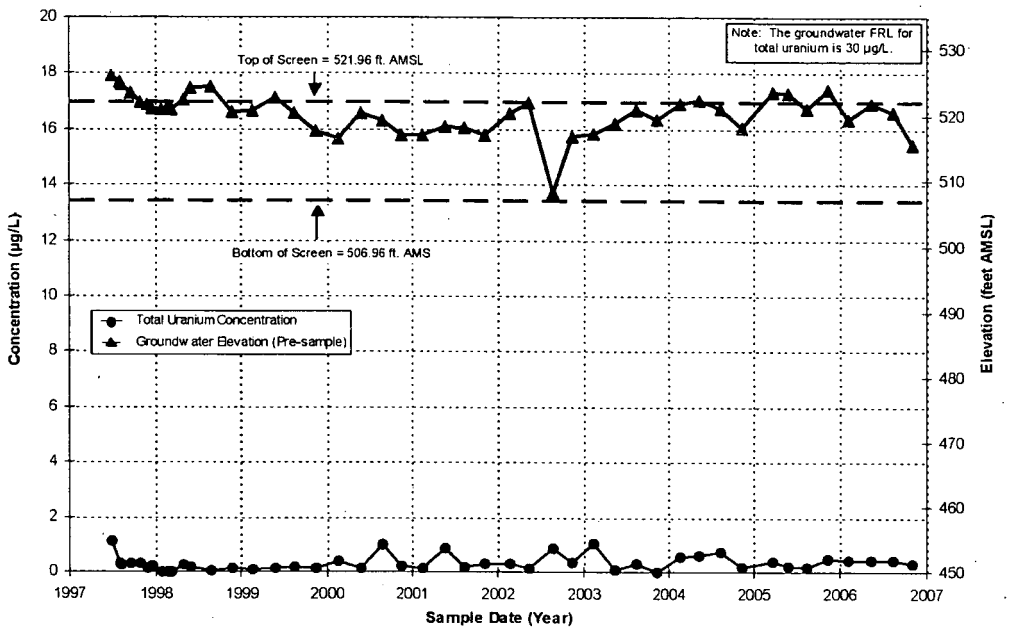


Figure A.5.2-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 2 Upgradient Monitoring Well 22200

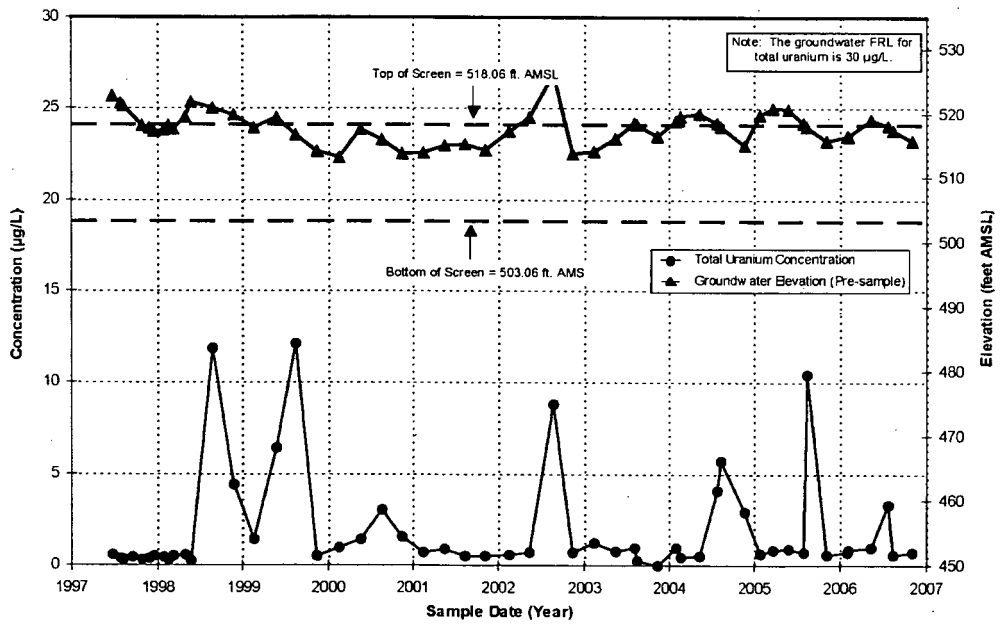


Figure A.5.2-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 2 Downgradient Monitoring Well 22199

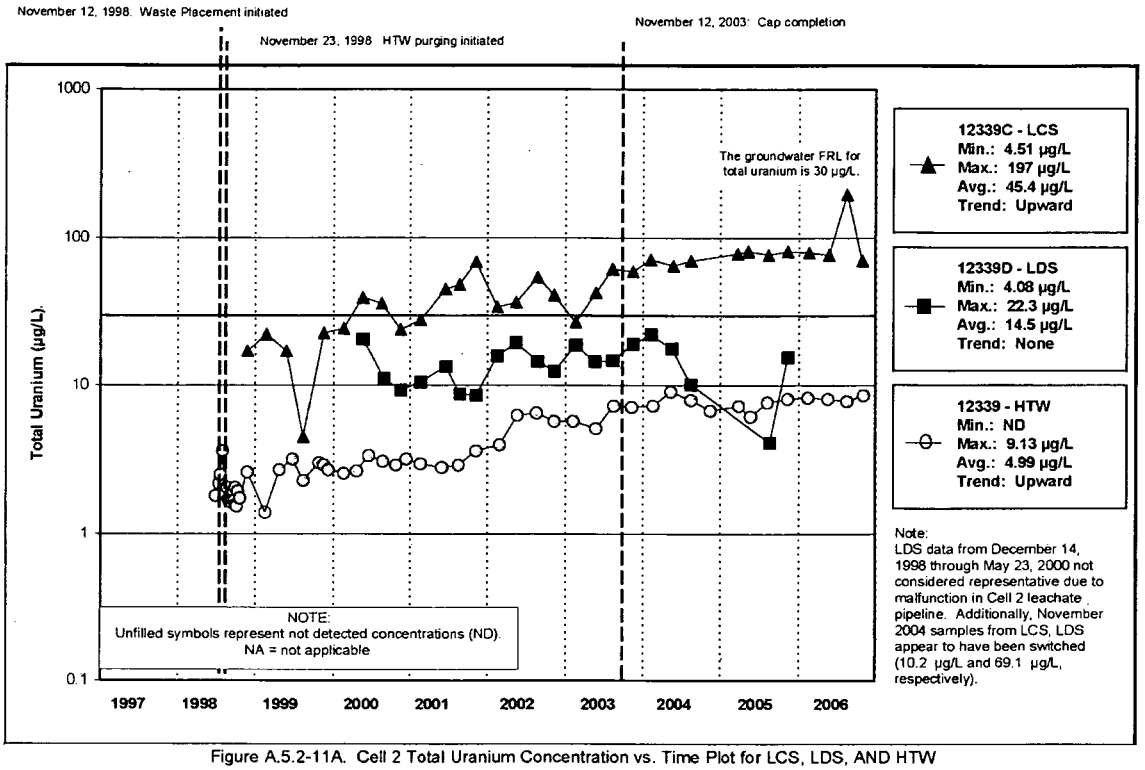


Figure A.5.2-11A. Cell 2 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

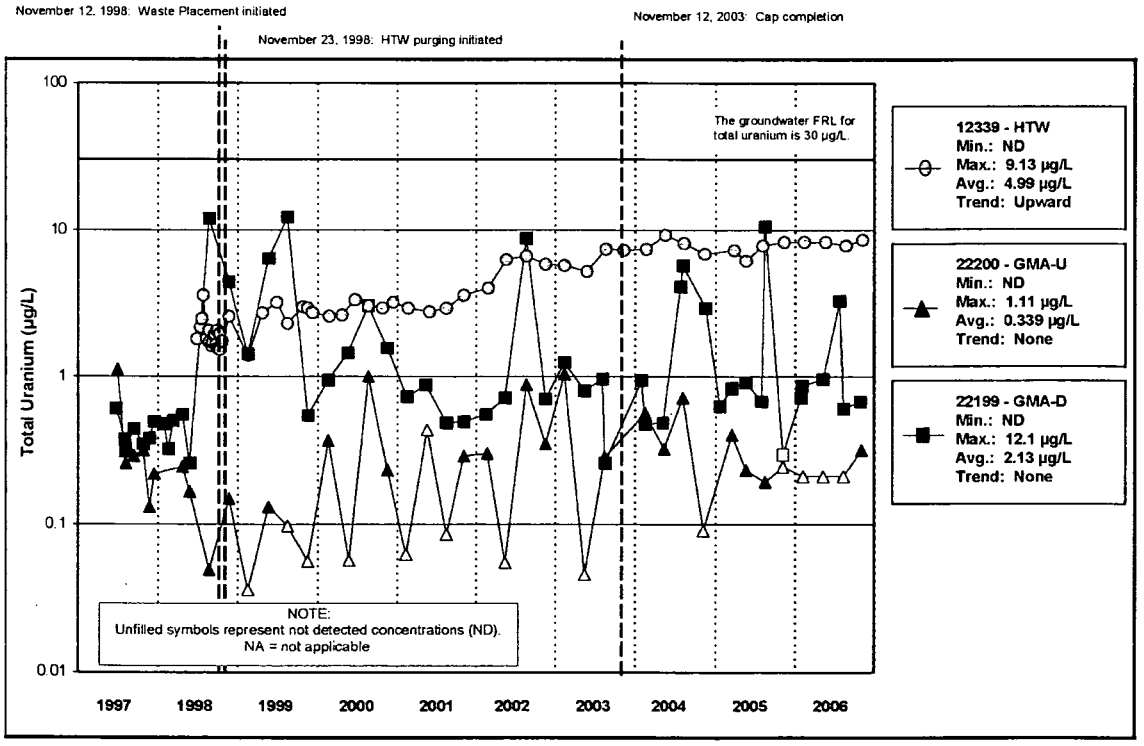


Figure A.5.2-11B. Cell 2 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

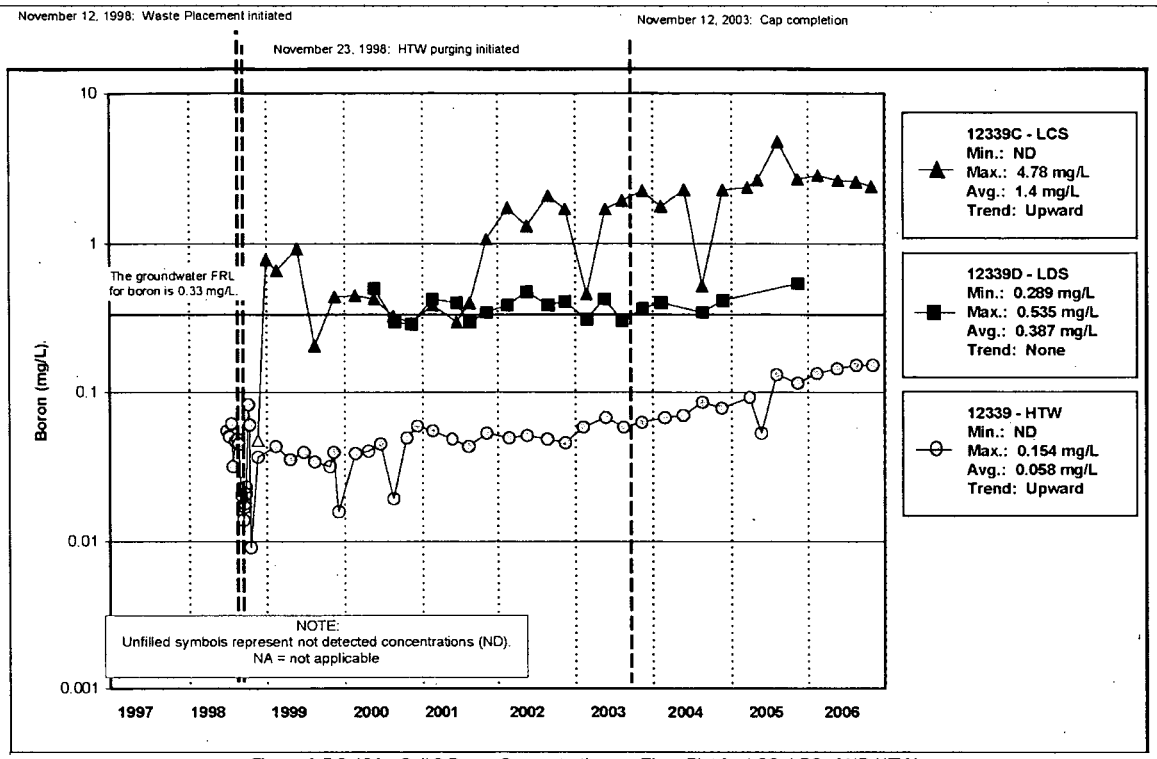


Figure A.5.2-12A. Cell 2 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

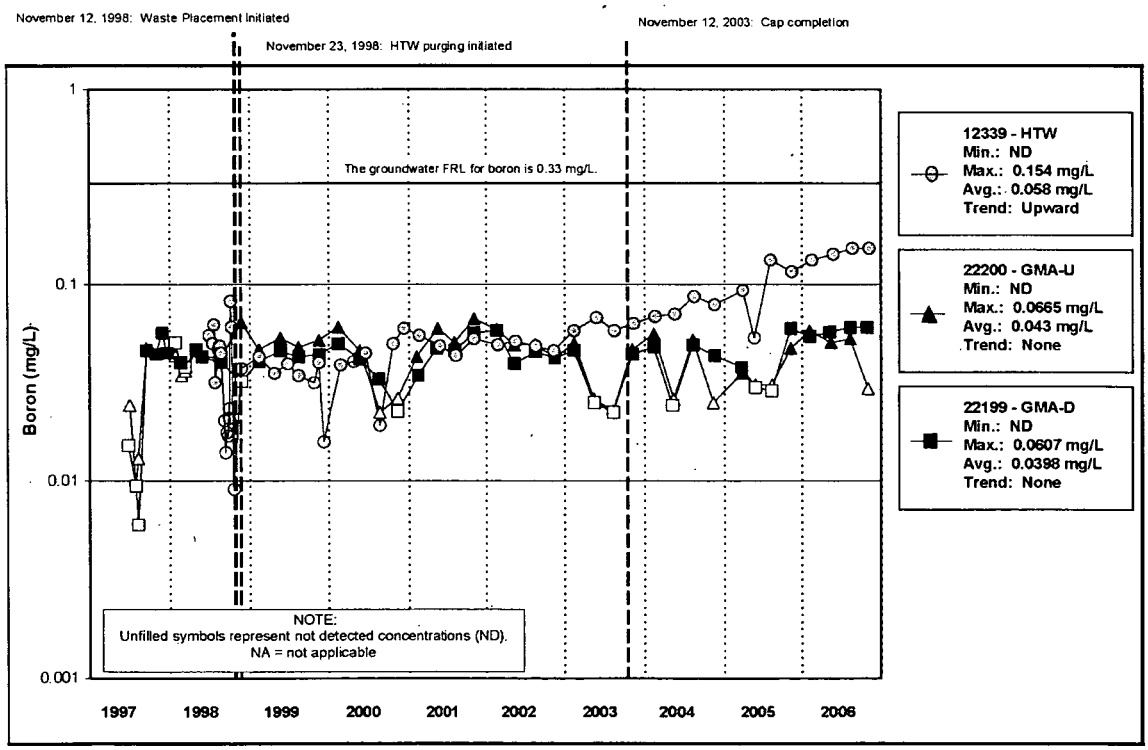


Figure A.5.2-12B. Cell 2 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

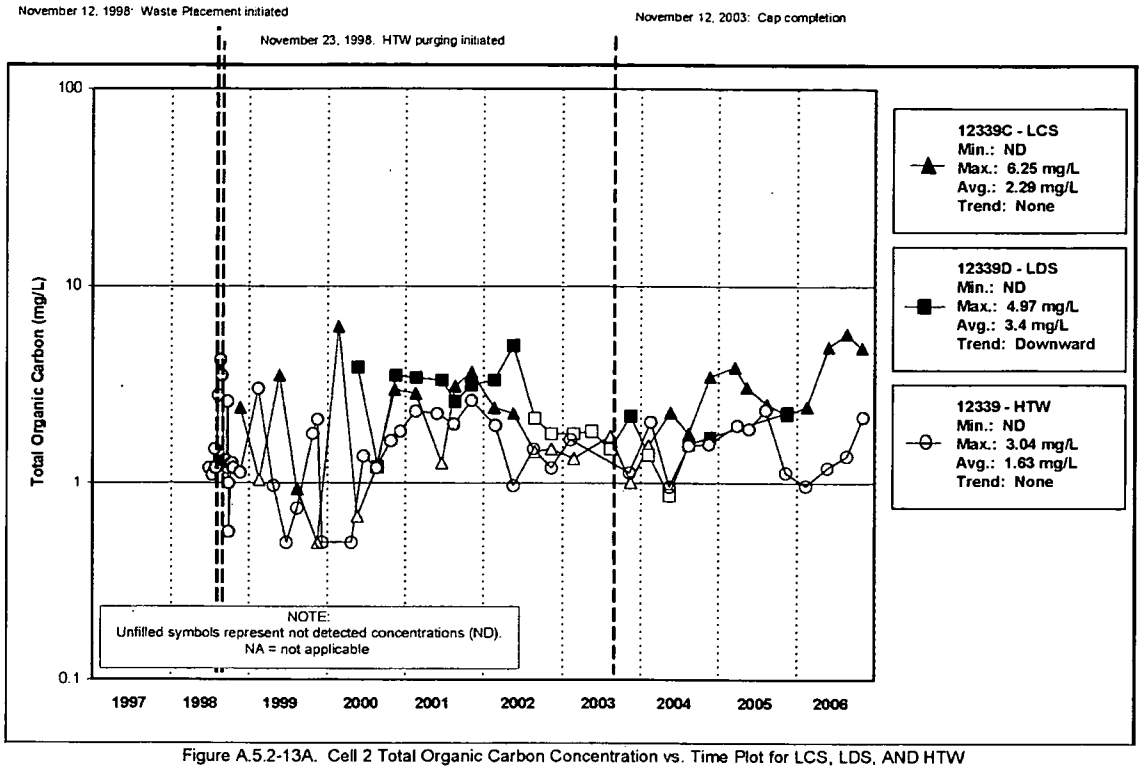


Figure A.5.2-13A. Cell 2 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

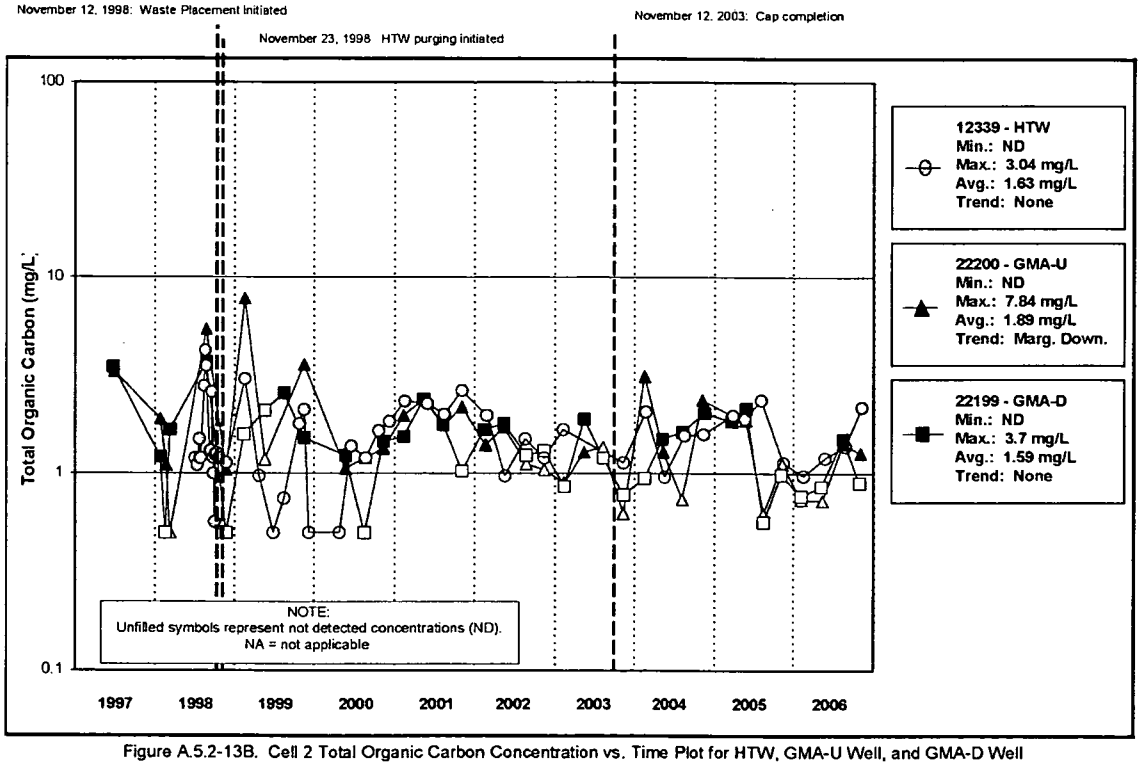


Figure A.5.2-13B. Cell 2 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

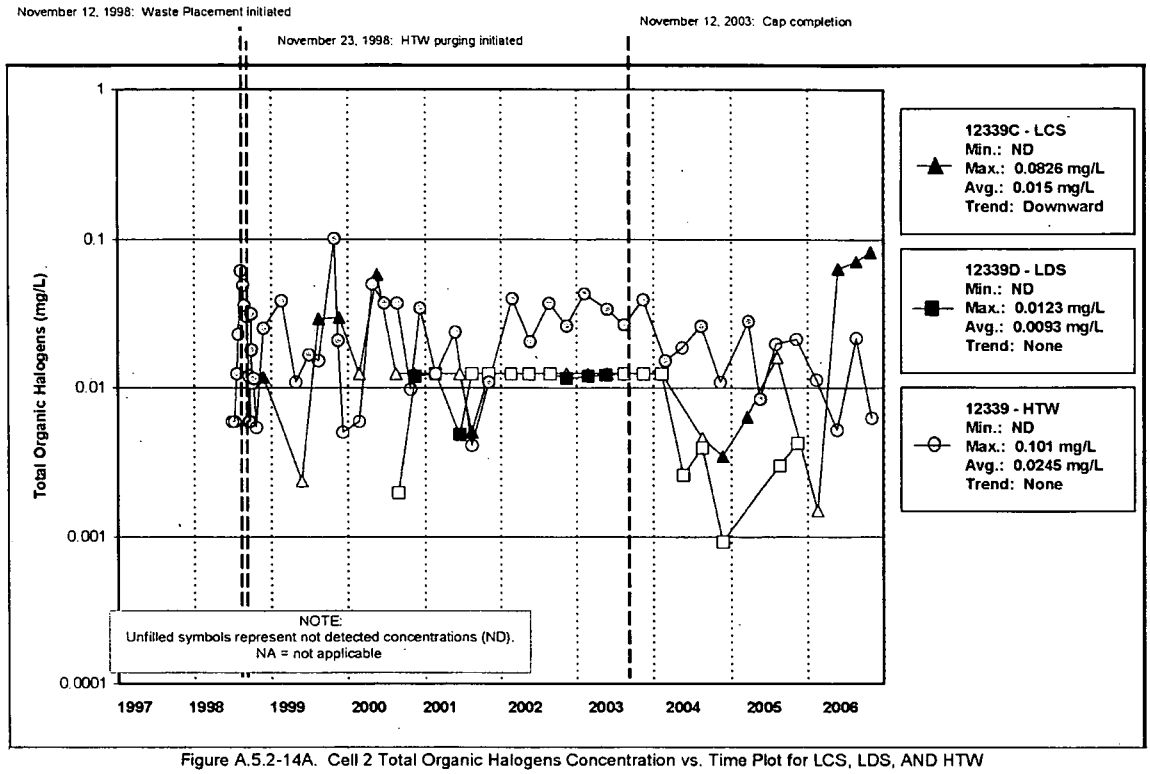


Figure A.5.2-14A. Cell 2 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

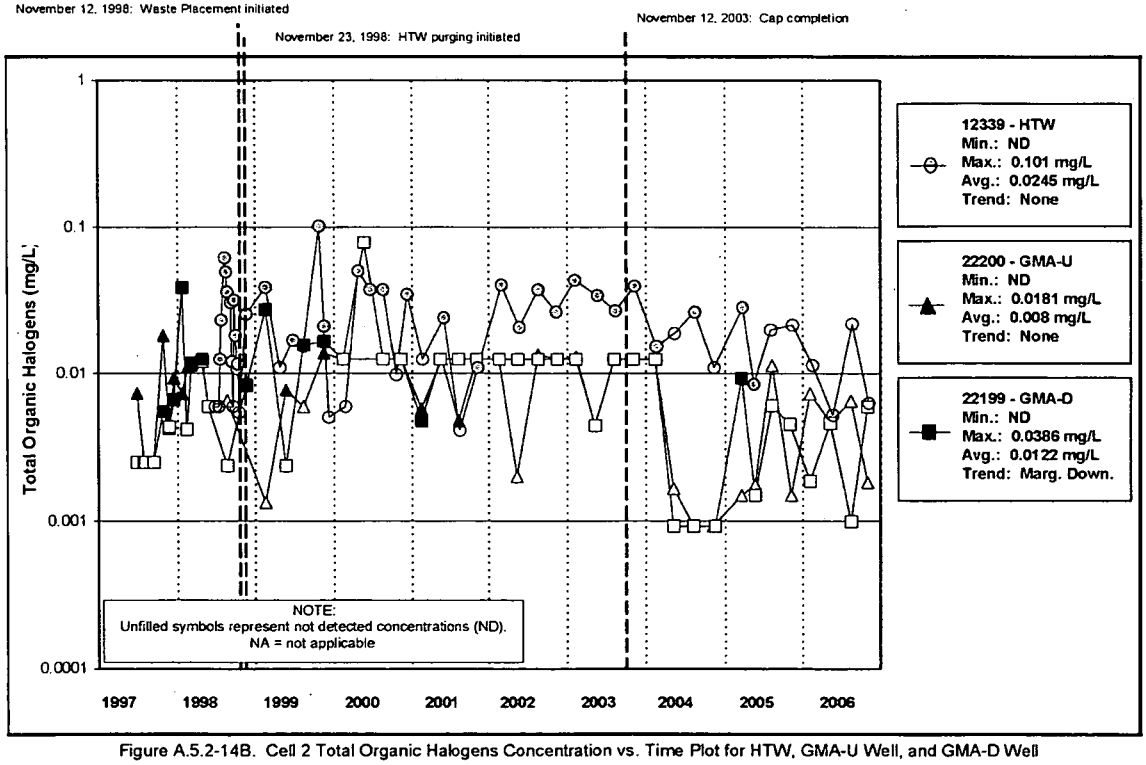


Figure A.5.2-14B. Cell 2 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

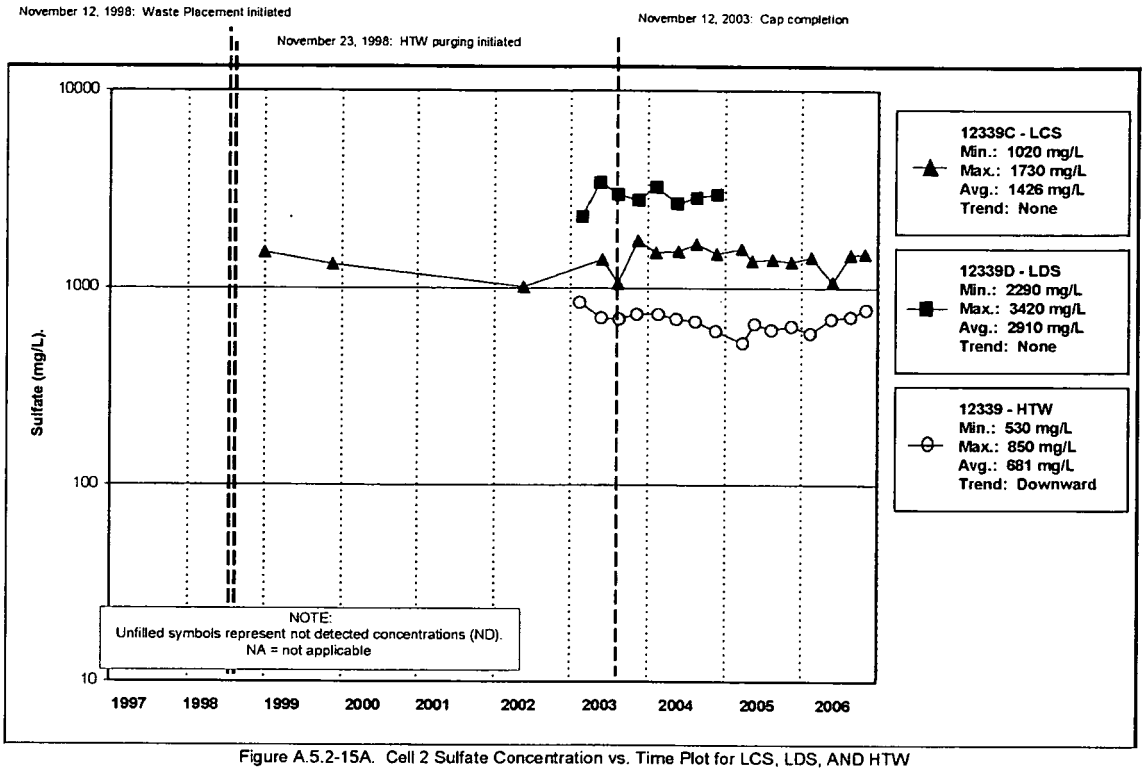


Figure A.5.2-15A. Cell 2 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

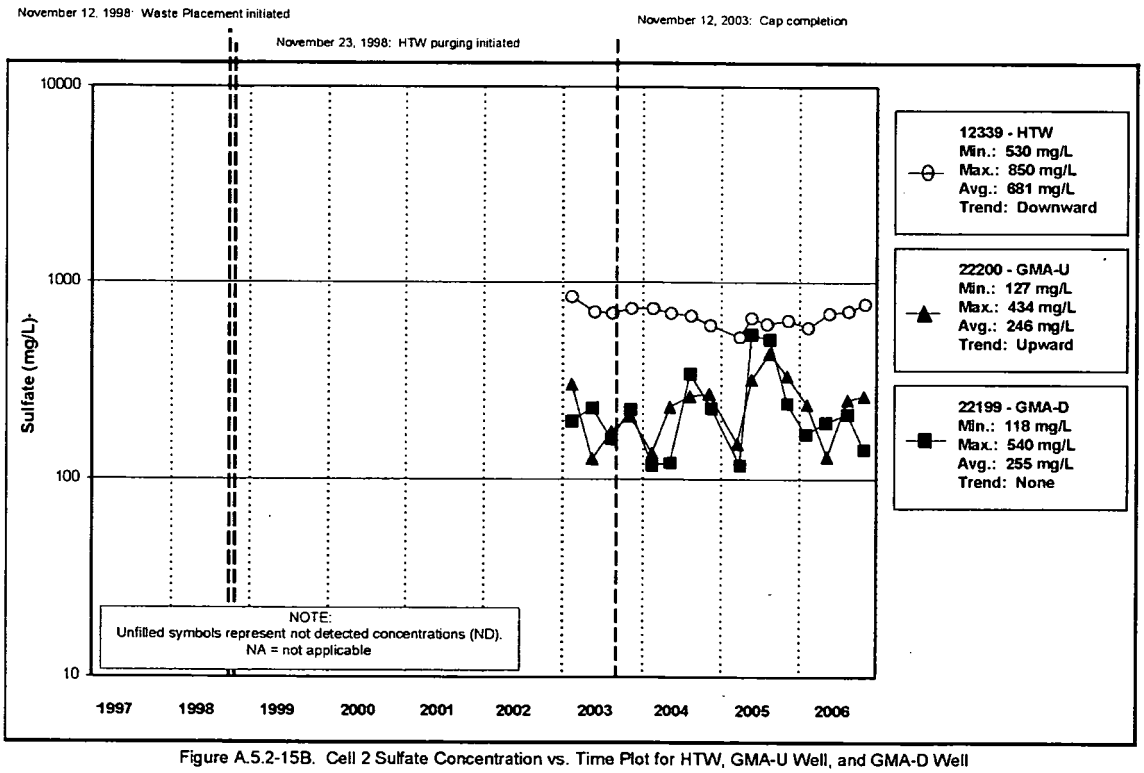


Figure A.5.2-15B. Cell 2 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

End of current text

Subattachment A.5.3

Cell 3

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.3–1 and A.5.3–2)
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.3–3 and A.5.3–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.3–5 and A.5.3–6)
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.3–7)
- Monthly liner efficiencies (refer to Table A.5.3–1)
- HTW Water Yield (refer to Figure A.5.3–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.3–9 and A.5.3–10)
- Summary statistics for refined baseline constituents (refer to Section A.5.3.1 and Table A.5.3–2)
- Concentration plots for refined baseline constituents (refer to Section A.5.3.1 and Figures A.5.3–11A through A.5.3–15B)
- Annual LCS monitoring results (refer to Section A.5.3.2 and Table A.5.3–3).
- Annual LDS monitoring results (refer to Section A.5.3.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. The LCS and LDS constituent sampling list for Cell 3 also includes 1,1-dichloroethene. In 2006, all samples were collected for the Cell 3 monitoring horizons.

A.5.3.1 Refined Baseline Results

Refined baseline constituents are those constituents that have been sampled for at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also listed in Table 2–3 are common ion constituents. A summary statistics table (Table A.5.3–2), and concentration plots are provided for the five refined baseline constituents of Cell 3. For Cell 3, these five constituents are: total uranium, boron, total organic carbon, total organic halogens, and sulfate. Note that with the addition of the 2006 data, total organic halogens concentrations are now detected less than 25 percent of the time in the down gradient GMA well.

A.5.3.2 LCS Monitoring Results

Ohio Solid Waste Regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 3 LCS took place in May.

Table A.5.3–3 summarizes the annual LCS sampling results for Cell 3 along with data collected in previous years.

Of the non-refined site specific baseline constituents that have been sampled at least eight times in Cell 3, 23 have been detected at least 25 percent of the time. Eleven of the 23 constituents are common ion constituents (alkalinity, calcium, chloride, fluoride, iron, magnesium, manganese, nitrate/nitrite, potassium, silicon, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 3 will be determined based upon results of the common ion study.

Eleven of the 12 constituents (considered to be "*potential*" site-specific leak detection monitoring constituents for Cell 3) are: 1,1,1-trichloroethane, barium, cadmium, chromium, cobalt, copper, nickel, selenium, total dissolved solids, vanadium, and zinc). These potential Cell 3 site-specific leak detection monitoring constituents will be assessed using the approach presented in Figures A.5–4A and A.5–4B, once final approval of the approach has been obtained from the EPA and OEPA. The assessment will be used to determine what potential constituent (if any) will be added to the Cell 3 site specific leak detection monitoring constituent list. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

The remaining constituent (1,1-dichloroethene) is a site specific leak detection parameter; however, it is not on the refined baseline list for Cell 3. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.3–3; 1,1-dichloroethene has been detected in the Cell 3 LCS. On May 16, 2005, a concentration of 9.2 µg/L was detected. The groundwater FRL is 7 µg/L. Confirmatory sampling began in the fourth quarter of 2005. Results are as follows:

- Nov 28, 2005 13 µg/L
- Feb 20, 2006 3.2 µg /L
- May 23, 2006 12 µg /L
- Aug 25, 2006 2.1 µg /L
- Nov 1, 2006 2.5 µg /L
- Feb 20, 2007 0.737 µg/L

The annual Cell 3 LDS result from May 30, 2006, was a non-detect. Based on the LCS results, it was decided to conduct confirmatory sampling in the LDS. Results are as follows:

- Aug 25, 2006 Non-detect
- Nov 1, 2006 Non-detect
- Feb 20, 2006 Non-detect

Confirmatory sampling at the Cell 3 LCS for 1,1-dichloroethene will continue in 2007 until the constituent is evaluated using the site specific parameter selection approach presented in Figures A.5–4A and A.5–4B. Confirmatory sampling at the Cell 3 LDS for 1,1-dichloroethene will be discontinued.

As shown in Figure A.5.3–3, technetium-99 is a site specific leak detection parameter that has been detected 11.1 percent of the time in the Cell 3 LCS; however, it is not on the refined baseline list for Cell 3. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.3–3, technetium-99 has been detected in the Cell 3 LCS, but these detections occurred prior to the establishment or the refined baseline for Cell 3. Therefore, confirmatory sampling for technetium-99 in the Cell 3 LCS is not required.

A.5.3.3 LDS Annual Monitoring Results

Each year the LDS of Cell 3 is sampled for site specific parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. In 2006, annual sampling of the Cell-3 LDS took place in May.

Of the non-refined baseline constituents that have been sampled at least eight times, two have been detected at least 25 percent of the time: (alkalinity and calcium). Both are common ion constituents.

Table A.5.3–1. Cell 3 – 2006 Monthly Liner Efficiencies

Month	Cell 3 Apparent Liner Efficiency (%)
January	96.52
February	97.32
March	98.21
April	98.20
May	98.24
June	98.16
July	NA[a]
August	NA[a]
September	98.87
October	98.74
November	98.86
December	99.22

[a]OSDF contingency plan executed due to inaccessibility of valve houses. Valve house road was closed to support site remediation activities. No data available

Table A.5.3.2. Summary Statistics for Cell 3

Note: The data used in this table have been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]			
Total Uranium (µg/L)	LCS	12340C	28	28	100%	49.8	Normal	Upward	Not Detected				
	LDS	12340D	16	16	100%	18.3	Lognormal	Downward	Not Detected				
	HTW	12340	32	32	100%	18.2	Undefined	Upward	Detected				
	GMA-U	22203	31	34	91%	2.10	Lognormal	None	Detected				
	GMA-D	22204	33	34	97%	2.86	Lognormal	Upward	Detected				
Boron (mg/L)	LCS	12340C	29	30	97%	1.70	Undefined	Upward	Detected				
	LDS	12340D	16	17	94%	0.245	Lognormal	Downward	Detected				
	HTW	12340	31	31	100%	0.112	Lognormal	Downward	Detected	0.96 (Q3-06)			
	GMA-U	22203	25	34	74%	0.0367	Normal	None	Detected				
	GMA-D	22204	27	33	82%	0.0360	Undefined	None	Marg. Detect				
Total Organic Carbon (mg/L)	LCS	12340C	16	27	59%	2.0	Lognormal	None	Not Detected	17.35 (Q4-99)			
	LDS	12340D	13	17	76%	6.49	Undefined	Marg. Up.	Not Detected				
	HTW	12340	21	30	70%	1.90	Normal	None	Detected	9.81 (Q1-00)			
	GMA-U	22203	19	32	59%	1.48	Lognormal	Downward	Detected	14.1 (Q4-00)	5.66 (Q1-00)		
	GMA-D	22204	16	33	48%	1.40	Lognormal	None	Not Detected	8.83 (Q1-00)			
Total Organic Halogens (mg/L)	LCS	12340C	7	27	26%	0.013	Undefined	Marg. Up.	Not Detected	0.141 (Q4-99)	0.057 (Q3-06)		
	LDS	12340D	7	17	41%	0.0257	Lognormal	Upward	Not Detected				
	HTW	12340	22	32	69%	0.0204	Normal	None	Detected	0.067 (Q4-99)			
	GMA-U	22203	11	33	33%	0.0072	Undefined	Downward	Detected	0.213 (Q2-00)			
	GMA-D	22204	8	34	24%	0.0125	Undefined	None	Not Detected	0.165 (Q2-00)	0.00184 U (Q2-04)	0.00184 U (Q2-03)	0.00184 U (Q2-02)
Sulfate (mg/L)	LCS	12340C	21	21	100%	1600	Undefined	Upward	Detected				
	LDS	12340D	15	15	100%	1610	Normal	Downward	Detected				
	HTW	12340	16	16	100%	667	Normal	Downward	Marg. Detect				
	GMA-U	22203	16	16	100%	340	Lognormal	Downward	Detected				
	GMA-D	22204	14	14	100%	581	Lognormal	None	Not Detected	319 (Q2-06)	338 (Q2-03)		

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.

Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

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Table A.5.3-3. Cell 3 Annual LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION[a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
1,1,1-Trichloroethane (ug/L)	8	2	25.0%	0.54	0.64	-	-	-	-	-	1 ug/L
1,1-Dichloroethane (ug/L)	8	1	12.5%	0.79		-	280 ug/L (0)	-	-	-	1 ug/L
1,1-Dichloroethene (ug/L)	20	7	35.0%	1.3	13.1	6.2	7 ug/L (3)	-	-	-	1 ug/L
Alkalinity as CaCO3 (mg/L)	13	13	100.0%	72	1080	450	-	422 mg/L (8)	430 mg/L (8)	-	10 mg/L
Arsenic (mg/L)	8	1	12.5%	0.0013	-	-	0.05 mg/L (0)	0.029 mg/L (0)	0.019 mg/L (0)	0.191 mg/L (0)	0.02 mg/L
Barium (mg/L)	8	8	100.0%	0.0375	0.118	0.057	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Beryllium (mg/L)	8	1	12.5%	0.0002	-	-	0.004 mg/L (0)	-	-	0.0343 mg/L (0)	0.001 mg/L
Cadmium (mg/L)	8	2	25.0%	0.000065	0.00044	-	0.014 mg/L (0)	0.014 mg/L (0)	-	0.05 mg/L (0)	0.002 mg/L
Calcium (mg/L)	16	16	100.0%	96	1200	510	-	159 mg/L (13)	172 mg/L (13)	1800 mg/L (0)	5 mg/L
Chloride (mg/L)	13	13	100.0%	4.7	42.8	26.8	-	7.3 mg/L (11)	45 mg/L (0)	6300 mg/L (0)	5 mg/L
Chromium (mg/L)	8	3	37.5%	0.00093	0.00564	0.00259	0.022 mg/L (0)	0.021 mg/L (0)	0.0048 mg/L (1)	0.818 mg/L (0)	0.005 mg/L
Cobalt (mg/L)	8	4	50.0%	0.000288	0.0309	0.0112	0.17 mg/L (0)	0.0088 mg/L (2)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	8	8	100.0%	0.00118	0.0122	0.0074	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	5	71.4%	0.056	0.197	0.141	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	16	16	100.0%	0.205	16.6	4.2	-	5.72 mg/L (3)	6.35 mg/L (2)	21.3 mg/L (0)	0.1 mg/L
Lead (mg/L)	8	1	12.5%	0.00146	-	-	0.015 mg/L (0)	0.022 mg/L (0)	0.0016 mg/L (0)	0.0114 mg/L (0)	0.008 mg/L
Magnesium (mg/L)	16	16	100.0%	19.2	380	155	-	38.5 mg/L (12)	50.7 mg/L (12)	690 mg/L (0)	5 mg/L
Manganese (mg/L)	16	15	93.8%	0.0014	7.27	3.83	0.9 mg/L (10)	0.9 mg/L (10)	0.21 mg/L (10)	35 mg/L (0)	0.09 mg/L
Nickel (mg/L)	8	8	100.0%	0.00298	0.0918	0.0278	0.1 mg/L (0)	0.0514 mg/L (2)	0.0072 mg/L (5)	0.981 mg/L (0)	0.02 mg/L
Nitrate/Nitrite (mg/L)	20	14	70.0%	0.238	2.2	0.96	11 mg/L[g] (0)	11 mg/L (0)	0.29 mg/L (12)	2670 mg/L (0)	1.1 mg/L
Phosphorus (mg/L)	9	1	11.1%	0.0853	-	-	-	-	-	-	0.1 mg/L
Potassium (mg/L)	16	16	100.0%	3.96	31.9	21.0	-	1.96 mg/L (16)	17.2 mg/L (12)	12400 mg/L (0)	5 mg/L
Selenium (mg/L)	8	3	37.5%	0.0019	0.0133	0.0065	0.05 mg/L (0)	0.00075 mg/L (3)	-	0.0494 mg/L (0)	0.005 mg/L
Silicon (mg/L)	10	10	100.0%	9.75	11.3	10.5	-	-	-	15 mg/L (0)	0.015 mg/L
Sodium (mg/L)	16	16	100.0%	4.79	49.9	21.6	-	47.1 mg/L (1)	50 mg/L (0)	1300 mg/L (0)	5 mg/L
Technetium-99 (pCi/L)	18	2	11.1%	3.84	9.89	-	94 pCi/L (0)	22 pCi/L (0)	30 pCi/L (0)	6130 pCi/L (0)	10 pCi/L
Thallium (mg/L)	8	1	12.5%	0.0021	-	-	-	-	-	0.0028 mg/L (0)	0.02 mg/L
Total Dissolved Solids (mg/L)	15	15	100.0%	342	3210	1590	-	-	-	-	10 mg/L
trans-1,3-Dichloropropene (ug/L)	8	1	12.5%	1	-	-	-	-	-	-	1 ug/L
Vanadium (mg/L)	8	2	25.0%	0.00371	0.00959	-	0.038 mg/L (0)	0.012 mg/L (0)	0.005 mg/L (1)	0.299 mg/L (0)	0.02 mg/L
Vinyl chloride (ug/L)	16	1	6.3%	16.1	-	-	2 ug/L (1)	-	-	-	1 ug/L
Zinc (mg/L)	8	4	50.0%	0.0144	0.0278	0.0208	0.021 mg/L (2)	0.02 mg/L (2)	0.35 mg/L (0)	1.78 mg/L (0)	0.015 mg/L

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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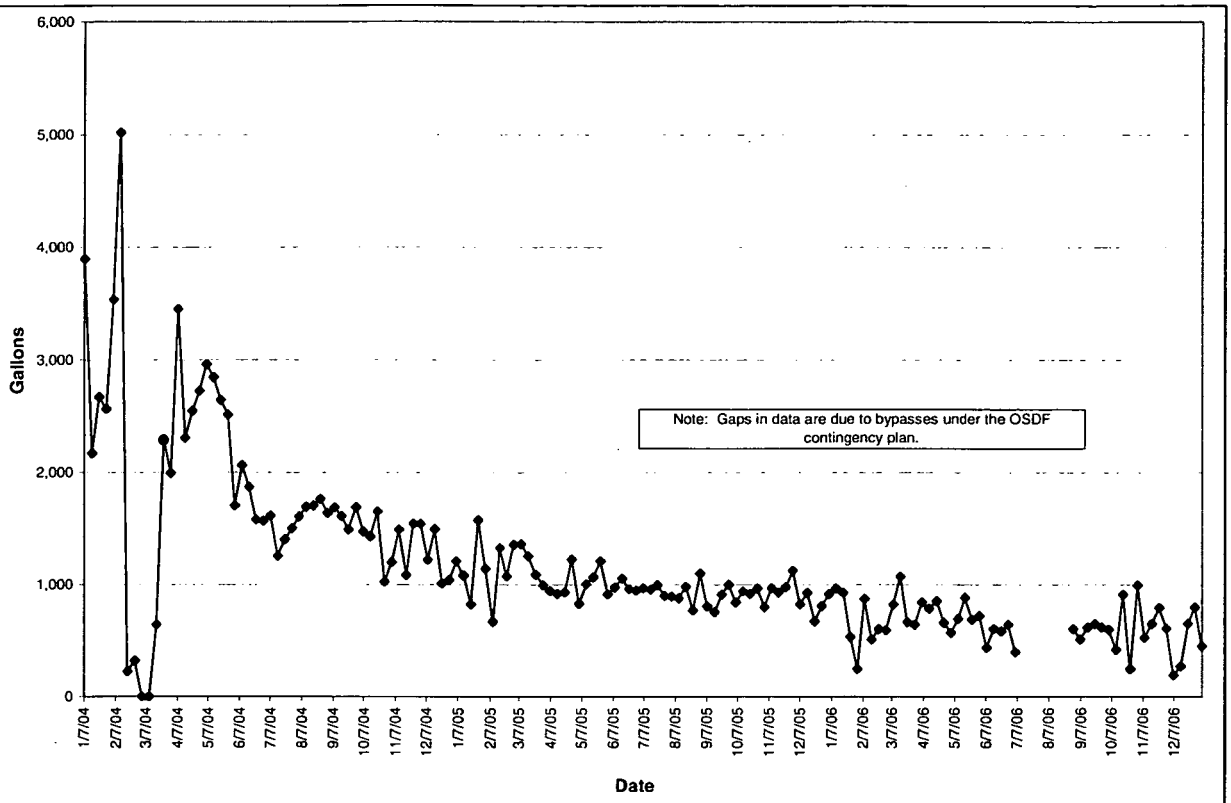


FIGURE A.5.3-1. Weekly Accumulation Volumes for Cell 3 LCS

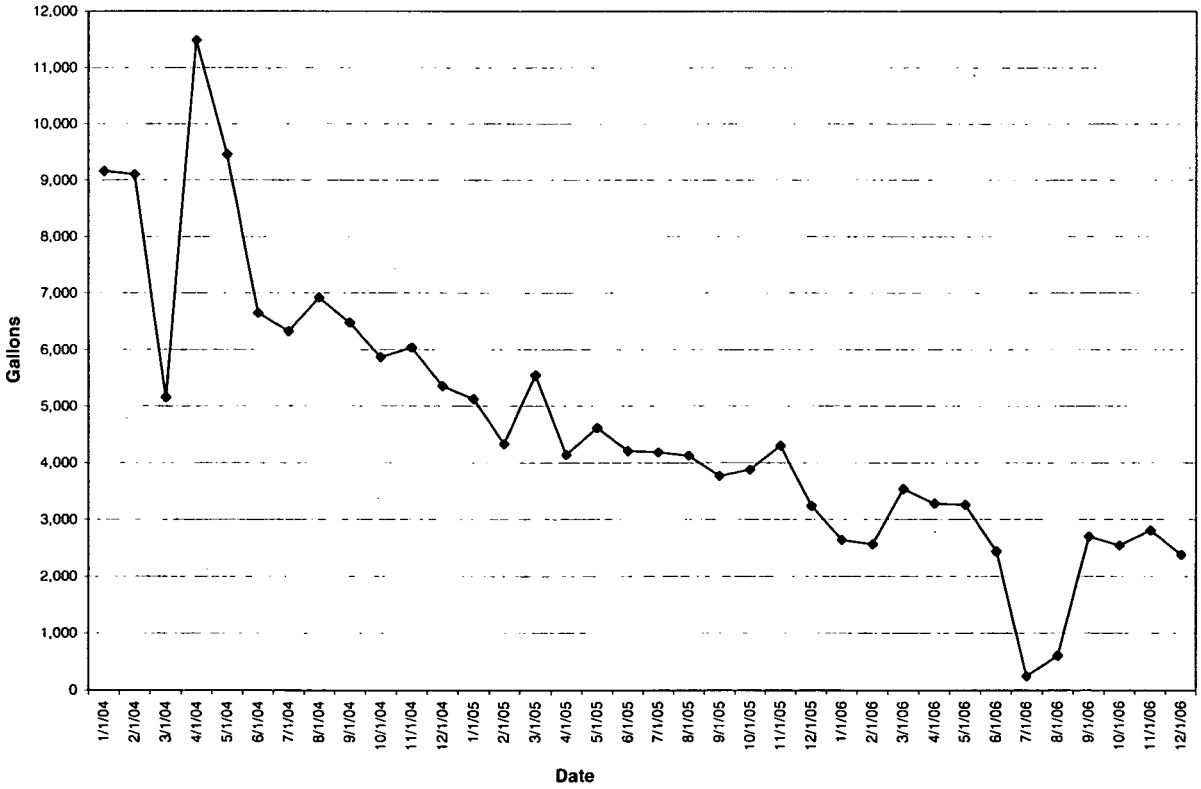


FIGURE A.5.3-2. Monthly Accumulation Volumes for Cell 3 LCS

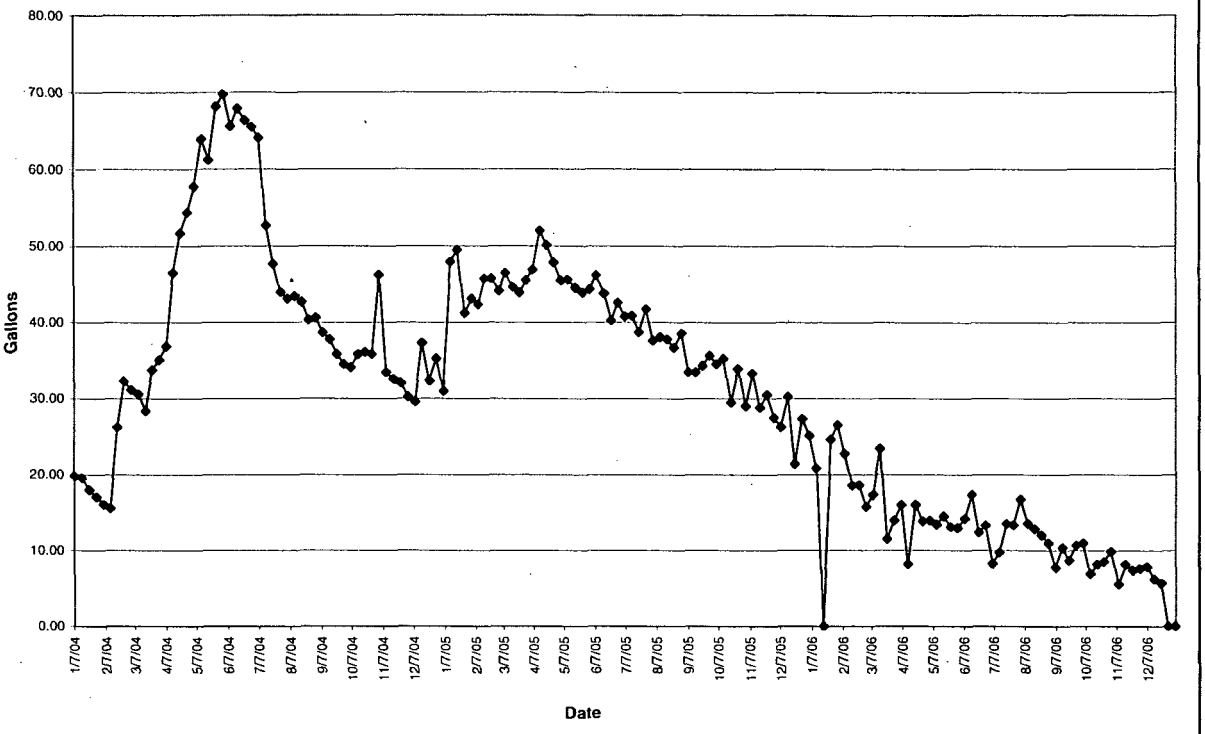


FIGURE A.5.3-3. Weekly Accumulation Volumes for Cell 3 LDS

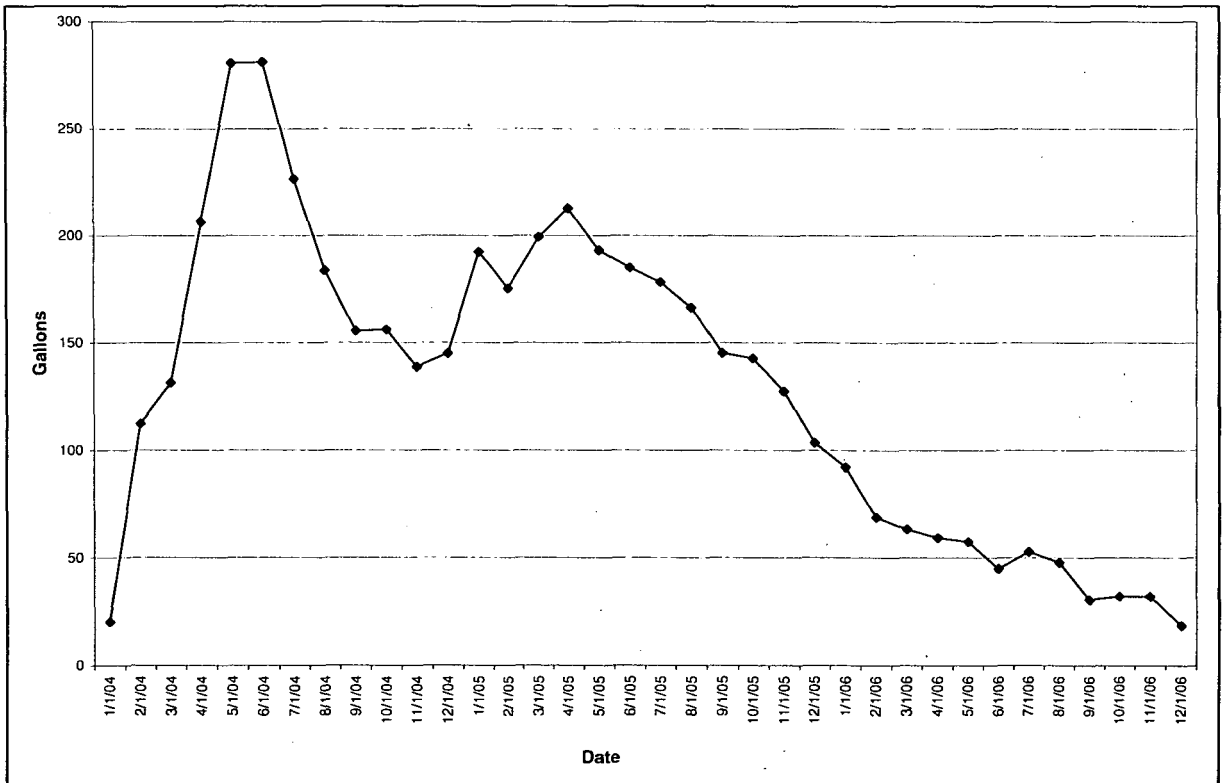


FIGURE A.5.3-4. Monthly Accumulation Volumes for Cell 3 LDS

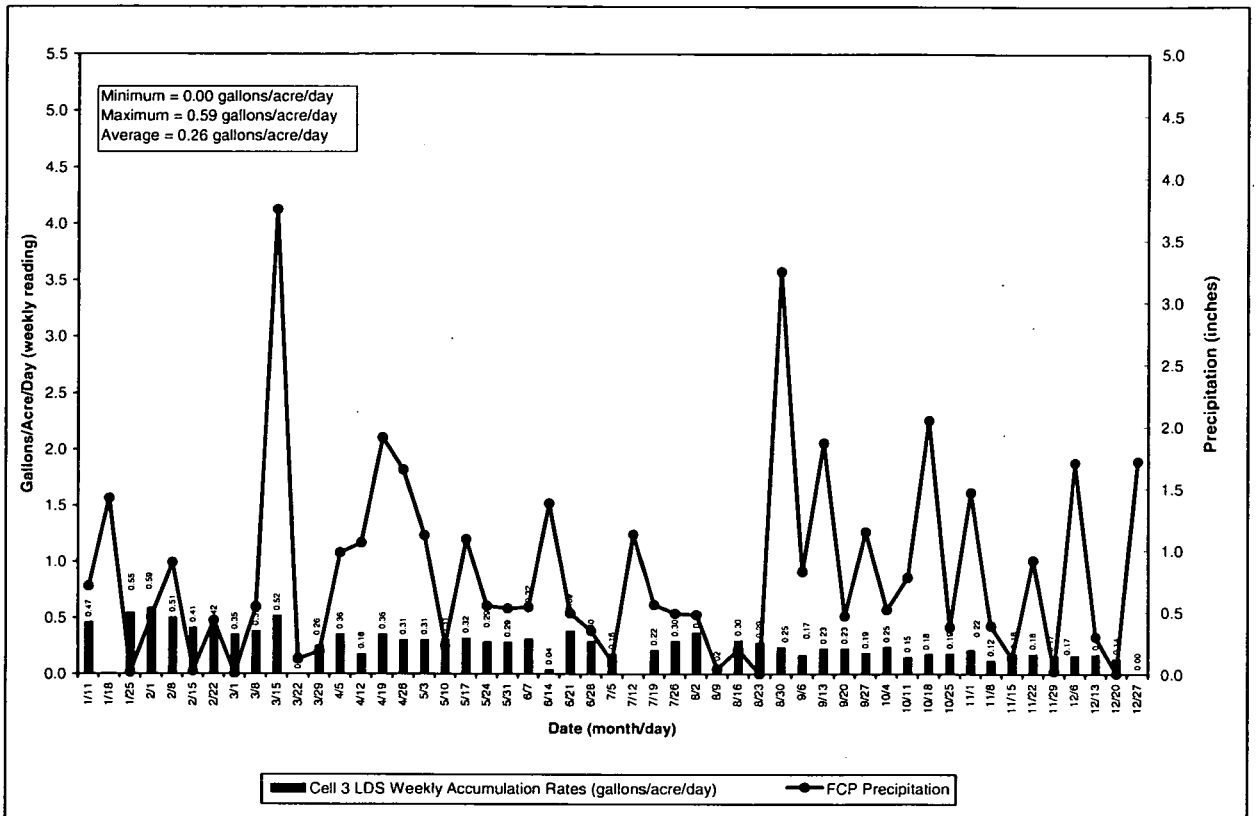


FIGURE A.5.3-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 3

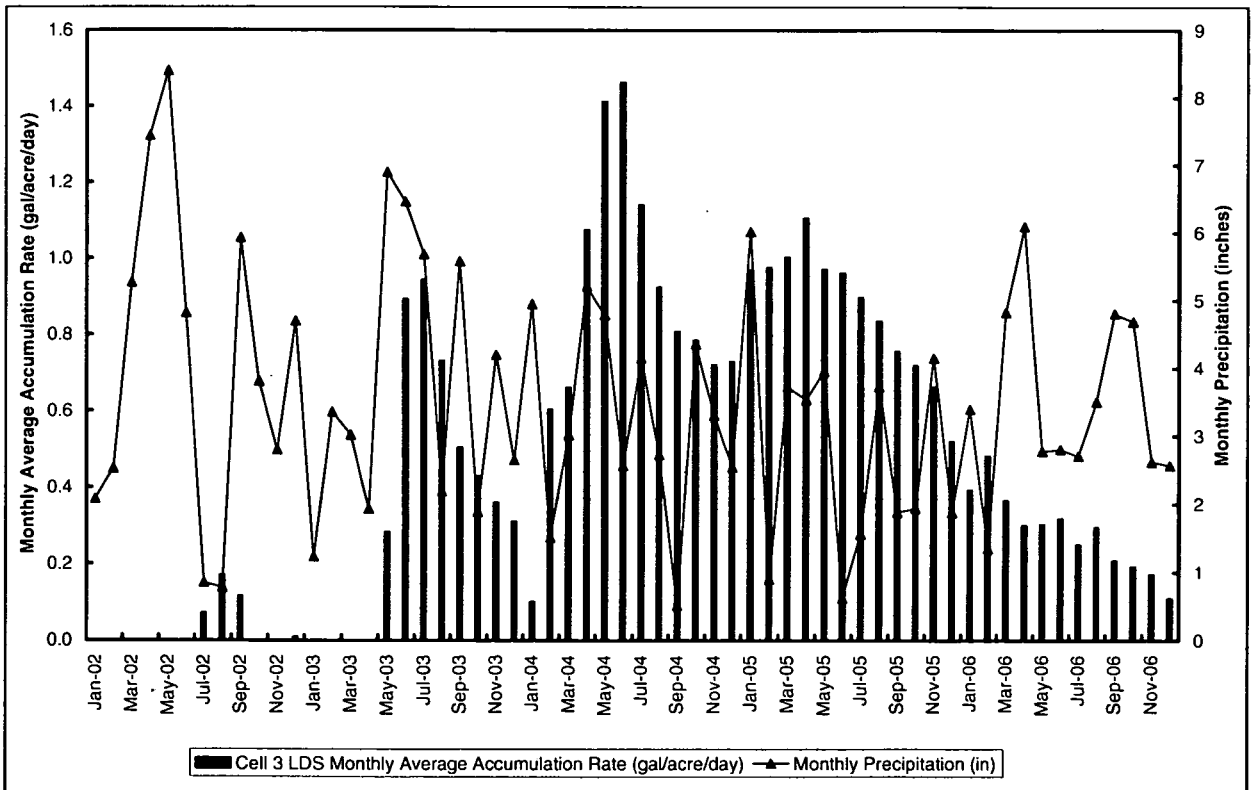


FIGURE A.5.3-6. OSDF Cell 3 LDS Monthly Average Accumulation Rates and Monthly Precipitation

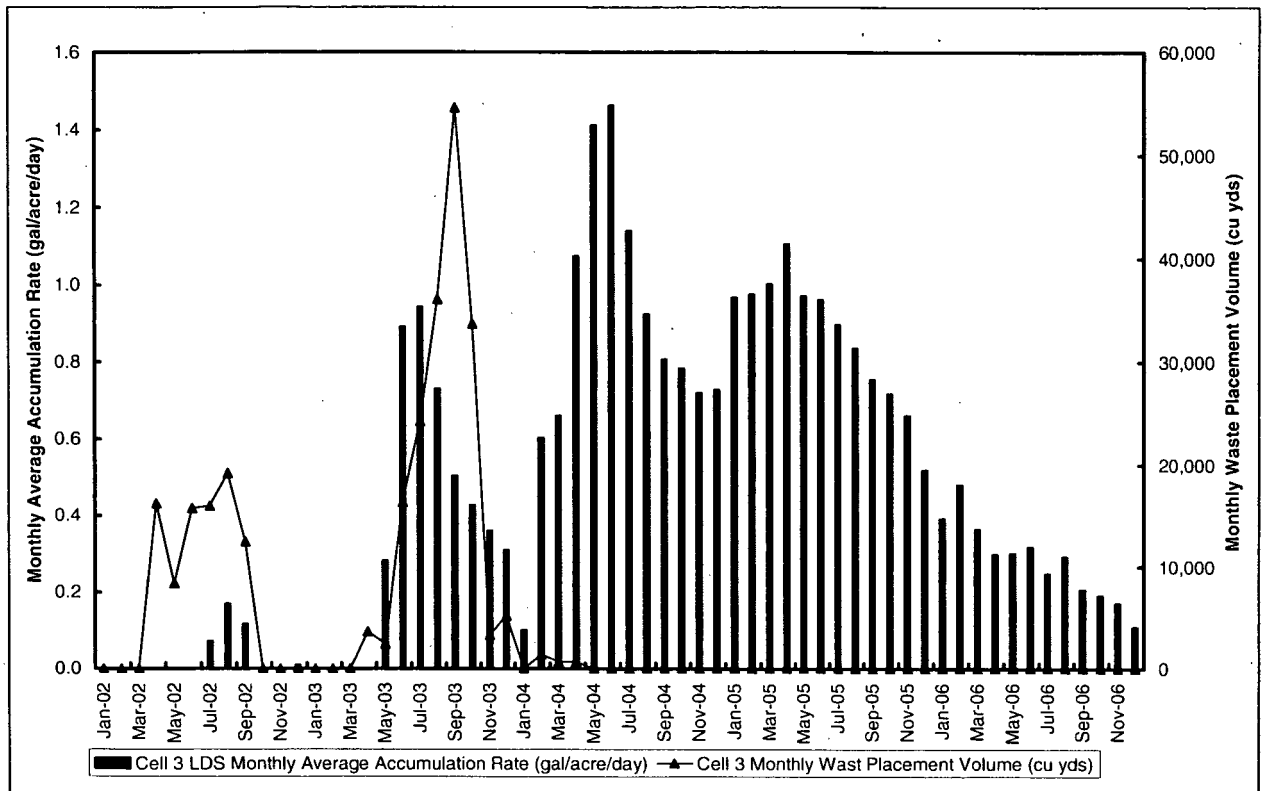
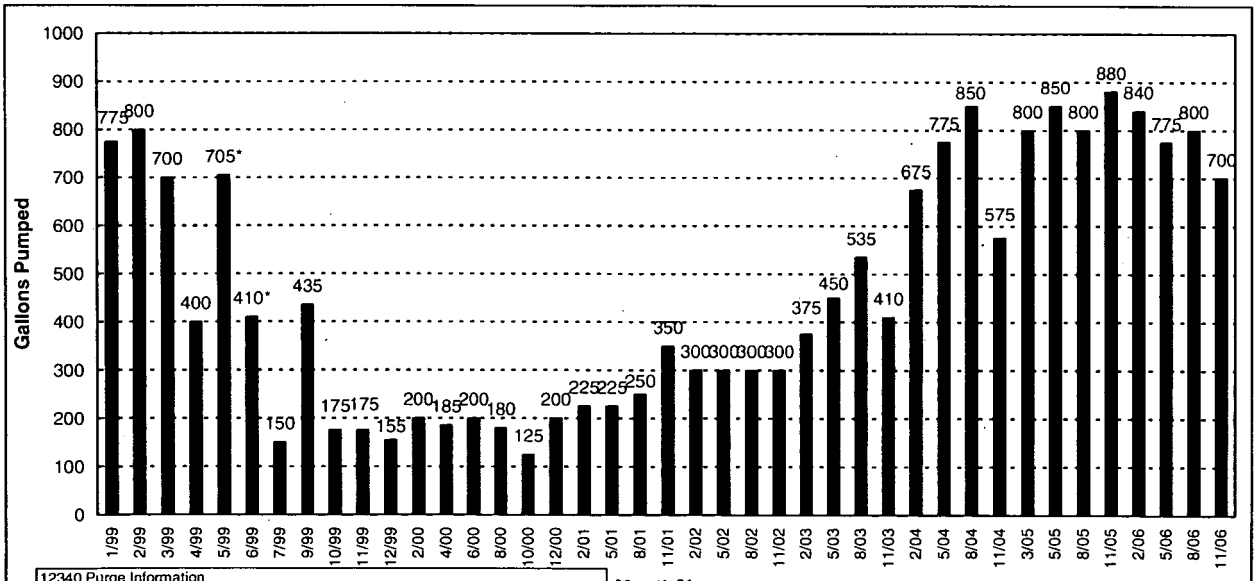


FIGURE A.5.3-7. OSDF Cell 3 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12340 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
1999:	4880	n=11	444
2000:	1090	n= 6	182
2001:	1050	n= 4	263
2002:	1200	n= 4	300
2003:	1770	n= 4	443
2004:	2875	n= 4	719
2005:	3330	n=4	833
2006:	3115	n=4	779
Overall:			471

*More than one purge of the well was completed during these months to help evaluate well yield.

FIGURE A.5.3-8. OSDF Horizontal Till Well 12340 (Cell 3) Water Yield

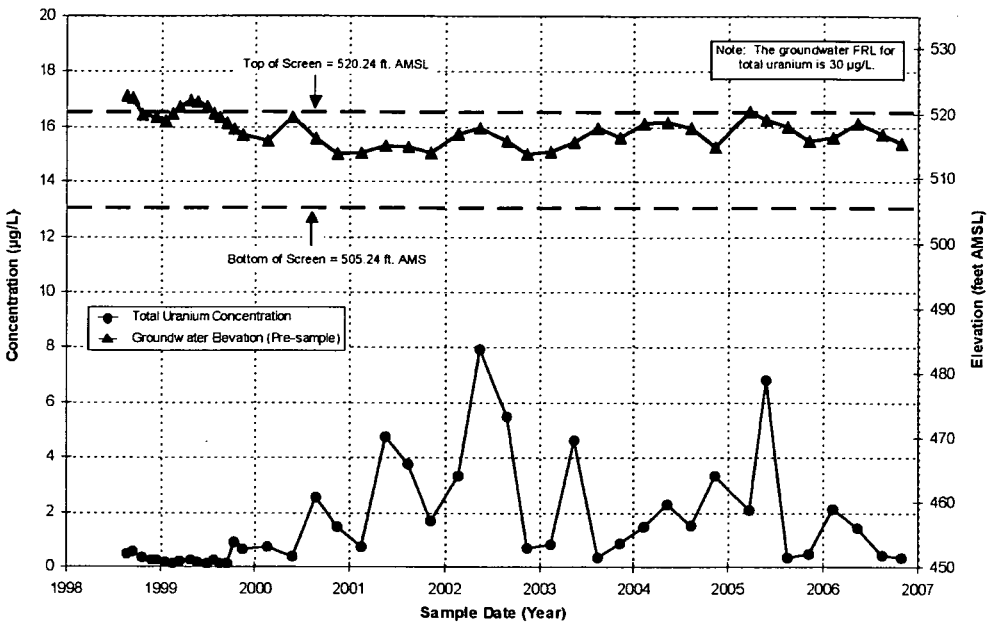


Figure A.5.3-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 3 Upgradient Monitoring Well 22203

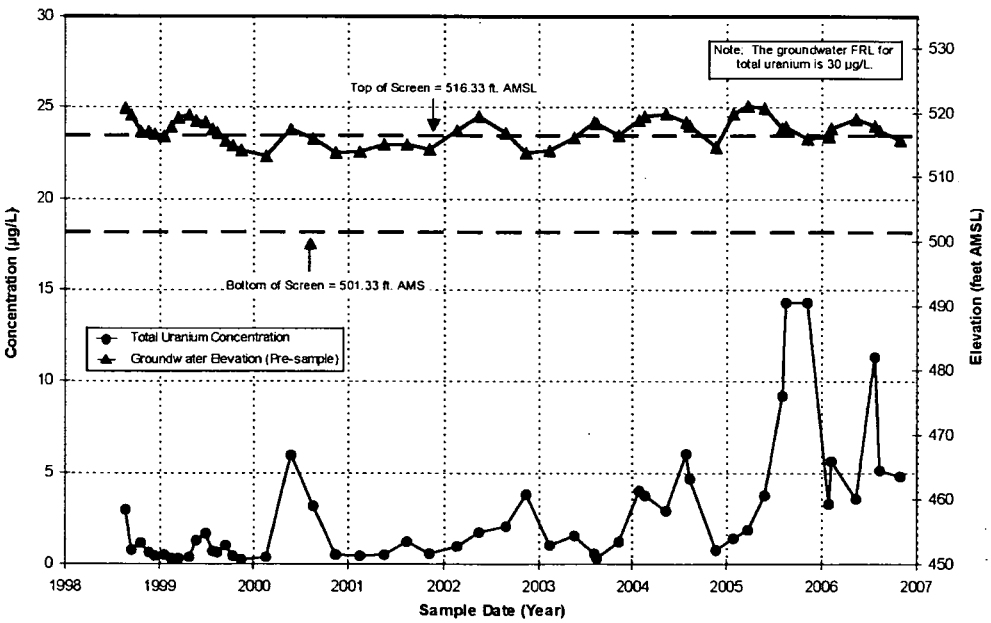


Figure A.5.3-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 3 Downgradient Monitoring Well 22204

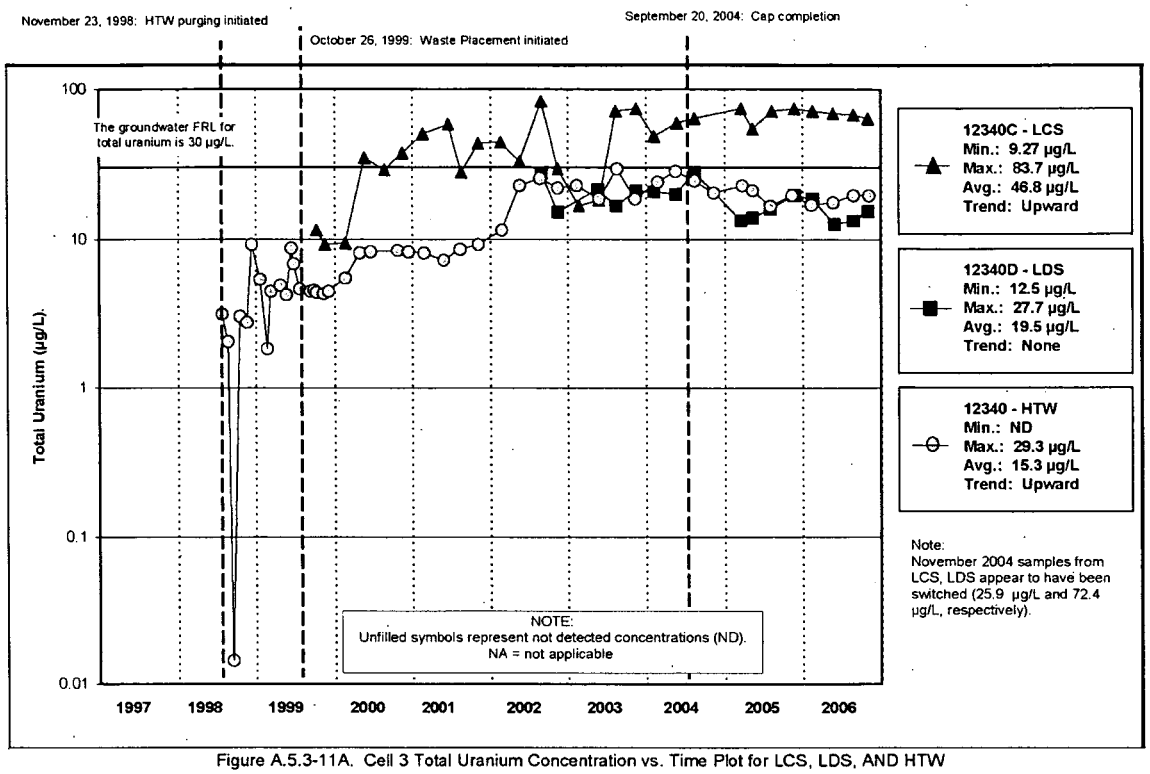


Figure A.5.3-11A. Cell 3 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

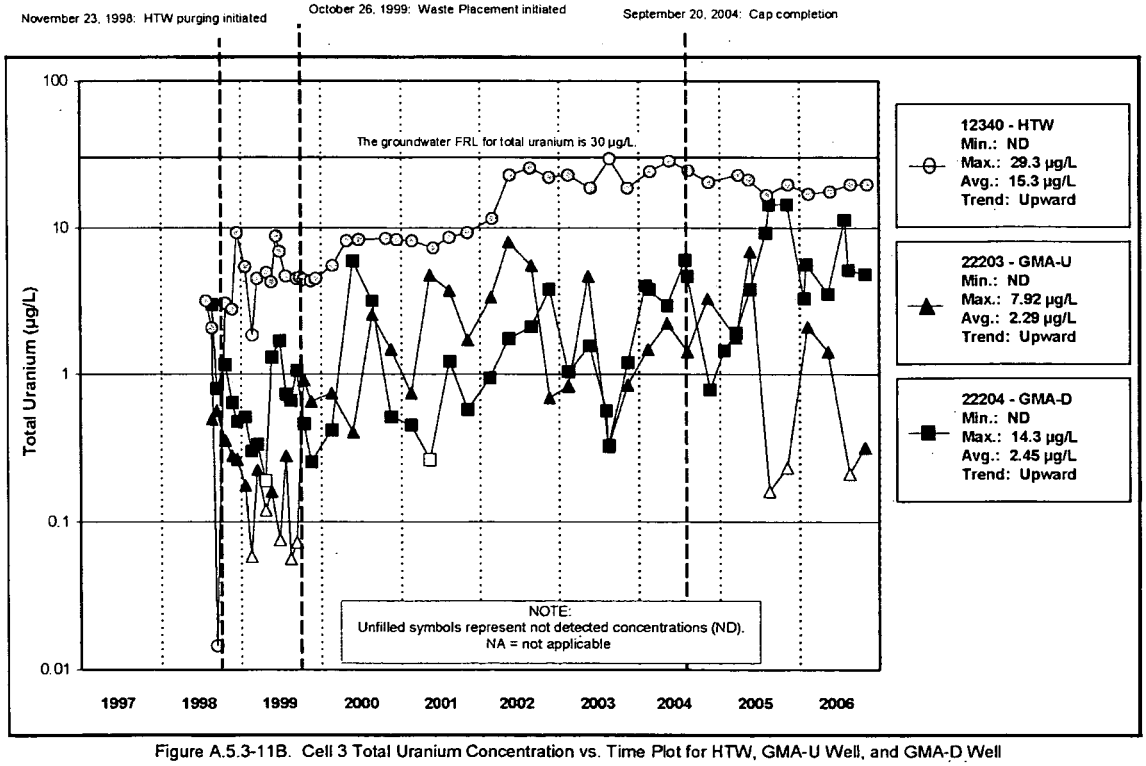


Figure A.5.3-11B. Cell 3 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

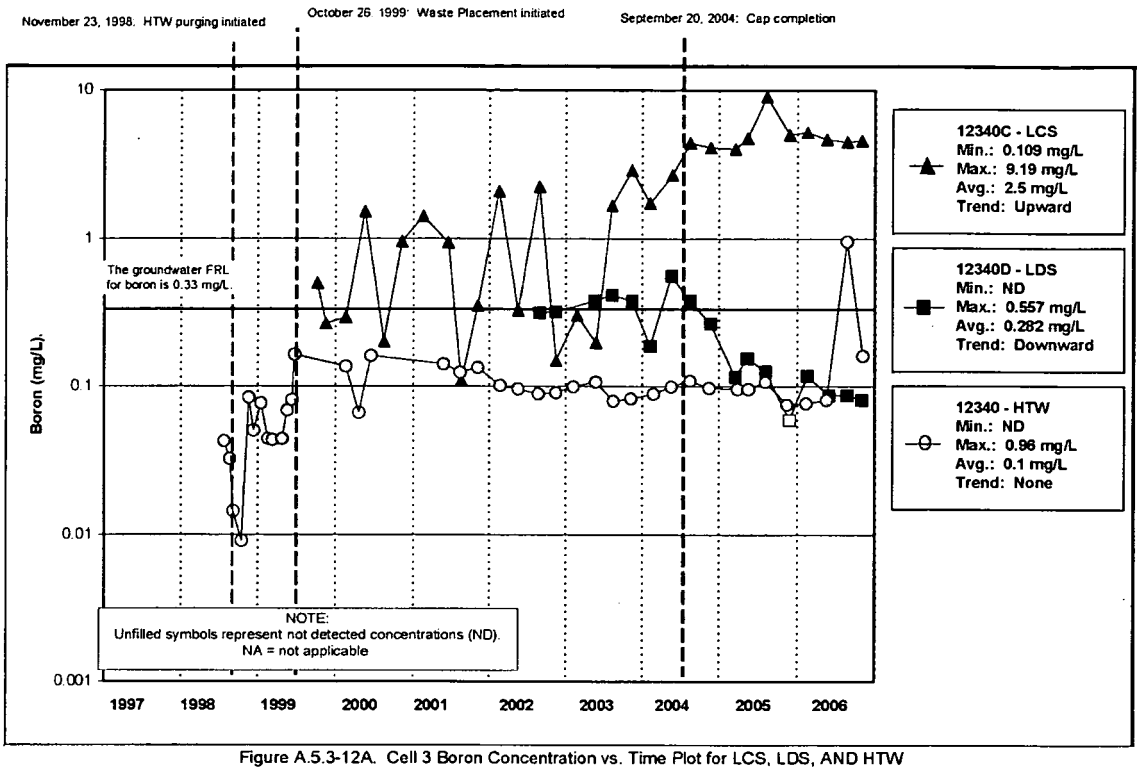


Figure A.5.3-12A. Cell 3 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

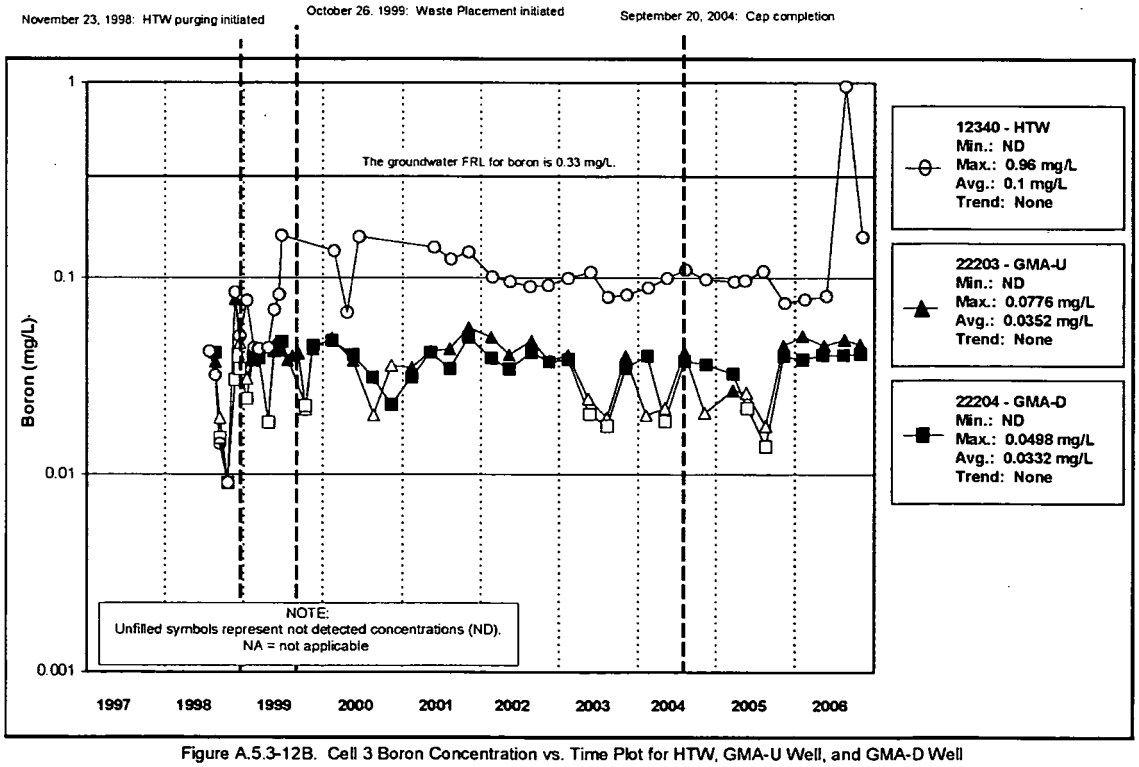


Figure A.5.3-12B. Cell 3 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

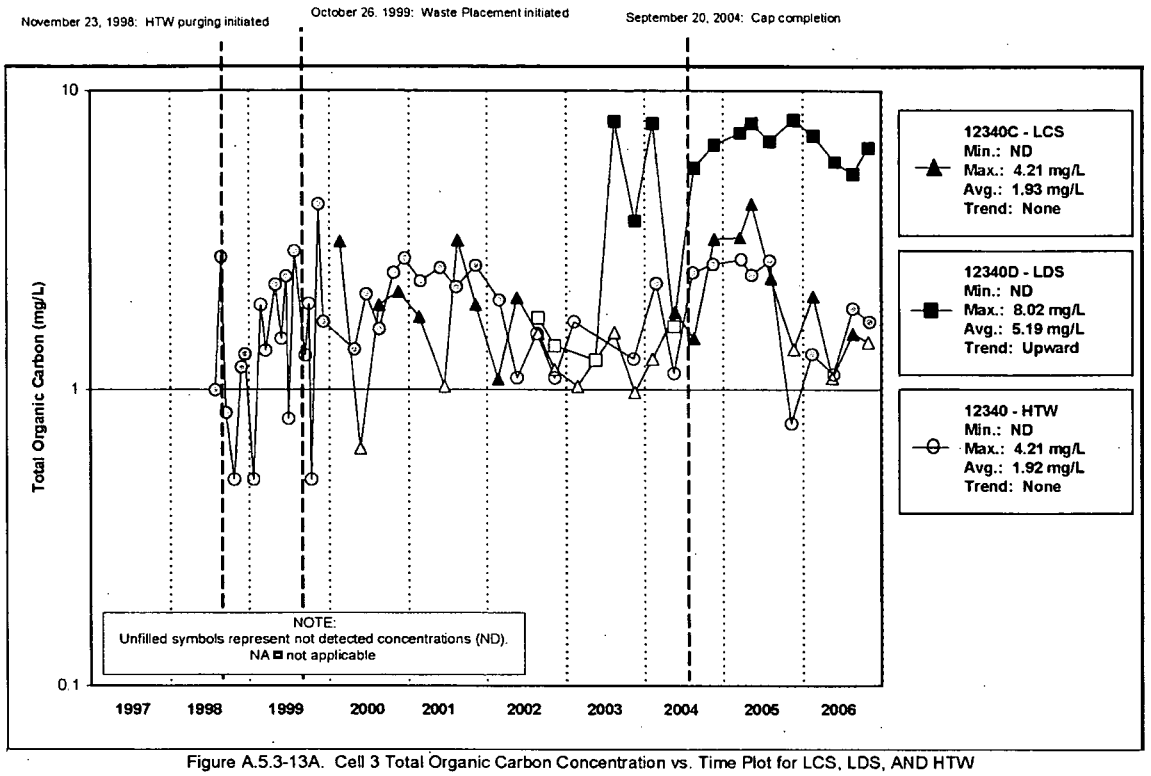


Figure A.5.3-13A. Cell 3 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

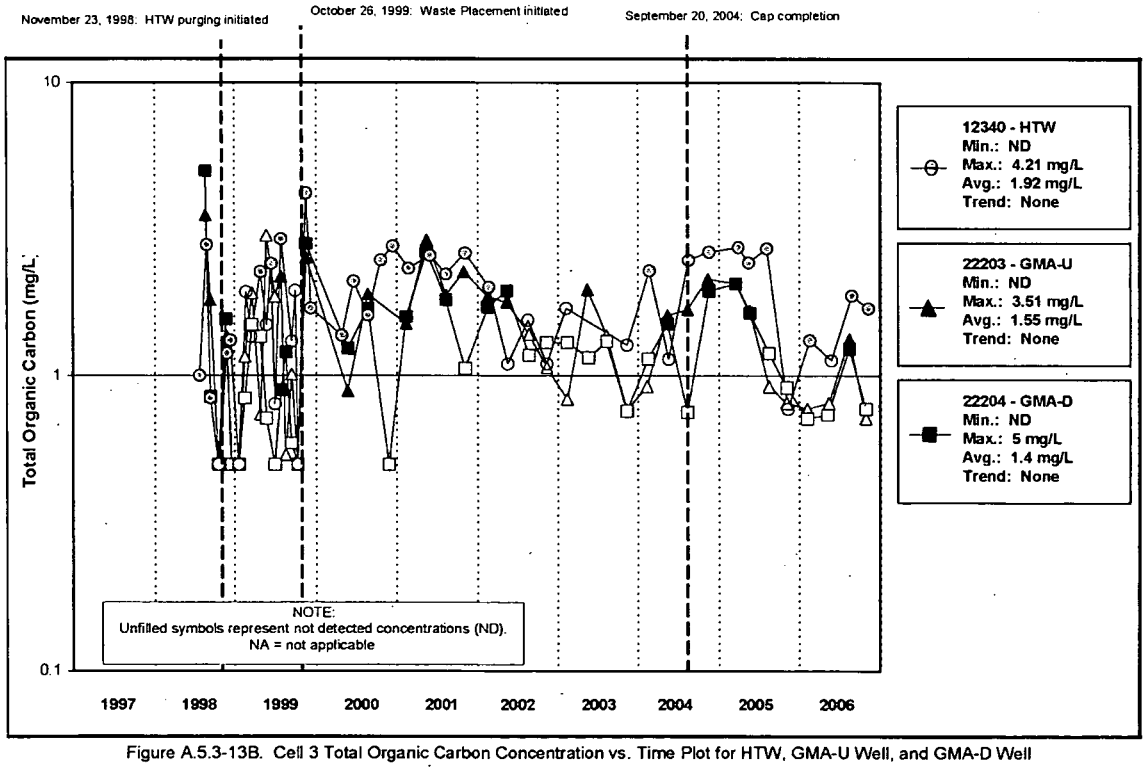


Figure A.5.3-13B. Cell 3 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

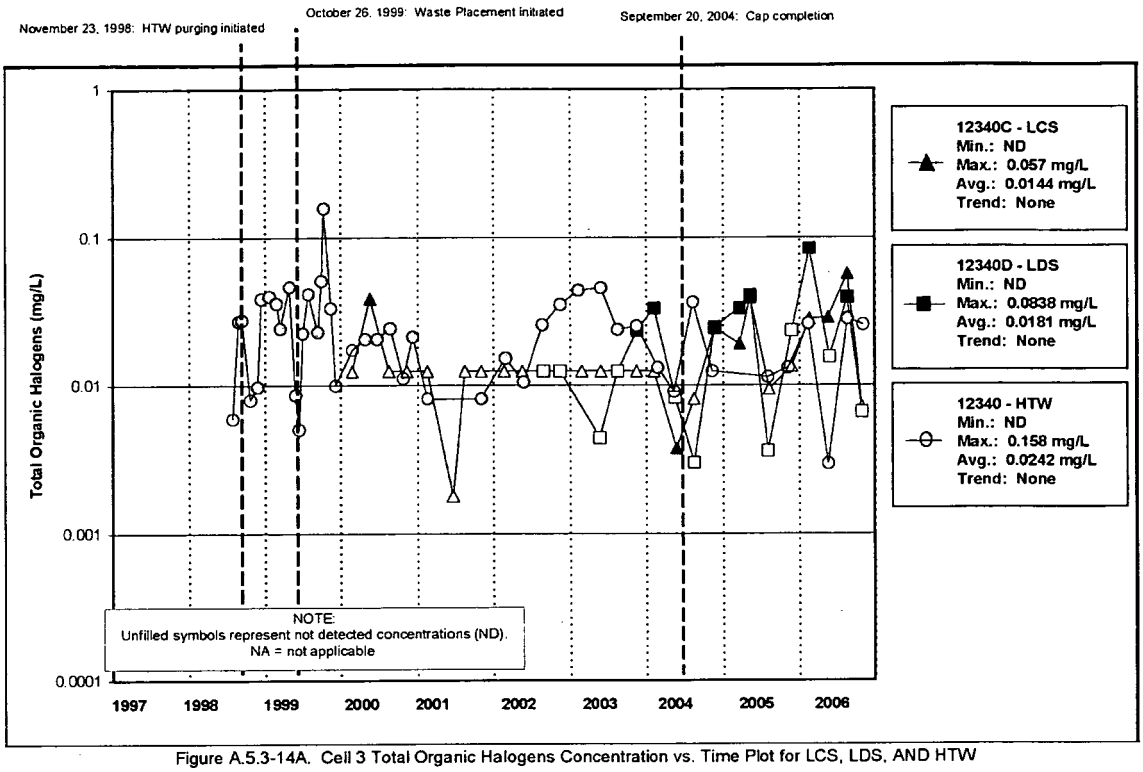


Figure A.5.3-14A. Cell 3 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

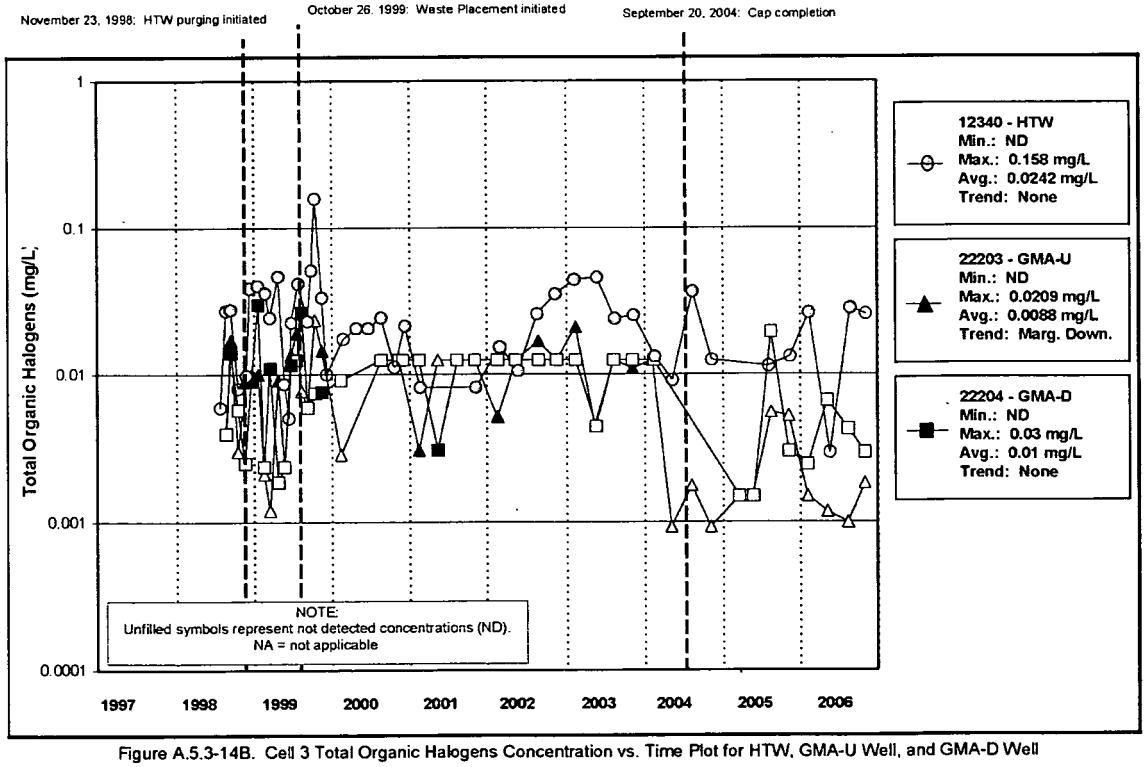


Figure A.5.3-14B. Cell 3 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

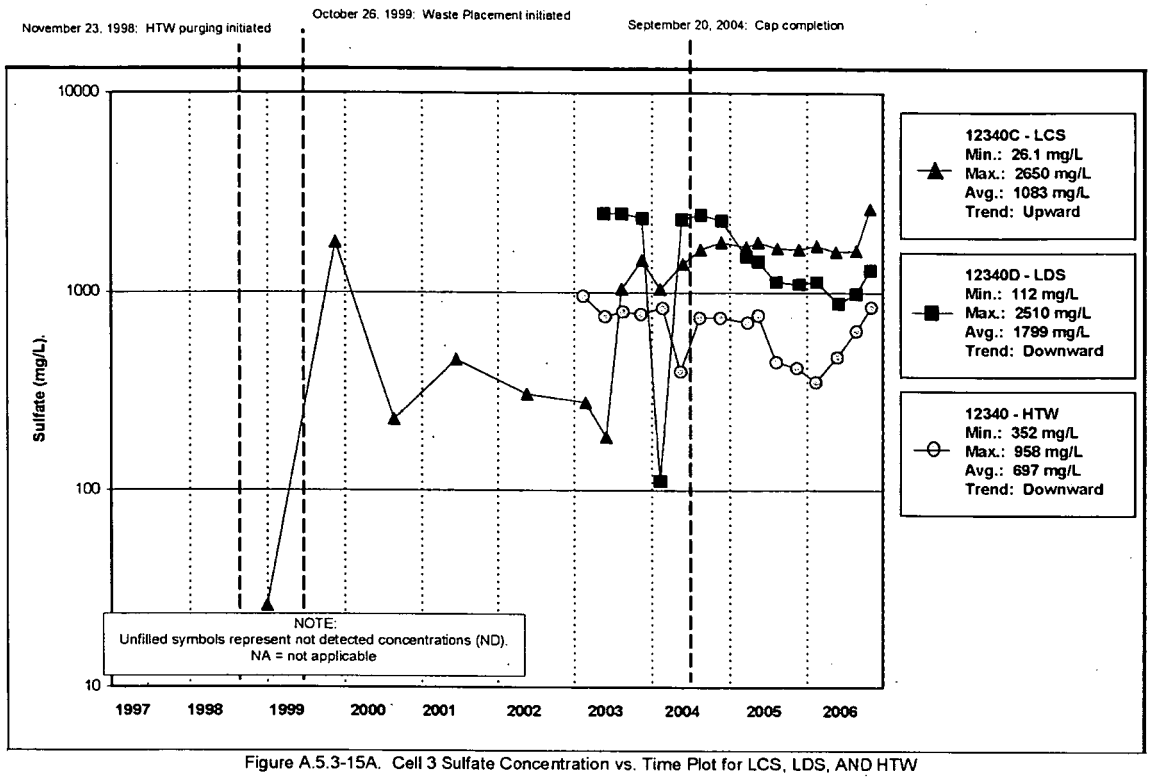


Figure A.5.3-15A. Cell 3 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

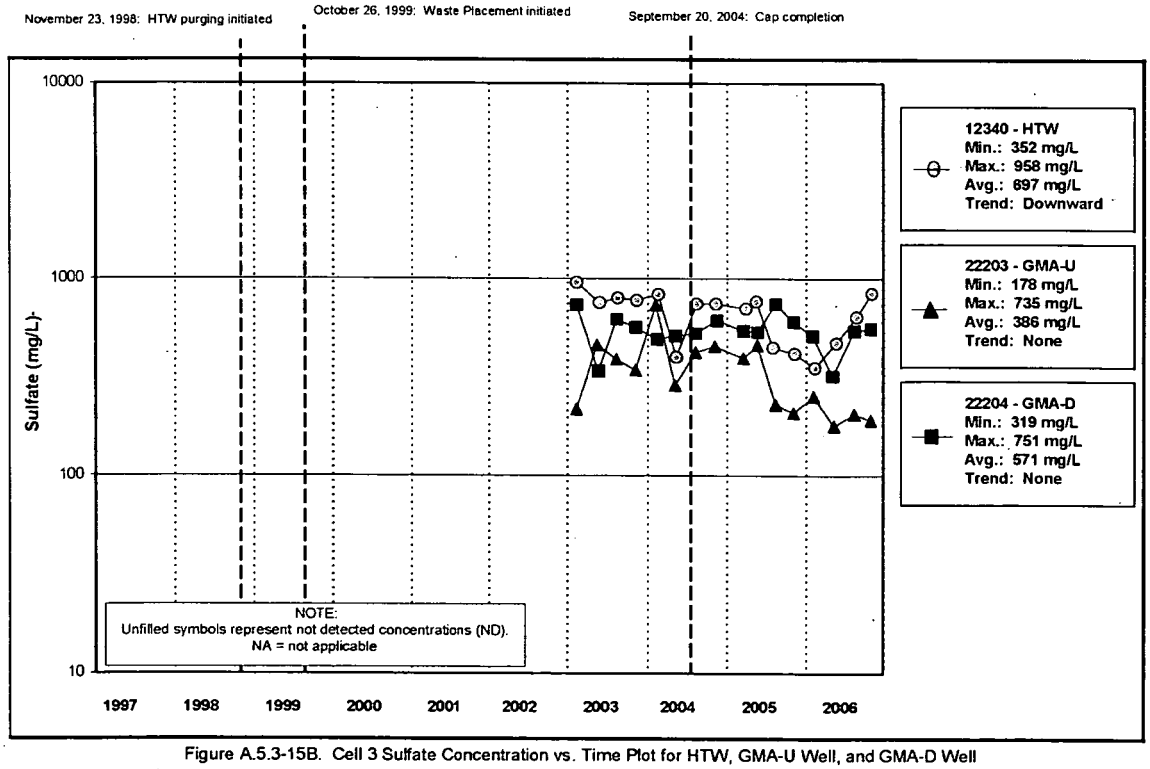


Figure A.5.3-15B. Cell 3 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

Subattachment A.5.4

Cell 4

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.4–1 and A.5.4–2).
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.4–3 and A.5.4–4).
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.4–5 and A.5.4–6).
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.4–7).
- Monthly liner efficiencies (refer to Table A.5.4–1).
- HTW Water Yield (refer to Figure A.5.4–8).
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.4–9 and A.5.4–10).
- Summary statistics for refined baseline constituents (refer to Section A.5.4.1 and Table A.5.4–2).
- Concentration plots for refined baseline constituents (refer to Section A.5.4.1 and Figures A.5.4–11A through A.5.4–15B).
- Annual LCS monitoring results (refer to Section A.5.4.2 and Table A.5.4–3).
- Annual LDS monitoring results (refer to Section A.5.4.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. In 2006, all samples were collected for Cell 4 monitoring horizons. Note: The 2004 Site Environmental Report, submitted in June 2005, recommended sampling continue in Cells 4 through 6 using a refined baseline constituent list based on initial baseline results. Refined baseline monitoring in Cells 4 through 6 was initiated in August 2005.

A.5.4.1 Refined Baseline Monitoring Results

Refined baseline constituents are those constituents that have been sampled at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also included in Table 2–3 are common ion constituents. A summary statistics table (Table A.5.4–2) and concentration plots (Figures A.5–4–11A through A.5.4–15B) are provided for the five refined baseline constituents of Cell 4. For Cell 4, these five constituents are: total uranium, boron, total organic carbon, total organic halogens, and sulfate. Note that with the addition of the 2006 data, total organic halogens concentrations are detected less than 25 percent of the time in the Great Miami Aquifer well 22205.

A.5.4.2 LCS Monitoring Results

Ohio Solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the

facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 4 LCS took place in May. Table A.5.4–3 summarizes the annual LCS sampling results for Cell 4, along with the data collected in previous years.

Of the non-refined baseline site specific constituents that have been sampled at least eight times in the Cell 4 LCS, 11 have been detected at least 25 percent of the time. Nine of the 11 constituents are common ion constituents (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, potassium, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 4 will be determined based upon results of the common ion study.

The remaining two constituents are total dissolved solids (TDS) and technetium-99. TDS will be assessed using the approach presented in Figures A.5–4A and A.5–4B, once final approval of the approach has been obtained from the EPA and OEPA. The assessment will be used to determine if TDS will be added to the site specific leak detection parameter list. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

Technetium-99 is a site specific leak detection parameter; however, it is not on the refined baseline list of Cell 4. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.4–3, technetium-99 has been detected in the Cell 4 LCS, but these detections occurred prior to the establishment of the refined baseline for Cell 4. Therefore, confirmatory sampling for technetium-99 in the Cell 4 LCS is not required.

A.5.4.3 LDS Monitoring Results

Each year the LDS of Cell 4 is sampled for site-specific parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. In 2006, annual sampling of the Cell-4 LDS took place in May.

Of the non-refined baseline constituents that have been sampled at least eight times, eight have been detected at least 25 percent of the time. All eight of the constituents are common ion constituents (alkalinity, calcium, chloride, iron, magnesium, manganese, potassium, and sodium).

Table A.5.4–1. Cell 4 – 2006 Monthly Liner Efficiencies

Month	Cell 4 Apparent Liner Efficiency (%)
January	83.61
February	91.90
March	93.10
April	93.02
May	93.64
June	93.95
July	NA[a]
August	NA[a]
September	96.21
October	97.41
November	96.53
December	92.82

[a]OSDF contingency plan executed due to inaccessibility of valve houses. Valve house road was closed to support site remediation activities. No data available.

Table A.5.4–2. Summary Statistics for Cell 4

Note: The data used in this table have been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]
Total Uranium (µg/L)	LCS	12341C	15	15	100%	90.9	Normal	Marg. Up.	Detected	
	LDS	12341D	15	15	100%	15.1	Lognormal	None	Not Detected	5.74 (Q4-02)
	HTW	12341	20	20	100%	6.13	Lognormal	Downward	Not Detected	
	GMA-U	22206	17	20	85%	1.27	Lognormal	None	Detected	0 U (Q4-03)
	GMA-D	22205	21	21	100%	3.51	Lognormal	None	Not Detected	
Boron (mg/L)	LCS	12341C	15	15	100%	0.81	Normal	Upward	Detected	
	LDS	12341D	16	16	100%	0.857	Lognormal	Downward	Detected	
	HTW	12341	16	18	89%	0.153	Normal	Downward	Detected	1.245 (Q1-02) 0.9085 (Q2-02)
	GMA-U	22206	19	21	90%	0.0398	Normal	Downward	Not Detected	
	GMA-D	22205	17	21	81%	0.0383	Undefined	None	Detected	
Total Organic Carbon (mg/L)	LCS	12341C	9	15	60%	2.9	Normal	None	Not Detected	
	LDS	12341D	13	16	81%	5.05	Normal	None	Detected	
	HTW	12341	14	19	74%	2.28	Lognormal	Marg. Down.	Detected	
	GMA-U	22206	10	20	50%	1.26	Lognormal	Marg. Down.	Not Detected	9.84 (Q2-03)
	GMA-D	22205	11	21	52%	1.40	Lognormal	None	Detected	
Total Organic Halogens (mg/L)	LCS	12341C	7	14	50%	0.017	Lognormal	Upward	Not Detected	0.00184 U (Q3-04)
	LDS	12341D	9	16	56%	0.0198	Normal	None	Marg. Detect	
	HTW	12341	14	20	70%	0.0113	Lognormal	None	Not Detected	
	GMA-U	22206	6	21	29%	0.0091	Lognormal	Marg. Down.	Not Detected	
	GMA-D	22205	3	21	14%	0.0086	Undefined	Marg. Down.	Detected	
Sulfate (mg/L)	LCS	12341C	15	15	100%	1870	Undefined	Upward	Detected	
	LDS	12341D	16	16	100%	1900	Lognormal	Downward	Detected	
	HTW	12341	15	15	100%	197	Normal	Downward	Detected	313 (Q3-05)
	GMA-U	22206	16	16	100%	317	Lognormal	Marg. Down.	Not Detected	
	GMA-D	22205	16	16	100%	352	Lognormal	None	Not Detected	

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.

Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

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Table A.5.4–3. Cell 4 Annual LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
Alkalinity as CaCO3 (mg/L)	10	10	100.0%	48	583	337	-	422 mg/L (3)	430 mg/L (3)	-	10 mg/L
Ammonia (mg/L)	5	1	20.0%	0.0328	-	-	-	4.2 mg/L (0)	4.34 mg/L (0)	220 mg/L (0)	0.1 mg/L
Barium (mg/L)	5	5	100.0%	0.0266	0.0580	0.0390	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Calcium (mg/L)	10	10	100.0%	52.9	1110	500	-	159 mg/L (9)	172 mg/L (9)	1800 mg/L (0)	5 mg/L
Chloride (mg/L)	10	9	90.0%	28	103	75	-	7.3 mg/L (9)	45 mg/L (7)	6300 mg/L (0)	5 mg/L
Chromium (mg/L)	5	1	20.0%	0.0137	-	-	0.022 mg/L (0)	0.021 mg/L (0)	0.0046 mg/L (1)	0.618 mg/L (0)	0.005 mg/L
Cobalt (mg/L)	5	4	80.0%	0.00046	0.0019	0.0012	0.17 mg/L (0)	0.0086 mg/L (0)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	5	3	60.0%	0.00076	0.0134	0.0079	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	6	85.7%	0.177	0.430	0.303	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	10	9	90.0%	0.543	4.18	2.35	-	5.72 mg/L (0)	6.35 mg/L (0)	21.3 mg/L (0)	0.1 mg/L
Magnesium (mg/L)	10	10	100.0%	15	732	322	-	38.5 mg/L (9)	50.7 mg/L (9)	690 mg/L (1)	5 mg/L
Manganese (mg/L)	10	10	100.0%	0.00563	2.14	0.28	0.9 mg/L (1)	0.9 mg/L (1)	0.21 mg/L (2)	35 mg/L (0)	0.09 mg/L
Nickel (mg/L)	5	5	100.0%	0.00112	0.0154	0.0088	0.1 mg/L (0)	0.0514 mg/L (0)	0.0072 mg/L (3)	0.981 mg/L (0)	0.02 mg/L
Nitrate/Nitrite (mg/L)	14	6	42.9%	0.351	3.62	1.74	11 mg/L[g] (0)	11 mg/L (0)	0.29 mg/L (6)	2670 mg/L (0)	1.1 mg/L
Potassium (mg/L)	10	10	100.0%	3.81	78.4	25.0	-	1.96 mg/L (9)	17.2 mg/L (7)	12400 mg/L (0)	5 mg/L
Selenium (mg/L)	5	3	60.0%	0.0025	0.0178	0.0077	0.05 mg/L (0)	0.00075 mg/L (3)	-	0.0494 mg/L (0)	0.005 mg/L
Silicon (mg/L)	7	7	100.0%	3.11	4.58	3.89	-	-	-	15 mg/L (0)	0.015 mg/L
Sodium (mg/L)	10	10	100.0%	22	117	53	-	47.1 mg/L (3)	50 mg/L (2)	1300 mg/L (0)	5 mg/L
Technetium-99 (pCi/L)	10	4	40.0%	8.16	37.8	17.9	94 pCi/L (0)	22 pCi/L (1)	30 pCi/L (1)	6130 pCi/L (0)	10 pCi/L
Total Dissolved Solids (mg/L)	9	9	1	351	4240	2130	-	-	-	-	10 mg/L

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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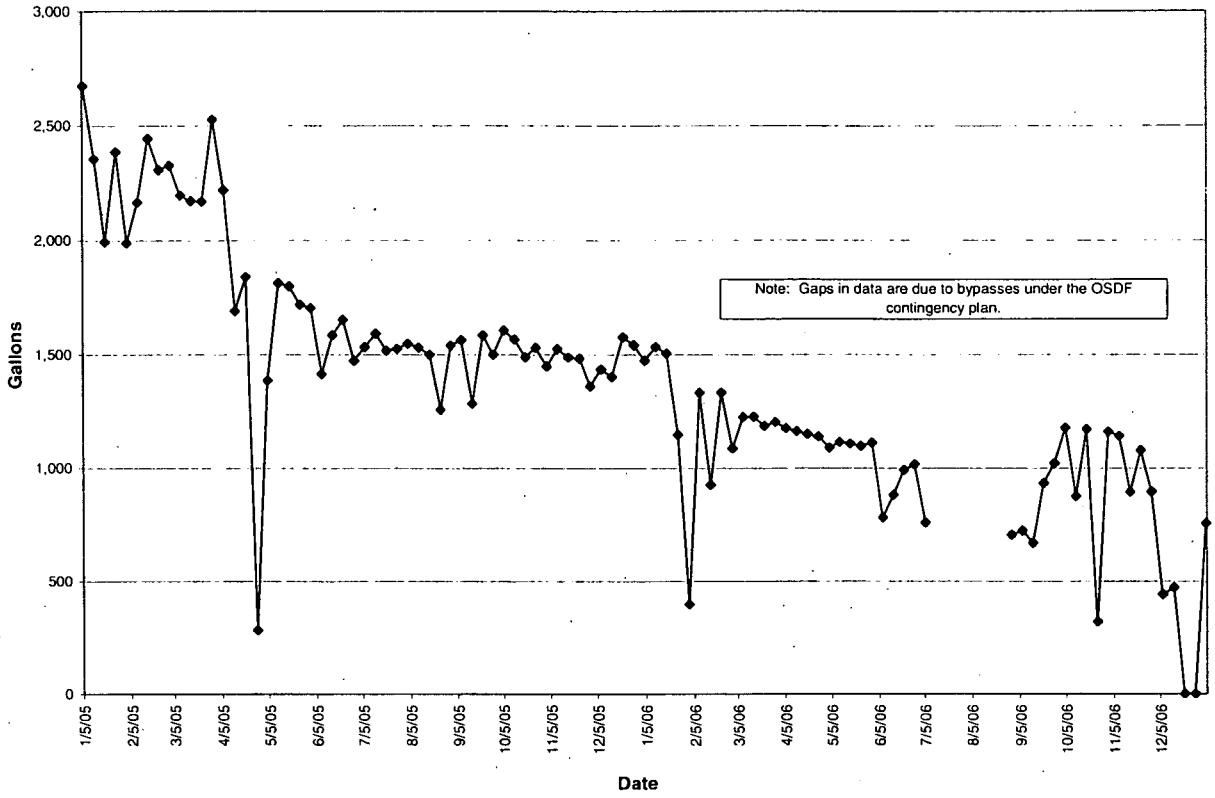


FIGURE A.5.4-1. Weekly Accumulation Volumes for Cell 4 LCS

FIGURE A.5.4-2. Monthly Accumulation Volumes for Cell 4 LCS

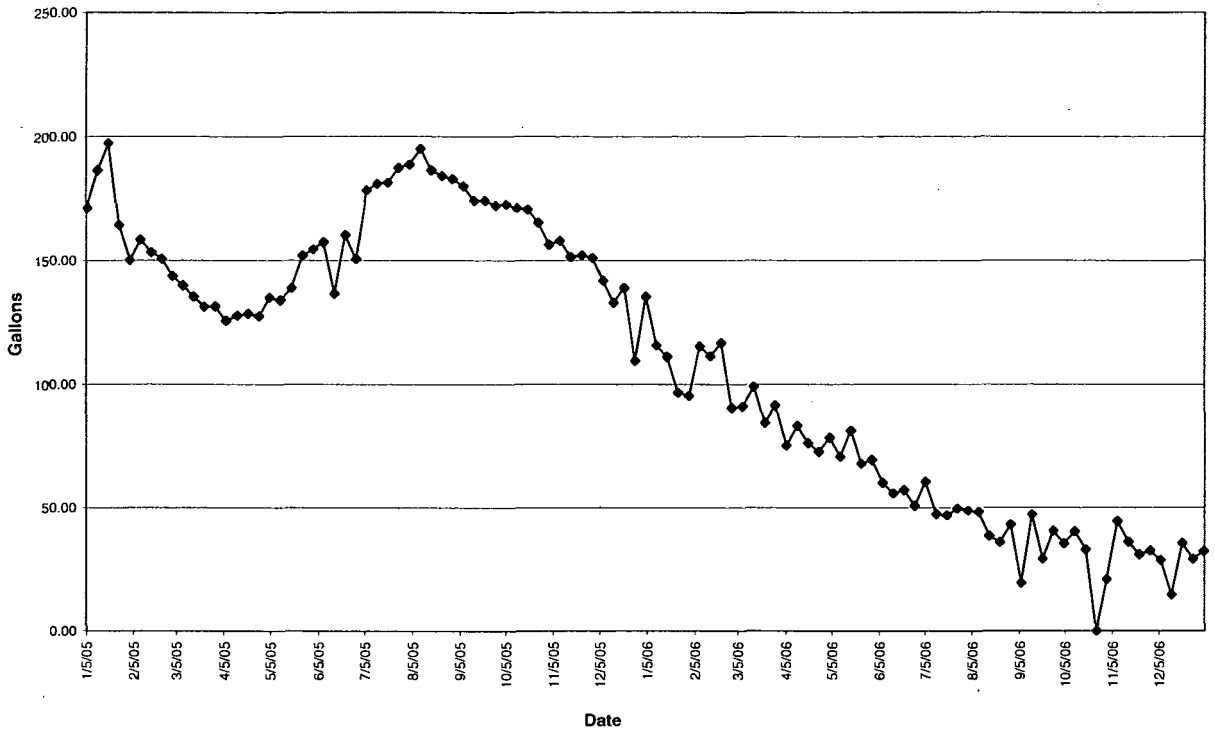


FIGURE A.5.4-3. Weekly Accumulation Volumes for Cell 4 LDS

FIGURE A.5.4-4. Monthly Accumulation Volumes for Cell 4 LDS

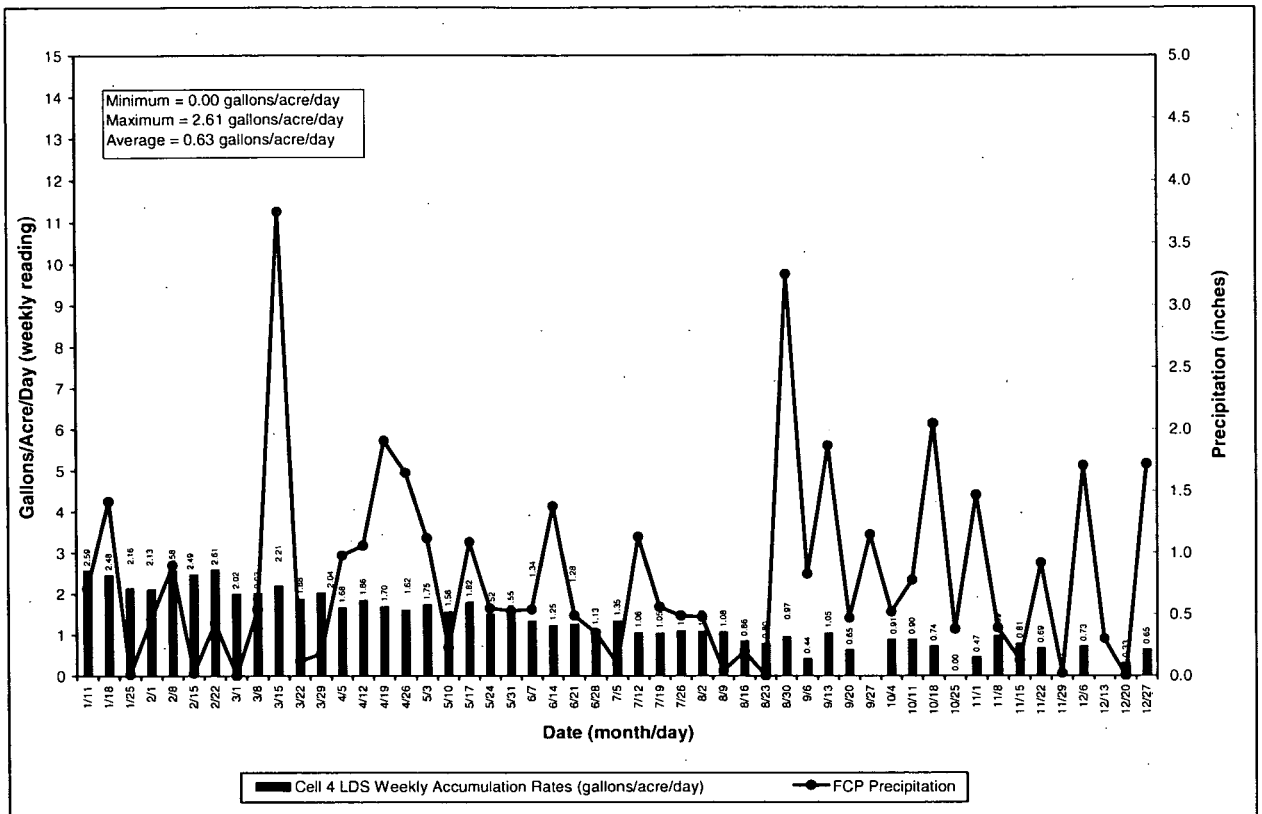


FIGURE A.5.4-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 4

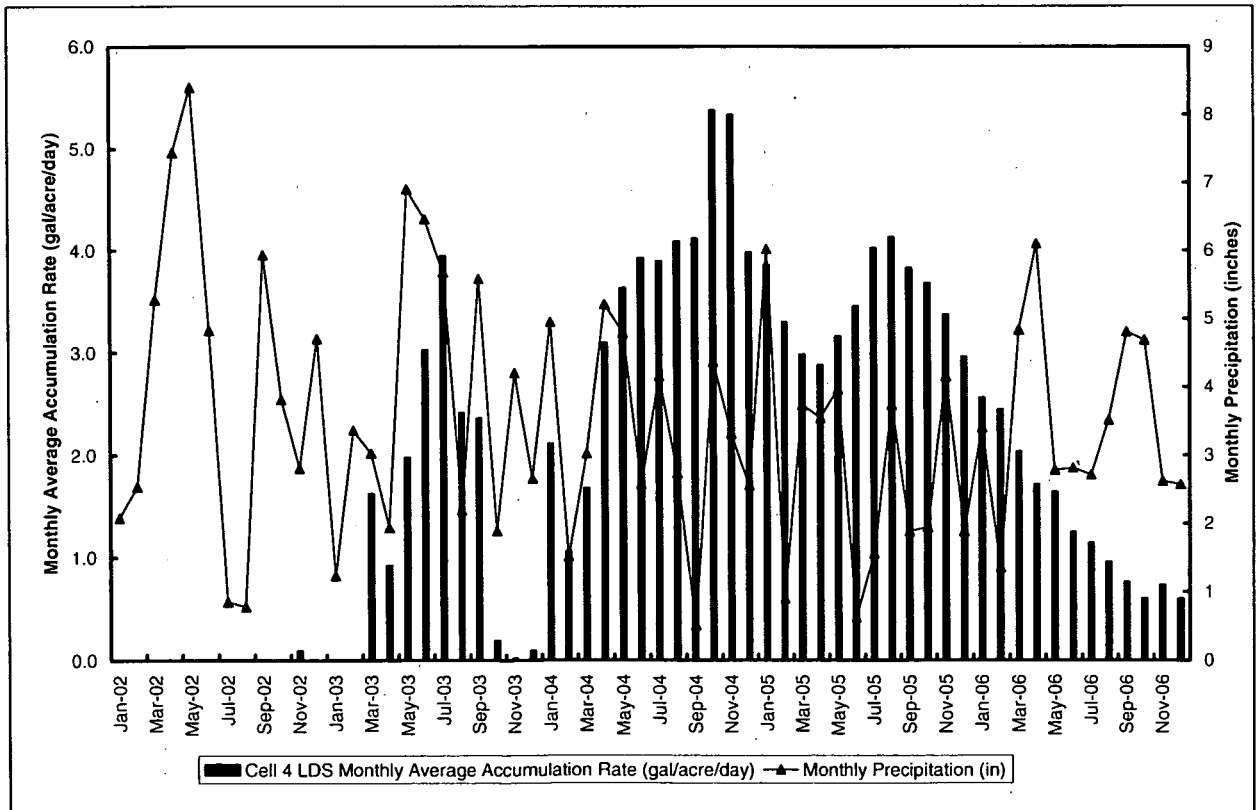


FIGURE A.5.4-6. OSDF Cell 4 LDS Monthly Average Accumulation Rates and Monthly Precipitation

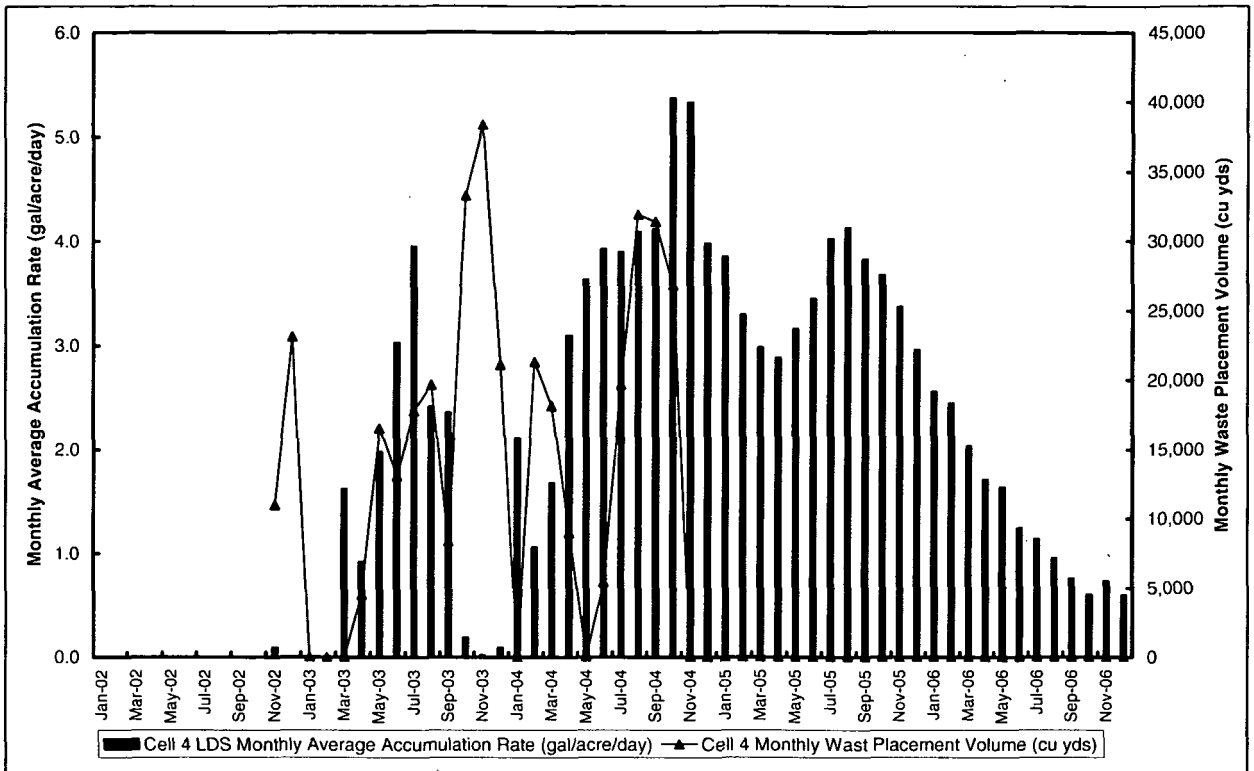
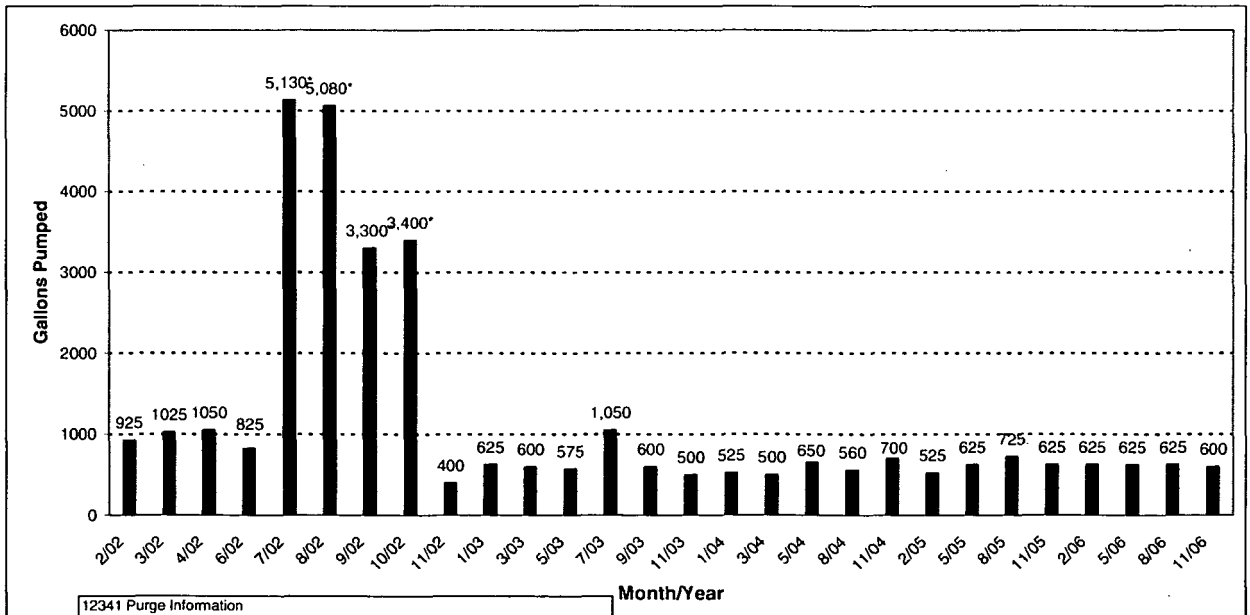


FIGURE A.5.4-7. OSDF Cell 4 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12341 Purge Information			
Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2002:	21115	n=9	2346
2003:	3950	n=6	658
2004:	2935	n=5	587
2005:	2500	n=4	625
2006:	2475	n=4	619
Overall:			1178

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

FIGURE A.5.4-8. OSDF Horizontal Till Well 12341 (Cell 4) Water Yield

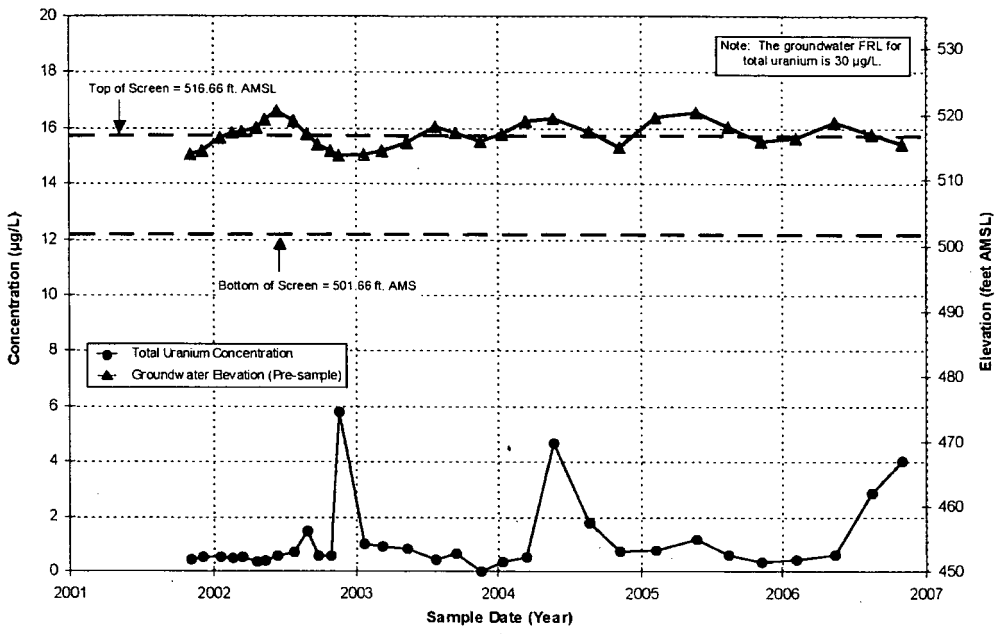


Figure A.5.4-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 4 Upgradient Monitoring Well 22206

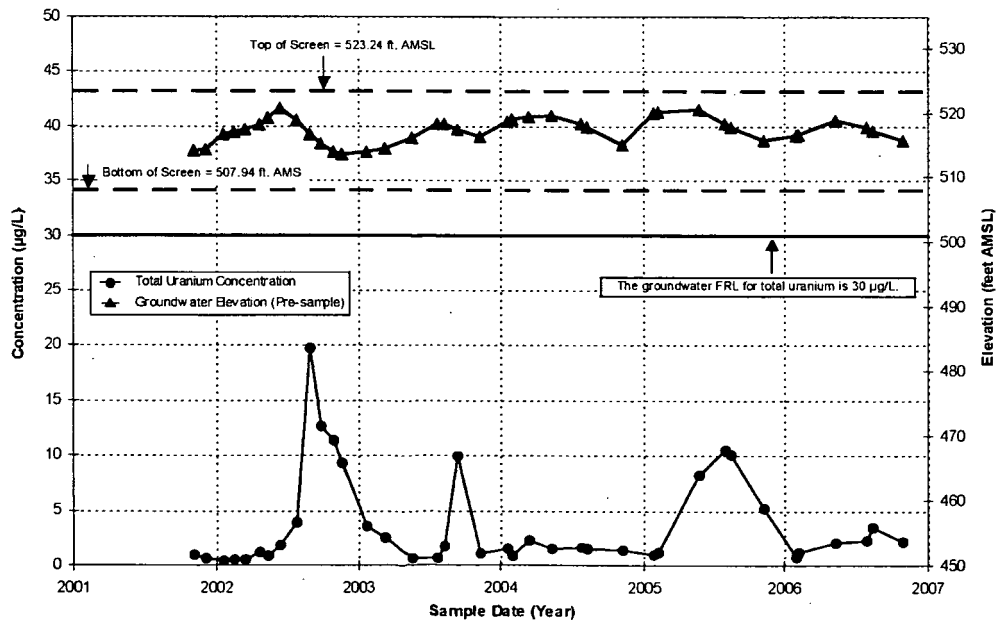


Figure A.5.4-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 4 Downgradient Monitoring Well 22205

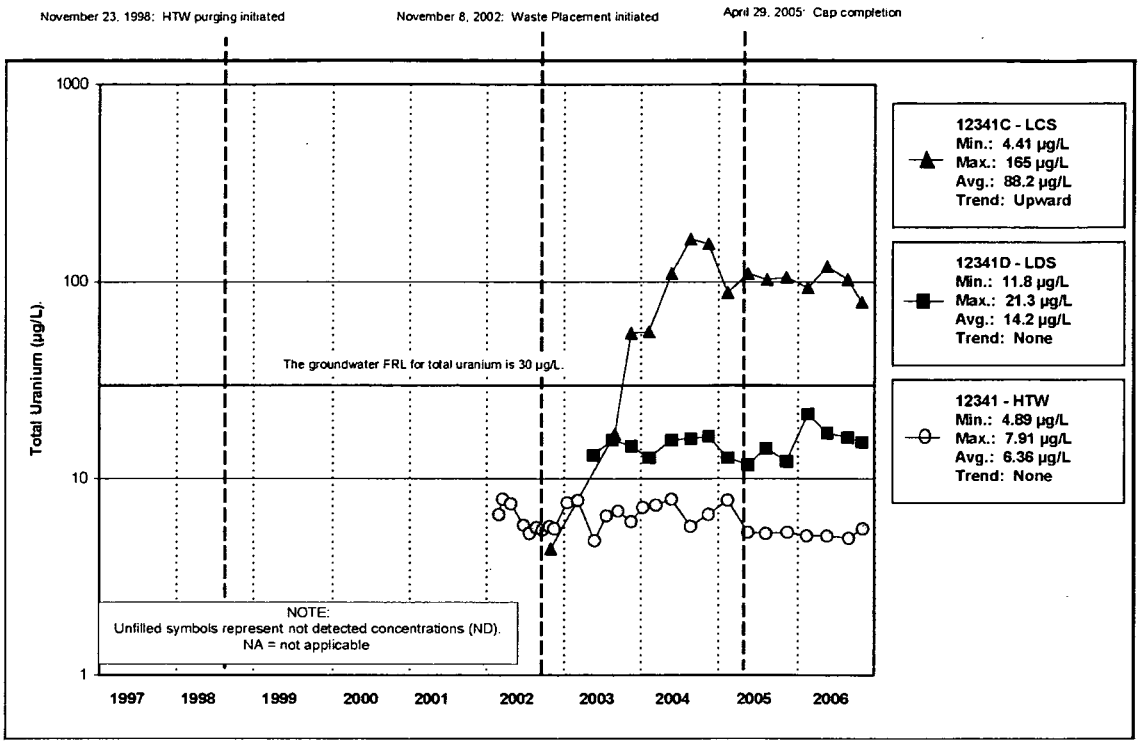


Figure A.5.4-11A. Cell 4 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

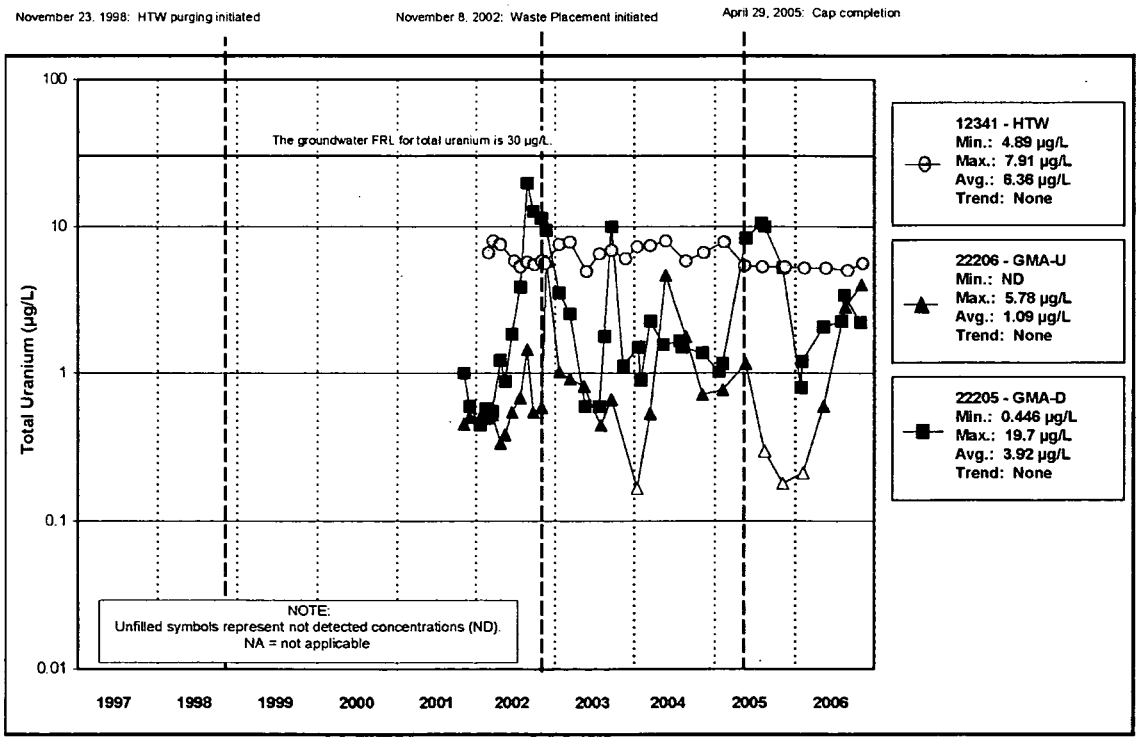


Figure A.5.4-11B. Cell 4 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

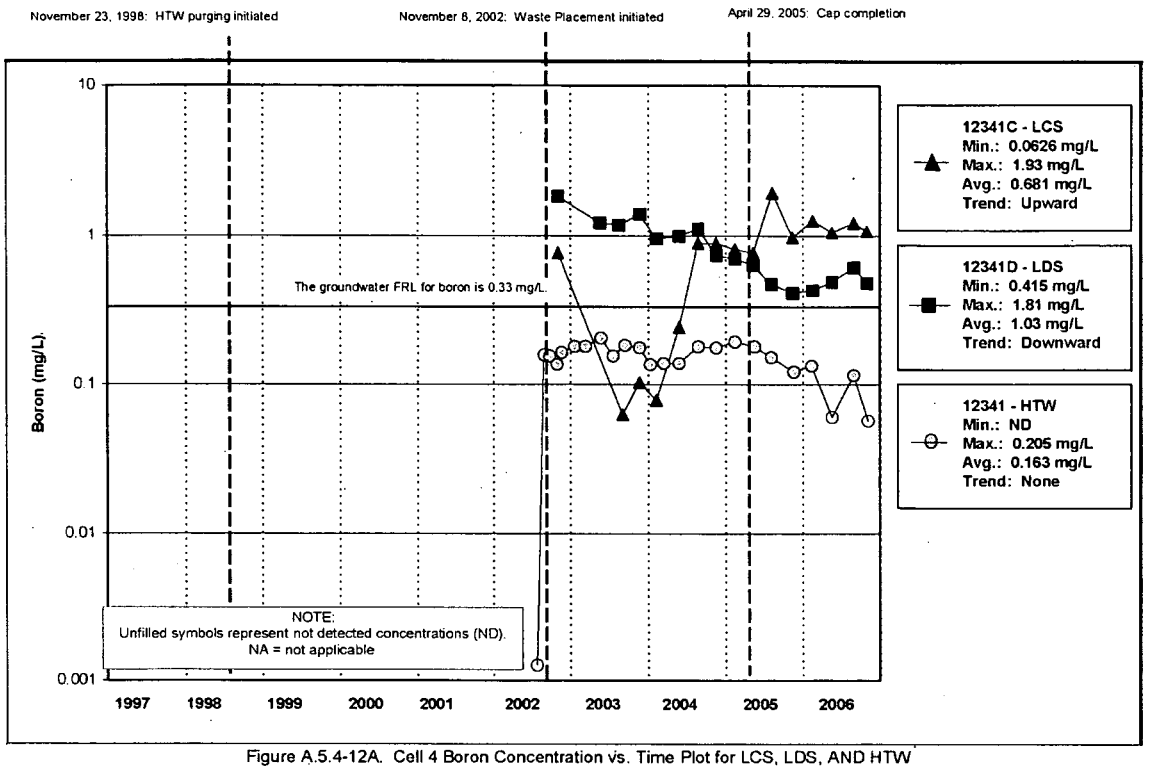


Figure A.5.4-12A. Cell 4 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

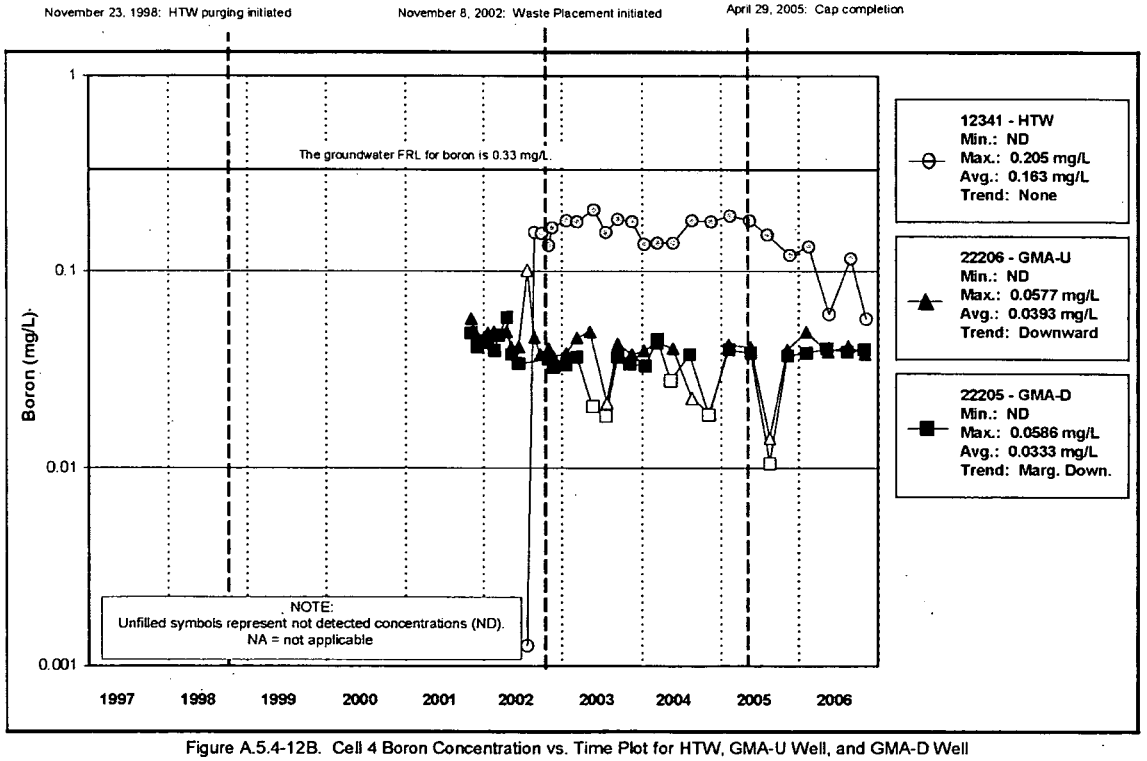


Figure A.5.4-12B. Cell 4 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

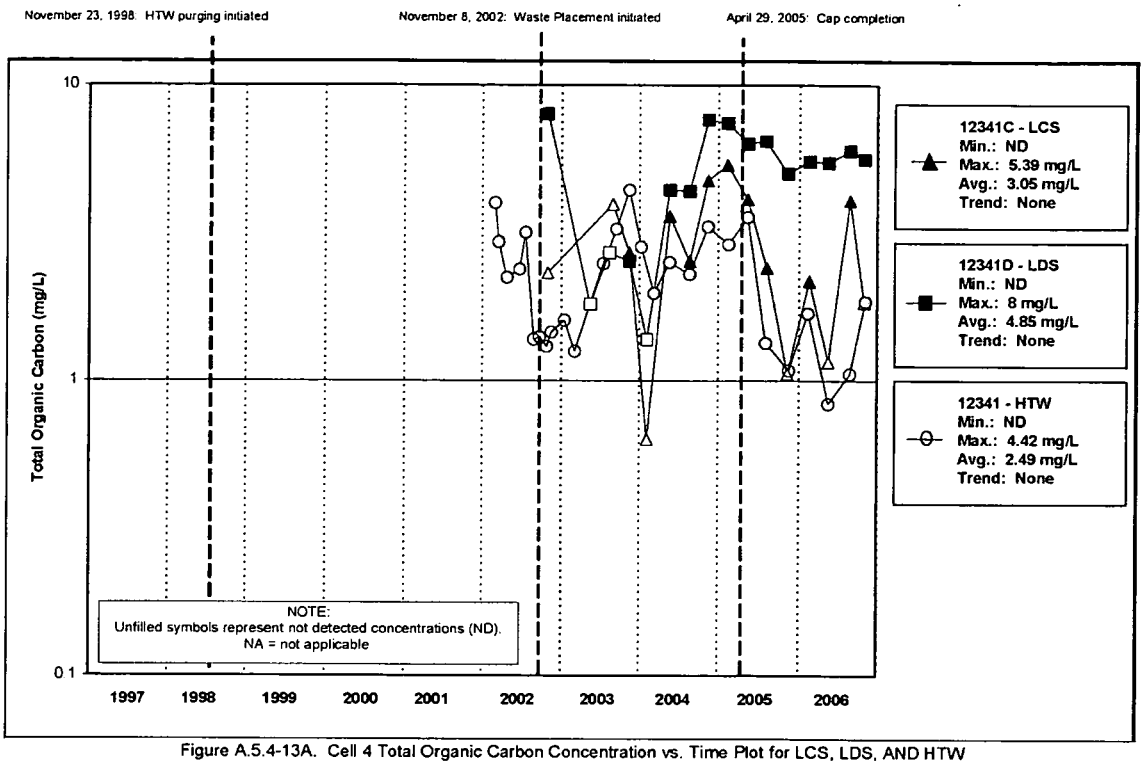


Figure A.5.4-13A. Cell 4 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

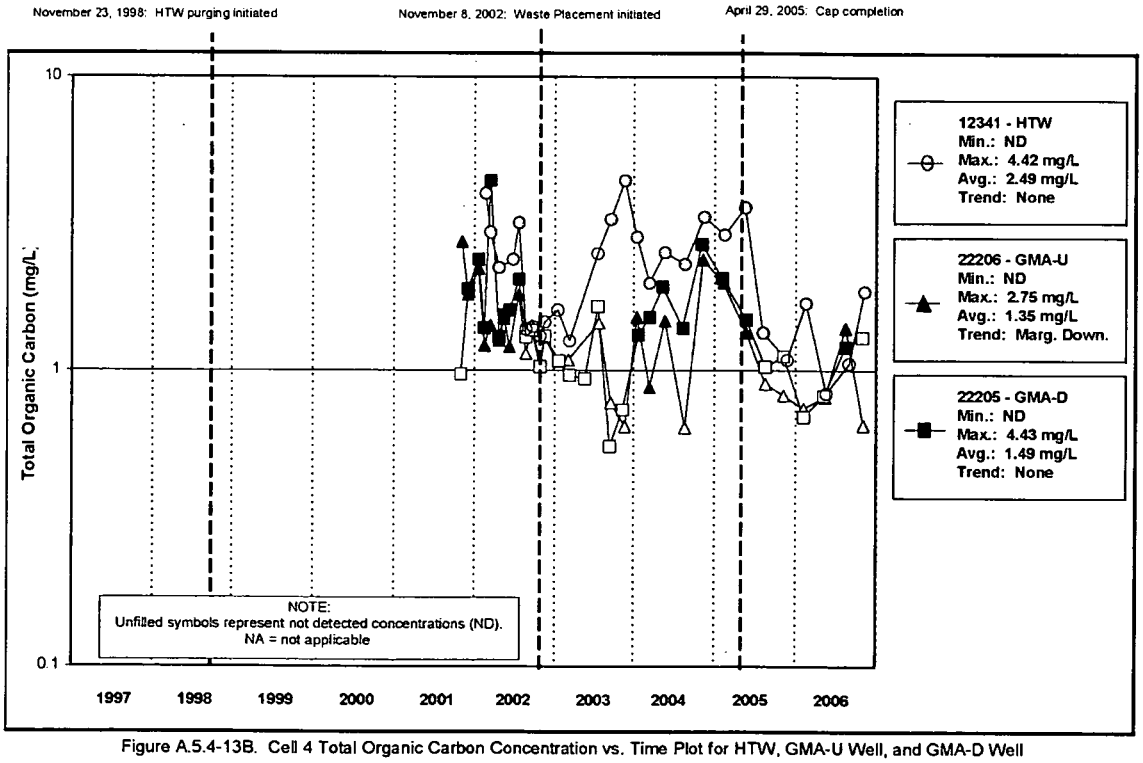


Figure A.5.4-13B. Cell 4 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

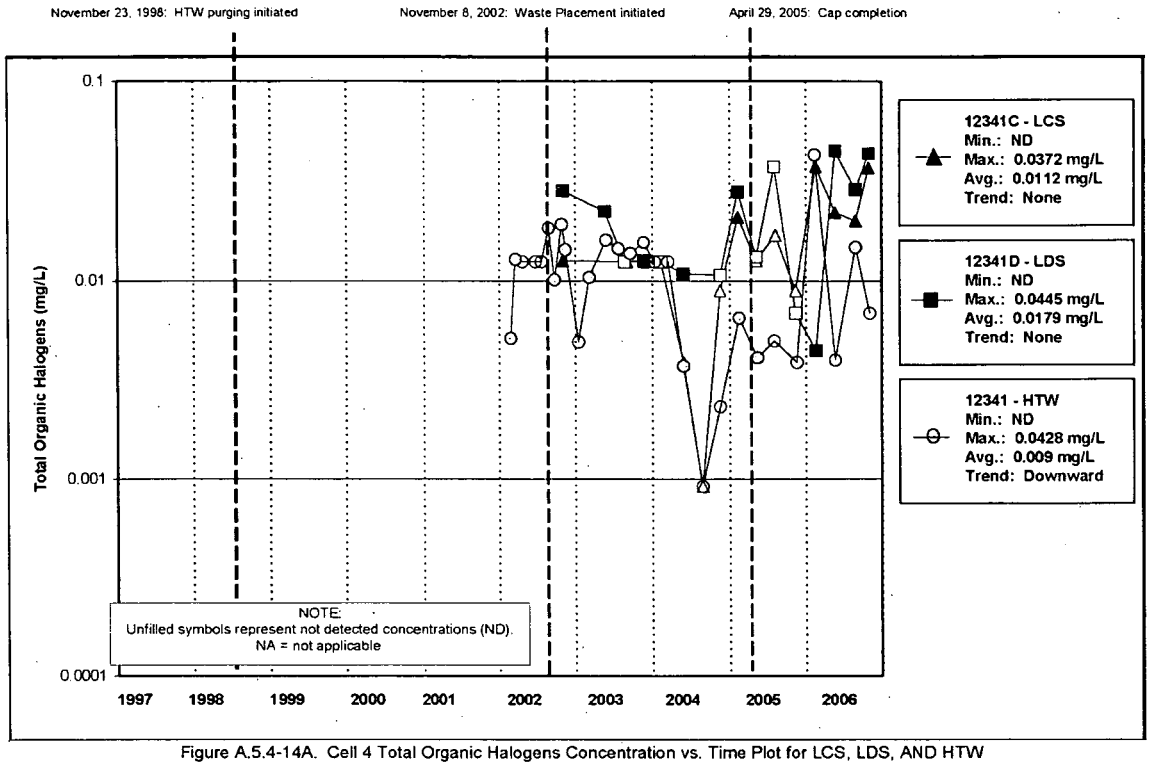


Figure A.5.4-14A. Cell 4 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

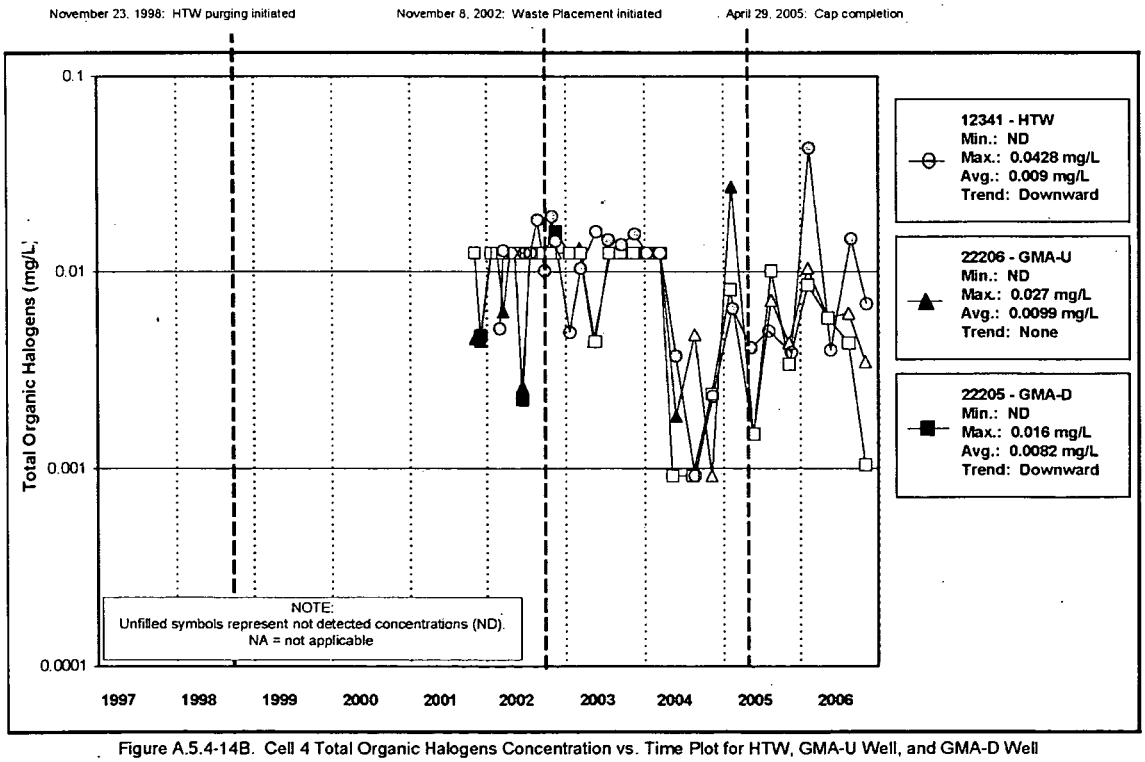


Figure A.5.4-14B. Cell 4 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

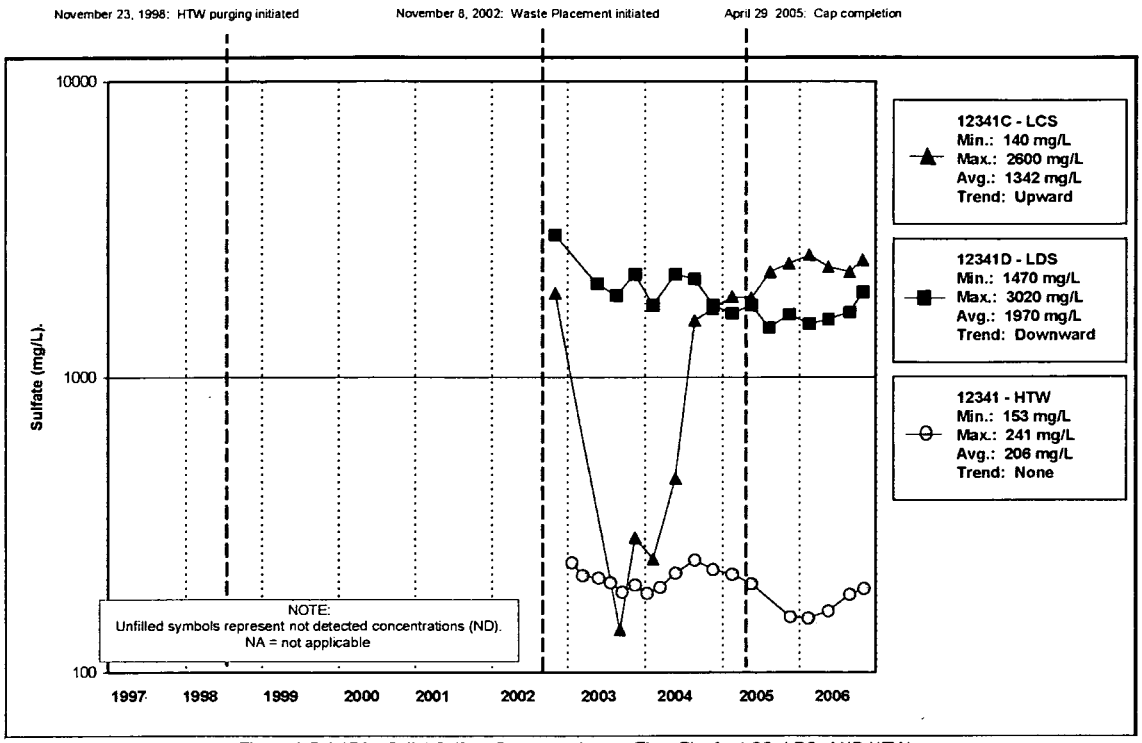


Figure A.5.4-15A. Cell 4 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

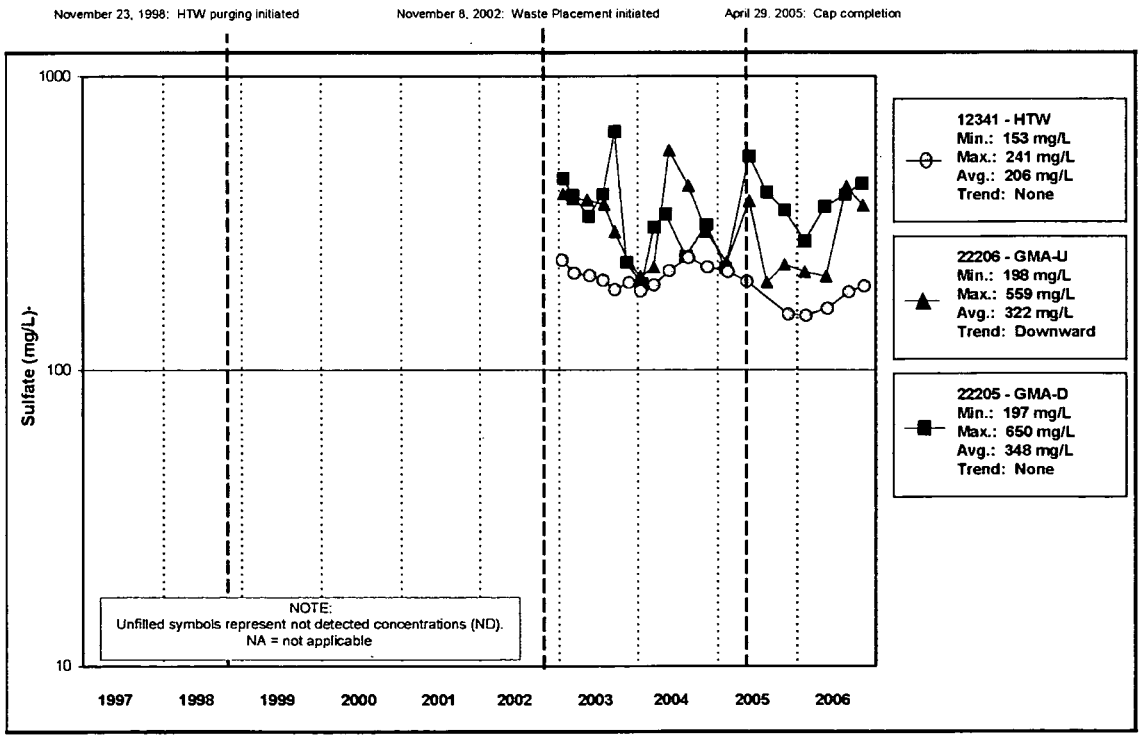


Figure A.5.4-15B. Cell 4 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

End of current text

Subattachment A.5.5

Cell 5

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.5–1 and A.5.5–2)
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.5–3 and A.5.5–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.5–5 and A.5.5–6)
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.5–7)
- Monthly liner efficiencies (refer to Table A.5.5–1)
- HTW Water Yield (refer to Figure A.5.5–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.5–9 and A.5.5–10)
- Summary statistics for refined baseline constituents (refer to Section A.5.5.1 and Table A.5.5–2)
- Concentration plots refined baseline constituents (refer to Section A.5.5.1 and Figures A.5.5–11A through A.5.5–15B)
- Annual LCS monitoring results (refer to Section A.5.5.2 and Table A.5.5–3)
- Annual LDS monitoring results (refer to Section A.5.5.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. In 2006, all samples were collected for Cell 5 monitoring horizons. Note: refined baseline monitoring in Cells 4 through 6 was initiated in August 2005.

A.5.5.1 Refined Baseline Monitoring Results

Refined baseline constituents are those constituents that have been sampled for at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also included in Table 2–3 are common ion constituents. A summary statistics table (refer to Table A.5.5–2) and concentration plots (Figures A.5.5–11A through A.5.5–15B) are provided for the five baseline constituents of Cell-5. For Cell 5, those five constituents are total uranium, boron, total organic carbon, total organic halogens, and sulfate. Note that with the addition of the 2006 data, total organic halogens concentrations are detected less than 25 percent of the time in the LCS and downgradient Great Miami Aquifer well 22208.

A.5.5.2 LCS Monitoring Results

Ohio solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of

the OSDF GWLMP. In 2006, annual sampling of the Cell 5 LCS took place in May. Table A.5.5–3 summarizes the annual LCS sampling results for Cell 5, along with data collected in previous years.

Of the non-refined site specific baseline constituents that have been sampled at least eight times, 11 have been detected at least 25 percent of the time. Nine of the 11 constituents are common ion constituents (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, potassium, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 5 will be determined based upon results of the common ion study.

The remaining two constituents are total dissolved solids (TDS) and technetium-99. TDS will be assessed using the approach presented in Figures A.5–4A and A.5–4B, once final approval of the approach has been obtained from the EPA and OEPA. The assessment will be used to determine if TDS will be added to the site specific leak detection parameter list. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

Technetium-99 is a site specific leak detection parameter; however, it is not on the refined baseline list for Cell 5. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.5–3, technetium-99 has been detected in the Cell 5 LCS, but these detections were prior to the establishment of the refined baseline for Cell 5. Therefore, confirmatory sampling for technetium-99 in the Cell 5 LCS is not required.

A.5.5.3 LDS Monitoring Results

Each year the LDS of Cell 5 is sampled for site specific baseline parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility.

In 2006, of the non-refined baseline constituents that have been sampled at least eight times, eight have been detected at least 25 percent of the time: (alkalinity, calcium, chloride, iron, magnesium, manganese, potassium and sodium). All eight of these constituents are common ion constituents.

Table A.5.5–1. Cell 5 – 2006 Monthly Liner Efficiencies

Month	Cell 5 Apparent Liner Efficiency (%)
January	NA[a]
February	NA[a]
March	NA[a]
April	79.56
May	75.92
June	NA[b]
July	NA[b]
August	NA[b]
September	76.28
October	77.25
November	79.76
December	73.77

[a]LCS flow not yet directed to tank. No data available.
[b]OSDF contingency plan executed due to inaccessibility of valve houses. Valve house road was closed to support site remediation activities. No data available.

Table A.5.5–2. Summary Statistics for Cell 5

Note: The data used in this table have been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]
Total Uranium (µg/L)	LCS	12342C	17	17	100%	125	Normal	Upward	Detected	
	LDS	12342D	15	15	100%	16.8	Normal	Upward	Detected	
	HTW	12342	20	20	100%	10.9	Lognormal	Downward	Detected	
	GMA-U	22207	14	20	70%	0.378	Normal	Downward	Marg. Detect	2.389 (Q3-02)
	GMA-D	22208	15	20	75%	0.347	Lognormal	None	Not Detected	0.012 U (Q2-05) 2.1 (Q2-04)[h]
Boron (mg/L)	LCS	12342C	15	17	88%	0.588	Normal	Upward	Detected	
	LDS	12342D	15	15	100%	0.539	Undefined	Downward	Detected	
	HTW	12342	19	20	95%	0.121	Lognormal	Downward	Detected	
	GMA-U	22207	18	21	86%	0.0357	Undefined	None	Detected	
	GMA-D	22208	16	21	76%	0.0268	Normal	None	Detected	
Total Organic Carbon (mg/L)	LCS	12342C	8	16	50%	1.84	Normal	Upward	Not Detected	
	LDS	12342D	12	15	80%	6.27	Normal	Upward	Detected	
	HTW	12342	15	19	79%	2.79	Lognormal	None	Marg. Detect	
	GMA-U	22207	11	21	52%	1.37	Lognormal	Downward	Marg. Detect	
	GMA-D	22208	11	20	55%	1.26	Lognormal	Marg. Down.	Detected	8.93 (Q4-01)
Total Organic Halogens (mg/L)	LCS	12342C	3	17	18%	0.0097	Undefined	None	Not Detected	
	LDS	12342D	6	15	40%	0.0307	Lognormal	Upward	Not Detected	
	HTW	12342	11	20	55%	0.0083	Normal	None	Not Detected	
	GMA-U	22207	6	21	29%	0.0094	Undefined	Downward	Detected	
	GMA-D	22208	4	21	19%	0.0054	Undefined	Downward	Detected	
Sulfate (mg/L)	LCS	12342C	17	17	100%	1140	Undefined	Upward	Detected	
	LDS	12342D	15	15	100%	1570	Lognormal	Downward	Detected	
	HTW	12342	16	16	100%	142	Undefined	Downward	Detected	
	GMA-U	22207	15	15	100%	300	Lognormal	None	Detected	770 (Q2-05)[i]
	GMA-D	22208	16	16	100%	442	Undefined	Marg. Up.	Marg. Detect	

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.

Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

[h]This result is an outlier. It is a higher concentration duplicate result, where the other duplicate result would not be an outlier. This outlier has been replace with the lower concetration duplicate result.

[i]This outlier is a "marginal outlier" rejected based on statistical judgement.

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Table A.5.5–3. Cell 5 Annual LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
4-Methyl-2-pentanone (ug/L)	5	1	20.0%	0.46	-	-	-	-	-	-	5 ug/L
Alkalinity as CaCO3 (mg/L)	**10**	**10**	**100.0%**	**58**	**563**	**400**	-	**422 mg/L (6)**	**430 mg/L (5)**	-	**10 mg/L**
Barium (mg/L)	5	5	100.0%	0.0226	0.0707	0.0448	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Beryllium (mg/L)	5	1	20.0%	0.000038	-	-	0.004 mg/L (0)	-	-	0.0343 mg/L (0)	0.001 mg/L
Calcium (mg/L)	**10**	**10**	**100.0%**	**163**	**990**	**497**	-	**159 mg/L (10)**	**172 mg/L (9)**	**1800 mg/L (0)**	**5 mg/L**
Carbon disulfide (ug/L)	5	1	20.0%	0.33	-	-	5.5 ug/L (0)	-	-	-	5 ug/L
Chloride (mg/L)	**10**	**10**	**100.0%**	**16.9**	**88.9**	**62.0**	-	**7.3 mg/L (10)**	**45 mg/L (7)**	**6300 mg/L (0)**	**5 mg/L**
Chromium (mg/L)	5	1	20.0%	0.0013	-	-	0.022 mg/L (0)	0.021 mg/L (0)	0.0046 mg/L (0)	0.818 mg/L (0)	0.005 mg/L
Cobalt (mg/L)	5	4	80.0%	0.00035	0.0028	0.0013	0.17 mg/L (0)	0.0086 mg/L (0)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	**5**	**3**	**60.0%**	**0.0097**	**0.0862**	**0.0357**	**1.3 mg/L (0)**	**0.035 mg/L (1)**	**0.029 mg/L (1)**	**0.298 mg/L (0)**	**0.008 mg/L**
Fluoride (mg/L)	7	6	85.7%	0.204	0.333	0.266	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	10	10	100.0%	0.652	4.61	2.75	-	5.72 mg/L (0)	6.35 mg/L (0)	21.3 mg/L (0)	0.1 mg/L
Magnesium (mg/L)	**10**	**10**	**100.0%**	**57.7**	**913**	**378**	-	**38.5 mg/L (10)**	**50.7 mg/L (10)**	**690 mg/L (1)**	**5 mg/L**
Manganese (mg/L)	**10**	**7**	**70.0%**	**0.0061**	**2.51**	**0.84**	**0.9 mg/L (3)**	**0.9 mg/L (3)**	**0.21 mg/L (3)**	**35 mg/L (0)**	**0.09 mg/L**
Nickel (mg/L)	**5**	**5**	**100.0%**	**0.00403**	**0.0377**	**0.0138**	**0.1 mg/L (0)**	**0.0514 mg/L (0)**	**0.0072 mg/L (2)**	**0.981 mg/L (0)**	**0.02 mg/L**
Nitrate/Nitrite (mg/L)	**16**	**9**	**56.3%**	**0.00366**	**4.18**	**1.51**	**11[g] mg/L (0)**	**11 mg/L (0)**	**0.29 mg/L (8)**	**2670 mg/L (0)**	**1.1 mg/L**
Potassium (mg/L)	**10**	**10**	**100.0%**	**6.22**	**65.5**	**25.0**	-	**1.96 mg/L (10)**	**17.2 mg/L (8)**	**12400 mg/L (0)**	**5 mg/L**
Selenium (mg/L)	**5**	**2**	**40.0%**	**0.0027**	**0.0194**	-	**0.05 mg/L (0)**	**0.00075 mg/L (2)**	-	**0.0494 mg/L (0)**	**0.005 mg/L**
Silicon (mg/L)	7	7	100.0%	2.92	3.84	3.28	-	-	-	15 mg/L (0)	0.015 mg/L
Sodium (mg/L)	**10**	**9**	**90.0%**	**16.4**	**108**	**61**	-	**47.1 mg/L (7)**	**50 mg/L (7)**	**1300 mg/L (0)**	**5 mg/L**
Technetium-99 (pCi/L)	12	7	58.3%	7.77	19	11.5	94 pCi/L (0)	22 pCi/L (0)	30 pCi/L (0)	6130 pCi/L (0)	10 pCi/L
Toluene (ug/L)	5	1	20.0%	0.416	-	-	-	-	-	-	1 ug/L
Total Dissolved Solids (mg/L)	11	11	100.0%	436	4640	1890	-	-	-	-	10 mg/L
Vanadium (mg/L)	5	2	40.0%	0.00089	0.00157	-	0.038 mg/L (0)	0.012 mg/L (0)	0.005 mg/L (0)	0.299 mg/L (0)	0.02 mg/L

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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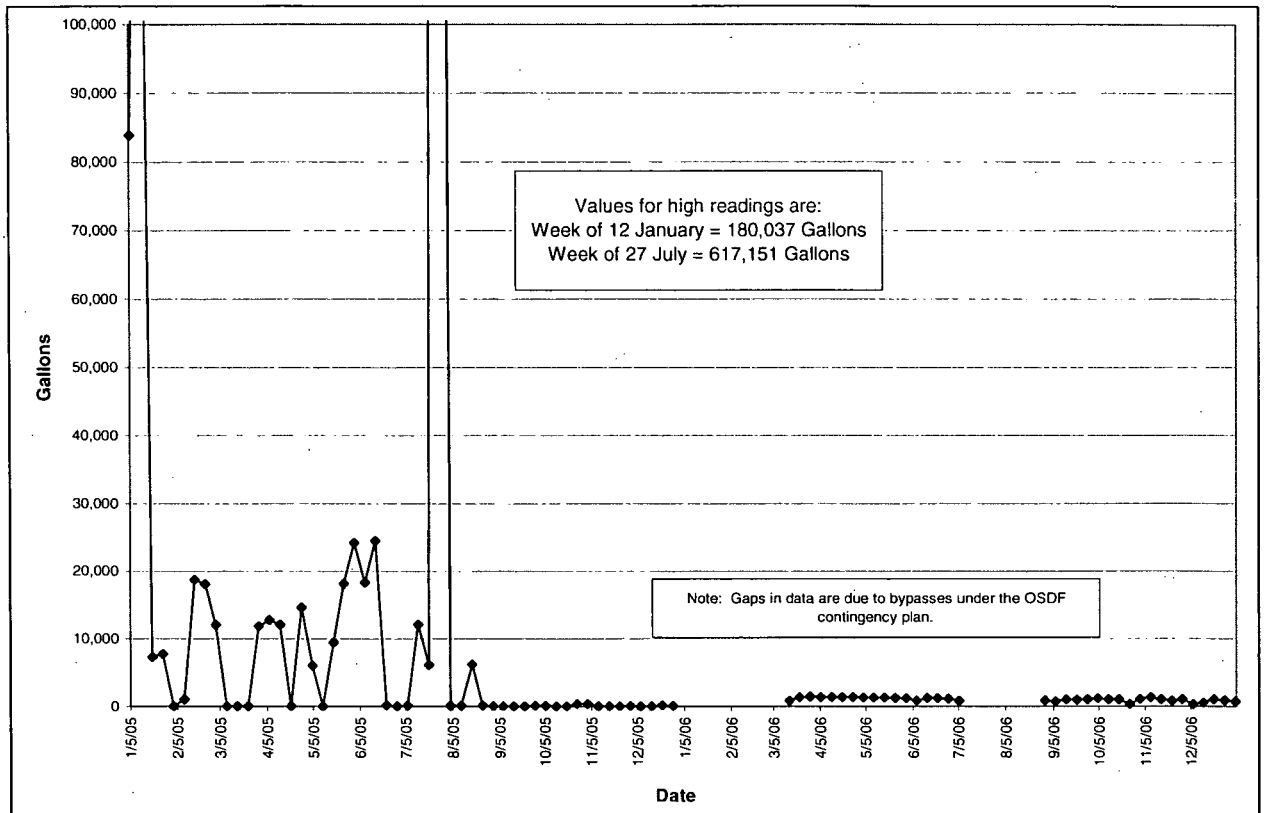


FIGURE A.5.5-1. Weekly Accumulation Volumes for Cell 5 LCS

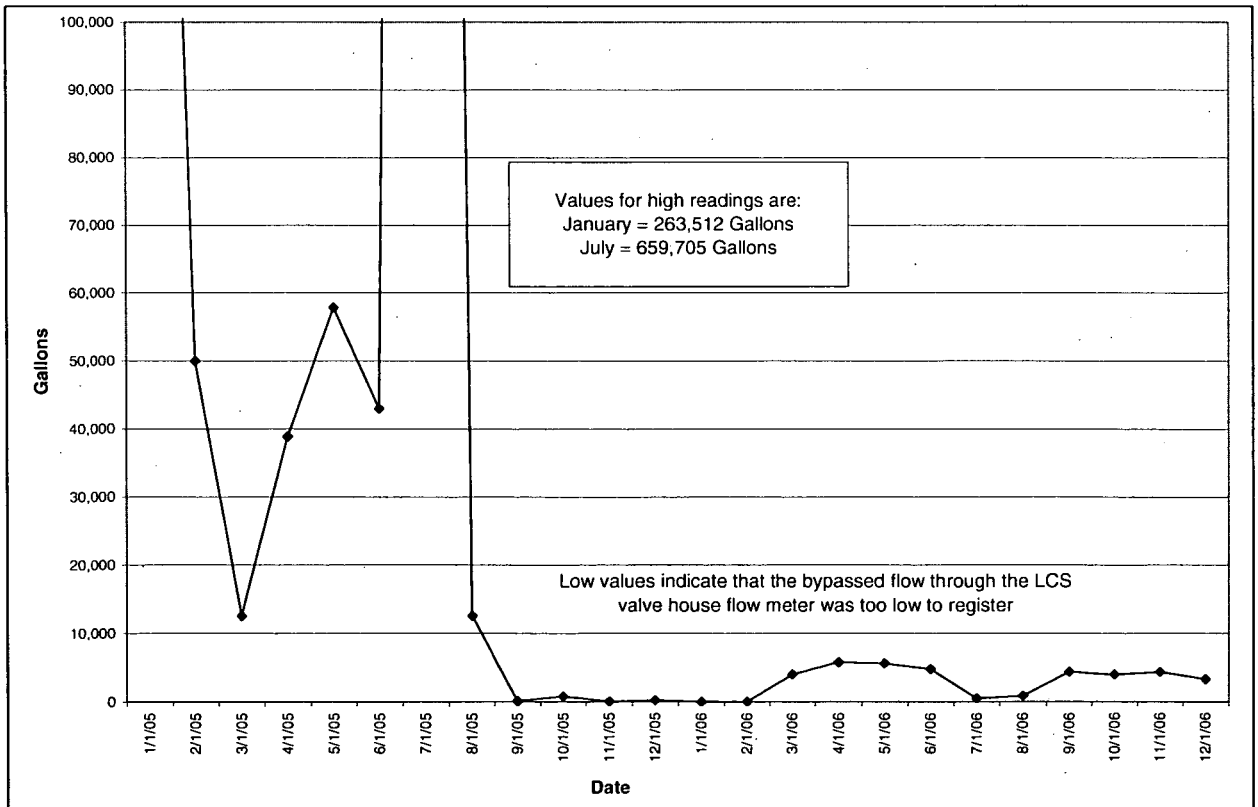


FIGURE A.5.5-2. Monthly Accumulation Volumes for Cell 5 LCS

FIGURE A.5.5-3. Weekly Accumulation Volumes for Cell 5 LDS

FIGURE A.5.5-4. Monthly Accumulation Volumes for Cell 5 LDS

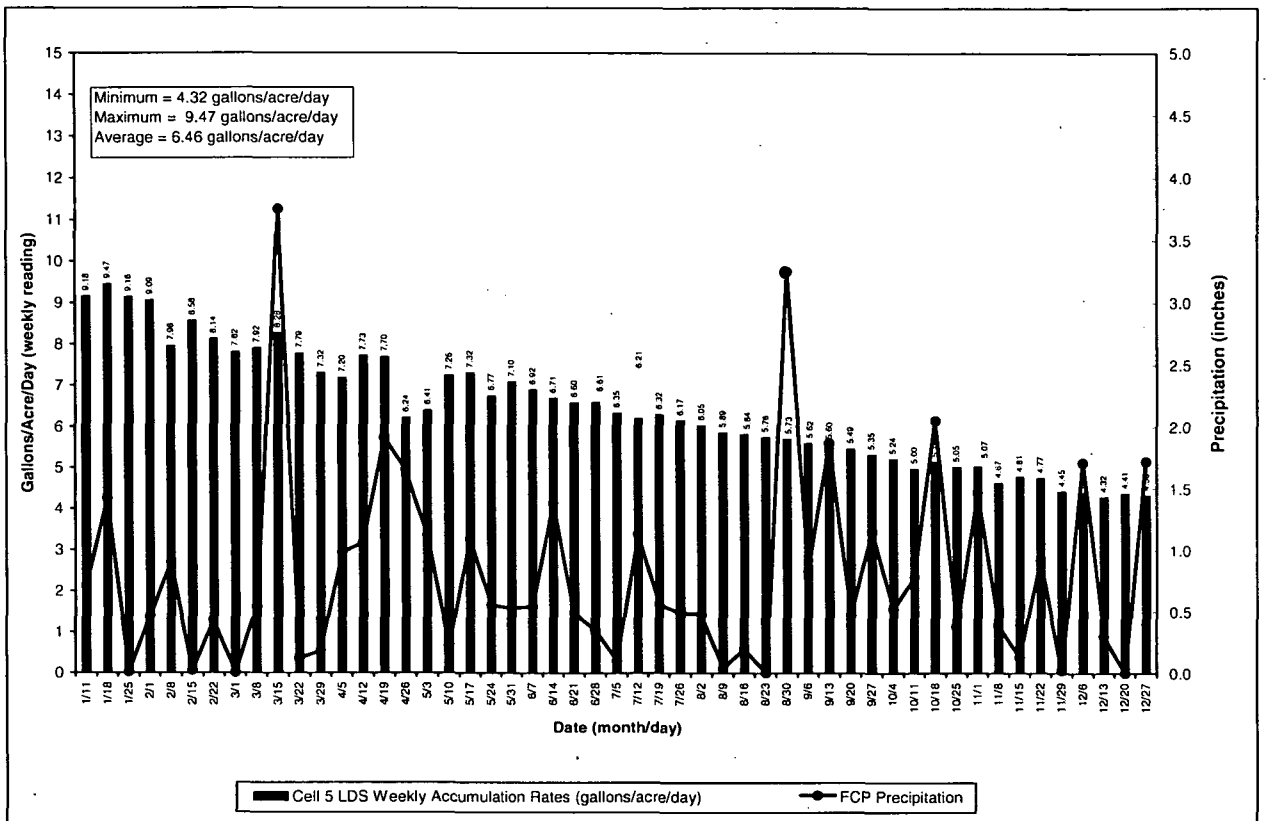


FIGURE A.5.5-5. 2006 OSDF LDSWeekly Accumulation Rates and Precipitation for Cell 5

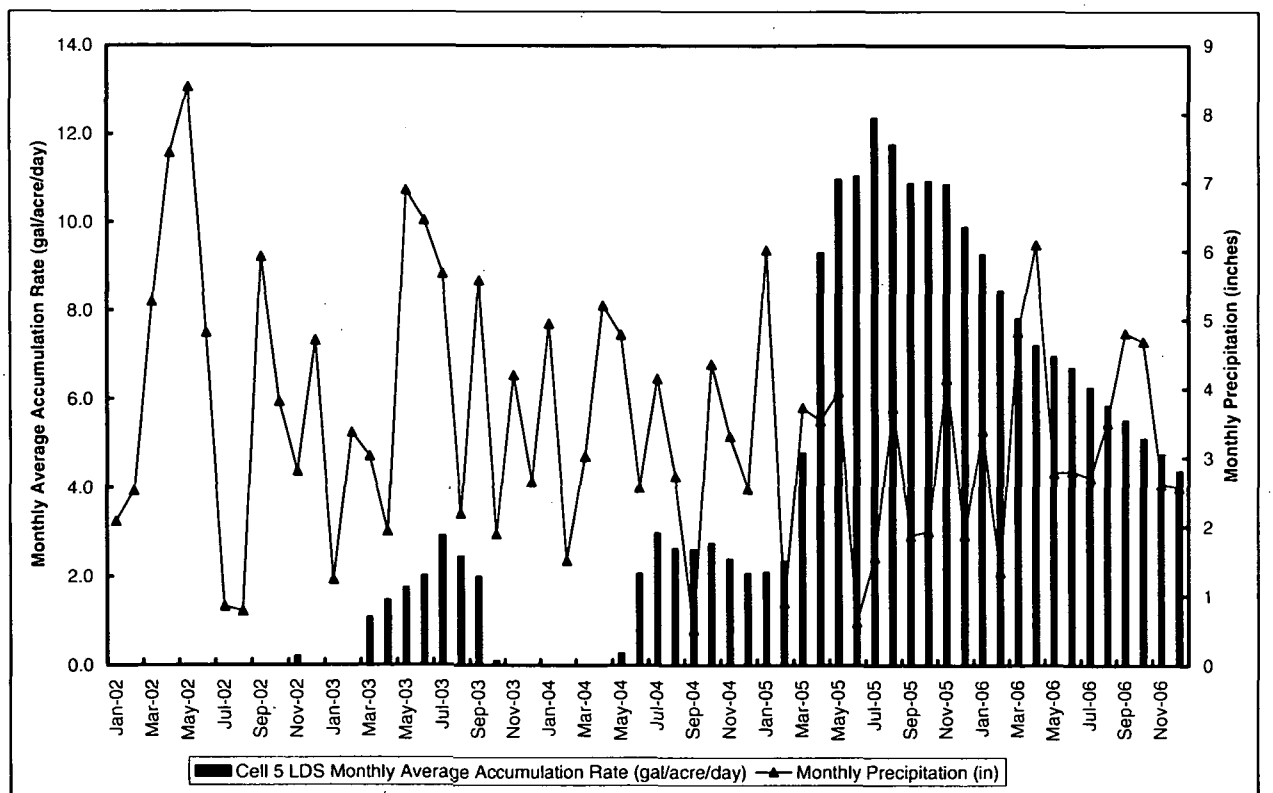


FIGURE A.5.5-6. OSDF Cell 5 LDS Monthly Average Accumulation Rates and Monthly Precipitation

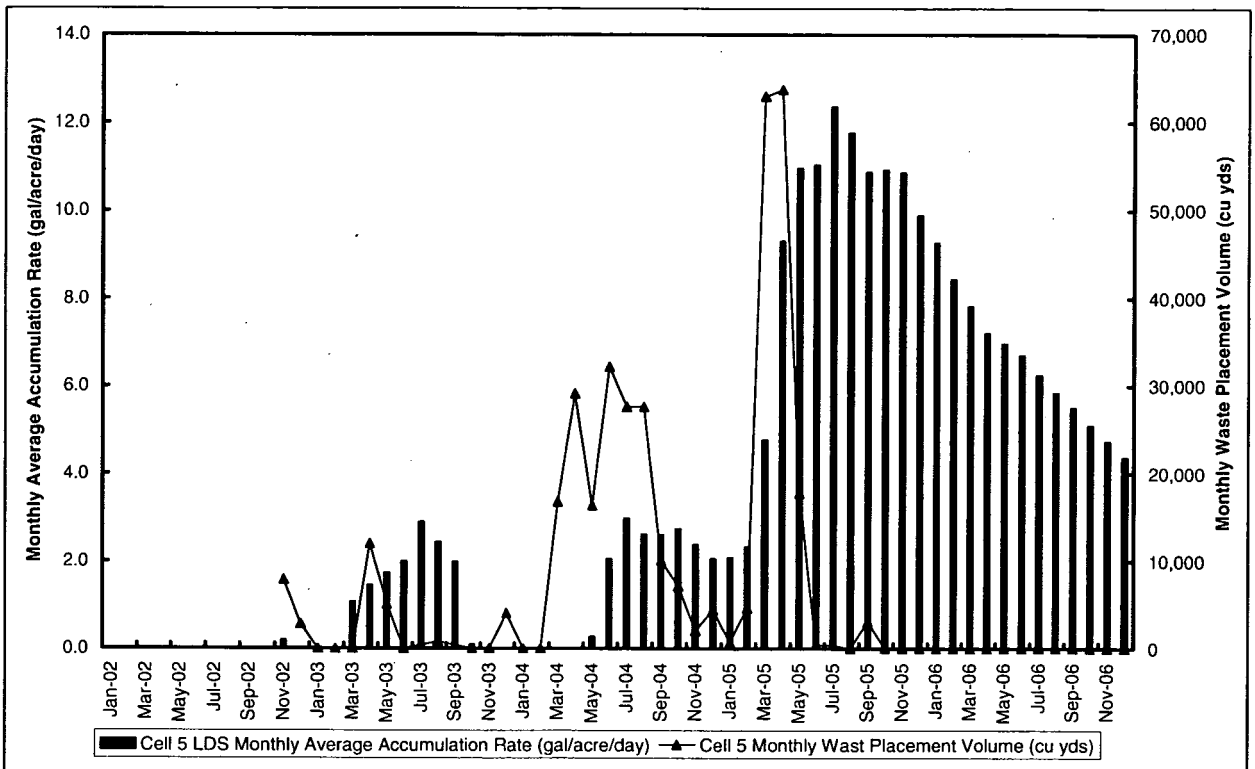
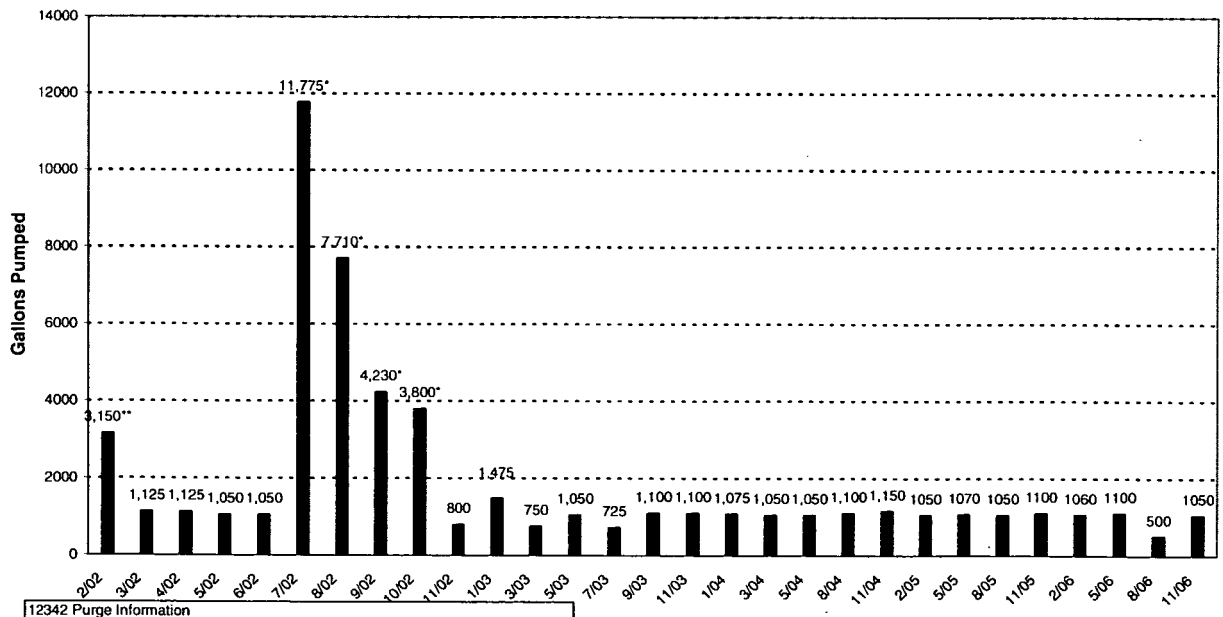


FIGURE A.5.5-7. OSDF Cell 5 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12342 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2002:	35815	n=10	3582
2003:	6200	n= 6	1033
2004:	5425	n= 5	1085
2005:	4270	n=4	1068
2006:	3710	n=4	928
Overall:			1911

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

**Excess water was pumped from this well in February 2002 for well development.

FIGURE A.5.5-8. OSDF Horizontal Till Well 12342 (Cell 5) Water Yield

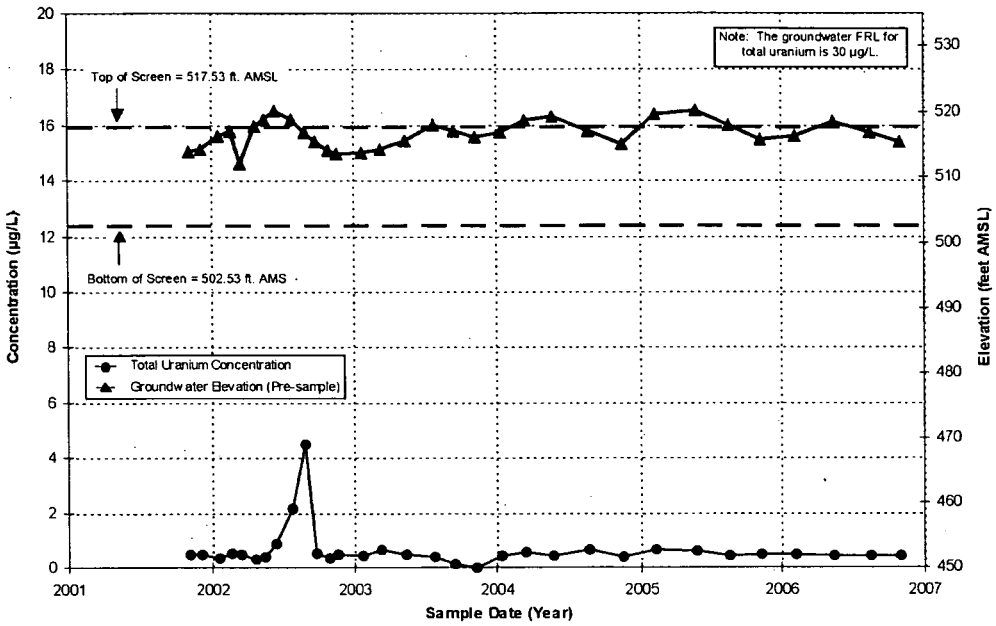


Figure A.5.5-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 5 Upgradient Monitoring Well 22207

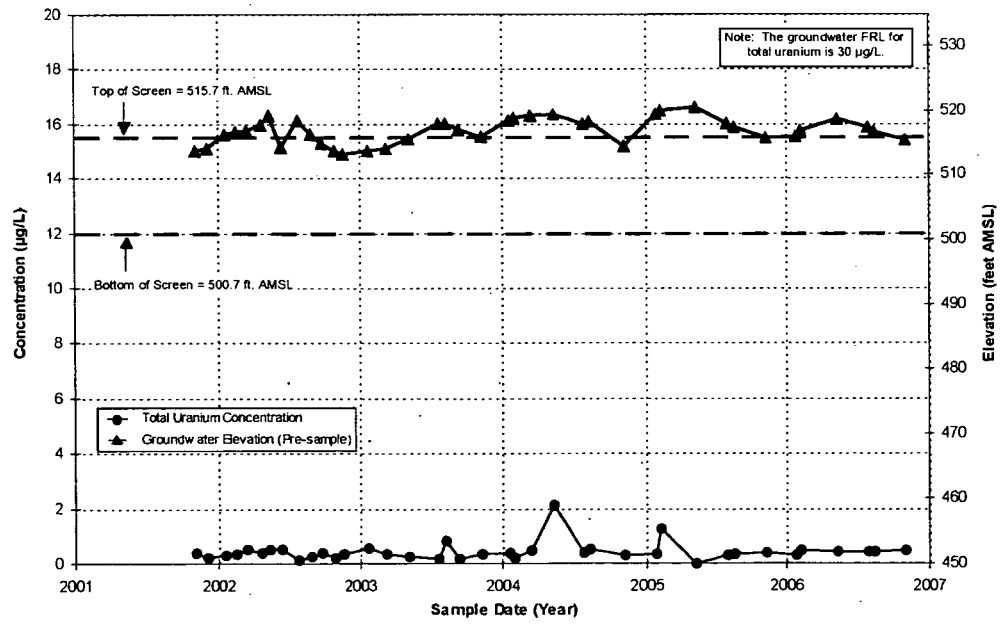


Figure A.5.5-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 5 Downgradient Monitoring Well 22208

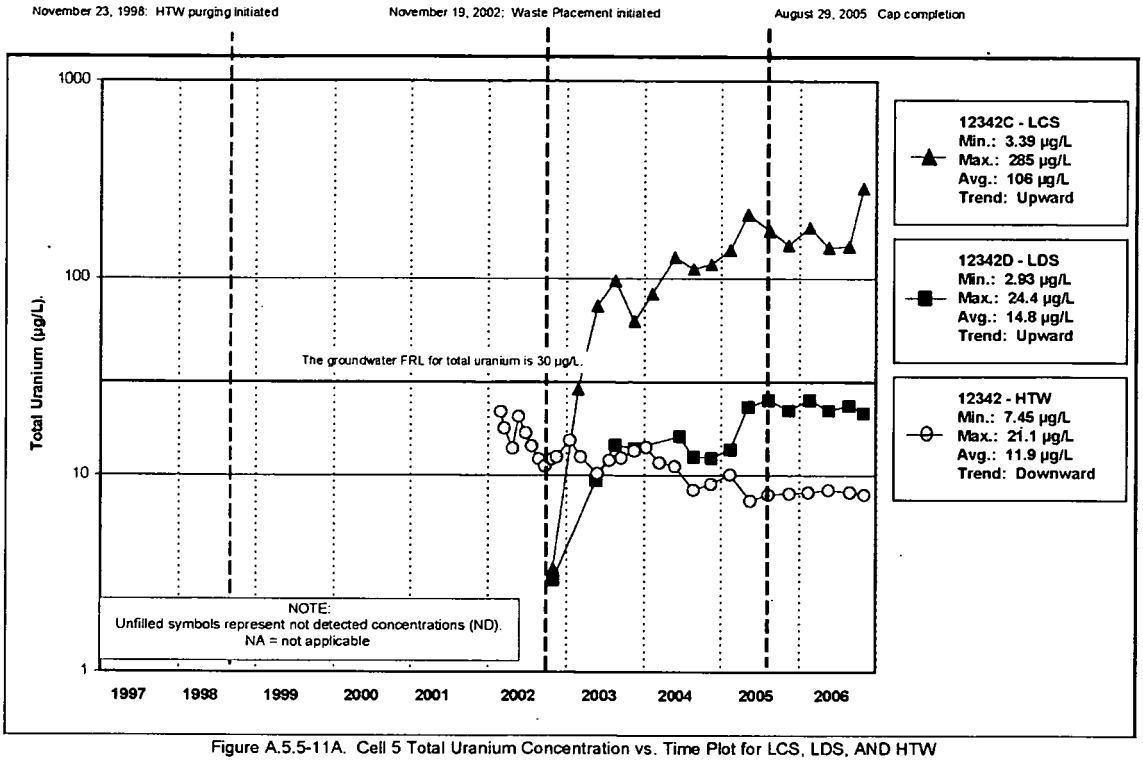


Figure A.5.5-11A. Cell 5 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

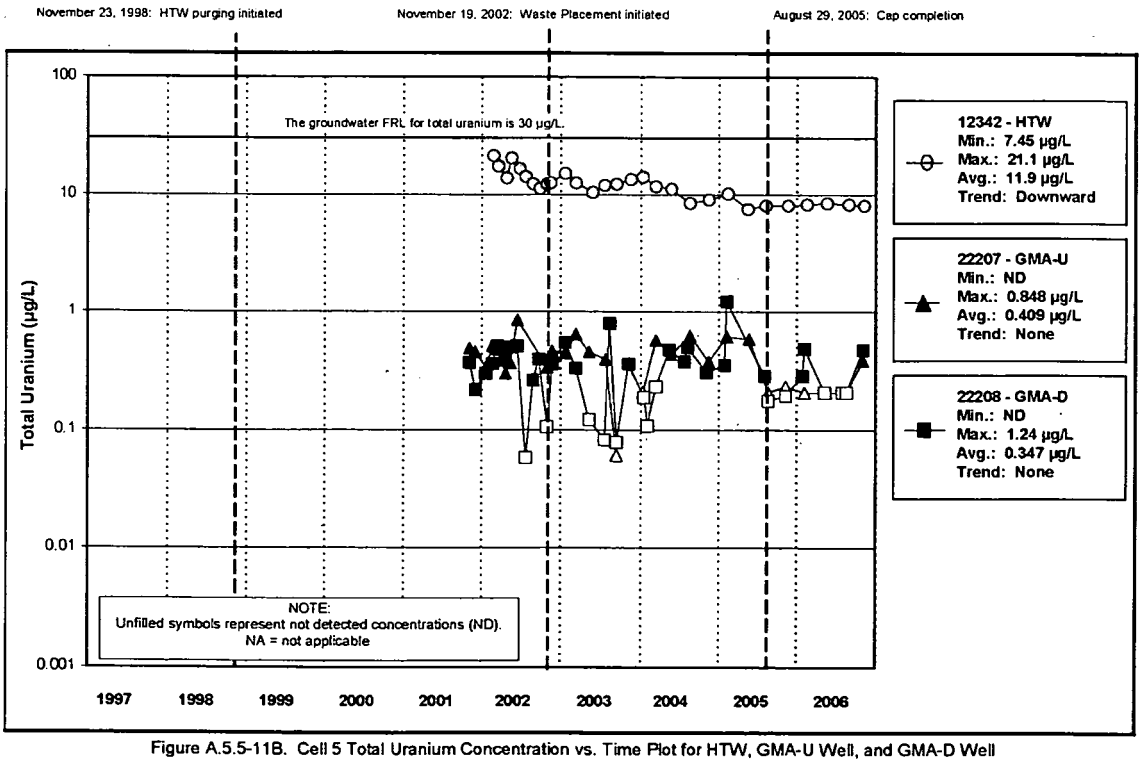


Figure A.5.5-11B. Cell 5 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

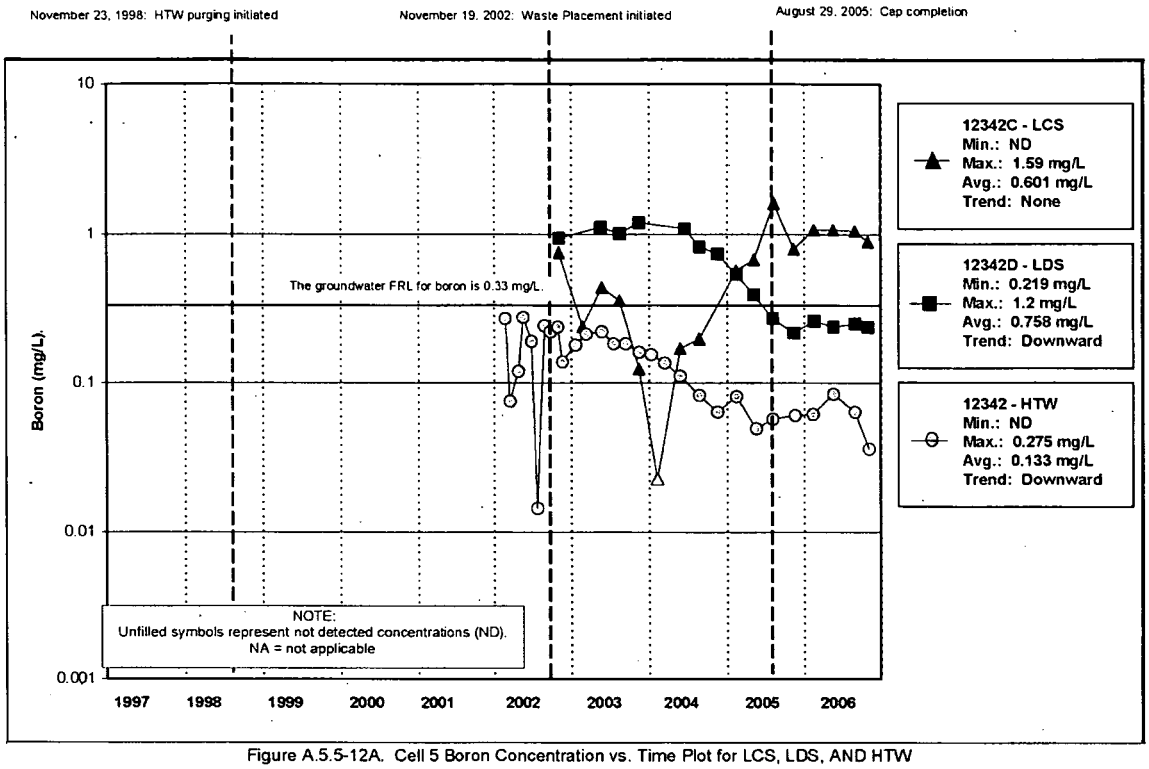


Figure A.5.5-12A. Cell 5 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

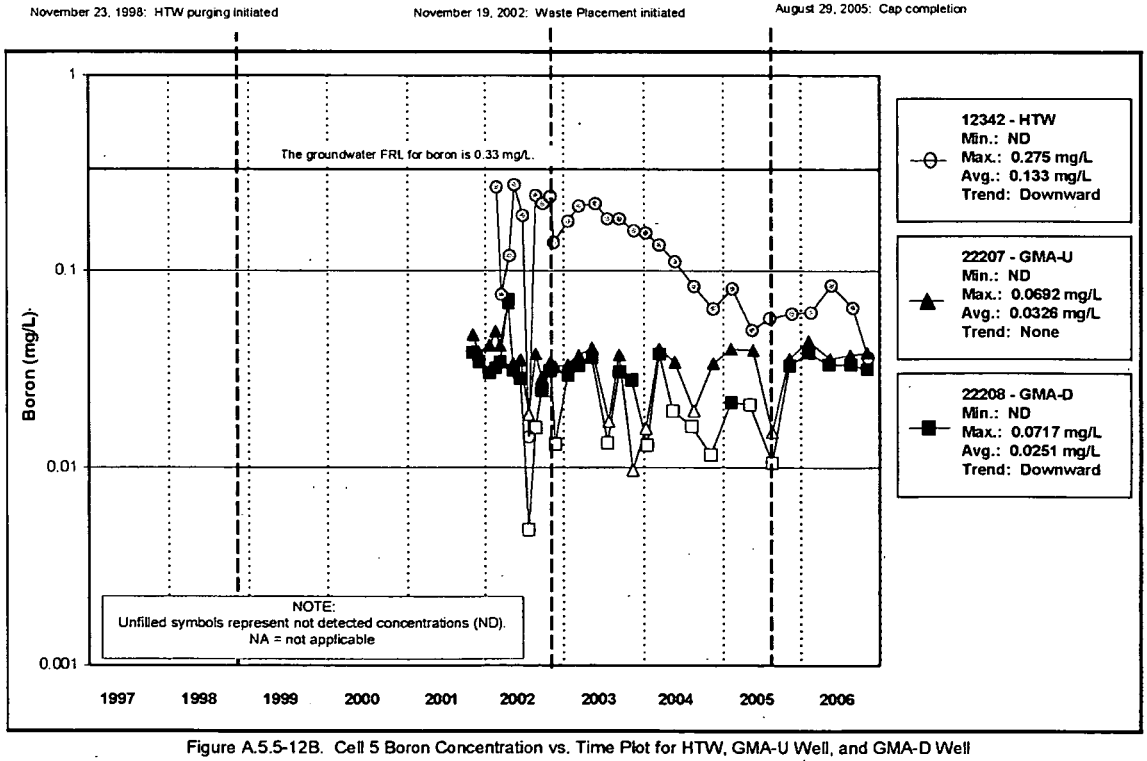


Figure A.5.5-12B. Cell 5 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

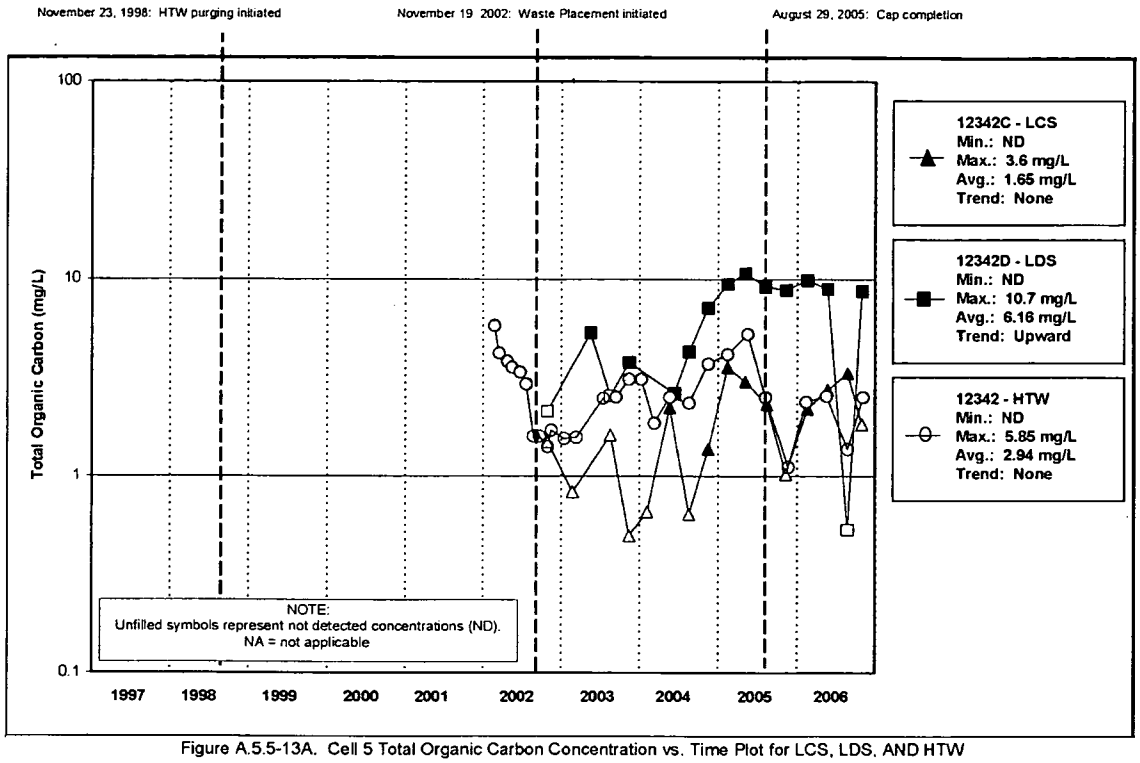


Figure A.5.5-13A. Cell 5 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

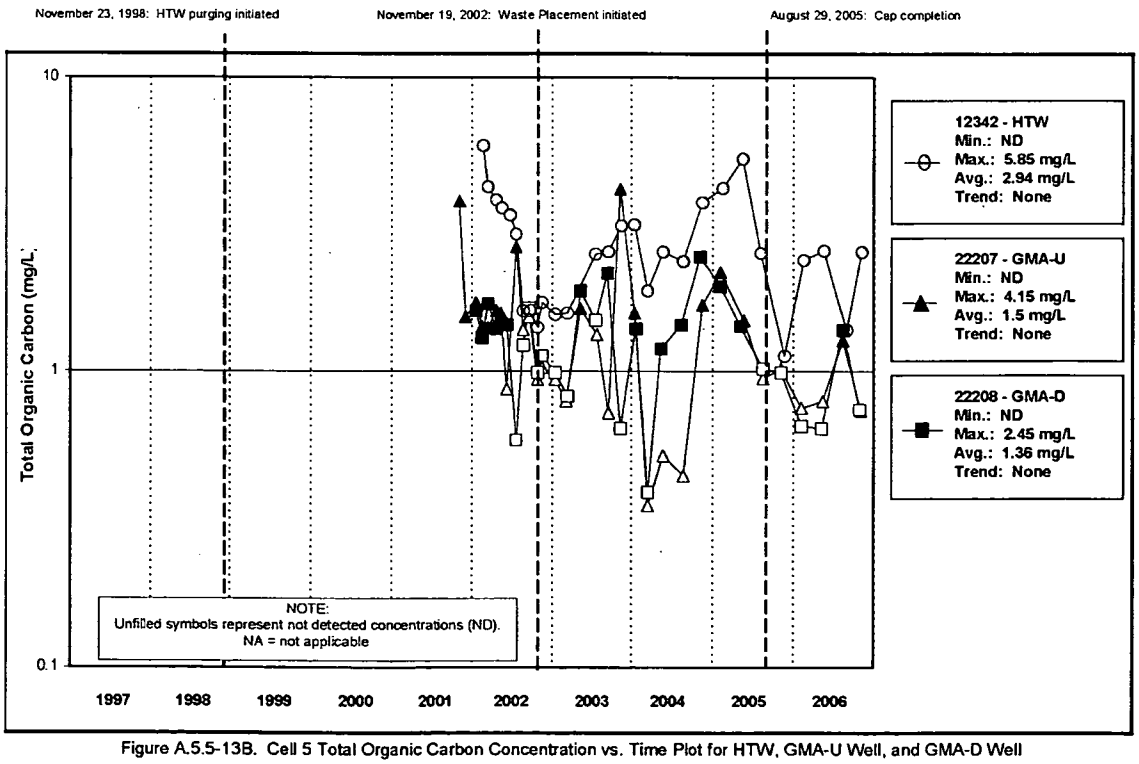


Figure A.5.5-13B. Cell 5 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

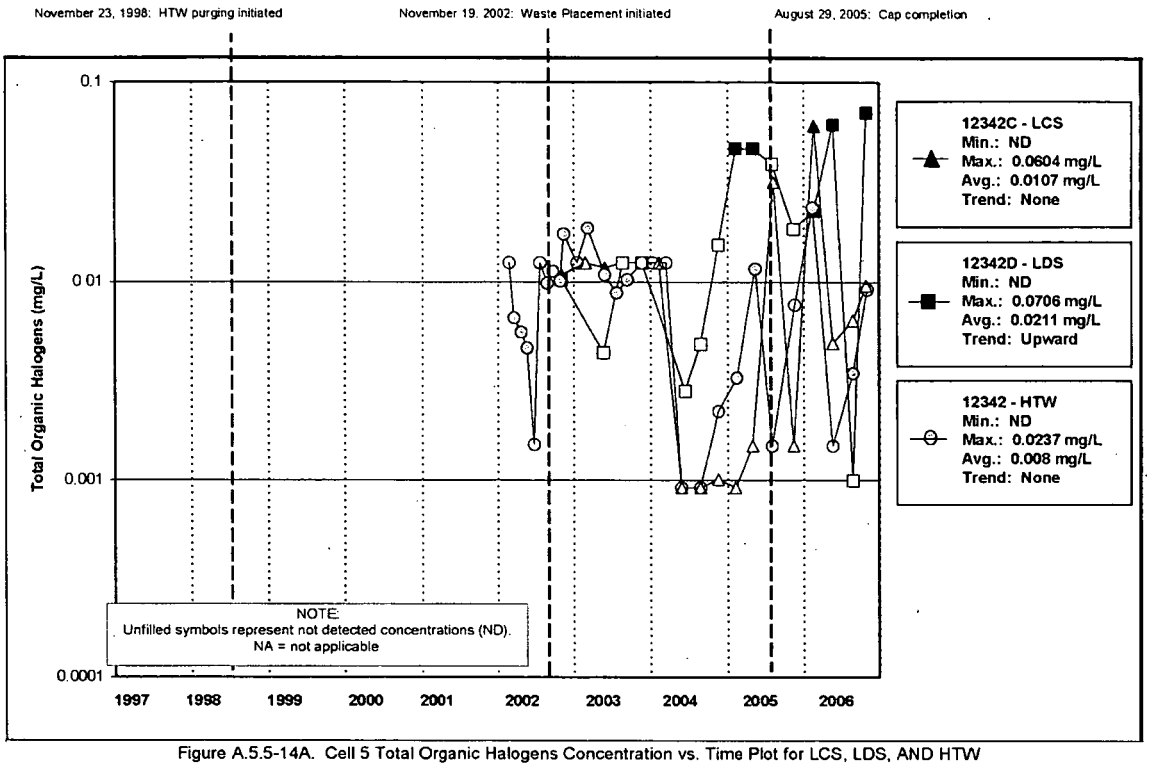


Figure A.5.5-14A. Cell 5 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

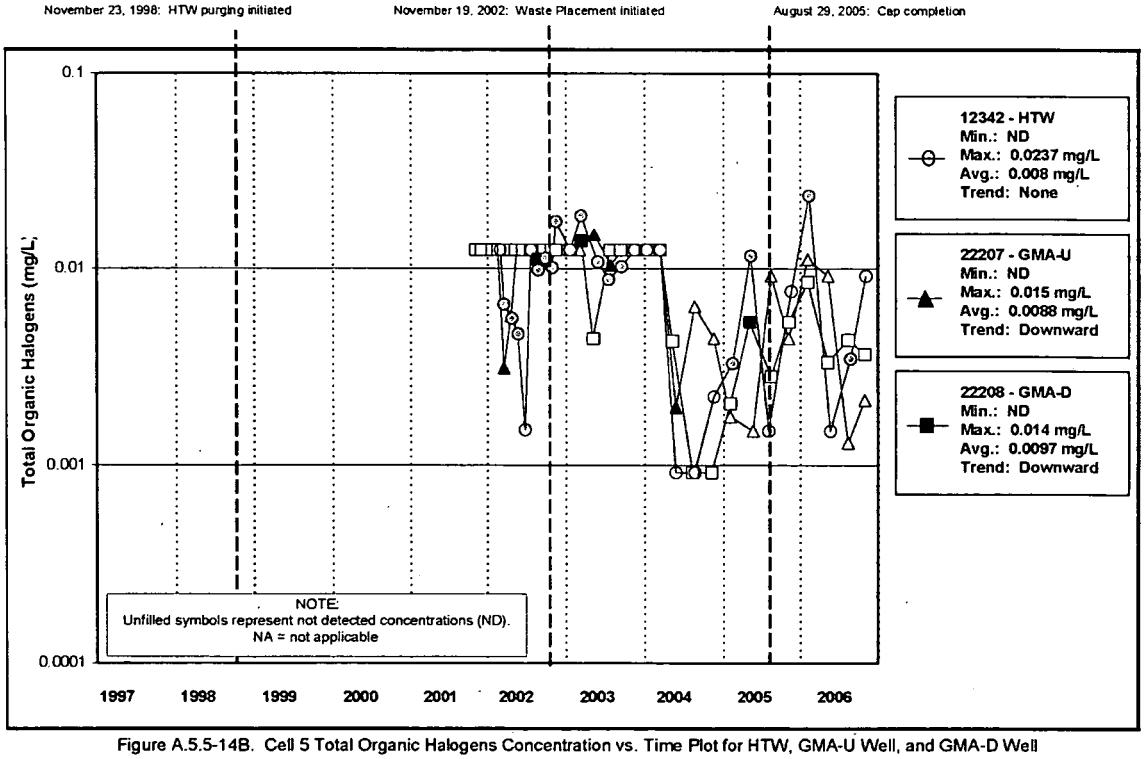


Figure A.5.5-14B. Cell 5 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

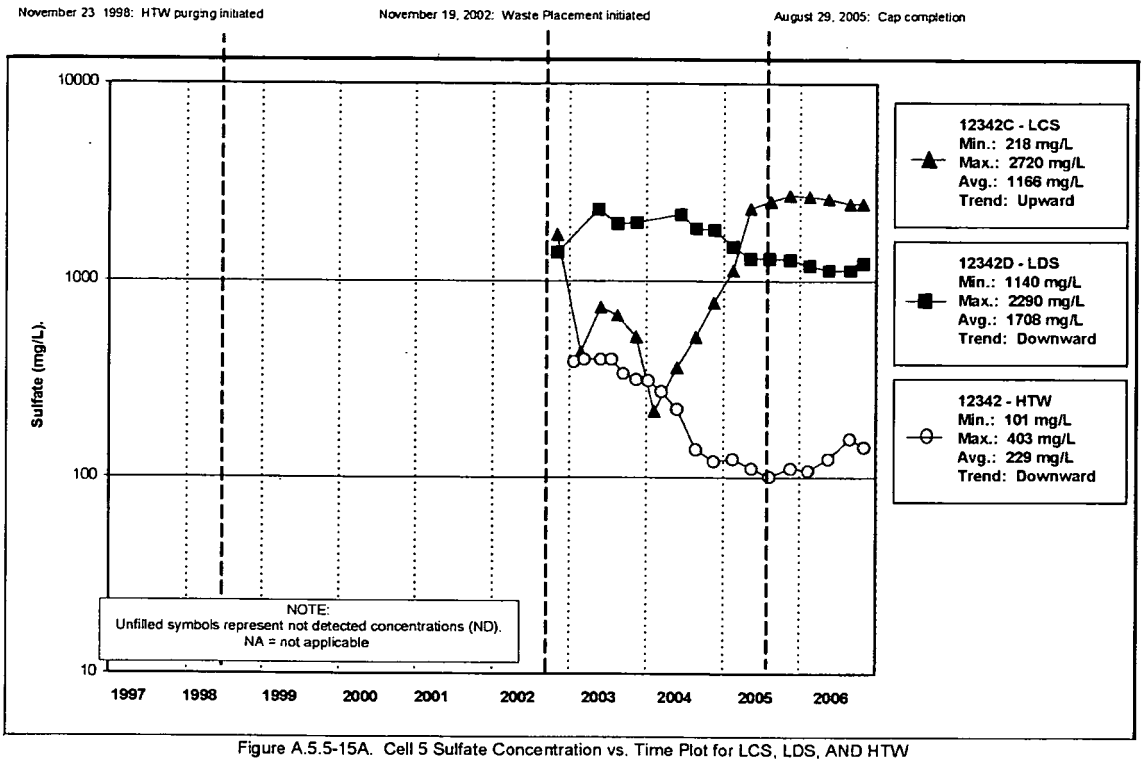


Figure A.5.5-15A. Cell 5 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

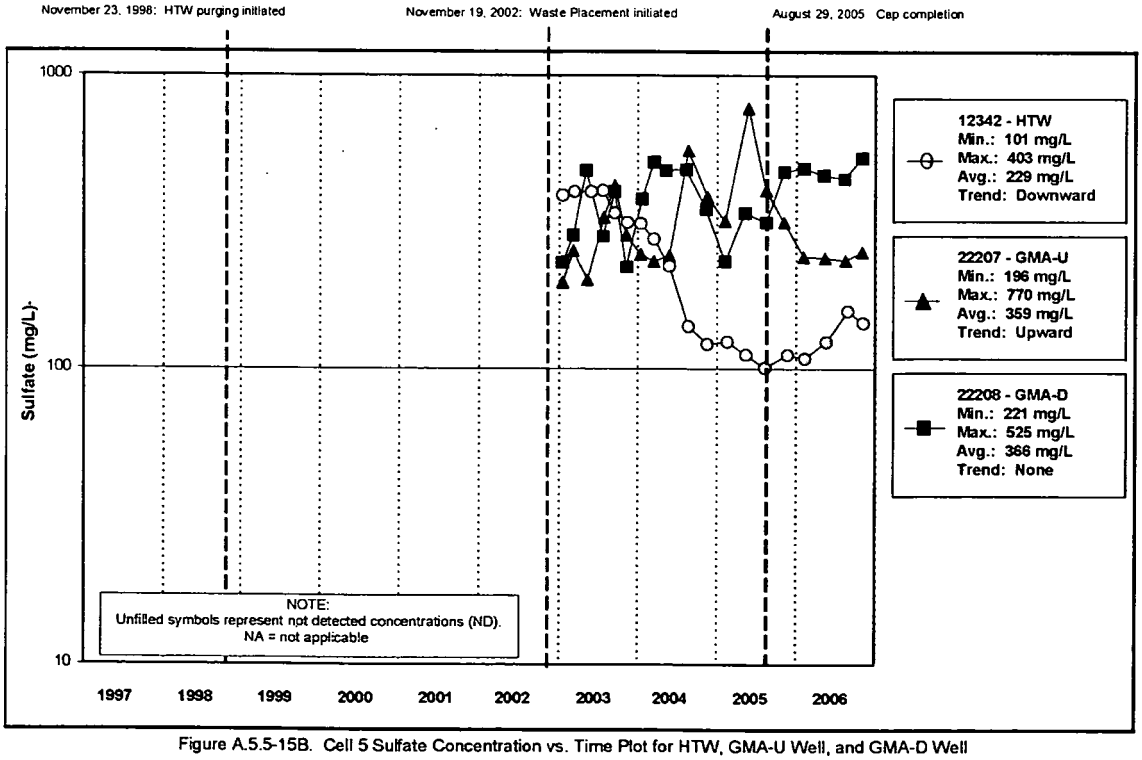


Figure A.5.5-15B. Cell 5 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

End of current text

Subattachment A.5.6

Cell 6

The following information is provided in this subattachment:

- LCS weekly and monthly average accumulation volumes (refer to Figures A.5.6–1 and A.5.6–2)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.6–3 and A.5.6–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.6–5 and A.5.6–6)
- LDS monthly accumulation rates and waste placement volumes (refer to Figure A.5.6–7)
- Monthly liner efficiencies (refer to Table A.5.6–1)
- HTW Water Yield (refer to Figure A.5.6–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.6–9 and A.5.6–10)
- Liner Efficiencies (refer to Table A.6.1–1)
- Summary statistics for refined baseline constituents (refer to Section A.5.6.1 and Table A.5.6–2)
- Concentration plots for refined baseline constituents (refer to Section A.5.6.1 and Figures A.5.6–11A through A.5.6–15B)
- Annual LCS monitoring results (refer to Section A.5.6.2 Table A.5.6–3)
- Annual LDS monitoring results (refer to Section A.5.6.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. In 2006, all samples were collected for Cell 6 monitoring horizons. Refined baseline monitoring in Cells 4 through 6 was initiated in August 2005.

A.5.6.1 Refined Baseline Monitoring Results

Refined baseline constituents are those constituents that have been sampled for at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also included in Table 2–3 are common ion constituents. A summary statistics table (refer to Table A.5.6–2) and concentration plots (Figures A.5.6–11A through A.5.6–15B) are provided for the five baseline constituents of Cell 6. For Cell 6, those five constituents are: total uranium, boron, total organic carbon, total organic halogens, and sulfate. Since 2005, total organic halogens concentrations have been detected less than 25 percent of the time in the Great Miami Aquifer wells 22209 and 22210.

A.5.6.2 LCS Monitoring Results

Ohio Solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition

of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 6 LCS took place in May. Table A.5.6–3 summarizes the annual LCS sampling results for Cell 6, along with data collected in previous years.

Of the non-refined baseline site specific constituents that have been sampled for at least eight times, 11 have been detected at least 25 percent of the time. Nine of the 11 constituents are common ions (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, potassium, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 6 will be determined based upon results of the common ion study.

The remaining two constituents are total dissolved solids (TDS) and technetium-99. TDS will be assessed using the approach presented in Figures A.5–4A and A.5–4B, once final approval of the approach has been obtained from the EPA and OEPA. The assessment will be used to determine if TDS will be added to the site specific leak detection parameter list. Results of the assessment will be presented to the EPA/OEPA as soon as they are available and they will also be reported in next year's SER.

Technetium-99 is a site specific leak detection parameter; however, it is not on the refined baseline list for Cell 6. If a site specific constituent (not on the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.6–3, technetium-99 has been detected in the Cell 6 LCS, but these detections occurred prior to the establishment of the refined baseline for Cell 6. Therefore, confirmatory sampling for technetium-99 in the Cell 6 LCS is not required.

Mercury has been detected in the Cell 6 LCS 11.1 percent of the time. Because these detections were made prior to the establishment of the refined baseline list for Cell 6, confirmatory sampling for mercury in Cell 6 is not required.

A.5.6.3 LDS Monitoring Results

Each year the LDS of Cell 6 is sampled for site specific baseline parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility.

In 2006, of the non-refined baseline constituents that have been sampled at least eight times, nine have been detected at least 25 percent of the time (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, potassium, and sodium). All nine are common ion constituents.

Table A.5.6–1. Cell 6 – 2006 Monthly Liner Efficiencies

Month	Cell 6 Apparent Liner Efficiency (%)
January	NA[a]
February	NA[a]
March	NA[a]
April	79.41
May	78.01
June	NA[b]
July	NA[b]
August	NA[b]
September	87.35
October	85.07
November	82.71
December	81.78

[a]LCS flow not yet directed to tank. No data available.
[b]OSDF contingency plan executed due to inaccessibility of valve houses. Valve house road was closed to support site remediation activities. No data available.

Table A.5.6–2. Summary Statistics for Cell 6

Note: The data used in this table have been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]		
Total Uranium (µg/L)	LCS	12343C	13	13	100%	126	Normal	Upward	Detected			
	LDS	12343D	13	13	100%	18.8	Normal	Upward	Detected			
	HTW	12343	13	13	100%	9.63	Normal	Marg. Up.	Not Detected	6.32 (Q2-03)		
	GMA-U	22209	13	15	87%	0.64	Lognormal	None	Not Detected	2.43 (Q2-06)	0.005 U (Q2-05)	
	GMA-D	22210	15	16	94%	0.64	Lognormal	Marg. Up.	Not Detected	0 U (Q2-05)		
Boron (mg/L)	LCS	12343C	13	13	100%	0.692	Normal	Upward	Not Detected			
	LDS	12343D	11	11	100%	0.470	Normal	Downward	Not Detected	1.22 (Q4-03)	2.38 (Q3-04)	
	HTW	12343	12	14	86%	0.084	Normal	Downward	Detected			
	GMA-U	22209	13	17	76%	0.0351	Undefined	None	Not Detected			
	GMA-D	22210	15	17	88%	0.0325	Undefined	None	Marg. Detect			
Total Organic Carbon (mg/L)	LCS	12343C	10	12	83%	2.25	Normal	Upward	Marg. Detect	14.6 (Q4-03)		
	LDS	12343D	11	11	100%	7.25	Lognormal	Downward	Detected	0.292 (Q2-04)	3.08 (Q1-04)	
	HTW	12343	10	14	71%	2.19	Normal	None	Not Detected			
	GMA-U	22209	6	17	35%	0.94	Lognormal	Marg. Down.	Detected			
	GMA-D	22210	7	17	41%	1.05	Lognormal	None	Not Detected			
Total Organic Halogens (mg/L)	LCS	12343C	5	13	38%	0.0117	Lognormal	None	Detected			
	LDS	12343D	7	13	54%	0.0265	Normal	None	Not Detected			
	HTW	12343	8	14	57%	0.0086	Normal	Marg. Down.	Not Detected			
	GMA-U	22209	4	17	24%	0.0097	Undefined	None	Marg. Detect			
	GMA-D	22210	1	17	6%	0.0071	Undefined	Marg. Down.	Detected			
Sulfate (mg/L)	LCS	12343C	11	11	100%	1760	Lognormal	Marg. Up.	Not Detected	491 (Q2-05)	690 (Q2-04)	
	LDS	12343D	13	13	100%	1660	Lognormal	None	Not Detected			
	HTW	12343	13	13	100%	418	Lognormal	None	Detected	383 U (Q1-03)		
	GMA-U	22209	13	13	100%	163	Normal	Upward	Detected	406 (Q2-06)	311 (Q2-03)	2.07 (Q3-06)
	GMA-D	22210	16	16	100%	188	Lognormal	Upward	Detected			

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.
Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.
Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.
Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.
Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

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Table A.5.6–3. Cell 6 Annual LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
Alkalinity as CaCO3 (mg/L)	**9**	**9**	**100.0%**	**64**	**557**	**440**	**-**	**422 mg/L (6)**	**430 mg/L (6)**	**-**	**10 mg/L**
Ammonia (mg/L)	4	1	25.0%	0.0882	-	-	-	4.2 mg/L (0)	4.34 mg/L (0)	220 mg/L (0)	0.1 mg/L
Barium (mg/L)	4	4	100.0%	0.0309	0.0868	0.0628	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Calcium (mg/L)	**9**	**9**	**100.0%**	**225**	**996**	**493**	**-**	**159 mg/L (9)**	**172 mg/L (9)**	**1800 mg/L (0)**	**5 mg/L**
Chloride (mg/L)	**9**	**9**	**100.0%**	**20.1**	**139**	**86**	**-**	**7.3 mg/L (8)**	**45 mg/L (6)**	**6300 mg/L (0)**	**5 mg/L**
Cobalt (mg/L)	4	3	75.0%	0.0006	0.0016	0.0010	0.17 mg/L (0)	0.0086 mg/L (0)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	4	4	100.0%	0.00421	0.0082	0.0057	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	6	85.7%	0.240	0.379	0.299	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	9	9	100.0%	0.989	4.48	2.81	-	5.72 mg/L (0)	6.35 mg/L (0)	21.3 mg/L (0)	0.1 mg/L
Magnesium (mg/L)	**9**	**9**	**100.0%**	**92.4**	**609**	**302**	**-**	**38.5 mg/L (9)**	**50.7 mg/L (9)**	**690 mg/L (0)**	**5 mg/L**
Manganese (mg/L)	**9**	**8**	**88.9%**	**0.0073**	**1.41**	**0.32**	**0.9 mg/L (1)**	**0.9 mg/L (1)**	**0.21 mg/L (4)**	**35 mg/L (0)**	**0.09 mg/L**
Mercury (mg/L)	9	1	11.1%	0.000338	-	-	0.002 mg/L (0)	-	-	0.0018 mg/L (0)	0.0002 mg/L
Nickel (mg/L)	**4**	**4**	**100.0%**	**0.007**	**0.0285**	**0.014**	**0.1 mg/L (0)**	**0.0514 mg/L (0)**	**0.0072 mg/L (2)**	**0.981 mg/L (0)**	**0.02 mg/L**
Nitrate/Nitrite (mg/L)	**13**	**7**	**53.8%**	**0.153**	**4.67**	**1.79**	**11 mg/L[g] (0)**	**11 mg/L (0)**	**0.29 mg/L (6)**	**2670 mg/L (0)**	**1.1 mg/L**
Potassium (mg/L)	**9**	**9**	**100.0%**	**9**	**75.5**	**25.1**	**-**	**1.96 mg/L (8)**	**17.2 mg/L (6)**	**12400 mg/L (0)**	**5 mg/L**
Selenium (mg/L)	**4**	**1**	**25.0%**	**0.0097**	**-**	**-**	**0.05 mg/L (0)**	**0.00075 mg/L (1)**	**-**	**0.0494 mg/L (0)**	**0.005 mg/L**
Silicon (mg/L)	7	7	100.0%	3.42	4.89	4.05	-	-	-	15 mg/L (0)	0.015 mg/L
Sodium (mg/L)	**9**	**9**	**100.0%**	**23.1**	**107**	**53**	**-**	**47.1 mg/L (5)**	**50 mg/L (3)**	**1300 mg/L (0)**	**5 mg/L**
Technetium-99 (pCi/L)	9	3	33.3%	6.54	11.7	9.0	94 pCi/L (0)	22 pCi/L (0)	30 pCi/L (0)	6130 pCi/L (0)	10 pCi/L
Total Dissolved Solids (mg/L)	8	8	100.0%	267	4140	2160	-	-	-	-	10 mg/L
Vanadium (mg/L)	4	1	25.0%	0.00088	-	-	0.038 mg/L (0)	0.012 mg/L (0)	0.005 mg/L (0)	0.299 mg/L (0)	0.02 mg/L
Zinc (mg/L)	**4**	**1**	**25.0%**	**0.0253**	**-**	**-**	**0.021 mg/L (1)**	**0.02 mg/L (1)**	**0.35 mg/L (0)**	**1.78 mg/L (0)**	**0.015 mg/L**

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

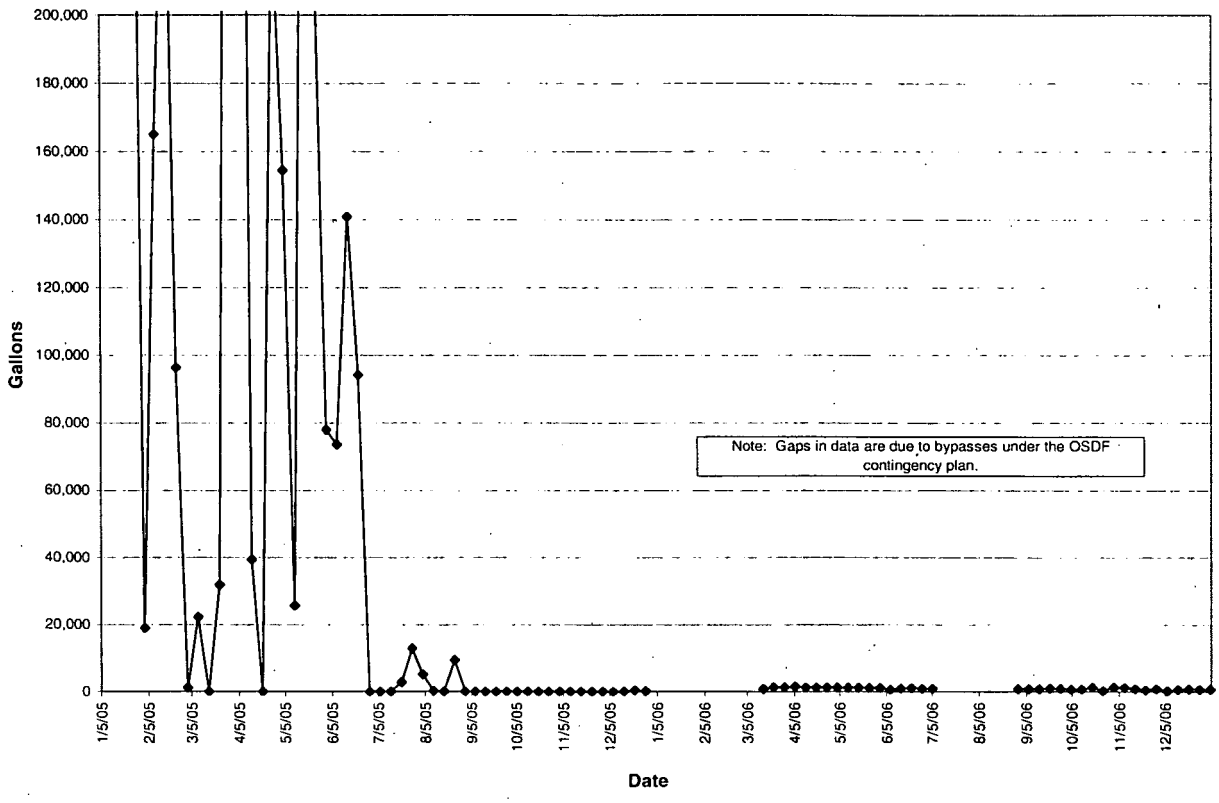


FIGURE A.5.6-1. Weekly Accumulation Volumes for Cell 6 LCS

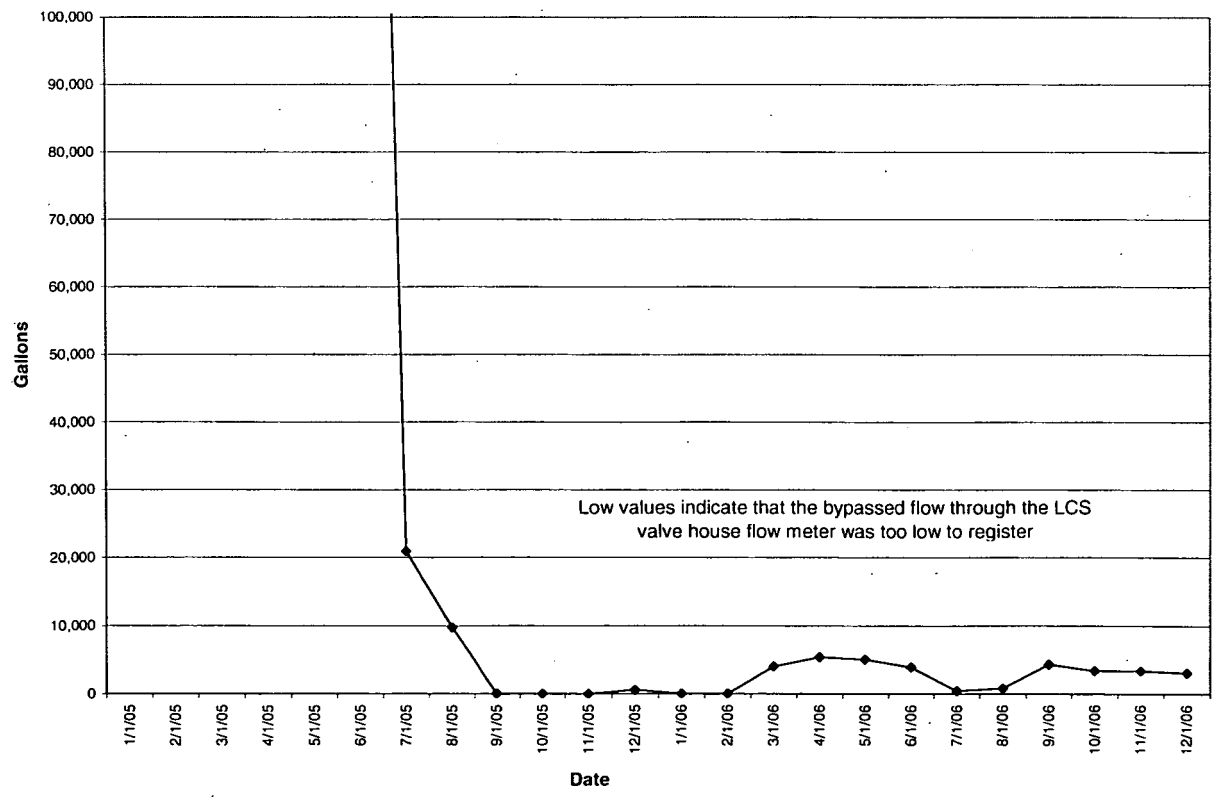


FIGURE A.5.6-2. Monthly Accumulation Volumes for Cell 6 LCS

FIGURE A.5.6-3. Weekly Accumulation Volumes for Cell 6 LDS

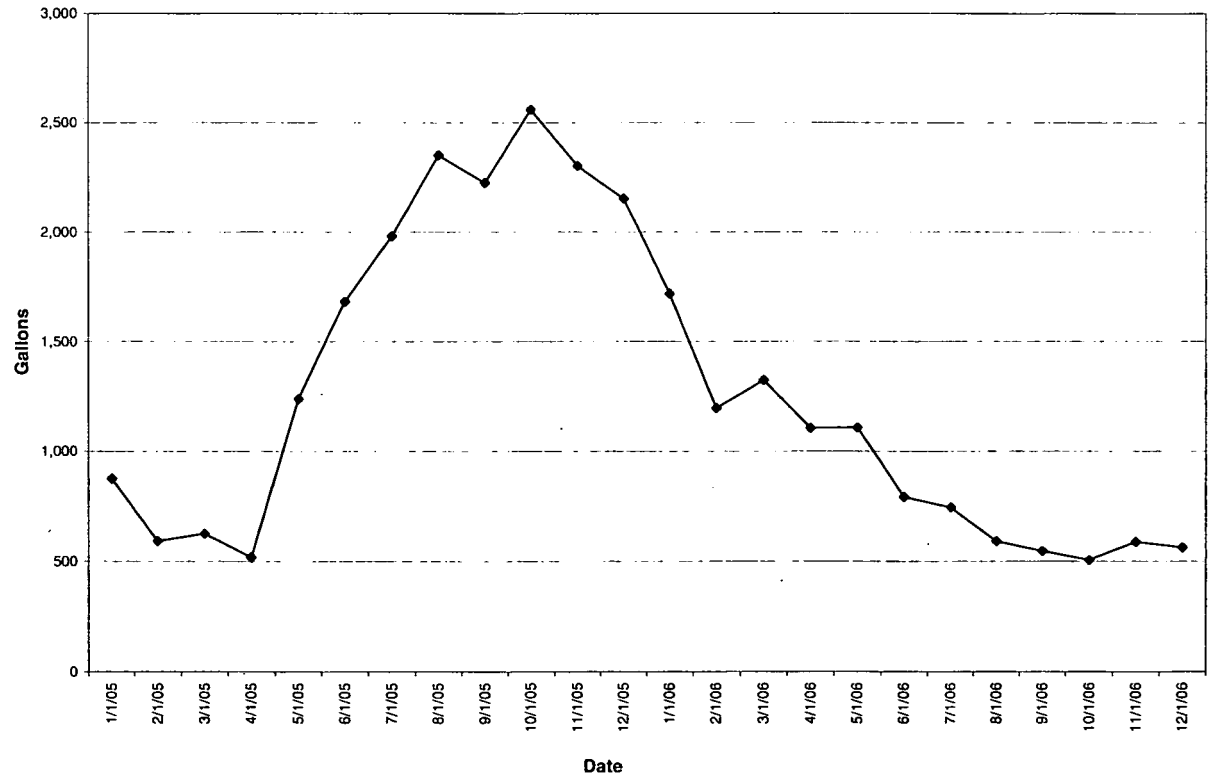


FIGURE A.5.6-4. Monthly Accumulation Volumes for Cell 6 LDS

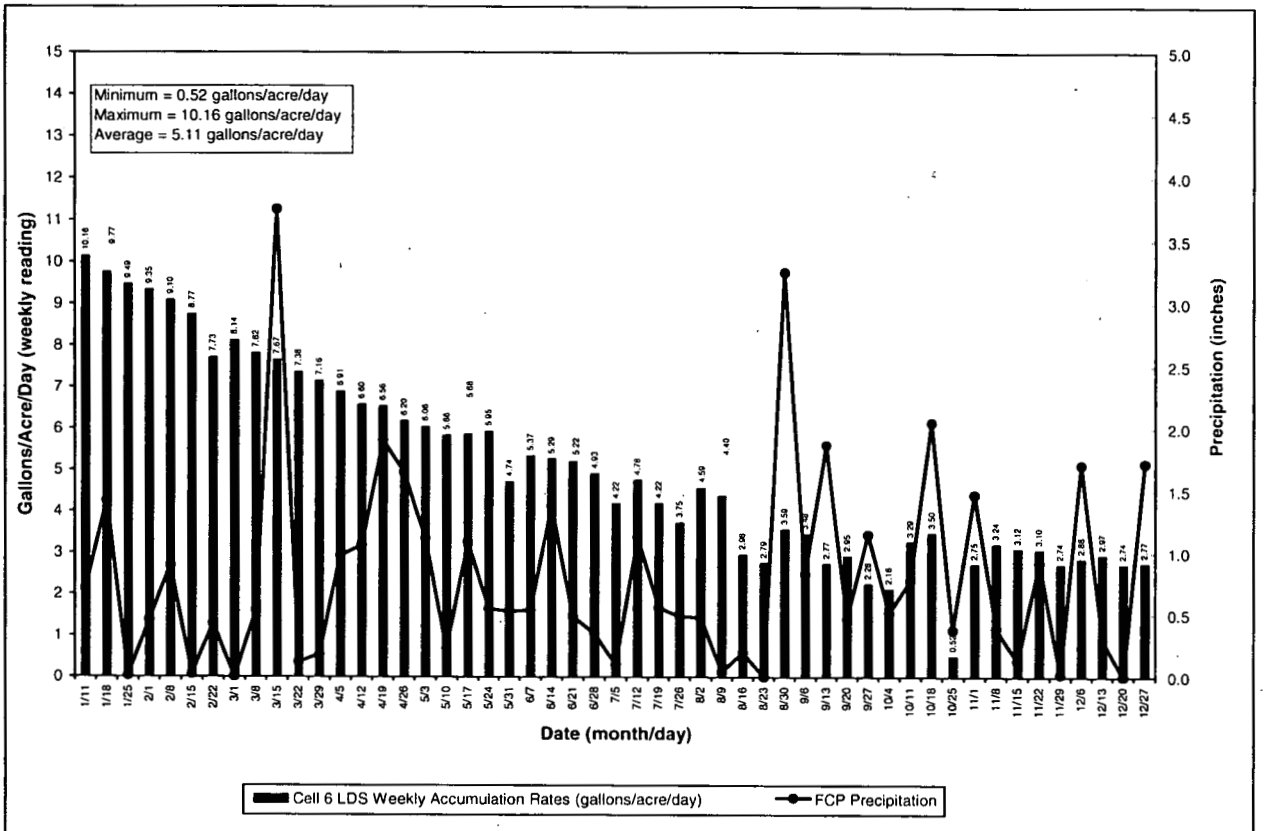


FIGURE A.5.6-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 6

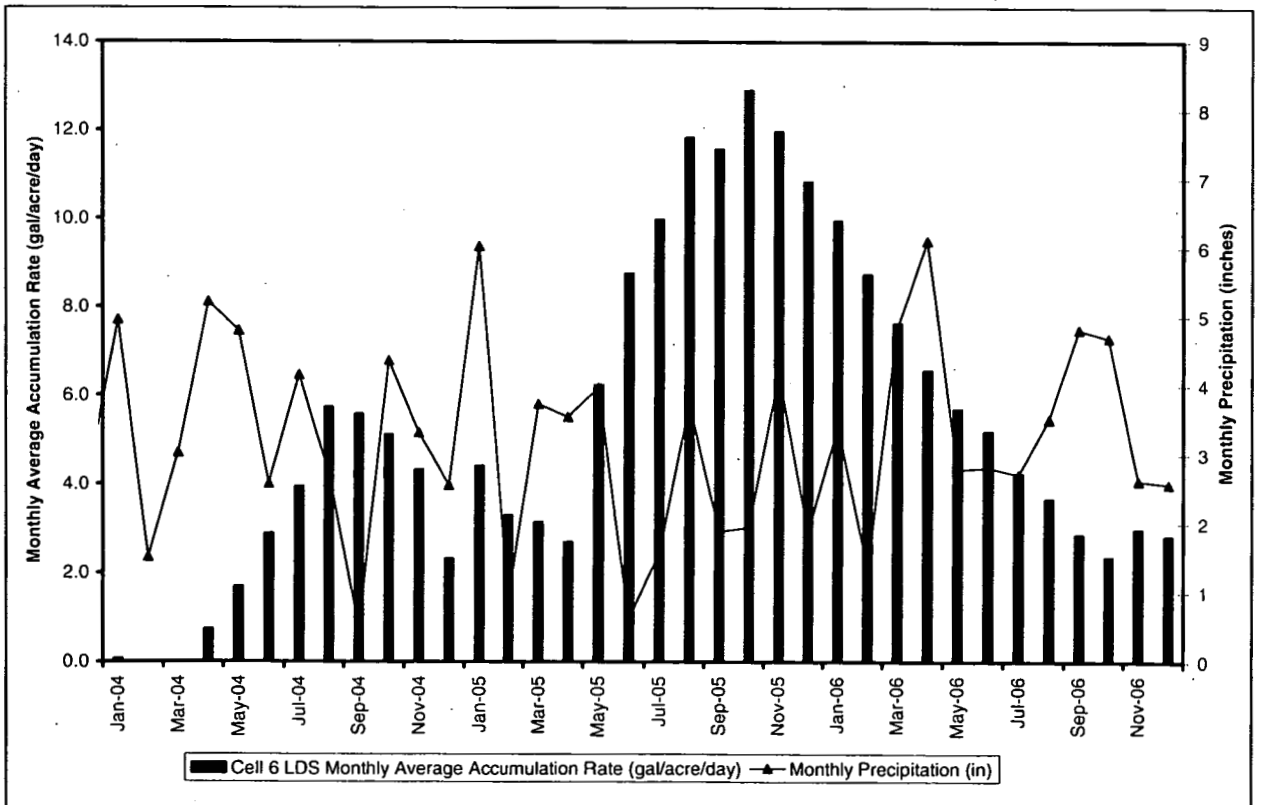


FIGURE A.5.6-6. OSDF Cell 6 LDS Monthly Average Accumulation Rates and Monthly Precipitation

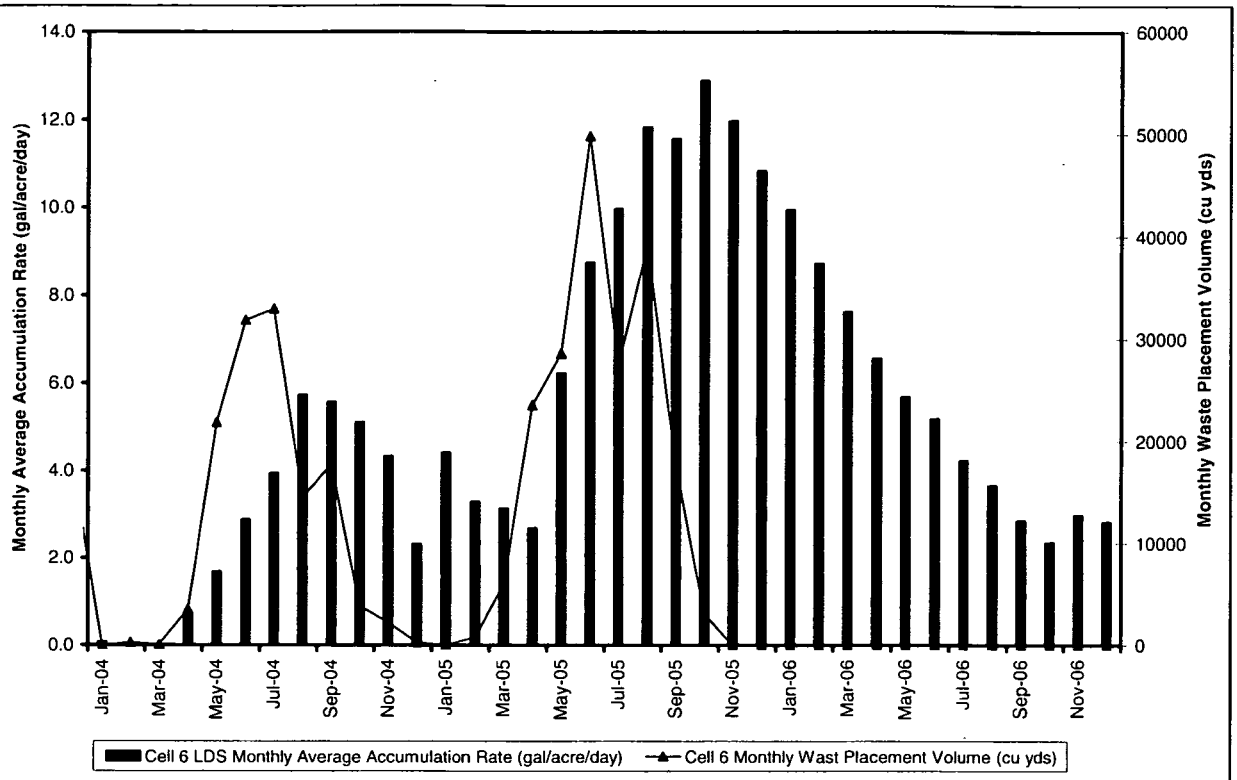
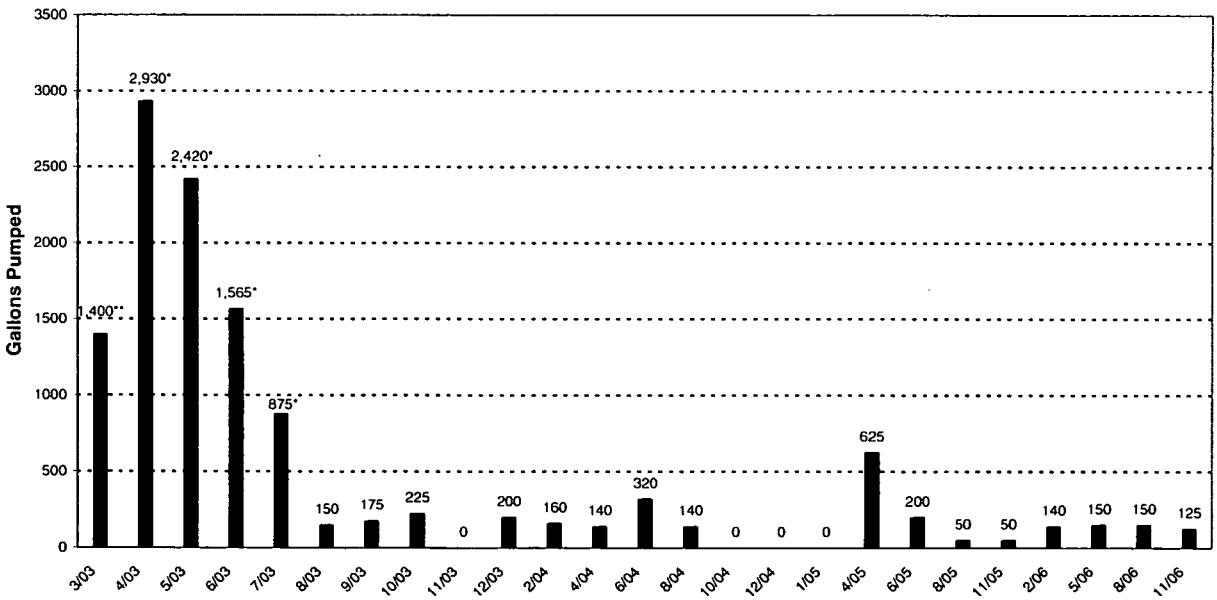


FIGURE A.5.6-7. OSDF Cell 6 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12343 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2003:	9940	n=10	994
2004:	760	n= 6	127
2005:	925	n=5	185
2006:	565	n=4	141
Overall:			488

*More than one purge of the well was completed during these months to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

**Excess water was pumped from this well in March 2003 for well development.

FIGURE A.5.6-8. OSDF Horizontal Till Well 12343 (Cell 6) Water Yield

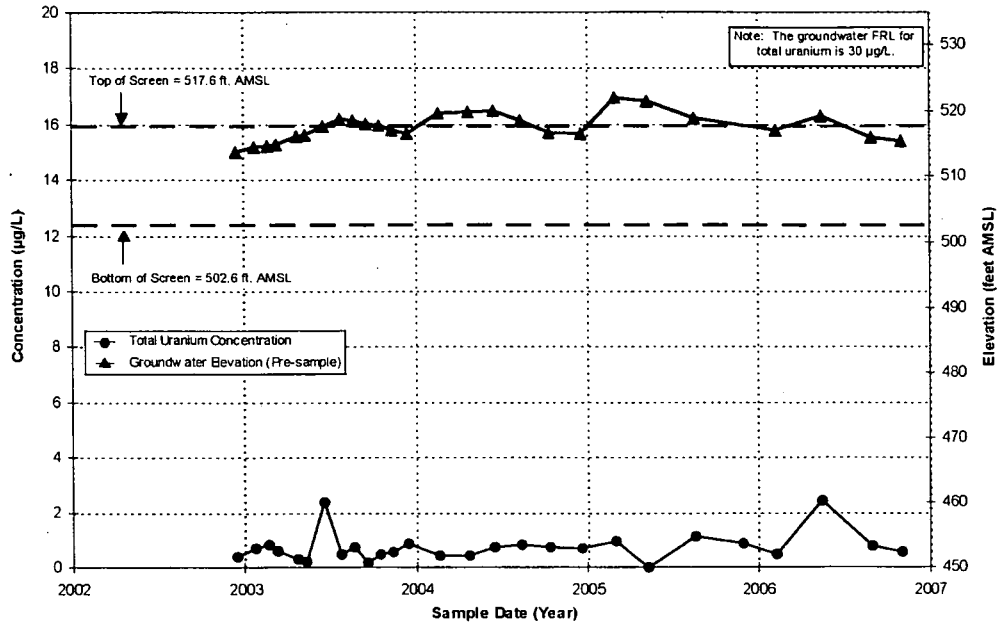


Figure A.5.6-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 6 Upgradient Monitoring Well 22209

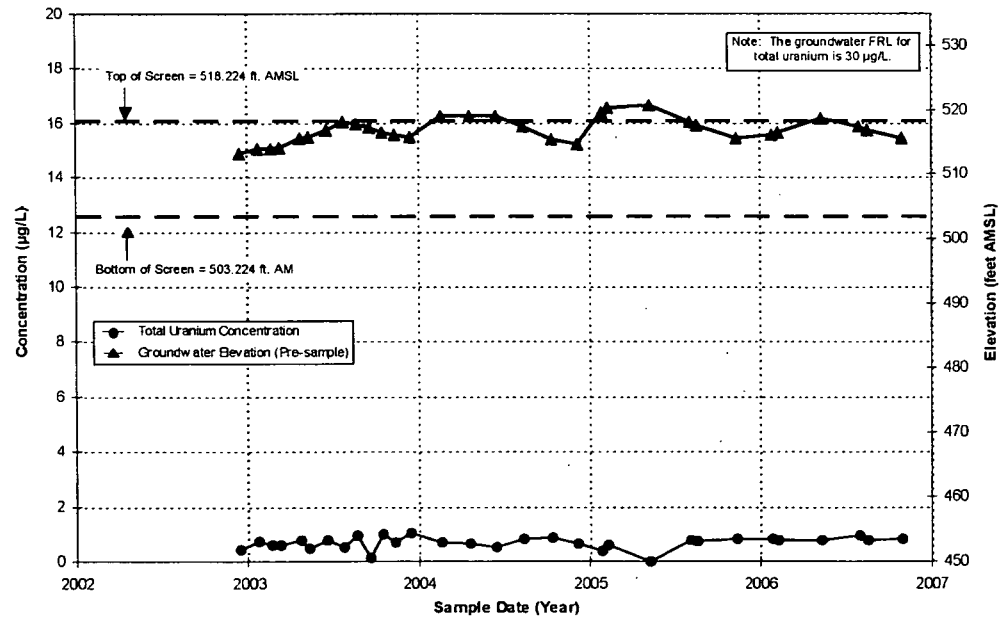


Figure A.5.6-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 6 Downgradient Monitoring Well 22210

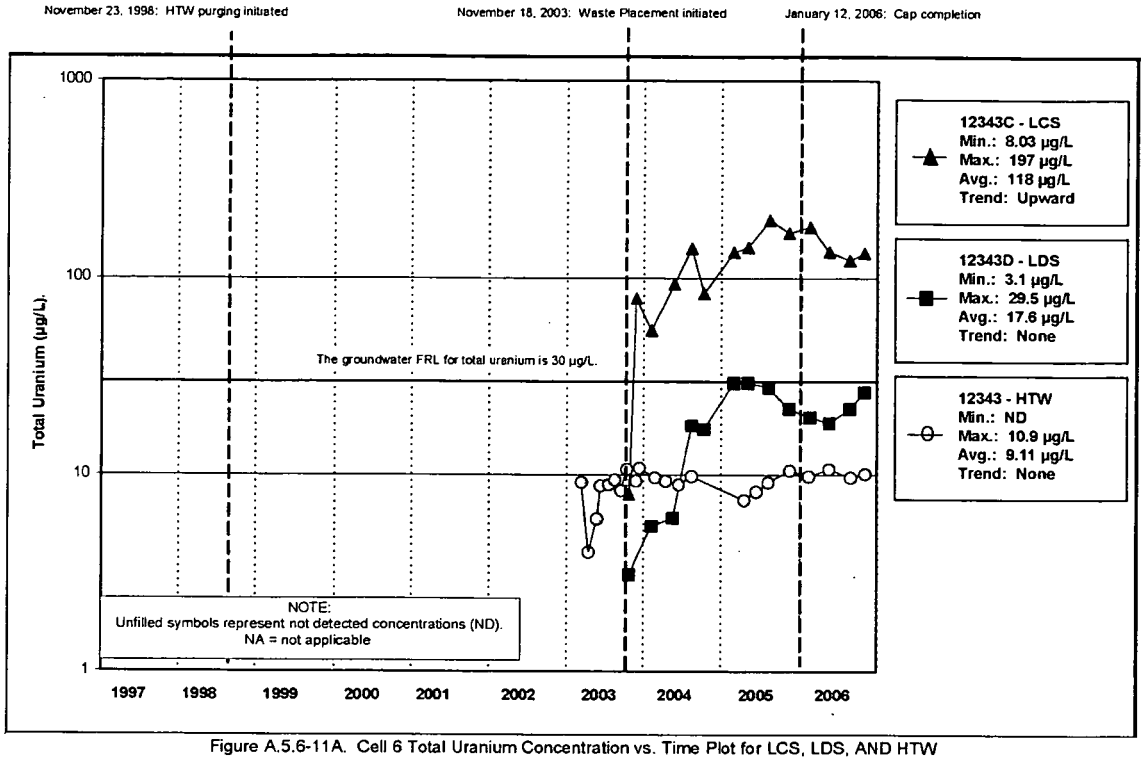


Figure A.5.6-11A. Cell 6 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

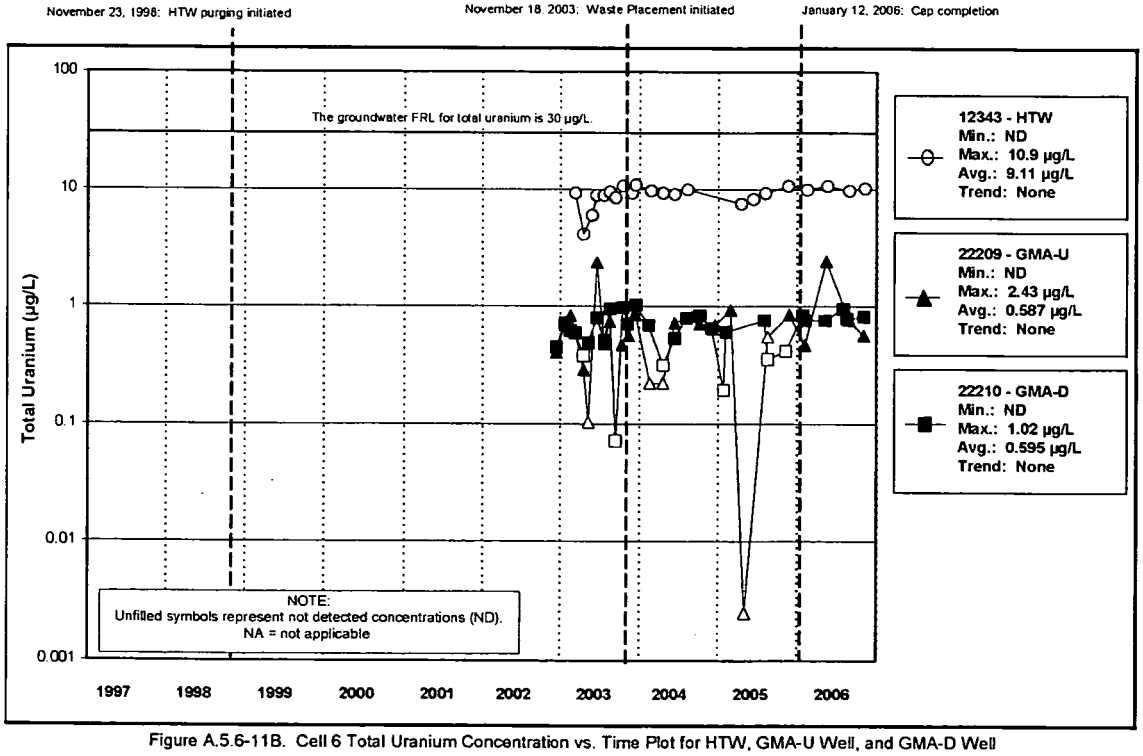


Figure A.5.6-11B. Cell 6 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

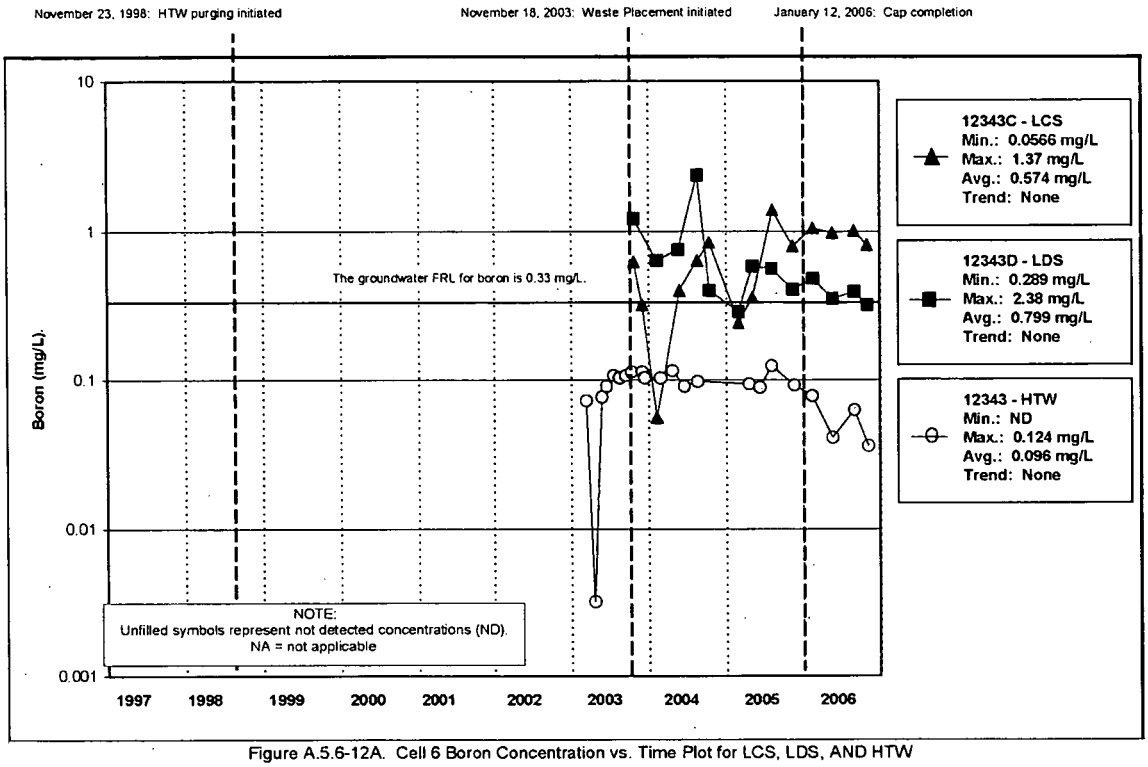


Figure A.5.6-12A. Cell 6 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

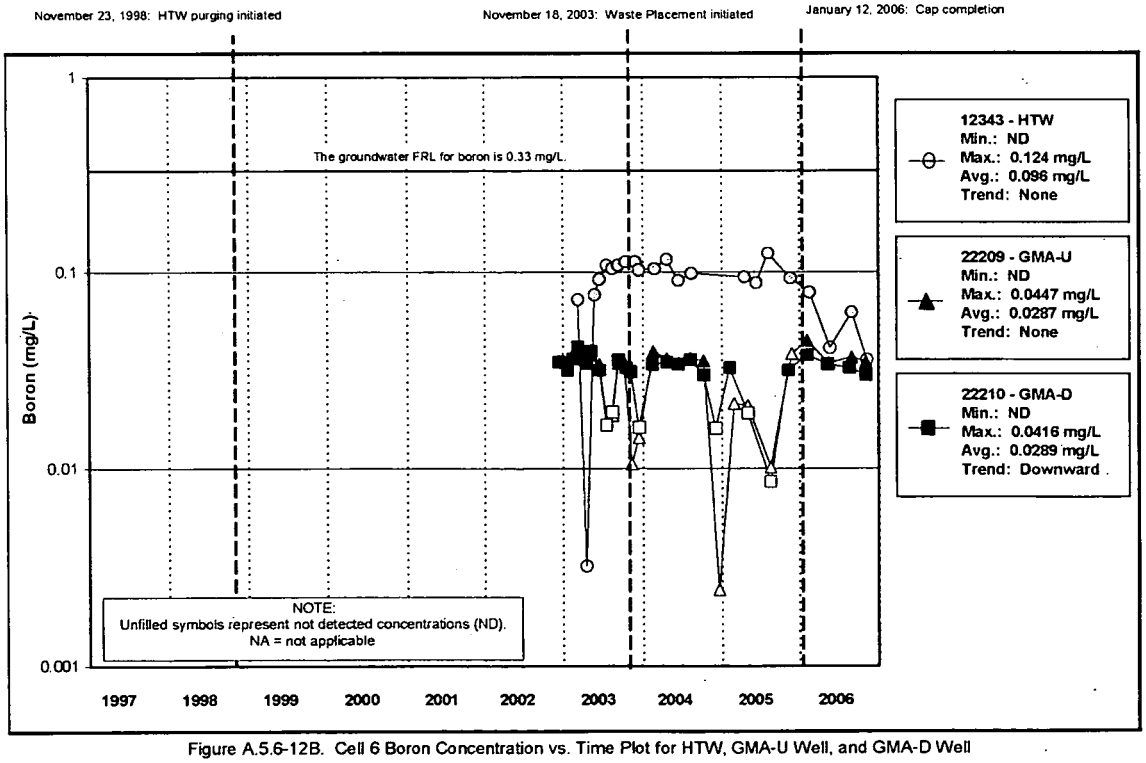


Figure A.5.6-12B. Cell 6 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

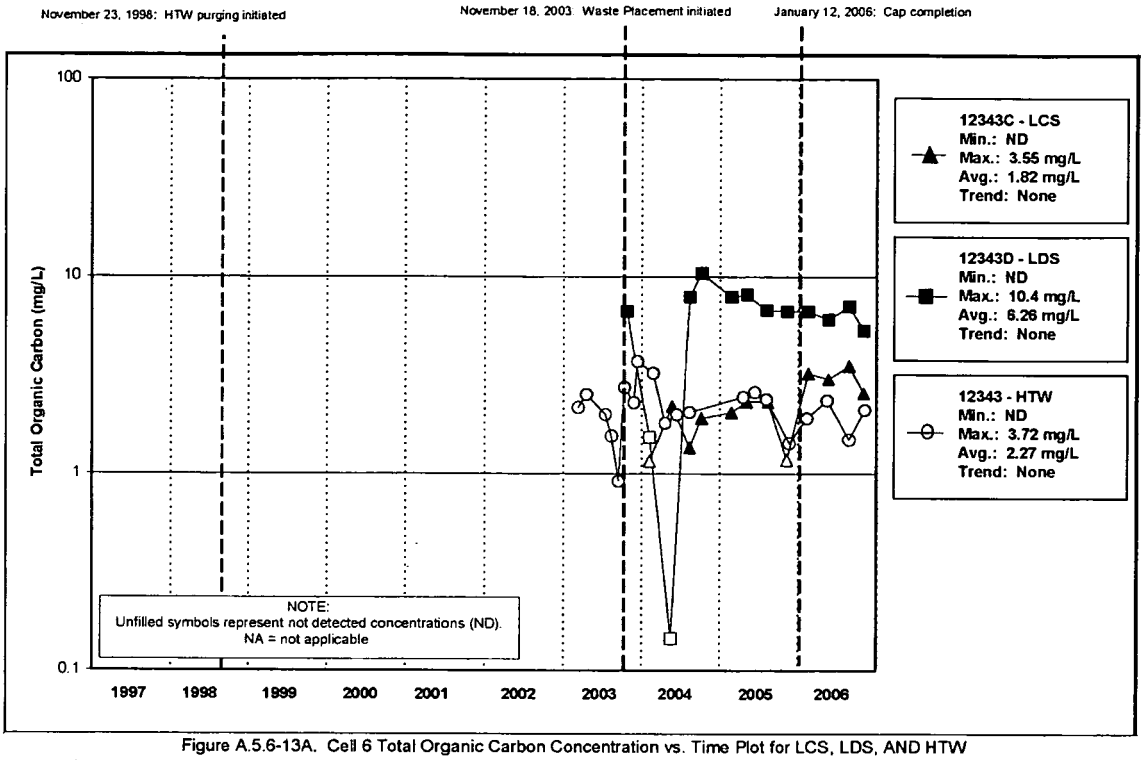


Figure A.5.6-13A. Cell 6 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

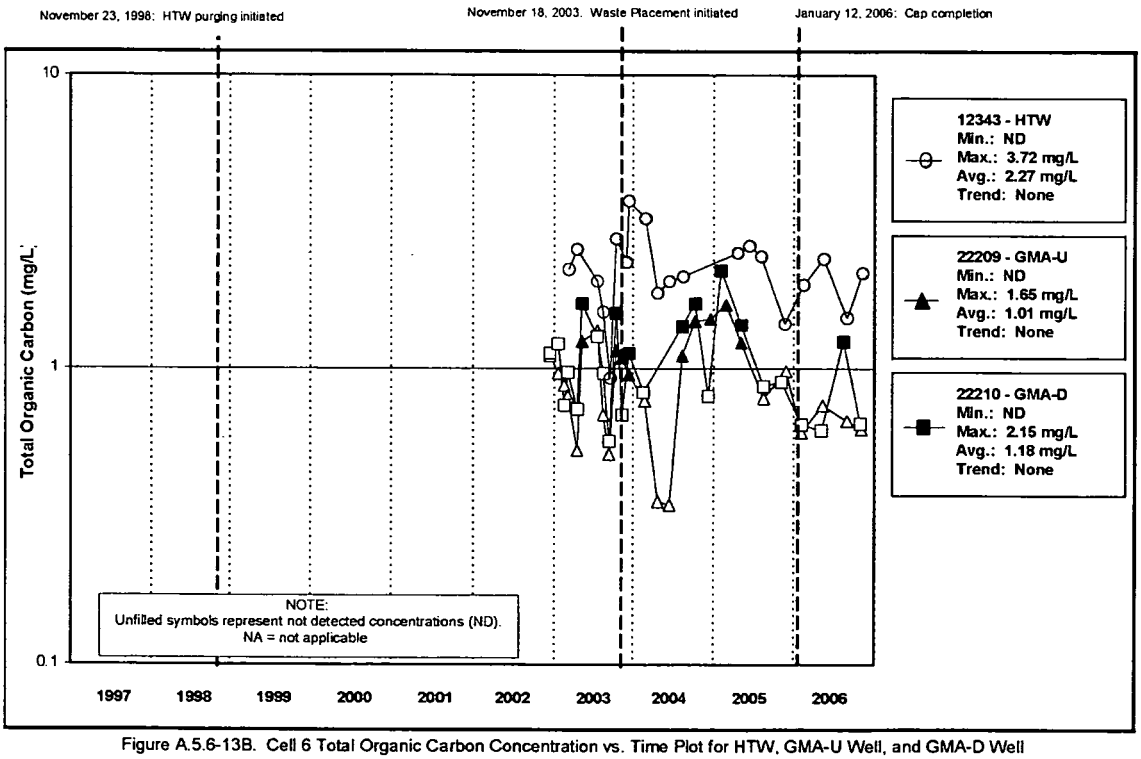


Figure A.5.6-13B. Cell 6 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

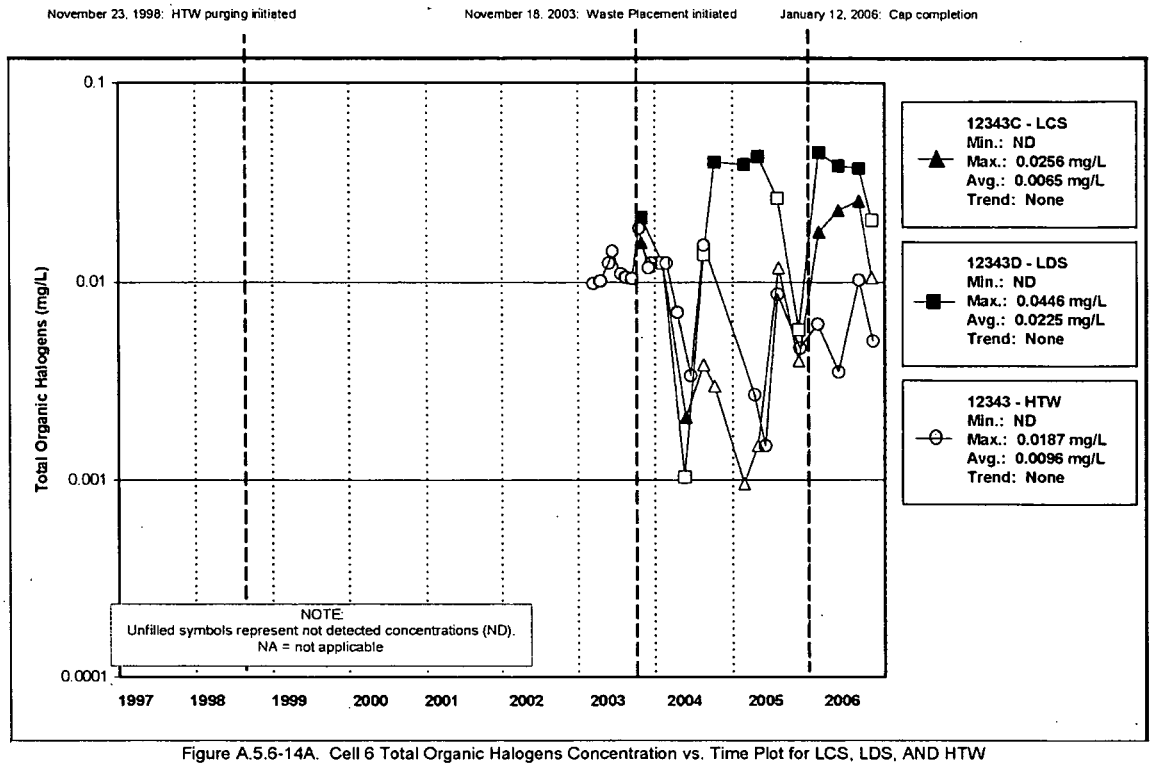


Figure A.5.6-14A. Cell 6 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

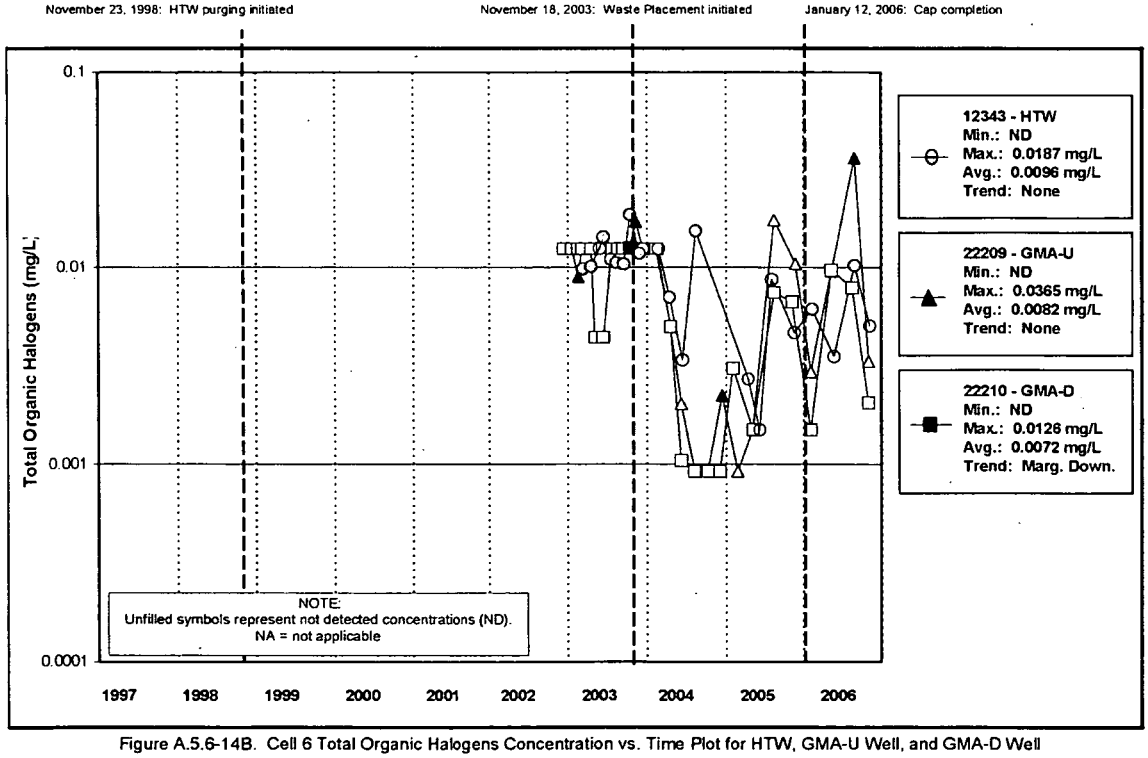


Figure A.5.6-14B. Cell 6 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

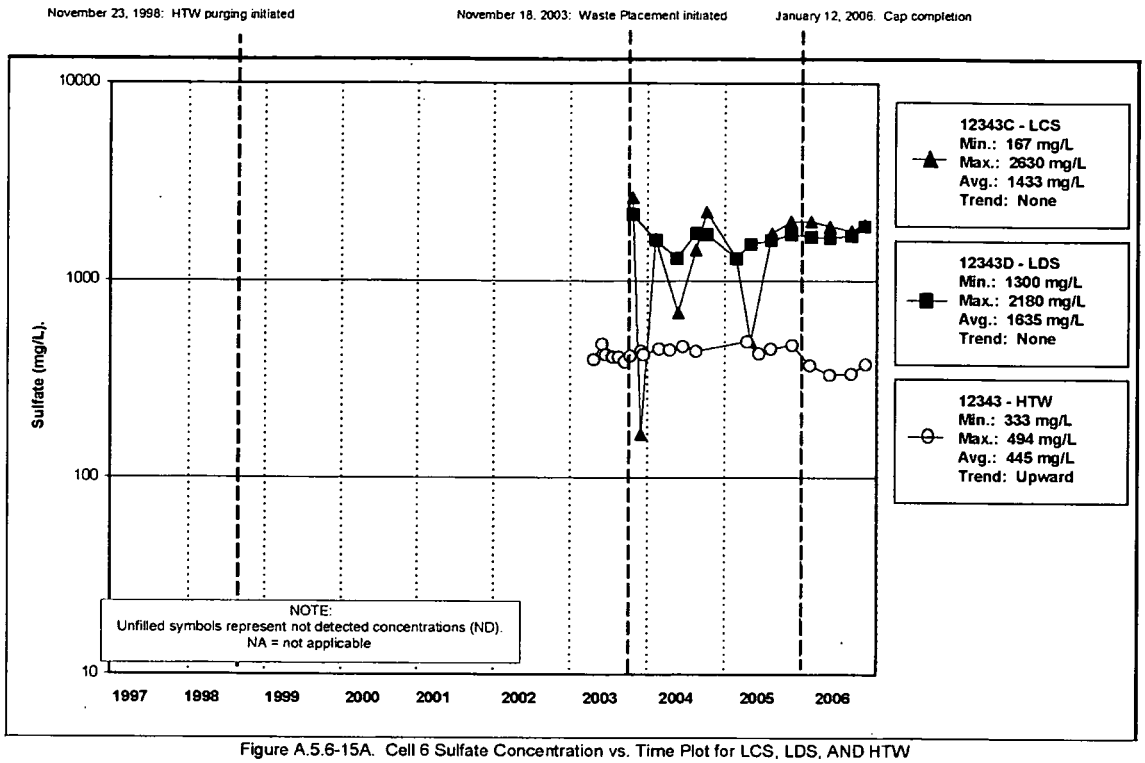


Figure A.5.6-15A. Cell 6 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

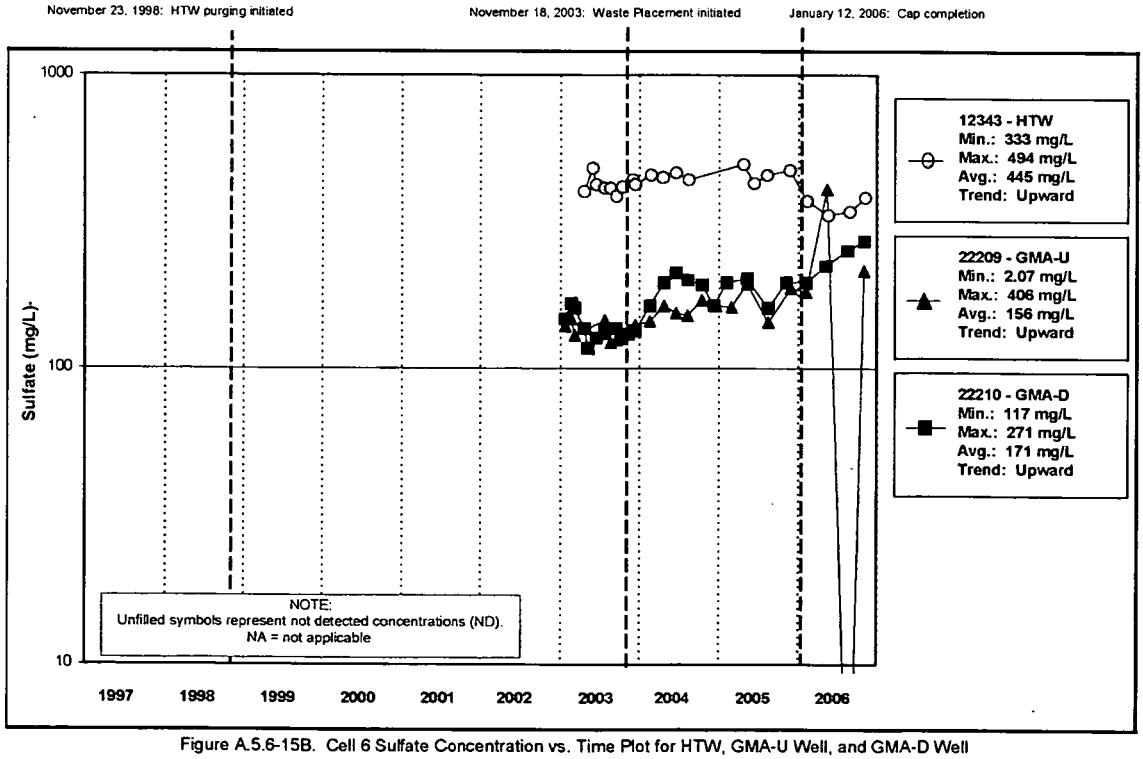


Figure A.5.6-15B. Cell 6 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

End of current text

Attachment A.5.7

Cell 7

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.7–1 and A.5.7–2)
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.7–3 and A.5.7–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.7–5 and A.5.7–6)
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.7–7)
- HTW Water Yield (refer to Figure A.5.7–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.7–9 and A.5.7–10)
- Summary statistics for refined baseline constituents (refer to Section A.5.7.1 and Table A.5.7–1)
- Concentration plots for refined baseline constituents (refer to Section A.5.7.1, and Figures A.5.7–11A through A.5.7–15B)
- Annual LCS monitoring results (refer to Section A.5.7.2 and Table A.5.7–2).
- Annual LDS monitoring results (refer to Section A.5.7.3)

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. At the end of 2005, sufficient data existed to evaluate initial baseline conditions and determine the refined baseline for Cell 7. The data review presented in the 2005 SER concluded that the constituents detected more than 25 percent of the time in the Cell 7 LCS, LDS, HTW, and GMA wells were the same five constituents that had been detected more than 25 percent of the time in Cells 1 through 6. Therefore, the recommendation to change to refined baseline monitoring in Cell 7 was requested in the 2005 SER. This monitoring change was approved by the EPA on July 6, 2006, and by OEPA on August 7, 2006 (via an email). In 2006, all samples were collected for Cell 7 monitoring horizons.

A.5.7.1 Refined Baseline Monitoring Results

Refined baseline constituents are those constituents that have been sampled at least eight times, and detected at least 25 percent of the time in the LCS, LDS, HTW, and GMA wells. Refined baseline constituents are listed in Table 2–3 of Appendix B of the OSDF GWLMP. Also included in Table 2–3 are common ion constituents. A summary statistics table (refer to Table A.5.7–1) and concentration plots (Figures A.5.7–11A through A.5.7–15B) are provided for the five baseline constituents of Cell 7. For Cell 7, the five constituents are: total uranium, boron, total organic carbon, total organic halogen, and sulfate. Since 2005, total organic halogens concentrations are detected less than 25 percent of the time in the Great Miami Aquifer wells 22211 and 22212.

A.5.7.2 LCS Monitoring Results

Ohio Solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine if the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 7 LCS took place in May. Table A.5.7–3 summarizes the annual LCS sampling results for Cell 7, along with data collected in previous years.

Of the non refined baseline site specific constituents that have been sampled at least eight times, 10 have been detected at lest 25 percent of the time. Nine of the 10 constituents are common ion constituents (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, potassium, and sodium). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 7 will be determined based upon results of the common ion study.

The remaining constituent is technetium-99. Technetium-99 is a site specific leak detection parameter. It is not on the refined baseline list for Cell 7. If a site specific constituent (not of the refined baseline list) is detected in the LCS or LDS, then confirmatory sampling for that constituent will take place. As shown in Table A.5.7–3, technetium-99 has been detected in the Cell 7 LCS, but these detections were prior to the establishment of the refined baseline for Cell 7. Therefore confirmatory sampling for technetium-99 in the Cell 7 LCS is not required.

A.5.7.3 LDS Monitoring Results

Each year the LDS of Cell 7 is sampled for site specific baseline parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility.

In 2006, of the non-refined baseline constituents that have been sampled at least eight times, 10 have been detected at least 25 percent of the time (alkalinity, calcium, chloride, iron, magnesium, manganese, nitrate/nitrite, phosphorous, potassium, and sodium). All ten of these constituents are common ion constituents.

Table A.5.7–1. Summary Statistics for Cell 7

Note: The data used in this table have been standardized to quarterly.

Parameter	Horizon[a]	Monitoring Location	No. of Detected Samples	Total No. of Samples	Percent of Detects	Average[b]	Distribution Type[c]	Trend[d]	Serial Correlation[e]	Outliers[f,g]
Total Uranium (µg/L)	LCS	12344C	10	10	100%	147	Normal	Upward	Marg. Detect	
	LDS	12344D	9	9	100%	22.6	Normal	None	Insuff. Data	
	HTW	12344	12	12	100%	2.61	Lognormal	None	Not Detected	
	GMA-U	22212	9	10	90%	0.44	Normal	None	Not Detected	1.64 (Q1-04) 4.46 (Q1-05)
	GMA-D	22211	12	12	100%	0.80	Lognormal	None	Not Detected	
Boron (mg/L)	LCS	12344C	10	10	100%	0.821	Lognormal	None	Not Detected	
	LDS	12344D	9	9	100%	0.603	Lognormal	Downward	Insuff. Data	
	HTW	12344	7	12	58%	0.0225	Lognormal	Downward	Marg. Detect	
	GMA-U	22212	10	10	100%	0.0350	Normal	None	Not Detected	0.0247 (Q3-04) 0.0269 (Q4-04)
	GMA-D	22211	10	10	100%	0.0269	Normal	None	Not Detected	0.0230 U (Q3-04) 0.0276 U (Q4-04)
Total Organic Carbon (mg/L)	LCS	12344C	6	9	67%	1.84	Normal	None	Insuff. Data	
	LDS	12344D	9	9	100%	6.20	Normal	None	Insuff. Data	
	HTW	12344	10	12	83%	2.09	Lognormal	Marg. Down.	Detected	
	GMA-U	22212	8	12	67%	0.91	Lognormal	None	Not Detected	
	GMA-D	22211	7	12	58%	0.70	Undefined	None	Not Detected	
Total Organic Halogens (mg/L)	LCS	12344C	3	10	30%	0.0066	Lognormal	None	Not Detected	
	LDS	12344D	3	9	33%	0.0211	Lognormal	None	Insuff. Data	
	HTW	12344	4	12	33%	0.0128	Lognormal	None	Not Detected	
	GMA-U	22212	2	12	17%	0.0050	Undefined	None	Not Detected	
	GMA-D	22211	1	12	8%	0.0031	Undefined	None	Not Detected	
Sulfate (mg/L)	LCS	12344C	10	10	100%	1340	Normal	Upward	Detected	
	LDS	12344D	9	9	100%	1670	Lognormal	Downward	Insuff. Data	
	HTW	12344	12	12	100%	114	Normal	Downward	Detected	
	GMA-U	22212	11	11	100%	145	Normal	Upward	Detected	352 (Q1-05)
	GMA-D	22211	12	12	100%	219	Lognormal	Marg. Up.	Not Detected	

[a]LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well; GMA-U = upgradient Great Miami Aquifer; and GMA-D = downgradient Great Miami Aquifer

[b]Averages were determined based on the distribution assumption. "Approx. Normal" was treated as if it was normal, and "Approx. Lognormal" was treated as if it was lognormal. This was done to compensate for the skewed (lognormal) or non-skewed (normal) nature of the data to give a better estimate of the underlying average.

[c]Data distribution based on the Shapiro-Wilk statistic.

Normal: Normal assumption could not be rejected at the 5 percent level and has a higher probability value than the lognormal assumption.

Lognormal: Lognormal assumption could not be rejected at the 5 percent level and has a higher probability value than the normal assumption.

Approx. Normal (Approximately Normal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the normal destribution better than the lognormal distribution.

Approx. Lognormal (Approximately Lognormal): Normal and lognormal assumptions were rejected at the 5 percent level. However, the data fit the lognormal destribution better than the normal distribution.

Undefined: Normal and Lognormal Distribution assumptiions are both rejected or there are less than 25% detected values. "Average" is defined as the Median of the data.

[d]Trend based on nonparametric Mann-Kendall procedure. Note that "Marg. Down." is a marginally downward trend and "Marg. Up." is a marginally upward trend.

[e]Serial correlation based on Rank Von Neumann test. Note that "Insuff." = Insufficient.

[f]Outliers determined by Rosner's (for sample sizes greater than 25) or Dixon procedure (for sample sizes less than or equal to 25).

[g]Q = quarterly

U = Not Detected at that concentration

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Table A.5.7-2. Cell 7 Annual LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
Alkalinity as CaCO3 (mg/L)	8	8	100.0%	86	822	330	-	422 mg/L (2)	430 mg/L (2)	-	10 mg/L
Ammonia (mg/L)	3	1	33.3%	0.254	-	-	-	4.2 mg/L (0)	4.34 mg/L (0)	220 mg/L (0)	0.1 mg/L
Arsenic (mg/L)	3	1	33.3%	0.0015	-	-	0.05 mg/L (0)	0.029 mg/L (0)	0.019 mg/L (0)	0.191 mg/L (0)	0.02 mg/L
Barium (mg/L)	3	3	100.0%	0.0347	0.112	0.073	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Beryllium (mg/L)	3	2	66.7%	0.00017	0.00025	-	0.004 mg/L (0)	-	-	0.0343 mg/L (0)	0.001 mg/L
Cadmium (mg/L)	3	1	33.3%	0.0002	-	-	0.014 mg/L (0)	0.014 mg/L (0)	-	0.05 mg/L (0)	0.002 mg/L
Calcium (mg/L)	8	8	100.0%	153	650	401	-	159 mg/L (7)	172 mg/L (6)	1800 mg/L (0)	5 mg/L
Chloride (mg/L)	8	8	100.0%	26.7	109	67	-	7.3 mg/L (7)	45 mg/L (4)	8300 mg/L (0)	5 mg/L
Cobalt (mg/L)	3	3	100.0%	0.0016	0.0050	0.0028	0.17 mg/L (0)	0.0086 mg/L (0)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	3	3	100.0%	0.0059	0.0138	0.0104	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	7	100.0%	0.210	0.536	0.364	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	8	8	100.0%	1.84	18.7	6.1	-	5.72 mg/L (2)	6.35 mg/L (2)	21.3 mg/L (0)	0.1 mg/L
Lead (mg/L)	3	1	33.3%	0.0061	-	-	0.015 mg/L (0)	0.022 mg/L (0)	0.0016 mg/L (1)	0.0114 mg/L (0)	0.008 mg/L
Magnesium (mg/L)	8	8	100.0%	60.5	380	208	-	38.5 mg/L (8)	50.7 mg/L (8)	690 mg/L (0)	5 mg/L
Manganese (mg/L)	8	8	100.0%	0.0226	0.898	0.225	0.9 mg/L (0)	0.9 mg/L (0)	0.21 mg/L (3)	35 mg/L (0)	0.09 mg/L
Nickel (mg/L)	3	3	100.0%	0.0063	0.0175	0.0117	0.1 mg/L (0)	0.0514 mg/L (0)	0.0072 mg/L (2)	0.981 mg/L (0)	0.02 mg/L
Nitrate/Nitrite (mg/L)	9	5	55.6%	0.117	10.7	3.4	11[g] mg/L (0)	11 mg/L (0)	0.29 mg/L (4)	2670 mg/L (0)	1.1 mg/L
Phosphorus (mg/L)	7	3	42.9%	0.11	0.254	0.17	-	-	-	-	0.1 mg/L
Potassium (mg/L)	8	8	100.0%	8.12	61.4	30.9	-	1.96 mg/L (8)	17.2 mg/L (5)	12400 mg/L (0)	5 mg/L
Silicon (mg/L)	7	7	100.0%	2.84	10.6	6.0	-	-	-	15 mg/L (0)	0.015 mg/L
Sodium (mg/L)	8	8	100.0%	18.1	75.2	50.1	-	47.1 mg/L (5)	50 mg/L (5)	1300 mg/L (0)	5 mg/L
Technetium-99 (pCi/L)	8	4	50.0%	10.8	16.2	13.0	94 pCi/L (0)	22 pCi/L (0)	30 pCi/L (0)	6130 pCi/L (0)	10 pCi/L
Thallium (mg/L)	3	1	33.3%	0.00046	-	-	-	-	-	0.0028 mg/L (0)	0.02 mg/L
Total Dissolved Solids (mg/L)	4	4	100.0%	960	3840	2080	-	-	-	-	10 mg/L
Vanadium (mg/L)	3	1	33.3%	0.0051	-	-	0.038 mg/L (0)	0.012 mg/L (0)	0.005 mg/L (1)	0.299 mg/L (0)	0.02 mg/L
Zinc (mg/L)	3	3	100.0%	0.0142	0.154	0.063	0.021 mg/L (1)	0.02 mg/L (2)	0.35 mg/L (0)	1.78 mg/L (0)	0.015 mg/L

Note: Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information

[b]Rejected data qualified with an R or Z were not included.

[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.

[d]From Operable Unit 5 Record of Decision, Table 9-4.

[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.

[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.

[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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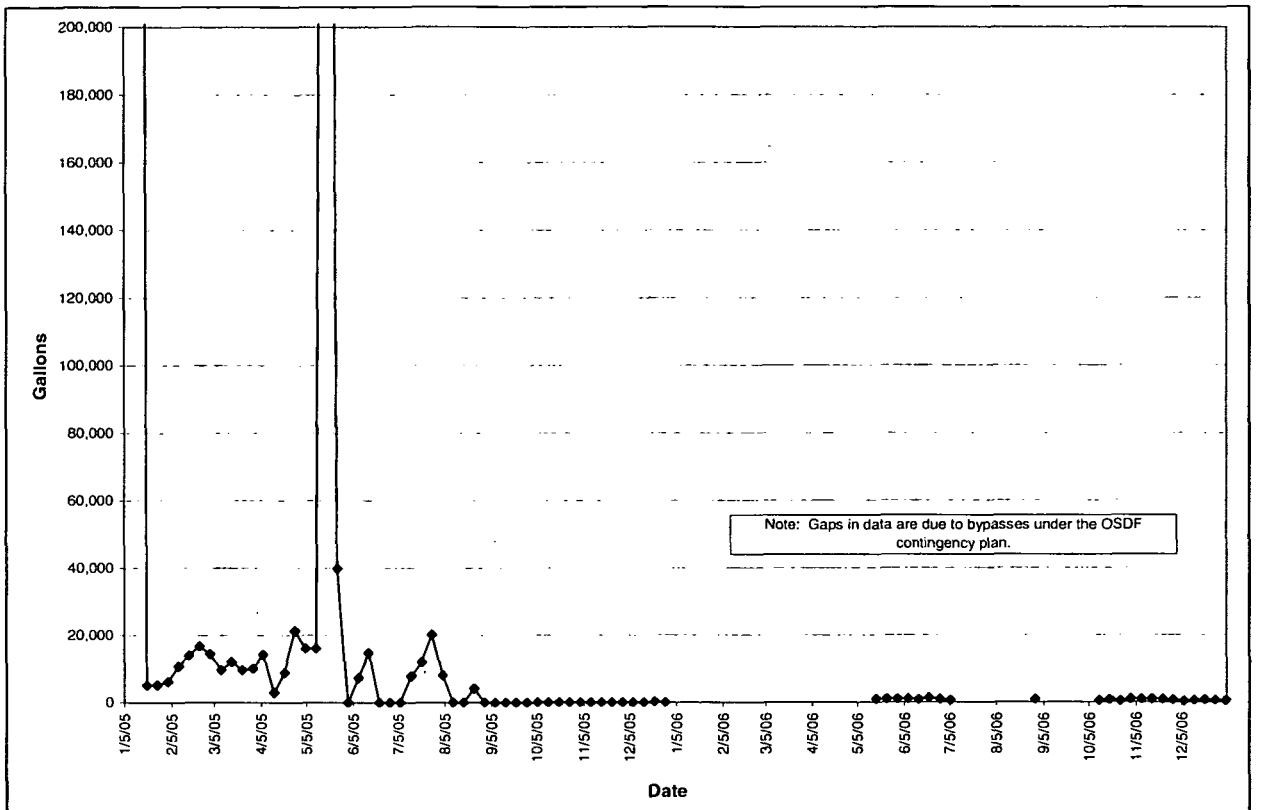


FIGURE A.5.7-1. Weekly Accumulation Volumes for Cell 7 LCS

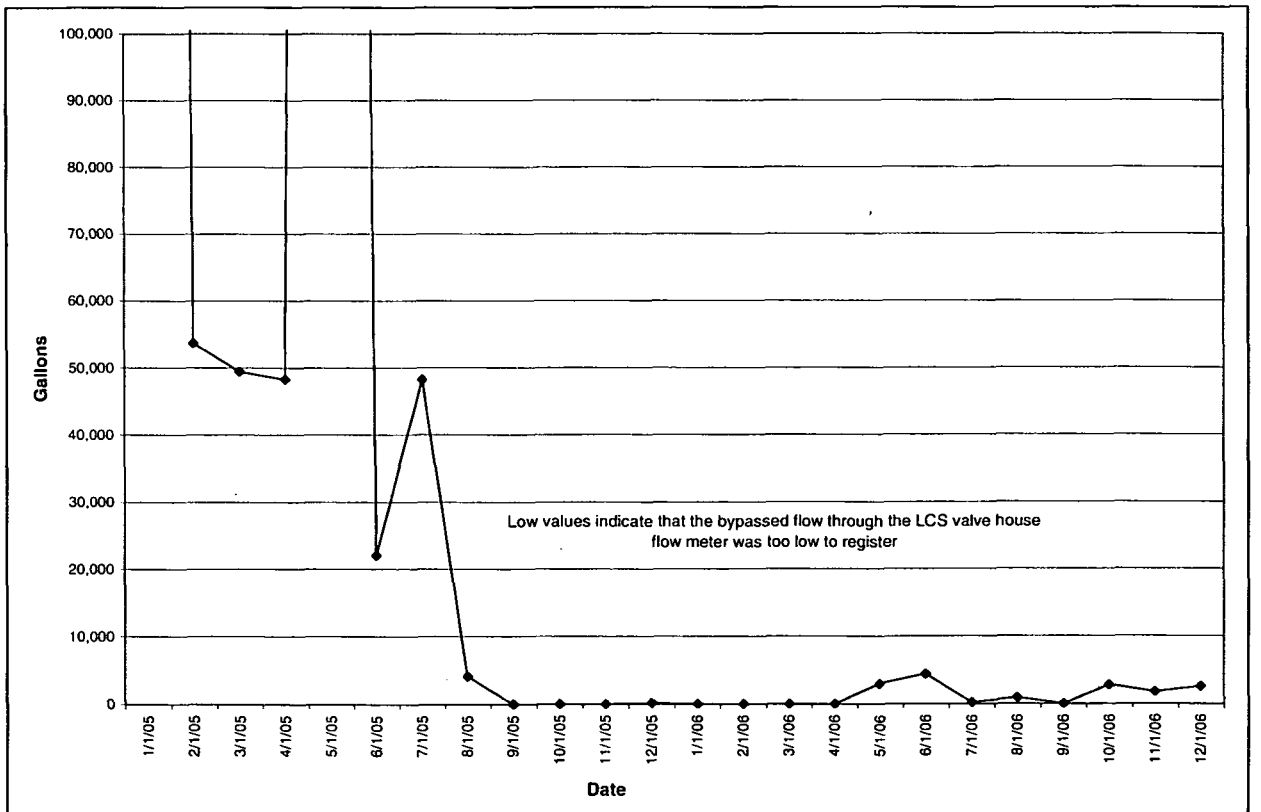


FIGURE A.5.7-2. Monthly Accumulation Volumes for Cell 7 LCS

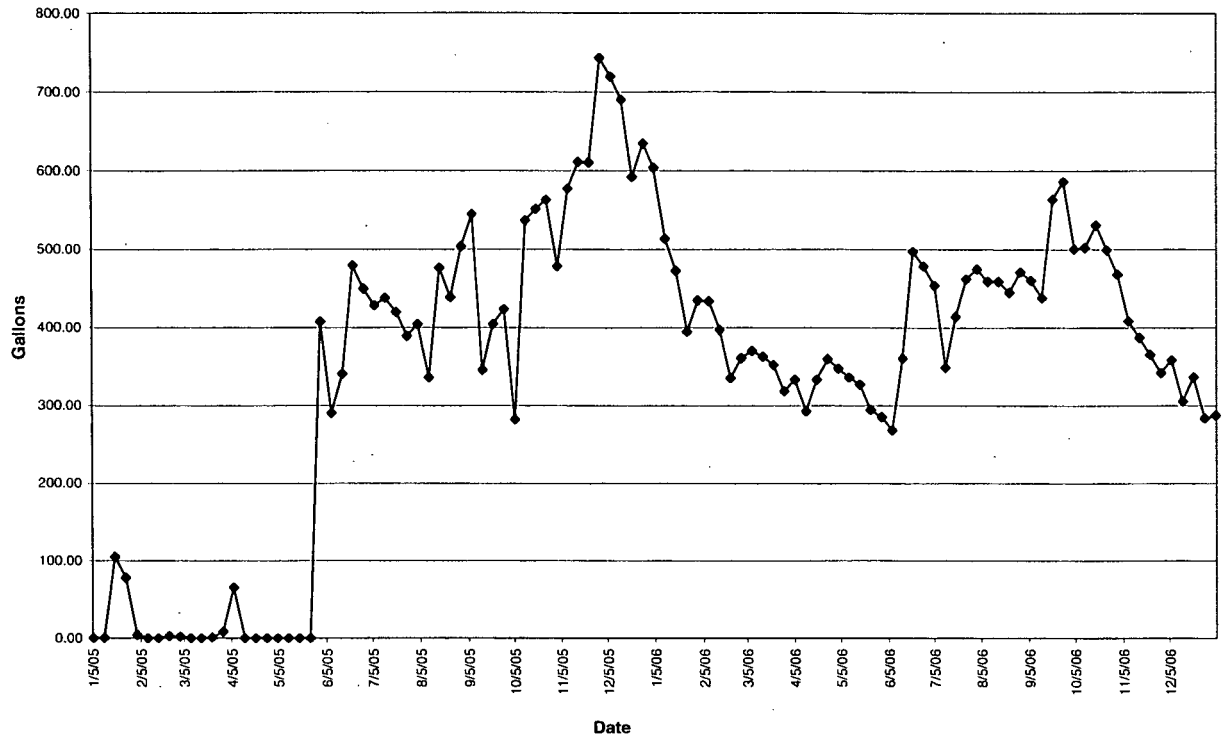


FIGURE A.5.7-3. Weekly Accumulation Volumes for Cell 7 LDS

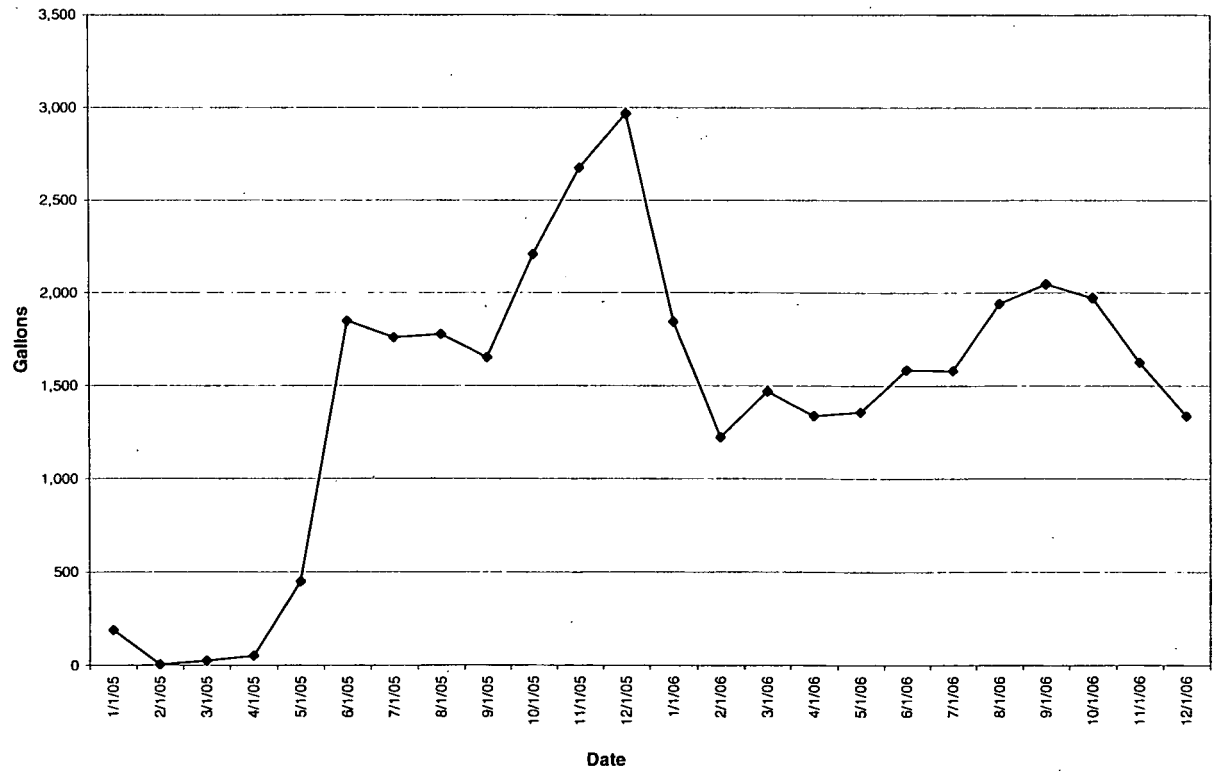


FIGURE A.5.7-4. Monthly Accumulation Volumes for Cell 7 LDS

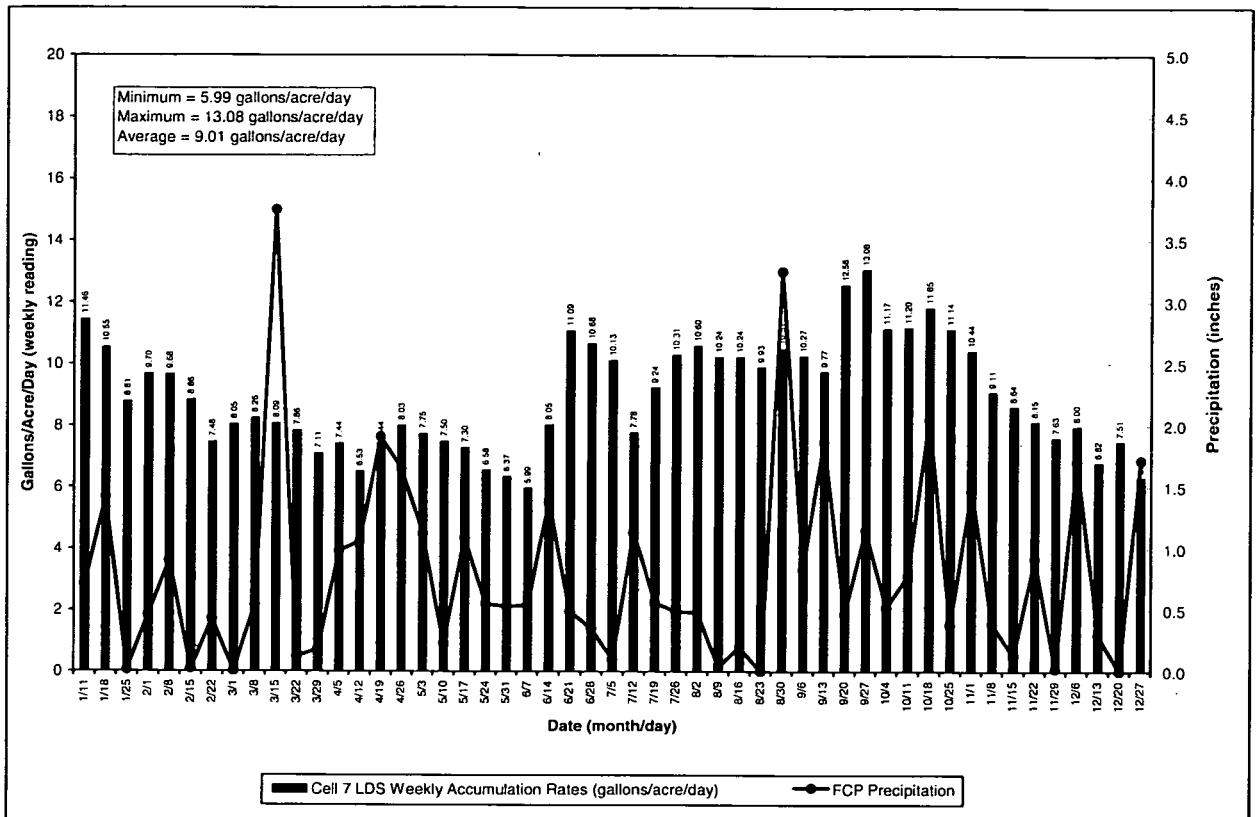


FIGURE A.5.7-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 7

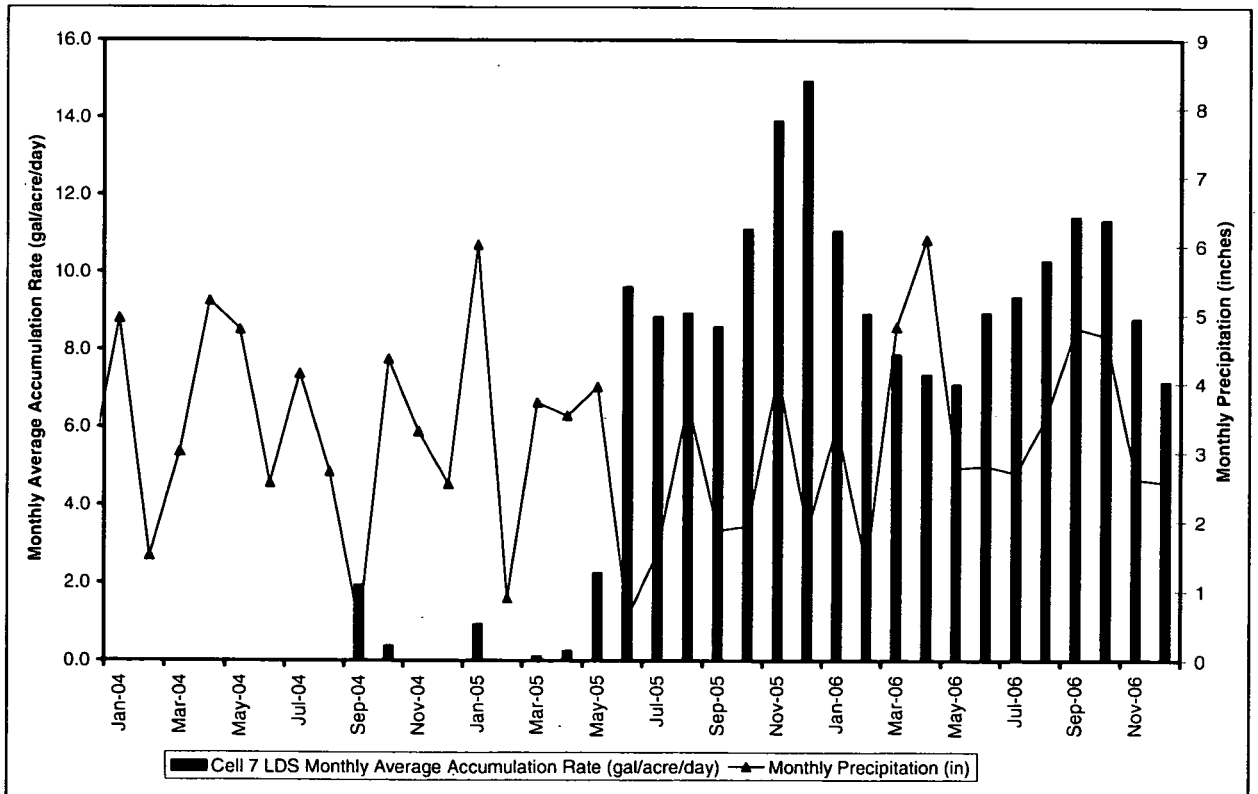


FIGURE A.5.7-6. OSDF Cell 7 LDS Monthly Average Accumulation Rates and Monthly Precipitation

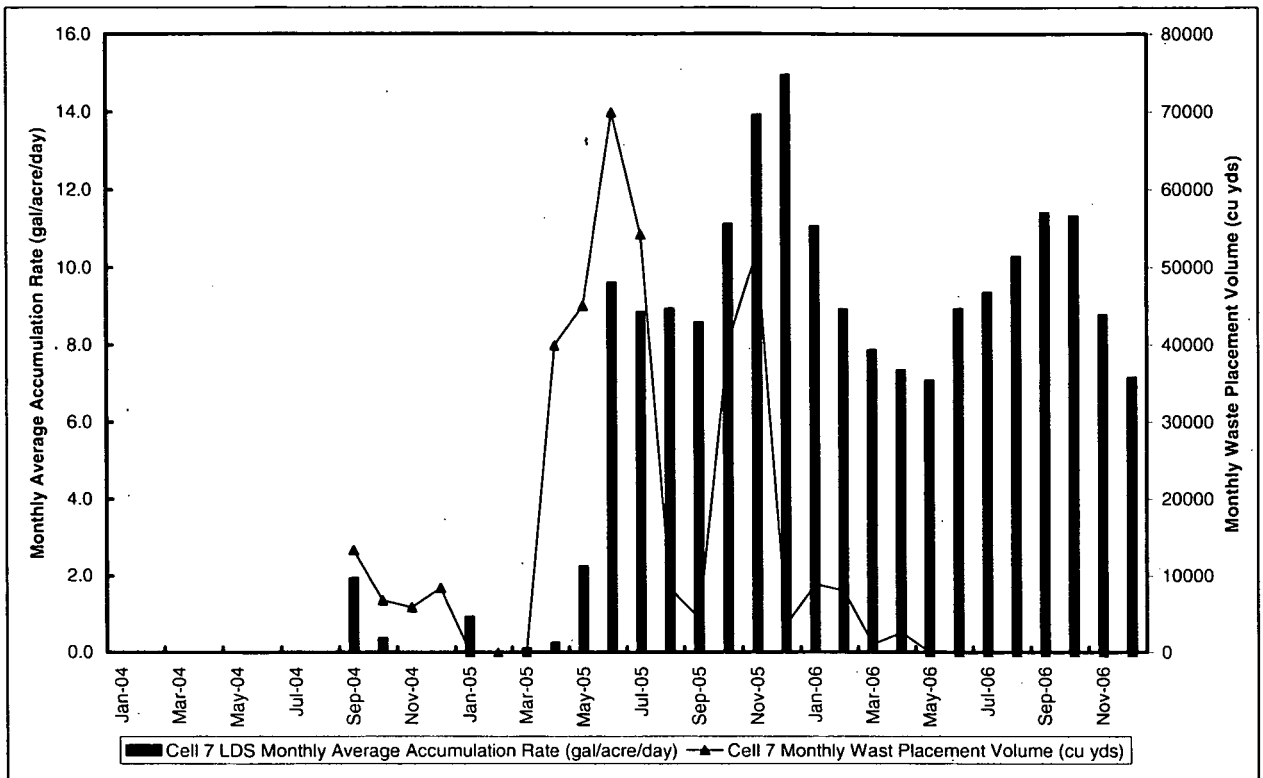
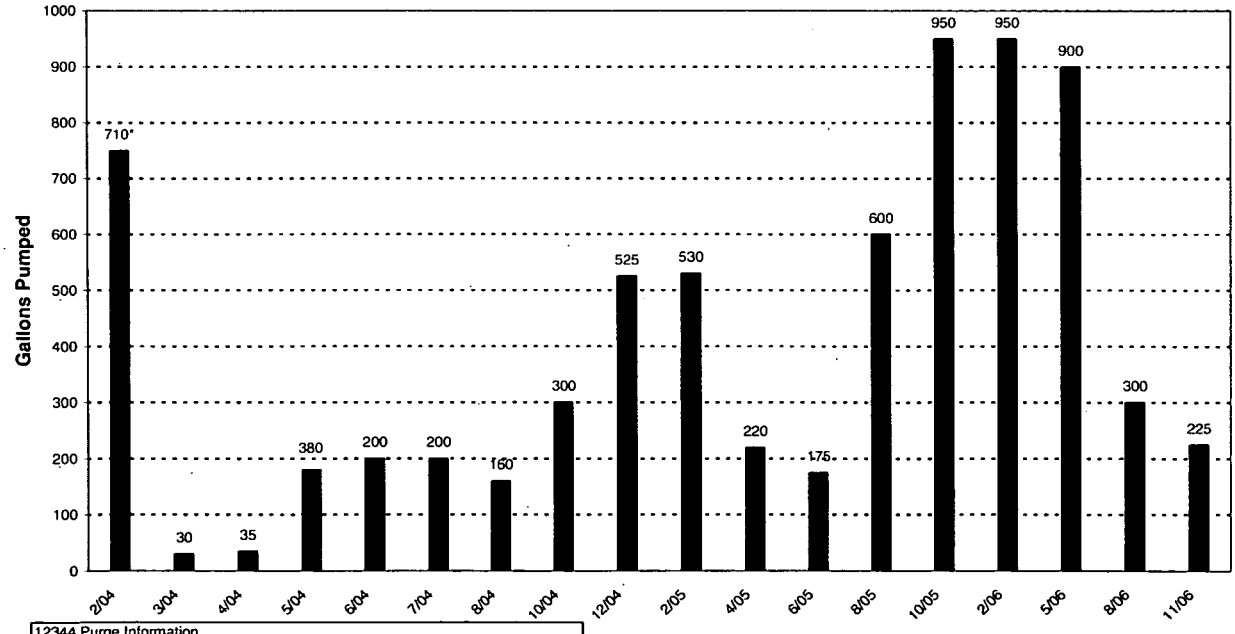


FIGURE A.5.7-7. OSDF Cell 7 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12344 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2004:	2380	n=9	264
2005:	2475	n=5	495
2006:	2375	n=4	594
Overall:			402

*More than one purge of the well was completed during this month to drain perched water and infiltrating surface water so the compacted clay liner could be constructed.

FIGURE A.5.7-8. OSDF Horizontal Till Well 12344 (Cell 7) Water Yield

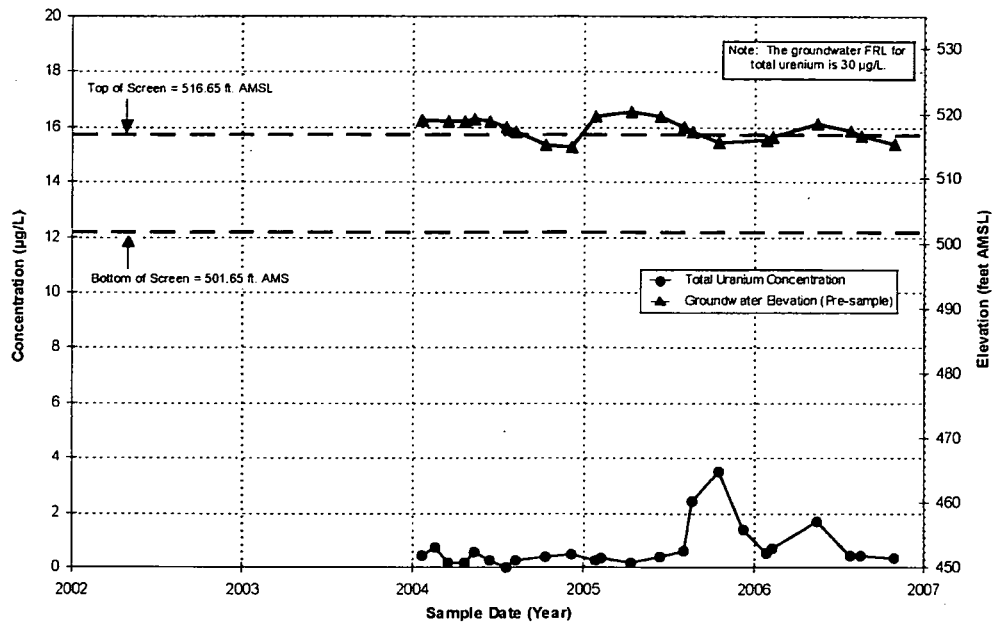


Figure A.5.7-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 7 Upgradient Monitoring Well 22212

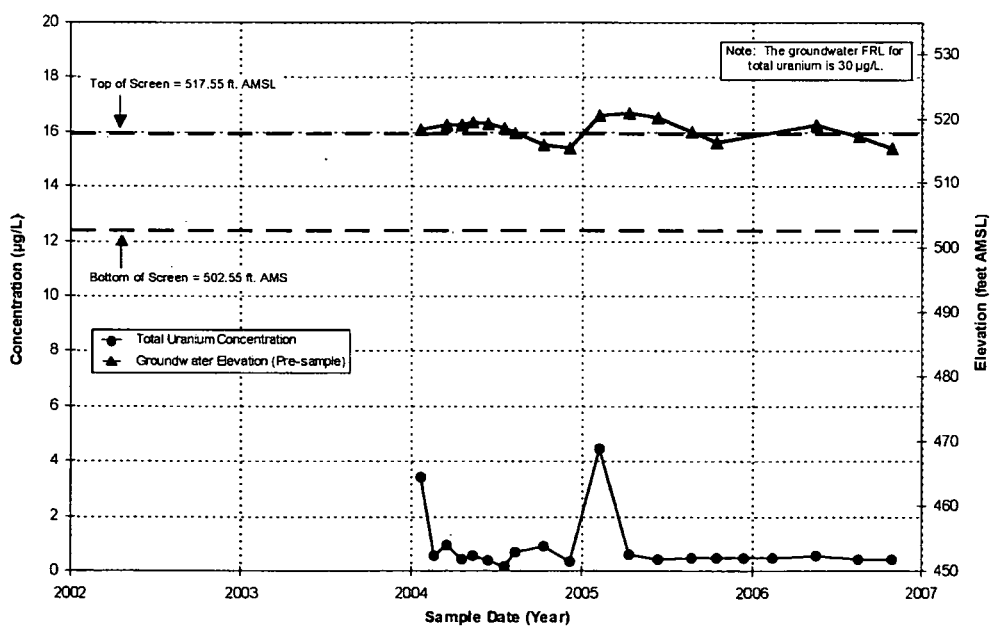


Figure A.5.7-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 7 Downgradient Monitoring Well 22211

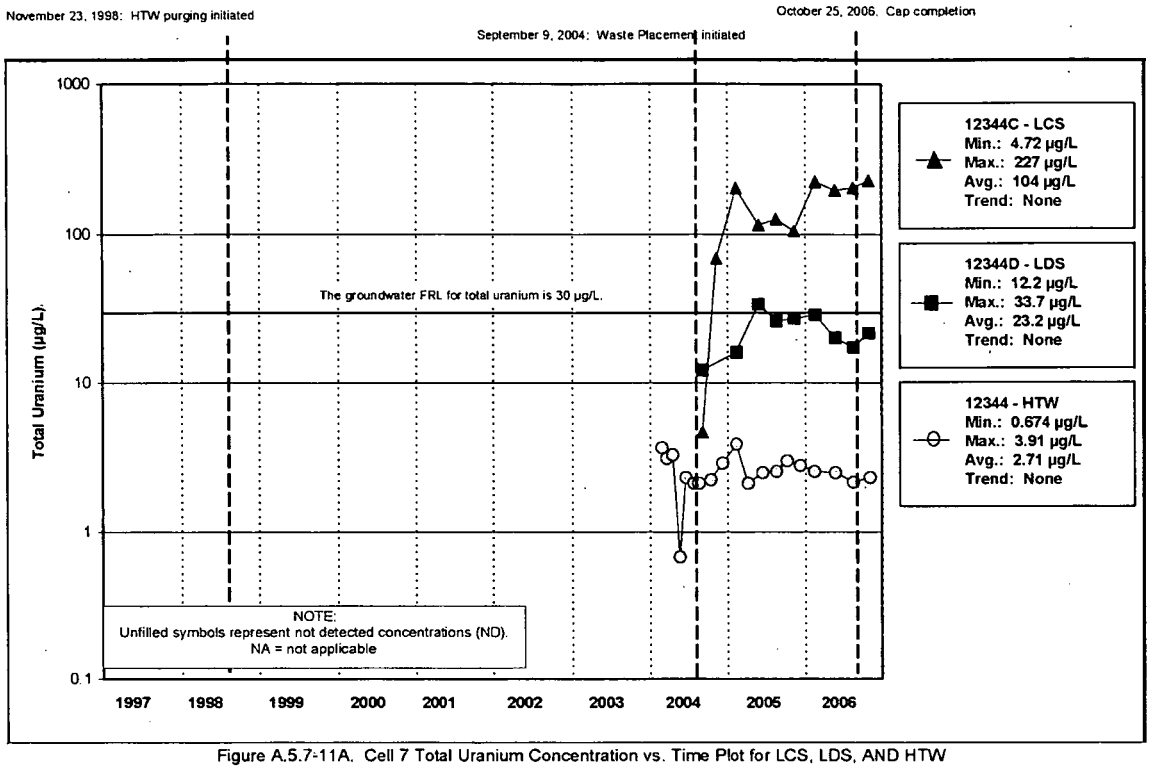


Figure A.5.7-11A. Cell 7 Total Uranium Concentration vs. Time Plot for LCS, LDS, AND HTW

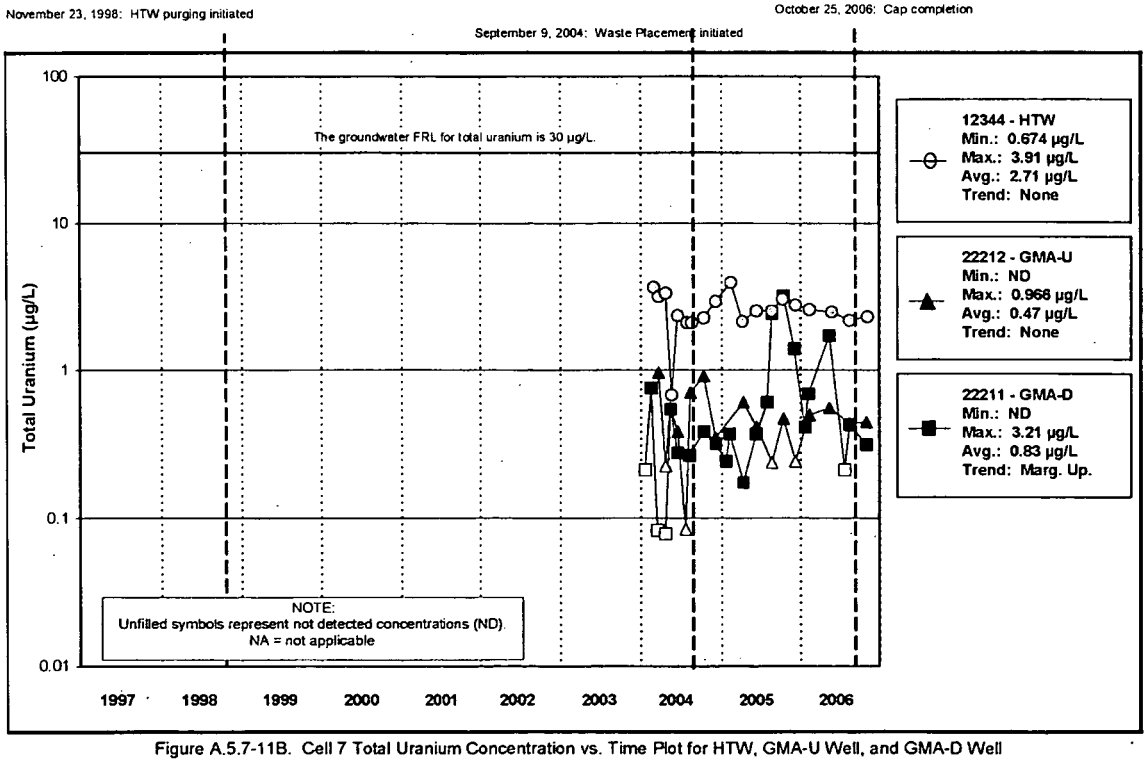


Figure A.5.7-11B. Cell 7 Total Uranium Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

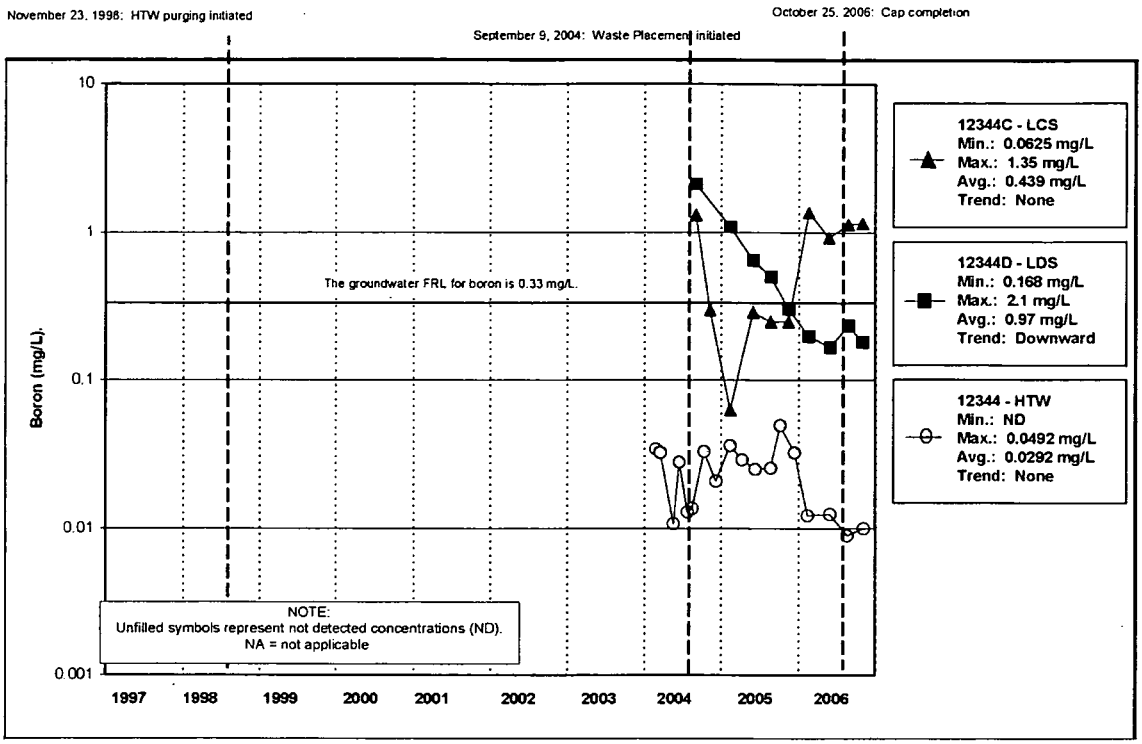


Figure A.5.7-12A. Cell 7 Boron Concentration vs. Time Plot for LCS, LDS, AND HTW

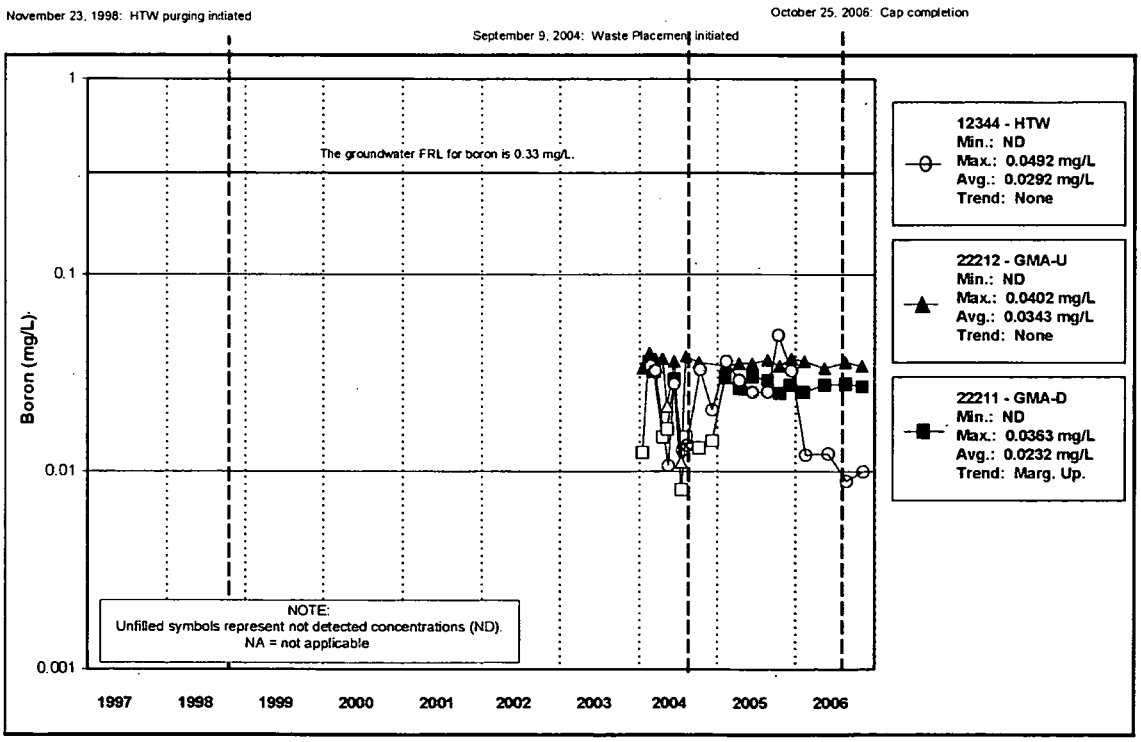


Figure A.5.7-12B. Cell 7 Boron Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

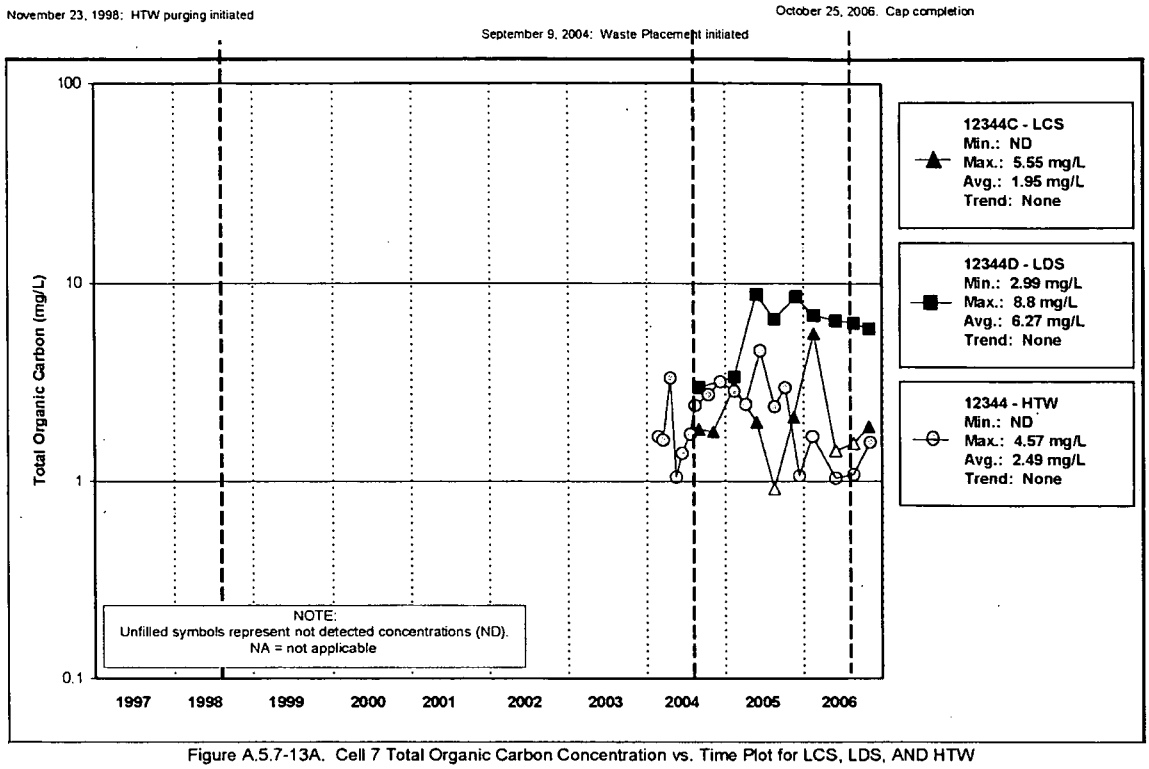


Figure A.5.7-13A. Cell 7 Total Organic Carbon Concentration vs. Time Plot for LCS, LDS, AND HTW

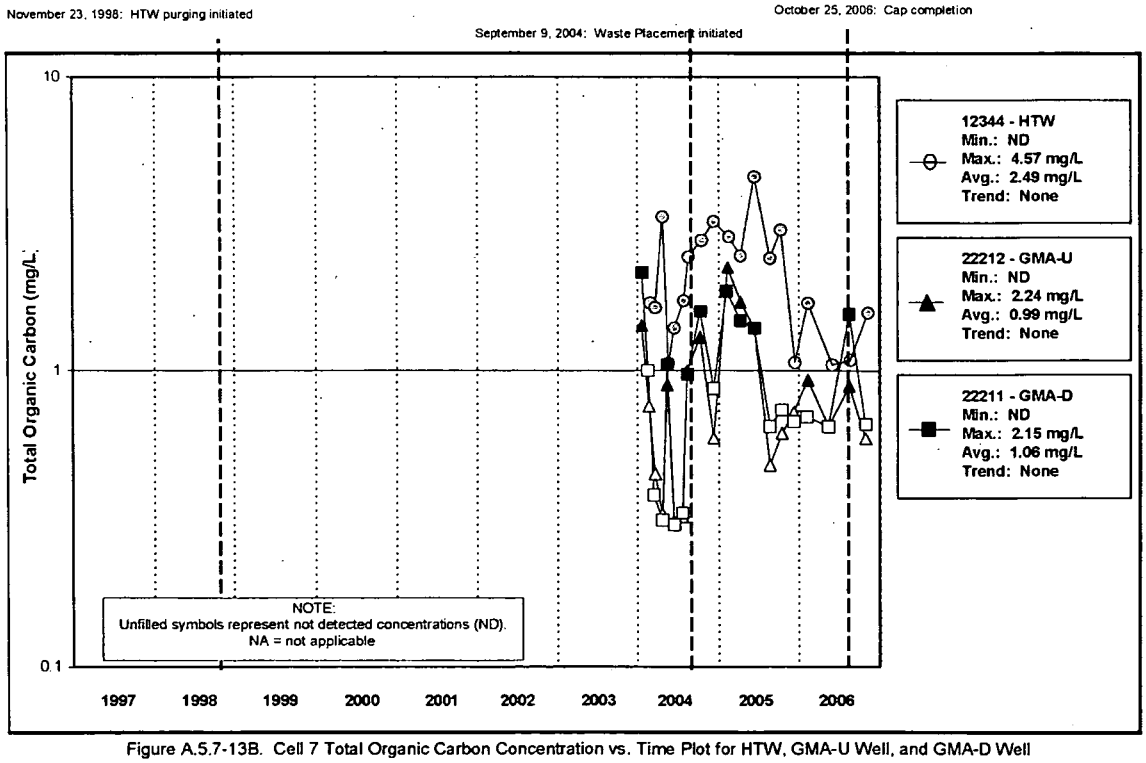


Figure A.5.7-13B. Cell 7 Total Organic Carbon Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

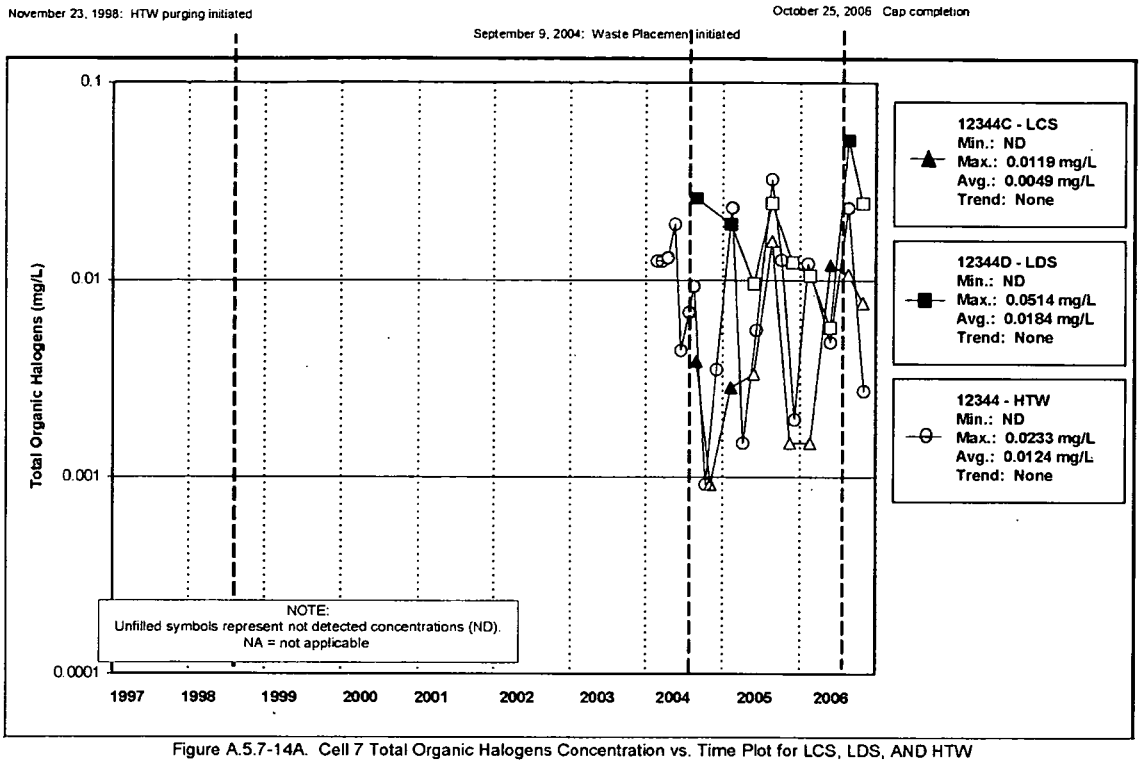


Figure A.5.7-14A. Cell 7 Total Organic Halogens Concentration vs. Time Plot for LCS, LDS, AND HTW

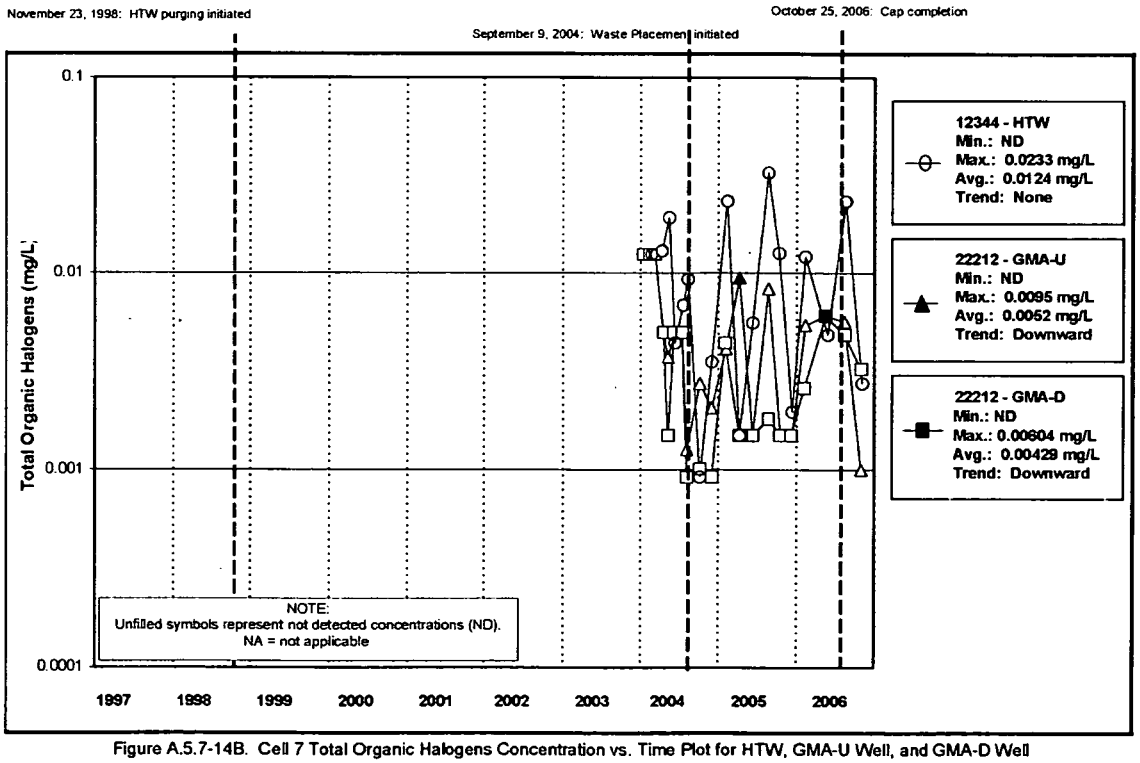


Figure A.5.7-14B. Cell 7 Total Organic Halogens Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

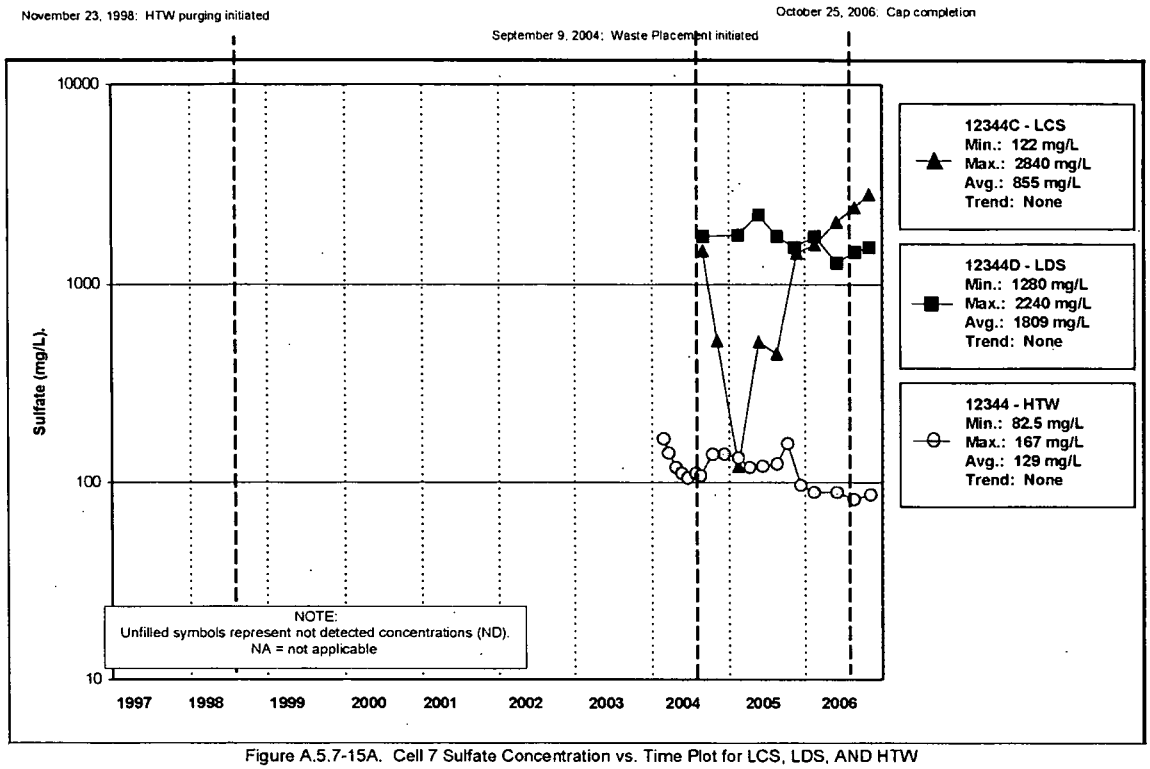


Figure A.5.7-15A. Cell 7 Sulfate Concentration vs. Time Plot for LCS, LDS, AND HTW

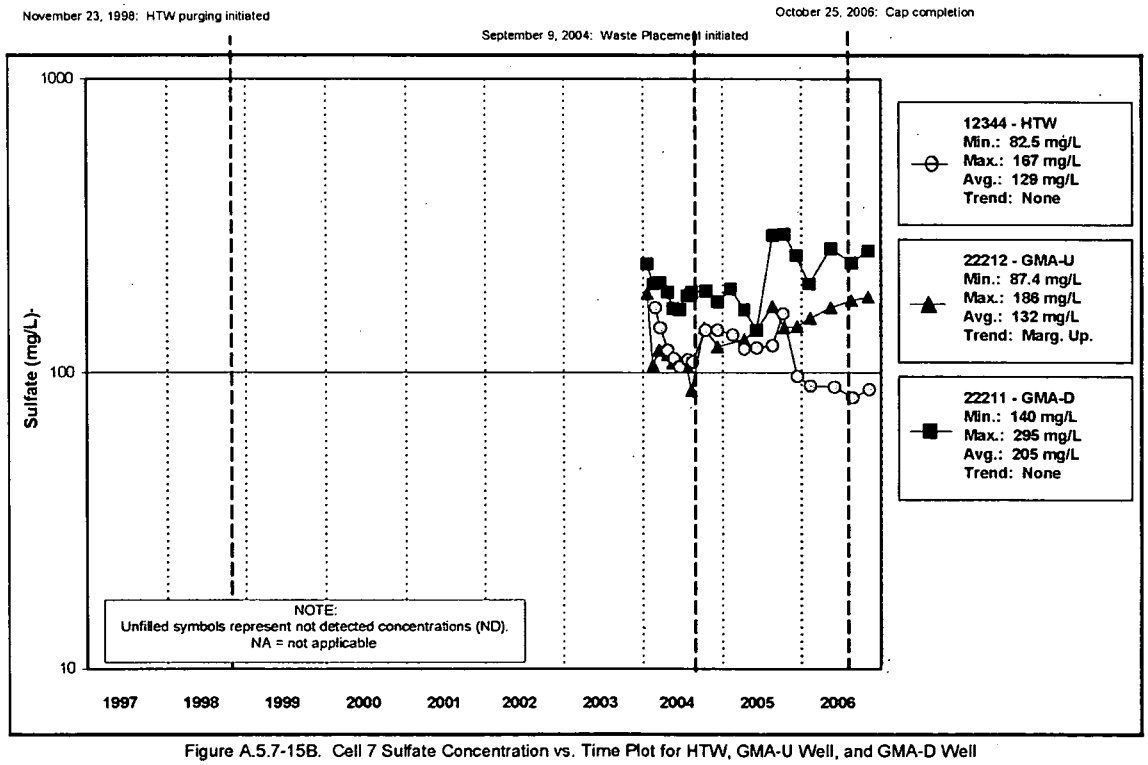


Figure A.5.7-15B. Cell 7 Sulfate Concentration vs. Time Plot for HTW, GMA-U Well, and GMA-D Well

Attachment A.5.8

Cell 8

The following information is provided in this subattachment:

- LCS weekly and monthly accumulation volumes (refer to Figures A.5.8–1 and A.5.8–2)
- LDS weekly and monthly accumulation volumes (refer to Figures A.5.8–3 and A.5.8–4)
- LDS weekly and monthly accumulation rates and precipitation (refer to Figures A.5.8–5 and A.5.8–6)
- LDS monthly average accumulation rates and waste placement volumes (refer to Figure A.5.8–7)
- HTW Water Yield (refer to Figure A.5.8–8)
- Great Miami Aquifer water levels and uranium concentrations versus time (refer to Figures A.5.8–9 and A.5.8–10)
- Summary of initial baseline constituents (refer to Section A.5.8.1 Table A.5.8–1)
- Annual LCS monitoring results (refer to Section A.5.8.2, and Table A.5.8–2)
- Annual LDS monitoring results (refer to Section A.5.8.3).

Samples for the OSDF monitoring horizons were collected according to the frequencies described in the OSDF GWLMP. Constituent sampling lists are provided in Table 2–1, Table 2–2, and Table 2–3 of Appendix B of the OSDF GWLMP. In 2006, Cell 8 was sampled for initial baseline constituents. All samples were collected from Cell 8 monitoring horizons.

A.5.8.1 Initial Baseline Monitoring Results

Initial baseline constituents are listed in Table 2–1 of Appendix B of the OSDF GWLMP. Table A.5.8–1 presents summary analytical information for Cell 8. The table shows that seven constituents were detected (i.e., total organic carbon, total organic halogens, boron, mercury, sulfate, technetium-99, and total uranium). Six of these constituents were detected more than 25 percent of the time. Mercury has not been detected more than 25 percent of the time and it has only been detected in the up gradient and down gradient GMA wells. Completion of 12 rounds of sampling for initial baseline constituents in all monitoring horizons of Cell 8 is scheduled for 2007. If the results for 2007 are similar to results through 2006, it appears that Cell 8 will have the same refined baseline list of sampling constituents as has Cell 1 through Cell 7.

A.5.8.2 LCS Sampling Results

Ohio solid Waste regulations (OAC 3745-27-19(M)(5)) require collection and analysis of leachate annually for Appendix I and polychlorinated biphenyl (PCB) parameters listed in OAC 3745-27-10. The objective of the annual LCS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility. A list of annual LCS sampling constituents is provided in Table 2–2 of Appendix B of the OSDF GWLMP. In 2006, annual sampling of the Cell 8 LCS took place in May. Table A.5.8–2 summarizes the annual LCS sampling results for Cell 8, along with data collected in previous years.

Of the non refined baseline site specific constituents that have been sampled at least eight times, four have been detected at least 25 percent of the time. Three of the four constituents are

common ion constituents (alkalinity, chloride, and nitrate/nitrite). Sampling for common ion constituents is temporary. Eight rounds of sampling are being conducted to support the common ion study. It is anticipated that eight rounds of sampling will be completed for all cells in August 2007. A decision concerning what common ion constituents (if any) will be added to the site specific leak detection monitoring list for Cell 8 will be determined based upon the results of the common ion study.

The remaining constituent is technetium-99. Technetium-99 is a site-specific leak detection parameter. A refined baseline list of Cell 8 has not yet been developed.

Two additional constituents (tetrachloroethene and trichloroethene) are also site specific detection constituents that have been detected in the Cell 8 LCS; however, the detection percentage for both constituents is only 11.1.

A.5.8.3 LDS Monitoring Results

Each year the LDS in Cell 8 is sampled for site specific baseline parameters listed in Table 2–1 of Appendix B of the OSDF GWLMP. As with the LCS, the objective of the annual LDS sampling is to determine whether the composition of the leachate within the facility is changing enough to impact monitoring activities beneath the facility.

In 2006, of the non-refined baseline constituents sampled, only one (alkalinity) has been sampled at least eight times and detected at least 25 percent of the time. Alkalinity is a common ion constituent.

Table A.5.8–1. Cell 8 Data Summary for Constituents Detected Through 2006

Constituent (FRL)[a,b]	LCS[b,c,d] (12345C) No. of Samples with Detections / No. of Samples	Range	LDS[b,c,d] (12345D) No. of Samples with Detections / No. of Samples	Range	HTW[b,c,d] (12345) No. of Samples with Detections / No. of Samples	Range	Upgradient[b,c,d] (22213) No. of Samples with Detections / No. of Samples	Range	Downgradient[b,c,d] (22214) No. of Samples with Detections / No. of Samples	Range	Southwest[b,c,d,e] (22215) No. of Samples with Detections / No. of Samples	Range	Southeast[b,c,d,e] (22216) No. of Samples with Detections / No. of Samples	Range	Southeast[b,c,d,e,f] (22217) No. of Samples with Detections / No. of Samples	Range
Boron	9/9	0.0681 to 0.74	8/8	0.659 to 2.4	14/14	0.0683 to 0.101	16/19	ND to 0.0392	13/19	ND to 0.0327	8/9	ND to 0.0347	4/4	0.0258 to 0.0321	2/3	ND to 0.0288
(0.33 mg/L)	***4/4***	***0.15 to 0.74***	***4/4***	***0.659 to 1.37***	***5/5***	***0.0683 to 0.0853***	***4/4***	***0.0346 to 0.0392***	***4/4***	***0.0255 to 0.0294***	***5/6***	***ND to 0.0347***	***1/1***	***0.0258***	***2/3***	***ND to 0.0288***
Trend	Up, Significant		Down, Significant		Down, Significant		No Significant Trend		No Significant Trend		Up, Significant		No Significant Trend		NA	
Mercury	0/9	ND	0/8	ND	0/14	ND	2/19	ND to 0.000085	1/19	ND to 0.000085	0/9	ND	0/4	ND	0/3	ND
(0.002 mg/L)	***0/4***	***ND***	***0/4***	***ND***	***0/5***	***ND***	***0/4***	***ND***	***0/4***	***ND***	***0/6***	***ND***	***0/1***	***ND***	***0/3***	***ND***
Trend	No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		NA	
Sulfate	9/9	146 to 2020	9/9	1730 to 2870	14/14	92.4 to 152	19/19	84.4 to 147	19/19	177 to 282	8/9	ND to 118	4/4	209 to 311	3/3	163 to 468
(N/A mg/L)	***4/4***	***317 to 2020***	***4/4***	***1730 to 2700***	***5/5***	***95.5 to 152***	***4/4***	***114 to 147***	***4/4***	***191 to 254***	***5/6***	***ND to 118***	***1/1***	***209***	***3/3***	***163 to 468***
Trend	Up, Marginal		No Significant Trend		No Significant Trend		Up, Significant		No Significant Trend		No Significant Trend		No Significant Trend		NA	
Technetium-99	5/9	ND to 70.2	0/8	ND	0/14	ND	4/19	ND to 24.8	3/19	ND to 11.8	0/9	ND	2/4	ND to 8.9	0/3	ND
(94 pCi/L)	***4/4***	***8.39 to 70.2***	***0/4***	***ND***	***0/5***	***ND***	***2/4***	***ND to 24.8***	***2/4***	***ND to 11.8***	***0/6***	***ND***	***1/1***	***8.9***	***0/3***	***ND***
Trend	Up, Significant		No Significant Trend		No Significant Trend		Up, Significant		Up, Significant		No Significant Trend		Up, Significant		NA	
Total Organic Carbon	7/9	ND to 5.31	7/8	ND to 5.45	6/14	ND to 2.14	11/19	ND to 3.77	10/19	ND to 3.28	2/9	ND to 1.19	0/4	ND	2/3	ND to 1.15
(N/A mg/L)	***2/4***	***ND to 3.68***	***4/4***	***3.24 to 5.45***	***1/5***	***ND to 1.62***	***2/4***	***ND to 1.1***	***1/4***	***ND to 1.28***	***2/6***	***ND to 1.19***	***0/1***	***ND***	***2/3***	***ND to 1.15***
Trend	No Significant Trend		Up, Significant		No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		NA	
Total Organic Halogens	2/9	ND to 0.0449	3/8	ND to 0.0794	8/14	ND to 0.0947	1/19	ND to 0.00622	2/19	ND to 0.00736	1/9	ND to 0.0121	0/4	ND	1/3	ND to 0.0199
(N/A mg/L)	***2/4***	***ND to 0.0449***	***0/4***	***ND***	***1/5***	***ND to 0.0439***	***0/4***	***ND***	***0/4***	***ND***	***1/6***	***ND to 0.0121***	***0/1***	***ND***	***1/3***	***ND to 0.0199***
Trend	Up, Marginal		No Significant Trend		No Significant Trend		No Significant Trend		No Significant Trend		Up, Marginal		No Significant Trend		NA	
Uranium, Total	9/9	1.51 to 181	8/8	9.38 to 30.1	14/14	3.48 to 5.89	9/19	ND to 0.421	19/23	ND to 1.53	5/9	ND to 0.625	3/4	ND to 1.65	3/3	1.3 to 8.1
(30 ug/L)	***4/4***	***78.5 to 181***	***4/4***	***14.3 to 30.1***	***5/5***	***3.8 to 4.72***	***2/4***	***ND to 0.421***	***2/4***	***ND to 1.23***	***4/6***	***ND to 0.486***	***1/1***	***1.65***	***3/3***	***1.3 to 8.1***
Trend	Up, Significant		Up, Significant		No Significant Trend		Up, Significant		No Significant Trend		No Significant Trend		Up, Significant		NA	

Note: Non-italicized pertains to total number of samples. ***Italicized/bold*** pertains to samples collected in 2006 only. ***Italicized/bold/larger font size*** pertains to new maximums.
Note: Shading indicates at least 25% detections for that constituent at that location.

[a]From Operable Unit 5 Record of Decision, Table 9-4.
[b]NA = not applicable; ND = not detected; LCS = leachate collection system; LDS = leak detection system; HTW = horizontal till well
[c]If there was more than one sample result per day (e.g., a duplicate sample), only the maximum sample concentration was counted and compared to the FRL.
[d]Rejected data qualified with either an R or Z were not used in this comparison.
[e]Southwest (22215) and Southeast (22216 and 22217) Great Maimi Aquifer wells close-out the south side of the OSDF.
[f]There must be at least four samples for trend to be computed.

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Table A.5.8–2. Cell 8 LCS Sample Summary Information

PARAMETER(UNIT)	NUMBER OF SAMPLES[a,b]	NUMBER OF SAMPLES WITH DETECTIONS[a,b]	PERCENT OF DETECTIONS[a,b]	MIN DETECTED CONCENTRATION[a,b,c]	MAX DETECTED CONCENTRATION[a,b,c]	AVG DETECTED CONCENTRATION[a,b,c]	GW FRL[d] (#OF SAMPLES>GWFRL)	GW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	PW BACKGROUND[a,b,e] (# OF SAMPLES>PW BACKGROUND)	MAX PW DETECTED CONCENTRATION [a,b,f] (# OF SAMPLES>MAX PW)	DETECTION LIMIT
Alkalinity as CaCO3 (mg/L)	8	8	100.0%	64.9	418	222	-	422 mg/L (0)	430 mg/L (0)	-	10 mg/L
Aroclor-1260 (ug/L)	3	1	33.3%	0.058	-	-	-	-	-	-	0.1 ug/L
Barium (mg/L)	3	3	100.0%	0.046	0.103	0.073	2 mg/L (0)	0.77 mg/L (0)	0.45 mg/L (0)	0.589 mg/L (0)	0.029 mg/L
Calcium (mg/L)	**6**	**6**	**100.0%**	**65.4**	**340**	**192**	**-**	**159 mg/L (4)**	**172 mg/L (3)**	**1800 mg/L (0)**	**5 mg/L**
Chloride (mg/L)	**8**	**8**	**100.0%**	**18.9**	**166**	**77**	**-**	**7.3 mg/L (8)**	**45 mg/L (5)**	**6300 mg/L (0)**	**5 mg/L**
Cobalt (mg/L)	3	3	100.0%	0.00067	0.0019	0.0011	0.17 mg/L (0)	0.0086 mg/L (0)	-	0.0886 mg/L (0)	0.034 mg/L
Copper (mg/L)	3	2	66.7%	0.0035	0.005	-	1.3 mg/L (0)	0.035 mg/L (0)	0.029 mg/L (0)	0.298 mg/L (0)	0.008 mg/L
Fluoride (mg/L)	7	7	100.0%	0.105	0.519	0.325	4 mg/L (0)	0.89 mg/L (0)	1.3 mg/L (0)	6.8 mg/L (0)	0.2 mg/L
Iron (mg/L)	6	6	100.0%	0.735	2.09	1.70	-	5.72 mg/L (0)	6.35 mg/L (0)	21.3 mg/L (0)	0.1 mg/L
Magnesium (mg/L)	**6**	**6**	**100.0%**	**21.9**	**117**	**68**	**-**	**38.5 mg/L (4)**	**50.7 mg/L (2)**	**690 mg/L (0)**	**5 mg/L**
Manganese (mg/L)	6	6	100.0%	0.0157	0.170	0.067	0.9 mg/L (0)	0.9 mg/L (0)	0.21 mg/L (0)	35 mg/L (0)	0.09 mg/L
Nickel (mg/L)	**3**	**3**	**100.0%**	**0.0049**	**0.0096**	**0.0072**	**0.1 mg/L (0)**	**0.0514 mg/L (0)**	**0.0072 mg/L (2)**	**0.981 mg/L (0)**	**0.02 mg/L**
Nitrate/Nitrite (mg/L)	**8**	**7**	**87.5%**	**1.52**	**44.6**	**18.4**	**11 mg/L[g] (3)**	**11 mg/L (3)**	**0.29 mg/L (7)**	**2670 mg/L (0)**	**1.1 mg/L**
Phosphorus (mg/L)	5	2	40.0%	0.0511	0.103	-	-	-	-	-	0.1 mg/L
Potassium (mg/L)	**6**	**6**	**100.0%**	**4.86**	**16.4**	**10.8**	**-**	**1.96 mg/L (6)**	**17.2 mg/L (0)**	**12400 mg/L (0)**	**5 mg/L**
Silicon (mg/L)	5	5	100.0%	1.76	12.4	5.7	-	-	-	15 mg/L (0)	0.015 mg/L
Sodium (mg/L)	6	6	100.0%	16.8	46.7	28.0	-	47.1 mg/L (0)	50 mg/L (0)	1300 mg/L (0)	5 mg/L
Technetium-99 (pCi/L)	**9**	**5**	**55.6%**	**8.39**	**70.2**	**40.8**	**94 pCi/L (0)**	**22 pCi/L (3)**	**30 pCi/L (3)**	**6130 pCi/L (0)**	**10 pCi/L**
Tetrachloroethene (ug/L)	9	1	11.1%	1.24	-	-	-	-	-	-	1 ug/L
Thallium (mg/L)	3	1	33.3%	0.00057	-	-	-	-	-	0.0028 mg/L (0)	0.02 mg/L
Total Dissolved Solids (mg/L)	3	3	100.0%	882	1820	1380	-	-	-	-	10 mg/L
Trichloroethene (ug/L)	9	1	11.1%	1.11	-	-	5 ug/L (0)	-	-	-	1 ug/L
Vanadium (mg/L)	**3**	**1**	**33.3%**	**0.016**	**-**	**-**	**0.038 mg/L (0)**	**0.012 mg/L (1)**	**0.005 mg/L (1)**	**0.299 mg/L (0)**	**0.02 mg/L**
Zinc (mg/L)	3	1	33.3%	0.0138	-	-	0.021 mg/L (0)	0.02 mg/L (0)	0.35 mg/L (0)	1.78 mg/L (0)	0.015 mg/L

Note; Shading indicates that at least one detected sample is greater than the FRL, groundwater background, PW background, or PW maximum.

[a]If more than one sample is collected per well per day (e.g., duplicates), then only one sample is counted for the total number of samples, and the sample with the maximum representative concentration is used for all the summary information
[b]Rejected data qualified with an R or Z were not included.
[c]If the number of detected samples is equal to two, then the minumun and maximumn are reported. If the number of detected is equal to one, then the data point is reported as the minimum. The "AVG DETECTED CONCENTRATION" is not reported for either of these cases.
[d]From Operable Unit 5 Record of Decision, Table 9-4.
[e]From the Characterization of Background Water Quality for Streams and Groundwater which was developed for Operable Unit 5 RI/FS documents.
[f]Max PW - maximum detected concentration in perched water as defined in the Remedial Investigation Report for Operable Unit 5.
[g]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4.

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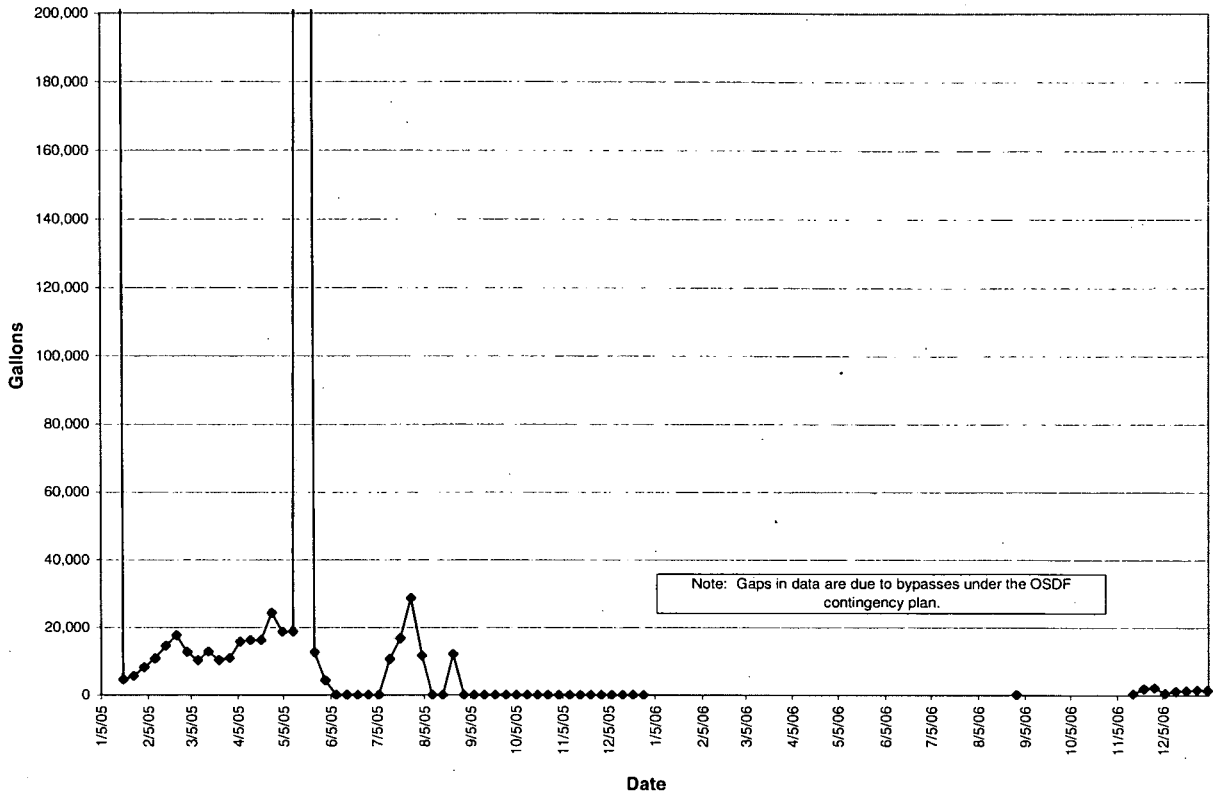


FIGURE A.5.8-1. Weekly Accumulation Volumes for Cell 8 LCS

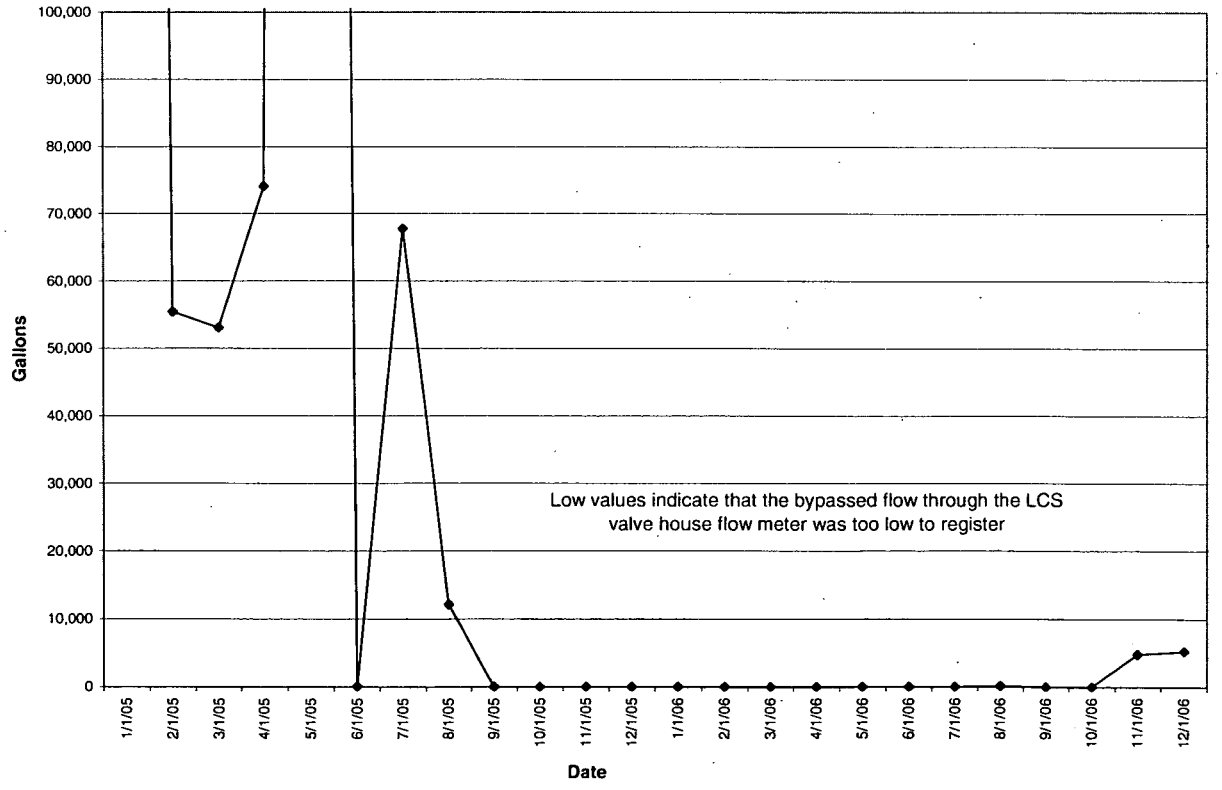


FIGURE A.5.8-2. Monthly Accumulation Volumes for Cell 8 LCS

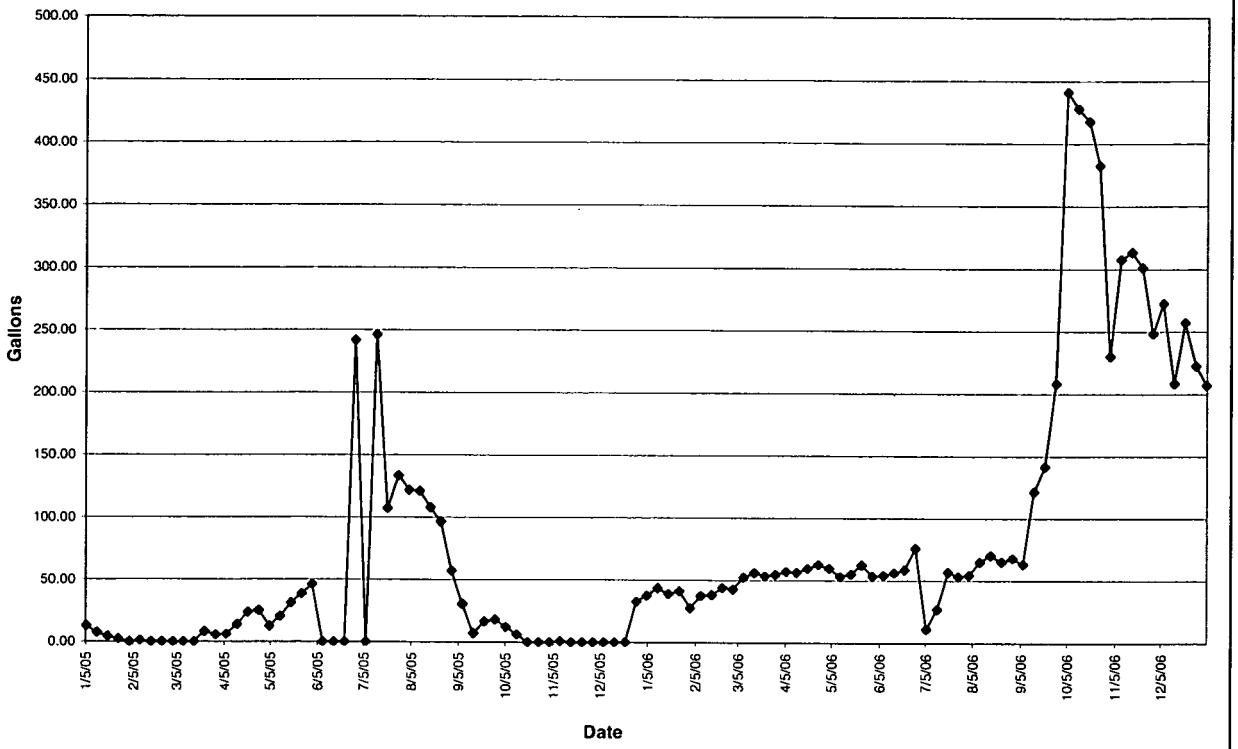


FIGURE A.5.8-3. Weekly Accumulation Volumes for Cell 8 LDS

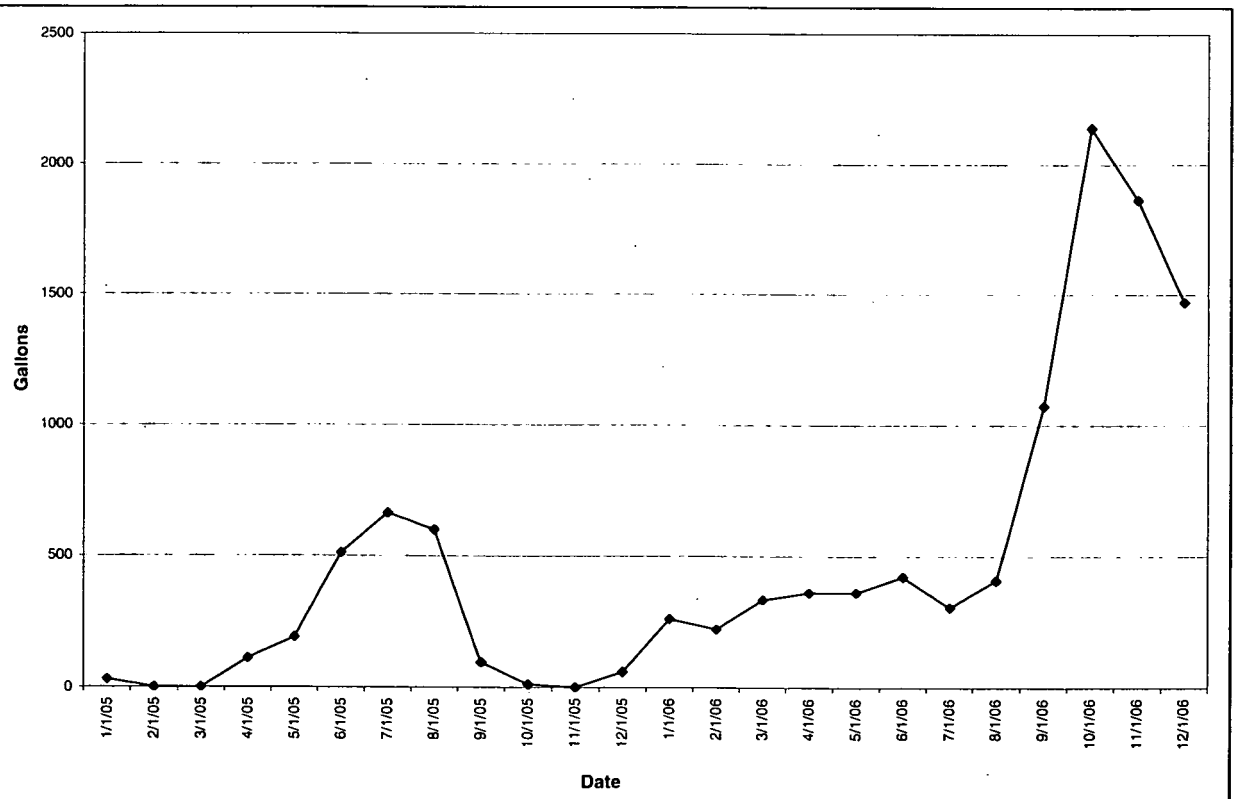


FIGURE A.5.8-4. Monthly Accumulation Volumes for Cell 8 LDS

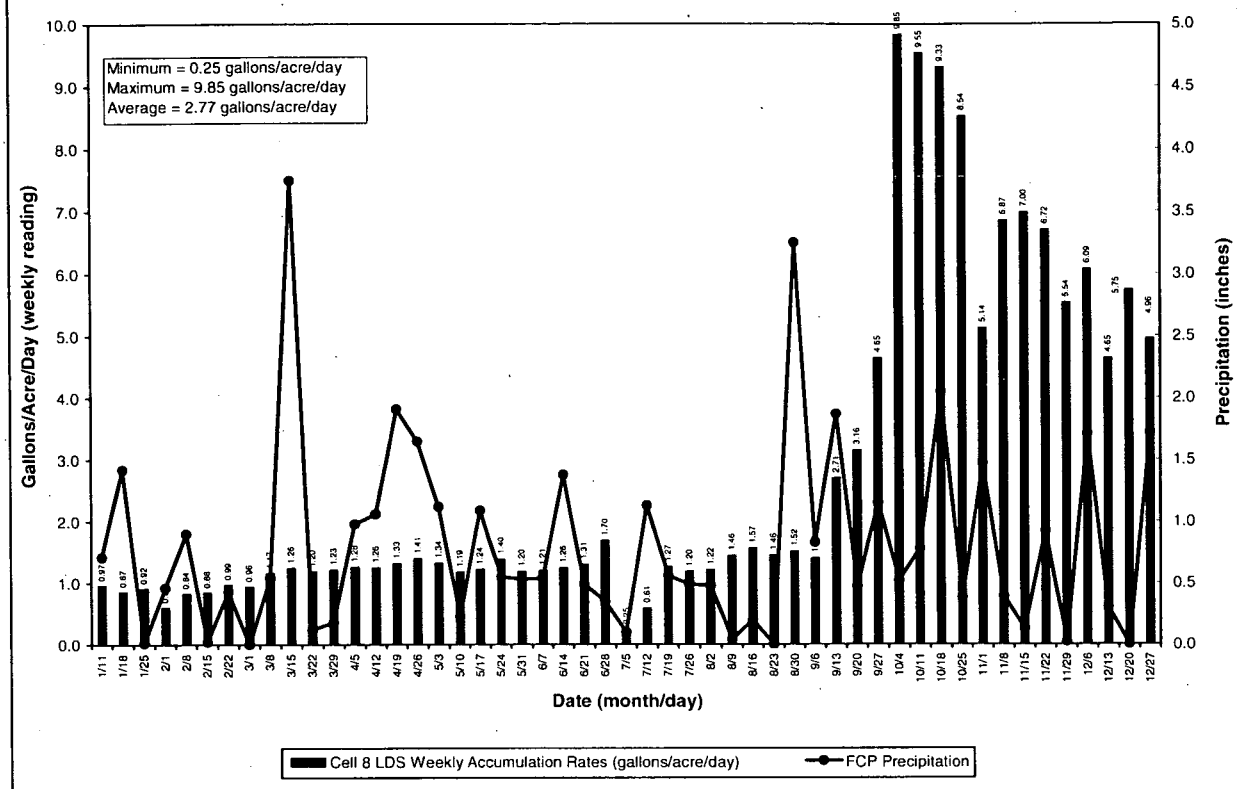


FIGURE A.5.8-5. 2006 OSDF LDS Weekly Accumulation Rates and Precipitation for Cell 8

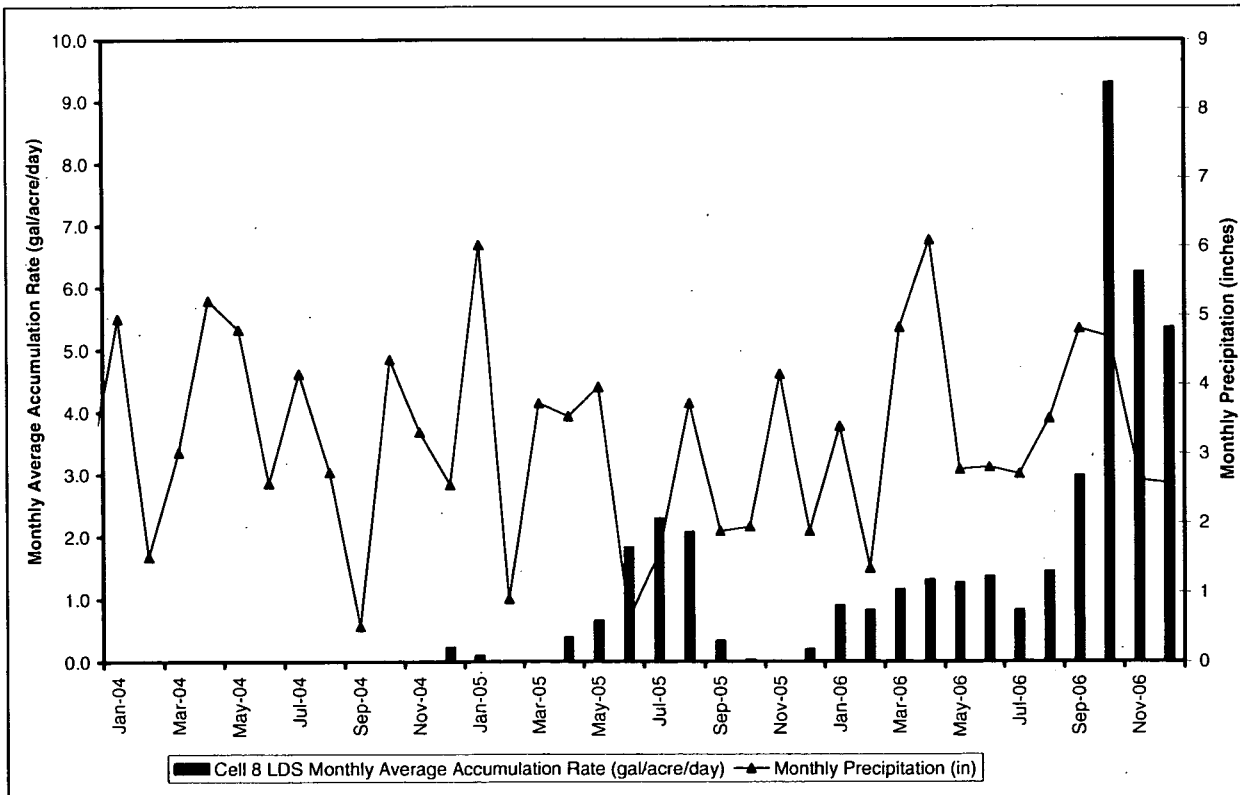


FIGURE A.5.8-6. OSDF Cell 8 LDS Monthly Average Accumulation Rates and Monthly Precipitation

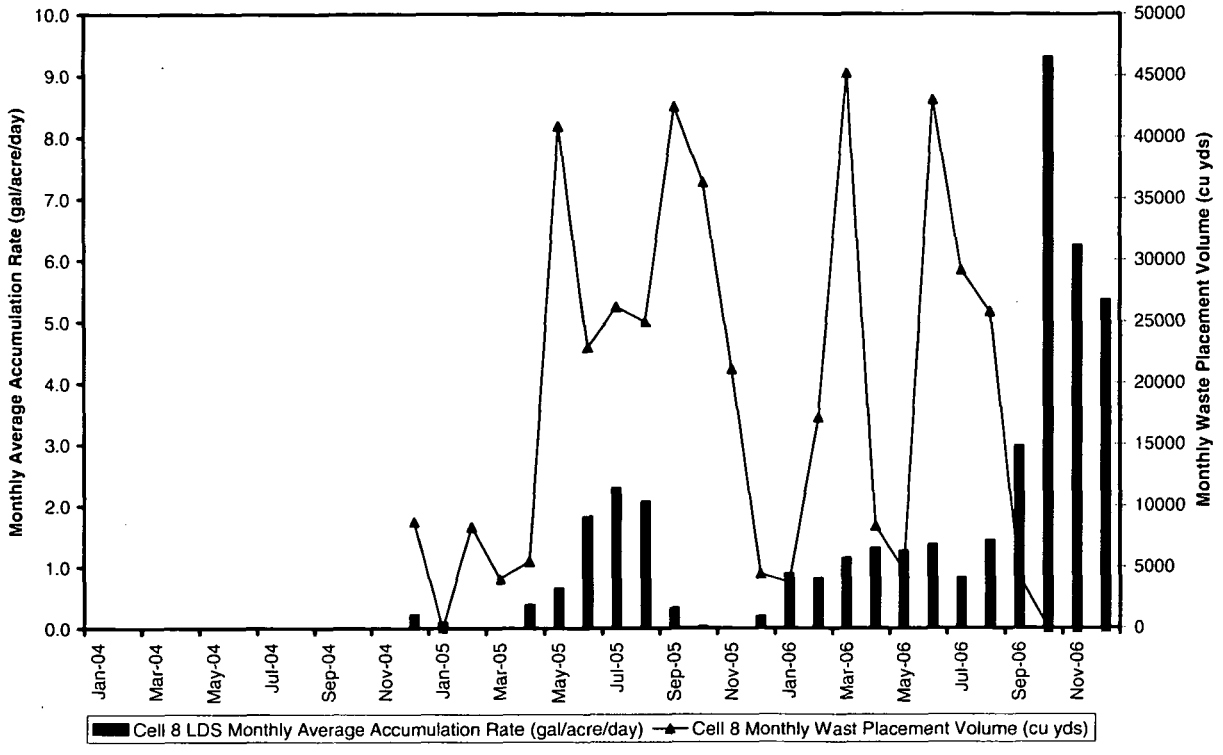
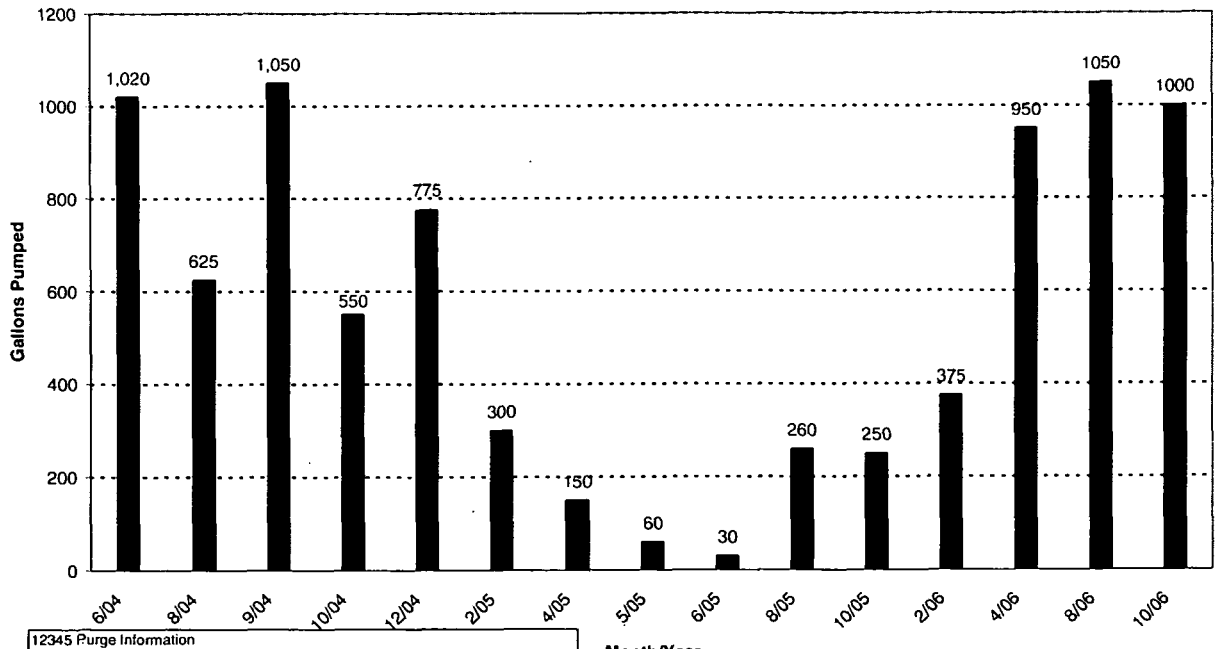


FIGURE A.5.8-7. OSDF Cell 8 LDS Monthly Average Accumulation Rates and Monthly Waste Placement Volumes



12345 Purge Information

Year	Total Volumes (gal.)	Months Purged	Avg. Monthly Purge (gal.)
2004:	4020	n=5	804
2005:	1050	n=6	175
2006:	3375	n=4	844
Overall:			563

FIGURE A.5.8-8. OSDF Horizontal Till Well 12345 (Cell 8) Water Yield

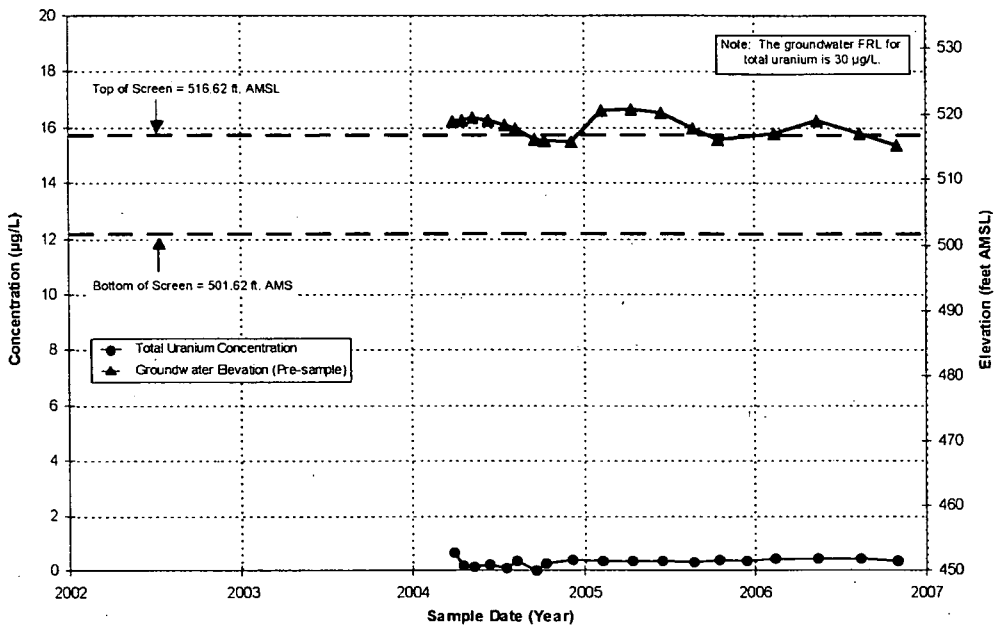


Figure A.5.8-9. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Upgradient Monitoring Well 22213

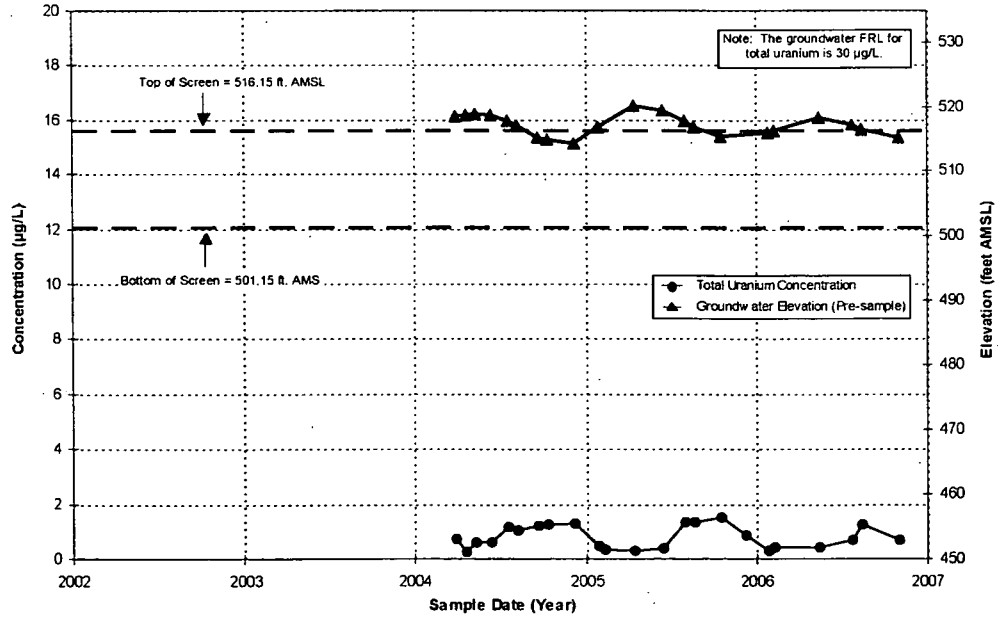


Figure A.5.8-10. Total Uranium Concentration and Groundwater Elevation vs. Time Plot for Cell 8 Downgradient Monitoring Well 22214

Appendix B

Supplemental Surface Water, Treated Effluent, and Sediment Information

Contents

Attachment B.1 Surface Water and Treated Effluent
Attachment B.2 Sediment

End of current text

List of Acronyms

AWWT	advanced wastewater treatment facility
CAWWT	converted advanced wastewater treatment facility
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facilities Compliance Agreement
FRL	final remediation level
IEMP	Integrated Environmental Monitoring Plan
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
PF	Parshall Flume
STP	sewage treatment plant
SWM Pond	Storm Water Management Pond
SWRB	Storm Water Retention Basin

List of Measurement Abbreviations

cfs	cubic feet per second
gpm	gallons per minute
µg/L	micrograms per liter
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
pCi/g	picoCuries per gram
pCi/L	picoCuries per liter

End of current text

Appendix B presents additional surface water, treated effluent, and sediment data in support of Chapter 4 of this 2006 Site Environmental Report. This appendix consists of two attachments as follows:

- Attachment B.1 provides an evaluation of the final remediation level (FRLs) exceedances for surface water and treated effluent including an assessment of potential cross-media impacts to the groundwater pathway. This attachment also provides information on any storm water-related bypasses pertaining to compliance with the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996) total uranium treated effluent discharge limits.
- Attachment B.2 provides additional details pertaining to the 2006 sediment analytical results and historical results for comparison purposes.

References

DOE (U.S. Department of Energy), 1995. "Remedial Investigation Report for Operable Unit 5," Final, Fernald Environmental Management Project, Cincinnati, Ohio, March.

DOE (U.S. Department of Energy), 1996. "Final Record of Decision for Remedial Actions at Operable Unit 5," 7478 U-007-501.4, Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2006. "Comprehensive Legacy Management and Institutional Controls Plan, Revision 1," Fernald Closure Project, DOE, Fernald Office, Cincinnati, Ohio, November.

End of current text

Attachment B.1

Attachment B.1

B.1.0 Surface Water and Treated Effluent

During 2006, surface water and treated effluent samples were collected under the Integrated Environmental Monitoring Plan (IEMP) which is Attachment D of the Comprehensive Legacy Management and Institutional Controls Plan (DOE 2006). Figures B.1–1 and B.1–2 show all surface water monitoring locations. The following information is discussed in this attachment:

- Surveillance monitoring (Section B.1.1)
- Federal Facilities Compliance Agreement (FFCA)/Operable Unit 5 Record of Decision compliance (Section B.1.2)
- Controlled and uncontrolled areas (Section B.1.3).

The National Pollutant Discharge Elimination System (NPDES) Permit sampling is not discussed in this attachment as it is discussed in sufficient detail in Chapter 4 of this report.

B.1.1 Surveillance Monitoring

Surveillance monitoring is the comparison of surface water and treated effluent analytical results to the surface water FRLs in order to determine effects of remediation activities on the surface water pathway. Surveillance monitoring also includes an assessment of the effects surface water may have on the groundwater pathway (referred to as cross-media impacts).

All 2006 data were compared to FRLs. Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point treated effluent is sampled prior to discharge to the Great Miami River.

Water discharges to the Great Miami River are required to be below the FRLs at the point where discharged water is completely mixed with water in the Great Miami River (i.e., outside the mixing zone). To make a determination of the concentration of each constituent at this point in the Great Miami River for comparison to the FRLs, the following calculation was applied to data from the Parshall Flume (PF 4001):

$$C_{PF4001} = \frac{[Q_{10}][C_{GMR}]+[Q_{PF}][C_{PF}]}{[Q_{10}]+[Q_{PF}]}$$

where:

C_{PF4001} = Flow-weighted average concentration outside the mixing zone in the Great Miami River, picoCuries per liter (pCi/L) or milligrams per liter (mg/L)

Q_{10} = 7-day, 10-year low flow, 706 cubic feet per second (cfs)

C_{GMR} = Background concentration in Great Miami River from the Remedial Investigation Report for Operable Unit 5 (DOE 1995), pCi/L or mg/L (zero was used when no background concentration was available)

Q_{PF} = Daily flow at Parshall Flume (PF 4001), cfs

C_{PF} = Daily concentration at Parshall Flume (PF 4001), pCi/L or mg/L

Note: Flow conditions at the Hamilton Dam gauge are periodically reviewed to determine if there is a lower flow than the 7-day, 10-year low flow of 706 cfs. The lowest daily flow measured at the Hamilton Dam gauge (if lower than 706 cfs) is used in the equation to see if an exceedance could potentially occur. The low flow of 706 cfs went into effect during the 2003 NPDES Permit renewal process.

B.1.1.1 Evaluation of Constituents Above FRLs for 2006

Table B.1–1 lists the surface water FRL exceedances at corresponding sample locations and the exceedance locations can be found on Figure B.1-1. The following are general observations:

- No FRL exceedances occurred in the Great Miami River using the mixing equation and Parshall Flume (PF 4001) concentrations. The lowest daily flow at the Hamilton Dam gauge during 2006 was 743 cfs. No further evaluation of FRLs was conducted beyond the previously described low flow condition (706 cfs).
- No exceedances of the surface water FRL for total uranium occurred at any surface water sample location. Figures B.1-3 through B.1-13 are plots of the total uranium concentration versus time for the surface water sample locations.

There was one FRL exceedance at the waste storage area location SWD-03. It occurred on July 29, 2006 (0.0129 mg/L versus the surface water FRL of 0.012 mg/L); however, no additional FRL exceedances occurred at this location and constituent for the year.

B.1.1.2 Evaluation of Cross-Media Impacts for 2006

Another objective of the IEMP surveillance monitoring program is to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. To conduct this assessment, sample locations were selected to evaluate contaminant concentrations in surface water just upstream from those areas where site drainages have eroded through the protective glacial overburden (e.g., the storm sewer outfall ditch, Pilot Plant Drainage Ditch, and certain reaches of Paddys Run). In areas where the glacial overburden is absent, a direct pathway exists for contaminants to reach the aquifer. Key sample locations associated with these areas of direct infiltration are SWP-02, SWD-02, STRM 4005, SWD-03, and the Storm Water Retention Basin overflow (SWRB 4002O). (Now that the Storm Water Retention Basin has been removed from service and excavated, SWRB2O is no longer a monitored point.)

Because it is the primary contaminant at the site, total uranium is used as an indicator to evaluate the impact of surface water on the Great Miami Aquifer. A conservative assumption is used in this assessment, which considers the total uranium concentration (and all other constituent concentrations) in the surface water to be at the same concentration when the water reaches the Great Miami Aquifer through infiltration. However, the more likely scenario is that the total uranium concentration (and all other constituent concentrations) would decrease because dilution and adsorption occur as the water infiltrates through the ground and is mixed with the groundwater in the Great Miami Aquifer.

The results of the cross-media impact assessment for 2006 indicates none of the five surface water locations evaluated had results that exceeded the total uranium groundwater FRL of 30 µg/L. Figures B.1–10 through B.1–13 present the total uranium concentrations for all cross-media impact sample locations.

Of the locations evaluated, only SWD-03 had results that exceeded the groundwater FRL for a constituent other than uranium. These groundwater FRL exceedances were for zinc from samples collected on March 9, 2006 (0.0438 mg/L), April 23, 2006 (0.0255 mg/L), and July 29, 2006 (0.0855 mg/L). The groundwater FRL for zinc is 0.021 mg/L.

The design of the groundwater restoration systems has accounted for this potential contaminant pathway by installing extraction wells downgradient of these areas where direct infiltration can occur.

B.1.2 FFCA/Operable Unit 5 Record of Decision Compliance

The Operable Unit 5 Record of Decision and subsequent Explanation of Significant Differences stipulate compliance with a monthly flow-weighted average total uranium concentration of 30 µg/L at the Great Miami River via the Parshall Flume (PF 4001). In addition to the concentration limitation, the Operable Unit 5 Record of Decision stipulated that the total mass discharged during a year not exceed 600 pounds.

During 2006, the total uranium concentrations were monitored daily at the Parshall Flume (PF 4001) to demonstrate compliance with these limitations. The Fernald site was in compliance with the total mass limitation as uranium discharges totaled 476.36 pounds, which is below the 600-pound limit. The Fernald site was in compliance with the monthly flow-weighted concentration limit every month in 2006, as identified on Figure B.1–14.

B.1.2.1 Storm Water-Related Bypasses

The Operable Unit 5 Record of Decision allowed the Fernald site to directly discharge water collected in the Storm Water Retention Basin to the Great Miami River during periods of significant precipitation (up to 10 days each year). These were referred to as bypass events (when storm water bypasses treatment and goes directly to the Great Miami River). The Operable Unit 5 Record of Decision allowed the Fernald site to eliminate the flow-weighted concentration for these bypass days due to significant precipitation in order to comply with the flow-weighted concentration total uranium limit.

As noted above, the Storm Water Retention Basins were removed from service in February 2006 so no direct precipitation or maintenance related bypasses occurred from the Storm Water Retention Basins during 2006. However, there was an occasion where the direct discharge of storm water to the Great Miami River was required. From March 17 through March 21, 2006, storm water was discharged from a large excavation within Remediation Area 4B. This effort was required to mitigate against the potential loss of control of the water within the excavation and the possible recontamination of other adjacent certified areas. Approval for this bypass was obtained from the regulatory agencies.

B.1.2.2 Maintenance-Related Bypasses

Bypassing during scheduled treatment plant maintenance was permissible under the Operable Unit 5 Record of Decision, provided prior notice is given to the U.S. Environmental Protection Agency (EPA) and Ohio Environmental Protection Agency (OEPA). For those days when a maintenance activity was performed, the uranium concentration could be eliminated from the monthly total uranium concentration calculation. There were no such bypasses in 2006.

B.1.3 Controlled and Uncontrolled Storm Water Runoff Areas

In 2006, there were no previously uncontrolled areas that were added to the Fernald site controlled storm water system (refer to Figure B.1–15). At the conclusion of remediation in October 2006, control of storm water runoff is no longer required. The only storm water collected for treatment is that which falls on the controlled pad of the CAWWT.

Table B.1-1. Summary Statistics and Trend Analysis for Constituents with 2006 Results above Final Remediation Levels

Location[a]	Constituent	No. of Samples[b,c,d]	No. of Samples Above FRL[b,c,d]	No. of Samples Above FRL for 2004[c,d]	FRL[e]	Min.[b,c,d,f]	Max.[b,c,d,f]	Avg.[b,c,d,f]	SD[b,c,d,f]	Trend[b,c,d,f]
SWD-03 (Waste Storage Area)	Copper	51	4	1	0.012 mg/L	0.00065 mg/L	0.0426 mg/L	0.00489 mg/L	0.00806 mg/L	Up, Significant

[a]Refer to Figure B.1-1.
[b]Based on samples collected from 1997 through 2006.
[c]If more than one sample is collected per surface water location per day (e.g., duplicate, grab, composite), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, average, and standard deviation), Mann-Kendall test for trend, and in determining FRL exceedances.
[d]Rejected data qualified with either an R or Z were not included in the count, the summary statistics, or Mann-Kendall test for trend.
[e]From Operable Unit 5 Record of Decision, Table 9-5.
[f]For results where the concentrations are below the detection limit, the results used in the summary statistics and Mann-Kendall test for trend are each set at half the detection limit.

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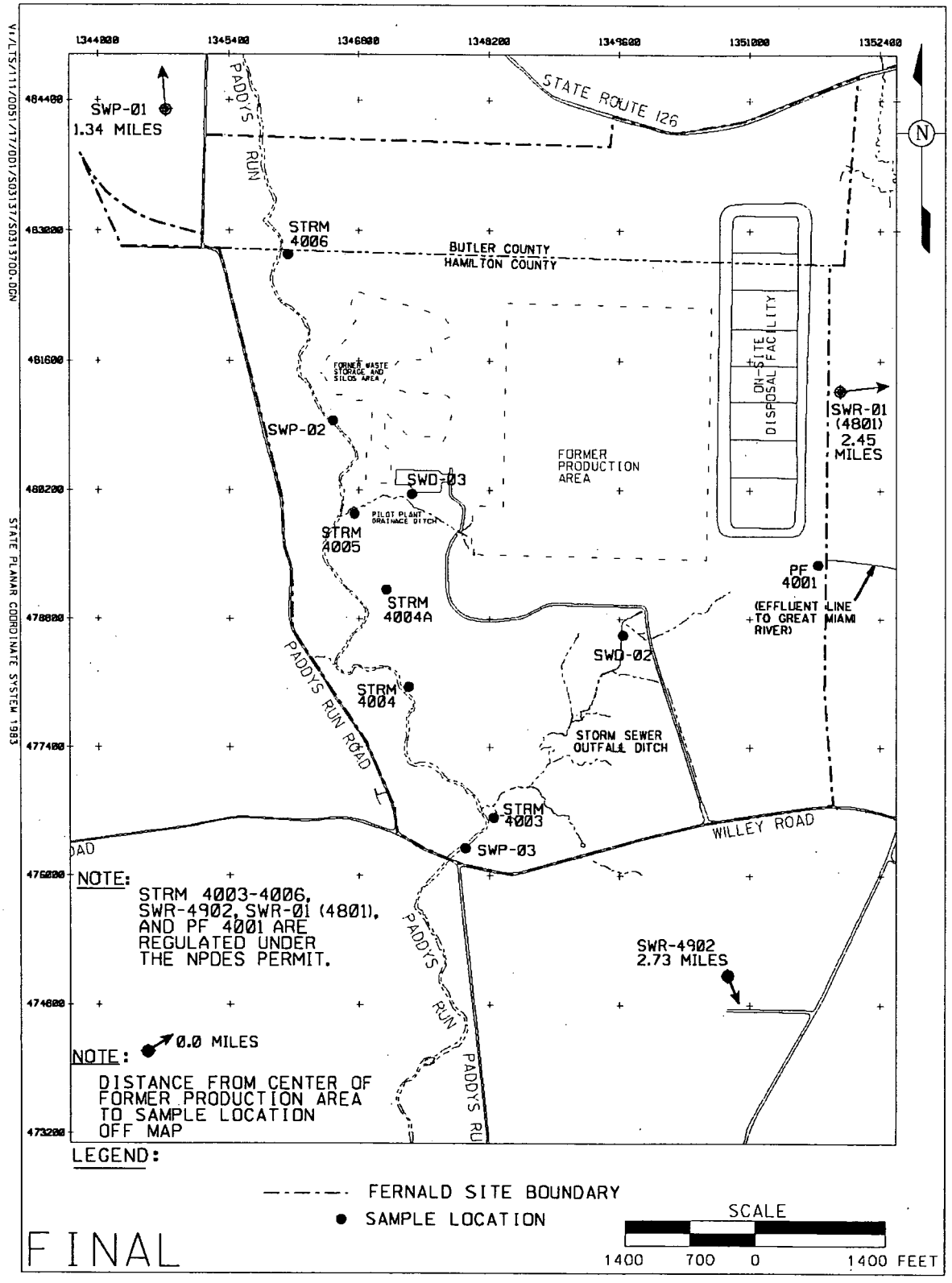

Figure B.1–1. IEMP Surface Water and Treated Effluent Sample Locations

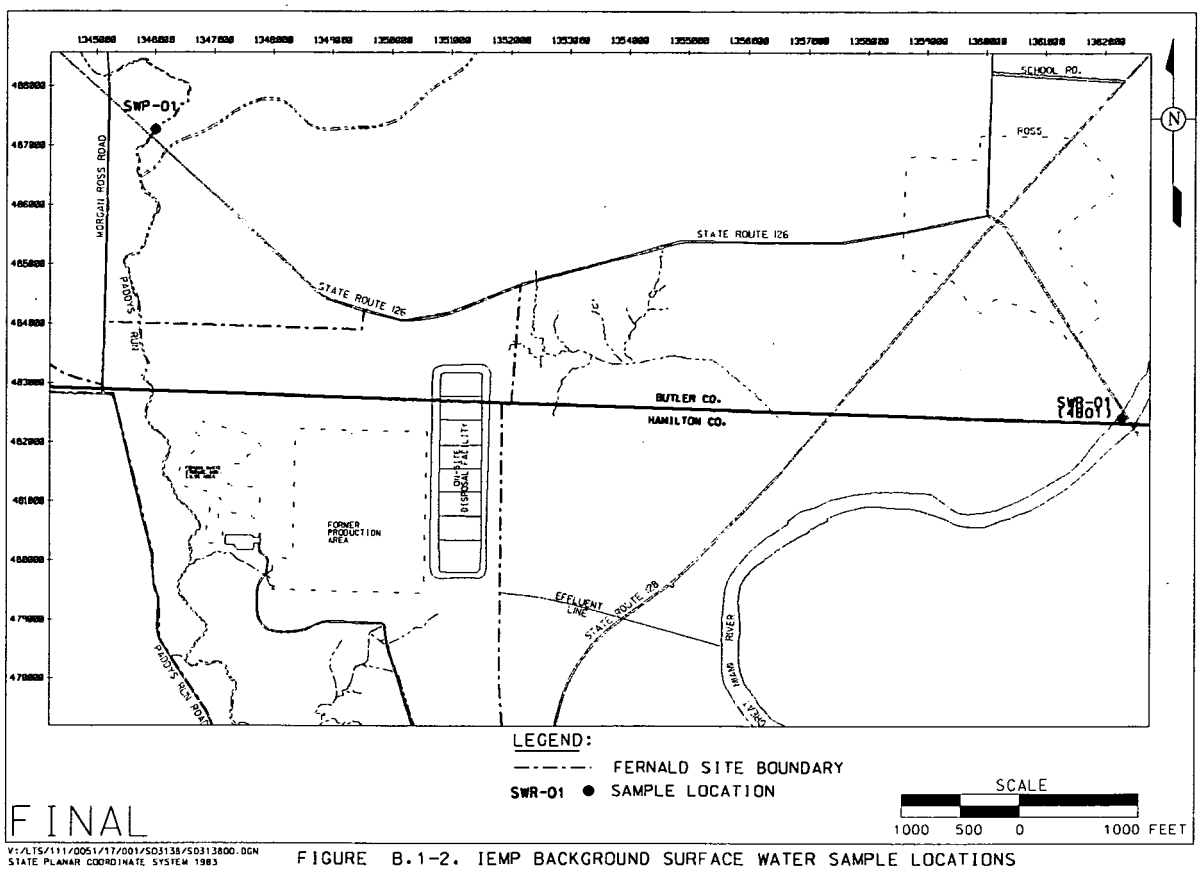

FIGURE B.1-2. IEMP BACKGROUND SURFACE WATER SAMPLE LOCATIONS

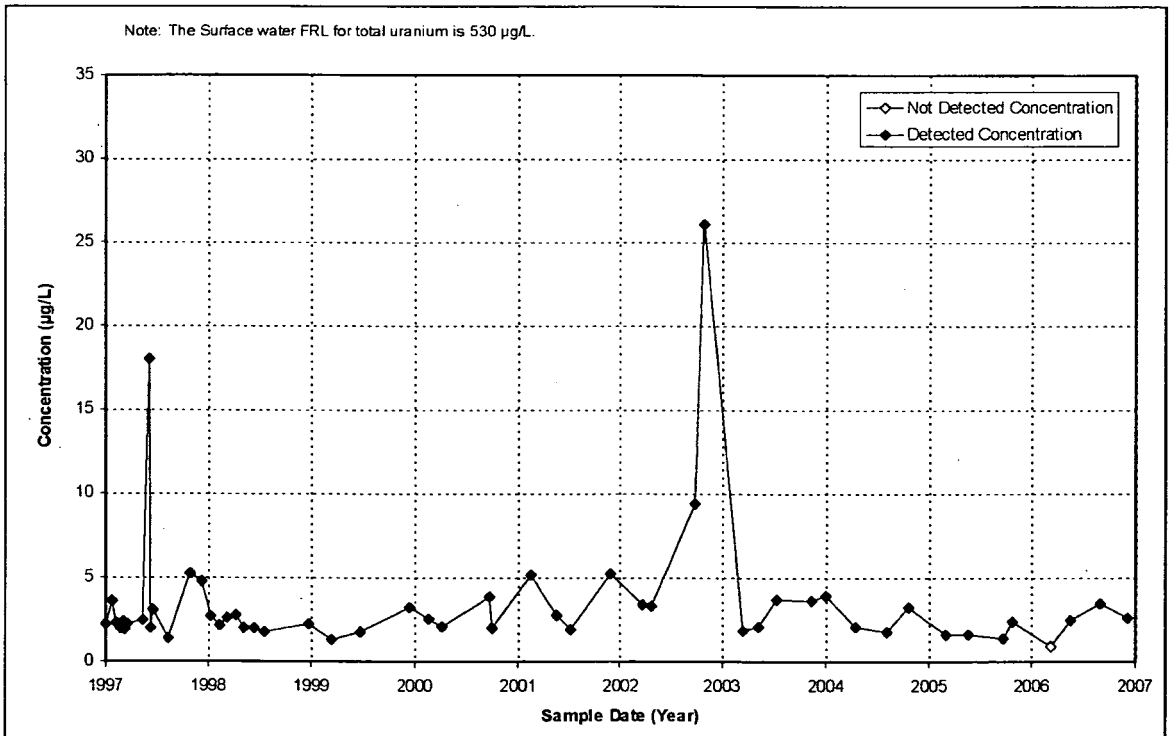

FIGURE B.1-3. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWP-03 (PADDYS RUN AT DOWNSTREAM PROPERTY BOUNDRY)

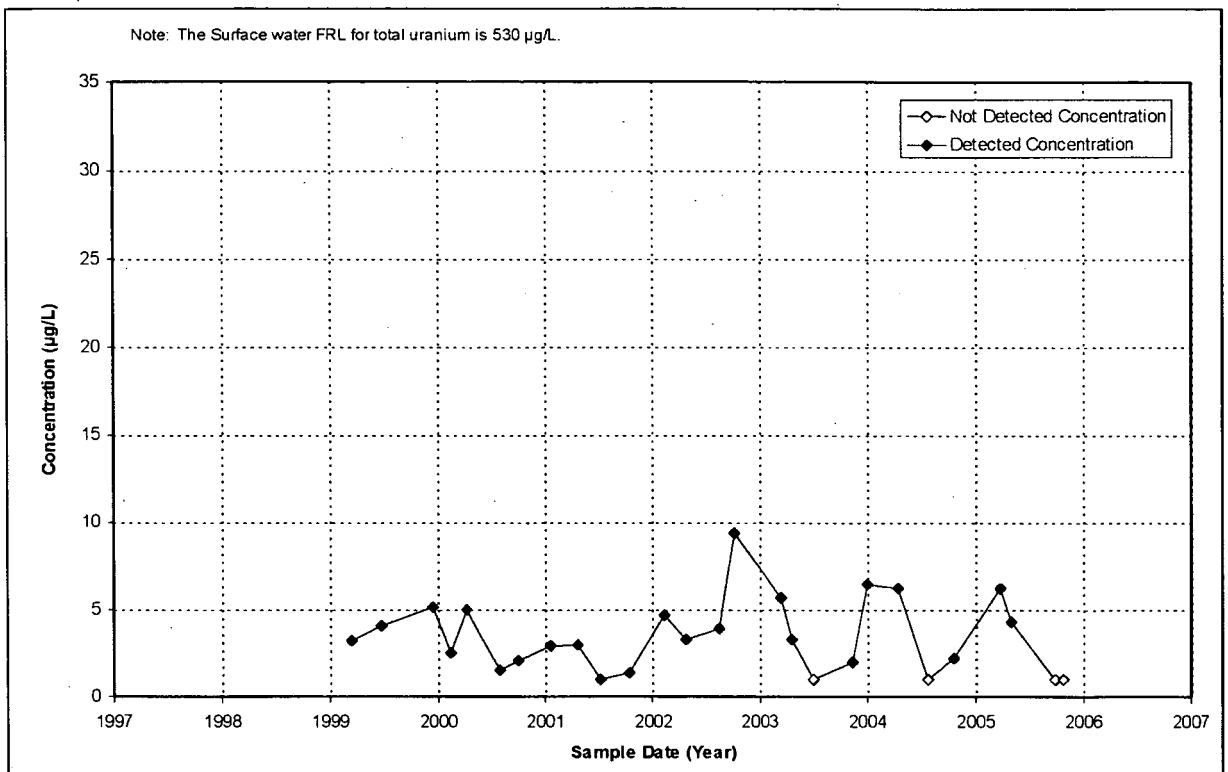

FIGURE B.1-4. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWD-01 (NORTHEAST DRAINAGE)

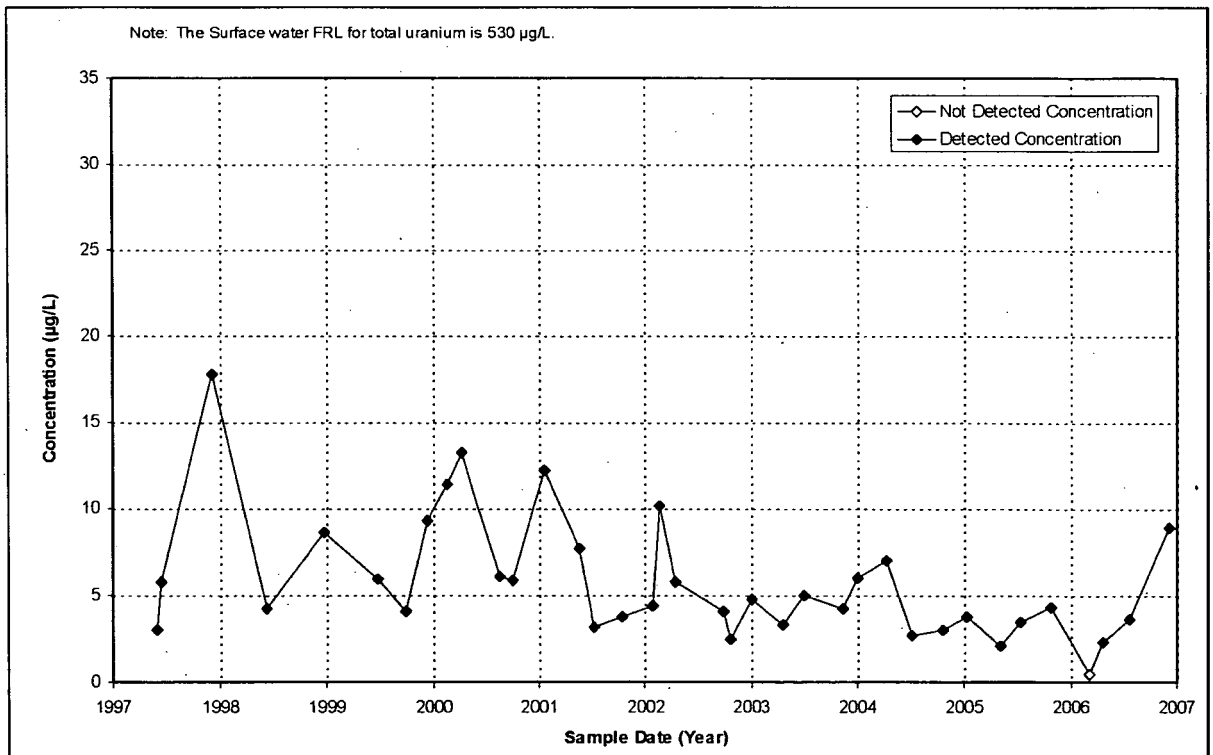

FIGURE B.1-5. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4003 (DRAINAGE TO PADDYS RUN)

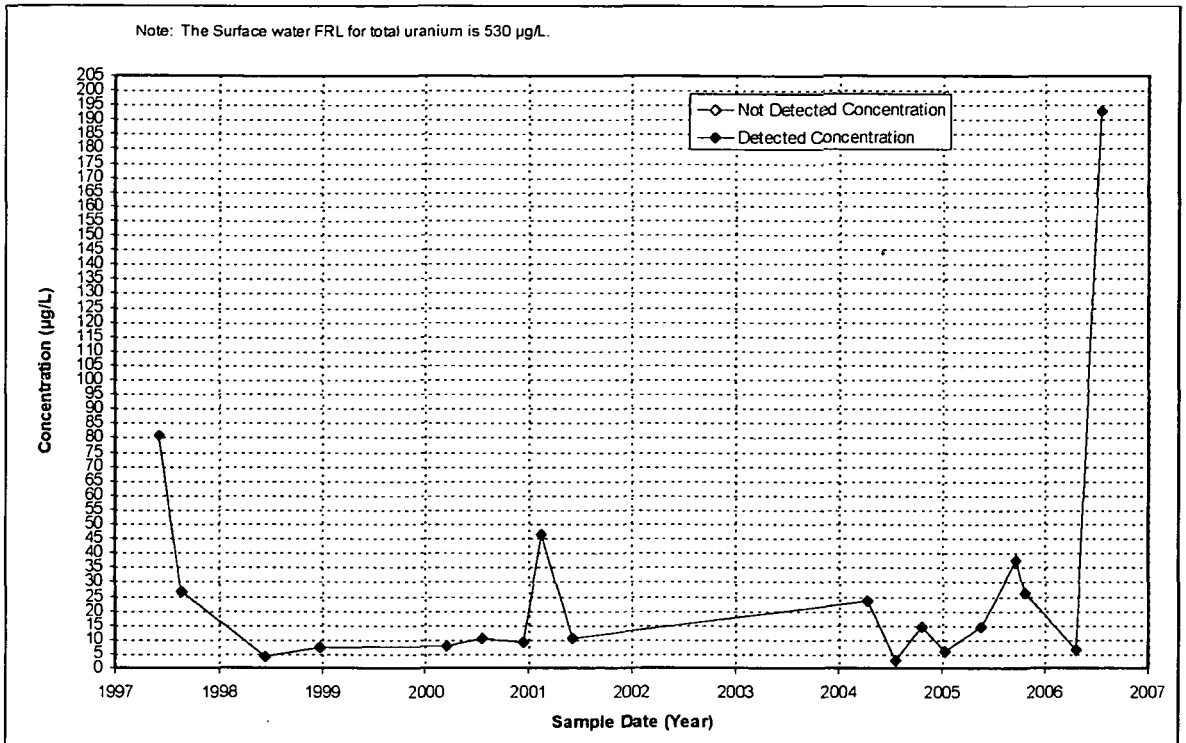

FIGURE B.1-6. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4004/4004A (DRAINAGE TO PADDYS RUN)

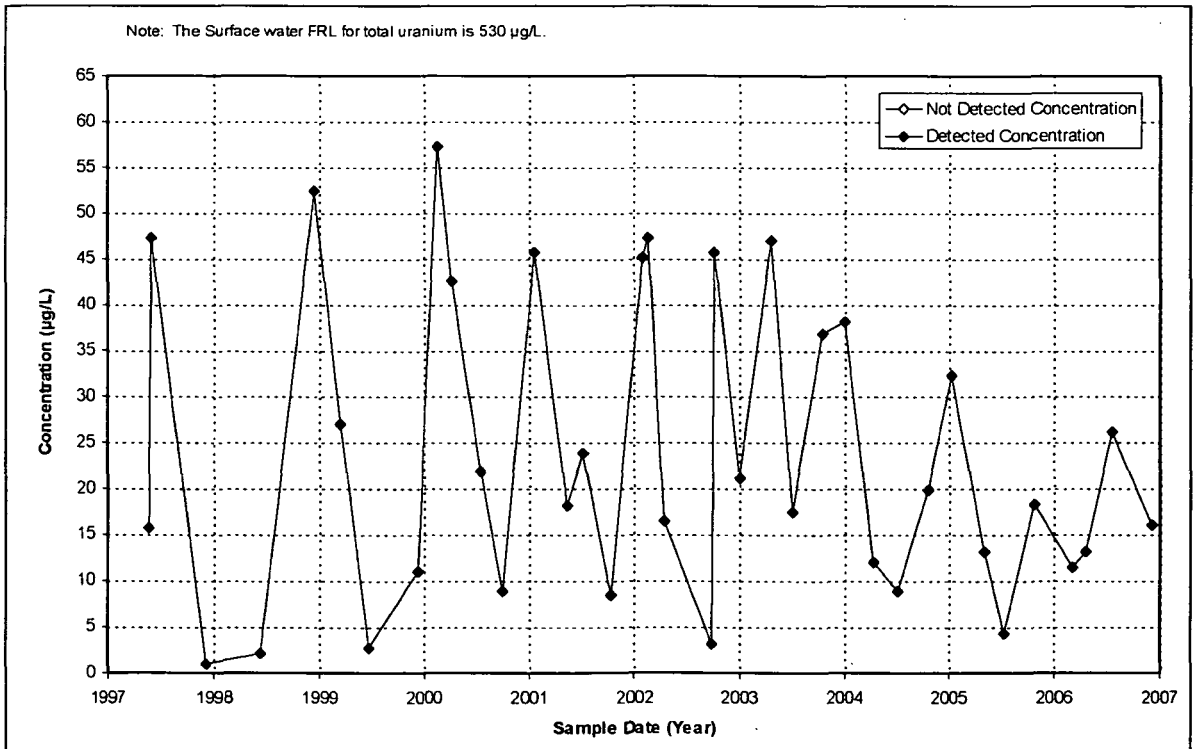

FIGURE B.1-7. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION STRM 4006 (DRAINAGE TO PADDYS RUN)

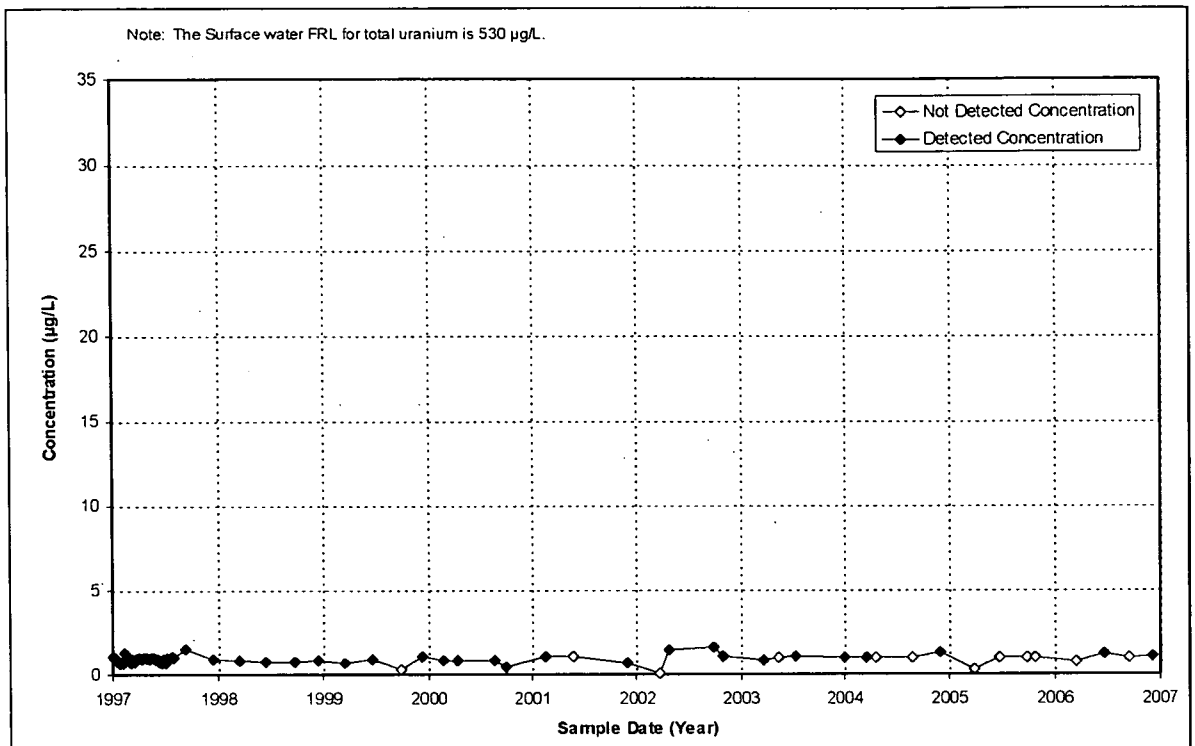

FIGURE B.1-8. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWP-01 (PADDYS RUN BACKGROUND)

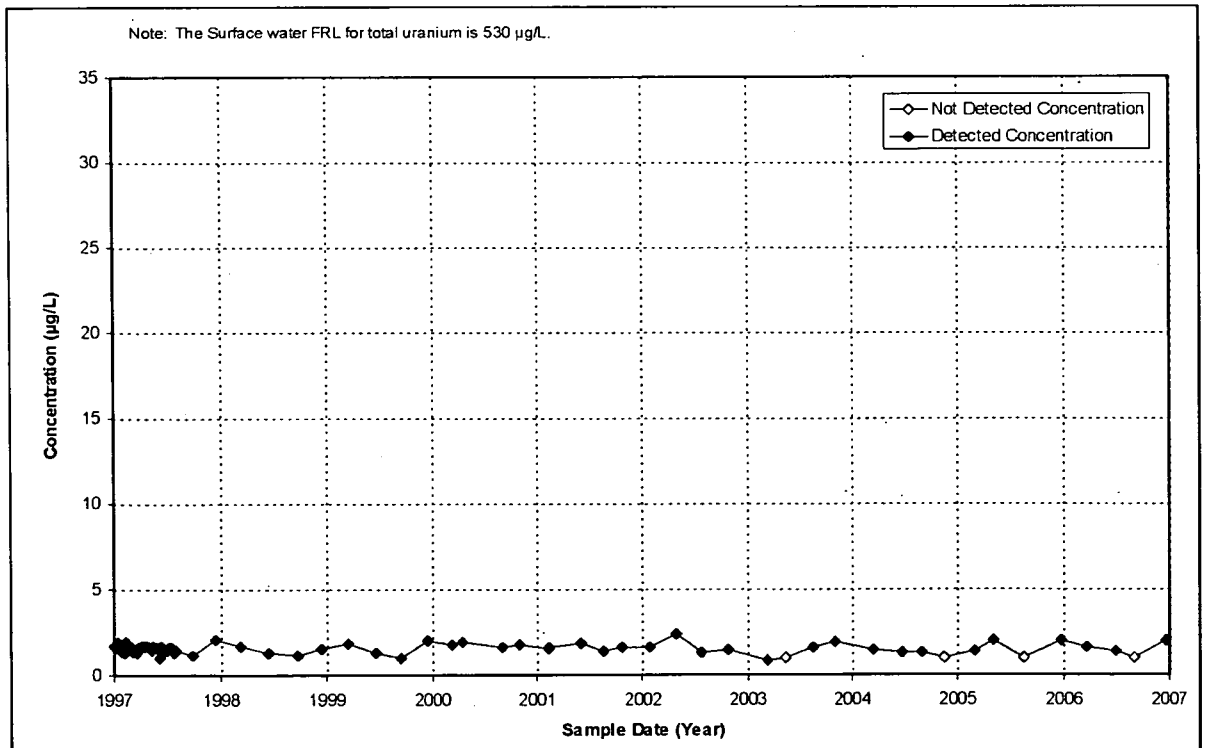

FIGURE B.1-9. TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR LOCATION SWR-01 (GREAT MIAMI RIVER BACKGROUND)

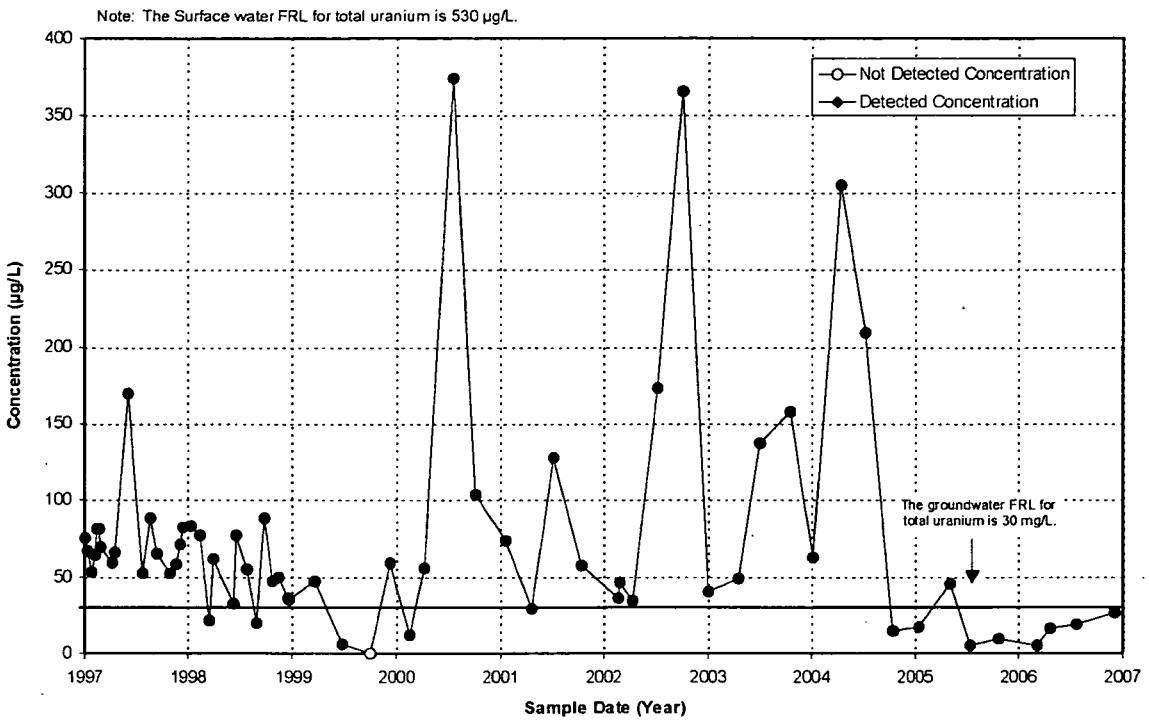

FIGURE B.1-10. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION STRM 4005 (DRAINAGE TO PADDYS RUN) FOR CROSS-MEDIA IMPACT EVALUATION

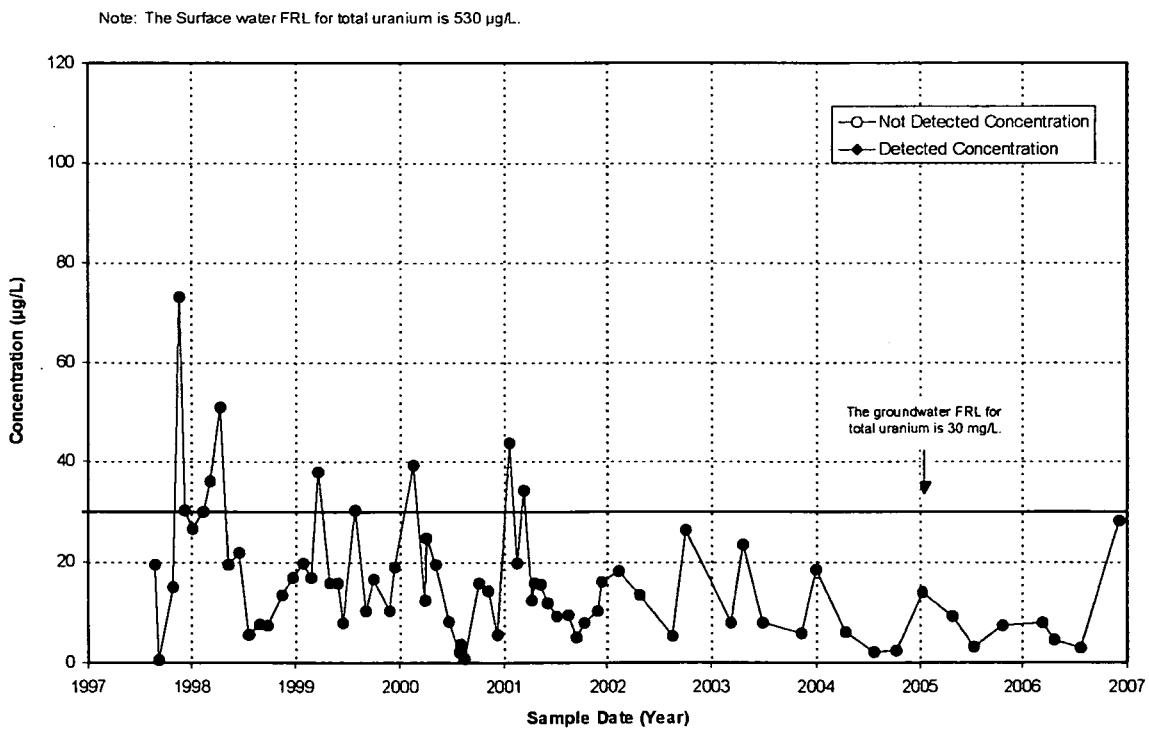

FIGURE B.1-11. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWD-02 (STORM SEWER OUTFALL DITCH) FOR CROSS-MEDIA IMPACT EVALUATION

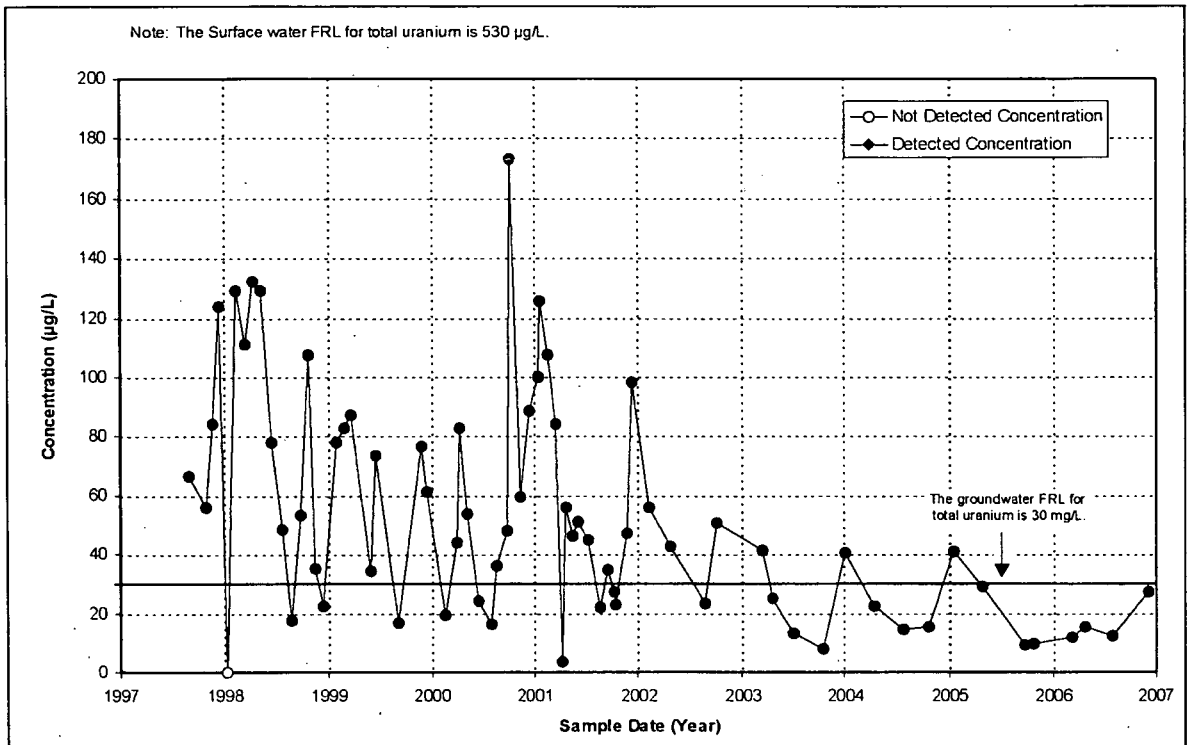

FIGURE B.1-12. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWD-03 (WASTE STORAGE AREA) FOR CROSS-MEDIA IMPACT EVALUATION

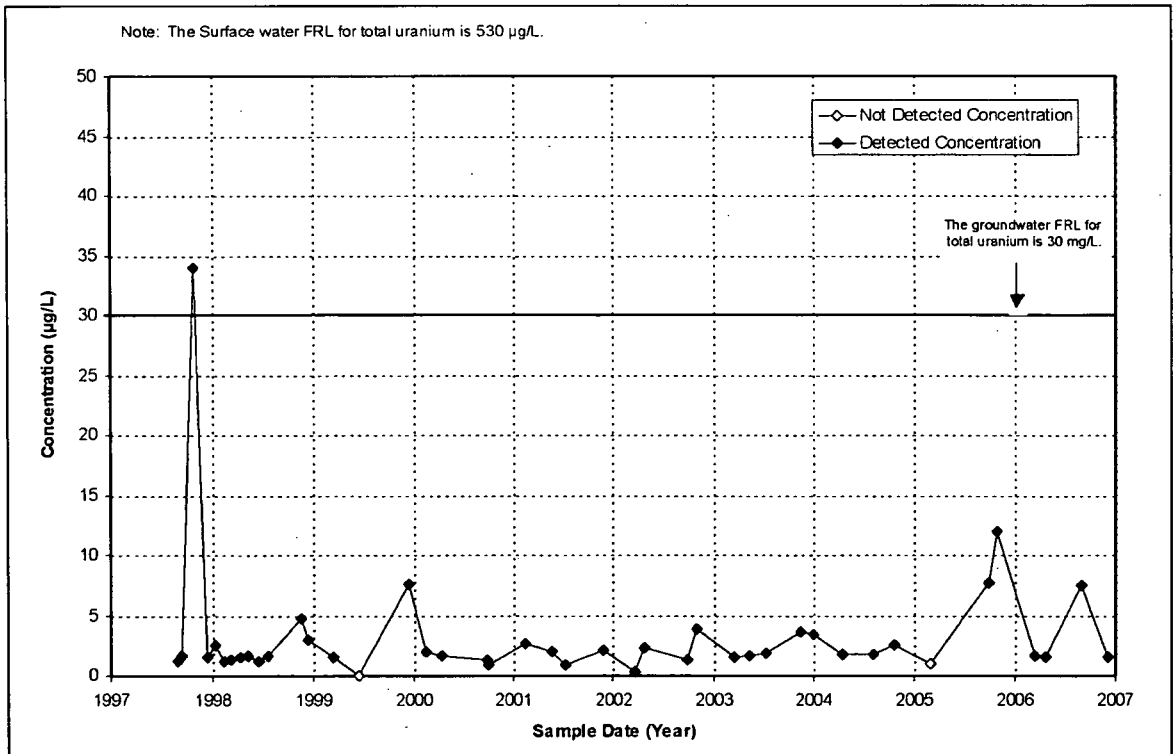

FIGURE B.1-13. TOTAL URANIUM CONCENTRATION VS. TIME PLOT
FOR LOCATION SWP-02 (PADDYS RUN) FOR CROSS-MEDIA IMPACT EVALUATION

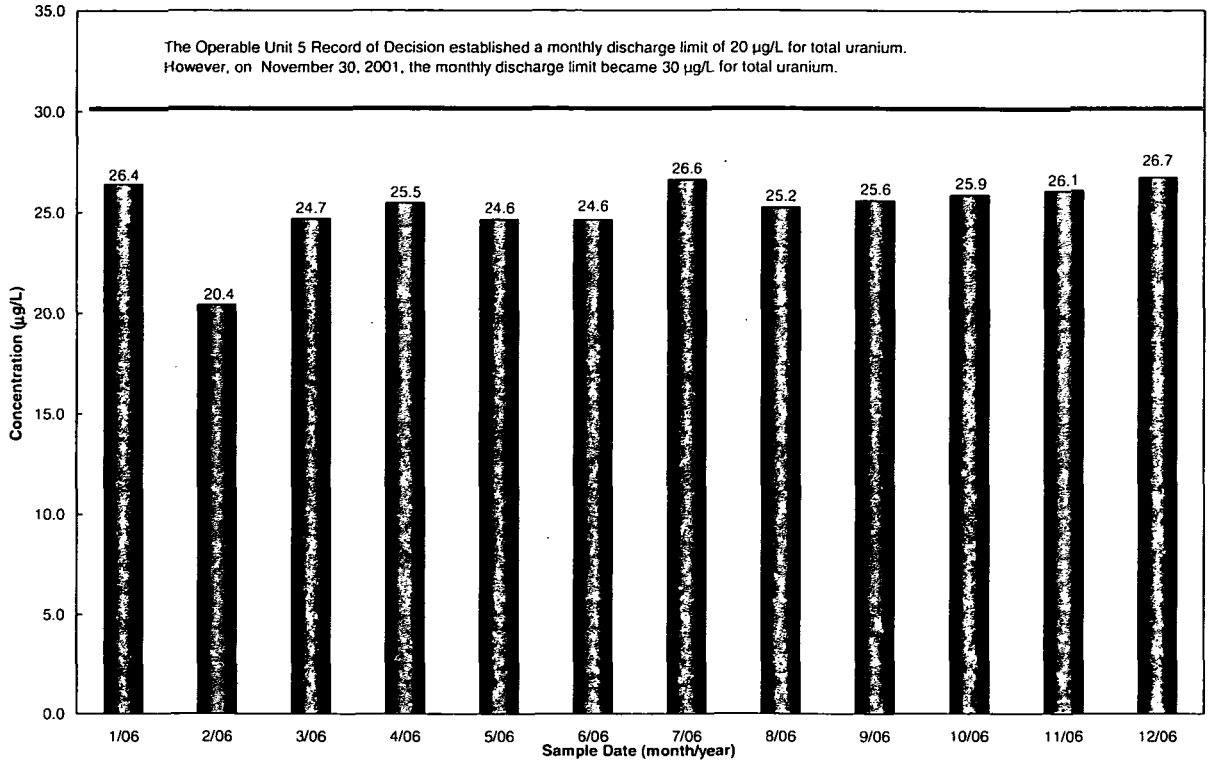

FIGURE B.1-14. 2006 MONTHLY AVERAGE TOTAL URANIUM CONCENTRATION IN WATER DISCHARGED FROM THE PARSHALL FLUME (PF 4001) TO THE GREAT MIAMI RIVER

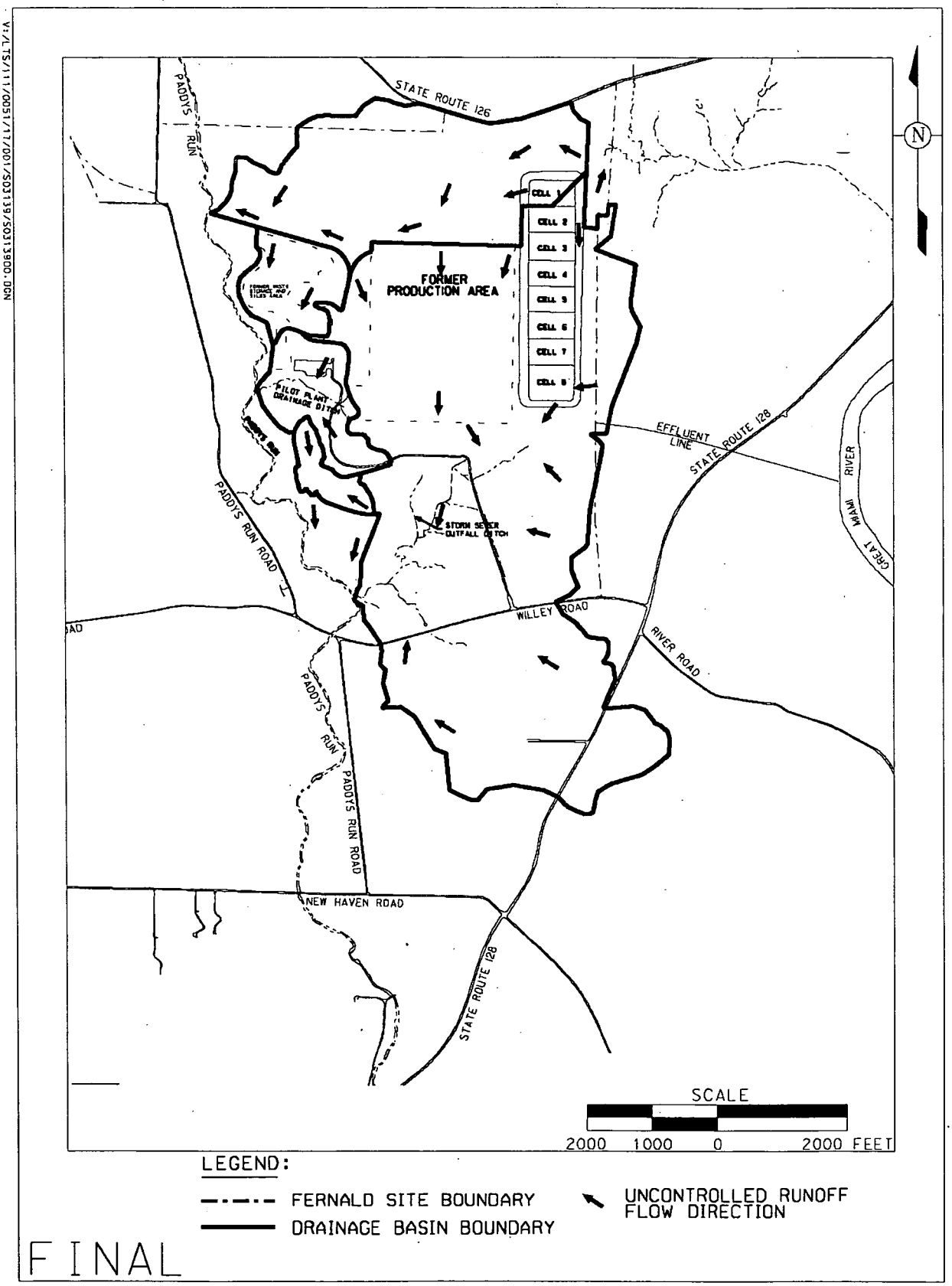

Figure B.1–15. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

Attachment B.2

Attachment B.2

B.2.0 Sediment

Sediment is a secondary exposure pathway and is monitored annually to assess the impact of remediation activities on sediments deposited along surface water drainages. In 2006 sediment was collected at strategic locations in the Great Miami River (i.e., upgradient and downgradient of the effluent line). The year 2006 marks the eighth year that sediment was collected under the IEMP.

Sediment samples in the Great Miami River were collected in October of 2006 at two locations (refer to Figure B.2–1) in accordance with the IEMP. Samples collected at these locations were analyzed for total uranium. Table B.2–1 and Figure B.2–2 identifies the 2006 uranium results and historical uranium results from the Great Miami River. Uranium results from the river were approximately 1 milligram per kilogram (mg/kg), which are comparable to historical results. The sediment FRL for uranium is 200 mg/kg.

Table B.2–1. Summary Statistics For Sediment Monitoring Program

Radionuclide	No. of Samples[a]	2006 Results – Concentration (mg/kg)	No. of Samples[a]	2005 Results – Concentration (mg/kg)
Great Miami River, North of the Effluent Line (G2)				
Uranium, Total	1	0.739	1	3.3
Great Miami River, South of The Effluent Line (G4)				
Uranium, Total	1	1.60	1	3.03

[a]If more than one sample is collected per sample location (e.g., split or duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum and maximum).

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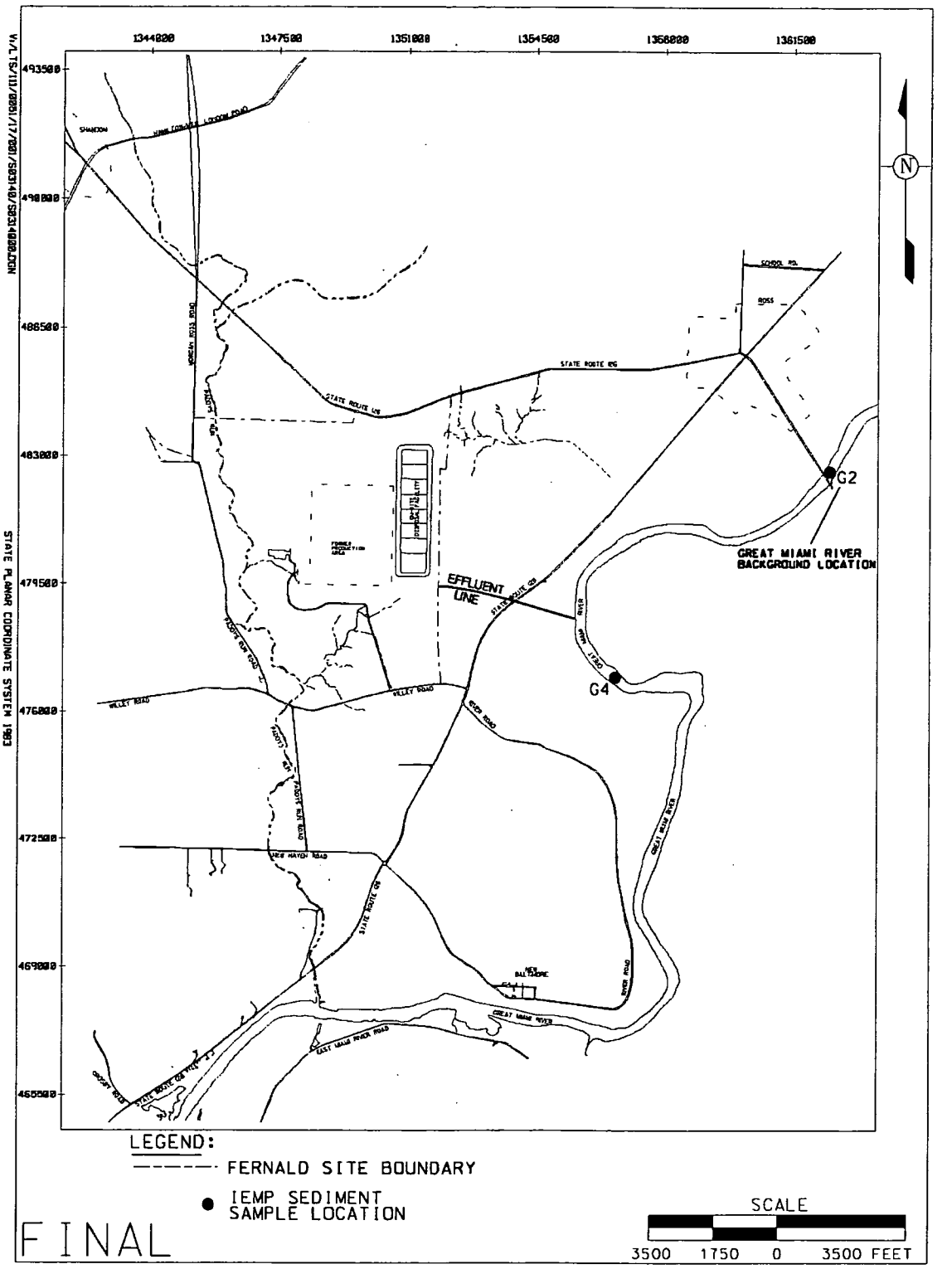

Figure B.2–1. 2006 Sediment Sample Locations

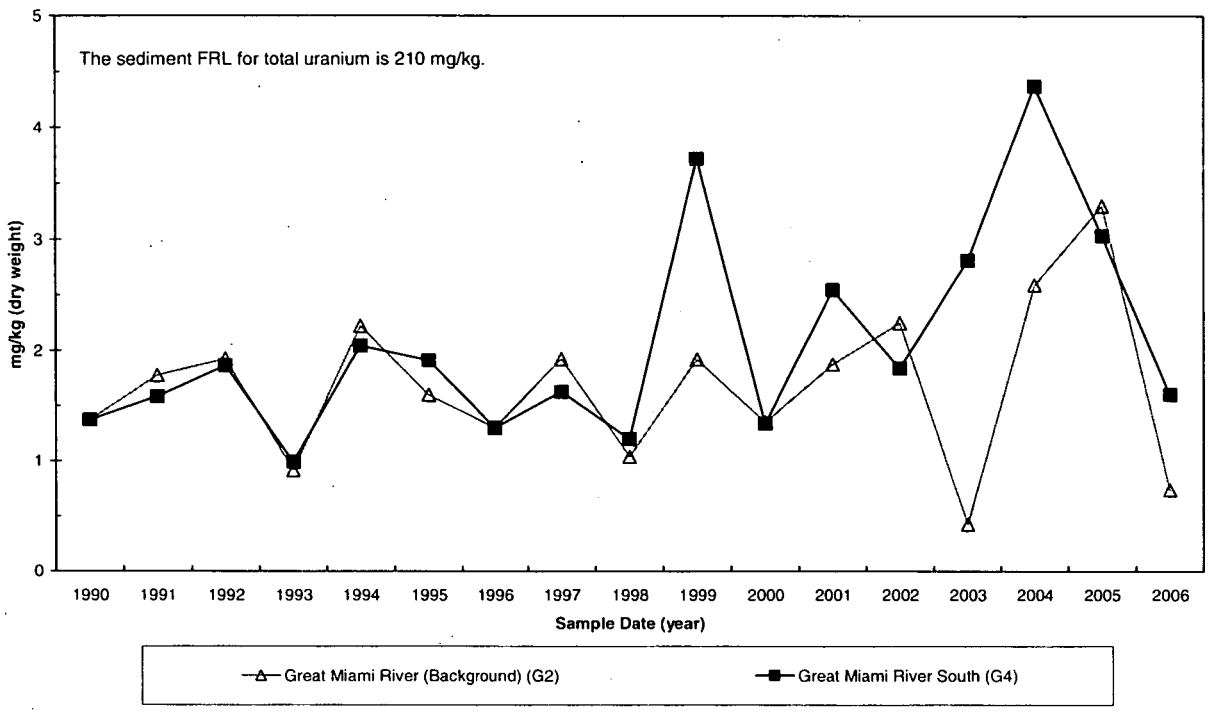

FIGURE B.2-2. AVERAGE TOTAL URANIUM CONCENTRATION VS. TIME PLOT FOR SEDIMENT

Appendix C

Supplemental Air Information

Contents

Attachment C.1 Radiological Air Particulate
Attachment C.2 Radon
Attachment C.3 Direct Radiation
Attachment C.4 Meteorological Data
Attachment C.5 Supplemental Dose Assessments

End of current text

Acronyms

BCG	Biota Concentration Guide
CFR	Code of Federal Regulations
DCG	derived concentration guidelines
DOE	U.S. Department of Energy
FCP	Fernald Closure Project
IEMP	Integrated Environmental Monitoring Plan
NESHAP	National Emissions Standards for Hazardous Air Pollutants
RCS	Radon Control System
TLD	thermoluminescent dosimeter

List of Measurement Abbreviations

cm	centimeters
m^3	cubic meters
°C	degrees Celsius
°F	degrees Fahrenheit
km	kilometer
kph	kilometers per hour
µCi	microCuries
µCi/hr	microCuries per hour
µCi/mL	microCuries per milliliter
$\mu g/m^3$	micrograms per cubic meter
mph	miles per hour
mCi	milliCuries
mrem	millirem
mSv	milliSievert
pCi/m^3	picoCuries per cubic meter
pCi/L	picoCuries per liter

End of current text

Appendix C presents additional air monitoring data and analysis in support of Chapter 5 of this 2006 Site Environmental Report. This appendix consists of five attachments as follows:

- Attachment C.1 provides the results of the radiological air particulate monitoring program, including an assessment of 2006 results with respect to historical data and concentration versus time plots of the total uranium, total particulate, and thorium data for 2006.
- Attachment C.2 provides the results of the radon monitoring program, including an assessment of radon data relative to continuous radon monitors. This discussion focuses on the U.S. Department of Energy (DOE) standards contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment (DOE 1993), proposed 10 CFR 834, and an evaluation of trends observed in the 2006 data.
- Attachment C.3 provides the results of the direct radiation monitoring program including an assessment of 2006 results with respect to historical data.
- Attachment C.4 provides a summary of the meteorological data measured at the Fernald site during 2006.
- Attachment C.5 provides the results of supplemental dose assessments that are part of the standards and requirements contained in DOE Order 5400.5. The methods and data sources used for the population dose assessment and a biota dose assessment are explained. In addition, an evaluation of trends observed in the dose assessments over the past 7 years is also provided.

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DOE (U.S. Department of Energy), 2006b. "Recommended Reduction for Environmental Air Monitors (DOE 2006b)," DOE-0172-06, DOE, Fernald Area Office, Cincinnati, Ohio, July 24, 2006.

DOE (U.S. Department of Energy), 2006c. "Recommendation for Air Monitoring Phase II Site Boundary Reductions (DOE 2006c)," DOE-0032-07, DOE, Fernald Area Office, Cincinnati, Ohio, July 24, 2006.

International Commission on Radiological Protection (ICRP), 1975, Reference Manual: "Anatomical, Physiological, and Metabolic Characteristics," ICRP Publication 23.

Attachment C.1

C.1.0 Radiological Air Particulate

In 2006, the Fernald site operated 18 monitoring stations (Figure C.1–1) as part of the Integrated Environmental Monitoring Plan (IEMP) Radiological Air Particulate Monitoring Program. The data from 16 boundary monitoring stations and one background monitoring station are used to demonstrate compliance with the National Emissions Standards for Hazardous Air Pollutants (NESHAP) Subpart H. Data from the project specific air monitoring station (WPTH 2) are used to supplement the boundary monitoring of thorium emissions from the excavation of the waste pits.

The final year of soil remediation at the Fernald site was 2006. As the number of sources of airborne contamination decreased throughout 2006, so did the number of active air monitoring stations (AMS). The reductions to the air monitoring program were as follows:

- AMS-4, 5, 7, 23, 25, and 28 were removed from service in April 2006, which was documented in DOE letter, Integrated Environmental Monitoring Plan (IEMP) Boundary Air Monitors – Phase 1 Reduction (DOE 2006a)
- Thorium monitor WPTH-2 was removed from service in August 2006, which was documented in DOE letter, Recommended Reduction for Environmental Air Monitors (DOE 2006b)
- AMS-9C, 22, 26, 27, and 29 were removed from service in December 2006, which was documented in DOE letter, Recommendation for Air Monitoring Phase II Site Boundary Reductions (DOE 2006c).

All air monitoring stations that were active in 2006 are shown in Figure C.1-1.

Table C.1–1 provides an operational summary for the IEMP air monitoring stations in 2006. Most instruments operated nearly 100 percent of the time, with the worst performance being 96.8 percent at AMS-29. Although the stations are shut down for about 5 minutes when the filters are changed out, this does not accumulate a sufficient amount of time to account for down time in the calculation. Therefore, some monitors show 100 percent operational time. Periodic electrical outages and equipment malfunctions created short periods of down time that result in operation times of less than 100 percent.

C.1.1 Particulate Monitoring Results

Air filters were exchanged in each instrument every two weeks, but this was discontinued at six boundary locations in April, five boundary locations in December, and at WPTH-2 in August. The biweekly filters from the 16 boundary monitors and background monitor were analyzed for total uranium and total particulate, and monthly composites (two times per quarter; eight times per year) were analyzed for isotopic thorium. The biweekly filters from the project specific monitor (WPTH-2) were not analyzed for total uranium.

Figures C.1–2 through C.1–19 summarize the total uranium, total particulate, and isotopic thorium measurements for each location. In general, particulate concentrations were highest at the eastern boundary monitors adjacent to the active OSDF cells (AMS-3 and AMS-9C) and the borrow area (AMS-29). This observation is consistent with the prevailing winds blowing from southwest to northeast. The highest uranium and thorium concentrations were observed at

AMS-3, which is the closest downwind monitor to the OSDF cells active in 2006 (Cells 7 and 8). Sharp decreases in thorium-228 (AMS-12, Figure C.1–10, and AMS-26, Figure C.1–15, on August 1) and thorium-232 (AMS-22, Figure C.1–11, on February 28) reflect analytical results at the monitor location that are similar to results reported for the blank. When the blank result is subtracted from the monitor result, a very low value is obtained, which accounts for the dip along the trend line on the charts.

Tables C.1–2 through C.1–6 tabulate information for total uranium, particulate, thorium-228, thorium-230, and thorium-232, respectively. The information summarizes minimum, maximum, and average values for 2006 and 2005 at each location, and also presents minimum and maximum values over the 1990 to 2006 time period. Relative to the 2005 results, all parameters decreased in 2006, which reflects the decrease in demolition and excavation activities as the site moved toward closure in October of 2006. The annual average thorium-230 concentration reached a maximum of 0.00003 picoCuries per square meter (pCi/m^3) at AMS-6, which remains well below the criterion of less than one percent of the DOE derived concentration guideline (DCG) for thorium-230 (0.04 pCi/m3).

Aliquots of the 16 boundary and background filters collected biweekly were combined every three months to produce a quarterly composite sample. The composite samples were analyzed for isotopes of uranium, thorium, and radium-226 (Table C.1–7), and all results are below the DOE DCG values. Data in Table C.1–7 are used to calculate the dose delivered to human receptors, using values listed in 40 CFR 61 (NESHAP) Subpart H, Appendix E, Table 2. The NESHAP analysis in Appendix D indicates that the results in Table C.1–7 are well below the NESHAP guidelines.

C.1.2 Evaluation of Isotopic Dose from Airborne Emissions

The 2006 particulate data from 16 boundary monitors indicates uranium isotopes (U-234/235/236/238) contributed an average of 22 percent of the dose at the boundary, thorium (Th-228/230/231/232) about 57 percent, and radium (Ra-224/226/228) approximately 21 percent. The 2006 background dose (AMS-12) is distributed as 3 percent uranium, 6 percent thorium and 81 percent radium, which differs from the 2005 distribution of 6 percent uranium, 40 percent thorium, and 54 percent radium. Background results for 2005 are similar to 2006 for radium and lower for thorium, which account for the percentage differences. An increase in radium activity on the particulate at AMS-12 was not observed in 2006. A comprehensive discussion of the dose is presented in Appendix D (the 2006 NESHAP annual report).

Figure C.1–20 shows the percentage contribution to dose from uranium, thorium, and radium isotopes at each boundary and background monitor. The boundary locations have been corrected for the background results at monitor AMS-12 prior to calculating the percent dose. Radium isotopes contribute to most of the dose at AMS-9C and a large share at AMS-3. These locations are on the east side of the OSDF and the only boundary points were radium-226 exceeded background levels. This is consistent with AMS-3 and AMS-9C being downwind from the OSDF cells and stockpiles that held radium contaminated soil and debris. The radium contribution for the other boundary monitors is low because radium-224 and radium-228 are the only above-background contributors to the radium dose. AMS-25 has no radium dose because all radium isotopes on the particulate were less than the background. AMS-26 has no thorium and radium dose because the activities for thorium and radium isotopes at this location were less than background.

Table C.1–1. Operational Summary for Air Particulate Monitoring Stations

Location	Number of Samples	Sample Start Date	Sample End Date	Operating Time (hours)	percent of Operation
Boundary					
AMS-2	27	20-Dec-05	02-Jan-07	8908	98.2
AMS-3	27	20-Dec-05	02-Jan-07	8872	97.8
AMS-4	8	20-Dec-05	11-Apr-06	2688	100
AMS-5	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-6	27	20-Dec-05	02-Jan-07	9035	99.6
AMS-7	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-8A	27	20-Dec-05	02-Jan-07	8840	97.4
AMS-9C	25	20-Dec-05	05-Dec-06	8399	100.0
AMS-22	25	20-Dec-05	05-Dec-06	8392	99.9
AMS-23	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-24	27	20-Dec-05	02-Jan-07	8971	98.9
AMS-25	8	20-Dec-05	11-Apr-06	2685	99.9
AMS-26	25	20-Dec-05	05-Dec-06	8373	99.7
AMS-27	25	20-Dec-05	05-Dec-06	8393	99.9
AMS-28	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-29	25	20-Dec-05	05-Dec-06	8131	96.8
Background					
AMS-12	27	20-Dec-05	02-Jan-07	9068	100
Project-Specific					
WPTH-2	16	20-Dec-05	01-Aug-06	5369	99.9

Table C.1–2. Total Uranium Particulate Concentrations in Air[a]

	2006 Results pCi/m^3 x 1E-06				2005 Results pCi/m^3 x 1E-06				1990 through 2006 pCi/m^3 x 1E-06	
Location	Number of Samples	minimum	maximum	average	Number of Samples	minimum	maximum	average	minimum	maximum
Boundary										
AMS-2	27	1.7	83	28	25	1.6	120	42	0.0	9060
AMS-3	27	2.7	260	83	25	4.3	350	113	0.0	17000
AMS-4[b]	8	1.6	42	20	25	2.3	81	34	0.0	2300
AMS-5[b]	8	0.91	28	13	25	1.8	71	29	0.0	4400
AMS-6	27	1.2	53	23	25	0.0	190	59	0.0	3200
AMS-7[b]	8	1.6	28	16	25	2.4	81	33	0.0	7800
AMS-8A	27	1.5	110	35	25	2.1	200	62	0.0	2100
AMS-9C[c]	25	1.7	130	52	25	3.2	240	87	0.0	1700
AMS-22[c]	25	1.5	260	36	25	1.7	180	61	0.0	8100
AMS-23[b]	8	1.4	65	20	25	1.6	160	48	0.0	13000
AMS-24	27	1.6	57	30	25	2.5	120	33	0.0	200
AMS-25[b]	8	0.69	19	11	25	1.0	45	20	0.0	400
AMS-26[c]	25	1.2	110	35	25	1.7	230	48	0.0	1500
AMS-27[c]	25	1.6	66	29	25	1.7	150	51	0.0	1300
AMS-28[b]	8	1.0	60	20	25	0.9	160	49	0.0	3000
AMS-29[c]	25	1.1	110	40	25	3.2	110	53	0.0	1900
Background										
AMS-12	27	0.78	23	11	25	0.0	23	12	0.0	480

[a]Biweekly samples (total U activity calculated assuming natural isotopic distribution)
[b]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
[c]AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table C.1-3. Total Particulate Concentrations in Air[a]

Location	2006 Results (ug/m^3) Number of Samples	minimum	maximum	average	2005 Results (ug/m^3) Number of Samples	minimum	maximum	average	1990 through 2006 (ug/m^3) minimum	maximum
Boundary										
AMS-2	27	0.0	50	30	26	14	73	34	7.0	77
AMS-3	27	20	110	56	26	17	110	48	8.0	160
AMS-4[b]	8	23	33	29	26	17	63	39	13	81
AMS-5[b]	8	15	30	20	26	13	43	29	9.6	48
AMS-6	27	0.0	39	27	26	15	49	34	8.0	62
AMS-7[b]	8	16	24	20	26	14	71	31	6.8	84
AMS-8A	27	11	53	30	26	14	57	34	8.6	89
AMS-9C[d]	25	19	90	46	26	21	69	42	7.1	140
AMS-22[d]	25	20	70	31	26	20	45	34	13	57
AMS-23[b]	8	16	28	22	26	13	49	31	11	75
AMS-24	27	16	61	38	26	12	78	34	5.4	110
AMS-25[b]	8	12	20	16	26	11	43	24	11	69
AMS-26[d]	25	16	47	30	26	16	42	30	5.5	120
AMS-27[d]	25	19	73	48	26	21	79	50	16	92
AMS-28[b]	8	13	24	18	26	13	43	27	8.1	69
AMS-29[d]	25	0	81	41	26	17	67	42	11	93
Background										
AMS-12	27	14	67	25	26	11	43	26	6.0	4100
Project Specific										
WPTH-2[c]	8	23	34	28	26	18	54	26	25	77

[a]Biweekly samples
[b]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
[c]WPTH-2 was taken out of service on August 2, 2006.
[d]AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table C.1–4. Total Thorium-228 Particulate Concentrations in Air[a]

	2006 Results (pCi/m^3 x 1E-06)				2005 Results (pCi/m^3 x 1E-06)				1990 through 2006 (pCi/m^3 x 1E-06)	
Location	Number of Samples	minimum	maximum	average	Number of Samples	minimum	maximum	average	minimum	maximum
Boundary										
AMS-2	18	0.084	17	5.3	17	5.8	25	13	0.0	38
AMS-3	18	0.55	31	10	17	7.7	35	23	0.0	30
AMS-4[b]	5	8.0	8.6	8.3	17	5.9	35	17	0.0	22
AMS-5[b]	5	4.1	7.2	5.4	17	4.8	21	13	0.0	18
AMS-6	18	0.0	14	5.0	17	4.4	25	15	0.0	21
AMS-7[b]	5	4.1	8.9	7.0	17	4.2	29	15	0.0	17
AMS-8A	18	0.094	24	6.3	17	3.5	26	14	0.0	39
AMS-9C[d]	18	0.15	19	5.7	17	9.6	26	15	0.0	50
AMS-22[d]	18	0.0	14	6.0	17	1.1	20	12	0.0	30
AMS-23[b]	5	7.0	7.6	7.4	17	2.4	31	17	0.0	22
AMS-24	18	0.080	12	5.0	17	6.4	25	14	0.0	27
AMS-25[b]	5	7.5	7.7	7.6	17	3.6	15	10	0.0	17
AMS-26[d]	18	0.0	14	5.6	17	6.5	24	14	0.0	24
AMS-27[d]	18	0.0	22	5.9	17	7.3	34	18	0.0	25
AMS-28[b]	5	6.2	16	10	17	3.9	15	9.4	0.0	39
AMS-29[d]	18	0.10	20	7.5	17	3.9	31	18	0.0	46
Background										
AMS-12	18	0.0	14	5.4	17	0.0	17	7.9	0.0	17
Project-Specific										
WPTH-2[c]	12	0.15	19	9.4	17	9.7	29	17	0.0	38

[a]Monthly composites (there are 2 to 3 sample filters in each composite)
[b]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
[c]WPTH-2 was taken out of service on August 2, 2006.
[d]AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table C.1–5. Total Thorium-230 Particulate Concentrations in Air[a]

	2006 Results (pCi/m^3 x 1E-06)				2005 Results (pCi/m^3 x 1E-06)				1990 through 2006 (pCi/m^3 x 1E-06)	
Location	Number of Samples	minimum	maximum	average	Number of Samples	minimum	maximum	average	minimum	maximum
Boundary										
AMS-2	18	0.04	12	4.4	17	0.0	24	12	0.0	140
AMS-3	18	0.47	25	7.9	17	9.7	53	32	0.0	740
AMS-4[b]	5	4.3	8.9	7.1	17	0.0	20	13	0.0	91
AMS-5[b]	5	0.75	6.5	4.2	17	2.1	19	8.4	0.0	620
AMS-6	18	0.16	30	8.4	17	6.4	78	33	0.0	490
AMS-7[b]	5	0.15	2.4	1.5	17	0.0	13	7.4	0.0	77
AMS-8A	18	0.21	19	7.3	17	0.0	32	18	0.0	460
AMS-9C[d]	18	0.11	29	8.5	17	6.6	43	26	0.0	410
AMS-22[d]	18	0.12	12	3.9	17	0.1	40	18	0.0	490
AMS-23[b]	5	2.3	5.1	3.4	17	0.0	31	17	0.0	210
AMS-24	18	0.26	13	5.7	17	1.9	21	11	0.0	130
AMS-25[b]	5	1.9	2.5	2.2	17	0.0	19	8.9	0.0	220
AMS-26[d]	18	0.11	17	5.0	17	3.4	18	13	0.0	230
AMS-27[d]	18	0.28	17	6.5	17	13	51	24	0.0	190
AMS-28[b]	5	1.0	1.4	1.2	17	0.0	23	10	0.0	400
AMS-29[d]	18	0.31	19	7.3	17	6.4	32	22	0.0	540
Background										
AMS-12	18	0.0	6.8	2.0	17	0.0	11	4.8	0.0	42
Project-Specific										
WPTH-2[c]	12	0.24	16	7.2	17	4.9	78	31	0.0	580

[a]Monthly composites (there are 2 to 3 sample filters in each composite)
[b]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
[c]WPTH-2 was taken out of service on August 2, 2006.
[d]AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table C.1–6. Total Thorium-232 Particulate Concentrations in Air[a]

	2006 Result (pCi/m^3 x 1E-06)				2005 Results (pCi/m^3 x 1E-06)				1990 through 2006 (pCi/m^3 x 1E-06)	
Location	Number of Samples	minimum	maximum	average	Number of Samples	minimum	maximum	average	minimum	maximum
Boundary										
AMS-2	18	0.10	12	3.8	17	1.7	9.5	5.5	0.0	22
AMS-3	18	0.40	15	4.8	17	0.6	20	11	0.0	25
AMS-4[b]	5	0.00	3.6	1.4	17	1.9	15	7.4	0.0	22
AMS-5[b]	5	0.95	1.6	1.3	17	0.0	13	4.1	0.0	25
AMS-6	18	0.072	5.5	2.3	17	3.9	17	8.7	0.0	22
AMS-7[b]	5	1.2	5.3	3.7	17	0.0	7.5	3.8	0.0	16
AMS-8A	18	0.15	6.6	2.9	17	3.1	14	6.9	0.0	33
AMS-9C[d]	18	0.24	16	4.3	17	2.8	19	10	0.0	36
AMS-22[d]	18	0.018	13	2.2	17	1.8	12	7.2	0.0	35
AMS-23[b]	5	3.8	6.6	5.5	17	0.9	16	8.9	0.0	75
AMS-24	18	0.055	9.1	3.6	17	0.4	12	6.9	0.0	16
AMS-25[b]	5	0.37	3.2	1.5	17	1.1	7.6	3.6	0.0	14
AMS-26[d]	18	0.077	8.7	2.8	17	2.1	10	6.3	0.0	14
AMS-27[d]	18	0.059	16	3.8	17	5	12	7.9	0.0	22
AMS-28[b]	5	0.52	2.3	1.2	17	0.1	12	3.7	0.0	33
AMS-29[d]	18	0.10	12	4.5	17	2.3	18	10	0.0	31
Background										
AMS-12	18	0.00	6.6	2.5	17	1.5	7.8	3.4	0.0	34
Project-Specific										
WPTH-2[c]	12	0.13	7.7	4.6	17	2.8	14	6.8	0.0	43

[a]Monthly composites (there are 2 to 3 sample filters in each composite)
[b]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
[c]WPTH-2 was taken out of service on August 2, 2006.
[d]AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table C.1–7. 2006 Annual Average Radionuclide Particulate concentrations in Air[ac]

Location	Gross Concentration (pCi/m^3)											
	U-238	U-234	U-235/6	Th-228	Th-230	Th-232	Ra-226	Th-234[b]	Ra-228[b]	Ac-228[b]	Ra-224[b]	Th-231[b]
Boundary												
AMS-2	4.60E-06	4.47E-06	0.00E+00	3.81E-06	9.56E-07	2.22E-06	1.92E-05	4.60E-06	2.22E-06	2.22E-06	2.22E-06	0.00E+00
AMS-3	1.16E-05	9.78E-06	1.32E-07	6.50E-06	5.51E-06	4.97E-06	7.08E-05	1.16E-05	4.97E-06	4.97E-06	4.97E-06	1.32E-07
AMS-4[d]	1.19E-05	9.26E-06	0.00E+00	7.19E-06	6.48E-09	5.22E-06	1.39E-05	1.19E-05	5.22E-06	5.22E-06	5.22E-06	0.00E+00
AMS-5[d]	6.12E-06	6.12E-06	0.00E+00	4.67E-06	6.20E-09	2.55E-06	3.73E-05	6.12E-06	2.55E-06	2.55E-06	2.55E-06	0.00E+00
AMS-6	4.26E-06	4.01E-06	6.65E-08	3.21E-06	1.34E-06	1.58E-06	3.32E-05	4.26E-06	1.58E-06	1.58E-06	1.58E-06	6.65E-08
AMS-7[d]	9.21E-06	6.54E-06	0.00E+00	5.84E-06	2.79E-08	2.28E-06	2.64E-05	9.21E-06	2.28E-06	2.28E-06	2.28E-06	0.00E+00
AMS-8A	6.04E-06	5.68E-06	4.57E-08	3.87E-06	2.26E-06	2.39E-06	2.46E-05	6.04E-06	2.39E-06	2.39E-06	2.39E-06	4.57E-08
AMS-9C[e]	7.43E-06	7.86E-06	6.33E-08	3.79E-06	1.68E-06	2.39E-06	7.80E-05	7.43E-06	2.39E-06	2.39E-06	2.39E-06	6.33E-08
AMS-22[e]	5.25E-06	5.98E-06	6.56E-07	3.28E-06	1.01E-06	1.78E-06	2.94E-05	5.25E-06	1.78E-06	1.78E-06	1.78E-06	6.56E-07
AMS-23[d]	1.12E-05	1.19E-05	1.74E-06	8.34E-06	5.51E-07	4.26E-06	2.60E-05	1.12E-05	4.26E-06	4.26E-06	4.26E-06	1.74E-06
AMS-24	6.00E-06	5.60E-06	0.00E+00	4.54E-06	2.93E-06	3.35E-06	1.95E-05	6.00E-06	3.35E-06	3.35E-06	3.35E-06	0.00E+00
AMS-25[d]	7.23E-06	6.52E-06	0.00E+00	3.73E-06	0.00E+00	3.73E-08	1.19E-05	7.23E-06	3.73E-08	3.73E-08	3.73E-08	0.00E+00
AMS-26[e]	1.46E-06	1.32E-06	5.37E-08	1.26E-06	6.37E-07	5.31E-07	9.31E-06	1.46E-06	5.31E-07	5.31E-07	5.31E-07	5.37E-08
AMS-27[e]	4.71E-06	4.46E-06	7.31E-08	4.70E-06	2.10E-06	2.92E-06	4.54E-05	4.71E-06	2.92E-06	2.92E-06	2.92E-06	7.31E-08
AMS-28[d]	8.42E-06	9.11E-06	0.00E+00	3.72E-06	4.91E-08	2.35E-06	4.26E-05	8.42E-06	2.35E-06	2.35E-06	2.35E-06	0.00E+00
AMS-29[e]	9.20E-06	7.40E-06	8.32E-08	5.56E-06	2.95E-06	3.72E-06	5.29E-05	9.20E-06	3.72E-06	3.72E-06	3.72E-06	8.32E-08
Background												
AMS-12	2.13E-06	1.89E-06	0.00E+00	2.99E-06	1.01E-06	1.18E-06	5.09E-05	2.13E-06	1.18E-06	1.18E-06	1.18E-06	0.00E+00
Compliance Limit												
DCGs	1.00E-01	9.00E-02	1.00E-01	4.00E-02	4.00E-02	7.00E-03	1.00E+00	4.00E+02	3.00E+00	4.00E+01	4.00E+00	1.00E+04

[a]A concentration of 0.0 indicates either the filter results were equal to or less than the blank results.
[b]Isotopes assumed to be in equilibrium with their parents.
[c]Annual Average obtained from sum of quarter results for total activity divided by total air volume through the monitor.
[d]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
[e]AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

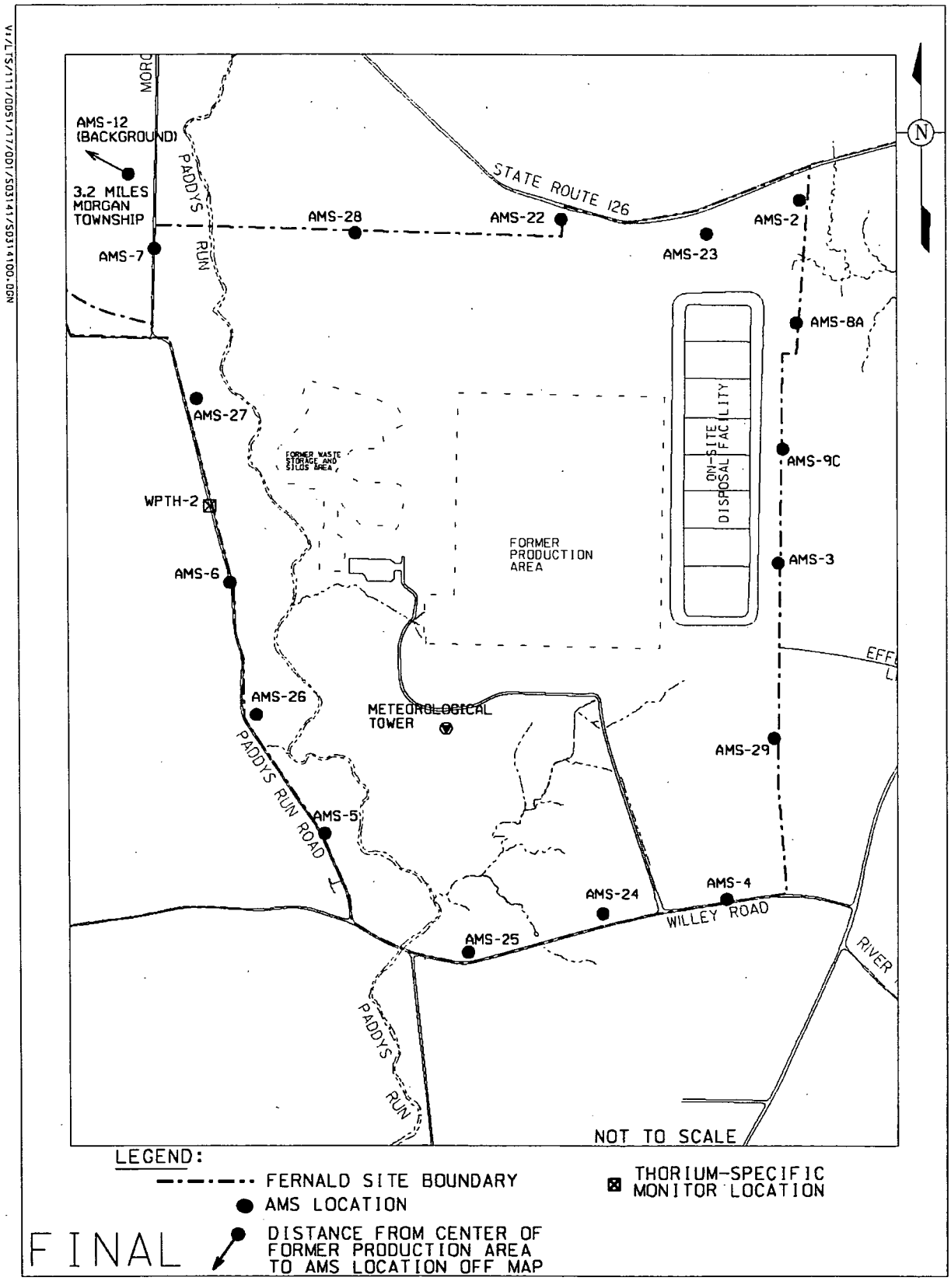

Figure C.1–1. IEMP Air Monitoring Locations

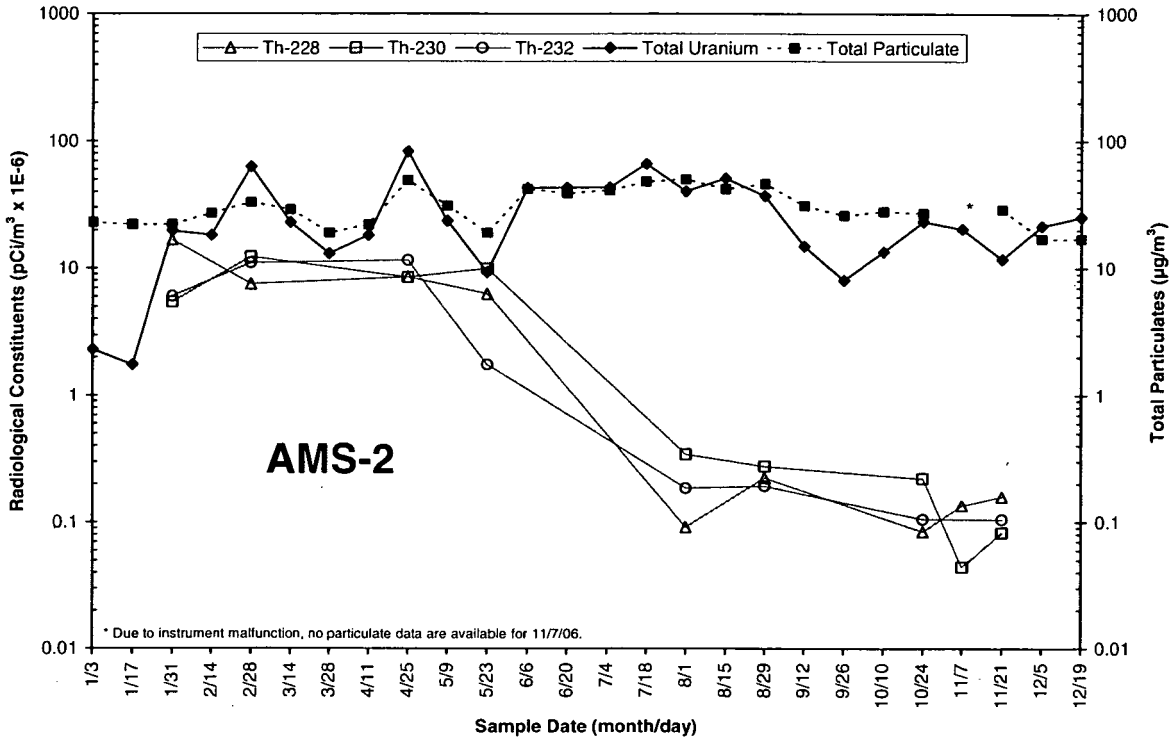

Figure C.1–2. 2006 Radiological and Particulate Concentrations in Air (AMS-2)

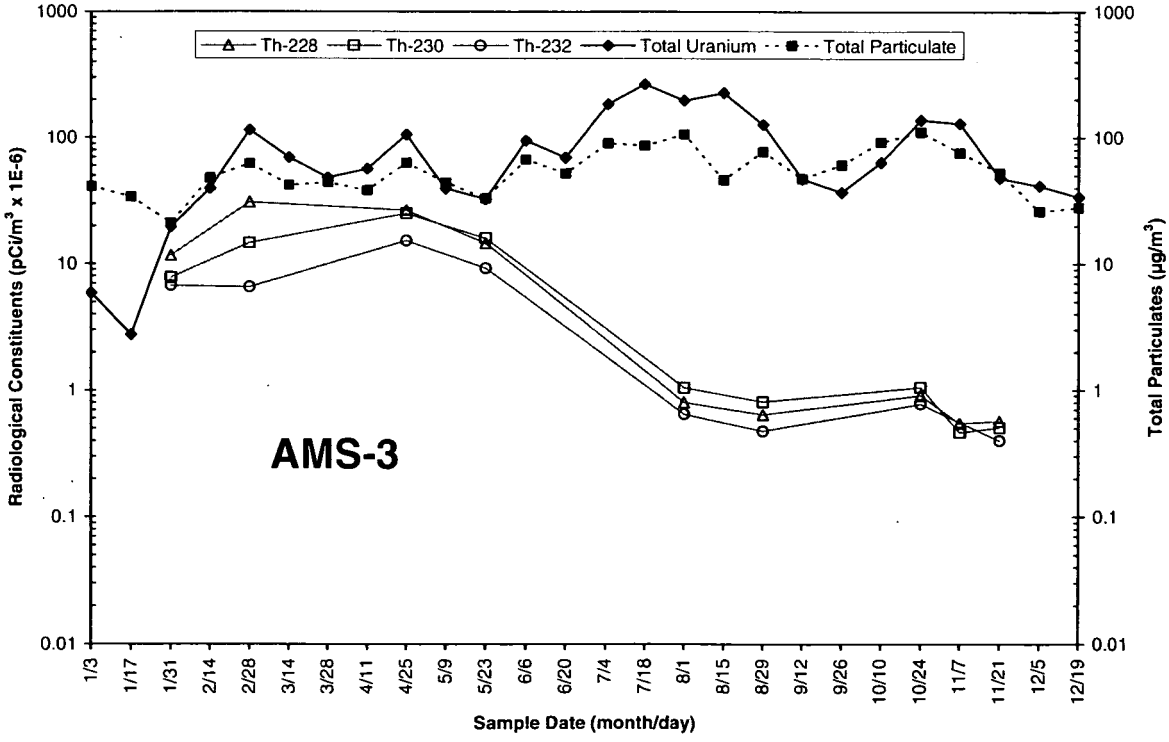

Figure C.1–3. 2006 Radiological and Particulate Concentrations in Air (AMS-3)

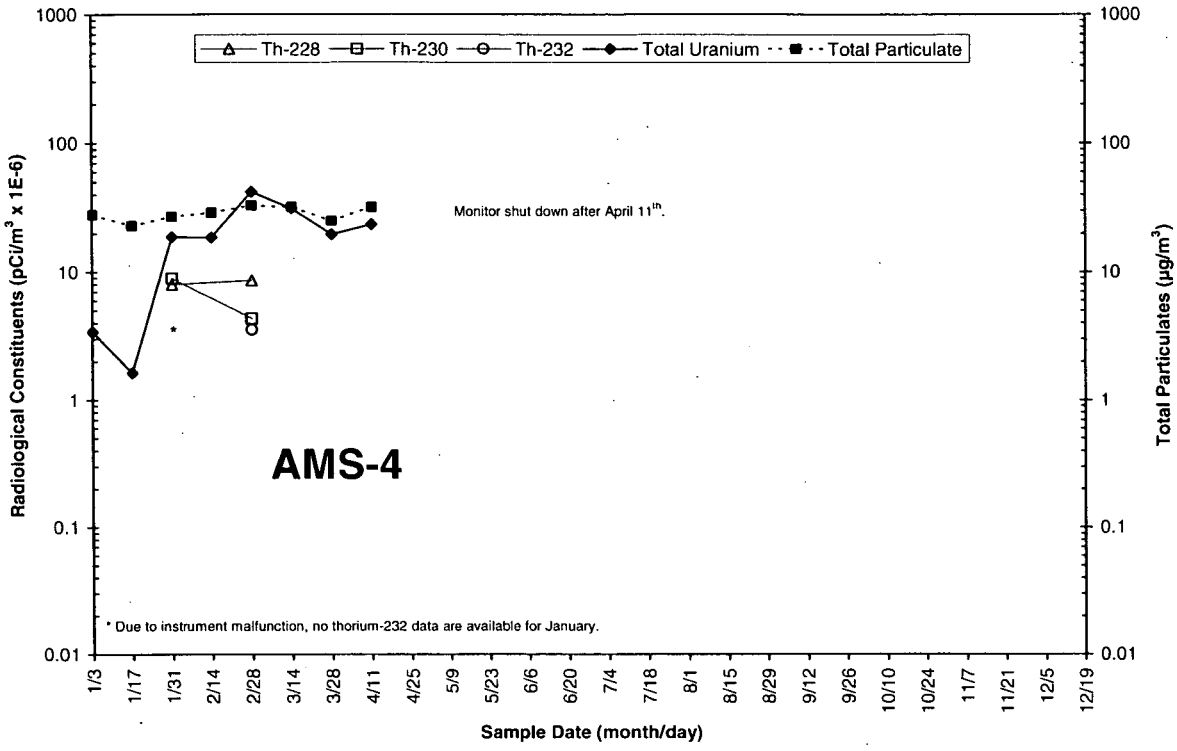

Figure C.1–4. 2006 Radiological and Particulate Concentrations in Air (AMS-4)

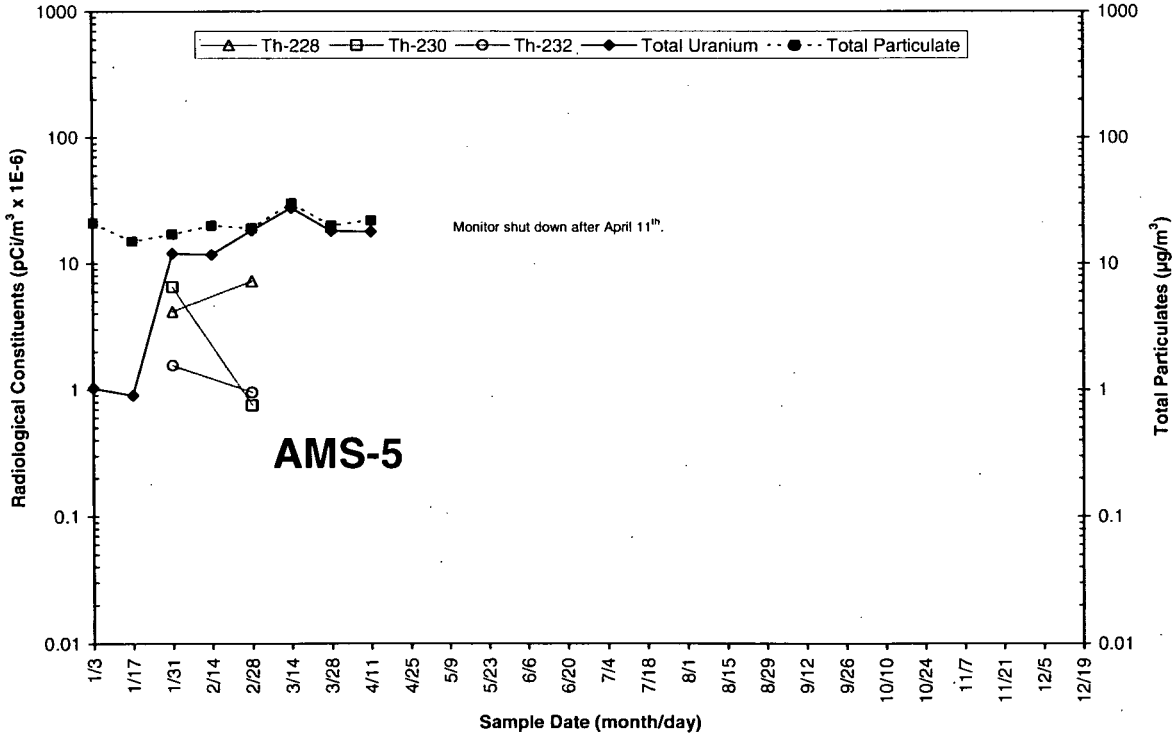

Figure C.1–5. 2006 Radiological and Particulate Concentrations in Air (AMS-5)

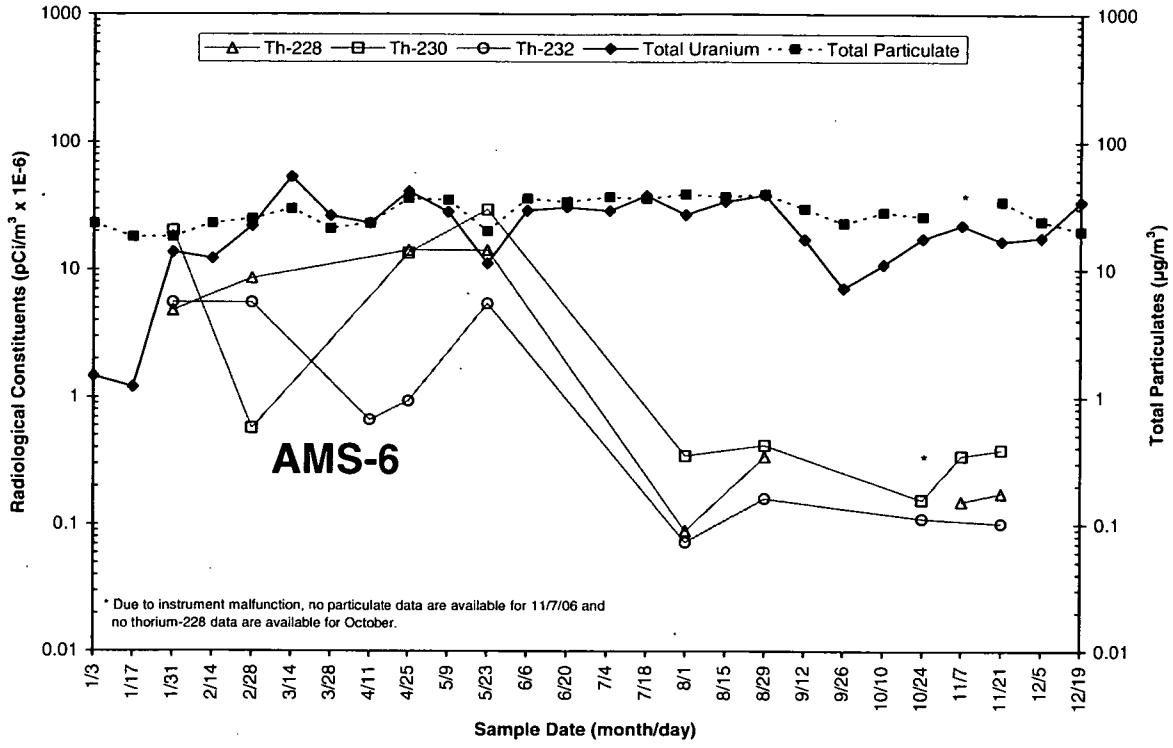

Figure C.1–6. 2006 Radiological and Particulate Concentrations in Air (AMS-6)

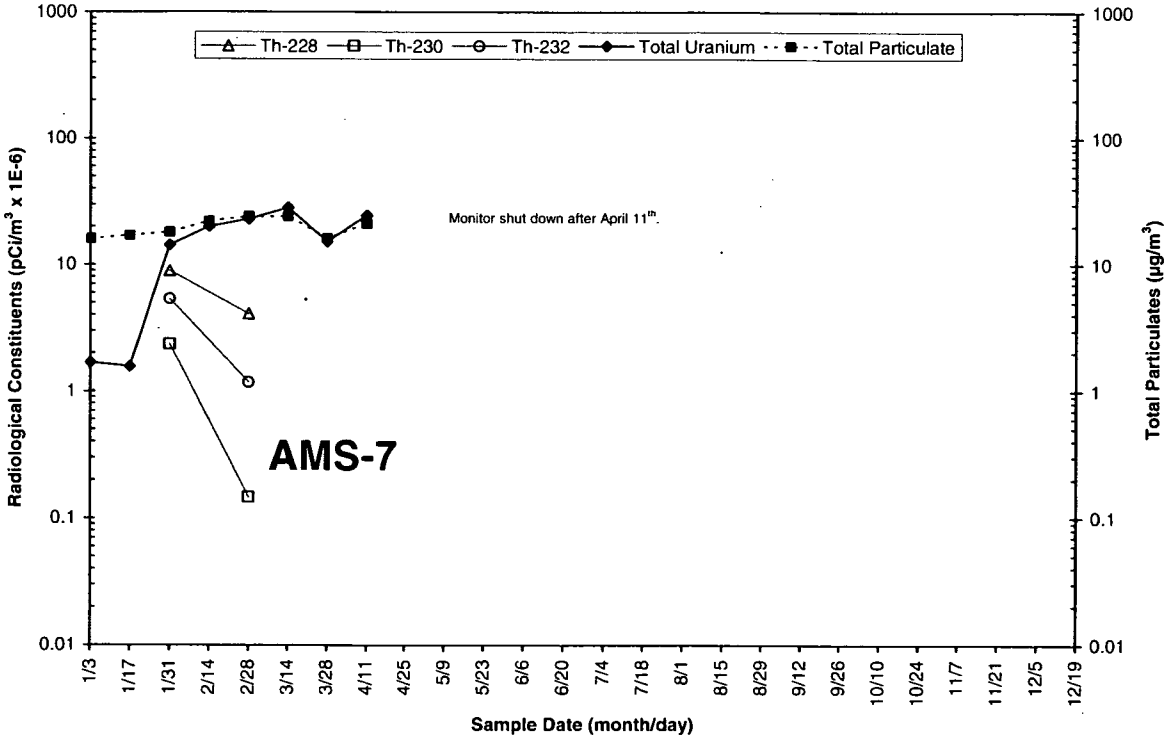

Figure C.1–7. 2006 Radiological and Particulate Concentrations in Air (AMS-7)

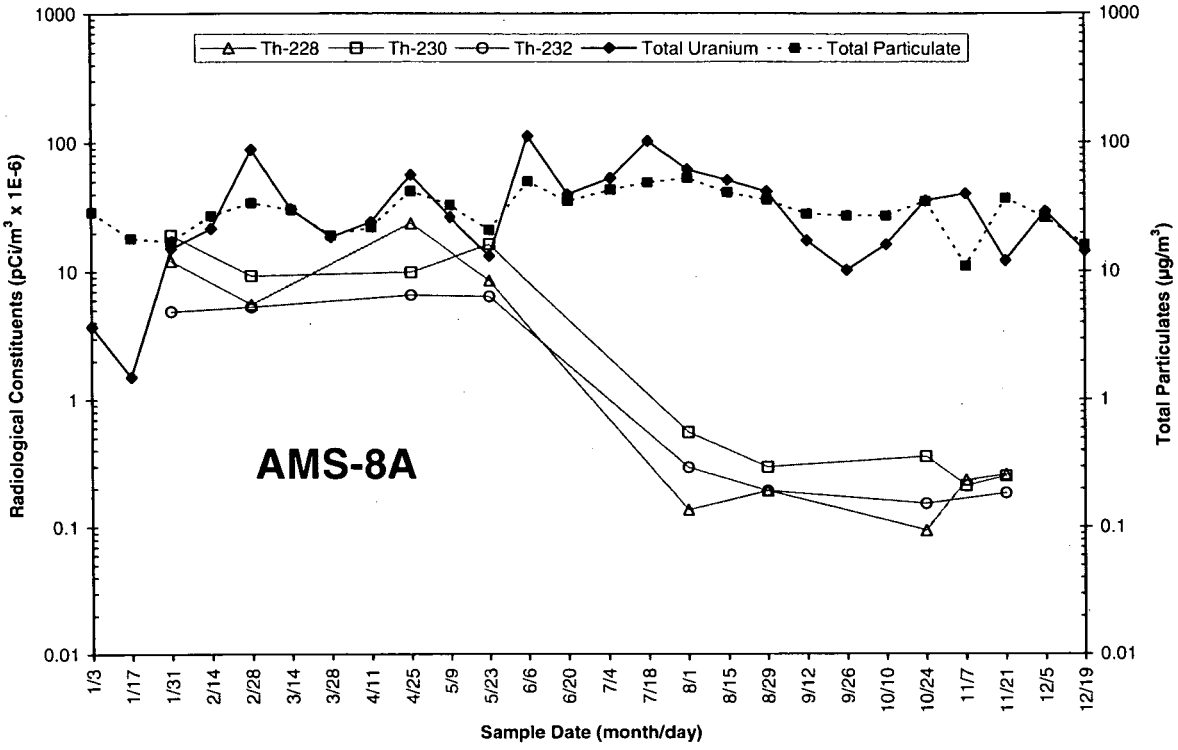

Figure C.1–8. 2006 Radiological and Particulate Concentrations in Air (AMS-8)

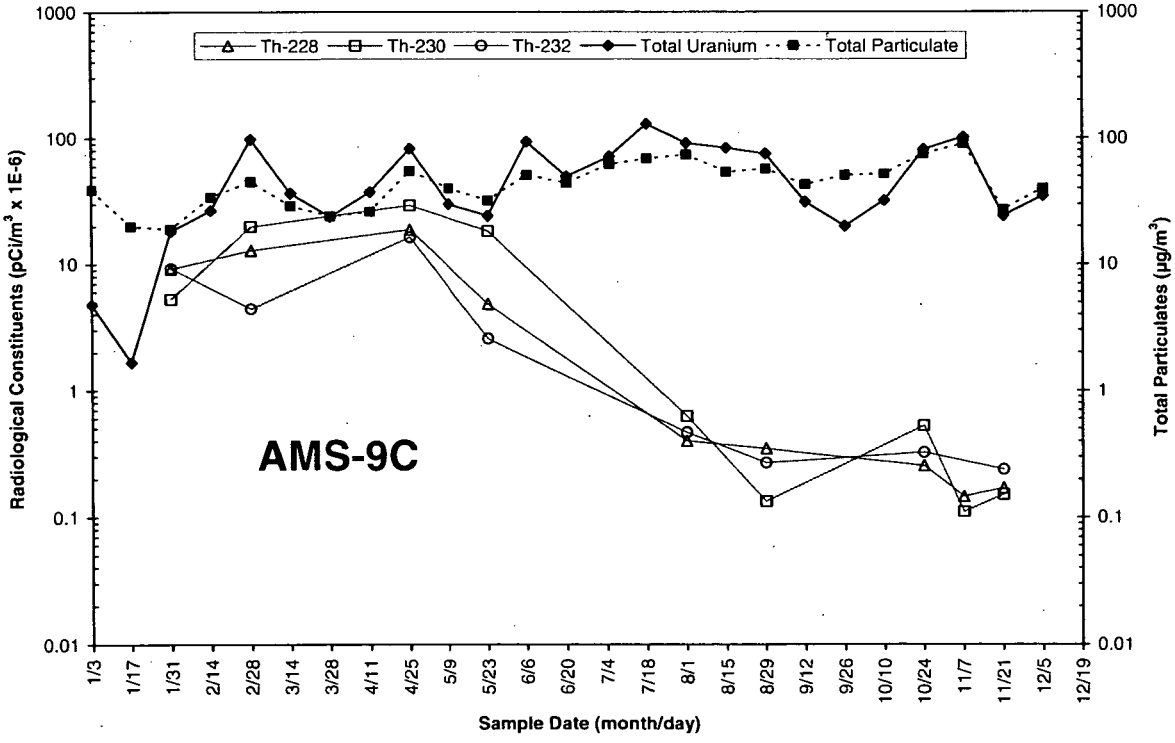

Figure C.1–9. 2006 Radiological and Particulate Concentrations in Air (AMS-9)

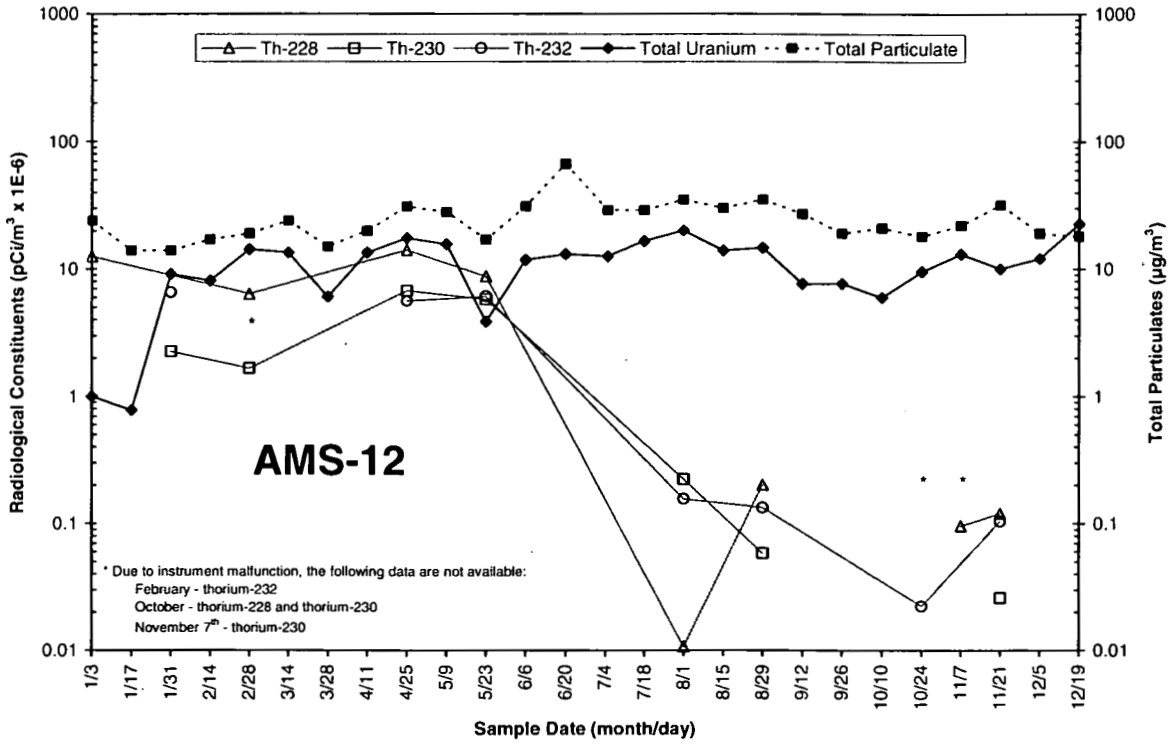

Figure C.1–10. 2006 Radiological and Particulate Concentrations in Air (AMS-12)

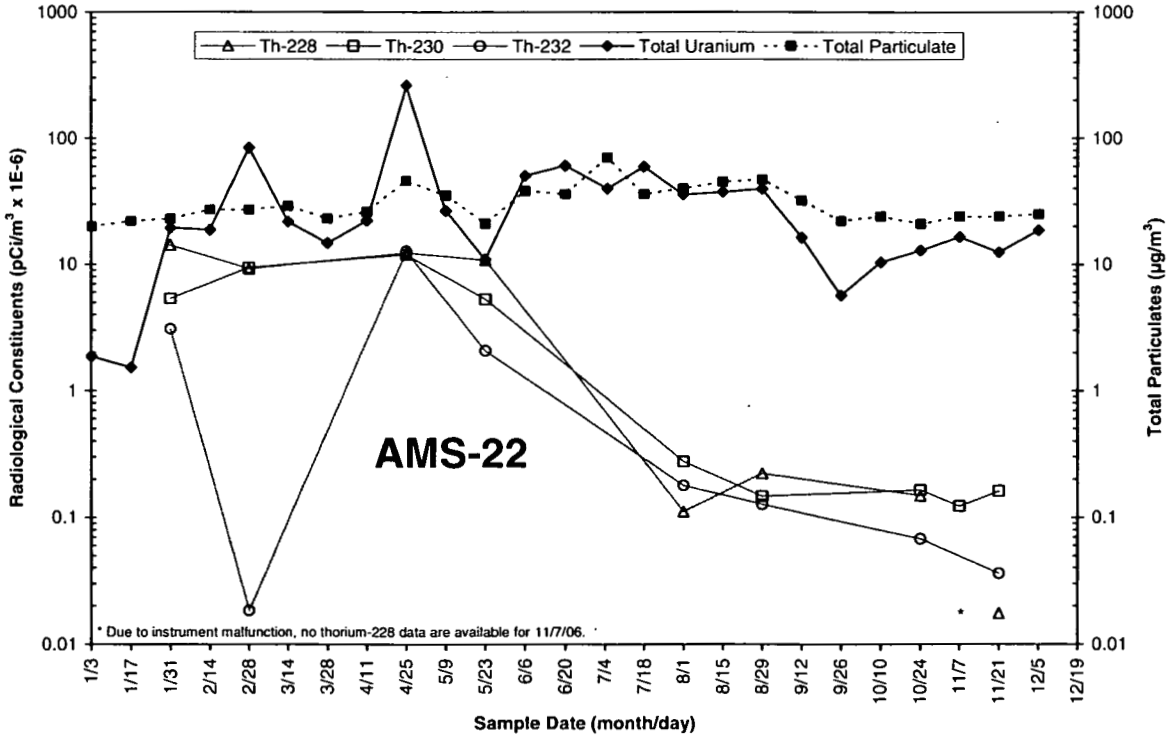

Figure C.1–11. 2006 Radiological and Particulate Concentrations in Air (AMS-22)

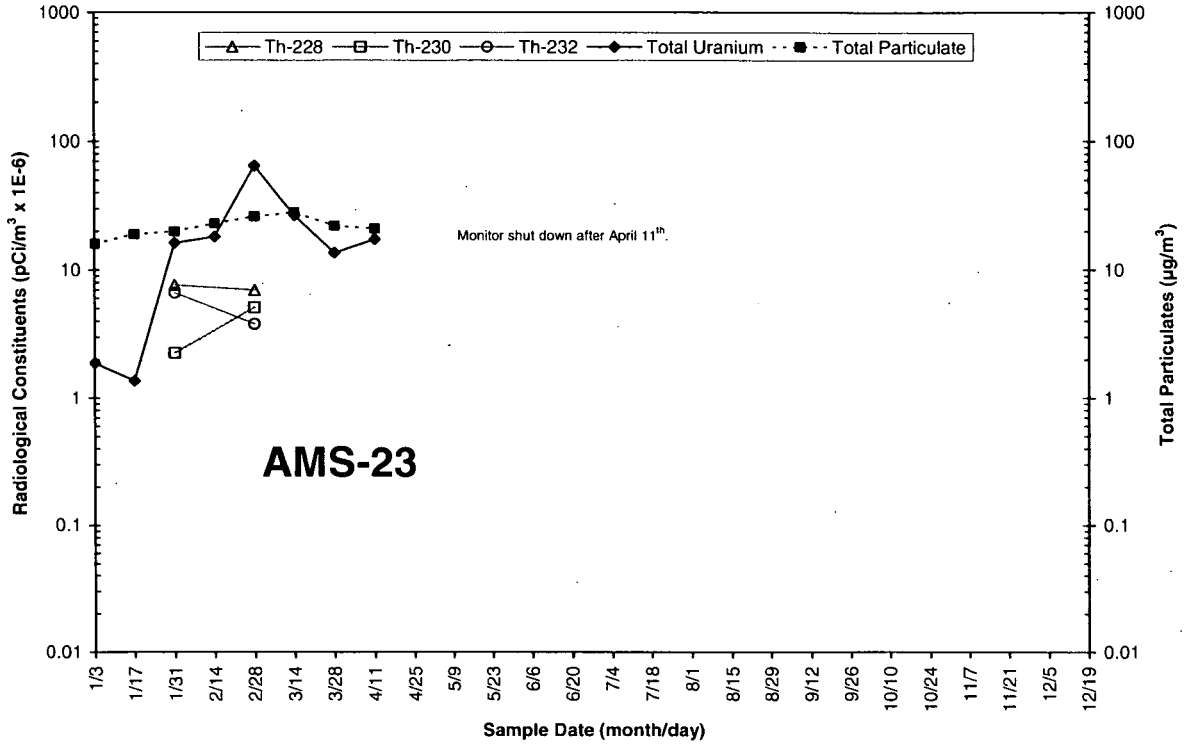

Figure C.1–12. 2006 Radiological and Particulate Concentrations in Air (AMS-23)

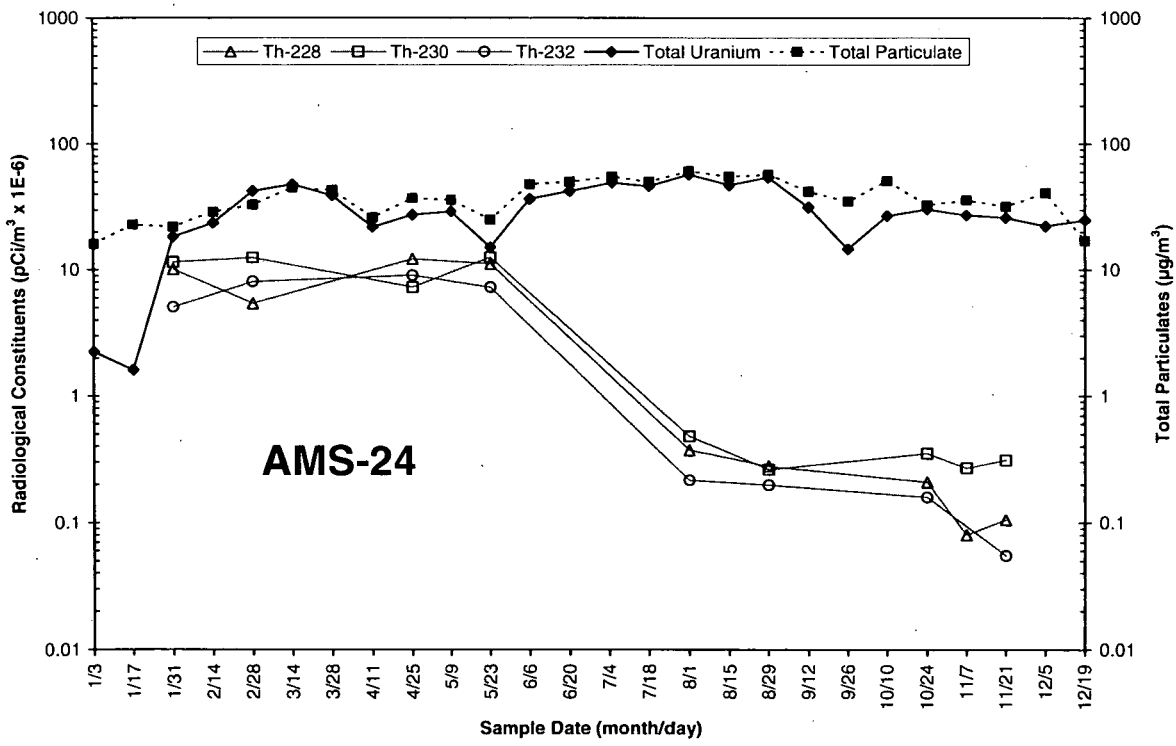

Figure C.1–13. 2006 Radiological and Particulate Concentrations in Air (AMS-24)

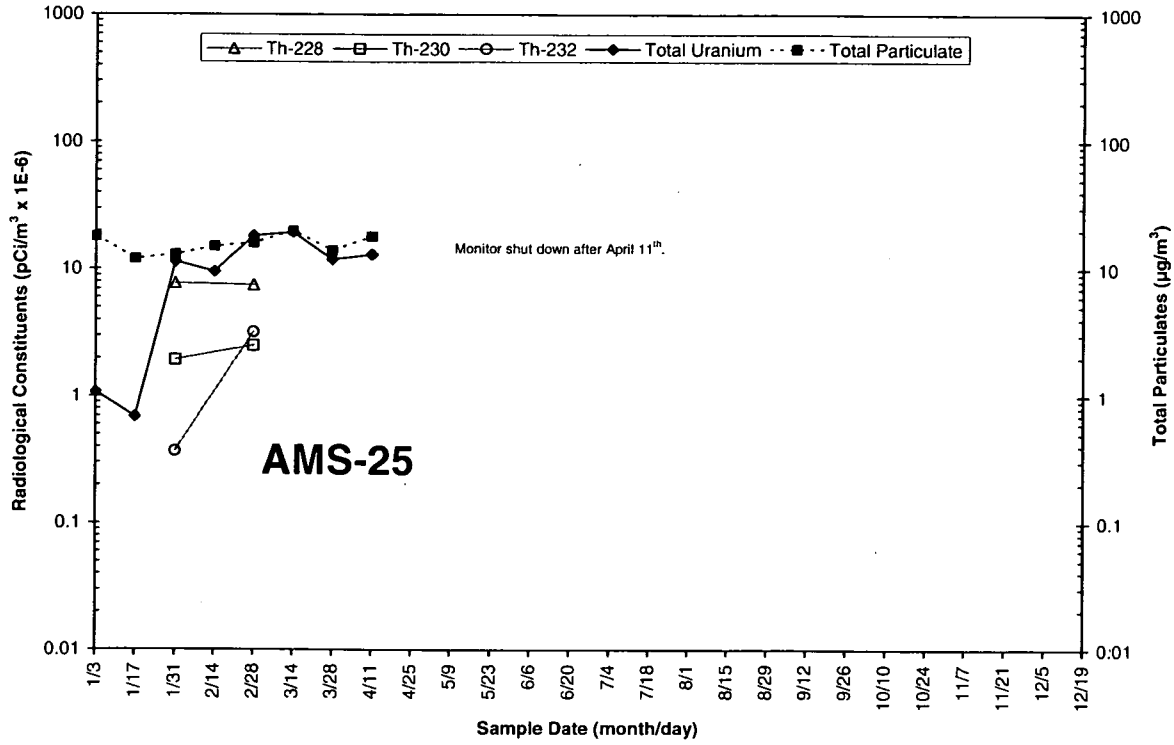

Figure C.1–14. 2006 Radiological and Particulate Concentrations in Air (AMS-25)

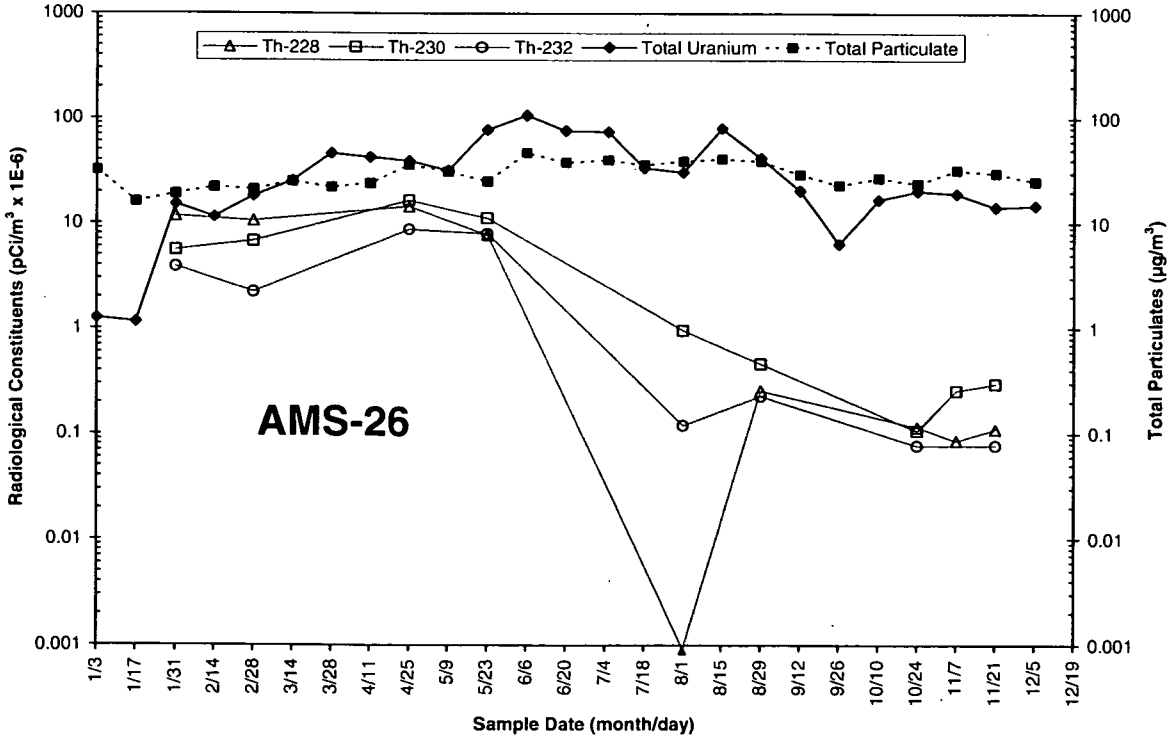

Figure C.1–15. 2006 Radiological and Particulate Concentrations in Air (AMS-62)

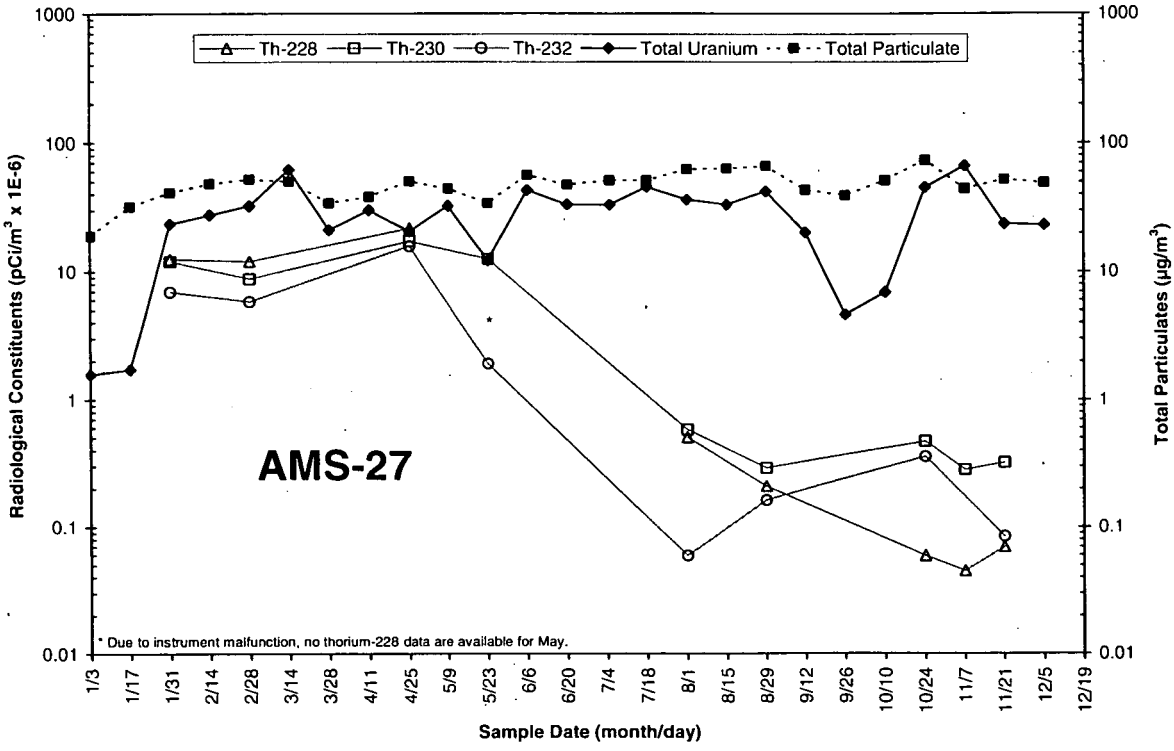

Figure C.1–16. 2006 Radiological and Particulate Concentrations in Air (AMS-27)

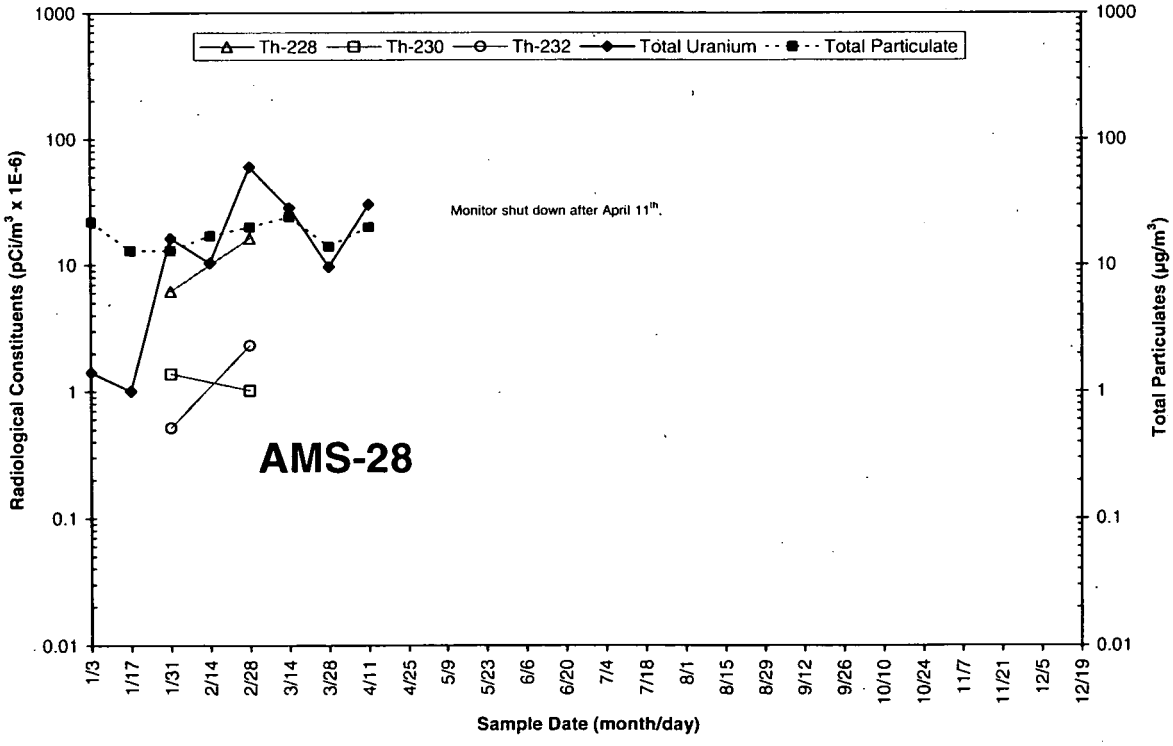

Figure C.1–17. 2006 Radiological and Particulate Concentrations in Air (AMS-28)

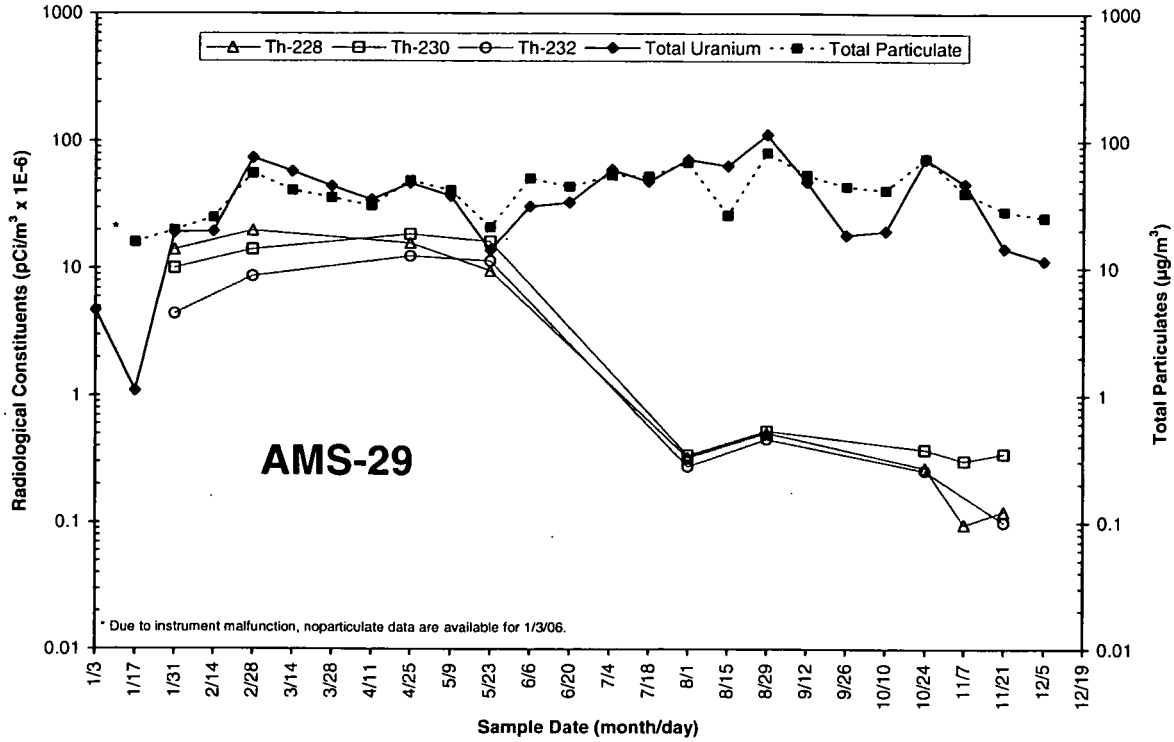

Figure C.1–18. 2006 Radiological and Particulate Concentrations in Air (AMS-29)

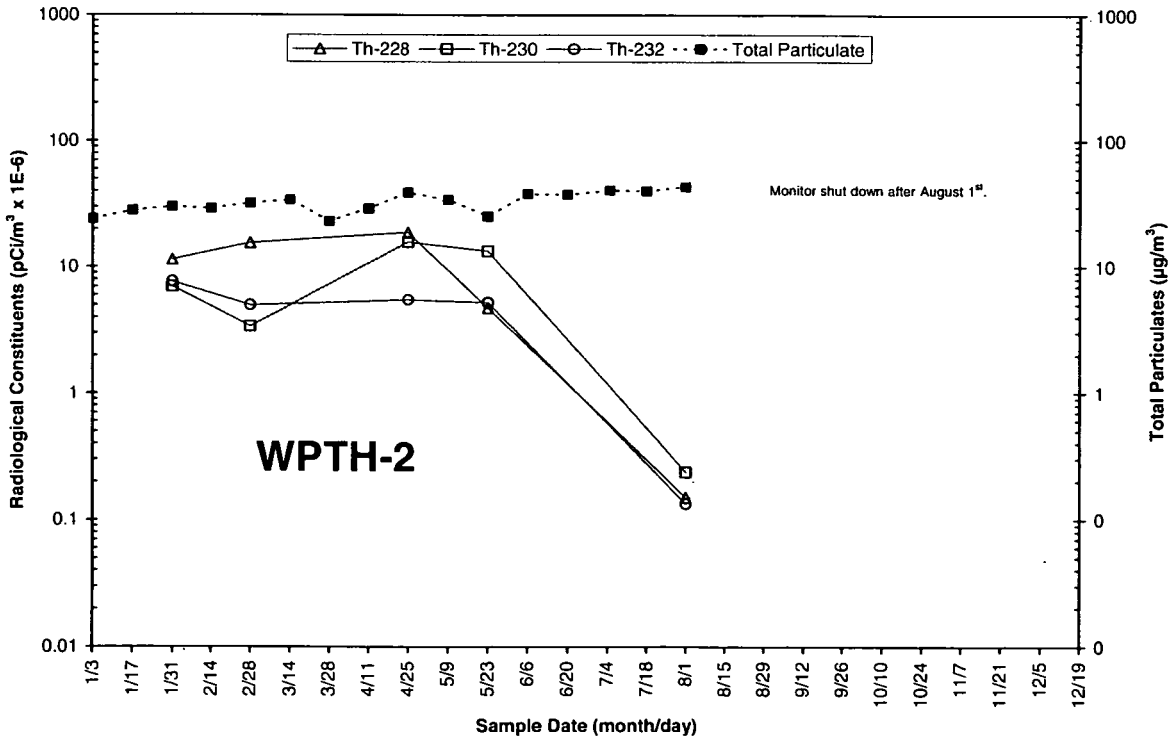

Figure C.1–19. 2006 Radiological and Particulate Concentrations in Air (WPTH-2)

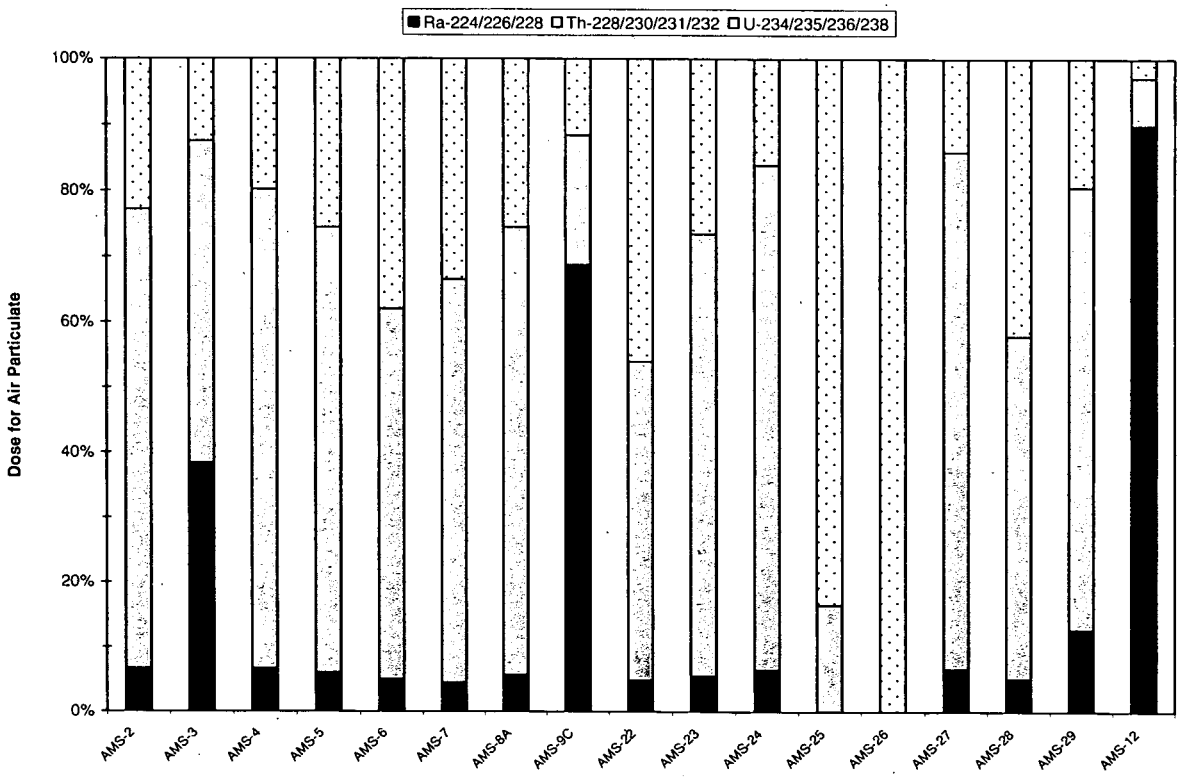

Figure C.1–20. 2006 Isotopic Dose Contributions at AMS Locations

Attachment C.2

Attachment C.2

C.2.0 Radon

The Fernald site's 2006 radon monitoring program evaluated the effects of radon emissions, from the silos treatment facilities and radon control system (RCS), on the surrounding environment. Radon data collected under the program are compared to the radon concentration standards contained in DOE Order 5400.5 (DOE 1993) and proposed 10 Code of Federal Regulations (CFR) 834. The pertinent standards and associated 2006 compliance status are as follows:

- The proposed 10 CFR 834 annual average limit at and beyond the facility boundary is 0.5 picoCuries per liter (pCi/L) above background; there were no exceedances in 2006.
- The DOE annual average limit within the site is 30 pCi/L above background; this limit was not exceeded in 2006.
- The DOE limit measured at any point over the facility is 100 pCi/L above background; there were no exceedances in 2006.

C.2.1 Boundary Monitors

Continuous monitors are used at the Fernald site to track daily changes in the radon levels and determine compliance with the noted standards. In 2006, the radon monitoring program sustained a 99 percent run-time for radon monitors at the site boundary. The one percent down time was associated with downloading instrument data, interruptions due to extremely cold temperatures, power interruptions, and/or an increase in routine maintenance or project activities. Table C.2–1 provides a summary of the minimum, maximum and average radon concentrations for 2006 and 2005. The 2006 values are similar to those reported in 2005.

Figure C.2–1 identifies the radon monitoring locations, and Figure C.2–2 compares the annual average values (uncorrected and background corrected) to the 10 CFR 834 proposed limit for the annual average radon level at the off-site location immediately adjacent to the site boundary. All locations show background corrected values that are below the 10 CFR 834 proposed limit. Figures C.2–3 through C.2–28 show the monthly average radon concentrations for each location (uncorrected and background corrected). In general, all boundary monitors maintained monthly averages less than 1 pCi/L, exceptions being AMS-6, AMS-26 and PR-1. The noted exceptions lie to the west of the silos project, and an increase in the radon readings for July and August are attributed to the demolition of the silos treatment facilities during the summer of 2006. This increasing trend for July and August is also observed for on-site radon monitors in the vicinity of the remediation work (Figures C.2–21 through C.2–28).

C.2.2 Stack Monitors

All stack monitoring was completed in April of 2006, and the 2006 results for the Silos Project RCS and the silos treatment facilities were discussed in the 2005 site environmental report. Therefore, they will not be addressed here.

Table C.2–1. Continuous Radon Monitors[a]

Location	2006 Summary Results (pCi/L)			2005 Summary Results (pCi/L)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
Boundary						
AMS-2	0.2	0.8	0.5	0.2	0.9	0.5
AMS-3	0.2	0.6	0.4	0.2	0.7	0.4
AMS-4[b]	0.2	0.3	0.3	0.1	0.6	0.4
AMS-5[b]	0.1	0.6	0.4	0.2	1.1	0.6
AMS-6	0.3	1.1	0.6	0.1	1.0	0.5
AMS-7[b]	0.3	0.5	0.4	0.2	1.1	0.6
AMS-8A	0.2	0.7	0.4	0.3	0.6	0.4
AMS-9C[d]	0.3	0.9	0.5	0.2	0.6	0.4
AMS-22[d]	0.2	0.5	0.3	0.2	0.5	0.3
AMS-23[b]	0.2	0.3	0.3	0.3	0.5	0.4
AMS-24	0.2	0.9	0.6	0.2	0.8	0.5
AMS-25[b]	0.4	0.6	0.5	0.3	0.8	0.6
AMS-26[d]	0.3	0.7	0.4	0.1	0.7	0.4
AMS-27[d]	0.5	0.9	0.6	0.2	1.0	0.5
AMS-28[b]	0.2	0.2	0.2	0.1	0.7	0.4
AMS-29[d]	0.2	0.6	0.4	0.3	0.6	0.4
Background						
AMS-12	0.1	0.5	0.3	0.2	0.6	0.4
On Site						
KNE-B[c]	0.2	1.1	0.4	0.3	1.7	0.9
KSE-A[c]	0.3	1.3	0.5	0.2	1.5	0.8
KSO-A[c]	0.1	1.0	0.5	0.2	0.7	0.5
LP2[c]	0.1	1.2	0.4	0.1	0.6	0.3
PR-1[c]	0.3	2.2	0.7	0.2	1.3	0.6
Rally Point 4[c]	0.3	1.0	0.4	0.3	0.7	0.4
BSL-A[c]	0.3	1.3	0.5	0.1	0.6	0.3
T117A[c]	0.4	1.1	0.5	0.3	0.8	0.5
T28A[c]	0.3	1.3	0.6	0.3	0.9	0.6

[a]monthy averages used to calculate annual minimum, maximum and average
[b]AMS-04, 05, 07, 23, 25 & 28 taken off line in April 2006
[c]KNE-B, KSE-A, KSO-A, LP2, PR-1, Rally Point 4, BSL-A, T117A, and T28A taken off line in August 2006
[d]AMS-09C, 22, 26, 27 & 29 taken off line in November 2006

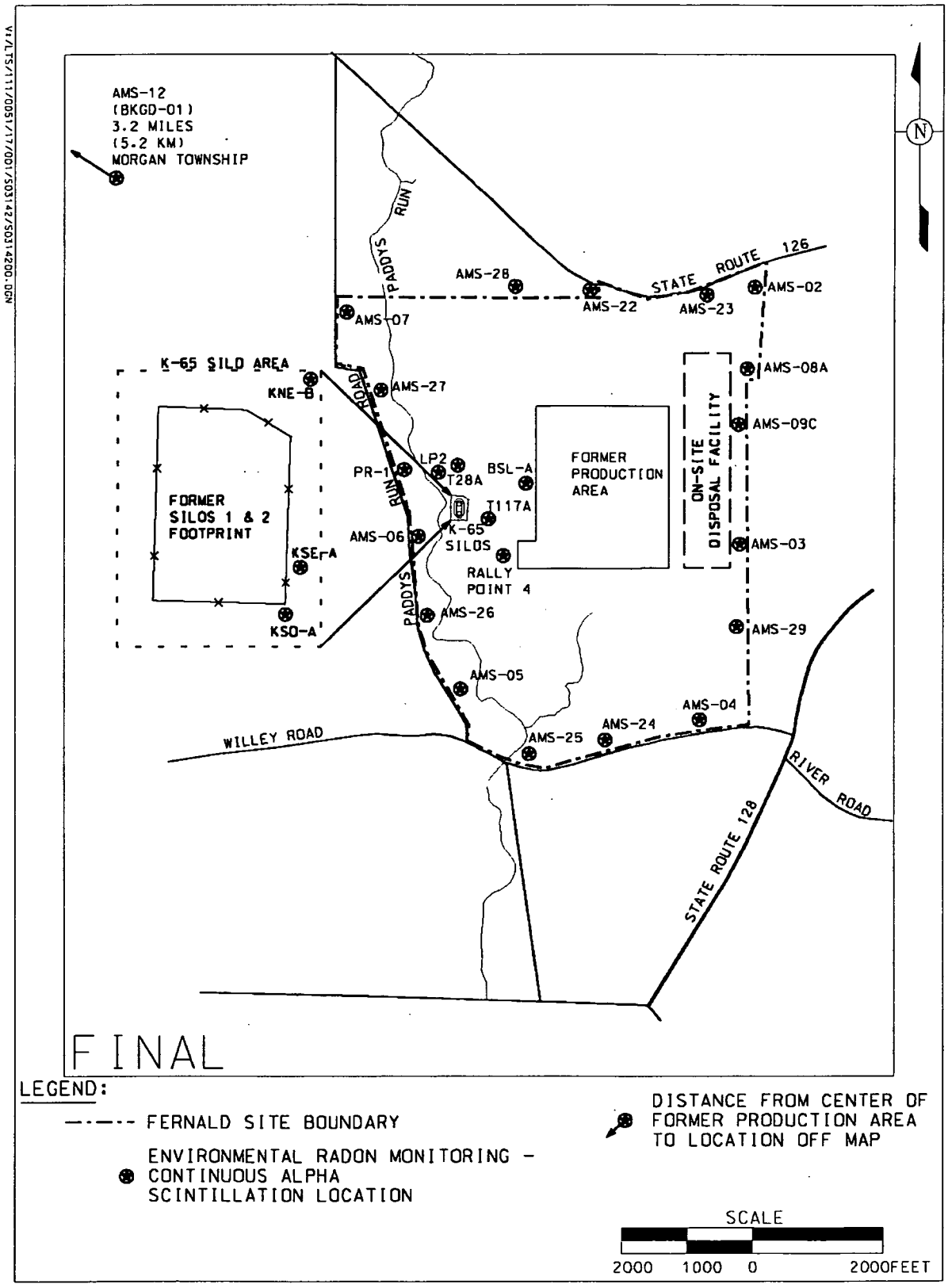

Figure C.2–1. Radon Monitoring Locations

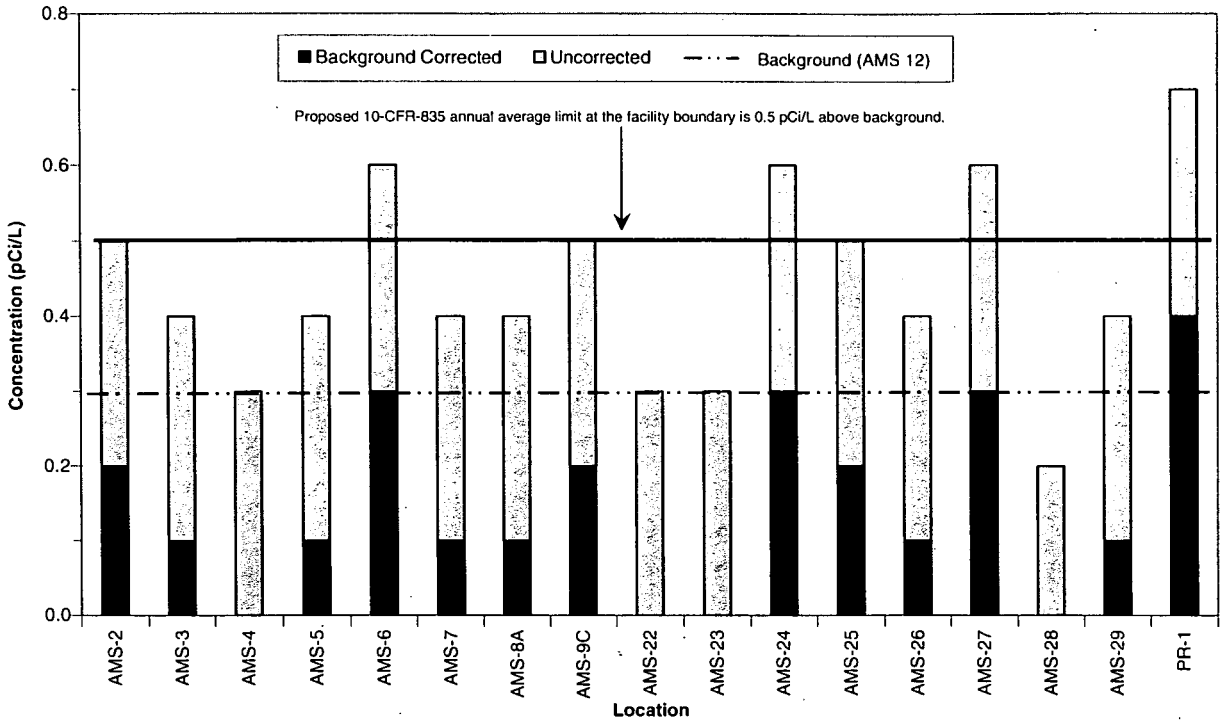

Figure C.2–2. 2006 Average Annual Radon Concentration for each Facility Boundary Monitor

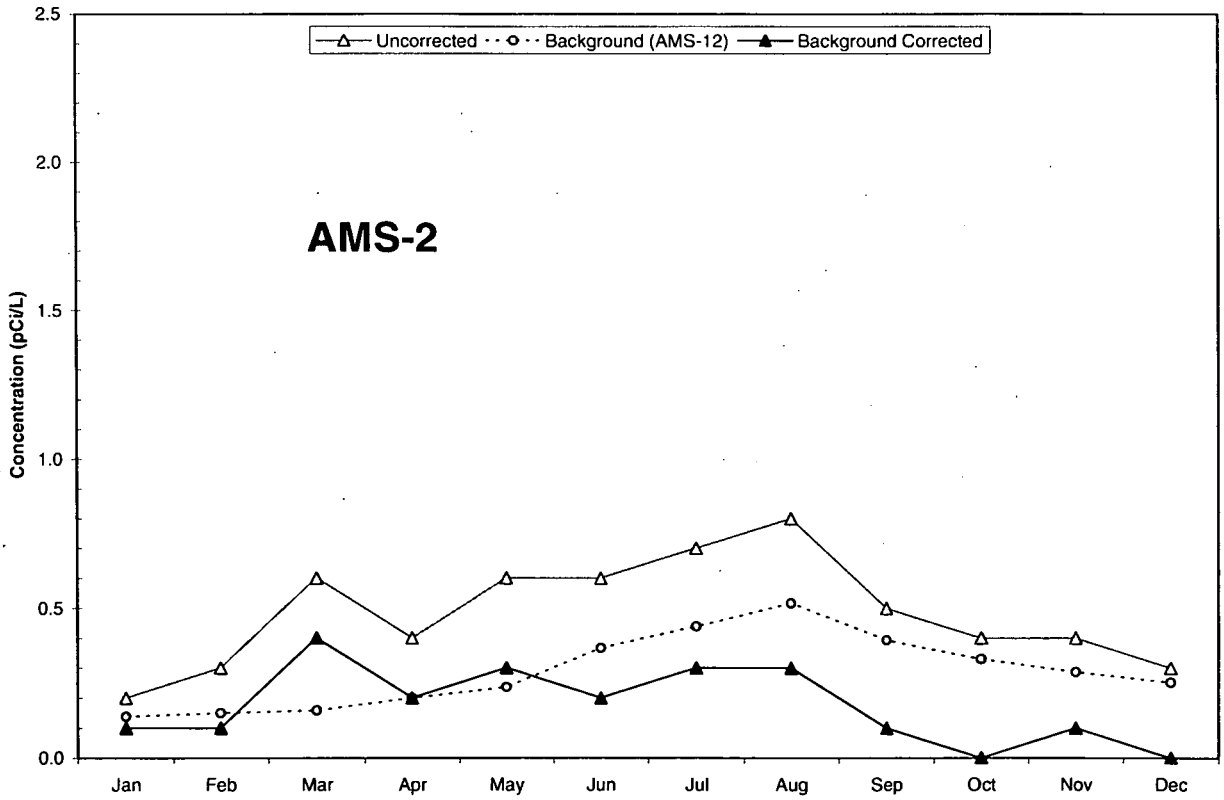

Figure C.2–3. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-2

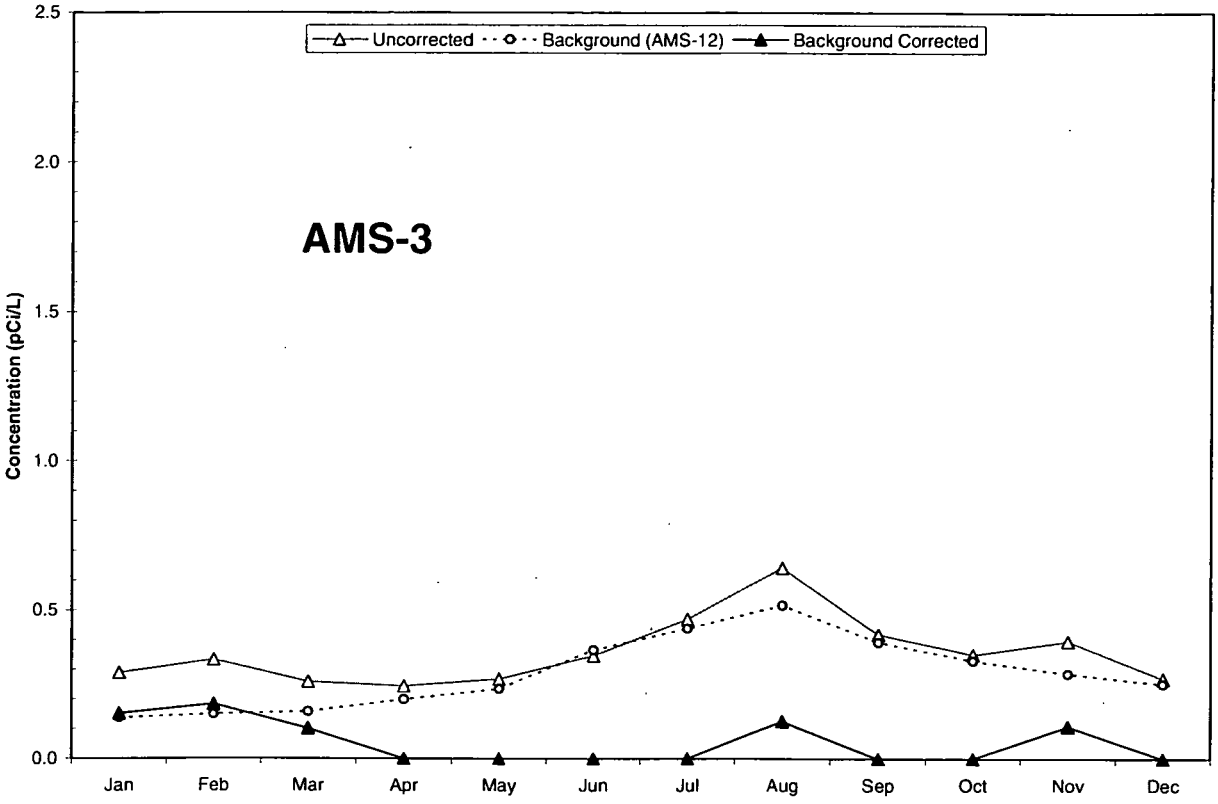

Figure C.2–4. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-3

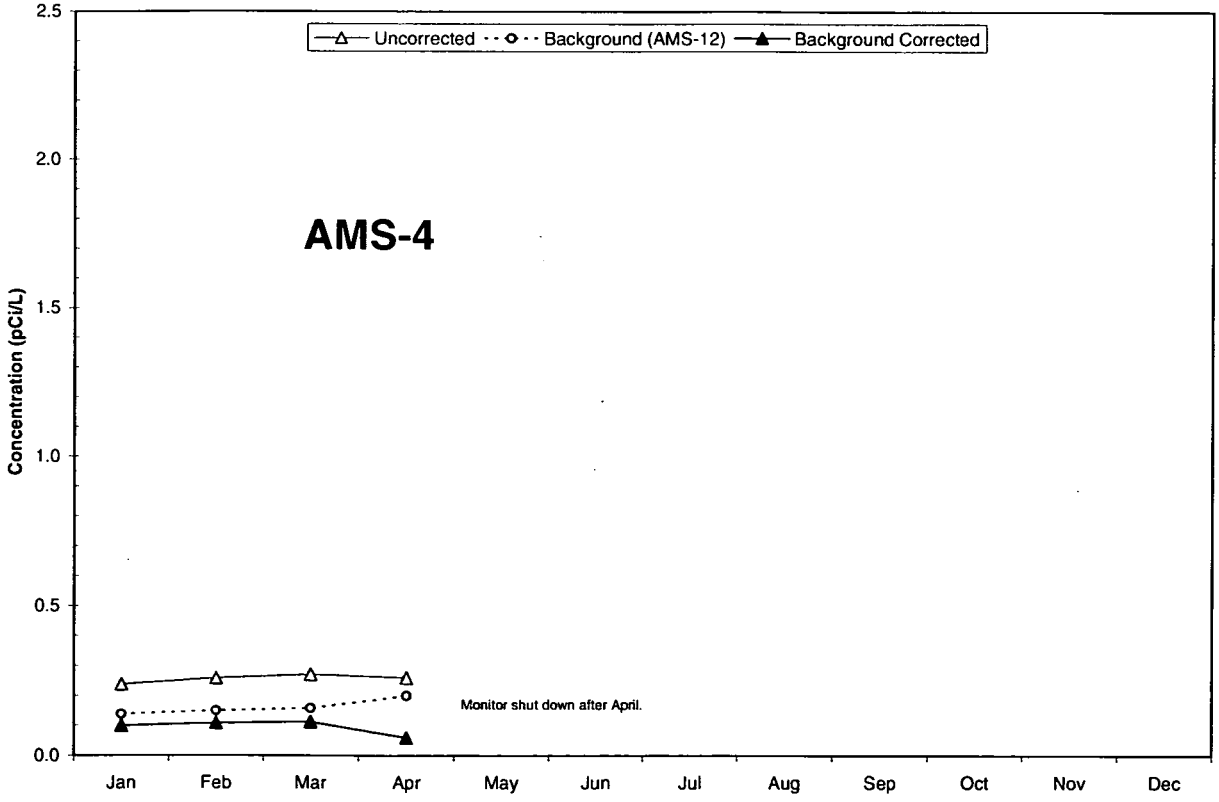

Figure C.2–5. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-4

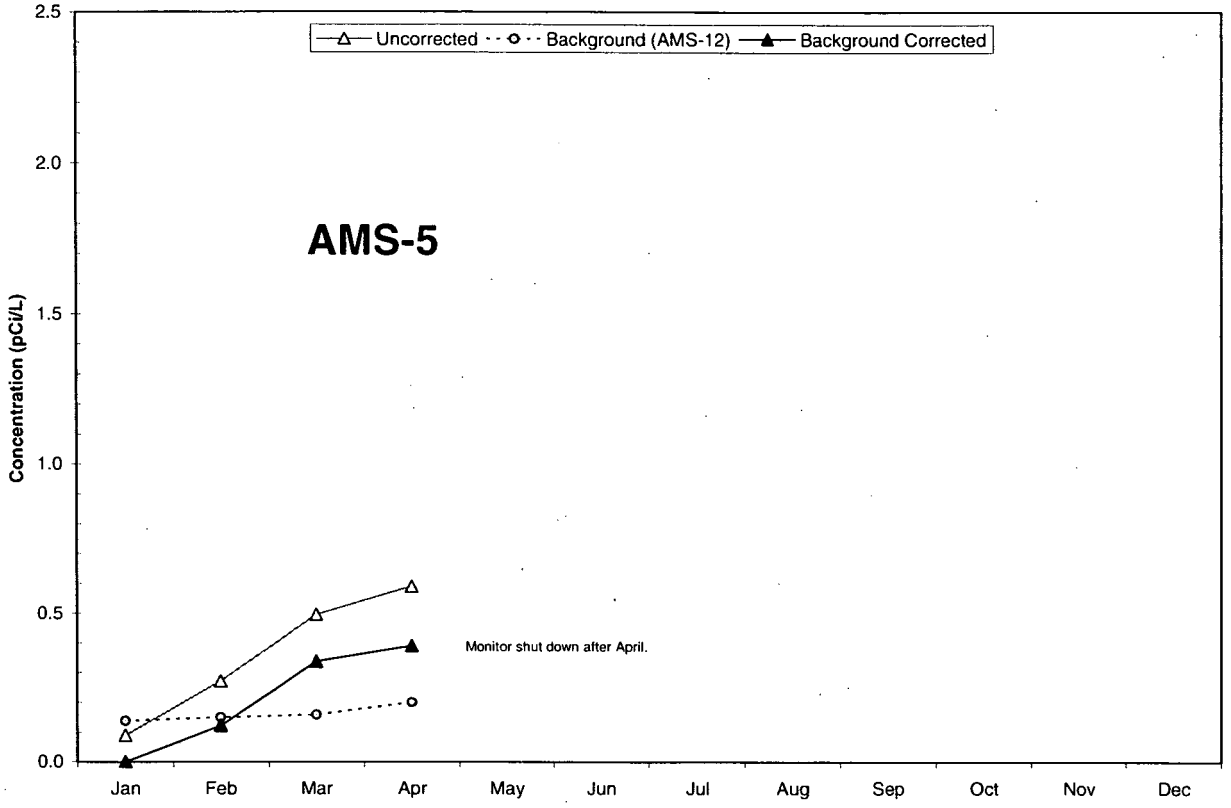

Figure C.2–6. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-5

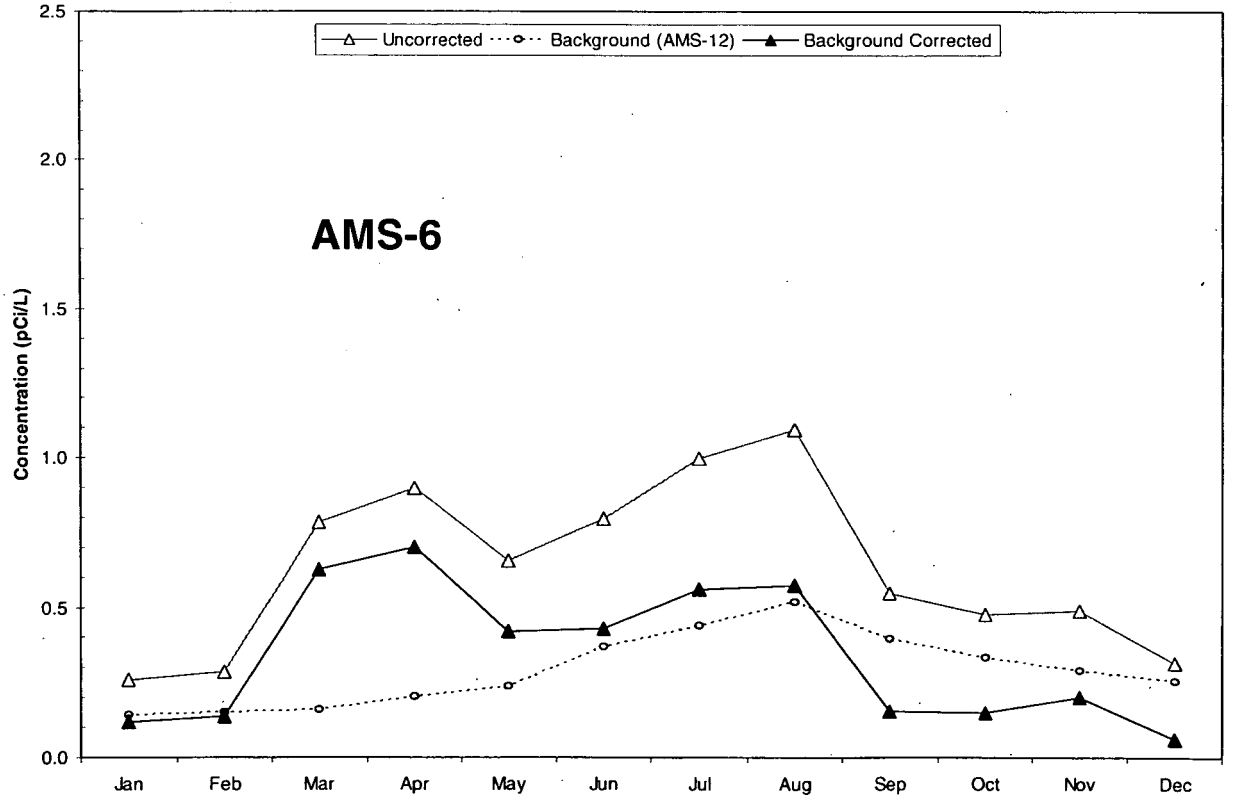

Figure C.2–7. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-6

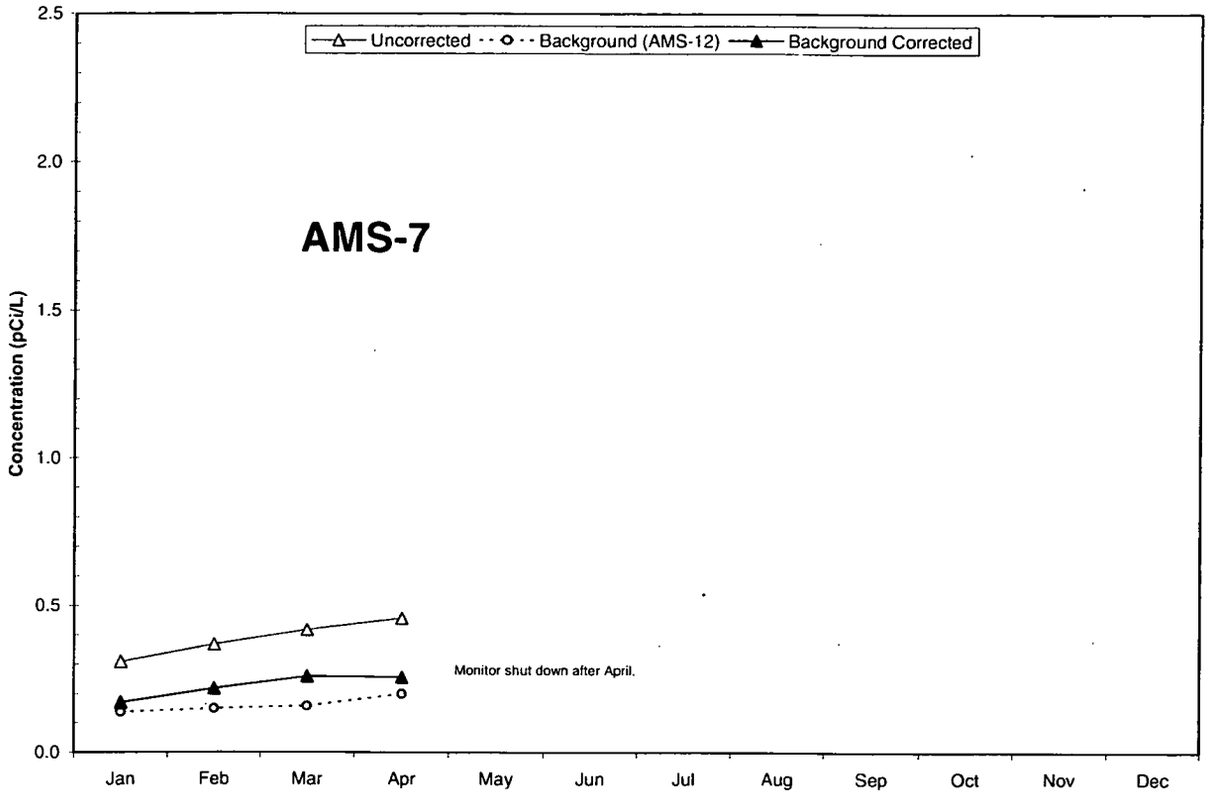

Figure C.2–8. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-7

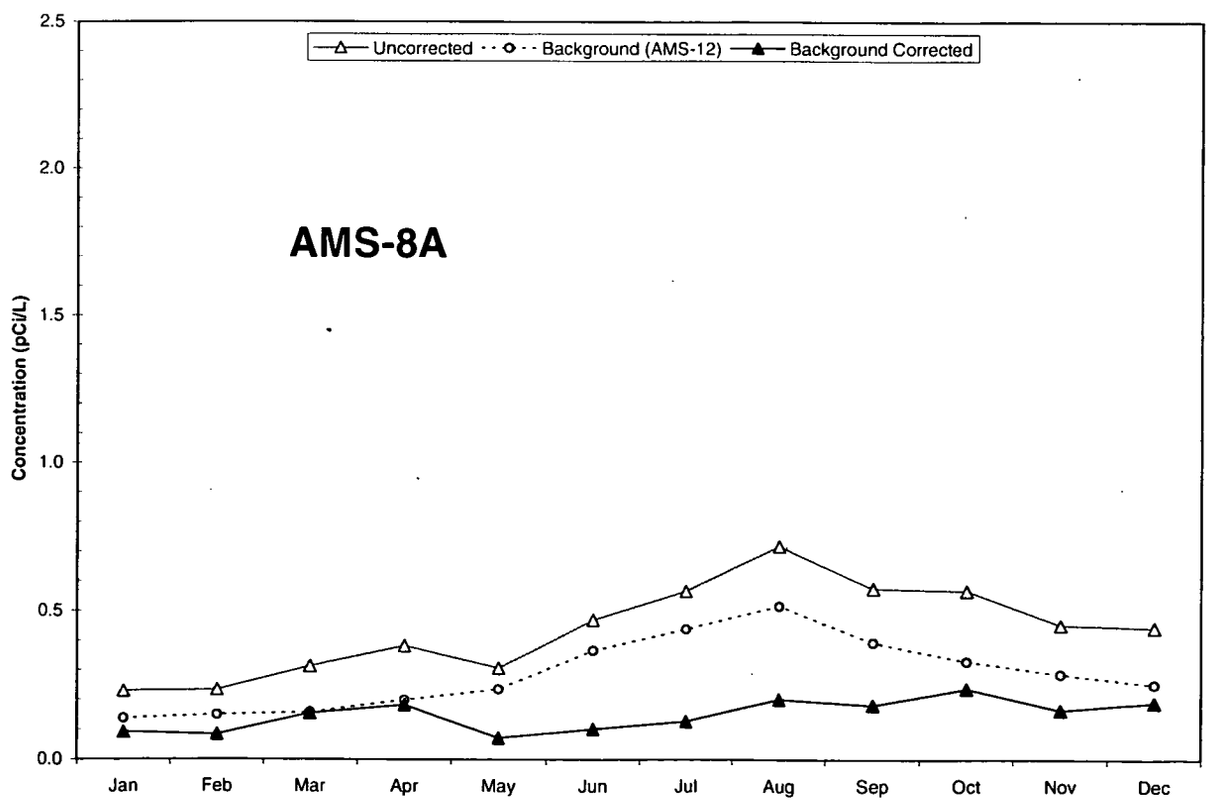

Figure C.2–9. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-8A

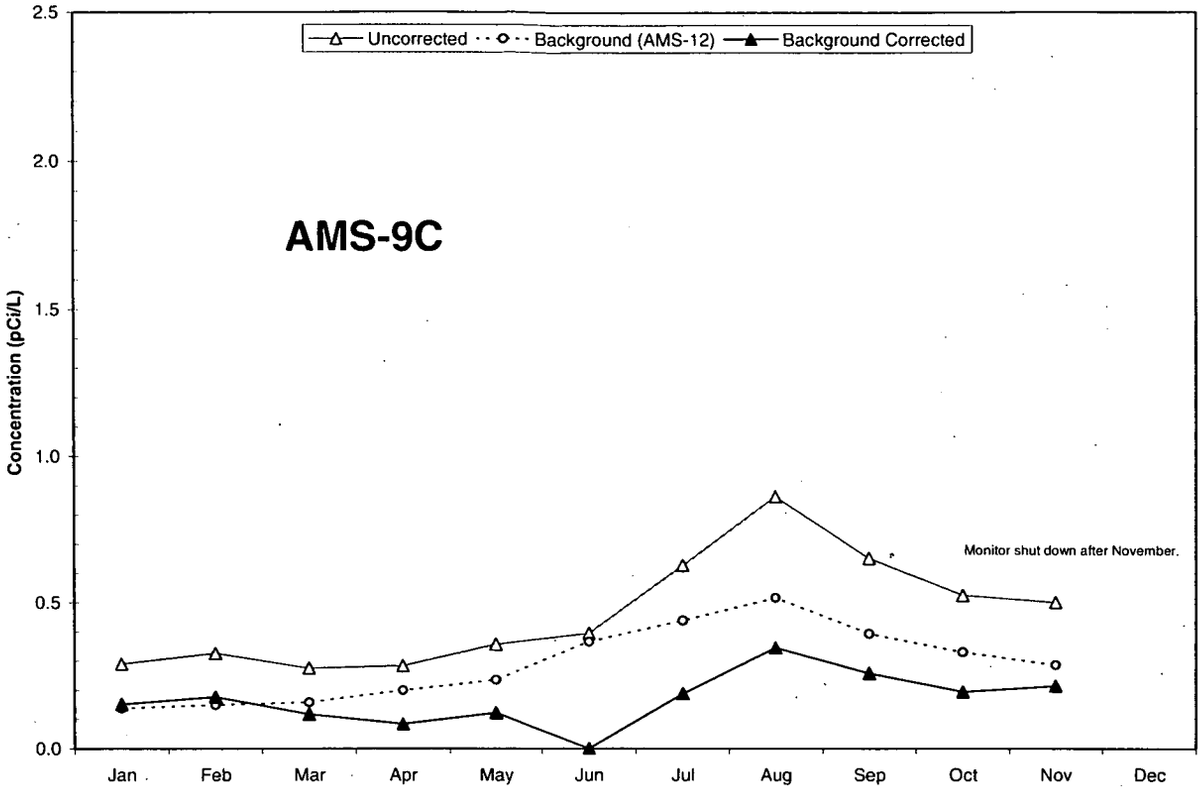

Figure C.2–10. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-9C

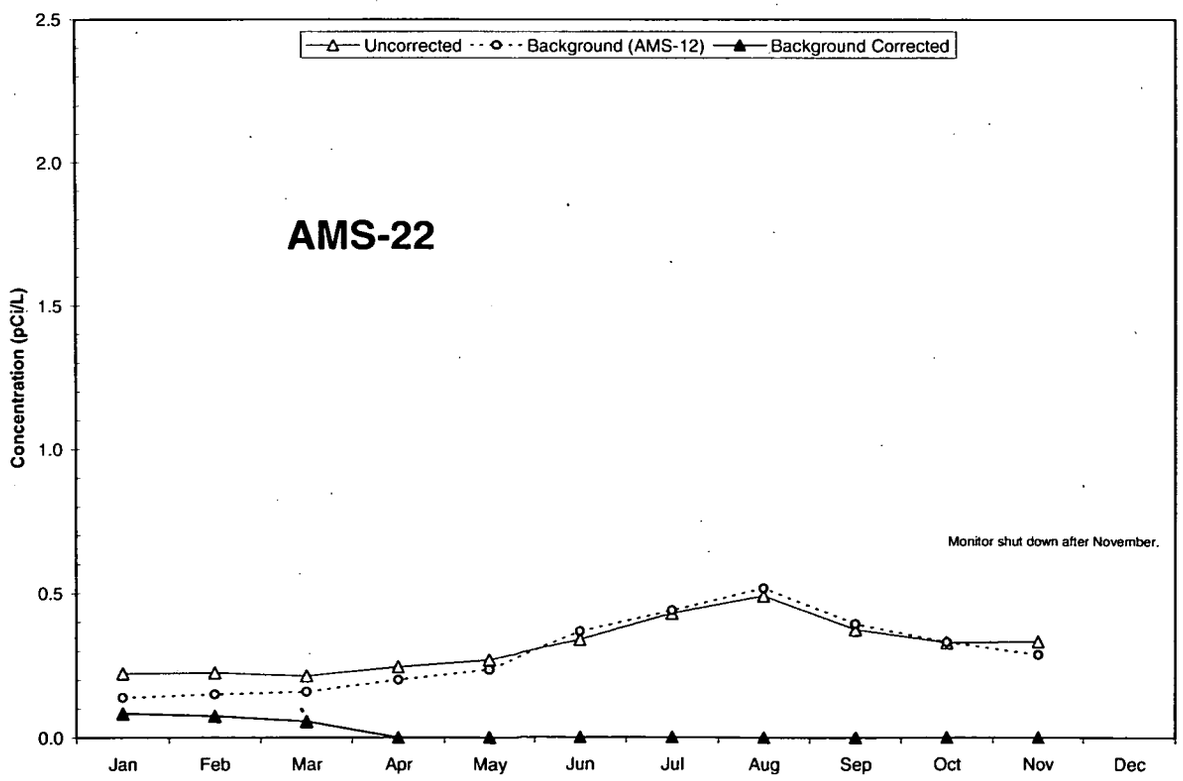

Figure C.2–11. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS 22

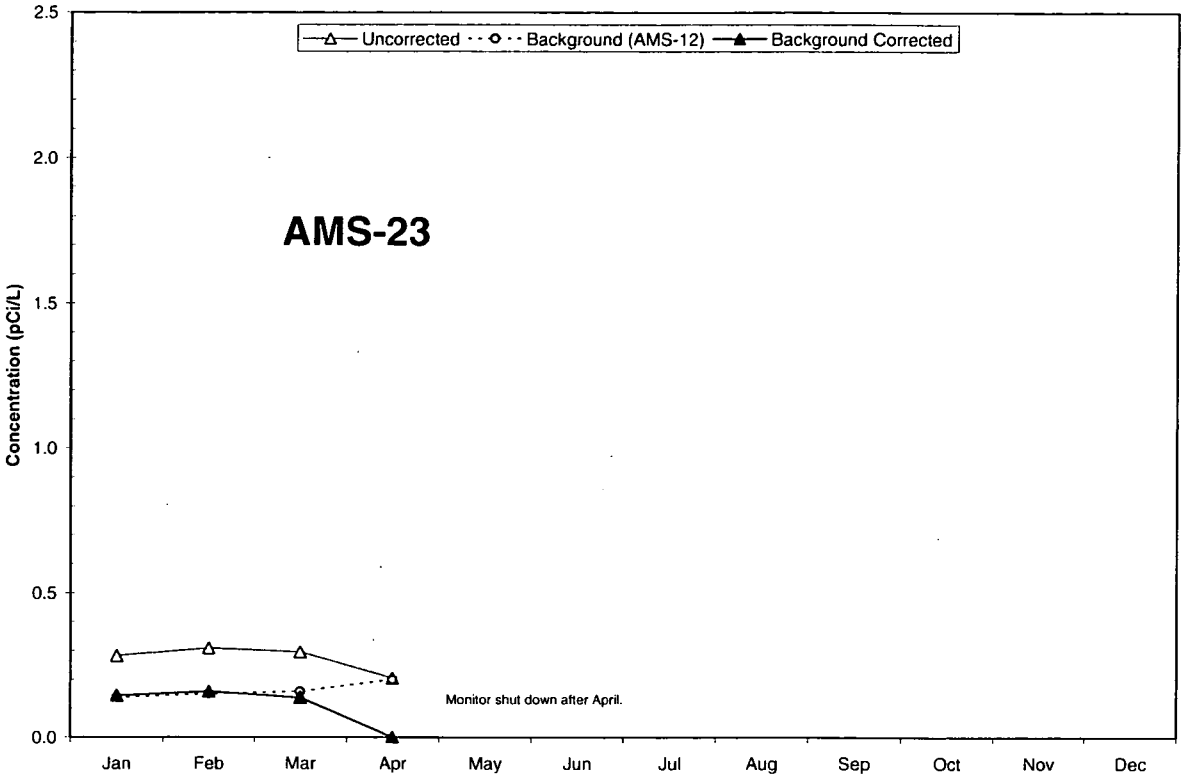

Figure C.2–12. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-23

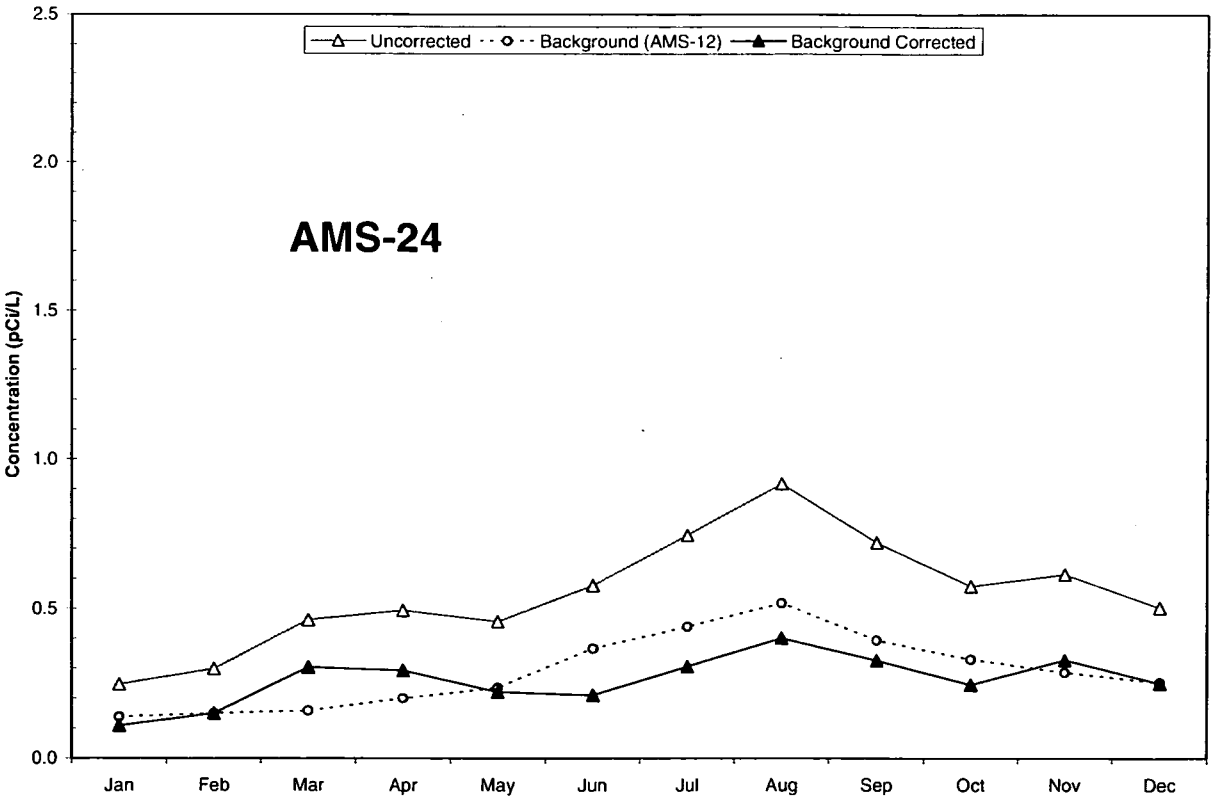

Figure C.2–13. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-24

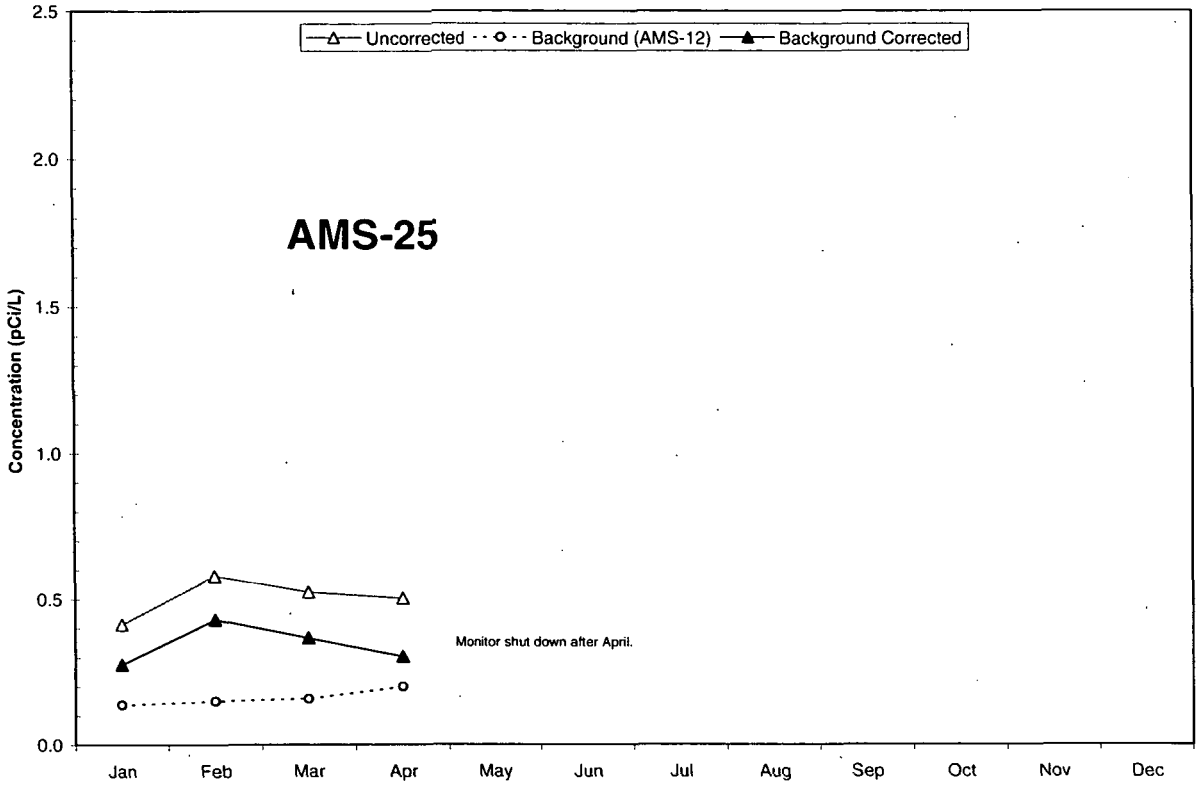

Figure C.2–14. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-25

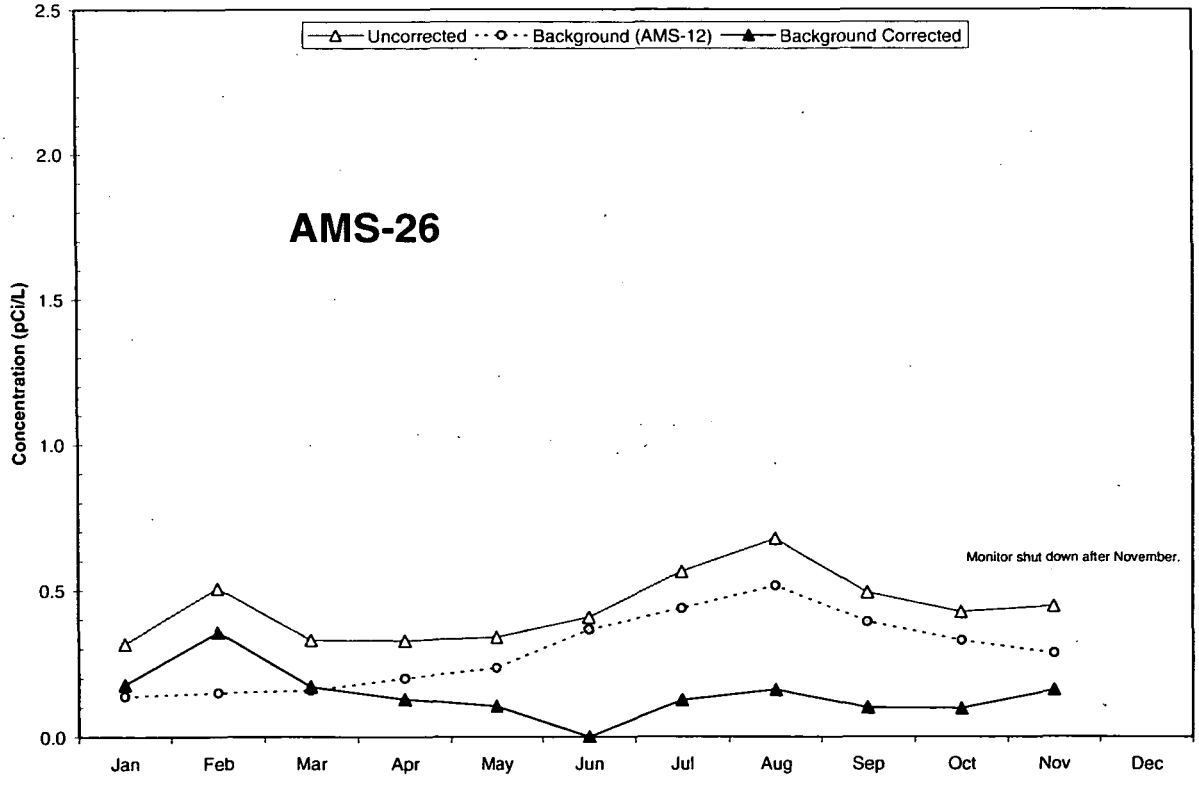

Figure C.2–15. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-26

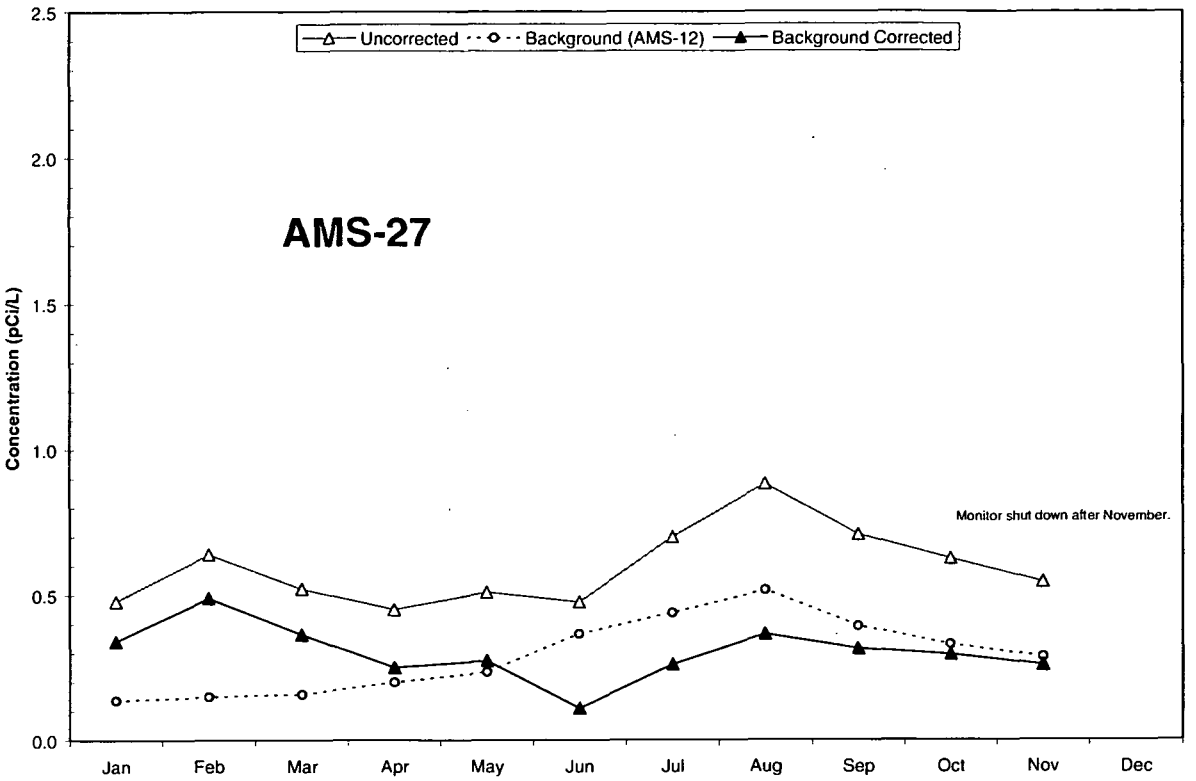

Figure C.2–16. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-27

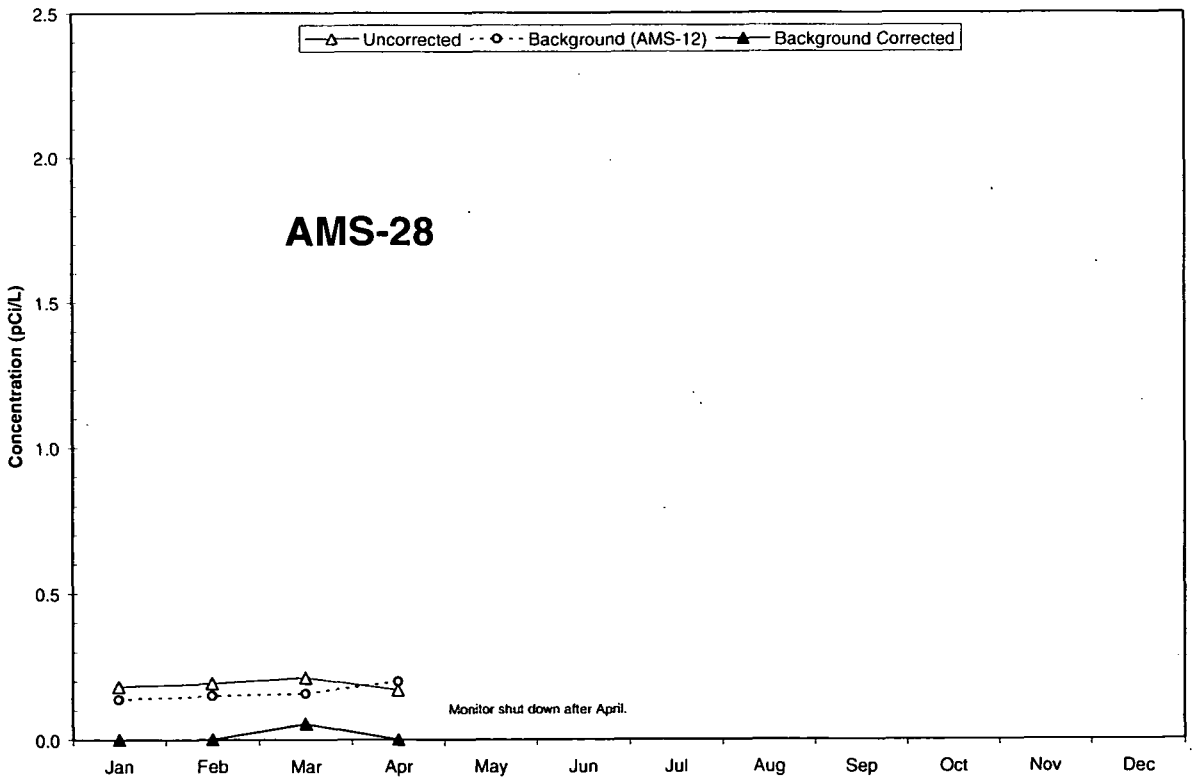

Figure C.2–17. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-28

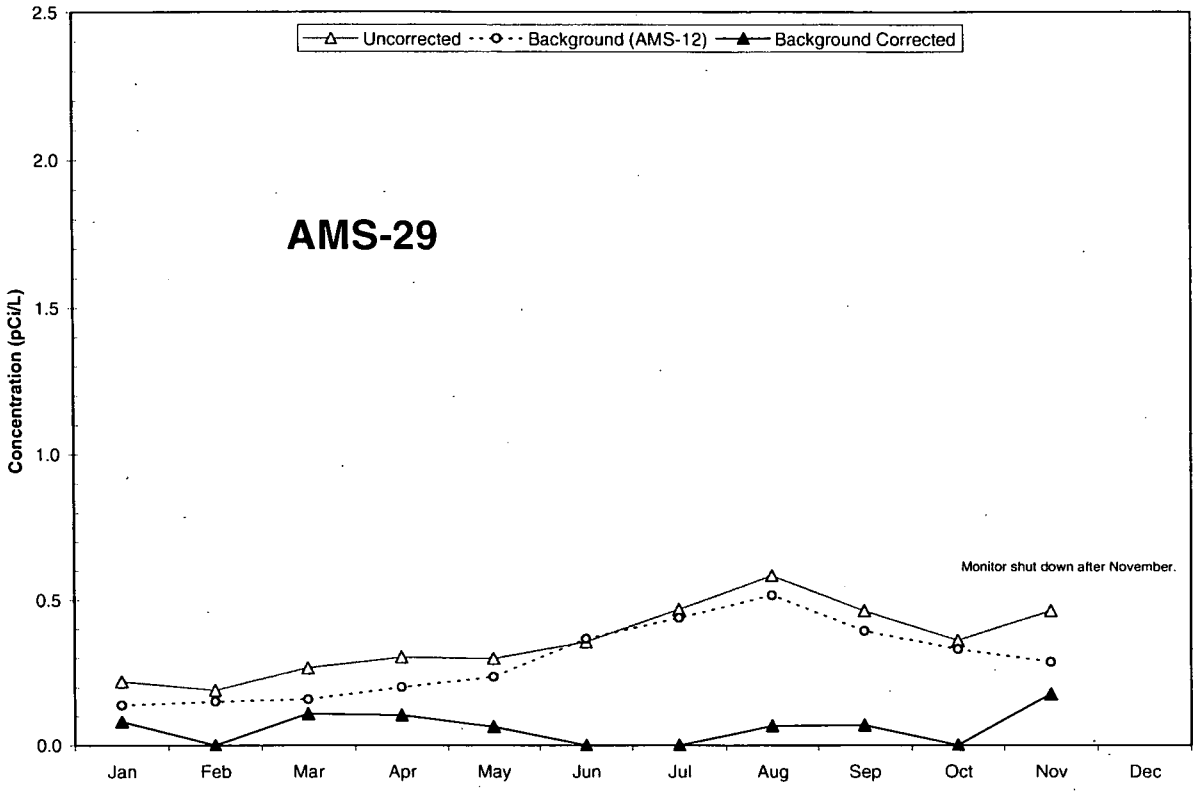

Figure C.2–18. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor AMS-29

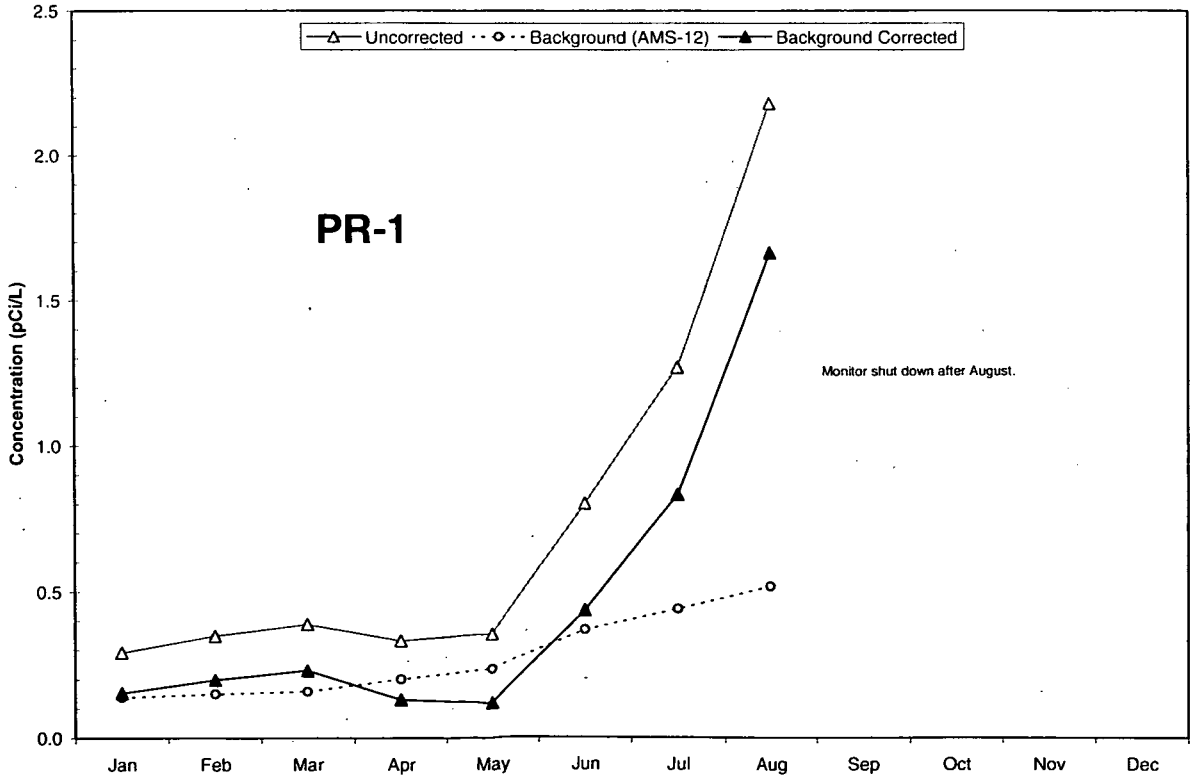

Figure C.2–19. 2006 Monthly Average Annual Radon Concentration for Facility Boundary Monitor PR-1

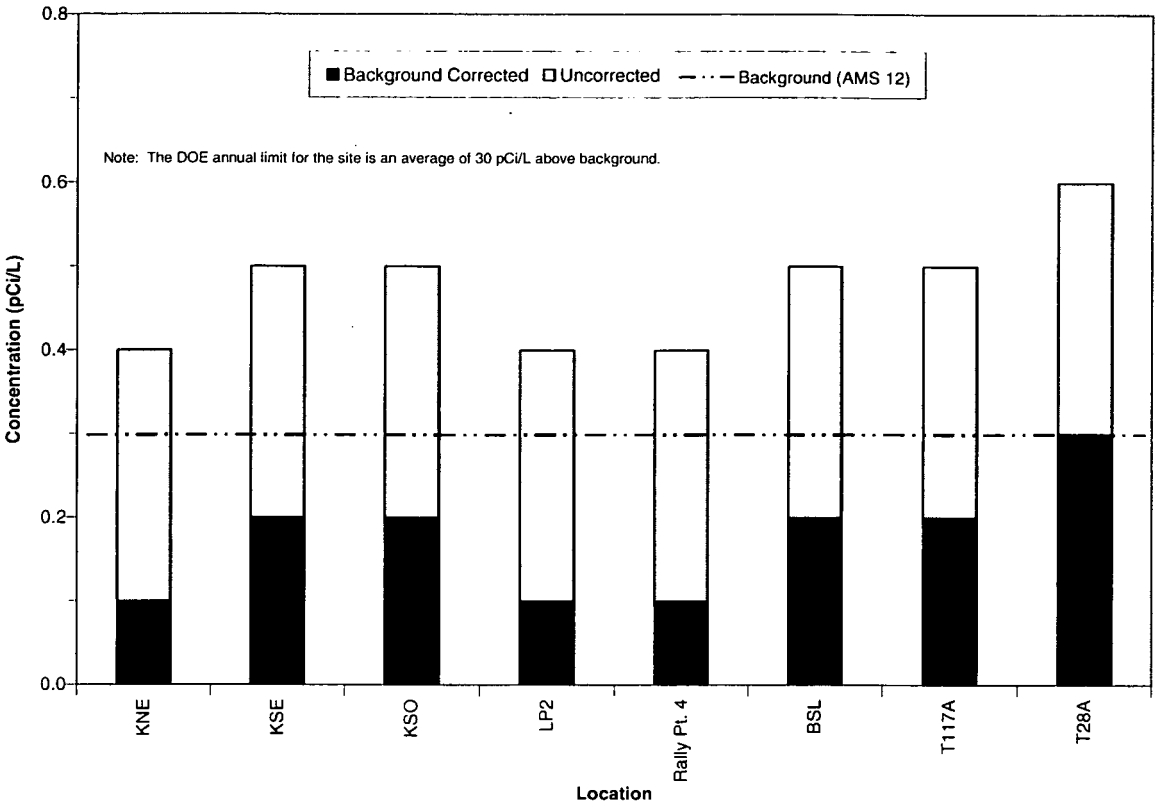

Figure C.2–20. 2006 Average Annual Radon Concentration for each Site Marker

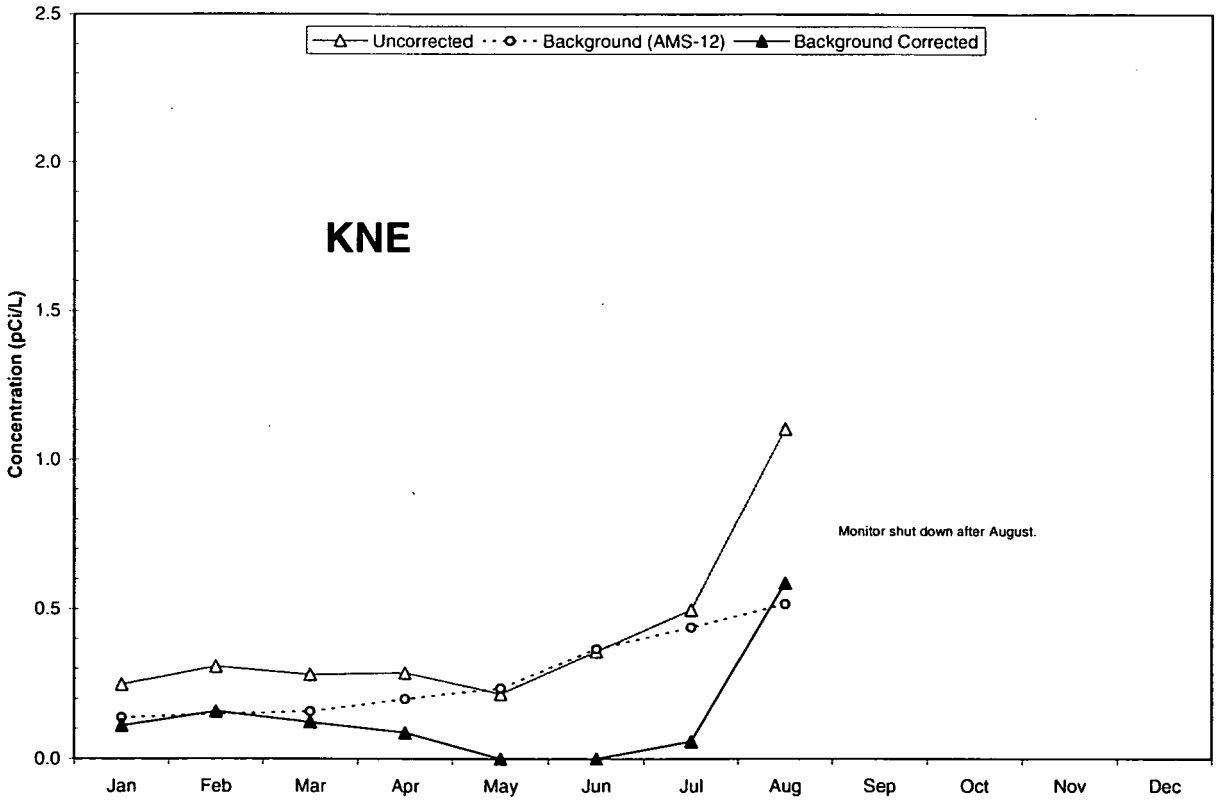

Figure C.2–21. 2006 Average Annual Radon Concentration for Site Marker KNE

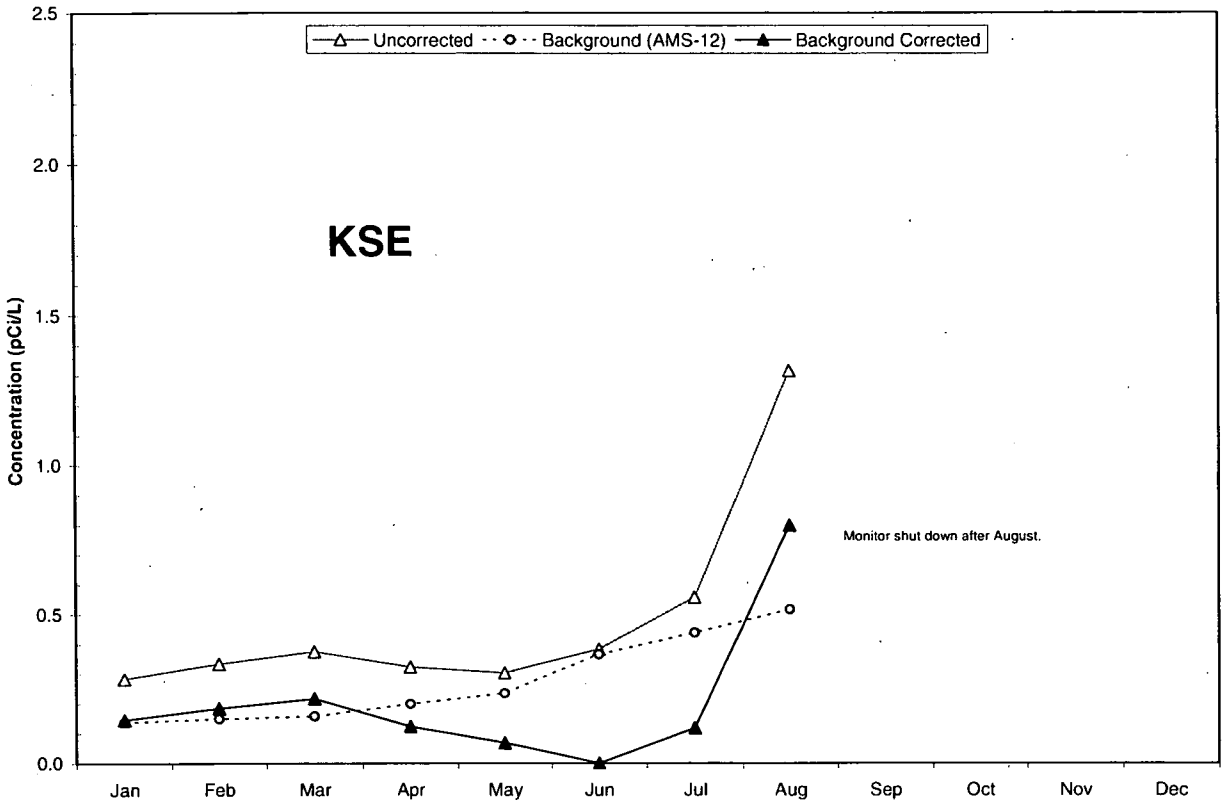

Figure C.2–22. 2006 Average Annual Radon Concentration for Site Marker KSE

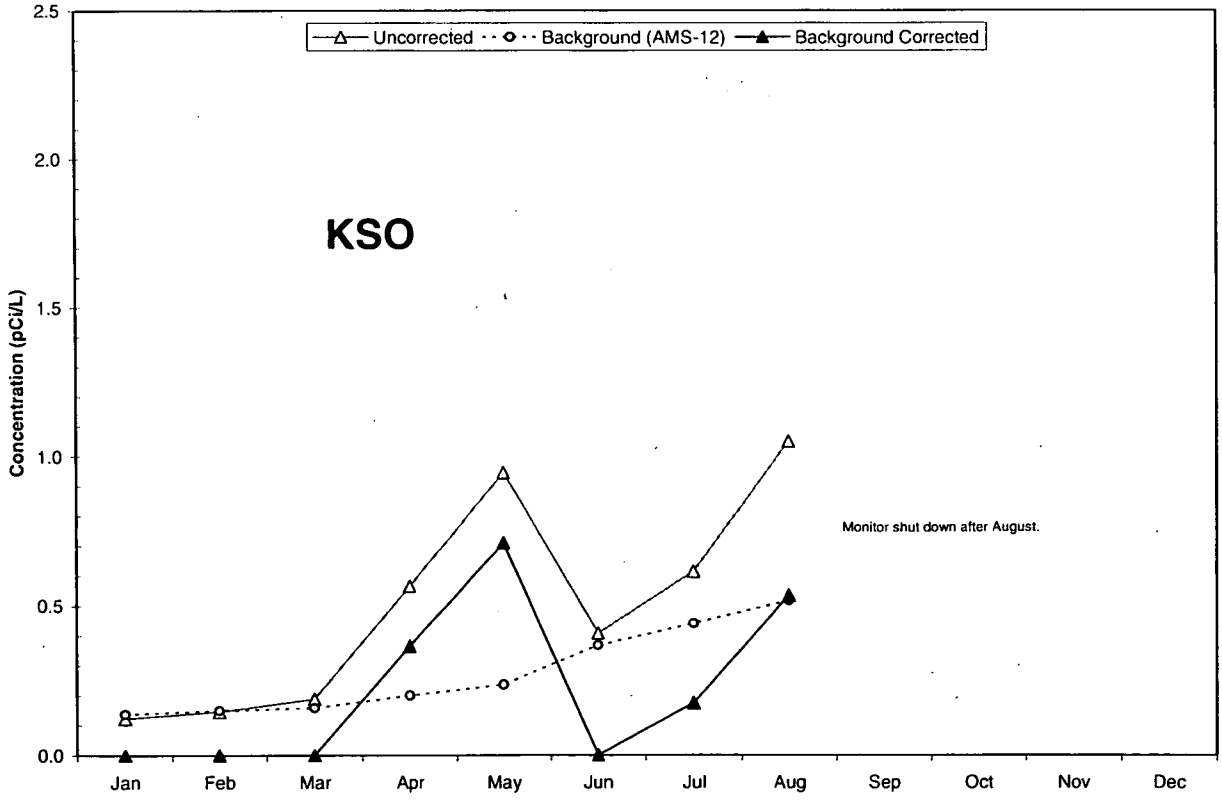

Figure C.2–23. 2006 Average Annual Radon Concentration for Site Marker KSO

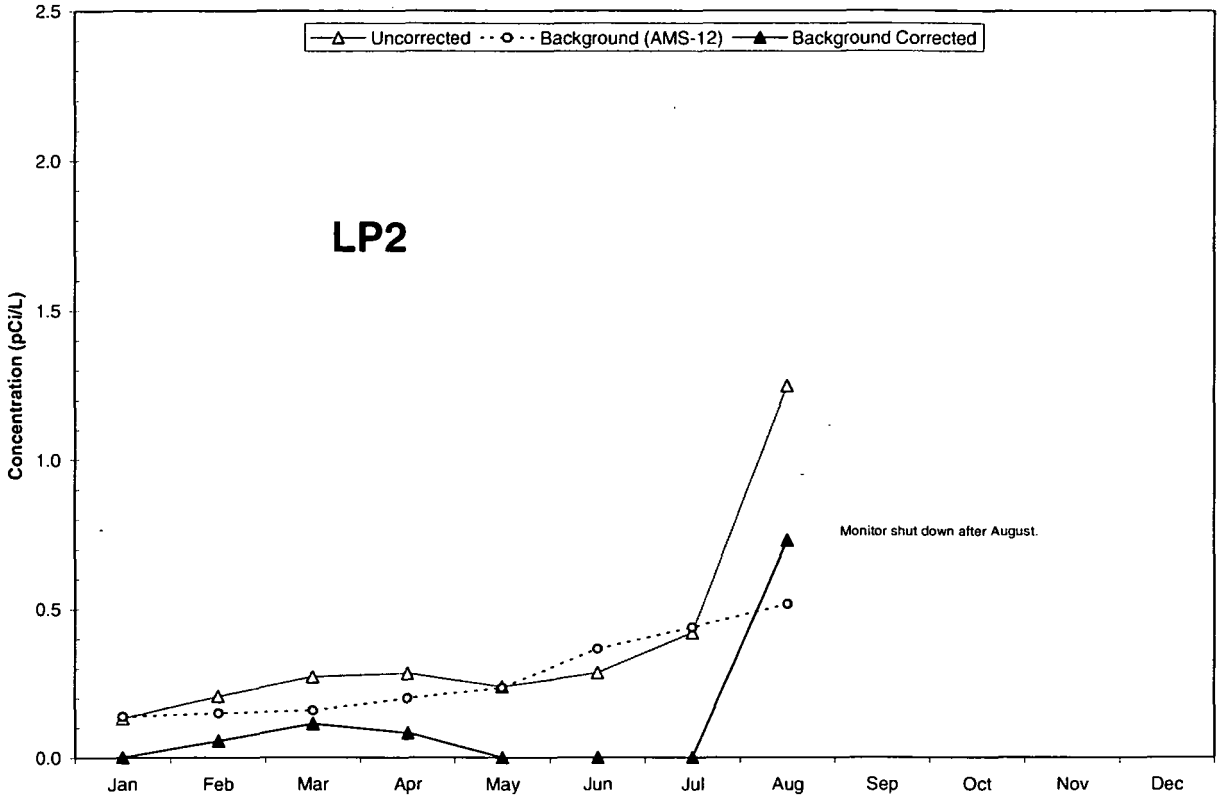

Figure C.2–24. 2006 Average Annual Radon Concentration for Site Marker LP2

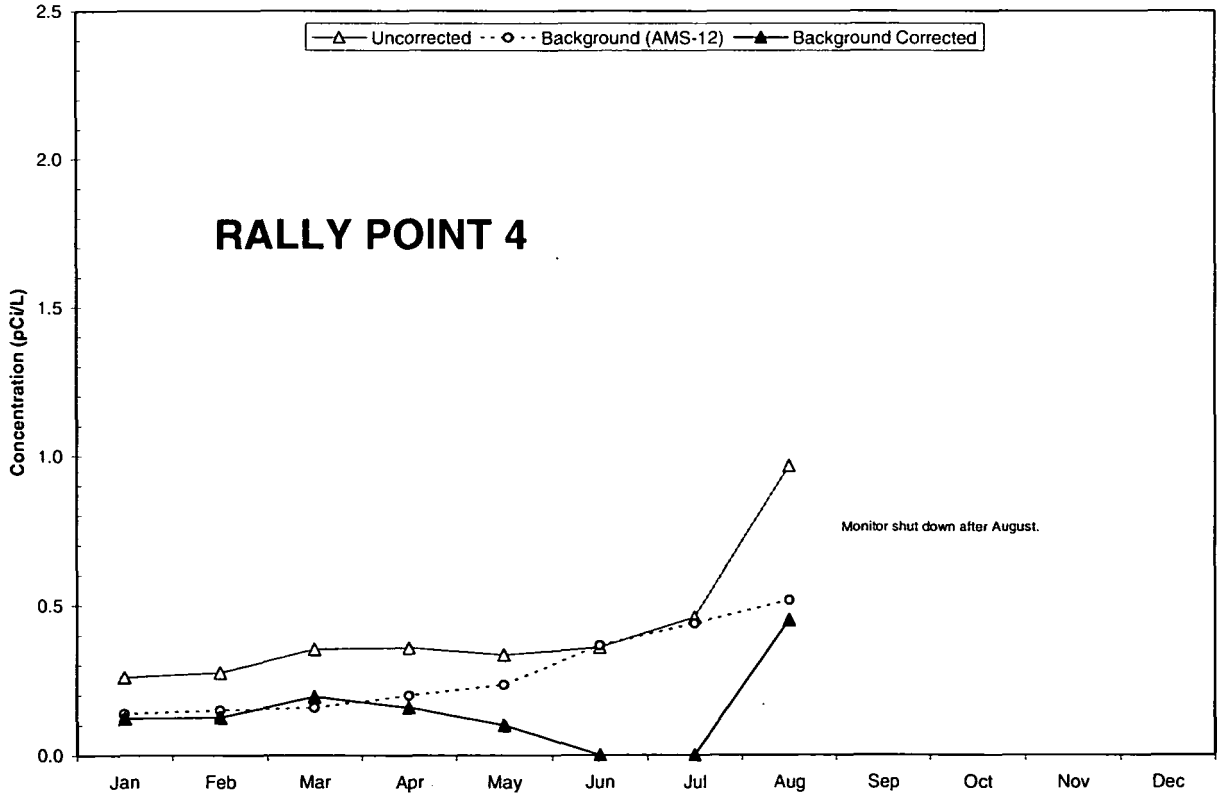

Figure C.2–25. 2006 Average Annual Radon Concentration for Site Marker Rally Point 4

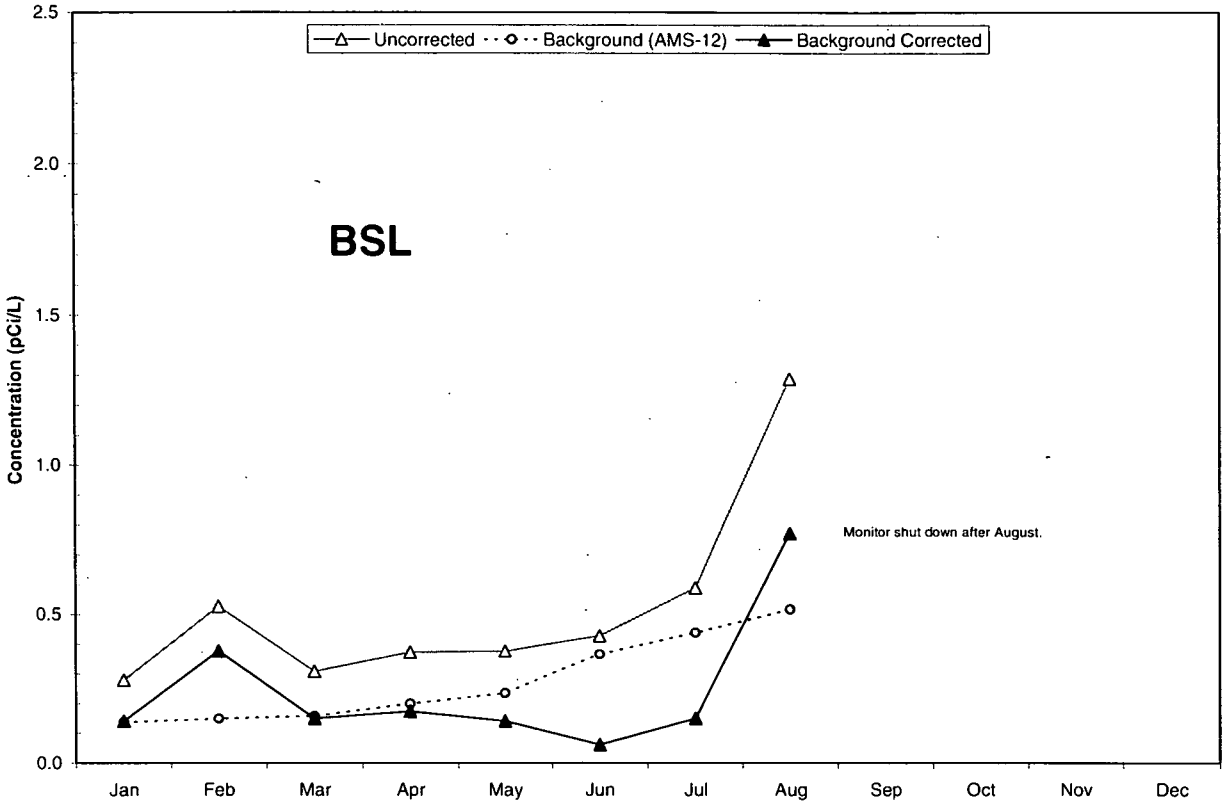

Figure C.2–26. 2006 Average Annual Radon Concentration for Site Marker BSL

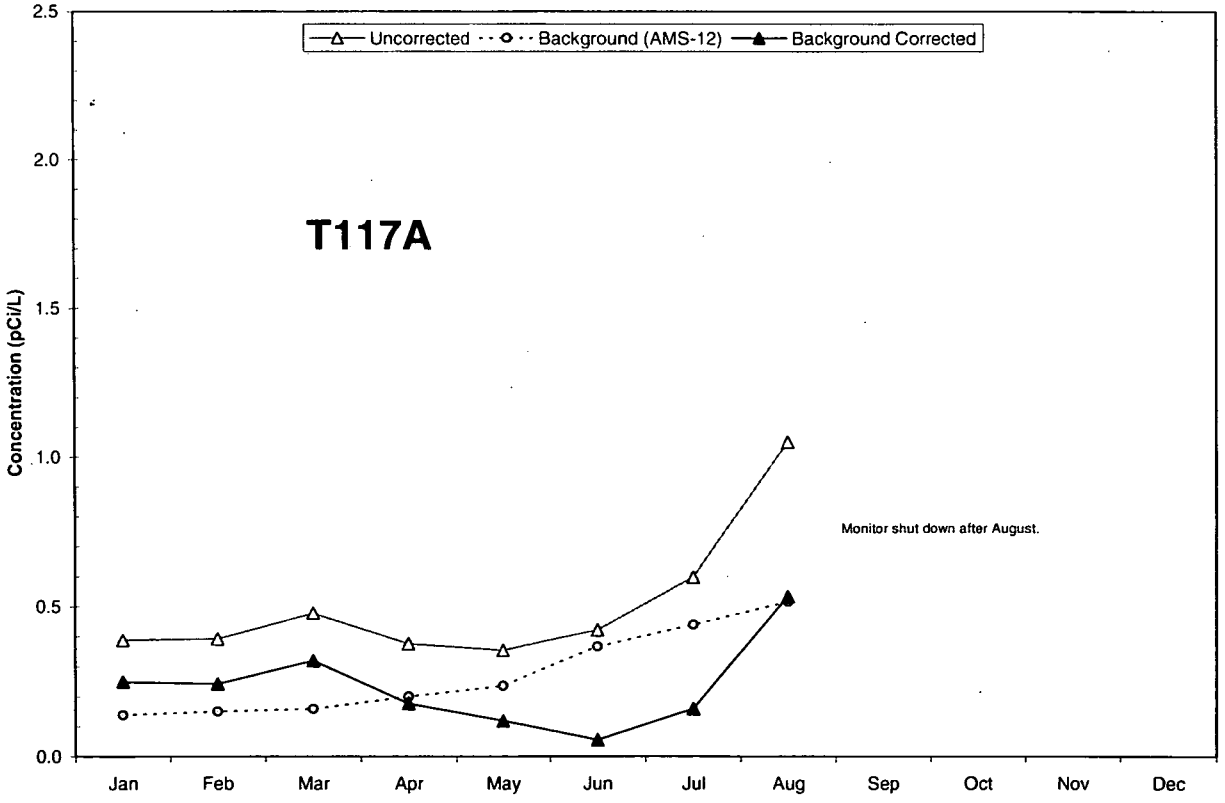

Figure C.2–27. 2006 Average Annual Radon Concentration for Site Marker T117A

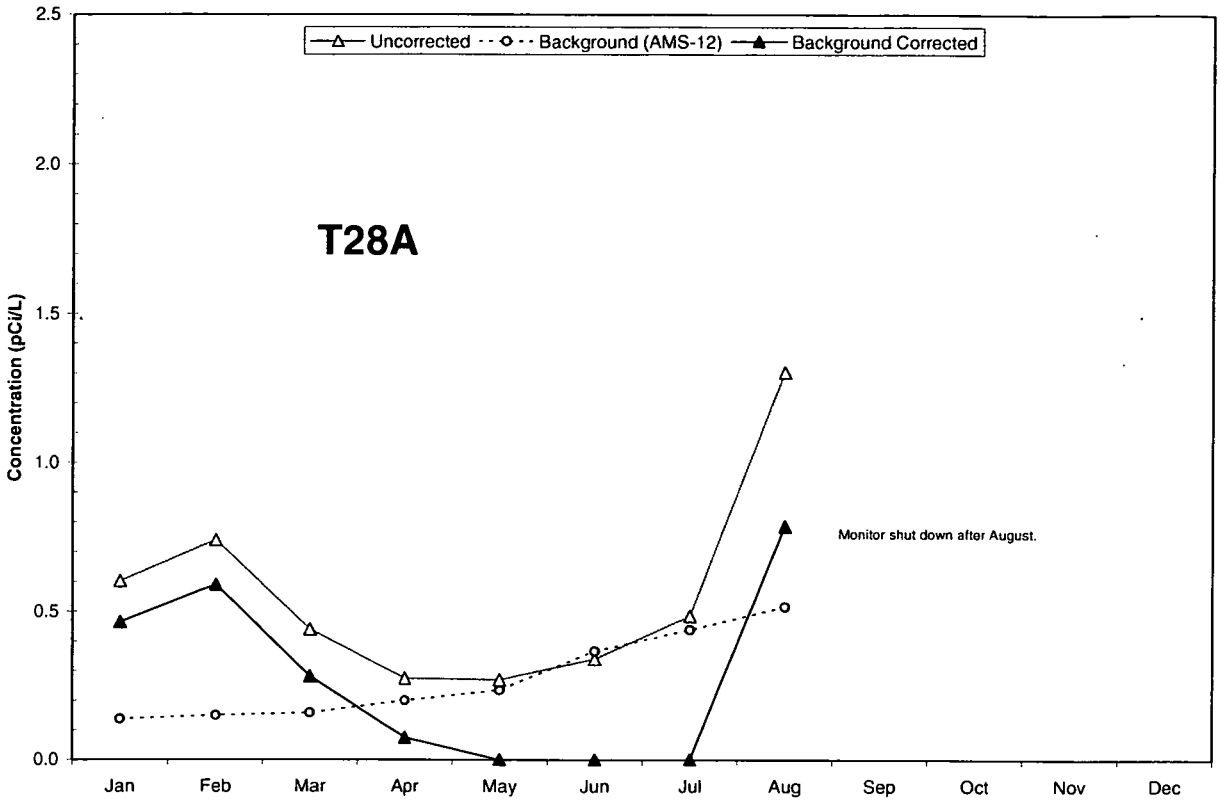

Figure C.2–28. 2006 Average Annual Radon Concentration for Site Marker T28A

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Attachment C.3

Attachment C.3

C.3.0 Direct Radiation

Direct radiation measurements were collected at monitoring locations using thermoluminescent dosimeters (TLDs). TLD stations are located on-site, at the site boundary and at background stations in the surrounding communities (Figure C.3–1). Three TLDs are deployed at each location to track and evaluate direct radiation, and the measurements from each TLD are averaged on a quarterly basis. However, monitoring was discontinued at locations 23A, 24, 25, 26, 43, 44, 45 and 46 in 2005, at locations 4, 5, 7, 36, 37 and 39 after the 2nd quarter of 2006, and stations 13, 14, 15, 16, 17, 19, 20, 22, 33, 36, 37, 39, 42 and 47 were removed after the 3rd quarter of 2006. Therefore, four quarters of 2006 monitoring data are available only at locations 2, 3, 6, 8A, 9A, 27, 34, 35, 38, 40 and 41.

Table C.3–1 provides a summary of the annual average dose for 2006, 2005 and 2004. Locations that have four quarters of 2006 data (bold font in the table) can be compared to the annual averages for 2005 and 2004. There are no on-site locations that have four quarters of data for 2006. Nine boundary locations and one background location indicate that the measurements for 2006 are all lower than results for 2005, and slightly higher than measurements collected in 2004.

In 2005, direct radiation dose was calculated using the average value from TLD elements 2, 3, and 4. Using element 2 to calculate the average dose is incorrect, as element 2 is a lithium borate crystal and elements 3 and 4 are calcium sulfate crystals. The lithium borate element estimates skin dose, while the calcium sulfate crystals measure deeper tissue dose. Therefore, average dose must be calculated using similar elements (i.e., elements 3 & 4, as in 2004). However, as the dose readings on the lithium borate crystal are high relative to the calcium sulfate crystal, the effect of this error on the 2005 dose assessment of deep tissue is to bias the annual dose to high values. That is, the annual dose was not underestimated by using the results from the lithium borate element.

Results for 2006 are slightly higher than those in 2004, and part of this increase could be due to a change in the vendor that provided the TLDs and counting services. Beginning in 2005, the Fernald site TLD services were contracted to the Savannah River site. However, note that the maximum values for the boundary and background locations are similar for 2006 and 2004, and much higher for 2005. The higher 2005 result is due to the inclusion of dose from the lithium borate crystal, as noted above. Therefore, 2006 data will be compared to 2004 results.

For the nine boundary detectors with four quarters of 2006 data (bold text in Table C.3–1), six locations have annual averages that exceed the annual average at background location 27, two are at background levels (west boundary, generally up wind from the site), and location 38 is lower than background. In 2004, eight of the nine locations were above background (location 38 was below background). The difference obtained when the background value is subtracted from the boundary monitors is similar for 2006 and 2004. However, fewer locations recorded above background readings in 2006, and this may reflect the completion of remedial activities in October of 2006.

Table C.3–1. Direct Radiation (TLD) Measurements

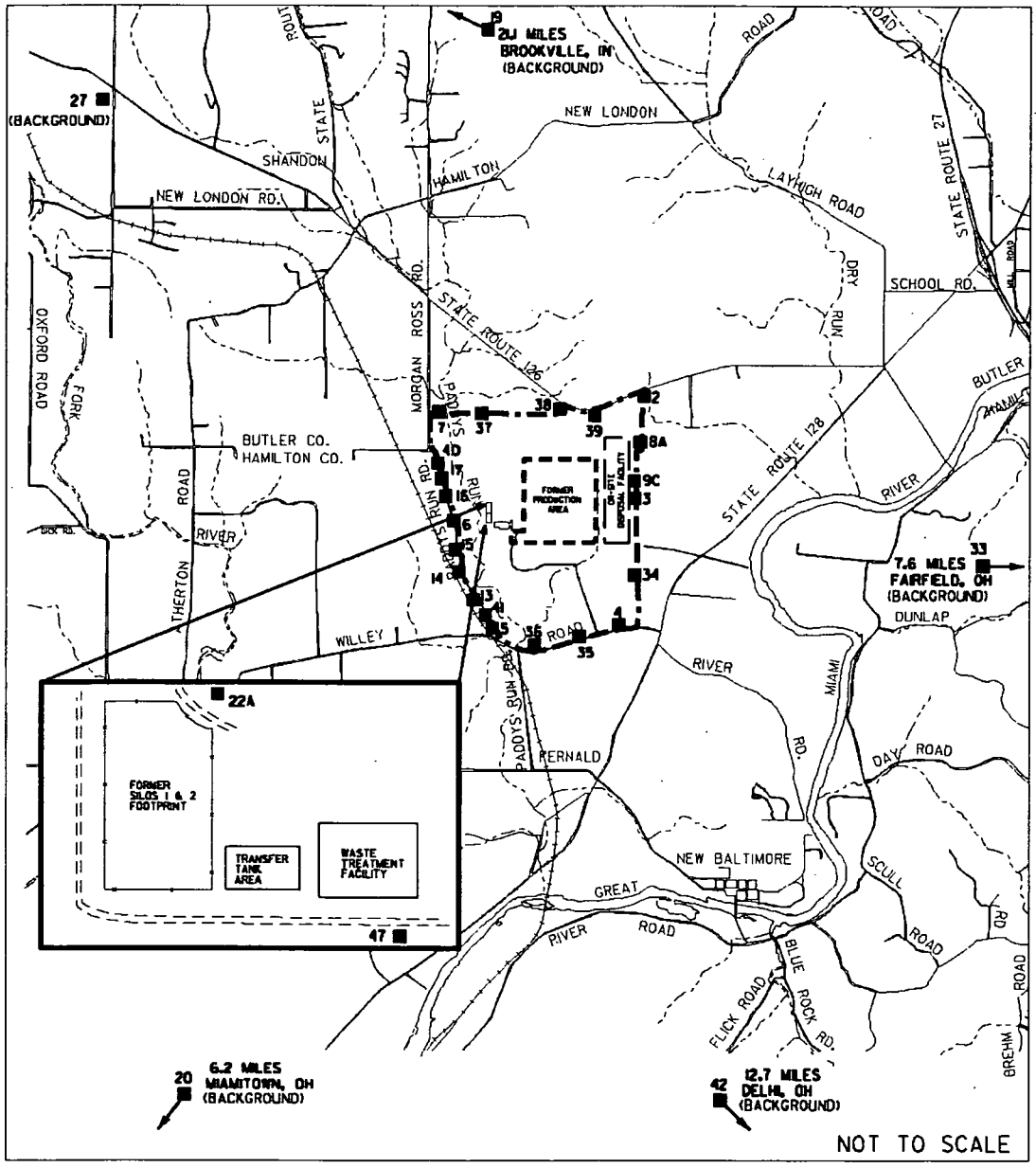
Location	Direct Radiation Summary Results (mrem)		
	2006	2005	2004
Boundary			
2	83	101	74
3	83	102	68
4[a]	38	100	69
5[a]	37	101	73
6	79	96	69
7[a]	37	97	71
8A	84	98	75
9C[c]	81	96	75
13[b]	55	91	64
14[b]	58	100	69
15[b]	62	99	73
16[b]	59	96	72
17[b]	60	97	70
34[c]	81	103	74
35	80	94	65
36[a]	36	92	65
37[a]	38	102	78
38[c]	77	91	64
39[a]	40	110	81
40[c]	79	94	68
41[c]	79	93	68
Minimum	**36**	**91**	**64**
Maximum	**84**	**110**	**81**
On site			
22[b]	96	272	209
47[b]	71	103	59
Minimum	**71**	**103**	**59**
Maximum	**96**	**272**	**216**
Background			
19[b]	58	94	66
20[b]	56	93	63
27	79	93	64
33[b]	62	101	69
42[b]	62	104	75
Minimum	**56**	**93**	**63**
Maximum	**79**	**104**	**75**

[a] Locations 4, 5, 7, 36, 37, & 39 discontinued after 2nd Quarter

[b] Locations 13, 14, 15, 16, 17, 19, 20, 22, 33, 42, & 47 discontinued after 3rd Quarter

[c] Locations 9C, 34, 38, 40, & 41 discontinued after 4th Quarter

NOTE: 2006 max values are lower than 2005 because 2005 included TLD results from element 2. Element 2 is a lithium borate crystal, and 2005 data from this detector should not have been averaged with elements 3 and 4, which are calcium sulfate crystals.



LEGEND:

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO SAMPLE LOCATIONS OFF MAP

FERNALD SITE BOUNDARY

DIRECT RADIATION (TLD) MONITORING LOCATION

FINAL

Figure C.3–1. Direct Radiation (Thermoluminescent Dosimeter) Monitoring Locations

End of current text

Attachment C.4

Attachment C.4

C.4.0 Meteorological Data

Meteorological data were recorded at the Fernald site's meteorological station from January 1, 2006 through May 16, 2006, when the station was shut down. A summary of the data for the first 4 ½ months of 2006 (based on hourly readings) is presented in Tables C.4–1 and C.4–2.

Wind speed data from the 10-meter and 60-meter elevations (Table C.4–1) are summarized as monthly maximum and minimum, with the largest range occurring in February (47 and 0.3 mph; 10-meter) and January (65 and 0.3 mph; 60-meter). Ambient air temperature at the 10-meter level includes monthly average, maximum and minimum. The yearly (4.5 months of data) maximum and minimum temperatures were recorded in April and February, respectively. Precipitation information includes the monthly total and daily maximum values, with April being the wettest month.

Table C.4–2 indicates the prevailing winds were from the southwest about 16 percent of the time at the 10 meter height and out of the south-southwest about 13 percent of the time for the 60-meter height. The winds out of the north were least predominant (less than one percent of the time at both heights). Average wind speed was the highest out of the north-northwest and north-northeast at the 10-meter height and out of the north-northwest and south-southwest for the 60-meter height.

Although meteorological data were collected only through May16, the 2006 wind speeds and directions are similar to 12-month data collected in 2005. Therefore, the 2006 summary in Table C.4–2 was used for the dose assessments presented in Attachment C.5.

Table C.4–1. 2006 Meteorological Data

	Units	Jan	Feb	Mar	Apr	May*
10-Meter Wind Speed						
Maximum (hourly average)	mph	42	47	41	41	37
	kph	67	75	66	66	59
Minimum (hourly average)	mph	0.3	0.3	0.3	0.3	0.3
	kph	0.5	0.5	0.5	0.5	0.5
60-Meter Wind Speed						
Maximum (hourly average)	mph	65	60	51	52	42
	kph	104	96	82	83	67
Minimum (hourly average)	mph	0.3	0.3	0.3	0.3	0.3
	kph	0.5	0.5	0.5	0.5	0.5
Ambient Air Temperature						
Average	°F	43	35	42	59	59
	°C	6	2	6	15	15
Daily Maximum	°F	62	66	74	85	78
	°C	17	19	23	29	26
Daily Minimum	°F	22	7	13	33	46
	°C	-6	-14	-11	1	8
Precipitation						
Total	in	3.4	1.4	4.8	6.5	1.0
	cm	8.6	3.6	12.2	16.5	2.5
Daily Maximum	in	0.4	0.3	0.4	0.9	0.2
	cm	1.0	0.8	1.0	2.3	0.5

*May data collected through May 16, when met tower was shut down.

Table C.4–2. 2006 Average Wind Speed and Percent of Time from Direction at 10 and 60 Meters Above Ground Level

Direction	Average 10-meter Wind Speed (mph)	Average 10-meter Wind Speed (kph)	Percent of Time from Direction	Average 60-meter Wind Speed (mph)	Average 60-meter Wind Speed (kph)	Percent of Time from Direction
N	6	9	0.0	10	16	0.1
NNE	9	14	1.3	12	19	2.3
NE	6	10	3.7	9	14	4.9
ENE	6	9	6.3	8	13	7.4
E	3	5	4.0	7	11	3.2
ESE	3	5	2.5	6	10	2.6
SE	3	5	3.8	6	10	3.3
SSE	4	6	4.4	7	12	5.1
S	5	8	7.7	9	15	9.3
SSW	7	11	13.2	12	19	12.7
SW	7	11	15.7	11	18	10.5
WSW	5	7	12.1	10	17	11.3
W	5	8	9.2	11	17	9.3
WNW	6	10	7.3	11	17	7.4
NW	6	10	6.3	10	16	7.2
NNW	9	15	2.5	11	18	3.4

End of current text

Attachment C.5

C.5.0 Supplemental Dose Assessments

This attachment contains a detailed discussion of the supplemental dose assessments performed for calendar year 2006, and compares the 2006 results to those from 1999 through 2005. The population and biota dose assessments comprise the supplemental dose assessment, which provides required information for compliance with the DOE standards contained in DOE Order 5400.5 (DOE 1993).

A population dose assessment provides an aggregate measure of the impact of airborne emissions and direct radiation from sources at the Fernald site to the population in the area. A biota dose assessment provides information related to the Fernald site's compliance with dose limits to aquatic organisms in the Great Miami River.

C.5.1 Population Dose Assessment

Computation of a population dose is a requirement of DOE Order 5400.5, which defines population dose as the collective effective dose equivalent. For 2006, the effective dose equivalent was 0.52 person rem/year. This includes 0.49 person rem/year from site airborne emissions (excluding radon) and 0.03 person rem/year from the direct radiation component (Table C.5–1). There was no estimated biota dose to the population from consumption of produce, as the produce monitoring program was terminated in 2003.

Table C.5–1. Estimated Population Doses

	1999	2000	2001	2002	2003	2004	2005	2006
Air Inhalation	1.19	3.29	3.35	3.47	3.84	3.87	1.2	0.485
Direct radiation	0.127	0.108	0.159	0.23	0.155	0.47	0.35	0.030
Biota[a,b]	NA	0.48	NA	NA	0.002	NA	NA	NA
Total	**1.317**	**3.88**	**3.51**	**3.70**	**4.00**	**4.34**	**1.55**	**0.515**

[a]NA = not applicable.
[b]Produce for biota dose was sampled every three years and program was completed in 2003.

The air inhalation dose component was estimated by using the 1990 census information for the population within 50 miles of the site, as distributed between four equally sized quadrants (NE, SE, SW, NW). A dose is estimated for each population quadrant based on the annual average air concentration in the quadrant at the site boundary, the population at varying distances from the site, and the dose conversion factors. The following conservative assumptions are used in the calculations:

- Inhalation rate of 1.2 cubic meters (m^3) per hour for 8,760 hours per year (ICRP 1975)
- Population distribution in area (DOE 1997)
- Wind rose data (refer to Appendix D, Figure D–2 of this report)

- Annual average boundary concentrations are applied out to a distance of three miles from the site boundary (the nearest site background monitor). For populations beyond three miles, the annual average concentration is diluted as the inverse square of the distance ($1/d^2$) from the boundary to account for dispersion of the site-generated particulate (e.g., between 3 and 4 miles from the boundary, the dose calculation uses the annual average concentration divided by 9).
- Inhalation dose conversion factors (DOE 1988).

The direct radiation dose component was estimated by using the population distribution within 50 miles of the site, as distributed between 16 equally sized compass sectors (N, NNE, NE, ENE, etc). A dose is estimated for each population sector based on the net increase in direct radiation levels at the site boundary, as measured by TLDs, and the distance between the location of the population and the major source of radiation at the Fernald site (e.g., silos project area). The following conservative assumptions are used in the calculations:

- Population lives 8,760 hours per year in area (DOE 1997)
- The number of people per household is estimated by total population per sector per mile divided by number of households per sector per mile
- The silo project area is modeled as a point source of radiation
- The net direct radiation levels are calculated from site boundary TLD results minus the background result
- The direct radiation levels attributable to the silos project area extends up to 6,000 feet away from the silos project area.

The decrease in the collective effective population dose from 2005 to 2006 reflects completion of remedial actions for the waste pits and silos project areas, which resulted in lower radionuclide concentrations in particulate samples and less direct radiation as silo waste was removed from the site. Air inhalation is the largest component of the collective population dose, because particulate emissions from the Fernald site are suspended in the wind and are generally distributed over a much larger area, relative to direct radiation. The total collective population doses attributed to remedial actions at the Fernald site, over the years 1999 through 2006 (Table C.5–1), are very low relative to background dose values. Background radiation, from the sun and naturally occurring radionuclides in the earth and food products, delivered an estimated collective effective dose of 300,000 person rem to the population within 50 miles of the Fernald site.

C.5.2 Biota Dose Assessment

DOE Order 5400.5 requires that populations of aquatic biota be protected at a dose limit of 1 rad/day. The DOE has issued a technical standard entitled, "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota" (DOE 2002), and supporting software (RAD BCG) for use in the evaluation and reporting of biota dose limits. A biota dose assessment divides the radionuclide concentrations in surface water and/or sediment samples to pre established biota concentration guides (BCGs) for specific radionuclides and sums the fractions for each radionuclide. If the resulting sum of fractions is less than 1.0, compliance with the biota dose limit is assured. BCGs have been established for radionuclides that are relatively common constituents in past radionuclide releases to the environment from DOE facilities. For

the isotopes at the Fernald site, the radium isotopes have the lowest BCG values, hence they account for most of the weight in the sum of fractions presented here.

For 1999 through 2005, the Fernald site determined compliance with the biota dose limit to aquatic biota using the RAD-BCG code and the diluted (i.e., mixed) concentration for each applicable radionuclide discharged to the Great Miami River at the Parshall Flume (refer to Chapter 4 of this report). However, only a single discharge point was evaluated when two discharge points (Paddys Run and the Parshall Flume) are delivering mass to the Great Miami River. In 2003, OEPA published a fact sheet that provided the harmonic mean flow for Paddys Run (0.19 cfs; OEPA 2003), allowing this discharge point to be evaluated in addition to the Parshall Flume. Therefore, the biota assessments for 2003 through 2006 were performed using the mass delivered from both discharge points to determine the annual average mixing concentration in the Great Miami River. Note that these assessments only evaluate the contaminant contribution from the Fernald site (i.e., the contribution that is above background).

The maximum measured concentration for each radionuclide at the Parshall Flume (PF-4001) and Paddys Run (SWP-03) monitoring locations was multiplied by the annual volume of water discharged to the Great Miami River at the Parshall Flume and Paddys Run to obtain an estimate of the maximum mass of each radionuclide delivered to the river at each discharge point (e.g., pCi/L * L = total pCi). For each radionuclide, the mass discharged at the Parshall Flume was added to the mass discharged at Paddys Run to obtain the annual total mass delivered to the river. The annual total mass delivered to the river was divided by the annual total volume of mixed water (Parshall Flume + Paddys Run + Great Miami River) to obtain the annual radionuclide concentrations used in the RAD-BCG model for the biota dose assessment (as noted above, this concentration represents the concentration above background).

Table C.5–2 contains a summary of the output from the RAD BCG computer model for 1999 through 2006, showing results for one discharge point (1999 through 2005) and two discharge points (2003 through 2006). Results for 2006 show the sum of fractions (0.062) is well below the compliance threshold value of 1.0, but above the results reported for every previous year. The increase in 2006 is due primarily to the radium-228 maximum concentration at the Parshall Flume (13.5 pCi/L), which is about 3 times greater than the radium-228 concentration used in previous calculations. Recalculated results for 2003 and 2004, for two discharge points, are identical to the initial results calculated for one discharge point. This indicates that the mass delivered from Paddys Run is insignificant relative to the mass delivered at the Parshall Flume. As discussed below, if the contaminant concentration is similar at the two discharge points, the contaminant mass delivered to the Great Miami River from Paddys Run will be much less than the mass delivered to the river at the Parshall Flume because of the large difference in discharge volume.

Table C.5–2. Estimated Sum-of-the-Fractions[a] for Biota Dose

	1999	2000	2001	2002	2003	2004	2005	2006
A	0.015	0.035	0.038	0.023	0.035	0.059	0.017	NA[b]
B	NA[b]	NA[b]	NA[b]	NA[b]	0.035	0.059	0.005	0.062

Note: A = 1999 through 2005 calculated using one discharge point (Parshall Flume)
B = 2003 through 2006 calculated using two discharge points (Paddys Run and Parshall Flume)

[a]Sum-of-the-fractions calculated with the RAD-BCG code.
[b]NA = not applicable.

When the 2005 concentration data are re-evaluated using two discharge points, the sum of fractions for 2005 decreases to 0.005, which is about three times less than the value of 0.017 reported in the 2005 SER. The basis for this decrease is that the radium-228 mass delivered to the river in the 2005 assessment was overestimated. A radium-228 activity of 3.15 pCi/L was obtained from a Paddys Run monitoring location and it was multiplied by the Parshall Flume annual water volume to obtain the mass of radium-228 delivered to the Great Miami River at the Parshall Flume. If the maximum radium-228 value at the Parshall Flume had been inserted into the evaluation for the 2005 SER, rather than the value from Paddys Run, the sum of fractions would have been 0.004, rather than 0.017. Therefore, the single-discharge-point calculation for 2005 should have yielded 0.004 for the sum of fractions, which indicates the contribution from the Parshall Flume. As noted above, the present evaluation with two point sources yields a result of 0.005, which indicates that Paddys Run contributes about 0.001 to the sum of fractions. Based on the harmonic mean flow for Paddys Run (0.19 cfs; OEPA 2003), the annual volume of water discharged to the Great Miami River is 1.70E+08 L, compared to 7.28E+09 L for the 2005 Parshall Flume data. Therefore, due to the large difference in the discharge volumes, the mass delivered from Paddys Run only becomes important if the radium concentrations in Paddys Run are much greater than those at the Parshall Flume.

Appendix D

2006 National Emissions Standards for Hazardous Air Pollutants (NESHAP) Annual Report

U.S. Department of Energy
Radionuclide Air Emissions Annual Report
(Under Subpart H of 40 Code of Federal Regulations Part 61)
Calendar Year 2006

Site Name: **Fernald Preserve, Fernald, Ohio**

Field Office Information:

Office: Fernald Area Office (FN), U.S. Department of Energy (DOE)
Address: Post Office Box 538705
Mail Stop SDC
Cincinnati, Ohio 45253-8705

Contact: Ed Skintik Phone: (513) 246-0602

Site Information

Operating Contractor: S.M. Stoller, Inc

Address: 7400 Willey Road
Fernald, Ohio 45030 (site location)

10995 Hamilton-Cleves Highway
Harrison, OH 45030 (mailing address)

Contact: Frank Johnston Phone: (513) 648-5294

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Acronyms

ALARA	as low as reasonably achievable
AMS	air monitoring station
BAT	best available technology
°C	degrees Celsius
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
cm	centimeter
CY	calendar year
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
°F	degrees Fahrenheit
ft^3/min.	cubic feet per minute
HEPA	high efficiency particulate air
IEMP	Integrated Environmental Monitoring Plan
km	kilometer
m^3/min.	cubic meters per minute
mrem	millirem
mSv	milliSieverts
NESHAP	National Emission Standards for Hazardous Air Pollutants
OEPA	Ohio Environmental Protection Agency
pCi/m^3	picoCuries per cubic meter
USC	United States Code
WPP	Waste Pits Project

End of current text

Preamble

On May 23, 1997, the U.S. Department of Energy (DOE) Fernald Closure Project submitted a written request to the U.S. Environmental Protection Agency (EPA) for approval to use an alternate approach for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP), Subpart H requirements (DOE 1997). The alternate approach uses environmental measurements of airborne radionuclide concentrations (as provided for under 40 CFR 61.93[b][5]) rather than air dispersion modeling to demonstrate that radionuclide emissions resulting from Fernald site operations remain below the annual NESHAP Subpart H standard. The request for approval of the alternative approach was driven by the recognition that the dominant sources of radiological emissions at the Fernald site had changed as the mission of the site changed from uranium metal production (which ended in 1989) to environmental remediation. During production, the primary emission sources from the facility were point sources (stacks and vents). However, under the current mission of full scale environmental remediation, the dominant emission sources are fugitive emissions from diffuse sources (e.g., large scale excavations, wind erosion from stockpiled materials, decontamination and dismantling, etc.). Because there is a high degree of uncertainty associated with modeling fugitive emissions, environmental measurements were proposed as an alternative to provide a more accurate assessment of site's emissions.

On August 11, 1997, the EPA granted approval to use environmental measurements as an alternative methodology for demonstrating NESHAP compliance (EPA 1997). The Fernald site began using environmental measurements for NESHAP compliance purposes in 1998.

Summary

For calendar year (CY) 2006, the maximum effective dose equivalent from emissions of radionuclides to the ambient air is estimated to be 0.17 millirem (mrem/yr) (0.0017 millisieverts [mSv/yr]) above background, which is in compliance with the Subpart H standard of less than 10 mrem/yr (0.1 mSv/yr) above background. This estimation is based on the Fernald site's radiological air particulate monitoring program, which consists of a network of high volume air monitoring stations (AMS) operated at the Fernald site boundary (16 locations) and a background location. As the site remedial actions associated with building demolition and soil excavation decreased through 2006, monitoring at six boundary stations was discontinued in April, and an additional five boundary stations were shut down in December as agreed upon in consultation with USEPA and OEPA.

End of current text

D.1.0 Facility Information

D.1.1 Site Description

The Fernald site is located on a 1,050-acre (425 hectare) area approximately 18 miles (29 kilometers [km]) northwest of downtown Cincinnati, Ohio, just north of the small farming community of Fernald, Ohio. The former production area covers approximately 136 acres (55 hectares) in the center of the site.

The area immediately surrounding the site is rural in nature and characterized by the predominance of agriculture, with some light industry and private residences. The site is located on a relatively level plain, outside of the 500-year flood plain of the Great Miami River, in an ancestral river valley known as the New Haven Trough.

The climate is characterized as continental/subtropical depending on the seasons, with average temperatures ranging from approximately 31 °F (–0.7 °C) in December to 76 °F (25 °C) in July. Average annual precipitation was approximately 40 inches (102 centimeters [cm]). Prevailing wind flow is from the southwest.

For 37 years, the former Feed Materials Production Center (the Fernald site) produced uranium metals for DOE and its predecessors. On July 10, 1989, uranium metals production was suspended. Management responsibilities of the Fernald site were transferred from the Defense Programs organization to the DOE's Office of Environmental Restoration and Waste Management.

Remedial action activities at the Fernald site are conducted under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). These activities included sample analysis; waste characterization; the management, treatment, storage, and disposal of hazardous, mixed, low level, and solid wastes; and the decontamination and cleanup of radioactively contaminated buildings, equipment, soil, and ground water. The site also managed containerized thorium wastes and K 65 Silos waste material, which contained radium and produced radon gas. All remedial actions, with the exception of ground water restoration, were completed in 2006.

D.1.2 Source Descriptions

The majority of the radioactive airborne contaminants at the Fernald site consisted of thorium and uranium isotopes. Additional radioactive airborne contaminants consisted of daughter products from the uranium, actinium, and thorium series decay chains.

For CY 2006, potential radionuclide emissions sources at the Fernald site included:

- Stockpiles; fugitive emission from wind erosion.
- Former production area and waste pit area; fugitive emission from continued excavation of contaminated soils and debris.
- On-site disposal facility waste placement and material transfer areas; fugitive emissions from size-reducing material prior to and during placement in the cells.

- Silos 1, 2 and 3; fugitive emissions generated from decontamination and dismantling of treatment facilities.
- Continued operation of the Radon Control System (until April 2006).

Stack monitoring of the RCS and silo treatment facilities was completed in early 2006 and reported in the 2005 NESHAP annual report (Appendix D of the 2005 SER); therefore it will not be repeated here.

D.1.3 Radiological Air Particulate Monitoring Program Description

The Fernald site's radiological air monitoring program for CY 2006 is defined in the Integrated Environmental Monitoring Plan (IEMP), Revision 4 (DOE 2005). The program design, as approved by the EPA, is summarized below.

D.1.3.1 Monitoring Equipment and Locations

- A network of 17 high-volume environmental AMSs comprise the Fernald site's radiological air particulate monitoring program for NESHAP compliance (Figure D–1). The monitors draw air continuously through 8-inch by 10-inch filters at a rate of 40 to 50 cubic feet per minute (ft^3/min.) (1.13–1.42 cubic meters per minute [m^3/min.]). Each AMS contains a flow rate chart recorder and a hour meter that provide a record of the monitor's operational run time over the sampling period. Additionally, each AMS is equipped with flow controllers that maintain a constant airflow through the monitor by automatically adjusting blower/motor speed to correct for variations in line voltage, temperature, pressure, or filter loading.
- The 17 AMSs are divided among boundary and background monitoring locations. Sixteen monitors are located on the Fernald site boundary, generally corresponding to the 16 wind rose sectors (Figure D-2). One monitor collects background data and is located in the northwest direction, approximately 3.2 miles (5.2 km) from the center of the Fernald site. The EPA siting criteria (40 CFR 58, Appendix E) were considered when selecting these locations.

D.1.3.2 Analytical Regime and Sampling Frequency

The analytical regime and sampling frequency for this program were designed to collect defensible data, account for the major dose sources, and demonstrate compliance with NESHAP Subpart H, as defined in 40 CFR 61.93(b)(5)(ii).

- Filters were exchanged biweekly throughout the year and analyzed for total uranium and total particulates. Analytical results are used to document site emissions and demonstrate that the emission controls at the Fernald site were operating effectively.
- A portion of each biweekly filter was retained and used to form a monthly composite sample for the analysis of thorium isotopes. This was done to supplement the thorium data from the quarterly composites (i.e., two monthly thorium composites per quarter). Analytical results from the monthly and quarterly thorium composites are used to document thorium emissions and demonstrate that process controls at the Fernald site were operating effectively.

- The remaining portion of each biweekly filter was retained and used to form a quarterly composite sample. This composite sample is analyzed for the radionuclides expected to be the major contributors to dose from site emissions. Results from the quarterly composite samples are used to track compliance against the NESHAP Subpart H standard for the calendar year.
- Isotopes that comprise the quarterly composite analysis were selected based on the following considerations:
  - Radionuclides that are stored in large quantities at the Fernald site and were handled or processed during the remediation effort (uranium-234, uranium-235, uranium-238, thorium-228, thorium-230, thorium-232, and radium-226)
  - Radionuclides that were the major contributors to dose based on environmental and stack filter measurements (uranium-234, uranium-235 and uranium-238)
  - Radionuclides that, due to their concentrations in waste and contaminated soil, were the major contributors to dose (uranium-234, uranium-235, uranium-238, thorium-228, and thorium-230).

Uranium-238, thorium-232, and uranium-235 are initial radionuclides in the uranium, thorium, and actinide decay chains, respectively. The majority of uranium and thorium isotopes received and processed during the production era of the Fernald site had been separated from their decay chain progeny prior to shipment to the site. As a result, all decay chain progeny are not in equilibrium with the parent activity, but short half-life progeny are expected to be in equilibrium with the parent. Because some of the progeny are difficult to quantify using standard radiochemistry analytical techniques, in part due to the limited sample volume and low environmental concentrations of all radionuclides in the quarterly composite samples, a number of progeny radionuclides can be considered to be present in equilibrium with their parents (i.e., thorium-234, radium-228, actinium-228, radium-224, and thorium-231). The progeny nuclides noted above are used in the dose assessment.

Net air concentrations for measured isotopes are summarized in Table D–1. For the boundary monitors, the net air concentration is defined as the gross result minus the blank and background values. The net air concentration at the background location is the gross result minus the blank.

D.1.3.3 Air Emission Data Reporting

In addition to this report, the environmental data from the Fernald site are available on the DOE Office of Legacy Management website: www.gjo.doe.gov/LM.

D.2.0 Air Emissions Data

D.2.1 Air Monitoring Data Completeness Status

During CY 2006, there were no concerns about data quality of the quarterly composite results. Blank filter results were within their historical limits, and observed positive detects on the blank samples were subtracted from the composite result.

D.2.2 Air Monitoring Station Operational Performance

During CY 2006, operational run times for the 17 NESHAP AMSs exceeded 96.8 percent (Table D–2). In general, interruptions in monitor operations that were encountered during CY 2006 were the result of short-term power failures and/or equipment failures.

D.3.0 Dose Assessment

Based on the sum of the quarterly isotopic results and annual air volumes, the net measured concentration for each radionuclide was calculated at each boundary (fence line) monitor to determine annual average concentrations. The annual average concentrations at each boundary air monitor are divided by the corresponding values listed in Subpart H of 40 CFR 61, Appendix E Table 2 to form a radionuclide specific compliance ratio. For each boundary monitor, the sum of the radionuclide compliance ratios was calculated (Table D–3), and the maximum value of the sum of the ratios was 0.017 at AMS-3. AMS-3 operated 97.8 percent of the time during 2006.

In accordance with 40 CFR 61.107, compliance with the NESHAP standard is demonstrated when the sum of the ratios is less than 1. Based on this approach for demonstrating compliance, the 40 CFR 61, Appendix E, Table 2 values represent the annual average radionuclide concentrations that correspond to a 10 mrem/yr effective dose equivalent. It follows that a fraction of the 40 CFR 61, Appendix E Table 2 values would correspond to an equivalent fraction of a 10 mrem/yr effective dose equivalent. Therefore, the ratio sum for each monitor, derived from all radionuclide ratios, is converted to a dose by multiplying the ratio sum by 10 mrem/yr (Table D–3). The maximum value of the sum of the ratios (0.017) is observed at AMS-3, and this converts to a maximum effective dose equivalent of 0.17 mrem/yr (0.0017 mSv/yr) at the Fernald site boundary.

Because the nearest residences are located approximately 1,555 feet (474 meters) downwind (east southeast) from AMS-3, the actual dose received by this receptor would be substantially lower than 0.17 mrem/yr (0.0017 mSv/yr).

D.4.0 Compliance Assessment

For CY 2006, the maximum effective dose equivalent from emissions of radionuclides to the ambient air, based on samples collected at the Fernald site boundary, is estimated to be 0.17 mrem/yr (0.0017mSv/yr), which is in compliance with the Subpart H standard of less than 10 mrem/yr (0.1 mSv/yr).

D.5.0 Additional Information

D.5.1 Meteorological Data

Meteorological data were collected from the Fernald site until May 16, 2006 when the meteorological tower was taken out of service and demolished. Meteorological data are currently being collected from the Butler County Regional Airport because it is the closest location that provides the most comprehensive meteorological data set. These data are used to evaluate site-specific climatic conditions.

Refer to Figure 2 for the CY 2006 wind rose data.

D.5.2 Construction/Modifications at the Fernald Site

In CY 2006, there were no project changes that resulted in a need to apply to the EPA for approval (under the provisions of 40 CFR 61.96) to construct or modify operations that control source emissions.

D.6.0 References

DOE (U.S. Department of Energy), 2005. "Integrated Environmental Monitoring Plan," 2505 WP 0022, Revision 4, Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, OH, January.

DOE (U.S. Department of Energy), 1997. "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," letter #DOE 0980 97, Johnny Reising to James Saric and Michael Murphy, May 23.

EPA (U.S. Environmental Protection Agency). 1997, "Application for Approval to Use Environmental Measurements to Demonstrate Compliance with the National Emission Standards for Hazardous Air Pollutants Subpart H," letter from Jack Barnett to Johnny Reising, August 11.

D.7.0 Certification

I certify under penalty of law that I have personally examined and am familiar with the information submitted herein and, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the submitted information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information including the possibility of fine and imprisonment (see 18 USC 1001).

Name: Johnny Reising

Signature: Signature on file Date: _____

Table D–1. CY 2006 Net Air Concentrations

	Radium (pCi/m^3)	Thorium (pCi/m^3)			Uranium (pCi/m^3)		
Location	226	228	230	232	234	235/236	238
Boundary [a,b]							
AMS-2	0	8.2E-07	0	1.0E-06	2.6E-06	0	2.5E-06
AMS-3	2.0E-05	3.5E-06	4.5E-06	3.8E-06	7.9E-06	1.3E-07	9.4E-06
AMS-4	0	4.2E-06	0	4.0E-06	7.4E-06	0	9.7E-06
AMS-5	0	1.7E-06	0	1.4E-06	4.2E-06	0	4.0E-06
AMS-6	0	2.2E-07	3.2E-07	4.0E-07	2.1E-06	6.7E-08	2.1E-06
AMS-7	0	2.8E-06	0	1.1E-06	4.7E-06	0	7.1E-06
AMS-8A	0	8.9E-07	1.2E-06	1.2E-06	3.8E-06	4.6E-08	3.9E-06
AMS-9C	2.7E-05	8.0E-07	6.7E-07	1.2E-06	6.0E-06	6.3E-08	5.3E-06
AMS-22	0	2.9E-07	0	6.0E-07	4.1E-06	6.6E-07	3.1E-06
AMS-23	0	5.4E-06	0	3.1E-06	1.0E-05	1.7E-06	9.0E-06
AMS-24	0	1.5E-06	1.9E-06	2.2E-06	3.7E-06	0	3.9E-06
AMS-25	0	7.4E-07	0	0	4.6E-06	0	5.1E-06
AMS-26	0	0	0	0	0	5.4E-08	0
AMS-27	0	1.7E-06	1.1E-06	1.7E-06	2.6E-06	7.3E-08	2.6E-06
AMS-28	0	7.3E-07	0	1.2E-06	7.2E-06	0	6.3E-06
AMS-29	1.9E-06	2.6E-06	1.9E-06	2.5E-06	5.5E-06	8.3E-08	7.1E-06
Background							
AMS-12	1.5E-02	9.6E-04	3.0E-04	1.9E-03	2.5E-04	0	2.6E-04

[a]For fenceline monitors, net = total - blank - background (0 if net is negative)
[b]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table D–2. CY 2006 Operational Summary for Air Particulate Monitoring Stations

Location	Number of Samples	Sample Start Date	Last Sample Collection Date	Operating Time (hours)	Percent of Operation
Boundary [a]					
AMS-2	27	20-Dec-05	02-Jan-07	8908	98.2
AMS-3	27	20-Dec-05	02-Jan-07	8872	97.8
AMS-4	8	20-Dec-05	11-Apr-06	2688	100
AMS-5	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-6	27	20-Dec-05	02-Jan-07	9035	99.6
AMS-7	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-8A	27	20-Dec-05	02-Jan-07	8840	97.4
AMS-9C	25	20-Dec-05	05-Dec-06	8399	100
AMS-22	25	20-Dec-05	05-Dec-06	8392	99.9
AMS-23	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-24	27	20-Dec-05	02-Jan-07	8971	98.9
AMS-25	8	20-Dec-05	11-Apr-06	2685	99.9
AMS-26	25	20-Dec-05	05-Dec-06	8373	99.7
AMS-27	25	20-Dec-05	05-Dec-06	8393	99.9
AMS-28	8	20-Dec-05	11-Apr-06	2686	99.9
AMS-29	25	20-Dec-05	05-Dec-06	8131	96.8
Background					
AMS-12	27	20-Dec-05	02-Jan-07	9068	100

[a]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006.
AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.

Table D–3. 2006 Annual NESHAP Compliance Ratios

Location	Ac-228[a]	Ra-224[a]	Ra-226	Ra-228[a]	Th-228	Th-230	Th-231[a]	Th-232	Th-234[a]	U-234	U-235/6	U-238	Annual Total	Annual Dose[b] (mrem/yr)
Boundary [c,d]														
AMS-2	2.8E-07	7.0E-06	0	1.8E-04	2.7E-04	0	0	1.7E-03	1.1E-06	3.3E-04	0	3.0E-04	2.8E-03	2.8E-02
AMS-3	1.0E-06	2.5E-05	6.0E-03	6.4E-04	1.1E-03	1.3E-03	4.6E-10	6.1E-03	4.3E-06	1.0E-03	1.8E-05	1.1E-03	1.7E-02	1.7E-01
AMS-4	1.1E-06	2.7E-05	0	6.8E-04	1.4E-03	0	0	6.5E-03	4.4E-06	9.6E-04	0	1.2E-03	1.1E-02	1.1E-01
AMS-5	3.7E-07	9.1E-06	0	2.3E-04	5.4E-04	0	0	2.2E-03	1.8E-06	5.5E-04	0	4.8E-04	4.0E-03	4.0E-02
AMS-6	1.1E-07	2.7E-06	0	6.8E-05	7.2E-05	9.5E-05	2.3E-10	6.4E-04	9.6E-07	2.8E-04	9.0E-06	2.6E-04	1.4E-03	1.4E-02
AMS-7	3.0E-07	7.4E-06	0	1.9E-04	9.2E-04	0	0	1.8E-03	3.2E-06	6.0E-04	0	8.5E-04	4.4E-03	4.4E-02
AMS-8A	3.3E-07	8.1E-06	0	2.1E-04	2.9E-04	3.7E-04	1.6E-10	2.0E-03	1.8E-06	4.9E-04	6.2E-06	4.7E-04	3.8E-03	3.8E-02
AMS-9C	3.3E-07	8.1E-06	8.2E-03	2.1E-04	2.6E-04	2.0E-04	2.2E-10	2.0E-03	2.4E-06	7.7E-04	8.6E-06	6.4E-04	1.2E-02	1.2E-01
AMS-22	1.6E-07	4.0E-06	0	1.0E-04	9.5E-05	0	2.3E-09	9.7E-04	1.4E-06	5.3E-04	8.9E-05	3.8E-04	2.2E-03	2.2E-02
AMS-23	8.3E-07	2.1E-05	0	5.2E-04	1.7E-03	0	6.0E-09	5.0E-03	4.1E-06	1.3E-03	2.4E-04	1.1E-03	9.9E-03	9.9E-02
AMS-24	5.9E-07	1.4E-05	0	3.7E-04	5.0E-04	5.6E-04	0	3.5E-03	1.8E-06	4.8E-04	0	4.7E-04	5.9E-03	5.9E-02
AMS-25	0	0	0	0	2.4E-04	0	0	0	2.3E-06	6.0E-04	0	6.1E-04	1.5E-03	1.5E-02
AMS-26	0	0	0	0	0	0	1.9E-10	0	0	0	7.3E-06	0	7.3E-06	7.3E-05
AMS-27	4.7E-07	1.2E-05	0	3.0E-04	5.5E-04	3.2E-04	2.5E-10	2.8E-03	1.2E-06	3.3E-04	9.9E-06	3.1E-04	4.6E-03	4.6E-02
AMS-28	3.2E-07	7.8E-06	0	2.0E-04	2.4E-04	0	0	1.9E-03	2.9E-06	9.4E-04	0	7.6E-04	4.0E-03	4.0E-02
AMS-29	6.9E-07	1.7E-05	5.8E-04	4.3E-04	8.3E-04	5.7E-04	2.9E-10	4.1E-03	3.2E-06	7.2E-04	1.1E-05	8.5E-04	8.1E-03	8.1E-02
Background														
AMS-12	3.2E-07	7.9E-06	1.5E-02	2.0E-04	9.6E-04	3.0E-04	0	1.9E-03	9.7E-07	2.5E-04	0	2.6E-04	NA[e]	NA[e]

Note: Compliance ratios are calculated with net concentrations (i.e., gross result - blank - background)

[a]Ratio determined by assuming air concentration is in secular equilibrium with the parent nuclide.
[b]Dose is based on the NESHAP standard of 10 mrem/yr multiplied by the annual total for all isotopes.
[c]For fenceline monitors, net = total - blank - background (0 if net is negative)
[d]AMS-4, 5, 7, 23, 25 and 28 were taken out of service on April 11, 2006. AMS-9C, 22, 26, 27, and 29 were taken out of service on December 5, 2006.
[e]NA = not applicable

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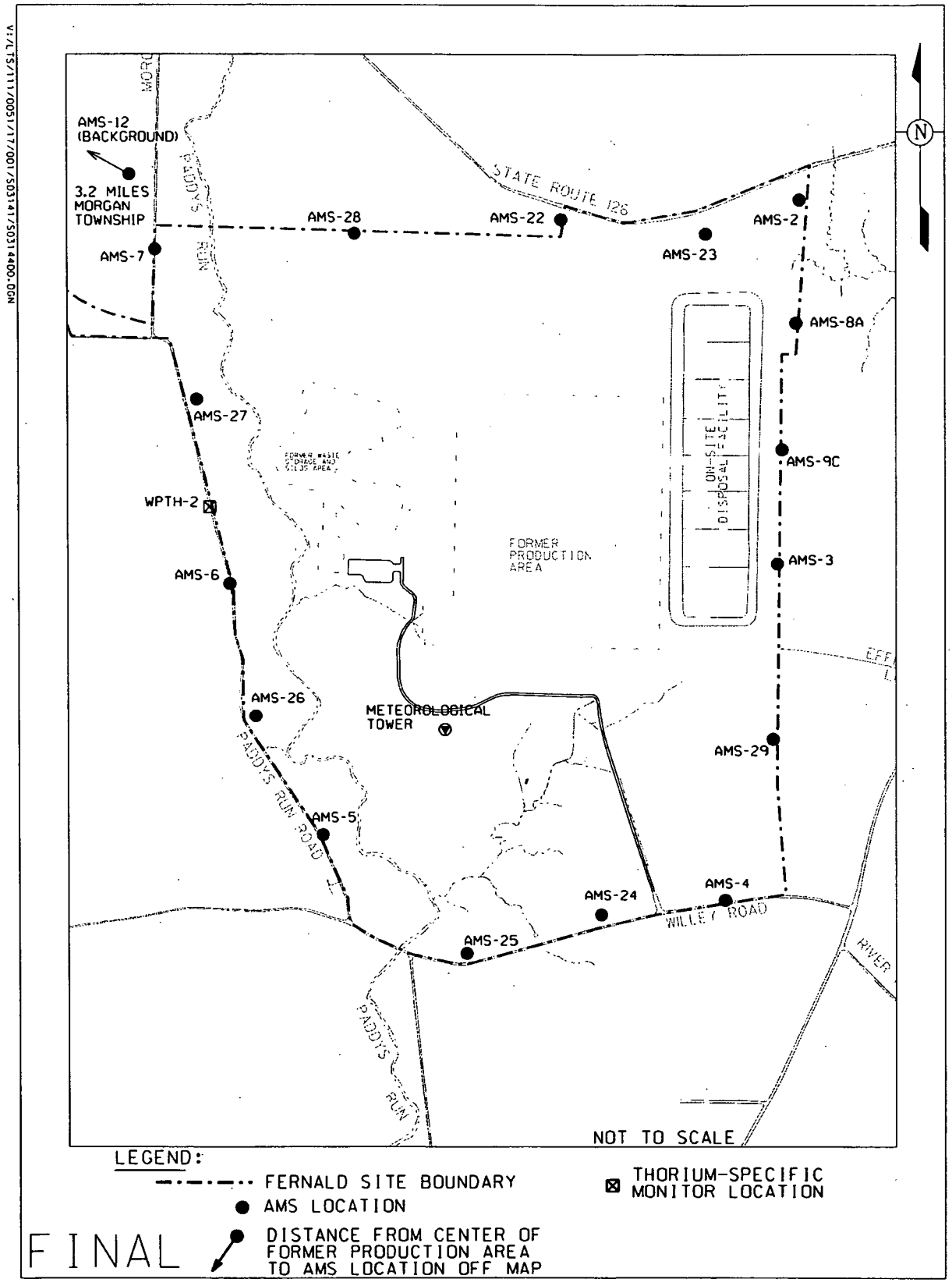

Figure D–1. Radiological Air Monitoring Locations

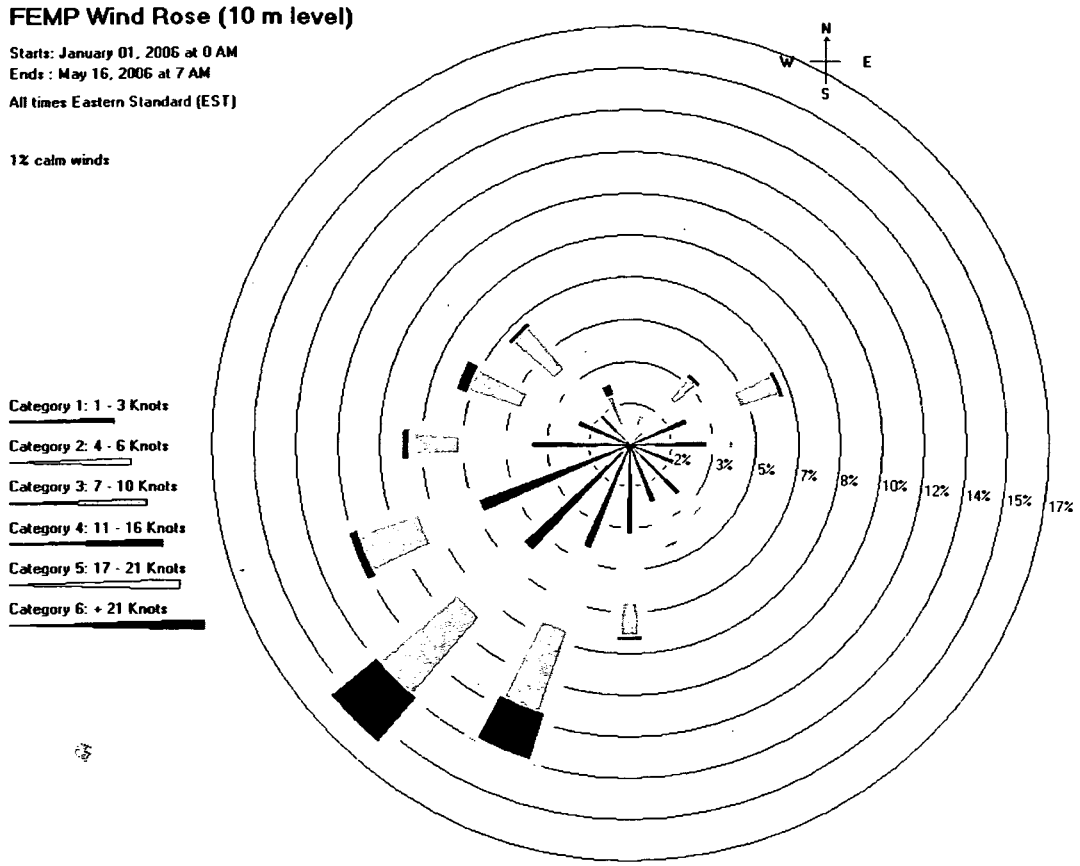

Figure D–2. Wind Rose Diagram

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