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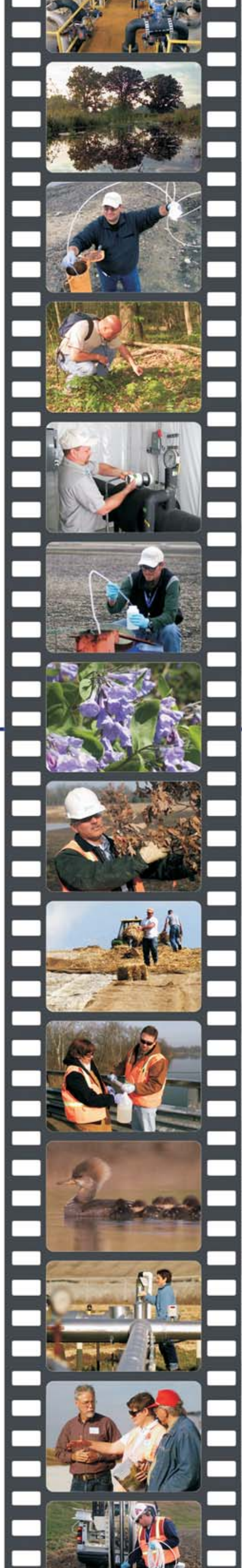

2006

Fernald
Site Environmental Report

U.S. Department of Energy
Office of Legacy Management
Contract DE-AC01-02GJ79491
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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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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
$\mu g/m^3$	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.

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.

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.

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).

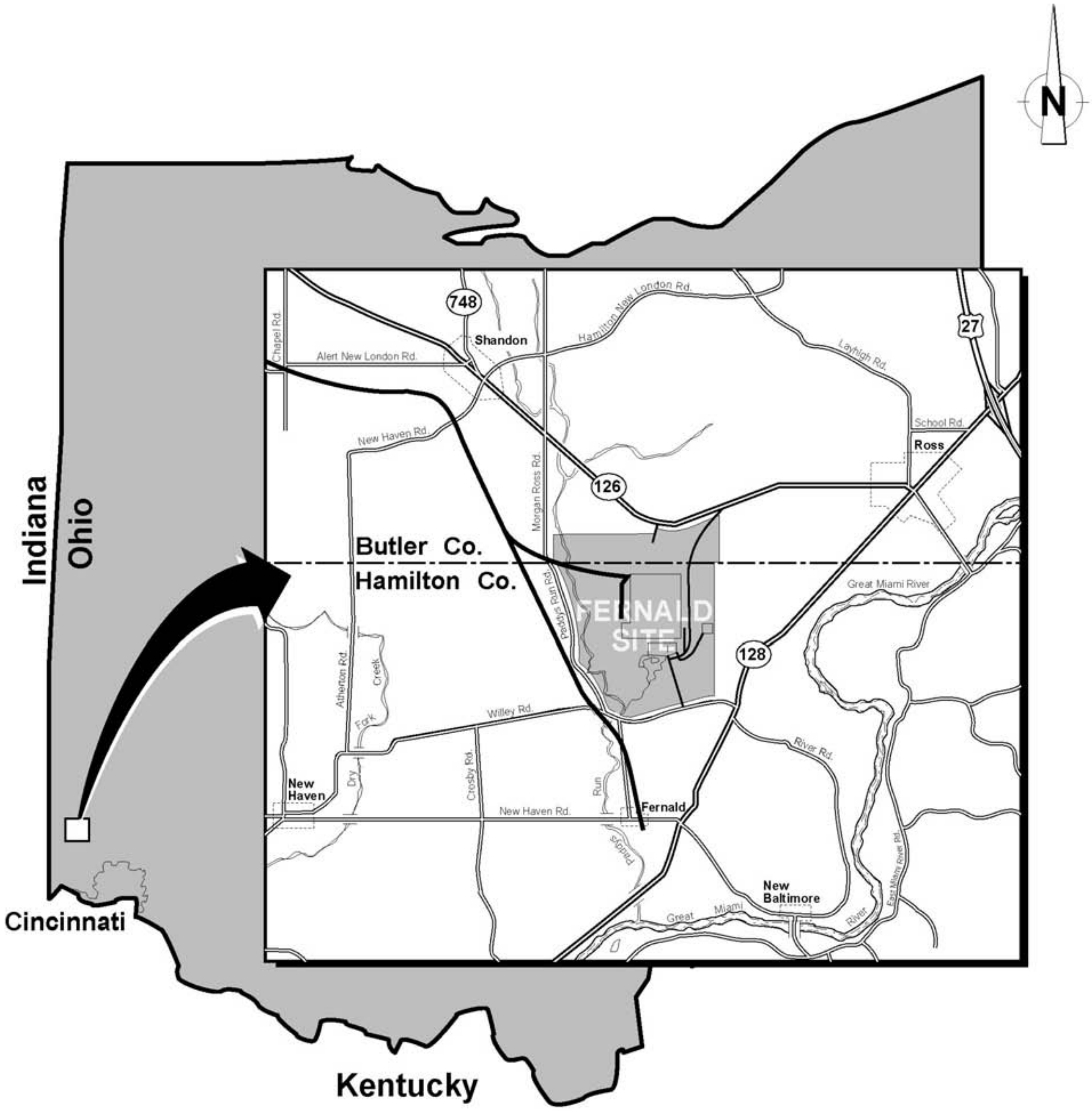
1.3.2 Geography

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

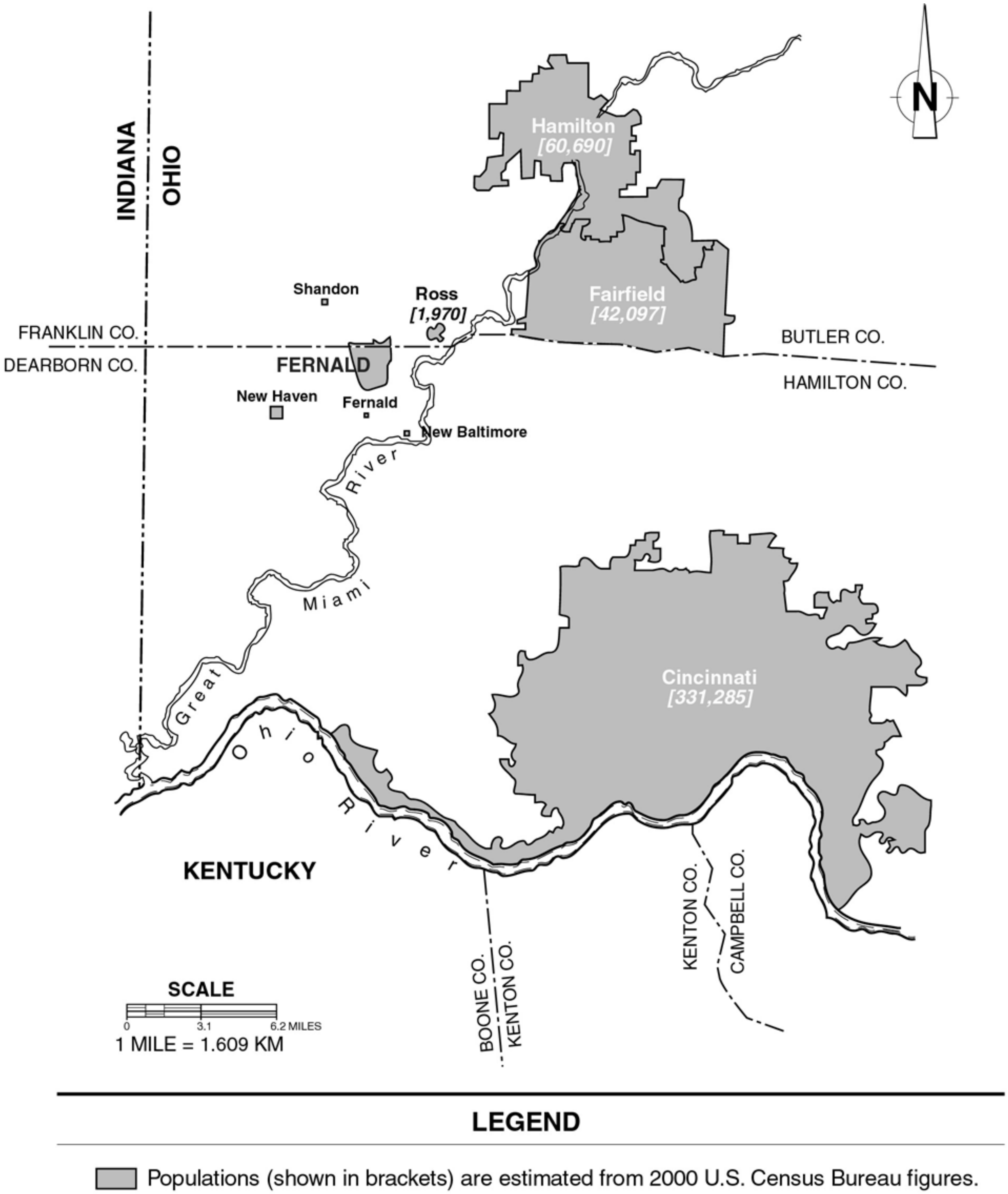


Figure 1–2. Major Communities in Southwestern Ohio

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.

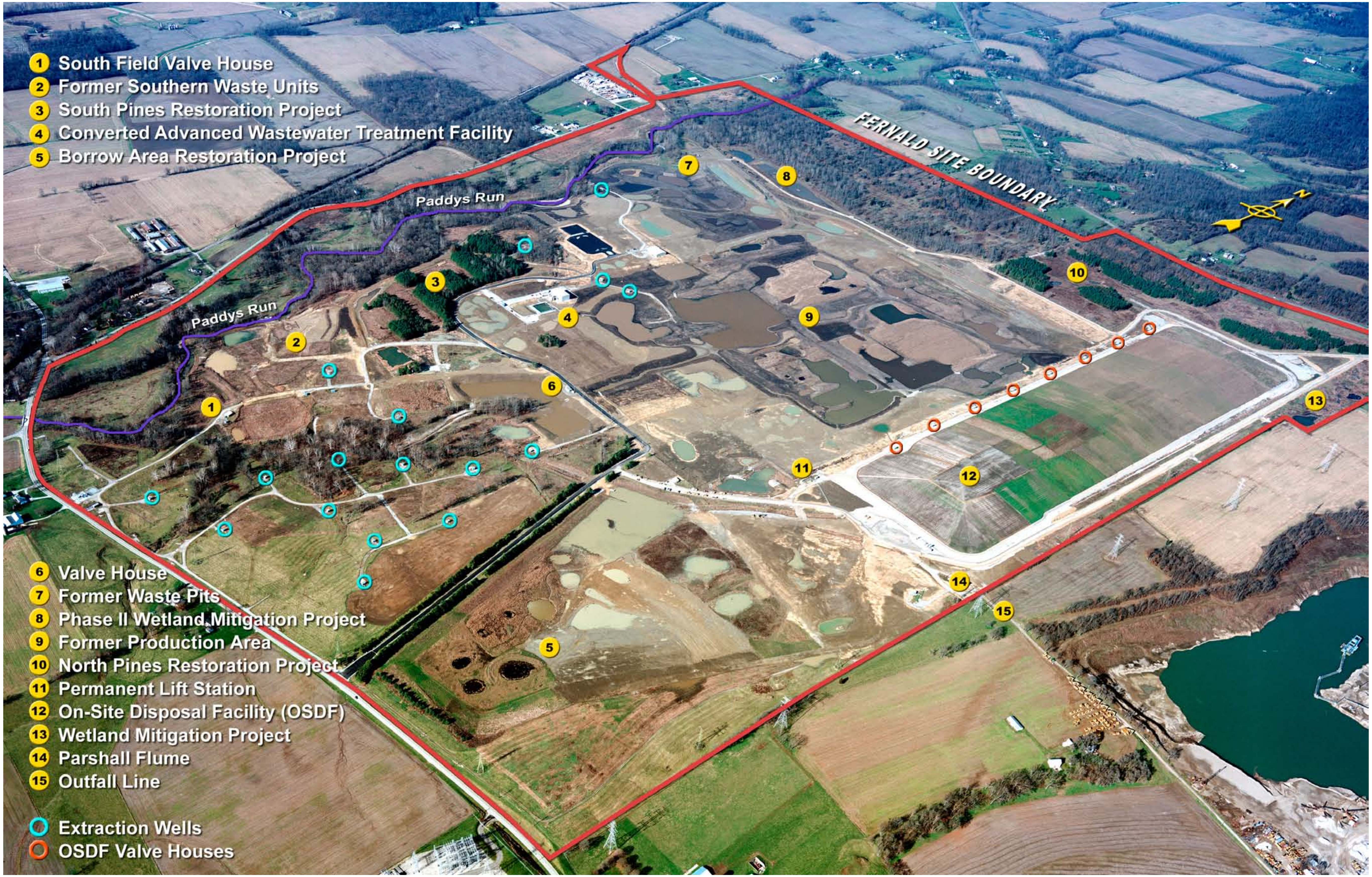


Figure 1–3. Fernald Site Perspective

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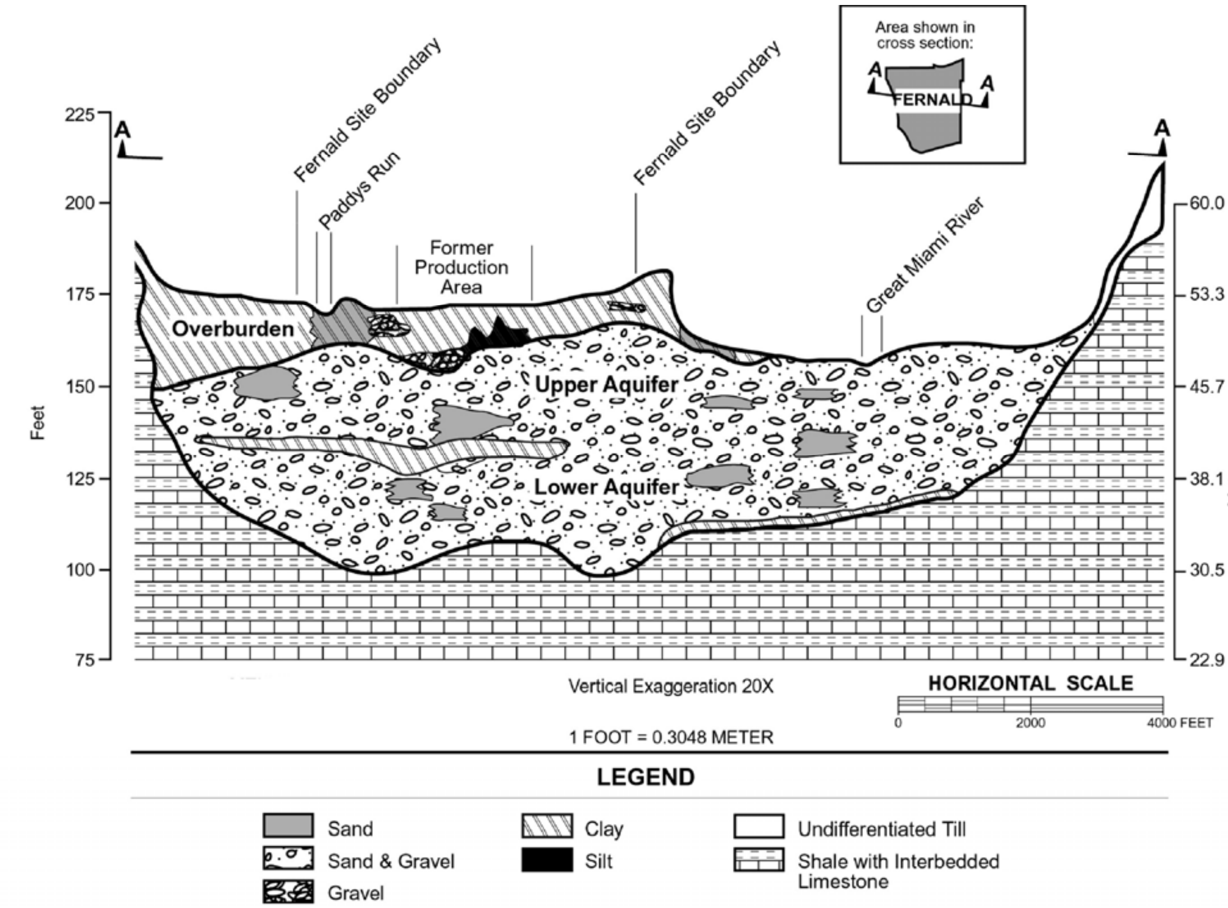

Figure 1–4. Cross Section of the New Haven Trough, Looking North

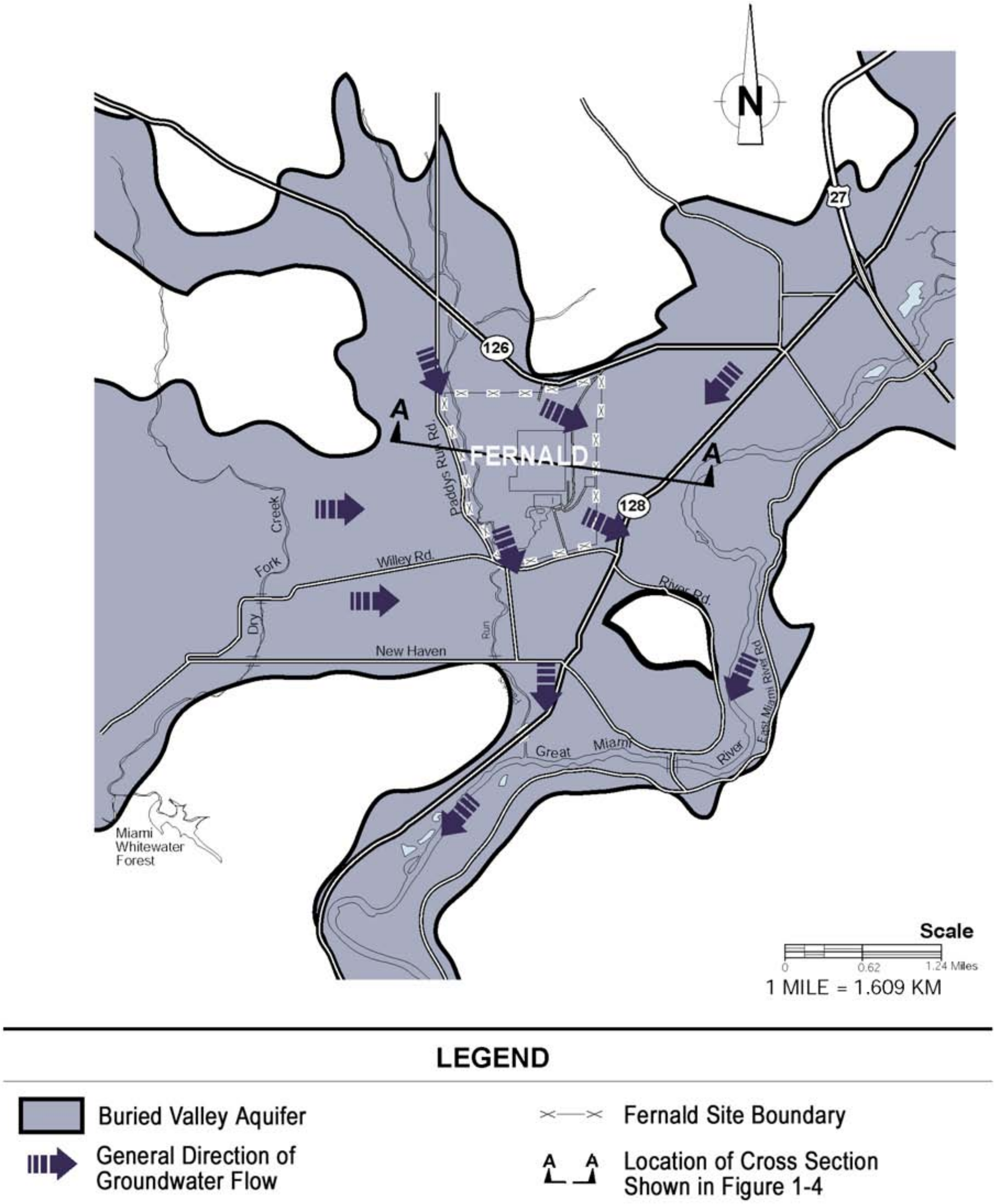

Figure 1–5. Regional Groundwater Flow in the Great Miami Aquifer

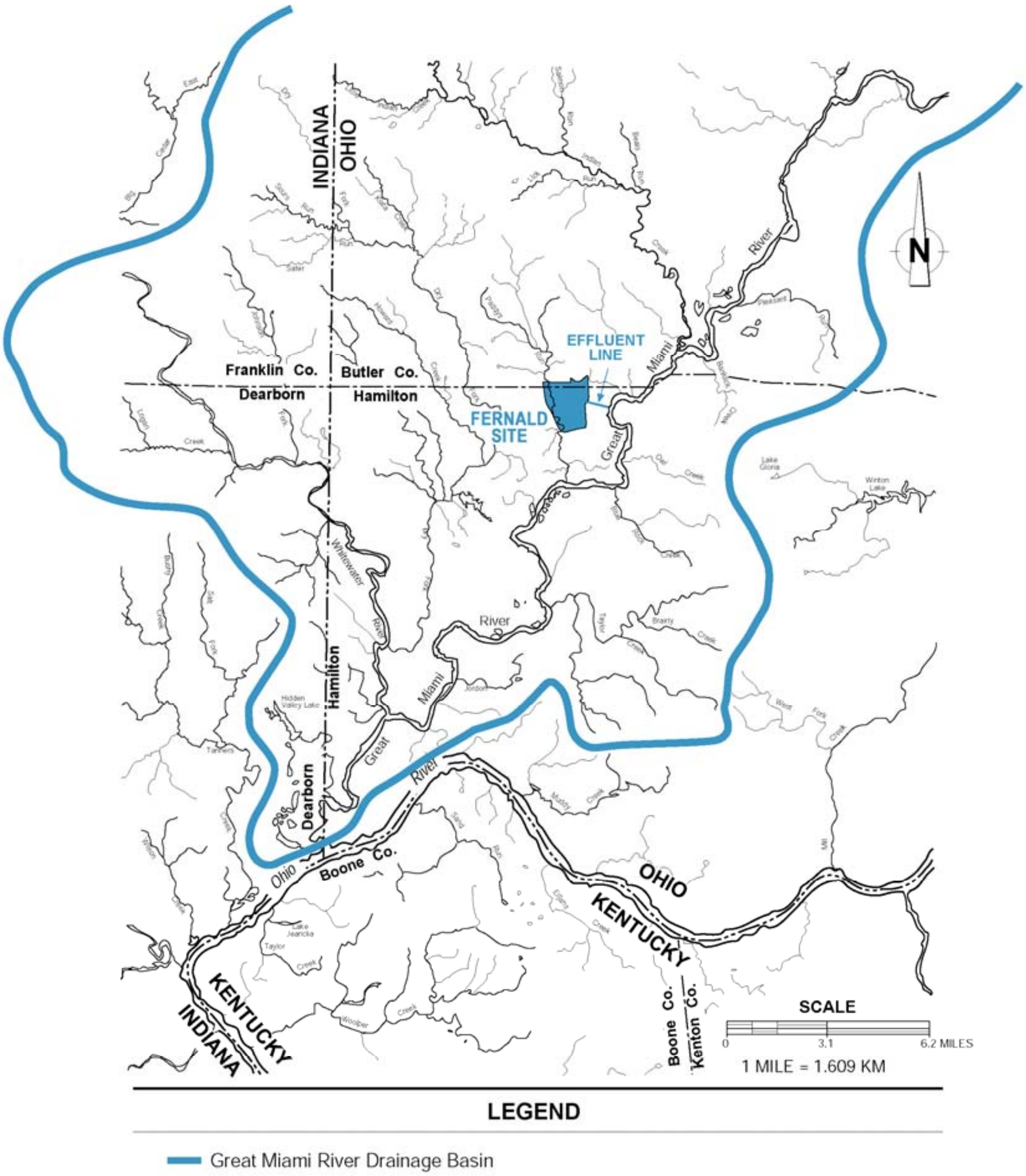

Figure 1–6. Great Miami River Drainage Basin

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.

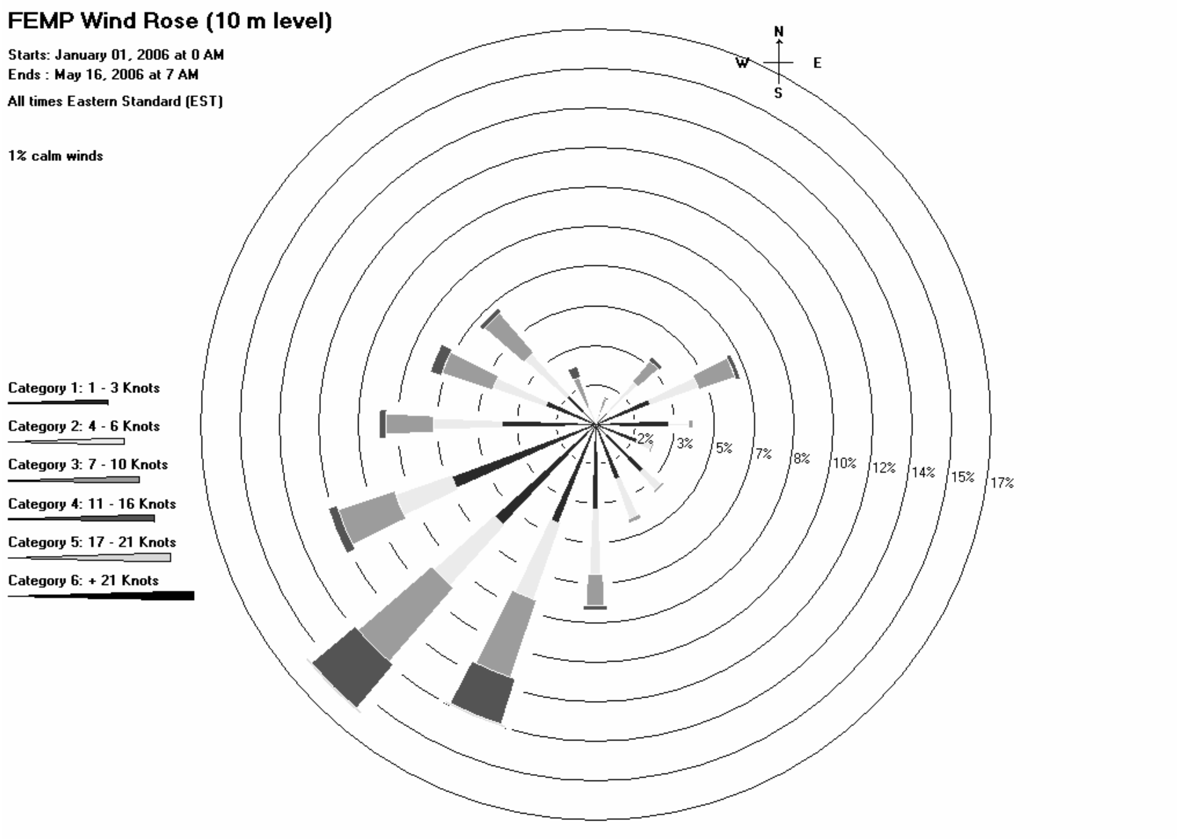

Figure 1–7. 2006 Wind Rose, 33-ft (10-m) Height

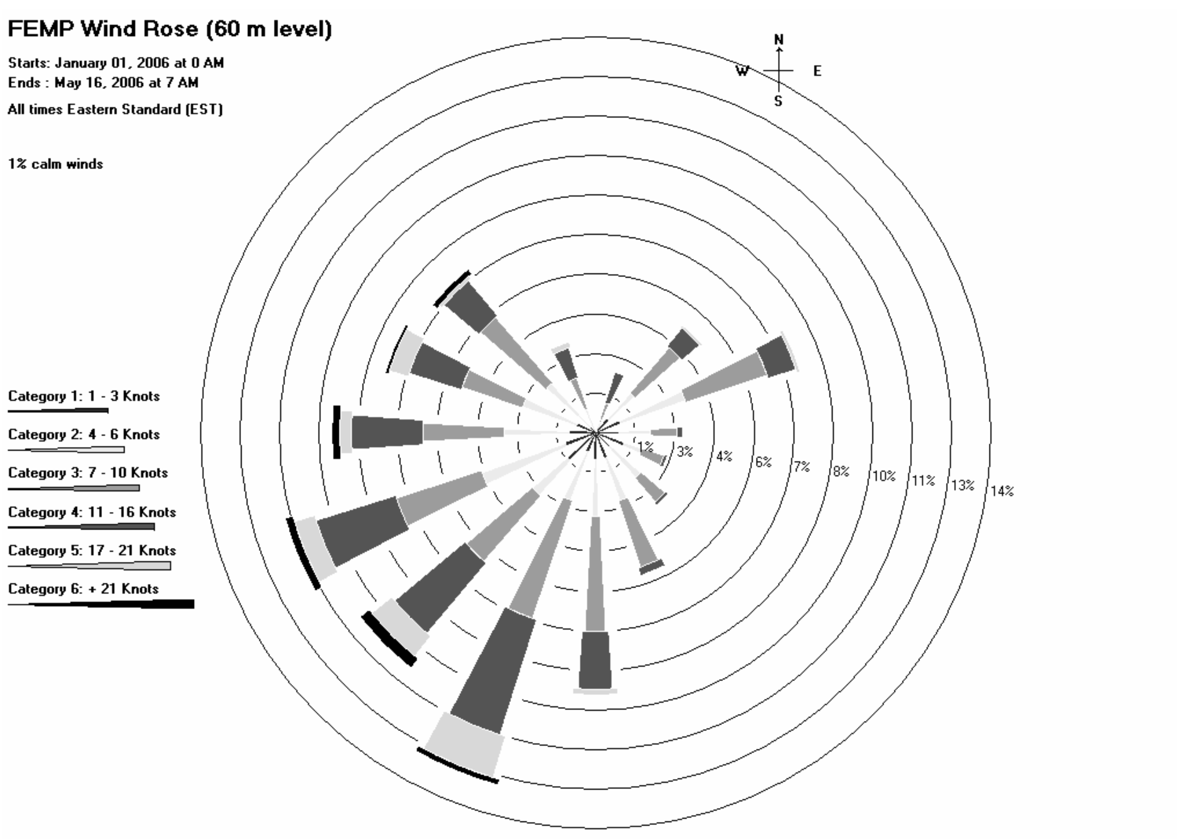

Figure 1–8. 2006 Wind Rose, 197-ft (60-m) Height

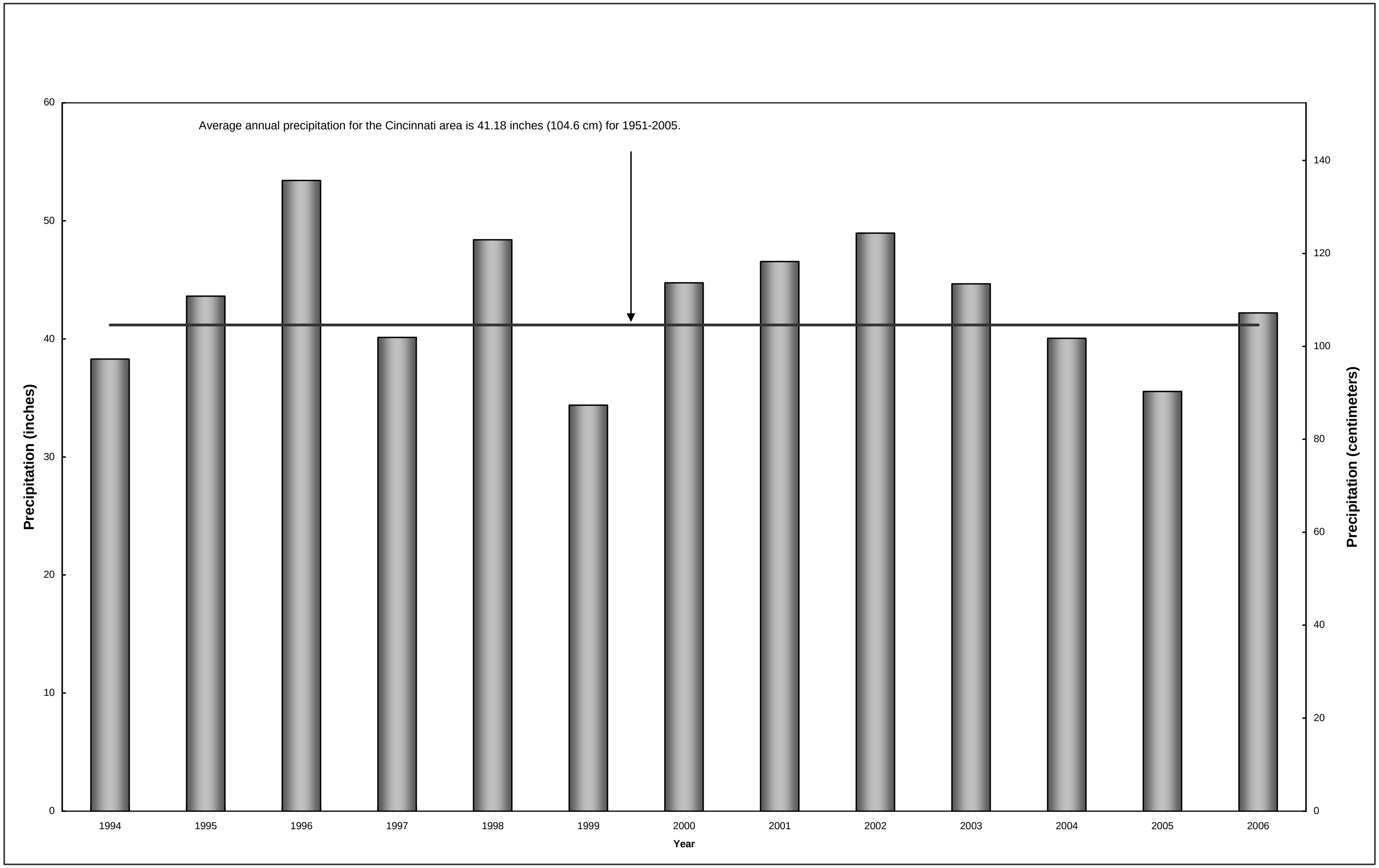

Figure 1–9. Average Annual Precipitation, 1994–2006

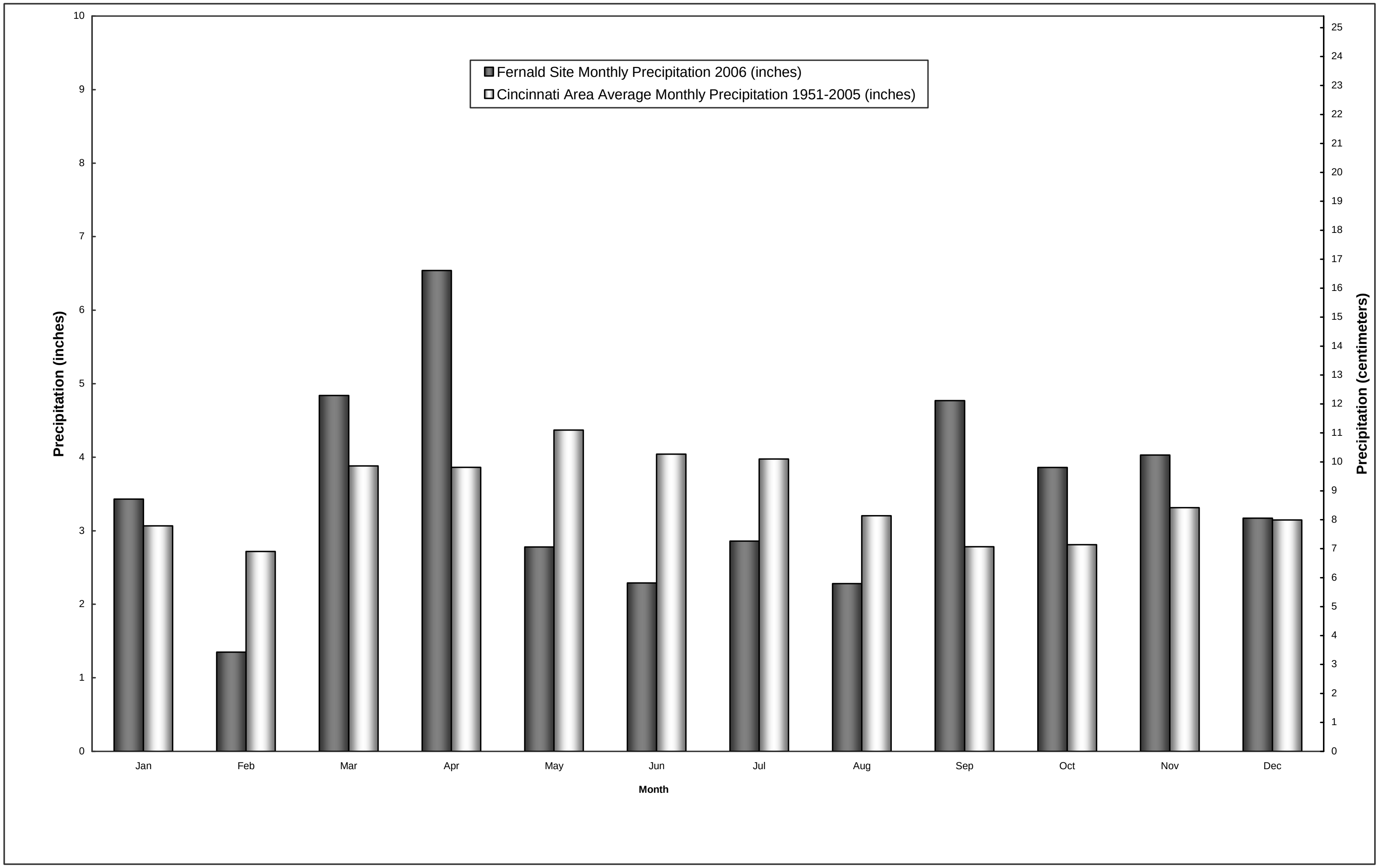

Figure 1–10. Monthly Precipitation for 2006 Compared to Average Monthly Precipitation for 1951–2005

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.

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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

	FRL[a]		
Constituent	**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.

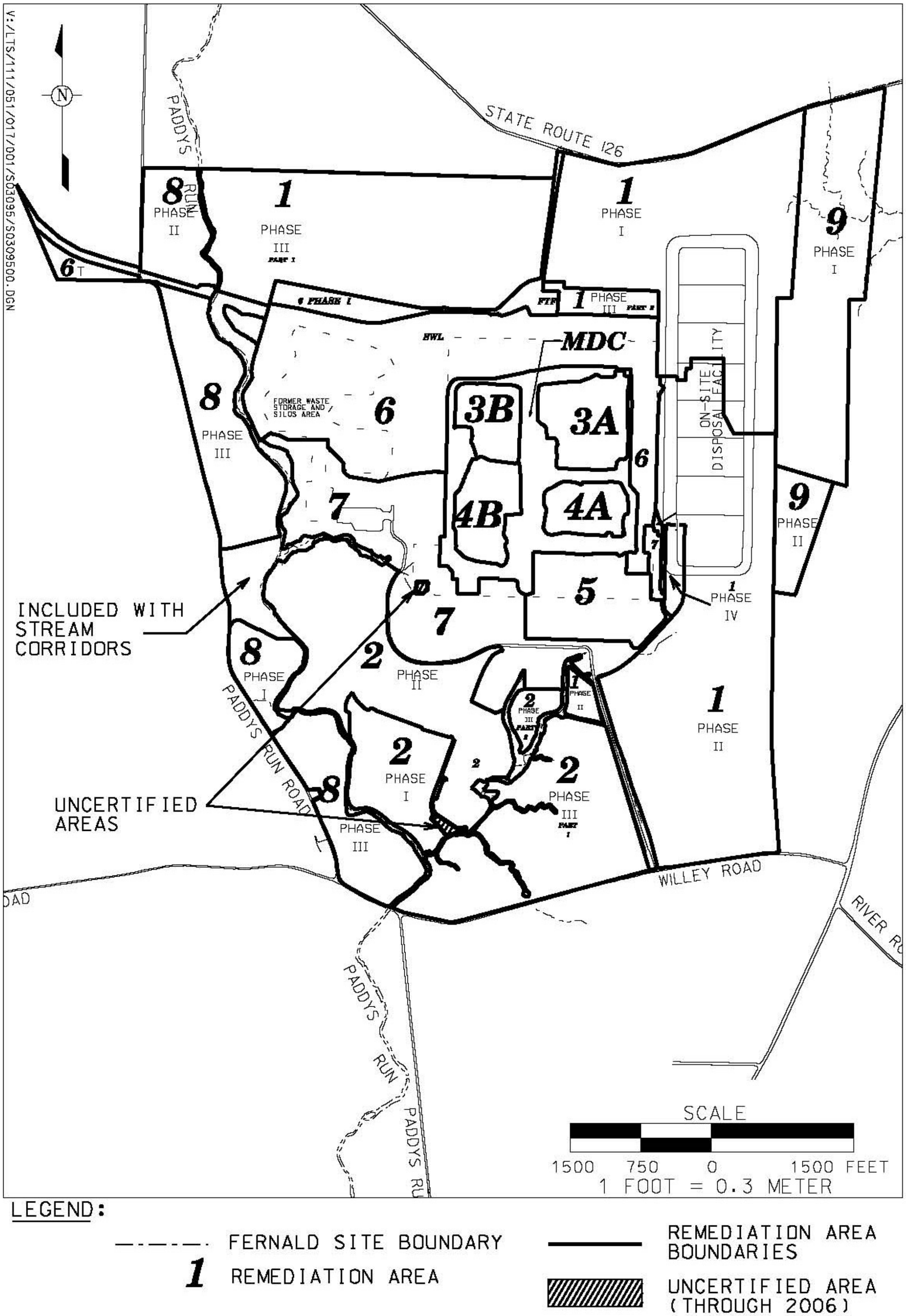

Figure 2–1. Site-Wide Soil Certified Areas

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.

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.

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.

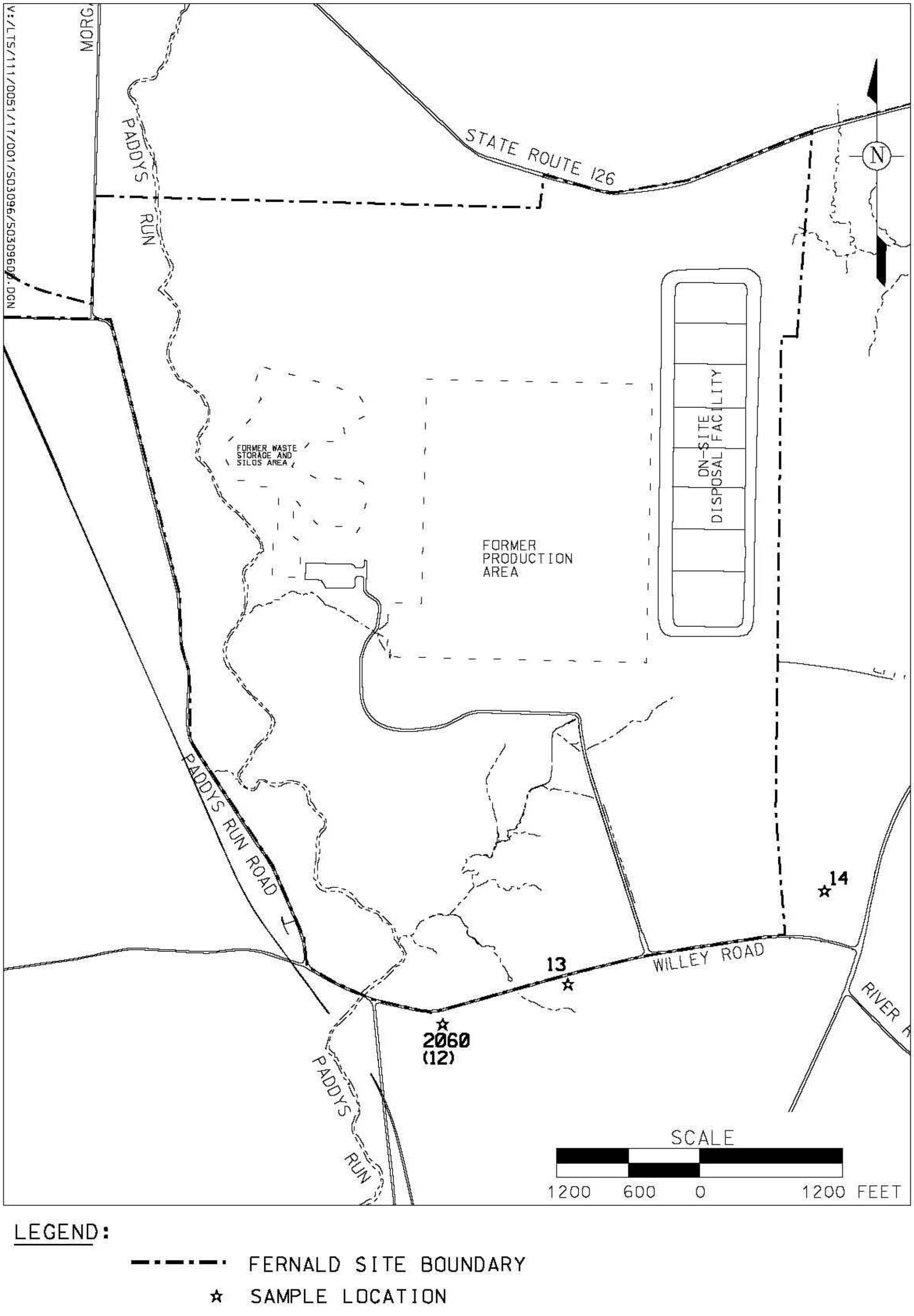

Figure 2–2. 2006 DOE and OEPA Groundwater Split Sample Locations

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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).

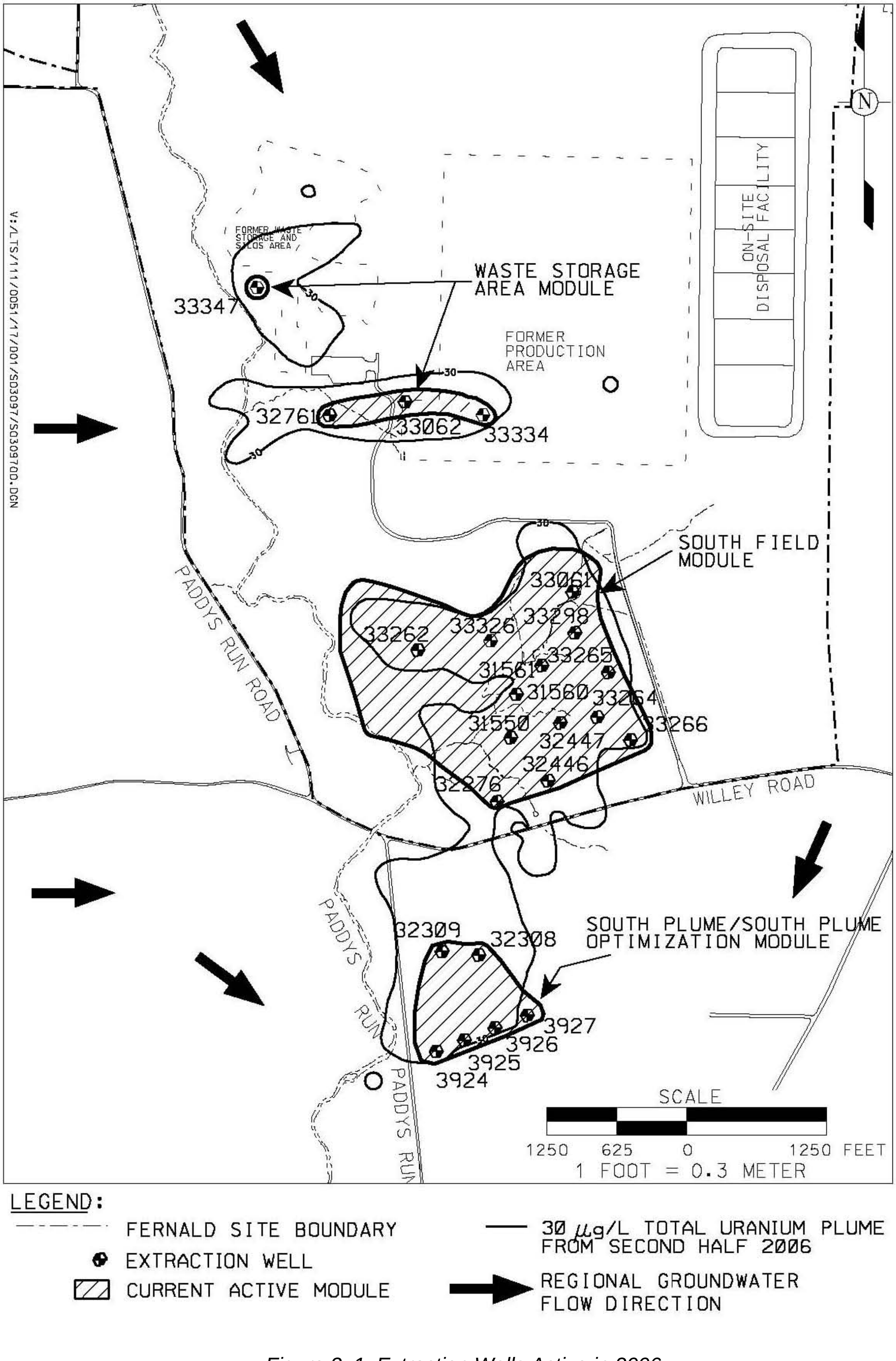

Figure 3–1. Extraction Wells Active in 2006

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.

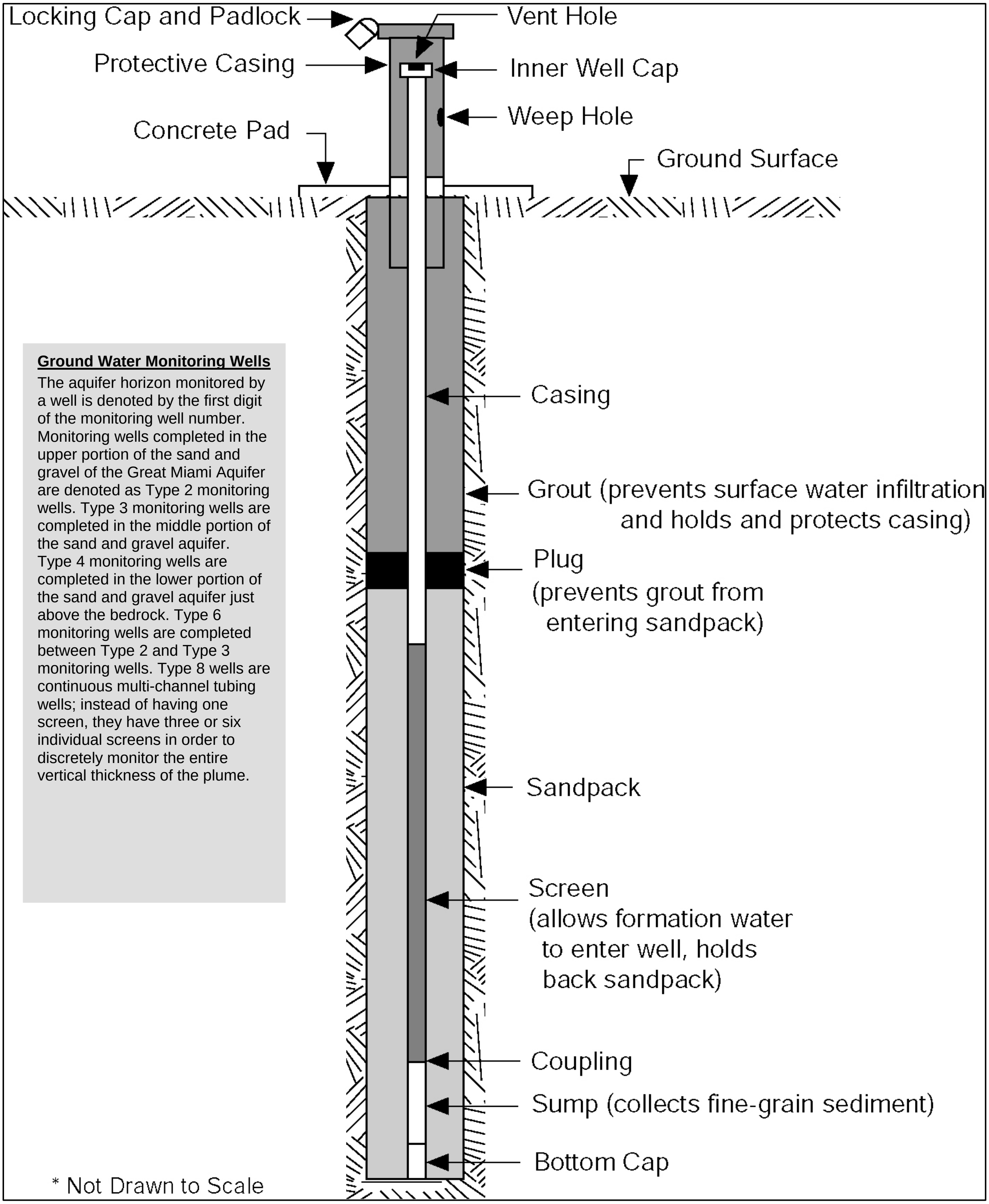

Figure 3–2. Diagram of a Typical Groundwater Monitoring Well

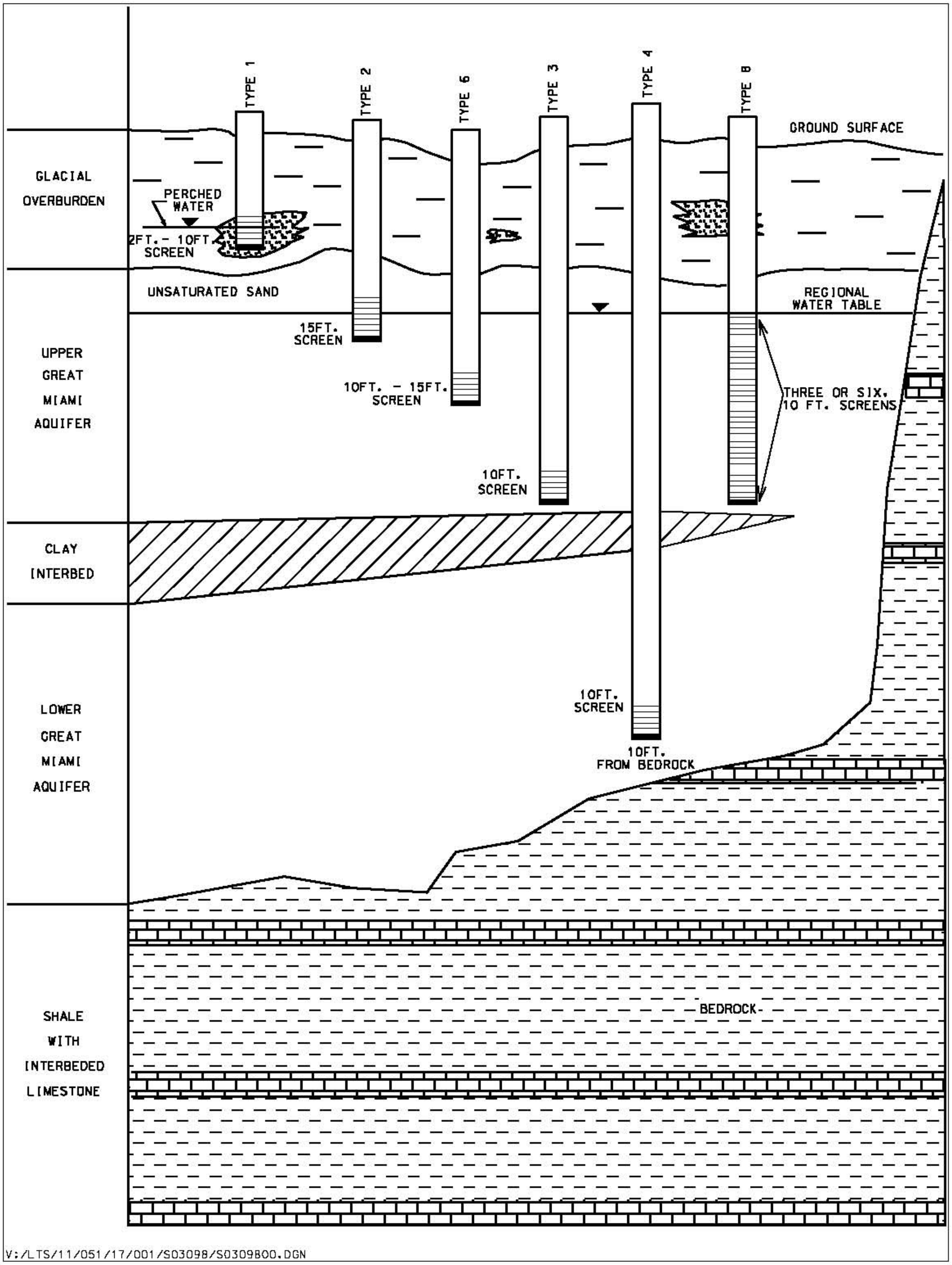

Figure 3–3. Monitoring Well Relative Depths and Screen Locations

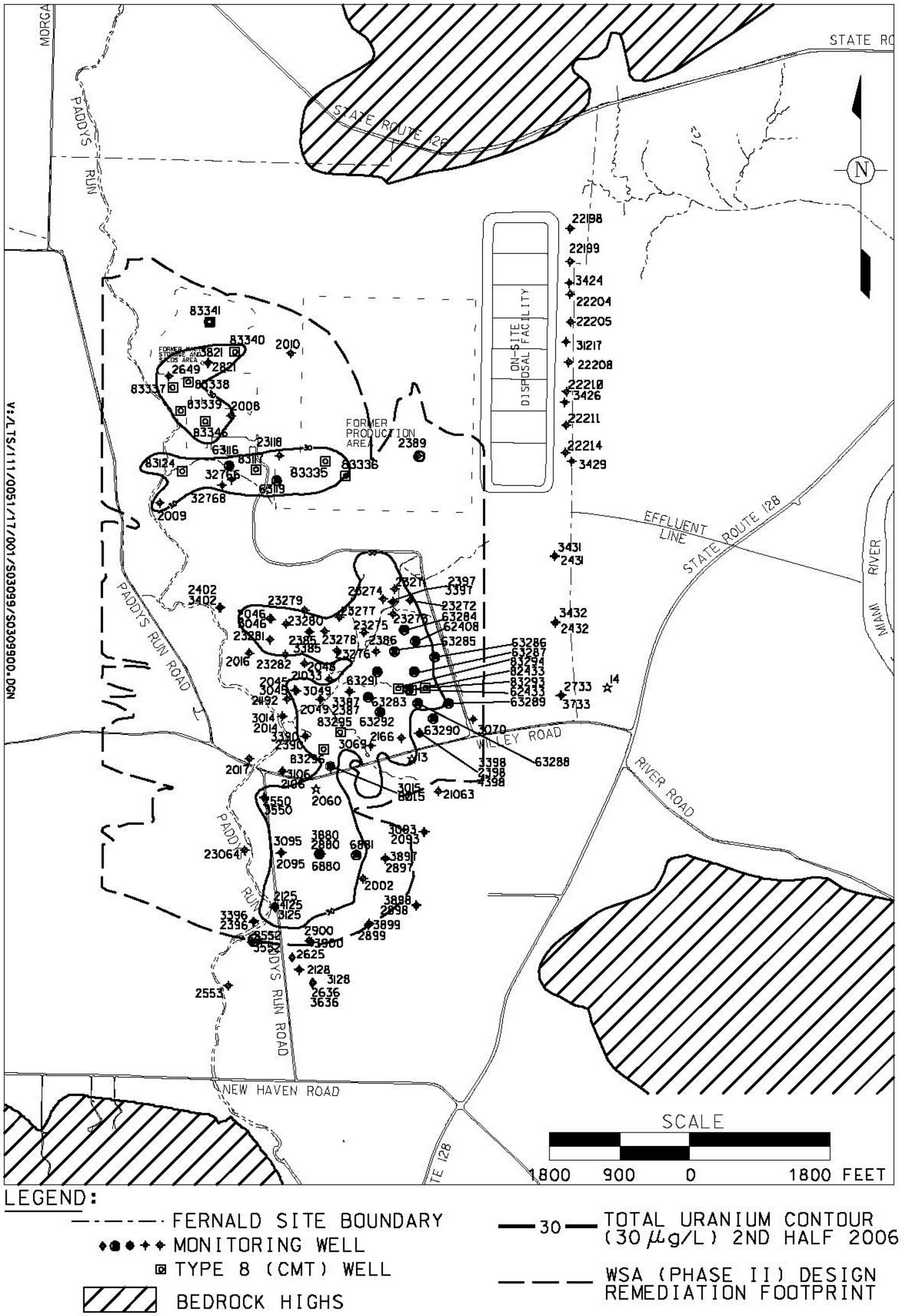

Figure 3–4. Locations for Semiannual Total Uranium Monitoring

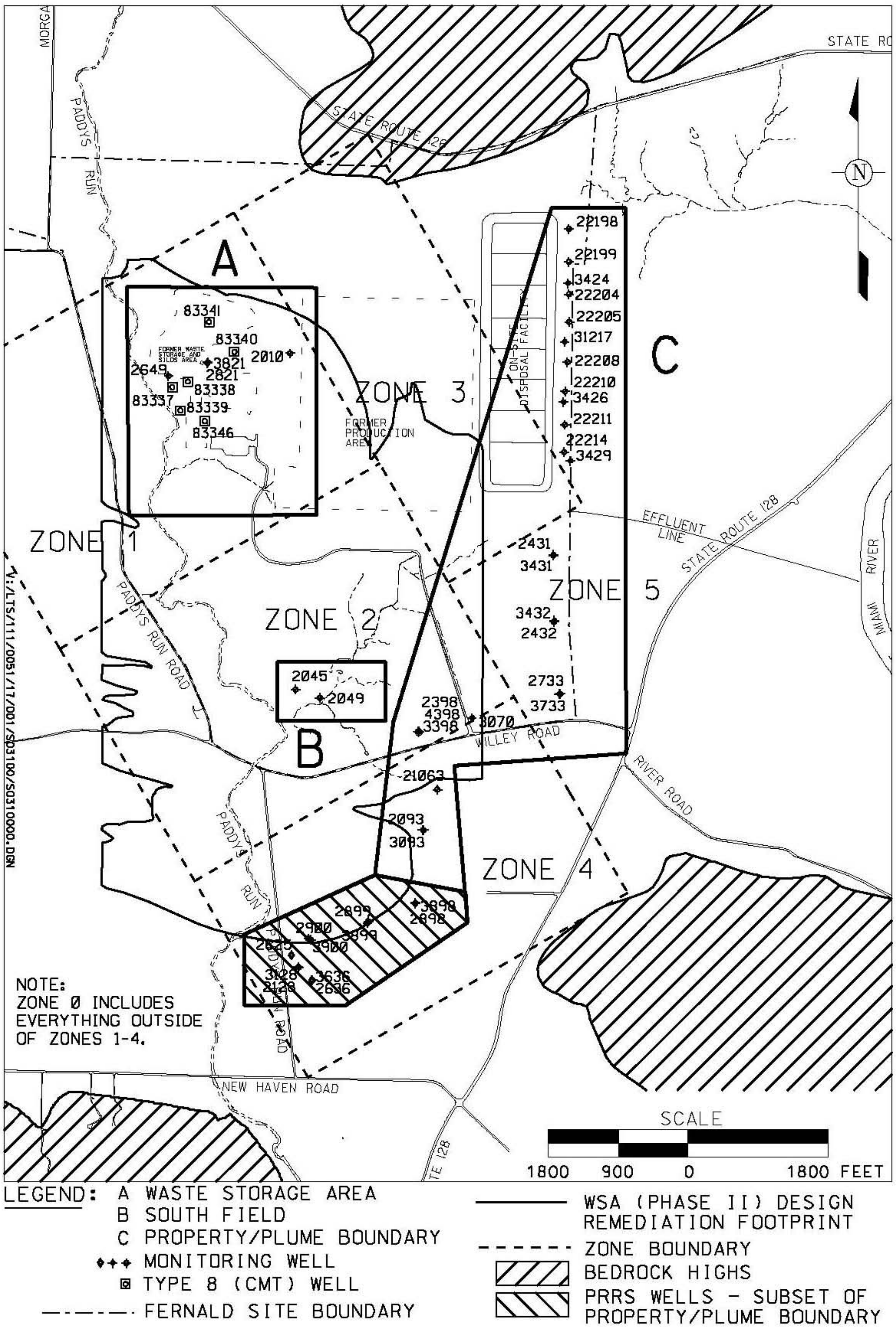

Figure 3–5. Locations for Semiannual Non-Uranium Monitoring

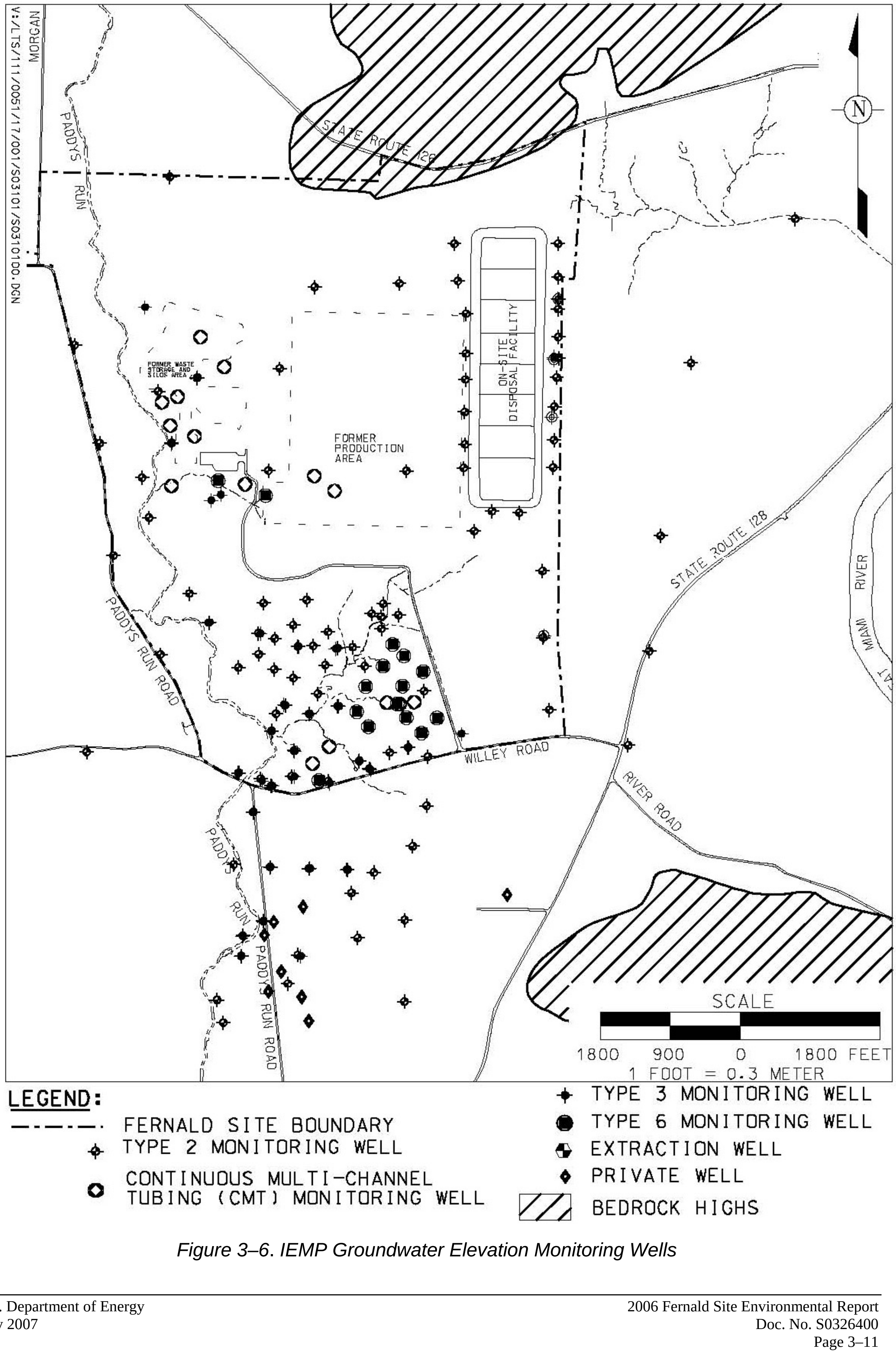

Figure 3–6. IEMP Groundwater Elevation Monitoring Wells

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.

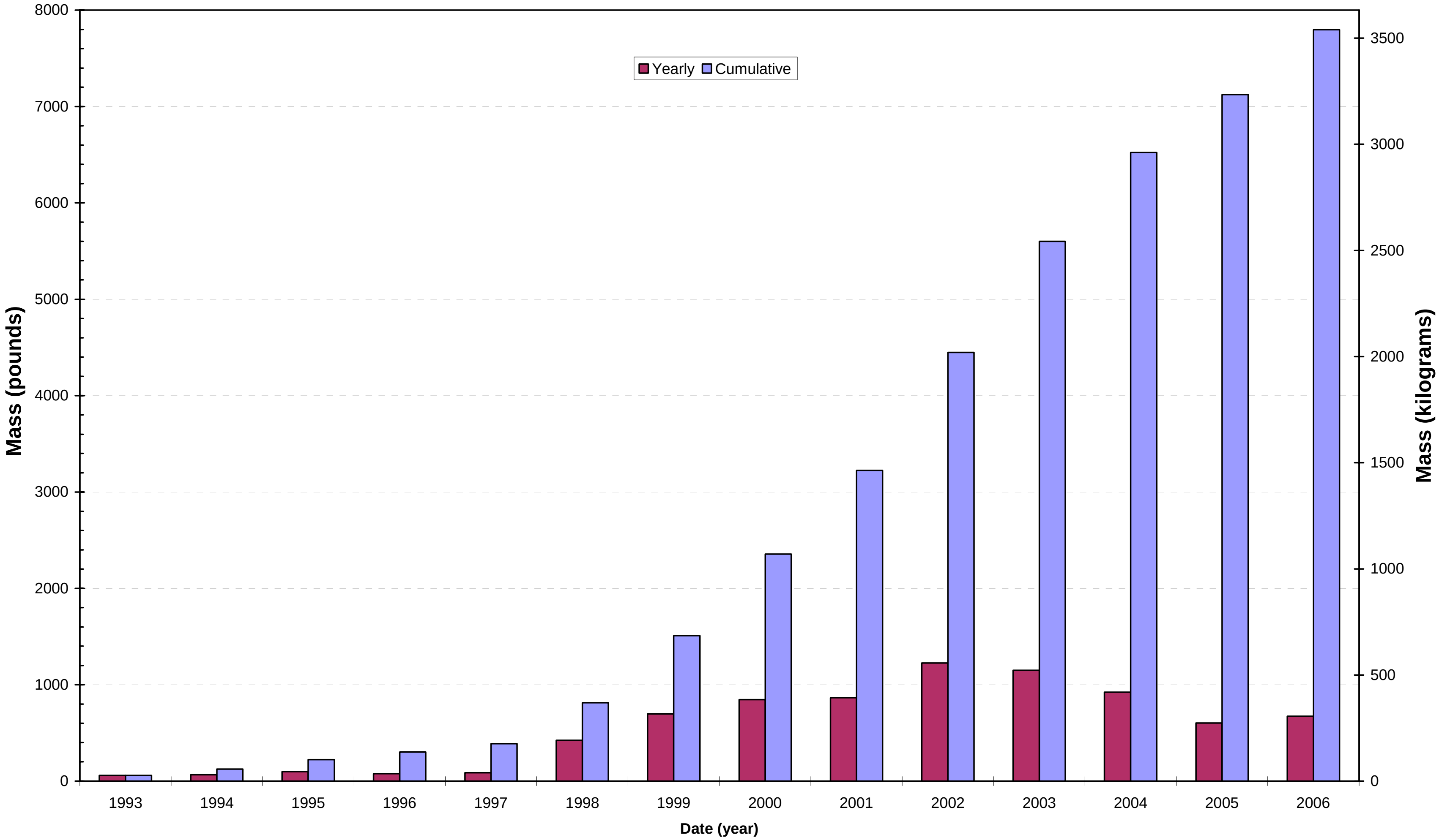

Figure 3–7. Net Pounds of Uranium Removed from the Great Miami Aquifer, 1993–2006

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.

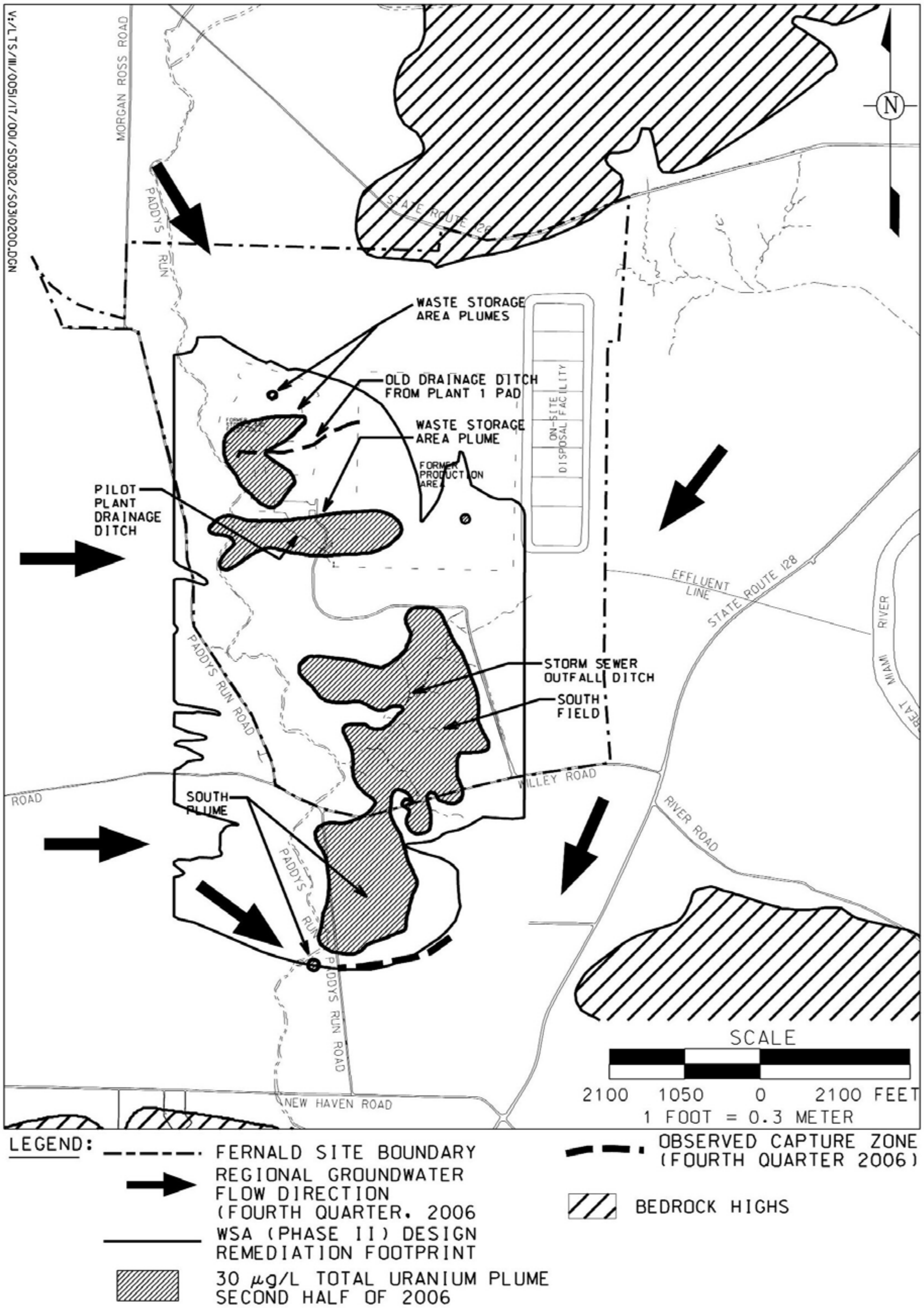

Figure 3–8. Total Uranium Plume in the Aquifer With Concentrations Greater than 30 µg/L at the End of 2006

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.

3.3.1.5 Monitoring Results for Total Uranium

> **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.

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.

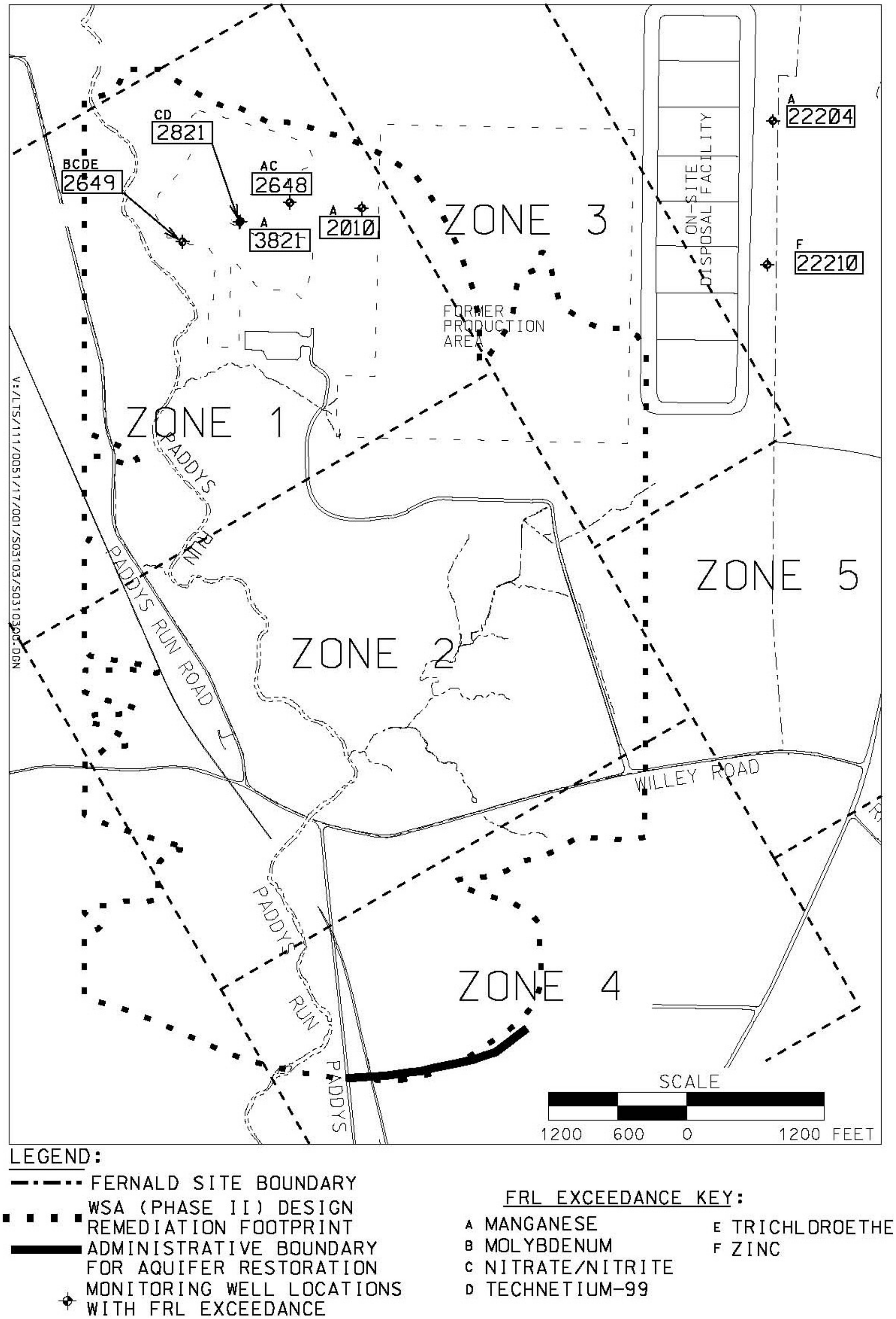

Figure 3–9. Non-Uranium Constituents With 2006 Results Above Final Remediation Levels

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

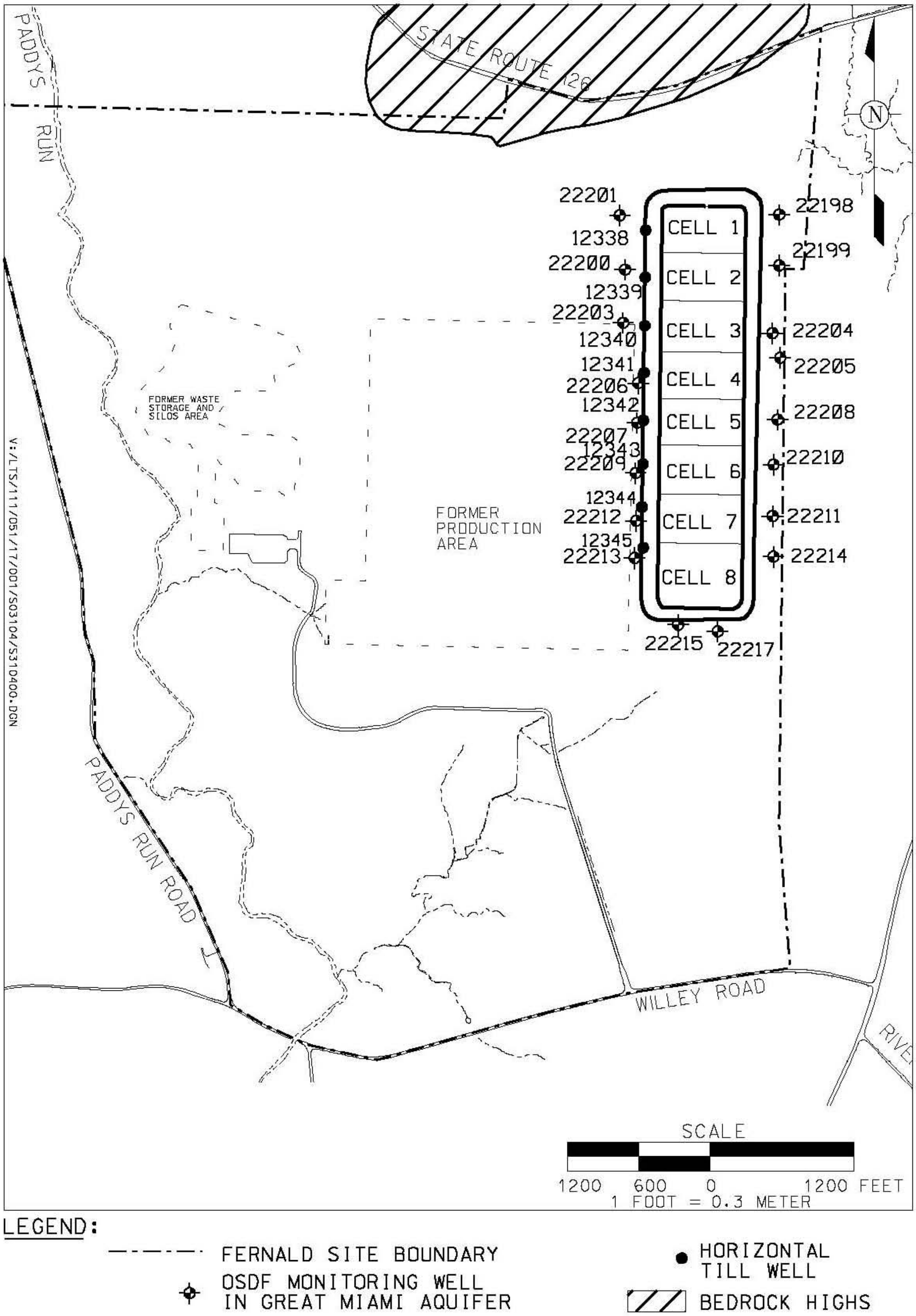

Figure 3–10. On-Site Disposal Facility Footprint and Monitoring Well Locations

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.

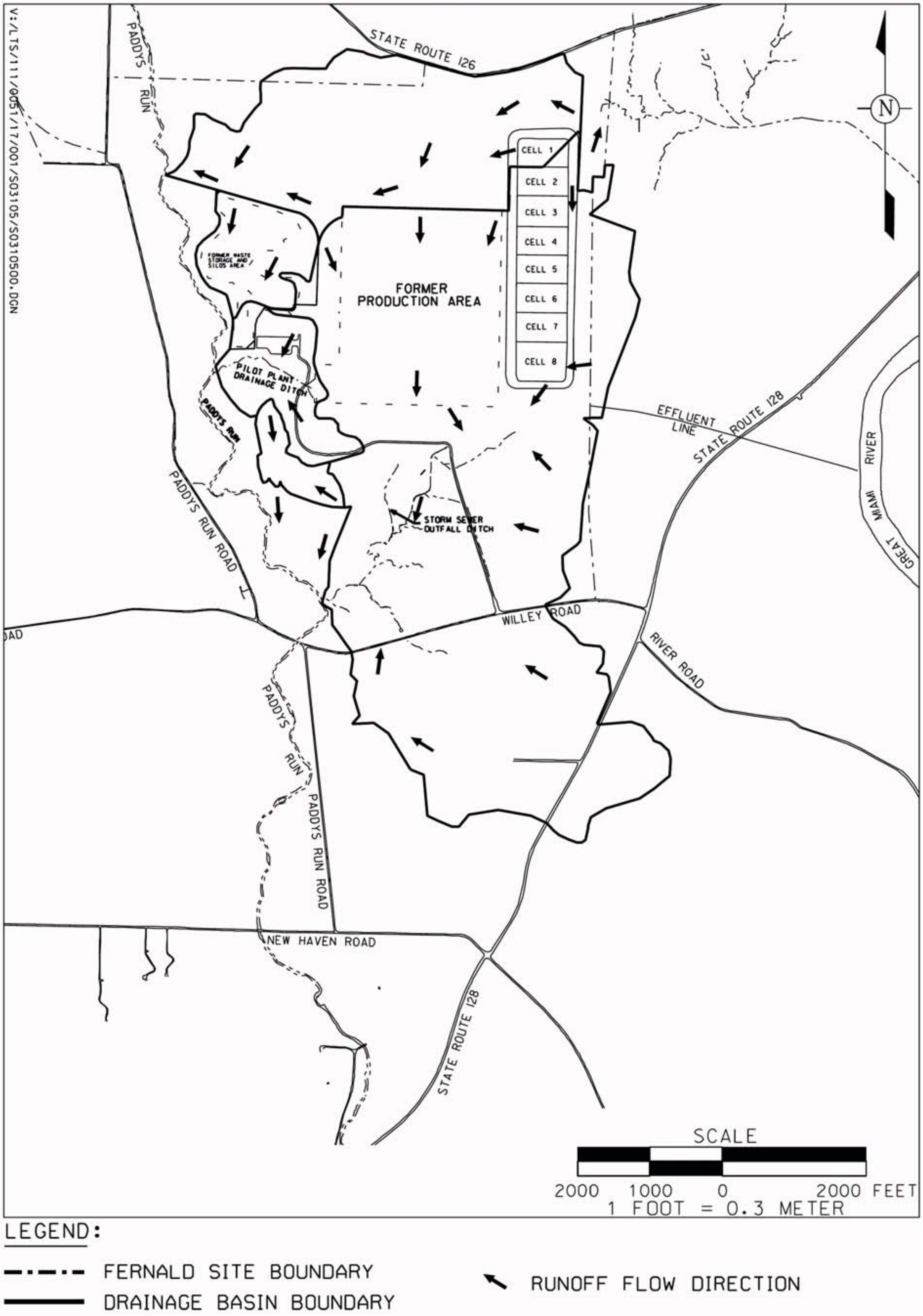

Figure 4–1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

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.

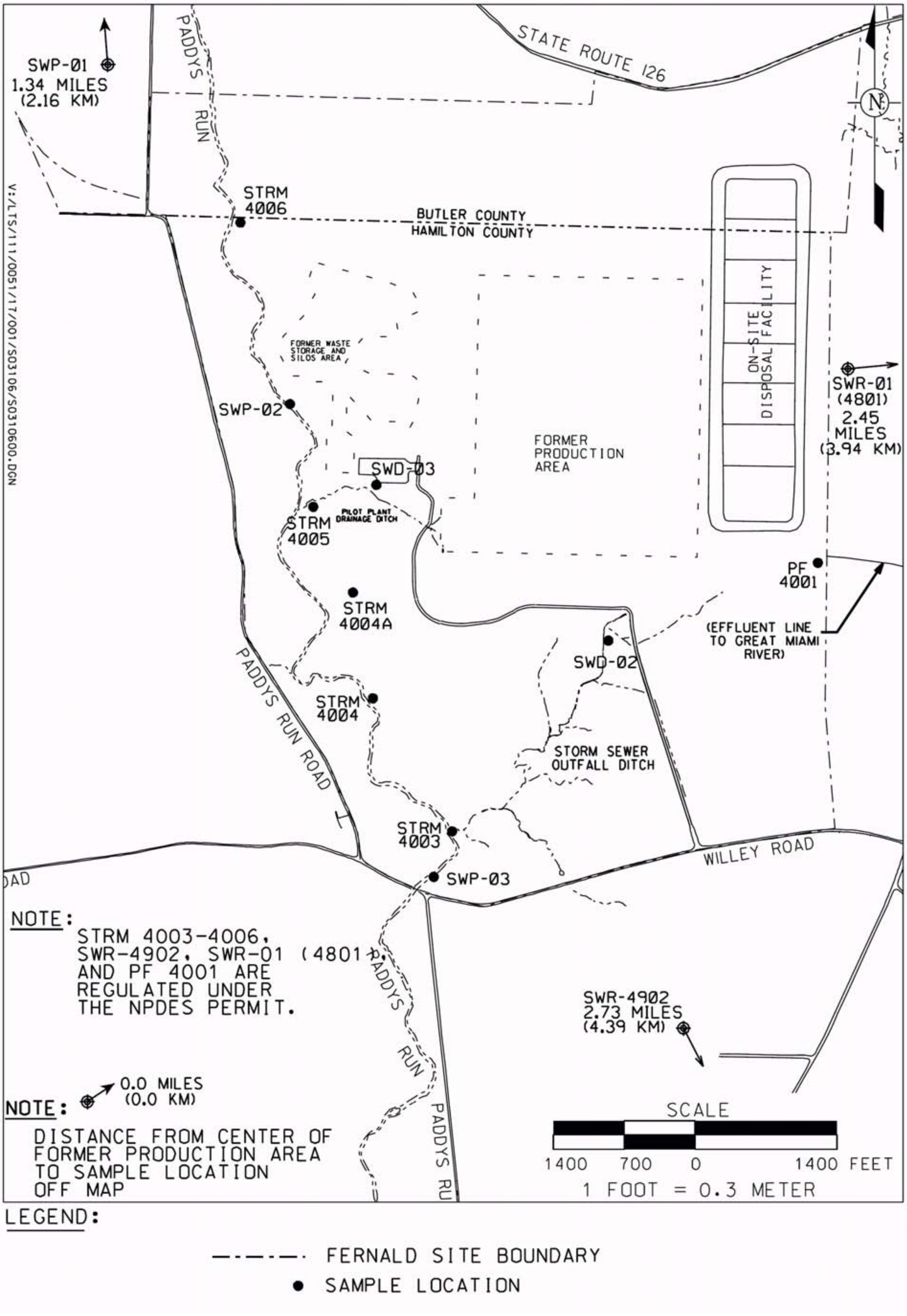

Figure 4–2. IEMP/NPDES Surface Water and Treated Effluent Sample Locations

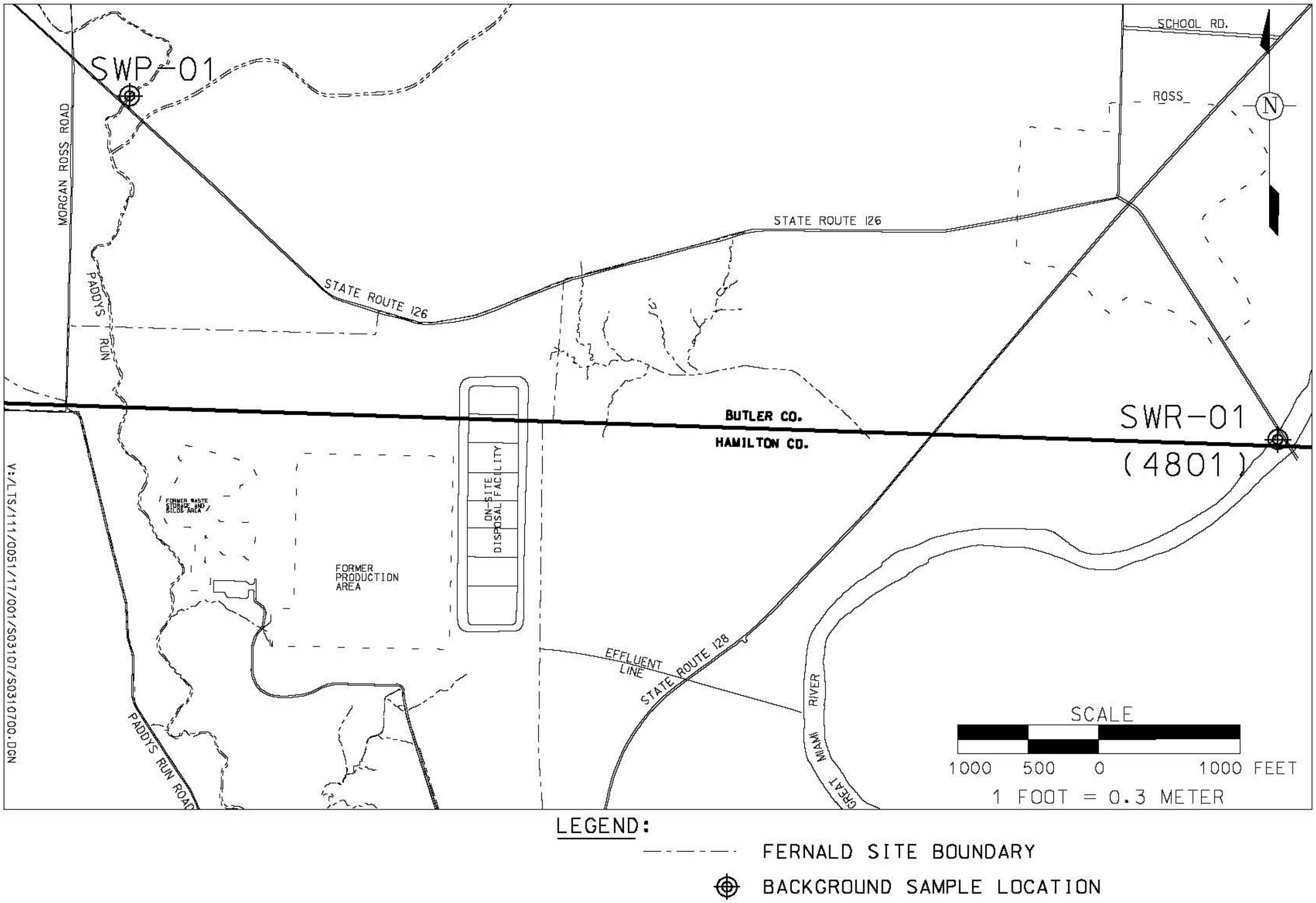

Figure 4–3. IEMP Background Surface Water Sample Locations

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.

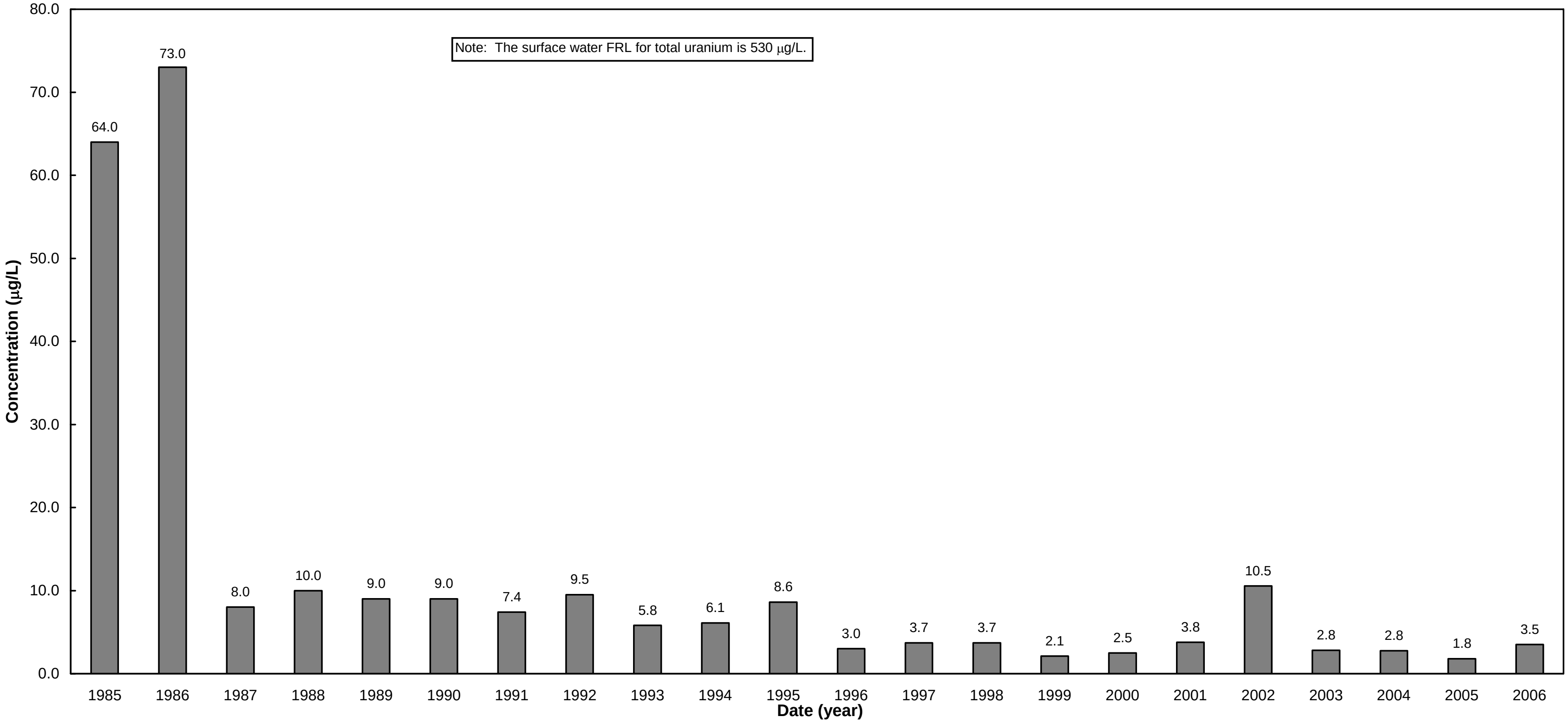

Figure 4–4. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985−2006

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.

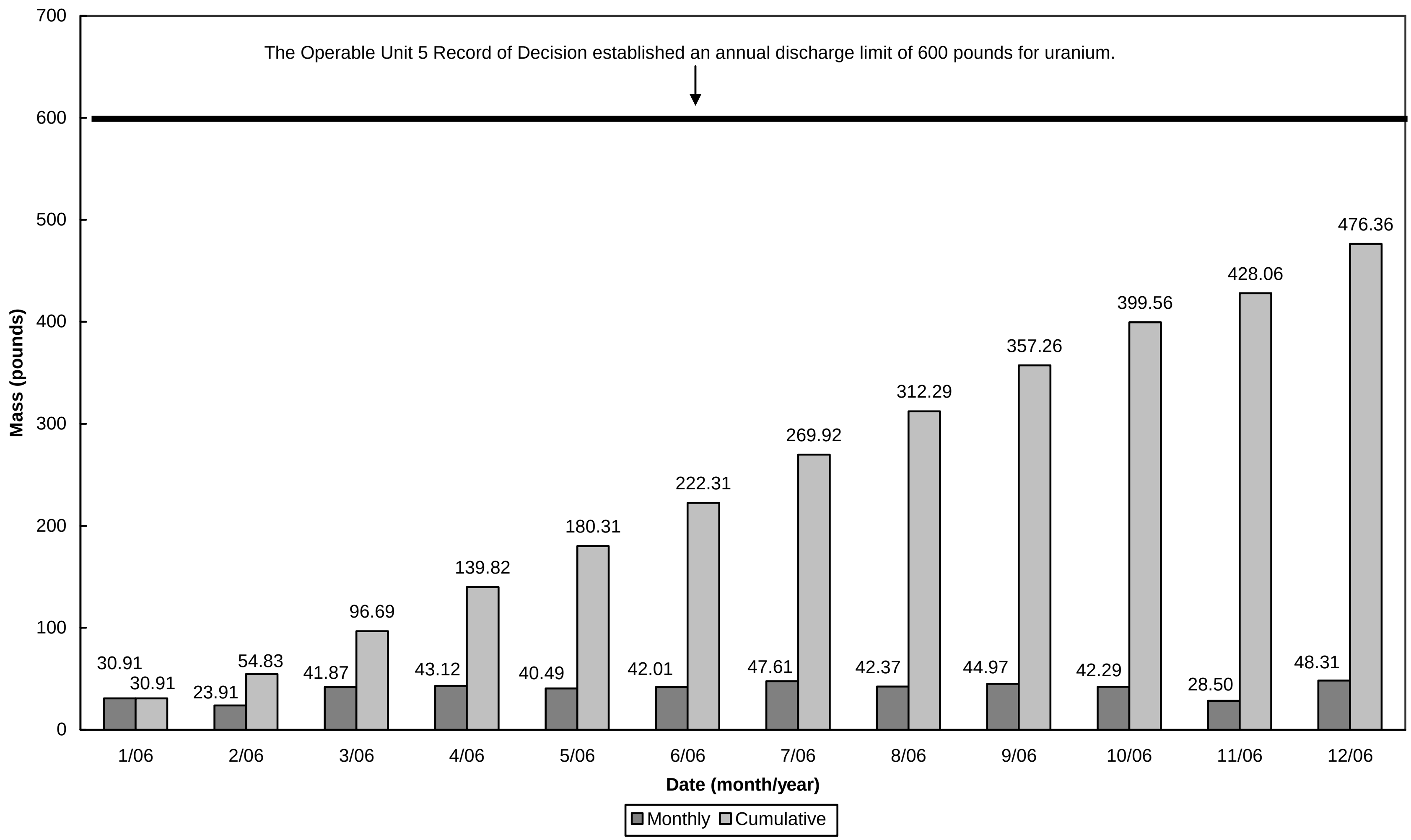

Figure 4–5. Pounds of Uranium Discharged to the Great Miami River Through the Parshall Flume (PF 4001) in 2006

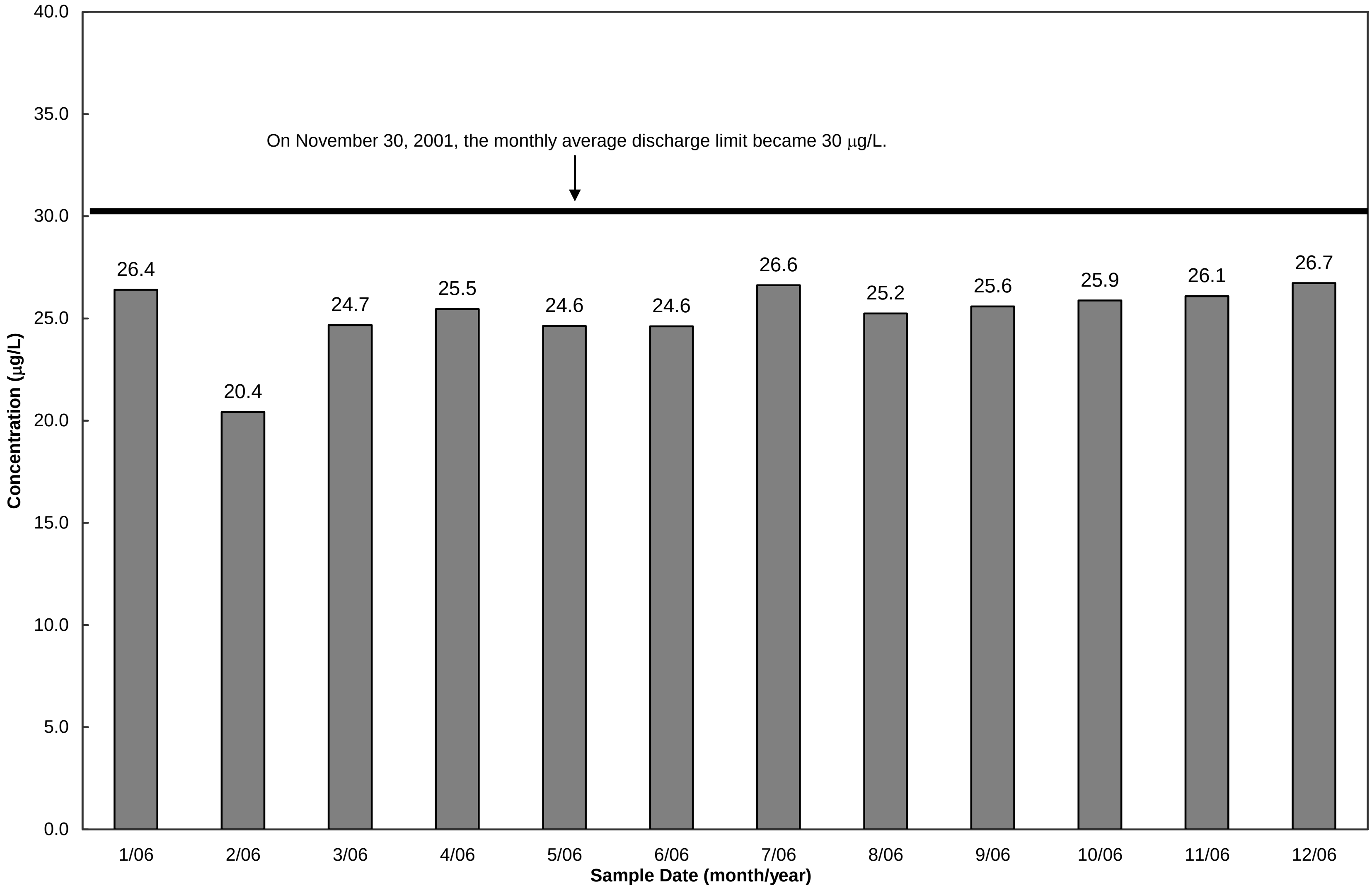

Figure 4–6. 2006 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River

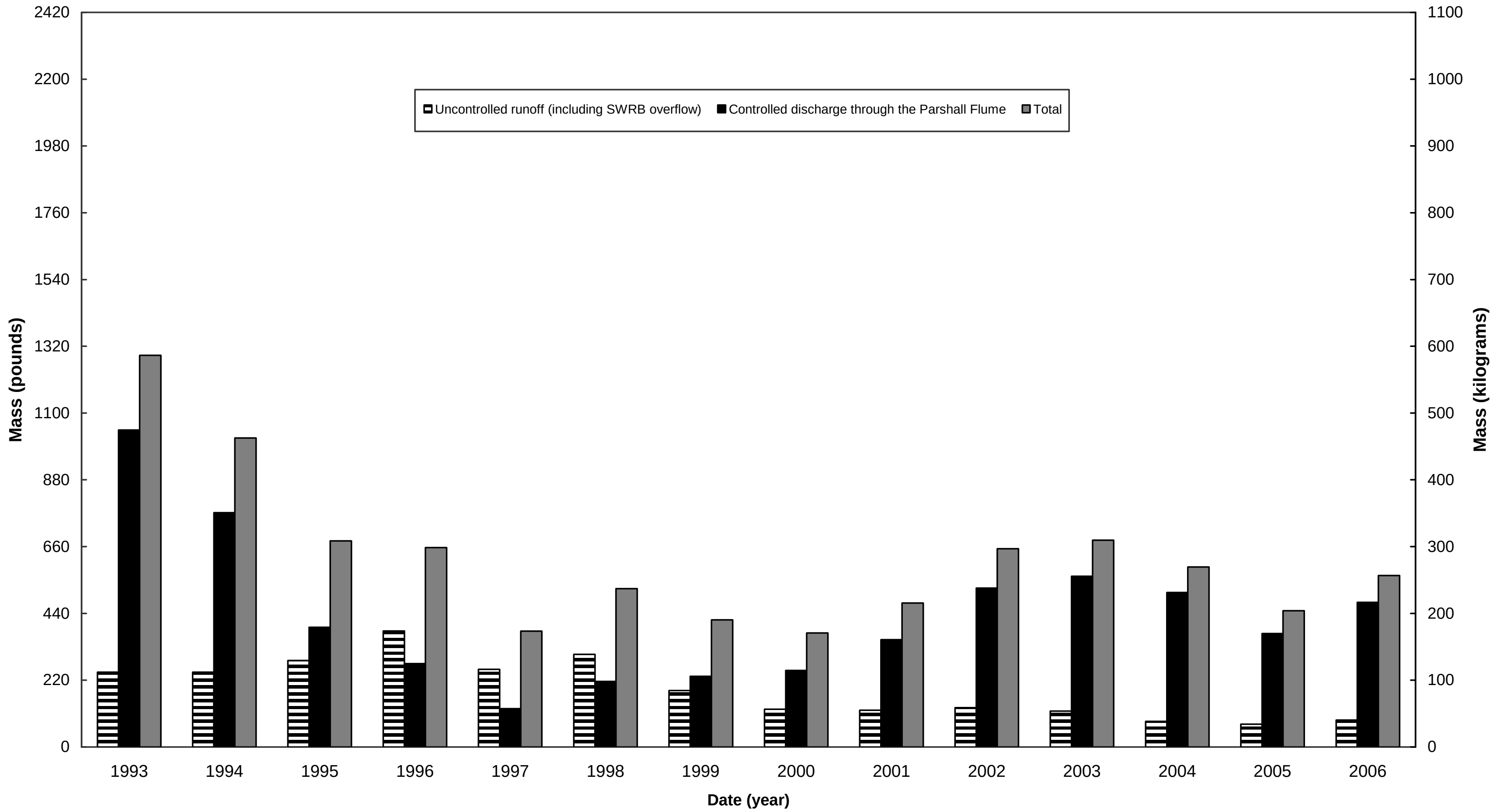

Figure 4–7. Uranium Discharged Via the Surface Water Pathway, 1993−2006

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

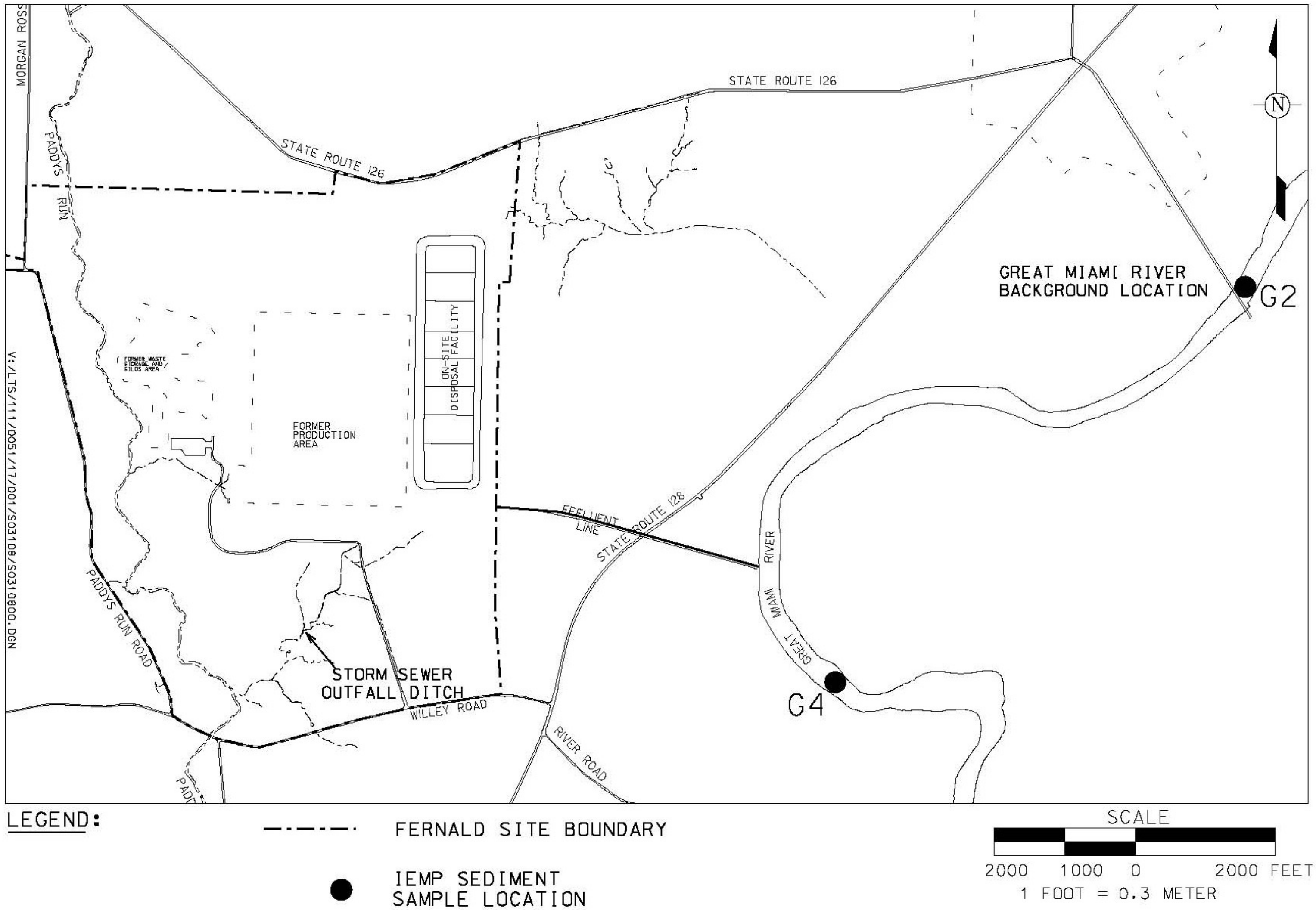

Figure 4–8. 2006 Sediment Sample Locations

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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.

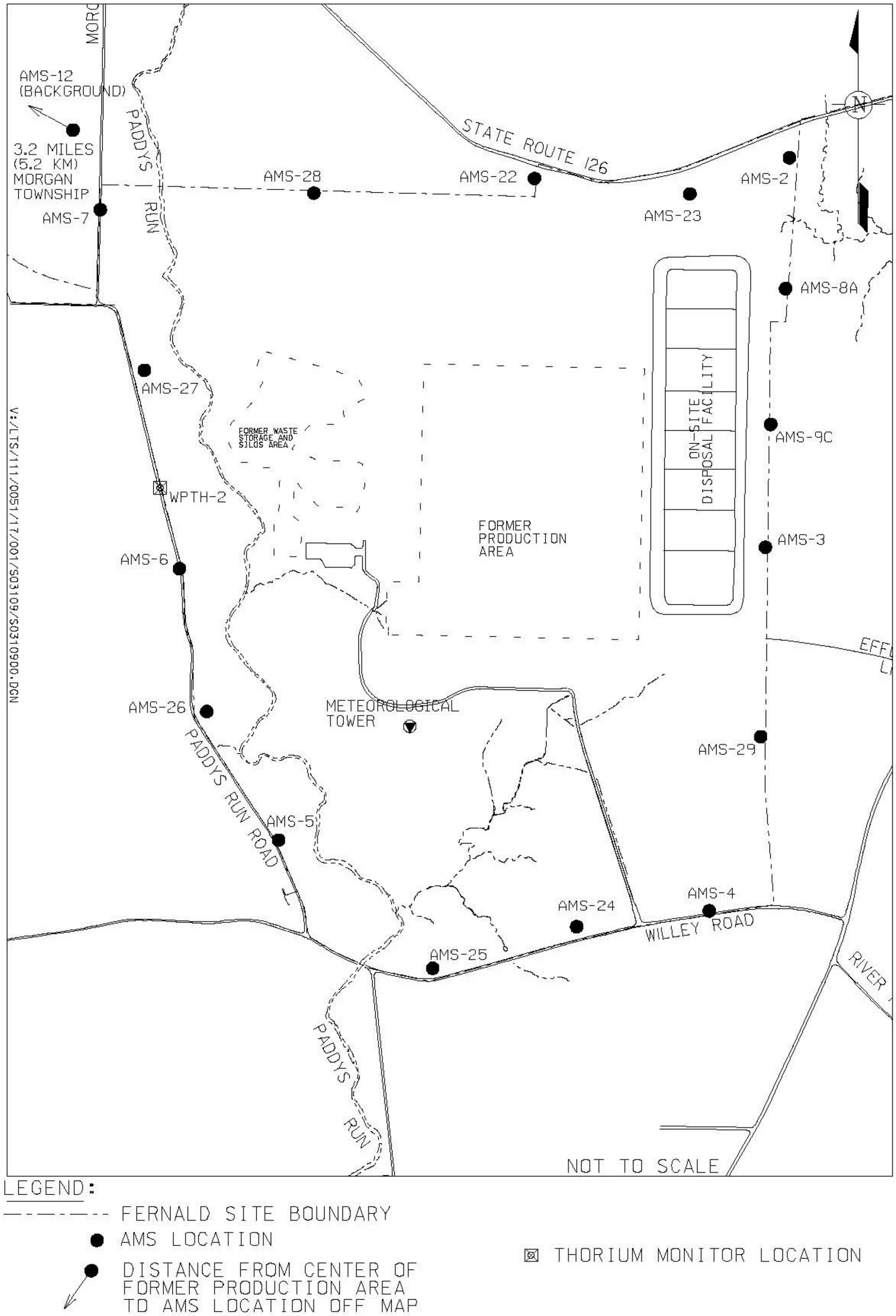


Figure 5–1. Radiological Air Monitoring Locations

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.

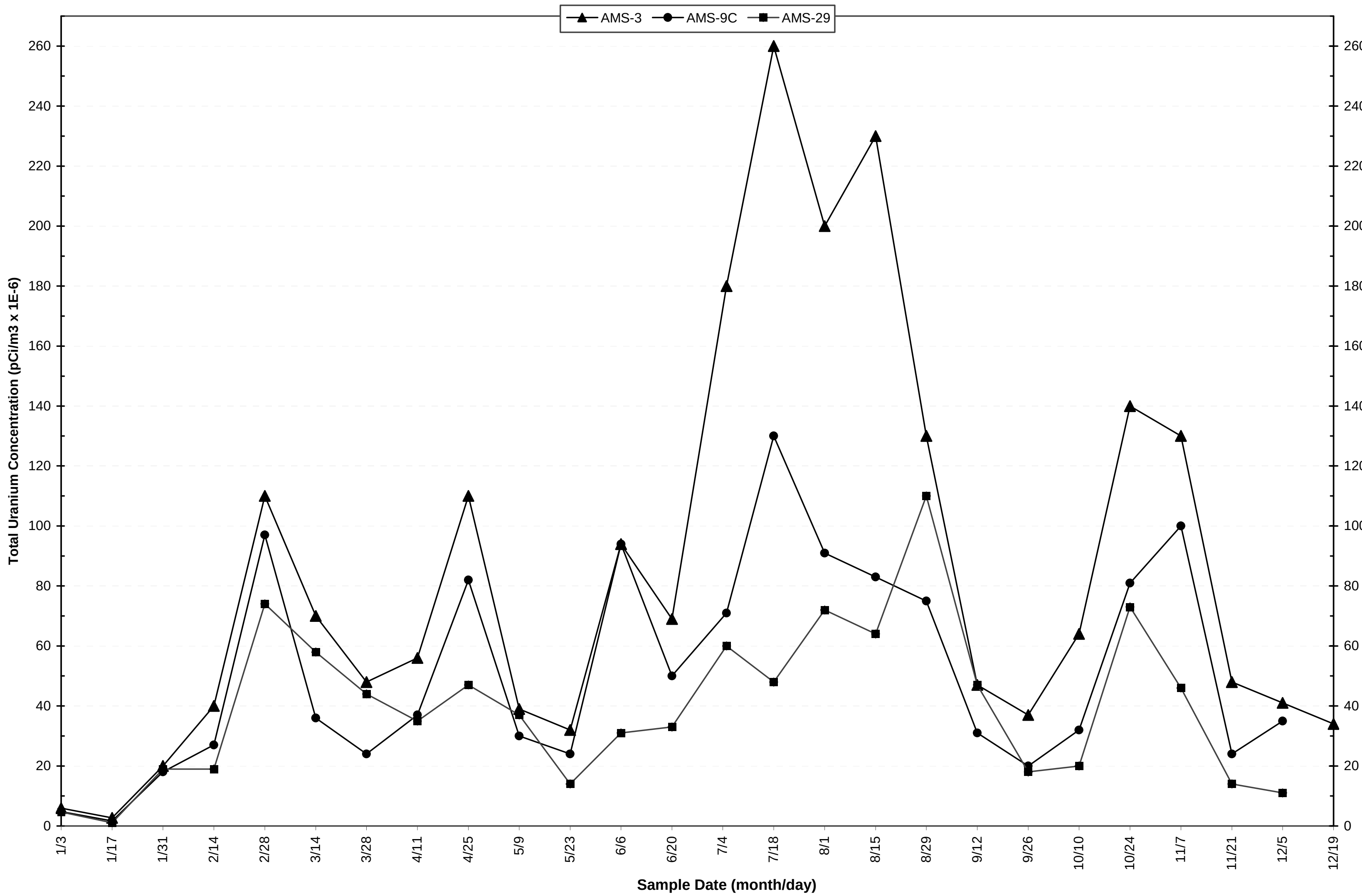


Figure 5–2. 2006 Total Uranium Concentrations in Air at Selected East Boundary Monitors (AMS-3, AMS-9C, and AMS-29)

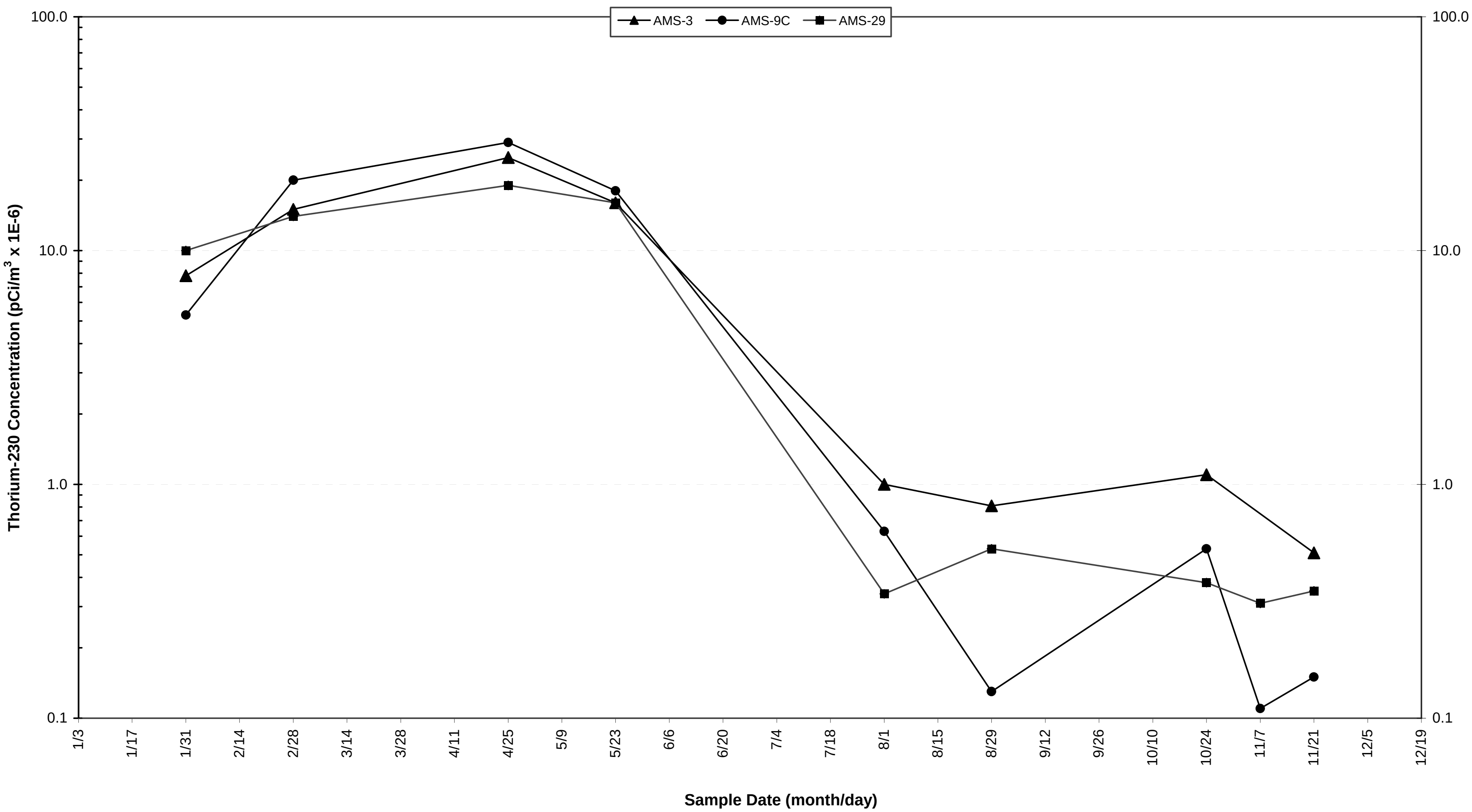


Figure 5–3. 2006 Thorium-230 Concentrations in Air at Selected East Boundary Monitors (AMS-3, AMS-9C, and AMS-29)

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).

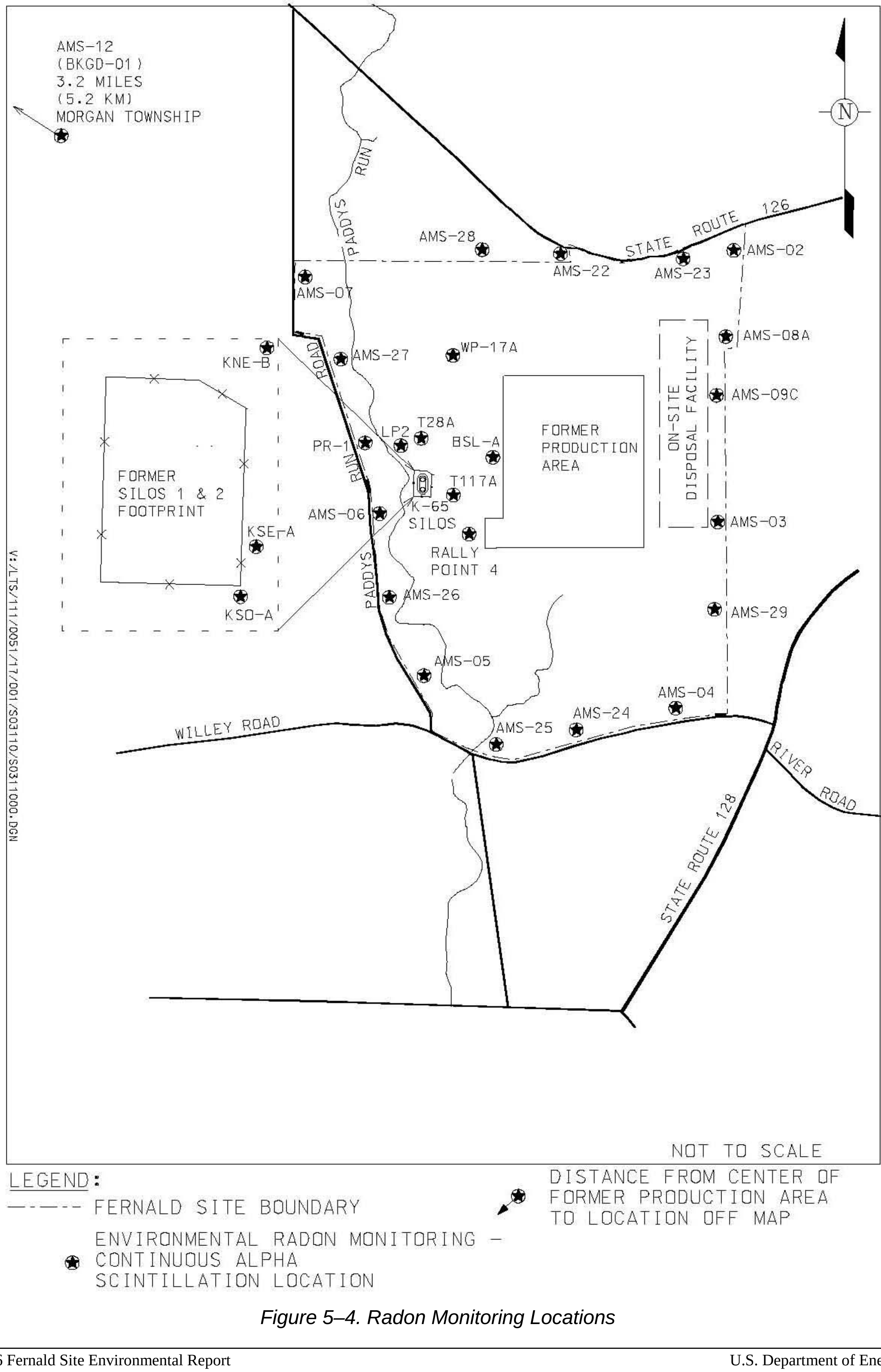


Figure 5–4. Radon Monitoring Locations

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

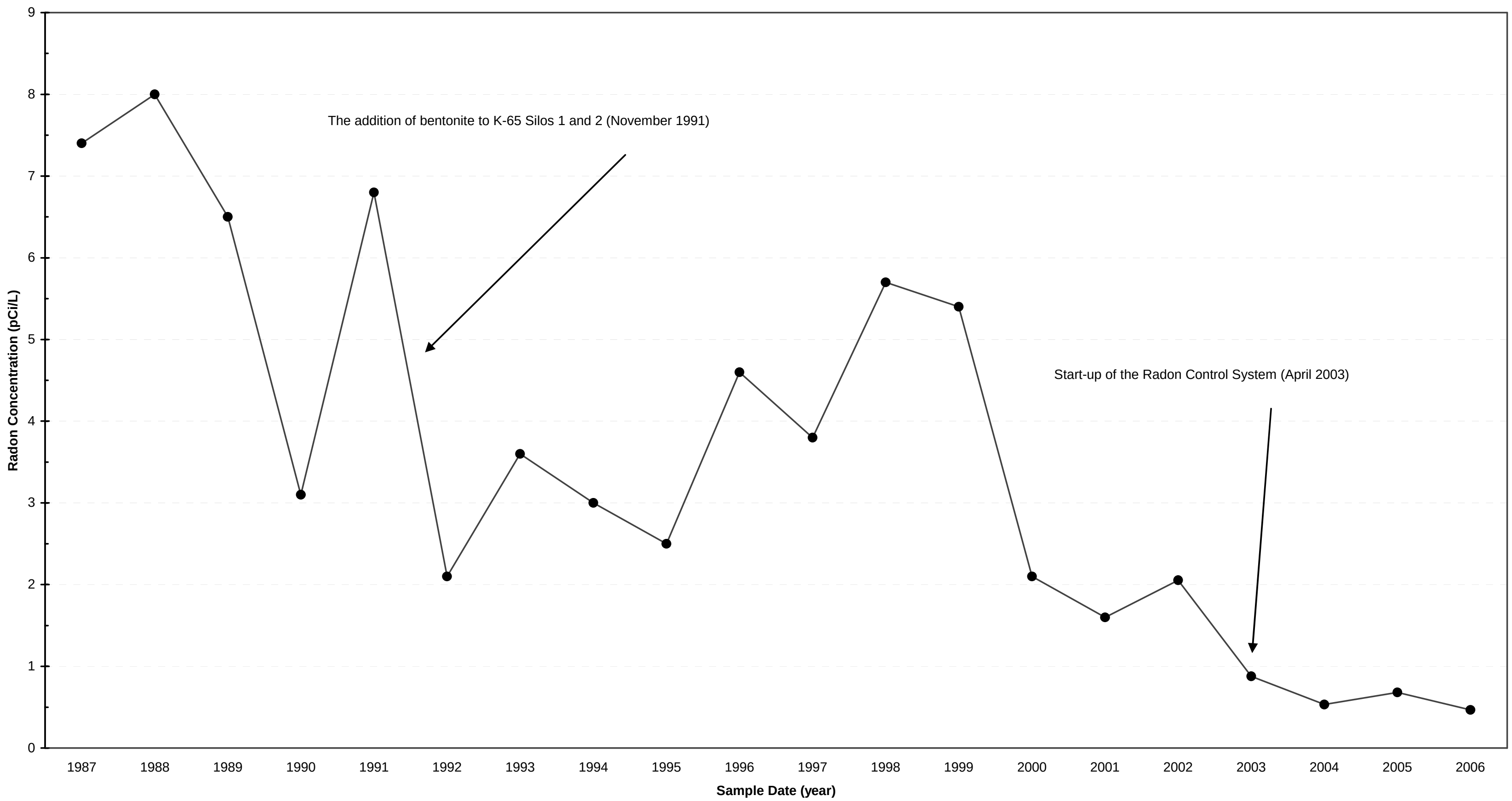
Direct radiation (e.g., x-rays, gamma rays, energetic beta particles, and neutrons) originates from sources such as cosmic radiation, naturally occurring radionuclides in soil and food, and radioactive materials at the Fernald site. The largest source of direct radiation was the silos waste materials. 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

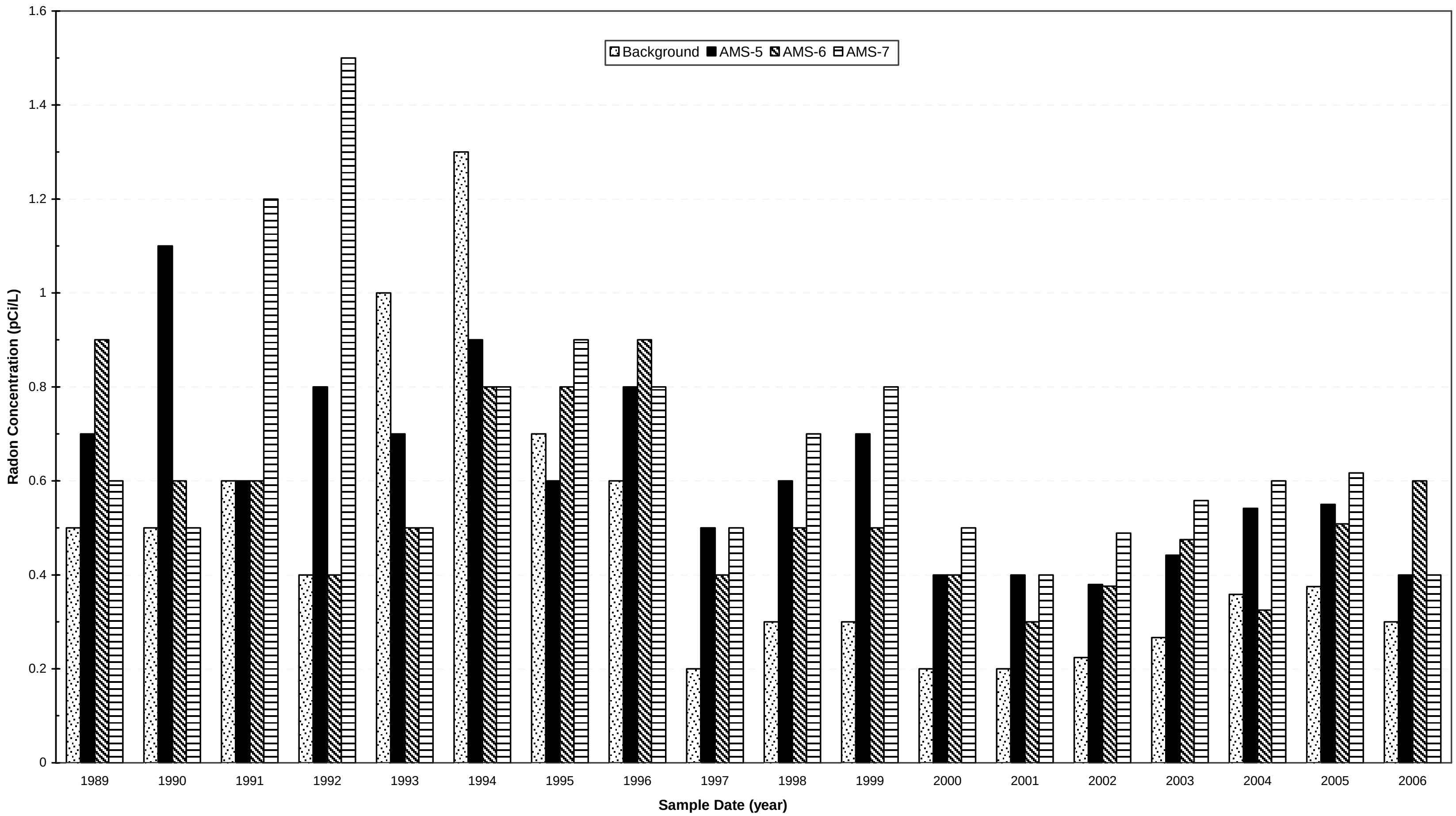
	Direct Radiation (mrem)	
TLD Location	**Summary of 2006 Results[ab]**	**Summary of 2005 Results**
Boundary		
Minimum	77	91
Maximum	84	110
On-Site		
Minimum	NA	85
Maximum	NA	781
Background		
Minimum	79	93
Maximum	79	104

[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



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

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.

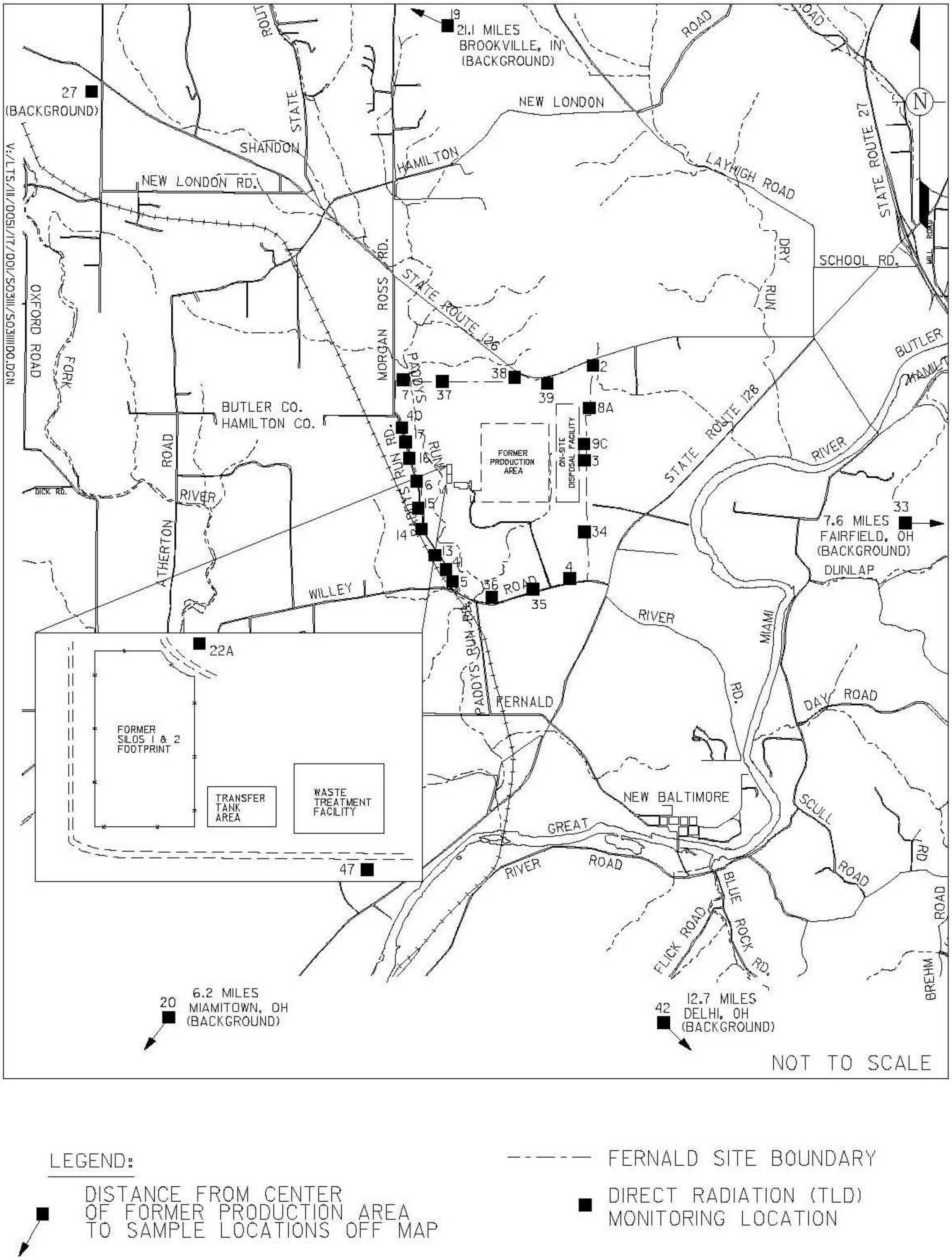


Figure 5–7. Direct Radiation (TLD) Monitoring Locations

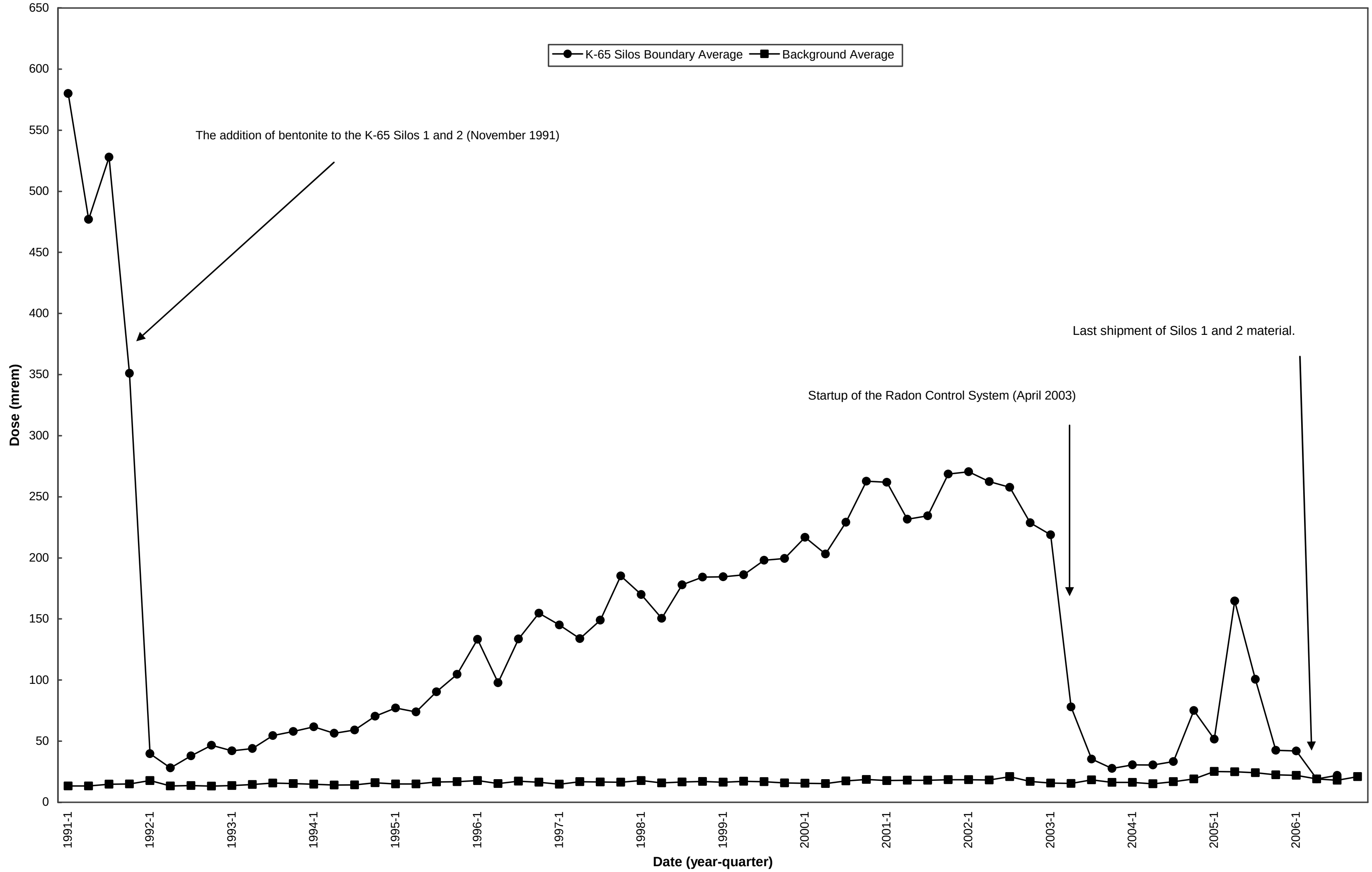


Figure 5–8. Direct Radiation (TLD) Measurements at Silos Boundary, 1991–2006 (Silos Boundary Average Versus Background Average)

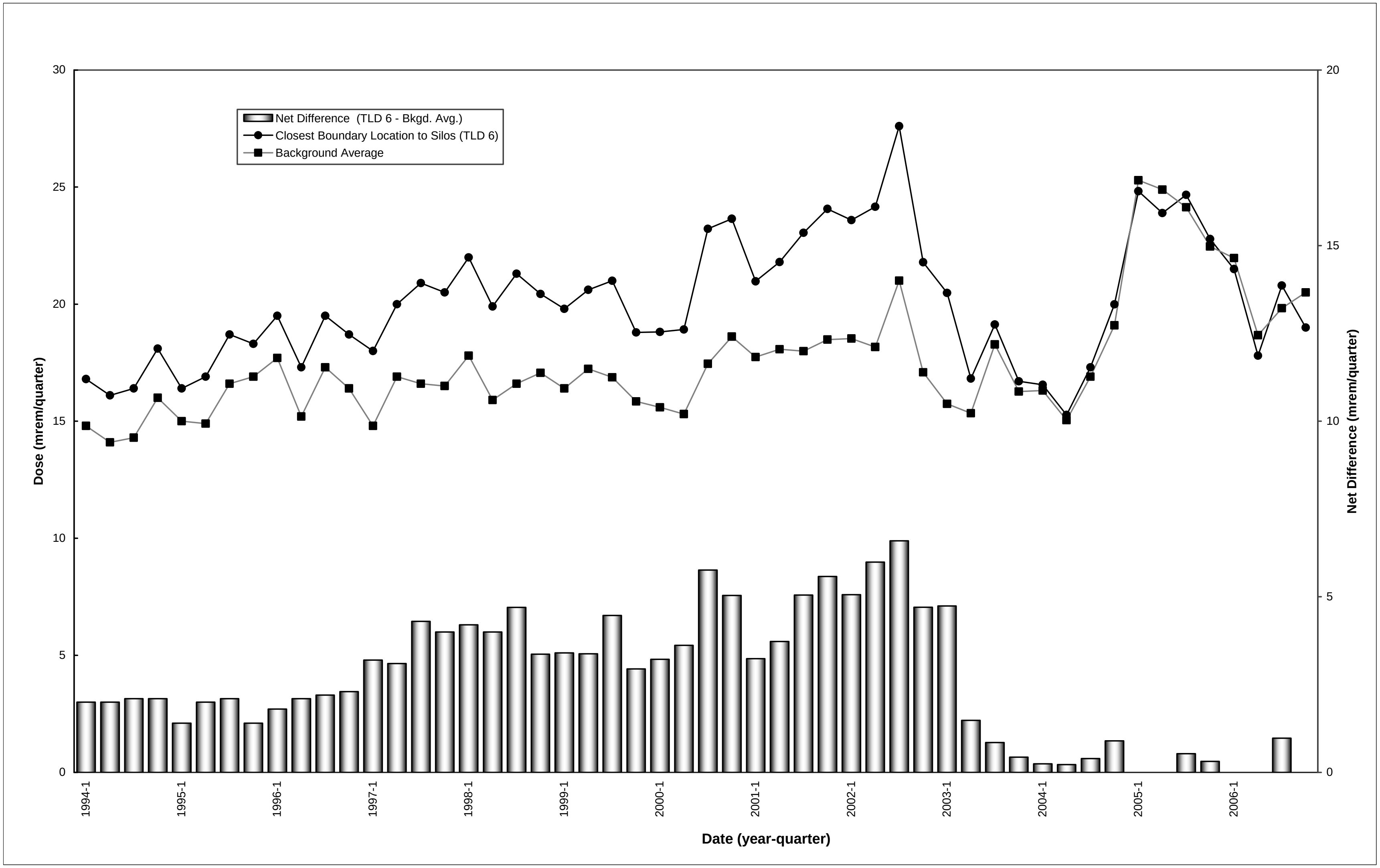


Figure 5–9. Quarterly Direct Radiation (TLD) Measurements, 1994–2006 (Location 6 Versus Background Average)

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.

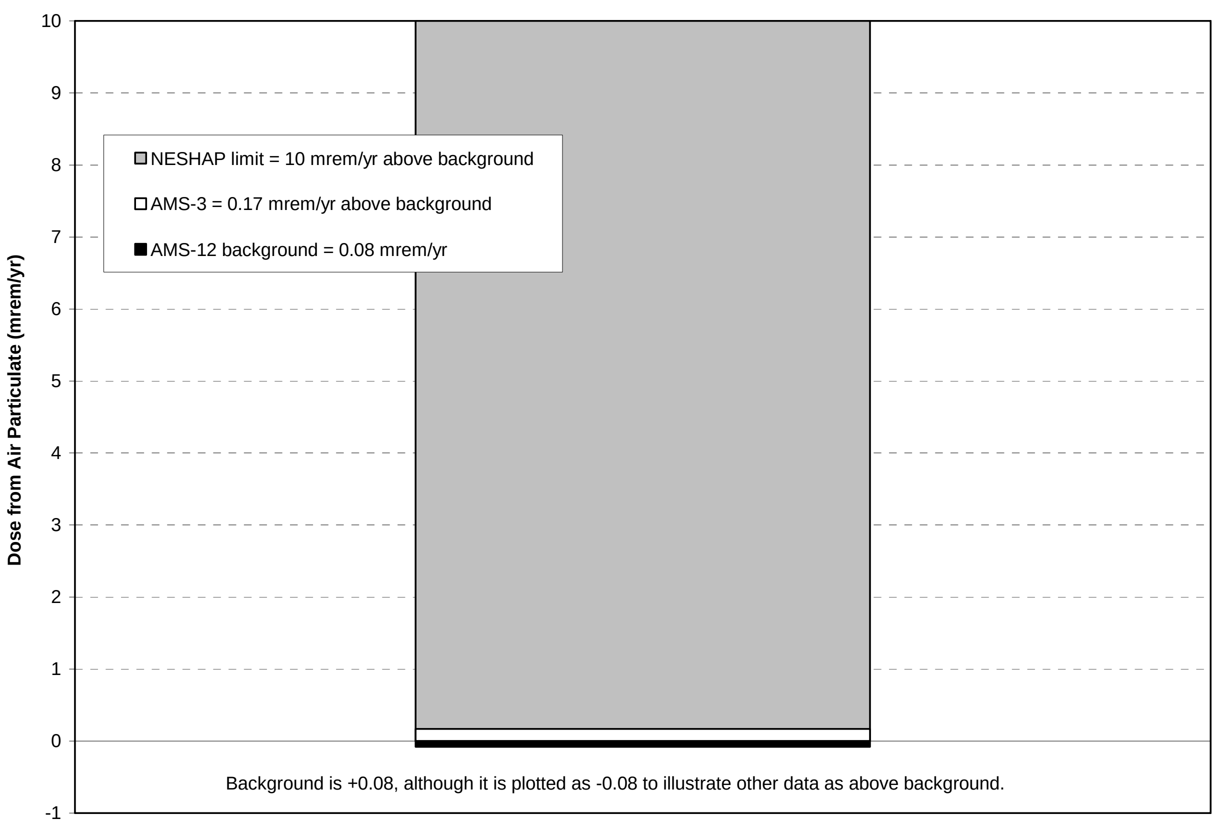


Figure 6–1. Comparison of 2006 Air-Pathway Doses and Allowable Limits

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]).

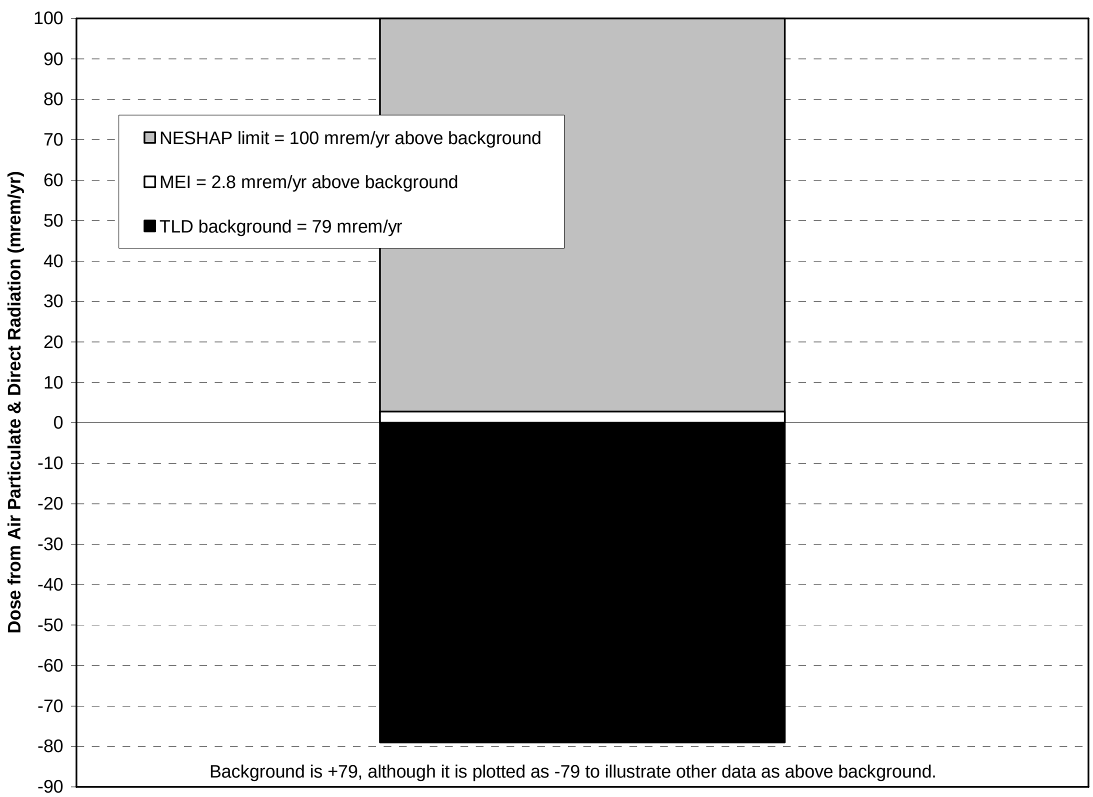


Figure 6–2. Comparison of 2006 All-Pathway Doses and Allowable Limits

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		ICRP Report 65 Effective Dose Equivalent
			(mrem)[b,c]	(mrem)[b,d]	(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.

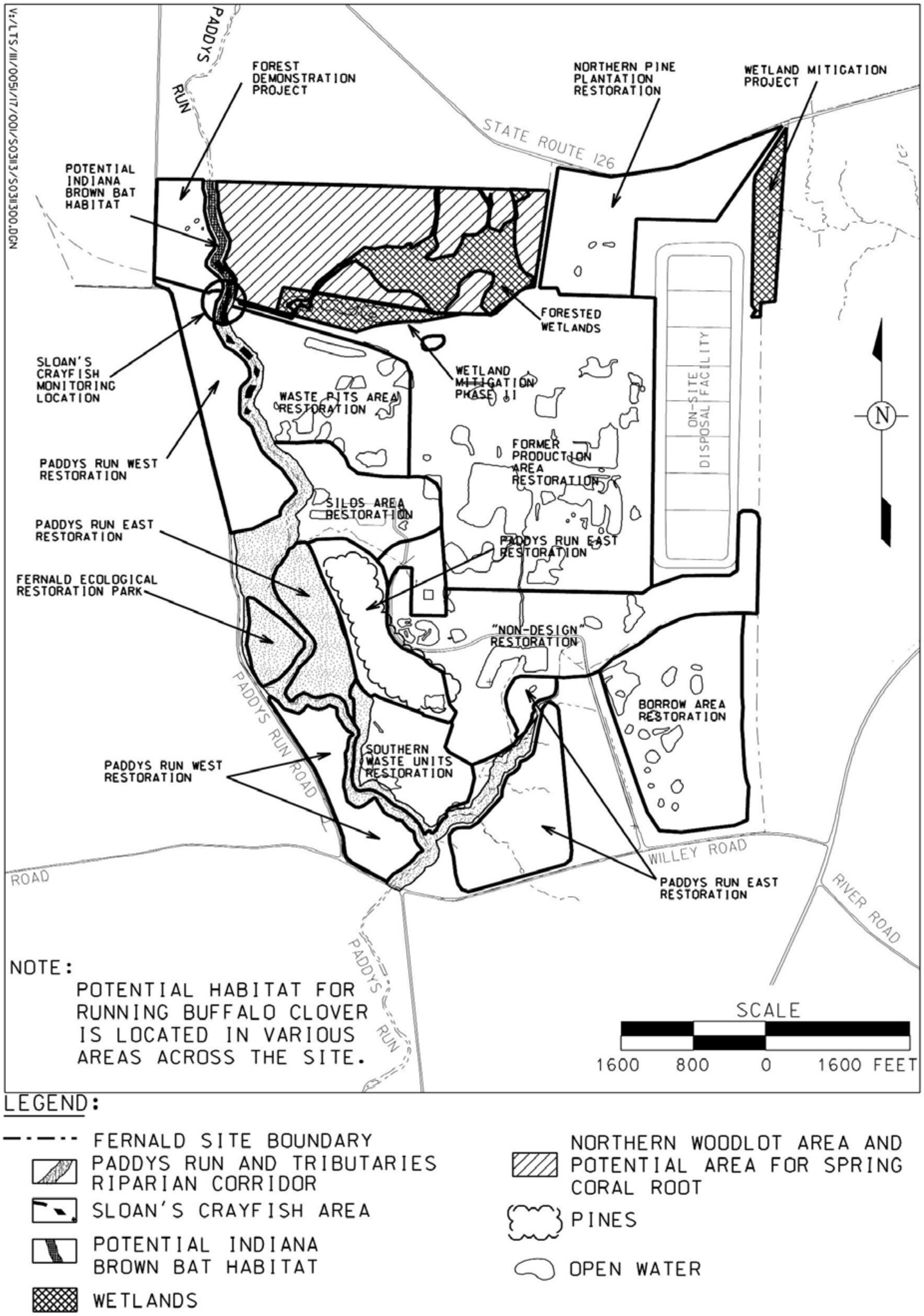


Figure 7–1. Priority Natural Resource Areas

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.

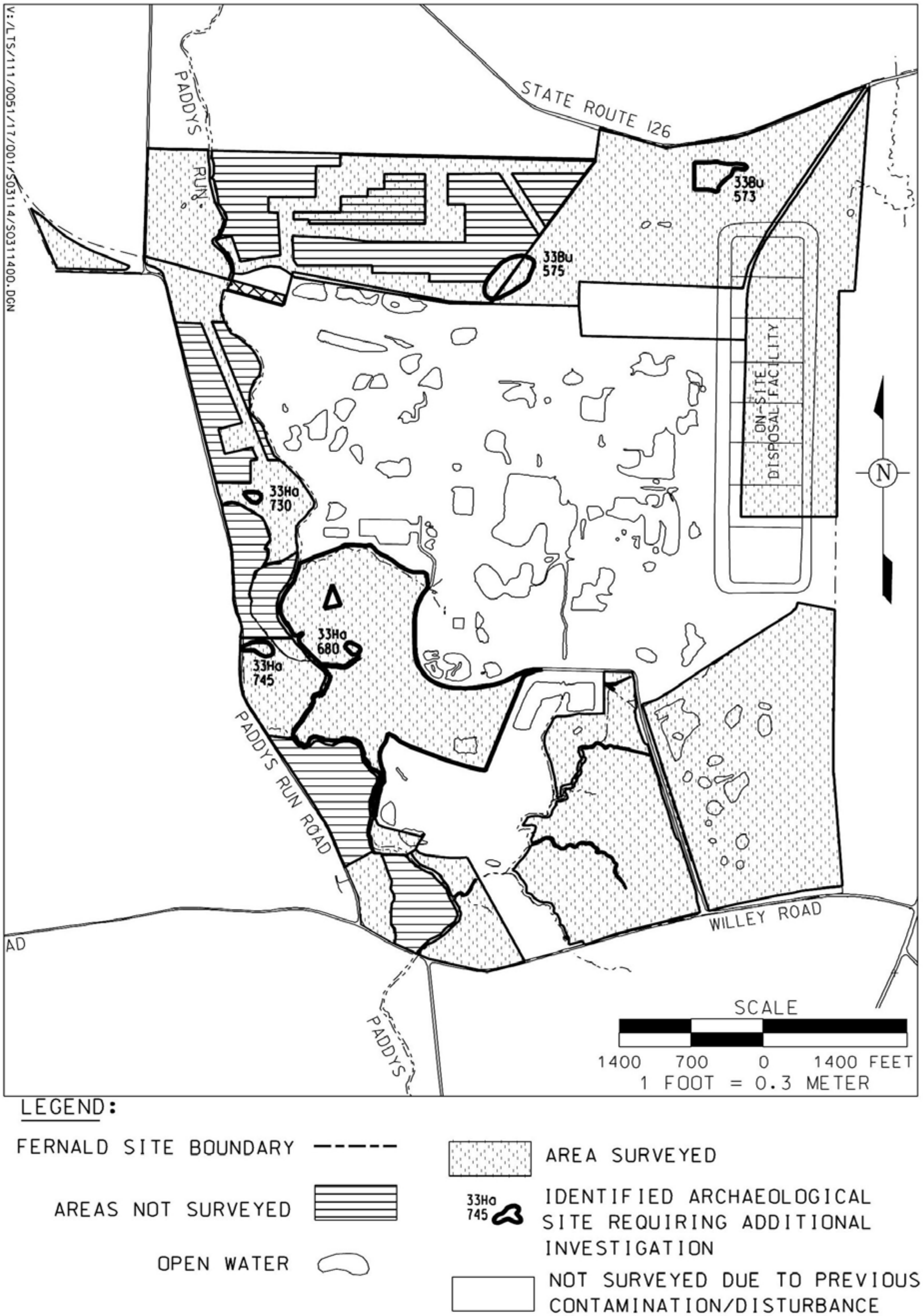


Figure 7–2. Cultural Resource Survey Areas

8.0 References

DOE (U.S. Department of Energy), 1990. *General Environmental Protection Program*, DOE Order 5400.1, Change 1, Washington, D.C., June 29.

DOE (U.S. Department of Energy), 1993. *Radiation Protection of the Public and the Environment*, DOE Order 5400.5, Change 2, Washington, D.C., January.

DOE (U.S. Department of Energy), 1995a. *Feasibility Study Report for Operable Unit 5*, Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 1995b. *Final Record of Decision for Remedial Actions at Operable Unit 1*, 513 U-003-501.3, Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 1995c. *Proposed Plan for Operable Unit 5*, 6865 U-007-405.3, Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 1995d. *Remedial Investigation Report for Operable Unit 5*, Final, Fernald Environmental Management Project, DOE, Fernald Area Office, 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), 1997a. *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)*, Final, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 1997b. *Best Available Technology Determination for Remedial Construction Activities on the Fernald Environmental Management Project*, Fernald Environmental Management Project, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2001a. *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas*, 52462-RP-0003, Revision A, Draft Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2001b. *First Five-Year Review Report for the FEMP* (Federal Environmental Management Project), Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2001c. *Memorandum of Understanding for Natural Resource Restoration Plan*, signed by DOE, Ohio Environmental Protection Agency, and Department of Interior, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, July 12.

DOE (U.S. Department of Energy), 2002a. *Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module*, 52462-RP-0001, Revision A, Draft Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2002b. "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota," Final Technical Standard, Project No. ENVR-0011, Washington, D.C.

DOE (U.S. Department of Energy), 2003a. *Comprehensive Groundwater Strategy Report*, Revision 0, Draft, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2003b. *2002 Consolidated Monitoring Report for Restored Areas at the Fernald Closure Project*, 20900-RP-0017, Draft, Revision B, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2004. *Groundwater Remedy Evaluation and Field Verification Plan*, 52460-PL-0001, Revision 0, Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, October.

DOE (U.S. Department of Energy), 2005a. *Environmental Protection Program*, DOE Order 450.1, Change 1, Washington, D.C., January.

DOE (U.S. Department of Energy), 2005b. *Fiscal Year 2005 Site Treatment Plan Annual Update*, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio.

DOE (U.S. Department of Energy), 2005c. *Integrated Environmental Monitoring Plan*, 2505-WP-0022, Revision 4, Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2005d. *Storm Sewer Outfall Ditch Infiltration Test Report*, 52460-RP-0001, Revision 0, Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, December.

DOE (U.S. Department of Energy), 2005e. *Waste Storage Area Phase II Design Report*, 52424-RP-0004, Revision A, Draft Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2006a. *Comprehensive Legacy Management and Institutional Controls Plan*, 20013-PL-0001, Revision 0, Draft Final, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 2006b. *Second Five-Year Review Report for the FCP*, 2500-RP-0044, Revision A, Draft, Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2006c. "2005 RCRA Annual Report," Fluor Fernald, DOE, Fernald Area Office, Cincinnati, Ohio.

Facemire, D.F., S.I. Guttman, D.R. Osborne, and R.H. Sperger, 1990. *Biological and Ecological Site Characterization of the Feed Materials Production Center*, FMPC-SUB 018, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, Ohio.

International Commission on Radiological Protection (ICRP), 1994a. *Human Respiratory Tract Model for Radiation Protection*, ICRP Publication 66.

International Commission on Radiological Protection (ICRP), 1994b. *Protection Against Radon-222 at Home and at Work*, ICRP Publication 65.

National Academy of Science (NAS), 1980, *Biological Effects of Ionizing Radiation*, BEIR III, National Academy Press.

National Council on Radiation Protection and Measurements (NCRP), 1984. *Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States*, NCRP Report No. 78.

National Council on Radiation Protection and Measurements (NCRP), 1987. *Ionizing Radiation Exposure of the Population of the United States,* NCRP Report No. 93.

OSWER Directive 9320.2-09A-P, *Close Out Procedures for National Priorities List Sites*, January 2000 (i.e., OSWER Directive).

Risk Assessments Corporation (RAC), 1996. *Task 6: Radiation Doses and Risk to Residents from FMPC Operations from 1951−1988,* RAC 1996.

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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.

Appendix A

Supplemental Groundwater Information

Click on blue text to view Appendix A

Appendix B

Supplemental Surface Water, Treated Effluent, and Sediment Information

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Appendix C

Supplemental Air Information

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Appendix D

2006 National Emissions Standards for Hazardous Air Pollutants (NESHAP) Annual Report

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