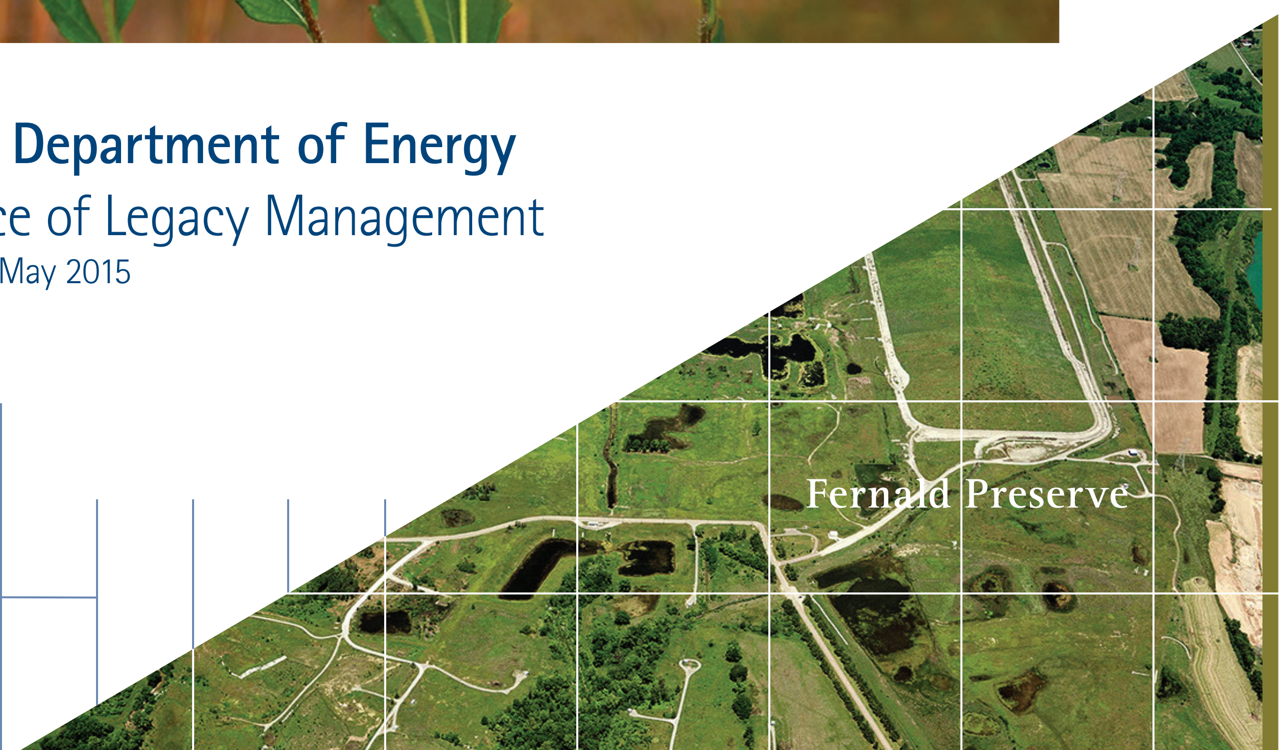
LMS/FER/S12455

FERNALD PRESERVE

2014 Site Environmental Report

U.S. Department of Energy
Office of Legacy Management
Issued May 2015



This page intentionally left blank

LMS/FER/S12455

Fernald Preserve

2014 Site Environmental Report

May 2015

This page intentionally left blank

Contents

Figures

Tables

Appendixes

Abbreviations

AIBI	Amphibian Index of Biotic Integrity
AR	Administrative Record
ARARs	applicable or relevant and appropriate requirements
BCG	Biota Concentration Guide
CAWWT	Converted Advanced Wastewater Treatment facility
CC	coefficient of conservatism
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
FQAI	Floristic Quality Assessment Index
FRL	final remediation level
IEMP	Integrated Environmental Monitoring Plan
LCS	leachate collection system
LDS	leak detection system
LM	DOE Office of Legacy Management
LMICP	*Comprehensive Legacy Management and Institutional Controls Plan*
MEI	maximally exposed individual
NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRRP	*Natural Resource Restoration Plan*
Ohio EPA	Ohio Environmental Protection Agency
OSDF	On-Site Disposal Facility
OSL	optically stimulated luminescence
OU5 ROD	Operable Unit 5 Record of Decision
PCB	polychlorinated biphenyl
PF	Parshall Flume
PPDD	Pilot Plant Drainage Ditch
RCRA	Resource Conservation and Recovery Act
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SN3	Stoller Newport News Nuclear, Inc., a wholly owned subsidiary of Huntington Ingalls Industries, Inc.
SSOD	storm sewer outfall ditch
TSS	total suspended solids

Measurement Abbreviations

cm	centimeter
ft	feet
gpm	gallons per minute
kg	kilograms
km	kilometer
lb	pounds
Lpm	liters per minute
m	meter
M gal	million gallons
mg/L	milligrams per liter
M liters	million liters
mGy/day	milligray per day
mrem/yr	millirem per year
mSv/yr	millisieverts per year
rem	roentgen equivalent man
μg/L	micrograms per liter

Units (Abbreviations) and Conversion Table

Multiply	By	To Obtain	Multiply	By	To Obtain
inches	2.54	centimeters (cm)	cm	0.3937	inches
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
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	10^{12}	pCi
pCi/L	10^{-6}	microcuries per liter (μCi/L)	μCi/L	10^{6}	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) × 5/9	Celsius (˚C)	˚C	(˚C × 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

Executive Summary

The *2014 Fernald Preserve Site Environmental Report* provides stakeholders with the results from the Fernald, Ohio, Site's environmental monitoring programs for 2014; a summary of the U.S. Department of Energy's (DOE's) activities conducted onsite; and a summary of the Fernald Preserve's compliance with the various environmental regulations, compliance agreements, and DOE policies that govern site activities. This report has been prepared in accordance with the "Integrated Environmental Monitoring Plan," which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2015).

The Fernald Preserve has been successfully remediated with the exception of the groundwater program and the care and maintenance of the On-Site Disposal Facility (OSDF), which are the only ongoing components of remediation.

During 2014, activities at the Fernald Preserve included:

- Environmental monitoring activities related to direct radiation, groundwater, and surface water.
- Ecological restoration monitoring and maintenance as well as inspections, care, and monitoring of the site and the OSDF to ensure that provisions of the LMICP are fully implemented.
- Collection, monitoring, and treatment of leachate from the OSDF.
- Extraction, monitoring, and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).
- Ongoing operation of the Fernald Preserve Visitors Center, associated outreach, and educational activities.
- National Pollutant Discharge Elimination System (NPDES) permit monitoring.

Environmental monitoring programs were developed to ensure that the remedy remains protective of the environment. The requirements of these programs are described in detail in the LMICP and reported in this Site Environmental Report as outlined below.

Liquid Pathway Highlights

Groundwater Pathway

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

- Verify that hydraulic capture is maintained, track the aquifer restoration in the area of the total uranium plume, including non-uranium constituents, and evaluate water quality conditions in the aquifer that may indicate a need to modify the design or the operation of restoration modules.
- Meet compliance-based groundwater monitoring obligations.

During 2014, active restoration of the Great Miami Aquifer continued. A total of 140 monitoring wells were sampled semiannually to determine water quality. Aquifer water elevations were measured in 179 monitoring wells. The following highlights describe the key findings from the 2014 groundwater data:

- Two billion, three hundred forty million gallons (8,857 million liters) of groundwater were extracted from the Great Miami Aquifer, and 516 pounds (lb) (234 kilograms [kg]) of uranium were removed from the aquifer in 2014.
- Since 1993, 39,250 million gallons (148,561 million liters) of water have been pumped from the Great Miami Aquifer, and 12,300 net lb (5,584 kg) of uranium have been removed from the Great Miami Aquifer.
- Data collected in 2014 indicate that uranium concentrations within the footprint of the maximum uranium plume continue to decrease in response to pumping. The footprint of the maximum uranium plume in 2014 was approximately 110.9 acres (44.88 hectares), a decrease of approximately 12.9 percent from what was mapped in 2013 (127.3 acres [51.5 hectares]).
- The results of the 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.

Groundwater Remedy

On July 1, 2014, a new operational design for the groundwater remedy was implemented. Three extraction wells that were no longer providing benefit to the remediation were shut down, and the pumping capacity from these wells was re-allocated to extraction wells in the South Plume and southern portion of the South Field to accelerate cleanup of those areas. The system pumping rate was increased 300 gallons per minute (gpm) from 4,775 gpm to 5,075 gpm.

The new operational design is more aggressive than the previous design because, for the first 9 years, the target system pumping rate is 300 gpm higher. The new design is also more efficient because pumping is more concentrated where pumping is needed, when it is needed. The result is lower pumping rates as the remedy progresses. The predicted lower pumping rates come with predicted cost savings of approximately 6 million dollars over the life of the pump-and-treat operation.

Under the previous operational design, the percentage of treatment needed to achieve discharge limits had decreased significantly, and uranium discharge limits could be achieved without groundwater treatment. With implementation of the new, more aggressive operational design in July 2014, groundwater treatment was once again needed through mid-November of 2014 to achieve discharge limits.

On-Site Disposal Facility Monitoring

Engineered features within the OSDF continue to perform as designed, indicating that a leak from the facility is not occurring. Leachate flow continues to diminish as expected, and leak detection system flow volumes indicate that the cell liners are performing well within design specifications.

Surface Water and Treated Effluent Pathway

Surface water, treated effluent, and sediment are monitored to determine the effects of Fernald Preserve 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 2014, 23 surface water, treated effluent, and sediment locations were sampled at various frequencies. The following highlights describe the key findings from the 2014 surface water and treated effluent monitoring programs.

- Five hundred and thirty-six pounds (244 kg) of uranium were discharged in treated effluent to the Great Miami River, which was below the limit of 600 lb (272 kg) per year. Approximately 84 lb (38 kg) of uranium were released to the environment through uncontrolled storm water runoff. Therefore, the total amount of uranium released through the treated effluent and uncontrolled surface water pathways during 2014 was estimated to be 620 lb (281 kg).
- Analytical results of 19 surface water samples collected from SWD-09 exceeded the surface water final remediation level for total uranium, the site's primary contaminant. SWD-09 is one of the two locations established to monitor the maintenance action completed west of the Former Waste Pits Area. Unlike in 2013, there were no total uranium FRL surface water exceedances at the second location in this area (SWD-05). Analytical results of surface water samples collected at these locations both show a downward trend. The surface water from this area does not drain directly to Paddys Run. In 2014, stabilization of the Paddys Run streambank in this area began after excessive erosion was noted earlier in the year, just west of location SWD-09. The project involves relocation of approximately 475 feet (ft) (145 meters [m]) of Paddys Run and bank stabilization using riprap and native vegetation. The streambed will also be stabilized with crossvanes, which are large rock foundations that keep the stream from eroding downward. Work on this project will be completed in 2015.
- Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald Preserve, is regulated under the State-administrated NPDES program. Discharges were in compliance with effluent limits identified in the NPDES permit with the exception of one instance of noncompliance at PF 4001 for the mass loading limit for total suspended solids.
- Two sediment locations in the Great Miami River, which were last sampled in 2009, were sampled for total uranium in 2014. Results were well below the sediment final remediation level and were similar to the results from 2009.

Direct Radiation Pathway Highlights

The direct radiation pathway is routinely monitored to assess the impact of direct radiation on the surrounding public and environment. In addition, the data are used to demonstrate compliance with various regulations and DOE orders. Eleven dosimeters (four trail locations, five boundary locations, one location at the Visitors Center, and one background location) were used in 2014 to determine compliance with the applicable limits.

The direct radiation levels measured in 2014 indicate that the individual measurements obtained in the northeast quadrant of the site are slightly higher than background, but annual averages for onsite and background locations are not significantly different. The highest value for an onsite dosimeter produced a dose of 7 millirem per year (mrem/yr) (0.7 millisievert per year [mSv/yr]) above background to an individual who spent the entire year (24 hours a day) at the location.

Estimated Dose

In 2014, the maximally exposed individual, standing at the northeastern boundary monitor with the highest above-background reading, could receive a dose of 7 mrem (0.7 mSv). This estimate represents the maximum incremental dose above background attributed to direct radiation. This dose is 7 percent of the adopted DOE limit, which is 100 mrem/yr (1 mSv/yr) above background as established by the International Commission on Radiological Protection.

Natural Resources

Natural resources include the diversity of plant and animal life and their supporting habitats in and around the Fernald Preserve. A number of ecological activities were conducted in 2014. Maintenance in ecologically restored areas focused on removal of woody invasive species such as bush honeysuckle. Other activities included mowing, spot herbicide application, repair and removal of deer exclosure fence, and hazing for control of nuisance geese. Two new public amenities were added. A shelter was constructed adjacent to the Visitors Center, and a 240 ft (73 m) boardwalk was installed along a portion of the Sycamore Trail.

Ecological monitoring in 2014 consisted of forest functional monitoring, continued wetland mitigation monitoring, and implementation monitoring within the Former Silos Area restoration project. Results of forest functional monitoring indicated continued establishment of native communities, although invasive species such as bush honeysuckle have reduced native diversity in some areas. Wetland mitigation monitoring indicated continued habitation of salamanders in wetlands created in the northern portions of the site. Hydrologic monitoring results were similar to those of previous years. Implementation monitoring of the Former Silos Area restoration project showed that the area had met restoration goals.

Quarterly site and OSDF inspections continued in 2014. No major issues were identified. Findings focused mainly on invasive plants and woody vegetation in the vicinity of the OSDF, and debris within portions of the Former Production Area and Waste Pits Area. Poor drainage in a portion of the west inner drainage of the OSDF was repaired in June.

Endangered species activities in 2014 included relocation of the state threatened Sloan's crayfish prior to construction of the Paddys Run streambank stabilization project. Field personnel captured and relocated 73 crayfish upstream. No other endangered species were identified at the Fernald Preserve in 2014. DOE collaborated with the U.S. Fish and Wildlife Service to release a population of the federally endangered American burying beetle at the Fernald Preserve. This project is part of an effort to reestablish populations of this beetle in the state of Ohio. DOE has signed a cooperative agreement with the U.S. Fish and Wildlife Service to release the beetles onsite from 2013 through 2017.

There were no unexpected discoveries of cultural resources, and no archaeological surveys were conducted in 2014.

This page intentionally left blank

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 under the National Contingency Plan.
1989	Uranium production suspended. The Fernald site was placed on the National Priorities List, 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 (ROD).
1996	The last operable unit's ROD was signed, signifying the end of the 10-year remedial investigation/feasibility study process. (The Operable Unit 4 ROD 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 the OSDF began. First waste placement began in December. Environmental monitoring and reporting were consolidated under the Integrated Environmental Monitoring Plan (IEMP).
1998	Operable Unit 2 remedial excavations began.
1999	Excavation of the waste pits was initiated (Operable Unit 1 ROD) and the first rail shipment of waste 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 OSDF was capped. Remediation of the Southern Waste Units was completed.
2002	The Silos 1 and 2 Radon Control System began operation and successfully reduced radon levels within the silos. The offsite transfer of nuclear product material was completed. Wastes were placed in OSDF Cells 2 through 5.
2003	All major Operable Unit 2 remedial actions were completed. In addition, approximately 412,000 cubic yards (315,015 cubic meters) of waste were placed in OSDF Cells 3 through 6.
2004	Removal of Silos 1 and 2 wastes from the silos to the holding tank facility began. 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. All eight cells of the OSDF were capped or received waste. Approximately 513,000 cubic yards (392,240 cubic meters) were placed in Cells 4 through 8.
2005	Removal of Silo 3 waste began, 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 wastes arrived at Waste Control Specialists in Texas.
2006	Remediation was completed October 29, 2006. The site was officially transferred to DOE's Office of Legacy Management November 17, 2006.
2008	The old Silos Warehouse was remodeled into the new Fernald Preserve Visitors Center and opened to the public in August 2008. The community was allowed unescorted access at the Fernald Preserve.
2012	The throughput capacity of the Converted Advanced Wastewater Treatment Facility (CAWWT) was reduced from 1,800 gallons per minute (gpm) to 500−600 gpm.
2014	On July 1, 2014, a new groundwater remediation operational design was implemented (DOE 2014). The target system pumping rate is 300 gpm higher than the previous design and accelerates cleanup.

In 1951, the U.S. Atomic Energy Commission, a predecessor agency of 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. These production operations caused releases to the surrounding environment, which resulted 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, also known as Superfund), 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. In 2007, the site name changed to the Fernald Preserve to reflect the completion of the cleanup (with the exception of groundwater) ushered by the successful transition to the DOE

Office of Legacy Management (LM) in late 2006, and the new mission to be an asset to the community as an undeveloped park with an emphasis on wildlife.

The Legacy Management Support contractor continues to be responsible for site activities, including the ongoing groundwater remedy. The U.S. Environmental Protection Agency (EPA) Region 5 and the Southwest District Office of the Ohio Environmental Protection Agency (Ohio EPA) provide regulatory oversight.

In the 1980s, the goals of environmental monitoring 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 Preserve, two primary exposure pathways (water and air) have been identified. A primary pathway is one that may allow pollutants to directly reach the public or the environment. Therefore, the water 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 by which 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 Preserve are insignificant routes of exposure to offsite receptors. Therefore, the main focus of the site monitoring program (described in the IEMP) is on the primary exposure pathways.

Refer to Section 5 of this report for information pertaining to 2014 dose calculations from all pathways.

After the conclusion of the site's uranium production and the completion of the CERCLA remedy selection process, the focus was 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 is described in the "Integrated Environmental Monitoring Plan" (IEMP), which is Attachment D of the *Comprehensive Legacy Management and Institutional Controls Plan* (LMICP) (DOE 2015). The environmental monitoring program is designed to ensure the continued protectiveness of the completed remedial actions as well as implementation of the ongoing groundwater remedy and performance of the On-Site Disposal Facility (OSDF).

This *Fernald Preserve 2014 Site Environmental Report* summarizes the findings from the monitoring program and provides a status on the progress toward final site restoration. This report consists of the following:

Summary Report. The summary report (Sections 1 through 6) documents the results of environmental monitoring activities at the Fernald Preserve in 2014. It includes a discussion of ongoing groundwater remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, direct radiation, and natural resources monitoring programs. It also summarizes the information contained in the appendixes.

Appendixes. The detailed appendixes provide the 2014 environmental monitoring data for the various media, primarily in the form of graphs, figures, and tables. The appendixes are generally distributed only to the regulatory agencies. However, a complete copy of the appendixes is available on the LM website at http://www.lm.doe.gov/fernald/Sites.aspx and by contacting LM at (513) 648-3333, Stoller Newport News Nuclear, Inc. (SN3), a wholly owned subsidiary of Huntington Ingalls Industries, Inc. Public Affairs at (513) 648-6000, or email at fernald@lm.doe.gov.

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 remedial action plan. After public comments are received, a remedy is selected and documented in a ROD.

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 CERCLA 5-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 ROD (DOE 1995b) was the first such action. This construction began on April 1, 1996. Three CERCLA 5-year reviews have been conducted and approved by the regulatory agencies to date (April 2001 [DOE 2001c], April 2006 [DOE 2006b], and September 2011 [DOE 2011b]). These reviews ensure that the remedy remains effective and continues to be protective of human health and the environment. The next scheduled 5-year review is in early 2016.

Site closure, relative to the completion of remediation, was defined in the contract between Fluor Fernald, Inc. and DOE as the physical completion of the scope of work required by the five R with the exception of the groundwater remedy.

LM assumed the long-term surveillance monitoring and maintenance of the Fernald site on November 17, 2006, to ensure continued protection of human health and the environment and continued operation of the groundwater remedy. The *Comprehensive Legacy Management and Institutional Controls Plan* (DOE 2015) defines the activities to be conducted with respect to long-term stewardship at the Fernald Preserve. The CERCLA 5-year review process will continue to provide stakeholders with information on the remedy performance and with long-term stewardship information.

The rest of this introductory section provides:

- An overview of the environmental remediation completed as well as ongoing remedy implementation.
- A description of environmental monitoring activities at the Fernald Preserve.
- A description of the physical and ecological 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 geographical function and 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 (RODs) for all five operable units. However, several of the RODs (including those for Operable Units 1, 4, and 5) have subsequently been modified through issuance of Explanation of Significant Difference documents or ROD Amendment documents. These documents were prepared, submitted for EPA and public review, and issued in accordance with CERCLA regulations. Following approval of the initial RODs, work began on the design and implementation of the operable unit remedies. Table 1 describes each operable unit and an overview of its associated remedy.

Table 1. Operable Unit Remedies

Operable Unit	Description	Remedy Overview
1	• Waste Pits 1-6 • Clearwell • Burn pit • Berms, liners, caps, and soil within the boundary	ROD approved: March 1995 Explanation of Significant Differences approved: September 2002 ROD Amendment approved: November 2003 Excavation of materials with constituents of concern above final remediation levels (FRLs), waste processing and treatment by thermal drying (as necessary), offsite disposal at a permitted facility, and soil remediation/certification. **Remedial actions completed: June 2005** **Final Remedial Action Report approved: August 2006**
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	ROD approved: May 1995 Post-ROD Fact Sheet approved: April 1999 Excavation of all materials with constituents of concern above FRLs, treatment for size reduction and moisture control as required, onsite disposal in the OSDF, and offsite disposal of excavated material that exceeded the waste acceptance criteria for the OSDF. **Remedial actions completed: June 2006** **Final Remedial Action Report approved: September 2006**
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	ROD for Interim Remedial Action approved: June 1994 ROD for Final Remedial Action approved: August 1996 Adoption of Operable Unit 3 Interim ROD; alternatives to disposal through the unrestricted or restricted release of materials as economically feasible for recycling, reuse, or disposal; treatment of material for onsite or offsite disposal; required offsite disposal for process residues, product materials, process-related metals, acid brick, concrete from specific locations, and any other material exceeding the OSDF waste acceptance criteria; and onsite disposal for material that meets the OSDF waste acceptance criteria. **Remedial actions completed: October 2006** **Final Remedial Action Report approved: February 2007**

Table 1 (continued). Operable Unit Remedies

Operable Unit	Description	Remedy Overview
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	ROD approved: December 1994 Explanation of Significant Differences for Silo 3 approved: March 1998 ROD Amendment for Silos 1 and 2 approved: July 2000 ROD 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 Removal of Silo 3 materials for treatment and Silos 1 and 2 residues and decant sump tank sludges with onsite stabilization of materials, residues, and sludges followed by offsite disposal. Excavation of silos area soils contaminated above the FRLs with onsite disposal for contaminated soils and debris that meet the OSDF waste acceptance criteria; and site restoration. Concrete from Silos 1 and 2, and contaminated soil and debris that exceeded the OSDF waste acceptance criteria were disposed of offsite. **Remedial actions for Silo 3 completed: April 2006** **Remedial actions involving the completion of the shipment of stabilized Silos 1 and 2 material to a temporary storage facility in Texas was completed in May 2006.** **Final Remedial Action Report approved: September 2006** **Permanent disposal of the 3,776 containers of Silos 1 and 2 material began on October 7, 2009, and the last container was placed November 2, 2009.**
5	• Groundwater • Surface water and sediments • Soil not included in the definitions of Operable Units 1 through 4 • Flora and fauna	ROD 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 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. Onsite disposal of contaminated soil and sediment that met the OSDF waste acceptance criteria. Soil and sediment with contaminant concentrations that exceeded the waste acceptance criteria for the OSDF was treated, when possible, to meet the OSDF waste acceptance criteria or was disposed of at an offsite facility. Also includes site restoration, institutional controls, and post-remediation maintenance. **Interim Remedial Action Report approved: August 2008**

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, direct radiation, and natural resources. In general, the primary exposure pathway (water) is monitored, and the program focuses on assessing the effect 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.
- The IEMP is reviewed annually and revised as necessary to ensure that the monitoring program adequately addresses changing activities.
- The IEMP consolidates routine reporting of environmental data into this comprehensive annual report.

1.3 Characteristics of the Site and Surrounding Area

The natural settings of the Fernald Preserve 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 Preserve that pumps groundwater primarily for industrial use.

Downtown Cincinnati is approximately 18 miles (29 km) southeast of the Fernald Preserve (Figure 1). The cities of Fairfield and Hamilton are 6 and 8 miles (10 and 13 km) to the east and northeast, respectively (Figure 2). Scattered residences and several villages, including Fernald, New Baltimore, New Haven, Ross, and Shandon, are located near the site.

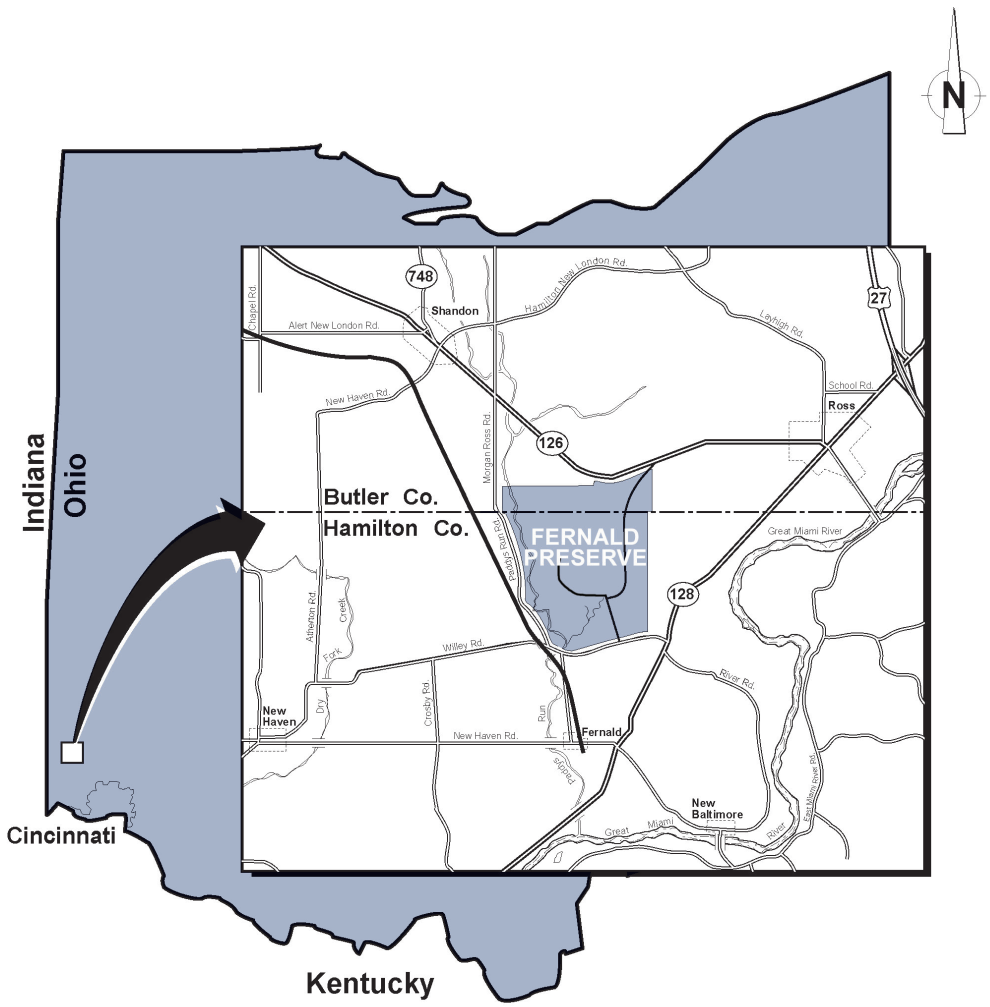


Figure 1. Fernald Preserve and Vicinity

1.3.2 Geography

Figure 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 OSDF dominate this view. The Former Production Area occupies approximately 136 acres (55 hectares) in the center of the site, and the OSDF occupies approximately 120 acres (48.6 hectares). The Great Miami River cuts a terraced valley to the east of the site, and 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 outcrops to the north, southeast, and southwest.

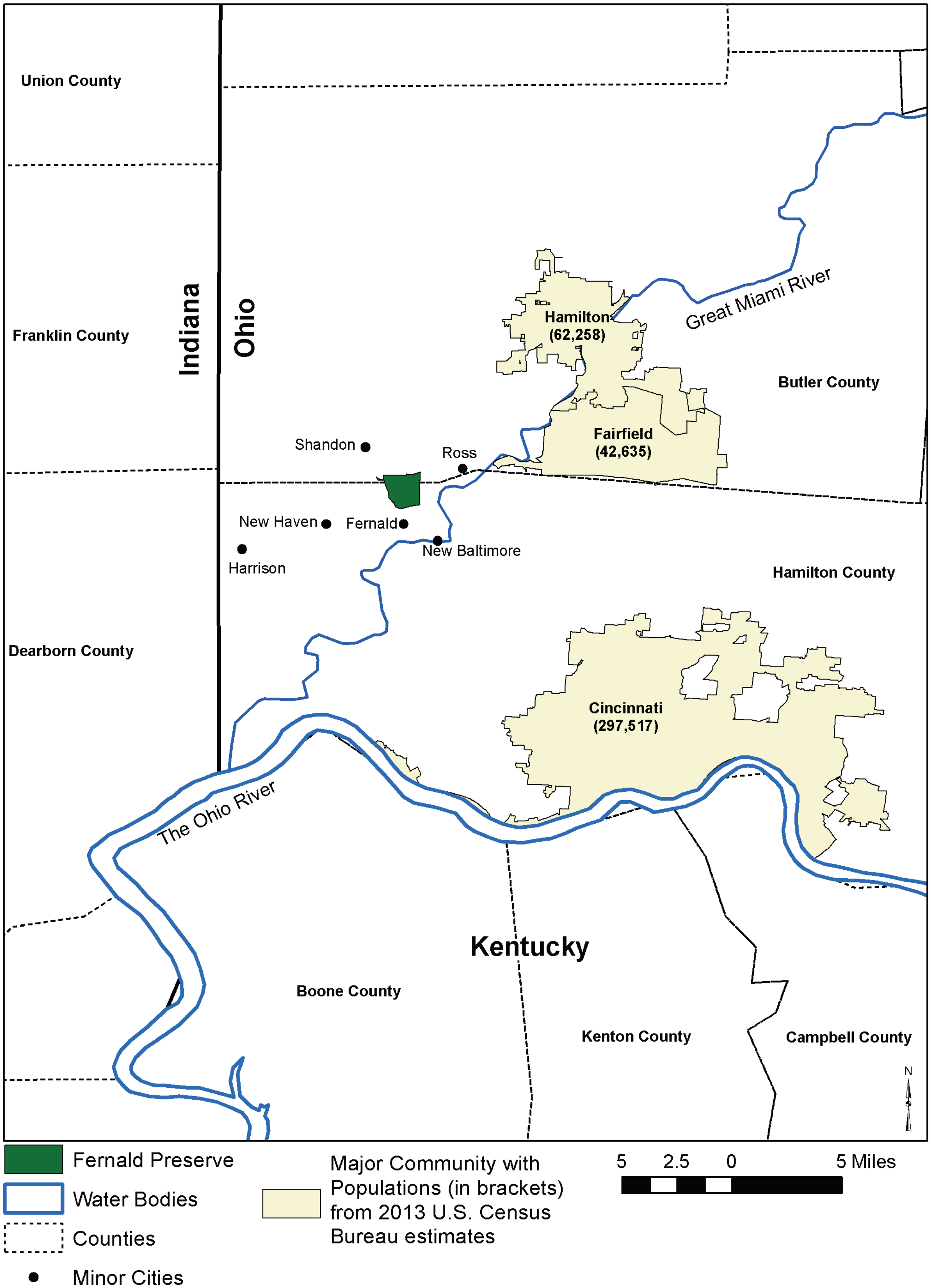


Figure 2. Major Communities in Southwestern Ohio

Figure 3. Fernald Preserve Perspective

This page intentionally left blank

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 a glacial overburden—a low-permeability mixture of clay and silt with minor amounts of sand and gravel—deposited across the land surface. The site is situated on a layer of glacial overburden that overlies portions of a 2- to 3-mile-wide (3- to 5-km-wide) 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 defines the edges and bottom of the New Haven Trough restricts 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 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 and transport contaminants 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 4 provides a view of the structure of subsurface deposits in the region along an east-west cross section through the site, and Figure 5 presents the regional groundwater flow patterns in the Great Miami Aquifer.

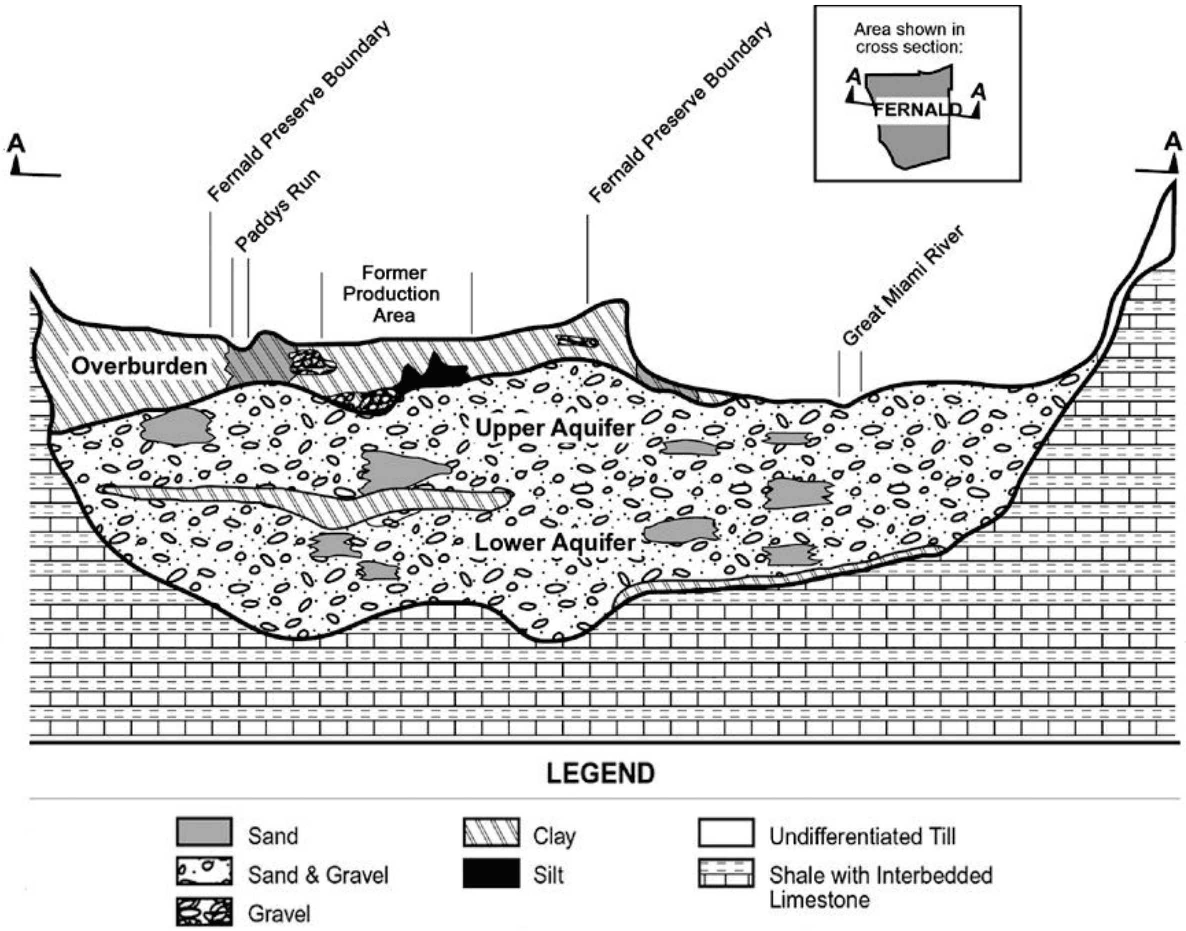


Figure 4. Schematic Cross Section of the New Haven Trough, Looking North

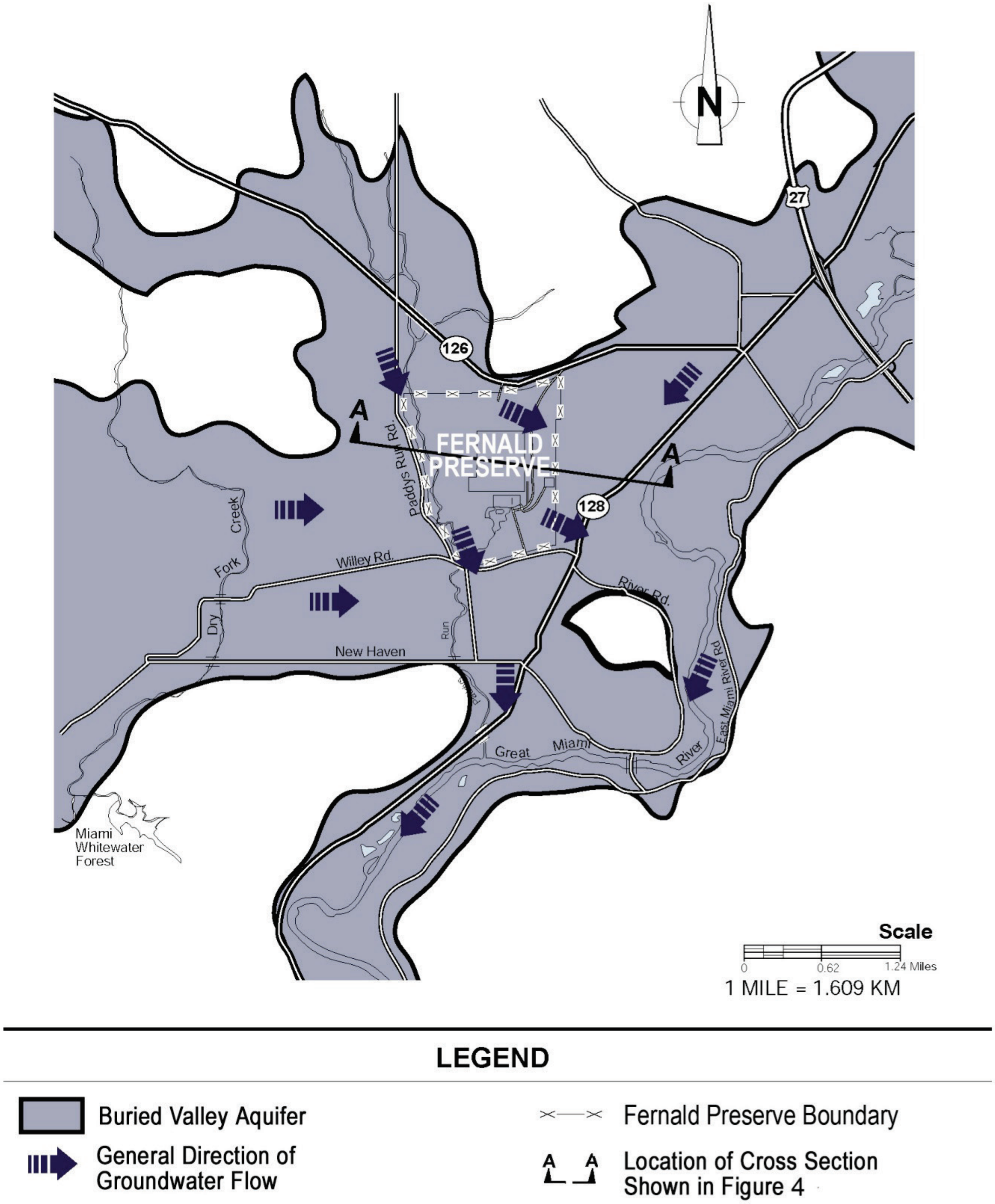


Figure 5. Regional Groundwater Flow in the Great Miami Aquifer

1.3.4 Surface Hydrology

The Fernald Preserve is located in the Great Miami River drainage basin (Figure 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 Pits 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 Preserve, 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 Preserve and the Ohio River is not used as a source of public drinking water.

The average flow volume for the Great Miami River in 2014 was 4,810 cubic feet per second (136.1 cubic meters per second). This average is based on daily measurements collected at the U.S. Geological Survey Hamilton stream gauge (USGS 3274000) approximately 10 river miles (16 river km) upstream of the site's effluent discharge.

In 2014, 40.0 inches (101.6 centimeters [cm]) of precipitation were measured at the Butler County Regional Airport. This measurement is lower than the average annual precipitation of 41.21 inches (104.7 cm) for 1951 through 2014. Figure 7 shows the average annual precipitation recorded at the Fernald Preserve for each year from 1991 through 2014 and the annual average precipitation for the Cincinnati area from 1951 through 2014. Figure 8 shows monthly precipitation at the site for 2014 compared to the Cincinnati area average monthly precipitation from 1951 through 2014.

1.3.5 Natural Resources

Natural resources have important aesthetic, ecological, economic, educational, historical, recreational, and scientific value to the United States. Their establishment and protection is an ongoing process at the Fernald Preserve. Section 6 discusses the site’s diverse natural and cultural resources, and it summarizes 2014 restoration projects, along with inspection, monitoring, and maintenance activities.

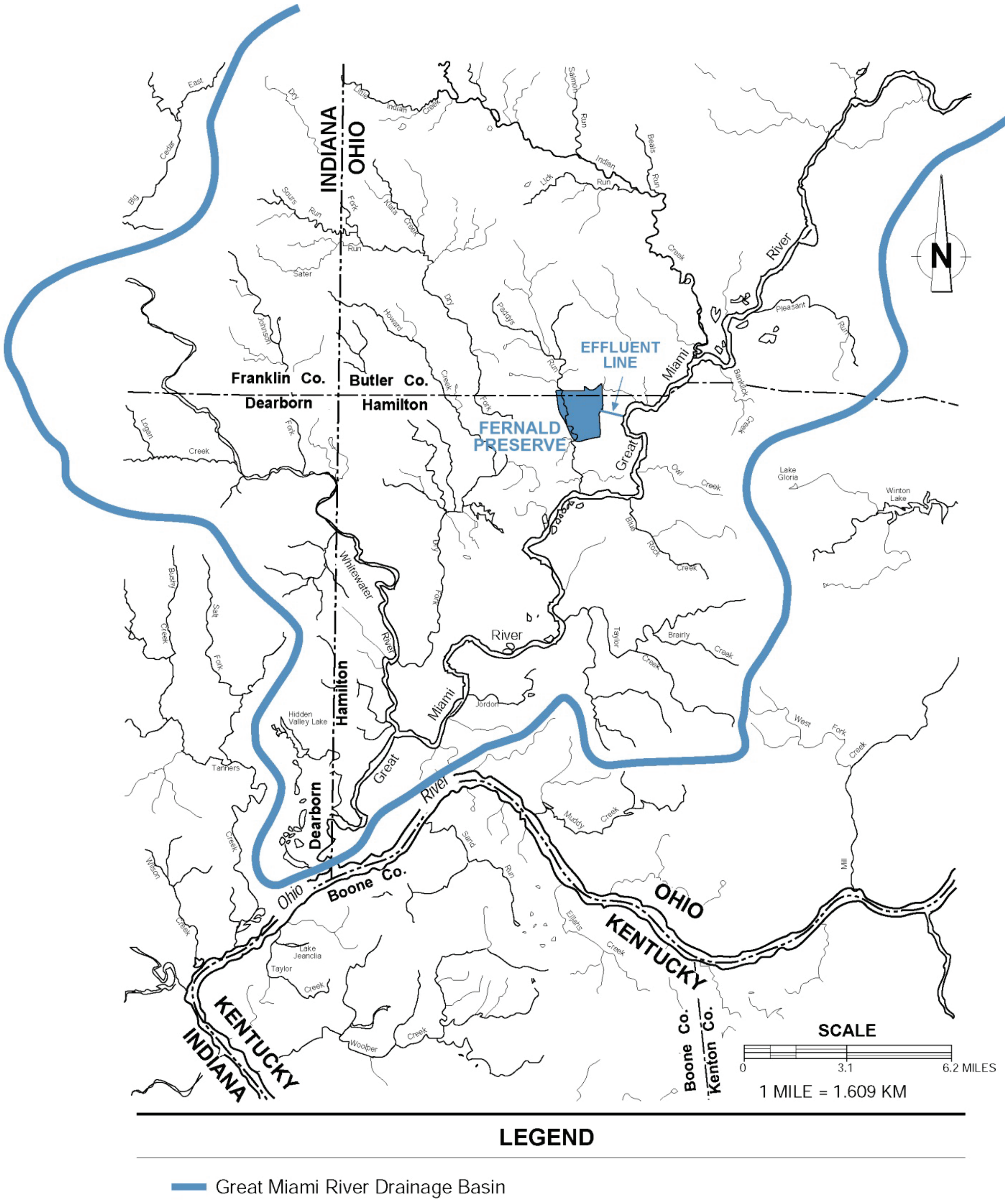


Figure 6. Great Miami River Drainage Basin

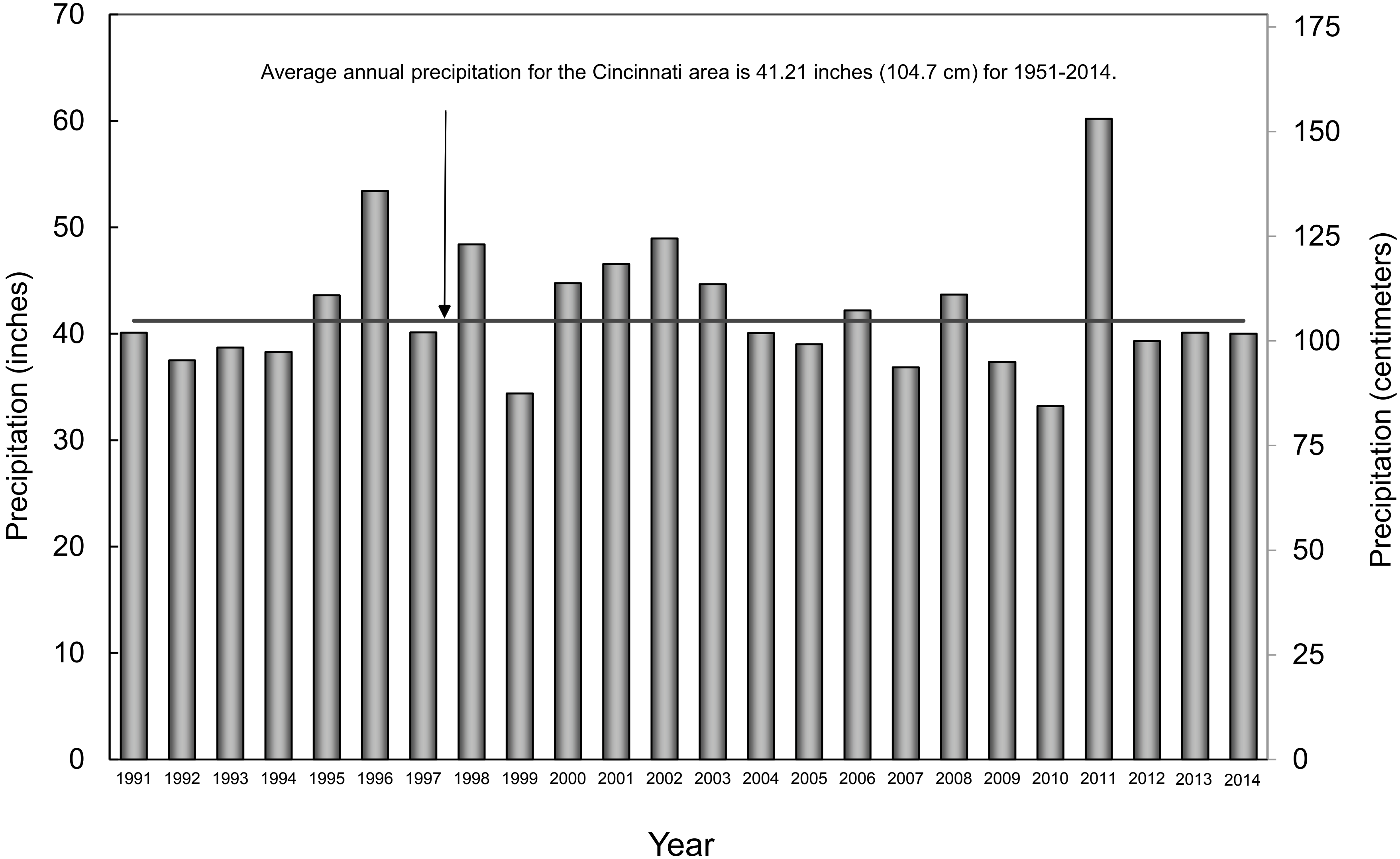


Figure 7. Annual Precipitation, 1991–2014

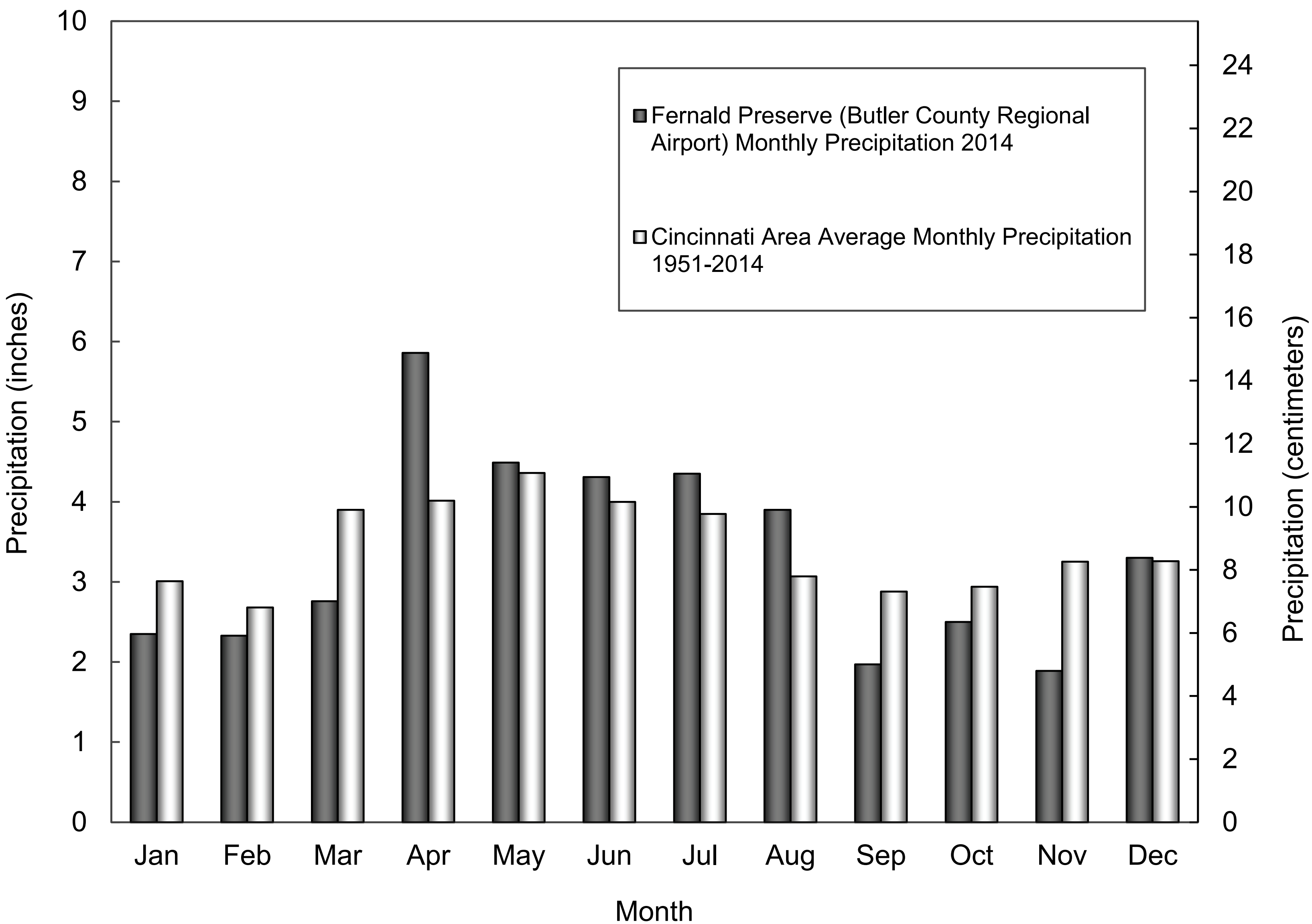


Figure 8. Monthly Precipitation for 2014 Compared to Average Monthly Precipitation for 1951–2014

This page intentionally left blank

2.0 Remediation Status and Compliance Summary

This section provides a summary of CERCLA remediation activities in 2014 and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. Compliance under CERCLA dictates the environmental remediation of the Fernald Preserve.

EPA and Ohio EPA enforce the environmental laws, regulations, and legal agreements governing work at the Fernald Preserve. 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 Preserve. EPA Region 5 has regulatory oversight of the CERCLA process at the Fernald Preserve, with active participation from Ohio EPA.

For some programs, such as those under the Resource Conservation and Recovery Act (RCRA), as amended, the Clean Air Act, as amended (excluding National Emissions Standards for Hazardous Air Pollutants 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 5, and Ohio EPA 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

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 involved the continuation of the groundwater remedy under Operable Unit 5. Other activities under CERCLA during 2014 involved monitoring the performance of the completed remedies and implementing the requirements of the LMICP.

All cleanup-related CERCLA documentation, including a copy of the Administrative Record (AR), is available online at http://www.lm.doe.gov/CERCLA_Home.aspx. The original and a copy of the AR are located in the records warehouse at the LM Business Center in Morgantown, West Virginia. A copy of the AR is also located at EPA's Region 5 office in Chicago, Illinois. The Fernald Preserve records staff can be contacted by phone at (513) 648-7516 for assistance in searching for a document in the CERCLA AR. The CERCLA AR will be updated as new documents are created.

The completion and closure of a National Priorities List (NPL) site encompasses several milestones and specific documentation requirements for each milestone completed (EPA 2011). These milestones begin with remedial action completion and end with deletion from the NPL and include:

- 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 cleanup goals are met, all RODs are complete, institutional controls are in place, and site conditions are protective of human health and the environment.
- Site deletion from the NPL (Notice of Intent to Delete).

Final Remedial Action Reports have been prepared and approved by both EPA and Ohio EPA for Operable Units 1, 2, 3, and 4. EPA approved the *Interim Remedial Action Report for Operable Unit 5* (DOE 2008) in August 2008. That report details the ongoing aquifer restoration activities and provides information indicating that all required groundwater infrastructure has been installed and is functioning as designed. Further, the report provides information that all soils have been remediated (except those associated with the groundwater infrastructure) and that the OSDF is functioning as designed. Operable Unit 5 will remain open until a future final Remedial Action Report for Operable Unit 5 has been prepared. This report will be developed once groundwater actions are complete, and all soils and infrastructure associated with the groundwater remedy have been adequately addressed (estimated completion date in 2035, based on modeling projections reported in the 2014 Operational Design report [DOE 2014b]). EPA issued the *Preliminary Closeout Report U.S. DOE Feed Materials Production Center, Fernald, Ohio* (EPA 2006) in December 2006.

CERCLA also requires a 5-year review process of remedial actions implemented under the signed ROD for each operable unit. The purpose of a 5-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. EPA approved the first 5-year review report for the Fernald Preserve (DOE 2001c) in September 2001. The second 5-year review report was submitted in April 2006 (DOE 2006b) and approved by EPA in September 2006. The third 5-year review report was submitted to EPA in March 2011 (DOE 2011b) and approved by EPA in August 2011.

CERCLA remediation highlights during 2014 included the following:

- The performance of the OSDF was satisfactory during 2014. The cap underwent four formal inspections. Minor maintenance of the cap and associated drainages continues. Activities include removal of small trees and shrubs, spot herbicide application, and repairing animal burrows. The presence of wetland vegetation in portions of the OSDF west inner drainage has been noted during OSDF inspections. This indicated that flow may be restricted at some locations. Minor repairs were conducted in 2013, but additional work was necessary to improve the flow. A follow-up inspection of the drainage was submitted to EPA and Ohio EPA in October 2013, which specified a path forward for repairs. This work was completed in June 2014. Subsequent inspections of the area show that the repair activities were successful in restoring proper drainage. Section 6 provides additional detail regarding this repair. Leachate generation has continued to decline, and liner performance is meeting design requirements. Leachate/leak detection performance is discussed in Section 3. Cap performance is discussed further in Section 6.
- Figure 9 indicates soil areas that remain uncertified pending the end of the groundwater remedy and the decontamination and decommissioning of the related facilities and the associated utilities. Elevated uranium concentrations persist in surface water in an area adjacent to former Waste Pit 3. No specific actions other than continued monitoring were conducted in 2014. This issue is further discussed in Section 4.

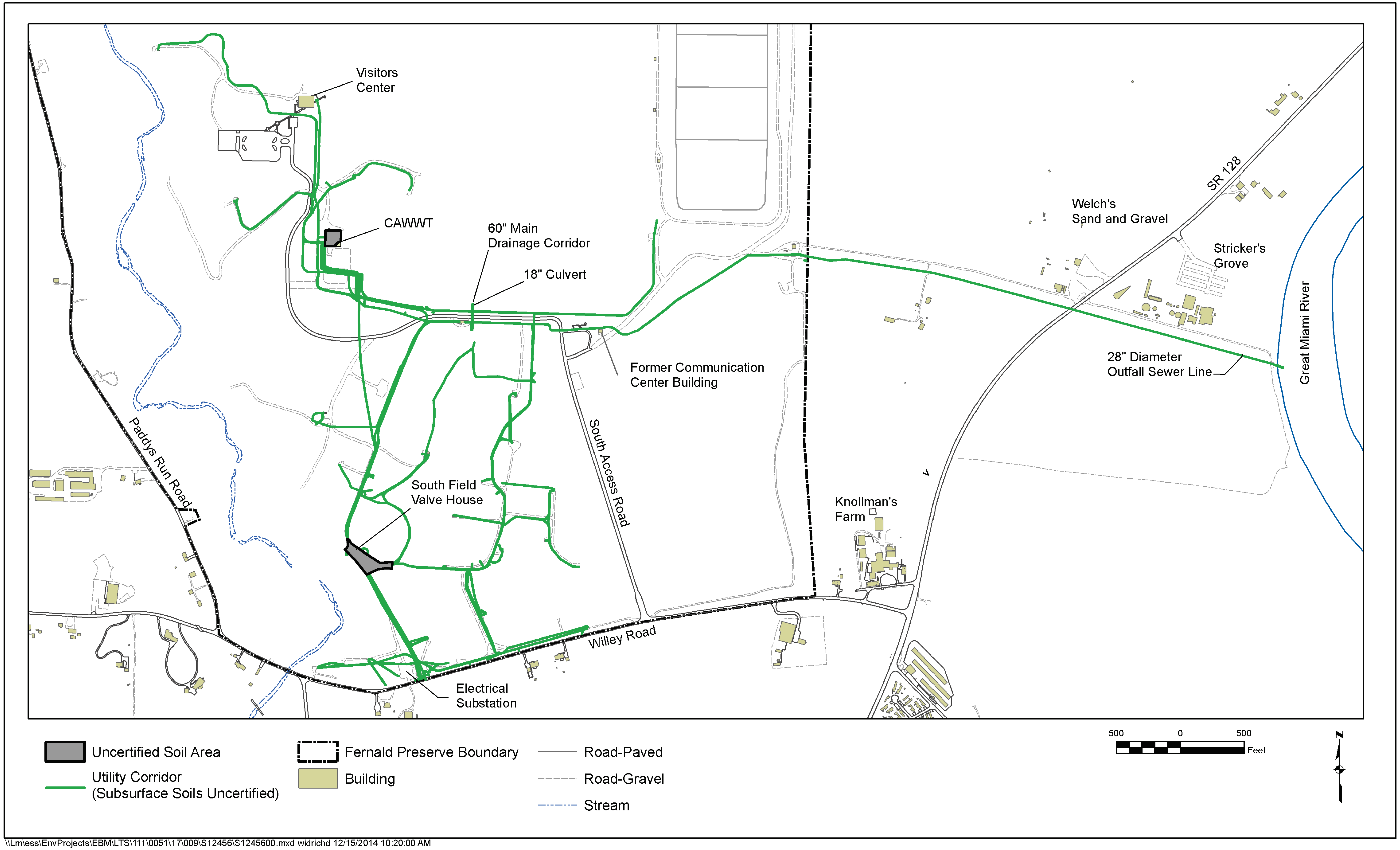


Figure 9. Uncertified Areas and Subgrade Utility Corridors

This page intentionally left blank

Aerial Photograph of OSDF, June 2014

The Converted Advanced Wastewater Treatment Facility

- Monitoring and maintenance of ecologically restored areas continued during 2014, and required site inspections were performed. Minor breaches in or violations of the institutional controls established in the LMICP included occasional instances of hikers straying off trail. Restoration activities included the Paddys Run streambank stabilization project. Other activities within restored areas include construction of a program shelter west of the Visitors Center and installation of a 240 ft (73 m) boardwalk along the Sycamore Trail. Section 6 includes further discussion of the restored area activities and the site inspection process.
- For 2014, the ongoing groundwater remedy resulted in extraction of 2,340 million gallons (M gal) (8,857 million liters [M liters]) of groundwater from the Great Miami Aquifer and removal of 516 lb (234 kg) of uranium from the aquifer. Section 3 discusses groundwater monitoring and remediation performance.

2.2 Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations as part of remediation of the Fernald Preserve. These requirements are referred to as applicable or relevant and appropriate requirements (ARARs). ARARs that are pertinent to remediation of the Fernald Preserve are specified in the ROD for each operable unit. This section of the report highlights some of the major requirements related to environmental monitoring and waste management and describes how the Fernald Preserve complied with these requirements in 2014.

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

2.2.1 RCRA

RCRA regulates the treatment, storage, and disposal of hazardous waste and mixed waste that contains radioactive and hazardous waste components. These wastes are regulated under RCRA and Ohio hazardous waste management regulations; therefore, the Fernald Preserve must comply with legal requirements for managing hazardous and mixed wastes. EPA has authorized Ohio 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 Ohio EPA.

2.2.1.1 RCRA Property Boundary Groundwater Monitoring

The Director’s Findings and Orders for Groundwater, 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 Section 3.

2.2.1.2 Waste Management

Although the RCRA regulations remain applicable, the Fernald Preserve had no hazardous waste treatment, storage, or disposal activities during 2014. Wastes managed during 2014 were limited to universal waste, uncontaminated solid wastes, and small quantities of low-level radioactive wastes. Wastewater from the OSDF is managed through the Clean Water Act.

2.2.2 Clean Water Act

Under the Clean Water Act, as amended, the Fernald Preserve is governed by the National Pollutant Discharge Elimination System (NPDES) regulations that require the control of discharges of nonradiological pollutants to waters of the State of Ohio. The NPDES permit, issued by the State of Ohio for storm water and wastewater, specifies discharge and sample locations, sampling and reporting schedules, and discharge limitations. The Fernald Preserve submits monthly reports on NPDES activities to Ohio EPA demonstrating compliance with stipulated discharge limits.

As discussed further in Section 4.0, the NPDES permit for the site expired on March 31, 2014. The Fernald Preserve discharged under the requirements of the expired permit during the entire calendar year. An NPDES permit application was submitted to Ohio EPA in 2013. A new permit took effect on March 1, 2015.

There was one instance of noncompliance at PF 4001 in 2014 which is discussed in Section 4.3.2.2. An NPDES compliance inspection was not conducted in 2014; however, as part of the NPDES permit application process, submitted to Ohio EPA in 2013, Ohio EPA performed a site visit to observe outfalls, samplings stations, and treatment during 2014.

2.2.3 Clean Air Act

Ohio EPA is authorized to enforce the State of Ohio's air standards for particulate matter at the Fernald Preserve. Compliance is accomplished by implementing the Fugitive Dust Control Policy negotiated between DOE and Ohio EPA in 1997. The policy allows for visual observation of fugitive dust and implementation of dust control measures.

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 requirements. SARA Title III is also known as the Emergency Planning and Community Right to Know Act.

A letter was submitted to Ohio EPA, to the local emergency planning committees of Hamilton and Butler Counties, and to the Crosby Township Fire Department on February 24, 2015, stating that the Fernald Preserve was not required to submit the SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report for 2014. During 2014 there were no chemicals stored on the Fernald Preserve above threshold planning quantities.

Another SARA Title III report, the Section 313 Toxic Chemical Release Inventory Report (Form R), is required if quantities of chemicals released at the Fernald Preserve exceed 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 chemical releases have exceeded the threshold for several years, and no chemical exceeded a reporting threshold during 2014.

Also under SARA Title III, any offsite 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 that might occur at the Fernald Preserve 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. There were no releases at the Fernald Preserve that met the reporting criteria under CERCLA during 2014.

2.2.5 Other Environmental Regulations

The Fernald Preserve is also required to comply with other environmental laws and regulations in addition to those described above. Table 2 summarizes compliance with each of these requirements for 2014.

2.2.6 Other Permits

Certain environmental laws are implemented through permits. The Fernald Preserve's permit for discharging water under NPDES regulations is discussed in Section 2.2.2. In addition, the Fernald Preserve maintains permits administered through the U.S. Fish and Wildlife Service and the Ohio Department of Natural Resources for collection of wildlife specimens. A permit is also in place to remove goose nests, if necessary. This program is discussed further in Section 6.1.2.

2.2.7 Federal Facilities Compliance Agreement

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

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

Table 2. Compliance with Other Environmental Regulations

Regulation and Purpose	Background Compliance Issues	2014 Compliance Activities
Toxic Substances Control Act		
Regulates the manufacturing, use, storage, and disposal of toxic materials, including polychlorinated biphenyls (PCBs) and PCB items.	EPA Region 5 conducted the last routine Toxic Substances Control Act inspection of the Fernald Preserve's program on September 21, 1994. No violations of PCB regulations were identified during the inspection.	No PCB liquids were used, stored, or shipped in 2014.
Ohio Solid Waste Act		
Regulates infectious waste.	The Fernald Preserve was registered with Ohio EPA as a generator of infectious waste (generating more than 50 lb [23 kg] per month) until December 6, 1999, when Ohio EPA concurred with the Fernald Preserve's qualification as a small quantity generator.	No infectious waste was generated in 2014.
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 5 on September 21, 1994, found the Fernald Preserve to be in full compliance with the requirements of the mandated Act.	Pesticide applications at the Fernald Preserve were conducted according to federal and state regulatory requirements.
National Environmental Policy Act		
Requires the evaluation of environmental, socioeconomic, 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 2014.
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 onsite: Cave salamander, state endangered, marginal habitat—small limestone outcrops and streams—none found; Sloan's crayfish, state-threatened—found on northern sections of Paddys Run; Indiana brown bat, federally endangered—found in riparian areas along Paddys Run; Running buffalo clover, federally endangered—potential habitat on disturbed areas along Paddys Run—none found; Spring coral root, state-threatened—potential habitat within northern wooded areas—none found.	A survey for running buffalo clover was conducted in 2014, prior to the Paddys Run streambank stabilization Project and the Sycamore Trail boardwalk, with none found. Additional activities associated with the Paddys Run streambank stabilization project include relocation of 73 Sloan's crayfish to a location upstream of the project area. Bat emergence surveys were also conducted prior to vegetation clearing. No bats were observed. DOE signed a Cooperative Agreement with the U.S. Fish and Wildlife Service and the Cincinnati Zoo to introduce the federally endangered American burying beetle to the Fernald Preserve for 5 years, starting in 2013 (DOE 2012a). The 2014 beetle release (48 pairs) took place in July. A population survey in August 2014 did not find any American burying beetles.

Table 2 (continued). Compliance with Other Environmental Regulations

Regulation and Purpose	Background Compliance Issues	2014 Compliance Activities
Floodplains/Wetlands Review Requirements		
DOE regulations require a floodplain/wetlands assessment for DOE construction and improvement projects.	A wetlands delineation of the Fernald Preserve, completed in 1992 and approved by the U.S. Army Corps of Engineers in August 1993, identified 36 acres (15 hectares) of freshwater wetlands on the Fernald Preserve property. Wetland mitigation monitoring activities from 2009 to 2011 resulted in the delineation of approximately 31 acres (13 hectares) of mitigated jurisdictional wetlands on the Fernald Preserve property.	No assessments were performed in 2014. Long-term monitoring of mitigation wetlands continued in 2014, with amphibian surveys and hydrologic monitoring in shallow piezometers.
National Historic Preservation Act		
Establishes a program for the protection, maintenance, and stewardship of federal prehistoric and historic properties.	The Fernald Preserve is located in an area of sensitive historic and prehistoric cultural resources that are eligible for or are on the National Register of Historic Places. These cultural resources include historic structures, buildings, and bridges, plus Native American villages and campsites.	No archaeological surveys were required in 2014.
Native American Graves Protection and Repatriation Act		
Establishes a means for Native Americans 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 Native American nations or tribes with cultural affiliation to the remains or material.	Native American remains have been discovered during remediation activities at the Fernald Preserve. Native American remains and artifacts have been removed or left in place, with consultation from Native American nations, tribes, and groups.	No Native American remains were discovered or repatriated to Native American nations, tribes, or groups in 2014.
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 Ohio EPA and the U.S. Department of the Interior (administered by the U.S. Fish and Wildlife Service), meet regularly to discuss potential impact to natural resources and to coordinate trustee activities. The trustees also interact with the Fernald Community Alliance.	In November 2008, the State of Ohio and DOE reached a settlement of the 1986 natural resource injury claim at Fernald. While the components of restoration had been established through a 2001 Memorandum of Understanding (DOE 2001d), the State of Ohio and DOE settled outstanding issues such as the payment of monetary penalties, establishment of environmental covenants, and a mutually agreed upon *Natural Resource Restoration Plan* (NRRP), which is Appendix B of the *Consent Decree Resolving Ohio's Natural Resource Damage Claim against DOE* (State of Ohio 2008). In 2009, activities commenced as required in the final NRRP. Activities in 2014 included implementation monitoring of the Former Silos Area restoration project. Also, continuation of functional monitoring and wetland mitigation monitoring was conducted as required by the Wetland Mitigation Monitoring Report (DOE 2012c). Functional monitoring in 2014 involved an evaluation of forest communities across the site, along with species inventory activities. Section 6 provides a summary of Trustee activities and monitoring data.

2.2.8 Environmental Management Systems Requirement

DOE requires that sites develop and implement an Environmental Management System 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 436.1, *Departmental Sustainability*.

The implementation of an Environmental Management System ensures that sound stewardship practices protective of the air, water, land, and other natural and cultural resources potentially affected by operations are employed throughout the project. An Environmental Management System is a systematic process for reducing the environmental impacts resulting from DOE and contractor work activities, products, and services and directs work to proceed in a manner that protects workers, the public, and the environment. The process adheres to "Plan-Do-Check-Act" principles, mandates environmental compliance, and integrates green initiatives into all phases of work, including scoping, planning, construction, subcontracts, and operations. Proposed site maintenance activities will be assessed for opportunities to improve environmental performance and sustainable environmental practices. Some areas for consideration include reusing and recycling products or wastes, using environmentally preferable products (i.e., products with recycled content, products with reduced toxicity, and energy efficient products), using alternative fuels and renewable energy, and making environmental habitat improvements.

The Fernald Preserve is actively involved in an effort to reduce solid, hazardous, radioactive, and mixed waste generation and to eliminate or minimize pollutants released to all environmental media. Various waste streams were recycled during 2014, including:

- 4,696 lb (2,130 kg) of paper
- 17 lb (7.7 kg) of lamps (universal waste)
- 70 lb (32 kg) of aluminum
- 54 lb (24 kg) of batteries
- 1,042 lb (472.6 kg) of electronic equipment
- 23,780 lb (10,786 kg) of copper/iron/steel
- 9,127 lb (4,140 kg) of commingled cardboard, glass, plastic, and paper
- 1,181,451 lb (535,897 kg) of wood
- 86 bales of hay (reused as soil amendment)

The Fernald Preserve'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 13514, *Federal Leadership in Environmental, Energy, and Economic Performance,* and Executive Order 13423*, Strengthening Federal Environmental, Energy and Transportation Management*, the Fernald Preserve uses 30 percent post-recycled-content copier paper. As part of the Annual Site Sustainability Plan required under DOE Order 436.1, the Fernald Preserve generated and submitted a summary report of waste generated and pollution prevention progress in December 2014 (DOE 2014c).

2.3 Split Sampling Program

Since 1987, DOE has participated in the split sampling program with Ohio EPA. 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 close as possible to being identical. The split samples are then submitted to two analytical laboratories; this allows for an independent comparison of data to ascertain quality assurance for laboratory analysis and field sampling methods. Ohio EPA occasionally performs independent sampling in addition to split sampling.

In 2014, DOE and Ohio EPA cooperated in the split sampling program. Table 3 provides the analytical results of split groundwater samples, and Figure 10 shows the split sample locations.

Table 3. 2014 DOE and Ohio EPA Groundwater Split Sampling Comparison

Sample Location[a]	2014 Sample Date	Constituent	DOE Result (µg/L)[b]	Ohio EPA Result (µg/L)	FRL[c] (µg/L)
2060	May	Total Uranium	33.3	35.9	30
2060	October	Total Uranium	32.1	31.83	30
13	May	Total Uranium	7.86	8.74	30
13	October	Total Uranium	6.72	6.38	30
14	May	Total Uranium	3.99	4.50	30
14	October	Total Uranium	3.63	3.98	30

[a] Refer to Figure 10 for groundwater split sample locations.
[b] µg/L = micrograms per liter.
[c] The groundwater pathway and final remediation levels (FRLs) are discussed in Section 3.

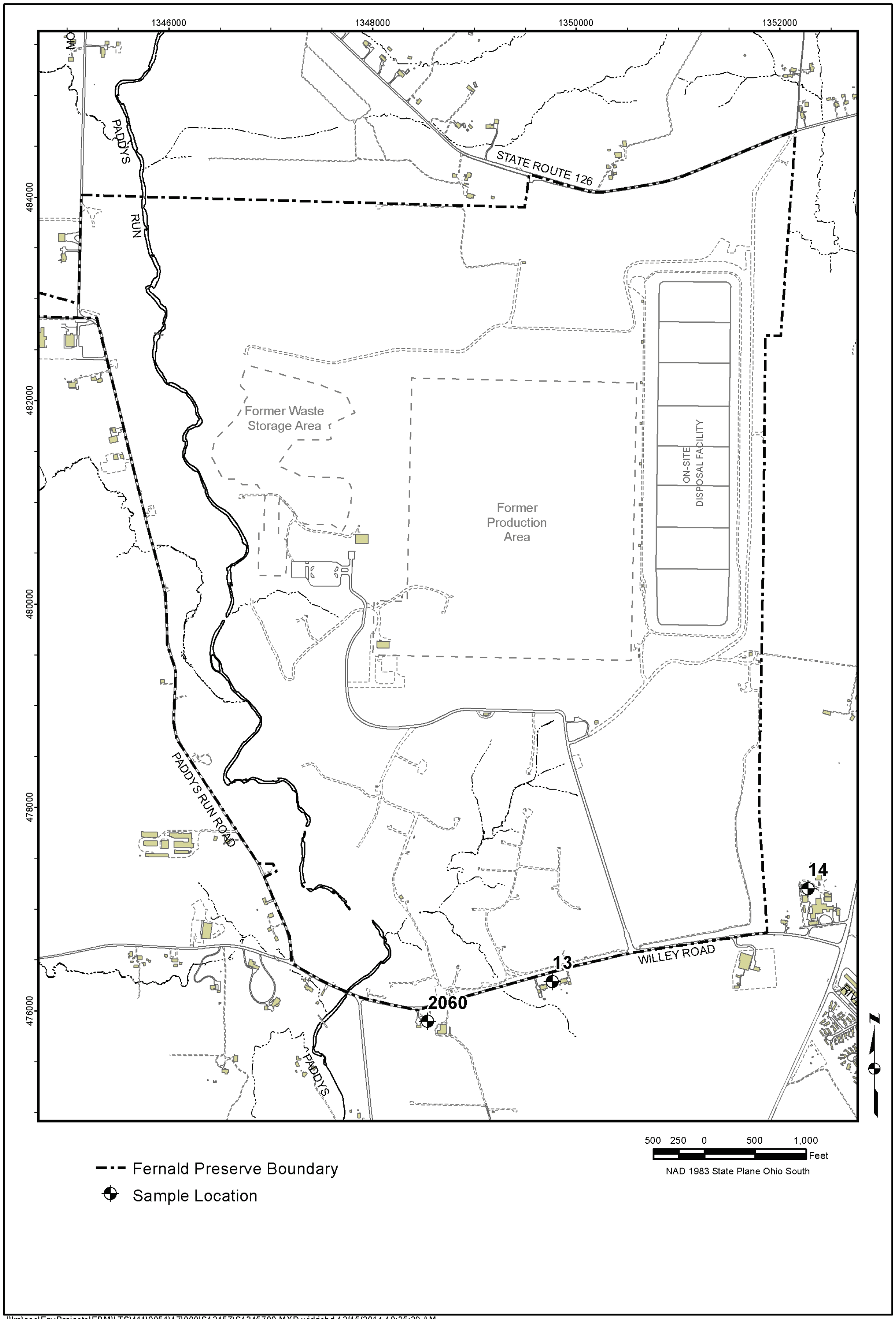


Figure 10. DOE and Ohio EPA Groundwater Split Sample Locations

This page intentionally left blank

3.0 Groundwater Pathway

Results in Brief: 2014 Groundwater Pathway

Groundwater Remedy

Since 1993

- 39,250 M gal (148,561 M liters) of water have been pumped from the Great Miami Aquifer.
- 12,300 net lb (5,584 kg) of uranium have been removed from the Great Miami Aquifer.

During 2014

- 2,340 M gal (8,857 M liters) of water were pumped from the Great Miami Aquifer.
- 516 lb (234 kg) of uranium were removed from the Great Miami Aquifer.

On July 1, 2014, a new operational design for the groundwater remedy was implemented. Three extraction wells that were no longer providing benefit to the remediation were shut down, and the freed up pumping capacity was re-allocated to extraction wells in the South Plume and southern portion of the South Field to accelerate cleanup of those areas. The system pumping rate was also increased 300 gpm from 4,775 gpm to 5,075 gpm.

Groundwater Monitoring Results—Data collected in 2014 show continued progress in reducing uranium concentrations and that the pumping wells were capturing the uranium plume in 2014. Between 2013 and 2014:

- The footprint of the 30 µg/L maximum uranium plume was reduced by 16.4 acres (6.64 hectares) (12.9 percent).
- The footprint of the 50 µg/L maximum uranium plume was reduced by 10.8 acres (4.37 hectares) (14.2 percent).
- The footprint of the 100 µg/L maximum uranium plume was reduced by 2.2 acres (0.89 hectare) (5.9 percent).

OSDF Monitoring—In 2014, the leachate collection system, leak detection system, and Great Miami Aquifer wells of each cell were sampled semiannually for up to 24 parameters. The horizontal till well of each cell was sampled for uranium, arsenic, sodium, and sulfate. The leachate collection system was sampled annually for *Ohio Administrative Code* 3745-27-10 Appendix I constituents and polychlorinated biphenyls. Flow data from the engineered facility, coupled with the water quality monitoring results and the results of quarterly disposal facility physical inspections, indicate that the facility performed as designed in 2014.

This section provides background information on the nature and extent of groundwater contamination in the Great Miami Aquifer due to past operations at the Fernald Preserve and summarizes aquifer restoration progress and groundwater monitoring activities and results for 2014.

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 Preserve. 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

Groundwater Modeling at the Fernald Preserve

The Fernald Preserve 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 laboratory analyses of groundwater samples collected during monitoring activities.

If groundwater monitoring data indicate the need for operational changes to the groundwater remedy, the groundwater 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 (DOE 1995d). 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 (SSOD), the Pilot Plant Drainage Ditch (PPDD), and the Old Drainage Ditch from the Plant 1 Pad. Figure 11 shows the footprint of the 30 micrograms per liter (µg/L) uranium plume within the aquifer.

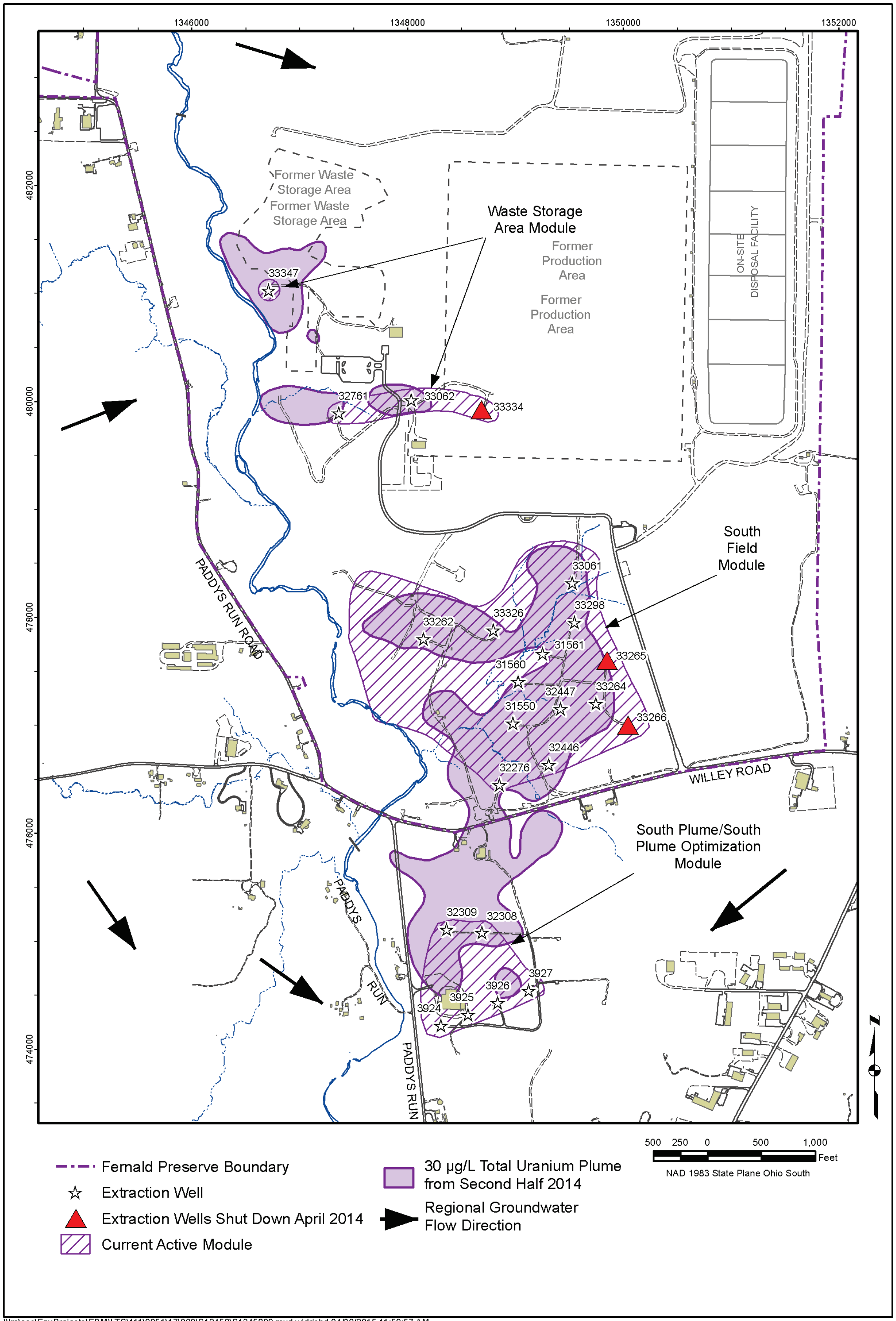


Figure 11. Extraction Wells Active in 2014

In these areas, the glacial overburden is absent (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/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 11 shows South Plume Module extraction wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southward 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 *Remedial Investigation Report for Operable Unit 5* (DOE 1995d), various remediation technologies were evaluated in the *Feasibility Study Report for Operable Unit 5* (DOE 1995a). Remediation cost and various land-use scenarios were considered during the development of the preferred remedy for restoring the quality of groundwater in the aquifer. The *Feasibility Study Report for Operable Unit 5* 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. Groundwater modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gpm (15,140 liters per minute [Lpm]) would remediate the aquifer within 27 years.

The recommended groundwater remedy, which included state and community acceptance, was presented in the *Proposed Plan for Operable Unit 5* (DOE 1995c) as the preferred groundwater remedy. Once the proposed plan was approved, the *Record of Decision for Remedial Actions at Operable Unit 5* (OU5 ROD) (DOE 1996) was issued. The OU5 ROD formally defines the selected groundwater remedy and establishes final remediation levels (FRLs) for all constituents of concern.

Re-injection at the Fernald Site

From 1998 to 2004, re-injection was an enhancement to the groundwater remedy at the Fernald site, supplementing pump-and-treat operations. The term "well-based" refers to the injection of treated groundwater through specially designed re-injection wells. Groundwater pumped from the aquifer was treated via ion exchange 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 groundwater 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 groundwater modeling and the unfavorable results of a cost/benefit analysis, well-based re-injection was discontinued in 2004.

The OU5 ROD 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 1997).

Groundwater modeling studies conducted 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 Ohio EPA approved the enhanced groundwater remedy that relied 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 1997), *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 2002b), *Comprehensive Groundwater Strategy Report* (DOE 2003), the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004), and the *Waste Storage Area Phase II Design Report* and Addendum (DOE 2005b).

The enhanced groundwater remedy commenced in 1998 with the startup of the South Field (Phase I), the South Plume Optimization, and the Re-injection Demonstration Modules. It focused primarily on the removal of uranium but was also designed to limit 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 boundary. Startup of the enhanced groundwater remedy included a year-long re-injection demonstration that began in September 1998. Through the years, extraction and re-injection wells have been added to and removed from these initial restoration modules.

In 2001, EPA and Ohio EPA approved the *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001a). 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 PPDD 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 (well 32761) was installed in 2000 to support an aquifer pumping test to help determine the restoration well field design. The remaining two Phase I wells (well 33062 and well 33063) were installed in summer 2001 after EPA and Ohio EPA approved the design. All three wells became operational on May 8, 2002. Well 33063 was abandoned in 2004 to facilitate site remediation work. A replacement well (well 33334) was installed and began operating in 2006. Figure 11 shows well locations.

The *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001a) also provided data indicating that the uranium plume in the former Plant 6 Area was no longer present. It was believed that the uranium concentrations in the plume had decreased to levels below the FRL as a result of 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 former 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 former Plant 6 Area with one well (well 2389) in the area having sporadic total uranium FRL exceedances. Figure 12 shows the location of monitoring well 2389.

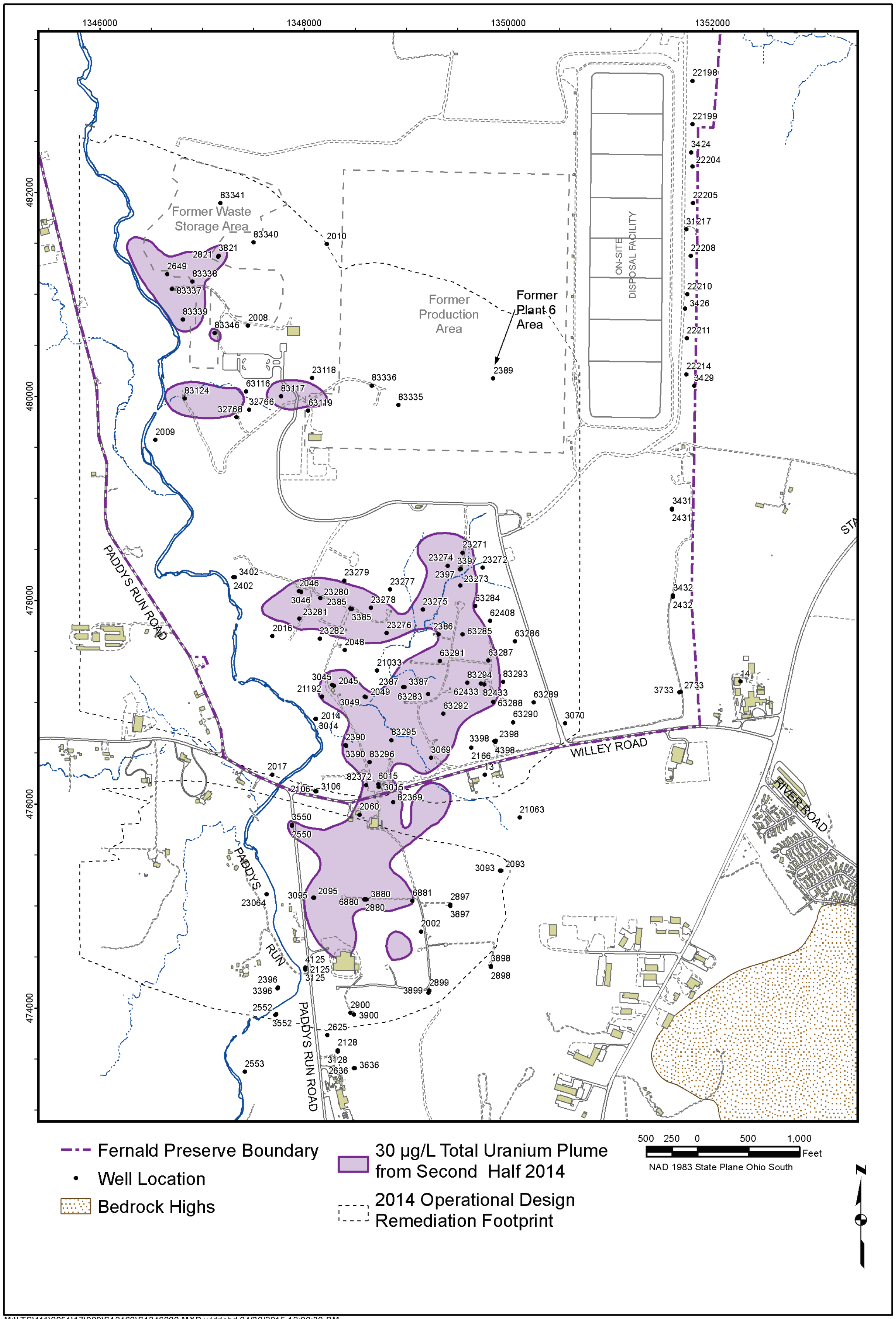


Figure 12. Locations for Semiannual Total Uranium Monitoring

In 2002, EPA and Ohio EPA approved the next planned groundwater restoration design document, the *Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module* (DOE 2002b). 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 began 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* (DOE 2003). In October 2003, DOE held initial discussions 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 Ohio EPA 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 Ohio EPA 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 OSDF 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 in 2004 on the basis of groundwater modeling cleanup predictions presented in the *Comprehensive Groundwater Strategy Report* (DOE 2003) and the *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004). The updated modeling indicated that the aquifer restoration time frame would likely be extended beyond dates previously predicted as a result of refined modeling input. The updated modeling also indicated that continued use of the groundwater re-injection wells would shorten the aquifer remedy by approximately 3 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 (CAWWT). All re-injection wells remain in place as potential groundwater remedy performance monitoring locations.

In 2005, the *Waste Storage Area Phase II Design Report* (DOE 2005b) was issued. Comments received from EPA and Ohio EPA resulted in the issuance of an addendum to the report in December 2005. The design consisted of the installation of one more extraction well (well 33347) in the former Waste Storage Area, near the Former Silos Area. Figure 11 shows the location of well 33347.

In 2005, an infiltration test was conducted in the SSOD. The test consisted of gauging the flow into and out of the SSOD with six Parshall flumes to obtain the overall infiltration rate along the SSOD. Findings from the test were included in the *Storm Sewer Outfall Ditch Infiltration Test Report* (DOE 2005a). The decision was made that pumped clean groundwater would supplement natural storm water flow into the SSOD. This activity continued from 2006 through 2012, when DOE concluded that enough data had been collected to document infiltration rates through the base of the SSOD. Under normal flow conditions, potential infiltration to the aquifer from within the monitored portion of the SSOD (while flowing at or near 500 gpm [1,893 Lpm]) is approximately 109 to 129 gpm (413 to 488 Lpm). With Ohio EPA and EPA concurrence, the flumes were removed in 2013 to allow water to flow down the SSOD unencumbered by the flumes. The rapid movement of water through the ditch during storm events will help to scour the ditch channel of fine-grained sediment and should increase the potential for infiltration.

The *Fernald Groundwater Certification Plan* (DOE 2006a) was issued and approved by EPA and Ohio EPA in 2005. Ohio EPA approved Revision 2 of the plan in 2006. Revision 2 addressed Ohio EPA comments 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 Ohio EPA. The *Fernald Groundwater Certification Plan* (DOE 2006a) 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 brought the total number of extraction wells in the former Waste Storage Area to four (wells 32761, 33062, 33334, and 33347). These four well locations are shown in Figure 11.

In 2014, with approval from EPA and Ohio EPA, DOE implemented operational changes to the groundwater remedy. Three wells no longer providing benefit to the groundwater remediation were shut down. The freed up pumping budget was reallocated to the South Plume and South Field to accelerate cleanup of those areas. The operational changes were based on groundwater modeling results reported in 2014 (DOE 2014). The new 2014 design is referred to in this report as the 2014 Operational Design which was implemented on July 1, 2014. Figure 11 shows the extraction well locations that were active in 2014. The following subsections present the operational information associated with these modules.

3.3 Groundwater Monitoring Highlights for 2014

For this annual Site Environmental Report, groundwater monitoring results are discussed in terms of restoration and compliance monitoring. The key elements of the Fernald Preserve groundwater monitoring program design are described below.

Sampling: Sample locations, frequency, and constituents address operational assessment, restoration assessment, and compliance requirements. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction.

As part of the comprehensive groundwater monitoring program specified in the current IEMP, 140 wells were monitored for water quality in 2014. Figure 12 identifies the location of the current water quality sampling locations for uranium. Figure 13 is a diagram of a typical groundwater monitoring well. Figure 14 illustrates monitoring well depths and screen locations. Figure 15 indicates the location for semiannual non-uranium monitoring. In addition to water quality monitoring, 179 wells are utilized to measure groundwater elevations to verify groundwater flow direction. Figure 16 depicts the routine water level (groundwater elevation) monitoring wells.

Additionally, 27 locations were sampled using a direct-push sampling tool in 2014. Results are provided in Appendix A, Attachment A.2.

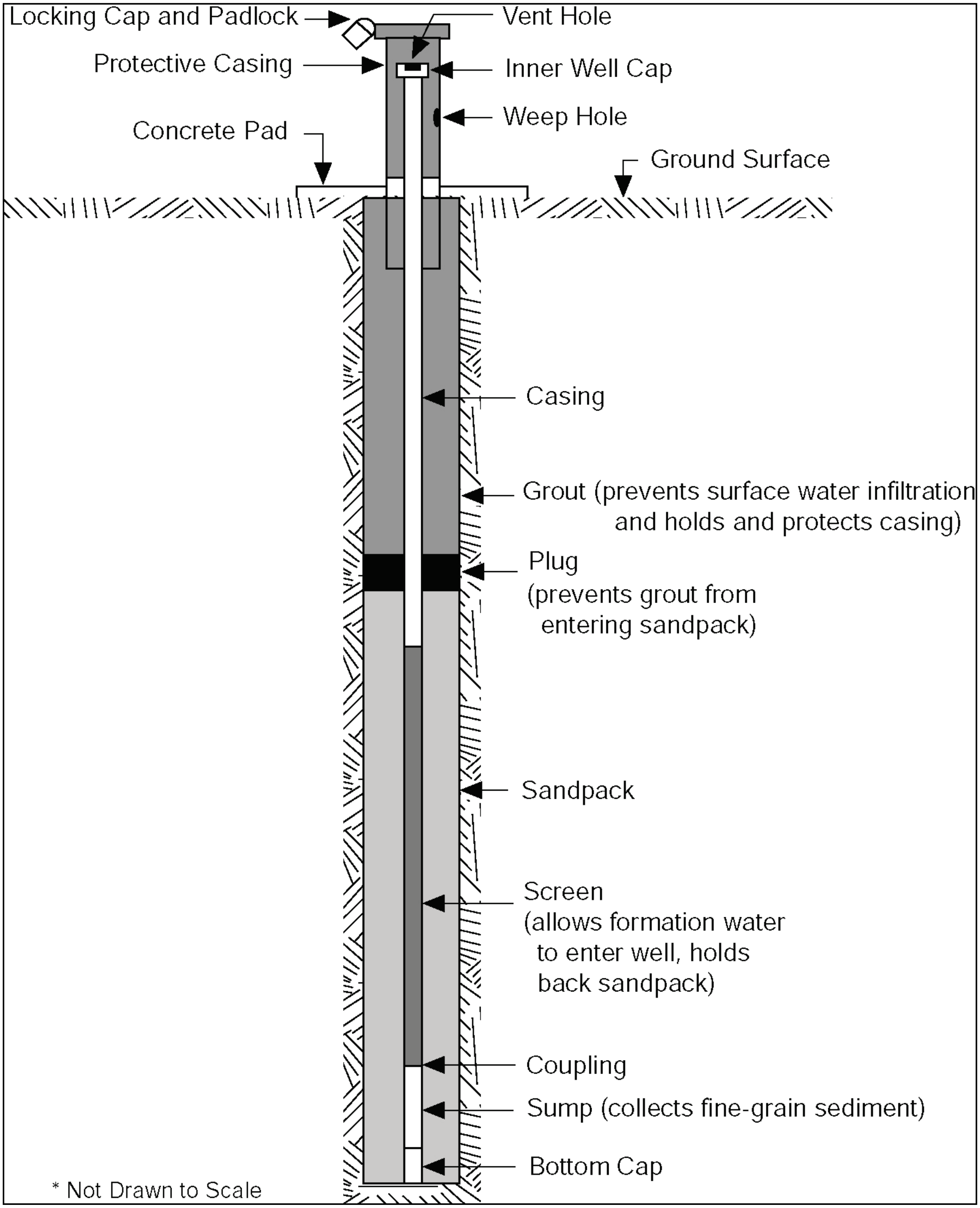


Figure 13. Diagram of a Typical Groundwater Monitoring Well

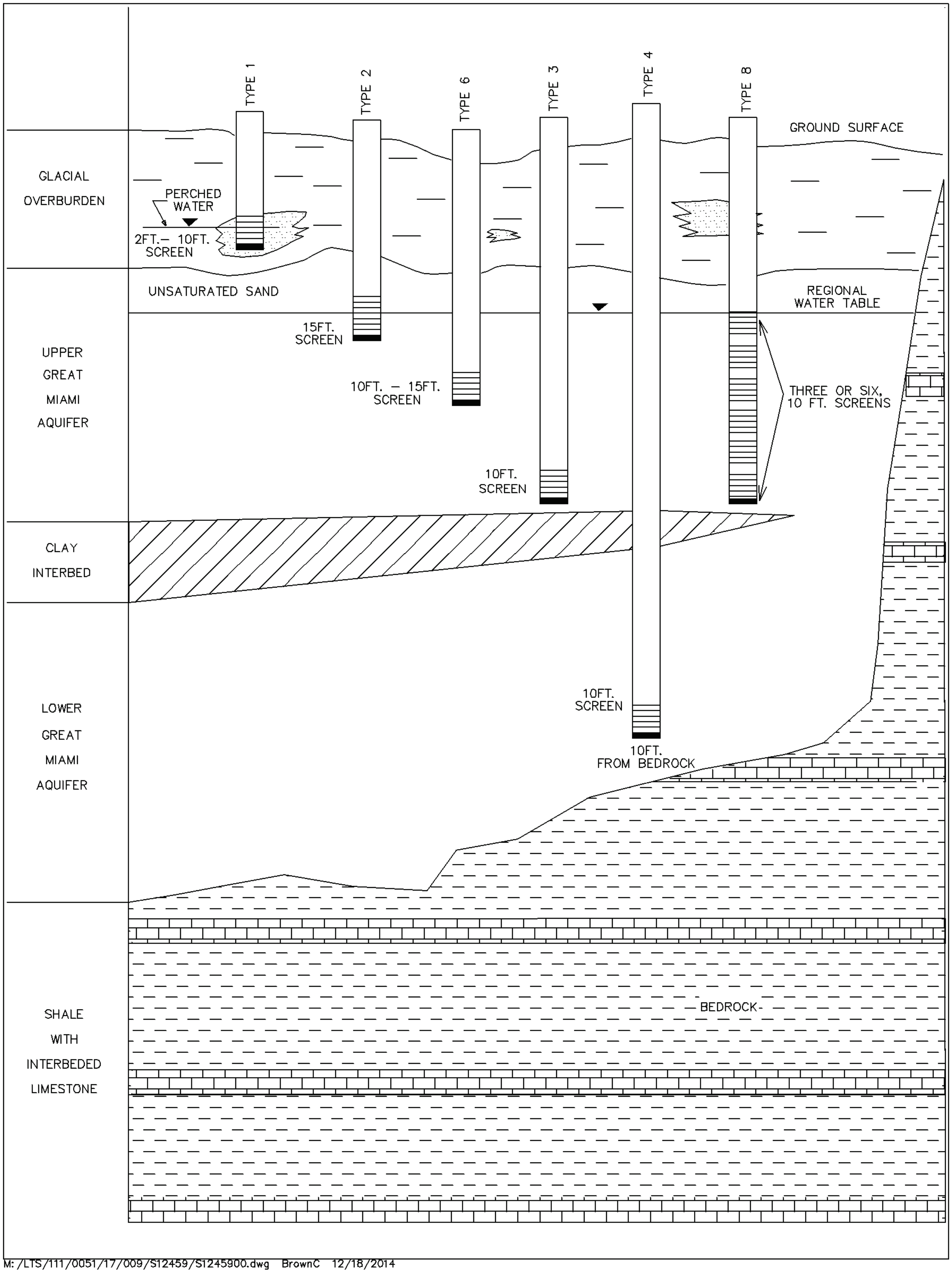


Figure 14. Monitoring Well Screen Locations

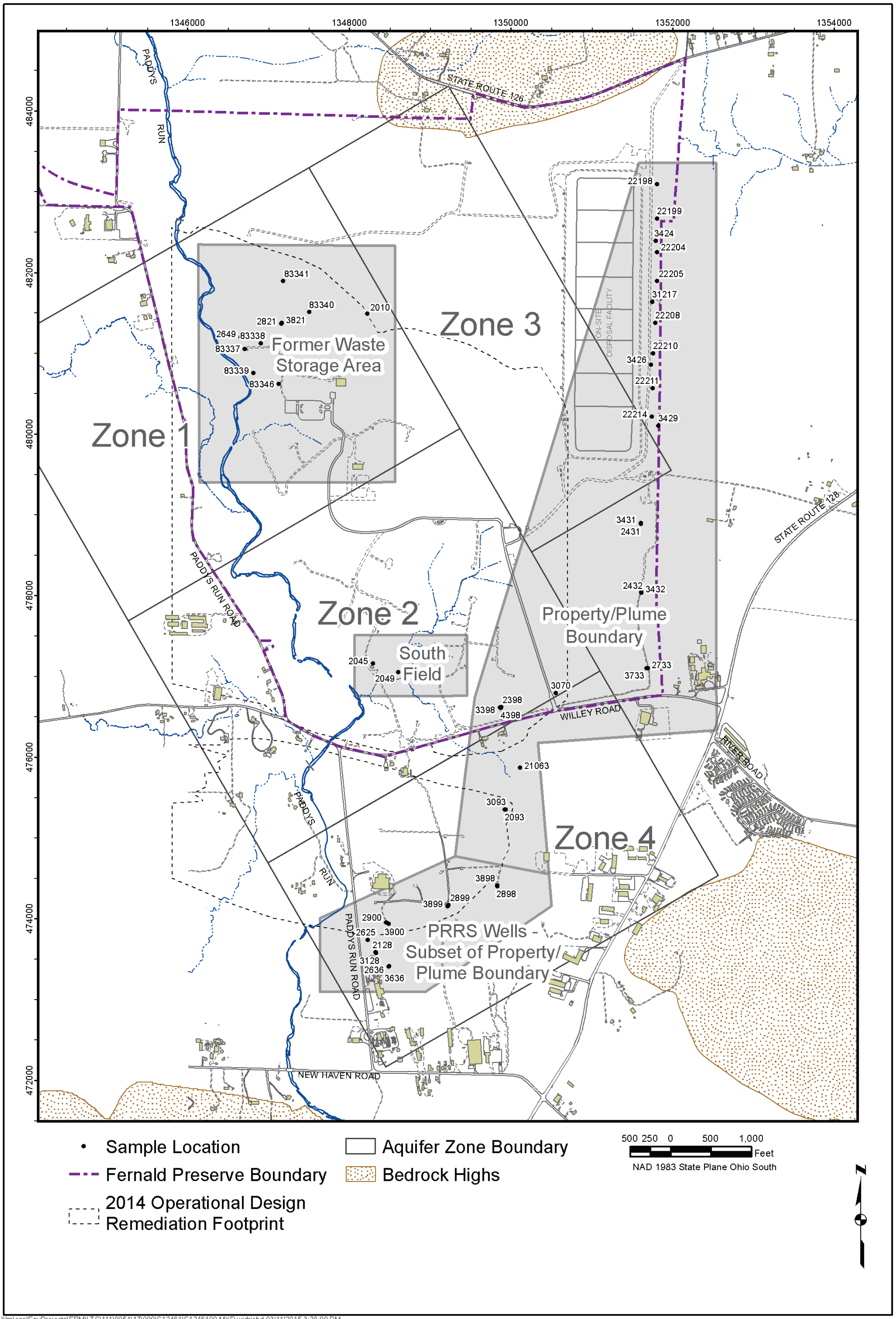
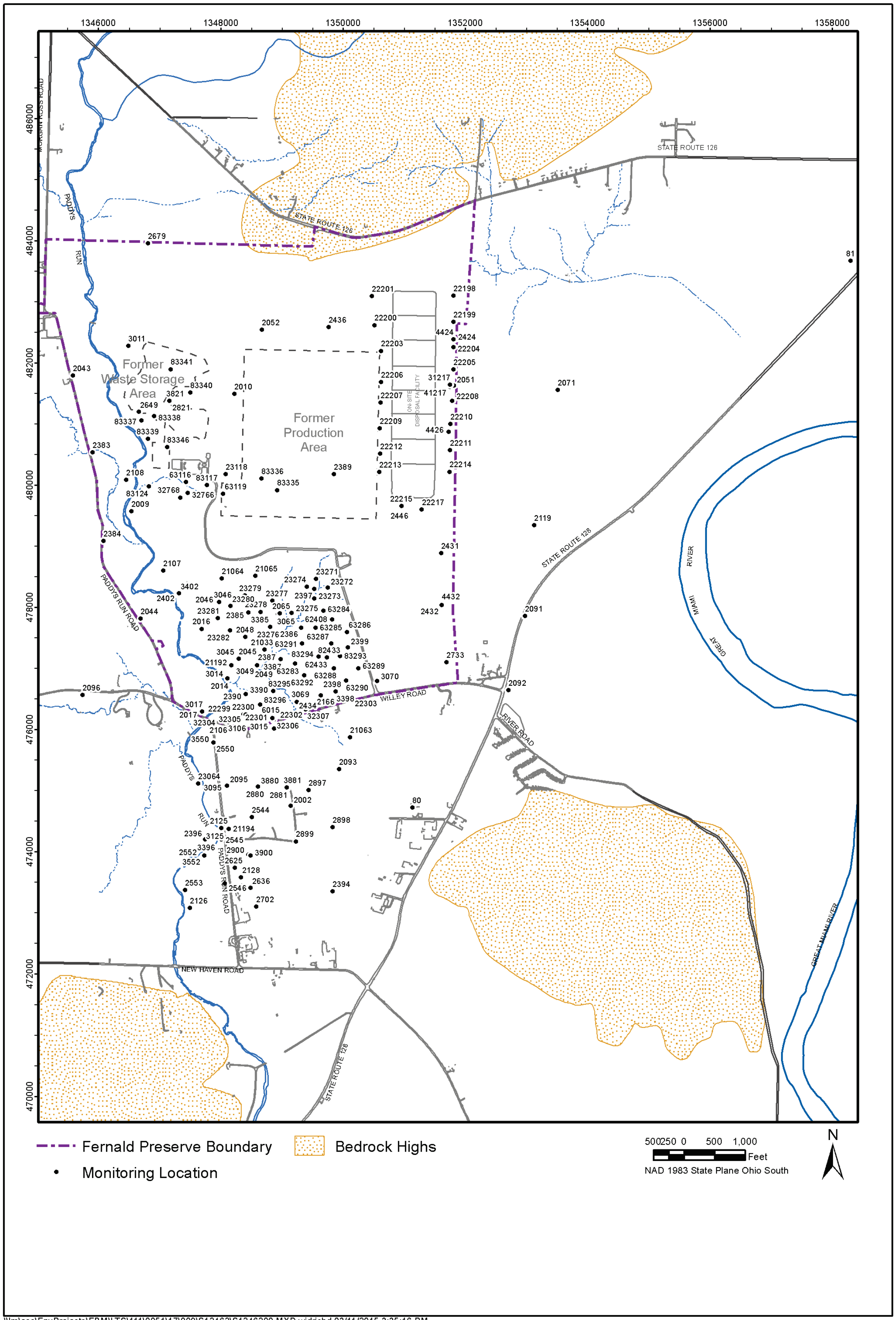


Figure 15. Locations for Semiannual Non-Uranium Monitoring



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12462\S1246200.MXD widrichd 03/11/2015 3:35:16 PM

Figure 16. Groundwater Elevation Monitoring Wells

Data Evaluation: The integrated data evaluation process involves review and analysis of the data collected from wells and direct-push sampling locations. The evaluation determines 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. The Paddys Run Road Site is a separate contaminant plume unrelated to the Fernald Preserve and resulted from industrial activities in the area south of the Fernald Preserve along Paddys Run Road.

Reporting: All data are reported in the annual Site Environmental Reports.

3.3.1 Restoration Monitoring

The OU 5 ROD (DOE 1996) states that "areas of the Great Miami Aquifer exceeding final remediation levels will be restored through extraction methods." Uranium is the primary constituent of concern for groundwater. The groundwater FRL for total uranium is 30 µg/L. The background total uranium concentration for unfiltered groundwater samples from the Great Miami Aquifer near the Fernald Preserve is 1.2 µg/L. Both the area of the aquifer targeted for remediation and the statistical procedures that will be used to verify that the aquifer cleanup objectives have been achieved are presented in the *Fernald Groundwater Certification Plan* (DOE 2006a).

In general, restoration monitoring tracks the progress of the pump-and-treat stage of the groundwater remedy and water quality conditions. Operations 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 to show the status of remediation progress and to verify capture of the uranium plume.

Operational changes were implemented on July 1, 2014. From January 1 to June 30, 2014, the remediation system operated to pumping rates defined in the *Waste Storage Area Phase II Design* (DOE 2005b), which was established in 2005. The Waste Storage Area Phase II Design called for the operation of 23 extraction wells at a target pumping rate of 4,775 gpm. From July 1 to December 31, 2014, the remediation system operated to the *Operational Design Adjustments-1 Design* (DOE 2014b). The new 2014 design requires the operation of 20 extraction wells at a target pumping rate of 5,075 gpm. The operational changes are further discussed in Appendix A, Section A.1.1.

Because of the operational change noted above, 23 extraction wells were operational from January 1 to April 15, 2014. On April 15, 2014, three extraction wells were shut down in preparation of the operational change on July 1, 2014; therefore, between April 15 and December 31, 2014, only 20 extraction wells were operational.

Appendix A provides more-detailed information. Sections that follow identify the specific attachment of Appendix A where the detailed information can be found.

3.3.1.1 Operational Summary

Until 2014, the amount of groundwater that needed to be treated to maintain compliance with the monthly average uranium discharge concentration limit had decreased dramatically since the remediation began. The aquifer remedy could achieve the uranium discharge limits (i.e., average monthly concentration of less than 30 µg/L and 600 lb [272 kg] annually) established in the OU5 ROD without groundwater treatment. In 2011, DOE, EPA, and Ohio EPA agreed to proceed with reducing the treatment capacity of the CAWWT from approximately 1,800 gpm (6,814 Lpm) to 500 to 600 gpm (1,893 to 2,271 Lpm). With implementation of the 2014 Operational Design changes, groundwater treatment was once again needed from July through November in order to meet the discharge limits.

In September 2012, with concurrence from EPA and Ohio EPA, a pulse-pumping exercise began at extraction wells 31550, 31560, 31561, and 33061. These four wells are equipped with pumps and motors that operate most efficiently at rates of approximately 300 gpm (1,140 Lpm). The Waste Storage Area (Phase II) Design called for a target pumping rate of 100 gpm (379 Lpm) for each of these wells. The 100 gpm rate was being achieved by throttling back on the flow from each of the wells; however, this type of operation was not energy efficient.

To become more energy efficient, the wells were being pumped at a higher rate for a shorter period of time each day to remove the daily volume of water prescribed by the Waste Storage Area (Phase II) Design (DOE 2005b). Specifically, the wells are being pumped for 300 gpm (1,140 Lpm) for 8 hours a day (a total of 144,000 gallons [545,100 liters] per day) rather than 100 gpm (379 Lpm) for 24 hours a day (a total of 144,000 gallons per day). Flow and particle path monitoring predictions indicate that the new pumping schedule will maintain capture of the 30 µg/L uranium plume. With implementation of the 2014 Operational Design, the target pumping rate of extraction well 31561 was increased from 100 gpm to 200 gpm, so pulse pumping was stopped at this well. Pulse pumping continues for the other three wells under the 2014 Operational Design.

Figure 11 shows the extraction well locations associated with the restoration modules operating in 2014. Also shown on Figure 11 are the three extraction wells that were shut down in April of 2014. Table 4 summarizes the mass of uranium removed and the volume of groundwater pumped during 2014. Additional details are provided in the module operational summaries in Sections 3.3.1.2 through 3.3.1.4. Figure 17 identifies the yearly and cumulative mass of uranium removed from the Great Miami Aquifer from 1993 through 2014.

Since 1993:

- 39,250 M gal (148,561 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.
- 12,300 net lb (5,584 kg) of total uranium have been removed from the Great Miami Aquifer.

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

Table 4. Groundwater Restoration Module Status for 2014

Modules and Restoration Wells[a]	Target Pumping Waste Storage Area Phase II Design[b]		Target Pumping 2014 Operational Design[b]		Volume Pumped (Millions)		Uranium Removed[c]	
	gpm	Lpm	gpm	Lpm	gallons	liters	lb	kg
South Plume/ South Plume Optimization Module: 3924, 3925, 3926, 3927, 32308, 32309	1,200	4,542	1,400	5,299	618	2,339	103	47
South Field Module: 31550, 31560, 31561, 32276, 32446, 32447, 33061, 33262, 33264, 33265, 33266, 33298, 33326	2,575	9,746	2,875	9,746	1,312	4,966	331	150
Waste Storage Area Module: 32761, 33062, 33334, 33347	1,000	3,785	800	3,028	411	1,556	82	37
Aquifer Restoration System Total Pumped	4,775	18,073	5,075	19,209	2,340	8,857	516	234

[a] Extraction wells 33265, 33266 and 33334 were shut down in April 2014.
[b] gpm = gallons per minute, Lpm = liters per minute.
[c] lb = pounds, kg = kilograms

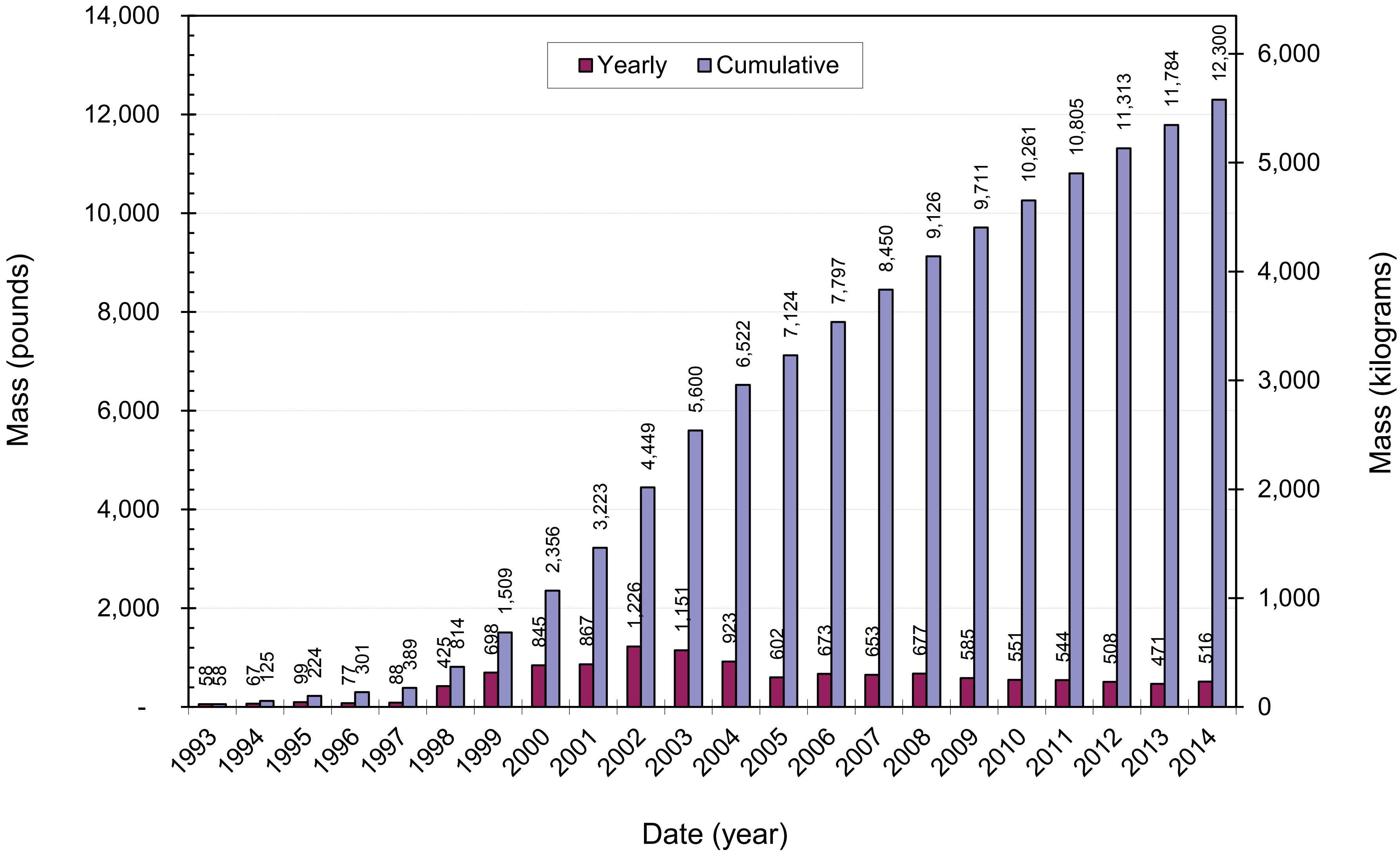


Figure 17. Net Mass of Uranium Removed from the Great Miami Aquifer, 1993–2014

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 18 illustrates the southern extent of capture observed for the South Plume/South Plume Optimization Module in the fourth quarter of 2014.

During 2014, the South Plume/South Plume Optimization Module removed 618 M gal (2,339 M liters) of groundwater and 103 lb (47 kg) of uranium from the Great Miami Aquifer. Based on analysis of the data collected in 2014, the module continues to meet its primary objectives as demonstrated by the following:

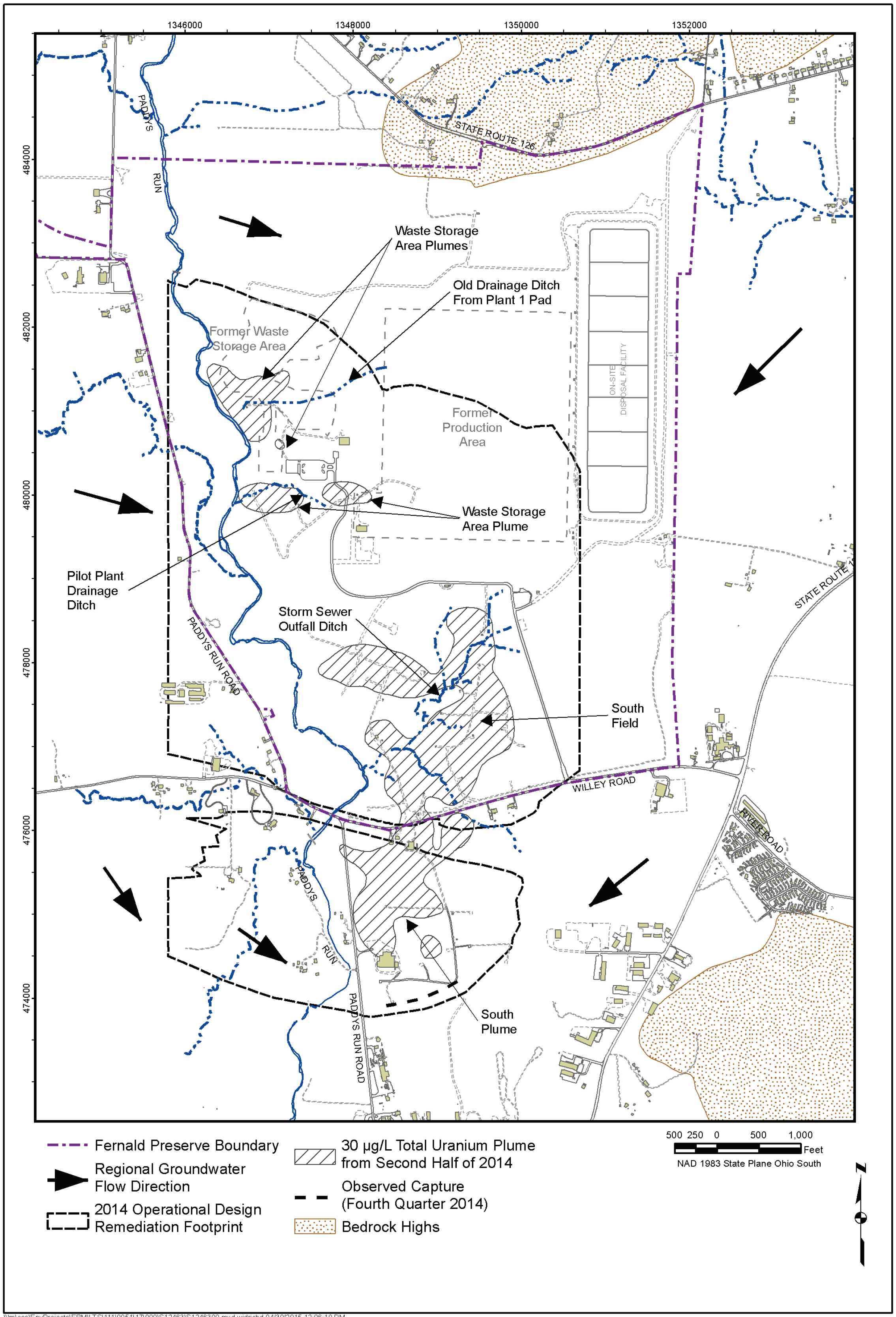
- Southward movement of the uranium plume beyond the southernmost extraction wells has not been detected.
- Active remediation of the central portion of the off-property uranium plume continues to reduce plume concentration. Nearly the entire off-property uranium plume concentration is now below 100 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 pulled toward the South Plume Extraction Wells.

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 2014, 13 extraction wells were operational from January 1 to April 14, and 11 extraction wells were operational from April 14 to December 31, 2014.

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 shut down (31564, 31565, 31566, 31563, 31562, and 31567).

- Extraction wells 31564 and 31565 were shut down in December 2001 and May 2001, respectively, because these wells were located near the upgradient edge of the plume, uranium concentrations in that region of the aquifer were low, and soil remediation was underway in the area around the wells.
- 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 operated in 2003 and 2004.
- Extraction well 31562 was shut down in March 2003 and replaced by extraction well 33298.
- Extraction well 31567 was shut down in September 2005 and replaced by extraction well 33326.



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12463\S1246300.mxd widrichd 04/30/2015 12:06:19 PM

Figure 18. Total Uranium Plume in the Aquifer with Concentrations Greater Than 30 µg/L at the End of 2014

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* (DOE 2002b), 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 former 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 former Southern Waste Units area (re-injection well 33263).
- An extraction well (31563) that was converted into a re-injection well.
- An injection pond that was located in the western portion of the former Southern Waste Units excavations.

In September 2004, the South Field Module re-injection components were shut down.

In 2014, operational changes were made to wells in the South Field following recommendations made in a modeling study that was released in 2014 (DOE 2014b). On April 14, 2014, extraction wells 33265 and 33266 were shut down because the data indicated that they were no longer providing benefit to the groundwater remedy.

During 2014, the South Field Module removed 1,312 M gal (4,966 M liters) of groundwater and 331 lb (150 kg) of uranium from the Great Miami Aquifer.

3.3.1.4 Waste Storage Area Module Operational Summary

The Waste Storage Area Module was constructed in two phases. Phase I 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. Phase I consisted of three extraction wells (32761, 33062, and 33063). These three wells were installed to remediate a uranium plume in the PPDD area, according to the *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001a). In July 2004, extraction well 33063 was plugged and abandoned to make way for surface excavation activities required for site remediation. A replacement well for extraction well 33063 was installed in 2005 (extraction well 33334) and became operational June 29, 2006. Phase II consisted of one additional extraction well (extraction well 33347), which became operational on October 5, 2006.

In 2014, operational changes were made to wells in the Waste Storage Area following recommendations made in a modeling study that was released in 2014 (DOE 2014b). On

April 14, 2014, extraction well 33334 was shut down because the data indicated that it no longer provided a benefit to the groundwater remedy.

During 2014, 411 M gal (1,556 M liters) and 82 lb (37 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

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant, and it has affected the largest area of the aquifer. Figure 18 shows the mapped outline of the total uranium plume in the aquifer updated through the end of 2014. The hatched areas represent the interpreted size of the maximum uranium plume in which concentrations are above the 30 µg/L groundwater FRL for total uranium.

Data collected in 2014 indicate that uranium concentrations in the aquifer continue to decrease in response to pumping, as described below.

- In 2014, the mapped footprint of the 30 µg/L uranium plume decreased in size by 16.4 acres (6.64 hectares) (12.9 percent). The area above 30 µg/L in 2013 was mapped as being 127.3 acres (51.52 hectares), and the area above 30 µg/L in 2014 was mapped as being 110.9 acres (44.88 hectares).
- In 2014, the area of the uranium plume above a concentration of 50 µg/L decreased in size by 10.8 acres (4.37 hectares) (14.2 percent). The area above 50 µg/L in 2013 was mapped as being 76.3 acres (30.0 hectares), and the area above 50 µg/L in 2014 was mapped as being 65.5 acres (26.5 hectares).
- In 2014, the area of the uranium plume above a concentration of 100 µg/L decreased in size by 2.2 acres (0.89 hectare) (5.9 percent). The area above 100 µg/L in 2013 was mapped as being 37.1 acres (15.0 hectares), and the area above 100 µg/L in 2014 was mapped as being 34.9 acres (14.1 hectares).

Figure 18 identifies capture observed during the fourth quarter of 2014 for the active restoration modules and also presents regional groundwater flow directions. The map indicates that the existing extraction system is capturing the South Plume and preventing further movement of uranium to the south of the extraction wells. Figure 18 also depicts the time-of-travel remediation footprint that was predicted by modeling the 2014 Operational Design.

Appendix A, Attachment A.2, provides detailed uranium plume maps for 2014. Appendix A, Attachment A.3, provides quarterly groundwater elevation maps and capture interpretations, along with graphical displays of groundwater elevation data. Highlights for 2014 for the former Waste Storage Area, former Plant 6 Area, and South Field/South Plume area are provided below.

Geoprobe (Direct-Push) Sampling
The Geoprobe, a hydraulically powered, direct-push sampling tool, is used at the Fernald Preserve to obtain groundwater samples at specific intervals without installing a permanent monitoring well. Direct-push employs the weight of the vehicle the tool is mounted on and percussive force (hammering) to push the tool into the ground without drilling (or cutting) to displace soil in the tool's path. The Fernald Preserve 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.

Former Waste Storage Area: This area includes the PPDD plume. In 2014, direct-push samples were collected from four locations in the former Waste Storage Area to supplement routine sampling of monitoring wells.

In 2014, the mapped footprint of the 30 µg/L uranium plume decreased in size by 1.5 acres (0.6 hectare). The area above 30 µg/L in 2013 was mapped as being 20.6 acres (8.3 hectares), and the area above 30 µg/L in 2014 was mapped as being 19.1 acres (7.7 hectares). Figure 18 shows the outline of the maximum uranium plumes in the former Waste Storage Area, as measured during the second half of 2014. Data are presented in Appendix A, Attachment A.2.

Former Plant 6 Area: Plans for a restoration module in the former Plant 6 Area were abandoned in 2001 based on the outcome of the *Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas* (DOE 2001a). The design data indicated that the total uranium plume in the former Plant 6 Area was no longer present. EPA and Ohio EPA concurred with this decision. Monitoring in the area continues.

Monitoring well 2389 is the only well remaining in the area. Uranium FRL exceedances were detected at this well again in 2014. As discussed in past reports, FRL exceedances occur in this area when the water table elevation exceeds 515 ft (157 m) above mean sea level. The two samples collected in 2014 at monitoring well 2389 had uranium concentrations above 50 µg/L. Both samples were collected when the water table had an elevation of approximately 515 ft (157 m) above mean sea level. The Former Plant 6 area will continue to be targeted for additional direct-push sampling when the water table is high to determine if the uranium groundwater FRL exceedance is dissipating over time. This location is within capture of the pump-and-treat system.

South Field and South Plume Areas: In 2014, direct-push samples were collected at 12 locations in the South field and South Plume areas to supplement routine sampling of monitoring wells. Direct-push data for 2014 are presented in Appendix A, Attachment A.2.

Uranium concentration data collected in 2014 indicate that uranium concentrations in the South Field and South Plume continue to decrease in response to pumping, as described below.

In 2014, the mapped footprint of the 30 µg/L uranium plume in the South Field and South Plume decreased by 15 acres (6.07 hectares). The area above 30 µg/L in 2013 was mapped as being 106.8 acres (43.2 hectares), and the area above 30 µg/L in 2014 was mapped as being 91.8 acres (37.2 hectares).

In 2014, the area of the uranium plume in the South Field and South Plume above a concentration of 50 µg/L decreased by 10 acres (4 hectares). The area above 50 µg/L in 2013 was mapped as being 62.4 acres (25.3 hectares), and the area above 50 µg/L in 2014 was 52.4 acres (21.2 hectares).

In 2014, the area of the uranium plume in the South Field and South Plume above a concentration of 100 µg/L decreased by 1.8 acres (0.7 hectare). The area above 100 µg/L in 2013 was mapped as being 27.3 acres (11 hectares), and the area above 100 µg/L in 2014 was mapped as being 25.5 acres (10.3 hectares).

3.3.1.6 Monitoring Results for Non-Uranium Constituents

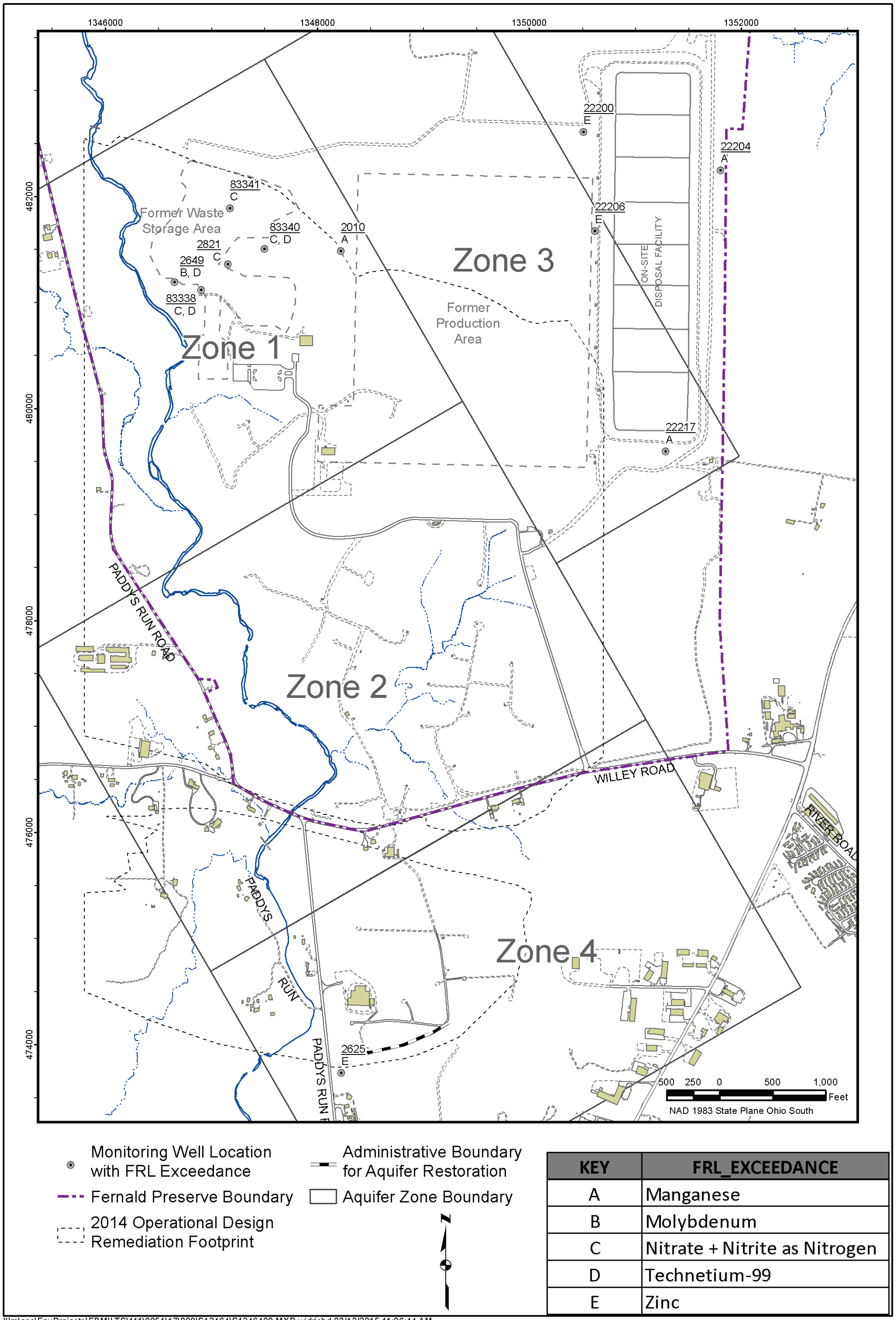
Although the groundwater remedy is primarily targeting remediation of the uranium plume, other FRL constituents within the uranium plume are also being monitored. Figure 19 identifies the locations of the wells that had non-uranium FRL exceedances. Table 5 shows the number of wells with constituents exceeding FRLs in 2014, the number of wells with constituents exceeding FRLs outside the 2014 Operational Design Remediation Footprint, the groundwater FRLs, and the range of 2014 data inside and outside the 2014 Operational Design Remediation Footprint.

Table 5. Non-Uranium Constituents with Results Above FRLs During 2014

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the 2014 Operational Design Remediation Footprint	Groundwater FRL[a]	Range of 2014 Data Inside the 2014 Operational Design Remediation Footprint[a,b]	Range of 2014 Data Outside the 2014 Operational Design Remediation Footprint[a,b]
General Chemistry			(mg/L)	(mg/L)	(mg/L)
Nitrate/Nitrite as N	7	0	11[c]	12.9 to 56.7	NA
Inorganics			(mg/L)	(mg/L)	(mg/L)
Manganese	3	2	0.90	1.44	0.996 to 1.26
Molybdenum	1	0	0.10	0.282 to 0.320	NA
Zinc	3	3	0.021	NA	0.0418 to 0.0499
Radionuclides			(pCi/L)	(pCi/L)	(pCi/L)
Technetium-99	4	0	94	106 to 321	NA

[a] mg/L = milligrams per liter, µg/L = micrograms per liter, pCi/L = picocuries per liter
[b] NA = not applicable
[c] FRL based on nitrate from OU5 ROD, Table 9-4; however, the sampling results are for nitrate/nitrite as nitrogen.

During 2014, five non-uranium constituents had FRL exceedances. Several of the locations are outside the 2014 Operational Design remediation footprint. No plumes for the non-uranium constituents above FRLs at the locations outside the 2014 Operational Design remediation footprint were identified in the extensive groundwater characterization efforts evaluated as part of the *Remedial Investigation Report for Operable Unit 5* (DOE 1995d).



KEY	FRL_EXCEEDANCE
A	Manganese
B	Molybdenum
C	Nitrate + Nitrite as Nitrogen
D	Technetium-99
E	Zinc

Figure 19. Non-Uranium Constituents with 2014 Results Above FRLs

Non-uranium constituents with FRL exceedances at the well locations outside the 2014 Operational Design remediation footprint were further evaluated to determine if they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment A.4. One of the exceedances in 2014 was classified as persistent (manganese at monitoring well 22204). In past years, many of the exceedances identified as persistent became non-persistent in later years. A change in the design of the aquifer remedy to address the persistent exceedance at monitoring well 22204 is not planned. Additional sampling for manganese near the OSDF was conducted in 2008 (and reported in the *Fernald Preserve 2008 Site Environmental Report* [DOE 2009a]) to determine if a localized manganese plume was present. Results did not support the presence of a localized manganese plume.

The manganese FRL is 0.90 milligram per liter (mg/L) and is based on background values in the aquifer. Unconsolidated glaciofluvial aquifers in Ohio have relatively high manganese concentrations naturally. Manganese is found in shale, which is a major component of bedrock in the area. The background value upon which the groundwater FRL is based may not be representative of the aquifer.

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 (2060, 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the uranium plume migration. Off-property groundwater contamination was initially detected at one of these wells (well 2060) in 1981. In 1997, 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 18.

During 2014, Property/Plume Boundary monitoring consisted of 36 monitoring wells located downgradient of the Fernald Preserve, along the eastern and southern portions of the property boundary. Twenty-five of these wells were monitored along the eastern Fernald Preserve boundary and slightly downgradient of the South Plume to determine if contaminants were migrating offsite. Eleven of these wells were sampled in the Paddys Run Road 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 2014 and were incorporated into the uranium plume maps shown in Figure 18 and in Appendix A, Attachment A.2. Non-uranium data from these wells are included in Section 3.3.1.6.

As indicated in Section 2, Ohio EPA issued the Director's Findings and Orders 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 Ohio EPA approval), without issuance of a new Director's Order. As determined by Ohio EPA, the IEMP will remain in effect following remediation.

3.4 Groundwater Remediation Assessment

Data collected in 2014 indicate that uranium concentrations within the footprint of the maximum uranium plume continue to decrease in response to pumping. A summary is provided in Table 6.

Table 6. Comparison of 2013 and 2014 Maximum Uranium Plume Footprint Areas

Year	Area > 30 µg/L	Area > 50 µg/L	Area > 100 µg/L
2013	127.3	76.3	37.1
2014	110.9	65.5	34.9
Difference (acres)	16.4	10.8	2.2
Difference (percent)	12.9%	14.2%	5.9%

Groundwater elevations measured in 2014 continue to indicate that the pumping wells are maintaining capture of the uranium plume by enhancing and modifying natural groundwater flow directions within the aquifer. Appendix A, Attachment A.3 provides additional information concerning capture of the uranium plume.

Data collected in 2014 continue to show that the mass of uranium being removed from the aquifer is in close agreement with groundwater model predictions, indicating that the pumping system remains effective in removing uranium from the aquifer. Appendix A, Attachment A.1 provides additional information concerning the mass of uranium removed from the aquifer.

Groundwater modeling was used in 2005 to support the final groundwater remediation design and to predict how uranium concentrations would decrease during the remedy. An assessment using 2010 uranium data indicated that the groundwater model predictions made in 2005 had remained reasonable over time. The next assessment was scheduled for 2014; however, because the design changed in 2014, the assessment was not necessary. The next comparison will be conducted in 2015 to allow the system time to operate under the new operational design that was implemented in 2014.

3.5 OSDF Monitoring

Monitoring of the OSDF is conducted in the leachate collection system (LCS), leak detection system (LDS), glacial till (perched water), and the Great Miami Aquifer. Figure 20 identifies the OSDF footprint and monitoring well locations for Cells 1 through 8. Flow is being monitored within the LCS and LDS to determine if the facility is operating as designed. Water quality is being monitored in the LCS, LDS, glacial till, and the Great Miami Aquifer to identify any potential leakage from the facility.

LCS and LDS flow data collected in 2014 indicate that engineered features within the OSDF continue to perform as designed. Leachate flow continues to diminish as expected, and LDS flow volumes indicate that the cell liners are performing well within design specifications.

A comparison of water quality data collected in 2014 from within the facility (LCS and LDS) to water quality data collected beneath the facility (perched groundwater in the glacial till and groundwater in the Great Miami Aquifer) indicates that a leak from the OSDF is not occurring. Table 7 summarizes the groundwater, LCS, and LDS monitoring information for Cells 1 through 8 of the OSDF by providing the range of total uranium concentrations measured in 2014. The majority of uranium concentrations measured in 2014 fell within the historical range of concentrations previously measured for that monitoring horizon. New low and high concentrations measured in 2014 are identified in bold font on Table 7. As shown in Table 7, one new high uranium concentrations was detected in one of the Great Miami Aquifer monitoring wells. A new high of 0.71 µg/L was measured in monitoring well 22213. This new high is well below the groundwater FRL (30 µg/L). Concentrations of two non-uranium constituents (manganese and zinc) exceeded groundwater FRLs in OSDF aquifer monitoring wells in 2014. Appendix A, Attachments A.4 and A.5 provide additional information on non-uranium groundwater FRL exceedances and on the groundwater, LDS, and LCS sampling results for the OSDF.

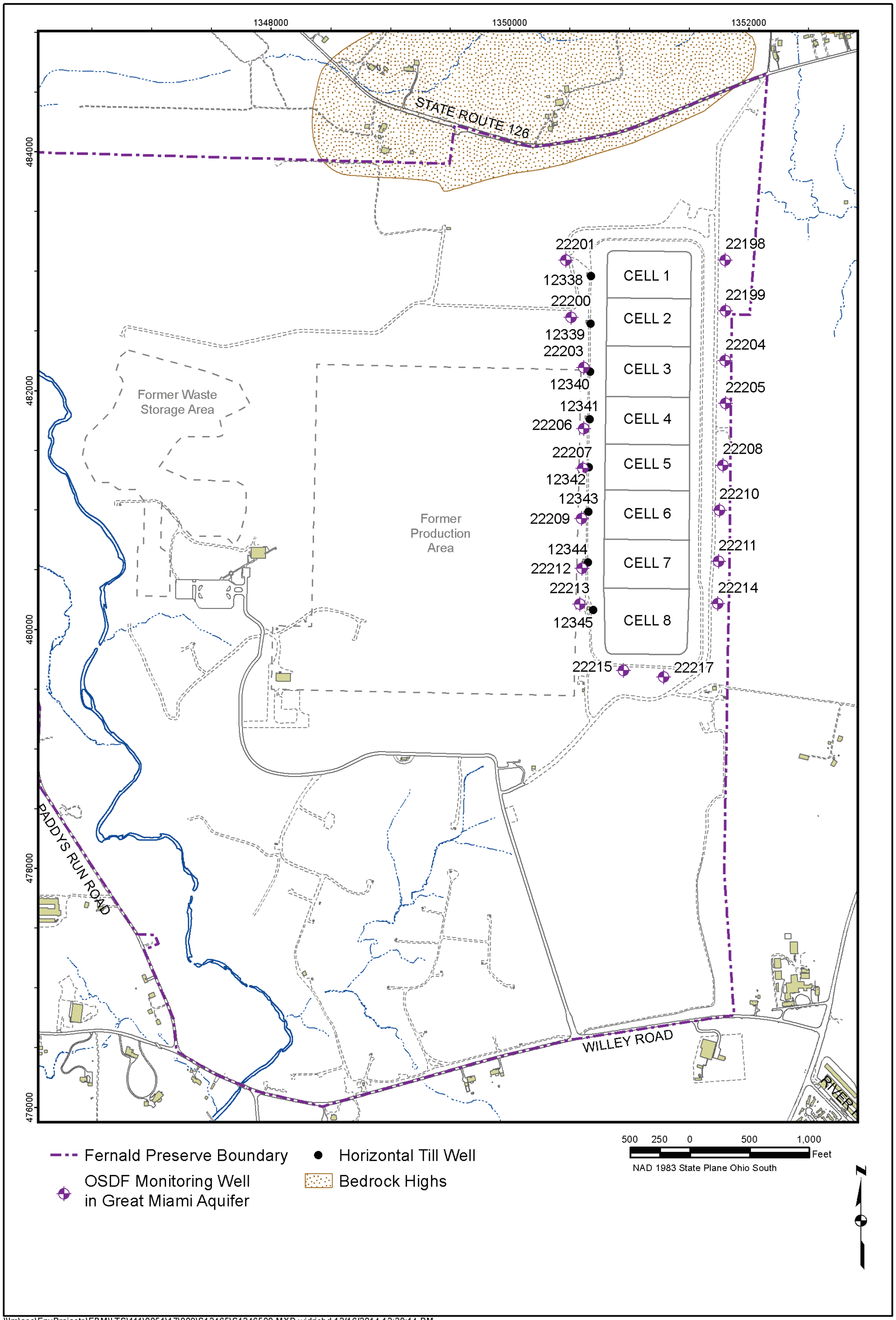


Figure 20. OSDF Footprint and Monitoring Well Locations

Table 7. OSDF Groundwater, Leachate, and LDS Monitoring Summary

Cell (Waste Placement Start Date)	Monitoring Location	Monitoring Zone	Date Sampling Started	Total # Samples	Range of Total Uranium Concentrations[a] (µg/L)
Cell 1 (Dec. 1997)	12338C	LCS	Feb. 17, 1998	64	ND–206
	12338D	LDS	Feb. 18, 1998	37	1.5–37.0
	12338	Glacial Till	Oct. 30, 1997	73	ND–19
	22201	Great Miami Aquifer	Mar. 31, 1997	80	ND–11.2
	22198	Great Miami Aquifer	Mar. 31, 1997	121	0.540–15.2
Cell 2 (Nov. 1998)	12339C	LCS	Nov. 23, 1998	61	4.51–448
	12339D	LDS	Dec. 14, 1998	29	4.08–25.8[b]
	12339	Glacial Till	Jun. 29, 1998	84	ND–36.9
	22200	Great Miami Aquifer	Jun. 30, 1997	75	ND–1.93
	22199	Great Miami Aquifer	Jun. 25, 1997	98	ND–12.1
Cell 3 (Oct. 1999)	12340C	LCS	Oct. 13, 1999	58	9.27–113
	12340D	LDS	Aug. 26, 2002	20	8.9–27.7[b]
	12340	Glacial Till	Jul. 28, 1998	77	ND–58.5
	22203	Great Miami Aquifer	Aug. 24, 1998	70	ND–9.51
	22204	Great Miami Aquifer	Aug. 24, 1998	93	ND–22.9
Cell 4 (Nov. 2002)	12341C	LCS	Nov. 04, 2002	44	4.41–171
	12341D	LDS	Nov. 04, 2002	34	5.74–21.3
	12341	Glacial Till	Feb. 26, 2002	57	4.56–7.91
	22206	Great Miami Aquifer	Nov. 06, 2001	61	ND–5.78
	22205	Great Miami Aquifer	Nov. 05, 2001	80	0.446–19.7
Cell 5 (Nov. 2002)	12342C	LCS	Nov. 04, 2002	46	3.39–285
	12342D	LDS	Nov. 04, 2002	40	2.93–27.1
	12342	Glacial Till	Feb. 26, 2002	58	7.45–21.1
	22207	Great Miami Aquifer	Nov. 06, 2001	61	ND–4.48
	22208	Great Miami Aquifer	Nov. 05, 2001	82	ND–2.1
Cell 6 (Nov. 2003)	12343C	LCS	Oct. 27, 2003	43	8.03–197
	12343D	LDS	Oct. 27, 2003	42	3.1–43.7
	12343	Glacial Till	Mar. 14, 2003	50	ND–24.2
	22209	Great Miami Aquifer	Dec. 16, 2002	56	ND–2.43
	22210	Great Miami Aquifer	Dec. 16, 2002	74	ND–1.02
Cell 7 (Sep. 2004)	12344C	LCS	Sep. 02, 2004	39	4.72–355
	12344D	LDS	Sep. 02, 2004	29	12.2–**169**[b]
	12344	Glacial Till	Feb. 24, 2004	47	0.674–12.1
	22212	Great Miami Aquifer	Jan. 21, 2004	49	ND–5.53
	22211	Great Miami Aquifer	Jan. 21, 2004	64	ND–3.21
Cell 8 (Dec. 2004)	12345C	LCS	Oct. 18, 2004	38	1.51–335
	12345D	LDS	Oct. 18, 2004	33	9.38–64.4
	12345	Glacial Till	May 19, 2004	20	3.48–7.3
	22213	Great Miami Aquifer	Mar. 31, 2004	48	ND–**0.71**
	22214	Great Miami Aquifer	Mar. 31, 2004	64	ND–2.95
	22215	Great Miami Aquifer	Aug. 22, 2005	39	ND–16.4
	22217[c]	Great Miami Aquifer	Aug. 22, 2005	38	ND–18.3

[a] ND = not detected. **Bold text indicates a new high or low detected in 2014.**
[b] Some data are not considered representative of LDS in Cell 2 (December 14, 1998, through May 23, 2000, data set) due to malfunction in Cell 2 leachate pipeline and resulting mixing of individual flows. It is suspected that some November 2004 samples were switched (i.e., 12339C with 12339D and 12340C with 12340D). If data from these events were included above, maximum total uranium concentrations would be 71 µg/L for 12339D and 72.4 µg/L for 12340D. It is suspected that samples were switched in 2014 (i.e., 12344D with the field duplicate for 12345C). If the data point from this sampling event was not included above, maximum total uranium concentration for 12344D would be 33.7 and would not be a new maximum for 2014.
[c] Monitoring location 22216 was plugged and abandoned in April 2006. Monitoring location 22217 is its replacement. The results listed for location 22217 also include the results for location 22216.

This page intentionally left blank

4.0 Surface Water and Treated Effluent Pathway

Results in Brief: 2014 Surface Water and Treated Effluent Pathway

Surveillance Monitoring: No treated effluent analytical results from samples collected in 2014 exceeded the surface water FRL for total uranium, the primary site contaminant. There was one surface water FRL exceedance (manganese) in 2014 at the Parshall Flume (PF 4001), the key sample location where treated effluent leaves the site. When considering effluent mixing with Great Miami River water, the manganese FRL was not exceeded.

Uranium Discharges: In 2014, 536 lb (244 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 84.0 lb (38.2 kg) of uranium were released to the environment through uncontrolled storm water runoff. The estimated total mass of uranium released through the surface water and treated effluent pathway was approximately 620 lb (282 kg).

NPDES Permit Compliance: There was one instance of noncompliance at PF4001 in 2014. The daily load limit for total suspended solids was exceeded on August 5, 2014 as a result of the operational changes implemented in July 2014 which resulted in increased flow rates.

This section presents the 2014 monitoring activities and results for surface water, treated effluent, and sediment to determine the effects of site activities on the surface water pathway.

In general, low levels of contaminants enter the surface water pathway at the Fernald Preserve 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 remediated areas that are now 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 minimize the site's impact on the surface water pathway.

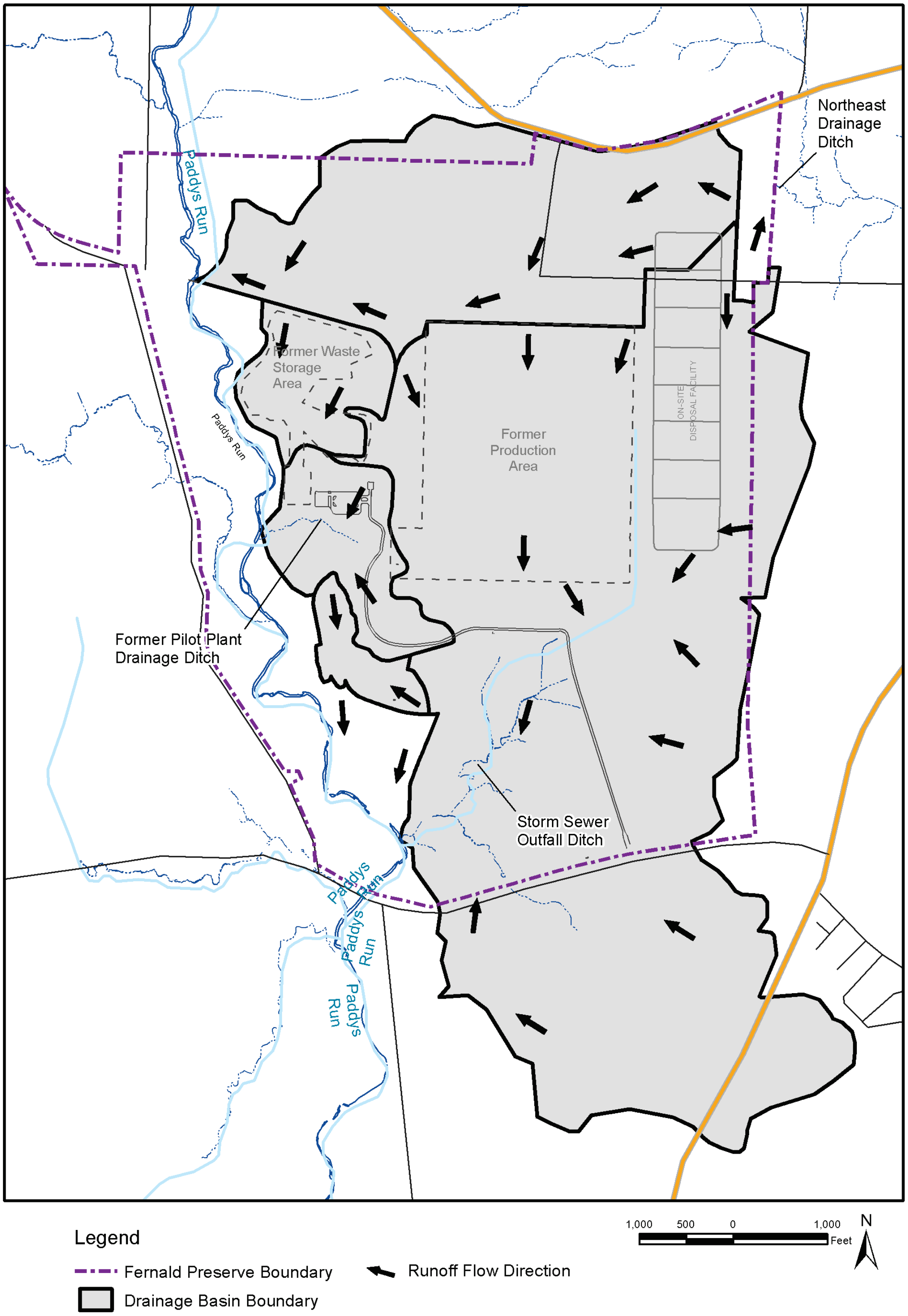
4.1 Summary of Surface Water and Treated Effluent Pathway

To assist in the understanding of this section, 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. However, currently the only storm water that is controlled is associated with the footprint of the outdoor processing activities at the wastewater treatment facility.
- **Uncontrolled runoff** is storm water that is not collected for treatment, but enters the site's natural drainages.
- **Treated effluent** is water that is treated through the site's wastewater treatment facility and 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. Treated effluent is currently composed of treated and untreated groundwater, leachate from the OSDF, and storm water associated with the footprint of the outdoor processing activities at the wastewater treatment facility.

The volume and flow rate of uncontrolled runoff depends on the amount of precipitation within a given period of time. Figure 8 in Section 1 shows monthly precipitation totals for 2014. Figure 21 shows the site's natural drainage features. The site's natural surface water drainages include several tributaries to Paddys Run (e.g., SSOD) as well as the northeast drainage that flows to the Great Miami River. The arrows on Figure 21 indicate the general flow direction of uncontrolled runoff as determined from the topography. Uncontrolled runoff from the Fernald Preserve leaves the property via two drainage pathways: Paddys Run and the northeast drainage ditch.



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12466\S1246600.mxd widrichd 02/04/2014 11:02:53 AM

Figure 21. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

4.2 Remediation Activities Affecting the Surface Water Pathway

Activities that had the potential to affect the surface water pathway included routine operation and maintenance activities of the OSDF and the CAWWT, and ecological restoration activities conducted throughout the property, including repairing areas of erosion.

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

Surface water monitoring conducted in a small area west of the former waste pits continued to show elevated uranium concentrations. The location in question is a series of small puddles and drainage ditches due west of the center of former Waste Pit 3, which drain generally south to a depression near the former cement pond. This area does not drain directly to Paddys Run. An inspection finding in March prompted the need for additional investigation. The east bank of Paddys Run has been encroaching into this area for several years and has moved approximately 13 ft eastward since 2012. Because of this, the Paddys Run streambank stabilization project was undertaken. Section 6 provides additional detail regarding this project.

After a limited maintenance activity was completed in the fall of 2007, DOE committed to continued monitoring of the area. Two monitoring points (SWD-05 and SWD-09) were added to the surface water program to fulfill this monitoring commitment (Figure 22). These two locations are sampled weekly when water is present. In 2014, there was a sufficient volume of surface water to collect 12 samples at SWD-05 and 31 samples at SWD-09.

4.3 Surface Water, Treated Effluent, and Sediment Monitoring Program

Surface water, treated effluent, and sediment are sampled to determine the effect of the Fernald Preserve's activities on the environment. Surface water is sampled at several locations in the site's drainages and analyzed for various radiological and nonradiological 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 requirements of the NPDES permit, the FFCA, and the OU5 ROD and to provide a comprehensive assessment of surface water quality at key locations, including two background locations (refer to Figure 22 and Figure 23). Surface water is monitored for 13 FRL constituents.
- **Data Evaluation:** The integrated data evaluation process focuses on tracking and evaluating data and comparing analytical results with background and historical ranges, FRLs, and NPDES permit 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 groundwater in the Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision-making.

- **Reporting:** Surface water and treated effluent data are reported through the annual Site Environmental Report. Monthly discharge monitoring reports required by the NPDES permit are submitted to Ohio EPA.

In 2009, the IEMP sediment monitoring sampling frequency was changed from annual to once every 5 years at the suggestion of Ohio EPA. The data are reported through the annual Site Environmental Report. Sediment sampling occurred in 2014 and is discussed in Section 4.3.4.

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 OU5 ROD. 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 22 depicts IEMP and NPDES surface water and treated effluent sample locations; Figure 23 shows IEMP background sample locations.

4.3.1 Surveillance Monitoring

> **Treated effluent** is discharged to the Great Miami River through the effluent line identified on Figure 22. 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.

Analytical results from 2014 sampling events were evaluated to provide surveillance monitoring of site activities. This evaluation indicated that during 2014 there were no exceedances of total uranium in any of the treated effluent samples analyzed. Nineteen surface water analytical results from sampling location SWD-09 exceeded the surface water FRL for total uranium. SWD-09 is a surface water monitoring location established to monitor the area west of the Former Waste Pits Area where elevated surface water uranium concentrations have been detected in the past. Appendix B provides additional details. Monitoring for uranium will continue at these locations.

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 (surface water sample location SWP-03).
- PF 4001 is located at the entry point of the treated effluent line leading to the Great Miami River.

There were no total uranium exceedances of the surface water FRLs during 2014 at these two locations.

The maximum total uranium concentration at SWP-03 during 2014 was 2.75 µg/L, well below the surface water total uranium FRL of 530 µg/L. Figure 24 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 2014. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986.

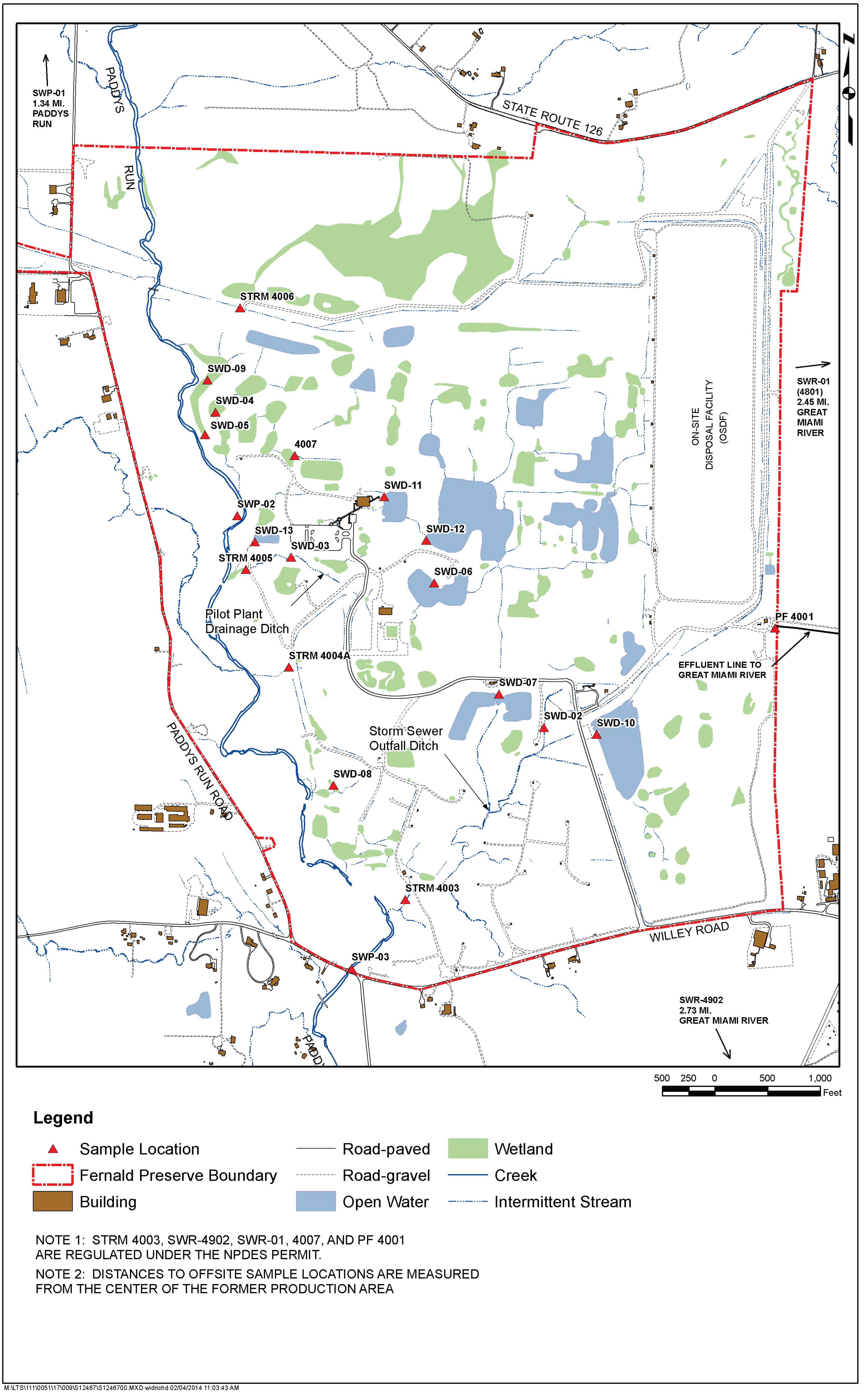
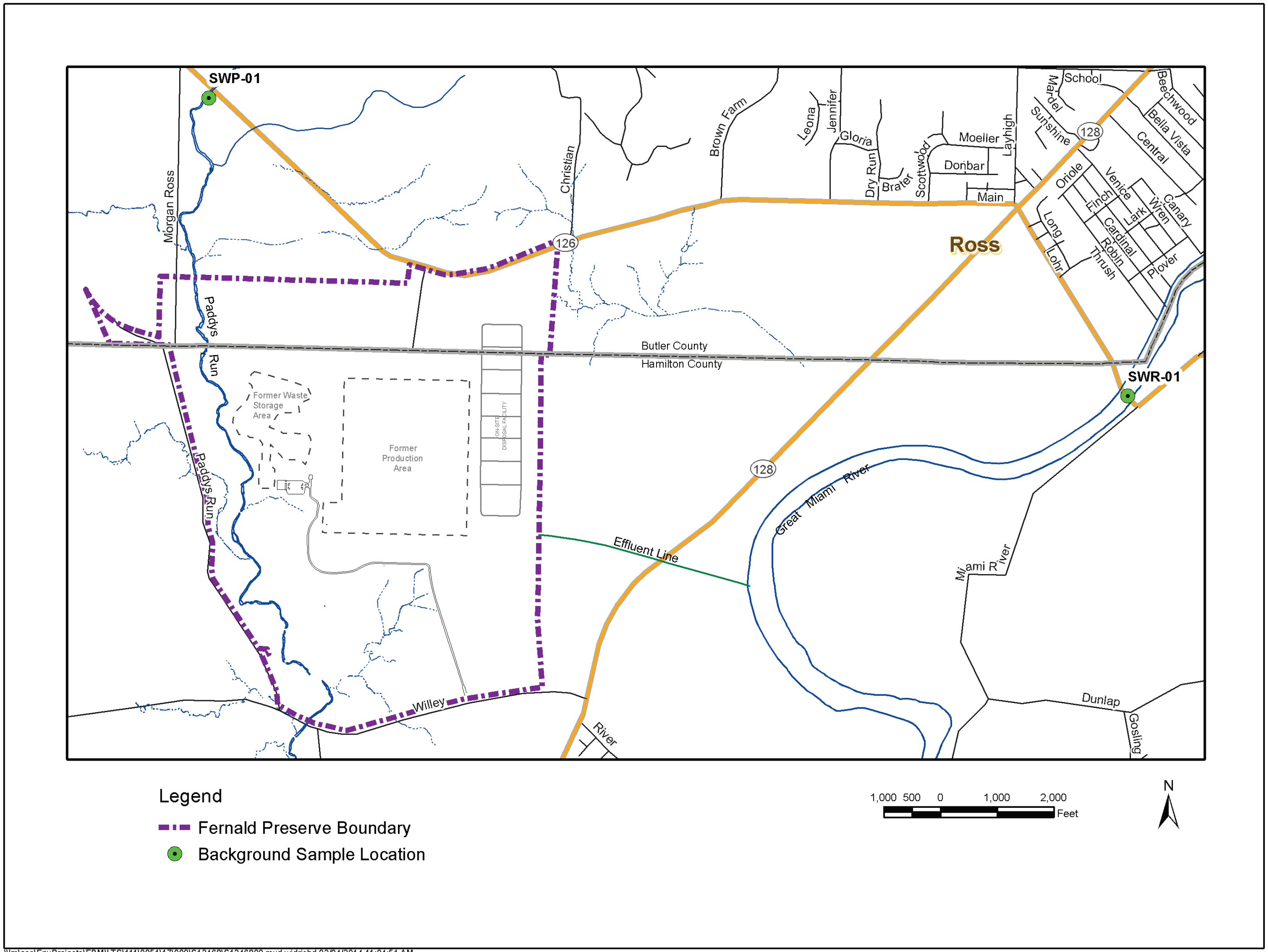


Figure 22. IEMP/NPDES Surface Water and Treated Effluent Sample Locations

This page intentionally left blank



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12468\S1246800.mxd widrichd 02/04/2014 11:04:51 AM

Figure 23. IEMP Background Surface Water Sample Locations

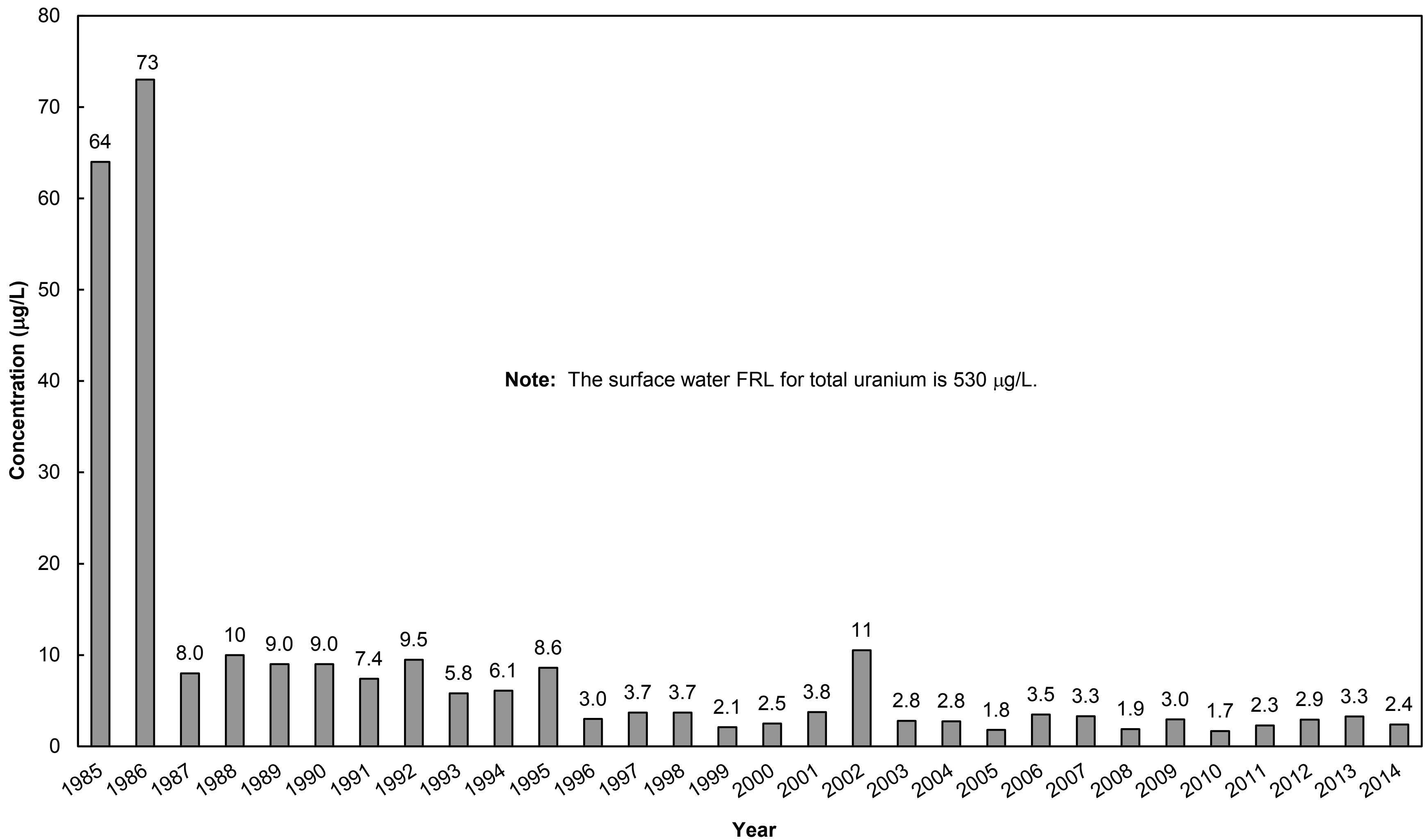


Figure 24. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985−2014

Samples collected at 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. The maximum daily total uranium concentration at PF 4001 in 2014 was 33.8 µg/L, well below the surface water total uranium FRL of 530 µg/L. Data collected from this location cannot directly be compared to the FRL without considering the effect of the effluent waters mixing with the Great Miami River. This comparison is done through the use of a mixing equation. The mixing equation is discussed further in Appendix B. After the actual flow rate in the Great Miami River and the discharge flow rate in which this maximum uranium concentration was observed were accounted for, the resulting concentration in the river was estimated to be 3.53 µg/L. Manganese exceeded the manganese surface water FRL (1.5 mg/L) at PF 4001 with a concentration of 3.71 mg/L in August 2014. When the mixing equation is applied, the concentration is below the FRL at 0.18 mg/L. Appendix B presents further discussion of this exceedance.

Surface water data is also evaluated to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. In areas where glacial overburden is absent, 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. The locations are SWP-02, SWD-02, SWD-03, SWD-04, SWD-05, SWD-07, SWD-08, and STRM 4005.

In 2014, samples results from surface water cross-media impact locations SWD-04, and SWD-05 exceeded the total uranium groundwater FRL of 30 µg/L. Sampling at these locations will continue to provide an assessment of the cross-media impacts. Appendix B presents additional details of the FRL exceedances. SWD-05 is located within a swale in the northwest corner of the former Waste Storage Area. Appendix A, Attachment A.2 provides additional information concerning the impact of surface water infiltrating through the base of the swale and down into the Great Miami Aquifer.

4.3.2 Compliance Monitoring

4.3.2.1 FFCA and OU5 ROD Compliance

The Fernald Preserve is required to monitor treated effluent discharges at PF 4001 for total uranium mass discharges and total uranium concentrations. This requirement is identified in the July 1986 FFCA and the OU5 ROD (DOE 1996). The OU5 ROD requires treatment of effluent so that the mass of total uranium discharged to the Great Miami River through PF 4001 does not exceed 600 lb (272 kg) per year. The OU5 ROD and the subsequent *Explanation of Significant Differences for Operable Unit 5* (DOE 2001b) also require that the monthly average total uranium concentration in the effluent must be at or below 30 µg/L.

Figure 25 shows that the cumulative mass of total uranium discharged to the Great Miami River during 2014 was 536 lb (244 kg), which is below the annual discharge limit of 600 lb (272 kg). Figure 26 shows that the monthly average total uranium concentration was below the 30 µg/L limit every month during 2014.

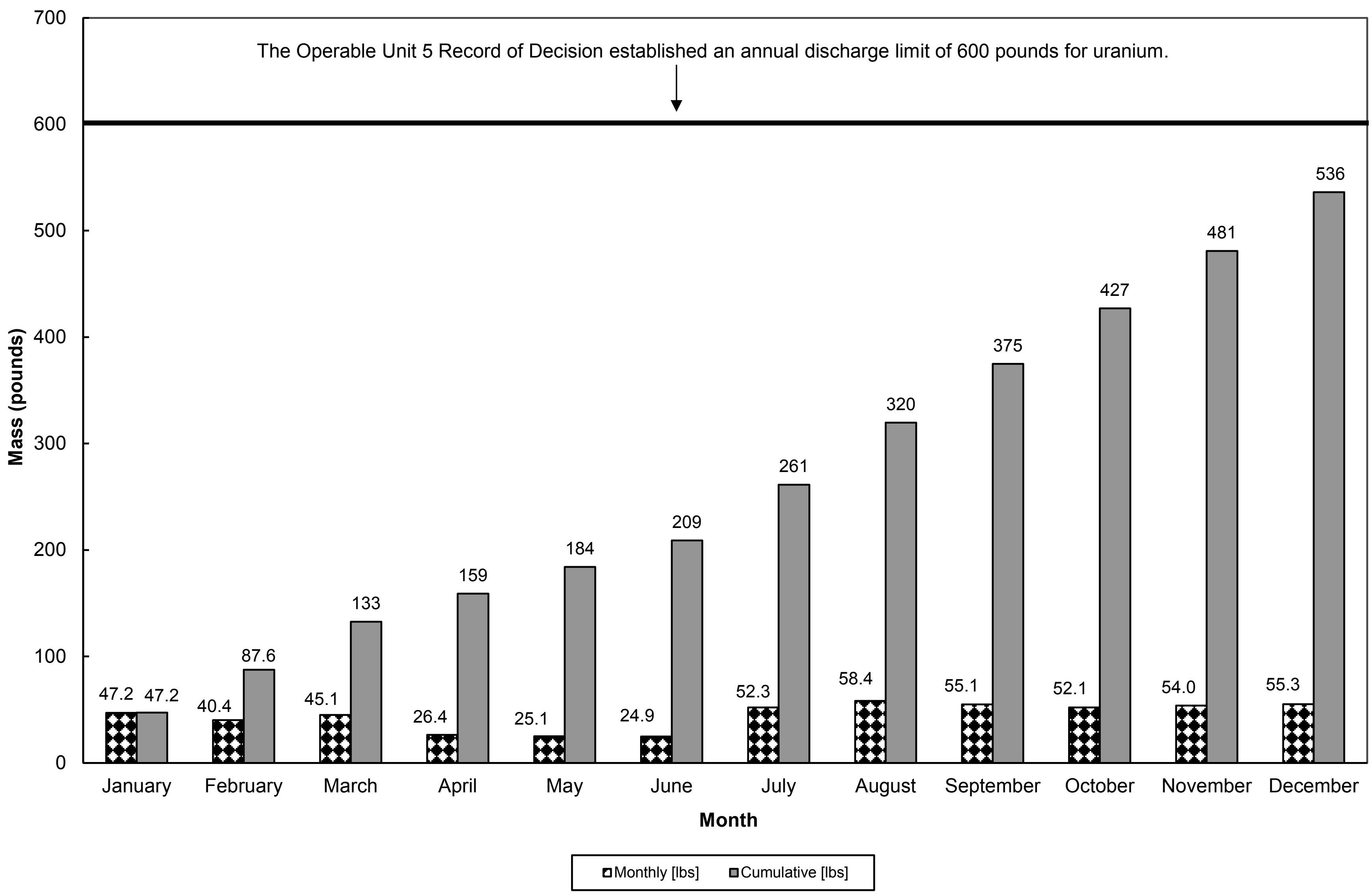


Figure 25. Mass of Uranium Discharged to the Great Miami River Through the Parshall Flume (PF 4001) in 2014

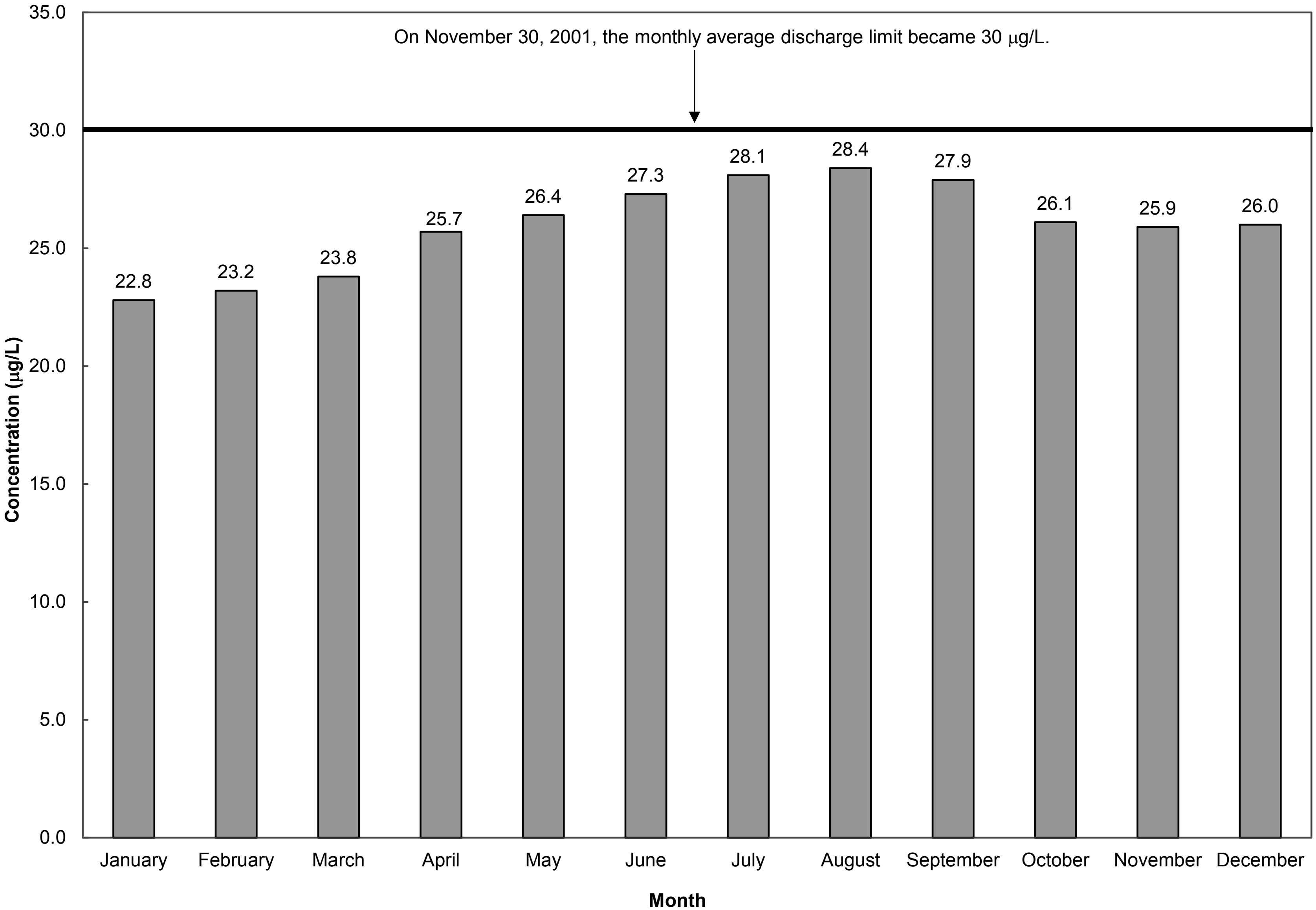


Figure 26. 2014 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River

4.3.2.2 NPDES Permit Compliance

Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald Preserve, is regulated under the state-administrated NPDES program. During 2014, the site operated under the permit that took effect on April 1, 2009, and expired on March 31, 2014. The Fernald Preserve operated under the requirements of this permit the entire year; a new permit took effect on March 1, 2015.

There was one instance of noncompliance at PF 4001 in 2014. The daily load limit for total suspended solids (TSS) was exceeded on August 5, 2014. Operational changes to the aquifer remedy implemented in July 2014 resulted in increased flow rates. The increased flow rate was higher than the design flow rate used to establish the NPDES limit for TSS. While the daily concentration limit was not exceeded, the daily loading limit was exceeded. A change to the 2013 NPDES permit application was submitted to increase the flow rate, concentrations, and loading limits for three parameters: carbonaceous biochemical oxygen demand, oil and grease, and TSS.

4.3.3 Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 25, 536 lb (244 kg) of uranium in treated effluent were discharged to the Great Miami River through PF 4001 in 2014. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of uranium entering surface water. Figure 27 presents the mass of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2014.

A loading term is used to estimate the pounds of uranium discharged to Paddys Run via uncontrolled runoff. This loading term was 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 were decreasing through remediation as a result of significant improvements in the capture of contaminated storm water and should remain low now that soil remediation has been completed. The loading term is 2.1 lb (0.95 kg) of uranium per inch (2.54 cm) of rainfall.

During 2014, 40.01 inches (101.6 cm) of precipitation fell at the Fernald Preserve; therefore, an estimated 84.0 lb (38.2 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 620 lb (282 kg).

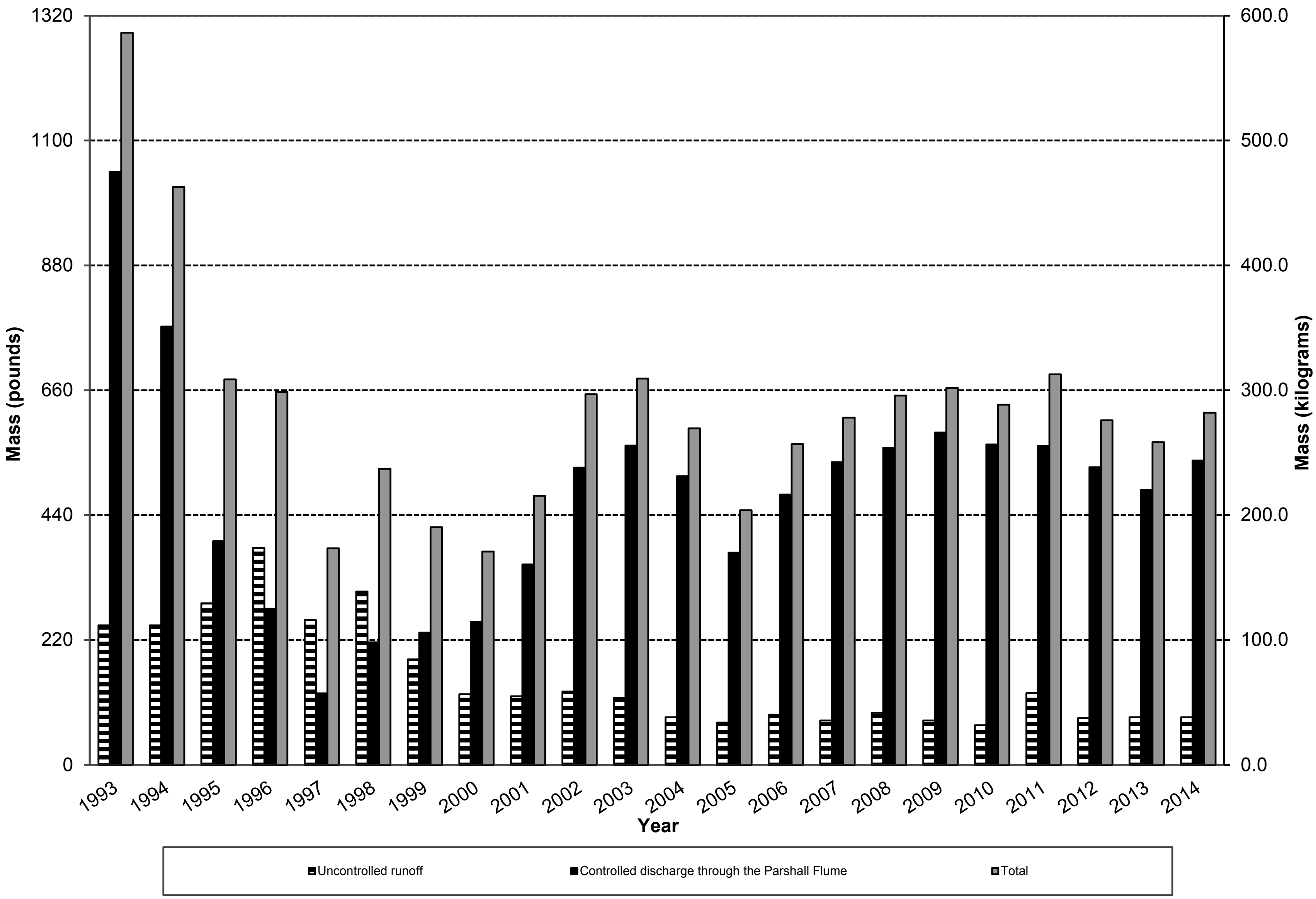


Figure 27. Uranium Discharged via the Surface Water Pathway, 1993−2014

4.3.4 Sediment Monitoring

Sediment is a secondary exposure pathway and is monitored every 5 years 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). In 2009, the downstream location was moved to the opposite side of the river and closer to the effluent line because of accessibility issues with the old downstream location. This downstream location, G10, was sampled again in 2014 along with the upstream location, G2 (see Figure 28). Sediment samples analyzed for total uranium were collected in September 2014 at the two locations in the Great Miami River. Results indicate that contaminant concentrations in sediment downstream from the site's treated effluent discharge are slightly lower than at the background (upstream) sediment location and these results are far below the sediment uranium FRL of 210 milligrams per kilogram. The information is presented in Table 8.

Table 8. Sediment Sampling Results

Radionuclide	Sediment FRL[a] (mg/kg)	Number of Samples	2014 Concentration[a] (mg/kg)
Great Miami River, North of the Effluent Line (G2)			
Total Uranium	210	1	1.37
Great Miami River, South of the Effluent Line (G10)			
Total Uranium	210	1	0.713

[a] mg/kg = milligrams per kilogram

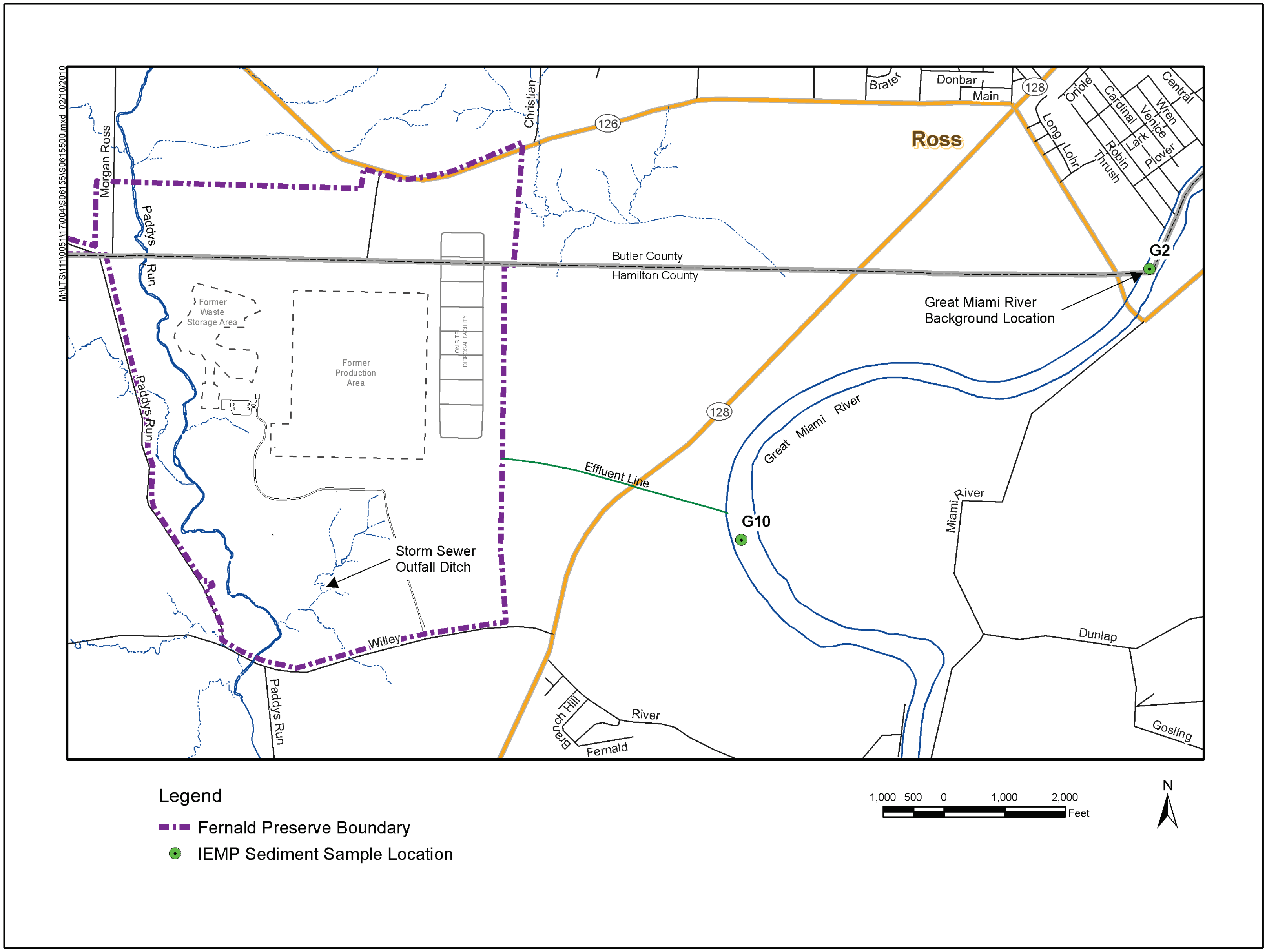


Figure 28. 2014 Sediment Locations

This page intentionally left blank

5.0 Direct Radiation Pathway and Radiation Dose

> **Results in Brief: 2014 Estimated Doses**
>
> **Direct Radiation:** The estimated 2014 effective dose equivalent at the east-central area of the site was 7 mrem/yr (0.07 mSv/yr). This is 7 percent of the 100-mrem/yr (1-mSv/yr) DOE limit.
>
> **Dose to the maximally exposed individual (MEI):** The dose to the MEI for 2014 was estimated to be 7 mrem/yr (0.7 mSv/yr) at the east-central area of the site. This is 7 percent of the 100-mrem/yr (1-mSv/yr) DOE limit.

This section provides the 2014 results for direct radiation monitoring and the estimated dose to the public from the direct radiation pathway. It also addresses biotic dose to aquatic organisms from remedial actions associated with the groundwater restoration program.

In the past, the Fernald Preserve demonstrated compliance with the DOE effective dose limit of 100 millirem per year (mrem/yr) (1 millisievert per year [mSv/yr]) from exposure pathways (excluding radon) using direct radiation measurements and data collected from samples of airborne emissions to estimate the total dose to the maximally exposed individual (MEI). In consultation with EPA and Ohio EPA, DOE ended air monitoring for particulate emissions on January 4, 2010, because 3 years of post-remediation data indicated that emissions are at or near background. Therefore, the 2014 dose estimate reflects the incremental dose above background that is attributed to direct radiation.

This section 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 458.1. By limiting the dose to aquatic organisms, DOE Order 458.1 seeks to limit the severity and likelihood of offsite environmental impacts attributable to the aquifer restoration effort at the Fernald Preserve. The dose assessment to biota is performed through the use of a computer model that estimates dose from measured radionuclide concentrations in Paddys Run and effluent discharged to the Great Miami River.

5.1 Monitoring for Direct Radiation

Direct radiation originates from sources such as cosmic radiation, naturally occurring radionuclides in soil and food, and anthropogenic radioactive 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. The largest historical source of direct radiation at the Fernald Preserve was waste material associated with the Silos Project. The last waste material associated with the Silos Project was removed from the site in 2006. Presently, there are no significant sources for direct radiation at the Fernald Preserve. During 2014, direct radiation levels at the Fernald Preserve were continuously measured at four trail locations, the Visitors Center, five boundary locations, and one background location with optically stimulated luminescence (OSL) dosimeters. The background location is 3.2 miles from the center of the Fernald Preserve (Figure 29).

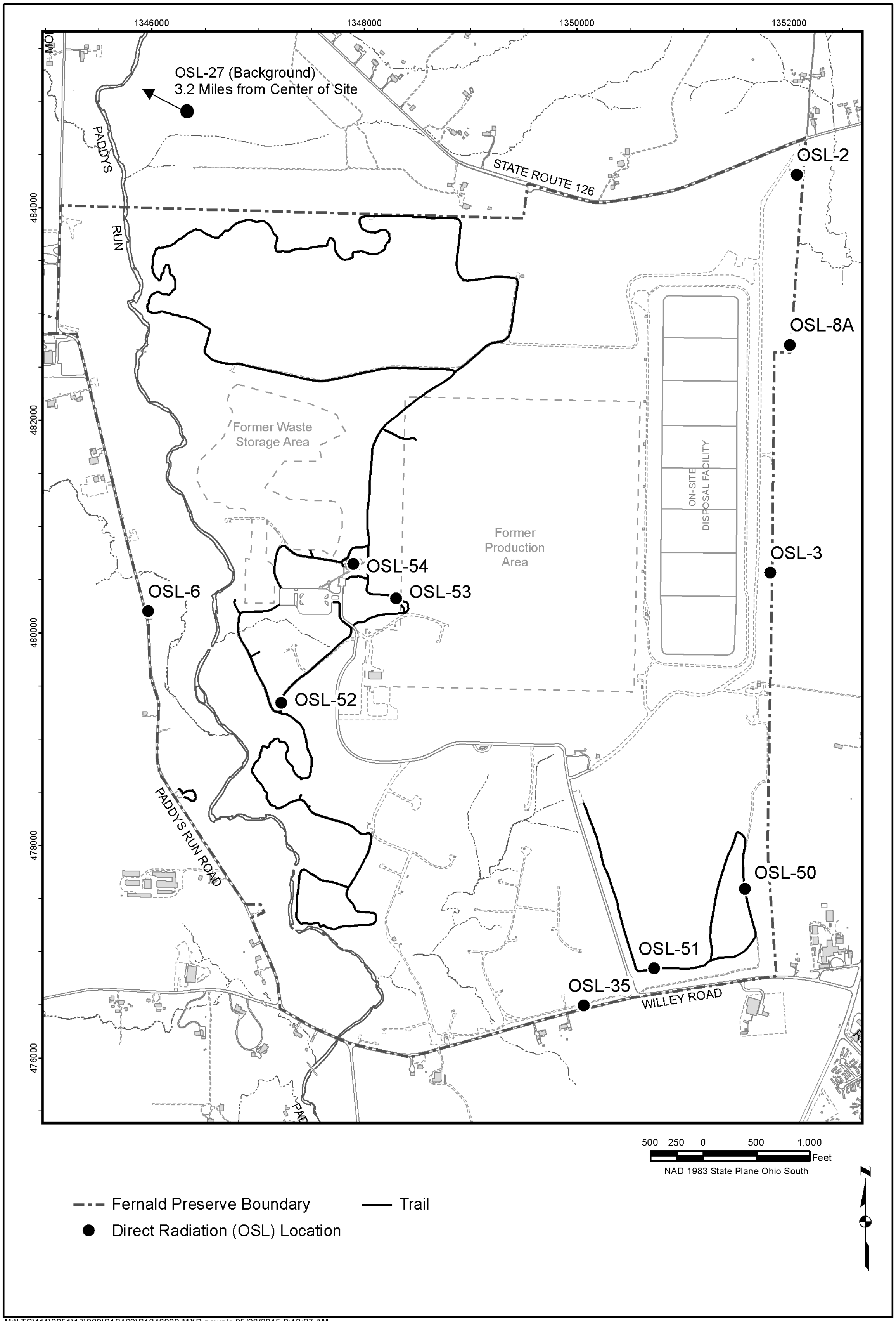


Figure 29. Direct Radiation (OSL) Monitoring Locations

Table 9 provides the annual range of direct radiation measurements for 2013 and 2014, and Figure 30 illustrates the quarterly results for 2014. Each quarterly result is the average of three measurements obtained from three dosimeters placed at each location. In general, the first- and second-quarter results are less than other quarters because they had fewer exposure days, and the winter months may hold more moisture in the ground, which can attenuate radiation emitted from soil particles.

Table 9. Direct Radiation (OSL) Measurement Summary

Location	Direct Radiation (mrem)	
	Sum of 2014 Quarterly Results	**Sum of 2013 Quarterly Results**
Onsite		
Minimum	15	15
Maximum	31	34
Background[a]		
Minimum	24	24
Maximum	24	24

[a] The minimum and maximum results are identical because there is only one background dosimeter.

Compared to background results, many of the onsite results are slightly higher, and the Visitors Center results (OSL-54) are lower due to the shielding provided by the building materials. Slightly higher results are not unexpected, as the Fernald site was remediated to reduce the radionuclide levels to values that were near or somewhat higher than background. However, as noted in Appendix C, the mean of the quarterly boundary measurements is similar to background when statistical variability is evaluated, which is in agreement with evaluations that followed removal of the last direct radiation waste sources in 2006.

5.2 Direct Radiation Dose

Direct radiation dose to deep tissue is primarily the result of gamma and X-ray emissions from radionuclides. The largest historical source of direct radiation at the site was the waste materials stored in the silos. This and all other significant surface radiation sources were removed from the site in 2006. Remaining surface sources for radiation are soil, which contains radium, thorium, and uranium isotopes at activities that are below the FRLs established in the OU5 ROD (DOE 1996) and small pieces of debris that are exposed by soil erosion.

From the data in Table 9, the maximum measurement is 31 mrem/yr (0.31 mSv/yr) at OSL-52 (Figure 29) and the background dose is 24 mrem/yr (0.24 mSv/yr). The difference in the OSL dose between OSL-52 and the background dosimeters is 7 mrem/yr (0.07 mSv/yr), which is assumed to be the direct radiation dose for a hypothetical individual who stands at the OSL-52 location for 1 year. This is a very conservative estimate of the dose, as an individual would not spend an entire year at OSL-52. Additionally, Appendix C shows that the present quarterly measurements at the boundary are indistinguishable from background results when statistical variability is considered.

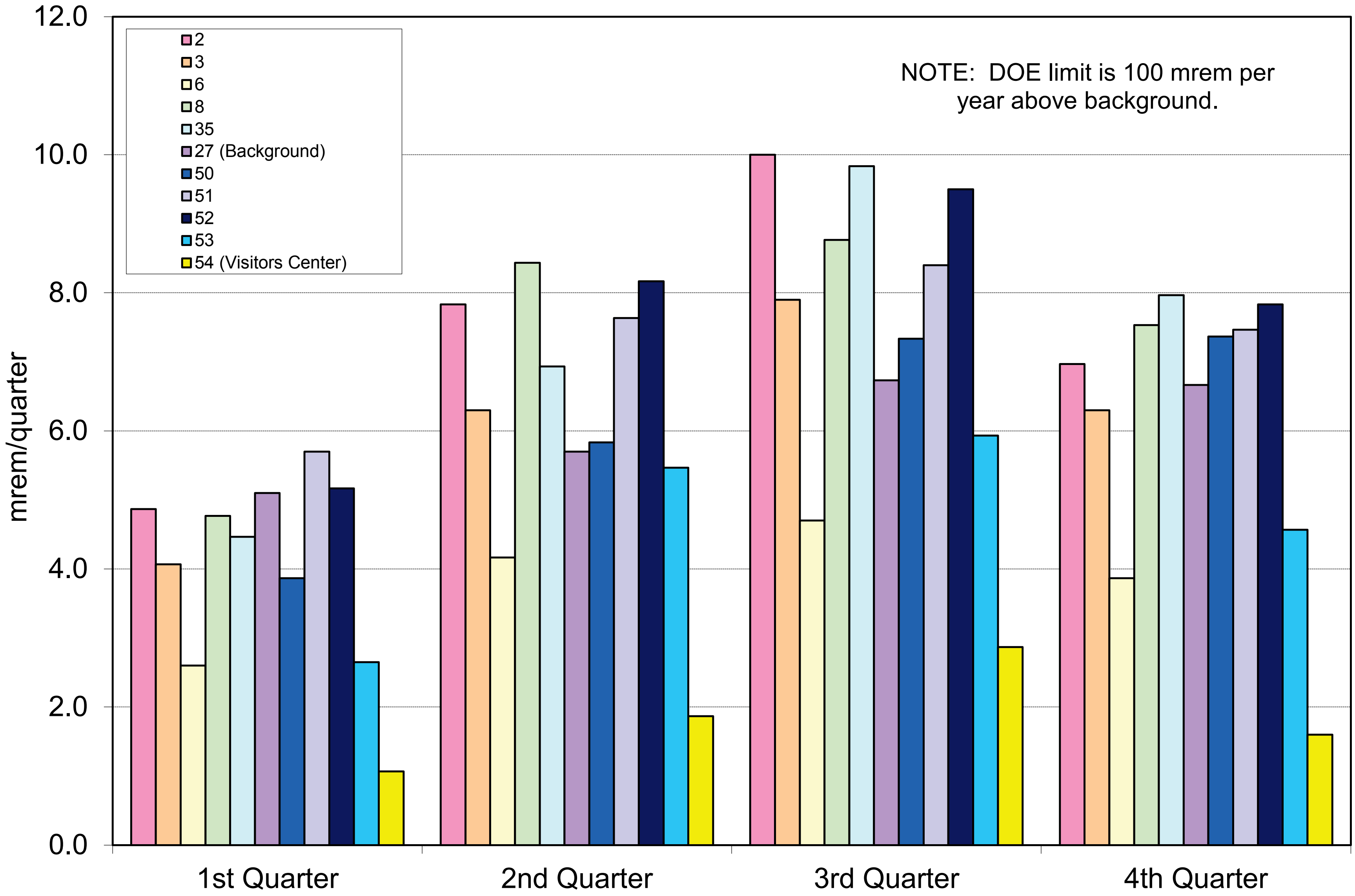


Figure 30. 2014 Quarterly Results for OSL Monitoring Locations

5.3 Total of Doses to the Maximally Exposed Individual

The MEI is the member of the public who receives the highest estimated effective dose based on the sum of the individual pathway doses (as noted above, direct radiation is the only pathway considered in 2014). It is the maximum dose because the MEI is assumed to spend 24 hours a day, 365 days a year at the location where the maximum direct radiation is measured. As shown in Table 10, the 2014 dose to the MEI is 7 mrem/yr (0.07 mSv/yr) and represents the sum of the estimated dose from direct radiation at OSL-52. The conservative exposure assumptions used to estimate the dose ensures that the dose to the MEI is the maximum possible dose any member of the public could receive.

Table 10. Dose to MEI

Pathway	Dose Attributable to the Fernald Preserve	Applicable Limit
Direct radiation[a]	7 mrem/yr (0.07 mSv/yr)	100 mrem/yr (1 mSv/yr) (total for all pathways)
MEI	7 mrem/yr (0.07 mSv/yr)	100 mrem/yr (1 mSv/yr) (total for all pathways)

[a] Represents the sum of the estimated dose from direct radiation at OSL-52.

The estimate represents the incremental dose above background attributable to the Fernald Preserve. Figure 31 provides a comparison between the average background radiation dose at the background location (24 mrem/yr [0.24 mSv/yr]) and the dose to the MEI (7 mrem/yr [0.0.07 mSv/yr]), relative to the annual DOE limit (100 mrem/yr [1 mSv/yr]).

5.4 Significance of Estimated Radiation Doses for 2014

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. This sum (54 mrem/yr) is about 2 times greater than the direct radiation dose of 24 mrem/yr at the background location and is approximately 8 times greater than the dose of 7 mrem/yr above background estimated for the individual at OSL-52. The 100 mrem/yr per person background also includes dose from the ingestion of food and from medical X-rays (about 46 mrem/yr), which is not recorded by the direct radiation OSLs at the boundary and background locations. 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 Denver, Colorado, increases the background to approximately 125 mrem/yr (1.25 mSv/yr) (National Academy of Science 1980, National Council on Radiation Protection and Measurements 1984).

Another method of determining the significance of the estimated dose is to compare it with dose limits developed to protect the public. The International Commission on Radiological Protection has recommended that members of the public receive less 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 458.1. The sum of all estimated doses from 2014 site operations (7 mrem/yr [0.07 mSv/yr]) is considerably below this limit (Figure 31).

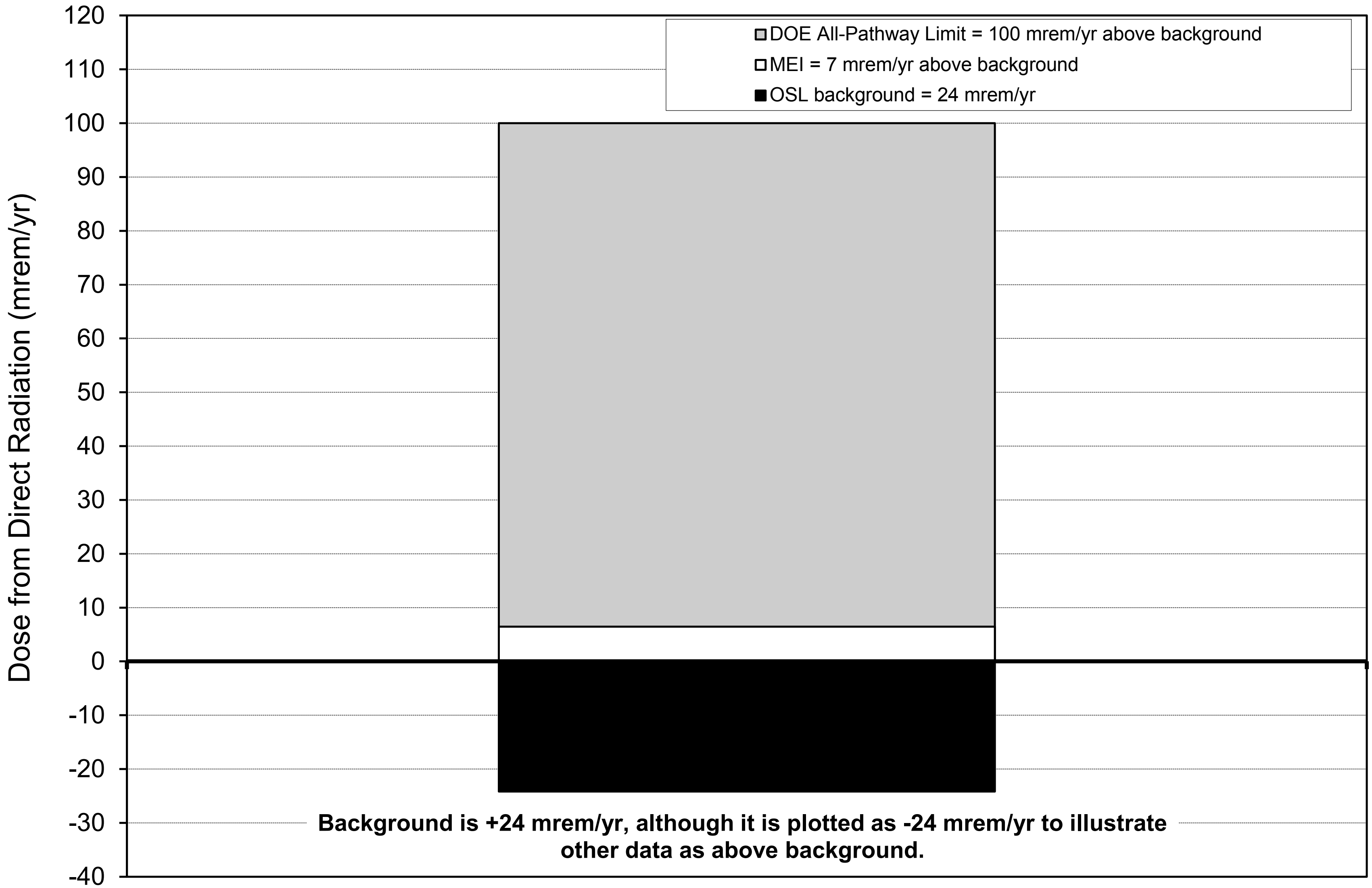


Figure 31. Comparison of 2014 All-Pathway Doses and Allowable Limits

5.5 Estimated Dose to Biota

DOE Order 458.1 requires that populations of aquatic biota be protected at a dose limit of 1 rad/day (10 milligray per day [mGy/day]). DOE has issued a technical standard entitled *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota* (DOE 2002a) 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 biota concentration guides (BCGs) established by researchers. 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 radionuclide. BCGs have been established for radionuclides that are relatively common constituents in past releases to the environment from DOE facilities. At facilities such as the Fernald Preserve, where multiple contaminants (e.g., radium, thorium, and uranium) can be released, a "sum-of-the-fractions" rule applies. The sum-of-the-fractions rule means each radionuclide fraction (i.e., the measured concentration divided by the BCG for that nuclide) must be summed and the sum of all radionuclide fractions must be less than 1.0.

For 2014, compliance with the dose limit to aquatic biota was determined by using the maximum concentration of each radionuclide found in Paddys Run at Willey Road (SWP-03) and effluent discharged from PF 4001 to the Great Miami River (refer to Section 4). The maximum concentration in water delivered from the Parshall Flume and Paddys Run is multiplied by the annual volume of water discharged from the Parshall Flume and Paddys Run to obtain a net mass for each radionuclide delivered to the Great Miami River. The net mass is divided by the sum of the discharge volumes and 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 technetium-99 (Parshall Flume only), radium, thorium (Paddys Run only), and uranium isotopes is 0.010, which is well below the compliance threshold value of 1.0. Appendix C provides additional information on the biota dose assessment.

This page intentionally left blank

6.0 Natural Resources

This section provides background information on the natural resources associated with the Fernald Preserve and summarizes the activities in 2014 relating to these resources. Included in this section is a discussion of the following:

- Ecological restoration activities.
- Fernald Preserve site and OSDF inspections.
- Affected habitat areas.
- Threatened and endangered species.
- Cultural resources.

Results in Brief: Ecological Monitoring Activities

Forest Functional Monitoring

- Vegetation results were mostly similar to those from previous years and showed sustained establishment of forest communities. Bush honeysuckle has reduced native diversity in some areas.

Wetland Mitigation Monitoring

- Amphibian results showed that salamander habitat is maintained across created wetlands located near existing forests. Fewer cricket frogs were observed in the Former Production Area, suggesting a change of habitat due to vegetation establishment.
- Hydrologic monitoring demonstrated patterns similar to that of previous years.

Implementation Monitoring

- Planting and seeding activities in the Former Silos Area have met restoration goals.

Site and OSDF Inspections

- No major issues were observed with respect to institutional controls or the integrity of the OSDF cap. Findings focused mainly on invasive plants and woody vegetation in the vicinity of the OSDF, and debris in portions of the Former Production Area and Former Waste Pits Area. A portion of the OSDF west inner drainage was repaired in June.

Much of the 1,050 acres (425 hectares) of the Fernald Preserve property is undeveloped land that provides habitat for a variety of animals and plants. Wetlands, deciduous and riparian (streamside) woodlands, old fields, grasslands, and aquatic habitats are among the site's natural resources. Over 900 acres (364 hectares) of the site have undergone ecological restoration. Figure 32 shows the restoration project areas that have been completed. Some of these areas provide habitat for state and federally endangered species. These endangered species are identified in Section 6.4. Cultural resources, such as prehistoric archaeological sites have also been surveyed.

Monitoring of these natural and cultural resources is addressed in the "Natural Resource Monitoring Plan," which is included as Appendix A of Attachment D of the LMICP (DOE 2015). The Natural Resource Monitoring Plan presents an approach for monitoring and reporting the status of several priority natural resources to remain in compliance with pertinent regulations and agreements. The approach for monitoring and maintenance of ecologically restored areas was expanded in 2009. DOE and Ohio EPA signed a Consent Decree in November 2008 that settled a long-standing natural resource damage claim under Section 107 of CERCLA. As a result, the Fernald Natural Resource Trustees (DOE, Ohio EPA, and the U.S. Department of Interior) have finalized the "Natural Resource Restoration Plan" (NRRP), which is Appendix B of the *Consent Decree Resolving Ohio's Natural Resource Damage Claim against DOE* (State of Ohio 2008). The NRRP specifies an enhanced monitoring program for ecologically restored areas at the site. This includes an enhanced wetland mitigation monitoring program and a functional monitoring program that evaluates restored communities.

Ecological monitoring in 2014 focused on implementation monitoring of the Former Silos Area restoration project and functional monitoring of established forest communities. The site and OSDF inspection process was also continued in 2014 as required in the LMICP.

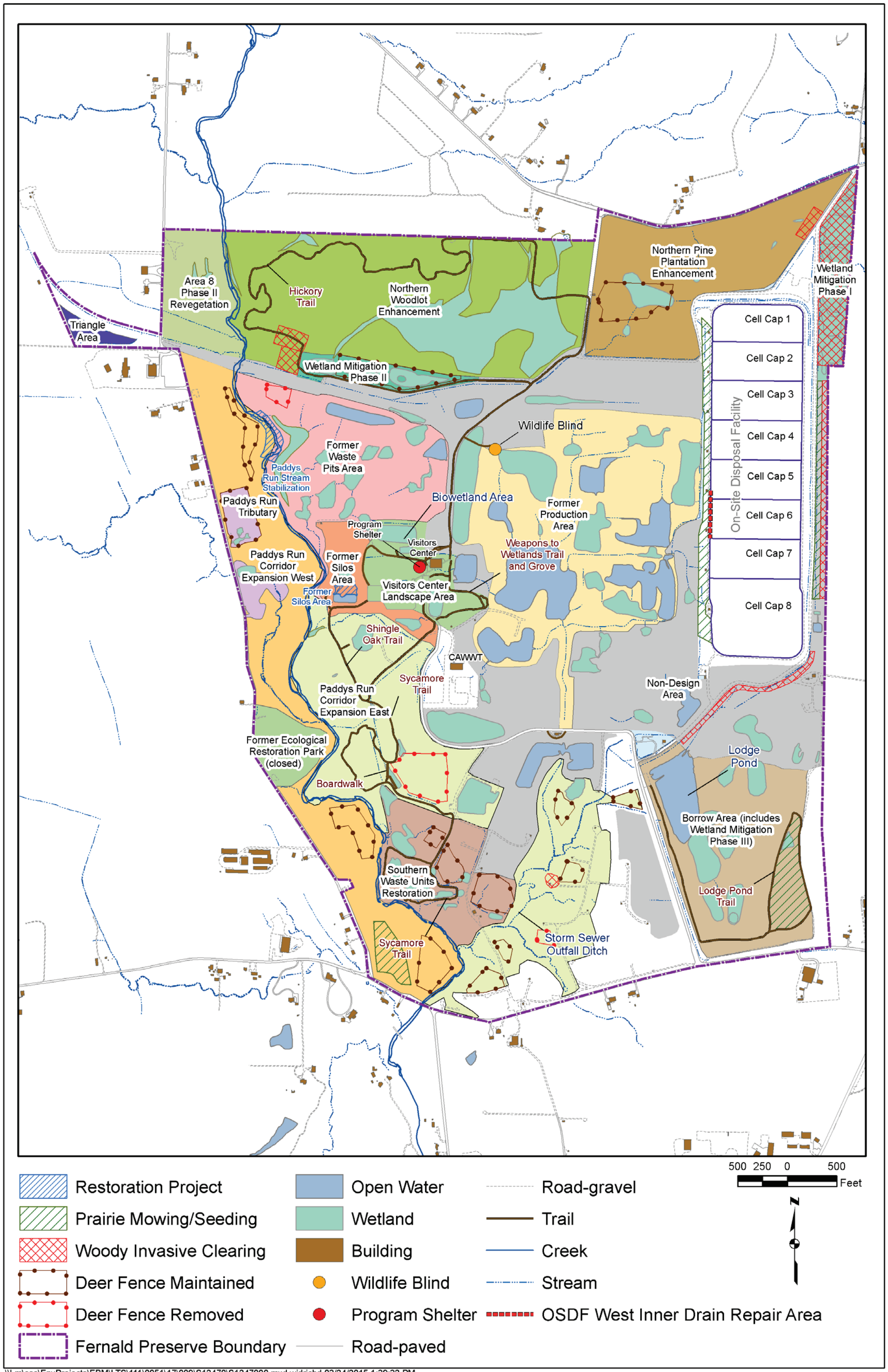


Figure 32. Restoration Project Areas

6.1 Ecological Restoration Activities

The Fernald Preserve's mission of long-term stewardship under LM includes the establishment, management, and monitoring of ecologically restored areas across the site. In 2014, repair and enhancement of ecologically restored areas focused primarily on the Paddys Run streambank stabilization project. This project began in September and involved relocation and stabilization of approximately 475 ft (145 m) of Paddys Run. Other projects focused on installation of public amenities, including a program shelter at the Visitors Center and a wetland boardwalk along a portion of the Sycamore Trail. Maintenance in ecologically restored areas included clearing invasive shrubs and trees (e.g., bush honeysuckle) in several locations, continued control of noxious weeds and invasive plants, and continued control of nuisance animals (e.g., deer and geese). Figure 32 shows the location of restoration activities discussed in the following sections.

6.1.1 Ecological Restoration Projects

As stated above, the Paddys Run streambank stabilization project was the focus of ecological restoration in 2014. Paddys Run had eroded approximately 13 ft eastward since 2012. The stream was channelized in 1961 and is meandering back towards its former location. If left unchecked, the channel may eventually reach the puddles with historically high surface water concentrations of uranium (refer to Section 4.0 for more information regarding elevated surface water concentrations). The goal of the project is to stabilize approximately 475 ft (145 m) of eroding bank along Paddys Run, west of the former Waste Storage Area. To accomplish this, the streambank will be relocated to provide a more gradual meander and the bank stabilized with large riprap, and a rock toe. Stabilization will also include planting and seeding the new streambank. A portion of the bank will include tree and shrub planting using a process called soil encapsulated lifts. This allows for vegetation to be established on steeper slopes when there is limited space for regrading. The relocated streambed will also be stabilized with two crossvanes. These features are large rock foundations that keep the streambed from eroding downward.

Paddys Run streambank stabilization activities in 2014 included channel relocation, construction of the rock toe and installation of the upstream crossvane. Weather conditions prevented completion of the project within the 2014 calendar year. The area was placed in a stable condition in December, and remaining work will be completed in 2015.

Two new public amenities were added in 2014. The Visitors Center program shelter was constructed in May and is located immediately west of the Visitors Center. The shelter includes several tables and benches for use during programs organized through the Visitors Center. A rain garden was installed on the north side of the shelter that captures water from the roof. The Program Shelter is available for reservation, similar to the Visitors Center Community Meeting Room.

The Sycamore Trail Boardwalk is a 240 ft (73 m) long boardwalk constructed across an on-property emergent wetland. The boardwalk is located along the Sycamore Trail and allows for up- close viewing of wetland plants and animals. The boardwalk will be used for school field trips and wetland programs. This project was completed in September.

6.1.2 Restored Area Maintenance and Repair

The focus of 2014 restored area maintenance involved removal of woody invasive species such as bush honeysuckle. Heavy infestation of honeysuckle prevents sunlight from reaching the ground. The shrub crowds out native species and prevents seedling development of desirable vegetation. Approximately 8 acres (3.2 hectares) of honeysuckle were cleared from woodlands in several locations across the site (Figure 32). Honeysuckle was physically cleared using heavy equipment and chainsaws. Glyphosate herbicide was applied to many of the stumps to prevent resprouting.

A similar process was also used to remove Callery pear and other woody vegetation from various locations within the OSDF. Callery pear continues to be an emerging nuisance at the site. Callery pear is the common name for any of a variety of commercial landscape trees, such as Bradford pear. In recent years, these trees have been observed in the northeastern portion of the site, as well as within the OSDF. Trees and shrubs are not permitted to become established on the OSDF cap, so these trees are removed once discovered.

Spot spraying with a broad-leaf herbicide, in conjunction with mowing and manual cutting, was continued in 2014 to control Canada thistle and other noxious weeds across the site. A number of prescribed burns were planned, but due to unfavorable field conditions, none were conducted. Instead, mowing was conducted in several prairie areas across the site. Figure 32 shows the location of prairie mowing areas. Functional monitoring efforts in 2013 showed reduced native diversity in some restored prairie areas; therefore, a revised approach to restored area management will be undertaken in 2015. Prairie areas will be prioritized and managed on a 3-year rotation by either burning or mowing. Moving to an area-specific approach will result in adjusting the timing of functional monitoring as well. Section 6.1.3 discusses this in more detail.

The primary nuisance animals onsite are white-tailed deer and Canada geese, which are an ongoing concern. Existing deer exclosure fencing was maintained sitewide to prevent deer from browsing and rubbing the planted trees. Older fences that were no longer needed were removed in several areas (Figure 32).

The goose-hazing program, which began in 2007, uses trained border collies to harass the geese. This program continued in 2014. The dogs, brought onto the Fernald Preserve by their handler, try to herd the geese. The geese believe the dogs are predators and fly off. This hazing is effective at keeping geese from both land and water. The goal is to keep the geese from areas that have been seeded so that the vegetation has time to become established. Once the grasses become tall, the geese are no longer attracted to those areas. A second goal is to make the geese too uncomfortable to nest at the Fernald Preserve.

Goose nests are counted and monitored across the site during the nesting season. For the last several years, the number of goose nests has decreased, which is due to the hazing program, but also to an increase in established vegetation and increased predation by coyotes. Goose hazing efforts in 2014 showed that over 60 percent of the active nests were predated, which is consistent with previous years. One nest was removed due to its proximity to a public trail. This activity is permitted through the Ohio Department of Natural Resources. The gosling population in 2014 was not significant.

6.1.3 Ecological Restoration Monitoring

> **Ecological Monitoring Parameters**
> There are a number of ways to evaluate the type and quality of habitats within an area. At the Fernald Preserve, ecological monitoring focuses on determining the extent of native species composition and calculating a Floristic Quality Assessment Index (FQAI). The FQAI process is described in the *Floristic Quality Assessment Index (FQAI) for Vascular Plants and Mosses for the State of Ohio* (Andreas et al. 2004). The specific parameters used at the Fernald Preserve include the following:
>
> - **Total Species**: The total number of species sampled within a given area.
> - **Native Species**: The total number of species native to Ohio. The *Ohio Vascular Plant Database* is used to determine whether a species is native (Andreas et al. 2004).
> - **Percent Native Species**: The number of native species divided into the total number of species. Relative frequency of native species is also used. This is calculated by dividing the frequency (or number of times a species is observed) into the total number of observations for a given area.
> - **Average Coefficient of Conservatism (CC)**: The CC is a number between 0 and 10 that has been assigned to virtually every species that may be found in Ohio. The CC value is related to how "tolerant" a species is and what its habitat requirements are. Non-native plants have a CC of 0. Common species that can grow in a wide variety of habitats are considered "tolerant," and are scored a CC between 0 and 3. Native plants with very specific habitat requirements are scored high CC values, in the 7 to 10 range. The *Ohio Vascular Plant Database* (Andreas et al. 2004) lists the CC for each plant found in Ohio.
> - **Floristic Quality Assessment Index (FQAI)**: The CC values described above are used to calculate the FQAI. The FQAI is the average CC value divided by the square root of the total number of species for a given area.
> - **Amphibian Index of Biotic Integrity (AIBI):** A scoring system using amphibians as a means of assessing the quality of wetland communities.

Monitoring of restored areas 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. The NRRP established goals for vegetation establishment of 50 percent native species and 90 percent total cover. For woody vegetation, the goal is 80 percent survival (State of Ohio 2008). Herbaceous and woody vegetation surveys of the Former Silos Area project were conducted in 2014.

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. The NRRP, which was finalized in November 2008 with settlement of the Natural Resource Damage Claim (State of Ohio 2008), reinstituted the use of functional-phase monitoring as a means of evaluating restored communities. Functional monitoring in 2014 focused on forest communities. A 3-year rotation of wetland, prairie and forest areas has been used to conduct the functional monitoring program. In order to support the revised prairie management approach discussed in Section 6.1.2, future functional monitoring efforts will be conducted based on area rather than habitat. Northern wetlands, prairies, and forests will be monitored in 2015.

Additional wetland monitoring was further specified in the *Wetland Mitigation Monitoring Report* (DOE 2012c). Most wetland mitigation monitoring activities were completed in 2011. However, amphibian monitoring and collection of hydrological data continued in 2014. Figure 33 shows the location of 2014 monitoring activities.

6.1.3.1 Forest Functional Monitoring

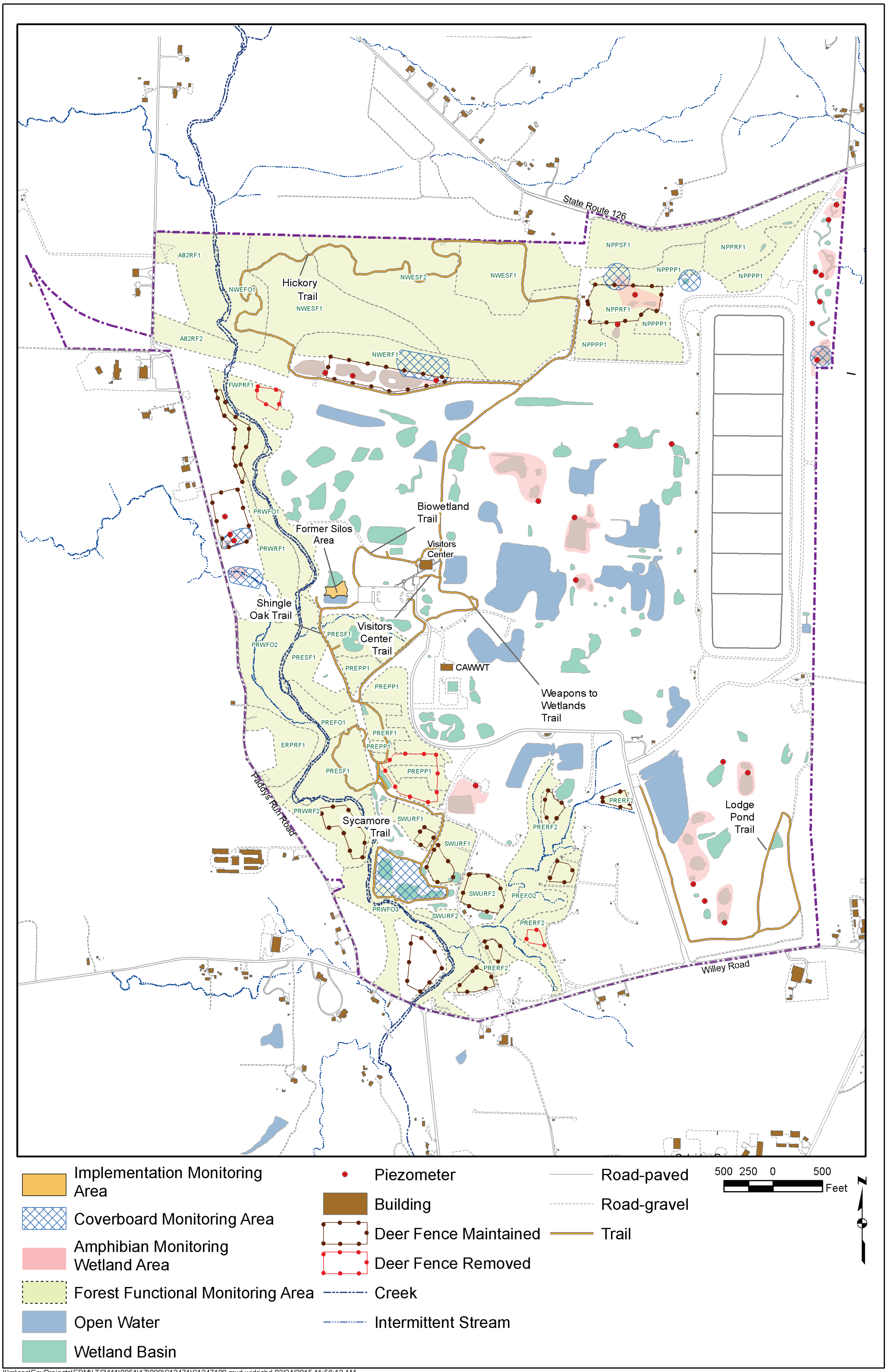
Functional monitoring compares restored communities to pre-restoration "baseline" conditions and high-quality reference sites. Baseline and reference sites were characterized in 2001 and 2002. From 2003 to 2005, restored areas were evaluated. Wetlands were evaluated in 2003, prairie communities in 2004, and forest habitats in 2005. This 3-year rotation resumed in 2009, so in 2011 a variety of restored forest communities were characterized. These areas were reevaluated in 2014 (DOE 2014a). Figure 33 shows forest functional monitoring locations, Table 11 presents summary herbaceous data, and Table 12 summarizes woody vegetation data. Results show that restoration goals for native species were met across all areas. The relative density of native woody vegetation was reduced in several locations, especially within young forest and mature forest communities. This is due to heavy infestations of bush honeysuckle. DOE will continue to clear honeysuckle and other invasives as part of restored area maintenance.

Table 11. Forest Functional Monitoring Herbaceous Vegetation Summary

Community Type	Functional Monitoring Area	Total Species	Native Species	Percent Native	Relative Frequency of Native Species (Percent)	Average CC[a]	FQAI[b]
Mature Forest	NWEFO1	52	40	77%	61%	2.02	14.58
	PREFO1	36	25	69%	52%	2.39	14.32
	PREFO2	45	26	58%	54%	1.48	9.89
	PRWFO1	45	28	62%	51%	1.79	11.98
	PRWFO2	52	33	63%	53%	2.00	14.42
	PRWFO3	44	29	66%	56%	2.26	15.01
Pine Plantation	NPPPP1	36	26	72%	61%	1.52	9.10
	PREPP1	38	23	61%	53%	0.97	5.96
Restored Forest	A82RF1	48	30	63%	61%	1.56	10.81
	A82RF2	43	24	56%	53%	1.27	8.33
	ERPRF1	36	16	44%	51%	1.15	6.91
	FWPRF1	35	23	66%	55%	1.79	10.61
	NPPRF1	38	24	63%	65%	1.48	9.15
	NWERF1	52	34	65%	59%	1.67	12.02
	PRERF1	54	30	56%	55%	1.20	8.82
	PRERF2	44	21	48%	53%	0.94	6.26
	PRWRF1	46	26	57%	50%	1.10	7.48
	PRWRF2	43	24	56%	47%	1.31	8.56
	SWURF1	48	27	56%	52%	1.71	11.85
	SWURF2	31	21	68%	67%	2.21	12.29
Young Forest	NWESF1	40	28	70%	61%	2.00	12.65
	NWESF2	51	33	65%	70%	1.90	13.60
	NPPSF1	40	27	68%	65%	1.45	9.20
	PRESF1	47	36	77%	76%	2.48	16.97

[a]CC = coefficient of conservatism

[b]FQAI = Floristic Quality Assessment Index



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12471\S1247100.mxd widrichd 03/24/2015 11:56:12 AM

Figure 33. Ecological Monitoring Activities

This page intentionally left blank

Table 12. Forest Functional Monitoring Woody Vegetation Summary

Community Type	Functional Monitoring Area	Total Species	Native Species	Percent Native	Relative Density of Native Species (Percent)	Average CC[a]	FQAI[b]	Average Size DBH (cm)
Mature Forest	NWEFO1	10	8	80%	90%	4.60	14.55	18.9
	PREFO1	16	15	94%	41%	3.88	15.50	19.5
	PREFO2	19	16	84%	39%	3.74	16.29	13.7
	PRWFO1	14	13	93%	12%	4.57	17.10	23.3
	PRWFO2	11	8	82%	61%	3.00	9.95	16.1
	PRWFO3	14	12	86%	16%	4.14	15.50	19.9
Pine Plantation	NPPPP1	16	12	75%	72%	2.75	11.00	10.9
	PREPP1	12	9	75%	90%	2.17	7.51	6
Restored Forest	A82RF1	20	18	90%	90%	3.65	16.32	9.3
	A82RF2	13	11	85%	77%	3.46	12.48	16.2
	ERPRF1	18	16	89%	89%	2.94	12.49	2.6
	FWPRF1	27	26	96%	80%	3.67	19.05	3.1
	NPPRF1	37	34	92%	99%	4.03	24.50	3.7
	NWERF1	20	16	80%	92%	2.70	12.07	7
	PRERF1	22	20	91%	98%	3.41	15.99	4.1
	PRERF2	38	35	92%	89%	3.89	24.01	2
	PRWRF1	30	26	87%	98%	3.50	19.17	2.9
	PRWRF2	25	23	92%	74%	3.64	18.20	2.9
	SWURF1	12	10	83%	75%	3.92	13.57	1.1
	SWURF2	13	12	92%	67%	4.38	15.81	1.8
Young Forest	NWESF1	17	15	88%	36%	3.71	15.28	26.4
	NPPSF1	17	15	88%	36%	3.41	14.07	15.2
	PRESF1	21	18	86%	26%	3.67	16.80	16

[a]CC = coefficient of conservatism
[b]FQAI = Floristic Quality Assessment Index
[c] DBH = diameter breast height

While the vegetation surveys are useful in comparing to baseline and reference sites, there is potentially greater value in using the data to compare results within the same area over time. Table 13 provides a data summary for the three areas surveyed in 2005, 2011, and 2014: Southern Waste Units (SWU); Area 8, Phase II (A82); and North Woodlot (NWE). Combined species lists from monitoring sub-areas are compared to corresponding baseline and reference sites. Results are mostly similar when comparing 2014 to 2011. Restored native forest communities continue to establish. There is a slight reduction in the FQAI score for the Area 8 Phase II Revegetation Area. This is due to invasive bush honeysuckle. Appendix D provides area-specific species lists that show increased frequency and density of honeysuckle across the project area. As stated above, continued management of this invasive species is required.

Table 13. Forest Functional Monitoring Comparison

	Southern Waste Units					Area 8, Phase II Revegetation					Northern Woodlot Enhancement				
Parameter	**2005**	**2011**	**2014**	**Reference (Upland Forest Complex)**	**Baseline (Developed)[a]**	**2005**	**2011**	**2014**	**Reference (Riparian)**	**Baseline (Grazed Pasture)**	**2005**	**2011**	**2014**	**Reference (Upland Forest Complex)**	**Baseline (Woodlot)**
Total Species	82	82	76	62	NA	66	74	65	95	38	82	68	67	62	56
Total Native Species	61	55	52	58	NA	44	55	49	85	15	58	50	47	58	42
Percent Native Species	74%	67%	68%	94%	NA	67%	74%	71%	91%	39%	71%	74%	70%	94%	75%
Average CC[b]	3	2.6	2.53	3.9	NA	2.2	2.5	2.22	3.3	0.4	1.8	2	1.98	3.9	2.4
FQAI[c]	26.70	23.13	22.04	30.50	NA	17.50	21.38	17.93	31.80	2.60	16.70	16.89	16.24	30.50	18.00

[a]NA = Not Applicable (Developed areas were not characterized. Baseline conditions are assumed to be zero for all parameters.)

[b]CC = Coefficent of Conservatism

[c]FQAI = Floristic Quality Assessment Index

6.1.3.2 Wetland Mitigation Monitoring

Pursuant to the *Wetland Mitigation Monitoring Report* (DOE 2012c), limited wetland monitoring continued in 2014. Activities included amphibian surveys to calculate Amphibian Index of Biotic Integrity (AIBI) and hydrologic monitoring using shallow wells (piezometers).

In the spring of 2014, amphibian monitoring was conducted using funnel traps in selected basins within mitigation wetlands. Table 14 lists the amphibian species observed, and Table 15 compares AIBI scores for each basin since 2011. These tables indicate that mitigated wetlands are mostly sustaining overall quality and function. Amphibians, especially mole (ambystomatid) salamanders, are considered key indicators of wetland health. Findings have been similar to those recorded in previous years with ambystomatid salamanders observed in wetlands that are located adjacent to established forest communities. Most of the ambystomatid salamanders observed in 2014 were young larvae that were difficult to identify to species.

Wetlands in the Former Production Area had a noticeably reduced abundance of cricket frogs, which resulted in lower AIBI scores across all wetland areas. Cricket frogs are a pioneer species that are found in newly created ponds and wetlands. It is possible that the Former Production Area wetlands are less attractive to cricket frogs as the community matures.

Water elevations in piezometers were recorded daily in 2014 to provide hydrologic data in each basin. Wetlands are dependent on extended periods of saturated conditions. The 2014 patterns of water levels were similar to those of past years, with saturated conditions observed through the winter and spring, followed by drier conditions in the summer and fall. These findings are also similar to those at other emergent wetlands in Ohio. This year marks the fifth year of monitoring for most wetland areas. Appendix D presents a summary table and hydrographs with results from all 5 years. The results are compared to the performance standards established in the *Fernald Preserve Wetland Mitigation Monitoring Plan* (DOE 2009b).

Three new piezometers were installed in the vicinity of the Paddys Run tributary restoration that was constructed in 2012. Results were similar to 2013, with the depth of water and the length of time with saturated conditions not meeting performance standards established in the *Fernald Preserve Wetland Mitigation Monitoring Plan* (DOE 2009b). Field observations showed that water levels were maintained in the main vernal pool basin for the whole year, and quality wetland vegetation has become established. Table 14 shows that several species of frogs and toads have been observed in the wetland. The AIBI score for the Paddys Run tributary project was 3 which is similar to the 2013 score (Table 15). Field personnel will evaluate the location of piezometers in 2015.

6.1.3.3 Implementation Monitoring

Implementation monitoring in 2014 consisted of herbaceous survey and woody survival counts in the Former Silos Area. Results of herbaceous monitoring show that the area met both native species and total cover goals. The percent native species and relative frequency of native species was 67 percent. Total cover was estimated at 94 percent. Appendix D provides the specific species list. Table 16 shows tree and shrub survival counts for the area which is identified on Figure 32.

Table 14. Amphibian Monitoring Summary

Wetland Area	Eastern Cricket Frog (*Acris crepitans*)	Streamside Salamander (*Ambystoma barbouri*)	Salamander Species (*Ambystomid sp*)	American and Fowlers Toad (*Anaxyrus species*)	Toad Species (*Anaxyrus sp*)	Gray Treefrog (*Hyla versicolor*)	Bullfrog (*Lithobates catesbeiana*)	Green Frog (*Lithobates clamitans*)	Northern Leopard Frog (*Lithobates pipiens*)	Frog Species (*Lithobates sp*)	Northern Spring Peeper (*Pseudacris crucifer*)
	Species and Number of Individuals										
BAPW2	0	0	0	0	0	0	0	0	2	13	0
BAPW4	0	0	0	0	0	0	0	0	1	2	0
BAPW7	0	0	0	0	0	0	0	0	5	29	0
FPAW2	0	0	0	0	0	0	1	1	0	4	0
FPAW7	2	0	0	0	0	0	0	0	0	10	0
FPAW9	3	0	0	0	15	0	0	2	0	24	0
PREW6	0	0	0	0	0	0	0	0	60	741	5
NPPW4	2	0	1	0	0	0	0	27	0	13	0
NPPW5	1	0	0	0	0	1	1	1	5	17	5
WM1W1	0	0	2	0	0	0	0	0	0	18	3
WM1W4	0	0	0	0	0	0	2	0	0	0	0
WM1W7	0	0	26	0	0	0	0	0	1	0	0
WM2W1	5	0	4	0	0	1	1	0	2	5	7
WM2W2	0	0	0	0	0	0	0	0	0	0	0
WM2W3	4	1	0	0	0	0	5	2	0	8	7
PRTW1	0	0	0	140	0	5	0	3	0	44	3

Table 15. Amphibian Index of Biotic Integrity

Restoration Project Area	Wetland Area	AIBI Score[a] 2011	2012	2013	2014
Borrow Area (BAP)	BAPW2	0	10	10	3
	BAPW4	0	10	3	3
	BAPW7	13	10	10	0
Former Production Area (FPA)	FPAW2	13	10	23	0
	FPAW7	0	20	24	3
	FPAW9	10	20	23	3
	PREW6	13	13	10	0
Northern Pine Plantation Enhancement (NPP)	NPPW4	33	13	13	6
	NPPW5	0	16	13	9
Wetland Mitigation Phase I (WM1)	WM1W1	3	10	13	3
	WM1W4	3	13	10	0
	WM1W7	0	10	3	27
Wetland Mitigation Phase II (WM2)	WM2W1	13	20	10	12
	WM2W2	6	16	10	6
	WM2W3	19	16	14	6
Paddys Run Tributary (PRT)	PRTW1	NA[b]	NA[b]	3	3

[a]AIBI= Amphibian Index of Biotic Integrity

[b]NA=Not Applicable; PRT wetland was created in 2012

Table 16. Former Silos Area Implementation Monitoring Woody Vegetation Survival

Species	Common Name	Total Number Planted 2012	Alive 2014	Resprout 2014	Vitality (<50% Alive) 2014	Dead or Unaccounted 2014	Survival (Percent) 2014	Survival (Percent) 2013
Acer rubrum	RED MAPLE	4	4	0	0	0	100%	100%
Acer saccharum	SUGAR MAPLE	3	3	0	0	0	100%	100%
Cephalanthus occidentalis	BUTTONBUSH	15	14	0	0	1	93%	93%
Cercis canadensis	REDBUD	3	3	0	0	0	100%	100%
Cornus amomum	SILKY DOGWOOD	15	6	0	3	6	40%	33%
Ilex verticulata	WINTERBERRY	15	13	0	0	2	87%	87%
Quercus bicolor	SWAMP WHITE OAK	3	4	0	0	0	100%	100%
Quercus macrocarpa	BUR OAK	4	4	0	0	0	100%	100%
Quercus palustris	PIN OAK	3	3	0	0	0	100%	100%
Rosa palustris	SWAMP ROSE	15	10	0	1	4	67%	60%
	Totals	80	64	0	4	13	89%	87%

The results above show that native herbaceous vegetation is sufficiently established within the Former Silos Area. For woody vegetation, 2014 results were similar to those of 2013. Table 16 shows greater than 80 percent overall survival within the project area. Silky dogwood is most heavily impacted. Field observations in 2013 revealed that the silky dogwood and the swamp rose suffered severe deer browsing. The 2014 results are slightly improved from 2013. This is most likely due to some of the shrubs recovering after the browsing in 2013.

6.2 Fernald Preserve Site and OSDF Inspections

The LMICP describes the routine inspection process for both the site and the OSDF. Inspections are conducted quarterly with joint participation from DOE and the regulators. Inspections document evidence of unauthorized uses of the site, the effectiveness of institutional controls, and the need for repairs. Ecologically restored areas are evaluated for the presence of noxious weeds, erosion, the condition of vegetation, potentially contaminated debris, and signs of damage from nuisance animals. As with recent years, findings in 2014 consisted mostly of the presence of weeds and deer fencing that was damaged by fallen trees and limbs. The invasive vegetation areas described in Section 6.1.2 were identified during the site inspection process. Debris also continues to be found, primarily in the Former Production Area and Former Waste Pits Area. 814 pieces of debris were discovered in 2014. Of those, eight pieces were found to have fixed radiological contamination above background levels. These pieces of debris were found in and removed from areas of the site that are not open to the public.

In addition to quarterly site inspections, the public trail overlooks are inspected weekly to ensure that they are safe and usable. No major issues were discovered in 2014.

For the OSDF inspections, the perimeter is walked down quarterly, and the vegetated cap is walked down annually and evaluated to ensure that its integrity is maintained. Erosion rills, holes from burrowing animals, noxious weeds, settlement cracks, and other indications that there may be an issue with the proper functioning of the cap are flagged and repaired. In 2014, there were no signs that the integrity of the cap had been compromised in any way. Findings consisted mainly of woody vegetation, noxious weeds, and animal burrows.

Wetland vegetation had been observed in several locations along the OSDF west inner drainage. The appearance of wetland vegetation indicated that flow was restricted within the drainage. Minor repair efforts in February 2013 were successful in restoring flow near Cell 6. However, several other poorly draining areas remained. Additionally, in the same area, water drained into a concrete culvert through a seam rather than the inlet as designed. These issues were repaired in June 2014. Subsequent inspections of the area show that the repair activities were successful in restoring proper drainage.

Quarterly inspection reports are posted on the Legacy Management website at http://www.lm.doe.gov/fernald/Sites.aspx. The quarterly inspection reports can also be viewed online at the Fernald Preserve Visitors Center or by contacting SN3 Public Affairs at (513) 648-6000. Appendix D presents the inspection findings from all 2014 quarterly site and OSDF inspections.

6.3 Affected Habitat Findings

The potential for unanticipated habitat impacts is limited but may occur during construction or maintenance activities. In 2014, most impacts were associated with clearing and stream location as part of the Paddys Run streambank stabilization project. Approximately 2 acres (0.8 hectare) of land were cleared in advance of stabilization work. Planting and seeding begun in 2014, and continuing into 2015, is expected to mitigate these impacts. In addition, 73 Sloan’s crayfish were relocated upstream in Paddys Run prior to the streambank stabilization.

6.4 Threatened and Endangered Species and Species Inventories

Sloan's Crayfish: The state 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 has been found at the Fernald Preserve in the northern reaches of Paddys Run.

Indiana Bat: The federally endangered Indiana bat (*Myotis sodalis*) forms colonies in hollow trees and under loose tree bark along riparian (streamside) areas during the summer. Excellent habitat for the Indiana bat has been identified at the Fernald Preserve 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 bat was captured and released on the property in August 1999.

Running Buffalo Clover: The federally 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 those of white clover in that they are heart-shaped and a lighter shade of green. Running buffalo clover has not been identified at the Fernald Preserve; 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 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 Preserve; however, suitable habitat exists in portions of the northern woodlot.

Cave Salamander: The state endangered cave salamander (*Eurycea lucifuga*) is slender, red to orange with irregular black dots. It is found in caves, springs, small limestone streams, outcrops, and old springhouses where groundwater is present. It has only been documented in Ohio in Hamilton, Butler, and Adams counties. Suitable habitat within the Fernald Preserve is limited, but populations have been observed just north of the site.

American Burying Beetle: The federally endangered American burying beetle (*Nicrophorus americanus)* is an orange and black carrion beetle that, with its mate, seeks out the remains of a recently deceased small animal. The beetles are natural decomposers, breaking down and burying the remains of the carrion. Once prepared, burying beetles will clean and protect the body, which serves as a source for larvae. The Fernald Preserve is within its historical range, but current known populations are limited to Rhode Island and Oklahoma. Recovery efforts have been ongoing in Ohio since 1998.

The Endangered Species Act requires the protection of any federally threatened or endangered species and any habitat critical for the species' existence. Several Ohio laws mandate the protection of state 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 site. As a result of these surveys, the federally endangered Indiana bat and the state threatened Sloan's crayfish have been found at the Fernald Preserve. In addition, suitable habitat exists for the federally endangered running buffalo clover, the state threatened spring coral root, and the state endangered cave salamander. None of these species have been found on the site, but their habitat ranges encompass the Fernald Preserve. The state threatened cobblestone tiger beetle has been considered a possible species in the past, but its habitat is limited to the Great Miami River. Figure 34 shows the potential habitats for these species. According to provisions in the LMICP, Section 6, "Natural Resource Monitoring Plan," threatened or endangered species habitat will be surveyed as needed prior to any construction activities. If threatened or endangered species are identified, appropriate avoidance or mitigation efforts will be taken.

In addition to the relocation of Sloan's crayfish discussed above, a survey for running buffalo clover was conducted in 2014, prior to the Paddys Run streambank stabilization project and construction of the Sycamore Trail Boardwalk. No populations were located in the project areas.

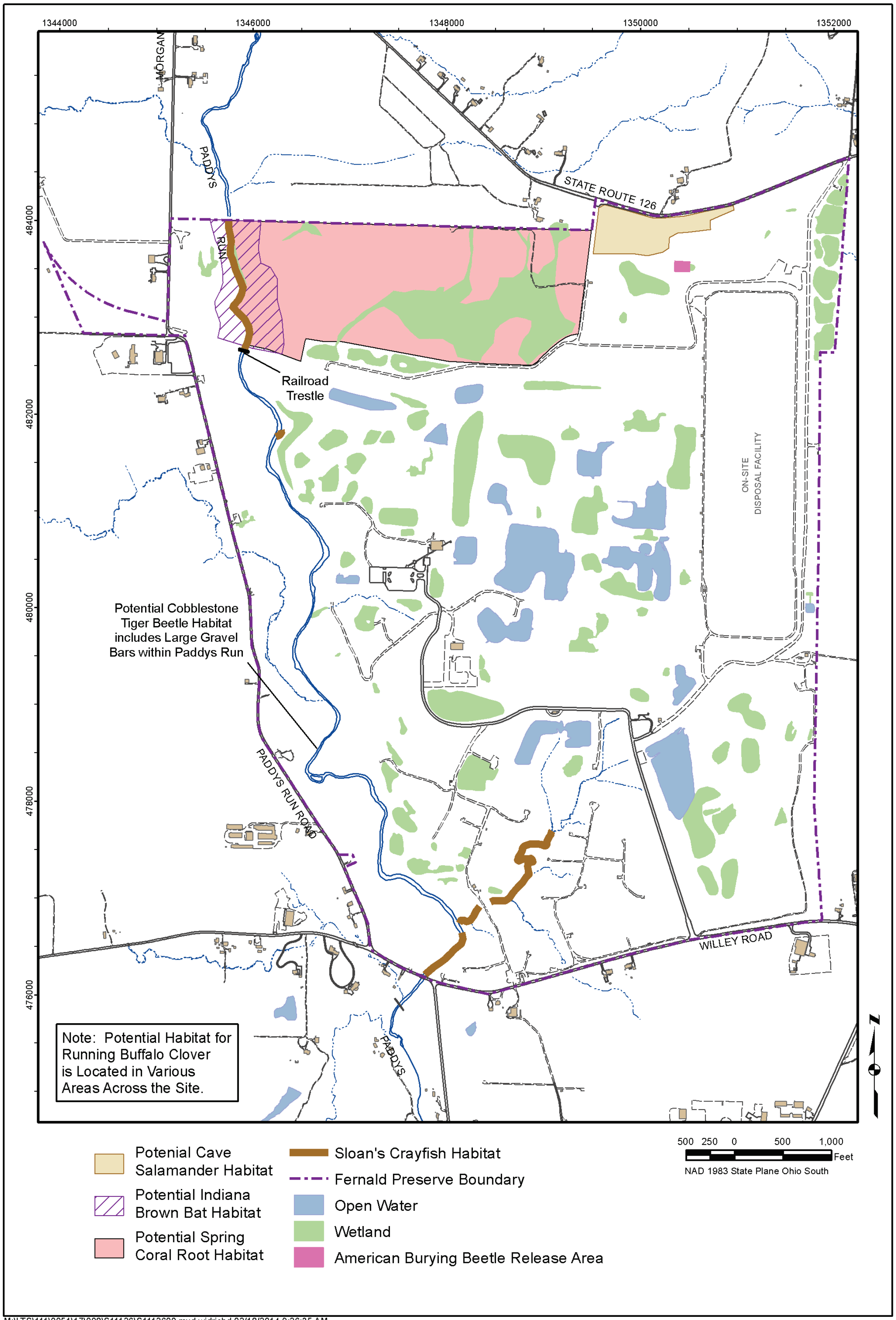


Figure 34. Threatened and Endangered Species Habitat Areas

Bat emergence surveys were conducted as well. The Paddys Run streambank stabilization project is located south of the potential Indiana Bat habitat area shown on Figure 34; however, there were several large dead trees at the northern edge of the project area. No bats were observed during the bat emergence survey, which was conducted prior to disturbance of the area.

In 2012, the Fernald Preserve was identified as a candidate for introduction of the American burying beetle. DOE signed a Cooperative Agreement with the U.S. Fish and Wildlife Service and the Cincinnati Zoo (DOE 2012a) to introduce the federally endangered beetle to the Fernald Preserve. This effort is part of the recovery plan for the beetle, which involves release and monitoring of beetles that were raised at the Cincinnati Zoo. Field personnel released 48 pairs of beetles and six individual females in July 2014. A post-release survey at the release site showed good initial results, with at least 50 percent of the pairs breeding. Similar to previous years, no American burying beetles were observed during a follow-up sitewide survey in August.

Virginia bluebells bloom in the spring within forest communities at the Fernald Preserve

In addition to endangered species survey work, several other species inventories took place in 2014. Coverboards continued to be monitored in 2014 as part of the site's species inventory activities. The boards are 2 ft by 4 ft sheets (0.61 m by 1.2 m) of corrugated metal that absorb heat and provide shelter for amphibians, reptiles, and small mammals. These boards are located along several wetland areas across the Fernald Preserve. These coverboards were surveyed from late summer through early fall. Additional wood boards are used in several northern wetlands. Wood and metal coverboards are placed side by side as an alternative coverboard technique to attract pond breeding salamanders. Table 17 lists the species observed in 2014. No new species were observed in 2014. The coverboards have proven to be useful in evaluating salamander activity near mitigation wetlands.

Table 17. Amphibian, Reptile, and Small Mammal Coverboard Observations

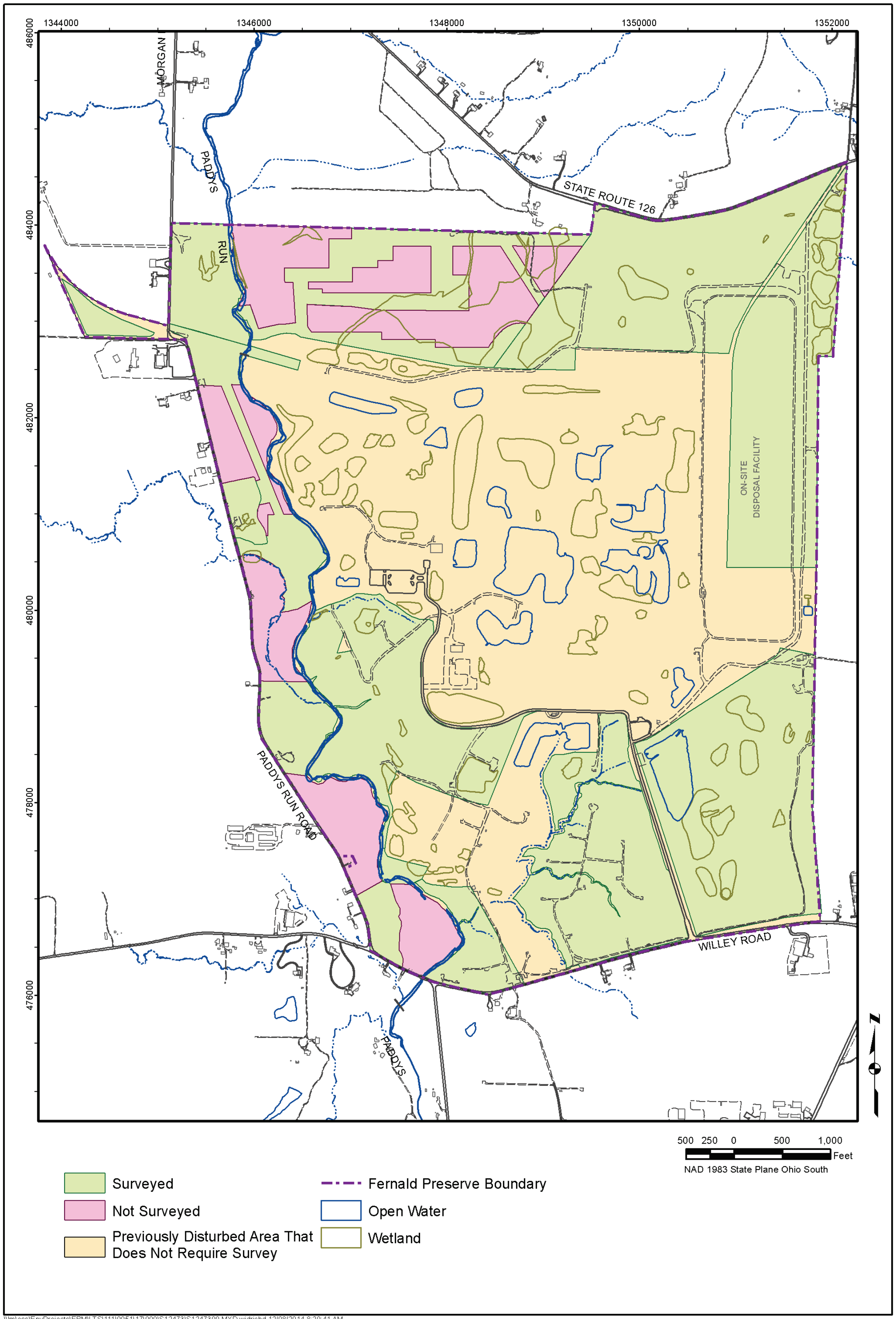
Species	**Common Name**	**NPPBR1**	**NPPW4**	**PRTW1**	**SWUPR1**	**WM1W4**	**WM2W3**	**Frequency**	**Relative Frequency**
Acris crepitans	CRICKET FROG	0	0	0	0	0	3	3	6%
Ambystoma barbouri	STREAMSIDE SALAMANDER	0	9	0	0	0	15	24	46%
Ambystoma opacum	MARBLED SALAMANDER	0	1	0	0	0	0	1	2%
Blarina brevicauda	NORTHERN SHORT-TAILED SHREW	0	2	0	0	4	0	6	12%
Lithobates species	UNKNOWN LITHOBATES SPECIES	0	0	0	0	0	5	5	10%
Nerodia sipedon	NORTHERN WATER SNAKE	0	0	1	0	0	0	1	2%
Pantherophis alleghaniensis	EASTERN RATSNAKE	0	0	1	2	0	0	3	6%
Peromyscus maniculatus	DEER MOUSE	0	1	0	0	0	0	1	2%
Plethodon cinereus	REDBACK SALAMANDER	0	4	0	0	0	0	4	7%
Thamnophis sirtalis	EASTERN GARTER SNAKE	3	0	1	0	0	0	4	7%
	Totals:	3	17	3	2	4	23	52	100%

6.5 Cultural Resources

The Fernald Preserve 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 historical time, resulting in diverse cultural resources. In summary, 148 prehistoric and 40 historic sites have been identified within 1.24 miles (2 km) of the Fernald Preserve.

Several laws have been established to protect cultural resources. 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 (43 CFR 10) requires that prehistoric human remains and associated artifacts be identified and returned to the appropriate Native American tribe. Compliance with these laws is addressed through a Programmatic Agreement for Archaeological Activities at the Fernald Preserve (DOE 2012b), which was updated in 2012.

To comply with these laws and the Programmatic Agreement, DOE conducted archaeological surveys prior to remediation activities in undeveloped areas of the Fernald Preserve. Figure 35 shows the areas of the Fernald Preserve that have been surveyed. These surveys have resulted in the identification of five sites that may be eligible for listing on the National Register of Historic Places. None of these sites were affected by construction activities. Because no construction activities occurred outside areas that were previously disturbed, no additional surveys were needed in 2014.



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\009\S12473\S1247300.MXD widrichd 12/08/2014 8:29:41 AM

Figure 35. Cultural Resource Survey Areas

7.0 References

43 CFR 10. U.S. Department of the Interior, "Native American Graves Protection and Repatriation Regulations," *Code of Federal Regulations*.

Andreas, B.K., J.J. Mack, and J.S. McCormac, 2004. *Floristic Quality Assessment Index (FQAI) for Vascular Plants and Mosses for the State of Ohio,* Ohio Environmental Protection Agency, Division of Surface Water, Wetland Ecology Group, Columbus, Ohio.

CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act of 1980), as amended, Title 42 *United States Code* Section 9601 et seq.

Clean Air Act, as amended, Title 42 *United States Code* Section 7401 et seq.

Clean Water Act (Federal Water Pollution Control Act), as amended, Title 33 *United States Code* Section 1251 et seq.

DOE Order 436.1. *Departmental Sustainability*, May 2, 2011.

DOE Order 458.1. *Radiation Protection of the Public and the Environment*.

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

DOE (U.S. Department of Energy), 1996. *Record of Decision for Remedial Actions at Operable Unit 5*, 7478 U 007 501.4, Final, Fluor Fernald, Cincinnati, Ohio, January.

DOE (U.S. Department of Energy), 1997. *Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)*, Final, Fernald Environmental Management Project, 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, Fernald Area Office, Cincinnati, Ohio, April.

DOE (U.S. Department of Energy), 2001b. *Explanation of Significant Differences for Operable Unit 5*, Final, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, October.

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

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

DOE (U.S. Department of Energy), 2002a. *A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota*, DOE-STD-1153-2002, Washington, D.C., July.

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

DOE (U.S. Department of Energy), 2003. *Comprehensive Groundwater Strategy Report*, Revision 0, Office of Legacy Management, Cincinnati, Ohio, June.

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

DOE (U.S. Department of Energy), 2005a. *Storm Sewer Outfall Ditch Infiltration Test Report*.

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

DOE (U.S. Department of Energy), 2006a. *Fernald Groundwater Certification Plan*, 51900-PL-0002, Revision 1, Final, Fluor Fernald, Office of Legacy Management Cincinnati, Ohio, April.

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

DOE (U.S. Department of Energy), 2008. *Interim Remedial Action Report for Operable Unit 5*, Office of Legacy Management, Cincinnati, Ohio, August.

DOE (U.S. Department of Energy), 2009a. *Fernald Preserve 2008 Site Environmental Report*, LMS/FER/S05082, Office of Legacy Management, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2009b. *Fernald Preserve Wetland Mitigation Monitoring Plan*, LMS/FER/S05034, Office of Legacy Management, Cincinnati, Ohio, October.

DOE (U.S. Department of Energy), 2011a. *Fernald Preserve 2010 Site Environmental Report*, Office of Legacy Management, Cincinnati, Ohio, June.

DOE (U.S. Department of Energy), 2011b. *Third Five-Year Review Report for the Fernald Preserve*, LMS/FER/S07045, Office of Legacy Management, Cincinnati Ohio, September.

DOE (U.S. Department of Energy), 2012a. *Cooperative Agreement to facilitate recovery of the American burying beetle in Ohio*, signed by M. Knapp, Field Supervisor, U.S. Fish and Wildlife Service; D. Geiser, Director, Office of Legacy Management; and T. Maynard, Executive Director, Cincinnati Zoo & Botanical Garden.

DOE (U.S. Department of Energy), 2012b. *Programmatic Agreement Among the U.S. Department of Energy Office of Legacy Management and the Ohio Historic Preservation Office Regarding Archaeological Investigations at the Fernald Preserve*, Office of Legacy Management, Cincinnati, Ohio, April.

DOE (U. S Department of Energy), 2012c. *Fernald Preserve Wetland Mitigation Monitoring Report*, LMS/FER/S08266, Final, Office of Legacy Management, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2014a. *Fernald Preserve Ecological Monitoring Methods Plan and Procedures*, LMS/FER/S06195, Office of Legacy Management, Cincinnati, Ohio, October.

DOE (U.S. Department of Energy, 2014b. *Operational Adjustment-1 WSA Phase-II Groundwater Remediation Design, Fernald Preserve*, Final, Office of Legacy Management, Cincinnati, Ohio, March.

DOE (U.S. Department of Energy), 2014c. *Site Sustainability Plan*, LMS/S07225, Final, Office of Legacy Management, Cincinnati, Ohio, December.

DOE (U.S. Department of Energy), 2015. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 8, Office of Legacy Management, Cincinnati, Ohio, January.

EPA (U.S. Environmental Protection Agency), 2006. *Preliminary Closeout Report U.S. DOE Feed Materials Production Center Fernald, Ohio*, EPA Region 5, December.

EPA (U.S. Environmental Protection Agency), 2011. *Close Out Procedures for National Priorities List Sites*, OSWER Directive 9320.2-22-P, Office of Superfund Remediation and Technology Innovation, May.

Executive Order 12580. *Superfund Implementation,* Office of the Federal Environmental Executive, January 23, 1987.

Executive Order 13423. *Strengthening Federal Environmental, Energy, and Transportation Management,* Office of the Federal Environmental Executive, January 24, 2007.

Executive Order 13514. *Federal Leadership in Environmental, Energy, and Economic Performance,* Office of the Federal Environmental Executive, October 5, 2009.

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

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

RCRA (Resource Conservation and Recovery Act), as amended. Title 42 *United States Code* Section 6901 et seq.

State of Ohio, 2008. *Consent Decree Resolving Ohio's Natural Resource Damage Claim against DOE*, State of Ohio *v.* United States Department of Energy et al., Civil Action No. C-1-86-0217, Judge Spiegel.

Toxic Substances Control Act, as amended. Title 7 *United States Code* Section 136 et seq.

8.0 Glossary

amphibian index of biotic integrity**:** A scoring system that uses amphibians as a means of assessing the quality of wetland communities.

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, according to 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.

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 OU5 ROD. 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 describes the rate of spontaneous, energy-emitting transformations in the nuclei of atoms; 1 curie is equal to 37 billion (3.7×10^{10}) nuclear transformations per second.

dose**:** Amount of radiation absorbed in biological 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.

***gamma ray*:** A 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.

***mixed waste*:** Hazardous waste that has been contaminated with low-level radioactive materials.

***point source*:** The single defined point (origin) of a release such as a stack, vent, or other discernible 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. A removal action is performed in response to 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 silo's headspace).

surface water**:** Water that is flowing within natural drainage features.

treated effluent**:** Water from numerous areas at the site that is treated through one of the site's wastewater treatment facilities and discharged to the Great Miami River.

uncontrolled runoff**:** Storm water that is not collected by the site for treatment, but enters the site's natural drainages.

vegetation index of biotic integrity**:** A scoring system that uses vascular plants as a means of assessing the quality of a given plant community.

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 of in that facility. These are known as waste acceptance criteria. Offsite disposal facilities such as the Nevada National Security Site (formerly called the Nevada Test Site) that dispose of Fernald waste have specific waste acceptance criteria. In addition, the OSDF had waste acceptance criteria that were approved by the regulatory agencies.

This page intentionally left blank