LMS/FER/S32359

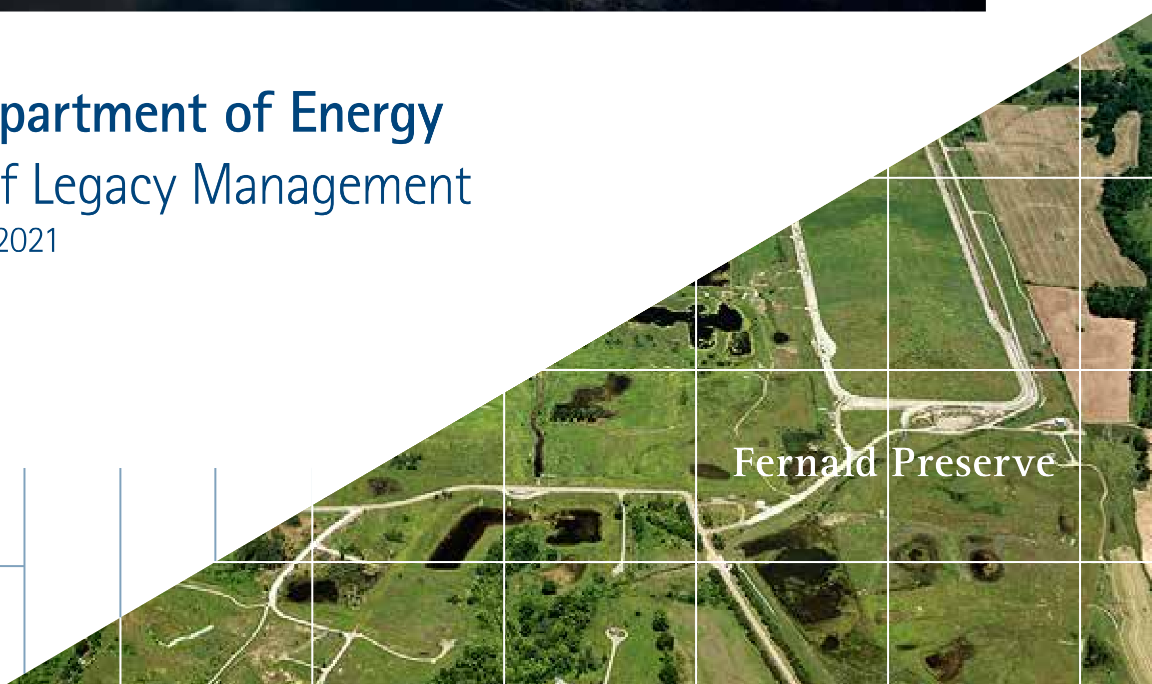
FERNALD PRESERVE

# 2020 Site Environmental Report

**U.S. Department of Energy**

Office of Legacy Management

Issued May 2021



Electronic versions of Fernald Preserve documents are available at
https://www.lm.doe.gov/Fernald/Documents.aspx.

U.S. Department of Energy Office of Legacy Management's Geospatial Environmental Mapping System (GEMS) application is available at https://gems.lm.doe.gov/#site=FER

LMS/FER/S32850

# Fernald Preserve

# 2020 Site Environmental Report

**May 2021**

**Site Address**
Fernald Preserve
7400 Willey Road
Hamilton, Ohio 45013

**Public Affairs Site Contact**
Fernald@lm.doe.gov
(513) 648-3330

**Emergency Contact**
Legacy Management 24-hour
Monitored Security Telephone Number
(877) 695-5322

This page intentionally left blank

# Contents

# Tables



# Figures

# Appendixes

# Abbreviations

| | |
|---|---|
| AIBI | Amphibian Index of Biotic Integrity |
| AR | Administrative Record |
| ARAR | applicable or relevant and appropriate requirement |
| CAWWT | Converted Advanced Wastewater Treatment |
| CC | coefficient of conservatism |
| CERCLA | Comprehensive Environmental Response, Compensation, and Liability Act |
| 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 | Office of Legacy Management |
| LMICP | *Comprehensive Legacy Management and Institutional Controls Plan* |
| NPDES | National Pollutant Discharge Elimination System |
| NPL | National Priorities List |
| NRMP | *Fernald Preserve, Ohio, Site Natural Resource Management Plan* |
| NRRP | Natural Resource Restoration Plan |
| ODNR | Ohio Department of Natural Resources |
| Ohio EPA | Ohio Environmental Protection Agency |
| OSDF | On-Site Disposal Facility |
| OU5 ROD | Operable Unit 5 Record of Decision |
| PFAS | polyfluorinated alkyl substance |
| PFOA | perfluorooctanoic acid |
| PFOS | perfluorooctane sulfonate |
| PPDD | Pilot Plant Drainage Ditch |
| RAMP | Restored Area Maintenance Plan |
| RCRA | Resource Conservation and Recovery Act |
| ROD | Record of Decision |
| SARA | Superfund Amendments and Reauthorization Act of 1986 |

| | |
|---|---|
| SSOD | storm sewer outfall ditch |
| USC | *United States Code* |
| VIBI-FQ | Vegetation Index of Biotic Integrity - Floristic Quality |

# Measurement Abbreviations

| | |
|---|---|
| ft | feet |
| gpm | gallons per minute |
| lb | pounds |
| µg/L | micrograms per liter |
| Mgal | million gallons |
| pCi/L | picocuries per liter |

This page intentionally left blank

# Executive Summary

The *Fernald Preserve 2020 Site Environmental Report* provides stakeholders with the results from the Fernald Preserve, Ohio, Site's environmental monitoring programs for 2020; a summary of U.S. Department of Energy (DOE) activities conducted onsite; a status of the ongoing groundwater remediation; and a summary of the site'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).

Remediation of the Fernald Preserve has been successfully completed, with the exception of the groundwater. Due to the COVID-19 pandemic in the spring of 2020, DOE requested and received regulatory relief from LMICP requirements to prevent the spread of COVID-19. Site staffing and activities beginning March 24 were greatly reduced. DOE continued to operate the Fernald extraction well field and the Converted Advanced Wastewater Treatment Facility (CAWWT) each Monday morning through Thursday morning to avoid substantial maintenance issues of the system. The site continued to monitor the CAWWT effluent to fulfill all regulatory requirements. DOE began a phased restart in accordance with available federal and state health guidance. Details of the missed requirements are provided in the appropriate sections of this report.

During 2020, activities at the Fernald Preserve (including details about regulatory requirements that were missed from the week of March 23 through the week of May 18, 2020) included the following:

- Environmental monitoring activities related to groundwater and surface water. Weekly surface water samples were not collected from the week of March 23 through the week of May 18, 2020.
- Monitoring as specified in the site's National Pollutant Discharge Elimination System (NPDES) permit. One weekly post-rain construction project inspection for the CAWWT backwash basin project was missed the week of March 23, 2020. The backwash basin construction project was completed in late 2019. Grass had become established for this project by the week of April 6, 2020, at which time the inspections were no longer required.
- Extraction, monitoring, and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5). Target extraction well pumping rates were not met due to the extraction well system operating only Monday morning through Thursday morning from the week of March 23 through the week of May 18, 2020.
- On-Site Disposal Facility (OSDF) leak detection monitoring and collection, monitoring, and treatment of leachate from the OSDF. No OSDF requirements were missed in 2020.
- 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. One of three rounds of amphibian monitoring and one of three rounds of forest functional monitoring were missed. Spring prescribed burns were also not completed in 2020.

- Ongoing operation of the Fernald Preserve Visitors Center, associated outreach, and educational activities. The site trails were closed week of March 25, 2020, and reopened on June 8, 2020. The Visitors Center also closed the week of March 23, 2021 and remains closed until further notice; DOE expanded virtual outreach and availability of virtual programs for the public during this closure.

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 of the total uranium plume is maintained; track the aquifer restoration in the area of the 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 the well field.
- Meet compliance-based groundwater monitoring obligations.

During 2020, active restoration of the Great Miami Aquifer continued. A total of 93 groundwater monitoring wells were sampled to determine water quality. Aquifer water elevations were measured in 172 groundwater monitoring wells. The following highlights describe the key findings from the 2020 groundwater data:

- A total of 2.2 billion gallons of groundwater were extracted from the Great Miami Aquifer, and 390 pounds (lb) of uranium were removed from the aquifer in 2020.
- Since 1993, 51 billion gallons of water have been pumped from the Great Miami Aquifer, and 15,034 net pounds of uranium have been removed from the Great Miami Aquifer. Net pounds of uranium removed include a small amount of uranium that was reinjected into the aquifer between 1998 and 2004.
- Data collected in 2020 indicate that uranium concentrations within the footprint of the 30 micrograms per liter (µg/L) maximum uranium plume continue to decrease in response to pumping. The footprint of the maximum uranium plume in 2020 was approximately 81.5 acres, a decrease of 5.0 acres or approximately 5.8% from what was mapped in 2019. Since 2005, the area of the total uranium plume has decreased from 196.1 acres to 81.5 acres (58.4%).
- 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 remains 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

The current Operational Design for the groundwater remedy has been in effect since design changes were implemented on July 1, 2014. Three extraction wells that were no longer providing benefit to the remediation were shut down, and the pumping capacity from these wells was reallocated 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 current 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 current Operational Design is also more efficient because pumping rates are initially higher in the more concentrated areas of the plume, resulting in lower overall pumping rates as the remedy progresses. No operational changes to the groundwater remediation occurred in 2020.

Data collected in 2020 shows that the mass and average concentration of uranium being removed from the aquifer is greater than what the groundwater model predicted in 2012 would be removed. This indicates that pumping remains effective in removing uranium, but that the cleanup will take longer than the model predicted. Additional groundwater modeling is needed to determine if the system can be optimized again, as it was in 2014. To address these challenges, DOE has developed a collaborative partnership with the DOE National Laboratory Network as discussed below.

As the current operational pumping remedy continues, DOE remains committed to continually evaluating potential enhancements that might improve the efficiency of the remedy. One potential improvement could be an update to the groundwater model to more accurately and reliably predict groundwater cleanup times. In 2021, DOE will participate in a collaborative exercise with experts in the field of groundwater modeling, remediation, and well field operations from the DOE National Laboratory Network. Since a potential outcome of the collaboration will be recommendations on how to improve modeling predictions, DOE does not plan to conduct any additional optimization modeling until after this collaboration concludes later in 2021.

The aquifer remedy in the current Operational Design is able to achieve the uranium discharge limits (i.e., average monthly concentration of less than 30 µg/L and 600 lb annually) established in the Operable Unit 5 Record of Decision without routine groundwater treatment. Routine groundwater treatment has not been needed since 2010. Occasionally, groundwater is sent to treatment for very short periods of time. The reasons for the short periods of treatment vary, but most are related to times when wells pumping low uranium concentrations are turned off for maintenance and wells pumping higher uranium concentrations continue pumping.

In 2020, 2.2 billion gallons of groundwater were pumped from the Great Miami Aquifer and 6.3 million gallons (0.29%) of groundwater were treated. During 2020, well field operations were impacted by the response to the COVID pandemic. In response to the pandemic and to prevent the spread of COVID-19, DOE greatly reduced site activities to align with the State of Ohio Department of Health Director's Stay at Home Order that was issued on March 22, 2020. Between the week of March 23 and the week of May 18, 2020, the wellfield and treatment system operated between Monday morning and Thursday morning. As a result, the well field was off for a total of 32 days. Due to the extra time that the pumping wells were not operated in 2020 due to the COVID-19 pandemic response, less water was pumped from the aquifer than was planned, resulting in less uranium being removed from the aquifer as well. Capture of the plume was maintained. Groundwater monitoring was not affected in 2020 due to the COVID-19 pandemic response. Site personnel completed all groundwater monitoring requirements.

**OSDF 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 as designed. OSDF monitoring was not affected by the response to the COVID-19 pandemic in 2020.

**Surface Water and Effluent Pathway**

Surface water and effluent 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, as well as to meet compliance-based surface water and effluent monitoring obligations.

In 2020, 18 surface water locations and one effluent location were sampled at various frequencies. The following highlights describe the key findings from the 2020 surface water and effluent monitoring programs:

- Since 1995, the annual uranium mass discharged in Fernald effluent to the Great Miami River has been less than the Operable Unit 5 Record of Decision limit of 600 lb per year. A total of 378 lb of uranium were discharged in effluent to the Great Miami River in 2020.
- An estimated 33 lb of uranium were released to the environment through uncontrolled storm water runoff from the site. Therefore, the total amount of uranium released through the effluent and uncontrolled surface water pathways during 2020 is estimated to be 411 lb.
- Analytical results of 17 of 29 surface water samples collected from location SWD-09 and 1 of 19 samples collected from location SWD-05 exceeded the surface water final remediation level for total uranium in 2020, the site's primary contaminant. SWD-09 and SWD-05 are the two locations established to monitor the 2007 maintenance action completed west of the former Waste Pits Area. These locations are in an area of the site that is not accessible to the public. Weekly surface water samples were not collected between week of March 23 and May 8, 2020, due to the COVID-19 pandemic response. Weekly monitoring of the two locations resumed the week of May 18, 2020.
- Analytical results of surface water samples collected at locations SWD-05 and SWD-09 have been trending downward since 2010. The surface water from this area remains isolated and does not drain to Paddys Run: it either evaporates or infiltrates into the ground. Any infiltration down to the aquifer in this area is within the capture zone of nearby extraction wells operating as part of the groundwater remediation.
- Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and effluent discharges from the Fernald Preserve, is regulated under the State-administrated NPDES program. Discharges in 2020 were in compliance with limits identified in the NPDES permit. No NPDES permit-required sampling events were missed as a result of reduced staffing during the COVID-19 pandemic.

## Natural Resources

The focus of restored area maintenance activities in 2020 involved continued eradication of invasive species, including targeted efforts at reed canarygrass (*Phalaris arundinacea*), callery pear (*Pyrus calleryana*), and multiflora rose (*Rosa multiflora*). Fall foliar herbicide application to Amur honeysuckle (*Lonicera maackii*) also continued in 2020. Approximately 10 acres of Amur honeysuckle were treated with herbicide. Vegetation clearing along portions of the on-property utility corridors also occurred in 2020.

Ecological monitoring in 2020 consisted of wetland, prairie, and forest functional monitoring in the southern and eastern portions of the site, along with continued wetland mitigation monitoring. Results of the functional monitoring indicated ongoing establishment of native vegetation and wetland communities. Wetland communities continue to improve in the northern and western portions of the site. Beaver activities continue to affect restored wetlands and infrastructure in a number of areas across the site.

Quarterly site and OSDF inspections continued in 2020. Findings were mainly of invasive plants and woody vegetation on the cap of the OSDF; no major findings were identified. Debris also continues to be found, primarily in the Former Production Area and the former Waste Storage Area. Examples of debris include pieces of concrete, rebar, clay tile, and metal. Weather, erosion, and earth-moving activities occasionally reveal small pieces of debris that were not visible during remediation and restoration efforts. A total of 242 pieces of debris were removed in 2020. One piece of debris had fixed radiological contamination above background levels, and all debris was properly disposed of. A summary table of annual debris counts is provided in Table C-16 in Appendix C.

A survey for the federally endangered running buffalo clover (*Trifolium stoloniferum*) was conducted in 2020 prior to aerial survey monument installation, with none found. No federally endangered American burying beetles (*Nicrophorus americanus*) were released in 2020, due to the COVID-19 pandemic. In 2020, there were no unexpected discoveries of cultural resources. Because all ground-disturbing field activities in 2020 occurred in previously surveyed areas, no archaeological surveys were necessary.

The Fernald Natural Resource Trustees conducted a 10-year review of the Restored Area Maintenance Plan, pursuant to the Natural Resource Restoration Plan. This has resulted in the development of the Fernald Natural Resource Management Plan. This document presents a revised community-based approach for management and evaluation of ecologically restored areas across the Fernald Preserve. DOE intends to implement the Natural Resource Management Plan in 2021.

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 Facility 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. |
| 1991 | As part of the Amended Consent Agreement, the site was divided into operable units for characterization and remedy determination. Uranium production formally ended. The site mission changed from uranium production to environmental remediation and site restoration. |
| 1992 | Large-scale groundwater pumping to contain the off-property South Plume began. |
| 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 reopened.) 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 On-Site Disposal Facility (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 began (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 Operable Unit 2 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 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 were placed in Cells 4 through 8. |
| 2005 | Removal of Operable Unit 4, Silo 3 waste began and the first shipment of this 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 | With the exception of groundwater remediation, site remediation was completed October 29, 2006. The site was officially transferred to DOE's Office of Legacy Management on 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 to 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 was 300 gpm higher than the previous design and accelerated cleanup. |
| 2015 | The decision to reduce wastewater treatment capacity to 50 gpm was made. |
| 2017 | Completed removal of treatment media, demolition of existing piping and tanks to allow room for the new wastewater treatment system within CAWWT, and design of the new system, which began in 2016. Low-level radioactive waste from the demolition project was disposed of at Waste Control Specialists in Texas. Construction of the new treatment system began. |
| 2018 | The new water treatment system became operational in April 2018. |
| 2019 | The refurbished CAWWT backwash basin was operational in November 2019. |

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 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) 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 (Title 42 *United States Code*

Section 9601 et seq. [42 USC 9601 et seq.]). 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 in by the successful transition to the DOE Office of Legacy Management (LM) in late 2006, with the site's new mission to be an asset to the community as an undeveloped park, with an emphasis on wildlife.

DOE's Legacy Management Support contractor continues to perform 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 (agricultural 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.

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, in 1997 the environmental monitoring program was revised 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 2019). Noting that it is expected that fewer changes to the LMICP will be required, DOE proposed to EPA and Ohio EPA that the variance process established in the Fernald Preserve Quality Assurance Project Plan (DOE 2014) be used to communicate LMICP changes instead of updating the entire document each year. This process was approved, and changes required to be implemented for calendar year 2020 were documented and approved by the regulatory agencies in January 2020.

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 2020 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 1.0 through 5.0) documents the results of environmental monitoring activities at the Fernald Preserve in 2020. It includes a discussion of ongoing groundwater remediation activities and summaries of environmental data from groundwater, surface water and effluent, and natural resources monitoring programs. It also summarizes the information contained in the appendixes. A glossary is included at the end of the summary report.

- **Appendixes:** The detailed appendixes provide the 2020 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 public website at https://www.lm.doe.gov/fernald/Sites.aspx or by contacting LM at (513) 648-3333; by contacting Interpretive Service at (513) 648-6000; or by sending an email to 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 and addressed, 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 five-year review process is triggered by the onset of construction for the first operable unit remedial action that will result in hazardous substances, pollutants, or contaminants remaining at the site above levels that allow for unlimited use and unrestricted exposure. Of all the operable units, the site preparation construction to support the Waste Pits Project under the Operable Unit 1 ROD (DOE 1995b) was the first such action. This construction began on April 1, 1996. To date, DOE has conducted, and the regulatory agencies have approved, four CERCLA five-year reviews (April 2001 [DOE 2001c], April 2006 [DOE 2006b], September 2011 [DOE 2011], and September 2016 [DOE 2016b]). These reviews verify that the remedy remains effective and continues to be protective of human health and the environment. The next CERCLA five-year review will begin in the fall of 2020 and will be finalized in 2021.

**Long-Term Stewardship of CERCLA Remedies:** 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 RODs 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 2019) defines the activities to be conducted with respect to long-term stewardship at the Fernald Preserve. The CERCLA five-year review process will continue to provide stakeholders information on remedy performance and long-term stewardship.

The remainder of this introductory Section 1.0 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 Fernald Preserve.

## 1.1 The Path to Site Closure

In 1986, the Fernald site initiated working through the CERCLA process to characterize the nature and extent of contamination at the site, to establish risk-based cleanup standards, and to select the appropriate remediation technologies to achieve those standards. To facilitate this process, in 1991 the site was organized into five operable units. The purpose of the operable unit concept under CERCLA was to organize site components by geographical location 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 gives an overview of its associated remedy.

*Table 1. Operable Unit Remedies*

| Operable Unit | Description | Remedy Overview |
|---|---|---|
| 1 | • Waste Pits 1–6<br>• Clear well<br>• Burn pit<br>• Berms, liners, caps, and soil within the boundary | ROD approved: March 1995<br>Explanation of Significant Differences approved: September 2002<br>ROD Amendment approved: November 2003<br>Excavation of materials with constituents of concern above FRLs, waste processing and treatment by thermal drying (as necessary), offsite disposal at a permitted facility, and soil remediation/certification.<br>**Remedial actions completed: June 2005**<br>**Final Remedial Action Report approved: August 2006** |
| 2 | • Solid waste landfill<br>• Inactive fly ash pile<br>• Active fly ash pile (now inactive)<br>• North and South Lime Sludge Ponds<br>• Other South Field areas<br>• Berms, liners, and soil within the operable unit boundary | ROD approved: May 1995<br>Post-ROD fact sheet approved: April 1999<br>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. This was the first ROD to specify an onsite disposal in the OSDF.<br>**Remedial actions completed: June 2006**<br>**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:<br>• All structures, equipment, utilities, effluent lines, and K-65 transfer line<br>• Wastewater treatment facilities<br>• Fire training facilities<br>• Coal pile<br>• Scrap metals piles<br>• Drums, tanks, solid waste, waste product, feedstocks, and thorium | ROD for Interim Remedial Action approved: June 1994<br>ROD for Final Remedial Action approved: August 1996<br>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.<br>Post-ROD fact sheet that identifies clean buildings, structures, and materials for beneficial reuse under LM.<br>Approved: December 2006.<br>**Remedial actions completed: October 2006**<br>**Final Remedial Action Report approved: February 2007** |

*Table 1. Operable Unit Remedies (continued)*

| Operable Unit | Description | Remedy Overview |
|---|---|---|
| 4 | • Silos 1 and 2 (containing K-65 residues; demolished in 2005)<br>• Silo 3 (containing cold metal oxides; demolished in 2006)<br>• Silo 4 (empty and never used; demolished in 2003)<br>• Decant tank system<br>• Berms and soil within the operable unit boundary | ROD approved: December 1994<br>Explanation of Significant Differences for Silo 3 approved: March 1998<br>ROD Amendment for Silos 1 and 2 approved: July 2000<br>ROD Amendment for Silo 3 approved: September 2003<br>Explanation of Significant Differences for Silos 1 and 2 approved: November 2003<br>Explanation of Significant Differences for Operable Unit 4 approved: January 2005<br>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 met 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.<br>**Remedial actions for Silo 3 completed: April 2006**<br>**Remedial actions involving the completion of the shipment of stabilized Silos 1 and 2 material to a temporary storage facility in Texas completed: May 2006.**<br>**Final Remedial Action Report approved: September 2006**<br>**Permanent disposal of the 3,776 containers of Silos 1 and 2 material began on October 7, 2009, and the last container was placed on November 2, 2009.** |
| 5 | • Groundwater<br>• Surface water and sediments<br>• Soil not included in the definitions of Operable Units 1 through 4<br>• Flora and fauna | ROD approved: January 1996<br>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.<br>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 presented 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 postremediation maintenance.<br>**Interim Remedial Action Report approved: August 2008** |

**Abbreviation:**
FRL = final remediation level

## 1.2 Environmental Monitoring Program

In the 1980s, DOE initiated an environmental monitoring program to assess the impact of past operations on the environment and to monitor potential exposure pathways to the local community. Additionally, for nearly 10 years DOE conducted characterization activities at the Fernald site 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 progressed. 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 effluent, and natural resources. In general, the primary exposure pathway 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. For example, environmental data are routinely evaluated to identify any significant trends that may indicate the potential for an unacceptable future impact to human health or the environment if action is not taken.
- The IEMP is reviewed annually and revised as necessary to ensure that the monitoring program adequately addresses monitoring requirements.
- 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 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 crop farming and gravel pit excavation operations. A private water utility approximately 2 miles east of the Fernald Preserve pumps groundwater primarily for industrial use.

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

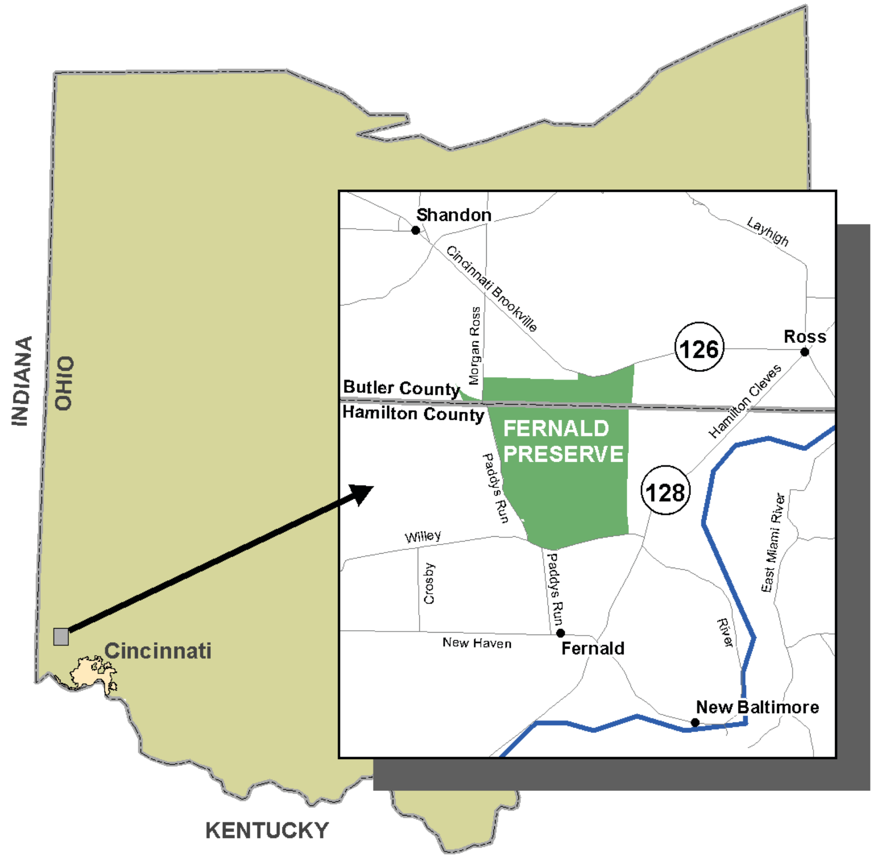



*Figure 1. Fernald Preserve and Vicinity*

### 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 occupied approximately 136 acres in the center of the site and the OSDF occupies approximately 120 acres. 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.

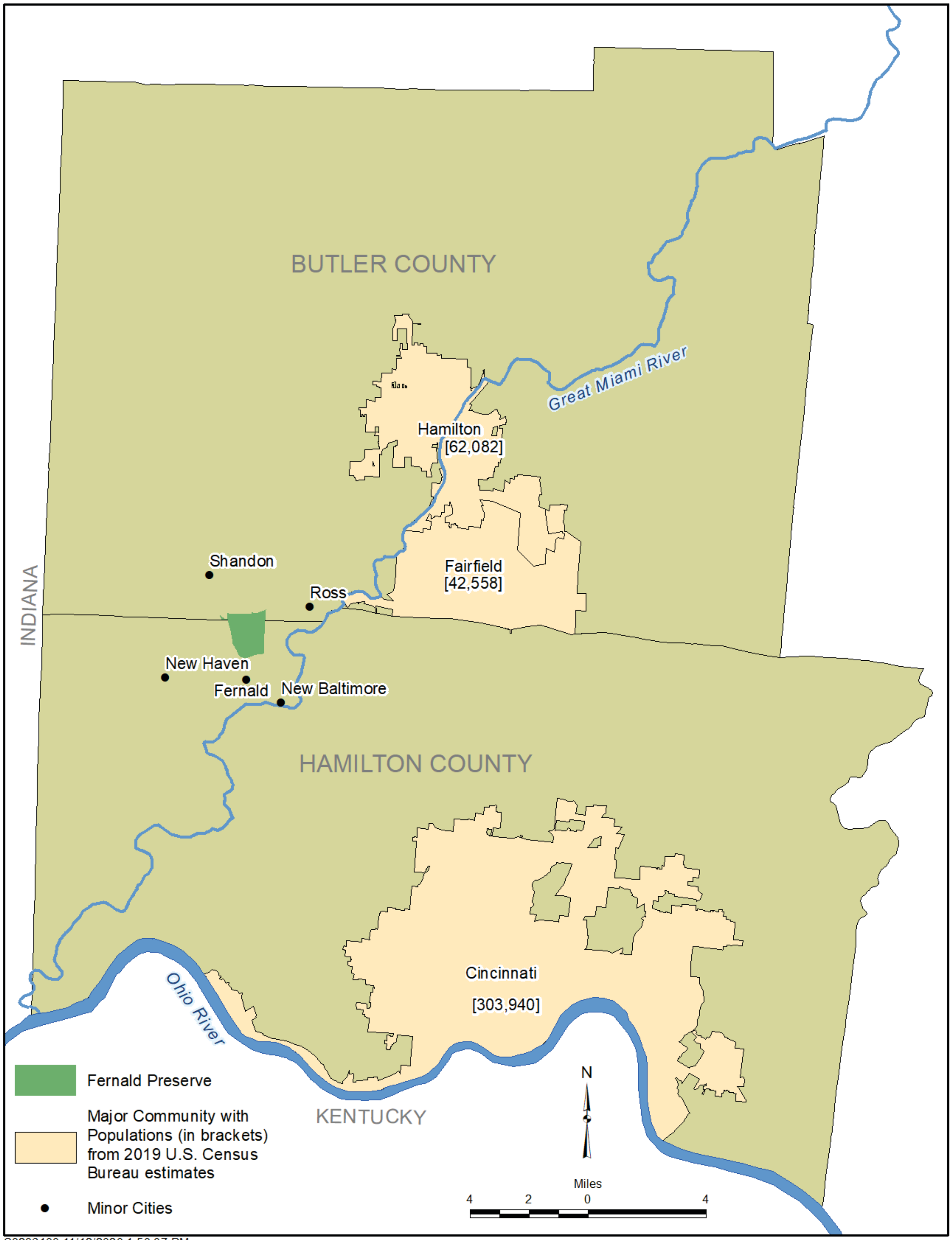



*Figure 2. Major Communities in Southwestern Ohio*


*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) 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 Fernald Preserve is situated on a layer of glacial overburden that overlies portions of a 2- to 3-mile-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 also transport contaminants to the aquifer. Natural and man-made breaches of the glacial overburden in some areas of the Fernald site were key pathways where contaminated water entered the aquifer, causing the groundwater contamination 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 beneath the site and through the New Haven Trough, and Figure 5 presents the regional groundwater flow patterns in the Great Miami Aquifer.

### 1.3.4 Surface Hydrology

The Fernald Preserve is 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 south of the site. The Great Miami River, 0.6 mile east of the Fernald Preserve, runs in a southerly direction and flows into the Ohio River about 24 miles downstream of the site. The segment of the Great Miami 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 2020 was 4,775 cubic feet 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 upstream of the site's effluent discharge.

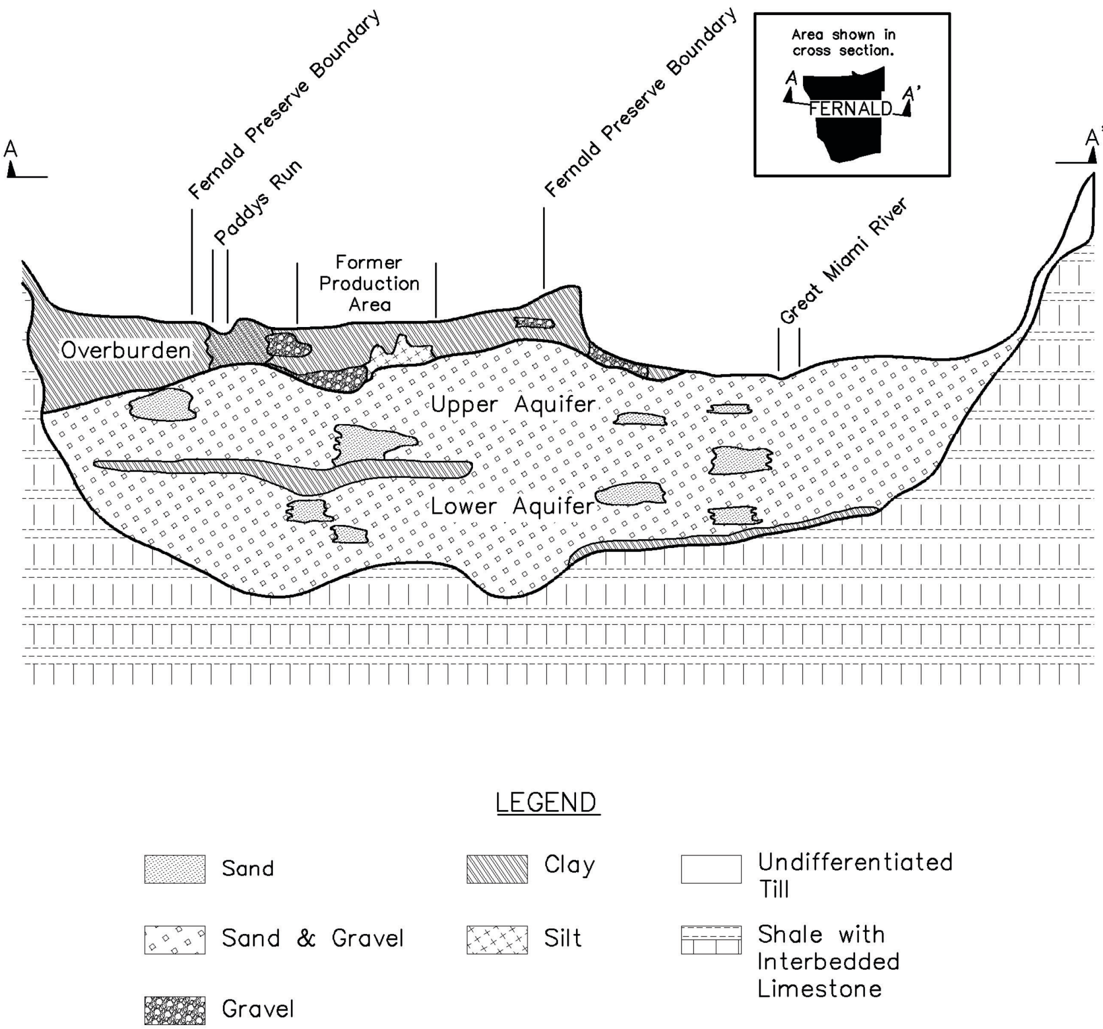



*Figure 4. Schematic Cross Section of the New Haven Trough, Looking North*

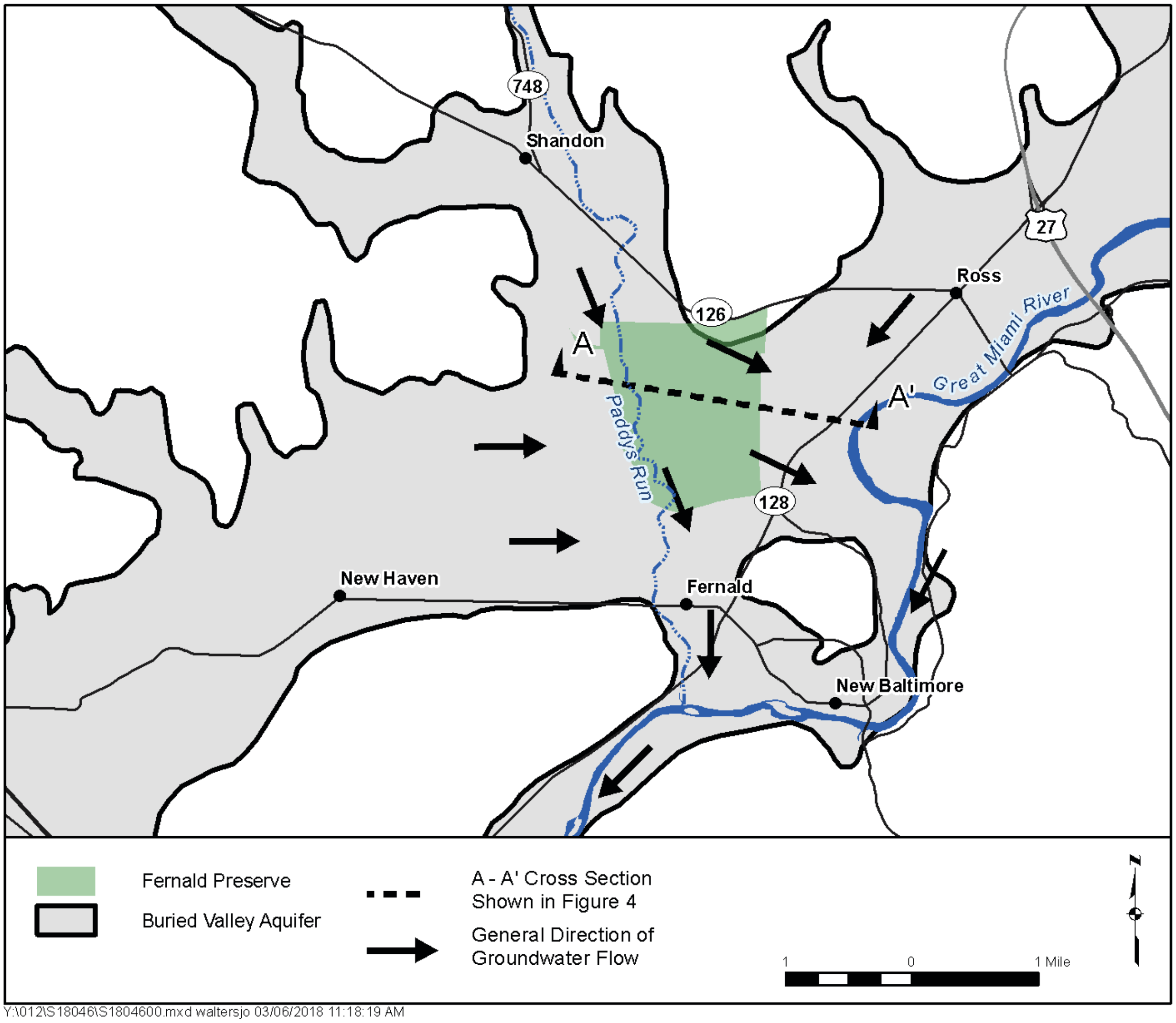



*Figure 5. Regional Groundwater Flow in the Great Miami Aquifer*

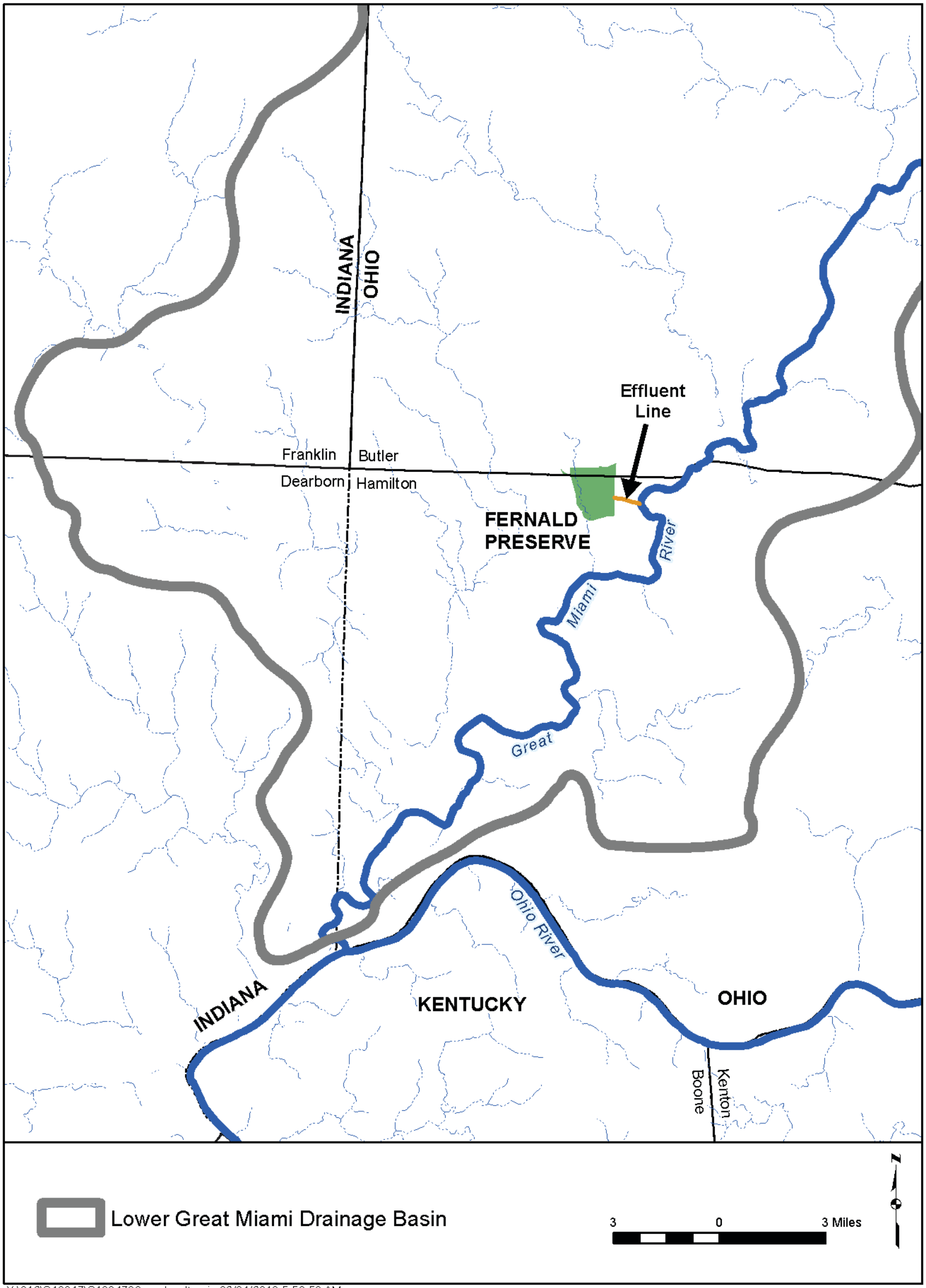



*Figure 6. Southern Portion of the Great Miami River Drainage Basin*

In 2020, 41.58 inches of precipitation were measured at the Butler County Regional Airport. This measurement, which represents precipitation at the site, is higher than the average annual Cincinnati-area precipitation of 41.4 inches for 1951 through 2020. Figure 7 shows the total annual precipitation recorded at the Fernald Preserve for each year from 1991 through 2020 and the average annual precipitation for the Cincinnati area from 1951 through 2020. Figure 8 shows monthly precipitation at the site for 2020, compared to the Cincinnati-area average monthly precipitation for 1951 through 2020.

### 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 5.0 discusses the site's diverse natural and cultural resources, and summarizes 2020 ecological restoration activities, including results of inspection, monitoring, maintenance, and repair.

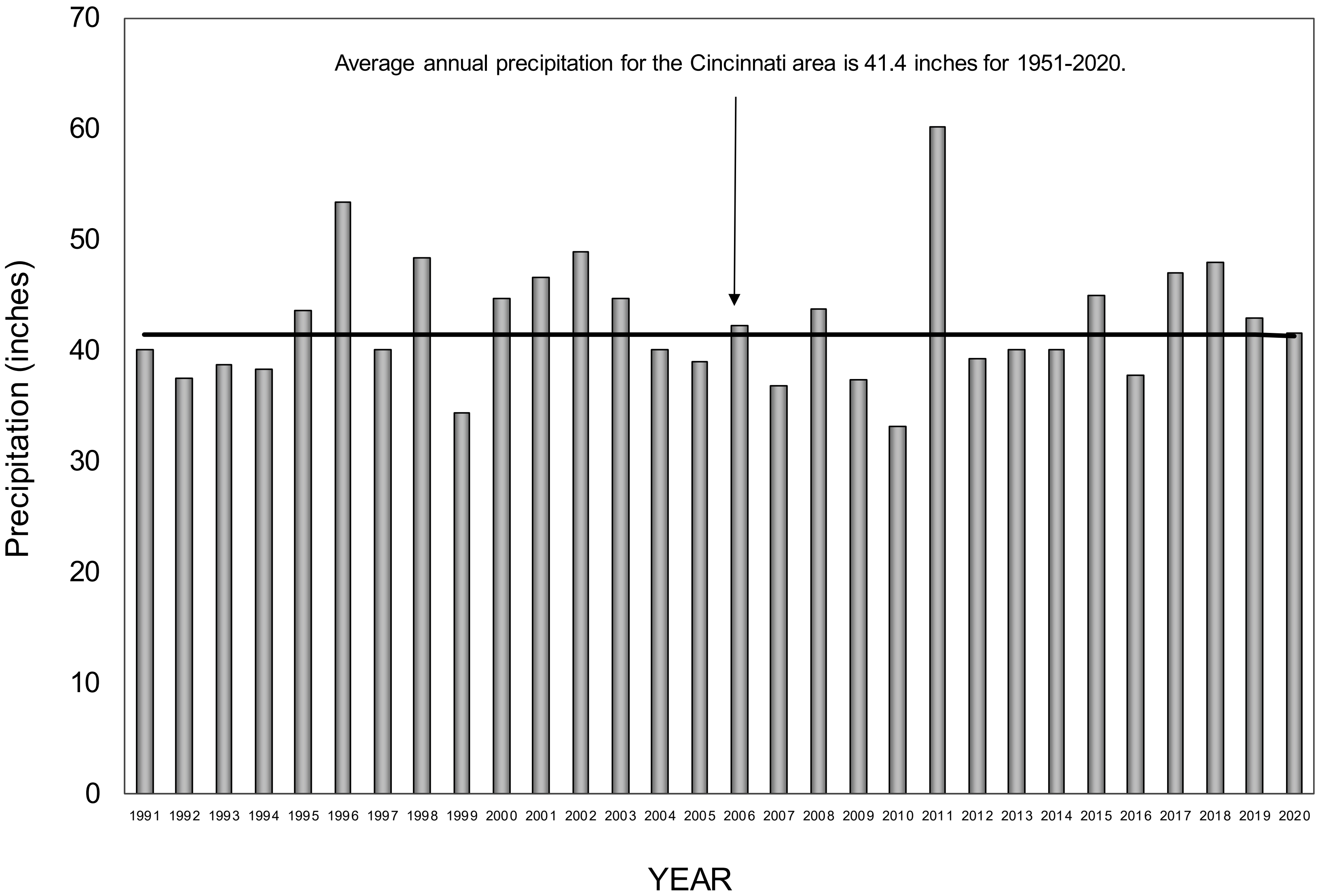



*Figure 7. Cincinnati Area Annual Precipitation, 1991–2020*

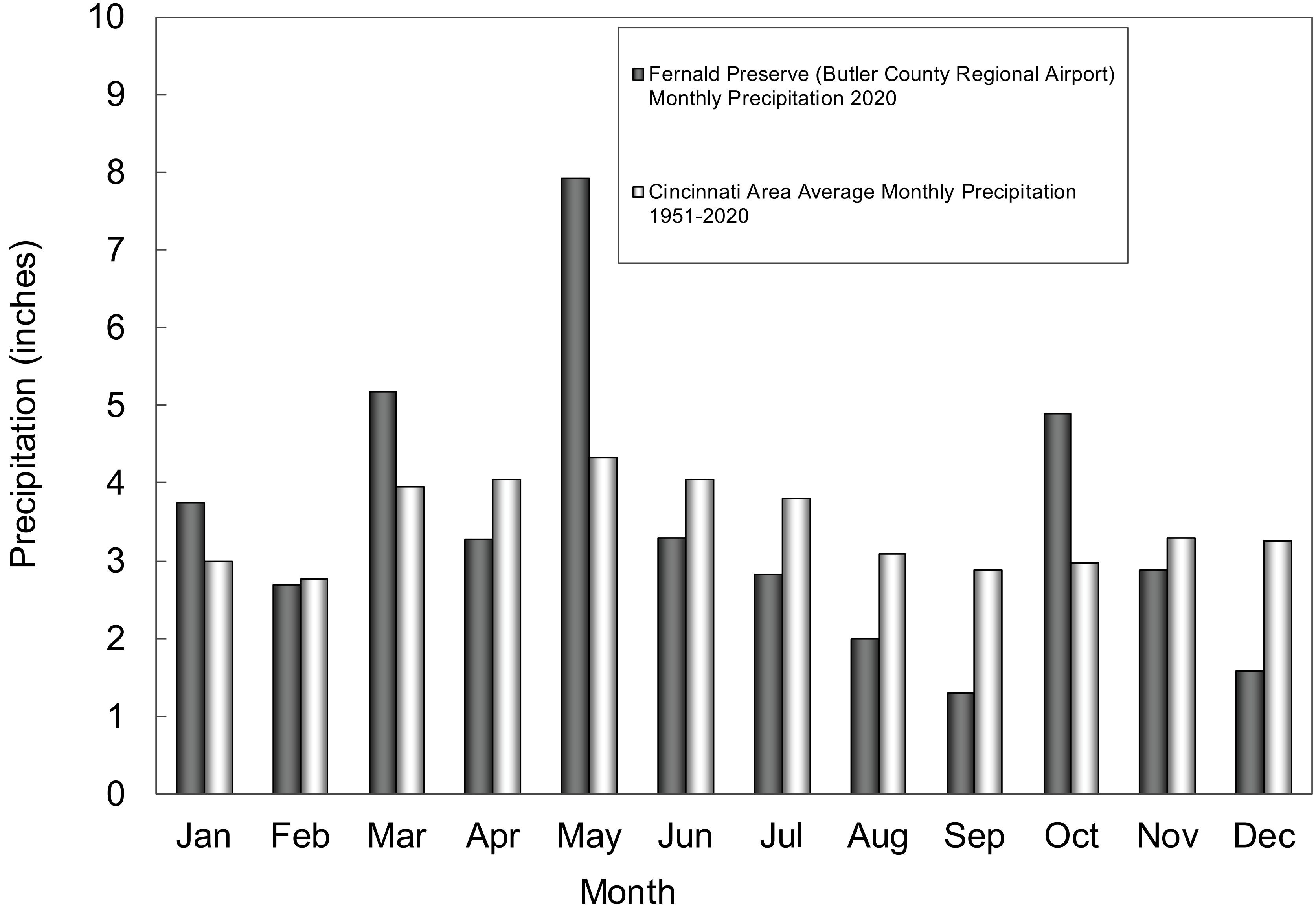



*Figure 8. Monthly Precipitation for 2020 Compared to Average Monthly Precipitation for 1951–2020*

This page intentionally left blank

# 2.0 Remediation Status and Compliance Summary

This section provides a summary of CERCLA remediation activities in 2020 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 (42 USC 6901 et seq.); the Clean Air Act, as amended (42 USC 7401 et seq.), excluding National Emissions Standards for Hazardous Air Pollutants compliance; and the Clean Water Act, as amended (33 USC 1251 et seq.)—EPA has authorized the State of Ohio to act as the primary enforcement authority. For these programs, the State of Ohio promulgates state regulations that must be at least as stringent as federal requirements. Several legal agreements between 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 and compliance agreements.

## 2.1 CERCLA Remediation Status

By October 2006, remedial actions were completed for four of the five operable units. As of October 29, 2006, the only remaining active remediation involves the ongoing groundwater remedy under Operable Unit 5. Activities under CERCLA during 2020 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 https://www.lm.doe.gov/CERCLA_Home.aspx. The original and a copy of the AR are in the records warehouse at the LM Business Center in Morgantown, West Virginia. The Fernald Preserve staff can be contacted by phone at (513) 648-3205 for assistance in searching for a document in the CERCLA AR. The CERCLA AR is 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, as specified in the EPA publication *Close Out Procedures for National Priorities List Sites* (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 completion (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).

DOE has prepared, and both EPA and Ohio EPA have approved, Final Remedial Action Reports 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 detailed the ongoing aquifer restoration activities and provided information indicating that all required groundwater infrastructure had been installed and was functioning as designed. Furthermore, the report provides information that all soils have been remediated (except those associated with the aquifer restoration 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. DOE will develop that report once groundwater actions are complete and all soils and infrastructure associated with the groundwater remedy have been adequately addressed (estimated completion date in 2039, based on modeling projections reported in the 2014 Operational Design report [DOE 2014]). EPA issued the *Preliminary Closeout Report, U.S. DOE Feed Materials Production Center, Fernald, Ohio* (EPA 2006) in December 2006. The estimated durations for certifying the last area of the aquifer as being clean and for removing the wellfield infrastructure can be found in the *Fernald Groundwater Certification Plan* (DOE 2006a).

CERCLA Section 121(c) also requires a five-year review process for remedial actions implemented under the signed ROD for each operable unit. The purpose of a five-year review is to determine, through evaluation of performance of the selected remedy, whether the remedy at a site remains protective of human health and the environment. The methods, findings, and conclusions are documented in five-year review reports. In addition, the five-year review reports identify issues found during the review, if any, and document recommendations to address the issues.

EPA approved the first five-year review report for the Fernald Preserve (DOE 2001c) in September 2001. The second five-year review report was submitted in April 2006 (DOE 2006b) and approved by EPA in September 2006. The third five-year review report was submitted to EPA in March 2011 (DOE 2011) and approved by EPA in August 2011. The fourth five-year review began in 2015 and was approved by EPA in September 2016 (DOE 2016b). The fifth five-year review began in the fall of 2020 and will be finalized in 2021.

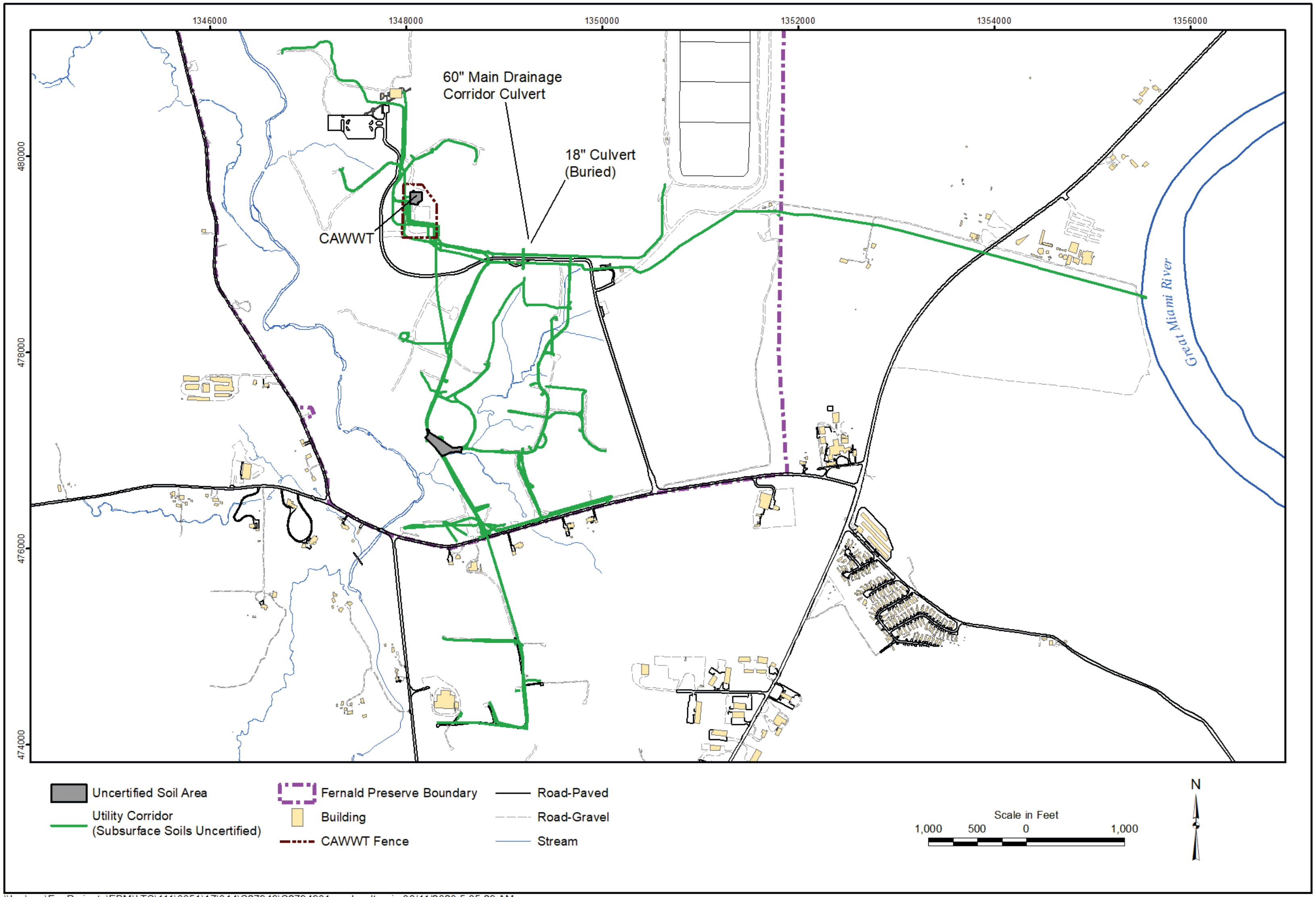
In the site's fourth CERCLA five-year review report, DOE was required to address the presence of perfluorinated compounds, now called polyfluorinated alkyl substance (PFAS) compounds, through two deliverables: (1) a PFAS groundwater screening sampling plan by December 31, 2016, and (2) a comprehensive PFAS investigation by March 31, 2018. PFASs are a large group of emerging potential chemicals of concern, of which perfluorooctane sulfonate (PFOS) and perfluorooctanoic acid (PFOA) are the two most prevalent. PFASs could be present at the Fernald site because very small volumes (i.e., less than 25 gallons) of aqueous foam firefighting agents containing PFOA and PFOS were used for fire training exercises at the former Fire Training Facility from 1976 to 1990. During the extensive site remediation, over 13,000 cubic yards of impacted soil were removed from the Fire Training Facility alone.

In December 2016, DOE submitted the *Draft Perfluorinated Compound Groundwater Screening Sampling and Analysis Plan* (DOE 2016c). In March 2018, DOE submitted the *Draft*

*Polyfluorinated Alkyl Substances (PFASs) Investigation Plan for the Fernald Preserve* (DOE 2018b). Based on information presented in both documents, PFASs are not a widespread issue at the Fernald Preserve. Interim recommendations were established for PFOA and PFOS by EPA in December 2019 (EPA 2019). To date, no sampling for these emerging contaminants has occurred at the Fernald Preserve. DOE will continue to work with EPA and will address any site-specific PFAS issues as more information and regulatory guidance is available. The upcoming CERCLA five-year review in 2021 provides an opportunity to revisit the issue.

CERCLA remediation highlights during 2020 included the following:

- For 2020, the ongoing groundwater remedy resulted in extraction of 2,201 million gallons (Mgal) of groundwater from the Great Miami Aquifer and removal of 390 lb of uranium from the aquifer. Section 3.0 discusses groundwater monitoring and remediation performance.
- The OSDF continues to operate as designed. The OSDF cap underwent four formal inspections. Such inspections are part of the standard operation and maintenance requirements for the facility. Minor maintenance of the cap and associated drainages continues; examples include the removal of small trees and shrubs, spot herbicide application on woody stumps and other invasive plant species and repairing animal burrows. A planned spring prescribed burn of the OSDF cap was cancelled due to the COVID-19 pandemic. The eight leachate valve houses continued to be inspected daily via operational rounds. Leachate generation has continued to decline as expected, and liner performance is meeting design requirements. Leachate flow and leak detection performance is discussed in Section 3.0. Cap performance is discussed further in Section 5.0.
- Figure 9 indicates soil areas that remain uncertified, pending completion of aquifer restoration and the decontamination and decommissioning of related facilities and associated utilities.
- Elevated uranium concentrations persist in surface water in an area adjacent to former Waste Pit 3. (This issue is further discussed in Section 4.0.) Weekly surface water monitoring in that area continued in 2020, except when monitoring was suspended for the approximately 8-week period from March 23 to May 14, 2020, in response to the COVID-19 pandemic. The Paddys Run streambank stabilization project was completed in 2016 to prevent migration of the Paddys Run streambed into this area. In 2017, DOE replaced several boulders on an in-stream crossvane that were dislodged during 2016 flooding. One additional stone became dislodged in 2018. Site personnel continue to monitor the streambed in 2020 and determined that repairs were not needed at this time. The area will continue to be evaluated in 2021.
- Monitoring and maintenance of ecologically restored areas continued during 2020 and all required site inspections were performed. One round of amphibian monitoring and one round of forest herbaceous vegetation monitoring was missed due to the response to the COVID-19 pandemic. Inspection findings in 2020 were similar to those from previous years and consisted mainly of the presence of invasive vegetation and deer exclosure fencing that was damaged by fallen trees and limbs. Debris also continues to be found, primarily in the Former Production Area and the former Waste Pits Area. Minor violations of the institutional controls established in the LMICP included occasional instances of hikers straying off trail. Section 5.0 includes further discussion of the restored area activities and the site inspection process.




\\Lm\ess\EnvProjects\EBM\LTS\111\0051\17\014\S27949\S2794901.mxd waltersjo 03/11/2020 5:35:29 AM

*Figure 9. Uncertified Areas and Subgrade Utility Corridors*

## 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 2020.

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 effluent discharges to the Great Miami River, which are also discussed in this section.

### 2.2.1 RCRA

RCRA regulates the treatment, storage, and disposal of hazardous waste and mixed waste (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 between the State of Ohio and DOE, the 1993 Stipulated Amendment to the Consent Decree 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 Ohio EPA Director's Findings and Orders for Groundwater, which were signed September 10, 1993, described an alternative 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. Section 3.3.2 provides a more detailed discussion of the groundwater monitoring program.

#### *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 2020. Wastes managed during 2020 were limited to universal waste (e.g., spent batteries) and uncontaminated solid wastes.

### 2.2.2 Clean Water Act

Under the Clean Water Act, as amended, the Fernald Preserve is governed by 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. A renewal application for the NPDES permit was requested in 2019 and is pending approval. The current permit will remain in effect until new one is issued. In addition to the NPDES permit application, an application for a conditional exclusion from storm water permitting based on No Exposure Certification for Exclusion from Ohio EPA's NPDES Storm Water Permitting was submitted to the State of Ohio. A condition of no exposure exists at an industrial facility when all industrial materials and activities are protected by a storm resistant shelter to prevent exposure to rain, snow, snowmelt, and runoff. This application was approved and will go into effect when the new NPDES permit is approved. Fernald Preserve submits monthly reports on NPDES activities to Ohio EPA to document compliance with stipulated discharge limits. The current NPDES permit for the site took effect on March 1, 2015. There were no instances of noncompliance at any of the permitted outfalls in 2020. With the exception of one weekly post-rain construction project inspection for the Converted Advanced Wastewater Treatment facility (CAWWT) backwash basin project that was missed during the week of March 23, 2020, in response to the COVID-19 pandemic, all required storm water inspections were conducted, and no issues were identified. Grass had become established for this project by the week of April 6, 2020, which resulted in the end of this requirement for the project.

As discussed further in Section 4.0, the NPDES permit for the site expired on February 29, 2020. An NPDES permit renewal application was submitted to Ohio EPA in 2019. The new permit has not yet been issued by Ohio EPA, but should be in place to take effect in 2021.

### 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. DOE maintains compliance 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. No chemicals exceeded threshold reporting quantities during 2020, so no report was required.

Another SARA Title III report, the Section 313 Toxic Chemical Release Inventory Report (Form R), is required if quantities of chemicals used or 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 usage or releases have exceeded the threshold for several years at the Fernald Preserve and, as in past years, no chemical exceeded a reporting threshold during 2020.

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. DOE evaluates and documents all releases that might occur at the Fernald Preserve 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. During 2020, there were no releases at the Fernald Preserve that met the reporting criteria.

### 2.2.5 Other Environmental Regulations

In addition to those described above, the Fernald Preserve is also required to comply with other environmental laws and regulations. Table 2 summarizes compliance with each of these requirements for 2020.

### 2.2.6 Permits and Licenses

Certain environmental regulations 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 (ODNR) for collection of wildlife specimens. A permit is also in place to remove Canada goose nests, if necessary. Burn-ban waivers and permits are secured for prescribed burning activities as well. A commercial pesticide applicator license is maintained by site personnel in order to apply herbicide at the Fernald Preserve. These activities are discussed in Section 5.0.

*Table 2. Compliance with Other Environmental Regulations*

| Regulation and Purpose | Background Compliance Issues | 2020 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 (15 U.S.C. 2601 et seq.) inspection of the Fernald Preserve's program on September 21, 1994. No violations of PCB regulations were identified during the inspection. | No PCB liquids or items were used, stored, or shipped in 2020. |
| **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 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 2020. |
| **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 (7 USC 136 et seq) 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 the National Environmental Policy Act, Title 10 *Code of Federal Regulations* Section 1021. The assessment requires DOE to consult the public before making any decisions on land use; it includes previous DOE commitments. | No National Environmental Policy Act activities were required in 2020. |

Table 2. Compliance with Other Environmental Regulations (continued)

| Regulation and Purpose | Background Compliance Issues | 2020 Compliance Activities |
|---|---|---|
| **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:<br>• Cave salamander (*Eurycea lucifluga*), state endangered, marginal habitat—small limestone outcrops and streams—none found.<br>• Sloan's crayfish (*Orconectes sloanii*), state-threatened—found on northern sections of Paddys Run.<br>• Indiana bat (*Myotis sodalis*), federally endangered—found in northern wooded areas along Paddys Run.<br>• Northern long-eared bat (*Myotis septentrionalis*), federally threatened—potential habitat within northern wooded areas along Paddys Run—none found.<br>• Running buffalo clover (*Trifolium stoloniferum*), federally endangered—potential habitat on disturbed areas along Paddys Run—none found.<br>• Spring coralroot (*Corallorhiza wisteriana*), state-threatened—potential habitat within northern wooded areas—none found.<br>• American burying beetle (*Nicrophorus americanus*), federally endangered—potential habitat within a variety of restored areas—released as part of ongoing recovery efforts—six found in 2019, including one overwinter beetle. | A survey for running buffalo clover was conducted in June 2020, prior to installation of aerial survey control monuments around the OSDF, with none found.<br><br>DOE renewed a five-year 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 through 2022 (DOE 2017). No beetles were released in 2020 due to the COVID-19 pandemic. |
| **Floodplains/Wetlands Review Requirements** | | |
| DOE regulations require a floodplain/wetlands assessment for DOE construction and improvement projects. The Clean Water Act also protects jurisdictional wetlands and "Waters of the U.S." | 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 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 (DOE 2012c). | Long-term monitoring of mitigation wetlands continued in 2020 with amphibian surveys and hydrologic monitoring using shallow piezometers. Hydrologic monitoring was limited to three wetland areas within the Paddys Run Tributary restoration project. |
| **National Historic Preservation Act** | | |
| Establishes a program for the protection, maintenance, and stewardship of federal prehistoric and historic properties. | The Fernald Preserve is in an area of sensitive historic and prehistoric cultural resources that are eligible for or are listed 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, and no unexpected cultural discoveries were identified in 2020. |

*Table 2. Compliance with Other Environmental Regulations (continued)*

| Regulation and Purpose | Background Compliance Issues | 2020 Compliance Activities |
|---|---|---|
| **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 2020. |
| **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 impacts to natural resources and to coordinate trustee activities. The trustees also interact with the Fernald Community Alliance, which is a stakeholder organization that works to promote the Fernald Preserve as an asset to the community.<br><br>In November 2008, the State of Ohio and DOE reached a settlement of the 1986 natural resource injury claim at the Fernald site. 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 2020 included continuation of functional monitoring and wetland mitigation monitoring, as required by the *Fernald Preserve Wetland Mitigation Monitoring Report* (DOE 2012c). Functional monitoring in 2020 involved an evaluation of wetland, prairie, and forest communities across the southern and eastern portions of the site. The Trustees conducted a review and update to the Restored Area Maintenance Plan, resulting in development of the Fernald Natural Resource Management Plan. This document presents a community-based approach for management and evaluation of restored areas at the site. Section 5.0 provides a summary of Trustee activities and monitoring data. |

### 2.2.7 Federal Facility 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 (DOE 1996a). These data are reported in Appendix A.
- Maintain a continuous sample collection program for radiological constituents at the effluent discharge point and report the results to EPA, Ohio EPA, and the Ohio Department of Health. The sampling program was modified several times and was governed by an agreement reached with EPA and Ohio EPA that became effective May 1, 1996 (DOE 1996a). The first IEMP, finalized in 1997, was developed to combine the multiple programs (including the FFCA effluent monitoring) under one reporting structure to facilitate review of the performance of the environmental protection actions for various media under CERCLA remediation of the site. These data are reported in Appendix B.

## 2.3 Split Sampling Program

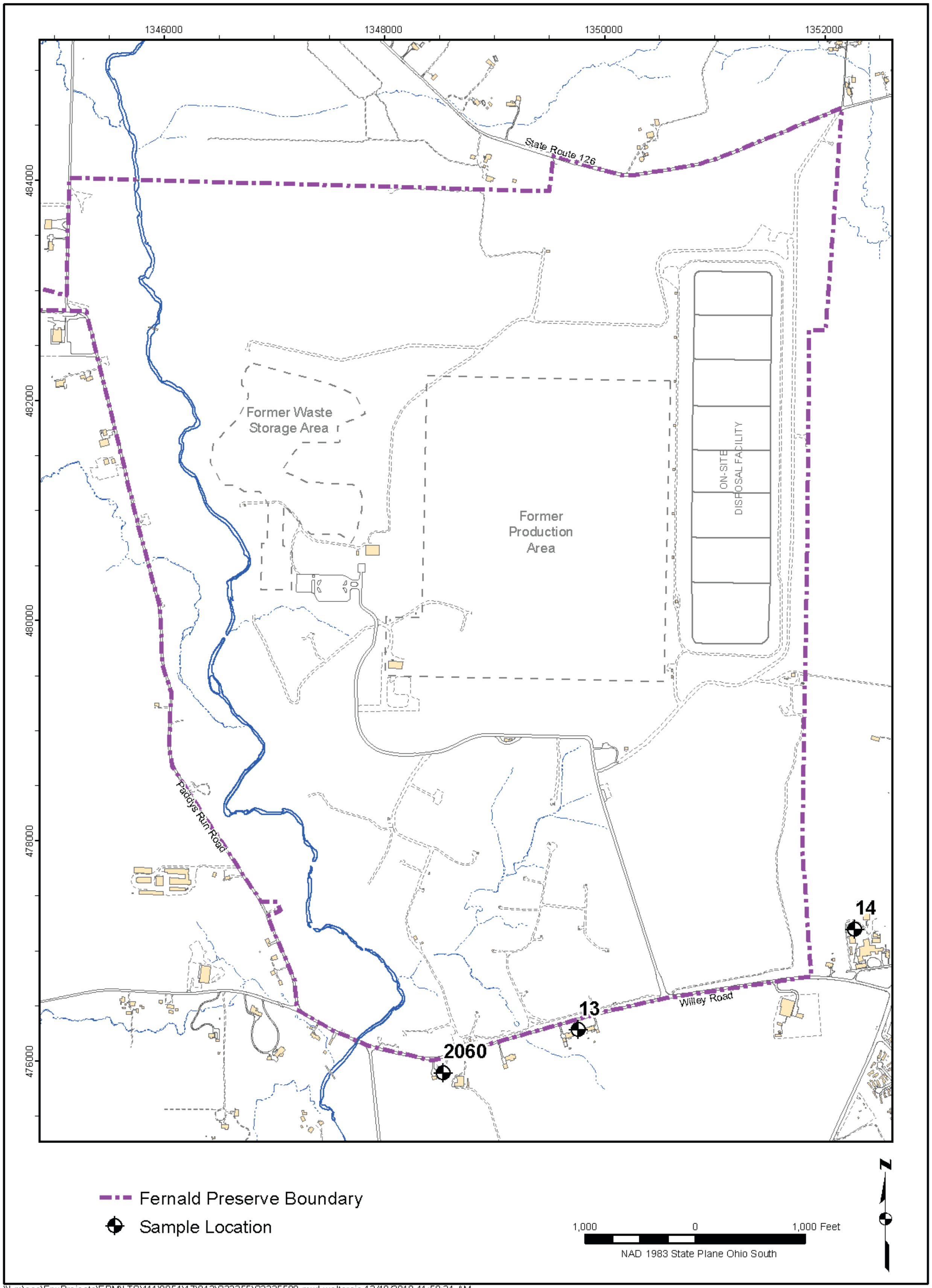
Since 1987, DOE has participated in a split sampling program with Ohio EPA. Split samples are obtained when technicians alternately add portions of a sample to two individual sample containers. This collection method helps ensure that both samples are as close as possible to being identical. The split 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.

The split sampling program was affected by the response to the COVID-19 pandemic as a result of Ohio EPA personnel being restricted from traveling to the site in 2020. Table 3 provides the analytical results of groundwater samples collected by DOE. Ohio EPA did not split samples in 2020, so split sample results are not presented. Additionally, sample location 13 was not sampled in June due to electrical issues with the homeowner’s pump. Figure 10 shows the split sample locations.

*Table 3. 2020 DOE and Ohio EPA Groundwater Split Sampling Total Uranium Result Comparison*

| Sample Location | 2020 Sample Date | DOE Result (µg/L) [a] | FRL[b] (µg/L) |
|---|---|---|---|
| 2060 | June | 20.1 | 30 |
| 2060 | November | 36.3 | 30 |
| 13 | June | Inaccessible | 30 |
| 13 | November | 2.9 | 30 |
| 14 | June | 2.92 | 30 |
| 14 | November | 3.99 | 30 |

[a] µg/L = micrograms per liter
[b] The groundwater pathway and final remediation levels (FRLs) are discussed in Section 3.0.




\\Lm\ess\EnvProjects\EBM\LTS\111\0051\17\013\S23355\S2335500.mxd waltersjo 12/18/2018 11:58:31 AM

*Figure 10. DOE and Ohio EPA Groundwater Split Sample Locations*

# 3.0 Groundwater Pathway

**Results in Brief: 2020 Groundwater Pathway**

**Groundwater Remedy**

Since 1993

- 50,940 Mgal of water have been pumped from the Great Miami Aquifer.
- 15,034 net lb of uranium have been removed from the Great Miami Aquifer.

During 2020

- 2,201 Mgal of water were pumped from the Great Miami Aquifer.
- 390 lb of uranium were removed from the Great Miami Aquifer.

**Groundwater Monitoring Results:** Data collected in 2020 show continued progress in reducing the 30 micrograms per liter (µg/L) uranium footprint, slight increases in the mapped areas of the 50 and 100 µg/L portions of the plume, and that the pumping wells were capturing the uranium plume. Between 2019 and 2020:

- The footprint of the greater than or equal to 30 µg/L total uranium plume was reduced by 5.0 acres (5.8%).
- The footprint of the greater than or equal to 50 µg/L total uranium plume increased slightly by 0.5 acre (1%).
- The footprint of the greater than or equal to 100 µg/L total uranium plume increased slightly by 1.7 acres (6.4%).

During 2020, well field operations were impacted by the response to the COVID pandemic. To comply with a State of Ohio Department of Health Director's Stay at Home Order, which was issued on March 22, 2020, to prevent the spread of COVID-19, DOE greatly reduced site activities. Between the weeks of March 24 and May 18, 2020, the well field and treatment system operated between Monday morning and Thursday morning. As a result, the well field was off for a total of 32 days. Groundwater monitoring was not affected in 2020 due to the response to the COVID-19 pandemic. During 2020, the well field underwent an annual planned shutdown that lasted for 29 days (from June 15 through July 13, 2020).

**OSDF Monitoring:** In 2020, Great Miami Aquifer wells of each of the eight OSDF cells were sampled semiannually for 13 parameters. The leachate collection system, leak detection system, and horizontal till well of each cell were sampled semiannually for uranium, boron sodium, and sulfate. Flow data from the disposal facility, coupled with the water quality monitoring results and the results of quarterly facility physical inspections, indicate that the OSDF performed as designed in 2020.

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 it summarizes aquifer restoration progress and groundwater monitoring activities and results for 2020.

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 be monitored following remediation according to the *Fernald Groundwater Certification Plan* (DOE 2006a).

## 3.1 Summary of the Nature and Extent of Groundwater Contamination

The *Remedial Investigation Report for Operable Unit 5* (DOE 1995d) described the nature and extent of groundwater contamination from operations at the Fernald site and evaluated the risk to human health and the environment from those contaminants. 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. 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.

Figure 11 shows the second half 2020 maximum extent (most conservative) footprint of the 30 micrograms per liter (µg/L) uranium plume within the aquifer as well as the current active restoration modules involved in the groundwater remedy. The current active restoration modules are represented by the cross-hatched areas in the figure as well as the extraction wells that belong to each module.

## 3.2 Selection and Design of the Groundwater Remedy

**Groundwater Modeling at the Fernald Preserve**

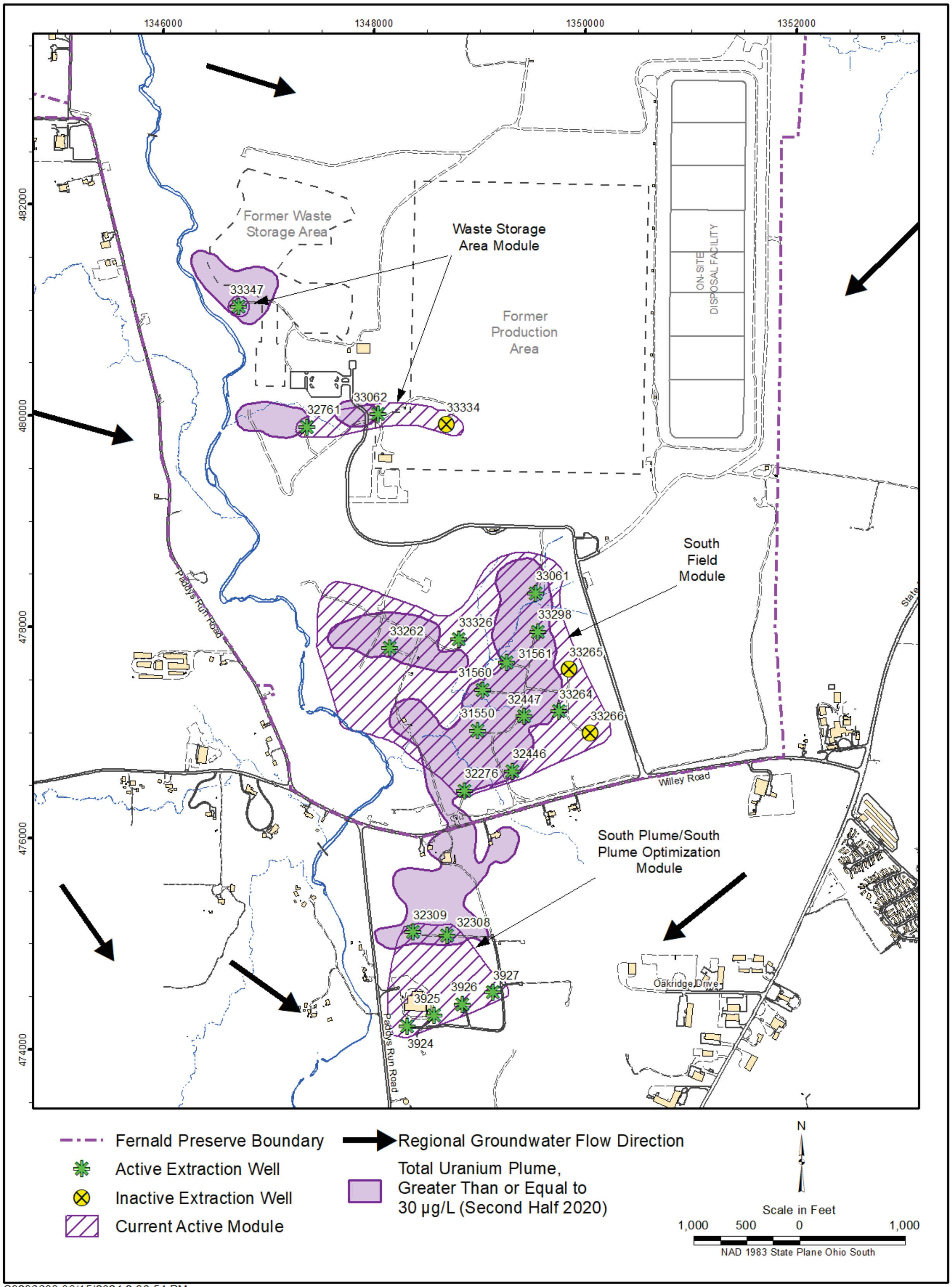
The Fernald Preserve uses a computer model to make predictions about how the concentration/location of contaminants in the aquifer will change over time. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with 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 potentially reduce the cleanup time and cost, the operational changes are made once EPA and Ohio EPA concurrence is obtained. Monitoring data are then collected after the changes to verify whether model predictions were correct. If model predictions prove to be incorrect, modifications may be made to the model to improve its predictive capabilities.

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 (i.e., sum of all of the isotopes of uranium, measured in µg/L) 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 gallons per minute (gpm) would remediate the aquifer within 27 years.

The recommended groundwater remedy, which included EPA, Ohio EPA, 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 1996b) was issued. The OU5 ROD formally defines the selected groundwater remedy and establishes final remediation levels (FRLs) for all constituents of concern.




S3236600 03/15/2021 2:38:54 PM

*Figure 11. Extraction Wells Active in 2020*

**Reinjection at the Fernald Site**
From 1998 to 2004, reinjection 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 reinjection wells. Groundwater pumped from the aquifer was treated via ion exchange to remove contaminants and then reinjected into the aquifer at strategic well locations. Because the treatment process was not 100% efficient, a small amount of uranium was reinjected into the aquifer with the treated water. However, the reinjected 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 reinjection 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 reinjection 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 reinjection technology. The groundwater remedy included the use of well-based reinjection until September 2004.

Evolution of the enhanced groundwater remedy has been documented through a series of approved designs. These designs are:

- 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 2002)
- *Comprehensive Groundwater Strategy Report* (DOE 2003)
- *Groundwater Remedy Evaluation and Field Verification Plan* (DOE 2004)
- *Waste Storage Area Phase II Design Report* and Addendum (DOE 2005b)
- *Operational Design Adjustments-1, WSA Phase-II Groundwater Remediation Design, Fernald Preserve* (DOE 2014)

The enhanced groundwater remedy commenced in 1998 with the startup of the South Field (Phase I), the South Plume Optimization, and the Reinjection 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 reinjection demonstration that began in September 1998. Through the years, extraction and reinjection wells had been added 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 former 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 the existing 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 identified as having intermittent uranium FRL exceedances. This well is further discussed in Attachment A.2. Figure 12 shows the location of monitoring well 2389.

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, following regulatory and public input, a decision regarding the future aquifer restoration and wastewater treatment approach was made. In May 2004, EPA and Ohio EPA approved the decision to reduce the size of the advanced wastewater treatment facility and in June 2004 approved the decision to discontinue the use of well-based reinjection. Reducing the size of the advanced wastewater treatment facility provided the opportunity to dismantle and dispose of approximately 90% 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 reinjection 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). As a result of refined modeling input, updated modeling indicated that the aquifer restoration time frame would likely be extended beyond dates previously predicted.

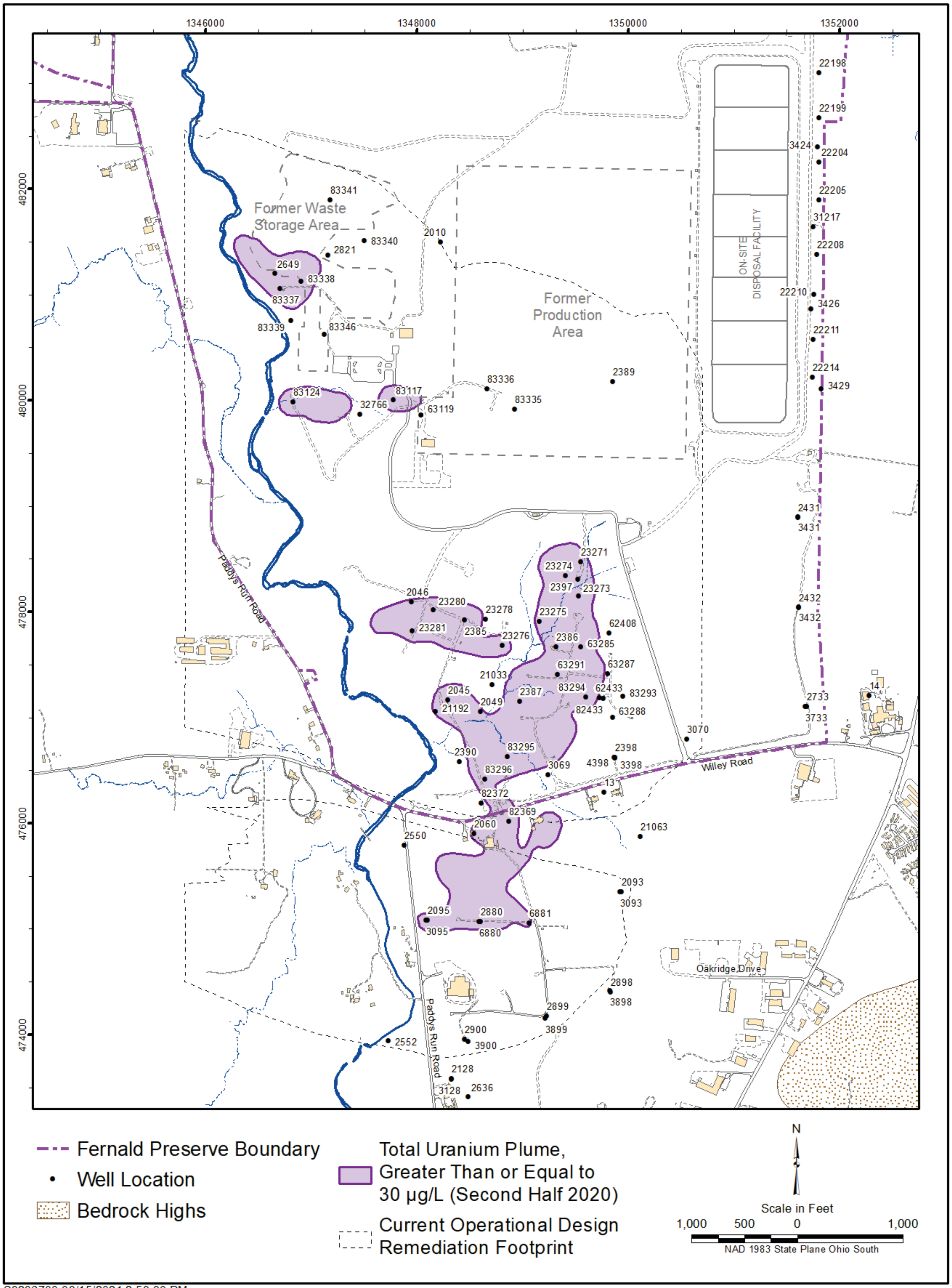



*Figure 12. Locations for Semiannual Total Uranium Monitoring*

The updated modeling also indicated that continued use of the groundwater reinjection wells would shorten the aquifer remedy by approximately 3 years. However, the cost of maintaining the reinjection infrastructure was more than operating the extraction well field for this time period. Therefore, well-based reinjection was discontinued in September 2004 to support construction of the CAWWT. All reinjection 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) is approximately 109–129 gpm. With Ohio EPA and EPA concurrence, supplemental pumping of clean groundwater to the ditch was stopped and the flumes were removed in 2013 to allow water to freely flow down the SSOD. The rapid movement of water through the ditch during storm events will help to scour the ditch channel of fine-grained sediment and is expected to increase the potential for infiltration.

The *Fernald Groundwater Certification Plan* (DOE 2006a) 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. Approved by EPA and Ohio EPA, the *Fernald Groundwater Certification Plan* identifies that the IEMP will continue to be the plan that includes remedy performance monitoring requirements.

In 2006, the Waste Storage Area Phase II Module components became operational, marking completion of the groundwater remediation system design. Completion of the Waste Storage Area Phase II Module construction 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 optimize 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 current Operational Design and was implemented on July 1, 2014. Figure 11 shows the extraction well locations. The following subsections present the operational information associated with these modules.

## 3.3 Groundwater Monitoring Highlights for 2020

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. Groundwater monitoring was not affected in 2020 due the response to the COVID-19 pandemic. Site personnel completed all groundwater monitoring requirements.

**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, 93 wells were monitored for water quality in 2020. 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 relative monitoring well depths and screen locations. Figure 15 indicates the locations for non-uranium monitoring. In addition to water quality monitoring, 172 wells are used to measure groundwater elevations to verify groundwater flow direction. Figure 16 depicts the routine water-level (groundwater elevation) monitoring wells.

Figure 14 illustrates that there are six different types of monitoring wells (i.e., Type 1, 2, 3, 4, 6, and 8). Monitoring well types 1, 2, 3, 4, and 6 are single-level monitoring wells with a well screen that is either 10 or 15 ft in length. Type 8 monitoring wells are multichannel monitoring wells that contain 3 to 6 individual 10 ft screens. The Type 8 multichannel monitoring wells provide for sampling a depth profile at a single location. The single-level wells monitor a single 10 ft depth. As summarized below, the location of the monitoring depth is identified by the first digit in the well identification number:

- Type 1 – Screen positioned in perched groundwater in the glacial overburden
- Type 2 – Screen positioned at the water-table zone of the Great Miami Aquifer
- Type 3 – Screen positioned above a clay layer in the Great Miami Aquifer
- Type 4 – Screen positioned below a clay layer in the Great Miami Aquifer
- Type 6 – Screen positioned at a depth that is between a Type 2 and Type 3

Additionally, 27 locations were sampled using a direct-push (i.e., temporary) sampling tool in 2020. Results are provided in Appendix A, Attachment A.2.

**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 total 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 Fernald Preserve groundwater restoration on the downgradient Paddys Run Road Site plume. The Paddys Run Road Site is a separate contaminant plume, unrelated to the Fernald Preserve, that resulted from industrial activities on privately owned land in the area south of the Fernald Preserve along Paddys Run Road.

**Reporting:** All data listed for collection in the IEMP are reported in the annual Site Environmental Reports.

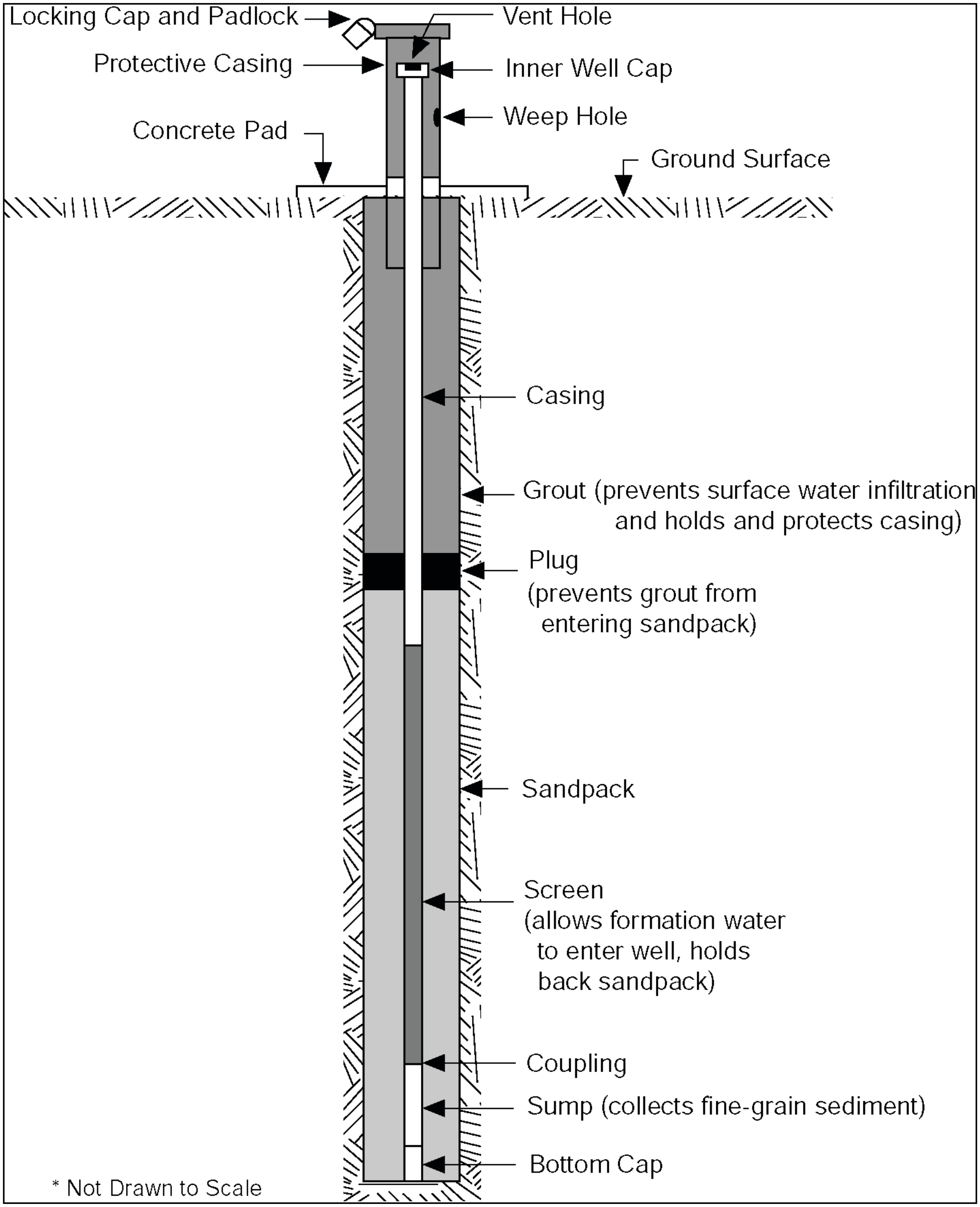



*Figure 13. Diagram of a Typical Groundwater Monitoring Well*

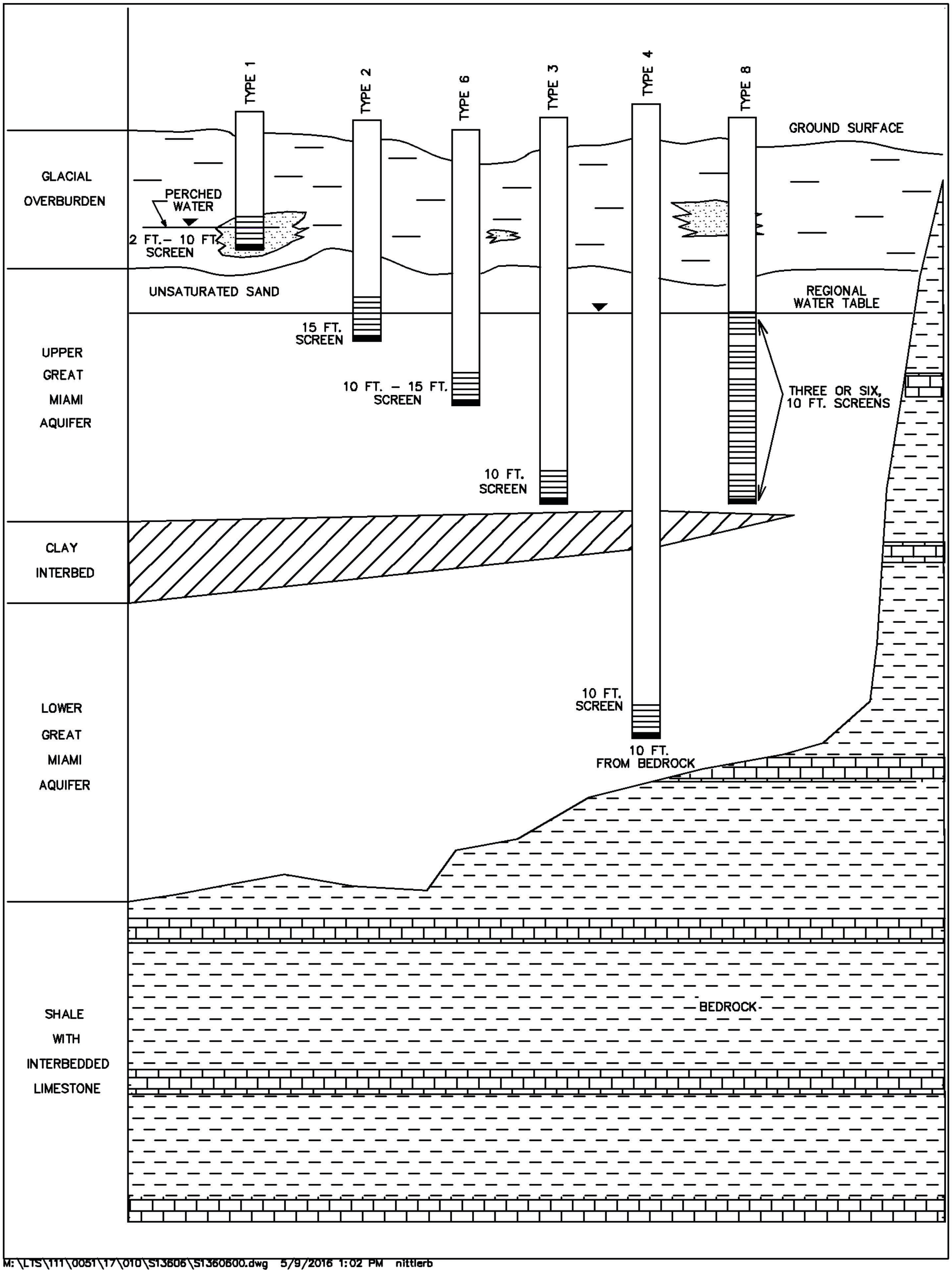



*Figure 14. Monitoring Well Screen Locations*

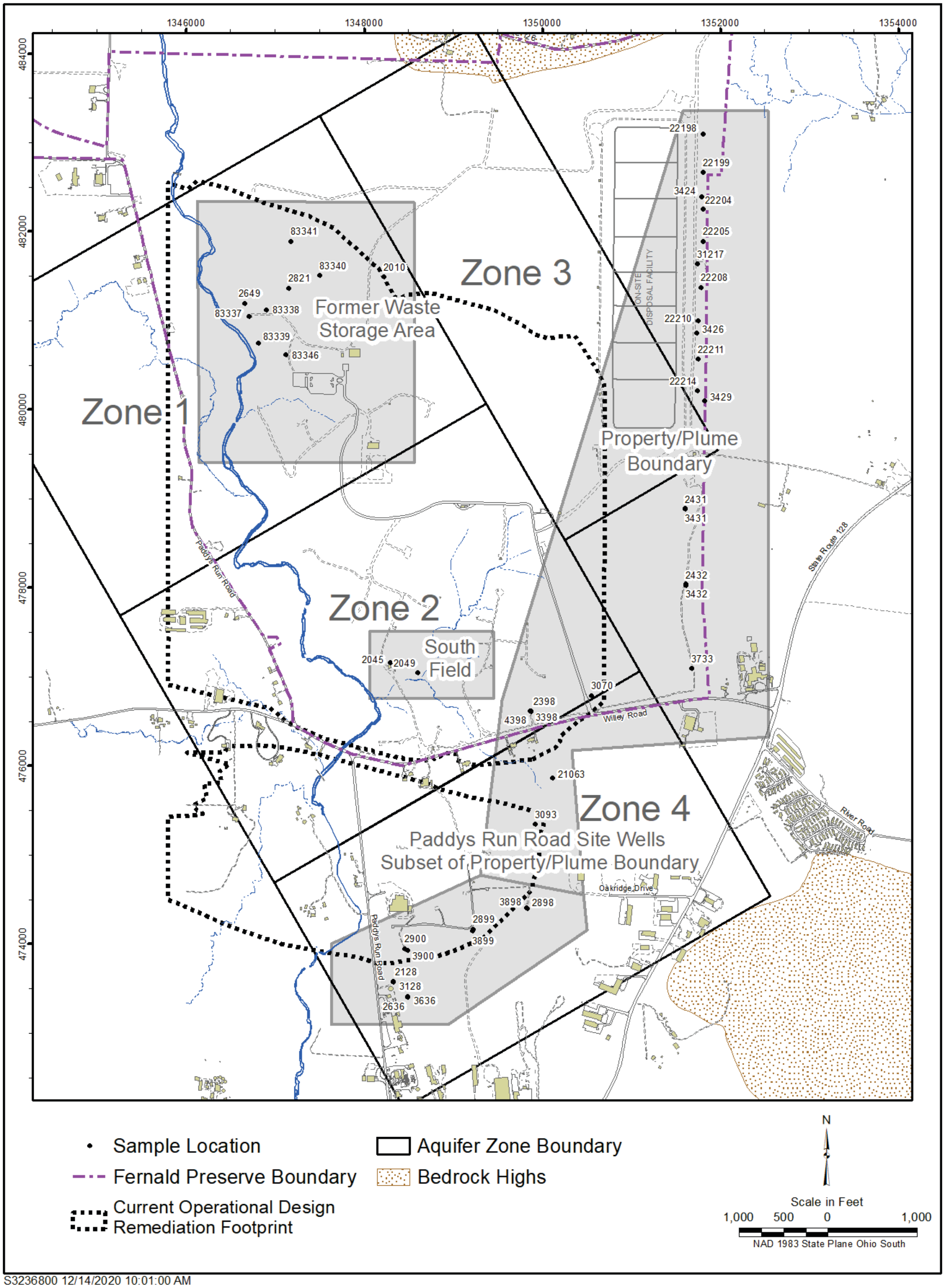
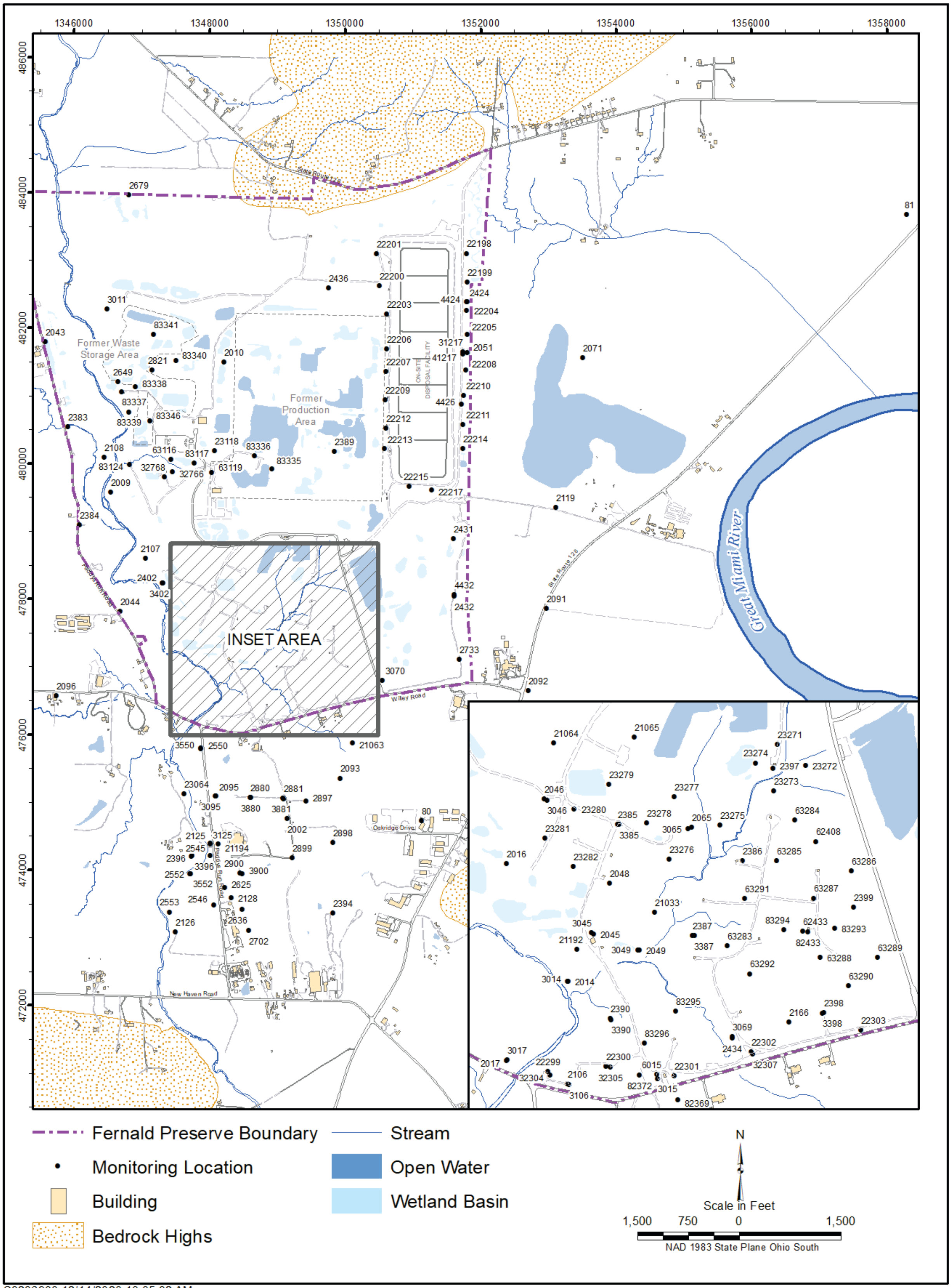



*Figure 15. Locations for Non-Uranium Monitoring*




S3236900 12/14/2020 10:05:32 AM

*Figure 16. Groundwater Elevation Monitoring Wells*

### 3.3.1 Restoration Monitoring

The Operable Unit 5 ROD (DOE 1996b) 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 (DOE 1994). 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 throughout the year to determine the progress of aquifer remediation. Total 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 total uranium plume.

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*

**<u>CAWWT</u>**

As presented in the *Fernald Preserve 2015 Site Environmental Report* (DOE 2016a), the CAWWT system had become oversized and reached the end of its useful life. Additionally, equipment corrosion and corrective maintenance had become ongoing issues for facility operations.

In March 2015, a CAWWT Condition Assessment Report was finalized (Whitman, Requardt & Associates 2015) confirming that many of the treatment system components were at or nearing the end of their useful life. A decision was made to replace the CAWWT treatment system with a 50 gpm system inside the CAWWT building. DOE received concurrence on a path forward in July 2015 from EPA and Ohio EPA and in August 2015 from the Fernald Community Alliance. DOE planning for the project began in August 2015.

The project was initiated in 2016 and completed in April 2018. The new system became operational on April 3, 2018.

Refurbishment of the nearby backwash basin occurred in 2019. The backwash basin is used to temporarily store wastewater originating from a variety of sources (i.e., well rehabilitation, CAWWT backwash, OSDF leachate, groundwater sampling, CAWWT laboratory, and CAWWT storm water drainage). Construction began in late summer of 2019 and was completed in December 2019. Accumulated sediment was removed, dried, and packaged for shipment to a licensed low-level radioactive waste disposal facility, Waste Control Specialists, in Texas. The basin liner and wall panels were replaced, and aeration cover systems were installed.

## Pulse Pumping

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. The Waste Storage Area (Phase II) Design called for a target pumping rate of 100 gpm 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, beginning in 2012, the wells were being pumped at a higher rate for a shorter period 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 for 8 hours a day (a total of 144,000 gallons per day) rather than 100 gpm 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 total uranium plume. With implementation of the current Operational Design in July 2014, the target pumping rate of extraction well 31561 was increased from 100 to 200 gpm, so pulse pumping was stopped at this well. Pulse pumping continues for the other three wells.

Figure 11 shows the extraction well locations associated with the restoration modules operating in 2020. Also shown in Figure 11 are the three extraction wells that were shut down in April 2014 (33265, 33266, and 33334). Table 4 summarizes the mass of total uranium removed and the volume of groundwater pumped during 2020. 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 total uranium removed from the Great Miami Aquifer from 1993 through 2020.

Since 1993:

- 50,940 Mgal of water have been pumped from the Great Miami Aquifer.
- 1,936 Mgal of treated water were reinjected into the Great Miami Aquifer.
- 15,034 net lb 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 2020*

| Modules and Restoration Wells | Target Design Pumping Rate | Volume Pumped | Uranium Removed |
|---|---|---|---|
| | gpm | Mgal | lb |
| **South Plume/ South Plume Optimization Module:** 3924, 3925, 3926, 3927, 32308, 32309 | 1,300[a] | 593 | 82 |
| **South Field Module:** 31550, 31560, 31561, 32276, 32446, 32447, 33061, 33262, 33264, 33298, 33326 | 2,875 | 1,286 | 246 |
| **Waste Storage Area Module:** 32761, 33062, 33347 | 800 | 322 | 62 |
| **Aquifer Restoration System Total** | 4,975[a] | 2,201 | 390 |

[a] In July 2018, the pumping rate of well 3927 was reduced from 200 to 100 gpm.

#### *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 at the end of 2020.

During 2020, the South Plume/South Plume Optimization Module removed 593 Mgal of groundwater and 82 lb of total uranium from the Great Miami Aquifer. Based on analysis of the data collected in 2020, the module continues to meet its primary objectives as demonstrated by the following:

- Southward movement of the total uranium plume beyond the southernmost extraction wells has not been detected.
- Active remediation of the central portion of the off-property total uranium plume continues to reduce plume concentration. Nearly the entire off-property total uranium plume concentration is now below 100 µg/L. When pumping began in 1993, areas in the off-property total uranium plume had concentrations of over 300 µg/L.
- The Paddys Run Road Site plume (contamination not attributed to Fernald site operations), located south of the Fernald extraction wells, is not being pulled toward the South Plume extraction wells.

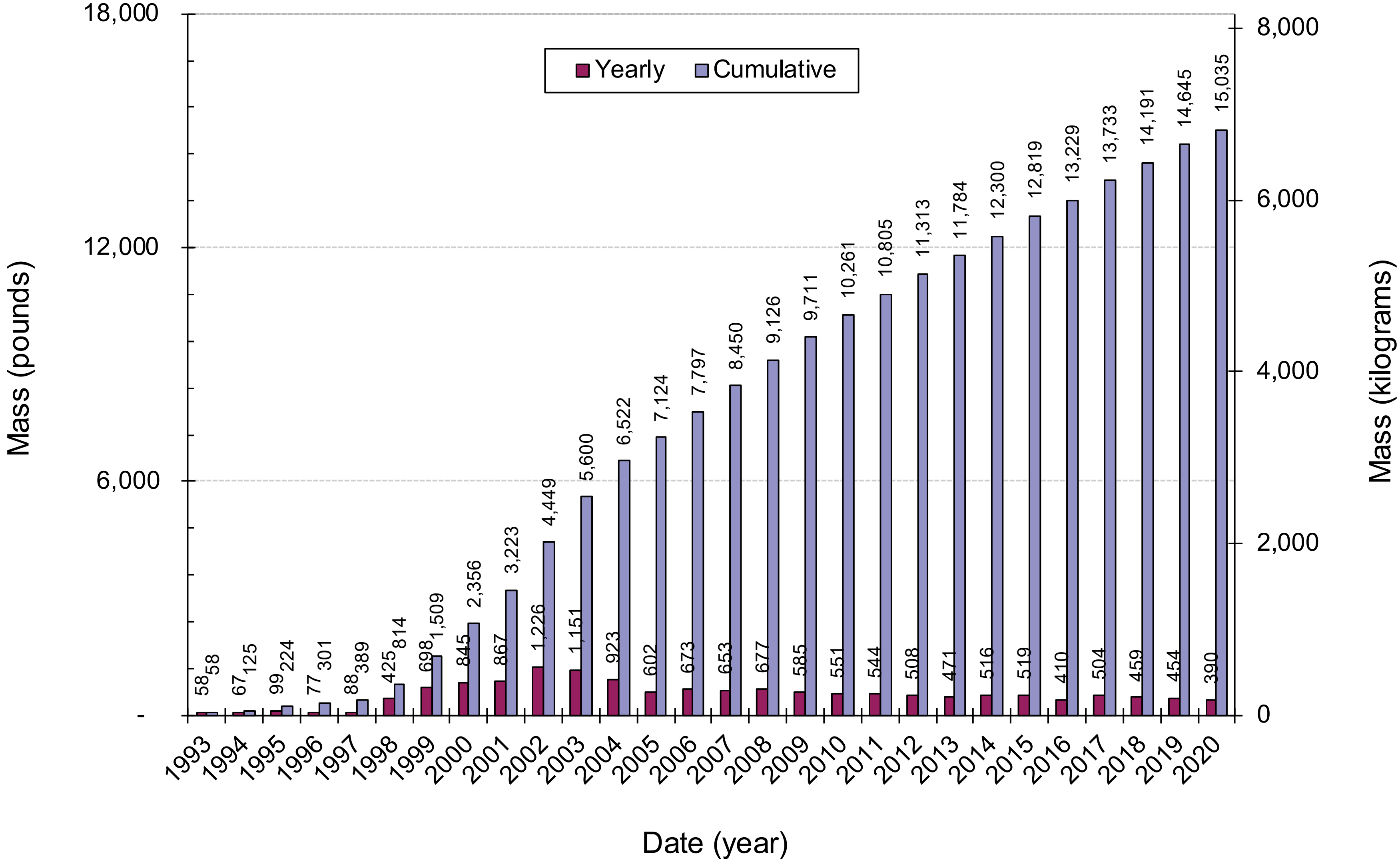
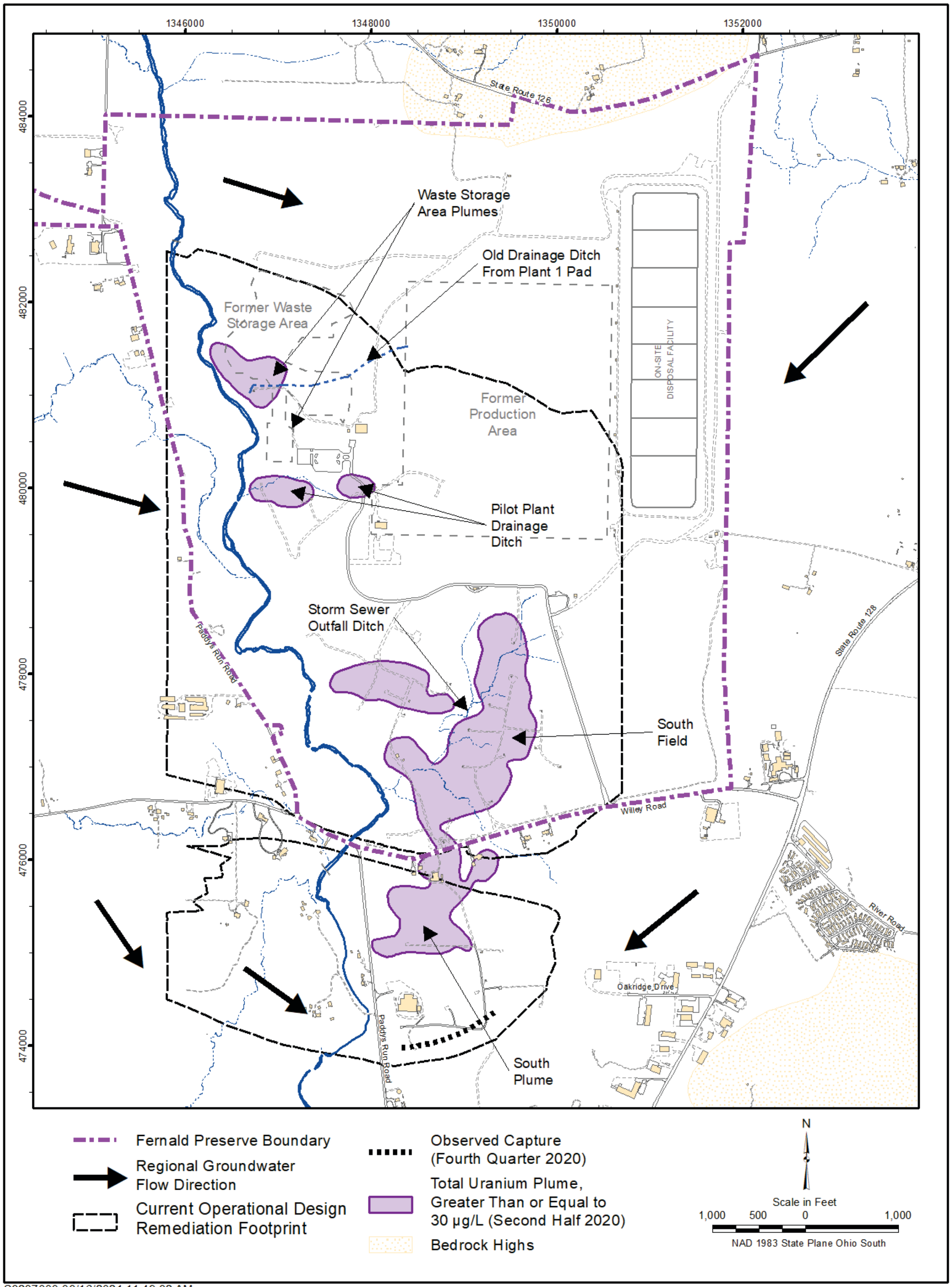



*Figure 17. Yearly and Cumulative Mass of Uranium Removed from the Great Miami Aquifer, 1993–2020*




S3237000 03/16/2021 11:49:32 AM

*Figure 18. Total Uranium Plume in the Aquifer with Concentrations Greater Than or Equal to 30 µg/L at the End of 2020*

#### *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 2020, 11 extraction wells were operational.

The 10 original extraction wells installed under Phase I were 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276. Six of the original 10 wells have been shut down (31562, 31563, 31564, 31565, 31566, 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, total uranium concentrations in that region of the aquifer were low. In addition, 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 reinjection 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.

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 2002), which was issued in May 2002. The design provided an updated characterization of the total 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 total uranium plume (extraction wells 33264, 33265, and 33266).
- One additional reinjection well in the former Southern Waste Units area (reinjection well 33263).
- An extraction well (31563) that was converted into a reinjection 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 reinjection 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 2014). 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 2020, the South Field Module removed 1,286 Mgal of groundwater and 246 lb of total 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 total 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 former Waste Storage Area following recommendations made in a modeling study that was released in 2014 (DOE 2014). 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 2020, 322 Mgal of groundwater and 62 lb 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. Focusing on remediating the uranium plume also addresses the remaining contaminants. Figure 18 shows the mapped outline of the total uranium plumes in the aquifer through the end of 2020. The total uranium plumes identified in the figure represent the interpreted size of the maximum total uranium plume in which concentrations are at or above the 30 µg/L groundwater FRL for total uranium.

Data collected in 2020 show continued progress in reducing the 30 µg/L uranium footprint, and slight increases in the mapped areas of the 50 µg/L and 100 µg/L portions of the plume, as described below:

- The mapped footprint of the total uranium plume decreased in size by 5.0 acres (5.8%). The area at or above 30 µg/L in 2019 was mapped as being 86.5 acres, and the area above 30 µg/L in 2020 was mapped as being 81.5 acres.
- The area of the total uranium plume above a concentration of 50 µg/L increased in size by 0.5 acre (1.0%). The area at or above 50 µg/L in 2019 was mapped as being 49.9 acres, and the area above 50 µg/L in 2020 was mapped as being 50.4 acres.

- The area of the total uranium plume above a concentration of 100 µg/L increased in size by 1.7 acres (6.4%). The area at or above 100 µg/L in 2019 was mapped as being 26.5 acres, and the area above 100 µg/L in 2020 was mapped as being 28.2 acres.

Figure 18 identifies hydraulic capture observed during the fourth quarter of 2020 for the active restoration modules and also presents regional groundwater flow directions. The map indicates that the existing extraction system is hydraulically capturing the South Plume and preventing further movement of uranium to the south beyond the extraction wells. Figure 18 also depicts the time-of-travel remediation footprint that was predicted by modeling the current Operational Design.

Appendix A, Attachment A.2, provides detailed total uranium plume maps for 2020. Appendix A, Attachment A.3, provides quarterly groundwater elevation maps and capture interpretations, along with graphical displays of groundwater elevation data. Highlights for 2020 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 depth 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 2020, direct-push samples were collected from three locations in the former Waste Storage Area, and from one location in the PPDD plume area, to supplement routine sampling of monitoring wells.

Between 2019 and 2020 the mapped footprint of the 30 µg/L total uranium plume decreased in size by 1.25 acres (8.4%). The area above 30 µg/L in 2019 was mapped as 14.3 acres, and the area above 30 µg/L in 2020 was mapped as 13.1 acres. Figure 18 shows the outline of the maximum total uranium plumes in the former Waste Storage Area, as measured during the second half of 2020. 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. Total uranium FRL exceedances were detected at this well again in 2020. As discussed in past Site Environmental Reports, FRL exceedances occur in this area when the water-table elevation exceeds 515 ft above mean sea level. The two samples collected in 2020 at monitoring well 2389 had total uranium concentrations above 30 µg/L. Both samples were collected when the water table had an elevation above 515 ft 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 total uranium groundwater FRL exceedance is dissipating over time. This location is within the capture zone of the pump-and-treat system.

**South Field and South Plume Area:** In 2020, direct-push samples were collected at 23 locations in the South Field and South Plume areas to supplement routine sampling of monitoring wells. Direct-push data for 2020 are presented in Appendix A, Attachment A.2.

In 2020, the mapped footprint of the 30 µg/L total uranium plume in the South Field and South Plume decreased by 3.9 acres. The area above 30 µg/L in 2019 was mapped as 72.3 acres, and the area above 30 µg/L in 2020 was mapped as 68.4 acres.

In 2020, the area of the total uranium plume in the South Field and South Plume above a concentration of 50 µg/L increased by 0.5 acre. The area above 50 µg/L in 2019 was mapped as 39.8 acres, and the area above 50 µg/L in 2020 was 40.3 acres.

In 2020, the area of the total uranium plume in the South Field and South Plume above a concentration of 100 µg/L increased by 1.4 acres. The area above 100 µg/L in 2019 was mapped as 18.9 acres, and the area above 100 µg/L in 2020 was 20.3 acres.

#### *3.3.1.6 Monitoring Results for Non-Uranium Constituents*

Although the groundwater remedy is primarily targeting remediation of the total uranium plume, other FRL constituents within the total uranium plume are also being monitored. Figure 19 identifies the locations of the monitoring wells that had non-uranium FRL exceedances. Table 5 shows the number of wells with non-uranium constituents exceeding FRLs in 2020, the number of wells with constituents exceeding FRLs outside the current Operational Design Remediation Footprint, the groundwater FRLs, and the range of 2020 data inside and outside the current Operational Design Remediation Footprint.

*Table 5. Non-Uranium Constituents with Results Above FRLs During 2020*

| Constituent | Number of Wells Exceeding the FRL | Number of Wells Exceeding the FRL Outside the Current Operational Design Remediation Footprint | Groundwater FRL[a] | Range of 2020 Data Inside the Current Operational Design Remediation Footprint[a] | Range of 2020 Data Outside the Current Operational Design Remediation Footprint[a,b] |
|---|---|---|---|---|---|
| **General Chemistry** | | | (mg/L) | (mg/L) | (mg/L) |
| Nitrate + Nitrite as Nitrogen | 7 | 0 | 11[c] | 14.4 to 761 | NA |
| **Inorganics** | | | (mg/L) | (mg/L) | (mg/L) |
| Manganese | 2 | 0 | 0.90 | 0.958 to 1.04 | NA |
| Molybdenum | 1 | 0 | 0.10 | 0.181 to 0.280 | NA |
| **Radionuclides** | | | (pCi/L) | (pCi/L) | (pCi/L) |
| Technetium-99 | 4 | 0 | 94 | 94.9 to 915 | NA |
| **Organics** | | | (µg/L) | (µg/L) | (µg/L) |
| Trichloroethene | 1 | 0 | 5.0 | 6.85 | NA |

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

During 2020, five non-uranium constituents had FRL exceedances. No locations were outside the current uranium-based Operational Design Remediation Footprint. No plumes were identified for the non-uranium constituents above FRLs at the locations outside the current Operational Design Remediation Footprint in the extensive groundwater characterization efforts evaluated as part of the *Remedial Investigation Report for Operable Unit 5* (DOE 1995d). More details are provided in Attachment A.4.

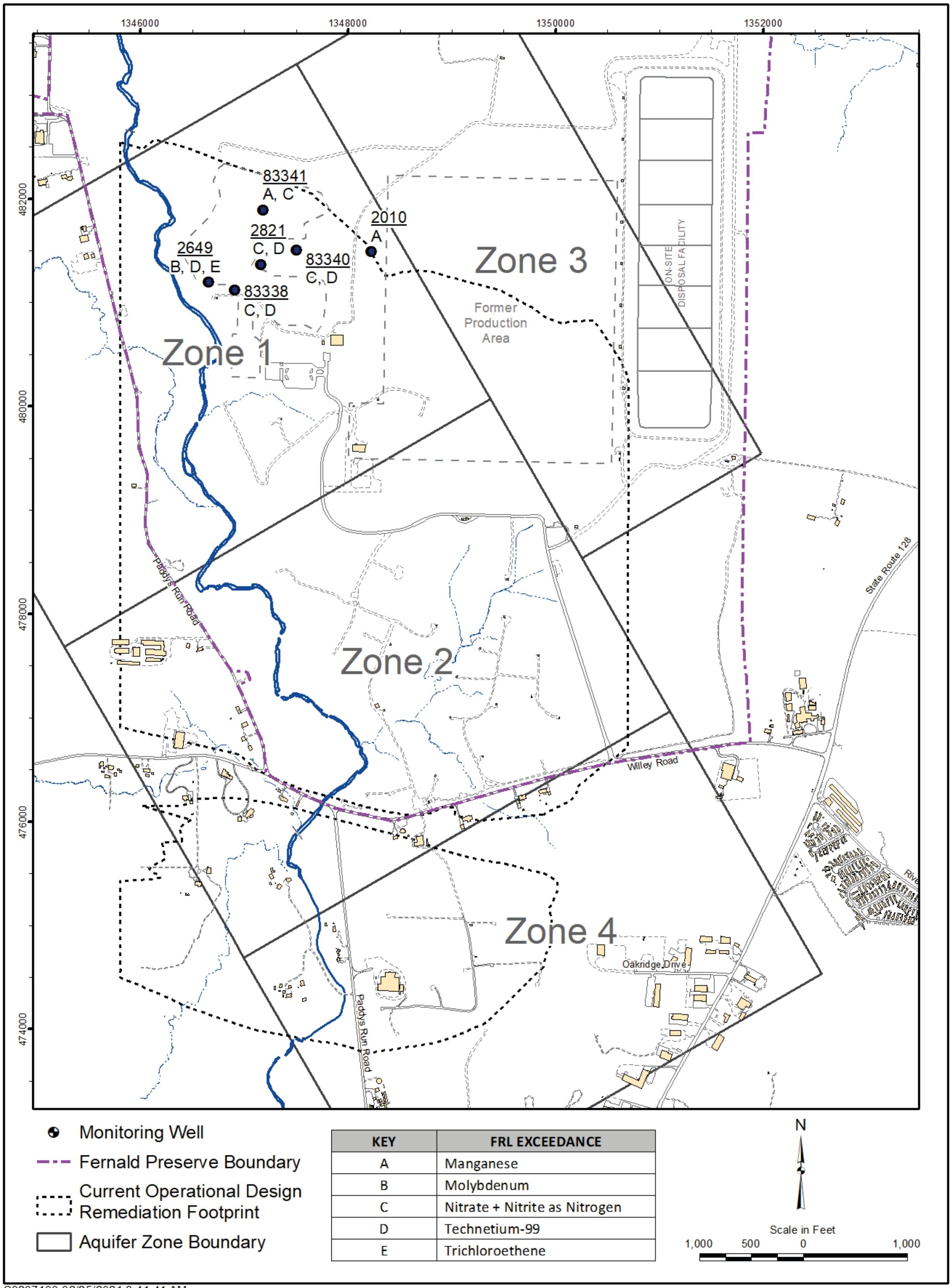
Non-uranium constituents with FRL exceedances in 2019 at the well locations outside the current Operational Design Remediation Footprint were further evaluated in 2020 to determine if they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment A.4. Additional routine data collection will be required in 2021 to determine if an FRL exceedance detected in well 22205 in 2019 is persistent.

### 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. This section provides additional details on these two other 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 total 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. When the public water supply became available, DOE discontinued monitoring at many off-property private wells. Data from the three private wells sampled under the IEMP are detailed in Section 2.3 and were incorporated into the uranium plume map shown in Figure 18.

During 2020, 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. The Paddys Run Road Site plume is contamination that is not attributed to Fernald site operations. Data from the property/plume boundary wells were integrated with other groundwater data for 2020 and incorporated into the total uranium plume maps shown in Figure 18 and Appendix A, Attachment A.2. Non-uranium data from these wells are included in Section 3.3.1.6. Data collected from the 11 wells in the Paddys Run Road area indicate that the Paddys Run Road Site plume (contamination not attributed to Fernald site operations), downgradient of the Fernald extraction wells, is not being pulled toward the South Plume extraction wells.




S3237100 02/25/2021 8:41:41 AM

*Figure 19. Non-Uranium Constituents with 2020 Results Above FRLs*

As indicated in Section 2.0, 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 or variance 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 2020 indicate that the 30 µg/L footprint of the maximum total uranium plume continues to decrease in response to pumping. Concentrations within the plume are fluctuating in response to the pumping with increases in the 50 µg/L and 100 µg/L footprints. Table 6 provides a summary.

*Table 6. Comparison of 2018 and 2020 Maximum Total Uranium Plume Footprint Areas*

| Year | Area Greater Than 30 µg/L | Area Greater Than 50 µg/L | Area Greater Than 100 µg/L[a] |
|---|---|---|---|
| 2019 (acres) | 86.5 | 49.9 | 26.5 |
| 2020 (acres) | 81.5 | 50.4 | 28.2 |
| Decrease (acres) | 5.0 | (-.5) | (-1.7) |
| Decrease (percent) | 5.8 | (-1.0) | (-6.4) |

[a] Negative numbers indicate increased plume area.

Groundwater elevations measured in 2020 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 total uranium plume.

Data collected in 2020 show that the mass of uranium being removed from the aquifer is greater than what the groundwater model predicted would be removed. This indicates that the pumping system remains effective in removing uranium from the aquifer, but that the model is underpredicting how much uranium will need to be removed to achieve cleanup. Appendix A, Attachment A.1, provides additional information concerning the mass of uranium removed from the aquifer.

A comparison of the average model-predicted uranium concentration for the end of 2020 to the average actual uranium concentration for the extraction wells in December 2020 shows that the average actual uranium concentration is higher than the average model-predicted uranium concentration (20.7 and 14.1 µg/L, respectively). As indicated in Table A.1-25, the difference between the average model predicted uranium concentration and the average actual uranium concentration has been increasing annually since 2016. From 2016 to 2020, the annual difference was 2.99, 3.5, 4.3, 4.7, and 6.6 µg/L, respectively. This indicates that pumping remains effective in removing uranium, but that the cleanup will take longer than the model predicted. Additional detail is provided in Attachment A.1.

In addition to the metrics provided above to track aquifer cleanup progress, bulk plume metrics (i.e., plume acres, average plume concentration, and dissolved uranium mass) are also provided to track progress. These bulk plume metrics are based on Ricker method calculations (Ricker 2008). Table 7 provides a summary of the bulk plume metrics over time, showing an overall decrease for all three metrics.

*Table 7. Bulk Plume Metrics (2006 to 2020)*

| Year | Plume Area (Acres) | Average Plume Concentration (µg/L) | Remaining Dissolved Uranium Mass (lb) |
|---|---|---|---|
| 2006 | 145.7 | 92.11 | 306 |
| 2010 | 132.7 | 89.96 | 272 |
| 2014 | 108.0 | 86.41 | 213 |
| 2016 | 108.0 | 79.32 | 195 |
| 2017 | 97.3 | 79.12 | 175 |
| 2018 | 95.9 | 86.23 | 190 |
| 2019 | 89.2 | 81.58 | 166 |
| 2020 | 85.9 | 80.77 | 158 |

Two calculations, plume center-of-mass and total uranium mass remaining in the aquifer, are presented in Attachment A.2. Plume center-of-mass calculations show that the center of mass of each plume area has remained fairly stationary between 2006 and 2020, indicating that the surrounding pumping wells are capturing the plume and not allowing the center of mass to migrate as it would if no pumping was taking place. Of note is that the center of mass has shifted to the north in the South Field. This provides additional support that uranium concentrations in the South Plume are decreasing, and that progress is being made in achieving the objective of cleaning up the South Plume first.

The Ricker method calculation for mass remaining in the aquifer estimates the dissolved mass present in the groundwater as total aqueous uranium. The estimate for the mass of aqueous uranium is used to estimate the solid uranium mass adsorbed to aquifer sediments (Deutsch 1997). The dissolved mass and solid mass combined provide an estimate of the total uranium mass remaining in the aquifer. Using 2020 data, the estimate of total uranium mass remaining in the aquifer is 3,291.14 lb.

The groundwater model predicts that not all of this remaining uranium mass will need to be removed to achieve concentration-based cleanup goals. The current model prediction is that an additional 1,289 lb of uranium needs to be removed. Upon removal of this additional dissolved mass, the remaining uranium contamination sorbed to the aquifer sediments should not dissolve back into the water at a rate that would cause a future exceedance of the groundwater FRL for uranium. Although the current operational remedy remains effective in removing uranium from the aquifer, data indicates that modeled cleanup time predictions are not being met. Additional groundwater modeling is needed to determine if the system can be optimized again, as it was in 2014. As discussed below, the timing for this additional modeling is subject to the outcome of a collaborative exercise planned for 2021 with the DOE National Laboratory Network.

As the current operational pumping remedy continues, DOE plans to determine if there is anything that could be changed to improve its efficiency and the ability of the groundwater model to predict more reliable cleanup times. In 2021, DOE will participate in a collaborative exercise with experts in the field of groundwater modeling, remediation, and well field operations from the DOE National Laboratory Network. Since a potential outcome of the collaboration will be recommendations on how to improve modeling predictions, DOE does not plan to conduct any additional optimization modeling until after this collaboration concludes.

## 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 Great Miami Aquifer. Figure 20 identifies the OSDF footprint and monitoring well locations for Cells 1 through 8. Flow is monitored within the facility in the LCS and LDS to determine if the facility is operating as designed. Water quality is monitored in the LCS, LDS, glacial till, and Great Miami Aquifer to identify any potential water quality changes that could have resulted from leakage from the facility.

LCS and LDS flow data collected in 2020 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 as designed.

OSDF monitoring was not affected by the response to the COVID-19 pandemic. A comparison of water quality data collected in 2020 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 the facility is operating as designed. Table 8 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 2020. The majority of total uranium concentrations measured in 2020 fell within the historical range of concentrations previously measured for each monitoring horizon. New high and new low concentrations measured in 2020 are identified in bold in Table 7.

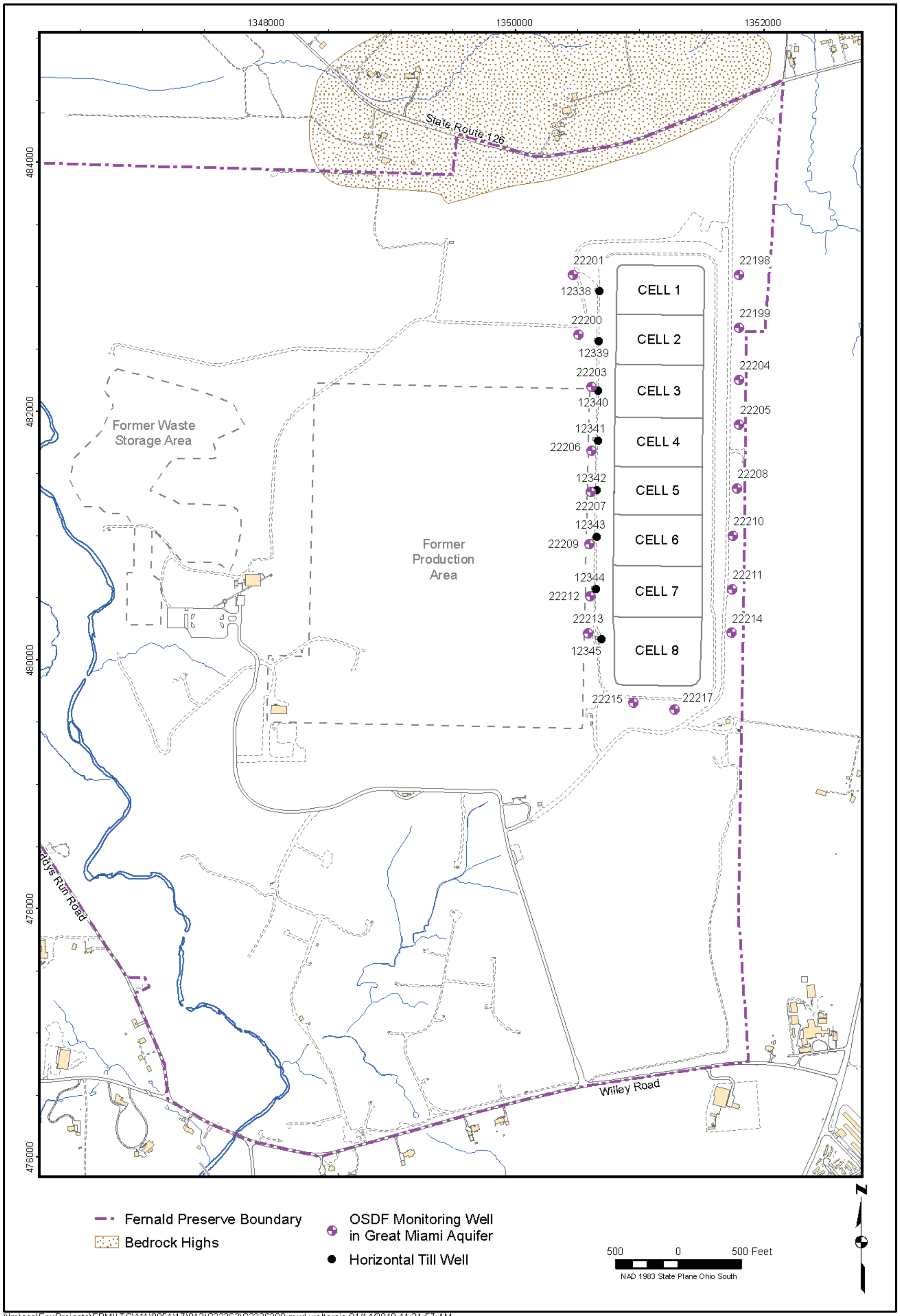



*Figure 20. OSDF Footprint and Monitoring Well Locations*

*Table 8. OSDF Groundwater, Leachate, and LDS Monitoring Summary*

| Cell (Waste Placement) | Monitoring Location | Monitoring Zone | Date Sampling Started | Total Number of Samples | Range of Total Uranium Concentrations[a,b] (µg/L) | First Half 2020[a,c] (µg/L) | Second Half 2020[a,c] (µg/L) | Historical Trend[d] (Year Last Sampled) |
|---|---|---|---|---|---|---|---|---|
| Cell 1 (Dec. 1997) | 12338C | LCS | Feb. 17, 1998 | 74 | ND–206 | 9.16 | 7.58 | Up (2020) |
| | 12338D | LDS | Feb. 18, 1998 | 37 | 1.50–37.0 | DRY | DRY | Up (2011) |
| | 12338 | Glacial Till | Oct. 30, 1997 | 83 | ND–19 | 7.84 | 8.22 | Up (2020) |
| | 22201 | Great Miami Aquifer | Mar. 31, 1997 | 90 | ND–12.4 | 9.82 | 6.68 | Up (2020) |
| | 22198 | Great Miami Aquifer | Mar. 31, 1997 | 137 | 0.540–15.2 | 3.31 | 3.11 | None (2020) |
| Cell 2 (Nov. 1998) | 12339C | LCS | Nov. 23, 1998 | 70 | 4.51–686 | 277 | 110 | Up (2020) |
| | 12339D | LDS | Dec. 14, 1998 | 29 | 4.08–25.8[e] | DRY | DRY | None (2013) |
| | 12339 | Glacial Till | Jun. 29, 1998 | 94 | ND–36.9 | 15.1 | 16.8 | Up (2020) |
| | 22200 | Great Miami Aquifer | Jun. 30, 1997 | 85 | ND–**4.69** | 0.202 | **4.69** | Up (2020) |
| | 22199 | Great Miami Aquifer | Jun. 25, 1997 | 114 | ND–12.1 | 0.336 | 2.35 | Down (2020) |
| Cell 3 (Oct. 1999) | 12340C | LCS | Oct. 13, 1999 | 68 | 9.27–206 | 128 | 116 | Up (2020) |
| | 12340D | LDS | Aug. 26, 2002 | 20 | 8.90–27.7[e] | DRY | DRY | Down (2007) |
| | 12340 | Glacial Till | Jul. 28, 1998 | 87 | ND–58.5 | 17.8 | 18.4 | None (2020) |
| | 22203 | Great Miami Aquifer | Aug. 24, 1998 | 80 | ND–15.4 | 11.9 | 5.32 | Up (2020) |
| | 22204 | Great Miami Aquifer | Aug. 24, 1998 | 109 | ND–22.9 | 3.27 | 5.55 | Up (2020) |
| Cell 4 (Nov. 2002) | 12341C | LCS | Nov. 04, 2002 | 54 | 4.41–**234** | **234** | 85.8 | Down (2020) |
| | 12341D | LDS | Nov. 04, 2002 | 40 | 5.74–**55.9** | DRY | **DRY** | Up (2019)[f] |
| | 12341 | Glacial Till | Feb. 26, 2002 | 67 | **3.76**–7.91 | 3.80 | **3.76** | Down (2020) |
| | 22206 | Great Miami Aquifer | Nov. 06, 2001 | 71 | ND–5.78 | 1.17 | 2.34 | Up (2020) |
| | 22205 | Great Miami Aquifer | Nov. 05, 2001 | 96 | 0.446–19.7 | 1.30 | 5.90 | None (2020) |
| Cell 5 (Nov. 2002) | 12342C | LCS | Nov. 04, 2002 | 56 | 3.39–285 | 206 | 130 | None (2020) |
| | 12342D | LDS | Nov. 04, 2002 | 40 | 2.93–27.1 | DRY | DRY | Down (2013) |
| | 12342 | Glacial Till | Feb. 26, 2002 | 68 | 7.45–21.1 | 8.28 | 8.59 | Down (2020) |
| | 22207 | Great Miami Aquifer | Nov. 06, 2001 | 71 | ND–4.48 | 0.344 | 0.347 | Down (2020) |
| | 22208 | Great Miami Aquifer | Nov. 05, 2001 | 95 | ND–2.1 | 0.364 | 0.358 | None (2020) |
| Cell 6 (Nov. 2003) | 12343C | LCS | Oct. 27, 2003 | 53 | 8.03–276 | 123 | 119 | Down (2020) |
| | 12343D | LDS | Oct. 27, 2003 | 52 | 3.1–**144** | 129 | **144** | Up (2020) |
| | 12343 | Glacial Till | Mar. 14, 2003 | 60 | ND–24.2 | 12.9 | 9.33 | Up (2020) |
| | 22209 | Great Miami Aquifer | Dec. 16, 2002 | 66 | ND–2.43 | 0.454 | 0.736 | Down (2020) |
| | 22210 | Great Miami Aquifer | Dec. 16, 2002 | 90 | ND–1.02 | 0.674 | 0.780 | None (2020) |
| Cell 7 (Sep. 2004) | 12344C | LCS | Sep. 02, 2004 | 49 | 4.72–355 | 176 | 107 | Down (2020) |
| | 12344D | LDS | Sep. 02, 2004 | 29 | 12.2–169[e] | DRY | DRY | Up (2015) |
| | 12344 | Glacial Till | Feb. 24, 2004 | 57 | 0.674–12.1 | 3.45 | 3.88 | Up (2020) |
| | 22212 | Great Miami Aquifer | Jan. 21, 2004 | 59 | ND–5.53 | 0.422 | 0.426 | None (2020) |
| | 22211 | Great Miami Aquifer | Jan. 21, 2004 | 80 | ND–4.31 | 0.433 | 0.995 | None (2020) |

*Table 8. OSDF Groundwater, Leachate, and LDS Monitoring Summary (continued)*

| Cell (Waste Placement) | Monitoring Location | Monitoring Zone | Date Sampling Started | Total Number of Samples | Range of Total Uranium Concentrations[a,b] (µg/L) | First Half 2020[a,c] (µg/L) | Second Half 2020[a,c] (µg/L) | Historical Trend[d] (Year Last Sampled) |
|---|---|---|---|---|---|---|---|---|
| Cell 8 (Dec 2004) | 12345C | LCS | Oct. 18, 2004 | 46 | 1.51–335 | 95.5 | 149 | None (2020) |
| | 12345D | LDS | Oct. 18, 2004 | 43 | 9.38–**209** | 120 | **209** | Up (2020) |
| | 12345 | Glacial Till | May 19, 2004 | 20 | 3.48–7.30 | DRY | DRY | Up (2008) |
| | 22213 | Great Miami Aquifer | Mar. 31, 2004 | 58 | ND–0.71 | 0.353 | 0.457 | Up (2020) |
| | 22214 | Great Miami Aquifer | Mar. 31, 2004 | 80 | ND–2.95 | 0.243 | 1.15 | Down (2020) |
| | 22215 | Great Miami Aquifer | Aug. 22, 2005 | 49 | ND–16.4 | 0.534 | 0.486 | Up (2020) |
| | 22217[g] | Great Miami Aquifer | Aug. 22, 2005 | 48 | ND–18.3 | 6.33 | 6.34 | Down (2020) |

Note: The data on this table represent the raw data from the database; however, data presented in Attachment A.5 has gone through statistical processing and analysis. In regard to the statistical processing, the data was quarterized (normalized to one result per quarter) and outliers removed to arrive at an accurate distribution model. Because of the processing, the total number of samples and range of concentrations on this table may not match the text, tables, and figures in Attachment A.5. The rules used for the statistical processing and analysis in Attachment A.5 are discussed in Attachment A.5, Section A.5.2.1, and summarized in Table A.5-3.

Note: Uranium concentration versus time graphs are located in the subattachments to Attachment A.5. See Figures A.5.1-5A and A.5.1-5B for Cell 1; Figures A.5.2-5A and A.5.2-5B for Cell 2; Figures A.5.3-5A and A.5.3-5B for Cell 3; Figures A.5.4-5A and A.5.4-5B for Cell 4; Figures A.5.5-5A and A.5.5-5B for Cell 5; Figures A.5.6-5A and A.5.6-5B for Cell 6; Figures A.5.7-5A and A.5.7-5B for Cell 7; and Figures A.5.8-7A and A.5.8-7B for Cell 8.

[a] **Bold text indicates a new high or low detected in 2020.**
[b] ND = not detected.
[c] Where there are more than two data points for the half year, the higher result is used.
[d] The trends presented here are based on nonparametric Mann-Kendall procedure and come from the tables in Attachment A.5 subattachments for each cell. See Tables A.5.1-1, A.5.2-1, A.5.3-1, A.5.4-1, A.5.5-1, A.5.6-1, A.5.7-1, and A.5.8-1.
[e] 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 37.6 µg/L.
[f] The Cell 4 LDS was dry, resulting in no data from fourth quarter 2011 through 2016.
[g] 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.

As shown in Table 8, and summarized below, two new high total uranium concentrations were detected in 2020 within the facility (LDS horizon). As reported in Attachment A.5, the uranium concentrations in the LDS horizons have historically increased as the LDSs dry out. Continued monitoring is the recommended action at this time.

- LDS of Cell 6: A new high of 144 µg/L was measured. The previous high was 115 µg/L.
- LDS of Cell 8: A new high of 209 µg/L was measured. The previous high was 102 µg/L.

Summary statistics and time versus concentration graphs for each of the monitoring horizons listed above are provided in subattachments to Attachment A.5. Also provided in subattachments to Attachment A.5 are bivariate plots for each of the eight cells that demonstrate that mixing between the LCS, LDS, and horizontal till well at each cell is not occurring. The new high concentrations summarized above for 2020 are attributed to decreasing flow rates in the LDS. Continued routine sampling is the recommended action.

# 4.0 Surface Water and Effluent Pathway

**Results in Brief: 2020 Surface Water and Effluent Pathway**

**COVID-19 Pandemic:** As a result of reduced site personnel activities in response to the COVID-19 pandemic, weekly surface water samples were not collected from the week of March 23 through the week of May 18, 2020. Also, during this time period, the CAWWT was operated only between Monday morning and Thursday morning, resulting in less effluent being discharged during the year. Personnel were available to meet all NPDES permit sampling requirements for the entire year.

**Surveillance Monitoring:** No effluent analytical results from samples collected in 2020 exceeded any surface water FRL.

**Uranium Discharges:** In 2020, 378 lb of uranium were discharged in effluent to the Great Miami River. Approximately 33 lb of uranium were released to the environment through uncontrolled storm water runoff. The estimated total mass of uranium released through the surface water and effluent pathway was approximately 411 lb.

**NPDES Permit Compliance:** There were no instances of noncompliance at any sample location in 2020.

This section presents the 2020 monitoring activities and results for surface water and effluent 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: 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 pathway will continue to be monitored.

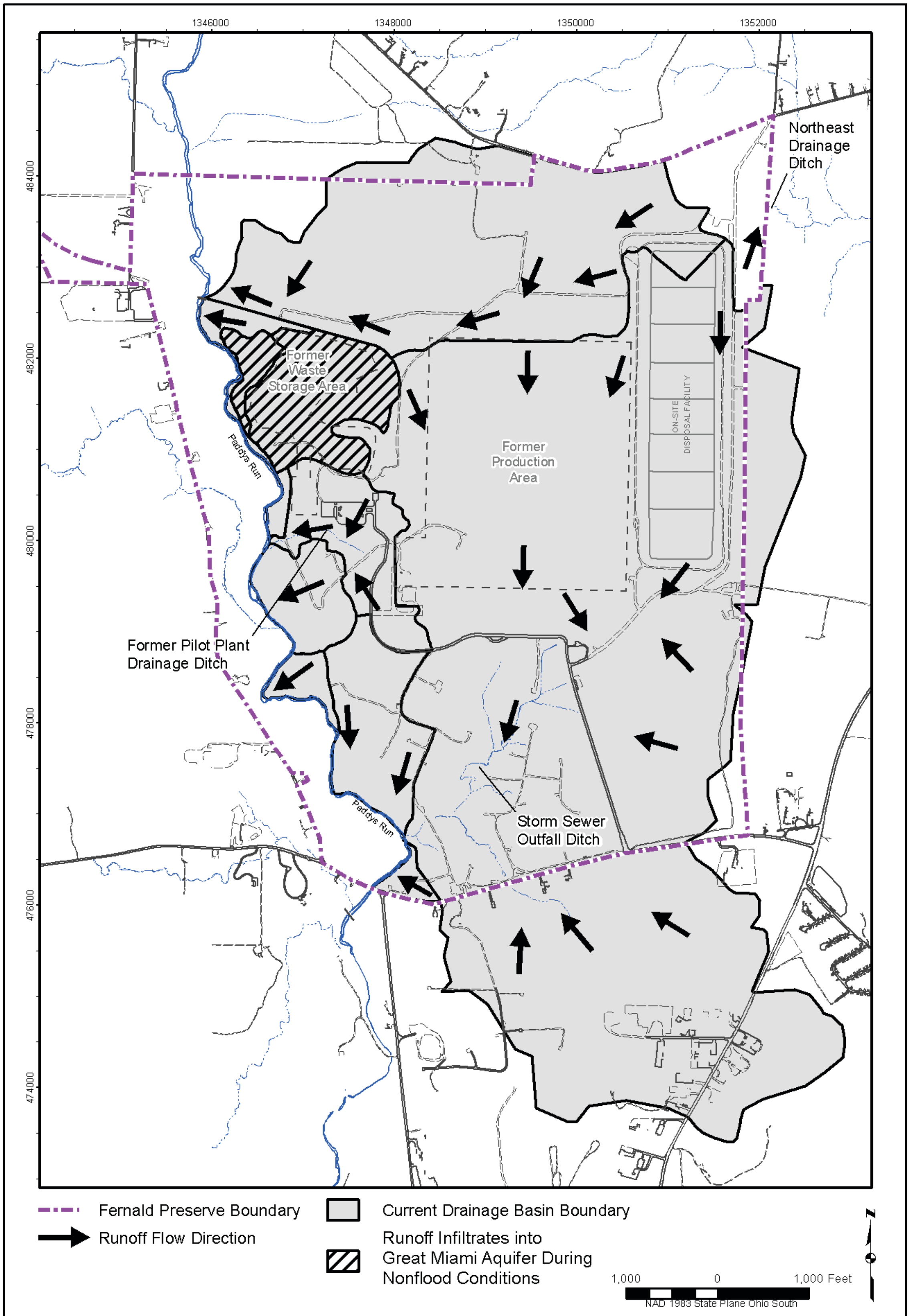
## 4.1 Summary of Surface Water and Effluent Pathway

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

- **Controlled runoff** is storm water that is collected and, under normal circumstances, treated and discharged to the Great Miami River as 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.
- **Effluent** is primarily untreated groundwater discharged to the Great Miami River via the effluent line. A small amount of groundwater is routed to treatment each month and blended with water from the backwash basin. The small volume of treated water is blended with untreated groundwater and is discharged to the Great Miami River via the outfall line.
- **Surface water** is water that flows within natural drainage features.

The 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 treatment operations. Effluent is currently composed of treated and untreated groundwater, treated leachate from the OSDF, and storm water associated with the footprint of the outdoor processing activities at the wastewater treatment facility. Groundwater is no longer routinely treated to meet discharge limits. A small volume of groundwater is blended with other wastewater stored in the CAWWT backwash basin when basin water is treated. The backwash basin is an above-ground lined impoundment that is used to temporarily store wastewater originating from a variety of sources (i.e., well rehabilitation, CAWWT backwash, OSDF leachate, groundwater sampling, CAWWT laboratory, and CAWWT storm water drainage).

The volume and flow rate of uncontrolled runoff depend on the amount of precipitation within a given period. Figure 8 in Section 1.0 shows monthly precipitation totals for 2020. 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 in 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\013\S23363\S2336300.mxd waltersjo 01/14/2019 11:15:51 AM

*Figure 21. Uncontrolled Surface Water Areas and 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 surface remediation has been completed at the Fernald Preserve and the groundwater remedy continues, the restored areas of the site are the primary focus relative to uncontrolled runoff. Controls to mitigate sediment leaving the site are primarily based on the vegetation and stabilization practices (e.g., erosion controls) within the restored areas.

One area, a small area west of the former waste pits, continued to show elevated total uranium concentrations in surface water samples. The location of elevated uranium area 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 Waste Storage Area runoff control basin known as the "cement pond." This area does not drain directly to Paddys Run and is not open to the public. A streambank stabilization project was conducted in 2014 and 2015 to ensure that Paddys Run does not erode into this area.

After a limited maintenance activity was completed in the fall of 2007, DOE committed to continue monitoring of the elevated uranium 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. Samples were not collected from the week of March 23 through the week of May 18, 2020, as a result of reduced site staffing in response to the COVID-19 pandemic. Surface water volume was sufficient to collect 19 samples at SWD-05 and 29 samples at SWD-09. In 2020, concentrations measured were within the historical range for the area.

## 4.3 Surface Water and Effluent Monitoring Program

Surface water and effluent 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 drainage areas and analyzed for various radiological and nonradiological constituents. Effluent is sampled prior to discharge into the Great Miami River.

The key elements of the surface water and 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 (i.e., offsite) locations (refer to Figure 22). Surface water is monitored for six 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 effluent to the Great Miami River. 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 effluent data are reported through the annual Site Environmental Report. Monthly discharge monitoring reports required by the NPDES permit are submitted to Ohio EPA.

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 effluent program are used to assess the collective effectiveness of site remediation in preventing unacceptable impacts to the surface water and groundwater. Compliance monitoring includes sampling at storm water and 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 effluent sample locations.

### 4.3.1 Surveillance Monitoring

**Effluent** is discharged to the Great Miami River through the effluent line identified in Figure 22. Samples of the 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 mixes with the water in the Great Miami River.

Surveillance monitoring in 2020 was based on an evaluation of analytical results from samples collected during the year. This evaluation indicated that during 2020, there were no exceedances of total uranium in any of the effluent samples analyzed. Seventeen of the 29 surface water analytical results from sample location SWD-09 exceeded the surface water FRL for total uranium (530 µg/L) in 2020. The 2020 high result of 1,066 µg/L is lower than the highest result of 2,087 µg/L collected in 2016. There was one surface water total uranium FRL exceedance in 19 samples collected at SWD-05 in 2020. Analysis of all results from samples collected at SWD-05 and SWD-09 indicates a downward trend for both locations. Residual uranium in the soil appears to be the cause for the elevated uranium concentrations. The contamination appears localized to the area around SWD-09, and the uranium concentrations measured in water collected from locations SWD-05 and SWD-09 appear to be influenced by seasonal changes. Surface water monitoring locations SWD-05 and SWD-09 were established to monitor the area west of the former Waste Pits Area where elevated uranium concentrations have been detected. Appendix B provides additional details. Monitoring for total uranium will continue at these locations.

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

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

No total uranium results exceeded the surface water FRL of 530 µg/L during 2020 at these two locations. The total uranium concentration at SWP-03 in the sample collected March 3, 2020, was 1.02 µg/L, well below the surface water total uranium FRL of 530 µg/L. Figure 23 illustrates the decrease of the total uranium concentration in Paddys Run from 1985 through 2020. The large decrease in concentration in 1987 is attributable to the installation of the storm water retention basin in 1986, which greatly reduced the volume of contaminated runoff flowing into Paddys Run from the Former Production Area.

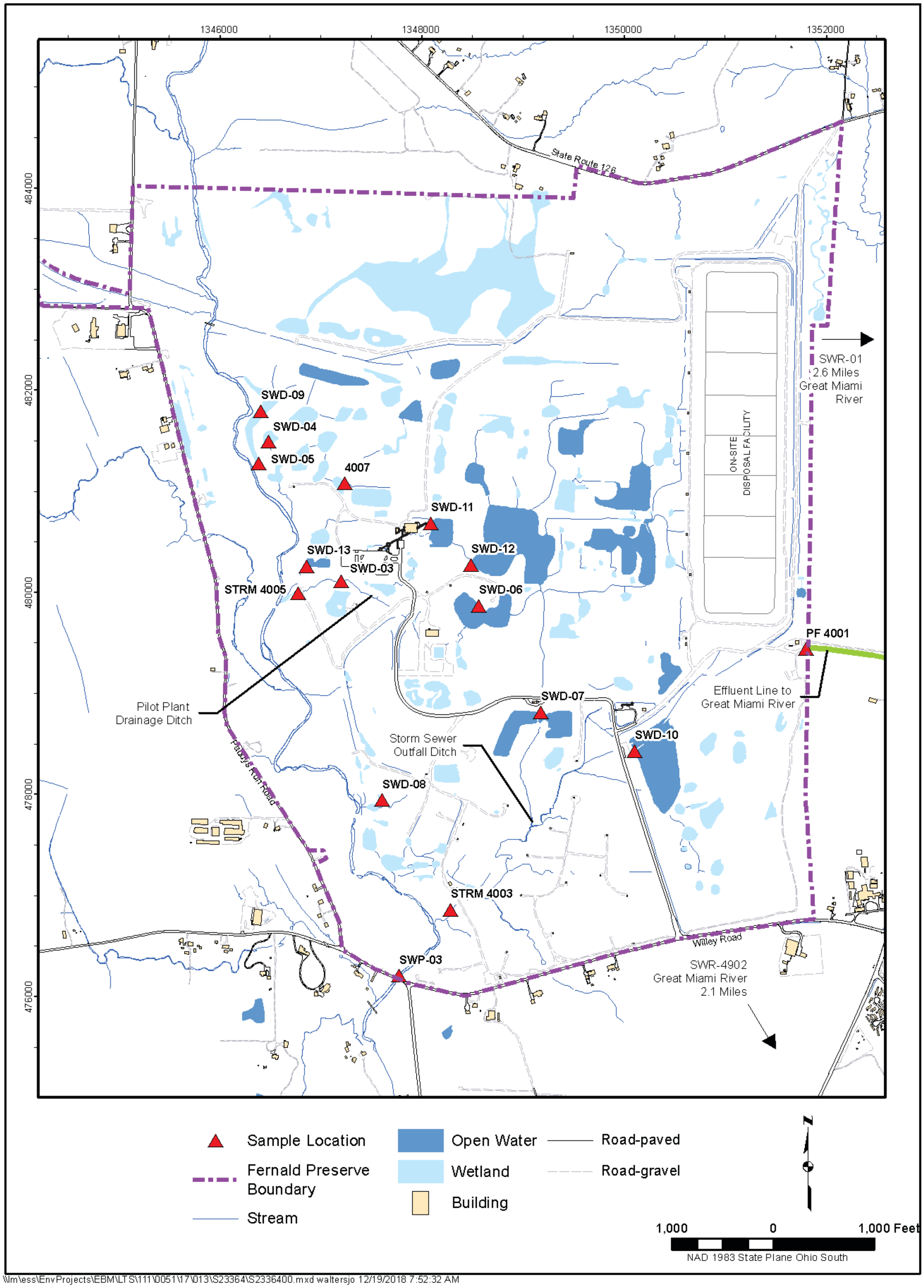



*Figure 22. IEMP/NPDES Surface Water and Effluent Sample Locations*

In 2015, DOE conducted an assessment of the scope of the surface water quality monitoring program. The assessment concluded that the scope of the program could be reduced. With approval from EPA, Ohio EPA, and local stakeholders, DOE implemented these reductions in 2017. The current surface water program is presented in the IEMP (Attachment D of the LMICP [DOE 2019]).

Samples collected at PF 4001 are used in the surveillance evaluation because this is the last point where effluent is sampled prior to discharge to the Great Miami River. The maximum daily total uranium concentration at PF 4001 in 2020 was 23.5 µg/L on May 28, 2020. This result is below the drinking water standard (30 µg/L) and far below the surface water total uranium FRL of 530 µg/L. Data collected from this location cannot directly be compared to the surface water FRL without considering the effect of the effluent waters mixing with the Great Miami River. A mixing equation (discussed further in Appendix B) is used to account for the actual flow rate in the Great Miami River and the discharge flow rate at PF 4001 when the maximum uranium concentration was detected. The resulting concentration in the river after mixing was estimated to be 2.94 µg/L for May 28, 2020.

Surface water data are 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 Fernald groundwater remedy. The groundwater remedy includes pumping from groundwater extraction wells downgradient of these areas where direct infiltration occurs. This pumping serves to capture and remove contaminated groundwater from the aquifer, mitigating any potential cross-media impacts. 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 SWD-03, SWD-04, SWD-05, SWD-07, SWD-08, and STRM 4005.

In 2020, sample results from surface water cross-media impact locations SWD-04, SWD-05, and STRM 4005 exceeded the total uranium groundwater FRL of 30 µg/L. Location SWD-05 had a thorium-228 exceedance (6.69 picocuries per liter [pCi/L]) and a thorium-232 exceedance (6.77 pCi/L) with concentrations above the groundwater FRLs of 4.0 and 1.2 pCi/L, respectively. Location SWD-08 had an exceedance of thorium-232 of 3.12 pCi/L, which is slightly above groundwater FRL of 1.2 pCi/L. Location SWD-04 is in the former Waste Storage Area; location SWD-05 is within a swale in the northwest corner of the former Waste Storage Area. STRM 4005 is along the former Pilot Plant Drainage Ditch. SWD-08 is located in the former Southern Waste Units. All of these locations are within the capture zone of the aquifer remediation system. Appendix A, Attachment A.2, provides additional information concerning the impact of surface water infiltrating into the Great Miami Aquifer. Sampling at these locations will continue to provide an assessment of the cross-media impact. Appendix B presents additional details of the FRL exceedances.

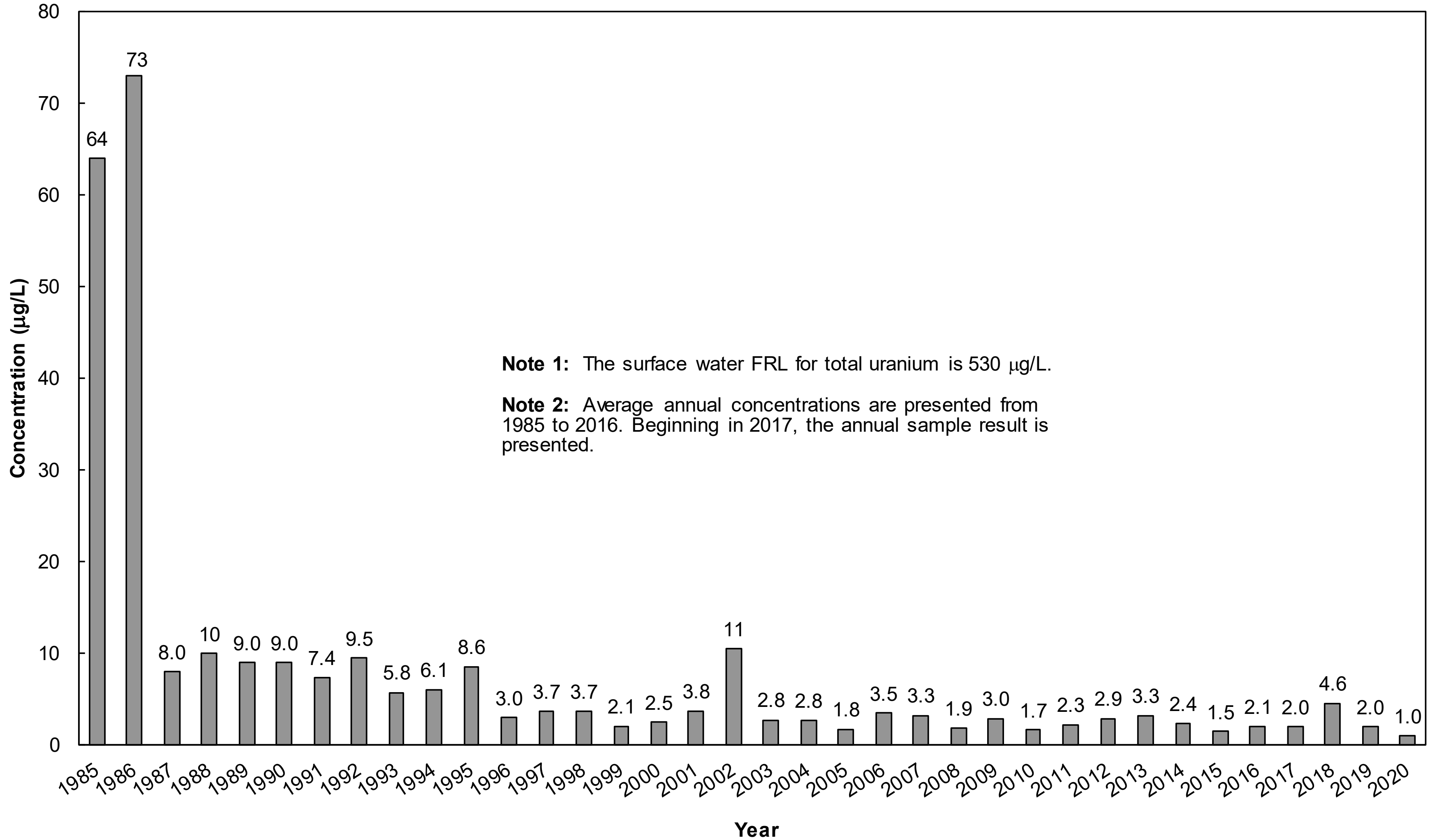



*Figure 23. Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03 Sample Location)*

### 4.3.2 Compliance Monitoring

#### *4.3.2.1 FFCA and OU5 ROD Compliance*

The Fernald Preserve is required to monitor effluent discharges at the Parshall Flume (sample location 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 1996b). 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 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 not exceed 30 µg/L, the EPA-established drinking water standard.

Figure 24 shows that the cumulative mass of total uranium discharged to the Great Miami River through the Parshall Flume (PF 4001) during 2020 was 378 lb, which is below the annual discharge limit of 600 lb. Figure 25 shows that the monthly average total uranium concentration in water discharged through the Parshall Flume (PF 4001) was below the 30 µg/L discharge limit every month during 2020.

#### *4.3.2.2 NPDES Permit Compliance*

Compliance sampling, consisting of sampling for nonradiological pollutants from uncontrolled runoff and effluent discharges from the Fernald Preserve, is regulated under the state-administrated NPDES program. The current NPDES permit took effect on March 1, 2015, and expired on February 29, 2020. An NPDES permit application was submitted to Ohio EPA in 2019. The site will operate under the current permit until a new permit is available.

There were no instances of noncompliance at any of the permitted outfalls in 2020.

### 4.3.3 Uranium Discharges in Surface Water and Effluent

As identified in Figure 24, 378 lb of uranium in effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 2020. In addition to the effluent, uncontrolled runoff is also contributing to the amount of uranium entering surface water. Figure 26 presents the mass of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2020.

A loading term is used to estimate the pounds of uranium discharged to Paddys Run via uncontrolled runoff. With the approval of the 2017 Site Environmental Report (DOE 2018a) by EPA and Ohio EPA, the loading term was revised. The revision of the loading term was based on total uranium data from surface water sampling locations, which reflects the decreasing total uranium concentrations measured at points discharging to Paddys Run as a result of significant historical improvements in the capture of contaminated storm water and remediation of site soil. The current loading term is 0.8 lb of uranium per inch of precipitation. During 2020, 41.58 inches of precipitation fell at the Fernald Preserve; therefore, an estimated 33.3 lb 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 effluent discharges and uncontrolled runoff, was approximately 411 lb.

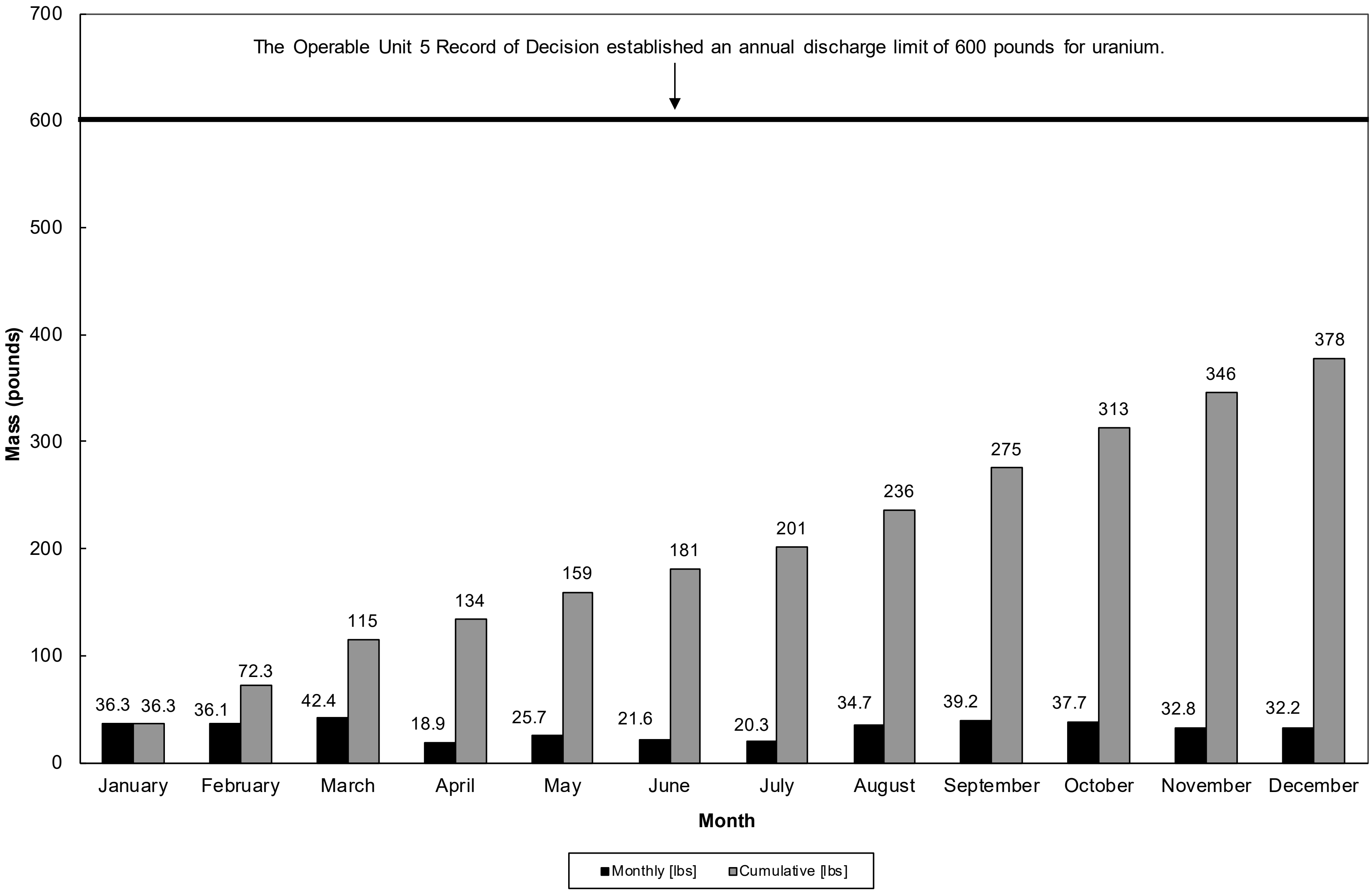



*Figure 24. Mass of Uranium Discharged to the Great Miami River Through the Parshall Flume (PF 4001) in 2020*

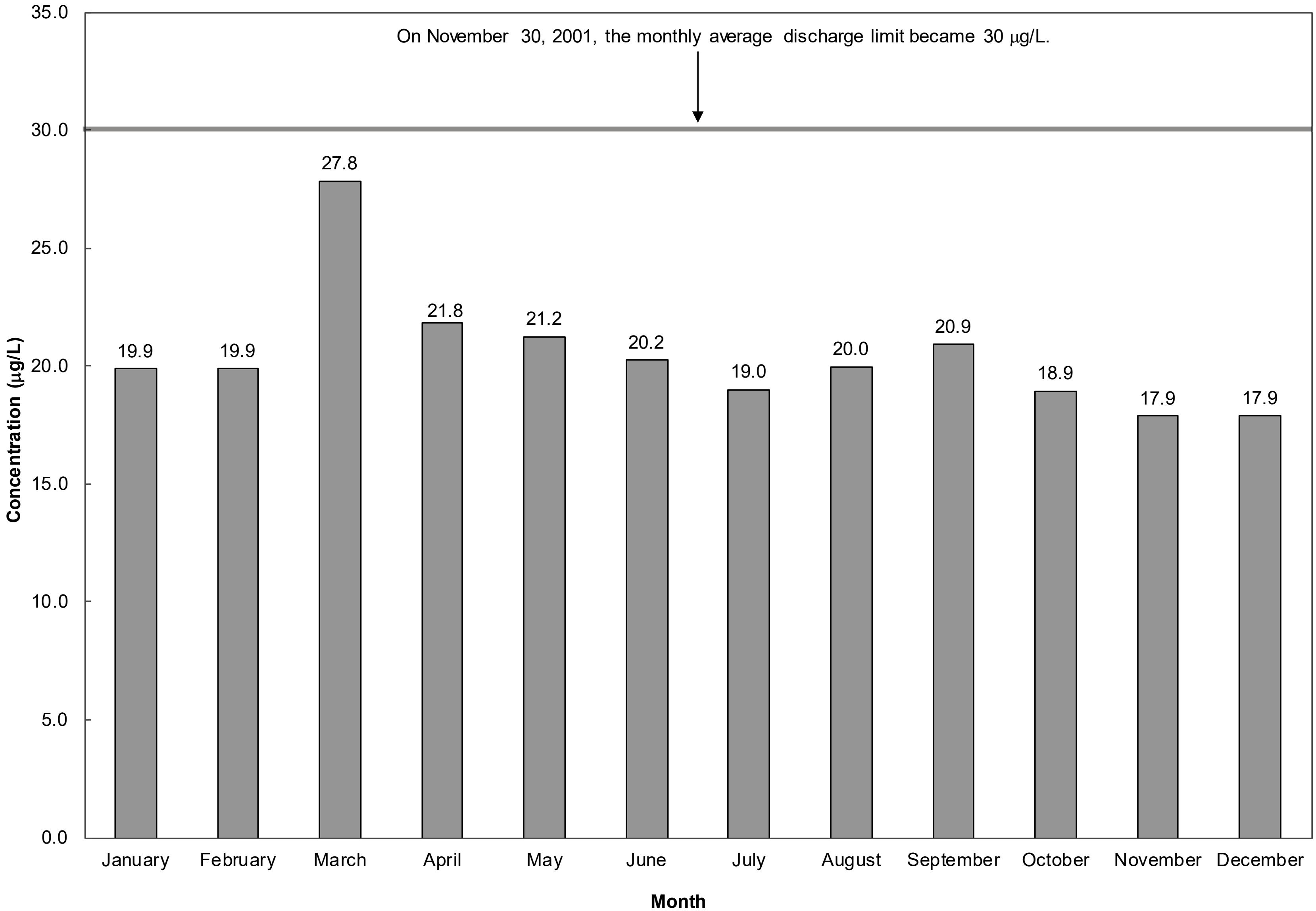



*Figure 25. 2020 Monthly Average Total Uranium Concentration in Water Discharged Through the Parshall Flume (PF 4001) to the Great Miami River*

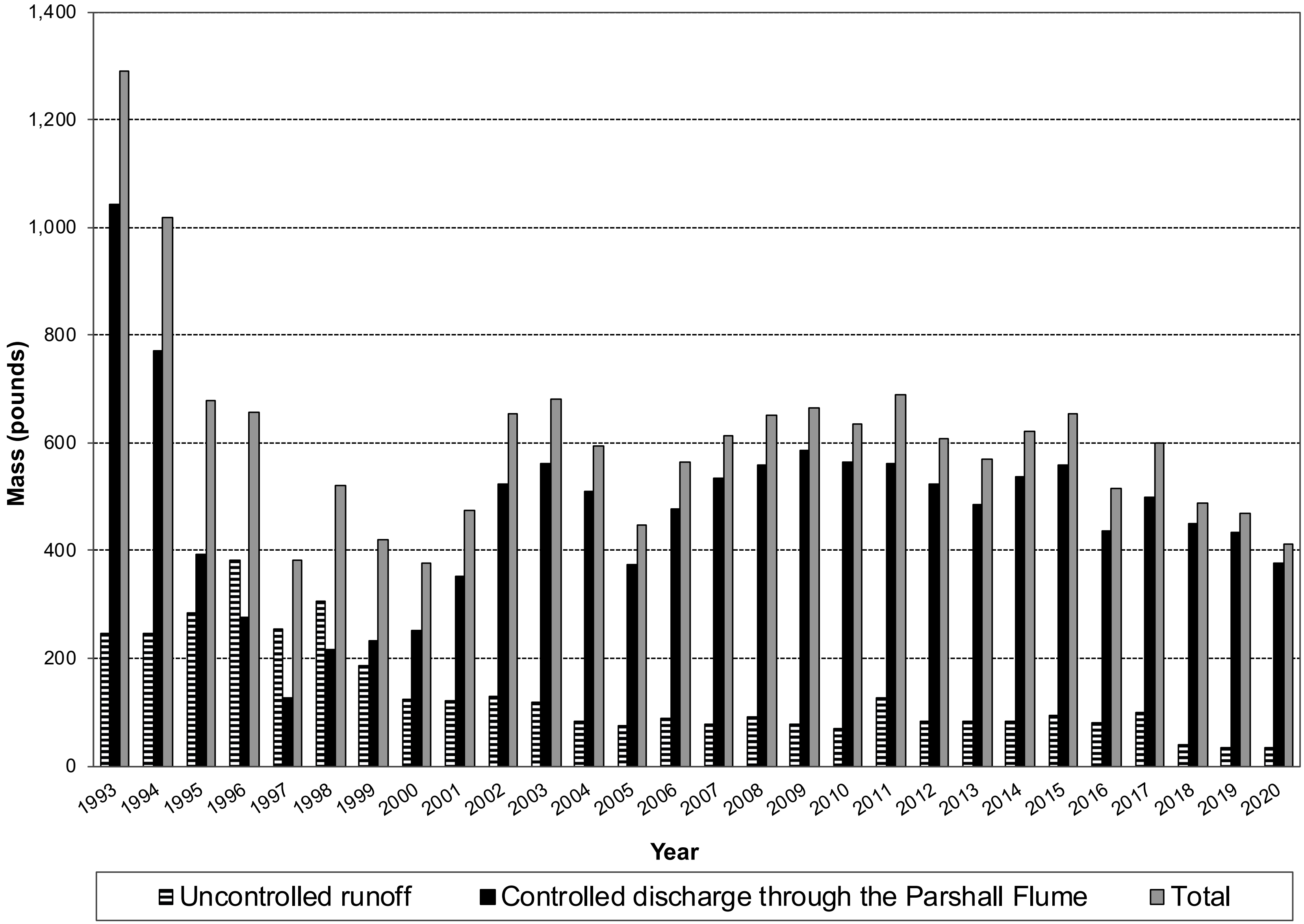



*Figure 26. Uranium Discharged via the Surface Water Pathway, 1993−2020*


Page 71

This page intentionally left blank

# 5.0 Natural Resources

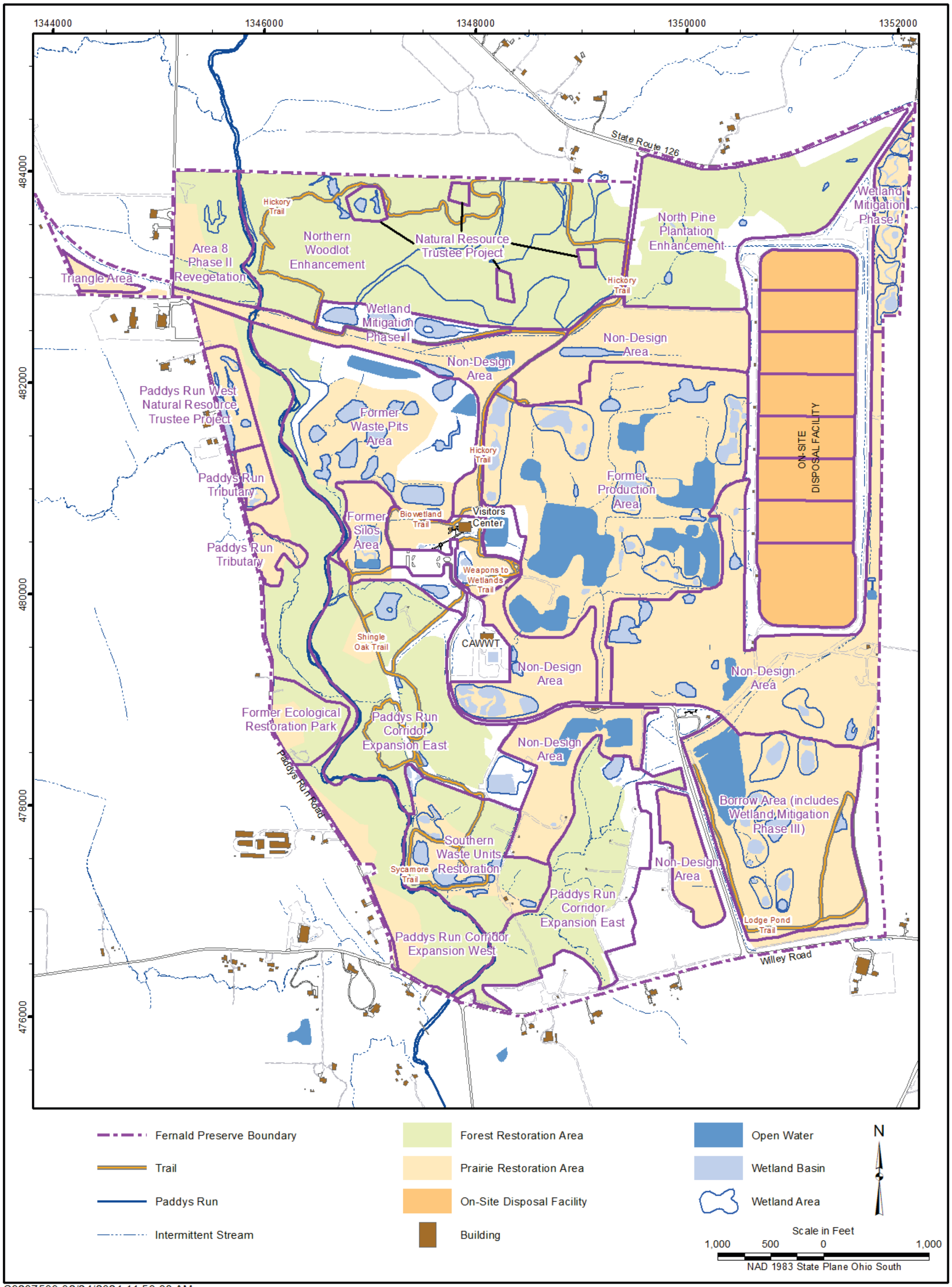
> **Results in Brief: Ecological Monitoring Activities**
>
> **Functional Monitoring**
>
> - Wetlands, prairies, and forests were surveyed across the southern and eastern portions of the site. Goals were met for all plant communities. Results show that as the site matures, wetlands in perimeter areas are improving while wetlands within previously disturbed areas are declining. Beaver activities continue to impact site wetlands as well. All areas are improving due to continued control of invasive plant species.
>
> **Wetland Mitigation Monitoring**
>
> - Amphibian monitoring results showed that salamander habitat is maintained across created wetlands located near existing forests in the northern portions of the site as well as the Paddys Run tributary area on the western edge of the property. Beavers have increased open water and forested wetlands across the project area, so the chance of capturing amphibians within the traps is reduced.
> - Hydrologic monitoring (wetland water elevations) demonstrated patterns similar to those of previous years. Monitoring was limited to three areas on the west side of the site in 2020.
>
> **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 herbaceous plants and woody vegetation on the cap and near the OSDF, as well as the need for repair of deer exclosure fencing. Debris continues to be found, mostly in the Former Production Area and the former Waste Storage Area.

This section provides background information on the natural resources associated with the Fernald Preserve and summarizes the activities in 2020 relating to these resources. Included in this section is a discussion of the following:

- Ecological restoration activities
- Site and OSDF inspections
- Affected habitat areas
- Threatened and endangered species
- Cultural resources

Much of the 1,050 acres of the Fernald Preserve property is currently 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 of the site have undergone ecological restoration. Figure 27 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 5.4. Cultural resources such as prehistoric archaeological sites have also been surveyed. The Fernald Preserve's mission of long-term stewardship under LM includes establishing, managing, and monitoring ecologically restored areas across the site.

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 2019). 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 is also addressed. Restoration monitoring has been ongoing following an expanded approach in 2009, when 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 part of the settlement, the Fernald Natural Resource Trustees (DOE, Ohio EPA, and the U.S. Department of Interior) 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 ecological monitoring program for restored areas at the site. This includes an enhanced wetland mitigation monitoring program and a functional monitoring program that evaluates restored communities. An implementation monitoring program is also in place and is used to determine whether revegetation efforts are successful following construction activities.




S3237500 02/24/2021 11:53:38 AM

*Figure 27. Restoration Project Areas*

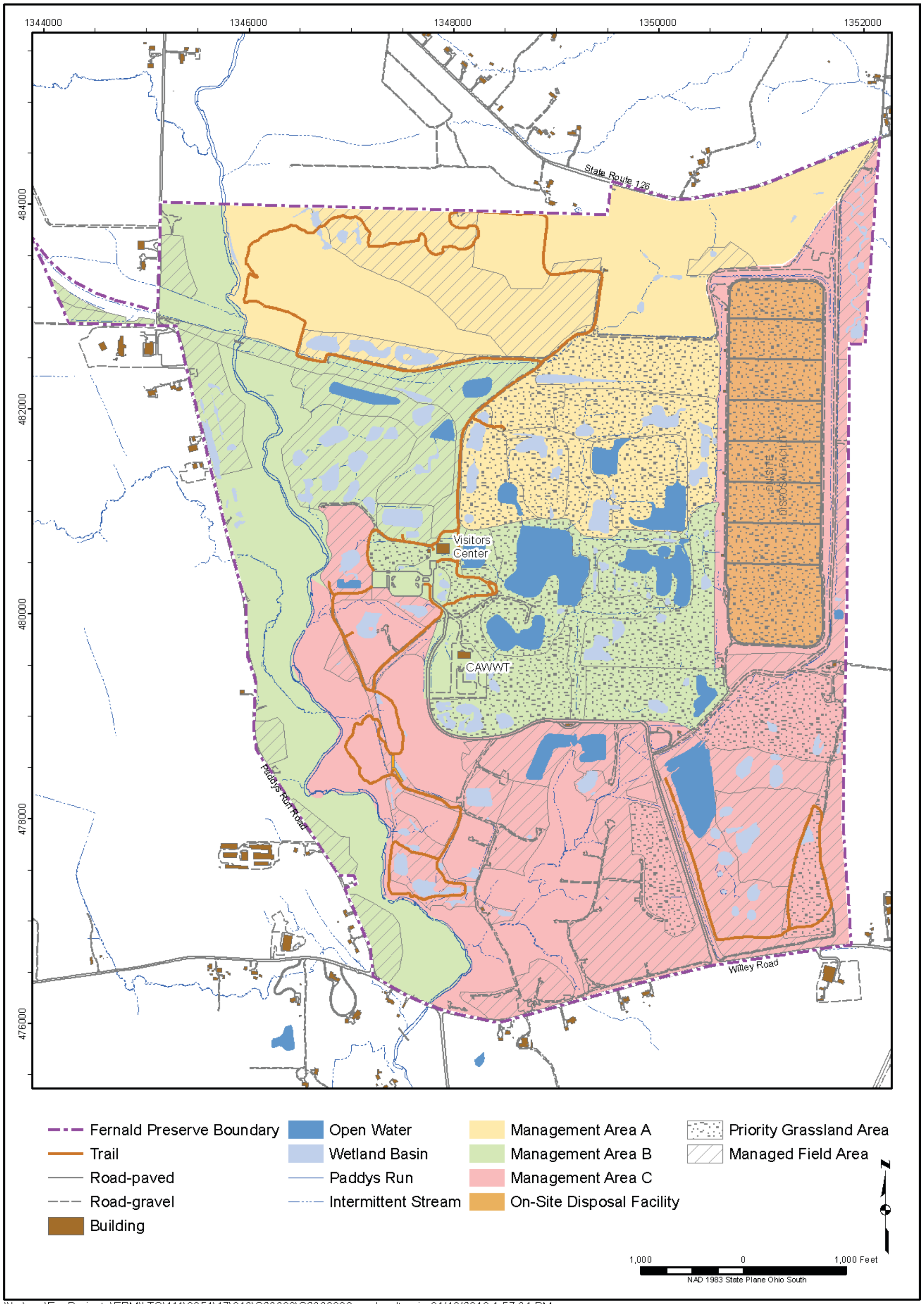
Ecological monitoring in 2020 focused on functional monitoring of wetland, prairie, and forest communities in Management Area C, which includes the southern and eastern portions of the site (Figure 28). Because no restored area projects occurred in 2020, implementation monitoring of restored areas was not necessary. The site and OSDF inspection process also continued in 2020, as specified in the LMICP.

The NRRP also specifies creation of a Restored Area Maintenance Plan (RAMP). This document details the approach for managing ecologically restored areas across the site. The RAMP includes provisions for planting and seeding, control of invasive species, management of wetland water levels, erosion control, nuisance animal control, and maintenance of public amenities (DOE 2012b). Field personnel use this plan as a basis for management of restored areas described in the annual Site Environmental Report.

The NRRP requires that the RAMP be reviewed after 10 years of implementation. DOE, along with the other Natural Resource Trustees, conducted this review in 2020, which resulted in the development of the *Fernald Preserve Natural Resource Management Plan* (NRMP). The NRMP outlines the management and evaluation approach for ecologically restored areas, including revised ecological monitoring methods. A ten-year review of ecological monitoring results has shown that restored communities have for the most part been successfully established across the site. The monitoring approach in the NRMP shifts the focus from project-specific to community-based evaluations. These results will be used to help manage restored areas in future years. The Management Area designations shown in Figure 28 will be replaced with habitat-based restoration areas in 2021.

## 5.1 Ecological Restoration Activities

Maintenance in ecologically restored areas included mowing; repair of deer exclosure fence; and control of invasive plants, shrubs, and trees in both prairie and forested areas. Field activities were suspended in the spring in response to the COVID-19 pandemic. Because of this, a planned spring prescribed burn of the OSDF did not occur in 2020. Figure 29 shows the location of 2020 restoration projects and maintenance activities, which are discussed in the following sections.



\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\013\S23366\S2336600.mxd waltersjo 01/16/2019 1:57:31 PM

*Figure 28. Ecological Restoration Management Areas*

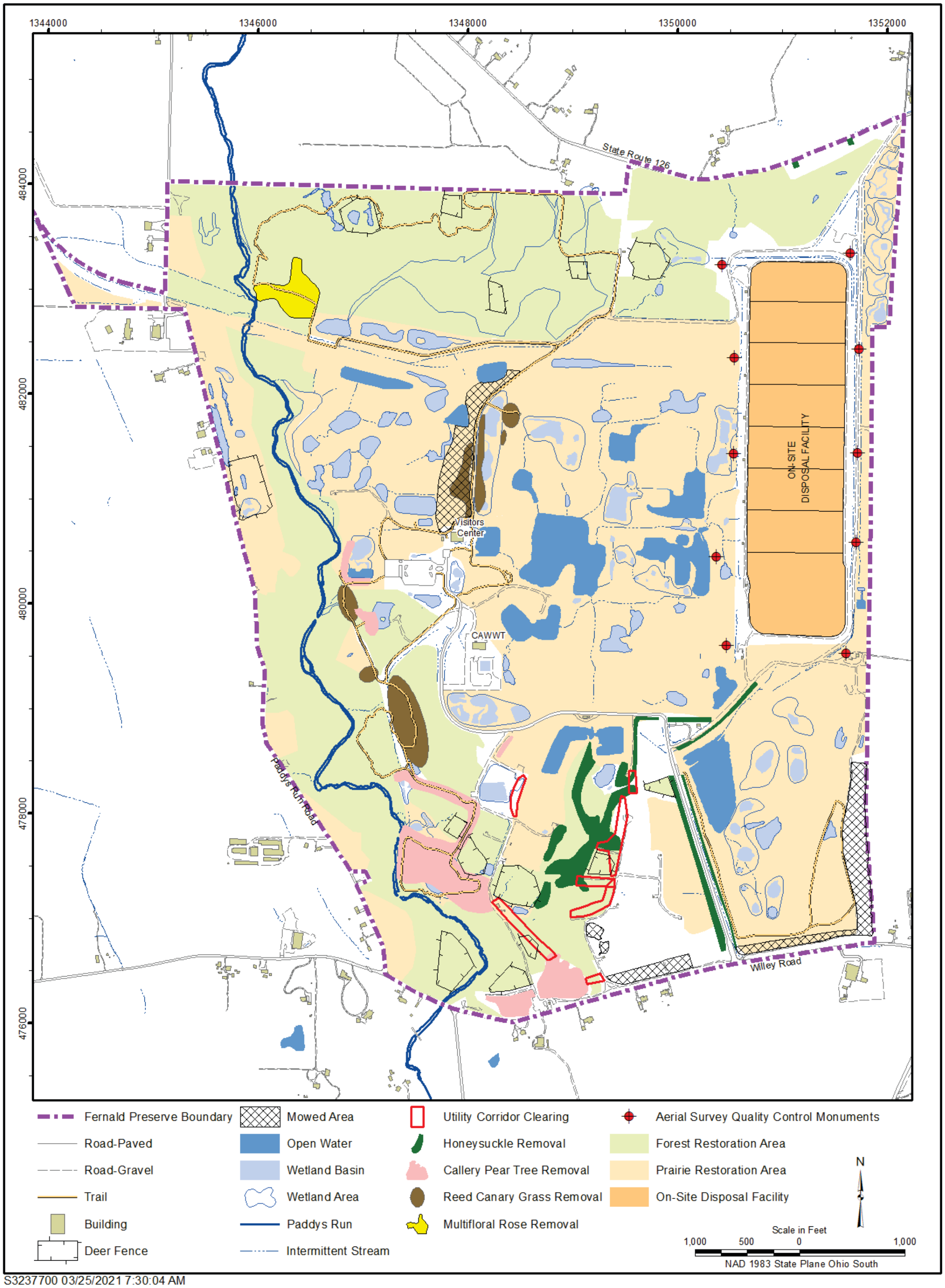



*Figure 29. 2020 Ecological Restoration Projects and Maintenance Activities*

### 5.1.1 Ecological Restoration Projects

In December, on-property utility corridors were cleared of trees and shrubs that were a potential hazard to overhead power and communication lines (Figure 29). Approximately 6 acres were cleared. Most of the vegetation removed was either dead or nonnative species such as callery pear and honeysuckle. This work was conducted in the winter, outside of bat breeding season, in order to avoid potential impacts to the federally endangered Indiana bat.

### 5.1.2 Restored Area Maintenance and Repair

The focus of 2020 restored area maintenance was vegetation management and follow-up on inspection findings. Prescribed burns were cancelled in response to the COVID-19 pandemic. All restoration-related fieldwork was suspended from late March to late May, so early-season spot herbicide and nuisance animal control was not possible during that time. Upon return to field activities in late May, field personnel focused on invasive species control, targeting reed canarygrass, callery pear, and multiflora rose (Figure 29). A total of 34 acres were addressed in 2020.

Spot spraying with herbicide to control other noxious and invasive weeds in restored areas resumed in Summer 2020 as well. Invasive woody vegetation continued to be physically removed or treated with herbicide across the site and on the OSDF cap. Trees and shrubs must not become established on the OSDF cap, so they are removed or treated with herbicide once discovered.

Fall foliar herbicide application to control Amur honeysuckle (*Lonicera maackii*) continued in 2020. Dense infestations of honeysuckle will crowd out native species, prevent sunlight from reaching the ground, and prevent seedling development of desirable vegetation. Field personnel began a fall foliar herbicide application program for Amur honeysuckle in 2015. A characteristic of honeysuckle is that it does not go dormant until several weeks after most other vegetation. Timing herbicide application after nearby plants have gone dormant in the fall allows the use of herbicide to treat honeysuckle while avoiding harm to surrounding vegetation. This technique is widely used and has proven to be an effective means of control. Approximately 14 acres of honeysuckle were treated with herbicide in fall 2020 (Figure 29). A significant portion of the honeysuckle treatment in 2020 was accomplished by cutting the honeysuckle near ground level and applying herbicide to the cut stump in late fall and early winter.

Additional 2020 maintenance activities included follow-up from site and OSDF inspections, including sign and fence repair and debris removal. Appendix C includes summary tables and maps that show the location of specific inspection findings.

There is a resident population of Canada geese at the Fernald Preserve. Canada geese are considered nuisance animals because of their potential for aggression to humans. However, due to establishment of vegetation and an increase in natural predators, there has not been a population growth, and goose hazing (i.e., scaring and harassing) has not been needed since 2014. Site personnel continue to monitor the Canada goose population each year. The site applies for an ODNR permit to remove nests or addle eggs annually, if necessary.

The mute swan is non-native, invasive, and considered a nuisance species by the ODNR; therefore, ODNR grants permission to addle the eggs of the mute swans. No formal permit is required. Reduced site staffing in response to the COVID-19 pandemic prevented Fernald Preserve staff from monitoring nesting activities and addling eggs in 2020 which resulted in several mute swans observed onsite. DOE is discussing options for additional control by ODNR, consistent with their statewide mute swan management plan.

### 5.1.3 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 plant 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 updated *Ohio Vascular Plant Database* is used to determine whether a species is native (Gara 2013).
> - **Percent Native Species**: The number of native species divided by 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) by 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, as well as its habitat requirements. Nonnative 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 7–10 range. The updated *Ohio Vascular Plant Database* (Gara 2013) 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.
> - **Vegetation Index of Biotic Integrity "Floristic Quality" (VIBI-FQ):** A scoring system for wetland habitats that is based on the diversity and quality of wetland vegetation.

Monitoring of restored areas consists of 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 plant mortality counts and herbaceous cover estimates that are conducted after a restoration project is completed. The NRRP states the goals for vegetation establishment of 50% native species and 90% total cover. For woody vegetation, the goal is 80% survival (State of Ohio 2008). No implementation monitoring data collection was needed in 2020.

Functional-phase monitoring is more general and considers projects in terms of their contribution to the whole ecological community. This is accomplished by comparing projects to pre-remediation baseline conditions and to ideal off-property reference sites. The NRRP, which was finalized in 2008 (State of Ohio 2008), reinstituted the use of functional-phase monitoring as a means of evaluating restored communities. Functional monitoring in 2020 focused on prairie, wetland, and forest communities in Management Area C, the southern and eastern portions of the site (Figure 30). As stated in Section 5.0, monitoring of ecological restoration areas was reviewed and updated as part of the 2020 RAMP revision. A new methodology for ecological monitoring at the Fernald Preserve is presented in the NRMP and will begin in 2021.

Additional wetland monitoring was further specified in the *Fernald Preserve Wetland Mitigation Monitoring Report* (DOE 2012c). Most wetland mitigation monitoring activities were completed in 2011. However, annual amphibian monitoring continued in 2020. Collection of hydrologic (wetland water elevation) data using piezometers also continued in 2020 within the Paddys Run

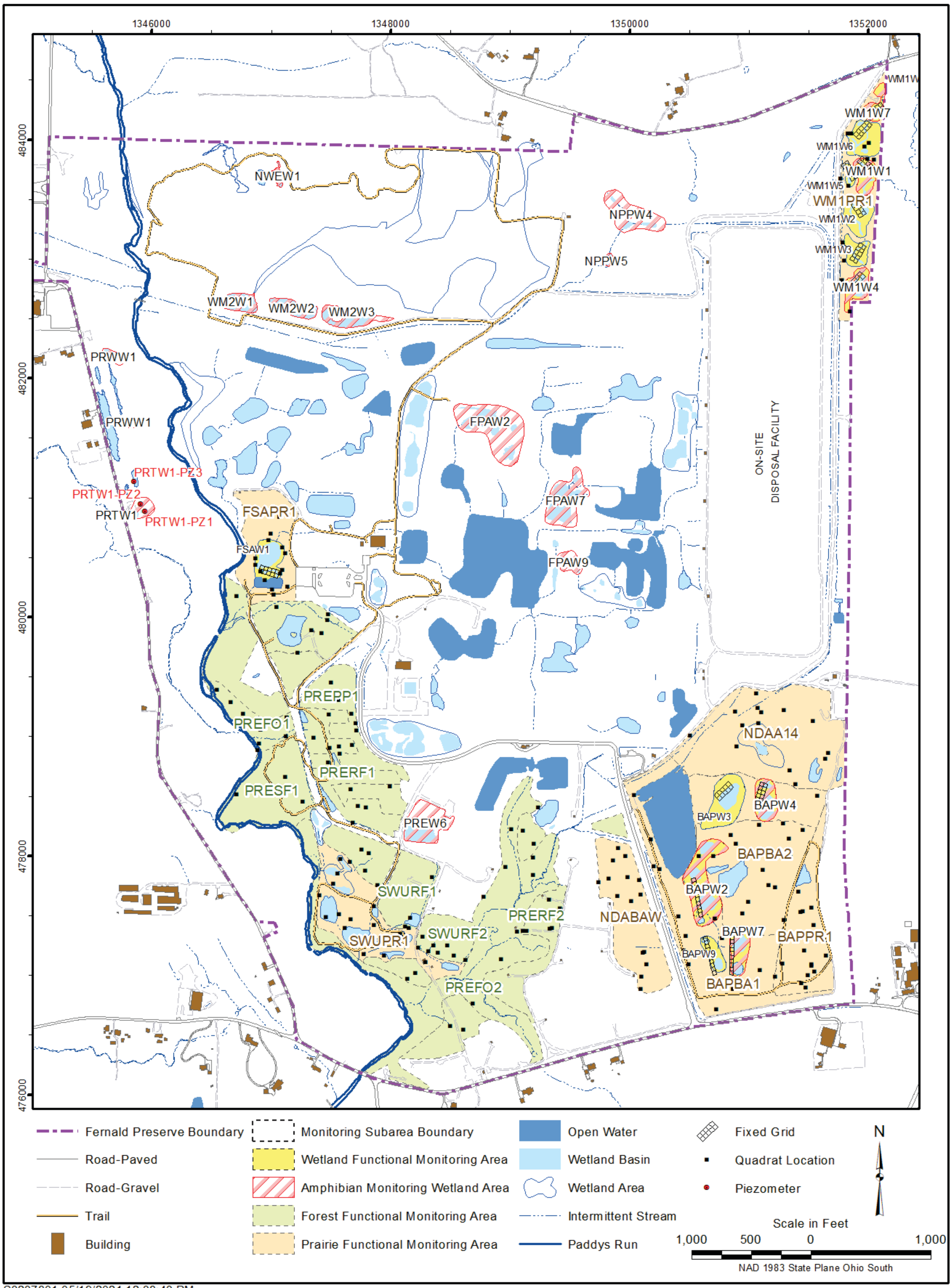
Tributary restoration project area. Figure 30 shows the amphibian monitoring wetland areas and the piezometers monitored for hydrologic data in 2020.

#### *5.1.3.1 Functional Monitoring*

Functional monitoring compares restored communities to prerestoration "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. The same 3-year rotation resumed in 2009 and continued through 2014. In 2015, monitoring efforts shifted from sitewide community types to an area-based approach on a 3-year basis. Figure 30 shows the 2020 wetland, prairie, and forest functional monitoring areas under the area-based approach. The 2020 monitoring activities completed two full cycles (A-B-C-A-B-C) of the area-based monitoring approach. Appendix C provides a more detailed discussion regarding ecological monitoring results, including the use of Floristic Quality Assessment Index (FQAI) and Vegetation Index of Biotic Integrity "Floristic Quality" (VIBI-FQ) to assess the condition of restored areas.

The 2020 wetland functional monitoring results indicate that native vegetation is fully established across all the wetland areas monitored, with the percentage of native species well above the goal of 50% in all basins. Percentage of relative cover of native species was above the goal of 50% in all basins monitored in 2020, except for one basin in the Wetland Mitigation Phase I wetlands. The Wetland Mitigation Phase I wetlands were the first mitigated wetlands at the Fernald Preserve. This wetland, consisting of a complex of basins, swales, and uplands, appears to be reaching a plateau in its development. The Borrow Area, the first highly disturbed area to be converted to wetlands, is continuing to mature slowly. There also may be a correlation between beaver activity and the improvements in this large basin. Invasive species continue to negatively impact some wetland areas. This is demonstrated by the monitoring results for the former Silos Area, as teasel species (*Dispacus sp*) have become more widespread across that area. Additional wetland mitigation monitoring activities are discussed in Section 5.1.3.2 and Appendix C.

The 2020 prairie functional monitoring results indicate that native vegetation has been established, goals have been mostly met, and prairie areas continue to be much improved over baseline conditions in the surveyed areas. There was little change in the metrics for the areas monitored in 2020. The long-term plan for the Borrow Area, former Silos Area, and Southern Waste Units is for conversion to forest over time. The Non-Design Areas will be maintained as prairie. The upland prairie areas of the Wetland Mitigation Phase I Area are becoming a successional area, converting to forest. The 2020 functional monitoring data indicate that invasive species, particularly teasel species, continue to impact the prairie areas. Spot herbicide treatment will continue in an effort to eliminate these invasive competitors.




S3237801 05/19/2021 12:38:43 PM

*Figure 30. 2020 Ecological Monitoring Activities*

This page intentionally left blank

The 2020 forest functional monitoring results also show that restoration goals have been met in the surveyed communities. While goals have been met, there was an impact to the metric values for some areas that resulted from a missed round of monitoring. The 2020 first round of forest herbaceous monitoring could not be conducted because of reduced site activities in response to the COVID-19 pandemic. Many species of native ephemeral wildflowers are typically encountered in the first round of monitoring. Nevertheless, several notable herbaceous species were identified during forest monitoring in 2020, including wild ginger (*Asarum canadense*), southern adder's-tongue (*Ophioglossum vulgatum),* and woodland sedge species (*Carex digitalis and Cares ablicans*). Several high-quality native trees were also observed, such as blue ash (*Fraxinus quadrangulata*), American beech (*Fagus grandifolia*), butternut (*Juglans cinerea*), mockernut hickory (*Carya tomentosa*), and shellbark hickory (*Carya laciniosa*). More information is provided in Appendix C.

Woody vegetation monitoring indicates that invasive Amur honeysuckle is an ongoing concern, but there is evidence that the fall foliar herbicide application is working to reduce density of honeysuckle in monitored areas. DOE will continue to clear honeysuckle and other invasive vegetation as part of restored area maintenance.

By the end of 2020, 6 years of "area-based" monitoring had taken place, which represents two rounds of annual surveys across the site. As stated in Section 5.0, the Fernald Natural Resource Trustees reviewed the ecological monitoring program as part of the 2020 RAMP update. An alternative approach to evaluation and monitoring of restored plant communities has been proposed for 2021. The new methodology will be a floristic inventory for a specific habitat type within all monitoring areas.

#### *5.1.3.2 Wetland Mitigation Monitoring*

Pursuant to the *Fernald Preserve Wetland Mitigation Monitoring Report* (DOE 2012c), limited wetland monitoring continued in 2020. Activities included amphibian surveys to calculate Amphibian Index of Biotic Integrity (AIBI) across the site and hydrologic monitoring using shallow wells (piezometers) at three locations.

In the spring of 2020, amphibian monitoring was conducted using funnel traps in selected basins within mitigation wetlands (Figure 30). Only two rounds of amphibian monitoring were completed. The first was in February and early March, and the second was in late May and early June. Typically, another round of monitoring would have been completed in April. As with other field activities in Spring 2020, the April round could not be completed because of the response to the COVID-19 pandemic. Despite the missed round of monitoring, the 2020 results were similar to those of previous years. Ambystomatid salamanders, also known as mole salamanders, continued to be observed in northern wetlands across the site and in the more recent wetland construction projects along Paddys Run Road. Mole salamanders are key indicators of high-quality wetlands. The site's highest scoring wetland, according to Ohio EPA's AIBI scoring method, has maintained its superior wetland habitat status. Appendix C provides additional details.

In 2020, hydrologic monitoring at the Fernald Preserve was limited to the three piezometers installed at the Paddys Run Tributary project in 2012. The two piezometers that recorded complete datasets throughout the year showed a pattern similar to that of previous 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. The results are compared to the performance standards established in the *Fernald Preserve Wetland Mitigation Monitoring Plan* (DOE 2009). Monitoring will continue at the three piezometers in 2021. Additional discussion regarding the status of hydrologic monitoring is provided in Appendix C.

## 5.2 Fernald Preserve Site, OSDF, and Trail Inspections

The LMICP describes the routine inspection process for both the site and the OSDF. Inspections are conducted quarterly with joint participation from the regulators. Inspections document evidence of unauthorized uses of the site, the effectiveness of institutional controls, and any need for repairs. Inspections are conducted in several phases. Quarterly inspections focus on signs, fencing, gates, site access points, etc. Field walkdowns take place in the winter months when less vegetation is dormant, optimizing visibility of site conditions and allowing for easier access to some areas. Ecologically restored areas are evaluated for the presence of noxious weeds, erosion, condition of vegetation, presence of potentially contaminated debris, and signs of damage from nuisance animals. Quarterly inspection reports are posted on the LM public website at https://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 the site at (513) 648-3330. Appendix C presents inspection findings from all 2020 quarterly site and OSDF inspections. In addition to quarterly inspections, the public trails and overlooks are inspected weekly to ensure that they are safe and usable.

Ohio EPA and other regulators are invited to participate in OSDF and site inspections. Like so many others, regulators were affected by the COVID-19 pandemic, with greatly reduced ability to participate in field activities. DOE worked with Ohio EPA to implement their virtual inspection process, where field personnel provided livestream video for Ohio EPA to participate in inspections remotely. Ohio Department of Health was also invited to participate in virtual inspections.

### 5.2.1 Site Inspections

As with recent years, site inspection findings in 2020 consisted mostly of the presence of noxious and invasive weeds and deer exclosure fencing that was damaged by fallen trees and limbs. The presence of individual tree cages that are no longer protecting vegetation was also a regular finding.

Site inspections were also affected by the COVID-19 pandemic. The last of four annual field walkdowns across the eastern portion of the site was not able to be conducted in March as originally planned. The walkdown was completed in June once field activities resumed, and results were presented in the June 2020 inspection report.

Debris continues to be found, primarily in the Former Production Area and former Waste Pits Area. During remediation and restoration of the Fernald Preserve, every effort was made to remove and dispose of all debris. However, weather, erosion, and earth-moving activities occasionally reveal small pieces of debris that were not visible during remediation and restoration efforts. Examples of debris include pieces of concrete, rebar, clay tile, asphalt, and metal. Debris is discovered during site inspections and construction activities and by personnel during field activities. In 2020, 242 pieces of debris were discovered. Radiological surveys of all debris found one piece had fixed radiological contamination above background levels. This debris was removed from the field and properly disposed. More information regarding debris and other inspection findings is provided in Appendix C.

### 5.2.2 OSDF Inspections

For inspections of the OSDF, inspectors perform a quarterly walkdown of the perimeter and toe, and an annual walkdown and evaluation of the vegetated cap to verify its integrity. Trees, shrubs, 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 2020, 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. As mentioned earlier, prescribed burns planned for spring 2020 were cancelled in response to the COVID-19 pandemic, but prescribed burns in previous years exposed tree and shrub seedlings, allowing field personnel to cut the woody vegetation and treat the stumps with herbicide. The December 2019 complete cap walkover revealed that this method of woody vegetation control is effective.

### 5.2.3 Trail Inspections

Weekly trail inspections continued in 2020 and there were no significant findings. The Hickory Trail repairs completed in 2019 were stable and functioning as intended.

## 5.3 Affected Habitat Findings

The potential for unanticipated habitat impacts is low, but they can occur during construction or site maintenance activities. The restoration projects described in Section 5.1.1 resulted in minimal impacts. Disturbance around the aerial survey monuments that were installed in 2020 was limited to the immediate area, and all areas were reseeded once construction was complete. The utility corridor project resulted in the clearing of approximately 6 acres of land (Figure 29). As stated above, much of the vegetation removed was nonnative invasives.

Beavers continued to be very active at the site in 2020, resulting in changes to water elevations and vegetation in several wetlands and ponds. An increase in the site beaver population has been observed for the last several years. Beavers are native, and their presence is evidence of continued development of restored plant communities. However, they may alter the landscape by impeding drainages, raising water levels in wetlands, flooding upland areas, and clearing trees. These naturally occurring changes are expected to continue in the future.

## 5.4 Threatened and Endangered Species and Species Inventories

**Potential Threatened and Endangered Species at the Fernald Preserve**

**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.

**Northern Long-Eared Bat:** The federally threatened northern long-eared bat (*Myotis septentrionalis*) will roost singly or in colonies in the summer using either live trees with loose bark or dead hollow trees (snags). The Fernald Preserve has been recognized as potential summer roosting habitat for the northern long-eared bat. Although no captures have been recorded at the preserve, a variety of live and dead trees and water sources in the preserve may provide ideal habitat within the known range of this species.

**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 Enhancement area.

**Cave Salamander:** The state-endangered cave salamander (*Eurycea lucifuga*) is slender and red to orange in color 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 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. Burying beetles will clean and protect the body, which serves as a food source for their larvae. The Fernald Preserve is within its historical range, but current established populations are limited to Rhode Island and Oklahoma. Recovery efforts have been ongoing in Ohio since 1998. The American burying beetle was down-listed from endangered to threatened in November 2020.

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 on the property. In addition, suitable habitat exists for the federally endangered running buffalo clover and northern long-eared bat, the state-threatened spring coral root, and the state-endangered cave salamander. With the exception of an Indiana bat, none of these species have been found on the site, but their habitat ranges encompass the Fernald Preserve. Figure 31 shows the potential habitats for these species. According to LMICP (DOE 2019), 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. Field walkdowns for running buffalo clover took place prior to the survey monument installation, with no individuals found.

In 2012, the Fernald Preserve was identified as a candidate for introduction of the American burying beetle (*Nicrophorus americanus*). DOE signed a five-year 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. In 2017, the parties signed a new agreement to continue releases at the Fernald Preserve through 2022 (DOE 2017). This effort is part of the recovery plan for the beetle, which involves release and monitoring of beetles raised at the Cincinnati Zoo. The first documented case of a beetle released at Fernald surviving through the winter occurred in spring 2019. In 2020, due to the COVID-19 pandemic, no beetles were released at the Fernald Preserve. One week of monitoring did take place, similar to the prerelease monitoring that would typically occur. No American burying beetles were identified.

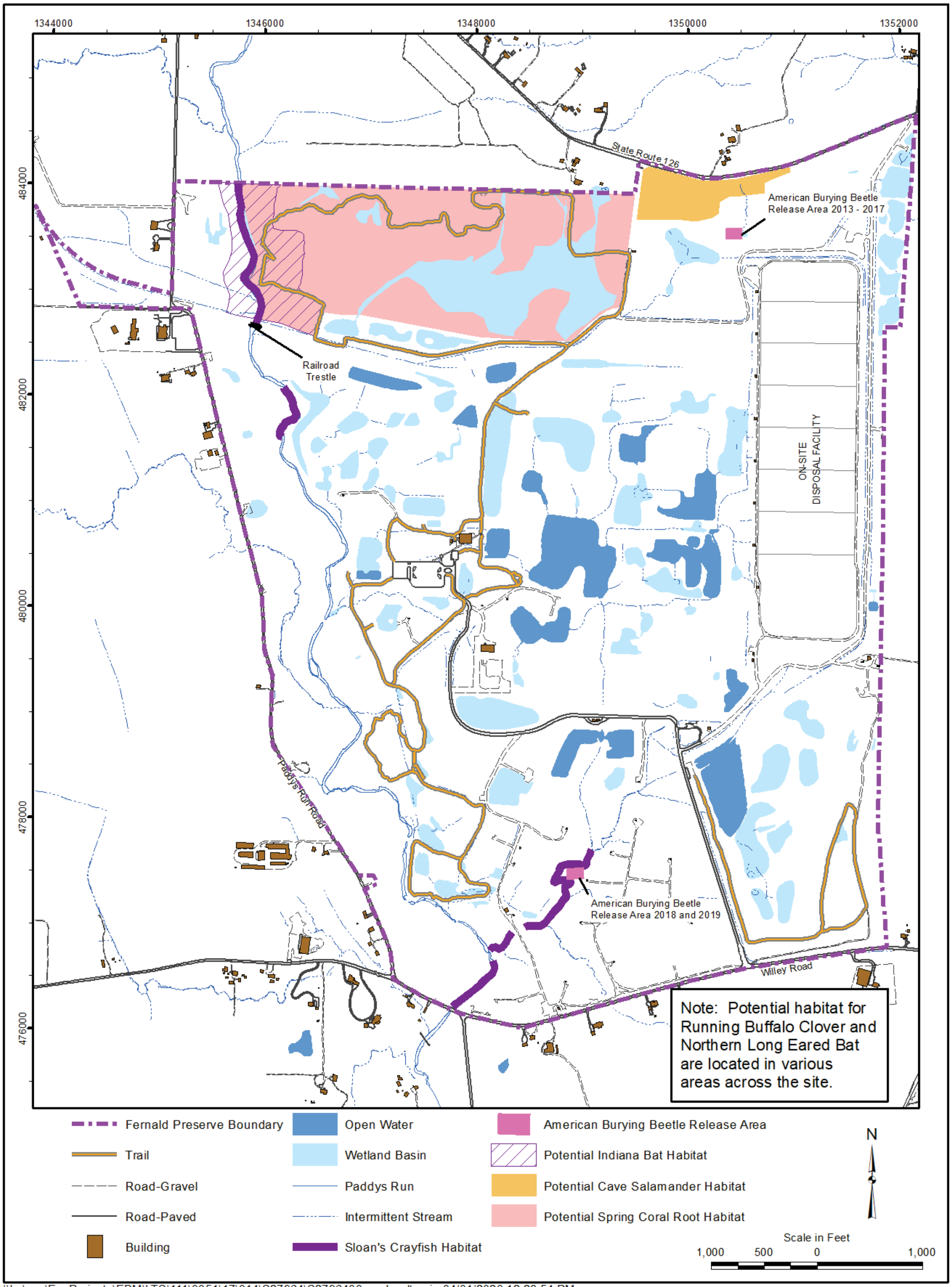
## 5.5 Cultural Resources

The Fernald Preserve and surrounding area are 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. At a minimum, 148 prehistoric and 40 historic sites have been identified within 1.2 miles 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 (Title 43 *Code of Federal Regulations* Section 10 [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 between DOE and the Ohio State Historic Preservation Office (DOE 2012d), which was updated in 2012.

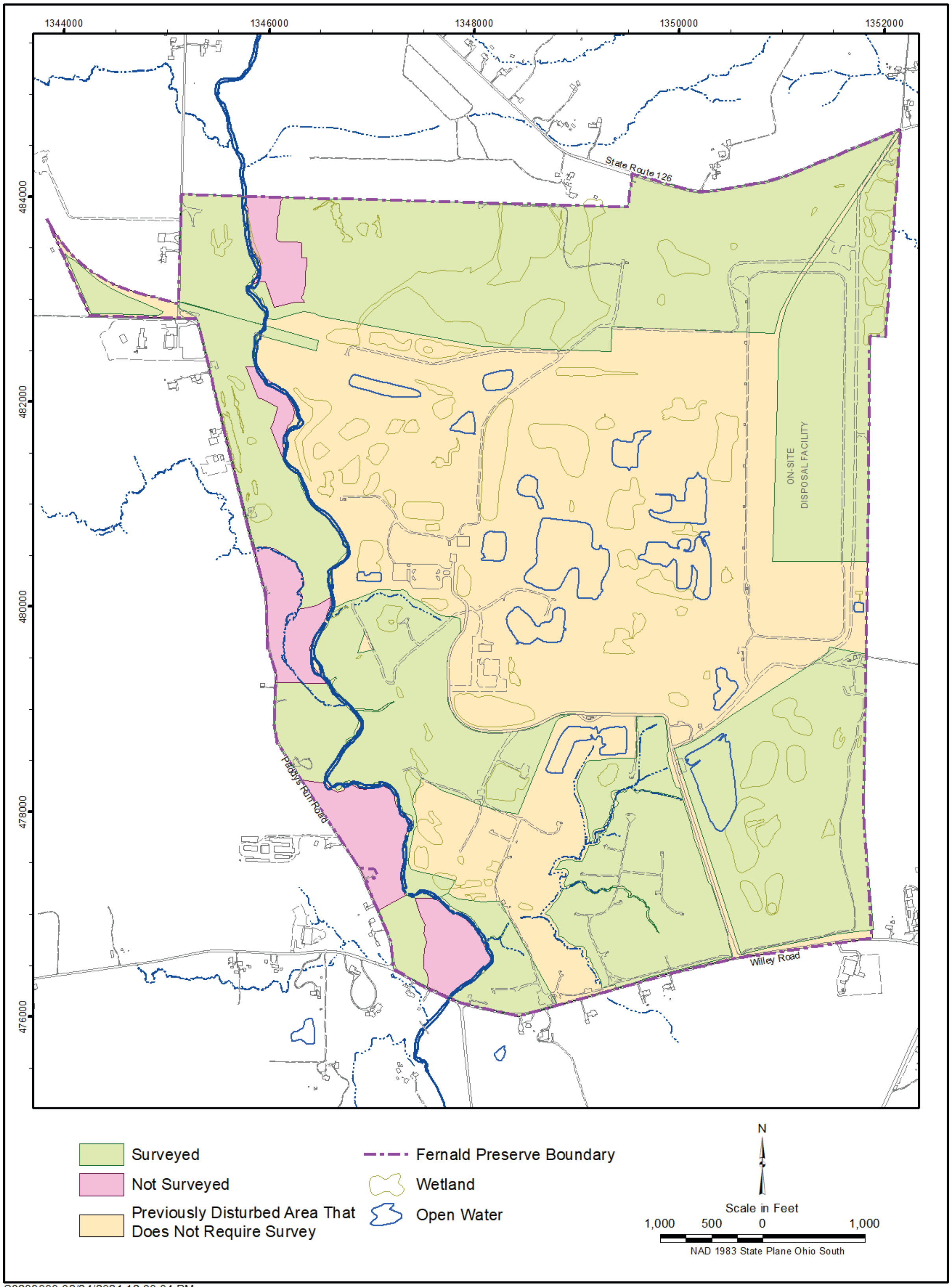
To comply with these laws and the Programmatic Agreement, DOE conducted archaeological surveys prior to remediation activities in undeveloped areas of the Fernald Preserve. Figure 32 shows the areas of the Fernald Preserve that have been surveyed. These surveys have resulted in the identification of five sites that may be eligible for listing on the National Register of Historic Places. None of these sites were affected by construction activities in 2020.

No archaeological surveys were conducted in 2020, and no unexpected discoveries were encountered during field activities. All ground-disturbing activities took place in previously disturbed or surveyed areas.




\\lm\ess\EnvProjects\EBM\LTS\111\0051\17\014\S27964\S2796400.mxd waltersjo 04/01/2020 12:28:54 PM

*Figure 31. Threatened and Endangered Species Habitat Areas*




S3238000 02/24/2021 12:30:04 PM

*Figure 32. Cultural Resource Survey Areas*

This page intentionally left blank

# 6.0 References

15 USC 2601 et seq. "Toxic Substances Control Act," as amended, *United States Code*.

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

42 USC 6901 et seq. "Resource Conservation and Recovery Act," as amended, *United States Code*.

42 USC 7401 et seq. "Clean Air Act," as amended, *United States Code*.

42 USC 9601 et seq. "Comprehensive Environmental Response, Compensation, and Liability Act of 1980," as amended, *United States Code*.

43 CFR 10. "Native American Graves Protection and Repatriation Act," *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 EPA, Division of Surface Water, Wetland Ecology Group, Columbus, Ohio.

*Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, continually updated, prepared by the LMS contractor for the U.S. Department of Energy Office of Legacy Management.

Deutsch, W.J. 1997. *Groundwater Geochemistry: Fundamentals and Applications to Contamination*, CRC Press, Boca Raton, Florida.

DOE (U.S. Department of Energy), 1994. *Characterization of Background Water Quality for Streams and Groundwater*, Fernald Environmental Management Project, Fernald Area Office, Cincinnati, Ohio, May.

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), 1996a. *Phase VII Removal Actions and Reporting Requirements Under the Fernald Environmental Monitoring Project Legal Agreements,* letter DOE-0395-96 from Johnny Reising, DOE, to James A. Saric, EPA, and Tom Schneider, Ohio EPA, dated January 16, 1996.

DOE (U.S. Department of Energy), 1996b. *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* (Fernald Environmental Management Project), Fernald Area Office, Cincinnati, Ohio, May.

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

DOE (U.S. Department of Energy), 2002. *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, 51900-RP-0001, Cincinnati, Ohio, June 30.

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*, 52460-RP-0001, Fernald Area Office, Cincinnati, Ohio.

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

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

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

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), 2009. *Fernald Preserve Wetland Mitigation Monitoring Plan*, LMS/FER/S05034, Office of Legacy Management, Cincinnati, Ohio, October.

DOE (U.S. Department of Energy), 2011. *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. *Fernald Preserve, Ohio Restored Area Maintenance Plan,* LMS/FER/S05080, Office of Legacy Management, Cincinnati, Ohio, January.

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), 2012d. *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), 2014. *Operational Design Adjustments-1, WSA Phase-II Groundwater Remediation Design, Fernald Preserve*, LMS/FER/S10798, Office of Legacy Management, Cincinnati, Ohio, March.

DOE (U.S. Department of Energy), 2016a. *Fernald Preserve 2015 Site Environmental Report,* LMS/FER/S13591, Office of Legacy Management, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2016b. *Fourth Five-Year Review Report for the Fernald Preserve*, LMS/FER/S13683, Office of Legacy Management, Cincinnati Ohio, September.

DOE (U.S. Department of Energy), 2016c. *Draft Perfluorinated Compound Groundwater Screening Sampling and Analysis Plan,* LMS/FER/S15292, Office of Legacy Management, Cincinnati, Ohio, December.

DOE (U.S. Department of Energy), 2017. *Memorandum of Agreement to Facilitate Recovery of the American Burying Beetle in Ohio*, signed by Dan Everson, Field Supervisor, U.S. Fish and Wildlife Service; Susan Smiley, Fernald Preserve Site Manager, Office of Legacy Management; and Winton Ray, Curator of Invertebrates, Aquatic Animals and Birds, Cincinnati Zoo & Botanical Garden, October.

DOE (U.S. Department of Energy), 2018a. *Fernald Preserve 2017 Site Environmental Report*, LMS/FER/S13983, Office of Legacy Management, Cincinnati, Ohio, May.

DOE (U.S. Department of Energy), 2018b. *Draft Perfluorinated Alkyl Substances (PFASs) Investigation Plan for the Fernald Preserve,* LMS/FER/S18662, Office of Legacy Management, Cincinnati, Ohio, March.

DOE (U.S. Department of Energy), 2019. *Comprehensive Legacy Management and Institutional Controls Plan*, LMS/FER/S03496, Revision 12, 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.

EPA (U.S. Environmental Protection Agency), 2019. *Interim Recommendations to Address Groundwater Contaminated with Perfluoroctanoic Acid and Perfluorooctanesulfonate*, OLEM Directive 9283.1-47, Office of Land and Emergency Management, December.

Executive Order 12580. *Superfund Implementation,* January 23, 1987.

Gara, B., 2013. *The Vegetation Index of Biotic Integrity "Floristic Quality" (VIBI-FQ)*, Ohio EPA Technical Report WET/2013-2, Ohio EPA, Wetlands Ecology Group, Division of Surface Water, Columbus, Ohio.

Ricker, J.A., 2008. "A Practical Method to Evaluate Ground Water Contaminant Plume Stability," *Groundwater Monitoring and Remediation* 28(4):85–94.

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.

Whitman, Requardt & Associates LLP, 2015. *Fernald Preserve Site Converted Advanced Wastewater Treatment Current Condition Assessment Report*, Final, March.

# 7.0 Glossary

***Amphibian Index of Biotic Integrity (AIBI)*:** A scoring system that uses amphibians as a means of assessing the quality of wetland communities.

***applicable or relevant and appropriate requirements (ARARs)*:** Requirements set forth in regulations that implement environmental and public health laws that a selected remedy must attain 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.

***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.

***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 total 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 FRLs established in the OU5 ROD. Not all soil remediation areas at the Fernald Preserve 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.

***crossvane:*** A U-shaped structure of boulders built across a stream channel to reduce water velocity and energy along the streambank.

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

***Floristic Quality Assessment Index (FQAI)*:** A method of evaluating an ecosystem based on the type and quality of plants present.

***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 (as defined by RCRA) that has been contaminated with low-level radioactive materials.

***piezometer*:** Shallow monitoring well that is used to measure water elevations in wetlands.

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

***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.

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

***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 (VIBI)*:** A scoring system that uses vascular plants as a means of assessing the quality of a given plant community.

***waste acceptance criteria*:** Disposal facilities specifications for the types and sizes of materials, the acceptable levels of constituents, and other criteria for all material that can be disposed of in that facility. Offsite disposal facilities such as the Nevada National Security Site (formerly called the Nevada Test Site) that dispose of Fernald Preserve waste have specific waste acceptance criteria. In addition, the OSDF had waste acceptance criteria that were approved by the regulatory agencies.