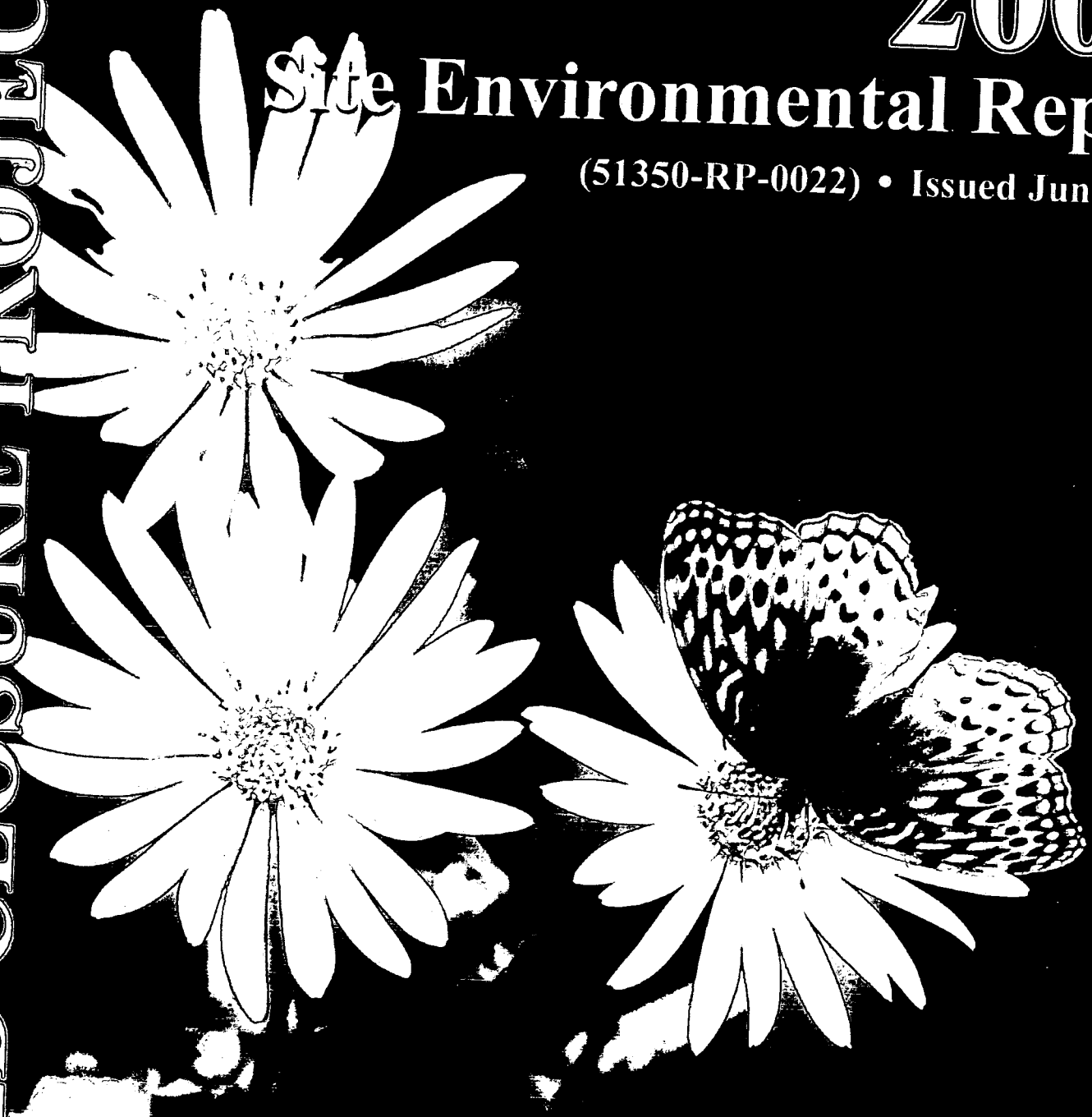
FERNALD CLOSURE PROJECT

2002 Site Environmental Report

(51350-RP-0022) • Issued June 2003



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Contract DE-AC24-01OH20115

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List of Acronyms

ALARA	as low as reasonably achievable
ARARs	applicable or relevant and appropriate requirements
BCG	Biota Concentration Guides
BDN	bio-denitrification
BTV	benchmark toxicity value
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
cm	centimeter
DOE	U.S. Department of Energy
EHS	Extremely Hazardous Substance
EPA	U.S. Environmental Protection Agency
EPCRA	Emergency Planning and Community Right-to-Know Act
FCP	Fernald Closure Project
FEMP	Fernald Environmental Management Project
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
ft^3/sec	cubic feet per second
gpm	gallons per minute
HEPA	high-efficiency particulate air
ICRP	International Commission on Radiological Protection
IEMP	Integrated Environmental Monitoring Plan
kg	kilogram
kg/d	kilograms per day
km	kilometer
lbs	pounds
lbs/kg	pounds per kilogram
lbs/yr	pounds per year
Lpm	liters per minute
μCi	microCuries
μCi/hr	microCuries per hour
μg/kg	micrograms per kilogram
μg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter

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List of Acronyms (Continued)

m^3	cubic meters
M gal	million gallons
M liters	million liters
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mGy/day	milliGray per day
mrem	millirem
m^3/sec	cubic meters per secon
mSv	milliSievert
NAR	nitric acid recovery
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NPDES	National Pollutant Discharge Elimination System
NRC	National Response Center
OEPA	Ohio Environmental Protection Agency
PCB	polychlorinated biphenyl
pCi/g	picoCuries/gram
pCi/hr	picoCuries per hour
pCi/L	picoCuries per liter
pCi/m^3	picoCuries/cubic meter
pCi/m^2/sec	picoCuries per square meter per second
person-Sv	person-Sievert
PVS	pugmill ventilation system
RCRA	Resource Conservation and Recovery Act
RCS	Radon Control System
RTS	Radon Treatment System
SARA	Superfund Amendment and Reauthorization Act
TLD	thermoluminescent dosimeter
TSCA	Toxic Substance Control Act
USGS	United States Geologic Survey
WPRAP	Waste Pits Remedial Action Project
yd^3	cubic yards

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Units (Abbreviations) and Conversion Table

Multiply	By	To Obtain	Multiply	By	To Obtain
inches (in)	2.54	centimeters (cm)	cm	0.3937	in
feet (ft)	0.3048	meters (m)	m	3.281	ft
miles (mi)	1.609	kilometers (km)	km	0.6214	mi
pounds (lb)	0.454	kilograms (kg)	kg	2.205	lb
tons	0.9072	metric tons	metric tons	1.102	tons
gallons	3.785	liters (L)	L	0.2642	gallons
square feet (ft^2)	0.0929	square meters (m^2)	m^2	10.76	ft^2
acres	0.4047	hectares	hectares	2.471	acre
cubic yards (yd^3)	0.7646	cubic meters (m^3)	m^3	1.308	yd^3
cubic feet (ft^3)	0.02832	cubic meters (m^3)	m^3	35.31	ft^3
picocuries (pCi)	10^{-12}	curies (Ci)	Ci	1012	pCi
pCi/L	10^{-6}	microcuries per liter (μCi/L)	μCi/L	106	pCi/L
Ci	3.7×10^{10}	becquerels (Bq)	Bq	2.7×10^{-11}	Ci
pCi	0.037	Bq	Bq	27.03	pCi
millirem (mrem)	0.001	rem	rem	1000	mrem
mrem	0.01	milliSievert (mSv)	mSv	100	mrem
rem	0.01	Sievert (Sv)	Sv	100	rem
mSv	0.001	Sv	Sv	1000	mSv
person-rem	0.01	person-Sv	person-Sv	100	person-rem
rad	0.01	Gray (Gy)	Gy	100	rad
milliGray (mGy)	0.001	Gy	Gy	1000	mGy
milligrams per liter (mg/L)	1000	micrograms per liter (μg/L)	μg/L	0.001	mg/L
Fahrenheit (°F)	(°F - 32) x 5/9	Celsius (°C)	°C	(°C x 9/5) + 32	°F
For Natural Uranium in Water					
pCi/L	0.0015	mg/L	mg/L	675.7	pCi/L
pCi/L	1.48	μg/L	μg/L	0.6757	pCi/L
μg/L	0.6757	pCi/L	pCi/L	1.48	μg/L
For Natural Uranium in Soil					
pCi/g	1.48	μg/g	μg/g	0.6757	pCi/g
mg/kg	1	μg/g	μg/g	1	mg/kg

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Executive Summary

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ES 1.0 Executive Summary

The 2002 Site Environmental Report provides stakeholders with the results from the Fernald site's environmental monitoring programs for 2002, along with a summary of the U.S. Department of Energy's (DOE's) progress toward final remediation of the site. In addition, this report provides a summary of the Fernald site's compliance with the various environmental regulations, compliance agreements, and DOE policies that govern site activities. All information presented in this Executive Summary is discussed more fully within the body of this summary report and the supporting appendices. This report has been prepared in accordance with DOE Order 5400.1, General Environmental Protection Program, and the Integrated Environmental Monitoring Plan (IEMP), Revision 2 (DOE 2001).

During 2002 DOE and Fluor Fernald, Inc., the prime contractor for the Fernald site, made considerable progress toward final cleanup goals established for the site. A wide range of environmental remediation activities continued during the year, including:

- Excavation and shipment of contaminated waste pit material to an off-site disposal facility (Operable Unit 1).
- Large-scale excavation of contaminated soil (Operable Unit 5) and materials from the southern waste units (Operable Unit 2) and former production area.
- Placement of contaminated soil and debris in the on-site disposal facility (Operable Unit 2).
- Decontamination and dismantlement of former production buildings and support facilities (Operable Unit 3).
- Start-up of the Radon Control System (RCS) (Phase I) in support of the Accelerated Waste Retrieval Project for Silos 1 and 2 (Operable Unit 4).
- Extraction and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).

Several important milestones toward remediation of the Fernald site were reached in 2002. The disposition of 31 million pounds (14 million kilograms [kg]) of nuclear material was completed, the majority through transfers to other government and private sector facilities. Two new on-site disposal facility cells (Cells 4 and 5) were opened for waste placement. Twenty-three building structures were demolished bringing the total to 119 of 298 structures. The first phase of the Waste Storage Area Module (groundwater pumping) began with the extraction of contaminated groundwater.

The following sections highlight the results of environmental monitoring activities conducted during 2002.

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ES 1.1 Liquid Pathway Highlights

ES 1.1.1 Groundwater Pathway

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

- Determine capture and restoration of the total uranium plume, as well as non-uranium constituents, and evaluate water quality conditions in the aquifer that indicate a need to modify the design and/or operation of restoration modules.

- Meet compliance-based groundwater monitoring obligations.

During 2002 active restoration of the Great Miami Aquifer continued or was initiated within each of the following groundwater restoration modules:

- South Field Extraction (Phase I) Module - continued pumping from nine extraction wells. During 2002 one extraction well was shut down (December 2002) and one more was added and began pumping in 2002.

- South Plume/South Plume Optimization Module - continued pumping from six extraction wells.

- Waste Storage Area (Phase I) Module – began pumping from three new extraction wells that became operational in 2002.

- Re-Injection Module - continued injecting water into the aquifer for most of the year via three re-injection wells. Two of the re-injection wells were not operating for much of the year due to an increased frequency of residual plugging and were replaced with newly installed re-injection wells. Both new re-injection wells were operated briefly in November.

In addition, approximately 120 monitoring wells were sampled at various frequencies to determine water quality. Water elevations were measured quarterly in approximately 140 monitoring wells. The following highlights describe the key findings from the 2002 groundwater data:

- 2,287 million gallons (8,656 million liters) of groundwater were pumped from the Great Miami Aquifer and 241 million gallons (912 million liters) of water were re-injected into the aquifer. As a result of these restoration activities, 1,225 pounds (556 kilograms) of uranium were removed from the aquifer.

- The results of 2002 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the enhanced groundwater remedy for the aquifer restoration system is appropriate for capture of the plume. Ongoing refinement of the wellfield configuration continued based on new monitoring data, particularly in the eastern, on-property portion of the South Field area. Installation of additional extraction wells was necessary to support the accelerated aquifer remediation schedule.

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- 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.

- Re-injection remains a viable component of the groundwater remediation strategy, as efforts to alleviate plugging of the re-injection wells appears to be effective.

- Pumping from the three Waste Storage Area (Phase I) Module extraction wells began during 2002 and sampling from nine new monitoring wells was initiated.

- Leak detection monitoring at Cells 1, 2 and 3 of the on-site disposal facility indicates that all the individual cell liner systems are performing within the specifications outlined in the approved cell design.

ES 1.1.2 Surface Water and Treated Effluent Pathway

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

In 2002, 16 surface water and treated effluent locations were sampled at various frequencies and 16 sediment locations were monitored. The following highlights describe the key findings from the 2002 surface water, treated effluent, and sediment monitoring programs:

- The uranium released to the Great Miami River through the treated effluent pathway was an estimated 524 pounds (238 kg), below the limit of 600 pounds (272 kg) per year. Uranium released through the uncontrolled runoff pathway was estimated at 127 pounds (58 kg). Therefore, the total amount of uranium released through the treated effluent and uncontrolled surface water pathways during 2002 was estimated to be 653 pounds (296 kg).

- No surface water or treated effluent analytical results from samples collected in 2002 exceeded the final remediation level for total uranium, the site's primary contaminant. Final remediation level exceedances were limited to four constituents, while benchmark toxicity value exceedances were limited to one constituent. These occasional, sporadic exceedances are expected to occur until site remediation is complete.

- Discharges were in compliance with effluent limits identified in the current National Pollutant Discharge Elimination System (NPDES) Permit well over 99 percent of the time during 2002.

- The 2002 sediment data showed concentrations within historical ranges, and there were no final remediation level exceedances.

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ES 1.2 Air Pathway Highlights

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

ES 1.2.1 Radiological Air Particulate Monitoring

- Data collected from the network of 17 fenceline and two background air monitoring stations showed that the annual average radionuclide concentrations were all less than one percent of DOE-derived concentration guidelines contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment.

- The maximum effective dose at the fenceline from 2002 airborne emissions (excluding radon) was estimated to be 0.8 millirem (mrem) per year and occurred at AMS-3 along the eastern fenceline of the site. This represents eight percent of the annual National Emission Standards for Hazardous Air Pollutants Subpart H limit of 10 mrem per year. For comparison, the 2000 and 2001 maximum effective dose was 1.1 mrem and 0.8 mrem, respectively.

- As in 2000 and 2001, thorium-230 continued to be the major dose contributor to the air inhalation dose in 2002. This is the result of fugitive emissions from the Waste Pits Remedial Action Project operations where thorium-230 is the primary isotope of concern.

ES 1.2.2 Radon Monitoring

As with previous years, a network of 34 continuous radon monitors was used for determining compliance with the applicable limits during 2002. The annual average radon concentration recorded at the site's property boundary ranged from 0.2 picoCuries per liter (pCi/L) to 0.5 pCi/L (inclusive of background concentrations). The annual average background concentration measured in 2002 was 0.2 pCi/L. Property boundary results were well below the DOE radon standard of 3.0 pCi/L above background concentrations.

- The annual average radon concentrations in the vicinity of Silos 1 and 2 (Operable Unit 4) during 2002 were comparable to the average concentrations measured in 2001. There were 10 exceedance events of the DOE limit of 100 pCi/L in 2002, compared to 15 exceedance events in 2001. As in past years, these exceedance events were observed during periods of atmospheric inversion.

- Radon concentrations within the headspace of Silos 1 and 2 were stable compared to 2001 levels. This is in contrast to slowly increasing headspace radon concentrations observed from 1991 to 2001, likely a result of the protective layer of bentonite clay (placed over the silo material in 1991 to lower headspace concentrations) that may have dried and reduced the effectiveness.

ES 1.2.3 Direct Radiation Monitoring

Direct radiation measurements were continuously collected at 37 locations at the Fernald site and at background locations. As in years past, the direct radiation levels observed in 2002 indicate that the highest measurements were obtained in proximity to Silos 1 and 2. The direct radiation measurements near Silos 1 and 2 were approximately the same as 2001 measurements. This correlates with the stable radon concentrations and associated decay products in the headspaces of these silos as observed during 2002.

ES 1.3 Estimated Dose for 2002

In 2002 the maximally exposed individual living nearest the Fernald site in a west direction could have hypothetically received a maximum dose of approximately 14.8 mrem. This estimate represents the maximum incremental dose above background attributable to the site and is exclusive of the dose received from radon. The contributions to this all-pathway dose were 0.6 mrem from air inhalation dose and 14.2 mrem from direct radiation. This dose can be compared to the limit of 100 mrem above background for all pathways (exclusive of radon) that was established by the International Commission on Radiological Protection and adopted by DOE.

ES 1.4 Natural Resources

Natural resources include the diversity of plant and animal life and their supporting habitats found in and around the Fernald site. During 2002 the following primary activities associated with natural resource monitoring and restoration occurred.

- The Area 2, Phase I Southern Waste Units Restoration Project was initiated to expand the riparian corridor along Paddys Run, create several open water and wetland areas, and establish the early stages of forest communities in upland areas. Soil amendment work was completed and half of the planned tree and shrub plantings were completed.

- The Area 1, Phase I Northern Pine Plantation Restoration Project commenced with the completion of clearing 19 acres of pine trees. The majority of grading and seeding was completed, and about one third of new trees and shrubs were planted. The objective for this area is enhancement by increasing the diversity of vegetation and creating new wetland and vernal pool features.

- The Area 2, Phase III restored area was planted with over 2,000 wetland shrubs in response to reduced survival in the wetland mitigation project area in Area 1, Phase I.

Fernald also has a number of archeological and historical sites representative of the cultural resources of the area. To protect these valuable resources, cultural resource surveys are conducted prior to soil excavation activities in designated areas of the site. During 2002 no archeological surveys were performed. Several unexpected discoveries of cultural resources occurred during 2002 remediation activities although none were significant and no impacts to cultural resources occurred.

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Chapter 1
Site Background

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1.0 Site Background

Abbreviated Timeline

1951	Construction of the Feed Materials Production Center began.
1952	Uranium production started.
1986	EPA and DOE signed the Federal Facilities Compliance Agreement, which initiated the remedial investigation/feasibility study process.
1989	Uranium production was suspended. The Fernald site was placed on the National Priorities List, which is the list of CERCLA sites most in need of cleanup.
1990	As part of the Amended Consent Agreement, the site was divided into operable units for characterization and remedy determination.
1991	Uranium production formally ended. The site mission changed from uranium production to environmental remediation and site restoration.
1996	The last operable unit's record of decision was signed, signifying the end of the 10-year remedial investigation/feasibility study process. (The Operable Unit 4 Record of Decision was later re-opened.)
1999	Excavation of the waste pits was initiated and the first rail shipment of waste material was transported to Envirocare of Utah, Inc. Safe Shutdown was completed ahead of schedule.
2000	The Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions was signed by EPA.
2001	On-site disposal facility Cell 1 was capped. Remediation of the southern waste units was completed.
2002	The Silos 1 and 2 Radon Control System began operations and successfully reduced radon levels within the silos. The off-site transfer of nuclear product material was completed. The on-site disposal facility conducted waste placement into Cells 2, 3, 4, and 5.

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

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

CERCLA Remedial Process

In broad terms, 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 and, with the input of stakeholders, a remedy is selected. Activities include the feasibility study and proposed plan. After public comments are received, a remedial alternative is selected and documented in a record of decision.

Remedial Design and Remedial Action – This phase of the CERCLA process includes the detailed design and implementation of the remedy.

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

Long-term Stewardship will take place at the Fernald site following completion of CERCLA activities. This means that DOE will assume the long-term monitoring and maintenance of the FCP after site closure in order to ensure continued protection of human health and the environment. The previously mentioned five-year review process will continue in order to provide long-term stewardship information to the public.

In 1991 the mission of the site officially changed from uranium production to environmental cleanup under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended. The site was renamed the Fernald Environmental Management Project (FEMP). Today the site is called the Fernald Closure Project (FCP) to reflect the current mission. Fluor Fernald, Inc. manages the remediation and restoration of the site under the terms of a prime contract with DOE. Regulatory oversight is provided by Region V of the U.S. Environmental Protection Agency (EPA) and the Southwest District Office of the Ohio Environmental Protection Agency (OEPA).

In the 1980s environmental monitoring activities began at the site. The goal was 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. The goal was to continuously measure the levels of contaminants associated with uranium production operations, and report this information to the regulatory agencies and stakeholders.

Since the conclusion of the site's uranium production mission and completion of the CERCLA remedy selection process, the focus is on the safe and efficient implementation of environmental remediation activities and facility decontamination and dismantling operations. In recognition of this shift in emphasis toward remedy implementation, the environmental monitoring program was revised in 1997 to align with the remediation activities planned for the Fernald site. The site's environmental monitoring program for 2002 is described in the Integrated Environmental Monitoring Plan (IEMP), Revision 2 (DOE 2001c). The IEMP is updated at a minimum of every two years to keep pace with the site's monitoring needs as remediation progresses.

The 2002 Site Environmental Report summarizes the findings from the IEMP monitoring program and provides a status on the progress toward final site restoration. This report consists of the following:

Summary Report This summary report (Chapters 1 through 7) documents the results of environmental monitoring activities at the Fernald site in 2002. It includes a discussion of remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, sediment, air, and natural resources monitoring programs. It also summarizes the information contained in the appendices.

Appendices The detailed appendices provide the 2002 environmental monitoring data for the various media, primarily in the form of graphs and tables. The National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 Code of Federal Regulations 61 Subpart H) (EPA 1985) compliance report is also included. The appendices are generally distributed only to the regulatory agencies. However, a complete copy of the appendices is available at the Public Environmental Information Center, which is located near the access point for the site in Trailer 210, and is open Tuesdays and Thursdays or by appointment.

The remainder of this introductory chapter provides:

- A brief overview of the current environmental remediation operations and a description of its current cleanup mission, organization, and major remediation activities.
- A description of environmental monitoring activities at the Fernald site.
- A description of the physical, ecological, and human characteristics of the area.

1.1 The Path to Site Closure

In 1986 the Fernald site began working through the CERCLA process to characterize the nature and extent of contamination at the site, establish risk-based cleanup standards, and select the appropriate remediation technologies to achieve those standards. To facilitate this process, the site was organized into five operable units in 1991. The purpose of the operable unit concept under CERCLA is to organize site components based on their location and/or the potential for similar technologies to be used for environmental remediation. The remedy selection process culminated in 1996 with approval of the final records of decision for each of the five operable units. However, the Record of Decision Amendment for Operable Unit 4 Silos 1 and 2 Remedial Actions was issued in July of 2000.

Following approval of the initial records of decision, work began on the design and implementation of the operable unit remedies. In order to align sitewide responsibilities and regulatory obligations of each operable unit and to most efficiently execute remedial design and remedial action, the site established integrated project organizations in 1996. Realignment into project organizations reflected the actual work processes and operations necessary to complete remediation while meeting the requirements of the records of decision. Table 1-1 describes each operable unit and its associated remedy and provides a crosswalk between each operable unit and the project organizations responsible for implementing each remedy. When a project organization is mentioned in this document, references to the applicable operable unit are included, as identified in the Table 1-1 description.

1.2 Environmental Monitoring Program

Exposure Pathways

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

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

Refer to Chapter 6 for information pertaining to 2002 dose calculations from all pathways.

Characterization activities were conducted at the Fernald site for nearly 10 years through the remedial investigation phase of the CERCLA process. The initial environmental evaluations performed during the remedial investigation/feasibility study process were used to select the final remedy for Operable Unit 5, which addressed contamination in soil, groundwater, surface water, sediment, air and biota (produce) – 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 both removing the contamination that might be released through these exposure pathways, and monitoring these pathways to measure the site's continuing impact on the environment as remediation progresses. The characterization data used to develop the final remedy were also used to focus and develop the environmental monitoring program documented in the IEMP. Following are descriptions of the IEMP's key elements:

- The IEMP defines monitoring activities for environmental media, such as groundwater, surface water and treated effluent, sediment, air (including air particulate, radon, and direct radiation), produce, and natural resources. In general, the primary exposure pathways (liquid and air) are monitored and the program focuses on assessing the collective effect of sitewide emissions on the surrounding environment.

- The IEMP establishes a data evaluation and decision-making process for each environmental medium. Through this process, environmental conditions at the site as a whole are continuously evaluated. These evaluations sometimes affect decisions made about the implementation of remediation activities. For example, environmental data are routinely evaluated to identify any significant trends that may indicate the potential for an unacceptable future impact to the environment if action is not taken. This information is communicated to the appropriate remediation project organization(s) so that corrective actions can be taken before conditions become unacceptable.

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TABLE 1-1
OPERABLE UNIT REMEDIES AND ASSOCIATED PROJECT ORGANIZATION RESPONSIBILITIES

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
1	- Waste Pits 1-6 - Clearwell - Burn pit - Berms, liners, caps, and soil within the boundary	Record of Decision Approved: March 1995 Excavation of materials with constituents of concern above final remediation levels (FRLs), waste processing and treatment by thermal drying (as necessary), off-site disposal at a permitted facility, and FCP remediation.	Waste Pits Remedial Action Project is responsible for rail upgrades; excavation of Operable Unit 1 waste units; pre-treatment of wastewater as necessary to meet Aquifer Restoration Project waste water acceptance criteria; waste processing and drying; and loading, rail transport, and off-site disposal of contaminated soil and debris that exceed the waste acceptance criteria for the on-site disposal facility. (Note: Some of the activities with this project are being performed by Shaw Environmental.) Soil and Disposal Facility Project is responsible for directing excavation and certification of contaminated soil beneath the waste pits, as well as at- and below-grade remediation facilities. Aquifer Restoration Project is responsible for final treatment of contaminated runoff, perched water collected during waste pit excavation, and processing wastewater discharges. Each project is responsible for transporting remediation wastewater to the head works of the advanced wastewater treatment facility for treatment. Decontamination and Demolition Project is responsible for decontamination and dismantling of Operable Unit 1 remediation facilities.
2	- Solid waste landfill - Inactive flyash pile - Active flyash pile (now inactive) - North and south Lime Sludge Ponds - Other South Field disposal areas - Berms, liners, and soil within the operable unit boundary	Record of Decision Approved: May 1995 Excavation of all materials with constituents of concern above FRLs, treatment for size reduction and moisture control as required, on-site disposal in the on-site disposal facility, off-site disposal of a small fraction of excavated material that exceeds the waste acceptance criteria for the on-site disposal facility and lead-contaminated soil from the South Field firing range, and remediation.	Soil and Disposal Facility Project is responsible for excavating and disposing of waste from all Operable Unit 2 subunits and certifying the footprints. This project is also responsible for the ongoing design, construction and maintenance, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil and debris, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for field oversight of soil excavations, for reviewing and signing manifests for impacted material delivered to the on-site disposal facility for placement, and for rejecting any unacceptable shipments. Aquifer Restoration Project is responsible for treating contaminated runoff and perched water collected during excavation of Operable Unit 2 subunit wastes. This project is responsible for leachate and leak detection monitoring at the on-site disposal facility and for treating leachate from the on-site disposal facility. Each project is responsible for transporting remediation wastewater to the head works of the advanced wastewater treatment facility for treatment.
3.	Former production area, associated facilities, and equipment (includes all above- and below-grade improvements) including, but not limited to: - All structures, equipment, utilities, effluent lines, and K-65 transfer line - Wastewater treatment facilities - Fire training facilities - Scrap metals piles - Drums, tanks, solid waste, waste product, feedstocks, and thorium	Record of Decision Approved: September 1996 Adoption of Operable Unit 3 Interim Record of Decision; alternatives to disposal through the unrestricted or restricted release of materials, as economically feasible for recycling, reuse, or disposal; treatment of material for on- or off-site disposal; required off-site disposal for process residues, product materials, process-related metals, acid brick, concrete from specific locations, and any other material exceeding the on-site disposal facility waste acceptance criteria; and on-site disposal for material that meets the on-site disposal facility waste acceptance criteria.	Decontamination and Demolition Project is responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the Fernald site. Soil and Disposal Facility Project is responsible for excavation and certification of soil beneath facilities and for removal of at- and below-grade structures. This project is also responsible for design, construction, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for reviewing facility decontamination and dismantling planning documents. This organization is also responsible for field oversight of debris sizing, segregation of on-site disposal facility material categories, and prohibited items; completing field tracking logs; completing manifests for material bound for the on-site disposal facility; and compiling final records of decontamination and dismantling debris placed in the on-site disposal facility. Aquifer Restoration Project is responsible for treating decontamination and other wastewaters during decontamination and dismantling activities and processing wastewater discharges. Each decontamination and dismantling project is responsible for transporting remediation wastewater to the head works of the advanced wastewater treatment facility

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TABLE 1-1
(Continued)

Operable Unit	Description	Remedy Overview	Project Organization Responsibilities
4	- Silos 1 and 2 (containing K-65 residues) - Silo 3 (containing cold metal oxides) - Silo 4 (empty and never used) - Decant tank system - Berms and soil within the operable unit boundary	Record of Decision Approved: December 1994 Record of Decision Amendment for Silos 1 and 2 Approved: July 2000 Silo 3: Explanation of Significant Differences Approved: March 1998 Removal of Silo 3 materials for off-site disposal (modification of the on-site treatment requirement is pending an amendment to the Record of Decision requiring regulatory approval). Removal of Silos 1 and 2 residues and decant sump tank sludges with on-site stabilization of materials, residues, and sludges followed by off-site disposal; and decontamination and demolition to the extent possible, of silos and remediation facilities. Excavation of silos area contaminated above the FRLs with on-site disposal for contaminated soils and debris that meet the on-site disposal facility waste acceptance criteria; and site restoration. Concrete from Silos 1 and 2, and contaminated soil and debris that exceed the on-site disposal facility waste acceptance criteria will be disposed of off site.	Silos 1 and 2 Project is responsible for transfer of Silos 1 and 2 residues to temporary transfer tanks, treatment, and transport off site. Waste treatment systems will be completed to support the final remediation of the silos. Silo 3 Project is responsible for Silo 3 content removal, treatment, and transport off site. Soil and Disposal Facility Project is responsible for certification, excavation, and disposition of contaminated soil beneath the silos and for removal of subsurface structures (i.e., sub-grade silo decant system). The project is also responsible for design, construction, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, an Operable Unit 3 debris. Aquifer Restoration and Wastewater Project is responsible for treating decontamination an other wastewaters during decontamination and demolition activities, and for tracking wastewaters as well as any contaminated storm water generated from the Silos 1 and 2 ar Silo 3 Projects. Each project is responsible for capturing and transporting remediation wastewater to the head works of the advanced wastewater treatment facility for treatmer Decontamination and Demolition Project is responsible for decontamination and dismantlin of all Operable Unit 4 remediation facilities and associated above-ground piping.
5	- Groundwater - Surface water and sediments - Soil not included in the definitions of Operable Units 1 through 4 - Flora and fauna	Record of Decision Approved: January 1996 Explanation of Significant Differences was approved in November 2001, formally adopting EPA's Safe Drinking Water Act Maximum Contaminant Level for uranium of 30 μg/L as both the FRL for groundwater remediation and the monthly average uranium effluent discharge limit to the Great Miami River. Extraction of contaminated groundwater from the Great Miami Aquifer to meet FRLs at all affected areas of the aquifer. Treatment of contaminated groundwater, storm water, and wastewater to attain concentration and mass-based discharge limits and FRLs in the Great Miami River. Excavation of contaminated soil and sediment to meet FRLs. Excavation of contaminated soil containing perched water that presents an unacceptable threat, through contaminant migration, to the underlying aquifer. On-site disposal of contaminated soil and sediment that meet the on-site disposal facility waste acceptance criteria. Soil and sediment that exceed the waste acceptance criteria for the on-site disposal facility will be treated, when possible, to meet the on-site disposal facility waste acceptance criteria or will be disposed of at an off-site facility. Also includes site restoration, institutional controls, and post-remediation maintenance.	Aquifer Restoration Project is responsible for designing, installing, and operating the extraction/re-injection systems for Great Miami Aquifer groundwater restoration. This project is responsible for groundwater monitoring in the Great Miami Aquifer; reporting or the progress of aquifer restoration; designing, constructing, and operating all treated effluent discharge systems; and treating and discharging contaminated groundwater, stor water, and remediation wastewaters at the Fernald site. This project is also responsible f operation, maintenance, and monitoring of the on-site disposal facility leachate collection system and leak detection system. Soil and Disposal Facility Project is responsible for certification of sitewide soil; excavatio and disposition of contaminated soil, sediment, perched groundwater and at- and below-grade structures; and final site restoration. The project is also responsible for design, construction, maintenance, and closure of the on-site disposal facility that will contain Operable Unit 2 subunit wastes, Operable Unit 5 soil, and Operable Unit 3 debris. Waste Acceptance Organization is responsible for reviewing Soils and Disposal Facility Project planning documents. This project is also responsible for oversight of field excavations; segregating on-site disposal facility material categories and segregating prohibited items; completing field tracking logs; completing manifests for material bound for the on-site disposal facility; and compiling final records of soil and at- and below-grad debris placed in the on-site disposal facility. Decontamination and Demolition Project is responsible for decontamination and dismantlir of all Operable Unit 5 remediation facilities necessary through the site completion phase following the completion of aquifer remediation.

- Recognizing that the type and pace of remediation activities will change over the life of the cleanup effort, the IEMP was developed as a "living document" allowing for adjustment of the program as site remediation progresses. The IEMP is reviewed annually and revised every two years to ensure that the monitoring program adequately addresses changing remediation activities.

- The IEMP consolidates routine reporting of environmental data into mid-year data summary reports and a comprehensive annual report.

1.3 Characteristics of the Site and Surrounding Area

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

1.3.1 Land Use and Demography

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

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

1.3.2 Geography

Figure 1-3 depicts the location of the major physical features of the site, such as the buildings and supporting infrastructure. The former production area and various administrative buildings dominate this view. The former production area occupies approximately 136 acres (55 hectares) in the center of the site. The waste pit area and K-65 Silos are located adjacent to the western edge of the former production area. The Great Miami River cuts a terraced valley to the east of the site while Paddys Run, an intermittent stream, flows from north to south along the site's western boundary. In general, the site lies on a terrace that slopes gently between vegetated bedrock outcroppings to the north, southeast, and southwest.

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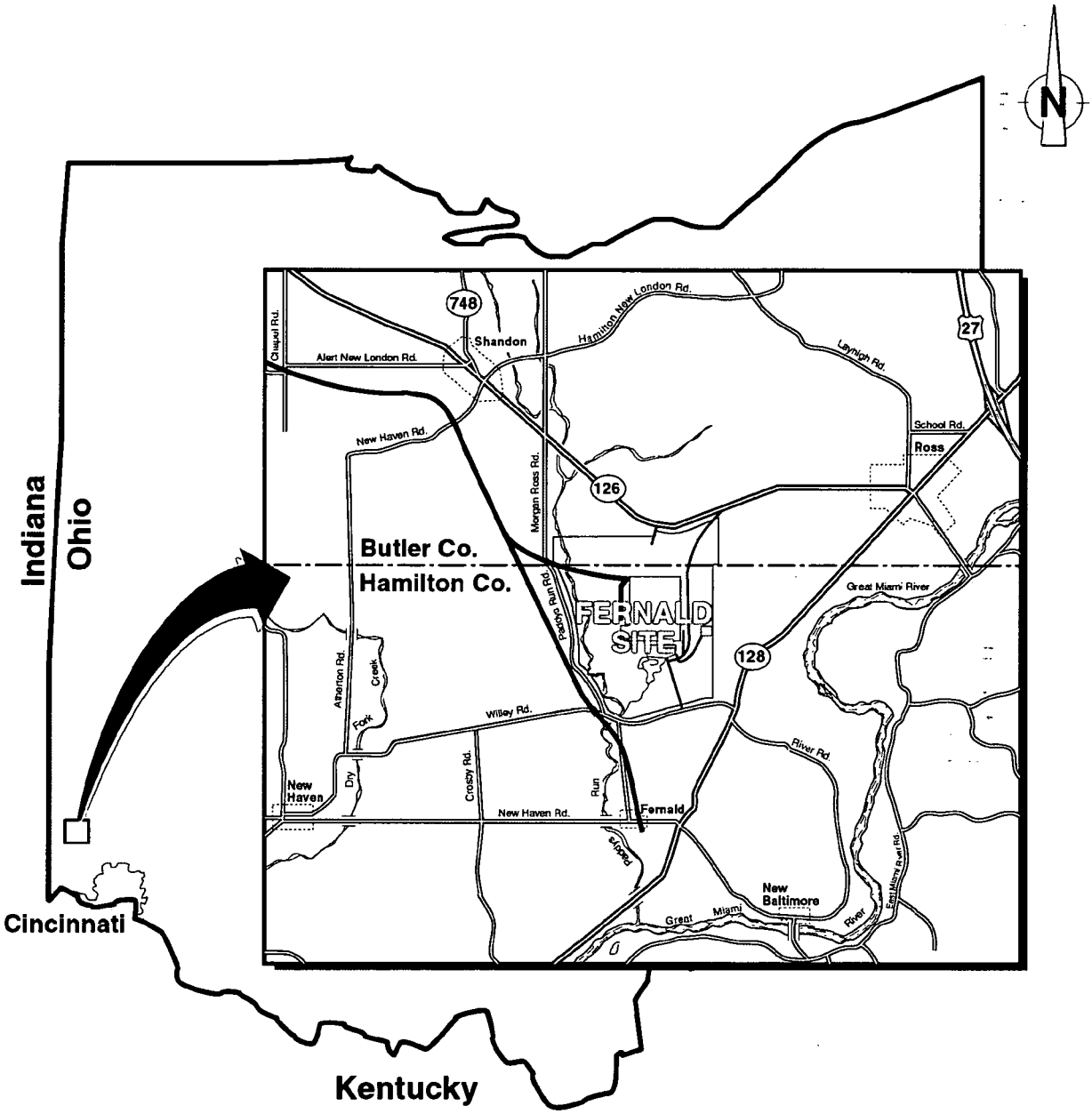

The Fernald site covers about 1,050 acres (425 hectares).

Figure 1-1. Fernald Site and Vicinity

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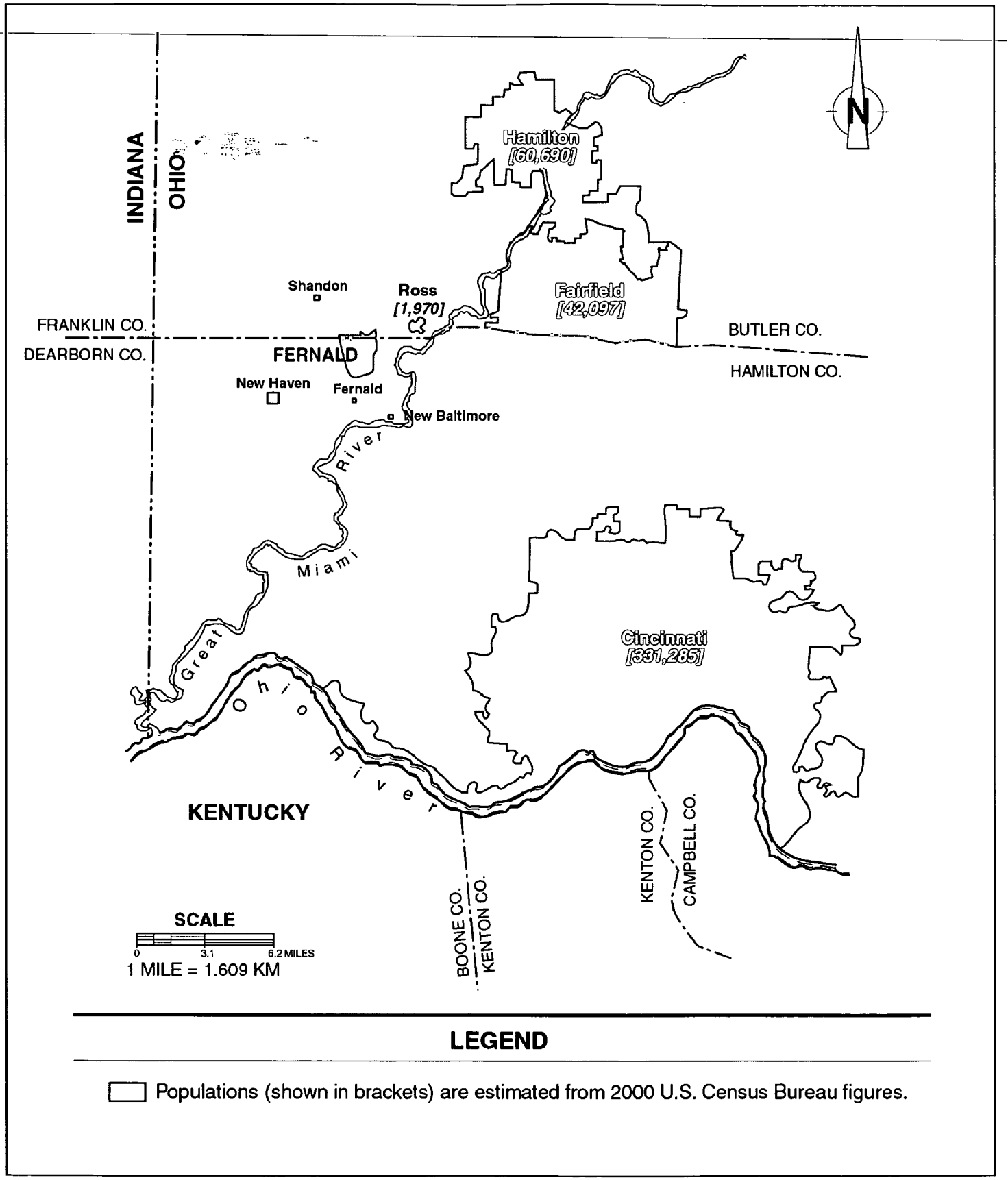

Figure 1-2. Major Communities in Southwestern Ohio

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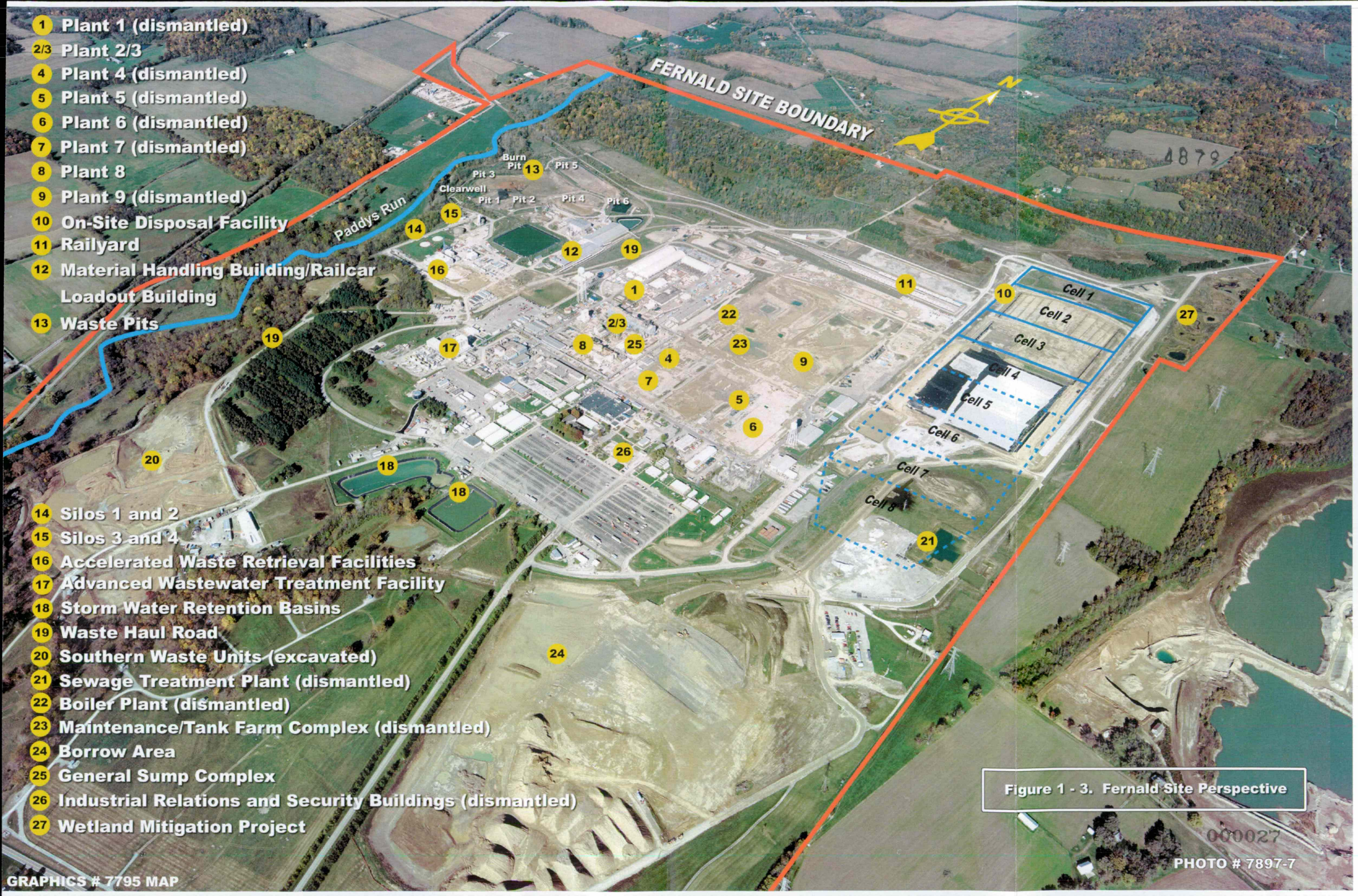

Figure 1 - 3. Fernald Site Perspective

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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 (61 meters) deep, which were then filled with sand and gravel when the glaciers melted. These filled river valleys are called buried valleys.

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

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

1.3.4 Surface Hydrology

The site is located in the Great Miami River drainage basin (refer to Figure 1-6). Natural drainage from the site to the Great Miami River occurs primarily via Paddys Run. This intermittent stream begins losing flow to the underlying sand and gravel aquifer south of the waste pit area. Paddys Run empties into the Great Miami River 1.5 miles (2.4 km) south of the site.

In addition to natural drainage through Paddys Run, surface water runoff from the former production area, the waste pit area, and other selected areas is collected, treated, and discharged to the Great Miami River. Since January 1995, the majority of this runoff has been treated for uranium removal in the advanced wastewater treatment facility before being discharged. The Great Miami River, 0.6 mile (1 km) east of the Fernald site, runs in a southerly direction and flows into the Ohio River about 24 miles (39 km) downstream of the site. The segment of the river between the Fernald site and the Ohio River is not used as a source of public drinking water.

The average flow volume for the Great Miami River in 2002 was 2,788 cubic feet per second (ft^3/sec) (79 cubic meters per second [m^3/sec]). This is based on daily measurements collected at the United States Geologic Survey (USGS) stream gauge approximately 10 river miles (16 river km) upstream of the site's effluent discharge.

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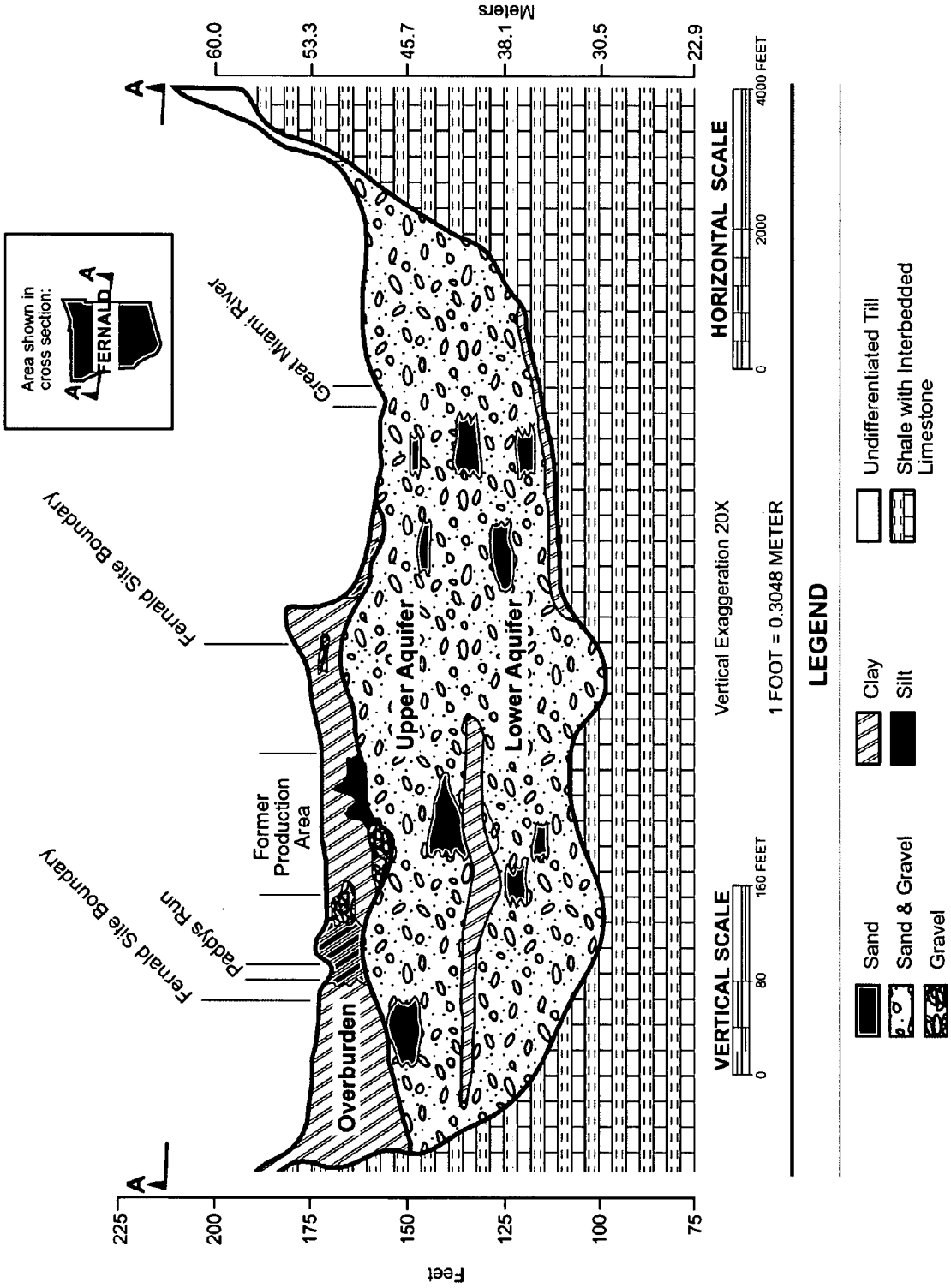

Figure 1-4. Cross Section of the New Haven Trough, Looking North

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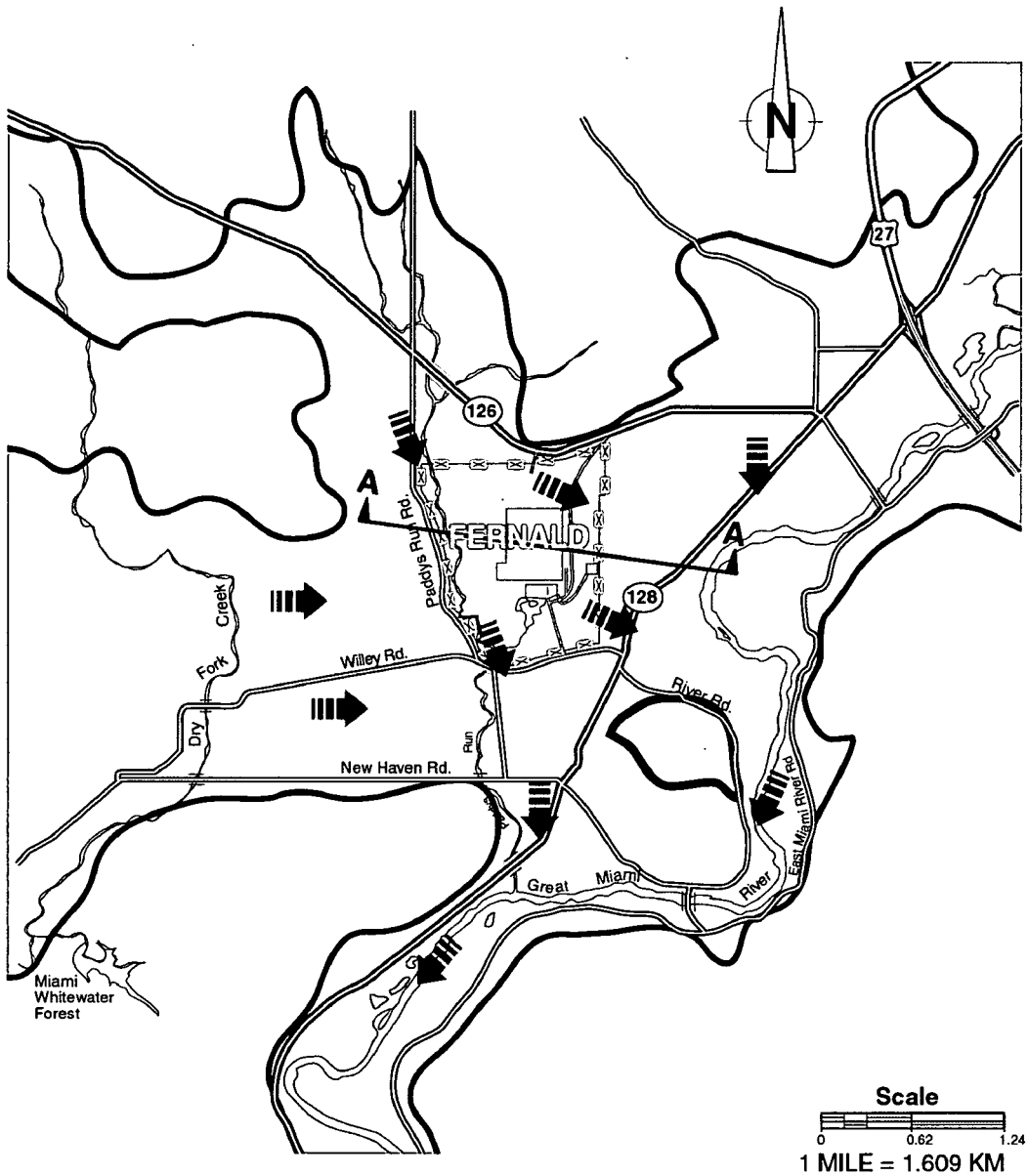

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- Buried Valley Aquifer
- General Direction of Groundwater Flow
- Fernald Boundary
- A A Location of Cross-Section Shown in Figure 1-4

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

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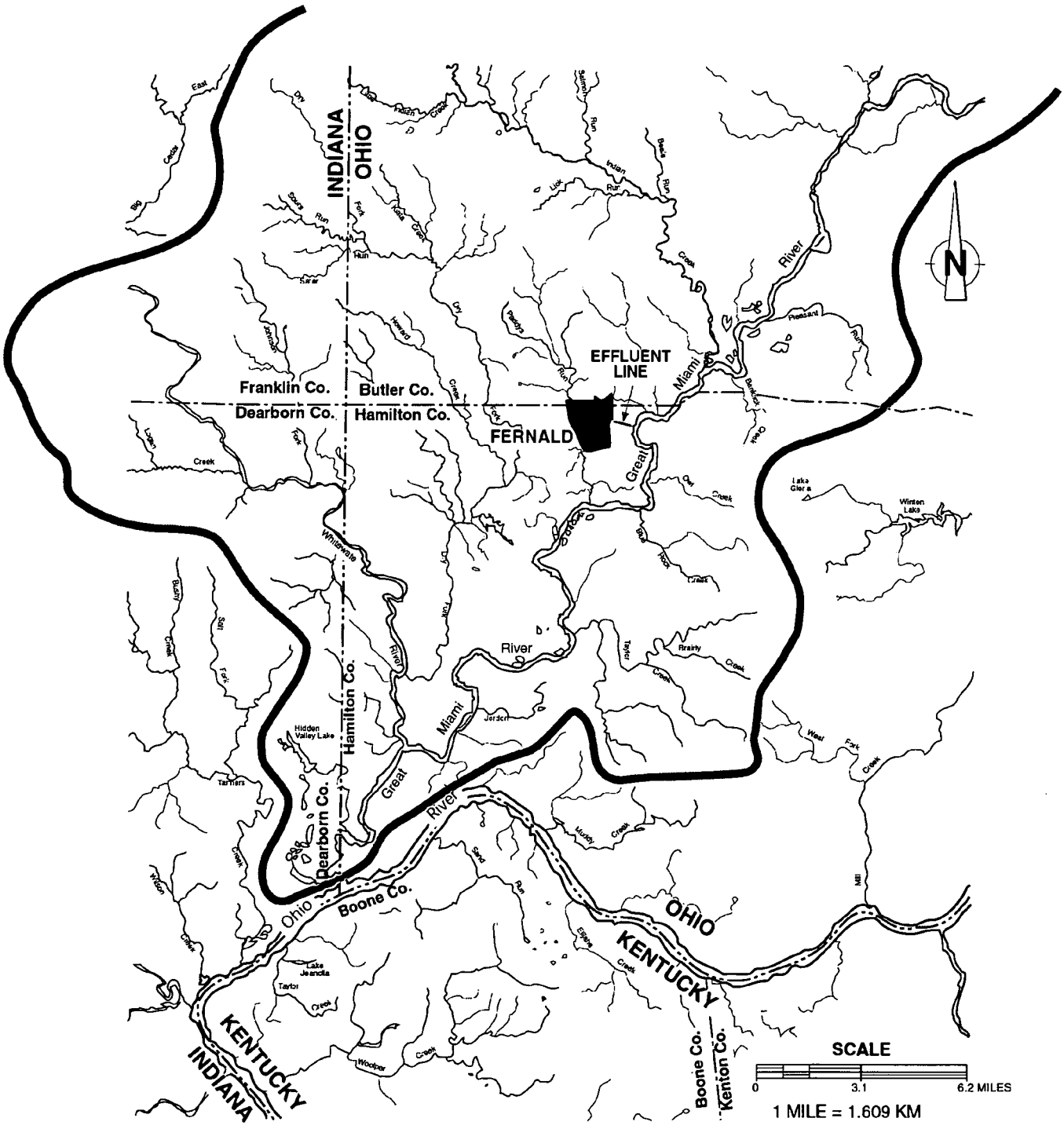

Figure 1-6. Great Miami River Drainage Basin

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1.3.5 Meteorological Conditions

Meteorological data are gathered at the Fernald site and used to evaluate site-specific climatic conditions. The environmental monitoring program uses atmospheric models to determine how airborne effluents are mixed and dispersed. These models are then used to assess the impact of operations on the surrounding environment, in accordance with DOE requirements. Airborne pollutants are subject to weather conditions. Wind speed and direction, precipitation, and atmospheric stability play a key role in predicting how pollutants are distributed in the environment and in interpreting environmental data.

Figures 1-7 and 1-8 illustrate the average wind speed and general direction for 2002 measured at the 33-foot (10-meter) and 197-foot (60-meter) levels, respectively, in wind rose format. The prevailing winds were from the west through south-southwest approximately 40 percent of the time at both the 33- and 197-foot (10- and 60-meter) levels. Tables in Appendix C, Attachment 4, of this report present meteorological data for 2002, including wind direction and average speed.

In 2002, 48.96 inches (124.4 centimeters [cm]) of precipitation were measured at the Fernald site. This is higher than the average annual precipitation of 41.02 inches (104.2 cm) for 1951 through 2001. Figure 1-9 shows 2002 total precipitation for the area in relation to the annual precipitation amounts recorded from 1991 through 2002. (Precipitation totals from 1990 through 1992 were taken from the measurements made at the Greater Cincinnati/Northern Kentucky International Airport because of a computer software problem at the site's meteorological tower.) Figure 1-10 shows 2002 precipitation by month at the site compared to the Cincinnati area average precipitation by month from 1951 through 2001.

1.3.6 Natural Resources

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

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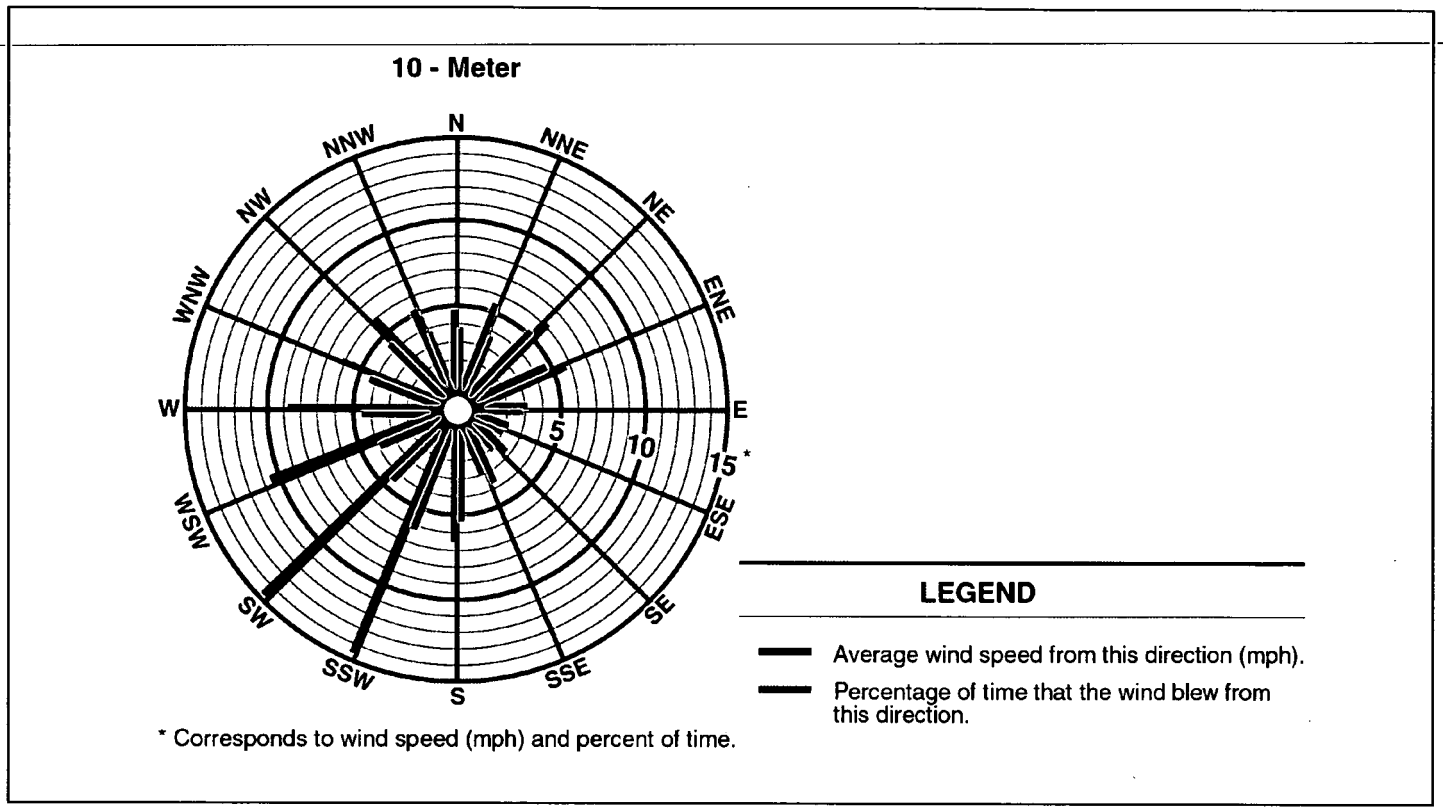

Figure 1-7. 2002 Wind Rose Data, 33-Foot (10-Meter) Height

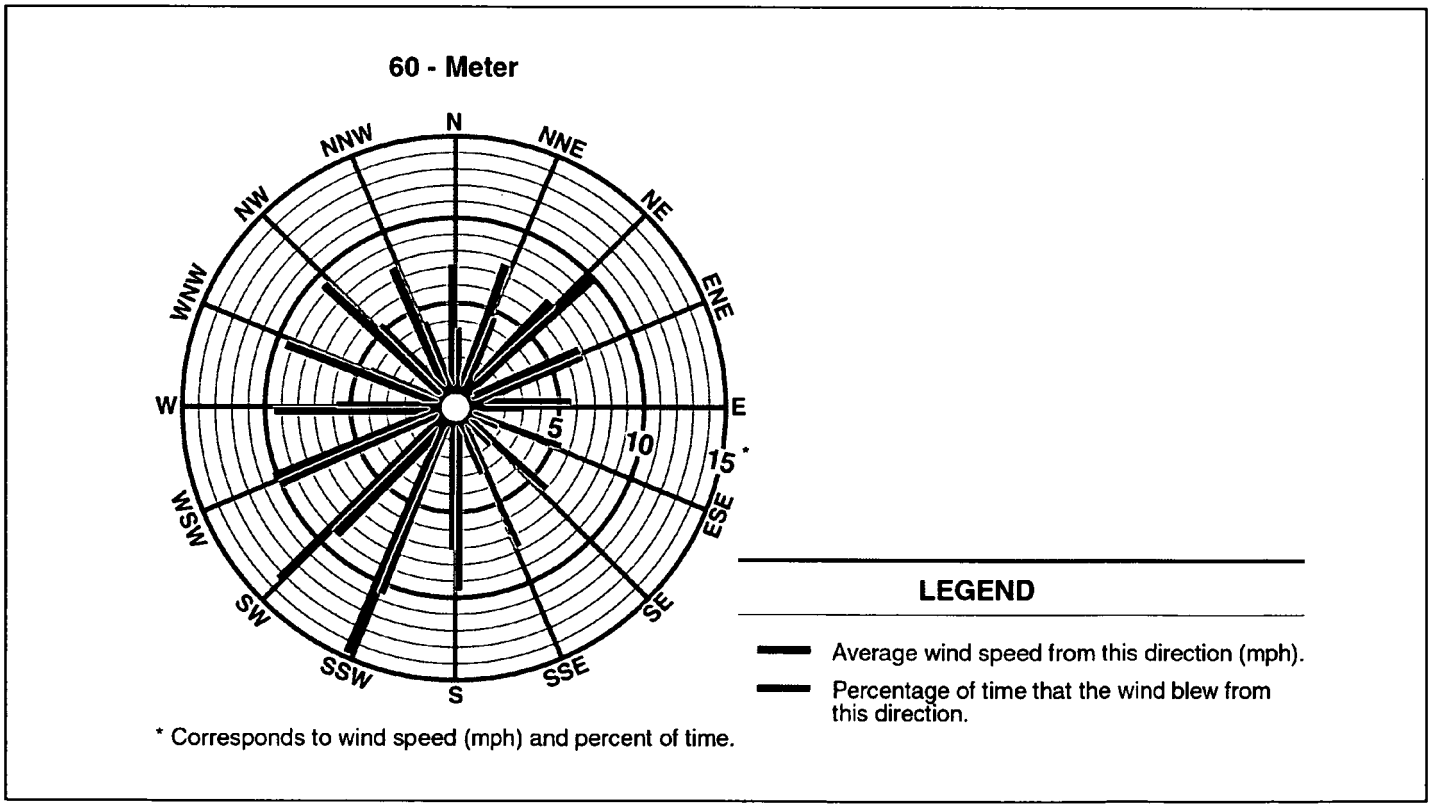

Figure 1-8. 2002 Wind Rose Data, 197-Foot (60-Meter) Height

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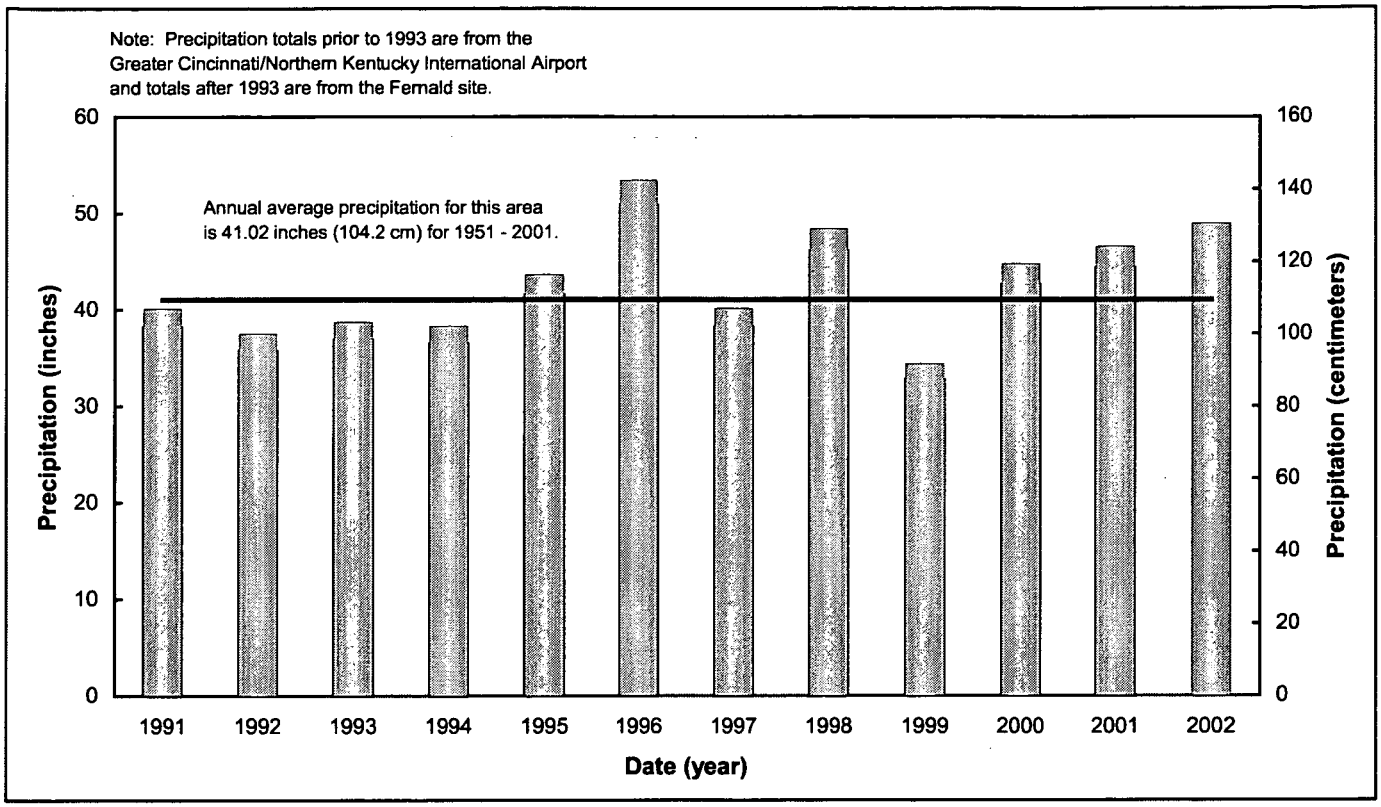

Figure 1-9. Annual Precipitation Data, 1991-2002

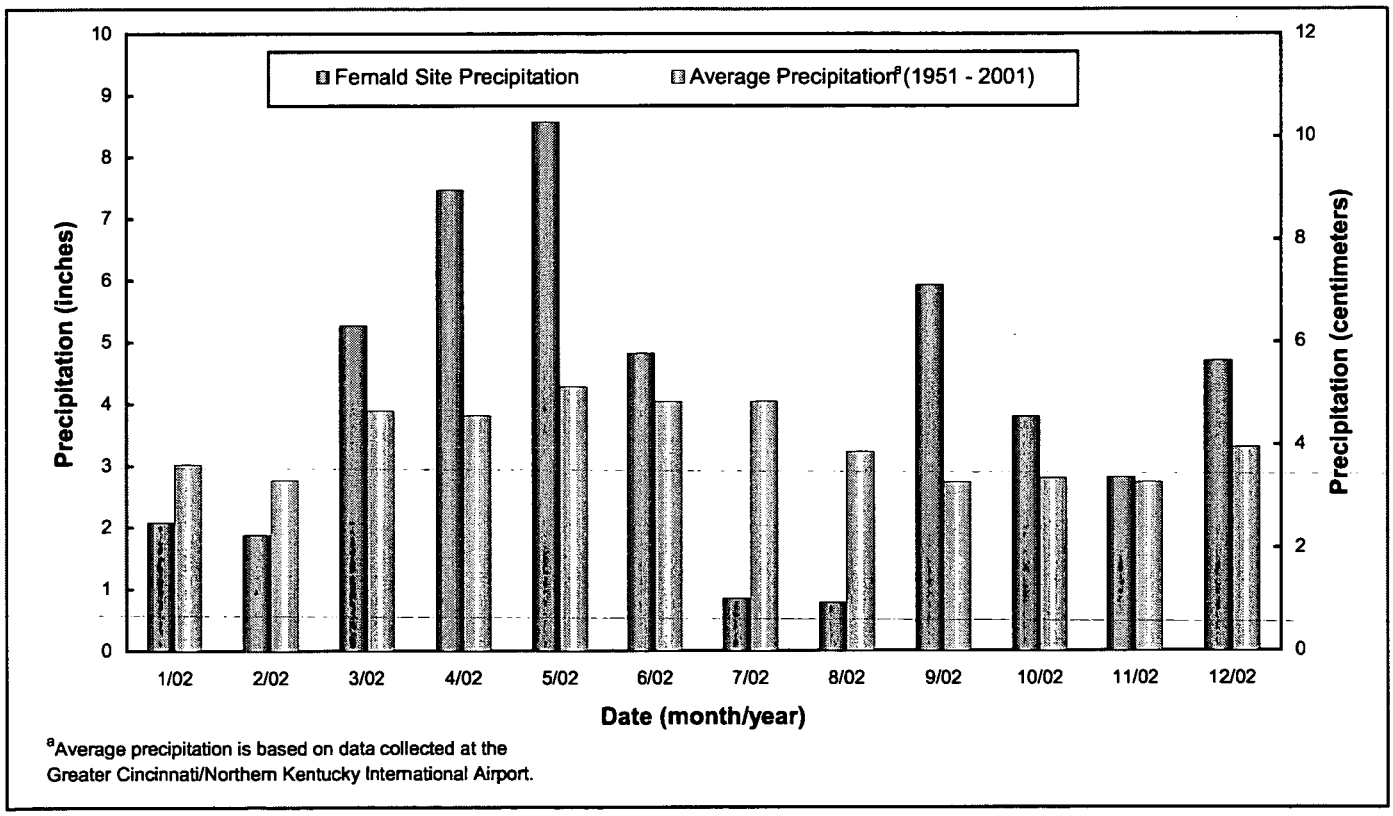

Figure 1-10. 2002 Monthly Precipitation Data

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Chapter 2

Remediation Status and Compliance Summary

Chapter 2

2.0 Remediation Status and Compliance Summary

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This chapter provides a summary of CERCLA remediation activities in 2002 for each project, and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements. CERCLA, the "Superfund Act," is the primary driver for environmental remediation of the Fernald site.

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

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

2.1 CERCLA Remediation Status

The process for remediating sites under CERCLA consists of three phases: site characterization, remedy selection, and implementation. The FCP has completed the first two phases, as the regulatory agencies have approved remedy selection documents (i.e., records of decision) for all operable units, as well as several amendments to these documents.

The FCP is currently involved in the implementation phase of CERCLA remediation, which includes remedial design, remedial action (construction and implementation of the remedy), certification of soil and groundwater to verify that the remedy was effective, and ultimately site closure. Remediation activities, documents, and schedules are identified in each operable unit's remedial design and remedial action work plan. Certification of soil remediation areas continued to progress in 2002; the Soil and Disposal Facility Project certified several more areas (described later in this chapter in subsection 2.1.2, Soil and Disposal Facility Project).

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Each phase of the CERCLA remediation process requires documentation. The documents produced reflect the input of stakeholders who have helped form the remediation strategy at the Fernald site. Many documents that describe specific remediation activities were issued or approved in 2002, as mentioned throughout this report. All cleanup-related CERCLA documentation, including a copy of the Administrative Record, is available to the public at the Public Environmental Information Center located near the Fernald site. A copy of the Administrative Record is also located at EPA's Region V office in Chicago, Illinois. The progress made by each remedial project toward CERCLA cleanup is summarized later in this chapter.

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

Cleanup levels at the Fernald site for surface water, sediment, and groundwater were established in the Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996). These final remediation levels (FRLs) were established for constituents of concern or those constituents at the Fernald site determined, through risk assessment, to present potential risk to human health or the environment. Table 2-1 lists FRLs identified for constituents in groundwater, surface water, and sediment; these constituents are all monitored under the IEMP. FRLs represent the maximum allowable residual levels (the maximum concentrations which may remain in the environment following remediation), and these levels drive excavation and cleanup.

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

Benchmark Toxicity Values originated from the Operable Unit 5 Sitewide Ecological Risk Assessment. These concentrations for sediment and surface water are used to determine if a constituent may have a detrimental effect on a particular ecological receptor. For surface water and sediment, ecological receptors include fish and animals that inhabit the surface water body or use surface water as a source of drinking water.

Acceptable levels for constituents of ecological concern were established in the Operable Unit 5 Sitewide Ecological Risk Assessment (Appendix B of the Operable Unit 5 Remedial Investigation Report). The Sitewide Ecological Risk Assessment established benchmark toxicity values (BTVs) for protection of ecological receptors. Through the BTV screening process presented in Appendix C of the final Sitewide Excavation Plan (DOE 1998b), three constituents of ecological concern (barium, cadmium, and silver) were selected for evaluation in the surface water pathway to be protective of aquatic receptors. Chapter 4 discusses BTVs for surface water.

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TABLE 2-1
FINAL REMEDIATION LEVELS
FOR GROUNDWATER, SURFACE WATER, AND SEDIMENT

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

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TABLE 2-1
(Continued)

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

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

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2.1.1 Waste Pits Remedial Action Project

The Waste Pits Remedial Action Project (Operable Unit 1) is responsible for the excavation, drying (as required), loading, and rail transport of the contents of Waste Pits 1 through 6, the burn pit, and the clearwell to an off-site disposal facility. Sampling and analysis of the waste pit material and the off-site disposal of contaminated soil and debris from other remedial projects that exceed the waste acceptance criteria (physical, chemical, and radiological standards) for the on-site disposal facility are part of this scope of work. The project is also responsible for collecting wastewater and storm water associated with the Waste Pits Remedial Action Project activities and as needed, pre-treating and discharging this remediation water to the advanced wastewater treatment facility. In addition, the project is responsible for implementing dust control measures, and for implementing point source emission controls for dryer operations.

The Waste Pits Remedial Action Project involves the pre-treatment (e.g., crushing, sorting, and shredding) of waste pit materials, drying (as required), and the loadout of railcars with pit material for shipment to Envirocare of Utah, Inc. During 2002, 23 unit trains left the Fernald site carrying approximately 150,000 tons (136,080 metric tons) of material. From April 1999, when the first rail shipment left the Fernald site, through December 2002, the Waste Pits Remedial Action Project shipped 74 unit trains carrying approximately 467,000 tons (423,662 metric tons) of material to Envirocare of Utah, Inc. for disposal. At the end of 2002, remediation of Waste Pit 1 was nearly complete, and Waste Pits 2, 3 and 5 were approximately 50 percent, 70 percent, and 20 percent complete, respectively. The total project was approximately 60 percent complete at the end of 2002.

Aerial View of the Waste Pits Remedial Action Project and K-65 Area

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2.1.2 Soil and Disposal Facility Project

The Soil and Disposal Facility Project, which includes components of both Operable Units 2 and 5, is responsible for soil characterization sampling, excavation of contaminated soil, treatment of soil if necessary, natural resource restoration, and the construction of on-site disposal facility cells and waste placement into those cells. (The on-site disposal facility's leachate and leak detection monitoring, as well as operation, maintenance, and monitoring of the leachate transmission system, are the responsibility of the Aquifer Restoration Project.)

For purposes of excavating contaminated soil, the Fernald site has been divided into nine separate soil remediation areas based on land use history and known contamination levels (refer to Figure 2-1). Area 9 includes all off-site soil that must be evaluated during remediation. In addition, the site's stream corridors (including Paddys Run) along with other potentially contaminated corridors may require remediation and are considered unique areas. Other utility corridors and access roads are not included with the remediation areas. These corridors will be addressed later in site remediation.

Prior to soil remediation, real-time scanning and soil sampling are performed to gather information related to the extent of surface and subsurface contamination, and to identify the materials that meet the waste acceptance criteria for the on-site disposal facility. Engineering personnel use this information to design soil and debris excavations. Materials that cannot be placed in the on-site disposal facility are stockpiled, monitored, and tracked for off-site disposal.

Area 3B/4B Remedial Excavation

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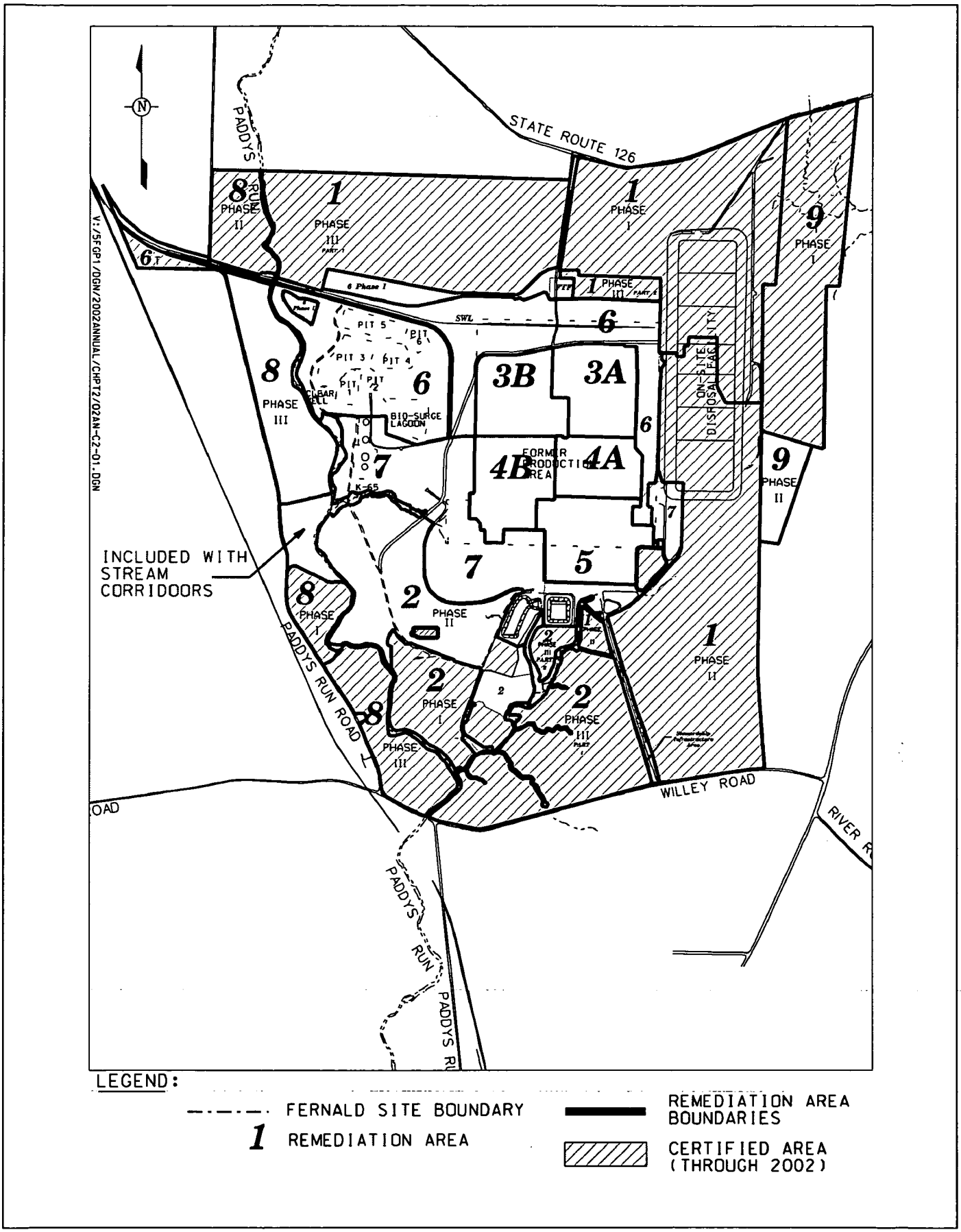

Figure 2-1. Sitewide Soil Remediation Areas and Certified Areas

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In 2002 the Soil and Disposal Facility Project continued soil and debris excavations, excavating nearly 300,000 cubic yards (yd^3) (229,380 cubic meters [m^3]). By the end of 2002, nearly 1.3 million yd^3 (1 million m^3) of soil had been excavated since remediation began, and the planned soil remediation activities at the site were about 40 percent complete. The following soil remedial excavation activities took place in 2002:

- Area 2, Phase II. One area of arsenic-contaminated soil and one area of debris were excavated in the wooded area south of Silos 1 and 2.
- Area 3A/4A. Large-scale remedial excavations continued on the east side of the former production area. The Lime Sludge Ponds were also excavated as part of the 3A/4A excavation project.
- Area 7, Phase I. Prior to construction of treatment facilities and infrastructure to support the Silos Project, contaminated soil in the area east of Silos 1, 2 and 3 was excavated. This included excavation of the western portion of the K-65 Trench.

When contaminated soil and debris have been excavated from each area, pre-certification real-time scanning and certification sampling are performed to demonstrate that the residual levels of the constituents of concern for that area are below the site's FRLs. After the laboratory results are reviewed to confirm that contaminants of concern are demonstrated to be below the site's FRLs, a certification report is submitted to EPA and OEPA, and upon their approval the area is certified as meeting the soil remediation goals.

During 2002 the following areas of the Fernald site were certified:

- Area 2, Phase I - the footprint of the inactive flyash pile and southern waste units, along with the surrounding area.
- Area 5 - the field east of the main parking area.

Also in 2002, Area 9, Phase I was certified. Area 9, Phase I includes the off-property land adjacent to the northern half of the eastern site boundary, and represents the first off-property area to be certified. Figure 2-1 identifies all remediation areas that have been certified as of December 31, 2002.

As of December 31, 2002, approximately 54 percent of the Fernald site had been certified. After an area of the site is certified, natural resource restoration activities can begin. Chapter 7 discusses the specific natural resource restoration activities that took place in 2002.

At the on-site disposal facility, waste placement continued in Cell 2 and it reached 100 percent capacity in October. Cell 2 will be capped during the 2003 construction season. At Cell 3, waste placement also continued in 2002, and by year's end it had reached 51 percent capacity. The liners of Cells 4 and 5 were constructed and waste placement began in 2002. By year's end, Cell 4 was at nine percent capacity and Cell 5 was at three percent capacity. Also related to the on-site disposal facility, construction of Sediment Basin 2 east of the main parking lot was completed in 2002. A discussion of the ongoing performance monitoring of the on-site disposal facility is provided in Chapter 3.

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2.1.3 Decontamination and Demolition Project

The Decontamination and Demolition Project (Operable Unit 3) is responsible for decontaminating and dismantling the above-grade structures and facilities associated with production operations and remedial actions. This includes decontamination of facilities; isolation of utilities; demolition of buildings, equipment, and other facilities; removal of uranium and other material from former processing equipment; and shipment of material and equipment off site. The scope includes the collection and proper management of associated decontamination wastewater. In August 2001, MACTEC Inc., was awarded the demolition closure contract, and has been responsible for all remaining above-grade demolition of structures at the Fernald site.

During 2002 decontamination and demolition activities were completed at the following facilities:

- 2F Cold Side Ore Conveyor
- 3D Nitric Acid Recovery (NAR) Towers
- 3J Combined Raffinate Tanks
- 3K Old Cooling Water Tower
- 5F Plant 5 Covered Storage Pad
- 8B Plant 8 Maintenance Building
- 8C Rotary Kiln/Drum Reconditioning
- 8H Soil Washing
- 13B Maintenance Rigger Shop
- 13C Sump Pump House
- 16M N78-1 Substation
- 16P N93-2 Substation
- 18H Bio-Denitrification (BDN) Effluent Treatment Facility
- 18M High Nitrate Storage Tank
- 22E Utility Trench to Pit Area
- 28D Guardpost West of Building 8A
- 34C Radon Treatment System (RTS) Building
- 39A Incinerator Building
- 53A Health and Safety Building
- 54B Pilot Plant Warehouse
- 54C Pilot Plant Dissociator Shelter
- 64 Thorium Warehouse
- 65 Old Plant 5 Warehouse

Demolition of these 23 structures brings the total number of structures demolished at the Fernald site to 119 out of a total of 298 structures.

Demolition of the Safety and Health Building #53A

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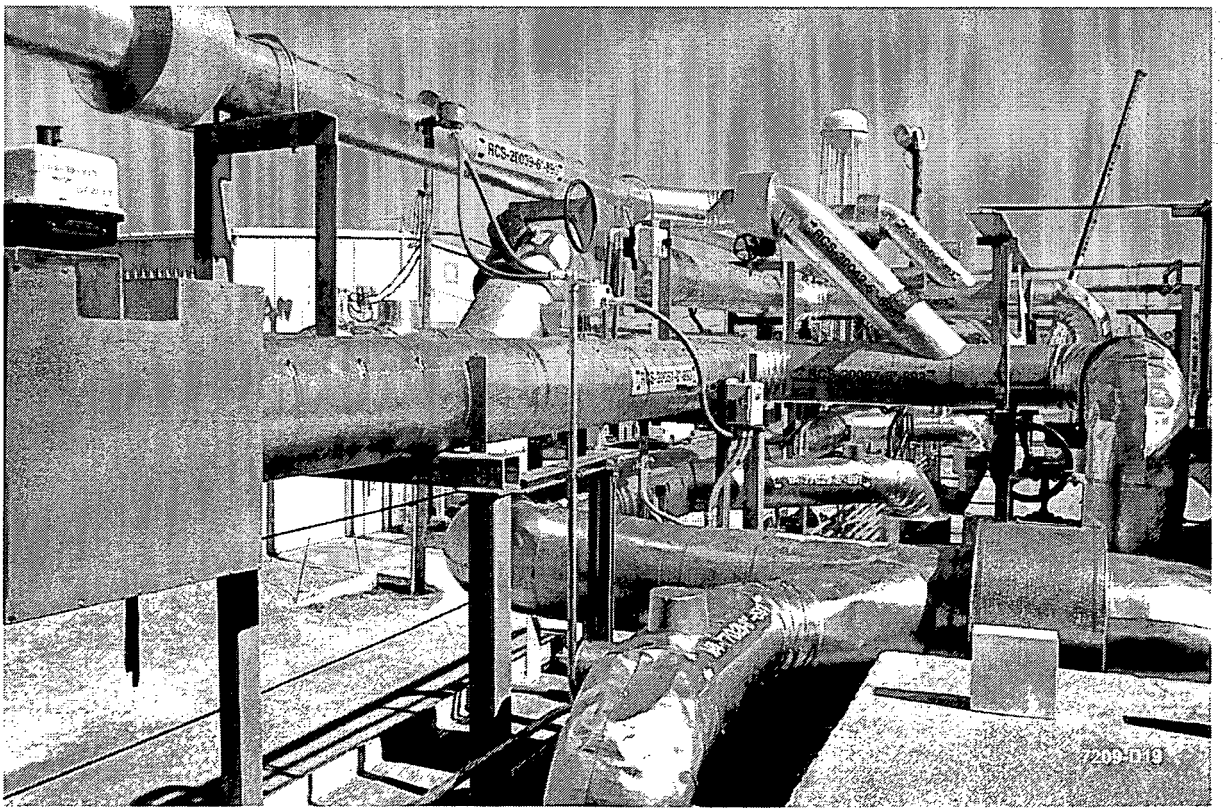
2.1.4 Silos Projects

The Silos Project (Operable Unit 4) includes Silos 1 and 2 (also known as the K-65 Silos), Silos 3 and 4, and several nearby structures. Silos 1 and 2 contain radium-bearing residues from the processing of uranium ore and ore concentrates during the 1950s. Silo 3 contains cold metal oxides generated from uranium recovery operations, and Silo 4 has never been used. The Silos Project remediation activities will include the retrieval, processing, and off-site disposal of the residues stored in the silos, as well as decontamination and dismantling of the silo structures and associated facilities.

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

2.1.4.1 Silos 1 and 2 Remediation

An Amendment to the Record of Decision for Operable Unit 4 Silos 1 and 2 Remedial Actions was approved by the EPA in July 2000, thus establishing a revised remedy for treatment of Silos 1 and 2 material. The final revised remedy consists of on-site chemical stabilization of the Silos 1 and 2 material followed by off-site disposal at the Nevada Test Site. Design and initial construction of the necessary equipment and facilities for implementation of the revised remedy for Silos 1 and 2 took place during 2002.



Radon Control System

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The Silos 1 and 2 Project initiated the Accelerated Waste Retrieval Project in 1998. The purpose of this project is to address the increasing radon concentrations in the Silos 1 and 2 headspace, as well as issues regarding silo integrity and heterogeneity of the material for the final treatment facility. The project scope includes design, construction, testing, and operation of interim storage facilities to hold the Silos 1 and 2 material until treatment is implemented. The project also includes design, construction, and startup of the Radon Control System (RCS) to provide control of radon emissions during the construction and operation phases of the Accelerated Waste Retrieval Project, as well as during interim storage and operation of the Silos 1 and 2 full-scale treatment facility. Construction startup testing and readiness activities for the RCS were completed during 2002. An initial test run was completed in December to demonstrate operation of the RCS to reduce radon concentrations in the Silos 1 and 2 headspaces. Other construction activities completed during 2002 include erection of the four 750,000-gallon tanks and shielded concrete containment in the Transfer Tank Area. The tanks will be used to receive and store the material from Silos 1 and 2 pending transfer to the remediation facility.

2.1.4.2 Silo 3 Project

In 2001 re-evaluation of alternatives for implementation of Silo 3 remediation was initiated with input from DOE, regulators, and stakeholders to identify the optimal path forward for remediation of the Silo 3 material. This process continued during 2002 and the Draft Revised Proposed Plan for Silo 3 (DOE 2002c) was submitted to the EPA and OEPA for review. Upon completion of the EPA/OEPA review and approval process, the proposed plan will be submitted for formal public review in 2003. Design and initial construction of facilities for retrieval and packaging of the Silo 3 material also took place during 2002.

2.1.4.3 Supplemental Environmental Projects

As a result of missed Operable Unit 4 enforceable milestones in 1996, the dispute resolution agreement with the EPA required DOE to do the following supplemental environmental projects:

- Perform ecological restoration research.
- Create a wild bird/wildflower habitat area.
- Develop railroad track recycling.
- Develop structural steel debris recycling.

The last of these was completed in 2002. The final report for the last of the ecological research projects will be submitted in 2003. Chapter 7 describes the ecological restoration research done in 2002.

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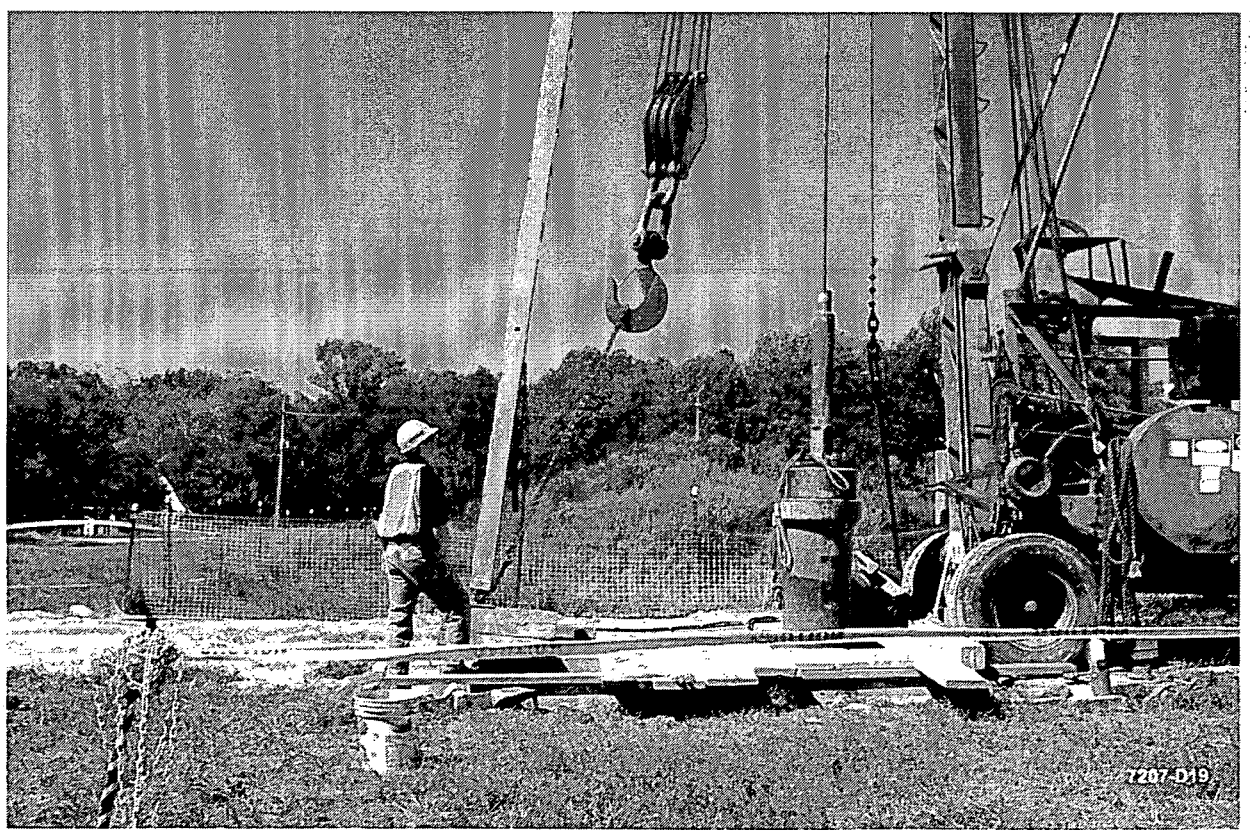
2.1.5 Aquifer Restoration and Wastewater Project

The Aquifer Restoration and Wastewater Project (Operable Unit 5) is responsible for the restoration of water quality in the affected portions of the Great Miami Aquifer, and for treating the site's extracted groundwater, storm water, sanitary wastewater, and remediation wastewater. These activities include the design, construction, operation, monitoring, and reporting of the groundwater restoration and wastewater treatment systems at the Fernald site. This project is also responsible for managing the on-site disposal facility's leachate and leak detection monitoring program, as well as operation, maintenance, and monitoring of the leachate transmission system.

In 2002 the Aquifer Restoration and Wastewater Project continued to operate the South Plume Module (including the South Plume Optimization Module), the South Field Extraction (Phase I) Module, and the Re-Injection Module. In addition four new extraction wells, three in support of the Waste Storage Area Extraction Module and one in support of the South Field Extraction (Phase I) Module, were placed into operation in May 2002.

In 2002 a total of 2,287 million gallons (8,656 million liters) of groundwater were extracted from the Great Miami Aquifer, 1,225 net pounds (556 kg) of uranium were removed from the aquifer, and 241 million gallons (912 million liters) of water were re-injected into the aquifer. Pumping began in the Waste Storage Area via three new extraction wells. An additional extraction well began pumping in the South Field. Chapter 3 discusses groundwater monitoring.

Phases I and II of the advanced wastewater treatment facility and the interim advanced wastewater treatment facility provide final treatment of contaminated storm water and wastewater. The advanced wastewater treatment facility Phase III and the South Plume interim treatment facility are dedicated to treatment of contaminated groundwater associated with groundwater remediation.



New Extraction Well Installation

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2.2 Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations as part of remediation of the Fernald site. These other requirements are referred to as applicable or relevant and appropriate requirements, or ARARs. ARARs that are pertinent to remediation of the site are specified in the record of decision for each operable unit. This section highlights some of the major requirements related to environmental monitoring and waste management, and how the FCP complied with these requirements in 2002.

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

2.2.1 Resource Conservation and Recovery Act (RCRA)

RCRA as amended regulates treatment, storage, and disposal of hazardous waste and the hazardous part of mixed waste (mixed waste contains both radioactive and hazardous waste components). Hazardous and mixed waste now generated at the site results from such activities as CERCLA remedial actions and maintenance activities. The Fernald site also has an inventory of mixed waste generated from former production activities. These wastes are regulated under RCRA and Ohio hazardous waste management regulations; therefore, the site must comply with legal requirements for managing hazardous and mixed wastes. OEPA has been authorized by EPA to enforce its hazardous waste management regulations in lieu of the federal RCRA program. In addition, hazardous waste management is subject to the 1988 Consent Decree and the 1993 Stipulated Amendment between the State of Ohio and DOE, as well as a series of Director's Final Findings and Orders issued by OEPA.

The FCP completed several administrative activities related to mixed waste storage and treatment during 2002, including:

- Submittal of the 2001 RCRA Annual Report (DOE 2002e), which describes hazardous waste activities for 2001.
- Revisions to several sections of the RCRA Part A and B permit application.
- Submittal of the Fiscal Year 2002 Annual Update to the Site Treatment Plan (DOE 2002d) as required in the 1992 Federal Facility Compliance Act and the implementing Director's Findings and Orders issued by OEPA in October 1995.

Additional details on projects involving treatment of mixed wastes are provided in subsection 2.2.1.4, Mixed Waste Treatment.

2.2.1.1 RCRA Property Boundary Groundwater Monitoring

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

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2.2.1.2 RCRA Closures

The 1993 Stipulated Amendment to Consent Decree required that DOE identify all hazardous waste management units at the site. As a result, burners, incinerators, furnaces, stills, process equipment, tank units, dust collectors, and other potential waste containment units were evaluated in the early 1990s to determine if they were hazardous waste management units or solid waste management units. This evaluation was completed in 1994. In 1996 OEPA issued a Director's Findings and Orders to integrate RCRA closure requirements with CERCLA response actions for FCP hazardous waste management units. In 2002 the FCP submitted plans for the remediation of twelve units: Pilot Plant Warehouse, Butler Building, Fire Training Facility, two storage pads located by the laboratory, Plant 1 Pad, Tank Farm Sump, Plant 8 East and West Storage Pads, the abandoned sump west of the pilot plant, and the soil contamination associated with the Box Furnace, and the Nitric Acid Recovery System.

2.2.1.3 Thorium Management

A thorium management strategy to improve the storage of thorium materials at the Fernald site, and a schedule to complete RCRA determinations of thorium materials, were developed as part of the Stipulated Amendment to the Consent Decree signed in 1991. This strategy is based on three primary objectives:

- To maintain environmentally stable interim storage of the thorium inventory while minimizing personnel radiation exposure.
- To implement actions required to complete RCRA evaluations of the thorium materials.
- To implement long-term storage and disposal alternatives.

The Thorium Overpacking Project, in which the FCP removed 3,400 containers of thorium material and shipped 10,875 drum-equivalents, or 80,480 ft^3 (2,279 m^3), of thorium material to the Nevada Test Site for disposal, was completed in 1997. The characterization documentation and formal RCRA waste determinations for the remaining estimated 8,500 containers of thorium legacy waste resumed continued in 1999. Through the end of 2002, over 7,100 of these containers were shipped to Nevada Test Site for disposal. This shipping effort removed over 1,250,000 pounds (568,000 kg) of thorium from the total site thorium inventory. The following activities are planned for the future:

- Low-level radioactive, non-RCRA thorium legacy waste will continue to be prepared and shipped to the Nevada Test Site for disposal.
- The thorium legacy waste determined to be hazardous under RCRA will be prepared and shipped for treatment to meet land disposal restrictions. These shipments are scheduled for completion by December 5, 2003. Upon analytical confirmation, the treated waste will be shipped from the treatment facility to an approved disposal facility.

2.2.1.4 Mixed Waste Treatment

The FCP stores mixed wastes that are subject to RCRA land disposal restrictions. These restrictions currently prohibit the storage of certain hazardous waste streams for longer than one year, unless OEPA approves an extension.

The 1992 amendment to RCRA, the Federal Facility Compliance Act, provided DOE with an exemption from enforcement under the land disposal restrictions storage prohibition as long as DOE sites complied with the plans and schedules for mixed waste treatment. This is identified in the Site Treatment Plan, and the implementing Director's Findings and Orders issued by OEPA on October 4, 1995. The FCP submitted the first Site Treatment Plan Annual Update to OEPA in December 1996. These updates are due by December 31 of each year. Since then, six additional annual updates have been submitted. The annual update describes the status of mixed waste treatment projects developed under the Site Treatment Plan. It also adds newly generated and newly identified mixed waste streams, and certifies that the FCP met all regulatory milestone dates for the treatment of mixed wastes identified in the plan and in the implementing Director's Findings and Orders.

Mixed waste is defined under RCRA as waste containing both a hazardous waste subject to RCRA, and a source, special nuclear, or radioactive byproduct material subject to the Atomic Energy Act as amended. RCRA mixed wastes at the Fernald site are stored in consolidation tanks until they are shipped to the incinerator at Oak Ridge, Tennessee. The consolidation tanks at the Fernald site hold approximately 20,000 gallons of material, which constitutes a "batch." Batches may contain oils, solvents, or a combination of the two.

In 2002, 11,787 gallons (44,614 liters) of liquid waste under the Mixed Waste Project were bulked into the Batch 13 consolidation tank for later shipment. The following mixed wastes were shipped during 2002:

- 5,465 gallons (20,685 liters) of liquid mixed waste from Batch 11 and 16,552 gallons (62,649 liters) of liquid mixed waste from Batch 12 were shipped to the K-25 Toxic Substances Control Act Incinerator in Oak Ridge, Tennessee for treatment.
- 261 ft^3 (7 m^3) of waste under the Mixed Waste Project were shipped to Materials and Energy Corporation in Oak Ridge, Tennessee for treatment.
- 9,749 ft^3 (276 m^3) of waste under the Mixed Waste Project were shipped to Waste Control Specialists in Andrews, Texas for treatment.
- 4,013 ft^3 (114 m^3) of waste under the Mixed Waste Project were shipped to Envirocare of Utah, Inc. for treatment.
- 19,028 gallons (72,021 liters; under specific Waste Management Project treatment campaigns) of liquid aqueous low-level radioactive and mixed wastes meeting National Pollutant Discharge Elimination System (NPDES) Permit requirements were treated at the advanced wastewater treatment facility.

2.2.2 Clean Water Act

Under the Clean Water Act as amended, the FCP is governed by NPDES regulations that require the control of discharges of non-radiological pollutants to waters of the State of Ohio. The NPDES Permit, issued by the State of Ohio, specifies discharge and sample locations, sampling and reporting schedules, and discharge limitations. The FCP submits monthly reports on NPDES activities to OEPA. The Fernald site's current NPDES Permit, Permit No. 1IO00004*FD, became effective on March 1, 2000. Chapter 4 discusses the surface water and treated effluent information in detail.

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2.2.3 Clean Air Act

NESHAP Subpart H imposes a limit of 10 millirem (mrem) per year on the effective dose equivalent to the maximally exposed individual as a result of all air emissions (with the exception of radon) from the facility in a single year. For 2002 the FCP was in compliance with the NESHAP dose limit as determined by ambient air monitoring at the site's fenceline boundary.

EPA regulates the Fernald site's radionuclide emission sources through NESHAP; OEPA has authority to enforce the State of Ohio's air standards including particulate, chemical, and toxic emission sources. In 2002 the FCP complied with all emissions standards, as discussed in Chapter 5. The NESHAP Annual Report for 2002 is included as Appendix D.

Several remediation activities, including the waste pits remediation, decontamination and dismantling, soil excavation, and on-site disposal facility construction and waste placement, may result in the generation of fugitive dust, which is also regulated by OEPA. Compliance is accomplished by implementing the Fugitive Dust Control Policy negotiated between DOE and OEPA in 1997. This policy is implemented in the Best Available Technology Determination for Remedial Construction Activities on the Fernald Environmental Management Project (DOE 1997b), the requirements of which are incorporated into each operable unit's remedial design and remedial action deliverables. The policy allows for visual observation of fugitive dust and implementation of dust control measures to determine compliance during remediation activities.

2.2.4 Superfund Amendments and Reauthorization Act of 1986

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

The SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report for 2002 was submitted to OEPA and other local emergency planning/response organizations in February 2003. This report lists the amount and location of hazardous chemicals and substances stored or used in amounts greater than the minimum reporting threshold at any time during the previous year.

A SARA Title III, Section 313, Toxic Chemical Release Inventory Report (Form R) is required if the Fernald site meets certain criteria and an applicable threshold for any SARA 313 chemical is reached. The Toxic Chemical Release Inventory Report lists routine and accidental releases, as well as information about the activities, uses, and waste for each reported toxic chemical. During 2002 an evaluation was begun to determine if the Fernald site has any chemicals that meet the SARA 313 manufactured, processed, or otherwise used reporting threshold requirements. The regulatory reporting threshold has changed for several chemicals; therefore, a thorough review of chemicals at the Fernald site was conducted. The evaluation will be completed in June of 2003 and will be reported, if required, to EPA and OEPA prior to the July 1, 2003 compliance date. Should reporting criteria not be met, a letter to this effect will be forwarded to the appropriate agencies.

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Also under SARA Title III, any off-site release meeting or exceeding a reportable quantity as defined by SARA Title III, Section 304, requires immediate notifications be made to local emergency planning committees and the state emergency response commission. Notifications are also made to the National Response Center and other appropriate federal, state, and local regulatory entities. All releases occurring at the Fernald site are evaluated and documented to ensure that proper notifications are made in accordance with SARA, and under CERCLA Section 103, RCRA, the Toxic Substances Control Act, the Clean Air Act, the Clean Water Act, and Ohio environmental laws and regulations.

In 2002 there was only one release at the Fernald site that met the reporting criteria under CERCLA. This was a release of 1.8 pounds (.82 kg) of friable asbestos from a damaged utility pipe. Asbestos is not an Extremely Hazardous Substance (EHS) and did not reach off site; thus, it was not reportable under SARA Title III. Notification was made only to the National Response Center (NRC) because it was only a CERCLA, not a SARA, release. Other informational notifications were made as deemed appropriate.

Table 2-2 summarizes the FCP's compliance with SARA Title III (i.e., EPCRA) reporting requirements during 2002. Note: The one reportable release notification was not under SARA Title III.

TABLE 2-2
SUPERFUND AMENDMENTS AND REAUTHORIZATION ACT, TITLE III (EMERGENCY PLANNING AND COMMUNITY RIGHT-TO-KNOW ACT) COMPLIANCE REPORTING, 2002[a]

Sections of the Act	Yes	No	Not Required
302-303: Planning notification	✓		
304: Extremely hazardous substances release notification			✓
311-312: Material safety data sheet/chemical inventory	✓		
313: Toxic chemical release inventory reporting (for calendar year 2001)[b]			✓[c]

[a]"Yes" indicates that notifications were provided and/or reports were issued under the applicable provisions. "No" indicates that notifications or reports should have been provided but were not. "Not required" indicates that no actions were required under the applicable provisions, either because triggering thresholds were not exceeded or no releases occurred.
[b]No 313 reporting is required, but will be done as applicable.
[c]One release notification was made under CERCLA, but notification was not required under SARA Title III as it was not an EHS, nor off site.

2.2.5 Other Environmental Regulations

The FCP is also required to comply with other environmental laws and regulations in addition to those described above. Table 2-3 summarizes compliance with each of these requirements for 2002.

2.2.6 Other Permits

Permits are the means by which some environmental laws are implemented. The FCP has permits for controlled releases to surface water and air. The FCP's permit for discharging water under NPDES regulations is discussed in subsection 2.2.2, Clean Water Act. The active Permits to Install remaining for the wastewater treatment system include those for the Storm Water Retention Basin and Bio-Surge Lagoon. Permits to Install govern the installation (and to a lesser degree, the operation) of specific wastewater treatment and control devices.

The FCP has six current air Permits to Operate and three associated Permits to Install. These permits cover four boilers, a diesel storage tank, and a gasoline dispensing facility. EPA and OEPA approve other air emission sources and wastewater systems related to remedial activities through the review and approval of CERCLA remedial design packages or CERCLA-allowed permit information summaries.

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TABLE 2-3
COMPLIANCE WITH OTHER ENVIRONMENTAL REGULATIONS

Regulation and Purpose	Background Compliance Issues	2002 Compliance Activities
Toxic Substances Control Act (TSCA)		
Regulates the manufacturing, use, storage, and disposal of toxic materials, including polychlorinated biphenyl (PCBs) and PCB items.	The last routine TSCA inspection of the FCP's program was conducted by EPA Region V on September 21, 1994. No violations of PCB regulations were identified during the inspection.	Non-radiologically contaminated PCBs and PCB items are shipped to TSCA-approved commercial disposal facilities for incineration on an as-needed basis. Radiologically contaminated PCB liquids were bulked for shipment to the TSCA-permitted DOE incinerator in Oak Ridge, Tennessee. Radiologically contaminated PCB solids are to be shipped off-site in 2003 for treatment by a commercial facility.
Ohio Solid Waste Act		
Regulates infectious waste.	The Fernald site was registered with OEPA as a generator of infectious waste (generating more than 50 pounds [23 kg] per month) until December 6, 1999, when OEPA concurred with the Fernald site's qualification as a small quantity generator.	All infectious wastes generated in the medical department were transported to a licensed treatment facility for incineration.
Federal Insecticide, Fungicide, and Rodenticide Act		
Regulates the registration, storage, labeling, and use of pesticides (such as insecticides, herbicides, and rodenticides).	The last inspection of the Federal Insecticide, Fungicide, and Rodenticide Act program conducted by EPA Region V on September 21, 1994, found the Fernald site to be in full compliance with the requirements mandated by Federal Insecticide, Fungicide, and Rodenticide Act.	Pesticide applications at the Fernald site were conducted according to Federal and State regulatory requirements.
National Environmental Policy Act (NEPA)		
Requires the evaluation of environmental, socio-economic, and cultural impacts before any action, such as a construction or cleanup project, is initiated by a federal agency.	An environmental assessment for proposed final land use was issued for public review in 1998. It was prepared under DOE's guidelines for implementation of NEPA, 10 Code of Federal Regulations 1021. The assessment requires consulting the public before any decisions on land use are made; it includes previous DOE commitments.	No NEPA activities were required in 2002.
Endangered Species Act		
Requires the protection of any threatened or endangered species found at the site as well as any critical habitat that is essential for the species' existence.	Ecological surveys conducted by Miami University and DOE, in consultation with the Ohio Department of Natural Resources and the U.S. Fish and Wildlife Service, have established the following list of threatened and endangered species and their habitats existing on site: Cave salamander, state-listed endangered -- marginal habitat, none found; Sloan's crayfish, state-listed threatened -- found on northern sections of Paddys Run; Indiana brown bat, federally listed endangered -- found in riparian areas along Paddys Run.	A survey of the federally endangered Indiana brown bat was conducted in 2002. Suitable habitat remains, but no individuals were identified.

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TABLE 2-3
(Continued)

Regulation and Purpose	Background Compliance Issues	2002 Compliance Activities
Floodplains/Wetlands Review Requirements		
DOE regulations require a floodplain/wetland assessment for DOE construction and improvement projects.	A wetlands delineation of the FCP, completed in 1992 and approved by the U.S. Army Corps of Engineers in August 1993, identified 36 acres (15 hectares) of freshwater wetland on the Fernald site property. Updated delineations are conducted approximately every five years.	No assessments were performed in 2002.
National Historic Preservation Act		
Mandates protection of historic and prehistoric cultural resources.	The Fernald site is in an area rich in historic and prehistoric cultural resources. These cultural resources include 148 prehistoric sites within 1.24 miles (2 km) of the Fernald site and 40 historic sites.	Activities were conducted to avoid and address impacts on cultural resources (refer to Chapter 7).
Native American Graves Protection and Repatriation Act		
Requires the identification and preservation of cultural resources on federal lands, and consultation with Native American Tribes on removal and management of inadvertently discovered Native American cultural items.	Historical remains and artifacts were discovered during a 1994 construction project. The Native American remains, which included an adolescent boy and his dog, were discovered during installation of pipelines for the Public Water Supply project. Partial remains of approximately 20 more people and numerous artifacts were also found.	No Native American remains were discovered or interred in 2002. Cultural resources were identified as a result of surveys performed (refer to Chapter 7).
Natural Resource Requirements Under CERCLA and Executive Order 12580		
Requires DOE to act as a Trustee (i.e., guardian) for natural resources at its federal facilities.	DOE and the other Trustees, which include the U.S. Department of the Interior, the U.S. Fish and Wildlife Service, OEPA, the Ohio Attorney General's Office, and EPA, meet regularly to discuss potential impact to natural resources and to coordinate Trustee activities. The Trustees also interact with the Fernald Citizens Advisory Board and Community Reuse Organization.	In 2002 the Trustees and stakeholders continued to discuss the scope of Natural Resource Restoration activities at the Fernald site. While the components of restoration have been established through a Memorandum of Understanding, the Trustees continue to negotiate regarding a future endpoint to a settlement agreement.

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2.2.7 Pollution Prevention and Source Reduction

The FCP is actively involved in an effort to reduce solid, hazardous, radioactive, and mixed-waste generation, and eliminate or minimize pollutant releases to all environmental media during site remediation. As part of the Annual Waste Reduction Report under the DOE Order 5400.1, the FCP submitted the site's summary of waste generated and pollution prevention progress (DOE 2002a), which is available from the DOE's pollution prevention web site (http://www.eh.doe.gov/p2). This report includes fiscal year 2002 data on waste quantities generated and avoided, as well as narrative text describing pollution prevention and waste minimization efforts and their effectiveness.

The following waste streams and quantities were recycled during calendar year 2002:

- 19.10 metric tons (21 tons) of office and mixed paper, corrugated cardboard
- 0.90 metric tons (1 ton) of aluminum cans
- 1.83 metric tons (2 tons) of toner cartridges
- 58.55 metric tons (65 tons) of scrap metal
- 0.39 metric tons (0.43 tons) of video tape.

The following hazardous wastes were shipped to approved recycle centers or treatment facilities in calendar 2002:

- 21.32 metric tons (23.5 tons) of lead acid batteries
- 619 cubic feet (18 cubic meters) of lab packs
- 1.68 metric tons (1.85 tons) of electrical waste (fluorescent light tubes)
- 0.33 metric tons (0.36 tons) of photochemicals for silver recovery.

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

2.2.8 Site-Specific Regulatory Agreements

2.2.8.1 Federal Facility Compliance Agreement

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

- Maintain a continuous sample collection program for radiological constituents at the treated effluent discharge points and report the results semi-annually to EPA, OEPA, and the Ohio Department of Health. The sampling program to address this requirement has been modified over the years and is currently governed by an agreement reached with EPA and OEPA that became effective May 1, 1996. This agreement requires sampling at the Parshall Flume (PF 4001), the point where treated effluent leaves the FCP, and the Storm Water Retention Basin spillway for radiological constituents. These data are reported through mid-year and annual reports (refer to Appendix B of this report) under the IEMP.

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- Maintain a sampling program for daily flow and total uranium at the South Plume extraction wells and report the results semi-annually to the EPA, OEPA, and Ohio Department of Health. The sampling program conducted to address this requirement has also been modified over the years and is currently governed by the agreement reached with EPA and OEPA on May 1, 1996.

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

The Federal Facility Agreement (FFA) between DOE and EPA, signed in November of 1991, ensures that DOE takes all necessary actions to control and abate radon-222 emissions at the Fernald site, under the authority of 40 Code of Federal Regulations 61, Subpart Q. This agreement acknowledges that Silos 1 and 2 exceed the radon flux rate of 20 picoCuries per square meter per second (pCi/m^2/sec). But it allowed the FCP to address this exceedance by implementing a removal action (installation of a bentonite cap in 1991) to bring radon emissions from the silos to a level as low as reasonably achievable (ALARA), and to attain the NESHAP Subpart Q standard upon completion of final remediation. The FFA also requires demonstration of compliance with the Subpart Q standard upon completion of remedial actions for the waste pits, clearwell, and any other sources found to contain radium-226 in sufficient concentrations to emit radon in excess of 20 pCi/m^2/sec. Chapter 5 further discusses the results of the Radon Monitoring Program for 2002.

2.3 Split Sampling Program

In 2002 DOE and OEPA cooperated in a program in which samples of groundwater were split. (Split samples are obtained when technicians alternately add portions of a sample to two individual sample containers.) This collection method helps ensure that both samples are as identical as possible. The split samples were sent to different analytical laboratories. The FCP has participated in this program with the state since 1987.

This program allows for an independent comparison of data to ascertain laboratory analysis and field quality assurance. The data from the split sampling program show reasonable agreement between DOE and OEPA results for groundwater samples. The differences in DOE and OEPA sample results presented for 2002 do not impact the site's compliance with federal or state regulations. The detailed results for the 2002 split samples are presented in Appendix E of this report.

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Chapter 3

Groundwater Pathway

3.0 Groundwater Pathway

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Results in Brief: 2002 Groundwater Pathway

Enhanced Groundwater Remedy – During 2002 active restoration of the Great Miami Aquifer continued at the following four groundwater restoration modules:

- South Plume Module, which became operational on August 27, 1993.
- South Field Extraction (Phase I) Module, which became operational on July 13, 1998.
- South Plume Optimization Module, which became operational on August 9, 1998.
- Re-Injection Module, which became operational on September 2, 1998.

Additionally, pumping for the Waste Storage Area (Phase I) Module, which is comprised of three extraction wells, was initiated on May 8, 2002.

Since 1993

- 11,812 million gallons (44,708 million liters) of water have been pumped from the Great Miami Aquifer.
- 1,247 million gallons (4,720 million liters) of water have been re-injected into the Great Miami Aquifer.
- 4,448 net pounds (2,019 kg) of total uranium have been removed from the Great Miami Aquifer.

During 2002

- 2,287 million gallons (8,656 million liters) of water were pumped from the Great Miami Aquifer.
- 241 million gallons (912 million liters) of water were re-injected into the Great Miami Aquifer.
- 1,225 net pounds (556 kg) of total uranium were removed from the Great Miami Aquifer.

Groundwater Monitoring Results – Groundwater sampling data in the South Field Module area continue to indicate total uranium concentration reductions in the western portion of the plume. These reductions are attributed to surface source removal, flushing of the contaminants toward the extraction wells by infiltrating surface water, re-injection of treated groundwater, and pumping of the extraction wells. However, in the eastern portion of the South Field Module, some monitoring wells still show steady or increasing total uranium concentrations. Additional extraction wells were installed in this portion of the plume in 2002 as part of the South Field Phase II Module and pumping will begin in 2003. One extraction well was installed as part of the South Field Phase I Module and pumping was initiated in May 2002.

IEMP Program Changes – Groundwater sampling frequencies were changed from quarterly to semi-annually in July 2002. Additional groundwater monitoring program changes were incorporated into the IEMP, Revision 3 for implementation in January of 2003.

On-Site Disposal Facility Monitoring – The Technical Memorandum for Cells 1, 2, and 3 Baseline Conditions was issued and approved by EPA and OEPA in 2002. Modified sampling protocol for Cells 1 through 3 were approved and initiated in the second half of 2002. Baseline sampling for Cells 4 and 5 continued and was initiated in Cell 6 Great Miami Aquifer wells in December 2002. Waste placement in Cells 4 and 5 was initiated in November 2002.

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

- Significant achievements realized by the Operable Unit 5 Aquifer Restoration and Wastewater Project in 2002.
- Groundwater monitoring activities and results for 2002.

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

3.1 Summary of the Nature and Extent of Groundwater Contamination

Groundwater Modeling at the Fernald Site

The Fernald site uses computer models to make predictions about how the contaminants in the aquifer will look in the future. Because the model contains simplifying assumptions about the aquifer and the contaminants, the predictions about future behavior must be verified with field measurements obtained from groundwater monitoring activities.

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

The nature and extent of groundwater contamination from operations at the Fernald site have been investigated, and the risk to human health and the environment from those contaminants has been evaluated in the Operable Unit 5 Remedial Investigation Report. As documented in that report, the primary groundwater contaminant at the site is uranium. Approximately 170 acres (69 hectares) of the Great Miami Aquifer are currently contaminated above the 30 µg/L groundwater FRL for total uranium.

Contamination of the groundwater resulted from infiltration through the bed of Paddys Run, the Storm Sewer Outfall Ditch, and the Pilot Plant Drainage Ditch. In these areas, the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium-contaminated surface water from the site. To a lesser degree, groundwater contamination also resulted where past excavations, such as the waste pits, removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination.

3.2 Selection and Design of the Groundwater Remedy

After the nature and extent of groundwater contamination were defined, various remediation technologies were evaluated in the Feasibility Study Report for Operable Unit 5 (DOE 1995a). Remediation cost, efficiency, and various land-use scenarios were considered during the development of the preferred remedy for restoring the quality of the groundwater in the aquifer.

The Operable Unit 5 Feasibility Study Report recommended a pump-and-treat remedy for the groundwater contaminated with uranium. The remedy consisted of 28 groundwater extraction wells located on and off property. Computer modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gallons per minute (gpm) (15,000 liters per minute [Lpm]) would remediate the aquifer within 27 years. The recommended groundwater remedy was presented to EPA, OEPA, and stakeholders in the Proposed Plan for Operable Unit 5 (DOE 1995b).

Once the preferred groundwater remedy was identified and approved in the Operable Unit 5 Proposed Plan, the Operable Unit 5 Record of Decision was presented to stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision formally defined the selected groundwater remedy and established FRLs for all constituents of concern. The Operable Unit 5 Record of Decision committed to ongoing evaluation of innovative remediation technologies so that remedy performance could be improved as such technologies become available. As a result of this commitment, an enhanced groundwater remedy was presented in the Operable Unit 5 Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997a).

The enhanced groundwater remediation strategy, which relies on pump-and-treat and re-injection technology, is being used to conduct a concentration-based cleanup of the Great Miami Aquifer. Active remediation commenced in 1998 with the start-up of the South Field (Phase I), South Plume Optimization, and Re-Injection Demonstration Modules. The restoration strategy primarily focuses on the removal of uranium, but also has been designed to limit the further expansion of the plume, achieve removal of all targeted contaminants to concentrations below designated FRLs, and prevent undesirable groundwater drawdown impacts beyond the site's boundary.

Re-Injection at the Fernald Site

Re-injection is an enhancement to the groundwater remedy. Groundwater pumped from the aquifer is treated to remove contaminants and then re-injected back into the aquifer at strategic locations. The re-injected groundwater increases the speed at which contaminants move through the aquifer and are pulled by extraction wells, thereby decreasing the overall remediation time.

A groundwater re-injection demonstration was also initiated at the Fernald site in September 1998. Following completion of the re-injection demonstration in September of 1999, the Re-Injection Demonstration Test Report (DOE 2000) was issued to EPA and OEPA on May 30, 2000. The report detailed the demonstration and recommended its incorporation into the site's aquifer restoration strategy. Based on the results of the demonstration, re-injection is continuing at the site. The Re-Injection Module Operational Summary section within this chapter provides more discussion of this topic.

The enhanced groundwater remedy also included additional extraction wells in on-site areas of aquifer contamination. Groundwater modeling studies conducted in support of the enhanced groundwater remedy suggested that, with the early installation of additional extraction wells and re-injection technology, the remedy could potentially be reduced to 10 years. EPA and OEPA approved the enhanced groundwater remedy.

While the remedial investigation and feasibility study process 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 total uranium plume in this area from migrating any further to the south. Figure 3-1 shows the South Plume Module Extraction Wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the total uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

The EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas in 2001. The design specified three extraction wells in the waste storage area (Phase I) to address contamination in the Pilot Plant Drainage Ditch plume and two extraction wells to address the remaining contamination after the waste pit excavation is completed (Phase II). One of the three Phase I wells was installed in 2000 to support an aquifer pumping test to help determine the restoration wellfield design. The remaining two Phase I wells were installed in the summer of 2001 after the design was approved by EPA and OEPA. These three wells became operational on May 8, 2002. Nine new monitoring wells were installed as part of Phase I. The waste storage area design report also provided data indicating that the total uranium plume in the Plant 6 area was no longer present (DOE 2001a). It was believed that the total uranium plume had dissipated to concentrations below the FRL as a result of the shut-down of plant operations in the late 1980s and the pumping of highly contaminated perched water as part of the Perched Water Removal Action #1 in the early 1990s. Because a total uranium plume with concentrations above the groundwater FRL was no longer present in the Plant 6 area at the time of the design, a restoration module for this area was determined to be unnecessary and was no longer planned. However, groundwater monitoring continued in the Plant 6 area in 2002 and one well in the area had a uranium concentration above 30 µg/L in 2002. On June 12, 2002 the uranium concentration was 40.9 µg/L and on October 21, 2002 the concentration was measured at 36.7 µg/L. Therefore, Figure 3-1 shows a small uranium plume in the Plant 6 Area. Continued monitoring will determine whether or not this small plume will dissipate or require some type of pumping action.

The EPA and OEPA approved the Design for Remediation of the Great Miami Aquifer South Field (Phase II) Module in 2002. 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 pending the updated plume interpretation. In the Phase II design, the existing Phase I module will be supplemented with four new extraction wells, and one new re-injection well. In addition, an existing extraction well (31563) will be converted into a re-injection well. The decision was also made to permanently shut down Extraction Wells 31565 and 31566 which had been inactive since May 22, 2001 and August 7, 1998, respectively. Phase II wells are scheduled to become operational in 2003.

During 2002 active remediation of the Great Miami Aquifer began in the waste storage area and continued at the following groundwater restoration modules: South Plume/South Plume Optimization Module, South Field Extraction (Phase I) Module, and Re-Injection Module. Figure 3-1 depicts the current extraction and re-injection well locations. The operational information associated with these modules is presented in subsequent subsections.

Figure 3-2 identifies current and future extraction and re-injection well locations. The location of the future wells in the South Field are based on the South Field (Phase II) design discussed above. The location of future waste storage area wells are based on the waste storage area (Phase I) design discussed above.

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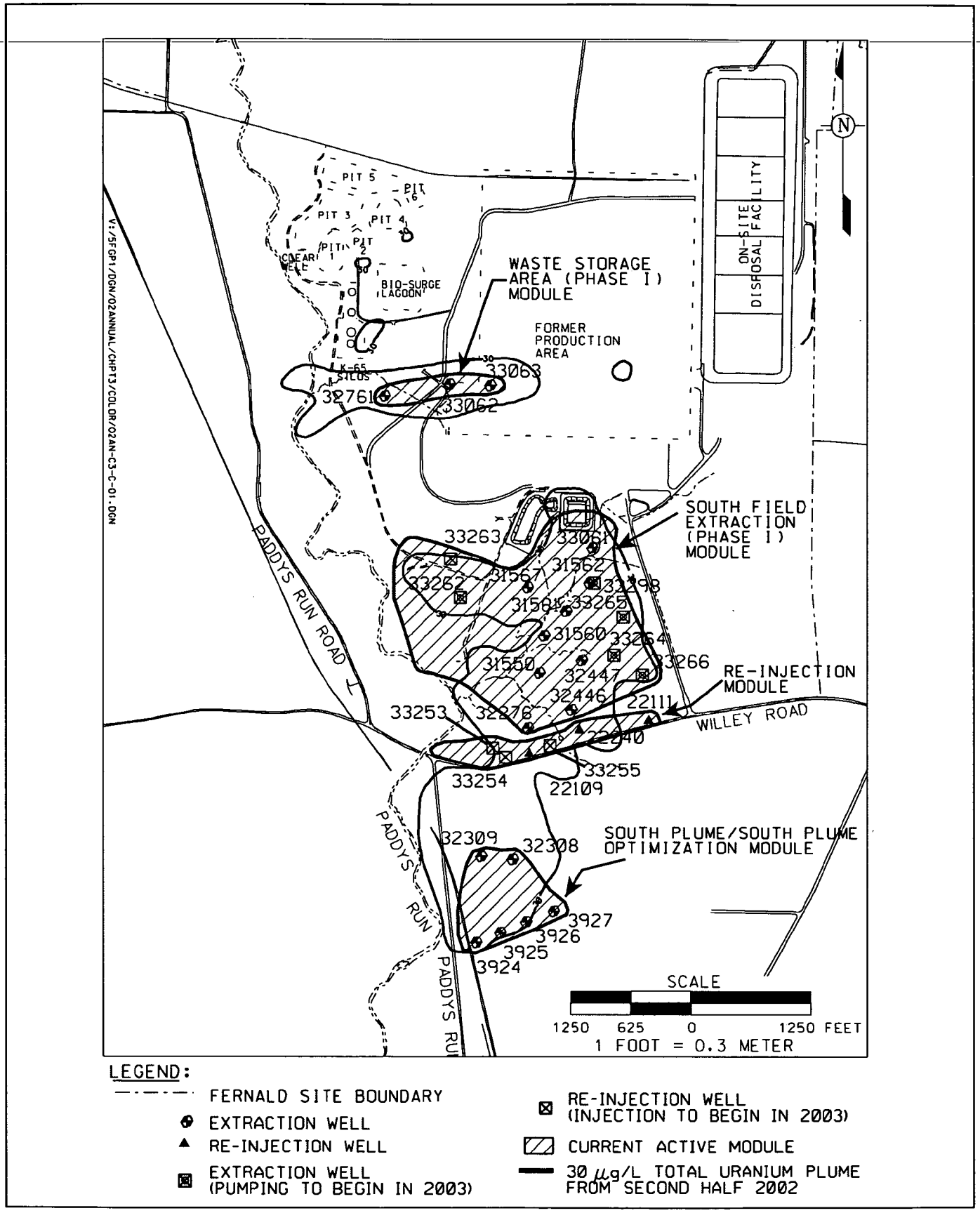

Figure 3-1. Current Extraction and Re-Injection Wells

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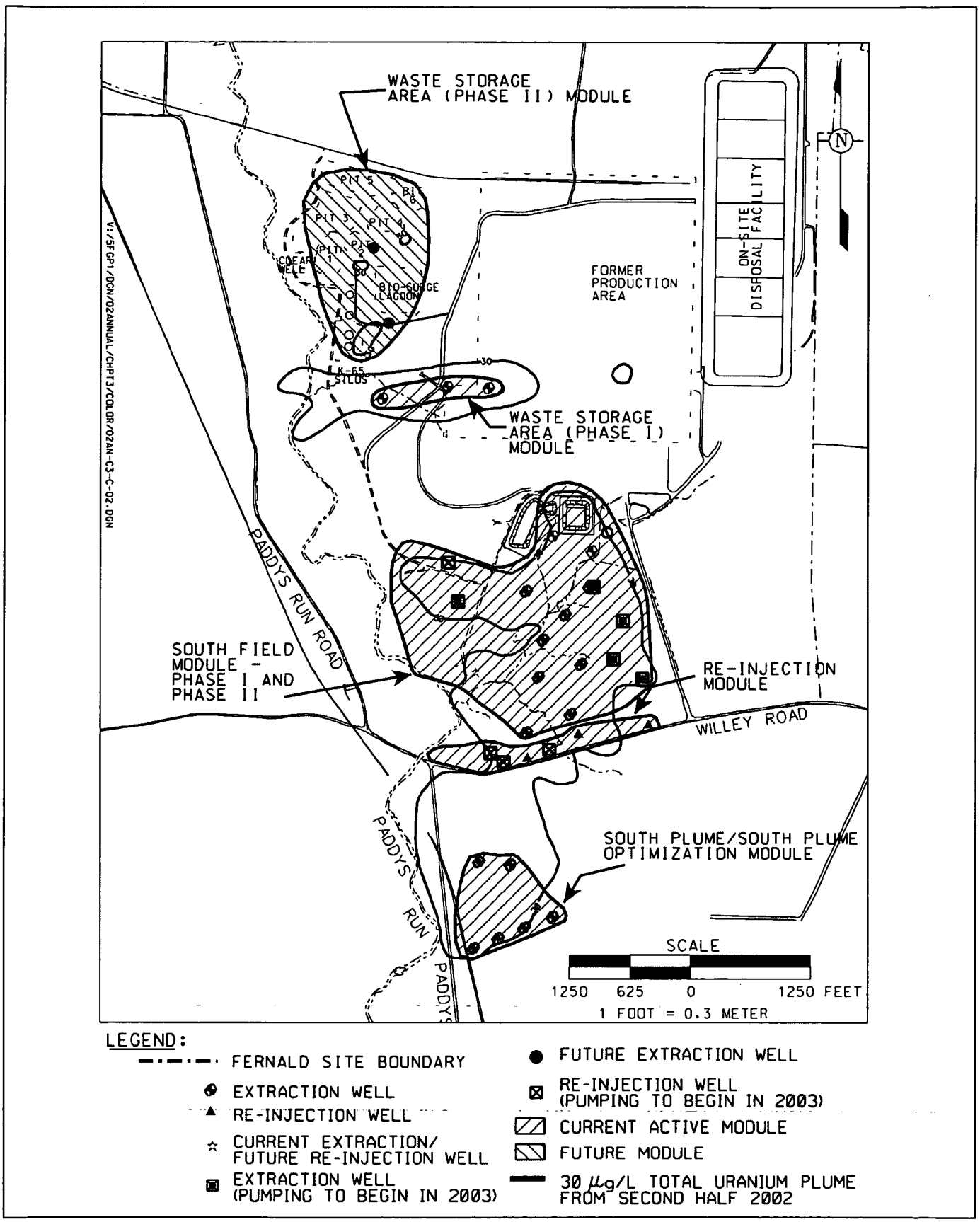

Figure 3-2. Current and Future Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

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3.3 Groundwater Monitoring Highlights for 2002

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

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

- **Sampling** – Sample locations, frequency, and the constituents were selected to address operational assessment, restoration assessment, and compliance requirements. Selected wells are monitored for up to 50 groundwater FRL constituents. Monitoring is conducted to ascertain groundwater quality and groundwater flow direction. Figure 3-3 shows a typical groundwater monitoring well at the site and Figure 3-4 identifies the relative placement depths of groundwater monitoring wells at the site. As part of the comprehensive IEMP groundwater monitoring program, approximately 120 wells were monitored for water quality in 2002. Figure 3-5 identifies the location of the current IEMP water quality monitoring wells, including extraction wells. In addition to water quality monitoring, approximately 140 wells were monitored quarterly for groundwater elevations. Figure 3-6 depicts the IEMP routine water level (groundwater elevation) monitoring wells, including extraction wells.

  Based on EPA and OEPA approval, beginning in July of 2002 the frequency of groundwater quality sampling went from quarterly to semiannually. Additional groundwater monitoring program changes were identified for implementation in 2003. All of the proposed changes are documented in Revision 3 of the IEMP, which became effective January 1, 2003.

- **Data Evaluation** – The integrated data evaluation process looks at the data collected from wells to determine: 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 groundwater restoration on the Paddys Run Road Site plume (a separate contaminant plume south of the Fernald site along Paddys Run Road resulting from independent industrial activities in the area).

- **Reporting** – All data are reported through the IEMP program mid-year data summary and annual site environmental reports.

3.3.1 Restoration Monitoring

In general, restoration monitoring tracks the progress of the groundwater remedy and water quality conditions. Restoration monitoring is discussed in the subsections that follow.

All operational modules were evaluated during the year to evaluate the progress of aquifer remediation. The evaluation was done by collecting and mapping groundwater quality and groundwater elevation data and then analyzing the results. Concentration maps are developed from analytical data and compared with groundwater elevation maps depicting the location of the capture zone.

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

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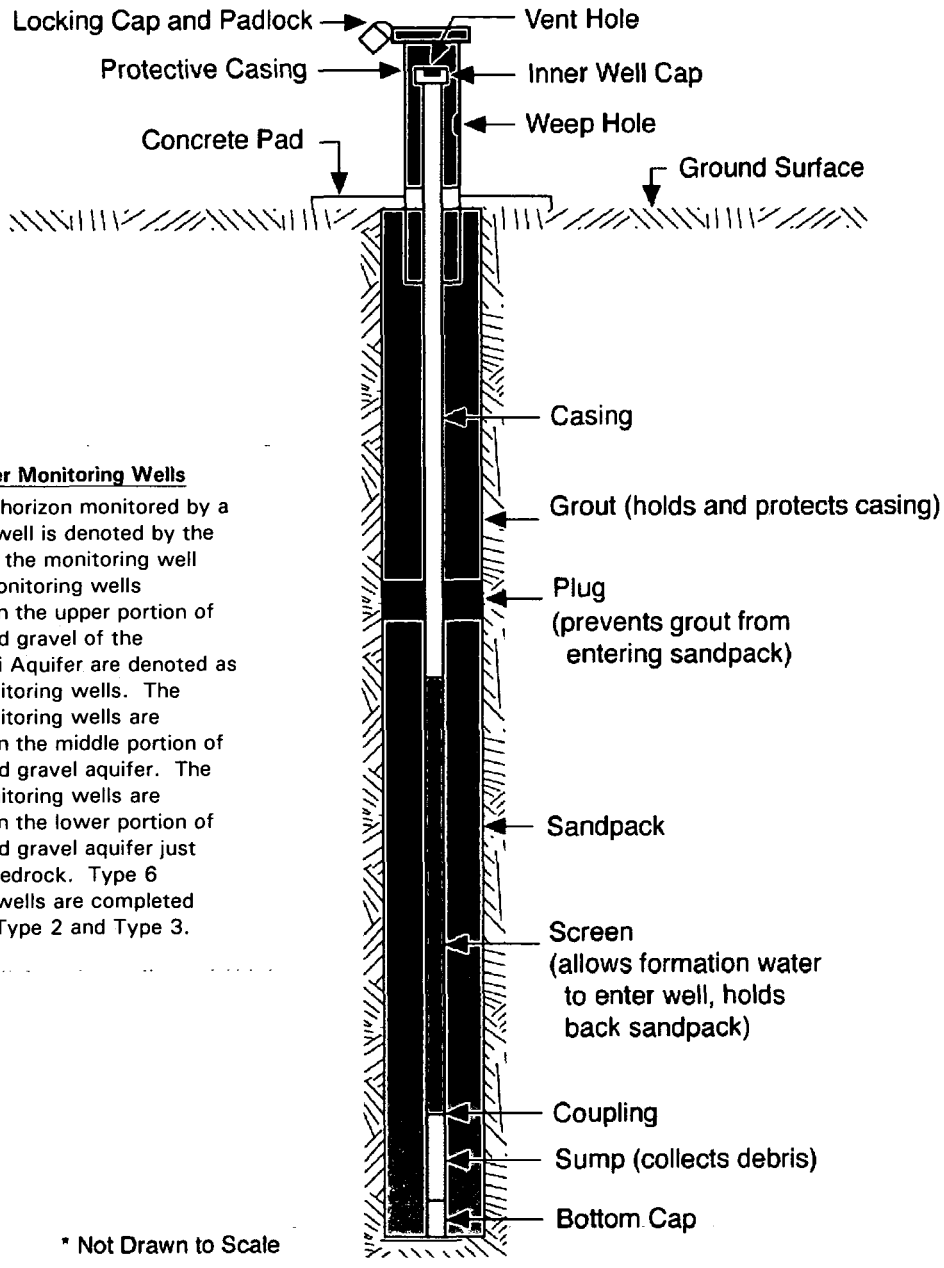

Groundwater Monitoring Wells

The aquifer horizon monitored by a monitoring well is denoted by the first digit of the monitoring well number. Monitoring wells completed in the upper portion of the sand and gravel of the Great Miami Aquifer are denoted as Type 2 monitoring wells. The Type 3 monitoring wells are completed in the middle portion of the sand and gravel aquifer. The Type 4 monitoring wells are completed in the lower portion of the sand and gravel aquifer just above the bedrock. Type 6 monitoring wells are completed between a Type 2 and Type 3.

* Not Drawn to Scale

Figure 3-3. Typical Groundwater Monitoring Well Diagram

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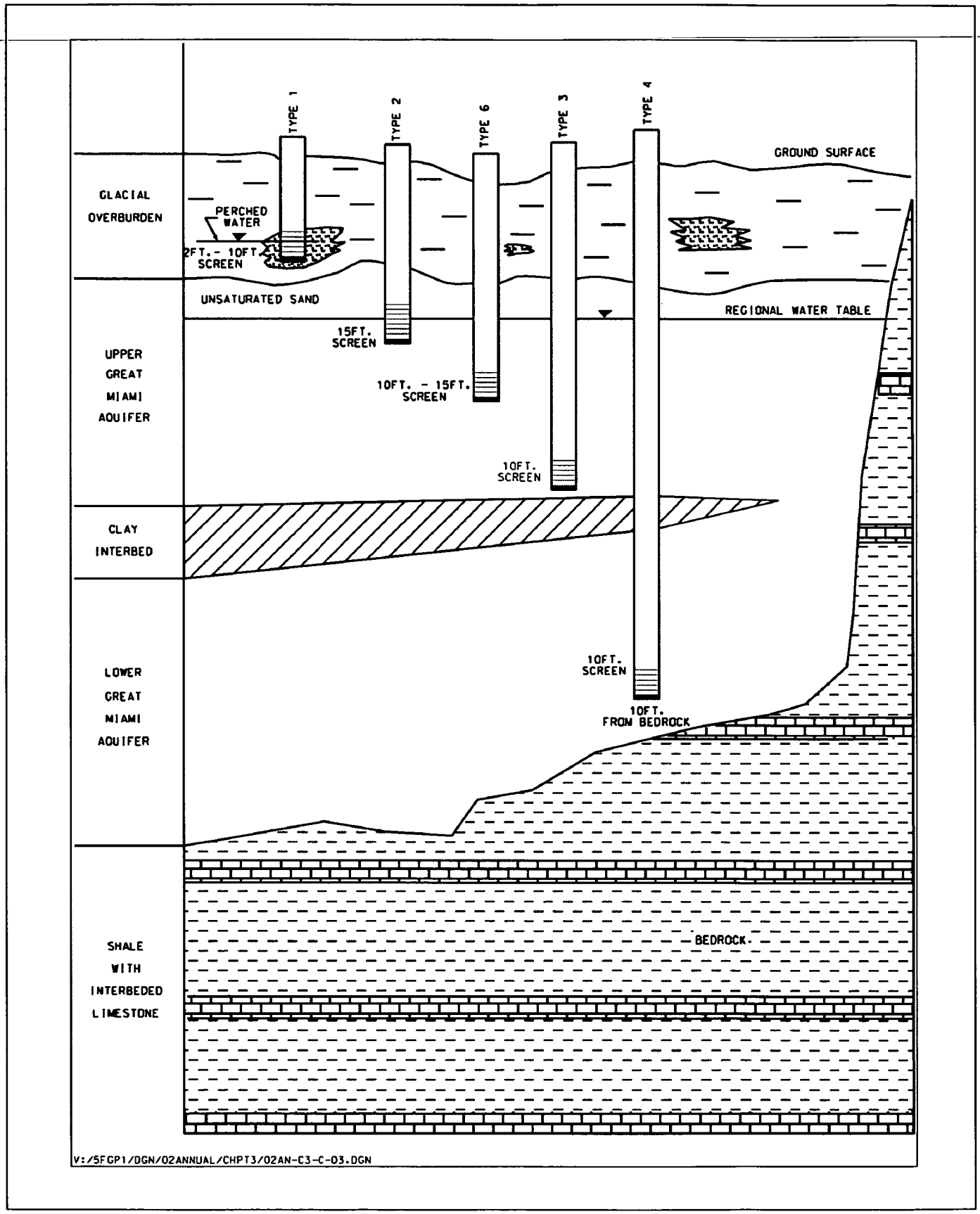

Figure 3-4. Monitoring Well Relative Depths and Screen Locations

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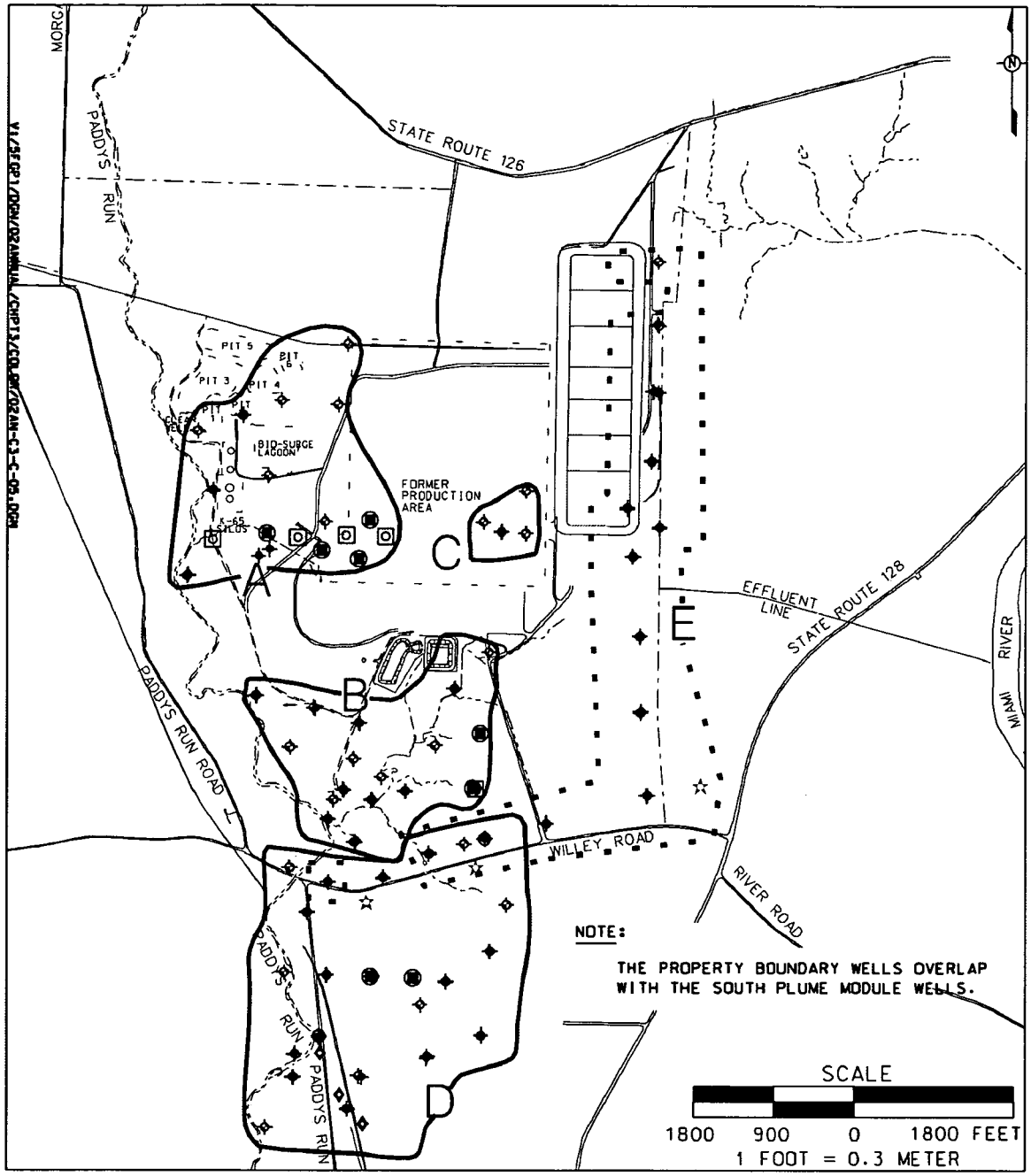

LEGEND:

A - WASTE STORAGE AREA
B - SOUTH FIELD EXTRACTION AREA
C - PLANT 6 AREA
D - SOUTH PLUME AREA
E - PROPERTY BOUNDARY WELLS

FERNALD SITE BOUNDARY
MONITORING WELL

Figure 3-5. IEMP Water Quality Monitoring Wells

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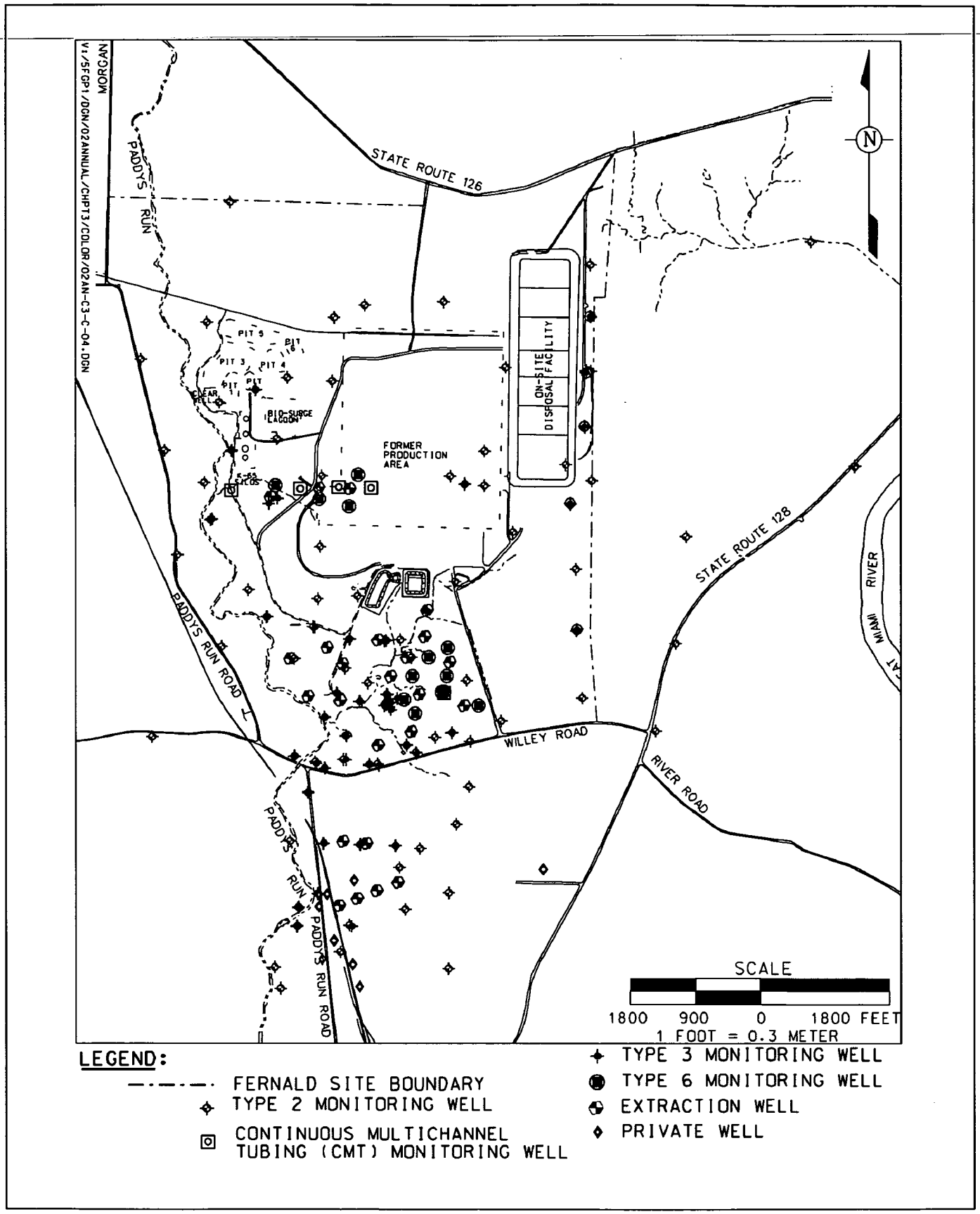

Figure 3-6. IEMP Groundwater Elevation Monitoring Wells

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3.3.1.1 Operational Summary

Figure 3-1 shows the extraction and re-injection well locations associated with the current restoration modules. Table 3-1 summarizes the pounds of uranium removed and the amount of groundwater pumped by the active restoration modules during 2002. Figure 3-7 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 2002. Since 1993:

- 11,812 million gallons (44,708 million liters) of water have been pumped from the Great Miami Aquifer.
- 1,247 million gallons (4,720 million liters) of treated water have been re-injected into the Great Miami Aquifer.
- 4,448 net pounds (2,019 kg) of total uranium have been removed from the Great Miami Aquifer.

Appendix A, Attachment 1, of this report provides detailed operational information on each extraction and re-injection well, such as pumping and re-injection rates, uranium removal indices, and total uranium concentration graphs. The following subsections provide overview information on the individual modules.

TABLE 3-1
GROUNDWATER RESTORATION MODULE STATUS FOR 2002

Module	Restoration Wells	Target Pumping Rate		Gallons Pumped/ Re-Injected		Uranium Removed/ Re-Injected	
		gpm	Lpm	M gal	M liters	lbs	kg
South Plume/ South Plume Optimization Module	3924	1,500	5,700	924	3,497	241	109
	3925						
	3926						
	3927						
	32308	500	1,900				
	32309						
South Field Extraction (Phase I) Module	31550	2,040	7,200	1,037	3,925	634	288
	31560						
	31561						
	31562						
	31563[a]						
	31564[b]						
	31565[c]						
	31566[d]						
	31567						
	32276						
	32446						
	32447						
	33061						
Waste Storage Area Module	32761	1,000	3,800	326	1,234	361	164
	33062						
	33063						
Re-Injection Module	22107[e]	1,000	3,800	241	912	11.34	5.15
	33253[f]						
	22108[g]						
	33254[f]						
	22109						
	22111						
	22240						
Aquifer Restoration System Totals							
(pumped)		5,040	18,600	2,287	8,656	1,236	561
(re-injected)		1,000	3,800	241	912	11.34	5.15
(net)		4,040	14,800	2,046	7,744	1,225	556

[a]Extraction well removed from service in December 2002.
[b]Extraction well removed from service in December 2001.
[c]Extraction well removed from service in May 2001.
[d]Extraction well removed from service in August 1998.
[e]Re-injection well replaced by Well 33253 in November 2002.
[f]Re-injection well began operating in November 2002.
[g]Re-injection well replaced by Well 33254 in November 2002.

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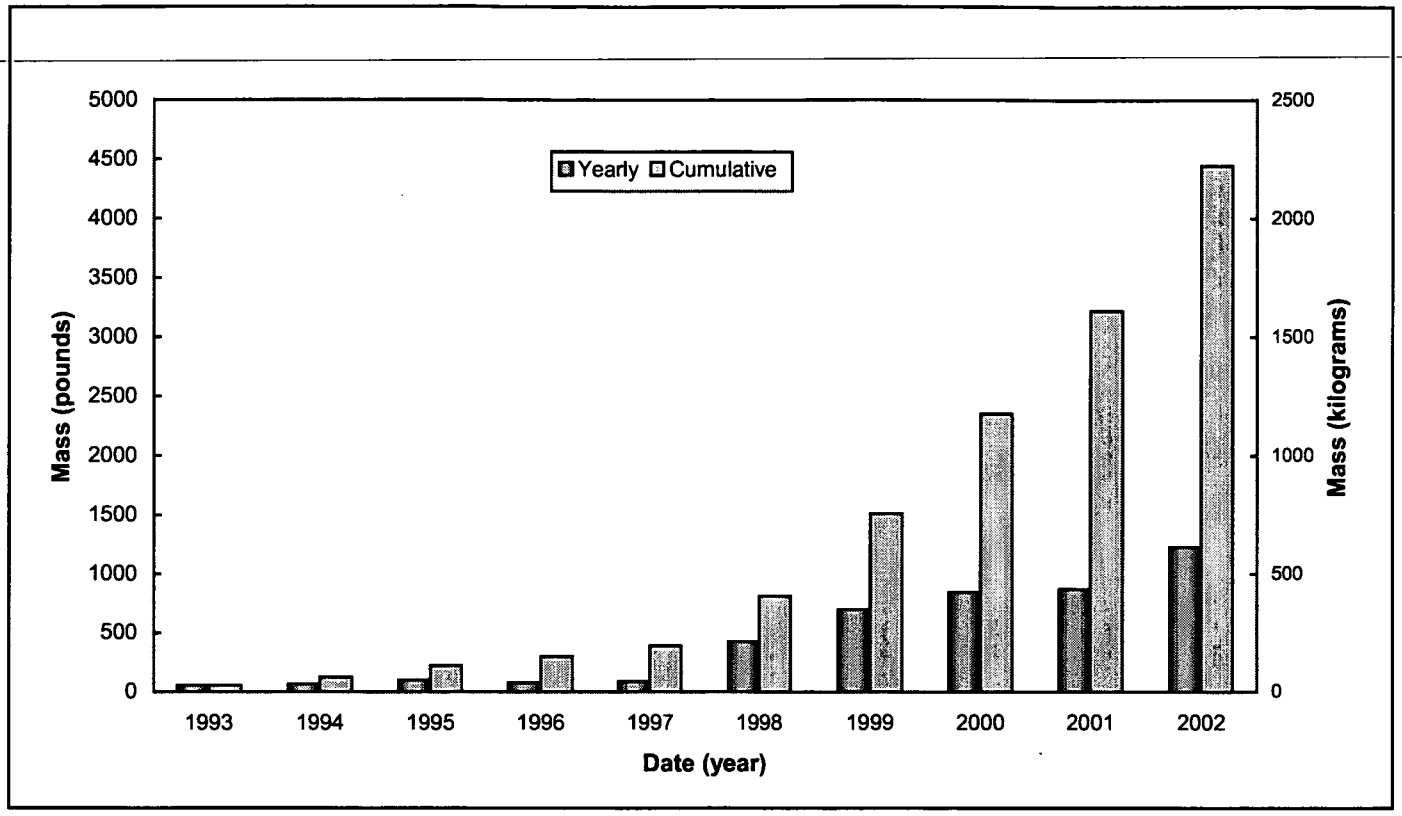

Figure 3-7. Net Pounds of Uranium Removed from the Great Miami Aquifer, 1993-2002

3.3.1.2 South Plume/South Plume Optimization Module Operational Summary

The four extraction wells of the South Plume Module include Extraction Wells 3924, 3925, 3926, and 3927, which began operating in August 1993. The two extraction wells of the South Plume Optimization Module (32308 and 32309) began operating in August 1998. Figure 3-8 illustrates capture zones associated with the South Plume/South Plume Optimization Module. Based on analysis of the data in 2002, the module continues to meet its primary objectives for the following reasons:

- Southward movement of the total uranium plume beyond the southern most extraction wells has not been detected.
- Active remediation of the central portion of the off-property total uranium plume continues.
- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

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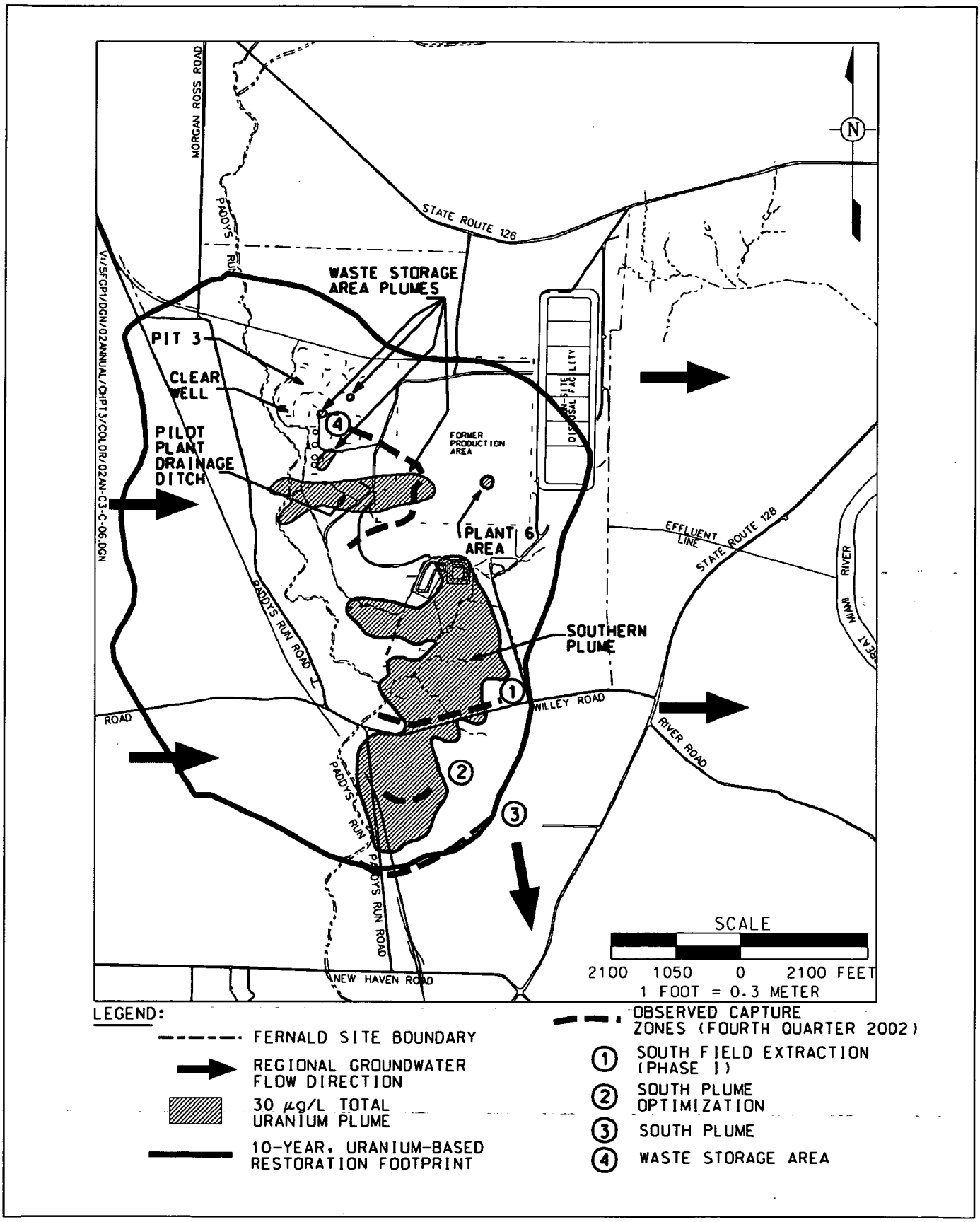

Figure 3-8. Total Uranium Plume in the Aquifer with Concentrations Greater than 30 µg/L at the End of 2002

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3.3.1.3 South Field Extraction (Phase I) Module Operational Summary

The 10 original extraction wells of the South Field Extraction (Phase I) Module include 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276, which began operating on July 13, 1998. Since then, three new extraction wells have been added to the module (32446, 32447, and 33061) and four of the original wells have been shut down (31566, 31564, 31565, and 31563). With the exception of Extraction Well 31563, the extraction wells that were shutdown are all located upgradient of the plume where total uranium concentrations in the Great Miami Aquifer are now below the uranium FRL. Extraction Well 31563 is being converted to a re-injection well. Additionally, Extraction Wells 31564 and 31565 were removed from service to accommodate soil remedial activities in the vicinity of the wells. Extraction Well 31566 was removed from service in 1998, Extraction Well 31564 was removed from service in May 2001, Extraction Well 31565 was removed from service in December 2001, and Extraction Well 31563 was removed from service in December 2002.

The three new wells added to the South Field Module (32446, 32447, and 33061) were installed at locations where total uranium concentrations are considerably above the groundwater uranium FRL, in the eastern, downgradient portion of the South Field plume. Two of the three new wells (32446 and 32447) were installed in late 1999 and began pumping in February 2000. Extraction Well 33061 was installed in 2001 and became operational in 2002. Figure 3-8 illustrates the capture zone associated with the South Field Extraction (Phase I) Module.

The Design for Remediation of the Great Miami Aquifer, South Field (Phase II) Module was issued in May of 2002 (DOE 2002b). The design provides an updated characterization of the uranium plume in the Great Miami Aquifer beneath the southern portion of the Fernald site and a modeled design for the South Field (Phase II) Module located in that area. The modeled design consists of the following components:

- Four additional extraction wells, one in the southern waste unit area (33262), and three along the eastern edge of the on-property portion of the southern uranium plume (33264, 33265, and 33266).
- One additional re-injection well in the southern waste unit area (33263).
- Converting Extraction Well 31563 into a re-injection well.
- Installing and operating one active re-injection basin to flush treated groundwater back into the aquifer to supplement re-injection through re-injection wells.

The new wells specified in the South Field (Phase II) design were installed in 2002, and are scheduled to begin operating in 2003.

3.3.1.4 Re-Injection Module Operational Summary

A groundwater re-injection demonstration test was conducted at the Fernald site from September 2, 1998 to September 2, 1999. The Re-Injection Module consisted of Re-Injection Wells 22107, 22108, 22109, 22111, and 22240. After this demonstration in September of 1999, it was decided to incorporate re-injection technology into the aquifer remedy. The Re-Injection Demonstration Test Report detailing the demonstration was issued to EPA and OEPA on May 30, 2000.

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The evaluation indicated that the testing results were favorable regarding the viability of re-injection at the Fernald site, that a reliable source of injection water could be maintained, and that an acceptable injection rate could be sustained without negative effects on the plume or aquifer. However, residual plugging of the re-injection wells became a concern in the last half of 2000. During 2001 the re-injection wells were subjected to the new treatment method and this new process was economically viable in three of the five wells (Re-Injection Wells 22111, 22240, and 22109). It was determined that it was more cost effective to replace the other two wells rather than attempt another treatment.

Re-Injection Well 22107 was replaced by Re-Injection Well 33253. Re-Injection Well 22108 was replaced by Re-Injection Well 33254. These two new replacement wells began operating for a brief period in November 2002. On November 21 all re-injection wells were shut down and remained off-line for the rest of the year to help ensure compliance with the site's monthly average uranium discharge limit. In addition to the two new replacement wells, a sixth re-injection well was added to the module (Re-Injection Well 33255). The new re-injection well is located half way between Re-Injection Wells 22109 and 22240, and is scheduled to become operational in 2003.

3.3.1.5 Waste Storage Area (Phase I) Operational Summary

The Waste Storage Area Module became operational on May 8, 2002, nearly 17 months ahead of the Operable Unit 5 Remedial Action Work Plan established start date of October 1, 2003. The module consists of three extraction wells, 32761, 33062, and 33063. These three wells were installed to remediate a uranium plume in the Pilot Plant Drainage Ditch area, according to the Design for Remediation of the Great Miami Aquifer in the Waste Storage and Plant 6 Areas (DOE 2001a).

3.3.1.6 Monitoring Results for Total Uranium

Total uranium is the primary FRL constituent because it is the most prevalent site contaminant and has impacted the largest area of the aquifer.

Figure 3-8 shows general groundwater flow directions and the interpretation of the total uranium plume in the aquifer, and is updated with data collected through 2002. The shaded areas represent the interpreted size of the total uranium plume that is above the 30 µg/L groundwater FRL for total uranium. Capture zones observed during the second half of 2002 for the active restoration modules are also identified on Figure 3-8. These capture zones indicate that the southern plume is being captured by the existing system and that further movement of uranium to the south of the extraction wells is being prevented. Figure 3-8 also depicts that the total uranium concentrations greater than the FRL are within the 10-year, uranium-based restoration footprint which was defined in the 1997 Baseline Remedial Strategy Report.

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

Waste Storage Area - Nine new monitoring wells were installed in the Pilot Plant Drainage Ditch area to monitor the remediation of the uranium plume around the three new extraction wells. Installation of the new monitoring wells was completed on January 17, 2002. Sampling of these new wells indicated the presence of uranium concentrations that were higher than previously recorded in the area by direct-push sampling. The impact that these higher uranium concentrations will have on the modeled cleanup time predictions is being examined. Results are scheduled to be available in 2003. The higher uranium concentrations found in 2002 did not have much effect on the size and shape of the 30 µg/L total uranium plume boundary depicted in Figure 3-8.

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South Field and South Plume Areas – Twenty-five different locations were sampled in 2002 using direct-push methods in the South Field and off-property South Plume areas to update uranium plume interpretations (22 locations in the portion of the South Plume and three locations in the South Field). Results from the off-property locations were also used to evaluate the need to install an additional extraction well. The results indicated that an additional extraction well is not needed at this time in the off-property portion of the uranium plume to achieve modeled cleanup predictions.

Data indicated that the western edge of the 30 µg/L total uranium plume boundary, just north of Willey Road, has shifted to the east, indicated by a decrease in uranium concentrations. This reduction is attributed to a combination of re-injection along Willey Road, recharge of clean water through Paddys Run, and pumping in the South Plume and South Field. As a result, the trailing edge of the 30 µg/L plume has moved to the east. Reduced uranium concentrations were measured all along Willey Road just downgradient of the re-injection wells. As re-injection continues, it is anticipated that the plume will eventually be cut in half near the re-injection wells along Willey Road. Uranium contamination south of the re-injection wells will move toward the South Plume extraction wells, uranium contamination north of the re-injection wells will move toward the South Field extraction wells.

Appendix A, Attachment 2, of this report provides individual monitoring well total uranium results and tw total uranium plume maps for 2002. Appendix A, Attachment 3, of this report provides capture zone evaluations based on groundwater flow directions interpreted from groundwater elevation data. It include quarterly groundwater elevation maps and graphical displays of groundwater elevation data.

3.3.1.7 Monitoring Results for Non-Uranium Constituents

Although the enhanced groundwater remedy is primarily targeting remediation of the total uranium plume, other FRL constituents contained within the total uranium plume are also being monitored.

Table 3-2 summarizes the results of monitoring for non-uranium FRL exceedances, and Figure 3-9 identifies the locations of the wells that had non-uranium FRL exceedances. Table 3-2 shows the number of wells exceeding the FRL in 2002, the range of 2002 data above the FRL from wells inside or outside th footprint, and the number of wells with 2002 FRL exceedances outside the Baseline Remedial Strategy Report 10-year, uranium-based restoration footprint.

TABLE 3-2
NON-URANIUM CONSTITUENTS WITH RESULTS ABOVE FINAL REMEDIATION LEVELS DURING 2002

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the BRSR[a] 10-Year, Uranium-Based Restoration Footprint	Groundwater FRL	Range of 2002 Data Inside the BRSR[a] 10-Year, Uranium-Based Restoration Footprint above the FRL[b]	Range of 2002 Data Outside the BRSR[a] 10-Year, Uranium-Based Restoration Footprint above the FRL[b]
General Chemistry			(mg/L)	(mg/L)	(mg/L)
Nitrate/Nitrite	2	0	11[c]	12.7 to 76.4	NA
Inorganics					
Arsenic	1	1	0.050	NA	0.0791
Boron	1	0	0.33	0.478	NA
Lead	1	1	0.015	NA	0.0173
Manganese	8	5	0.90	1.33 to 2.86	1 to 2.29
Mercury	1	0	0.0020	NA	0.0167
Molybdenum	1	0	0.10	0.423	NA
Nickel	1	0	0.10	0.134	NA
Zinc	3	1	0.021	0.0212 to 0.0317	0.0282
Volatile Organics			(µg/L)	(µg/L)	(µg/L)
Trichloroethene	1	0	5.0	78	NA
Radionuclides			(pCi/L)	(pCi/L)	(pCi/L)
Technetium-99	2	0	94	103 to 1120	NA

[a]Baseline Remedial Strategy Report (DOE 1997a)
[b]NA = not applicable
[c]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for nitrate/nitrite.

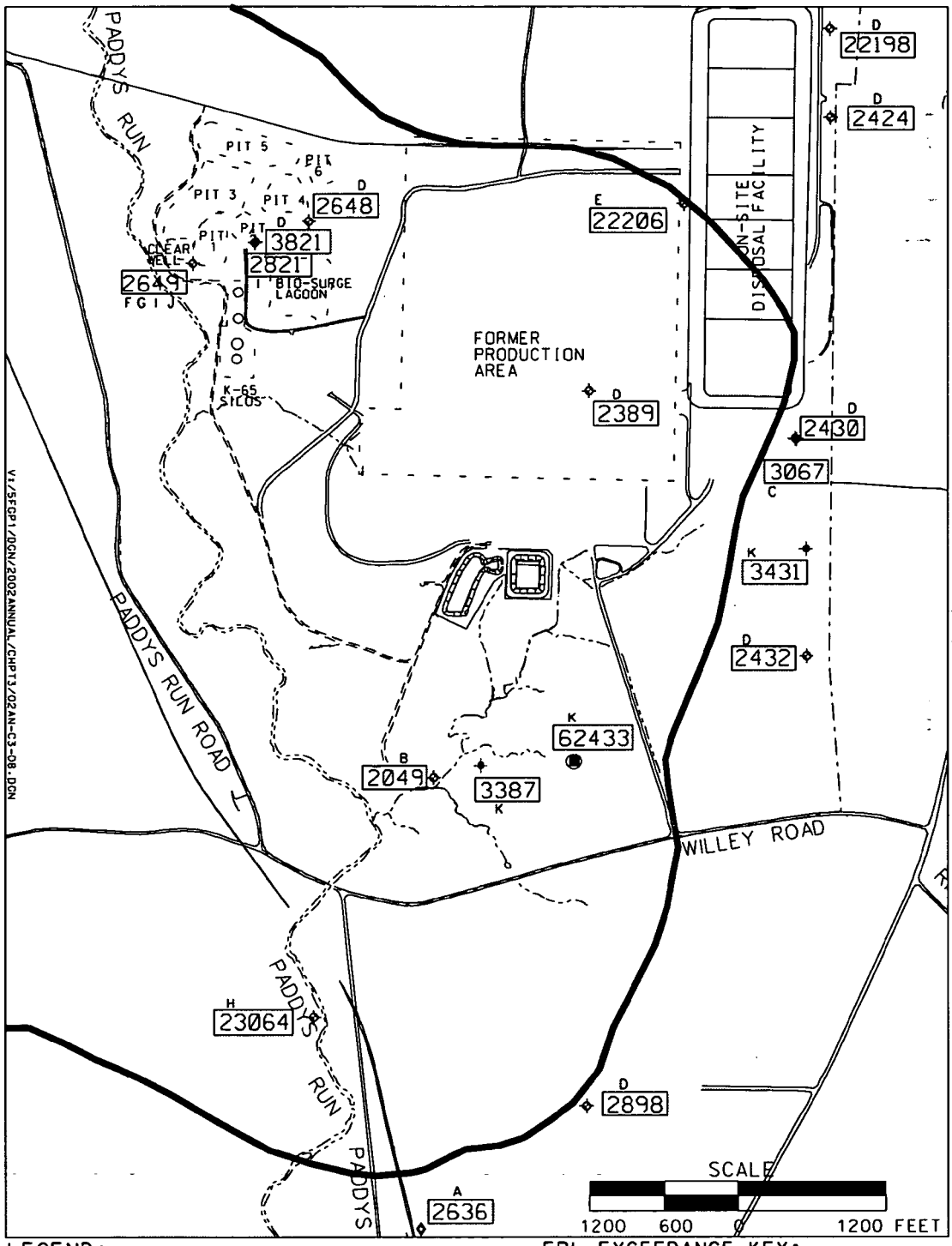

Figure 3-9. Non-Uranium Constituents with 2002 Results Above Final Remediation Levels

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During 2002 non-uranium FRL exceedances were observed at 18 monitoring well locations as shown in Figure 3-9. A total of 11 non-uranium FRL constituents exceeded FRLs in 2002. All these exceedances were within the Baseline Remedial Strategy Report 10-year, uranium-based restoration footprint, except the following: one exceedance for arsenic in the Paddys Run Road Site area; one exceedance each for lead and zinc along the eastern property boundary; and five exceedances for manganese along the eastern restoration footprint perimeter (refer to Figure 3-9). No plumes for the above-FRL constituents at the locations outside the 10-year, uranium-based restoration footprint were identified in the extensive groundwater characterization efforts evaluated as part of the Remedial Investigation Report for Operable Unit 5.

The constituents with FRL exceedances at the well locations outside the 10-year, uranium-based restoration footprint were further evaluated to determine if they were random events or if they were persistent according to criteria discussed in Appendix A, Attachment 4, of this report. None of the exceedances in 2002 were classified as persistent. All former exceedances that were classified as persistent have disappeared with subsequent sampling.

Appendix A, Attachment 4, of this report provides detailed information of non-uranium FRL exceedances and the persistence of these exceedances.

3.3.2 Other Monitoring Commitments

Two other groundwater monitoring activities are included in the IEMP:

- Private Well Monitoring.
- Property Boundary Monitoring.

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

The three private wells (Monitoring Wells 2060 [12], 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the total uranium plume migration (refer to Appendix A, Attachment A.2, Figure A.2-1 for well locations). It was at one of these private wells that off-property groundwater contamination was initially detected in 1981. Monitoring at other private wells in 1997 because a DOE-sponsored public water supply became available to Fernald site neighbors who have been affected by off-property groundwater contamination.

The availability of the public water supply resulted in the plugging and abandonment of many private wells in the affected off-property areas where groundwater is being remediated. Data from the three private wells sampled under the IEMP were incorporated into the total uranium plume map shown in Figure 3-8.

During 2002 Property Boundary Monitoring was comprised of 33 monitoring wells located downgradient of the Fernald site, along the eastern and southern portions of the property boundary. Twenty-seven Type 2 and 3 wells were monitored for 27 of the most mobile FRL constituents in order to determine if contaminant excursions at the property boundary are occurring during the remediation process. During 2000 the frequency of monitoring the six property boundary Type 4 wells was decreased to once every five years due to lack of contamination in the aquifer at the depth these wells monitor. Data from the property boundary wells were integrated with other IEMP data for 2002 and were incorporated into the total uranium plume map shown in Figure 3-8. Non-uranium data from these wells were included above in the section on monitoring results for non-uranium constituents.

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

3.4 On-Site Disposal Facility Monitoring

Groundwater monitoring for the cells of the on-site disposal facility is conducted in the glacial till (perched water) and in the Great Miami Aquifer. Groundwater monitoring in support of the on-site disposal facility continued in 2002. This monitoring program is designed to accomplish the following:

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

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

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Table 3-3 summarizes the groundwater monitoring information associated with the on-site disposal facility. Table 3-3 also summarizes leachate collection system and leak detection system monitoring information. Sampling of the leachate collection system and the leak detection system is generally initiated after waste placement, while groundwater sampling is initiated before waste is placed in a particular cell. Table 3-3 provides information for Cells 1 through 6 along with sample information and range of total uranium concentrations. With respect to samples collected from the horizontal till wells and Great Miami Aquifer wells, there was only one exceedance for a groundwater FRL during 2002. This exceedance was for mercury at Monitoring Well 22206, which monitors the aquifer beneath Cell 4.

During 2002 the Technical Memorandum for establishing baseline groundwater conditions for Cells 1 through 3 was issued and approved by the OEPA and EPA. Data in the memorandum establish initial groundwater conditions to be compared with future sampling results as part of the leak detection data evaluation process. As part of the memorandum process, changes to the sampling protocol for Cells 1 through 3 were recommended. The new sampling protocol for these cells was approved and implemented in the second half of 2002. Additionally in 2002, baseline sampling for Cells 4 and 5 continued and sampling for Cell 6 was initiated in December 2002 in the Great Miami Aquifer wells.

Placement of contaminated soil and debris in Cell 1 concluded at the end of December 2000 (Cell 1 was 100 percent full), and cap material was placed on Cell 1 through November 2001. Placement of contaminated soil and debris in Cell 2 concluded at the end of October 2002 (Cell 2 was 100 percent full). Soil and debris placement continued in Cell 3, and began in Cells 4 and 5 during 2002. At the end of December 2002, Cell 3 was approximately 51 percent full, Cell 4 was approximately nine percent full, and Cell 5 was approximately three percent full. Waste placement in Cells 4 and 5 was initiated in November 2002. Based on 2002 leak detection flow monitoring data associated with the on-site disposal facility, the liner systems for Cells 1 through 5 are performing within the specifications outlined in the approved cell design.

Figure 3-10 identifies the on-site disposal facility footprint and monitoring well locations for Cells 1 through 6. (Additional cells will be activated at the on-site disposal facility, and will be monitored similar to Cells 1 through 6.) For additional information on the groundwater, leak detection and leachate sampling results for the on-site disposal facility, refer to Appendix A, Attachment 5, of this report.

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TABLE 3-3
ON-SITE DISPOSAL FACILITY GROUNDWATER, LEACHATE, AND LEAK DETECTION SYSTEM MONITORING SUMMARY

Cell (Waste Placement Start Date)[a]	Monitoring Location	Monitoring Zone	Date Sampling Started	Total Number of Samples	Range of Total Uranium Concentrations[a] (µg/L)
Cell 1 (December 1997)	22201	Great Miami Aquifer	March 31, 1997	35	ND – 8.33
	22198	Great Miami Aquifer	March 31, 1997	53	0.557 – 8.474
	12338	Glacial Till	October 30, 1997	40	ND – 19
	12338C	Leachate Collection System	February 17, 1998	20	ND – 142.186
	12338D	Leak Detection System	February 18, 1998	19	1.5 – 23.2
Cell 2 (November 1998)	22200	Great Miami Aquifer	June 30, 1997	30	ND – 1.11
	22199	Great Miami Aquifer	June 25, 1997	30	0.259 – 12.1
	12339	Glacial Till	June 29, 1998	39	ND – 6.56
	12339C	Leachate Collection System	November 23, 1998	17	4.51 – 68.6
	12339D	Leak Detection System	December 14, 1998	17	8.69 – 71[b]
Cell 3 (November 1999)	22203	Great Miami Aquifer	August 24, 1998	28	ND – 7.92
	22204	Great Miami Aquifer	August 24, 1998	28	ND – 5.924
	12340	Glacial Till	July 28, 1998	32	ND – 25.4
	12340C	Leachate Collection System	October 13, 1999	14	9.27 – 83.7
	12340D	Leak Detection System	August 26, 2002	2	15.1 – 27.3
Cell 4 (November 2002)	22205	Great Miami Aquifer	November 5, 2001	13	0.446 – 19.7
	22206	Great Miami Aquifer	November 6, 2001	13	0.335 – 5.78
	12341	Glacial Till	February 26, 2002	9	11.1 – 21.1
	12341C	Leachate Collection System	November 4, 2002	1	4.41
	12341D	Leak Detection System	November 4, 2002	1	5.74
Cell 5 (November 2002)	22207	Great Miami Aquifer	November 6, 2001	13	0.3 – 4.48
	22208	Great Miami Aquifer	November 5, 2001	13	ND – 0.514
	12342	Glacial Till	February 26, 2002	6	0.557 – 8.474
	12342C	Leachate Collection System	November 4, 2002	1	3.39
	12342D	Leak Detection System	November 4, 2002	1	2.93
Cell 6 (NA)	22209	Great Miami Aquifer	December 16, 2002	1	0.407
	22210	Great Miami Aquifer	December 16, 2002	1	0.447

[a]ND = not detectable; NA = not applicable

[b]Data not considered representative of true leak detection system uranium concentrations in Cell 2 (December 14, 1998 through May 23, 2000 data set) due to malfunction in the Cell 2 leachate pipeline and the resultant mixing of individual flows.

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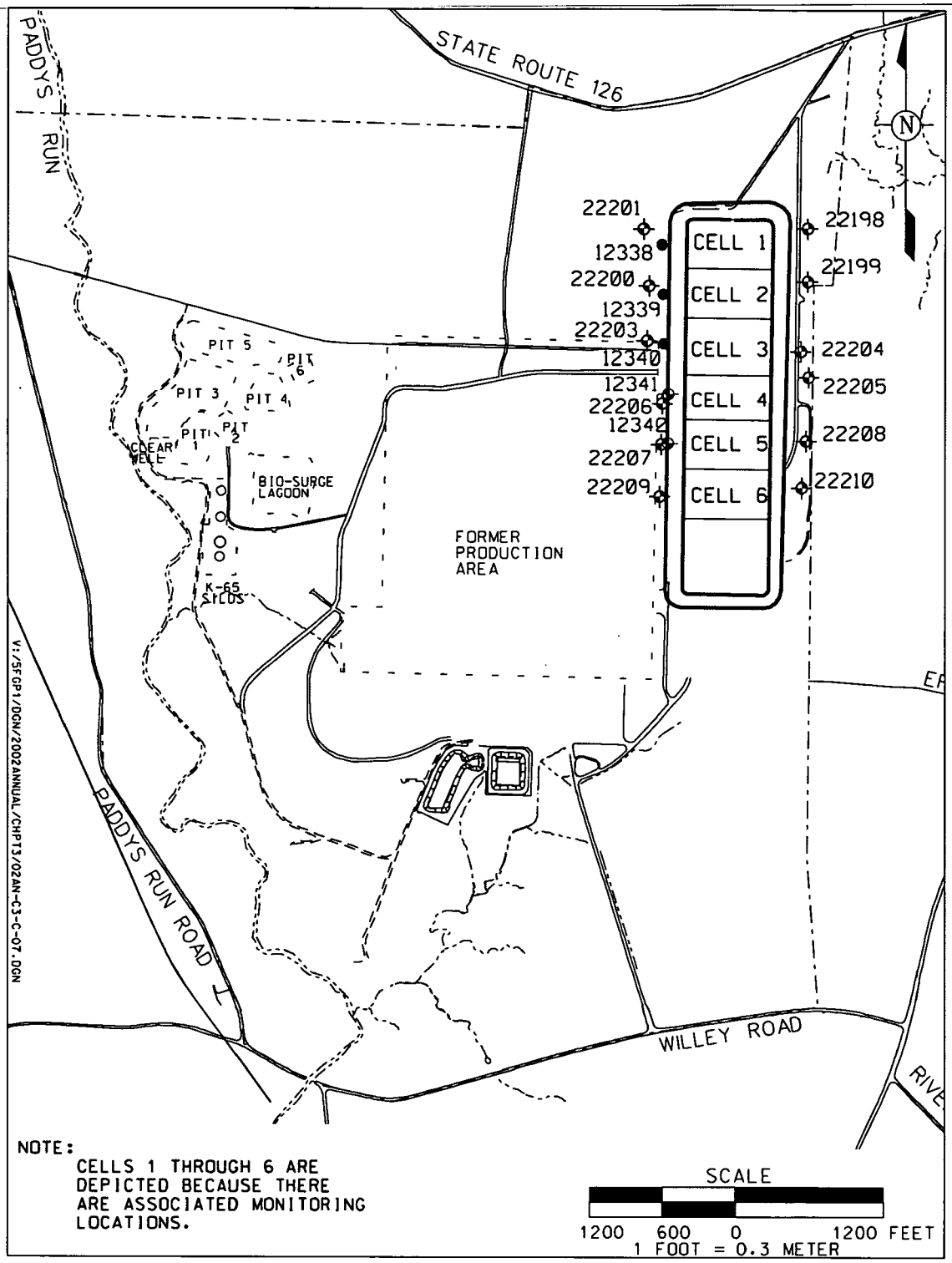

Figure 3-10. On-Site Disposal Facility Footprint and Monitoring Well Locations

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Chapter 4

Surface Water and Treated Effluent Pathway

Chapter 4

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4.0 Surface Water and Treated Effluent Pathway

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Results in Brief: 2002 Surface Water and Treated Effluent Pathway

Surveillance Monitoring - No surface water or treated effluent analytical results from samples collected in 2002 exceeded the surface water FRL for total uranium, the primary site contaminant. FRL exceedances that may be attributable to the Fernald site were limited to four constituents and three locations, while BTV exceedances that may be attributable to the Fernald site were limited to one constituent at one location. Occasional, sporadic FRL and BTV exceedances are to be expected until site remediation is complete.

Uranium Discharges - In 2002, 524 pounds (238 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 127 pounds (58 kg) of uranium were released to the environment through uncontrolled storm water runoff. The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 653 pounds [296 kg]) increased 38 percent from the 2001 estimate.

Sediment - The 2002 sediment results are within the range of historical concentrations. In addition, there were no FRL exceedances for any sediment result in 2002.

This chapter presents the 2002 monitoring activities and results for surface water, treated effluent, and sediment to determine the effects of remediation activities on the surface water pathway.

In general, low levels of contaminants enter the surface water pathway at the Fernald site by two primary mechanisms: treated effluent that is monitored as it is discharged to the Great Miami River, and uncontrolled runoff entering the site's drainages from areas with low levels of soil contamination. Because these discharges will continue throughout remediation, the surface water and sediment pathways will continue to be monitored. Effective use of the site's wastewater treatment capabilities, and implementation of runoff and sediment controls, minimize the site's impact on the surface water pathway.

4.1 Summary of Surface Water and Treated Effluent Pathway

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

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

The treated effluent pathway is comprised of those flows discharged to the Great Miami River via the Parshall Flume (PF 4001). Discharges through this point are considered under the control of wastewater operations. Under normal operation this combined flow is comprised of:

- Storm water runoff collected from the former production area and the waste pit area.
- Treated and untreated groundwater from the South Plume, South Field (Phase I), and Waste Storage Area Aquifer Restoration Modules.
- Treated remediation wastewater, such as on-site disposal facility leachate, decontamination rinse water generated during building decontamination and dismantling activities, and wastewater generated from pit dewatering and the operation of the Waste Pits Remedial Action Project dryer facility.
- Treated sanitary wastewater from the sewage treatment plant.

During periods of heavy and/or sequential rainfall events when the Storm Water Retention Basin is close to overflowing, untreated storm water is bypassed directly to the Great Miami River in order to minimize or prevent the Storm Water Retention Basin from overflowing into Paddys Run.

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The volume and flow rate of uncontrolled runoff depends on the amount of precipitation within any given period of time. Figure 1-10 in Chapter 1 shows monthly precipitation totals for 2002. Figure 4-1 shows the site's natural drainage features and defines the areas from which runoff is either controlled or uncontrolled. The site's natural surface water drainages include several tributaries to Paddys Run (e.g., Pilot Plant Drainage Ditch and Storm Sewer Outfall Ditch) as well as the northeast drainage that flows to the Great Miami River. The arrows on Figure 4-1 indicate the general flow direction of uncontrolled runoff that is determined from the topography. Uncontrolled runoff from the Fernald site leaves the property via two drainage pathways, Paddys Run and the northeast drainage.

4.2 Remediation Activities Affecting Surface Water Pathway

Major remediation activities in 2002 that affected (or had the potential to affect) the surface water pathway include:

- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area.
- Waste hauling and placement activities associated with the on-site disposal facility.
- Soil excavation activities conducted by the Soil and Disposal Facility Project (refer to Chapter 2).
- Activities associated with the Waste Pits Remedial Action Project including dryer operation, pit excavation and waste material handling, and railcar loading.
- Construction activities associated with the Accelerated Waste Retrieval; Radon Control System; and Silos 1 and 2, and Silo 3 Projects.

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

Engineered sediment controls can include the construction of sedimentation basins (lined or unlined), silt fences, check dams, and permanent or temporary seeding. Diversion ditches are also constructed as an engineered control to divert clean water from upgradient areas away from areas of remediation. Ditches are sometimes lined with riprap (large rocks) and/or synthetic liners to control erosion. Administrative controls include limiting the duration of open excavations, as well as routinely inspecting each of the engineered controls used.

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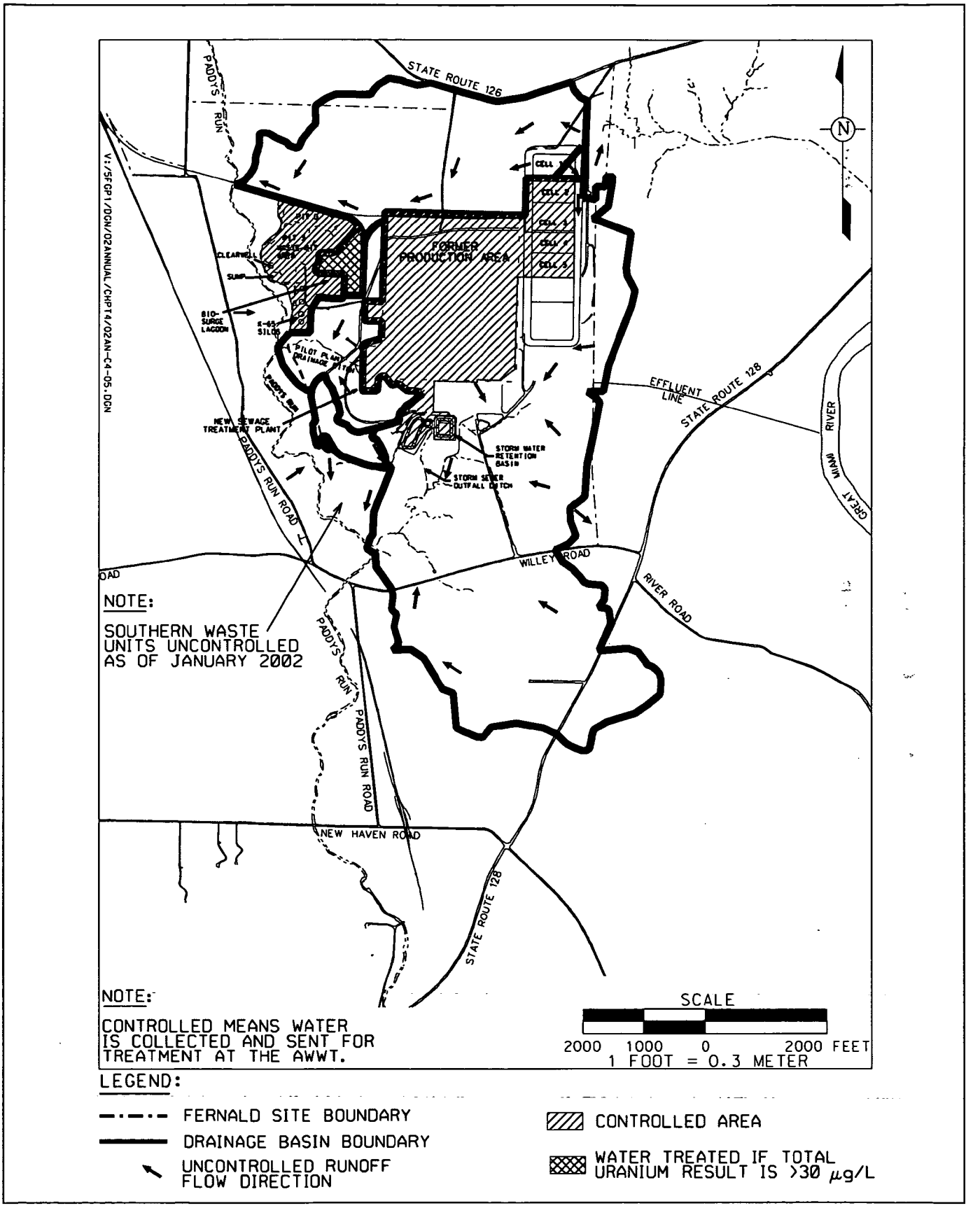

Figure 4-1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

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Each remediation project is responsible for constructing and maintaining the engineered control structures required under their remedial design. All engineered sediment and surface water controls are inspected at least once a week, and within 24 hours of any rain event measuring greater than 0.5 inch (1.3 cm) of rain in a 24-hour period. Discharge points for uncontrolled runoff to Paddys Run are also inspected periodically to assess the effectiveness of upgradient controls in preventing significant impacts to Paddys Run. Minor maintenance activities (e.g., silt fencing repairs and reseeding of eroded areas) were performed in 2002 as a result of these inspections. Though no new storm water controls were installed in 2002, many engineered controls installed during previous years were still used and maintained.

4.3 Surface Water, Treated Effluent, and Sediment Monitoring Program for 2002

Surface water, treated effluent, and sediment are sampled to determine the effect of the Fernald site's remediation activities on the environment. Surface water is sampled at several locations in the site's drainages and analyzed for various radiological and non-radiological constituents. Treated effluent is sampled prior to discharge into the Great Miami River. Sediment is sampled for radiological constituents in the major site drainages (i.e., Paddys Run and Storm Sewer Outfall Ditch), and in the Great Miami River.

Following is a description of the key elements of the surface water and treated effluent program design:

- **Sampling** – Sample locations, frequency, and constituents were selected to address the requirements of the NPDES Permit, FFCA, and the Operable Unit 5 Record of Decision, and to provide a comprehensive assessment of surface water quality at 16 key locations including two background locations (refer to Figures 4-2 and 4-3). Surface water is monitored for up to 55 FRL constituents (refer to Table 2-2 in Chapter 2) and three BTV constituents (barium, cadmium, and silver).

- **Data Evaluation** – The integrated data evaluation process focuses on tracking and evaluating data compared with background and historical ranges, FRLs, BTVs, and NPDES limits. This information is used to assess impacts on surface water due to site remediation activities affecting uncontrolled runoff or treated effluent. The assessment also includes identifying the potential for impacts from surface water to the groundwater in the underlying Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision-making by providing timely feedback to the remediation project organizations on the effectiveness of storm water runoff controls and treatment processes.

- **Reporting** – Surface water and treated effluent data are reported under the IEMP program and annual site environmental reports. Monthly discharge monitoring reports required by the NPDES Permit are submitted to OEPA.

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

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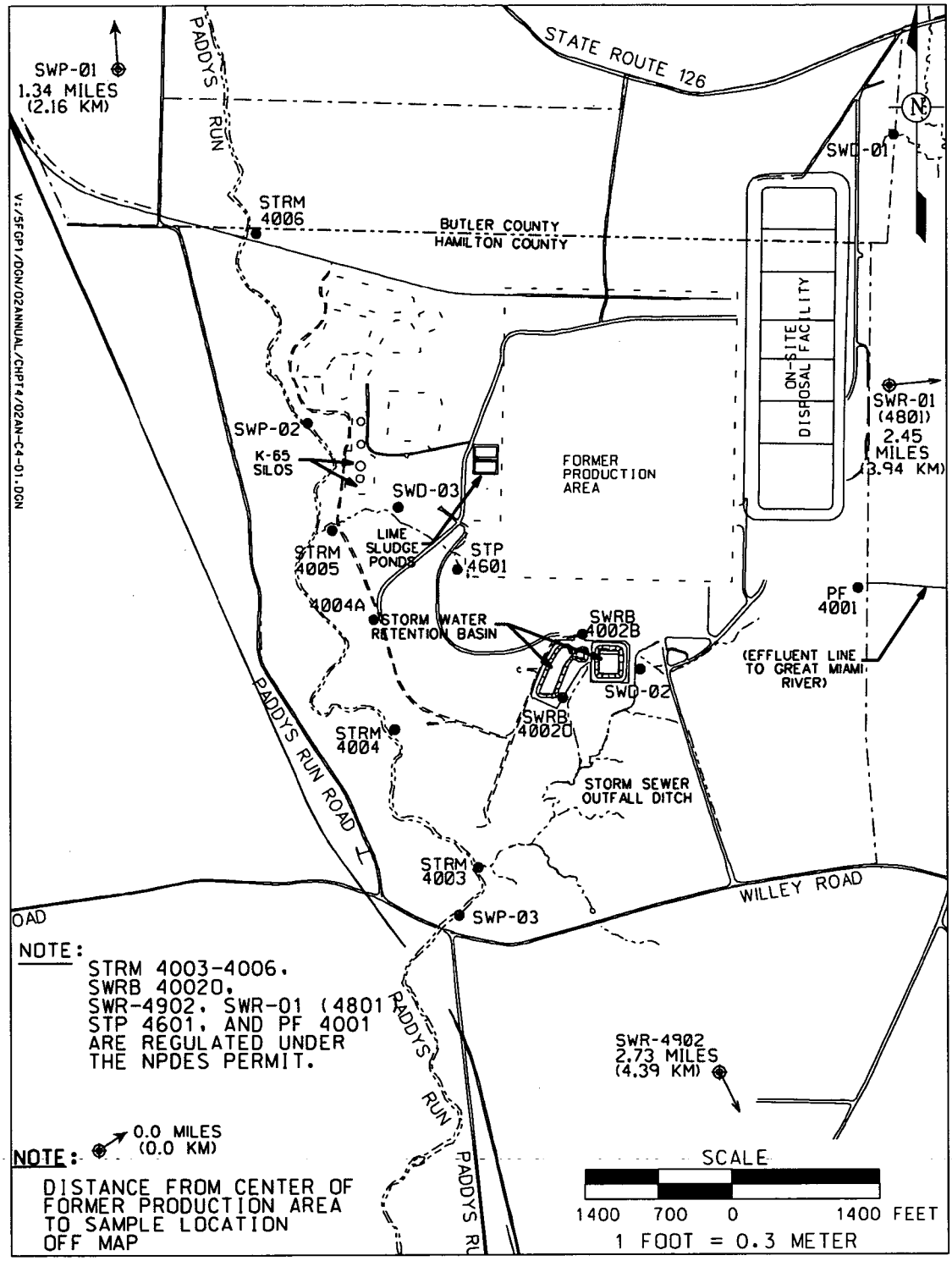

Figure 4-2. IEMP/NPDES Surface Water and Treated Effluent Sample Locations

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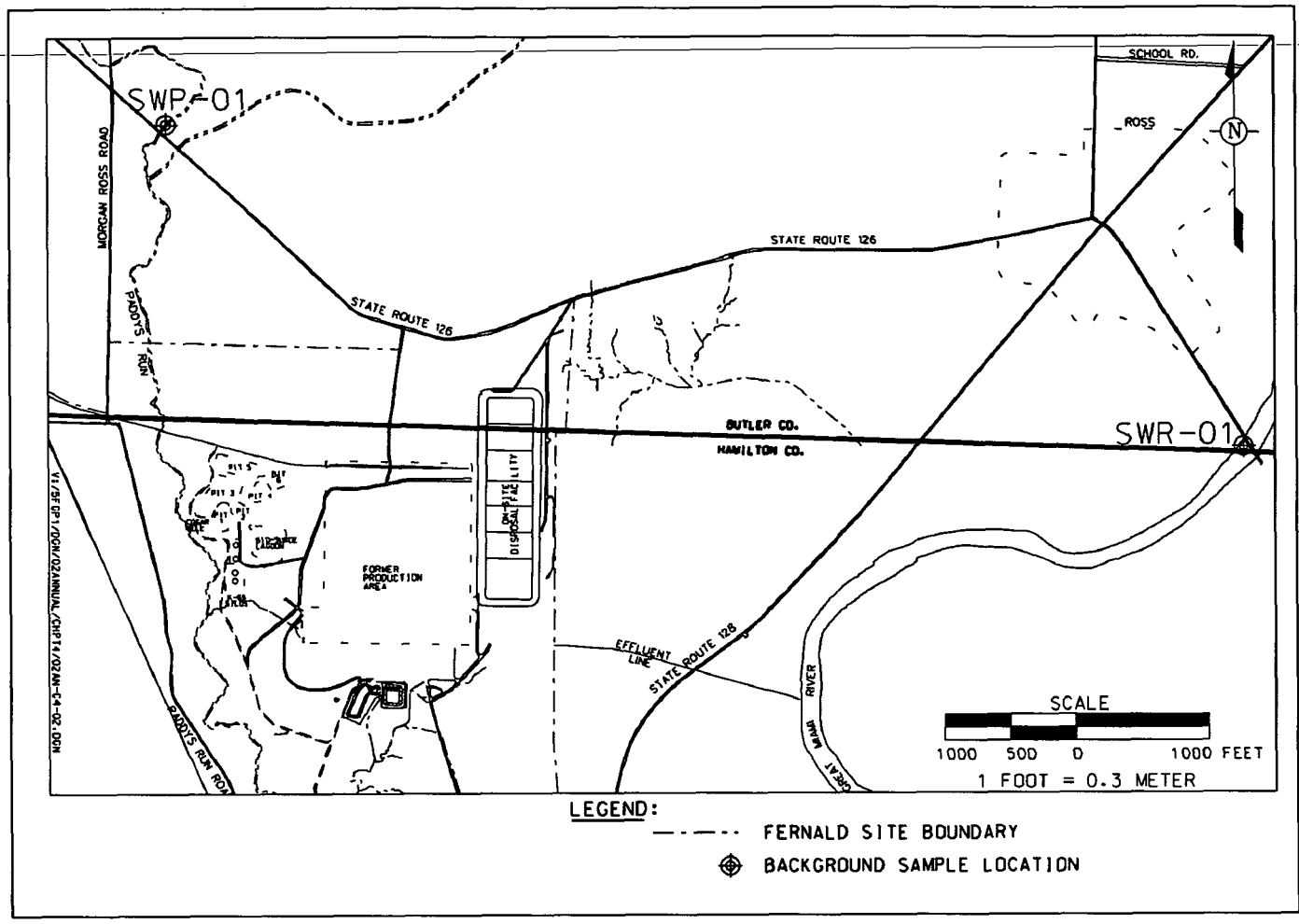

Figure 4-3. IEMP Background Surface Water Sample Locations

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

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

4.3.1 Surveillance Monitoring

Data resulting from 2002 sampling efforts were evaluated to provide surveillance monitoring of remediation activities. This evaluation showed that during 2002, there were no exceedances of the surface water total uranium FRL (530 µg/L) detected in any of the surface water and treated effluent samples. There were four non-uranium constituents with FRL exceedances, and one constituent with a BTV exceedance. Table 4-1 summarizes these exceedances and Figure 4-4 identifies the locations of these exceedances.

There were two FRL exceedances in 2002 at location SWR-01, one for chromium and one for copper. There were no BTV exceedances at this location. In addition, there was one FRL exceedance at location SWP-01 for chromium. There were no BTV exceedances at this location. Locations SWR-01 and SWP-01 are background monitoring locations, and are situated upstream and outside the influence of Fernald site discharges. The background data are used to distinguish impacts from site activities against upstream water quality conditions. Therefore, concentrations at the background locations (Great Miami River [SWR-01] and Paddys Run [SWP-01]) are not attributable to the Fernald site.

TABLE 4-1
CONSTITUENTS WITH RESULTS ABOVE SURFACE WATER FRLs OR BTVs DURING 2002

Constituent	Number of Locations Exceeding FRL	Number of Locations Exceeding BTV[a]	Surface Water FRL	Surface Water BTV[a]	Range of 2002 Data above FRL[a]	Range of 2002 Data above BTV[a]
Inorganics			(mg/L)	(mg/L)	(mg/L)	(mg/L)
Cadmium	0	1	0.0098	0.0035	NA	0.0039[b]
Chromium	3	NA	0.010[c]	NA	0.0134 to 0.0267	NA
Copper	3	NA	0.012	NA	0.0134 to 0.0426	NA
Lead	1	NA	0.010	NA	0.0137	NA
Zinc	1	NA	0.11	NA	0.124	NA

[a]NA = not applicable
[b]The cadmium BTV exceedances in the Great Miami River for the Parshall Flume (PF 4001) occurred because the mixing equation uses the background number of 0.0098 mg/L, which is above the associated BTV.
[c]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-5; however, due to holding time considerations, total chromium is analyzed which is acceptable because total chromium provides a more conservative result.

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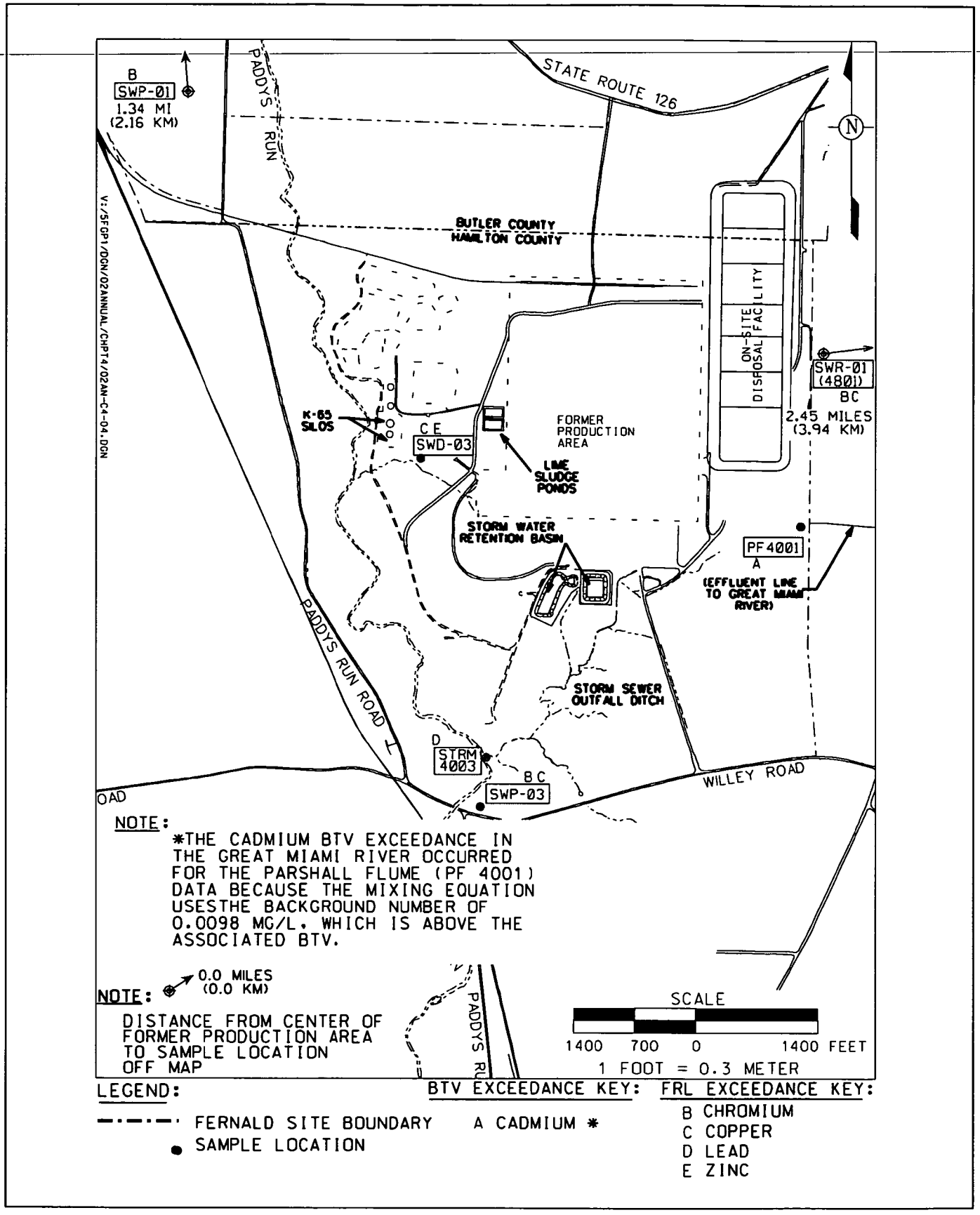

Figure 4-4. Constituents with 2002 Results Above FRLs or BTVs

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The remaining FRL and BTV exceedances, which may be attributable to Fernald site activities, were sporadic in nature and do not indicate any significant impacts to the environment or operational problems with the Fernald site's storm water and sediment control systems. There were two FRL exceedances at location SWD-03, one for copper and one for zinc. There were also two FRL exceedances at location SWP-03, one for copper and one for chromium. There was one FRL exceedance for lead at STRM-4003. Finally, there was one exceedance of the cadmium BTV at the Parshall Flume (PF 4001), as discussed later in this chapter.

Even with the Fernald site's implementation of storm water and sediment controls, sporadic FRL and BTV exceedances can be expected to occur until final remediation of contaminated source areas (soils and sediments) are complete. A Mann-Kendall statistical test for trend was run for each 2002 FRL exceedance at each location where the exceedance occurred. No statistically significant trends were identified with the exception of chromium at location SWP-03 which has been determined to be "up significantly." The FRL and BTV exceedances will continue to be evaluated for persistence and increasing trends through the IEMP sampling program throughout remediation. This information will be used to provide feedback to the remediation projects on the collective effectiveness of their storm water and sediment controls. Additional details of the FRL and BTV exceedances are presented in Appendix B, Attachment 1, of this report.

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

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

Evaluation of the data from these locations is especially important because the locations represent points beyond which direct exposure to the public is possible.

There were two FRL exceedances at location SWP-03, one for copper and one for chromium. The SWP-03 sampling location measures the cumulative drainage from the several drainage basins from Fernald site property as well as drainage from areas north of the Fernald site. No specific activity has been identified as a causal event. However, it should be noted that the concentrations for these parameters at the background location were also elevated on the days the samples at SWP-03 were collected.

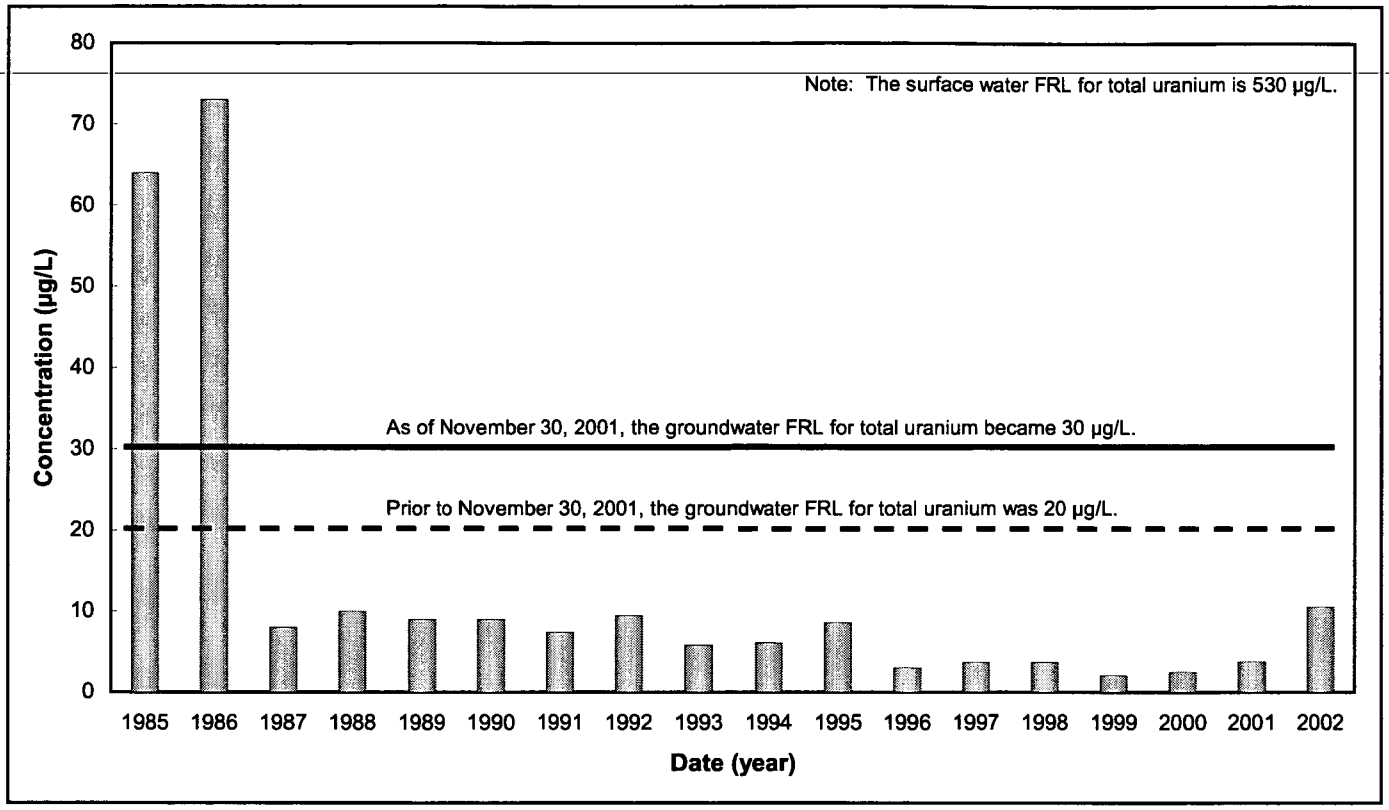

Figure 4-5. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985-2002

The maximum total uranium concentration at SWP-03 during 2002 was 26.1 µg/L, which is below the surface water total uranium FRL of 530 µg/L. Figure 4-5 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 2002. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986 following completion of the Storm Water Retention Basin, which collects contaminated storm water from the former production area.

Samples collected at the Parshall Flume (PF 4001) are used in the surveillance evaluation because this is the last point where treated effluent is sampled prior to discharge to the Great Miami River. Data collected from this location cannot directly be compared to the surface water FRL without considering the effect of the effluent waters mixing with the Great Miami River. This is done through the use of a mixing equation. After applying the mixing equation, there were no FRL exceedances at the Parshall Flume (PF 4001) but there was one BTV exceedance, for cadmium, as mentioned above. The FRL for cadmium is based on the background number of 0.0098 mg/L (milligrams per liter), and the BTV is 0.0035 mg/L, which is lower than the FRL. The cadmium BTV exceedance in the Great Miami River occurred after using the mixing equation (from the Parshall Flume [PF 4001] data), but note that the mixing equation uses the background number which is above the associated BTV.

There were no surface water FRL exceedances for uranium in the Great Miami River outside the Fernald site mixing zone during 2002. The maximum daily total uranium concentration at the Parshall Flume (PF 4001) prior to discharge through the effluent line to the Great Miami River was 114.1 µg/L. After the water from the Parshall Flume (PF 4001) mixed with the water in the Great Miami River, the concentration would have been approximately 3.21µg/L. Both concentrations, those from the Parshall Flume (PF 4001) and after mixing with the Great Miami River, were well below the surface water total uranium FRL of 530 µg/L. Contaminant concentrations observed at the Parshall Flume (PF 4001) in 2002 are further discussed in the compliance monitoring section.

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

During 2002, three of the five surface water locations were evaluated (STRM 4005, SWRB-4002O, and SWD-03) had results that exceeded the total uranium groundwater FRL of 30 µg/L. Table 4-2 summarizes the total uranium cross-media exceedances. Of the locations evaluated, only SWD-03 had results that exceeded the groundwater FRL for a constituent other than uranium. The SWD-03 zinc results of 0.0297 and 0.124 mg/L exceeded the respective groundwater FRL of 0.021 mg/L.

TABLE 4-2
SURFACE WATER TOTAL URANIUM RESULTS EXCEEDING THE GROUNDWATER FRL AT CROSS-MEDIA IMPACT LOCATIONS DURING 2002

Location	Number of Surface Water Results Exceeding the Groundwater FRL for Total Uranium[a]	Total Number of Samples	Range of 2002 Data above FRL (µg/L)
STRM 4005	5	5	34 – 365.5
SWD-03	3	4	42.6 – 55.8
SWRB-4002O	1	1	291.4

[a]The surface water result is compared to the groundwater FRL of 30 µg/L for the purpose of evaluating potential cross-media impacts.

Under the IEMP, both surface water and groundwater data from monitoring wells will continue to be collected at these sensitive areas under the IEMP to address the cross-media concern. Additional details concerning the cross-media impacts are presented in Appendix B, Attachment 1, of this report.

4.3.2 Compliance Monitoring

4.3.2.1 FFCA and Operable Unit 5 Record of Decision Compliance

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

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

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In addition to significant precipitation-related bypasses, the site is also allowed to bypass water from the Storm Water Retention Basin during certain scheduled wastewater treatment plant maintenance activities. These maintenance bypasses must be pre-approved by the regulatory agencies. The total uranium concentration in the discharge related to maintenance activities may be deducted from the monthly average calculation demonstrating compliance with the total uranium monthly average concentration limit. However, the mass of total uranium discharged during these maintenance bypasses is still considered in the total discharge mass to ensure the discharge limit of 600 pounds (272 kg) per year is not exceeded.

During 2002 there were three bypass events as a result of significant precipitation, and one bypass event for maintenance activities. Table 4-3 summarizes these Storm Water Retention Basin treatment bypass events during 2002. Figure 4-6 shows that the cumulative mass of total uranium discharged to the Great Miami River during 2002 was 523.75 pounds (237.8 kg), which is below the 600 pound (272 kg) annual discharge limit. Figure 4-7 shows that the total uranium monthly average concentration limit was met every month during 2002. As indicated on Figure 4-7, during the fourth quarter of 2002 the monthly average uranium concentration in treated effluent approached the limit of 30 µg/L. A combination of above-normal precipitation and high concentrations of total dissolved solids in the influent to the advanced wastewater treatment facility (Phase II) system reduced the uranium removal efficiency of that system. This resulted in much higher than normal uranium concentrations in the effluent from the Phase II system. Pumping rates of groundwater restoration wells were reduced and shutdown of groundwater re-injection was required to compensate for the high uranium concentrations from the advanced wastewater treatment facility (Phase II) system. This compensation was required to maintain compliance with the 30 µg/L monthly average uranium discharge limit.

TABLE 4-3
2002 SIGNIFICANT PRECIPITATION AND TREATMENT PLANT MAINTENANCE BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a]	Cumulative Number of Bypass Days	Total Uranium Discharge (pounds) (to Great Miami River)	Total Water Discharged (millions of gallons) (to Great Miami River)
Significant Precipitation Bypasses					
May 9	14.5	1	1	2.49	0.422
May 13 through May 15	57	2	3	14.86	3.126
September 27 through September 29	66.75	3	6	6.45	3.759
Treatment Plant Maintenance Bypasses[b]					
July 4 through July 7	96	4	4	7.68	23.589

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project.
[b]Typically during planned maintenance outages, pumping and treatment systems are taken off-line in stages and returned to service in stages. There were portions of all four days where pumping and/or treatment systems were off-line due to a major electrical outage for the Silos Project in support of office trailer relocation and to allow relocation of a power pole in preparation for the Silos 1 and 2 rail upgrade (EPA and OEPA were notified in advance of this scheduled outage). The information is provided for these four days in total.

Appendix B, Attachment 1, of this report provides more detail on the bypass days deleted from the monthly average calculation to determine compliance with the monthly average total uranium concentration limit.

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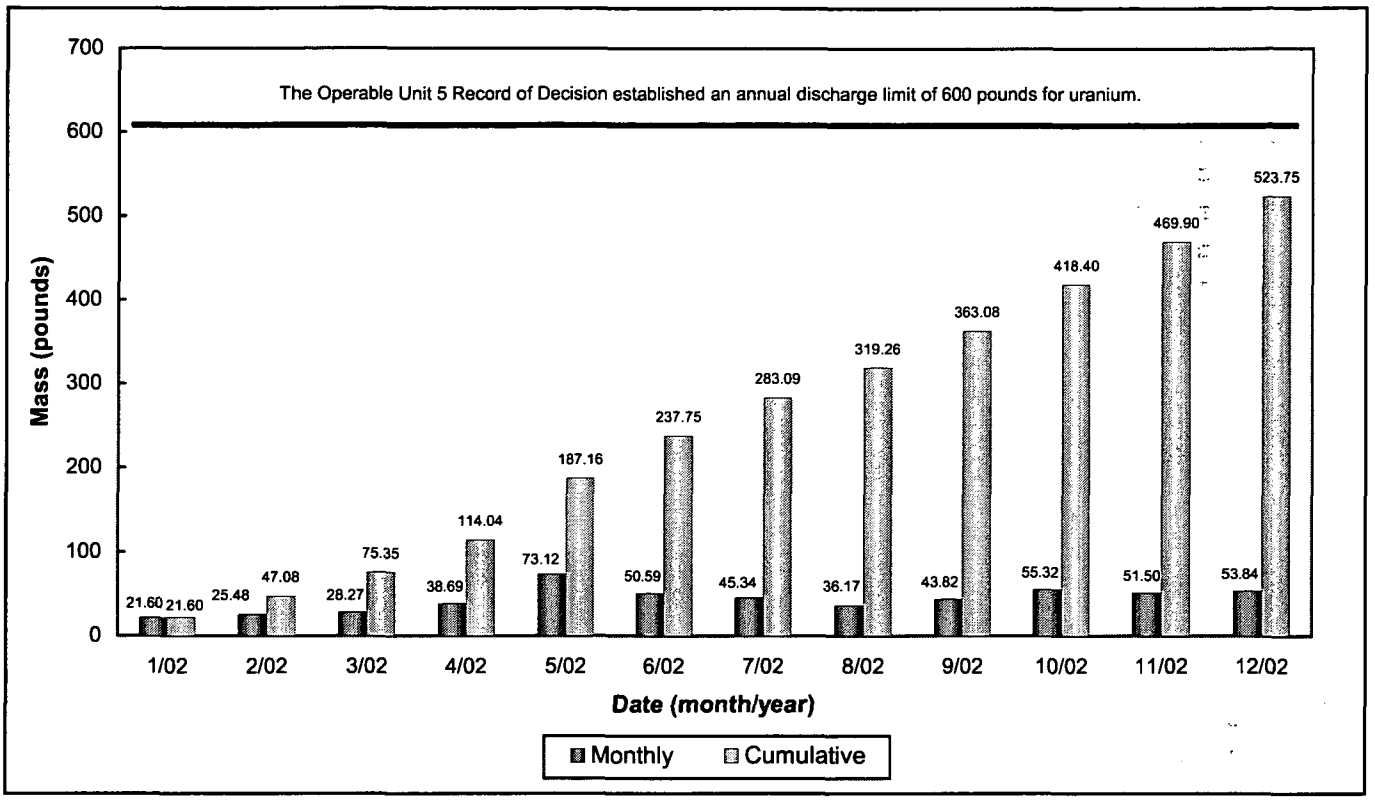
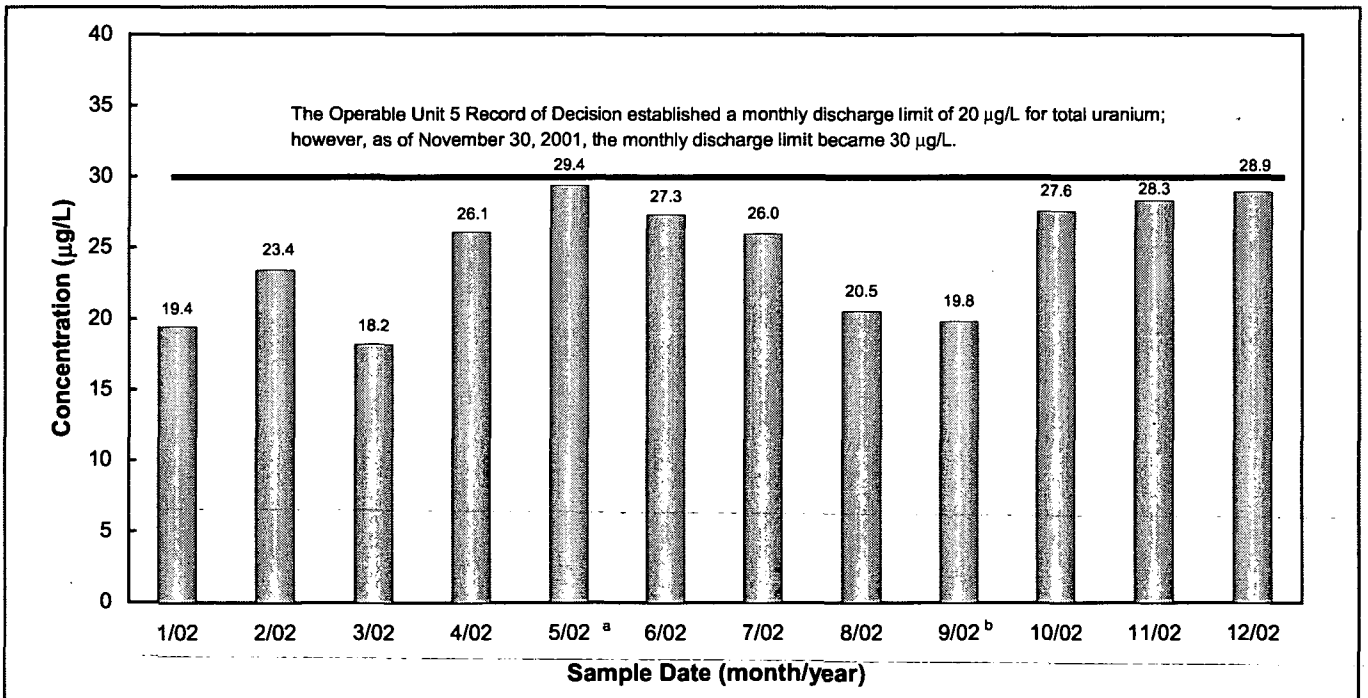


Figure 4-6. Pounds of Uranium Discharged to the Great Miami River from the Parshall Flume (PF 4001) in 2002



[a]The monthly average for May of 29.4 µg/L was achieved by accounting for three storm water bypass days during the storm water bypass events that occurred on May 9 and May 13 through May 15, 2002.

[b]The monthly average for September of 19.8 µg/L was achieved by accounting for three storm water bypass days which occurred September 27 through September 29.

Figure 4-7. 2002 Monthly Average Total Uranium Concentration in Water Discharged from the Parshall Flume (PF 4001) to the Great Miami River

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4.3.2.2 NPDES Permit Compliance

Compliance sampling, consisting of sampling for non-radiological pollutants from uncontrolled runoff and treated effluent discharges from the Fernald site, is regulated under the state-administrated NPDES program. The current permit became effective on March 1, 2000, and expired on October 31, 2002. An NPDES Permit Renewal Application was submitted to OEPA on April 30, 2002, which allows the FCP to continue to discharge under the expired permit until a new permit is issued. The permit specifies discharge and sample requirements, as well as discharge limits for several constituents. Figure 4-2 identifies NPDES sample locations.

During 2002 wastewater and uncontrolled runoff discharges from the Fernald site were in compliance with the NPDES Permit requirements in well over 99 percent of the samples collected. A total of three noncompliances were reported to OEPA pursuant to the terms of the NPDES Permit, as summarized in Table 4-4.

TABLE 4-4

EXCEEDANCES OF THE NPDES PERMIT DURING 2002

Date/ Month	Location	Parameter	Permit Limit	Actual Result	Possible Cause	Corrective Action
5/6	PF 4001 (Parshall Flume Treated Effluent)	Oil and Grease	105 kg/d	142.2 kg/d	Unknown	None. Continue to monitor and observe.
9/27	PF 4001 (Parshall Flume Treated Effluent)	Total Suspended Solids	473 kg/d	549.7 kg/d	Storm Water Bypass	None. Continue to monitor and observe.
9/27	SWRB 40020 (Storm Water Retention Basin Overflow)	Total Suspended Solids	50 mg/L	139.6 mg/L	Storm Water Bypass	None. Continue to monitor and observe.

4.3.3 Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4-6, 523.75 pounds (237.8 kg) of uranium in treated effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 2002. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of uranium entering the environment. Figure 4-8 presents the pounds of uranium from the uncontrolled runoff and controlled discharges from 1993 through 2002.

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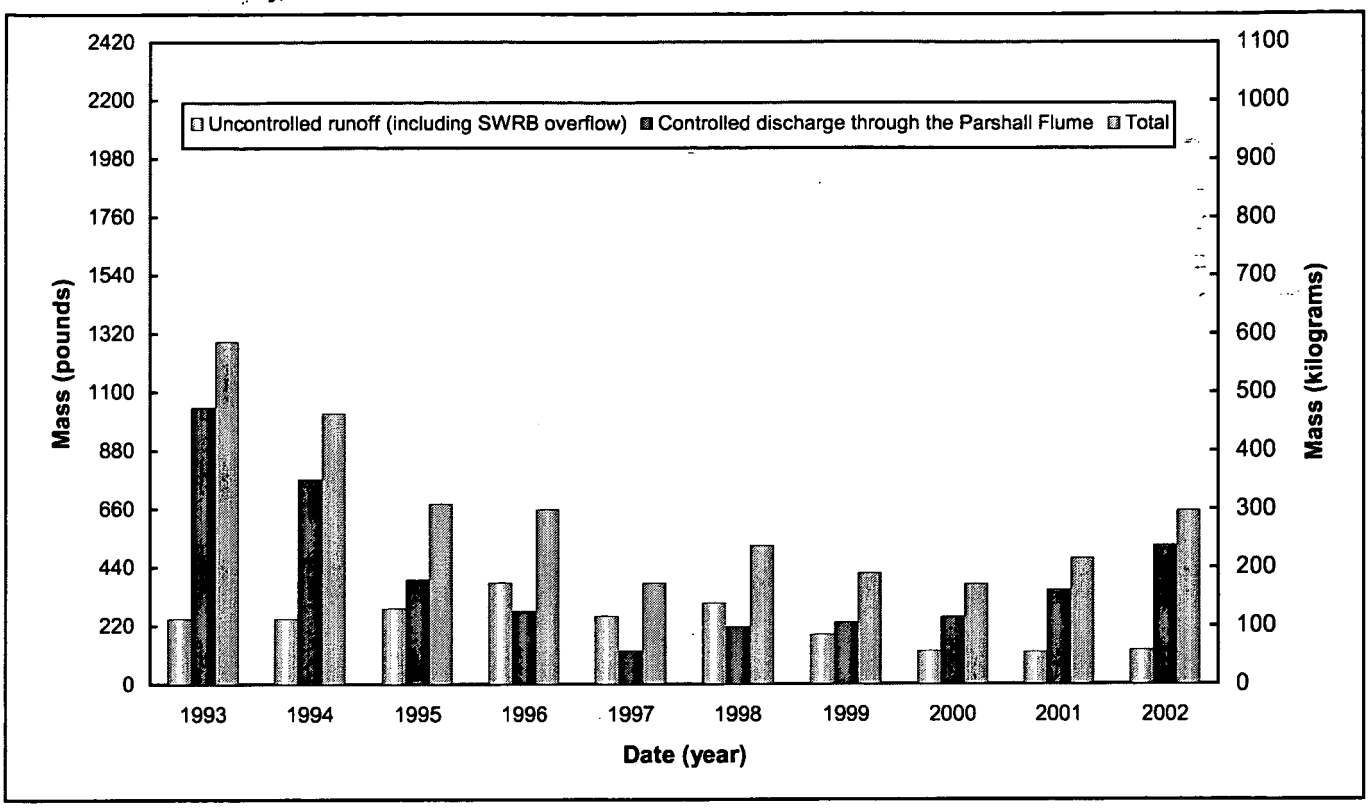

Figure 4-8. Uranium Discharged Via the Surface Water Pathway, 1993-2002

Beginning in 1999, estimates of uncontrolled runoff have been calculated using a loading term of 2.6 pounds (1.2 kg) of uranium discharged to Paddys Run for every inch (2.54 cm) of rainfall. This term was revised in 1999 based on analytical data reflecting the decreasing total uranium concentrations measured at points discharging to Paddys Run. Total uranium concentrations have been decreasing due to significant improvements in the capture of contaminated storm water by the Pilot Plant Drainage Sump, southern waste unit source removal, and excavation and placement of contaminated soils into the on-site disposal facility.

During 2002, 48.96 inches (124.4 cm) of precipitation fell at the Fernald site; therefore, an estimated 127.3 pounds (57.8 kg) of uranium entered the environment through uncontrolled runoff.

The estimated total amount of uranium discharged to the surface water pathway for the year, including both controlled treated effluent discharges and uncontrolled runoff, was approximately 653.29 pounds (296.6 kg).

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4.4 Sediment Monitoring

Sediment is a secondary exposure pathway and is monitored annually to assess the impact of remediation activities on sediments deposited along surface water drainages. Sediment is collected at strategic locations to ensure that the most recently deposited sediment is collected.

Sediment samples were collected in August 2002 at 16 locations along Paddys Run, the Storm Sewer Outfall Ditch, and the Great Miami River (refer to Figure 4-9). All of these samples were analyzed for total uranium. Samples collected from the Storm Sewer Outfall Ditch, Paddys Run (north and south of the outfall ditch), the Storm Sewer Outfall Ditch south of the outfall ditch (one sample point at PS-1), and the Paddys Run background location, were also analyzed for radium-226, radium-228, thorium-228, thorium-230, and thorium-232.

Figure 4-9 illustrates specific sediment sample locations, summarized as follows:

- Storm Sewer Outfall Ditch - five samples collected along the Storm Sewer Outfall Ditch from its confluence with Paddys Run to immediately south of the Storm Water Retention Basin (D1 through D5).

- Paddys Run - five samples collected upstream (north) of the confluence with the Storm Sewer Outfall Ditch (PN1 through PN5), three samples collected down stream (south) of the confluence (PS1 through PS3), and one background sample collected upgradient (north) of the site (P1).

- Great Miami River - one sample collected north of the effluent line (background location, G2) and one sample collected south of the effluent line (G4).

Table 4-5 presents analytical results of samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River in 2002. All results for all constituents were below the respective sediment FRL and consistent with data collected in previous years.

Until final certification of the site's drainage ways, monitoring of sediment will continue under the IEMP to determine the effectiveness of the engineered controls designed to reduce erosion from the Fernald site, and sedimentation of Paddys Run and its tributaries. Appendix B, Attachment 2, of this report contains additional details of the sediment monitoring results.

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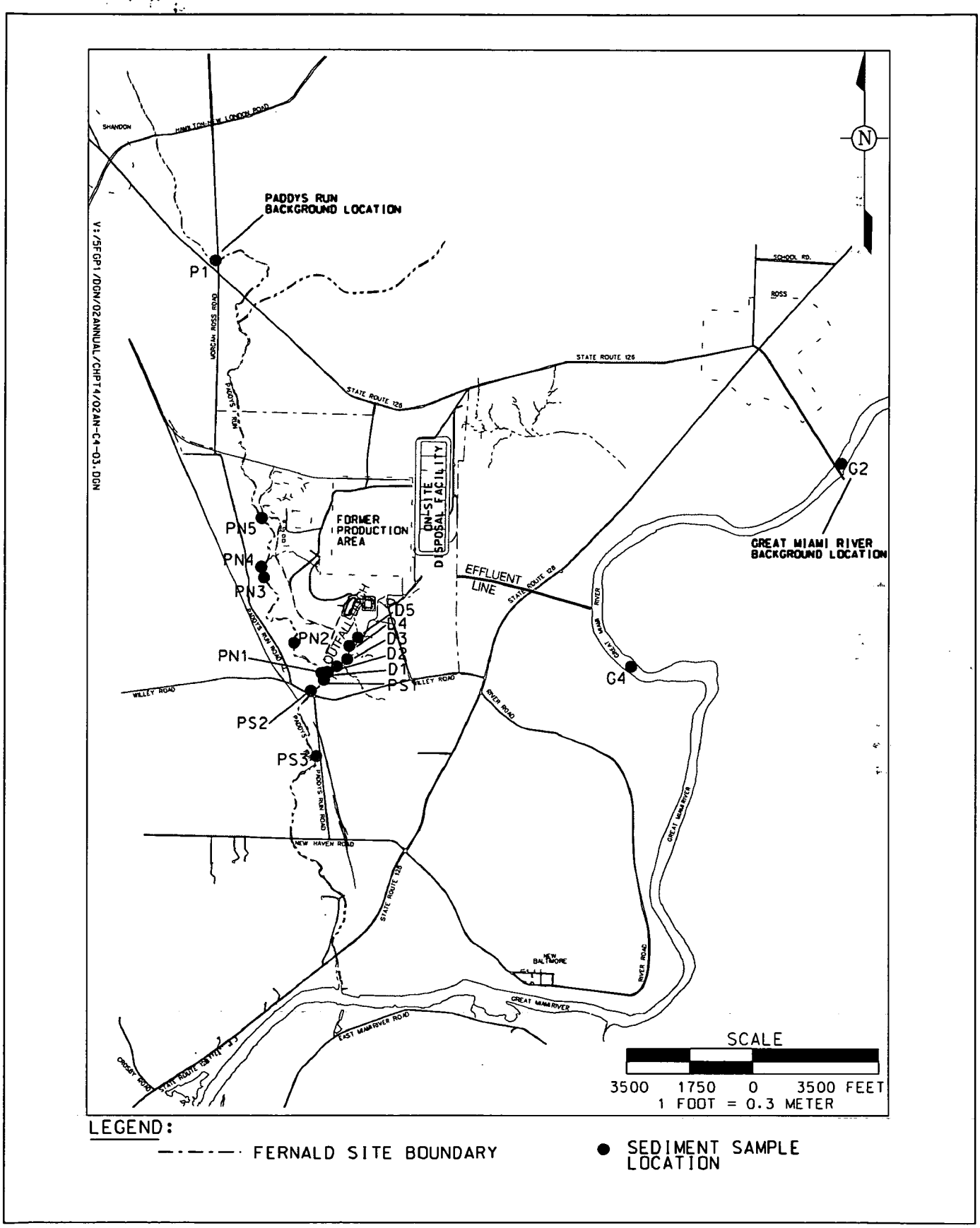

Figure 4-9. 2002 Sediment Sample Locations

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TABLE 4-5

2002 SUMMARY STATISTICS FOR SEDIMENT MONITORING PROGRAM

			2002 Results - Concentration (dry weight)					
			Minimum[a,b,c,d]		Maximum[a,b,c]		Average[a,b,c,d]	
Radionuclide	Sediment FRL	No. of Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)
Great Miami River, North of the Effluent Line (G2)								
Total Uranium	210 mg/kg	1	1.52	(2.25)	NA	NA	NA	NA
Great Miami River, South of the Effluent Line (G4)								
Total Uranium	210 mg/kg	1	1.24	(1.84)	NA	NA	NA	NA
Paddys Run Background, North of S.R. 126 (P1)								
Radium-226	2.9 pCi/g	1	0.441	NA	NA	NA	NA	NA
Radium-228	4.8 pCi/g	1	0.537	NA	NA	NA	NA	NA
Thorium-228	3.2 pCi/g	1	0.400	NA	NA	NA	NA	NA
Thorium-230	18,000 pCi/g	1	0.757	NA	NA	NA	NA	NA
Thorium-232	1.6 pCi/g	1	0.362	NA	NA	NA	NA	NA
Total Uranium	210 mg/kg	1	0.703	(1.04)	NA	NA	NA	NA
Paddys Run, North of the Storm Sewer Outfall Ditch (PN1-PN5)								
Radium-226	2.9 pCi/g	5	0.407	NA	0.607	NA	0.5396	NA
Radium-228	4.8 pCi/g	5	0.313	NA	0.503	NA	0.4246	NA
Thorium-228	3.2 pCi/g	5	0.164	NA	0.665	NA	0.4008	NA
Thorium-230	18,000 pCi/g	5	0.785	NA	1.29	NA	0.954	NA
Thorium-232	1.6 pCi/g	5	0.251	NA	0.503	NA	0.3752	NA
Total Uranium	210 mg/kg	5	0.953	(1.41)	2.86	(4.24)	1.462	(2.164)
Storm Sewer Outfall Ditch (D1-D5)								
Radium-226	2.9 pCi/g	5	0.492	NA	0.894	NA	0.6782	NA
Radium-228	4.8 pCi/g	5	0.308	NA	0.703	NA	0.567	NA
Thorium-228	3.2 pCi/g	5	0.1475	NA	1.28	NA	0.6731	NA
Thorium-230	18,000 pCi/g	5	0.777	NA	1.85	NA	1.124	NA
Thorium-232	1.6 pCi/g	5	0.215	NA	1.59	NA	0.6112	NA
Total Uranium	210 mg/kg	5	1.493	(2.21)	17.4	(25.7)	5.12	(7.578)
Paddys Run, South of the Storm Sewer Outfall Ditch (PS1-PS3)								
Radium-226	2.9 pCi/g	1	0.648	NA	NA	NA	NA	NA
Radium-228	4.8 pCi/g	1	0.456	NA	NA	NA	NA	NA
Thorium-228	3.2 pCi/g	1	0.400	NA	NA	NA	NA	NA
Thorium-230	18,000 pCi/g	1	0.859	NA	NA	NA	NA	NA
Thorium-232	1.6 pCi/g	1	0.360	NA	NA	NA	NA	NA
Total Uranium	210 mg/kg	3	0.689	(1.02)	1.01	(1.49)	0.831	(1.23)

[a]If more than one sample is collected per sample location (e.g., split or duplicate), then only one sample is counted for the number of samples, and the sample with the maximum concentration is used for determining the summary statistics (minimum, maximum, and average).
[b]If the number of samples is greater than or equal to three, then the minimum, maximum, and average are reported. If the number of samples is equal to two, then the minimum and maximum are reported. If the number of samples is equal to one, then the result is reported as the minimum.
[c]NA = not applicable
[d]Where concentrations are below the detection limit, each result used in the summary statistics is set at half the detection limit.

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Chapter 5
Air Pathway

Chapter 5

5.0 Air Pathway

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This chapter describes the air pathway monitoring program used to track and evaluate airborne emissions from the Fernald site. It includes a discussion of radiological air particulates, radon, and direct radiation monitoring. In addition, this chapter provides a summary of radiological emissions from stacks and vents, as well as non-radiological emissions associated with the combustion of fossil fuel.

Results in Brief: 2002 Air Pathway

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

Radon - There were no exceedances of the DOE standard (3 pCi/L annual average above background) at the site fenceline and off-property locations. The maximum annual average concentration at the FCP fenceline measured by continuous radon monitors was 0.3 pCi/L above background.

Direct Radiation - Direct radiation measurements increased slightly at the site fenceline and the K-65 Silos boundary when compared to 2001. However, the K-65 Silos boundary levels are still approximately 50 percent lower than the radiation levels measured in 1991 prior to the addition of the bentonite layer within the K-65 Silos. These measurements are consistent with the fact that the K-65 Silos contain radium and its decay products, which contribute to direct radiation levels.

Boiler Plant - There were no opacity excursions reported during 2002.

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

Monitoring the air pathway is critical to ensuring the continued protection of the public and the environment during the remediation process because airborne contaminants can potentially migrate beyond the Fernald site. The site's air monitoring approach (presented in the IEMP) provides an ongoing assessment of the collective emissions originating from remediation activities. The results of this assessment are used to provide feedback to remediation project organizations regarding the sitewide effectiveness of project-specific emission controls relative to DOE, EPA, and OEPA standards. In response to this feedback, project organizations modify or maintain emission controls.

5.1 Remediation Activities Affecting the Air Pathway

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

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The following primary emission sources were active during 2002:

- Decontamination and Demolition Project activities, most notably Plant 2/3 and Plant 8 (Operable Unit 3).
- Excavation of the waste pits and the associated waste processing and rail car load-out operations at the Waste Pits Remedial Action Project (Operable Unit 1).
- Excavation of contaminated soil and debris (Operable Unit 5).
- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area (Operable Unit 2).
- Transportation and placement of contaminated material in the on-site disposal facility and interim storage at the on-site material transfer area (Operable Unit 2).
- Start-up testing of the RCS (Operable Unit 4).

Each project is responsible for designing and implementing engineered and administrative controls for each remediation activity. The fugitive emissions control policy mandates that fugitive emissions be visually monitored and controls be implemented as necessary. The following types of controls are used to keep point source and fugitive emissions to a minimum.

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

5.2 Air Monitoring Program Summary for 2002

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

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

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

- **Sampling** – Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the Fernald site. Key considerations in the design of the sampling program included prevailing wind directions, location of potential sources of emissions, and the location of off-property receptors. The IEMP program includes monitoring radiological air particulates at 19 locations, radon measurements at 34 locations, and direct radiation at 37 locations on and off the property.

- **Data Evaluation** – The data evaluation process focuses on tracking and trending data against historical ranges and DOE, EPA, and OEPA standards. Each section in this chapter presents an evaluation of data and a comparison to applicable standards and guidelines.

- **Reporting** – All data are reported through the IEMP program and annual site environmental reports.

5.3 Radiological Air Particulate Sampling Results

As described in the IEMP, a network of 19 high-volume air particulate monitoring stations is used to measure the collective contributions from all fugitive and point source particulate emissions from the site. This monitoring network includes 16 monitoring locations on the fenceline and two background locations. In addition, one thorium monitor was operated on the western fenceline. Figure 5-1 provides the locations of the IEMP air monitoring stations.

The sampling and analysis program for the 16 fenceline and two background locations consists of biweekly total uranium, isotopic thorium, and total particulate analyses in addition to a quarterly composite sample. The quarterly composite sample is analyzed for the expected major contributors (i.e., uranium, thorium, and radium) to the radiological air inhalation dose at the site's boundary. The thorium monitor includes biweekly particulate and isotopic thorium analyses. Analytical data from this program are used to assess the effectiveness of the emission control practices throughout the year to ensure particulate emissions remain below health protective standards.

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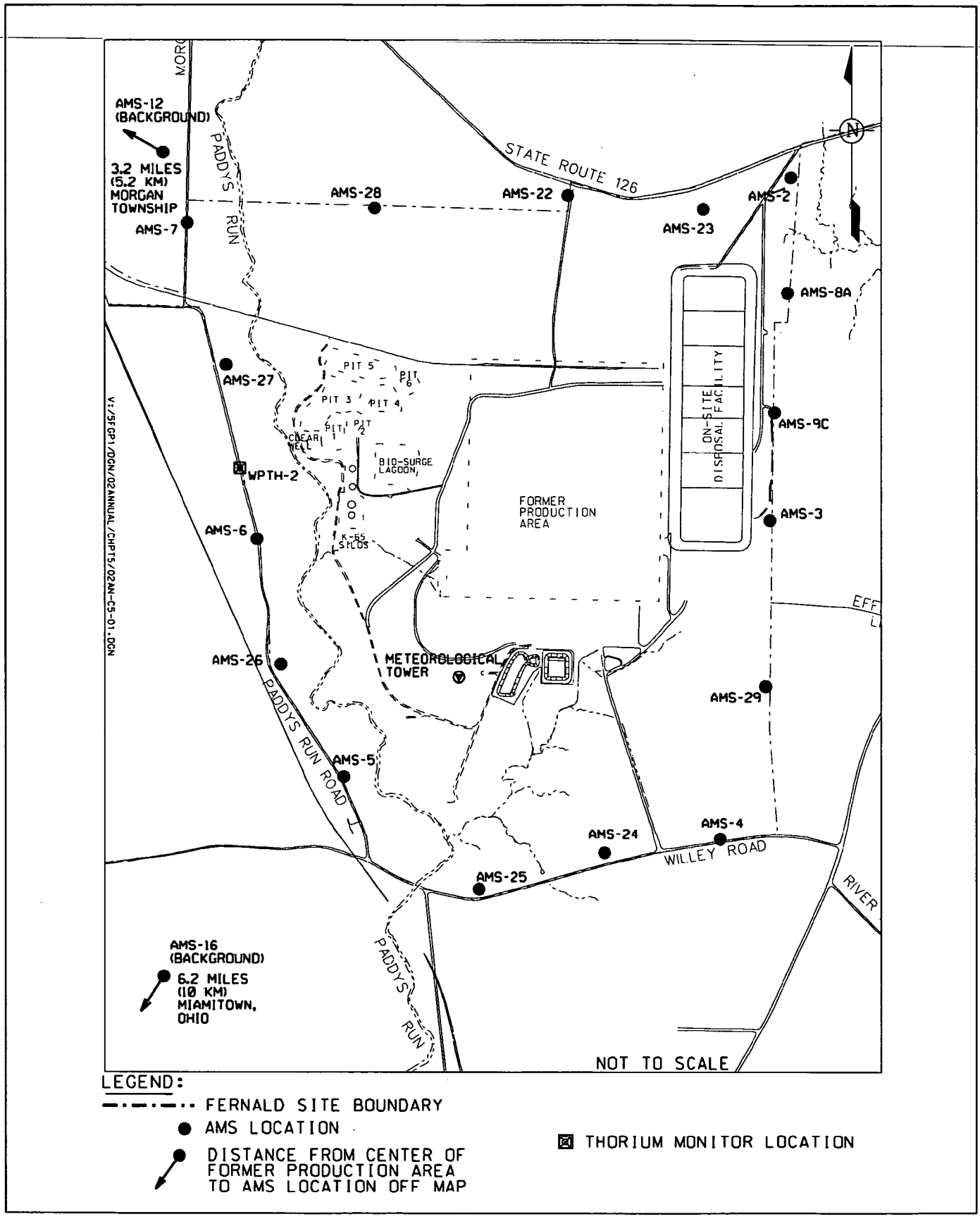

Figure 5-1. Radiological Air Monitoring Locations

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

- NESHAP Subpart H requirements which stipulate that radionuclide emissions (not including radon) to the ambient air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem in a year above background levels. This dose is reported in the annual NESHAP Subpart H compliance report and is included as Appendix D of this report.

- DOE Order 5400.5, Radiation Protection of the Public and Environment, guidelines for concentrations of radionuclides in air emissions. These guidelines, referred to as derived concentration guide values, are concentrations of radionuclides that, under conditions of continuous exposure for one year by one exposure mode (e.g., inhalation or ingestion), would result in a dose of 100 mrem to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

Table 5-1 presents a summary of the minimum, maximum, and average concentrations for total uranium, thorium-230, and total particulate in 2002 and 2001 based on the biweekly sample results used for monitoring air emission trends. For 2002 the annual average concentrations of total uranium at all fenceline air monitoring stations were less than one percent of the DOE-derived concentration guide value (0.1 picoCuries per cubic meter [pCi/m^3]). In 2002 total uranium at all air monitoring locations ranged from less than detectable concentrations to a maximum concentration of 1.9E-03 pCi/m^3 at AMS-8A. For comparison, background locations ranged from less than detectable to 6.3 E-05 pCi/m^3 at AMS-16.

TABLE 5-1

SUMMARY OF BIWEEKLY TOTAL URANIUM, TOTAL PARTICULATE, AND THORIUM-230 CONCENTRATIONS IN AIR

Location	2002 Total Uranium (pCi/m^3)	2001 Total Uranium (pCi/m^3)	2002 Total Particulate (µg/m^3)	2001 Total Particulate (µg/m^3)	2002 Thorium-230 (pCi/m^3)	2001 Thorium-230 (pCi/m^3)
Fenceline Locations						
Minimum	0.0E+00	0.0E+00	13	3.0	0.0E+00	0.0E+00
Maximum	1.9E-03	9.9E-04	94	82	5.8E-04	7.4E-04
Average	1.1E-04	1.1E-04	34	33	6.2E-05	5.1E-05
Background Locations						
Minimum	0.0E+00	0.0E+00	4	14	0.0E+00	0.0E+00
Maximum	6.3E-05	5.6E-05	100	62	1.5E-04	4.2E-05
Average	1.8E-05	2.0E-05	27	34	1.1E-05	9.5E-06

Biweekly thorium monitoring at the fenceline provides timely feedback on project engineered and administrative controls that are implemented to control fugitive emissions, primarily at the Waste Pits Remedial Action Project. The fenceline concentrations of thorium-230 (the primary thorium isotope of concern in the waste pit material being excavated) ranged from less-than-detectable to 5.8 E-04 pCi/m^3, which was detected at AMS-3. For comparison, background locations ranged from less than detectable to 1.5 E-04 pCi/m^3 at AMS-16.

In addition to the total uranium and isotopic thorium analyses, total particulate measurements are also obtained from each filter every two weeks as summarized in Table 5-1. Total particulate concentrations at the fenceline ranged from 13 micrograms per cubic meter milligrams per cubic meter (mg/m^3) to a maximum of 94 mg/m^3 at AMS-9C. There are no general or site-specific regulatory limits associated with total particulate measurements used in the data evaluation process.

Total particulate, total uranium, and thorium-230 data were collectively evaluated to identify any increasing trends that may be related to remediation activities. Several temporary increases of these three constituents were observed at various monitoring locations; however, the short-lived increases did not pose a potential exceedance of the NESHAP dose limit of 10 mrem or DOE guidelines. The majority of increases in total uranium and thorium-230 concentrations were detected at some of the air monitoring stations on the eastern fenceline (AMS-3, AMS-8A, and AMS-9C) during the first quarter of 2002. Figures 5-2 and 5-3 show total uranium and thorium-230 concentrations, respectively, at the selected eastern fenceline locations. These temporary increases were due to the remediation activities associated with the Waste Pits Remedial Action Project, on-site disposal facility and its associated material transfer area, and Decontamination and Demolition Project activities. The radiological air particulate data are discussed with remediation project personnel to ensure that emission controls are operating as expected and to consider actions as necessary. Appendix C, Attachment 1, of this report provides graphical displays of the 2002 total uranium, thorium-230, and total particulate data.

Quarterly composite air filter samples were formed from the biweekly samples at each IEMP air monitoring station during 2002 to determine the radiological air inhalation dose for each location. The samples were analyzed for isotopes of radium, thorium, and uranium. The quarterly results were used to track compliance with the NESHAP 10-mrem dose limit throughout the year and to demonstrate compliance with the limit at the end of 2002. The maximum dose associated with the quarterly composite results for 2002 was 0.8 mrem (compared to the 10 mrem limit) and occurred at AMS-9C. The composite results from the fenceline monitors show that, on average, thorium isotopes contribute 61 percent of the dose from 2002 airborne emissions. Isotopes of uranium and radium account for 32 and 6 percent of the dose, respectively. The higher percentage of dose from thorium isotopes is a result of thorium-230 becoming the major dose contributor through fugitive emissions from the Waste Pits Remedial Action Project operations. Thorium-230 became the major dose contributor beginning in 2000 with the commencement of Waste Pits Remedial Action Project excavation activities. Given the methods required to excavate, transport, and process waste pit material, fugitive emissions were expected to increase the average concentration of thorium-230 at the fenceline. Although the project uses several environmental compliance-based dust abatement practices and controls, some fugitive emissions are expected to be generated from the project based on the large-scale waste handling operations. Chapter 6 and Appendix D of this report provide more detailed information on the dose associated with the composite results.

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

The WPTH-2 fenceline monitor was installed in late 1998 on the west property boundary to specifically monitor thorium emissions from the Waste Pits Remedial Action Project on a biweekly basis. Measured airborne concentrations of thorium-228 and thorium-232 were comparable to background concentrations throughout 2002. These fenceline data reflect the fact that, in comparison to thorium-230, the concentrations of thorium-228 and thorium-232 in the waste pit material are relatively low thus far into the excavation of waste. The Waste Pits Remedial Action Project operations are not expected to significantly impact the fenceline concentrations of thorium-228 and thorium-232. Appendix C, Attachment 1, of this report provides graphical displays of the isotopic thorium data from the WPTH-2 monitor.

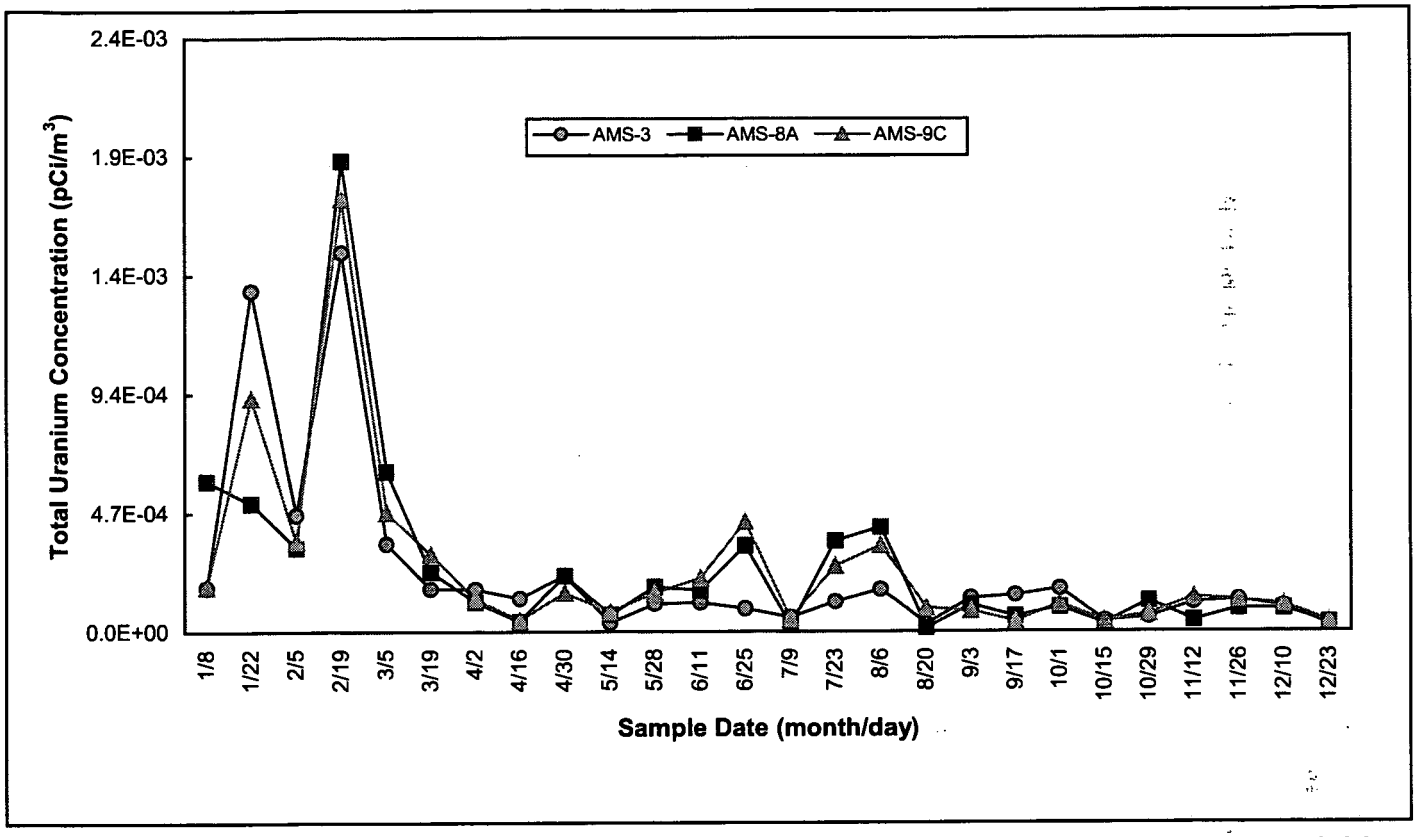

Figure 5-2. 2002 Total Uranium Concentrations in Air at Selected East Fenceline Monitors (AMS-3, AMS-8A, and AMS-9C)

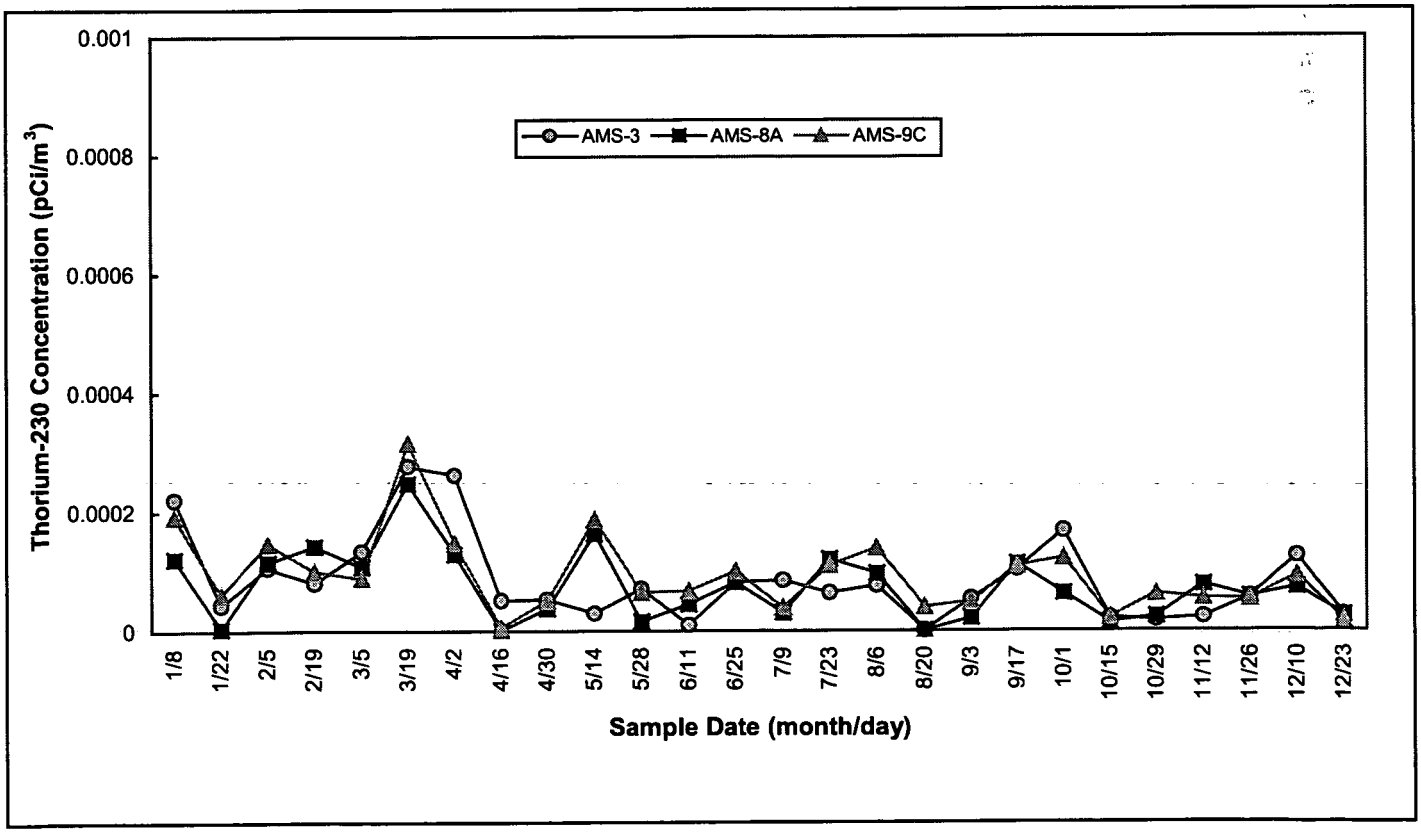

Figure 5-3. 2002 Thorium-230 Concentrations in Air at Selected East Fenceline Monitors (AMS-3, AMS-8A, and AMS-9C)

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5.4 Radon Monitoring

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

Many factors influence the concentration of radon in the environment, including the distribution of radium-226 in the ground, porosity of the soil, weather conditions, etc. For instance, radon diffusion from the ground is minimized by the presence of precipitation and snow cover. Alternatively, elevated temperatures and the absence of precipitation can produce cracks in the ground and changes in porosity that increase the rate at which radon escapes. Summary level meteorological data from 2002 are presented in Appendix C, Attachment 4, and Figures 1-7 through 1-10 of this report.

Environmental radon concentrations are also influenced by atmospheric conditions. During periods of calm winds and temperature inversions (the air near the earth's surface is cooler than the air above it), air is held near the earth's surface, minimizing the mixing of air. Consequently, when these inversions occur, radon's movement is limited vertically and concentrations tend to increase near the ground.

Waste material that produces radon is stored at the Fernald site. This waste was generated from uranium extraction processes performed decades ago and contains radium-226. This material is contained in K-65 Silos 1 and 2, and Silo 3 (part of the Operable Unit 4 remediation) and the waste pits (currently being remediated per the Operable Unit 1 Record of Decision).

DOE Order 5400.5, Radiation Protection of the Public and the Environment, defines radiological protection requirements, guidelines for cleanup of residual radioactive material, management of resulting wastes and residues, and the release of radiological property. Radon limits at interim storage facilities (such as at the Fernald site) are also defined under DOE Order 5400.5 and must not exceed:

- 100 pCi/L at any given location and any given time.
- Annual average concentration of 30 pCi/L (above background) over the facility.
- Annual average concentration of 3 pCi/L (above background) at and beyond the facility fenceline.

Figure 5-4 illustrates the continuous radon-monitoring network used in 2002 for determining compliance with the above limits. The continuous monitoring network provides frequent feedback to remediation projects, regulatory agencies, and stakeholders on trends in ambient radon concentrations, while providing sufficient radon monitoring to ensure compliance with DOE Order 5400.5 requirements. Access to real-time radon monitoring data from selected continuous radon monitoring locations is available at the Public Environmental Information Center.

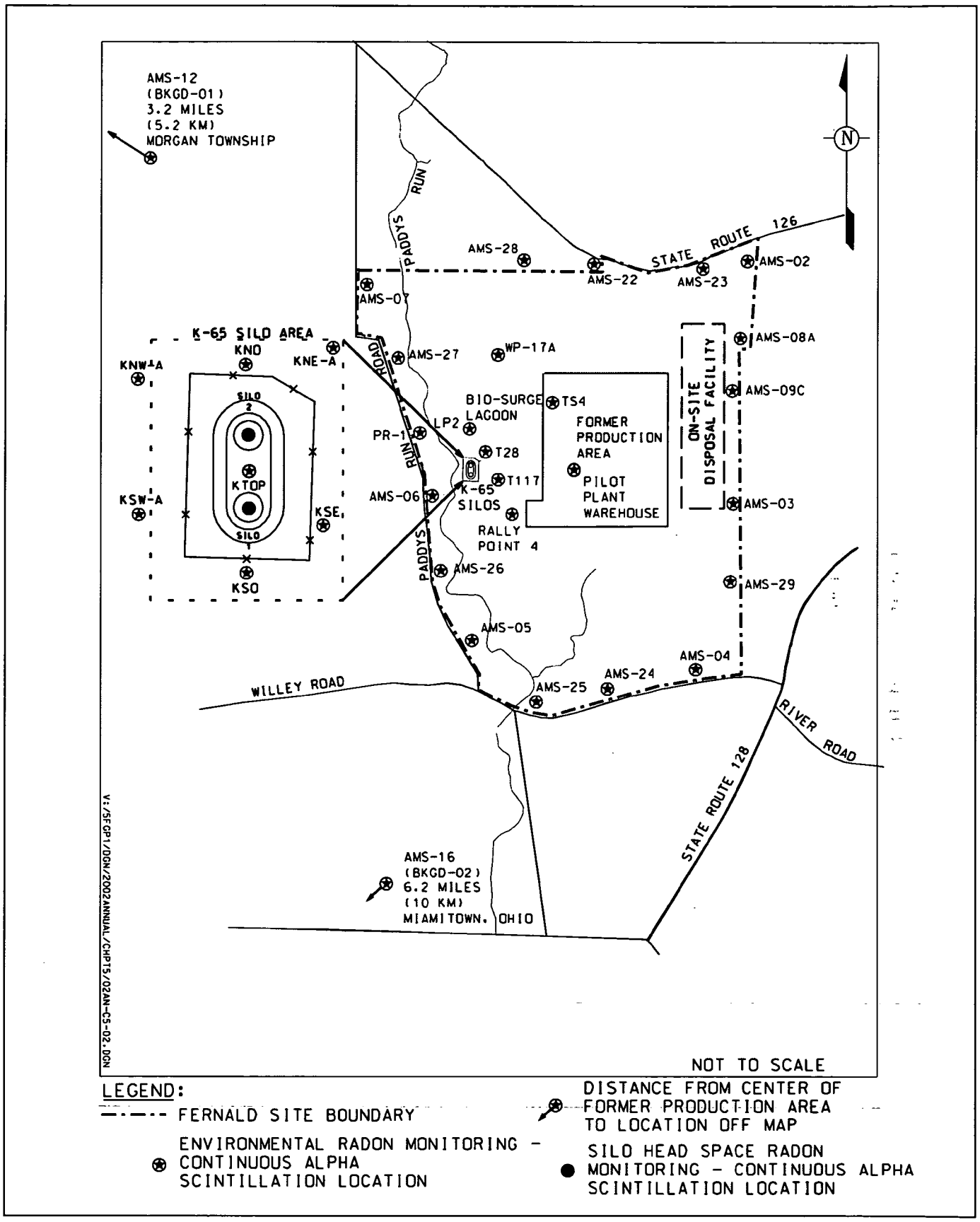

Figure 5-4. Radon Monitoring Locations

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In general, monitoring locations were selected near radon-emitting sources, at the property fenceline, and at background locations. The FFA identifies additional environmental radon monitoring locations, as well as continuous measurement of radon concentrations in the headspace of the K-65 Silos. DOE guidance and EPA air monitor siting criteria were considered when selecting monitoring locations.

5.4.1 Continuous Radon Monitors

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

Continuous monitors reveal important information regarding the dynamics of radon concentrations at different times during the day and at various locations on and off site. These monitors allow for timely review of radon concentrations, which may indicate concentrations are significantly changing from day to day and week to week. However, the use of these monitors is restricted by certain conditions. For example, potential monitoring sites are limited by the availability of electricity.

Table 5-2 provides monthly average radon concentration data from the continuous radon monitors for 2002. The data are used to track radon concentrations throughout the year to ensure the DOE limits are not exceeded. In addition to the summary data presented here, Appendix C, Attachment 2, of this report provides graphical displays of monthly average radon concentrations from continuous radon monitors during 2002 and 2001.

Results from the fenceline monitoring locations indicate radon levels for 2002 were within historical ranges and well below the DOE limit of 3 pCi/L above background. The annual average radon concentrations at the fenceline ranged from 0.2 to 0.5 pCi/L. The annual average radon concentration at the background monitoring locations was 0.2 pCi/L. A review of site fenceline data suggests that during 2002, Waste Pits Remedial Action Project operations did not significantly impact the radon concentrations at the site fenceline (refer to Table 5-2).

TABLE 5-2
CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS[a]

Location[b]	2002 Summary Results[c] (Instrument Background Corrected) (pCi/L)			2001 Summary Results[c] (Instrument Background Corrected) (pCi/L)		
	Min.	Max.	Avg.	Min.	Max.	Avg.
Fenceline						
AMS-02	0.0	0.8	0.4	0.1	0.6	0.3
AMS-03	0.2	0.8	0.4	0.1	0.7	0.3
AMS-04	0.1	0.7	0.3	0.1	0.5	0.3
AMS-05	0.1	0.9	0.4	0.1	0.8	0.4
AMS-06	0.1	0.8	0.4	0.1	0.6	0.3
AMS-07	0.2	1.2	0.5	0.2	0.8	0.4
AMS-08A	0.1	0.7	0.3	0.1	0.7	0.4
AMS-09C	0.0	0.7	0.3	0.0	0.8	0.3
AMS-22	0.1	0.6	0.2	0.1	0.3	0.2
AMS-23	0.0	0.4	0.2	0.1	0.3	0.2
AMS-24	0.1	1.1	0.4	0.1	0.7	0.3
AMS-25	0.1	0.8	0.3	0.1	0.7	0.3
AMS-26	0.1	0.7	0.3	0.2	0.5	0.3
AMS-27	0.1	1.0	0.4	0.1	0.8	0.4
AMS-28	0.1	0.8	0.4	0.1	0.6	0.3
AMS-29	0.1	0.5	0.3	0.1	0.5	0.2
Background						
AMS-12	0.1	0.5	0.2	0.1	0.5	0.3
AMS-16	0.1	0.4	0.2	0.0	0.3	0.1
On Site						
KNE-B[d]	1.4	5.6	3.7	1.1	13.1	3.9
KNO	1.1	2.7	1.7	0.9	2.3	1.9
KNW-A	0.5	2.0	1.1	0.4	1.9	0.8
KSE	1.1	3.6	2.4	0.9	4.5	2.1
KSO	0.2	1.2	0.6	0.3	1.6	0.6
KSW-A	0.7	1.7	1.0	0.2	1.8	0.8
KTOP	2.8	8.8	4.7	3.0	9.0	5.5
LP2	0.4	1.4	0.8	0.3	1.2	0.6
Pilot Plant Warehouse	0.1	0.7	0.4	0.3	0.8	0.4
PR-1	0.1	1.2	0.5	0.3	0.9	0.6
Rally Point 4	0.2	0.8	0.4	0.2	0.7	0.4
Surge Lagoon	0.4	1.3	0.8	0.2	1.4	0.6
T117	0.2	1.0	0.4	0.2	1.3	0.5
T28	0.4	1.0	0.6	0.3	1.1	0.6
TS4	0.1	1.1	0.6	0.2	1.0	0.5
WP-17A	0.1	1.1	0.5	0.2	0.7	0.4

[a]Monthly average radon concentrations are calculated from the daily average concentrations.
[b]Refer to Figure 5-4 for sample locations.
[c]Instrument background changes as monitors are replaced.
[d]Instrument relocated 60' North on November 25, 2002; formerly identified as KNE-A.

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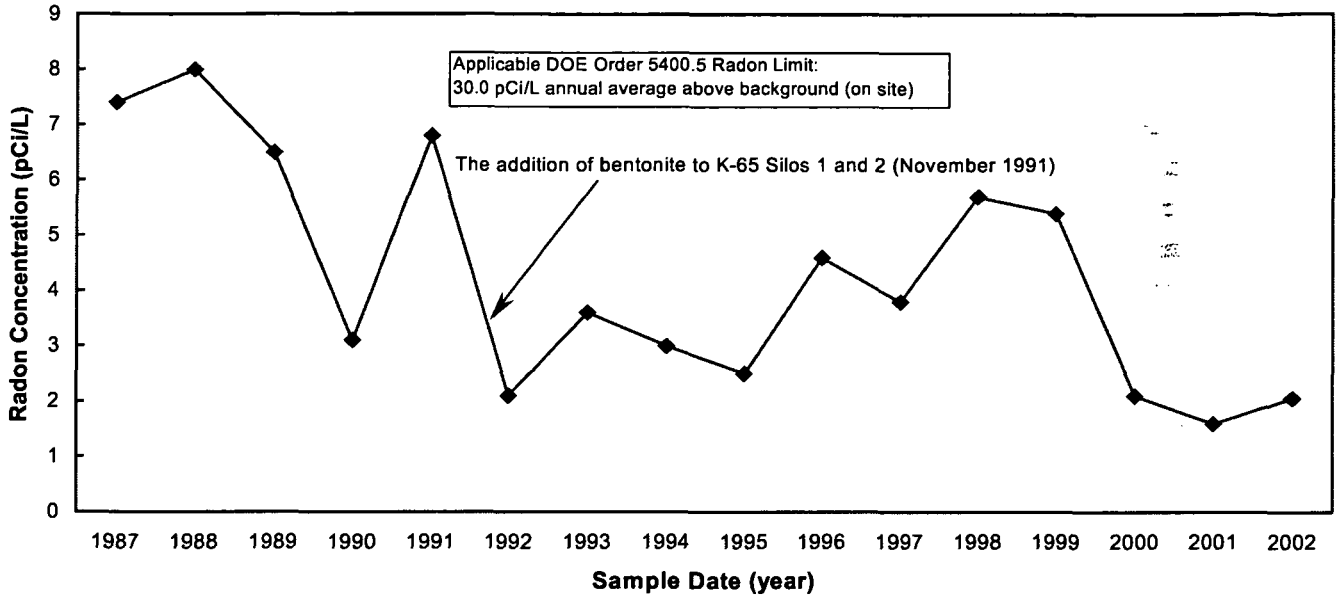
In accordance with the FFA, radon concentrations within the headspace of K-65 Silos 1 and 2 are continuously monitored to assess the effectiveness of control measures in reducing radon emissions. From 1993 to 2001, there was a gradual upward trend in silo headspace radon concentrations. The increases in the headspace concentration were attributable to degradation of the 1991 application of bentonite clay to the surface of the K-65 Silo residues. During 2002 seasonal fluctuations in the silo headspace radon concentrations were observed, but the upward trend slowed and headspace concentrations stabilized. In December 2002, the headspace radon concentrations were temporarily lowered through the initial short-term test of the RCS. Appendix C, Attachment 2, of this report provides a graphical display of quarterly average headspace radon concentrations from 1992 to 2002. During 2002 there were 10 exceedance events related to the 100-pCi/L DOE limit measured on site (refer to Table C.2-1) compared with 15 recorded in 2001. As in past years, the exceedances were observed at monitoring locations adjacent to the K-65 Silos and occurred during periods of atmospheric inversions.

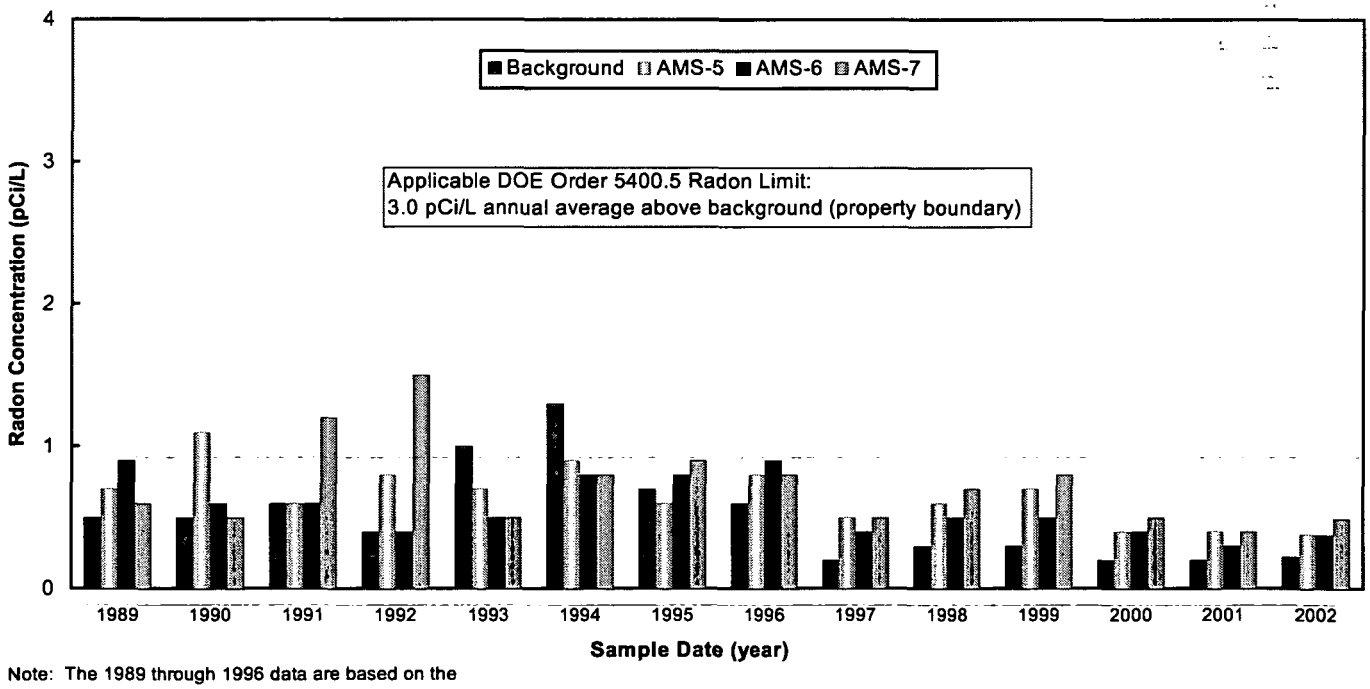
Long-term comparisons are performed on average radon concentrations recorded at the K-65 Silos exclusion fence locations. Historical alpha track-etch and alpha scintillation detector data were used for this comparison (refer to Figure 5-5). The average concentrations adjacent to the K-65 Silos are still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

Long-term comparisons are also performed on average radon concentrations at western property fenceline locations and background locations as a basis for comparison to the 3 pCi/L annual average limit. In 2002 a marginal difference in radon concentrations was observed between background and western property fenceline monitoring locations (refer to Figure 5-6). The on-property monitoring locations also recorded radon levels well below the applicable DOE limit of 30 pCi/L annual average.



Note: The 1987 through 1996 data are based on the alpha track-etch detectors and averaging locations corresponding to continuous radon monitors. The 1997 through 2002 data are based on the average radon concentration from continuous radon monitors at the K-65 exclusion fence.

Figure 5-5. Annual Average Radon Concentrations at K-65 Silos Exclusion Fence, 1987-2002



Note: The 1989 through 1996 data are based on the alpha track-etch detectors and the 1997 through 2002 data are based on the continuous radon monitors.

Figure 5-6. Annual Average Radon Concentrations at Selected Radon Locations, 1989-2002

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5.5 Monitoring for Direct Radiation

Direct radiation (e.g., x-rays, gamma rays, energetic beta particles, and neutrons) originates from sources such as cosmic radiation, naturally occurring radionuclides in soil, as well as radioactive materials at the Fernald site. The largest source of direct radiation is the material stored in K-65 Silos 1 and 2. Gamma rays and x-rays are the dominant types of radiation emitted from the silos. Energetic beta particles, alpha particles, and neutrons are not a significant component of direct radiation at the Fernald site because uranium, thorium, and their decay products do not emit these types of radiation at levels that create a public exposure concern.

Direct radiation levels at and around the Fernald site were continuously measured at 37 locations with thermoluminescent dosimeters (TLDs) during 2002. The TLD monitoring network was modified in late 2002 to take into account the pending relocation of the wastes stored in Silos 1 and 2. The following additional TLD locations were added to the Silo area:

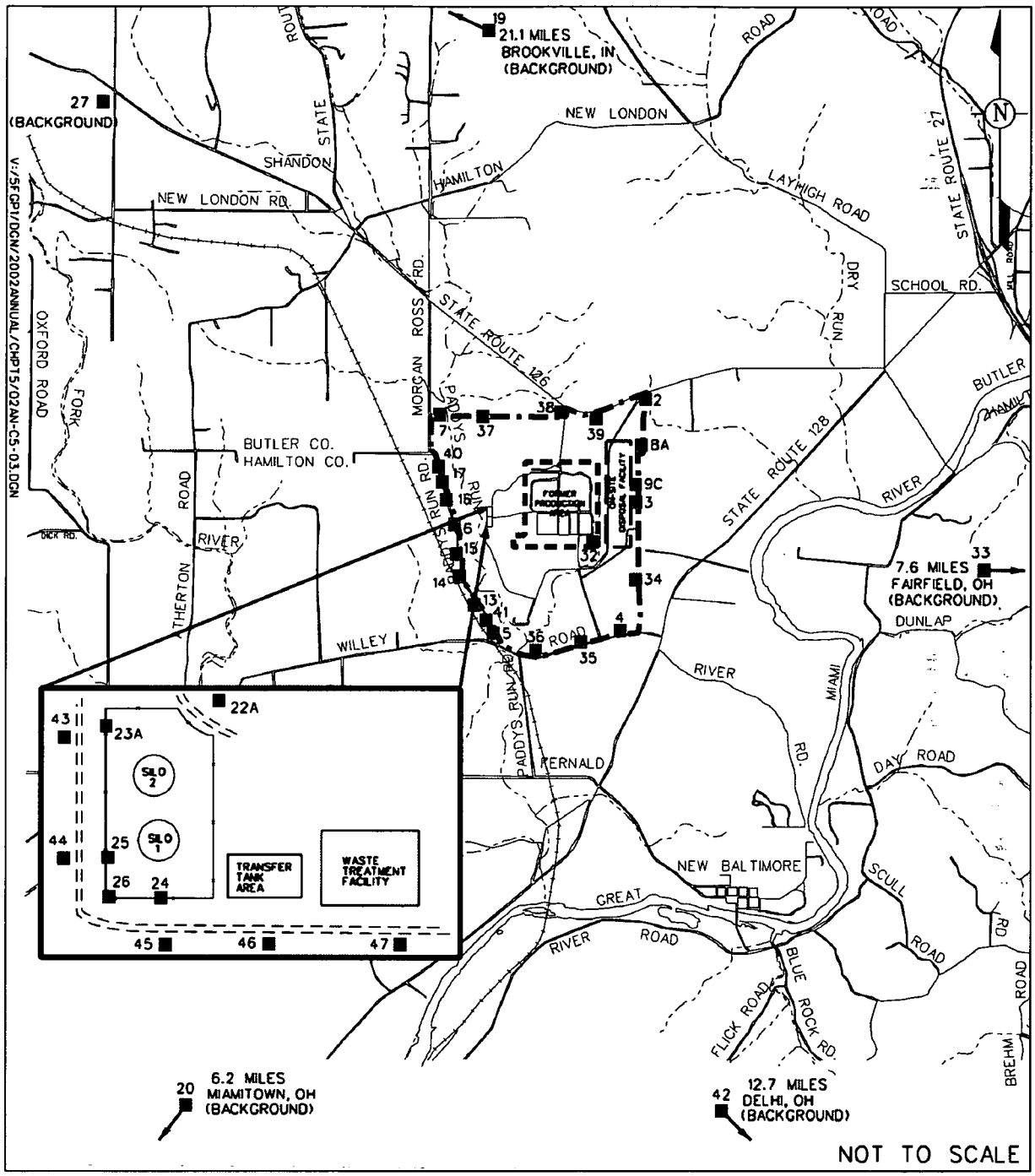
- Location 43, on the western side of the silos near the KNW-A radon monitor.
- Location 44, on the western side of the silos near the KSW-A radon monitor.
- Location 45, on the southern side of the silos near the KSO radon monitor.
- Location 46, on the project boundary south of the transfer tank area building.
- Location 47, on the project boundary south of the waste treatment facility.

Two of the five new monitoring locations (43 and 44) were selected based on the need to monitor direct radiation levels from the silo wastes as the berm is excavated. The excavation of the berm will change the radiation shielding in place at the silos and may affect radiation levels at the fenceline. These locations will also serve as secondary monitoring locations in the event that Silo construction activity eliminates locations 23A, 24, 25, and 26. Three new monitoring locations (45, 46, and 47) were selected based on the need to monitor direct radiation levels from the silo wastes and their associated high levels of radon as the wastes are transferred from the silos, to the transfer tank area, and eventually to the waste treatment facility. More specifically, the new locations were selected to monitor the movement of these materials as it affects radiation levels at the site fenceline.

TLDs absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions in a laboratory, the stored energy is released as light, measured, and correlated to the amount of direct radiation. Figure 5-7 identifies the TLD monitoring locations. These monitoring locations were selected based on the need to monitor the K-65 Silos, the fenceline, and background locations. Table 5-3 provides summary level information pertaining to direct radiation measurements for 2002 and 2001.

TABLE 5-3
DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MEASUREMENT SUMMARY

	Direct Radiation (mrem)	
TLD Location	**Summary of 2002 Results**	**Summary of 2001 Results**
Fenceline (21 locations)		
Minimum	71	69
Maximum	97	90
On Site (11 locations)		
Minimum (Health & Safety Bldg.)	56	58
Maximum (K-65 Silo area)	1220	1204
Background (5 locations)		
Minimum	70	67
Maximum	83	79



LEGEND:

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

FERNALD SITE BOUNDARY

DIRECT RADIATION (TLD) MONITORING LOCATION

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

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All monitoring results from TLDs for 2002 were within historical or expected ranges. From 1993 to 2001, there was a gradual upward trend in direct radiation measurements in the immediate area of the K-65 Silos (refer to Figure 5-8). During 2002, the upward trend slowed and direct radiation measurements near the K-65 Silos stabilized. The change in the upward trend was attributable to comparatively stable radon concentrations and associated decay products within the K-65 Silos' headspace. As noted earlier, in December 2002 the headspace radon concentrations were temporarily lowered through the initial short-term test of the RCS. The decrease in the direct radiation levels during the fourth quarter of 2002 is in some part attributable to the operation of the RCS.

The increasing trend in direct radiation levels at the site's western fenceline (1998 through 2001) also stabilized in 2002, particularly at TLD location 6 which is located closest to the K-65 Silos (refer to Figure 5-9). The relatively small changes in direct radiation levels at the fenceline are difficult to measure consistently due to small variations in the sensitivity and accuracy of the environmental TLDs. These changes at the fenceline are also attributable to the radon concentrations and associated decay products within the K-65 Silos' headspace. The slight upward trend in background radiation levels shown in Figure 5-9 is attributed to changes in the laboratory processing of the TLDs. These trends will continue to be monitored and presented through the annual site environmental reports.

Chapter 6 provides more information on the dose associated with the direct radiation results. Detailed results of direct radiation measurements for 2002 and 2001 are provided in Appendix C, Attachment 3, of this report.

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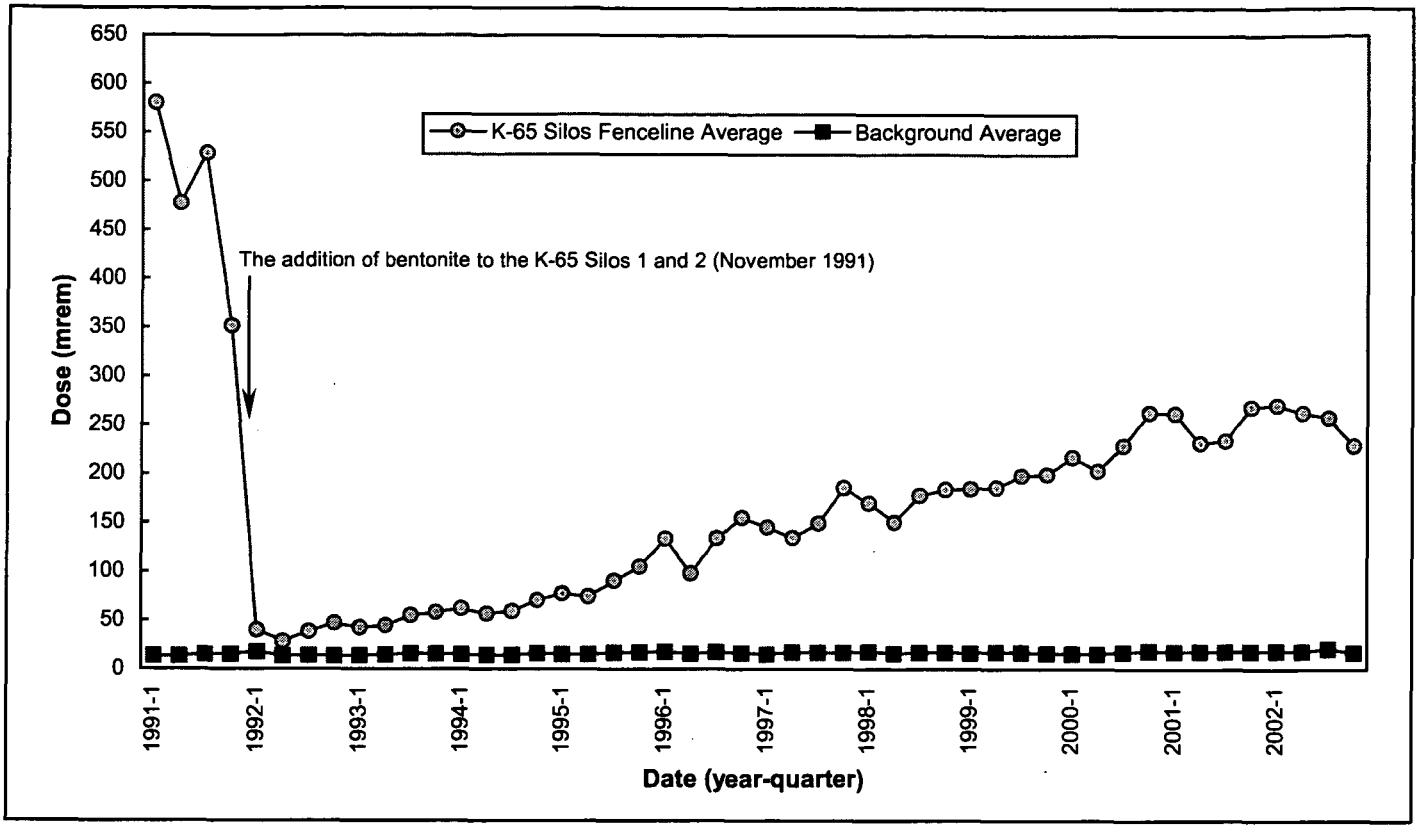

Figure 5-8. Direct Radiation (TLD) Measurements at K-65 Silos Boundary, 1991-2002 (K-65 Silos Fenceline Average Versus Background Average)

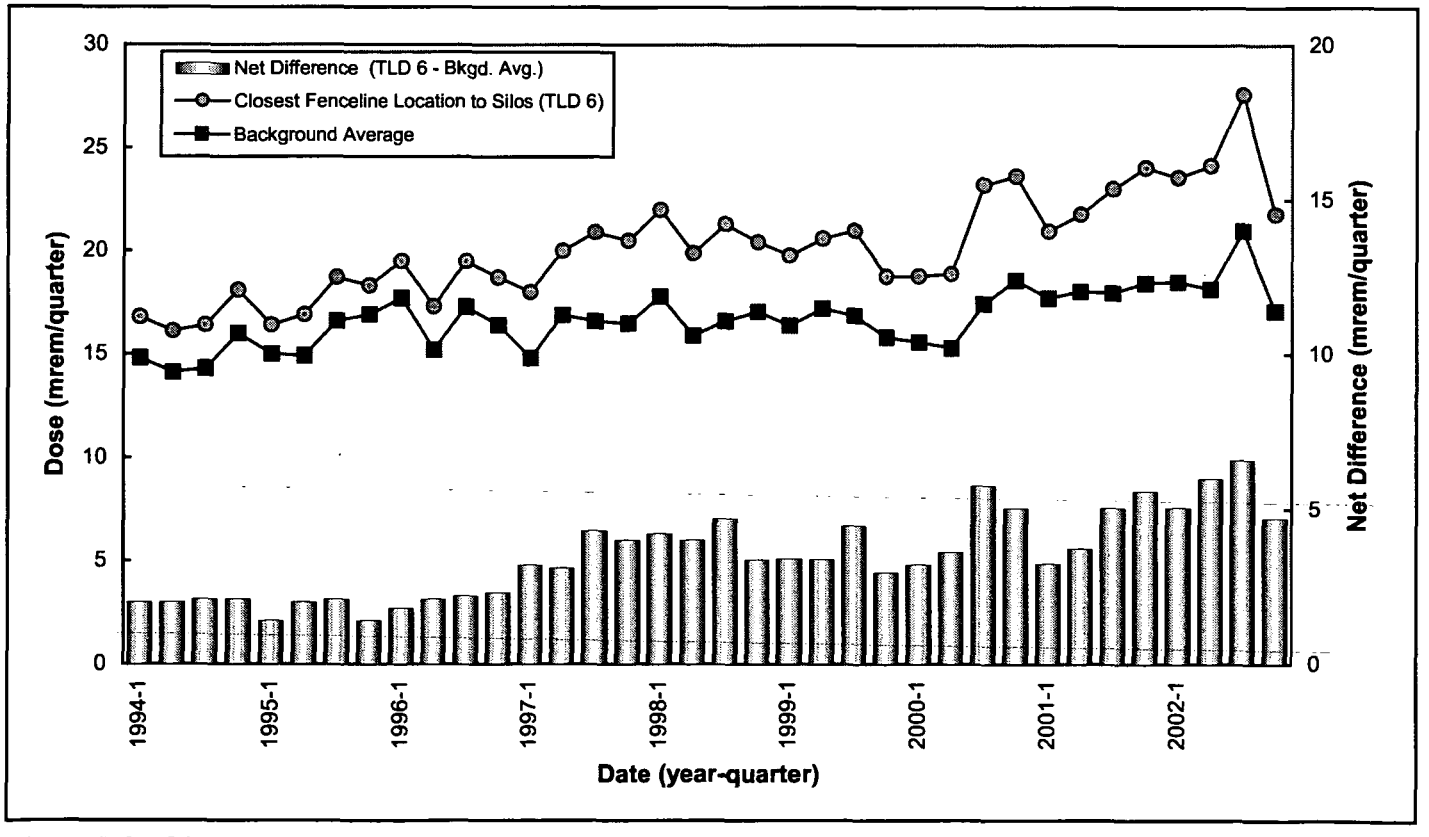

Figure 5-9. Direct Radiation (TLD) Measurements, 1994-2002 (Location 6 Versus Background Average)

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5.6 Stack Monitoring for Radionuclide Emissions

During 2002 there were four stacks (or vents) that were monitored for radionuclide emissions as part of the requirements under the NESHAP Subpart H. The locations of the four stacks are show in Figure 5-10. Stack sampling systems typically consist of a continuously operating pump that draws a representative volume of air from the stack through a filter or, in the case of radon monitoring, through a detector. Periodically, the filter is exchanged and analyzed for radiological contaminants that have the potential to be released during remediation activities or processes.

The Building 71 stack filters were analyzed for isotopes of uranium, thorium, and total particulate. Results for 2002 were very low and comparable to 2001 results. The results confirm that emissions from the waste processing operations conducted in Building 71 were not a significant source of airborne emissions to the environment. No significant changes in source operations associated with the Building 71 stack were noted during 2002.

The Waste Pits Remedial Action Project dryer stack particulate filters were analyzed for isotopes of uranium, thorium, and radium. The results confirmed that Waste Pits Remedial Action Project stack particulate emissions are very low and are not the primary source of the increases in thorium-230 concentrations at the fenceline in recent years. The stack also contains a continuous radon monitor (i.e., radon-220 and radon-222). The maximum daily release of radon (radon-220 and radon-222) during 2002 was 195,255 μCi. This equates to 8,136 μCi/hr (microCuries per hour), which is below the estimated maximum hourly release rate of 13,000 μCi/hr (DOE 1998a) for radon-222. The daily average release rate of radon in 2002 was 12,268 μCi, which equates to 511 μCi/hr, and is well below the estimated maximum hourly release rate of 13,000 μCi/hr for radon-222.

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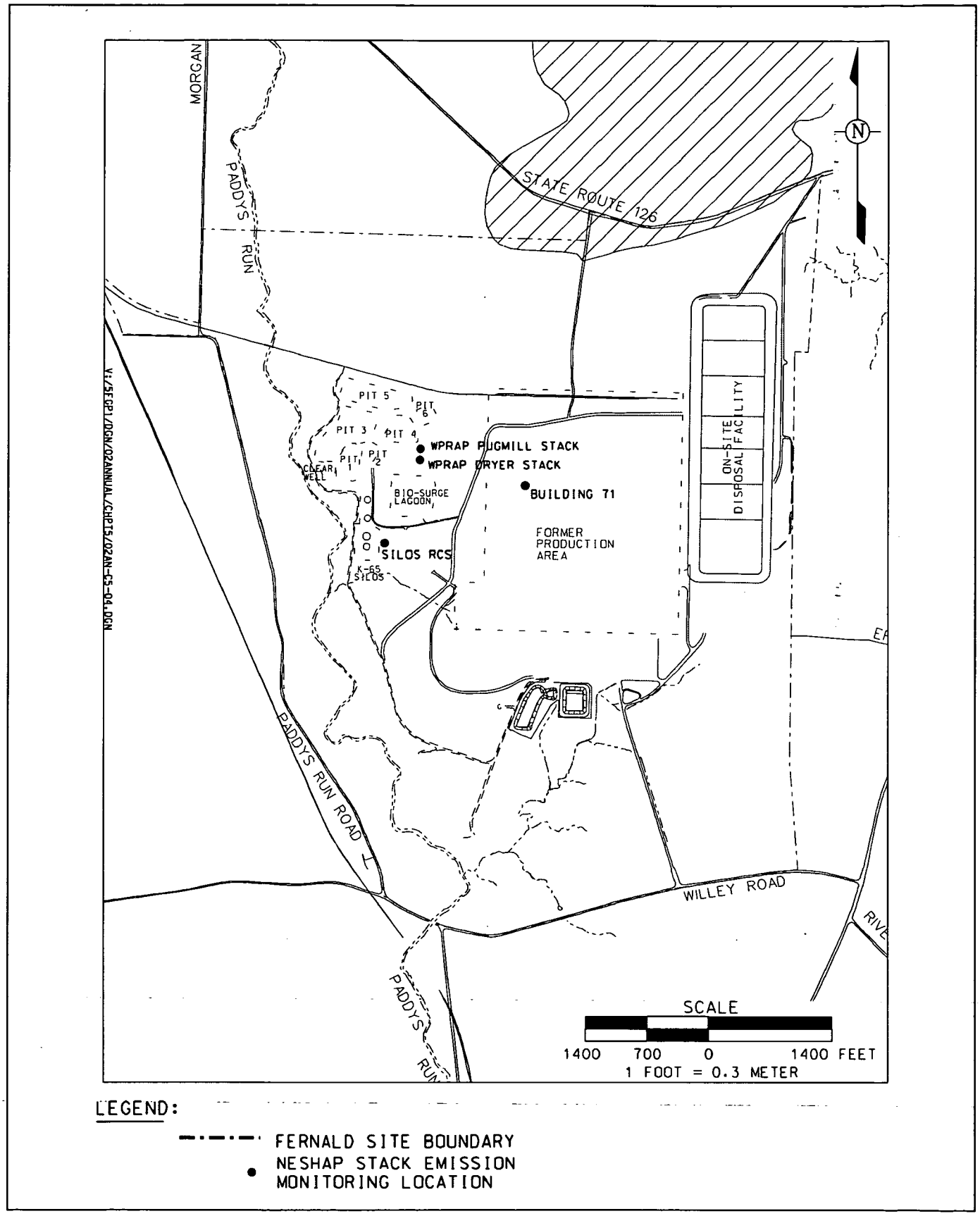

Figure 5-10. NESHAP Stack Emission Monitoring Locations

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In 2002 the Waste Pits Remedial Action Project installed a new ventilation system to control emissions of steam and fine particulate from the pugmill discharge bin. The pugmill discharge bin collects the dried solids from the Waste Pits Remedial Action Project dryer. Waste Pits Remedial Action Project personnel concluded that fine radioactive particles were entrained with the steam being emitted from the discharge bin. The radionuclide releases were believed to be responsible for elevated airborne radiological levels in the area of the pugmill as well as the increased levels of thorium-230 at the site fenceline. The ventilation system was installed to control these fugitive emissions and minimize the spread of radioactive contamination from the pugmill discharge bin. The system also controls fugitive emissions from designated areas in the Material Handling Building. The pugmill ventilation system (PVS) began operation in April 2002. The PVS stack particulate filters were analyzed for isotopes of uranium, thorium, and radium, and are presented in Table 5-4.

TABLE 5-4
2002 NESHAP STACK EMISSIONS

Radionuclide (Unit)	WPRAP Dryer Stack[a]	WPRAP PVS Stack[a]	Silos RCS Stack[a]	Building 71 Stack[a]
Total Uranium (lbs/yr)	NS	NS	NS	2.7E-05
Uranium-238 (lbs/yr)	1.6E-05	9.1E-04	ND	1.5E-05
Uranium-235/236 (lbs/yr)	2.5E-08	3.3E-06	ND	ND
Uranium-234 (lbs/yr)	5.8E-10	2.5E-08	ND	1.0E-09
Thorium-232 (lbs/yr)	1.0E-06	2.1E-04	ND	3.1E-05
Thorium-230 (lbs/yr)	2.4E-10	5.8E-08	1.5E-09	4.3E-10
Thorium-228 (lbs/yr)	3.2E-16	3.5E-14	ND	4.2E-15
Thorium-227 (lbs/yr)	NS	NS	ND	NS
Radium-226 (lbs/yr)	4.4E-13	6.1E-11	ND	NS
Polonium-210 (lbs/yr)	NS	NS	2.9E-15	NS
Total Particulates (lbs/yr)	NS	NS	0.0E+00	1.1E-01
Total Radon (mCi/yr)	4,500	NS	23[b]	NS

[a]NS = not sampled
ND = not detectable
[b]Estimated value due to difficulties with RCS stack monitor.

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In 2002 the Silos Project installed an RCS as part of the Accelerated Waste Retrieval Project. The operation of the RCS was tested for 15 hours in December 2002. The RCS was designed to control radon emissions for the Accelerated Waste Retrieval Project and from the future operation of the Silos 1 and 2 remediation facility. Specifically, emissions from the Silos 1 and 2 headspace, the Silos Waste Retrieval System, and the Transfer Tank Area are controlled by the RCS. The RCS is designed to maintain negative pressure in the silo headspaces, Silos 1 and 2 Waste Retrieval System, and Transfer Tank Area tanks, and to control process emissions from the Silos 1 and 2 remediation facility. Airflow in the air emission control system will be closely controlled to minimize the release of air emissions to the environment during all phases of operation. To the extent practical, the system will be operated in a "recycle" mode where all or most of the air is withdrawn from the silo or Transfer Tank Area headspace, circulated through the RCS, and discharged back into the silo or Transfer Tank Area. A continuous stack monitoring system has been installed on the exhaust stack to continuously monitor/sample air emissions (particulate radionuclides and radon) from the exhaust stack in accordance with 40 Code of Federal Regulations 61 Subpart H. The results of the RCS stack filter analysis are presented in Table 5-4. There were difficulties with the RCS stack radon monitor during the initial test; therefore, RCS stack radon data is not reported in Table 5-4. However, radon monitoring data from monitoring points within the RCS (and upstream of stack radon monitor) indicated that radon emissions during the test were not large enough to exceed the maximum allowable release rate. Furthermore, monitoring data from environmental monitors in the vicinity of the silos and at the site fenceline detected no significant increase in radon concentrations during the RCS test.

Typically, post-production era (1990 and later) monitoring data have shown stack emissions of radionuclides to be very low or not detectable. The use of high-efficiency particulate air (HEPA) filtration systems in many remediation activities and processes effectively controls stack emissions and limits the release of airborne contaminants. In summary, the 2002 stack emissions are consistent with the low stack emission data for the post-production period.

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5.7 Monitoring for Non-Radiological Pollutants

The FCP continued to operate the Waste Pits Remedial Action Project gas-fired dryers during 2002. The estimated emissions from the dryer operations were based on emission factors from the AP-42 technical reference document (Compilation of Air Pollution Emission Factors, Vol. 1; Stationary Point and Area Sources, 5th edition, January 1995 [EPA 1995]). The sulfur dioxide emissions were estimated to be 188 pounds (85 kg). Nitrogen oxide emissions for 2002 were estimated to be 25,410 pounds (11,536 kg). Carbon monoxide emissions were estimated to be 19,136 pounds (8,688 kg). The estimate for particulate as PM10 (particles with an aerodynamic diameter less than or equal to a nominal 10 micron) was 4,298 pounds (1,951 kg). Total organic compound emissions for 2002 were estimated to be 1,819 pounds (826 kg). There are no regulatory limits associated with non-radiological pollutants from the dryers; however, the dryers are required to employ the best available technology to limit emissions. In order to meet the best available technology requirement, burners designed to lower emissions of nitrogen oxides are used in the dryers.

OEPA requires an estimate of emissions from the boiler plant as part of the FCP's effort to demonstrate compliance with the Clean Air Act. The boilers at the site are dual fired by natural gas and diesel fuel. Non-radiological pollutants from boiler operations include particulate matter, sulfur dioxide, nitrogen oxides, carbon monoxide, and non-methane volatile organic compounds. Opacity is a measure of how much light is blocked by particulate matter present in stack emissions. Excursions occur when regulatory limits for opacity are exceeded. There were no opacity excursions at the boilers for 2002. There have been no excursions since the site converted from coal-fired boilers to natural gas/diesel-fired boilers in 1997.

In order to estimate sulfur dioxide emissions, scientists determine the sulfur and heat content of the fuel. Using this information and the total amount of fuel burned, the amount of sulfur dioxide emissions can be calculated. For 2002 sulfur dioxide emissions from all boilers were calculated to be 59 pounds (27 kg). This was well below the allowable limit of over 79 tons (72 metric tons) per year calculated from information in the permits issued by OEPA.

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The nitrogen oxide emissions are estimated using data obtained from stack emission test results. Nitrogen oxide emissions for all boilers for 2002 were estimated to be 8,367 pounds (3,799 kg). Particulate matter emissions, based on emission factors from AP-42 for all boilers in 2002, were estimated to be 1,244 pounds (565 kg). This was below the allowable limit of over 6.3 tons (5.7 metric tons) per year calculated from information in the permits issued by OEPA. Carbon monoxide emissions, based on emission factors from AP-42 for all boilers in 2002, were estimated to be 3,202 pounds (1,454 kg). To date, OEPA has not set nitrogen oxide or carbon monoxide limits for the Fernald site. Table 5-5 provides a comprehensive list of 2002 emissions from the Waste Pits Remedial Action Project dryers and boiler plant.

TABLE 5-5
CHEMICAL EMISSIONS FROM WASTE PITS REMEDIAL ACTION PROJECT DRYERS AND BOILER PLANT

Chemical Name	Emissions from WPRAP Dryers (lb/kg)	Emissions from Boiler Plant (lb/kg)	Sources of Emissions	Basis of Estimate
Particulates	4,298/1,951	1,244/565	Fossil Fuel Combustion	AP-42 Emission Factors[a]
Sulfur Dioxide	188/85	59/27	Fossil Fuel Combustion	AP-42 Emission Factors[a] or sulfur content of fuel
Nitrogen Oxide	25,410/11,536	8,367/3,799	Fossil Fuel Combustion	Stack Emission Test Results for natural gas or AP-42 Emission Factors[a] for diesel fuel
Carbon Monoxide	19,13/8,688	3,202/1,454	Fossil Fuel Combustion	AP-42 Emission Factors[a]
Non-Methane Volatile Organic Compounds	1,819/826	221/100	Fossil Fuel Combustion	AP-42 Emission Factors[a]

[a]Compilation of Air Pollution Emission Factors, Vol. 1; Stationary Point and Area Sources, 5th edition, January 1995 (EPA 1995)

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Chapter 6
Radiation Dose

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6.0 Radiation Dose

Results in Brief: 2002 Estimated Doses

Airborne Emissions - The estimated maximum effective dose equivalent at the site fenceline from 2002 airborne emissions (excluding radon) was calculated to be 0.8 mrem (0.008 mSv), which is 8 percent of the EPA NESHAP 10 mrem annual dose limit.

Direct Radiation - The estimated 2002 effective dose equivalent at an off-site receptor location near the western fenceline of the site was 14.2 mrem (0.142 mSv).

Dose to the Maximally Exposed Individual - The dose to the maximally exposed individual for 2002 was estimated to be 14.8 mrem (0.148 mSv) at an off-site receptor location near the western fenceline of the site. This is 14.8 percent of the 100 mrem (1 mSv) DOE limit.

This chapter provides estimated doses to the public from the air and direct radiation pathways for 2002 as a result of remedial actions taken at the Fernald site. EPA NESHAP regulations require the FCP to demonstrate that the site's radionuclide airborne emissions are low enough to ensure that no one in the public receives an effective dose of 10 millirem (mrem) (0.1 milliSievert [mSv]) or more in any one year. Moreover, to determine whether the Fernald site is within the DOE effective dose limit of 100 mrem (1 mSv) per year from all exposure pathways (excluding radon), estimates of dose due to direct radiation are combined with airborne emissions to estimate the total dose to the maximally exposed individual. This estimate reflects the incremental dose above background that is attributable to the site.

The DOE limits for radon and its decay products in air are provided in terms of concentrations rather than dose limits and are addressed independently of the all-pathway dose limit. A concentration-based limit is used because dose calculations associated with radon and its decay products are highly sensitive to input parameters which are difficult to confirm with environmental measurements. Nevertheless, dose estimates for radon have been included in this section in response to stakeholders' interests in radon exposures. A number of different radon dose calculations are presented in this section to demonstrate the variation of radon doses based on each method of calculation. The radon dose estimates in this section can also be compared with radon dose estimates presented in previous annual site environmental reports and other radon dose studies (e.g., the Fernald Dosimetry Reconstruction Project [RAC 1996]).

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

6.1 Estimated Dose from Airborne Emissions

The estimated dose from 2002 airborne emissions was calculated from annual average radionuclide concentrations measured at the 18 IEMP air particulate monitoring locations (two background and 16 fenceline locations [refer to Figure 5-1 in Chapter 5 for the location of the air particulate monitoring locations]). Annual average background concentrations were subtracted from the fenceline concentrations in order to account for the natural occurrence of airborne radionuclides. Dose estimates were determined by converting the net annual average radionuclide concentrations measured at each fenceline monitoring location to doses using values listed in 40 Code of Federal Regulations 61 (NESHAP) Subpart H, Appendix E, Table 2.

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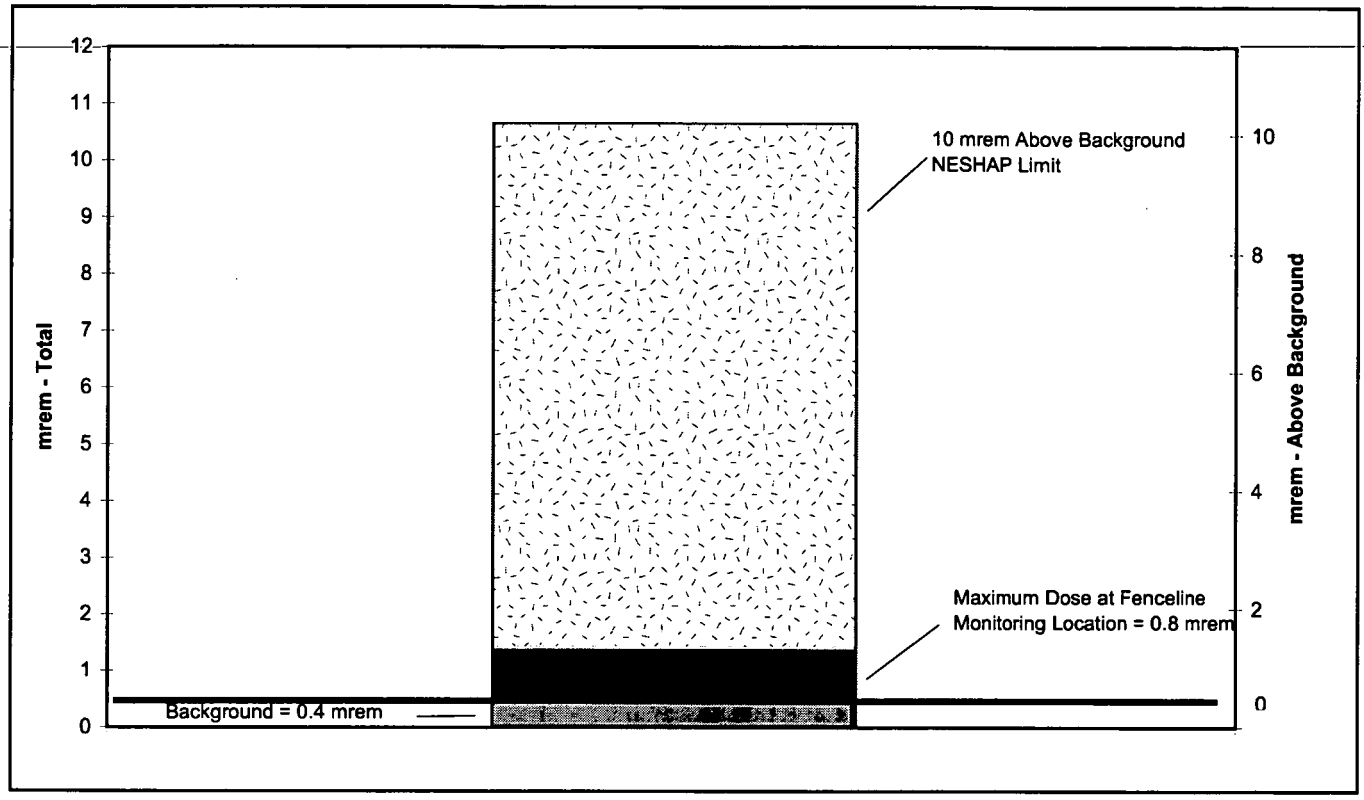

Figure 6-1. Comparison of 2002 Air Pathway Doses and Allowable Limits

The maximum effective dose at the fenceline from 2002 airborne emissions was estimated to be 0.8 mrem (0.008 mSv) per year and occurred at AMS-9C along the eastern fenceline of the site. The dose estimate is based on the conservative assumption that a person remains outdoors at the AMS-9C location for 100 percent of the time during the year. Recognizing that the nearest residence is located approximately 2,500 feet (762 meters) downwind from AMS-9C (east-southeast from the site), the actual dose received by this receptor would be substantially lower than 0.8 mrem (0.008 mSv) per year.

The maximum fenceline dose of 0.8 mrem (0.008 mSv) in 2002 is the same as the maximum fenceline dose of 0.8 mrem (0.008 mSv) in 2001. The equivalence between the 2001 and 2002 doses is particularly noteworthy given that the Waste Pits Remedial Action Project accelerated waste processing activities in 2002. Fugitive emissions from the Waste Pits Remedial Action Project waste processing activities, and specifically thorium-230 emissions, have been the major contributor to the maximum fenceline dose for the past three years. The startup and operation of the pugmill ventilation system in 2002, which was designed to capture particulate emissions from waste material processed by the dryers, is credited with limiting Waste Pits Remedial Action Project emissions and maintaining the 2002 maximum dose to 0.8 mrem (0.008 mSv), well below the NESHAP limit.

Figure 6-1 provides a comparison between the air pathway doses at the average background and maximum fenceline locations with the annual NESHAP limit of 10 mrem (0.1 mSv). The average background and maximum fenceline doses shown in Figure 6-1 are primarily attributable to the airborne concentration of uranium, thorium, and radium and exclude contributions from radon (dose from radon is excluded from the annual NESHAP limit of 10 mrem [0.1 mSv]). The maximum air pathway dose of 0.8 mrem (0.008 mSv) above background, (which is in addition to the average air pathway background dose of 0.4 mrem [0.004 mSv]) is 8 percent of the annual NESHAP limit. The estimated dose for each radionuclide from airborne emissions measured at each fenceline air monitor is provided in Appendix D of this report.

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The collective effective dose from 2002 airborne emissions (not including radon) to the population within 50 miles (80 km) of the Fernald site was estimated to be 0.23 person-rem (0.0023 person-Sievert [person-tSv]) for a population of 2.7 million. The collective effective dose provides an aggregate measure of the impact of airborne emissions from the Fernald site to the population in the area. For comparison, the same group of people received an estimated collective effective dose of 300,000 person-rem (3,000 person-Sv) from background radiation, excluding radon.

6.2 Direct Radiation Dose

Direct radiation dose is the result of gamma and x-ray radiation emitted from radionuclides stored on site. The largest source of direct radiation at the site is the waste stored in the K-65 Silos. As the waste in the silos undergoes radioactive decay, gamma rays and x-rays are emitted. Direct radiation from the decay of radon progeny in the silos' headspace contributes a major fraction of the direct radiation from the K-65 Silos. As the headspace radon concentrations have increased over the last ten years (1993 through 2002), the direct radiation from the silos has also increased. Direct radiation levels at the K-65 Silos and site fenceline are monitored by a network of environmental TLDs. Chapter 5 provides a description of the direct radiation monitoring.

The direct radiation dose for 2002 at the fenceline was estimated using the highest dose from the fenceline monitoring locations and subtracting the average dose measured at background TLD locations. This method provides a conservative estimate of direct radiation dose and measures the impact of increasing radiation levels near the silos and the fenceline due to increasing levels of radon and associated decay products in the silo headspace (refer to Chapter 5). From the data in Table 5-3, the maximum fenceline measurement was 97 mrem (0.97 mSv) per year and occurred at TLD location 16. The average background dose from the five background TLD locations was 74.4 mrem (0.744 mSv). The difference in these values (22.6 mrem [0.226 mSv]) is the estimated fenceline direct radiation dose for a hypothetical individual who stands at the fenceline, specifically TLD location 16, for the entire year.

In accordance with DOE Order 5400.5, Radiation Protection of the Public and the Environment, which requires that realistic exposure conditions be used for conducting dose evaluations, an estimate of direct radiation dose was calculated for the residence nearest the K-65 Silos. This dose was estimated by using the net fenceline TLD measurement at TLD 16 and accounting for the distance between the fenceline TLD location and the residence (approximately 326 feet [99 meters]), which would lower the direct radiation dose to approximately 14.2 mrem (0.142 mSv). This estimate remains extremely conservative in that it assumes a resident at this location is present 24 hours per day for a full year and does not account for shielding provided by the structure of the house.

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6.3 Total of Doses to Maximally Exposed Individual

The maximally exposed individual is the member of the public who receives the highest estimated effective dose equivalent based on the sum of the individual pathway doses. As shown in Table 6-1, the 2002 dose to the maximally exposed individual is the sum of the estimated doses from direct radiation dose and airborne emissions (excluding radon). The conservative assumptions used throughout the dose calculation process ensure that the dose to the maximally exposed individual is the maximum possible dose any member of the public could receive. The 2002 dose to the maximally exposed individual is estimated to be 14.8 mrem (0.148 mSv). The contributions to this all-pathway dose are:

- 14.2 mrem (0.142 mSv) from direct radiation to an off-site receptor located near the western fenceline of the site.
- 0.6 mrem (0.006 mSv) from air inhalation dose, as measured at AMS-6, to an off-site receptor located near the western fenceline of the site.

This estimate represents the incremental dose above background attributable to the Fernald site, exclusive of the dose received from radon. Figure 6-2 provides a comparison between the average background radiation dose at background locations (74.8 mrem [0.748 mSv]) and the all-pathway dose to the maximally exposed individual (14.8 mrem [0.148 mSv]). Figure 6-2 also provides a graphical comparison to the annual DOE all-pathway limit of 100 mrem (1 mSv).

TABLE 6-1
DOSE TO MAXIMALLY EXPOSED INDIVIDUAL

Pathway	Dose Attributable to the Fernald Site	Applicable Limit
Air		
Airborne emissions at AMS-6 (excluding radon)	0.6 mrem	10 mrem (air pathway)
Direct radiation	14.2 mrem	100 mrem (total of all pathways)
Maximally exposed individual	14.8 mrem	100 mrem (total of all pathways)

6.4 Significance of Estimated Radiation Doses for 2002

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

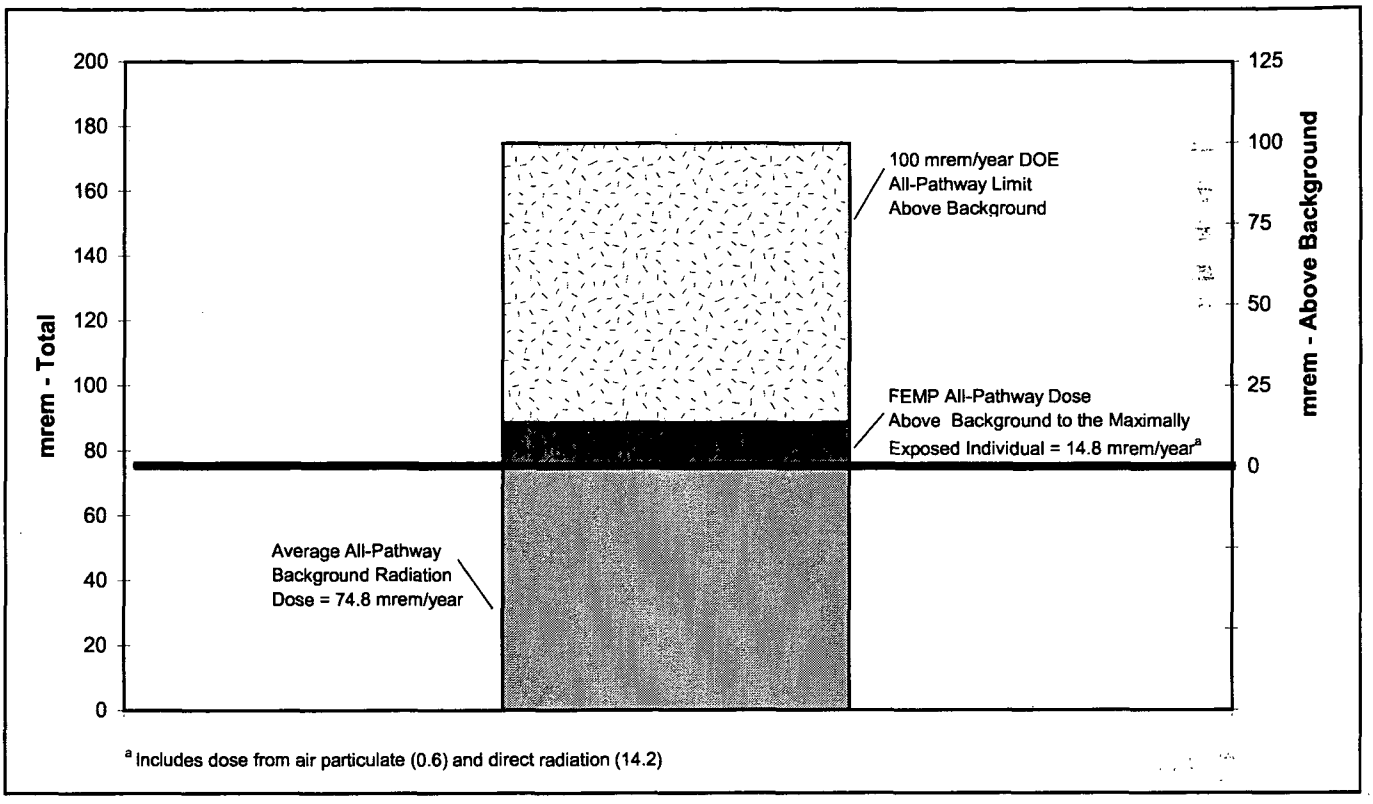

Figure 6-2. Comparison of 2002 All Pathway Doses and Allowable Limits

Another method of determining the significance of the estimated doses is to compare them with dose limits developed to protect the public. The International Commission on Radiological Protection (ICRP) has recommended that members of the public receive no more than 100 mrem (1 mSv) per year above background. As a result of this recommendation, DOE has incorporated 100 mrem (1 mSv) per year above background as the limit in DOE Order 5400.5, Radiation Protection of the Public and the Environment. The sum of all estimated doses from site operations for 2002 (14.8 mrem [0.148 mSv]) was significantly below this limit.

6.5 Estimated Dose from Radon

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

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

- Working level-month determination
  Historically, radon daughter exposure rates have been measured in the units of working levels, a measure of the activity concentration of the radon daughters in air. A working level is approximately equivalent to a radioactivity concentration of 100 pCi/L of radon in 100 percent equilibrium with its daughters. An individual exposure is then determined by multiplying the working level by the number of 170-hour periods (i.e., a work month) at that level, yielding the exposure unit working level-month. Working level-months of exposure are provided because all dose conversion factors and detriment coefficients used in estimating a dose from radon and its daughters are derived from this fundamental unit.

- NCRP 78 report
  This document, in part, provides equations for converting exposure resulting from inhalation of radon daughter products to an equivalent lung dose. This method considered the whole lung as the target organ for the radiation exposure. A number of dose conversion factors and assumptions are used to equate the lung dose to a whole body radiation dose (i.e., effective dose equivalent). Equations from this report were utilized in previous annual site environmental reports and are presented here for direct comparison to previous years' estimates.

- ICRP 66 tissue weighting factor modification to NCRP 78 equation
  ICRP 66 introduced a specific tissue-weighting factor representing the localized radiation exposure to the bronchial epithelium (a specific region of the lung thought to be the source for lung cancer) from inhalation of radon daughter products. Using the NCRP 78 equations, this new weighting factor results in a reduction of the effective dose by a factor of three. Incorporation of factors from this report allows comparison to dose estimates provided in the Fernald Dosimetry Reconstruction Project performed by Radiological Assessments Corporation under contract with the Centers for Disease Control.

- ICRP 65 report
  This report suggests the use of detriment coefficients for estimating dose from exposure to radon daughter products. These detriment coefficients are based on epidemiological studies of the lung cancer rates among uranium miners. The new coefficients result in a dose conversion factor of approximately 500 mrem per working level-month. This report was released in 1994 and represents a more recent methodology for calculating radon dose.

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Table 6-2 presents the 2002 radon dose estimates, and includes concentration values for fenceline and background locations, as well as DOE radon concentration limit values. Estimated working level-month exposures are given for each concentration value, as well as effective dose equivalents utilizing the NCRP 78, ICRP 66, and ICRP 65 methods. Doses were calculated from annual average continuous radon data (assuming the suggested environmental radon daughter product equilibrium concentration of 70 percent). All dose estimates are for a hypothetical maximally exposed reference man of average body size and breathing rate who continuously breathed air at the site's fenceline while engaged in light, physical activity 24 hours a day for the entire year. This exposure scenario is highly conservative, but suggests that in using the ICRP 65 methodology the dose from radon emissions at the fenceline monitor nearest a public receptor is 18 mrem per year above background.

Although there are no regulatory limits for dose from radon and its daughters, the radon concentration limits imposed by DOE Order 5400.5 provide a benchmark for evaluating the estimated doses from radon at the Fernald site boundary. In DOE Order 5400.5, the annual average radon concentration limit at the facility boundary is 3 pCi/L above background. Using the ICRP 65 methodology, a concentration of 3 pCi/L equates to an effective dose equivalent of 547 mrem. As presented in Table 6-2, the maximum measured radon concentration and corresponding dose at the Fernald site boundary are well below the limits associated with DOE Order 5400.5.

TABLE 6-2
2002 RADON DOSE ESTIMATE[a]

Location	Radon Concentration (pCi/L)	Exposure in Working Level-Months (WLM)	NCRP 78 Effective Dose Equivalent Equation (mrem)[b]	NCRP 78 Effective Dose Equivalent Equation (mrem)[c]	ICRP 65 Effective Dose Equivalent (mrem)[d]
Average Background	0.2	0.072	144	48	36
FCP Fenceline Nearest Receptor (net, above background)	0.1	0.035	72	24	18
Maximum Fenceline (net, above background)	0.3	0.108	216	72	55
DOE Order 5400.5 Limit (net, above background)	3.0	1.08	2,160	720	547

[a]Assuming the suggested environmental radon daughter product equilibrium concentration of 70 percent.
[b]NCRP 78 suggests whole lung tissue weighting factor of 0.12.
[c]NCRP 78 calculation using the ICRP 66 bronchial epithelium weighting factor of 0.04.
[d]Using the dose conversion factor for the maximally exposed reference man.

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6.6 Estimated Dose to Biota

DOE Order 5400.5 requires that populations of aquatic biota be protected at a dose limit of 1 rad/day (10 milliGray per day [mGy/day]). The DOE has issued a technical standard entitled "A Graded Approach for Evaluating Radiation Doses to Aquatic and Terrestrial Biota (ENVR-0011)" and supporting software (RAD-BCG) for use in the evaluating and reporting of compliance with biota dose limits.

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

For 2002 compliance with the dose limit to aquatic biota was determined by using the maximum concentrations of applicable radionuclides found in effluent discharged to the Great Miami River (see Chapter 4) as input into the RAD-BCG computer model. The results of the assessment indicate that the sum of the fractions was 0.023, which is well below the compliance threshold value of 1.0.

Detailed data and information on evaluating compliance with the biota dose limits for 2002 and previous years are provided in Appendix C, Attachment 5, of this report.

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Chapter 7
Natural Resources

Chapter 7

7.0 Natural Resources

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This chapter provides background information on the natural resources associated with the Fernald site and summarizes the activities in 2002 relating to these resources. Included in this chapter is a discussion of the following:

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

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

7.1 Threatened and Endangered Species

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

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

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

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

The Endangered Species Act requires the protection of any federally listed threatened or endangered species, as well as any habitat critical for the species' existence. Several Ohio laws mandate the protection of state-listed endangered species as well. Since 1993 several surveys have been conducted to determine the presence of any threatened or endangered species at the Fernald site. As a result of these surveys, the federally endangered Indiana brown bat and the state-threatened Sloan's crayfish have been found at the Fernald site. In addition, suitable habitat exists at the site for the federally endangered running buffalo clover and the state-threatened spring coral root. Neither of these species has been found on property, but their habitat ranges encompass the Fernald site. Figure 7-1 shows the habitats and potential habitats of these species. Based on provisions set forth in the IEMP, any threatened or endangered species habitat will be surveyed prior to any remediation or restoration activities. If threatened or endangered species are present, appropriate avoidance or mitigation efforts will be undertaken. The Indiana brown bat was surveyed in 2002. No individuals were identified, but suitable habitat remains along the northern reaches of Paddys Run.

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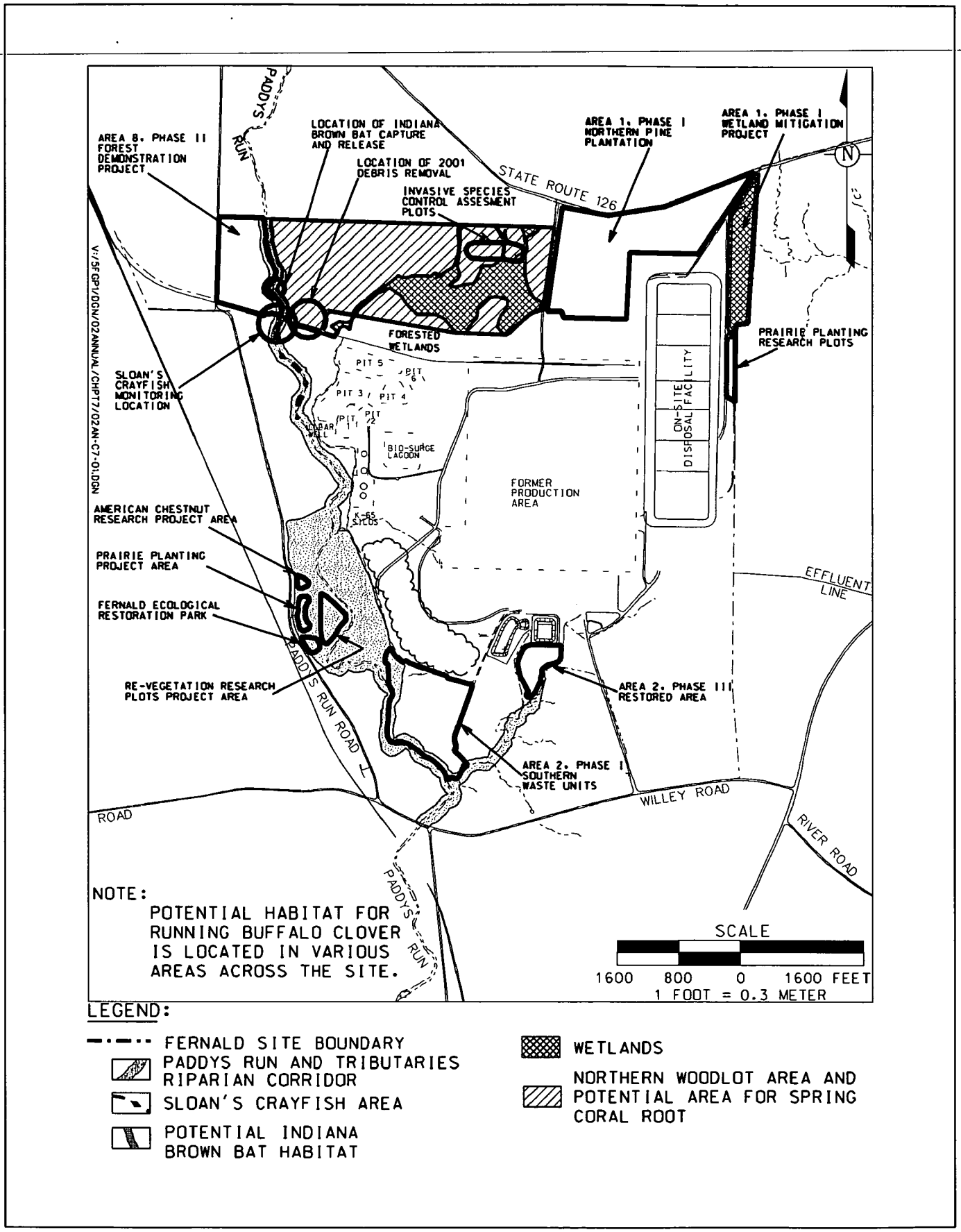

Figure 7-1. Priority Natural Resource Areas

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7.1.1 Sloan's Crayfish Monitoring and Provisions for Protection

No surveys for the Sloan's crayfish were conducted in 2002. A survey was conducted in August 2001 in order to determine if there were any impacts following debris removal near Paddys Run in Area 1, Phase III. The survey results from the 2001 sampling effort demonstrated that the Paddys Run Sloan's crayfish population was not impacted by the debris removal operation. A large number of individuals were observed both downstream and upstream of the project area. Researchers did note a general decline in the ratio between Sloan's crayfish and *Orconectes rusticus*, which is a larger, more aggressive crayfish species that often competes with the Sloan's crayfish. Similar trends are observed statewide, and are attributed to the aggressive nature of *Orconectes rusticus*.

The IEMP originally required that visual field inspections of sediment loading be conducted within one day of a "significant rain event," which is considered to be (0.5 inch [1 cm] or more of rain in one 24-hour period). The purpose of this field-inspection monitoring is to determine if there is an increase of sediment in the northern reaches of Paddys Run due to remediation activities. Sediment loading can adversely impact the Sloan's crayfish by restricting its ability to "breathe" in water. If remediation activities cause sustained (four to five days) increased sediment loading to Sloan's crayfish habitat in Paddys Run, alternatives such as crayfish relocation are considered. Figure 7-1 identifies the Sloan's crayfish monitoring location.

The monitoring effort in the first five months of 2002 yielded similar findings to previous years. Results of visual field inspections indicated that sediment loading from remediation activities in the vicinity of the northern drainage ditch has not impacted Sloan's crayfish habitat in Paddys Run. No increased sediment loading was observed in 2002, and only one isolated instance was observed in 2001. Based on these findings, sediment loading observations were suspended in May 2002 with approval from EPA and OEPA. Monitoring will resume when construction activities near the northern drainage ditch are undertaken.

7.2 Impacted Habitat Areas

DOE and the Natural Resource Trustees tentatively agreed that it would not be necessary to quantitatively assess habitat impacted through remediation, because DOE will be conducting natural resource restoration on approximately 884 acres (358 hectares) of the site. Therefore, a summary of the year's habitat impacts is presented here.

Two separate projects were conducted in Area 2, Phase II, resulting in the clearing of approximately 2 acres (1 hectare) of successional woodlot and pine plantation. The projects were undertaken to remove contaminated soil and debris south of the Pilot Plant Drainage Ditch. Tree removal was minimized to the extent possible, and field personnel were successful in saving several mature oaks. Ecological restoration of these areas will be incorporated into the design for the eastern portion of Paddys Run.

Several small areas (less than 1 acre [0.4 hectare]) of grasses and pine plantation were cleared in support of extraction well installation activities. Where possible, disturbed areas were reseeded with native grasses and wildflowers.

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7.3 Ecological Restoration Activities

Ecological restoration of the Southern Waste Units and the Northern Pine Plantation began in 2002. These projects are described in more detail below and are identified on Figure 7-1. Figure 7-1 also shows the location for previous restoration projects implemented at the Fernald site. Monitoring activities for several projects also continued in 2002.

The Area 2, Phase I Southern Waste Units Restoration project encompasses approximately 25 acres (10 hectares) in the southwest portion of the Fernald site. The area consists of the former active and inactive flyash piles, the South Field, and the Carolina area. The ecological restoration objectives for this project are to expand the riparian corridor along Paddys Run, create several open water and wetland areas, and establish the early stages of forest communities in upland areas. Several of the open water areas may provide additional recharge to the Great Miami Aquifer. The project involves extensive soil amendment and seeding, and the planting of over 4,300 trees and shrubs in 2002 and 2003. All soil amendments and roughly half of the tree and shrub plantings were completed in 2002.

The Area 1, Phase I Northern Pine Plantation Restoration Project involves the conversion of the planted pine plantation in the northern portion of the Fernald site to the early stages of a deciduous forest with interspersed areas of wetlands and grasslands. The overall restoration objective is to enhance the Northern Pine Plantation by increasing the diversity of vegetation in the area, and creating new wetland and vernal pool features. Native deciduous trees and shrubs are to be planted between remnant patches of pines. Over 4,600 trees and shrubs will be planted within four large plots. The existing stand of deciduous trees in the northwestern portion of the Northern Pine Plantation is to remain unchanged except for continued efforts to eliminate invasive and aggressive species (e.g., honeysuckle, wild grape, garlic mustard, multiflora rose) during project implementation and monitoring. Existing drainage swales and depressions are to be expanded, creating new wetland features. Access corridors for deer movement are to be interspersed throughout the project area. All cleared areas of the Northern Pine Plantation project area are to be seeded with native prairie grasses. In 2002 approximately 19 acres (8 hectares) of pines were cleared, the majority of grading and seeding was completed, and about one third of the trees and shrubs were planted.

The restored area within Area 2, Phase III encompasses approximately 2 acres (0.81 hectares) south of the Stormwater Retention Basin. The post-remediation excavated area has been seeded with wetland grasses, sedges, and wildflowers. In 2002 portions of the project area were planted with about 2,100 wetland shrubs in response to reduced survival in the wetland mitigation project. DOE decided against planting additional trees and shrubs in the mitigation project due to concerns about damaging established vegetation and continuing issues relating to drought and deer impacts. The shrubs installed in the restored area are easily transplanted from cuttings or seeds, so they will serve as a potential source of plant material for future restoration projects.

Monitoring of ecological restoration projects has been divided into two phases: the Implementation Phase and the Functional Phase. Implementation Phase monitoring is conducted to ensure that restoration projects are completed as intended in their designs. This effort involves the mortality counts and herbaceous cover estimates that are conducted for several years after a project is completed. Functional Phase monitoring is more general and considers projects in terms of their contribution to the ecological community as a whole. This kind of monitoring is new to restoration projects at the Fernald site. It compares restoration projects to pre-remediation baseline conditions and to ideal reference sites.

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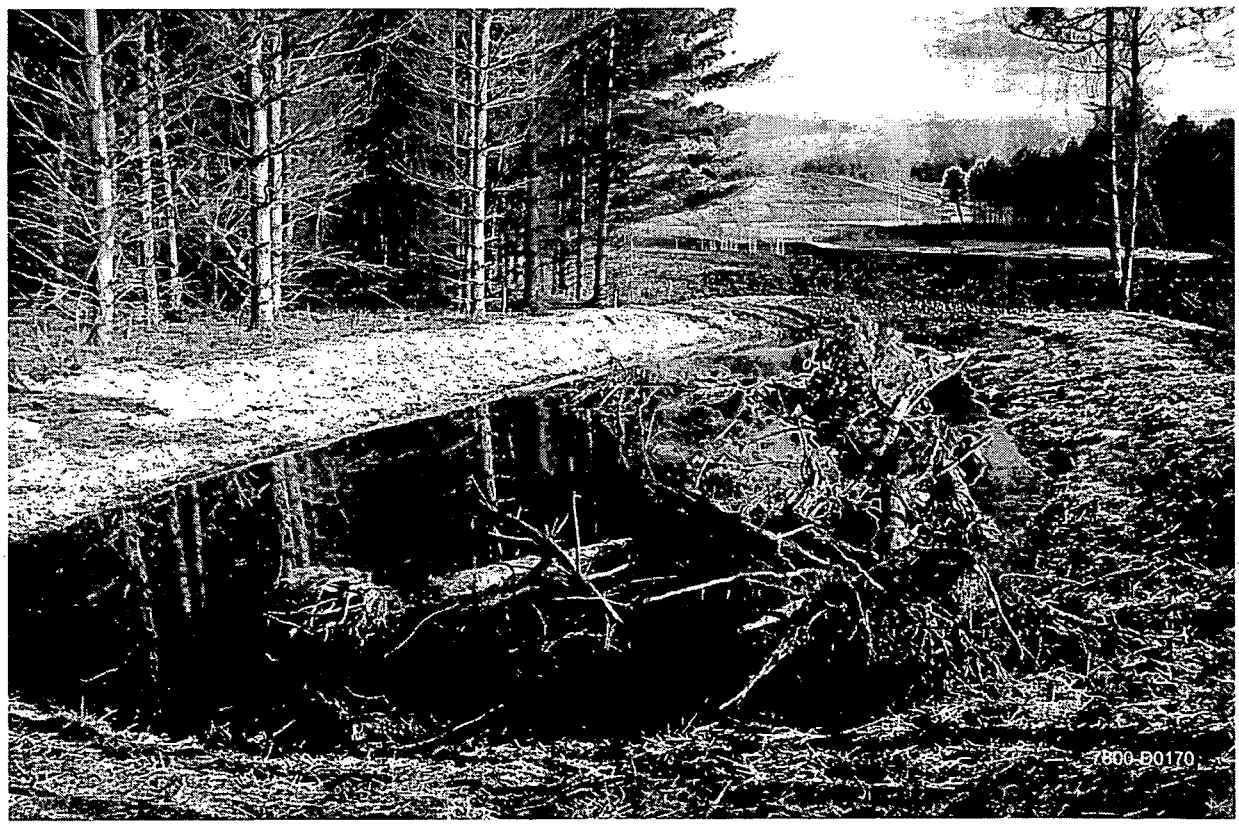
In 2002 Implementation Phase monitoring continued for the Area 1, Phase I Wetland Mitigation Project and the Area 8, Phase II Forest Demonstration Project. In the Wetland Mitigation Project, planted vegetation continued to be impacted by deer and drought, but herbaceous vegetation was much improved. Pond and subsurface water levels were determined in each of the eight wetland basins. Water quality samples were also collected and analyzed for pH, dissolved oxygen, conductivity, temperature, turbidity, odor, and color. Over time, this information will be used to assess the health of the wetland system. Results in 2002 show that the wetland is healthy and progressing as planned. As the wetland system has matured, the management goals for the project have evolved to focus on expansion and enhancement of herbaceous vegetation. The original 80 percent tree and shrub survival requirement is no longer applicable. Nevertheless, a replanting effort is planned adjacent to the Fernald Ecological Restoration Park, among the former re-vegetation research plots. About 270 trees and shrubs will be planted around the research plots, expanding the forested riparian corridor along Paddys Run.

In the Area 8, Phase II Forest Demonstration Project, deer and drought also had an impact in 2002. However, overall tree and shrub survival across the project remained near 80 percent. Also, a number of volunteer trees were observed throughout the project area. Herbaceous vegetation remained in good shape. Some limited replanting was undertaken in the fall of 2002, and 165 additional plants will be installed in 2003. These efforts will complete the Implementation Monitoring Phase for the Forest Demonstration Project.

Functional Phase monitoring involved the characterization of baseline conditions and reference sites for restoration projects at the Fernald site. Functional Phase monitoring of restoration projects will not begin until 2003, when wetland systems will be evaluated within the Area 1, Phase I Wetland Mitigation Project; the Area 8, Phase II Forest Demonstration Project; and the restored area in Area 2, Phase III.



Area 1. Phase I Northern Pines Plantation Restoration Project

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7.4 Ecological Restoration Research Projects

Several ecological restoration research projects have been conducted under an ecological research grant as part of the 1996 Operable Unit 4 dispute resolution agreement. The Invasive Plant Control Research Project and the Prairie Plots Project were completed in 2002. Results from these efforts will be used in the development of ecological restoration designs at the Fernald site. Researchers have made several interesting findings. For the Invasive Plant Control Research Project, herbicide injection appears to be the quickest and most effective method for controlling honeysuckle. Results from the Prairie Planting Research Project indicate that a thin surface layer of wood chip mulch accelerates prairie establishment and retards weed growth.

The last ongoing restoration research at the Fernald site is the American Chestnut Research Project. This project is part of the nationwide effort to restore disease-resistant populations of the American chestnut (*Castanea dentata*) tree. American chestnuts were once a dominant species in the eastern deciduous forest. In the past century, a fungal blight has killed virtually all mature chestnuts across the country. The research is testing the blight resistance of American chestnuts that have been bred with blight-resistant Chinese chestnuts (*Castanea mollissima*). In 2002 efforts focused on growing the chestnut seedlings in the field.

7.5 Cultural Resources

The Fernald site and surrounding area are located in a region of rich soil and many sources of water, such as the Great Miami River. Because of its advantageous location, the area was settled repeatedly throughout prehistoric and historic time, resulting in richly diverse cultural resources. A thorough overview of the cultural history at the Fernald site was provided in the 2001 Site Environmental Report. This report showed that there are 148 prehistoric and 40 historic sites within 1.24 miles (2 km) of the Fernald site.

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

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To comply with these laws, DOE conducts archeological surveys prior to remediation activities in undeveloped areas of the Fernald site. Figure 7-2 shows that the majority of the Fernald site has been surveyed. These surveys have resulted in the identification of six sites that may be eligible for listing on the National Register of Historic Places. None of these sites was impacted by remediation activities and no additional surveys were needed in 2002.

DOE also keeps track of unexpected discoveries of cultural resources during remediation activities at the Fernald site. Table 7-1 lists the artifacts that were encountered in 2002. None of the findings was significant, and no impacts to cultural resources occurred.

TABLE 7-1
UNEXPECTED CULTURAL RESOURCE DISCOVERIES FOUND IN 2002

Unexpected Discovery [a]	Time Period	Location of Discovery [b]
Pottery	Historic	Area 8, Phase I
Pottery	Historic	Area 2, Phase II
Projectile Point	Prehistoric	Area 2, Phase II
Skeletal Remains (animal)	Historic	Area 2, Phase II
Bone (animal)	Historic	Area 1, Phase I
Bone (animal)	Prehistoric	Area 7
Skeletal Remains (animal)	Historic	Area 2, Phase II
Bone (animal)	Historic	Area 2, Phase II
Pottery	Historic	Area 2, Phase II
Bone Knife	Prehistoric	Area 1, Phase I

[a]No further excavation is warranted.
[b]Identified by soil remediation area. Refer to Figure 2-1.

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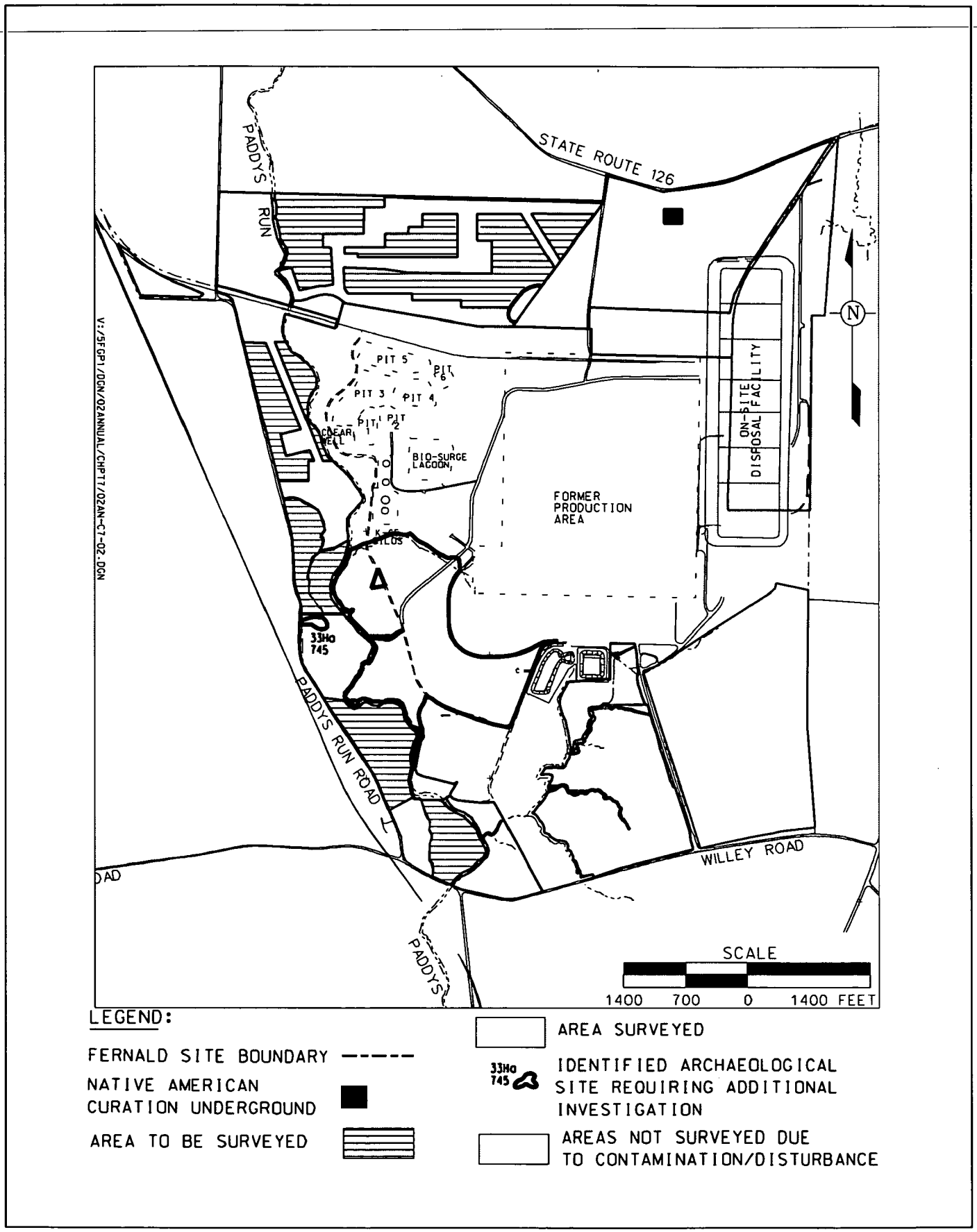

Figure 7-2. Cultural Resource Survey Areas

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Glossary

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Glossary

10-year, Uranium-based Restoration Footprint

The 10-year, uranium-based restoration footprint shows the anticipated areal extent of the effects of aquifer restoration activities on the Great Miami Aquifer over the 10-year duration of the remediation as presented in aquifer restoration remedial design documents. The boundary of impact was developed using groundwater modeling results which shows the composite groundwater capture zone derived from the capture zones for each extraction well

ALARA

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

Alpha Particle

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

Applicable or Relevant and Appropriate Requirements (ARARs)

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

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.

Background Radiation

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

Beta Particle

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

Bypass Events

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

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

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

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

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

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

Dose Quantity of radiation absorbed in tissue.

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

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

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

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

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

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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 sand and gravel aquifer.
Groundwater	Water in a saturated zone or stratum beneath the surface of land.
Head Works	Includes the various flow equalization basins and/or preliminary treatment units which serve as the central collection and distribution points to the wastewater treatment operations in the main facility.
Mixed Waste	Hazardous waste that has been contaminated with low-level radioactive materials.
Opacity	The amount of light that is blocked by particulates present in stack emissions.
Overpacking	The act of placing a deteriorating drum inside a new, larger drum to prevent further deterioration or the possible release of contaminants during storage.
Point Source	The single defined point (origin) of a release such as a stack, vent, or other discernable conveyance.
Radiation	The energy released as particles or waves when an atom's nucleus spontaneously loses or gains neutrons and/or protons. The three main types are alpha particles, beta particles, and gamma rays.
Radioactive Material	Refers to any material or combination of materials that spontaneously emits ionizing radiation.
Radionuclide	Refers to a radioactive nuclide. There are several hundred known radionuclides, both artificially produced and naturally occurring. Radionuclides are characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay processes.
Receptors	Individuals or organisms that are or could be impacted by contamination.
Remedial Action	The actual construction and implementation phase of a Superfund site cleanup that follows the remedy selection process and remedial design.
Remedial Investigation/ Feasibility Study	The first major event in the remedial action process which serves to assess site conditions and evaluate alternatives to the extent necessary to select a remedy.

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Remedial Response	A long-term action potentially involving site characterization, risk assessment, a technology treatability study, a feasibility study, a remedial design, and remedial implementation.
Removal Action	A short-term cleanup or removal of released hazardous substances from the environment. This occurs in the event of a release or the imminent threat of release of hazardous substances into the environment.
Roentgen Equivalent Man (Rem)	A special unit of dose equivalent that expresses the effective dose calculated for all radiation on a common scale; the absorbed dose in rads multiplied by certain modifying factors (e.g., quality factor); 100 rem = 1 Sievert.
Sediment	The unconsolidated inorganic and organic material that is suspended in surface water and is either transported by the water or has settled out and become deposited in beds.
Source	A controlled source of radioactive material used to calibrate radiation detection equipment. Can also be used to refer to any source of contamination (e.g., a point source such as the stack on the waste pits stack, a source of radon such as the silos' headspace, etc.).
Surface Water	Water that is flowing within natural drainage features.
Treated Effluent	Water from numerous sources at the site which is treated through one of the site's wastewater treatment facilities and discharged to the Great Miami River.
Thermoluminescent Dosimeter	A device used to monitor the amount of radiation to which it has been exposed.
Uncontrolled Runoff	Storm water that is not collected by the site for treatment, but enters the site's natural drainages.
Volatile Organic Compound	A hydrocarbon compound, except methane and ethane, with a vapor pressure equal to or greater than 0.1 millimeter of mercury.
Waste Acceptance Criteria	Disposal facilities specify the types and sizes of materials, acceptable levels of constituents, and other criteria for all material that will be disposed in that facility. These are known as waste acceptance criteria. Off-site disposal facilities that will dispose of Fernald waste (such as the Nevada Test Site) have specific waste acceptance criteria. In addition, the on-site disposal facility has waste acceptance criteria that have been approved by the regulatory agencies. The Waste Acceptance Organization is responsible for ensuring that all waste to be placed in the on-site disposal facility meets all these criteria before waste placement.

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