Department of Energy

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JUL 23 1998

DOE-1023-98

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

Mr. Tom Schneider, Project Manager
Ohio Environmental Protection Agency
401 East 5th Street
Dayton, Ohio 45402-2911

Dear Mr. Saric and Mr. Schneider:

TRANSMITTAL OF COLOR COPIES OF THE 1997 INTEGRATED SITE ENVIRONMENTAL REPORT

Reference: Letter, DOE-0830-98, J. Reising to J. Saric and T. Schneider, "Transmittal of the 1997 Integrated Site Environmental Report," dated May 29, 1998.

This letter serves to transmit color copies of the Fernald Environmental Management Project's (FEMP) 1997 Integrated Site Environmental Report. The color copies of the summary report are intended to replace the black and white reproduction copies previously transmitted to you (referenced letter).

A few minor grammatical corrections have been made in the color version of the summary report. In addition, a correction was made to Figure 5-1, where air monitoring station locations AMS-17 and AMS-18 had been incorrectly identified as Integrated Environmental Monitoring Plan locations in the black and white version.

Recycled and Recyclable

If you have any questions concerning this report, please contact Kathleen Nickel at (513) 648-3166.

Sincerely,

Johnny Reising

FEMP:Nickel

Johnny W. Reising
Fernald Remedial Action
Project Manager

Enclosure: As Stated

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Department of Energy

Ohio Field Office
Fernald Area Office
P. O. Box 538705
Cincinnati, Ohio 45253-8705
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JUL 23 1998

DOE-1024-98

Dear Fernald Stakeholder:

1997 INTEGRATED SITE ENVIRONMENTAL REPORT

Enclosed for your information and reference is the annual Fernald Environmental Management Project's 1997 Integrated Site Environmental Report. This report presents results from environmental monitoring conducted during Calendar Year 1997, as well as a summary of the site's compliance status during the year.

The 1997 Integrated Site Environmental Report was prepared by Fluor Daniel Fernald (FDF) for the Department of Energy, Fernald Environmental Management Project (DOE-FEMP). Both organizations have reviewed the report to ensure its accuracy. This report is distributed to local, state, and federal agencies; Congress; the public; and the media.

The 1997 Integrated Site Environmental Report begins the transition to the annual reporting format outlined in the FEMP's Integrated Environmental Monitoring Plan and, therefore, differs in some aspects from past annual site environmental reports. Specifically, the report has been expanded to include a summary report and two volumes of detailed supporting appendices.

The summary report (enclosed) is a stand-alone document providing the results of the site's environmental monitoring program for Calender Year 1997 and a summary of the DOE's progress toward final remediation of the Fernald site. The summary report serves the same wide audience as past annual reports and will receive broad distribution to Fernald stakeholders. The detailed data appendices are intended to serve a more technical audience, such as the regulatory agencies, and therefore, will receive a limited initial distribution. If you are interested in receiving the data appendices or additional copies of the report, please contact the Public Environmental Information Center located at: 10995 Hamilton-Cleves Highway, Harrison, OH 45030, Phone Number (513) 648-7480.

Recycled and Recyclable

If you have any questions regarding this report, please contact Kathleen Nickel at (513) 648-3166,or Gary Stegner at (513) 648-3153.

Sincerely,

Jack R. Craig
Director

FEMP:Reising

Enclosure: As Stated

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1997 Integrated Site Environmental Report

U.S. Department of Energy Fernald Field Office
Contract DE-A24-92OR21972

PAST

PRESENT

FUTURE

FERNALD
Environmental Management Project

By Fluor Daniel Fernald
Issued June 1998
(51350-RP-0001)

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Additional information about the Fernald Environmental Management Project is available through:

- The Fernald Environmental Management Project Public Environmental/Technical Information Center.
  10995 Hamilton/Cleves Highway
  Harrison, OH 45030
  Phone: (513) 648-7480
  Fax: (513) 648-7490

- The Fernald Web Page at www.fernald.gov

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List of Acronyms

ALARA	as low as reasonably achievable
AMS	air monitoring station
ARAR	applicable or relevant and appropriate requirement
BTV	benchmark toxicity value
CAP88-PC	Clean Air Act Assessment Package 1988
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
D&D	decontamination and dismantling
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
FDF	Fluor Daniel Fernald
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
FS	feasibility study
gpm	gallons per minute
IEMP	Integrated Environmental Monitoring Plan
NESHAP	National Emissions Standards for Hazardous Air Pollutant
NPDES	National Pollutant Discharge Elimination System
OEPA	Ohio Environmental Protection Agency
OSDF	on-site disposal facility
PCB	polychlorinated biphenyl
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
SARA	Superfund Amendment and Reauthorization Act
SWRB	Storm Water Retention Basin
TLD	thermoluminescent dosimeter
TSCA	Toxic Substance Control Act

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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	10^{12}	pCi
pCi/L	10^{-6}	microcuries per liter (µCi/L)	µCi/L	10^{6}	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
rem	0.01	Sievert	Sv	100	rem
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

Executive Summary

The Fernald Environmental Management Project (FEMP) is a federally owned facility with operations administered through the Department of Energy (DOE). The facility produced high-quality uranium metals for military defense for nearly 40 years. DOE suspended production at the FEMP in 1989 and formally ended production in 1991. The current mission of the FEMP is environmental restoration under the Comprehensive Environmental Response, Compensation, and Liability Act. Although production activities have ceased, the FEMP continues to monitor the air and liquid pathways as possible routes through which pollutants from past operations and current remediation activities may leave the FEMP.

The 1997 Integrated Site Environmental Report is prepared in accordance with DOE Order 5400.1, General Environmental Protection Program, and the FEMP Integrated Environmental Monitoring Plan (IEMP) (DOE 1997g). This annual report provides FEMP stakeholders with the results from the FEMP's environmental monitoring program for calender year 1997 and provides a summary of DOE's progress toward final remediation of the FEMP. In addition, this report provides a summary of the FEMP's compliance with the various environmental regulations, compliance agreements, and DOE policies which govern FEMP activities.

For some readers, the highlights provided in this Executive Summary may provide sufficient information. Many readers, however, may wish to read the more detailed information presented in subsequent chapters. All information presented in this Executive Summary is discussed more fully within the body of this summary report and its two volumes of supporting appendices.

1997 was a year of important accomplishments at the FEMP. Significant progress was made toward implementing the full range of remediation activities required to achieve the final cleanup goals of the FEMP. Some of the major remediation highlights for 1997 include:

- Cell 1 of the on-site disposal facility was constructed and the first waste was placed in the cell in December 1997. Construction activities included the completion of a leachate conveyance system which conveys leachate from the on-site disposal facility to the headworks of the advanced wastewater treatment facility.

- Significant progress was made in several aspects of the soil remediation effort at the FEMP. Large-scale excavations of contaminated soil were completed in the northeast area of the FEMP. In addition, site preparation activities in support of excavation of the southern waste units (South Field, active and inactive flyash piles) was initiated. Excavation of the southern waste units is scheduled to begin in the summer of 1998. Furthermore, a portion of the bank of Paddys Run near the K-65 Silos was stabilized in 1997 to prevent further erosion by the creek.

- The Plant 1 Complex was decontaminated and dismantled. During the production years, uranium and thorium ore stocks were prepared for on-site processing at the Plant 1 Complex.

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- A waste haul road was built to support transport of excavated wastes, primarily soil, from the southern waste units to the on-site disposal facility for disposal. (Note: only wastes meeting the waste acceptance criteria for the on-site disposal facility will be disposed of on site).

- A remedial action contract was awarded to International Technology Corporation for the excavation and waste processing operations required to complete remediation of Waste Pits 1 through 6 and the associated wastes within Operable Unit 1.

- Major construction activities associated with the on-site railyard were completed. The railyard will support transport of wastes designated for off-site disposal.

- Significant activities were initiated to implement the accelerated remediation strategy for the Great Miami Aquifer. These include the installation of groundwater extraction wells, re-injection wells, an extensive piping network, and expansion of the advanced wastewater treatment facility to provide additional groundwater treatment capacity beginning in 1998.

In conjunction with implementation of full-scale remediation activities at the FEMP, significant changes were made to the FEMP's environmental monitoring program during 1997. The changes focused on consolidatng various sitewide environmental monitoring and reporting activities under a single comprehensive program aligned with the FEMP's accelerated remediation plan. The programmatic changes and monitoring strategy are documented in the IEMP which was approved by the United States Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) in July 1997 and implemented in August 1997. The integrated monitoring and reporting strategy presented in the IEMP is designed to provide an ongoing assessment of environmental conditions at the FEMP and to communicate findings to the remediation projects, the regulatory agencies, and FEMP stakeholders in a timely manner. This information provides the basis for ensuring that the cumulative environmental effects associated with remediation activities at the FEMP remain below established thresholds.

The following highlight the results of environmental monitoring activities conducted during 1997.

Liquid Pathway Highlights

Groundwater Pathway

The groundwater pathway is routinely monitored at the FEMP to:

- Provide groundwater data to assess the capture and remediation of the total uranium plume

- Provide groundwater data to assess the capture and remediation of non-uranium constituents which have concentrations exceeding their respective final remediation levels (FRLs)

- Meet compliance-based groundwater monitoring obligations.

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In 1997, approximately 128 monitoring wells were periodically sampled for water quality. Water elevations were measured quarterly in up to 161 monitoring wells. The following highlights describe the key findings from the assessment of the 1997 groundwater data:

- Pumping of the South Plume Removal Action System continues to meet the objective of preventing the further southward migration of the South Plume beyond the extraction wells.

- Additional groundwater monitoring data collected on property in 1997 confirms that the design of the enhanced groundwater remedy is appropriate in that the on-property portion of the total uranium plume remains within the projected 10-year, uranium-based restoration footprint.

- Groundwater data collected in 1997 continues to confirm that the enhanced groundwater remedy design is appropriate in that there are no other significant contaminants present in the aquifer with concentrations above their respective FRLs which would require modification of the enhanced groundwater remedy design.

- Groundwater monitoring data collected under the IEMP in 1997 continued to meet specific regulatory and compliance requirements. Specifically, groundwater monitoring data was collected in support of the Resource Conservation and Recovery Act Property Boundary Monitoring Program, the KC-2 Warehouse Well Monitoring Program, the Private Property Well Monitoring Program, and the Coal Pile Runoff Basin Monitoring Program.

Surface Water and Treated Effluent Pathway

Surface water and treated effluent are routinely monitored to determine the effects of FEMP remediation activities on Paddys Run, the Great Miami River, and the underlying Great Miami Aquifer. In addition, the results from sediment sampling are discussed as a component of this primary exposure pathway because sediment (a secondary exposure pathway) is most directly affected by the surface water pathway.

The amount of total uranium discharged in uncontrolled runoff and treated effluent during 1997 continued the decreasing trend observed since production operations were discontinued in 1989.

- The estimated pounds of uranium discharged to the environment through uncontrolled storm water runoff decreased by 31 percent in 1997 compared to 1996 results. In 1997, an estimated 252 pounds (114 kilograms [kg]) of uranium were discharged versus an estimated 369 pounds (168 kg) discharged in 1996.

- The pounds of uranium in treated effluent discharged to the Great Miami River decreased by 54 percent in 1997 compared to 1996 results. In 1997, 126 pounds (57.2 kg) of uranium were discharged versus 275 pounds (125 kg) discharged in 1996.

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- The pounds of uranium discharged through overflows of the Storm Water Retention Basin decreased by approximately 88 percent in 1997 compared to 1996. In 1997, 3.46 pounds (1.57 kg) of uranium were discharged versus 13 pounds (6 kg) discharged in 1996.

These decreases are attributable to less than average rainfall in 1997, increased efficiency in the site's advanced wastewater treatment facility, decreases in storm water-related bypasses, and aggressive implementation of storm water runoff controls.

No surface water or treated effluent analytical results from samples collected in 1997 exceeded the FRL for total uranium, the primary site contaminant. FRL and benchmark toxicity value (BTV) exceedances in surface water samples were limited to nine and 11 constituents, respectively. These occasional, sporadic FRL and BTV exceedances are to be expected until site remediation is complete.

Radiological results of sediment samples indicate a general decrease when compared to 1996 results. Only one sample collected during 1997 exceeded a sediment FRL. This sample was collected from the Storm Sewer Outfall Ditch near the Storm Water Retention Basin. The 1997 result slightly exceeded the thorium-232 FRL (1.60 picoCuries per gram [pCi/g]) at 1.63 pCi/g.

Air Pathway Highlights

Monitoring under the air pathway includes radiological air particulates, radon, and direct radiation. In addition, the results from biota (produce) sampling are discussed under the air pathway because produce (a secondary exposure pathway) would most likely be affected by air deposition of contaminants on the produce itself or the soil with subsequent uptake of contaminants through the roots.

Radiological Air Particulate Monitoring

Significant changes occurred in the radiological air particulate monitoring program during the fourth quarter of 1997. These changes were made in preparation for full implementation of the IEMP Radiological Air Particulate Monitoring Program beginning January 1, 1998. This included the installation of eight new air monitoring stations on the site fenceline and the relocation of one existing monitor. The program was redesigned to provide a monitoring-based approach for demonstrating compliance with the National Emission Standards for Hazardous Air Pollutants (NESHAP) Subpart H requirements which limit radionuclide emissions from DOE facilities. Beginning in 1998, the FEMP will utilize a network of 18 high volume air monitors to measure radionuclide concentrations at the site fenceline. This information will be used to estimate the annual dose received by members of the public due to FEMP emissions. During 1997, as in the past, this assessment was conducted using computer models to estimate off-property exposures.

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Data collected from fenceline air monitoring stations showed that the annual average radionuclide concentrations were all less than one percent of DOE derived concentration guidelines. When converted to dose, the concentrations represent less than 10 percent of

the NESHAP standard of 10 millirem (mrem) per year. Airborne total uranium emissions for 1997 were estimated to be 19.5 pounds (8.84 kg). This compares to 11.1 pounds (5.0 kg) estimated in 1996. This increase in estimated total uranium emissions reflects the implementation of full-scale remediation activities at the FEMP. However, the estimated emissions remain well below the levels observed during active production and all EPA, OEPA, and DOE standards.

Radon Monitoring

In 1997, the annual average radon concentration (measured with alpha track-etch cups) recorded at the FEMP fenceline ranged from 0.2 ± 0.1 picoCuries per liter (pCi/L) to 1.0 ± 0.2 pCi/L. Fenceline and off-property results were well below the DOE standard of 3.0 pCi/L annual average above background. Background concentrations measured in 1997 ranged between 0.1 ± 0.1 pCi/L to 0.2 ± 0.2 pCi/L.

The head spaces of K-65 Silos 1 and 2 (part of Operable Unit 4) continue to be monitored for radon concentrations. The protective layer of bentonite clay placed over the silo material in 1991 to lower head space radon concentrations has lost some effectiveness due to the "drying out" of the clay. As a result, radon concentrations in both silos have increased. As of December 1997, the head space concentrations remain approximately 60 percent lower than values measured prior to the addition of the bentonite. The increasing radon concentrations in the silo head space will be mitigated through implementation of the Operable Unit 4 remediation.

Direct Radiation Monitoring

Measurements of direct radiation indicate that levels increase with proximity to K-65 Silos 1 and 2. The increasing direct radiation measurements correlate with the increasing radon concentrations in the head spaces of K-65 Silos 1 and 2. However, these levels remain approximately 67 percent lower than radiation levels measured in 1991 prior to the addition of the bentonite layer to K-65 Silos 1 and 2. These measurements are consistent with the fact that the silos contain radium and its decay products which contribute to the direct radiation in the vicinity of the silos. Direct radiation measurements at the FEMP fenceline in 1997 were similar to background concentrations.

Biota (Produce) Monitoring

Biota (produce) is collected to determine if total uranium concentrations in produce grown within 3 miles (5 kilometers [km]) of the FEMP are higher than concentrations in produce grown at distant locations (7 to 26 miles [11 to 42 km]). The sample results are then used to estimate the potential dose to people from this secondary component of the air pathway.

Comparisons between the average total uranium concentrations in corn, soybeans, squash, and tomatoes grown near the FEMP with concentrations in produce grown at a distance from the FEMP indicate very little difference in average concentrations. In addition, when compared to historical background ranges for each of the produce listed, the data for 1997 are within the background range reported for 1990 to 1996. As seen in previous years,

these comparisons suggest that there is no substantial impact from past or current FEMP emissions on produce grown in the area.

Estimated Dose for 1997

Scientists calculate potential radiation doses to nearby residents by utilizing mathematical models which include off-property radionuclide concentrations determined through environmental monitoring and sampling.

In 1997, the hypothetical maximally exposed individual living closest to the FEMP, exclusively consuming local produce from the Fernald area, could have received a maximum committed effective dose (exclusive of radon dose) of approximately 1.5 mrem. This dose can be compared to the limit of 100 mrem for all pathways that was established by the International Commission on Radiological Protection and adopted by DOE.

Natural Resources

Natural resources encompass the rich diversity of plant and animal life and their supporting habitats found in and around the FEMP. During 1997, monitoring was conducted to evaluate the impacts to Sloan's crayfish (a State of Ohio threatened species) habitat in Paddys Run from FEMP remediation activities. This measured impact was based on an evaluation of sediment from the FEMP that deposits into Paddys Run Creek. The monitoring results indicated no significant impact from sediment loading to Paddys Run as a result of FEMP remediation activities.

The FEMP also monitors impacts to sensitive habitat areas including northern woodlot/pines, southern pines and waste units, grassland, Paddys Run corridor, and wetlands. The projected impacts to these habitats resulting from FEMP remediation activities have been assessed and documented in the Draft Natural Resource Impact Assessment (DOE 1997i). During 1997, approximately 55 acres (22 hectares) of habitat were impacted. The cumulative impacted habitat through 1997 equals approximately 110 acres (44.5 hectares). The projected total impacted habitat through FEMP remediation is 305 acres (123 hectares).

In addition, the FEMP has a number of archeological and historical sites representative of the cultural resources of the area. To protect these valuable resources, the FEMP conducts cultural resource surveys prior to soil excavation activities in designated areas of the FEMP. During 1997, there were no significant unexpected cultural resource discoveries.

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Chapter 1
The Fernald Environmental Management Project

The Fernald Environmental Management Project

The scope of the Fernald Environmental Management Project (FEMP) is the implementation of full-scale environmental remediation and waste management activities at an inactive uranium processing facility located near the village of Fernald in Southwestern Ohio. Mission direction and project oversight for the federally owned facility are provided by the U.S. Department of Energy (DOE) Fernald site office. Project activities are managed and executed by Fluor Daniel Fernald operating under the terms of a prime contract with DOE.

The site's production mission spanned more than 37 years. During that time, in excess of 500 million pounds (227 million kilograms [kg]) of uranium metal products were delivered to other DOE sites in support of national security initiatives. As a consequence of this large-scale production operation, an estimated 400,000 to 1 million pounds (180,000 to 450,000 kg) of uranium were released to the environment. These environmental releases resulted in widespread contamination of surface soil, surface water, sediment, and groundwater.

In the 1980s, an environmental monitoring program was initiated to assess the impact of past operations on the environment and monitor potential exposure pathways to the local community. This monitoring program has been continually refined and improved to provide a comprehensive assessment of the impact of FEMP operations on the surrounding environment. Consistent with this approach of continuous program improvement, the environmental monitoring program underwent significant changes during 1997 to align with the types of remedial construction, excavation, demolition, and waste processing operations which are occurring as the FEMP moves toward final site restoration. These changes are reflected in the Integrated Environmental Monitoring Plan (IEMP) (DOE 1997g) which was approved by the U.S. Environmental Protection Agency (EPA) and the Ohio Environmental Protection Agency (OEPA) in July 1997 and implemented in August 1997. The IEMP established a comprehensive framework for consolidating various sitewide environmental monitoring activities and routine reports into a single program aligned with the FEMP's accelerated remediation plan. Transition to the monitoring program design presented in the IEMP began in August 1997 and was completed by the end of the calendar year.

A key component of the IEMP is an integrated reporting strategy designed to communicate the results of environmental monitoring and groundwater remediation activities on a routine basis. The reporting strategy includes a routine quarterly status report which provides a timely assessment of key environmental data and a comprehensive annual report that provides a detailed roll-up of the environmental data, associated findings, and actions presented in the quarterly reports. This annual report begins the transition to the annual reporting format outlined in the IEMP. It has been expanded to include this summary report and two volumes of detailed supporting appendices. A brief description of each component of this annual report is provided below.

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Summary Report This summary report documents the results of the environmental monitoring activities for calendar year 1997 and highlights the significant programmatic changes which took place through implementation of the IEMP. Similar to previous annual site environmental reports, it includes background information about the FEMP and associated remediation activities. It also provides a summary-level presentation of environmental data for groundwater, surface water and treated effluent, sediment, air, biota (produce), and natural resources. This summary report also includes an exposure pathway dose assessment for 1997.

Appendices Volume I Volume I of the appendices provides a detailed presentation of environmental data for 1997, primarily in graphical and tabular formats for 1997. This detailed information supports the findings and data interpretations presented in the summary report.

Appendices Volume II Volume II of the appendices provides the National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 Code of Federal Regulations 61 Subpart H) (EPA 1985) compliance report and supporting documentation.

The expanded format of this annual report is intended to provide FEMP stakeholders a comprehensive assessment of environmental impacts resulting from FEMP remediation activities and a status of the progress toward final remediation of the FEMP.

The remainder of this chapter provides the following:

- **The FEMP Mission: Past and Present**, a brief historical overview of the FEMP's former operations and a description of its current cleanup mission, organization, and major remediation activities
- **Environmental Monitoring Program Information**, a description of FEMP activities aimed at monitoring environmental quality, including a detailed discussion of the FEMP's transition to the monitoring program design as presented in the IEMP
- **Site Setting**, an introduction to the physical, ecological, and human characteristics of the area.

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The FEMP Mission: Past and Present

The FEMP was originally called the Feed Materials Production Center because it produced "feed" materials in the form of purified uranium metal for use by other DOE sites in production. The facility was built by the Atomic Energy Commission (a predecessor to the DOE). After evaluating several sites, the government selected a 1,050-acre (425-hectare) site situated just north of the small farming community of Fernald, Ohio, located approximately 18 miles (29 kilometers [km]) northwest of downtown Cincinnati. Construction began in 1951 in the midst of the Cold War era. Production operations began in 1952 and ended in July 1989.

In general, the relative importance and corresponding funding of the former production and environmental activities reflect the course of United States defense history from the end of World War II until today. Uranium-metal production reached a peak during the height of the Cold War in the 1950s and 1960s. During the late 1970s, funding for production and supporting organizations was significantly reduced. Production accelerated again in the early 1980s when the United States increased defense spending. By the late 1980s, however, an increasing demand for environmental accountability, combined with a decreasing demand for uranium metal at other DOE facilities, led DOE to change the FEMP's mission from uranium production to environmental restoration.

Production was suspended in July 1989. In October 1990, DOE transferred management responsibility for the FEMP from its Defense Programs organization to the Office of Environmental Restoration and Waste Management. In February 1991, DOE announced its intention to formally end the production mission and submitted a closure plan to Congress, which became effective in June 1991.

CERCLA Remedial Process

In broad terms, the remedial response process for remediating sites under CERCLA consists of the following three general phases.

Site Characterization - This phase determines what contaminants are present, and at what levels, and evaluates the potential impacts of those contaminants on human health and the environment. Activities associated with this phase include the remedial investigation (RI) and the baseline risk assessment.

Remedy Selection - This phase develops and evaluates different cleanup alternatives and, with appropriate public involvement, selects a remedy. Activities associated with this phase are the feasibility study (FS) and proposed plan. Following a public comment period, this phase culminates in the selection of a remedial alterative which is documented in a record of decision.

The first and second phases discussed above are commonly referred to as the "study" portions of the process. These phases of the process at the FEMP are essentially complete.

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

Environmental Restoration

The current mission of the FEMP is full-scale environmental restoration under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In 1986, the FEMP 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 FEMP was organized into five operable units in 1991. The operable units were defined based on their location and/or the potential for similar technologies to be used for remediation. The remedy selection process culminated in 1996 with approval of the final records of decision for the operable units.

Following approval of the records of decision, work began on the design and implementation of the operable unit remedies. While the operable unit management approach was successful for completing the characterization and remedy-selection process, it did not represent the most effective organization of FEMP responsibility to complete remedial design and to

implement the remedial actions. In order to align sitewide responsibilities and regulatory obligations across the five operable units to most efficiently execute remedial design and remedial action, the FEMP established fully integrated project organizations in 1996. Realignment into project organizations reflected the actual work processes and operations necessary to complete the remediation and did not alter the requirements of the FEMP's records of decision. The project organizations with primary responsibilities for CERCLA remediation at the FEMP are as follows:

- Waste Pits Remedial Action Project: This project is responsible for the completion of remediation activities for the excavation, drying (as required), loading, and rail transport of contents of Waste Pits 1-6, the burn pit and the clearwell to an off-site disposal facility, and responsibility for the off-site disposal of contaminated soil and debris that exceed the waste acceptance criteria for the on-site disposal facility. In addition, this project is responsible for the collection, pretreatment (as needed), and transport of remediation wastewaters to the headworks of the advanced wastewater treatment facility.

- Soil Characterization and Excavation Project: This project is responsible for the completion of remediation activities to address contaminated soil at the FEMP and miscellaneous waste units including the South Field, flyash piles, lime sludge ponds, and the solid waste landfill; also excavation/removal of building foundations, roadways, underground utilities and piping systems, sitewide remediation activities, and collection and transport of perched water encountered during remediation to the headworks of the advanced wastewater treatment facility.

- On-Site Disposal Facility Project: This project is responsible for the construction of an eight-cell engineered disposal facility, and operation and maintenance of a leachate collection system that will transport leachate to the advanced wastewater treatment facility, and a haul road that will be used to transport material to the on-site disposal facility. Located near the FEMP's northeastern border, the facility will contain 2.5 million cubic yards (yd^3) (1.9 million cubic meters [m^3]) of soil and debris from remediation of the FEMP. Material and soil to be disposed of in the facility must meet the facility's waste acceptance criteria.

- Facilities Closure and Demolition Project: This project is responsible for the completion of decontamination and dismantling of the above-grade portion of the former uranium processing facilities and all remedial action facilities. This project's scope includes the collection and transport of associated wastewaters to the headworks of the advanced wastewater treatment facility.

- Silos Projects: This project is responsible for the completion of remediation activities for the contents of K-65 Silos 1 and 2 and Silo 3, including the removal, stabilization, and transport of the inventoried residues for off-site disposal. This project's scope includes the collection and transport of associated wastewaters to the headworks of the advanced wastewater treatment facility.

- Aquifer Restoration and Wastewater Project: This project is responsible for the completion of remediation activities necessary to restore the water quality in the affected portions of the Great Miami Aquifer. These activities include the design, construction, operation, monitoring, and reporting for the groundwater restoration and wastewater treatment systems at the FEMP. This project's range of

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responsibilities also includes treatment of the waters within Operable Units 1 through 5 necessary to meet the FEMP's storm water, sanitary, and remediation wastewater treatment needs.

Table 1-1 describes each operable unit and its associated remedy and provides a crosswalk between each operable unit and the FEMP project organizations' responsibilities for implementing each remedy.

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 FEMP, 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 the environment.

The liquid pathway accounts for all waterborne pollutants that may be present in the groundwater and treated effluent discharge and/or surface water runoff from the site to the Great Miami River and Paddys Run. The type and concentration of the waterborne pollutant will determine how and where samples should be collected. Refer to Chapters Three and Four for monitoring activities associated with this primary exposure pathway.

The air pathway includes consideration of all airborne pollutants from FEMP activities, such as stack and vent emissions, dust from construction and remediation activities, waste handling, and wind erosion. Refer to Chapter Five for monitoring activities associated with this primary exposure pathway.

In addition to the primary exposure pathways, **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 the food chain whereas one organism directly consumes a contaminant and is accumulated prior to human consumption. The air-to-soil-to-roots-to-produce-to-human is one such scenario. An evaluation of past monitoring activities has shown that secondary exposure pathways at the FEMP are insignificant routes of exposure to off-site receptors. Therefore, to ensure continued protection of the public and the environment, the IEMP focuses on the primary exposure pathways.

Refer to Chapter Six for information pertaining to dose calculations for 1997 from all pathways.

Environmental Monitoring Program

The environmental monitoring program historically has provided comprehensive on- and off-property environmental surveillance monitoring that specifically addressed the monitoring and reporting needs associated with active uranium production at the site. However, with the conclusion of the FEMP's uranium production mission and completion of the CERCLA remedy selection process (with the exception of certain elements of Operable Unit 4, which are discussed in Chapter Two), focus is now being directed to the safe and efficient implementation of FEMP remediation activities and facility decontamination and dismantling operations. In recognition of this shift in emphasis toward remedy implementation, the FEMP's environmental monitoring program was revised during 1997 to align with the remediation activities planned for the FEMP. As discussed earlier, this revised program is defined in the IEMP.

A key element in directing the focus of the environmental monitoring program presented in the IEMP is the depth of understanding site environmental conditions gained from nearly 10 years of detailed site characterization efforts through the CERCLA process. These detailed environmental evaluations culminated in the Final Record of Decision for Remedial Actions at Operable Unit 5 (DOE 1996a). Operable Unit 5 represents all of the FEMP's environmental media and contaminant transport pathways (soil, groundwater, surface water, sediment, air, and biota [produce]) that have been affected by past uranium production operations at the FEMP. The selected remedy for Operable Unit 5 designates the FEMP's final cleanup levels and establishes the aerial extent of on- and off-property remedial actions necessary to provide permanent solutions to environmental concerns posed by the site.

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TABLE 1-1

FEMP OPERABLE UNIT REMEDIES AND ASSOCIATED PROJECT RESPONSIBILITIES

Operable Unit	Description	Remedy Overview[a]	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 FEMP remediation	Waste Pits Remedial Action Project is responsible for rail upgrade, excavation of Operable Unit 1 waste units, waste processing and drying, 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: This project will be performed by International Technology (IT) Corporation.) Soil Characterization and Excavation Project is responsible for directing excavation and certification of contaminated soil beneath the waste pits, as well as at- and below-grade remediation facilities, including the railroad. Aquifer Restoration and Wastewater 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 headworks of the advanced wastewater treatment facility for treatment. Facilities Closure and Demolition Project is responsible for decontamination and dismantling of Operable Unit 1 remediation facilities not specifically the responsibility of IT Corporation.
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 FEMP remediation	Soil Characterization and Excavation Project is responsible for excavation and disposition of waste from all Operable Unit 2 subunits and certify the footprints. On-Site Disposal Facility Project is 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 debris, and Operable Unit 3 debris; responsible for monitoring leachate within the on-site disposal facility and perched groundwater in the till beneath the on-site disposal facility. Waste Acceptance Operations are 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 and Wastewater Project is responsible for treating contaminated runoff and perched water collected during excavation of Operable Unit 2 subunit wastes; responsible for treating leachate from the on-site disposal facility; each project is responsible for transporting remediation wastewater to the headworks 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 • Coal pile • 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, concreted 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	Facilities Closure and Demolition Project is responsible for decontamination and dismantling of all above-grade portions of buildings and facilities at the FEMP. Soil Characterization and Excavation Project is responsible for excavation and certification of soil beneath facilities and for removal of at- and below-grade structures. Waste Acceptance Operations are responsible for reviewing facility decontamination and dismantling planning documents; performing field oversight of debris sizing, segregation of on-site disposal facility material categories, and segregation of prohibited items; completing field tracking logs; completing manifests for on-site disposal facility-bound material; and compiling final records of decontamination and dismantling debris placed in the on-site disposal facility. Aquifer Restoration and Wastewater 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 headwater of the advanced wastewater treatment facility for treatment. On-Site Disposal Facility Project is 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.

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TABLE 1-1
(Continued)

Operable 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 Silos 1 and 2 submit Record of Decision mendment to EPA: December 2000 Silo 3 Explanation of Significant Differences Approved: March 1998 Removal of Silo 3 materials and Silos 1 and 2 residues and decant sump tank sludges with on-site stabilization of materials and residues and sludges followed by off-site disposal; demolition and decontamination, to the extent possible, of silos and remediation facilities; excavation of contaminated soil 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. Contaminated soil and debris that exceed the on-site disposal facility waste acceptance criteria will be disposed of off site	Silo 3 Project is responsible for Silo 3 content removal, treatment, and transport off site. Silos 1 and 2 Project is responsible for transfer of Silos 1 and 2 residues content to temporary transfer tanks, treatment, and transport off site. Infrastructure and support systems such as roads and utilities will be completed to support the final remediation of the silos. Soil Characterization and Excavation 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). Aquifer Restoration and Wastewater Project is responsible for treating decontamination and other wastewaters during decontamination and demolition activities; each project is responsible for capturing and transporting remediation wastewater to the headwaters of the advanced wastewater treatment facility for treatment. On-Site Disposal Facility Project is 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. Facilities Closure and Demolition Project is responsible for decontamination and dismantling of all Operable Unit 4 remediation facilities and associated above ground pipings.
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 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 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. Site restoration, institutional controls, and post-remediation maintenance	Aquifer Restoration and Wastewater Project is responsible for designing, installing, and operating the extraction/injection systems for Great Miami Aquifer groundwater restoration; for groundwater monitoring in the Great Miami Aquifer; for designing, constructing, and operating all treated effluent discharge systems, and for treating, discharging, and reporting of contaminated groundwater, storm water, and remediation wastewaters at the FEMP. Soil Characterization and Excavation Project is responsible for certification of sitewide soil; excavation and disposition of contaminated soil, sediment, perched groundwater and at- and below-grade structures; and final site restoration. On-Site Disposal Facility Project is responsible for design, installation, 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; and for operation and maintenance of a leachate collection system. Waste Acceptance Operations are responsible for reviewing Soils Characterization and Excavation Project planning documents; performing field oversight of soil excavations, segregation of on-site disposal facility material categories, and segregation of prohibited items; completing field tracking logs; completing manifests for on-site disposal facility-bound material; and compiling final records of soil and at- and below-grade debris placed in the on-site disposal facility. Facilities Closure and Demolition Project is responsible for decontamination and dismantling of all Operable Unit 5 remediation facilities.

*Source of information is each operable unit's Record of Decision and remedial design documents.

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The results of the cleanup decisions reached in the Operable Unit 5 and the information gained from the site characterization activities conducted over the past 10 years served as the foundation for the development of the integrated environmental monitoring approach presented in the IEMP. The key elements of the IEMP are described below:

- The IEMP defines monitoring activities for environmental media, such as groundwater, surface water and treated effluents, sediment, air (including air particulate, radon, and direct radiation), biota (produce), and natural resources. Monitoring activities, in general, concentrate on the primary exposure pathways (liquid and air) and focus on assessing the collective effect of sitewide emissions on the surrounding environment.

- The plan establishes an integrated data evaluation and decision-making process for each environmental media. Through this process, environmental conditions at the FEMP are continuously evaluated and used to support a wide range of decisions affecting the implementation of remediation activities. For example, environmental data are routinely evaluated to identify any significant trends which 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 identified and implemented before an unacceptable condition is reached.

- Recognizing that the dominant types and pace of remediation activities will change over the life of the cleanup effort, the IEMP was developed as a "living document" with a two-year focus. Under the living document concept, the IEMP will be reviewed annually and revised every two years to ensure that the monitoring program adequately addresses emerging remediation activities.

- The IEMP consolidates routine reporting of environmental data under a system consisting of quarterly status reports and a comprehensive annual report available to stakeholders.

The scope and intensity of the monitoring activities defined under the IEMP will change as remediation of the FEMP progresses; however, the core objectives of the IEMP will continue to serve as the framework for developing programmatic changes as needed. The core objectives of the IEMP are to:

- Maintain an integrated monitoring approach which provides a comprehensive assessment of environmental conditions at the FEMP

- Communicate monitoring results in a timely manner to support project decision making and stakeholder involvement

- Track the performance of the groundwater remedy

- Document that contaminant releases attributable to the implementation of the FEMP's sitewide remediation activities remain within established thresholds.

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Site Setting

A brief description of the FEMP within the regional landscape encompasses its natural features and their characteristics. Elements of the site setting include: land use and demography, local geography, geology, surface hydrology, meteorological conditions, and natural resources.

Land Use and Demography

Modern economic activities in the area of the FEMP rely heavily on the physical environment. Examples of the primary land use in the area are as follows:

- Farming and raising beef cattle account for the majority of the land use in the area. Major crops include field corn, sweet corn, soybeans, and winter wheat. Several nearby farms sell produce locally or in nearby urban markets.
- Many gravel pit operations extract sand and gravel along the Great Miami River valley with a number operating in close proximity to the FEMP.
- A private water utility is located approximately 1.25 miles (2 km) upstream of the FEMP's effluent discharge to the Great Miami River; presently, this utility pumps about 20 million gallons (76 million liters) of groundwater per day for primarily industrial use.

Scattered residences and several villages including Fernald, New Baltimore, Ross, New Haven, and Shandon are located near the FEMP. Downtown Cincinnati is approximately 18 miles (29 km) southeast of the FEMP, and the cities of Hamilton and Fairfield are six to eight miles (10 to 13 km) to the northeast, respectively (Figure 1-1).

There is an estimated population of 14,600 within five miles (eight km) of the FEMP and an estimated 2.74 million within 50 miles (80 km). Figure 1-2 shows an estimate of population distribution in the surrounding areas.

Geography

The location of the major physical features associated with the FEMP, such as the buildings and supporting FEMP infrastructure, are depicted in Figure 1-3. The former production area and various administrative buildings dominate this view of the FEMP. The former production area occupies approximately 136 acres (55 hectares) in the center of the FEMP. 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 FEMP while Paddys Run, an intermittent stream, flows from north to south along the FEMP's western boundary. In general, the FEMP lies on a gently sloping terrace between vegetated bedrock outcroppings to the north, southeast, and southwest.

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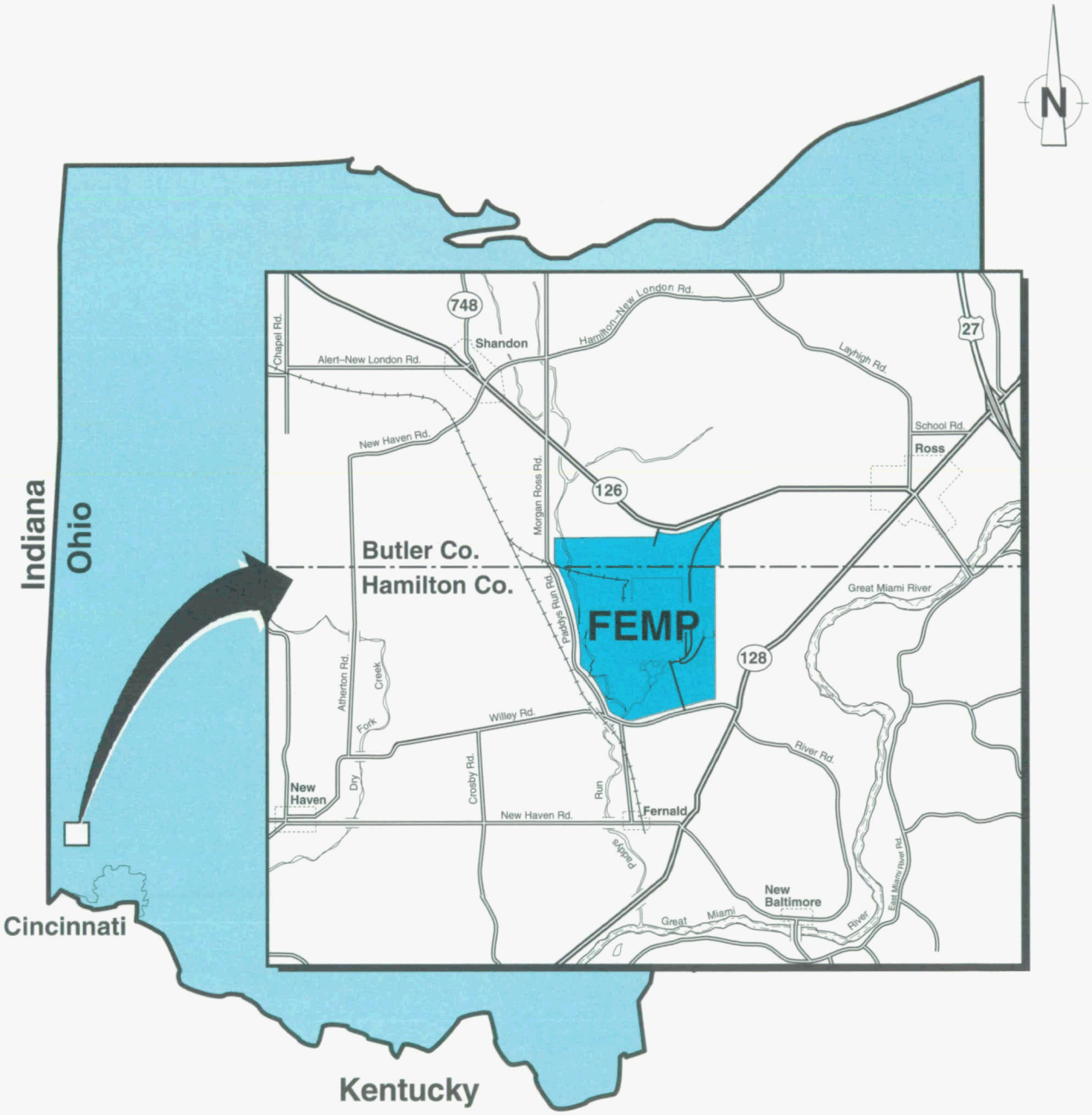

The FEMP covers about 1,050 acres (425 hectares).

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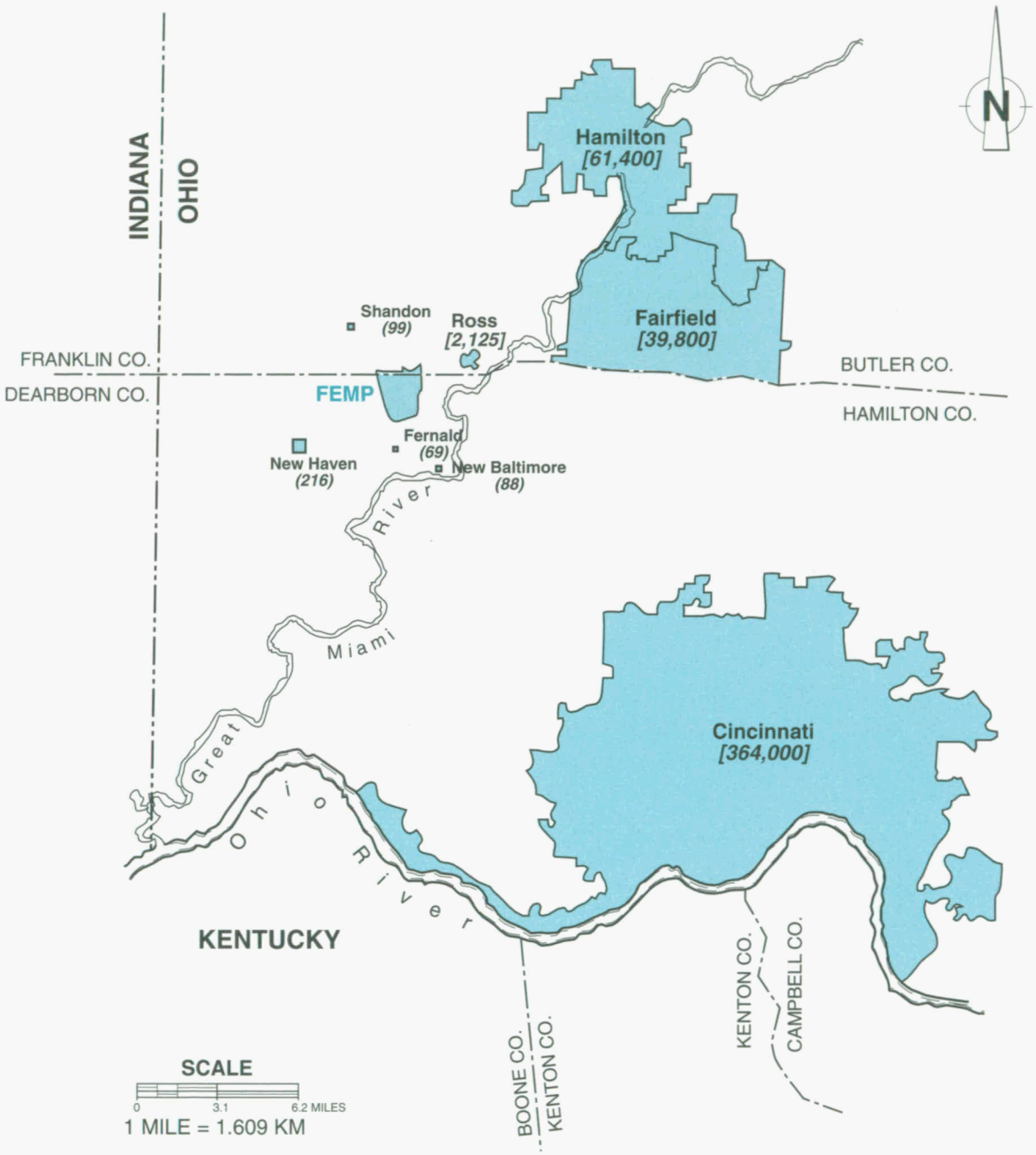
Figure 1-1. FEMP and Vicinity



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Population in parentheses estimated in 1989 and population in brackets estimated from 1990 U.S. Census Figures.

Figure 1-2. Major Communities in Southwestern Ohio

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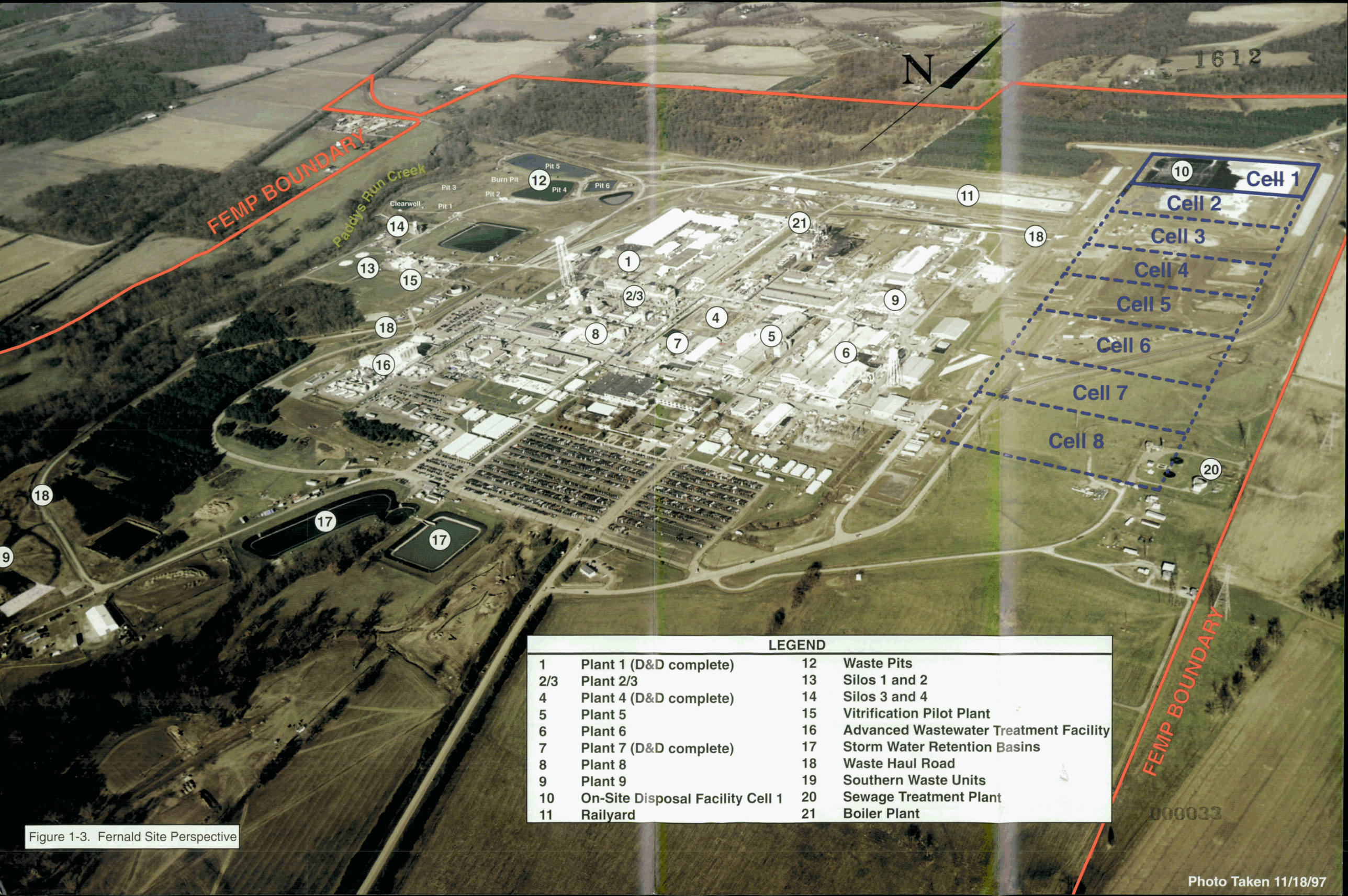

LEGEND			
1	Plant 1 (D&D complete)	12	Waste Pits
2/3	Plant 2/3	13	Silos 1 and 2
4	Plant 4 (D&D complete)	14	Silos 3 and 4
5	Plant 5	15	Vitrification Pilot Plant
6	Plant 6	16	Advanced Wastewater Treatment Facility
7	Plant 7 (D&D complete)	17	Storm Water Retention Basins
8	Plant 8	18	Waste Haul Road
9	Plant 9	19	Southern Waste Units
10	On-Site Disposal Facility Cell 1	20	Sewage Treatment Plant
11	Railyard	21	Boiler Plant

Figure 1-3. Fernald Site Perspective

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Geology

Bedrock, sediments, and land forms in the area surrounding the FEMP indicate that approximately 450 million years ago the Cincinnati area was covered by a shallow sea. Flat-lying shale with interbedded limestone was deposited in the shallow sea as evidenced by the abundance of marine fossils that are present in the bedrock in the Cincinnati area. 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 (60 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 FEMP area left a relatively impermeable mixture of clay and silt with minor amounts of sand and gravel deposited across the land surface. This deposit of clay and silt is called glacial overburden.

The FEMP is situated on a layer of glacial overburden that overlies portions of a two to three mile (three to five km) wide buried valley. This valley, known as the New Haven Trough, makes up part of the Great Miami Aquifer. The impermeable nature of the shale and limestone bedrock that defines the edges and bottom of the New Haven Trough confines 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 the areas where the glacial overburden has been eroded away, precipitation and surface water runoff can easily migrate into the underlying Great Miami Aquifer. Figure 1-4 provides a glimpse into the structure of subsurface deposits in the region along an east-west cross-section through the FEMP, while Figure 1-5 presents the regional groundwater flow patterns in the Great Miami Aquifer.

Surface Hydrology

The FEMP is part of the Great Miami River drainage basin, although it is situated above the floodplain (Figure 1-6). Natural drainage from the FEMP 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 FEMP.

In addition to natural drainage through Paddys Run, FEMP surface runoff from the former production area and waste pit area 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 (one km) east of the FEMP, runs in a southerly direction and flows into the Ohio River about 24 miles (39 km) downstream of the FEMP. The segment of the river between the FEMP and the Ohio River is not used as a source of public drinking water.

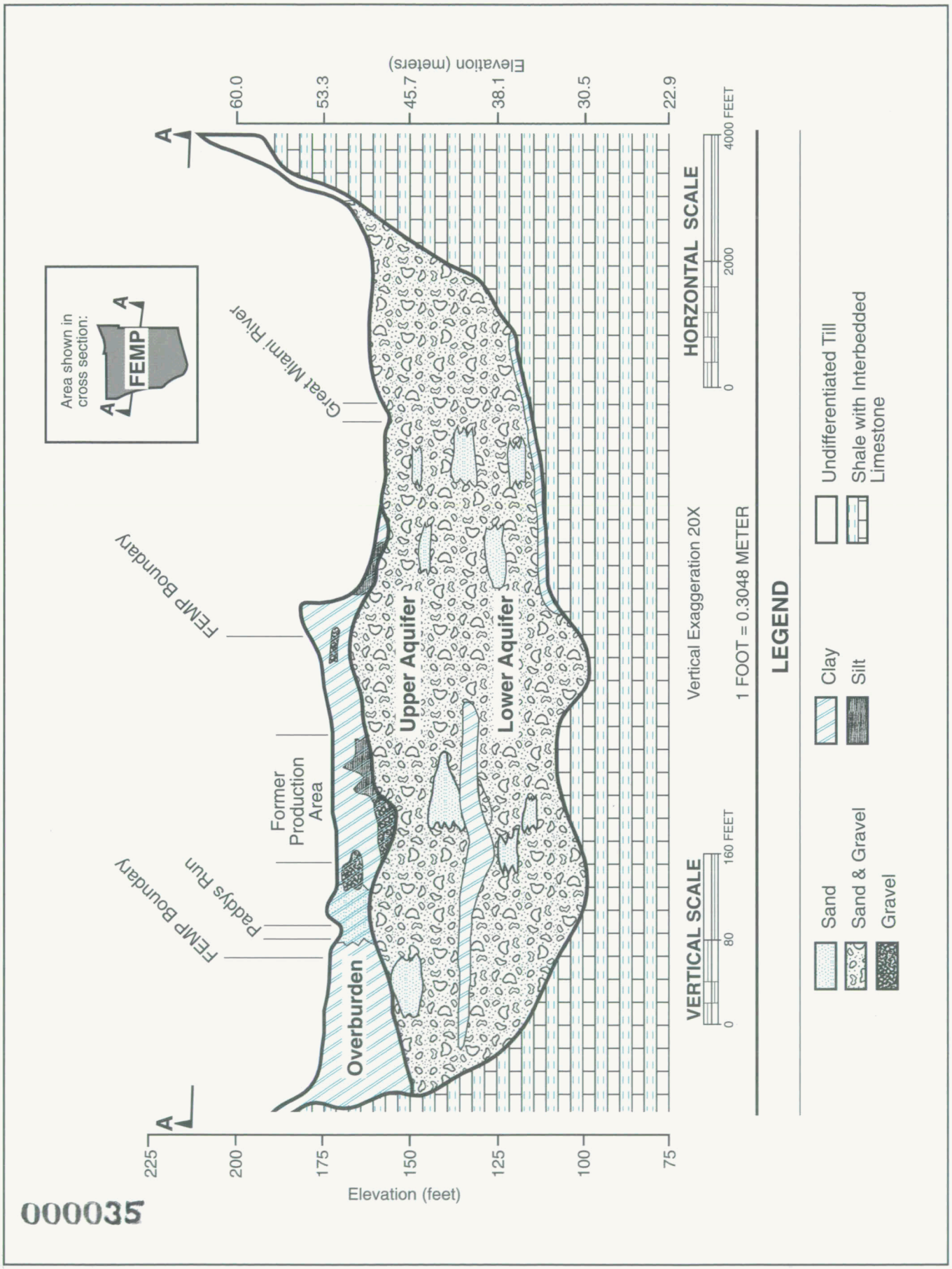

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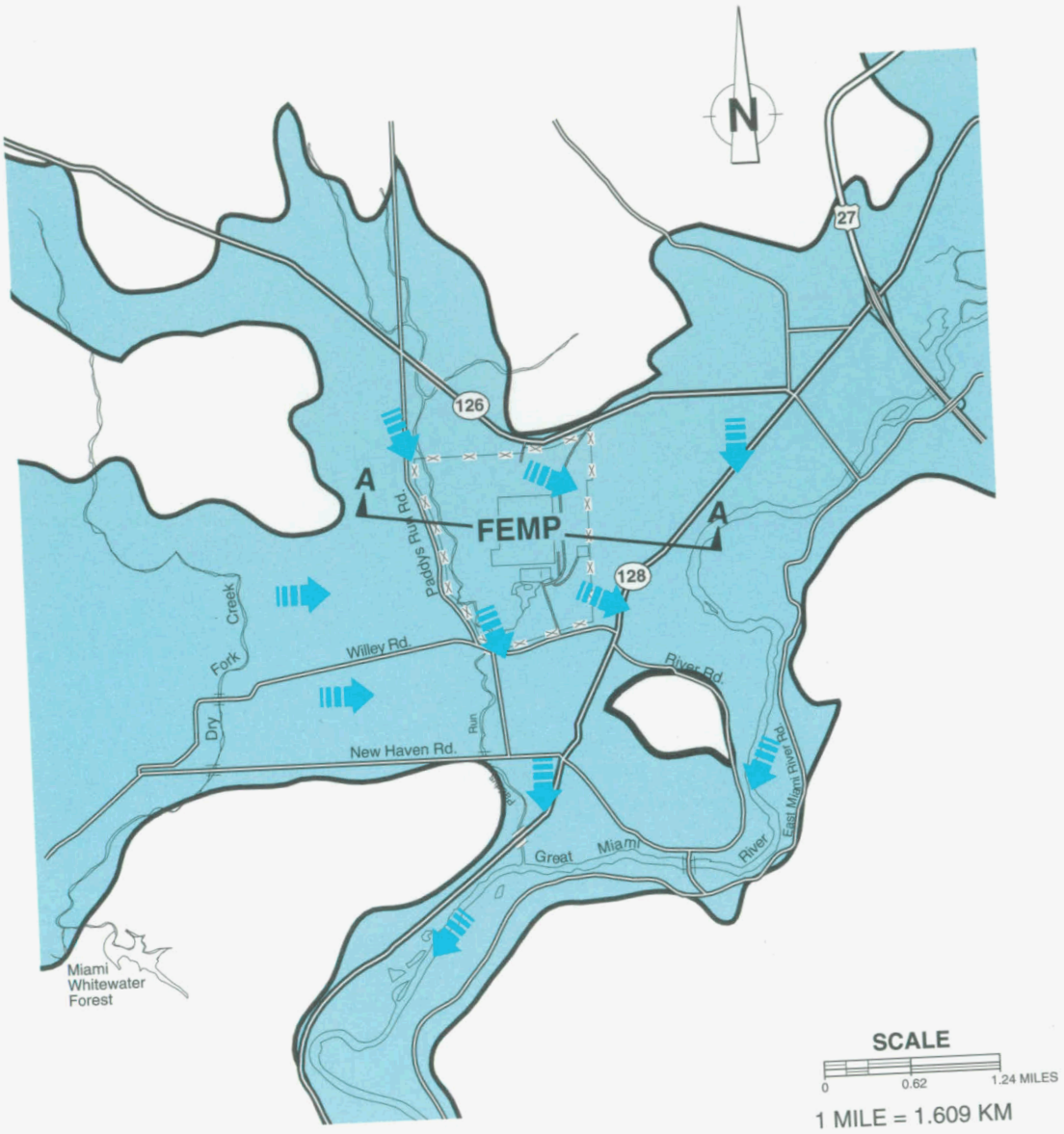
Figure 1-4. Cross-Section of the New Haven Trough, Looking North



LEGEND

- Buried Valley Aquifer
- General Direction of Groundwater Flow
- FEMP 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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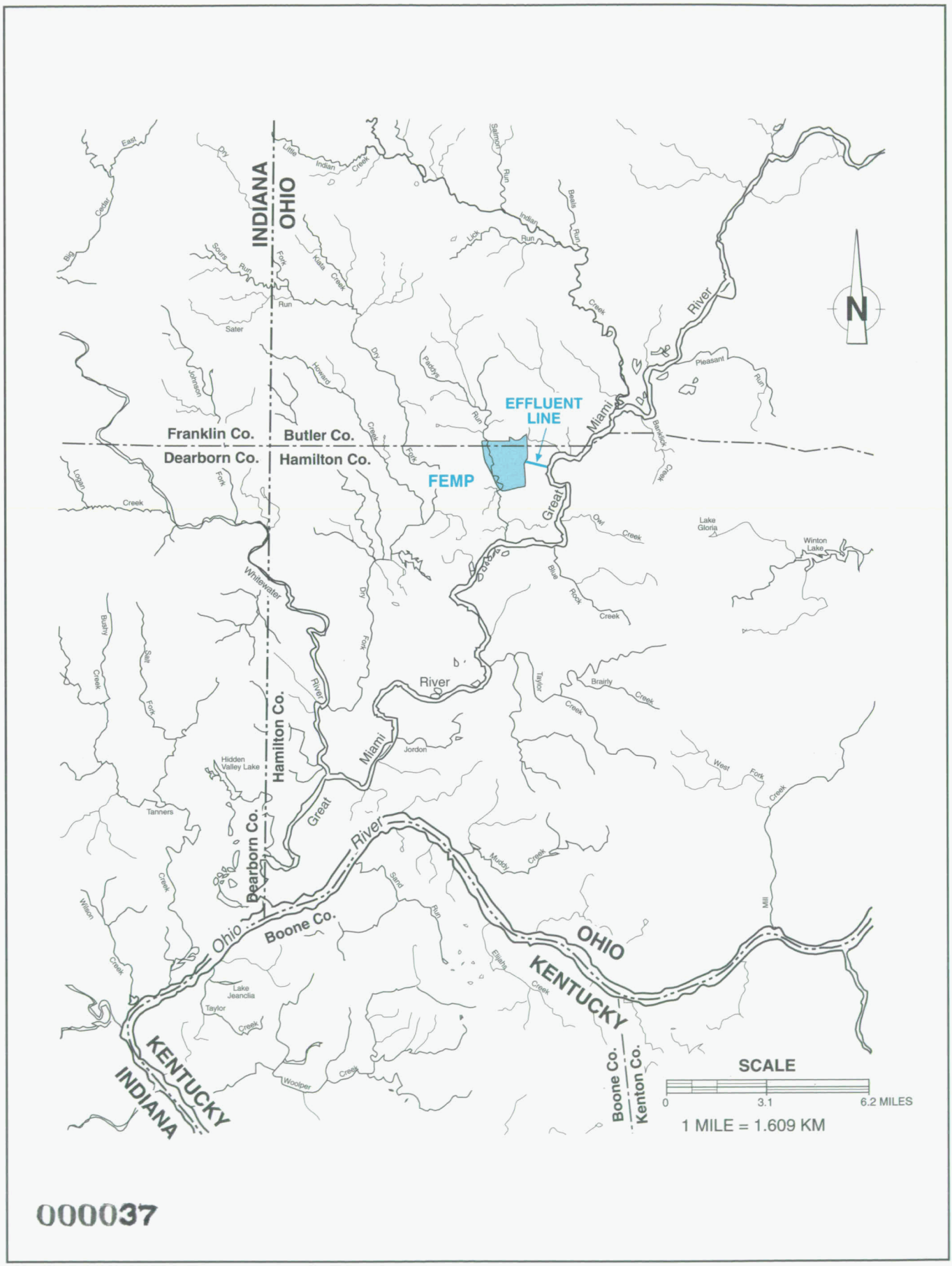

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Figure 1-6. Great Miami River Drainage Basin

The average flow rate for the Great Miami River in 1997 was 3,850 cubic feet per second (ft^3/sec) (109 cubic meters per second [m^3/sec]), measured daily approximately 10 river miles (16 river km) upstream of the FEMP's effluent discharge.

Meteorological Conditions

Meteorological data gathered at the FEMP are primarily used to evaluate climatic conditions at the FEMP. 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 existing weather conditions. Wind speed and direction, precipitation, and atmospheric stability play a role in predicting how pollutants are distributed in the environment. Weather data, particularly wind speed and direction, and precipitation play an important role in developing the monitoring program design and in interpreting environmental data.

Figures 1-7 and 1-8 are annual wind roses illustrating the average wind speed and general direction measured at the 33-foot (10-meter) and 197-foot (60-meter) levels in 1997. The prevailing winds were from the west through south-southwest approximately 30 to 40 percent of the time at both the 33- and 197-foot (10- and 60-meter) level. Tables in Appendix C, Attachment 4, of this report present meteorological data and wind direction and average speed for 1997.

In 1997, the precipitation measured at the FEMP was 40.11 inches (101.9 centimeters [cm]), which is slightly below the average annual precipitation of 41 inches (104 cm) for 1987 through 1996. Figure 1-9 shows 1997 total precipitation for the area in relation to the annual precipitation amounts recorded since 1987. (Precipitation totals through 1992 were taken from the measurements made at the Greater Cincinnati/Northern Kentucky International Airport because of a computer software problem at the FEMP meteorological tower. This problem was corrected, and the 1993 through 1997 totals were obtained from measurements made at the FEMP.) In addition, Figure 1-10 shows 1997 precipitation by month compared to average precipitation from 1919 to 1995.

Natural Resources

Natural resources have important aesthetic, ecological, educational, historical, recreational, and scientific value to the United States. Their management will be an ongoing process throughout federal ownership of the FEMP. 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 FEMP are diverse, healthy, and similar in abundance and species composition to those populations of surrounding ecological communities. A detailed discussion of the site's diverse ecological habitats and cultural resources is provided in Chapter Seven.

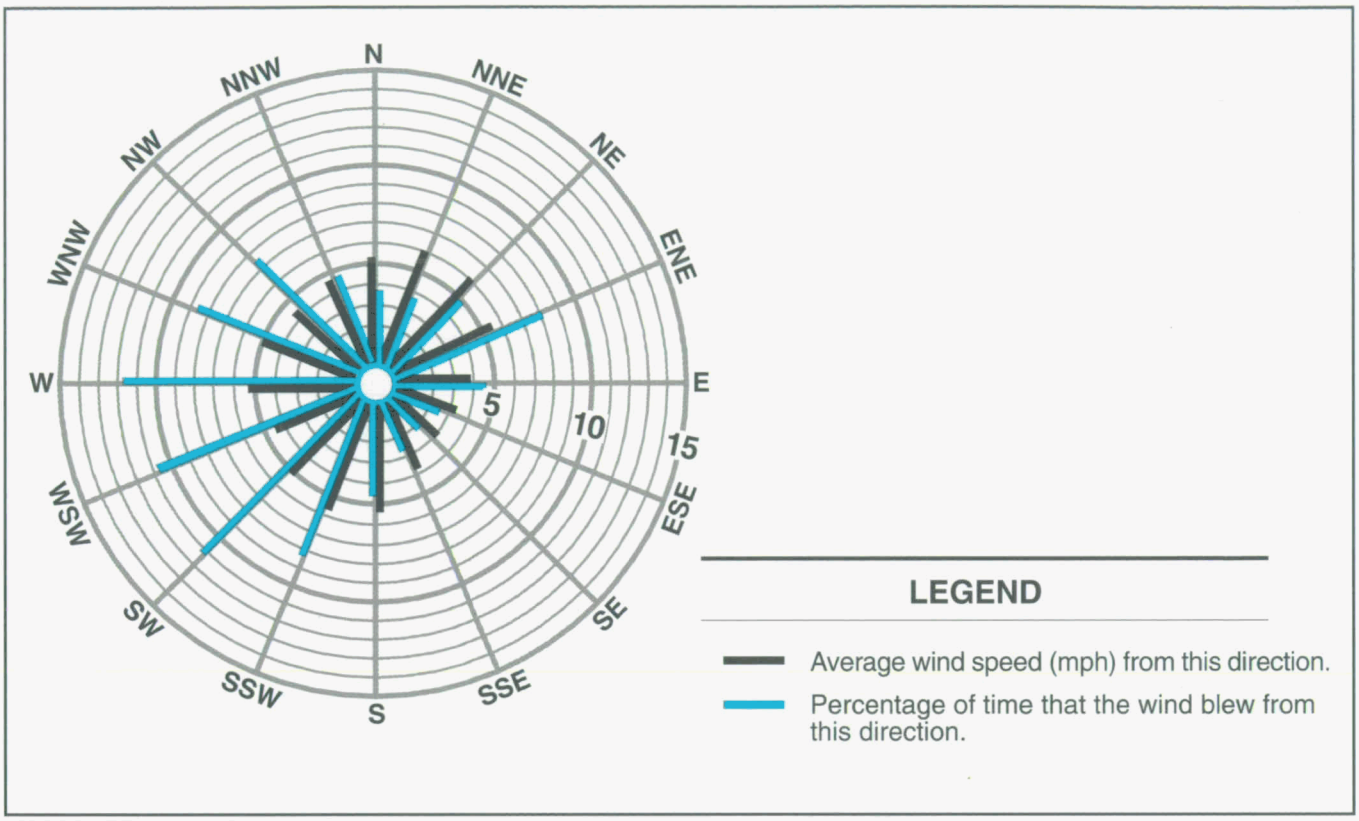

Figure 1-7. 1997 Wind Rose Data, 10-Meter Height

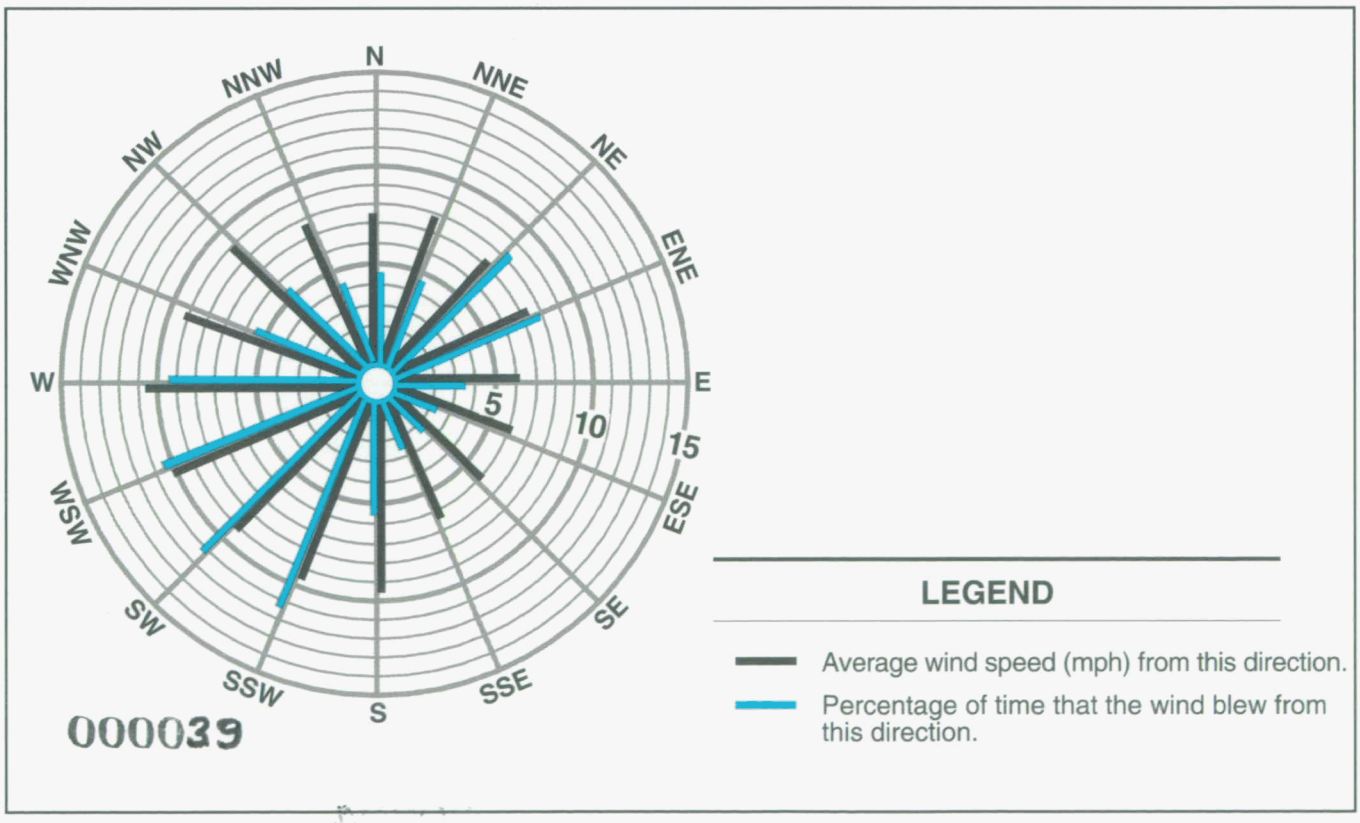

Figure 1-8. 1997 Wind Rose Data, 60-Meter Height

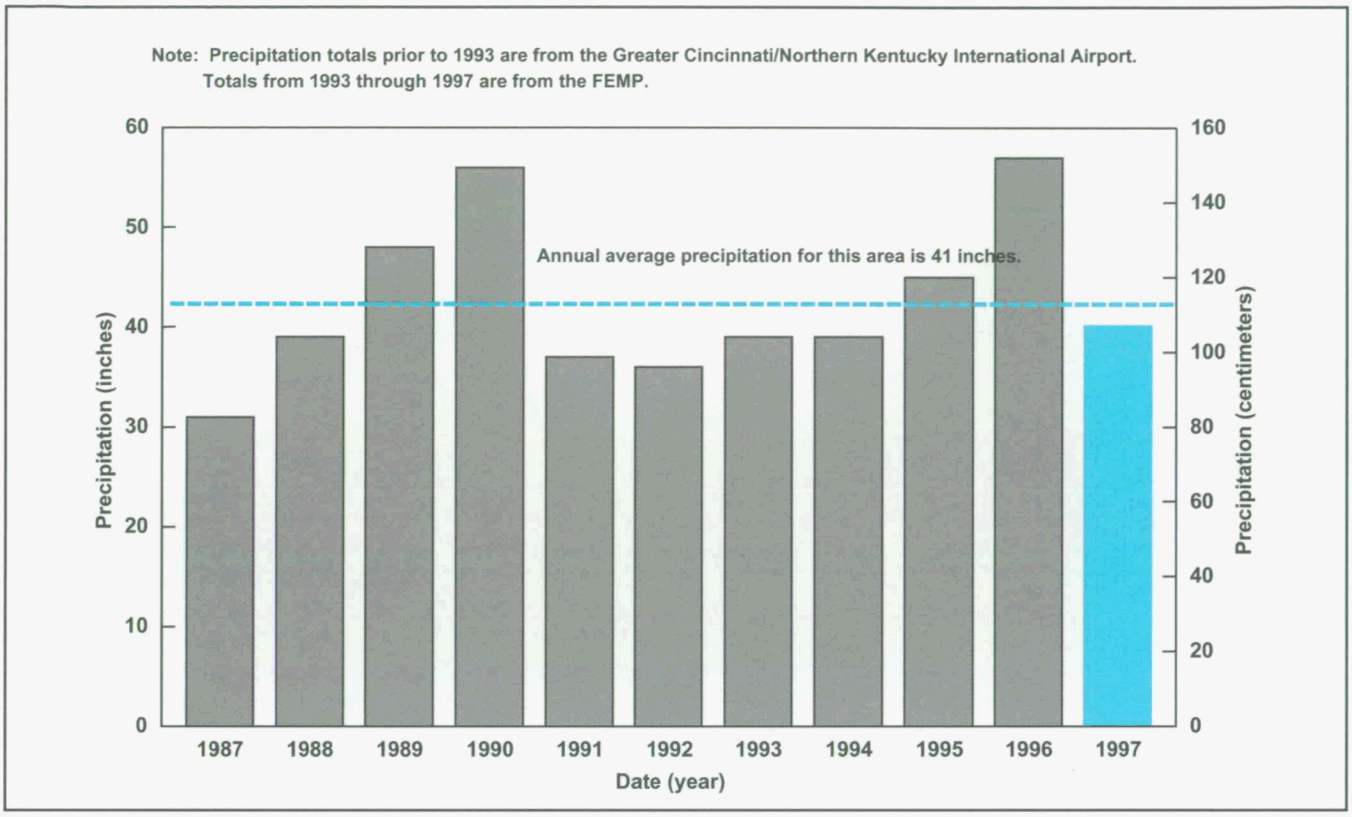

Figure 1-9. Annual Precipitation Data, 1987-1997

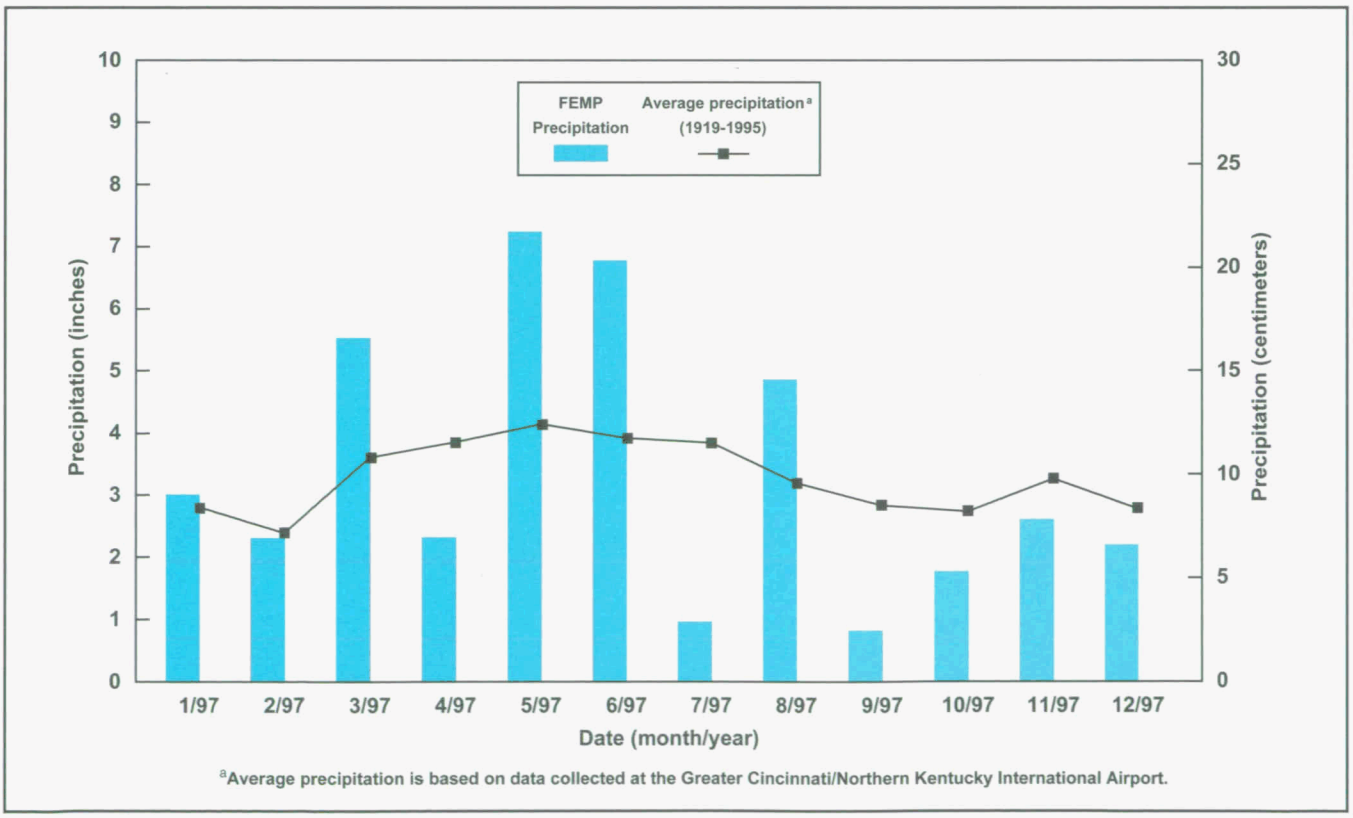

Figure 1-10. 1997 Monthly Precipitation Data

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Chapter 2
Remediation Status and Compliance Summary

Remediation Status and Compliance Summary

In 1997, visible progress was made in site remediation at the FEMP. This section provides a status of the site remediation for 1997 and a summary of the FEMP's compliance with applicable environmental laws, regulations, and related legal agreements.

Compliance with these requirements is enforced by several agencies, including EPA, OEPA, and other local agencies. The EPA develops, promulgates, and enforces environmental protection regulations and technology-based standards. These regulations and standards are enforced by EPA regional offices and state agencies such as the OEPA. EPA Region V implements the CERCLA process, with the active participation of the OEPA. CERCLA is the primary driver for remediation of the FEMP.

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

CERCLA History and Remediation Status

Since 1989, the FEMP has been on the National Priorities List, which names sites requiring environmental cleanup under CERCLA. Consistent with the requirements of CERCLA Section 120, DOE and EPA signed the Consent Agreement in 1990 (EPA 1990) that outlined activities and schedules for FEMP remediation.

This agreement, which was amended in 1991 and 1993, divided the FEMP into operable units so that the site investigation portion of the CERCLA remedial response process could be more effectively managed. The operable units were defined, as described in Chapter One, based on their location or the potential for similar technologies to be used during FEMP remediation. The agreement set schedules for completion of the remedial investigation (RI) and feasibility study (FS) activities for each operable unit and initiated removal actions, which are tasks undertaken to abate immediate threats to the environment and public health.

In broad terms, the remedial response process for remediating sites under CERCLA consists of three general phases. The FEMP has completed the first two phases, site characterization and remedy selection (see CERCLA phases description in Chapter One). The final phase is remedial design and implementation of the remedial action(s). Remediation activities, documents, and schedules are identified in each operable unit's remedial design and remedial action work plans.

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The EPA, with OEPA's concurrence, has approved remedy selection documents for all operable units and is currently re-examining the remedy for Operable Unit 4. Among the decisions recorded in these documents are the final remediation levels (FRLs) for specific media. Table 2-1 lists FRLs for the following IEMP-monitored media: groundwater, surface water, and sediment. The groundwater FRLs for fluoride and lead changed and were documented in the Operable Unit 5 Record of Decision by change pages.

In 1997, many documents that describe specific remediation activities were issued and approved. These documents include work plans, engineering designs and reports. Each document listed is available to the public in the FEMP Public Environmental Information Center.

These documents reflect the impact and input from stakeholders who have helped form the remediation strategy at the FEMP. Stakeholder participation is important under CERCLA and in the DOE philosophy at the FEMP. In 1997, stakeholder involvement included the following highlights:

- Fernald Citizens Advisory Board
  In July 1997, the Fernald Citizens Task Force changed its name to the Fernald Citizens Advisory Board to better align itself with the other site-specific advisory boards in the DOE complex. During the year, the Citizens Advisory Board focused on the Operable Unit 4/Silos Project dispute resolution process and path forward, recycling efforts, natural resource management, and transition of the FEMP's monitoring program to the IEMP.

- Fernald Community Reuse Organization
  In April 1997, the Fernald Community Reuse Organization established itself as a nonprofit corporation under Ohio statutes and received a $150,100 grant from DOE to support start-up activities, including retaining professional consultant services to help the group organize and plan its economic development strategy. Later in the year, the Community Reuse Organization awarded a contract to a local economic development consultant and established working committees to focus on economic development/worker transition issues and potential reuse of site assets, including property and equipment.

- Silos Projects Public Involvement
  Public involvement activities were extensive for the Silos Project during 1997. During the year, the Silos Project held several meetings, including public hearings, with local stakeholders and concerned citizens associated with the Nevada Test Site to involve them in developing a revised path forward for the project. As a result, consensus was reached with regulators and stakeholders and documented in a Dispute Resolution Agreement, which outlined future key milestones for the project.

- Monthly Meetings
  In September 1997, DOE and Fluor Daniel Fernald introduced a new monthly forum, the Cleanup Progress Briefing, which is designed to update stakeholders on current remediation projects, preview upcoming activities, and link stakeholders with decision makers. The new briefings have been endorsed by community leaders, regulatory agencies, and FEMP personnel as an effective method of

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

	FRL[a,b]		
Constituent	**Groundwater**	**Surface Water**	**Sediment**
General Chemistry	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Cyanide	NA	0.012	NA
Fluoride	4[c]	2	NA
Nitrate[d]	11	2,400	NA
Inorganics	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Antimony	0.006	0.19	NA
Arsenic	0.05	0.049	94
Barium	2	100	NA
Beryllium	0.004	0.0012	33
Boron	0.33	NA	NA
Cadmium	0.014	0.0098	71
Chromium VI[d]	0.022	0.01	3,000
Cobalt	0.17	NA	36,000
Copper	1.3	0.012	NA
Lead	0.015[c]	0.01	NA
Manganese	0.9	1.5	410
Mercury	0.002	0.0002	NA
Molybdenum	0.1	1.5	NA
Nickel	0.1	0.17	NA
Selenium	0.05	0.005	NA
Silver	0.05	0.005	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
Neptunium-237	1	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	41	7,100
echnetium-99	94	150	200,000
Thorium-228	4	830	3.2
Thorium-230	15	3500	18,000
Thorium-232	1.2	270	1.6
	(µg/L)	**(µg/L)**	**(mg/kg)**
TotalUranium[e]	20	530	210

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TABLE 2-1
(Continued)

Constituent	FRL[a,b] Groundwater	Surface Water	Sediment
Organics	**(µg/L)**	**(µg/L)**	**(µg/kg)**
Alpha-chlordane	2	0.31	NA
Aroclor-1254	0.2	0.2	670
Aroclor-1260	NA	0.2	670
Benzene	5	280	NA
Benzo(a)anthracene	NA	1	190,000
Benzo(a)pyrene	NA	1	19,000
Benzo(b)fluoranthene	NA	NA	190,000
Benzo(k)fluoranthene	NA	NA	1,900,000
Bis(2-chloroisopropyl)ether	5	280	NA
Bis(2-ethylhexyl)phthalate	6	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	NA	NA
Chloroform	100	79	NA
Chrysene	NA	NA	19,000,000
Dibenzo(a,h)anthracene	NA	1	NA
3,3'-Dichlorobenzidene	NA	7.7	NA
1,1-Dichloroethane	280	NA	NA
1,1-Dichloroethene	7	15	NA
1,2-Dichloroethane	5	NA	NA
Dieldrin	NA	0.02	NA
Di-n-butylphthalate	NA	6,000	NA
Di-n-octylphthalate	NA	5	NA
Methylene chloride	5	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	0.01	NA	NA
Tetrachloroethene	NA	45	NA
1,1,1-Trichloroethane	NA	1	NA
1,1,2-Trichloroethane	NA	230	NA
Trichloroethene	5	NA	NA
Vinyl Chloride	2	NA	NA

[a]From Record of Decision for Remedial Actions at Operable Unit 5, Tables 9-4 through 9-6, January 1996
[b]Not Applicable - Indicates no FRL was required for this constituent in this particular environmental media.
[c]The groundwater FRLs for fluoride and lead were changed and 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 chromium VI. This is acceptable because total chromium and nitrate/nitrite provide a more conservative result.
[e]Uranium consists of several isotopes. The common isotopes of uranium are: uranium-234, uranium-235, uranium-236, and uranium-238. This report interchangeably uses the terms uranium and total uranium. Either of these terms is defined as the sum of the various isotopic components.

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communicating timely information on cleanup plans and activities while reducing the number of evening meetings.

- Public Tour
  To respond to stakeholders' increasing interest in FEMP cleanup progress, DOE and Fluor Daniel Fernald hosted a public bus tour of the FEMP during the October 1997 Cleanup Progress Briefing. Over 60 stakeholders attended.

- New Publications
  During 1997, DOE and Fluor Daniel Fernald created several new publications to appeal to both external and internal stakeholders: the Cleanup Progress Report is a new quarterly report that documents completed and ongoing remediation activities in a visual format; A Look Ahead is a one-page, bi-monthly newsletter highlighting future activities to alert FEMP stakeholders of upcoming cleanup plans and activities; and Let's Talk is a new information tool specifically designed to encourage FEMP management to share information with team members through regular, personal interaction.

- Volunteers
  The Fernald Community Involvement Team, a volunteer task force of FEMP employees dedicated to supporting humanitarian and/or environmental projects, was named Outstanding Corporate Volunteer Program for 1997 by the Cincinnati Association of Volunteer Administrators. Also, Fernald's Community Outreach Program received approximately $20,000 in fiscal year 1997 for DOE-funded science enrichment programs to benefit teachers and students in the Greater Cincinnati area. Over 10,000 students and 500 teachers participated in the programs.

The following sections summarize each remediation project's activities performed in 1997, including associated removal actions. Each project summary includes a list of important documents issued in 1997. Refer to Table 1-1 in Chapter One for an explanation of each project's responsibility for implementing operable unit records of decision.

Waste Pits Remedial Action Project

In 1997, the Waste Pits Remedial Action Project awarded a contract to International Technology Corporation to remove and dry the pit waste. Numerous rail improvements were also made during the year. Field work performed during 1997 consisted of upgrades to off-site trestles along the branch line connecting the FEMP with the CSXT main rail line at Cottage Grove, Indiana and on-site infrastructure improvements to rail facilities in the support area for the remediation facilities. Other activities included:

- Site preparation for construction of the waste processing facility and loadout facility. This included an upgrade to the current rail system and installation of a storm water management system.

- North railyard upgrade preparation, construction of storm water controls and a sedimentation basin, and actual construction on the north railyard

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- Paddys Run, Okeana, Camp Run, and South Wynn railway trestles upgrades (structural improvements)

- Relocation of the old north access road and turning lane upgrade on State Route 126 occurred. These improvements will provide safe access for deliveries through the old north access road, especially during heavy delivery times.

The key project documents submitted by the Waste Pits Remedial Action Project are summarized in Table 2-2.

TABLE 2-2
1997 WASTE PITS REMEDIAL ACTION PROJECT
(Supports Operable Unit 1)

Document	Date
Final Operable Unit 1 Remedial Action Work Plan was submitted to agencies.	January 3, 1997
Request for Proposal #F96P157987, Waste Pits Remedial Action Project was submitted to offerers.	January 31, 1997

Soil Characterization and Excavation Project

The Soil Characterization and Excavation Project conducted a variety of excavation-related activities in 1997, including characterization sampling and analysis, certification that FRLs had been reached, and site preparation activities for soil remediation. The following list describes the actions taken for each remediation area:

- Certification sampling for Area 1, Phase I was completed and the Area 1, Phase I Certification Report, including Waste Acceptance Criteria Attainment Completion Reports for the East and West Soil Stockpiles Generated During Area 1, Phase I Activities (DOE 1997c) were submitted to the regulatory agencies. Area 1, Phase I is in the northeastern part of the FEMP and overlaps the footprint of the on-site disposal facility.

- In Area 1, Phase II, which is located in the eastern portion of the FEMP, several pre-design characterization studies were conducted to support the development of the Integrated Remedial Design Package for Area 1, Phase II. The Draft Integrated Remedial Design Package for Area 1, Phase II (DOE 1997h) was submitted to the regulatory agencies for review.

- In Area 2, Phase I, the Operable Unit 2 southern waste units in the southern part of the site, pre-design characterization studies were completed and site preparation activities, such as installing sedimentation basins and runoff ditches, were initiated.

The list of Soil Characterization and Excavation Project document deliverables to the regulatory agencies in 1997 is summarized in Table 2-3.

TABLE 2-3
1997 SOIL CHARACTERIZATION AND EXCAVATION PROJECT
(Supports Operable Units 2 and 5)

Document	Date
Draft Sitewide Excavation Plan and Draft Radiological Tracking System Applicability Study were submitted to agencies.	July 11, 1997
Certification Report for Area 1, Phase I was submitted to agencies.	June 30, 1997
Pre-final Integrated Remedial Design Package for Area 1, Phase II was submitted to agencies.	November 20, 1997
Pre-final Integrated Remedial Design Package for Area 2, Phase I was submitted to agencies.	October 23, 1997

On-Site Disposal Facility Project

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The completion of Cell 1 of the on-site disposal facility in 1997 was vital to the progress of other FEMP projects which were generating waste. Construction and contracting activities

were heavy in 1997, and the first waste was placed into Cell 1 of the eight-cell on-site disposal facility in December 1997.

Construction activities for the on-site disposal facility in 1997 also included:

- The leachate conveyance system to carry leachate from the on-site disposal facility for eventual treatment at the advanced wastewater treatment facility
- A new haul road for transporting contaminated soil and debris from the southern waste units to the on-site disposal facility
- The new north access road to the FEMP was relocated to allow for on-site disposal facility construction.

In addition to these activities, groundwater monitoring was initiated in 1997 to establish baseline conditions prior to waste placement. Details of this monitoring are provided in Chapter Three.

All waste being placed in the on-site disposal facility must meet the physical, chemical, and radiological standards known as on-site waste acceptance criteria. These criteria are established to ensure the physical protection of the cell and underlying Great Miami Aquifer. The Waste Acceptance Organization, an internal oversight organization, was created in 1997 to ensure that all waste placed in the on-site disposal facility meets the facility's waste acceptance criteria. The Waste Acceptance Organization reviews waste generation and placement plans and documentation for compliance with the Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility (DOE 1998b), which describes the approach for demonstrating attainment with the radiological, chemical, and physical waste acceptance criteria for all FEMP waste streams identified for on-site disposal. Waste Acceptance Organization also provides field inspectors who oversee waste generation and disposal into the facility.

The key project documents submitted by the on-site disposal facility project in 1997 are summarized in Table 2-4.

TABLE 2-4
1997 ON-SITE DISPOSAL FACILITY PROJECT
(Supports All Operable Units)

Document	Date
Final On-Site Disposal Facility Groundwater Leak Detection and Leachate Monitoring Plan was submitted to agencies. August 7, 1997	August 7, 1997
Impacted Materials Placement Plan was submitted to agencies.	August 21, 1997
Revision 0, Final On-Site Disposal Facility and Remedial Action Work Plan was submitted to the agencies.	May 22, 1997

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TABLE 2-5
1997 FACILITIES CLOSURE AND DEMOLITION PROJECT
(Supports Operable Unit 3)

Document	Date
Comment responses and revision to the Operable Unit 3 Integrated Remedial Design/Remedial Action Work Plan were submitted to agencies.	March 7, 1997
Comment responses and revisions to the Operable Unit 3 Integrated Remedial Design/Remedial Action Work Plan were submitted to agencies.	May 12, 1997
Received EPA approval of the Integrated Remedial Design/Remedial Action Work Plan	June 11, 1997
Final Integrated Remedial Design/Remedial Action Work Plan was submitted to agencies.	June 19, 1997
Thorium/Plant 9 Complex	
Operable Unit 3 Integrated Remedial Action Thorium/Plant 9 Complex Implementation Plan for Above-Grade Decontamination and Dismantlement was submitted to agencies.	January, 2, 1997
Comment responses and revisions to the Thorium/Plant 9 Implementation Plan were submitted to agencies.	April 4, 1997 June 26, 1997
Building 4A	
Building 4A Remediation Report/Project Closure Report was submitted to agencies.	January 15, 1997
Comment Responses and revised Project Completion Report for the Building 4A Decontamination and Dismantlement were submitted to agencies.	March 27, 1997
Boiler Plant/Water Plant	
Responses to Comments on Boiler Plant/Water Plant Implementation Plan were submitted to agencies.	February 13, 1997
High and Low Nitrate Tanks	
Comment responses and revised Project Completion Report for the High- and Low-Nitrate Tanks Decontamination and Dismantlement were submitted to agencies.	March 27, 1997
Plant 1	
Plant 1 Decontamination and Dismantlement Completion Report was submitted to agencies.	August 25, 1997
Revised Plant 1 Complex Project completion Report was submitted to agencies.	December 23, 1997
Air Monitoring	
Annual NESHAP report was submitted to EPA.	June 20, 1997

Facilities Closure and Demolition Project

In June 1997, the EPA approved the Final Operable Unit 3 Integrated Remedial Design/Remedial Action Work Plan (DOE 1997j). This work plan integrated Removal Actions 9, 12, 17, and 26 into the Operable Unit 3 remedial action. Decontamination and dismantlement activities and removal actions are discussed below. The list of Facilities Closure and Demolition Project documents during 1997 is summarized in Table 2-5.

Decontamination and dismantlement activities focused on the Plant 1 Complex, the boiler plant/water plant, the Thorium/Plant 9 complex, and the high- and low-nitrate tanks. These activities are summarized below:

- Plant 1, the preparation plant, was imploded in February 1997. Decontamination and dismantlement field activities were complete by June 1997, seven months ahead of schedule. Chapter Five discusses related air monitoring activities.
- Dismantlement of the high- and low-nitrate tanks was completed and the project completion report submitted to the agencies in January 1997.
- Boiler plant/water plant decontamination and dismantlement began in March 1997. Activities included demolition of office trailers, the utilities heavy equipment building, the water treatment plant and clearwell building, the railroad scale house, the water plant east and west reactivator tanks, the boiler plant flyash silo, and the boiler plant electrostatic precipitators. Completion of boiler plant/water plant decontamination and dismantlement is projected for September 1998.

As stated before, removal actions are undertaken when immediate action is required to protect public health and/or the environment. The following removal actions were initiated or continued in 1997 within the work scope of the Facilities Closure and Demolition Project:

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Removal Actions - *Thirty-two removal actions have been initiated at the FEMP in response to a need to accelerate cleanup activities that address releases or potential releases of hazardous substances. Twenty-seven removal actions were completed prior to 1997 and five are ongoing - one that is being incorporated into the remediation of the groundwater in the Great Miami Aquifer and four that focus on removal of waste inventories and asbestos, safe shutdown of the former production area, and improved storage of soil and debris. All removal actions are being incorporated into final remediation activities for the site.*

Removal Action No. 9, Removal of Waste Inventories, involves the characterization, overpacking, and disposition of low-level radioactive waste materials. Under Removal Action No. 9, some waste inventory is being treated on site prior to off-site disposal. The FEMP's aggressive waste shipping program was interrupted during 1997 due to problems with some shipping containers bound for the Nevada Test Site. DOE is working to resolve all related issues before waste shipping resumes. The 1997 waste shipping activities are summarized in Table 2-6.

TABLE 2-6
FEMP's 1997 REMOVAL OF WASTE INVENTORIES UNDER REMOVAL ACTION NO. 9

Category	Drum Equivalent
Asbestos	3,587
Uranium residues	9,754
Process area scrap	44,023
Contaminated trash	1,562
Thorium	10,875
Stabilized mixed waste	1,309
Legacy construction waste	840
Newly generated construction waste	6,773
Liquid Mixed Waste Project	0[a]
Non-LDR Project	1,847
Total to Off Site, Calendar Year 1997	80,570

[a]The Liquid Mixed Waste Project bulked 391 drum equivalents, but none were shipped to the Toxic Substances Control Act incinerator in Oak Ridge, Tennessee. Shipments to the incinerator have been delayed pending resolution of approval issues between the incinerator and the State of Tennessee.

The 1997 total represents an increase of 31,190 drum equivalents shipped off site compared to 1996.

Several mixed waste treatment projects are being conducted under Removal Action No. 9 and in accordance with the Director's Findings and Orders issued by OEPA in October 1996. These waste streams are being treated to meet RCRA land disposal restrictions and will be shipped off site for final disposition after treatment is complete. In 1997, the Mixed Waste Treatment Project completed chemical treatment by neutralization, precipitation, deactivation, and stabilization on 72 yd^3 (55 m^3) of waste. The Liquid Mixed Waste Project bulked 102 yd^3 (78.2 m^3) of mixed waste, for a total of 174.2 yd^3 (133.2 m^3). This volume is considerably lower than the 1996 total because the liquid mixed waste that had accumulated on site had been bulked and shipped prior to 1997. Liquid waste is now bulked as it is generated.

Approximately half of the FEMP's 32.0 million net pounds (14.5 million net kg) of uranium products that were in inventory when the site shut down in 1989 have been removed from the FEMP by either being transferred to other DOE sites for future use,

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returned to suppliers, sold to commercial vendors for nonmilitary uses, or buried as waste. Table 2-7 identifies the FEMP's inventory of uranium product materials as of the end of 1997.

TABLE 2-7
1997 FEMP URANIUM PRODUCT MATERIALS INVENTORY

Waste	Million Net Pounds	Million Net Kg
Depleted	8.5	3.9
Normal	0.4	0.2
Enriched	6.3	2.9
Total	15.2	7.0

In 1997, most of the effort to disposition product materials focused on continuing sampling/analytical activities, negotiating contracts, and reviewing inventories to determine whether or not all avenues of dispositioning the materials as product had been exhausted. It was concluded during this time period that no disposition alternatives for the depleted materials were feasible outside of declaring the material as waste. Accordingly, in November 1997, a waste recommendation was forwarded to DOE for almost all of the depleted metal and the uranium tetrafluoride contained in bulk packages known as T-hoppers (the remaining depleted compounds were held for a potential technology initiative). The final waste declaration has not been made by DOE and is still pending on this material. As the technology initiative has not yet proven to be viable, it is expected that the remaining depleted materials will be recommended for waste declaration in 1998 as well. Two contracts are still being negotiated for a small portion of the depleted metal and all of the normal metal. In addition, a contract was finalized in September 1997 to sell approximately one-third of the enriched materials.

Table 2-8 identifies the uranium product inventories shipped off site in 1997:

TABLE 2-8
1997 URANIUM PRODUCT INVENTORIES SHIPPED OFF SITE

Waste	Net Pounds	Net Kg
Depleted metal and compounds	25,287	11,480
Normal metal	48,590	22,060
Enriched metal	3,163	1,436
Total	77,040	34,976

Removal Action No. 12, Safe Shutdown, was initiated to ensure the safe and permanent shutdown of production facilities in the former production area. This includes the removal of uranium and other process/raw materials and waste materials from equipment, lines, and ductwork.

Removal Action No. 17, Improved Storage of Soil and Debris, was initiated to address the interim storage of contaminated soil and debris generated as a result of continued construction and maintenance projects, removal actions, and remediation actions at the

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FEMP. Removal Action No. 17 is ultimately being phased out, as pertinent elements are incorporated into Operable Units 2, 3, and 5 design plans.

Removal Action No. 26, Asbestos Removal, which documents the ongoing asbestos abatement activities at the FEMP, continued in 1997.

Silos Projects

1997 was a year of refocusing and reorganizing for the FEMP Silos Projects. A number of remedial design/remedial action milestones, associated with performance testing of the vitrification process for on-site treatment of Silos 1, 2, and 3 residues, were missed in 1996. One of the contributors was the leak that occurred in the melter in the vitrification pilot plant in December 1996. DOE then entered into a period of informal dispute resolution with EPA. During this period, DOE, EPA, OEPA, and other FEMP stakeholders began reassessing the path forward for the silos remedy. As part of this process, DOE, in consultation with EPA and OEPA, established an independent review team of industry experts and local stakeholders to evaluate the results of the silos vitrification program and the technical and schedule impacts associated with the increase in cost estimates for the final remediation of the silos. As a result of the dispute resolution in July 1997, the following path forward and regulatory milestones were established:

- The Silo 3 material will be remediated separately from K-65 Silos 1 and 2 material. The change in the remedy for Silo 3 will be documented in an Explanation of Significant Differences.

- The Feasibility Study Report for Operable Unit 4 (DOE 1994a), and the Proposed Plan for Operable Unit 4 (DOE 1994b), and Record of Decision for Remedial Actions at Operable Unit 4 (DOE 1994c) will be amended and resubmitted for approval in order to document changes to the remedy for K-65 Silos 1 and 2.

- The dispute resolution amended the Amended Consent Agreement with the following new milestones for silos remediation:

  - Draft Silo 3 Explanation of Significant Differences (DOE 1997f) (submitted September 12, 1997)

  - Award multi-tech proof of principle contract for Silos 1 and 2 by August 10, 1998

  - Submit Draft Silos 1 and 2 Feasibility Study/Proposed Plan to EPA by February 1, 2000

  - Submit Draft Silos 1 and 2 Record of Decision Amendment to EPA by December 29, 2000

  - Submit the revised Remedial Design Work Plans for Silo 3 and K-65 Silos 1 and 2 to EPA within 60 days of approval of the explanation of significant differences and record of decision amendment, respectively.

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To compensate for missed Operable Unit 4 milestones in 1996, the dispute agreement also requires the DOE to perform the following five supplemental environmental projects at the FEMP:

- Establishment of a conservation area near the FEMP
- Research grants for ecological restoration
- Creation of a wild bird/wild flower habitat area
- Railroad track recycling
- Structural steel debris recycling.

DOE, with the support of EPA, OEPA, and other FEMP stakeholders, began refining the scopes of these supplemental projects during 1997.

TABLE 2-9
1997 SILOS PROJECTS
(Supports Operable Unit 4)

Document	Date
Silo 3 Explanation of Significant Differences was submitted to agencies.	September 12, 1997
Work Plan for Structural Steel Debris Recycling Project and Work Plan for Railroad Track Recycling Project were submitted to agencies.	September 12, 1997
Work Plan for Establishment of a Conservation Area Near the FEMP and Work Plan for Research Grants for Ecological Restoration were submitted to agencies.	November 20, 1997
Draft Final Work Plan for Recycling Supplemental Environmental Project was submitted to agencies.	December 9, 1997
Supplemental Analysis for Operable Unit 4 was submitted to agencies.	December 22, 1997
Work Plan for Habitat Area Project was submitted to agencies.	December 29, 1997

As a result of the decision to separate the remediation of Silo 3 waste from K-65 Silos 1 and 2 waste, the Silos Project reorganized into the Silos 1 and 2 Project, and the Silo 3 Project in 1997. The documents submitted by the Silos Projects in 1997 are summarized in Table 2-9. Following is a summary of each project's activities during the year.

Silos 1 and 2 Project

Silos 1 and 2 Project activities in 1997 focused on developing a modified path forward for the project in cooperation with its stakeholders. On July 22, 1997, DOE resolved its dispute with the EPA over certain Operable Unit 4 milestones. As specified by the Operable Unit 4 dispute settlement, the original Silos Project Record of Decision, which was approved by EPA in 1994, must be amended. As part of the process, DOE has agreed to reevaluate/reconfirm the best stabilization technology to use when remediating K-65 Silos 1 and 2. The next step of this amendment process entails testing and proving the following technology families, a process known as proof-of-principle testing:

- Vitrification - joule-heated
- Vitrification - non-joule-heated
- Chemical Stabilization - cement based
- Chemical Stabilization - non-cement based.

Results of this testing will be included in a revised feasibility study document, which is expected to be completed by February 2000. In the interim, DOE has agreed with EPA to award the contracts for the proof-of-principle testing by August 10, 1998. One contract will be awarded in each of the four technology families.

An accelerated waste retrieval project is underway to address the technical uncertainties of the overall silos project remediation. The accelerated waste retrieval project will address the risks associated with the increasing radon concentrations in the K-65 Silos 1 and 2 head space, silo integrity, heterogeneity of the material for the final treatment facility, as well as streamlining the overall remediation process for Operable Unit 4.

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Silo 3 Project

EPA approved the Draft Final Silo 3 Explanation of Significant Differences on November 5, 1997. The Explanation of Significant Differences explained how the newly proposed remediation of Silo 3 waste differs from the remediation identified in the Operable Unit 4 Record of Decision. The draft final version was available for public review from November 17, 1997, through December 16, 1997. Formal public hearings were held at the FEMP and at the Nevada Test Site to receive stakeholder comments and concerns. The new proposed remedy for Silo 3 material consists of:

- Treatment, using either chemical stabilization/solidification or a polymer-based encapsulation process, to stabilize characteristic metals to meet limits imposed by RCRA and to meet off-site disposal facility waste acceptance criteria
- Off-site disposal at either the Nevada Test Site or an appropriately permitted commercial disposal facility.

The Explanation of Significant Differences is expected to be finalized in March 1998, and will include the responsiveness summary which will document to the stakeholders how comments on the Explanation of Significant Differences will be incorporated.

Aquifer Restoration and Wastewater Project

Many plans and reports relating to water treatment and groundwater restoration were issued in 1997 (Table 2-10). Activities of the Aquifer Restoration and Wastewater Project for 1997 include the following:

- The advanced wastewater treatment facility underwent improvements and a major expansion project was initiated to accommodate groundwater remediation activities.
- In support of the enhanced groundwater remedy (described in Chapter Three), extraction wells were added in the South Plume and South Field areas; five groundwater re-injection demonstration wells and nine associated monitoring wells were installed on property along Willey Road; and part of the pipeline to carry groundwater was installed.
- The biodenitrification/effluent treatment system was relocated and utilized as part of the new sewage treatment plant.
- The parking lot storm water runoff diversion project was completed in June 1997.

In addition to these remediation activities, the Aquifer Restoration and Wastewater Project is also responsible for continuing operation of the South Plume Removal Action System. A total of 645.6 million gallons (2,444 million liters) of groundwater were extracted through the South Plume Extraction System in 1997, and approximately 88.6 pounds (40.2 kg) of total uranium were removed from the aquifer. The South Plume Performance Monitoring and Maintenance Plan for Operable Unit 5 (DOE 1997o) was developed and implemented in 1997. This plan will support the successful long-term operation of the extraction well

system and has been incorporated into the Operations and Maintenance Master Plan for Aquifer Restoration and Wastewater Treatment (1997l).

The advanced wastewater treatment facility, which began operating in 1995, provides final treatment of FEMP contaminated storm water and wastewater. It also provides treatment for contaminated groundwater associated with FEMP groundwater remediation. In 1997, the following projects supported this facility:

- Construction was completed and testing began of a system to regenerate the resins used to remove uranium from contaminated water.
- Continuous operation of new multi-media filters began at the existing facility. These filters remove particulates from the wastewater prior to treatment for uranium removal.
- Construction of the advanced waste water treatment facility expansion began in February 1997. The expansion is expected to treat an average of 1,500 gallons per minute (gpm) (5,700 liters per minute [L/min]). Operation of the expansion is expected to begin in 1998.

TABLE 2-10
AQUIFER RESTORATION AND WASTEWATER TREATMENT PROJECT
(Supports Operable Unit 5)

Document	Date
Draft Final Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) and Draft Final Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5 were submitted to agencies.	April 11, 1997
Response to Comments Document of the Restoration Area Verification Sampling Program, Project-Specific Plan was submitted to agencies .	March 27, 1997
Final Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5 and Final Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) were submitted to agencies.	June 27, 1997
Final Restoration Area Verification Sampling Program, Project-Specific Plan was submitted to agencies.	May 21, 1997
South Plume	
Design Monitoring Evaluation Program Plan, System Evaluation Report was submitted to agencies.	March 27, 1997
Design Monitoring Evaluation Program Plan Semi-Annual Report was submitted to agencies.	September 23, 1997
Aquifer Restoration Extraction/Re-Injection Modules	
Comment Responses on the South Field Injection Test Phase II Report were submitted to agencies.	January 8, 1997
South Plume Optimization and Re-Injection Demonstration Pre-Final Design Packages were submitted to agencies.	February 3, 1997
South Plume Optimization and Re-Injection Demonstration Systems design was approved.	May, 1997
South Plume Optimization and Re-Injection Demonstration Test Plan was submitted to agencies.	August 29, 1997
Groundwater Monitoring	
RCRA Annual Report (includes RCRA annual groundwater monitoring data) was submitted to OEPA.	February 28, 1997
Ohio Department of Natural Resources Water Report was submitted to agencies.	February 28, 1997
Draft Operations and Maintenance Master Plan for the Aquifer and Wastewater Treatment Project was submitted to agencies.	June 30, 1997
Final Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project was submitted to agencies.	November 7, 1997

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Summary of Compliance with Other Requirements

CERCLA requires that certain laws and regulations must be complied with as part of remediation of the FEMP. These other requirements are referred to as applicable or relevant and appropriate requirements, or ARARs. ARARs that are pertinent to remediation of the FEMP are specified in the record of decision for each operable unit. This section of Chapter Two highlights some of these requirements and how the FEMP complied with these requirements in 1997.

The regulations discussed in this section have been identified as ARARs in the FEMP operable unit records of decision. The FEMP must comply with these regulations while site remediation under CERCLA is underway.

Some of these requirements include permits for controlled releases to surface water and air, and for managing hazardous waste. The FEMP's permit for discharging water under the National Pollutant Discharge Elimination System (NPDES) regulations is discussed in the "Clean Water Act" section of this chapter. Another permit to install, issued in September 1990 by OEPA, covers the monitoring of the Coal Pile Runoff Basin and is discussed in Chapter Three of this report. The FEMP's permit for RCRA treatment, storage, and disposal (OH6890008976) cover RCRA activities described later in this chapter. The FEMP has 14 current air Permits to Operate and 10 associated Permits to Install, one of which was issued in 1997. These permits cover boilers, diesel storage tanks, clothes dryers, the respirator washing facility, maintenance shop facilities, a laboratory hood system, and a gasoline dispensing facility.

DOE requirements applicable to FEMP activities are identified in the FEMP Standards/Requirements Identification Document, which is included in the Fluor Daniel Fernald Management Plan (FDF 1998), and compliance with them is mandatory. DOE orders are pivotal in defining business practices and operations standards for remediation.

Resource Conservation and Recovery Act (RCRA)

RCRA regulates treatment, storage, and disposal of hazardous waste. Hazardous wastes and radioactive wastes mixed with hazardous waste (referred to as mixed waste) are generated during uranium production. These wastes are regulated under RCRA and Ohio hazardous waste regulations; thus, the FEMP must comply with legal requirements for managing these hazardous and mixed wastes. OEPA has been authorized by EPA to enforce its hazardous waste regulations in lieu of the federal RCRA program. In addition, hazardous waste management is subject to the 1988 Consent Decree and its 1993 Stipulated Amendment entered into between the State of Ohio and the DOE, and a series of Director's Final Findings and Orders issued by OEPA.

The FEMP completed several administrative activities related to mixed waste storage and treatment during 1997, including:

- Submittal of the 1996 RCRA Annual Report (DOE 1997a), which described hazardous waste activities for 1997
- Revisions to several sections of the RCRA Part A and B permit application
- Submittal of the annual 1997 update to the Site Treatment Plan (DOE 1997b) required under the Federal Facility Compliance Agreement (FFCA).

Additional details on projects involving treatment of mixed wastes are provided in the subsection "Mixed Waste Treatment" later in this chapter.

RCRA Property Boundary Groundwater Monitoring

The Director's Findings and Orders, which was signed September 10, 1993, and described an alternate groundwater monitoring system, was modified in 1997 to coincide with the groundwater monitoring strategy identified in the IEMP. This program is discussed in more detail in Chapter Three.

RCRA Closures

The Stipulated Amendment to Consent Decree required that the FEMP identify all hazardous waste management units at the FEMP. 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 these units were hazardous waste management units or solid waste management units. This evaluation was completed in 1994. In 1996, the OEPA issued a Director's Findings and Orders to integrate RCRA closure requirements with CERCLA response actions for FEMP hazardous waste management units. During 1997, the FEMP continued to integrate RCRA closure activities with CERCLA response actions for FEMP hazardous waste management units. Remediation of one hazardous waste management unit, the Plant 1 Storage Building (Building 67), was completed in 1997 under this integrated RCRA/CERCLA remediation process. Also, between 1993 and 1996, 12 hazardous waste management units were reclassified to solid waste management unit status, based upon additional analytical and/or process knowledge. These units were not required to undergo RCRA hazardous waste management unit closure criteria, or to meet the RCRA requirements of the Director's Findings and Orders.

Thorium Management

A thorium management strategy and schedule to complete RCRA determinations of thorium materials and to improve the storage of thorium materials at the FEMP were developed as part of the Stipulated Amended Consent Decree. This strategy is based on three primary objectives:

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- 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.

In 1997, the FEMP removed 3,400 containers of thorium material and shipped 10,875 drum equivalents, or 80,480 cubic feet (2,279 m^3), of thorium material to the Nevada Test Site for disposal, completing the Thorium Overpack Project. Characterization of the remaining estimated 8,500 containers of thorium legacy waste at the FEMP was initiated in 1997. An extensive sampling and analysis program was implemented and formal characterization documentation was initiated. The characterization documentation and formal RCRA waste determinations are expected to be completed in 1998. The thorium legacy waste determined to be low-level radioactive non-hazardous waste will be prepared and shipped to the Nevada Test Site for disposal. The thorium legacy waste determined to be hazardous under RCRA will be treated to meet land disposal restrictions and, upon analytical confirmation, prepared and shipped to the Nevada Test Site for disposal. Both the low-level and hazardous waste activities are expected to begin in 1998.

Mixed Waste Treatment

The FEMP 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 an extension is approved by the EPA or the appropriate state regulatory agency (i.e., OEPA).

The 1992 amendment to RCRA provided DOE with an exemption from enforcement under the land disposal restrictions storage prohibition, provided that the FEMP complies with the plans and schedules for mixed waste treatment provided in the Site Treatment Plan and the implementing Director's Findings and Orders issued by OEPA on October 4, 1995. The FEMP submitted the Site Treatment Plan Annual Update to OEPA in December 1997. This update contains an amendment to treat remaining thorium inventories on site by stabilization. It describes the status of mixed waste treatment projects developed under the plan, added newly generated/newly identified waste streams, and certified that the FEMP met all regulatory milestone dates for the treatment of mixed wastes identified in the plan and in implementing Director's Findings and Orders through December 31, 1997.

The implementation of the Directors' Findings and Orders is accomplished through Removal Action No. 9, Removal of Waste Inventories. The Final Operable Unit 3 Record of Decision adopts the procedures and disposition decisions of this removal action to continue the disposition of the products, residues, and nuclear materials generated during site operations.

Radiologically contaminated polychlorinated biphenyls (PCBs) solids (also regulated under the Toxic Substances Control Act) have no current treatment or disposal options and will remain in storage on site until treatment or disposal capacity is available. Options for their

disposal are scheduled to be pursued in conjunction with Removal Action No. 9, Removal of Waste Inventories. Mixed waste treatment technology developed as part of the Site Treatment Plan was being tested during 1997.

In 1997, the FEMP initiated and completed the following projects to treat mixed wastes:

- Completed treatment by chemical precipitation and cement stabilization of 6,630 pounds (3,010 kg) of barium chloride residues
- Neutralized 9,587 pounds (4,352 kg) of corrosive wastes
- Deactivated 4,110 pounds (1,866 kg) of reactive wastes
- Treated 10,279 pounds (4,667 kg) of oxidizers, uranyl, and thorium nitrate solids and liquids, and other thorium-contaminated wastes by chemical precipitation, chemical reduction, and cement stabilization
- Treated 33,458 pounds (15,190 kg) of lead-based paint chips, cleaning residues, scrap salts, and hazardous trash using a cement-based stabilization process as part of the Chemical Treatment Stabilization Subproject
- Bulked 172,000 pounds (78,088 kg) of liquid mixed waste into Batches 7, 8, and 9 for shipment to the K-25 Toxic Substance Control Act Incinerator in Oak Ridge, Tennessee, for treatment
- Shipped 755,062 pounds (342,798 kg) of mixed waste to Envirocare of Utah in Clive, Utah, for disposal
- Treated 2,386 pounds (1,083 kg) of mixed (radioactive/hazardous) PCB waste to meet land disposal restriction requirements through the Terra-Kleen demonstration.

Clean Water Act

Under the Clean Water Act, the FEMP is governed by NPDES regulations which require the control of discharges of non-radioactive 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 FEMP submits monthly reports on NPDES activities to the OEPA. The current permit 1IO00004*ED became effective November 1, 1995, and expires March 31, 1998. On September 22, 1997, the FEMP applied for the new permit. The permit covers both surface water and effluent discharges. Chapter Four discusses the surface water and treated effluent results in detail.

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 emissions (with the exception of radon) from the facility in a single year. This standard also imposes requirements for continuous monitoring of certain emission sources and periodic confirmatory measurements of smaller sources. Because the FEMP is a former uranium

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processing plant, uranium is the radioactive particulate of most concern in monitoring airborne emissions. The FEMP estimated that airborne uranium emissions for 1997 were 19.5 pounds (8.84 kg).

EPA regulates the FEMP's radionuclide sources. OEPA has authority to enforce the State of Ohio's air standards while EPA enforces the NESHAP regulations. FEMP air emissions are regulated by OEPA as either particulate, chemical, or toxic emission sources. In 1997, the FEMP complied with all particulate, chemical, and toxic emissions standards.

Several activities during remediation may result in the generation of fugitive dust, which is also regulated by OEPA. These activities include decontamination and dismantlement, soil excavation, on-site disposal facility construction and waste placement, and other construction activities. In 1997, OEPA and DOE agreed on how the FEMP will comply with regulatory fugitive dust limits. The requirements in the Best Available Technology Determination for Remedial Construction Activities on the Fernald Environmental Management Project (DOE 1997e) are incorporated into each operable unit's remedial design and remedial action deliverables. Compliance is primarily determined through visual inspection of dust during activities and through proper dust control. In 1997, the FEMP complied with the fugitive dust requirements.

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. The SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report (DOE 1998a) for 1997 will be submitted to OEPA and other local emergency planning/response organizations in February 1998. The report lists the amount and location of hazardous chemicals/substances stored or used in amounts greater than the minimum reporting threshold during any one given 24-hour period.

The SARA Title III, Section 313, Toxic Chemical Release Inventory Report (DOE 1997n) was submitted to OEPA and EPA on July 1, 1997. 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. In 1997, no chemicals met the SARA 313 manufactured, processed, or otherwise used reporting threshold requirements.

Any off-site release meeting or exceeding a reportable quantity as defined by SARA Title III, Section 304, requires immediate notifications to local emergency planning committees and the state emergency response commission. Depending on the respective requirements, notifications are made to the National Response Center and to the appropriate federal, state, and local regulatory entities. All releases occurring at the FEMP are evaluated and documented to ensure that proper notifications are made in accordance with SARA. In addition to SARA, releases are also evaluated for notification under CERCLA Section 103, RCRA, the Toxic Substances Control Act, the Clean Air Act, the Clean Water Act, Ohio environmental laws and regulations, and the Ohio Fire Code.

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In 1997, one FEMP release was reported to regulatory and other agencies. On December 3, 1997, the National Response Center was notified of a release to the environment that occurred at the FEMP. The notification was made because water with a pH of 12.6 was detected in an excavated trench. The water in the trench was perched groundwater (defined as groundwater existing above a dense clay layer of soil which limits vertical migration). The high pH value of the water was attributed to historical operations of two nearby caustic tanks which were installed at the site in the 1950s. Weathering of the tanks' secondary containment system over time allowed a pathway from the tanks to the soils beneath and adjacent to the trench. Precipitation and runoff from the tanks and secondary containment over the years contributed to seepage into the adjacent soils and underlying perched water. An estimated 2,994 pounds (1,359 kg) of water were collected in the excavated trench. The reportable quantity for liquids with a pH greater than or equal to 12.5 is 100 pounds (45.4 kg). The water in the trench was collected and treated through the FEMP's wastewater treatment system. The trench was backfilled with soil on December 3, 1997. The caustic tanks were emptied and rinsed to the extent practicable to mitigate any future leaks, prior to final removal of the tanks.

Other Environmental Regulations

The FEMP is also required to comply with several other environmental laws and regulations besides those described above. Table 2-11 summarizes compliance with each of these requirements for 1997.

Site-Specific Regulatory Agreements

Federal Facility Compliance Agreement (FFCA)

In 1986, the FEMP entered into a FFCA with the EPA. The key components of this agreement requires the FEMP to:

- Maintain a continuous sample collection program for radiological constituents at the FEMP's treated-effluent discharge points and report the results quarterly to the 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 in early 1996. This agreement became effective May 1, 1996. This agreement requires sampling at the Parshall Flume (PF 4001) and the Storm Water Retention Basin spillway for radiological parameters.

- Maintain a sampling program for daily flow and total uranium at the South Plume Extraction Wells and report the results quarterly 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.

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TABLE 2-11
COMPLIANCE WITH OTHER ENVIRONMENTAL REGULATIONS

Purpose of Regulation	Background Compliance Issues	1997 Compliance Activities
Toxic Substances Control Act (TSCA)		
Regulates the manufacturing, use, storage, and disposal of toxic materials, including PCBs and PCB items	An OEPA Director's Findings and Orders allowed for extended storage of mixed wastes, which include PCB wastes.	Non-radiologically contaminated PCBs and PCB items were shipped to TSCA-approved commercial disposal facilities for incineration on an "as-needed basis".
	EPA conducted a routine TSCA compliance inspection of the FEMP on September 21, 1994. No violations of PCB regulations were identified during the inspection.	Radiologically contaminated PCB liquids were bulked for later shipment to the TSCA permitted DOE incinerator in Oak Ridge, TN. Most radiologically contaminated PCB solids currently had no treatment or disposal options and remain in storage on site. Some radiologically contaminated PCB wastes were treated as part of a treatment technology demonstration under Removal Action No. 9 and the Site Treatment Plan.
Ohio Solid Waste Act		
Regulates infectious waste	The FEMP is registered with OEPA as a large generator of infectious waste, generating more than the 50 lbs (23 kg) per month.	All infectious wastes generated in the medical department were transported to a licensed treatment facility for incineration.
Federal Insecticide, Fungicide, and Rodenticide Act		
Regulate 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 FEMP to be in full compliance with the requirements mandated by Federal Insecticide, Fungicide, and Rodenticide Act.	All pesticide applications at the FEMP were conducted according to Federal and State regulatory requirements.
National Environmental Policy Act		
Requires the evaluation of environmental, socio-economic, and cultural impacts before any action, such as a construction or cleanup project, is initiated by a federal agency	An environmental assessment was completed in 1995 for the disposition of the Native American remains uncovered as part of the Public Water Supply Project. A Finding of No Significant Impact, to close out the National Environmental Policy Act environmental assessment process, was placed on hold by DOE-FEMP until final disposition of the remains could be negotiated with the participating Native American tribes and groups.	The Finding of No Significant Impact for disposition of the Native American remains was approved by DOE-Ohio Field Office on April 28, 1997 prior to final disposition of the remains. Final disposition of the remains occurred on the FEMP in May of 1997. A supplemental analysis for Operable Unit 4 that addressed the proposed accelerated waste retrieval from K-65 Silos 1 and 2 was submitted to DOE-FEMP on December 22, 1997.
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 U.S. Fish and Wildlife Service, have established the following list of threatened and endangered species and their habitats existing onsite: Cave salamander, state-listed endangered – marginal habitat, none found; Sloan's crayfish, state-listed threatened – found on northern sections of Paddys Run; Indiana bat, federally-listed endangered – suitable habitat in riparian areas along Paddys Run.	No surveys were conducted in 1997, however, visual observations were conducted of Sloan's crayfish habitat after storm events which indicated no FEMP-induced adverse effects.

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TABLE 2-11
COMPLIANCE WITH OTHER ENVIRONMENTAL REGULATIONS

Purpose of Regulation	Background Compliance Issues	1997 Compliance Activities
Floodplains/ Wetlands Review Requirements		
DOE regulations require a floodplain/wetland assessment for DOE construction and improvement projects.	A wetlands delineation of the FEMP, 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 FEMP property. Updated delineations are conducted approximately every five years.	A Wetland Notice of Involvement and Wetland Assessment were completed in 1997 in support of the installation of an air monitoring station. The Notice was published in the Federal Register on October 14, 1997.
National Historic Preservation Act		
Mandates protection of historic and prehistoric cultural resources	The FEMP site is within an area rich in historic and prehistoric cultural resources. These cultural resources include 104 prehistoric sites within two 1.24 miles (two km) of the FEMP and 27 historic sites.	Activities were conducted to avoid and address impacts to cultural resources (Chapter Seven).
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 on private property during installation of pipelines for the Public Water Supply project. Partial remains of approximately 20 more people and numerous artifacts were also found.	On May 25, 1997, Native American remains and associated artifacts dating back 950 years were interred on Fernald property — protected federal land — during a sacred ceremony performed by representatives from several tribes.
Natural Resource Trusteeship		
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 U.S. Department of the Interior, U.S. Fish & Wildlife Service, OEPA, 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.	The Trustees agreed to develop a natural resource restoration plan, integrating on-property natural resource restoration activities with remediation activities at the FEMP in an effort to resolve DOE's liability for injuries to natural resources.

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Federal Facility Agreement (FFA), Control and Abatement of Radon-222 Emissions

This agreement between DOE and EPA, signed on November 19, 1991, ensures that DOE takes all necessary actions to control and abate radon-222 emissions at the FEMP, under the authority of 40 Code of Federal Regulations 61, Subpart Q. This agreement acknowledges that the K-65 Silos 1 and 2 exceed the radon flux rate of 20 picoCuries per square meter per second (pCi/m²/sec), but allows the FEMP to address this exceedance by implementing a removal action 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 emit radon in excess of 20 pCi/m²/sec.

ALARA

DOE Order 5400.5 requires the FEMP to adopt an ALARA philosophy. The ALARA philosophy was adopted to minimize exposure of general employees, the public, or the environment to ionizing radiation to the extent that social, technical, economic, practical, and public policy considerations allow. The FEMP is committed to reducing radiation exposures by applying ALARA concepts and practices in all activities in accordance with DOE 5400.5, other applicable DOE orders, and Title 10 of the Code of Federal Regulations, part 835.

The ALARA process ensures the selection of the optimum physical design features and administrative controls which will eliminate, control, or mitigate radiological exposure of general employees, the public, and the environment.

ALARA requires judgement with respect to what is reasonably achievable. Factors that relate to societal, technological, economic, and other public policy considerations shall be evaluated to the extent practicable in making such judgements. The minimum factors to be considered when applying the philosophy of ALARA to the environment shall include:

- The maximum dose to members of the public
- The collective dose to the population
- Alternative processes, such as alternative treatments of discharge streams, operating methods, or controls
- Doses for each process alternative
- Costs for each of the technological alternatives
- Examination of the changes in cost among alternatives
- Changes in societal impact associated with process alternatives (e.g., differential doses from various pathways).

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Split Sampling Program

In 1997, DOE and OEPA cooperated in a program in which samples of ground water, surface water, sediment, and produce were "split" and sent to different analytical laboratories. This is an important part of the quality assurance program at the FEMP. The FEMP has participated in this program with the state since 1987. In the split sampling program, the true variability in analysis between laboratories is measured with the comparison of sample results that were directly collected from the environment.

To obtain split samples, technicians alternately add a portion of the sample being collected to two individual sample containers. This collection method helps ensure that both samples are as identical as possible. Split samples are then submitted to two independent laboratories for analysis.

In 1997, the results from the split sampling program show close agreement between DOE and OEPA results for the groundwater and surface water samples. However, a greater degree of variability exists between DOE and OEPA results for sediment and produce samples. This is not unusual for these types of sample matrices based on the potential variability within the samples themselves. In addition, variability in the sample results may be affected by incomplete sample homogenization (mixing) in the field and differences in sample preparation methods at the analytical laboratories. DOE and OEPA have discussed these issues and will continue to work together to ensure the highest degree of quality in the split sampling program. The results for the 1997 OEPA split samples are presented in Table 1-1 in Appendix D, Attachment 1, of this report.

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Chapter 3
Groundwater Pathway

Groundwater Pathway

Results in Brief: 1997 Groundwater Pathway

Enhanced Groundwater Remedy Construction - Significant portions of the enhanced groundwater remedy were put in place in 1997. Two extraction wells were completed in the South Plume area to optimize the existing South Plume Removal Action System. Five groundwater re-injection test wells were installed on property along Willey Road. Another extraction well was installed on property in the South Field area to enhance contaminant recovery. Significant portions of the pipeline to convey groundwater to and from the well fields were installed in 1997. The South Plume Optimization, South Field Extraction (Phase I), and the Re-Injection Demonstration systems are scheduled to begin operations in the summer of 1998.

South Plume Removal Action System Operations - A total of 645.6 million gallons (2443.6 million liters) of groundwater and 88.6 pounds (40.2 kg) of total uranium were removed from the Great Miami Aquifer by four wells in the South Plume Removal Action System. The system continued to meet the primary objective of preventing further southward movement of the total uranium plume.

Groundwater Monitoring Results - The results of groundwater monitoring for total uranium and non-uranium constituents confirm that the enhanced remedy design for aquifer restoration is appropriate. No significant contaminants were identified in the aquifer with concentrations above their respective FRLs which would require modification of the enhanced groundwater remedy design. The design includes 37 groundwater extraction wells and 10 groundwater re-injection wells.

On-Site Disposal Facility Monitoring - Groundwater sampling to establish a baseline of groundwater quality prior to waste placement was completed for Cell 1. A technical memorandum will be issued in 1998 to discuss the baseline results. Groundwater sampling was also initiated in 1997 to obtain a baseline around Cell 2.

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

- Significant achievements realized by the Aquifer Restoration and Wastewater Project in 1997
- Groundwater monitoring activities and results for 1997.

Restoration and continued protection of the groundwater pathway are primary considerations in the accelerated remediation strategy for the FEMP. While significant achievements have been made in limiting exposure to contaminated groundwater, such as the installation of a public water supply in 1996, the FEMP continues to focus on accelerating the groundwater restoration. In addition, the FEMP will continue to monitor the groundwater pathway throughout remediation to ensure the future protection of this primary exposure pathway.

Groundwater Modeling at the FEMP

The FEMP uses computer models to make predictions about how the aquifer and contaminants in the aquifer will look in the future, based on current conditions. Because the model contains simplifying assumptions about the aquifer and the contaminants, it makes approximate predictions about future behavior which 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, then 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 clean-up efficiency and reduce the clean-up time and cost, then 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, then modifications will be made to the model to improve its predictive capabilities.

Summary of the Nature and Extent of Groundwater Contamination

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

Contamination of the groundwater resulted from infiltration through the bed of Paddys Run where the glacial overburden is eroded, and the sand and gravel of the aquifer are in direct contact with uranium-contaminated surface water from the FEMP. To a lesser degree, groundwater contamination also resulted where man-made excavations, such as the waste pits, removed some of the protective glacial overburden and exposed the aquifer to contamination.

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Selection and Design of the Groundwater Remedy

After the nature and extent of groundwater contamination was 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 in arriving at a preferred remedy for restoring the quality of the groundwater in the aquifer.

The Operable Unit 5 FS 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 gpm (15,140 L/min) would remediate the aquifer within 27 years. The recommended groundwater remedy was presented to the EPA, the OEPA, and FEMP 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 FEMP stakeholders and subsequently approved by EPA and OEPA in January 1996. The Operable Unit 5 Record of Decision established FRLs for all constituents of concern and formalized the agreement to implement the selected remedy. The Operable Unit 5 Record of Decision committed to continue evaluating 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 Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1) (DOE 1997d).

Re-injection at the FEMP

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 "push" from 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.

The enhanced groundwater remedy includes a test of large-scale groundwater re-injection. If groundwater re-injection proves to be viable, then it will increase the rate at which contaminants are flushed through the sand and gravel of the aquifer and into the extraction wells. The enhanced groundwater remedy also included additional extraction wells in on-property areas of aquifer contamination which are not accessible until after contaminated surface soils are remediated. Groundwater modeling studies conducted in support of the enhanced groundwater remedy suggest that, with the early installation of additional extraction wells and re-injection technology, the remedy could potentially be shortened by as much as 17 years. The enhanced groundwater remedy was approved by the EPA and OEPA.

The extraction and re-injection well locations for the enhanced groundwater remedy are shown in Figure 3-1. Extraction wells are indicated by a shaded dot; re-injection wells are indicated by an open dot; and three wells in the South Field area, which are scheduled to be converted from extraction to re-injection during the later years of the remedy, are indicated by a star symbol. Schedules for the design, construction, and start-up of the enhanced groundwater remedy can be found in the Remedial Design Work Plan for Remedial Actions at Operable Unit 5 (DOE 1996b) and in the Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5 (DOE 1997m).

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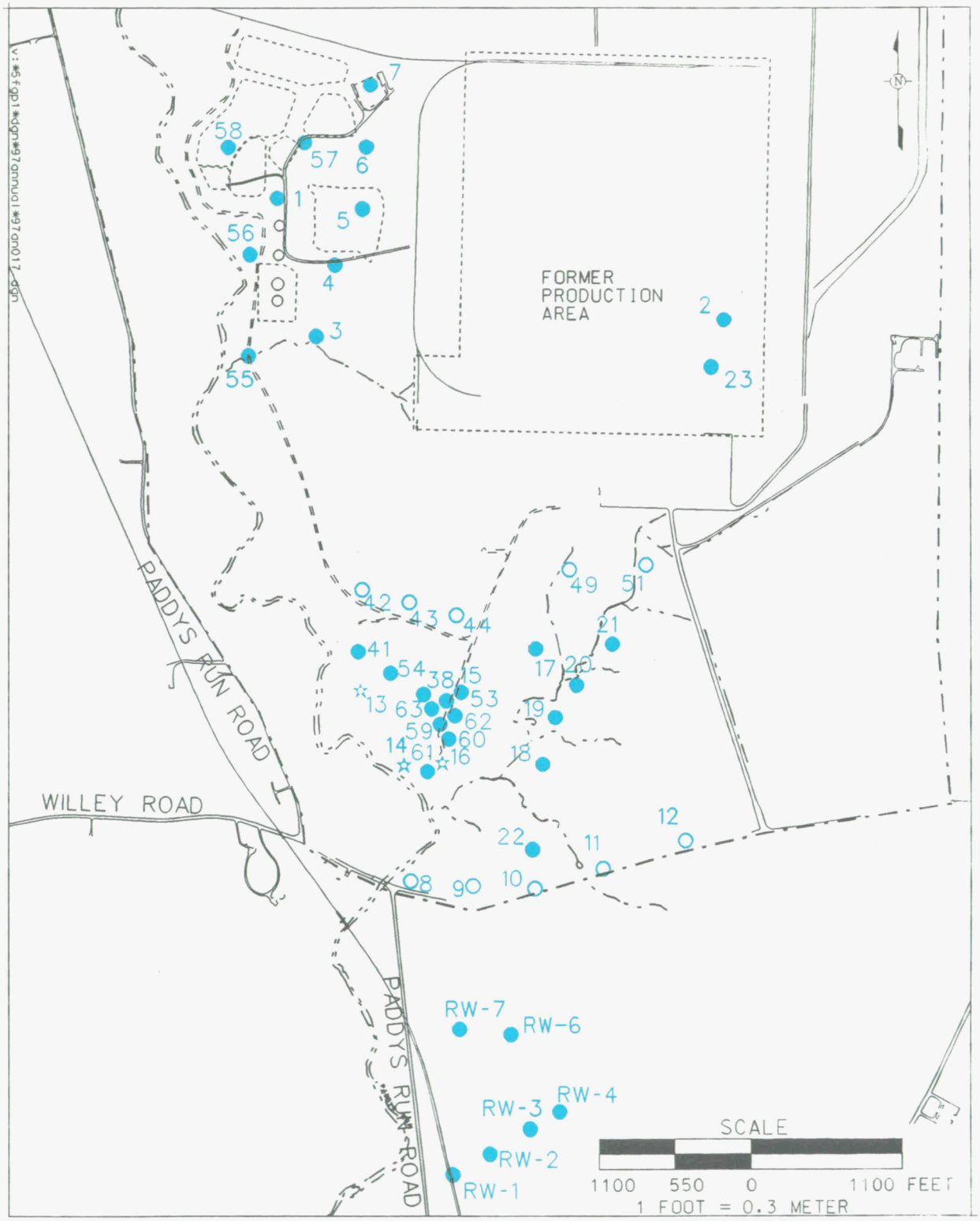

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Figure 3-1. Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

While the RI and FS process was in progress and a groundwater remedy was being selected, off-property contaminated groundwater was being pumped in the South Plume area under Removal Action 3 by the South Plume Removal Action System. 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 moving any further to the south. Figure 3-1 identifies the four operational extraction wells: RW-1, RW-2, RW-3, and RW-4. These extraction wells have successfully stopped further migration of the total uranium plume and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume. Furthermore, the South Plume Removal Action System is included as part of the final enhanced groundwater remedy design.

Groundwater Monitoring Highlights for 1997

Transition to IEMP

Groundwater elevation measurements are collected from aquifer monitoring wells at the FEMP. Elevations are plotted on maps and then contoured to see the shape of the water table beneath the FEMP. The elevation contour maps are used by FEMP scientists to study the direction and rate of groundwater flow in the aquifer.

Reporting under the IEMP combines all FEMP groundwater monitoring programs into a single program and ensures that groundwater monitoring efficiently supports the enhanced groundwater remedy. With the approval of the IEMP in July 1997, the following groundwater monitoring programs at the FEMP were incorporated under the IEMP:

- Radiological Environmental Monitoring (Private Well) Program
- RCRA Property Boundary Monitoring Program
- South Plume Removal Action Monitoring Program
- KC-2 Warehouse Well Monitoring Program.

The key elements of the IEMP groundwater program design are described below:

- Sampling - Sample locations, frequency, and the constituents were selected to address operational assessment, restoration assessment, and compliance requirements. In general, under the IEMP, more constituents are monitored (up to 50 groundwater FRL constituents, Table 2-1) and more well locations are monitored than under previous separate monitoring programs in order to monitor the enhanced groundwater remedy. Figure 3-2 shows a typical groundwater monitoring well at the FEMP. As part of the comprehensive IEMP groundwater monitoring program, 109 wells are monitored quarterly; 18 wells are monitored semi-annually; and one well is monitored annually for groundwater quality (Figure 3-3). In addition to water quality monitoring, 161 wells are monitored quarterly for groundwater elevations (Figure 3-4).

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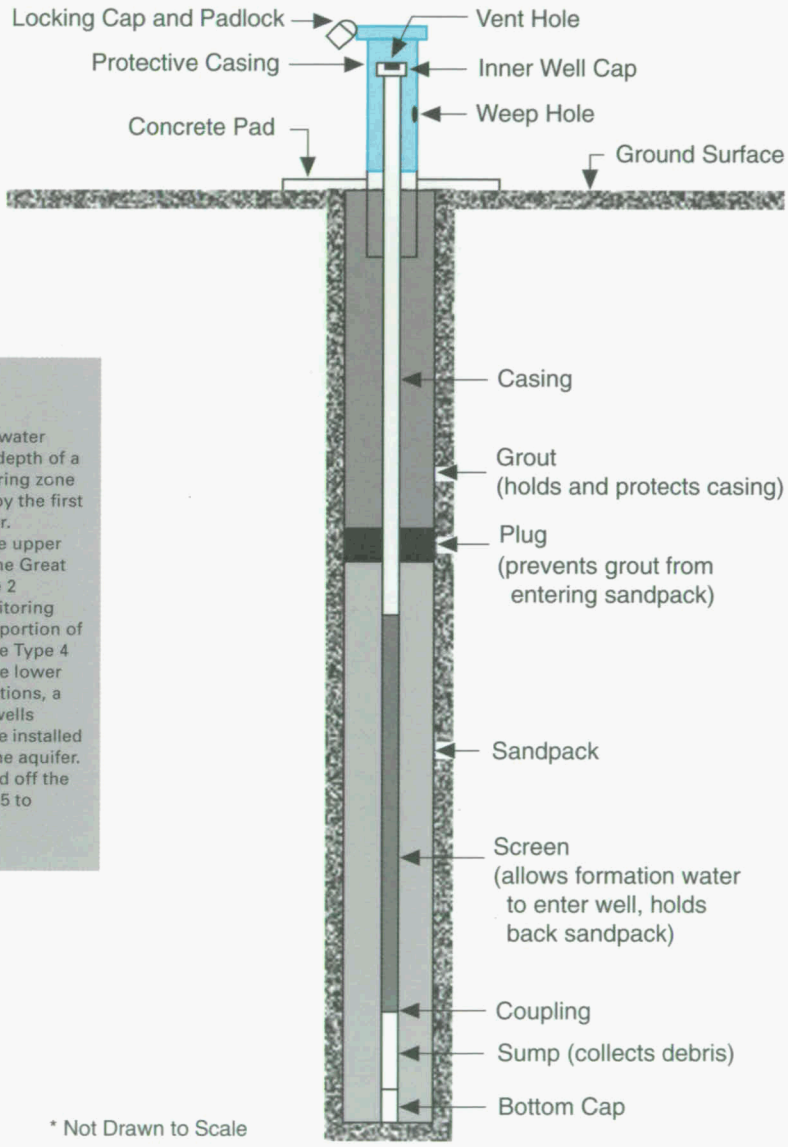

Groundwater Monitoring Wells

Figure 3-2 depicts a typical groundwater monitoring well at the FEMP. The depth of a monitoring well and the water-bearing zone into which it extends are denoted by the first digit of the monitoring well number. Monitoring wells extending into 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 placed within the middle portion of the sand and gravel aquifer, and the Type 4 monitoring wells are installed in the lower portion of the sand and gravel locations, a group of two or more monitoring wells (cluster wells) of different depths are installed to sample different depths within the aquifer. These wells are located both on and off the FEMP property. They range from 35 to 250 feet (11 to 76 meters) in depth.

Figure 3-2. Monitoring Well Diagram

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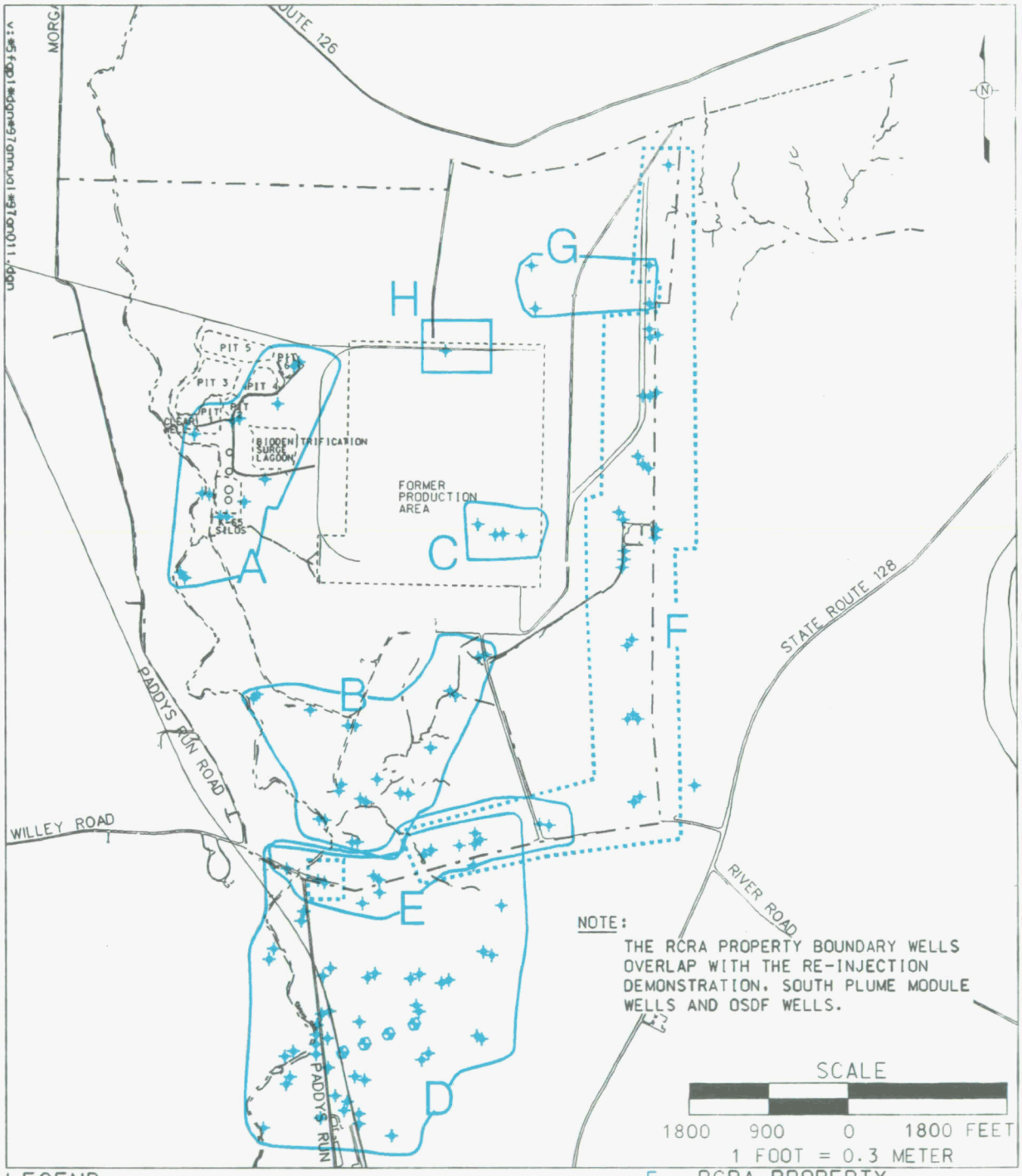

LEGEND:

- A - WASTE STORAGE AREA
- B - SOUTH FIELD EXTRACTION AREA
- C - PLANT 6 AREA
- D - SOUTH PLUME AREA
- E - RE-INJECTION DEMONSTRATION AREA
- F - RCRA PROPERTY BOUNDARY WELLS
- G - OSDF MONITORING WELLS
- H - KC-2 WAREHOUSE WELL
- FEMP BOUNDARY
- MONITORING WELL
- EXTRACTION WELL

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Figure 3-3. IEMP Monitoring Wells for Groundwater Quality

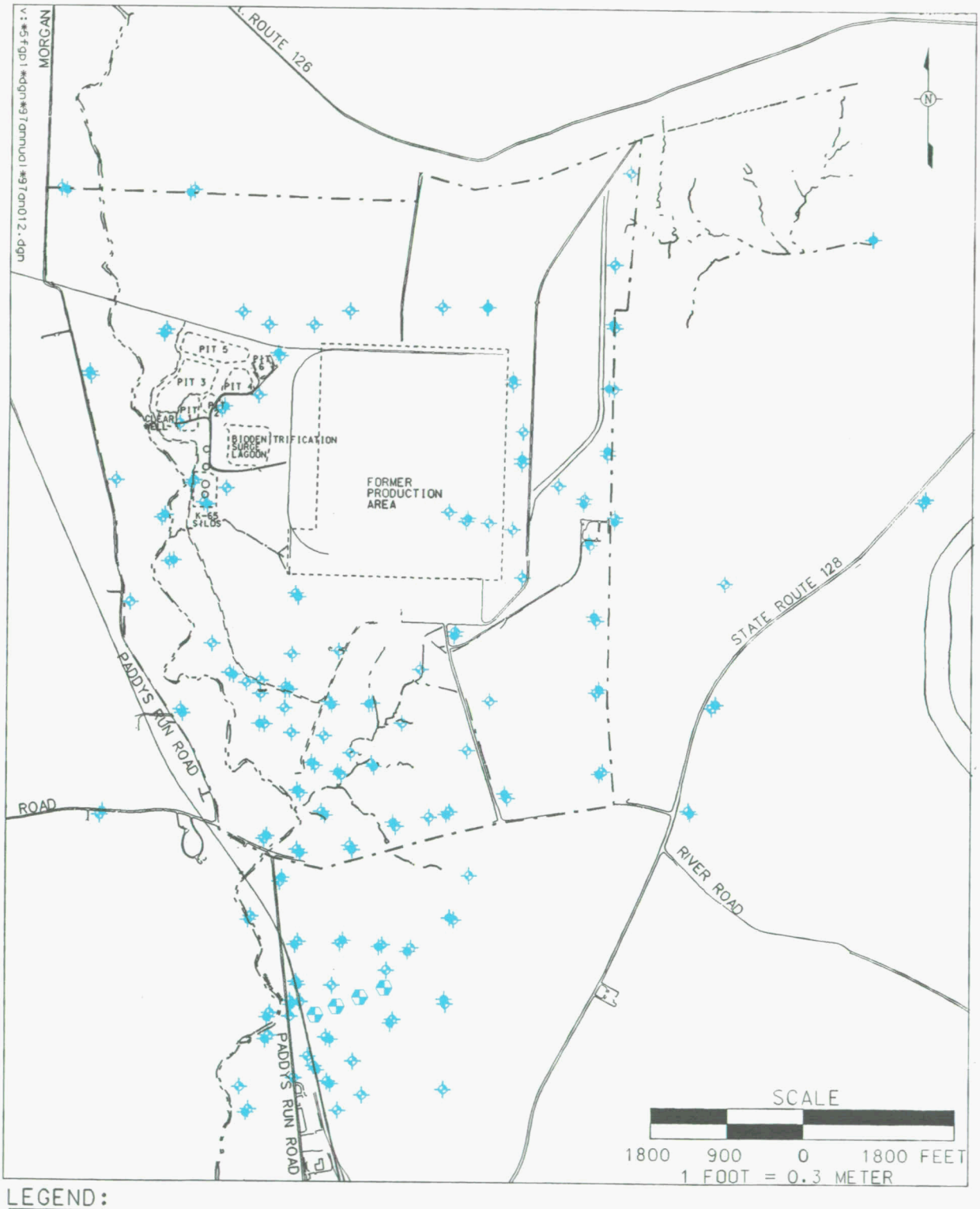

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Figure 3-4. IEMP Monitoring Wells for Groundwater Elevation

- Data Evaluation - The integrated data evaluation process focuses on looking at the data collected from all 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 current groundwater restoration on the Paddys Run Road Site plume (a separate contaminant plume south of the FEMP property along Paddys Run Road resulting from independent industrial activities in the area).

- Reporting - The separate FEMP groundwater monitoring activities and associated reports (i.e., the semi-annual south plume removal action design monitoring evaluation program plan, system evaluation reports, RCRA annual reports, annual site environmental reports, and various other minor groundwater reports) are replaced by an annual integrated site environmental report and quarterly status reports.

Status of Enhanced Groundwater Remedy Construction

Significant portions of the enhanced groundwater remedy were completed in 1997. Two additional extraction wells, RW-6 and RW-7, were completed in the South Plume area to optimize the existing South Plume Removal Action System (Figure 3-1). Five groundwater re-injection wells (8, 9, 10, 11, and 12) as shown in Figure 3-1 were installed on property along Willey Road, and a significant portion of the pipeline network to carry groundwater has been installed. Another extraction well, 22, was installed on property in the South Field area to enhance contaminant recovery (Figure 3-1). The South Plume Optimization, South Field Extraction (Phase I), and the Re-Injection Demonstration systems are scheduled to begin operations in the summer of 1998. When all three systems are on line with the existing South Plume Removal Action System, they will pump 3,500 gpm (13,250 L/min) from the aquifer and re-inject 1,000 gpm (3,785 L/min) for a net pumping rate of 2,500 gpm (9,462 L/min).

Work continues on a 1,500 gpm (5,678 L/min) expansion of the advanced wastewater treatment facility. This expansion will add significant groundwater treatment capacity and will be used to provide treated groundwater for re-injection. When the expansion is completed, the total treatment capacity at the FEMP for extracted groundwater, storm water, and remediation wastewater will be 2,875 gpm (10,880 L/min).

Restoration Monitoring

Restoration monitoring is discussed in the following subsections:

- South Plume Removal Action System Operation Summary
- Monitoring Results for Total Uranium
- Monitoring Results for Non-Uranium Constituents.

South Plume Removal Action System Operational Summary

As mentioned earlier during the discussion of selection and design of the groundwater remedy, a removal action was initiated in August 1993 in the South Plume area to halt further advance of the plume away from FEMP property. Five groundwater extraction

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wells were installed in an east-west line just east of Paddys Run Road and south of Willey Road along the leading edge of the plume. Contaminated groundwater from the South Plume is pumped back on property where it is monitored and treated, as necessary to meet discharge limitations, before being pumped to the Great Miami River.

Pumping at four of the five extraction wells in the South Plume Removal Action System continued during the groundwater remedy design and construction in 1997. The eastern most well of the five extraction wells was removed from service in December 1994 because operational data indicated that it was not needed to prevent further movement of the South Plume contamination. In addition to accomplishing the objective of halting further southward migration of the plume beyond the wells, the system removed 388.9 pounds (176.6 kg) of total uranium from the aquifer and pumped 2.8 billion gallons (11 billion liters) of groundwater by the end of 1997. The annual uranium removal performance data are shown in Figure 3-5. Additional data summarizing the operation of the South Plume Removal Action System for 1997 can be found in Appendix A, Attachment 1, of this report.

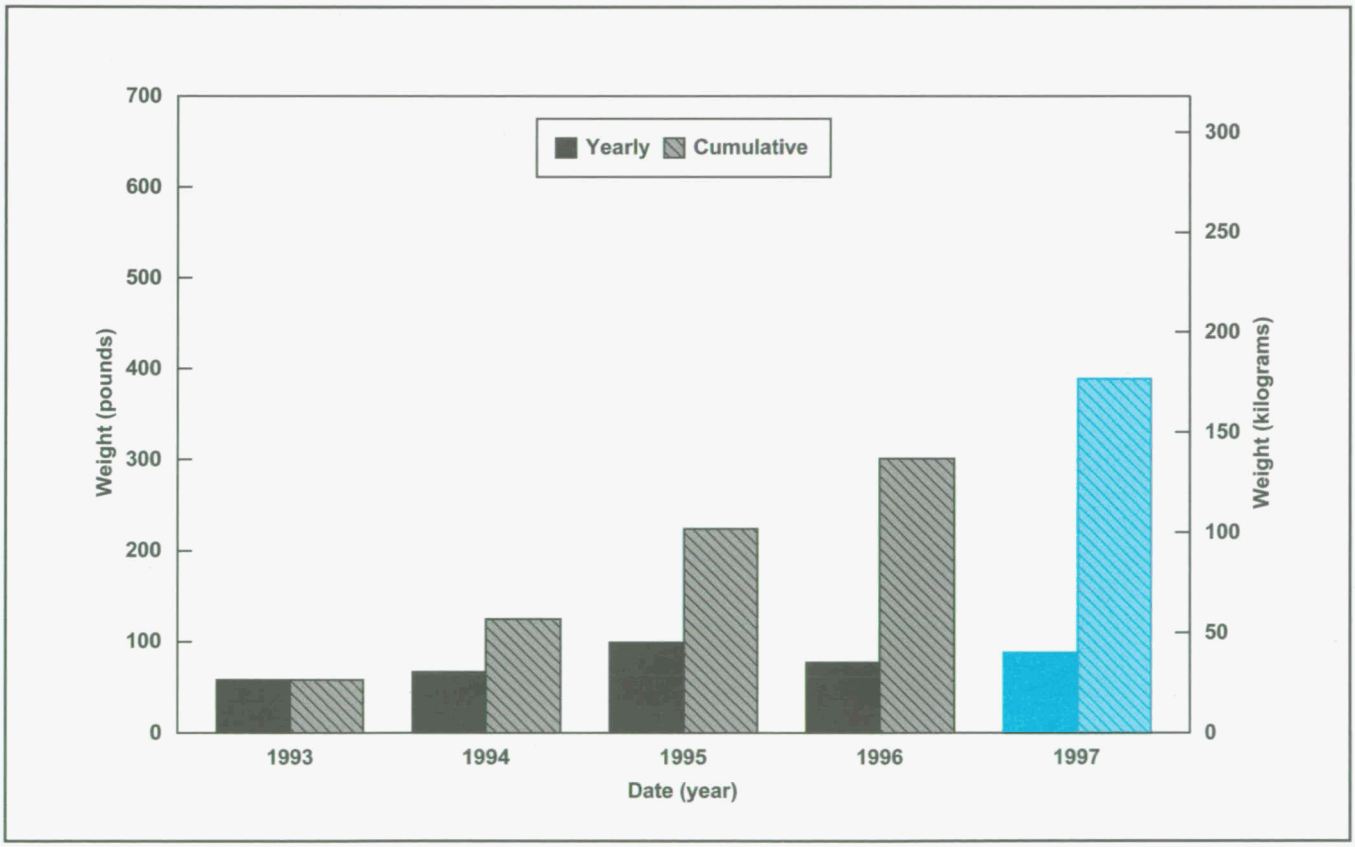

Figure 3-5. Pounds of Uranium Removed from the Great Miami Aquifer, 1993-1997

The South Plume Removal Action System is evaluated quarterly to ensure that it continues to meet the primary objective of preventing the further southward movement of the plume. The evaluation is done by collecting and mapping groundwater quality data and groundwater elevation data, and then analyzing the results. Concentration maps were developed from analytical data and compared with groundwater elevation maps depicting the location of the capture zone. Based on analysis of this data, the South Plume Removal Action System continues to meet the primary objective of the removal action in that

southward movement of the total uranium plume, beyond the extraction wells, has not been detected.

A secondary objective of the South Plume Removal Action System is to ensure that the pumping action of the system does not adversely impact the Paddys Run Road Site Plume immediately south of the extraction wells. This plume is a result of separate industrial activities along Paddys Run Road that is not associated with the FEMP. Based on groundwater results from around the Paddys Run Road Site, it can be concluded that the South Plume Removal Action System is not adversely impacting the Paddys Run Road Site plume.

Additional data to support the interpretations made here can be found in Appendix A, Attachments 2 and 3, of this report.

Monitoring Results for Total Uranium

Although there are 50 groundwater FRLs, total uranium is the primary FRL constituent because it is the most prevalent site contaminant and has impacted the largest area of the aquifer. For this reason, beginning in late 1996 and continuing into the first quarter of 1997, an extensive groundwater sampling program was conducted in support of groundwater remedial design to refine the definition of the vertical and lateral extent of the total uranium plume in the South Field and South Plume areas. A "direct push" sampling system (Geoprobe®) was used which allowed for collection of groundwater samples at specified intervals to obtain vertical profile information on total uranium concentrations. The additional data gathered from the 19 locations sampled was used to finalize the design of the enhanced groundwater remedy discussed above. The sampling results were presented in detail in the Baseline Remedial Strategy Report.

Figure 3-6 shows the extent of the total uranium plume in the aquifer at the end of 1997 and the groundwater flow directions in the aquifer. The shaded areas represent the total uranium plume which is above the 20 microgram per liter (µg/L) or 13.5 picoCuries per liter (pCi/L) FRL for total uranium in groundwater. Figure 3-6 also shows that the total uranium concentrations greater than the FRL are within the 10-year, uranium-based restoration footprint. The actual observed capture zone resulting from pumping at the South Plume Removal Action System is also depicted in Figure 3-6 to show that the main portion of the South Plume is being captured by the existing system and that further movement of uranium to the south is being prevented by the system.

Groundwater sample data collected during the third and fourth quarters of 1997 in the South Field and South Plume areas (areas B, D, and E in Figure 3-3) indicate that the total uranium plume in the southern half of the South Field area and in the South Plume area has not significantly changed in size or concentration since the data acquired in support of the enhanced groundwater remedy design, as finalized in the Baseline Remedial Strategy Report.

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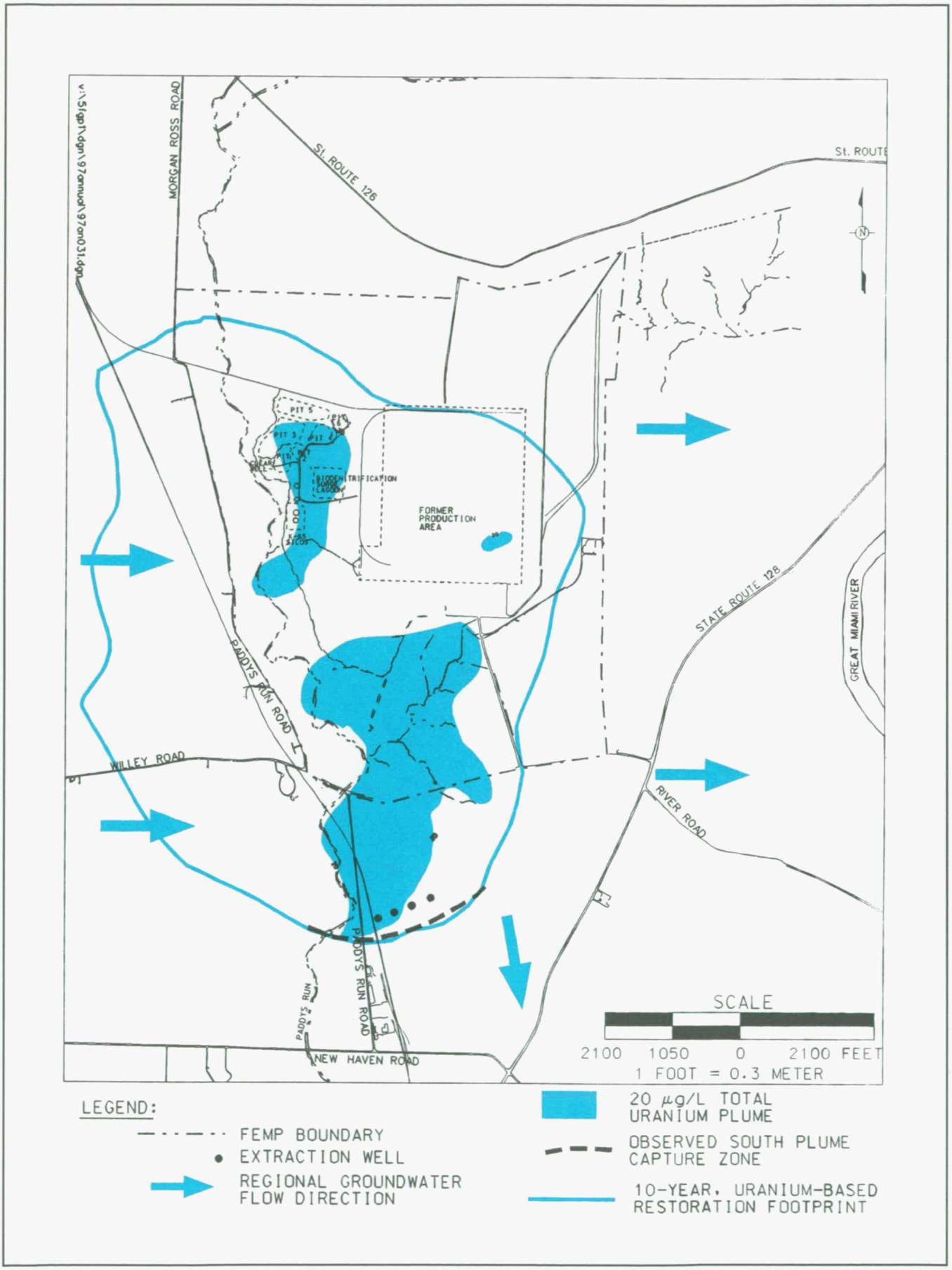

Figure 3-6. Total Uranium Plume in the Aquifer with Concentrations Greater than 20 µg/L at the End of 1997

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The northern half of the South Field Plume was also sampled during the third and fourth quarters of 1997, and as in the southern portion of the plume, no significant changes in concentration or plume size were noted.

Groundwater was sampled for the first time since 1993 in the waste pit area (waste storage area) and in the Plant 6 area during the fourth quarter of 1997 to track water quality conditions and determine if changes to the enhanced groundwater remedy design were needed. While the total uranium plume in the Plant 6 area has not significantly changed since sampling began in 1993, the total uranium plume in the waste pit area has increased and has moved eastward slightly from the 1993 plume location. The enhanced groundwater remedy, including 10 extraction wells in the waste pit area and two extraction wells in the Plant 6 area, is scheduled to begin operation after soil remediation is complete in these areas.

Groundwater monitoring for total uranium and other constituents of concern under the IEMP will continue in these areas, and results will be presented and discussed in future IEMP quarterly status reports and annual integrated site environmental reports.

Additional data on the total uranium plumes can be found in Appendix A, Attachment 2, of this report.

Monitoring Results for Non-Uranium Constituents

Although the enhanced groundwater remedy was primarily designed to remediate uranium from groundwater, other FRL constituents (Table 2-1) which occur above their respective FRLs are being addressed by the enhanced groundwater remedy. Because FRL constituents move at different rates in groundwater, the FEMP also monitors these other constituents to see where they exceed the FRL and to see if any of the locations with FRL exceedances fall outside the 10-year, uranium-based restoration footprint.

Table 3-1 summarizes the results of monitoring for non-uranium FRL constituents, and Figure 3-7 identifies the locations of the wells that had FRL exceedances. Included in the table for each FRL constituent are the number of wells with 1997 FRL exceedances, the number of wells with FRL exceedances outside the 10-year, uranium-based restoration footprint, and the range of 1997 data above the FRL from wells inside or outside the 10-year, uranium-based restoration footprint.

During 1997, FRL exceedances were observed for 11 FRL constituents at 29 monitoring well locations, as shown in Figure 3-7. All these exceedances are within the 10-year, uranium-based restoration footprint and are expected to be addressed by the enhanced groundwater remedy, except exceedances for zinc, manganese, lead, cadmium, and chromium at various monitoring well locations along the property boundary (Figure 3-7). No plumes for these constituents at these locations were identified in the extensive groundwater characterization efforts evaluated as part of the Operable Unit 5 RI Report. These constituents with FRL exceedances at the well locations outside the 10-year, uranium-based restoration footprint were further evaluated to see if they were random events or if they were persistent according to criteria discussed in Appendix A,

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TABLE 3-1
NON-URANIUM CONSTITUENTS WITH 1997 RESULTS ABOVE FINAL REMEDIATION LEVELS

Constituent	Number of Wells Exceeding FRL	Number of Wells Exceeding FRL Outside 10-Year, Uranium-Based Restoration Footprint	GW FRL	Range of 1997 Data Inside 10-Year, Uranium-Based Restoration Footprint above FRL[a]	Range of 1997 Data Outside 10-Year, Uranium-Based Restoration Footprint above FRL[a]
Inorganics			**(mg/L)**	**(mg/L)**	**(mg/L)**
Antimony	1	0	0.006	0.0196	NA
Boron	1	0	0.33	0.467 to 1.14	NA
Cadmium	1	1	0.014	NA	0.0147
Chromium	13	1	0.022	0.023 to 0.212	0.0362
Lead	5	1	0.015	0.0159 to 0.0636	0.028
Manganese	12	4[b]	0.9	0.917 to 2.93	0.956 to 2.86
Molybdenum	1	0	0.1	0.69	NA
Nickel	1	0	0.1	0.103 to 0.252	NA
Nitrate/Nitrite	1	0	11	36	NA
Zinc	18	5	0.021	0.0331 to 3.78	0.0298 to 0.0476
Radionuclides			**(pCi/L)**	**(pCi/L)**	**(pCi/L)**
Technetium-99	1	0	94	1207.77	NA

[a]NA = not applicable
[b]Manganese exceedances were determined to be persistent at three of the four monitoring wells (2426, 2430, and 2431) that had FRL exceedances in 1997.

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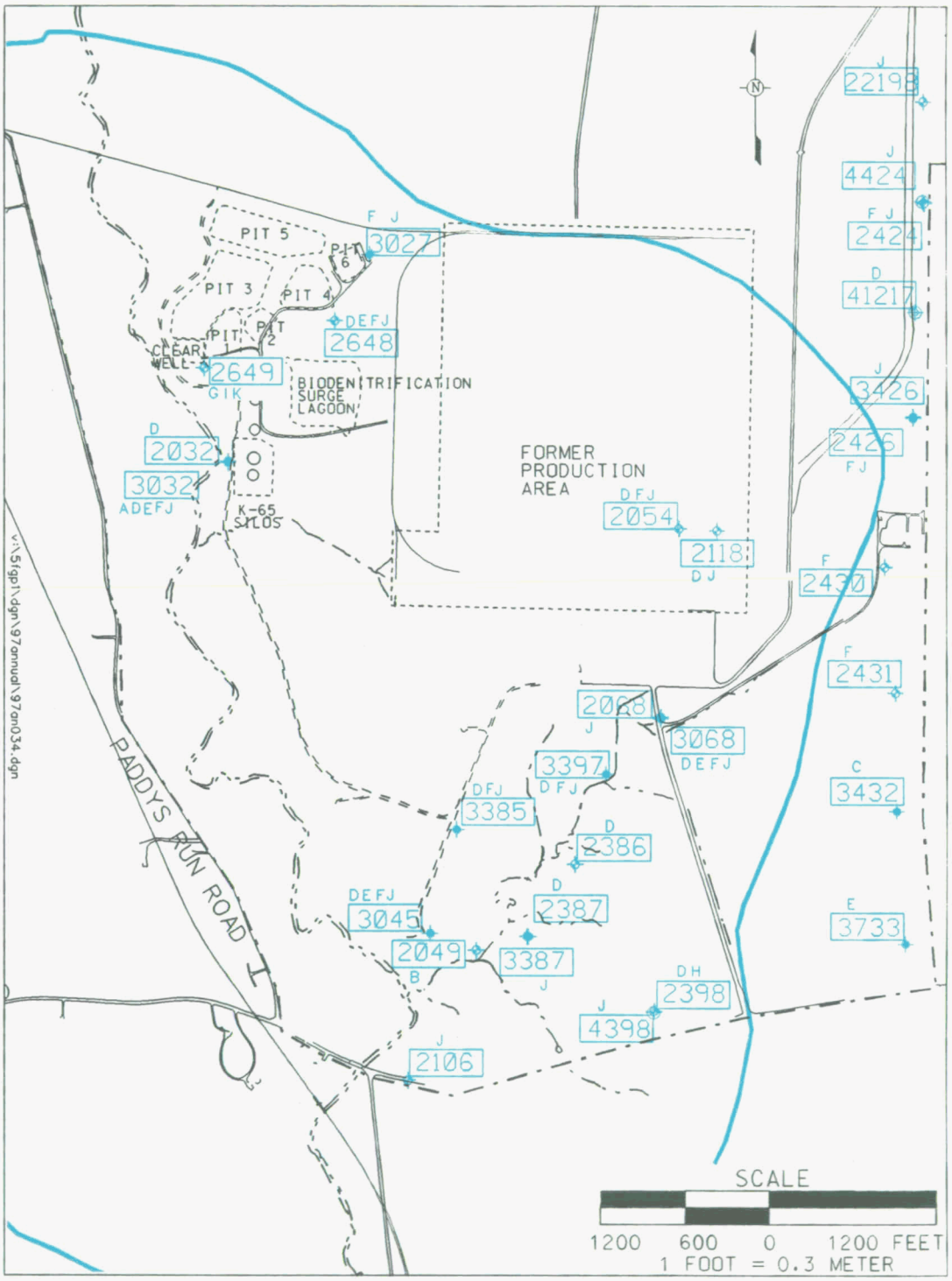

LEGEND:

- FEMP BOUNDARY
- MONITORING WELL LOCATIONS WITH FRL EXCEEDANCE
- 10-YEAR, URANIUM-BASED RESTORATION FOOTPRINT

FRL EXCEEDANCE KEY:

- A ANTIMONY
- B BORON
- C CADMIUM
- D CHROMIUM
- E LEAD
- F MANGANESE
- G MOLYBDENUM
- H NICKEL
- I NITRATE/NITRITE
- J ZINC
- K TECHNETIUM-99

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Figure 3-7. Non-uranium Constituents with 1997 Results above Final Remediation Levels

Attachment 4, of this report. Persistent FRL exceedances are further evaluated to determine the potential cause of persistence.

Of the constituents exceeding the FRL outside the 10-year, uranium-based restoration footprint, only manganese was persistent. Manganese exceedances are believed to be associated with bacterial growth in and around the monitoring wells which tend to accumulate iron, manganese, and other metals. Bacterial growth is not uncommon in wells in the Great Miami Aquifer. The monitoring wells with persistent manganese exceedances will be treated for bacterial growth to see if future monitoring data show a decrease in manganese concentrations.

The remaining FRL exceedances occurring outside the 10-year, uranium-based restoration footprint were determined to be one-time events, which require no further evaluation other than the routine monitoring, which will continue under the IEMP or additional data is required to determine persistence. The FRL exceedances requiring additional data will be further evaluated using 1998 IEMP monitoring data. For additional details on the evaluation of 1997 FRL exceedances, see Appendix A, Attachment 4, of this report.

Compliance Monitoring

Three compliance monitoring programs have been integrated into the IEMP:

- Private Well Monitoring
- RCRA Property Boundary Monitoring
- KC-2 Warehouse Well Monitoring.

The groundwater data from these former compliance monitoring programs, along with the data from all other IEMP groundwater monitoring activities, are collectively evaluated and conclusions are presented in the monitoring results for total uranium and non-uranium constituents of concern. The discussion below provides additional details on the Private Well, RCRA Property Boundary, and KC-2 Warehouse well monitoring activities.

Three of the private wells from the former radiological environmental monitoring program were monitored in 1997 and will continue to be monitored quarterly for total uranium as part of the IEMP. These three wells located along Willey Road include the private well where off-property contamination was initially reported in 1981. The other private wells previously monitored have not been carried forward into the IEMP program because a public water supply is now available to FEMP neighbors who have been affected by off-property groundwater contamination. In addition, the wells being monitored under the IEMP provide adequate monitoring coverage both on and off property. Data from the three private wells sampled under the IEMP were used to produce the total uranium plume map shown in Figure 3-6.

The RCRA Property Boundary Monitoring Program has also been incorporated into the IEMP. This network of 33 monitoring wells, located downgradient of the FEMP along the eastern and southern property boundaries, is monitored quarterly for 27 of the most mobile FRL constituents. Sampling of these 33 wells is conducted in order to determine if

contaminant excursions at the property boundary are occurring during the remediation process. Data from these wells are integrated with other IEMP data for 1997 and were used to produce the total uranium plume map shown in Figure 3-6. Non-uranium data from these wells were included above in the section on monitoring results for non-uranium constituents. Additional detail can be found in Appendix A, Attachments 2 and 4, of this report.

The KC-2 Warehouse well monitoring has been included as part of the IEMP. Monitoring of this well is conducted on an annual basis and will continue until the warehouse is decommissioned and dismantled, at which time the well will be removed.

The August 1997 sampling event for the KC-2 Warehouse well indicated concentrations of hazardous substance list metals which were higher than routinely indicated in previous sampling results. Similar anomalously high concentrations were also recorded in the January 1995 sampling event. On that occasion, the elevated results were believed to have been caused by a disturbance of the contaminated sediment at the bottom of the well. In an effort to determine if the sediment at the bottom of the well may have been disturbed in the August 1997 sampling event, the well was resampled in January 1998 ensuring the bottom sediment was not disturbed. The results from the January 1998 sampling event are more consistent with sample results reported prior to August 1997, indicating that the August 1997 event was not representative. The monitoring results for this well and additional details on the sampling events are presented in Appendix A, Attachment 5, of this report.

Monitoring for Coal Pile Runoff Basin

Two monitoring wells installed in the perched groundwater zone within the glacial overburden have been used to monitor the Coal Pile Runoff Basin on a routine basis. Monitoring and reporting is conducted in accordance with Ohio Permit to Install No. 05-4172, issued and effective on September 13, 1990. As required by the Permit to Install, the monitoring data from the Coal Pile Runoff Basin for 1997 is presented in Appendix A, Attachment 5, of this report.

On-Site Disposal Facility Monitoring

Groundwater monitoring in support of the on-site disposal facility was initiated in 1997. This monitoring program is designed to accomplish the following:

- Establish a baseline of groundwater conditions in the perched water and Great Miami Aquifer for each cell of the on-site disposal facility prior to first waste placement in the cell. This data will be used to evaluate future changes in perched groundwater and groundwater quality to determine if the changes are due to on-site disposal facility operations.

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

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Construction of Cells 1 and 2 of the on-site disposal facility in 1997 was accompanied by groundwater sampling from Monitoring Wells 22198, 22199, 22200, and 22201 around the cells (Figure 3-8). Monitoring Well 12338, in Figure 3-8, is a horizontal till well which is used to sample the perched groundwater in the glacial overburden beneath the sump for Cell 1.

Groundwater sampling was initiated and completed for Cell 1 in 1997 to establish a baseline for the monitoring wells prior to waste placement. A technical memorandum will be issued in 1998 to discuss the baseline results. Baseline sampling was also initiated in 1997 for wells around Cell 2.

Construction of the leachate collection system and the leak detection system for Cell 1 was completed as of December 1997, and waste placement was initiated. Construction of the leachate collection system and the leak detection system for Cell 2 is expected to be completed in late 1998.

None of the constituents sampled and analyzed under this program exceeded the groundwater FRLs except Monitoring Well 22198 (also sampled under the RCRA Property Boundary Monitoring Program) which had a single exceedance for zinc in 1997. Zinc is not a constituent of concern associated with the waste acceptance criteria for the on-site disposal facility and is therefore not considered to be significant. However, it will continue to be monitored over time under the RCRA Property Boundary Monitoring Program. For additional information on the groundwater sampling results for the on-site disposal facility, refer to Appendix A, Attachment 6, of this report.

Guide to Aquifer Restoration Project Documents

As described in Chapter Two, the FEMP is on the National Priorities List, a list of sites requiring environmental cleanup under CERCLA. Numerous studies and reports have been issued by the FEMP during the CERCLA process to document the progress of the cleanup.

Table 3-2 is a reference for the reader to consult when seeking additional information about any phase of the site CERCLA process related to groundwater which has been completed to date. The times during which the major accomplishments under the CERCLA process and predictions of future activities are shown on the left. The middle column identifies the major CERCLA process which was in progress at the time. The last column indicates the documents where significant findings, results, and recommendations can be located. These documents are available for public viewing in the FEMP Public Environmental Information Center.

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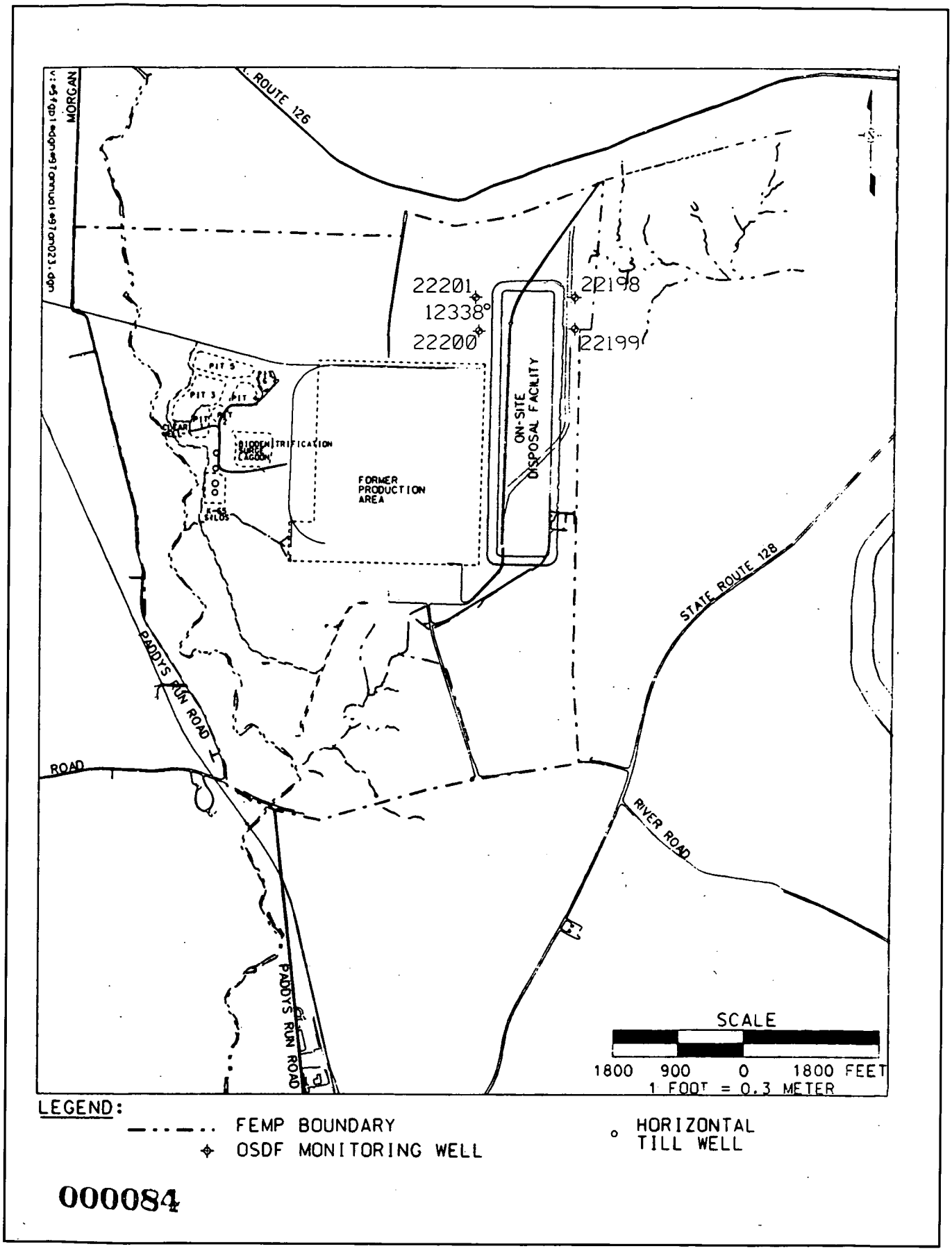

Figure 3-8. On-Site Disposal Facility Footprint and Monitoring Well Locations

TABLE 3-2

CHRONOLOGICAL SUMMARY OF AQUIFER RESTORATION ACTIVITIES

Date	Activity	Reporting Document[a]
1988	Determine the Scope of the Problem and Select A Solution	
	Determine the nature and extent of groundwater contamination and investigate the risk posed to human health and/or the environment	**Remedial Investigation Report for Operable Unit 5** (1995)
	Evaluate various remediation technologies; consider efficiency, land use scenarios, and cost	**Feasibility Study Report for Operable Unit 5** (1995)
	Establish remediation goals for site contaminants in environmental media; commit to a selected cleanup remedy	**Record of Decision for Remedial Actions at Operable Unit 5** (1996)
1996	Design and Construct a System to Clean Up the Aquifer	
	Define how and when needed construction drawings, specifications, plans, and procurement documents will be prepared	**Remedial Design Work Plan for Remedial Actions at Operable Unit 5** (1996)
	Develop a strategy and schedule for completing restoration of the aquifer	**Remedial Action Work Plan for Aquifer Restoration at Operable Unit 5** (1997)
	Design the aquifer restoration system (e.g., number of wells, pumping rates, well locations, etc.)	**Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)** (1997)
	Develop a plan to monitor progress of the clean up	Chapter 3 of the **Integrated Environmental Monitoring Plan** (1997)
	Develop operational strategy for the aquifer system	**Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project** (1997)
1997-1998	Start-Up the Systems to Clean Up the Aquifer	
	South Plume Module activity began as a removal action in 1993 integrated into remediation.	**South Plume Removal Action Design Monitoring Evaluation Program Plan** (1993)
		Design Monitoring Evaluation Program Plan System Evaluation Report (various dates through September 1997)
	South Field (Phase 1) & South Plume Optimization Modules, which are scheduled to begin operation in 1998	**Start-Up Monitoring Plan for the South Field Extraction and South Plume Optimization Modules** (1998)
	Re-Injection Demonstration Module, which is scheduled to begin operation in 1998	**Re-Injection Demonstration Test Plan** (1997)
1997-1998	Operation of the systems to clean up the Aquifer	IEMP quarterly status reports beginning with December 1997

[a]These documents are available for review at the FEMP Public Environmental Information Center.

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Chapter 4
Surface Water and Treated Effluent Pathway

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Surface Water and Treated Effluent Pathway

Results in Brief: 1997 Treated Effluent and Surface Water Pathway

Surveillance Monitoring - No surface water or treated effluent analytical results from samples collected in 1997 exceeded the FRL for total uranium, the primary site contaminant. FRL and benchmark toxicity value (BTV) exceedances in surface water samples were limited to nine and 11 constituents, respectively. These occasional, sporadic FRL and BTV exceedances are to be expected until site remediation is complete.

NPDES - Permitted discharges were in compliance with the current NPDES permit requirements 99.8 percent of the time. Total suspended solids exceeded the permit limits three times in treated effluent at the Parshall Flume (PF 4001) and two times in treated effluent from the Sewage Treatment Plant (STP 4601).

Uranium Discharges - In 1997, 126 pounds (57.2 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 252 pounds (114 kg) of uranium were released to the environment through uncontrolled storm water runoff. Additionally, 3.46 pounds (1.57 kg) of uranium were released to Paddys Run during overflow of the Storm Water Retention Basin due to excessive amounts of precipitation. The total pounds of uranium released through the surface water and treated effluent pathway (approximately 378 pounds [172 kg]) decreased 42 percent from 1996 (approximately 657 pounds [298 kg]).

Sediment - Sediment results in general, decreased when compared to 1996 results. One sample result for thorium-232 (1.63 picoCuries per gram [pCi/g]) collected in the Storm Sewer Outfall Ditch slightly exceeded the thorium-232 FRL of 1.60 pCi/g.

This chapter presents the 1997 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 FEMP by two primary mechanisms: treated effluent that is monitored as it is discharged to the Great Miami River, and through uncontrolled runoff entering the site's drainages from areas of the site containing low levels of soil contamination. Recognizing that these discharges will continue throughout remediation, the FEMP continues to place emphasis on monitoring this exposure pathway. Through expansion of the site's wastewater treatment capabilities and through strict implementation of the site's runoff and sediment controls, the FEMP strives to minimize its impact on the surface water pathway.

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

- **Controlled runoff** is contaminated storm water requiring treatment that is collected, treated and eventually discharged as treated effluent.
- **Uncontrolled runoff** is storm water that is not collected by the site 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 and discharged to the Great Miami River.
- **Surface water** is water that is flowing within natural drainage features.

Summary of Surface Water and Treated Effluent Pathway

The sources of treated effluent include groundwater extracted from the aquifer, controlled runoff from the waste storage area and former production area, process wastewaters (e.g., Boiler Plant and decontamination wastewater), and effluent from the Sewage Treatment Plant. Controlled runoff and process wastewater are routed to one of the designated site water treatment facilities, treated, and then discharged through the effluent line to the Great Miami River (Figure 4-1).

The volume and flow rate of uncontrolled runoff is dependent upon the amount of precipitation within any given period of time. Monthly precipitation totals for 1997 are shown in Figure 1-10 in Chapter One. 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, Storm Sewer Outfall Ditch, etc.) and the northeast drainage. The arrows on this figure indicate the general flow direction of uncontrolled runoff which is determined from the site's topography. Uncontrolled runoff from the FEMP leaves the property via two drainage pathways, Paddys Run and the northeast drainage.

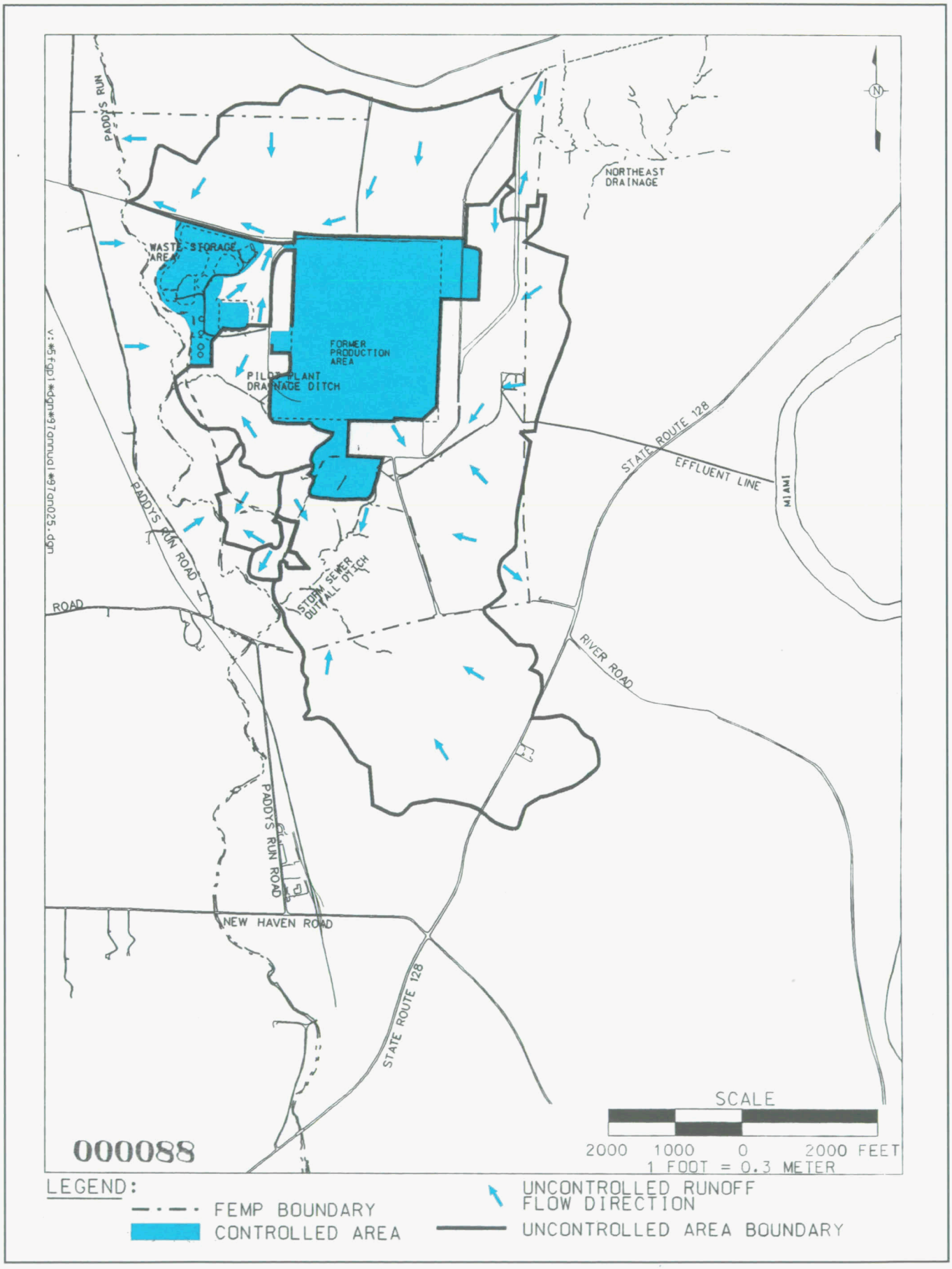

Figure 4-1. Controlled Runoff Delineation and Uncontrolled Runoff Flow Directions

Remediation Activities Affecting Surface Water Pathway

Activities associated with remediation in 1997 that potentially affect the surface water pathway included:

- Construction of the on-site disposal facility, on-site disposal facility leachate conveyance system, north railyard complex, new north access road, waste haul road, and numerous storm water sediment basins
- Installation of the pipelines for the Groundwater Re-Injection Demonstration Project and South Field Extraction System
- Stabilization activities on the bank of Paddys Run near K-65 Silos 1 and 2
- Excavation and construction activities associated with the remediation of the southern waste units
- Remediation of soil in Area 1, Phase I, located on the northeastern portion of the site
- Diversion of parking lot storm water to the Storm Sewer Outfall Ditch.

To minimize the effects of remediation on the environment, engineered and administrative controls are used at the FEMP 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 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 also sometimes lined with riprap and/or synthetic liners to control erosion. In areas where remediation activities may expose contaminated materials (e.g., the southern waste units), contaminated runoff is collected in lined basins and routed for treatment at one of the site's wastewater treatment facilities. Administrative controls include limiting the duration of open excavations, as well as routinely inspecting each of the engineered controls constructed at the FEMP.

Each remediation project is responsible for constructing 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 problems (e.g., silt fence requiring repairs, reseeding of eroded areas, etc.) were identified in 1997

during these inspections. The problems identified were communicated to the responsible individual for implementation of corrective action. No measurable impacts from these problems were detected through the IEMP surface water, treated effluent, and sediment monitoring programs.

During 1997, numerous engineered controls were installed to protect surface water drainages downgradient of remediation activities. Nine basins were installed at various locations around the FEMP including the northeastern portion of the FEMP, southeast of the Silos, east of the waste pit area, and west of the new north railyard. Construction of a series of diversion ditches and sedimentation basins was initiated in the fall of 1997 to provide storm water control during remediation of the southern waste units. At a minimum, silt fencing was installed to control erosion at all excavation and construction projects. Temporary seeding was completed for those areas where final grading was postponed pending completion of other portions of a project.

Surface Water, Treated Effluent, and Sediment Highlights for 1997

Surface water, treated effluent, and sediment are sampled to determine the effect of the FEMP'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 in the major site drainages (i.e., Paddys Run and Storm Sewer Outfall Ditch) and in the Great Miami River for radiological constituents.

Transition to IEMP

Historically, surface water and treated effluent sampling has been conducted under three separate programs, each designed to meet the requirements of a unique regulatory driver, with a distinct technical focus and reporting requirement. These three programs were defined in the Fernald Site Environmental Monitoring Plan (FERMCO 1995), NPDES permit, and FFCA, respectively. With approval of the IEMP in July 1997, these programs were integrated into a single monitoring program providing a comprehensive assessment of the site's impact on the surface water pathway.

The IEMP sediment sampling program largely reflects a continuation of the FEMP's sediment sampling program conducted prior to development of the IEMP. This includes an annual sampling program with data reported through annual integrated site environmental reports.

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

Benchmark Toxicity Values (BTVs) are concentrations in sediment and surface water established in scientific literature to be used as a "benchmark" to determine if a particular constituent may be having a detrimental effect on a particular ecological receptor. For surface water and sediment, ecological receptors include any fish or animal that inhabits the surface water body or uses surface water as a source of drinking water. Additional details concerning BTVs can be found in the Operable Unit 5 Sitewide Ecological Risk Assessment, (Appendix B of the Operable Unit 5 RI Report), Operable Unit 5 FS Report, and in the IEMP.

- **Sampling** - Sample locations, frequency, and constituents were selected to address both the prescriptive requirements of the NPDES permit, FFCA, and Operable Unit 5 Record of Decision, and to provide a comprehensive assessment of surface water quality at 19 key locations in on-site drainages and off property in the Great Miami River. Prior to implementation of the IEMP, primarily total uranium and NPDES constituents were monitored. With the IEMP sampling program, surface water is monitored for up to 55 FRL constituents (Table 2-1) and 31 benchmark toxicity value (BTV) constituents.

- **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 to surface water due to site remediation activities affecting uncontrolled runoff or treated effluent. The assessment 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** - Prior to implementation of the IEMP, surface water and treated effluent reporting requirements consisted of quarterly FFCA reports, monthly NPDES reports, and annual site environmental reports. These surface water and treated effluent reporting requirements were combined into quarterly status reports and annual integrated site environmental reports. The FFCA surface water and treated effluent requirements were reported for the entire year of 1997 in the FFCA quarterly reports; however, beginning in 1998, the surface water and treated effluent results will not be reported in the FFCA quarterly reports but will be reported in annual integrated site environmental reports and the quarterly status reports. The monthly discharge monitoring reports required by the NPDES permit will continue to be submitted separately as scheduled.

Data from samples collected under the IEMP are used to fulfill both compliance monitoring and surveillance monitoring functions. 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, including the Storm Water Pollution Prevention Plan and the FFCA. 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. 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. Surface water and treated effluent sample locations for pre-IEMP and IEMP are identified in Figures 4-2 and 4-3, respectively.

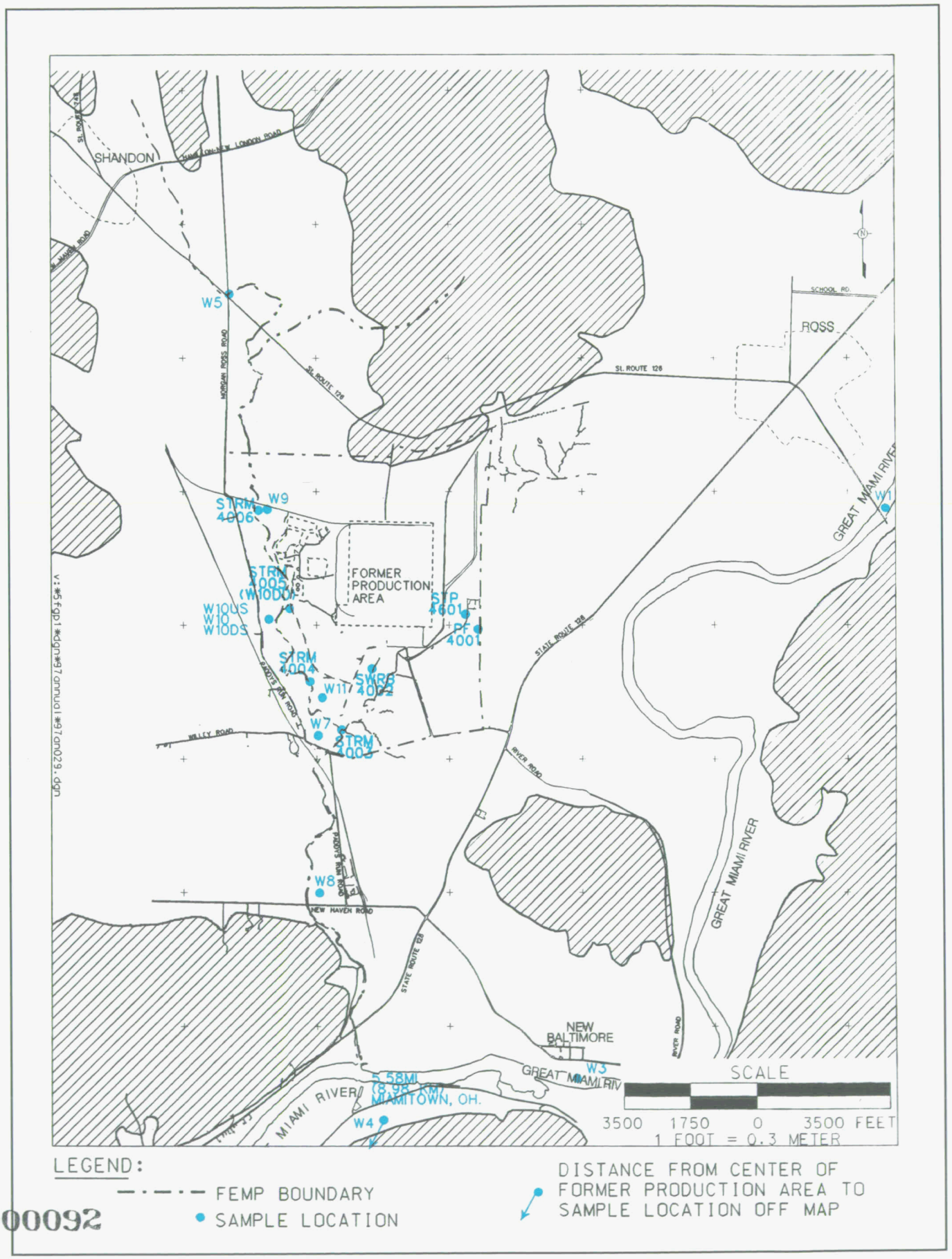

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Figure 4-2. Pre-IEMP Surface Water and Treated Effluent Sample Locations

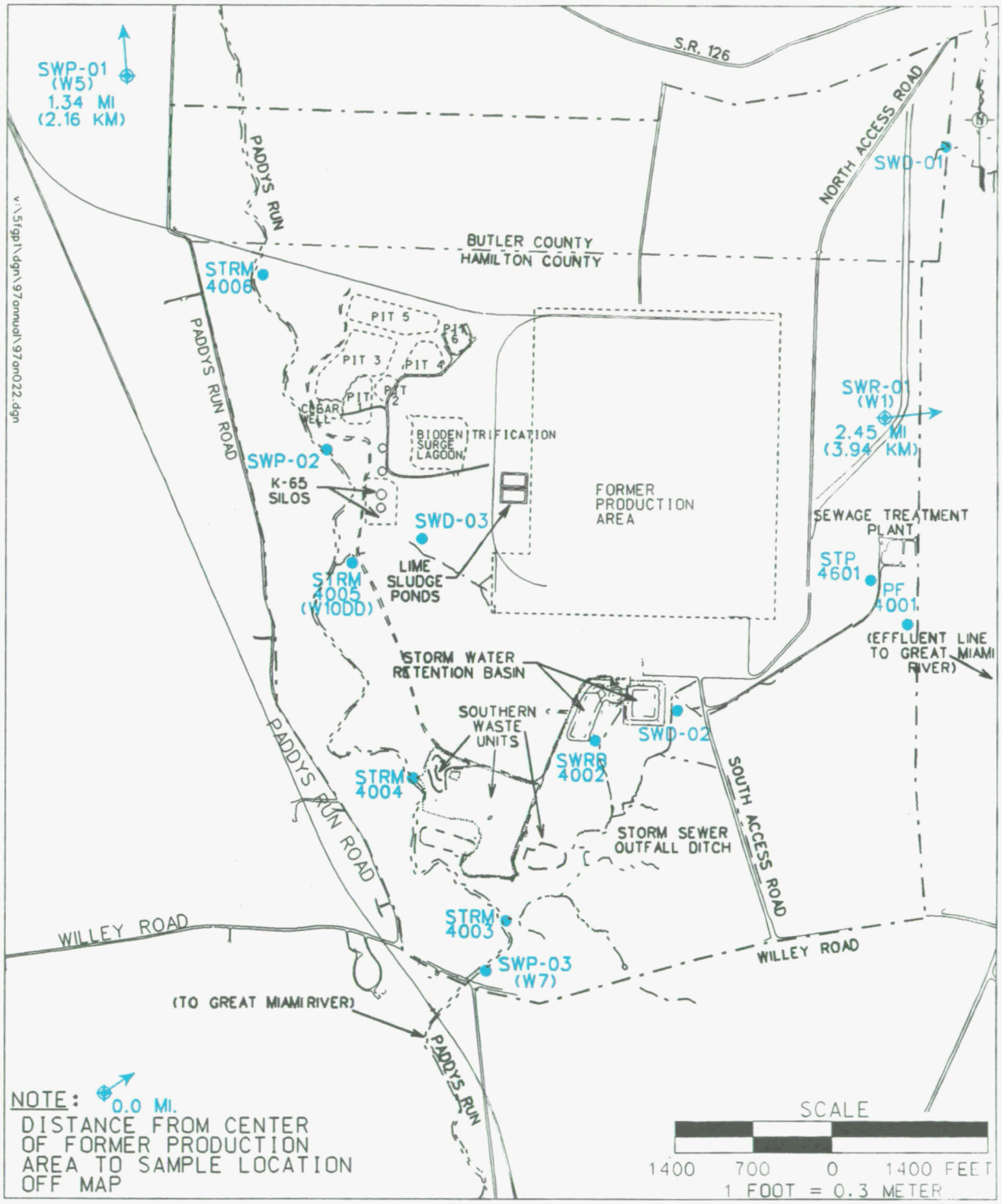

Figure 4-3. IEMP Surface Water and Treated Effluent Sample Locations

Treated effluent is discharged to the Great Miami River through the effluent line, identified on Figure 4-1. Prior to discharge through the effluent line, samples of the treated effluent are collected using an automated continuous sampling device at the Parshall Flume (PF 4001). The resulting data are used to calculate the concentration of each FRL constituent after the water mixes with water in the Great Miami River.

Surveillance Monitoring

Data resulting from 1997 sampling efforts were evaluated to provide surveillance monitoring of the remediation activities. This evaluation showed that during 1997 there were no exceedances of the surface water total uranium FRL detected in any of the surface water and treated effluent samples. There were, however, nine non-uranium FRL exceedances and 11 BTV non-uranium exceedances detected. These exceedances are summarized in Table 4-1. In general, these exceedances were sporadic in nature and do not indicate any significant impacts to the environment or operational problems with the site's storm water and sediment control systems. The persistent aluminum BTV exceedances are due to the background aluminum concentrations in Paddys Run and the Great Miami River being above the BTV for this constituent and is not necessarily the result of FEMP operations.

Even with the FEMP's strict implementation of storm water and sediment controls, these types of occasional, sporadic FRL and BTV exceedances can be expected to occur until final remediation of contaminated source areas (soils and sediments) are complete. The IEMP sampling program will continue to evaluate FRL and BTV exceedances for persistence and to identify any increasing trends in the data through final 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.

TABLE 4-1
CONSTITUENTS WITH 1997 RESULTS ABOVE FRLs OR BTVs

Constituent	Number of Locations Exceeding FRL[a]	Number of Locations Exceeding BTV	FRL[a]	BTV	Range of 1997 Data above FRL[a]	Range of 1997 Data above BTV[a]
General Chemistry			**(mg/L)**	**(mg/L)**	**(mg/L)**	**(mg/L)**
Ammonia	NA	1	NA	1	NA	1.73
Inorganics						
Aluminum	NA	11	NA	0.087	NA	0.102 to 161
Barium	0	2	100	0.145	NA	0.16 to 0.284
Beryllium	3	0	0.0012	0.15	0.0016 to 0.0076	NA
Cadmium	1	1	0.0098	0.0035	0.0105	0.0105
Chromium	4	4	0.010	0.011	0.0207 to 0.181	0.0207 to 0.181
Copper	6	2	0.012	0.034	0.0144 to 0.269	0.0448 to 0.269
Lead	3	0	0.010	0.030	0.0149 to 0.0259	NA
Manganese	2	8	1.5	0.098	1.57 to 9.69	0.106 to 9.69
Mercury	1	1	0.00020	0.00020	0.0004	0.0004
Silver	0	1	0.0050	0.0013	NA	0.0014
Zinc	2	1	0.11	0.28	0.201 to 0.366	0.32 to 0.366
SemivolatileOrganics			**(µg/L)**	**(µg/L)**	**(µg/L)**	**(µg/L)**
Bis(2-ethylhexyl) phthalate	1	1	8.4	8.4	23	23

[a]NA = not applicable

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

- Paddys Run at the property boundary (Willey Road) sample location SWP-03 (formerly referred to as location W7 in past site environmental reports)
- 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 it represents points beyond which direct exposure to the public is possible.

The annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 1997 is shown in Figure 4-4. This figure illustrates the decrease of the total uranium concentration in Paddys Run from 1986 following completion of the Storm Water Retention Basin; the basin collects contaminated storm water from the former production area.

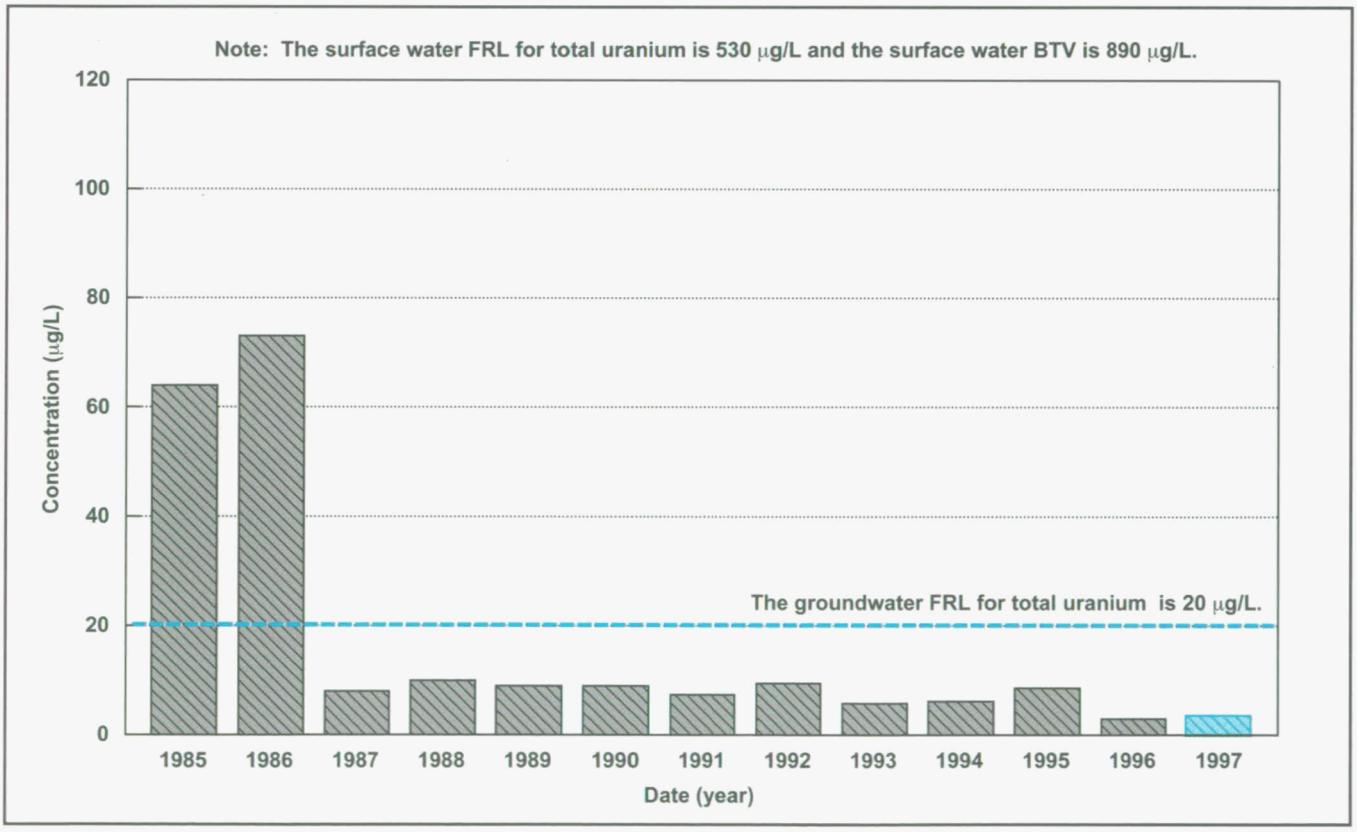

Figure 4-4. Annual Average Total Uranium Concentration in Paddys Run at Willey Road (SWP-03-W7) Sample Location, 1985-1997

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Figure 4-5 shows the total uranium concentrations in Paddys Run at Willey Road for 1997. An elevated total uranium concentration detected on June 4, 1997, at this sample location was due to a storm-water related overflow of the Storm Water Retention Basin. The total uranium concentration, although elevated from previous sampling events, was still below both the surface water FRL (530 µg/L [358 pCi/L]) and groundwater FRL (20 µg/L [13.5 pCi/L]).

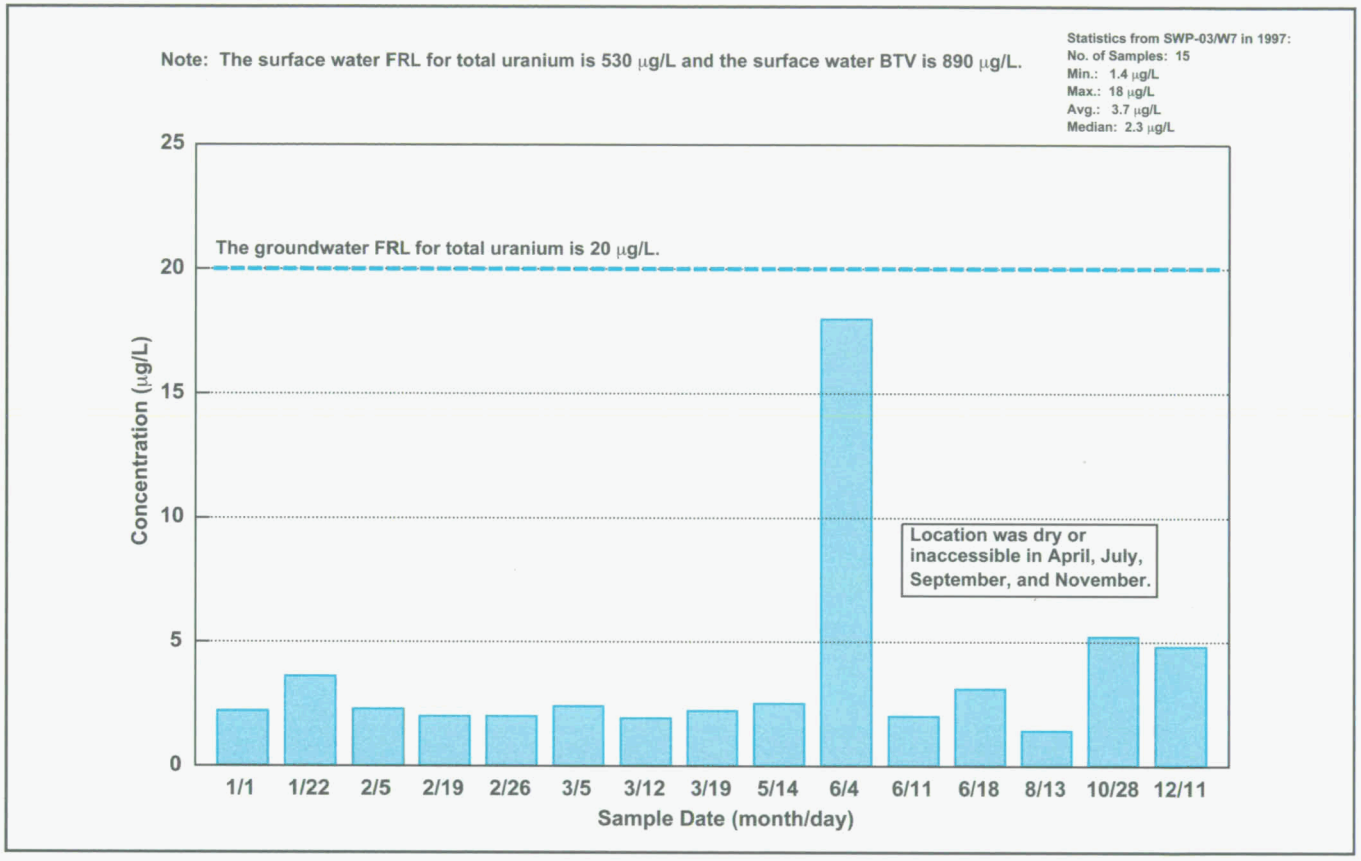

Figure 4-5. 1997 Total Uranium Concentration in Paddys Run at Willey Road (SWP-03-W7) Sample Location

Total uranium concentrations from the Parshall Flume (PF 4001) were also well below the associated total uranium FRL and are discussed in more detail in the compliance monitoring section.

Evaluation of surface water data is also performed to provide an ongoing assessment of the potential for cross-media impacts from surface water to the underlying Great Miami Aquifer. To provide this assessment, sample locations were selected to evaluate contaminant concentrations in surface water just upstream or within those areas where site drainages have eroded through the protective glacial overburden. These sample locations are SWP-02, SWD-02, and SWRB 4002. In areas where the overburden is absent, a direct pathway exists for contaminants to reach the aquifer. This contaminant pathway to the aquifer was considered in the design of the enhanced groundwater remedy and includes placing groundwater extraction wells downgradient of these areas where direct infiltration occurs to mitigate any potential cross-media impacts.

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During 1997, total uranium in surface water samples exceeded the groundwater FRL at the selected locations; however, the exceedances were not persistent. Table 4-2 summarizes these exceedances. Based on the limited duration of these exceedances, it is not likely that there were any significant cross-media impacts to the Great Miami Aquifer. Data 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 provided in Appendix B, Attachment 1, of this report.

TABLE 4-2
EVALUATION OF 1997 TOTAL URANIUM GROUNDWATER FRL EXCEEDANCES FOR CROSS-MEDIA IMPACTS[a]

	Number of Exceedances	Number of Samples	Maximum Total Uranium Result (µg/L)
SWP-02	1	4	37
SWD-02	2	5	73
Overflow of Storm Water Retention Basin	1	1	314[b]

[a]Groundwater total uranium FRL is 20 µg/L.
[b]Overflows from the Storm Water Retention Basin are rare (i.e., only one overflow of the Storm Water Retention Basin occurred in 1997).

Data are also evaluated to determine the impact of soil erosion on surface water. During the summer of 1997, it was discovered that erosion of the streambank in Paddys Run west of the K-65 Silos had resulted in approximately 1,700 ft^3 (48 m^3) of soil, trees, and metal debris falling into the streambed. In the fall of 1997, the Paddys Run Embankment Stabilization Project was initiated to construct erosion prevention measures on the eastern bank of Paddys Run, directly west of K-65 Silos 1 and 2, and to remove contaminated soil and debris that had fallen into Paddys Run. The collapsed soil and debris contained elevated levels of radionuclides; however, based on the 1997 sampling results, no impact to surface water or sediment downstream of the debris was observed.

Compliance Monitoring

FFCA and Operable Unit 5 Record of Decision Compliance

The FEMP is required to monitor treated effluent discharges at the Parshall Flume (PF 4001) for the mass of total uranium discharged and the total uranium concentration. These requirements are encompassed under the 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 does not exceed 600 pounds (272 kg) per year. The Operable Unit 5 Record of Decision also requires that as of January 1, 1998, the monthly average total uranium concentration in the effluent must be at or below 20 µg/L.

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The regulatory agencies allow the FEMP to discharge water from the Storm Water Retention Basin directly to the Great Miami River during periods of heavy precipitation to minimize the possibility of overflowing the Storm Water Retention Basin. These allowable "significant precipitation" bypasses are necessary to provide relief during those times when the volume of storm water has the potential to exceed retention and treatment capacities. To comply with the 20 µg/L limit during these types of bypasses, the FEMP is allowed to deduct the concentration of uranium from the monthly average calculation for up to 10 significant precipitation bypass days per year. The mass of total uranium discharged during these 10 days per year is still counted in the total discharge mass to ensure the 600 pound per year discharge limit is not exceeded. Additionally, the concentration of these bypasses can not be such that they would cause an exceedance of the surface water total uranium FRL (530 µg/L) outside the mixing zone in the Great Miami River (i.e., the point where discharged water is completely mixed with water in the Great Miami River).

In addition to "significant precipitation" related bypasses, the FEMP is also allowed to bypass water from treatment during certain scheduled wastewater treatment plant maintenance activities. These maintenance bypasses must be preapproved by the regulatory agencies. The mass of total uranium discharged during these maintenance bypasses is added to the annual calculation to determine compliance with the 600 pound discharge limit. The total uranium concentration in the discharge is not added to the 20 µg/L concentration limit; however, the bypasses can not cause an exceedance of the surface water total uranium FRL in the Great Miami River.

The 600 pound annual limit for total uranium discharges was effective with approval of the Operable Unit 5 Record of Decision in 1996. Figure 4-6 shows that the total cumulative mass of total uranium discharged to the Great Miami River for 1997 (126 pounds [57.2 kg]) is well below the 600 pound annual limit. The 20 µg/L monthly discharge limit does not become effective until January 1, 1998; however, during 1997, the FEMP monitored total uranium concentrations to determine compliance with the future limit. Figure 4-7 shows that the FEMP complied with the future limit for the entire year, ahead of the effective date for the limit. Table 4-3 shows a summary of the treatment bypass events during 1997. 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 20 µg/L limit.

TABLE 4-3
1997 STORM WATER TREATMENT BYPASS EVENTS

Bypass Days	Duration (hours)	Total No. of Bypass Days	Cumulative No. of Bypass Days	Total Uranium Discharged to Great Miami River (pounds)	(kg)
Significant Precipitation-Related					
January 27 to January 28	22.5	1	1	2.71	1.23
March 2 to March 4	57.5	2	3	10.1	4.59
June 1 to June 3	71.0	3	6	7.24	3.29
June 8 to June 10	48.75	2	8	4.55	2.07
Maintenance-Related					
August 18 to August 20	60.5	3	3	10.4	4.72

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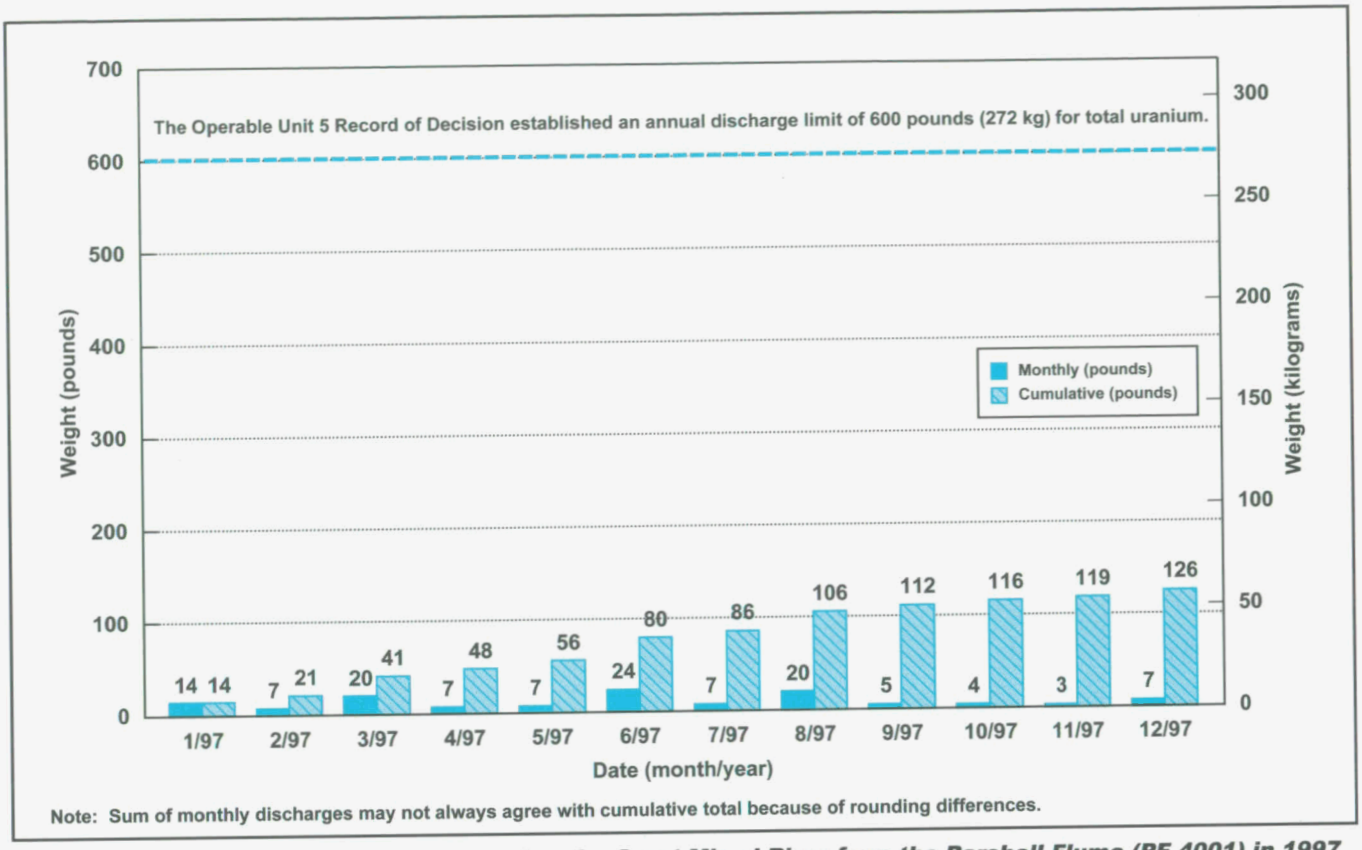

Figure 4-6. Pounds of Uranium Discharged to the Great Miami River from the Parshall Flume (PF 4001) in 1997

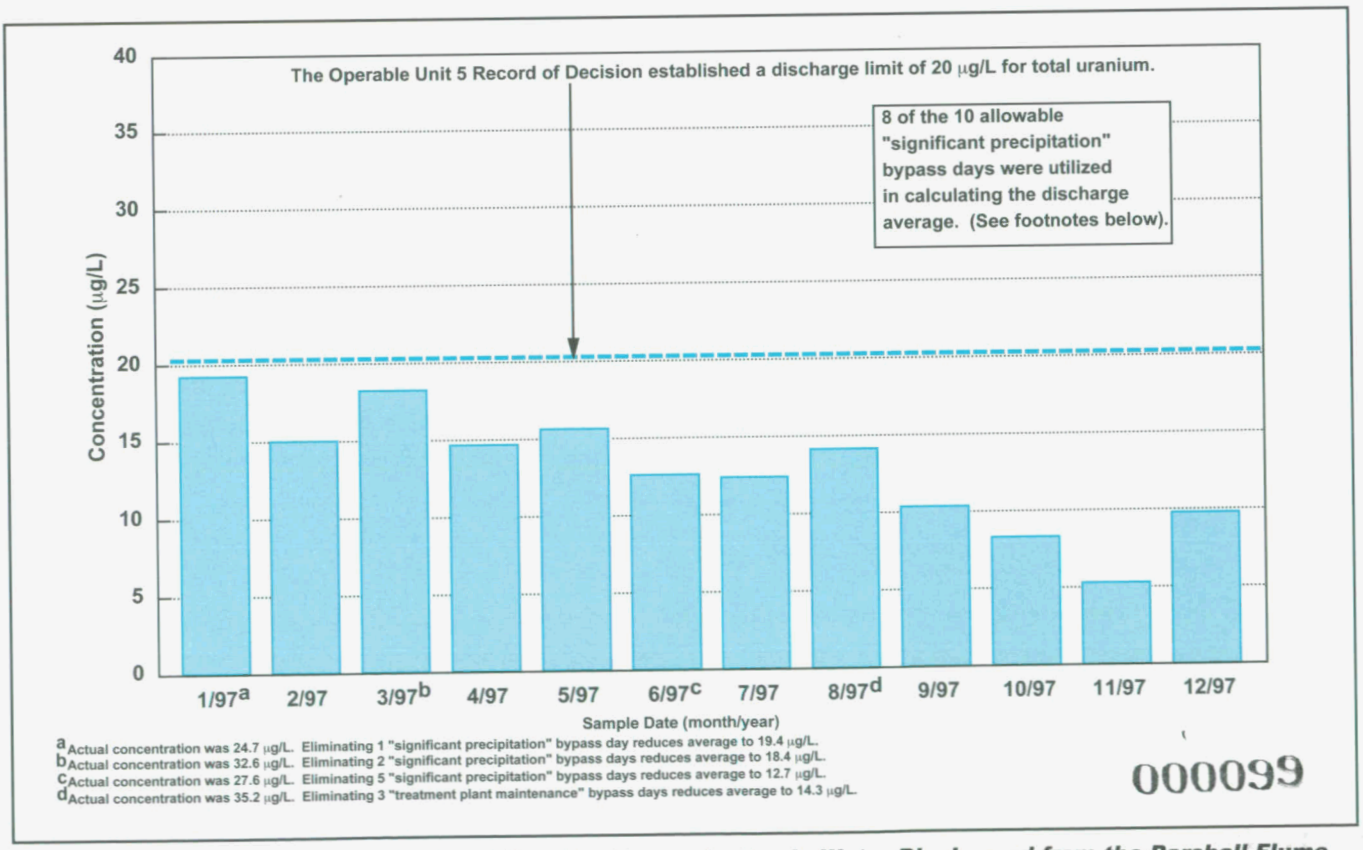

Figure 4-7. 1997 Monthly Average Total Uranium Concentration in Water Discharged from the Parshall Flume (PF 4001) to the Great Miami River

NPDES Permit Compliance

Compliance sampling, consisting of sampling uncontrolled runoff and treated effluent discharges from the FEMP, is regulated under the state-administrated NPDES program and remains unchanged with implementation of the IEMP. The current permit became effective November 1, 1995, and expires on March 31, 1998. The permit specifies discharge and sample requirements, as well as discharge limits for several chemical constituents. NPDES sample locations are shown on Figures 4-2 and 4-3.

Sampling to support the renewal of the NPDES permit was accomplished in 1997. The data collected during this sampling effort were submitted with the NPDES permit renewal application on September 22, 1997. The submittal of the application allows the FEMP to continue to abide by the terms of the expired permit until approval of the permit application by the OEPA.

Wastewater and uncontrolled runoff discharges from the FEMP were in compliance with the current permit requirements 99.8 percent of the time during 1997. Of the 2,274 monitoring results reported to OEPA during the year, only five were not within the discharge limits specified by the permit. Three violations occurred at the Parshall Plume (PF 4001) which discharges to the Great Miami River. The remaining violations occurred at an internal location monitoring treated effluent from the Sewage Treatment Plant (STP 4601). All of the violations resulted from exceedances of the total suspended solid limits. All non-compliant conditions were reported to OEPA, as required by the NPDES permit. All required data were successfully obtained. The only effluent limitation stipulated at the four uncontrolled storm water runoff monitoring locations is for pH, for which the FEMP demonstrated compliance 100 percent of the time.

Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4-6, 126 pounds (57.2 kg) of total uranium in treated effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 1997. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of total uranium entering the environment. It is estimated that 6.3 pounds (2.9 kg) of total uranium is discharged to the environment through uncontrolled runoff with every inch (2.54 cm) of rain. During 1997, 40.11 inches (101.9 cm) of precipitation fell at the FEMP; therefore, it is estimated that approximately 252 pounds (114 kg) of total uranium entered the environment through uncontrolled runoff. In addition to this calculated total uranium discharge to the environment, 3.46 pounds (1.57 kg) of total uranium were discharged to Paddys Run during an overflow of the Storm Water Retention Basin due to excessive amounts of precipitation on June 1, 1997. The total for the year for both controlled treated effluent discharges and uncontrolled runoff is 378 pounds (172 kg). This total represents a continued reduction in the pounds of total uranium being discharged to the environment, as presented graphically in Figure 4-8.

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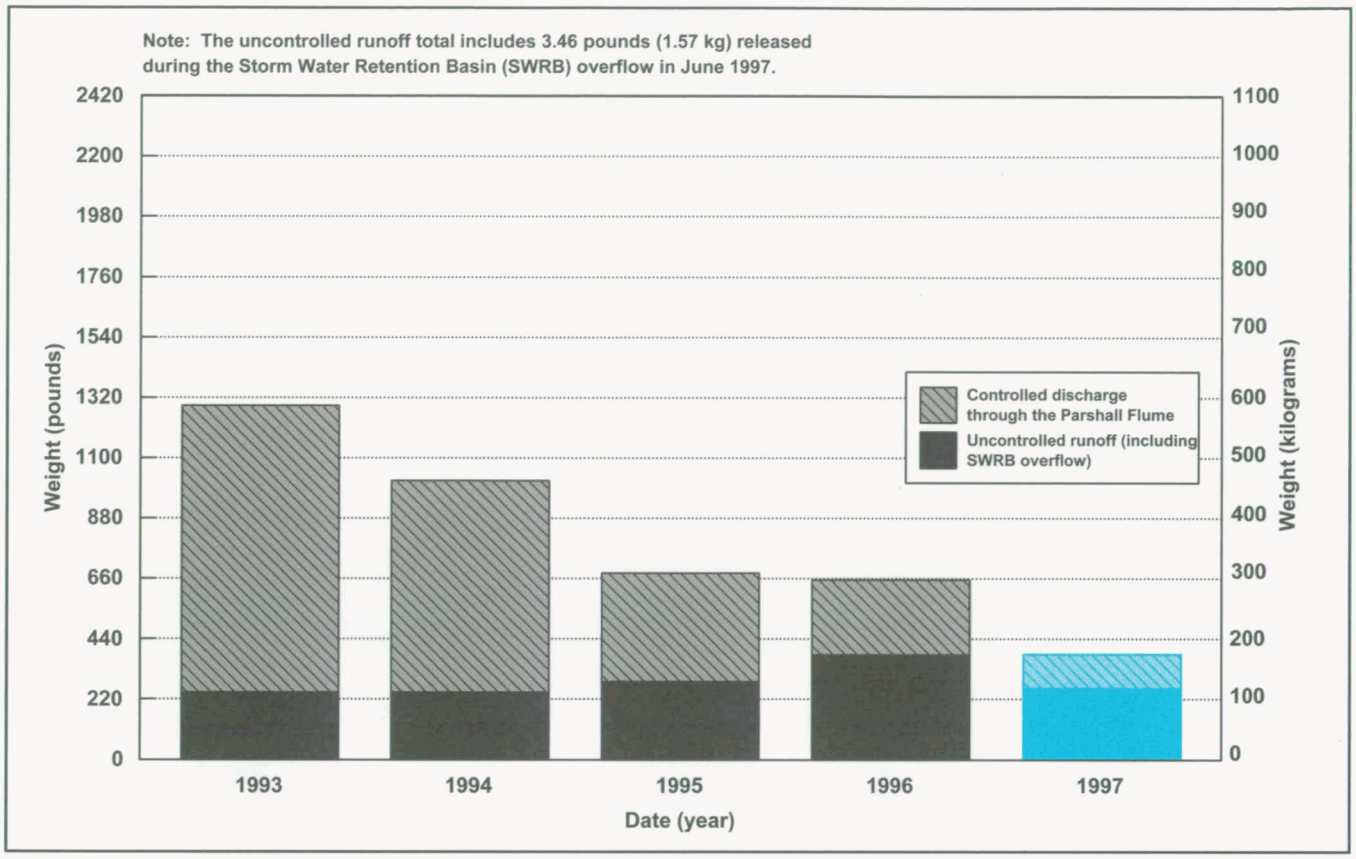

Figure 4-8. Total Uranium Discharged from the FEMP, 1993-1997

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 late June and early July at 20 locations along Paddys Run, the Storm Sewer Outfall Ditch, and the Great Miami River (Figure 4-9). Samples collected at each location were analyzed for total uranium. All samples collected from the Storm Sewer Outfall Ditch, Paddys Run north of the outfall ditch, and from the Paddys Run background location were also analyzed for radium-226 and isotopic thorium. Also, one location south of the Great Miami River effluent line and one location on Paddys Run south of the Storm Sewer Outfall Ditch were sampled and analyzed for radium-226 and isotopic thorium. Figure 4-9 illustrates specific sample locations that are summarized below:

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

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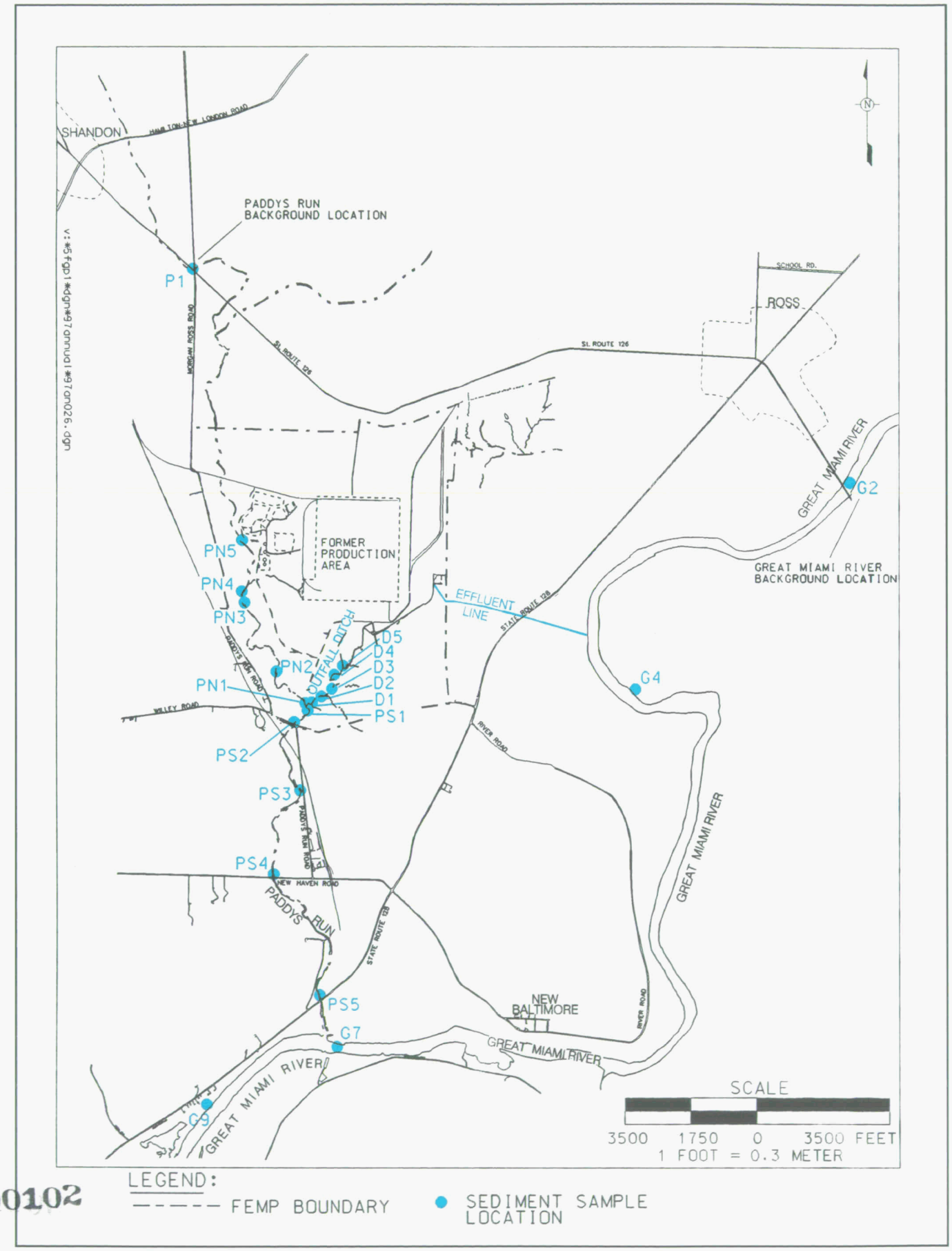

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Figure 4-9. 1997 Sediment Monitoring Locations

- **Paddys Run**: five samples collected north of the confluence with the Storm Sewer Outfall Ditch (PN1 through PN5), five samples collected south of the confluence (PS1 through PS5), and one background sample collected north of the site (P1)

- **Great Miami River**: one sample collected north of the effluent line (background location, G2) and three locations south of the effluent line (G4, G7, and G9).

Analytical results of samples collected from Paddys Run and Great Miami River were below the FRL for total uranium, isotopic thorium, and radium-226. In general, the 1997 sample results indicate a decrease in concentrations from the 1996 samples. Total uranium results for 1997 from Paddys Run were within the range of background levels. The average total uranium concentration in the Storm Sewer Outfall Ditch is above background levels but well below the sediment FRL.

One sample collected in the Storm Sewer Outfall Ditch at location D5 near the Storm Water Retention Basin had a thorium-232 concentration of 1.63 picoCuries per gram (pCi/g) which slightly exceeds the FRL of 1.60 pCi/g. In 1996, a sediment sample was collected in the same vicinity with a thorium-232 concentration of 1.8 pCi/g, also slightly above the FRL. Sediment samples collected immediately downstream of these locations did not exceed the thorium-232 FRL in 1996 or 1997. The sources of this contamination are either Storm Water Retention Basin overflows or controlled runoff from the former production area prior to the installation of the storm water controls currently in place. Sporadic exceedances of the FRLs are expected until final remediation of the site occurs. Monitoring of the sediment will continue with the IEMP to determine the effectiveness of the engineered controls designed to reduce erosion and sedimentation of Paddys Run and its tributaries. Additional details of the sediment monitoring results are presented in Appendix B, Attachment 2, of this report.

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Chapter 5
Air Pathway

Air Pathway

This chapter describes the air pathway components used to track and trend airborne emissions from the FEMP. It includes a discussion of radiological air particulates, radon, and direct radiation. In addition, the results from biota (produce) sampling are discussed under the air pathway because produce (a secondary exposure pathway) is most affected by air deposition of contaminants on the produce itself or on the soil with subsequent uptake of contaminants through plant roots.

Results in Brief: 1997 Air Pathway

Radiological Air Particulates and Uranium Emissions - 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. Airborne uranium emissions for 1997 were estimated to be 19.5 pounds (8.84 kg).

Radon - There were no exceedances of the DOE standard (3.0 pCi/L annual average above background) at the FEMP fenceline and off-property locations. The maximum annual average concentration at the FEMP fenceline measured by alpha track-etch cups was 1.0 ± 0.2 pCi/L.

Direct Radiation - Measurements of direct radiation indicate levels increasing with proximity to the K-65 Silos. However, these levels are still approximately 67 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 in the vicinity.

Produce - Total uranium concentrations in produce were consistent with previous years' data. Laboratory analyses did not detect significant differences in total uranium concentrations between produce grown near the FEMP and produce grown in outlying areas.

Boiler Plant - The FEMP converted from coal-fired to natural gas/diesel-fired boilers in 1997, which dramatically reduced boiler emissions. Additionally, there were no opacity excursions reported during 1997.

As discussed in Chapter One, the public may be exposed to radiation from the FEMP through the air pathway. This pathway includes emissions from specific point sources, such as plant stacks, as well as fugitive dust from large, active excavations. When production operations were suspended in July 1989, the major point source emissions from the FEMP were eliminated. Since then, the principal sources of airborne uranium emissions have been the cooling tower mists and laboratory fume hoods, which contain low levels of uranium, and fugitive dust from locations where environmental remediation activities are underway.

Air pathway monitoring focuses on airborne pollutants that may be carried from the FEMP as a particulate or gas and how these pollutants are distributed in the environment. The physical form and chemical makeup 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 surface. Chemical properties determine whether the pollutant will dissolve in water, be absorbed by plants and animals, or settle in sediment and soil.

Fugitive Dust - The term fugitive dust is used to describe the small amounts of airborne soil, waste materials, and construction dusts released from the FEMP as a result of ongoing remediation activities. Sources of fugitive dust at the FEMP as a result of ongoing remediation activities include active soil excavation, waste handling, and construction activities ongoing at the FEMP. To a lesser degree, fugitive dust is generated as a result of wind erosion of stockpiled materials and exposed excavations.

Diffuse Source - In contrast to a point source such as a stack or vent, diffuse sources of airborne emissions represent aerial sources with no concentrated or directed point of emission release. Examples include: soil stock-piles, open excavations, construction activities, and roadways.

Summary of Air Pathway

During 1997, radioactive materials in the air pathway continued to be monitored by sampling air particulates, radon, direct radiation, and as a secondary exposure pathway, biota (produce). Air pathway monitoring is conducted to evaluate the effects of remediation activities at the FEMP and fulfill the FEMP's obligations toward ongoing environmental surveillance and dose estimating.

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Remediation Activities Affecting the Air Pathway

When the mission of the FEMP changed from production to remediation, the scope of work activities also changed. This major change in work scope altered the mechanics of how airborne pollutants are distributed in the environment via the air pathway.

During the production years, the primary emission sources were point sources (i.e., stack and vents) from process facilities (see the Stack Monitoring section in this Chapter). Today primary emission sources include diffuse sources with fugitive emissions from current remediation activities (i.e., large scale excavations, demolition activities, wind erosion, and construction activities).

The following are 1997 remediation activities that generated emissions which may affect the air pathway:

- Construction activities associated with the on-site disposal facility, new north access road, railroad tracks, railroad spurs, and locomotive repair facility
- Large scale excavations associated with the waste haul road, on-site disposal facility, leachate collection system for the on-site disposal facility, waste pit site improvement activities, and excavation of contaminated soil in the northeast quadrant of the site
- Demolition activities associated with the completion of decontamination and dismantlement of Plant 1 and the ongoing decontamination and dismantlement of the Thorium/Plant 9 Complex.

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

- Administrative Controls - typical administrative controls that are implemented include: management and control procedures, record keeping and periodic assessments; establishing speed limits, control zones, and construction zones.
- Engineered Controls - typical engineered controls that are applied include: physical barriers; wetting agents; control, collection, and treatment systems; filtration; fixatives; sealants; and dust suppressants. 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.

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Air and Biota (Produce) Highlights for 1997

Transition to IEMP

The air pathway represents a critical exposure pathway because the potential exists for contaminants to migrate off property quickly and travel long distances. Recognizing the importance of this pathway, a significant level of consideration was given to the design of the air monitoring program presented in the IEMP. The IEMP air monitoring approach provides an ongoing assessment of the collective emissions originating from multiple concurrent remediation activities at the FEMP. Additionally, the results from this monitoring effort are intended to provide "early warning" feedback to remediation project organizations regarding the cumulative sitewide effectiveness of project-specific emission controls relative to health-protective standards. The key elements of the IEMP program design for air monitoring are:

- **Sampling** - Sample locations, frequency, and the constituents were selected to evaluate the air pathway, as well as for providing feedback to the remediation projects to assist in evaluating the effectiveness of administrative and engineered controls. Existing pre-IEMP radon, direct radiation, and biota (produce) monitoring locations were incorporated into the IEMP with little change. The Radiological Air Particulate Monitoring Program, however, underwent significant change through implementation of the IEMP. These changes are described in detail later in this section. In 1997, produce was sampled for the last time on an annual basis. In the future, produce will be sampled every third year from local farms and gardens.

- **Data Evaluation** - The data evaluation process focuses on the tracking and trending of data compared with historical data. In addition, comparisons to regulatory requirements and standards are conducted, when applicable. Each section contained within this chapter provides information pertaining to data evaluation and a comparison to applicable DOE, EPA, and OEPA regulatory standards and guidelines.

- **Reporting** - Prior to implementation of the IEMP, all data associated with the air monitoring program (air particulate, radon, direct radiation, and produce) were reported through the FEMP's annual site environmental reports. In addition, continuous radon monitoring data were submitted to EPA through Enclosure C of the FFCA/FFA quarterly reports. All data are now reported through IEMP quarterly status reports, in addition to annual site integrated environmental reports. The addition of quarterly reporting provides more timely information to the remediation projects, regulatory agencies, and FEMP stakeholders.

IEMP Radiological Air Particulate Monitoring Program Design

During the production years at the FEMP, emissions were primarily from point sources where direct, continuous measurements of point source emission rates and contaminant concentrations served as direct inputs to the Clean Air Act Assessment Package 1988 (CAP88-PC) dispersion model. This model is used to simulate the transport of contaminants from the source to potential receptor locations and generate an estimated dose received by potential off-property receptors via the air pathway. This process has been

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used at the FEMP since the late 1980s to estimate the FEMP's radiological impacts beyond the site fenceline and for demonstrating compliance with the radiological dose limits established under NESHAP Subpart H. The NESHAP dose limit is 10 mrem per year to any member of the public. Modeling estimates have again been used for the dose assessment from airborne particulates for 1997. This will be the last year modeling will be utilized for demonstrating compliance with the NESHAP Subpart H limit. The NESHAP Subpart H Compliance Report for 1997 is included as Appendix E of this report.

Recognizing that the primary source of air emissions at the FEMP has changed under full scale remediation from point sources to fugitive emissions from diffuse sources, the IEMP Radiological Air Particulate Monitoring Program defines a new approach for demonstrating NESHAP Subpart H compliance. The new approach, which will begin on January 1, 1998, utilizes radiological air particulate monitoring results rather than computer modeling to estimate the dose from airborne particulates to off-site receptors. This change to a monitoring-based approach for demonstrating NESHAP compliance was necessary to eliminate the high degree of uncertainty that is associated with modeling fugitive emissions from diffuse sources.

With approval of the IEMP in July 1997, work began on the installation of the infrastructure (i.e., new electrical services, access roads, and security fencing) that was necessary to support the new air monitoring stations required under the IEMP. These activities continued through the fourth quarter of 1997. On January 1, 1998, the FEMP will begin utilizing a network of 18 high volume air particulate monitoring stations to measure the collective contributions from all fugitive and point source emissions from the site relative to the NESHAP dose limit. This monitoring network will include 16 monitoring locations (including eight new locations) on the FEMP fenceline and two background locations. Monitoring data will include routine bi-weekly total uranium and particulate analyses and a quarterly composite sample targeted at the expected major contributors to dose from the site (i.e., uranium, thorium, and radium). These data will be tracked and reported through the IEMP quarterly status reports throughout the year and provided in annual integrated site environmental reports.

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Air Particulate Monitoring Research Project

The DOE Environmental Measurements Laboratory initiated a research project in 1997 to measure the particle size distribution of FEMP particulate emissions. The objective of the study was to evaluate the dose associated with various particle sizes and calculate the dose contributions from the respirable fraction of the total emissions. High volume samplers are the traditional method of air sampling for radionuclide analyses. These samplers not only collect particles in the respirable range, but they also collect particles greater than 15 microns (µm), which are not transported to the lungs.

To assess the uranium contribution of the various sizes of particles to the dose calculations, the Environmental Measurements Laboratory set up downwind (co-located with AMS-3), and upwind (co-located with AMS-10) sampling stations that separate the spectrum of airborne particles into distinct size fractions. The samples were analyzed for isotopic uranium at the Environmental Measurements Laboratory. The results are comparable to the average uranium concentration measured at the same location by the DOE-FEMP high volume air samplers. After subtracting background concentrations, it was found that a significant fraction (30 to 50 percent) of the uranium is attributable to the nonrespirable size fraction (greater than 15 µm). A second data set was collected on October 31, 1997, and showed similar results.

The evaluated data represented single day samples, however, in November 1997, Environmental Measurements Laboratory set up an instrument that would continuously sample particle size distribution at a flow rate of one liter per minute for a four week period. These samples are analyzed according to a schedule that matches the DOE-FEMP high volume sample analysis. This instrument, co-located with AMS-9, also separates the spectrum of airborne particles into distinct size fractions. The instrument has been continuously operating during the winter and spring months. Analyses of December 1997 and January 1998 samples showed all size fractions below the detection limit. This is not unusual for this period of low activity in the eastern portion of the FEMP and the comparatively low sample flow rate of one liter per minute.

Improvements to the analytical procedures are planned that should significantly lower the detection limit. In addition, a new sampler with a flow rate of 10 liters per minute has been developed by the Environmental Measurements Laboratory. With the improved analytical procedures and new sampler, DOE should be able to determine uranium particle size distributions and associated doses for most samples collected at the FEMP during any part of the year. Additional progress on this research project will be reported in future quarterly status reports and annual integrated site environmental reports.

Radiological Air Particulate Sampling Results

In 1997, the FEMP operated 20 air monitoring stations 24 hours per day, seven days per week, as part of the Radiological Air Particulate Monitoring Program. During 1997, several changes were made to the program. These changes, summarized below, resulted from the implementation of the IEMP. Several off-property air monitoring stations were removed from service between October and December 1997. Eight new monitoring locations were installed along the site fenceline, and one monitor was relocated along the fenceline during this same time period. Figure 5-1 identifies all air particulate monitoring locations monitored during 1997.

The following summarizes the major changes in air monitoring locations which occurred throughout the year:

- AMS-1B was removed from service in late June due to power interruption from remediation activities in the area north of the former production area. This monitoring location was not necessary because three new locations to the north were installed to support the IEMP.
- AMS-9B was relocated south of the original location in order to better monitor remediation and construction activities along the eastern edge of the site. These activities include the construction of the on-site disposal facility and the new north access road. This location was renumbered AMS-9C.
- AMS-22 through AMS-29 were installed along the site fenceline in October 1997 to complete the NESHAP compliance monitoring network specified in the IEMP.
- AMS-10, AMS-11, AMS-13, AMS-14, and AMS-21 were located at off-site locations near the FEMP through the first three quarters of 1997. These monitors were removed from service during fourth quarter 1997 because they were not necessary to support a comprehensive assessment of radiological air particulate concentrations at the FEMP fenceline as identified in the IEMP. It should be noted that two of these locations (AMS-11 and AMS-13) will be operated by the OEPA in 1998 to support its oversight role at the FEMP.

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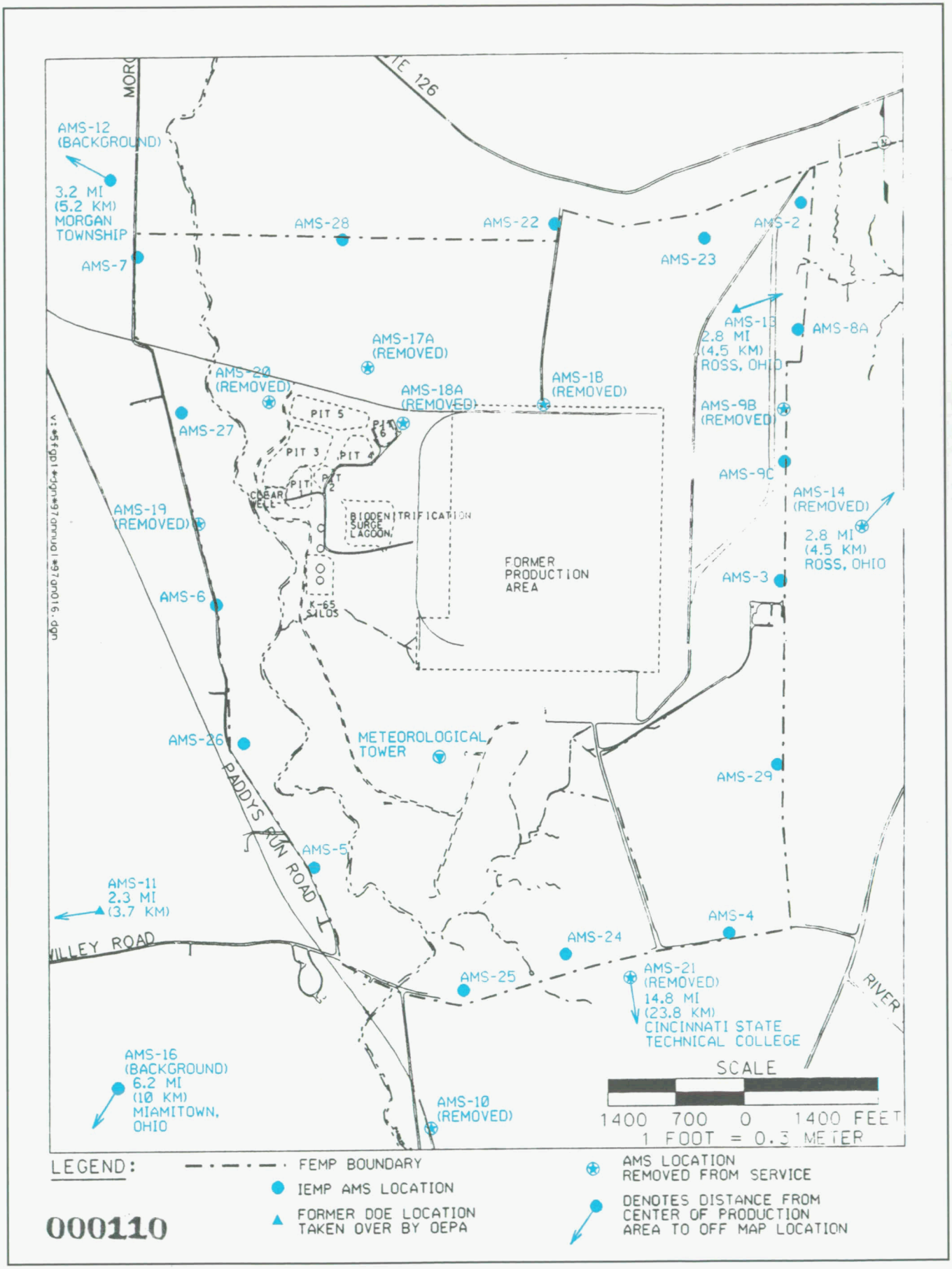

Figure 5-1. IEMP Radiological Air Monitoring Program

- Onsite monitors AMS-17A, AMS-18A, AMS-19, and AMS-20, which provided monitoring of the waste pit emissions during the remedial investigation and characterization of the pit contents, are expected to be removed from service during the first two weeks of 1998. With implementation of the IEMP Radiological Air Particulate Monitoring Program in January 1998, fugitive emissions associated with the waste pit area will be monitored collectively with other project emissions to evaluate compliance with NESHAP Subpart H requirements. As implementation of the remedy for Operable Unit 1 proceeds, future needs for project-specific air monitoring will be evaluated based on the pertinent regulatory drivers and process control needs of the project.

During 1997, air monitoring station filters were collected on a two-week interval for total uranium analysis. A portion of each two-week sample was also retained for an annual composite analysis for an expanded suite of radionuclides. The results of these analyses are compared to the following DOE guidelines and regulatory limits to assist in interpreting the data:

- DOE Order 5400.5, Radiation Protection of the Public and Environment, establishes 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, 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.

- The NESHAP Subpart H annual dose limit of 10 mrem is used as a benchmark for assessing the annual composite data.

Table 5-1 presents the total uranium concentrations for 1997 and 1996. Total uranium concentrations for 1997 were within historical ranges for all air monitoring stations. The average concentrations of total uranium at all fenceline air monitoring stations were less than one percent of the DOE derived concentration guide value for total uranium (0.1 picoCuries per cubic meter [pCi/m^3]). In 1997, ranges for total uranium at all air monitoring locations were from less than detectable concentrations to a maximum concentration of 1.2E-03 pCi/m^3 at AMS-3. For comparison, background locations ranged from less than detectable to 1.1E-04 pCi/m^3 at AMS-16.

In addition to the total uranium analyses, total particulate measurements are made from each filter every two weeks. Table 5-1 presents the toal particulate results for 1997 and 1996. Total particulate concentrations ranged from 7.1 micrograms per cubic meter (μg/m^3) to a maximum of 159 μg/m^3 at AMS-3. Historical data have been included for comparison. There are no general or site-specific regulatory limits associated with total particulate measurements used in the data evaluation process.

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However, total particulate data were evaluated with the total uranium results to identify any significant trends that may be related to remediation activities. During 1997, no significant trends were identified in the data which would indicate the potential for a significant impact to the environment. However, short-term increases in particulate and total uranium concentrations were detected at some air monitoring stations on the east fenceline during late September and early October. These temporary increases were due to the high level of construction activity associated with the on-site disposal facility and new north access road and the extremely dry, warm weather during this period. While these types of temporary increases present no significant impact to the environment, they will continue to be monitored and the data will be provided to the remediation projects to ensure that emission controls are operating as expected.

TABLE 5-1
TOTAL URANIUM AND TOTAL PARTICULATE CONCENTRATIONS IN AIR

Location	1997 Total Uranium (pCi/m³)	1996 Total Uranium (pCi/m³)	1997 Total Particulate[a] (µg/m³)	1996 Total Particulate[a] (µg/m³)
Fenceline Locations				
Minimum	0.0E+00	0.0E+00	7.1	7.2
Maximum	1.2E-03	9.4E-04	159	66
Background Locations				
Minimum	0.0E+00	0.0E+00	17	NS
Maximum	1.1E-04	6.2E-05	79	NS
Onsite Locations				
Minimum	0.0E+00	0.0E+00	15	16
Maximum	8.5E-04	2.2E-03	84	102
Offsite Locations				
Minimum	0.0E+00	0.0E+00	NS	NS
Maximum	7.1E-05	2.2E-04	NS	NS

[a]NS = not sampled

As discussed earlier, an annual composite sample was collected at each air monitoring station during 1997. The samples were analyzed for a list of trace radionuclides, including isotopes of radium, thorium, and uranium, as well as cesium-137, plutonium-238, plutonium-239/240, strontium-90, and technetium-99. The results of these analyses were compared to the DOE derived concentration guide values. All results at each monitoring station were below one percent of the corresponding DOE derived concentration guide values. In addition, the results at each air monitoring station were converted to a dose value and compared to the NESHAP 10 mrem dose limit. The calculated dose at each air monitoring station was below 10 percent of the NESHAP limit. Composite results also confirm that uranium isotopes are the major contributors to the dose. On average, uranium isotopes contribute 94 percent of the dose. Isotopes of thorium and radium account for the remainder of the dose.

Results from the data collected in 1997 for total uranium, total particulate, and the annual composite sample are provided in table format in Appendix C, Attachment 1, of this report. In addition to the data tables, Appendix C, Attachment 1, of this report provides graphical display of the 1997 total uranium and total particulate data.

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Summary of Project-Specific Air Monitoring

Prior to dismantling operations at Plant 1, four air monitoring stations were placed around the project boundary. The monitoring effort was designed to verify that negligible amounts of airborne radionuclide contaminants were released to the environment while dismantling the building. The monitors also provided data for evaluating the effectiveness of contamination control techniques. Plant 1 monitors went into operation in December 1995 and were in service until May 1997 when the rubble removal phase of Plant 1 was completed. Plant 1 was imploded on February 22, 1997. Air monitoring station filters were changed weekly and analyzed for total uranium.

Throughout decontamination and dismantlement activities, Plant 1 monitoring results indicated that airborne total uranium levels were relatively constant during the removal of equipment and duct work from the plant interior. Airborne total uranium levels remained below the DOE derived concentration guide values for total uranium in the air in the vicinity of Plant 1. As previously described, the DOE derived concentration guide values are used for comparative purposes and are not strict limits on the airborne total uranium concentration.

Project-specific radiological air monitoring activities were initiated in October 1997 and remain in place in support of Operable Unit 3 decontamination and dismantlement for the Thorium/Plant 9 Complex. Five air monitors were deployed near the project boundary and filters are exchanged weekly for total uranium analyses. Total uranium was analyzed because it is identified as the primary constituent of concern based on process knowledge and engineering evaluations. As per the Operable Unit 3, Integrated Remedial Action, Thorium/Plant 9 Complex Implementation Plan for Above-Grade Decontamination and Dismantlement (DOE 1997k), data from each monitor have been and will be continually evaluated to ensure project emission controls perform as expected.

Air monitoring in the vicinity of Plant 1 and the Thorium/Plant 9 Complex have, to date, verified that negligible amounts of radionuclide contaminants were released while dismantling the buildings. Each decontamination and dismantlement project will continue to be assessed to determine if air monitoring will be required to support the evaluation of project-specific emission controls.

Radon Monitoring

The concentration of radon in the atmosphere shows daily, seasonal, and annual variability. Many factors affect environmental radon concentrations, including the distribution of uranium in the earth's crust, porosity of the soil, local weather conditions, etc. These factors are not constant; for instance, rainfall or snowcover limits radon's ability to escape from the ground. Additionally, extreme temperatures cause cracks and porosity changes in the ground, influencing the rate at which radon escapes. Summary level meteorological data from 1997 are presented in Appendix C, Attachment 5, of this report. Also refer to Figures 1-7 through 1-10.

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Radon fluctuations are also caused by atmospheric conditions. During periods of calm winds and temperature inversions, 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 more near the ground.

The FEMP stores residual radioactive materials that generate radon. The principal source of radon is radium-bearing waste generated during the extraction of uranium from ore. This material is stored in K-65 Silos 1 and 2 (part of the Operable Unit 4 remediation). Other relatively small radon sources are six waste pits (part of the Operable Unit 1 remediation) and Building 65 Thorium Warehouse (part of the Operable Unit 3 remediation).

The radon monitoring program has gathered data concerning concentrations at various on- and off-property locations since the early 1980s. The program assesses potential impacts on the public and the environment and operates within the requirements of DOE Order 5400.5, Radiation Protection of the Public and the Environment. This order 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 above interim storage facilities (such as the FEMP) are 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.

Two monitoring devices are used to determine compliance with these limits: 1) long-term, time integrating monitors; and 2) continuous monitors. Long-term monitoring produces data used for assessing compliance with the annual limits. Long-term monitoring devices (alpha track-etch cups) used at the FEMP have no electrical requirements and can be placed virtually at any location. In contrast, continuous monitoring produces data used for assessing compliance with the instantaneous ambient radon concentration limit of 100 pCi/L and to track short-term and seasonal fluctuations through the year to ensure the DOE annual average radon concentration limits are not exceeded. Continuous monitoring devices (alpha scintillation detectors) used at the FEMP require electricity and are restricted in their placement.

In general, monitoring locations were selected based on DOE guidance and are consistent with siting criteria associated with air particulate monitoring (Figures 5-2 and 5-3). Both indicator and background locations have been selected for comparison purposes. In response to public concerns, several monitors are placed at nearby residences and schools. Additional radon monitoring locations near specific sources ensure regulatory compliance or are used during site-specific project activities that could produce radon. Also, the FFA

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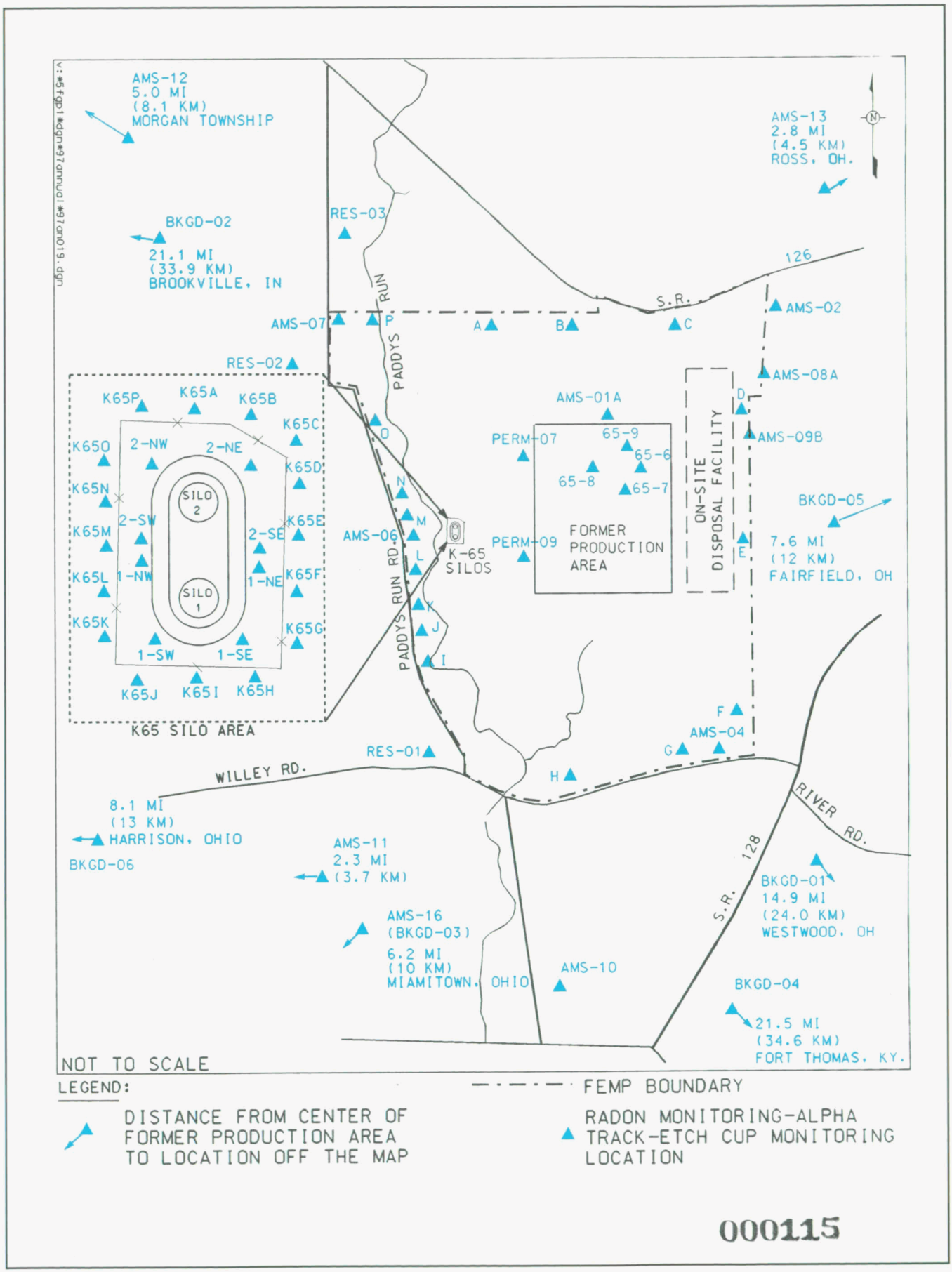

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Figure 5-2. Radon Monitoring - Alpha Track-Etch Cup Locations

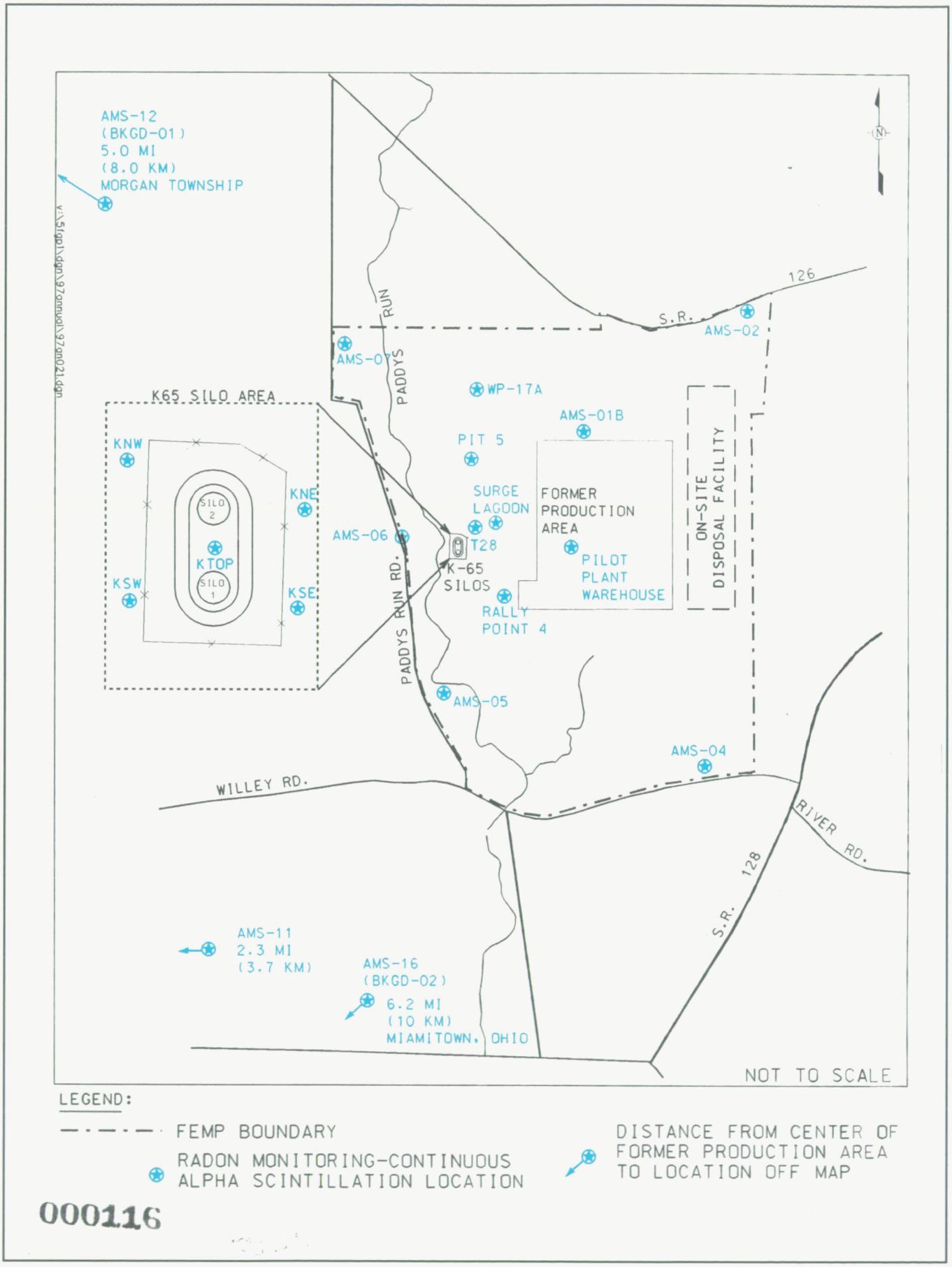

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Figure 5-3. Radon Monitoring - Continuous Alpha Scintillation Locations

requires routine reporting of data from nine continuous radon monitors (collected in hourly intervals and summarized as daily averages). The FFA also requires the continuous measurement (collected in five-minute intervals) of radon concentrations in the head space of the K-65 Silos.

Alpha Track-Etch Detectors

Alpha track-etch detectors (radon cups) are used when monitoring requirements pertain to annual limits because they consider data over long periods of time and provide an overall average concentration. The detectors are placed at many locations and gather both site-specific and background information regarding the dispersion of radon. Currently, there are approximately 62 locations, with two to three detectors placed at each location. Most of the detectors are placed within the immediate vicinity of the K-65 Silos (24 locations) and at the FEMP fenceline (22 locations). Additionally, data are collected at other onsite locations, three local residences, and nine background locations.

During 1997, radon cups were analyzed over two six-month periods. Results from the fenceline and off-property locations were compared to the annual average limit of 3.0 pCi/L above background. Data from fenceline and off-property locations were within historical ranges and well below the DOE limit of 3.0 pCi/L above background. The annual range of concentrations at the fenceline was 0.2 ± 0.1 pCi/L to 1.0 ± 0.2 pCi/L. The annual range for background radon concentrations was 0.1 ± 0.1 pCi/L to 0.2 ± 0.2 pCi/L. In addition, other off-property locations had an annual range between 0.3 ± 0.2 pCi/L and 0.4 ± 0.2 pCi/L.

Concentrations at on-property locations along the K-65 exclusion fence ranged between 0.7 ± 0.2 pCi/L and 3.5 ± 0.8 pCi/L; the K-65 Silos dome locations ranged between 3.8 ± 0.7 pCi/L and 18.0 ± 1.6 pCi/L with the maximum concentration recorded at Silo 2. The maximum values recorded on property remain below the DOE limit of 30 pCi/L annual average, for any one location.

Table 5-2 presents minimum and maximum radon concentrations at alpha track-etch cup monitoring locations for 1997 and 1996. Appendix C, Attachment 2, of this report contains the environmental radon data collected during 1997 using alpha track-etch cups.

TABLE 5-2
RADON MONITORING - ALPHA TRACK-ETCH CUPS,
SUMMARY CONCENTRATIONS FOR 1997

	Radon Concentration ± Precision[a] (pCi/L)	
Location	1997 Location Average	1996 Location Average[b]
K-65 Silos 1 & 2 Exclusion Fence Locations		
Minimum	0.7 ± 0.2	1.2 ± 0.4
Maximum	3.5 ± 0.8	3.9 ± 1.1
K-65 Silos 1 & 2 Dome Locations		
Minimum	3.8 ± 0.7	4.1 ± 1.5
Maximum	18.0 ± 1.6	27.6 ± 14.9
Fenceline Locations		
Minimum	0.2 ± 0.1	0.6 ± 0.2
Maximum	1.0 ± 0.2	1.0 ± 0.2
Background Locations		
Minimum	0.1 ± 0.1	0.5 ± 0.1
Maximum	0.2 ± 0.2	0.9 ± 0.5
Other Onsite Locations		
Minimum	0.2 ± 0.1	0.6 ± 0.3
Maximum	0.4 ± 01	2.2 ± 0.3
Other Offsite Locations		
Minimum	0.3 ± 0.2	0.8 ± 0.5
Maximum	0.4 ± 0.2	1.0 ± 0.4

[a]±2 standard deviations
[b]Data for 1996 presented in Table 21 of the 1996 Site Environmental Report were not adjusted for the exposure period. 1996 data presented here have been adjusted and are correct.

In support of Operable Unit 4, and in accordance with the FFA, K-65 Silos 1 and 2 head space radon concentrations are monitored to supply the necessary information for evaluation of the K-65 Silos regarding remediation activities and to assess the effectiveness of the bentonite layer in reducing radon emissions. Recognizing that radon concentrations in the silo head space are trending upward, an evaluation was conducted during 1997 comparing historical annual average radon concentrations at the K-65 Silos exclusion fence to background concentrations and the annual average concentrations measured at the nearest fenceline monitoring points (alpha track-etch data were used for this comparison). The results indicate a measurable increase at the K-65 Silos exclusion fence with little or no effect observed at the site fenceline (Figure 5-4). It is important to note that the increase in average concentrations adjacent to the K-65 Silos are still well below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

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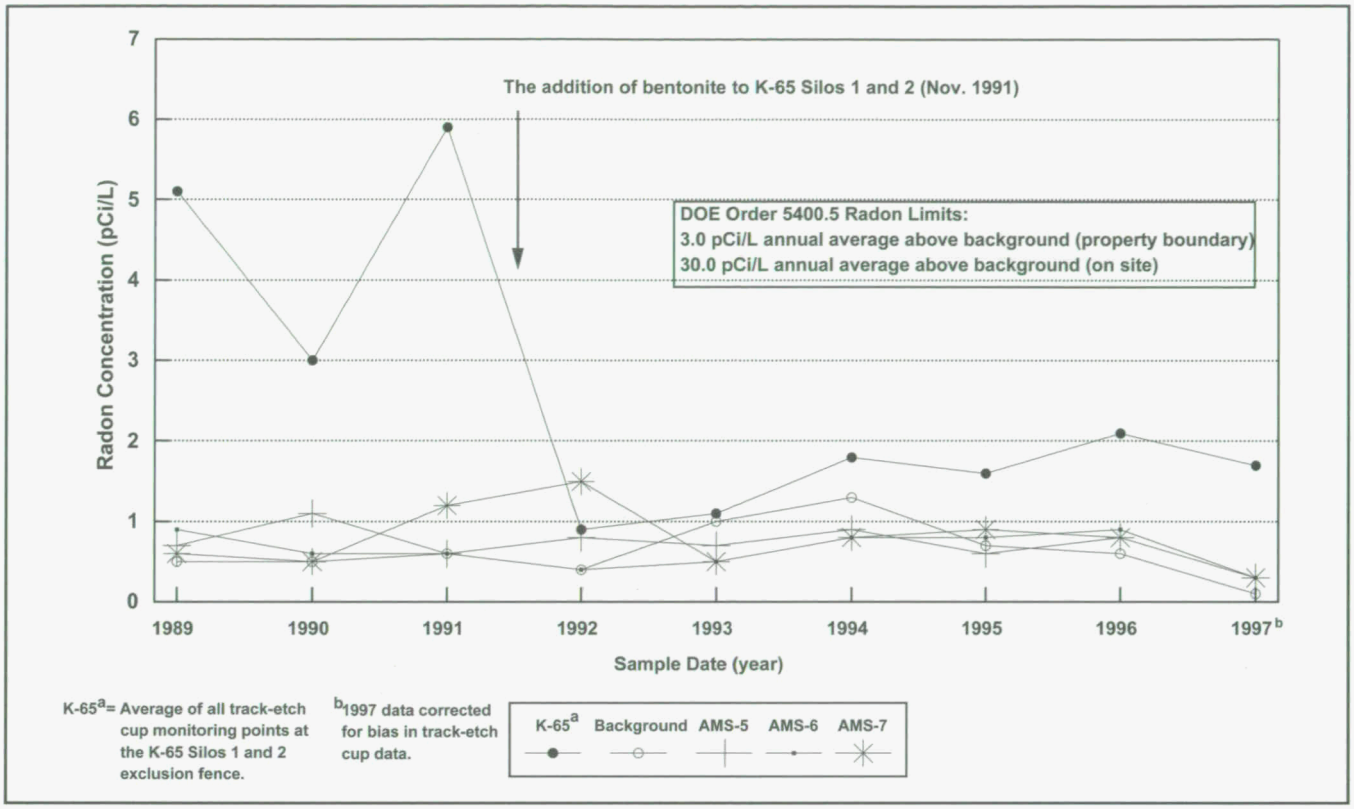

Figure 5-4. Annual Average Radon Concentrations at Selected Radon Locations, 1989 - 1997

Continuous Alpha Scintillation Detectors

Continuous monitors reveal important information regarding the dynamics of radon concentrations on and off property. 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, there are certain restrictions to using these monitors. Electrical power is only available at a limited number of locations and due to the extensive remediation activities at the site, access to electric utilities is frequently changing. Additionally, extreme cold weather affects the reliability of the instruments and some of the data are rendered unusable due to instrument malfunction under these severe conditions.

During 1997, there were five exceedances of the 100 pCi/L DOE limit measured onsite. The exceedances were detected in continuous radon monitors located immediately adjacent to the K-65 Silos. The detections were of short duration and were not observed outside the immediate vicinity of the K-65 Silos exclusion fence. As in the past, these exceedances associated with radon emissions from the K-65 Silos were observed during particularly strong atmospheric inversions rather than with any operational change associated with the K-65 Silos. Based on the limited occurrence, short duration, and limited aerial extent of the exceedances, no additional actions were taken. More detail on these exceedances is provided in Appendix C, Attachment 2, of this report.

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Table 5-3 provides monthly average radon concentration data from the continuous radon monitors for 1997. This data is used to track radon concentrations through the year to ensure the DOE limits for annual average radon concentrations 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 1997 and graphical displays of data from 1992 through 1997.

TABLE 5-3
1997 CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS[a]

	Location	Minimum (pCi/L)	Maximum (pCi/L)	Average (pCi/L)
Fenceline/Offsite	AMS-02	0.7	1.2	0.9
	AMS-04	0.6	1.1	0.8
	AMS-05	0.7	1.6	1.0
	AMS-06	0.8	1.1	0.9
	AMS-07	0.7	2.3	1.3
	AMS-11	0.6	1.5	0.9
Background	AMS-12	0.4	1.0	0.7
	AMS-16	0.6	0.9	0.7
Onsite	AMS-01B	0.8	1.3	1.0
	KNE	3.5	8.3	6.1
	KNW	1.4	2.9	2.1
	KSE	3.6	12.1	6.3
	KSW	1.8	4.3	2.8
	KTOP	6.5	13.0	10.3
	Pilot Plant Warehouse	0.5	1.4	0.8
	Pit5	0.5	1.4	0.9
	Rally Point 4	0.9	1.6	1.3
	Surge Lagoon	0.9	1.8	1.4
	T28	1.4	3.0	2.3
	WP-17A	0.7	1.6	1.0

[a]Radon data presented in this table includes a contribution from instrument background. Beginning in 1998, radon data will be reported without instrument background.

Monitoring for Direct Radiation

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

Direct radiation levels at and around the FEMP were continuously measured at 30 locations with thermoluminescent dosimeters during the first three quarters of 1997. Eight additional locations were deployed during the fourth quarter at the new air monitoring locations. Thermoluminescent dosimeters absorb and store the energy of direct radiation within the thermoluminescent material. By heating the thermoluminescent material under controlled conditions, the stored energy is released as light, measured, and correlated to the amount of

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direct radiation. Figure 5-5 identifies the thermoluminescent dosimeter monitoring locations. These monitoring locations were selected based on the need to monitor the K-65 Silos, the FEMP fenceline, and several offsite locations, including background locations.

Table 5-4 provides summary level information pertaining to direct radiation measurements for 1997 and 1996. Direct radiation levels vary from one location to another because of the differences in the terrestrial and cosmic components of natural background radiation. For example, varying concentrations of naturally occurring radium, thorium, and their decay products in soil result in different radiation levels.

TABLE 5-4
DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MEASUREMENT SUMMARY

	Direct Radiation ± Uncertainty[a] (mrem)	
TLD Location	Summary of 1997 Results	Summary of 1996 Results
Fenceline		
Minimum	60 ± 12	64 ± 6.1
Maximum	79 ± 11	83 ± 8.0
Onsite		
Minimum	54 ± 7.5	55 ± 5.4
Maximum	778 ± 108	630 ± 61
Offsite		
Minimum	52 ± 7.3	55 ± 5.3
Maximum	65 ± 9.1	67 ± 6.5
Background		
Minimum	57 ± 8.0	59 ± 5.7
Maximum	74 ± 10	74 ± 7.2
Average	64 ± 12	66 ± 11

[a]Associated laboratory uncertainty

All monitoring results from thermoluminescent dosimeters for 1997 were within historical ranges. A slight increasing trend in the immediate area of the K-65 Silos has been identified and will continue to be monitored (Figure 5-6). This trend is attributable to a corresponding increase in radon concentrations observed in K-65 Silos head space as reported through Enclosure C of the FFCA/FFA quarterly reports. The increase in environmental direct radiation measurements adjacent to K-65 Silos are still well below the levels observed prior to the addition of bentonite to the K-65 Silos in 1991.

Detailed results of direct radiation measurements for 1997 and 1996 are provided in Appendix C, Attachment 3, of this report.

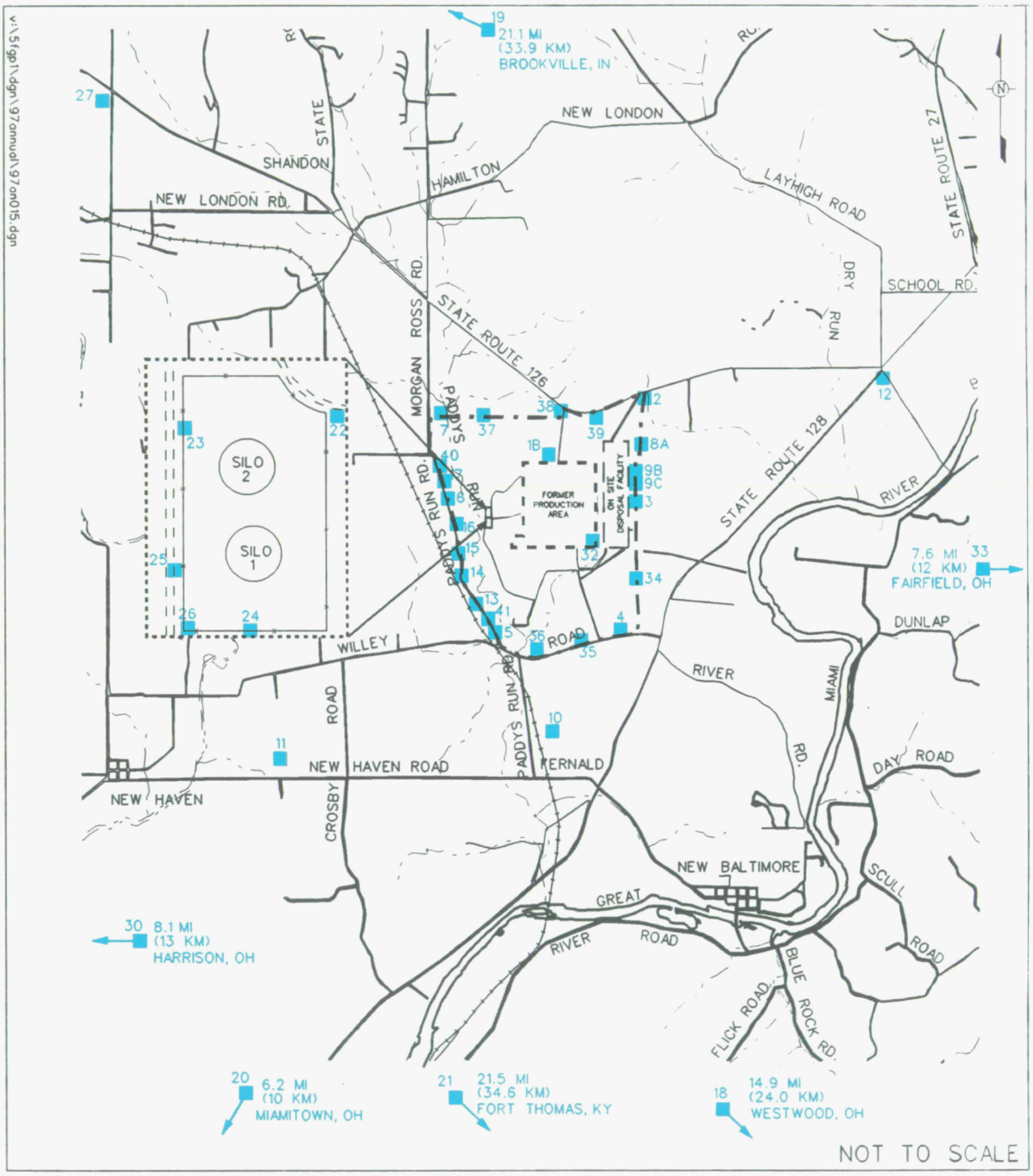

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Figure 5-5. Direct Radiation (Thermoluminescent Dosimeter) Monitoring Locations

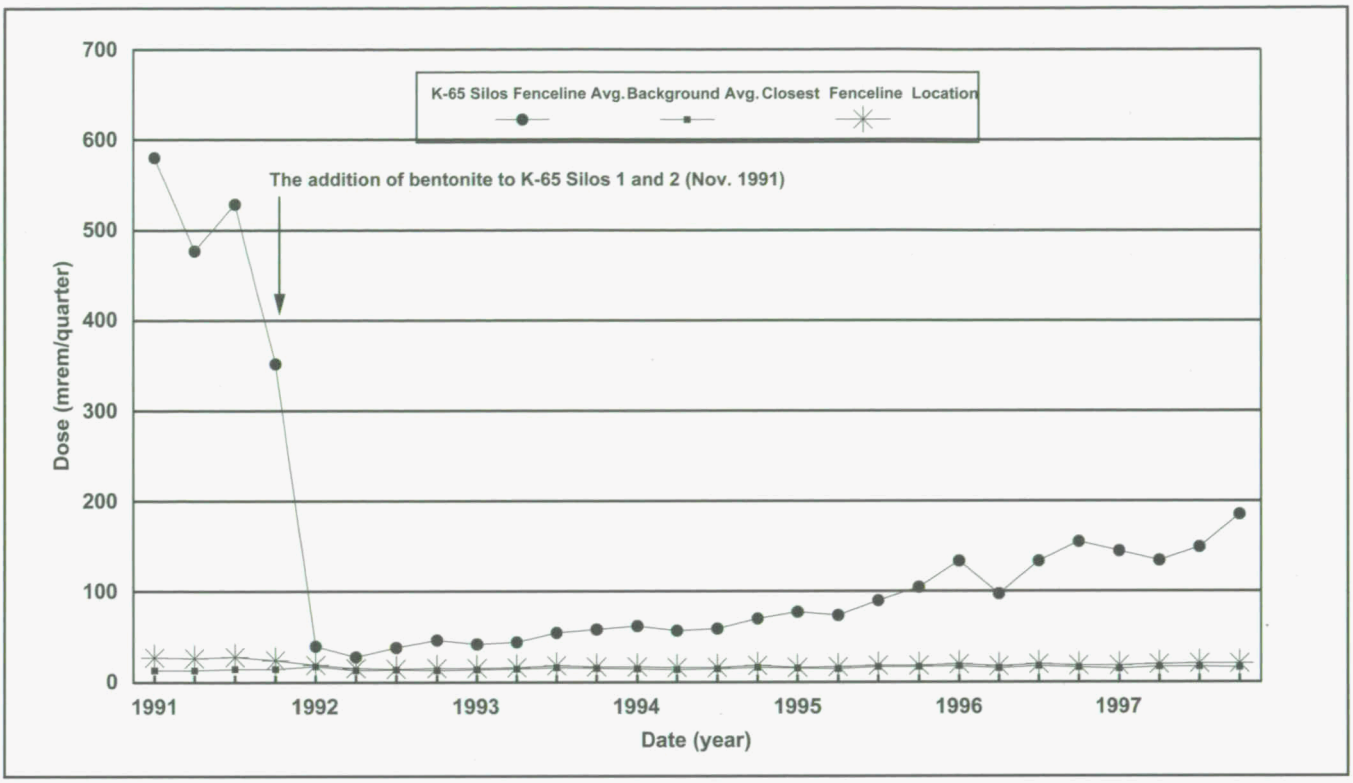

Figure 5-6. Quarterly Direct Radiation (Thermoluminescent Dosimeter) Measurements, 1991-1997

Stack Monitoring

With the transition from uranium production to full-scale remediation activities came a significant reduction in the number of stacks and vents (point sources) which require monitoring. During 1997, a total of four stack locations were continuously monitored. Figure 5-7 provides monitored stack locations.

In order to estimate the total 1997 airborne emissions from the FEMP, the results from stack monitoring were combined with estimated emissions from unmonitored stacks and vents. Emissions from unmonitored stacks and vents are estimated through modeling. This is accomplished by estimating the total amount of material handled in each facility, along with existing weather conditions (wind speed, direction, rainfall, temperature, etc.). Finally, fugitive emissions are estimated based on air monitoring data, meteorological data, and modeling. Table 5-5 summarizes FEMP estimated total uranium airborne emissions for 1997. Summary level meteorological data from 1997 are presented in Appendix C, Attachment 5, of this report.

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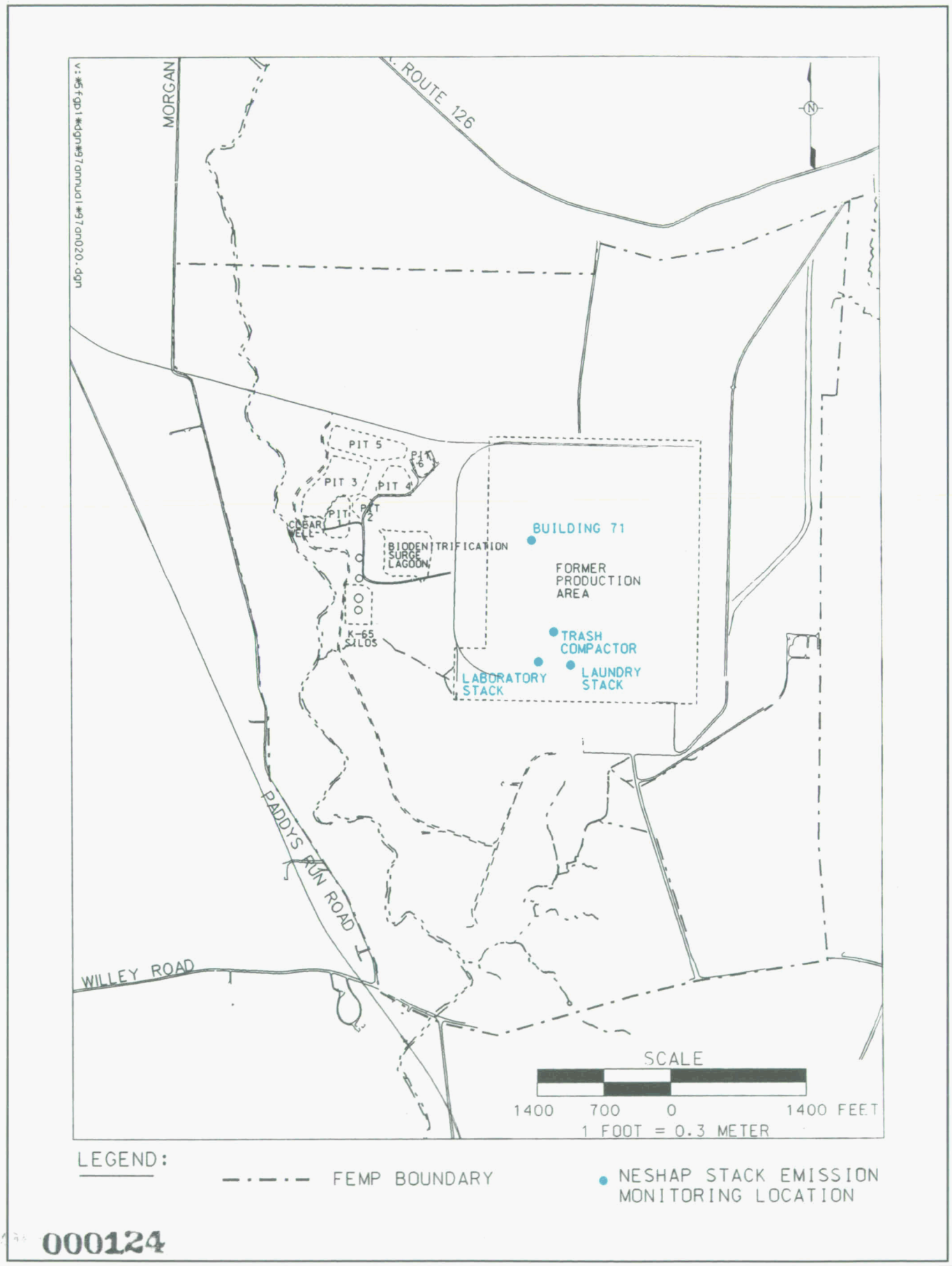

Figure 5-7. NESHAP Stack Emission Monitoring Locations

Method Used to Determine Airborne Emissions

Total uranium airborne emissions are determined by summing the estimated and measured emissions from a number of stacks, vents, and processes on site. Measured and estimated total uranium emissions for 1997 totaled 19.5 pounds (8.84 kg). This compares to 11.1 pounds (5.0 kg) estimated in 1996. Total uranium discharges from monitored stacks were the only measured emissions. Emissions from all other sources listed below were estimated.

TABLE 5-5
TOTAL URANIUM AIRBORNE EMISSIONS

Emission Category	Amount of Total Uranium Emission	Sources	Comments
Monitored Stacks	0.018 kg	3 stacks: Buildings 11-Laundry; 15-Laboratory; 71-Process Vent	High efficiency filters used to control emissions
Unmonitored Stacks, and Vents	0.331 kg	Plants 6 and 8; Buildings 11, 15, 20, 53, and 78	Estimated based on processes and amount of material handled in each facility
Fugitive Emissions	8.49 kg	Plant 1; Buildings 20, 51, 65; Waste Pit 5; WPRAP and miscellaneous soil stockpiles	Estimate based on ambient air monitoring data, meteorological conditions, and modeling

Monitoring for Nonradiological Pollutants

The OEPA requires an estimate of emissions from the Boiler Plant as part of the FEMP's effort to demonstrate compliance with the Clean Air Act. The FEMP estimated the amount of nonradiological pollutants including particulate matter, sulfur dioxide, nitrogen oxides, and carbon monoxide and measured the shade, or density, of particulate emissions from the boilers. Shade, or density, also called opacity, is a measure of how much light is blocked by particulate matter present in stack emissions. There were no excursions in opacity at the boilers for 1997. For comparison, there were a total of 14 excursions of the opacity standard in 1996. This reduction in opacity excursions is due to the FEMP's conversion from coal-fired boilers to natural gas/diesel-fired boilers which dramatically reduced boiler emissions.

In order to estimate sulfur dioxide emissions, scientists regularly 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 1997, sulfur dioxide emissions from all boilers were calculated to be 180 pounds (82 kg). This was well below the allowable limit calculated from information in the permit issued by the OEPA.

The nitrogen oxide and carbon monoxide emissions are estimated using EPA-developed emission factors. Nitrogen oxide emissions for all boilers for 1997 were estimated to be 27,300 pounds (12,400 kg). Carbon monoxide emissions for all boilers in 1997 were estimated to be 13,500 pounds (6,130 kg). To date, the OEPA has not set nitrogen oxide or carbon monoxide limits for FEMP industrial processes.

Table 5-6 provides a comprehensive list of 1997 Boiler Plant emissions.

TABLE 5-6
BOILER PLANT EMISSIONS

Chemical Name	Type of Release	Quantity Released (lb/kg)	Major Release Sources	Basis of Estimate
Particulates	Stack Emissions	3,600/1,600	Fossil Fuels Combustion	AP-42 Emission Factors
Sulfur Dioxide	Stack Emissions	180/82	Fossil Fuels Combustion	AP-42 Emission Factors
Nitrogen Oxide	Stack Emissions	27,300/12,400	Fossil Fuels Combustion	AP-42 Emission Factors
Carbon Monoxide	Stack Emissions	13,500/6,130	Fossil Fuels Combustion	AP-42 Emission Factors
Non-methane Volatile Organic Compounds	Stack Emissions	70/30	Fossil Fuels Combustion	AP-42 Emission Factors

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Biota (Produce) Sampling for Total Uranium

As mentioned in Chapter One, the FEMP is surrounded by farmland. Locally grown sweet corn and tomatoes are two of the major crops sold from roadside stands within three miles (five km) of the FEMP. Local residents also grow and sell apples, beets, cucumbers, lettuce, peppers, potatoes, and squash.

With air emissions reduced to very low levels, the possibility of uranium contamination in produce from air deposition is very low. While washing the produce before eating removes any surface contamination which may be present, some uranium may be taken up by plants through their root systems and incorporated into their edible portions. Uranium detected in produce may be uranium that was deposited from the air pathway, naturally occurring in the soil, or added by fertilizers.

Produce is collected to determine if total uranium concentrations in produce grown within three miles (five km) of the FEMP are higher than concentrations in produce grown at distant locations, seven to 26 miles (11 to 42 km). The sample results are then used to estimate the potential dose to people from this component of the air pathway (Chapter Six). Figure 5-8 presents produce monitoring locations.

The summary results of the produce sampling program are reported in Table 5-7. In general, total uranium concentrations greatly varied for each type of produce. Comparisons between the average total uranium concentrations in corn, soybeans, squash and tomatoes grown near the FEMP with concentrations grown distant from the FEMP indicated very little difference in average concentrations. In addition, when compared to historical background ranges, the data for 1997 are within the range of background reported for 1990 to 1996. These comparisons suggest that there is no substantial impact from past or current FEMP emissions on produce grown in the area.

Under the IEMP, produce will continue to be sampled once every three years. The next sampling round is scheduled for the year 2000.

TABLE 5-7
1997 BIOTA (PRODUCE) TOTAL URANIUM SUMMARY RESULTS

					1990-1996 Historical Background Range[c]	
Produce	Number of Samples[a]	Minimum[a] (pCi/g, dry weight)	Maximum[a,b] (pCi/g, dry weight)	Background[b] (pCi/g, dry weight)	Minimum (pCi/g, dry weight)	Maximum (pCi/g, dry weight)
Corn[d]	9	2.4E-04	1.8E-03	4.2E-03	ND	2.0E-01
Squash[e]	2	3.8E-02	NA	1.9E-02	ND	3.4E-01
Soybean	5	1.8E-03	2.1E-02	NS	ND	1.2E+00
Tomatoes	6	5.6E-03	1.3E-01	2.4E-02	1.8E-04	6.1E-01

[a]If the number of "non-background" samples is equal to one, then the data point is reported as the minimum.
[b]NA =not applicable
NS = not sampled
[c]ND indicates less than blank values or less than background.
[d]The corn family includes sweet corn for human consumption and field corn for livestock feed.
[e]The term squash includes, zucchini, and eggplant.

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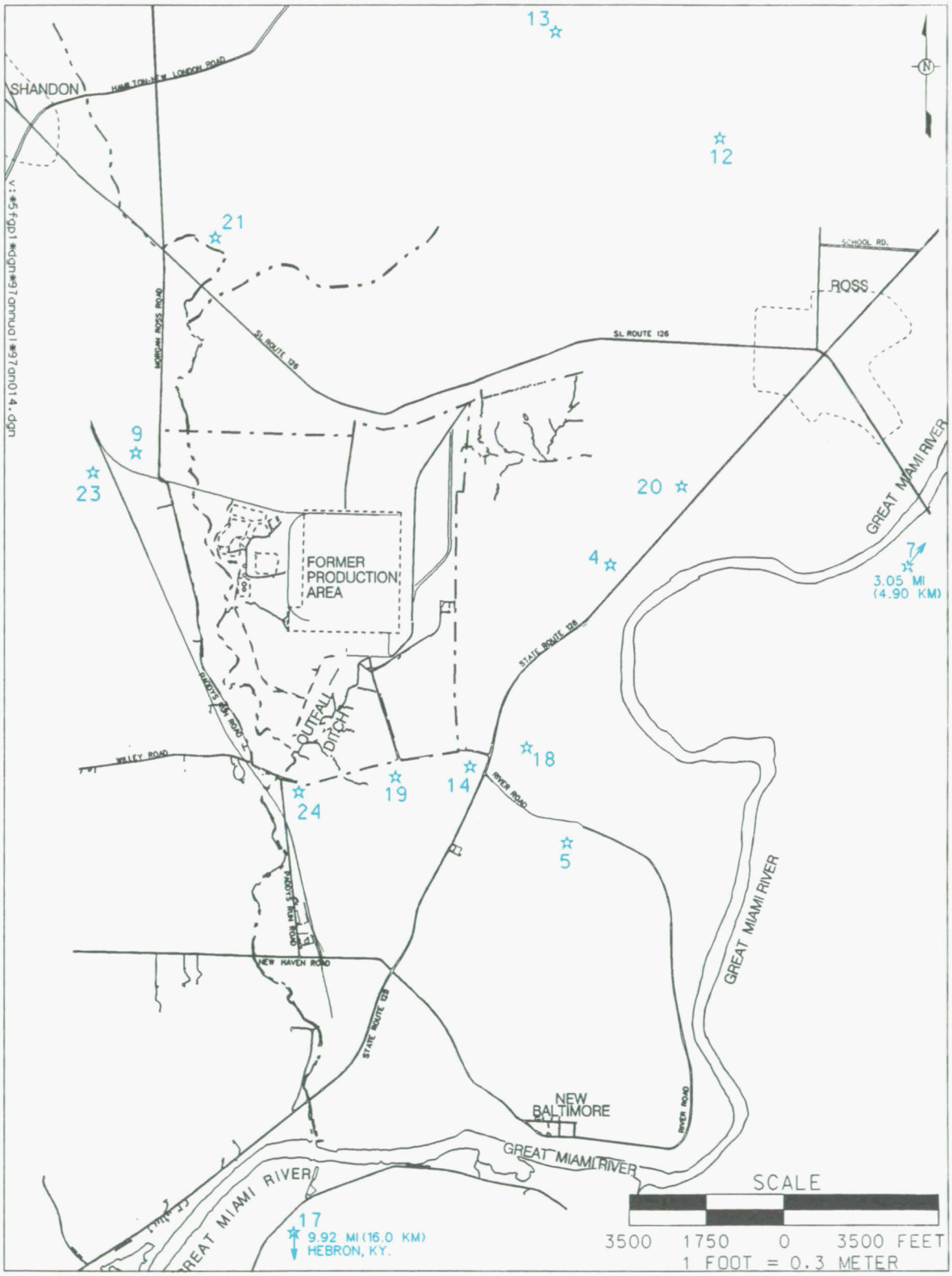

Figure 5-8. Produce Monitoring Locations

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Chapter 6
Radiation Dose

Radiation Dose

Results in Brief: 1997 Estimated Doses

Airborne Emissions - The estimated maximum committed effective dose to a member of the public from 1997 airborne emissions (excluding radon) was calculated to be 1.4 mrem.

Produce - The committed effective dose from eating produce grown within 3 miles (5 km) of the FEMP was estimated to be 0.1 mrem.

Direct Radiation - There was no significant statistical difference between direct radiation measurements at the site fenceline and measurements at background locations. Therefore no dose was attributable to direct radiation in 1997.

This chapter provides estimated doses from the air and direct radiation pathways for 1997. EPA regulations require the FEMP to demonstrate that its radionuclide airborne emissions are low enough to ensure that no one in the public receives an effective dose of 10 mrem or more in any one year. Moreover, to determine whether the FEMP is within the DOE dose limit of 100 mrem per year from all exposure pathways, estimates of the dose from eating produce grown near the FEMP and the dose due to direct radiation are made.

In previous annual reports, estimated doses from drinking well water and eating fish from the Great Miami River were provided. The installation of public water to the area surrounding the FEMP eliminated the groundwater pathway as a source of dose from FEMP operations; therefore, dose from drinking well water is no longer reported. Repeated assessments of the dose from eating fish from the Great Miami River have established this pathway as an insignificant contributor to dose from FEMP emissions. In addition, the emissions to the Great Miami River have been significantly reduced over the past several years. The sampling of fish and the assessment of dose from eating fish has therefore been eliminated under the IEMP.

Estimated Dose from Airborne Emissions

Dose estimates from airborne emissions are determined through the use of a set of computer models. The FEMP uses the computer model CAP88-PC to determine compliance with the NESHAP requirements of the Clean Air Act. The AIRDOS computer model calculates concentrations of radionuclides in the air, on the ground, and in food based on estimates of the amount of airborne radioactive material released. The concentrations are then used to calculate the intakes and subsequent doses to people.

The CAP88-PC model calculates airborne radionuclide concentrations based on estimated, calculated, or measured emission rates. The CAP88-PC computer model calculates both individual and collective doses. Collective dose is the sum of individual doses to people in the FEMP area and is reported in the units of person-Roentgen equivalent man (person-rem). (For example, if 10 people each receive one rem, then the collective dose is "10 person-rem"; if 20 people each receive 0.5 rem, then the collective dose also is "10 person-rem".) The person-rem unit is used as a broad measure of the radiological impacts of the FEMP and is useful in comparing the risks from FEMP operations with other facilities and industries.

The CAP88-PC model requires a large amount of data to estimate dose, which includes the number, height, and location of release points; wind speed and direction; the amount of radioactive material released; and population distribution in the FEMP area. Although some of the data were obtained through measurements and sampling, many were not directly measured and were estimated. Examples of estimated data are the amounts of airborne radioactive material released from the Laboratory Building and the cooling tower. The FEMP made very conservative estimates for these and all other emission sources

which were not directly measured. Conservative estimates, which are frequently used in environmental monitoring and dose calculations, are based on assumptions about an exposure situation that should result in the highest estimate of a dose. For example, an assumption about estimated doses at the air monitoring stations is that a person is outdoors at one location for 100 percent of the time during the year. Conservative estimates of emissions are used to ensure that dose estimates are not underestimated but are the maximum doses that could have resulted from FEMP operations during 1997.

Results of the CAP88-PC model estimated the maximum effective dose from 1997 airborne emissions to be 1.4 mrem to a person located 3,317 feet (1,011 meters) east-southeast of the former production area. This dose was well below the NESHAP standard of 10 mrem from the air pathway and was only 1.4 percent of the DOE guideline of 100 mrem per year from all pathways (Figure 6-1).

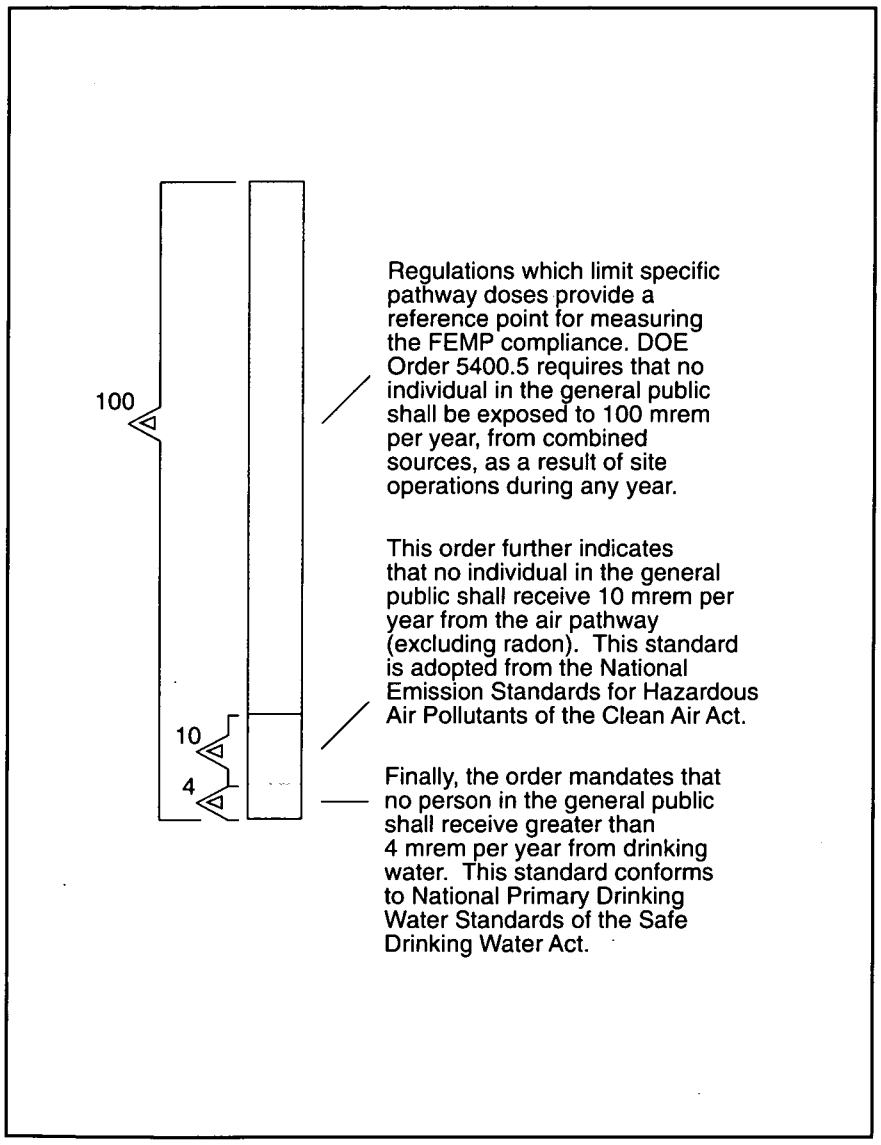

Figure 6-1. DOE Dose Limits

The collective effective dose from 1997 airborne emissions to the population within 50 miles (80 km) of the FEMP was also calculated by the CAP88-PC model. This dose was estimated to be 9.7 person-rem for a population of 2.7 million. For comparison, the same group of people received an estimated collective effective dose of 300,000 person-rem from background radiation, excluding radon.

Radon is subject to different regulations than other components of the air pathway. DOE Orders place limits on the concentration of radon but do not place limits on the dose from radon. Therefore, radon is not included as a component of the air pathway when calculating dose from FEMP emissions.

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Estimated Dose from Eating Produce Grown Near the FEMP

Uranium deposited onto soil during the years the FEMP was in production may be absorbed by produce and thereby deliver a secondary pathway dose. This secondary pathway dose is estimated using the conservative assumption that a large fraction of a person's diet of vegetables comes from gardens and farms in the FEMP area. This modeled diet assumes an annual consumption of 100 pounds (45 kg) of grains (corn and soybeans) and 100 pounds (45 kg) of other vegetables (tomatoes and squash). To represent the foods in the diet, samples of corn, soybeans, tomatoes, and squash from local gardens and farms were analyzed for total uranium. The maximum total uranium concentration found in locally grown foods was used to estimate dose. The average total uranium background concentration in foods was subtracted from the maximum concentration to account for the natural occurrence of uranium in foods.

The committed effective dose received was calculated to be 0.1 mrem. This dose is comparable to the estimated doses from produce in previous years and is well below the 100 mrem per year limit for all pathways. Furthermore, this data, in conjunction with previous year's data, confirms that past and current emissions from the FEMP have had no substantial impact on produce grown in the area.

Direct Radiation Dose

Direct radiation dose is the result of radiation (i.e., gamma and x-rays) emitted from radionuclides stored on site. The largest sources of direct radiation are the wastes stored in the K-65 Silos and the thorium compounds stored at selected locations on site. Direct radiation dose is estimated using environmental thermoluminescent dosimeter measurements, rather than through the use of computer models.

The direct radiation dose was estimated using the highest dose from the fenceline monitoring locations (Figure 5-5) and subtracting the average dose measured at background thermoluminescent dosimeter locations 18, 19, 20, 21, 30, and 33, as shown in Figure 5-5. Limits in the precision on thermoluminescent dosimeter data and variations in natural background radiation require consideration of the uncertainty (the plus/minus [±] values) associated with each measurement in calculating dose. The uncertainty is calculated for a 95 percent confidence interval (two standard deviations) around the average.

From the data in Table 5-4, the highest 1997 fenceline dose occurred at location 6 and is 79 ± 11 mrem per year (two standard deviations). The average background dose from locations 18, 19, 20, 21, 30, and 33 is 63.8 ± 12.2 mrem per year. The data indicate that the highest fenceline dose is between 68 mrem (79 - 11 mrem) and 90 mrem (79 + 11 mrem) per year, while the average background dose is between 51.6 mrem (63.8 - 12.2 mrem) and 76 mrem (63.8 + 12.2 mrem) per year. Because the range of background and the range of fenceline doses overlap, there is no firm basis for stating that there is a difference between the fenceline and average background doses. Given this lack

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of significant statistical difference between the doses, no dose was attributed to direct radiation for 1997.

Total of Doses to a Maximally Exposed Individual

The maximally exposed individual is a hypothetical member of the public who receives the highest calculated effective dose based on the location of his or her home, weather conditions, and the individual pathway doses. Because it is not possible to single out a specific individual in the FEMP area who receives the most dose, the results of the individual pathways and the CAP88-PC evaluation are added to predict the maximum dose that a person could receive. The dose to the maximally exposed individual (Table 6-1) is a total of estimated doses from breathing 1997 airborne emissions (excluding radon), eating produce grown near the FEMP, and receiving the direct radiation dose at the FEMP fenceline. The conservative assumptions used throughout the dose calculation process ensure that the dose to the maximally exposed individual is the upper limit of the actual dose any member of the public receives. The 1997 dose to the maximally exposed individual is estimated to be 1.5 mrem, which is well below the guideline of 100 mrem per year for all pathways. Figure 6-2 shows the doses to the maximally exposed individual from 1993 through 1997. Although an increasing trend is evident in Figure 6-2, it is important to note that the dose to the maximally exposed individual is below applicable DOE guidelines and EPA limits. Futhermore, the slight increase for 1997 is attributable to the substantial amount of activity at the FEMP and confirms that techniques used to control fugitive emissions (dust) from remediation projects were effective.

TABLE 6-1
DOSE TO MAXIMALLY EXPOSED INDIVIDUAL

Pathway	Dose Attributable to the FEMP	Applicable Guideline
Air		
Estimated 1997 emissions	1.4 mrem	10 mrem/air
Produce grown in Fernald area	0.1 mrem	100 mrem/all pathways
Direct radiation	0.00 mrem	100 mrem/all pathways
Maximally exposed individual	1.5 mrem	100 mrem/all pathways

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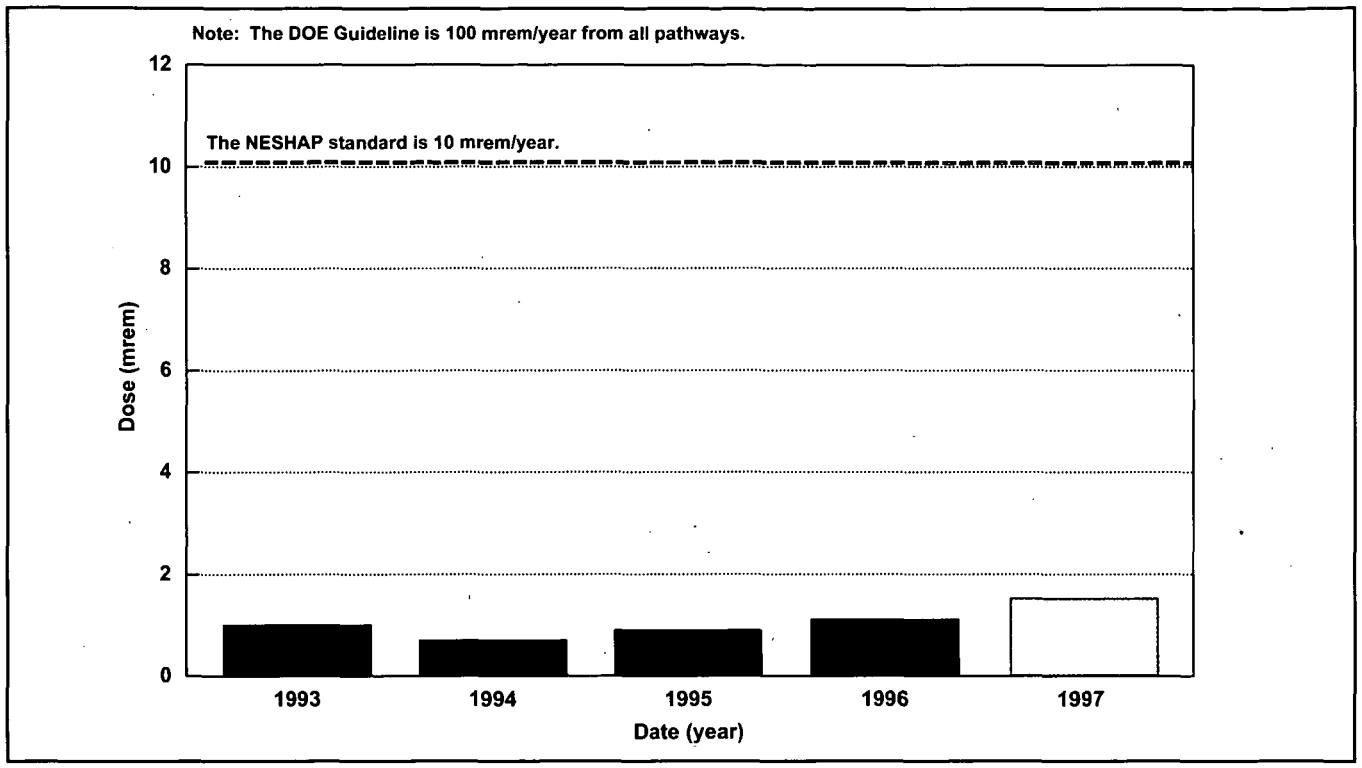

Figure 6-2. Dose to Maximally Exposed Individual, 1993-1997

Significance of Estimated Radiation Doses for 1997

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 per year from natural sources, excluding radon. For example, the dose received each year from cosmic and terrestrial background radiation contributes approximately 26 mrem and 28 mrem, 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, while living in the Denver area would contribute approximately 125 mrem 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 from the FEMP is much less than background. 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. A dose that is small in comparison to that of background radiation will produce no measurable health effects.

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 has recommended that members of the public receive no more than 100 mrem per year. As a result of this recommendation, DOE has incorporated 100 mrem per year as the limit in Order 5400.5. The sum of all estimated doses from FEMP operations for 1997 was well below this limit.

Chapter 7
Natural Resources

Natural Resources

This chapter provides background information on the natural resources associated with the FEMP and summarizes the 1997 activities relating to these resources. Included in this chapter is a discussion of the following:

- Threatened and endangered species
- Cultural resources
- Impacted habitat areas.

Much of the 1,050 acres (425 hectares) of the FEMP property is undeveloped land that provides habitat for a variety of animals and plants. These areas, which are termed natural resources, include wetlands, deciduous and riparian (stream side) woodlands, old fields, grasslands, and aquatic habitats, like Paddys Run. Some of these areas provide habitat for state and federal endangered species. Cultural resources, such as archaeological sites, can also be found at the FEMP. These resources are considered in the Natural Resource Impact Monitoring Plan which was developed in 1997 and included in the IEMP. The plan outlines a monitoring and reporting approach to status several priority natural resources in order to remain in compliance with the pertinent regulations and agreements.

Sloan's Crayfish - The state-listed threatened Sloan's Crayfish (Orconectes sloanii) is a small crayfish found in the streams of 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 FEMP 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 FEMP along the wooded banks of the northern reaches of Paddys Run. The habitat provides an extensive mature canopy from older trees and water throughout the year.

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 FEMP. However, because Running Buffalo Clover is found nearby in the Miami Whitewater Forest, the potential exists for this species to establish at the FEMP. The Running Buffalo Clover prefers habitat with well-drained soil, filtered sunlight, 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 FEMP. However, suitable habitat exists in portions of the northern woodlot.

Threatened and Endangered Species

The Endangered Species Act requires the protection of any federally listed threatened or endangered species, as well as any critical habitat that is essential for the species' existence. Several Ohio laws mandate the protection of state-listed endangered species as well. The FEMP conducted surveys in 1993 and 1994 to establish baseline information on any threatened or endangered species that may be found at the FEMP. As a result of these surveys, the state-listed threatened Sloan's Crayfish is the only threatened or endangered species determined to have a known population on the FEMP property. However, there is the potential for the presence of other state- and federally listed threatened and endangered species, such as the Indiana Brown Bat, Running Buffalo Clover, and Spring Coral Root, because each of their habitat ranges encompass the FEMP. No surveys were conducted in 1997 for the Indiana Brown Bat, Running Buffalo Clover, or Spring Coral Root because no remediation activities occurred within their respective potential habitat areas. Figure 7-1 shows the habitats and potential habitats of these species.

Sloan's Crayfish Monitoring and Provisions for Protection

As identified above, in 1993 and 1994, a population of the state-listed threatened species Sloan's Crayfish was found in the northern reaches

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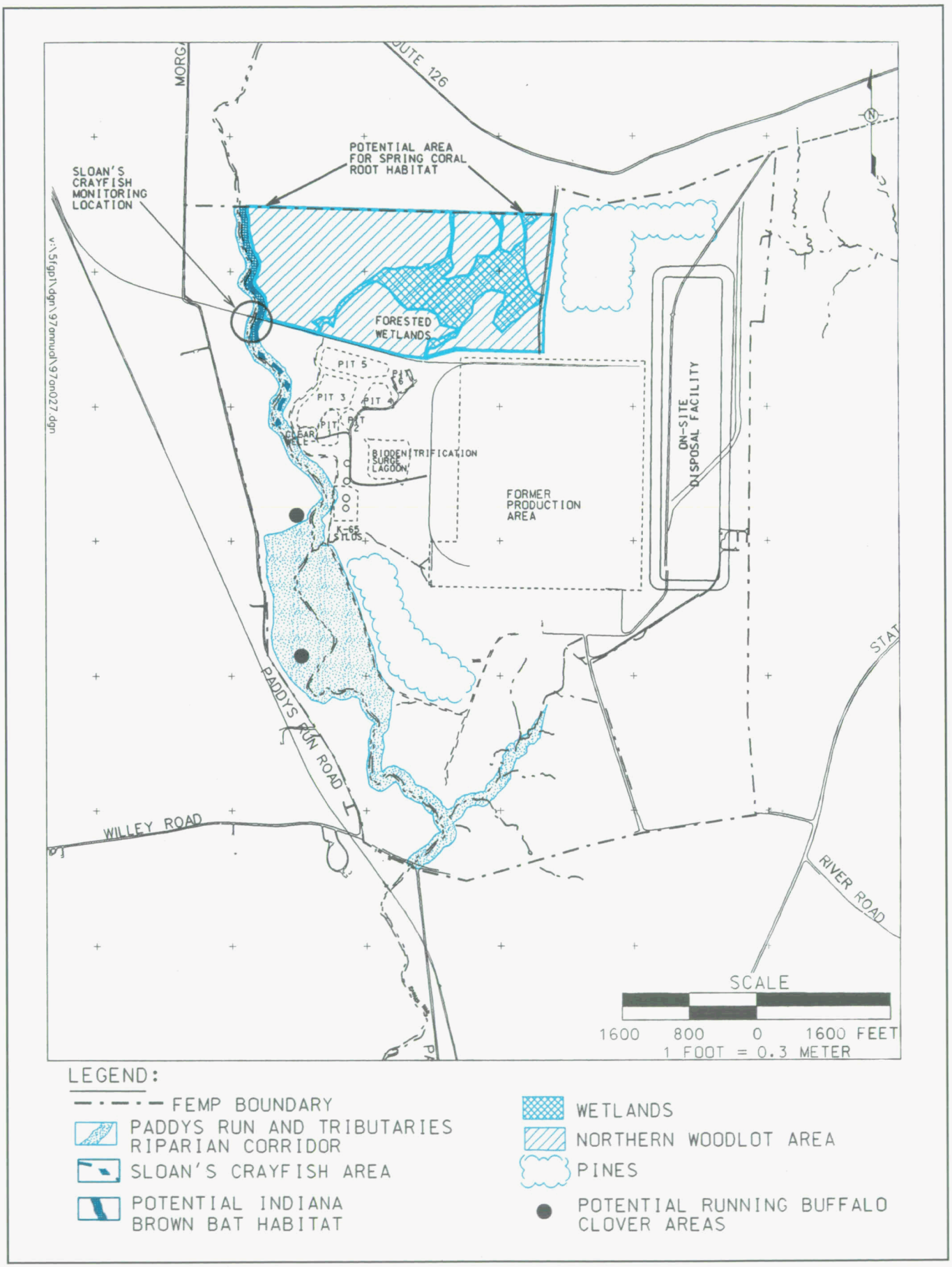

Figure 7-1. Priority Natural Resource Areas

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of Paddys Run. In 1996, a follow-up survey for the Sloan's Crayfish was conducted in Paddys Run; the survey found a large, healthy population still residing in the creek.

A significant rain event is considered to be 0.5 inch (1 cm) or more of rain in one storm event. There were approximately 20 significant rainfall events in 1997.

During 1997, visual field inspections of sediment loading in the Sloan's Crayfish habitat area were conducted within 24 hours of a significant rain event. The purpose of this monitoring was to determine if there was an increase of sediment in the northern reaches of Paddys Run due to FEMP activities. Sediment loading can adversely impact the Sloan's Crayfish by restricting its ability to "breathe" in water. If site activities caused sustained (four to five days) increased sediment loading to Sloan's Crayfish habitat in Paddys Run, then alternatives such as crayfish relocation would be considered.

Results of approximately 20 visual field inspections conducted in 1997 indicated that sediment loading from site activities has not impacted Sloan's Crayfish habitat in Paddys Run. When higher sediment loading conditions were observed, these conditions appeared to be a function of upstream influences unrelated to site activities. Field notes indicated that these higher sediment loading conditions persist for only one day or less following each rain event. Based on these findings, the FEMP has recommended to the EPA and OEPA to discontinue visual field inspections and is awaiting approval, which is expected to occur during early 1998. Visual field inspections will be reinitiated if significant soil disturbances occur in the drainage areas discharging to Paddys Run or if storm water control inspections indicate that sediment controls are not functioning properly. The routine inspections associated with storm water controls will continue and provide the necessary measure of protection to ensure that the Sloan's Crayfish habitat is not adversely impacted.

Cultural Resources

Factors such as geologic setting, surface water, soil, vegetation, and climate determine the population and cultural growth of an area. The FEMP and surrounding area are located in a region of rich soil and many sources of water, such as the Great Miami River. As a result, the area has rich cultural resource diversity. This diversity is by the number of historical periods represented in the area's history. These periods include the Paleo-Indian Occupation (12000 B.C. to 8000 B.C.), Archaic Occupation (8000 B.C. to 1000 B.C.), Woodland Tradition (1000 B.C. to 1000 A.D.), Mississippian Tradition (1000 A.D. to 1660 A.D.), and Historic Times (1660 A.D. to present).

Several laws have been established in order to protect cultural resources. The National Historic Preservation Act requires that DOE take into consideration the effects of its actions on sites that are either listed or eligible for listing on the National Register of Historic Places, sites which are termed "historic properties." Also, certain Native American artifacts, such as human remains, funerary objects, and sacred objects, are protected under the Native American Graves Protection and Repatriation Act.

Pursuant to implementing regulations for these laws, DOE has worked with the Advisory Council on Historic Preservation and the Ohio Historic Preservation Office to develop two programmatic agreements for the FEMP. These agreements specify all activities required to consider and protect cultural resources at the FEMP. As a result, DOE must survey for and recover historic properties prior to any ground-disturbing activity in non-contaminated or previously undisturbed areas. Once construction activities start, DOE must have

contingency plans in place if unexpected cultural resources are uncovered. The site has implemented procedures to ensure effective contingency plans are in place.

Prior to 1997, there were three known historic sites located on FEMP property (Figure 7-2). These sites consist of either prehistoric Native American artifacts or historic homesites. One of the sites at the FEMP is associated with both prehistoric and historic time periods.

TABLE 7-1
UNEXPECTED DISCOVERIES FOUND IN 1997

Unexpected Discovery*
Chert Blade (Prehistoric affiliation. Age unknown)
Kirk Corner Notched Cluster (7500 to 6900 B.C.)
Unnotched Pentagonal Cluster (500 to 1000 A.D.)
Spear Weight (10000 B.C. to 1000 A.D.)
Bone Handle (Prehistoric affiliation. Age unknown)

*No further excavation is warranted.

For 1997, most remediation activities at the FEMP occurred in areas that were already surveyed or otherwise exempt from cultural resource survey requirements (i.e., previously disturbed areas). However, there were five unexpected discoveries encountered during remediation activities in 1997 (Table 7-1). Figure 7-2 identifies the areas that have been surveyed and the location of the unexpected discoveries. In each case, archaeologists determined that the unexpected discoveries were not of a level of significance to prompt further excavation. No Native American Graves Protection and Repatriation Act items were uncovered in 1997.

Impacted Habitat Areas

Wetlands are defined as areas covered or saturated with water for enough time to support growth of hydrophytic (water-loving) vegetation and the formation of hydric soil.

Sensitive habitat impact reporting fulfills requirements set forth in the Natural Resources Impact Monitoring Plan. Current negotiations with the FEMP natural resource trustees involve the formulation of a comprehensive restoration plan based on an estimate of past and future impacts to FEMP natural resources. The FEMP natural resource trustees require that several different habitats be monitored to compare estimated impacts with actual impacts. There are five habitat areas monitored for impacts: northern woodlot/pines, southern pines and waste units, grasslands, Paddys Run corridor, and wetlands. Figure 7-3 identifies the cumulative areas that were impacted through the end of 1997.

Approximately 55 acres (22 hectares) of habitat were impacted in 1997 bringing the total impacted habitat acreage to approximately 110 acres (44.5 hectares). It is estimated that a total of 305 acres (123 hectares) will ultimately be impacted through final remediation of the site. The extent of each impacted habitat area was surveyed using a Global Positioning System, or by visual observation in the case of wetlands associated with the waste pits/process areas. Wetlands are protected under the Clean Water Act, as well as other federal regulations. A wetlands delineation of the FEMP was conducted in December 1992 and approved by the U.S. Army Corps of Engineers in August 1993. A total of 36 acres (15 hectares) of freshwater wetlands were delineated on the FEMP. In 1997, an additional 0.5 acre (0.2 hectare) wetland was identified.

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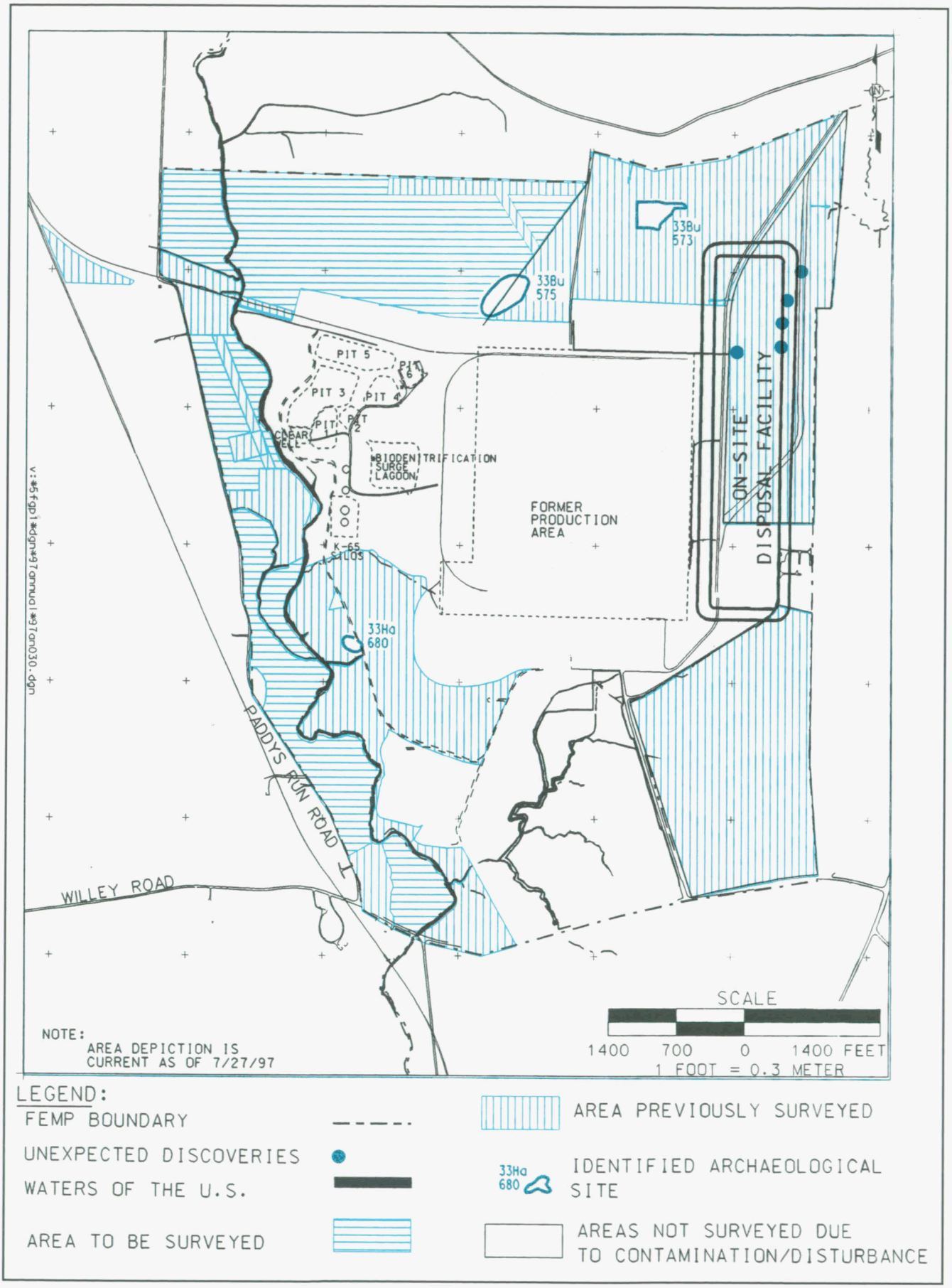

Figure 7-2. Cultural Resource Survey Areas

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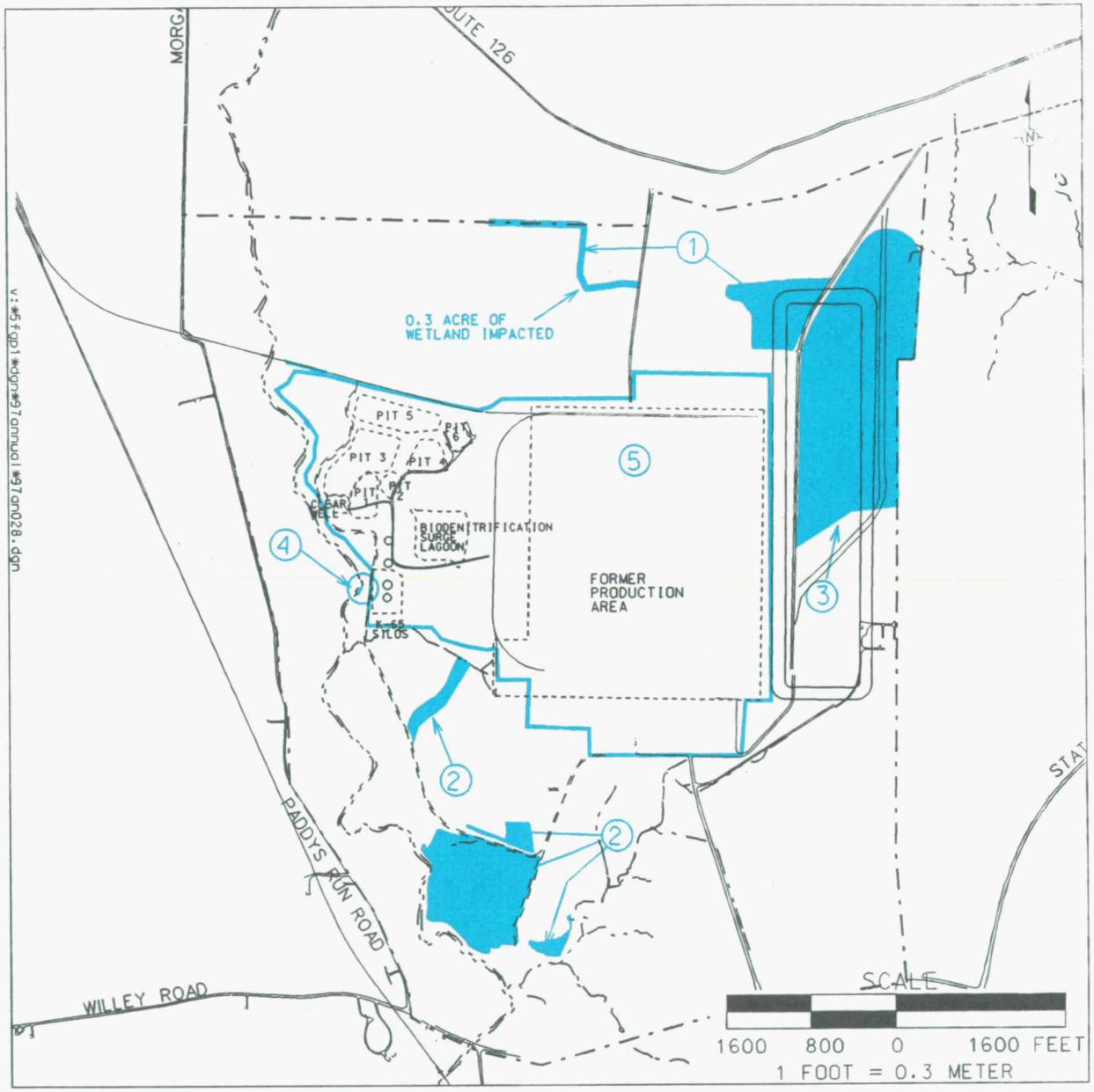

LEGEND:

—·—·— FEMP BOUNDARY

IMPACTED HABITAT AREAS:	TOTAL IMPACTED ACREAGE/HECTARES:
① NORTHERN WOODLOT/PINES	9.77 (3.95)
(WETLANDS)	0.3 (0.1)
② SOUTHERN PINES/ WASTE UNITS	24.32 (9.84)
③ GRASSLAND	55.10 (22.30)
④ PADDYS RUN CORRIDOR	11.07 (4.48)
⑤ WETLANDS ASSOCIATED WITH WASTE PITS/PROCESS AREA	10.00 (4.05)

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Figure 7-3. Impacted Habitat Monitoring Map

Wetlands

By the end of 1997, 10.3 acres (4.17 hectares) of wetlands had been impacted. The impacted wetland acreage is identified on Figure 7-3 and has occurred at two locations: within the waste pits/process area and within the northern woodlots due to an access road that was installed to reach an air monitoring station. During the remediation process, impacts to wetlands will be mitigated in accordance with the Clean Water Act.

Glossary

ALARA — A phrase and acronym (As Low As Reasonably Achievable) used to describe an approach to radiation exposure and emissions control or management whereby the exposures and resulting doses to the public are maintained as far below the specified limits as economic, technical, and practical considerations will permit.

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

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

ARARs — 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. These depend on whether the requirement is triggered by the presence or emission of a chemical, by a vulnerable or protected location, or by a particular action.

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

Baseline Risk Assessment — The study that characterized the threats to human health and the environment that may be posed by contaminants within FEMP soil, groundwater, sediment, and surface water.

Bedrock — Any solid rock exposed at the surface of the earth or overlain by unconsolidated material.

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.

Bulking — Consolidation of small volumes of materials from multiple containers into a single container.

Bypass Events

A bypass event occurs when storm water is bypassed around treatment and is directly discharged to the Great Miami River via the FEMP 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 FEMP's storm water retention capacity is in danger of being exceeded.

Confidence Interval

A value interval that has a designated probability (the confidence coefficient) of including some defined parameter of the population.

Conservative Estimate

Used frequently in environmental monitoring and dose calculation, it is based on assumptions about an exposure situation that should result in the highest reasonable estimate of a dose.

Contaminant

A substance that when introduced to air, surface water, sediment, soil, or groundwater causes degradation of the media.

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.

Drum Equivalent

The number of 55-gallon drums that it would take to contain a given volume of waste.

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. The FEMP ecological receptors were: the white-footed deer mouse, the western meadow vole, pine trees, and shiners.

Effective Dose Equivalent

The summation 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 health-effects risk of 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.

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FEMP — The Fernald Environmental Management Project, the present name (beginning August 23, 1991) for the former Feed Materials Production Center near Fernald, Ohio.

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

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

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

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

Headworks — 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.

Holding Time — The maximum allowable time from sample collection to laboratory analysis.

Hydrology — The study of the properties, distribution, and circulation of water through the local environment.

Implosion — A demolition method used at the FEMP to collapse structures with minimal damage to the surrounding infrastructure. This method employs strategic cutting of horizontal beams and vertical load-bearing columns and detonation of explosives to accomplish structural collapse.

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

Monitoring Well — A well that is used to collect groundwater samples to monitor the water quality. It may be used to monitor groundwater level fluctuations.

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.

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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 potentially 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 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.

Thermoluminescent Dosimeter A devised used to monitor the amount of radiation to which it has been exposed.

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 FEMP waste (such as the Nevada Test Site) have specific waste acceptance criteria. In addition, the FEMP on-site disposal facility has waste acceptance criteria that have been approved by the regulatory agencies. The FEMP Waste Acceptance Operations is responsible for ensuring that all waste to be placed in the on-site disposal facility meet all these criteria before waste placement.

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