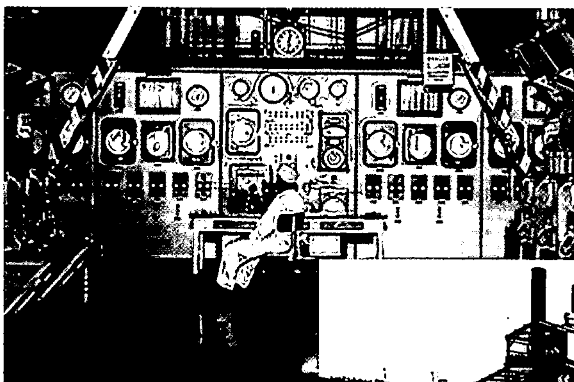
1998 Integrated Site Environmental Report

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

-- 2479



PAST

PRESENT

FUTURE

FERNALD
Environmental Management Project

By Fluor Daniel Fernald

Issued June 1999

51350-RP-0002
Rev. 1

000001

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

Table of Contents

--2479

000002

000003

Appendices - 1998 Environmental Summary (Volume 1)

000004

List of Figures

000005

2479

List of Tables

000006

List of Acronyms

ALARA	as low as reasonably achievable
AMS	air monitoring station
ARAR	applicable or relevant and appropriate requirement
BTV	benchmark toxicity value
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
FEMP	Fernald Environmental Management Project
FFA	Federal Facility Agreement
FFCA	Federal Facility Compliance Agreement
FRL	final remediation level
gpm	gallons per minute
ICRP	International Commission on Radiological Protection
IEMP	Integrated Environmental Monitoring Plan
NCRP	National Council on Radiation Protection
NEPA	National Environmental Policy Act
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
SARA	Superfund Amendment and Reauthorization Act
SWRB	Storm Water Retention Basin
TLD	thermoluminescent dosimeter
TSCA	Toxic Substance Control Act

000007

Jnits (Abbreviations) and Conversion Table 2479

ultiply	By	To Obtain	Multiply	By	To Obtain
ches (in)	2.54	centimeters (cm)	cm	0.3937	in
et (ft)	0.3048	meters (m)	m	3.281	ft
iles (mi)	1.609	kilometers (km)	km	0.6214	mi
ounds (lb)	0.454	kilograms (kg)	kg	2.205	lb
ns	0.9072	metric tons	metric tons	1.102	tons
allons	3.785	liters (L)	L	0.2642	gallons
quare feet (ft^2)	0.0929	square meters (m^2)	m^2	10.76	ft^2
cres	0.4047	hectares	hectares	2.471	acre
ubic yards (yd^3)	0.7646	cubic meters (m^3)	m^3	1.308	yd^3
ubic feet (ft^3)	0.02832	cubic meters (m^3)	m^3	35.31	ft^3
icocuries (pCi)	10^{-12}	curies (Ci)	Ci	10^{12}	pCi
Ci/L	10^{-6}	microcuries per liter (µCi/L)	µCi/L	10^{6}	pCi/L
i	3.7×10^{10}	becquerels (Bq)	Bq	2.7×10^{-11}	Ci
Ci	0.037	Bq	Bq	27.03	pCi
illirem (mrem)	0.001	rem	rem	1000	mrem
m	0.01	Sievert	Sv	100	rem
illigrams per liter (mg/L)	1000	micrograms per liter (µg/L)	µg/L	0.001	mg/L
ahrenheit (°F)	(°F - 32) x 5/9	Celsius (°C)	°C	(°C x 9/5) + 32	°F
or Natural Uranium in Water					
Ci/L	0.0015	mg/L	mg/L	675.7	pCi/L
Ci/L	1.48	µg/L	µg/L	0.6757	pCi/L
g/L	0.6757	pCi/L	pCi/L	1.48	µg/L
or Natural Uranium in Soil					
Ci/g	1.48	µg/g	µg/g	0.6757	pCi/g
ng/kg	1	µg/g	µg/g	1	mg/kg

000008

2479

Executive Summary

2479

Executive Summary

The Fernald Environmental Management Project's (FEMP) 1998 Integrated Site Environmental Report is prepared in accordance with U.S. Department of Energy (DOE) Order 5400.1, General Environmental Protection Program, and the FEMP's Integrated Environmental Monitoring Plan (IEMP) (DOE 1997c). This annual report provides FEMP stakeholders with the results from the FEMP's environmental monitoring program for 1998 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. All information presented in this Executive Summary is discussed more fully within the body of this summary report and the supporting appendices.

During 1998 the FEMP made significant progress toward achieving the final cleanup goals established for the site. A wide range of environmental remediation activities continued during the year including:

- Decontamination and dismantlement of former production buildings and support facilities (Operable Unit 3)
- Large-scale excavation of contaminated soils (Operable Unit 5)
- Placement of approximately 200,000 cubic yards (150,000 cubic meters) of contaminated soil and debris in the on-site disposal facility (Operable Unit 2)
- Extraction and treatment of contaminated groundwater from the Great Miami Aquifer (Operable Unit 5).

In conjunction with these ongoing activities, the FEMP made final preparation for implementing the remedial actions for the waste pits (Operable Unit 1) which includes the excavation, processing, and shipment of waste materials to a commercial off-site disposal facility beginning in 1999. The FEMP also moved forward with the evaluation of technologies for stabilizing the K-65 Silos 1 and 2 wastes and stabilization technologies for the Silo 3 wastes (Operable Unit 4).

The following sections highlight the results of environmental monitoring activities conducted during 1998.

Liquid Pathway Highlights

Groundwater Pathway

The groundwater pathway is routinely monitored at the FEMP to:

- Determine capture and restoration of the total uranium plume, capture and restoration of non-uranium final remediation level (FRL) constituents, and water quality conditions in the aquifer that indicate a need to modify the design and installation of restoration modules
- Meet compliance-based groundwater monitoring obligations.

000010

During 1998 active restoration of the Great Miami Aquifer began with key portions of the enhanced groundwater remedy coming on line including:

- South Field (Phase 1) Extraction Module - 10 extraction wells became operational on July 13, 1998.
- South Plume Optimization Module - two extraction wells became operational on August 9, 1998.
- Re-Injection Demonstration Module - five re-injection/extraction wells became operational on September 2, 1998.

In addition, approximately 130 monitoring wells were sampled at various frequencies to determine water quality. Water elevations were measured quarterly in up to 161 monitoring wells. The following highlights describe the key findings from the 1998 groundwater data:

- 973.6 million gallons (3,685 million liters) of water were pumped from the Great Miami Aquifer and 150.9 million gallons (571.2 million liters) of groundwater were re-injected into the aquifer. As a result of these aquifer restoration activities, 424.9 pounds (192.9 kilograms [kg]) of uranium were removed from the aquifer.
- The results of 1998 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the enhanced groundwater remedy for the aquifer restoration system is appropriate. No new areas of contamination were identified which would require a modification of the enhanced groundwater remedy design.
- Pumping of the South Plume Module continues to meet the objective of preventing the further southward migration of the southern total uranium plume beyond the extraction wells.

Surface Water and Treated Effluent Pathway

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

In 1998 up to 15 surface water and treated effluent locations were sampled at various frequencies and 16 sediment locations were monitored. The following highlights describe the key findings from the 1998 surface water and treated effluent along with sediment data:

- The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 521 pounds [237 kg]) increased 38 percent from the 1997 estimate of 378 pounds (172 kg). This increase, in general, is attributable to above average rainfall during 1998 and to the additional groundwater extraction wells coming on line.

000011

- 2479

- No surface water or treated effluent analytical results from samples collected in 1998 exceeded the FRL for total uranium, the site's primary contaminant. FRL and benchmark toxicity value (BTV) (DOE 1995c) exceedances in surface water samples were limited to five and three constituents, respectively. These occasional, sporadic FRL and BTV exceedances are to be expected until site remediation is complete.

- Permitted discharges were in compliance with the current National Pollutant Discharge Elimination System (NPDES) Permit requirements 98.5 percent of the time. Exceedances of total suspended solids and chlorine residual limits accounted for the permit excursions observed in 1998. The FEMP is actively working to improve the performance of the effected treatment units to prevent future exceedances of these limits.

- On July 27, 1998, the FEMP received a Notice of Violation under the NPDES Permit from the Ohio Environmental Protection Agency (OEPA) concerning initiating earth work activities prior to the completion of a borrow area sediment trap to be used for sediment control. Additionally, OEPA determined the installed sediment trap was undersized. DOE/Fluor Daniel Fernald completed the work on the sediment trap on July 28, 1999, and the sediment trap was inspected and accepted by OEPA on July 29, 1999, thus satisfactorily resolving the issues raised by the Notice of Violation.

- The 1998 sediment results indicated a decrease in concentrations when compared to 1997 results. In addition, there were no FRL exceedances for any sediment result in 1998.

Air Pathway Highlights

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

Radiological Air Particulate Monitoring

- Data collected from the network of 16 fenceline and two background air monitoring stations showed that the annual average radionuclide concentrations were all less than one percent of DOE derived concentration guidelines contained in DOE Order 5400.5, Radiation Protection of the Public and the Environment.

- The maximum air inhalation effective dose equivalent at the site fenceline was estimated to be 0.26 millirem (mrem) at AMS-9C located on the eastern fenceline of the FEMP. This represents 2.6 percent of the National Emission Standards for Hazardous Air Pollutants Subpart H standard of 10 mrem.

000012

Radon Monitoring

- The annual average radon concentration (measured with alpha track-etch cups) recorded at the FEMP fenceline and off-property locations ranged from 0.1 ± 0.1 picoCuries per liter (pCi/L) to 0.8 ± 0.3 pCi/L. Fenceline and off-property results were well below the DOE standard of 3.0 pCi/L above background concentrations. Background concentrations measured in 1998 ranged between 0.1 ± 0.1 pCi/L to 0.3 ± 0.2 pCi/L.

- Radon concentrations in the vicinity of the K-65 Silos 1 and 2 (part of Operable Unit 4) continued to exhibit an increasing trend in 1998 as did the radon concentrations within the silo head space. The protective layer of bentonite clay placed over the silo material in 1991 to lower head space radon concentrations continued to lose effectiveness during 1998 due to the "drying out" of the clay. As of the fourth quarter 1998, the head space concentration in Silo 1 is still 47 percent lower than levels measured prior to the addition of the bentonite. The Silo 2 head space radon concentration is 71 percent below pre-bentonite levels.

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 and associated decay products in the head spaces of K-65 Silos 1 and 2. These levels remain approximately 65 percent lower than radiation levels measured in 1991 prior to the addition of the bentonite layer to K-65 Silos 1 and 2. Additionally, increases in direct radiation measurements at the FEMP western fenceline near the K-65 Silos were also identified in 1998.

Estimated Dose for 1998

In 1998 the hypothetical maximally exposed individual living nearest the FEMP in a west-southwest direction, could have received a maximum dose of approximately 8.2 mrem. This estimate represents the incremental dose above background attributable to the FEMP. This dose is exclusive of the dose received from radon. The contributions to this all pathway dose were 0.05 mrem from air inhalation dose and 8.16 mrem from direct radiation. This dose can be compared to the limit of 100 mrem for all pathways (exclusive of radon) 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 1998 the following activities associated with natural resource monitoring and restoration occurred:

- 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. The monitoring results indicated no significant impact from sediment loading to Paddys Run as a result of FEMP remediation activities.

000013

- An aesthetic barrier consisting of several rows of conifers and deciduous trees was installed on the FEMP property along Willey Road to reduce the view of excavations occurring in the southeast quadrant of the site.

- The Fernald Ecological Restoration Park was constructed on the western side of the site. This project provides an on-property wildlife viewing area that is accessible to the public. Several different habitats have been planted within this park and two public overlook areas are provided.

000014

2479

Chapter 1
The Fernald Environmental Management Project

The Fernald Environmental Management Project

2479

FEMP Abbreviated Timeline

1951 Construction of the Fernald site began

1952 Uranium production started (through 1989)

1986 EPA and DOE signed the Federal Facilities Compliance Agreement which initiated the remedial investigation/feasibility study process

1989 Uranium production was suspended, and formally ended in 1991

The Fernald site was placed on the National Priorities List, which is the list of CERCLA sites most in need of cleanup

1991 Mission changed from uranium production to environmental remediation and site restoration

To better characterize the level of cleanup and determine the appropriate remedy, the site was divided into study areas called operable units.

1993 Environmental remediation activities were initiated at the FEMP

1994 Environmental remediation activities under each of the operable unit's records of decision were initiated

1996 All five operable units had signed records of decision, signifying the end of the 10-year remedial investigation/feasibility study process

1997 Environmental remediation activities continued at the FEMP, including construction of Cell 1 of the on-site disposal facility with the first waste placement beginning in December

1998 Decontamination of nuclear buildings and facilities (Safe Shutdown) neared completion, full-scale aquifer restoration was implemented, excavated soil volumes exceeded expectations, and cell construction at the on-site disposal facility continued.

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

Uranium metal production at the Fernald site spanned more than 37 years (1952 through 1989). During that time, over 500 million pounds (227 million kilograms [kg]) of uranium metal products were delivered to other sites, and approximately 400,000 to 1,000,000 pounds (180,000 to 450,000 kg) of uranium were released to the environment. These environmental releases resulted in contamination of soil, surface water, sediment, and groundwater.

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 and the baseline risk assessment.

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

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

The CERCLA process ends with certification and site closure, which are followed by five-year reviews.

In 1991 the mission of the Fernald site officially changed from uranium production to environmental remediation and site restoration under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The site was renamed the Fernald Environmental Management Project (FEMP) to reflect the changing mission. Project activities at the FEMP are implemented by Fluor Daniel Fernald under the terms of a prime contract with DOE. Regulatory oversight is conducted by Region V of the U.S. Environmental Protection Agency (EPA) and the Southwest District Office of the Ohio Environmental Protection Agency (OEPA).

In the 1980s, an environmental monitoring program was initiated at the site to assess the impact of operations on the environment and monitor potential exposure pathways to the local community. The environmental monitoring program historically 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.

000016

However, with the conclusion of the FEMP's uranium production mission and completion of the CERCLA remedy selection process (with the exception of Operable Unit 4), focus is now being directed to the safe and efficient implementation of FEMP environmental remediation activities and facility decontamination and dismantlement 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. The FEMP's environmental monitoring program is described in the Integrated Environmental Monitoring Plan (IEMP) (DOE 1997c).

This 1998 Integrated Site Environmental Report summarizes the findings from the IEMP monitoring programs and provides a status on the progress toward final site restoration. The report consists of the following:

Summary Report This summary report (Chapters 1 through 7) documents the results of environmental monitoring activities at the FEMP in 1998. It includes a discussion of remediation activities and summaries of environmental data from groundwater, surface water and treated effluent, sediment, air and natural resources.

Appendices The appendices provide the 1998 environmental monitoring data for the various media, primarily in graphs and tables. The National Emission Standards for Hazardous Air Pollutants (NESHAP) (40 Code of Federal Regulations 61 Subpart H) (EPA 1985) compliance report is also included. This detailed information is summarized in the Summary Report.

The remainder of this chapter provides:

- A brief overview of the FEMP's current environmental remediation operations and a description of its current cleanup mission, organization, and major remediation activities
- A description of activities pertaining to monitoring environmental quality at the FEMP
- A description of the physical, ecological, and human characteristics of the area.

The Path to Site Restoration

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 environmental remediation. The remedy selection process culminated in 1996 with approval of the final records of decision for the operable units, although the Record of Decision for Operable Unit 4 is being amended.

000017

Following approval of the initial 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 was not the most effective organizational structure for completing remedial design and implementing the remedial actions. In order to align sitewide responsibilities and regulatory obligations across the operable units to most efficiently execute remedial design and remedial action, the FEMP established integrated project organizations in 1996. Realignment into project organizations reflected the actual work processes and operations necessary to complete remediation while maintaining the requirements of the FEMP's records of decision. 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.

Environmental Monitoring Program

Exposure Pathways

An **exposure pathway** is a route by which materials could travel between the point of release (a source) and the point of delivering a radiation or chemical dose (a receptor). At the 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/or the environment.

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

Refer to Chapter 6 for information pertaining to 1998 dose calculations from all pathways.

A key element in directing the focus of the environmental monitoring program presented in the IEMP is the depth of understanding of 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 1996b). Operable Unit 5 represents all of the FEMP's environmental media and contaminant exposure 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 areal extent of on- and off-property remedial actions necessary to provide permanent solutions to environmental concerns posed by the site. The results of the cleanup decisions reached for Operable Unit 5 and the information gained from the site characterization activities 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 medium. Through this process, environmental conditions at the FEMP are continuously evaluated, and these evaluations are 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.

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 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 is being 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 headworks 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.

TABLE 1-1
(Continued)

Operable Unit	Description	Remedy Overview[a]	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 will submit Record of Decision Amendment 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 concentration and mass-based discharge limits and FRLs in the Great Miami River. Excavation of contaminated soil and sediment to meet FRLs. Excavation of contaminated soil containing perched water that presents an unacceptable threat, through contaminant migration, to the underlying aquifer. On-site disposal of contaminated soil, and sediment that meet the on-site disposal facility waste acceptance criteria. Soil and sediment that exceed the waste acceptance criteria for the on-site disposal facility will be treated, when possible, to meet the on-site disposal facility waste acceptance criteria or will be disposed of at an off-site facility. Site restoration, institutional controls, and post-remediation maintenance	Aquifer Restoration and Wastewater Project is responsible for designing, installing, and operating the extraction/re-injection systems for Great Miami Aquifer groundwater restoration; for groundwater monitoring in the Great Miami Aquifer; for reporting on the progress of aquifer restoration; for designing, constructing, and operating all treated effluent discharge systems, and for treating and discharging 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.

[a]Source of information is each operable unit's record of decisions and remedial design documents.

2479

000020

- 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 changing remediation activities.

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

Characteristics of the Site and Surrounding Area

Both natural and human factors comprise the setting of the site and the surrounding area. Elements of the setting include: land use and demography, local geography, geology, surface hydrology, meteorological conditions, and natural resources.

Land Use and Demography

Economic activities in the area of the FEMP rely heavily on the physical environment. Land in the area is used primarily for livestock and crop farming and gravel pit operations. A private water utility is also located approximately 1.25 miles (2.01 kilometers [km]) upstream of the FEMP's effluent discharge to the Great Miami River. This utility pumps about 20 million gallons (76 million liters) of groundwater per day.

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

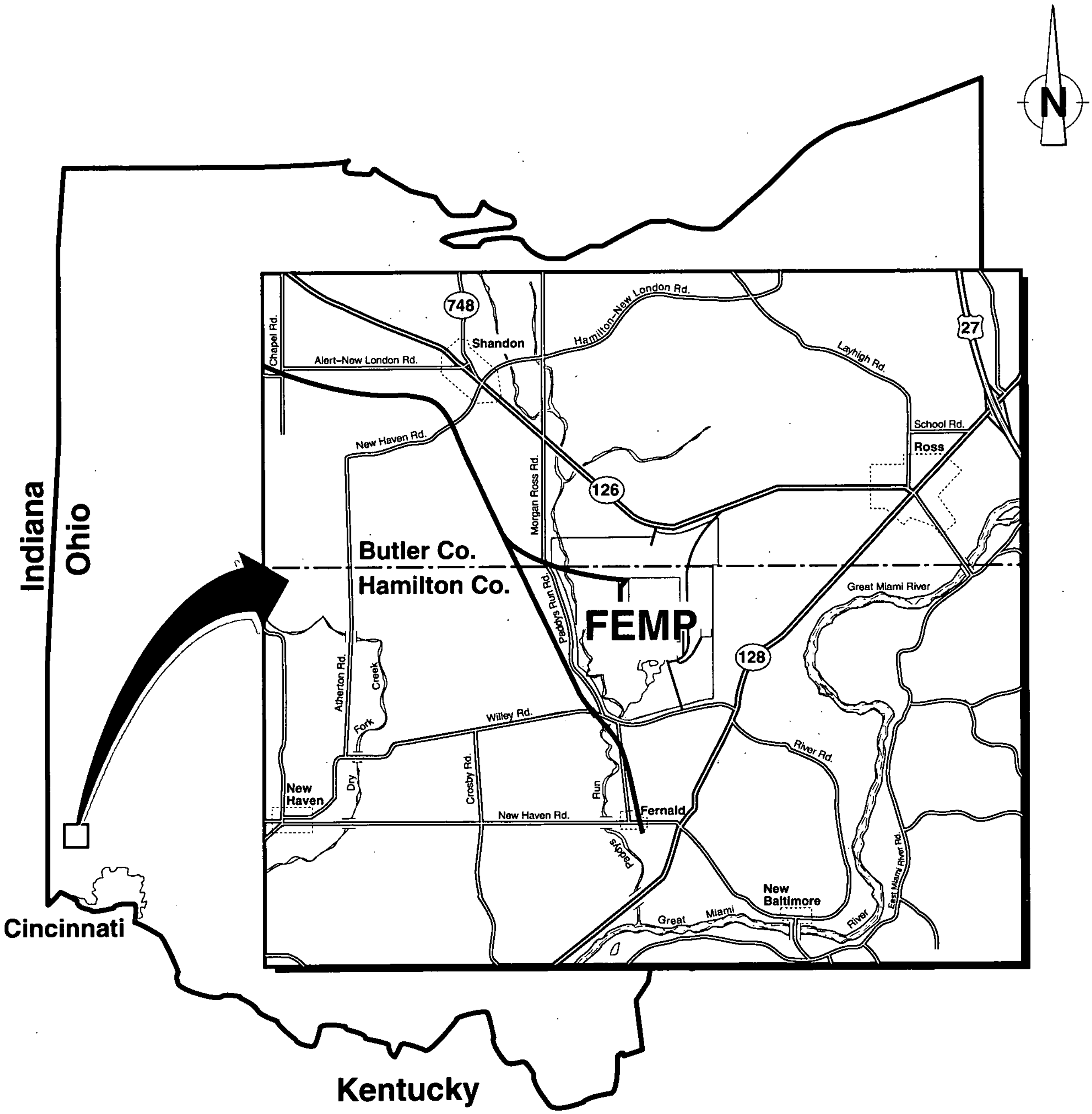
There is an estimated population of 14,600 within 5 miles (8 km) of the FEMP and an estimated 2.74 million within 50 miles (80 km). Figure 1-2 shows an estimate of population distribution in the surrounding areas.

Geography

Figure 1-3 depicts the location of the major physical features of the FEMP, such as the buildings and supporting infrastructure. The former production area and various administrative buildings dominate this view. The former production area occupies approximately 136 acres (55 hectares) in the center of the 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 terrace which slopes gently between vegetated bedrock outcroppings to the north, southeast, and southwest.

000021

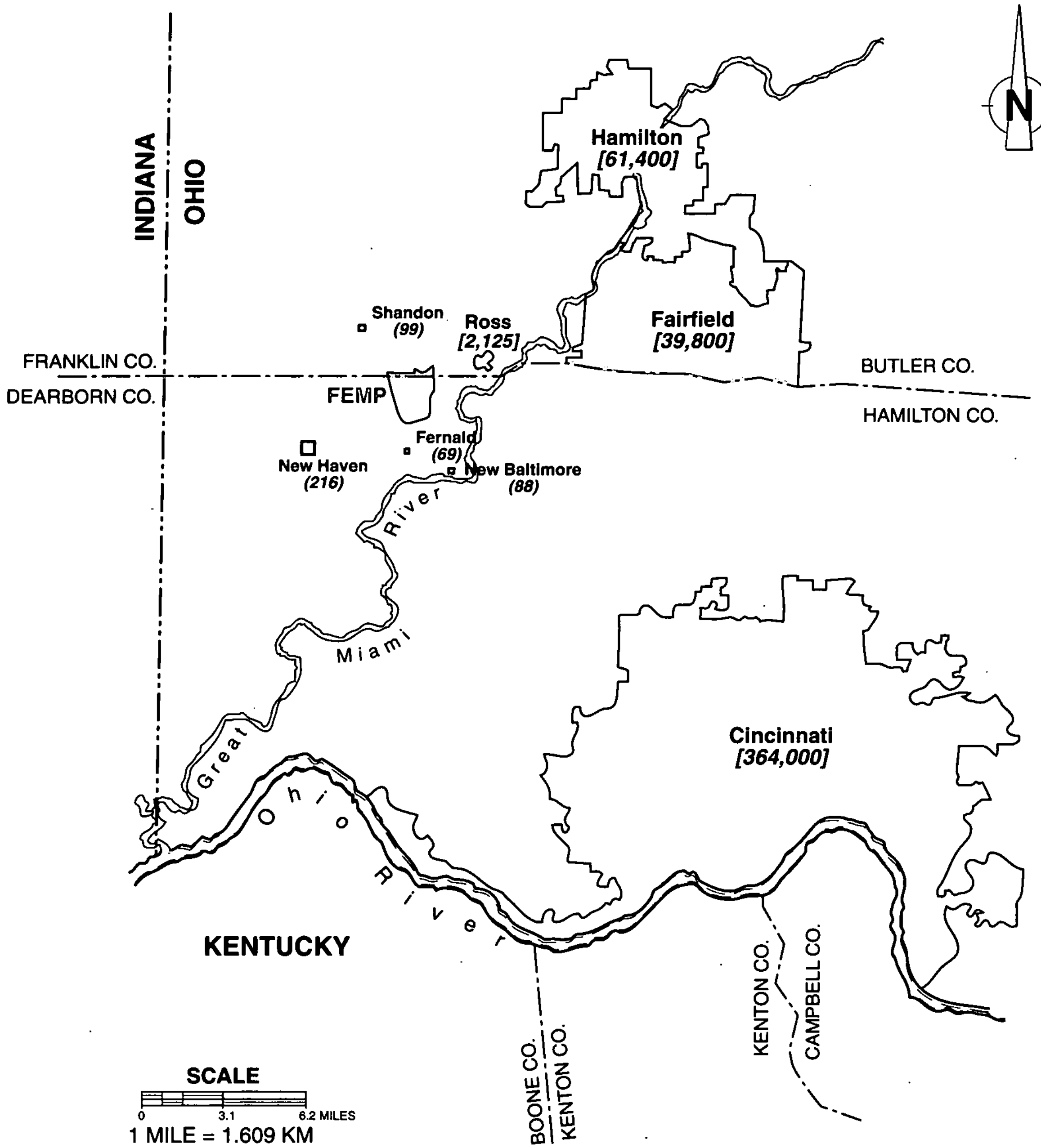
– 2479



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

Figure 1-1. FEMP and Vicinity

000022



LEGEND

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

000023

Figure 1-3. Fernald Site Perspective

Geology

- 2479

Bedrock in the area indicates that approximately 450 million years ago the Cincinnati area was covered by a shallow sea. Sediments which later became flat-lying shale with interbedded limestone were deposited in the shallow sea as evidenced by the abundance of marine fossils in the bedrock. In the more recent geologic past, the advance and retreat of three separate glaciers shaped the southwestern Ohio landscape. A large river drainage system south of the glaciers created river valleys up to 200 feet (61 meters) deep, which were then filled with sand and gravel when the glaciers melted. These filled river valleys are called buried valleys.

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

The Great Miami River and its tributaries have eroded significant portions of the glacial overburden and exposed the underlying sand and gravel of the Great Miami Aquifer. Thus, in some areas where the glacial overburden has been eroded away, precipitation and surface water runoff can easily migrate into the underlying Great Miami Aquifer, permitting contaminants to be transported to the aquifer as well. Natural and man-made breaches of the glacial overburden were key pathways where contaminated water entered the aquifer, causing the groundwater plumes that are being addressed by the FEMP's aquifer restoration activities. Figure 1-4 provides a glimpse into the structure of subsurface deposits in the region along an east-west cross-section through the 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 (refer to 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, waste pit area, and other selected areas is collected, treated, and discharged to the Great Miami River. Since January 1995, the majority of this runoff has been treated for uranium removal in the advanced wastewater treatment facility before being discharged. The Great Miami River, 0.6 mile (1 km) east of the 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.

000025

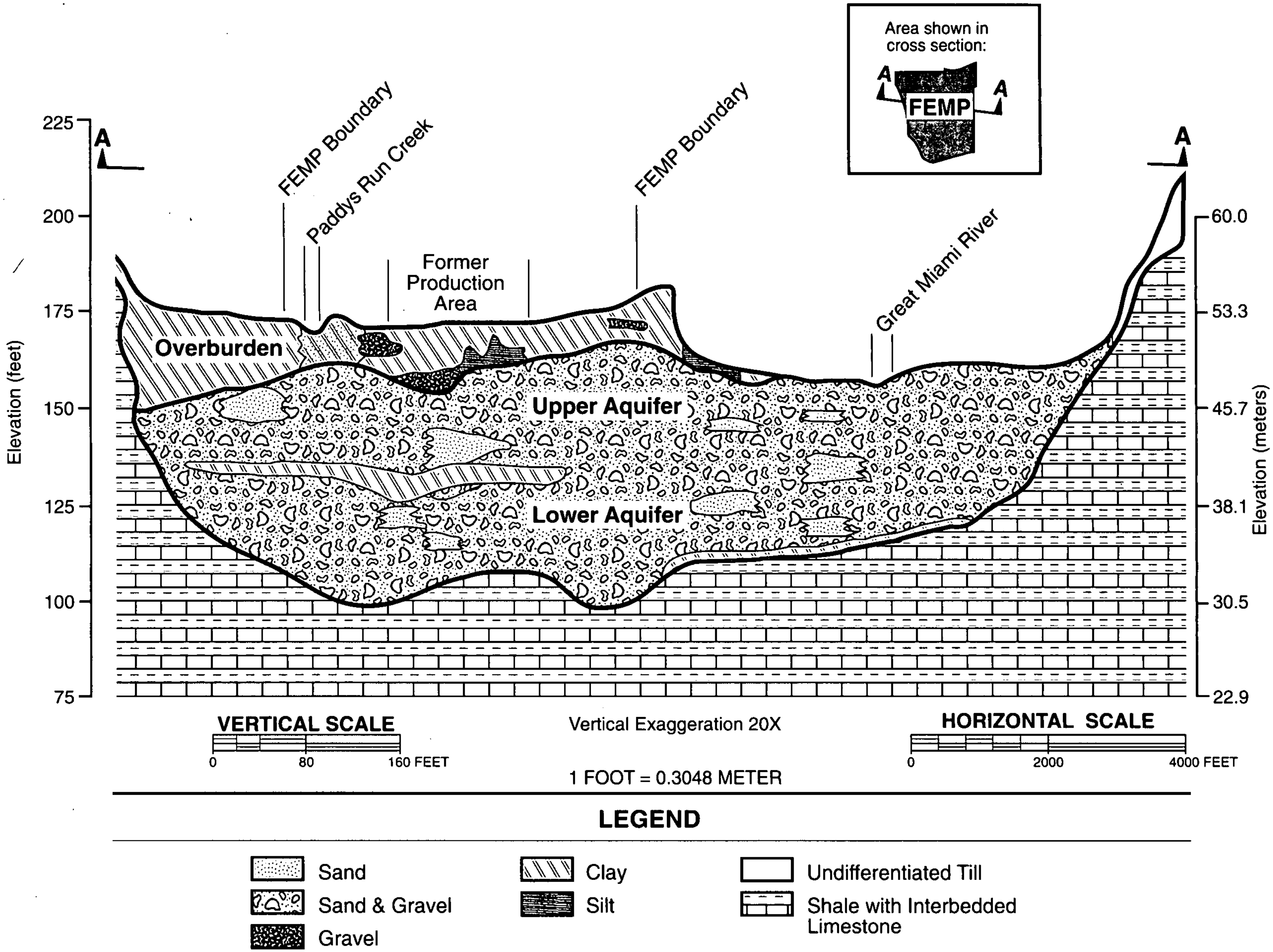


Figure 1-4. Cross-Section of the New Haven Trough, Looking North

000026

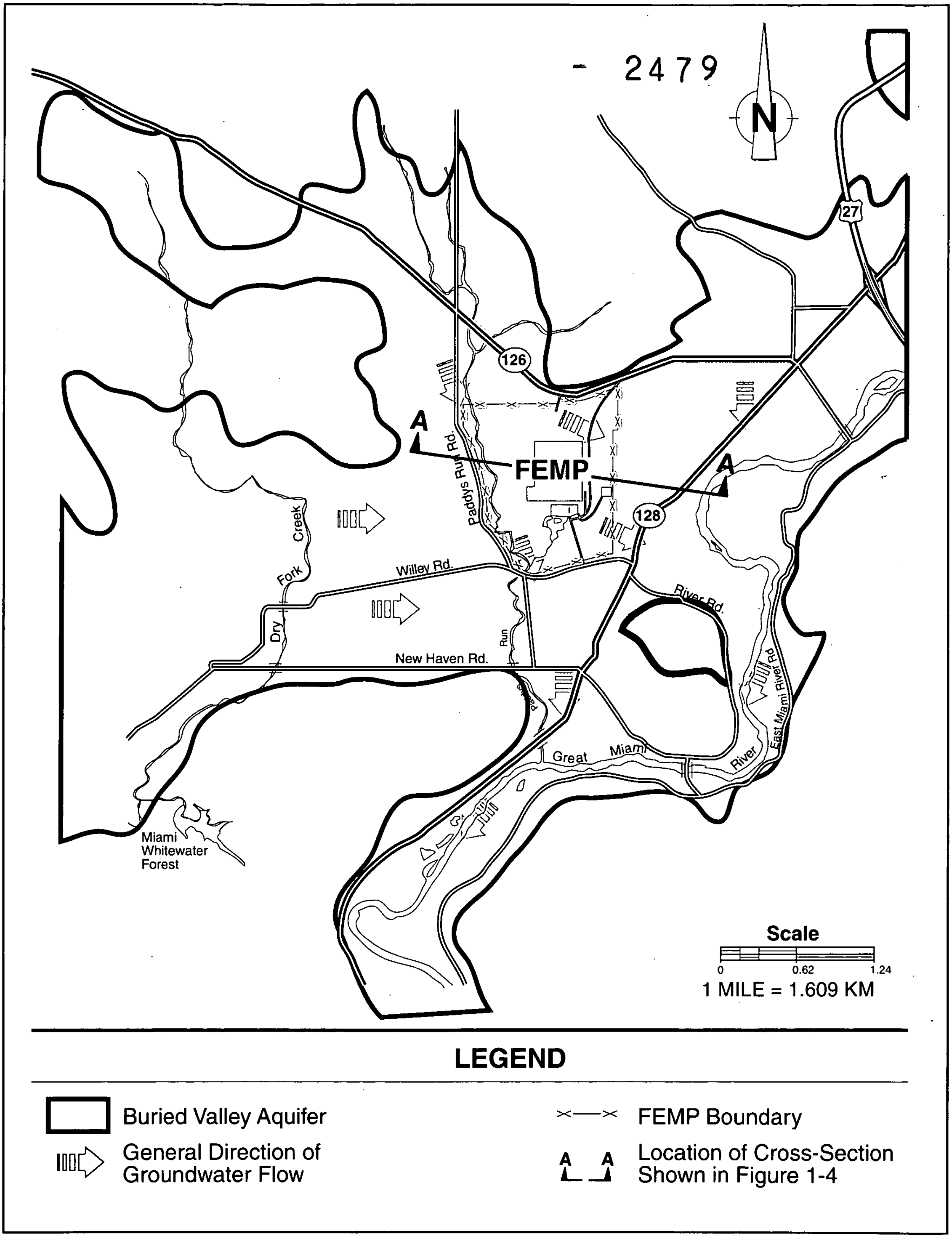


Figure 1-5. Regional Groundwater Flow in the Great Miami Aquifer

000027

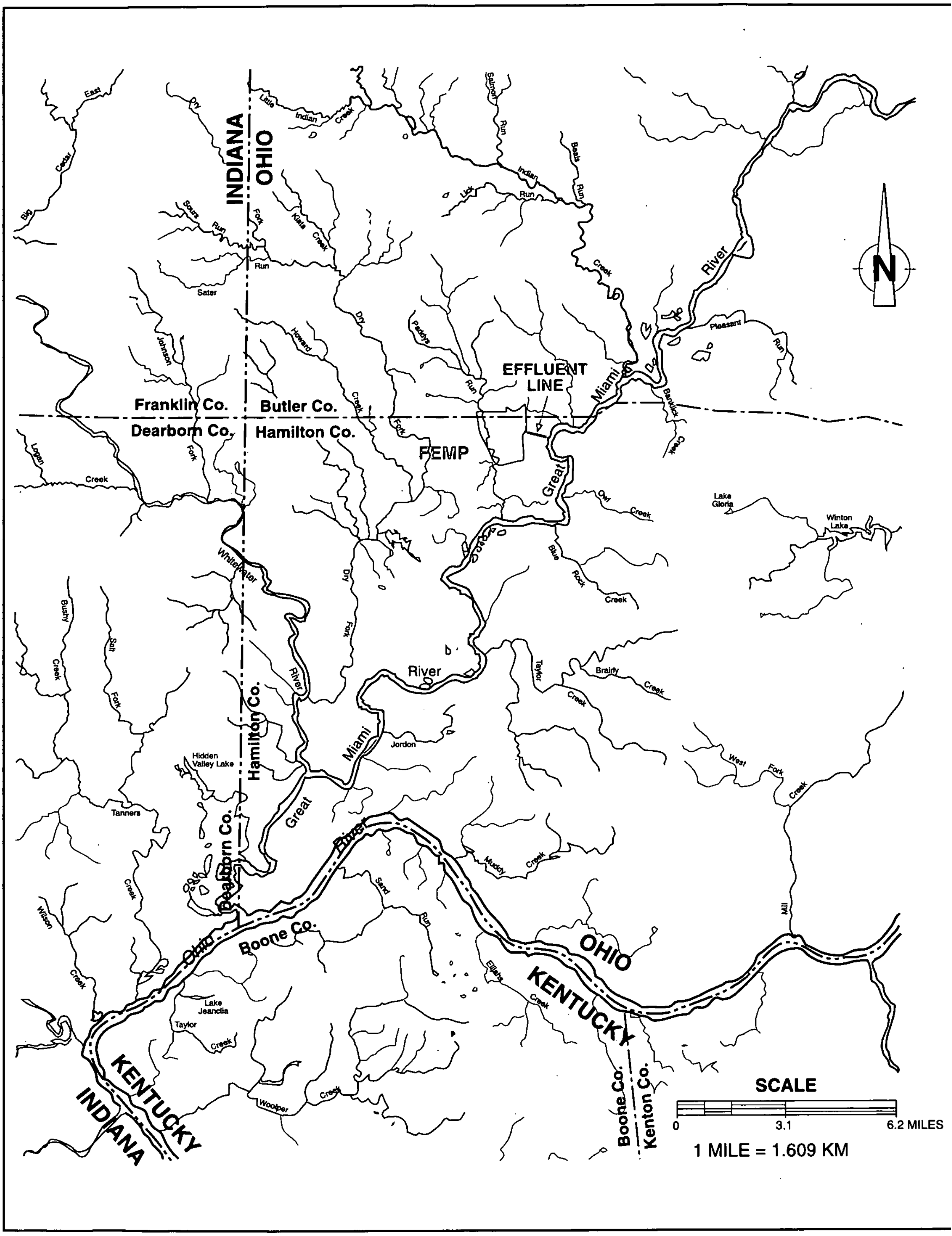


Figure 1-6. Great Miami River Drainage Basin

000028

2479

The average flow rate for the Great Miami River in 1998 was 3,568 cubic feet per second (ft^3/sec) (101 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. 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 1998. 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 for 1998, including wind direction and average speed.

In 1998 the precipitation measured at the FEMP was 48.43 inches (123.0 centimeters [cm]), which is above the average annual precipitation of 40.86 inches (103.78 cm) for 1948 through 1997. Figure 1-9 shows 1998 total precipitation for the area in relation to the annual precipitation amounts recorded from 1988 through 1998. (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 1998 totals were obtained from measurements made at the FEMP.) In addition, Figure 1-10 shows 1998 precipitation by month at the FEMP compared to the Cincinnati area average precipitation by month from 1948 through 1997, based on data collected at the Greater Cincinnati/Northern Kentucky International Airport.

Natural Resources

Natural resources have important aesthetic, ecological, economic, 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 7.

000029

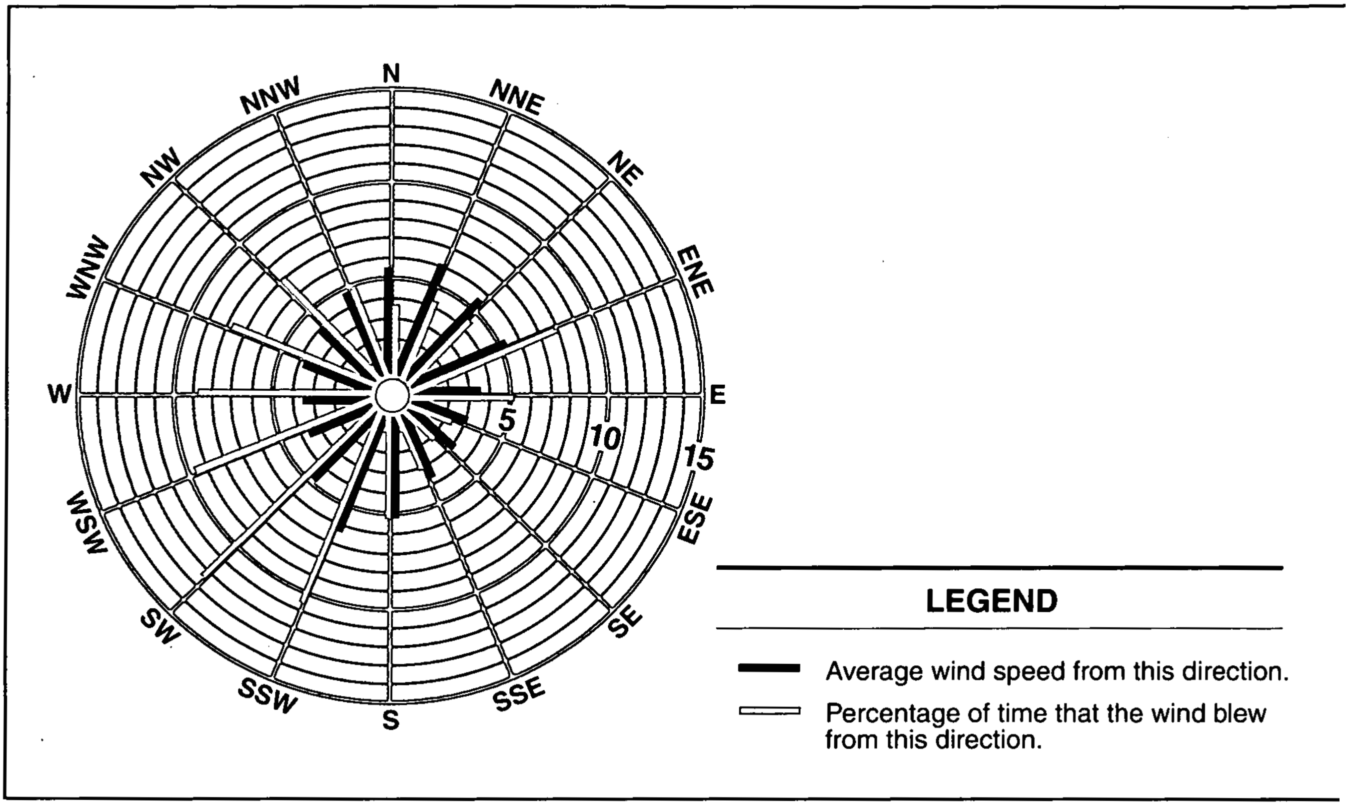


Figure 1-7. 1998 Wind Rose Data, 10-Meter Height

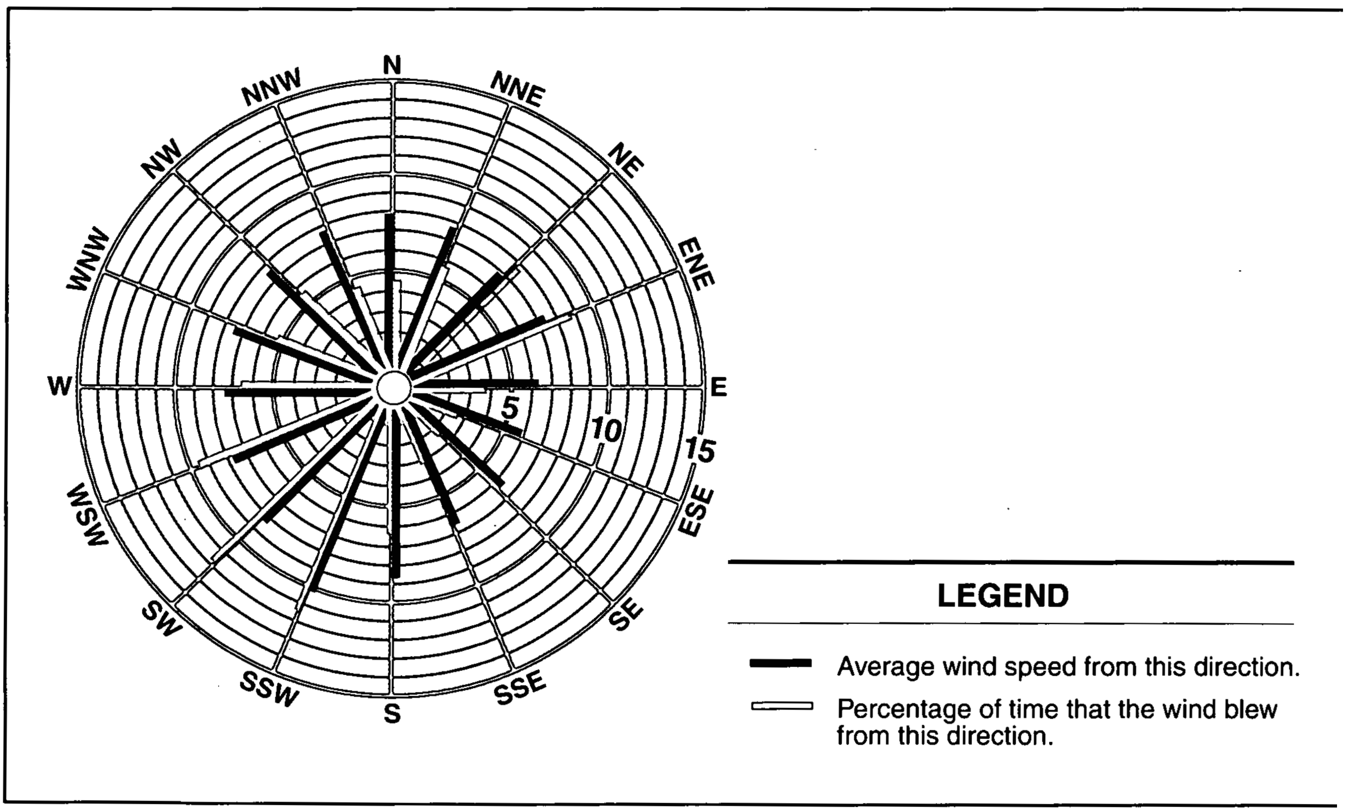


Figure 1-8. 1998 Wind Rose Data, 60-Meter Height

000030

2479

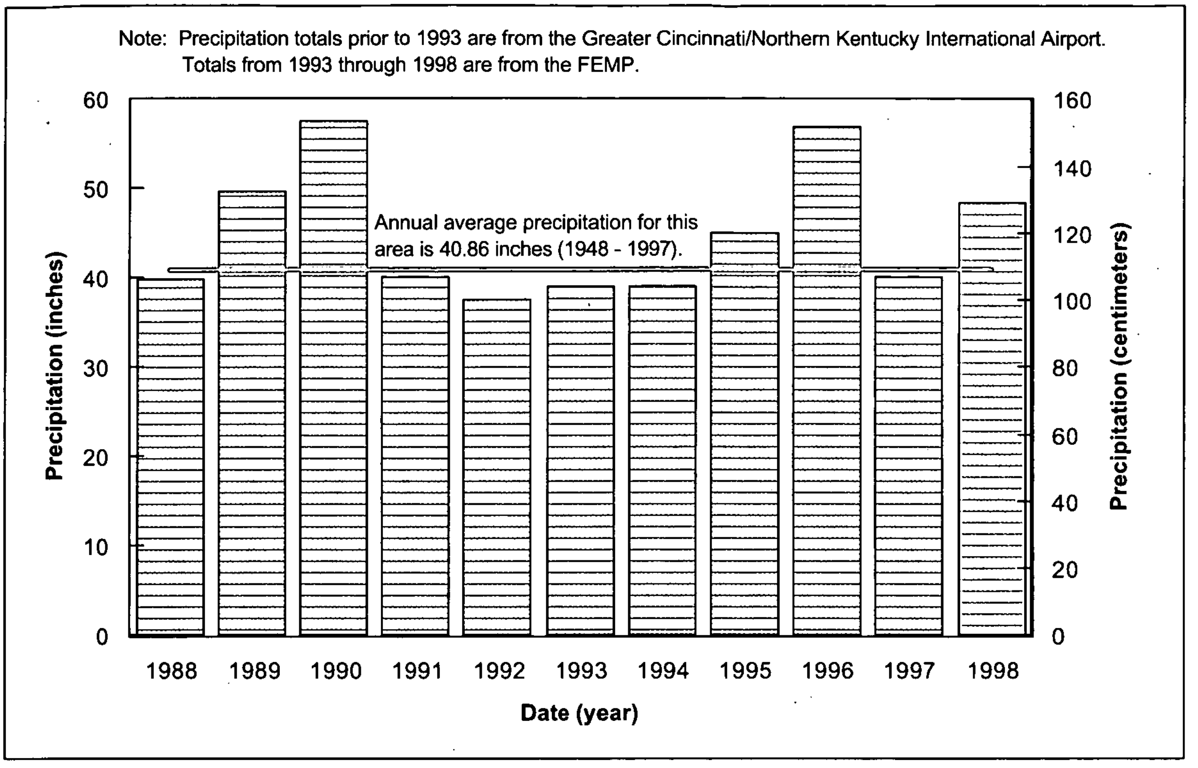
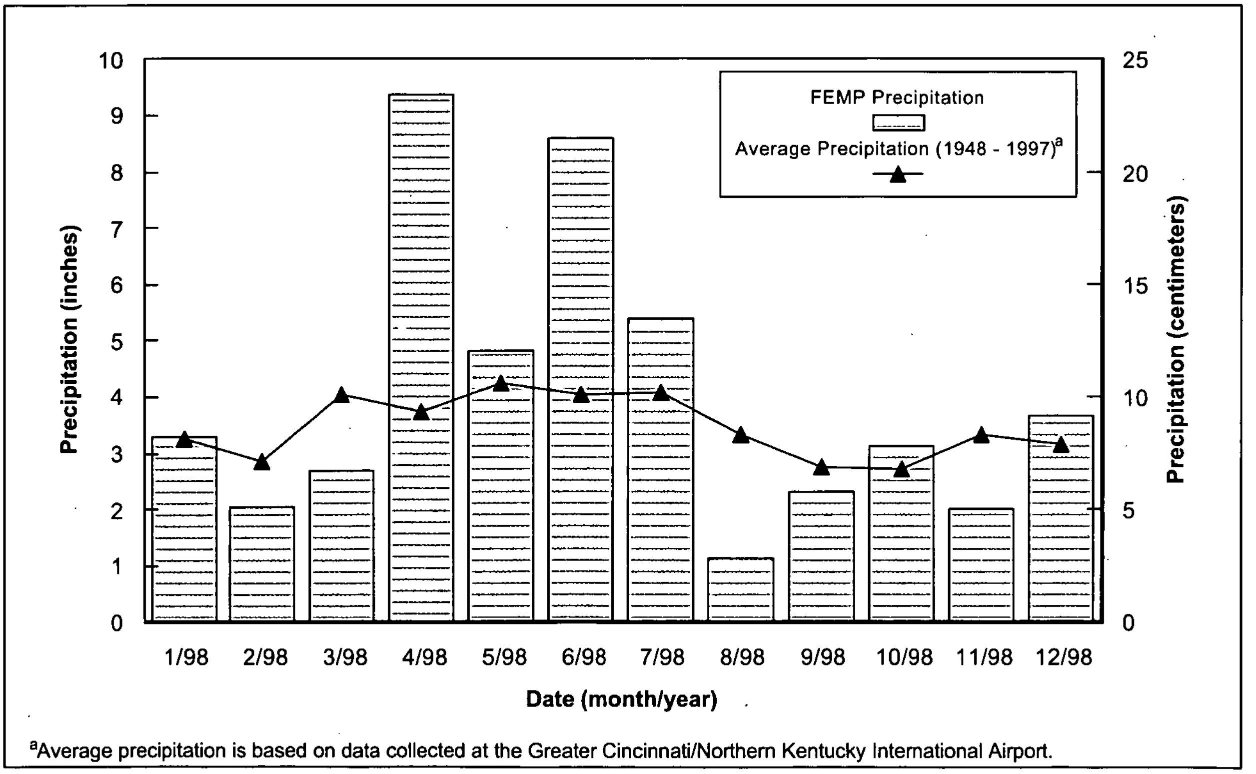


Figure 1-9. Annual FEMP Precipitation Data, 1988-1998



[a]Average precipitation is based on data collected at the Greater Cincinnati/Northern Kentucky International Airport.

Figure 1-10. 1998 FEMP Monthly Precipitation Data

000031

This page intentionally
left blank

000032

- 2479

Chapter 2
Remediation Status and Compliance Summary

- 2479

Remediation Status and Compliance Summary

This chapter provides a status of CERCLA remediation activities by project (CERCLA is the primary driver for environmental remediation of the FEMP), and summarizes compliance activities with other applicable environmental laws, regulations, and legal agreements.

Compliance with these requirements is enforced by EPA, OEPA, and local regulatory 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. EPA Region V implements the CERCLA process, with active participation from OEPA.

For some programs, such as those under the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (excluding NESHAP compliance) and the Clean 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 and area offices and conducts audits to ensure compliance with all regulations.

CERCLA Remediation Status

The process for remediating sites under CERCLA consists of three phases. The FEMP has completed the first two phases, site characterization and remedy selection. Specifically, the regulatory agencies have approved remedy selection documents for all operable units, with the exception of the remedy for Operable Unit 4, which is being re-evaluated. The FEMP is currently involved in the remedial design and implementation phase of CERCLA remediation. Remediation activities, documents, and schedules are identified in each operable unit's remedial design and remedial action work plan. The final phase of CERCLA remediation is certification, site closure, and five-year reviews. Certification activities have already begun in some areas of the site.

Each phase of the CERCLA remediation process requires documentation. The documents produced reflect the input of stakeholders who have helped form the remediation strategy at the FEMP. All CERCLA cleanup-related documentation is available to the public at the Public Environmental Information Center near the FEMP. In 1998 many documents that describe specific remediation activities were issued and approved. Major documents issued in 1998 are listed in Table 2-1 and the progress made in 1998 by the projects toward CERCLA cleanup is summarized in the following sections.

000034

TABLE 2-1
MAJOR FEMP DOCUMENTS FOR 1998

Project	Documents	Status	Approval Date
Waste Pits Remedial Action Project	Amendment to Final Remedial Action Work Plan for Operable Unit 1	Approved by regulatory agencies	February
	Transportation and Disposal Plan	Approved by regulatory agencies	August
	Waste Pits Remedial Action Project Remedial Design Package	Approved by regulatory agencies	October
Soil Characterization and Excavation Project	Sitewide Excavation Plan	Approved by regulatory agencies	July
	Area 2 Phase I Integrated Remedial Design Package	Approved by regulatory agencies	June
	Certification Report for Area I, Phase II, Sector 1	Approved by regulatory agencies	June
	Certification Report for Area 8, Phase I	Approved by regulatory agencies	August
	Certification Report for Area I, Phase I	Approved by regulatory agencies	June
Natural Resources	Natural Resource Impact Assessment	Public comments received by DOE	
	Natural Resource Restoration Plan	Public comments received by DOE	
	Environmental Assessment for Proposed and Final Land Use at the FEMP	Public comments received by DOE	
	Work Plan for the Aesthetic Barrier	Approved by regulatory agencies	October
	Work Plan for Ecological Research Grants	Approved by regulatory agencies	June
	Habitat Area Project Work Plan	Approved by regulatory agencies	August
On-Site Disposal Facility Project	Amendment to Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility	Approved by regulatory agencies	July
	Impacted Materials Placement Plan	Approved by regulatory agencies	March
	Leachate Management Contingency Plan for the On-Site Disposal Facility, Rev. 1	Approved by regulatory agencies	November
Facilities Closure and Demolition Project	Project Closeout Report on the Sewage Treatment Plant Complex	Submitted to regulatory agencies	
	Operable Unit 3 Maintenance/Tank Farm Complex Implementation Plan	Approved by regulatory agencies	June
Silos Projects	Silo 3 Explanation of Significant Differences	Approved by regulatory agencies	March
Aquifer Restoration and Wastewater Project	South Field Extraction System/South Plume Optimization Start-Up Monitoring Plan	Approved by regulatory agencies	May
	Restoration Area Verification Sampling Report	Approved by regulatory agencies	June
Environmental Monitoring	Quarterly Integrated Environmental Monitoring Status Reports	Not applicable	
	1997 Annual Integrated Site Environmental Report	Not applicable	

000035

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

Benchmark Toxicity Values originated from the Operable Unit 5 Sitewide Ecological Risk Assessment. These concentrations for sediment and surface water are used to determine if a constituent may 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.

Acceptable levels for constituents of ecological concern were established in the Operable Unit 5 Sitewide Ecological Risk Assessment (Appendix B of the Operable Unit 5 Remedial Investigation Report). The Sitewide Ecological Risk Assessment established benchmark toxicity values (BTVs). Through the BTV screening process presented in Appendix C of the Final Sitewide Excavation Plan (DOE 1998g), three constituents of ecological concern (barium, cadmium, and silver) were selected to be evaluated in the surface water pathway. BTVs for surface water are discussed in Chapter 4 of this report.

Waste Pits Remedial Action Project

The Waste Pits Remedial Action Project is responsible for the excavation, drying (as required), loading, and rail transport of the contents of waste pits 1-6, the burn pit, and the clearwell to an off-site disposal facility. Sampling and analysis of the waste pit material and the off-site disposal of contaminated soil and debris that exceed the waste acceptance criteria (physical, chemical, and radiological standards) for the on-site disposal facility is part of this scope of work. The project is also responsible for the following:

- Collection and treatment of wastewater and stormwater associated with Waste Pits Remedial Action Project activities
- Pretreatment (as needed) and transport of this remediation wastewater to the advanced wastewater treatment facility
- Implementing controls for point source air emissions resulting from pit excavations and dryer operations.

Improvements of on- and off-site railroad facilities were necessary to prepare for transporting the material. In 1998 the Waste Pits Remedial Action Project was in the final planning stages and continued construction of new facilities and railroad upgrades. Work on the remedial design and remedial action document packages commenced, and the remedial design package was later approved by the EPA.

000036

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

	FRL[a]		
Constituent	**Groundwater**	**Surface Water**	**Sediment**
General Chemistry	**(mg/L)**	**(mg/L)**	**(mg/kg)**
Cyanide	NA[b]	0.012	NA
Fluoride	4[c]	2	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
Technetium-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)**
Total Uranium[e]	20	530	210
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

000037

--2479

TABLE 2-2
(Continued)

Constituent	FRL[a] Groundwater	Surface Water	Sediment
Organics (Cont'd)			
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]NA = not applicable because no FRL was required for this constituent in this particular environmental media.
[c]The groundwater FRLs for fluoride and lead were changed from 0.89 mg/L and 0.002 mg/L, respectively, due to the RestorationArea Verification Program 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 hexavalentchromium. 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 include uranium-234, uranium-235, uranium-236, anduranium-238. This report interchangeably uses the terms uranium and total uranium. Either of these terms is defined as the sum ofthe various isotopic components.

000038

6944-D657

After drying and/or waste acceptance criteria demonstration, waste pit material will be shipped to Envirocare of Utah, Inc for disposal. Because the material from the waste pits will be shipped off site, the success of the Waste Pits Remedial Action Project is dependent on the condition of both on- and off-site rail facilities. The following rail construction and improvement activities were completed in 1998:

- Upgrade of Shandon Railyard facilities (off site in the town of Shandon, through which all trains from Fernald will pass)
- Construction of a locomotive maintenance facility
- Construction of on-site rail infrastructure
- Construction of a rail maintenance facility
- Construction of rail and access road lighting.

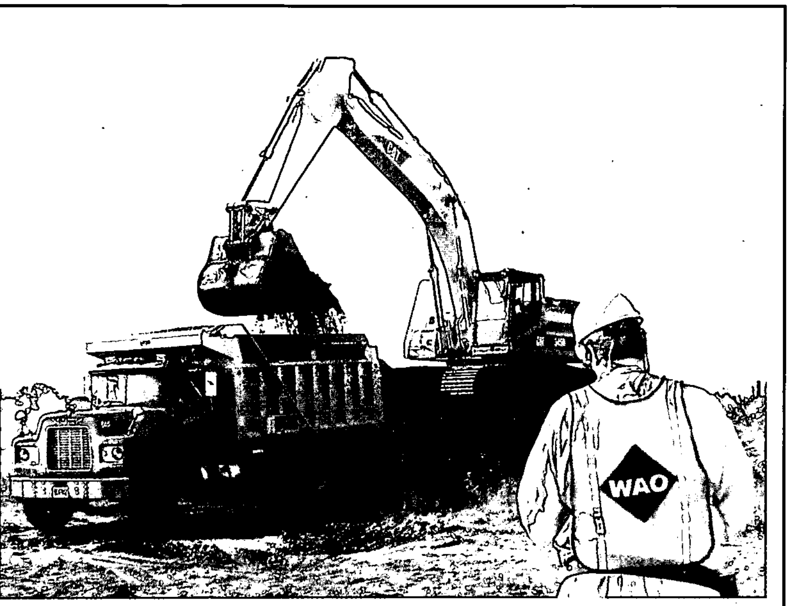
Two 60-ton locomotives were also acquired from the Department of Defense, and 50 gondola cars were procured for the movement of waste to Envirocare.

Construction of the Material Handling Building/Railcar Loadout Building was nearly completed in 1998. The first load of material is scheduled for shipment in early 1999.

Soil Characterization and Excavation Project

The Soil Characterization and Excavation Project is responsible for remediation of contaminated soil at the FEMP and miscellaneous waste units including the South Field, flyash piles, lime sludge ponds, and the solid waste landfill; excavation/removal of building foundations, roadways, underground utilities, and piping systems; and proper management of all perched groundwater encountered during excavation, appropriate measures to control stormwater and associated erosion and sediment controls, as well as control of fugitive dust during excavation.

000039



6734-D634

The Soil Characterization and Excavation Project continued soil excavation in 1998. For purposes of excavation, the FEMP has been divided into remediation areas. Figure 2-1 depicts nine of the remediation areas. Area 10 consists of potentially contaminated corridors which will not be addressed until the end of remediation, such as haul routes and access roads. Area 10 is not shown on Figure 2-1. Each remediation area is treated as a separate subproject from the standpoint of engineering design, planning, characterization, and remediation activities. Once an area is remediated, the soil must be certified to show that the FRLs have been met for the constituents of concern identified for that specific area. Once the area is certified clean, either interim or final restoration can begin.

The Final Sitewide Excavation Plan, which is the guiding document for the Soil Characterization and Excavation Project, was issued in 1998 as a plan that provides strategies for design, characterization, and excavation of soil and at- and below-grade debris.

The following activities took place in the Soil Characterization and Excavation Project in 1998:

- <u>Paddys Run Embankment Stabilization Project</u>: Design and construction activities were completed near the silos, where unacceptable erosion was occurring.

- <u>Area 1, Phase I (northeast portion of the site)</u>: Certification report was approved by the regulatory agencies.

- <u>Area 1, Phase II (sewage treatment plant, trap range, additional area and facilities in the southeast corner of the FEMP)</u>: Additional characterization sampling (performed to support design and to determine the appropriate treatment, storage, and disposition of excavated material and debris) and site preparation for remediation (i.e., removal of vegetation) activities began. Sampling was performed in Area 1, Phase II, Sectors 1 and 2B to ensure that FRLs were achieved.

000040

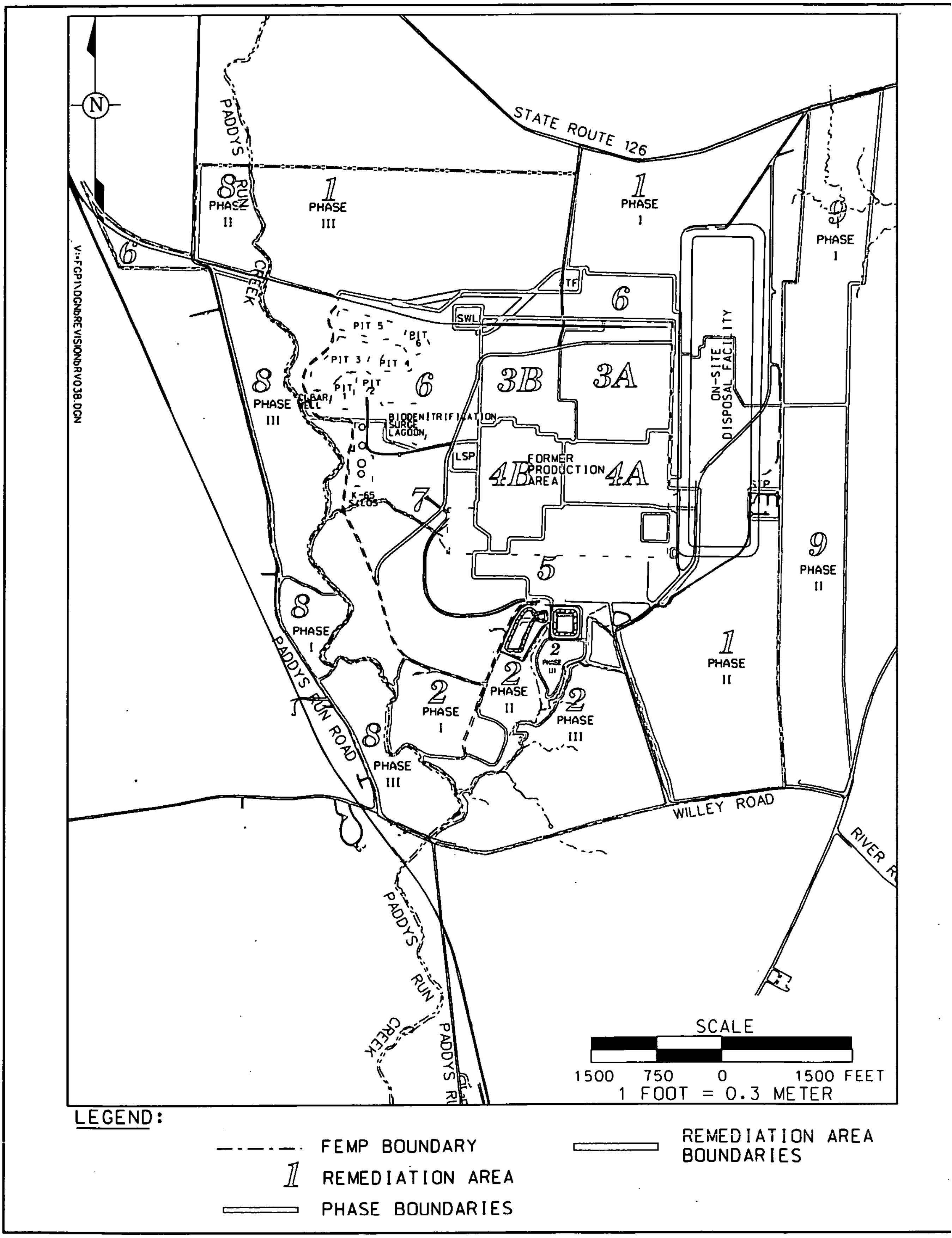


Figure 2-1. Sitewide Remediation Areas

000041

2479

- Area 2, Phase I (southern waste units, southwest corner of the FEMP): Site preparation for remediation was completed. Stockpile 5 and the inactive flyash pile were excavated, and excavation of the active flyash pile began. Bioengineering stabilization of Paddys Run embankment was planned and completed. A total of 183,661 cubic yards (yd^3) (140,427 cubic meters [m^3]) of soil were removed from Area 2, Phase I and placed in the on-site disposal facility or Stockpile 7.

- Areas 3, 4, 5 (former production area): Characterization sampling and three dimensional modeling of uranium contamination to support excavation designs were initiated late in 1998.

- Area 6 (Waste Pits area): Characterization sampling was performed in the Waste Pits area.

- Area 7 (Silos area): Characterization sampling was performed in the Silos area.

- Area 8, Phases I and II (along the western margin of the FEMP): No excavation is necessary in this area because no contamination was found. Area 8, Phase I was certified as having met the FRLs and the certification report was approved by the regulatory agencies. Sampling was initiated in Area 8, Phase II to determine certification readiness.

- Area 9 (off-property adjacent to the east boundary of the FEMP): As in Area 8, no excavation is expected in Area 9 to meet FRLs. Planning for certification of Area 9 was completed in 1998.

The strategy for remedial actions in Areas 3 and 4 changed during 1998. Plans to extend the use of the Plant 1 Pad, located in Area 3, made it necessary to delay excavation in at least part of Area 3. Therefore, the area was split into west (3B) and east (3A) halves and the excavation schedule was changed. Presently, Areas 3A and 4A, which are on the east side of the former production area, will be excavated together, followed by excavation of Areas 3B and 4B, which are on the west side of the former production area.

Activities associated with natural resources are closely related to those activities of the Soils Characterization and Excavation Project. Specific natural resource activities which occurred during 1998 are discussed in Chapter 7 of this report.

On-Site Disposal Facility Project

The On-Site Disposal Facility Project is responsible for the construction of an eight-cell engineered disposal facility, operation and maintenance of a leachate collection system that transports leachate to the advanced wastewater treatment facility, and a haul road that is used to transport material to the on-site disposal facility. Located near the FEMP's northeastern border, the facility will contain approximately 2.5 million yd^3 (1.9 million 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. The On-Site Disposal Facility Project is closely integrated with the progress of other projects.

000042

Figure 1-3 shows the site from an aerial perspective, and gives a visual perspective of the progress made at the on-site disposal facility during 1998. Waste placement into Cell 1 began in December 1997, and continued throughout 1998. Construction on Cell 2 began in 1998; those items completed include construction of the primary and secondary liner systems and installation of the leachate collection system drainage layer and installation of the leak detection system. Excavation of the Cell 3 area was also completed in 1998.

Additional work at the on-site disposal facility included:

- Completion of the material transfer area, and movement of containers of debris into the area
- Completion of the North Access Road, which was relocated to allow for on-site disposal facility construction
- Completion of a haul road, which was constructed for transporting contaminated soil and debris to the on-site disposal facility from various projects
- Construction of the Decontamination Facility, on-site disposal facility access control and laboratory trailers, and the equipment wash facility
- Preparation of the clay borrow area
- Continued work on the leachate conveyance system to carry leachate from the on-site disposal facility for eventual treatment at the advanced wastewater treatment facility.

6319-D1557

000043

All waste placed in the on-site disposal facility must meet the physical, chemical, and radiological standards known as the on-site waste acceptance criteria. The Waste Acceptance organization ensures that waste generation and placement complies with the requirements of the Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility (DOE 1998h), which describes the approach for demonstrating attainment with the waste acceptance criteria for all FEMP waste streams identified for on-site disposal. The Waste Acceptance organization provides field inspectors who oversee waste generation and disposal at the facility.

Groundwater monitoring associated with the on-site disposal facility is discussed in Chapter 3 of this report.

6494-D312

Facilities Closure and Demolition Project

The Facilities Closure and Demolition 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 proper management of associated decontamination wastewaters.

Facilities Closure and Demolition Project work includes decontamination of facilities, isolation of utilities, removal of material stored in buildings, and demolition of buildings, equipment, and other facilities. The 1998 Facilities Closure and Demolition activities having the most effect on environmental media were decontamination activities and dismantling of equipment and facilities.

The origin of the Safe Shutdown organization is former Removal Action No. 12, the scope of which was to remove uranium and other material from former processing equipment and ship material and equipment off site. This work scope was incorporated into the overall scope of the Facilities Closure and Demolition Project in May 1997. The scope of the Safe Shutdown organization also includes isolation of utilities, where necessary, and other building shutdown activities. Safe Shutdown decontamination and closure activities during 1998 included the following facilities:

- Plant 8 (complete)
- Plant 2/3 (complete)
- Building 78 (complete)

000044

- Plant 6
- Boiler plant/cooling tower (complete)
- Underground excavation of the tank farm fire protection and treated domestic waterline (complete).

Dismantlement of facilities and equipment continued in 1998. The following activities occurred:

- Boiler plant/water plant complex was dismantled.
- Thorium/Plant 9 complex dismantlement continued (several smaller buildings were demolished).
- Recycling supplemental environmental projects were initiated, specifically decontamination and free release of rail and shipping copper windings to DOE-Oak Ridge (further detail in Section 2.1.5, Supplemental Environmental Projects).
- Sewage treatment plant complex was dismantled.
- Miscellaneous Small Structures Project began with the dismantlement of structures 3F, 3G, 38A, 38B, and 24B. Dismantlement of structures 8F, 22A, 39C, and 45B began in November.

A total of 28 structures were demolished in 1998, bringing the total number of structures demolished at the FEMP to 53.

Silos Projects

The Silos Projects are responsible for remediation of Silos 1 and 2, which are the K-65 Silos, and Silos 3 and 4. Silos remediation includes the removal, stabilization, and transport of the inventoried residues for off-site disposal, as well as decontamination and dismantling of the silo structures. During 1997 the decision was reached among DOE, EPA, and OEPA to separate the remediation of Silo 3 waste from Silos 1 and 2 waste. As a result, the Silos Project reorganized into the Silos 1 and 2 Project, which includes the Advanced Waste Retrieval Project, and the Silo 3 Project. Silo 4 was never used to store waste materials and will be dismantled with the other silos structures. Following is a summary of each project's major activities during the year.

Silos 1 and 2 Project

Silos 1 and 2 Project activities in 1998 continued to focus on reevaluating stabilization technologies to determine the best technology to use when remediating K-65 Silos 1 and 2.

"Proof-of-principle" testing is being conducted on four technology families to support evaluation and selection of treatment alternatives.

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

000045

In 1998 the Silos 1 and 2 Project issued a request for proposal for Silos 1 and 2 Multi-Technology Proof-of-Principle Testing and awarded four contracts to private companies with expertise in the application of these technologies to conduct the testing. Results of this testing will be included in a revised feasibility study document, which will document the detailed analysis of each technology leading to the selection of the preferred remedial alternative. The revised feasibility study is expected to be completed by February 2000.

In parallel with the proof-of-principle testing and consistent with input from FEMP stakeholders and an independent Critical Analysis Team, the Silos 1 and 2 Project initiated the Accelerated Waste Retrieval Project. The project scope includes transferring the K-65 Silos 1 and 2 residues to an interim storage facility that would be built in the vicinity of the existing silo structures. This facility would be built ahead of the selection and construction of the processing facilities to be used for stabilizing the residues. 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.

Silo 3 Project

During 1998, EPA approved the Final Silo 3 Explanation of Significant Differences, which documents the selection of an alternate remedy for Silo 3 material. The new remedy for Silo 3 material consists of treatment using either chemical stabilization/solidification or polymer-based encapsulation followed by off-site disposal. A contract for the Silo 3 stabilization/solidification facility was awarded to Rocky Mountain Remediation Services in December 1998. The Silo 3 Project also initiated and completed the Silo 3 Small-Scale Waste Retrieval Project, in which material was removed from Silo 3 for treatability testing.

Supplemental Environmental Projects

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

- 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.

Aquifer Restoration and Wastewater Project

The Aquifer Restoration and Wastewater Project is responsible for the restoration of water quality in the affected portions of the Great Miami Aquifer and treating the FEMP's extracted ground water, storm water, sanitary water, and remediation wastewater. These activities include the design, construction, operation, monitoring, and reporting for the groundwater restoration and wastewater treatment systems at the FEMP.

In 1998 the Aquifer Restoration and Wastewater Project continued to operate the South Plume Removal Action System (South Plume Module) and key portions of the enhanced groundwater remedy came online. Construction completion and initiation of operations occurred at the following three new groundwater restoration modules:

- South Field (Phase 1) Module - Operational on July 13, 1998
- South Plume Optimization Module - Operational on August 9, 1998
- Re-Injection Demonstration Module - Operational on September 2, 1998.


6860-D13

In 1998, a total of 975.2 million gallons (3,691 million liters) of groundwater were extracted from the Great Miami Aquifer, 424.9 pounds (192.9 kg) of total uranium were removed from the aquifer, and 150.9 million gallons (571.2 million liters) of water were re-injected into the aquifer. Refer to Chapter 3 for more details on groundwater monitoring.

000047

2479

The advanced wastewater treatment facility, interim advanced waste water treatment facility, and the South Plume Interim Treatment Facility provides final treatment of FEMP contaminated storm water and wastewater. It also provides treatment for contaminated groundwater associated with FEMP groundwater remediation. In 1998 the following construction projects were performed:

- Construction of the resin regeneration system, used to regenerate the resins which remove uranium from contaminated water, was completed.

- Construction of the advanced wastewater treatment facility expansion was completed in February and operation began in April 1998. The expansion is expected to treat an average of 1,500 gallons per minute (gpm) (5,700 liters per minute [L/min]).

Other activities of the Aquifer Restoration and Wastewater Project for 1998 include the following:

- The new sewage treatment plant was completed and operations began in May.

- The sludge removal system design for the stormwater retention basin and biosurge lagoon design was completed.

Removal Actions

CERCLA allows removal actions to be implemented when immediate action is required to protect public health and/or the environment. As the FEMP moved into full-scale remediation, some removal actions, many of which were temporary measures intended to bridge the gap between the remediation planning stages and full-scale remediation, remained open. The work scopes of these removal actions were incorporated into remedial actions. Work continues on Removal Actions 3, 9, 12, 17, 26, and 27 within the scopes of the projects, but is gradually being incorporated into remedial actions. The scopes of these removal actions and the projects into which they have been incorporated are identified in Table 2-3.

000048

TABLE 2-3
PROGRAMMATIC REMOVAL ACTIONS WITHIN THE SCOPES OF OTHER PROJECTS[a]

Removal Action	Scope	Absorbed by Project
No. 3 - South Plume	Install new alternate water supply, pump and discharge groundwater from the South Plume Install and operate interim advanced wastewater treatment system Conduct groundwater monitoring and institutional controls Conduct groundwater modeling and geotechnical investigation	Aquifer Restoration and Wastewater Project
No. 9 - Removal of Waste Inventory	Disposition of low-level waste off site	Waste Management/ Nuclear Materials Disposition Projects
No. 12 - Safe Shutdown	Remove uranium and other material from former processing equipment and ship material and equipment off site	Facilities Closure and Demolition Project
No. 17 - Improved Storage of Soil and Debris	Improve storage of existing and future generated soils and debris	Soil and Water Projects Waste Acceptance
		Organization
No. 26 - Asbestos Removal	Mitigate the potential for contaminants and migration of asbestos fibers	Facilities Closure and Demolition Project
No. 27 - Management of Contaminated Structures	Manage contaminated structures	Facilities Closure and Demolition Project

[a]This table lists the programmatic removal actions on site, which were all transferred to the scopes of remedial actions on May 22, 1997. Gradually work performed under these actions is being phased out and being done pursuant to appropriate remedial actions.

Summary of Compliance with Other Requirements

CERCLA requires compliance with other laws and regulations 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 highlights some of the major requirements related to environmental monitoring and waste management and how the FEMP complied with these requirements in 1998.

The regulations discussed in this section have been identified as ARARs in the FEMP's operable unit's record of decisions. The FEMP must comply with these regulations while site remediation under CERCLA is underway; compliance is enforced by EPA, OEPA, and local regulatory agencies. Some of these requirements include permits for controlled releases, which are also discussed in this section.

000049

Resource Conservation and Recovery Act (RCRA)

RCRA regulates treatment, storage, and disposal of hazardous waste and the hazardous part of mixed waste, which is radioactive waste mixed with hazardous waste. Hazardous and mixed waste currently generated at the FEMP results from activities such as CERCLA remedial actions, construction, and maintenance and miscellaneous activities. The FEMP also has an inventory of mixed waste generated from former production. These wastes are regulated under RCRA and Ohio hazardous waste management 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 management 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 DOE, as well as 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 1998, including:

- Submittal of the 1997 RCRA Annual Report (DOE 1998a), which described hazardous waste activities for 1997
- Revisions to several sections of the RCRA Part A and B permit application
- Submittal of the 1998 annual update to the Site Treatment Plan (DOE 1998b) as required in the 1992 Federal Facility Compliance Act (FFCA) and the implementing Director's Findings and Orders issued by OEPA in October 1995.

Additional details on projects involving treatment of mixed wastes are provided in the Mixed Waste Treatment sub-section.

RCRA Property Boundary Groundwater Monitoring

The Director's Findings and Orders, which were signed September 10, 1993, and described an alternate groundwater monitoring system, are being revised to coincide with the groundwater monitoring strategy identified in the IEMP. This program is discussed in more detail in Chapter 3.

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 they were hazardous waste management units or solid waste management units. This evaluation was completed in 1994. In 1996 OEPA issued a Director's Findings and Orders to integrate RCRA closure requirements with CERCLA response actions for FEMP hazardous waste management units. During 1998 the FEMP continued to integrate RCRA closure activities with CERCLA response actions for FEMP hazardous waste management units. Plans were developed to address the remediation of four hazardous waste management units under the integrated RCRA/CERCLA process: the trane incinerator, uranyl nitrate hexahydrate tanks in the Hot Raffinate and Nuclear Fuel Systems Storage Buildings, and KC-2 Warehouse. Information was also submitted to OEPA documenting decontamination activities completed at a fifth hazardous waste management unit, Tank T-2, which is west of the pilot plant.

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 Amendment to the Consent Decree, signed in 1991. This strategy is based on three primary objectives:

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

The Thorium Overpacking Project, in which the FEMP removed 3,400 containers of thorium material and shipped 10,875 drum equivalents, or 80,480 ft^3 (2,279 m^3), of thorium material to the Nevada Test Site for disposal, was completed in 1997. The characterization documentation and formal RCRA waste determinations for the remaining estimated 8,500 containers of thorium legacy waste continued in 1998. Low-level radioactive, non-RCRA thorium legacy 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. The low-level and hazardous waste activities will begin in 1999. The hazardous thorium legacy waste is being evaluated for possible inclusion in the Silo 3 Stabilization Project. The low-level waste is scheduled to be shipped to the Nevada Test Site in 1999.

000051

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 EPA or OEPA.

The 1992 amendment to RCRA, the Federal Facility Compliance Act, provided DOE with a three-year exemption from enforcement under the land disposal restrictions storage prohibition, provided that the DOE sites complied 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 first Site Treatment Plan Annual Update to OEPA in December 1996. Since then, two additional annual updates have been submitted. The annual update describes the status of mixed waste treatment projects developed under the Site Treatment Plan, adds newly generated/newly identified waste streams, and certifies 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, 1998.

The implementation of the Director's Findings and Orders is accomplished through Removal Action No. 9, Removal of Waste Inventories. The Final Operable Unit 3 Record of Decision for Final Remedial Action (DOE 1996a) 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.

In 1998 the FEMP initiated and completed the following projects to treat mixed wastes:

- Completed treatment of 318.1 yd^3 (243.2 m^3) waste by neutralization/precipitation of deactivation/stabilization

- Bulked 253,385 pounds (115,037 kg) of liquid mixed waste into batches 7, 8 and 9 for shipment to the K-25 Toxic Substances Control Act Incinerator in Oak Ridge, Tennessee.

Clean Water Act

Under the Clean Water Act, the FEMP is governed by National Pollutant Discharge Elimination System (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 OEPA. The current permit, 1IO00004*ED, became effective on November 1, 1995 and expired on March 31, 1998. On September 22, 1997, the FEMP submitted a permit renewal application. An addendum to the permit renewal application, providing information on Operable Unit 1, was submitted to OEPA on August 31, 1998, but was not yet approved at the end of the year. Pursuant to Ohio Administrative Code 3745-33-04(c)(1), submittal of the renewal application allows the FEMP to continue operating under the terms of the expired permit until approval of the new permit application is received from OEPA. Chapter 4 discusses the surface water treated effluent results in detail.

On July 27, 1998, DOE received a Notice of Violation under the NPDES Permit concerning initiating earth work activities prior to the completion of a borrow area sediment trap to be used for sediment control. Additionally OEPA determined the installed sediment trap was undersize DOE and Fluor Daniel Fernald completed the work on the sediment trap on July 28, 1998, and the sediment trap was inspected and accepted by OEPA on July 29, 1998, thus satisfactorily resolving the issues raised by the Notice of Violation.

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 o radon) from the facility in a single year. For 1998, the FEMP was in compliance with the NESHAP dose limit, as determined by ambient air monitoring.

This regulation also imposes requirements for monitoring emission sources, including stack monitoring. Because the FEMP is a former uranium processing plant, uranium is the radioactiv particulate of most concern in monitoring airborne emissions. The FEMP estimated that airborne uranium emissions from all monitored point sources for 1998 were 7.16E-04 pounds (3.25E-04 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 1998 the FEMP complied with all emissions standards.

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

000053

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 1998e) for 1998 was submitted to OEPA and other local emergency planning/response organizations in February 1999. 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 must be submitted to OEPA and EPA before July 1, 1999. 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 1998 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, and Ohio environmental laws and regulations.

In 1998 two FEMP releases were reported to regulatory and other agencies. On May 27, 1998, the National Response Center, State Emergency Response Commission, Butler and Hamilton County Local Emergency Planning Committees, and the Crosby Township Local Fire Department were notified that 7.48 gallons (28.3 liters) of diesel fuel were released into Paddys Run during the Paddys Run Embankment Stabilization Project at the southwest corner of the site. Some of the fuel migrated beyond the FEMP boundary. Absorbent pads were placed in the creek at several downstream locations. Gravel and soil were also retrieved from the impacted areas in the vicinity of the spill. This release was reported pursuant to CERCLA 103 and SARA 304 because it migrated off FEMP property. The required follow-up reporting under SARA 304 was completed.

On July 15, 1998, the National Response Center was notified of a release above a reportable quantity of "friable" asbestos contained in insulation fallen from overhead piping. This release did not migrate off site and thus, was only reported pursuant to CERCLA 103. This notification was based on information available at the time of the event, as required. Upon confirmatory analysis, the insulation was determined to be "negative" for asbestos. The release report was revised with an update call made to the National Response Center.

000054

Other Environmental Regulations

The FEMP is also required to comply with other environmental laws and regulations besides those described above. Table 2-4 summarizes compliance with each of these requirements for 1998.

Permits

Permits are the means by which some environmental laws are implemented. The FEMP has permits for controlled releases to surface water and air. The FEMP's permit for discharging water under the NPDES regulations is discussed in Section 2.2.2 of this chapter. Another Permit to Install covers the monitoring of the Coal Pile Runoff Basin and is discussed in Chapter 3 of this report. The FEMP's permit for RCRA treatment, storage, and disposal (OH6890008976) covers RCRA activities described later in this chapter. The FEMP has 14 current air Permits to Operate and 10 associated Permits to Install. 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.

Site-Specific Regulatory Agreements

Federal Facility Compliance Agreement (FFCA)

In July 1986 the FEMP entered into a FFCA with the EPA, which 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 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 constituents.

- Maintain a sampling program for daily flow and total uranium at the South Plume extraction wells and report the results quarterly to 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.

000055

COMPLIANCE WITH OTHER ENVIRONMENTAL REGULATIONS

Regulation and Purpose	Background Compliance Issues	1998 Compliance Activities
Toxic Substances Control Act (TSCA)		
Regulates the manufacturing, use, storage, and disposal of toxic materials, including polychlorinated biphenyl (PCBs) and PCB items	The last routine TSCA inspection of the FEMP's program was conducted by EPA-Region V on September 21, 1994. No violations of PCB regulations were identified during the inspection.	Non-radiologically contaminated PCBs and PCB items were shipped to TSCA-approved commercial disposal facilities for incineration on an "as-needed basis". 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 the Mixed Waste Projects Organization (Phase II of the Organic Extraction Project Demonstration Project) 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 pounds (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 (NEPA)		
Requires the evaluation of environmental, socio-economic, and cultural impacts before any action, such as a construction or cleanup project, is initiated by a federal agency	An environmental assessment for proposed final land use was completed in 1998. It was prepared under DOE's guidelines for implementation of NEPA, 10 Code of Federal Regulations 1021). It also addresses previous DOE commitments to consult with the public prior to any decisions on land use.	This environmental assessment is being made available for public review consistent with the spirit of NEPA, which mandates public input into decisions of federal agencies. Upon completion of the public involvement process, DOE will either issue a Finding of No Significant Impact documenting their final decision, or proceed with a full Environmental Impact Statement. The Finding of No Significant Impact would function as the decision document in the NEPA environmental assessment process, and would be made available for public comment for 15 days prior to finalization. If an Environmental Impact Statement is initiated, then DOE will issue a Notice of Intent.

2479

000056

TABLE 2-4
(Continued)

Regulation and Purpose	Background Compliance Issues	1998 Compliance Activities
Endangered Species Act		
Requires the protection of any threatened or endangered species found at the site as well as any critical habitat that is essential for the species' existence	Ecological surveys conducted by Miami University and DOE, in consultation with the Ohio Department of Natural Resources and U.S. Fish and Wildlife Service, have established the following list of threatened and endangered species and their habitats existing on site: Cave salamander, state-listed endangered — marginal habitat, none found; Sloan's crayfish, state-listed threatened — found on northern sections of Paddys Run; Indiana Brown Bat, federally listed endangered — suitable habitat in riparian areas along Paddys Run	No surveys were conducted in 1998; however, visual observations were conducted of Sloan's crayfish habitat after storm events which indicated no FEMP-induced adverse effects.
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.	No assessments were performed in 1998.
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 1.24 miles (2 km) of the FEMP and 27 historic sites.	Activities were conducted to avoid and address impacts to cultural resources (Chapter 7).
Native American Graves Protection and Repatriation Act		
Requires the identification and preservation of cultural resources on federal lands, and consultation with Native American Tribes on removal and management of inadvertently discovered Native American cultural items	Historical remains and artifacts were discovered during a 1994 construction project. The Native American remains — which included an adolescent boy and his dog — were discovered 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.	No Native American remains were discovered or interred in 1998. Cultural resources were identified as a result of surveys performed.
Natural Resource Requirements Under CERCLA and Executive Order 12580		
Requires DOE to act as a Trustee (i.e., guardian) for natural resources at its federal facilities.	DOE and the other Trustees, which include 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 developed the Natural Resource Restoration Plan and the Natural Resource Impact Assessment and submitted it for public review. Comments from FEMP stakeholders were received in November.

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 ($pCi/m^2/sec$), but allowed the FEMP to address this exceedance by implementing a removal action (installation of a bentonite cap) 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 $pCi/m^2/sec$. The results of the FEMP Radon Monitoring Program for 1998 are located in Chapter 5.

ALARA

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 with respect to what is reasonably achievable.

Split/Co-Located Sampling Program

In 1998 DOE and OEPA cooperated in a program in which samples of groundwater, surface water, and sediment, were "split" and sent to different analytical laboratories, or "co-located," meaning samples were collected from the same location but at different times. The FEMP has participated in this program with the state since 1987. This program allows for an independent comparison of data to ascertain laboratory analysis and field quality assurance.

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 1998 the results from the split/co-located sampling program show reasonable agreement between DOE and OEPA results for the groundwater (except at one location) and surface water samples. However, a greater degree of variability exists between DOE and OEPA results for sediment. The reslts for the 1998 split/co-located samples are presented in Appendix E of this report.

000059

Chapter 3
Groundwater Pathway

2479

Groundwater Pathway

Results in Brief: 1998 Groundwater Pathway

Enhanced Groundwater Remedy - During 1998 active restoration of the Great Miami Aquifer began with key portions of the enhanced groundwater remedy coming on line. Construction completion and initiation of operations occurred at the following three new groundwater restoration modules:

- South Field (Phase 1) Extraction Module - Operational on July 13, 1998
- South Plume Optimization Module - Operational on August 9, 1998
- Re-Injection Demonstration Module - Operational on September 2, 1998.

Additionally, pumping for the South Plume Module, which was initiated in August of 1993, continued during 1998.

Since 1993
- 3,937.0 million gallons (14,902 liters) of water have been pumped from the Great Miami Aquifer.
- 150.9 million gallons (571.2 liters) of water have been re-injected into the Great Miami Aquifer.
- 814.3 pounds (369.7 kg) of uranium have been removed from the Great Miami Aquifer.

During 1998
- 973.6 million gallons (3,685 liters) of water were pumped from the Great Miami Aquifer.
- 150.9 million gallons (571.2 liters) of water were re-injected into the Great Miami Aquifer.
- 424.9 pounds (192.9 kg) of uranium were removed from the Great Miami Aquifer.

Groundwater Monitoring Results - The results of 1998 groundwater capture analysis and monitoring for total uranium and non-uranium constituents indicate that the design of the enhanced groundwater remedy for the aquifer restoration system is appropriate. No new areas of contamination were identified which would require modification of the enhanced groundwater remedy design.

On-Site Disposal Facility Monitoring - Groundwater monitoring continued during 1998 for Cell 1 and Cell 2 and was initiated for Cell 3. Also during 1998, a draft technical memorandum was issued to establish the baseline groundwater conditions.

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 1998
- Groundwater monitoring activities and results for 1998.

Restoration of the affected portions of the Great Miami Aquifer and continued protection of the groundwater pathway are primary considerations in the accelerated remediation strategy for the FEMP. The FEMP will continue to monitor the groundwater pathway throughout remediation to ensure the 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 are 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 Remedial Investigation Report. As documented in that report, the primary groundwater contaminant at the FEMP is uranium. Approximately 220 acres (89 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 and the Storm Sewer Outfall Ditch where the glacial overburden is eroded, and the sand and gravel of the aquifer were in direct contact with uranium-contaminated surface water from the FEMP. To a lesser degree, groundwater contamination also resulted where excavations such as the waste pits removed some of the protective clay contained in the glacial overburden and exposed the aquifer to contamination.

000061

Selection and Design of the Groundwater Remedy

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

The Operable Unit 5 Feasibility Study Report recommended a pump-and-treat remedy for the groundwater contaminated with uranium. The remedy consisted of 28 groundwater extraction wells located on- and off-property. Computer modeling suggested that the 28 extraction wells pumping at a combined rate of 4,000 gpm (15,000 L/min) would remediate the aquifer within 27 years. The recommended groundwater remedy was presented to EPA, 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 1997a).

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 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 wells. 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 EPA and OEPA. Figure 3-1 identifies current and future extraction and re-injection well locations for the enhanced groundwater remedy.

000062

-- 2479

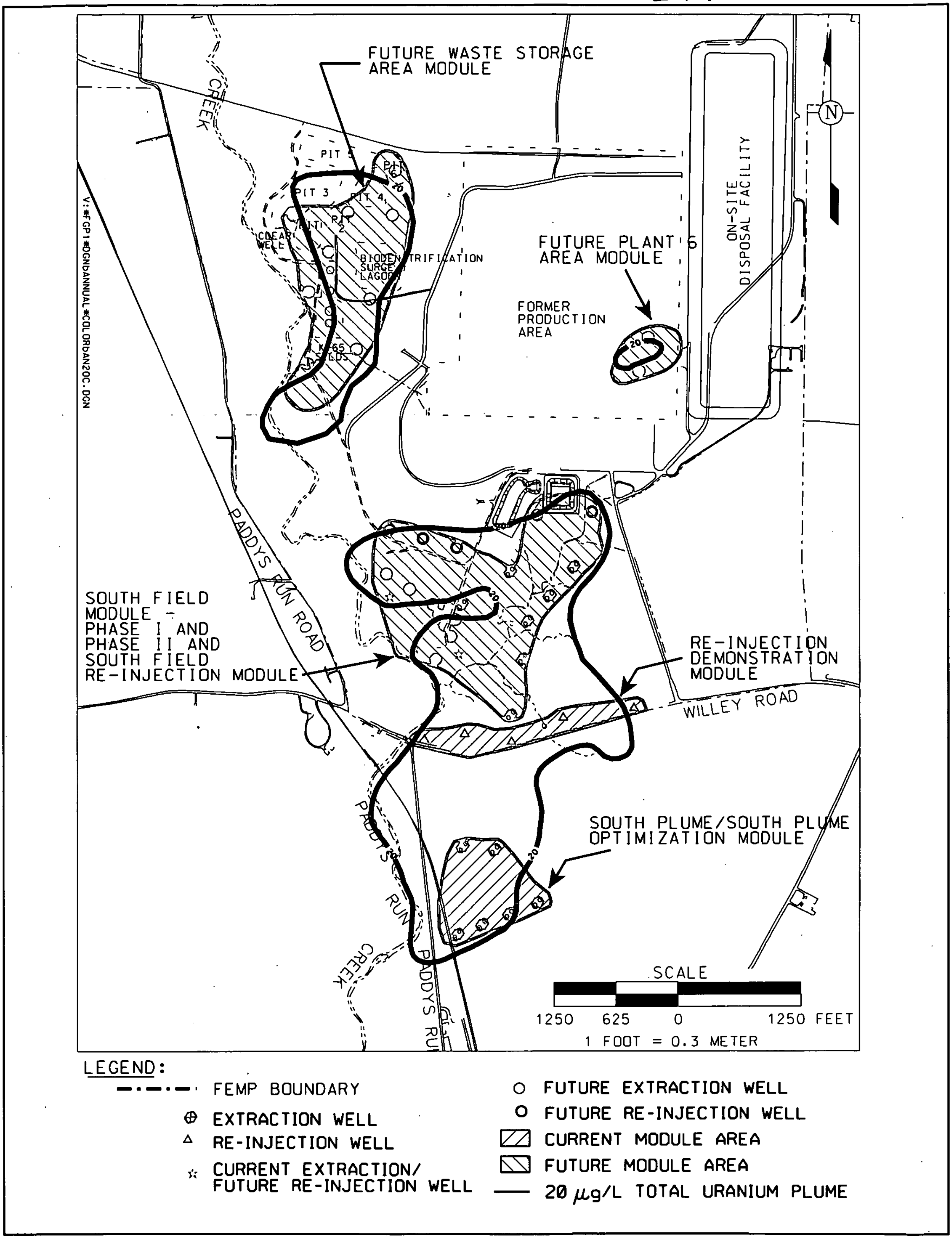


Figure 3-1. Current and Future Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

000063

While the remedial investigation and feasibility study process was in progress and a groundwater remedy was being selected, off-property contaminated groundwater was being pumped in the South Plume area by the South Plume Removal Action System (referred to as the South Plume Module). In 1993 this system was installed south of Willey Road and east of Paddys Run Road to stop the total uranium plume in this area from moving any further to the south. Figure 3-2 shows the four South Plume Module Extraction Wells 3924, 3925, 3926, and 3927. These extraction wells have successfully stopped further southern migration of the total uranium plume beyond the wells and have contributed to significantly reducing total uranium concentrations in the off-property portion of the plume.

During 1998 significant portions of the enhanced groundwater remedy were completed. By the end of June 1998, construction was complete on the pipeline distribution network and associated electronic controls for three groundwater restoration modules: South Plume Optimization Module, South Field (Phase I) Extraction Module, and Re-Injection Demonstration Module. By September 1998, all three modules were on line and, along with the South Plume Module, which has been in operation since August 1993, were pumping 3,500 gpm (13,000 L/min) from the aquifer and re-injecting 1,000 gpm (3,800 L/min). Figure 3-2 depicts the current extraction and re-injection well locations. The operational information associated with these modules is presented in subsequent sections.

Groundwater Monitoring Highlights for 1998

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

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

Groundwater elevation measurements are collected from aquifer monitoring wells at the FEMP. Elevations are plotted on maps and then contoured. The elevation contour maps are used by FEMP scientists to study the direction and rate of groundwater flow in the aquifer. A key use of these maps is to estimate the area that is being "captured" by pumping of the FEMP's groundwater extraction wells. Definition of this capture zone is important in ensuring that the uranium plumes targeted for clean up are being remediated.

- **Sampling** - Sample locations, frequency, and the constituents were selected to address operational assessment, restoration assessment, and compliance requirements. Selected wells are monitored for up to 50 groundwater FRL constituents as identified in Table 2-2. Monitoring is conducted to ascertain groundwater quality, groundwater elevations, and groundwater flow direction. Figure 3-3 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 3-4 identifies the location of the current IEMP water quality monitoring wells, extraction wells, and re-injection wells. In addition to water quality monitoring, 161 wells are monitored quarterly for groundwater elevations. Figure 3-5 depicts the IEMP routine water-level (groundwater elevation) monitoring wells.

000064

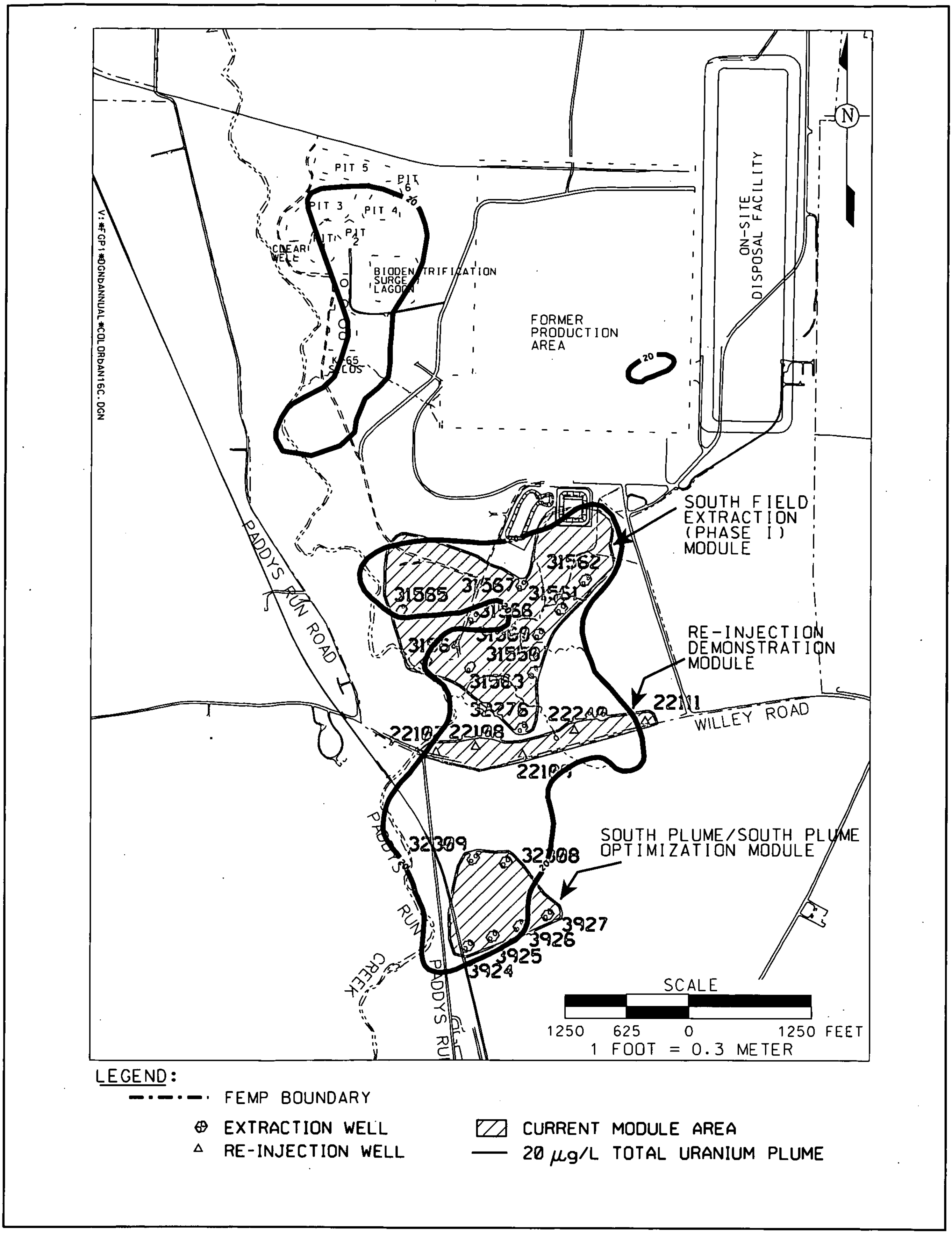
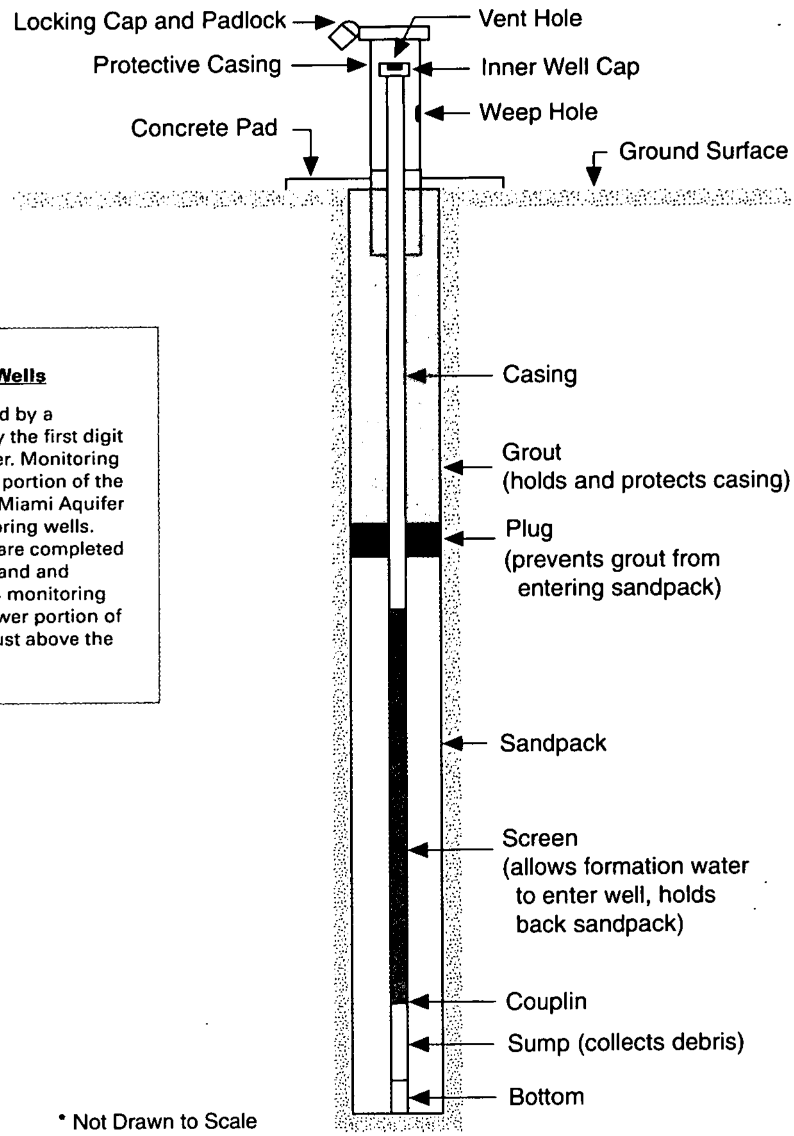


Figure 3-2. Current Extraction and Re-Injection Wells for the Enhanced Groundwater Remedy

000065



Groundwater Monitoring Wells

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

Figure 3-3. Monitoring Well Diagram

000066

– 2479

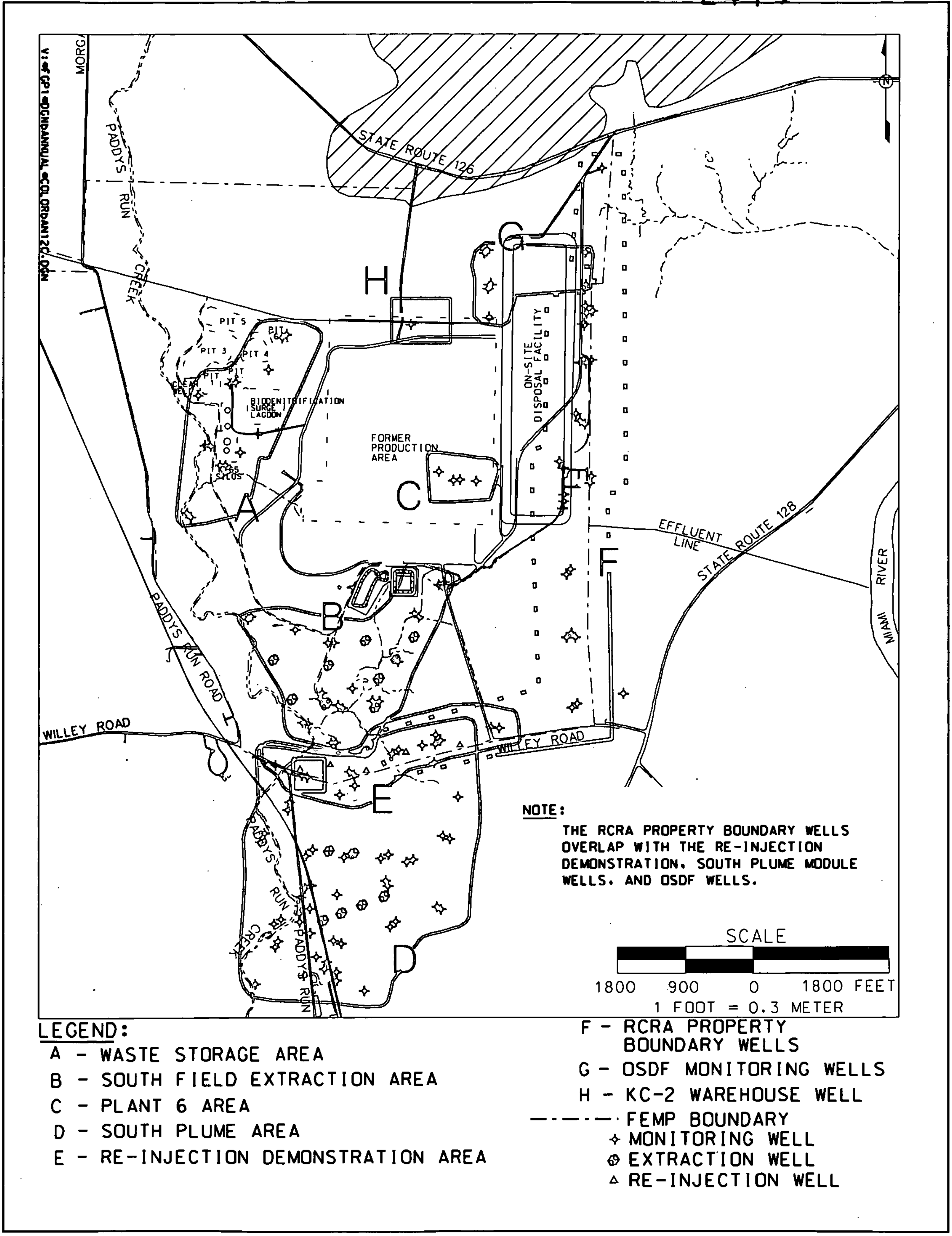


Figure 3-4. IEMP Water Quality Monitoring Wells

000067

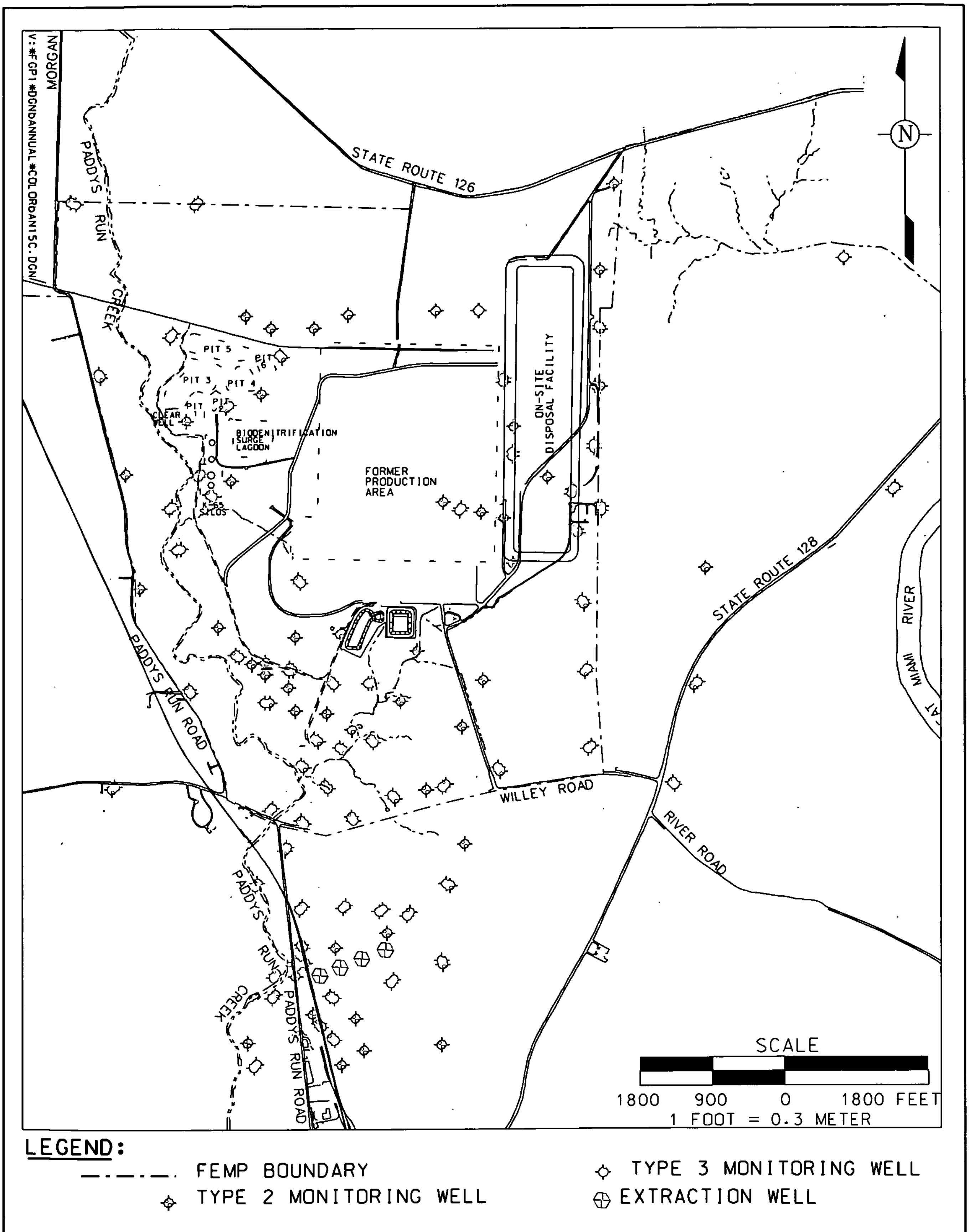


Figure 3-5. IEMP Groundwater Elevation Monitoring Wells

000068

- **Data Evaluation** - The integrated data evaluation process looks at the data collected from wells to determine: capture and restoration of the total uranium plume, capture and restoration of non-uranium FRL constituents, water quality conditions in the aquifer that indicate a need to modify the design and installation of restoration modules, and the impact of 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** - Groundwater reporting requirements are combined into IEMP quarterly status reports and annual integrated site environmental reports.

Restoration Monitoring

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

- Operational Summary
  - South Plume/South Plume Optimization Module
  - South Field (Phase I) Extraction Module
  - Re-Injection Demonstration Module
- Monitoring Results for Total Uranium
- Monitoring Results for Non-Uranium Constituents.

More detailed information on the above can be found in Appendix A of this report. Each subsection below identifies the specific Attachment of Appendix A where the detailed information can be found.

Operational Summary

Figure 3-2 shows the extraction and re-injection well locations associated with the current restoration modules. Table 3-1 summarizes the pounds of uranium removed and the amount of groundwater pumped by the three restoration modules active during 1998 and Figure 3-6 identifies the yearly and cumulative pounds of uranium removed from the Great Miami Aquifer from 1993 through 1998. Note that with the start-up of the additional extraction wells, more uranium was removed from the aquifer in 1998 than in the previous five years combined. Since 1993:

- 3,937.0 million gallons (14,902 liters) of water have been pumped from the Great Miami Aquifer.

- 150.9 million gallons (571.2 liters) of water have been re-injected into the Great Miami Aquifer.

- 814.3 pounds (369.7 kg) of uranium have been removed from the Great Miami Aquifer.

000069

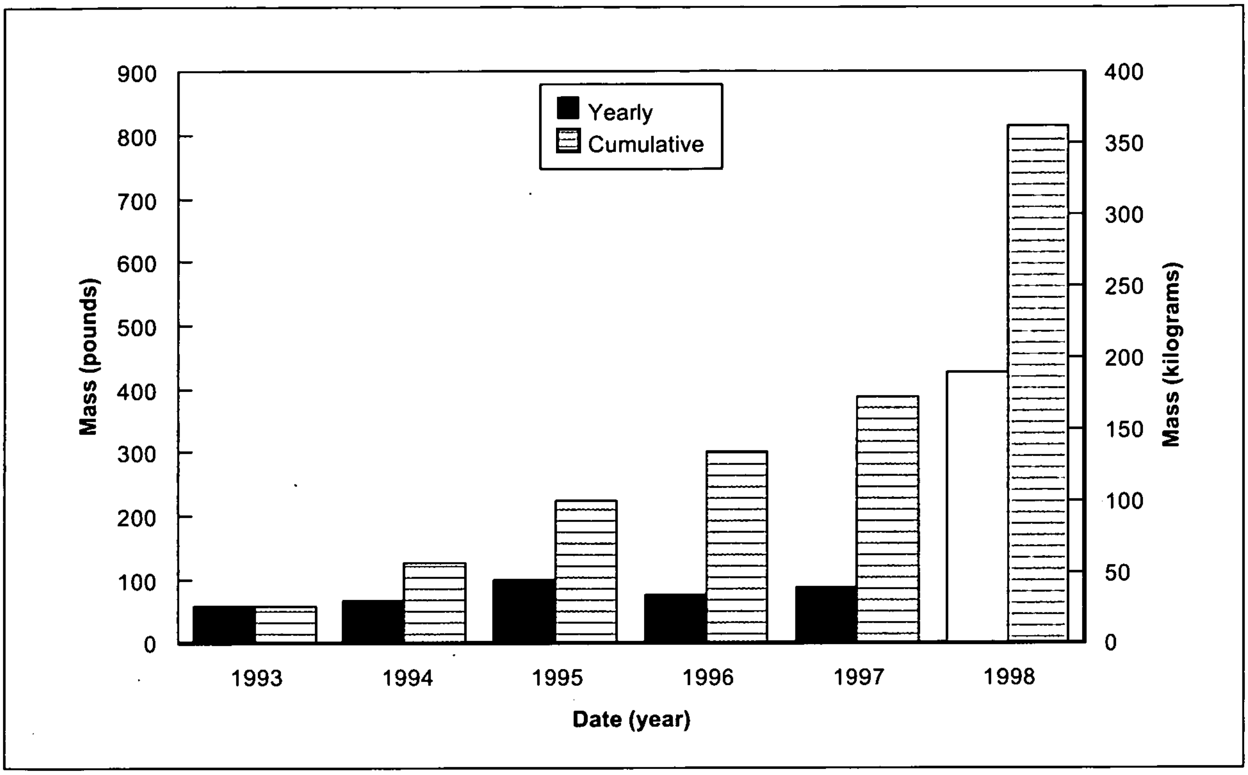


Figure 3-6. Pounds of Uranium Removed from the Great Miami Aquifer, 1993-1998

TABLE 3-1
1998 GROUNDWATER RESTORATION MODULE STATUS

Module	Restoration Wells	Operational Status	Target Pumping Rate Gpm	Target Pumping Rate Lpm	Gallons Pumped/ Re-Injected M gal.	Gallons Pumped/ Re-Injected M Liters	Pounds of Uranium Removed in 1998[a] lbs	Pounds of Uranium Removed in 1998[a] kg
South Plume/ South Plume Optimization Module					770.8	2924	185.2	84.08
South Plume Module	3924 3925 3926 3927	Operating since August 1993	1500	5700				
South Plume Optimization Module	32308 32309	Operating since August 1998	500	1900				
South Field (Phase I) Extraction Module	31550 31560 31561 31562 31563 31564 31565 31566 31567 32276	Operating since July 1998	1500	5700	353.7	1339	239.7	108.8
Re-Injection Demonstration Module	22107 22108 22109 22111 22240	Operating since September 1998	1000	3800	150.9	571.2	NA	NA
Aquifer Restoration System Totals								
(pumped)					1124.5	4262.3	424.9	192.9
(re-injected)					150.9	571.2	NA	NA
(net)					973.6	3691	424.9	192.9

[a]NA = not applicable

000070

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

South Plume/South Plume Optimization Module Operational Summary

As previously identified, the South Plume Module has been operational since 1993. Extraction Wells 3924, 3925, 3926, and 3927, which comprise the South Plume Module, continued to pump during 1998. The two extraction wells of the South Plume Optimization Module (Extraction Wells 32308 and 32309) began operating on August 9, 1998.

Start-up sampling for the South Plume Optimization Module was initiated during the second quarter of 1998. As part of the start-up monitoring program for this module, weekly groundwater elevations were taken in the area surrounding this module to observe aquifer flow conditions prior to and just after start-up of the two extraction wells. These observations were needed to determine the affect additional pumping would have on the aquifer. Evaluation of pre- and post- start-up groundwater elevation data indicates that the aquifer response to the pumping was favorable. (Refer to Figure 3-7 for the capture zone associated with the South Plume Optimization Module.)

In addition, the South Plume/South Plume Optimization Module 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 and groundwater elevation data and then analyzing the results. Concentration maps are developed from analytical data and compared with groundwater elevation maps depicting the location of the capture zone. Based on analysis of the data in 1998, the module continues to meet its primary objectives in that the:

- Southward movement of the total uranium plume beyond the extraction wells has not been detected.

- Active remediation of the central portion of the total uranium plume has begun.

- Paddys Run Road Site plume, located south of the extraction wells, is not being adversely affected by the pumping.

The Paddys Run Road Site plume is a result of separate industrial activities along Paddys Run Road that are not associated with the FEMP.

000071

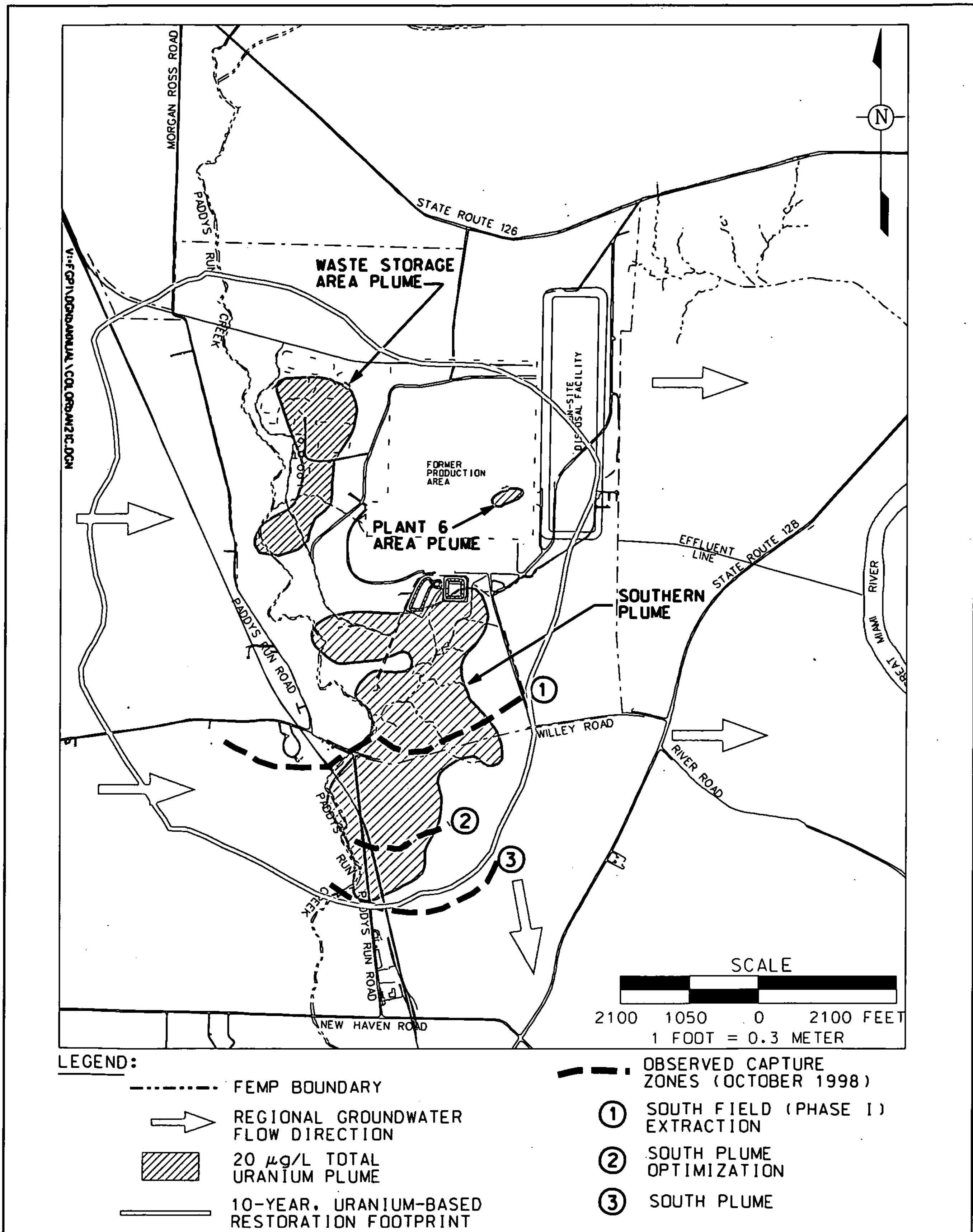


Figure 3-7. Total Uranium Plume in the Aquifer with Concentrations Greater than 20 µg/L at the end of 1998

000072

South Field (Phase I) Extraction Module Operational Summary

The 10 extraction wells of the South Field (Phase I) Module (Extraction Wells 31550, 31560, 31561, 31562, 31563, 31564, 31565, 31566, 31567, and 32276) began operating on July 13, 1998. These extraction wells pumped groundwater at or above rates specified in the Baseline Remedial Strategy Report for the majority of the period with the exception of Extraction Well 31566.

After evaluating the total uranium concentrations from Extraction Well 31566 and finding the concentrations averaging much less than the 20 micrograms per liter (µg/L) total uranium FRL, DOE decided to discontinue operation of this well. The well pump was shut off on August 7, 1998. To compensate for the decreased total system flow with Extraction Well 31566 turned off, pumping rates were increased at Extraction Wells 31562 and 32276. EPA and OEPA were informed of these changes through weekly site status conference calls.

Start-up sampling for the South Field (Phase I) Extraction Module was initiated during the second quarter of 1998. As part of the start-up monitoring program for this module, weekly groundwater elevations were taken in the area surrounding this module to observe aquifer flow conditions prior to and just after operating the 10 extraction wells. These observations were needed to determine the affect additional pumping would have on the aquifer. Evaluation of pre- and post- start-up groundwater elevation data indicates that the aquifer response to the pumping was favorable. (Refer to Figure 3-7 for the capture zone associated with the South Field [Phase I] Extraction Module.)

Re-Injection Demonstration Module Operational Summary

A one year re-injection demonstration is being conducted to determine whether enhanced large-scale flushing of the aquifer is feasible at the FEMP. The five re-injection wells of the Re-Injection Demonstration Module (Re-Injection Wells 22107, 22108, 22109, 22111, and 22240) began operating on September 2, 1998. The five re-injection wells re-injected groundwater at the rates specified in the Baseline Remedial Strategy Report for the majority of the last four months of the year.

Sampling specified in the Re-Injection Demonstration Test Plan (DOE 1998d) was initiated during the second quarter of 1998. As part of the start-up monitoring program for this module, weekly groundwater elevations were taken in the area surrounding this module to observe aquifer conditions prior to operating the five re-injection wells.

Also as part of the Re-injection Demonstration Module Test Plan, total uranium samples were collected at various depths in the aquifer using a Geoprobe®. These samples were collected at seven locations along Willey Road (refer to Figure 3-2 for the Re-injection Demonstration Module area) in May and June 1998 prior to the start-up of the South Field (Phase 1) Extraction Module. Additional data were collected at three of the locations during the third quarter of 1998. These data were used to supplement the total uranium plume map discussed in the next section and will also be used to assess the effects of active pumping and re-injection on the plume in this area.

Geoprobe®

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

000073

Monitoring Results for Total Uranium

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

The 10-year, uranium-based restoration footprint

The 10-year, uranium-based restoration footprint shows the anticipated total areal extent of the Great Miami Aquifer which is to be influenced by the aquifer restoration activities over the 10-year duration of the remediation as presented in aquifer restoration remedial design documents. The extent is determined from groundwater modeling results which show the composite groundwater capture zone derived from the capture zones for each extraction well.

Figure 3-7 shows the interpretation of the total uranium plume in the aquifer at the end of 1998 and the general groundwater flow directions in the aquifer. The shaded areas represent the total uranium plume which is above the 20 µg/L groundwater FRL for total uranium. The fourth quarter 1998 observed capture zones for the South Field (Phase I) Extraction, South Plume, and South Plume Optimization Modules are also identified on Figure 3-7. These capture zones indicate that the southern plume is being captured by the existing system and that further movement of uranium to the south of the extraction wells is being prevented. Figure 3-7 also depicts that the total uranium concentrations greater than the FRL are within the 10-year, uranium-based restoration footprint.

The interpreted 20 µg/L total uranium plume boundary in the area of the South Field has changed in shape somewhat from 1997 in that the plume shape has been modified to better reflect the data in the northwest area of the southern plume. No significant changes occurred in the remaining areas of the southern total uranium plume.

Groundwater was sampled in the waste storage area and in the Plant 6 area during 1998 to track water quality conditions and to determine if changes to the enhanced groundwater remedy design may be needed. The interpreted total uranium plumes in the Plant 6 area and waste storage area do not appear to have significantly changed since sampling in 1997. Groundwater remediation in these areas, including 10 extraction wells in the waste storage area and two extraction wells in the Plant 6 area, is scheduled to begin operation after soil remediation is completed. Groundwater monitoring for total uranium and other constituents of concern identified in 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.

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

Monitoring Results for Non-Uranium Constituents

Although the enhanced groundwater remedy was primarily designed to remediate the uranium plume, other FRL constituents (refer to Table 2-2) contained within the uranium plume, which occur above their respective FRLs, are being addressed by the enhanced groundwater remedy. The FEMP monitors these other constituents to determine where they exceed the FRL and if any of the locations with FRL exceedances fall outside the 10-year, uranium-based restoration footprint.

000074

Table 3-2 summarizes the results of monitoring for non-uranium FRL constituents, and Figure 3-8 identifies the locations of the wells that had FRL exceedances. Included in the table for each FRL constituent are the number of wells with 1998 FRL exceedances, the number of wells with FRL exceedances outside the 10-year, uranium-based restoration footprint, and the range of 1998 data above the FRL from wells inside or outside the 10-year, uranium-based restoration footprint.

During 1998 non-uranium FRL exceedances were observed at 27 monitoring well locations as shown in Figure 3-8. A total of 15 non-uranium FRL constituents were noted as exceeding their FRL. 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 arsenic, chromium, fluoride, manganese, vanadium, and zinc at various monitoring well locations along the eastern property boundary (refer to Figure 3-8). No plumes for these constituents at these locations were identified in the extensive groundwater characterization efforts evaluated as part of the Operable Unit 5 Remedial Investigation Report.

The 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, Attachment 4, of this report. No 1998 FRL exceedances were classified as persistent. However, as footnoted in Table 3-2, some FRL exceedances require additional data to be collected in 1999 before a determination of persistence can be made.

Appendix A, Attachment 4, of this report provides detailed information of non-uranium FRL exceedances, the persistence of these exceedances, and if it is necessary to collect additional samples.

Compliance Monitoring

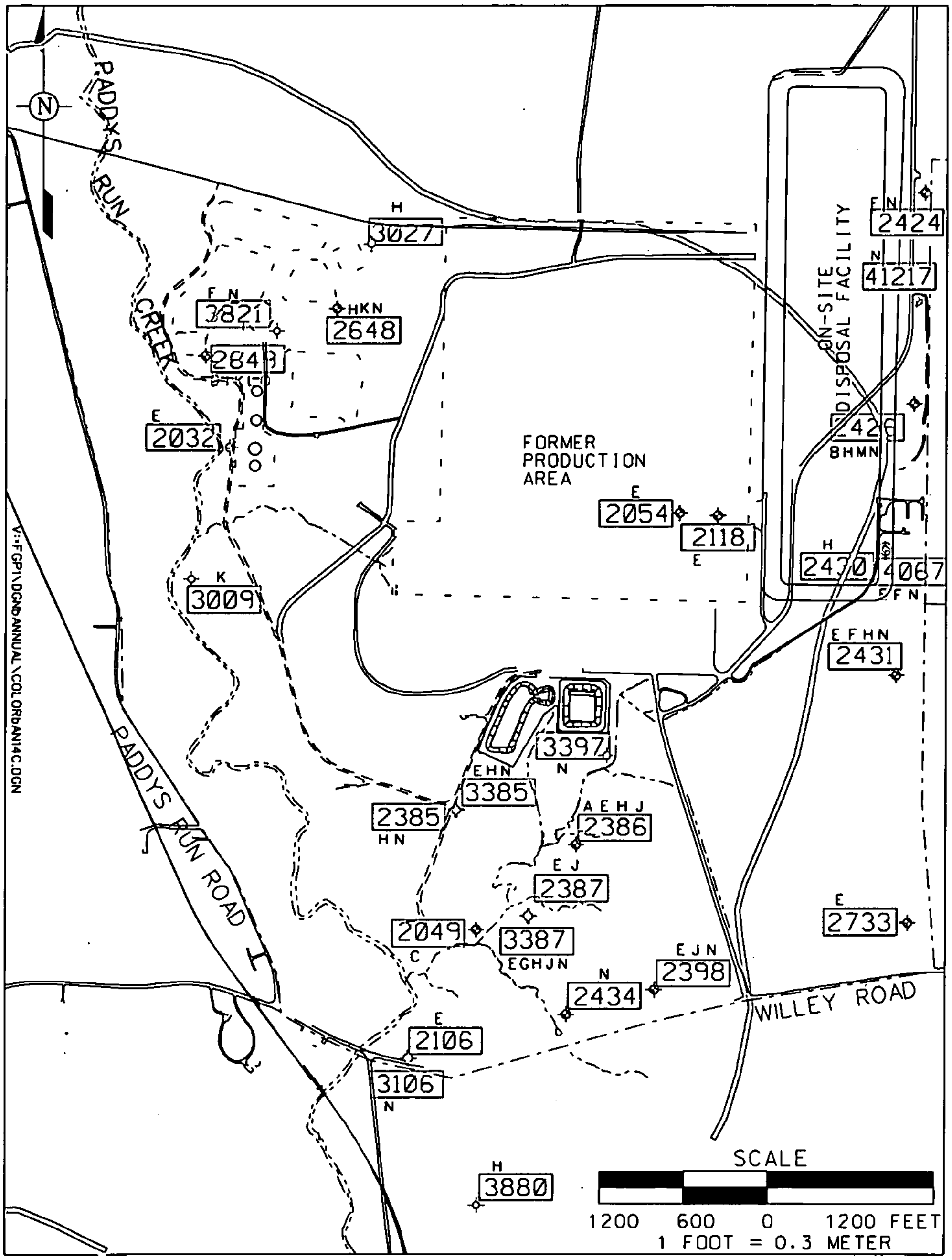
Three compliance monitoring programs are included in the IEMP:

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

As stated earlier, the groundwater data from these programs, along with the data from all other IEMP groundwater monitoring activities, are collectively evaluated for total uranium and non-uranium constituents of concern. The results have been presented in the previous sections. The discussion below provides additional details on the three compliance monitoring activities.

The three private wells (Monitoring Wells 2060[12], 13, and 14) located along Willey Road are monitored under the IEMP to assist in the evaluation of the total uranium plume migration. One of these private wells is where off-property contamination was initially reported in 1981. During 1997, other private wells ceased to be monitored because a public water suppy is now available to FEMP neighbors who have been affected by off-property groundwater contamination, and therefore private wells are no longer in use in areas being remediated. Data from the three private wells sampled under the IEMP were incorporated into the total uranium plume map shown in Figure 3-7.

000075



LEGEND:

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

FRL EXCEEDANCE KEY:

A ANTIMONY	H MANGANESE
B ARSENIC	I MOLYBDENUM
C BORON	J NICKEL
D CARBON DISULFIDE	K NITRATE/NITRITE
E CHROMIUM	L TRICHLOROETHENE
F FLUORIDE	M VANADIUM
G LEAD	N ZINC
	O TECHNETIUM-99

Figure 3-8. Non-Uranium Constituents with 1998 Results above Final Remediation Levels

000076

TABLE 3-2
NON-URANIUM CONSTITUENTS WITH 1998 RESULTS ABOVE FINAL REMEDIATION LEVELS

Constituent	Number of Wells Exceeding the FRL	Number of Wells Exceeding the FRL Outside the 10-Year, Uranium-Based Restoration Footprint	Groundwater FRL	Range of 1998 Data Inside the 10-Year, Uranium-Based Restoration Footprint above the FRL[a]	Range of 1998 Data Outside the 10-Year, Uranium-Based Restoration Footprint above the FRL[a]
General Chemistry			(mg/L)	(mg/L)	(mg/L)
Fluoride	4	3[b]	4	5.76	5.3 to 12.3
Nitrate/Nitrite	3	0	11[c]	11.5 to 47.3	NA
Inorganics					
Antimony	1	0	0.0060	0.01	NA
Arsenic	1	1	0.050	NA	0.113 to 0.125
Boron	1	0	0.33	0.592 to 0.779	NA
Chromium	12	3[d]	0.022[e]	0.0242 to 8.51	0.0246 to 0.0458
Lead	1	0	0.015	0.0437	NA
Manganese	10	3	0.90	1.18 to 9.15	1.28 to 5.52
Molybdenum	1	0	0.10	0.502	NA
Nickel	4	0	0.10	0.135 to 1.42	NA
Vanadium	1	1	0.038	NA	0.0664
Zinc	14	5[f]	0.021	0.0223 to 0.162	0.0256 to 13.6
Volatile Organics		(µg/L)	(µg/L)	(µg/L)	
Carbon disulfide	1	0	5.5	7	NA
Trichloroethene	1	0	5.0	120	NA
Radionuclides		(pCi/L)	(pCi/L)	(pCi/L)	
Technetium-99	1	0	94	1139.368	NA

[a]NA = not applicable
[b]Additional 1999 data are needed from Monitoring Wells 2424, 2431, and 4067 before a determination of persistence can be made.
[c]FRL based on nitrate, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for nitrate/nitrite.
[d]Additional 1999 data are needed from Monitoring Wells 2431 and 4067 before a determination of persistence can be made.
[e]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-4; however, the sampling results are for total chromium.
[f]Additional 1999 data are needed from Monitoring Wells 2424, 2431, 4067, and 41217 before a determination of persistence can be made.

2479

000072

The RCRA Property Boundary Monitoring Program is comprised of 33 monitoring wells, located downgradient of the FEMP, along the eastern and southern property boundaries. These wells are monitored quarterly for 27 of the most mobile FRL constituents in order to determine if contaminant excursions at the property boundary are occurring during the remediation process. Data from these wells are integrated with other IEMP data for 1998 and were incorporated into the total uranium plume map shown in Figure 3-7. Non-uranium data from these wells were included above in the section on monitoring results for non-uranium constituents.

The KC-2 Warehouse well monitoring has also been included as part of the IEMP. Monitoring of this well (Well 67) is conducted on an annual basis as a result of the discovery of contaminated debris at the bottom of the well and will continue until the warehouse is decommissioned and dismantled, at which time the well will be removed. 1998 sampling results from this well revealed lower concentrations of hazardous substance list metals than the previous year's sampling results. All results were below their respective groundwater FRLs. The monitoring results for this well and additional details on the sampling events are presented in Appendix A, Attachment 5, of this report.

Coal Pile Runoff Basin Monitoring

Monitoring Wells 1675 and 1676 installed in the perched groundwater zone within the glacial overburden (till) 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 1998 are presented in Appendix A, Attachment 5, of this report.

Monitoring of the two wells was conducted during the first quarter of 1998. However, in May, OEPA gave permission to cease monitoring of these wells primarily because the coal storage area which drained to the basin was no longer utilized for bulk coal storage and the useable coal had been removed (letter dated May 20, 1998, from OEPA's Office of Federal Facilities Oversight to DOE FEMP). The groundwater data that had been collected from these wells over the seven years of monitoring did not indicate a threat to human health and/or the environment.

000078

On-Site Disposal Facility Monitoring

Groundwater monitoring in support of the on-site disposal facility was initiated in 1997 and continued in 1998. 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. These 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.

Groundwater monitoring for the cells of the on-site disposal facility is conducted in the till (perched water) and in the Great Miami Aquifer. Table 3-3 summarizes the groundwater monitoring information associated with the on-site disposal facility. Table 3-3 also summarizes leachate (leachate collection system) and leak detection system information. Sampling of the leachate collection system and the leak detection system is initiated after waste placement. Table 3-3 provides information for Cells 1, 2, and 3, along with sample information and total uranium concentrations. Figure 3-9 identifies the on-site disposal facility footprint and monitoring well locations.

TABLE 3-3

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

Cell (Waste Placement Date[a])	Monitoring Location	Monitoring Zone	Date Sampling Started	Total Number of Samples	Range of Total Uranium Concentrations[b] (μg/L)
Cell 1 (December 1997)	22201	Great Miami Aquifer	March 31, 1997	19	ND - 5.196
	22198	Great Miami Aquifer	March 31, 1997	24	0.5 - 3.814
	12338	Till	October 30, 1997	19	1.106 - 19
	12338C	Leachate Collection System	February 17, 1998	4	47.018 - 119
	12338D	Leak Detection System	February 18, 1998	3	1.5 - 13.744
Cell 2 (November 1998)	22200	Great Miami Aquifer	June 30, 1997	14	ND - 1.11
	22199	Great Miami Aquifer	June 25, 1997	14	0.259 - 11.826
	12339	Till	June 29, 1998	18	1.53 - 3.607
	12339C	Leachate Collection System	November 23, 1998	1	17.1
	12339D	Leak Detection System	December 14, 1998	1	71[c]
Cell 3 (NA)	22203	Great Miami Aquifer	August 24, 1998	5	0.266 - 0.559
	22204	Great Miami Aquifer	August 24, 1998	5	0.481 - 2.995
	12340	Till	July 28, 1998	6	ND - 9.14

[a]NA = not applicable
[b]ND = not detectable
[c]Data not considered reliable due to malfunction in the leachate pipeline and the resultant mixing of individual flows.

000079

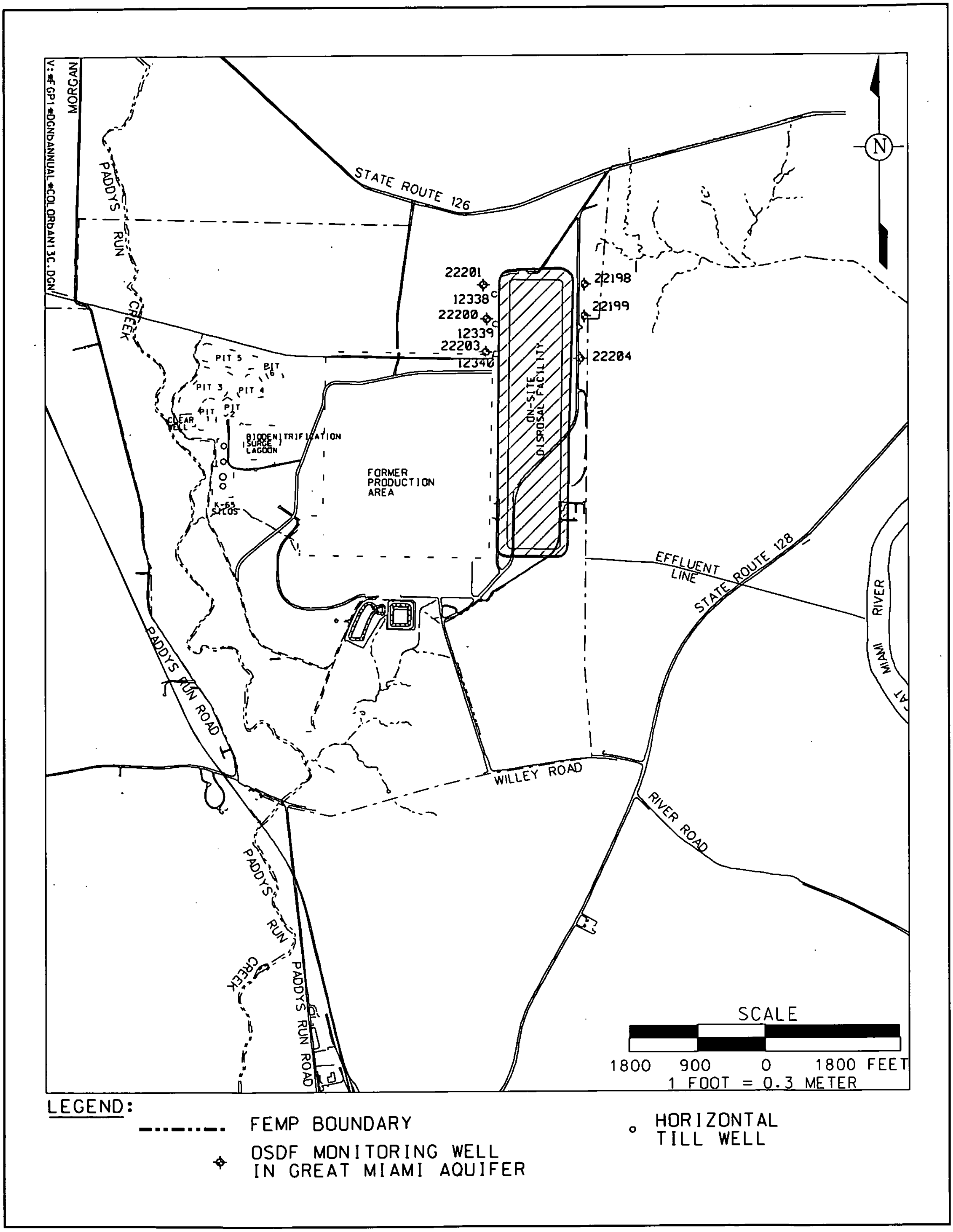


Figure 3-9. On-Site Disposal Facility Footprint and Monitoring Well Locations

000080

Groundwater sampling was initiated for Cell 1 in 1997 in an effort to establish a baseline for the monitoring wells prior to waste placement in December 1997. During 1998 a draft technical memorandum was issued to discuss the baseline results. The regulatory agencies issued comments on this technical memorandum identifying that it would be necessary to extend sampling in order to better establish baseline conditions. Approval of a strategy to establish baseline is anticipated in 1999. Groundwater sampling also continued in 1998 and leachate and leak detection system monitoring was initiated in 1998. Table 3-3 identifies that total uranium concentrations ranged from not detectable to 119 μg/L.

Groundwater sampling was also initiated in 1997 for Cell 2 and continued in 1998. Waste placement was initiated in November 1998, and then leachate and leak detection system monitoring began. It should be noted that during 1998 the leachate pipeline for the on-site disposal facility was found to be malfunctioning. The malfunction (discussed in greater detail in Appendix A, Attachment 6 of this report) resulted in water originating within the Cell 1 leachate collection system periodically mixing with water collected from the Cell 2 leak detection system. This condition resulted in non-representative water quality data for the Cell 2 leak detection system. The data presented in Table 3-3 for the Cell 2 leak detection system have been footnoted accordingly. The leachate pipeline is expected to be non-operational through the spring of 1999 to accommodate repairs.

Groundwater sampling was initiated in 1998 for Cell 3. Waste placement is not anticipated until 1999. Table 3-3 identifies that total uranium concentrations ranged from not detectable to 9.14 μg/L.

None of the constituents sampled and analyzed for this program exceeded the groundwater FRLs for the Great Miami Aquifer wells. 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

Numerous studies and reports have been issued by the FEMP during the CERCLA process to document the progress of the cleanup.

Table 3-4 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 were performed 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.

000081

TABLE 3-4
CHRONOLOGICAL SUMMARY OF AQUIFER RESTORATION ACTIVITIES

Date	Activity	Reporting Document[a]
1988-1995	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)
1996-1997	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)
1993-1998	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) and South Plume Optimization Modules, which began operation in 1998	**Start-Up Monitoring Plan for the South Field Extraction and South Plume Optimization Modules** (1998)
	Re-Injection Demonstration Module, which began operation in 1998	**Re-Injection Demonstration Test Plan** (1997)
1997-1998	Monitoring of the Systems to Clean Up the Aquifer	**Integrated Environmental Monitoring Quarterly** status reports (beginning with December 1997 and ending with December 1998)

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

000082

2479

Chapter 4
Surface Water and Treated Effluent Pathway

000083

--2479

Surface Water and Treated Effluent Pathway

Results in Brief: 1998 Treated Effluent and Surface Water Pathway

Surveillance Monitoring - No surface water or treated effluent analytical results from samples collected in 1998 exceeded the surface water FRL for total uranium, the primary site contaminant. FRL and BTV exceedances in surface water samples were limited to five and three 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 98.5 percent of the time. Total suspended solids exceeded the permit limits nine times in treated effluent at the Parshall Flume (PF 4001); 21 times in treated effluent from the sewage treatment plant (STP 4601); and two times from the overflow of the Storm Water Retention Basin. Additionally, a temporary limitation (imposed by OEPA during the project to install the new sewage treatment plant) for residual chlorine at the Parshall Flume was exceeded twice.

Uranium Discharges - In 1998, 216 pounds (98.1 kg) of uranium were discharged in treated effluent to the Great Miami River. Approximately 303 pounds (138 kg) of uranium were released to the environment through uncontrolled storm water runoff. Additionally, 2.47 pounds (1.12 kg) of uranium were released to Paddys Run during overflow of the Storm Water Retention Basin due to excessive amounts of precipitation. The estimated total pounds of uranium released through the surface water and treated effluent pathway (approximately 521 pounds [237 kg]) increased 38 percent from the 1997 estimate (approximately 378 pounds [172 kg]). This increase is attributable to above average rainfall during 1998 and to the additional extraction wells coming on line.

Sediment - The 1998 sediment results indicated a decrease in concentrations when compared to 1997 results. In addition, there were no FRL exceedances for any sediment result in 1998.

This chapter presents the 1998 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 to the Great Miami River 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 FEMP'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 storm water runoff from the waste storage area and former production area, remediation wastewaters (e.g., on-site disposal facility leachate and decontamination wastewater), and effluent from the sewage treatment plant. Controlled runoff, remediation wastewater, and some groundwater is routed to the appropriate FEMP water treatment facility, treated, and then discharged through the effluent line to the Great Miami River (refer to Figure 4-1).

The volume and flow rate of uncontrolled runoff is dependent upon the amount of precipitation within any given period of time. Figure 1-10 shows monthly precipitation totals for 1998. 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.

000084

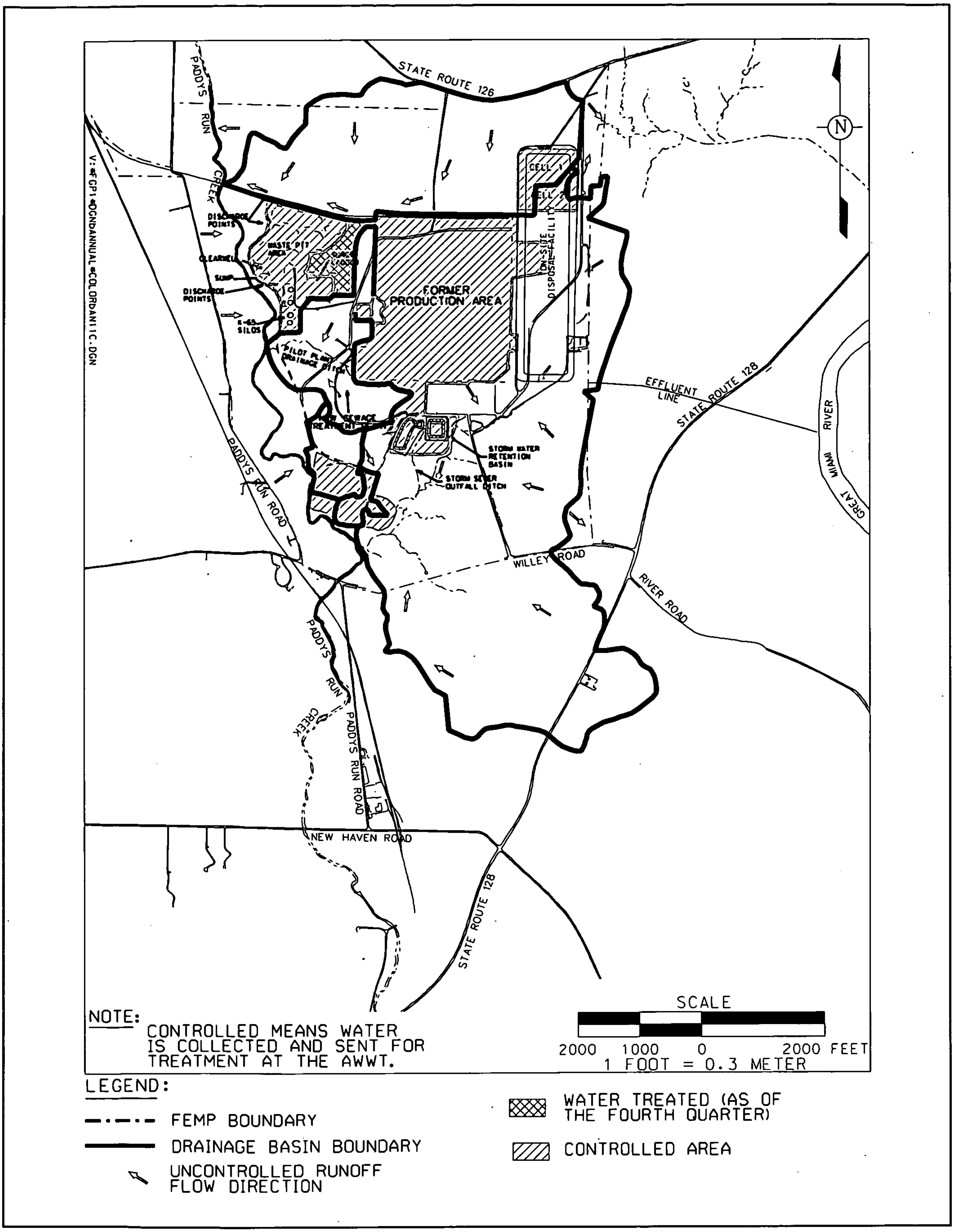


Figure 4-1. Controlled Surface Water Areas and Uncontrolled Runoff Flow Directions

000085

Remediation Activities Affecting Surface Water Pathway

Major remediation activities in 1998 that affected (or had the potential to affect) the surface water pathway included:

- Construction activities associated with the on-site disposal facility including installation of the on-site disposal facility borrow area storm water controls and excavation, screening, and hauling activities in the on-site disposal facility borrow area

- Construction and excavation activities associated with the southern waste units (Area 2, Phase I)

- Construction and excavation activities along with decontamination and dismantling activities associated with the old sewage treatment plant (Area 1, Phase II)

- Mobilization and construction activities associated with the Waste Pit Remedial Action Project

- Construction activities associated with groundwater restoration modules: South Field (Phase 1) Extraction, South Plume Optimization, and Re-Injection Demonstration Modules.

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 sediment controls can include the construction of sedimentation basins (lined or unlined), silt fences, check dams, and permanent or temporary seeding. Diversion ditches are also constructed as an engineered control to divert clean water from up gradient 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 FEMP'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.

000086

Each remediation project is responsible for constructing and maintaining the engineered control structures required under their remedial design. All engineered sediment and surface water controls are inspected at least once a week and within 24 hours of any rain event measuring greater than 0.5 inch (1.3 cm) of rain in a 24-hour period. Discharge points for uncontrolled runoff to Paddys Run are also inspected periodically to assess the effectiveness of up gradient controls in preventing significant impacts to Paddys Run. Minor maintenance activities (e.g., silt fence repairs, reseeding of eroded areas, etc.) were performed in 1998 as a result of these inspections.

Engineered controls installed during 1997 continued to be used and maintained in 1998. New storm water controls installed during 1998 included a sediment basin and outfall channel which will collect runoff from Area 1, Phase II (which includes the old sewage treatment plant) as well as two sediment traps in the on-site disposal facility borrow area.

Surface Water, Treated Effluent, and Sediment Highlights for 1998

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.

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

- **Sampling** - Sample locations, frequency, and constituents were selected to address the requirements of the NPDES permit, FFCA, and Operable Unit 5 Record of Decision, and to provide a comprehensive assessment of surface water quality at 15 key locations (refer to Figures 4-2 and 4-3). Surface water is monitored for up to 55 FRL constituents (refer to Table 2-2) and three BTV constituents (refer to Section 2.1).

- **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 FEMP remediation activities affecting uncontrolled runoff or treated effluent. The assessment also includes identifying the potential for impacts from surface water to the groundwater in the underlying Great Miami Aquifer. The ongoing data evaluation is designed to support remedial action decision making by providing timely feedback to the remediation project organizations on the effectiveness of storm water runoff controls and treatment processes.

000087

- 2479

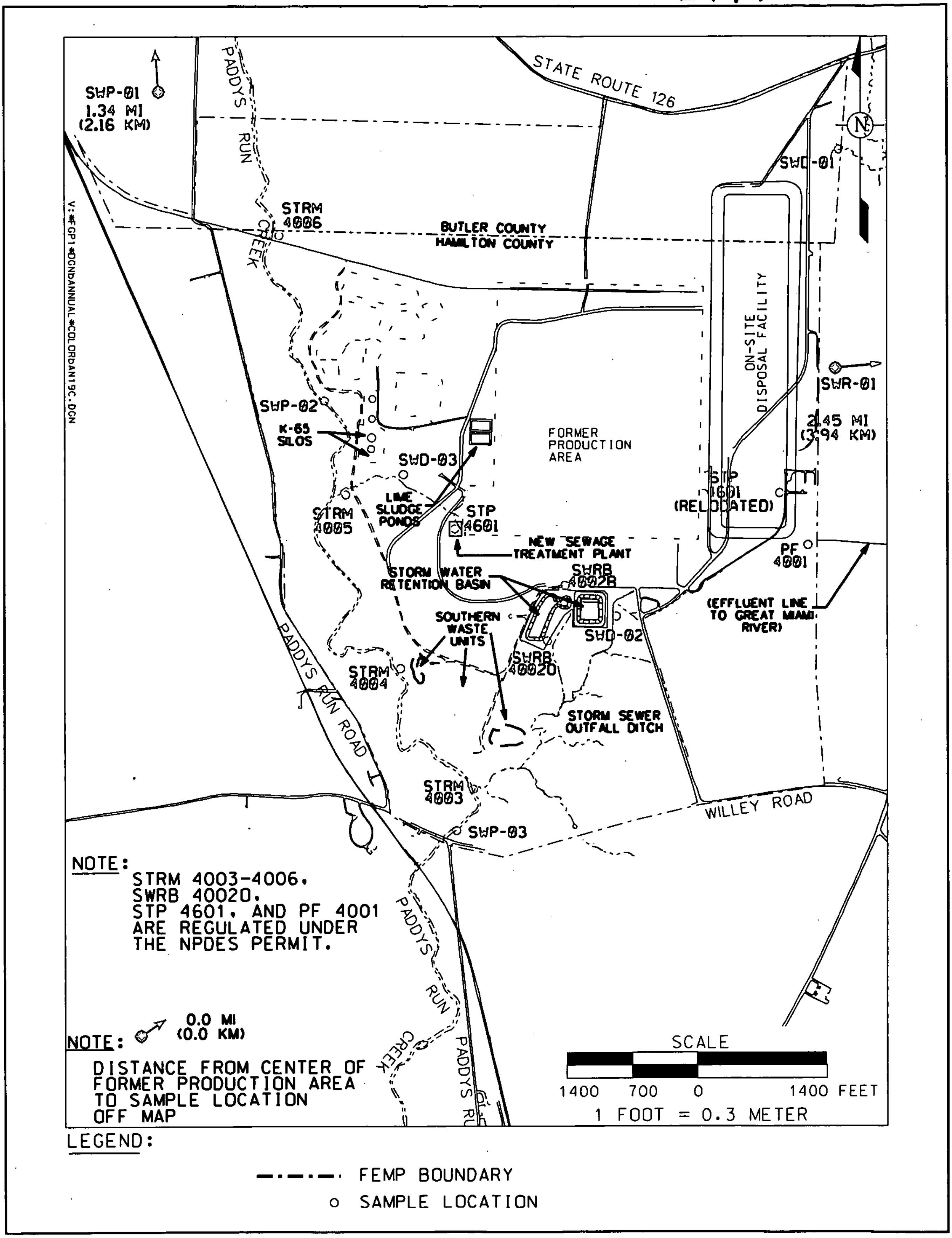


Figure 4-2. IEMP Surface Water and Treated Effluent Sample Locations

000088

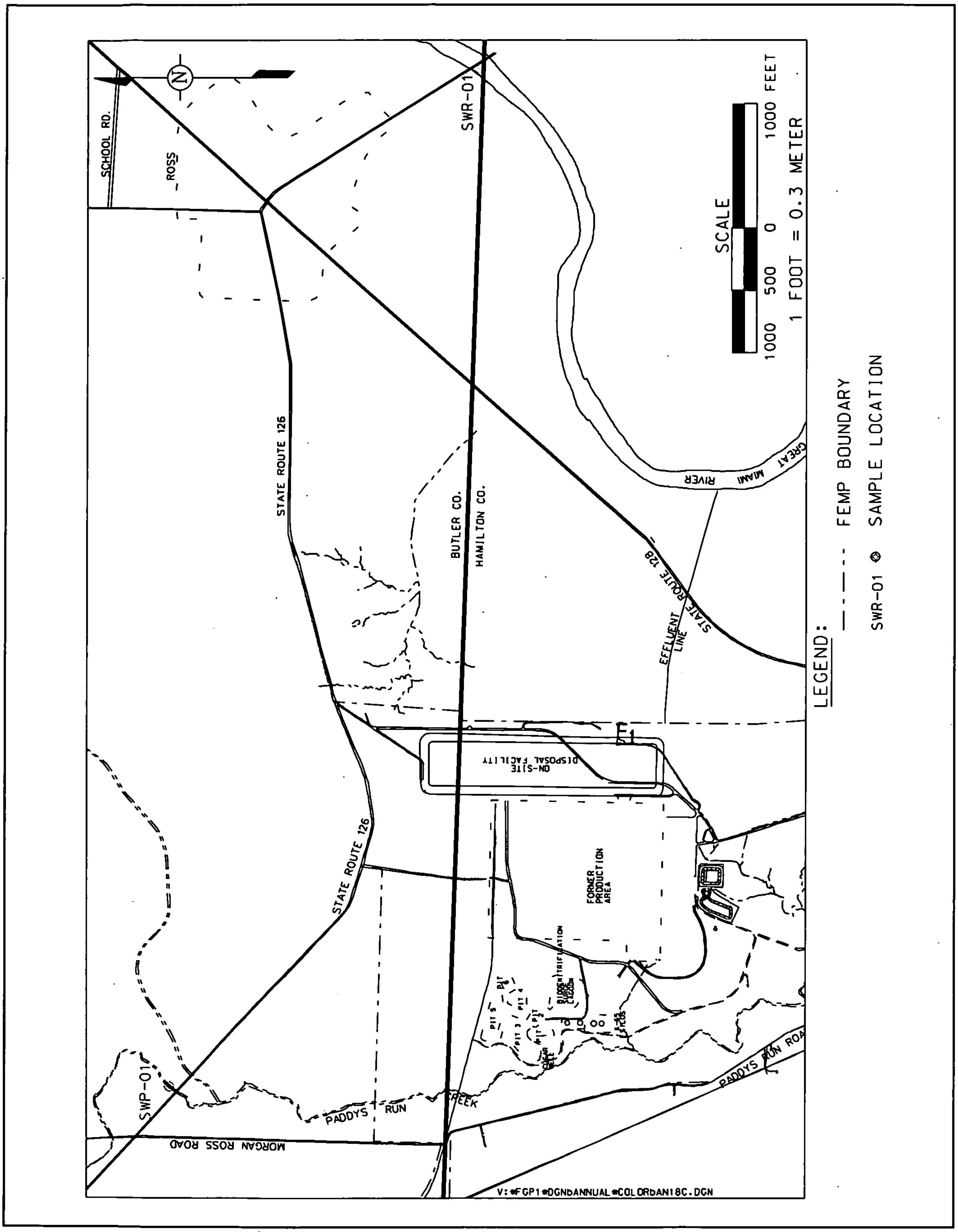


Figure 4-3. IEMP Background Surface Water Sample Locations

000089

- **Reporting** - Surface water and treated effluent reporting requirements are combined into IEMP quarterly status reports and annual integrated site environmental reports. The monthly discharge monitoring reports required by the NPDES permit continue to be submitted to OEPA.

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

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 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. Figure 4-2 depicts IEMP surface water and treated effluent sample locations while Figure 4-3 shows IEMP background 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 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 1998 sampling efforts were evaluated to provide surveillance monitoring of remediation activities. This evaluation showed that during 1998, there were no exceedances of the surface water total uranium FRL (530 µg/L) detected in any of the surface water and treated effluent samples. There were five non-uranium constituents with FRL exceedances and three non-uranium constituents with BTV exceedances. These exceedances are summarized in Table 4-1 and Figure 4-4 identifies the locations of the exceedances.

TABLE 4-1
CONSTITUENTS WITH 1998 RESULTS ABOVE FRLs OR BTVs

Constituent	Number of Locations Exceeding FRL	Number of Locations Exceeding BTV[a]	Surface Water FRL	Surface Water BTV[a]	Range of 1998 Data above FRL[a]	Range of 1998 Data above BTV[a]
			(mg/L)	(mg/L)	(mg/L)	(mg/L)
Inorganics						
Barium	0	1	100	0.145	NA	0.172
Cadmium	0	1	0.0098	0.0035	NA	0.0038
Chromium[b]	4	NA	0.010	NA	0.0124 to 0.0267	NA
Copper	5	NA	0.012	NA	0.0121 to 0.0273	NA
Lead	1	NA	0.010	NA	0.0222	NA
Mercury	1	NA	0.00020	NA	0.00027	NA
Silver	0	1	0.0050	0.0013	NA	0.0034
Zinc	1	.NA	0.11	NA	0.261	NA

[a]NA = not applicable
[b]FRL based on hexavalent chromium, from Operable Unit 5 Record of Decision, Table 9-5; however, the sampling results are for total chromium.

000090

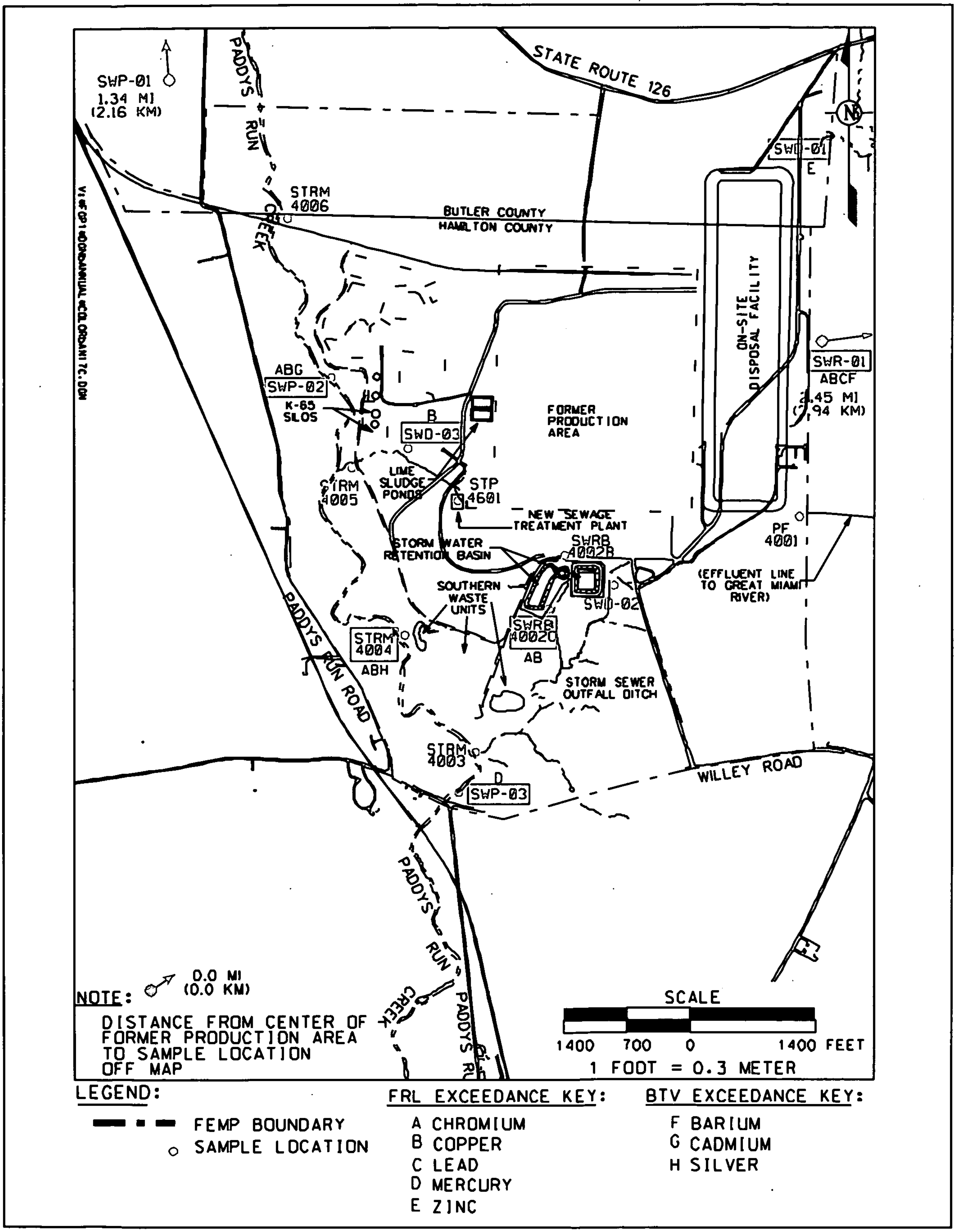


Figure 4-4. Constituents with 1998 Results Above Final Remediation Levels and/or Benchmark Toxicity Values

000091

The highest concentrations for chromium, copper, and lead (three of the five constituents with FRL exceedances) and barium (one of the three constituents with BTV exceedances) during 1998 occurred at the Great Miami River background location SWR-01. Background monitoring locations are located upstream and outside the influence of FEMP discharges. The Parshall Flume (PF 4001), which monitors site effluent to the Great Miami Aquifer, showed no exceedances of FRLs or BTVs. The background data are used to distinguish impacts from FEMP activities against upstream water quality conditions. Therefore, concentrations at the background locations (both in Paddys Run [SWP-01] and in the Great Miami River [SWR-01]) are not attributable to the FEMP. The remaining FRL/BTV exceedances, which may be attributable to FEMP activities were sporadic in nature and do not indicate any significant impacts to the environment or operational problems with the FEMP's storm water and sediment control systems. In addition, trend analysis indicates no significant trends for these constituents.

Even with the FEMP's implementation of storm water and sediment controls, sporadic FRL and BTV exceedances can be expected to occur until final remediation of contaminated source areas (soils and sediments) are complete. 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.

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
- 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.

There was one exceedance at SWP-03 for the mercury FRL of 0.00020 milligrams per liter (mg/L). The exceedance concentration was 0.00027 mg/L, which is minimally above the associated FRL. Total uranium concentrations at this location were very low. Figure 4-5 shows the annual average total uranium concentration in Paddys Run at Willey Road for the period 1985 through 1998. 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. The maximum total uranium concentration at SWP-03 during 1998 was 2.78 µg/L which was well below the surface water total uranium FRL of 530 µg/L.

000092

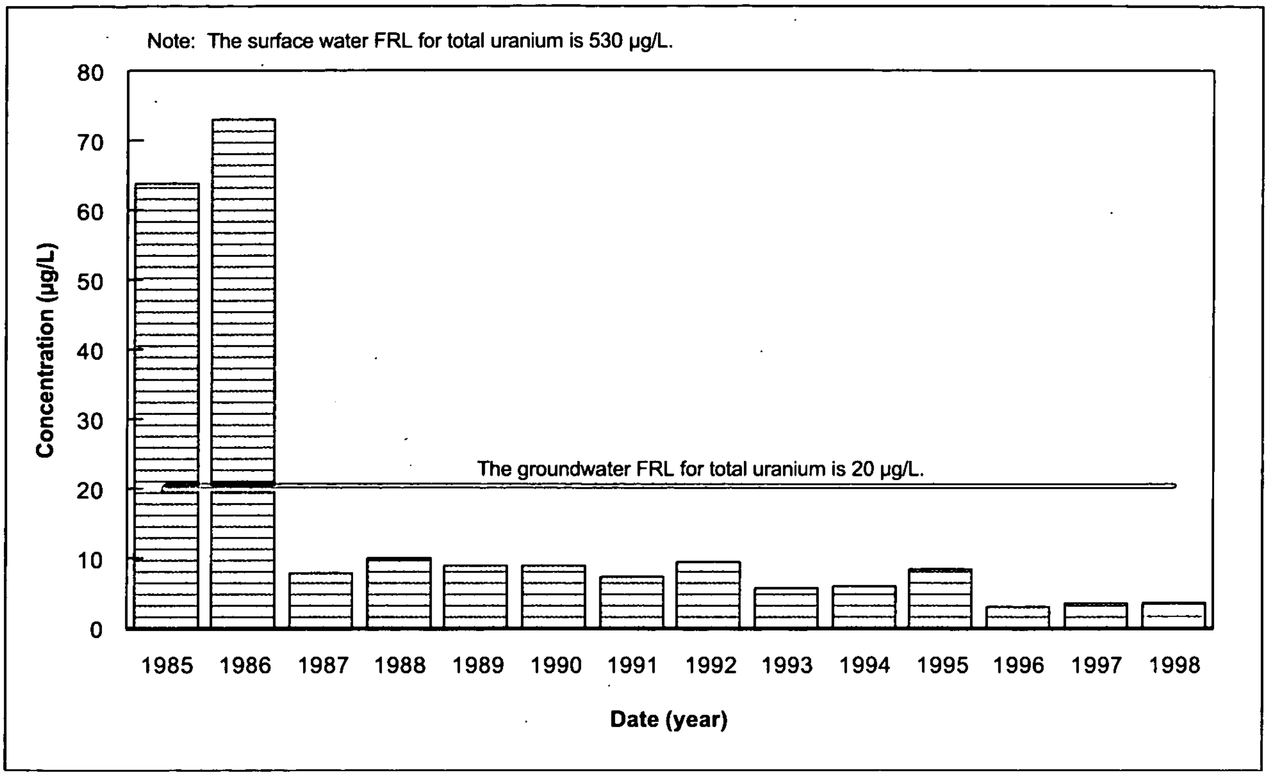


Figure 4-5. Annual Average Total Uranium Concentrations in Paddys Run at Willey Road (SWP-03) Sample Location, 1985-1998

There were no FRL or BTV exceedances at the Parshall Flume during 1998. The 1998 maximum daily total uranium concentration at the Parshall Flume prior to discharge through the effluent line to the Great Miami River was 145 µg/L. After the water from the Parshall Flume mixed with the water in the Great Miami River the concentration would have been approximately 2.4 µg/L. Both concentrations, those from the Parshall Flume and after mixing with the Great Miami River, were well below the surface water total uranium FRL. Contaminant concentrations observed at the Parshall Flume in 1998 are further discussed 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 at the Storm Water Retention Basin overflow (SWRB 4002O). 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.

000093

During 1998 total uranium in surface water samples exceeded the groundwater FRL at two of the three locations. No other constituents monitored at surface water locations, besides total uranium, exceeded groundwater FRLs. Table 4-2 summarizes the total uranium cross-media exceedances.

Based on these exceedances, it is not likely that there were any significant cross-media impacts to the Great Miami Aquifer. Both surface water and groundwater data from monitoring wells will continue to be collected at these sensitive areas under the IEMP to address the cross-media concern. Additional details concerning the cross-media impacts are provided in Appendix B, Attachment 1, of this report.

TABLE 4-2

EVALUATION OF 1998 TOTAL URANIUM GROUNDWATER FRL EXCEEDANCES FOR CROSS-MEDIA IMPACTS

	Number of Exceedances	Number of Samples	Maximum Total Uranium Result[a] (μg/L)
SWD-02	5	11	51
Overflow of Storm Water Retention Basin (SWRB 4002O)	2	2	171[b]

[a]The groundwater FRL for total uranium is 20 μg/L.
[b]Overflows of the Storm Water Retention Basin are infrequent (i.e., only two overflows of the Storm Water Retention Basin occurred in 1998).

Compliance Monitoring

FFCA and Operable Unit 5 Record of Decision Compliance

The FEMP is required to monitor treated effluent discharges at the Parshall Flume for total uranium mass discharges and the total uranium concentrations. These requirements are encompassed under the July 1986 FFCA and the Operable Unit 5 Record of Decision. The Operable Unit 5 Record of Decision requires treatment of effluent so that the mass of total uranium discharged to the Great Miami River through the Parshall Flume does not exceed 600 pounds (272 kg) per year. The Operable Unit 5 Record of Decision also requires that the monthly average total uranium concentration in the effluent must be at or below 20 μg/L. This 20 μg/L concentration limit became effective January 1, 1998.

The Operable Unit 5 Record of Decision remedy allows the FEMP to discharge water from the Storm Water Retention Basin directly to the Great Miami River during periods of heavy precipitation. This is allowed in order to reduce the possibility of Storm Water Retention Basin overflows which effectively minimizes the potential cross-media impacts described above and to maximize the available treatment capacity. 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. However, the mass of total uranium discharged during these 10 days per year is still considered in the total discharge mass to ensure the 600 pound (272 kg) per year discharge limit is not exceeded.

000094

In addition to "significant precipitation" related bypasses, the FEMP is also allowed to bypass water from the Storm Water Retention Basin during certain scheduled wastewater treatment plant maintenance activities. The total uranium concentration in the discharge related to maintenance activities may be deducted from the monthly average calculation demonstrating compliance with the 20 μg/L concentration limit. However, the mass of total uranium discharged during these maintenance bypasses is still considered in the discharge mass to ensure compliance with the 600 pound (272 kg) discharge limit. These maintenance bypasses must be preapproved by the regulatory agencies.

Table 4-3 shows a summary of the Storm Water Retention Basin treatment bypass events during 1998; Figure 4-6 shows that the total cumulative mass of total uranium discharged to the Great Miami River during 1998 was 216 pounds (98.1 kg) which is well below the 600 pound (272 kg) annual limit; and Figure 4-7 depicts that for two months (July and December) during 1998, the 20 μg/L concentration limit was not met.

TABLE 4-3
1998 STORM WATER RETENTION BASIN TREATMENT BYPASS EVENTS

Event	Duration (hours)	Number of Bypass Days[a]	Cumulative Number of Bypass Days	Total Uranium Discharged to Great Miami River (pounds/kg)	Total Water Discharged to Great Miami River (millions of gallons/ millions of liters)
Significant Precipitation Bypasses					
January 7 through January 9	53.8	2	2	7.82/3.56	3.19/12.1
April 16 through April 19	76.8	3	5	9.78/4.44	6.09/23.1
June 11 through June 14	80.0	3	8	11.16/5.07	5.72/21.7
June 16 through June 17	22.8	0	8	2.48/1.13	1.43/5.41
June 19 through June 20	24.0	1	9	3.17/1.44	2.01/7.61
July 20 through July 23	83.8	4	13	6.45/2.93	6.17/23.4
December 21 through December 23	34.7	1	14	4.92/2.23	2.04/7.72
Treatment Plant Maintenance Bypasses					
December 18 through December 19	48.0	2	2	3.81/1.73	9.75/36.9

[a]Days are counted according to the definition provided in the Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project (DOE 1997e), which states that a bypass day occurs when a bypass lasts for 12 hours or longer on any given day.

000095

2479

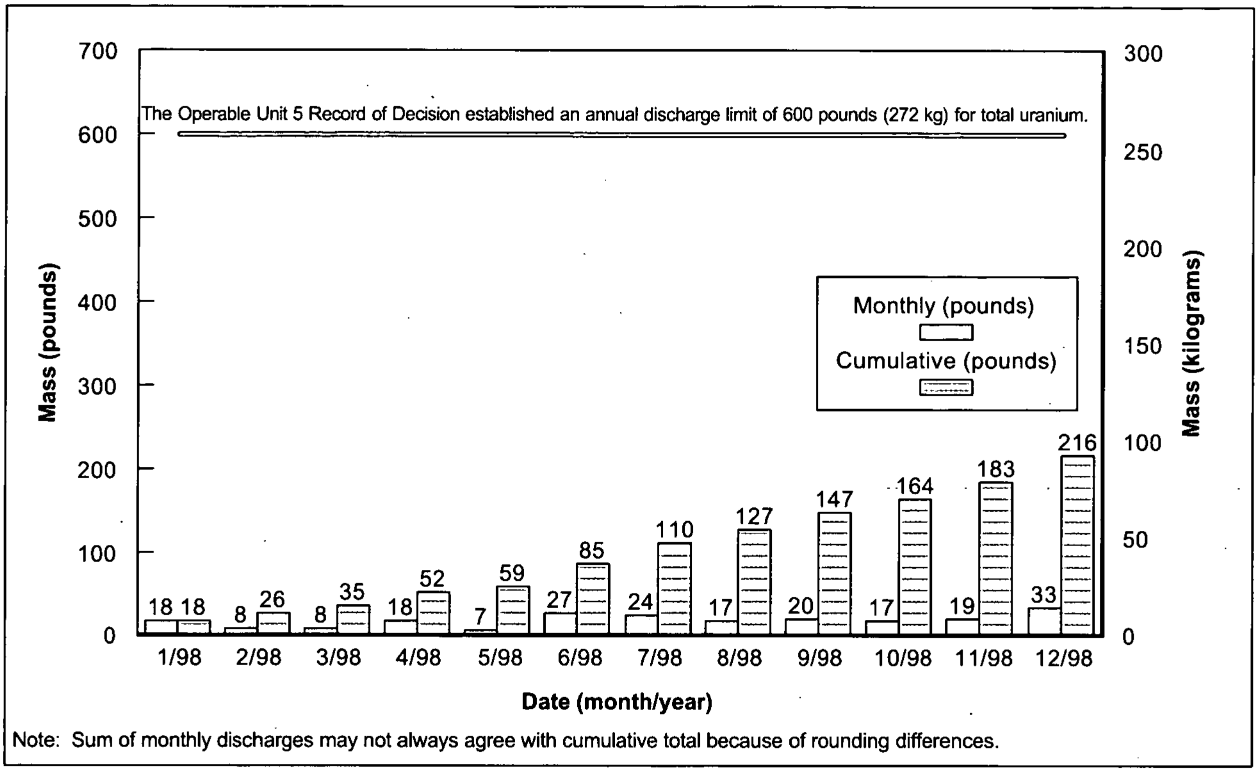


Figure 4-6. Pounds of Uranium Discharged to the Great Miami River from the Parshall Flume (PF 4001) in 1998

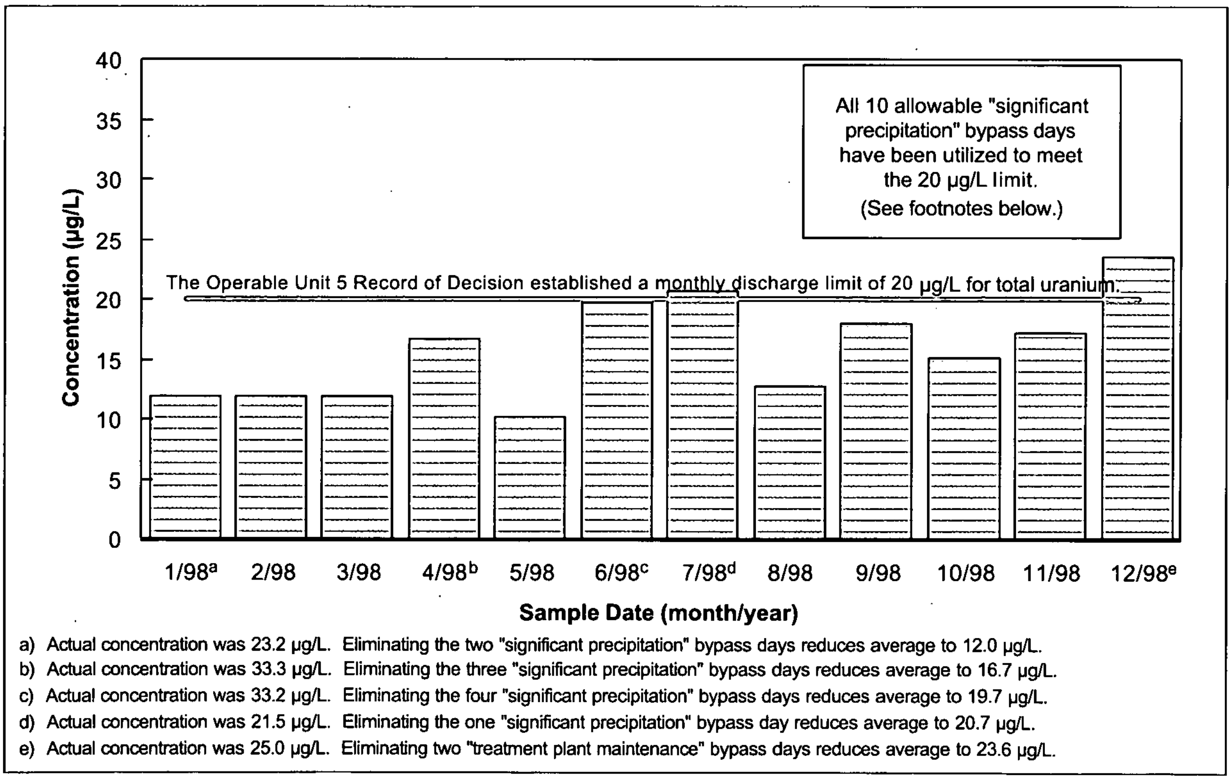


Figure 4-7. 1998 Monthly Average Total Uranium Concentration in Water Discharged from the Parshall Flume (PF 4001) to the Great Miami River

000096

The following summarizes why the monthly concentration limit was not met during July and December of 1998. Prior to the significant precipitation event that occurred on July 20, nine of the 10 allowable bypass days had been exhausted. As a result of this rainfall event, the Storm Water Retention Basin was bypassed for a total of four days. Nonetheless, only one of the four days could be deducted from the 20 µg/L calculation. Furthermore, the duration of the bypass was extended because non-uranium contaminated storm water from the on-site disposal facility construction area was mistakenly pumped to the Storm Water Retention Basin. The 20 µg/L concentration limit was not met in December primarily because all 10 of the allowable significant precipitation bypass days were exhausted prior to the heavy precipitation on December 21. The duration of the bypass was determined to result, in part, to storm water from the southern waste units being sent to the Storm Water Retention Basin after the bypass had been initiated. In the future, the pumping of storm water from the southern waste units to the Storm Water Retention Basin during a bypass event will be stopped. This change in operational philosophy was presented to the regulatory agencies in October 1998, but was not fully implemented until January 1999.

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.

NPDES Permit Compliance

Compliance sampling, consisting of sampling for non-radiological pollutants from uncontrolled runoff and treated effluent discharges from the FEMP, is regulated under the state-administrated NPDES program. The current permit became effective November 1, 1995, and expired on March 31, 1998. A NPDES Permit Renewal Application was submitted to OEPA in September 1997, and was amended by addendum in August 1998. The addendum provided information related to the Waste Pits Remedial Action Project. Pursuant to Ohio Administrative Code 3745-33-04(c)(1), submittal of the renewal application allows the FEMP to continue operating under the terms of the expired permit until approval of the new permit application is received from OEPA. The permit specifies discharge and sample requirements, as well as discharge limits for several chemical constituents. Figure 4-2 also identifies NPDES sample locations. It is important to note that the monitoring location associated with the sewage treatment plant (STP 4601) was relocated during 1998 with the completion of the new sewage treatment plant. Both locations are shown on Figure 4-2.

Wastewater and uncontrolled runoff discharges from the FEMP were in compliance with the current permit requirements 98.5 percent of the time during 1998. Of the 2,312 sample results associated with NPDES monitoring, 34 sample results at three locations (Parshall Flume [PF 4001], Storm Water Retention Basin overflow [SWRB 4002O], and the new sewage treatment plant location [STP 4601]) were not within the discharge limits specified by the permit.

000097

Thirty-two of these noncompliances were related to total suspended solids exceedances at three locations.

- Nine noncompliances of total suspended solids were experienced at the Parshall Flume, primarily due to those instances involving storm water bypassing explained above. Of these, six were within specified concentration limitations; however, they exceeded the total mass limit because of the high discharge rate.

- Two noncompliances of total suspend solids were experienced at the Storm Water Retention Basin overflow. During 1998 there were two overflow events associated with the Storm Water Retention Basin (SWRB 4002O) due to heavy precipitation events. These overflows occurred on April 16 and July 20.

- Twenty-one noncompliances of total suspended solids were experienced at the new sewage treatment plant.

The FEMP is continuing to make adjustments to the sewage treatment plant system in order to avoid future exceedances. None of the permit exceedances at the sewage treatment plant have caused an exceedance at the Parshall Flume which is the final effluent sample location prior to discharge in the Great Miami River.

In addition to the total suspended solids exceedances, in 1998, there were two noncompliances of an interim total residual chlorine limit at the Parshall Flume. Disinfection at the old sewage treatment plant had been accomplished through ultraviolet disinfection technology. During the time when the ultraviolet disinfection units were being relocated to the new sewage treatment plant for reuse, it became necessary to disinfect the old sewage treatment plant's effluent with chlorine. OEPA imposed temporary limitations for total residual chlorine at the Parshall Flume (because this location is the final effluent sample location prior to discharge in the Great Miami River) during the time chlorination was used.

The noncompliance conditions that occurred throughout 1998 were reported to OEPA, as required by the NPDES permit.

Uranium Discharges in Surface Water and Treated Effluent

As identified in Figure 4-6, 216 pounds (98.1 kg) of uranium in treated effluent were discharged to the Great Miami River through the Parshall Flume (PF 4001) in 1998. In addition to the treated effluent, uncontrolled runoff is also contributing to the amount of uranium entering the environment. It is estimated that 6.25 pounds (2.84 kg) of uranium is discharged to the environment through uncontrolled runoff with every inch (2.54 cm) of rain. This is a conservative equation that was developed during the Operable Unit 5 Remedial Investigation.

During 1998, 48.43 inches (123.0 cm) of precipitation fell at the FEMP; therefore, it is estimated that approximately 303 pounds (138 kg) of uranium entered the environment through uncontrolled runoff. In addition to this calculated uranium discharge to the environment, 2.47 pounds (1.12 kg) of uranium were discharged to Paddys Run during the overflow events from the Storm Water Retention Basin (refer to Table 4-4). Therefore, the estimated total amount of uranium discharged to the surface water pathway for the year, including both controlled treated effluent discharges and uncontrolled runoff, was 521 pounds (237 kg). This anticipated increase in uranium discharges represents an approximate 37 percent increase in uranium released compared to 1997. Uranium from the uncontrolled runoff and controlled discharges from 1993 through 1998 are presented in Figure 4-8.

TABLE 4-4
1998 STORM WATER RETENTION BASIN OVERFLOW EVENTS

Event	Duration (hours)	Total Uranium Discharged to Paddys Run (pounds/kg)	Total Water Discharged to Paddys Run (*millions of gallons/ millions of liters*)
Overflows			
April 16	15.9	1.99/0.903	1.39/5.26
July 20	8.25	0.48/0.218	0.55/2.08

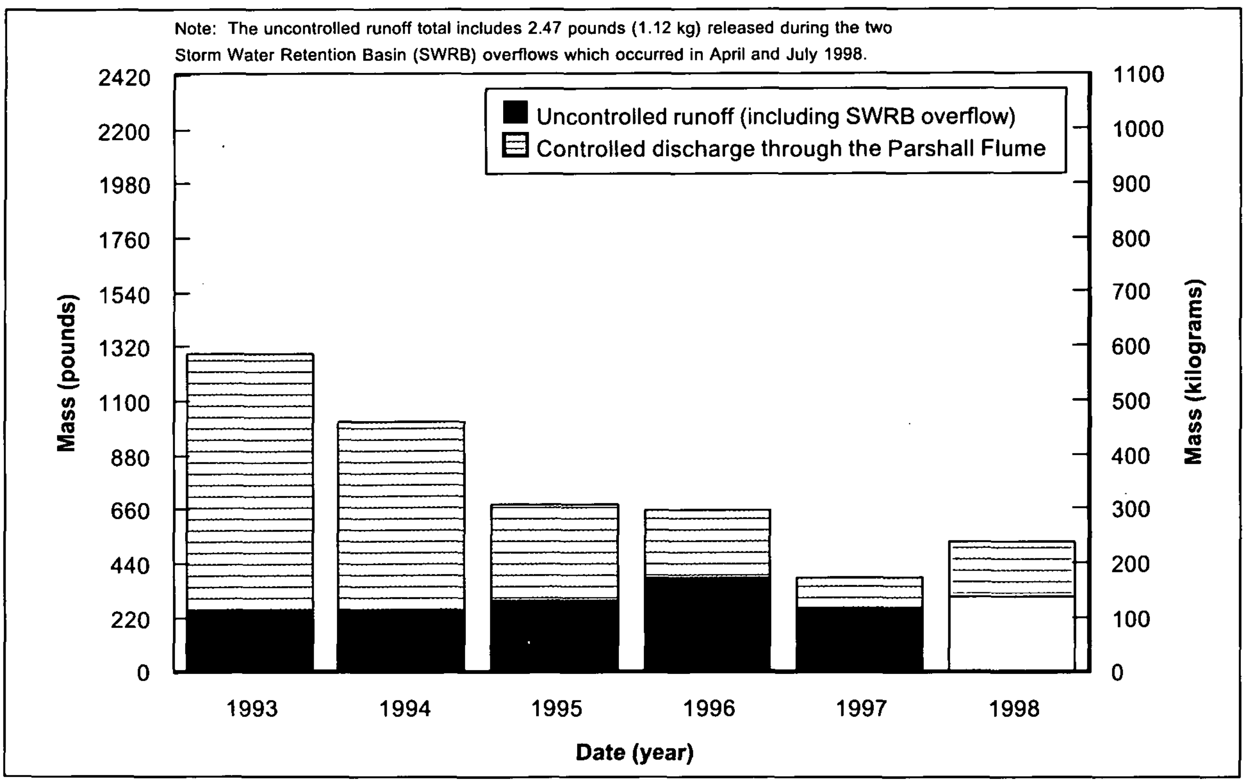


Figure 4-8. Uranium Discharged from the FEMP Via the Surface Water Pathway, 1993-1998

000099

The following summarizes the reasons for the increase in uranium discharges during 1998:

- **Increased flow rates at the Parshall Flume:** The flow rates increased primarily due to the increase of extracted water from the Great Miami Aquifer associated with groundwater remediation facilities coming on line in 1998. In 1997, 645.6 million gallons (2,444 million liters) of extracted water were sent to the Parshall Flume versus 975.2 million gallons (3,691 million liters) in 1998. The concentration of total uranium flowing through the Parshall Flume was approximately the same in 1997 and 1998. As a result, increased flow rates through the Parshall Flume to the Great Miami River caused an increase in the total mass of uranium discharged from the FEMP. However, FEMP treatment capabilities have kept the concentration of total uranium near or below the 20 μg/L limit.

- **Increased rainfall:** Approximately 8 inches (20 cm) more precipitation fell on the FEMP in 1998 than in 1997. The increase in rainfall resulted in an increase in the estimated amount of uncontrolled runoff leaving the site. In 1998, 8.32 inches (21.1 cm) more precipitation fell at the FEMP than in 1997, which resulted in an estimated 51 pounds (23 kg) more of total uranium being discharged from the FEMP via uncontrolled runoff than in 1997.

It is important to note that even with this increase, the amount of uranium discharged to the Great Miami River (216 pounds/98.1 kg) was well below the FEMP's annual limit of 600 pounds (272 kg) as identified in Section 4.3.3.

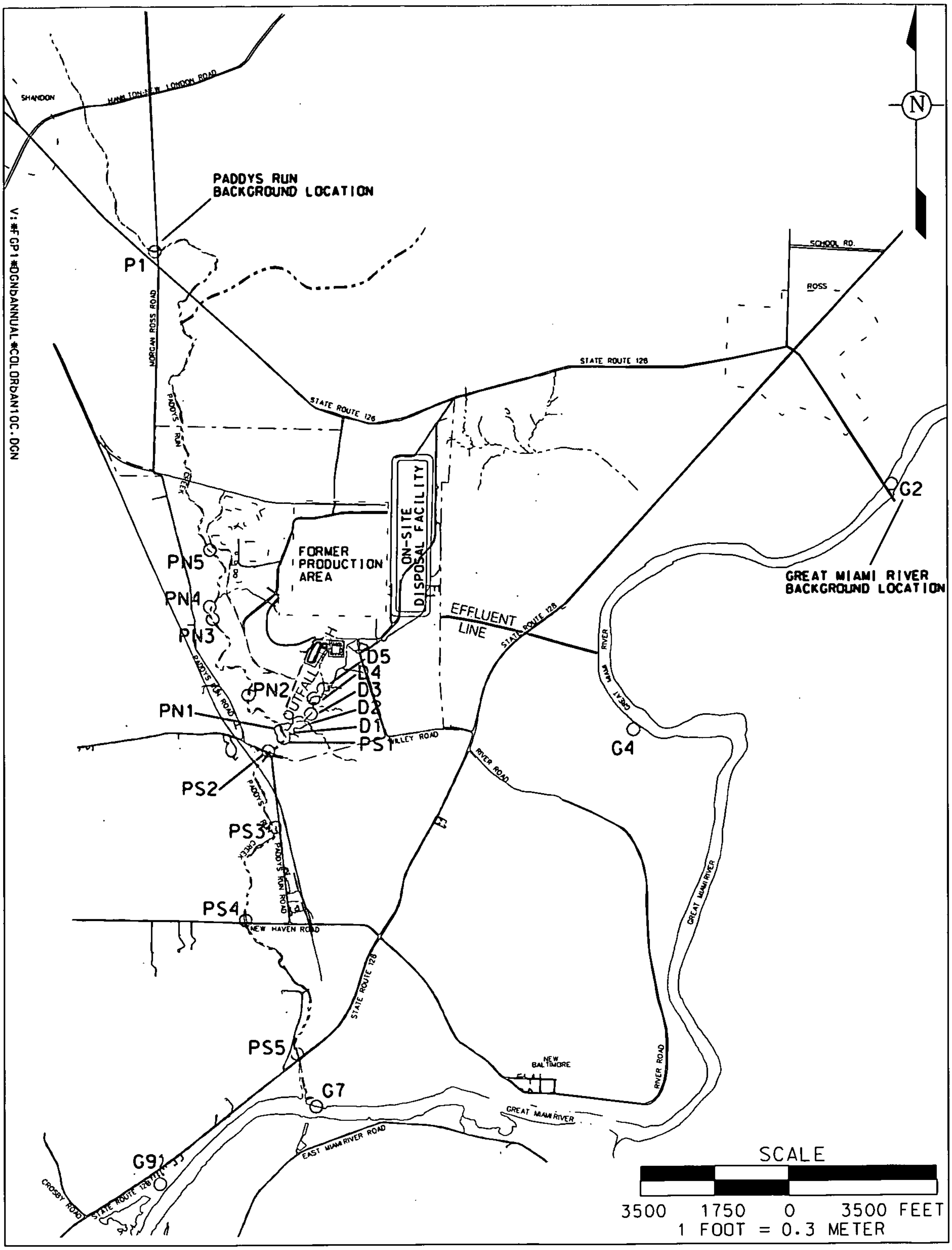
The conservative assumption developed during the remedial investigation, that 6.25 pounds (2.84 kg) of uranium is discharged to the environment through uncontrolled runoff with every inch (2.54 cm) of rain, will be reevaluated in order to determine a more accurate estimate in the future. The actual amount of uranium released through uncontrolled runoff is thought to be significantly less as a result of the additional measures that have been taken to control runoff and remediate the site.

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 16 locations along Paddys Run, the Storm Sewer Outfall Ditch, and the Great Miami River (refer to 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.

000100



LEGEND:

—·—·— FEMP BOUNDARY ○ SEDIMENT SAMPLE LOCATION

Figure 4-9. 1998 Sediment Sample Locations

000101

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)
- **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 samples collected south of the effluent line (G4, G7, and G9).

Analytical results of samples collected from the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River from 1998 are presented in Table 4-5 and were below the FRL for total uranium, isotopic thorium, and radium-226. The overall 1998 analytical results indicate a general decrease in all constituent concentrations compared to previous years. All sediment locations sampled in 1998 had results below the FRLs, whereas, one location sampled in 1997 slightly exceeded the FRL for thorium-232. In addition, all results are within the range of historical background levels.

TABLE 4-5
SUMMARY STATISTICS FOR SEDIMENT MONITORING PROGRAM

			1998 Results - Concentration (dry weight)					
		No. of	Minimum[a,b,c]		Maximum[a,b,c]		Average[a,b,c]	
Radionuclide	Sediment FRL	Samples[a]	pCi/g	(mg/kg)	pCi/g	(mg/kg)	pCi/g	(mg/kg)
Great Miami River, North of the Effluent Line								
Total Uranium	210 mg/kg	1	0.70	(1.04)	NA	NA	NA	NA
Great Miami River, South of the Effluent Line								
Total Uranium	210 mg/kg	3	0.46	(0.68)	1.13	(1.7)	0.83	(1.2)
Paddys Run Background, North of S.R. 126								
Radium-226	2.9 pCi/g	1	0.57	NA	NA	NA	NA	NA
Thorium-228	3.2 pCi/g	1	0.36	NA	NA	NA	NA	NA
Thorium-230	18000 pCi/g	1	0.48	NA	NA	NA	NA	NA
Thorium-232	1.6 pCi/g	1	0.42	NA	NA	NA	NA	NA
Total Uranium	210 mg/kg	1	0.78	(1.2)	NA	NA	NA	NA
Paddys Run, North of the Storm Sewer Outfall Ditch								
Radium-226	2.9 pCi/g	5	0.40	NA	0.52	NA	0.47	NA
Thorium-228	3.2 pCi/g	5	0.33	NA	0.37	NA	0.34	NA
Thorium-230	18000 pCi/g	5	0.28	NA	0.67	NA	0.54	NA
Thorium-232	1.6 pCi/g	5	0.24	NA	0.45	NA	0.35	NA
Total Uranium	210 mg/kg	5	0.66	(0.97)	1.26	(1.9)	0.89	(1.3)
Storm Sewer Outfall Ditch								
Radium-226	2.9 pCi/g	5	0.46	NA	0.52	NA	0.48	NA
Thorium-228	3.2 pCi/g	5	0.24	NA	0.39	NA	0.30	NA
Thorium-230	18000 pCi/g	5	0.49	NA	0.85	NA	0.64	NA
Thorium-232	1.6 pCi/g	5	0.22	NA	0.41	NA	0.29	NA
Total Uranium	210 mg/kg	5	1.04	(1.5)	1.71	(2.5)	1.33	(2.0)
Paddys Run, South of the Storm Sewer Outfall Ditch								
Total Uranium	210 mg/kg	5	0.67	(0.99)	1.16	(1.7)	0.88	(1.3)

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

000102

Monitoring of sediment will continue with the IEMP to determine the effectiveness of the engineered controls designed to reduce erosion from the FEMP and sedimentation of Paddys Run and its tributaries. Appendix B, Attachment 2, of this report contains additional details of the sediment monitoring results.

000103

Chapter 5
Air Pathway

Air Pathway

2479

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, this chapter provides a summary of radiological emissions from stacks and vents and non-radiological emissions associated with boiler plant operations at the FEMP.

Results in Brief: 1998 Air Pathway

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

Radon - There were no exceedances of the DOE standard (3.0 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 0.8 ± 0.3 pCi/L.

Direct Radiation - Measurements of direct radiation indicate levels increasing with proximity to the K-65 Silos. However, these levels are still approximately 65 percent lower than the radiation levels measured in 1991 prior to the addition of the bentonite layer within the K-65 Silos. These measurements are consistent with the fact that the K-65 Silos contain radium and its decay products, which contribute to direct radiation levels.

Boiler Plant - There were no opacity excursions reported during 1998.

As discussed in Chapter 1, 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 active remediation activities such as soil 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 emissions have been the cooling tower mists and laboratory fume hoods, which contain low levels of uranium, and fugitive dust from environmental remediation activities.

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.

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

000105

Remediation Activities Affecting the Air Pathway

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

During the production years, the primary emission sources were point sources (i.e., stacks and vents) from process facilities (see Section 5.6). Today, the dominant emission sources are associated with remediation activities (i.e., excavation and hauling of contaminated soil, demolition of production facilities, and general construction activities supporting the remediation process) and the storage of radon generating waste materials.

The following are examples of emission sources that were active during 1998:

- Excavation of contaminated soil, flyash, and debris from the southern waste units (Operable Unit 2)
- Construction activities associated with the on-site disposal facility including excavation, screening, and hauling activities in the on-site disposal facility borrow area (Operable Unit 2)
- Transportation and placement of contaminated material in the on-site disposal facility (Operable Unit 2)
- Decontamination and dismantlement of the Thorium/Plant 9 complex and the Sewage Treatment Plant complex (Operable Unit 3)
- Radon and direct radiation emissions from the K-65 Silos (Operable Unit 4).

Each project is responsible for designing and implementing administrative and engineered controls for each remediation activity. The FEMP fugitive emissions control policy mandates that fugitive emissions be visually monitored and controls be implemented as necessary. The following 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 and establishing speed limits, control zones, and construction zones.

000106

2479

- 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.

Air Highlights for 1998

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

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

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

- **Sampling** - Sample locations, frequency, and the constituents were selected to address DOE and EPA requirements for assessing radiological emissions from the site. Key considerations in the design of the sampling program included prevailing wind directions, location of potential sources of emissions, and the location of off-property receptors. The program includes monitoring radiological air particulates at 18 locations, radon measurements at 85 locations, and direct radiation at 38 locations on and off the FEMP property.

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

- **Reporting** - All data are reported through IEMP quarterly status reports and annual integrated site environmental reports. The addition of quarterly reporting provides more timely information to the remediation projects, regulatory agencies, and FEMP stakeholders.

000107

Radiological Air Particulate Sampling Results

Air Particulate Monitoring Research Project

During 1998 the DOE Environmental Measurements Research Laboratory continued collecting air particulate samples as part of a research study initiated at the FEMP in 1997. The objective of the study is to evaluate the dose associated with various particle size and calculate the dose contributions from the respirable fraction (those particles small enough to pass deep into the lungs when inhaled) of the total emissions.

In 1998 the reseach project focused on improving the sample analytical procedure and developing a new sampler with a higher flow rate in order to improve the detection limit for samples. The new sampler was placed into operation during September. In December, the sampler experienced mechanical problems which required it to be removed from service. When repaired and returned to service (expected to occur in mid-1999), the new sampler should provide data which helps to characterize the uranium concentration and the particle size distribution of particulate emissions. Additional information on this research project will be included in future IEMP quarterly status reports and annual integrated site environmental reports.

The FEMP utilizes a network of 18 high volume air particulate monitoring stations to measure the collective contributions fror all fugitive and point source particulate emissions from the site This monitoring network includes 16 monitoring locations on th FEMP fenceline and two background locations (refer to Figure 5-1). The sampling and analysis program consists of biweekly total uranium and particulate analyses and a quarterl composite sample targeted at the expected major contributors to dose from the site (i.e., uranium, thorium, and radium). The analytical data from this program are used to assess the effectiveness of the FEMP's emission control practices throughout the year to ensure particulate emissions remain below health protective standards.

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

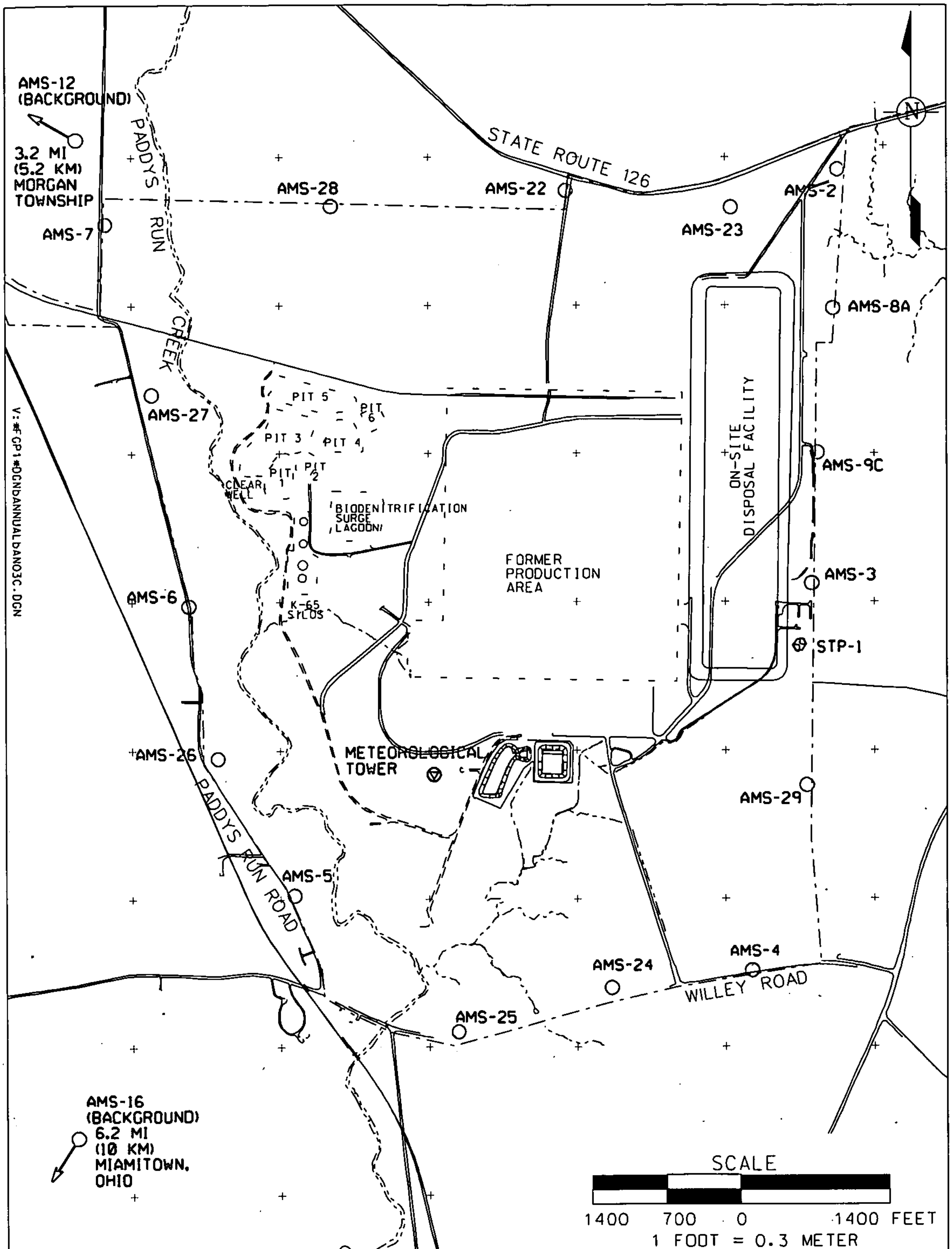
- NESHAP Subpart H requirements which stipulate that radionuclide emissions to the ambien air from DOE facilities shall not exceed those amounts that would cause any member of the public to receive an effective dose equivalent of 10 mrem in a year. This dose is reported in the annual NESHAP Subpart H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

- DOE Order 5400.5, Radiation Protection of the Public and Environment, 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 (e.g., inhalation, ingestion), would result in a dose of 100 mrem to the public. These derived concentration guide values are not limits, but serve as reference values to assist in evaluating the radiological air particulate data.

Table 5-1 presents the total uranium concentrations for 1998 and 1997. Total uranium concentrations for 1998 were within historical ranges for all fenceline 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 (0.1 picoCuries per cubic meter [pCi/m^3]). In 1998 total uranium at all air monitoring locations ranged from less than detectabl concentrations to a maximum concentration of 7.6E-04 pCi/m^3 at AMS-3. For comparison, background locations ranged from not detectable to 1.1E-04 pCi/m^3 at AMS-16.

000108

-- 2479



LEGEND:

FEMP BOUNDARY

○ AMS LOCATION

DISTANCE FROM CENTER OF FORMER PRODUCTION AREA TO AMS LOCATION OFF MAP

⊕ PROJECT-SPECIFIC LOCATION

Figure 5-1. Radiological Air Monitoring Locations

000109

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

Location	1998 Total Uranium (pCi/m³)	1997 Total Uranium (pCi/m³)	1998 Total Particulate (μg/m³)	1997 Total Particulate (μg/m³)
Fenceline Locations				
Minimum	0.0E+00	0.0E+00	6.8	7.1
Maximum	7.6E-04	1.2E-03	86	159
Average	6.3E-05	6.4E-05	33	34
Background Locations				
Minimum	0.0E+00	0.0E+00	12	18
Maximum	1.1E-04	1.1E-04	84	79
Average	1.3E-05	1.6E-05	36	36

In addition to the total uranium analyses, total particulate measurements are obtained from each filter every two weeks. Table 5-1 presents the total particulate results for 1998 and 1997. Total particulate concentrations ranged from 6.8 micrograms per cubic meter ($\mu g/m^3$) to a maximum of 86 $\mu g/m^3$ at AMS-27. There are no general or site-specific regulatory limits associated with total particulate measurements used in the data evaluation process.

Total particulate data were evaluated with the total uranium results to identify any increasing trends that may be related to remediation activities. During 1998 no increasing trends were identified that indicated the potential for exceeding the NESHAP dose limit or DOE guidelines. However, increases in particulate and total uranium concentrations were detected at some air monitoring stations (AMS-3, AMS-8A, and AMS-9C) on the eastern fenceline during August, September, and early October. These temporary increases were due to the construction activity associated with the on-site disposal facility and demolition activity at the Sewage Treatment Plant complex. While these types of temporary increases can be expected when periods of increased remediation activity coincide with warm dry weather, 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. Appendix C, Attachment 1, of this report provides graphical display of the 1998 total uranium and total particulate data.

As discussed earlier, quarterly composite samples were collected at each air monitoring station during 1998. The samples were analyzed for isotopes of radium, thorium, and uranium. The results were used to track compliance with the NESHAP 10 mrem dose limit throughout the year and for demonstrating compliance with the limit at the end of 1998. The dose associated with the quarterly composite results for 1998 was 0.26 mrem. Chapter 6 and Appendix D of this report provide more detailed information on the dose associated with the composite results.

In addition, the quarterly composite results were compared to DOE derived concentration guide values. Results at each monitoring station were below one percent of the corresponding DOE derived concentration guide values. Composite results from the fenceline monitors confirm that on average uranium isotopes contribute 76 percent of the dose from 1998 airborne emissions. Isotopes of thorium and radium account for the remainder of the dose. Appendix C, Attachment 1, of this report contains a graphical display of the contributors to dose at each air monitoring station.

000110

The data collected in 1998 for total uranium, total particulate, and the annual average concentrations are provided in Appendix C, Attachment 1, of this report.

Summary of Project-Specific Air Monitoring

Project-specific radiological air monitoring activities continued through 1998 to support the decontamination and dismantling of the Thorium/Plant 9 complex. The program includes weekly monitoring of five project-specific air monitoring stations located near the project boundary for total uranium and total particulate concentrations. This program is conducted under the Operable Unit 3, Integrated Remedial Action, Thorium/Plant 9 Complex Implementation Plan for Above-Grade Decontamination and Dismantlement (DOE 1997d) and was implemented to evaluate the effectiveness of project-specific emission controls during the project.

Air monitoring in the vicinity of the Thorium/Plant 9 complex did indicate periodic increases in uranium concentrations during 1998; however, uranium concentrations remained below the DOE derived concentration guide value for total uranium (0.1 pCi/m^3). In response to these increases, engineering evaluations were performed to assess the performance of the project-specific emission controls and additional controls were implemented. The increases in uranium concentrations measured at the Thorium/Plant 9 complex were not observed at the FEMP fenceline monitoring network. More detailed environmental data from the Thorium/Plant 9 complex dismantlement project will be reported in the project completion report as specified in the Thorium/Plant 9 Complex Implementation Plan.

Project-specific radiological air monitoring for the dismantlement of the Sewage Treatment Plant complex began during late June 1998. This monitoring program, consisting of biweekly total uranium and total particulate measurements, is conducted under the Sewage Treatment Plant Complex Implementation Plan for Above-Grade Decontamination and Dismantlement (DOE 1998f). Project-specific monitoring was implemented at the Sewage Treatment Plant complex because it is located immediately adjacent to the east fenceline of the FEMP. As such, fugitive emissions resulting from project activities could cross the FEMP property boundary without being monitored by the IEMP fenceline monitoring network. To address this concern, a project-specific air monitor, STP-1, was installed just south of the sewage treatment plant, between AMS-3 and AMS-29 (refer to Figure 5-1).

Total uranium concentrations at STP-1 ranged from 3.8E-05 to 8.9E-04 pCi/m^3. These uranium concentrations were less than one percent of DOE derived concentration guide value for total uranium (0.1 pCi/m^3) and less than two percent of the applicable NESHAP Subpart H values. Total particulate concentrations ranged from 25 to 86 $\mu g/m^3$. Total particulate concentrations at STP-1 were comparable to levels measured at other fenceline monitors.

000111

An increase in particulate and total uranium concentrations were detected at the STP-1 location during August, September, and early October. This temporary increase was due to the demolition activity associated with the Sewage Treatment Plant complex. The STP-1 project monitor will remain in place until all excavation activities in the area of the sewage treatment plant have been completed.

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

Radon-222 (referred to in this section as radon) is a radioactive gas that occurs naturally throughout the environment. Radon is produced by the radioactive decay of radium-226 which is present in the earth's crust. Radon is a chemically inert gas and can easily move from beneath the earth's surface to the atmosphere before undergoing radioactive decay. 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, and local weather conditions. These factors are not constant; for instance, rainfall or snowcover limits radon's ability to escape from the ground. Additionally, extreme temperatures produce cracks and porosity changes in the ground, influencing the rate at which radon escapes. Summary level meteorological data from 1998 are presented in Appendix C , Attachment 4, and Figures 1-7 through 1-10 of this report.

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

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 the six waste pits (part of the Operable Unit 1 remediation).

DOE Order 5400.5, Radiation Protection of the Public and the Environment, defines radiological protection requirements, guidelines for cleanup of residual radioactive material, management of resulting wastes and residues, and the release of radiological property. Radon limits 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.

000112

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.

In general, monitoring locations were selected near radon emitting sources, at the FEMP property fenceline, and at background locations. The FFA identifies additional environmental radon monitoring locations as well as continuous measurement of radon concentrations in the head space of the K-65 Silos. In addition, several monitoring locations were also established at nearby residences and schools to address public concerns (refer to Figures 5-2 and 5-3). DOE guidance and EPA air monitor siting criteria were considered when selecting monitoring locations.

Alpha Track-Etch Detectors

An alpha-track etch detector is a cup that contains a special plastic chip inside. Some of the alpha particles from the decay of radon (or its daughter products) will interact with the plastic chip by leaving a latent track in the material. The tracks are made detectable by chemical or electrochemical etching. The number of etches or tracks in the material is proportional to the number of alpha particles that have reached the plastic. This number can then be related to the average concentration of radon in the cup. Filters are placed over the cup to allow only radon to enter the cup and be measured.

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. During 1998 there were approximately 65 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 on-site locations, three local residences, and nine background locations.

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 pCi/L above background. Data from fenceline and off-property locations were within historical ranges and well below the DOE limit of 3 pCi/L above background. The annual range of concentrations at the fenceline was 0.1 ± 0.1 pCi/L to 0.8 ± 0.3 pCi/L.

000113

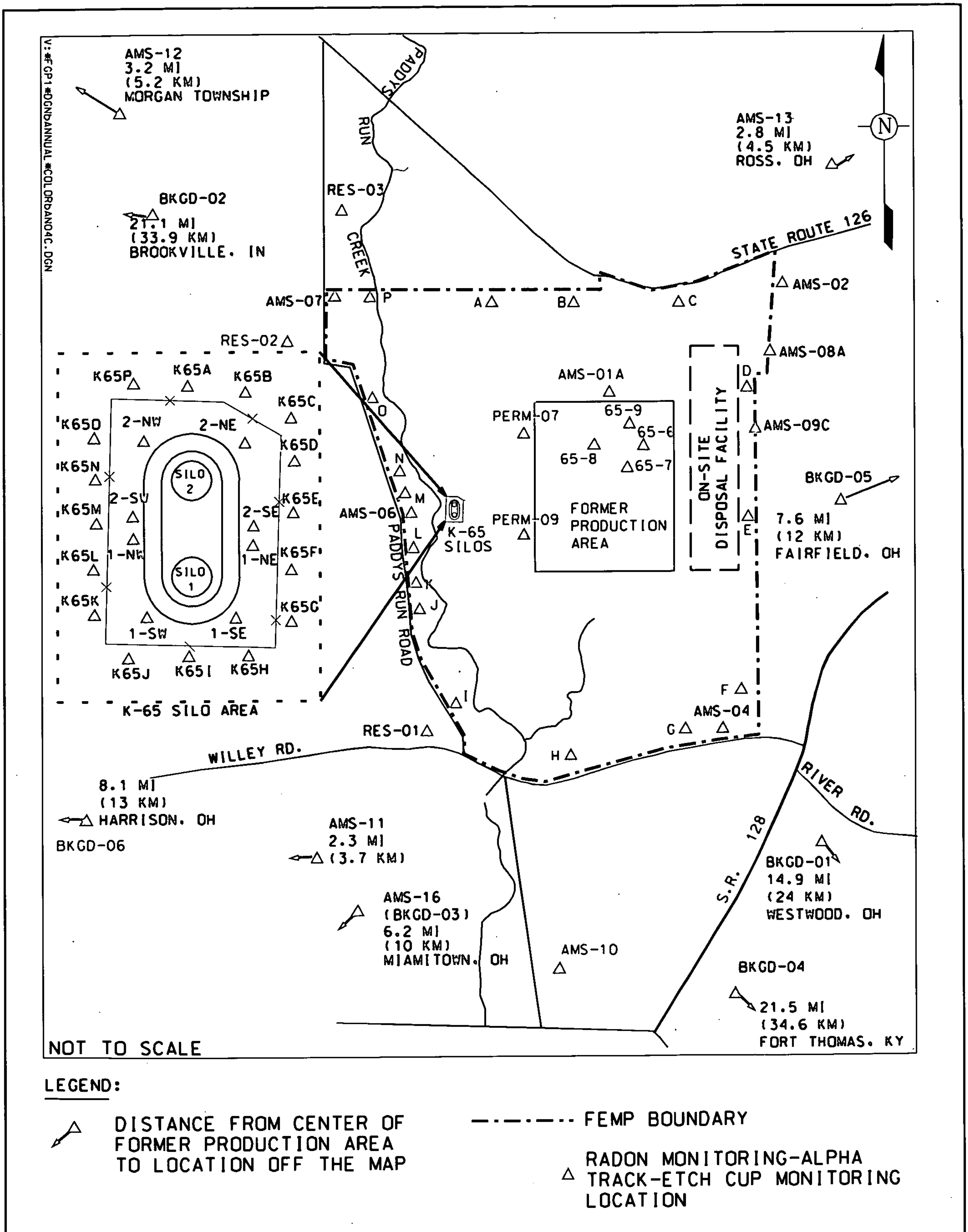


Figure 5-2. Radon Monitoring – Alpha Track-Etch Cup Locations

000114

--2479

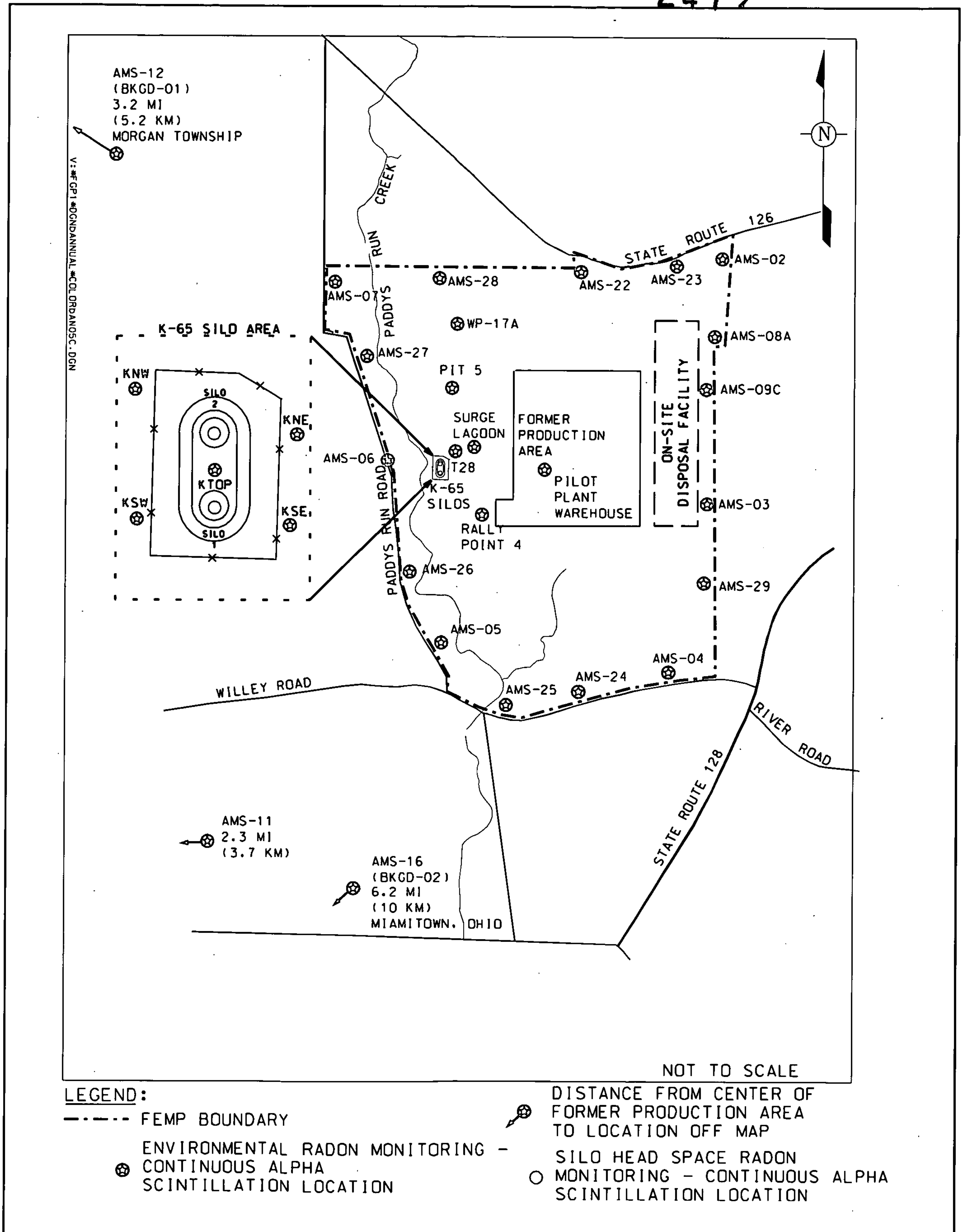


Figure 5-3. Radon Monitoring – Continuous Alpha Scintillation Locations

000115

The annual range for background radon concentrations was 0.1 ± 0.1 pCi/L to 0.3 ± 0.2 pCi/L. In addition, other off-property locations had an annual range between 0.3 ± 0.1 pCi/L and 0.4 ± 0.2 pCi/L.

Concentrations at on-property locations along the K-65 exclusion fence ranged between 1.0 ± 0.2 pCi/L and 5.2 ± 0.7 pCi/L; the K-65 Silo dome locations ranged between 0.4 ± 0.1 pCi/L and 28.0 ± 0.4 pCi/L with the maximum concentration recorded northeast of 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 1998 and 1997 location average concentrations at alpha track-etch cup monitoring locations. Appendix C, Attachment 2, of this report contains the environmental radon data collected during 1998 using alpha track-etch cups.

TABLE 5-2

RADON MONITORING - ALPHA TRACK-ETCH CUPS, SUMMARY CONCENTRATIONS FOR 1997 AND 1998

	Radon Concentration ± Precision[a] (pCi/L)	
Location	**1998 Location Average**	**1997 Location Average**
K-65 Silos 1 & 2 Exclusion Fence Locations		
Minimum	1.0 ± 0.2	0.7 ± 0.2
Maximum	5.2 ± 0.7	3.5 ± 0.8
K-65 Silos 1 & 2 Dome Locations		
Minimum	5.4 ± 0.1	3.8 ± 0.7
Maximum	28.0 ± 0.4	18.0 ± 1.6
Fenceline Locations		
Minimum	0.1 ± 0.1	0.2 ± 0.1
Maximum	0.8 ± 0.3	1.0 ± 0.2
Background Locations		
Minimum	0.1 ± 0.1	0.1 ± 0.1
Maximum	0.3 ± 0.2	0.2 ± 0.2
Other On-Site Locations		
Minimum	0.3 ± 0.1	0.2 ± 0.1
Maximum	0.4 ± 0.2	0.4 ± 0.1
Other Off-Site Locations		
Minimum	0.3 ± 0.1	0.3 ± 0.2
Maximum	0.3 ± 0.2	0.4 ± 0.2

[a]± 2 standard deviations

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 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 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 over time (Figure 5-4) and a marginal difference between background and western fenceline monitoring locations (Figure 5-5). 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. 000116

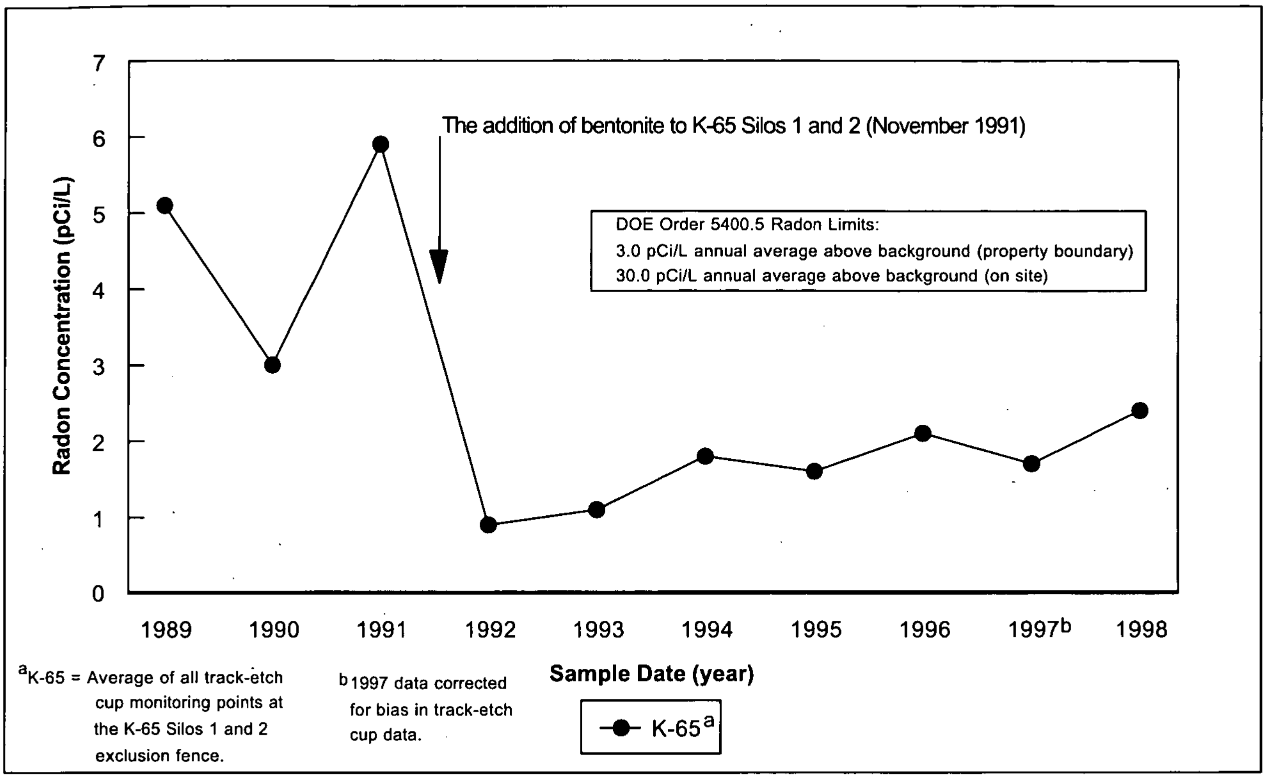


Figure 5-4. Annual Average Radon Concentrations at K-65 Silos Exclusion Fence, 1989-1998

During the biennial review of the IEMP conducted in 1998, DOE proposed expanding the use of continuous radon monitors, while simultaneously eliminating the use of alpha track-etch detectors for measuring environmental radon concentrations at the FEMP. After gaining regulatory agency concurrence, DOE discontinued the use of alpha track-etch detectors for environmental radon monitoring at the end of 1998. This decision was prompted by the need to provide more frequent trending of radon concentration data in support of the remedial action decision-making process. The alpha track-etch cup detector data are ineffective for decision-making regarding project activities due to the lengthy exposure required (at least six months). Additionally, past sensitivity problems have affected the quality of the data. The expansion of the continuous monitoring network allows for frequent feedback to remediation projects, regulatory agencies, and FEMP stakeholders on trends in ambient radon concentrations, while providing sufficient radon monitoring to ensure compliance with DOE Order 5400.5 requirements.

000117

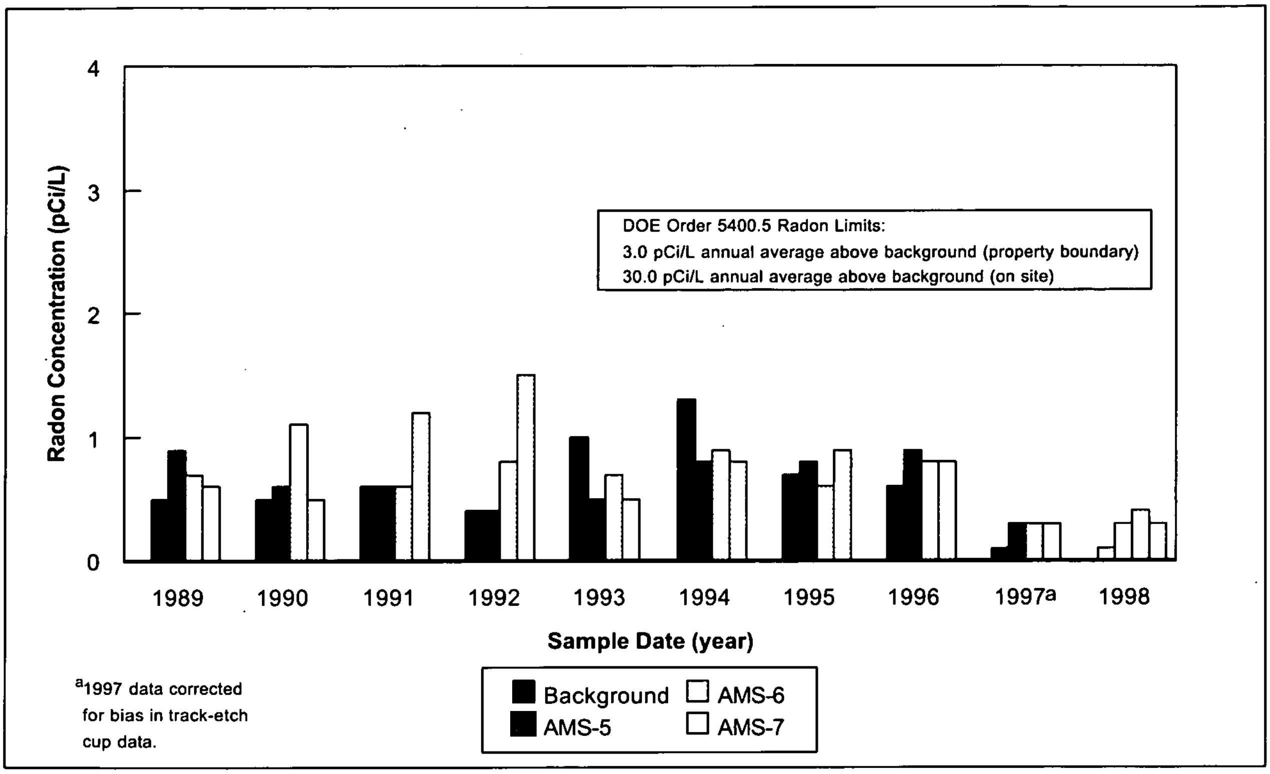


Figure 5-5. Annual Average Radon Concentrations at Selected Monitoring Locations, 1989-1998

Continuous Alpha Scintillation Detectors

Alpha scintillation detectors, use alpha scintillation cells to continuously monitor radon concentrations. These continuous monitors record radon concentrations on an hourly basis. An alpha scintillation cell detects alpha particles from the decay of radon gas by the interaction of the alpha particle with the material inside the scintillation cell. The interactions are produce light pulses which are amplified and counted. The number of light pulses counted is proportional to the radon concentration inside the cell. When monitoring the ambient outside air, the air diffuses into the scintillation cell through a foam barrier. The radon gas present in the diffused air decays into its daughter products, emitting alpha particles which are then counted. This technique is called passive sampling.

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

Table 5-3 provides monthly average radon concentration data from the continuous radon monitors for 1998. The data are used to track radon concentrations through the year to ensure the DOE limits for annual average 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 1998 and 1997.

000118

-- 2479

TABLE 5-3

1998 CONTINUOUS ENVIRONMENTAL RADON MONITORING MONTHLY AVERAGE CONCENTRATIONS

Location[a]	1998 Results[b,c] (Instrument Background Corrected) (pCi/L)			1997 Results[b,c] (Instrument Background Corrected) (pCi/L)
	Minimum	Maximum	Average	Average
Fenceline				
AMS-02	0.2	0.7	0.4	0.5
AMS-03d	0.6	0.8	0.7	NA
AMS-04	0.1	0.7	0.4	0.4
AMS-05	0.2	1.3	0.6	0.5
AMS-06	0.2	0.9	0.5	0.4
AMS-07	0.2	1.5	0.7	0.5
AMS-08A[e]	0.8	NA	NA	NA
AMS-09C[f]	0.2	0.9	0.6	NA
AMS-22[f]	0.2	0.7	0.4	NA
AMS-23[d]	0.4	0.5	0.4	NA
AMS-24[e]	0.7	NA	NA	NA
AMS-25[e]	0.6	NA	NA	NA
AMS-26[f]	0.2	0.8	0.6	NA
AMS-27[f]	0.2	1.1	0.7	NA
AMS-28[e]	0.4	NA	NA	NA
AMS-29[e]	0.7	NA	NA	NA
Off Site				
AMS-11	0.1	1.0	0.4	0.4
Background				
AMS-12	0.1	0.6	0.3	0.2
AMS-16	0.2	0.6	0.4	0.2
On Site				
KNE	2.0	18.2	9.1	5.5
KNW	1.0	4.8	2.4	1.6
KSE	2.4	16.9	8.3	5.6
KSW	1.4	5.2	3.1	2.3
KTOP	7.2	24.6	13.0	9.9
Pilot Plant Warehouse	0.1	0.9	0.4	0.4
Pit 5	0.2	1.0	0.5	0.5
Rally Point 4	0.2	1.3	0.7	0.6
Surge Lagoon	0.3	1.3	0.7	0.7
T28	0.9	2.8	1.8	1.8
WP-17A	0.2	0.9	0.5	0.5

[a]See Figure 5-3
[b]Instrument background changes as monitors are replaced.
[c]NA = not applicable
[d]Unit was placed in service in August 1998.
[e]Unit was placed in service in December 1998.
[f]Unit was placed in service in June 1998.

000119

During the fourth quarter of 1998, there was a noticeable increase in the number and magnitude of exceedances of the DOE Order 5400.5 100 pCi/L radon limit recorded by the continuous radon monitors located at the K-65 exclusion fenceline. There were 24 exceedances of the 100 pCi/L DOE limit measured on site during 1998 compared with five in 1997. As in past years, the exceedances during 1998 were observed at monitoring locations adjacent to the K-65 Silos and occurred during periods of particularly strong atmospheric inversions. The increase in the number and magnitude of exceedances recorded in 1998 are the result of a general increase in silo head space radon concentrations and associated emissions from the K-65 Silos. The increase in emissions is attributable to the deterioration over time of the bentonite clay layer within the silos (applied in 1991) and the foam sealant covering on the silos (applied in 1987). These controls were implemented as interim measures to control radon emissions ahead of the final remedy for Operable Unit 4.

In response to the increasing radon concentrations in the vicinity of the K-65 Silos, DOE conducted detailed inspections of the silo domes using radiological survey instruments. Increased radon emissions were detected at gasketed surfaces of manway flanges, sounding ports, and access port covers. In an attempt to lower silo emissions, DOE attached plastic coated tarps over each silo port using an adhesive and silicone-based sealant. Other maintenance activities are being evaluated based on the radiological survey data and are expected to be implemented in Spring 1999.

The recommended long-term solution for controlling radon emissions from the silos is encompassed within the Accelerated Waste Retrieval Project, which includes the installation of a new radon control system. This system has been forecasted to become operational during 2001. DOE is currently evaluating the need to implement interim control measures until the radon control system is fully operational. The need for interim measures will be based largely on keeping work area exposures ALARA.

Monitoring for Direct Radiation

Direct radiation (i.e., x-rays, gamma rays, energetic beta particles, and neutrons) originates from sources such as cosmic radiation, naturally occurring radionuclides in soil, as well as radioactive materials at the 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, alpha particles, and neutrons are not a significant component of direct radiation at the FEMP because uranium, thorium, and their decay products do not emit these types of radiation at levels that create a public exposure concern.

Direct radiation levels at and around the FEMP were continuously measured at 38 locations with thermoluminescent dosimeters (TLDs) during 1998. TLDs 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 direct radiation. Figure 5-6 identifies the TLD monitoring locations. These monitoring locations were selected based on the need to monitor the K-65 Silos, the FEMP fenceline, and several off-site locations, including background locations.

Table 5-4 provides summary level information pertaining to direct radiation measurements for 1998 and 1997.

TABLE 5-4

DIRECT RADIATION (THERMOLUMINESCENT DOSIMETER) MEASUREMENT SUMMARY

	Direct Radiation ± Uncertainty[a] (mrem)	
TLD Location	**Summary of 1998 Results**	**Summary of 1997 Results**
Fenceline		
Minimum	63 ± 10	60 ± 12
Maximum	84 ± 14	79 ± 11
On Site		
Minimum	55 ± 9.0	54 ± 7.5
Maximum	817 ± 132	778 ± 108
Off Site		
Minimum	56 ± 9.1	52 ± 7.3
Maximum	69 ± 11	65 ± 9.1
Background		
Minimum	61 ± 9.9	57 ± 8.0
Maximum	77 ± 13	74 ± 10
Average	67 ± 5.9	64 ± 12

[a]Associated laboratory uncertainty

All monitoring results from thermoluminescent dosimeters for 1998 were within historical ranges. However, an increasing trend in direct radiation measurements in the immediate area of the K-65 Silos has been identified and will continue to be monitored (refer to Figure 5-7). This trend is attributable to a corresponding increase in radon concentrations and associated decay products within the K-65 Silos head space. The increased 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.

Additionally, an increasing trend in direct radiation levels above background has also been detected at the FEMP western fenceline, particularly at TLD location 6 which is located closest to the K-65 Silos (refer to Figure 5-8). This trend is also attributable to the increase in radon concentrations and associated decay products within the K-65 Silos head space. The slight upward trend in background radiation levels shown in Figure 5-8 is attributed to changes in the laboratory processing of the TLDs. These trends will continue to be monitored and presented in IEMP quarterly status reports and annual integrated site environmental reports.

000121

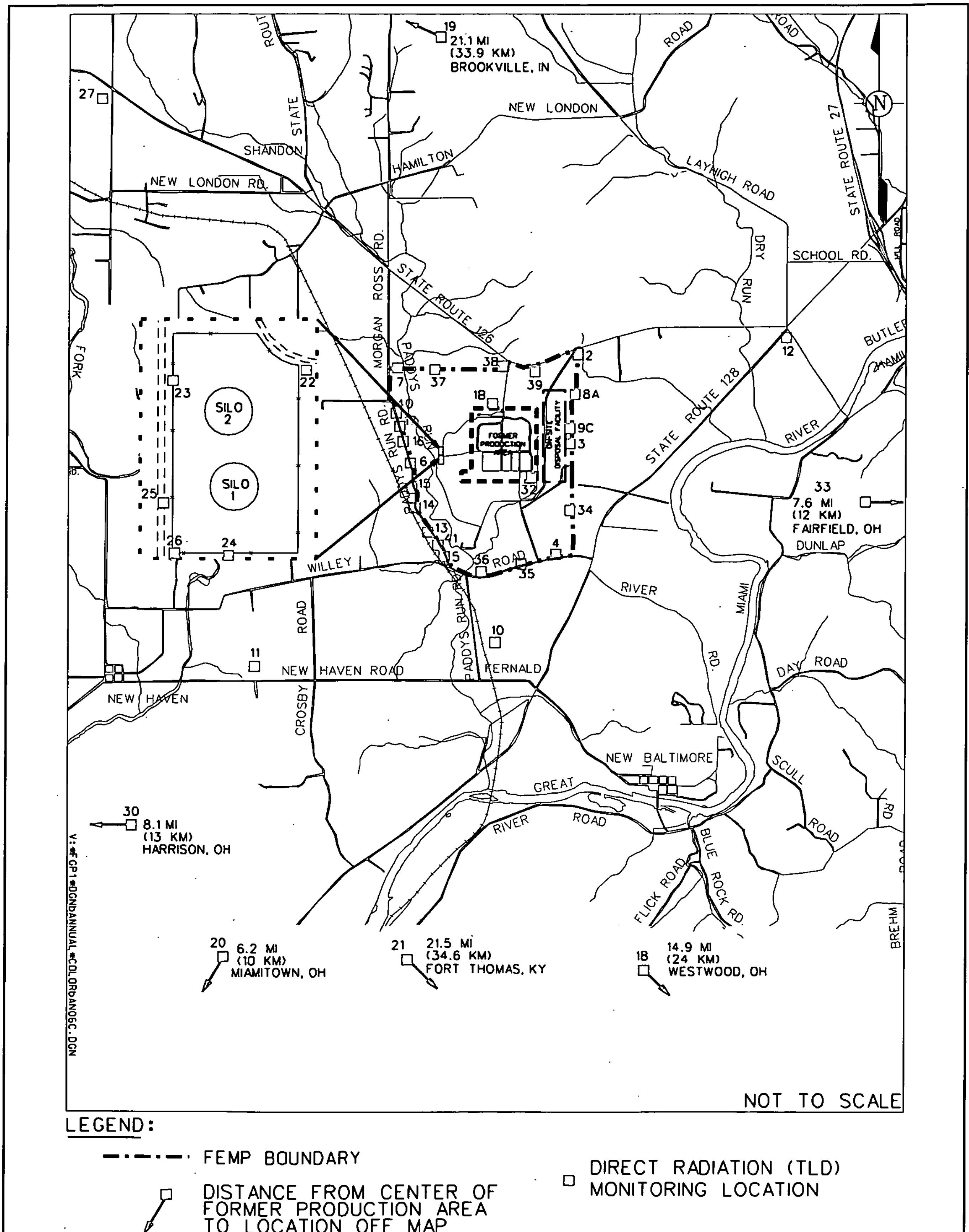


Figure 5-6. Direct Radiation (TLD) Monitoring Locations

000122

-2479

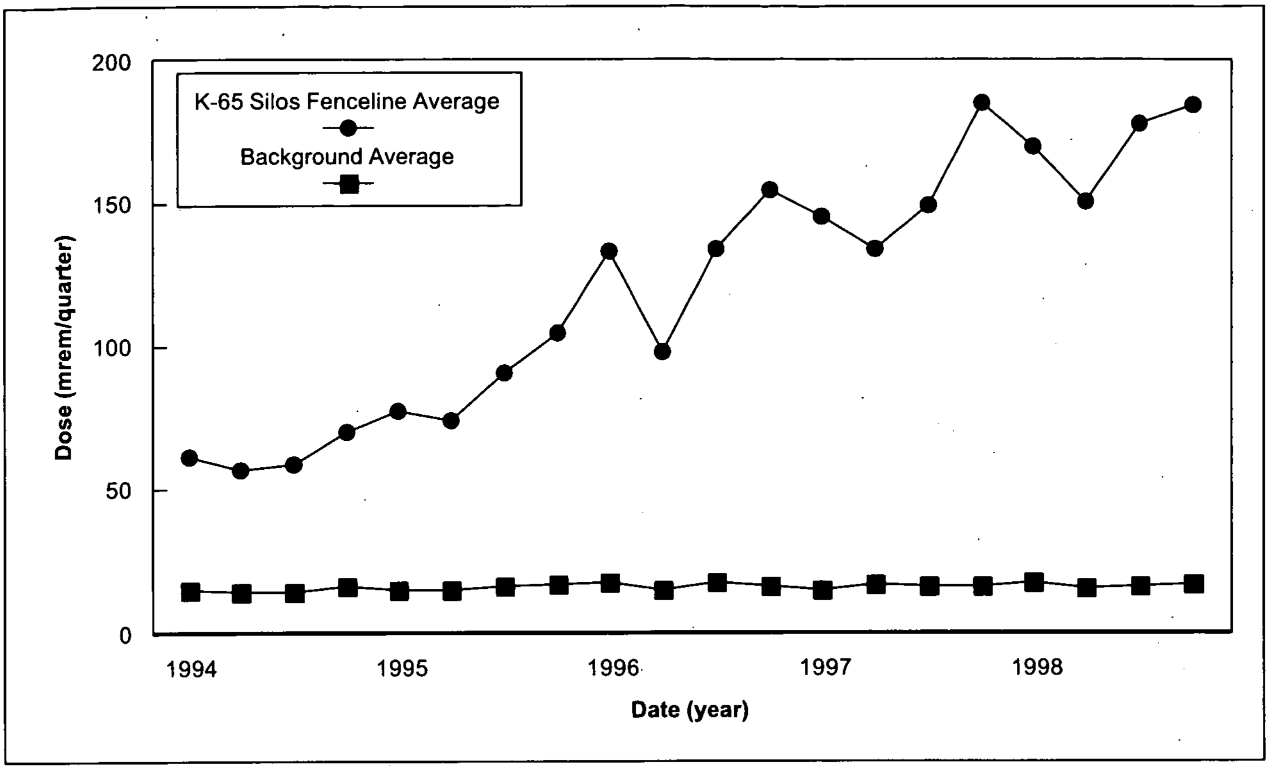


Figure 5-7. Direct Radiation (TLD) Measurements, 1994-1998 (K-65 Silos Fenceline Average Versus Background Average)

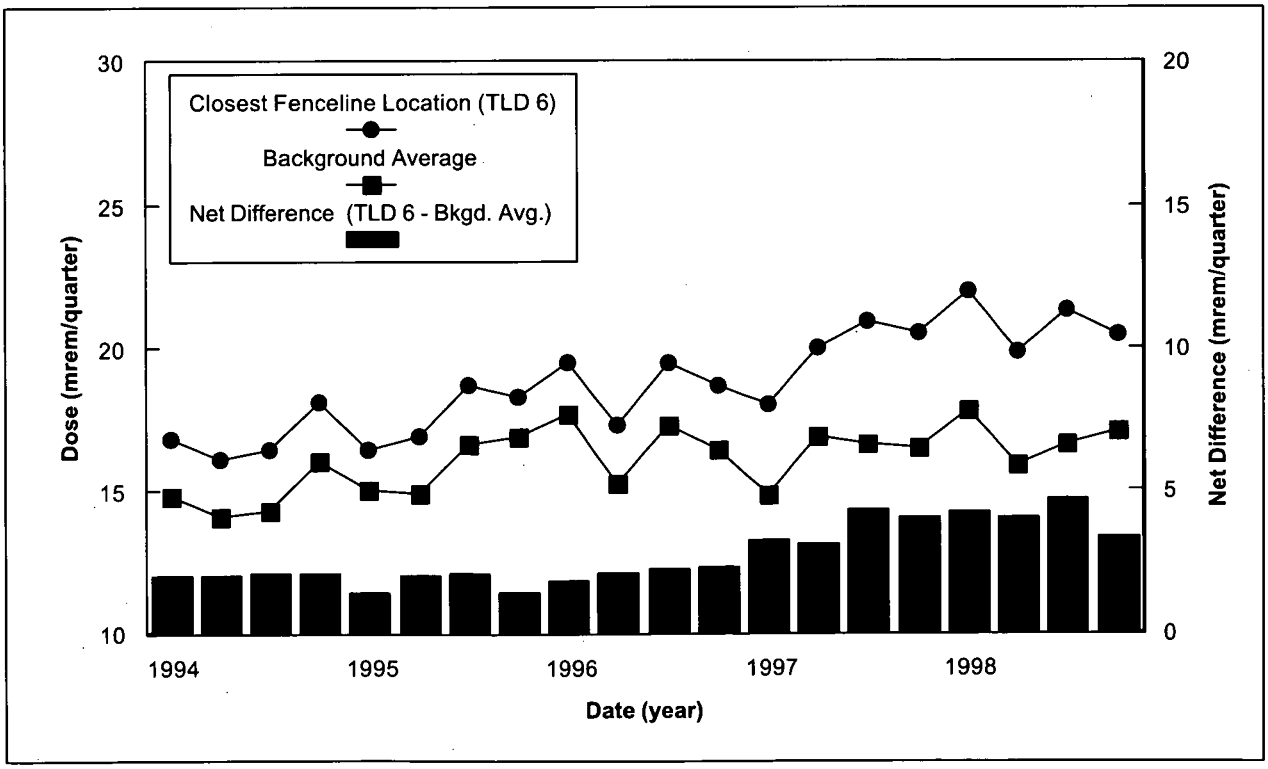


Figure 5-8. Direct Radiation (TLD) Measurements, 1994-1998 (Location 6 Versus Background Average)

000123

Detailed results of direct radiation measurements for 1998 and 1997 are provided in Appendix C, Attachment 3, of this report.

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. Four stacks monitors were in operation during 1998. The laundry and laboratory stacks operated continuously throughout the year. In Building 6 and Building 71, where material sorting and repacking operations occurred, stacks were only in operation during work activities. Table 5-5 summarizes FEMP stack emissions for 1998. Figure 5-9 provides monitored stack locations.

Typically, post production monitoring data have shown stack emissions of uranium and thorium to be very low or not detectable. The 1998 stack emissions are consistent with historical stack emission data.

TABLE 5-5

1998 NESHAP STACK EMISSIONS

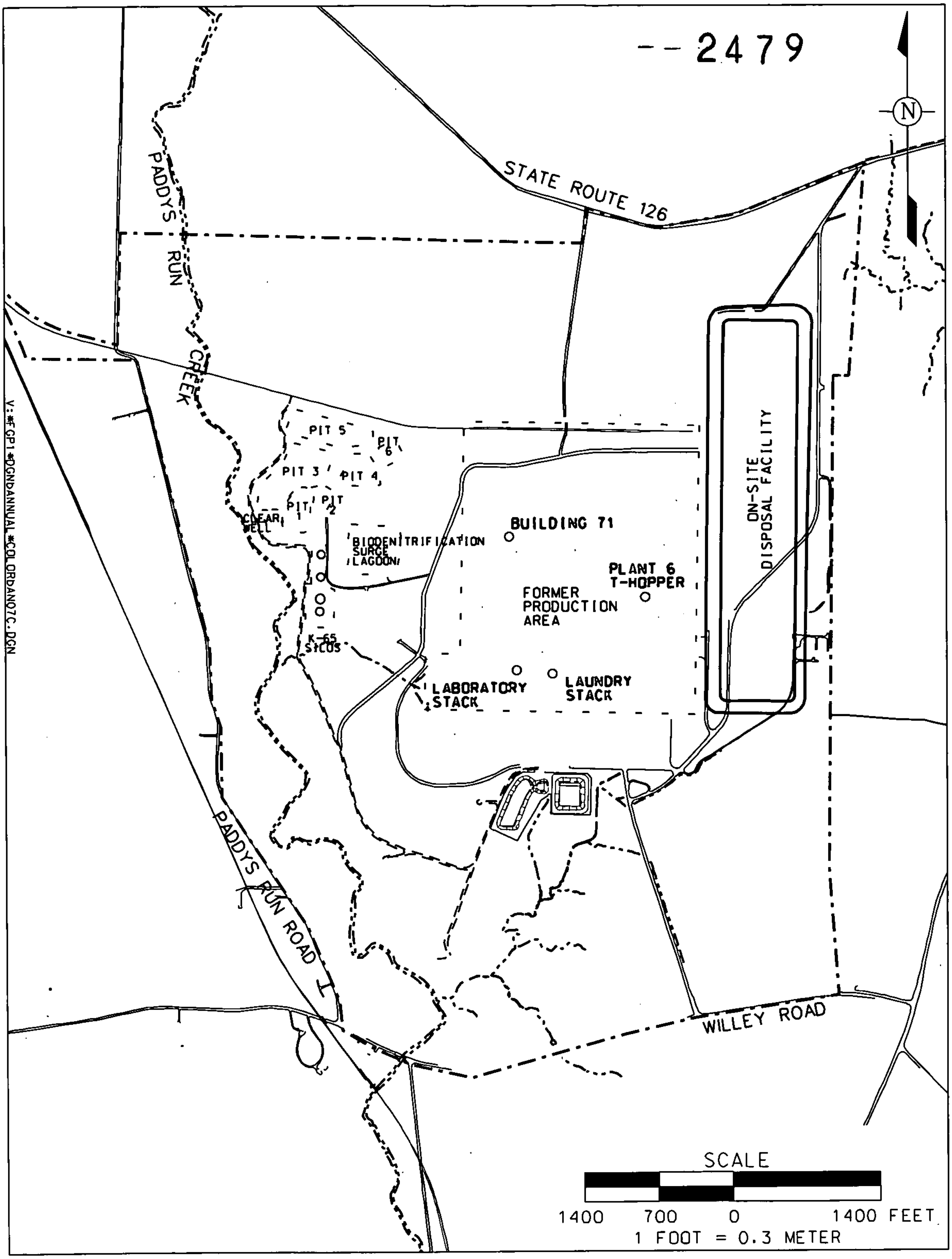
Radionuclide	Building 71	Laboratory Stack	Laundry Stack	Building 6 Stack
Uranium, Total (lbs/yr.)	1.3E-05	1.0E-04	7.0E-06	5.9E-04
Thorium-232 (lbs/yr.)	8.6E-05	4.2E-04	4.5E-04	4.5E-04
Thorium-230 (lbs/yr.)	1.2E-09	5.1E-09	5.8E-09	5.2E-09

Monitoring for Nonradiological Pollutants

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, 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 1998. For comparison, there were no excursions in 1997 and 14 excursions in 1996. The reduction in opacity excursions in 1997 and 1998 is due to the FEMP's conversion from coal-fired boilers to natural gas/diesel-fired boilers.

In order to estimate sulfur dioxide emissions, scientists determine the sulfur and heat content of the fuel. Using this information and the total amount of fuel burned, the amount of sulfur dioxide emissions can be calculated. For 1998 sulfur dioxide emissions from all boilers were calculated to be 121 pounds (54.9 kg). This was well below the allowable limit of over 79 tons (72 metric tons) per year calculated from information in the permits issued by OEPA.

000124



LEGEND:

FEMP BOUNDARY

o NESHAP STACK EMISSION MONITORING LOCATION

Figure 5-9. NESHAP Stack Emission Monitoring Locations

000125

The nitrogen oxide and carbon monoxide emissions are estimated using EPA-developed emission factors. Nitrogen oxide emissions for all boilers for 1998 were estimated to be 22,900 pounds (10,400 kg). Carbon monoxide emissions for all boilers in 1998 were estimated to be 9,400 pounds (4,300 kg). To date, OEPA has not set nitrogen oxide or carbon monoxide limits for FEMP industrial processes.

Table 5-6 provides a comprehensive list of 1998 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	2,800/1,300	Fossil Fuels Combustion	AP-42 Emission Factors
Sulfur Dioxide	Stack Emissions	121/54.9	Fossil Fuels Combustion	AP-42 Emission Factors
Nitrogen Oxide	Stack Emissions	22,900/10,400	Fossil Fuels Combustion	AP-42 Emission Factors
Carbon Monoxide	Stack Emissions	9,400/4,300	Fossil Fuels Combustion	AP-42 Emission Factors
Non-Methane Volatile Organic Compounds	Stack Emissions	560/250 Combustion	Fossil Fuels Factors	AP-42 Emission

000126

Chapter 6
Radiation Dose

- · 2479

Radiation Dose

Results in Brief: 1998 Estimated Doses

Airborne Emissions - The estimated maximum effective dose at the site fenceline from 1998 airborne emissions (excluding radon) was calculated to be 0.26 mrem. This equals 2.6 percent of the EPA NESHAP 10 mrem annual dose limit.

Direct Radiation - The estimated 1998 effective dose at an off-site receptor location near the western fenceline of the FEMP was approximately 8 mrem.

Dose to the Maximally Exposed Individual - The dose to the maximally exposed individual for 1998 was estimated to be 8.2 mrem at an off-site receptor location near the western fenceline of the FEMP.

This chapter provides estimated doses from the air and direct radiation pathways for 1998. 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 (excluding radon), estimates of dose due to direct radiation are combined with the airborne emissions to estimate the total effective dose to the maximally exposed (hypothetical) individual. This estimate reflects the incremental dose above background that is attributable to the FEMP.

In previous annual reports (1996 and earlier), estimated doses were provided from drinking well water and eating locally grown produce and locally caught fish from the Great Miami River. 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 local produce and fish from the Great Miami River have established this pathway as an insignificant contributor to dose from FEMP emissions. Produce sampling will be performed every three years (next sampling period in 2000) to ensure the dose contribution remains insignificant. In addition, the emissions to the Great Miami River have been significantly reduced over the past several years. Consequently, the sampling of fish and the assessment of dose from eating fish has been eliminated under the IEMP. As a result of the changes in the sampling programs, only the estimated doses from airborne emissions and direct radiation will continue to be reported annually.

The DOE limits for dose from radon and its decay products in air are provided in terms of concentrations and are addressed independently of the all pathway dose limit. A concentration based limit is used because dose calculations associated with radon and its decay products are highly sensitive to input parameters which are difficult to confirm with environmental measurements. Nonetheless, dose estimates for radon have been included in this section in response to FEMP stakeholders' interests in radon exposures. A number of different radon dose calculations are presented in this section to provide readers with a basis for comparison with radon dose estimates presented in previous annual site environmental reports and other radon dose studies (i.e., The Fernald Dosimetry Reconstruction Project [RAC 1996]).

Estimated Dose from Airborne Emissions

The estimated dose from 1998 airborne emissions was calculated from annual average radionuclide concentrations measured at the 18 IEMP air particulate monitoring locations (two background and 16 fenceline locations). Annual average background concentrations were subtracted from the fenceline concentrations in order to account for the natural occurrence of airborne radionuclides. Dose estimates were determined by converting the net annual average radionuclide concentrations measured at each fenceline monitoring location to dose using values listed in 40 Code of Federal Regulations 61 Subpart H, Appendix E, Table 2.

000128

The maximum effective dose at the fenceline from 1998 airborne emissions was estimated to be 0.26 mrem per year and occurred at AMS-9C along the eastern fenceline of the site. The dose estimate is based on the conservative assumption that a person remains outdoors at the AMS-9C location for 100 percent of the time during the year. Recognizing that the nearest residence is located approximately 2,000 feet (600 meters) downwind from AMS-9C (east-northeast from the site), the actual dose received by this receptor would be substantially lower than 0.26 mrem. This dose is 2.6 percent of the NESHAP limit of 10 mrem for the air pathway dose.

The estimated dose from airborne emissions at each fenceline air monitor is provided in Appendix D of this report.

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 source of direct radiation at the FEMP is the waste stored in the K-65 Silos. As the waste in the silos undergoes radioactive decay, gamma rays and x-rays are emitted. Direct radiation from the decay of radon progeny in the silo head space contributes a major fraction of the direct radiation from the K-65 Silos. As the head space radon concentrations have increased, the direct radiation from the silos has also increased. Direct radiation levels at the K-65 Silos and site fenceline are monitored by a network of environmental TLDs. Chapter 5 provides a description of the environmental TLD program.

In 1998 the FEMP revised the method for comparing fenceline and background TLD data and estimating direct radiation dose. The revised method provides a more conservative estimate of direct radiation dose and provides a clearer analysis of the impact of increasing radiation levels near the silos and the fenceline due to increasing levels of radon and associated decay products in the silo head space (refer to Chapter 5). In 1998 the direct radiation dose at the fenceline was estimated using the highest dose from the fenceline monitoring locations and subtracting the average dose measured at background TLD locations (refer to Figure 5-6). From the data in Table 5-4, the maximum fenceline measurement was 84 mrem for 1998 and occurred at TLD location 6. The average background dose from TLD locations 18, 19, 20, 21, 27, and 33 was 67 mrem. The difference in these values (17 mrem) is the estimated fenceline direct radiation dose for a hypothetical individual who stands at the fenceline, specifically TLD 6, for the entire year.

In accordance with DOE Order 5400.5, Radiation Protection of the Public and the Environment, which requires that realistic exposure conditions be used for conducting dose evaluations, a more realistic estimate of direct radiation dose was calculated for a residence nearest the K-65 Silos. This dose was estimated by subtracting the average background dose (67 mrem) from the fenceline measurement of 76 mrem measured at TLD location 14, which is closest to this potential receptor location. The difference in these values is 9 mrem. Accounting for the distance between the fenceline TLD location and the residence (approximately 100 feet [30 meters]) lowers the direct radiation dose to approximately 8 mrem. This estimate remains extremely conservative in that it assumes a resident at this location is present 24 hours per day for a full year and that no shielding is provided by the structure of the house.

000129

Total of Doses to Maximally Exposed Individual

The maximally exposed individual is a hypothetical receptor who receives the highest estimated effective dose based on the sum of the individual pathway doses. For 1998 the dose to the maximally exposed individual (Table 6-1) is the sum of the estimated doses from airborne emissions (excluding radon) and the estimated direct radiation dose at a location approximately 100 feet (30 meters) west-southwest of the FEMP fenceline at a location near the K-65 Silos. The conservative assumptions used throughout the dose calculation process ensure that the dose to the maximally exposed individual is the maximum possible dose any member of the public could receive.

The 1998 dose to the maximally exposed individual is estimated to be 8.2 mrem. The contributions to this all pathway dose are:

- 0.05 mrem from air inhalation dose which was measured at AMS-26 on the western fenceline of the FEMP nearest to the off-site receptor location
- 8.16 mrem from direct radiation measured at TLD location 14 on the western fenceline of the FEMP nearest to the off-site receptor location.

This estimate represents the incremental dose above background attributable to the FEMP, exclusive of the dose received from radon. This dose can be compared to the limit of 100 mrem for all pathways (Figure 6-1) that was established by the International Commission on Radiological Protection (ICRP) and adopted by DOE.

TABLE 6-1
DOSE TO MAXIMALLY EXPOSED INDIVIDUAL

Pathway	Dose Attributable to the FEMP	Applicable Limit
Air		
Airborne emissions at AMS-26 (excluding radon)	0.05 mrem	10 mrem/air
Direct radiation	8.16 mrem	100 mrem/all pathways
Maximally exposed individual	8.2 mrem	100 mrem/all pathways

000130

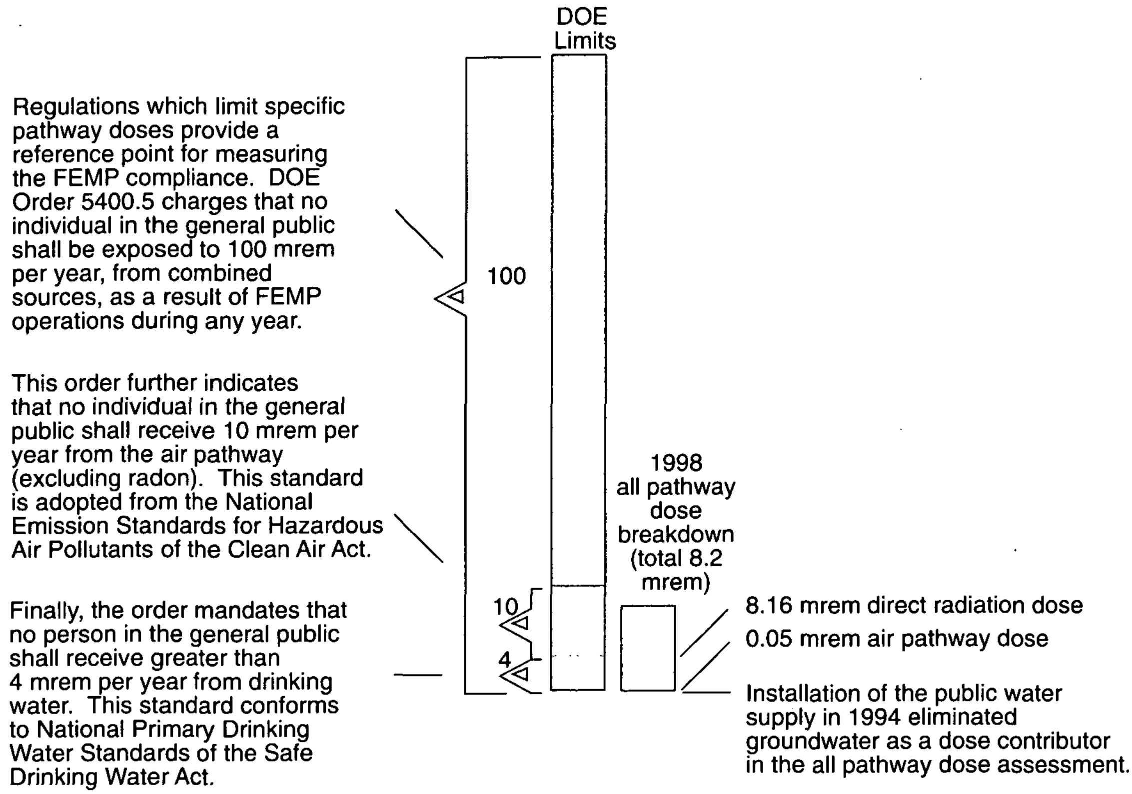


Figure 6-1. 1998 Dose Comparison to DOE Limits

Significance of Estimated Radiation Doses for 1998

One method of evaluating the significance of the estimated doses is to compare them with dos received from background radiation. Background radiation yields approximately 100 mrem pe year from natural sources, excluding radon. For example, the dose received each year from cosmic and terrestrial background radiation contributes approximately 26 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, whereas 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 backgroun dose demonstrates that, even with the conservative estimates, the dose from the FEMP is muc 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.

Another method of determining the significance of the estimated doses is to compare them wit dose limits developed to protect the public. The ICRP has recommended that members of the public receive no more than 100 mrem per year above background. As a result of this recommendation, DOE has incorporated 100 mrem per year as the limit in DOE Order 5400.5. The sum of all estimated doses from FEMP operations for 1998 was below this limit.

000131

2479

Estimated Dose from Radon

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

Dose estimate methodologies have changed over the years with the primary effect being a decrease in the estimated health damage (detriment) per unit of radiation exposure. The changes were based on re-evaluations of studies examining the detrimental health effects (i.e., epidemiological studies) on highly exposed worker populations (i.e., uranium miners). Therefore, radon dose estimates were generated for this report using the following four different calculation methods:

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

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

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

000132

- ICRP 65 report

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

Table 6-2 presents the 1998 radon dose estimates. The table includes both fenceline, background, and DOE radon concentration limit values. Estimated working level-month exposures are given for each concentration value, as well as, effective dose equivalents utilizin both the NCRP 78, ICRP 66, and ICRP 65 methods. Doses were calculated utilizing the radoı concentration data recorded using the alpha track-etch cup detectors (assuming the suggested environmental radon daughter product equilibrium concentration of 70 percent). All estimates are for a hypothetical maximally exposed reference man (i.e., average body size and breathing rate) who continuously breathed air at the FEMP west fenceline while engaged in light, physic activity 24 hours a day for the entire year. This dose is highly conservative.

TABLE 6-2
1998 RADON DOSE ESTIMATE[a]

Location	Radon Concentration (pCi/L)	Working Level-Months (WLM)	NCRP 78 Effective Dose Equivalent Equation		ICRP 65 Effective Dose Equivalent (mrem)[d]
			(mrem)[b]	(mrem)[c]	
Average Background	0.1	0.036	72	24	19
FEMP Fenceline Nearest Receptor (net)	0.3	0.108	216	72	57
Maximum Fenceline (net)	0.7	0.252	504	168	127
DOE Order 5400.5 Limit	3.0	1.08	2160	720	547

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

Because there are no limits for effective dose equivalent from radon and its daughters, it is important to refer to the concentration limits imposed by DOE Order 5400.5. As previously stated, the annual average radon concentration limit at the facility boundary is 3 pCi/L above background. Measured concentrations for all fenceline monitoring points are well below this limit.

000133

2479

Chapter 7
Natural Resources

2479

Natural Resources

2479

This chapter provides background information on the natural resources associated with the FEMP and summarizes the 1998 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. Wetlands, deciduous and riparian (stream side) woodlands, old fields, grasslands, and aquatic habitats, like Paddys Run, are among the FEMP's natural resources. 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 Monitoring Plan, which is included in the IEMP. The plan presents an approach for monitoring and reporting the status of several priority natural resources to remain in compliance with the pertinent regulations and agreements.

Threatened and Endangered Species

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

The Endangered Species Act requires the protection of any federally listed threatened or endangered species, as well as any habitat critical for the species' existence. Several Ohio laws mandate the protection of state-listed endangered species as well. 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. Figure 7-1 shows the habitats and potential habitats of these species.

000135

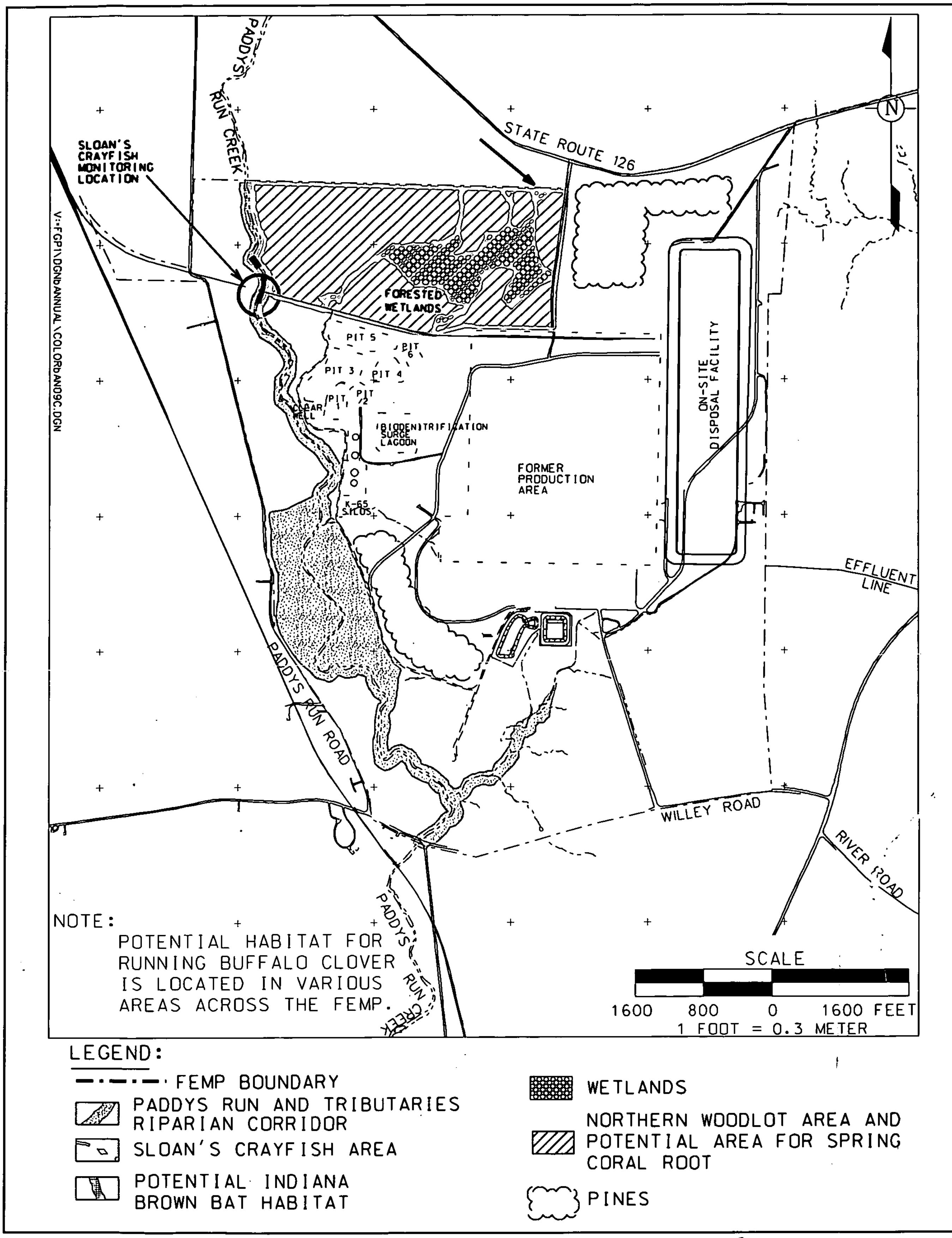


Figure 7-1. Priority Natural Resource Areas

000136

No specific surveys were conducted in 1998 for the Indiana Brown Bat, Running Buffalo Clover, or Spring Coral Root because no remediation activities occurred within their respective potential habitat areas. However, a survey was conducted in 1998 by Ohio University in order to identify the plants in the northern woodlot area. Researchers did not find any Spring Coral Root or Running Buffalo Clover in this area.

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 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.

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 remediation activities. Sediment loading can adversely impact the Sloan's Crayfish by restricting its ability to "breathe" in water. If remediation 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.

Based on the 1997 field inspections, sustained sediment loading was not observed and EPA and OEPA agreed that DOE could discontinue post-rain event field monitoring until construction activities were initiated in the Operable Unit 1 area. Monitoring was not conducted for the early months of 1998; however, it resumed later in 1998 after construction activities in the Operable Unit 1 area were initiated. Figure 7-1 identifies the Sloan's Crayfish monitoring location.

The 1998 monitoring effort yielded similar findings to 1997. Results of visual field inspections conducted in 1998 indicated that sediment loading from remediation 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 FEMP activities.

Cultural Resources

Factors such as geologic setting, surface water, soil, vegetation, and climate determined 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. Because of its advantageous location, the area was settled repeatedly throughout prehistoric and historic time, resulting in richly diverse cultural resources. The periods of occupation include the Paleo-Indian (12000 to 8000 B.C.), Archaic (8000 to 1000 B.C.), Woodland Tradition (1000 B.C. to 1000 A.D.), Mississippian Tradition (1000 to 1660 A.D.), and Historic Times (1660 A.D. to present).

000137

The National Historic Preservation Act requires that DOE take into consideration the effects of its actions on sites that are listed or eligible for listing on the National Register of Historic Places. These sites are termed "historic properties." Native American remains and artifacts such as funerary objects and sacred objects are protected under the Native American Graves Protection and Repatriation Act.

Pursuant to implementing regulations for these laws, DOE 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 activities in non-contaminated or previously undisturbed areas. Once construction activities begin, DOE also has contingency plans in place if unexpected cultural resources are uncovered during construction activities. These incidences are termed "unexpected discoveries".

During 1998 approximately 10 acres (4 hectares) were surveyed prior to the initiation of ground-disturbing activities. The surveys were conducted to the west and south of Paddys Run Creek and along Paddys Run Road prior to initiation of the following projects/activities:

- Construction of the Fernald Ecological Restoration Park
- Implementation of the Paddys Run Stabilization Project
- Installation of an air monitoring station roadway turn-around area
- Planting of trees in support of the Area 8, Phase I (west of Paddys Run), re-vegetation and American Chestnut projects.

Figure 7-2 depicts the areas that have been surveyed. The 1998 surveys resulted in the discovery of eight archaeological sites, seven prehistoric and one historic. Of these eight sites, two of them, one prehistoric and one historic, have potential eligibility for inclusion on the National Register of Historic Places. Further investigations will be conducted on these two sites prior to any disturbance. Under the Archaeological Resources Protection Act, the location of specific archaeological sites is considered sensitive information. Therefore, these locations are not indicated on Figure 7-2. There were no "unexpected discoveries" in 1998.

Impacted Habitat Areas

During 1998, DOE and the Natural Resource Trustees tentatively agreed that since DOE will be restoring 884 acres (358 hectares), it will not be necessary to quantitatively assess impacted habitat. Therefore, impacted habitat information is presented in a narrative format. This information is provided in the following sections, along with a summary of ecological restoration activities that have occurred during 1998.

000138

2479

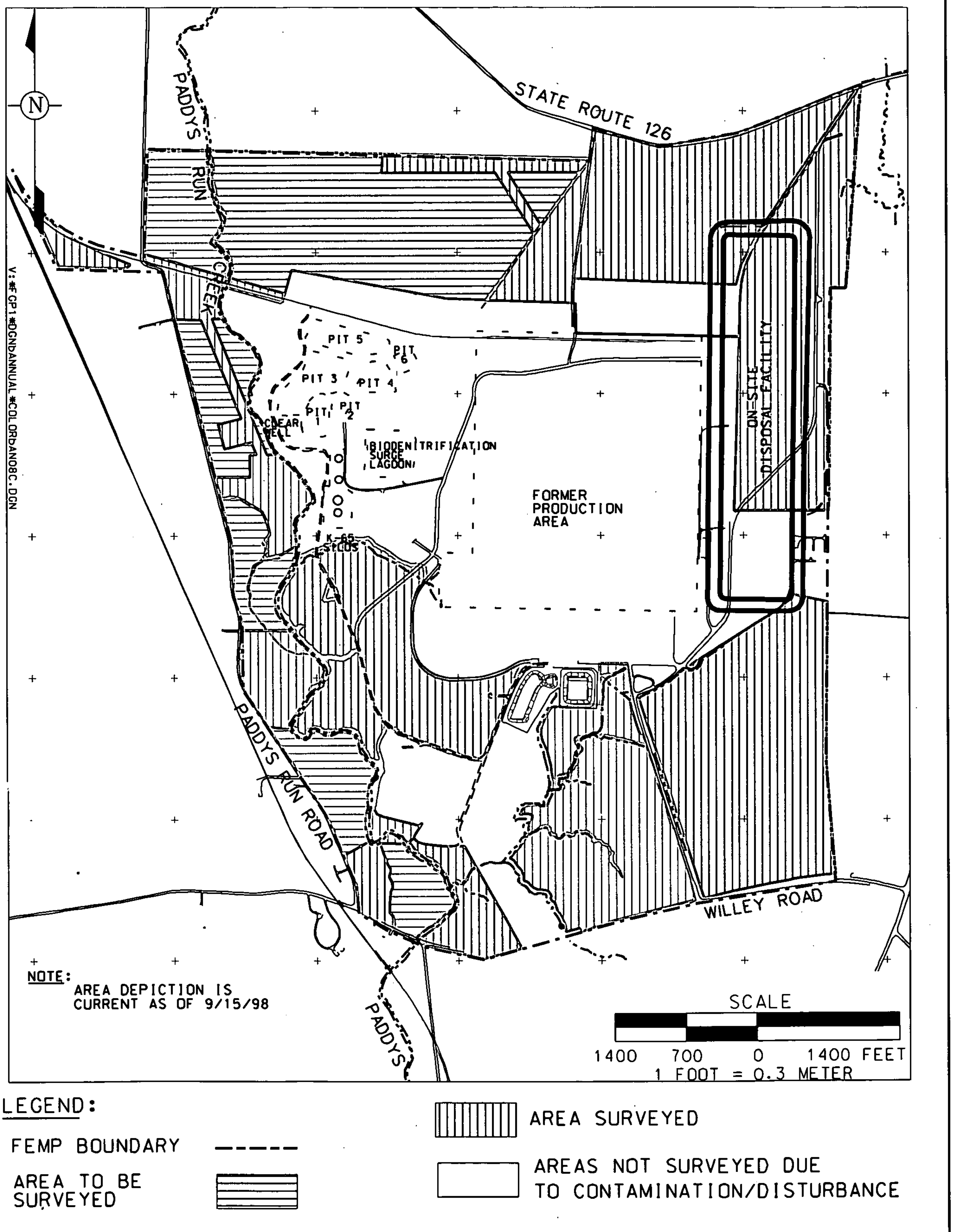


Figure 7-2. Cultural Resource Survey Areas

000139

During 1998 the Paddys Run Stabilization Project, in the vicinity of the southern waste units, resulted in altered streambank and streambed habitat and loss of some riparian (streamside) trees. However, the use of bioengineering minimized the extent of impacts. Area 1, Phase II (described in Section 2.1.2) borrow activities also resulted in impacts to grassland habitat.

Although no wetlands were impacted during 1998, activities pertinent to the mitigation of site wetlands continued. The design for the Wetland Mitigation Project was completed in 1998.

Two ecological restoration projects were completed during the fourth quarter of 1998. An aesthetic barrier consisting of several rows of conifers and deciduous trees was installed on the FEMP property along Willey Road to reduce the view of Area 1, Phase II borrow operations. This project is the first in a series of ecological restoration projects aimed at resolving DOE's natural resource damage liability, as identified in the Draft Final Natural Resource Restoration Plan (DOE 1998c). The second project involved the construction of the Fernald Ecological Restoration Park. This project provides an on-property wildlife viewing area that is accessible to the public. Several different habitats have been planted within this park, including old field, successional woodlot, oak-hickory forest, beech-maple forest, tallgrass prairie, and tallgrass savanna. An additional aspect of this project involved the construction of two overlooks for viewing several other habitats that will be restored through research efforts. This project was conducted as one of five supplemental environmental projects required under a dispute resolution agreement between DOE, EPA, and OEPA for missed Operable Unit 4 milestones.

In 1997 the Natural Resource organization worked with the Natural Resource Trustees to develop the Draft Natural Resource Restoration Plan. This organization continued to facilitate public involvement regarding final land use in 1998. They are currently working with DOE to resolve comments from the public and the Trustees on the Draft Final of the Natural Resource Restoration Plan.

000140

2479

ɜlossary

0-year, Uranium-based .estoration Footprint

The 10-year, uranium-based restoration footprint shows the anticipated total areal extent of the Great Miami Aquifer which is to be influenced by the aquifer restoration activities over the 10-year duration of the remediation as presented in aquifer restoration remedial design documents. The extent is determined from groundwater modeling results which shows the composite groundwater capture zone derived from the capture zones for each extraction well.

.LARA

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.

.lpha 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.

.quifer

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.

.RARs

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.

ackground 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.

eta 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.

ypass 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.

000141

Capture Zone

Estimated area that is being "captured" by pumping of groundwater extraction wells. Definition of capture zone is important in ensuring that the uranium plumes targeted for clean up are being remediated.

Contaminant

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

Controlled Runoff

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

Curie (Ci)

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

Dose

Quantity of radiation absorbed in tissue.

Ecological Receptor

A biological organism selected by ecological risk assessors to represent a target species most likely to be affected by site-related chemicals, especially through bioaccumulation. Such organisms may include terrestrial and aquatic species. 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 tha would be contributed by that particular tissue. The effective dos 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.

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.

000142

Great Miami Aquifer — 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.

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

Opacity — How much light is blocked by particulates present in stack emissions.

Overpacking — The act of placing a deteriorating drum inside a new, larger drum to prevent further deterioration or the possible release of contaminants during storage.

Point Source — The single defined point (origin) of a release such as a stack, vent, or other discernable conveyance.

Radiation — The energy released as particles or waves when an atom's nucleus spontaneously loses or gains neutrons and/or protons. The three main types are alpha particles, beta particles, and gamma rays.

Radioactive Material — Refers to any material or combination of materials that spontaneously emits ionizing radiation.

Radionuclide — Refers to a radioactive nuclide. There are several hundred known radionuclides, both artificially produced and naturally occurring; radionuclides are characterized by the number of neutrons and protons in an atom's nucleus and their characteristic decay processes.

Receptors — Individuals or organisms that are or 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 Investigation/ Feasibility Study — The first major event in the remedial action process which serves to assess site conditions and evaluate alternatives to the extent necessary to select a remedy.

000143

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.

Surface Water Water that is flowing within natural drainage features.

Treated Effluent Water from numerous sources at the site which is treated through one of the FEMP's wastewater treatment facilities and discharged to the Great Miami River.

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

Uncontrolled Runoff Storm water that is not collected by the site for treatment, but enters the site's natural drainages.

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.

000144

2479

References

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

International Commission on Radiological Protection, 1994a, "Human Respiratory Tract Model for Radiological Protection," ICRP Publication 66, ICRP66.

International Commission on Radiological Protection, 1994b, "Protection Against Radon-222 at Home and at Work," ICRP Publication 65, ICRP65.

National Council on Radiation Protection and Measurements, 1987, "Ionizing Radiation Exposure of the Population of the United States," NCRP-93.

National Council on Radiation Protection, 1984, "Evaluation of Occupational and Environmental Exposures to Radon and Radon Daughters in the United States," NCRP Report No. 78, NCRP78.

Radiological Assessments Corporation (RAC), 1996, "Task 6: Radiation Doses and Risk to Residents from FMPC Operations from 1951-1988," RAC1996.

U.S. Dept. of Energy, 1998a, "1997 RCRA Annual Report," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998b, "Annual Update to the Federal Facility Compliance Act Site Treatment Plan," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998c, "Natural Resource Restoration Plan," Draft Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998d, "Re-Injection Demonstration Test Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998e, "SARA Title III, Section 312, Emergency and Hazardous Chemical Inventory Report," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998f, "Sewage Treatment Plant Complex Implementation Plan for Above-Grade Decontamination and Dismantlement," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1998g, "Sitewide Excavation Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

000145

U.S. Dept. of Energy, 1998h, "Waste Acceptance Criteria Attainment Plan for the On-Site Disposal Facility," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997a, "Baseline Remedial Strategy Report, Remedial Design for Aquifer Restoration (Task 1)," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997b, "Best Available Technology Determination for Remedial Construction Activities on the Fernald Environmental Management Project," Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997c, "Integrated Environmental Monitoring Plan," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997d, "Operable Unit 3, Integrated Remedial Action, Thorium/Plant 9 Complex Implementation Plan for Above-Grade Decontamination and Dismantlement," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1997e, "Operations and Maintenance Master Plan for the Aquifer Restoration and Wastewater Treatment Project," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996a, "Operable Unit 3 Record of Decision for Final Remedial Action," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1996b, "Record of Decision for Remedial Actions at Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995a, "Feasibility Study Report for Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995b, "Proposed Plan for Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Area Office, Cincinnati, OH.

U.S. Dept. of Energy, 1995c, "Remedial Investigation Report for Operable Unit 5," Final, Fernald Environmental Management Project, U.S. Dept. of Energy, Fernald Field Office, Cincinnati, OH.

- 2479

U.S. EPA, 1985, "National Emission Standards for Hazardous Air Pollutants -- Subpart H -- National Emission Standards for Emissions of Radionuclides other than Radon from DOE Facilities, Code of Federal Regulations, Title 40, Parts 61.93 and 61.94, Vol. 50, No. 25," February 1985.

U.S. National Academy of Science, 1980, "Biological Effects of Ionizing Radiation," BEIR III, National Academy Press.

000147