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**REMEDIAL INVESTIGATION REPORT FOR  
OPERABLE UNIT 2 VOLUME 1 OF 6 TABLE OF  
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# REMEDIAL INVESTIGATION REPORT FOR OPERABLE UNIT 2

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT  
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

VOLUME 1 OF 6  
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U.S. DEPARTMENT OF ENERGY  
FERNALD FIELD OFFICE

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## LIST OF ACRONYMS AND ABBREVIATIONS

AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
ARAR	applicable or relevant and appropriate requirement
ASI	Advanced Sciences, Inc.
ASL	Analytical Support Level
ASTM	American Society for Testing and Materials
BDN	bio-denitrification
BOB	bottom of boring
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CERCLIS	Comprehensive Environmental Response, Compensation, and Liability Information System
CFR	Code of Federal Regulations
CIS	Characterization Investigation Study
CLP	Contract Laboratory Program (EPA)
cm/s	centimeter/second
COA	Certificate of Analysis
COE	U.S. Army Corps of Engineers
COC	contaminant of concern
COPC	constituent of potential concern
CPC	contaminant of potential concern
CSM	conceptual site model
CT	central tendency
CWA	Clean Water Act
DCR	Document Change Request
DOE	U.S. Department of Energy
dpm	disintegrations per minute
DQO	data quality objective
EIS	environmental impact statement
EM	electromagnetic
EP	extraction procedure
EPA	U.S. Environmental Protection Agency
ERDA	U.S. Energy Research and Development Administration
ERMC	Environmental Restoration Management Contract
°F	degrees Fahrenheit
FEMA	Federal Emergency Management Agency
FEMP	Fernald Environmental Management Project

**LIST OF ACRONYMS AND ABBREVIATIONS**  
(Continued)

FERMCO	Fernald Environmental Restoration Management Company
FFCA	Federal Facility Compliance Agreement
FID	flame ionization detector
FIDLER	field instrument for detecting low-energy radiation
FMPC	Feed Materials Production Center
FR	Federal Register
FS	feasibility study
ft/yr	feet/year
GC/MS	gas chromatograph/mass spectrometry
GFAA	Graphite Furnace Atomic Absorption
GIS	Geographic Information System
GPR	ground penetrating radar
HI	hazard index
HQ	hazard quotient
HSL	Hazardous Substance List
HWMU	hazardous waste management unit (RCRA)
ICAP	Inductively Coupled Atomic Plasma
ILCR	incremental lifetime cancer risk
IT	IT Corporation
µg/g	microgram/gram
µg/L	microgram/liter
µg/kg	microgram/kilogram
µm	micrometer
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MEK	2-butanone (synonym: methyl ethyl ketone)
mg/kg	milligram/kilogram
mg/L	milligram/liter
MSL	mean sea level
MUSLE	Modified Universal Soil Loss Equation
NAD	North American Datum
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NESHAP	National Emission Standards for Hazardous Air Pollutants
NEPA	National Environmental Policy Act
NLO	National Lead (Company) of Ohio
NOAA	National Oceanic and Atmospheric Administration

LIST OF ACRONYMS AND ABBREVIATIONS  
(Continued)

NPDES	National Pollutant Discharge Elimination System
NPL	National Priorities List
NRC	U.S. Nuclear Regulatory Commission
O&M	operations and maintenance
OAC	Ohio Administrative Code
ODH	Ohio Department of Health
OEPA	Ohio Environmental Protection Agency
ORAU	Oak Ridge Associated Universities
PAH	polynuclear aromatic hydrocarbon
PC	personal computer
PCB	polychlorinated biphenyls
pCi/g	picoCuries/gram
pCi/L	picoCuries/liter
PIC	products of incomplete combustion
PID	photoionization detector
PP	proposed plan
PPE	personal protective equipment
ppm	parts per million
QA	quality assurance
QAPP	quality assurance project plan
QC	quality control
RA	risk assessment
RAGS	Risk Assessment Guidance for Superfund
RCRA	Resource Conservation and Recovery Act
RD	remedial design
RFA/CC	request for analysis/chain of custody
RfD	reference dose
RFI	RCRA Facility Investigation
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RM	river mile
RME	reasonable maximum exposure
RMI	Reactive Metals, Inc.
ROD	record of decision
RSE	Removal Site Evaluation
SAP	Sampling and Analysis Plan

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**LIST OF ACRONYMS AND ABBREVIATIONS**  
(Continued)

SARA	Superfund Amendment and Reauthorization Act of 1986
SAR/CR	site-wide analysis request/custody record
SC/DM	Site Characterization/Data Management
SCQ	Site-Wide CERCLA Quality Assurance Project Plan
SDWA	Safe Drinking Water Act
SED	Site-wide Environmental Database
SHPO	State Historic Preservation Officer
SPA	scintillation detector
SR	State Route
SVOC	semivolatile organic compound
SWIFT III	Sandia Waste Isolation Flow and Transport (computer model)
SWMU	solid waste management unit (RCRA)
TAL	target analyte list
TBC	to be considered
TCA	trichloroethane
TCLP	toxicity characteristic leaching procedure
TLD	thermoluminescence dosimeters
TOC	total organic carbon
UCL	upper confidence limit
USCS	Unified Soils Classification System
USDA	United States Department of Agriculture
USGS	U.S. Geological Survey
VOA	volatile organic analysis
VOC	volatile organic compound
WEMCO	Westinghouse Environmental Management Company of Ohio
WMCO	Westinghouse Materials Company of Ohio

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**OPERABLE UNIT 2**

**RI/FS GLOSSARY**

*This fact sheet has been prepared as part of the effort to familiarize the reader with the specific vocabulary used in discussions about environmental restoration and waste management at Fernald.*

**1000-series wells** - Wells extending into the perched groundwater within the till.

**Analytical Support Level** - The level of accuracy and documentation used to support analytical analyses. There are five general levels and these levels are distinguished by the types of technology and documentation used.

**Billet** - A billet is an ingot with the top section of each ingot is cropped to remove shrinkage cavities and impurities, machined, and heat treated.

**Blowdown** - Water from the boiler in the boiler plant.

**Baseline Risk Assessment** - The study undertaken to characterize the current and potential threats to human health and the environment that may be posed by contaminants within an area. The Baseline Risk Assessment provides a framework for developing risk

information necessary to

assist in developing remedial alternatives, and considers the risks that currently exist at the site, if no further response actions or institutional controls are applied. There are four steps in the Baseline Risk Assessment process: identification of constituents of potential concern; exposure assessment; toxicity assessment; and risk characterization and analysis. The Baseline Risk Assessment contributes to site characterization and subsequent development, evaluation, and selection of appropriate response alternatives.

**Clay Lens** - A body of clay with the general form of a lens, thick in the central part and thinning toward the edges.

**Data Quality Objectives (DQO)** - Defines 1) the decisions, 2) the level of data quality needed for those decisions, and 3) the specific procedures required to produce this level of data quality. Also, ensures that the resources expended to collect and analyze each sample are justified.

**Deciduous (Woodlots)** - Trees with leaves that fall off or shed seasonally or at a certain stage of development in the tree's life cycle.

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**Derby** - UF<sub>4</sub> is blended with magnesium granules and placed in a closed reduction pot; the reduction pot is heated in a furnace until the contents react to produce a uranium metal ingot shaped in the form of a man's derby.

**Dose** - Quantity of radiation absorbed in living tissue.

**DQOs** - See Data Quality Objectives.

**Enrichment** - The percent of U<sub>235</sub> isotopes in the amount of total uranium above that which is naturally occurring (greater than 0.71%).

**Exposure Pathway** - An exposure pathway describes a unique mechanism by which an individual or population is exposed to chemicals or physical agents at or originating from a site, such as air transport of dust. Each pathway includes a source or release from a source, an exposure point, and an exposure route.

**Feasibility Study** - The study that evaluates and develops remedial action alternatives to prevent or mitigate the migration or release of hazardous substances, pollutants, contaminants, or hazardous constituents at and from the site. The FS is generally performed in conjunction with the RI and uses data gathered during the RI to develop remedial action alternatives and undertake an initial screening and detailed analysis of the alternatives. The FS includes a

report that describes remedial action alternatives and documents the selection process.

**Fluvial** - Deposits produced by streams or river action.

**FS** - See Feasibility Study.

**Gamma Spectroscopy** - An analytical method of measuring radiation of a sample.

**Glaciofluvial** - Pertaining to streams flowing from glaciers or to the deposits made by such streams.

**Gross Alpha** - The measurement of total alpha activity for a sample. Total alpha activity is the sum of the activities of all isotopes within a sample that decay by releasing an alpha particle.

**Ingot** - An ingot is formed by melting a derby until the metal reaches the proper temperature to be poured into a graphite mold to form an ingot. Ingots vary in weight, size, and shape depending on how they will be used.

**Isotope** - The species of a chemical element having the same atomic number but different atomic mass.

**Isotopic Uranium** - The listing of uranium mass or concentration in a sample by its isotope.

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**Isotopic Thorium** - The listing of thorium mass or concentration in a sample by its isotopes.

**Joint** - Fracture in rocks or soils generally more or less vertical or horizontal to bedding, along which no appreciable movement has occurred.

**Kriging** - The mathematical process of interpreting data by a weighted-moving-average interpolation method.

**Lacustrine** - Pertaining to, produced by, or formed in a lake or lakes.

**Leach** - To dissolve out by the action of a percolating liquid.

**Loess** - A consistent, nonstratified, fine-grained silt which lacks any bedding but often has vertical joints. Loess is transported by wind from deserts, from dried-up flood plains, from river courses, or from glacial deposits.

**millirem (mrem)** - A unit of radiation dosage equal to one-thousandth of a rem. A member of the public can safely receive up to 500 millirems per year, according to federal standards, but the U.S. EPA ordinarily limits public exposure to 25 to 200 mrem per year.

**Moraine** - Deposits of glacial till formed either as curved or bowed mounds at the front of the glacier (terminal moraine) or as sheets of till

over considerable areas (boulder clay). 1

Successive terminal moraines often mark retreat stages of glaciers (recessional moraine). 2

Moraines are made up of a variety of unsorted rock fragments in unbedded clay matrix. 3

**mrem** - (See millirem). 4

**Nuclide** - A species of atom characterized by the constitution of its nucleus and hence by the number of protons, the number of neutrons, and the energy content. 5

**Outcrops** - The exposure of bedrock or strata projecting through the overlying cover of soil. 6

**Overburden** - Material of any nature, consolidated or unconsolidated, that overlies a deposit of useful material, ores, or coal, especially those deposits that are mined from the surface by open cuts. At the FEMP, glacial till is the overburden that overlies the sands and gravels of the Great Miami Aquifer formation. 7

**Perched Groundwater** - Groundwater separated from an underlying body of groundwater by unsaturated rock or soil. 8

**Permeability** - The permeability of a rock or soil is its capacity for transmitting or yielding fluids. The degree of permeability depends upon the size and shape of pores (porosity) within the rock or soil, the size and shape of 9

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pore interconnections, and the extent of interconnections between pores.

**Photogrammetric Surveys** - A shadow like photograph made by placing objects between light sensitive paper and a light source. To examine as to condition, situation, or value.

**Radionuclide** - A radioactive nuclide.

**Receptor Populations** - The human, animal, or plant populations that may be exposed to radioactive or hazardous materials.

**rem** - Roentgen equivalent man, a unit used in radiation protection to measure the amount of damage to human tissue from a dose of ionizing radiation. Incorporates the health risks from radiation.

**Remedial Investigation** - An investigation conducted to determine the nature and extent of a release or threat of release of hazardous substances, pollutants, contaminants, or hazardous constituents. The RI emphasizes data collection and site characterization. The RI includes sampling and monitoring, as necessary, as well as the gathering of sufficient information to determine the necessity for remedial action and support the evaluation of remedial alternatives.

**RI** - (See Remedial Investigation).

**Silt** - Broken rock fragments grading down into particles of which are between 1/16 and 1/256 mm in diameter.

**State Planar Coordinates** - A coordinate system based on a survey of the State of Ohio.

**Till** - Nonsorted, nonstratified sediment carried or deposited by a glacier.

**Transuranics** - Manmade, radioactive elements above atomic number 92.

**Treatability Study** - A laboratory or field test designed to provide critical data needed to evaluate and ultimately implement one or more treatment technologies. Treatability studies generally involve characterizing untreated waste and evaluating the performance of the technology under different operating conditions. Treatability studies conducted during the RI/FS to support remedy selection are generally used to determine whether the technology can achieve the ROD goals.

**Well Logs** (also called boring logs) - The written or recorded facts relating to the drilling of a well (e.g., depth, soil consistency, texture, color, etc.).

**Vadose Zone** - The portion of a geologic formation that is not saturated with water.

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EXECUTIVE SUMMARY

This report documents the Remedial Investigation (RI) phase of the Fernald Environmental Management Project (FEMP) Operable Unit 2 Remedial Investigation/Feasibility Study (RI/FS). The FEMP is a U.S. Department of Energy (DOE) facility located near Fernald, Ohio, which operated from 1952 to 1989 providing high purity uranium metal products to support United States defense programs. In 1989, the mission of the facility was changed to environmental restoration. Also in 1989, the facility was placed on the National Priorities List ("Superfund List"). The RI/FS for the FEMP is executed according to an Amended Consent Agreement between DOE and the U.S. Environmental Protection Agency (EPA), under authority of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). The Ohio Environmental Protection Agency (OEPA) also is participating in the FEMP RI/FS process through direct involvement in review meetings, public meetings, and technical review of project documentation.

The RI/FS is part of a process through which decisions are made to determine the specific environmental cleanup methods that will be used at a site. The Operable Unit 2 Feasibility Study (FS) will develop and compare a range of possible remedial alternatives to identify the most effective approach for meeting specific cleanup goals. Consistent with the Amended Consent Agreement, selection of the preferred cleanup alternative will be documented in a Record of Decision (ROD), which is issued by EPA after consideration of comments received from the public and other interested parties. The Operable Unit 2 RI Report provides a detailed understanding of the nature and extent of the waste materials, their present and future impacts on the surrounding environment, and the present and future risks to human health if the Operable Unit 2 wastes were not remediated. Therefore, this RI Report meets the need for the evaluation of risks due to the Operable Unit 2 wastes and provides the basis to develop and evaluate a wide range of remedial alternatives.

EPA approved the FEMP RI/FS Work Plan in May 1988. The work plan provided the overall technical approach, identified areas to be investigated, and presented the objectives and data evaluation criteria for the planned investigations. The work plan identified 27 specific areas, or units, within the FEMP for investigation. Subsequent evaluations increased the number of units to 39. It soon became apparent that for purposes of effective management, the 39 units should be categorized and grouped. The resultant groupings formed the five operable units of the FEMP. The operable units are:

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- Operable Unit 1 - Waste Pit Area
- Operable Unit 2 - Other Waste Areas
- Operable Unit 3 - Former Production Area
- Operable Unit 4 - Silos 1 through 4
- Operable Unit 5 - Environmental Media

Operable Unit 2 is comprised of five subunits: Solid Waste Landfill, Lime Sludge Ponds, Active Flyash Pile, Inactive Flyash Pile, and South Field. Large volumes of conventional industrial wastes, assumed to have small amounts of hazardous chemicals and radionuclides, were placed in these subunits during the period of production operations.

NEPA Integration

Consistent with DOE policy, the FEMP is integrating the requirements of the National Environmental Policy Act (NEPA) into the RI/FS process. On May 15, 1990, a Notice of Intent was published in the Federal Register to announce that DOE intended to prepare an Environmental Impact Statement (EIS) to evaluate the environmental impacts associated with the planned cleanup activities at the FEMP. As identified in the Notice of Intent, the FS and Proposed Plan (PP) for the earliest scheduled operable unit, (Operable Unit 4) will be issued as a FS/PP-EIS. The FS/PP-EIS will examine the environmental impacts associated with Operable Unit 4 remedial activities as well as the cumulative impacts associated with the implementation of remedial actions for all five operable units at the FEMP. An additional element of NEPA compliance is the FEMP Site-Wide Characterization Report, which supplements the Operable Unit 4 FS/PP-EIS by providing an assessment of cumulative environmental impacts associated with the existing conditions at the FEMP on a site-wide basis.

The Operable Unit 2 FS and PP will be coordinated with the Operable Unit 4 FS/PP-EIS for purposes of NEPA integration, and if necessary, the cumulative impact analysis presented in the Operable Unit 4 impact statement will be updated and attached to the Operable Unit 2 NEPA evaluation. The Operable Unit 2 RI Report will be incorporated by reference into the Operable Unit 2 FS and PP NEPA evaluation. This RI Report includes the characterization of Operable Unit 2 and hence, will support the necessary description of the affected environment in the Operable Unit 2 NEPA evaluation. This report also provides the baseline risk assessment that will support the evaluation of the no action alternative for Operable Unit 2.

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DESCRIPTION OF OPERABLE UNIT 2

The FEMP is a 1050 acre facility located about 17 miles northwest of downtown Cincinnati near Fernald, Ohio, a small farming community. The site lies on the boundary of Hamilton and Butler counties. The primary mission of the FEMP during its 37 years as an operating production facility was to process, refine, and machine high-grade natural uranium ores into high purity uranium metal. The high purity metals were shipped to other DOE or U.S. Department of Defense facilities for use as "feed materials" in the nuclear weapons program. These uranium production activities generated large quantities of waste materials. The storage and disposal of wastes at the site and their potential for impacting human health led to the site being placed on the National Priorities List. Operable Unit 2 is comprised of five areas, or subunits, in which various conventional industrial wastes were disposed.

The FEMP is situated on an area of glacial overburden deposits; the overburden primarily is composed of till, a dense silty clay that may contain lenses of poorly sorted fine to medium grained sand and gravel, silty sand, and silt. Undisturbed glacial till has relatively low permeability. The thickness of the till varies from 0 to 50 feet on site, and the till tends to be thicker in the northern part of the site (the Solid Waste Landfill, for example is sited in thick till) and pinches out completely in the South Field area in the southern part of the site. Areas not covered with till may exhibit higher infiltration rates than those covered with glacial till.

Erratically distributed pockets of sand and gravel within the till contain zones of perched groundwater. Perched groundwater is separated from the underlying aquifer by the surrounding relatively impermeable till materials. Depth to perched groundwater at the FEMP ranges from 1 to 15 feet below ground surface. The depth may fluctuate seasonally by up to 10 feet at a given location, with the highest levels occurring in the early spring and the lowest in the late fall.

The FEMP is sited above a major aquifer system, the Great Miami Aquifer. The Great Miami Aquifer is considered a sole source aquifer and sustains numerous industrial, municipal, and private drinking water wells. The FEMP includes several areas that probably function as recharge zones to the aquifer, including Paddys Run, the Storm Sewer Outfall Ditch, and parts of the South Field.

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The subunits comprising Operable Unit 2 are briefly described below.

Solid Waste Landfill

The Solid Waste Landfill is located in the northeast corner of the Waste Storage Area, and is a flat, rectangular area of about one acre. The landfill has been inactive since 1986 and is covered with a layer of soil. The operational history of the landfill is not well documented. A review of historical site aerial photographs indicates that disposal activities may have occurred as early as 1954. Available documentation and interviews indicate that the landfill was intended to be used for "nonburnable wastes"; field investigations have revealed a variety of waste materials including medical wastes, rubbish, wastes from areas other than the Production Area, and on-site construction/demolition wastes.

Lime Sludge Ponds

The North and South Lime Sludge Ponds are two unlined, rectangular ponds, each measuring approximately 125 by 225 feet, located in the southeast corner of the Waste Storage Area. The sludge is confined by earthen dikes of unknown origin. The operational history of the ponds is well understood. Wastes disposed of in the ponds originated from water plant operations, coal pile storm water runoff, and boiler plant blowdown. The South Pond is full and has been inactive since the mid-1960s, and is now overgrown with grasses and shrubs. The North Pond currently remains in use. The west side of the North Pond usually is covered with one to two feet of water, mainly depending on precipitation. The remainder of the pond is dry and sparsely covered with vegetation.

The waste from water plant operations is generated from a water softening process. About one cubic yard of waste sludge is generated each day and is pumped to Tanks 6 and 7 of the General Sump. Coal pile runoff is treated in a retention basin to settle out the solids, then pumped to Tanks 6 and 7 of the General Sump. The boiler plant blowdown consists of backflush water, generated when the boilers are backflushed to prevent scale buildup. This water is also pumped to Tanks 6 and 7 of the General Sump. Tanks 6 and 7 contain only sludges from these three sources.

Sludge is allowed to accumulate in the tanks for about two weeks. It is then pumped as a slurry to the North Lime Sludge Pond. The bulk of the material comprising the slurry is sludge from the water softening operations. The Lime Sludge Ponds have been operated in this manner since the early 1950s. Based on this process knowledge as well as the resulting analysis of the sludge, it appears that

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the lime sludge is relatively homogenous (uniform in composition). The Lime Sludge Ponds are presently classified as Solid Waste Management Units by OEPA.

Inactive Flyash Pile

The Inactive Flyash Pile is located about 2,000 feet southwest of the former Production Area and covers approximately 2 acres. Paddys Run forms the western boundary; the South Field lies to the east. The Inactive Flyash Pile and South Field are contiguous and lack a defined physical boundary. In appearance, this subunit resembles a relatively steep hill covered with shrubs and trees. The soil covering the southern half of the Inactive Flyash Pile is of unknown origin.

The operating history of the Inactive Flyash Pile is not well understood. The bulk of the waste material in the pile is reported to be bottom ash and flyash from the facility's boiler plant operations, commonly referred to as flyash. Based on a review of historical aerial photographs, flyash appears to have been taken by truck to an existing slope near Paddys Run and dumped. The photographs indicate that flyash disposal at this subunit had ceased by the mid-1960s. Various other wastes, including building rubble, gravel, asphalt, and process waste, were also deposited at the Inactive Flyash Pile.

South Field

The South Field is an 11-acre area that lies between the Inactive Flyash Pile and the Active Flyash Pile. A physical boundary with the Inactive Flyash Pile is not distinguishable. Currently, the South Field is relatively flat and is covered with grasses, shrubs, and trees.

The operational history of the South Field is neither well documented nor understood. It is not an engineered disposal site. A review of historical aerial photographs indicates that disposal may have been initiated in 1954 and continued until the mid-1960s. Disposal appears to have taken place in a random manner. Available documentation indicates that a number of wastes were disposed in the South Field, including construction and demolition materials, flyash, soils that may have been contaminated with low levels of radioactive materials, and possibly process wastes.

Active Flyash Pile

The Active Flyash Pile is bounded to the east and north by the Storm Sewer Outfall Ditch, and is separated from the South Field to the west by an unpaved road. The Active Flyash Pile appears as a

large, steep pile of black flyash, and covers about three acres. Wind screens and silt fences have been installed to prevent wind and water erosion, and a crusting agent has been applied. A crusting agent is applied to harden the surface of the Active Flyash Pile to minimize erosion and resuspension of dust. The operational history of the subunit is well understood.

Flyash from the site's coal-fired boiler plant was disposed at the Active Flyash Pile from the mid-1960s until December 1992. Flyash presently being generated at the FEMP is disposed at an approved, off-site facility. The waste at the Active Flyash Pile is comprised of about 70 percent bottom ash and 30 percent flyash. Small quantities of unburned coal and rock are present, as is typical of boiler ashes. Previous investigations have discussed the possibility that waste oils, which theoretically could contain PCBs or uranium, might have been applied to the Active Flyash Pile as a dust control measure. However, attempts to document this possibility have not been successful.

NATURE AND EXTENT OF CONTAMINATION

The nature and extent of contamination at Operable Unit 2 subunits have been established through several environmental investigations. The investigations most relied on in this report are the Environmental Survey (ES), the Characterization Investigation Study (CIS), and the CERCLA Remedial Investigation. The ES and CIS primarily were focused on site-wide issues and were not intended to provide a detailed analysis of contamination related to Operable Unit 2 subunits. The ES data have not been validated; portions of the CIS data have been validated. The RI field investigations rigorously examined the nature and extent of contamination in Operable Unit 2 subunits and the potential for the spread of contamination into the various environmental media. All RI data were validated. The evaluation of the nature and extent of contamination is based primarily on RI data, and CIS data were used in a supplementary manner. ES data were used only for descriptive purposes. Neither ES nor CIS data were used in the fate and transport modeling for the baseline risk assessment.

The following sections briefly summarize the findings on the nature and extent of contamination.

Solid Waste Landfill

Trenching and boring activities in the Solid Waste Landfill have determined that cafeteria, laboratory, construction/maintenance, and manufacturing wastes were disposed in the landfill. One waste disposal cell and an evaporation pond were identified in historical photographs and trench

observations, but waste was observed in numerous other areas within the battery limits. The depth of waste is generally 10 feet with the a maximum depth is the southeastern corner of the landfill of 15 feet.

Thirteen Contaminants of Concern (COCs) have been identified for the Solid Waste Landfill that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 3 organic compounds. The extent of COCs in the Solid Waste Landfill is distributed throughout the surface and subsurface fill materials with the maximum levels in the southeastern corner of the landfill. The COCs were also detected in the glacial till beneath the landfill and in the perched groundwater near the southeast corner of the subunit. No impact has been observed on the Great Miami Aquifer. The number of COCs detected in the surface water, sediment, and perched groundwater are fewer than those detected in the surface and subsurface soils.

The media pathways considered significant for the Solid Waste Landfill as a result of the modeling include air, surface water, groundwater, and perched water. Perched water was modeled under the Solid Waste Landfill because of a potential for household use of the perched water.

#### Lime Sludge Ponds

Field investigations of the Lime Sludge Ponds indicate that the sludge within the subunit is homogeneous. Sampling in the berm soils and glacial till beneath the ponds has determined that the soils have higher concentrations of most constituents than the sludge. This means that future impacts from the sludge upon the soil are not likely. Elevated concentrations of uranium and thorium were detected in downgradient perched groundwater wells, but samples collected from the K-65 Trench (outside of Operable Unit 2 boundaries) detected elevated radioisotope activities. The K-65 Trench is believed to be the source of the perched groundwater contamination.

Seven COCs have been identified for the Lime Sludge Ponds that contribute greater than one percent of the total risk for a medium. These COCs consist of 4 radionuclides, 2 metals, and 1 organic compound. The extent of COCs in the Lime Sludge Ponds is limited mostly to the berm soils surrounding the ponds. Beryllium is the only COC that is believed to have originated in the lime sludge. Radionuclides and organics appear to have originated in the surface and berm soils. The COCs were also detected in the perched groundwater downgradient of the subunit, but the source of

these contaminants is believed to be the K-65 Trench. No impact has been observed on the Great Miami Aquifer.

The media pathways considered significant for the Lime Sludge Ponds as a result of the modeling include the air and groundwater pathways. No surface water pathway exists near the Lime Sludge Ponds and all surface water is contained within the subunit. Perched water was modeled under the Lime Sludge Ponds because of a potential for household use of the perched water.

Inactive Flyash Pile

Field investigations of the Inactive Flyash Pile indicate that waste other than flyash were disposed of in the subunit. Organic waste, sludge, clay tile drain pipe, wood, nails, wire, and construction debris were found in addition to flyash. Field measurements with an alpha-beta meter indicated that all materials except for flyash had elevated levels of radioactivity. The identified waste materials appear to be resting on or near the interface between the flyash and the native glacial overburden.

The occurrence of uranium contamination in the perched groundwater appears to be related to waste materials buried within or near this subunit. The perched groundwater appears to discharge through seeps into the Paddys Run drainage channel or directly into the Great Miami Aquifer through regions where the glacial overburden has been eroded. This means that a mechanism exists to transport uranium contamination vertically into the Great Miami Aquifer. Uranium contamination in the Great Miami Aquifer was not detected upgradient or from the northern part of the subunit. Uranium contamination was detected in two wells in the Great Miami Aquifer downgradient from the central part of the subunit. This suggests that a source of uranium contamination to the Great Miami Aquifer exists beneath the central part of the Inactive Flyash Pile.

Ten COCs have been identified for the Inactive Flyash Pile that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 1 organic compound. The extent of COCs in the Inactive Flyash Pile covers most of the surface and subsurface soils and groundwater within the subunit. Radionuclides appear to be connected to non-flyash waste such as sludge, wood, and construction debris, whereas organics appear to be intermixed with the flyash, possibly from dust control spraying. Uranium is the only COC detected in the Great Miami Aquifer downgradient of the subunit.

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The media pathways considered significant for the Inactive Flyash Pile as a result of the modeling include air, surface water, and groundwater pathways.

South Field

Test trenches uncovered a range of waste materials including concrete, steel pipe, sheet steel, wood, and clay tile. The results of wipe samples taken from these materials indicate that they represent a potential source of the leaching of radionuclides to groundwater.

Sixteen COCs have been identified for the South Field that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 7 organic compounds. The extent of COCs in the South Field covers most of the surface and subsurface soils and groundwater sampled within the subunit. Radionuclides and organics were detected in higher concentrations in the northern portion of the South Field.

The media pathways considered significant for the South Field as a result of the modeling include air, surface water, and groundwater pathways.

Active Flyash Pile

The Active Flyash Pile contains only flyash from field observations and historical documentation. Interviews with former processing personnel indicated that organic compounds could have been sprayed on the flyash to reduce dust. The analytical results of the RI field investigation do not support such speculation.

Eight COCs have been identified for the Active Flyash Pile that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides and 2 metals. The extent of COCs in the Active Flyash Pile covers most of the surface soil subsurface soil within the subunit. The COCs uranium-234, uranium-235/236, and uranium-238 were detected in the Great Miami Aquifer downgradient of the subunit.

The media pathways considered significant for the Active Flyash Pile as a result of the modeling include air, surface water, and groundwater pathways.

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BASELINE RISK ASSESSMENT

The Operable Unit 2 baseline risk assessment accomplished the following for each subunit:

- Determination of the constituents of potential concern (CPCs)
- Assessment of the potential for and magnitude of constituent transport from Operable Unit 2 sources to potential points of human exposure
- Quantification of potential exposures to human receptors under current and future land use scenarios
- Characterization of the nature and magnitude of potential risks associated with Operable Unit 2, assuming there were no remedial action in the future
- Evaluation of the uncertainty associated with the risk estimations.

The Operable Unit 2 baseline risk assessment addresses only potential risks associated with waste subunits within the battery units of Operable Unit 2. It does not consider existing sources or contamination in soil, surface water, and sediment outside the boundaries of Operable Unit 2, nor does it consider groundwater contamination. These risks will be evaluated in the Operable Unit 5 RI. Risks due to groundwater in this and other operable unit risk assessments are based on estimates of future concentrations which are based on modeling. This risk assessment does not consider the potential impacts on flora and fauna (ecological risks). Evaluation of site-wide ecological risks will take place in the Operable Unit 5 RI/FS; areas likely to be remediated on the basis of human health protection will not be evaluated.

Operable Unit 2 includes five subunits for which remedial decisions must be made. In order to facilitate the decisions, risk was quantified separately for each subunit. The specific risk assessment methodology followed was consistent across all subunits, and the cumulative risk from Operable Unit 2 sources was calculated.

Potential human exposure to risk is evaluated in the context of three land use scenarios: (1) current land use having DOE ownership with both access and no access control, (2) future land use assuming federal ownership, and (3) future land use assuming private ownership. For all scenarios, it is assumed that no additional cleanup of Operable Unit 2 occurs beyond that which already has taken place.

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The postulated human receptors of incremental risk for the current land use scenario include a trespassing youth, off-property residents, and on-property groundskeeper. For the future land use scenario assuming federal ownership, the receptors are expanded trespasser and off-property farmers. For the future land use scenario assuming private ownership, the receptors are on-property farmers, homebuilders, and users of "perched" groundwater (isolated bodies of groundwater within the glacial till). Recreational users of the Great Miami River were also considered future receptors regardless of whether federal or private ownership is assumed. For the future land use scenarios, the constituent concentrations at the specific geographical and temporal points of human exposures were determined by the application of approved air dispersion, and surface water and groundwater transport computer simulation models.

Epidemiological evidence indicates that the typical human being has a risk of developing cancer of about one in three, or  $3.3 \times 10^{-1}$ . Federal regulations for the management of waste sites limit the allowable excess risk to any person, resulting from exposure to carcinogenic materials, to one in 10,000 or  $10^{-4}$ . Accordingly, the baseline risk assessment presents the risks due to exposure to carcinogens in terms of incremental lifetime cancer risk (ILCR); that is the additional risk to a given person, given a lifetime of exposure to Operable Unit 2 wastes and impacted media. Hazards due to exposure to noncarcinogenic constituents also are evaluated. Noncarcinogenic risks are reported as a hazard index (HI). HIs of greater than 1.0 or "above unity" indicate a concern for potential health effects.

To ensure that the most sensitive or most exposed individuals in the population are protected, EPA guidance provides for calculation of reasonable maximum exposure (RME), which is the maximum exposure a person reasonably could receive from the waste site being evaluated. For example, in the Operable Unit 2 future land use scenario assuming private ownership, the on-property RME farmer (adult and child) builds a home on (where physically feasible) and actively farms the unremediated Operable Unit 2 waste units and is exposed to the following for each CPC:

- Inhalation of fugitive dust, volatile organic compounds, and gases
- Incidental ingestion, inhalation, and dermal contact while using groundwater (separate evaluations for Great Miami Aquifer and perched groundwater) in the home
- Consumption of foodstuffs grown on the waste site, including fruits and vegetables, and meat and milk

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- Incidental ingestion, external radiation, and dermal contact with soil
- Inhalation of indoor radon

Thus, the RME receptors usually will have the highest estimated risks in a risk assessment. Risk and hazard results are also presented for a central tendency (CT) receptor, whose exposures are thought to be more typical of the average individual in the exposed population. For all subunits, future risks to off-property receptors (with the exception of the expanded trespasser, whose exposures primarily occur on site) will be the same for federal or private ownership. A summary of results from the risk assessment for each subunit is presented below. All site-related risks were calculated without accounting for (removing) the potential contribution from natural background sources.

Solid Waste Landfill

For the current land use scenario, a total carcinogenic risk to a trespassing youth is  $1.6 \times 10^{-5}$  due mostly to external radiation from radium-226 and thorium-228 and dermal contact with beryllium in soil. HIs are less than 1.0. Total risk to the on-property groundskeeper are within the same order of magnitude as the trespassing youth. Major contributors to risk for this receptor are the same as those to the trespassing youth. Off-property farmers have carcinogenic risks on the order of  $10^{-8}$  and HIs of less than 1.0.

For the future land use scenario assuming private ownership, total carcinogenic risk and hazard to the RME farmer are  $1.2 \times 10^{-3}$  and 1.5, respectively. The greatest contributors to risk are from radium-226, uranium-238, and thorium-228 in soils via external radiation and dermal contact with beryllium in soil. Risks exceeded the  $1.0 \times 10^{-4}$  level for the perched groundwater users due primarily to the estimated presence of carbazole in perched groundwater.

For the future scenario having federal ownership, the expanded trespasser has a combined carcinogenic risk of  $4.4 \times 10^{-5}$  due mostly to external radiation by radium-228, thorium-228, and uranium-238 and dermal contact with beryllium in soil. Total HI is less than 1.0. Total carcinogenic risk for off-property farmers range from  $10^{-5}$  to  $10^{-8}$ .

Risk to the recreational users of the Great Miami River is in the range of  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-5}$  due mostly to external radiation from thorium-228, radium-228, and uranium-238 in sediment. HIs are below 1.0.

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The media pathways with the most significant risk for COCs are related to ingestion, inhalation, and dermal contact with soil and consumption of fruit and vegetables, milk and beef contaminated by soil. Two COCs, carbazole and technetium-99, contribute risk to the on-property resident farmer if perched groundwater is used for as a household drinking water source. Approximately 86 percent of the total risk to the on-property resident farmer is derived from four COCs: radium-228, thorium-228, uranium-238, and beryllium in soil.

Lime Sludge Ponds

For the current land use scenario, a total carcinogenic risk to a trespassing youth is  $2.8 \times 10^{-5}$  due primarily to exposure to surface soil containing radium-228 and thorium-228, via external radiation, and to dermal contact with beryllium and Aroclor-1254. Total risk to the current on-property groundskeeper is  $4.7 \times 10^{-5}$  due mostly to the presence of thorium-228 and beryllium in soil. Total HI for these receptors is less than 1.0. Carcinogenic risks to off-property residents are on the order of  $10^{-7}$  and the combined HI is much less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total risk of  $1.9 \times 10^{-3}$  due almost entirely to the presence of radium-228, thorium-228, uranium-238, and beryllium in soil. Total HI is less than 1.0 for the farmer, but for the on-property child, the HI exceeded 1.0 due to the presence of total uranium in soil.

For the future land use scenario with federal ownership, the expanded trespasser has a total risk of less than  $9.8 \times 10^{-5}$  due to the same compounds as the on-property farmer HI is less than 1.0. Off-property farmers have carcinogenic risks on the order of  $10^{-7}$  and HIs of less than 1.0. uranium in soil.

The media pathways with the most significant risk for COCs are related to ingestion, inhalation, and dermal contact of soils. No COCs were determined for perched groundwater even if perched groundwater is used for a household drinking water source. Approximately 88 percent of the risk to the on-property resident farmer is derived from four COCs in soil: radium-228, thorium-228, beryllium and Aroclor-1254.

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Inactive Flyash Pile

Because of the contiguous nature of the Inactive Flyash Pile and South Field, the complexity of the geology and lithology, and the patterns of groundwater flow in the area, it was not possible to completely separate these potential groundwater sources on other than an arbitrary basis. Therefore, the groundwater modeling for these subunits included simultaneous inputs from the entire area of these combined subunits. Hence, the risk contribution of the groundwater pathway is based on the combined effects of these subunits.

For the current land use scenario, total carcinogenic risks range from slightly greater than  $10^{-5}$  for the trespassing youth to about  $10^{-8}$  for off-property receptors. Total risk to the trespassing youth is  $3.3 \times 10^{-5}$  due mostly to the presence of radium-228, thorium-228, and beryllium in soil. Risk to the on-property groundskeeper are on the same order of magnitude as the trespassing youth. Major contributors are the same as those for the trespassing youth. HIs for all current scenario receptors are less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total risk of  $3.2 \times 10^{-3}$  and HI far greater than 1.0. The major contributors of risk are thorium-228 and beryllium in soil and uranium-234 and uranium-238 in groundwater and consequently in irrigated produce, and in milk and beef from livestock that are watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. The most significant components of the elevated HI are due to total uranium in groundwater and consequently in irrigated produce.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of  $1.2 \times 10^{-4}$  and HI of less than 1.0. The off-property farmer has a total carcinogenic risk of  $6.6 \times 10^{-5}$  and HI of 3.4. Major contributors of risk to the off-property farmer are uranium-234 and uranium-238 in groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. The major contributors to hazard are from total uranium in groundwater and consequently in irrigated produce, and in milk and beef from cattle that are watered with contaminated groundwater from the Inactive Flyash Pile/South Field source area.

Total estimated risk to future Great Miami River users are in the range of  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-5}$ . Major contributors to risk were from thorium-228, uranium-235/236, and radium-228. HIs are less than 1.0.

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Pathways contributing to risk include ingestion, inhalation, and dermal contact with soil, and ingestion of groundwater. Approximately 85 percent of the risk to the on-property resident farmer is derived from five COCs: radium- 228, thorium-228, uranium-234, uranium-238, and beryllium.

South Field

For the current land use scenario, total carcinogenic risks range from slightly greater than 10<sup>-5</sup> for the trespassing youth to about 10<sup>-7</sup> for off-property receptors. Major contributors of risk to the trespassing youth are mostly due to radium-228, and thorium-228, and beryllium in soil. Total estimated risk to the on-property groundskeeper is 6.5 x 10<sup>-4</sup> due primarily to thorium-228 in soil. HIs for all current receptors are less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total carcinogenic risk of 3.8 x 10<sup>-3</sup> and the resident child has a risk of 4.5 x 10<sup>-4</sup>. The on-property RME farmer, and resident child have HIs greater than 1.0. The largest component of risk to the on-property farmers are from thorium-228, radium-228, beryllium and benzo(a)pyrene in soil, and uranium-234, uranium-238, and total uranium in groundwater and consequently in irrigated produce, and in milk and beef from livestock that is watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. Risks for the on-property RME farmer at the South Field are somewhat higher than for the Inactive and Active Flyash Piles because it is feasible to build a house on the South Field. Therefore, the South Field RME farmer has higher direct radiation exposures as well as exposure to indoor radon.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of about 2.2 x 10<sup>-4</sup> and a HI of less than 1.0. Major contributor to risk is from beryllium in soil and sediment. Off-property farmers have carcinogenic risks as great as 10<sup>-5</sup> and HIs greater than 1.0. The largest component of risk to the off-property farmers is uranium-234, uranium-238, and total uranium in groundwater and consequently in irrigated produce, and in milk and beef from livestock that is watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area.

Total estimated risk to the Great Miami River users are within a 1.0 x 10<sup>-5</sup> to 1.0 x 10<sup>-4</sup> range. Major contributors to risk include benzo(a)pyrene, thorium-230, and beryllium. Pathways contributing most to risk include ingestion, inhalation, and dermal contact with soil, and ingestion of

groundwater. Over 80 percent of the risk to the on-property resident farmer is derived from five COCs: radium-228, thorium-228, uranium-234, uranium-238, and beryllium.

Active Flyash Pile

For the current land use scenario, total carcinogenic risk to a trespassing youth is  $6.8 \times 10^{-5}$  due to the presence of radium-226, radium-228, and thorium-228 in soil. Total risk to the on-property groundskeeper is  $9.2 \times 10^{-5}$  due mostly from thorium-228 and beryllium in soil. Total HI for all current receptors are less than 1.0. Carcinogenic risks to off-property residents are on the order of  $10^{-6}$ .

For the future land use scenario assuming private ownership, the on-property RME farmer has a total carcinogenic risks of  $1.9 \times 10^{-3}$  due mostly to the presence of neptunium-237, radium-228, thorium-228, and arsenic in surface flyash material. Total HI is less than 1.0.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of  $2.4 \times 10^{-4}$  and HI of less than 1.0. Exposure to the expanded trespasser is due mostly to beryllium in surface flyash. Off-property farmers have carcinogenic risks greater than  $1.0 \times 10^{-6}$  due mostly to uranium-234 and uranium-238 in groundwater contaminated from the Active Flyash Pile source area. Total HI is less than 1.0. Total estimated risks to the Great Miami River users are in the range of  $1.0 \times 10^{-5}$  to  $1.0 \times 10^{-4}$  due mostly to arsenic and beryllium in sediment.

The pathway which contributes most significant risk is dermal contact. Over 85 percent of the risk to the on-property resident farmer is derived from three COCs in soil: radium-228, thorium-228, and arsenic.

OPERABLE UNIT 2 CUMULATIVE RISK

Future land use receptors were evaluated for cumulative risk from the presence of contaminants within Operable Unit 2. It is emphasized that the risks and hazards presented are those resulting primarily from the three subunits contributing most to groundwater contamination: the Active Flyash Pile, South Field and Inactive Flyash Pile.

The greatest carcinogenic risk posed was to the RME on-property farmer which had a total risk of  $3.7 \times 10^{-3}$ . The major contributors to risk for the on-property receptor is from the presence of

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thorium-228, radium-228 and beryllium in soil, and the estimated presence of uranium-238 in groundwater.

Total risk to the off-property farmer slightly exceeded  $1.0 \times 10^{-4}$  due primarily to uranium-234 and uranium-238 in groundwater, and thorium-228, thorium-230, and uranium-238 in soil.

Total HIs exceed 1.0 for both the on- and off-property farmers due primarily to the estimated presence of total uranium in groundwater.

Total risk to the expanded trespasser was  $6.6 \times 10^{-5}$  due primarily to beryllium and thorium-228 in soil which contributed 64.5 percent and 15.5 percent, respectively. Total HI for this receptor was below 1.0.

Approximately 68 percent of the total risk to the on-property farmer is attributed from four COCs in soil and groundwater: thorium-228, radium-226, beryllium, and uranium-238.

Risk Assessment Uncertainty

Every quantitative risk assessment is subject to sources of uncertainty. To ensure that risk is not underestimated and that human health is protected, CERCLA guidance and the conventions followed in this report address areas of uncertainty through application of conservative (i.e., protective) assumptions. The greatest uncertainty associated with the Operable Unit 2 baseline risk assessment is due to the assumptions made to estimate constituent concentrations at the spatial and temporal points of human exposure. Specifically, the exposure point concentrations in groundwater, air, produce, and beef and milk for human receptors in the future are the most conservatively estimated. All risk and hazard estimates for future on-property residents are subject to uncertainty, and hence conservatism, because the future site ownership and access controls are unknown. Taken together and interactively, the uncertainties identified with site data, exposure parameters, fate and transport, toxicity assessment, and risk characterization are judged to be high, having the potential to overestimate risk by two orders of magnitude or more.

One way to evaluate the degree of conservatism in the risk assessment methodology is to follow the risk estimation protocol, substituting natural background concentrations for the contaminants that were found, in place of the values actually measured at the waste site. This was done for the Operable

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Unit 2 land use and human exposure scenarios. The use of background constituent levels in the Operable Unit 2 risk assessment results in a carcinogenic risk for the on-property RME residents of greater than  $1.0 \times 10^{-4}$ . Major contributors to total background risk are from thorium-228, radium-228, and beryllium in surface soil.

Conclusions

This RI presents a detailed understanding of the nature and extent of the contamination of the individual subunits that comprise Operable Unit 2. The contaminant data are used for two major purposes: (1) after the application of rigorous validation and statistical procedures, the data are used to drive the contaminant fate and transport models used in the risk assessment, and (2) the types and quantities of contaminants are used in the FS in the screening of appropriate cleanup technologies and the development of specific remedial alternatives. The data collected for the Operable Unit 2 RI are completely adequate for both purposes and no data gaps have been identified.

The Operable Unit 2 baseline risk assessment utilizes a data set in which every data element has been validated for its intended usability. The fate and transport models are approved by EPA and calibrated to the specific site conditions. The risk assessment rigorously follows CERCLA guidance, the approved Risk Assessment Work Plan Addendum, and specific guidance to the FEMP from EPA Region V.

This report concludes that none of the Operable Unit 2 subunits presents a risk to current off-property receptors above allowable levels. Risk to the trespassing youth and the on-property groundskeeper would be greater than the lower risk threshold ( $10^{-6}$ ) but are within the same range as the risk due to background levels calculated to test the conservatism (over estimate) of the risk assessment methodology.

The risk assessment shows that in the future assuming federal ownership, in the absence of remediation, the Lime Sludge Ponds present an unacceptable risk for both the on-property receptors and the expanded trespasser.

The risk assessment shows that in the future, in the absence of remediation, the Active Flyash Pile, Inactive Flyash Pile, South Field, and Solid Waste Landfill will present greater than allowable risk to both on- and off-property receptors.

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Remedial Action Objectives

The development of the following general remedial action objectives (RAOs) is based only on the results of the baseline risk assessment. The Operable Unit 2 FS will include a consideration of the ARARs for each subunit, and ARARs have the potential to significantly affect the remedial action objectives. For the Operable Unit 2 subunits requiring remedial action, feasible remedial action alternatives will be developed and evaluated in the FS Report to be issued for Operable Unit 2.

The remediation of existing contamination in the Great Miami Aquifer is not considered here because remediation of the aquifer is within the scope of the Operable Unit 5 remedial actions. During remediation of Operable Unit 2, contaminated perched water will be controlled to prevent the recontamination of the areas being cleaned up. The treatment or disposal of the perched water will be coordinated with the remedial actions for Operable Unit 5. Also, during the remediation of Operable Unit 2, storm water will be controlled to prevent the spread of contaminants. The treatment or disposal of the storm water will be coordinated with the remedial actions for Operable Unit 5.

The RAOs for all subunits in Operable Unit 2 are to prevent the release or migration of contaminants from waste materials and contaminated soils that could potentially (1) affect future groundwater users (perched and aquifer) on the site, (2) be harmful as sources of external radiation, (3) prevent the availability of harmful waste materials or contaminated soils for inhalation or ingestion by on-property resident farmers, and (4) prevent the availability of harmful waste materials or contaminated soils for plant uptake, disposition on plants, or ingestion by animals raised for meat and milk products.

## 1.0 INTRODUCTION

This report documents the Remedial Investigation (RI) phase of the Remedial Investigation/Feasibility Study (RI/FS) for Operable Unit 2 at the U.S. Department of Energy (DOE) Fernald Environmental Management Project (FEMP) or "the Fernald site." The FEMP was known as the Feed Materials Production Center (FMPC) until August 23, 1991. Its primary function was the production of metallic uranium fuel elements, target cores, and other uranium products for use in weapons production reactors and other programs operated by the DOE. At times, thorium was also processed and stored at the facility. As a result of these processes, the facility generated both radioactive and non-radioactive hazardous wastes.

The FEMP is a 1,050 acre, government-owned, contractor-operated facility located in southwestern Ohio, about 18 miles northwest of downtown Cincinnati, Ohio. The facility is located north of Fernald, Ohio, a small farming community, and lies on the boundary between Hamilton and Butler counties (Figure 1-1). Of the total site area, 850 acres are in Crosby Township of Hamilton County, and 200 acres are in Ross and Morgan townships of Butler County.

In 1989, the Fernald site was placed on the National Priorities List (NPL) (Superfund List) as a result of past releases of hazardous waste as part of the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). Under CERCLA, the RI/FS is a process designed to investigate the extent of site contamination and risks to human health and the environment, and evaluate the potential remedial (cleanup) alternatives. The Fernald site is defined as all areas within the property boundary of the FEMP and any other areas that received released hazardous substances, pollutants, contaminants, or hazardous constituents from FEMP activities. The RI/FS is being conducted pursuant to the terms of a 1991 Amended Consent Agreement with the U.S. Environmental Protection Agency (EPA) to identify the most effective remedial actions to be undertaken at the FEMP. Operable Unit 2 is one of five operable units at the FEMP and consists of waste subunits with relatively large volumes of conventional industrial wastes that were assumed to contain small amounts of hazardous chemicals or radionuclides.

This section describes the purpose and organization of the report and presents a facility description and history of operations for the FEMP site, more specifically for the facilities included as part of Operable Unit 2. It also describes previous Operable Unit 2 studies and other relevant prior

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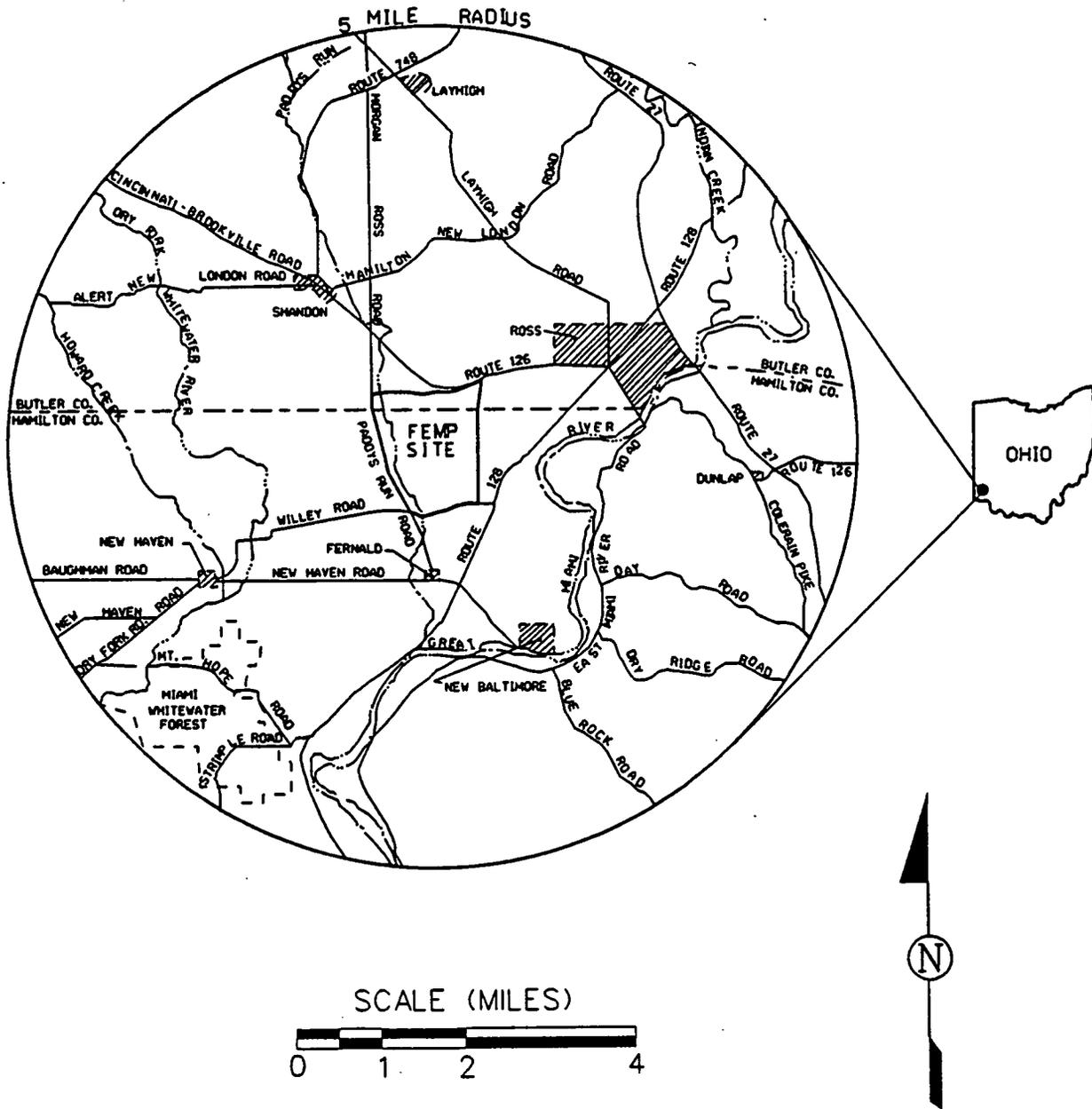


FIGURE 1-1  
FEMP FACILITY  
LOCATION MAP

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environmental investigations conducted at the FEMP. The overall objective of this section is to provide a historical and regional perspective to assist in evaluating potential environmental and human health impacts associated with Operable Unit 2.

### 1.1 PURPOSE OF REPORT

In the CERCLA remedial response process, a series of activities and subactivities are undertaken to provide a permanent resolution of actual or potential hazardous substance releases from a site. These activities consist of the RI, Feasibility Study (FS), Remedial Design (RD), Remedial Action (RA), and Operations and Maintenance (O&M). The purpose of the Operable Unit 2 RI is to gather data necessary to determine the nature and extent of contamination potentially posing significant risk to human health and/or the environment, and support the technical and cost analysis of alternatives carried out in the FS phase. Specifically, this report documents the investigations relating to Operable Unit 2; provides a detailed understanding of the nature and extent of contamination; determines the fate and transport of constituents of potential concern (CPC); and defines the risk posed to human receptors from Operable Unit 2 waste materials.

Under DOE regulation 10 Code of Federal Regulations (CFR) 1021, NEPA reviews are required for all DOE activities, including CERCLA actions. The NEPA/CERCLA integration plan, presented in DOE Order 5400.4, is designed to avoid duplicate effort and a larger commitment of resources needed to implement NEPA and CERCLA separately; to avoid conflicts in analysis and the choice of a remedial alternative; and to minimize the risk of delaying remedial actions on procedural grounds. The primary instrument for DOE's NEPA/CERCLA integration is the RI/FS process, supplemented as needed to meet the procedural and documentation requirements of NEPA.

This RI Report supports the Operable Unit 2 FS, which will evaluate the range of available remedial alternatives (including the no-action alternative) for Operable Unit 2 wastes and certain associated contaminated media. Results of the Operable Unit 2 FS will be reported in a separate document. The remedial alternatives will be evaluated for overall protectiveness of human health and the environment; compliance with applicable or relevant and appropriate requirements (ARARs); long- and short-term effectiveness; reduction of toxicity, mobility, or volume; implementability; cost; and state and community acceptance. As mandated by the 1991 Amended Consent Agreement, the Operable Unit 2 FS will include a Comprehensive Response Action Risk Evaluation (CRARE) to

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evaluate the cumulative residual risks resulting from each operable unit following remediation. The CRARE will include consideration of current and future use scenarios of the FEMP site.

To facilitate public participation in the remedy selection process, a Proposed Plan (PP) for Operable Unit 2 will be issued to the public for comment. The PP will present the proposed remedial action along with a summary of the RI findings and FS results. The PP will include an explanation of the alternatives considered and the preference for the proposed remedial action. After evaluating public comments on the PP, a Record of Decision (ROD) will be prepared to select the final remedial actions and provide a legal and technical basis for the selection actions.

Remaining remedial response activities consist of the RD/RA and O&M. The RD consists of the engineering design and preparation of the engineering drawings and specifications in a bid package for the implementation of the remedy. The RA is the actual implementation of the remedial measures through construction activities. After completion of the RA, any action necessary to ensure the sustained effectiveness of the applied remedy will be performed under the O&M phase.

1.2 HISTORY OF THE FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

The Atomic Energy Commission (AEC), predecessor to the U.S. Energy Research and Development Administration (ERDA) and then DOE, established the FMPC in conformance with AEC orders in the early 1950s. In 1951, National Lead Company of Ohio, Inc., (now NLO) entered into a contract with the AEC as the O&M contractor for the facility. This contract was effective until January 1, 1986.

The contractual relationship between NLO and DOE continued until January 1, 1986. Westinghouse Materials Company of Ohio (WMCO), a wholly-owned subsidiary of Westinghouse Electric Corporation, then assumed management responsibilities for the site operations and facilities. Production ceased in the summer of 1989 due to a decline in uranium metal demand, and plant resources were focused on environmental cleanup activities. In June 1991, the site was officially closed as a federal production facility. Also in 1991, WMCO was renamed the Westinghouse Environmental Management Company of Ohio (WEMCO), and DOE renamed the site to Fernald Environmental Management Project to reflect the change in mission. On December 1, 1992, Fernald Environmental Restoration Management Company (FERMCO) assumed responsibility for the site

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under the first Environmental Restoration Management Contract (ERMC) for DOE. FERMCO is a wholly-owned subsidiary of Fluor Daniel, Inc.

Production operations at the FMPC began in 1951 and were limited to a fenced, 136-acre tract of land known as the Production Area, located near the center of the site (Figure 1-2). The Waste Storage Area was constructed west of the Production Area to dispose of large quantity liquid and solid wastes and includes two of the Operable Unit 2 subunits. Prior to 1984, solid and slurried wastes from site processes were stored or disposed in the Waste Storage Area. Figure 1-3 presents the Waste Storage Area and identifies the battery limits of the Solid Waste Landfill and Lime Sludge Ponds.

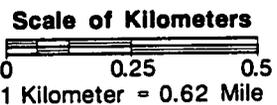
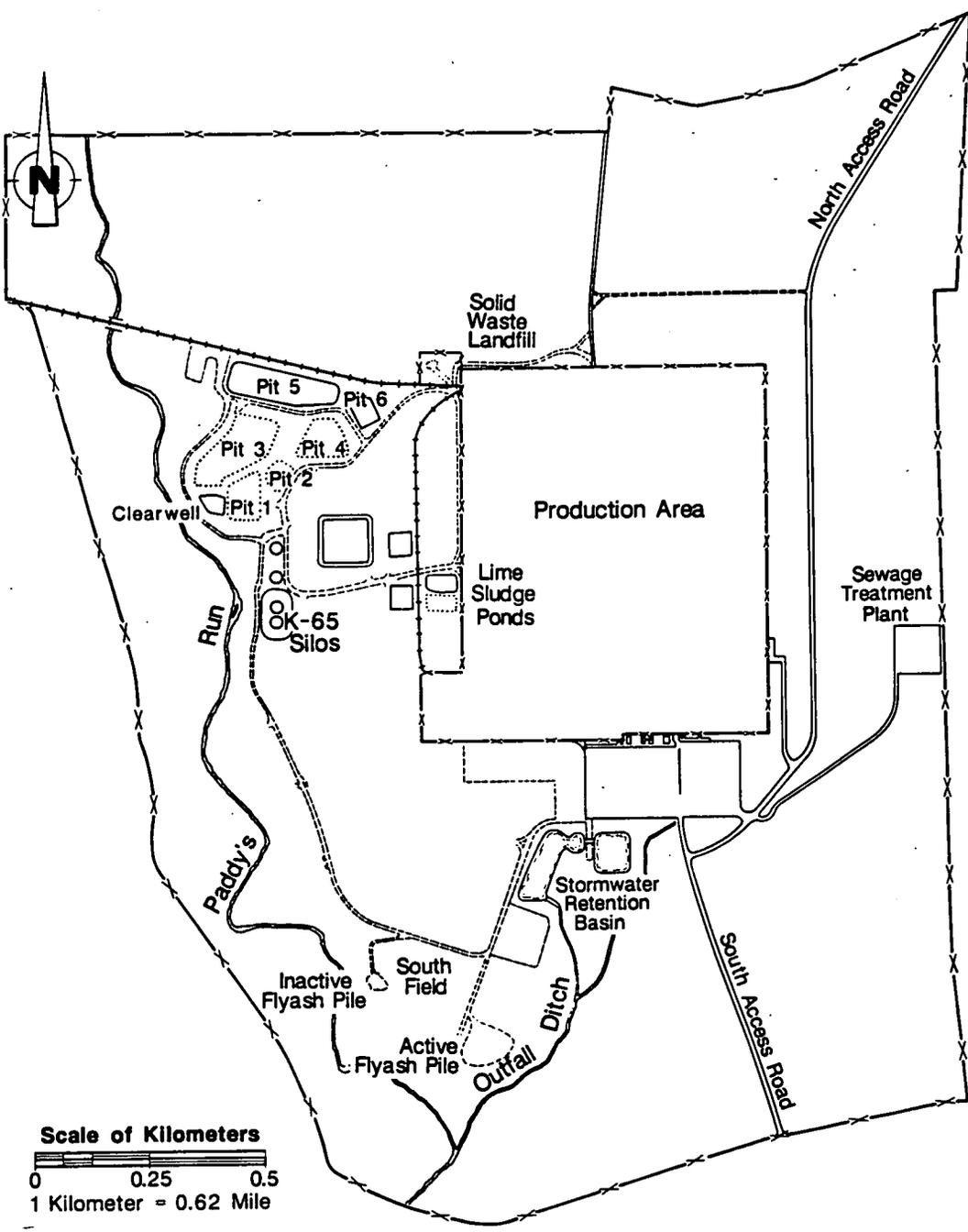
The remaining subunits in Operable Unit 2 are located in an area to the southwest of the former Production Area (Figure 1-2). This area was used to dispose of construction rubble, boiler plant flyash and bottom ash, and other waste. Wastes stored within Operable Unit 2 are believed to be primarily generated from support operations and not from direct uranium production. Battery limits are defined as the boundaries of the investigation for sources contained in the Operable Unit 2 subunits.

1.2.1 FEMP Production Process

The primary mission of the FEMP during its 37 years of operation was the processing of "feed" materials to produce high purity uranium metal, explaining the site's original title, the Feed Materials Production Center. These high purity uranium metals were then shipped to other DOE facilities for use in the nation's weapons program (Figure 1-4). The following discussion is an overview of the production activities and materials handled at the FEMP.

Raw materials at the FEMP consisted of pitchblende ores obtained from mines in the Belgian Congo (an area now known as Zaire) and Australia; uranium concentrates (yellowcake) obtained from uranium mills in Canada and the United States; uranium tetrafluoride (green salt or UF<sub>4</sub>) and uranium hexafluoride (UF<sub>6</sub>) obtained from the DOE gaseous diffusion plants; uranium trioxide (UO<sub>3</sub>) as a slightly enriched recycled material from the DOE Hanford Purex Plant; and recovered uranium-bearing residues from processing operations at the FEMP site and elsewhere. Enriched uranium is defined as uranium that contains a higher percentage of uranium-233 or -235 isotopes than that which occurs in natural uranium.

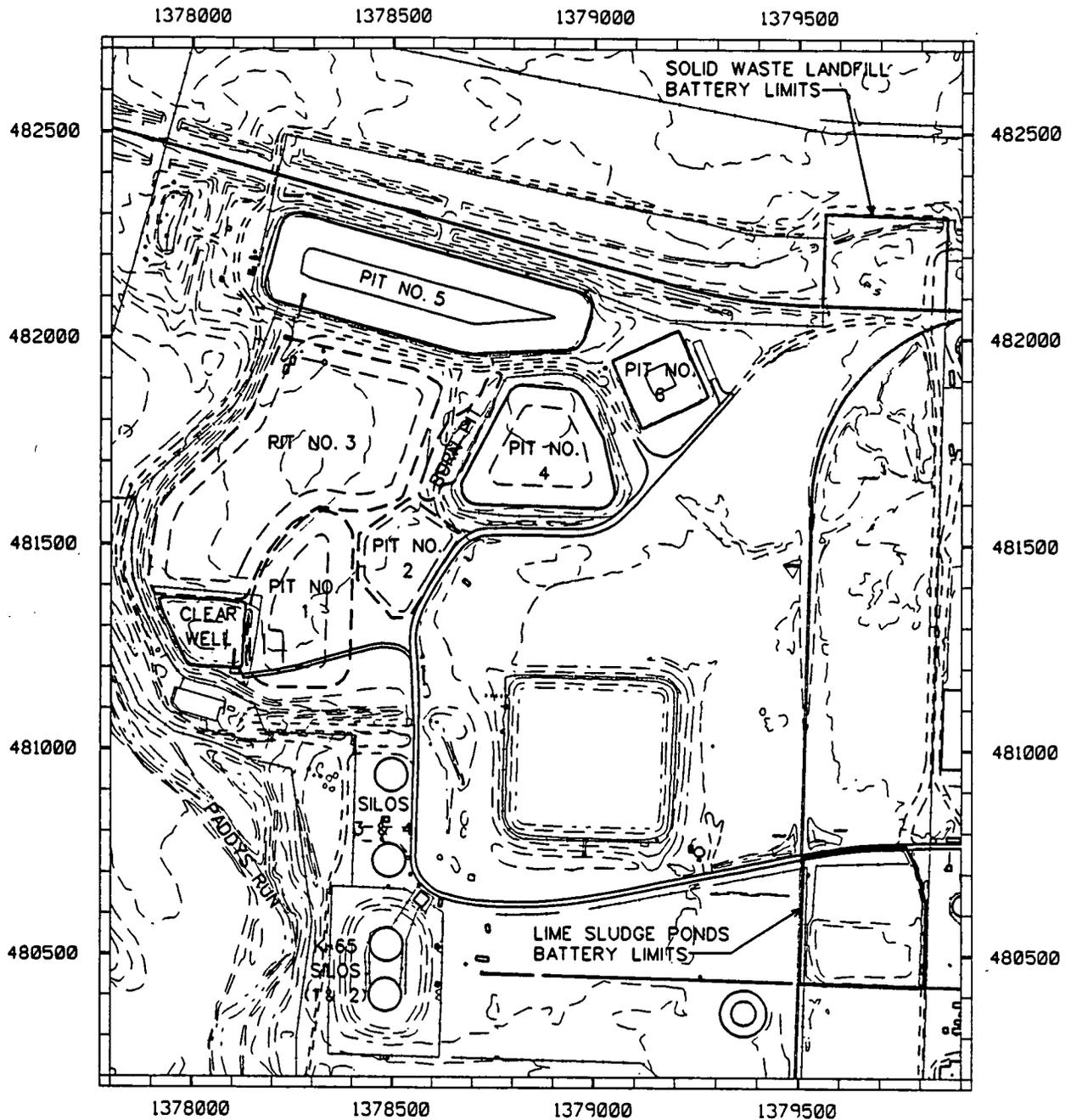
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### LEGEND

- ..... Covered Pit
- + + + Railroad Spur
- x — x Fence
- Roadway

Figure 1-2: FEMP Site Map



**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
- FENCE
- RAILROAD

**NOTE:**  
 Coordinates are in State Planar NAD 1927.  
 Surface contours based on 1992 flyover.

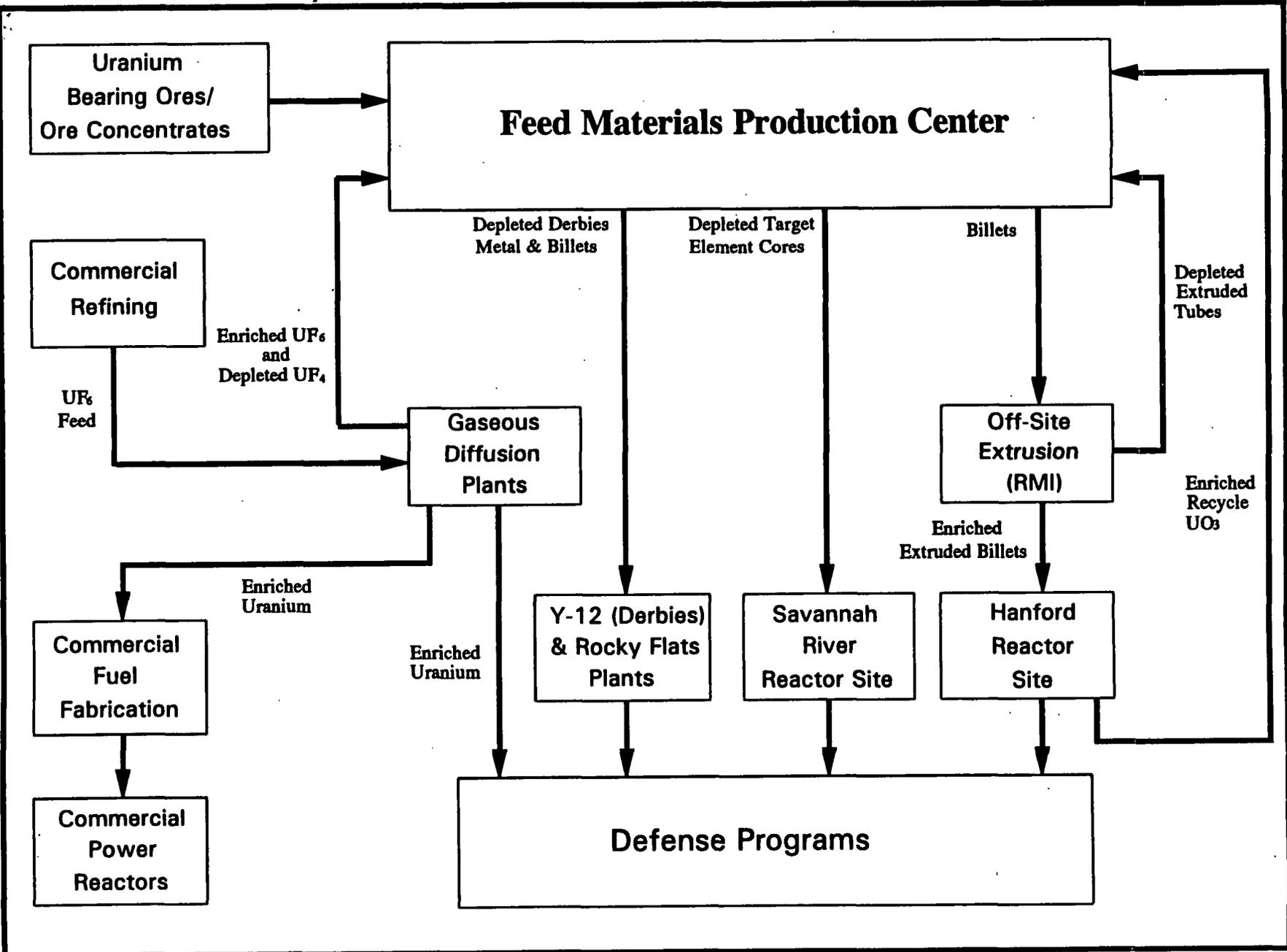
SCALE (FT)

**FIGURE 1-3  
 WASTE STORAGE AREA**

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February 18, 1994

FIGURE 1-4. FMPC URANIUM METAL PRODUCTION FLOW DIAGRAM

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The chemical and metallurgical processes for the manufacture of uranium metal products occurred in seven of the FEMP's more than 50 production, storage, and support buildings. The physical layout of those buildings in the former Production Area is shown in Figure 1-5, and a flow chart of the production process is illustrated in Figure 1-6. Much of the discussion of the refining process and handling of wastes is taken from the following documents and will not be specifically referenced in all instances in the text:

- "Uranium Production Technology" (Harrington and Ruehle 1959)
- "A Closer Look at Uranium Metal Production, A Technical Overview" (WMCO 1988)

Impure starting materials were first introduced into the process through the sampling plant (Plant 1) where they were sampled to determine the uranium concentration and the uranium enrichment status. Impure starting materials were transferred to the refinery (Plant 2/3) where they were dissolved in nitric acid; the uranium was purified through solvent extraction to yield a solution of uranyl nitrate. Uranyl nitrate solution was changed to uranium trioxide (UO<sub>3</sub>) powder by evaporation and denitrification.

Uranium trioxide from Plant 2/3 was transported to the green salt plant (Plant 4) where it was converted to uranium tetrafluoride (UF<sub>4</sub>) by reaction with anhydrous hydrogen fluoride. The UF<sub>4</sub> was then transported to Plant 5 (a metals production plant) where it was blended with magnesium metal granules and placed in a closed refractory-lined steel pot for heating and melting. The resulting product was a 300 to 375 pound piece of pure uranium metal and a by-product, magnesium fluoride slag. The uranium metal had the shape of a gentleman's top hat, or derby.

Some of the derbies were shipped directly to the Y-12 and Rocky Flats Plants. However, most remained in Plant 5 where they were remelted along with uranium scrap-metal from earlier machining operations and poured into graphite molds to form flat or cylindrical ingots. Flat ingots consisted of depleted uranium and were top-cropped, machined into billets, then shipped to Rocky Flats.

The cylindrical ingots consisted of either slightly enriched or depleted uranium. The ingots were center drilled into billets and then sent to Reactive Metals, Incorporated (RMI) in Ashtabula, Ohio. The enriched uranium billets were upset forged, machined, and then shipped to the DOE Hanford site. The depleted uranium billets were extruded into tubes and returned to the FMPC where they were cut into sections, heat treated, and machined to final dimensions. The completed tubes were

finally shipped to the DOE Savannah River site to be used as target element cores. Small amounts of thorium were processed at the FEMP on several occasions from 1954 through 1975. Thorium operations were conducted in Plants 1, 4, 6, 8, and 9, and the Pilot Plant. Although thorium materials are no longer being received for storage, the FEMP serves as the thorium repository for DOE and maintains storage facilities for a variety of thorium materials. Existing thorium inventories have now been declared as waste and are being shipped to DOE's Nevada Test Site (NTS) for disposal.

Production at the FEMP peaked in 1960 at approximately 12,000 metric tons of uranium per year. A product decline began in 1964 and reached a low in 1975 of about 1,230 tons. During the 1970s, consideration was given to closing the FEMP. Thus, capital improvements and staffing were minimized. The staffing level, which peaked at 2,891 personnel in 1956, slowly declined to 662 personnel in 1972 and then to 538 personnel in 1979.

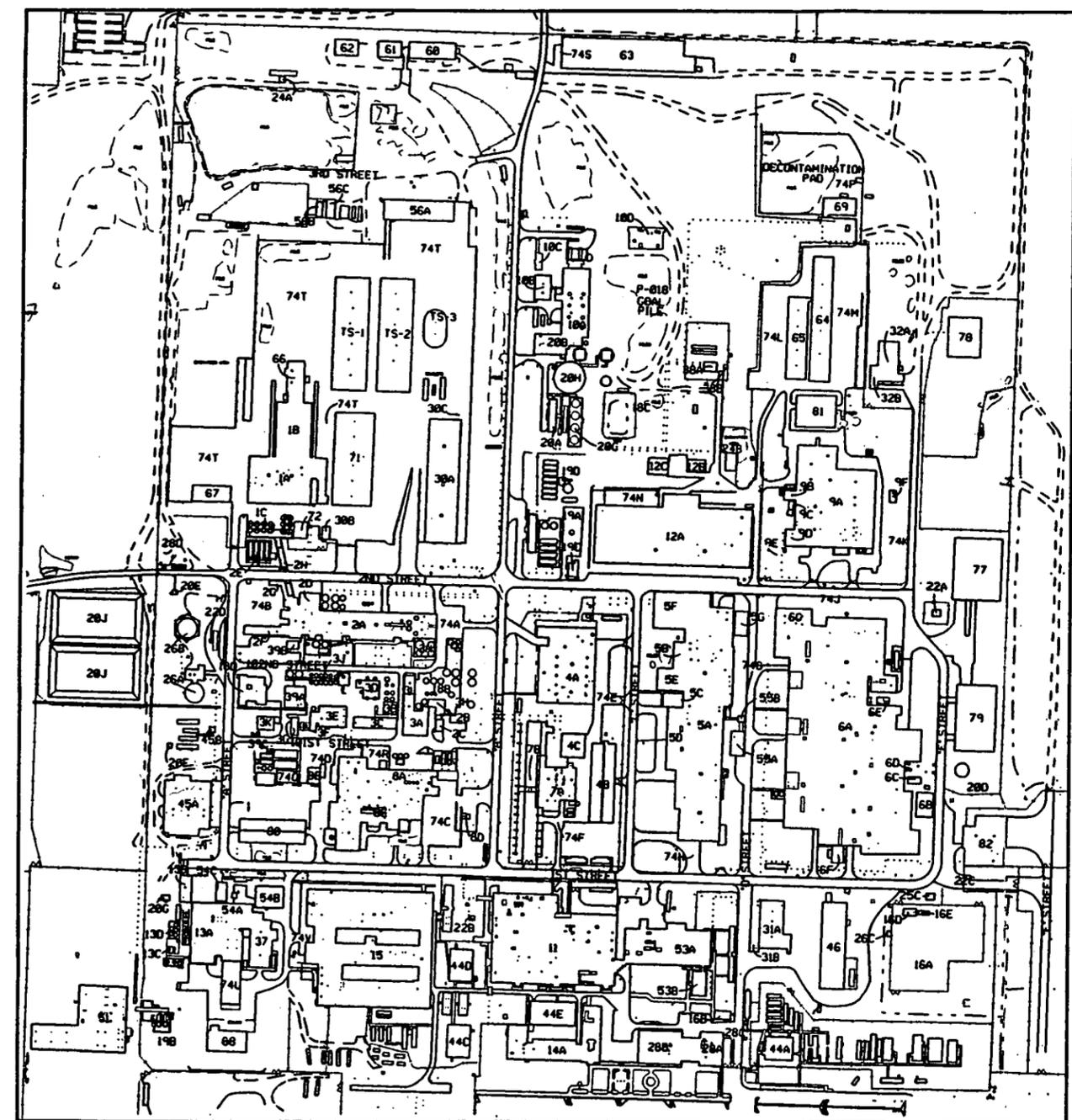
In 1981, the FEMP once again began planning to accommodate increased production requirements. Production levels significantly increased and there was a rapid staff buildup for several years. The renewed need for uranium metal resulted in the implementation of a major facilities restoration program.

1.2.2 FEMP Compliance History

Current environmental investigations and cleanup activities are being directed through the CERCLA process and will meet ARARs. However, many other environmental regulations [e.g., NEPA, Resource Conservation and Recovery Act (RCRA), Clean Water Act (CWA), and Clean Air Act (CAA)] impact site activities. On-site activities will meet the substantive requirements of other regulations without complying with all of the administrative controls. CERCLA activities conducted off site and non-CERCLA on-site activities are required to comply with both the administrative and substantive requirements of the regulations. The following paragraphs describe a chronological history of regulatory events at the FEMP.

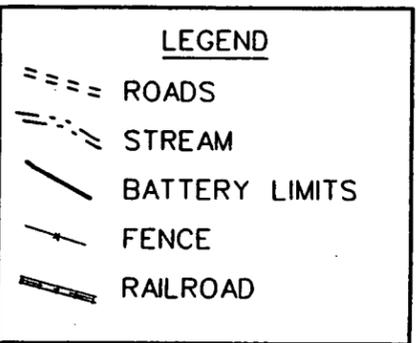
On October 13, 1978, President Carter signed Executive Order 12088 (Federal Compliance with Pollution Control Standards) mandating all DOE facilities to comply with existing environmental statutes and regulations including the CAA, CWA, and RCRA. Consequently, on March 9, 1985, EPA issued a Notice of Noncompliance to DOE identifying potential environmental impacts associated

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FEMP SITE INDEX

- TS-1 TENSION SUPPORT STRUCTURE #1
- TS-2 TENSION SUPPORT STRUCTURE #2
- TS-3 TENSION SUPPORT STRUCTURE #3
- TS-4 TENSION SUPPORT STRUCTURE #4
- TS-5 TENSION SUPPORT STRUCTURE #5
- TS-6 TENSION SUPPORT STRUCTURE #6
- TS-7 TENSION SUPPORT STRUCTURE #7
- TS-8 TENSION SUPPORT STRUCTURE #8
- 9A PREPARATION PLANT
- 9B PLANT 1 STORAGE BLDG.
- 9C PLANT 1 SLAG BLDG.
- 9D ORE REFINERY PLANT
- 9E GENERAL/REFINERY SLURRY CONTROL BLDG.
- 9F BALL MILK HANDLING BLDG.
- 9G METAL DISSOLVER BLDG.
- 9H P-810 COAL PUMP HOUSE
- 9I COAL SIDE ORE CONVEYOR
- 9J HOT SIDE ORE CONVEYOR
- 9K CONVEYOR TUNNEL FROM PLANT 9
- 9L MAINTENANCE BLDG.
- 9M OZONE BLDG.
- 9N MAP CONTROL HOUSE
- 9O HMI TOWER
- 9P NOT RAFFINATE BLDG.
- 9Q MARSHMAN SYSTEM
- 9R REFRIGERATION BLDG.
- 9S REFINERY SUMP
- 9T COMBINED RAFFINATE TANKS
- 9U OLD COOLING WATER TOWER
- 9V ELECTRICAL POWER CENTER BLDG.
- 9W GREEN SALT PLANT
- 9X PLANT 4 WAREHOUSE
- 9Y PLANT 4 MAINTENANCE BLDG.
- 9Z METALS PRODUCTION PLANT
- 10A PLANT 5 INGT. PICKLING
- 10B PLANT 5 ELECTRICAL SUBSTATION
- 10C WEST DERBY BREAK/OUT/SLAG MILLING
- 10D PLANT 5 FILTER BLDG.
- 10E PLANT 5 COVERED STORAGE PAD
- 10F PLANT 5 INGT. STORAGE SHELTER
- 10G METALS FABRICATION PLANT
- 10H PLANT 6 COVERED STORAGE AREA
- 10I PLANT 6 ELECTROSTATIC PRECIPITATOR (SOUTH)
- 10J PLANT 6 ELECTROSTATIC PRECIPITATOR (CENTRAL)
- 10K PLANT 6 ELECTROSTATIC PRECIPITATOR (NORTH)
- 10L PLANT 6 SALT OR HEAT TREAT BLDG.
- 10M SUMP BLDG.
- 10N PLANT 7
- 10O PLANT 7 OVERHEAD CRANE
- 10P RECOVERY PLANT
- 10Q PLANT 8 MAINTENANCE BLDG.
- 10R ROTARY KILN/DROM RECONDITIONING
- 10S PLANT 8 RAILROAD FILTER BLDG.
- 10T DRUM CONVEYOR SHELTER
- 10U PLANT 8 OLD DRUM WASHER
- 10V PLANT 8 SUMP TREATMENT FACILITY
- 10W PLANT 8 DUST COLLECTOR
- 10X PLANT 8 SUBSTATION
- 10Y PLANT 8 SHED
- 10Z PLANT 8 ELECTROSTATIC PRECIPITATOR
- 11A BURNER PLANT
- 11B BURNER PLANT MAINTENANCE BLDG.
- 11C WET SALT STORAGE BLDG.
- 11D CONTAMINATED OR GRANULATE BURN PAD
- 11E UTILITIES HEAVY EQUIP. BLDG. (PROPOSED)
- 11F SERVICE BLDG.
- 11G HMI MAINTENANCE BLDG.
- 11H CYLINDER STORAGE BLDG.
- 11I LUMBER STORAGE BLDG.
- 11J MAINTENANCE BLDG. WAREHOUSE (PROPOSED)
- 11K PILOT PLANT
- 11L PILOT PLANT MAINTENANCE BLDG.
- 11M SUMP PLANT HOUSE
- 11N PILOT PLANT THORIUM TANK FARM
- 11O ADMINISTRATION BLDG.
- 11P BLDG. W/ EOC GENERATOR SET
- 11Q LABORATORY
- 11R LABORATORY CHEMICAL STORAGE BLDG.
- 11S HMI ELECTRICAL STATION
- 11T ELECTRICAL SUBSTATION
- 11U ELECTRICAL PANELS & TRANSFORMER
- 11V HMI ELECTRICAL SWITCH HOUSE
- 11W HMI ELECTRICAL TRANSFORMERS
- 11X TRAILER SUBSTATION #1
- 11Y TRAILER SUBSTATION #2
- 11Z IO PLEX NORTH SUBSTATION
- 12A IO PLEX SOUTH SUBSTATION
- 12B BURN SLURRY LAGOON
- 12C GENERAL SUMP
- 12D COAL PILE RUNOFF BASIN
- 12E BIODEGRADATION TOWERS
- 12F STORM WATER RETENTION BASIN
- 12G PIT #5 SLURRY GATE
- 12H CLEARWELL PUMP HOUSE
- 12I BOW EFFLUENT TREATMENT FACILITY
- 12J METHANOL TANK
- 12K LOW NITRATE TANK
- 12L HIGH NITRATE TANK
- 12M HIGH NITRATE STORAGE TANK
- 12N WASTE PIT AREA STORM WATER RUNOFF CONTROL
- 12O DISSOLVED OXYGEN BLDG.
- 12P IAWWT VALVE HOUSE
- 12Q MAM TANK FARM
- 12R PILOT PLANT AMMONIA TANK FARM
- 12S TANK FARM CONTROL HOUSE
- 12T OLD NORTH TANK FARM
- 12U TANK FARM LIME SLITTER BLDG.
- 12V PUMPTATION & POWER CENTER
- 12W WATER PLANT
- 12X COOLING TOWERS
- 12Y ELEVATED POTABLE STORAGE TANK
- 12Z WELL HOUSE #1
- 13A WELL HOUSE #2
- 13B WELL HOUSE #3
- 13C PROCESS WATER STORAGE TANK
- 13D LIME SLURRY PITS
- 13E GAS METER BLDG.
- 13F STORM SEWER LIFT STATION
- 22C TRUCK SCALE
- 22D SCALE HOUSE & WEIGH SCALE
- 22E UTILITY TRENCH TO PIT AREA
- 22F METEOROLOGICAL TOWER
- 22G RAILROAD SCALE HOUSE
- 22H RAILROAD ENGINE HOUSE
- 22I INFORMATION BLDG.
- 22J HMI #15/STRT LINE/SAMPLING BLDG.
- 22K SEWAGE LIFT STATION BLDG.
- 22L DYE/ST & CONTROL BLDG.
- 22M U.V. DISINFECTION BLDG.
- 22N DEESTER & CONTROL BLDG.
- 22O SLUDGE DRYING BEDS
- 22P PRIMARY SETTLING BASINS
- 22Q TRICKLING FILTERS
- 22R IO PLEX SEWAGE LIFT STATION
- 22S PUMP HOUSE-HP FIRE PROTECTION
- 22T ELEVATED WATER STORAGE TANK
- 22U MAM ELECTRICAL STRAINER HOUSE
- 22V MAM ELECTRICAL BLDG.
- 22W HMI/MAM RESOURCE BLDG.
- 22X GUARD POST ON SOUTH END OF "D" STR.
- 22Y GUARD POST ON WEST END OF "2K" STR.
- 22Z CHEMICAL WAREHOUSE
- 30A DRUM STORAGE WAREHOUSE
- 30B OLD TEN TON SCALE
- 30C ENGINE HOUSE/GARAGE
- 30D OLD TRUCK SCALE
- 30E MAGNESIUM STORAGE BLDG.
- 30F BLDG. #3 COVERED LOADING DOCK
- 30G K-65 STORAGE TANK (NORTH)
- 30H K-65 STORAGE TANK (SOUTH)
- 30I RTS BLDG.
- 30J METAL OXIDE STORAGE TANK (NORTH)
- 30K METAL OXIDE STORAGE TANK (SOUTH)
- 30L PILOT PLANT ANNEX
- 30M PILOT PLANT STORAGE
- 30N CYLINDER FILLING STATION
- 30O INCINERATOR BLDG.
- 30P WASTE OR DECONTAMINATION SHELTER
- 30Q INCINERATOR SPRINKLER RISER HOUSE
- 30R SEWAGE TREATMENT PLANT INCINERATOR
- 30S TRAILER COMPLEX (17-FLEX S)
- 30T TRAILER COMPLEX (17-FLEX S)
- 30U TRAILER COMPLEX (17-FLEX N)
- 30V TRAILER COMPLEX (10-FLEX)
- 30W RUST ENGINEERING BLDG.
- 30X UTILITY SHED EAST OF RUST TRAILERS
- 30Y HEAVY EQUIPMENT BLDG.
- 30Z SO TO FOUR REDUCTION FACILITY #2
- 31A HEALTH & SAFETY BLDG.
- 31B HMI BLDG.
- 31C SO TO FOUR REDUCTION FACILITY #1
- 31D PILOT PLANT SHELTER
- 31E PILOT PLANT DISSOCIATOR SHELTER
- 31F SLAG RECYCLING BLDG.
- 31G SLAG RECYCLING PIT/ELEVATOR
- 31H CP STORAGE WAREHOUSE
- 31I STORAGE SHED (WEST)
- 31J STORAGE SHED (EAST)
- 31K BURNER HUT #1
- 31L OLDEST HUT #2
- 31M OLDEST HUT #3
- 31N EC-1 THORIUM WAREHOUSE
- 31O THORIUM WAREHOUSE
- 31P OLD PLANT 3 WAREHOUSE
- 31Q DRUM RECONDITIONING BLDG.
- 31R PLANT 1 THORIUM WAREHOUSE
- 31S PILOT PLANT WAREHOUSE
- 31T DECONTAMINATION BLDG.
- 31U GENERAL M-PROCESS WAREHOUSE
- 31V DRUM STORAGE BUILDING
- 31W BRONZE TRAINING CENTER BLDG.
- 31X FIRE TRAINING PAD
- 31Y FIRE TRAINING TANK
- 31Z FIRE TRAINING BURN TROUGH
- 32A COMPOUND SPACE BURN TANK
- 32B PLANT 2 EAST PAD
- 32C PLANT 2 WEST PAD
- 32D PLANT 3 EAST PAD
- 32E PLANT 3 WEST PAD
- 32F PLANT 4 PAD
- 32G PLANT 5 EAST PAD
- 32H PLANT 5 SOUTH PAD
- 32I PLANT 6 PAD
- 32J BUILDING 65 WEST PAD
- 32K BUILDING 6 EAST PAD & R.R. DOCK
- 32L BUILDING 12 NORTH PAD
- 32M DECONTAMINATION PAD
- 32N PLANT 8 OLD METAL DISSOLVER PAD
- 32O PLANT 8 NORTH PAD
- 32P BUILDING 63 WEST PAD
- 32Q PLANT 1 STORAGE PAD
- 32R PILOT PLANT PAD
- 32S LABORATORY PAD
- 32T INCINERATOR BLDG. PAD
- 32U FINISHED PRODUCTS WAREHOUSE (44A)
- 32V D & D BUILDING
- 32W PLANT 6 WAREHOUSE
- 32X PLANT 9 WAREHOUSE
- 32Y PLANT 9 WAREHOUSE
- 32Z RECEIVING/STORAGE MATLS. DEP.
- 33A CLEARWELL LINE
- 33B PARKING LOTS
- 33C INTERM OFFICE SPACE
- 33D INTERM OFFICE SPACE
- 33E INTERM OFFICE SPACE
- 33F INTERM OFFICE SPACE



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

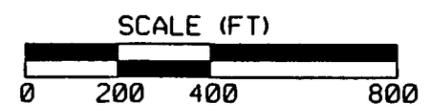


FIGURE 1-5  
FORMER PRODUCTION  
AREA LAYOUT

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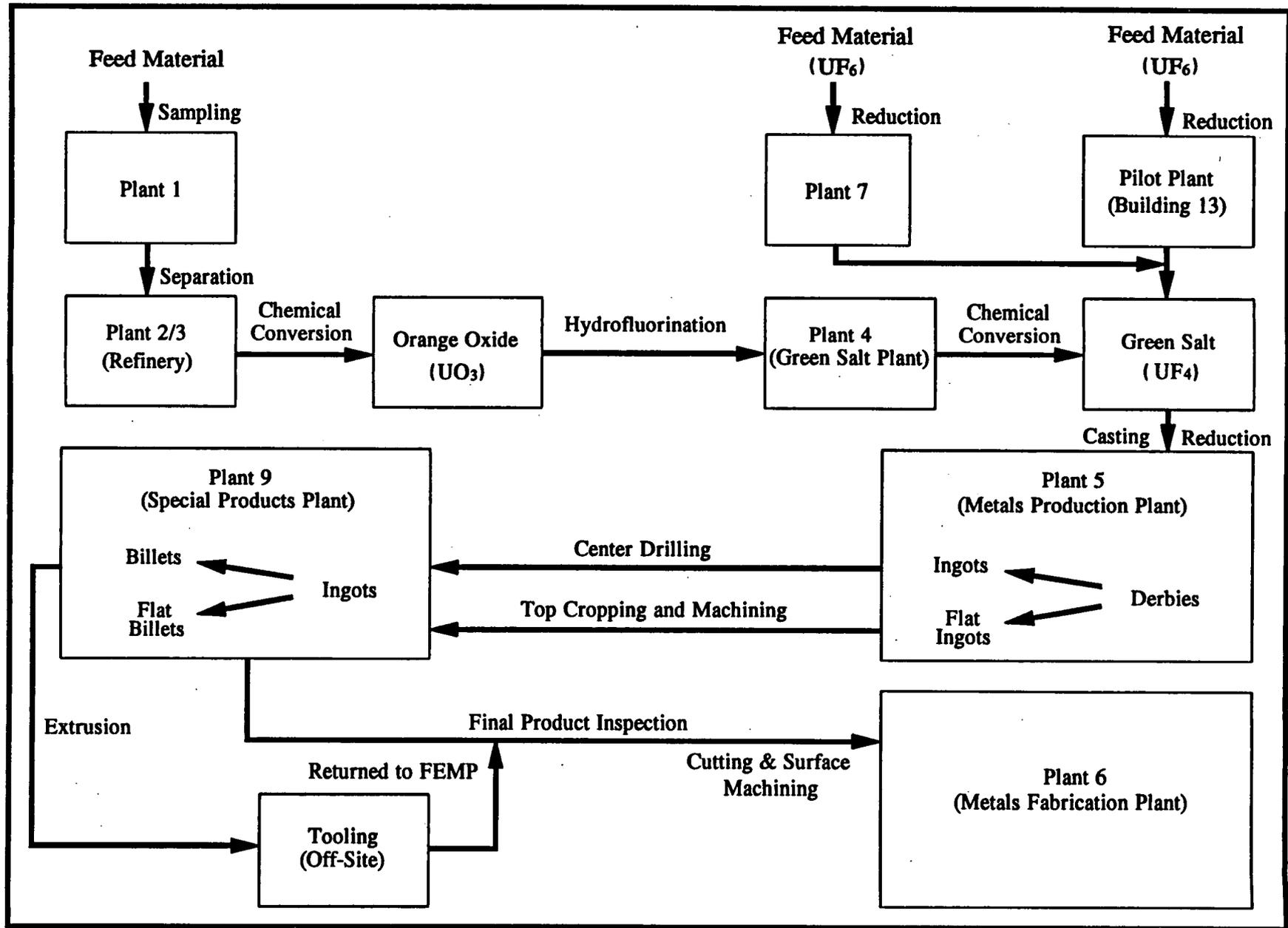


FIGURE 1-6 URANIUM METAL REFINEMENT PROCESS DIAGRAM

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with the FEMP's past and ongoing operations. Between April 1985 and July 1986, conferences were held between DOE and EPA representatives to discuss the issues and to identify steps to achieve and maintain environmental compliance.

A groundwater detection monitoring program for Waste Pit 4, an Operable Unit 1 area located in the Waste Storage Area, was initiated in August 1985 pursuant to the substantive and administrative RCRA, Subtitle C groundwater monitoring requirements. The detection monitoring program was required because of the disposal of a hazardous waste, barium salts, in Waste Pit 4 after 1980.

On July 18, 1986 a Federal Facility Compliance Agreement (FFCA), detailing actions to be taken by DOE to assess environmental impacts associated with the FEMP, was jointly signed by DOE and EPA. The FFCA was entered into to ensure compliance with existing environmental statutes and regulations. In particular, the FFCA required DOE to thoroughly and adequately investigate past and continuing activities at the FEMP to formulate, assess, and implement appropriate remedial response actions. In response to the FFCA, a RI/FS was initiated pursuant to CERCLA as defined by the National Oil and Hazardous Substances Pollution Contingency Plan, known as the National Contingency Plan (NCP), and amended by the 1986 Superfund Amendment and Reauthorization Act (SARA). The FEMP developed a CERCLA RI/FS Work Plan, Quality Assurance Project Plan, Health and Safety Plan (DOE 1987a), a RCRA Assessment Monitoring Plan for groundwater (DOE 1987b), and RCRA Part A (DOE 1984) and B (DOE 1985) permit applications.

The Ohio Environmental Protection Agency (OEPA) brought suit against the DOE on March 11, 1986 for alleged violations of state RCRA and CWA regulations. The suit was settled when DOE entered into a Consent Decree with the State of Ohio on December 2, 1988. The Consent Decree outlined specific actions necessary to attain compliance with RCRA and CWA regulations, including characterization and proper management of hazardous waste, groundwater monitoring of RCRA regulated units, and control of wastewater discharges and storm water runoff.

The FEMP was added to the NPL on November 21, 1989 [54 Federal Register (FR) 48184]. On June 29, 1990, a Consent Agreement (the 1990 Consent Agreement), amending the 1986 FFCA, was signed by the DOE and EPA. The agreement included continued compliance with the FFCA, the division of the site into five operable units, and an outline of activities and schedules for the RI/FS and ROD for each operable unit in accordance with the requirements of Sections 106(a) and 120 of

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CERCLA. The 1990 Consent Agreement was revised in September 1991 to address additional environmental issues and revise the CERCLA schedules. The revised Consent Agreement is referred to as the 1991 Amended Consent Agreement.

In December 1990, amendments were proposed to update the Consent Decree of 1988 to reflect the new agreement between EPA and DOE (i.e., the 1990 Consent Agreement) and to resolve compliance issues raised by the OEPA. The Stipulated Amended Consent Decree was signed on January 22, 1993.

The 1991 Amended Consent Agreement was modified on April 9, 1993 by an agreement between EPA and DOE resolving a dispute concerning EPA's denial of DOE's request for an extension of time to submit Operable Unit 2 documents. This agreement established new schedules extending the submittal dates of the Operable Unit 2 RI, FS/PP, and draft ROD, and also accelerated Operable Unit 1, Operable Unit 3, and Operable Unit 5 draft ROD submission dates by 30 days each.

A Notice of Intent to prepare an Environmental Impact Statement (EIS) for the FEMP RI/FS was published in the Federal Register (55 FR 20183, May 15, 1990). In this notice, it was proposed that:

- An RI/FS-EIS is the appropriate level of NEPA documentation for the "lead" operable unit, (i.e., Operable Unit 4).
- NEPA/CERCLA integration will be provided in the remaining operable unit RI/FS-NEPA reports. These documents will reference the lead RI/FS-EIS and will present impacts specific to the operable units and update site-wide and cumulative impacts as necessary.

As identified in the Notice of Intent, the FS and PP for the earliest scheduled operable unit, Operable Unit 4, will be issued as an FS/PP-EIS. The FS/PP-EIS will examine the environmental impacts associated with Operable Unit 4 remedial activities as well as the cumulative impacts (Operable Unit 4 FS/PP-EIS, Appendix I) associated with the implementation of remedial actions for all five operable units at the FEMP. An additional element of NEPA compliance is the FEMP Site-Wide Characterization Report (DOE 1993), which supplements the Operable Unit 4 FF/PP-EIS by providing an assessment of cumulative environmental impacts associated with the existing conditions at the FEMP on a site-wide basis.

The Operable Unit 2 FS and PP will be coordinated with the Operable Unit 4 FS/PP-EIS for purposes of NEPA integration. The cumulative impact analysis presented in the Operable Unit 4 EIS will be updated and included in the Operable Unit 2 FS/PP-EA as Appendix G. The Operable Unit 2 RI Report will be incorporated by reference in the Operable Unit 2 FS and PP. This RI Report includes the characterization of Operable Unit 2 and, hence, will support the necessary description of the affected environment in the Operable Unit 2 NEPA evaluation. This report also provides the Baseline Risk Assessment that will support the evaluation of the no-action alternative for Operable Unit 2.

1.3 FEMP OPERABLE UNITS

To promote a more structured and expeditious cleanup of the FEMP, the facility and related environmental issues have been partitioned into five study areas called operable units. An operable unit is a definition to logically group similar environmental issues at a cleanup site. FEMP operable unit study areas are depicted in Figure 1-7. Separate RI/FS documentation is being issued for each of the five operable units at the FEMP.

FEMP operable units are as follows:

- Operable Unit 1 - Waste Pit Area
- Operable Unit 2 - Other Waste Units
- Operable Unit 3 - Former Production Area
- Operable Unit 4 - Silos 1-4
- Operable Unit 5 - Environmental Media

Operable Unit 1 consists of on-site facilities that were used during uranium production for storage of low-level radioactive waste. The operable unit covers approximately 37 acres in the Waste Storage Area and consists of:

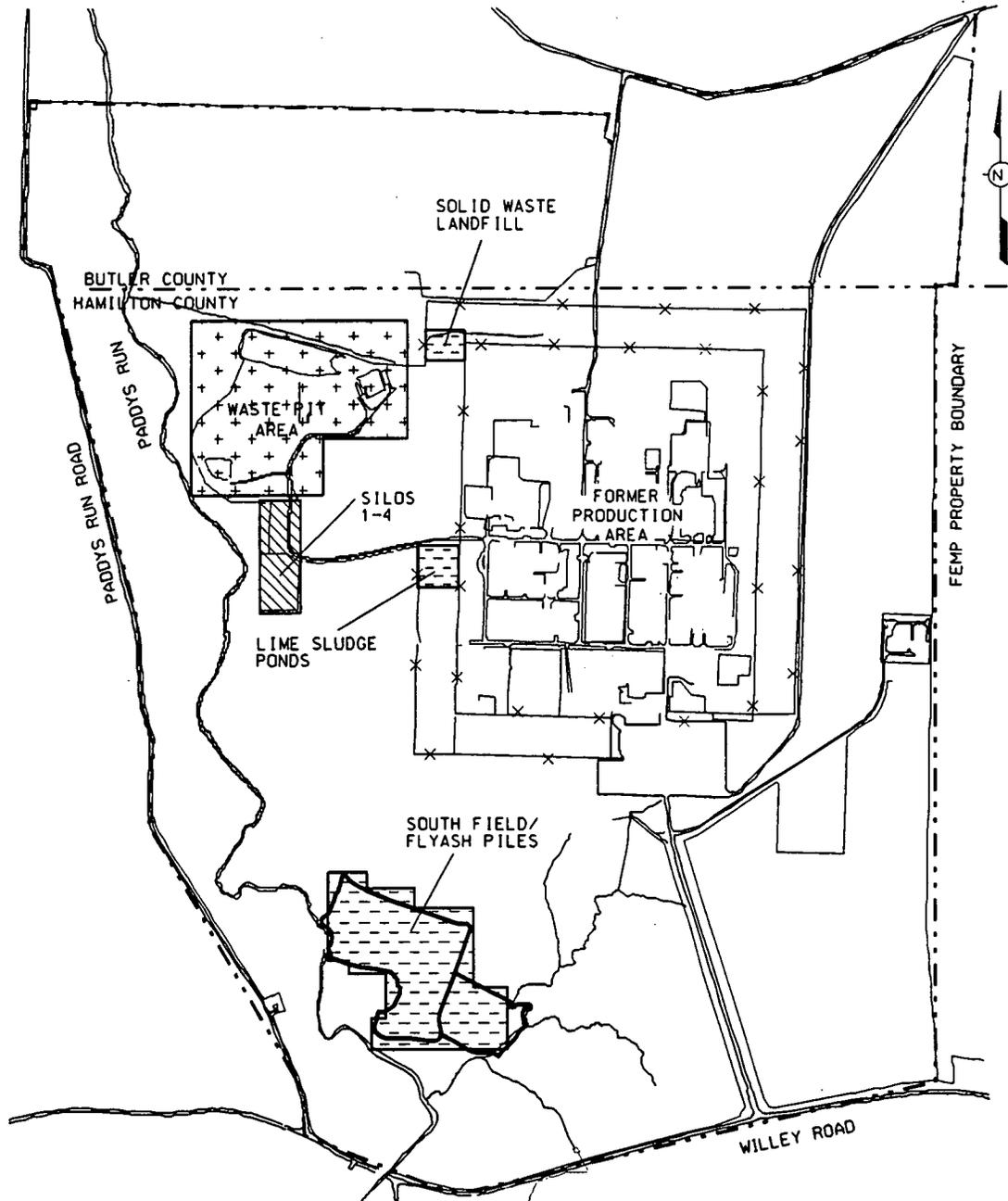
- Waste Pits 1 through 6
- Waste pit liners
- Berms
- The Clearwell
- The Burn Pit

Waste Pits 1 through 6, located west of the former Production Area, contain a variety of liquid and solid wastes that were generated by the eight separate operations plants at the site. Pits 1 through 4 are covered with earth, and Pits 5 and 6 are covered with water. The Clearwell was a settling pond, and the Burn Pit contains residue from burned refuse.

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**LEGEND**

-  OPERABLE UNIT 1
-  OPERABLE UNIT 2
-  OPERABLE UNIT 4

**NOTE**

OPERABLE UNIT 3 INCLUDES ALL BUILDINGS, PIPELINES, AND ABOVEGROUND STRUCTURES IN THE FORMER PRODUCTION AREA. OPERABLE UNIT 5 INCLUDES GROUNDWATER, SURFACE WATER, SOILS, SEDIMENTS, FLORA AND FAUNA IN THE REGIONAL AREA AS WELL AS THE FORMER PRODUCTION AREA.

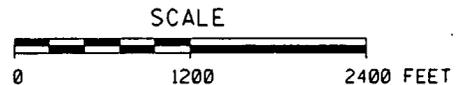


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FIGURE 1-7  
RI/FS OPERABLE UNITS

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Operable Unit 2 consists of those facilities used for the storage or disposal of solid wastes from the nonprocess site operations. These waste subunits are:

- Solid Waste Landfill
- North and South Lime Sludge Ponds
- Inactive Flyash Pile
- South Field
- Active Flyash Pile
- Berms, liners, and soils within the Operable Unit 2 boundary

These waste subunits are discussed in detail in Section 1.3 and throughout this report.

Operable Unit 3 includes all plants and facilities that were involved in producing uranium metal products and in processing thorium for other DOE programs. The former Production Area and production-associated facilities and equipment (includes all above-grade improvements) included in

Operable Unit 3 are:

- |                            |                                   |
|----------------------------|-----------------------------------|
| • All structures           | • Equipment                       |
| • Utilities                | • Drums                           |
| • Tanks                    | • Solid waste                     |
| • Waste                    | • Effluent lines                  |
| • K-65 slurry line         | • Wastewater treatment facilities |
| • Fire training facilities | • Thorium                         |
| • Scrap metal piles        | • Feedstocks                      |
| • Coal pile                | • Product                         |

Operable Unit 4 is defined as the geographic area that includes:

- The two K-65 silos (Silos 1 and 2)
- The metal oxide silo (Silo 3)
- The empty Silo 4
- The decant sump system
- The buried transfer trench
- Soils and perched water that lie above the Great Miami Aquifer within the Operable Unit 4 boundary.

Operable Unit 4 is partially fenced and bounded by an exclusion zone that surrounds Silos 1 and 2 and extends to the north, towards Silo 3. Silos 1 and 2 are concrete storage structures that contain radium-bearing residues from past DOE operations. Silo 3 received only dry materials that are primarily metal oxides. Silo 4 was never used and, therefore, is not considered to be a past, current, or future source of contaminant release to the environment.

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Operable Unit 5 consists of environmental media that can serve as pathways for transporting contaminants. The environmental media that make up Operable Unit 5 are:

- Soils
- Flora and fauna
- Surface water and sediments
- Groundwater (including perched groundwater)

Soils not addressed in the other operable units will be considered as part of this operable unit. Investigations into the flora and fauna include terrestrial vegetation and animals, aquatic communities in the Great Miami River and Paddys Run, locally grown produce and crops, and cattle grazing on potentially affected land areas.

Surface water channels included in Operable Unit 5 are the Great Miami River, Paddys Run, and the Storm Sewer Outfall Ditch. The Great Miami Aquifer underlying the facility is a major source of drinking water and has been declared a sole-source aquifer by EPA Region V (53 FR 25670).

1.4 FEMP OPERABLE UNIT INTERFACES

The RIs for each operable unit will determine the current and future impacts that the respective waste units have on the environment and the risk posed to human health from those impacts. The RI activities for Operable Units 1 through 4 are specific and not directly related to other operable unit activities. The Operable Unit 5 RI will assess the impacts of site production operations on environmental media; its RI activities are coordinated with the RI/FS activities related to other operable units.

The Operable Unit 2 RI characterizes the nature and extent of contamination in environmental media within the five subunits (Section 4.0). Impacts to perched water and the Great Miami Aquifer from waste subunit releases are presented. Data pertaining to physical and chemical characterization of environmental media outside Operable Unit 2 are presented and discussed as necessary to define the nature and extent of contamination within Operable Unit 2. The Operable Unit 5 RI will determine the full nature and extent of contaminants in the Great Miami Aquifer and in soils outside the battery limits (boundaries that define an area of responsibility) of the Operable Unit 2 waste subunits.

The Operable Unit 2 RI has investigated the fate and transport of constituents in air, surface water, and groundwater released from its waste subunits to determine exposure levels for risk assessment.

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The fate and transport assessment (Section 5.0) includes analysis of contaminant migration to off-site receptors. The Operable Unit 5 RI will determine transport of constituents from site-wide to off-site receptors. A complete assessment of fate and transport of constituents in air, surface water, and groundwater at the FEMP will be reported in the Operable Unit 5 RI Report.

The Operable Unit 2 Baseline Risk Assessment (presented in Appendix B and summarized in Section 6.0) addresses only the risks to human health associated with the waste subunits within Operable Unit 2. Risks due to waste material and associated contamination in groundwater, surface water, sediment, and soil are considered. All risks due to existing groundwater contamination outside the Operable Unit 2 battery limits will be evaluated as part of the Operable Unit 5 RI/FS.

Ecological risks are not addressed in the Operable Unit 2 Baseline Risk Assessment. Baseline ecological risks for the Fernald site will be addressed in the Site-Wide Ecological Risk Assessment to be submitted as part of the Operable Unit 5 RI/FS. The site-wide ecological risk assessment will address only on-site and off-site areas not likely to be remediated on the basis of human health concerns. Since significant areas within Operable Unit 2 are likely to be remediated based on human health concerns, ecological risks are not evaluated in the Operable Unit 2 RI. However, the FS/PP-EA will contain a qualitative evaluation of residual ecological risks associated with Operable Unit 2 as agreed to by the U.S. EPA in their concurrence with the Ecological Risk Assessment Strategy (Sarc to Craig, October 1993).

## 1.5 PREVIOUS REGIONAL INVESTIGATIONS AND SITE MONITORING

Numerous environmental investigations have been conducted in and around the FEMP site by DOE and other organizations. During operation of the FEMP, air, groundwater, surface water, soil, and biota were routinely monitored. The following paragraphs describe the data from these previous activities that were used for scoping the RI/FS and preparing the RI/FS Work Plan. Because of data quality and validation issues, the historical data have been used as general information for screening and support of nature and extent but will not be used directly in support of fate and transport modeling or risk assessment.

### 1.5.1 Meteorological Monitoring

The Miami Conservancy District has collected precipitation records for the Miami River Valley since the early 1900s (Houck 1921). Meteorological records have also been collected at the

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Cincinnati/Northern Kentucky International Airport since 1975. The FEMP installed a 60 meter meteorological tower on site and southwest of the former Production Area in 1986 to collect site specific meteorological data.

Meteorological records for regional and site specific weather patterns are comprehensive and provide suitable information for the Operable Unit 2 RI. Meteorological records have been used in surface water evaluations, air transport modeling, and hydrogeologic assessments.

### 1.5.2 Surface Soil Investigation

During 1986 and 1987, a Characterization Investigation Study (CIS) was performed at the FEMP site. The CIS involved the investigation of the FEMP waste storage areas, including the Operable Unit 2 Study Area and the area surrounding the flyash piles. During the CIS, samples were collected from the waste units, surrounding surface soils, and drainages leading to Paddys Run. The surface soil sample results from the samples collected during the CIS have been used in a supplementary manner to evaluate the nature and extent of contamination in Operable Unit 2.

### 1.5.3 Geologic Investigations

Geologic investigations of the area that surrounds and includes the FEMP site have contributed substantial information to the RI/FS investigation. Fenneman (1916) performed an extensive survey of the geology in the Cincinnati area. This report is among the first that describes in detail the interbedded limestone and shale bedrock and its mantle of glaciofluvial and alluvial sediments that constitute the buried-channel aquifers in southwestern Ohio. Later investigators such as Durrell (1961) supported Fenneman's observations.

The shape of the buried-channel aquifer was further refined by Watkins and Spieker (1971) via geophysical surveys of the area around the Fernald site. More recent information includes various maps of the geology of Hamilton and Butler Counties, Ohio, as well as individual quadrangle maps of areas located in those counties (Leow 1985; Vormelker 1985; Ford 1974; Swinford in preparation). Maps showing the extent and age of glacial till in the Operable Unit 4 Study Area have also been produced (Brockman 1988). The Soil Conservation Service (USDA 1980, 1982) has performed detailed soil surveys of Butler and Hamilton counties in Ohio, including the environs of the FEMP site.

The previous geologic studies have provided an adequate regional geological evaluation for the FEMP site. The Operable Unit 2 RI utilized the previous studies to develop the regional and site-wide geology and to guide more detailed geologic investigations of the Operable Unit 2 waste subunits.

1.5.4 Surface Water and Sediment Investigations

The Miami Conservancy District has kept runoff records for the Miami River Valley since the early 1900s (Houck 1921). Flood information for the Great Miami River and Paddys Run is available from the Federal Emergency Management Agency (FEMA 1982). Additional information on the Great Miami River has been well documented with respect to flow duration and water quality (Cross and Hedges 1959; OEPA 1982).

Flow from the Great Miami River drainage basin is monitored by the U.S. Geological Survey (USGS) using a gaging station on the Great Miami River at Hamilton, Ohio. Flow regulation on the Great Miami River has been studied by Spieker (1968a); Paddys Run data have been compiled by Dames and Moore (1985a). Realignments and other modifications of Paddys Run and its tributaries on the FEMP site have been documented by Dove (1961) and WMCO (1987). Surface water quality data have been collected for the FEMP area for the period 1950 through the present as part of the site environmental monitoring program. The OEPA collected water quality data during the period 1977 through 1983.

In 1986, the FEMP performed a comprehensive radiological survey of the sediment in Paddys Run. The survey included a walkover scan, with hand-held radiation detection instrumentation, of the creek bed from above the facility to the confluence of the creek with the Great Miami River. Sediment samples were collected and analyzed at points in the creek bed displaying elevated radiological readings.

In 1988, under the terms of a Director's Findings and Orders issued by the State of Ohio, further sampling was performed. Samples were collected from a series of drainage ditches and storm water manholes on the FEMP property.

Previous surface water investigations provided sufficient information to develop regional data for use in the Operable Unit 2 RI Report. Additional studies required to support the Operable Unit 2 RI

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include an evaluation of the 100-year and 500-year floodplain of Paddys Run. The floodplain evaluation for Paddys Run was completed in October 1993.

#### 1.5.5 Hydrogeologic Investigations

Dove (1961) and Spieker (1968a) described the general hydrology and hydrogeology of the Great Miami Aquifer in the lower Great Miami River Valley. These studies document recharge rates, permeabilities of various lithologies, and other aquifer characteristics. These studies also discussed groundwater and surface water interactions, specifically for the Great Miami River and Paddys Run. Other studies of the regional valley-fill aquifer in the vicinity of the FEMP site include a study by the Miami Conservancy District (1985), several studies by the Ohio Department of Natural Resources (Walker 1986; Walton and Schaefer 1956), and various contracted studies (GeoTrans 1985; Dames and Moore 1985a; ATEC Associates, Inc. 1982). Two other studies by Spieker (1968b and 1868c) deal with the potential effects of increased groundwater pumping and future development of the groundwater resources, respectively. The Miami Conservancy District (1992) also performed a study on the effects of FEMP pumping centers on the Great Miami Aquifer.

The Operable Unit 2 RI used the referenced information to develop the regional and site-wide hydrogeology. The operable unit-specific hydrogeologic properties of the vadose zone and perched groundwater above the Great Miami Aquifer were not a focus of previous studies, and Operable Unit 2 RI activities were developed to address the characterization of the geologic formations in Operable Unit 2. Also, the Operable Unit 2 RI activities collected new hydrogeologic information to supplement previous findings.

#### 1.5.6 Vegetation and Wildlife Studies

Vegetation and wildlife in the FEMP Study Area have been studied and characterized by NLO/DOE, WEMCO, and OEPA. Battelle (1977) performed an environmental impact assessment for the DOE that included impacts on terrestrial and aquatic ecosystems. WMCO performed two studies of the fish that are indigenous to Paddys Run and the Great Miami River in the vicinity of the FEMP site (WMCO 1986, 1987). The OEPA performed a comprehensive study (1982) of the aquatic environment in the Great Miami River. A survey study by Facemire et al. (1990), under contract to WMCO, described the general terrestrial and aquatic environments of the FEMP site and surrounding areas. The database compiled in the Facemire study is the most complete characterization of the

environmental resources available and will be used along with the other referenced sources in the Operable Unit 5 ecological baseline risk assessment.

1.5.7 Environmental Monitoring

Environmental monitoring has been conducted at the FEMP site since the late 1950s as part of ongoing efforts at the facility to protect the health and safety of nearby residents. The monitoring entailed a broad range of activities related to analytical sampling of surface water, sediment, groundwater, soils, and air. These activities have been identified over the years in response to the changing requirements of the facility and evolving regulations.

Water sampling and uranium analysis of the Great Miami River and Paddys Run have been conducted since 1955. Beginning in 1974, sediment was sampled and analyzed for uranium in the Great Miami River and on-site locations in Paddys Run and the Storm Sewer Outfall Ditch. Off-site sediment sampling in Paddys Run was first conducted in 1985.

Groundwater monitoring has been performed since the early 1960s. Monitoring from 1960 through 1980 focused primarily on detecting contaminants that may affect the quality of the site production wells. Groundwater monitoring expanded during the 1980s to include monitoring for off-site contamination and home-owner well water quality. A continuous sampling and analysis program to comply with the requirements of RCRA was initiated in 1985. Soil sampling for total uranium has been performed on and off site since 1970. The focus of this sampling was to determine air deposition from production operations.

Gummed-film testing of airborne deposition was conducted on site from 1952 to 1965. This testing was used to determine uranium deposition from air as a function of distance from the center of the Production Area. Environmental monitoring for direct radiation and airborne radionuclide concentrations has been conducted at the boundaries of the FEMP site beyond the facility property since the 1950s. Prior to 1958, samples from off-site locations were taken infrequently for short periods of time. Samples were routinely obtained at the perimeter of the Production Area from 1958 through 1971. In 1971, site property boundary stations were established. In the mid-1980s, permanent air monitoring stations at off-site locations were established.

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During the period of January 1985 through 1988, the Ohio Department of Health (ODH), through a cooperative agreement with DOE, conducted a special environmental monitoring program on and around the FEMP site (ODH 1988). The program included the collection of more than 300 water samples from area wells, cisterns, and surface waters including ponds; 34 soil samples; the measurement of direct radiation levels at 40 locations; and measurement of environmental radon at 16 on-site locations and 25 off-site locations.

The results of environmental monitoring conducted at the FEMP site were collected and stored in site records whenever possible. Environmental monitoring data have been used for contamination studies such as the site Annual Environmental Report, currently known as the Site Environmental Report. Discussions of the environmental monitoring program data sets utilized in the description of the nature and extent of contamination associated with Operable Unit 2 are presented in Section 2.0.

1.5.8 Contamination Release Studies

Dove and Norris (1951) were the first to describe the possible fate of chemical and radionuclide releases that infiltrate the groundwater of the Great Miami Aquifer. Eye (1961) reported on the potential for groundwater pollution as a result of production activities. Spieker and Norris (1962) investigated radionuclide contamination of the groundwater and the transport of the contaminated water through the Fernald, Ohio area. NLO reported on the results of the FMPC Ground Contamination Study Committee in 1962. In 1977, the DOE conducted an assessment of environmental impacts from site operations (DOE 1977), and NLO performed a study on the radioactive waste storage area (NLO 1977).

Battelle Laboratories was contracted by NLO to conduct an environmental study in 1981 (Battelle 1981). NLO (Spenceley 1983) performed an internal investigation to distinguish between contamination caused by FEMP activities and other sources. Sedam (1984) investigated the occurrence of uranium in the groundwater in the vicinity of the FEMP site for DOE.

Other environmental contamination studies were conducted by DOE (1985a, 1987), Oak Ridge Associated Universities (ORAU 1985), and various FEMP-related committees (WMCO 1986, 1987; Fleming and Ross 1984). The DOE and ORAU documents include environmental impact assessments and environmental surveys. Internal study reports by NLO and WMCO include the annual Environmental Monitoring Reports and the Aquifer Contamination Control Reports (NLO 1965

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through 1985). Additionally, the ODH has documented radionuclide contamination in private wells in the FEMP area (ODH 1988). In 1988, under the terms of a Director's Findings and Orders issued by the State of Ohio, the FMPC performed sampling at a series of drainage ditches and storm water manholes on the FEMP property. Previous sediment investigations guided the development of Operable Unit 2 RI sampling plans.

An environmental study was performed by Dames and Moore in 1985 to determine the source of uranium contamination in off-site wells. The study performed surface water, sediment, and groundwater sampling. The study concluded that a source of groundwater contamination in the Great Miami Aquifer was due to storm water runoff into the Storm Sewer Outfall Ditch and Paddys Run. The study also developed a groundwater model to predict future concentrations of uranium in groundwater.

In the mid-1980s, the FEMP contracted two environmental investigations that provided the majority of historical data used to supplement the Operable Unit 2 RI data. The first study, the Environmental Survey of the FEMP, was part of a larger DOE-wide environmental survey announced by the U.S. Secretary of Energy on September 18, 1985. The purpose of the survey at each DOE facility, including the FEMP, was to identify existing environmental concerns and areas of environmental risk. Environmental concerns at that time were defined as:

- Concerns resulting from DOE operations where pollutants or hazardous materials exist in the air, surface water, groundwater, or soil in concentrations that pose or may pose a hazard to human health or the environment.
- Conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

Levels of contaminants that constituted an environmental concern were generally those that exceeded federal, state, or local statutes and regulations for release, contamination, or exposure to such materials. The survey also evaluated the potential for some unregulated materials, if present, to create an environmental concern.

The Environmental Survey sampling and analysis program was intended only to confirm the presence of contamination in selected locations. It was not intended to characterize the extent of contamination, define the rate of contaminant movement, identify specific isolated incidents of

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noncompliance, or analyze environmental management practices. The Environmental Survey sampled surface media, subsurface media, and groundwater across the site.

The second study conducted was the Characterization Investigation Study (CIS) (Weston 1987a, b, and c and 1988). Selected investigations of the waste storage areas were performed to provide additional data to characterize the nature and extent of contamination. The investigations pertinent to Operable Unit 2 include the Geophysical Survey (Weston 1987a), Chemical and Radiological Analysis of Waste Storage Pits (Weston 1987b), Radiological Survey of Surface Soils (Weston 1987c) and the Geotechnical Evaluation of Material Properties of Waste Pit Materials (Weston 1988).

The historical investigations differ in scope and data quality. Most were focused on site-wide contamination issues. Data that are relevant to the Operable Unit 2 evaluations were utilized to supplement data collected for the RI. Discussions of contaminant data sets utilized in the description of the nature and extent of contamination associated with Operable Unit 2 are presented in Section 2.0.

#### 1.5.9 Historical Photographs of the FEMP

Historical aerial photographs of the FEMP were presented in a 1988 EPA Report (Sitton 1988). Additional aerial photographs were obtained to understand the operational history of the Operable Unit 2 waste subunits and to identify locations for sample collection. Aerial photographs relating to each subunit will be discussed in Section 1.6.

#### 1.6 DESCRIPTION OF OPERABLE UNIT 2

Operable Unit 2 incorporates waste subunits with relatively large volumes of waste presumed to contain small quantities of hazardous materials and radionuclides. Battery limits for the Operable Unit 2 waste subunits have been identified to coordinate soil media remediation with Operable Unit 5 and are presented in Table 1-1. Battery limits are boundaries that define the area of responsibility. Since the physical separation between the Inactive Flyash Pile and the South Field is not clearly defined, the two subunits have been grouped together.

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TABLE 1-1

BATTERY LIMITS FOR OPERABLE UNIT 2 SUBUNITS

Solid Waste Landfill	- Fence lines to the north and east	2
	- Railroad to the south	3
	- Former fence line to the west	
Lime Sludge Ponds	- Roadway to the north and east	4
	- Railroad on the west	
	- K-65 Slurry Line to the south	
Inactive Flyash Pile/South Field	- Access roadway to the north and east	5
	- Drainage ditch along the northwest perimeter	
	- Paddys Run bank to the west	
	- Nearby fence and roadway to the south	
Active Flyash Pile	- Access roadway to the west	6
	- Drainage ditch to the east and south	
	- 50 feet from toe of the slope to the north	

For sources of contamination within the battery limits, the Operable Unit 2 RI characterizes the waste materials; determines the impact of contaminants on the surface water, soils, air, and groundwater; defines the potential pathways for human exposure; and assesses the risk to the public through a baseline risk assessment. These activities are completed for each waste subunit, and the cumulative risk from all Operable Unit 2 waste subunits is presented. The Operable Unit 2 RI does not address site-wide characterization of nature and extent of groundwater contamination or air contamination. The Operable Unit 2 RI also does not address site-wide evaluation of ecological and human health risks. These subjects are within the scope of the Operable Unit 5 RI Report and the CRARE, respectively.

1.6.1 History of Operable Unit 2

The FEMP was divided into five operable units in 1989 after the site was placed on the NPL and during the negotiation of the 1990 Consent Agreement. In March 1991, EPA approved the Operable Unit 2 Initial Screening of Alternatives, the first step in the RI/FS process (DOE 1991). This document included development and screening of technologies and process options that were potentially applicable to remediation of the specific wastes present in Operable Unit 2. Five potential remedial alternatives were evaluated for each subunit.

The Operable Unit 2 Treatability Study investigated the effectiveness of solidification techniques for possible use in the final remedial action for Operable Unit 2 wastes. The purpose of a treatability

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study is to provide information needed for the detailed analysis of alternatives in the FS and subsequent selection of remedial action.

In accordance with the 1991 Amended Consent Agreement, DOE submitted a Draft Operable Unit 2 RI Report to the EPA and OEPA on October 19, 1992. This draft document was based on results of previous environmental investigations conducted up to 1987 as discussed in Section 1.2.5, and RI/FS sampling completed from 1987 through 1992 as discussed in Section 2.0. The RI/FS sampling was performed according to a series of work plans and work plan addenda. The "Work Plan for Conducting the Site-Wide Remedial Investigation and Feasibility Study of the Feed Materials Production Center" (the RI/FS Work Plan) was approved in March 1988 and included a Work Plan, Sampling Plan, Quality Assurance Project Plan, Health and Safety Plan, Data Management Plan, and Community Relations Plan for the entire site. The document change requests (DCRs) in Table 1-2 contain addenda that were specific to the Operable Unit 2 subunits.

**TABLE 1-2**  
**OPERABLE UNIT 2 RELATED DCRs**

DCR No.	Title	Effective Date
DCR 13	Surface Soil Sampling	9/05/89
DCR 14	Installation Plan for Additional Wells for the RI/FS	1/05/89
DCR 33	Production and Additional Suspect Areas Work Plan	10/4/89
DCR 38	Additional Monitoring Well Program for the RI/FS Work Plan	3/23/90
DCR 39	South Plume Groundwater Sampling for the RI/FS Work Plan	4/24/90
DCR 44	Additional Monitoring Well Program for the RI/FS Work Plan	6/20/90

The trenching investigations conducted in 1992 in the Solid Waste Landfill and the South Field were based on the "Work Plan Addendum for Excavation of Trenches in the Operable Unit 2 Solid Waste Landfill, FEMP RI/FS" (February 1992) and DCR 33.

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EPA disapproved the initial submittal of the Draft Operable Unit 2 RI Report because the data collected for the report were not "adequate to characterize the sources of contamination, or determine if the sources are contributing to the contamination of the various media." The OEPA commented that the data were incomplete and that the report failed to determine if any of the waste subunits are contributing to groundwater contamination.

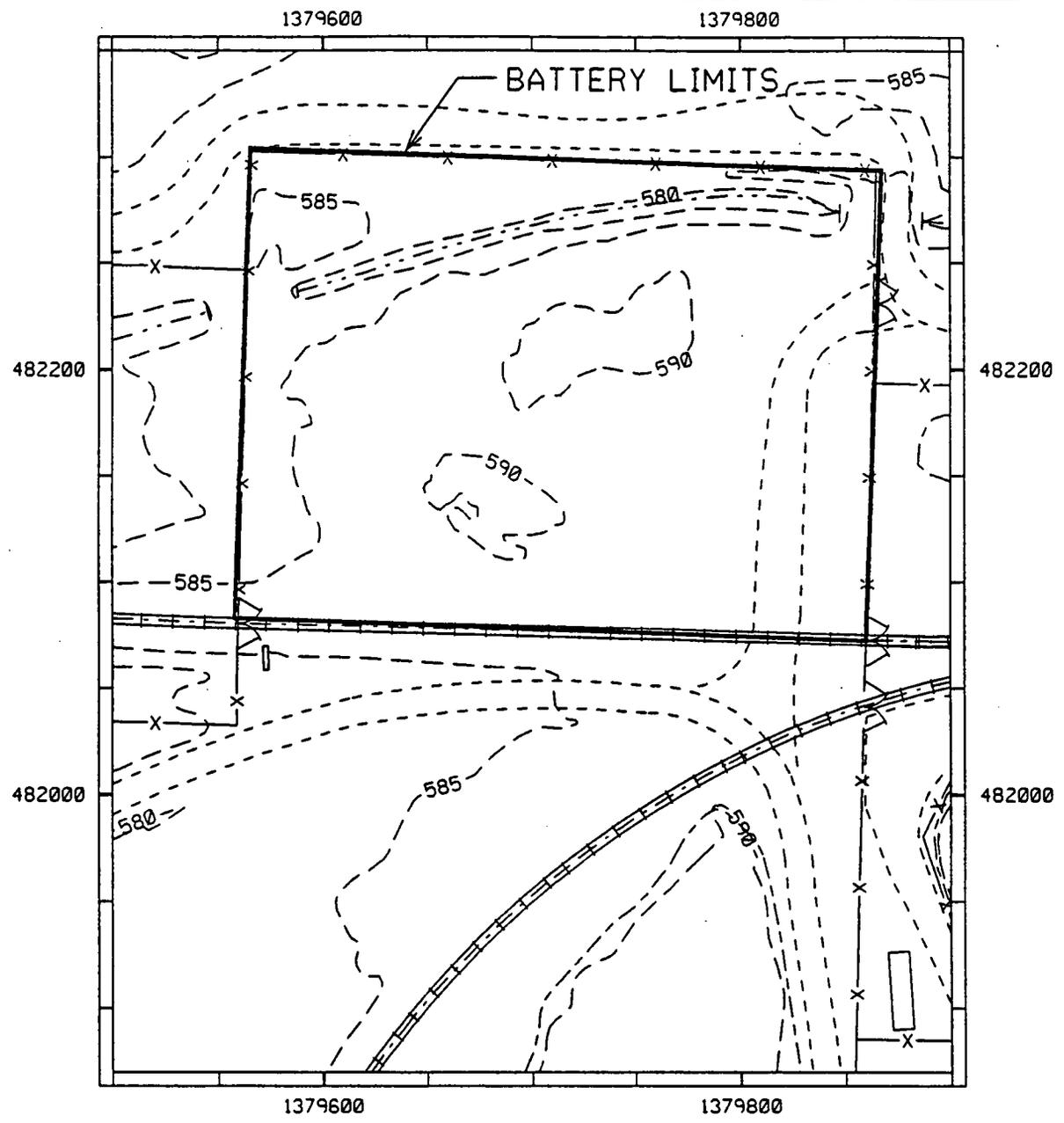
Based on EPA and OEPA review comments (December 17, 1992) to the Draft Operable Unit 2 RI Report and responses to those comments submitted by DOE (February 7, 1993), additional field investigations were planned and completed at the Operable Unit 2 waste subunits from April through July 1993. These additional investigations were defined in the Operable Unit 2 Sampling and Analysis Plan (SAP) submitted to EPA in April 1993. The objectives of the additional investigations were to further characterize the nature and extent of contamination of the various media for fate and transport modeling and risk assessment; determine and quantify the impacts of the waste subunits on groundwater; and develop remedial alternatives.

1.6.2 Solid Waste Landfill

The Solid Waste Landfill is located in the northeast corner of the Waste Storage Area (Figure 1-8). This landfill, a flat rectangular area of approximately one acre, has been inactive since 1986. A soil cover has been placed over the disposal area. A drainage ditch serving the northwest portion of the former Production Area is located in the northern portion of the Solid Waste Landfill. This drainage ditch has been identified as a jurisdictional wetland (EBASCO 1993).

The operational history of the Solid Waste Landfill is not well documented. The facility was planned as a sanitary landfill for non-burnable trash with up to five cells and an evaporation pond planned according to design drawings. Limited operation records state that dumping commenced on June 19, 1974, with dumping planned for two to three times weekly. According to records, the evaporation pond was to collect drainage from the exposed dumping area. The Solid Waste Landfill reportedly was used for the disposal of cafeteria waste, rubbish, and other types of wastes from FMPC nonprocess areas and on-site construction/demolition activities. Interviews conducted with former employees of the FEMP revealed no new relevant information. A review of historical site aerial photographs indicates that activity at the Solid Waste Landfill may have occurred as early as 1954. It is thought that the landfill was organized into an original disposal area, one to five individual waste disposal cells, and an evaporation pond which served as a surface water drainage pond. One disposal

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**LEGEND**

- 575 — ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
- FENCE
- RAILROAD

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

SCALE (FT)

**FIGURE 1-8  
SOLID WASTE LANDFILL**

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cell has been confirmed from an aerial photograph taken in November 1974. Historical aerial photographs from November 1974 to April 1976 show a drainage pond on the west side of the landfill area; however, it is not present in photographs later than 1980.

Aerial photographs from November 1974 to 1976 indicate that a stock pile of an aggregate material covered the northeast quarter of the site. Materials reportedly buried at the Solid Waste Landfill include non-burnable and nonradioactive solid wastes generated on FEMP property, nonradioactive construction-related rubble, and double-bagged and bulk quantities of nonradioactive asbestos. Field investigation results, however, indicate that some apparent process wastes have been placed in the landfill. The following wastes were encountered during a trenching investigation in 1992:

- Burnable wastes - bagged trash and wood
- Possibly burnable wastes - respirator cartridges, asphalt roofing materials, medical wastes, firehoses, and rubber hoses/belts
- Non-burnable wastes - unidentified high-activity waste, medicine vials, bagged asbestos, ceramic tiles, possible magnesium fluoride, glass acid bottles, steel cables/cans, paint cans, and copper tubing

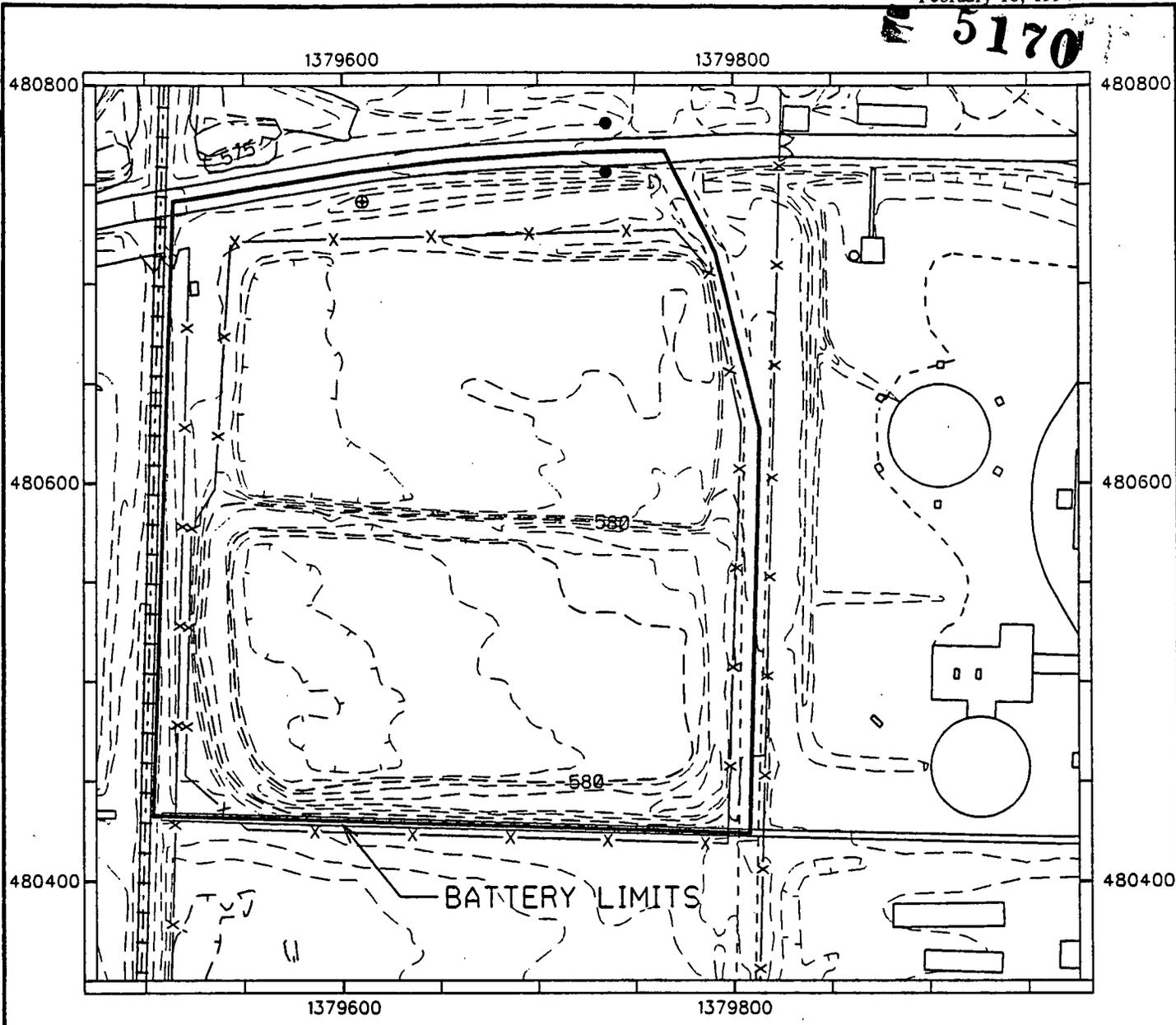
Nonradioactive, nonhazardous general refuse is now shipped for disposal to approved, off-site locations.

Sections 2.3 and 4.2 present the characterization and nature and extent of contamination of the Solid Waste Landfill.

1.6.3 Lime Sludge Ponds

The North and South Lime Sludge Ponds are two unlined, rectangular ponds, each measuring approximately 125 by 225 feet, and are located in the southeast corner of the Waste Storage Area (Figure 1-9). Wastes that were disposed of in the North and South Lime Sludge Ponds originated from water plant operations, coal pile storm water runoff, and boiler plant blowdown. The waste from the water plant operations is generated from a water softening process, which consists of the addition of lime and aluminum sulfate to precipitate calcium and magnesium salts. Approximately one cubic yard of lime sludge is generated on a daily basis and is pumped to Tanks 6 and 7 of the General Sump. Solids from coal pile storm water runoff are allowed to settle in a retention basin, and the remaining decant is pumped to Tanks 6 and 7 of the General Sump. Boiler plant blowdown

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**LEGEND**

- 575 ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
- FENCE
- RAILROAD



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

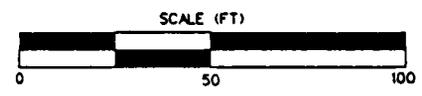


FIGURE 1-9  
LIME SLUDGE PONDS

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consists of backflush water from the boilers at the coal plant. The boilers are backflushed to prevent scale build-up. This water is also sent to Tanks 6 and 7 of the General Sump.

Currently, sludge from the above three sources is allowed to accumulate in the General Sump for approximately two weeks. While there, the sludge is partially dewatered and polymers are added to induce sludge thickening. After two weeks, the resultant slurry is pumped to the North Lime Sludge Pond. Although this waste is from three distinct waste streams, the bulk of the slurry is lime sludge from the water treatment process. Over time, the solids in the slurry settle in the Lime Sludge Pond and the remaining decant is pumped from the pond back through the General Sump where it is sampled and analyzed. Based on the analytical results, the water is discharged directly to the Great Miami River or treated as required prior to discharge. The Lime Sludge Ponds have been operated in this manner since the early 1950's. The lime sludge is, therefore, considered to be relatively homogeneous.

The South Lime Sludge Pond is full and has been inactive since the mid-1960s; it is now overgrown with grasses and shrubs. The North Lime Sludge Pond is currently in use. A new water treatment system, which will eliminate lime sludge generation, is scheduled to become operational in January 1995. The west side of the North Lime Sludge Pond is usually covered with 1 to 2 feet of water, depending mainly on precipitation. The remaining area is dry and covered with sparse vegetation.

The Lime Sludge Ponds were identified as RCRA Subtitle C Hazardous Waste Management Units (HWMUs) in the FEMP RCRA permit application of June 1991, based on the belief that the ponds received a F-listed hazardous waste, 1,1,1-trichloroethane (TCA), after July 26, 1982. This belief was based on an assumption that TCA was discharged to the water treatment system at a concentration greater than 25 parts per million (ppm). Based upon revised calculations, on May 13, 1993, FERMC0 proposed that the FEMP permit application be modified to reclassify the Lime Sludge Ponds as Solid Waste Management Units (SWMUs). OEPA concurred with the reclassification on June 7, 1993.

Sections 2.4 and 4.3 present the characterization and nature and extent of contamination of the Lime Sludge Ponds.

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1.6.4 Inactive Flyash Pile

The Inactive Flyash Pile is located approximately 2,000 feet southwest of the former Production Area. The pile covers roughly two acres with Paddys Run as the western boundary (Figure 1-10). The operating history of this subunit is not well understood. The Inactive Flyash Pile and the South Field are contiguous without a clearly defined boundary between the two subunits. Based on a review of historical photos (EPA 1988b) and borehole logs (Weston 1988), the northern portion of this waste area is located adjacent to a presently buried drainage ditch leading to Paddys Run. Beginning in 1957, flyash appears to have been trucked to the working face of the flyash pile and dumped. Historical aerial photographs from September 1962 indicate that dumping of flyash in the Inactive Flyash Pile was in two working piles. The photographs indicate that flyash disposal at this location ceased by the mid-1960s. Drill cuttings and water from RI/FS borings outside the former Production Area and Waste Storage Area, including off-property wells, were disposed of on the Inactive Flyash Pile until March 1990. Composite samples of the water were analyzed to ensure that total uranium was below a WMCO established action limit.

Based on information provided by WEMCO, 1,500 to 2,000 tons per year of flyash were generated during the period of disposal; however, an unknown quantity of flyash was also disposed of in the Burn Pit and Pit 3 within Operable Unit 1 (Weston 1988). The Inactive Flyash Pile is currently covered with vegetation and soil of unknown origin.

Previous investigations have mentioned that waste oils (possibly containing uranium or PCBs) may have been spread on the flyash in this waste area to control dust (DOE 1988a; Weston 1987b). Attempts to document this have been unsuccessful. An objective of this RI is to determine if uranium detected in the vicinity of the pile is a result of such activities. Nonprocess wastes from the FEMP and building rubble such as concrete, gravel, asphalt, masonry, and steel rebar from on-site construction/demolition activities were also discarded in the Inactive Flyash Pile (DOE 1988a; Weston 1987b) and are visible along embankments surrounding the subunit. Transite containing asbestos was also deposited in the Inactive Flyash Pile. Field investigation results also reveal that some apparent process waste may have been placed in the subunit.

Section 1.7 discusses two removal actions that were performed at the Inactive Flyash Pile. Sections 2.5 and 4.4 present the characterization and nature and extent of contamination of the Inactive Flyash Pile.

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### 1.6.5 South Field

The South Field is an 11-acre area that lies between the Active Flyash Pile and the Inactive Flyash Pile. The actual boundary with the Inactive Flyash Pile is not clearly defined (Figure 1-10). The operational history of the South Field is neither well documented nor understood. This area was reportedly used as a burial site for FEMP nonprocess wastes such as flyash, on-site construction/demolition rubble, including debris from the razing of the old administration building (DOE 1988a; Weston 1987b), and soils that may have contained low levels of radioactivity. The South Field was not an engineered disposal site. Historical information and aerial photographs indicate that its use was on an as-needed basis. Disposal in the South Field apparently was performed in a random manner, thus the thickness of fill and the nature of waste are variable. Discrete mounds of waste material are visible in an aerial photograph taken in March 1957.

The southwest border of the South Field slopes toward the west and was used as the backstop for a firing range for FEMP security personnel over a period of 35 years. Lead ammunition used during target practice is deposited along the southwest border of the South Field (see Section 1.7.1).

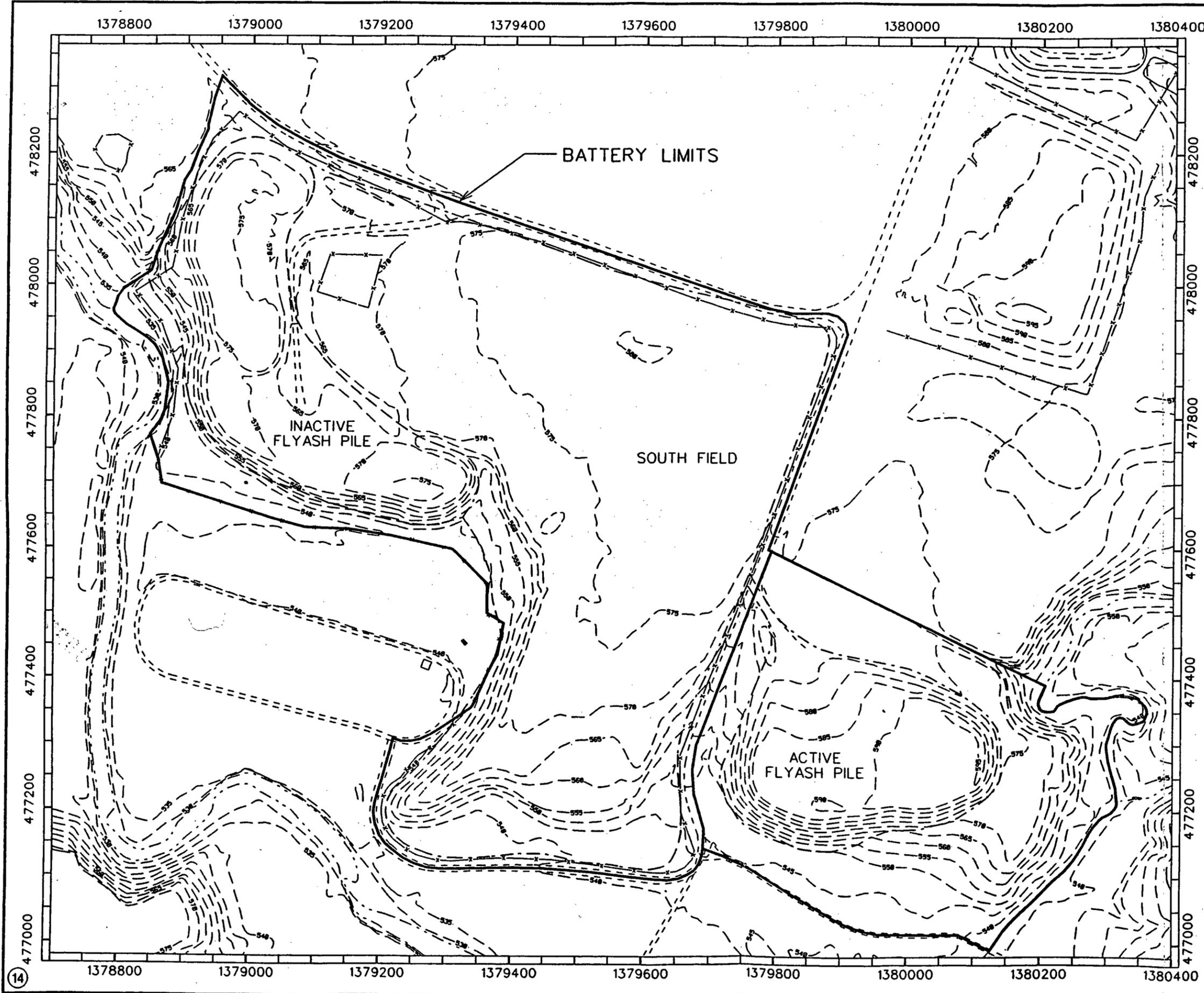
A review of historical aerial photographs, topographical maps, and borehole logs (Weston 1988) was undertaken to estimate boundaries of waste deposition and filled areas. Pre-construction aerial photographs taken in 1938 and 1950 show a north-to-south trenching drainage that was filled and used as a haul road. Aerial photographs taken from 1954 to 1964 show this haul road. This road is the approximate western limit for the South Field. Disposal activities in the South Field appear to have ceased during the mid-1960s. Currently, the South Field is covered with grasses, shrubs, and trees.

Section 1.7 discusses a removal site evaluation (RSE) and a removal action that were performed at the South Field. Sections 2.5 and 4.5 present the characterization and nature and extent of contamination of the South Field.

### 1.6.6 Active Flyash Pile

This waste disposal area is located just east of the South Field and is bounded on the east and south by the Storm Sewer Outfall Ditch (Figure 1-10). The Active Flyash Pile has a surface area of approximately three acres and has received flyash waste since the mid-1960s. The operational history of this unit is well understood. The flyash pile has a crusting agent sprayed upon the surface as a

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**LEGEND**

- 575- ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
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NOTE:  
Coordinates are in State  
Planar NAD 1927.  
Surface contours based on  
1992 flyover.

SCALE (FT)

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**FIGURE 1-10**  
**SOUTH FIELD AND**  
**FLYASH PILES**

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means of dust control. A silt fence has been constructed at the base of the pile to prevent storm water transport of the flyash off the pile.

Flyash from the FEMP coal-fired boiler plant was disposed of at the Active Flyash Pile. Flyash waste is comprised of 70 percent bottom ash collected below the boilers; the remaining 30 percent is a combination of precipitator ash collected from pollution control devices and flyash removed from the middle levels of the boiler. Some unburned coal and rock are also present in small quantities in the active flyash material. Since December 1992, newly generated flyash has been transported off site to a licensed disposal facility. Previous investigations have mentioned that waste oils (possibly containing uranium or PCBs) may have been spread on the flyash in this waste area to control dust (DOE 1988a; Weston 1987b). Attempts to document this practice have been unsuccessful. An objective of this RI to determine if uranium or PCBs detected in the pile are a result of such activities.

Section 1.7 discusses a removal action that was performed at the Active Flyash Pile. Sections 2.6 and 4.6 present the characterization and nature and extent of contamination of the Active Flyash Pile.

### 1.7 OPERABLE UNIT 2 CERCLA ACTIONS

A RSE and a removal action are CERCLA actions that are performed before the final remediation is implemented to protect the public health, welfare, or the environment from a release or threat of release of hazardous substances. A RSE is conducted to determine if a removal action is warranted. This section discusses the RSE and removal actions that were conducted at the Operable Unit 2 subunits.

#### 1.7.1 Firing Range Removal Site Evaluation

A RSE was conducted to assess lead contamination in the South Field firing range and to determine whether the nature and extent of contamination warranted a removal action. In January and February 1992, vertical and horizontal borings were completed in the western embankment of the South Field, just east of the FEMP running track/firing range. It was determined from the sampling results that a removal action was not necessary.

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1.7.2 Active Flyash Pile Control Removal Action (Removal No. 10)

The objective of the Active Flyash Pile Control Removal Action, a time-critical removal action, was to mitigate the wind and water erosion of the Active Flyash Pile. This was accomplished by implementing the following controls: (1) installation of a silt trap made from permeable geotextile fabric around the entire perimeter of the pile at the toe of the slope; (2) installation of a wind barrier made from high-density polyethylene around the top perimeter of the flyash pile; (3) alteration of the active working surface to minimize the noncompacted area and to prevent an increase in the maximum height of the existing pile; (4) minor regrading of the outer berm and compacting the nonworking top surfaces of the flyash pile; (5) application of water, foam, and binding-type dust-control agents on side slopes and top; and (6) periodic inspection and necessary maintenance identified during inspection. Planning and design of the removal action began in December 1991 and implementation was completed in June 1992. Periodic routine inspections and necessary maintenance are ongoing.

1.7.3 Inactive Flyash Pile/South Field Disposal Area Control Removal Action (Removal No. 8)

The Inactive Flyash Pile/South Field Disposal Area Control Removal Action consisted of the installation of ropes, fences, and warning signs around the perimeter of these waste areas to control access. During the course of the removal action, walk-over radiation surveys were conducted over the entire area to define locations that should be delineated as regulated areas. Implementation began in September 1991. Phase I of the activities, which included fencing and roping the areas to be controlled, was completed in December 1991. Phase II, which included surveying the area for additional hot spots, was completed on June 30, 1992.

1.7.4 Paddys Run Erosion Control Removal Action

A time-critical removal action was implemented in Paddys Run to provide bank stabilization adjacent to the Inactive Flyash Pile. Continued erosion of the bank could have undermined the Inactive Flyash Pile's western slope and resulted in a discharge of contamination into Paddys Run.

During late April and early May 1993, interim slope improvement was performed with the installation of a weighted berm to address the erosion problem. This interim action constituted Phase I of the removal action. Phase II was completed during September 1993 when additional riprap stone was installed at the top and toe of the weighted berm. The additional height was sufficient to cover the

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exposed soil face adjacent to Paddys Run, and toe protection was added to insure the long-term stability of the berm.

1.8 ORGANIZATION OF REPORT

This RI Report was prepared in accordance with the latest EPA guidance (EPA 1988) and recommended format. The report consists of an Executive Summary, Sections 1.0 through 7.0, and appendices.

The environmental investigations of the site and each Operable Unit 2 waste area are presented in Section 2.0. This includes a discussion of the characterization of each media (surface soil, waste material, subsurface soil, surface water, sediment, and groundwater) and a summary of the geological and geophysical investigations that were performed. The Phase II field program is explained in detail in this section.

Section 3.0 describes the physical characteristics of the site and the Operable Unit 2 Study Area. Meteorological, topographical, geological, hydrogeological, and ecological data is presented for the FEMP site. The specific topography, geology, and hydrogeology of each Operable Unit 2 waste subunit are also discussed and illustrated.

Section 4.0 presents the results of the RI investigations identified in Section 2.0. The characterization of the nature and extent of contamination associated with each of the five Operable Unit 2 waste subunits is also presented. A summary of detected analytes is included in this section.

Section 5.0 summarizes the contaminant fate and transport modeling for contaminants originating from Operable Unit 2. Modeling results for air, groundwater, and surface water are presented for each subunit. A detailed discussion of the fate and transport modeling is presented in Appendix A.

Section 6.0 summarizes the significant findings of the Baseline Risk Assessment for Operable Unit 2. The detailed Baseline Risk Assessment is included as Appendix B of this RI Report.

Section 7.0 summarizes the results, evaluations, and conclusions made from the Operable Unit 2 data.

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Appendices C through G consist of tables of chemical and radiological data specific to each of the Operable Unit 2 waste areas. Each appendix contains data for surface media, subsurface media, surface water, sediments, and groundwater data from all Operable Unit 2 investigations. Also included in each of these appendices are boring logs, monitoring well construction records, biological resources data, geotechnical data, water elevation data, and on-site screening results. The results of Operable Unit 2 hydraulic testing are presented in Appendix H.

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## 2.0 OPERABLE UNIT 2 INVESTIGATIONS

This section discusses previous site investigation data useful to the Operable Unit 2 RI and the field programs that have been implemented to address RI/FS data requirements. Data requirements for the Phase II Field Investigation were defined by scoping the RI objectives and evaluating available information. The data requirements for the RI objectives and an index identifying the specific section of the report in which the data are presented are given in Table 2-1. Because the objectives, sampling methods, and analytical procedures differed among the sampling programs, the data usability with respect to the Operable Unit 2 RI is discussed.

Studies of the waste units that make up Operable Unit 2 began as early as 1985; data from the following two investigations were used to provide a preliminary characterization of the Operable Unit 2 waste areas to assist in developing RI sampling plans: the Environmental Survey conducted from 1986 to 1987 and the CIS conducted from 1987 to 1988.

### 2.1 PREVIOUS INVESTIGATIONS

Other previous investigations and environmental monitoring performed at the FEMP were site-wide in scope and their objectives did not include an assessment of Operable Unit 2 specific waste units. The Environmental Survey and the CIS were the only two previous investigations that performed sampling in the Operable Unit 2 waste subunit areas.

#### 2.1.1 Environmental Survey

The Environmental Survey of the FEMP was part of a larger DOE-wide environmental survey announced by the U.S. Secretary of Energy on September 18, 1985. The purpose of the survey at each DOE facility, including the FEMP, was to identify existing environmental concerns and areas of environmental risk. Environmental concerns at that time were defined as:

- concerns resulting from DOE operations where pollutants or hazardous materials exist in the air, surface water, groundwater, or soil in concentrations that pose or may pose a hazard to human health or the environment.
- conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

**TABLE 2-1**  
**DATA REQUIREMENTS FOR THE RI/FS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Objective	Data Requirement	Source of Data	Section(s) Presented
Physical Characteristics	Prevailing Winds	Cincinnati and Dayton Airports, FEMP Meteorological Tower	3.1.1
	Precipitation and Evaporation	Cincinnati and Dayton Airports, FEMP Meteorological Tower, Miami Conservancy District	3.1.1
	Temperature	Cincinnati and Dayton Airports, FEMP Meteorological Tower	3.1.1
	Topography	Historical Pre-Construction Surveyed Map, Aerial Photography	3.1.2
	Surface Water Hydrology	Miami Conservancy District, United States Geological Survey (USGS), Federal Emergency Management Agency (FEMA)	3.1.2
	Regional Geology and Groundwater Hydrogeology	USGS, Ohio Department of Natural Resources, Ohio Geologic Society, Operable Unit 2 RI	3.1.3
	Regional Soil Characteristics	United States Department of Agriculture, RI field investigations	3.1.4
	Demography	Ohio Department of Development Ohio-Kentucky-Indiana Regional Council of Governments	3.1.5
	Ecology	United States Forest Service, Shelford, Facemire	3.1.6
	Subunit Specific Geology and Hydrogeology	CIS, RI field investigations	3.2 - 3.5
Nature and Extent of Contamination	Background Concentrations	RI field investigations	4.1
	Subunit Specific Volume and Physical Characteristics of Waste	FEMP Process Knowledge, RI field investigations	4.2 - 4.6

**TABLE 2-1  
(Continued)**

Objective	Data Requirement	Source of Data	Section(s) Presented
Nature and Extent of Contamination (cont.)	Subunit Specific Surface Water and Sediment	FEMP Environmental Monitoring, and RI field investigations	4.2 - 4.6
	Subunit Specific Surface Material (waste, fill, or soil)	Environmental Survey, CIS, RI field investigations	4.2 - 4.6
	Subunit Specific Subsurface Material (waste, fill, or soil)	CIS, RI field investigations and process knowledge	4.2 - 4.6
	Subunit Specific Groundwater	Environmental Monitoring, and RI field investigations	4.0
Fate and Transport	Geotechnical	RI field investigations	4.2 - 4.6
	Geochemical	RI field investigations	4.2 - 4.6
	Source Loading	RI field investigations	4.2 - 4.6
	Calibration Assessment	CIS, RI field investigations	5.0
Risk Assessment	Exposure Point Concentration	RI analytical data, transport modeling	4.0, 5.0
Evaluation of Alternative	Chemicals of Concern	RI field investigations	4.0
	Exposure Route(s) and Receptor(s)	Risk Assessment	6.0
	Volumes or Areas of Media	RI field investigations, fate and transport modeling	4.0, 5.0
	Geotechnical	RI field investigations	4.0

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Levels of contaminants that constituted an environmental concern were generally those that exceeded federal, state, or local statutes and regulations for release of, contamination by, or exposure to such materials. The survey also evaluated the potential for some unregulated materials, if present, to create an environmental concern. The objective of the Environmental Survey sampling and analysis program was to confirm the presence of contamination in selected locations using limited sampling. It was not intended to characterize the full extent of contamination or rate of contaminant movement, to identify specific isolated incidents of noncompliance, or to analyze environmental management practices.

The Environmental Survey samples included: surface media from Operable Unit 2 waste areas taken by collecting composite and grab samples, subsurface media by collecting grab samples using hand augers and open trenches, and groundwater when encountered in open trenches. Since the sample locations were not surveyed, positions can only be approximated. Environmental Survey analytical laboratory result packages did not contain sufficient documentation to perform validation. Due to these uncertainties, the Environmental Survey data were used during the RI/FS only to guide field activities. Environmental Survey analytical data were not used to determine nature and extent of contamination, contaminant fate and transport, or risk assessment (see Table 2-1). Analytical results for the Environmental Survey samples are provided in Appendices C through G.

2.1.2 Characterization Investigation Study

The CIS was comprised of selected investigations of the waste storage areas to provide a preliminary Operable Unit 2 characterization of the nature and extent of contamination. The investigations pertinent to Operable Unit 2 are:

- Geophysical Survey (Weston 1987a)
- Geotechnical Evaluation of Material Properties of Waste Pit Materials (Weston 1988)
- Chemical and Radiological Analysis of Waste Storage Pits (Weston 1987b)
- Radiological Survey of Surface Soils (Weston 1987c)

The objective of the CIS Geophysical and Geotechnical Surveys was to provide preliminary information on waste volumes and shallow stratigraphy for optimizing the placement of soil borings and groundwater monitoring wells at the Fernald site, and more specifically, to identify locations that were potentially hazardous for drilling because of buried steel drums and tanks. Magnetic surveys were performed in the Solid Waste Landfill and the South Lime Sludge Pond using an EG&G Geometrics Model G-856 portable proton precession magnetometer. Electromagnetic terrain

conductivity (EM) surveys were performed in all Operable Unit 2 waste areas using Geonics, Ltd. EM 31 and EM 34-3 terrain conductivity meters. Ground-penetrating radar (GPR) surveys were performed at the Solid Waste Landfill and the South Lime Sludge Pond using the Geophysical Survey Systems, Inc., S/R System 8.

Additionally, during March 1987 through April 1987, samples from the Solid Waste Landfill and the Lime Sludge Ponds were collected for a geotechnical evaluation of material properties. The samples were collected with a split-spoon sampler and were analyzed for grain size, specific gravity, Atterberg limits, and moisture content.

The CIS chemical and radiological analyses of the waste storage pits were completed by collecting soil samples from soil borings installed in the waste areas to determine a preliminary vertical distribution of chemical and radiological constituents. Soil borings that were drilled in the fill material of each Operable Unit 2 waste are listed in Table 2-2. The original intent was to distribute the borings evenly within each waste area, but boring locations were adjusted based on the results of the geophysical surveys to avoid areas with high potential for buried metal objects. Borings were advanced until native soil was encountered. Table 2-2 summarizes the subsurface sample collection methodology for the Operable Unit 2 waste area from each boring. A sample interval of approximately one foot was used to collect samples for on-site radiological screening. The samples were then composited for each boring and sent to an off-site laboratory for analysis. These composite samples were analyzed for organics, inorganics, radionuclides, and RCRA characteristics (in the Solid Waste Landfill and Lime Sludge Ponds).

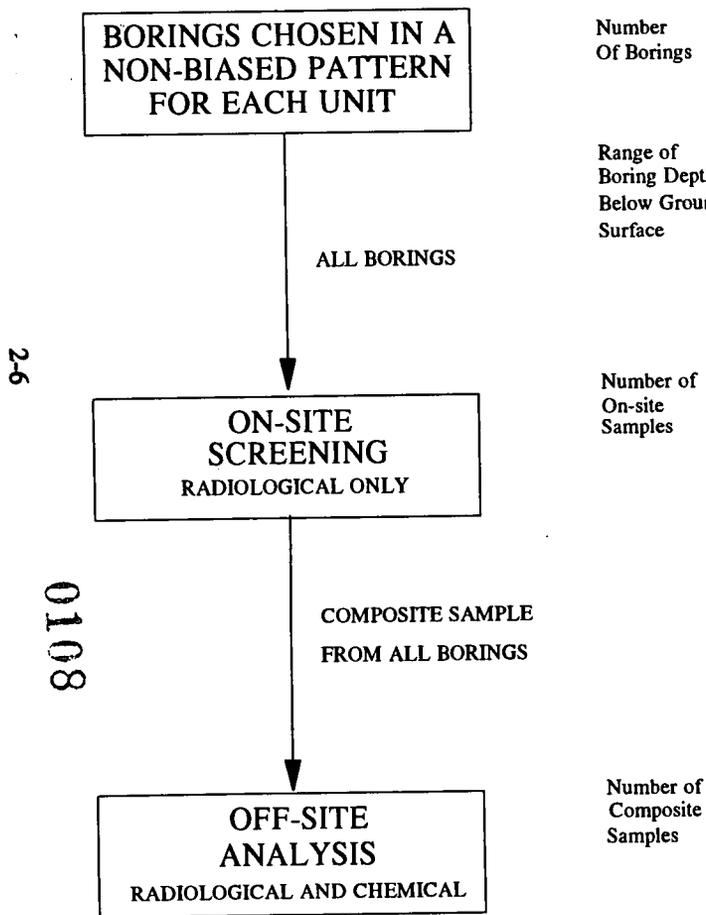
The objective of the CIS Radiological Survey of Surface Soils was to provide a systematic survey of surface media throughout the Solid Waste Landfill, Lime Sludge Ponds, Inactive Flyash Pile, and associated on-site drainages within the Operable Unit 2 Study Area to determine the locations(s) of areas with elevated radionuclide activity. Before surface samples were collected, a gamma radiation measurement was made on the surface using a field instrument for detecting low energy radiation (FIDLER). An Eberline SPA-3 scintillation probe was used in both the Inactive Flyash Pile and South Field. Areas of field correlated levels of 35 picoCuries per gram (pCi/g) or greater were sampled and screened on site for radionuclides. Those samples with the highest screening levels were sent off site for analysis. Table 2-3 summarizes the sample collection methodology for the Operable

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TABLE 2-2  
CIS RADIOLOGICAL SURVEY OF SUBSURFACE SOILS

SAMPLE SUMMARY  
NUMBER OF SAMPLES

	SOLID WASTE LANDFILL	LIME SLUDGE PONDS	INACTIVE FLYASH PILE/SOUTH FIELD	ACTIVE FLYASH PILE
Number Of Borings	6	6	12	1
Range of Boring Depth Below Ground Surface	8-18 ft	North Pond: 6-8 ft (below Residue/water Surface)  South Pond: 8-9 ft	8-34 ft	8-16 ft
Number of On-site Samples	66	42	139	7
Number of Composite Samples	7	6	12	1



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TABLE 2-3

CIS RADIOLOGICAL SURVEY OF SURFACE  
AND NEAR-SURFACE SOILS

SAMPLE SUMMARY  
NUMBER OF SAMPLES

SOLID WASTE LANDFILL		LIME SLUDGE PONDS		INACTIVE FLYASH PILE/SOUTH FIELD		ACTIVE FLYASH PILE			
Surface		Surface		Surface		Surface			
Fidler		146		3637		522			
Beta Gamma		54		209		-			
Exposure rate		5		19		5			
Number of On-site Samples		Surface	Near-surface	Surface	Near-surface	Surface	Near-surface		
		16	3	21	8	90	125	6	5
Number of Off-site Samples		Surface	Near-surface	Surface	Near-surface	Surface	Near-surface	Surface	Near-surface
		-	1	3	-	17	16	-	1

FIELD  
SCREENING  
RADIOLOGICAL ONLY

> 35 pCi/g  
(FIELD CORRELATED)

ON-SITE  
SCREENING  
RADIOLOGICAL ONLY

HIGHEST  
VALUES

OFF-SITE  
ANALYSIS  
RADIOLOGICAL ONLY

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Unit 2 waste area. The analytical results from the CIS sampling program are presented in Appendices C through G.

The geophysical and radiological CIS data were used to guide the planning of RI field activities. A portion of the analytical results for the CIS could be validated and were considered as supplementary information. The CIS data were not used in contaminant fate and transport modeling or risk assessment.

2.2 RI FIELD INVESTIGATIONS

The RI/FS investigative activities that pertain to Operable Unit 2 were conducted in two phases. All RI field investigation activities conducted from 1988 through 1992 are referenced collectively as the Phase I Field Investigation (Phase I). Additional field investigations carried out in 1993 are referenced as the Phase II Field Investigation (Phase II).

2.2.1 Phase I Field Investigation

Phase I was carried out according to objectives and procedures outlined in the following documents:

- RI/FS Sampling Plan, Volume 1, and the Quality Assurance Project Plan, Volume 4, of the "Remedial Investigation and Feasibility Study Work Plan," Revision 3, March 1988
- "Remedial Investigation Work Plan Addendum - Production and Additional Suspect Areas Work Plan," Revision 1 (Document Change Request No. 33, October 1989)
- "Operable Unit 2 Sampling and Analysis Plan Addendum" (Document Change Request No. 41, Rev. D, July 1991)
- Addenda to Volume 1 of the RI/FS Work Plan

Work plan addenda that apply to Operable Unit 2 are: (1) the Production and Additional Suspect Areas Work Plan that cover trenching and sampling of the South Field, (2) a number of addenda that cover the installation and sampling of monitoring wells adjacent to the Operable Unit 2 waste areas, and (3) the Operable Unit 2 Sampling and Analysis Plan Addendum that cover drilling and sampling of the contents of the waste areas. The latter work plan, the only addendum that focused specifically on Operable Unit 2, outlines samples to be collected to fill specific data gaps in the Operable Unit 2 investigation.

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In summary, the Phase I field sampling activities included surface and subsurface media, surface water and sediment, geotechnical, and groundwater. The specific Phase I field activities are discussed and sampling locations are illustrated in Sections 2.3 through 2.6. Analytical data collected for Phase I field activities have been validated and were used to determine nature and extent of contamination, complete contaminant fate and transport modeling, and perform the baseline risk assessment.

The objectives and methods of sample collection carried out in Phase I are described in the sections below. Additional details of sample collection and sample management protocols may be found in the Quality Assurance Project Plan (QAPP) and the Sampling Plan of the RI/FS Work Plan (1988b). For some waste areas, the term "study area" is attached to the name of the waste area, indicating that some sample locations outside the battery limits of the waste area are being considered because of their proximity to that waste area.

2.2.1.1 Phase I Surface Media Investigation

Under this task, as outlined in the site-wide RI/FS Work Plan, Revision 3 (DOE 1988b), five surface media samples were collected in and around Operable Unit 2 areas. Three were collected near the Solid Waste Landfill using the results of a radiation survey that was conducted prior to the surface media sampling (biased samples). At other locations where elevated radionuclide levels were not measured, grid sampling was performed to collect nonbiased samples (Sample Nos. 5001 and 5017). The three biased samples collected near the Solid Waste Landfill were located outside the battery limits of Operable Unit 2 and will be considered by Operable Unit 5. Sample No. 5017 was collected near the Inactive Flyash Pile and Sample No. 5001 was collected near the South Field; however, results of both samples were rejected during data validation.

2.2.1.2 Phase I Surface Water/Sediment Investigation

The site-wide RI/FS surface water and sediment sampling program included Paddys Run, seepage from the eastern embankment of Paddys Run, the Great Miami River, and a number of drainages across the Fernald site. Surface water and sediment samples were collected from various seeps and trenches within Operable Unit 2. Table 2-4 summarizes the surface water and sediment samples collected during Phase I. Appendices C through G provide more detailed sampling information by subunit.

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**TABLE 2-4**  
**SUMMARY OF PHASE I RI/FS SURFACE WATER AND**  
**SEDIMENT SAMPLING FOR OPERABLE UNIT 2**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	Number of Sediment Samples	Analytical Parameters	Number of Surface Water Samples	Analytical Parameters
Solid Waste Landfill	1	Radionuclides	2	Radionuclides Organics Inorganics Pesticides/PCBs General Chemistry
Lime Sludge Ponds	None	--	4	Radionuclides Organics Inorganics Pesticides/PCBs General Chemistry
Inactive Flyash Pile	6	Radionuclides Organics Inorganics Pesticides/PCBs	7	Radionuclides Organics Inorganics Pesticides/PCBs General Chemistry
South Field	None	--	None	--
Active Flyash Pile	4	Radionuclides Organics Inorganics Pesticides/PCBs General Chemistry	12	Radionuclides Inorganics General Chemistry

2.2.1.3 Phase I Subsurface Media Investigation

Subsurface media samples were collected during execution of each of the RI work plans. Subsurface media samples were collected during the drilling of monitoring wells, from trenches excavated in the South Field and Solid Waste Landfill, and from all borings completed in the subunits. Table 2-5 summarizes subsurface media samples that were submitted to an off-site laboratory for analysis.

Six trenches were excavated in the South Field in 1990 to evaluate areas that had not been previously sampled. Forty-two subsurface samples were collected from location numbers 1455 through 1472. Trenches were approximately 50 feet long and placed in an approximate north-south orientation throughout the northern and eastern portions of the South Field where building rubble was thought to be buried. Trenching continued until native soil was encountered. Depths of the trenches ranged from 3.75 to 5.75 feet. Samples for radionuclide analysis were collected from the bottom of the fill material and from the native soil immediately below fill material at the north, south, and middle locations of each trench.

In 1991, additional borings were drilled in each of the Operable Unit 2 waste areas using continuous flight hollow-stem augers. Continuous split-spoon samples were collected in 1.5- to 2-foot increments.

In 1992, two additional trenches were excavated northwest of the South Field/Inactive Flyash Pile area in the pine plantation. The purpose of these trenches was to investigate three historical trenches observed in a 1954 aerial photograph. It was determined that no burial activity occurred in that area. Four subsurface samples were collected from one trench for analysis.

Also in 1992, three exploration trenches were excavated in the Solid Waste Landfill. The purpose of these trenches was to visually characterize the waste disposed in the Solid Waste Landfill. Five leachate samples were collected from the trenches.

2.2.1.4 Phase I Groundwater Investigation

Forty-nine monitoring wells were installed within and adjacent to the Operable Unit 2 waste areas to determine if contaminants were present in perched water or the Great Miami Aquifer. Table 2-6 summarizes groundwater samples collected from these wells. Appendices C through G provide more detailed information by subunit.

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**TABLE 2-5**  
**SUMMARY OF PHASE I RI/FS PHASE I FIELD INVESTIGATION**  
**SUBSURFACE MEDIA SAMPLING WITHIN**  
**OPERABLE UNIT 2 WASTE AREA LIMITS**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	No. of Sample Locations	Sample Depth (feet)	Analytical Parameter	No. of Analyses
Solid Waste Landfill	10	0 - 96.5	Radionuclides	23
			Inorganics	16
			Organics	19 (3 dioxins only)
			General Chemistry	10 (4 sulfide only, 6 TOC only)
			EP Toxicity	3
			TCLP	8 (2 organics only)
Lime Sludge Ponds	5	0 - 46.5	Radionuclides	6
			Inorganics	2
			Organics	2
			General Chemistry	2 (sulfide only)
			TCLP	2
Inactive Flyash Pile	12	0 - 116.5	Radionuclides	21 (1 Total uranium and thorium only)
			Inorganics	12
			Organics	16
			General Chemistry	6 (TOC only)
			EP Toxicity	1
			TCLP	10 (1 metals only)
South Field	48	0 - 141.5	Radionuclides	121 (9 Total uranium only)
			Inorganics	17
			Organics	17
			TCLP	14 (5 organics only)
Active Flyash Pile	11	0 - 106.5	Radionuclides	28 (8 Total uranium only)
			Inorganics	11
			Organics	13
			General Chemistry	5 (TOC only)
			EP Toxicity	3 (1 metals only)
			TCLP	11 (1 organics only)

**TABLE 2-6**

**SUMMARY OF RI/FS PHASE I FIELD INVESTIGATION  
GROUNDWATER SAMPLING WITHIN AND ADJACENT TO  
OPERABLE UNIT 2 WASTE AREAS  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	No. of Wells	Sample Depth (Well Series)	Analytical Parameters	No. of Analyses
Solid Waste Landfill	7	1000, 2000, 3000	Radionuclides Inorganics Organics General Chemistry	43 (1 Total uranium only) 36 15 (6 VOCs only) 40 (4 sulfide only)
Lime Sludge Ponds	7	1000, 2000	Radionuclides Inorganics Organics General Chemistry	21 (3 Total uranium only) 17 2 (1 VOCs only) 23 (6 nitrate only)
Inactive Flyash Pile	9	1000, 2000, 3000, 4000	Radionuclides Inorganics Organics General Chemistry	26 26 4 23
South Field	19	1000, 2000, 3000, 4000	Radionuclides Inorganics Organics General Chemistry	56 (5 Total uranium only, 1 Gross Alpha/Beta only) 47 8 (1 VOCs only) 53 (6 nitrate only)
Active Flyash Pile	7	1000, 2000, 3000	Radionuclides Inorganics Organics General Chemistry	30 27 0 27

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The depth of a Fernald site well and location in the water-bearing zone in which it was completed (screened) are denoted by the first digit of the well number. Wells completed in the perched groundwater within the glacial overburden are denoted as 1000-series wells. Wells completed in the upper portion of the Great Miami Aquifer are denoted as 2000-series wells. The 3000-series wells are completed in the upper portion of the Great Miami Aquifer, immediately above a layer of blue clay which separates the upper and lower portion of the aquifer. The 4000-series wells are completed in the Great Miami Aquifer beneath the layer of blue clay. Sometimes a group of two or more wells of different depths are completed at the same location to sample different water-bearing zones; these groups are called well clusters. On-site monitoring wells were installed between 1985 and 1993 using cable-tool drilling techniques, with the exception of the 1000-series wells, which were typically drilled using hollow-stem continuous flight augers.

The Operable Unit 2 groundwater investigation examined the potential for release of contaminants to groundwater from the Solid Waste Landfill, Lime Sludge Ponds, Active Flyash Pile, Inactive Flyash Pile, and South Field. Releases from other operable unit study areas and the determination of rate and the resultant extent of contamination from other operable unit waste areas were not evaluated.

Monitoring wells 1014, 1016, 2014, 2016, 3014, and 3016 were installed prior to the RI/FS as part of the Groundwater Study Task C by Dames & Moore (1985a). A total of 27 monitoring wells were installed within the Operable Unit 2 Study Areas during Phase I (see Figures 2-2, 2-8, and 2-14). The locations were selected on the basis of data gaps identified from previous groundwater studies and on sampling results from the existing wells.

Monitoring Well 1433 was installed in the South Field in August 1992 as part of Phase I to collect leachate/perched groundwater for analysis and assist in determining the source of uranium contamination found in the Great Miami Aquifer around Monitoring Well 2046.

2.2.1.5 Phase I Geotechnical Investigation

In-place density measurements using the nuclear density technique were made on the wastes in each of the five subunits of Operable Unit 2. An expanded suite of geotechnical analyses required to support the FS was performed on subsurface samples from the Active and Inactive Flyash piles. These analyses included the following:

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- Grain size, American Society for Testing and Materials (ASTM D-422) 1
- Atterberg limits, ASTM D-4318 2
- Moisture content, ASTM D-2216 3
- Specific gravity, ASTM D-854 4
- Standard proctor, ASTM D-698 5
- Relative density, ASTM D-2049 6
- 1-D consolidation, ASTM D-2435 7
- Permeability, EPA METHOD 9100 (SW 846) 8
- In-place density, ASTM D-2922, D-2167, or D-1556 9

Additional RI sampling and analyses were undertaken to meet the objectives of the Operable Unit 2 RI. This supplemental Phase II sampling resulted from review comments received from EPA and OEPA (December 17, 1992) on the October 1992 version of the Draft RI Report for Operable Unit 2 and responses to those comments by DOE (February 7, 1993).

2.2.2 Phase II Field Investigations

A sampling program was implemented in 1993 to meet the additional data requirements. The scope of Phase II field activities for the RI included sampling of all media. Field activities were defined by identifying data requirements not fulfilled by previous sampling efforts. Development of data requirements and sampling objectives is summarized in the SAP for the RI/FS Work Plan Addendum for Operable Unit 2 (DOE 1993b). A list of variances to the SAP is provided in Table 2-7.

2.2.2.1 Phase II Field Investigation Data Requirements

The Phase II Field Investigation data requirements were developed by defining the information required to achieve the RI objectives. The specific data requirement resultant field activities are presented for each Operable Unit 2 waste unit in Sections 2.3 through 2.6.

2.2.2.2 Phase II Field Investigation Methods

Procedures used during the field operations were defined by the FEMP program plans, procedures, and EPA guidance. FEMP program plans, specifically the Draft (at the time) Site-Wide CERCLA Quality Assurance Project Plan (SCQ), QAPP, Site-Wide RI/FS Work Plan, and FEMP Site Characterization/Data Management (SC/DM) Department and Environmental Monitoring Section Standard Operating Procedures were used as guidance documents. EPA procedure reference sources include the "Compendium of Superfund Field Operations Methods" and "Hazardous Waste Site Disposal Operations."

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**TABLE 2-7**  
**VARIANCE REQUESTS**  
**SAMPLING AND ANALYSIS PLAN FOR**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Variance Request Number	Summary	Justification
CRU2-93-1	Unused	Not required
CRU2-93-2	Preselect screen size and filter pack, and proceed with 2000-series well installation without receipt of sieve analysis results. Variance to SCQ, which states that the size of screen openings and filter pack shall be determined based on the effective grain size of the monitored zone.	Review of existing 2000-series wells indicates they were completed with 0.010-inch screen and a medium to coarse grain filter sand; a paper prepared by ASI/IT presented justification for obtaining turbidity-free groundwater samples from existing wells of similar construction.
CRU2-93-3	Relocate Hydropunch™ boring 11018 in South Field. Variance to the SAP, which states ten Hydropunch™ borings will be completed at specific locations in the South Field regardless of findings during field activities.	Groundwater gradient information indicates that the new proposed location is more directly upgradient of well 1516, which has exhibited high concentrations of total uranium in past sampling events. The new proposed location would be more effective in determining the source of this contamination.
CRU2-93-4	Relocate monitoring well 1941 from central part of South Field to north central South Field. Variance to SAP.	Field data indicated that perched groundwater was not encountered in a Hydropunch™ at the SAP original location. Significant uranium contamination of perched groundwater was encountered in hydropunches at the new proposed 1941 location.
CRU2-93-5	Collect six additional soil gas samples (AA-3, A-2, A-4, C-1, CD-1, and D-1) from the Solid Waste Landfill based on field data. Field data exhibited high organic vapor concentrations at the selected locations; analyze for VOC's by EPA Method T-014. Variance to the SAP.	A more focused second round of selected sampling and analysis was performed to confirm the results of the initial round and collect data to determine the location of several discretionary borings.

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 February 18, 1994

TABLE 2-7  
(Continued)

Variance Request Number	Summary	Justification
CRU2-93-6	Complete a Hydropunch™ boring (11029) that will penetrate the Great Miami Aquifer at the proposed 2944 monitoring well location using hollow stem auger drilling. Variance is to SCQ, which requires installation of large diameter temporary casing in areas, even where contamination is NOT suspected.	To select monitor well location for uncontaminated upgradient conditions, pre-evaluation of the proposed 2944 location for presence of contaminants is necessary. A temporary casing is not necessary due to data from adjacent boring 1966, which indicates that the subsurface has no perched water or elevated radioactive readings.
CRU2-93-7	Drilling of Hydropunch™ borings (11019, 11020, 11021, 11022, 11023) in southern portion of South Field without continuous split barrel soil sampling. Variance to SAP.	The Hydropunches™ will be located in the vicinity of previous Hydropunch™ and monitoring well locations making the available data sufficient for lithological interpretation.
CRU2-93-8	Relocate monitoring well 1954 from Inactive Flyash Pile to South Field. Variance to SAP.	Perched groundwater was encountered at the new proposed location and not at the old location.
CRU2-93-9	Drill additional Hydropunch™ (11047) north of Inactive Flyash Pile in field. Variance to SAP.	Define uncontaminated groundwater at the most northerly perched groundwater boundary near the Inactive Flyash Pile. Groundwater contamination was detected in the most upgradient Hydropunch™ samples collected from Inactive Flyash Pile.
CRU2-93-10	Drill additional Hydropunch™ (11028) in South Field at boring location 1965 with hollow stem auger to further determine uncontaminated conditions prior to locating monitoring well 2944. Variance to SAP.	Previous investigation indicates no perched water conditions or radioactive soil contamination; previous Hydropunch™ indicated Great Miami Aquifer radioactive contamination (Variance CRU2-93-6).
CRU2-93-11	Complete 10 additional borings (11048, 11049, 11050, 11051, 11052, 11053 11054, 11055, 11056, and 11057) at the Inactive Flyash Pile to further define vertical and horizontal extent of contamination. Variance to SAP.	Previous investigation indicates contamination sources which need to be further defined horizontally and vertically.
CRU2-93-12	Delete surface water and sediment sample SF-SW-04, and SF-SD-04. Variance to SAP.	Surface water and sediment did not exist at the proposed location.
CRU2-93-13	Collect additional targeted samples to provide data used in chemical fate and transport modeling for subunits (K <sub>d</sub> samples). Variance to SAP.	Literature derived values for the distribution coefficient of U-Total have not proved satisfactory in predicting the migration of radionuclides in a transport computer model.

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**TABLE 2-7  
(Continued)**

Variance Request Number	Summary	Justification
CRU2-93-14	Obtain procedural changes for screening, sampling, sample analysis, and surveying of Lime Sludge Ponds and South Field investigative trenches. Variance to SAP.	Based on site specific conditions, procedures are more explicitly defined to provide the desired results.
CRU2-93-15	Perform additional Hydropunch™ boring (11030) with hollow stem auger drilling in the Great Miami Aquifer in the South Field, 75 feet northeast of boring location 1964 to further determine uncontaminated conditions for locating monitoring well 2944. Variance to SAP.	Previous investigation indicates no perched water conditions or radioactive soil contamination; previous Hydropunch™ indicated Great Miami Aquifer radioactive contamination (Variance CRU2-93-10).
CRU2-93-16	Perform additional Hydropunch™ borings (11082, 11083, and 11084) and install additional monitoring well (11085) east of the South Field (next to Great Miami Aquifer Well No. 2385). Variance to SAP.	Investigation of perched zone in north end of South Field indicates contamination. Further definition of horizontal extent toward the east is required.
CRU2-93-17	Install additional 2000-series monitoring well (2954) adjacent to 1954. Variance to SAP.	Investigation of Inactive Flyash indicates possible source of Great Miami Aquifer contamination, which needs further definition. Well is downgradient of Inactive Flyash Pile.
CRU2-93-18	Perform an additional soil boring (11040) in the Solid Waste Landfill. Variance to SAP.	Obtain a lithological description of the deep part (> 40 feet deep) of till beneath the Landfill, which has not been accomplished in the past.
CRU2-93-19	Obtain core samples of unearthed concrete debris and analyze for radiological contaminants. Variance to SAP.	Determine penetration of radioactivity into the concrete debris to determine handling and disposal requirements.
CRU2-93-20	Collect seven additional surface water samples from the outfall ditch west of the Inactive Flyash Pile. Variance to SAP.	More accurately define the source of radioactivity observed in early on-site analyses.
CRU2-93-21	Extend the depth (6-inches) of hand augering in boring 1963, Lime Sludge Ponds, and move LSP-SS-10 location 30 feet west of LSP-SS-09. Variance to SAP.	Extending the depth will not adversely impact the integrity of the underlying soil, and moving the proposed location for LSP-SS-10 will improve the safety of the sampling crew.
CRU2-93-22	Collect soil samples from areas exhibiting the highest radiological field screening results in each trench excavation for on-site radionuclide screening (i.e., thorium, radium, uranium, and gross characteristics). Trenching will continue until the anomaly is adequately identified. Variance to SAP.	Previous analytical results for the South Field indicate these are the contaminants of concern and the on-site lab can provide the quality levels necessary. Trenching activity is being conducted to visually identify the anomalies detected from the geophysical survey.

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FEMP-OU02-4 DRAFT  
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**TABLE 2-7  
(Continued)**

Variance Request Number	Summary	Justification
CRU2-93-23	Install additional monitoring well (11032) north of the South Field. Variance to SAP.	Define uncontaminated groundwater at the upgradient perched groundwater boundary near to the South Field. Groundwater contamination has been detected in the most upgradient areas investigated within the South Field.
CRU2-93-24	Obtain approval for data validation to deviate from procedure SSOP-1004. Variance to SCQ.	The IT laboratory contract did not stipulate SCQ-type radiological QC requirements and thus, the new database is not in place and SSOP-1004 was not implemented at the time the samples were taken.
CRU2-93-25	Perform five additional soil borings (11036, 11037, 11038, 11039, 11040) in the Solid Waste Landfill. Variance to SAP.	Previous investigation indicates contamination which needs further definition of nature and extent.
CRU2-93-26	Collect three additional surface water samples from the ditch east and north of South Field. Variance to SAP.	More accurately define the potential surface migration of contaminants to complete fate and transport modeling.

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**2.2.2.2.1 Phase II Geophysical Survey**

Magnetic and EM conductivity surveys were conducted in the South Field to locate buried ferrometallic materials and areas of elevated conductivity that represent potentially contaminated metal debris and reinforced concrete rubble. Instruments consisted of a EDA Omni Plus proton precession magnetic gradiometer and a Geonics EM-31 DL terrain conductivity meter (with Omni digital data logger). Spatial control was established with a 20-foot by 20-foot grid. Magnetometer data were collected at all grid points with the instrument aligned with the magnetic north direction. EM conductivity data were collected at all grid points with the instrument boom aligned with the north-south grid axis. The EM survey was performed in both the vertical and horizontal dipole to further evaluate near surface disturbances. The locations of all known metallic surface features were recorded and considered in data interpretation. Trenching and subsurface media sampling were performed at the ten strongest anomalies.

**2.2.2.2.2 Phase II Soil Gas Survey**

A soil gas survey was completed to locate sources of organic contamination in the Solid Waste Landfill. Forty-seven gas samples were collected from 50 proposed locations by driving a hollow stainless steel probe equipped with an extraction point approximately three feet into the subsurface materials. A vacuum was then applied to the probe to extract soil gas into Tedlar bags for screening with an organic vapor meter (OVM) and organic vapor analyzer (OVA). Based on these results, five samples were selected and sent to an off-site laboratory for organic analysis by EPA Method TO-14. Gas sampling points were located on a grid based on the reported east-west orientation of disposal cells in the landfill. Sampling points were located with an east-west spacing of 50 feet and a north-south spacing of 20 feet.

**2.2.2.2.3 Phase II Surface Media Sampling**

Surface media sampling locations were selected based on criteria established for each subunit investigation. All surface soil samples were screened in the field for volatile organic vapor with a photoionization detector (HNu) and screened with a beta/gamma pancake probe survey instrument for radiation. All samples were visually described, and all sample collection points were surveyed to define the surface elevation and the north and east location. Samples which exhibit screening levels greater than 10 times background were considered "elevated" and were considered for further laboratory analysis. Table 2-8 summarizes the surface samples collected and analytical parameters.

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**TABLE 2-8**  
**SUMMARY OF RI/FS PHASE II**  
**FIELD INVESTIGATION SURFACE MEDIA SAMPLES**  
**WITHIN OPERABLE UNIT 2 WASTE AREAS**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	No. of Sample Locations	Sample Depth (feet)	Analytical Parameters	No. of Analyses
Solid Waste Landfill	12	0 - 0.5	Radionuclides	12
			HSL	12
			On-Site Screening	0
			Geotechnical	1
Lime Sludge Ponds	14	0 - 0.5	Radionuclides	15
			HSL	15 (1 Pest/PCBs only)
			On-Site Screening	4
			Geotechnical	1
Inactive Flyash Pile	7	0 - 0.5	Radionuclides	7
			HSL	7
			On-Site Screening	0
			Geotechnical	1
South Field	21	0 - 0.5	Radionuclides	21
			HSL	21
			On-Site Screening	0
			Geotechnical	0
Active Flyash Pile	14	0 - 0.5	Radionuclides	14
			HSL	14
			On-Site Screening	0
			Geotechnical	2

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2.2.2.2.4 Phase II Subsurface Media Sampling

Soil and waste borings were completed using a truck-mounted hollow-stem auger drill rig and split-spoon or Shelby™ tube type sampler. Subsurface media were collected from monitoring well soil samples and Hydropunch™ borings. Continuous samples were collected in advance of the hollow-stem auger from six inches below surface to a planned total depth. All samples were field screened with beta/gamma and photoionization detectors, and values were recorded. Depending on the subunit, various samples of both fill and glacial till with the highest above background radiological response were analyzed at an off-site contract laboratory. Table 2-9 summarizes subsurface samples collected and analytical parameters.

After sampling objectives were accomplished, each boring not completed as a monitoring well was plugged with Volclay grout from the bottom to surface through the hollow stem auger or via a tremie pipe. After the grout settled, a minimum of a 12-inch cement plug was placed in the hole.

Hand augering was used to collect near surface soil and sludge samples in the Lime Sludge Ponds subunit. Wastes identified for possible sampling were field screened with a photoionization detector and alpha-beta meter. If field screening results indicated that a sample should be taken, the sample for volatile analyses was collected first.

All soil samples were visually described. A sample was collected for toxicity characteristic leaching procedure (TCLP) analysis if the sample contained significant volatile organic vapor readings. The sample from each boring with the highest reading from the photoionization detector was also analyzed for the analytes in the Target Analyte List (TAL) 20.03.05 C (see Table 2-13). Samples of elevated radioactivity (10 times background and above) were candidates for on-site screening by gamma spectrometry to quantify radionuclide activities for uranium, thorium, and radium.

2.2.2.2.5 Phase II Trench Investigations

Excavations using a backhoe were completed at suspect locations in the South Field and Lime Sludge Ponds to determine if rubble/debris might be a source of contamination to surrounding subsoils and groundwater. Ten South Field trenching locations were selected according to anomalous electromagnetic data (see Section 2.2.2.2.1). A trench at the Lime Sludge Ponds subunit was located adjacent to the existing K-65 Slurry Line. Excavation procedures for trenching, screening, sampling,

**TABLE 2-9**  
**SUMMARY OF RI/FS PHASE II**  
**FIELD INVESTIGATION SUBSURFACE SOIL SAMPLING**  
**WITHIN OPERABLE UNIT 2 WASTE AREAS**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	No. of Sample Locations	Sample Depth (feet)	Analytical Parameters	No. of Analyses
Solid Waste Landfill	25	0 - 78.0	Radionuclides	36
			HSL	38 (1 VOCs only)
			TCLP	6 (2 metals only)
			Geotechnical	49
			On-Site Screening	14
Lime Sludge Ponds	30	0 - 18.5	Radionuclides	33
			HSL	36 (2 VOCs only)
			TCLP	8
			Geotechnical	42
			On-Site Screening	14
Inactive Flyash Pile	26	0 - 65.0	Radionuclides	24
			HSL	35 (2 VOCs only)
			TCLP	6
			Geotechnical	15
			On-Site Screening	70
South Field	48	0 - 65.0	Radionuclides	45
			HSL	42
			TCLP	0
			Geotechnical	34
			On-Site Screening	44
Active Flyash Pile	4	0 - 60.0	Radionuclides	12
			HSL	12
			TCLP	4
			Geotechnical	6
			On-Site Screening	0

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backfilling, and regrading are defined in the SAP for the RI/FS Work Plan Addendum for Operable Unit 2.

South Field trenching began at the center point of an anomaly and proceeded toward either end to a maximum depth of 15 feet. The trenches were excavated by segments. If groundwater was encountered during trenching, that segment of the trench was temporarily abandoned, the backhoe was moved to another position along the centerline, and a new excavation was begun.

Soil debris or waste material was taken from the bucket of the backhoe for sampling. Sample locations were selected in the field by the project geologist based upon radiological and organic vapor screening and upon visual descriptions. During and following excavation of the trench, the project geologist constructed a cross-section profile of one sidewall of each trench. Cross sections showed all significant soil, subsoil and unconsolidated material, and differentiated depositional, lithologic, or visual differences revealed in the trenches. Areas of fill, debris, or other obvious cultural-related fill material were clearly labeled and shown on the cross sections (see Tables D-18B and F-18B in Appendices D and F). In addition, the trench excavations were photographed.

Upon completion of the cross sections, if sidewalls were stable, a vertical radiological survey of one of the trench sidewalls was performed. This survey was performed with a SPA-3 probe. The results were recorded on the project geologist's trench cross sections. As material was removed, samples were collected from the backhoe bucket and screened. Undisturbed native materials were sampled only if screening detected elevated (greater than 10 times background) readings. If no previous disturbance of the soils or soil material was evident and no elevated field readings were observed, no samples were collected. Five trenching samples from three trenches were submitted to an off-site contract laboratory.

Upon completion of the investigation at each trench, the trench was backfilled with the materials which were removed during the excavation; no clean fill was imported for trenching purposes. The area was then graded and returned to its approximate original contour and slope. Trenching was accomplished at a minimum rate of one trench per day.

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2.2.2.2.6 Phase II Hydropunch™ Groundwater Sampling

Hydropunch™ sampling was performed in conjunction with hollow-stem auger drilling to collect groundwater samples with a bailer from saturated till deposits. Thirty-five groundwater samples were analyzed for total uranium by laser phosphorimetry in the on-site laboratory. These analyses provided a total uranium concentration value for characterization purposes, typically within 24 hours of collection. The detection limit varied depending upon the concentrations of total uranium, but was at or below 0.10 ppm. The objective was to define saturated soil conditions and determine approximate boundaries of groundwater uranium contamination prior to selecting monitor well locations.

The procedure was to drill borings and collect soil samples for lithologic description. The expected depth to water at the sampling site was estimated from nearby wells, and a Hydropunch™ sample was collected once saturated conditions were encountered in soil samples recovered from the borings. Hydropunch™ samples were not collected if clay soil or unsaturated soil conditions were encountered. These conditions typically do not yield sufficient water in a timely manner to justify sampling activities.

2.2.2.2.7 Phase II Monitoring Well Installations

Eleven monitoring wells in perched water formations (1000-series wells) were drilled with a truck-mounted auger rig using nominal 8-inch or 10-inch hollow stem augers as available. Continuous 18-inch long split-spoon samples were collected in advance of the auger through the till to an approximate maximum depth of 20 feet. Wells were completed using two-inch diameter, 316 stainless steel risers and 0.010-inch slotted screen across the perched water interval. Filter pack material was well-sorted quartz sand, ranging between 10-20 mesh (coarse) and 20-40 mesh (medium).

Thirteen monitoring wells in the upper Great Miami Aquifer (2000-series wells) were drilled by cable-tool methods, using a nominal 10-inch diameter drill casing. Continuous 18-inch long split-spoon samples were taken in the glacial till and at five-foot intervals in sand and gravel of the upper Great Miami Aquifer. Wells monitoring the Great Miami Aquifer in waste or contaminated areas required the advance placement of a shallow surface casing. Depending upon the combined thickness of the fill and till, approximately 35 feet of nominal 12-inch inner-diameter (ID) steel surface casing was cemented in place within a boring of 14 to 16 inches. The cement was allowed to cure for a

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minimum of 24 hours before continuation of drilling to the planned total depth with an 8-inch ID casing.

Wells were completed using four-inch diameter 316 stainless steel slotted screen (15-feet) and riser. Either a 0.010-inch or 0.020-inch screen and medium or coarse quartz sand filter pack as defined in the RCRA Groundwater Monitoring Plan (DOE 1991b) were installed based on field classification of the formation material or sieve analysis. However, for expedience, 0.010 inch screens were installed in lieu of sieve analyses, which commonly required a minimum of 24 hours to complete.

#### 2.2.2.2.8 Phase II Groundwater Level Measurements and Sampling

At least three complete rounds of groundwater level measurements from the existing monitoring wells in each subunit were taken at two week intervals during the Phase II Field Investigation. After the well installations were complete in each subunit, a final round of measurements was taken from both the existing and newly installed wells. All groundwater level measurements for each round were collected within a 24-hour period of consistent weather conditions to minimize changes due to atmospheric and precipitation effects. In addition, groundwater levels were recorded for all new wells at the time of completion and after well development. All measurements were recorded to the nearest 0.01 feet. Individual monitoring well hydrographs characterized whether water levels had reached equilibrium.

One round of groundwater sampling was conducted within 24 hours of developing the newly drilled monitoring wells and within 24 hours of purging the existing wells. Equipment included bailers, surge blocks, pumps, and hoses. All wells were developed to achieve turbidity-free water (less than five turbidity units); no less than five times the standing water in the well (casing volume) was purged during development. Existing wells were purged of at least three times volume, depending upon available rates of recharge. Samples were collected according to the SCQ and RI/FS QAPP. Water levels were measured using a Hazco Water Level Meter and recorded in all new and existing wells prior to sampling to establish baseline information. Field measurements of water temperature, pH, conductivity, and dissolved oxygen were taken and recorded. Groundwater samples were properly preserved and transferred under chain of custody protocols to the contract RI/FS laboratory for the designated analyses. Table 2-10 summarizes the groundwater samples collected and analytical parameters.

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**TABLE 2-10**  
**SUMMARY OF RI/FS PHASE II**  
**FIELD INVESTIGATION GROUNDWATER SAMPLES**  
**WITHIN OPERABLE UNIT 2 WASTE AREAS**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	No. of Wells	Sample Depth (Well Series)	Analytical Parameters	No. of Analyses
Solid Waste Landfill	16 <sup>a</sup>	1000, 2000	Radionuclides	20
			HSL	20 (6 metals only) (2 metals and cyanide only)
			On-Site Screening	20
Lime Sludge Ponds	10	1000, 2000	Radionuclides	20
			HSL	21 (5 metals only) (3 metals and cyanide only) (1 VOCs and TOC only)
			On-Site Screening	15
Inactive Flyash Pile	5	1000, 2000	Radionuclides	6
			HSL	6 (1 metals only)
			On-Site Screening	6
South Field	16	1000, 2000	Radionuclides	25
			HSL	26 (7 metals only) (2 metals and cyanide only) (1 VOCs and TOC only)
			On-Site Screening	20
Active Flyash Pile	6	1000, 2000	Radionuclides	6
			HSL	6 (1 metals, VOCs, and cyanide only)
			On-Site Screening	7

<sup>a</sup> Four of these locations are not wells, but are groundwater samples collected from borings.

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2.2.2.2.9 Phase II Surface Water and Sediment Sampling

Surface water sampling was accomplished by the use of a grab bottle or, where necessary, a length of rope or an extension pole was attached to the grab bottle. The sample was then transferred to the sample containers allowing minimal disturbance. Field determinations of temperature, conductivity, and pH were made on aliquots of the selected sample. Sampled water was placed into the appropriate container with preservative where required, capped, and placed into a cooler. Ten surface water samples were collected for risk assessment purposes and shipped unfiltered to the laboratory.

Unconsolidated sediment was collected using a glass or plastic grab bottle. The sediment was allowed to dewater prior to emplacement into the sample collection container. Once the sediment settled, the water sample was decanted into the sample container. During the sample dewatering period, the sample underwent field screening for radiological activity and the presence of organic contamination.

For sediment samples to be taken at nonflowing surface water locations, sampling consisted of obtaining bottom sediments with a stainless steel trowel. For sampling locations where the standing water was too deep for trowel sampling, a stainless steel bucket auger was used. For flowing surface water bodies, samples were collected from the downstream positions first, followed by the upstream samples. Table 2-11 summarizes the surface water and sediment samples collected and the analytical parameters.

2.2.2.2.10 Phase II Geotechnical Sampling

Geotechnical tests were conducted to characterize the engineering properties of the soil and waste material from the Operable Unit 2 subunits. Soil and waste material samples were collected from borings completed by truck-mounted hollow-stem auger drill rigs and by means of split-spoon or Shelby™ tube type samplers. Samples were selectively analyzed for specific gravity, liquid limit, plasticity index, natural moisture content, particle size and distribution, maximum density, optimum moisture content and color, and physical state. Table 2-9 includes a breakdown of geotechnical samples by subunit.

2.2.2.2.11 Phase II Project Surveying

Locations of sampling points, borings, and wells were surveyed by a Registered Professional Land Surveyor. All surveyed locations are accurate to the nearest 0.01 feet vertical accuracy and 0.10 feet horizontal accuracy. Survey points were located and integrated into the existing FEMP Geographic

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**TABLE 2-11**  
**SUMMARY OF RI/FS PHASE II**  
**FIELD INVESTIGATION SURFACE WATER/SEDIMENT SAMPLES**  
**WITHIN OPERABLE UNIT 2 WASTE AREAS**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Waste Unit	No. of Sample Locations	Analytical Parameters	No. of Analyses
<b>SURFACE WATER</b>			
Solid Waste Landfill	3	Radionuclides	2
		HSL	2
		On-Site Screening	3
Lime Sludge Ponds	2	Radionuclides	2
		HSL	2
		On-Site Screening	3
Inactive Flyash Pile	11	Radionuclides	6
		HSL	6
		On-Site Screening	15
South Field	6	Radionuclides	2
		HSL	2
		On-Site Screening	6
Active Flyash Pile	1	Radionuclides	1
		HSL	1
		On-Site Screening	1
<b>SEDIMENT</b>			
Solid Waste Landfill	2	Radionuclides	2
		HSL	2
		Geotechnical	2
		On-Site Screening	4
Lime Sludge Ponds	0	Radionuclides	0
		HSL	0
		Geotechnical	0
		On-Site Screening	0
Inactive Flyash Pile	3	Radionuclides	4
		HSL	6
		Geotechnical	2
		On-Site Screening	0
South Field	3	Radionuclides	3
		HSL	3
		Geotechnical	2
		On-Site Screening	3
Active Flyash Pile	1	Radionuclides	1
		HSL	1
		Geotechnical	0
		On-Site Screening	0

Information System (GIS) and incorporated into the site database. The basis for map coordinates is the State Planar North American Datum (1927).

2.2.2.2.12 Phase II Field Quality Assurance Sampling

Field quality assurance (QA) samples were collected during the sampling program for each of the Operable Unit 2 subunit investigations. Trip and preservative blanks were provided by the QA group and the remaining samples were prepared or collected by the sampling teams. The QA sample types and requirements are:

- Trip blank samples for volatile organic analyses (VOA) were prepared in a controlled environment by pouring distilled water meeting the ASTM Type II standards into 40 milliliter (mL) vials. A trip blank for VOA accompanied each sampling team during each day's sampling to the field location and was shipped to the laboratory with the field samples for analyses. Trip blanks were required during sampling events for all media types when the target analytes included volatile organics for analytical support levels (ASLs) C, D, and E.
- Field blank samples were prepared for every 10 groundwater and/or surface water samples and analyzed for the same target analytes specified for the field sample collected during the sampling event. The 1/10 frequency of field blanks is based on the number of groundwater/surface water samples collected from each Operable Unit 2 subunit. A field blank sample was prepared at the sampling site by the field team by pouring deionized/organic free water into the appropriate sample containers.
- An equipment rinsate sample was collected for every 20 field samples of any media type following decontamination of the sampling equipment. Rinsate samples were collected after a sampling event entailing Full Hazardous Substance List (HSL) and Full Radioisotope parameters and in conjunction with sampling events having the highest potential for contamination coming in contact with the equipment. This assessed the effectiveness of the field decontamination procedures.
- Duplicate water samples were collected at a frequency of 1 per every 20 groundwater or surface water samples. The duplicate samples were collected at sampling locations which were known or suspected of being contaminated. These samples were assigned a unique sample number and sent to the laboratory as a blind sample. No duplicate soil samples were collected due to the lack of an effective field compositing technique which would produce meaningful data where discrepancies could absolutely be considered a laboratory precision problem.
- One preservative blank for each type of preservative used was prepared and analyzed for the respective parameters of interest. This consisted of an analyses of separate ASTM Type II water samples preserved with each respective acid and base preservative. The hydrochloric (HCl) acid-preserved sample was analyzed for volatile organic compounds, the sodium hydroxide (NaOH) preserved sample for cyanide, and the nitric acid (HNO<sup>3</sup>) preserved sample for metals.

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- Container blanks were not included in the QA samples since all containers used for RI/FS sampling activities were precleaned by the manufacturer and had a certificate of analysis for each lot of containers.

2.2.2.2.13 Phase II Sample Collection Documentation

Surface water and groundwater samples collected in the field were documented on the Sample Collection Log and Water Quality Field Collection Report forms. The collection of soil and subsoil materials were documented on the Sample Collection Log, Visual Classification of Soils, and Subsurface Soil Sample Collection Log. In addition to these forms, daily field activities were recorded on the Field Activity Daily Log form. Examples of these forms are found in Appendix B of the FEMP SCQ.

Consistent with standard FEMP RI/FS practice, a unique six-digit sample number was assigned to each collected sample. Specific number ranges were allocated for each Operable Unit 2 subunit being characterized. Each sample container was affixed with a RI/FS label containing, at a minimum, the information specified on Form 7-2, Appendix B of the FEMP SCQ.

Sample custody procedures as outlined in the FEMP SCQ were adhered to throughout the sample handling process from field collection to shipment or delivery of the samples to the laboratory. A combined Request for Analysis/Chain of Custody (RFA/CC) record was used to document collection data, chain of custody, and the analytical parameters requested for each sample in accordance with FEMP RI/FS Procedure FPP-401. The Site-Wide Analysis Request/Custody Record (SAR/CR) form was completed for all samples delivered to the on-site sample processing laboratory.

2.2.2.2.14 Investigation Derived Waste Handling/Storage/Disposal

During field work, wastes were generated in the form of excess surface water, sediment, sludge and solid wastes sampling media, contaminated well purge water, contaminated sampling equipment, contaminated drilling equipment, contaminated personal protective equipment (PPE), drill cuttings, and decontamination.

Contaminated drill cuttings from auger drilling and cable tool drilling were placed in clean 55-gallon drums and labeled according to project and location of origin. Contaminated PPE consisting of disposable items were labeled as radiological wastes and placed in designated disposal containers, labeled, and sent to the appropriate interim storage location.

Decontamination of drilling and sampling equipment was performed at authorized FEMP Decontamination Areas. Fluids and solid material residuals were handled in accordance with the normal operation of that facility's contamination treatment/control devices. Well sampling purge water was disposed of in the General Sump.

Material excavated during trenching was backfilled into the trench it was removed from; no clean fill was added.

2.2.2.3 Phase II Analytical Methods

Project specific TALs were developed for analytes of interest for the Operable Unit 2 RI. The TALs were based on the following data gaps from previous investigations:

- The lack of sufficient characterization data in some portions of the subunits.
- The need for consistency with the Operable Unit 5 investigation, particularly when addressing fate and transport modeling and risk assessment.
- The need to define source areas and the upgradient and downgradient extent of groundwater contaminant migration across the Inactive Flyash Pile, South Field, and Active Flyash Pile areas.

The TAL 20.03.05 A is equivalent to total uranium screening at the FEMP laboratory. The other Phase II project specific TALs are provided in Tables 2-12 through 2-15. These analyses were performed by IT Corporation Analytical Service, an off-site contract laboratory. The analytes that compose TAL 20.03.05 B and TAL 20.03.05 C are referred to as the Full HSL and Full Radioisotope lists. Because TAL 20.03.05 B is for aqueous matrix samples and TAL 20.02.05 C is for solid matrix samples, general chemistry parameters are included in TAL 20.03.05 B only.

EPA contract laboratory program (CLP) or SW-846 methods were followed for organic and inorganic analyses. Analytical methods for radioisotopes followed performance-based criteria cited directly by the SCQ. In all cases, the laboratory generated a CLP data package or equivalent for non-CLP analytes such as general wet chemistry. The goal of the analytical documentation was to provide CLP data packages for all samples that were able to be validated to ASL C, with 10 percent ASL D validation for each matrix.

**TABLE 2-12**  
**FEMP RI/FS TAL 20.03.05 B**  
**OPERABLE UNIT 2 TARGET ANALYTE LIST**  
**PHASE II FIELD INVESTIGATION**  
**GROUNDWATER AND SURFACE WATER SAMPLES**

FULL HAZARDOUS SUBSTANCE LIST (HSL)			
<b>Inorganics</b>			
aluminum	chromium (total)	manganese	silver
antimony	cobalt	mercury	sodium
arsenic	copper	molybdenum	thallium
barium	cyanide	nickel	vanadium
beryllium	iron	potassium	zinc
cadmium	lead	selenium	
calcium	magnesium	silicon	
<b>Volatile Organics</b>			
1,1-dichloroethane	2-hexanone	chlorobenzene	tetrachloroethene
1,1-dichloroethene	4-methyl-2-pentanone	chloroethane	toluene
1,1,1-trichloroethane	acetone	chloroform	total xylenes
1,1,2-trichloroethane	benzene	chloromethane	trans-1,3-dichloropropene
1,1,2,2-tetrachloroethane	bromodichloromethane	cis-1,3-dichloropropene	trichloroethene
1,2-dichloroethane	bromoform	dibromochloromethane	vinyl acetate
1,2-dichloroethylene	bromomethane	ethylbenzene	vinyl chloride
1,2-dichloropropane	carbon disulfide	methylene chloride	
2-butanone	carbon tetrachloride	styrene	
<b>Semivolatile Organics</b>			
1,2-dichlorobenzene	2-nitroaniline	2,6-dinitrotoluene	4-nitroaniline
1,2,4-trichlorobenzene	2-nitrophenol	3-nitroaniline	4-nitrophenol
1,3-dichlorobenzene	2,4-dichlorophenol	3,3-dichlorobenzidine	4,6-dinitro-2-methylphenol
1,4-dichlorobenzene	2,4-dimethylphenol	4-bromophenyl phenyl ether	acenaphthene
2-chloronaphthalene	2,4-dinitrophenol	4-chloro-3-methylphenol	acenaphthylene
2-chlorophenol	2,4-dinitrotoluene	4-chloroaniline	anthracene
2-methylnaphthalene	2,4,5-trichlorophenol	4-chlorophenyl phenyl ether	benzoic acid
2-methylphenol	2,4,6-trichlorophenol	4-methylphenol	benzo(a)anthracene

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TABLE 2-12  
(Continued)

FULL HAZARDOUS SUBSTANCE LIST (HSL)			
Semivolatile Organics (Continued)			
benzo(a)pyrene	butyl benzyl phthalate	fluoranthene	nitrobenzene
benzo(b)fluoranthene	carbazole	fluorene	n-nitroso-di-n-propylamine
benzo(g,h,i)perylene	chrysene	hexachlorobenzene	n-nitrosodiphenylamine
benzo(k)fluoranthene	dibenzofuran	hexachlorobutadiene	pentachlorophenol
benzyl alcohol	dibenzo(a,h)anthracene	hexachlorocyclopentadiene	phenanthrene
bis(2-chloroethoxy)methane	diethyl phthalate	hexachloroethane	phenol
bis(2-chloroethyl)ether	dimethyl phthalate	indeno(1,2,3-cd)pyrene	pyrene
bis(2-chloroisopropyl) ether	di-n-butyl phthalate	isophorone	
bis(2-ethylhexyl)phthalate	di-n-octyl phthalate	naphthalene	
Pesticides / PCBs			
4,4'-DDD	aroclor 1221	delta-BHC	endrin ketone
4,4'-DDE	aroclor 1232	dieldrin	gamma-BHC
4,4'-DDT	aroclor 1242	endosulfan sulfate	gamma-chlordane
aldrin	aroclor 1248	endosulfan-I	heptachlor
alpha-BHC	aroclor 1254	endosulfan-II	heptachlor epoxide
alpha-chlordane	aroclor 1260	endrin	methoxychlor
aroclor 1016	beta-BHC	endrin aldehyde	toxaphene
GENERAL GROUNDWATER QUALITY			
alkalinity	fluoride	phosphate	total organic carbon (TOC)
ammonia	nitrate	sulfate	total organic halogens (TOX)
chloride	phenols	sulfide	total organic nitrogen (TON)
FULL RADIOLOGICAL			
cesium 137	plutonium 239/240	technetium 99	total uranium
gross alpha	radium 226	thorium 228	uranium 234
gross beta	radium 228	thorium 230	uranium 235/236
neptunium 237	ruthenium 106	thorium 232	uranium 238
plutonium 238	strontium 90	total thorium	

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**TABLE 2-13**  
**FEMP RI/FS TAL 20.03.05 C**  
**OPERABLE UNIT 2 TARGET ANALYTE LIST**  
**PHASE II FIELD INVESTIGATION**  
**SOIL, SLUDGE, SEDIMENT, AND WASTE SAMPLES**

FULL HAZARDOUS SUBSTANCE LIST (HSL)			
<b>Inorganics</b>			
aluminum	chromium (total)	manganese	silver
antimony	cobalt	mercury	sodium
arsenic	copper	molybdenum	thallium
barium	cyanide	nickel	vanadium
beryllium	iron	potassium	zinc
cadmium	lead	selenium	
calcium	magnesium	silicon	
<b>Volatile Organics</b>			
1,1-dichloroethane	2-hexanone	chlorobenzene	tetrachloroethene
1,1-dichloroethene	4-methyl-2-pentanone	chloroethane	toluene
1,1,1-trichloroethane	acetone	chloroform	total xylenes
1,1,2-trichloroethane	benzene	chloromethane	trans-1,3-dichloropropene
1,1,2,2-tetrachloroethane	bromodichloromethane	cis-1,3-dichloropropene	trichloroethene
1,2-dichloroethane	bromoform	dibromochloromethane	vinylacetate
1,2-dichloroethylene	bromomethane	ethylbenzene	vinylchloride
1,2-dichloropropane	carbon disulfide	methylenechloride	
2-butanone	carbon tetrachloride	styrene	
<b>Semivolatile Organics</b>			
1,2-dichlorobenzene	2-methylnaphthalene	2,4-dinitrophenol	3,3-dichlorobenzidine
1,2,4-trichlorobenzene	2-methylphenol	2,4-dinitrotoluene	4-bromophenyl phenylether
1,3-dichlorobenzene	2-nitroaniline	2,4,5-trichlorophenol	4-chloro-3-methylphenol
1,4-dichlorobenzene	2-nitrophenol	2,4,6-trichlorophenol	4-chloroaniline
2-chloronaphthalene	2,4-dichlorophenol	2,6-dinitrotoluene	4-chlorophenyl-phenyl ether
2-chlorophenol	2,4-dimethylphenol	3-nitroaniline	4-methylphenol

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TABLE 2-13  
(Continued)

FULL HAZARDOUS SUBSTANCE LIST (HSL) (continued)			
Semivolatile Organics (Continued)			
4-nitroaniline	benzo(k)fluoranthene	diethylphthalate	isophorone
4-nitrophenol	benzyl alcohol	dimethylphthalate	naphthalene
4,6-dinitro-2-methylphenol	bis(2-chloroethoxy)methane	di-n-butyl phthalate	nitrobenzene
acenaphthene	bis(2-chloroethyl)ether	di-n-octyl phthalate	n-nitroso-di-n-propylamine
acenaphthylene	bis(2-chloroisopropyl) ether	fluoranthene	n-nitrosodiphenylamine
anthracene	bis(2-ethylhexyl)phthalate	fluorene	pentachlorophenol
benzoic acid	butyl benzyl phthalate	hexachlorobenzene	phenanthrene
benzo(a)anthracene	carbazole	hexachlorobutadiene	phenol
benzo(a)pyrene	chrysene	hexachlorocyclopentadiene	pyrene
benzo(b)fluoranthene	dibenzofuran	hexachloroethane	
benzo(g,h,i)perylene	dibenzo(a,h)anthracene	indeno(1,2,3-cd)pyrene	
Pesticides / PCBs			
4,4'-DDD	aroclor 1221	delta-BHC	endrin ketone
4,4'-DDE	aroclor 1232	dieldrin	gamma-BHC
4,4'-DDT	aroclor 1242	endosulfan sulfate	gamma-chlordane
aldrin	aroclor 1248	endosulfan-I	heptachlor
alpha-BHC	aroclor 1254	endosulfan-II	heptachlor epoxide
alpha-chlordane	aroclor 1260	endrin	methoxychlor
aroclor 1016	beta-BHC	endrin aldehyde	toxaphene
FULL RADIOLOGICAL			
cesium 137	plutonium 239/240	technetium 99	total uranium
gross alpha	radium 226	thorium 228	uranium 234
gross beta	radium 228	thorium 230	uranium 235/236
neptunium 237	ruthenium 106	thorium 232	uranium 238
plutonium 238	strontium 90	total thorium	

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**TABLE 2-14**  
**OPERABLE UNIT 2 TARGET ANALYTE LIST**  
**PHASE II FIELD INVESTIGATION**  
**GEOTECHNICAL TESTING**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

<b>FEMP RI/FS TAL 20.03.05 D</b>		
General Chemistry		
total organic carbon		
Geotechnical		
specific gravity	liquid limit	particle size - hydrometer
water/moisture content	plastic limit	sieve analysis

<b>FEMP RI/FS TAL 20.03.05 E</b>		
one dimensional consolidation		

<b>FEMP RI/FS TAL 20.03.05 F</b>		
permeability (constant head)		

<b>FEMP RI/FS TAL 20.03.05 G</b>		
unconfined compressive strength	direct shear - slow	CU triaxial (3pts)

<b>FEMP RI/FS TAL 20.03.05 J</b>		
dry unit weight		

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**TABLE 2-15**  
**OPERABLE UNIT 2 TARGET ANALYTE LIST**  
**PHASE II FIELD INVESTIGATION**  
**TOXICITY CHARACTERISTIC LEACHING PROCEDURE**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

FEMP RI/FS TAL 20.03.05 H			
<b>Inorganics</b>			
arsenic	cadmium	lead	selenium
barium	chromium	mercury	silver
<b>Volatile Organics</b>			
1,1-dichloroethene	benzene	chloroform	vinyl chloride
1,2-dichloroethane	carbon tetrachloride	tetrachloroethene	
2-butanone	chlorobenzene	trichloroethene	
<b>Semivolatile Organics</b>			
1,4-dichlorobenzene	2,4,6-trichlorophenol	hexachlorobutadiene	pyridine
2-methylphenol	3-methylphenol	hexachloroethane	
2,4-dinitrotoluene	4-methylphenol	nitrobenzene	
2,4,5-trichlorophenol	hexachlorobenzene	pentachlorophenol	
<b>Herbicides</b>			
2,4-D	2,4,5-TP		
<b>Pesticides</b>			
alpha-chlordane	gamma-BHC	heptachlor	methoxychlor
endrin	gamma-chlordane	heptachlor epoxide	toxaphene

FEMP RI/FS TAL 20.03.05 I			
<b>Inorganics</b>			
arsenic	cadmium	lead	selenium
barium	chromium	mercury	silver
<b>Additional Inorganics</b>			
copper	iron	manganese	zinc
<b>Volatile Organics</b>			
1,1-dichloroethene	benzene	chloroform	vinyl chloride
1,2-dichloroethane	carbon tetrachloride	tetrachloroethene	
2-butanone	chlorobenzene	trichloroethene	
<b>Semivolatile Organics</b>			
1,4-dichlorobenzene	2,4,6-trichlorophenol	hexachlorobutadiene	pyridine
2-methylphenol	3-methylphenol	hexachloroethane	
2,4-dinitrotoluene	4-methylphenol	nitrobenzene	
2,4,5-trichlorophenol	hexachlorobenzene	pentachlorophenol	
<b>Herbicides</b>			
2,4-D	2,4,5-TP		
<b>Pesticides</b>			
alpha-chlordane	gamma-BHC	heptachlor	methoxychlor
endrin	gamma-chlordane	heptachlor epoxide	toxaphene

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2.2.2.4 Phase II Data Validation Methods

RI/FS data, which is used as the basis for remedial action decision-making, has been validated. This section presents discussions of the data validation process for the RI/FS.

Data validation is an independent, systematic process of evaluating data to provide confirmation that the data is of the technical quality necessary to meet its intended use, and assure that a legally defensible "road map" can be established to trace each sample from the time it is collected in the field to its ultimate end use. To verify that the analytical data met its data quality objectives (DQOs) and to determine compliance with appropriate and applicable procedures, the validation process examines field measurements, sampling and handling procedures, laboratory analysis and reporting, and any nonconformities and discrepancies in the data. Data qualifiers are assigned to the analytical data to alert the user of any nonconformances to quality assurance/quality control (QA/QC) requirements. The list of qualifiers assigned and their definitions is provided in Table 2-16.

The level of quality required depends on the intended use of the data, which in turn dictates the appropriate level or extent of validation. The FEMP SCQ classifies data into one of five ASLs as described in Table 2-17.

The validation program is divided into two phases. The first phase considers field data, which is collected at ASL A or B. The second phase deals with analytical data, which is collected at ASL C, D, or E. For most of the organic and inorganic data, reviews are performed under the CLP Statement of Work, corresponding to data collected at ASL D. Data reported under a Certificate of Analysis (COA) are reviewed and qualified as ASL C. Radiological data are normally qualified based on deliverables provided for ASL E. Separate evaluations are conducted for radiological, organic, and inorganic analytes.

2.2.2.5 Phase II Data Management Methods

Once the samples were collected and sent to the appropriate laboratory for analysis, field information was collected and reviewed to verify that all required field information was received. Copies of all appropriate records were made and the originals were stored in a secure place. Copies of the field records were used for data entry into the Site-Wide Environmental Database (SED) and for data validation if the analyses generated for the task are either ASL C, D, and/or E. Field records

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**TABLE 2-16**  
**Data Qualifiers and Definitions**

**DATA QUALIFIERS AND DEFINITIONS**

- J** Analyte was analyzed for and positively identified, but the associated numerical value may not be consistent with the amount present in the environmental sample. Data should be seriously considered for making decisions and are usable for many purposes.
- N** Analysis indicates that an analyte is present and there are strong indications that the identity is correct.
- R** Data are unusable for any purpose. Analyte was analyzed for, but the presence or absence of the analyte was not verified. Resampling and reanalysis are necessary to confirm or deny presence of the analyte.
- U** Analyte was analyzed for and was not present above the level of the associated value. Associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.
- UJ** This is a combination of the "U" and "J" qualifiers. Analyte was analyzed for and was not present above the level of the associated value. The associated value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample. If a decision requires quantitation of the analyte close to the associated numerical level, reanalysis or alternative analytical methods should be considered.

(Notation from QAPP March 1992)

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**TABLE 2-17**  
**ANALYTICAL SUPPORT LEVELS**

Support Level	Description	Typical Data Uses
A	<p><i>Qualitative Field Analysis</i> - This level is characterized by the use of portable instruments that can provide real-time data to assist in the optimization of sampling point locations and in providing health and safety support. Data can be generated regarding the presence or absence of contaminants (e.g., radionuclides, volatiles) at sampling locations. Analogous to EPA analytical level 1.</p>	<ul style="list-style-type: none"> <li>• Site characterization</li> <li>• Monitoring during implementation</li> <li>• Establishing worker protective equipment</li> </ul>
B	<p><i>Qualitative, Semi-Quantitative, and Quantitative Analyses</i> - This level may include the use of more sophisticated screening techniques, such as portable analytical instruments that can be used on site (close-support laboratories). Depending upon the types of contaminants, sample matrix, and QC checks applied, qualitative and quantitative data can be obtained. Analogous to EPA analytical level 2.</p>	<ul style="list-style-type: none"> <li>• Site characterization</li> <li>• Evaluation of alternatives</li> <li>• Engineering design</li> <li>• Monitoring during implementation</li> </ul>
C	<p><i>Quantitative with fully defined QA/QC</i> - Laboratory analyses generated with full QA/QC checks of types and frequencies specified for ASL D according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The analytical methods are identical to ASL D for QA/QC sample analysis and method performance criteria. However, the data package does not typically contain raw instrument output but does include summaries of QA/QC sample results. ASL C may be used when analyses require a rigid, well-defined protocol, but where other information is available, so that a complete raw data package validation effort is not required. Laboratories are required to retain raw instrument data to upgrade ASL C reports to ASL D in the project file. Analogous to EPA analytical level 3.</p>	<ul style="list-style-type: none"> <li>• Risk assessment</li> <li>• Site characterization</li> <li>• Evaluation of alternatives</li> <li>• Engineering design</li> <li>• Monitoring during implementation</li> </ul>
D	<p><i>Confirmational with complete QA/QC and reporting</i> - Provides data generated with a full complement of QA/QC checks of specified types and frequencies according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The data package includes raw instrument output for validation. These data may be used to confirm data gathered at ASLs B and C, and when full validation of raw data is required. Analogous to EPA analytical level 4.</p>	<ul style="list-style-type: none"> <li>• Risk assessment</li> <li>• Evaluation of alternatives</li> <li>• Engineering design</li> </ul>
E	<p><i>Nonstandard</i> - Analyses by nonstandard protocols that often require method development or validation (e.g., when extracting detection limits or analysis of an unusual chemical compound is required). New methods may be developed for ASL E data to allow for parameters or matrices that cannot be analyzed by existing standard methods. Analogous to EPA analytical level 5.</p>	<ul style="list-style-type: none"> <li>• Risk assessment</li> </ul>

generated for ASL B analyses were also validated when the project specific plan specified that results and data required validation.

After the completed laboratory analyses of the samples were received, the following activities took place:

- Verification that all required deliverables were received.
- Verification that contract performance requirements were met.
- Analytical data were entered into the SED.
- Data packages were reproduced for use in data validation and the original data packages were stored in a secure location.

The data was validated according to standard validation protocols. The data was qualified, data validation summaries were generated, and validation checklists were added to the data package. The validated data packages were then copied for use in data entry and the originals were stored in a secure location. The data validation qualifiers were entered into the SED.

Once data entry was completed, a printout of the SED was compared to the analytical and validation information to verify the accuracy of the database. After the verification of the database was complete, access to the data was limited and changes required documentation and approval. All subsequent RI activities accessed the controlled database to ensure correct data was being used.

2.3 ENVIRONMENTAL CHARACTERIZATION INFORMATION FOR THE SOLID WASTE LANDFILL

The Solid Waste Landfill has been preliminarily characterized by the Environmental Survey and CIS Sampling Program followed by characterization by the RI/FS Sampling Program. The following sections discuss the sample locations and analytical parameters from each of these sampling programs. Results of these sampling programs are presented in Appendix C.

2.3.1 Surface Sampling

As part of the Environmental Survey (DOE 1988a), four surface media samples (0620, 0621,

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0622, and 0623) were composited from the Solid Waste Landfill. These samples were analyzed for radionuclides, total uranium, asbestos, TCLP metals, and PCBs. All but one of the samples (000623) were also analyzed for VOCs. It is unknown as to why this sample was not analyzed for VOCs.

During the CIS (Weston 1987c), four surface media samples were collected, two within the Solid Waste Landfill and two north of the Solid Waste Landfill, for on-site gamma spectroscopy analysis for cesium-137, radium-226, ruthenium-106, thorium-232, and uranium-238. Based on this initial screening, four surface media samples (46-238, 46-348, 46-349, and 46-362) were sent off site to be analyzed for 16 radionuclides. Locations of the samples that were analyzed off site are shown on Figure 2-1.

The objectives of RI/FS surface media (soil) sampling (1991-1993) in the Solid Waste Landfill were to:

- Characterize the nature and extent of contamination in the cover soils for risk assessment purposes.
- Provide data to evaluate the potential for exposure via the direct contact pathway.
- Provide data to evaluate the potential for exposure via the air migration pathway.

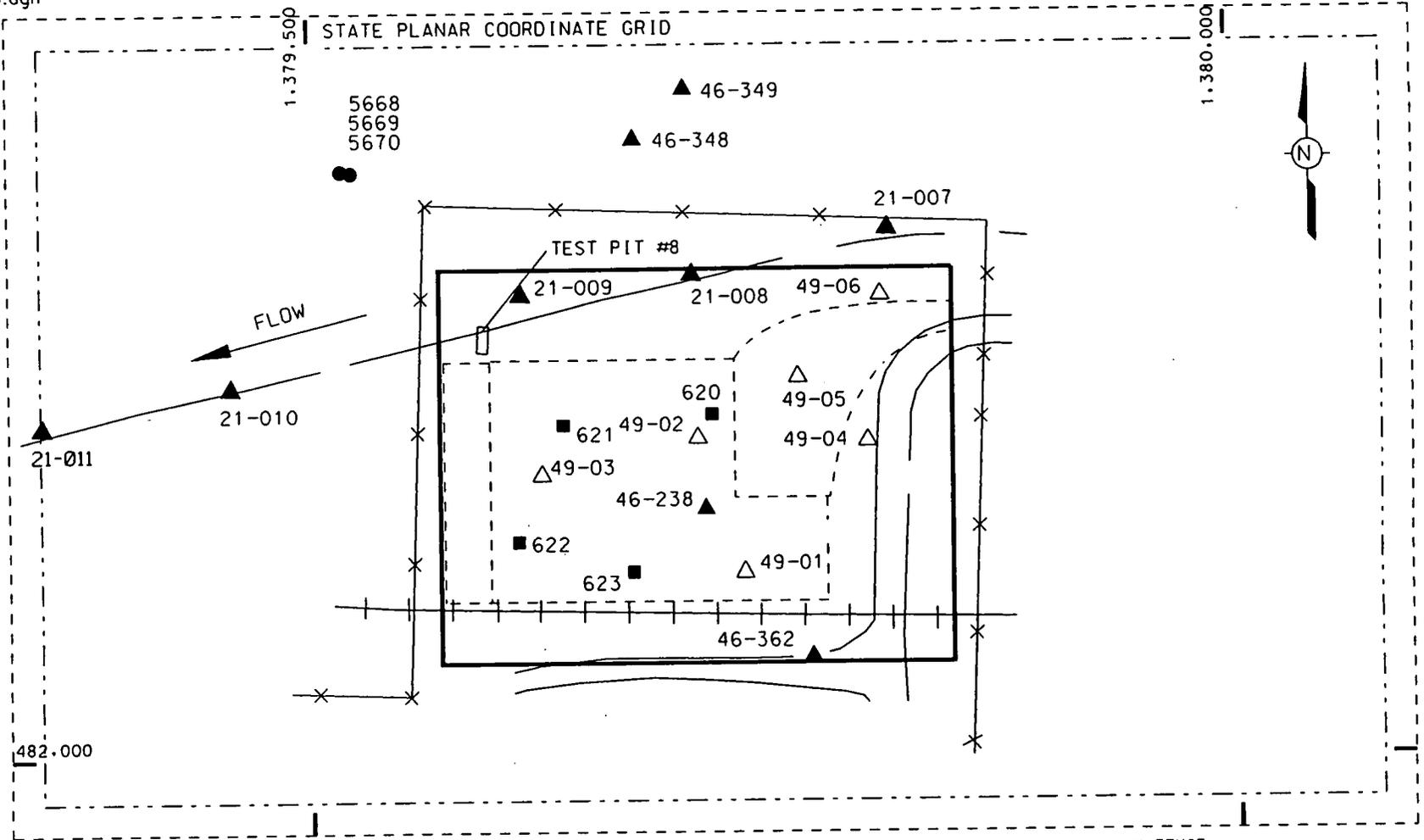
Twelve surface locations (SWL-SS-01 through SWL-SS-12) distributed across the landfill area were sampled during the Phase II Field Investigation in the Solid Waste Landfill (Figure 2-1a). Each location had one sample analyzed for full HSL and full radiological parameters (TAL 20.03.05 C).

2.3.2 Subsurface Sampling

During the Environmental Survey, Test Pit No. 8 was excavated on the west side of the Solid Waste Landfill and the south side of the drainage ditch. The pit was not surveyed; therefore, the precise location is unknown. Samples were collected in the pit from depths of 3.5 and 6.5 feet and were analyzed for radionuclides, total uranium, and TCLP metals.

During March and April 1987, six borings (49-01 through 49-06) were completed in the Solid Waste Landfill for the CIS (Weston 1987b). Split-spoon samples were collected at 1- to 2-foot intervals and were analyzed for radium-226, thorium-232, and uranium-238 at the on-site gamma spectroscopy laboratory. The purpose of this sampling was to develop activity profiles for these three

fig0293.dgn



- LEGEND:**
- |                              |                              |                                 |                                      |               |
|------------------------------|------------------------------|---------------------------------|--------------------------------------|---------------|
| SUBSURFACE MEDIA SAMPLES:    |                              | SURFACE MEDIA SAMPLES:          |                                      | ××××× FENCE   |
| □ ES (LOCATIONS APPROXIMATE) | ■ ES (LOCATIONS APPROXIMATE) | +++++ RAILROAD                  | - - - - - EXTENT OF FILL             | — DRAINAGEWAY |
| △ CIS                        | ▲ CIS                        | — SOLID WASTE LANDFILL BOUNDARY | - - - - - OPERABLE UNIT 2 STUDY AREA |               |

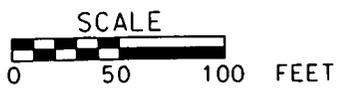
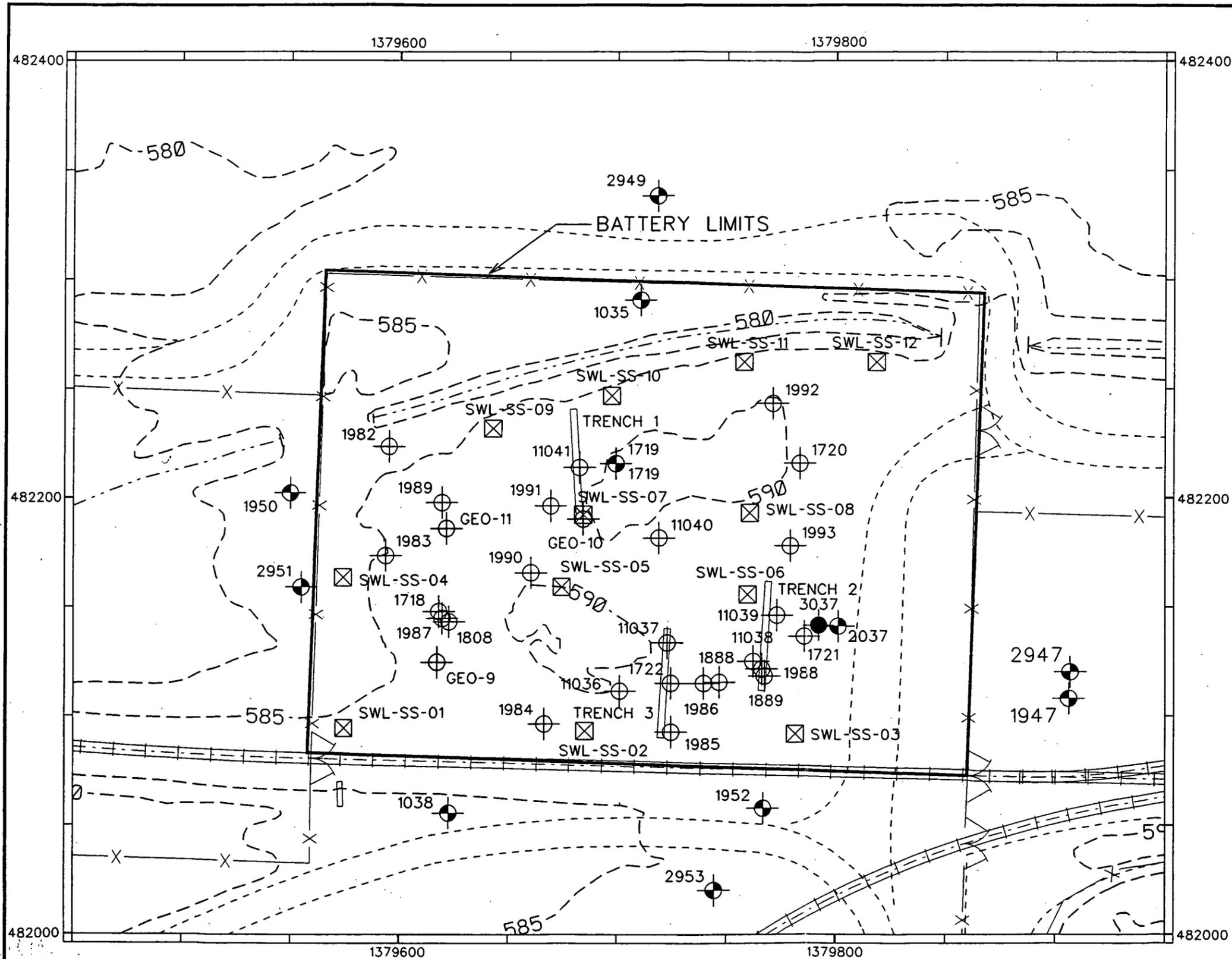


FIGURE 2-1  
CIS AND ES SAMPLE LOCATIONS  
IN THE SOLID WASTE LANDFILL AREA

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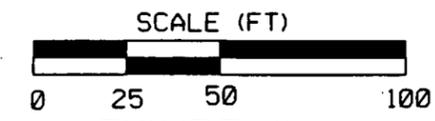


**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE WAY
- BATTERY LIMITS
- FENCE
- RAILROAD
- 1000 MONITORING WELLS
- 2000 MONITORING WELLS
- 3000 MONITORING WELLS
- SOIL BORING
- SURFACE SAMPLE
- TRENCH

NOTE: 'GEO' REPRESENTS GEOTECHNICAL SAMPLE LOCATIONS.

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



**FIGURE 2-1a**  
SURFACE, SUBSURFACE,  
AND GEOTECHNICAL  
SAMPLE LOCATIONS  
SOLID WASTE LANDFILL  
(PHASE I AND PHASE II)

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radionuclides. Composite samples were also collected from each boring and sent to off-site laboratories for chemical and radiological analyses. Chemical analyses included VOCs, semivolatile organic compounds (SVOCs), pesticide/PCBs, metals, extraction procedure (EP) Toxicity, reactivity, ignitability, and corrosivity. Locations of the samples that were analyzed off site are shown on Figure 2-1.

During 1988, three borings (1035, 1038, and 3037) were drilled near the Solid Waste Landfill as a part of the site-wide monitoring well installation program (Figure 2-1a). A total of five samples were collected from these borings and were analyzed for radionuclides.

The objectives of RI/FS subsurface media (soil) sampling in the Solid Waste Landfill were to:

- Characterize the physical nature of buried waste materials in the landfill and improve the conceptual model for waste deposition.
- Characterize the nature and extent of contamination, particularly in the suspect evaporation pond area and the waste cells (see Section 4.0).
- Determine fill depths and volumes.
- Determine whether contaminants have migrated from fill into underlying native soils.
- Provide data to support the modeling of contaminant migration from the Solid Waste Landfill.

During July and August 1991, six borings (1718, 1808, 1719, 1720, 1721, and 1722) were drilled during the Phase I Field Investigation (Figure 2-1a). Boring Nos. 1888 and 1889 were drilled in 1992 (Figure 2-1a). Boring Nos. 1718 and 1808 were placed within the abandoned evaporation pond near CIS Boring No. 49-03 (Figure 2-1), where elevated concentrations of radionuclides were detected in the CIS composite sample. Samples were collected from the shallow fill, deep fill, and underlying native soils of each boring. These samples were analyzed for different combinations of radionuclides, total uranium, total thorium, dioxins/furans, herbicide organics, organophosphorus pesticides, pesticides/polychlorinated biphenyls (PCBs), volatile organic compounds (VOCs), SVOCs, metals, TCLP, and EP Toxicity.

TCLP VOC/SVOC samples were collected from the portion of the boring that displayed the highest HNu reading during screening. When there was no Hnu reading, samples were collected from the

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midpoint of the boring. A composite sample from each boring was analyzed for the remainder of the TCLP analytes. The purpose of TCLP analysis was to determine whether the waste met criteria for regulation under RCRA and to determine leaching and transport potentials for waste transport modeling.

Subsurface samples were taken from 26 borings (1947, 1950, 1952, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 11036, 11037, 11038, 11039, 11040, 11041, 2037, 2947, 2949, 2951, and 2953) in the Solid Waste Landfill as part of the Phase II Field Investigation (Figure 2-1a). A total of 37 samples were analyzed for full HSL and full radiological parameters. In addition, six samples were taken for TCLP analysis. Fourteen subsurface soil screening samples were collected and analyzed for total uranium at the on-site laboratory. Three subsurface soil screening samples were collected and analyzed for gross alpha and beta.

2.3.3 Surface Water and Sediment Sampling

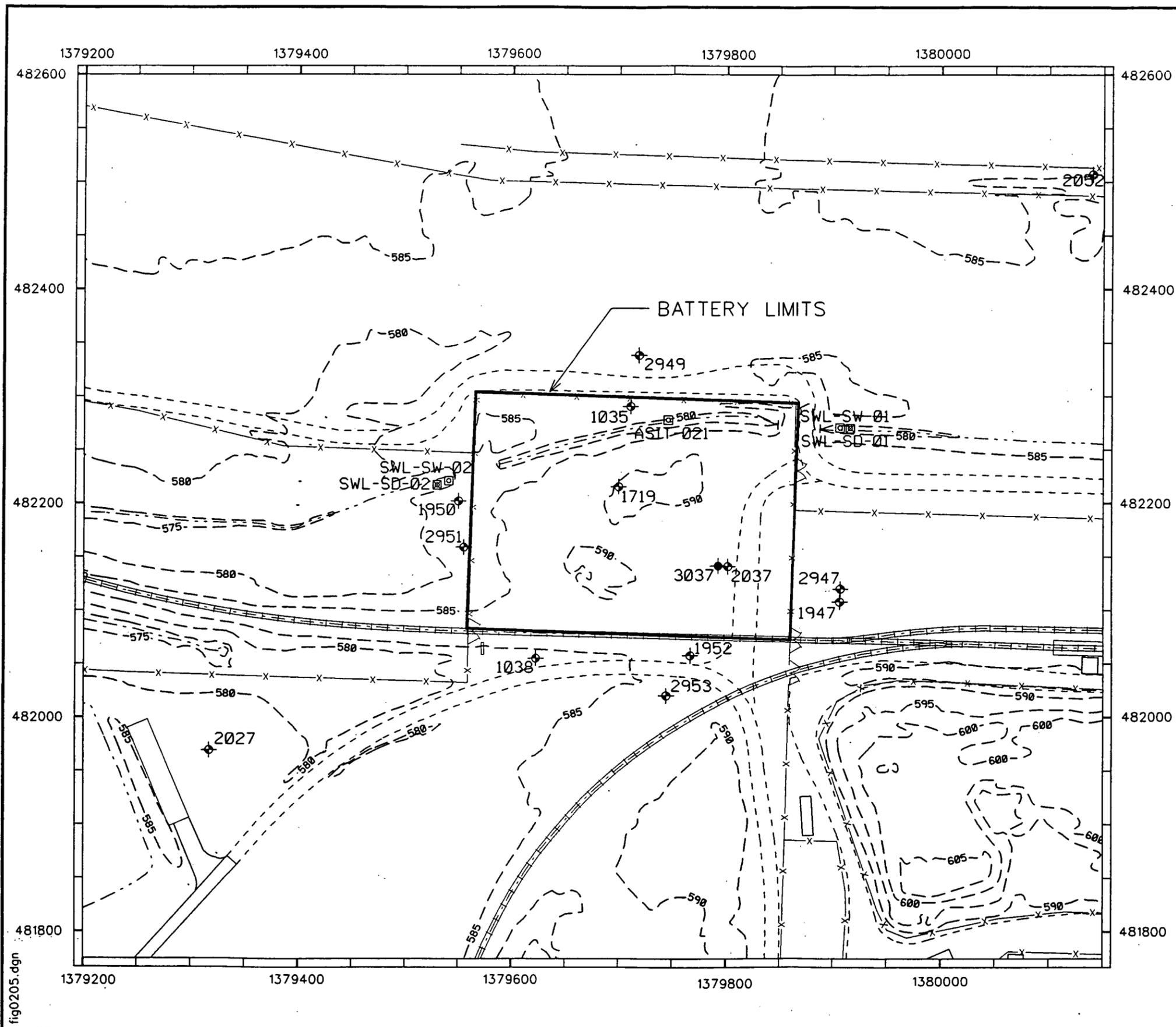
Sediment samples were collected during the CIS (Weston 1987b) at five locations (21-007 through 21-011) in the drainageway and analyzed for cesium-137, radium-226, ruthenium-106, thorium-232, and uranium-238 at the on-site gamma spectroscopy laboratory. Sample Location 21-009 was selected for off-site analysis of 16 radionuclides because it showed the highest results from the on-site analysis. These sample locations are shown on Figure 2-1.

Storm water runoff and seepage from the landfill appears to reach the drainage ditch just north of the landfill (Figure 2-2). This drainage flows westerly toward Paddys Run. The objective of surface water and sediment sampling in the Solid Waste Landfill Study Area was to determine whether contaminants from the landfill migrated from the area via the surface water pathway.

Two surface water samples were collected during the Phase I Field Investigation from one location (ASIT-021) in the drainageway to the north of the Solid Waste Landfill. One sample was analyzed for radionuclides, total uranium, pesticides/PCBs, VOCs, SVOCs, metals, and general chemistry. The other sample was analyzed for radionuclides and total uranium only.

Surface water (SWL-SW-01 and SWL-SW-02) and sediment (SWL-SD-01 and SWL-SD-02) samples were taken both upstream and downstream of the Solid Waste Landfill during the Phase II Field Investigation (Figure 2-2). One sample from each location was analyzed for full HSL and full

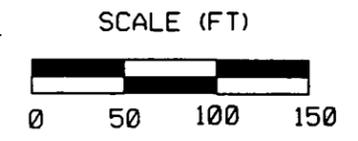
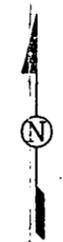
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**LEGEND**

- 575- ELEVATION CONTOURS
- - - ROADS
- - - - - STREAM
- - - BATTERY LIMITS
- x - FENCE
- - - RAILROAD
- ◆ 1000 MONITORING WELLS
- ◆ 2000 MONITORING WELLS
- ◆ 3000 MONITORING WELLS
- SURFACE WATER SAMPLE
- SEDIMENT SAMPLE

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



**FIGURE 2-2**  
**GROUNDWATER MONITORING**  
**WELLS, SURFACE WATER AND**  
**SEDIMENT SAMPLE LOCATIONS**  
**SOLID WASTE LANDFILL**  
**(PHASE I AND PHASE II)**

fig0205.dgn

radiological parameters. The water samples were also analyzed for general chemistry. Two surface water screening samples were collected at the same locations where full samples were collected. In addition, one surface water screening sample was collected at Boring No. 1947. Four sediment screening samples were collected at location SWL-SD-01. The screening samples were analyzed for total uranium at the on-site laboratory.

#### 2.3.4 Groundwater Investigations

Three leachate samples were collected from Test Pit No. 8, which was excavated during the Environmental Survey (Figure 2-1). The exact sampling location within the pit is not known because the Environmental Survey locations were not surveyed. One leachate sample was analyzed for radionuclides while the other two were analyzed for total uranium and metals.

The objectives of RI/FS groundwater sampling in the Solid Waste Landfill Study Area were to:

- Determine contaminant impacts to perched groundwater in the landfill.
- Characterize the hydrology of the perched groundwater zone.
- Complete the physical characterization of, and determine contaminant impacts to, the upper regional aquifer.

Seven monitoring wells (1035, 1037, 1038, 2027, 2037, 2052, and 3037) were installed in the vicinity of the Solid Waste Landfill during the Phase I Field Investigation (Figure 2-2). Monitoring Well 1037, located in a cluster with 2037 and 3037, was plugged and abandoned because of concerns about installation practices. The monitoring wells were screened in the perched water and in the top and bottom of the Upper Great Miami Aquifer. These wells were sampled periodically during 1988 through 1990 and were analyzed for different combinations of radionuclides, total uranium, total thorium, dioxins/furans, herbicide organics, pesticides/PCBs, VOCs, SVOCs, metals, and general chemistry. Boring No. 1719, which was drilled in May 1992, was converted to a perched groundwater monitoring well. This well was sampled and analyzed for total uranium, VOCs, metals, and general chemistry. Detail on the sampling frequency and parameters for each well is included in Table C-12 of Appendix C.

During July 1992, three trenches (Trench 1, Trench 2, and Trench 3) were excavated in the Solid Waste Landfill (Figure 2-1a) to locate and visually inspect the buried materials (DOE 1992e). A total

of five in situ leachate samples were collected from the three trenches and four were analyzed for radionuclides, herbicide organics, dioxins/furans, VOCs, SVOCs, pesticides/PCBs, metals, and general chemistry. The fifth sample was analyzed for SVOCs and pesticides/PCBs only.

During the Phase II Field Investigation, three 1000-series wells (1947, 1950, and 1952) and four 2000-series wells (2947, 2949, 2951, and 2953) were completed (Figure 2-2), and wells installed under the RI/FS Phase I and Phase II Field Investigations were sampled. Samples were analyzed for full HSL, full radiological, and general chemistry parameters at an off-site laboratory or for total uranium screening at the on-site laboratory. Well 1719 was planned to be sampled, but at the time of sampling, the well was found to be dry.

Water samples were also collected using a bailer from soil borings during the RI/FS Phase II Field Investigation if sufficient seepage occurred during drilling. Samples from Boring Nos. 1985, 11037, 11039, and 11040 were collected and analyzed for total uranium at the on-site laboratory.

2.3.5 Geotechnical Investigations

During the Weston CIS Boring Program (Weston 1988), a composite sample was collected from Boring No. 49-03 from a depth of 0 to 18 feet. This sample was analyzed for specific gravity, liquid limit, plasticity index, natural moisture content, particle size and distribution, maximum dry density, optimum moisture content and color, and physical state. An additional CIS composite sample was collected from a depth of 0 to 12 feet, but the CIS report did not specify the exact location. Due to being composited, these samples and other composited samples had limited use in guiding the RI Field Investigation.

In 1991, the Phase I RI/FS sampling team measured in-place density at three locations (GEO-9, GEO-10 and GEO-11) in the Solid Waste Landfill by ASTM Method D-2922 for nuclear density measurements (Figure 2-1a). Wet density, dry density, and moisture content were measured at each sampling location.

During the Phase II Field Investigation, geotechnical samples were collected from SWL-SD-02, SWL-SS-02, and 12 of the subsurface borings (1947, 1950, 1952, 1982, 1983, 1984, 1986, 1988, 1989, 1990, 1992, and 2949). The samples from these locations were analyzed for different combinations of specific gravity, water content, liquid limit, plastic limit, sieve analysis, hydrometer

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analysis, consolidated isotropic undrained triaxial, direct shear, and dry unit weight. Sample intervals and exact analytical parameters are presented in Table C-20 of Appendix C.

2.3.6 Soil Gas Survey

A soil gas survey was performed in the Solid Waste Landfill to locate sources of organic contamination in the shallow disturbed surface that were detected during trenching activities. Forty-seven soil gas samples were collected from fifty proposed locations in a grid pattern across the surface of the Solid Waste Landfill.

Figure 2-3 shows the grid and sample locations. Forty-seven of the fifty proposed locations were measured in the field using an OVM and OVA. Samples were then collected in Tedlar bags and screened at the on-site laboratory using an OVM and OVA to measure total VOCs and methane, respectively. The five locations with the highest detections of total VOCs and one new location (CD-1) were sampled and sent to an off-site laboratory for a gas chromatography/mass spectrometry (GC/MS) scan (EPA Method TO-14). The results of the soil gas survey were used to select locations for borings intended to collect subsurface samples of waste material.

2.3.7 Geophysical Survey

The CIS performed geophysical surveys of the Solid Waste Landfill. Three types of geophysical methods were used to survey the Solid Waste Landfill: magnetic, EM, and GPR. Magnetic data measurements were conducted on a 25 by 25 foot grid with the sensor oriented in a northerly direction. Figure 2-4 represents the magnetic grid locations for the Solid Waste Landfill. The EM survey was conducted on a 50 by 25 foot grid, with 50 feet separating the north-to-south trending profiles. The EM survey was performed in both the vertical and horizontal dipole to further evaluate rear surface disturbances. Additional data points were surveyed on a 25 foot grid between the 50 foot grid lines when anomalies were detected. The grid locations for the EM survey are identified in Figure 2-5. The GPR survey was performed on a 25 by 25 foot grid and is identified in Figure 2-6.

2.4 ENVIRONMENTAL CHARACTERIZATION INFORMATION FOR THE LIME SLUDGE PONDS

The Lime Sludge Ponds have been preliminarily characterized by the Environmental Survey and CIS Sampling Program, followed by characterization by the RI/FS Sampling Program. The following

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sections discuss the sample locations and analytical parameters for each of these sampling programs. Results of these sampling programs are presented in Appendix D.

2.4.1 Surface Sampling

During the Environmental Survey, 12 surface media samples were collected from four locations (0616, 0617, 0618, and 0619) in the South Lime Sludge Pond (Figure 2-7). Each location had samples analyzed for radionuclides, total uranium, VOCs, and TCLP metals.

As part of the CIS radiological survey of surface soils, ten samples were collected and analyzed for 16 radionuclides. Seven of these samples (46-534, 46-542, 46-543, 46-544, 23-005, 46-526, and 46-527) were collected at four locations along the K-65 Slurry Line (Weston 1987c). This slurry line, which lies in a 3.5-foot-deep concrete trench, was used to pump waste from the former Production Area to the K-65 silos. Two surface samples (23-012 and 23-013) were taken in the western portion of the South Lime Sludge Pond and one sample (46-187) was collected about 40 feet north of the North Lime Sludge Pond. Locations of the samples that were analyzed off site are shown on Figure 2-7.

The objectives of RI/FS surface media (including soil and lime sludge residue) sampling at the Lime Sludge Ponds were to:

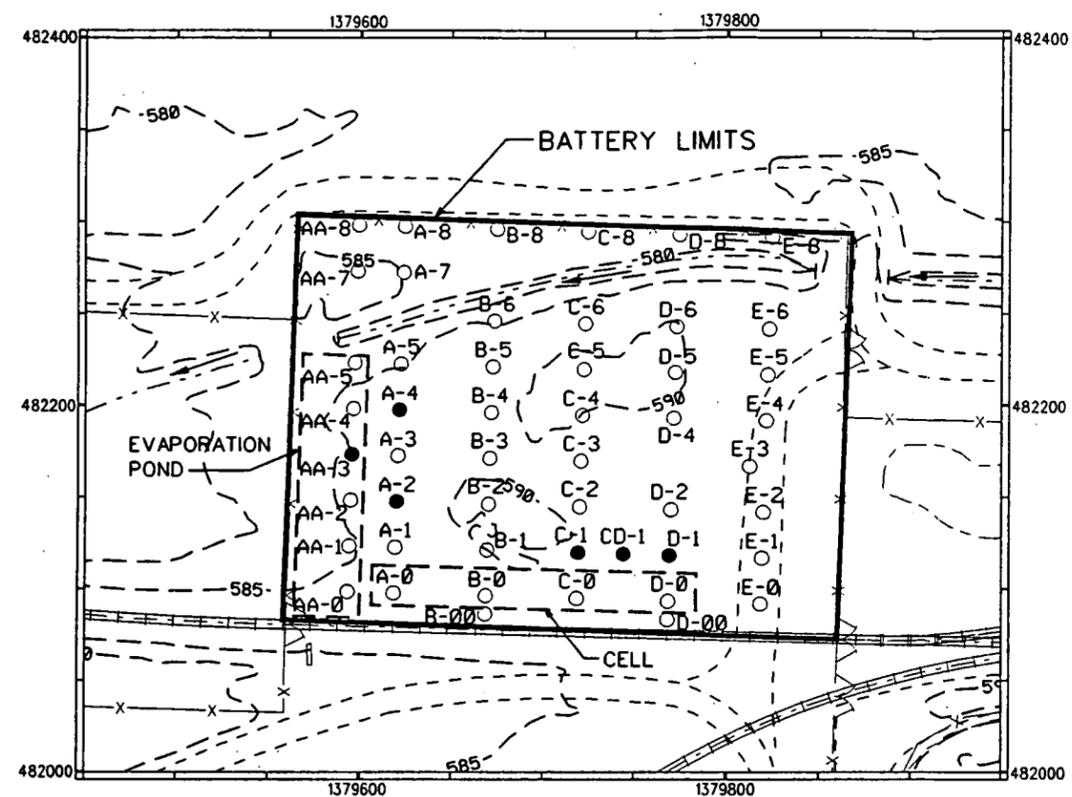
- Determine surface contamination of the roadways at the north edge of subunit.
- Provide data to evaluate the potential for exposure via the direct contact pathway.
- Provide data to evaluate the potential for exposure via the air migration pathway.

Surface media samples were collected from 14 locations (LSP-TR-01, LSP-TR-02, and LSP-SS-03 through LSP-SS-14) in the North and South Lime Sludge Ponds under the Phase II Field Investigation (Figure 2-7a). Fourteen samples from these locations were analyzed for full HSL and full radiological analysis. One sample was analyzed for pesticides/PCBs only, making a total of 15 samples for off-site analysis. Screening samples were collected from four locations (LSP-TR-01, LSP-TR-02, LSP-SS-03, and LSP-SS-04) and sent to the on-site laboratory for total uranium analysis. A screening sample from LSP-TR-02 was analyzed for gamma activity by gamma spectroscopy.

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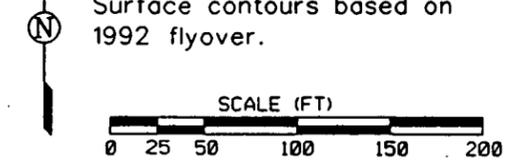


**LEGEND**

- 575 ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- RAILROAD
- SOIL GAS SURVEY SAMPLE LOCATIONS ANALYZED
- SOIL GAS SURVEY SAMPLE LOCATION SENT FOR LABORATORY ANALYSIS

▪ INDICATES TEDLAR BAG READINGS

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



LOCATION	TOTAL VOC (ppm)	TOTAL METHANE (ppm)
A-0	22.0	44.0*
A-1	37.0	8.2*
A-2	21.0	100.0*
A-3	40.6	1000.0*
A-4	38.2	1320.0*
A-5	0.0	4.0*
A-7	0.0*	0.0*
A-8	10.0*	12.0*

LOCATION	TOTAL VOC (ppm)	TOTAL METHANE (ppm)
C-0	80.0*	89.0*
C-1	60.0	1000.0*
C-2	0.0	126.0*
C-3	0.0	136.0*
C-4	0.0	0.0*
C-5	0.0	0.0*
C-6	0.2	0.0*
C-8	0.0*	0.0*

LOCATION	TOTAL VOC (ppm)	TOTAL METHANE (ppm)
E-0	0.0*	24.0*
E-1	0.0	2.0, 0.0*
E-2	0.0	71.0, 36.0*
E-3	0.0	6.0, 0.6*
E-4	0.0	6.0, 0.0*
E-5	0.0	5.0, 2.0*
E-6	0.0	6.0, 0.0*
E-8	0.0*	0.0*

LOCATION	TOTAL VOC (ppm)	TOTAL METHANE (ppm)
B-00	6.8	26.0*
B-0	4.8	48.0*
B-1	4.6	8.9*
B-2	7.0	8.8*
B-3	7.0	420.0*
B-4	0.7	92.0*
B-5	0.3	0.0*
B-6	0.0*	0.0*
B-8	NA	NA

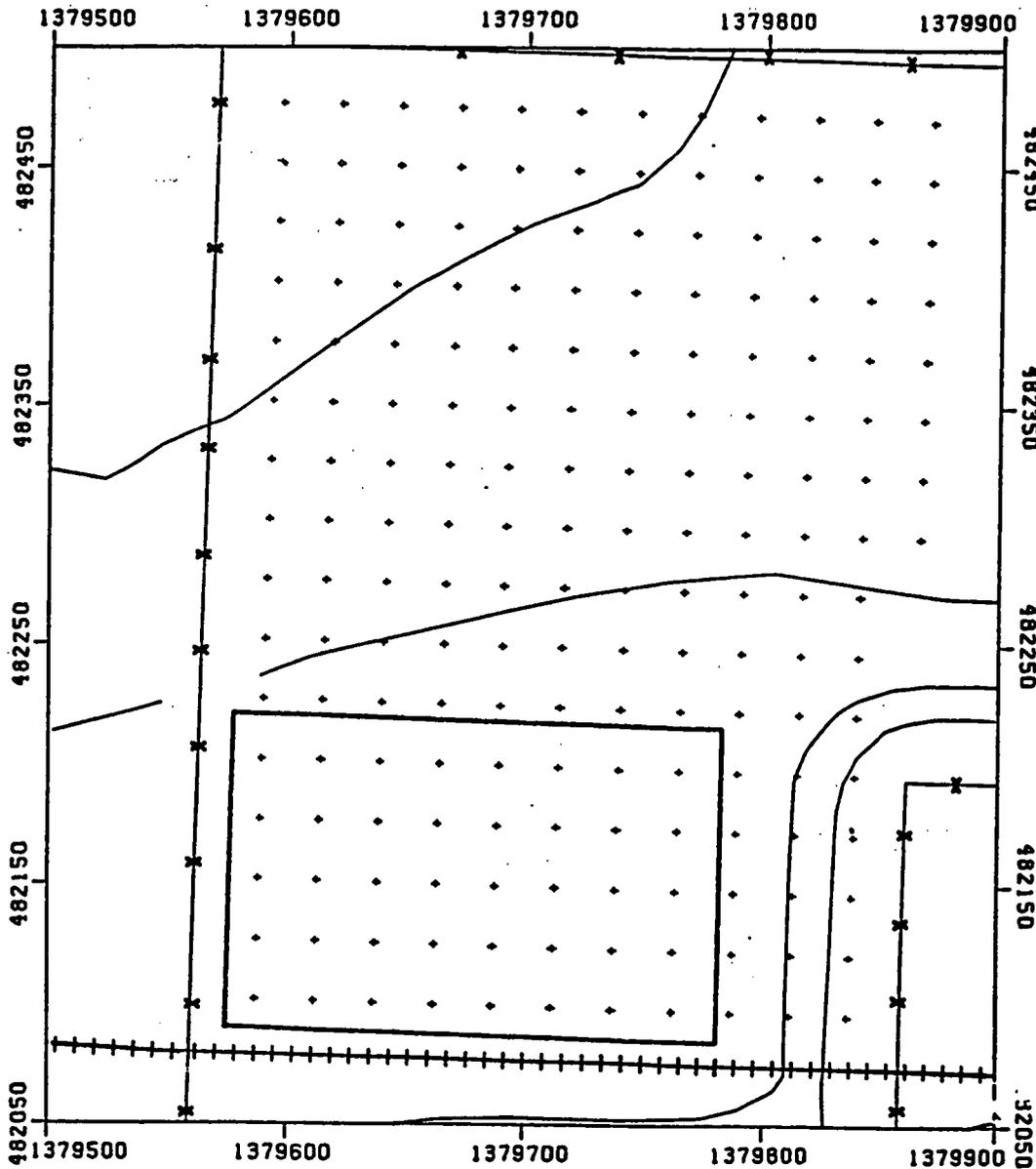
LOCATION	TOTAL VOC (ppm)	TOTAL METHANE (ppm)
D-00	NA	NA
D-0	1.3	2.0, 1000.0*
D-1	767.0	110.0, 100.0*
D-2	0.7	27.0, 27.0*
D-4	0.0	160.0, 100.0*
D-5	0.4	0.0, 0.0*
D-6	2.0	2.0, 0.0*
D-8	NA	NA

LOCATION	TOTAL VOC (ppm)	TOTAL METHANE (ppm)
AA-0	12.0*	14.0*
AA-1	38.0*	42.0*
AA-2	68.0*	74.0*
AA-3	82.0*	98.0*
AA-4	7.8*	7.2*
AA-5	12.0*	12.0*
AA-7	0.0*	0.0*
AA-8	0.0*	0.0*

fig0203.dgn

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**FIGURE 2-3**  
**SOIL GAS SURVEY**  
**SCREENING RESULTS**  
**SOLID WASTE LANDFILL**



**Legend**

- + Data Point Location
- Approximate Sanitary Landfill Boundary
- x-x Fence
- ++++ Railroad Tracks
- Hydrology

STATE PLANE COORDINATE SYSTEM  
OHIO SOUTH ZONE



PREPARED BY

ROY F. WESTON, INC. 9/1/87

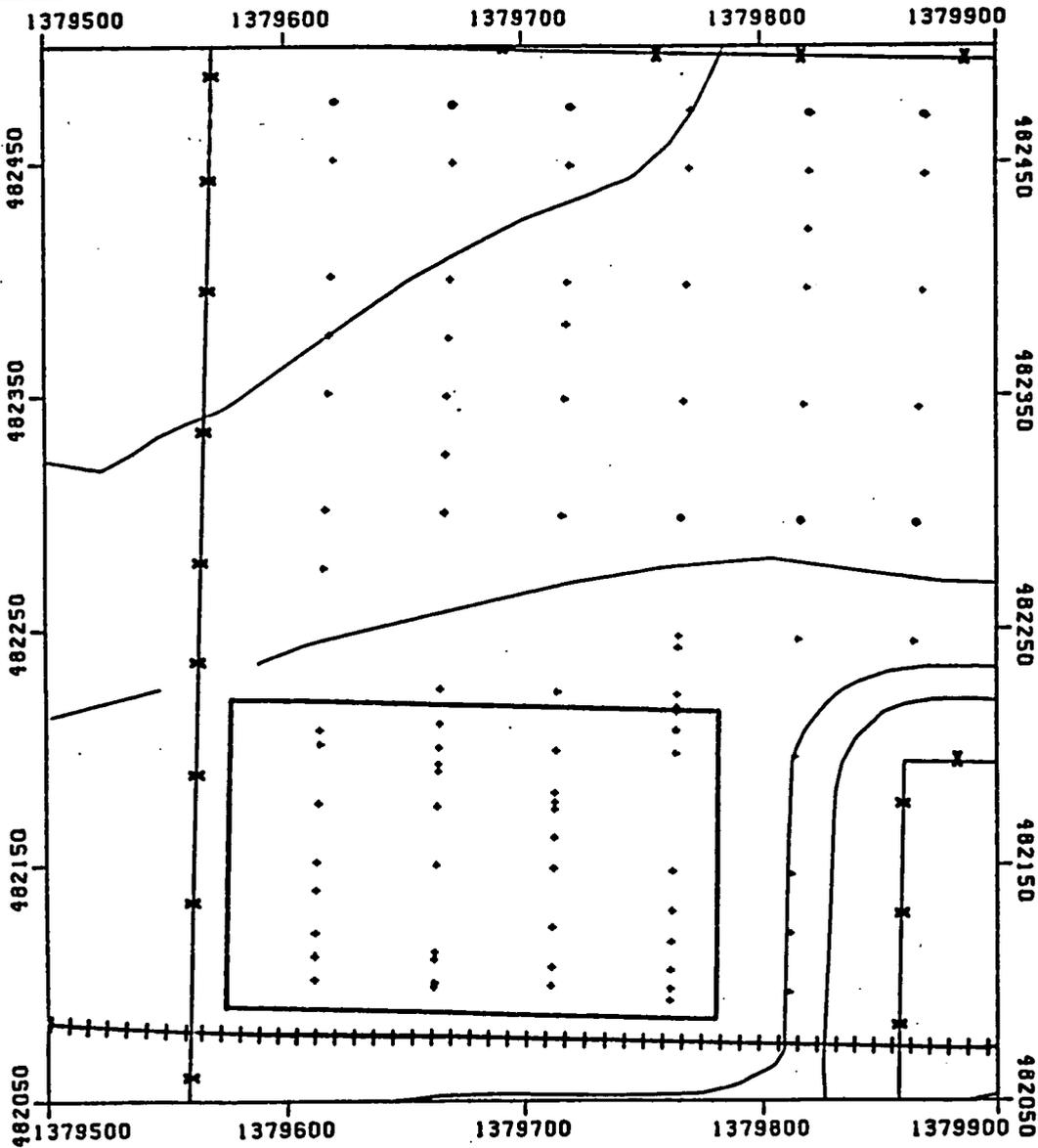
FIGURE 2-4  
CIS MAGNETIC SURVEY  
DATA POINTS  
SOLID WASTE LANDFILL

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**Legend**

- + Data Point Location
- Approximate Sanitary Landfill Boundary
- x—x— Fence
- + + + + + Railroad Tracks
- Hydrology

STATE PLANE COORDINATE SYSTEM

8N18 SOUTH ZONE

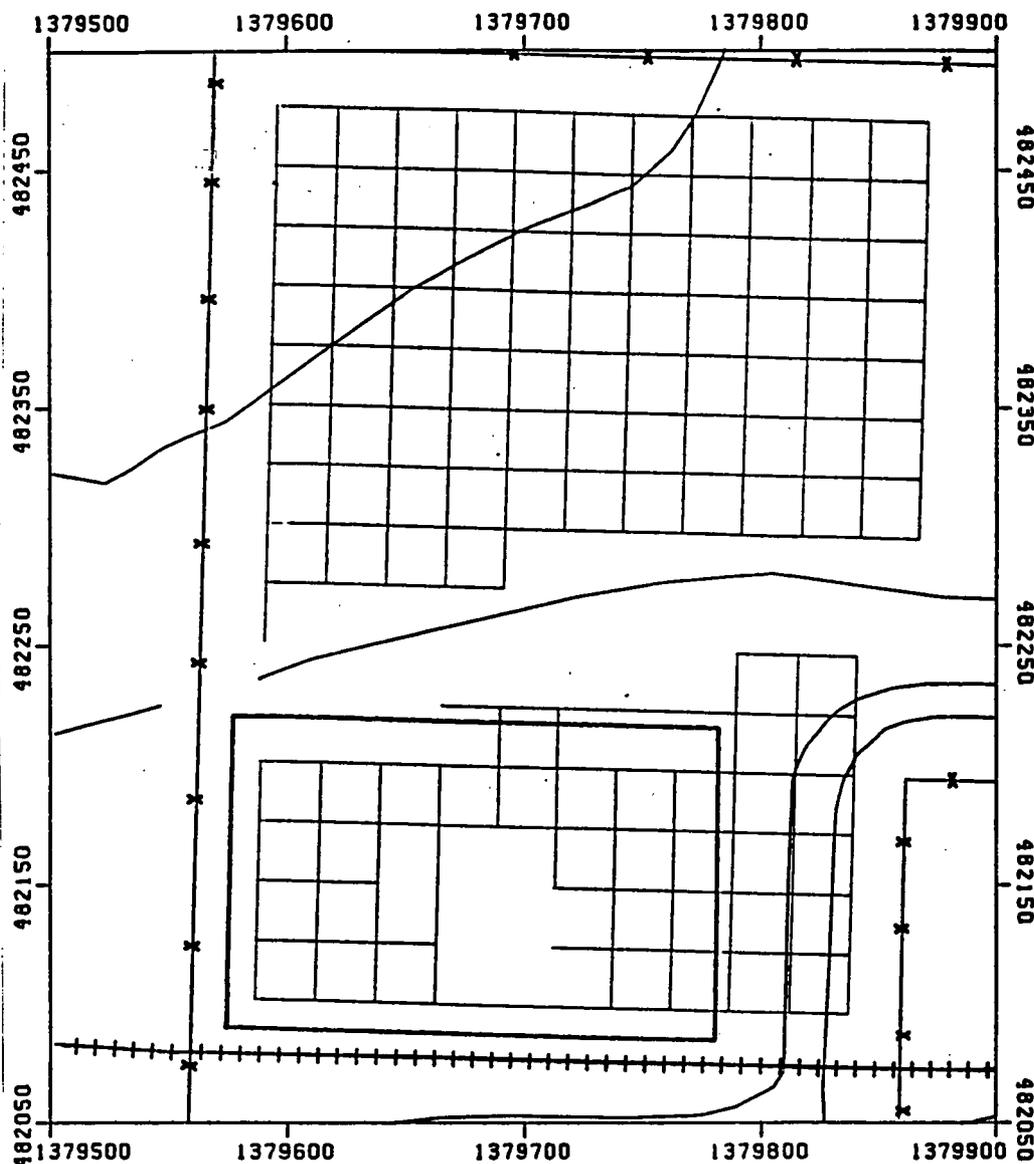


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ROY F. WESTON, INC. 9/1/87

FIGURE 2-5  
CIS ELECTROMAGNETIC  
SURVEY DATA POINTS  
SOLID WASTE LANDFILL

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**Legend**

- GPR Profile Location
- - - Approximate Sanitary Landfill Boundary
- x-x Fence
- + + + + Railroad Tracks
- Hydrology

STATE PLANE COORDINATE SYSTEM

OHIO SOUTH ZONE



PREPARED BY

ROY F. WESTON, INC. 9/1/87

FIGURE 2-6  
CIS GROUND PENETRATING  
RADAR SURVEY  
PROFILE LOCATIONS  
SOLID WASTE LANDFILL

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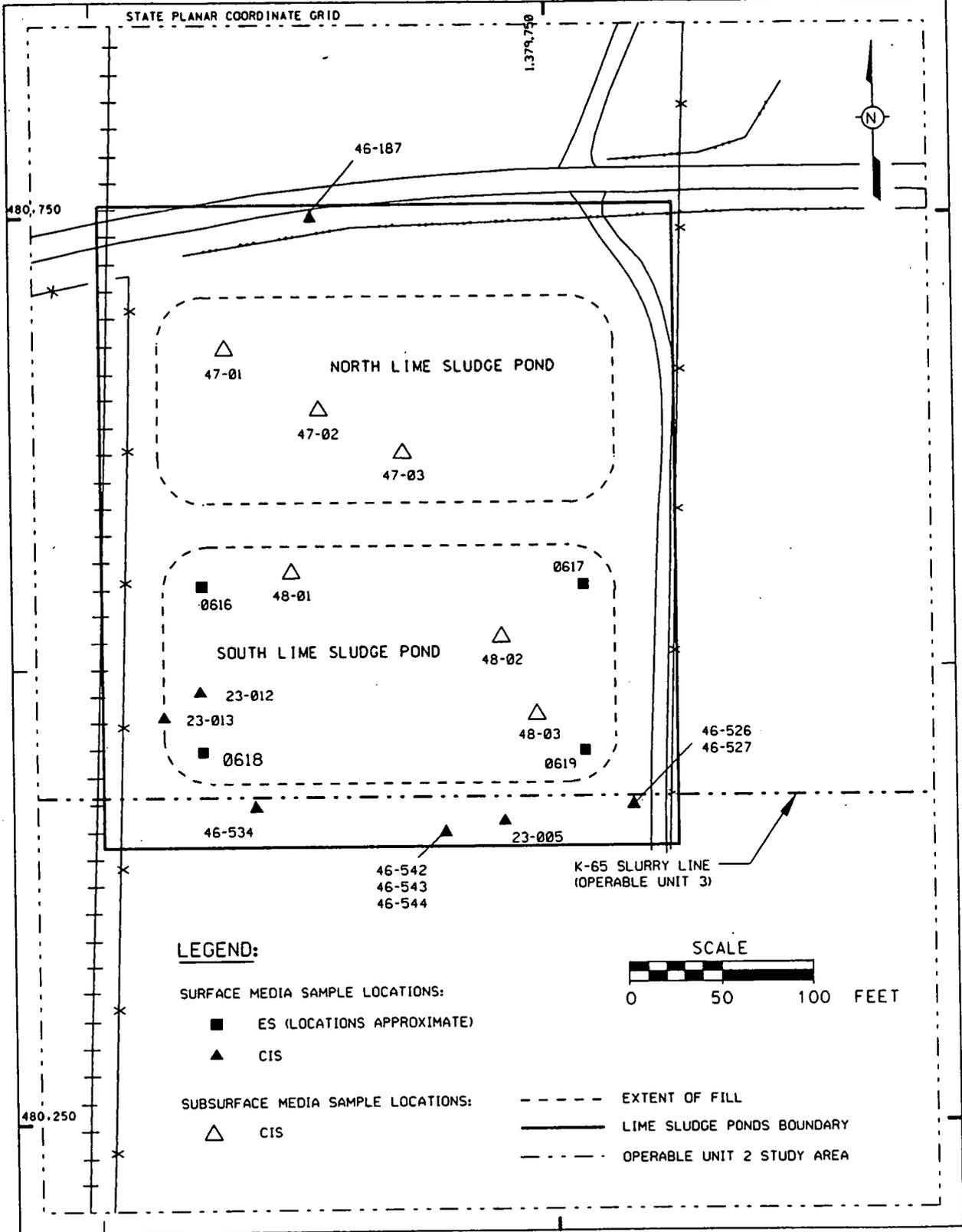
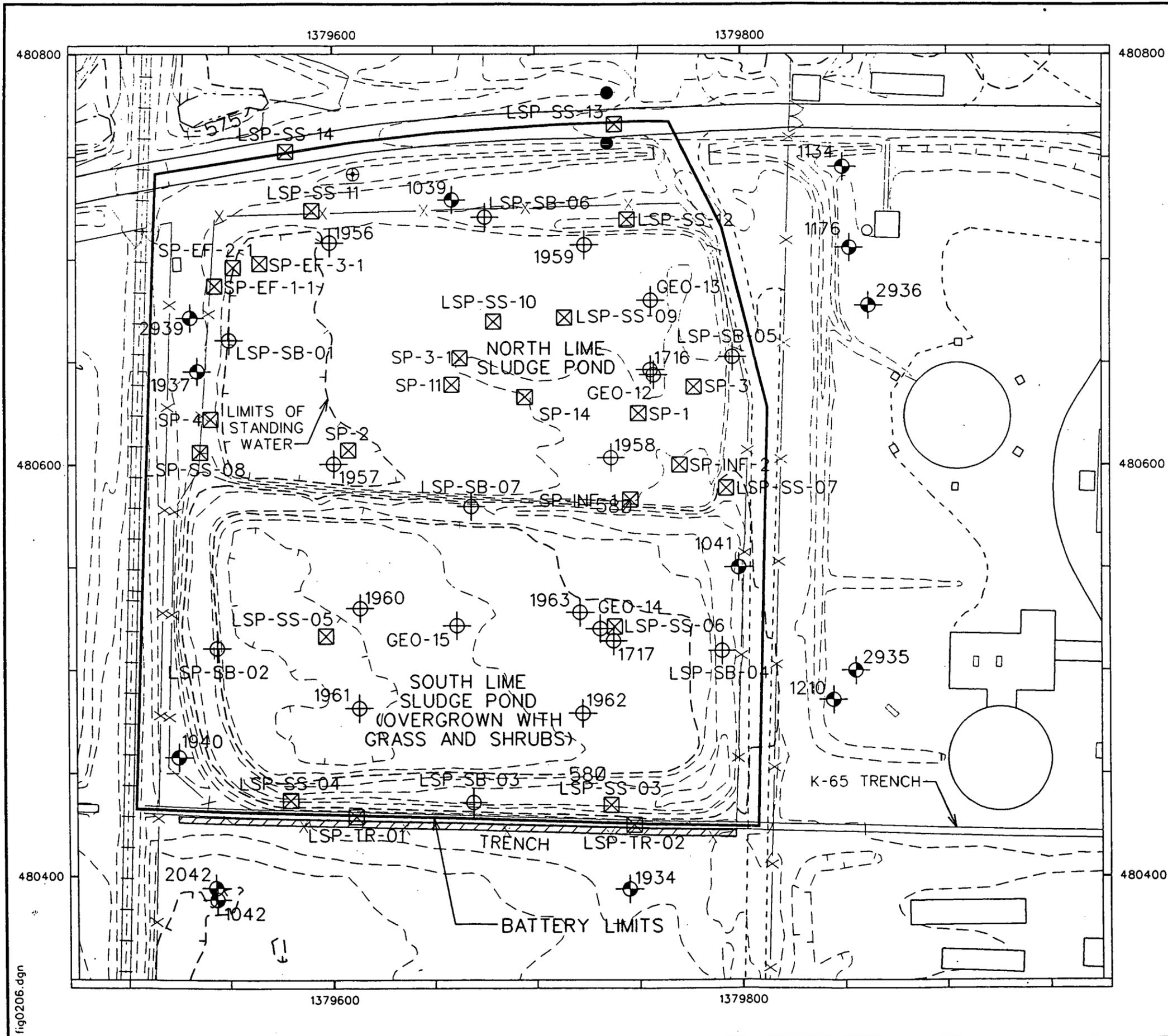


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FIGURE 2-7  
CIS AND ES SAMPLE LOCATIONS  
IN LIME SLUDGE PONDS AREA

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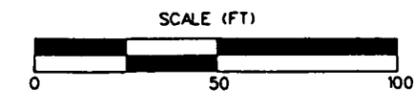
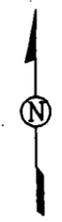


**LEGEND**

- 575- ELEVATION CONTOURS
- ROADS
- - - - - STREAM
- - - - - FENCE
- ||| RAILROAD
- MANHOLE
- ⊕ CATCH BASIN
- 1000 MONITORING WELLS
- 2000 MONITORING WELLS
- ⊕ SOIL BORING
- ⊗ SURFACE SOIL SAMPLE
- ▨ TRENCH

NOTE: "GEO" REPRESENTS GEOTECHNICAL SAMPLE LOCATIONS.

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



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**FIGURE 2-7a**  
SURFACE, SUBSURFACE,  
AND GEOTECHNICAL  
SAMPLE LOCATIONS  
LIME SLUDGE PONDS  
(PHASE I AND PHASE II)

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2.4.2 Subsurface Sampling

During the CIS boring program (Weston 1987b), three borings (47-01, 47-02, and 47-03) were drilled in the North Lime Sludge Pond and three in the South Lime Sludge Pond (48-01, 48-02, and 48-03) (Figure 2-7). Profile samples were collected from the North Pond at 6- to 20-inch depth increments and from the South Pond at 1-foot depth increments. These were analyzed for radium-226, thorium-232, and uranium-238 at the on-site laboratory to evaluate the vertical distribution of radionuclides. One composite sample from each of the six borings was also collected and shipped to an off-site laboratory for analyses of radionuclides, VOCs, SVOCs, pesticides/PCBs, metals, EP toxicity metals, and the RCRA characteristics of ignitability, reactivity, and corrosivity.

In 1990, three borings (1039, 1041, and 2042) were drilled adjacent to the Lime Sludge Ponds as part of the site-wide monitoring well installation program (Figure 2-7a). One sample was collected from the glacial overburden sequence in each of these borings for radiological analysis. In addition, a soil sample was collected from the underlying sand and gravel in Boring No. 2042 for radiological analysis.

Objectives of RI/FS subsurface media (including soil and lime sludge residue) sampling at the Lime Sludge Ponds were to:

- Characterize the nature and extent of contamination within the ponds, berms, and underlying soil.
- Determine fill depths and volumes.
- Provide data to support the modeling of contaminant migration from the Lime Sludge Ponds, particularly vertical contaminant migration from the K-65 trench.

In 1991, as part of the Phase I Field Investigation, samples were collected from one hand-augured boring in each pond. The locations for Boring No. 1716 in the North Pond and Boring No. 1717 in the South Pond (Figure 2-7a) were selected at random, since the waste deposited in each pond was assumed to be evenly mixed within horizontal layers. In each boring, a grab sample was taken at approximately two feet below the surface and analyzed for radionuclides, total uranium, total thorium, dioxins/furans, herbicide organics, VOCs, SVOCs, pesticides/PCBs, and metals. A second sample from each boring was analyzed for TCLP.

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In March 1992, WEMCO conducted a RCRA facility assessment of the North Lime Sludge Pond. As part of this assessment, lime sludge residue samples were collected from 13 locations (SP-EF-1-1, SP-EF-2-1, SP-EF-3-1, SP-INF-1, SP-INF-2, SP-1, SP-2, SP-3, SP-3-1, SP-4, SP-10, SP-11, and SP-14) (Figure 2-7a). At seven of these locations, a single sample was collected, typically from the top one to three feet of residue. At six locations, samples were collected at multiple depths (depth is measured from the pond water/residue interface). Samples were analyzed for VOCs and TCLP.

During the Phase II Field Investigation, 14 borings (1934, 1937, 1940, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 2935, 2936, and 2939) were drilled in the Lime Sludge Pond area (Figure 2-7a). Eight borings were located in the ponds and seven were advanced into the berms surrounding the ponds. Twenty samples from these borings were analyzed for full HSL and full radiological parameters. In addition, one sample from each boring in the ponds was taken for TCLP analysis and six samples were collected for on-site total uranium screening. Fourteen near-surface soil samples (6 to 12 inches) were also collected from LSP-SS-03, -04, -07, -08, -11, -12, and LSP-SB-01 through LSP-SB-07) and analyzed for full HSL and full radiological parameters (Figure 2-7a). Six near-surface samples were collected for on-site total uranium screening.

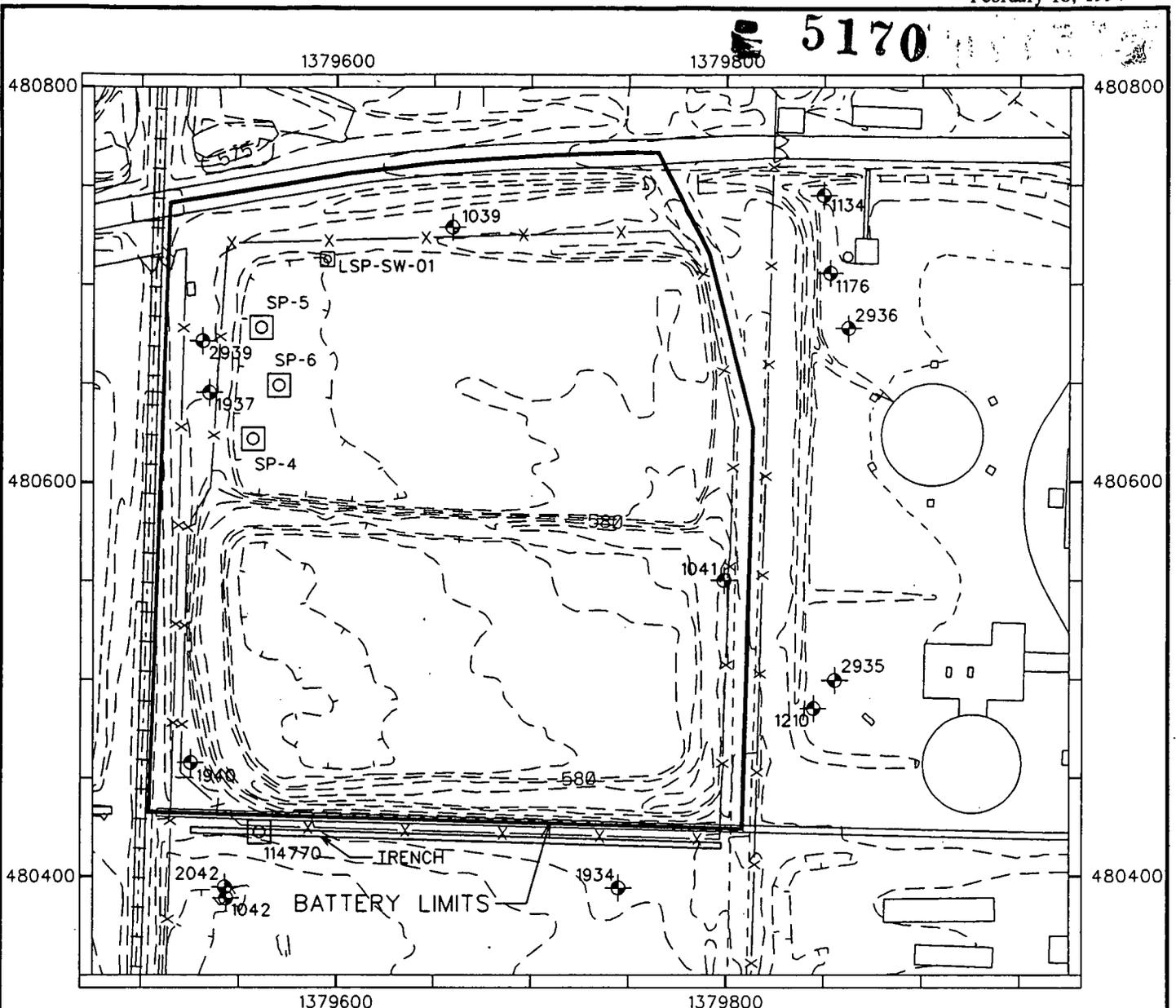
A trench was excavated parallel to the K-65 Slurry Line that traverses east to west along the southern battery limits of the Lime Sludge Ponds. The trench was excavated to evaluate the impact of the K-65 Slurry Line on the surrounding soil and groundwater. Two soil samples were collected from the trench and analyzed for full HSL and full radiological parameters. Two soil samples were collected and sent to the on-site laboratory for total uranium, thorium, and radium screening.

#### 2.4.3 Surface Water and Sediment Sampling

During the March 1992 RCRA Facility Assessment, three surface water samples were collected at SP-4, SP-5, and SP-6 (Figure 2-8). These samples were analyzed for VOCs and TCLP.

The objectives of RI/FS surface water sampling in the North Lime Sludge Pond were to:

- Characterize the nature of the contamination of surface water in the ponds to complete the risk assessment.
- Provide data to evaluate the potential for contaminants to leach into underlying soils and groundwater from the ponds.



**LEGEND**

- 575— ELEVATION CONTOURS
- ROADS
- STREAM
- FENCE
- RAILROAD
- 1000 MONITORING WELLS
- 2000 MONITORING WELLS
- 3000 MONITORING WELLS
- 4000 MONITORING WELLS
- SURFACE WATER SAMPLE
- SEDIMENT SAMPLE

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

SCALE (FT)

**FIGURE 2-8**  
MONITORING WELLS,  
SURFACE WATER AND  
SEDIMENT SAMPLE LOCATIONS  
LIME SLUDGE PONDS  
(PHASE I AND PHASE II)

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During the Phase I Field Investigation, four surface water samples were collected from the standing water in the North Lime Sludge Pond and analyzed for different combinations of radionuclides, total uranium, total thorium, VOCs, SVOCs, pesticides/PCBs, herbicide organics, metals, and general chemistry. No water samples were taken from the South Pond because it does not contain standing water.

Four additional surface water samples were taken from location LSP-SW-01 during the Phase II Field Investigation (Figure 2-8). Two of these samples were analyzed off site for full HSL, full radiological, and general chemistry parameters, and the other two were screened for total uranium and the on-site laboratory. An additional surface water sample (114770) was collected during the excavation of the trench parallel to the K-65 Slurry Line (Figure 2-8). It was sent to the on-site laboratory for total uranium screening.

2.4.4 Groundwater Investigations

The objectives of groundwater sampling in the Lime Sludge Pond Study Area were to:

- Determine if contaminants from the ponds have migrated to shallow or deep groundwater.
- Characterize perched groundwater that could be encountered during remediation of the ponds.
- Determine the impact of the K-65 Slurry Line on shallow groundwater.

Seven monitoring wells (1039, 1041, 1042, 1134, 1176, 1210, and 2042) were completed during Phase I in the general vicinity of the Lime Sludge Ponds (Figure 2-8). Well No. 1176 was a dry well and therefore, was never sampled. These wells were screened in the perched water, and the Upper Great Miami Aquifer. Samples were collected periodically from 1988 to 1990 and analyzed for different combinations of radionuclides, total uranium, total thorium, VOCs, SVOCs, pesticides/PCBs, metals, and general chemistry parameters. Detail on the sampling frequency and parameters for each well is included in Table D-11 of Appendix D.

As part of the Phase II Field Investigation, three 1000-series wells (1934, 1937, and 1940) and three 2000-series wells (2935, 2936, and 2939) were installed around the Lime Sludge Ponds area (Figure 2-8). Samples were collected from these new wells and from the wells installed under the RI/FS Phase I Field Investigation. Samples from each well were analyzed for full HSL, full

0164

radiological, and general chemistry parameters. Additional samples were collected from each well for on-site total uranium screening. It was planned to take samples from Well Nos. 1134, 1176, 1210, and 1229, but 1176 and 1210 were completely dry, 1134 was purged dry and did not recover, and 1229 was found to have a bent casing due to a surface vehicle collision.

RCRA quarterly groundwater monitoring was performed on the Lime Sludge Ponds wells during 1991 and 1992. Because the results cannot be validated to the same level as the RI/FS data, it is considered a secondary source of information and was not used in the preparation of this report.

2.4.5 Geotechnical Investigations

During the CIS boring program (Weston 1988), one sample from the North Lime Sludge Pond and two samples from the South Lime Sludge Pond were collected for geotechnical evaluation. Samples from the North Lime Sludge Pond were collected from the 0- to 5.5-foot depth interval and those from the South Pond were collected from the 0- to 12-foot and the 2- to 11.2-foot depth intervals. The exact location of these samples was not specified in the CIS report so they are not illustrated on Figure 2-7. The testing parameters included specific gravity, liquid limit, plasticity index, natural moisture content, particle size distribution, maximum dry density, optimum moisture content, color, and physical state.

In October 1991, in-place density was measured at two locations in each pond (GEO 12, GEO 13, GEO 14, and GEO 15) by the nuclear density measurement methods (ASTM Method D-2922) as part of RI/FS Phase I sampling (Figure 2-7a). Wet density, dry density, and moisture content were measured at each sampling location.

Twenty-seven geotechnical samples were taken from LSP-SS-06, LSP-SB-01, LSP-SB-04, LSP-SB-07, and all monitoring well and soil borings completed as part of the RI/FS Phase II Field Investigation (Figure 2-7a). The samples from these locations were taken from varying depths and were analyzed for different combinations of specific gravity, water content, liquid limit, plastic limit, sieve analysis, hydrometer analysis, consolidated isotropic undrained triaxial, direct shear, and dry unit weight.

2.4.6 Geophysical Survey

The CIS performed geophysical surveys of the South Lime Sludge Pond. No geophysical surveys were performed in the North Lime Sludge Pond since it was a completely saturated media and would not support any weight. Three types of geophysical methods were used to survey the South Lime Sludge Pond: magnetic, EM, and GPR. Magnetic data measurements were conducted on a 25 by 25 foot grid with the sensor oriented in a northerly direction. Figure 2-9 represents the grid locations for the South Lime Sludge Pond. The EM survey was conducted on a 50 by 25 foot grid, with 50 feet separating the north-to-south trending profiles. The EM survey was performed in both vertical and horizontal dipole to further evaluate near surface disturbances. Additional data points were surveyed on a 25 foot grid between the 50 foot grid lines when anomalies were detected. The grid locations for the EM survey are identified in Figure 2-10. The GPR survey was performed on a 25 by 25 foot grid. The GPR survey grid is identified in Figure 2-11.

2.5 ENVIRONMENTAL CHARACTERIZATION INFORMATION FOR THE INACTIVE FLYASH PILE AND SOUTH FIELD

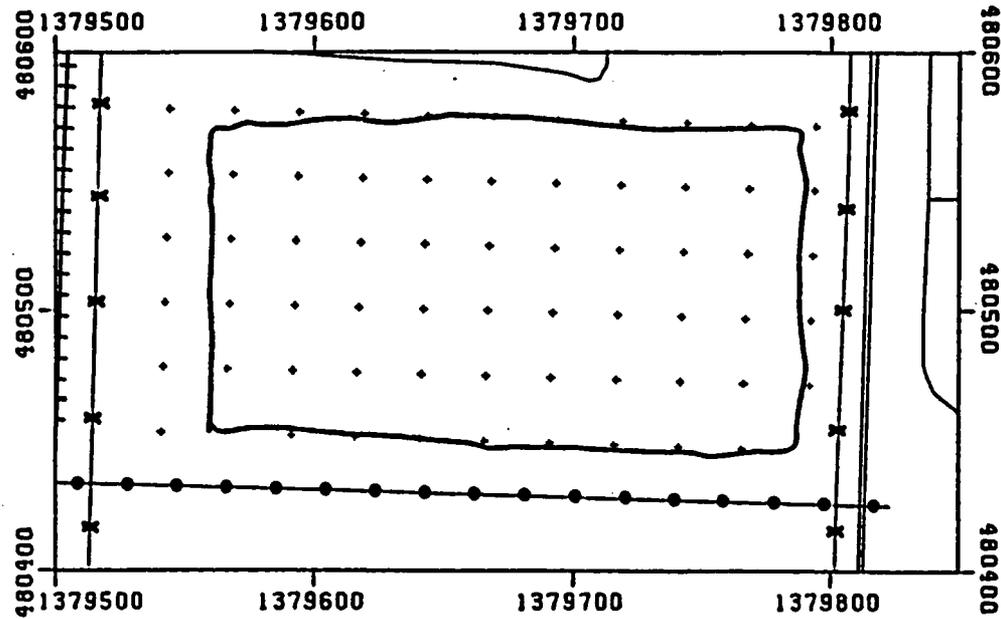
The Inactive Flyash Pile and South Field has been preliminarily characterized by the Environmental Survey and CIS Sampling Program followed by characterization by the RI/FS Sampling Program. The following sections discuss the sample locations and analytical parameters from each of these sampling programs. Results of these sampling programs are presented in Appendices E and F.

2.5.1 Surface Sampling

During the Environmental Survey (DOE 1988a), a radiological survey in the Inactive Flyash Pile and the South Field was conducted using an Eberline PG-2 and PRM-5-3. Based on elevated radiation levels measured at ground surface, three surface media samples (0111, 0113, and 0114) were collected from the Inactive Flyash Pile and five (0108, 0109, 0110, 0112, and 0115) from the South Field (Figure 2-12a). These samples were analyzed for radionuclides, total uranium, asbestos, VOCs, and TCLP metals.

During the CIS, a FIDLER was used to conduct a radiological survey to estimate uranium-238 activities in surface media. Based on these estimates, surface media samples were collected from the Inactive Flyash Pile and South Field at depth intervals from 0- to 0.16 feet, 0.16- to 0.5-feet, 0.5- to 1- feet, and 1- to 1.5-feet (Weston 1987c). Additionally, samples were taken along the steep berm on the northwestern perimeter of the South Field adjacent to the Inactive Flyash Pile where gamma-ray

5170



Legend	
+	Data Point Location
—	Approximate Boundary of South Lime Sludge Pond
x	Fence
++++	Railroad Tracks
—●—	Pipeline
—	Hydrology

STATE PLANE COORDINATE SYSTEM

8110 SOUTH ZONE



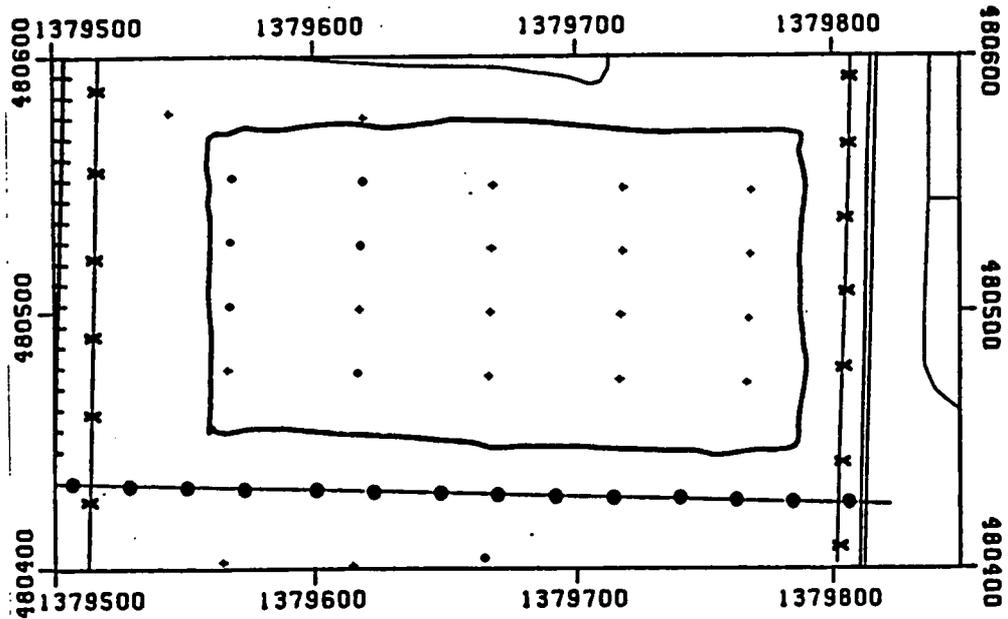
PREPARED BY

ROY F. WESTON, INC. 9/1/87

0167

FIGURE 2-9  
 TOTAL MAGNETIC INTENSITY  
 DATA CONTROL POINT  
 POSTINGS MAP OF THE  
 SOUTH LIME SLUDGE POND

5170



**Legend**

- + Data Point Location
- Approximate Boundary of South Lime Sludge Pond
- x—x—x Fence
- + + + + Railroad Tracks
- ● ● Pipeline
- Hydrology

STATE PLANE COORDINATE SYSTEM

8N18 SOUTH ZONE



PREPARED BY

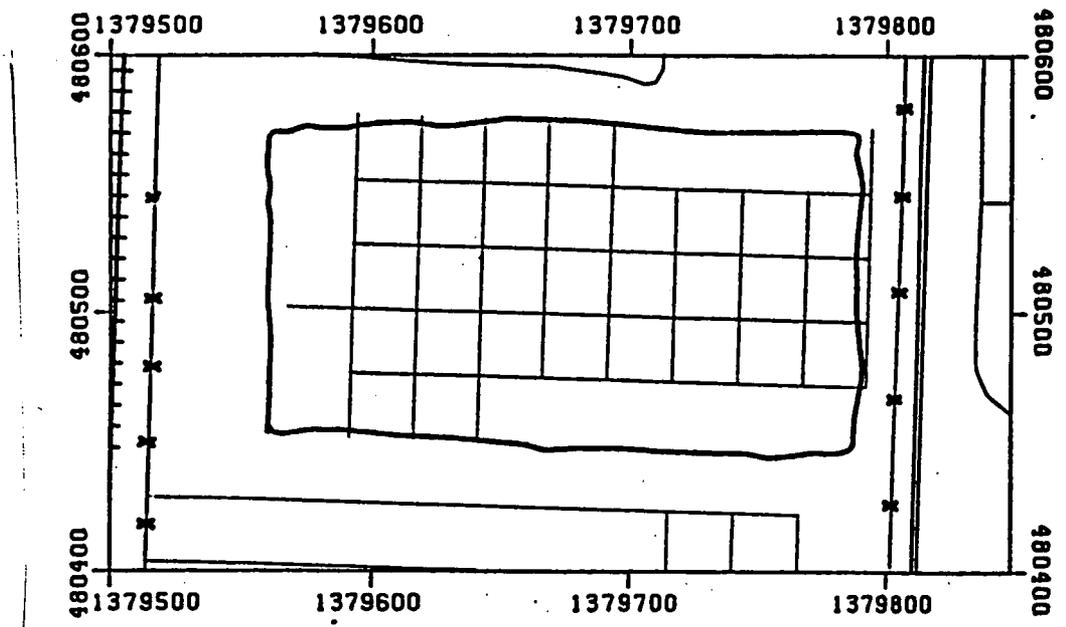
ROY F. WESTON, INC. 9/1/87

FIGURE 2-10  
EM 31 DATA CONTROL POINT  
POSTINGS MAP OF THE  
SOUTH LIME SLUDGE POND

0168

fig0298.dgn

5170



**Legend**

- GPR Profile Location
- Approximate Sanitary Landfill Boundary
- x—x— Fence
- + + + + Railroad Tracks

STATE PLANE COORDINATE SYSTEM  
8118 SOUTH ZONE



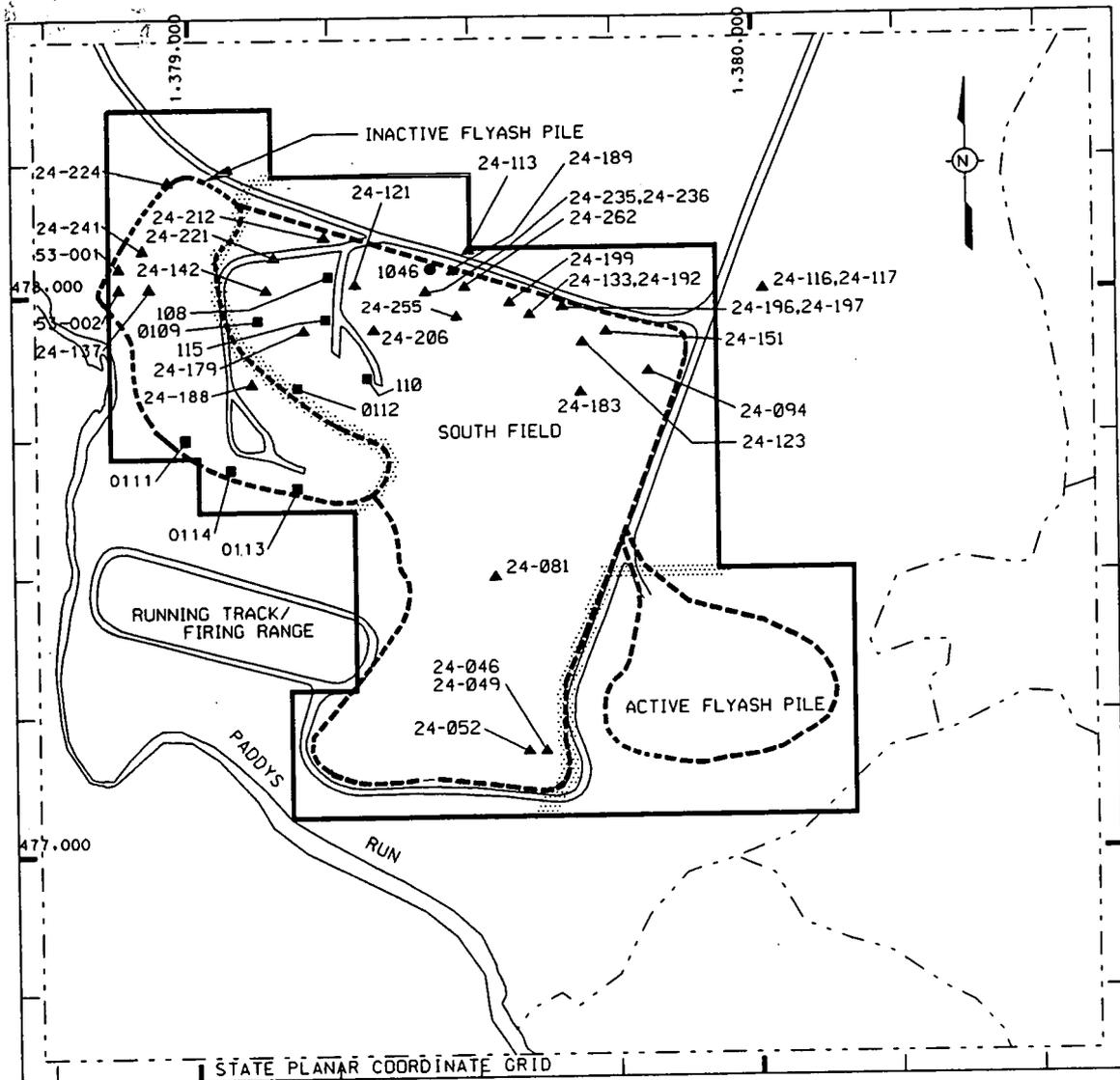
PREPARED BY

ROY F. WESTON, INC. 9/1/87

0169

FIGURE 2-11  
GROUND PENETRATING  
RADAR BASE MAP OF THE  
0169 SOUTH LIME SLUDGE POND

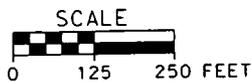
fig0297.d



**LEGEND:**

**SURFACE MEDIA SAMPLING LOCATIONS:**

- ES (LOCATION APPROXIMATE)
- ▲ CIS
- - - - - EXTENT OF FILL
- FLYASH/SOUTH FIELD BOUNDARY
- ▨ BOUNDARY BETWEEN FLYASH PILES AND SOUTH FIELD
- ..... OPERABLE UNIT 2 STUDY AREA



0170

FIGURE 2-12a  
CIS AND ES SURFACE SOIL AND SEDIMENT SAMPLE LOCATIONS  
IN SOUTH FIELD/INACTIVE FLYASH PILE AREA

fig0295.dgn

measurements, taken with a scintillometer (SPA-3), were statistically greater than background (i.e., greater than three standard deviations above background). The on-site gamma spectrometry laboratory was used to analyze all samples for cesium-137, radium-226, ruthenium-106, thorium-232, and uranium-238. Tables E-18B and F-15B of Appendices E and F report results for the on-site surface sample screening. Based on this initial screening, four samples from the Inactive Flyash Pile and 27 samples from the South Field were selected for off-site analysis for 16 radionuclides (Figure 2-12a).

The objectives of RI/FS surface media (including flyash) sampling at the Inactive Flyash Pile and South Field were to:

- Characterize the nature of contamination in surface media and flyash.
- Provide data to evaluate the potential for exposure via the direct contact pathway.
- Provide data to evaluate the potential for migration via the air pathway.

Two surface soil samples (05001 and 5017) were collected from the Inactive Flyash Pile/South Field area during Phase I field activities, but the analytical results of both samples were rejected during data validation.

Seven surface samples (IFP-SS-01 through IFP-SS-07) were collected during the Phase II Field Investigation from the Inactive Flyash Pile. Twenty-one surface samples were collected from locations in the South Field (SF-SB-01 through SF-SB-09, SF-SS-10, SF-SS-11, SF-SB-12 through SF-SB-15, and SF-SS-16 through SF-SB-21) [Figure 2-12 (see Volume 2, Oversized Figures)]. These samples were analyzed for full HSL and full radiological parameters. Three South Field surface soil samples from Locations SF-SS-17, -18 and -21 were analyzed for gross alpha and gross beta at the on-site laboratory.

### 2.5.2 Subsurface Sampling

During the Environmental Survey (DOE 1988a), subsurface media samples from two hand-auger borings were collected in the Inactive Flyash Pile. Sample Nos. 0605, 0607, 0608, and 0609 were collected at five-foot depths from a boring located near the center of the Inactive Flyash Pile. Sample

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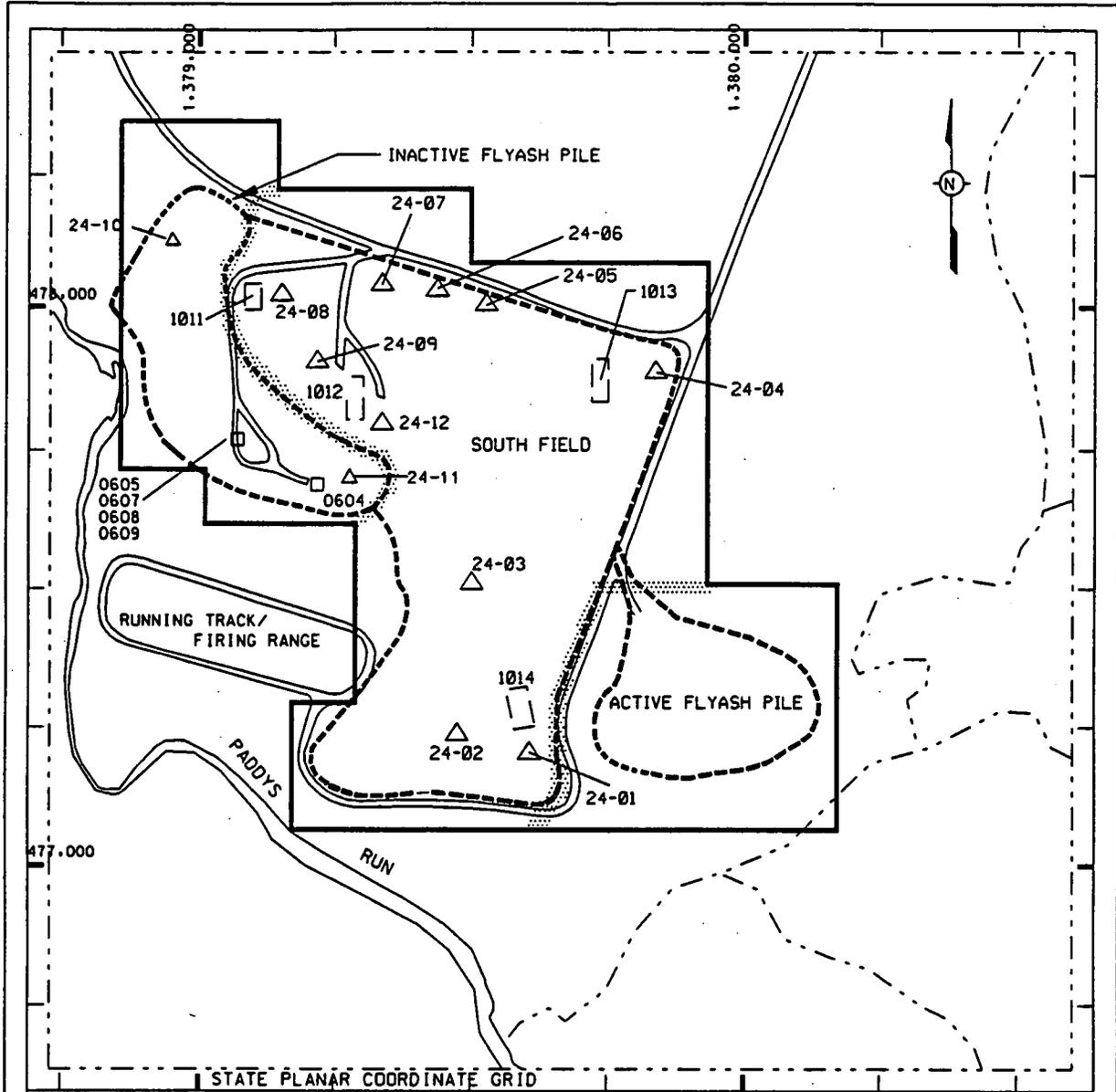
No. 0604 was collected from another boring located in the southeastern part of the Inactive Flyash Pile from the depth interval of 0- to 2-feet (Figure 2-12b). These samples were analyzed for radionuclides, total uranium, asbestos, VOCs, and TCLP metals.

Also during the Environmental Survey, nine grab samples were collected from the South Field from four trenches (Test Pits 1014 through 1017) that were excavated (Figure 2-12b). The trench locations were selected based on prior radiological surveys. The locations are estimated because the trenches were not surveyed at the time of excavation. These trenches were oriented north to south and varied in depth from 2 to 10 feet. Two samples each were collected from Test Pits 1014, 1016, and 1017, and three samples were collected from Test Pit 1015. Eight of the samples were analyzed for radionuclides, total uranium, and TCLP metals. The ninth sample from Test Pit 1015 was analyzed for VOCs only.

Twelve borings were completed in the Inactive Flyash Pile and South Field (24-01 through 24-12) during the CIS (Weston 1987b); split samples were collected at one-foot intervals to depths ranging from 4 feet at Boring No. 24-04 to 34 feet at Boring No. 24-11 (Figure 2-12b). The boring locations were selected based upon radiological surveys indicating elevated levels of radionuclides at the surface location. Geotechnical survey data was reviewed to avoid areas with a high potential for buried metal objects which were potentially considered to be buried drums. Samples from the borings were analyzed at the on-site gamma spectrometry laboratory for radium-226, thorium-232, and uranium-238 to evaluate the vertical distribution of these radionuclides. A composite sample from each boring was analyzed for radionuclides, VOCs, SVOCs, pesticides/PCBs, metals, and EP toxicity.

During 1988, four borings (1016, 1047, 2047, and 4016) were drilled near the northern and southern boundaries of the Inactive Flyash Pile, and five borings (1046, 2046, 3046, 2385, and 3385) were completed near the northern boundary of the South Field as part of the site-wide monitoring well installation program [Figure 2-12 (see Volume 2, Oversized Figures)]. One sample each was collected from each of the Boring Nos. 1016, 1047, and 2047 and analyzed for radionuclides; the sample collected from Boring No. 2047 was also analyzed for total uranium. Three samples were collected from Boring No. 4016 and were analyzed for radionuclides and total uranium. Out of a total of nine samples from the South Field borings, seven samples were analyzed for radionuclides. The other sample (from Boring No. 2046) was analyzed for total uranium only.

0172



**LEGEND:**

**SUBSURFACE MEDIA SAMPLING LOCATIONS:**

- ES MEDIA BORING (LOCATION APPROXIMATE)
- △ CIS BORING    [ ] ES TRENCH (LOCATION APPROXIMATE)
- - - EXTENT OF FILL
- FLYASH/SOUTH FIELD BOUNDARY
- [Hatched Box] BOUNDARY BETWEEN FLYASH PILES AND SOUTH FIELD
- - - - OPERABLE UNIT 2 STUDY AREA

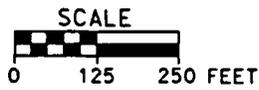


FIGURE 2-12b  
CIS AND ES SUBSURFACE SOIL SAMPLE LOCATIONS  
IN SOUTH FIELD/INACTIVE FLYASH PILE AREA

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fig0296.dgn

During the installation of Piezometer Wells 1516, 1517, and 1518 (1518 is located just south of the South Field and is not shown in Figure 2-12), samples were collected at 1- to 2-foot intervals to a depth of 20 feet [Figure 2-12 (see Volume 2, Oversized Figures)]. Fifty-one samples were analyzed for radionuclides, total uranium, and total thorium. One additional sample from Boring No. 1516 was analyzed for TCLP.

The objectives of RI/FS subsurface media sampling (including flyash and underlying native soil) in the Inactive Flyash Pile and South Field were to:

- Characterize the physical nature of buried waste materials in the Inactive Flyash Pile and South Field.
- Determine the nature and extent of contamination.
- Determine fill depths and volumes.
- Determine whether contaminants have migrated from the fill into the underlying native soils.
- Provide data to support the modeling of contaminant migration from the Inactive Flyash Pile and South Field.

Because previous sampling had not sufficiently quantified the vertical distribution of contaminants in the Inactive Flyash Pile to meet the study objectives, seven additional borings (1708, 1709, 1710, 1711, 1791, 1849, and 1850) were drilled in 1991 during the Phase I Field Investigation to further characterize the nature of the fill and the underlying native soil [Figure 2-12 (see Volume 2, Oversized Figures)]. Except for Boring No. 1791 (which only had two profile samples collected), samples were collected from the shallow fill, the deep fill, and the underlying native soils. These samples were analyzed for different combinations of radionuclides, total uranium, total thorium pesticides/PCBs, VOCs, SVOCs, metals, TCLP, EP toxicity, and total organic carbon (TOC). The TCLP VOC/SVOC sample was collected from the portion of the boring that displayed the highest HNu reading during screening. TCLP samples from borings for which there were no HNu readings were collected from the midpoint of the boring. A composite sample from each boring (except 1709, 1849, and 1850) was analyzed for the remainder of the TCLP analytes. The purpose of TCLP analysis was to determine whether the waste met criteria for regulation under RCRA and to determine leaching and transport potentials for waste transport modeling.

Twelve additional borings were also completed in the South Field [Figure 2-12 (see Volume 2, Oversized Figures)]. For Boring Nos. 1712 through 1715, one sample from each was collected at the 1.5 to 2.0 foot depth interval and was analyzed for TCLP. Samples from Borings Nos. 1792 and 1793 were sampled at 5-foot intervals until native soil was encountered. A total of five samples from Boring No. 1792 and one sample from Boring No. 1793 were analyzed for dioxins/furans, VOCs, SVOCs, pesticides/PCBs, and metals. At the base of each of these two borings, above the native soil, a sample was collected for TCLP analysis. At Boring Nos. 1794 and 1795, a subsurface media sample was collected from approximately the 1- to 2-foot depth interval and another from the 4- to 5-foot depth interval (or from the base of fill if the fill was less than 5 feet thick). These samples were analyzed for dioxins/furans, VOCs, SVOCs, pesticides/PCBs, and metals. One sample was collected from Boring No. 1794 and two samples from Boring No. 1795 for TCLP analysis. Boring Nos. 1882, 1883, 1884 (shown as GEO-6), and 1885 each had one sample taken for TCLP analysis.

Six trenches were excavated during the South Field Phase I Field Investigation from the surface through the fill and into the underlying native soil. The trenches, with an approximate north to south orientation, were 50 feet long, and their depths ranged from 3.75 to 5.75 feet. Samples from these trenches were collected from the bottom of the fill as well as from the native soil immediately below the fill at the north, south, and middle of each trench (Locations 1455 through 1472) [Figure 2-12 (see Volume 2, Oversized Figures)]. Trench traces are not shown but are included by the sample locations. Fill samples were screened in the field for VOCs using a portable photoionization detector to further identify sources of contamination and for health and safety protocols. The samples were analyzed for radionuclides, total uranium, and total thorium in order to characterize the nature of radionuclide contamination in both the fill and the underlying native soil. The fill samples from the middle of each trench (Locations 1456, 1459, 1462, 1465, 1468, and 1471) were also analyzed for VOCs, SVOCs, pesticides/PCBs, and metals.

In early 1992, one sample was collected from Boring No. 2401 during the installation of a monitoring well. This boring is located in the South Field near the South Field/Inactive Flyash Pile boundary [Figure 2-12 (see Volume 2, Oversized Figures)]. The sample was analyzed for total uranium and total thorium.

In January and February 1992, six vertical borings (SP-1 through SP-6) were completed to a depth of

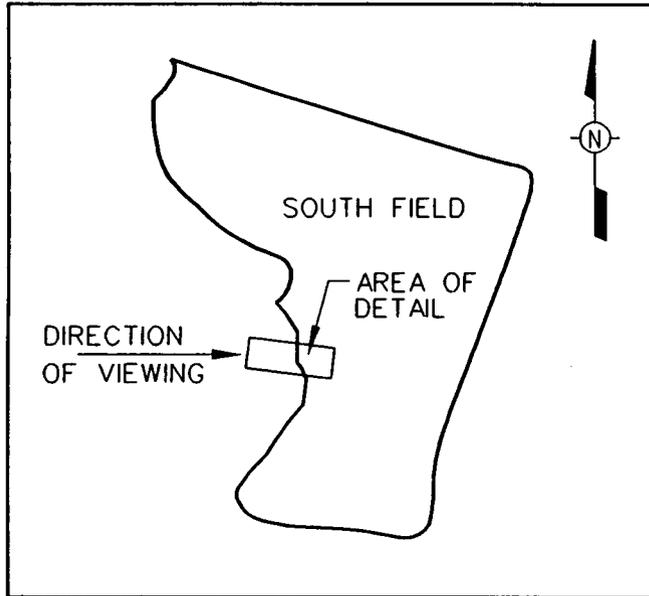
5 feet in the abandoned FEMP Firing Range as part of the removal site evaluation conducted by WEMCO (Figure 2-12c). Samples were collected from consecutive 1-foot intervals, with an additional sample collected from the 0.0- to 0.5-foot interval. In the approximate center of the firing zone, a 50-foot horizontal boring (SP-7) was drilled into the embankment; successive 5-foot intervals were sampled. In addition, two surface soil samples (SP-8 and SP-9) were taken from the flat area between the firing line and the embankment. Each sample was sieved to capture spent lead ammunition fragments greater than 2 millimeters in diameter. Material that passed through the sieve was analyzed for TCLP lead (DOE 1992c).

In November 1992, one soil sample was collected during the installation of Well 1433 in the South Field [Figure 2-12 (see Volume 2, Oversized Figures)]. The sample was analyzed for radionuclides.

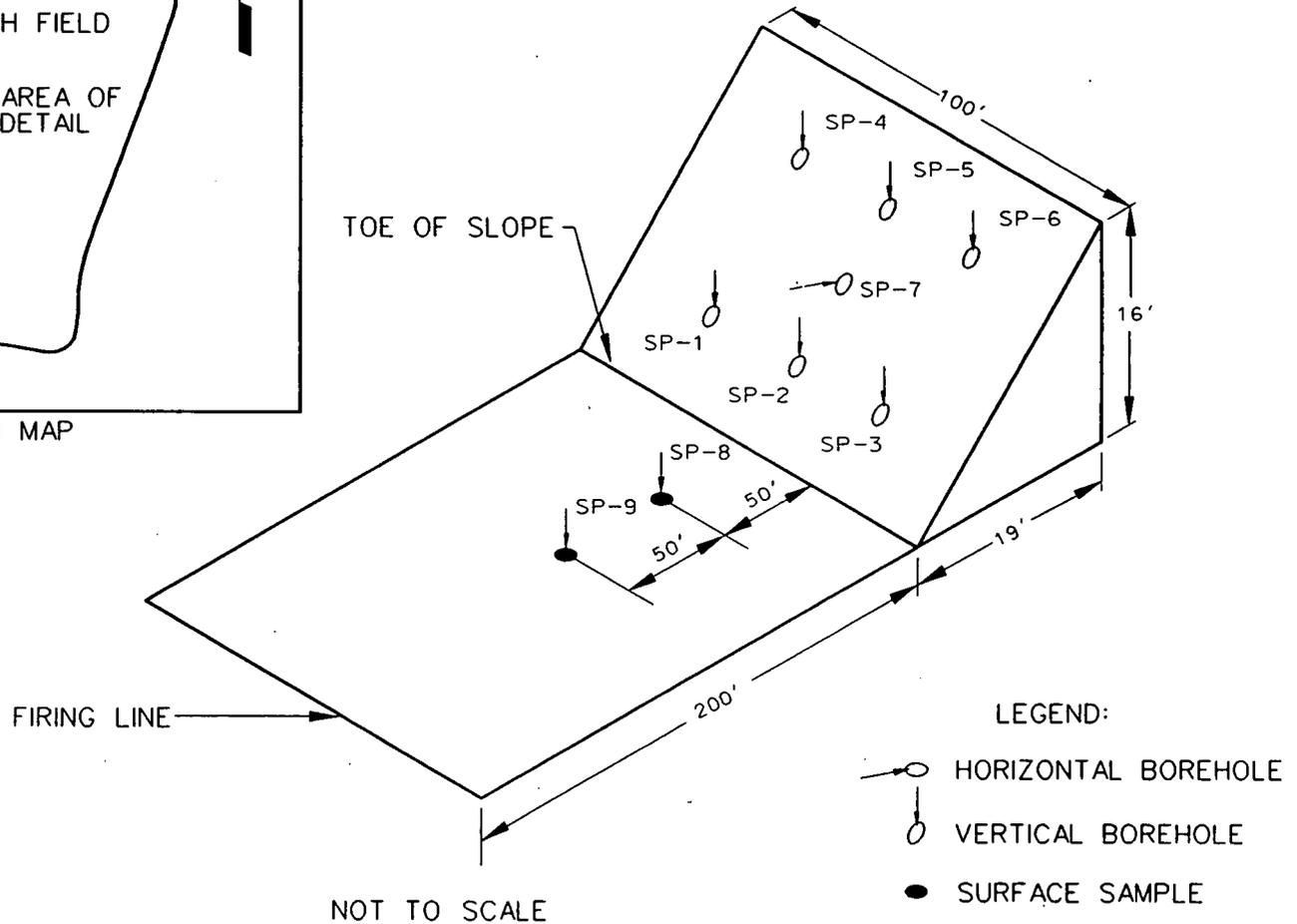
During the Phase II Field Investigation, subsurface samples were collected from 11 borings (1994 through 1998 and 11052 through 11057), 14 Hydropunch™ borings (1999, 11000 through 11008, and 11048 through 11051), and one monitoring well boring (2955) in the Inactive Flyash Pile [Figure 2-12 (see Volume 2, Oversized Figures)]. Eighteen samples from Boring Nos. 1994 through 1998 were analyzed for full HSL and full radiological parameters. Five additional samples were analyzed for subsets of full HSL and full radiological parameters. Each of these borings has one TCLP sample, except Boring No. 1998, which has two. Boring No. 11052 has one sample for full HSL and full radiological parameters and Boring Nos. 11054 through 11057 each have two samples analyzed for VOCs, SVOCs, and pesticides/PCBs only. In addition, 36 samples from the 11 Inactive Flyash Pile borings were sent to the on-site laboratory for total uranium screening. Three samples from the Inactive Flyash Pile Hydropunch™ borings were sent off site for full HSL and full radiological analysis. Thirty-three samples from the Hydropunch™ borings were sent to the on-site laboratory for total uranium screening. One sample from monitoring well Boring No. 2955 was sent to the on-site laboratory for total uranium screening. A complete summary of Inactive Flyash Pile Phase II subsurface samples, including sample intervals, is provided in Table E-1B of Appendix E.

During the Phase II Field Investigation, near-surface soil samples (6 to 12 inches) were collected from 11 South Field locations (SF-SB-03 through -06, -08, -09, -12, and -15, and SF-SS-10, -11, and -19) [Figure 2-12 (see Volume 2, Oversized Figures)]. These samples were analyzed off site for full HSL and full radiological parameters.

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LOCATION MAP



NOT TO SCALE

LEGEND:

-  HORIZONTAL BOREHOLE
-  VERTICAL BOREHOLE
-  SURFACE SAMPLE

FIGURE 2-12c  
SUBSURFACE SAMPLING LOCATIONS FOR  
FIRING RANGE REMOVAL SITE EVALUATION

2-75

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Subsurface samples were collected from the South Field from 15 borings (1964 through 1972, 1975 through 1978, and 11186 through 11188), 11 Hydropunch™ borings (11009 through 11018, and 11027), and six monitoring well borings (1941, 1942, 2943, 2944, 2945, and 2954) [Figure 2-12 (see Volume 2, Oversized Figures)]. Two samples from each boring were analyzed off-site for full HSL and full radiological parameters and one sample from each was sent to the on-site laboratory for total uranium screening. Nineteen samples from the Hydropunch™ borings were sent to the on-site laboratory for total uranium screening. One sample from each monitoring well boring, except Boring No. 2945, was sent to the on-site laboratory for total uranium screening. Geotechnical samples were only collected from Boring No. 2945. A complete summary of South Field Phase II subsurface samples, including sample intervals, is provided in Table F-1B of Appendix F.

Ten of the most significant geophysical anomalies located by nonintrusive EM and magnetometry measurements (see Section 2.5.6) were investigated by excavation, observation, and screening for total organic vapors and radioactivity. Samples from areas exhibiting high readings were collected from Trenches 1, 2, and 4 and sent off site for full HSL and full radiological analysis. Five samples from Trenches 1, 2, 4, and 5 were also collected for total uranium screening at the on-site laboratory. No samples were collected from the remaining trenches because no anomalous readings were found at that location. In addition to soil samples, 16 surface wipe samples were collected from debris in Trenches 1, 2, and 4. These samples were analyzed on site for uranium and thorium. Three concrete core samples were collected from debris in Trenches 1 and 2 and analyzed for total uranium, thorium, and radium.

### 2.5.3 Surface Water and Sediment Sampling

The objective of surface water and sediment sampling in the Inactive Flyash Pile and South Field was to determine whether contaminants from the waste area are migrating across its boundaries via the surface water pathway. The topography of the Inactive Flyash Pile is such that runoff flows west toward Paddys Run, east into the drainage ditch separating the Inactive Flyash Pile from the South Field, and south toward the running track. Topography of the South Field directs runoff east into a drainage ditch and south where it has no defined channel and appears to seep into the ground at the southeast corner of the subunit.

Sediments were sampled at two locations (53-001 and 53-002) west of the Inactive Flyash Pile as part of the CIS (Weston 1987b) (Figure 2-12a). The two samples were analyzed for cesium-137, radium-

0178

E 5170

226, ruthenium-106, thorium-232, and uranium-238 at the on-site gamma spectroscopy laboratory. 1  
Based on those results, neither was selected for more extensive off-site laboratory analysis. 2

3  
4 An additional objective for surface water and sediment sampling in the Inactive Flyash Pile and South  
5 Field was to assess potential surface migration pathways for risk assessment purposes. As part of the  
6 Phase I Field Investigation, sediments were sampled at two locations west of the Inactive Flyash Pile  
7 (ASIT-008 and ASIT-009) (Figure 2-13). Two surface water samples were also collected at ASIT-  
8 009. Sediment and surface water samples were analyzed for radium-226, radium-228, total uranium,  
9 gross alpha, and gross beta, while one surface water sample was also analyzed for metals and general  
10 chemistry. 11

12 Surface water samples were collected from 11 locations around the Inactive Flyash Pile during the  
13 Phase II Field Investigation (Figure 2-13). Six samples from IFP-SW-02, -03, and -04 were analyzed  
14 for full HSL, full radiological, and general groundwater quality parameters. Fifteen surface water  
15 samples were sent to the on-site laboratory for total uranium screening. Six sediment samples were  
16 also collected at three locations in the Inactive Flyash Pile (Figure 2-13). Four samples were  
17 analyzed for full HSL and full radiological parameters and two samples were analyzed for full HSL  
18 only. No samples were collected at IFP-SW-01 or IFP-SD-01 because no surface water or sediments  
19 were present. 20

21 Samples were also collected during the Phase II Field Investigation from the South Field at five  
22 surface water and three sediment sample locations (Figure 2-13). Two surface water samples from  
23 SF-SW-01 and -02 were analyzed off site for full HSL, full radiological, and general chemistry  
24 parameters. Six surface water samples from all locations were analyzed at the on-site laboratory for  
25 total uranium. It was planned to take surface water samples from two additional locations (SF-SW-03  
26 and SF-SW-04) but there was no surface water present at the time of sampling. One additional  
27 surface water sample was collected from the surface of Hydropunch™ Boring No. 11018 and sent to  
28 the on-site laboratory for total uranium screening. 29

30 One sediment sample from each of three locations was analyzed for full HSL, full radiological, and  
31 general chemistry parameters. Another sample from each location was sent to the on-site laboratory  
32 for total uranium screening. One additional location was identified for sediment sampling (SF-SD-04)  
33 but there was no sediment present at that location.

2.5.4 Groundwater Investigations

The objectives of groundwater sampling in the Inactive Flyash Pile and South Field were to:

- Characterize the hydrogeology of perched groundwater aquifer.
- Determine if contaminants from the Inactive Flyash Pile and South Field appear to have migrated to shallow or deep groundwater.
- Determine if any contaminant that may have entered the shallow or deep groundwater are migrating away (off site) from the Inactive Flyash Pile/South Field area.

During the Phase I Field Investigation, two monitoring wells (1047 and 2047) were installed outside of north boundary of the Inactive Flyash Pile and four (1016, 2016, 3016, and 4016) at the south boundary (all in the Great Miami Aquifer) (Figure 2-14). The South Field had three monitoring wells (1046, 2046, and 3046) installed at the northern boundary, six (1065, 2048, 2065, 2385, 3065, and 3385) beyond the eastern boundary, eight (1014, 1516, 1517, 1518, 2014, 3014, 3045, and 4014) south of the area, and one (4016) southwest of the South Field (Figure 2-14). These wells are screened in perched water of the glacial overburden, the Upper Great Miami Aquifer, and the Lower Great Miami Aquifer. They were sampled periodically during 1988 through 1990 and were analyzed for different combinations of radionuclides, total uranium, total thorium, pesticides/PCBs, VOCs, SVOCs, metals, and general chemistry. Wells 1711, 2402, and 3402 were installed in 1991 and 1992 in the Inactive Flyash Pile area. Well 1711 was sampled only once under the Phase I Field Investigation and was analyzed for metals. Four samples from 2402 and 3402 were analyzed for metals and general chemistry. One sample from 2402 was also analyzed for radionuclides. Two wells (1433 and 2401) were installed in the northwest corner of the South Field in 1991 and 1992. Two samples from 1433 were analyzed for radionuclides, pesticides/PCBs, VOCs, SVOCs, metals, and general chemistry. One sample was analyzed for radionuclides only. One sample from 2401 was analyzed for metals and general chemistry. Detail on the sampling frequency and parameters for each well is included in Table E-12 of Appendix E and Table F-11 of Appendix F.

One additional well (2955) was installed south of Well No. 1711 in the Inactive Flyash Pile during the Phase II Field Investigation. Five 1000-series (1941, 1942, 1954, 11032, and 11085) and four 2000-series (2943, 2944, 2945, and 2954) wells were installed in the South Field during the Phase II field activities. Following completion of Phase II wells, all of the wells, including the Phase I and the ten Phase II wells, in the Inactive Flyash Pile and South Field were sampled and analyzed for full HSL, full radiological, and general groundwater quality parameters. At least one sample from each

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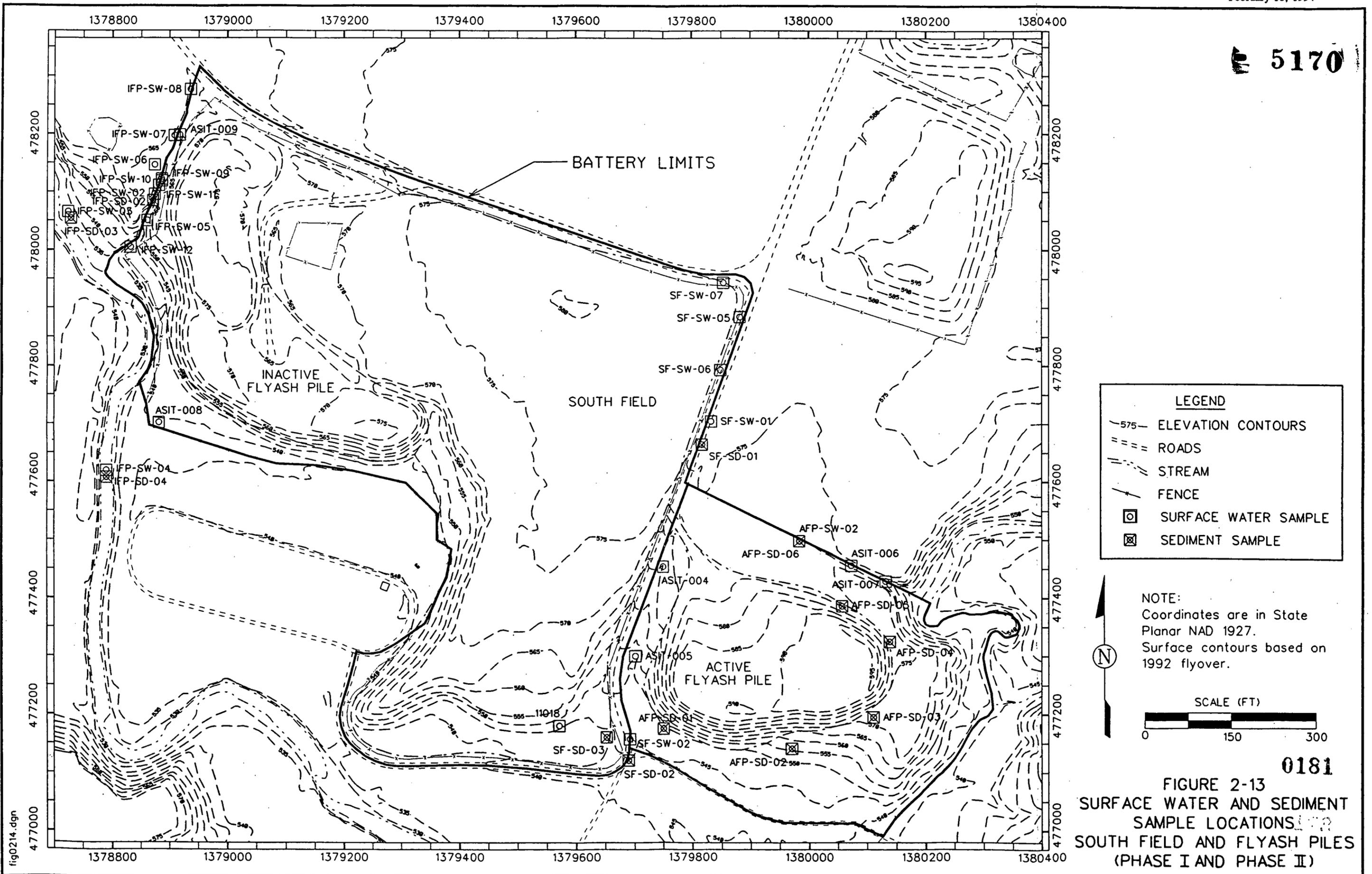


fig0214.dgn

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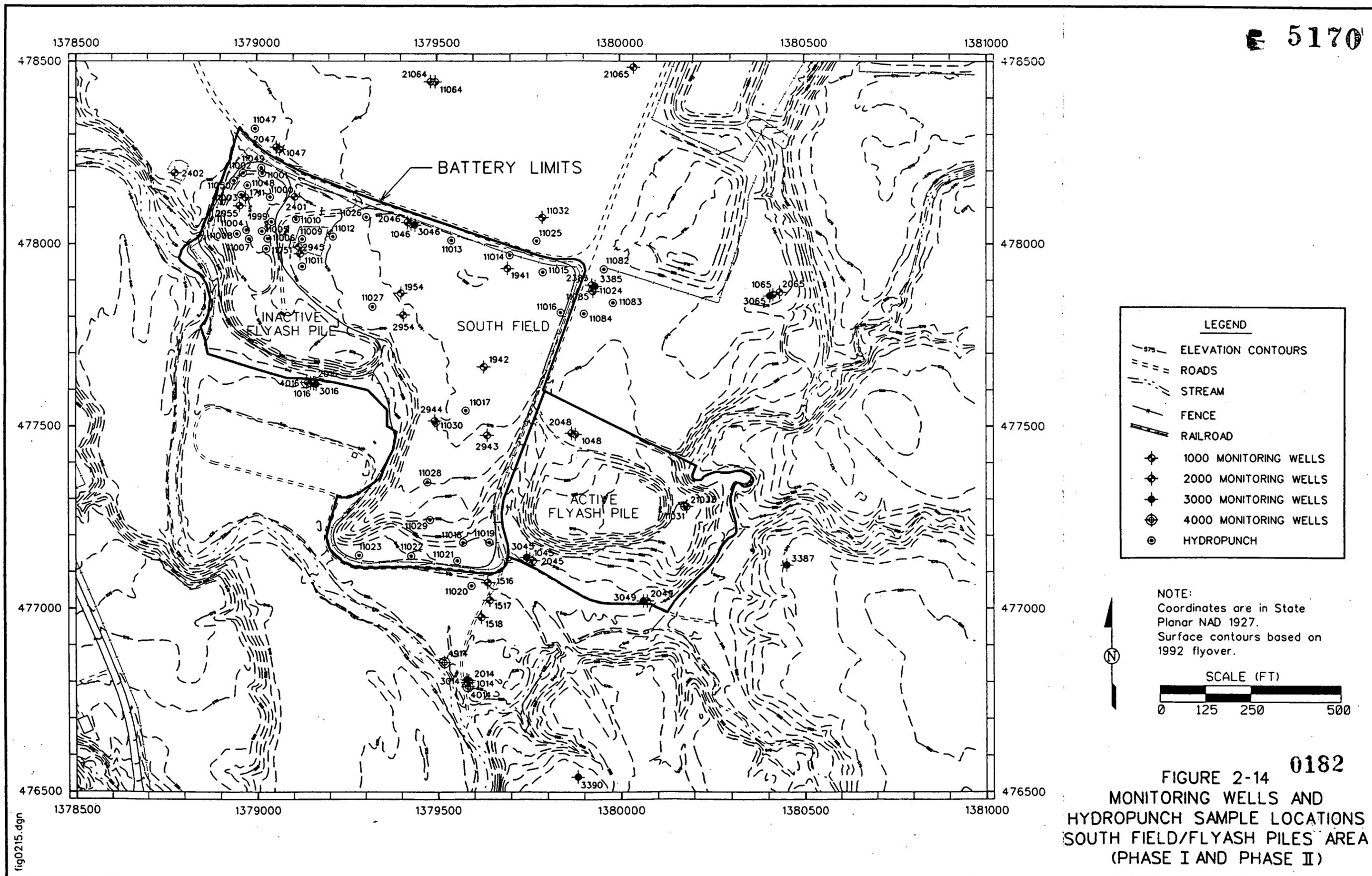


fig0215.dgn

HSL, full radiological, and general groundwater quality parameters. At least one sample from each well was collected for on-site screening for total uranium. Total uranium screening samples were also collected from 12 Hydropunch™ borings that were completed in the Inactive Flyash Pile and 23 Hydropunch™ borings in the South Field (Figure 2-14). Groundwater samples were not collected from five Hydropunch™ borings (11005, 11006, 11008, 11011, and 11017) because they were dry.

#### 2.5.5 Geotechnical Investigations

In October 1991, the in-place density was measured by ASTM Method D-2922 at two locations in the Inactive Flyash Pile (GEO 4 and GEO 5) and three locations in the South Field (GEO 6, GEO 7, and GEO 8) during the Phase I Field Investigation [Figure 2-12 (see Volume 2, Oversized Figures)]. Wet density, dry density, and moisture content were measured at each location. Shelby™ tube samples for geotechnical analysis were collected from Inactive Flyash Pile Boring No. 1708. These samples were collected from the 7.5- to 12-foot depth interval and were analyzed for moisture content, specific gravity, and particle size distribution.

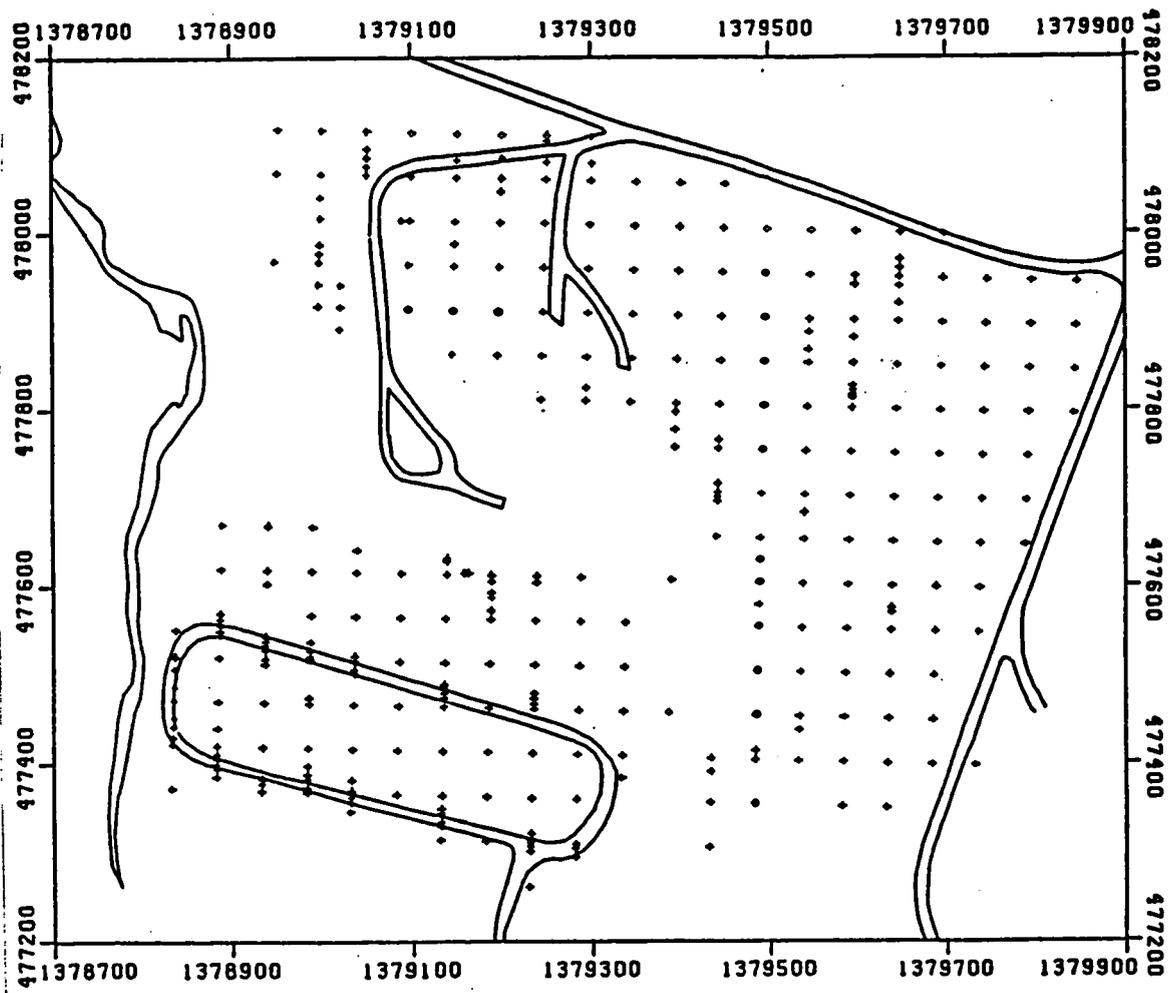
Geotechnical sampling was also completed during the Phase II Field Investigation. Inactive Flyash Pile samples were collected from IFP-SD-02 (Figure 2-13), IFP-SS-05, and Boring Nos. 1994, 1995, 1996, 1997, and 1998 [Figure 2-12 (see Volume 2, Oversized Figures)]. South Field geotechnical samples were collected from SF-SD-02 and Boring Nos. 1964, 1965, 1966, 1968, 1969, 1970, 11187 (1974), 1975, 1977, and 2945. The samples from these locations were taken from varying depths and were analyzed for different combinations of specific gravity, water content, liquid limit, plastic limit, sieve analysis, hydrometer analysis, consolidated isotropic undrained triaxial, hydraulic conductivity, and direct shear and dry unit weight.

#### 2.5.6 Geophysical Survey

The CIS performed a geophysical survey of the Inactive Flyash Pile and South Field. The EM method was used for this geophysical survey. The EM survey was conducted on a 50 by 25 foot grid, with 50 feet separating the north-to-south trending profiles. The EM survey was performed in both the vertical and horizontal dipole to further evaluate near surface disturbances. Additional data points were surveyed on a 25 foot grid between the 50 foot grid lines when anomalies were detected. The survey grids for two EM methods (EM 31 and EM 34-3) are provided in Figures 2-15 through 2-17.

1810

0183



**Legend**  
 + Data Point Location  
 — Hydrology

STATE PLANE COORDINATE SYSTEM

8N18 SOUTH ZONE



PREPARED BY

ROY F. WESTON, INC. 9/1/87

FIGURE 2-15  
 EM 31 DATA CONTROL POINT  
 POSTINGS MAP OF THE  
 SOUTH FIELD/INACTIVE  
 FLYASH PILE AREA

fig0219.dgn

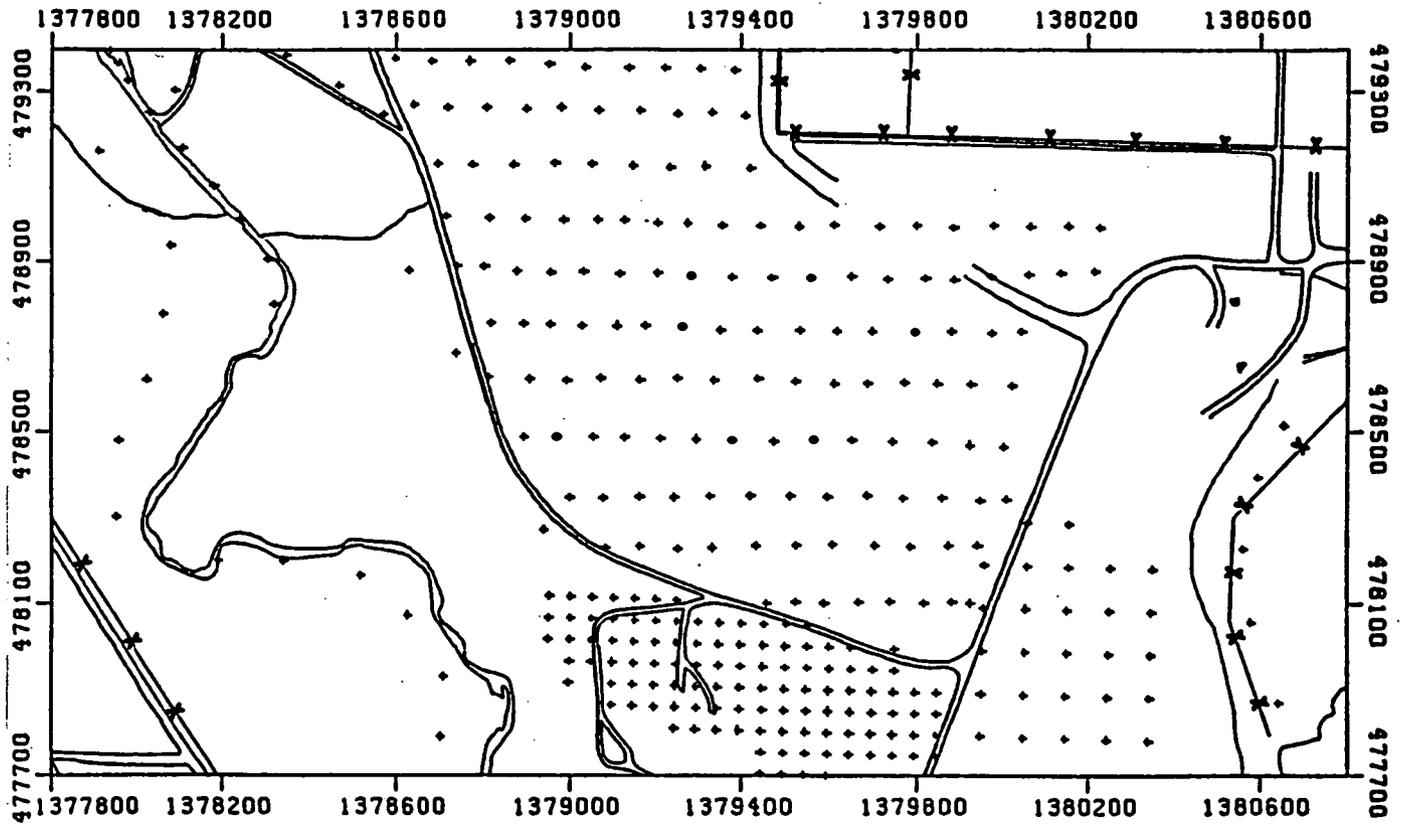
0810

0184

(21)

(21)

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**Legend**

- + Data Point Location
- x-x Fence
- Hydrology

STATE PLANE COORDINATE SYSTEM

OHIO SOUTH ZONE



PREPARED BY

RBY F. WESTON, INC. 9/1/87

0185

6810

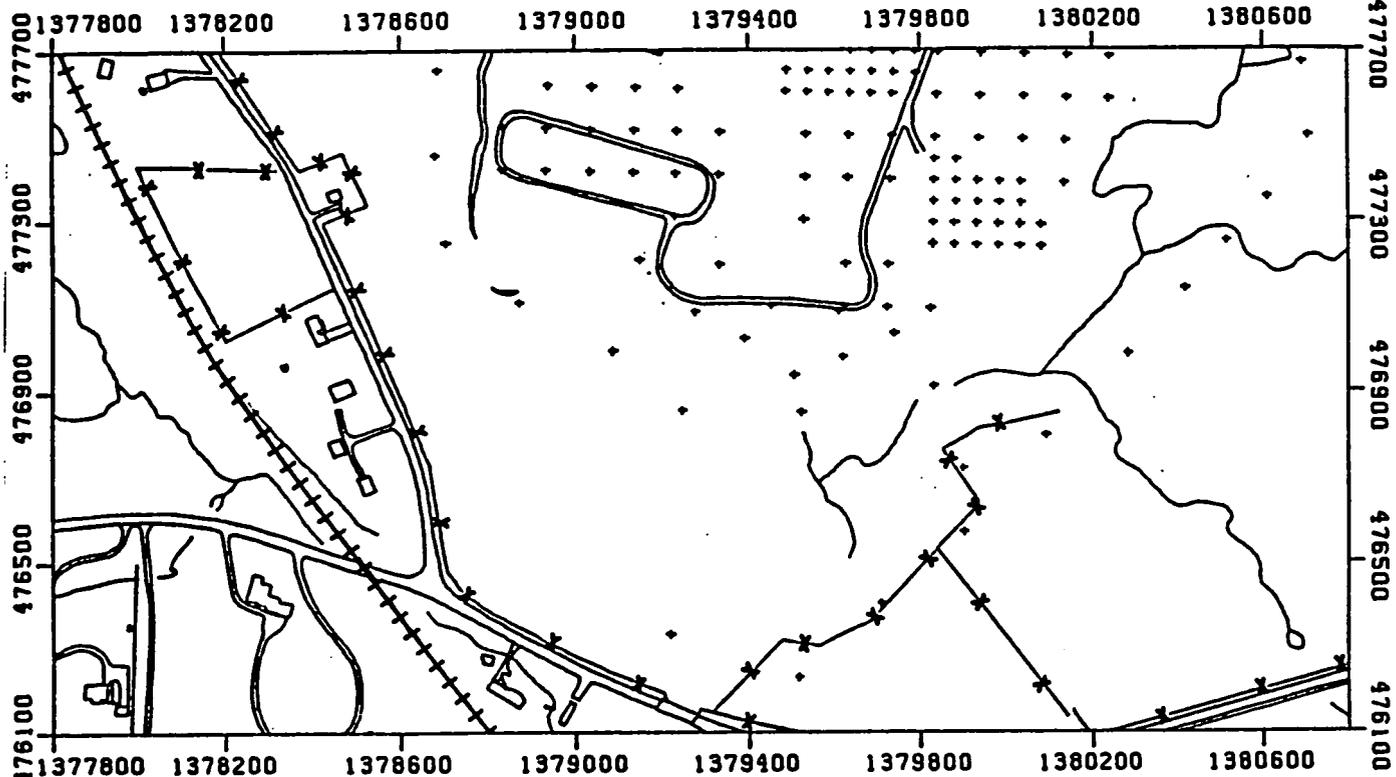
FIGURE 2-16  
EM 34-3 DATA CONTROL  
POINT POSTINGS MAP OF  
THE SOUTH FIELD/INACTIVE  
FLYASH PILE AREA

fig0220.c

31

31

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**Legend**

- + Data Point Location
- x—x— Fence
- ++++ Railroad Tracks
- Hydrology

STATE PLANE COORDINATE SYSTEM  
BH10 SOUTH ZONE



PREPARED BY

ROY F. WESTON, INC. 9/1/87

FIGURE 2-17  
EM 34-3 DATA CONTROL  
POINT POSTINGS MAP OF  
THE SOUTH FIELD/ACTIVE  
FLYASH PILE AREA

0186

fig0221.dgn

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31

During the Phase II Field Investigation, nonintrusive EM and magnetometry measurements were conducted in the South Field on a 20 by 20 foot grid to locate buried metal and thus, waste disposal trenches. The Magnetics Geophysical survey was performed using the EDA OMNI plus proton precession magnetic gradiometer. The EM Conductivity survey was performed using the GEONICS EM-31 DC terrain conductivity meter with an OMNI digital data logger. Data was downloaded to portable computers, processed by contouring with Geosoft™ mapping system to provide vertical magnetic gradient, EM conductivity values, and in-phase component values. Ten of the most significant geophysical anomalies were investigated by excavation, observation, and screening for total organic vapors and radioactivity.

2.6 ENVIRONMENTAL CHARACTERIZATION INFORMATION FOR THE ACTIVE FLYASH PILE

The Active Flyash Pile has been preliminarily characterized by the Environmental Survey and CIS Sampling Program, followed by characterization by the RI/FS Sampling Program. The following sections discuss the sample locations and analytical parameters for each of these sampling programs. Result of these sampling programs are presented in Appendix G.

2.6.1 Surface Sampling

During the Environmental Survey, surface media from eight locations (0100 through 0107) across the waste area were sampled. These samples were analyzed for asbestos, TCLP metals, VOCs, radionuclides, and total uranium. Four CIS surface soil samples were collected from around the Active Flyash Pile (25-013, 25-014, 25-015, and 25-022) and were analyzed for radionuclides. Flyash media from the Active Flyash Pile was not sampled for during either the CIS or the Phase I Field Investigation.

The overall objectives of Phase II RI/FS surface media sampling (including flyash) in the Active Flyash Pile were to:

- Characterize the nature of contamination in surface media and flyash.
- Provide data to evaluate the potential for exposure via the direct contact pathway.
- Provide data to evaluate the potential for migration via the air pathway.

To address the shortage of surface samples that could be used for nature and extent or risk analysis, samples were taken from 14 locations (1979, 1980, 1981, AFP-SD-01 through -05, and AFP-SS-01 through -06) on and around the Active Flyash Pile during the Phase II Field Investigation [Figure 2-12 (see Volume 2, Oversized Figures)]. One sample from each location was analyzed for full HSL and full radiological parameters. PCBs were included in the suite of analytes to attempt to determine if PCB-contaminated waste oils may have been used to control dust at the Active Flyash Pile. As the flyash is considered homogeneous, the flyash samples taken in the pile were also considered to represent surface samples.

2.6.2 Subsurface Sampling

As part of the Environmental Survey, three subsurface media samples were collected from a boring at one location in the Active Flyash Pile. Samples Nos. 0601, 0602, and 0603 were taken at depths of 0 to 5 feet, 5 to 11 feet, and 11 to 13.5 feet, respectively, and were analyzed for asbestos, TCLP metals, VOCs, radionuclides, and total uranium. Two subsurface samples for off-site analysis were taken during the CIS. One sample was analyzed for pesticides/PCBs and metals. The other sample was a composite of Boring No. 25-01 and was analyzed for radionuclides. The sample location was south of the Active Flyash Pile in the Storm Sewer Outfall Drainage Channel.

During 1987 and 1988, five borings were drilled outside of the fill area (1048, 2048, 1045, 2045 and 3045) as part of the site-wide groundwater installation program [Figure 2-12 (see Volume 2, Oversized Figures)]. A total of six subsurface samples were collected from these borings and were analyzed for radionuclides. Three of these samples were also analyzed for total uranium and one for total thorium.

The objectives of RI/FS subsurface media sampling (including flyash and underlying native soil) in the Active Flyash Pile were to:

- Characterize the physical nature of buried waste materials in the Active Flyash Pile.
- Characterize the nature and extent of contamination.
- Determine fill depths and volumes.
- Determine whether contaminants have migrated from fill into the underlying native soils.
- Provide data to support the modeling of contaminant migration from the Active Flyash Pile.

Because previous sampling had not sufficiently quantified the vertical distribution of contaminants, five borings (1723, 1724, 1726, 1820, and 1846) were drilled under the Phase I Field Investigation to further characterize the nature of the fill and the underlying native soil [Figure 2-12 (see Volume 2, Oversized Figures)]. Except in the case of Boring No. 1846 (which only had two samples, both taken within the flyash), samples were collected from the shallow fill, deep fill, and the underlying native soils. These samples were analyzed for different combinations of analytes including radionuclides, total uranium, total thorium, pesticides/PCBs, VOCs, SVOCs, EP Toxicity, TCLP, metals, and general chemistry. The TCLP VOC/SVOC samples were collected from the portion of the boring that displayed the highest HNu reading during field screening. When there was no HNu reading, samples were collected from the midpoint of the boring. A composite sample from each boring (except 1846) was analyzed for the remainder of the TCLP analytes. The purpose of TCLP analysis was to determine whether the waste met criteria for regulation under OEPA and to determine leaching and transport potentials for waste transport modeling.

Three additional borings (1979, 1980, and 1981) were advanced in the Active Flyash Pile under the Phase II Field Investigation [Figure 2-12 (see Volume 2, Oversized Figures)]. Twelve samples from these borings were analyzed for full HSL and full radiological parameters and one sample from each boring was analyzed for TCLP. Boring No. 1725, shown in the northwest portion of the Active Flyash Pile, was plugged and abandoned. Boring No. 1820 was located near the abandoned Boring No. 1725.

### 2.6.3 Surface Water and Sediment Sampling

The objective of surface water and sediment sampling in the Active Flyash Pile Study Area was to determine if contaminants from the Active Flyash Pile migrated via the surface water pathway. The topography of Active Flyash Pile is such that surface runoff is radial, so surface water and sediments were sampled during the Phase I Field Investigation at two location (ASIT-004 and ASIT-005) to the west of the Pile and two locations to the northeast (ASIT-007 and ASIT-008) (Figure 2-13). Four surface water samples were analyzed for radionuclides, total uranium, and total thorium. Two samples were analyzed for radium-226, radium-228, total uranium, gross alpha, gross beta, metals, and general chemistry. The remaining six samples were analyzed for radium-226, radium-228, total uranium, gross alpha, and gross beta only. All four sediment samples were analyzed for radium-226, radium-228, total uranium, gross alpha, and gross beta. One sample (from ASIT-007) was also analyzed for pesticides/PCBs, VOCs, SVOCs, metals, and general chemistry.

Additional surface water and sediment samples were taken during the Phase II Field Investigation (Figure 2-13). One surface water sample was taken from the north of the Active Flyash Pile (AFP-SW-02) and analyzed for full HSL, full radionuclides, and general chemistry parameters. An additional surface water sample was collected from the same location and sent to the on-site laboratory for total uranium screening. One sediment sampling location (AFP-SD-06) was positioned in the drainage ditch to the north of the Active Flyash Pile. The sample was analyzed for full HSL and full radiological parameters. Five other sediment samples were collected in the field (AFP-SD-01 through AFP-SD-05) but an evaluation of the material determined that they were flyash material, not sediment.

#### 2.6.4 Groundwater Investigations

Seven wells were installed in the Active Flyash Pile during the Phase I Field Investigation (1045, 1048, 2045, 2048, 2049, 3045, and 3049) (Figure 2-14). These wells were sampled periodically during 1988 through 1990 and were analyzed for different combinations of radionuclides, total uranium, total thorium, metals, and general chemistry. Detail on the sampling frequency and parameters for each well is included in Table G-11 of Appendix G.

One additional 2000-series well (21033) was installed during the Phase II Field Investigation (Figure 2-14). This well and five previously installed wells (1045, 1048, 2045, 2048, and 2049) were sampled and analyzed for full HSL, full radiological, general groundwater quality parameters. One sample from each well (except Well No. 2045) was sent to the on-site laboratory for total uranium screening. Well No. 1045 had two samples analyzed on site for total uranium and one sample analyzed off site for full radiological, VOCs, and metals.

#### 2.6.5 Geotechnical Investigations

In October 1991, in-place density was measured at three locations (GEO 1, GEO 2, and GEO 3) by ASTM Method D-2922 during the Phase I Field Investigation [Figure 2-12 (see Volume 2, Oversized Figures)]. Wet density, dry density, and moisture content were measured at each location. Also during this program, a Shelby™ tube sample for geotechnical analysis was collected from Boring No. 1724 [Figure 2-12 (see Volume 2, Oversized Figures)]. These samples were collected from the 12- to 14.5-foot depth interval and were analyzed for moisture content, specific gravity, and grain size distribution.

Geotechnical samples were taken from AFP-SD-01, AFP-SS-01, and Boring Nos. 1979, 1980, and 1981 [Figure 2-12 (see Volume 2, Oversized Figures)]. The samples from these locations were taken from varying depths and were analyzed for different combinations of specific gravity, water content, liquid limit, plastic limit, sieve analysis, hydrometer analysis, consolidated isotropic undrained triaxial, direct shear, and dry unit weight.

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2.6.6 Geophysical Survey

The CIS performed a geophysical survey of the Active Flyash Pile. The EM method was used for this geophysical survey. The EM survey was conducted on a 50 by 25 foot grid, with 50 feet separating the north-to-south trending profiles. The EM survey was performed in both the vertical and horizontal dipole to further evaluate near surface disturbances. Additional data points were surveyed on a 25 foot grid between the 50 foot grid lines when anomalies were detected. The survey grid is indicated in Figures 2-15 through 2-17.

### 3.0 PHYSICAL CHARACTERISTICS OF THE STUDY AREA

#### 3.1 SITE-WIDE CHARACTERISTICS

Physical characteristics include the meteorological, geological, and hydrological environment surrounding the FEMP Study Area. Physical characteristics also can represent man-made features that affect meteorology, geology, or hydrology. The evaluation of physical characteristics is significant to the RI process because the nature, extent, transport, and risk of a contaminant are related to the physical characteristics. This section describes the physical characteristics relating to Operable Unit 2. Some of these physical characteristics are presented on a site-wide basis such as meteorology, topography and surface water hydrology, and demography. These site-wide characteristics are discussed first. Physical characteristics relating to specific Operable Unit 2 waste subunits such as detailed lithology, stratigraphy, and vadose zone hydrogeology are discussed by subunit.

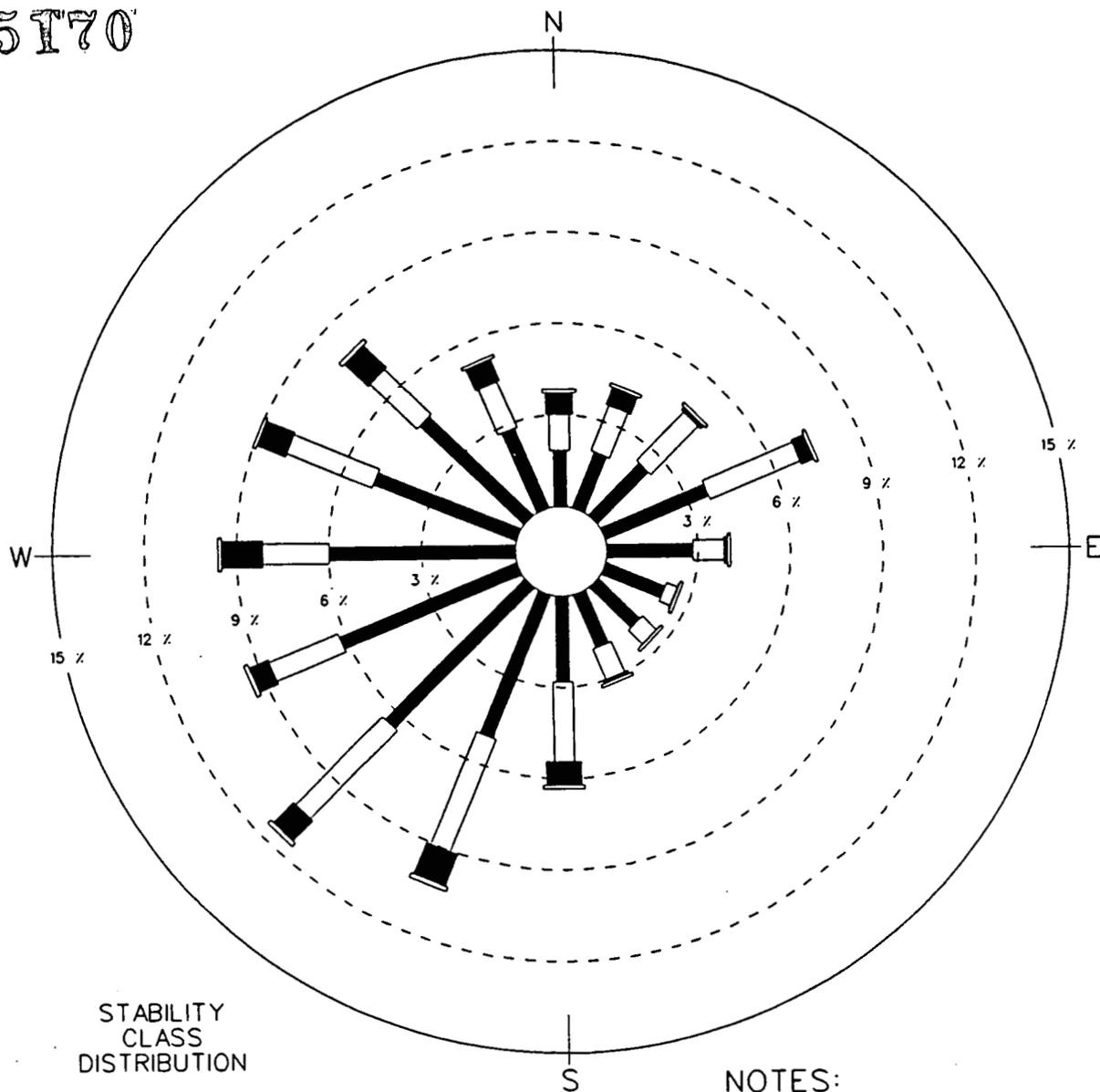
##### 3.1.1 Meteorology

Information on the local climate was obtained from two primary sources. The first source is an on-property meteorological system installed at the FEMP in 1986. The second source is the National Weather Service Office at the Greater Cincinnati/Northern Kentucky International Airport.

The FEMP meteorological system was installed to collect site-specific data for wind speed and direction, ambient air temperature, lapse rate, dew point, temperature, relative humidity, barometric pressure, and precipitation, and was used by the National Oceanic and Atmospheric Administration (NOAA) to examine the complexity of the local wind field at the Fernald site. The NOAA study showed that two major features affect the site, the Great Miami River Valley and the ridges surrounding the site. A study by International Technology Corporation (IT) (1986) showed that the wind flow data from the Greater Cincinnati/Northern Kentucky International Airport were sufficiently representative of local conditions to serve as a database for the years prior to the installation of the on-property meteorological system.

Figure 3-1 shows the yearly wind patterns at the FEMP recorded from a 33-foot (10-meter) aboveground surface sampling station during 1992. Data from 1987 to 1990 were presented in the CERCLA/RCRA Background Soil Study (DOE 1993). Prevailing winds are generally from the southwest and west-southwest. The annual frequency distribution and stability class distribution are

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STABILITY CLASS DISTRIBUTION

- A - 9 %
- B - 4 %
- C - 4 %
- D - 33 %
- E - 27 %
- F - 22 %

NOTES:

1. DIAGRAM OF THE FREQUENCY OF OCCURRENCE FOR EACH WIND DIRECTION. WIND DIRECTION IS THE DIRECTION FROM WHICH THE WIND IS BLOWING. EXAMPLE - WIND IS BLOWING FROM THE NORTH 4.8 PERCENT OF THE TIME.
2. RECORDED AT FEMP FROM A 33-FEET (10 METERS) TOWER DURING 1992.

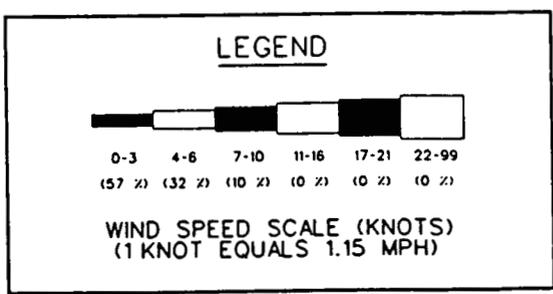


FIGURE 3-1  
WIND ROSE FOR  
THE FEMP SITE  
YEAR 1992

fig0301.dgn

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also shown on Figure 3-1. The stability class distribution is a parameter that is used in air dispersion modeling. Atmospheric stability is a measure of the potential for vertical mixing, both mechanical and thermal. It is classified from A through F based on the wind speed, net solar radiation, and atmospheric turbulence. Class A is the most stable, and F is the most unstable.

The most frequent adverse weather conditions in the region occur from severe thunderstorms and tornados. As part of the probabilistic risk assessment performed for the FEMP (DOE 1990), an annual probability was assessed for a tornado occurring per square mile within Ohio. Based on data accumulated for Ohio during the years 1978 through 1990, the annual probability was calculated to be 1.25 in 10,000.

The average annual precipitation for the Greater Cincinnati area for the period of 1960 through 1989 was 40.56 inches and ranged from 27.99 inches in 1963 to 52.76 inches in 1979. The highest precipitation occurs during the spring and early summer. The maximum 24-hour rainfall event on record occurred in March 1964 when 5.21 inches fell. Precipitation is typically lowest in late summer and fall. A histogram summarizing monthly precipitation recorded at the Greater Cincinnati/Northern Kentucky International Airport from 1988 to 1993 is shown in Figure 3-2. Data from daily on-property precipitation measurements from March 1993 to September 1993 are shown in Figure 3-3. The greater detail of daily rainfall amounts in Figure 3-3 provides a more precise comparison of rainfall events to groundwater elevation changes.

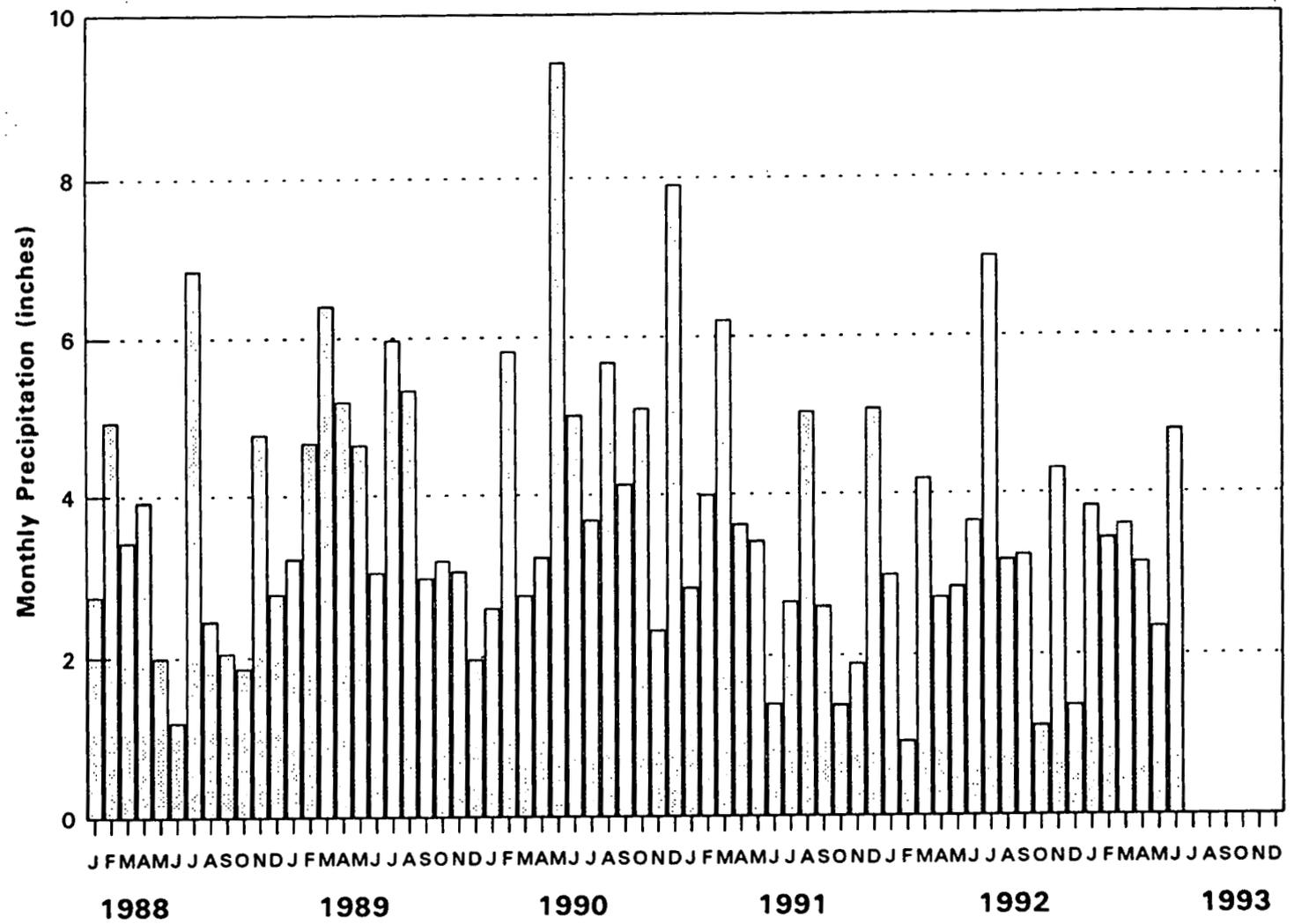
The average annual snowfall for the 1960 to 1989 period was 23.5 inches, with the heaviest snowfall usually occurring in January. The maximum monthly snowfall of 31.5 inches occurred in January 1978. The maximum recorded snowfall over a 24-hour period occurred in March 1968 when 9.8 inches was recorded at the Greater Cincinnati/Northern Kentucky International Airport.

The regional climate is defined as continental, with temperatures ranging from a monthly average of 29.2° F in January to 75.7° F in July. The highest temperature recorded from 1960 through 1989 was 103° F in July 1988, and the lowest was -25° F in January 1977. Average ambient air temperatures measured at the FEMP meteorological system for the period of 1987 through 1992 are shown in Table 3-1. The average number of days per year with a minimum temperature of 32° F or less is 109 days, and the average number of days per year with a maximum temperature of 90° F or greater is 20 days. Frost depth ranges from 30 to 36 inches.

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**FIGURE 3-2**  
**MONTHLY PRECIPITATION HISTOGRAM FOR BOONE COUNTY, KY. AIRPORT**

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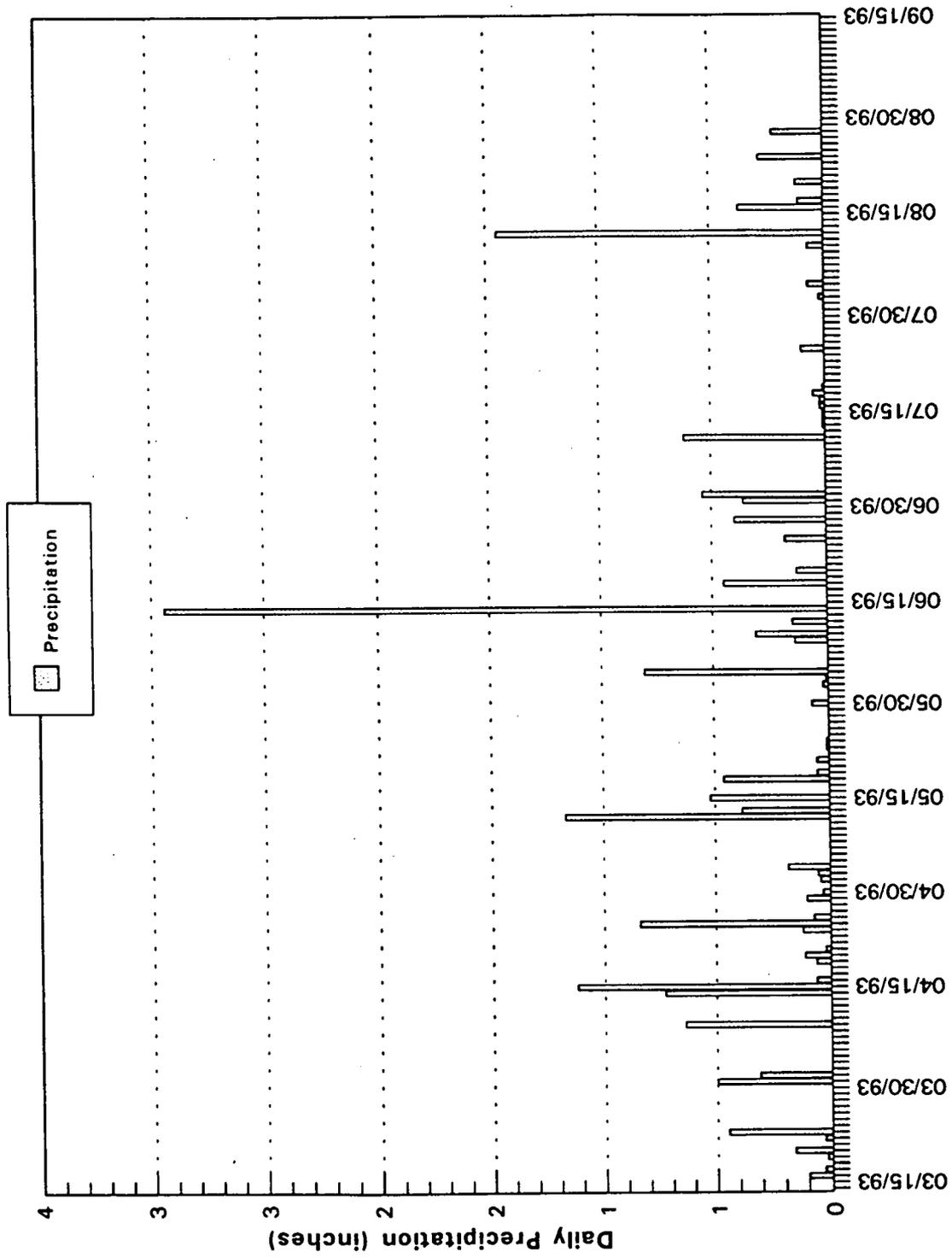


FIGURE 3-3  
PRECIPITATION HISTOGRAM FOR ON-SITE DATA

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**TABLE 3-1**  
**AMBIENT AIR TEMPERATURE MEASURED**  
**BY THE FEMP METEOROLOGICAL SYSTEM**

Year	Average Annual Temperature (°F)	Average Annual Daily Minimum Temperature (°F)	Average Annual Daily Maximum Temperature (°F)
1987	50.7	41.0	61.5
1988	52.3	41.9	63.7
1989	52.2	44.1	62.8
1990	52.5	43.2	62.4
1991	55.4	46.8	65.1
1992	52.0	43.3	61.7

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3.1.2 Topography and Surface Water Hydrology

The topographic features of the FEMP were evaluated using data from aerial photogrammetry. Maximum elevation along the northern boundary of the FEMP property is a little more than 700 feet above mean sea level (MSL) (Figure 3-4). The former Production Area and Waste Storage Area rest on a relatively level plain at about 580 feet above MSL. The plain slopes from 600 feet above MSL along the eastern boundary of the FEMP to approximately 575 feet above MSL at the west edge of Waste Pit 3, and then drops off toward Paddys Run at an elevation of 550 feet above MSL. Surface water drainage on the FEMP is generally from east to west toward Paddys Run, with the exception of the extreme northeast corner, which drains east toward the Great Miami River (Figure 3-5). The storm water drainage from the former Production Area and Waste Storage Area is now controlled and discharged to the Great Miami River.

Data concerning surface water hydrology has been derived from site studies and from data provided by the USGS, Federal Emergency Management Agency (FEMA), and the Miami Conservancy District. The Fernald site is located within the Great Miami River Basin drainage, and parts of the site are within the Paddys Run 100-year floodplain. The Great Miami River flows within 0.75 miles of the facility's eastern boundary and discharges into the Ohio River approximately 24.1 river miles (RM) from the FEMP effluent line. Tributaries to the Great Miami River in the FEMP region include Banklick Creek at RM 28; Indian Creek at RM 27, just east of Ross, Ohio; Owl Creek at RM 22; and Blue Rock Creek, which enters the river at RM 21. Paddys Run flows along the FEMP's western boundary and joins the Great Miami River at approximately RM 19.5. Taylor Creek enters the river at approximately RM 14.4. The Whitewater River discharges into the Great Miami River at RM 6.

Rivers and intermittent streams on or adjacent to the FEMP are the Storm Sewer Outfall Ditch, Paddys Run, and the Great Miami River and are shown in Figure 3-6. No lakes occur near the Fernald site. The Storm Sewer Outfall Ditch originates within the FEMP and flows toward the southwest where it enters Paddys Run, which flows southward along the western boundary of the facility. Paddys Run, in turn, is a tributary of the Great Miami River. The Great Miami River flows generally toward the southwest. In the vicinity of the FEMP, however, it flows to the east and south. The drainage that feeds the Storm Sewer Outfall Ditch originates east of the former Production Area and is channeled within a culvert under the parking lot south of the former Production Area where it enters the Storm Sewer Outfall Ditch. The Storm Sewer Outfall Ditch then flows southwest across

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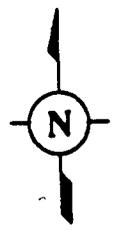
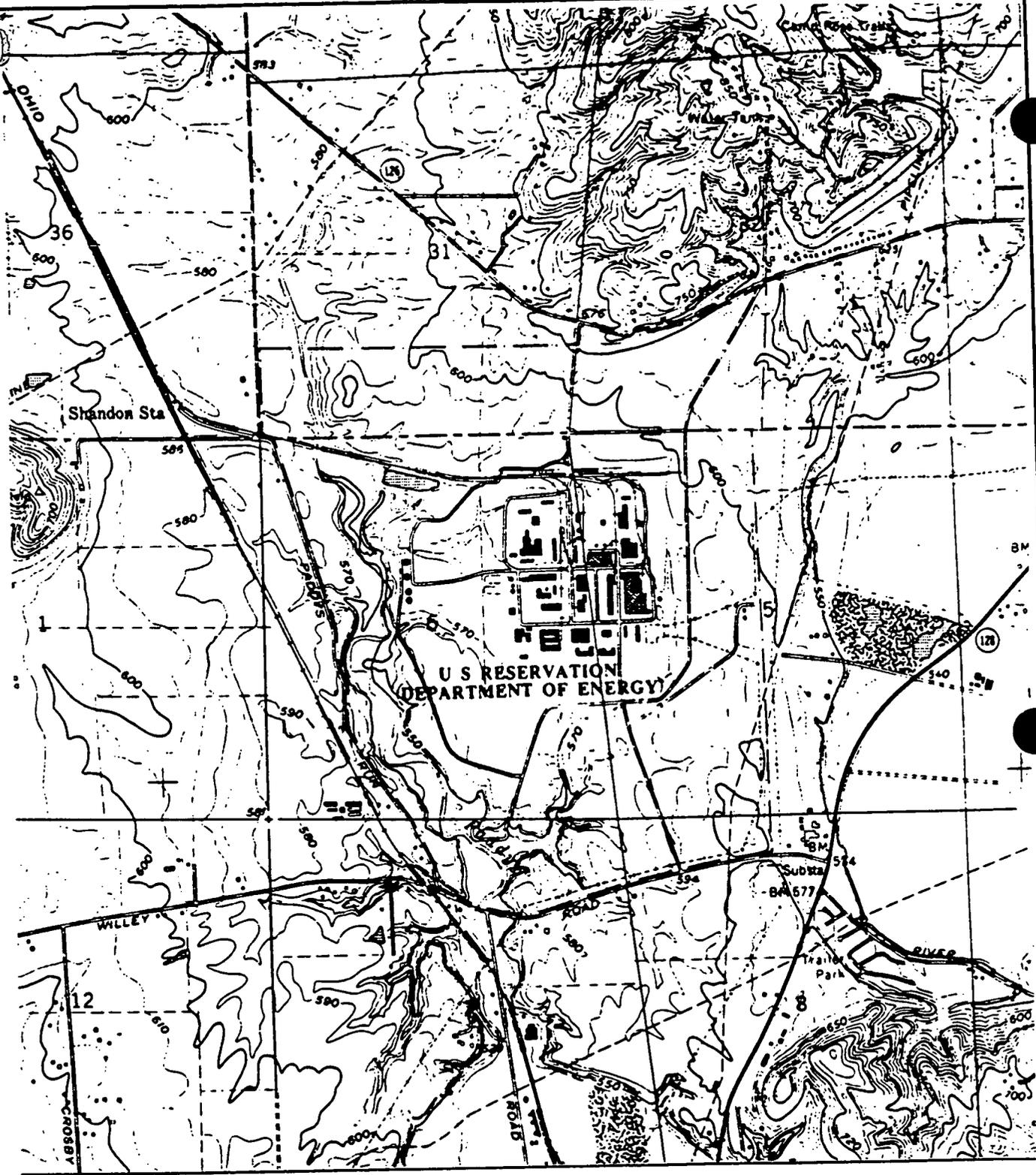


fig0304.dgn

SOURCE: USGS 7.5 MINUTE QUADRANGLE, SHANDON, OHIO (1981)

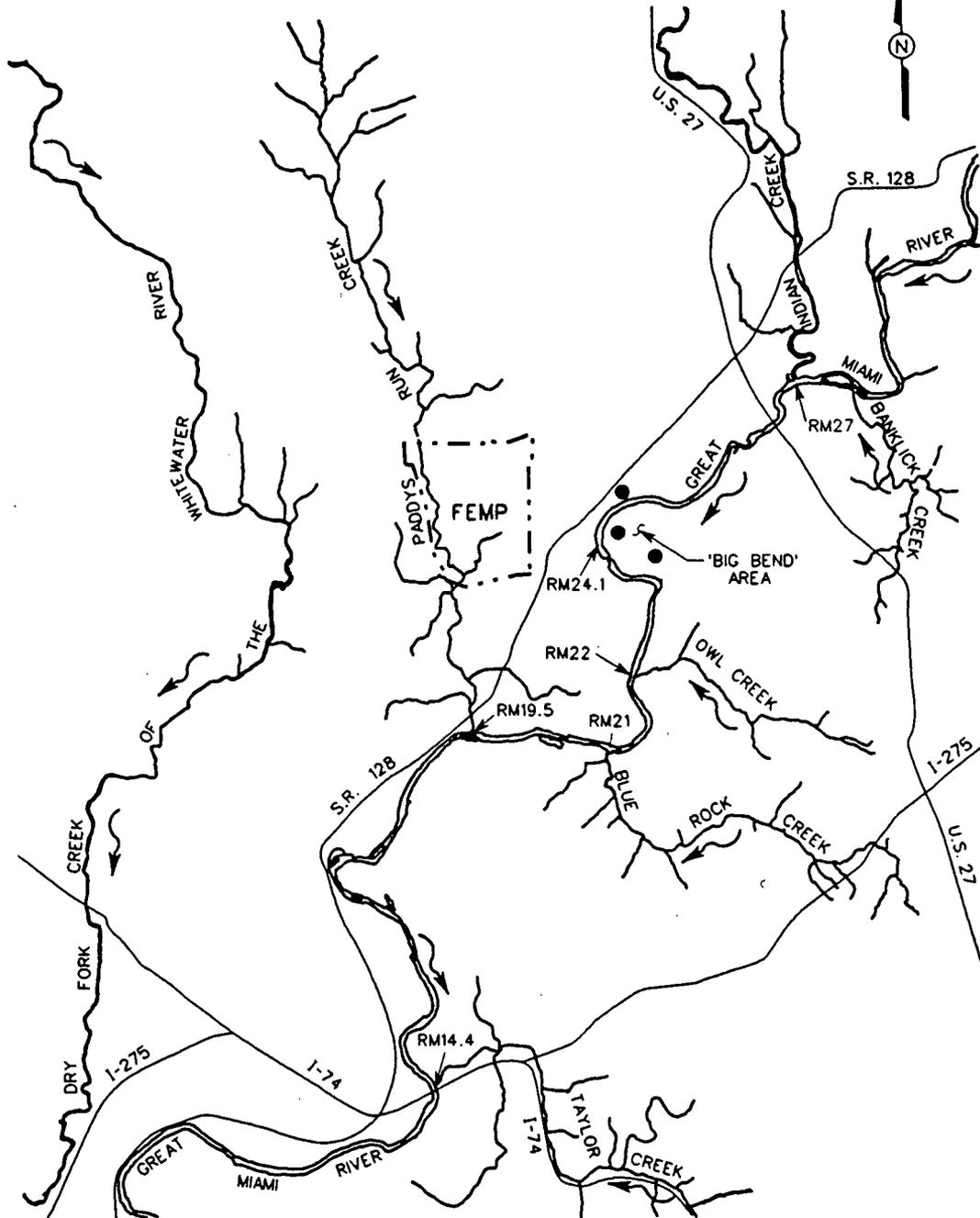
FIGURE 3-4

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TOPOGRAPHIC MAP OF THE FEMP

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**LEGEND**

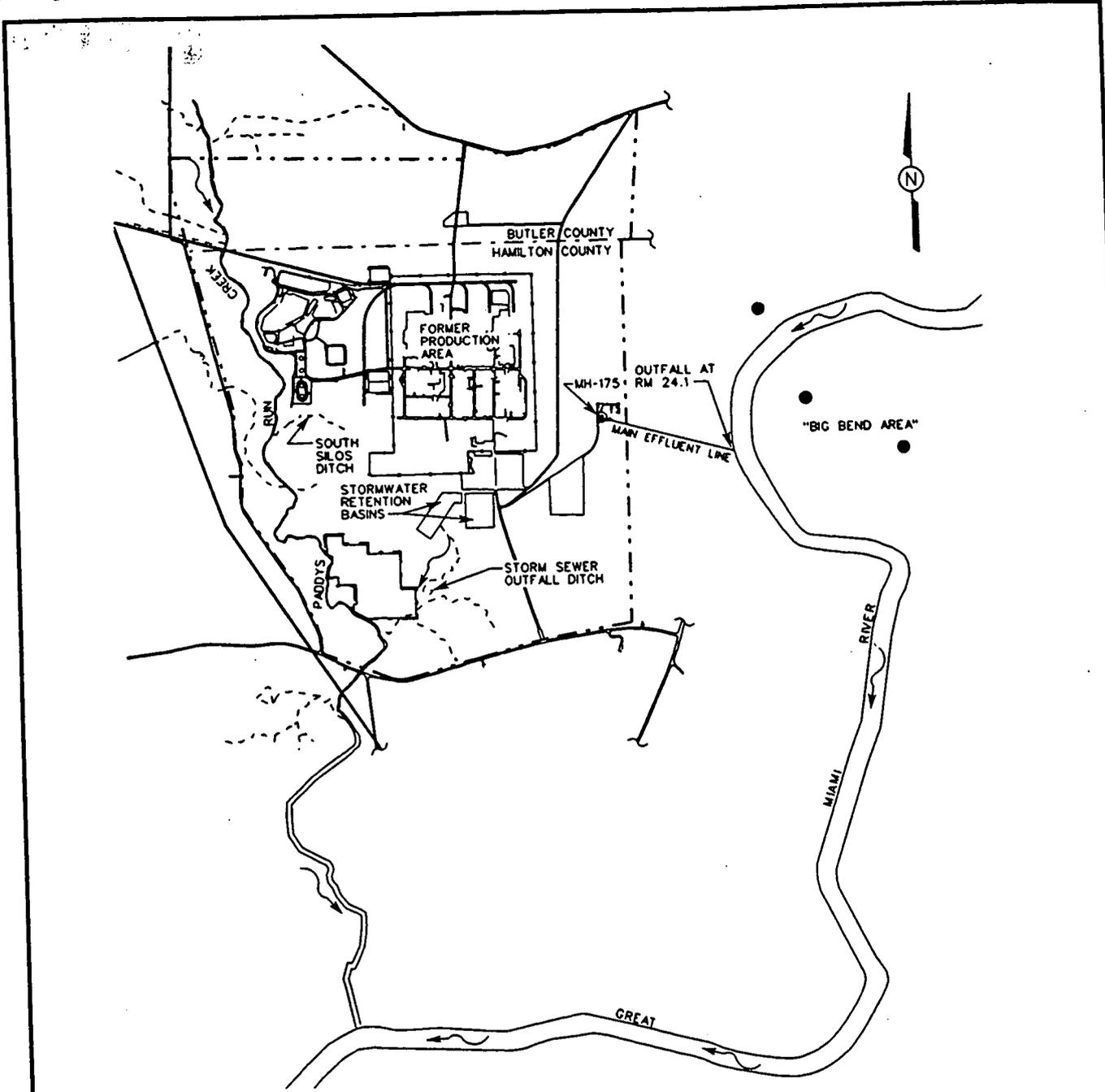
- FEMP PROPERTY BOUNDARY
- SOUTHWESTERN OHIO WATER COMPANY WELL FIELD
- RM22 RIVER MILE ALONG THE OHIO RIVER
- DIRECTION OF FLOW
- ROADWAYS



0200

**FIGURE 3-5  
SURFACE WATER FEATURES  
AND DRAINAGE PATTERNS**

fig0306.dgn



**LEGEND**

- RM24.1 RIVER MILE FROM THE OHIO RIVER
- DRAINAGE WAY
- CSX RAIL LINE
- ~> DIRECTION OF FLOW
- - - FEMP PROPERTY BOUNDARY
- SOUTHWESTERN OHIO WATER COMPANY WELL FIELD

NOT TO SCALE

NOTE:

1. SOURCE-RI/FS OU1 REPORT, 2-93, FIGURE 3-4.

**FIGURE 3-6**  
**SURFACE WATER BODIES**  
**ON AND ADJACENT TO**  
**THE FEMP**

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fig0305.dgn

the southern portion of the site and enters Paddys Run near the southwest corner of the property. The Storm Sewer Outfall Ditch has cut a gully more than 30 feet deep through the clay-rich surface deposits of the Fernald site. This erosion has occurred since the last glaciation (Wisconsin) over a period of approximately 20,000 years. Much of the stream bottom of this drainage is composed of sand and gravel and may be highly permeable. Loss of flow to the underlying Great Miami Aquifer may be significant. Throughout the year, this drainage course is generally dry, with flows occurring only during and immediately after precipitation.

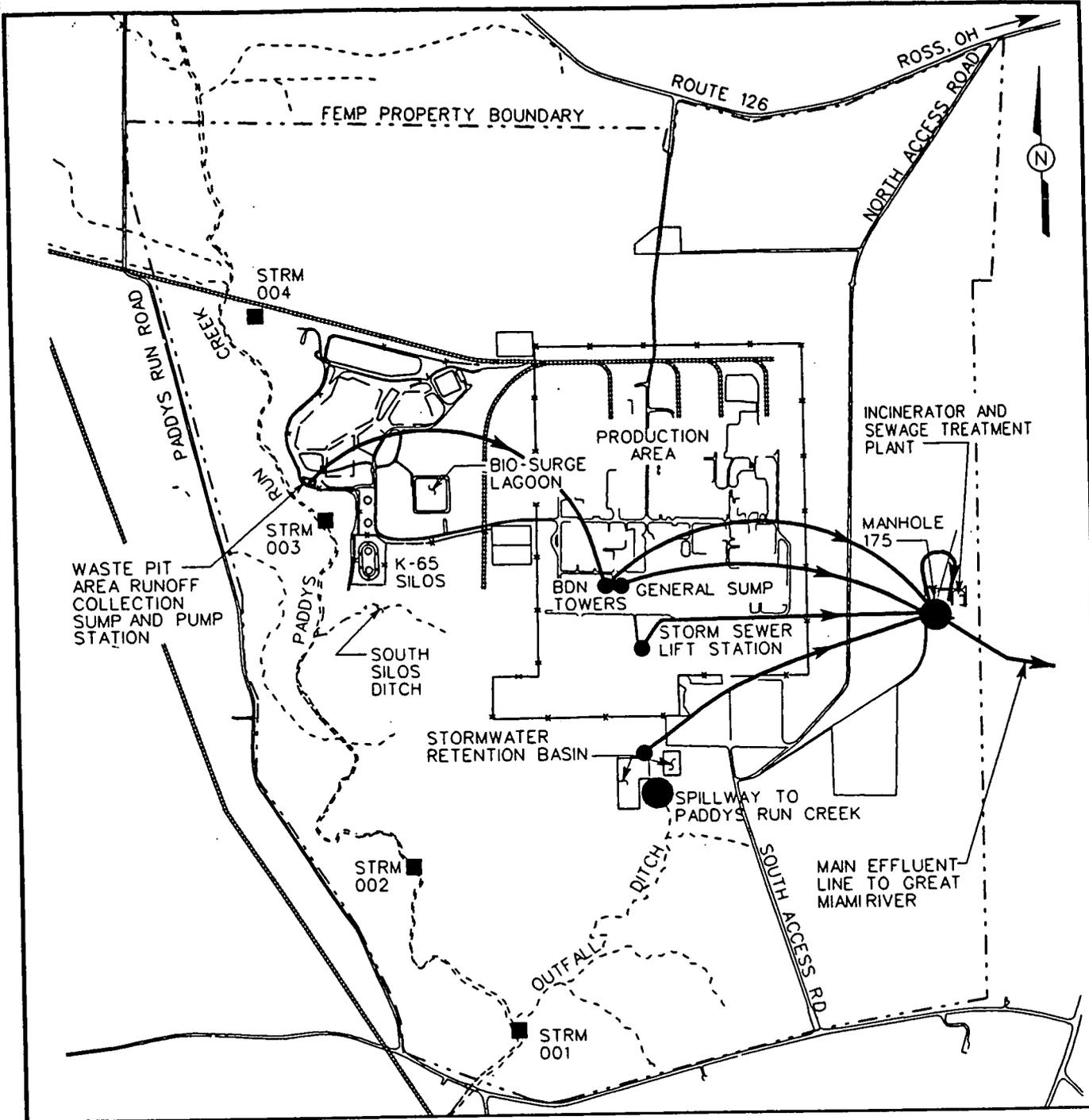
The Storm Sewer Outfall Ditch historically has conveyed surface water runoff from the former Production Area directly into Paddys Run during periods of heavy precipitation when the pumping capacity of the FEMP storm sewer lift station was exceeded. The storm sewer lift station transfers former Production Area storm water runoff through an effluent line to the Great Miami River. A two-chamber storm water retention basin was constructed to collect storm water runoff at the discharge point on the Storm Sewer Outfall Ditch (Figure 3-7). The first chamber was constructed in October 1986 and the second in December 1989. Storm water runoff from the former Production Area is now conveyed to the Storm Water Retention Basin. After a minimum retention period of 24 hours to allow for settling of suspended solids, the water is pumped out of the basin into the Great Miami River through the main effluent line of the FEMP. The basin is designed to retain the runoff from a 10-year, 24-hour rainfall event. Only in the event of an overflow would storm water from the former Production Area enter the Storm Sewer Outfall Ditch.

Paddys Run originates north of the Fernald site, intermittently flows southward along the western boundary of the facility, and enters the Great Miami River approximately 1.5 miles south of the southwest corner of the FEMP property. The stream is approximately 8.8 miles long and drains an area of approximately 15.8 square miles. Natural surface drainage from the FEMP is toward Paddys Run, which in post-glacial time, has eroded 30 feet or more through the glacial till deposits upon which the facility is built. Significant loss of Paddys Run flow to the regional Great Miami Aquifer begins approximately south of the Waste Pit Area. This characteristic contributes to the intermittent nature of the stream, which usually flows throughout its entire length between January and May.

Paddys Run is a steep-sided stream, and its banks erode severely during high flow periods. In 1961 and 1962, the course of the stream was altered to prevent it from eroding into the Silo and Waste Pit Areas (WMCO 1987). In 1970, a reach of the stream south of the K-65 silos was straightened to

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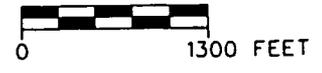
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**NOTE:**

1. SOURCE-FEMP ANNUAL SITE ENVIRONMENTAL REPORT FOR CALENDAR YEAR 1991, FEMP-2255.

**SCALE:**



**LEGEND:**

●	NPDES EXTERNAL DISCHARGE TO OHIO WATERS	-x-x-	FENCE LINE
●	NPDES INTERNAL MONITORING LOCATION	---	DRAINAGE WAY
■	NPDES STORMWATER MONITORING LOCATION	==	CSX RAIL LINE
STRM 002		---	ROADWAY
→	PATH OF PUMPING	---	FEMP PROPERTY BOUNDARY

**FIGURE 3-7  
STORM WATER  
COLLECTION SYSTEM  
FOR THE FEMP**

fig0307.dgn

0203

prevent erosion of Paddys Run Road. The stream is ungauged, but typical flows for the January through May period range from 0.2 to 4.0 cubic feet per second (ft<sup>3</sup>/s). Channel overflow resulting from 25-year, 100-year, and 24-hour storm events is possible, but peak flows occurring during storm events have not been measured.

The Great Miami River is the main surface water feature in the vicinity of the FEMP and receives water from the FEMP NPDES-permitted discharge. The river generally flows to the southwest and has a drainage area of approximately 3,360 square miles at the Hamilton gauge, which is located about 10 miles upstream from the FEMP discharge outfall.

The river exhibits meandering patterns that result in sharp directional changes over distances of less than 3,000 feet. Directly east of the FEMP, the river passes through a 180-degree curve known as the Big Bend (Figure 3-6). A 90-degree bend in the river also occurs near New Baltimore, Ohio, approximately two miles downstream from the FEMP point of discharge.

The average discharge of the Great Miami River at Hamilton, Ohio, based on 55 years of records, is 3,305 ft<sup>3</sup>/s. Using drainage area scaling, the corresponding average flow at the FEMP point of discharge has been estimated at 3,460 ft<sup>3</sup>/s. The maximum discharge recorded for the Great Miami River at Hamilton, Ohio, occurred on March 26, 1913, and was estimated at 352,000 ft<sup>3</sup>/s. The maximum discharge since the construction of five retarding basins in 1922, located approximately seven miles upstream of Ross, Ohio, was 108,000 ft<sup>3</sup>/s and occurred on January 21, 1959. The minimum daily discharge of 155 ft<sup>3</sup>/s was recorded on September 27, 1941. This value is approximately half of the 7-day, 10-year low flow value of 267 ft<sup>3</sup>/s, as computed by the USGS for the Hamilton gauge, which corresponds to 280 ft<sup>3</sup>/s along the portion of the river shown in Figure 3-6.

### 3.1.3 GEOLOGY AND GROUNDWATER HYDROLOGY

This section presents a summary of the geologic history, geology, and hydrogeology, which has been developed for the FEMP and surrounding area based on published studies, with modifications and extensions resulting from data collected during the Phase I and Phase II field investigations.

3.1.3.1 Physiography

The Fernald site lies in the Till Plains section of the Central Lowland physiographic province, characterized by structural and sedimentary basins and domes. Among these features, the Cincinnati Arch is structurally significant in this region. The regional bedrock is shale and fossiliferous limestone of Middle and Late Ordovician Age (Fenneman 1916). In some areas, it is overlain by glacial deposits that range in thickness to as much as 400 feet.

The main physiographic features in the area are gently rolling uplands, steep hillsides along the major streams, and the Great Miami River Valley. This valley is a relatively broad, flat-bottomed valley flanked on either side by bluffs that rise to a maximum of 300 feet above the general level of the valley floor.

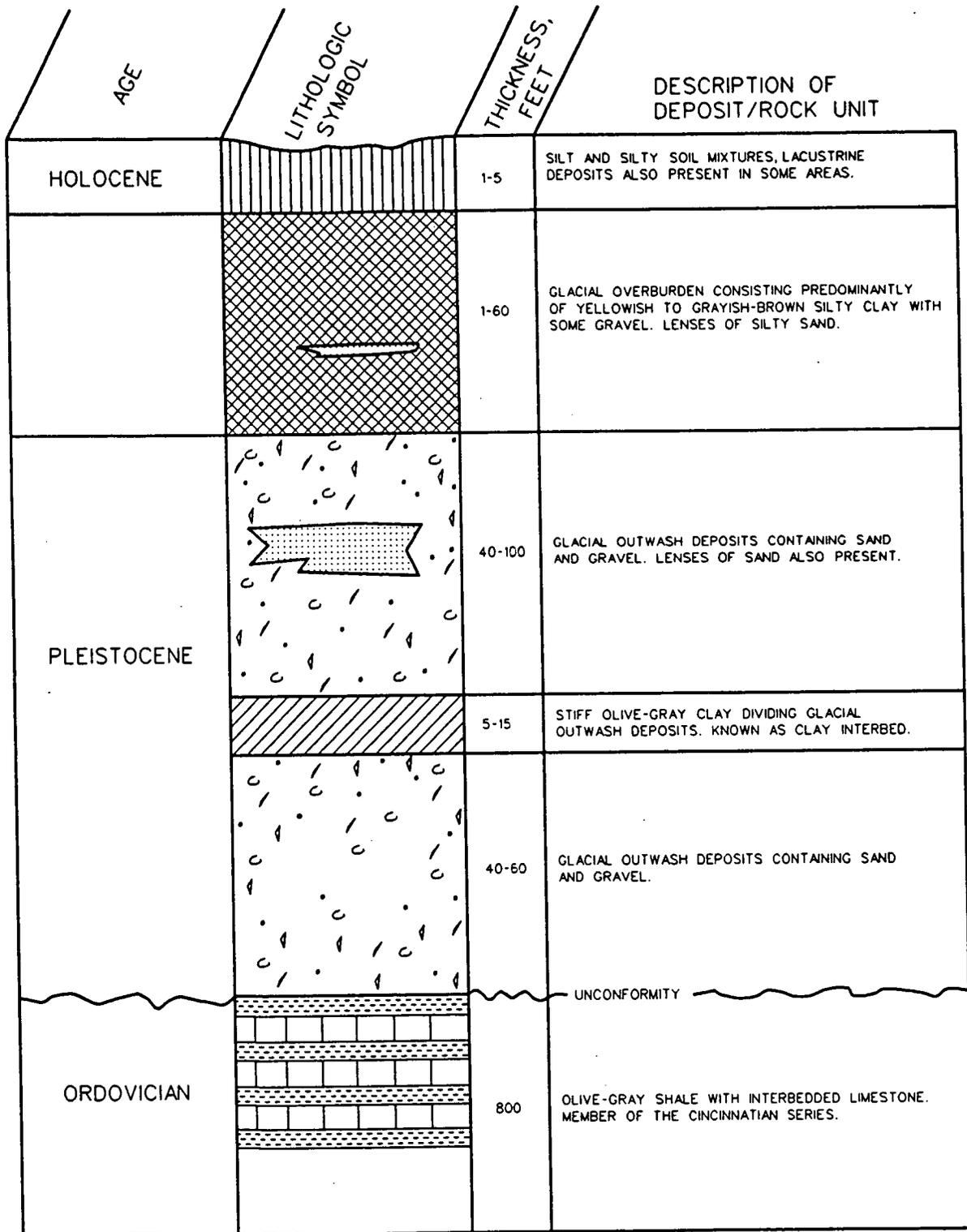
3.1.3.2 Geologic History

The geologic history of the FEMP is based on Fenneman (1916), Brockman (1988), and the ongoing field investigation for the Operable Unit 5 RI Report. A generalized stratigraphic column of the FEMP region is shown in Figure 3-8. In summary, the FEMP overlies a 2- to 3-mile-wide, buried Pleistocene valley known as the New Haven Trough. This valley was formed (eroded) by the ancestral Ohio River during the Pleistocene Age (approximately 3 million years to 8,000 years ago) and was subsequently filled with glacial outwash deposits (primarily sands and gravels). These materials were covered by glacial overburden (loess and glacial till with the inclusion of glaciofluvial and glaciolacustrine deposits) as glaciers advanced and receded across the area (Figure 3-9). The outwash deposits under the Fernald site are a part of the Great Miami Aquifer, which is a widely distributed buried valley aquifer. In addition to surface water, the valley fill aquifer system is the major source of drinking water in the southwestern Ohio area.

During the late Ordovician (approximately 450 million years ago), sediment that eventually became a predominantly flat-lying shale with thin interbedded limestone was deposited in a shallow sea. This shale is the relatively impermeable bedrock that now underlies the FEMP Study Area and forms the adjacent highlands. The advance of Nebraskan and Kansan glaciation to the north of Cincinnati created a drainage system known as the Deep Stage Drainage System (Figure 3-10). This drainage system was composed of three major rivers: the Great Miami River, the East Fork of the Little Miami River, and the Licking River. The Great Miami River followed much the same channel as the present-day Great Miami River from Middletown, Ohio to Ross, Ohio. The East Fork of the Little

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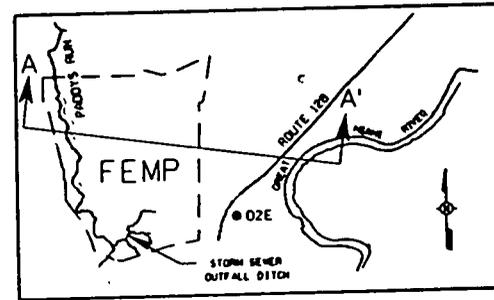
FIGURE 3-8  
GENERALIZED STRATIGRAPHIC  
COLUMN OF THE FEMP REGION

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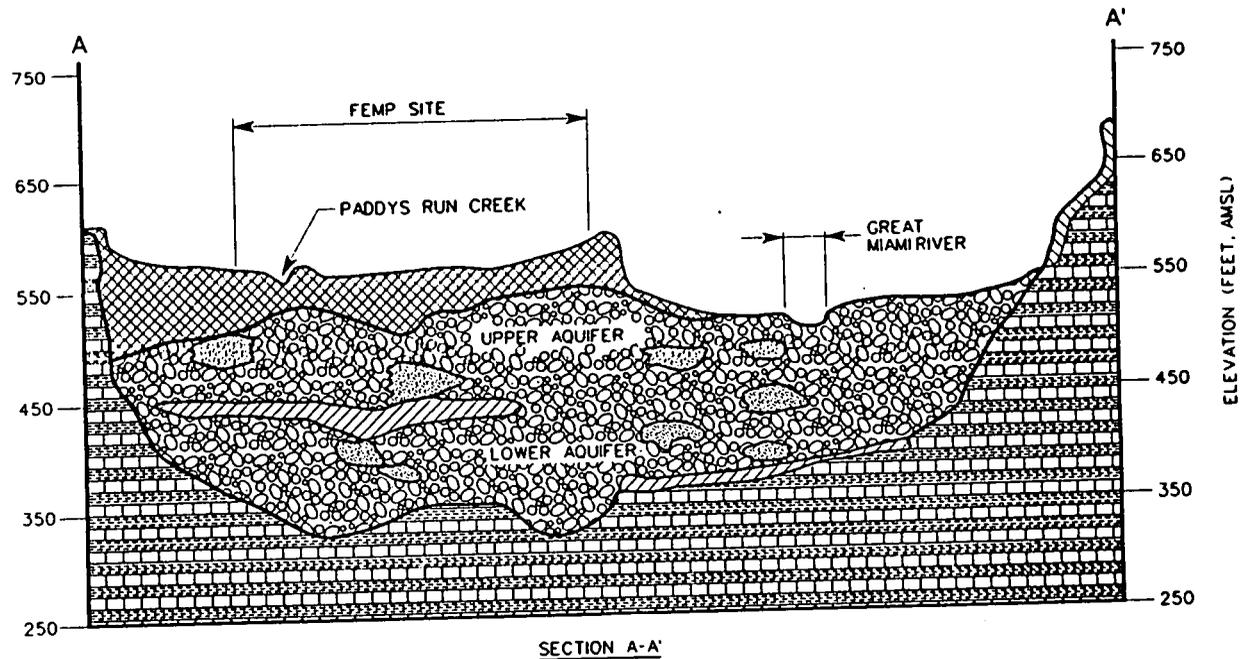
fig0309.dgn

**LEGEND**

-  SAND
-  SHALE WITH INTERBEDDED LIMESTONE
-  GLACIAL OVERBURDEN
-  CLAY
-  SAND & GRAVEL
-  UNDIFFERENTIATED TILL



LOCATION KEY



VERTICAL SCALE:  
(AS SHOWN)

HORIZONTAL SCALE:  
 0 2000 FEET

NOTE:

1. SOURCE-1991 RCRA ANNUAL REPORT, FIGURE 2.0B.

3-16

FIGURE 3-9  
SCHEMATIC CROSS SECTION  
OF THE FEMP AREA

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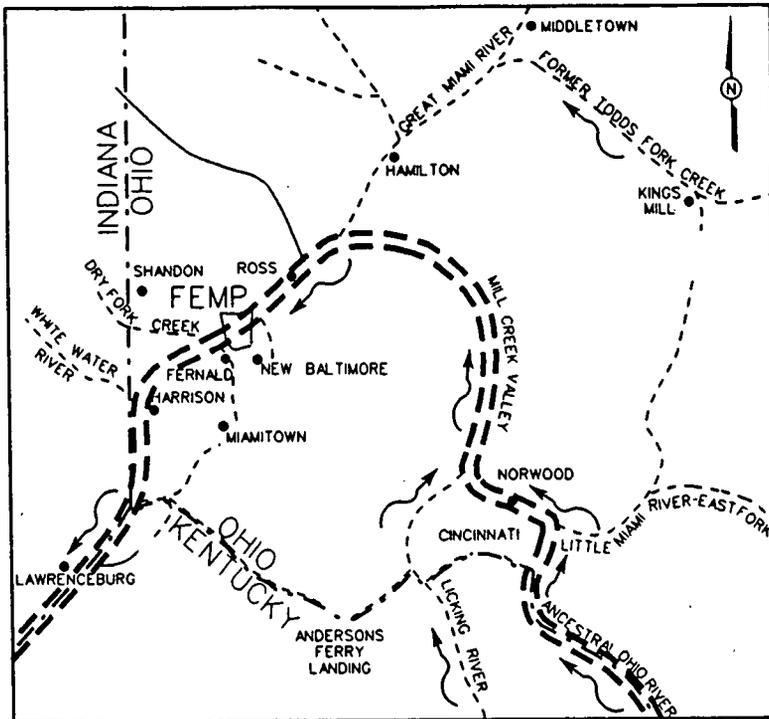
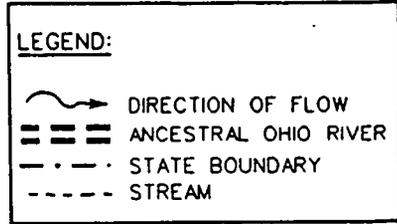


FIGURE 3-10A. DEEP STAGE (ANCESTRAL) DRAINAGE SYSTEM



**NOTE:**

1. SOURCE - FENNEMAN, N.M., 1916  
"THE GEOLOGY OF CINCINNATI  
AND VICINITY", GEOLOGICAL  
SURVEY OF OHIO, BULLETIN 19.

NOT TO SCALE

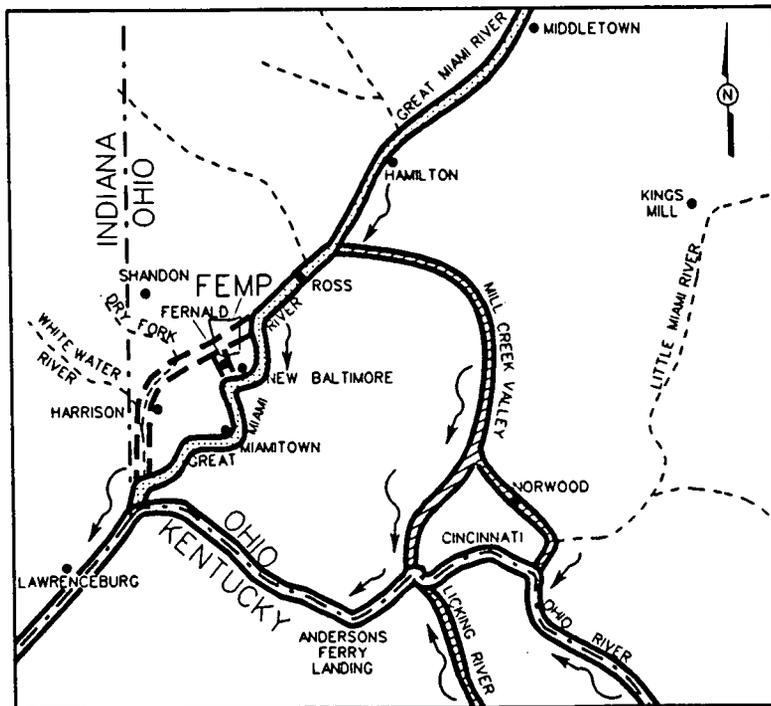
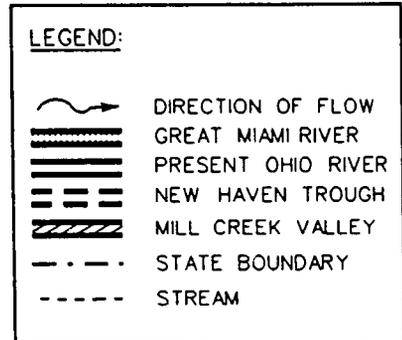


FIGURE 3-10B. PRESENT DRAINAGE SYSTEM



**NOTE:**

1. SOURCE - FENNEMAN, N.M., 1916  
"THE GEOLOGY OF CINCINNATI  
AND VICINITY", GEOLOGICAL  
SURVEY OF OHIO, BULLETIN 19.

NOT TO SCALE

FIGURE 3-10  
SCHEMATIC DIAGRAM OF  
THE DEEP STAGE DRAINAGE  
AND THE PRESENT DRAINAGE SYSTEM

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fig0310.dgn

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Miami River entered the area from the east. The Licking River came in from the south in essentially its present-day channel, but continued to the north of the present day Ohio River. These three rivers combined to form what is known as the ancestral Ohio River, which entered the area from the east along the present-day channel of the Ohio River, then turned northeast through the valley now occupied by the Little Miami River.

Several tributary streams of later importance entered the main stream in the vicinity of the Fernald site. Two streams originated near Miamitown, Ohio: one flowed north to join the main stream between Shandon, Ohio and Fernald, Ohio and the other flowed south following the course of the present-day Great Miami River. One other small stream originated near New Baltimore, Ohio and flowed north to the main stream. The Dry Fork of the Whitewater River, which now lies to the west of the area, formerly turned eastward to Shandon, Ohio and then flowed south through what is now the Paddys Run Valley.

During the time of Deep Stage Drainage and the early stages of Illinoian Glaciation (300,000 to 400,000 years ago), the river valleys cut deeply into the shale bedrock to depths up to 200 feet below current land elevations. As the Illinoian ice sheet advanced into the area, ice began to block the Great Miami River and its confluence with the ancestral Ohio River. For a time, water still flowed westward along the front of the advancing ice sheet and carved the present-day Great Miami River Valley along the tributary system near Miamitown, Ohio.

When the confluence of the Great Miami River and the ancestral Ohio River was completely blocked, ponded water in the Mill Creek Valley rose until it overflowed low divides and carved outlets at Anderson's Ferry and at what is now downtown Cincinnati. This course created the present-day channel of the Ohio River (Figure 3-10).

The Great Miami River was forced out of the Deep Stage Valley during a subsequent ice advance, carving a new narrow deep stage valley from just north of New Baltimore, Ohio to a location about one mile west of Cleves, Ohio, where it returned to the original Deep Stage Valley. Because only water from the Great Miami River and its tributaries carved this valley, it was much smaller than the ancestral Ohio Valley. This 2-mile-wide valley where the FEMP is located was termed the New Haven Trough by Fenneman (1916). As the ice retreated, the Deep Stage Valley, including the New Haven Trough, was filled with well-sorted sand and gravel outwash deposits. This formed the Great

Miami Aquifer, and the Great Miami and Ohio rivers were established in their present-day channels. During the last stage of glaciation, Wisconsin Glaciation (approximately 20,000 years ago), the ice sheet advanced only as far as the south side of the FEMP deflecting the Dry Fork of the Whitewater River to the west from its former valley (Figure 3-11). A terminal moraine was deposited at a point near the glaciers southernmost extent (Figures 3-11 and 3-12). As the ice front receded northward, till and lacustrine strata were deposited by the glacier. Within the till are deposits of debris flows and discontinuous sand bodies. The lacustrine strata are lake deposits that accumulated within a closed topographic depression (basin) on the northeast side of the Shandon Trough terminal moraine (see Figures 3-11 and 3-12). The lake deposits are debris flows, shoreline and deltaic sands, and lake clays of low energy deposition. The process of ice retreat left a second moraine, a recessional moraine, west and north of the present day former Production Area (Figure 3-12). Subsequent to the glaciers retreat, wind-blown silt and loess were deposited as a blanket over the area.

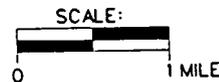
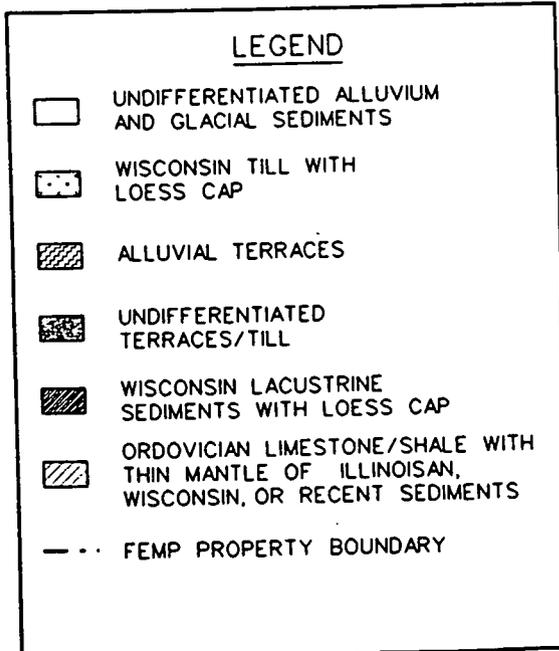
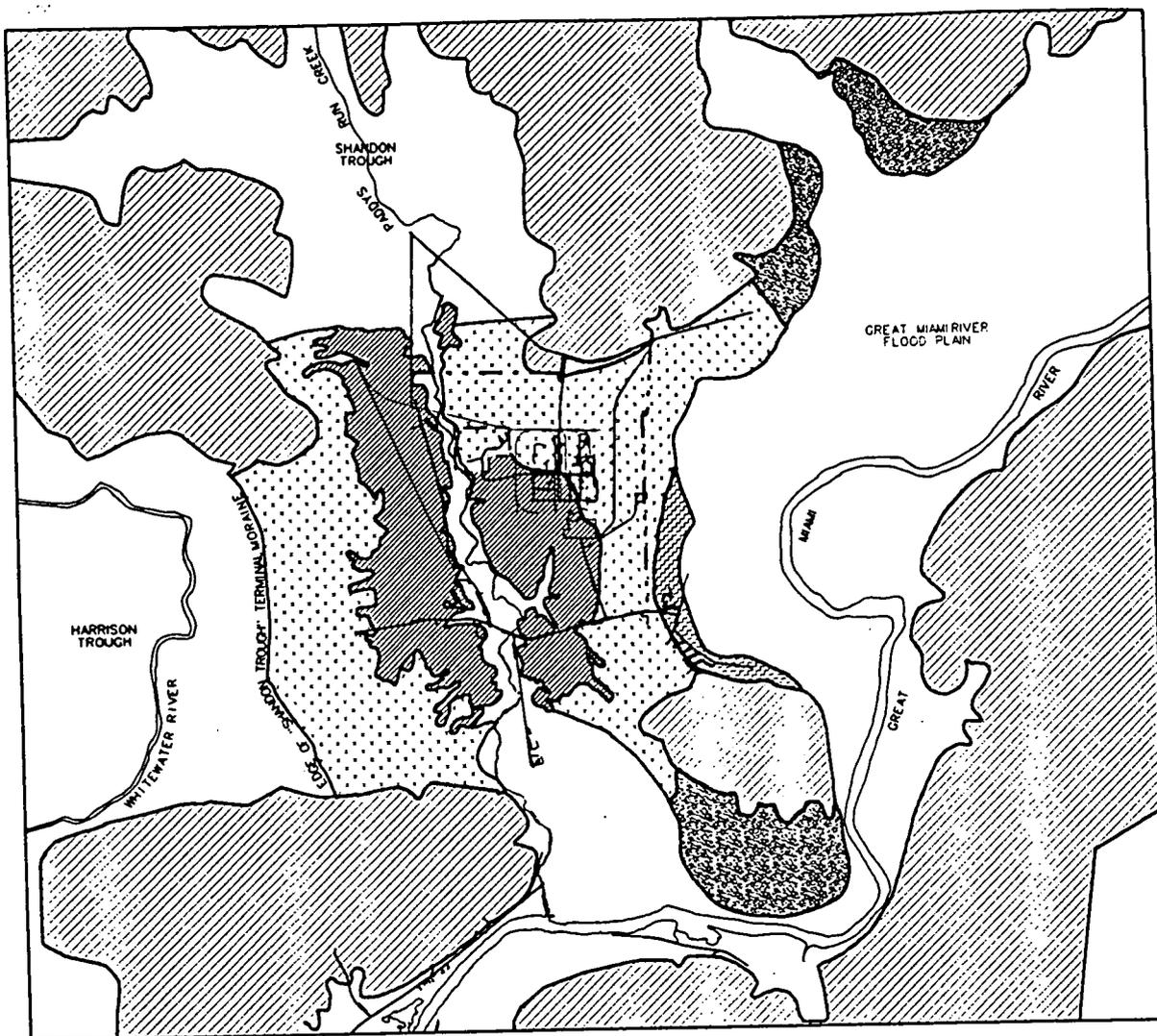
Since the last retreat of continental glaciers, the streams in the area have removed much of the glacial overburden and lacustrine strata left by the ice sheets. The Great Miami River has eroded through the glacial overburden and is now in direct contact with the glaciofluvial outwash deposits that comprise the Great Miami Aquifer. Paddys Run is also in contact with these deposits in its lower reaches. The Fernald site is located on a dissected glacial overburden plain left by the Wisconsin Glaciation.

Figures 3-11 and 3-12 show the surface geology as it would have appeared prior to site construction. The schematic cross section in Figure 3-9 and stratigraphic column in Figure 3-8 show the general subsurface geology: a valley carved into shale bedrock; filled with outwash sand and gravel; capped by a predominantly clay/silt dominated glacial overburden; and dissected by erosion along Paddys Run and the Great Miami River.

3.1.3.3 Site-Wide Hydrogeology

The stratigraphic column for the FEMP was presented as Figure 3-8. Significant hydrogeologic components of that stratigraphy include (from surface to bedrock) the glacial overburden, glacial outwash, and the Ordovician shale and limestone bedrock.

Overlying the Great Miami Aquifer throughout most of the FEMP property are a series of glacial overburden deposits. The glacial overburden is composed primarily of till: a dense, silty clay that



**NOTE:**

SOURCE- RI/FS OU4 REPORT, 4-93, FIGURE 3-12.

**FIGURE 3-11  
CONCEPTUAL MAP OF  
SURFACE GEOLOGY**

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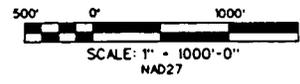
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**LEGEND:**

- ALLUVIUM, FLUVIAL DEPOSITS OF RECENT (HOLOCENE)
- TILL, WISCONSIN AGE.
- FINE TO COARSE SAND.
- LACUSTRINE DEPOSITS OF LATE WISCONSIN (?) AGE.
- TILL, WISCONSIN AGE (SHELBYVILLE TILL).
- ORDOVICIAN AGE BEDROCK (ALTERNATING LAYERS OF LIMESTONE AND SHALE)
- CONTACT OF MAP UNITS
- FEMP PROPERTY BOUNDARY
- LOCATION OF RECESSIONAL MORAINES. BARS INDICATE WIDTH OF TOPOGRAPHIC EXPRESSION OF MORAINES.

**NOTE:**  
1. SOURCE-R1/FS OU4 REPORT FIGURE 3-13.



**FIGURE 3-12  
GENERALIZED MAP OF  
PRE-SITE CONSTRUCTION  
SURFACE GEOLOGY**

fig0312.dgn

contains lenses of poorly sorted fine- to medium-grained sand and gravel, silty sand, and silt. The saturation of the clay in the till is variable, from saturated to unsaturated. This is evident by the moisture content observed from samples collected within the till, which ranged from approximately 6 percent to 28 percent. Undisturbed glacial till exposed at the surface has relatively low permeability, so most of the precipitation that falls on it is lost to evaporation and surface water runoff. Limited infiltration occurs along the upper weathered portion of the overburden, where occasionally small fracture zones of approximately one-foot thick were observed, and in isolated areas where more permeable deposits of silt, sand, and gravel are the primary overburden constituents. Lacustrine deposits lie upon till in places. The lacustrine deposits incorporate laterally extensive permeable sand/silt strata.

The thickness of the glacial overburden ranges from 0 to 50 feet within the FEMP Study Area, but most commonly averages between 20 and 30 feet. Except for some scattered deposits, this overburden does not exist along the floodplain of the Great Miami River to the east and south of the FEMP. Streams in this area are in direct contact with the upper Great Miami Aquifer along their reaches, allowing surface water leakage directly to the Great Miami Aquifer. Areas of inferred surface water infiltration to the aquifer along Paddys Run and the Storm Sewer Outfall Ditch are shown in Figure 3-13.

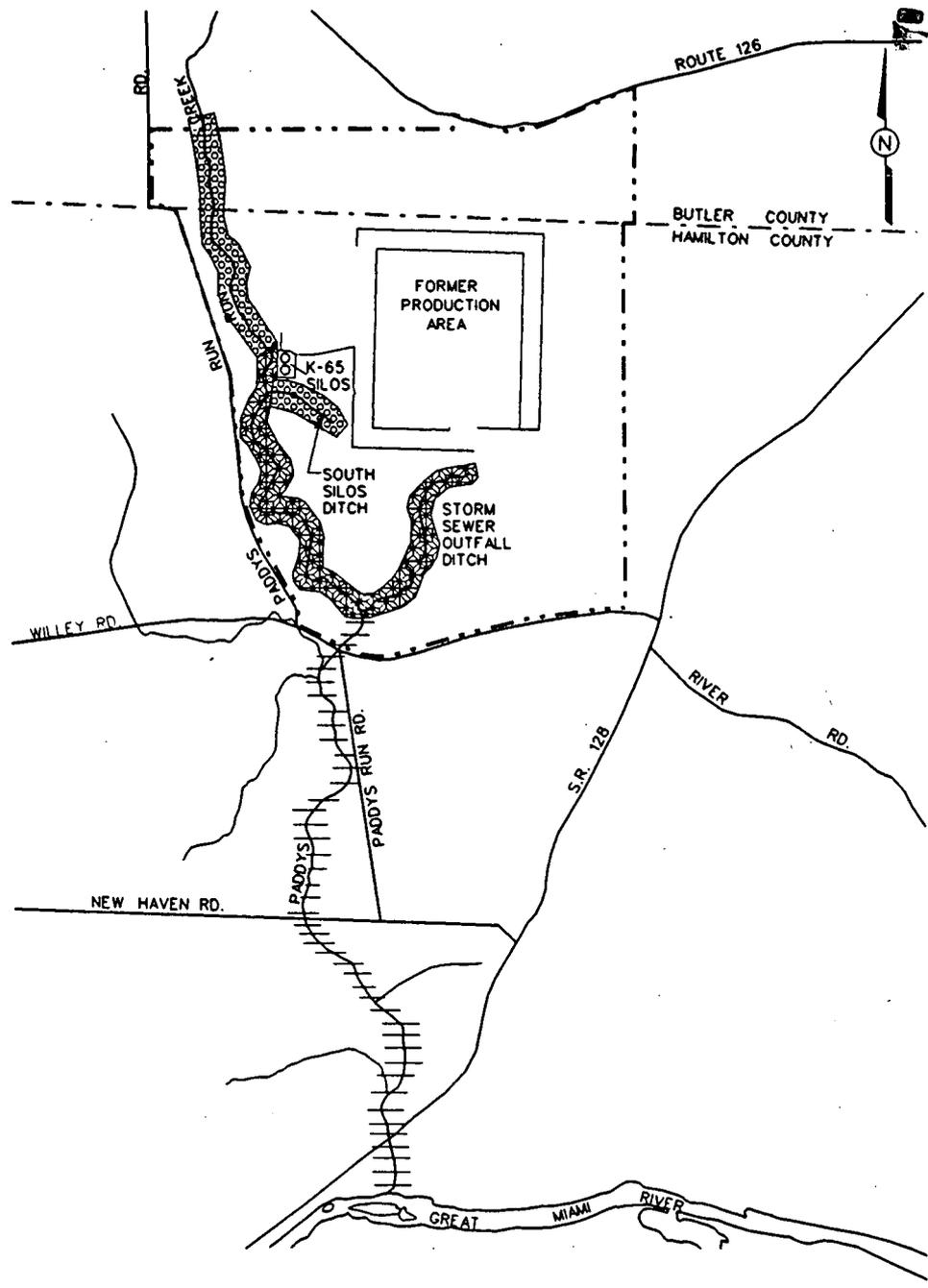
Erratically distributed pockets of sand and gravel within the glacial overburden contain zones of perched groundwater. Perched groundwater is separated from the underlying aquifer by the relatively impermeable clays and silts of the glacial overburden. These low-permeability clay and silt units behave as an aquitard that can store groundwater but transmit it slowly downward from one more porous saturated zone to another.

Depth to perched groundwater at the FEMP ranges from 1 to 15 feet below ground surface. This measurement can fluctuate seasonally by up to 10 feet at a single location, with the highest water levels occurring during the early spring and the lowest during the late fall.

Perched groundwater underlying the FEMP property is believed to flow laterally down topographic gradients or toward surface drains as well as vertically downward. There is uncertainty, however, regarding the rate of horizontal and vertical movement of perched groundwater. Perched zones may not be interconnected across the property, and layered materials comprising the overburden vary

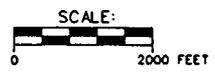
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**LEGEND:**

- FEMP PROPERTY BOUNDARY
- COUNTY LINE
- [Cross-hatched pattern] GLACIAL OVERBURDEN PRESENT: MINIMUM STREAM INFILTRATION EXPECTED
- [Dotted pattern] PERENNIAL WATER INFILTRATION
- [Vertical line pattern] SEASONAL SURFACE WATER INFILTRATION



**NOTES:**

1. AREAS OF SURFACE WATER INFILTRATION ARE APPROXIMATE.
2. SOURCE - RWFS OUI REPORT, 2-93, FIGURE 3-8.

FIGURE 3-13  
AREAS OF INFERRED  
SURFACE WATER INFILTRATION  
TO THE GREAT MIAMI AQUIFER  
ALONG PADDY'S RUN AND THE  
STORM SEWER OUTFALL DITCH

fig0313.dgn

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considerably in their ability to confine or transport water. Other influences on flow patterns within perched zones may include seasonal variations in rainfall and recharge and the presence of features such as storm sewers and agricultural drain tiles that were installed before the construction of the FEMP.

Core permeability tests on undisturbed soil samples have been performed on 28 samples from soil borings drilled during the site-wide investigation. Materials in these cores were described as clay-rich till and lacustrine deposits collected from depths of 1.0 to 33.0 feet. The values of hydraulic conductivities measured for these cores ranged from  $3.9 \times 10^{-9}$  to  $7.2 \times 10^{-7}$  centimeters per second (cm/s), suggesting that clay-rich tills have very low hydraulic permeabilities.

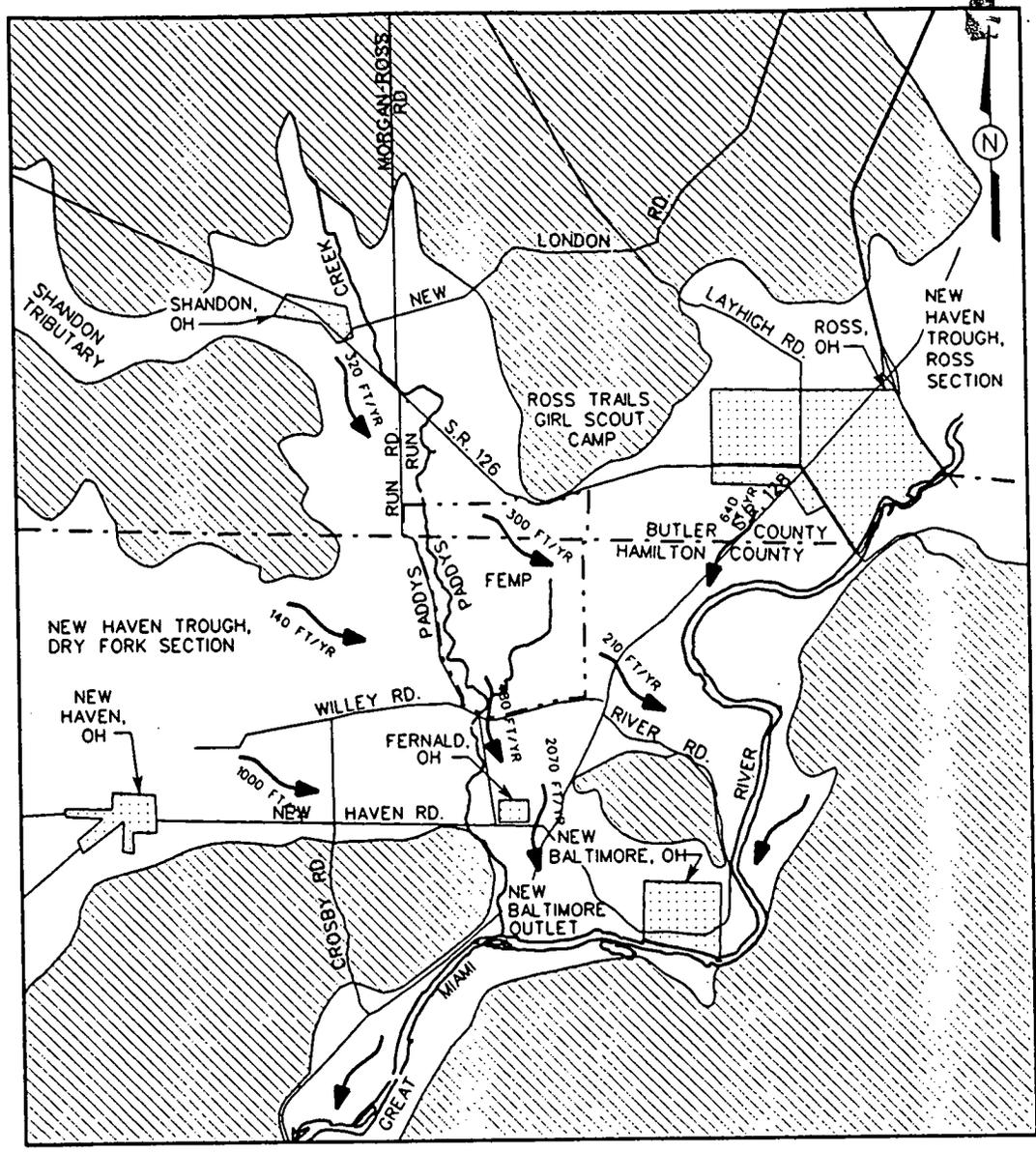
Hydraulic conductivity measurements from 18 slug tests are shown in Table 3-2. Slug tests were performed in wells or piezometers completed in glacial overburden materials that included at least a few feet of glaciofluvial sand or sandy silt; permeability ranged from  $4.1 \times 10^{-6}$  to  $4.7 \times 10^{-3}$  cm/s (Appendix H of this RI report). Differences between laboratory core tests and in situ slug tests suggest that sandy layers have a significant hydraulic conductivity contribution in the glacial overburden. No attempt was made to correlate sand unit thickness and the hydraulic conductivity measured by slug tests. Slug test measurements are controlled by sand grain texture and so the gradational sand unit thickness is believed to be as important as sorting. The sand unit was correlated across several of the Operable Unit 2 waste units and was called the perched ground water aquifer within each subunit. The relationship of this sand layer to Site-Wide hydrogeological system will be investigated by Operable Unit 5.

The uppermost saturated zone within the glacial out wash deposits underlying the glacial overburden is unconfined and is known as the Great Miami Aquifer. Out wash deposits of the Great Miami Aquifer are regionally extensive and act as a conduit for groundwater that flows south and east beneath the site from off site. The regional generalized groundwater flow pattern in the Great Miami Aquifer is shown in Figure 3-14.

Groundwater enters the FEMP area from three directions. In the northeast, groundwater moves southwest from the Ross area into the portion of the New Haven Trough now occupied by the Great Miami River. The second source of groundwater is the Shandon Tributary to the northwest of the FEMP, which contains a tributary of the New Haven Trough under the town of Shandon, Ohio. The

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**LEGEND**

--- COUNTY LINE

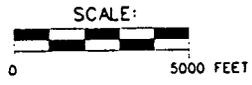
--- FEMP PROPERTY BOUNDARY

← GENERALIZED GROUNDWATER FLOW DIRECTION, & HORIZONTAL FLOW VELOCITY AT THE 2000-SERIES LEVEL.

340 FT/YR

▨ BEDROCK OUTSIDE GREAT MIAMI AQUIFER

▤ TOWNS AND VILLAGES



- NOTES:**
1. DIRECTION OF GROUNDWATER FLOW BASED ON APRIL 1986 WATER LEVEL CONTOURS AND GROUNDWATER MODELING OUTPUT (3DPART07.OUT).
  2. VELOCITIES CALCULATED FROM GRADIENTS ON SEVERAL POTENTIOMETRIC MAPS, USING HYDRAULIC CONDUCTIVITY EQUAL TO 450 FT/DAY AND EFFECTIVE POROSITY EQUAL TO 0.23.

**FIGURE 3-14**  
**GREAT MIAMI AQUIFER**  
**UNDERLYING THE**  
**FEMP AND VICINITY**

fig0314.dgn

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**TABLE 3-2**  
**SLUG TEST RESULTS FOR MONITOR WELLS**  
**COMPLETED IN WATER BEARING LENSES OF THE GLACIAL OVERBURDEN**

Unit	Well No.	USTM Soil Type	Hydraulic Conductivity <sup>a</sup> (cm/sec)		
			Falling Head Test	Rising Head Test	
Active Flyash Pile	1048	SM-GM-ML	1.8x10 <sup>-4</sup>	2.0x10 <sup>-4</sup>	
	1046	SM	6.4x10 <sup>-4</sup>	5.2x10 <sup>-4</sup>	
	1433	FILL/CL-GM	Not Done	1.1.x10 <sup>-4</sup>	
	South Field	1941	SC	Not Done	1.2x10 <sup>-4</sup>
		1942	SM	6.3x10 <sup>-5</sup>	5.5x10 <sup>-5</sup>
		1954	SM	1.5x10 <sup>-4</sup>	1.3x10 <sup>-4</sup>
		11085	SW	5.6x10 <sup>-4</sup>	5.4X10 <sup>-4</sup>
Solid Waste Landfill	1035	GW	1.2X10 <sup>-4</sup>	5.4X10 <sup>-5</sup>	
	1038	SM	1.0X10 <sup>-4</sup>	4.2X10 <sup>-5</sup>	
	1947	CL (weathered)	1.4X10 <sup>-4</sup>	1.5X10 <sup>-4</sup>	
	1950	ML-SP	7.3X10 <sup>-6</sup>	4.1X10 <sup>-6</sup>	
	1952	CL	2.4X10 <sup>-5</sup>	2.4X10 <sup>-5</sup>	
	Lime Sludge Ponds	1039	SW-GC	4.2 x 10 <sup>-3</sup>	4.7 x 10 <sup>-3</sup>
1041		CL	5.1 x 10 <sup>-4</sup>	4.9 x 10 <sup>-4</sup>	
1042		SM-SW-SP	4.4 x 10 <sup>-3</sup>	4.1 x 10 <sup>-3</sup>	
1934		CL	2.9 x 10 <sup>-5</sup>	2.9 x 10 <sup>-5</sup>	
1937		SM-ML (Dense Packing)	5.0 x 10 <sup>-5</sup>	2.0 x 10 <sup>-5</sup>	

<sup>a</sup>Hydraulic tests conducted during June and July 1993.

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third source of groundwater flows east from the Dry Fork of the Whitewater River, located about two miles west of the FEMP. Groundwater from this source flows into the FEMP area, turns, and flows southward to the Great Miami River under the southern part of Paddys Run, termed the Paddys Run Outlet. A portion of the groundwater from the Shandon Tributary also reaches the Great Miami River via Paddys Run Outlet. Although these general flow patterns dominate the regional flow 46 system, local and short-term variations do occur. For example, pumping of production wells near the Great Miami River may influence local groundwater movement due to the groundwater depression around these production wells in the Big Bend area shown in Figure 3-15. The pumping may affect a more easterly component to the groundwater flow direction at the FEMP. Only localized effects (<500 feet) have been observed in the lower Great Miami Aquifer from the pumping of the FEMP production wells.

Aquifer water table elevations in the FEMP area display a broad cyclic trend on a yearly basis, as typified by elevation changes in Well No. 02E shown in Figure 3-16. Maximum water table elevations usually occur during the spring and early summer months corresponding to peak rainfall months. Minimum water table elevations generally occur during the late fall and early winter months. These low groundwater elevations occur at the end of southern Ohio's dry season, which usually starts in late summer or early fall and runs to late fall. During most years, the water table fluctuates on the order of four to five feet. Hydrographs of paired wells that are completed on opposing sides of the clay interbed are shown for the Inactive Flyash Pile (Figure 3-17) and for the area west of the Solid Waste Landfill (Figure 3-18). The hydrograph trend for the nested wells appears to be similar; namely, the water elevations in wells completed above and below the clay interbed respond alike. This suggests that the upper (2000- and 3000-series wells) and lower (4000-series wells) aquifers are not hydraulically isolated from each other by the clay interbed in these areas.

Regional groundwater elevations corresponding to relatively low (December 1989) and high (May 1989) groundwater elevations are presented in Figures 3-19 and 3-20, respectively. During a dry season, as shown by the December contours in Figure 3-19, groundwater in the Great Miami Aquifer appears to flow in a generally south-east to east direction. During a wet season, as shown by the May contours in Figure 3-20, groundwater in the Great Miami Aquifer appears to flow in a generally east direction.

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3.1.3.4 Seismology

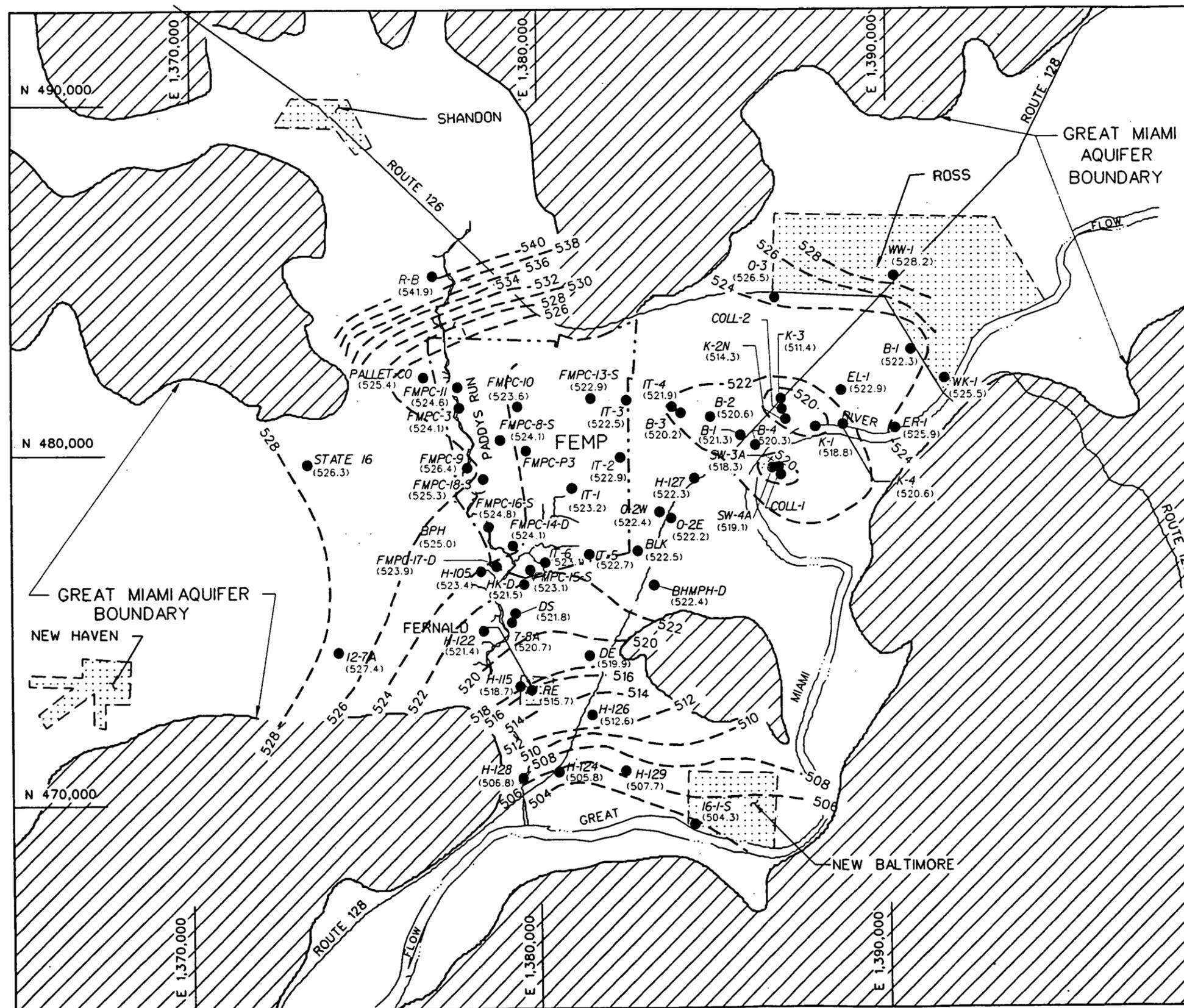
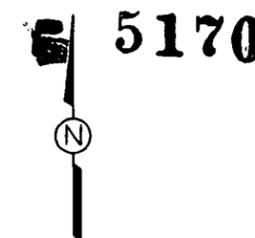
A seismic risk zone of two on a measurement of earthquake intensity on a scale of less-than-one to four has been assigned to the FEMP region. An earthquake in the FEMP region could damage facilities and cause release of contaminants into the environment. Local geologic structures and historical seismicity are used to analyze the potential for seismic events and structural damage.

Based on published regional geologic maps of southwestern Ohio, there are no major faults, active or inactive, in the vicinity of the FEMP. However, the presence of minor faults cannot be dismissed because bedrock in the region is largely covered by Pleistocene sediments. Pre-Pleistocene fault traces could potentially be obscured; however, the historical record of seismicity and the absence of post-Wisconsin faults indicate that significant local earthquakes are unlikely. Nine earthquakes caused minor damage at locations between 71 and 199 miles from the Fernald site. Most of these earthquakes were clustered in the Anna, Ohio (Bowling Green Fault) seismic zone. One earthquake caused moderate damage at Anna, Ohio, which is located 81 miles north of the FEMP. The Anna, Ohio earthquake had a reported intensity of VIII on a scale of I to XII, according to the Modified Mercalli Intensity (MMI) scale (IT 1993). The equivalent Richter Scale magnitude for the Anna, Ohio earthquake is estimated to be 5 to 6 (Nuttli 1979).

3.1.3.4.1 Historical Earthquakes Affecting the FEMP Area

The National Geophysical Data Center in Boulder, Colorado maintains the earthquake database for the NOAA. The earthquake database contains information on more than 500,000 earthquakes and can provide data on the seismicity of a selected region, prepare an edited list of earthquakes chronologically, geographically, or by radial distance from a center point.

The origins of earthquakes in the Central Stable physiographic region, as with earthquakes throughout the eastern United States, are not thoroughly understood at this time. The earthquakes in this region appear to be associated with ancient zones of weakness in the earth's crust that formed during continental collision and mountain-building events that took place about a billion years ago. These zones are characterized by deeply buried and poorly known faults, some of which serve as the sites for periodic release of strain that is constantly building up in the North American continental plate due to continuous movement of the plates. The following discussion reviews the historical earthquake activity in Ohio and the surrounding regions.



**LEGEND:**

- H-122 (521.4) WELL NAME AND LOCATION. VALUE IN PARENTHESIS INDICATES MEASURED GROUNDWATER LEVEL ELEVATION IN FEET ABOVE MEAN SEA LEVEL (MSL).
- 524— GROUNDWATER CONTOUR (FEET-MSL). DASHED INDICATES AREA OF UNCERTAINTY
- - - FEMP PROPERTY BOUNDARY
- [Hatched Box] BEDROCK OUTSIDE GREAT MIAMI AQUIFER
- [Dotted Box] TOWNS AND VILLAGES

**NOTES:**

1. GROUNDWATER ELEVATIONS WERE MEASURED DURING THE PERIOD MARCH 27 THROUGH APRIL 11, 1986.
2. GROUNDWATER ELEVATIONS AT PUMPING WELLS FMPC-P3, COLL-1, AND COLL-2 WERE NOT USED FOR CONSTRUCTION OF THIS MAP.

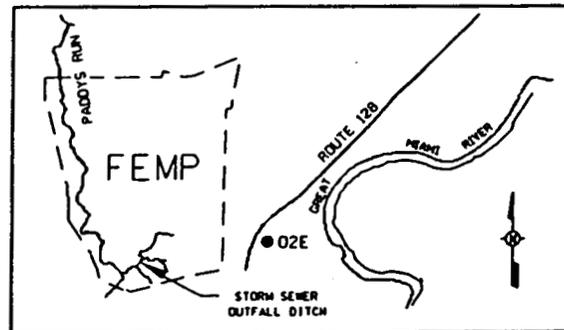
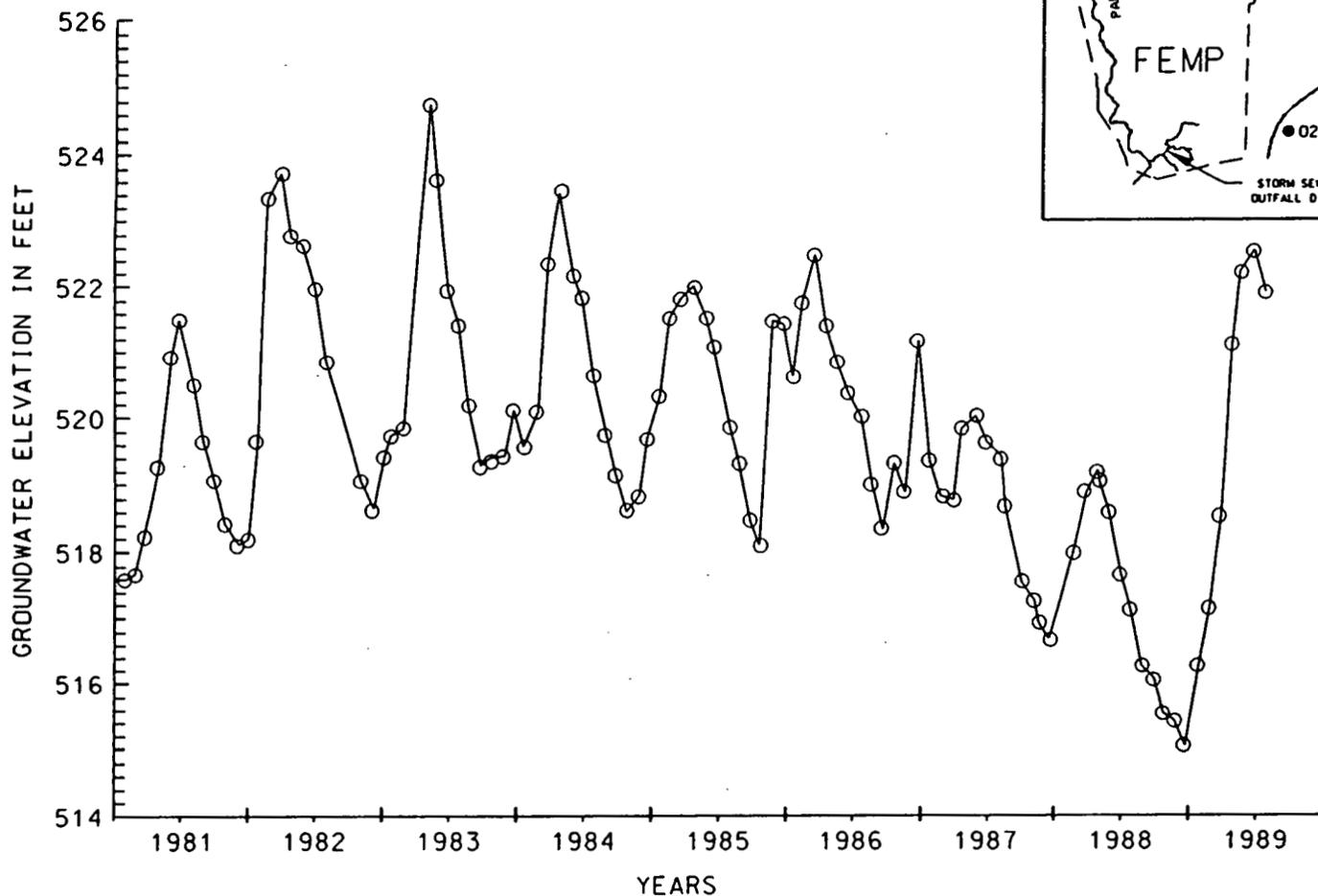


FIGURE 3-15  
REGIONAL GROUNDWATER  
ELEVATIONS, APRIL 1986

fig0315.dgn

SSS11

3-30



NOTES:

LEVELS SHOWN WERE RECORDED AT WELL 02E  
(SEE INSET FOR LOCATION)

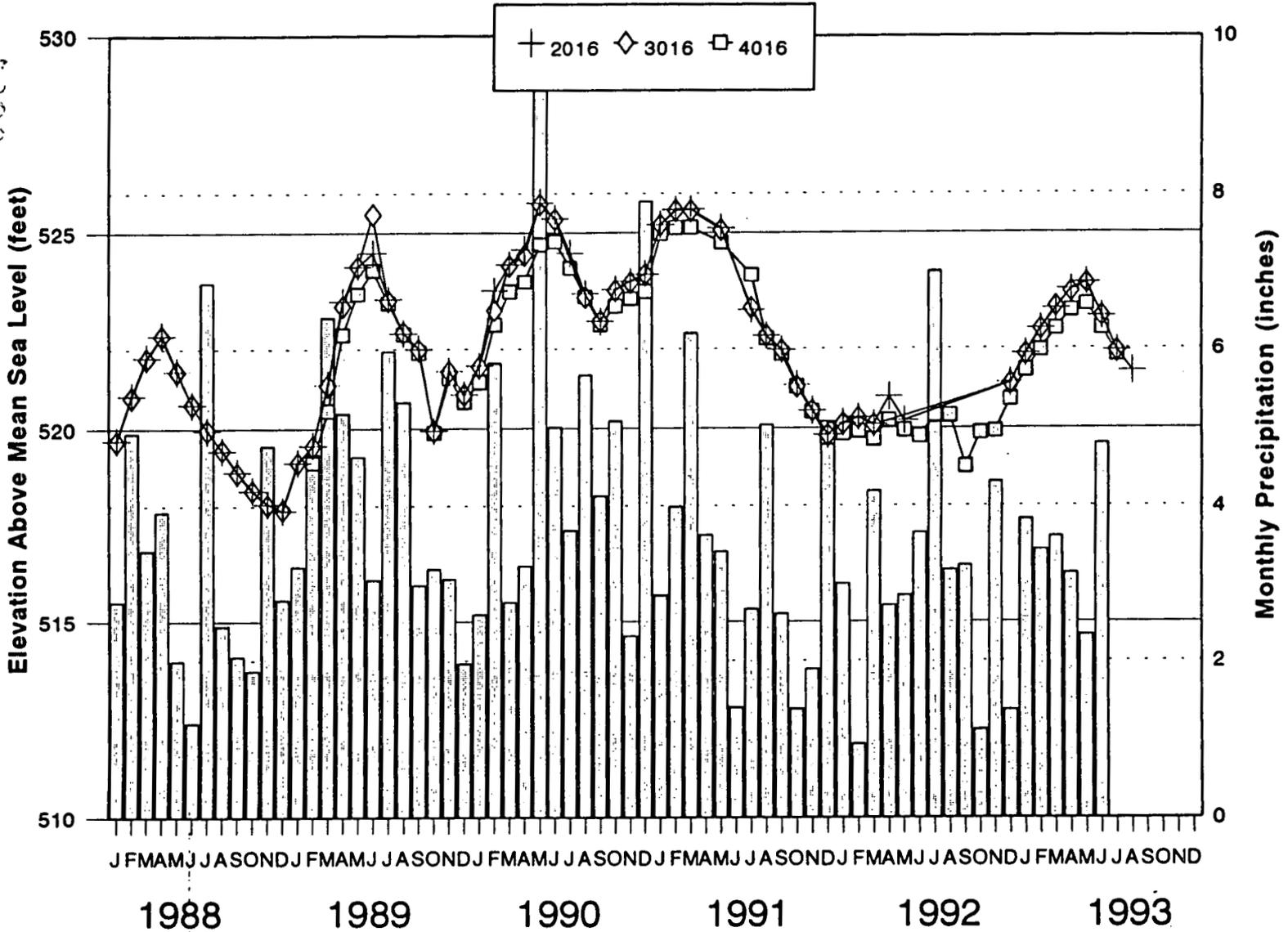
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FIGURE 3-16  
GROUNDWATER ELEVATION FOR WELL 02E BETWEEN JANUARY 1981 AND DECEMBER 1989

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0250



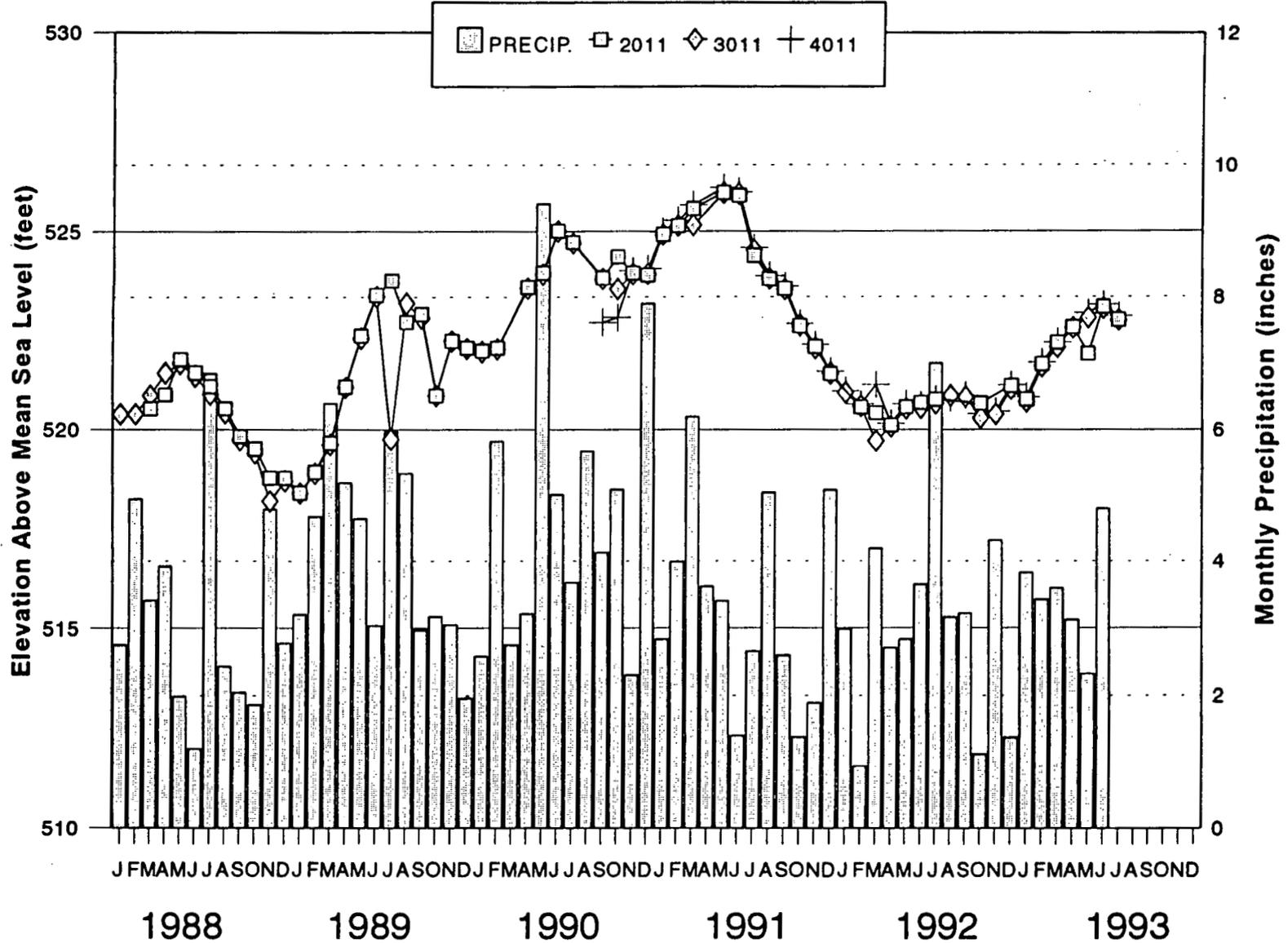
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NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

FIGURE 3-17

HYDROGRAPHS FOR MONITORING WELLS 2016, 3016, AND 4016, INACTIVE FLYASH PILE



NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

FIGURE 3-18

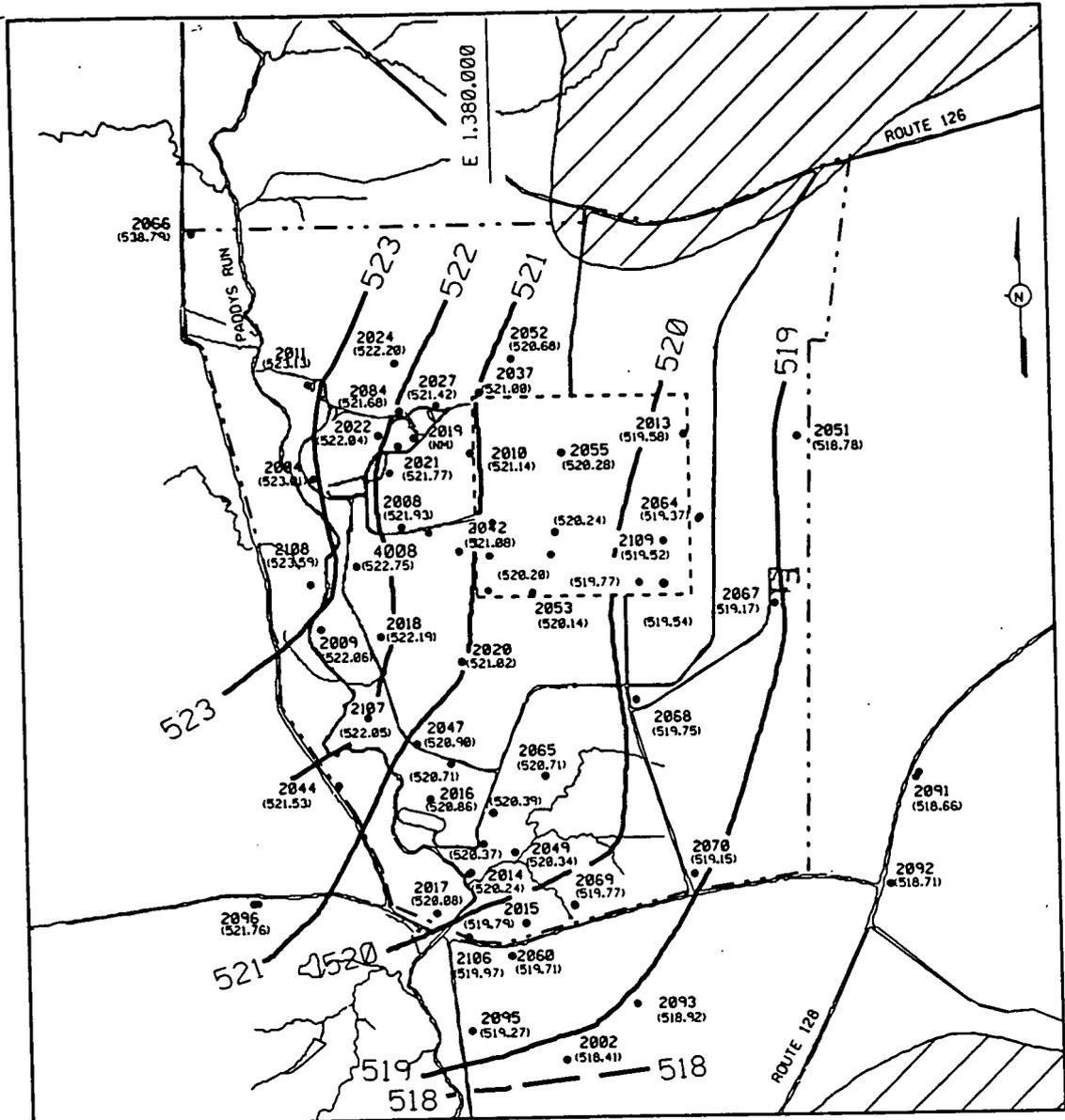
HYDROGRAPHS FOR MONITORING WELLS 2011, 3011, AND 4011, WEST OF SOLID WASTE LANDFILL

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**LEGEND**

● 2013 (519.58) MONITORING WELL LOCATION.  
VALUE IN PARENTHESES INDICATES  
GROUNDWATER LEVEL IN FEET  
ABOVE MEAN SEA LEVEL (MSL)

● 2129 (NH) WATER LEVEL NOT MEASURED

-518- GROUNDWATER ELEVATION CONTOUR.  
UNITS ARE FEET ABOVE MSL. DASHED  
WHERE INFERRED.

- - - FEMP RESERVATION BOUNDARY

- - - - - FORMER PRODUCTION AREA BOUNDARY

▨ BEDROCK OUTSIDE  
GREAT MIAMI AQUIFER

SCALE  
(IN FEET)



**FIGURE 3-19  
GROUNDWATER ELEVATIONS  
2000-SERIES WELLS  
DECEMBER 1989**

fig0319.dgn



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3.1.3.4.2 Historical Earthquake Activity in Ohio

Three areas of Ohio appear to have susceptibility to seismic activity. Shelby County and surrounding counties in western Ohio have experienced more earthquakes than any other area of the state. The most frequent and damaging earthquakes in Ohio have originated near the Bowling Green fault zone and the Findlay Arch in the vicinity of the western Ohio town of Anna, Shelby County. This area has often been referred to as the "Anna, Ohio," seismic source zone. during the last 100 years, the Anna area has experienced more than 30 earthquakes; the decade of the 1930s was the seismically most active period. During this time, 23 earthquakes were recorded, including the most severe shock ever reported from Ohio. This earthquake, which occurred on March 9, 1937, had a reported intensity of VIII on the MMI scale and was felt in an area of 150,000<sup>2</sup>. A shock of intensity VII preceded the March 9 earthquake by seven days. Considerable damage including breaking of dishes and windows, cracking of plaster on ceilings and walls, and extensive cracking of masonry in several large buildings, including the school, the firehouse, and two churches, was done to buildings in Anna and nearby communities by these quakes. Since the considerable activity of the 1930s, only three minor earthquakes have been centered in the Anna area.

The Anna earthquakes occurred approximately 93 miles from the Fernald site. Assuming an attenuation of one MMI per 40 miles, the site MMI would have been IV to V at Fernald. Zimmer (1970) states an estimated MMI of III at the site of the Zimmer Nuclear Power Plant. There have been four earthquakes in the Anna, Ohio, area having MMIs of VII. These occurred on June 18, 1875; September 30, 1930; September 20, 1931; and March 2, 1937 and would have probably have resulted in intensities of IV to V at Fernald. The March 2, 1937 earthquake may have been a foreshock to the March 9, 1937 earthquake; however, their epicentral locations have been listed as being five miles apart (Beavers et al. 1982).

Northeastern Ohio has experienced at least 20 felt earthquakes since 1836 (Hansen 1988). Most of these events were small and caused little or no damage. However, an earthquake on January 31, 1986 strongly shook Ohio and was felt in 10 other states and southern Canada. This event had a Richter magnitude of 5.0 (MMI VI to VII) and caused minor to moderate damage, including broken windows and cracked plaster, in the epicentral area of Lake and Geauga Counties.

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Southeastern Ohio has been the site of at least 10 felt earthquakes with epicenters in the state since 1776. The 1776 event, recorded by a Moravian missionary, has a very uncertain location. Earthquakes in 1901 near Portsmouth, in 1926 near Pomeroy, and in 1952 near Crooksville caused minor to moderate damage (Hansen 1988).

The precise cause or causes of earthquakes in Ohio have not been thoroughly characterized. Data from recent tremors indicate focal depths of 12 to 18 miles or less (Hansen 1988). These shallow-focus earthquakes suggest minor crustal adjustments like those which occur continuously in many parts of the world. The specific nature of these adjustments in Ohio is unknown. One factor partially responsible for the lack of precise data on the location of active faults or other bedrock structures responsible for Ohio's earthquakes is the relative infrequency of significant seismic activity within the state. Collection of definitive data on these bedrock structures is partially dependent upon the occurrence of earthquakes that are strong enough to be recorded simultaneously by a number of standardized seismograph stations. However, no earthquakes of sufficient magnitude have occurred within the state since an adequate distribution of standardized seismographs became available in the late 1960s. Future research is expected to provide data from which more precise conclusions can be drawn as to the cause of Ohio's earthquakes.

#### 3.1.3.4.3 Historical Earthquake Activity in Surrounding Areas

Based on historical seismic activity, the New Madrid seismic zone and the Appalachian seismic zone can be greater threats to the Fernald sites than the Anna, Ohio, seismic zone. The New Madrid seismic zone is located in an area of southeastern Missouri and was the site of the largest earthquake to occur in historical times in the continental United States. Four great earthquakes were part of a series at New Madrid in 1811 and 1812. The distance to the December 16, 1911 earthquake epicenter from Fernald was 320 miles. These events were felt throughout the eastern United States and were of sufficient intensity to topple chimneys in Cincinnati (Hansen 1988). Some estimates suggest that these earthquakes were in the range of 8.0 on the Richter scale. The estimate MMIs for the 1811 and 1812 series ranged between VII and VIII (Sterns and Wilson 1972). These earthquakes resulted in higher intensities in the Fernald sites than earthquakes occurring at other locations in Ohio.

The Appalachian seismic zone has also been an area of recorded seismic activity, although the intensities are lower than those observed for the New Madrid seismic zone. An earthquake with a Richter magnitude of 5.3 centered at Sharpsburg, Kentucky, on July 27, 1980 was strongly felt

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throughout Ohio and caused minor to moderate damage in communities near the Ohio River and southwestern Ohio (Reinbold et al. 1981). This earthquake was felt as far north as Cleveland, and into Canada, and as far south as Atlanta, Georgia. The epicentral intensity has been estimated as an MMI of VII. The earthquake epicenter was approximately 60 miles from the Fernald site. Although isoseismal maps for this earthquake had not been completed prior to the report by Beavers et al. (1982), they estimated that the intensities at both sites were probably in the range of MMIs of V to VI. They also pointed out that this earthquake occurred in a very low seismicity area and should be considered and isolated event with an approximately recurrence interval in the 1000- to 2000-year range (Reinbold et al. 1981).

Another major historical earthquake from the Appalachian seismic zone that may have had some impact on the FEMP area took place in Giles County, Virginia on May 31, 1897. This earthquake has been estimated to have an epicentral MMI from VII to VIII. However, according to Bollinger (1981), the impact in the FEMP vicinity was probably insignificant since the estimated intensity ranged from an MMI of II to IV. It has been proposed that the Giles County area has a potential of producing an earthquake of epicentral MMI of IX (Bollinger 1981); however, the resulting intensity of this event in the Fernald area would be an MMI of less than VI (Beavers et al. 1982).

#### 3.1.4 Soils

Soil characteristics affect the suitability of a site for agriculture or construction, the likelihood of erosion during remedial actions, and the kinds of habitat, such as wetlands, which can develop on a site. As a result, soil types may be important to consider during the FS phase of remediation at the FEMP. Soils in the region of the FEMP were formed from materials deposited by the Wisconsin and Illinoian glaciers. These parent materials consist mainly of glacial till and include sand, gravel, glacial lake clays, and silt clays. Glacial tills are typically a composite of materials carried forward or pushed to an advancing glacier. These materials may be locally derived or transported long distances, in some cases hundreds of miles. A portion of the till appears to be derived from the local bedrock; however, it is not known which portion is derived from the possible sources. Three major soil associations, that is, groups of soils which typically occur together, exist in the vicinity of the FEMP: Russell-Xenia-Wynn, Fincastle-Xenia-Wynn, and Fox-Genesee (U.S. Department of Agriculture 1980, 1982). These soils are usually light colored, acidic, and poorly- to moderately-well drained. Many of them have developed on windblown material (loess), except along river basins

where the Fox-Genesee soils are of glacial till origin. The soils are moderately high in productivity and are frequently used for growing cash crops and producing livestock.

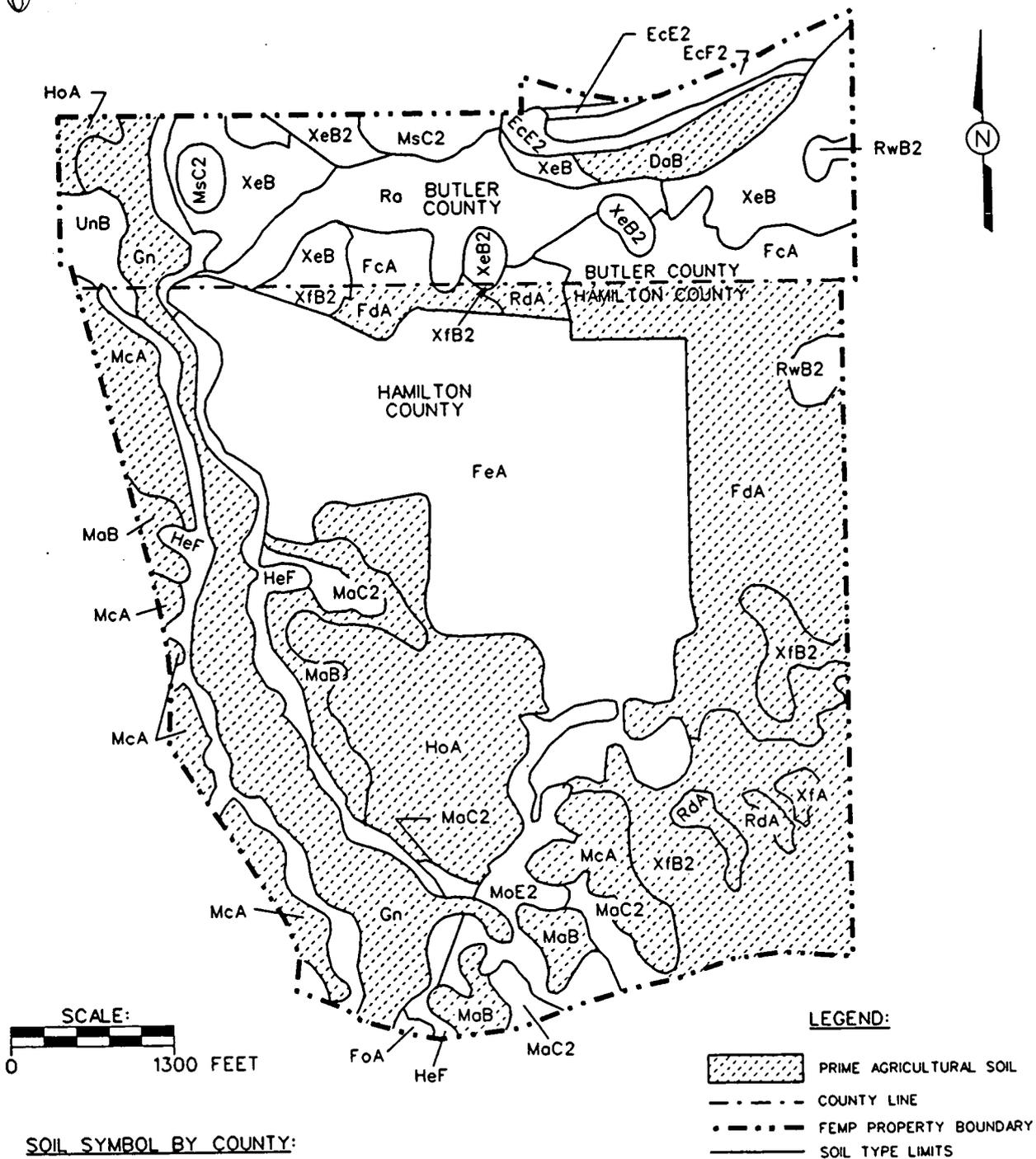
The Butler County and Hamilton County Soil Surveys have 15 specific soil series or types mapped within FEMP boundaries as described in Table 3-3 and shown on Figure 3-21 (U.S. Department of Agriculture 1980, 1982). The major soil series, which cover large areas west of the FEMP, are Fincastle-Xenia silt loams. These soils are light colored, medium acidic, and moderately high in productivity when properly managed. Moisture-supplying capacity is moderate, as is fertility and organic content. The Fincastle Series consists of deep, nearly level, poorly-drained soils on broad flats. Permeability is low, and the available water capacity is high. The seasonal high water table is commonly found between one and three feet below the ground surface from January to April. In areas where these soils are predominant, artificial drainage is required for moderate crop productivity. These soils are associated with the former Production Area and the pastures to the east and west. The Xenia soil series is a deep, nearly level, moderately well-drained soil located on till plains. Permeability is moderately low, available water capacity is high, and the runoff hazard is low. The seasonal high water table is usually within two to six feet of the surface from March to April. These soils are located within the pine plantation in the northern portion of the site and in the pastures to the east of this area.

The remaining soil series occurring within the FEMP are Dana, Eden, Fox, Genesee, Hennepin, Henshaw, Markland, Martinsville, Miamian, Ragsdale, Raub, Russell, and Uniontown. Table 3-3 summarizes the soil drainage classifications within the FEMP boundaries.

One soil mapped within FEMP boundaries is considered hydric, that is, periodically depleted of oxygen due to water saturation (U.S. Department of Agriculture 1987a and 1987b). This very poorly-drained soil, Ragsdale silty clay loam, is mapped for approximately 53 acres (five percent of the area of the FEMP) in the northern portion of the FEMP. The Ragsdale soil series is nearly level, deep, and very poorly drained. It is usually located in long, narrow depressions or in shallow basins. The permeation rate is slow, available water capacity high, and the seasonal high water table is near the surface from December through May. These soils are associated with a jurisdictional wetland in the northern end of the FEMP.

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**SOIL SYMBOL BY COUNTY:**

SOIL NAME	BUTLER COUNTY	HAMILTON COUNTY
DANA	DaB	N/A
EDEN	EcE2, EcF2	N/A
FINCASTLE	FcA	FdA, FeA
FOX	N/A	FoA
GENESEE	Gn	Gn
HENNEPIN	N/A	HeF
HENSHAW	HoA	HoA
MARKLAND	N/A	MaB, MoC2
MARTINSVILLE	N/A	McA
MIAMIAN-HENNEPIN	N/A	MoE2
MIAMIAN-RUSSEL	MsC2	N/A
RAGSDALE	Ro	N/A
RAUB	N/A	RdA
RUSSELL	RwB2	RwB2
UNIONTOWN	UnB	N/A
XENA	XeB, XeB2	XfA, XfB2

**NOTES:**

1. SEE TABLE 4-3 AND 4-4 FOR SOIL CLASSIFICATIONS.
2. SOURCE - OHIO DEPARTMENT OF NATURAL RESOURCES.

**FIGURE 3-21  
SOIL CLASSIFICATIONS AND  
PRIME AGRICULTURAL SOIL  
AT THE FEMP**

fig0321.dgn

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**TABLE 3-3**  
**SOIL CONSERVATION SERVICE SOILS DRAINAGE CLASSIFICATIONS AT THE FEMP**

Symbol	Name	Slopes (%)	Drainage Classification
DaB	Dana silt loam	2-6	Moderately well drained
EcE2	Eden silty clay loam	15-25	Well drained
EcF2	Eden silty clay loam	25-50	Well drained
FcA and FdA	Fincastle silt loam	0-2	Somewhat poorly drained
FeA	Fincastle-Urban land complex	0-2	Somewhat poorly drained
FoA	Fox loam	0-2	Well drained
Gn	Genesee loam	0-2	Well drained
HeF	Hennepin silt loam	35-60	Well drained
HoA	Henshaw silt loam	0-2	Somewhat poorly drained
MaB	Markland silty clay loam	2-6	Moderately well drained
MaC2	Markland silty clay loam	6-12	Moderately well drained
McA	Martinsville silt loam	0-2	Well drained
MnC2	Miamian silt loam	8-15, eroded	Well drained
MoE2	Miamian-Hennepin silt loams	25-35, eroded	Well drained
MsC2	Miamiam-Russell silt loams	2-6	Well drained
MsD2	Miamiam-Russell silt loams	12-18, moderately eroded	Well drained
Ra	Ragsdale silty clay loam	level	Very poorly drained
RdA	Raub silt loam	0-2	Somewhat poorly drained
RvB	Russell-Miamian silt loams	2-6	Well drained
RwB2	Russell silt loam	3-8, eroded	Well drained
UnA	Uniontown silt loam	0-2	Well drained
UnB	Uniontown silt loam	2-6	Well drained
XeB	Xenia silt loam	2-6	Moderately well drained
XeB2	Xenia silt loam	2-6	Moderately well drained
XfA	Xenia silt loam	0-2	Moderately well drained
XfB2	Xenia silt loam	0-2, eroded	Moderately well drained

SOURCES: USDA (1980, 1982)

Three soil series at the FEMP, represented by four map units, are classified as somewhat poorly-drained soils. These series include the Fincastle Series described above, the Henshaw Series, and the Raub Series. Somewhat poorly-drained soils occupy approximately 364 acres (35 percent) at the FEMP, excluding the highly-developed portions of the Fincastle-Urban Land Complex. Henshaw soils are deep, nearly level, somewhat poorly-drained soils on flats and low stream terraces and in basins.

Permeability is moderately low, available water capacity is high, and runoff is slow. The seasonal high water table is usually within 2 feet of the ground surface between November and March. These soils exist along the western property line adjacent to Paddys Run Road and south of the former Production Area.

Raub soils are deep, nearly level, somewhat poorly drained, dark soils located on glacial till plains. These soils have slow permeation rates and high available water capacity. The seasonal high water table is between 1 and 3 feet during January through April. These soils are located on upland terraces in the southeast portion of the FEMP and immediately north of the former Production Area.

The remaining 10 soil series mapped within FEMP boundaries are moderately well-drained and well-drained upland soils. The Dana Series consists of deep, gently sloping, moderately well-drained soils on slopes or in gently sloping basins on till plains and moraines. This series has moderate permeability, and the available water capacity is high. The water table is usually perched at a depth of 3 to 6 feet between March and April. These soils occupy the upper third of the northern pine plantation.

The Eden Series is moderately deep, steep, well-drained soil on valley walls and hillsides. This series has a low permeability and the available water capacity is low. The water table is usually found at a depth greater than 6 feet. This series is located between the northern pine plantation and State Route 126.

Soils along Paddys Run are categorized as Fox-Genesee loams. Fox soils are deep, gently sloping, well-drained soils on slight rises and stream terraces. Erosion has removed the majority of the original surface layer, and permeability is moderate in the upper horizons and very rapid in the lower horizons. The seasonal high water table is normally more than 6 feet below the surface. A small

area of Fox soils exists along the southern property line of the FEMP on the upland terrace immediately east of Paddys Run. Genesee soils are deep, nearly level, well-drained soils located on terraces adjacent to floodplains. The areas that they occupy are subject to occasional brief flooding. The permeability is moderate, and the available water capacity is very high. Normally, the seasonal high water table is deeper than 6 feet below the surface. These soils are associated with the steep banks of Paddys Run, on either of the Genesee soils. Hennepin soils also occur in association with Miamian soils along the Storm Sewer Outfall Ditch.

The Markland series consists of deep, gently sloping, moderately well-drained soils, permeability of this soil is low, the available water capacity is moderate, and the runoff hazard is medium. The seasonal high water table is usually perched between 3 and 6 feet below the surface from March to April. These soils are located adjacent to the Hennepin soils, just outside the woodlands bordering Paddys Run, the Storm Sewer Outfall Ditch, and other drainings on the property.

Martinsville soils are deep, nearly level, well-drained soils on stream terraces and outwash plains. The permeability is moderate, the available water capacity is high, and the runoff hazard is low. The seasonal high water table is more than six feet below the surface. Martinsville soils are found on a level terrace in the southern end of the FEMP, adjacent to a tributary to Paddys Run.

Miamian soils are deep, steeply sloping, well-drained soils located on dissected plains. Erosion has removed portions of the original surface layer and the subsoil has been filled into the existing surface layer. Permeability is moderately low, and the available water capacity is moderate. The seasonal high water table is usually greater than six feet below the surface. Miamian soils exist along the northern property line of the FEMP and, associated with Hennepin soils, along the Storm Sewer Outfall Ditch and one of its tributary drainages running from Willey Road to the northwest. Russell silt loams are gently sloping, deep, well-drained soils on slight rises and knolls of till plains. Russell soils have moderate permeability in the lower horizons, and surface runoff is medium. The seasonal high water table is perched and commonly found between 3 to 6 feet below the surface from March to April. Russell soils are mapped east of the former Production Area.

Uniontown soils are deep, gently sloping, well-drained soils formed in deposits on stream terraces. These soils have moderate permeability with a very high available water capacity. The seasonal high

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water table is between 2.5 and 6 feet below the surface from November to May. Uniontown soils are mapped in the northwest corner of the FEMP on a terrace above Paddys Run.

Neither the former Production Area or Waste Storage Area have undisturbed soils. In almost every area, natural soil profiles were destroyed or modified during construction and regrading. These soils are described as Fincastle Urban Land Complex.

3.1.5 Population and Land Use

This section provides a summary of population data from the FEMP regional area and information regarding land use for the FEMP Study Area. Additionally, a summary of available archaeological and historical resource data is presented for the FEMP Study Area.

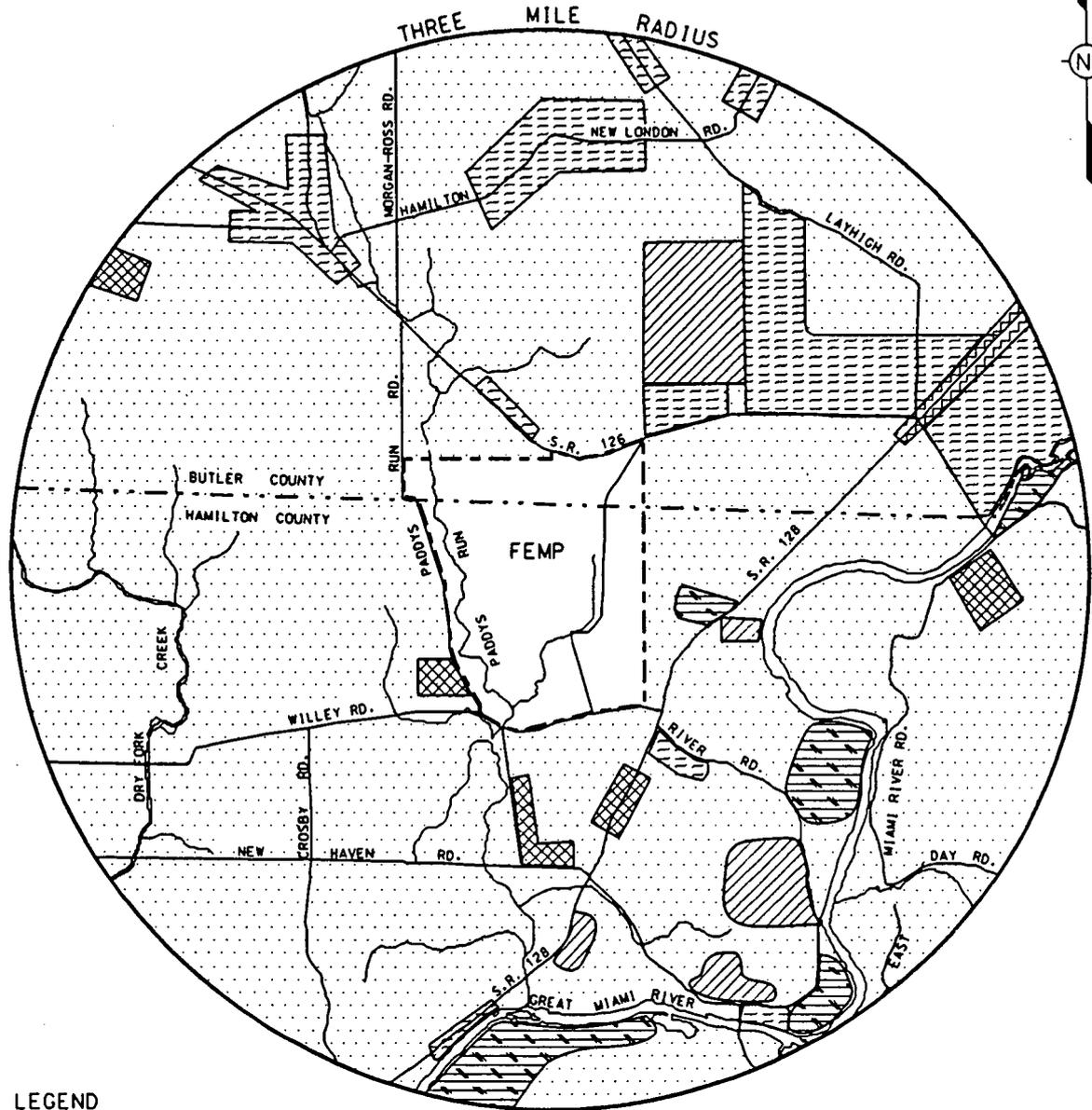
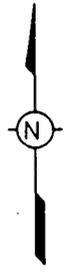
The FEMP is located approximately 29 km (17 mi) northwest of Cincinnati, the focal point of a regional market encompassing thirteen counties in Ohio, Kentucky, and Indiana. Referred to as the Consolidated Metropolitan Statistical Area (CMSA), the 13 county region consists of: Brown, Butler, Clermont, Hamilton, and Warren counties in Ohio; Boone, Campbell, Gallatin, Grant, Kenton, and Pendleton counties in Kentucky; and Dearborn and Ohio counties in Indiana. Population within the thirteen counties was 1.8 million in 1991, and within the 8 km (5 mi) radius of the FEMP site there were an estimated 22,927 residents in 1990 (SWCR 1993). Population density throughout the CMSA varies from 796 residents/km<sup>2</sup> (2062 residents/mi<sup>2</sup>) in Hamilton County to 17 residents/km<sup>2</sup> (44 residents/mi<sup>2</sup>) in Pendleton County. Excluding the heavily urbanized area in Hamilton County (Cincinnati), the average population density in the thirteen county region is 108 residents/km<sup>2</sup> (278 residents/mi<sup>2</sup>). Population density within the 8 km (5 mi) radius of the site is 352 residents/km<sup>2</sup> (917 residents/mi<sup>2</sup>). The labor force in the multicounty area was 951,987 with unemployment at approximately 8.7 percent in March 1992.

There are no residential structures within the FEMP boundaries. The 2000 on-property worker population includes employees of the DOE, the prime contractor, and other subcontractors. Most of the 2000 employees reside on site approximately 8 hours per day, 5 days per week. Only a fraction of those reside on site throughout the evening and night shifts.

The land adjacent to the FEMP is primarily devoted to open land use such as agriculture and recreation (Figure 3-22). Commercial activity is generally restricted to the village of Venice (Ross),

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LEGEND

- - - - COUNTY LINE
- - - - FEMP PROPERTY BOUNDARY

	RESIDENTIAL		MINING
	INDUSTRIAL		MIXED USE
	RECREATION		AGRICULTURE/OPEN LAND

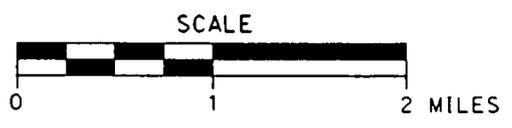


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FIGURE 3-22  
LAND USE ADJACENT TO THE FEMP

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approximately 4.8 km (3 mi) northeast of the facility, and along State Route (SR) 128 between Willey Road and New Haven Road. Residential units are situated immediately north of the FEMP, in Ross, and directly east in a trailer park adjacent to the intersection of Willey Road and SR 128. Other residents located around the site are generally associated with farmsteads. Several of these farmsteads are located off Paddys Run Road, approximately one-half mile south of the FEMP property boundary. These residents are in the vicinity of the South Plume, a portion of the Great Miami Aquifer that contains a plume of uranium contamination extending south of the FEMP property, approximately three-quarters of a mile. There are no areas within the FEMP site boundaries considered to be Prime Farmlands under the Farmland Protection Act of 1981 (7 CFR 658). Pine plantations are located to the northeast and southwest of the former Production Area. Approximately 172 hectare (425 acres) of the open land on the FEMP are leased to a nearby dairy farmer who grazes livestock on the property. Because the area had been intensively used for agriculture purposes prior to the establishment of the FEMP site, there is no land on or in the vicinity of the FEMP site where a predevelopment natural environment remains intact. The land closest to the description is the recreated prairie lands on the Miami Whitewater Forest property, located several miles south of the FEMP site.

Current subpopulations of potential concern within five miles of the FEMP are identified below and listed by the categories suggested by the EPA (1989a). The information presented on sensitive subpopulations includes an area extending between three and four miles beyond the leading edge of the South Plume. Population descriptions within this area are based on 1990 census data.

- Schools: No schools are located within one mile of the FEMP. The Northwest, Ross, and Southwest school districts provide public education from kindergarten through high school for children living within five miles of the FEMP. The 1989-90 total enrollment is 3,316 in the six schools from these districts.
- Daycare Centers: No daycare facilities are located within one mile of the FEMP. Two daycare centers operate within the FEMP Study Area: (1) Ross County Day Nursery, with an average enrollment of 126 students per day and a total weekly enrollment of 180, is located north of the intersection of State Route 128 (SR 128) and US 27 about two and a half miles northeast of the center of the FEMP; (2) Venice Presbyterian Preschool, with an average daily enrollment of 30 and a total weekly enrollment of 110, is located in the village of Ross, approximately two miles northeast of the center of the FEMP.
- Hospitals, Nursing Homes, and Retirement Communities: No care facilities of these types operate within five miles of the FEMP.

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- Residential Areas - In 1990, approximately 87 residents, occupying 30 homesteads, resided within a 1.6 km (1 mi.) radius around the FEMP site. Most of the residents are scattered within the five-mile radius reflecting the agricultural history of the area. Population concentrations include Ross, Harrison, Shandon, New Haven, New Baltimore, and one large trailer park near the FEMP.
- Commercial and Recreational Fisheries: No commercial fisheries operate within one mile of the center of the FEMP. Recreational fishing occurs on Whitewash Lake of the Miami Whitewater Forest. This heavily stocked lake lies completely within five miles of the FEMP. The Great Miami River supports no commercial fisheries in the vicinity of the FEMP, and a recreational fishing advisory for PCBs in bottom-feeding fish was issued in 1989, based on data collected by OEPA.

The source(s) of these PCBs in the Great Miami River are unknown. Records indicate that PCB usage at the FEMP was limited to Aroclor 1254 (used as hydraulic fluid), electric capacitors, transformers, and fluorescent light ballasts. PCBs may have been introduced into the Great Miami River by leakage from the heavy equipment used in maintenance activities or by direct deposit into the waste pits without proper documentation; however, no records have been located which describe how the PCB oils from any source(s) were deposited prior to this time.

- Major Industries Using Chemicals: No industrial facilities are located within one mile of the center of the FEMP. Two companies located within two miles of the FEMP store and handle chemicals: Ruetgers-Nease Chemical Company and Albright & Wilson, Co. These facilities, collectively known as the Paddys Run Road Site, are classified as CERCLA sites, listed on the Comprehensive Environmental Response, Compensation, and Liability Information System (CERCLIS), and are undergoing a state-led RI/FS. Proctor & Gamble has a research facility approximately two miles from the FEMP that is listed on CERCLIS and has undergone a Screening Site Inspection by EPA. Employees at these facilities are considered a sensitive subpopulation only if they reside within five miles of the FEMP.

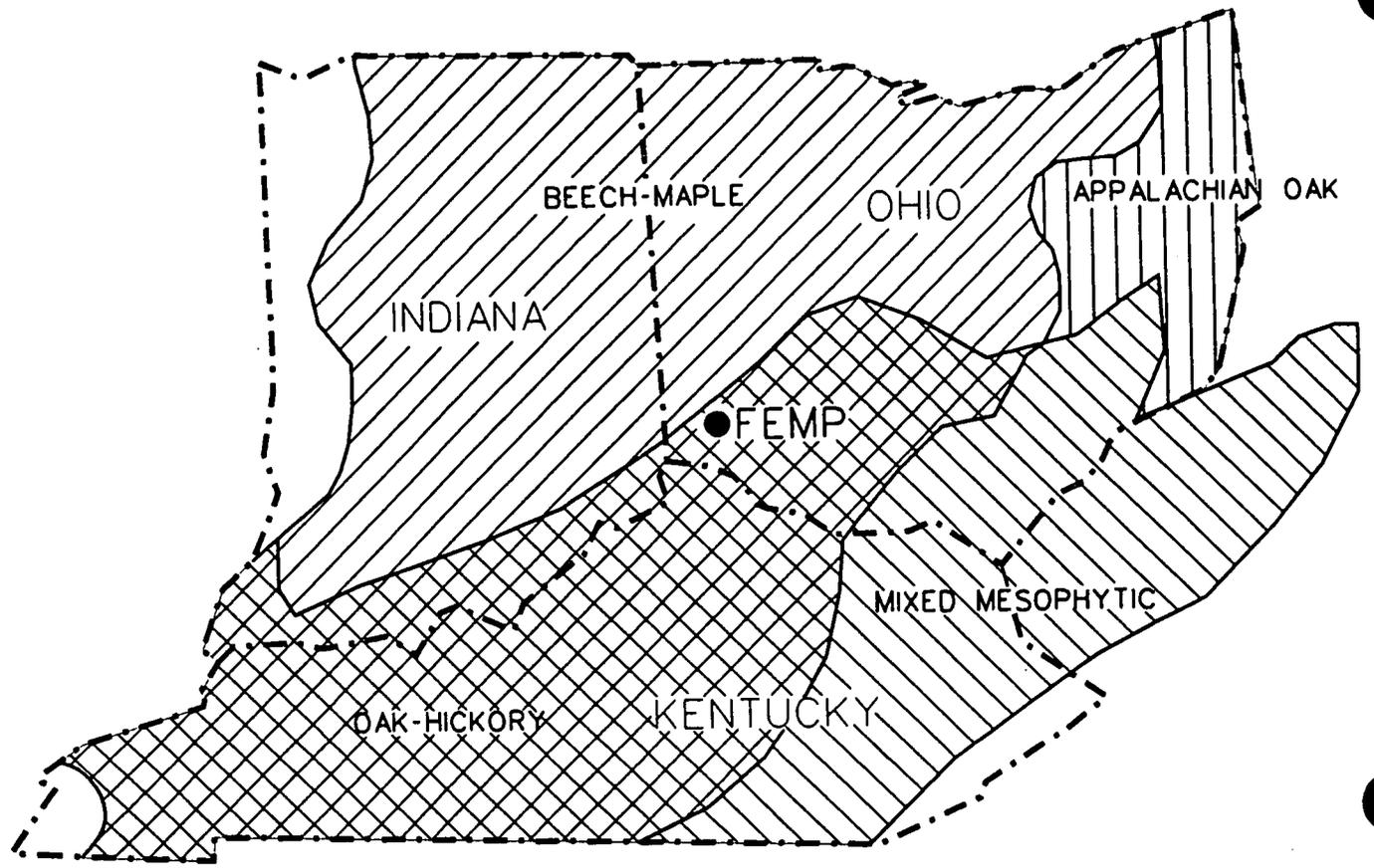
The area surrounding the FEMP has a large and diverse archaeological and historical resource base. According to records kept by the Miami Purchase Association for Historic Preservation, an unusually high percentage of the existing 19th century buildings in the area are historically important. Within the vicinity of the FEMP (a two-mile radius from the boundary), there are three properties listed in the National Register of Historic Places (NRHP) and a number of additional structures that have been judged eligible for inclusion in the listing. Six major archaeological sites lie within five miles of the FEMP; five of these are included in the NRHP.

3.1.6 Ecology 5890

The FEMP and surrounding areas lie in a transition zone between two distinct sections of the Eastern Deciduous Forest Province as described by Bailey (1978): the Oak-Hickory and the Beech-Maple (Figure 3-23). The region is characterized by the presence of a mosaic of these forest types. The

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LEGEND	
---	STATE LINE
—	PROVINCE BOUNDARY



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FIGURE 3-23  
SECTIONS OF THE EASTERN DECIDUOUS FOREST PROVINCE  
IN THE REGION OF THE FEMP

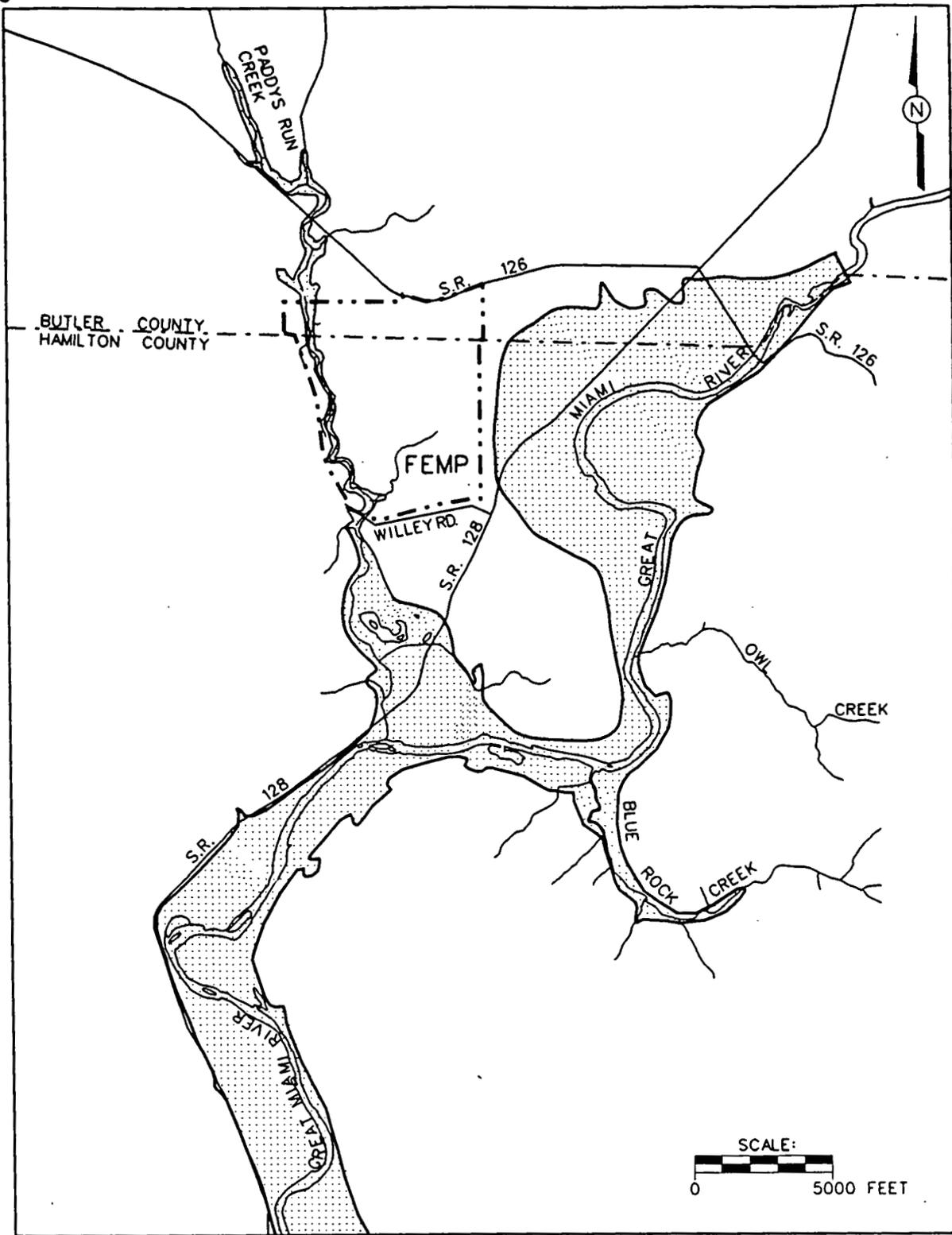
Oak-Hickory and Beech-Maple forest sections share many characteristics, including similar fauna and the presence of white oak as a common species. The Beech-Maple section covers northern Ohio, Indiana, and lower Michigan. It is bordered by Oak-Hickory to the southwest, Mixed Mesophytic to the southeast, and Appalachian Oak to the east. Beech-Maple forests are typically dominated by beech trees in the canopy, the uppermost layer of the forest, with sugar maples dominant in the understory, below the canopy. The Oak-Hickory section covers southwest Ohio, western Kentucky and Tennessee, and parts of Indiana, Illinois, Missouri, and Arkansas. The dominant species are oaks, with an abundance of hickories. The fauna vary little between the two forest sections and include white-tailed deer, gray fox, gray squirrel, white-footed mouse, and short-tailed shrew; the cardinal, woodthrush, summer tanager, red-eyed vireo, and the hooded warbler; and the box turtle, common garter snake, and timber rattlesnake (Bailey 1978; Shelford 1963).

Floodplains within the FEMP property are related to the north-south corridor containing Paddys Run (Figure 3-24). Within the limits of the FEMP, the 100-year floodplain for Paddys Run has been defined in a study by Parsons (1993). The 100-year flood affects the western-most portion of Operable Unit 2. In the vicinity of the Inactive Flyash Pile and South Field, the 100-year flood plain is predicted to range between 544 and 546 feet MSL. At that elevation, the flood waters will cover the lower portions of the western slope of the Inactive Flyash Pile and just reach the toe of the slope along the southwestern boundary of the South Field. Outside the boundaries of the FEMP, the 100-year floodplain of the Great Miami River extends west of Big Bend, nearly to the eastern boundary of the facility. The 100-year floodplain of the river also extends northward along Paddys Run from the confluence of the two streams to a point about 600 feet from the southern boundary of the FEMP. This area overlaps the South Plume, a zone of uranium-contaminated groundwater that is a component of Operable Unit 5.

A site-wide wetlands delineation was conducted in February 1993, in accordance with the 1987 Army Corps of Engineers Wetlands Delineation Manual and in compliance with 10 CFR 1022 [the month of February was determined to be acceptable based on coordination efforts with the Army Corps of Engineers (COE)]. The purpose of the delineation was to determine the extent of jurisdictional wetlands and waters of the United States and to avoid or minimize impacts to these resources during future activities at the FEMP. A jurisdictional determination has been requested from the COE to verify the wetland boundaries and waters of the United States. Results from the site-wide delineation indicate a total of 35.9 acres of wetlands on the FEMP site. Delineated wetlands included 26.58

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- LEGEND:**
-  FEMP PROPERTY BOUNDARY
  -  COUNTY LINE
  -  100-YEAR FLOODPLAIN

**NOTE:**  
1. SOURCE - THE RALPH M. PARSONS CO. 1993

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**FIGURE 3-24**  
**GREAT MIAMI RIVER AND PADDY'S RUN CREEK**  
**100-YEAR FLOODPLAIN**

fig0325.dgn

acres of palustrine forested wetlands, 6.95 acres of drainage ditches/swales, and 2.37 acres of isolated emergent and emergent-scrub/shrub wetlands. Figure 3-25 shows the results of the site-wide wetlands delineation including wetland areas in close proximity to the Solid Waste Landfill subunit of Operable Unit 2.

The largest of the four palustrine forested wetland areas is located north of the former Production Area. The remaining three areas are located: (1) along the east bank of Paddys Run near the northern site border, (2) in the northeast corner of the site, and (3) southwest of the K-65 silos. Drainage ditches and swales constituting wetlands are located in four sections throughout the site: (1) north of the former Production Area traversing west into Paddys Run, (2) drainage of the Waste Pit Area, (3) drainage of the area south of the K-65 silos, and (4) adjacent to the eastern boundary of the former Production Area, draining higher elevations of the site to the east.

Two of the four isolated scrub/shrub and/or emergent wetlands are located in the northern part of the FEMP: one near the eastern corner and the other just east of Paddys Run near the western corner of the FEMP. The remaining two are located in the vicinity of the Waste Pit Area, one to the east, and one to the west. On-site waters of the site are confined to Paddys Run and its unnamed tributary and total approximately 8.9 acres.

Ecological communities on the FEMP consist of grazed and ungrazed pastures, two pine plantations, deciduous woodlands, riparian woodlands, and the "reclaimed flyash pile area" (Figure 3-26). The reclaimed flyash area coincides approximately with the South Field and the Inactive Flyash Pile, and was considered a distinct habitat by Facemire et al. (1990) due to the unique plant and animal species composition. A total of 47 species of trees and shrubs, 190 species of herbaceous plants, 20 mammal species, 98 bird species, 10 species of amphibians and reptiles, 21 species of fish, 47 families of benthic macroinvertebrates, and 132 families of terrestrial invertebrates inhabit the FEMP.

Typical grasses found on the Fernald site are red fescue, Kentucky bluegrass, timothy, and red top. Herbs include teasel, red and white clovers, and goldenrod. The dominant tree species in the pine plantations are white and Austrian pine, with Norway spruce occurring occasionally. Common trees in the deciduous woodlands are white ash, American elm, shagbark hickory, and slippery elm. Dominant tree species in the riparian woodlands are eastern cottonwood, hackberry, American elm, and box elder. The reclaimed flyash pile is dominated by American elm, eastern cottonwood, and black locust.

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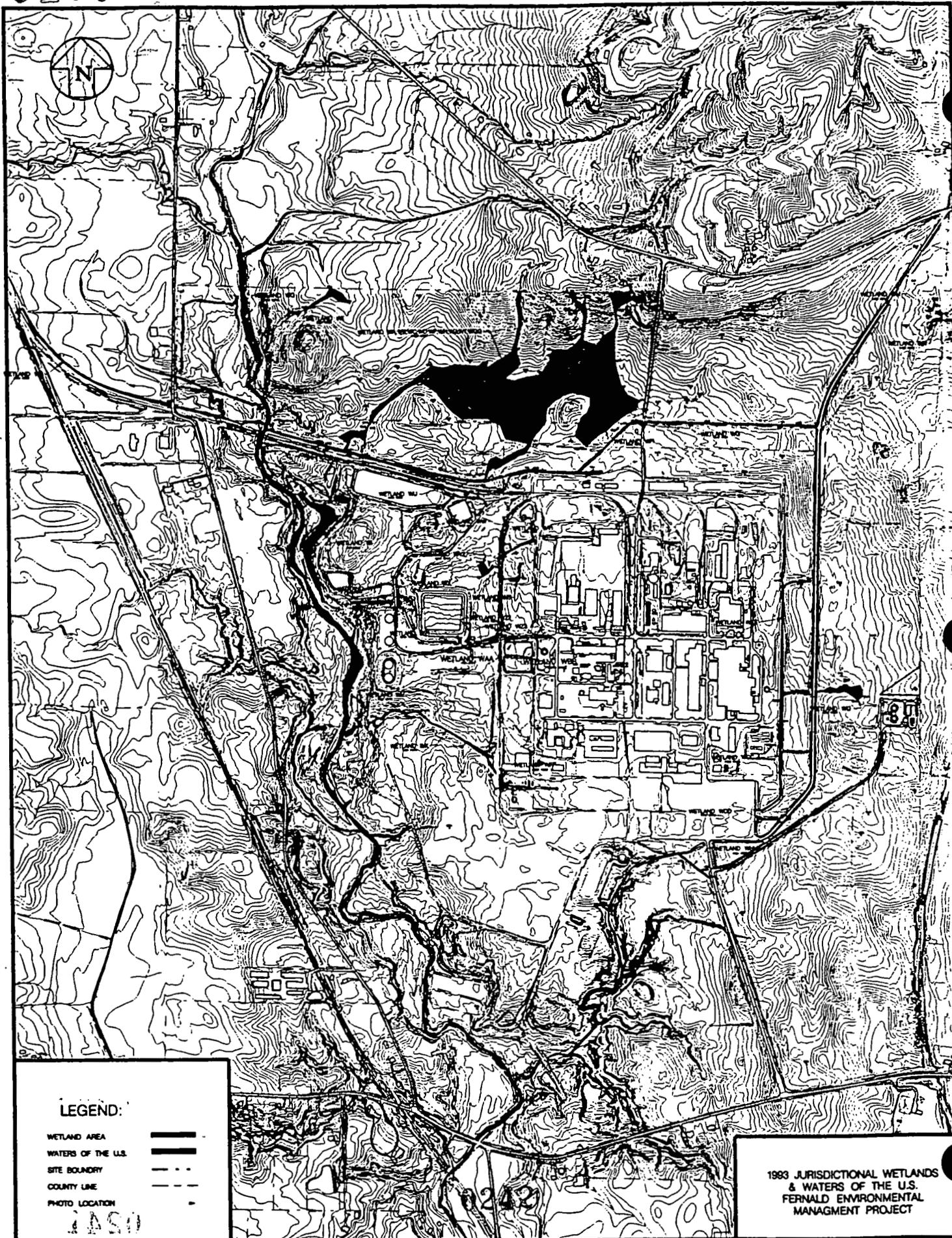
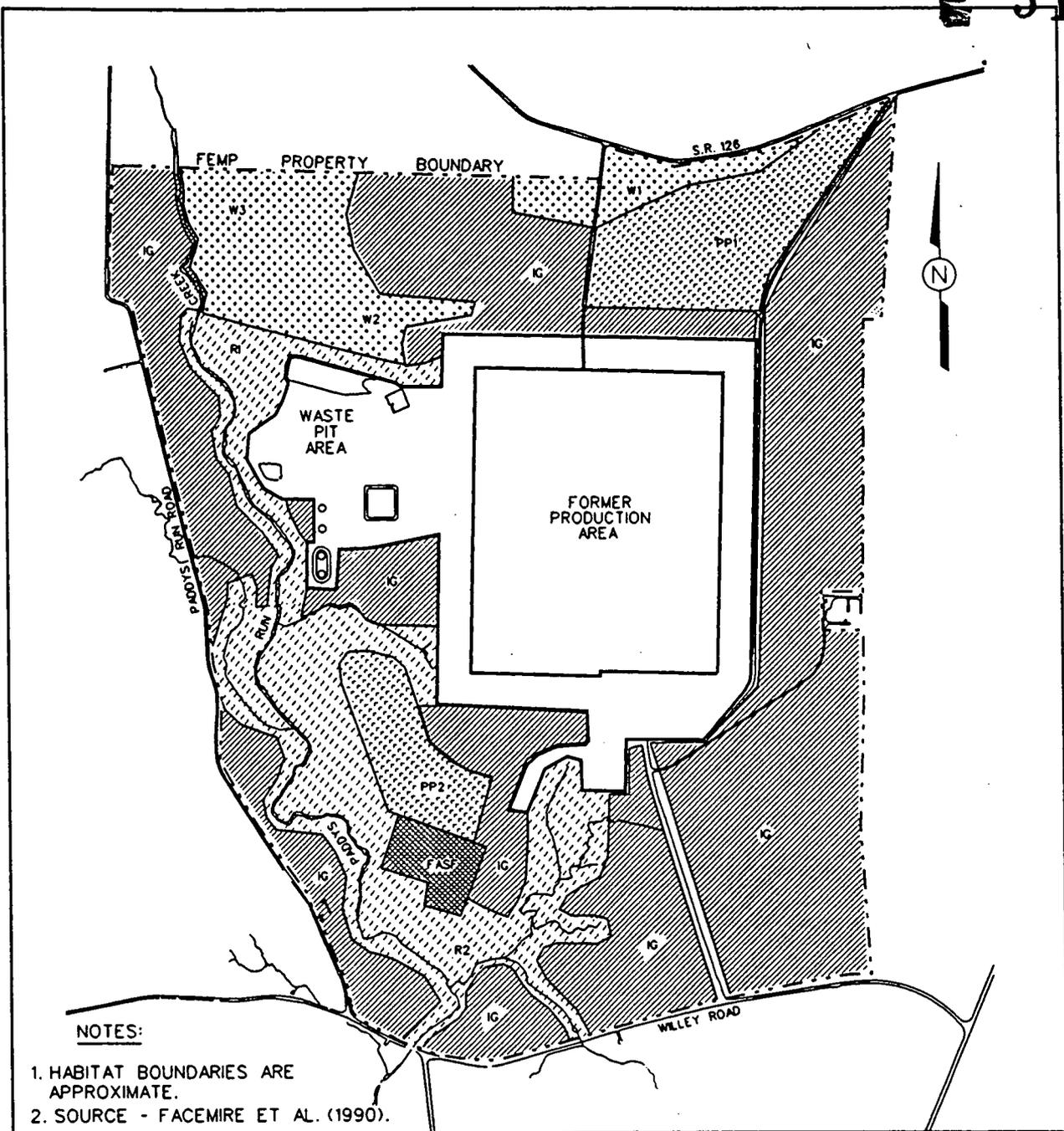


FIGURE 3-25 JURISDICTIONAL WETLANDS AT THE FEMP SITE

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NOTES:

- 1. HABITAT BOUNDARIES ARE APPROXIMATE.
- 2. SOURCE - FACEMIRE ET AL. (1990).

**LEGEND:**

	FEMP PROPERTY BOUNDARY
	INTRODUCED GRASSLAND (IG)
	FLYASH/SOUTH FIELD (FASF)
	PLANTED PINE PP1 PP2
	WOODLANDS W1 - INTERMEDIATE W2 - YOUNG W3 - MATURE
	RIPARIAN R1 R2
	DISTURBED



FIGURE 3-26  
HABITAT TYPES  
PRESENT ON THE FEMP

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Mammal species observed on the FEMP include white-tailed deer, coyote, red fox, opossum, raccoon, groundhog, eastern cottontail, fox squirrel, and several species of bats. Common small mammals are the white-footed mouse, short-tailed shrew, meadow vole, meadow jumping mouse, and eastern chipmunk.

The most common birds breeding on site include the mourning dove, American robin, blue jay, American crow, American goldfinch, northern bobwhite, and common grackle. Species occurring in the greatest density are the goldfinch, song sparrow, and robin. Raptor species observed on site are the northern harrier, red-shouldered hawk, Cooper's hawk, red-tailed hawk, and American kestrel. The eastern screech owl and great horned owl have been observed in the vicinity of the FEMP.

Amphibians and reptiles that occur on the FEMP include the American toad, spring peeper, eastern box turtle, and snapping turtle. Several species of snakes also occur on site, including the eastern garter snake, Butler's garter snake, black rat snake, northern water snake, and the queen snake. Approximately 130 insect families from 15 orders are represented in FEMP habitats. Leaf hoppers are abundant in all habitats, while less abundant groups include short-horned grasshoppers, leaf beetles, springtails, fruit flies, dark-winged fungus gnats, ants, bees, and wasps.

A baseline ecological risk assessment was performed as part of the Site-Wide Characterization Report (DOE 1993) to estimate potential, present, and future baseline risks that FEMP contaminants may present to ecological receptors. This risk assessment was based on data available as of December 1991. Ecological receptors considered included all organisms, exclusive of humans and domestic animals. Pursuant to the Amended Consent Agreement, an ecological risk assessment for FEMP will be completed as part of the Operable Unit 5 RI/FS process.

To comply with Section 7(a)(2) of the Endangered Species Act (ESA) of 1973, as amended, that requires federal agencies, "in consultation with and with the assistance of [the Secretaries of the Interior and Commerce, to ensure that their actions are] not likely to jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of the critical habitat of such species....," Miami University performed an Ecological Characterization Study of the FEMP in 1989. The following discussion concerning threatened and endangered species with potential habitats in the vicinity of the FEMP were drawn from conclusions of the study and supplemental investigations conducted as part of the Operable Unit 4 RI.

Indiana Bat (*Myotis sodalis*)

The Indiana bat is listed as both a federal and state endangered species and occurs in Butler and Hamilton counties. Surveys were conducted at the FEMP to determine the distribution and presence of the Indiana bat and to identify potential habitat on the FEMP and in the immediate vicinity. The Indiana bat has not been identified at the FEMP; however, during the summer of 1988, a population was identified approximately 5 km (3 miles) east of the FEMP (DOE 1993). Potential habitat for the Indiana bat occurs in portions of the riparian woodland associated with Paddys Run. Figure 3-27 classifies the habitat locations from excellent to poor. Very little habitat was considered excellent due to a general lack of dead trees suitable for colonies. Habitat along the banks of Paddys Run was somewhat better than habitat along the banks of Great Miami River. Within the FEMP, the majority of good habitat was located in the northern portion of the site. There were some questions over the accuracy of the methodology used in these surveys. Therefore, a follow-up survey will be performed in the summer of 1994, and updated information will be provided in future RI/FS documents.

Running buffalo clover (*Trifolium stoloniferum*)

Known populations exist at Miami Whitewater Forest, approximately 2.5 km southwest of the property. The FEMP has areas of similar habitat where this species might occur. In 1992, a limited survey of habitats suitable for this species failed to find any populations on property. A comprehensive survey for this species will be conducted in early summer 1994.

Cave Salamander (*Eurycea lucifuga*)

After an initial survey by ASI in 1988 (DOE 1993), a follow-up was completed in October 1993 (Davis 1994). Preliminary results show suitable habitat was found in a ravine in the north woodlot, as well as in a limestone-lined well at an old homestead, east of the east access road (Figure 3-28). It also appears that salamanders may utilize another well south of the FEMP property. However, because of severe drought conditions in the summer and fall of 1993, the survey only found two individuals (at the Girl Scout control site). It may be necessary to perform a brief survey in the spring 1994 to verify these assumptions.

Other Species

The northern water thrush (*Seiurus noveboracensis*), a state listed endangered species, was reported as a spring migrant along Paddys Run during the spring of 1987 by Facemire et al. (1990).

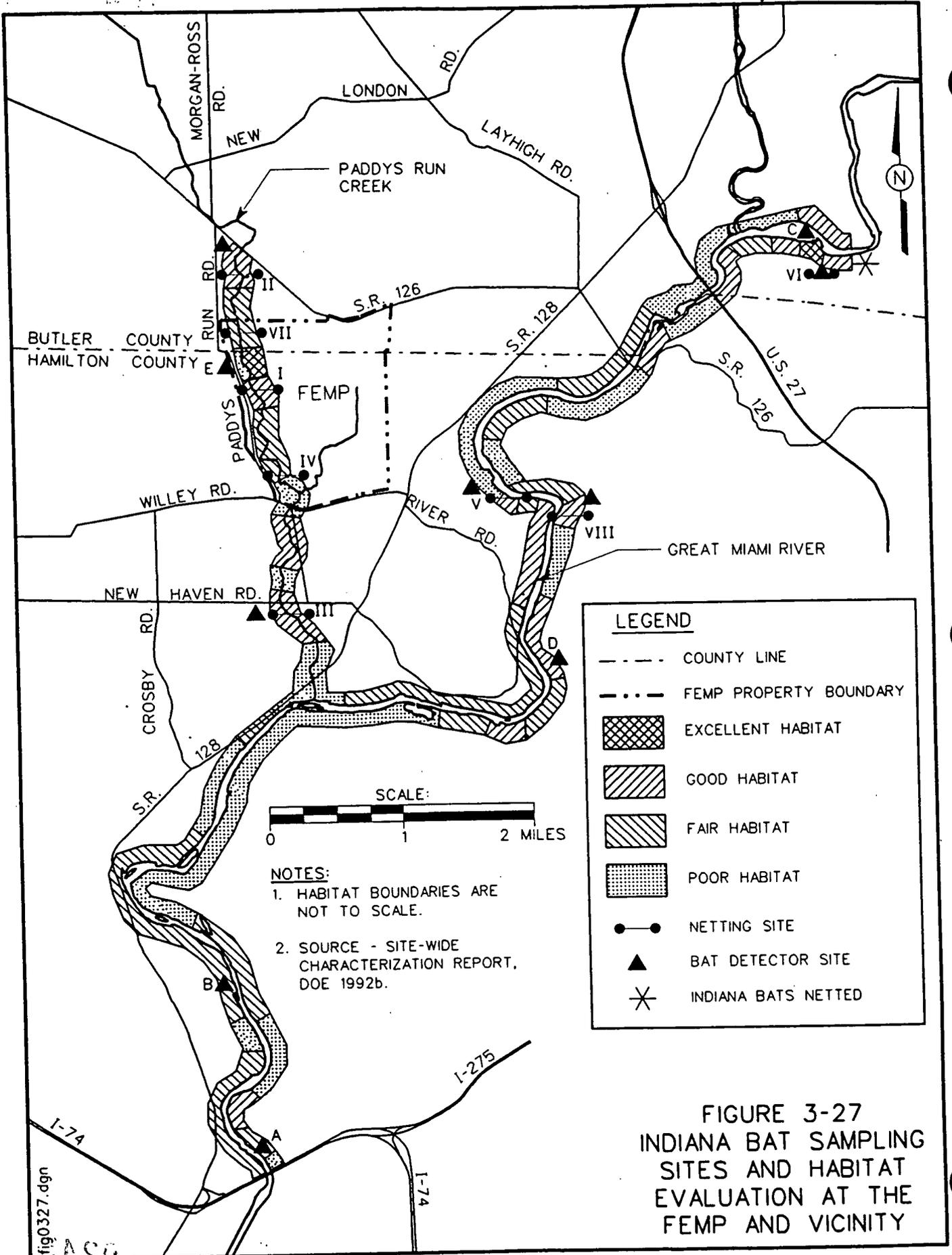


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**LEGEND:**

**POTENTIAL HABITAT**

- ▲ ADULT CAVE SALAMANDERS ARE NORMALLY FOUND IN LIMESTONE SEEPS, WELLS, SPRINGHOUSES, AND UNDER ROCKS IN SPRING-FED STREAMS.

**KNOWN HABITAT**

- ADULT CAVE SALAMANDERS HAVE BEEN OBSERVED IN THESE AREAS.

SCALE



FIGURE 3-28. KNOWN AND POTENTIAL HABITATS OF CAVE SALAMANDERS

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February 18, 1994

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The northern harrier (*Circus Canesus*), a state listed endangered species, and the red-shouldered hawk (*Buteo lineatus*), a state listed threatened species, were observed flying over the FEMP by Facemire et al. (1990) on two separate occasions. Neither species has been reported to nest at the FEMP. The dark-eyed junco (*Junco ayemalis*), a state listed endangered species, was observed throughout the FEMP during the winter of 1986 and 1987 by Facemire et al. (1990).

Slender fingergrass (*Digitaria filiformis*) was listed in Facemire et al. (1990) as rare in the riparian area along Paddys Run. A survey will be conducted in the summer of 1994 to verify the presence of this species on the FEMP property. The mountain bindweed (*Polygonum cilinode*) also listed in the Facemire study, is reported by the Ohio Department of Natural Resources (ODNR) that the only other population have been reported from three counties near Lake Erie (ODNR 1992). A survey to verify this information will be conducted in the summer of 1994.

Spring coralroot (*Corallorhiza wisteriana*) is found locally at Miami Whitewater Forest in swampy woods. Although it was not found during the Facemire survey, northern areas of the FEMP appear to be appropriate habitat for this species. a survey will be conducted in the early spring of 1994.

Sloan's crayfish (*Orconectes sloanii*), also known as the Cincinnati crayfish, is a state listed threatened species reported from Paddys Run by Facemire et al. (1990). This crayfish is found in streams of Ohio and Indiana. One individual of this genus, not identified to species, was recorded in Paddys Run during RI/FS sampling (DOE 1993). A survey was completed in October 1993 (St. John 1993). Despite the fact that Paddys run was completely dry for most of the section on FEMP property, this species resided in pools in the north section of the property and downstream off property. It is uncertain if the population is large enough to repopulate the entire stream when water flows. An additional abbreviated survey may be performed in the spring of 1994 to define this species' range within Paddys Run during regular water flow.

The cobblestone tiger beetle (*Cicendela margipennis*), which is under review by the U.S. Fish and Wildlife Service for possible consideration as a threatened or endangered species, was found on a gravel bar in the Great Miami River two miles west southwest of the bridge at New Baltimore, Ohio. It is listed as a federal category two species, as well as a special interest species for the state of Ohio. Category two species are considered appropriate for federal listing as threatened or endangered;

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however, this data is insufficient to support their protection under the Endangered Species Act. Additional field investigations will be done in 1994 to verify the status and distribution of this species.

### 3.2 SOLID WASTE LANDFILL CHARACTERISTICS

The Solid Waste Landfill occupies an approximate area of 1.5 acres and is located northwest of the former Production Area near the center of the FEMP property. The present elevation of land surface ranges from 585 to 590 feet MSL, which is about 5 to 10 feet above the 1950 surveyed elevation for the area. This suggests that there are at least 5 to 10 feet of fill in the landfill. The Solid Waste Landfill was capped with soil and currently has a grassy vegetation cover. A detailed assessment of topography, surface water, geology, and hydrogeology was performed around this unit to define specific pathways and potential impacts from the Solid Waste Landfill to the environment.

#### 3.2.1 Topography and Surface Water

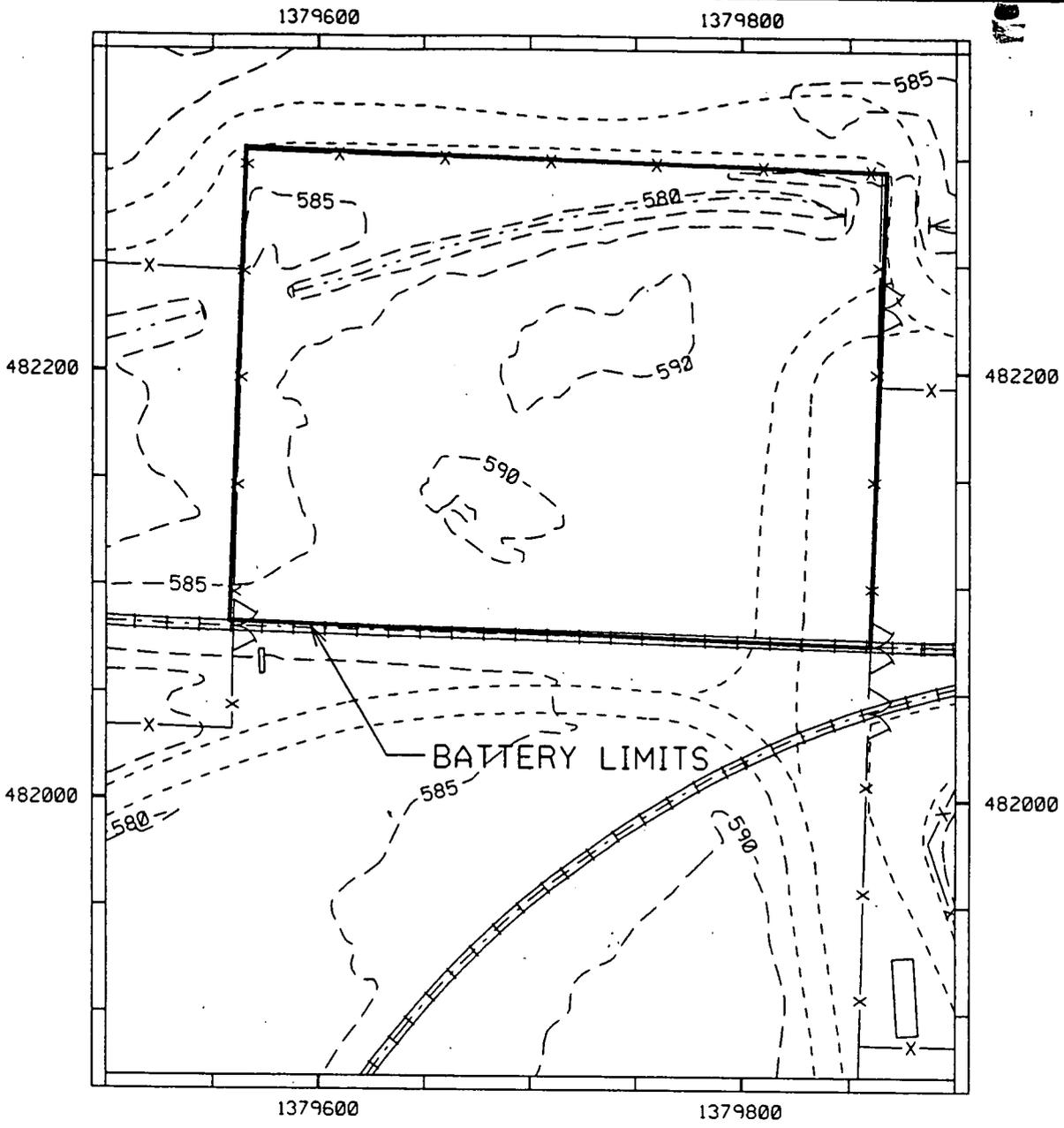
Surface drainage at the Solid Waste Landfill has been controlled by grading the area toward a drainage channel that flows westward along the northern portion of the landfill (Figure 3-29). The drainage channel discharges into Paddys Run. A drainage pond, seen in aerial photographs from 1973 to 1986, was located along the western boundary of the landfill and was apparently designed to receive storm water runoff from the landfill. The pond contents would then evaporate, percolate into the soil, or overflow via a spillway into the drainage channel. A railroad bed to the south of the landfill serves as a berm to divert any surface water runoff from the landfill into the aforementioned drainage channel. Surface drainage south of the railroad bed and outside the landfill limits has been altered by recontouring the area to allow westwardly flow toward Paddys Run.

The highest point in the landfill, with an elevation of 593 feet above MSL, is situated in its north central portion (Figure 3-29). The landfill's lowest point, excluding the drainage channel, is approximately 584.5 feet above MSL and is located at the culvert crossing near the northwest boundary of the landfill. The access road on the east side of the landfill is at an elevation of approximately 590 feet above MSL. Surface water drainage off of the site was observed to be inefficient, with ponding of water visible on the surface after rain events. Percolation is also slow since the ponded water was observed for up to several weeks after rain events.

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**LEGEND**

- 575- ELEVATION CONTOURS
- - - ROADS
- ..... DRAINAGE
- x-x- FENCE
- x-x- RAILROAD

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

SCALE (FT)

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FIGURE 3-29  
TOPOGRAPHY OF THE SOLID WASTE LANDFILL

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3.2.2 Geology and Groundwater Hydrology

Soil samples from subsurface borings were examined to define the lithology of the subsurface strata. Groundwater monitoring wells were installed to determine concentrations of various chemical constituents in groundwater and to determine groundwater elevations. Based on the lithologic descriptions presented in the boring logs (Appendix C), a general description of the strata below the landfill was determined.

Two geological cross sections are presented for the Solid Waste Landfill. The geologic cross sections represent the interpreted geology along the actual cross-section traces shown on the map insets. These sections do not represent straight-line correlations from boring to boring; rather, they were derived from a three-dimensional aerial model based on all soil borings and prepared using Intergraph Corporation Microsoft PC Software. Figure 3-30 shows the location of cross sections. The Solid Waste Landfill study area consists of approximately 40 feet of glacial overburden overlying the Great Miami Aquifer. The glacial overburden consists of interbedded layers of hard and stiff clay and silt with varying amounts of sand and gravel. At several locations, vertical fractures with iron staining were also noted. The clay and silt appear as yellowish-brown layers that grade downward into a stiff gray clay. This color transition is thought to be a function of the weathering, which has oxidized the upper layers from a gray to a yellowish-brown color.

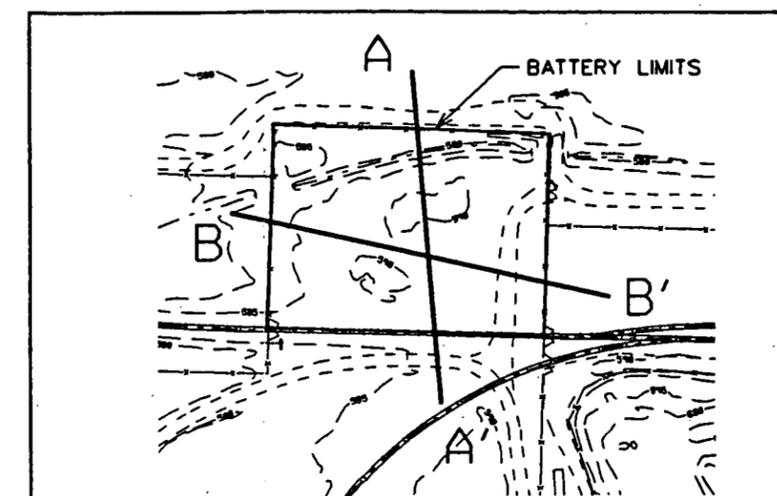
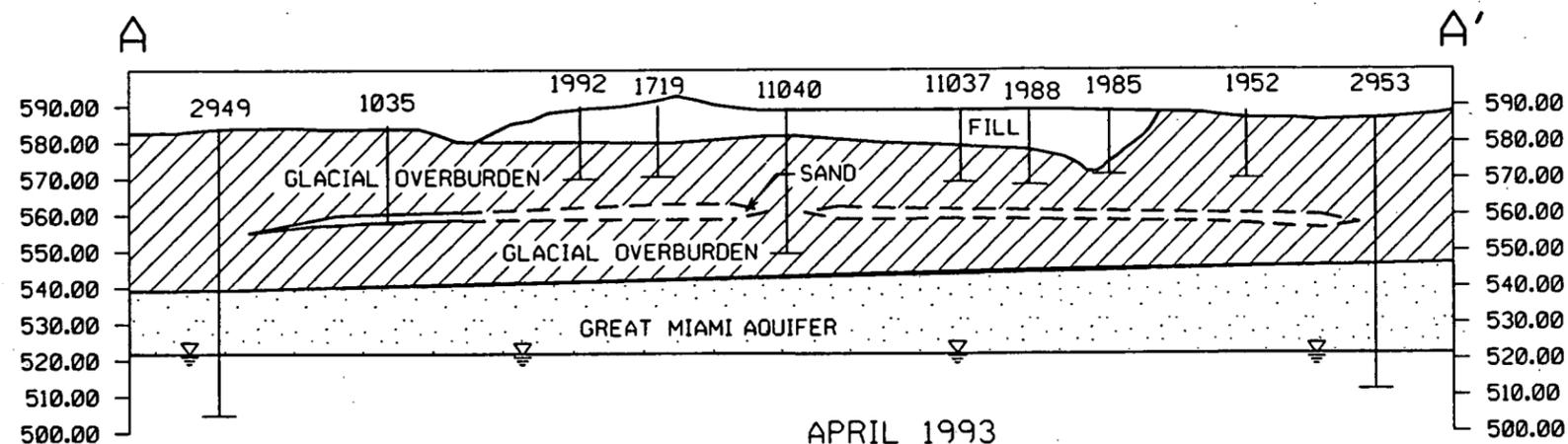
The gray clay layer beneath the oxidized layer varies in shading from olive-gray to dark gray and consists of a very soft to very dense hard clay with some sands and gravels. The thickness of this layer ranges from greater than 15.0 feet at Boring No. 1038 to 24 feet at Boring No. 3037. Within this gray clay layer, there appear to be discontinuous lenses of wet gray sand varying in thickness between 2.5 feet at Boring No. 2027 and 6 feet at Boring No. 1038. The sand lenses were not apparent in Boring No. 3037. This gray sand is described as a medium dense to very dense, well-graded sand of olive-gray to dark gray color with varying degrees of gravel.

A sand and gravel unit, approximately 90.0 feet thick at Boring No. 3037, underlies the gray clay layer. This unit, described in the boring logs as being very dense, dark, yellowish-brown sand and gravel layer, is the Upper Great Miami Aquifer. The Great Miami Aquifer is separated into the Upper and Lower Great Miami Aquifers by a blue clay aquitard (clay interbed). The deepest boring in the area, Boring No. 3037, terminated at a depth of approximately 135 feet in a dark gray clay, which is interpreted to be the blue clay aquitard.

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CROSS-SECTION LOCATION KEY (1"=200')

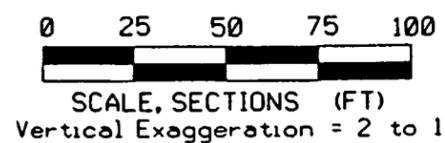
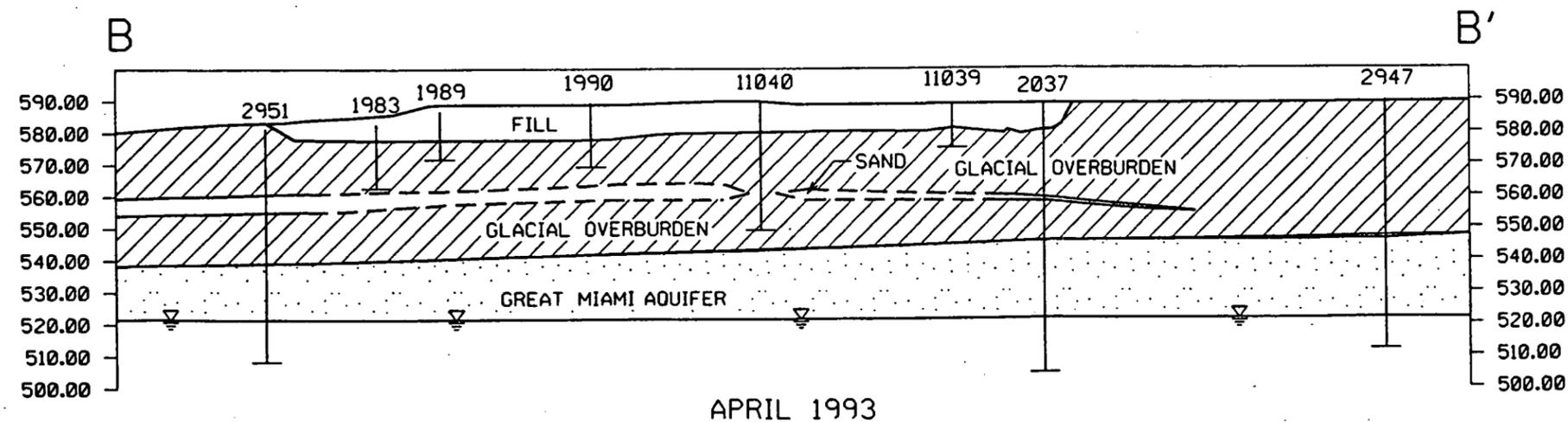
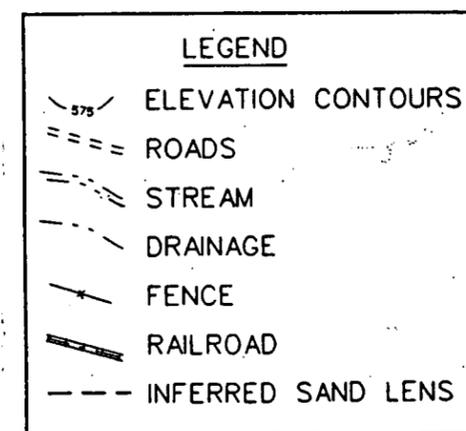


FIGURE 3-30  
GEOLOGIC CROSS-SECTIONS  
OF THE SOLID WASTE LANDFILL

Groundwater was encountered at shallow depths in two boreholes while drilling during April 1993, which was an unseasonably wet period. Otherwise, samples of till appeared to be unsaturated to dry during drilling with the exception of a thin (less than 1-inch thick) sand lens. However, all monitoring wells completed in the till eventually filled with groundwater. The groundwater elevation surface map for the glacial overburden is provided in Figure 3-31. Groundwater elevations within the glacial overburden ranged from approximately 550 to 580 feet above MSL, which is about 10 to 40 feet below land surface. Groundwater appears to flow toward the southwest, which parallels the trend in local topography, with an apparent discharge area in the vicinity of Paddys Run.

Hydrographs for the glacial overburden groundwater monitoring wells are presented in Figure 3-32 along with a rainfall histogram from March to September 1993. Groundwater elevation changes in the wells show poor correlation to rainfall events. This trend suggests that direct precipitation recharge at the Solid Waste Landfill is slow, which is consistent with the low permeability expected in the thick clay at the site. A summary of slug tests conducted in wells completed in the glacial overburden was shown on Table 3-2. Calculated hydraulic conductivities range from  $4.1 \times 10^{-6}$  cm/s to  $4.7 \times 10^{-3}$  cms (Appendix H). Soil samples of silty sand collected from the interval beneath the glacial till and above the Great Miami Aquifer water table were unsaturated. This fact suggests that the upper groundwater system and the Great Miami Aquifer are not in saturated hydraulic contact beneath the Solid Waste Landfill; therefore, the upper groundwater system is defined as a perched groundwater system.

Groundwater elevation data from 2000-series monitoring wells completed within the upper Great Miami Aquifer indicate that the regional aquifer is essentially flat beneath the Solid Waste Landfill, displaying an southeasterly potential flow direction with a gradient of 0.001 on June 21, 1993 (Figure 3-33). Groundwater elevations for monitoring wells screened within the aquifer are approximately 520 to 525 feet above MSL as shown on the hydrograph in Figure 3-34, which is about 60 feet below ground surface. Groundwater elevation hydrographs from the Great Miami Aquifer in Well No. 2037 (Figure 3-34) above and Well No. 3037 at the blue clay aquitard are approximately the same. This suggests that there is very little vertical gradient in this area, a condition that does not favor deep recharge to the Great Miami Aquifer.

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### 3.3 LIME SLUDGE PONDS CHARACTERISTICS

The Lime Sludge Ponds are located immediately west of the former Production Area. A north-south railway is located along the western boundary of this waste area (Figure 3-35). Access roads lie to the north and east of the waste area. A portion of the K-65 Slurry pipeline (part of Operable Unit 3) lies in a covered, concrete trench and forms the southern boundary.

The Lime Sludge Ponds were constructed at the beginning of the production activity, although the exact method of construction is not known.

The South Lime Sludge Pond has been inactive for approximately 25 years and is currently covered by grass and weeds. The North Lime Sludge Pond is still active and has only sparse vegetation on the lime sludge surface. A portion of the North Lime Sludge Pond contains standing water whose depth varies depending on site processes. The standing water ranges from three feet deep at the west edge to several inches deep approximately 20 feet to the east.

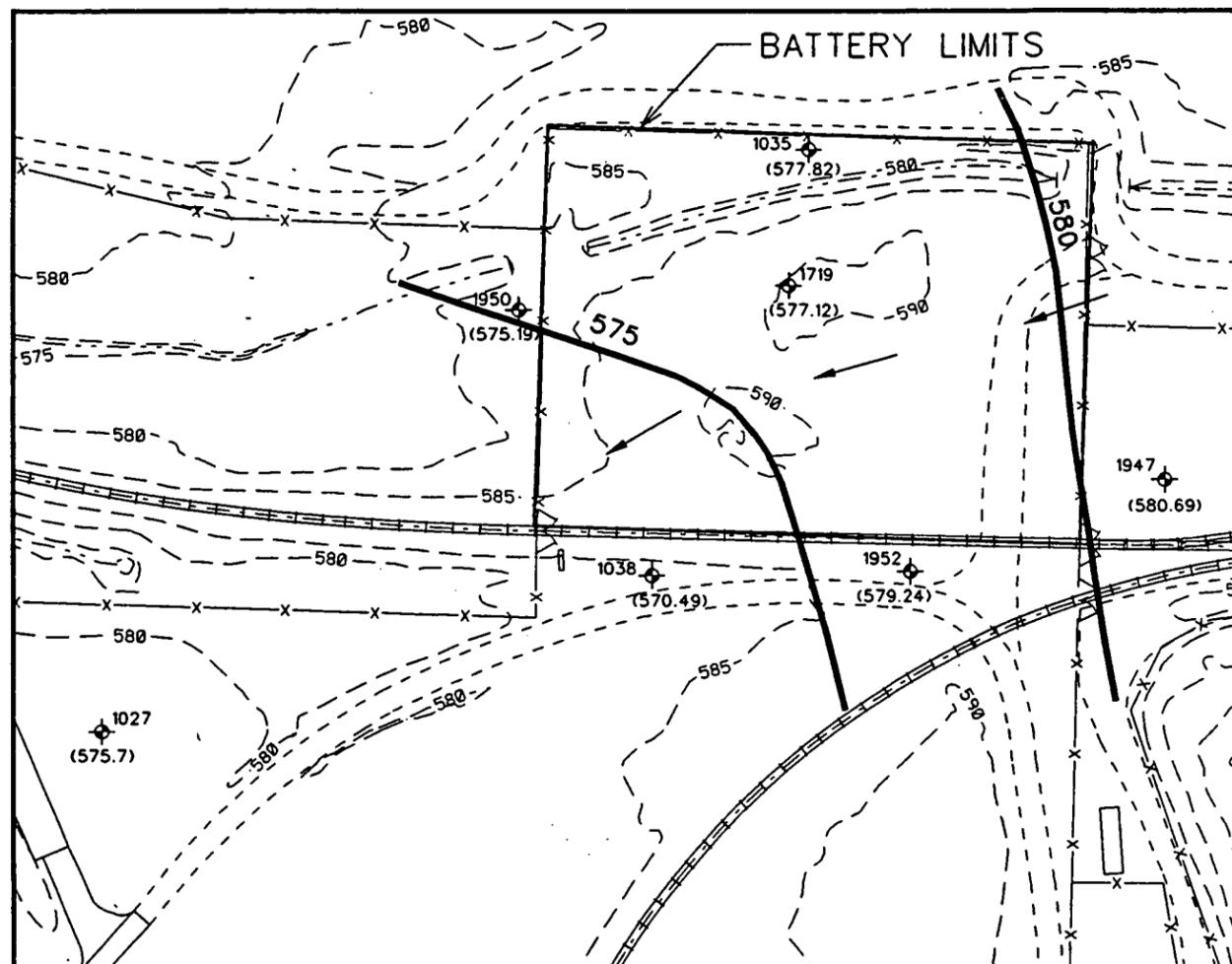
#### 3.3.1 Topography and Surface Water

Topography in the vicinity of the Lime Sludge Ponds slopes gently to the west. The topography was recontoured to the west of this waste area during construction of the ponds and again during recent alterations of the Waste Pit Area drainage. The ponds are bermed and unlined. A central east-west oriented berm is common to both ponds. The berms of the south pond exhibit elevations from a low of 580.6 feet above MSL to a high of 583.5 feet above MSL (the highest surveyed point within the Lime Sludge Ponds area). The maximum surveyed elevation of the north pond is located on the east berm and is 579.5 feet above MSL. This means that the surface of the south pond is approximately three feet higher than the north pond. Precipitation is intercepted by the Lime Sludge Ponds and retained within them due to the surrounding berms. Outside the berms, surface water to the east, north, and west collects in a drainage ditch on the north side of the North Lime Sludge Pond, drains toward the west, and eventually drains into the drainage ditch located south of the K-65 silos. The drainage discharges to Paddys Run. Surface water to the south generally flows to the southwest as sheet flow.

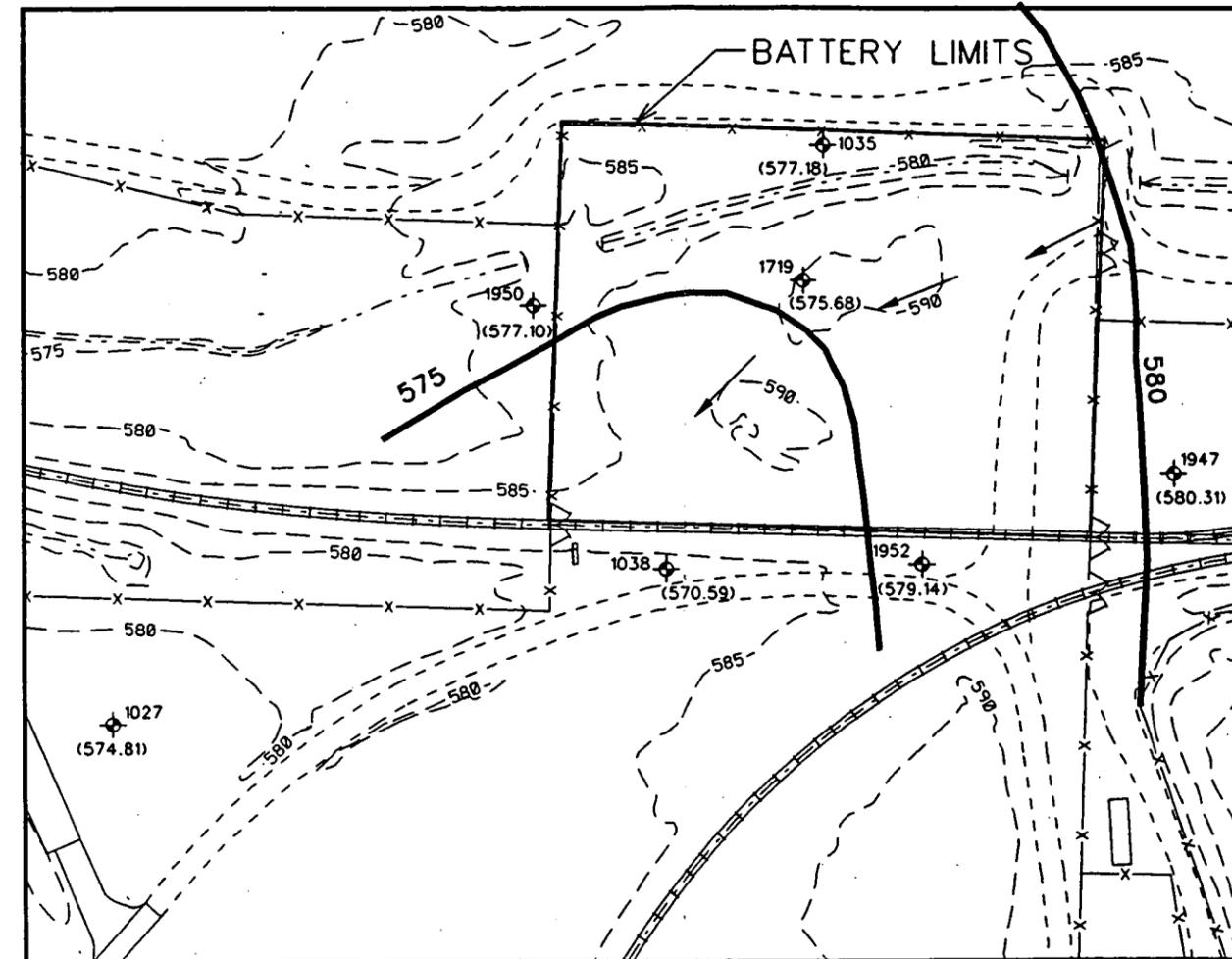
#### 3.3.2 Geology and Groundwater Hydrology

Soil samples from subsurface borings were examined to define the lithology of the subsurface strata. Groundwater monitoring wells were constructed to determine concentrations of various chemical

0254



JUNE 21, 1993



JULY 19, 1993

LEGEND

-  ELEVATION CONTOURS
-  ROADS
-  DRAINAGE
-  FENCE
-  RAILROAD
-  1000 MONITORING WELLS
-  (570.49) GROUNDWATER ELEVATIONS
-  GROUNDWATER CONTOURS
-  INFERRED DIRECTION OF PERCHED GROUNDWATER ZONE

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

SCALE (FT)

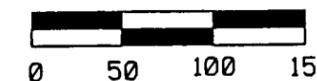
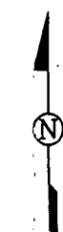
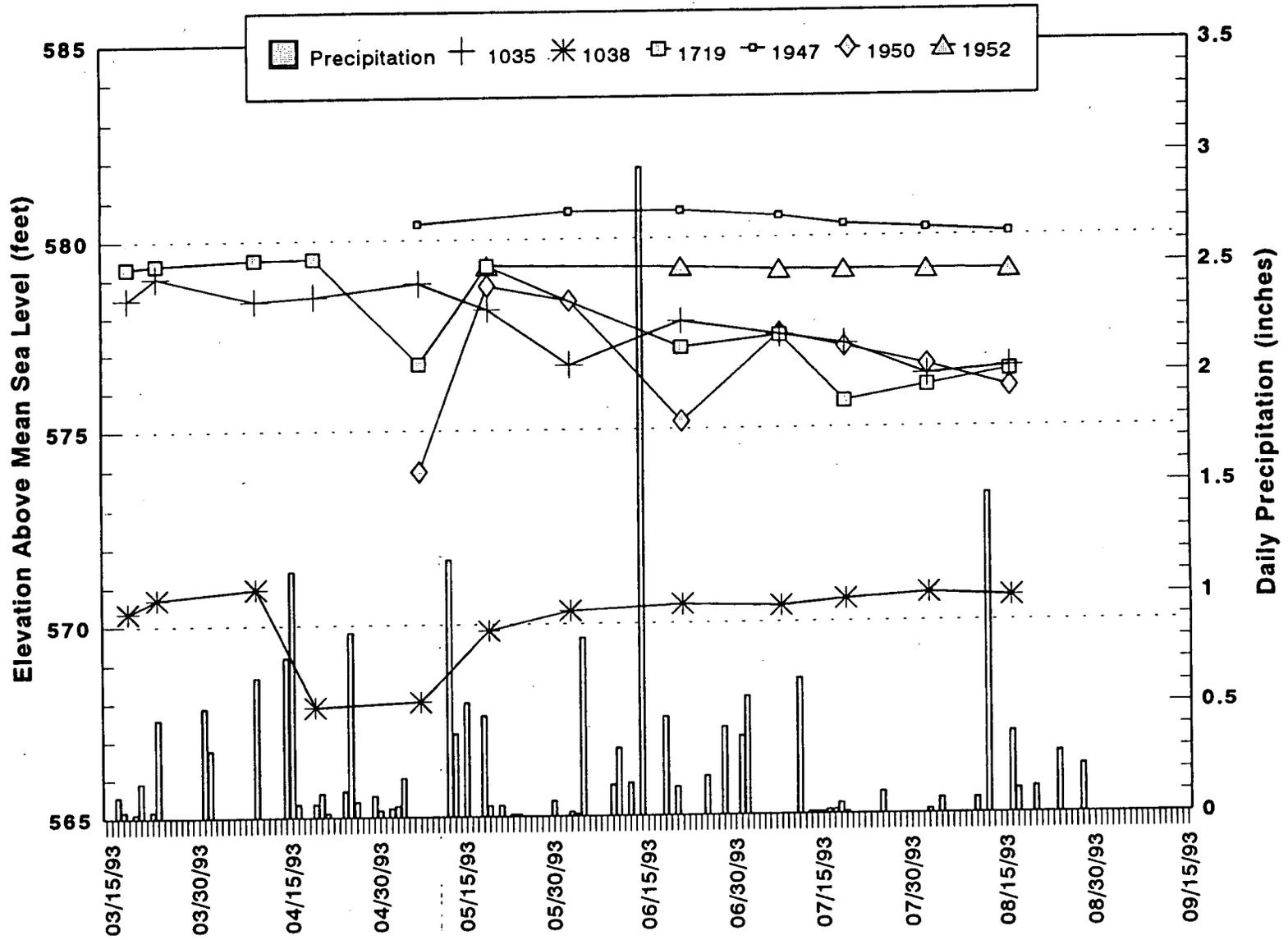


FIGURE 3-31  
GROUNDWATER ELEVATIONS  
FOR 1000-SERIES WELLS,  
SOLID WASTE LANDFILL,  
JUNE 21, 1993 AND  
JULY 19, 1993

0255

3-65

0256



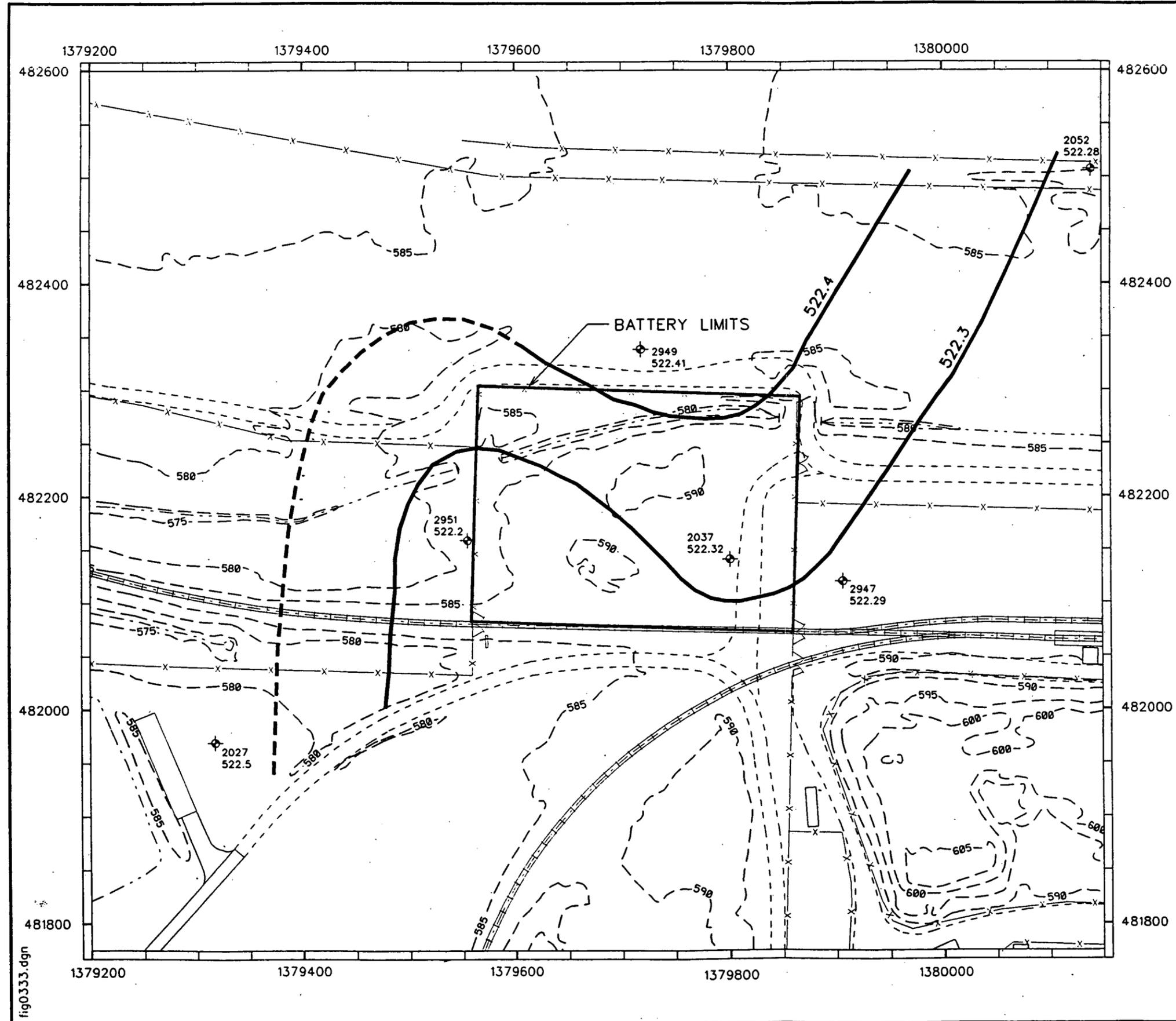
NOTE: SURFACE ELEVATIONS IN SOLID WASTE LANDFILL RANGE FROM APPROXIMATELY 593 TO 584.

PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

FIGURE 3-32  
HYDROGRAPHS FOR 1000-SERIES WELLS, SOLID WASTE LANDFILL

51701

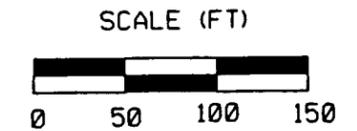
5170



**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- 2000 MONITORING WELLS
- GROUNDWATER ELEVATIONS
- GROUNDWATER CONTOURS

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



**FIGURE 3-33**  
**GROUNDWATER ELEVATIONS**  
**FOR 2000-SERIES WELLS,**  
**SOLID WASTE LANDFILL,**  
**JUNE 21, 1993**

fig0333.dgn

3-67

0258

0258

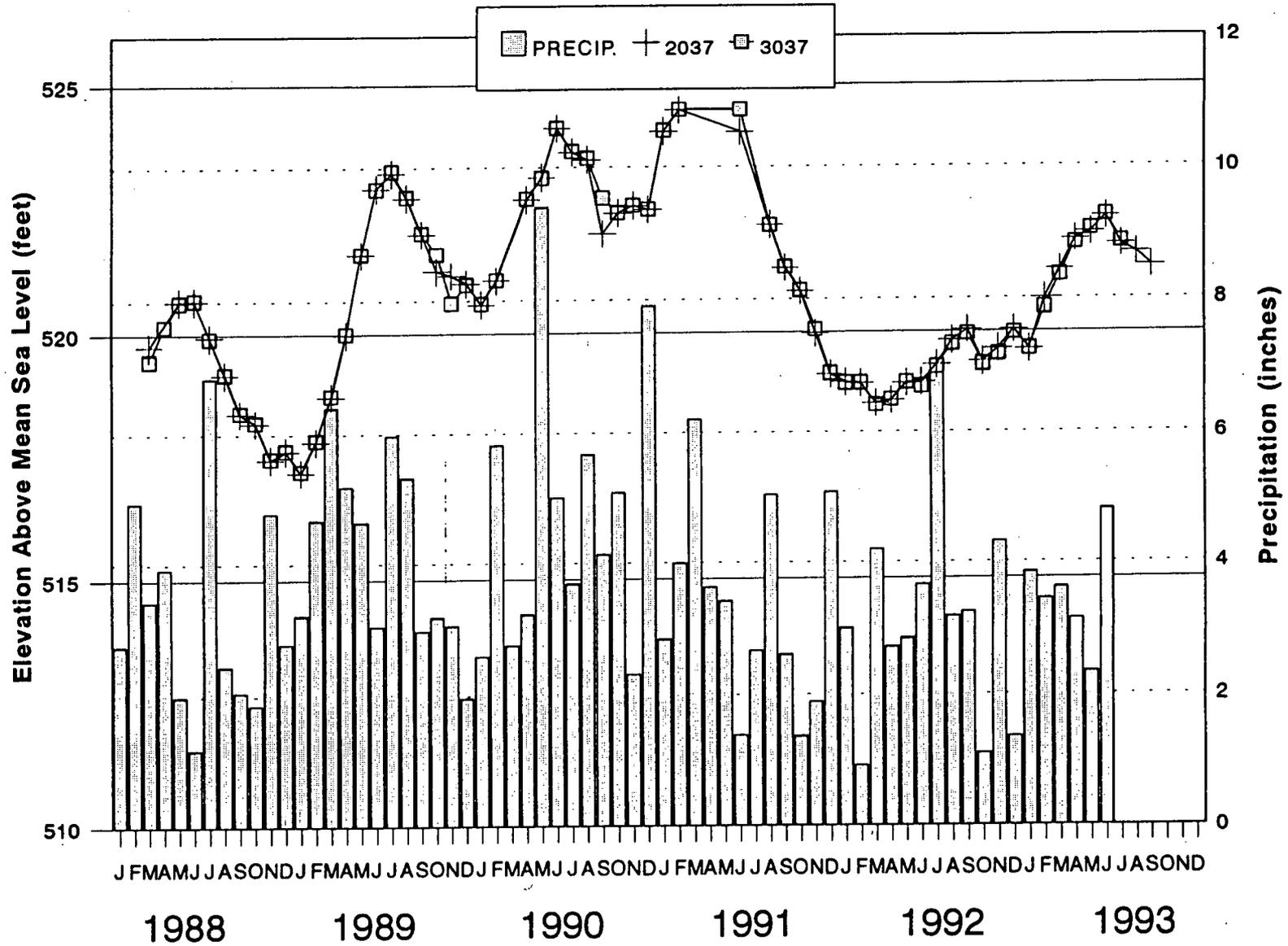
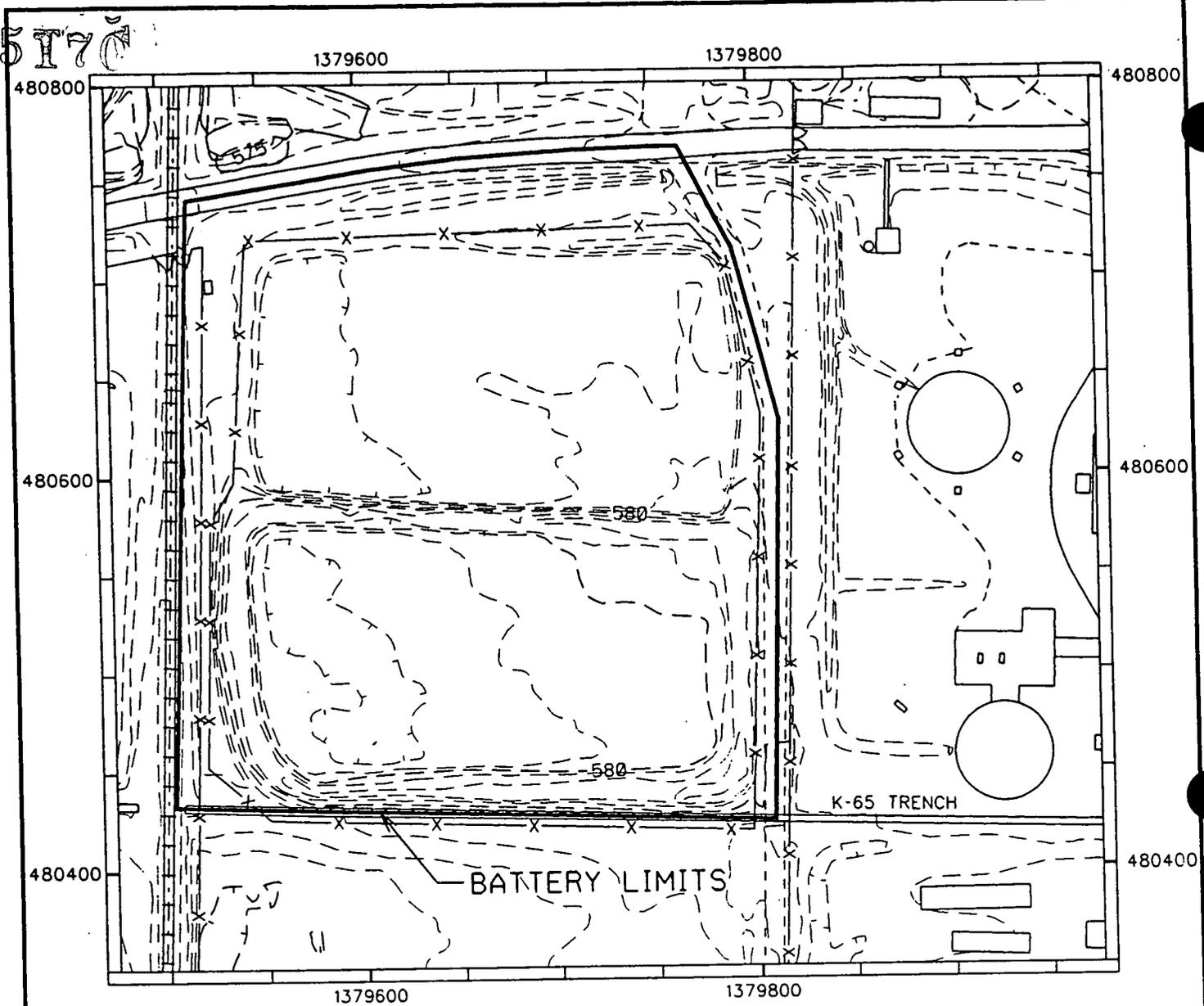


FIGURE 3-34

HYDROGRAPHS FOR MONITORING WELLS 2037 AND 3037, SOLID WASTE LANDFILL



**LEGEND**

- 575 — ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD



NOTE:  
Coordinates are in State  
Planar NAD 1927.  
Surface contours based on  
1992 flyover.

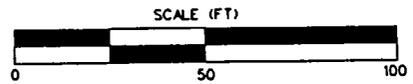


fig0334.dgn

FIGURE 3-35  
TOPOGRAPHY OF THE LIME SLUDGE PONDS

0259

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constituents in groundwater and to determine groundwater elevations. Based on the lithologic descriptions presented in the boring logs (Appendix D), a general description of the strata below the Lime Sludge Ponds was determined.

Fill material in the Lime Sludge Ponds consists of residue that has settled out of the sludge. The depth of this lime sludge residue, based on boring logs, was found to vary from 3.5 to 11.5 feet. Geological cross sections were prepared for the Lime Sludge Ponds (Figure 3-36). The geologic cross sections represent the interpreted geology along the actual cross-section traces shown on the map insets. These sections do not represent straight-line correlations from boring to boring; rather, they were derived from a three-dimensional aerial model based on all soil borings and prepared using Intergraph Corporation Microsoft PC Software. The Lime Sludge Ponds Study Area consists of a 30- to 40-foot thick layer of glacial overburden overlying the Great Miami Aquifer. The glacial overburden consists primarily of clay containing some sand and gravel. The clay appears as a stiff yellowish-brown clay that grades downward into a stiff gray clay, a transition thought to be a function of the weathering of the clay that is closer to the ground surface. The depth at which this transition occurs is approximately seven feet at Borings Nos. 1039 and 2042.

A lens of sand, detected in the glacial overburden at Borings Nos. 1039 and 2042, may extend continuously beneath the Lime Sludge Ponds. The sand lens occurs at a depth of 19 feet at Boring No. 1039 and at approximately 16.5 feet at Boring No. 2042. This zone is approximately five feet thick and appears to be continuous from northeast and southwest beneath the entire north pond and through the western portion of the south pond. The sand lens is approximately two feet below the deepest point of the Lime Sludge Ponds.

Groundwater elevations for wells completed in the glacial overburden in the Lime Sludge Ponds Study Area are shown in Figure 3-37. Groundwater in the perched system flowed toward the southwest in July and August 1993 and presumably discharged in the vicinity of Paddys Run. The gradient of the perched groundwater surface appeared to be consistent in July 8, 1993 (a gradient of 0.006) and August 16, 1993 (a gradient of 0.010).

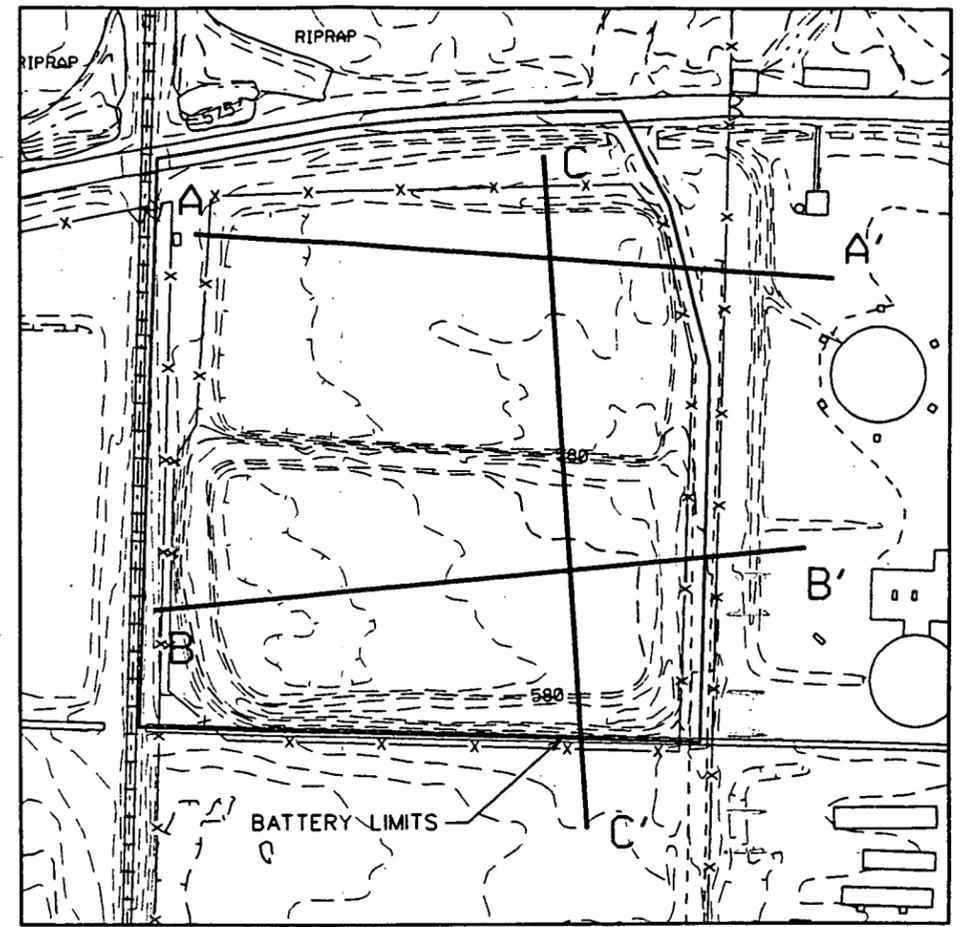
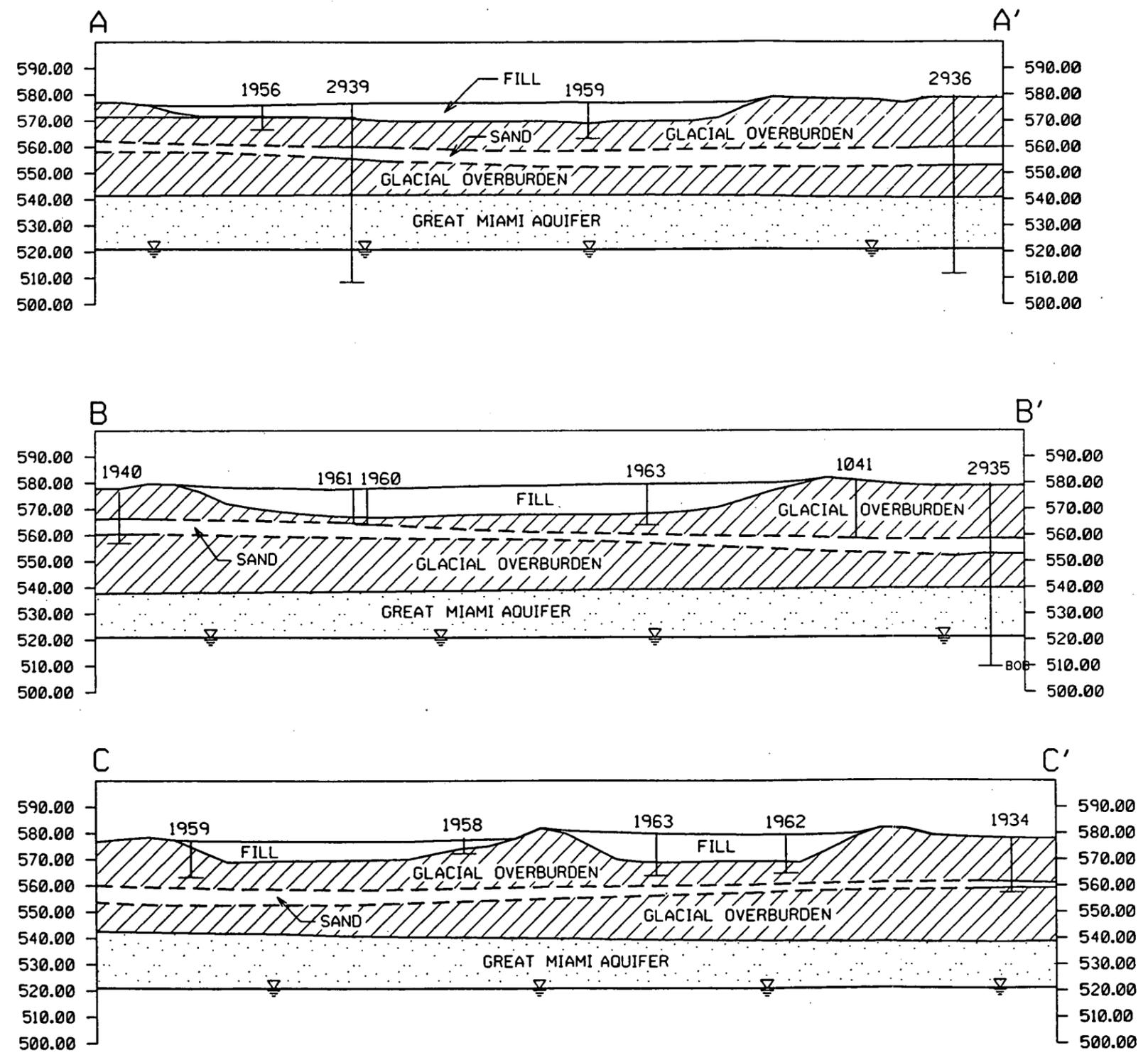
The potentiometric surface of the perched groundwater intersects the ponds, indicating possible hydraulic connection of the perched groundwater with the impounded materials. The south pond does not have a free water surface, even after heavy precipitation events. This indicates that water can

percolate vertically to drain the upper zone of the south pond and that the drainage may recharge the perched zone groundwater system. Groundwater in the glacial overburden is located approximately two to four feet below ground surface, and an annual fluctuation of about five feet between 1988 and 1993 has been observed, which is shown in Figure 3-38. Hydrograph measurements during 1993 in 1000-series wells, completed in the glacial overburden, are presented in Figure 3-39 and Figure 3-40. A comparison of precipitation and groundwater elevation data indicate that groundwater elevation in the vicinity of the sludge ponds responds rapidly to precipitation events, with the greatest response observed in the wells located closest to the ponds. For example, groundwater elevations increased over three feet in Well No. 1039, which is approximately 15 feet north the North Pond, in response to a rain event of 2.9 inches on June 15, 1993. In contrast, water levels in 1000-series wells (1210, 1229, and 1934) located further away from the ponds did not show an elevation response to the June 15, 1993 rain event (Figure 3-40). Well 1210 is approximately 100 feet east of the South Pond, 1229 is approximately 180 feet south of the South Pond, and 1934 is approximately 50 feet south of the South Pond.

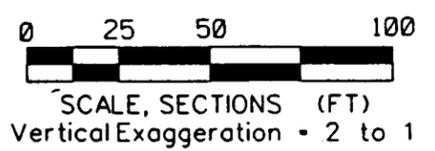
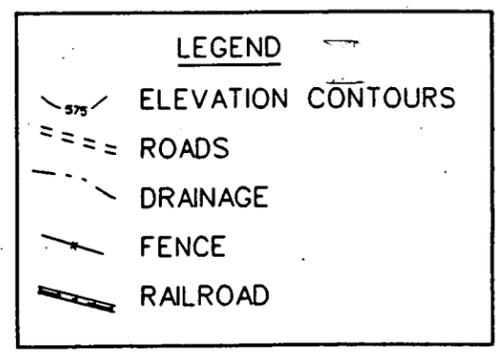
The Great Miami Aquifer, which consists of glacial outwash deposits containing sand and gravel, underlies the glacial overburden approximately 40 feet below the surface. The Great Miami Aquifer is divided into an upper and a lower unit; however, only the upper unit was penetrated by wells in the Lime Sludge Ponds Study Area. The deepest boring in the area, Boring No. 2042, terminated at a depth of 68.0 feet in the upper unit. In the vicinity of the Lime Sludge Ponds, shown in Figure 3-41, the groundwater elevation of the Great Miami Aquifer averages approximately 521 to 522 feet above MSL (about 60 feet below ground surface). The groundwater flow direction was to the southeast at a gradient of 0.0006 in August 1993.

#### 3.4 INACTIVE FLYASH PILE AND SOUTH FIELD

The Inactive Flyash Pile was constructed by dumping material off the previously existing steep embankment adjacent to Paddys Run. Additional dumping occurred along a haul road constructed along a south facing embankment; thus, the Inactive Flyash Pile also has a south facing slope. The Inactive Flyash Pile is bounded on the west by a drainage ditch and a portion of Paddys Run, on the north by an access road, on the east by a drainage ditch (which separates it from the South Field), and on the south by the running track/firing range facility (Figure 3-42). Once disposal activities were completed, portions of the southern part of the Inactive Flyash Pile were covered with soil/fill. A covering of trees and dense brush have grown over the Inactive Flyash Pile.

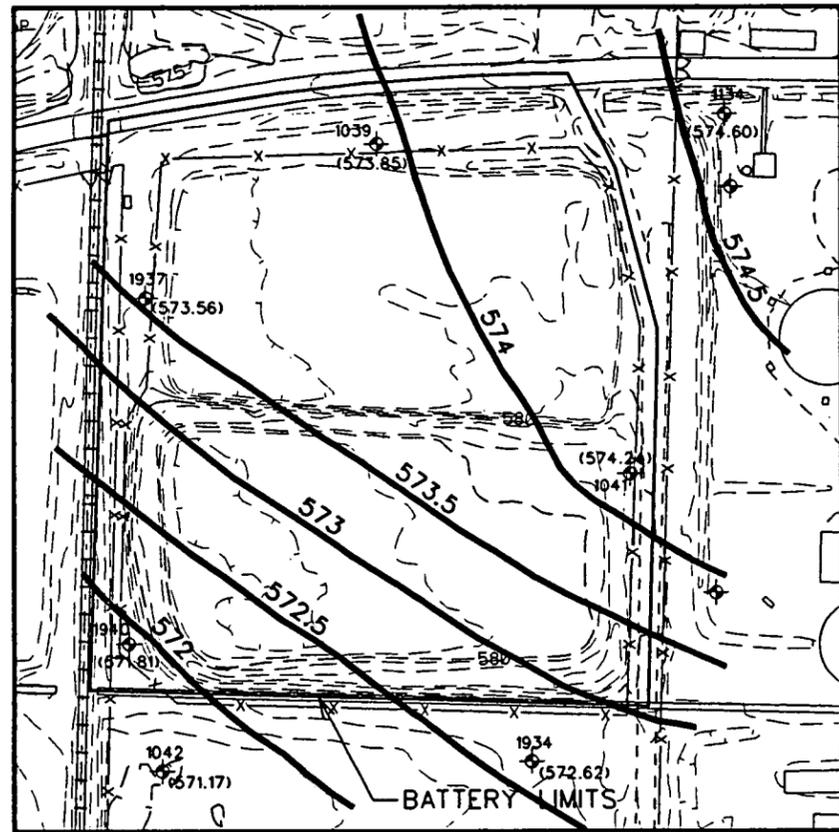


CROSS-SECTION LOCATION KEY (1"=100')

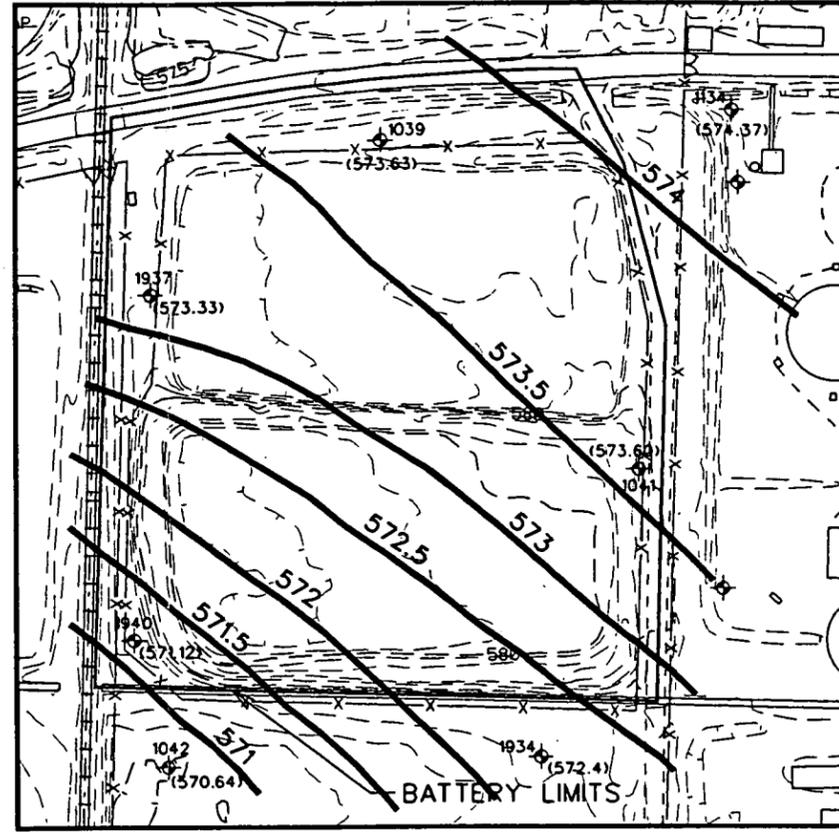


0262  
 FIGURE 3-36  
 GEOLOGIC CROSS SECTIONS,  
 LIME SLUDGE PONDS

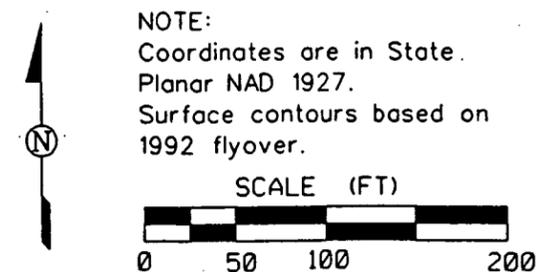
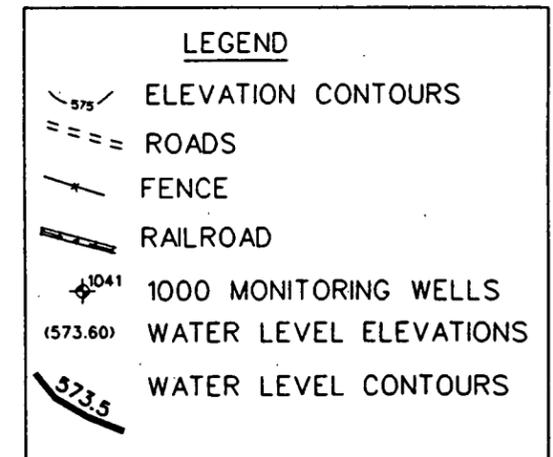
5170



JULY 8, 1993



AUGUST 16, 1993



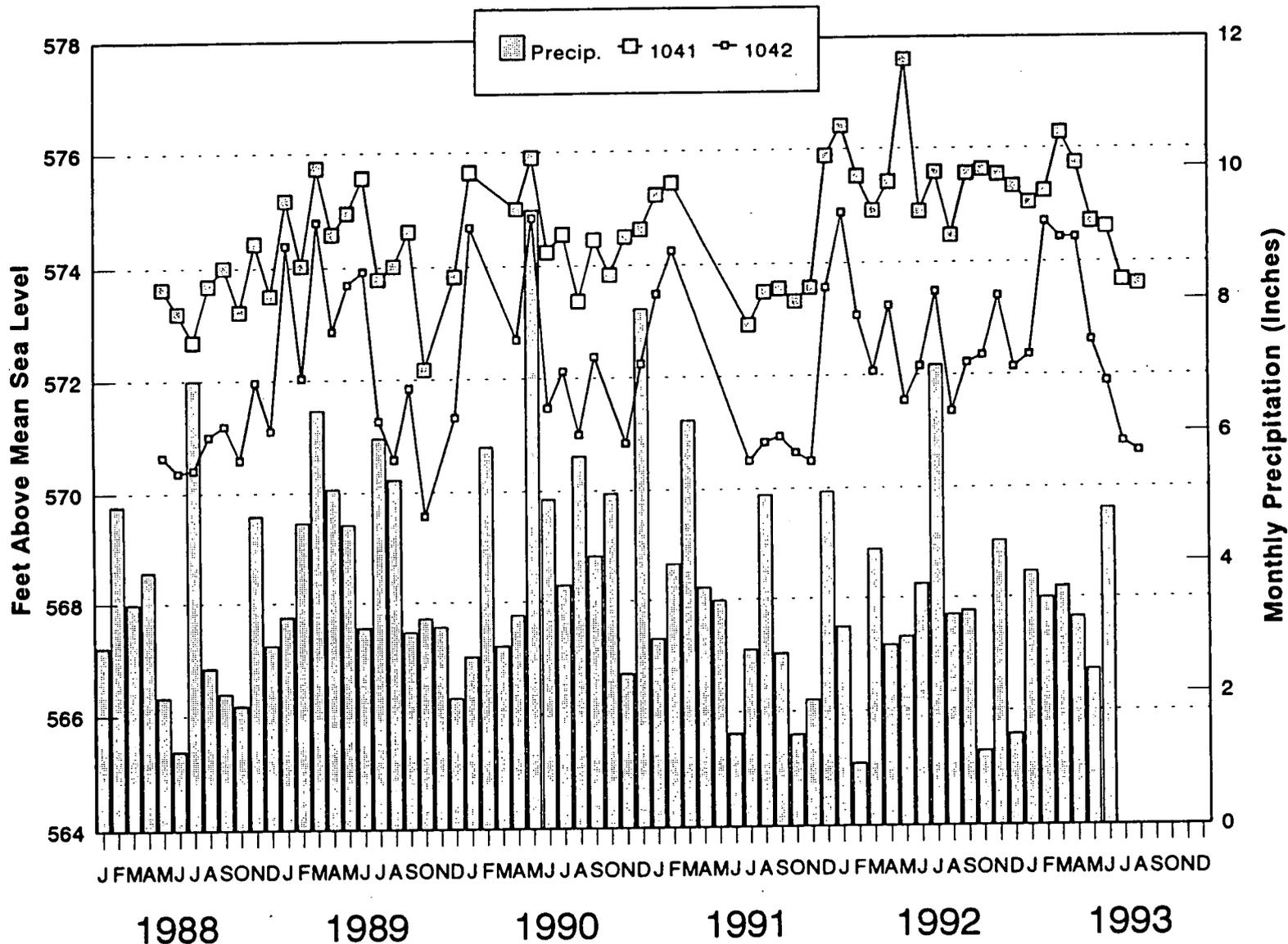
**FIGURE 3-37**  
**GROUNDWATER ELEVATIONS**  
**FOR 1000-SERIES WELLS,**  
**LIME SLUDGE POND,**  
**JULY 8, 1993 AND**  
**AUGUST 16, 1993**

0263

3-73

7050

0264



NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

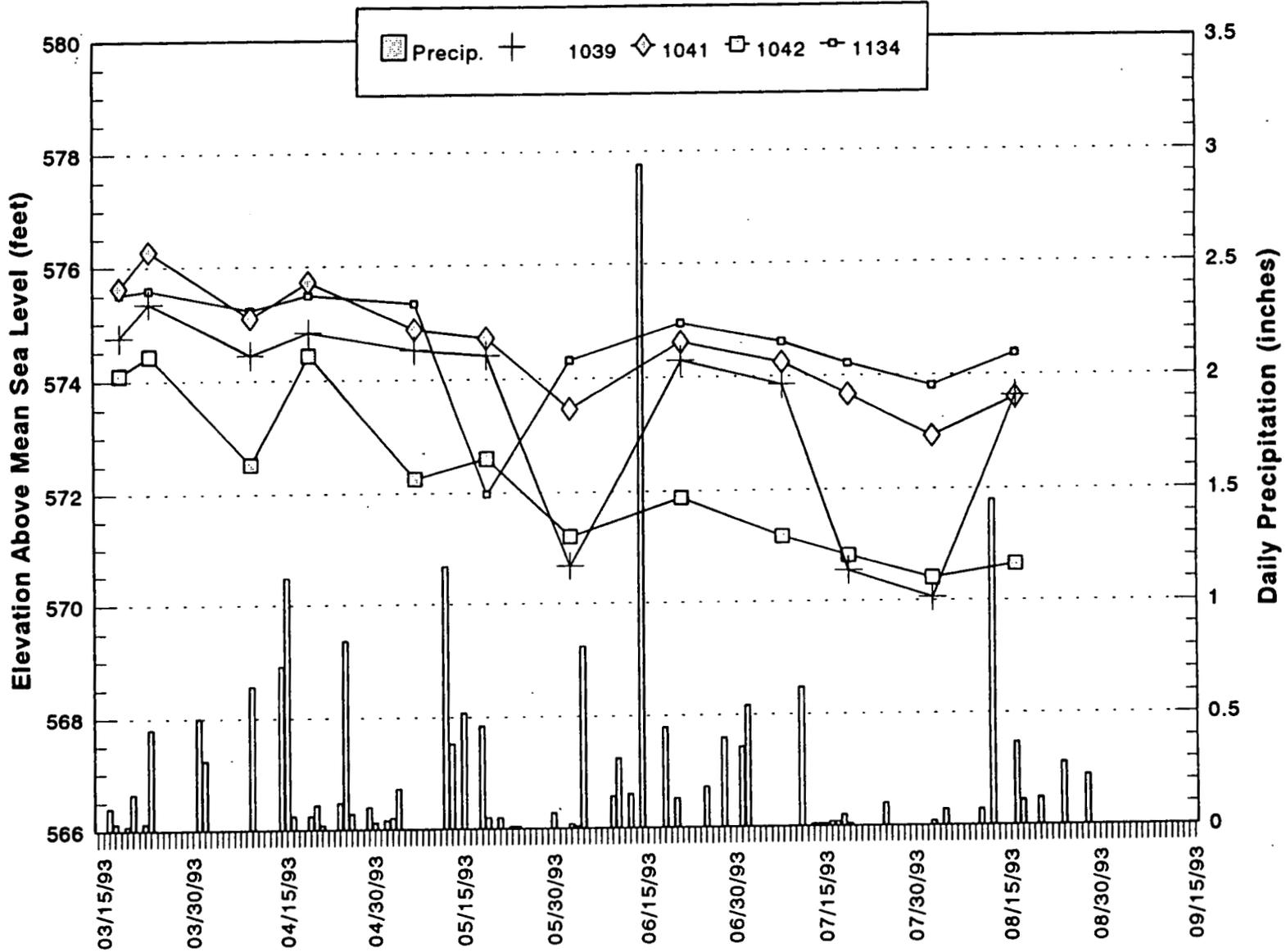
FIGURE 3-38  
HYDROGRAPHS FOR MONITORING WELLS 1041 AND 1042, LIME SLUDGE PONDS

5170

3-74

0265

0507



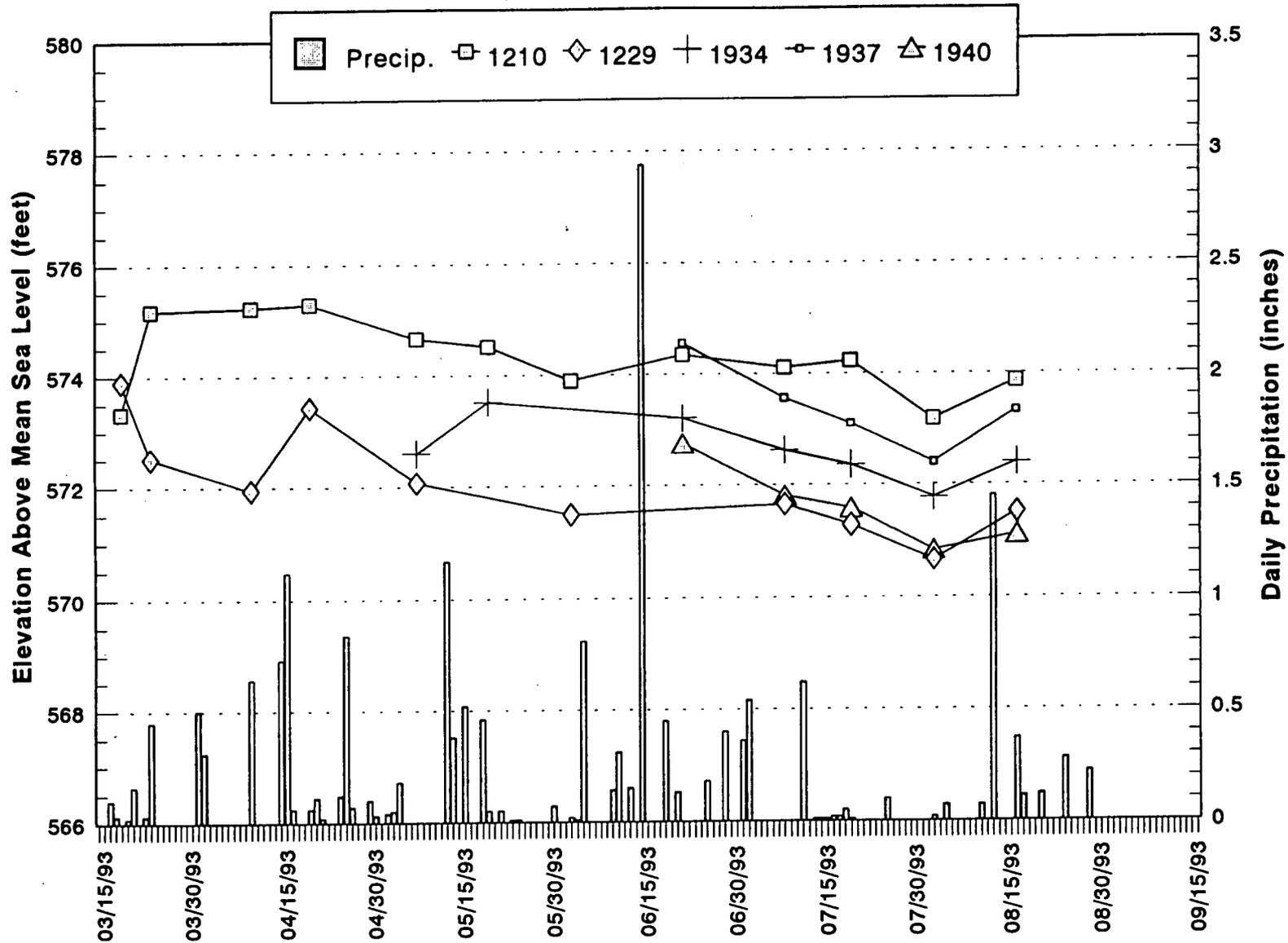
NOTE: PRECIPITATION DATA FROM ONSITE RECORDS

FIGURE 3-39  
HYDROGRAPHS FOR 1000-SERIES WELLS, LIME SLUDGE PONDS

0215

3-75

0266



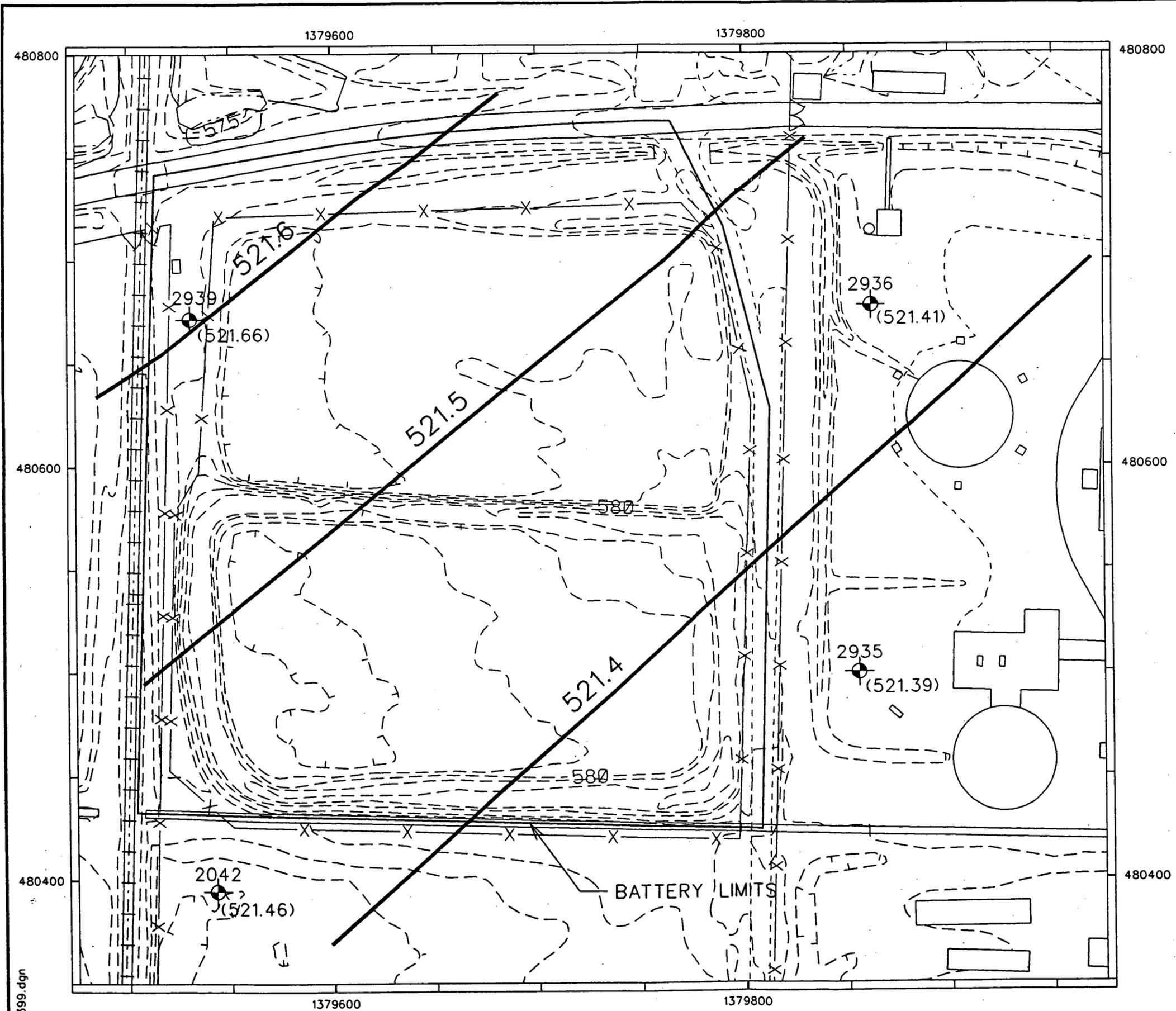
NOTE: PRECIPITATION DATA FROM ONSITE RECORDS

FIGURE 3-40

HYDROGRAPHS FOR ADDITIONAL 1000-SERIES MONITORING WELLS, LIME SLUDGE POND

0215 5170

5170



**LEGEND**

- ELEVATION CONTOURS
- ROADS
- FENCE
- RAILROAD
- 2936  
2000 MONITORING WELLS
- (521.41) GROUNDWATER ELEVATIONS
- 521.5 GROUNDWATER CONTOURS

**NOTE:**  
Coordinates are in State  
Planar NAD 1927.  
Surface contours based on  
1992 flyover.

**SCALE (FT)**

**FIGURE 3-41**  
**GROUNDWATER ELEVATIONS**  
**FOR 2000-SERIES WELLS,**  
**LIME SLUDGE PONDS**  
**0267 AUGUST 16, 1993**

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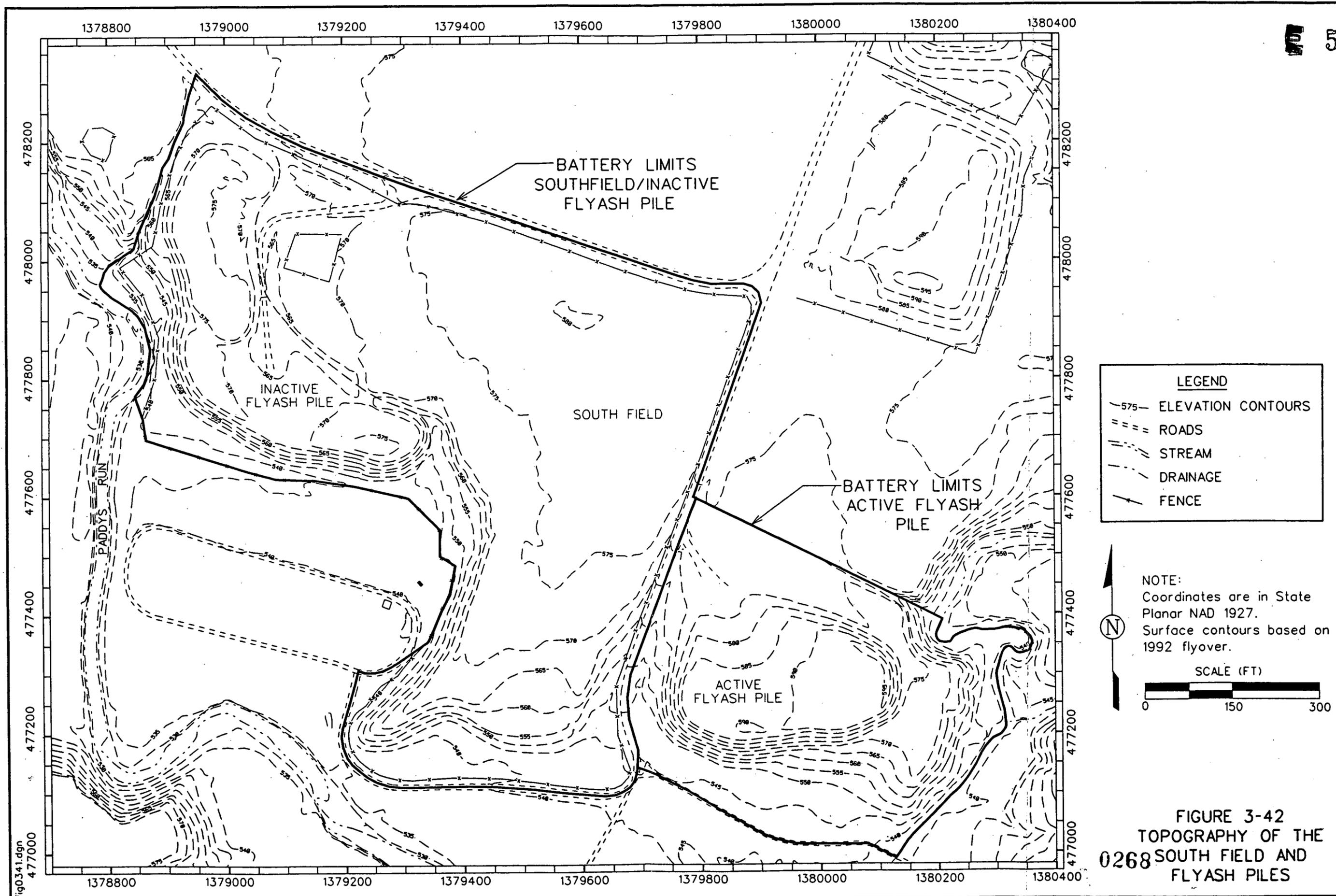


FIGURE 3-42  
TOPOGRAPHY OF THE  
0268 SOUTH FIELD AND  
FLYASH PILES

The South Field is located south of the former Production Area and is between the Inactive Flyash Pile on the west and the Active Flyash Pile on the east. An east-west oriented access road borders the northern extent of the South Field. A north-south oriented access road (which turns east and leads to the running track/shooting range facility), borders the eastern and southern extent of the South Field. The western edge of the South Field is bordered by a drainage ditch which divides the Inactive Flyash Disposal Area from the South Field. The South Field was used to dispose of construction rubble and fill excavated from the Production Area. The South Field was graded with a covering of clay fill and is now overgrown with grass, brush and, less abundantly, trees.

3.4.1 Topography and Surface Water

The topography of the Inactive Flyash Pile is shown in Figure 3-42. Elevations range from approximately 540 to 580 feet above MSL across the Inactive Flyash Pile from north to south. The western edge of the area slopes steeply toward Paddys Run, and the southern edge of the area slopes steeply toward the running track in the south. Both the south facing slope and the west facing slope are covered with dense vegetation including stands of trees. An eroded drainage channel is located at the approximate center of the west facing slope and directs flow to Paddys Run. The remainder of this waste area slopes more gently toward a drainage ditch that borders the South Field to the east. The north edge of the unit is bordered by a drainage ditch and an access road.

Surface water drains in a radial pattern from the center of the Inactive Flyash Pile; however, the pile is covered with dense shrubs, trees, and grass, so sheet flow runoff east toward the South Field has not been observed. Shallow interflow at the north edge of the pile was seen to fill a drainage ditch that is parallel to the north boundary, and this runoff joins drainage crossing under the road from the north before flowing southwest to Paddys Run. Surface water from the south facing slope joins shallow drainage from the former running track area in a drainage ditch at the toe of the pile. The combined drainage flows west to Paddys Run. Drainage from the west facing slope either infiltrates into the flyash before reaching the toe of the pile or flows in the drainage observed at the center of the pile to Paddys Run.

Topography in the vicinity of the South Field slopes from the northeast at 580 feet above MSL to the west at 560 feet above MSL and to the south at 540 feet MSL (Figure 3-42). The natural topography of the South Field has been recontoured as fill was introduced. Drainage from the South Field appears to be shallow interflow originating near to the boundaries of the unit that is intercepted by

0,50

engineered channels. Drainage channels are adjacent to the north boundary road, the east boundary road, and the running track. Sheet flow caused by average precipitation events would most likely infiltrate or pool on the South Field surface since it is covered by dense shrubs and grass and has mature trees. Drainage is directed to the west along the north boundary, where it joins drainage from the off-site wooded area north of the boundary road and discharges to Paddys Run. Drainage in the east channel flows south and pools at the southern edge of the South Field. Flow in both channels was observed to continue for several days after heavy rain events. Drainage that flows south toward the running track is intercepted by a channel that flows west to Paddys Run.

3.4.2 Geology and Groundwater Hydrology

The Inactive Flyash Pile was used to dispose of flyash and bottom ash from the coal-fired boiler plant. Soil samples from borings indicate that the fill consists primarily of flyash, but building rubble (such as concrete, gravel, asphalt, masonry, and steel rebar) is also present. Cross sections of the South Field/Inactive Flyash Pile are shown in Figure 3-43 and Figure 3-44.

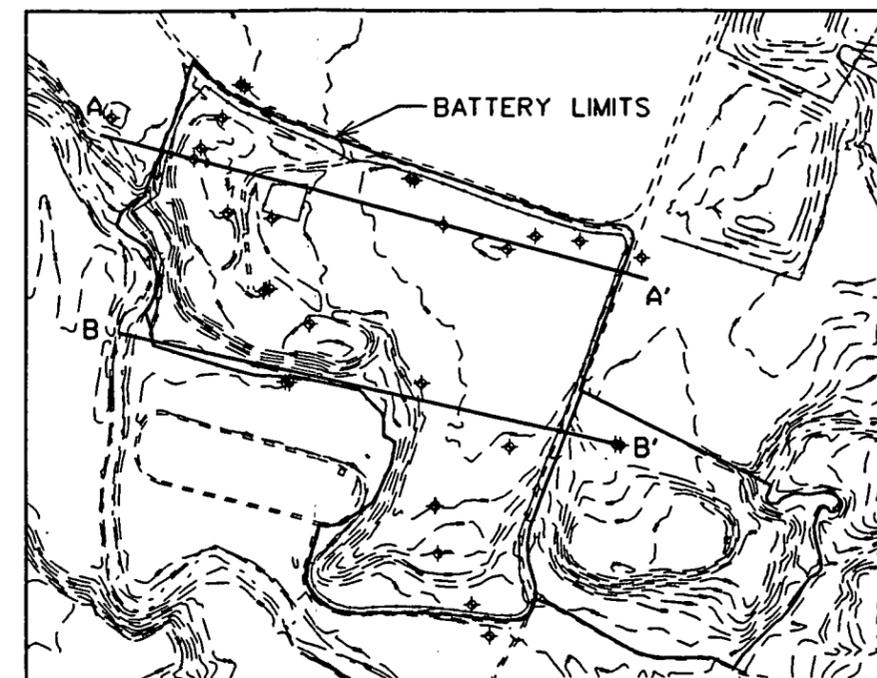
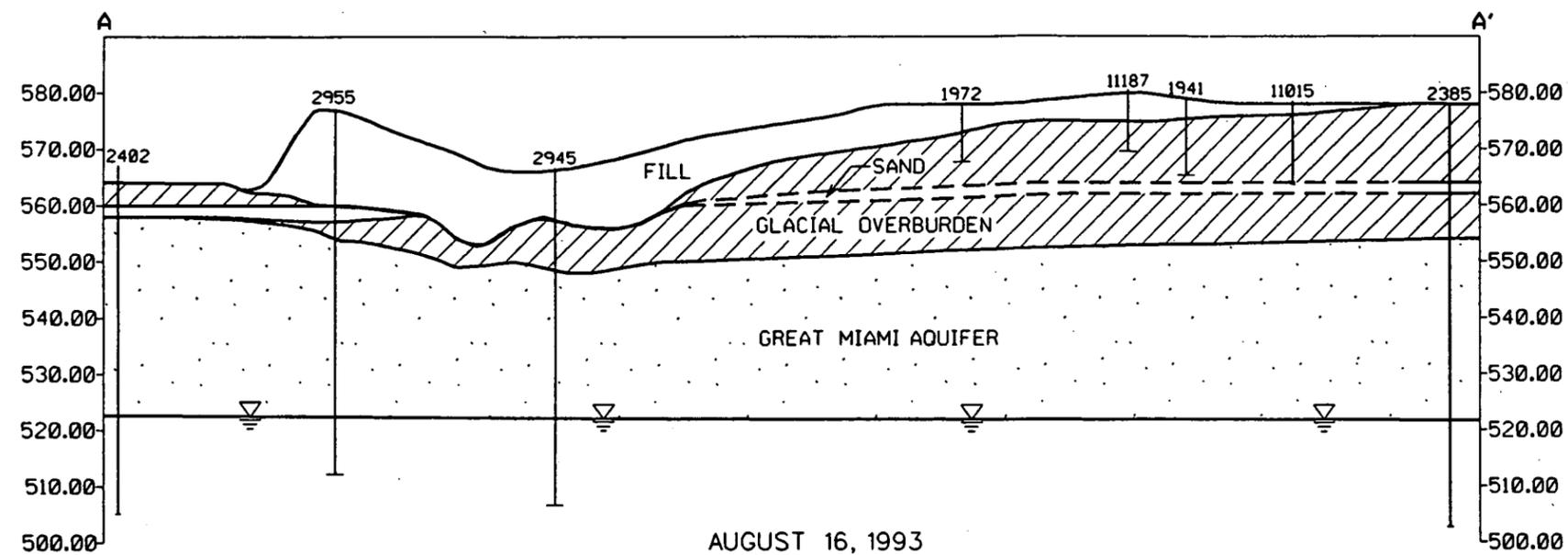
The Inactive Flyash Pile is predominately flyash, with up to six feet of silt and clay at the surface in the southern half of the unit that appears to be a cap. The flyash overlies the till surface existing in 1951; therefore, the topography of the flyash fill/till interface is characterized by erosional channels that were cut into the pre-existing till surface prior to 1951. Cross sections of these features are presented in Figures 3-43 and 3-44.

Glacial till overburden is present beneath most of the Inactive Flyash Pile and becomes thinner toward the west and south boundaries of the unit. There was no till encountered beneath the most southern portion of the flyash in Borings Nos. 1994 and 1996 (see cross section C-C' on Figure 3-44). The geologic cross sections represent the interpreted geology along the actual cross-section traces shown on the map insets. These sections do not represent straight-line correlations from boring to boring; rather, they were derived from a three-dimensional aerial model based on all soil borings and prepared using Intergraph Corporation Microsoft PC Software.

Soil samples were examined from subsurface borings in the South Field to define lithology of the subsurface strata. Chemical analyses of soil samples and groundwater samples from monitoring wells were used to determine concentrations of various chemical constituents in soil, waste material, and groundwater. Groundwater elevations were measured to determine the potential groundwater flow

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CROSS-SECTION LOCATION KEY (1"=400')

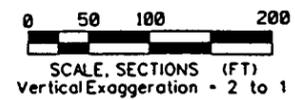
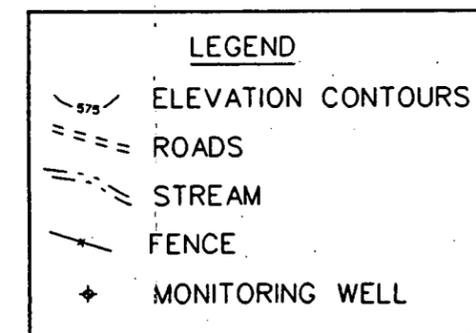
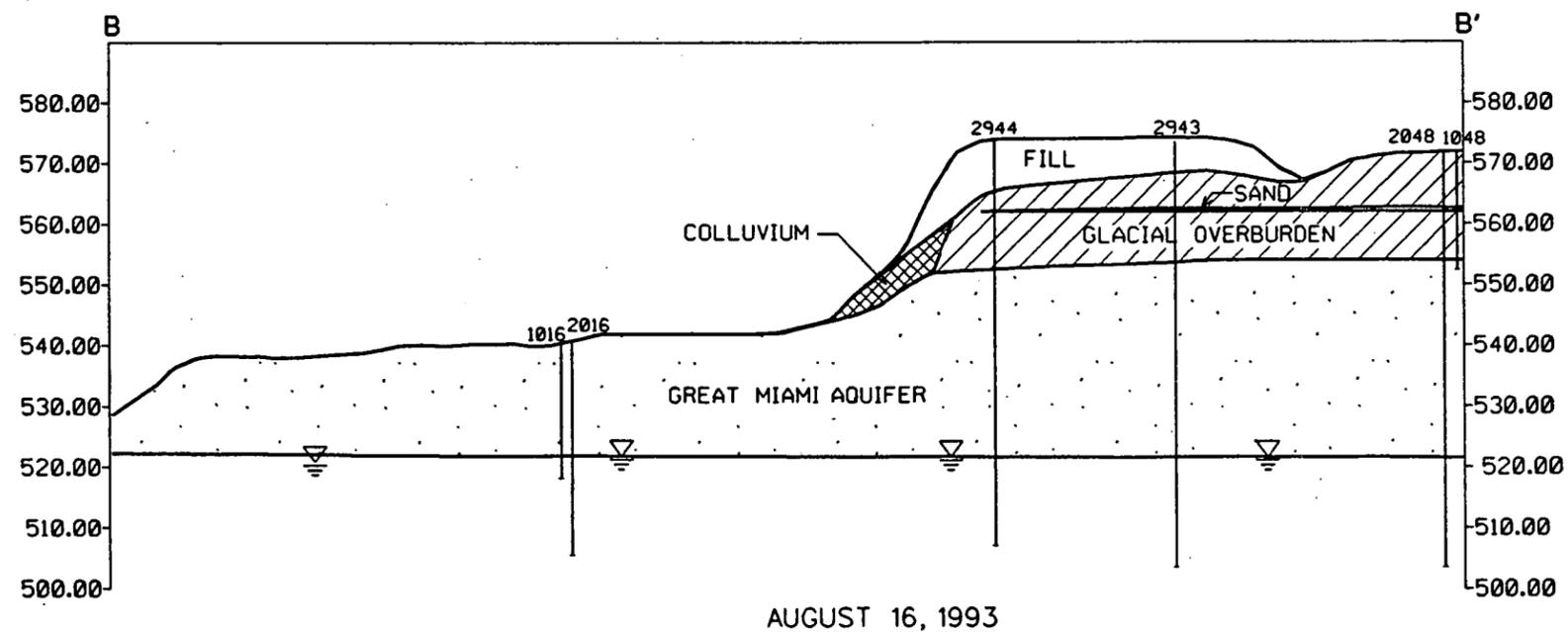
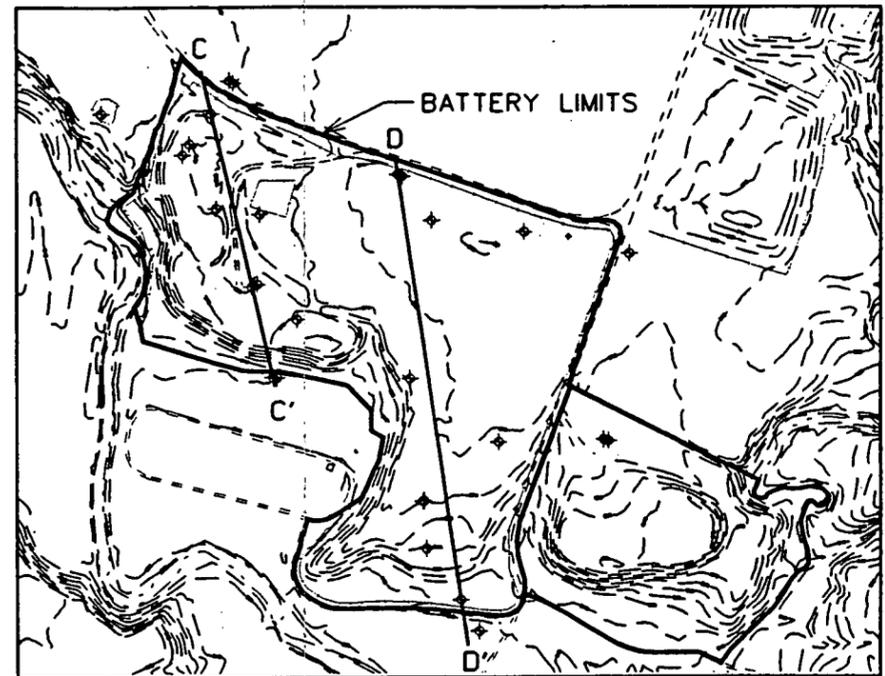
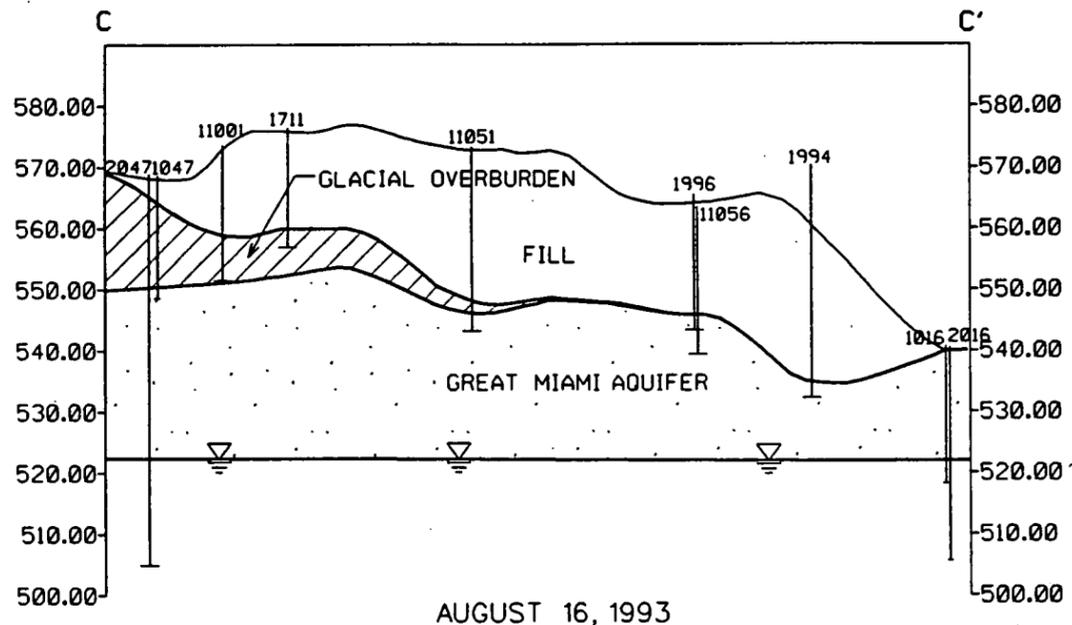


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0271

FIGURE 3-43  
GEOLOGIC CROSS SECTIONS  
WEST TO EAST  
SOUTH FIELD/INACTIVE  
FLYASH PILE



CROSS-SECTION LOCATION KEY (1"=400')

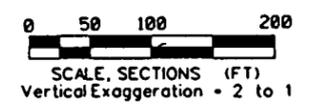
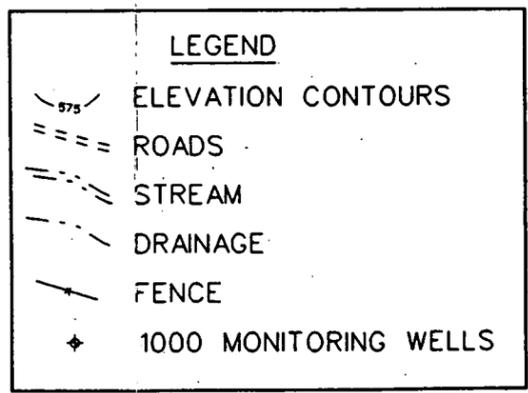
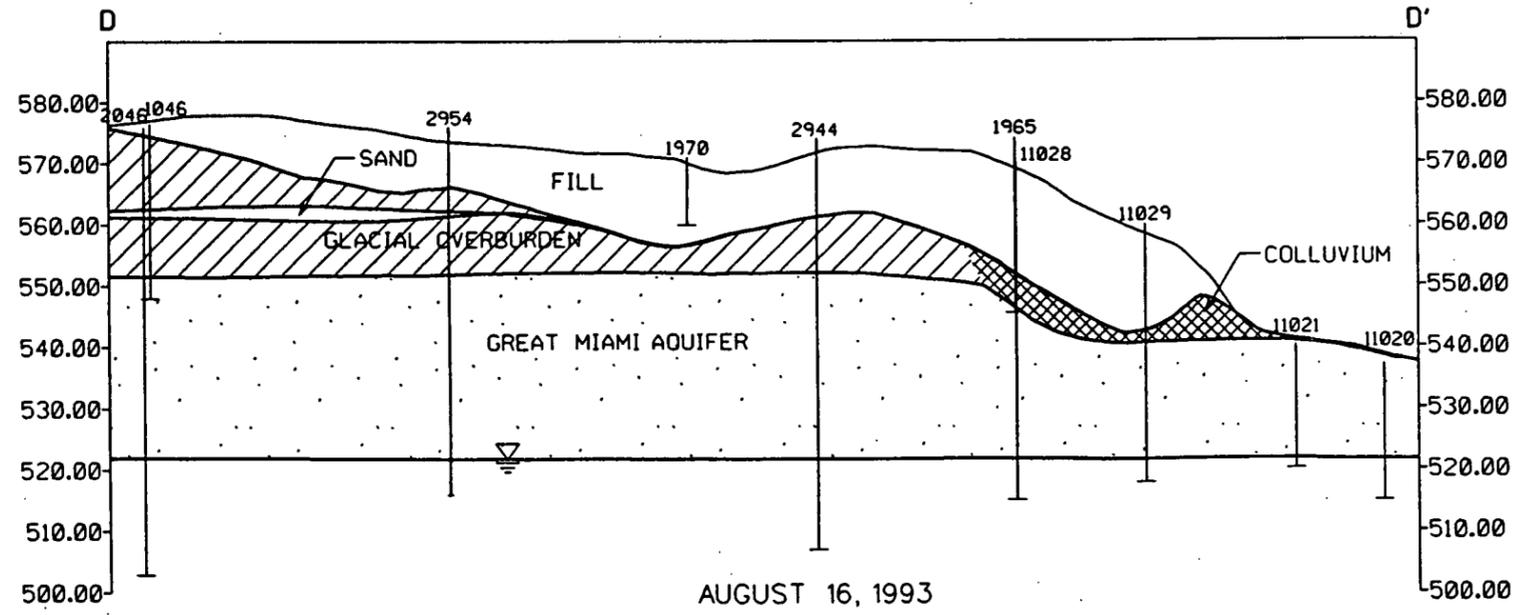


fig0343.dgn

0272

FIGURE 3-44  
GEOLOGIC CROSS SECTIONS  
NORTH TO SOUTH  
SOUTH FIELD/INACTIVE  
FLYASH PILE

direction. Based on the lithologic descriptions presented in the boring logs (Appendices F and G for the Inactive Flyash Pile and South Field, respectively), a general description of the strata below the South Field area was determined.

Geologic cross sections derived from boring data were prepared for the South Field area and are shown in Figures 3-43 and 3-44. Cross-section traces are shown on insets in the upper right-hand corner of the figures. Boring log data indicate that the glacial overburden is overlain by deposits of fill material of unknown origin and variable thickness. Beneath this fill, a series of glacial overburden deposits underlie the South Field/Inactive Flyash Pile Area. The Great Miami Aquifer, consisting of glacial outwash deposits containing sand and gravel, underlies these glacial overburden deposits.

The glacial overburden is composed predominantly of silty clay interbedded with lenses of clay and silt, sandy clay, silty sand, and sand and gravel. These lithologies are potentially discontinuous and often cannot be correlated laterally between borings. One sand layer was correlated in soil borings drilled throughout the site and is shown in the cross sections presented in Figures 3-43 and 3-44. The color of the overburden generally grades downward from a yellowish-brown to brown, silty clay into a gray to gray-brown clay. This color transition may be related to oxidation during weathering. The depth at which this transition occurs below the surface is variable, ranging from 27.0 feet in Boring No. 2047 to 0.0 feet in Boring No. 1045. The thickness of the glacial overburden in the South Field/Inactive Flyash Pile Area ranges from approximately five feet at Boring No. 2049 (south of the Active Flyash Pile) to approximately 27 feet at Boring No. 1046 (located on the north side of the Inactive Flyash Pile). Overall, in the South Field/Inactive Flyash Pile Area, the glacial overburden averages between 20 and 30 feet thick.

Data collected from hydropunch and soil borings are summarized in Table 3-4 and provide the most current data concerning the distribution of saturated/unsaturated groundwater conditions within the Inactive Flyash Pile. No saturated groundwater conditions were detected in 21 soil borings drilled into the flyash throughout the area. Groundwater was detected in sand and silt lenses within glacial till overburden underlying the east edge of the flyash pile. Glacial overburden was reported to be dry beneath the west side of the Inactive Flyash Pile. The flyash was reported to directly overlie the Great Miami Aquifer at the southern tip of the Inactive Flyash Pile, and there was no perched groundwater system encountered. Borings and hydropunch activities did not locate any layers or

5770

**TABLE 3-4**  
**SUMMARY OF DATA RELATED TO SATURATED GROUNDWATER CONDITIONS**  
**INACTIVE FLYASH PILE**

Boring No.	Depth of Flyash (Ft. Below Surface)	Depth of First Water (Ft. Below Surface)	Water Bearing Unit	Comment
1994	25	NA	NA*	Located at south end of Inactive Flyash Pile. Flyash rests directly on Great Miami Aquifer.
1995	26	NA	NA	Located at south end of Inactive Flyash Pile in center of pile. Layers of clay/silt cap to 8 feet deep; Great Miami Aquifer at 31.5 below ground surface.
1996	17	NA	NA	Located at east edge of Inactive Flyash Pile. Waste material at surface. Tough drilling. Flyash from surface to depth. Great Miami Aquifer directly under flyash.
1997	28.5	NA	NA	Located at west edge of Inactive Flyash Pile. Great Miami Aquifer at 39 feet below surface. Clay/silt to 5 feet deep.
1998	9	9	Interface of flyash and till	Located at east edge of Inactive Flyash Pile at north end. Saturation occurs at flyash/till interface. Very stiff clay beneath flyash reported to be dry.
		12	Gravelly sand in till	Second saturated unit. A third sand lens at 16 feet deep reported to be dry.
1999	4	8	Well graded sand lens in till	Located at east side of Inactive Flyash Pile.
11000	8	12.5	Silty sand lens	Located at east side of Inactive Flyash Pile.
11001	8.5	13	Gray silty sand in till	Second wet sand lens at 20 feet deep. Location at north end of Active Flyash Pile.
11002	3.5	12.5	Gravelly clay in till	Located at northwest corner Active Flyash Pile.
11003	16.5-18	18-23	Silty clay in till	Located at north end of Active Flyash Pile, near center.
11004	15.5	22.5	Silty sand lens in till	Located at center of Active Flyash Pile in east/west direction near to north 1/3.

See footnote at end of page

5170

**TABLE 3-4  
(Continued)**

Boring No.	Depth of Flyash (Ft. Below Surface)	Depth of First Water (Ft. Below Surface)	Water Bearing Unit	Comment
11005	8.5	NA	NA	Located at east edge of Active Flyash Pile. Poor recovery, moist samples otherwise.
11006	12.5	13.5	Gray sand lens	Located at east edge of Inactive Flyash Pile. Flyash rests directly upon Great Miami Aquifer. Poor recovery due to concrete.
11007	15	19.5	Brown sand lens	Located at center of Inactive Flyash Pile.
11008	17.5	NA	NA	Located at west edge of Inactive Flyash Pile. Sand lens at 21.5 feet deep was dry.
11047	0	8.5	Light brown sand in till	Located outside of Inactive Flyash Pile to north.
11048	11.5	21.5	Silty sand lens in till	Saturated zone in till approximately 2 feet above top of Great Miami Aquifer. Location is at the north center part of the Inactive Flyash Pile.
11049	0	4.5	Clay/sand lens in till	Located at north end of Inactive Flyash Pile.
11050	6.5	10-13	Silty sand in till	Very moist conditions. Not noted as saturated.
11051	19	19	NA	Drilled south of 11005 to obtain sample. Waste materials encountered.
11053	NA	NA	NA	Located south and east of 11005. Drilled to obtain sample since one was not collected from dry 11005. There is no perched water at this location.

\* N/A - Not applicable since no saturated interval was identified.

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zones within the flyash that were saturated. This is reflected in Table 3-4, where the depth of first water is consistently greater than the depth of flyash at the same location. Saturated groundwater conditions in the flyash/till are monitored by Well 1711, which was completed at the north end of the Inactive Flyash Pile in May 1991. Eight groundwater elevation measurements in Well 1711 from July 1991 to March 1992 differed by 0.01 feet, while from March 1992 to August 1993, the elevation increased 2.5 feet (Figure 3-45). Examination of the boring log (Appendix E) indicates that Well 1711 is completed at the interface between the flyash and a sand gravel zone within the till. The elevation data suggest that groundwater flow may be in the sand/gravel until intense precipitative conditions (like those encountered during early 1993) occur to raise the perched water table into the flyash.

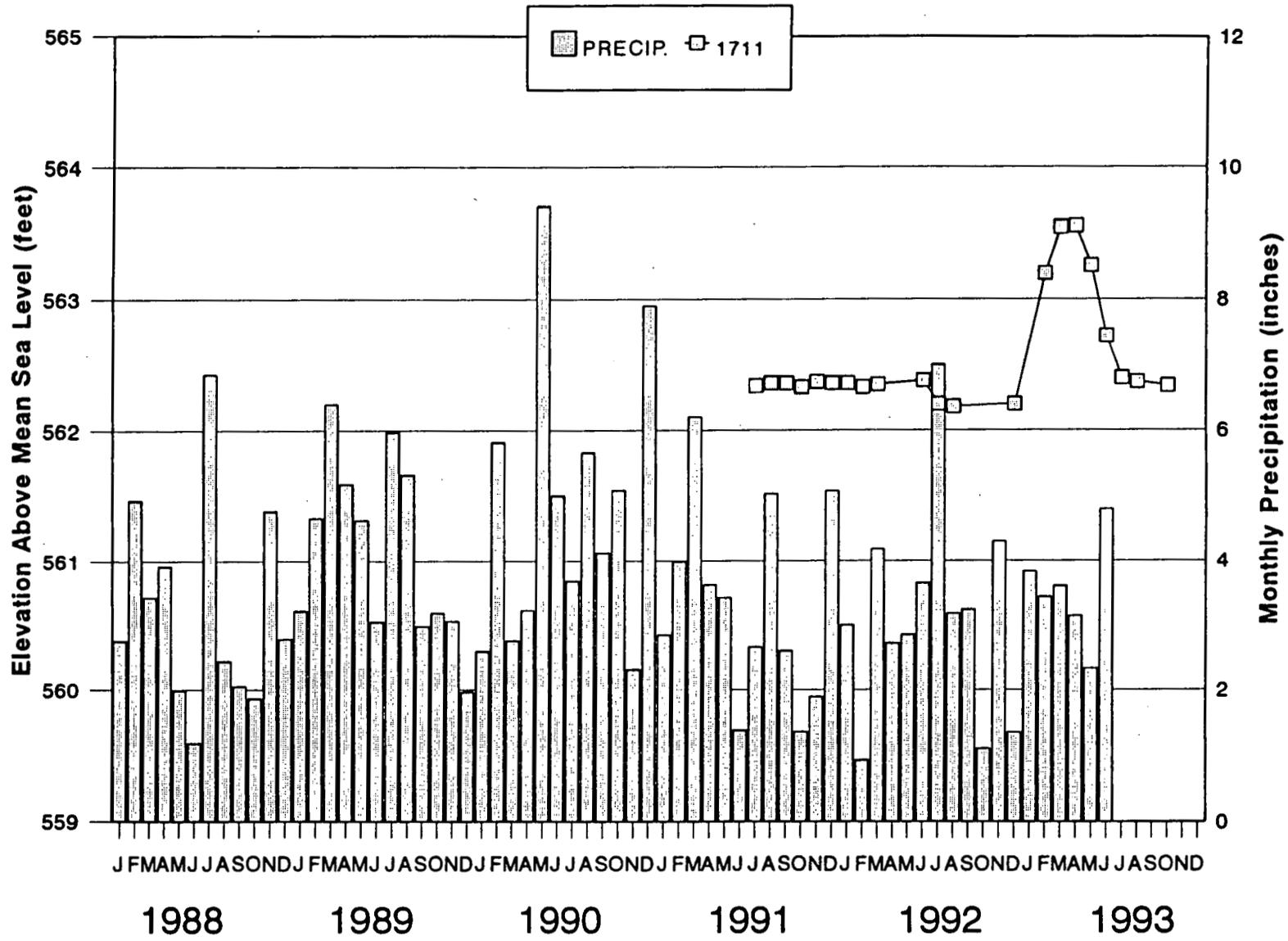
Saturated groundwater conditions in the South Field were encountered in the glacial overburden within sand and silt lenses. One sand/silt lens was correlated across the site at approximately 8 to 12 feet below ground surface. The extent of groundwater appears to be directly related to the geometry and existence of this sand layer. Slug tests (Table 3-2) were conducted in several 1000-series wells in the South Field and indicate an average hydraulic conductivity for the glacial overburden of  $3.8 \times 10^{-4}$  cm/s (falling head tests) to  $3.41 \times 10^{-4}$  cm/s (rising head test). The elevation of perched groundwater was contoured and is shown on Figure 3-46. Data indicate that flow in the perched system follow topography and is toward the southwest in the South Field area. The gradient was 0.021 on August 16, 1993. Flow direction east of the Solid Waste Landfill is to the east/southeast and parallels the local topographic trend. The potentiometric surface indicates a groundwater divide in the perched water, extending north/northwest from the northeast corner of the South Field. This divide is reflective of the local topography of the area.

Groundwater elevations from January 1988 to November 1992 in two perched zone monitor wells are plotted as hydrographs in Figures 3-47 and 3-48. Groundwater elevations within the glacial overburden vary from approximately 555 to 575 feet above MSL (approximately 5 to 20 feet below the surface) in the South Field. Wells 1046 and 1047, located north of the South Field, displayed over 10 feet of elevation variation, and there appears to be a good correlation between the two wells and precipitation events (Figure 3-47). No defined groundwater recharge zone was discovered during the field study, but groundwater elevations response to precipitation measured in Wells 1046 and 1047 may indicate the location of a possible recharge area. Groundwater elevations in Well 1046 displayed a 10.8 foot range from May 1988 to March 1992. Well 1047 displayed a 13.8 foot range

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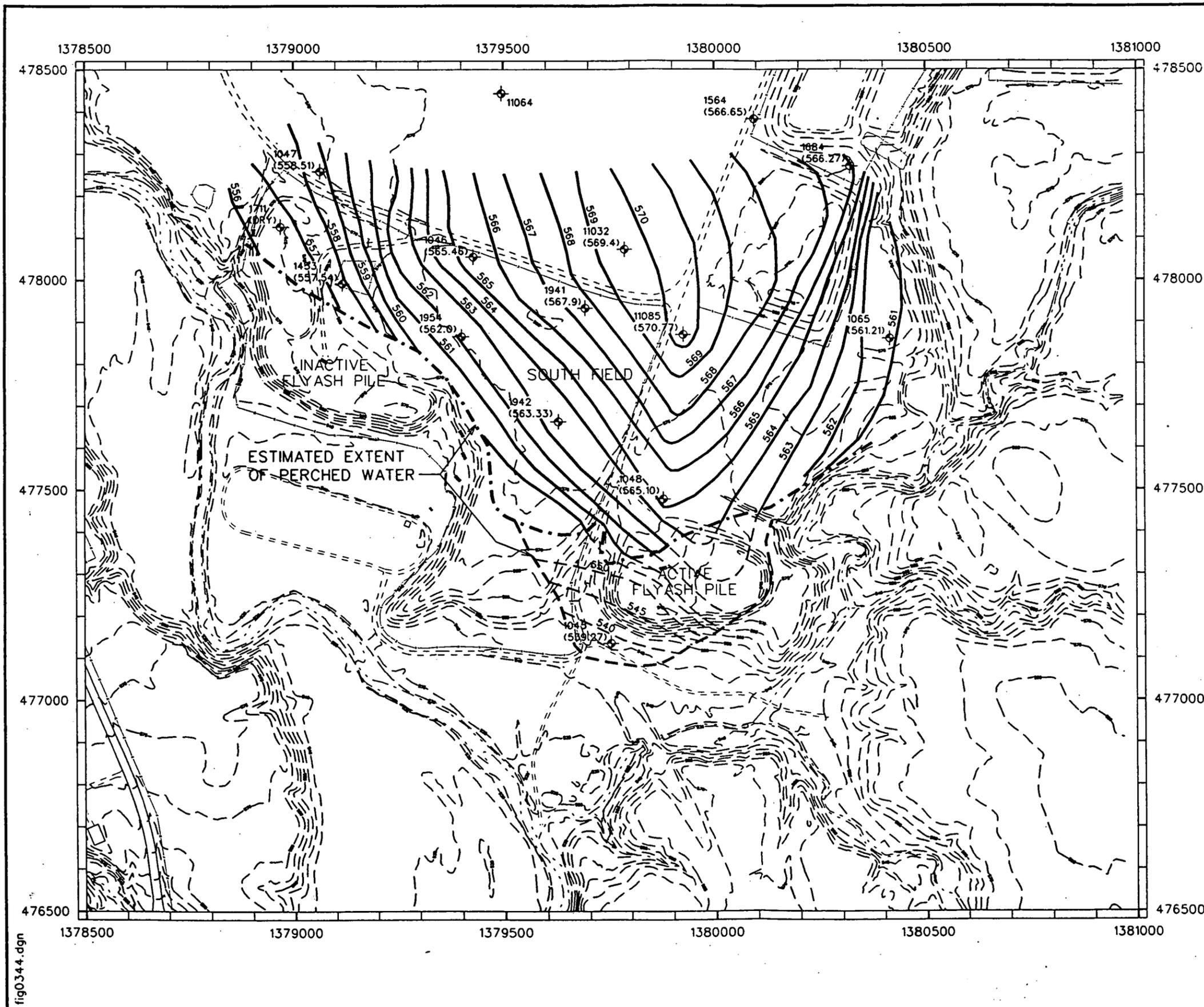


NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

FIGURE 3-45  
HYDROGRAPH FOR MONITORING WELL 1711, INACTIVE FLYASH PILE

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**LEGEND**

- 575 — ELEVATION CONTOURS
- 575 — WATER LEVEL CONTOURS
- 575 — INFERRED WATER LEVEL CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- 1065 1000 MONITORING WELLS
- (561.21) GROUNDWATER ELEVATION
- ESTIMATED EXTENT OF SAND AND GRAVEL LAYER IN GLACIAL OVERBURDEN

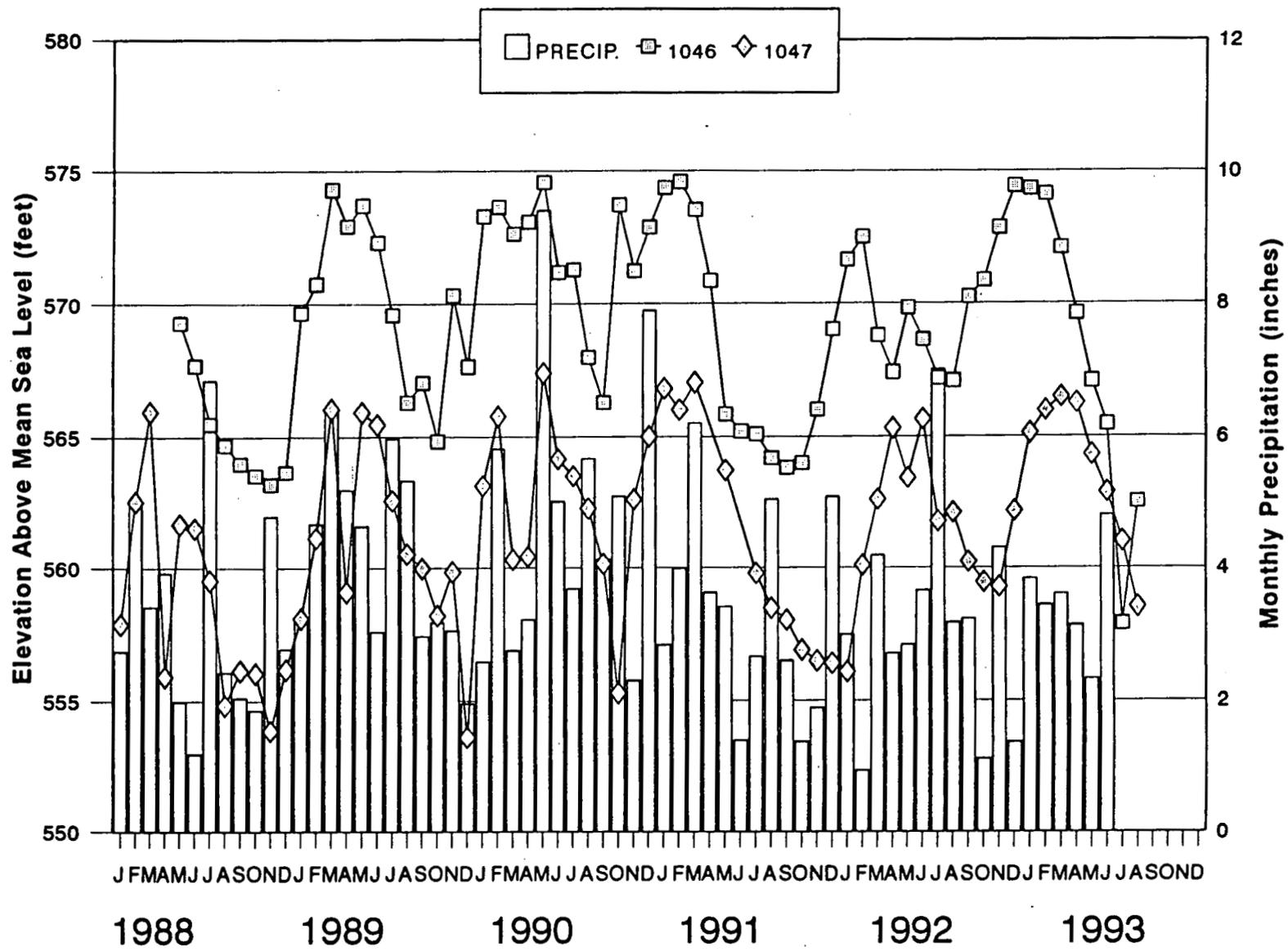
**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

**SCALE (FT)**

0 125 250 500

**FIGURE 3-46**  
**GROUNDWATER ELEVATIONS**  
**1000-SERIES WELLS**  
**SOUTH FIELD AND**  
**FLYASH PILE AREAS**  
**AUGUST 16, 1993**

fig0344.dgn



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0279

NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

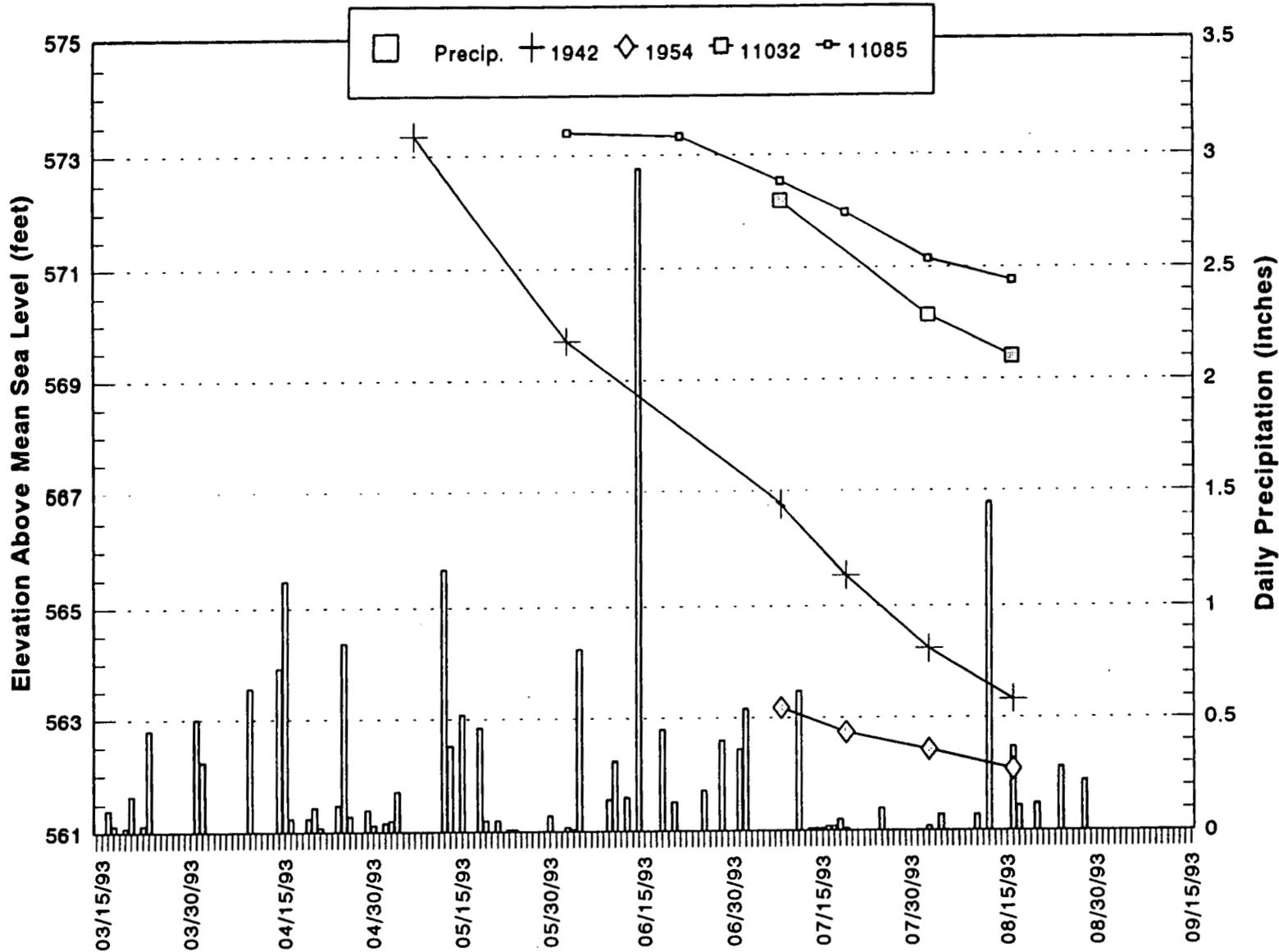
FIGURE 3-47

HYDROGRAPHS FOR MONITORING WELLS 1046 AND 1047, SOUTH FIELD/INACTIVE FLYASH PILE

3-89

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0570



NOTE: PRECIPITATION DATA FROM ONSITE RECORDS

FIGURE 3-48

HYDROGRAPHS FOR MONITORING WELLS 1942, 1954, 11032 AND 11085, SOUTH FIELD

0219

from January 1988 to February 1992. The highest groundwater levels are within two feet of ground surface. Since wide groundwater elevations fluctuations are characteristic of groundwater recharge zones, it is possible that the north section of the South Field is a groundwater recharge zone for perched groundwater. Hydrographs for downgradient 1000-series wells (Well 1942 and Well 1954) are shown in Figure 3-48. These wells show no response to significant precipitations events on June 15 and August 12, 1993, suggesting that direct recharge at these locations is limited.

Data from soil borings have been evaluated to determine the thickness of till materials beneath the South Field/Inactive Flyash Pile Area. Thickness of till isopacs are presented in Figure 3-49. Contours presented in Figure 3-49 indicate that the southern portion of the South Field and the Inactive Flyash Pile overlie till that ranges in thickness from 0 to 2 feet. This means that fill materials at the southern end of the Inactive Flyash Pile and the South Field lie directly upon the sand and gravel of the Great Miami Aquifer, with a few feet of colluvial material separating them. This is also shown on the cross sections in Figures 3-43 and 3-44.

Several borings were drilled through the glacial overburden into the top of the Great Miami Aquifer. The lithology of the Great Miami Aquifer consists principally of sand and gravel with scattered lenses of clay or fine-grained material. It is not believed that clay materials are of a sufficient thickness and areal extent to act as semi-confining layers or to otherwise affect groundwater movement.

Groundwater elevations within the Upper Great Miami Aquifer are approximately 520 to 525 feet above MSL or about 30-50 feet below the surface. Contours of this potentiometric surface from elevations measured in 2000-series wells on August 16, 1993 are shown in Figure 3-50. Groundwater flows east to southeast in the Great Miami Aquifer beneath the South Field/Inactive Flyash Pile Area with a gradient of 0.001. Local groundwater mounding appears to occur near monitoring Wells 2401 and 2065. These wells occur near areas where the glacial overburden is projected to be absent due to erosion; therefore, recharge from the perched water may be occurring.

Groundwater elevation data for the 3000- and 4000-series wells (completed at the base of the Upper and Lower Great Miami Aquifer, respectively) are also approximately 520 to 525 feet above MSL (Figures 3-51 and 3-52). Groundwater elevations in these wells display approximately eight feet of change, and there is an excellent correlation between the nested wells. This indicates that there is hydraulic communication between the upper and lower aquifer above and below the clay layer, and

that there is no significant vertical gradient during recharge events. Water levels in the 2000- and 3000-series wells appear to be the same, while the elevation of groundwater in Well 4016, shown in Figure 3-52, appears to lag behind the 2000- and 3000-series wells during recharge events, as exemplified by the period from November 1992 to April 1993. This suggests that there may be an impediment to vertical flow between the aquifer zones divided by the clay layer.

3.5 ACTIVE FLYASH PILE

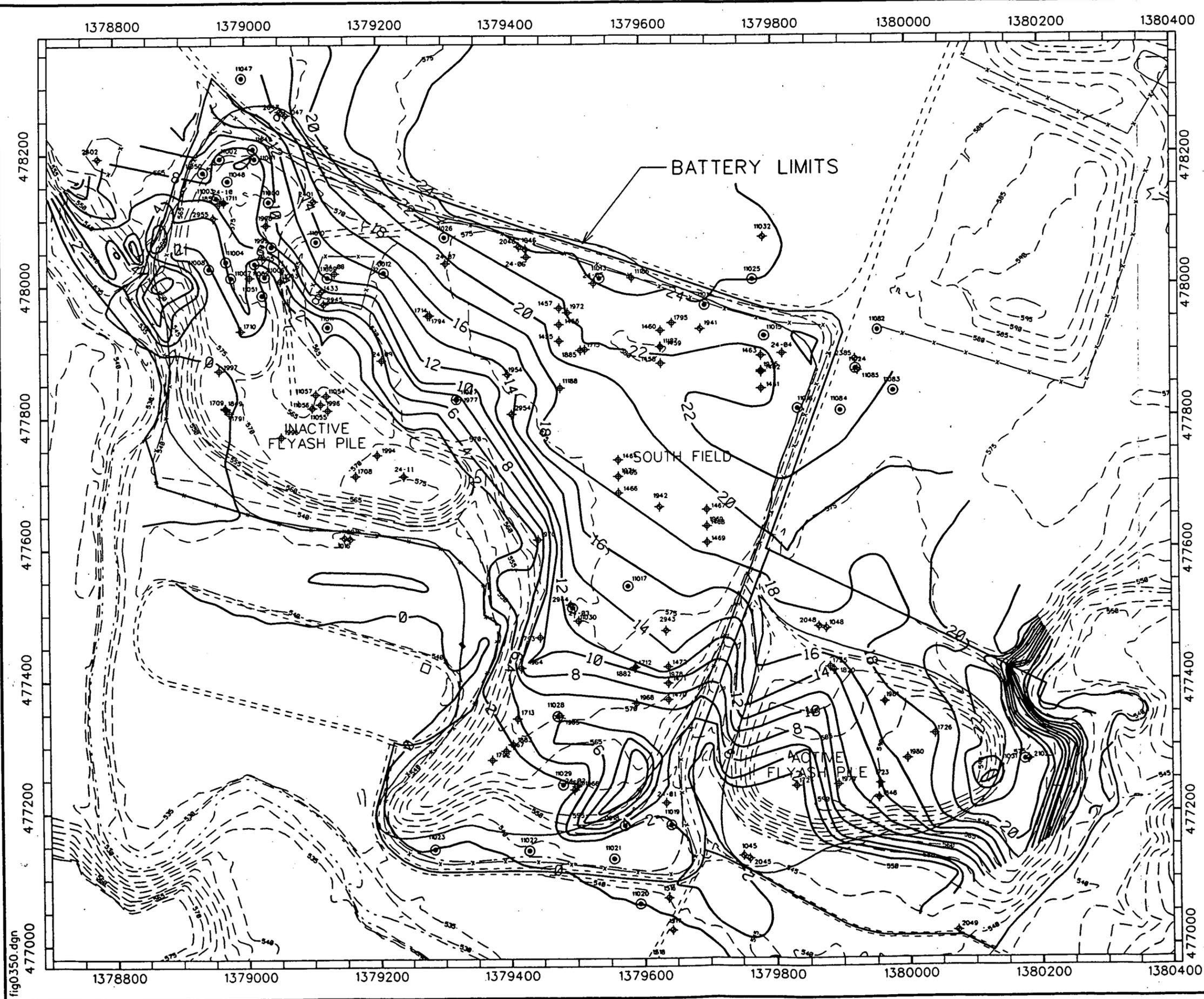
The Active Flyash Pile is a steep-sided pile of flyash that was built up over the years by truck-hauled loads of flyash that were dumped and compacted. The Active Flyash Pile is bounded on the west by a gravel access road that separates it from the South Field (Figure 3-42). A gravel lined ditch runs between the waste area and this road. To the north, east, and south, the Active Flyash Pile is bounded by an area that slopes downward toward the Storm Sewer Outfall Ditch. The Active Flyash Pile is uncovered, but wind barriers and a crusting agent have been applied to reduce wind erosion; silt barriers have been installed to control surface water erosion. The Active Flyash Pile is surrounded on the east, south, and west by dense trees and brush and on the north by a grass field.

3.5.1 Topography and Surface Water

The top of the Active Flyash Pile, at an elevation of approximately 597 feet above MSL, is presently a relatively flat surface that slopes towards the northwest. Steep slopes around the flyash pile drain surface water radially off the pile. The topography of the Active Flyash Pile is shown in Figure 3-42. Observations have indicated that surface water runoff is rapid for the top and side slopes of the Active Flyash Pile, which may indicate a lower permeability. Drainage from the top surface is downslope to the northwest, collected at the northwest corner, and directed along the west toe of the pile into an engineered drainage channel. Drainage from the north side slope is directed toward a drainage, shown in Figure 3-42, that channels flow east to the Storm Sewer Outfall Ditch. Drainage from the west and south slopes flows south and west along the toe of the pile and joins the engineered drainage channel to discharge at a silt trap located at the southwest corner of the pile. A small quantity of flow from the west slope drains east through a wooded area toward the Storm Sewer Outfall Ditch and infiltrates along the west bank of the Storm Sewer Outfall Ditch.

Runoff from the pile is rapid, and there is little to no residual drainage visible after a rain event is complete. Drainage through the silt trap is also rapid with little to no standing water visible after

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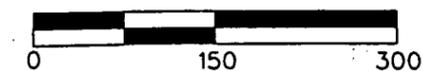
**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- 1000 MONITORING WELLS
- 2000 MONITORING WELLS
- SOIL BORING
- HYDROPUNCH
- THICKNESS CONTOUR

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



SCALE (FT)

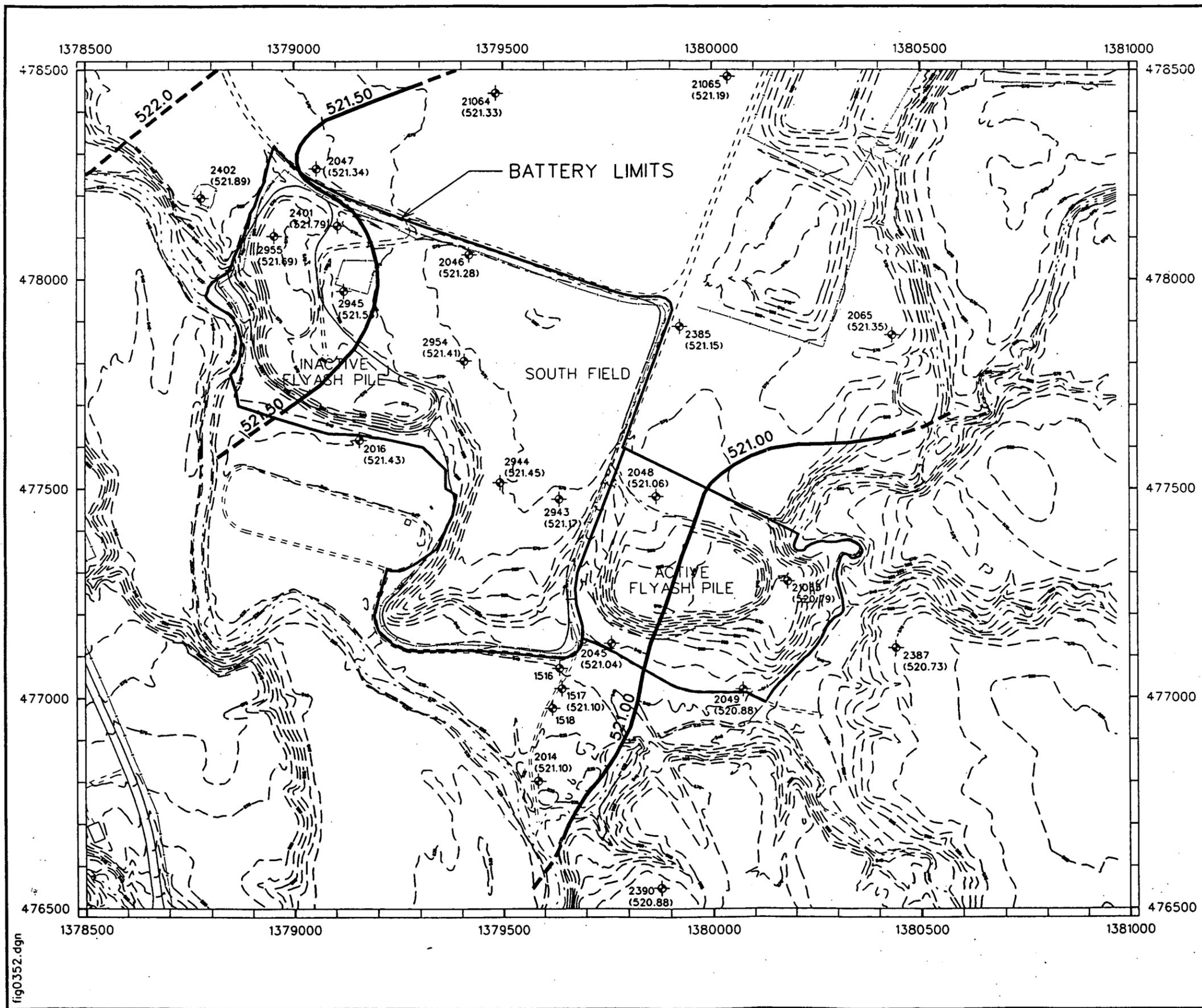


0283

**FIGURE 3-49**  
**THICKNESS OF TILL,**  
**SOUTH FIELD/**  
**FLYASH PILES AREA**

fig0350.dgn

5170



**LEGEND**

- 575— ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- 521.50 GROUNDWATER CONTOURS
- 2065 2000 MONITORING WELLS
- (521.35) GROUNDWATER ELEVATION

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

**SCALE (FT)**

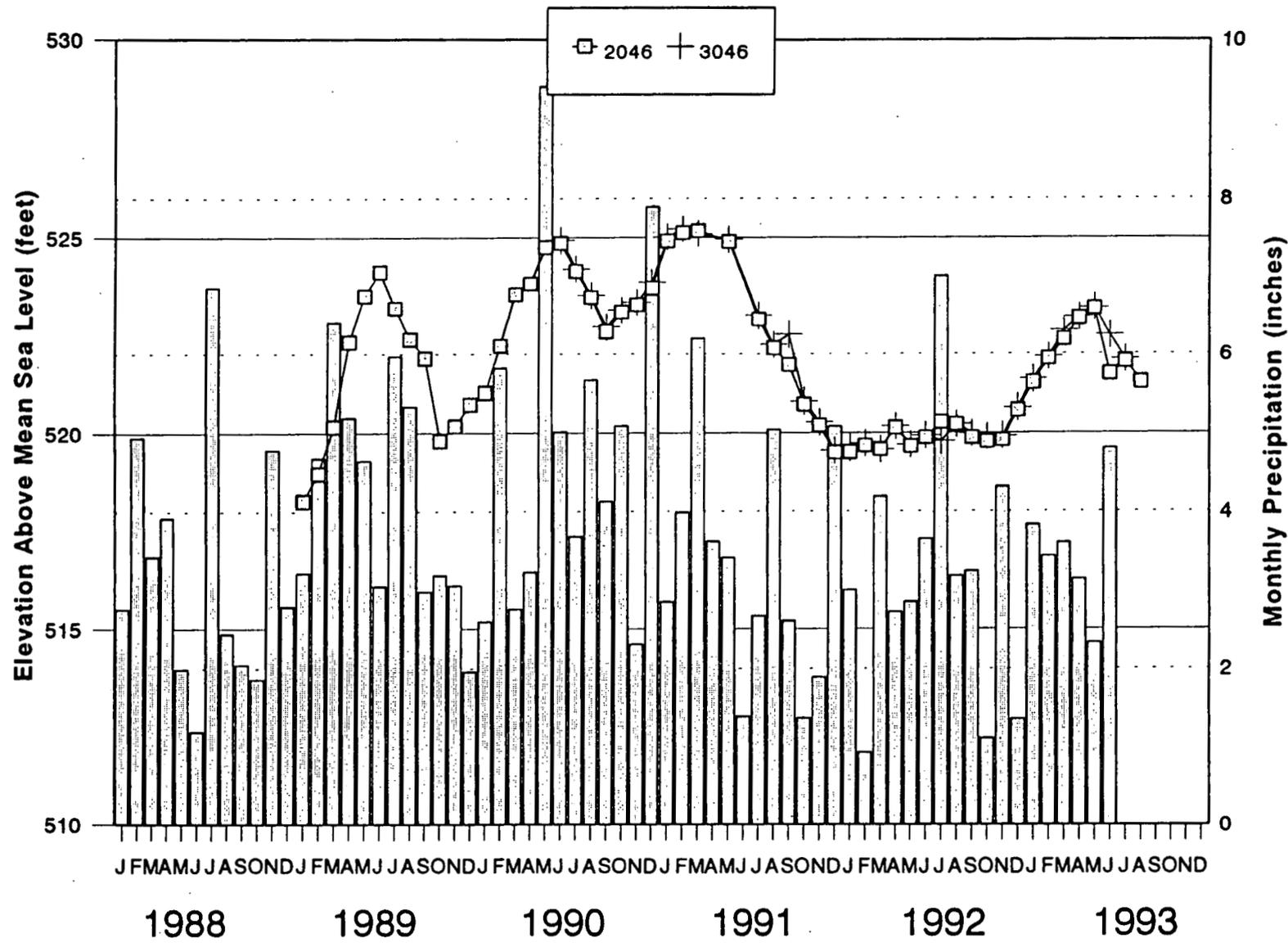
FIGURE 3-50 <sup>0284</sup>  
GROUNDWATER ELEVATIONS  
2000-SERIES WELLS  
SOUTH FIELD AND  
FLYASH PILE AREAS  
AUGUST 16, 1993

fig0352.dgn

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02850

02855



NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

5170

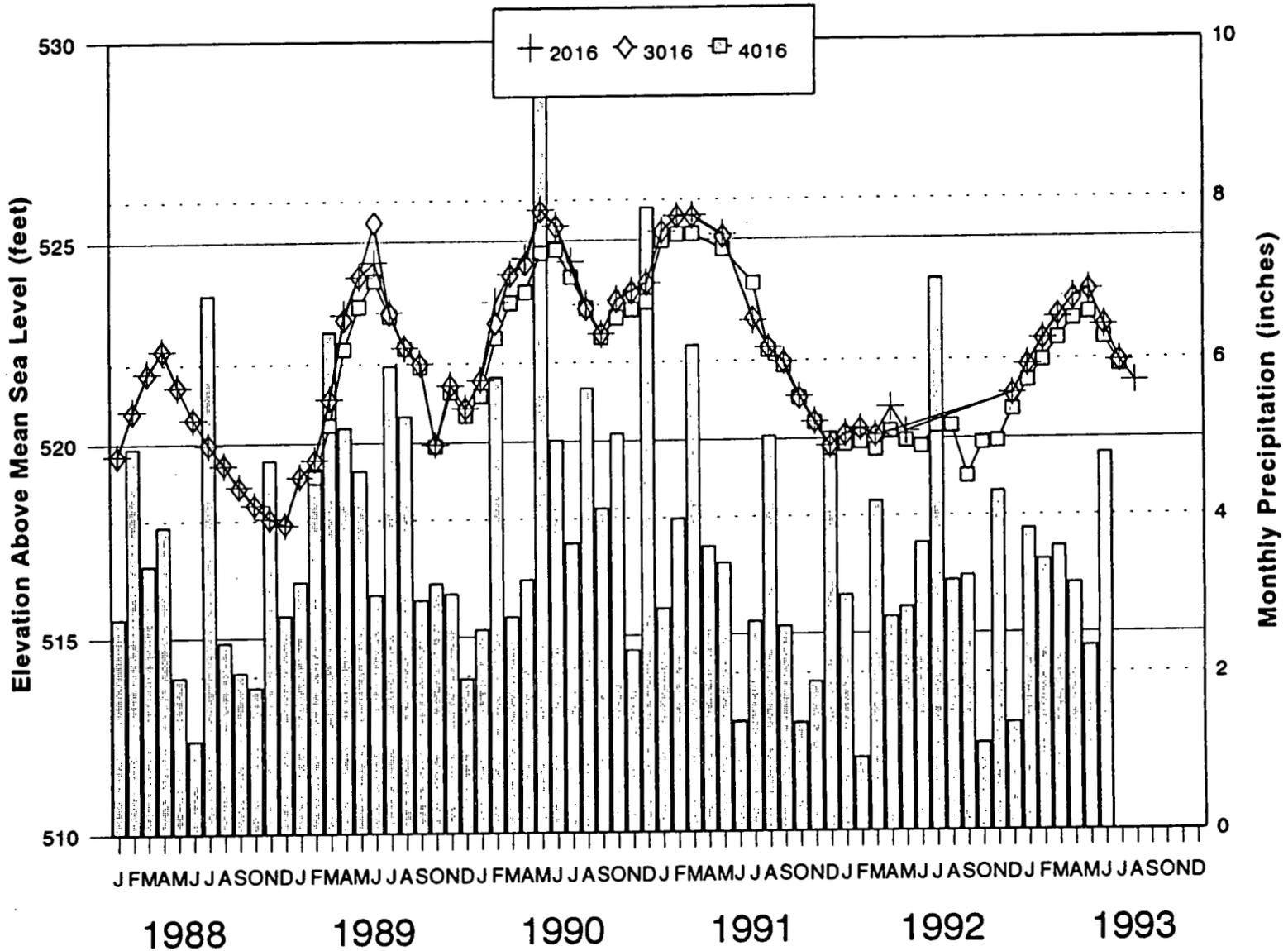
FEMF-U002-4 DRAFT 1  
February 18, 1994

FIGURE 3-51  
HYDROGRAPHS FOR MONITORING WELLS 2046 AND 3046, INACTIVE FLYASH PILE

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NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

FIGURE 3-52

HYDROGRAPHS FOR MONITORING WELLS 2016, 3016, AND 4016, INACTIVE FLYASH PILE

0219

precipitation ceases. Flow from the silt trap is south by sheet flow toward the Storm Sewer Outfall Ditch.

### 3.5.2 Geology and Groundwater Hydrology

The Active Flyash Pile has been used to dispose of flyash and bottom ash from the coal-fired boiler plant. Soil samples collected from borings in the Active Flyash Pile were used to define its structure. Groundwater monitoring wells were installed to define groundwater conditions. Two geologic cross sections are shown in Figure 3-53. The geologic cross sections represent the interpreted geology along the actual cross-section traces shown on the map insets. These sections do not represent straight-line correlations from boring to boring, rather they were derived from a three-dimensional aerial model based on all soil borings, prepared using Intergraph Corporation Microsoft PC Software. The cross sections indicate that the flyash pile was constructed on glacial overburden materials that range from less than 2 feet thick south of the pile (Well 1045) to 16 feet thick north of the pile (Well 1048). Approximately 19 feet of glacial overburden was encountered in a boring advanced on the east side of the pile (Well 21033). Contours of the thickness of glacial overburden are presented on Figure 3-49.

Groundwater within the glacial overburden ranges from 3 feet to 7 feet below the surface; however, a Hydropunch™ boring (11031) advanced at the east side of the pile did not locate saturated conditions in the glacial overburden. Hydrographs from wells in the glacial overburden (Wells 1045 and 1048) are presented in Figure 3-54 and Figure 3-55. Trends in elevation changes indicate that the two wells are monitoring a common hydrogeologic unit, and water levels in the glacial overburden fluctuate about five to seven feet per year.

Groundwater elevations in the perched groundwater aquifer were presented in Figure 3-46. Groundwater flows toward the southwest and southeast due to an apparent groundwater divide that exists north of the flyash pile (see Section 3.4.2 for detailed discussion). The calculated gradient, 0.019, was based on inferred equipotentials on August 16, 1993, in till underlying the pile that does not contain sand layers.

Saturated groundwater conditions were detected within sand and silt in Well 1048 and within a sandy clay unit in Well 1045. Water levels in these wells fluctuated 7.7 feet in Well 1048 (upgradient) and 4.8 feet in Well 1048 (downgradient) from January 1988 to March 1992. The groundwater levels in

5170

FEMP-OU02-4 DRAFT  
February 18, 1994

Well 1045 typically rose to within two feet of the surface during the January to March wet period, suggesting that the upgradient well at the north edge of the Active Flyash Pile is monitoring a potential recharge zone. In contrast, no saturated groundwater conditions were detected at the east edge of the Active Flyash Pile.

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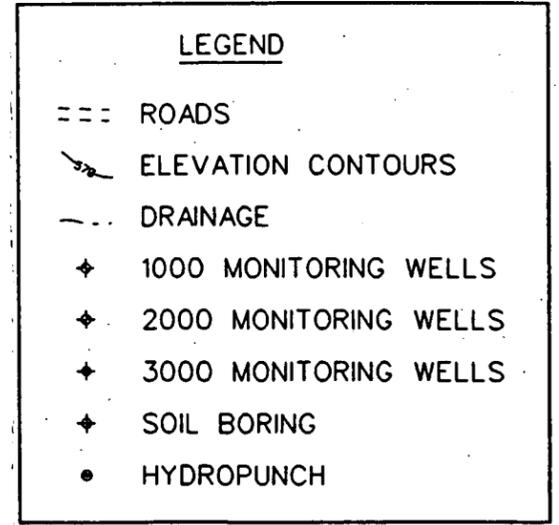
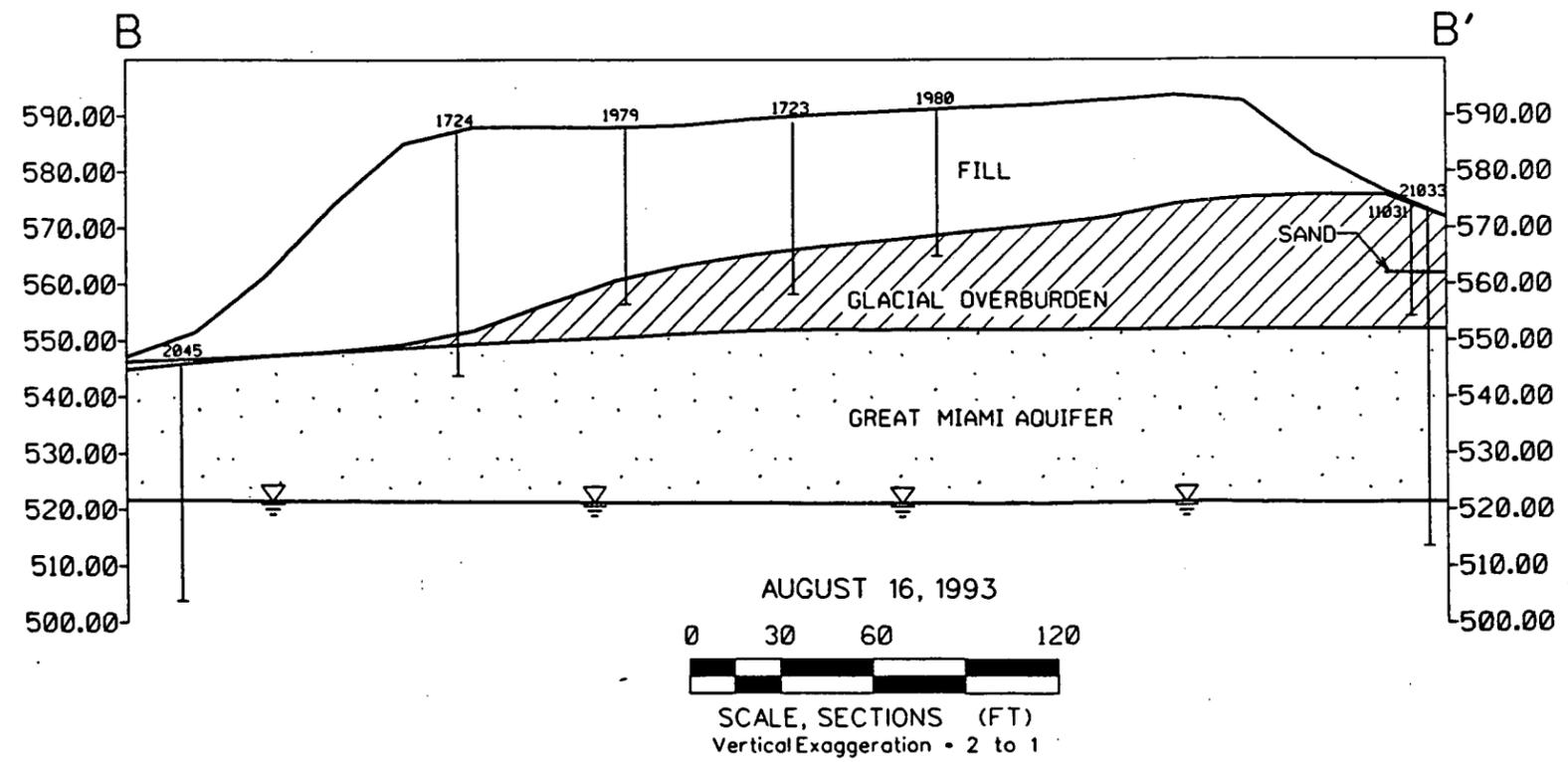
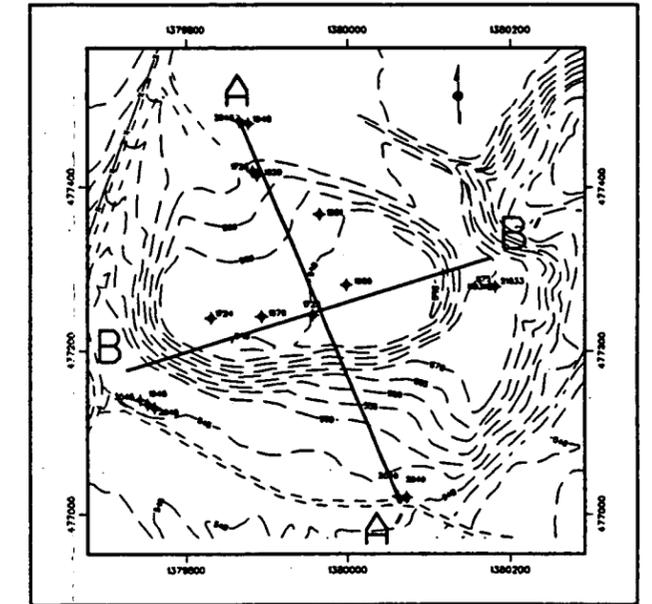
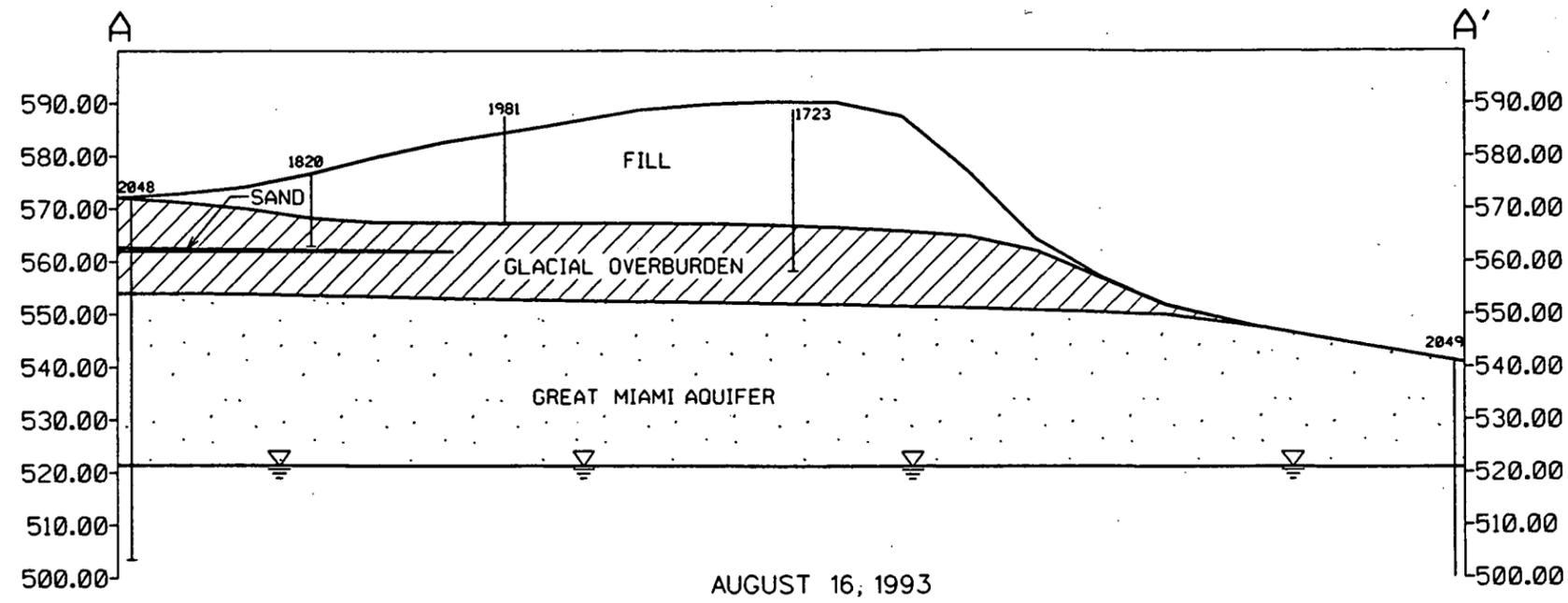


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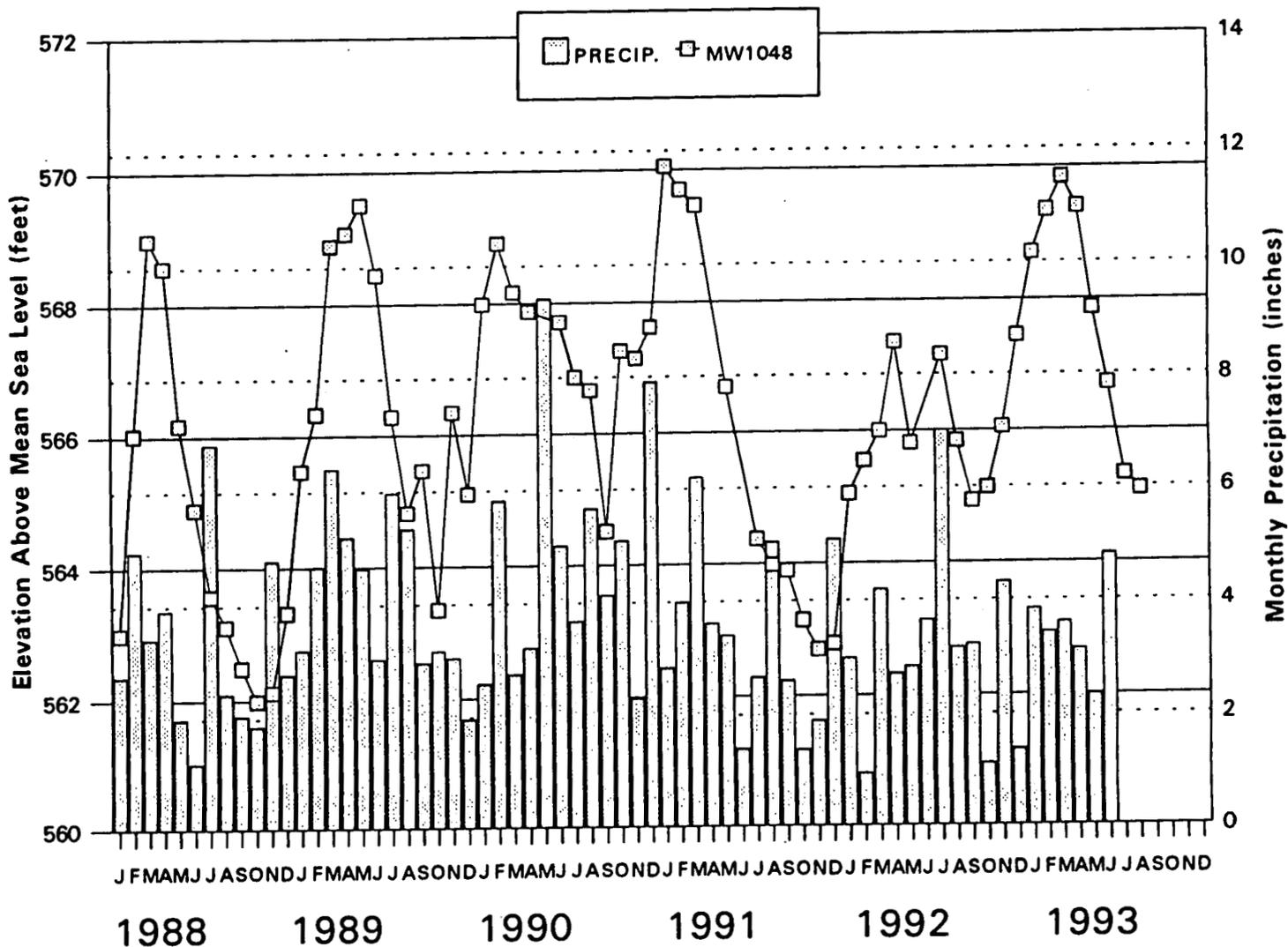
FIGURE 3-53  
GEOLOGIC CROSS SECTIONS,  
ACTIVE FLYASH PILE



3-100

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0580



NOTE: PRECIPITATION DATA FROM BOONE CO., KY AIRPORT

FIGURE 3-55  
HYDROGRAPH FOR MONITORING WELL 1048, ACTIVE FLYASH PILE

0291

#### 4.0 NATURE AND EXTENT OF CONTAMINATION

Section 4.0 provides a detailed discussion of nature and extent of constituents focuses on constituents that were determined to be contaminants of concern (COC's), which are defined in Section 6.0 of this RI report. This section also addresses radionuclides detected above background in ground water, surface water, sediment, and soils in Operable Unit 2. This allows for a more focused approach for discussing the nature and extent of constituents that comprise the greatest risk to human health. The summary tables in section 4.0 (i.e., Table 4-3) list all of the constituents analyzed, summarize the number of occurrences where constituents were detected above background, and provide the ranges of concentrations for each constituent. Detailed tables used to formulate the section 4.0 summary tables and tables listing all sampling results are provided in the appendices C through G. The discussion of nature and extent in this section concentrates on areas within the battery limits of the Operable Unit 2 subunits. Also included are data used to define background concentrations for comparison purposes.

The nature and extent of radiological and chemical constituents within Operable Unit 2 are based upon data collected during the Phase I and II field investigations and, to a limited extent, on field investigations conducted prior to Phase I (e.g., CIS and ES).

The range of chemical and radionuclide constituents that are present in Operable Unit 2 reflect the various uranium production and thorium operations conducted in the past at the FEMP. The radiological constituents include uranium and thorium isotopes and their progenies. Because the FEMP also processed recycled uranium from the Hanford facility during the 1970s, Operable Unit 2 could also be contaminated with uranium fission products. Other chemical constituents likely to be encountered at the FEMP based upon process knowledge include: tributyl phosphate, a mobilizing agent used in the extraction of uranium; PCBs; polynuclear aromatic Hydrocarbons (PAHs) from flyash or fuel oils; common organics such as acetone, 2-butanone (MEK), and methylene chloride; chlorinated phenoxy acid herbicides (used for weed control) and their degradation products; chlorinated organics used as degreasers or paint thinner; and various inorganic species (such as calcium, magnesium, fluoride, and heavy metals).

#### 4.1 BACKGROUND DATA

This section summarizes background data used to define the nature and extent of contamination in Operable Unit 2. The full range of statistical tests, which includes a comparison to background,

applied to identify CPC are presented in Section 6.0. A summary of the processes that generated the waste stored in Operable Unit 2 and the nature of the materials that are known. The results of environmental media background studies performed in the vicinity of the FEMP are discussed in this section. In addition, baseline concentrations of constituents in flyash are presented to support the evaluation of the Active Flyash Pile.

The background values presented for surface and subsurface soil were based on direct analysis of regional soils at three depths (0 to 6 inches, 36 to 42 inches, and 48 to 54 inches). Background concentrations calculated for surface soil includes the 0- to 6-inch sample set; subsurface soil include the combined 36- to 42-inch and 48- to 54-inch sample sets, as presented in the CERCLA/RCRA Background Soil Study (DOE 1993b). The values presented for perched groundwater and the Great Miami Aquifer were calculated from datasets developed for the Characterization of Background Water Quality for Streams and Groundwater (DOE 1993a). Samples collected for metals in the groundwater background study were filtered through a 0.45 micrometer ( $\mu\text{m}$ ) membrane filter; therefore, the background metal concentrations represent dissolved levels. Background radiological samples were not filtered; all radiological background concentrations and activities represent total levels.

4.1.1 Operable Unit 2 Process Data

In general, waste materials in Operable Unit 2 subunits consist of conventional industrial wastes associated with any large industrial facility such as boiler plant ash, water treatment sludge, construction rubble, and nonprocess trash. The wastes placed in Operable Unit 2 are not direct byproducts of the chemical and metallurgical processes used for uranium production. These process wastes were included in the three major waste streams (general sump sludge, neutralized raffinate, and magnesium fluoride) that were disposed on site in the Waste Pit Area (Operable Unit 1). Therefore, radionuclide contamination in Operable Unit 2 is apparently due to contamination resulting from past waste management practices.

The understanding of processes that generated the waste contained in Operable Unit 2 varies with each subunit. Operations that generated wastes contained in the Lime Sludge Ponds and the Active Flyash Pile are well known, whereas operations which contributed waste to the Solid Waste Landfill and the South Field are poorly documented.

The Lime Sludge Ponds received waste consisting of water treatment sludge, coal pile runoff, and boiler blowdown. The largest component, sludge, was generated by the addition of lime and aluminum sulfate to treat the site water supply for hardness. Elevated levels of certain inorganic constituents including aluminum, calcium, and magnesium would be expected, while organic and radionuclide contamination are not anticipated as a result of the processes that generated the lime sludge.

Ash from the coal-fired boiler plant was transported by truck and placed on the Inactive Flyash Pile from 1952 until the mid-1960s; after the mid-1960s, most flyash was sent to the Active Flyash Pile. Ash material placed at the Inactive Flyash Pile consists of bottom ash and flyash and includes ash collected from precipitators installed to control emissions from the boiler plant operation. Some unburned coal and rock are found in both piles, while soils and construction debris such as transite, reinforced concrete, and asphalt have also been disposed of at the Inactive Flyash Pile. To support evaluation of analytical results for the flyash pile samples, a literature search produced comparison data for normal constituents of ash. The findings are presented in Section 4.1.4.

No documentation of the types of wastes dumped at the Solid Waste Landfill has been discovered, although documents from the NLO engineering files indicate that the facility was intended as a sanitary landfill for nonburnable trash. A construction drawing, dated May 23, 1974, depicts five waste cells planned for the facility, but historical photographs and field investigations defined only one disposal cell and an evaporation pond. According to visual observation made during Phase I field investigation trenching at the landfill, the contents are mostly nonburnable. Trenching revealed that a variety of nonprocess solid wastes were placed in the landfill in addition to bagged trash, including bagged and loose asbestos materials, ceramic tiles, glass acid bottles, rubber hoses and tubing, medical wastes, fire hoses, steel cables, full and empty paint cans, asphalt roofing materials, respirator cartridges, and copper tubing. The trenching also uncovered very localized areas of higher radioactivity that could be process samples or media contaminated by process activities.

The least information is available on the activities that generated wastes disposed in the South Field, the largest of the Operable Unit 2 subunits. Field investigation confirm reports that this area was used for disposal of on-site construction/demolition rubble and soil with low levels of radioactivity. This material appears to have been placed within excavated pits by trucks and covered with native soils.

#### 4.1.2 Statistical Evaluation of Background Data

Data collected from Operable Unit 2 environmental media were compared with the 95th percentile of the validated background concentration datasets to identify constituent concentrations that exceeded naturally occurring or other non-site related levels of radiological or chemical constituents. Table 4-1A presents the calculated 95th percentile background concentrations for radiological and inorganic constituents in surface soil, subsurface soil, perched groundwater, and Great Miami Aquifer groundwater. Organic compounds in the soil and groundwater were considered to be waste-related regardless of their concentration. Background data for surface water in Paddys Run is not available because data have not been validated (DOE 1993a). Individual samples whose constituent concentrations exceed the respective 95th percentile background concentrations are identified as being not consistent with background data (Note: 95<sup>th</sup> percentile background concentrations are used in Section 4.0, to address nature and extent. The 95% UCL of the mean is used to determine the source terms for fate and transport modeling (Section 5.0) and the risk assessment (Section 6.0). The 95<sup>th</sup> percentile is used in this section because individual constituent concentrations are being compared to the population of background concentrations).

The initial step in calculating a 95th percentile background concentration is to determine the distribution of the data. This procedure is discussed in Appendix B. The 95th percentile background concentration is determined based on one of the following three methods dependent upon the distribution assumed to best fit the data.

#### Normal Distribution

If the background data distribution is assumed to be normal, the equation used to calculate the 95th percentile is:

$$\text{95th Percentile} = \bar{x} + Z_{(.95)} \times S$$

where:

- n = number of samples
- $\bar{x}$  = sample mean concentration
- $Z_{(.95)}$  = percentage point from the Normal distribution
- s = sample standard deviation

$$= \sqrt{\frac{1}{n-1} \sum_{i=1}^n (x_i - \bar{x})^2}$$

**TABLE 4-1A**  
**BACKGROUND CONCENTRATIONS**  
**FOR SOILS AND GROUNDWATER**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Analyte	Background Concentration <sup>a</sup>			
	Soils		Groundwater	
	Surface (0-6 inches)	Subsurface (36-42 and 48-54 inches combined)	Perched	Great Miami Aquifer
	(pCi/g)	(pCi/g)	(pCi/L)	(pCi/L)
<b>Radionuclides</b>				
Actinium-227	0.090	0.6 <sup>b</sup>	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Bismuth-210	1.003	0.564	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Bismuth-214	1.003	0.564	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Cesium-137	0.849	0.0 <sup>d,e</sup>	0.0 <sup>d,e</sup>	0.0 <sup>d,e</sup>
Lead-210	1.459	0.857	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Neptunium-237	0.0	0.0 <sup>c</sup>	0.0 <sup>d</sup>	0.0 <sup>d</sup>
Plutonium-238	0.0	0.0 <sup>c</sup>	0.0 <sup>d</sup>	0.0 <sup>d</sup>
Plutonium-239	0.0	0.0 <sup>c</sup>	0.0 <sup>d</sup>	0.0 <sup>d</sup>
Plutonium-240	0.0	0.0 <sup>c</sup>	0.0 <sup>e</sup>	0.0 <sup>d</sup>
Polonium-210	1.003	0.564	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Potassium-40	20.692	28.034	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Protactinium-231	0.090	0.6	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Radium-224	0.900	1.019	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Radium-226	1.528	1.470	1.0 <sup>b</sup>	1.20
Radium-228	1.170	1.325	5.2	4.50
Ruthenium-106	0.0 <sup>d</sup>	0.0	0.0 <sup>d</sup>	0.0 <sup>d</sup>
Strontium-90	0.0 <sup>d</sup>	0.56 <sup>b</sup>	0.0 <sup>d</sup>	0.0 <sup>d</sup>
Technetium-99	0.0 <sup>d</sup>	0.0 <sup>d</sup>	0.0 <sup>d</sup>	36.0
Thorium-228	1.519	1.341	1.04 <sup>b</sup>	1.52
Thorium-230	2.112	1.897	2.0 <sup>b</sup>	1.79
Thorium-232	1.469	1.269	0.0 <sup>d</sup>	0.0 <sup>d</sup>
Total Thorium	10.70 $\mu$ g/g <sup>g</sup>	9.470 $\mu$ g/g <sup>g</sup>	3.0 $\mu$ g/L <sup>b</sup>	2.0 $\mu$ g/L <sup>b</sup>
Uranium-234	1.319	1.037	1.9	1.9
Uranium-235/236	0.181	0.142	0.0 <sup>d</sup>	0.0 <sup>d</sup>

See footnotes at end of table

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0296

TABLE 4-1A  
(Continued)

Analyte	Background Concentration <sup>a</sup>			
	Soils		Groundwater	
	Surface (0-6 inches)	Subsurface (36-42 and 48-54 inches combined)	Perched	Great Miami Aquifer
<b>Radionuclides (Continued)</b>	(pCi/g)	(pCi/g)	(pCi/L)	(pCi/L)
Uranium-238	1.270	1.122	1.07 <sup>b</sup>	0.90 <sup>b</sup>
Total Uranium	3.24mg/kg <sup>g</sup>	2.54mg/kg <sup>g</sup>	4.0μg/L <sup>g</sup>	2.92μg/L <sup>g</sup>
<b>Metals</b>	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
Aluminum	13125.282	16277.291	0.123	0.184
Antimony	0.0 <sup>c</sup>	0.0 <sup>c</sup>	0.0 <sup>c</sup>	0.038
Arsenic	11.608	9.704	0.122	0.30
Barium	88.500	121.064	0.459	0.413
Beryllium	0.6	0.620	0.0018	0.003
Boron	25.100	43.204	not analyzed	not analyzed
Cadmium	0.770	0.910	0.007	0.006
Calcium	5296.781	150000	125.574	135.163
Chromium	17.057	20.953	0.0345	0.042
Cobalt	16.913	15.929	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Copper	15.700	20.23	0.03	0.130
Cyanide	0.230	0.17 <sup>b</sup>	0.0 <sup>c</sup>	0.0 <sup>c</sup>
Iron	24788.749	31188.164	10.965	4.0
Lead	29.575	15.780	0.05	0.029
Magnesium	1460	43052.339	49.627	38.070
Manganese	2257.945	1045.407	0.165	0.80
Mercury	0.30	0.29	0.0037	0.001
Molybdenum	0.0 <sup>c</sup>	0.27	0.028	0.027
Nickel	25.145	34.747	0.026	0.026
Potassium	1349.530	2007.519	29.736	3.087
Selenium	0.72	0.0 <sup>c</sup>	0.0 <sup>c</sup>	0.005 <sup>b</sup>
Silicon	1914.313	1609.496	not analyzed	10.491
Silver	0.0 <sup>c</sup>	0.0 <sup>c</sup>	0.04	0.023
Sodium	55.145	227.947	49.178	51.918

See footnotes at end of table

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TABLE 4-1A  
(Continued)

Analyte	Background Concentration <sup>a</sup>			
	Soils		Groundwater	
	Surface (0-6 inches)	Subsurface (36-42 and 48-54 inches combined)	Perched	Great Miami Aquifer
	(mg/kg)	(mg/kg)	(mg/L)	(mg/L)
<b>Metals (Continued)</b>				
Thallium	0.58	0.49 <sup>b</sup>	not analyzed	0.0 <sup>c</sup>
Tin	not analyzed	not analyzed	not analyzed	0.0 <sup>c</sup>
Vanadium	33.693	38.088	0.0195	0.027
Zinc	58.500	73.158	0.0317	0.105
<b>All Organic Compounds</b>				
	0.0	0.0	0.0	0.0
<b>General Water Chemistry</b>			(mg/L)	(mg/L)
Ammonia	NA	NA	4.5	3.24
Chloride	NA	NA	110.159	145.065
Fluoride	NA	NA	1.352	0.938
Nitrate	NA	NA	0.522	11.40
Total Phosphorus	NA	NA	0.223	0.030
Sulfate	NA	NA	141.894	359.847

<sup>a</sup>Source: DOE1993b (Soils), DOE1993a (Groundwater.) Value presented represents 95 percentile from site specific data except as noted. Metal background values for groundwater based on filtered samples; all other compounds are based on unfiltered samples.

<sup>b</sup>Value presented represents minimum detected value since 95th percentile UCL would be a nondetect.

<sup>c</sup>All values in the data set are nondetects; value assumed to be zero.

<sup>d</sup>This radionuclide is a fission product, and its presence in the environment is due only to atmospheric releases of radiation (e.g., weapons testing). This radionuclide is not naturally occurring and is only expected to be present at or near detectable activities in the surface soil.

<sup>e</sup>Not analyzed; value assumed to be zero.

<sup>f</sup>NA = Not Applicable.

<sup>g</sup>Individual activity concentrations of the three isotopes for uranium and thorium were converted to mass concentrations. The three isotope mass concentrations were added to obtain the total thorium or uranium mass concentrations.

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Lognormal Distribution

If the background data distribution is assumed to be lognormal, the equation used to calculate the 95th percentile is:

$$95\text{th Percentile} = e^{\bar{y} + Z_{(.95)} \times S_y}$$

where:

$$\begin{aligned} n &= \text{number of samples} \\ \bar{y} &= \text{sample mean of the log-transformed data} \\ Z_{(.95)} &= \text{percentage points from the Normal distribution} \\ S_y &= \text{sample standard deviation of the log-transformed data} \\ &= \sqrt{\frac{1}{n-1} \sum_{i=1}^n (y_i - \bar{y})^2} \end{aligned}$$

Undetermined Distribution

If the distribution of the background data could not be adequately determined, a non-parametric method was used to estimate the 95th percentile concentration. The initial step in this procedure is to order the data such that

$$x_1 \leq x_2 \leq \dots \leq x_i$$

where:

$$\begin{aligned} x_{j, (j-1 \text{ to } i)} &= \text{sample concentrations} \\ i &= \text{the number of background samples} \end{aligned}$$

The 95th percentile concentration is then determined to be

$$x_k$$

such that

$$k \geq i \times 0.95 \quad (i = \text{number of samples})$$

4.1.3 Flyash Baseline Concentrations

Typical flyash concentrations of trace elements, radionuclides, and organics were obtained from a literature search for comparison with data collected from the Active Flyash Pile to support evaluation of the nature and extent of contamination in the Active Flyash Pile. These values are presented in Table 4-1B. To develop a baseline with a greater degree of statistical confidence, particularly for the



TABLE 4-1B  
(Continued)

ELEMENTS COMPOSITION OF FLYASH (ppm)  
TOTAL METALS

	Mg	Mn	Ni	Se	Ag	V	Zn	Hg	B	Sn	Sr	Mo
	1432	157	263	1.7	< 1	390	195	0.126	218	75	668	293
	350	242	34.2	3.27	0.0008	< 50	92	< 0.01	179	85	68	10
	14700	273	75.1	14.7	< 1	< 100	102	0.146	274	3	0.43	40
	4200	374	108	16.4	0.7	14.7	386	< 0.01	392	10	2000	70
	181	12	92.9	73	0.7	0.3	854	0.14	1040	10	200	70
	4200	1000	37	0.02	1	47	56	0.22	2.4	15	150	46
	6100	50	0.12	5	0.28	0.5	0.3	< 0.01	260		3000	25
	73100	300	50	20	14	195	20	< 1	100		947	
	8700	200	169	20		270	800	< 1	300		4390	
	5600	500	65	5			120	< 1	200			
	15000	290		0.28			300	< 1	400			
	5500	150		11			403	0.72	290			
	4630	1190					106		980			
	5510						254					
	9470						153					
	24000						320					
	4720											
	5200											
	5200											
	5910											
	6200											
	5000											
	4180											
	4530											
	40000											
COUNT:	25	13	10	12	8	9	16	12	13	6	9	7
MEAN:	10544.52	364.46	89.43	14.20	2.34	118.61	260.08	0.45	356.57	33.00	1269.27	79.14
95%	40000.0	1610.7	215.6	73.6	14.0	390.0	677.3	0.70	1040.0	85.0	4390.0	269.6

RADIONUCLIDE COMPOSITION OF FLYASH

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TABLE 4-1B  
(Continued)

	Th-232 (pCi/g)	U-238 (pCi/g)	Ra-226 (pCi/g)	Pb-210 (pCi/g)	Po-210 (pCi/g)	Escaping Rn-222 (pCi/L)	Total U (ug/g)	Total Th (ug/g)
	1.56	2.31	2.22	2.07	0.86	0.039	19	150
	2.35	3.09	3.2	5	2.6	0.018		16
	2.3	3.2	3.44	4.6	1.9	0.079		330
	4.12	6.46	5.65	9.28	5.32	0.011		
	2.25	3.45	4.06	6.3	5	0.025		
	2.41	3.78	3.72	4.4	3.1			
	0.87	2.42	3	3.12	2.06			
	0.73	1.2	1.37	12.7	10.6			
	1.41	2.23	2.27	2.53	0.94			
COUNT:	9	9	9	9	9	5	1	3
MEAN:	2.000	3.127	3.214	5.556	3.598	0.0344	19	165.333
95%	4.3	6.1	5.3	12.5	10.3	0.1	19.0	330.0

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metals and radionuclides, numerous sources were utilized. The criteria for obtaining applicable values were as follows:

- Data resulting from the combustion/conversion of coal only were used. All flyash data resulting from oil-fired boiler systems were excluded.
- The types of coal used in the systems were generally bituminous and sub-bituminous, although a few of the studies included lignite coal-fired units. This is considered applicable since a search of the historical coal delivery records was unable to define a single type of source coal.
- Data included in the baseline mean were obtained only from flyash piles and electrostatic precipitator hopper ash (or similar dry ash technology). All data obtained from wet ash control technologies were excluded.
- All data were analyzed in accordance with comparable methods for the determination of total metals (e.g., ICAP, GFAA, X-ray diffraction, etc.).
- Data were reported in units of ppm [milligrams per kilogram (mg/kg)] or percentages convertible to ppm and pCi/g for radionuclides.

The background ash 95th percentile concentrations were developed in accordance with the procedures described in section 4.1.2 and presented in Table 4-1A. A few of the reference studies reported data as a mean developed from multiple data points; these data were considered to be a single data point for the purpose of calculating the 95th percentile. Multiple data points presented within a single reference were considered in the calculations as discreet data points. Not all studies contained data for each parameter of concern.

### Metals

The majority of the data obtained for trace constituents of flyash from the combustion of coal were metals. Many studies have been conducted to determine the amount and type of metals in flyash due to the environmental concerns regarding the potential for the leaching of metals. Three data points were eliminated from the final dataset of trace element composition because these concentrations were two orders of magnitude greater than all other data points for that analyte. By removing these three data points, the dataset is more conservative (e.g., biased low rather than high). It should also be noted that one study presented Extraction Procedure Toxicity test data to indicate the leaching potential of metals from typical flyash. The following summary provides the results of the extraction test using the Extraction Procedure Toxicity test for metals:

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Extraction Procedure	Concentration
<b>Toxicity Metals</b>	
Arsenic	< 0.2 µg/L
Barium	2.8 µg/L*
Cadmium	< 0.1 µg/L
Chromium	< 0.5 µg/L
Lead	< 0.5 µg/L
Selenium	< 0.2 µg/L
Silver	< 0.1 µg/L
Mercury	< 0.0005 µg/L

\*Note that seven total data points were collected. The result listed for barium was the only detectable result reported.

Source: Kilkelly Environmental Associates, 1991

Radionuclides

Only two studies were found that met the data acceptance criteria presented (see references; Garcez and Titlebaum, 1984; and Labuz, 1986). Few values were found for the parameters of total uranium and total thorium. The limited data for these two parameters (only one data point in the case of total uranium), is presented in Table 4-1B.

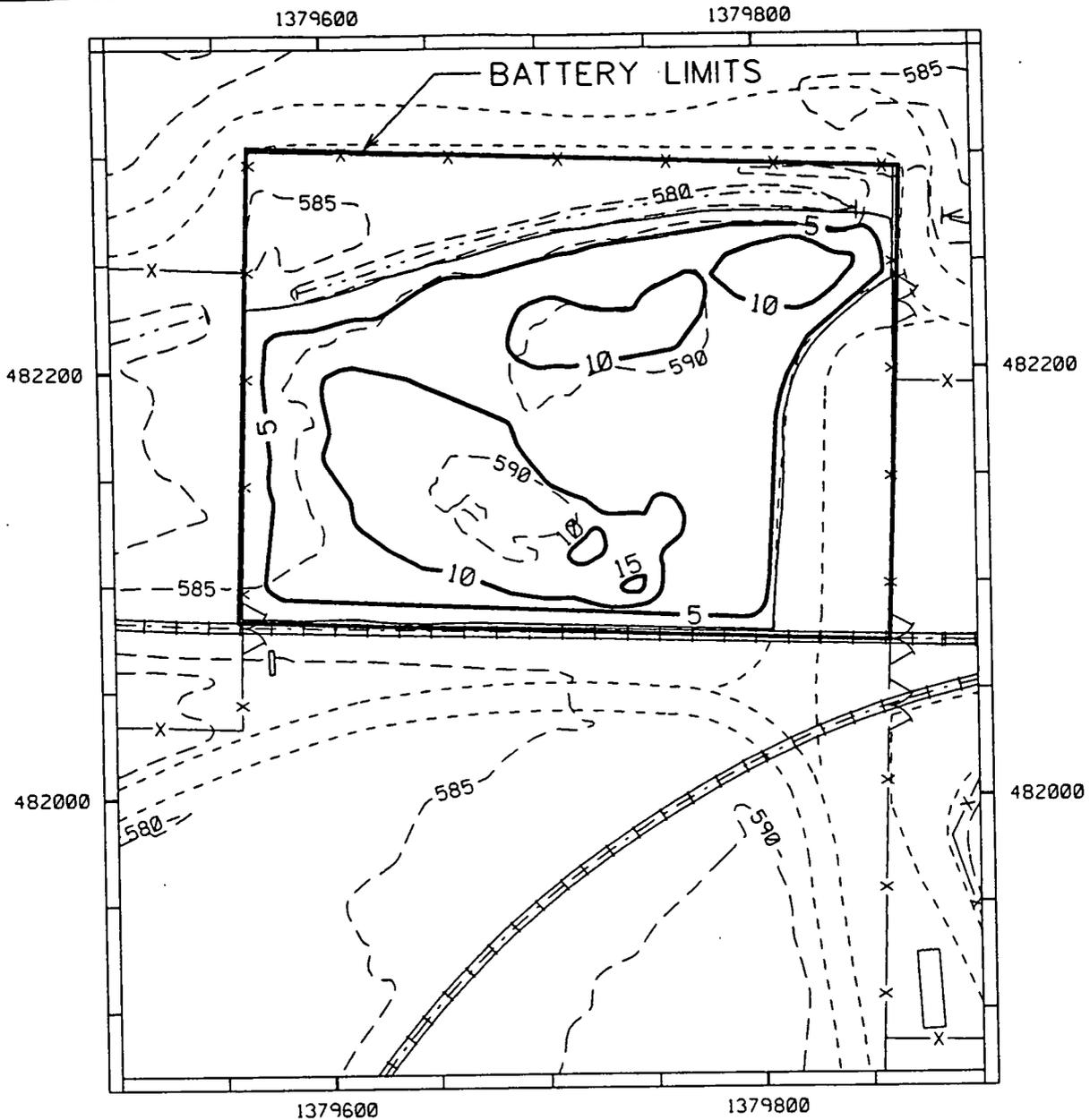
4.2 SOLID WASTE LANDFILL

Analytical results for samples collected from the Solid Waste Landfill are presented in Appendix C. The nature and extent of COCs for the Solid Waste Landfill and radionuclides detected above background will be discussed in this section. Geology and hydrogeology of the Solid Waste Landfill referred to in this section are discussed in more detail in Section 3.0.

4.2.1 Volume and Physical Characteristics

The volume of waste material at the Solid Waste Landfill was estimated by means of digitized topographic maps, boring log data, and interpolation using Intergraph Corporation Microstation PC software. Volume calculations are summarized in Figure 4-1. The volume of waste material is calculated to be approximately 14,425 cubic yards.

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**LEGEND**

- 575- ELEVATION CONTOURS
- == ROADS
- - - DRAINAGE
- 5- THICKNESS OF FILL
- x- FENCE
- == RAILROAD

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
SCALE (FT)

Fill Depth From	To	Volume (Cu. Yd.)
0	5	641
5	10	7659
10	15	6078
15	20	47
<b>TOTAL</b>		<b>14425</b>

**FIGURE 4-1  
VOLUME OF  
WASTE MATERIAL,  
SOLID WASTE LANDFILL**

fig0401.dgn

A plan for an extension to the Solid Waste Landfill prepared by the National Lead Company in May 1974 showed five waste disposal cells and an evaporation pond. However, construction of four of the five waste cells could not be confirmed through interviews with employees or by examining historical aerial photographs. A 1976 aerial photograph of the landfill shows the presence of the evaporation pond at the west edge of the landfill and Cell 1, located parallel to the south boundary of the landfill. Soil gas sample collection and trenching were used to determine the extent of waste disposal. Soil gas data from samples analyzed in the field indicate areas of elevated methane and VOC in the southeast corner and the east side of the landfill. These results are consistent with the existence of one waste cell and the evaporation pond and were shown in Figure 2-3.

Visual identification of waste materials encountered in three trenches excavated in July 1992, and borings completed in 1993 are summarized in Table 4-2A. These data were used to improve the conceptual model of the landfill construction. Visual examination of samples from excavations dug in the landfill detected waste in discrete locations at depths ranging from near surface to ten feet. The waste materials found at a depth of ten feet appear to have been dumped and buried close to the estimated original land surface in the landfill. The waste distribution appears to be consistent with face dumping practices and not waste disposal trenches. A few samples of waste were detected in soil borings deeper than 10 feet deep.

Waste materials identified in the landfill included materials possibly originating from the cafeteria (plastic cup lids), the medical lab (plastic bag containing medical waste), maintenance/construction department (wood, roofing shingles, and paint cans) and from the process sampling [(yellow material emitting estimated 50,000 counts per minute (cpm))]. A summary of detected chemicals and their possible origin at the FEMP is presented as Table 4-2B. Detected organic compounds in samples from the landfill indicate that historical sources for the detected compounds include cafeteria wastes (benzoic acid), medical laboratory wastes (phenanthrene and pyrene), manufacturing waste (2-butanone and carbon disulfide) or construction and maintenance waste (pentachlorophenol, carbazole, and 4,4-DDE).

4.2.2 Surface and Subsurface Media

To determine the presence of constituents due to DOE activities, chemical and radiological analytical results were compared to soil background concentrations. Analytes detected above background in surface soils during Phase II are presented in Table C-2A in Appendix C and summarized in

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**TABLE 4-2A**  
**SUMMARY OF WASTE CHARACTERISTICS**  
**AND ANALYTICAL RESULTS FROM TRENCHING**  
**ACTIVITIES AND SOIL BORINGS IN THE SOLID WASTE LANDFILL**

Location/Date	Materials encountered, samples and field observations	Analytical Results	
Trench 1. Located perpendicular to possible waste Cell 5 and 4. 7/7/92	<p><u>South end:</u> medical vials and bagged asbestos at shallow depths (&lt;3' deep). Construction debris, found as deep as 10 feet. Leachate sample collected.</p> <p><u>North end:</u> (at edge of landfill where drainage cuts through) plastic bags, glass bottles and trash found to 10' deep.</p>	Leachate <sup>a</sup> from the south end (Sample 039151): U-238 = 151 pCi/L Total U = 375 µg/L Total Th = 1.36 µg/L	No organics detected
Trench 2. Located perpendicular to possible Cell 2 and North edge of Cell 1. 7/16/92	<p><u>South end:</u> Trash found at less than 1 foot deep Leachate sample collected (rads)</p> <p><u>Center:</u> Medical waste material and plastic bags found to 5' deep. No sample collected.</p> <p><u>North end:</u> Roofing materials and wood found to 5' deep. Leachate sample collected (rad and organic)</p>	<p>Leachate from south end (039160): U-238 = 311 pCi/L Total U = 776 µg/L Total Th = 2.38 µg/L</p> <p>Leachate from North end (039163): U-238 = 532 pCi/L Total U = 1530 µg/L Total Th = 1.69 µg/L</p>	Organics from north end (039163) Fluoride = 1.9 mg/L Phenols = 558 µg/L Benzoic Acid = 290 µg/L Acenaphthene = 89 µg/L Phenanthrene = 89 µg/L Fluorene = 68 µg/L 2-methylnepthalene = 70 µg/L 2-methylphenol = 48 µg/L Anthracene = 25 µg/L Pyrene = 11 µg/L
Trench 3. Located perpendicular to Cell 1, approximately midway in Cell 1 7/13/92	<p><u>South end:</u> Trash at surface, assorted medical and production waste from 3 to 7 feet deep. One report of copper tubing at 10-12' deep. Leachate sample collected (rad and organic)</p> <p><u>Center:</u> A yellow colored material registering a reported 50,000 cpm detected at 6' deep. No sample collected.</p> <p><u>North end:</u> Paint cans at 2-3' deep. Trench terminated at 3' deep here. No sample collected.</p>	Leachate from South end (039155): U-238: 868 pCi/L Total U : 1610 µg/L Total Th : <0.5 µg/L	No organics detected

See notes at end of table

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TABLE 4-2A  
(Continued)

Location/Date	Materials encountered, samples and field observations	Analytical Results	
Boring 11036 Located at possible west end of Cell 1 completed 5/17/93	No waste observed up to 4.5' deep. Silty clay had 3500-4000 cpm at 5' deep.  Sample 115381 (2.5'-5.0' deep)	U-238 = 557 pCi/g Total U = 1770 µg/g Ra-228 = 6.65 pCi/g Total Th = 75.6 µg/g Tc99 = 5.13 pCi/g	20 organic compounds including: Benzopyrene = 230 µg/kg Crysene = 350 µg/kg Fluoranthene = 630 µg/kg Total Xylenes = 54 µg/kg Ethylbenzene = 15 µg/kg
	Sample 115380 (17'-19' deep) collected to define clean conditions beneath waste.	U-238 = 1.08 pCi/g Total U = 3.1 µg/g Ra228 = 0.86 pCi/g Total Th = 6.5 pCi/g	bis(2-Ethylhexyl) phthalate = 1600 µg/kg Toluene = 13 µg/kg 1,1-Dichloroethene = 1 µg/kg
Boring 11037 Located at North end of Trench 3, in area of possible waste disposal Cell 2. 5/15/93	Sample 115374 collected from leachate at 21-22' deep	Leachate analyzed on site: Total U = 1000 µg/L	
	Plastic cup lids, assorted kitchen waste, glass Sample 115371 (5'-7' deep)	U-238 = 1.19 pCi/g Total U = 5.01 µg/g Ra228 = 1.16 pCi/g Total Th = 9.12 µg/g	Fluoranthene = 89 µg/kg Benzo(a)anthrene = 48 µg/kg Crysene = 48 µg/kg Benzo(b)fluoranthene = 67 µg/kg
	Native till beneath waste material Sample 115372 (17.5'-20' deep)	U-238 = 1.56 pCi/g Total U = 5.5 µg/g Ra228 = 0.81 Total Th = 7.19	Di-n-octylphthalate = 55 µg/kg 4-Methyl-2-pentanone = 30 µg/kg 2-Hexanone = 2 µg/kg
Boring 11038 Located within possible waste Cell 1. 5/16/93	Yellow material detected at 2.5' deep that had 28,000 cpm (approximate location of center of Trench 3) Sample 115376 (0'-2.5' deep)	U-238 = 78.4 pCi/g Total U = 230 µg/g Ra228 = 1.45 Total Th = NA**	12 organic compounds including: Fluoranthene = 780 µg/kg Phenanthrene = 400 µg/kg Pyrene = 630 µg/kg Crysene = 400 µg/kg
	Sample 115377 (12.5'-15' deep) Collected to define clean conditions beneath waste	U-238 = 0.82 pCi/g Total U = 5.32 pCi/g Ra228 = 0.88 pCi/g Total Th = 6.85 µg/g	Toluene = 5 µg/kg

See notes at end of table

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TABLE 4-2A  
(Continued)

Location/Date	Materials encountered, samples and field observations	Analytical Results	
Boring 11039 Located adjacent to North end of Trench 2, in area of possible waste disposal Cell 2 5/19/93	Sample 115388 of Leachate collected from 8-10' deep (water detected between 6-7' deep)	Leachate analyzed on site: 650 ppb Total U	
	Sample 115384 (2.5-5' deep) Black roofing shingles, tar observed in soil	U-238 = 119 pCi/g Total U = 375 µg/g Ra228 = 1.06 pCi/g Total Th = 6.9 pCi/g	over 21 organics detected including: Acenaphthene = 140,000 µg/kg Benzo(K)fluoranthene = 140,000 µg/kg Fluorene = 180,000 µg/kg Pyrene = 610,000 µg/kg
	115385 (12-14' deep) Collected to detect clean conditions below waste	U-238 = 1.18 pCi/g Total U = 6.08 µg/g Ra228 = 0.759 pCi/g Total Th = 47 pCi/g	19 organics detected including: Acenaphthene = 370 µg/kg Benzo(k)fluoranthene = 740 µg/kg Fluorene = 430 µg/kg Pyrene = 1900 µg/kg
Boring 11040 5/20/93	Sample 115398 of leachate collected from 25-30' deep	Leachate analyzed on site: 50 µg/L Total U	
	Sample 115392 (2.5-5' deep) pieces of plastic and wood detected	U-238 = 1.84 pCi/g U-Total = 8.49 µg/g Ra228 = 1.13 pCi/g Total Th = ND*	14 organics detected including: Fluoranthene = 770 mg/kg Benzo(K)Fluoranthene = 290 mg/kg Pyrene = 640 µg/kg
	Sample 115393 (12.5-15' deep) Sample collected to detect clean conditions beneath waste	U-238 = 0.9 pCi/g Total U = 2.49 µg/g Ra228 = 0.9 pCi/g Total Th = ND	No organics detected
Boring 1985 Located adjacent to South boundary of waste Cell 1 4/27/93	No waste material detected in borehole no change from background cpm Sample 111441 (2-4' deep)	U-238 = 19.77 pCi/g Total U = 62.3 µg/g Ra228 = 1.19 pCi/g Total Th = 6.03 µg/g	20 organic compounds including: Fluoranthene = 1700 µg/kg Benzo(k)fluoranthene = 700 µg/kg Crysene = 940 µg/kg Phenanthrene = 970 µg/kg Pyrene = 1500 µg/kg

See notes at end of table

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TABLE 4-2A  
(Continued)

Location/Date	Materials encountered, samples and field observations	Analytical Results	
Boring 1985 Located adjacent to South bound of Waste Cell I 4/27/93 (continued)	Sample 111448 (15'-17' deep) Sample collected to detect clean conditions beneath possible waste disposal zone	U-238 = 1.52 pCi/g Total U = 5.91 µg/g Ra228 = 0.98 pCi/g Total Th = 8.52 µg/g	bis(2-ethylhexyl) Phthalate = 1700 µg/kg
Boring 1986 Located adjacent to center of trench 2, possibly in Waste Cell 1 4/30/93	Yellow material detected at 4.5' deep had 10,000 cpm, green material observed to 10' deep. (170 cpm) Sample 111452 (2.5-5' deep)	Total U = 1280 µg/g Total Th = 15.5 µg/g	18 organic compounds including: Pyrene = 1100 µg/kg Phenanthrene = 1100 µg/kg Benzo(a)anthracene = 490 µg/kg Fluoranthene = 1300 µg/kg
	Sample 111458 (12.5-15' deep) Clayey sand sample collected to detect clean conditions beneath waste	U238 = 0.83 pCi/g Total U = 11.4 µg/g Ra228 = 0.92 pCi/g Total Th = 7.35 µg/g	Acetone = 9 µg/kg bis(2-ethylhexyl) Phthalate = 950 µg/kg
Boring 1988 Located South end of Trench 2, possibly in waste disposal Cell 1 or 2 5/12/93	Waste material seen in soil samples collected to 4.5-5' deep including plastic burned materials and mica (vermiculite?). 300 cpm detected at 4' deep. Sample 115351 (2.5-5' deep)	U-238 = 37.8 pCi/g U-Total = 109 µg/g Ra228 = 2.56 pCi/g Total Th = 17.8 µg/g	7 organic compounds including Fluoranthene = 160 µg/kg Total xylenes = 260 µg/kg Phenanthrene = 82 µg/kg Pyrene = 100 µg/kg
	Sample 115351 (17.5-20' deep) Collected to detect clean conditions beneath waste	U-238 = 0.961 pCi/g U Total = 3.62 µg/g Ra228 = 1 pCi/g Total Th = 7.58 µg/g	Total xylenes = 1 µg/kg bis(2-ethylhexyl)phthate = 410 µg/kg

<sup>a</sup>All leachate samples are unfiltered.

\*ND = Not detected

\*\*NA = Not analyzed

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TABLE 4-2B

SELECTED CHEMICALS DETECTED IN SAMPLES COLLECTED  
FROM THE SOLID WASTE LANDFILL AND THEIR COMMON USAGE  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Detected Chemical	Common Usage	Possible Historical Use at FEMP
Anthracene	associated with phenanthrene, possible biomedical research	medical lab
Acenaphthene	insecticide	maintenance
Benzoic acid	food preservative	kitchen
2-butanone (MEK)	cleaning fluid	maintenance, metallurgy
Carbon disulfide	floatation agent, solvent	metallurgy
Carbazole	pesticide	maintenance
Chrysene	organic intermediary	metallurgy
Chlorophenol	organic intermediary	metallurgy
Di-n-butyl phthalate	organic intermediary	metallurgy
Chloro-methylphenol	germicide	medical, kitchen
2 methyl-naphthalene	emulsion breaker	metallurgy
Naphthelene	scintillation counters	lab
Pentachlorophenol	wood preservative	construction department
Phenanthrene	biochemical research	medical lab
Pyrene	biochemical research	medical lab
1,1,1-trichloroethane	degreaser	maintenance, metallurgy

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0  
5  
1  
7  
0

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Table 4-3. Twelve surface soil samples were collected from twelve locations during the Phase II field program. These samples were analyzed for the constituents listed in summary Table 4-3.

Background concentrations were exceeded for fifteen metals, isotopes of six elements, and twenty three organic compounds. No surface soil samples were collected during Phase I. Beryllium and chromium were detected above background concentrations in surface soil samples as shown on Figure 4-2 (see Volume 2 Oversized Figures). Molybdenum and silver were consistently detected at concentrations that were ten times above background, suggesting that metallurgical wastes are part of the surface soil cover at the landfill. Arsenic was not detected above background in surface soil samples. Radioisotopes detected above background surface soil concentrations are shown on Figure 4-2 (see Volume 2, Oversized Figures). Isotopes of uranium exceeded five times background in most samples and the isotopes of plutonium, cesium, and radium were detected at trace activity levels. The distribution does not suggest a single hot spot source area.

Organic compounds detected in surface soil samples are shown on Figure 4-2. Four volatiles organic compounds, eighteen semivolatile organic compounds, and one pesticide were detected in 12 samples. Volatile organics were found at trace concentrations in surface soil samples and the semivolatile organics, representing the greater portion of detected organics, were generally detected at higher than trace concentrations. The distribution of organic constituents suggests that organic chemical waste from production, metallurgy, medical laboratory, construction, and maintenance are incorporated throughout the surface soil cover and that there are no defined hot spots.

A comparison of the Phase II surface soil data to the CIS and ES surface soil data, for samples collected within the battery limits of the Solid Waste Landfill in Appendix C-4 and C-5, indicates that the parameters that were detected in these preliminary studies were also detected in Phase II and within the same order of magnitude, except for uranium-238, which was one order of magnitude higher in the CIS results for location SS46362.

Analytes detected above background in subsurface soil samples are presented in Table C-2B and Table C-2C in Appendix C and summarized in Table 4-4 and Table 4-5. Radionuclides and metals detected above background in subsurface soil samples are shown on Figure 4-3 (see Volume 2, Oversized Figures) and organic compounds are shown on Figure 4-4 (see Volume 2, Oversized Figures).

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**TABLE 4-3**  
**SOLID WASTE LANDFILL**  
**SURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>METALS</b>							
Aluminum	mg/kg	13125.282	12	12	6610	18400	3
Antimony	mg/kg	.000	0	12	0	0	0
Arsenic	mg/kg	11.608	12	12	4.4	8.3	0
Barium	mg/kg	88.500	12	12	44.6	101	4
Beryllium	mg/kg	.600	12	12	.46	.97	4
Cadmium	mg/kg	.770	1	12	.85	.85	1
Calcium	mg/kg	5296.781	12	12	6970	112000	12
Chromium	mg/kg	17.057	12	12	8.2	19.9	2
Cobalt	mg/kg	16.913	12	12	2.8	10.2	0
Copper	mg/kg	15.700	12	12	8.6	57.6	6
Cyanide	mg/kg	.230	0	12	0	0	0
Iron	mg/kg	24788.749	12	12	10600	24000	0
Lead	mg/kg	29.575	12	12	3.2	33.3	1
Magnesium	mg/kg	1460.000	12	12	4330	37900	12
Manganese	mg/kg	2257.945	12	12	349	826	0
Mercury	mg/kg	.300	0	12	0	0	0
Molybdenum	mg/kg	.000	10	12	4.4	7.3	10
Nickel	mg/kg	25.145	12	12	7.7	23.1	0
Potassium	mg/kg	1349.530	12	12	924	1800	5
Selenium	mg/kg	.720	1	12	.42	.42	0
Silicon	mg/kg	1914.313	12	12	453	996	0
Silver	mg/kg	.000	12	12	3.1	7.4	12
Sodium	mg/kg	55.145	12	12	65.6	206	12
Thallium	mg/kg	.580	0	12	0	0	0
Vanadium	mg/kg	33.693	12	12	17.7	46	3
Zinc	mg/kg	58.500	12	12	28.8	83.4	2
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.849	5	12	.0718	.257	0
GROSS ALPHA	pCi/g	.000	12	12	17.4	95	12
GROSS BETA	pCi/g	.000	12	12	22.1	112	12
NP-237	pCi/g	.000	8	8	.0457	3.11	8
PU-238	pCi/g	.000	10	12	.0191	.9024	10
PU-239/240	pCi/g	.000	7	12	.0191	.126	7
RA-226	pCi/g	1.528	12	12	.915	2.26	2
RA-228	pCi/g	1.170	12	12	.721	2.99	6
RU-106	pCi/g	.000	0	12	0	0	0
SR-90	pCi/g	.000	8	12	.527	1.44	8

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TABLE 4-3  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
TC-99	pCi/g	.000	0	12	0	0	0
TH-228	pCi/g	1.519	9	9	.482	2.33	1
TH-230	pCi/g	2.112	9	9	.939	9.61	7
TH-232	pCi/g	1.469	9	9	.601	2.5	1
TH-TOTAL	mg/kg	10.700	9	9	5.48	22.8	2
U-234	pCi/g	1.319	12	12	1.43	48.9	12
U-235/236	pCi/g	.181	12	12	.0764	3.33	9
U-238	pCi/g	1.270	12	12	2.34	63.8	12
U-TOTAL	mg/kg	3.240	12	12	6.86	194	12
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	12	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	12	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	12	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	12	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	12	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	12	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	12	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	12	0	0	0
2-Butanone	ug/kg	.000	1	12	1	1	1
2-Hexanone	ug/kg	.000	0	12	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	12	0	0	0
Acetone	ug/kg	.000	4	12	1	5	4
Benzene	ug/kg	.000	0	12	0	0	0
Bromodichloromethane	ug/kg	.000	0	12	0	0	0
Bromoform	ug/kg	.000	0	12	0	0	0
Bromomethane	ug/kg	.000	1	12	2	2	1
Carbon Tetrachloride	ug/kg	.000	0	12	0	0	0
Carbon disulfide	ug/kg	.000	0	12	0	0	0
Chlorobenzene	ug/kg	.000	0	12	0	0	0
Chloroethane	ug/kg	.000	0	12	0	0	0
Chloroform	ug/kg	.000	0	12	0	0	0
Chloromethane	ug/kg	.000	1	12	2	2	1
Dibromochloromethane	ug/kg	.000	0	12	0	0	0
Ethylbenzene	ug/kg	.000	0	12	0	0	0
Methylene chloride	ug/kg	.000	0	12	0	0	0
Styrene	ug/kg	.000	0	12	0	0	0
Tetrachloroethene	ug/kg	.000	0	12	0	0	0
Toluene	ug/kg	.000	0	12	0	0	0
Trichloroethene	ug/kg	.000	0	12	0	0	0
Vinyl Acetate	ug/kg	.000	0	12	0	0	0
Vinyl chloride	ug/kg	.000	0	12	0	0	0
Xylenes, Total	ug/kg	.000	0	12	0	0	0

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TABLE 4-3  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
cis-1,3-Dichloropropene	ug/kg	.000	0	12	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	12	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	12	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	12	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	12	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	12	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	12	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	12	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	12	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	12	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	12	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	12	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	12	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	12	0	0	0
2-Chlorophenol	ug/kg	.000	0	12	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	12	0	0	0
2-Methylphenol	ug/kg	.000	0	12	0	0	0
2-Nitroaniline	ug/kg	.000	0	12	0	0	0
2-Nitrophenol	ug/kg	.000	0	12	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	12	0	0	0
3-Nitroaniline	ug/kg	.000	0	12	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	12	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	12	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	12	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	12	0	0	0
4-Methylphenol	ug/kg	.000	0	12	0	0	0
4-Nitroaniline	ug/kg	.000	0	12	0	0	0
4-Nitrophenol	ug/kg	.000	0	12	0	0	0
Acenaphthene	ug/kg	.000	2	12	49	120	2
Acenaphthylene	ug/kg	.000	0	12	0	0	0
Anthracene	ug/kg	.000	2	12	120	230	2
Benzo(a)anthracene	ug/kg	.000	6	12	55	880	6
Benzo(a)pyrene	ug/kg	.000	6	12	59	760	6
Benzo(b)fluoranthene	ug/kg	.000	5	12	64	710	5
Benzo(g,h,i)perylene	ug/kg	.000	4	12	82	500	4
Benzo(k)fluoranthene	ug/kg	.000	7	12	42	880	7
Benzoic acid	ug/kg	.000	0	12	0	0	0
Benzyl alcohol	ug/kg	.000	0	12	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	12	0	0	0
Carbazole	ug/kg	.000	1	12	77	77	1
Chrysene	ug/kg	.000	8	12	45	1100	8
Di-n-butyl phthalate	ug/kg	.000	1	12	55	55	1

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TABLE 4-3  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Di-n-octyl phthalate	ug/kg	.000	0	12	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	2	12	56	200	2
Dibenzofuran	ug/kg	.000	1	12	56	56	1
Diethyl phthalate	ug/kg	.000	0	12	0	0	0
Dimethyl phthalate	ug/kg	.000	0	12	0	0	0
Fluoranthene	ug/kg	.000	8	12	57	1900	8
Fluorene	ug/kg	.000	2	12	56	100	2
Hexachlorobenzene	ug/kg	.000	0	12	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	12	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	12	0	0	0
Hexachloroethane	ug/kg	.000	0	12	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	5	12	46	480	5
Isophorone	ug/kg	.000	0	12	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	12	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	12	0	0	0
Naphthalene	ug/kg	.000	0	12	0	0	0
Nitrobenzene	ug/kg	.000	0	12	0	0	0
Pentachlorophenol	ug/kg	.000	0	12	0	0	0
Phenanthrene	ug/kg	.000	7	12	59	1500	7
Phenol	ug/kg	.000	0	12	0	0	0
Pyrene	ug/kg	.000	9	12	49	2100	9
bis(2-Chloroethoxy)methane	ug/kg	.000	0	12	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	12	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	12	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	4	12	40	48	4
p-Chloroaniline	ug/kg	.000	0	12	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	12	0	0	0
4,4'-DDE	ug/kg	.000	1	12	12	12	1
4,4'-DDT	ug/kg	.000	0	12	0	0	0
Aldrin	ug/kg	.000	0	12	0	0	0
Aroclor-1016	ug/kg	.000	0	12	0	0	0
Aroclor-1221	ug/kg	.000	0	12	0	0	0
Aroclor-1232	ug/kg	.000	0	12	0	0	0
Aroclor-1242	ug/kg	.000	0	12	0	0	0
Aroclor-1248	ug/kg	.000	0	12	0	0	0
Aroclor-1254	ug/kg	.000	0	12	0	0	0
Aroclor-1260	ug/kg	.000	0	12	0	0	0
Dieldrin	ug/kg	.000	0	12	0	0	0
Endosulfan II	ug/kg	.000	0	12	0	0	0
Endosulfan sulfate	ug/kg	.000	0	12	0	0	0
Endosulfan-I	ug/kg	.000	0	12	0	0	0
Endrin	ug/kg	.000	0	12	0	0	0

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TABLE 4-3  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Endrin aldehyde	ug/kg	.000	0	12	0	0	0
Endrin ketone	ug/kg	.000	0	12	0	0	0
Heptachlor	ug/kg	.000	0	12	0	0	0
Heptachlor epoxide	ug/kg	.000	0	12	0	0	0
Methoxychlor	ug/kg	.000	0	12	0	0	0
Toxaphene	ug/kg	.000	0	12	0	0	0
alpha-BHC	ug/kg	.000	0	12	0	0	0
alpha-Chlordane	ug/kg	.000	0	12	0	0	0
beta-BHC	ug/kg	.000	0	12	0	0	0
delta-BHC	ug/kg	.000	0	12	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	12	0	0	0
gamma-Chlordane	ug/kg	.000	0	12	0	0	0

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**TABLE 4-4**  
**SOLID WASTE LANDFILL**  
**SUBSURFACE SOIL**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	15	16	748	25200	2
Antimony	mg/kg	.000	11	16	3.8	27.3	11
Arsenic	mg/kg	9.704	16	16	2.2	15.4	4
Barium	mg/kg	121.064	16	16	16.7	223	4
Beryllium	mg/kg	.620	16	16	.19	1.6	13
Boron	mg/kg	43.204	8	11	7.2	32.8	0
Cadmium	mg/kg	.910	15	16	.48	6.5	12
Calcium	mg/kg	150000.000	16	16	6330	141000	0
Chromium	mg/kg	20.953	16	16	6.3	51.8	13
Cobalt	mg/kg	15.929	16	16	2.4	26	4
Copper	mg/kg	20.230	16	16	4.2	41.5	8
Cyanide	mg/kg	.170	3	20	.14	.79	2
Iron	mg/kg	31188.164	16	16	3350	42600	4
Lead	mg/kg	15.780	16	16	6.5	147	4
Magnesium	mg/kg	43052.339	16	16	3320	31500	0
Manganese	mg/kg	1045.407	16	16	115	1690	2
Mercury	mg/kg	.290	0	16	0	0	0
Molybdenum	mg/kg	.270	16	16	2.9	29.3	16
Nickel	mg/kg	34.747	16	16	4.4	47.1	5
Potassium	mg/kg	2007.519	16	16	830	2430	2
Selenium	mg/kg	.000	1	16	.54	.54	1
Silicon	mg/kg	1069.496	14	14	132	2620	3
Silver	mg/kg	.000	15	16	3.3	19.7	15
Sodium	mg/kg	227.947	16	16	30	342	2
Thallium	mg/kg	.490	3	16	.6	12.5	3
Tin	mg/kg	.000	0	7	0	0	0
Vanadium	mg/kg	38.088	15	16	6.7	68.8	2
Zinc	mg/kg	73.158	16	16	10.3	108	3
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	0	22	0	0	0
NP-237	pCi/g	.000	0	21	0	0	0
PB-210	pCi/g	.857	3	4	.68	1.03	1
PU-238	pCi/g	.000	0	22	0	0	0
PU-239/240	pCi/g	.000	0	22	0	0	0
RA-224	pCi/g	1.019	4	4	1.11	2.14	4

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TABLE 4-4  
(Continued)

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Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>							
RA-226	pCi/g	1.470	20	22	.38	1.55	2
RA-228	pCi/g	1.325	19	22	.5	3.15	4
RU-106	pCi/g	.000	0	22	0	0	0
SR-90	pCi/g	.560	10	20	.73	3.09	10
TC-99	pCi/g	.000	0	19	0	0	0
TH-228	pCi/g	1.341	22	23	.7	4.01	9
TH-230	pCi/g	1.897	21	23	.69	12.3	10
TH-232	pCi/g	1.269	14	20	.64	3.59	3
TH-TOTAL	mg/kg	9.470	16	16	2.65	32.4	6
U-234	pCi/g	1.034	21	23	.89	334	17
U-235	pCi/g	.000	2	4	.27	1.89	0
U-235/236	pCi/g	.142	10	23	.126	22.4	9
U-238	pCi/g	1.122	21	23	.9	420	18
U-TOTAL	mg/kg	2.540	18	18	3.05	940	18
<u>VOLATILE ORGANICS</u>							
1,1,1,2-Tetrachloroethane	ug/kg	.000	0	6	0	0	0
1,1,1-Trichloroethane	ug/kg	.000	0	16	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	16	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	16	0	0	0
1,1-Dichloroethane	ug/kg	.000	2	16	16	130	2
1,1-Dichloroethene	ug/kg	.000	0	16	0	0	0
1,2,3-Trichloropropane	ug/kg	.000	0	6	0	0	0
1,2-Dibromo-3-chloropropane	ug/kg	.000	0	6	0	0	0
1,2-Dibromoethane	ug/kg	.000	0	6	0	0	0
1,2-Dichloroethane	ug/kg	.000	1	16	16	6	1
1,2-Dichloroethene	ug/kg	.000	3	16	2	12	3
1,2-Dichloropropane	ug/kg	.000	0	16	0	0	0
1,4-Dioxane	ug/kg	.000	2	2	66	12900	2
2-Butanone	ug/kg	.000	1	15	3	3	1
2-Chloro-1,3-butadiene	ug/kg	.000	0	6	0	0	0
2-Hexanone	ug/kg	.000	1	15	1	1	1
3-Chloropropene	ug/kg	.000	0	6	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	2	15	1	1	2
Acetone	ug/kg	.000	5	15	7	39	5
Acetonitrile	ug/kg	.000	0	6	0	0	0
Acrolein	ug/kg	.000	0	5	0	0	0
Acrylonitrile	ug/kg	.000	0	5	0	0	0
Benzene	ug/kg	.000	0	16	0	0	0
Bromodichloromethane	ug/kg	.000	0	16	0	0	0
Bromoform	ug/kg	.000	0	16	0	0	0
Bromomethane	ug/kg	.000	0	16	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	16	0	0	0
Carbon disulfide	ug/kg	.000	0	16	0	0	0

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TABLE 4-4  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>VOLATILE ORGANICS (Continued)</u>							
Chlorobenzene	ug/kg	.000	2	16	2	6	2
Chloroethane	ug/kg	.000	0	16	0	0	0
Chloroform	ug/kg	.000	0	16	0	0	0
Chloromethane	ug/kg	.000	1	16	6	6	1
Dibromochloromethane	ug/kg	.000	0	16	0	0	0
Dibromomethane	ug/kg	.000	0	6	0	0	0
Dichlorodifluoromethane	ug/kg	.000	1	1	576	576	1
Ethyl cyanide	ug/kg	.000	0	6	0	0	0
Ethyl methacrylate	ug/kg	.000	0	6	0	0	0
Ethylbenzene	ug/kg	.000	1	16	18	18	1
Iodomethane	ug/kg	.000	0	6	0	0	0
Isobutyl alcohol	ug/kg	.000	0	3	0	0	0
Methacrylonitrile	ug/kg	.000	0	6	0	0	0
Methyl methacrylate	ug/kg	.000	0	6	0	0	0
Methylene chloride	ug/kg	.000	5	16	6	13	5
Pyridine	ug/kg	.000	1	3	3	3	1
Styrene	ug/kg	.000	1	16	2	2	1
Tetrachloroethene	ug/kg	.000	1	16	30	30	1
Toluene	ug/kg	.000	3	16	1	8	3
Trichloroethene	ug/kg	.000	0	16	0	0	0
Trichlorofluoromethane	ug/kg	.000	1	5	840	840	1
Vinyl Acetate	ug/kg	.000	0	16	0	0	0
Vinyl chloride	ug/kg	.000	0	16	0	0	0
Xylenes, Total	ug/kg	.000	1	16	100	100	1
cis-1,3-Dichloropropene	ug/kg	.000	0	16	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	16	0	0	0
trans-1,4-Dichloro-2-butene	ug/kg	.000	0	4	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
2,4,5-Tetrachlorobenzene	ug/kg	.000	0	4	0	0	0
1,2,4-Trichlorobenzene	ug/kg	.000	0	13	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	13	0	0	0
1,3,5-Trinitrobenzene	ug/kg	.000	0	2	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	13	0	0	0
1,3-Dinitrobenzene	ug/kg	.000	0	3	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	13	0	0	0
1,4-Naphthoquinone	ug/kg	.000	0	4	0	0	0
1-Naphthylamine	ug/kg	.000	0	4	0	0	0
2,3,4,6-Tetrachlorophenol	ug/kg	.000	0	4	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	13	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	13	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	13	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	13	0	0	0

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TABLE 4-4  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
2,4-Dinitrophenol	ug/kg	.000	0	13	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	13	0	0	0
2,6-Dichlorophenol	ug/kg	.000	0	4	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	13	0	0	0
2-Acetylaminofluorene	ug/kg	.000	0	4	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	13	0	0	0
2-Chlorophenol	ug/kg	.000	1	14	49	49	1
2-Methylnaphthalene	ug/kg	.000	1	13	93	93	1
2-Methylphenol	ug/kg	.000	0	13	0	0	0
2-Naphthylamine	ug/kg	.000	0	4	0	0	0
2-Nitroaniline	ug/kg	.000	0	13	0	0	0
2-Nitrophenol	ug/kg	.000	0	13	0	0	0
2-Picoline	ug/kg	.000	0	3	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	13	0	0	0
3,3'-Dimethylbenzidine	ug/kg	.000	0	4	0	0	0
3-Methylcholanthrene	ug/kg	.000	0	4	0	0	0
3-Methylphenol	ug/kg	.000	0	3	0	0	0
3-Nitroaniline	ug/kg	.000	0	13	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	13	0	0	0
4-Aminobiphenyl	ug/kg	.000	0	4	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	13	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	1	14	55	55	1
4-Chlorophenylphenyl ether	ug/kg	.000	0	13	0	0	0
4-Methylphenol	ug/kg	.000	0	13	0	0	0
4-Nitroaniline	ug/kg	.000	0	13	0	0	0
4-Nitrophenol	ug/kg	.000	0	13	0	0	0
4-Nitroquinoline-1-oxide	ug/kg	.000	0	2	0	0	0
5-Nitro-o-toluidine	ug/kg	.000	0	4	0	0	0
7,12-Dimethylbenz(a)anthracene	ug/kg	.000	0	4	0	0	0
Acenaphthene	ug/kg	.000	5	16	53	840	5
Acenaphthylene	ug/kg	.000	0	13	0	0	0
Acetophenone	ug/kg	.000	0	4	0	0	0
Aniline	ug/kg	.000	0	4	0	0	0
Anthracene	ug/kg	.000	5	15	130	1000	5
Aramite	ug/kg	.000	0	3	0	0	0
Benzo(a)anthracene	ug/kg	.000	8	16	43	7500	8
Benzo(a)pyrene	ug/kg	.000	6	16	69	8200	6
Benzo(b)fluoranthene	ug/kg	.000	7	16	54	15000	7
Benzo(g,h,i)perylene	ug/kg	.000	4	15	300	650	4
Benzo(k)fluoranthene	ug/kg	.000	3	15	300	1800	3
Benzoic acid	ug/kg	.000	1	12	110	110	1
Benzyl alcohol	ug/kg	.000	0	13	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	13	0	0	0
Chrysene	ug/kg	.000	9	16	47	5600	9

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TABLE 4-4  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Di-n-butyl phthalate	ug/kg	.000	1	13	120	120	1
Di-n-octyl phthalate	ug/kg	.000	0	13	0	0	0
Diallate	ug/kg	.000	0	4	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	5	15	49	250	5
Dibenzofuran	ug/kg	.000	2	13	160	340	2
Diethyl phthalate	ug/kg	.000	3	16	45	750	3
Dimethyl phthalate	ug/kg	.000	0	13	0	0	0
Diphenylamine	ug/kg	.000	0	4	0	0	0
Ethyl methanesulfonate	ug/kg	.000	0	3	0	0	0
Fluoranthene	ug/kg	.000	8	16	94	12000	8
Fluorene	ug/kg	.000	4	15	88	640	4
Hexachlorobenzene	ug/kg	.000	0	13	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	13	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	13	0	0	0
Hexachloroethane	ug/kg	.000	0	13	0	0	0
Hexachlorophene	ug/kg	.000	0	4	0	0	0
Hexachloropropene	ug/kg	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	5	15	210	5500	5
Isophorone	ug/kg	.000	0	13	0	0	0
Isosafrole	ug/kg	.000	0	4	0	0	0
Methapyrilene	ug/kg	.000	0	2	0	0	0
Methyl methanesulfonate	ug/kg	.000	0	4	0	0	0
Methyl parathion	ug/kg	.000	0	16	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	13	0	0	0
N-Nitrosodi-n-butylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodiethylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	13	0	0	0
N-Nitrosomethylethylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosomorpholine	ug/kg	.000	0	3	0	0	0
N-Nitrosopiperidine	ug/kg	.000	0	3	0	0	0
N-Nitrosopyrrolidine	ug/kg	.000	0	3	0	0	0
Naphthalene	ug/kg	.000	2	13	41	140	2
Nitrobenzene	ug/kg	.000	0	13	0	0	0
O,O,O-Triethylphosphorothioate	ug/kg	.000	0	13	0	0	0
Parathion	ug/kg	.000	0	16	0	0	0
Pentachlorobenzene	ug/kg	.000	0	4	0	0	0
Pentachloroethane	ug/kg	.000	0	4	0	0	0
Pentachloronitrobenzene	ug/kg	.000	0	4	0	0	0
Pentachlorophenol	ug/kg	.000	0	14	0	0	0
Phenacetin	ug/kg	.000	0	4	0	0	0
Phenanthrene	ug/kg	.000	9	16	53	4800	9
Phenol	ug/kg	.000	1	14	61	61	1
Pronamide	ug/kg	.000	0	4	0	0	0

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TABLE 4-4  
(Continued)

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Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Pyrene	ug/kg	.000	9	16	73	12000	9
Safrole	ug/kg	.000	0	4	0	0	0
Sulfotep	ug/kg	.000	0	13	0	0	0
a,a-Dimethylphenethylamine	ug/kg	.000	0	4	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	13	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	13	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	13	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	3	13	40	1200	3
o-Toluidine	ug/kg	.000	0	4	0	0	0
p-Chloroaniline	ug/kg	.000	0	13	0	0	0
p-Dimethylaminoazobenzene	ug/kg	.000	0	4	0	0	0
p-Phenylenediamine	ug/kg	.000	0	2	0	0	0
<u>PESTICIDES/PCBs</u>							
2,4,5-T	ug/kg	.000	0	5	0	0	0
2,4,5-TP (Silvex)	ug/kg	.000	0	5	0	0	0
2,4-D	ug/kg	.000	0	5	0	0	0
Dinoseb	ug/kg	.000	0	5	0	0	0
4,4'-DDD	ug/kg	.000	0	16	0	0	0
4,4'-DDE	ug/kg	.000	0	16	0	0	0
4,4'-DDT	ug/kg	.000	0	16	0	0	0
Aldrin	ug/kg	.000	0	16	0	0	0
Aroclor-1016	ug/kg	.000	0	16	0	0	0
Aroclor-1221	ug/kg	.000	0	16	0	0	0
Aroclor-1232	ug/kg	.000	0	16	0	0	0
Aroclor-1242	ug/kg	.000	0	16	0	0	0
Aroclor-1248	ug/kg	.000	0	16	0	0	0
Aroclor-1254	ug/kg	.000	1	16	150	150	1
Aroclor-1260	ug/kg	.000	1	16	610	610	1
Chlorobenzilate	ug/kg	.000	0	5	0	0	0
Dieldrin	ug/kg	.000	0	16	0	0	0
Endosulfan II	ug/kg	.000	0	16	0	0	0
Endosulfan sulfate	ug/kg	.000	0	16	0	0	0
Endosulfan-I	ug/kg	.000	0	16	0	0	0
Endrin	ug/kg	.000	0	16	0	0	0
Endrin ketone	ug/kg	.000	0	16	0	0	0
Heptachlor	ug/kg	.000	0	16	0	0	0
Heptachlor epoxide	ug/kg	.000	0	16	0	0	0
Isodrin	ug/kg	.000	0	5	0	0	0
Kepone	ug/kg	.000	0	5	0	0	0
Methoxychlor	ug/kg	.000	0	16	0	0	0
Toxaphene	ug/kg	.000	0	16	0	0	0
alpha-BHC	ug/kg	.000	0	16	0	0	0
alpha-Chlordane	ug/kg	.000	0	16	0	0	0

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TABLE 4-4  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
beta-BHC	ug/kg	.000	0	16	0	0	0
delta-BHC	ug/kg	.000	0	16	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	16	0	0	0
gamma-Chlordane	ug/kg	.000	0	16	0	0	0
<u>DIOXIN/FURAN</u>							
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	ug/kg	.000	1	19	.38	.38	1
1,2,3,4,6,7,8-Heptachlorodibenzofuran	ug/kg	.000	1	19	.073	.073	1
1,2,3,4,7,8,9-Heptachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	19	0	0	0
1,2,3,4,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	19	0	0	0
1,2,3,6,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	19	0	0	0
1,2,3,7,8,9-Hexachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	ug/kg	.000	1	20	.067	.067	1
1,2,3,7,8-Pentachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
2,3,4,6,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
2,3,4,7,8-Pentachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
2,3,7,8-TCDD	ug/kg	.000	0	19	0	0	0
2,3,7,8-TCDF	ug/kg	.000	0	19	0	0	0
Heptachlorodibenzo-p-dioxin	ug/kg	.000	2	19	.65	.9	2
Heptachlorodibenzofuran	ug/kg	.000	1	19	.25	.25	1
Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	19	0	0	0
Hexachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
Octachlorodibenzo-p-dioxin	ug/kg	.000	18	19	.05	13.7	18
Octachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
Pentachlorodibenzo-p-dioxin	ug/kg	.000	0	19	0	0	0
Pentachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
Tetrachlorodibenzo-p-dioxin	ug/kg	.000	0	19	0	0	0
Tetrachlorodibenzofuran	ug/kg	.000	0	19	0	0	0
<u>GENERAL CHEMISTRY</u>							
Sulfide	mg/kg	.000	6	6	7.27	12.7	0
Total Organic Carbon	mg/kg	.000	6	6	6020	27071	6
<u>MISCELLANEOUS</u>							
Azinphosmethyl	ug/kg	.000	0	16	0	0	0
Benzidine	ug/kg	.000	0	1	0	0	0
Demeton	ug/kg	.000	0	16	0	0	0
Diazinon	ug/kg	.000	0	16	0	0	0
Dimethoate	ug/kg	.000	0	13	0	0	0
Disulfoton	ug/kg	.000	0	16	0	0	0
Ethion	ug/kg	.000	0	15	0	0	0

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TABLE 4-4  
(Continued)

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Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>MISCELLANEOUS (Continued)</u>							
Famphur	ug/kg	.000	0	13	0	0	0
Malathion	ug/kg	.000	0	16	0	0	0
Phorate	ug/kg	.000	0	13	0	0	0
Tetraethylpyrophosphate	ug/kg	.000	0	16	0	0	0
Thionazin	ug/kg	.000	0	13	0	0	0

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**TABLE 4-5**  
**SOLID WASTE LANDFILL**  
**SUBSURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<b>METALS</b>						
Aluminum	mg/kg	16277.291	37	37	2750 16900	2
Antimony	mg/kg	.000	0	32	0 0	0
Arsenic	mg/kg	9.704	37	37	3.5 13.9	3
Barium	mg/kg	121.064	37	37	26.8 251	7
Beryllium	mg/kg	.620	32	37	.37 1.8	23
Cadmium	mg/kg	.910	20	37	.7 2	14
Calcium	mg/kg	150000.000	37	37	4500 151000	1
Chromium	mg/kg	20.953	37	37	4 36.9	2
Cobalt	mg/kg	15.929	36	37	3.8 20.4	1
Copper	mg/kg	20.230	37	37	4.8 26.9	10
Cyanide	mg/kg	.170	2	27	.16 1	1
Iron	mg/kg	31188.164	37	37	5630 32500	1
Lead	mg/kg	15.780	37	37	3.1 17.3	4
Magnesium	mg/kg	43052.339	37	37	3520 63400	2
Manganese	mg/kg	1045.407	37	37	296 1130	1
Mercury	mg/kg	.290	1	37	.24 .24	0
Molybdenum	mg/kg	.270	27	37	.86 9	27
Nickel	mg/kg	34.747	36	37	10.1 36.5	1
Potassium	mg/kg	2007.519	37	37	550 2480	5
Selenium	mg/kg	.000	1	37	.48 .48	1
Silicon	mg/kg	1069.496	37	37	392 1690	3
Silver	mg/kg	.000	14	37	.43 7.7	14
Sodium	mg/kg	227.947	37	37	70.3 338	2
Thallium	mg/kg	.490	9	37	.23 .32	0
Vanadium	mg/kg	38.088	37	37	8.4 38.4	1
Zinc	mg/kg	73.158	37	37	22.8 84.7	1
<b>RADIONUCLIDES</b>						
CS-137	pCi/g	.000	6	35	.091 .522	6
GROSS ALPHA	pCi/g	.000	34	35	7.63 2532	34
GROSS BETA	pCi/g	.000	35	35	16.1 1220	35
NP-237	pCi/g	.000	25	25	.047 1.67	25
PU-238	pCi/g	.000	28	35	.0148 .433	28
PU-239/240	pCi/g	.000	23	35	.0148 1.67	23
RA-226	pCi/g	1.470	35	35	.79 113	2
RA-228	pCi/g	1.325	35	35	.618 6.65	7
RU-106	pCi/g	.000	0	35	0 0	0
SR-90	pCi/g	.560	5	33	.195 1.99	3

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TABLE 4-5  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
TC-99	pCi/g	.000	3	33	.754	5.13	3
TH-228	pCi/g	1.341	30	30	.584	9.36	7
TH-230	pCi/g	1.897	30	30	.792	720	11
TH-232	pCi/g	1.269	30	30	.489	8.22	7
TH-TOTAL	mg/kg	9.470	30	30	4.5	75.6	8
TH-TOTAL	pCi/g	9.470	30	30	4.5	75.6	8
U-234	pCi/g	1.034	35	35	.651	553	20
U-235/236	pCi/g	.142	33	35	.015	28.9	14
U-238	pCi/g	1.122	35	35	.731	577	22
U-TOTAL	mg/kg	2.540	35	35	2.49	1770	34
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	38	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	36	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	38	0	0	0
1,1-Dichloroethane	ug/kg	.000	2	38	1	55	2
1,1-Dichloroethene	ug/kg	.000	0	38	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	38	0	0	0
1,2-Dichloroethene	ug/kg	.000	1	37	2	2	1
1,2-Dichloropropane	ug/kg	.000	0	38	0	0	0
2-Butanone	ug/kg	.000	2	33	13	110	2
2-Hexanone	ug/kg	.000	2	38	1	2	2
4-Methyl-2-pentanone	ug/kg	.000	2	38	3	20	2
Acetone	ug/kg	.000	5	30	6	88	5
Benzene	ug/kg	.000	2	38	3	4	2
Bromodichloromethane	ug/kg	.000	0	38	0	0	0
Bromoform	ug/kg	.000	0	38	0	0	0
Bromomethane	ug/kg	.000	0	38	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	38	0	0	0
Carbon disulfide	ug/kg	.000	1	38	2	2	1
Chlorobenzene	ug/kg	.000	0	38	0	0	0
Chloroethane	ug/kg	.000	0	38	0	0	0
Chloroform	ug/kg	.000	0	38	0	0	0
Chloromethane	ug/kg	.000	0	38	0	0	0
Dibromochloromethane	ug/kg	.000	0	38	0	0	0
Ethylbenzene	ug/kg	.000	4	38	2	76	4
Methylene chloride	ug/kg	.000	0	38	0	0	0
Styrene	ug/kg	.000	0	38	0	0	0
Tetrachloroethene	ug/kg	.000	2	38	1	2	2
Toluene	ug/kg	.000	16	38	1	54	16
Trichloroethene	ug/kg	.000	0	38	0	0	0
Vinyl Acetate	ug/kg	.000	0	25	0	0	0
Vinyl chloride	ug/kg	.000	1	38	2	2	1
Xylenes, Total	ug/kg	.000	4	38	1	260	4

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TABLE 4-5  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>VOLATILE ORGANICS (Continued)</u>							
cis-1,3-Dichloropropene	ug/kg	.000	0	38	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	38	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	37	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	37	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	37	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	37	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	36	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	36	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	37	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	37	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	37	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	37	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	37	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	2	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	37	0	0	0
2-Chlorophenol	ug/kg	.000	0	37	0	0	0
2-Methylnaphthalene	ug/kg	.000	4	37	97	46000	4
2-Methylphenol	ug/kg	.000	0	37	0	0	0
2-Nitroaniline	ug/kg	.000	0	37	0	0	0
2-Nitrophenol	ug/kg	.000	0	37	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	34	0	0	0
3-Nitroaniline	ug/kg	.000	0	36	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	37	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	37	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	37	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	37	0	0	0
4-Methylphenol	ug/kg	.000	1	37	140	140	1
4-Nitroaniline	ug/kg	.000	0	34	0	0	0
4-Nitrophenol	ug/kg	.000	0	37	0	0	0
Acenaphthene	ug/kg	.000	11	37	47	140000	11
Acenaphthylene	ug/kg	.000	1	37	2500	2500	1
Anthracene	ug/kg	.000	14	37	70	250000	14
Benzo(a)anthracene	ug/kg	.000	18	37	48	310000	18
Benzo(a)pyrene	ug/kg	.000	17	37	47	260000	17
Benzo(b)fluoranthene	ug/kg	.000	17	37	49	220000	17
Benzo(g,h,i)perylene	ug/kg	.000	15	37	64	150000	15
Benzo(k)fluoranthene	ug/kg	.000	14	37	56	140000	14
Benzoic acid	ug/kg	.000	0	20	0	0	0
Benzyl alcohol	ug/kg	.000	0	18	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	37	0	0	0
Carbazole	ug/kg	.000	11	37	58	89000	11
Chrysene	ug/kg	.000	17	37	48	310000	17

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TABLE 4-5  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Di-n-butyl phthalate	ug/kg	.000	2	37	71	170	2
Di-n-octyl phthalate	ug/kg	.000	1	37	55	55	1
Dibenzo(a,h)anthracene	ug/kg	.000	11	37	40	79000	11
Dibenzofuran	ug/kg	.000	9	37	38	120000	9
Diethyl phthalate	ug/kg	.000	0	37	0	0	0
Dimethyl phthalate	ug/kg	.000	0	37	0	0	0
Fluoranthene	ug/kg	.000	20	37	46	790000	20
Fluorene	ug/kg	.000	10	37	46	180000	10
Hexachlorobenzene	ug/kg	.000	0	37	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	34	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	37	0	0	0
Hexachloroethane	ug/kg	.000	0	37	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	16	37	45	150000	16
Isophorone	ug/kg	.000	0	37	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	37	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	37	0	0	0
Naphthalene	ug/kg	.000	7	37	46	96000	7
Nitrobenzene	ug/kg	.000	0	37	0	0	0
Pentachlorophenol	ug/kg	.000	0	36	0	0	0
Phenanthrene	ug/kg	.000	18	37	66	900000	18
Phenol	ug/kg	.000	0	37	0	0	0
Pyrene	ug/kg	.000	20	37	44	610000	20
Tributyl phosphate	ug/kg	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	37	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	37	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	37	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	22	37	48	3200	22
p-Chloroaniline	ug/kg	.000	0	34	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	3	36	4.3	5	3
4,4'-DDE	ug/kg	.000	0	37	0	0	0
4,4'-DDT	ug/kg	.000	0	37	0	0	0
Aldrin	ug/kg	.000	0	36	0	0	0
Aroclor-1016	ug/kg	.000	0	37	0	0	0
Aroclor-1221	ug/kg	.000	0	37	0	0	0
Aroclor-1232	ug/kg	.000	0	37	0	0	0
Aroclor-1242	ug/kg	.000	0	37	0	0	0
Aroclor-1248	ug/kg	.000	0	37	0	0	0
Aroclor-1254	ug/kg	.000	1	37	48	48	1
Aroclor-1260	ug/kg	.000	4	37	26	170	4
Dieldrin	ug/kg	.000	1	36	13	13	1
Endosulfan II	ug/kg	.000	1	37	6.2	6.2	1

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TABLE 4-5  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>PESTICIDES/PCBs (Continued)</u>							
Endosulfan sulfate	ug/kg	.000	3	37	6.2	10	3
Endosulfan-I	ug/kg	.000	0	36	0	0	0
Endrin	ug/kg	.000	0	37	0	0	0
Endrin aldehyde	ug/kg	.000	1	37	180	180	1
Endrin ketone	ug/kg	.000	2	37	5.7	7.1	2
Heptachlor	ug/kg	.000	0	37	0	0	0
Heptachlor epoxide	ug/kg	.000	0	37	0	0	0
Methoxychlor	ug/kg	.000	0	37	0	0	0
Toxaphene	ug/kg	.000	0	37	0	0	0
alpha-BHC	ug/kg	.000	0	37	0	0	0
alpha-Chlordane	ug/kg	.000	0	36	0	0	0
beta-BHC	ug/kg	.000	0	37	0	0	0
delta-BHC	ug/kg	.000	0	37	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	36	0	0	0
gamma-Chlordane	ug/kg	.000	0	37	0	0	0

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During Phase I subsurface soil samples were collected from ten locations and were analyzed for the constituents listed in summary Table 4-3. Background concentrations were exceeded for twenty three metals, isotopes of five elements, and fifty one organic compounds. During Phase II subsurface soil samples were collected from twenty six locations and were also analyzed for the constituents listed in summary Table 4-4. Background concentrations for these locations were exceeded for twenty three metals (the same metals in Phase I except for calcium, which was detected above background only in Phase II, Thallium and Antimony were detected above background only in Phase I), isotopes of eight elements (neptunium-237, cesium-137, plutonium-238, plutonium-239/240, and technetium-99 were detected above background for Phase II and not detected above background during Phase I; lead-210, and radium-224 were detected above background during Phase I and not for Phase II), and forty four organic compounds. Cesium-137, strontium-90, and technetium-99 were detected, indicating the presence of materials from reprocessing activities at the FEMP. Five dioxins were detected for Phase I, except for Octochlorodibenzo-p-dioxin, which was detected in eighteen samples at concentrations ranging from 0.05 to 13.7 ug/kg, the remaining four dioxins were detected once or twice at trace concentrations. Arochlor-1254 and Arochlor-1260 were detected; however, due to the large number of dioxin detections, these Arochlor detections may be attributed to trace contamination from other organic chemicals. Other radionuclides and organic compounds detected in the subsurface soils lead to the assumption that waste materials are a mixture of wastes from production, metallurgy, medical laboratory, construction, and maintenance activities. Comparison of the detected organic compounds for Phase I and Phase II shows that there were a variety of compounds detected in each sampling event. For both the surface soil and subsurface soil in the Solid Waste Landfill the concentrations for the constituents detected were variable and distributed throughout the subunit. The highest concentration for the surface soil radionuclides is 143 ug/g for uranium-total at location SWL-SS-05, and the highest concentration for an organic constituent is 2100 ug/kg for Pyrene at location SWL-SS-01 (Figure 4-2). The highest concentration for the subsurface soil radionuclides is 1770 ug/g for uranium-total at location 11036 (Figure 4-3, south-central portion), and the highest concentration for an organic constituent is 900000 ug/kg for Phenanthrene at location 11039 (Figure 4-4, east-central portion). A review illustrates that concentrations for these same constituents, or even other constituents, are within the same order of magnitude, or one order of magnitude lower, and are distributed throughout the Solid Waste Landfill south of the north drainage ditch. Therefore, as previously stated, there are not single hot spot source areas for the surface soil or subsurface soil within the landfill.

Radionuclides and organic compounds have been detected to an approximate depth of 2 to 4 feet (approximately 566 to 568 feet above the MSL) into the glacial overburden. The approximate extent of impact is 21 to 23 feet above the Great Miami Aquifer (551 to 553 feet above the MSL) and approximately 44 to 46 feet above the average ground water elevation (522 feet above the MSL) under the Solid Waste Landfill. A review of surface soil concentrations and subsurface soil concentrations indicates that analyte concentration are variable throughout the fill material. Concentrations in the borings decrease rapidly with depth, particularly in the glacial overburden (Figures 4-3 and 4-4). However, radionuclides were detected in higher concentrations in the vicinity of 11036; and organic constituents were detected in higher concentrations in the vicinity of 11039, and in the vicinity of 1719.

A likely scenario for waste disposal is that organic and radioactive contaminated materials were dumped and inadvertently mixed, and were exposed with no cover materials; thereby, allowing greater rainwater infiltration and increasing the potential of downward vertical migration of leachable material during the act of waste disposal. The present configuration of the Solid Waste Landfill has a soil cover, which has reduced the amount of rainwater infiltration and the potential for downward migration.

A comparison of the Phase I and Phase II subsurface soil data with the CIS and ES subsurface soil data in Appendices C-7 and C-8 indicates that the parameters detected in the preliminary studies were also detected in Phase I and Phase II, and were within the same order of magnitude.

Total uranium in leachate detected in trenches and borings is presented in Table 4-2A. A comparison of soil and leachate data shown in Table 4-2A from the south end of Trench 2 (located within former Waste Cell 1) indicates that similar isotopes and organic compounds were detected in the soil and in leachate collected from the trench. This suggests that water in contact with the buried waste material is a potential transport media for organic and radioisotope constituent migration to perched groundwater. The leachate results were used in fate and transport modeling in Section 5.

Six soil samples were collected for hazardous waste characteristic determination by TCLP analyses, and analytical data are summarized in Table 4-6. The data did not exceed the RCRA standard for determining toxic characteristic hazardous waste, although manganese was detected at trace levels in five of the six leach samples. Note; the TCLP analysis detection limits for heptachlor epoxide were

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TABLE 4-6  
 SOLID WASTE LANDFILL TCLP RESULTS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)					
			1983	1986	1987	1990	1991	2951
			111478	111454	115358	115334	115320	111432
Arsenic	5.0	1.5	<0.0303	rejected <sup>a</sup>	0.0548	<0.1	<0.048	<0.0303
Barium	100.0	30.0	1.33	1.11	1.46	<0.0016	1.32	1.14
Benzene	0.5		<sup>b</sup>	<0.005	<0.005	<0.005	<0.005	<0.015
Cadmium	1.0	0.3	<0.0021	<0.0021	<0.0021	<0.005	<0.0021	<0.0021
Carbon Tetrachloride	0.5		-	<0.005	<0.005	<0.005	<0.005	<0.015
Chlordane	0.03		-	<0.0014	<0.0014	<0.0014	<0.0014	<0.015
Chlorobenzene	100.0		-	<0.005	<0.005	<0.005	<0.005	<0.015
Chloroform	6.0		-	<0.005	<0.005	<0.005	<0.005	<0.015
Chromium	5.0	1.5	<0.0031	<0.0031	<0.0031	<0.05	<0.0031	<0.0031
Copper			<0.0017	0.0098	<0.0017	<0.025	<0.0017	-
2,4-D	10.0		-	<0.12	<0.12	<0.120	<0.12	-
1,4-Dichlorobenzene	7.5		-	<0.05	<0.05	<0.05	<0.05	-
1,2-Dichloroethane	0.5		-	<0.005	<0.005	<0.005	<0.005	<0.015
1,1-Dichloroethene	0.7		-	<0.005	<0.005	<0.005	<0.005	<0.015
2,4-Dinitrotoluene	0.13		-	<0.05	<0.05	<0.05	<0.05	-
Endrin	0.02		-	<0.0006	<0.0006	<0.0006	<0.0006	-
Heptachlor	0.008		-	<0.0003	<0.0003	<0.0003	<0.0003	-
Heptachlor epoxide	0.008		-	<0.0083	<0.0083	<0.0083	<0.0083	-
Hexachlorobenzene	0.13		-	<0.05	<0.05	<0.05	<0.05	-
Hexachlorobutadiene	0.5		-	<0.05	<0.05	<0.05	<0.05	-
Hexachloroethane	3.0		-	<0.05	<0.05	<0.05	<0.05	-

See footnotes at end of table

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TABLE 4-6  
(Continued)

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)					
			1983	1986	1987	1990	1991	2951
			111478	111454	115358	115334	115320	111432
Iron			<0.0158	0.0636	<0.0254	<0.1	<0.046	-
Lead	5.0	1.5	<0.0155	<0.125	<0.0155	<0.05	0.0657	<0.0155
Lindane	0.4		-	<0.0004	<0.0004	<0.0004	<0.0004	-
Manganese			0.0775	1.93	0.228	6.05	5.5	-
Mercury	0.2	0.06	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002
Methoxychlor	10.0		-	<0.018	<0.018	<0.018	<0.018	-
Nitrobenzene	2.0		-	<0.05	<0.05	<0.05	<0.05	-
Pentachlorophenol	100.0		-	<0.25	<0.25	<0.25	<0.25	-
Pyridine	5.0		-	<0.25	<0.25	<0.25	<0.25	-
Selenium	1.0	0.3	<0.0296	rejected	<0.0296	<0.05	0.129	<0.0296
Silver	5.0		<0.0022	<0.0134	<0.0022	<0.01	<0.0022	<0.0022
Tetrachloroethene	0.7		-	<0.005	<0.005	<0.005	<0.005	<0.015
Toxaphene	0.5		-	<0.024	<0.024	<0.024	<0.024	-
2,4,5-TP (Silvex)	1.0		-	<0.017	<0.017	<0.017	<0.017	-
Trichloroethene	0.5		-	<0.005	<0.005	<0.005	<0.005	<0.015
2,4,5-Trichlorophenol	400.0		-	<0.25	<0.05	<0.05	<0.05	-
2,4,6-Trichlorophenol	2.0		-	<0.05	<0.05	<0.05	<0.05	-
Vinyl chloride	0.2		-	<0.01	<0.01	<0.01	<0.01	<0.015
Zinc			rejected	rejected	rejected	0.024		-

Note: A box surrounding a number indicates a result or detection limit that is above an EPA or OEPA standard.

<sup>a</sup>"Rejected" means that the sample could not be validated.

<sup>b</sup>The sample was not analyzed for the parameter.

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above the regulatory standard (0.0083 mg/L compared to the limit of 0.008 mg/L), however, the compound was not detected by the TCLP analysis or direct analyses of samples collected from the Solid Waste Landfill.

Five Extraction Procedure Toxicity test samples were collected during the CIS and are listed in Appendix C, Table C-16. Barium was the only parameter detected and ranged from 1276.00 to 3307.00 µg/L

4.2.3 Surface Water and Sediment

The one source of surface water within the battery limits of the Solid Waste Landfill is a drainage ditch which flows from east to west along the north boundary of the subunit. Surface water and sediment samples were collected in this drainage ditch. Chemical and radiological analytical results for surface water were not compared against background concentrations since background concentrations for surface water have not yet been defined for the site. A table of detected constituent concentrations is provided in Appendix C as Tables C-2D through C-2G. A summary of the number of detected analytes is provided as Table 4-7 and Table 4-8. Radionuclide and organic compounds detected in surface media are presented on Figure 4-2 (Volume 2: Oversized Figures).

One surface water sample was collected during Phase I and was analyzed for constituents listed in summary Table 4-7. Seventeen metals and two semivolatile organic compounds were detected from Phase I samples. During Phase II surface water was collected from three locations and analyzed for the constituents listed in summary Table 4-8. Seven metals (silicon was detected for Phase II but not analyzed for Phase I, the other six were also detected during Phase I), isotopes of two elements (radionuclides were not analyzed for Phase I surface water samples), and one semivolatile organic compound (bis(2-ethylhexyl)phthalate, which was not detected during Phase II) were detected from Phase II samples. A comparison of water sample results on Figure 4-2 from upstream and downstream locations indicates that there is an approximately equal concentration of total uranium (46.1 µg/L and 59.3 µg/L, respectively). A sample of standing water collected after a rain event on April 28, 1993, adjacent to Well 1947 (approximately 50 feet east of the battery limits for the Solid Waste Landfill; see Figure 4-2), detected 70 µg/L total uranium. This is within the same order of magnitude as the two forementioned water samples, and indicates that the Solid Waste Landfill may not be the only source for concentrations of uranium detected in surface water samples in the Solid Waste Landfill drainage ditch.

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TABLE 4-7  
**SOLID WASTE LANDFILL  
 SURFACE WATER<sup>a</sup>  
 PHASE I FIELD INVESTIGATION  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.000	1	1	.161	.161	1
Antimony		mg/L	.000	0	1	0	0	0
Arsenic		mg/L	.000	0	1	0	0	0
Barium		mg/L	.000	1	1	.0633	.0633	1
Beryllium		mg/L	.000	1	1	.0015	.0015	1
Cadmium		mg/L	.000	1	1	.0063	.0063	1
Calcium		mg/L	.000	1	1	47	47	1
Chromium		mg/L	.000	1	1	.0175	.0175	1
Cobalt		mg/L	.000	1	1	.0136	.0136	1
Copper		mg/L	.000	1	1	.0156	.0156	1
Iron		mg/L	.000	1	1	.0866	.0866	1
Lead		mg/L	.000	0	1	0	0	0
Magnesium		mg/L	.000	1	1	10.7	10.7	1
Manganese		mg/L	.000	1	1	.0651	.0651	1
Mercury		mg/L	.000	0	1	0	0	0
Molybdenum		mg/L	.000	1	1	.023	.023	1
Nickel		mg/L	.000	1	1	.0159	.0159	1
Potassium		mg/L	.000	1	1	2.02	2.02	1
Selenium		mg/L	.000	0	1	0	0	0
Silver		mg/L	.000	0	1	0	0	0
Sodium		mg/L	.000	1	1	4.96	4.96	1
Thallium		mg/L	.000	0	1	0	0	0
Vanadium		mg/L	.000	1	1	.0187	.0187	1
Zinc		mg/L	.000	1	1	.0325	.0325	1
<b>VOLATILE ORGANICS</b>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	0	0	0	0

See footnote at end of table

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TABLE 4-7  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
2-Hexanone	UNFL	ug/L	.000	0	1	0 0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0 0	0
Acetone	UNFL	ug/L	.000	0	1	0 0	0
Benzene	UNFL	ug/L	.000	0	0	0 0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0 0	0
Bromoform	UNFL	ug/L	.000	0	1	0 0	0
Bromomethane	UNFL	ug/L	.000	0	1	0 0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0 0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0 0	0
Chlorobenzene	UNFL	ug/L	.000	0	0	0 0	0
Chloroethane	UNFL	ug/L	.000	0	1	0 0	0
Chloroform	UNFL	ug/L	.000	0	1	0 0	0
Chloromethane	UNFL	ug/L	.000	0	1	0 0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0 0	0
Ethylbenzene	UNFL	ug/L	.000	0	0	0 0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0 0	0
Styrene	UNFL	ug/L	.000	0	0	0 0	0
Tetrachloroethene	UNFL	ug/L	.000	0	1	0 0	0
Toluene	UNFL	ug/L	.000	0	0	0 0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0 0	0
Vinyl Acetate	UNFL	ug/L	.000	0	1	0 0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0 0	0
Xylenes, Total	UNFL	ug/L	.000	0	0	0 0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0 0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0 0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0 0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0 0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0 0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0 0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0 0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0 0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0 0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0 0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0 0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	1	0 0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0 0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0 0	0

See footnote at end of table

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TABLE 4-7  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
2-Chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	0	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	1	1	3	3	1
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	1	1	3	3	1
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0

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TABLE 4-7  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	0	0	0	0
<u>PESTICIDES/PCBs</u>								
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-7  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>PESTICIDES/PCBs (Continued)</u>								
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	.000	0	1	0	0	0
Chloride	UNFL	mg/L	.000	1	1	12	12	1
Fluoride	UNFL	mg/L	.000	1	1	.14	.14	1
Nitrate	UNFL	mg/L	.000	1	1	1.8	1.8	1
Phenols	UNFL	mg/L	.000	0	1	0	0	0
Phosphorus	UNFL	mg/L	.000	1	1	.27	.27	1
Sulfate	UNFL	mg/L	.000	1	1	36.8	36.8	1
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	1	1.0283	1.0283	1
Total Organic Halides	UNFL	mg/L	.000	1	1	.0189	.0189	1
Total Organic Nitrogen	UNFL	mg/L	.000	1	1	1.03	1.03	1

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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**TABLE 4-8**  
**SOLID WASTE LANDFILL**  
**SURFACE WATER<sup>a</sup>**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<b>METALS</b>								
Aluminum		mg/L	.000	1	2	.14	.14	1
Antimony		mg/L	.000	0	2	0	0	0
Arsenic		mg/L	.000	0	2	0	0	0
Barium		mg/L	.000	2	2	.0385	.0405	2
Beryllium		mg/L	.000	0	2	0	0	0
Cadmium		mg/L	.000	0	2	0	0	0
Calcium		mg/L	.000	2	2	92.5	105	2
Chromium		mg/L	.000	0	2	0	0	0
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.000	0	2	0	0	0
Iron		mg/L	.000	0	2	0	0	0
Lead		mg/L	.000	0	2	0	0	0
Magnesium		mg/L	.000	2	2	23.5	25.7	2
Manganese		mg/L	.000	2	2	.177	.185	2
Mercury		mg/L	.000	0	2	0	0	0
Molybdenum		mg/L	.000	0	2	0	0	0
Nickel		mg/L	.000	0	2	0	0	0
Potassium		mg/L	.000	2	2	.865	.869	2
Selenium		mg/L	.000	0	2	0	0	0
Silicon		mg/L	.000	2	2	1.91	2.03	2
Silver		mg/L	.000	0	2	0	0	0
Sodium		mg/L	.000	2	2	11.3	13	2
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.000	0	2	0	0	0
Zinc		mg/L	.000	0	2	0	0	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	2	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	2	2	24.7	32.9	2
GROSS BETA	UNFL	pCi/L	.000	2	2	11.5	11.8	2
NP-237	UNFL	pCi/L	.000	0	2	0	0	0
PU-238	UNFL	pCi/L	.000	2	2	.035	.196	2
PU-239/240	UNFL	pCi/L	.000	0	2	0	0	0
RA-226	UNFL	pCi/L	.000	0	2	0	0	0
RA-228	UNFL	pCi/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-8  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RU-106	UNFL	pCi/L	.000	0	2	0	0	0
SR-90	UNFL	pCi/L	.000	0	2	0	0	0
TC-99	UNFL	pCi/L	.000	0	2	0	0	0
TH-228	UNFL	pCi/L	.000	0	1	0	0	0
TH-230	UNFL	pCi/L	.000	0	1	0	0	0
TH-232	UNFL	pCi/L	.000	0	1	0	0	0
TH-TOTAL	UNFL	ug/L	.000	0	1	0	0	0
U-234	UNFL	pCi/L	.000	2	2	17.1	17.2	2
U-235/236	UNFL	pCi/L	.000	2	2	.846	1.3	2
U-238	UNFL	pCi/L	.000	2	2	18.7	20.2	2
U-TOTAL	UNFL	ug/L	.000	2	2	46.1	59.3	2
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	2	0	0	0
2-Butanone	UNFL	ug/L	.000	0	2	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	2	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	2	0	0	0
Acetone	UNFL	ug/L	.000	0	2	0	0	0
Benzene	UNFL	ug/L	.000	0	2	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	2	0	0	0
Bromoform	UNFL	ug/L	.000	0	2	0	0	0
Bromomethane	UNFL	ug/L	.000	0	2	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	2	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	2	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
Chloroethane	UNFL	ug/L	.000	0	2	0	0	0
Chloroform	UNFL	ug/L	.000	0	2	0	0	0
Chloromethane	UNFL	ug/L	.000	0	2	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	2	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	2	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	2	0	0	0
Styrene	UNFL	ug/L	.000	0	2	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	2	0	0	0
Toluene	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-8  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>VOLATILE ORGANICS (Continued)</u>								
Trichloroethene	UNFL	ug/L	.000	0	2	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	2	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	2	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	2	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	2	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	2	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	2	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	2	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	2	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	2	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	2	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	2	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	2	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	2	0	0	0
Anthracene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-8  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	2	0 0	0
Benzoic acid	UNFL	ug/L	.000	0	2	0 0	0
Benzyl alcohol	UNFL	ug/L	.000	0	2	0 0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Carbazole	UNFL	ug/L	.000	0	2	0 0	0
Chrysene	UNFL	ug/L	.000	0	2	0 0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	2	0 0	0
Dibenzofuran	UNFL	ug/L	.000	0	2	0 0	0
Diethyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Fluoranthene	UNFL	ug/L	.000	0	2	0 0	0
Fluorene	UNFL	ug/L	.000	0	2	0 0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	2	0 0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	0	0 0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	2	0 0	0
Hexachloroethane	UNFL	ug/L	.000	0	2	0 0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	2	0 0	0
Isophorone	UNFL	ug/L	.000	0	2	0 0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	2	0 0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	2	0 0	0
Naphthalene	UNFL	ug/L	.000	0	2	0 0	0
Nitrobenzene	UNFL	ug/L	.000	0	2	0 0	0
Pentachlorophenol	UNFL	ug/L	.000	0	2	0 0	0
Phenanthrene	UNFL	ug/L	.000	0	2	0 0	0
Phenol	UNFL	ug/L	.000	0	2	0 0	0
Pyrene	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	1	2	1 1	1
p-Chloroaniline	UNFL	ug/L	.000	0	2	0 0	0
<u>PESTICIDES/PCBS</u>							
4,4'-DDD	UNFL	ug/L	.000	0	2	0 0	0
4,4'-DDE	UNFL	ug/L	.000	0	2	0 0	0
4,4'-DDT	UNFL	ug/L	.000	0	2	0 0	0
Aldrin	UNFL	ug/L	.000	0	2	0 0	0
Aroclor-1016	UNFL	ug/L	.000	0	2	0 0	0
Aroclor-1221	UNFL	ug/L	.000	0	2	0 0	0

See footnote at end of table

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**TABLE 4-8  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS (Continued)</u>								
Aroclor-1232	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	2	0	0	0
Dieldrin	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	2	0	0	0
Endrin	UNFL	ug/L	.000	0	2	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	2	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	2	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	2	0	0	0
Toxaphene	UNFL	ug/L	.000	0	2	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	2	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
beta-BHC	UNFL	ug/L	.000	0	2	0	0	0
delta-BHC	UNFL	ug/L	.000	0	2	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	2	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	2	2	276	276.5	0
Ammonia	UNFL	mg/L	.000	0	2	0	0	0
Chloride	UNFL	mg/L	.000	2	2	17.1	24.6	2
Fluoride	UNFL	mg/L	.000	2	2	.19	.22	2
Nitrate	UNFL	mg/L	.000	1	2	2.34	2.34	1
Phenols	UNFL	mg/L	.000	0	2	0	0	0
Sulfate	UNFL	mg/L	.000	1	2	61.01	61.01	1
Sulfide	UNFL	mg/L	.000	1	2	1.01	1.01	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	2	2	.2	.23	2
Total Organic Carbon	UNFL	mg/L	.000	2	2	2.7	2.8	2
Total Organic Halides	UNFL	mg/L	.000	0	2	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	2	2	.2	.23	2
Total Phosphorous	UNFL	mg/L	.000	2	2	.03	.04	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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Sediment sample data were compared to background surface soil data because it was assumed that the source for sediment is eroded surface soil. A table of detected analytes is provided in Appendix C, Table C-2F and summarized in Table 4-9 and Table 4-10. One sediment sample was collected during Phase I and analyzed for the constituents listed in summary Table 4-9. Total Uranium was the only constituent detected above background. During Phase II sediment samples were collect from two locations and analyzed for the constituents listed in summary Table 4-10. Exceeding background concentrations were six metals, isotopes of four elements (including uranium which was also detected during Phase I), and fifteen organic compounds. Comparing sediment samples collected downstream from the Solid Waste Landfill and the Solid Waste Landfill surface soil samples shows that silver, thallium, zinc, acenaphthene, anthracene, Benzo(a)pyrene, phenanthrene, indeno(1,2,3-cd)pyrene, neptunium-237, plutonium-238, strontium-90, uranium-234, uranium-235/236, and uranium-238 were detected in both locations. This indicates that constituent migration from the Solid Waste Landfill into the drainage ditch may have occurred.

A comparison of Phase I and Phase II sediment samples with the CIS sediment sample data in Appendix C-10 indicates that the parameters detected during the CIS were also detected during Phase I and Phase II, and within the same order of magnitude.

#### 4.2.4 Groundwater

Groundwater analytical data from the 1000-series wells in the Solid Waste Landfill were available from the Phase I and Phase II activities, and these data were compared to perched groundwater background data developed for the site (Appendix C, Table C-18). Analytical data from the Phase I and Phase II sampling are included in Appendix C in Table C-2H and Table C-2I. A summary of analytes detected in 1000-series wells and their frequency of detection is provided in Table 4-11 and Table 4-12.

Phase I sampling was conducted on three 1000-series wells and detected 12 metals, isotopes of four elements, and no organic compounds that exceeded the background concentrations in eight samples. Phase II sampling was conducted on four 1000-series wells (Wells 1719 and 1947 were dry). During Phase II twelve metals were detected (Cobalt, Iron, Potassium, and Zinc were not detected above background during Phase I, and Arsenic, Molybdenum, Silicon, and Thallium were detected for Phase I but not for Phase II), isotopes of six elements (plutonium-238, Strontium-90, Total thorium, and uranium-235/236 were not detected above background during Phase I), and one organic

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TABLE 4-9  
SOLID WASTE LANDFILL  
SEDIMENT  
PHASE I FIELD INVESTIGATION  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>RADIONUCLIDES</b>							
RA-226	pCi/g	1.528	1	1	.8	.8	0
RA-228	pCi/g	1.170	1	1	1	1	0
U-TOTAL	mg/kg	3.240	1	1	24	24	1

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**TABLE 4-10**  
**SOLID WASTE LANDFILL**  
**SEDIMENT**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	2	2	7010	8380	0
Antimony	mg/kg	.000	0	2	0	0	0
Arsenic	mg/kg	11.608	2	2	4.5	5.3	0
Barium	mg/kg	88.500	2	2	55.9	62.5	0
Beryllium	mg/kg	.600	0	2	0	0	0
Cadmium	mg/kg	.770	0	2	0	0	0
Calcium	mg/kg	5296.781	2	2	105000	161000	2
Chromium	mg/kg	17.057	1	2	11.5	11.5	0
Cobalt	mg/kg	16.913	1	2	6.4	6.4	0
Copper	mg/kg	15.700	2	2	11.9	15.3	0
Cyanide	mg/kg	.230	0	2	0	0	0
Iron	mg/kg	24788.749	2	2	13400	15400	0
Lead	mg/kg	29.575	2	2	11.4	14.1	0
Magnesium	mg/kg	1460.000	2	2	22500	26000	2
Manganese	mg/kg	2257.945	2	2	424	1640	0
Mercury	mg/kg	.300	0	2	0	0	0
Molybdenum	mg/kg	.000	0	2	0	0	0
Nickel	mg/kg	25.145	1	2	16.4	16.4	0
Potassium	mg/kg	1349.530	2	2	1030	1100	0
Selenium	mg/kg	.720	0	2	0	0	0
Silicon	mg/kg	1914.313	2	2	1280	1330	0
Silver	mg/kg	.000	1	2	4.2	4.2	1
Sodium	mg/kg	55.145	2	2	158	346	2
Thallium	mg/kg	.580	1	2	.76	.76	1
Vanadium	mg/kg	33.693	2	2	19	23.8	0
Zinc	mg/kg	58.500	2	2	45.7	72.6	1
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.849	0	2	0	0	0
GROSS ALPHA	pCi/g	.000	2	2	15.3	27.7	2
GROSS BETA	pCi/g	.000	2	2	16.3	26.9	2
NP-237	pCi/g	.000	1	2	.62	.62	1
PU-238	pCi/g	.000	1	2	.036	.036	1
PU-239/240	pCi/g	.000	1	2	.039	.039	1
RA-226	pCi/g	1.528	2	2	.9	.97	0
RA-228	pCi/g	1.170	2	2	.75	1.07	0
RU-106	pCi/g	.000	0	2	0	0	0
SR-90	pCi/g	.000	2	2	.59	.99	2

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TABLE 4-10  
(Continued)

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Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
TC-99	pCi/g	.000	0	2	0	0	0
TH-228	pCi/g	1.519	1	1	.73	.73	0
TH-230	pCi/g	2.112	1	1	1.05	1.05	0
TH-232	pCi/g	1.469	1	1	.57	.57	0
TH-TOTAL	mg/kg	10.700	1	1	5.2	5.2	0
U-234	pCi/g	1.319	2	2	3.66	4.18	2
U-235/236	pCi/g	.181	1	2	.25	.25	1
U-238	pCi/g	1.270	2	2	4.56	6.8	2
U-TOTAL	mg/kg	3.240	2	2	14.7	22.6	2
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	2	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	2	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	2	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	2	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	2	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	2	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	2	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	2	0	0	0
2-Butanone	ug/kg	.000	0	2	0	0	0
2-Hexanone	ug/kg	.000	0	2	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	2	0	0	0
Acetone	ug/kg	.000	1	2	2	2	1
Benzene	ug/kg	.000	0	2	0	0	0
Bromodichloromethane	ug/kg	.000	0	2	0	0	0
Bromoform	ug/kg	.000	0	2	0	0	0
Bromomethane	ug/kg	.000	0	2	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	2	0	0	0
Carbon disulfide	ug/kg	.000	0	2	0	0	0
Chlorobenzene	ug/kg	.000	0	2	0	0	0
Chloroethane	ug/kg	.000	0	2	0	0	0
Chloroform	ug/kg	.000	0	2	0	0	0
Chloromethane	ug/kg	.000	0	2	0	0	0
Dibromochloromethane	ug/kg	.000	0	2	0	0	0
Ethylbenzene	ug/kg	.000	0	2	0	0	0
Methylene chloride	ug/kg	.000	0	2	0	0	0
Styrene	ug/kg	.000	0	2	0	0	0
Tetrachloroethene	ug/kg	.000	0	2	0	0	0
Toluene	ug/kg	.000	0	2	0	0	0
Trichloroethene	ug/kg	.000	0	2	0	0	0
Vinyl Acetate	ug/kg	.000	0	2	0	0	0
Vinyl chloride	ug/kg	.000	0	2	0	0	0
Xylenes, Total	ug/kg	.000	0	2	0	0	0

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TABLE 4-10  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
cis-1,3-Dichloropropene	ug/kg	.000	0	2	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	2	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	2	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	2	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	2	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	2	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	2	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	2	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	2	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	2	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	2	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	2	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	2	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	2	0	0	0
2-Chlorophenol	ug/kg	.000	0	2	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	2	0	0	0
2-Methylphenol	ug/kg	.000	0	2	0	0	0
2-Nitroaniline	ug/kg	.000	0	2	0	0	0
2-Nitrophenol	ug/kg	.000	0	2	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	2	0	0	0
3-Nitroaniline	ug/kg	.000	0	2	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	2	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	2	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	2	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	2	0	0	0
4-Methylphenol	ug/kg	.000	0	2	0	0	0
4-Nitroaniline	ug/kg	.000	0	2	0	0	0
4-Nitrophenol	ug/kg	.000	0	2	0	0	0
Acenaphthene	ug/kg	.000	1	2	98	98	1
Acenaphthylene	ug/kg	.000	0	2	0	0	0
Anthracene	ug/kg	.000	1	2	240	240	1
Benzo(a)anthracene	ug/kg	.000	1	2	500	500	1
Benzo(a)pyrene	ug/kg	.000	1	2	550	550	1
Benzo(b)fluoranthene	ug/kg	.000	1	2	730	730	1
Benzo(g,h,i)perylene	ug/kg	.000	1	2	240	240	1
Benzo(k)fluoranthene	ug/kg	.000	1	2	270	270	1
Benzoic acid	ug/kg	.000	0	2	0	0	0
Benzyl alcohol	ug/kg	.000	0	2	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	2	0	0	0
Carbazole	ug/kg	.000	1	2	120	120	1
Chrysene	ug/kg	.000	1	2	510	510	1
Di-n-butyl phthalate	ug/kg	.000	0	2	0	0	0

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TABLE 4-10  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Di-n-octyl phthalate	ug/kg	.000	0	2	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	2	0	0	0
Dibenzofuran	ug/kg	.000	0	2	0	0	0
Diethyl phthalate	ug/kg	.000	0	2	0	0	0
Dimethyl phthalate	ug/kg	.000	0	2	0	0	0
Fluoranthene	ug/kg	.000	1	2	1400	1400	1
Fluorene	ug/kg	.000	0	2	0	0	0
Hexachlorobenzene	ug/kg	.000	0	2	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	2	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	2	0	0	0
Hexachloroethane	ug/kg	.000	0	2	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	1	2	310	310	1
Isophorone	ug/kg	.000	0	2	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	2	0	0	0
Naphthalene	ug/kg	.000	0	2	0	0	0
Nitrobenzene	ug/kg	.000	0	2	0	0	0
Pentachlorophenol	ug/kg	.000	0	2	0	0	0
Phenanthrene	ug/kg	.000	1	2	1000	1000	1
Phenol	ug/kg	.000	0	2	0	0	0
Pyrene	ug/kg	.000	2	2	58	990	2
bis(2-Chloroethoxy)methane	ug/kg	.000	0	2	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	2	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	2	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	1	2	53	53	1
p-Chloroaniline	ug/kg	.000	0	2	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	2	0	0	0
4,4'-DDE	ug/kg	.000	0	2	0	0	0
4,4'-DDT	ug/kg	.000	0	2	0	0	0
Aldrin	ug/kg	.000	0	2	0	0	0
Aroclor-1016	ug/kg	.000	0	2	0	0	0
Aroclor-1221	ug/kg	.000	0	2	0	0	0
Aroclor-1232	ug/kg	.000	0	2	0	0	0
Aroclor-1242	ug/kg	.000	0	2	0	0	0
Aroclor-1248	ug/kg	.000	0	2	0	0	0
Aroclor-1254	ug/kg	.000	0	2	0	0	0
Aroclor-1260	ug/kg	.000	0	2	0	0	0
Dieldrin	ug/kg	.000	0	2	0	0	0
Endosulfan II	ug/kg	.000	0	2	0	0	0
Endosulfan sulfate	ug/kg	.000	0	2	0	0	0
Endosulfan-I	ug/kg	.000	0	2	0	0	0
Endrin	ug/kg	.000	0	2	0	0	0

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TABLE 4-10  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Endrin aldehyde	ug/kg	.000	0	2	0	0	0
Endrin ketone	ug/kg	.000	0	2	0	0	0
Heptachlor	ug/kg	.000	0	2	0	0	0
Heptachlor epoxide	ug/kg	.000	0	2	0	0	0
Methoxychlor	ug/kg	.000	0	2	0	0	0
Toxaphene	ug/kg	.000	0	2	0	0	0
alpha-BHC	ug/kg	.000	0	2	0	0	0
alpha-Chlordane	ug/kg	.000	0	2	0	0	0
beta-BHC	ug/kg	.000	0	2	0	0	0
delta-BHC	ug/kg	.000	0	2	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	2	0	0	0
gamma-Chlordane	ug/kg	.000	0	2	0	0	0

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**TABLE 4-11**  
**SOLID WASTE LANDFILL**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.123	2	3	.149	.168	2
Antimony		mg/L	.000	0	1	0	0	0
Arsenic		mg/L	.122	1	9	.35	.35	1
Barium		mg/L	.459	10	11	.04	.125	0
Beryllium		mg/L	.002	0	3	0	0	0
Cadmium		mg/L	.007	3	9	.007	.0128	2
Calcium		mg/L	125.574	11	11	81.7	156	6
Chromium		mg/L	.035	4	11	.023	.039	2
Cobalt		mg/L	.000	0	3	0	0	0
Copper		mg/L	.030	2	11	.011	.016	0
Iron		mg/L	10.965	10	11	.009	1.15	0
Lead		mg/L	.050	2	11	.003	.005	0
Magnesium		mg/L	49.627	11	11	29.9	82.4	7
Manganese		mg/L	.165	9	9	.028	.379	6
Mercury		mg/L	.004	1	9	.0012	.0012	0
Molybdenum		mg/L	.028	3	9	.029	.0377	3
Nickel		mg/L	.026	3	11	.0226	.133	2
Potassium		mg/L	29.736	9	9	.958	2.4	0
Selenium		mg/L	.000	0	9	0	0	0
Silicon		mg/L	.000	1	1	7.55	7.55	1
Silver		mg/L	.040	2	11	.0139	.014	0
Sodium		mg/L	49.178	9	9	6.8	37.5	0
Thallium		mg/L	.000	1	1	.337	.337	1
Vanadium		mg/L	.020	2	3	.026	.0279	2
Zinc		mg/L	.032	3	3	.0087	.016	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	1	8	1	1	1
PU-238	UNFL	pCi/L	.000	0	8	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	8	0	0	0
RA-226	UNFL	pCi/L	1.000	1	8	2	2	1
RA-228	UNFL	pCi/L	5.200	1	8	5	5	0
RU-106	UNFL	pCi/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-11  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
SR-90	UNFL	pCi/L	.000	0	7	0	0	0
TC-99	UNFL	pCi/L	.000	0	8	0	0	0
TH-228	UNFL	pCi/L	1.040	1	8	4	4	1
TH-230	UNFL	pCi/L	2.000	1	8	4.6	4.6	1
TH-232	UNFL	pCi/L	.000	1	8	2.6	2.6	1
TH-TOTAL	UNFL	ug/L	3.000	0	6	0	0	0
U-234	UNFL	pCi/L	1.900	6	8	1.2	4.6	2
U-235/236	UNFL	pCi/L	.000	0	8	0	0	0
U-238	UNFL	pCi/L	1.070	7	8	1	3.9	6
U-TOTAL	UNFL	ug/L	4.000	8	8	2	17	3
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	3	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	3	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	3	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	3	0	0	0
Toluene	UNFL	ug/L	.000	0	3	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	3	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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**TABLE 4-11**  
**(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>VOLATILE ORGANICS (Continued)</u>								
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity as CaCO <sub>3</sub>	UNFL	mg/L	.000	1	1	535	535	0
Ammonia	UNFL	mg/L	4.500	5	9	.16	.3	0
Chloride	UNFL	mg/L	110.159	9	10	2	25.2	0
Fluoride	UNFL	mg/L	1.352	10	10	.36	.76	0
Nitrate	UNFL	mg/L	.522	4	6	.1	.58	1
Nitrate/nitrite	UNFL	mg/L	.000	0	1	0	0	0
Phenols	UNFL	mg/L	.000	3	8	.02	.02	0
Phosphorus	UNFL	mg/L	.223	8	9	.022	4.9	5
Sulfate	UNFL	mg/L	141.894	10	10	50.3	296.2	5
Sulfide	UNFL	mg/L	.000	0	1	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	3	4	.16	.42	3
Total Organic Carbon	UNFL	mg/L	.000	1	3	7.34	7.34	1
Total Organic Halides	UNFL	mg/L	.000	3	8	.0105	.0612	3
Total Organic Nitrogen	UNFL	mg/L	.000	5	7	.1	4.6	5

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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**TABLE 4-12**  
**SOLID WASTE LANDFILL**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	5	8	.0133	.275	3
Antimony		mg/L	.038	2	6	.0005	.0008	0
Arsenic		mg/L	.300	1	12	.0022	.0022	0
Barium		mg/L	.413	14	15	.0537	.15	0
Beryllium		mg/L	.003	1	8	.0024	.0024	0
Cadmium		mg/L	.006	2	13	.007	.0103	2
Calcium		mg/L	135.163	15	15	106	449	10
Chromium		mg/L	.042	6	15	.03	.0527	1
Cobalt		mg/L	.000	1	8	.0128	.0128	1
Copper		mg/L	.130	1	15	.012	.012	0
Iron		mg/L	4.000	15	15	2.7	8.06	6
Lead		mg/L	.029	4	13	.0034	.0066	0
Magnesium		mg/L	38.070	15	15	27.3	72.2	6
Manganese		mg/L	.800	13	13	.218	1.94	1
Mercury		mg/L	.001	1	12	.00078	.00078	0
Molybdenum		mg/L	.027	3	11	.01	.026	0
Nickel		mg/L	.026	2	15	.0257	.0371	1
Osmium		mg/L	.000	0	1	0	0	0
Potassium		mg/L	3.087	12	13	.917	6.4	3
Selenium		mg/L	.005	1	12	.004	.004	0
Silver		mg/L	.023	2	14	.0187	.02	0
Sodium		mg/L	51.918	13	13	10.9	34	0
Thallium		mg/L	.000	0	6	0	0	0
Tin		mg/L	.000	0	1	0	0	0
Vanadium		mg/L	.027	4	8	.015	.0438	2
Zinc		mg/L	.105	8	8	.026	.228	2
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	6	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	1	6	25.6	25.6	1
GROSS BETA	UNFL	pCi/L	.000	3	6	13.3	178	3
NP-237	UNFL	pCi/L	.000	2	4	.3	1.94	2
PU-238	UNFL	pCi/L	.000	3	6	.144	.67	3
PU-239/240	UNFL	pCi/L	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-12  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
RA-226	UNFL	pCi/L	1.000	3	6	.193 5.11	1
RA-228	UNFL	pCi/L	5.200	1	6	3.72 3.72	0
RU-106	UNFL	pCi/L	.000	0	6	0 0	0
SR-90	UNFL	pCi/L	.000	2	6	.9 1.35	2
TC-99	UNFL	pCi/L	.000	0	6	0 0	0
TH-228	UNFL	pCi/L	1.040	2	6	.566 14	1
TH-230	UNFL	pCi/L	2.000	4	6	.26 13.8	1
TH-232	UNFL	pCi/L	.000	2	6	.654 11.5	2
TH-TOTAL	UNFL	ug/L	3.000	2	6	5.96 104	2
U-234	UNFL	pCi/L	1.900	6	6	1.1 12	5
U-235/236	UNFL	pCi/L	.000	3	6	.208 .432	3
U-238	UNFL	pCi/L	1.070	6	6	.67 15.2	5
U-TOTAL	UNFL	ug/L	4.000	6	6	2.05 55.8	5
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,2-Dichloroethane	UNFL	ug/L	.000	1	4	16 16	1
1,2-Dichloroethane (Total)	UNFL	ug/L	.000	0	0	0 0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	4	0 0	0
2-Butanone	UNFL	ug/L	.000	0	4	0 0	0
2-Hexanone	UNFL	ug/L	.000	0	4	0 0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	4	0 0	0
Acetone	UNFL	ug/L	.000	0	2	0 0	0
Benzene	UNFL	ug/L	.000	0	4	0 0	0
Bromodichloromethane	UNFL	ug/L	.000	0	4	0 0	0
Bromoform	UNFL	ug/L	.000	0	4	0 0	0
Bromomethane	UNFL	ug/L	.000	0	4	0 0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	4	0 0	0
Carbon disulfide	UNFL	ug/L	.000	0	4	0 0	0
Chlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
Chloroethane	UNFL	ug/L	.000	0	4	0 0	0
Chloroform	UNFL	ug/L	.000	0	4	0 0	0
Chloromethane	UNFL	ug/L	.000	0	2	0 0	0
Dibromochloromethane	UNFL	ug/L	.000	0	4	0 0	0
Ethylbenzene	UNFL	ug/L	.000	0	4	0 0	0
Methylene chloride	UNFL	ug/L	.000	0	4	0 0	0

See footnote at end of table

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TABLE 4-12  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Styrene	UNFL	ug/L	.000	0	4	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	4	0	0	0
Toluene	UNFL	ug/L	.000	0	4	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	4	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	4	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	4	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	4	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	4	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	4	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	4	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	4	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	4	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	4	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	4	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	4	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	4	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	4	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	4	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	4	0	0	0

See footnote at end of table

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TABLE 4-12  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Anthracene	UNFL	ug/L	.000	0	4	0 0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	4	0 0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	4	0 0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	4	0 0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	4	0 0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	4	0 0	0
Benzoic acid	UNFL	ug/L	.000	0	2	0 0	0
Benzyl alcohol	UNFL	ug/L	.000	0	3	0 0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	4	0 0	0
Carbazole	UNFL	ug/L	.000	0	4	0 0	0
Chrysene	UNFL	ug/L	.000	0	4	0 0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	4	0 0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	4	0 0	0
Dibenzofuran	UNFL	ug/L	.000	0	4	0 0	0
Diethyl phthalate	UNFL	ug/L	.000	0	4	0 0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	4	0 0	0
Fluoranthene	UNFL	ug/L	.000	0	4	0 0	0
Fluorene	UNFL	ug/L	.000	0	4	0 0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	4	0 0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	4	0 0	0
Hexachloroethane	UNFL	ug/L	.000	0	4	0 0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	4	0 0	0
Isophorone	UNFL	ug/L	.000	0	4	0 0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	4	0 0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	2	0 0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	4	0 0	0
Naphthalene	UNFL	ug/L	.000	0	4	0 0	0
Nitrobenzene	UNFL	ug/L	.000	0	4	0 0	0
Pentachlorophenol	UNFL	ug/L	.000	0	4	0 0	0
Phenanthrene	UNFL	ug/L	.000	0	4	0 0	0
Phenol	UNFL	ug/L	.000	0	4	0 0	0
Pyrene	UNFL	ug/L	.000	0	4	0 0	0
Tributyl phosphate	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	4	0 0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	4	0 0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	4	0 0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	4	0 0	0
p-Chloroaniline	UNFL	ug/L	.000	0	4	0 0	0

See footnote at end of table

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TABLE 4-12  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	4	0	0	0
Aldrin	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	4	0	0	0
Dieldrin	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	4	0	0	0
Endrin	UNFL	ug/L	.000	0	4	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	4	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	4	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	4	0	0	0
Toxaphene	UNFL	ug/L	.000	0	4	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	4	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
beta-BHC	UNFL	ug/L	.000	0	4	0	0	0
delta-BHC	UNFL	ug/L	.000	0	4	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	4	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	4	4	44.3	625	0
Alkalinity as CaCO3	UNFL	mg/L	.000	0	0	0	0	0
Ammonia	UNFL	mg/L	4.500	2	4	.11	.12	0
Chloride	UNFL	mg/L	110.159	4	4	3.95	27	0
Fluoride	UNFL	mg/L	1.352	4	4	.19	1.25	0
Nitrate	UNFL	mg/L	.522	3	3	.16	.93	2
Phenols	UNFL	mg/L	.000	0	4	0	0	0
Phosphorus	UNFL	mg/L	.223	1	1	.91	.91	1
Sulfate	UNFL	mg/L	141.894	4	4	67.9	190.7	2
Sulfide	UNFL	mg/L	.000	1	4	7.87	7.87	0

See footnote at end of table

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TABLE 4-12  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>GENERAL CHEMISTRY (Continued)</u>								
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	3	4	.21	.67	3
Total Organic Carbon	UNFL	mg/L	.000	2	4	2.24	2.8	2
Total Organic Halides	UNFL	mg/L	.000	2	4	.0148	.094	2
Total Organic Nitrogen	UNFL	mg/L	.000	3	4	.21	.67	3
Total Phosphorous	UNFL	mg/L	.000	3	3	.03	.21	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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compound (1,2-dichloroethane) exceeded background concentrations. The concentrations of radionuclides detected in samples from the 1000-series wells during Phase II are presented on Figure 4-5.

A comparison of selected analytes detected in surface and subsurface soil samples and in groundwater samples is provided below:

Phase II Detections Above Background for Selected Analytes								
	Metals		Radioisotopes			Organic Compounds		
	Silver	Copper	Cesium-137	Strontium-90	Technetium-99	Volatile Organic Compounds	Polynuclear Aromatic Hydrocarbons	Pesticides
Surface	12/12 <sup>a</sup>	6/12	0/12	8/12	0/12	4	18	1
Subsurface	14/37	10/37	6/35	3/33	3/33	13	22	8
Perched Groundwater	0/14	1/15	0/6	2/6	0/6	1	0	0

<sup>a</sup>Number refers to detections above background relative to number of analyses

The data indicate that analytes detected in surface and subsurface soil samples above background are detected in downgradient Well 1952. This indicates impacts on the perched groundwater from the constituents detected in the subsurface soil.

Total uranium data in groundwater for samples collected from the 1000-series and the 2000-series wells are presented in Table 4-13. Upgradient wells in the perched aquifer (Well 1035 and Well 1947) detected total uranium concentrations from on site screening results that ranged from 2.3 µg/L to 11 µg/L. Downgradient wells (Well 1038, Well 1952, and Well 1950) detected concentrations that ranged from 4.11 µg/L to 55.8 µg/L. These data suggest that uranium has leached into the perched groundwater from the waste unit. Table 4-2A, which contains leachate results, indicates that the waste material is leachable and confirms its potential impact on the perched groundwater.

A comparison of strontium-90 and total thorium values from upgradient and downgradient wells indicates an increase in downgradient Well 1952. The following table summarizes these data:

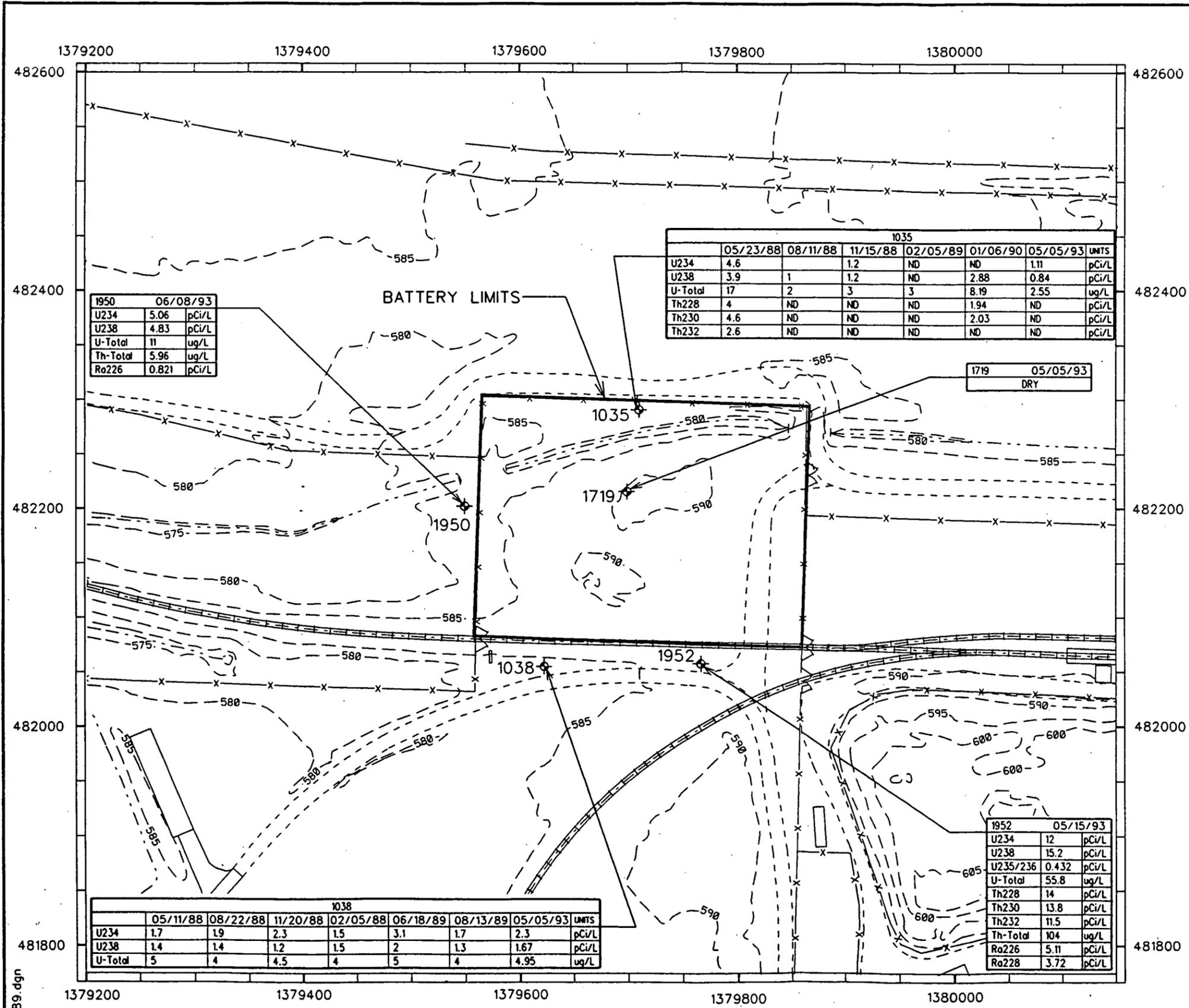
Type of Well	Well No.	Strontium-90	Total Thorium
Upgradient	1035	ND*	<3
Downgradient	1950	ND	5.96
	1038	ND	<3
	1952	0.900	104

\*ND = Not detected

These data indicate that thorium and strontium-90 have leached from the waste subunit into perched groundwater.

Groundwater analytical data from the 2000-series and 3000-series wells were compared to background data from the regional aquifer. A summary of analytes detected and their frequency of detection is presented in Table 4-14 and Table 4-15. Phase I sampling of three 2000-series wells detected twelve metals, isotopes of two elements, and eight organic compounds that exceeded background concentrations. Phase II sampling of six 2000-series wells detected five metals isotopes of five elements (neptunium-237, plutonium-238, Strontium-90, and uranium-235/236 were not detected above background for Phase I), and one organic compound that exceeded background (butyl benzyl phthalate), which was also detected in Phase I.

Upgradient 2000-series wells (Well 2949 and Well 2951), shown in Figure 4-6, did not detect total uranium above background. Downgradient 2000-series wells (Well 2947 and Well 2953) did not detect concentrations of total uranium above background. These data indicate that uranium from the subunit has not impacted the regional aquifer outside the battery limits. Radium was detected in downgradient Wells 2947 and 2953 (Figure 4-6), and upgradient Well 2-27. Radium was not detected in Well 2037, which is in the landfill boundaries and upgradient from Well 2947 and 2953. This suggests that radium from the landfill did not impact the groundwater, and the source for the radium is from outside the landfill. A groundwater sample collected from Well 2037, located inside the limits of the Solid Waste Landfill detected elevated uranium isotopes, strontium-90, and carbon disulfide. These constituents were detected in samples collected from Well 1037, located adjacent to Well 2037. Construction information indicates that Well 1037 was completed to within three feet of

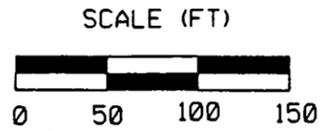


**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- 1000 MONITORING WELLS

ND = NOT DETECTED ABOVE BACKGROUND CONCENTRATIONS

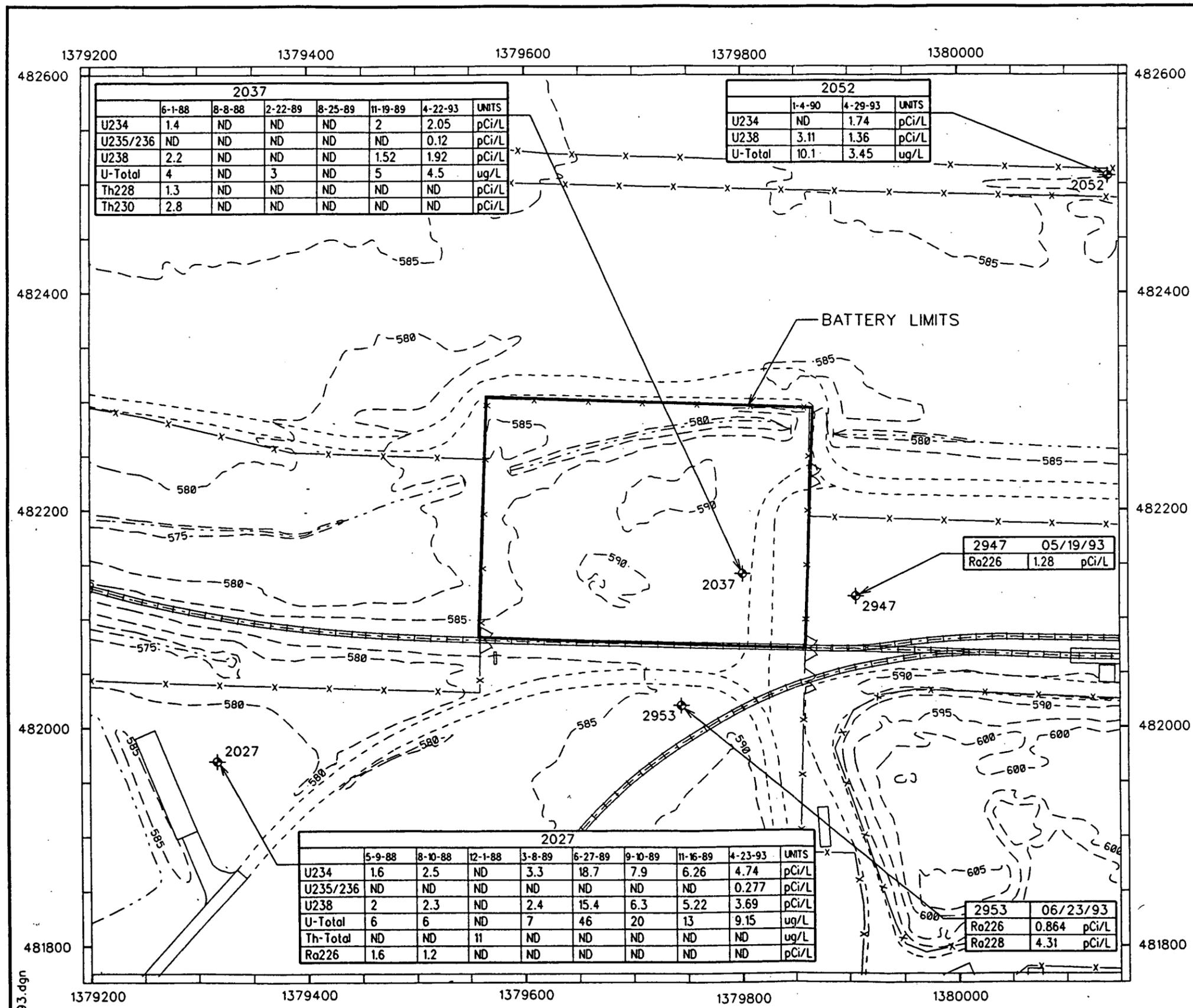
NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



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**FIGURE 4-5  
RADIONUCLIDES IN  
1000-SERIES WELLS  
DETECTED ABOVE BACKGROUND  
IN THE SOLID WASTE LANDFILL**

fig0489.dgn



2037							
	6-1-88	8-8-88	2-22-89	8-25-89	11-19-89	4-22-93	UNITS
U234	1.4	ND	ND	ND	2	2.05	pCi/L
U235/236	ND	ND	ND	ND	ND	0.12	pCi/L
U238	2.2	ND	ND	ND	1.52	1.92	pCi/L
U-Total	4	ND	3	ND	5	4.5	ug/L
Th228	1.3	ND	ND	ND	ND	ND	pCi/L
Th230	2.8	ND	ND	ND	ND	ND	pCi/L

2052			
	1-4-90	4-29-93	UNITS
U234	ND	1.74	pCi/L
U238	3.11	1.36	pCi/L
U-Total	10.1	3.45	ug/L

2027									
	5-9-88	8-10-88	12-1-88	3-8-89	6-27-89	9-10-89	11-16-89	4-23-93	UNITS
U234	1.6	2.5	ND	3.3	18.7	7.9	6.26	4.74	pCi/L
U235/236	ND	ND	ND	ND	ND	ND	ND	0.277	pCi/L
U238	2	2.3	ND	2.4	15.4	6.3	5.22	3.69	pCi/L
U-Total	6	6	ND	7	46	20	13	9.15	ug/L
Th-Total	ND	ND	11	ND	ND	ND	ND	ND	ug/L
Ra226	1.6	1.2	ND	ND	ND	ND	ND	ND	pCi/L

2947	05/19/93
Ra226	1.28 pCi/L

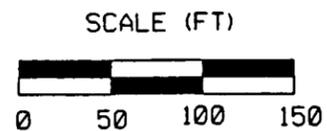
2953	06/23/93
Ra226	0.864 pCi/L
Ra228	4.31 pCi/L

**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- 2000 MONITORING WELLS

ND-NOT DETECTED ABOVE BACKGROUND CONCENTRATIONS

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



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**FIGURE 4-6  
RADIONUCLIDES IN  
2000-SERIES WELLS  
DETECTED ABOVE BACKGROUND  
IN THE SOLID WASTE LANDFILL**

fig0493.dgn

TABLE 4-13

TOTAL URANIUM IN SAMPLES COLLECTED DURING PHASE II  
 FROM WELLS IN THE SOLID WASTE LANDFILL  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

1000-SERIES WELLS

Well and Location	Date	Sample	Total Uranium ( $\mu\text{g/L}$ )
<b><u>UPGRADIENT</u></b>			
1035	5/5/93	111554 on-site analysis	2.3
Located upgradient outside of waste unit completed within sand lense in till		111555 on-site analysis	2.3
		111553 off-site analysis	2.55
1947	4/28/93	111650 on-site analysis	10
Located upgradient from waste unit	7/28/93	120488 on-site analysis	11
<b><u>DOWNGRADIENT</u></b>			
1038	5/5/93	111550 on-site analysis	5.0
located directly downgradient of waste unit completed in sand unit		111551 on-site analysis	4.7
		111548 off-site analysis	4.11
		111549 off-site analysis	4.95
1950	6/8/93	115485 on-site analysis	21
Located downgradient from north end of waste unit completed in sand unit within till		115480 off-site analysis	7.67
1952	5/15/93	115469 on-site analysis	23
Located directly downgradient of waste unit. Completed in till unit above sand lense		115468 off-site analysis	15.8
		115471 off-site analysis	55.8

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**TABLE 4-13  
(Continued)**

**2000-SERIES WELLS**

Well and Location	Date	Sample	Total Uranium (µg/L)
<b><u>UPGRADIENT</u></b>			
2949 Located upgradient of waste unit	4/17/93	111490 on-site analysis 115479 off-site analysis	0.4 0.378
2951 Located upgradient of waste unit	5/1/93	111538 on-site analysis 115478 off-site analysis 111536 off-site analysis	0.8 0.781 1.08
<b><u>DOWNGRADIENT</u></b>			
2027 Located adjacent to a waste pond near Operable Unit 1	4/23/93	111544 on-site analysis 111543 off-site analysis	11 9.15
2037 Located within waste unit	4/22/93	111541 on-site analysis 111540 off-site analysis	4.6 4.5
2052 Located cross-gradient and approximately 300 feet northeast from waste unit	4/29/93	111547 on-site analysis 111546 off-site analysis	4.7 3.45
2947 Located downgradient of waste unit	5/19/93	111573 on-site analysis 115474 on-site analysis	0.5 0.5
2953 Located downgradient of waste unit	6/23/93	115490 on-site analysis 115488 off-site analysis	1.1 1.23

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**TABLE 4-14A**  
**SOLID WASTE LANDFILL**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum		mg/L	.184	5	8	.0133 .275	3
Antimony		mg/L	.038	2	6	.0005 .0008	0
Arsenic		mg/L	.300	1	12	.0022 .0022	0
Barium		mg/L	.413	14	15	.0537 .15	0
Beryllium		mg/L	.003	1	8	.0024 .0024	0
Cadmium		mg/L	.006	2	13	.007 .0103	2
Calcium		mg/L	135.163	15	15	106 449	10
Chromium		mg/L	.042	6	15	.03 .0527	1
Cobalt		mg/L	.000	1	8	.0128 .0128	1
Copper		mg/L	.130	1	15	.012 .012	0
Iron		mg/L	4.000	15	15	2.7 8.06	6
Lead		mg/L	.029	4	13	.0034 .0066	0
Magnesium		mg/L	38.070	15	15	27.3 72.2	6
Manganese		mg/L	.800	13	13	.218 1.94	1
Mercury		mg/L	.001	1	12	.00078 .00078	0
Molybdenum		mg/L	.027	3	11	.01 .026	0
Nickel		mg/L	.026	2	15	.0257 .0371	1
Potassium		mg/L	3.087	12	13	.917 6.4	3
Selenium		mg/L	.005	1	12	.004 .004	0
Silver		mg/L	.023	2	14	.0187 .02	0
Sodium		mg/L	51.918	13	13	10.9 34	0
Thallium		mg/L	.000	0	6	0 0	0
Tin		mg/L	.000	0	1	0 0	0
Vanadium		mg/L	.027	4	8	.015 .0438	2
Zinc		mg/L	.105	8	8	.026 .228	2
<b>RADIONUCLIDES</b>							
CS-137	UNFL	pCi/L	.000	0	0	0 0	0
NP-237	UNFL	pCi/L	.000	0	11	0 0	0
PU-238	UNFL	pCi/L	.000	0	11	0 0	0
PU-239/240	UNFL	pCi/L	.000	0	11	0 0	0
RA-226	UNFL	pCi/L	1.200	2	9	1.2 1.6	1
RA-228	UNFL	pCi/L	4.500	0	9	0 0	0

See footnote at end of table

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TABLE 4-14A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	11	0	0	0
TC-99	UNFL	pCi/L	36.000	0	11	0	0	0
TH-228	UNFL	pCi/L	1.520	0	11	0	0	0
TH-230	UNFL	pCi/L	1.790	0	11	0	0	0
TH-232	UNFL	pCi/L	.000	0	11	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	9	0	0	0
U-234	UNFL	pCi/L	1.900	4	10	1.6	3.3	2
U-235/236	UNFL	pCi/L	.000	0	11	0	0	0
U-238	UNFL	pCi/L	.900	4	10	2	2.4	4
U-TOTAL	UNFL	ug/L	2.920	6	11	2	7	5
<u>VOLATILE ORGANICS</u>								
1,1,1,2-Tetrachloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	5	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	5	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	5	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	8	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	4	0	0	0
1,2,3-Trichloropropane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dibromo-3-chloropropane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dibromoethane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	3	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	5	0	0	0
1,4-Dioxane	UNFL	ug/L	.000	0	2	0	0	0
2-Butanone	UNFL	ug/L	.000	0	3	0	0	0
2-Chloro-1,3-butadiene	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	5	0	0	0
3-Chloropropene	UNFL	ug/L	.000	0	2	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	5	0	0	0
Acetone	UNFL	ug/L	.000	1	8	4	4	1
Acetonitrile	UNFL	ug/L	.000	0	2	0	0	0
Acrolein	UNFL	ug/L	.000	0	2	0	0	0
Acrylonitrile	UNFL	ug/L	.000	0	2	0	0	0
Benzene	UNFL	ug/L	.000	0	4	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	5	0	0	0
Bromoform	UNFL	ug/L	.000	0	5	0	0	0
Bromomethane	UNFL	ug/L	.000	0	4	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	4	0	0	0
Carbon disulfide	UNFL	ug/L	.000	2	5	10	11	2

See footnote at end of table

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TABLE 4-14A  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>VOLATILE ORGANICS (Continued)</u>								
Chlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
Chloroethane	UNFL	ug/L	.000	0	5	0	0	0
Chloroform	UNFL	ug/L	.000	0	5	0	0	0
Chloromethane	UNFL	ug/L	.000	0	5	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	5	0	0	0
Dibromomethane	UNFL	ug/L	.000	0	2	0	0	0
Dichlorodifluoromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethyl cyanide	UNFL	ug/L	.000	0	1	0	0	0
Ethyl methacrylate	UNFL	ug/L	.000	0	2	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	5	0	0	0
Iodomethane	UNFL	ug/L	.000	0	2	0	0	0
Isobutyl alcohol	UNFL	ug/L	.000	0	2	0	0	0
Methacrylonitrile	UNFL	ug/L	.000	0	1	0	0	0
Methyl methacrylate	UNFL	ug/L	.000	0	2	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	8	0	0	0
Pyridine	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	5	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	8	0	0	0
Toluene	UNFL	ug/L	.000	0	7	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	6	0	0	0
Trichlorofluoromethane	UNFL	ug/L	.000	0	2	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	5	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	5	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	5	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	5	0	0	0
trans-1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	5	0	0	0
trans-1,4-Dichloro-2-butene	UNFL	ug/L	.000	0	2	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4,5-Tetrachlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,3,5-Trinitrobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,3-Dinitrobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,4-Naphthoquinone	UNFL	ug/L	.000	0	2	0	0	0
1-Naphthylamine	UNFL	ug/L	.000	0	2	0	0	0
2,3,4,6-Tetrachlorophenol	UNFL	ug/L	.000	0	0	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-14A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>SEMIVOLATILE ORGANICS (Continued)</b>								
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	2	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	4	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Chrysene	UNFL	ug/L	.000	0	4	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Diallate	UNFL	ug/L	.000	0	2	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	4	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Diphenylamine	UNFL	ug/L	.000	0	2	0	0	0
Ethyl methanesulfonate	UNFL	ug/L	.000	0	2	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Fluorene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorophene	UNFL	ug/L	.000	0	0	0	0	0
Hexachloropropene	UNFL	ug/L	.000	0	2	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Isophorone	UNFL	ug/L	.000	0	4	0	0	0
Isosafrole	UNFL	ug/L	.000	0	2	0	0	0
Methapyrilene	UNFL	ug/L	.000	0	2	0	0	0
Methyl methanesulfonate	UNFL	ug/L	.000	0	2	0	0	0
Methyl parathion	UNFL	ug/L	.000	0	4	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	4	0	0	0
N-Nitrosodi-n-butylamine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosodiethylamine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	1	4	3	3	1
N-Nitrosomethylethylamine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosomorpholine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosopiperidine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosopyrrolidine	UNFL	ug/L	.000	0	2	0	0	0
Naphthalene	UNFL	ug/L	.000	0	4	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	4	0	0	0
O,O,O-Triethylphosphorothioate	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-14A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Parathion	UNFL	ug/L	.000	0	4	0	0	0
Pentachlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
Pentachloroethane	UNFL	ug/L	.000	0	2	0	0	0
Pentachloronitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	2	0	0	0
Phenacetin	UNFL	ug/L	.000	0	2	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	4	0	0	0
Phenol	UNFL	ug/L	.000	0	2	0	0	0
Pronamide	UNFL	ug/L	.000	0	2	0	0	0
Pyrene	UNFL	ug/L	.000	0	4	0	0	0
Safrole	UNFL	ug/L	.000	0	2	0	0	0
Sulfotep	UNFL	ug/L	.000	0	1	0	0	0
a,a-Dimethylphenethylamine	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	3	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	1	4	10	10	1
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	2	4	3	7	2
o-Toluidine	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	3	0	0	0
p-Dimethylaminoazobenzene	UNFL	ug/L	.000	0	2	0	0	0
p-Phenylenediamine	UNFL	ug/L	.000	0	2	0	0	0
2,4,5-T	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-TP (Silvex)	UNFL	ug/L	.000	0	1	0	0	0
2,4-D	UNFL	ug/L	.000	0	1	0	0	0
Dinoseb	UNFL	ug/L	.000	0	2	0	0	0
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	5	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	5	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	4	0	0	0
Aldrin	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	5	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	5	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	5	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	5	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	5	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	5	0	0	0
Dieldrin	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	5	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	5	0	0	0

See footnote at end of table

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TABLE 4-14A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS (Continued)</u>								
Endosulfan-I	UNFL	ug/L	.000	0	5	0	0	0
Endrin	UNFL	ug/L	.000	0	4	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	5	0	0	0
Heptachlor	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	5	0	0	0
Isodrin	UNFL	ug/L	.000	0	2	0	0	0
Kepone	UNFL	ug/L	.000	0	2	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	5	0	0	0
Toxaphene	UNFL	ug/L	.000	0	5	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	5	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
beta-BHC	UNFL	ug/L	.000	0	5	0	0	0
delta-BHC	UNFL	ug/L	.000	0	5	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	4	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	5	0	0	0
<u>DIOXIN/FURAN</u>								
2,3,7,8-TCDD	UNFL	ug/L	.000	0	2	0	0	0
2,3,7,8-TCDF	UNFL	ug/L	.000	0	1	0	0	0
Heptachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	2	0	0	0
Heptachlorodibenzofuran	UNFL	ug/L	.000	0	2	0	0	0
Hexachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorodibenzo-p-dioxins	UNFL	ug/L	.000	0	2	0	0	0
Hexachlorodibenzofuran	UNFL	ug/L	.000	1	3	.00038	.00038	1
Octachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	2	0	0	0
Octachlorodibenzofuran	UNFL	ug/L	.000	0	2	0	0	0
Pentachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	3	0	0	0
Pentachlorodibenzofuran	UNFL	ug/L	.000	1	3	.00031	.00031	1
Tetrachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	2	0	0	0
Tetrachlorodibenzofuran	UNFL	ug/L	.000	1	3	.00022	.00022	1
Azinphosmethyl	UNFL	ug/L	.000	0	3	0	0	0
Demeton	UNFL	ug/L	.000	0	3	0	0	0
Diazinon	UNFL	ug/L	.000	0	3	0	0	0
Dimethoate	UNFL	ug/L	.000	0	1	0	0	0
Disulfoton	UNFL	ug/L	.000	0	4	0	0	0
Ethion	UNFL	ug/L	.000	0	3	0	0	0
Famphur	UNFL	ug/L	.000	0	1	0	0	0
Malathion	UNFL	ug/L	.000	0	3	0	0	0
Phorate	UNFL	ug/L	.000	0	1	0	0	0
Thionazin	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-14A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<b>GENERAL CHEMISTRY</b>								
Ammonia	UNFL	mg/L	3.240	9	11	.1	.68	0
Chloride	UNFL	mg/L	145.065	13	14	12	140	0
Fluoride	UNFL	mg/L	.938	14	14	.12	1.8	1
Nitrate	UNFL	mg/L	11.400	1	8	.11	.11	0
Phenols	UNFL	mg/L	.000	4	11	.012	.17	0
Phosphate	UNFL	mg/L	.000	1	1	1	1	0
Phosphorus	UNFL	mg/L	.693	7	8	.02	26.4	2
Sulfate	UNFL	mg/L	359.847	11	11	125	726	3
Sulfide	UNFL	mg/L	.000	0	2	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	6	8	.39	5	6
Total Organic Carbon	UNFL	mg/L	3.764	2	4	1.49	3.33	0
Total Organic Halides	UNFL	mg/L	.021	3	11	.017	.028	1
Total Organic Nitrogen	UNFL	mg/L	.652	7	10	.22	4.36	3

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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**TABLE 4-14B**  
**SOLID WASTE LANDFILL**  
**GROUNDWATER<sup>a</sup> - 3000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<b>METALS</b>								
Aluminum		mg/L	.184	2	2	.2006	.224	2
Antimony		mg/L	.038	0	1	0	0	0
Arsenic		mg/L	.300	0	4	0	0	0
Barium		mg/L	.413	5	5	.045	.06	0
Beryllium		mg/L	.003	0	2	0	0	0
Cadmium		mg/L	.006	1	4	.007	.007	1
Calcium		mg/L	135.163	5	5	254	305	5
Chromium		mg/L	.042	2	5	.05	.0572	2
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.130	1	5	.01	.01	0
Iron		mg/L	4.000	5	5	3.02	16.9	4
Lead		mg/L	.029	2	4	.0022	.0034	0
Magnesium		mg/L	38.070	5	5	61	67.2	5
Manganese		mg/L	.800	4	4	.65	.722	0
Mercury		mg/L	.001	0	3	0	0	0
Molybdenum		mg/L	.027	1	3	.02	.02	0
Nickel		mg/L	.026	2	5	.0282	.04	2
Osmium		mg/L	.000	0	0	0	0	0
Potassium		mg/L	3.087	4	4	13	15.9	4
Selenium		mg/L	.005	0	4	0	0	0
Silver		mg/L	.023	2	5	.01	.0213	0
Sodium		mg/L	51.918	4	4	51.2	62.7	3
Thallium		mg/L	.000	0	1	0	0	0
Tin		mg/L	.000	0	0	0	0	0
Vanadium		mg/L	.027	1	2	.0382	.0382	1
Zinc		mg/L	.105	2	2	.0389	.267	1
<b>RADIONUCLIDES</b>								
NP-237	UNFL	pCi/L	.000	0	6	0	0	0
PU-238	UNFL	pCi/L	.000	0	6	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	6	0	0	0
RA-226	UNFL	pCi/L	1.200	0	5	0	0	0
RA-228	UNFL	pCi/L	4.500	0	6	0	0	0
SR-90	UNFL	pCi/L	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-14B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
TC-99	UNFL	pCi/L	36.000	0	6	0	0	0
TH-228	UNFL	pCi/L	1.520	0	6	0	0	0
TH-230	UNFL	pCi/L	1.790	1	6	1	1	0
TH-232	UNFL	pCi/L	.000	0	6	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	5	0	0	0
U-234	UNFL	pCi/L	1.900	3	6	1.2	3.7	1
U-235/236	UNFL	pCi/L	.000	0	6	0	0	0
U-238	UNFL	pCi/L	.900	2	6	1.8	13	2
U-TOTAL	UNFL	ug/L	2.920	4	5	1	6	1
<u>VOLATILE ORGANICS</u>								
1,1,1,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2,3-Trichloropropane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dibromo-3-chloropropane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dibromoethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	2	0	0	0
1,4-Dioxane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	2	0	0	0
2-Hexanone	UNFL	ug/L	.000	1	2	2	2	1
3-Chloropropene	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	2	0	0	0
Acetone	UNFL	ug/L	.000	1	3	29	29	1
Acetonitrile	UNFL	ug/L	.000	0	1	0	0	0
Acrolein	UNFL	ug/L	.000	0	1	0	0	0
Acrylonitrile	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	2	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	2	0	0	0
Bromoform	UNFL	ug/L	.000	0	2	0	0	0
Bromomethane	UNFL	ug/L	.000	0	2	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	2	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	2	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
Chloroethane	UNFL	ug/L	.000	0	2	0	0	0
Chloroform	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-14B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	2	0	0	0
Dibromomethane	UNFL	ug/L	.000	0	1	0	0	0
Dichlorodifluoromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethyl cyanide	UNFL	ug/L	.000	0	1	0	0	0
Ethyl methacrylate	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Iodomethane	UNFL	ug/L	.000	0	1	0	0	0
Isobutyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Methacrylonitrile	UNFL	ug/L	.000	0	1	0	0	0
Methyl methacrylate	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	3	0	0	0
Pyridine	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	2	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	3	0	0	0
Toluene	UNFL	ug/L	.000	0	2	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	3	0	0	0
Trichlorofluoromethane	UNFL	ug/L	.000	0	1	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	2	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	2	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	2	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0	0	0
trans-1,4-Dichloro-2-butene	UNFL	ug/L	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4,5-Tetrachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,3,5-Trinitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,3-Dinitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,4-Naphthoquinone	UNFL	ug/L	.000	0	1	0	0	0
1-Naphthylamine	UNFL	ug/L	.000	0	1	0	0	0
2,3,4,6-Tetrachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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**TABLE 4-14B**  
**(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>SEMIVOLATILE ORGANICS (Continued)</b>								
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	2	0	0	0
2,6-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	2	0	0	0
2-Acetylaminofluorene	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	2	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	2	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	2	0	0	0
2-Naphthylamine	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
2-Picoline	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	2	0	0	0
3,3'-Dimethylbenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Methylcholanthrene	UNFL	ug/L	.000	0	1	0	0	0
3-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Aminobiphenyl	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	2	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	2	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
4-Nitroquinoline-1-oxide	UNFL	ug/L	.000	0	1	0	0	0
5-Nitro-o-toluidine	UNFL	ug/L	.000	0	1	0	0	0
7,12-Dimethylbenz(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	2	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	2	0	0	0
Acetophenone	UNFL	ug/L	.000	0	1	0	0	0
Aniline	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	2	0	0	0
Aramite	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	2	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-14B  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of		Range of Detects		Number of Detects Above Background
	FLAG	UNITS			Analyses	Minimum	Maximum		
<u>SEMIVOLATILE ORGANICS (Continued)</u>									
Butyl benzyl phthalate	UNFL	ug/L	.000	1	2	3	3		1
Chrysene	UNFL	ug/L	.000	0	2	0	0		0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	2	0	0		0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	2	0	0		0
Diallate	UNFL	ug/L	.000	0	1	0	0		0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	2	0	0		0
Dibenzofuran	UNFL	ug/L	.000	0	2	0	0		0
Diethyl phthalate	UNFL	ug/L	.000	1	2	2	2		1
Dimethyl phthalate	UNFL	ug/L	.000	0	2	0	0		0
Diphenylamine	UNFL	ug/L	.000	0	1	0	0		0
Ethyl methanesulfonate	UNFL	ug/L	.000	0	1	0	0		0
Fluoranthene	UNFL	ug/L	.000	0	2	0	0		0
Fluorene	UNFL	ug/L	.000	0	2	0	0		0
Hexachlorobenzene	UNFL	ug/L	.000	0	2	0	0		0
Hexachlorobutadiene	UNFL	ug/L	.000	0	2	0	0		0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	2	0	0		0
Hexachloroethane	UNFL	ug/L	.000	0	2	0	0		0
Hexachloropropene	UNFL	ug/L	.000	0	1	0	0		0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	2	0	0		0
Isophorone	UNFL	ug/L	.000	0	2	0	0		0
Isosafrole	UNFL	ug/L	.000	0	1	0	0		0
Methapyrilene	UNFL	ug/L	.000	0	1	0	0		0
Methyl methanesulfonate	UNFL	ug/L	.000	0	1	0	0		0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	2	0	0		0
N-Nitrosodi-n-butylamine	UNFL	ug/L	.000	0	1	0	0		0
N-Nitrosodiethylamine	UNFL	ug/L	.000	0	1	0	0		0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	1	0	0		0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	2	0	0		0
N-Nitrosomethylethylamine	UNFL	ug/L	.000	0	1	0	0		0
N-Nitrosomorpholine	UNFL	ug/L	.000	0	1	0	0		0
N-Nitrosopiperidine	UNFL	ug/L	.000	0	1	0	0		0
N-Nitrosopyrrolidine	UNFL	ug/L	.000	0	1	0	0		0
Naphthalene	UNFL	ug/L	.000	0	2	0	0		0
Nitrobenzene	UNFL	ug/L	.000	0	2	0	0		0
O,O,O-Triethylphosphorothioate	UNFL	ug/L	.000	0	1	0	0		0
Pentachlorobenzene	UNFL	ug/L	.000	0	1	0	0		0
Pentachloroethane	UNFL	ug/L	.000	0	1	0	0		0
Pentachloronitrobenzene	UNFL	ug/L	.000	0	1	0	0		0
Pentachlorophenol	UNFL	ug/L	.000	0	2	0	0		0
Phenacetin	UNFL	ug/L	.000	0	1	0	0		0
Phenanthrene	UNFL	ug/L	.000	0	2	0	0		0

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TABLE 4-14B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Phenol	UNFL	ug/L	.000	1	2	17	17	1
Pronamide	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	2	0	0	0
Safrole	UNFL	ug/L	.000	0	1	0	0	0
a,a-Dimethylphenethylamine	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	1	2	10	10	1
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	1	2	4	4	1
o-Toluidine	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	2	0	0	0
p-Dimethylaminoazobenzene	UNFL	ug/L	.000	0	1	0	0	0
p-Phenylenediamine	UNFL	ug/L	.000	0	1	0	0	0
<u>PESTICIDES/PCBs</u>								
Dinoseb	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Isodrin	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-14B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>								
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>DIOXIN/FURAN</u>								
1,2,3,4,7,8-Hexachlorodibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	1	0	0	0
1,2,3,7,8-Pentachlorodibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
2,3,7,8-TCDD	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorodibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorodibenzo-p-dioxin	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorodibenzofuran	UNFL	ug/L	.000	1	1	.00043	.00043	1
Tetrachlorodibenzo-p-dioxin	UNFL	ug/L	.000	1	1	.0038	.0038	1
Tetrachlorodibenzofuran	UNFL	ug/L	.000	1	1	.0011	.0011	1
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	4	4	1.82	18.8	3
Chloride	UNFL	mg/L	145.065	5	5	4	250	4
Fluoride	UNFL	mg/L	.938	5	5	.1	.35	0
Nitrate	UNFL	mg/L	11.400	3	4	.02	1.32	0
Phenols	UNFL	mg/L	.000	1	4	.01	.01	0
Phosphate	UNFL	mg/L	.000	1	1	.88	.88	0
Phosphorus	UNFL	mg/L	.693	2	3	.01	.1	0
Sulfate	UNFL	mg/L	359.847	4	4	390	475	4
Sulfide	UNFL	mg/L	.000	0	1	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	3	3	3.39	27	3
Total Organic Carbon	UNFL	mg/L	3.764	1	2	2.01	2.01	0
Total Organic Halides	UNFL	mg/L	.021	2	4	.013	.027	1
Total Organic Nitrogen	UNFL	mg/L	.652	3	4	1.57	12	3

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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**TABLE 4-15**  
**SOLID WASTE LANDFILL**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	6	11	.0688	1.23	4
Antimony		mg/L	.038	1	11	.0029	.0029	0
Arsenic		mg/L	.300	2	11	.0025	.0025	0
Barium		mg/L	.413	11	11	.0671	.112	0
Beryllium		mg/L	.003	0	11	0	0	0
Cadmium		mg/L	.006	0	11	0	0	0
Calcium		mg/L	135.163	11	11	109	258	8
Chromium		mg/L	.042	1	11	.0198	.0198	0
Cobalt		mg/L	.000	0	11	0	0	0
Copper		mg/L	.130	0	11	0	0	0
Cyanide		mg/L	.000	0	6	0	0	0
Iron		mg/L	4.000	11	11	2.32	7.23	6
Lead		mg/L	.029	2	11	.0028	.0045	0
Magnesium		mg/L	38.070	11	11	24.3	61.3	1
Manganese		mg/L	.800	11	11	.202	.657	0
Mercury		mg/L	.001	0	11	0	0	0
Molybdenum		mg/L	.027	0	11	0	0	0
Nickel		mg/L	.026	0	11	0	0	0
Potassium		mg/L	3.087	11	11	1.24	6.95	3
Selenium		mg/L	.005	0	11	0	0	0
Silicon		mg/L	10.491	11	11	5.91	8.1	0
Silver		mg/L	.023	0	11	0	0	0
Sodium		mg/L	51.918	11	11	11.5	41.9	0
Thallium		mg/L	.000	0	11	0	0	0
Vanadium		mg/L	.027	0	11	0	0	0
Zinc		mg/L	.105	4	11	.0069	.0584	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	8	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	8	0	0	0
GROSS BETA	UNFL	pCi/L	.000	1	8	12.6	12.6	1
NP-237	UNFL	pCi/L	.000	1	5	.318	.318	1
PU-238	UNFL	pCi/L	.000	3	8	.052	.278	3
PU-239/240	UNFL	pCi/L	.000	0	8	0	0	0
RA-226	UNFL	pCi/L	1.200	8	8	.222	1.34	1

See footnote at end of table

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TABLE 4-15  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>								
RA-228	UNFL	pCi/L	4.500	1	8	4.31	4.31	0
RU-106	UNFL	pCi/L	.000	0	8	0	0	0
SR-90	UNFL	pCi/L	.000	6	8	.754	2.38	6
TC-99	UNFL	pCi/L	36.000	0	8	0	0	0
TH-228	UNFL	pCi/L	1.520	1	8	.025	.025	0
TH-230	UNFL	pCi/L	1.790	3	8	.313	.712	0
TH-232	UNFL	pCi/L	.000	0	8	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	8	0	0	0
U-234	UNFL	pCi/L	1.900	7	8	.17	4.74	2
U-235/236	UNFL	pCi/L	.000	3	8	.05	.277	3
U-238	UNFL	pCi/L	.900	7	8	.16	3.69	3
U-TOTAL	UNFL	ug/L	2.920	7	8	.378	9.15	3
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	7	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	7	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	7	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	7	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	7	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	7	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	7	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	7	0	0	0
2-Butanone	UNFL	ug/L	.000	0	7	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	7	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	7	0	0	0
Acetone	UNFL	ug/L	.000	1	7	2	2	1
Benzene	UNFL	ug/L	.000	0	7	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	7	0	0	0
Bromoform	UNFL	ug/L	.000	0	7	0	0	0
Bromomethane	UNFL	ug/L	.000	0	7	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	7	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	7	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	7	0	0	0
Chloroethane	UNFL	ug/L	.000	0	7	0	0	0
Chloroform	UNFL	ug/L	.000	0	7	0	0	0
Chloromethane	UNFL	ug/L	.000	0	7	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	7	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	7	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	7	0	0	0
Styrene	UNFL	ug/L	.000	0	7	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	7	0	0	0

See footnote at end of table

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TABLE 4-15  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Toluene	UNFL	ug/L	.000	0	7	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	7	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	6	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	7	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	7	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	7	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	7	0	0	0
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	7	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	7	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	7	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	7	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	7	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	7	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	6	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	7	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	7	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	7	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	7	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	7	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	7	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	7	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	7	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	7	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	7	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	7	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	7	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	7	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	7	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	6	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	7	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	7	0	0	0
Anthracene	UNFL	ug/L	.000	0	7	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	7	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	7	0	0	0

See footnote at end of table

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TABLE 4-15  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	7	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	7	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	7	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	4	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	6	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	2	7	1	1	2
Carbazole	UNFL	ug/L	.000	0	7	0	0	0
Chrysene	UNFL	ug/L	.000	0	7	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	7	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	6	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	7	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	7	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	7	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	7	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	7	0	0	0
Fluorene	UNFL	ug/L	.000	0	7	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	7	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	6	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	7	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	7	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	7	0	0	0
Isophorone	UNFL	ug/L	.000	0	7	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	7	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	4	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	7	0	0	0
Naphthalene	UNFL	ug/L	.000	0	7	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	7	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	7	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	7	0	0	0
Phenol	UNFL	ug/L	.000	0	7	0	0	0
Pyrene	UNFL	ug/L	.000	0	7	0	0	0
Tributyl phosphate	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	7	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	7	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	7	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	7	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	7	0	0	0
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	7	0	0	0

See footnote at end of table

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TABLE 4-15  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS (Continued)</u>							
4,4'-DDE	UNFL	ug/L	.000	0	7	0 0	0
4,4'-DDT	UNFL	ug/L	.000	0	7	0 0	0
Aldrin	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1016	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1221	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1232	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1242	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1248	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1254	UNFL	ug/L	.000	0	7	0 0	0
Aroclor-1260	UNFL	ug/L	.000	0	7	0 0	0
Dieldrin	UNFL	ug/L	.000	0	7	0 0	0
Endosulfan II	UNFL	ug/L	.000	0	7	0 0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	7	0 0	0
Endosulfan-I	UNFL	ug/L	.000	0	7	0 0	0
Endrin	UNFL	ug/L	.000	0	7	0 0	0
Endrin aldehyde	UNFL	ug/L	.000	0	7	0 0	0
Endrin ketone	UNFL	ug/L	.000	0	7	0 0	0
Heptachlor	UNFL	ug/L	.000	0	7	0 0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	7	0 0	0
Methoxychlor	UNFL	ug/L	.000	0	7	0 0	0
Toxaphene	UNFL	ug/L	.000	0	7	0 0	0
alpha-BHC	UNFL	ug/L	.000	0	7	0 0	0
alpha-Chlordane	UNFL	ug/L	.000	0	7	0 0	0
beta-BHC	UNFL	ug/L	.000	0	7	0 0	0
delta-BHC	UNFL	ug/L	.000	0	7	0 0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	7	0 0	0
gamma-Chlordane	UNFL	ug/L	.000	0	7	0 0	0
<u>GENERAL CHEMISTRY</u>							
Alkalinity	UNFL	mg/L	.000	5	5	235 410	0
Ammonia	UNFL	mg/L	3.240	3	5	.15 .34	0
Chloride	UNFL	mg/L	145.065	5	5	30.87 135.2	0
Fluoride	UNFL	mg/L	.938	5	5	.15 .26	0
Nitrate	UNFL	mg/L	11.400	1	1	2.33 2.33	0
Phenols	UNFL	mg/L	.000	0	5	0 0	0
Phosphorus	UNFL	mg/L	.693	2	3	.03 .04	0
Sulfate	UNFL	mg/L	359.847	5	5	128.4 333.3	0
Sulfide	UNFL	mg/L	.000	1	5	5.66 5.66	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	4	4	.11 .58	4
Total Organic Carbon	UNFL	mg/L	3.764	2	5	1.55 3.2	0
Total Organic Halides	UNFL	mg/L	.021	2	5	.0104 .0242	1

See footnote at end of table

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**TABLE 4-15  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>							
Total Organic Nitrogen	UNFL	mg/L	.652	4	5	.11 .24	0
Total Phosphorous	UNFL	mg/L	.000	1	2	.1 .1	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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the top of the regional aquifer. A water level hydrograph prepared for Well 1037 showed that water levels vary from 549.76 to 555.8 feet above MSL approximately 20-25 feet below the perched water in the landfill. These data may indicate that leakage from Well 1037 is influencing water quality in Well 2037 and that concentrations of constituents detected above background are not a result of leakage through the matrix of the glacial till under the landfill; rather, they are a local effect of poor well construction.

A comparison of selected data from paired wells is shown in the following table:

Regional Aquifer	2000-Series Well	Strontium-90	Total Uranium	Total Thorium
	1000-Series Well			
Upgradient Well	2949	0.754	0.378	<2
	1035	ND*	2.55	<3
	2951	1.740	0.781	<2
	1950	ND	7.67	5.96
Downgradient Well	2953	1.010	1.23	<2
	1952	ND	55.8	104

\*ND = Not detected

The data indicate that strontium-90, total uranium, and total thorium, which are detected in elevated concentrations in the perched zone, are detected below background concentrations in regional aquifer wells upgradient and downgradient of the Solid Waste Landfill. A comparison of nested wells, for example, Wells Nos. 1952 and 2953 data indicates that vertical leakage from the perched zone to the regional aquifer is not evident.

#### 4.2.5 Biota

Ecological impacts from the Solid Waste Landfill are not addressed in the Operable Unit 2 RI because a Site-wide Ecological Risk Assessment will be prepared as part of the Operable Unit 5 RI/FS.

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4.2.6 Summary

The following conclusions concerning the Solid Waste Landfill are made:

- The constituents and their concentrations for the surface soils are found in varying degrees throughout the Solid Waste Landfill suggesting that there are no defined surface hot spots.
- The concentrations for the subsurface soils constituents are found in varying degrees throughout the landfill. The greatest concentrations for the radionuclides are apparently detected in the vicinity of location 11036 (south-central portion). The highest concentrations for the organic constituents apparently are in the vicinity of location 11039 (east-central) and 1719 (central). However, the overall distribution of constituents suggests that there are no defined subsurface hot spots.
- Sediment samples and surface water samples downstream of the landfill indicate a possible impact from the landfill.
- Waste material analyzed in investigation trenches and borings appears to be of relatively low-level radioactivity, and may have originated in various areas of the operating plant (i.e. laboratory and manufacturing areas).
- One waste disposal cell (Cell 1) was identified in photographs and in trench and boring samples. Elsewhere, waste material was found mixed with soil at depths from the surface to about 10 feet deep. The average uranium depth of waste burial appears to be the original till surface or about 10 feet deep; however, deeper pits may have been used for disposal at the southeast corner of the landfill.
- Concentrations of radionuclides and organic compounds were detected above background levels in surface soil, subsurface soil, and in leachate from two test trenches.
- A sample of perched groundwater downgradient from the waste unit detected elevated concentrations of uranium and thorium, which indicates an impact from the landfill. Samples from downgradient regional Great Miami Aquifer wells did not detect any concentrations of uranium or thorium above background. A comparison of concentration data from paired wells indicates that vertical constituent migration from the perched aquifer into the regional aquifer is not evident.
- A comparison of Phase I and Phase II data with the CIS and ES data didn't produce any unexpected anomalies. This comparison confirmed, as a whole, the validity of the Phase I and Phase II sampling program.

4.3 LIME SLUDGE PONDS

Analytical results for samples collected from the Lime Sludge Ponds are presented in Appendix D. Sample analyses that detected analytes at concentrations above background (defined in Table 4-1A) will be discussed in this section. Geology and hydrogeology of the Lime Sludge Ponds referred to in this section were discussed in more detail in Section 3.3. The North Lime Sludge Pond was in use at

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the time of the Phase I and Phase II investigations. The South Lime Sludge Pond was no longer in use at the time of the Phase I and Phase II investigations.

4.3.1 Volume and Physical Characteristics

The volume of lime sludge material was estimated by means of digitized topographic maps, boring log data, pre-construction engineering drawings, and interpolation using Intergraph Corporation Microstation PC software. Volume calculations are summarized in Figure 4-7. The volume of lime sludge and berm material is calculated to be approximately 16,231 cubic yards. The K-65 slurry line trench that is parallel to the south battery limits of the waste unit has not been included in the estimate of waste material, because the line is part of OU3.

Lime sludge was generated from the water softening process applied to the raw groundwater feed for the process plant. The sludge material is the residue of lime used in the softening process and consists primarily of calcium carbonate and precipitated metal hydroxides. Additional solid material has been contributed from solids settled out of coal pile storm runoff and from solids contained in boiler plant blowdown water.

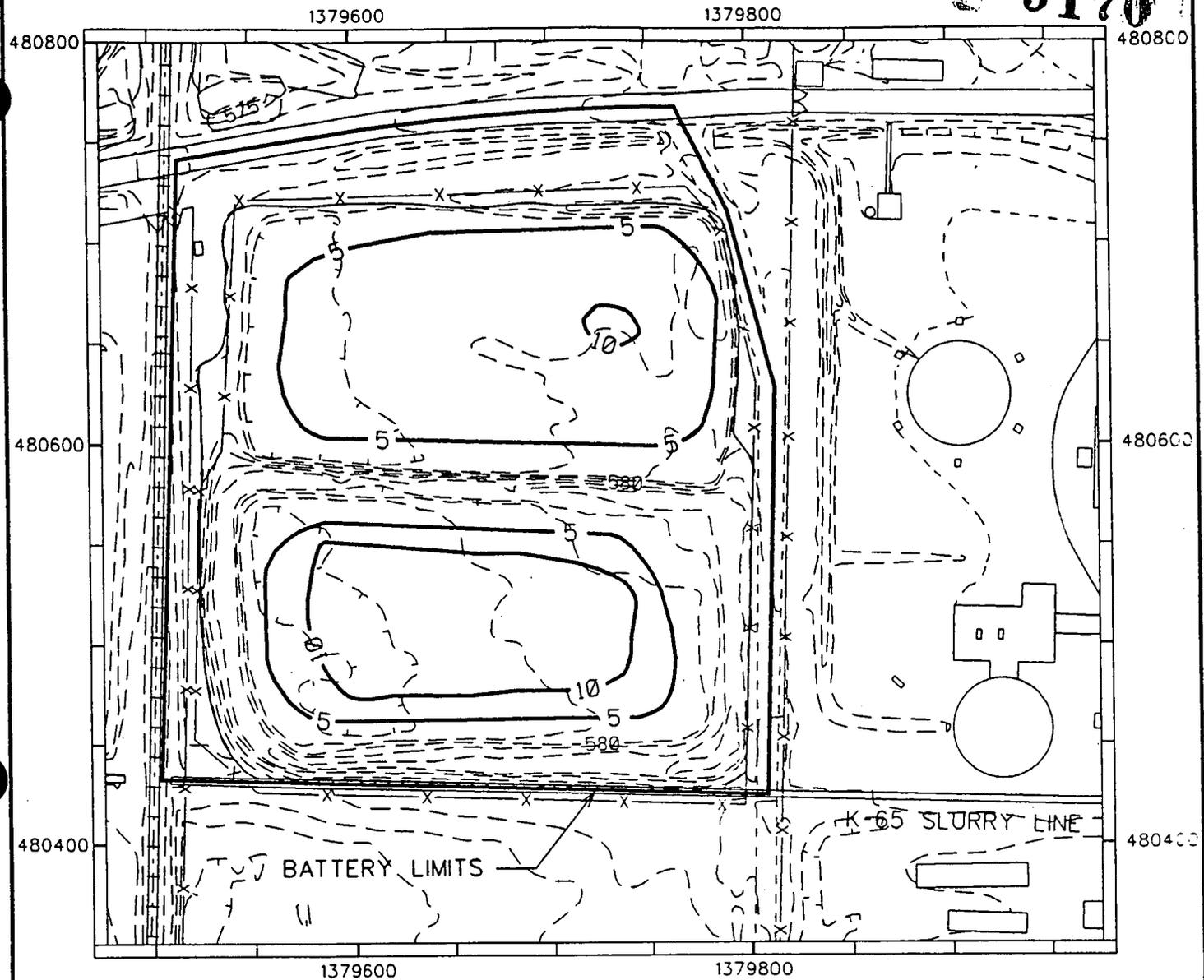
The south battery limit is marked by the K-65 slurry line trench. The trench is a six foot deep by two foot wide concrete containment that houses several steel pipelines. Steel plates that are loosely fitted cover the trench. The K-65 slurry line was used to pump waste material containing high levels of uranium, thorium, and radium to the silos (Operable Unit 4). Waste material in the concrete trench consists of surface runoff that has leaked through gaps between the plates and a thin layer of silt carried in by erosion of the surrounding area. Water in the trench drains west to a sump and then is pumped out of the trench to the site wide storm water treatment system. No waste material originating from the pipeline was observed in the trench during the Phase II investigation.

4.3.2 Surface and Subsurface Media

Surface soil samples were collected during Phase II from the ponds, berms, and from the roadway that is at the north boundary. The analytical data values that are detected above background are included in Appendix D, Table D-2A. A summary of the constituents in surface soil is provided in Table 4-16.

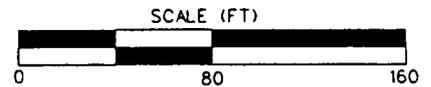
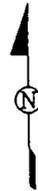
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LEGEND	
	575 ELEVATION CONTOURS
	ROADS
	DRAINAGE
	WASTE MATERIAL THICKNESS CONTOUR
	FENCE
	RAILROAD

NOTE:  
 Coordinates are in State Planar NAD 1927.  
 Surface contours based on 1992 flyover.



TOTAL FILL VOLUME = 16231 Cu. Yds.

FIGURE 4-7  
 VOLUME OF  
 WASTE MATERIAL,  
 LIME SLUDGE PONDS

fig0407.dgn

**TABLE 4-16**  
**LIME SLUDGE PONDS**  
**SURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	14	14	4070	12800	0
Antimony	mg/kg	.000	0	13	0	0	0
Arsenic	mg/kg	11.608	14	14	3.5	9.5	0
Barium	mg/kg	88.500	14	14	62	101	5
Beryllium	mg/kg	.600	10	14	.47	2	9
Cadmium	mg/kg	.770	7	14	.96	1.2	7
Calcium	mg/kg	5296.781	14	14	20100	350000	14
Chromium	mg/kg	17.057	12	14	5.1	54.2	5
Cobalt	mg/kg	16.913	12	14	4.1	13.8	0
Copper	mg/kg	15.700	14	14	16.5	67.1	14
Cyanide	mg/kg	.230	7	12	.15	.82	5
Iron	mg/kg	24788.749	14	14	3960	74000	2
Lead	mg/kg	29.575	14	14	1.5	240	4
Magnesium	mg/kg	1460.000	14	14	8160	27500	14
Manganese	mg/kg	2257.945	14	14	460	1210	0
Mercury	mg/kg	.300	1	14	.27	.27	0
Molybdenum	mg/kg	.000	3	14	1.6	21	3
Nickel	mg/kg	25.145	12	14	5.2	24.6	0
Potassium	mg/kg	1349.530	12	14	58.7	2080	5
Selenium	mg/kg	.720	2	14	.26	.37	0
Silicon	mg/kg	1914.313	14	14	485	3550	3
Silver	mg/kg	.000	2	14	7.1	20.8	2
Sodium	mg/kg	55.145	14	14	90.1	410	14
Thallium	mg/kg	.580	0	14	0	0	0
Vanadium	mg/kg	33.693	13	14	3.6	39.1	1
Zinc	mg/kg	58.500	13	14	33.6	107	4
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.849	11	14	.064	.89	1
GROSS ALPHA	pCi/g	.000	12	14	12.9	145	12
GROSS BETA	pCi/g	.000	14	14	7.74	108	14
NP-237	pCi/g	.000	14	14	.04	.72	14
PU-238	pCi/g	.000	11	14	.04	.662	11
PU-239/240	pCi/g	.000	11	14	.03	.47	11
RA-226	pCi/g	1.528	12	14	.205	3.48	5
RA-228	pCi/g	1.170	10	14	.709	2.92	7
RU-106	pCi/g	.000	0	14	0	0	0

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TABLE 4-16  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
SR-90	pCi/g	.000	2	13	.508	.785	2
TC-99	pCi/g	.000	2	14	1.05	1.79	2
TH-228	pCi/g	1.519	12	13	.082	2.91	4
TH-230	pCi/g	2.112	13	13	.373	44.8	10
TH-232	pCi/g	1.469	11	12	.037	2.75	1
TH-TOTAL	mg/kg	10.700	13	13	.34	25.1	2
U-234	pCi/g	1.319	14	14	1.08	26.5	12
U-235/236	pCi/g	.181	14	14	.025	1.83	10
U-238	pCi/g	1.270	14	14	.856	84	12
U-TOTAL	mg/kg	3.240	14	14	2.45	244	13
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	14	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	14	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	14	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	14	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	14	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	14	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	14	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	14	0	0	0
2-Butanone	ug/kg	.000	0	14	0	0	0
2-Hexanone	ug/kg	.000	0	14	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	14	0	0	0
Acetone	ug/kg	.000	1	14	2	2	1
Benzene	ug/kg	.000	0	14	0	0	0
Bromodichloromethane	ug/kg	.000	0	14	0	0	0
Bromoform	ug/kg	.000	0	14	0	0	0
Bromomethane	ug/kg	.000	0	14	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	14	0	0	0
Carbon disulfide	ug/kg	.000	0	14	0	0	0
Chlorobenzene	ug/kg	.000	0	14	0	0	0
Chloroethane	ug/kg	.000	0	14	0	0	0
Chloroform	ug/kg	.000	0	14	0	0	0
Chloromethane	ug/kg	.000	0	14	0	0	0
Dibromochloromethane	ug/kg	.000	0	14	0	0	0
Ethylbenzene	ug/kg	.000	0	14	0	0	0
Methylene chloride	ug/kg	.000	0	14	0	0	0
Styrene	ug/kg	.000	0	14	0	0	0
Tetrachloroethene	ug/kg	.000	0	14	0	0	0
Toluene	ug/kg	.000	3	14	4	17	3
Trichloroethene	ug/kg	.000	0	14	0	0	0
Vinyl Acetate	ug/kg	.000	0	9	0	0	0
Vinyl chloride	ug/kg	.000	0	14	0	0	0
Xylenes, Total	ug/kg	.000	0	14	0	0	0

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**TABLE 4-16**  
**(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>VOLATILE ORGANICS</u>							
cis-1,3-Dichloropropene	ug/kg	.000	0	14	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	14	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	14	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	14	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	14	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	14	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	13	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	13	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	13	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	13	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	9	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	14	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	14	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	4	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	14	0	0	0
2-Chlorophenol	ug/kg	.000	0	13	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	14	0	0	0
2-Methylphenol	ug/kg	.000	0	13	0	0	0
2-Nitroaniline	ug/kg	.000	0	14	0	0	0
2-Nitrophenol	ug/kg	.000	0	13	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	14	0	0	0
3-Nitroaniline	ug/kg	.000	0	14	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	9	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	14	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	13	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	14	0	0	0
4-Methylphenol	ug/kg	.000	0	13	0	0	0
4-Nitroaniline	ug/kg	.000	0	11	0	0	0
4-Nitrophenol	ug/kg	.000	0	8	0	0	0
Acenaphthene	ug/kg	.000	0	14	0	0	0
Acenaphthylene	ug/kg	.000	0	14	0	0	0
Anthracene	ug/kg	.000	4	14	1	240	4
Benzo(a)anthracene	ug/kg	.000	4	14	1	910	4
Benzo(a)pyrene	ug/kg	.000	4	14	1	1100	4
Benzo(b)fluoranthene	ug/kg	.000	5	14	2	1000	5
Benzo(g,h,i)perylene	ug/kg	.000	2	14	170	630	2
Benzo(k)fluoranthene	ug/kg	.000	4	14	2	800	4
Benzoic acid	ug/kg	.000	0	7	0	0	0
Benzyl alcohol	ug/kg	.000	0	10	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	10	0	0	0
Carbazole	ug/kg	.000	2	14	71	140	2

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TABLE 4-16  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Chrysene	ug/kg	.000	6	14	2	1100	6
Di-n-butyl phthalate	ug/kg	.000	2	14	42	120	2
Di-n-octyl phthalate	ug/kg	.000	1	10	87	87	1
Dibenzo(a,h)anthracene	ug/kg	.000	3	14	110	320	3
Dibenzofuran	ug/kg	.000	1	14	42	42	1
Diethyl phthalate	ug/kg	.000	0	14	0	0	0
Dimethyl phthalate	ug/kg	.000	0	14	0	0	0
Fluoranthene	ug/kg	.000	6	14	3	2100	6
Fluorene	ug/kg	.000	1	14	79	79	1
Hexachlorobenzene	ug/kg	.000	0	14	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	10	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	14	0	0	0
Hexachloroethane	ug/kg	.000	0	14	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	3	14	210	720	3
Isophorone	ug/kg	.000	0	14	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	14	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	1	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	14	0	0	0
Naphthalene	ug/kg	.000	0	14	0	0	0
Nitrobenzene	ug/kg	.000	0	14	0	0	0
Pentachlorophenol	ug/kg	.000	0	13	0	0	0
Phenanthrene	ug/kg	.000	4	14	1	1600	4
Phenol	ug/kg	.000	0	13	0	0	0
Pyrene	ug/kg	.000	6	14	3	1900	6
Tributyl phosphate	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	14	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	14	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	14	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	8	14	78	10000	8
p-Chloroaniline	ug/kg	.000	0	14	0	0	0
<u>PESTICIDES/PCBS</u>							
4,4'-DDD	ug/kg	.000	0	15	0	0	0
4,4'-DDE	ug/kg	.000	0	15	0	0	0
4,4'-DDT	ug/kg	.000	0	15	0	0	0
Aldrin	ug/kg	.000	0	15	0	0	0
Aroclor-1016	ug/kg	.000	0	15	0	0	0
Aroclor-1221	ug/kg	.000	0	15	0	0	0
Aroclor-1232	ug/kg	.000	0	15	0	0	0
Aroclor-1242	ug/kg	.000	0	15	0	0	0
Aroclor-1248	ug/kg	.000	0	15	0	0	0
Aroclor-1254	ug/kg	.000	3	15	43	590	3
Aroclor-1260	ug/kg	.000	0	15	0	0	0

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TABLE 4-16  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS (Continued)</u>							
Dieldrin	ug/kg	.000	0	15	0	0	0
Endosulfan II	ug/kg	.000	0	15	0	0	0
Endosulfan sulfate	ug/kg	.000	0	15	0	0	0
Endosulfan-I	ug/kg	.000	0	15	0	0	0
Endrin	ug/kg	.000	0	15	0	0	0
Endrin aldehyde	ug/kg	.000	0	15	0	0	0
Endrin ketone	ug/kg	.000	0	15	0	0	0
Heptachlor	ug/kg	.000	0	15	0	0	0
Heptachlor epoxide	ug/kg	.000	0	15	0	0	0
Methoxychlor	ug/kg	.000	0	15	0	0	0
Toxaphene	ug/kg	.000	0	15	0	0	0
alpha-BHC	ug/kg	.000	0	15	0	0	0
alpha-Chlordane	ug/kg	.000	0	15	0	0	0
beta-BHC	ug/kg	.000	0	15	0	0	0
delta-BHC	ug/kg	.000	0	15	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	15	0	0	0
gamma-Chlordane	ug/kg	.000	0	15	0	0	0

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Seventeen metals, isotopes of eight elements, and 21 organic compounds were detected in 14 surface soil samples collected during Phase II. There were three detections of Aroclor-1254 in samples collected from the northeast corner of the north pond and from the adjacent road and are shown on Figure 4-8A.

Concentrations of metals were detected in surface samples collected from sludge, berm material, the roads, and from the K-65 trench. Beryllium and copper were detected in all areas at concentrations above background. Lead was detected in samples from the road and trench, but not in the berms or pond material. Calcium concentrations in sludge were greater than 279 mg/kg, while berm materials had a maximum concentration of 67 mg/kg calcium. Samples collected from within the K-65 trench detected the highest concentrations for the metals: copper (67.1 mg/kg), zinc (107 mg/kg), lead (240 mg/kg), and chromium (54.2 mg/kg). A comparison of berm, roadway, and sludge sample metal concentrations suggests that these are composed of three separate materials.

Radionuclides detected in surface soil are shown on Figure 4-8. The radionuclide data indicate that activity of isotopes is highest in the samples collected within the K-65 slurry line trench (samples LSP-TR-01 and LSP-TR-02), and in samples from the road surface (LSP-SS-13 and LSP-SS-14). A sample collected adjacent to the roads east of the ponds (LSP-SS-07) and samples collected adjacent to the K-65 slurry line trench (LSP-SS-03 and LSP-SS-04) also detected elevated concentrations of uranium and thorium isotopes. These data suggest that the surface soil outside of the ponds has been impacted by the K-65 slurry line trench, possibly during maintenance of the line, and by carry-over from spillage on the haul roads in the former Production Area.

Organic analytical data is shown on Figure 4-8A. Maximum concentrations for organic compounds detected in surface samples of the sludge included bis(2-ethylhexyl)phthalate (390 µg/kg) and di-n-butyl phthalate (120 µg/kg). Maximum concentrations for the following compounds were detected in samples from the road along the north boundary: crysene (1100 µg/kg), and benzo(a)pyrene (1100 µg/kg), aroclor 1254 (590 µg/kg), benzo(k)fluoranthene (800 µg/kg). A comparison of the number of organic compounds detected in surface samples and their location suggests that the haul road north of the Lime Sludge Ponds has contributed to the organic compounds detected in surface soil samples from the unit. Aroclor-1254 is an indicator that the source for organic compounds in LSP-SS-12 (north pond berm) is the same as for LSP-SS-13 and LSP-SS-14 (the haul road). Concentrations of PCBs were higher in samples collected from the road (590 µg/kg

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and 90 µg/kg, aroclor-1254) when compared to pond surface samples (one detection of 43 µg/kg Arochlor-1254 at LSP-SS-12).

A comparison of Phase I and Phase II surface soil samples with the CIS data (Appendix D-16A) indicates that the parameters detected in the CIS were detected in Phase I and Phase II and within the same order of magnitude.

Concentrations of constituents detected above background in subsurface samples collected from the Lime Sludge Ponds are presented in Appendix D in Table D-2B and Table D-2C. A summary of the analytes for Phase I and II is provided in Table 4-17 and Table 4-18. Twelve metals, isotopes of three elements, and no organic compounds for were detected above background for Phase I from two sample locations. From thirty sample locations during Phase II there were twenty four metals (Aluminum, Arsenic, Barium, Cadmium, Cobalt, Iron, Lead, Manganese, Mercury, Nickel, Potassium, Selenium, and Vanadium were detected above background for Phase II but not for Phase I; and Thallium was detected above background for Phase I but not Phase II), isotopes of eight elements (cesium-137, neptunium-237, plutonium-238, plutonium-239/240, radium-226, radium-228, technetium-99, thorium-total, uranium-238, and uranium-235/236 were detected above background for Phase II but not Phase I), and thirteen organic compounds were detected above background for Phase II.

The concentration of selected metals in sludge and underlying soil was compared as shown in Table 4-19. The data shows that soil background concentrations were most frequently exceeded in sludge for copper (three of seven samples) and beryllium (three of seven samples). Soil samples collected from beneath the sludge exceeded background concentrations for copper (five of nine samples), beryllium (six of nine samples), zinc (three of nine samples), and arsenic (two of nine samples). A comparison of sludge data and data from soil underlying the sludge indicates that impacts from the sludge upon the soil have been detected for the metals copper, beryllium, and zinc.

Two locations in the north pond contained concentrations of metals that most frequently exceeded background concentrations. Boring No. 1956 (northwest corner) detected four of eight metals in sludge and Boring No. 1959 (northeast corner) detected five of eight metals in sludge above background concentrations. The highest lead, copper, zinc, vanadium, and chromium concentrations

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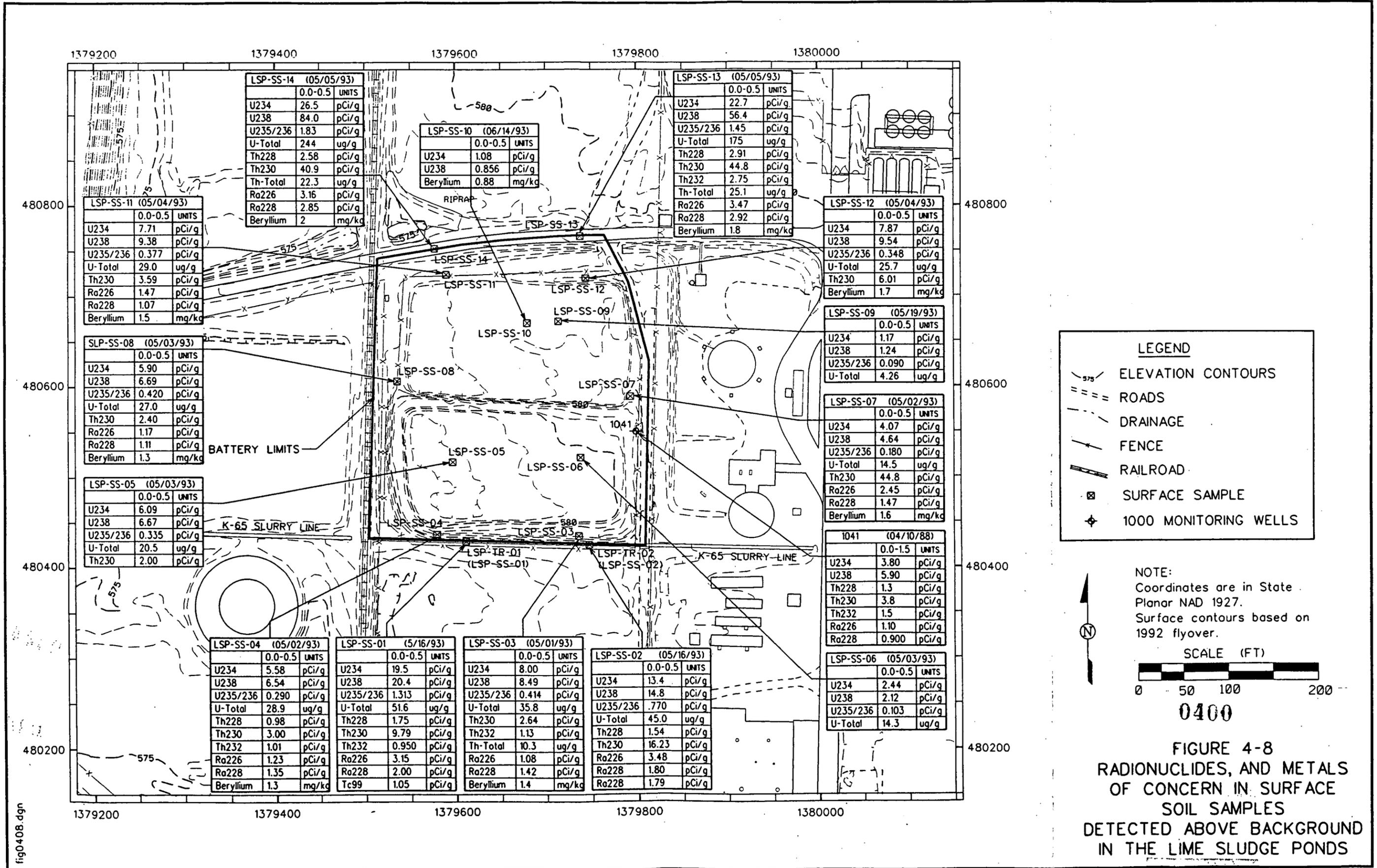
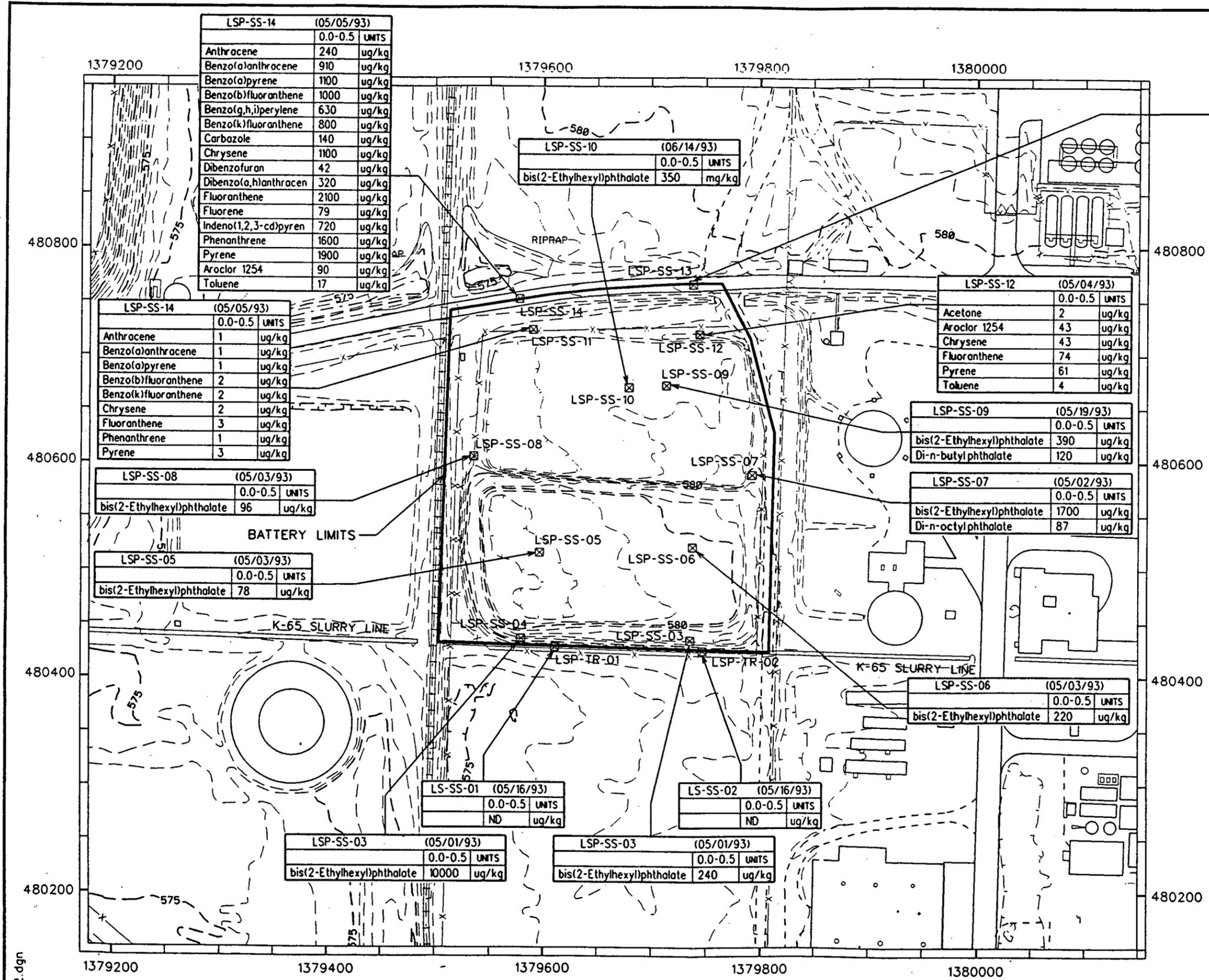


fig0408.dgn



LSP-SS-13 (05/05/93)		
	0.0-0.5	UNITS
Anthracene	120	ug/kg
Aroclor 1254	590	ug/kg
Benzo(a)anthracene	630	ug/kg
Benzo(a)pyrene	820	ug/kg
Benzo(b)fluoranthene	680	ug/kg
Benzo(k)fluoranthene	660	ug/kg
Carbazole	71	ug/kg
Chrysene	720	ug/kg
Dibenzo(a,h)anthracene	240	ug/kg
Di-n-butylphthalate	42	ug/kg
Fluoranthene	1300	ug/kg
Indeno(1,2,3-cd)pyrene	580	ug/kg
Phenanthrene	640	ug/kg
Pyrene	1100	ug/kg
Toluene	7	ug/kg

LSP-SS-14 (05/05/93)		
	0.0-0.5	UNITS
Anthracene	240	ug/kg
Benzo(a)anthracene	910	ug/kg
Benzo(a)pyrene	1100	ug/kg
Benzo(b)fluoranthene	1000	ug/kg
Benzo(g,h,i)perylene	630	ug/kg
Benzo(k)fluoranthene	800	ug/kg
Carbazole	140	ug/kg
Chrysene	1100	ug/kg
Dibenzofuran	42	ug/kg
Dibenzo(a,h)anthracene	320	ug/kg
Fluoranthene	2100	ug/kg
Fluorene	79	ug/kg
Indeno(1,2,3-cd)pyrene	720	ug/kg
Phenanthrene	1600	ug/kg
Pyrene	1900	ug/kg
Aroclor 1254	90	ug/kg
Toluene	17	ug/kg

LSP-SS-10 (06/14/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	350	mg/kg

LSP-SS-12 (05/04/93)		
	0.0-0.5	UNITS
Acetone	2	ug/kg
Aroclor 1254	43	ug/kg
Chrysene	43	ug/kg
Fluoranthene	74	ug/kg
Pyrene	61	ug/kg
Toluene	4	ug/kg

LSP-SS-14 (05/05/93)		
	0.0-0.5	UNITS
Anthracene	1	ug/kg
Benzo(a)anthracene	1	ug/kg
Benzo(a)pyrene	1	ug/kg
Benzo(b)fluoranthene	2	ug/kg
Benzo(k)fluoranthene	2	ug/kg
Chrysene	2	ug/kg
Fluoranthene	3	ug/kg
Phenanthrene	1	ug/kg
Pyrene	3	ug/kg

LSP-SS-08 (05/03/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	96	ug/kg

LSP-SS-05 (05/03/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	78	ug/kg

LSP-SS-09 (05/19/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	390	ug/kg
Di-n-butylphthalate	120	ug/kg

LSP-SS-07 (05/02/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	1700	ug/kg
Di-n-octylphthalate	87	ug/kg

LSP-SS-06 (05/03/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	220	ug/kg

LS-SS-01 (05/16/93)		
	0.0-0.5	UNITS
	ND	ug/kg

LS-SS-02 (05/16/93)		
	0.0-0.5	UNITS
	ND	ug/kg

LSP-SS-03 (05/01/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	10000	ug/kg

LSP-SS-03 (05/01/93)		
	0.0-0.5	UNITS
bis(2-Ethylhexyl)phthalate	240	ug/kg

**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- SURFACE SAMPLE
- 1000 MONITORING WELLS

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

SCALE (FT)  
0 50 100 200

**0401**

**FIGURE 4-8A**  
ORGANIC COMPOUNDS IN  
SURFACE SOIL SAMPLES  
DETECTED ABOVE BACKGROUND  
IN THE LIME SLUDGE PONDS

fig0482.dgn

**TABLE 4-17**  
**LIME SLUDGE PONDS**  
**SUBSURFACE SOIL**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	2	2	2700	4580	0
Antimony	mg/kg	.000	2	2	20	22.1	2
Arsenic	mg/kg	9.704	2	2	1.7	4.2	0
Barium	mg/kg	121.064	2	2	63.4	71.1	0
Beryllium	mg/kg	.620	2	2	.65	.76	2
Boron	mg/kg	43.204	2	2	28.9	.37	0
Cadmium	mg/kg	.910	2	2	2.5	4	2
Calcium	mg/kg	150000.000	2	2	323000	339000	2
Chromium	mg/kg	20.953	2	2	28.1	28.2	2
Cobalt	mg/kg	15.929	2	2	3.9	5.1	0
Copper	mg/kg	20.230	2	2	8.4	20.5	1
Cyanide	mg/kg	.170	1	2	1.7	1.7	1
Iron	mg/kg	31188.164	2	2	3240	3980	0
Lead	mg/kg	15.780	2	2	.98	2	0
Magnesium	mg/kg	43052.339	2	2	13300	19600	0
Manganese	mg/kg	1045.407	2	2	499	515	0
Mercury	mg/kg	.290	0	2	0	0	0
Molybdenum	mg/kg	.270	2	2	5.7	8.2	2
Nickel	mg/kg	34.747	2	2	9	11.7	0
Potassium	mg/kg	2007.519	1	2	68.7	68.7	0
Selenium	mg/kg	.000	0	2	0	0	0
Silicon	mg/kg	1069.496	2	2	3220	5920	2
Silver	mg/kg	.000	2	2	21.7	22	2
Sodium	mg/kg	227.947	2	2	327	599	2
Thallium	mg/kg	.490	1	2	.51	.51	1
Tin	mg/kg	.000	0	2	0	0	0
Vanadium	mg/kg	38.088	2	2	17.1	17.5	0
Zinc	mg/kg	73.158	2	2	8.2	13.8	0
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	0	6	0	0	0
NP-237	pCi/g	.000	0	4	0	0	0
PU-238	pCi/g	.000	0	6	0	0	0
PU-239/240	pCi/g	.000	0	4	0	0	0
RA-226	pCi/g	1.470	5	6	.35	1.1	0

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TABLE 4-17  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>							
RA-228	pCi/g	1.325	2	6	.9	1.2	0
RU-106	pCi/g	.000	0	6	0	0	0
SR-90	pCi/g	.560	1	6	6	6	1
TC-99	pCi/g	.000	0	3	0	0	0
TH-228	pCi/g	1.341	5	6	.7	1.46	1
TH-230	pCi/g	1.897	4	6	1.3	3.8	2
TH-232	pCi/g	1.269	3	6	.9	1.5	2
TH-TOTAL	mg/kg	9.470	0	2	0	0	0
U-234	pCi/g	1.034	5	6	.8	3.8	2
U-235	pCi/g	.000	0	2	0	0	0
U-235/236	pCi/g	.142	0	6	0	0	0
U-238	pCi/g	1.122	5	6	.7	5.9	2
U-TOTAL	mg/kg	2.540	2	2	2.08	5.49	1
<u>VOLATILE ORGANICS</u>							
1,1,1,2-Tetrachloroethane	ug/kg	.000	0	2	0	0	0
1,1,1-Trichloroethane	ug/kg	.000	0	2	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	2	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	2	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	2	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	2	0	0	0
1,2,3-Trichloropropane	ug/kg	.000	0	2	0	0	0
1,2-Dibromo-3-chloropropane	ug/kg	.000	0	2	0	0	0
1,2-Dibromoethane	ug/kg	.000	0	2	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	2	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	2	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	2	0	0	0
2-Butanone	ug/kg	.000	0	2	0	0	0
2-Chloro-1,3-butadiene	ug/kg	.000	0	2	0	0	0
2-Hexanone	ug/kg	.000	1	2	2	2	1
3-Chloropropene	ug/kg	.000	0	2	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	2	0	0	0
Acetone	ug/kg	.000	0	2	0	0	0
Acetonitrile	ug/kg	.000	0	2	0	0	0
Acrolein	ug/kg	.000	0	2	0	0	0
Benzene	ug/kg	.000	0	2	0	0	0
Bromodichloromethane	ug/kg	.000	0	2	0	0	0
Bromoform	ug/kg	.000	0	2	0	0	0
Bromomethane	ug/kg	.000	0	2	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	2	0	0	0
Carbon disulfide	ug/kg	.000	0	2	0	0	0

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TABLE 4-17  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Chlorobenzene	ug/kg	.000	0	2	0	0	0
Chloroethane	ug/kg	.000	0	2	0	0	0
Chloroform	ug/kg	.000	0	2	0	0	0
Chloromethane	ug/kg	.000	0	2	0	0	0
Dibromochloromethane	ug/kg	.000	0	2	0	0	0
Dibromomethane	ug/kg	.000	0	2	0	0	0
Ethyl cyanide	ug/kg	.000	0	2	0	0	0
Ethyl methacrylate	ug/kg	.000	0	2	0	0	0
Ethylbenzene	ug/kg	.000	0	2	0	0	0
Iodomethane	ug/kg	.000	0	2	0	0	0
Isobutyl alcohol	ug/kg	.000	0	2	0	0	0
Methacrylonitrile	ug/kg	.000	0	2	0	0	0
Methyl methacrylate	ug/kg	.000	0	2	0	0	0
Methylene chloride	ug/kg	.000	0	2	0	0	0
Pyridine	ug/kg	.000	0	2	0	0	0
Styrene	ug/kg	.000	0	2	0	0	0
Tetrachloroethene	ug/kg	.000	0	2	0	0	0
Toluene	ug/kg	.000	0	2	0	0	0
Trichloroethene	ug/kg	.000	0	2	0	0	0
Trichlorofluoromethane	ug/kg	.000	0	2	0	0	0
Vinyl Acetate	ug/kg	.000	0	2	0	0	0
Vinyl chloride	ug/kg	.000	0	2	0	0	0
Xylenes, Total	ug/kg	.000	0	2	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	2	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	2	0	0	0
trans-1,4-Dichloro-2-butene	ug/kg	.000	0	2	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4,5-Tetrachlorobenzene	ug/kg	.000	0	2	0	0	0
1,2,4-Trichlorobenzene	ug/kg	.000	0	2	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	2	0	0	0
1,3,5-Trinitrobenzene	ug/kg	.000	0	2	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	2	0	0	0
1,3-Dinitrobenzene	ug/kg	.000	0	2	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	2	0	0	0
1,4-Naphthoquinone	ug/kg	.000	0	2	0	0	0
1-Naphthylamine	ug/kg	.000	0	2	0	0	0
2,3,4,6-Tetrachlorophenol	ug/kg	.000	0	2	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	2	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	2	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	2	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	2	0	0	0

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**TABLE 4-17  
(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
2,4-Dinitrophenol	ug/kg	.000	0	2	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	2	0	0	0
2,6-Dichlorophenol	ug/kg	.000	0	2	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	2	0	0	0
2-Acetylaminofluorene	ug/kg	.000	0	2	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	2	0	0	0
2-Chlorophenol	ug/kg	.000	0	2	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	2	0	0	0
2-Methylphenol	ug/kg	.000	0	2	0	0	0
2-Naphthylamine	ug/kg	.000	0	2	0	0	0
2-Nitroaniline	ug/kg	.000	0	2	0	0	0
2-Nitrophenol	ug/kg	.000	0	2	0	0	0
2-Picoline	ug/kg	.000	0	2	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	2	0	0	0
3,3'-Dimethylbenzidine	ug/kg	.000	0	2	0	0	0
3-Methylcholanthrene	ug/kg	.000	0	2	0	0	0
3-Methylphenol	ug/kg	.000	0	2	0	0	0
3-Nitroaniline	ug/kg	.000	0	2	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	2	0	0	0
4-Aminobiphenyl	ug/kg	.000	0	2	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	2	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	2	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	2	0	0	0
4-Methylphenol	ug/kg	.000	0	2	0	0	0
4-Nitroaniline	ug/kg	.000	0	2	0	0	0
4-Nitrophenol	ug/kg	.000	0	2	0	0	0
5-Nitro-o-toluidine	ug/kg	.000	0	2	0	0	0
7,12-Dimethylbenz(a)anthracene	ug/kg	.000	0	2	0	0	0
Acenaphthene	ug/kg	.000	0	2	0	0	0
Acenaphthylene	ug/kg	.000	0	2	0	0	0
Acetophenone	ug/kg	.000	0	2	0	0	0
Aniline	ug/kg	.000	0	2	0	0	0
Anthracene	ug/kg	.000	0	2	0	0	0
Aramite	ug/kg	.000	0	2	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	2	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	2	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	2	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	2	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	2	0	0	0
Benzoic acid	ug/kg	.000	0	2	0	0	0
Benzyl alcohol	ug/kg	.000	0	2	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	2	0	0	0

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TABLE 4-17  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Chrysene	ug/kg	.000	0	2	0	0	0
Di-n-butyl phthalate	ug/kg	.000	0	2	0	0	0
Di-n-octyl phthalate	ug/kg	.000	0	2	0	0	0
Diallate	ug/kg	.000	0	2	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	2	0	0	0
Dibenzofuran	ug/kg	.000	0	2	0	0	0
Diethyl phthalate	ug/kg	.000	0	2	0	0	0
Dimethyl phthalate	ug/kg	.000	0	2	0	0	0
Diphenylamine	ug/kg	.000	0	2	0	0	0
Ethyl methanesulfonate	ug/kg	.000	0	2	0	0	0
Fluoranthene	ug/kg	.000	0	2	0	0	0
Fluorene	ug/kg	.000	0	2	0	0	0
Hexachlorobenzene	ug/kg	.000	0	2	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	2	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	2	0	0	0
Hexachloroethane	ug/kg	.000	0	2	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	2	0	0	0
Isophorone	ug/kg	.000	0	2	0	0	0
Isosafrole	ug/kg	.000	0	2	0	0	0
Methapyrilene	ug/kg	.000	0	2	0	0	0
Methyl methanesulfonate	ug/kg	.000	0	2	0	0	0
Methyl parathion	ug/kg	.000	0	2	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodi-n-butylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodiethylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosomethylethylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosomorpholine	ug/kg	.000	0	2	0	0	0
N-Nitrosopiperidine	ug/kg	.000	0	2	0	0	0
N-Nitrosopyrrolidine	ug/kg	.000	0	2	0	0	0
Naphthalene	ug/kg	.000	0	2	0	0	0
Nitrobenzene	ug/kg	.000	0	2	0	0	0
O,O,O-Triethylphosphorothioate	ug/kg	.000	0	2	0	0	0
Parathion	ug/kg	.000	0	2	0	0	0
Pentachlorobenzene	ug/kg	.000	0	2	0	0	0
Pentachloroethane	ug/kg	.000	0	2	0	0	0
Pentachloronitrobenzene	ug/kg	.000	0	2	0	0	0
Pentachlorophenol	ug/kg	.000	0	2	0	0	0
Phenacetin	ug/kg	.000	0	2	0	0	0
Phenanthrene	ug/kg	.000	0	2	0	0	0

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TABLE 4-17  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Phenol	ug/kg	.000	0	2	0	0	0
Pronamide	ug/kg	.000	0	2	0	0	0
Pyrene	ug/kg	.000	0	2	0	0	0
Safrole	ug/kg	.000	0	2	0	0	0
Sulfotep	ug/kg	.000	0	2	0	0	0
Tributyl phosphate	ug/kg	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	2	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	2	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	2	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	0	2	0	0	0
o-Toluidine	ug/kg	.000	0	2	0	0	0
p-Chloroaniline	ug/kg	.000	0	2	0	0	0
p-Dimethylaminoazobenzene	ug/kg	.000	0	2	0	0	0
<u>PESTICIDES/PCBS</u>							
2,4,5-T	ug/kg	.000	0	2	0	0	0
2,4,5-TP (Silvex)	ug/kg	.000	0	2	0	0	0
2,4-D	ug/kg	.000	0	2	0	0	0
Dinoseb	ug/kg	.000	0	2	0	0	0
4,4'-DDD	ug/kg	.000	0	2	0	0	0
4,4'-DDE	ug/kg	.000	0	2	0	0	0
4,4'-DDT	ug/kg	.000	0	2	0	0	0
Aldrin	ug/kg	.000	0	2	0	0	0
Aroclor-1016	ug/kg	.000	0	2	0	0	0
Aroclor-1221	ug/kg	.000	0	2	0	0	0
Aroclor-1232	ug/kg	.000	0	2	0	0	0
Aroclor-1242	ug/kg	.000	0	2	0	0	0
Aroclor-1248	ug/kg	.000	0	2	0	0	0
Aroclor-1254	ug/kg	.000	0	2	0	0	0
Aroclor-1260	ug/kg	.000	0	2	0	0	0
Chlorobenzilate	ug/kg	.000	0	2	0	0	0
Dieldrin	ug/kg	.000	0	2	0	0	0
Endosulfan II	ug/kg	.000	0	2	0	0	0
Endosulfan sulfate	ug/kg	.000	0	2	0	0	0
Endosulfan-I	ug/kg	.000	0	2	0	0	0
Endrin	ug/kg	.000	0	2	0	0	0
Endrin ketone	ug/kg	.000	0	2	0	0	0
Heptachlor	ug/kg	.000	0	2	0	0	0
Heptachlor epoxide	ug/kg	.000	0	2	0	0	0
Isodrin	ug/kg	.000	0	2	0	0	0
Kepone	ug/kg	.000	0	2	0	0	0
Methoxychlor	ug/kg	.000	0	2	0	0	0
Toxaphene	ug/kg	.000	0	2	0	0	0

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TABLE 4-17  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>PESTICIDES/PCBS (Continued)</u>							
alpha-BHC	ug/kg	.000	0	2	0	0	0
alpha-Chlordane	ug/kg	.000	0	2	0	0	0
beta-BHC	ug/kg	.000	0	2	0	0	0
delta-BHC	ug/kg	.000	0	2	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	2	0	0	0
gamma-Chlordane	ug/kg	.000	0	2	0	0	0
<u>DIOXIN/FURAN</u>							
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
1,2,3,4,6,7,8-Heptachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
1,2,3,4,7,8,9-Heptachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
1,2,3,4,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
1,2,3,6,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
1,2,3,7,8,9-Hexachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
1,2,3,7,8-Pentachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
2,3,4,6,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
2,3,4,7,8-Pentachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
2,3,7,8-TCDD	ug/kg	.000	0	2	0	0	0
2,3,7,8-TCDF	ug/kg	.000	0	2	0	0	0
Heptachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
Heptachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
Hexachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
Octachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
Octachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
Pentachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
Pentachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
Tetrachlorodibenzo-p-dioxin	ug/kg	.000	0	2	0	0	0
Tetrachlorodibenzofuran	ug/kg	.000	0	2	0	0	0
<u>GENERAL CHEMISTRY</u>							
Sulfide	mg/kg	.000	0	2	0	0	0
<u>MISCELLANEOUS</u>							
Dimethoate	ug/kg	.000	0	2	0	0	0
Disulfoton	ug/kg	.000	0	2	0	0	0
Famphur	ug/kg	.000	0	2	0	0	0
Phorate	ug/kg	.000	0	2	0	0	0

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TABLE 4-17  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>MISCELLANEOUS (Continued)</u>							
Tetraethylpyrophosphate	ug/kg	.000	0	2	0	0	0
Thionazin	ug/kg	.000	0	2	0	0	0

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**TABLE 4-18**  
**LIME SLUDGE POND**  
**SUBSURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>METALS</b>							
Aluminum	mg/kg	16277.291	33	33	2990	19700	5
Antimony	mg/kg	.000	3	32	21.8	29.2	3
Arsenic	mg/kg	9.704	33	33	1.1	14.6	3
Barium	mg/kg	121.064	33	33	15.4	166	7
Beryllium	mg/kg	.620	21	33	.4	2.1	17
Cadmium	mg/kg	.910	14	33	.65	1.6	13
Calcium	mg/kg	150000.000	33	33	4980	353000	7
Chromium	mg/kg	20.953	30	33	2.2	22.1	2
Cobalt	mg/kg	15.929	29	33	2.7	30.2	5
Copper	mg/kg	20.230	25	33	8.4	44.6	18
Cyanide	mg/kg	.170	3	26	.11	.3	2
Iron	mg/kg	31188.164	32	32	3330	48100	2
Lead	mg/kg	15.780	31	33	.77	104	5
Magnesium	mg/kg	43052.339	33	33	4660	40300	0
Manganese	mg/kg	1045.407	33	33	285	1360	1
Mercury	mg/kg	.290	3	33	.21	2.3	2
Molybdenum	mg/kg	.270	9	33	1.4	8.9	9
Nickel	mg/kg	34.747	27	33	7	46.7	2
Potassium	mg/kg	2007.519	26	33	739	3170	6
Selenium	mg/kg	.000	4	33	.26	.55	4
Silicon	mg/kg	1069.496	33	33	150	7220	16
Silver	mg/kg	.000	5	33	2.5	7.8	5
Sodium	mg/kg	227.947	33	33	70	1620	13
Thallium	mg/kg	.490	3	32	.22	.33	0
Vanadium	mg/kg	38.088	31	33	3.4	42.2	3
Zinc	mg/kg	73.158	32	32	11.8	122	5
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	11	33	.029	.17	11
GROSS ALPHA	pCi/g	.000	22	33	9.73	61.4	22
GROSS BETA	pCi/g	.000	29	33	6.43	43.36	29
NP-237	pCi/g	.000	23	24	.03	.541	23
PU-238	pCi/g	.000	22	33	.016	.536	22
PU-239/240	pCi/g	.000	20	33	.011	.133	20
RA-226	pCi/g	1.470	33	33	.37	5.93	3
RA-228	pCi/g	1.325	27	33	.59	1.72	6
RU-106	pCi/g	.000	0	33	0	0	0
SR-90	pCi/g	.560	8	33	.237	.959	3

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**TABLE 4-18**  
**(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>RADIONUCLIDES (Continued)</b>							
TC-99	pCi/g	.000	1	33	.89	.89	1
TH-228	pCi/g	1.341	27	30	.11	1.75	1
TH-230	pCi/g	1.897	30	31	.294	32.2	14
TH-232	pCi/g	1.269	29	30	.06	1.43	2
TH-TOTAL	mg/kg	9.470	29	30	.551	13	6
U-234	pCi/g	1.034	33	33	.62	5.45	27
U-235/236	pCi/g	.142	32	33	.03	.96	18
U-238	pCi/g	1.122	33	33	.59	8.75	27
U-TOTAL	mg/kg	2.540	33	33	2.17	26.4	32
<b>VOLATILE ORGANICS</b>							
1,1,1-Trichloroethane	ug/kg	.000	0	33	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	33	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	33	0	0	0
1,1-Dichloroethane	ug/kg	.000	1	33	5	5	1
1,1-Dichloroethene	ug/kg	.000	0	33	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	33	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	33	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	33	0	0	0
2-Butanone	ug/kg	.000	3	33	1	5	3
2-Hexanone	ug/kg	.000	0	33	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	33	0	0	0
Acetone	ug/kg	.000	11	33	3	38	11
Benzene	ug/kg	.000	0	33	0	0	0
Bromodichloromethane	ug/kg	.000	0	33	0	0	0
Bromoform	ug/kg	.000	0	33	0	0	0
Bromomethane	ug/kg	.000	0	33	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	33	0	0	0
Carbon disulfide	ug/kg	.000	0	33	0	0	0
Chlorobenzene	ug/kg	.000	0	33	0	0	0
Chloroethane	ug/kg	.000	0	33	0	0	0
Chloroform	ug/kg	.000	0	33	0	0	0
Chloromethane	ug/kg	.000	0	32	0	0	0
Dibromochloromethane	ug/kg	.000	0	33	0	0	0
Ethylbenzene	ug/kg	.000	0	33	0	0	0
Methylene chloride	ug/kg	.000	1	33	31	31	1
Styrene	ug/kg	.000	0	33	0	0	0
Tetrachloroethene	ug/kg	.000	0	33	0	0	0
Toluene	ug/kg	.000	6	33	2	11	6
Trichloroethene	ug/kg	.000	0	33	0	0	0
Vinyl Acetate	ug/kg	.000	0	29	0	0	0
Vinyl chloride	ug/kg	.000	0	33	0	0	0

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TABLE 4-18  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	33	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	33	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	33	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	33	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	33	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	33	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	33	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	33	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	33	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	33	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	33	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	27	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	33	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	33	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	23	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	34	0	0	0
2-Chlorophenol	ug/kg	.000	0	33	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	34	0	0	0
2-Methylphenol	ug/kg	.000	0	33	0	0	0
2-Nitroaniline	ug/kg	.000	0	33	0	0	0
2-Nitrophenol	ug/kg	.000	0	33	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	33	0	0	0
3-Nitroaniline	ug/kg	.000	0	32	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	29	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	33	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	33	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	33	0	0	0
4-Methylphenol	ug/kg	.000	0	33	0	0	0
4-Nitroaniline	ug/kg	.000	0	30	0	0	0
4-Nitrophenol	ug/kg	.000	0	29	0	0	0
Acenaphthene	ug/kg	.000	0	34	0	0	0
Acenaphthylene	ug/kg	.000	0	34	0	0	0
Anthracene	ug/kg	.000	1	34	82	82	1
Benzo(a)anthracene	ug/kg	.000	0	34	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	34	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	34	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	34	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	34	0	0	0
Benzoic acid	ug/kg	.000	2	21	90	160	2
Benzyl alcohol	ug/kg	.000	0	19	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	29	0	0	0
Carbazole	ug/kg	.000	0	34	0	0	0

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**TABLE 4-18  
(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Chrysene	ug/kg	.000	0	34	0	0	0
Di-n-butyl phthalate	ug/kg	.000	8	33	2	140	8
Di-n-octyl phthalate	ug/kg	.000	0	29	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	34	0	0	0
Dibenzofuran	ug/kg	.000	0	33	0	0	0
Diethyl phthalate	ug/kg	.000	0	33	0	0	0
Dimethyl phthalate	ug/kg	.000	0	33	0	0	0
Fluoranthene	ug/kg	.000	1	34	57	57	1
Fluorene	ug/kg	.000	0	34	0	0	0
Hexachlorobenzene	ug/kg	.000	0	33	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	30	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	33	0	0	0
Hexachloroethane	ug/kg	.000	0	33	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	34	0	0	0
Isophorone	ug/kg	.000	0	33	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	33	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	1	19	5	5	1
N-Nitrosodiphenylamine	ug/kg	.000	0	33	0	0	0
Naphthalene	ug/kg	.000	0	34	0	0	0
Nitrobenzene	ug/kg	.000	0	33	0	0	0
Pentachlorophenol	ug/kg	.000	0	33	0	0	0
Phenanthrene	ug/kg	.000	1	34	82	82	1
Phenol	ug/kg	.000	0	33	0	0	0
Pyrene	ug/kg	.000	1	34	51	51	1
Tributyl phosphate	ug/kg	.000	0	19	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	33	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	33	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	33	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	19	33	2	4800	19
p-Chloroaniline	ug/kg	.000	0	33	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	34	0	0	0
4,4'-DDE	ug/kg	.000	0	34	0	0	0
4,4'-DDT	ug/kg	.000	0	34	0	0	0
Aldrin	ug/kg	.000	0	34	0	0	0
Aroclor-1016	ug/kg	.000	0	34	0	0	0
Aroclor-1221	ug/kg	.000	0	34	0	0	0
Aroclor-1232	ug/kg	.000	0	34	0	0	0
Aroclor-1242	ug/kg	.000	0	34	0	0	0
Aroclor-1248	ug/kg	.000	0	34	0	0	0
Aroclor-1254	ug/kg	.000	0	34	0	0	0
Aroclor-1260	ug/kg	.000	0	34	0	0	0
Dieldrin	ug/kg	.000	0	34	0	0	0

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**TABLE 4-18  
(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Endosulfan II	ug/kg	.000	0	34	0	0	0
Endosulfan sulfate	ug/kg	.000	0	34	0	0	0
Endosulfan-I	ug/kg	.000	0	34	0	0	0
Endrin	ug/kg	.000	0	34	0	0	0
Endrin aldehyde	ug/kg	.000	0	34	0	0	0
Endrin ketone	ug/kg	.000	0	34	0	0	0
Heptachlor	ug/kg	.000	0	34	0	0	0
Heptachlor epoxide	ug/kg	.000	0	34	0	0	0
Methoxychlor	ug/kg	.000	0	34	0	0	0
Toxaphene	ug/kg	.000	0	34	0	0	0
alpha-BHC	ug/kg	.000	0	34	0	0	0
alpha-Chlordane	ug/kg	.000	0	34	0	0	0
beta-BHC	ug/kg	.000	0	34	0	0	0
delta-BHC	ug/kg	.000	0	34	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	34	0	0	0
gamma-Chlordane	ug/kg	.000	0	34	0	0	0

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**TABLE 4-19**  
**COMPARISON OF METALS CONCENTRATIONS IN LIME SLUDGE AND SOIL**  
**CONSTITUENTS IN MG/KG**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Boring	Depth (feet)	Matrix <sup>a</sup>	Copper	Arsenic	Lead	Beryllium	Zinc	Antimony	Vanadium	Chromium	Number of Samples that Exceed Soil Background
1956	0.0 - 4.0	SL	29.8	11.2	104	0.72	72.6	0.44	8.9	2.2	4/8
	6.0 - 7.0	SL/S	36.6	7.4	14	0.79	79.8	0.27	15.7	12.1	3/8
1957	0.5 - 2.0	SL	25	6	13.7	0.52	69.6	1.70	18.8	11.1	1/8
	4.0 - 5.0	S	25.1	14.6	17.3	0.85	73.2	15.8	29.6	13	3/8
1958	0.5 - 2.5	SL	18.1	8.4	3.6	0.12	N/A	23.2	2.5	6	0/8
	4.5 - 5.0	S	28.3	13.8	17.6	1	84.1	15.5	40.3	20	5/8
1959	3.0 - 5.0	SL	44.6	6.1	6.4	1.5	122	29.2	42.2	21.1	5/8
	8.0 - 8.5	SL	16.5	8.7	15.1	0.21	28.5	15.2	1.2	2.3	0/8
	11.0 - 13.5	S	23.7	7.5	10.9	0.82	70	15.4	23.6	14.6	2/8
1960	5.0 - 6.0	SL	2.1	2.1	0.45	0.43	11.8	1.1	3.4	2.5	0/8
	13.0 - 13.5	S	9.6	3.8	6.2	0.46	30.3	1.2	14	4.7	0/8

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See footnotes at end of table

TABLE 4-19  
(Continued)

Boring	Depth (feet)	Matrix <sup>a</sup>	Copper	Arsenic	Lead	Beryllium	Zinc	Antimony	Vanadium	Chromium	Number of Samples that Exceed Soil Background
1961	2.0 - 4.0	SL	4.1	4.0	0.81	0.83	25.6	2.7	7.5	6.1	1/8
	12.0 - 13.0	S	20.3	4.3	10.2	0.47	64.6	1.2	28.3	13.7	1/8
1963	2.0 - 4.0	SL/S	3.3	2.5	0.77	0.66	16.9	1.7	5.0	3.4	1/8
	12.0 - 13.0	SL/S	8.4	2.8	5.9	0.43	30.4	1.1	14.4	4.8	1/8
	17.0 - 18.0	S	16.4	3.8	9.0	0.68	46.3	1.0	18.5	9.2	2/8
Number of Sludge Samples that Exceed Background			3/7	1/7	1/7	3/7	1/7		1/7	1/7	
Number of Soil Samples that Exceed Soil Background			5/9	2/9	1/9	6/9	3/9		1/9	0/9	

<sup>a</sup>Matrix SL = lime sludge  
 Matrix S = till  
 Matrix SL/S = A mixture of till and lime sludge

<sup>b</sup>Shaded numbers exceed background soil concentrations for those metals

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were detected in sludge from these two borings, which are adjacent to the north edge of the north pond.

Radionuclide data presented in Table 4-20 and shown on Figure 4-9 (see Volume 2, Oversized Figures) indicate that activities measured in sludge, soil beneath the sludge, and in the berm materials exceeded background levels. Berm samples detected higher activities of uranium-238 when compared to sludge samples. When subsurface sludge, soil, and berm sample data are compared, the following conclusions can be made:

- Thorium was detected more frequently and at higher concentrations in samples of the native material underlying the lime sludge.
- Concentrations of total uranium were approximately the same or lower in samples collected from the sludge when compared to the underlying soil.
- Samples from the berm were, on average, higher in total uranium than the lime sludge.

The data suggests that the upper one foot of the berms has a supplemental source of radioisotopes when compared to the lime sludge material. Samples of sludge and underlying soil indicated that the sludge contains lower concentrations of the radionuclides than the soil. A possible scenario for the elevated radionuclide concentrations underlying the lime sludge is that the soils were already contaminated prior to and after the excavation of the lime sludge ponds and then the lime sludge was disposed of on top of the contaminated soil.

A comparison of the Phase I and Phase II subsurface soil results with the CIS profile sample results (Appendix D-16B) indicates the radionuclide parameters detected during the CIS were also detected in Phase I and Phase II and were within the same order of magnitude.

Two volatile organic compounds, acetone and toluene, were detected in surface and subsurface soil samples. These are believed to be laboratory induced contaminants since they are detected at random depths and locations. Trace levels of 2-butanone were detected in two borings. This volatile is a common lab contaminant and also believed to be a lab contaminant in this case since it was detected in soil underlying the pond in Boring No. 1963 but not in overlying material. Trace concentrations of 1,1-dichloroethane (5  $\mu\text{g}/\text{kg}$ ) and methylene chloride (31  $\mu\text{g}/\text{kg}$ ) were detected in Boring Nos. 1959 and 1958, respectively.

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TABLE 4-20

SUMMARY OF RADIOISOTOPE AND ORGANIC DATA FROM SOIL SAMPLES  
COLLECTED WITH DEPTH IN THE LIME SLUDGE POND

Location	Sample/Material	Depth (ft. below surface)	Analyte Concentration							
			BP <sup>a</sup> μg/kg	DBP <sub>b</sub> μg/kg	Ra-226 pCi/g	Th-228 pCi/g	Th-230 pCi/g	Th Total mg/g	U-238 pCi/g	U-Total μg/g
Background data	soil	>0.5	0	0	1.325	1.341	1.897	9.47	1.222	2.54
1956 At northwest corner of N. Lime Sludge Pond	114857/Lime Sludge	0-4	440	<0.780	0.78	0.310	1.09	2.27	3.17	16.8
	114859/Lime Sludge	6-7	88	75	0.90	0.710	1.24	9.08	0.97	13.7
1957 at southwest corner of N. Lime Sludge Pond	114835/Lime Sludge	0.5-2	91	<0.550	0.59	0.599	1.37	4.84	2.84	9.73
	114838/soil	4-5	410	59	1.440	1.270	1.51	12.3	1.14	11.1
1958 SE corner of N Lime Sludge Pond	114821/Lime Sludge	0.5-2.5	92	<0.680	0.458	0.130	0.294	0.551	1.84	14
	114823/soil	4.5-5.0	ND	<0.420	1.180	1.070	1.35	11	1.37	13.1
1959 NE corner of N Lime Sludge Pond	114812/sludge	3-5	260	140	0.460	0.228	0.405	1.02	2.47	15
	114814/sludge	8-8.5	ND	48	1.060	1.020	1.28	11.5	1.15	
	114815//soil	11-13.5	ND	62	1.050	0.811	0.857	5.74	1.15	11.3
1960 NW corner of S Lime Sludge Pond	114734/sludge	5-6	ND	<0.590	0.362	0.111	1.88	0.75	1.59	3.72
	114737/soil	13-13.5	ND	<0.410	0.670	0.540	4.51	3.31	0.66	12.3
1961 SW corner of S Lime Sludge Pond	114745/sludge	2-4	ND	<0.740	0.960	0.780	2.7	2.09	1.86	13.5
	114743/soil	12-13	78	68	0.490	0.260		7.84	1.17	14.3
1962 SE corner of Lime Sludge Pond	114605/sludge	4.5-7	ND	72	0.500	0.113	3.06	1.34	3.33	6.76
	114607/	12.5-14	2	2	.842	0.536	2.470	3.050	0.732	2.170
1963 NE corner of S Lime Sludge Pond	114762/Lime Sludge	2-4	88	<0.620	0.400	0.110	0.48	1.02	0.67	10.6
	114766/soil	13.5-15.5	ND	<0.390	0.730	0.481	0.48	3.95	0.59	8.61
	114874/soil	17-18.5	93	<0.410	0.890	0.919	1.34	8.56	1.02	4.01
LSP-SS-11 N. Berm of N. Pond	114500/BERM	0.5-1	ND	<0.400	1.080	0.898	1.150	7.750	4.050	11.20

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See footnotes at end of table

FER/CRU2RI/JLG/SECTION4/TAB4-20/February 9, 1994 7:25pm

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TABLE 4-20  
(Continued)

Location	Sample/Material	Depth (ft. below surface)	Analyte Concentration							
			BP <sup>a</sup> μg/kg	DBP <sub>b</sub> μg/kg	Ra-226 pCi/g	Th-228 pCi/g	Th-230 pCi/g	Th Total mg/g	U-238 pCi/g	U-Total μg/g
LSP-SS-12 N. Berm of N. Pond	114503/BERM	0.5-1	ND	<0.390	0.983	0.859	2.020	7.460	4.100	13.700
LSP-SS-8 W. Berm of N. Pond	114490/BERM	0.5-1	230	<0.400	1.330	0.960	2.900	8.550	4.680	22.700
LSP-SS-04 S. Berm of S. Pond	114476/BERM	0.5-1	580	<0.400	1.120	0.960	1.800	8.5400	4.520	20.700
LSP-SS-03 S. Berm of S. Pond	114469/BERM	0.5-1	140	<0.400	1.330	1.070	2.000	9.400	4.690	24.000
LSP-SS-07 E. Berm of N. Pond	114479/BERM	0.5-1	4800	<0.400	1.320	1.270	5.190	9.840	5.090	26.40

<sup>a</sup>bis(2-Ethylhexyl)phthalate

<sup>b</sup>Di-n-butyl phthalate

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Eight semivolatile organics were detected in subsurface samples. All were detected two times or less except for di-n-butyl phthalate and bis(2-Ethylhexyl)phthalate. Detected concentrations of these compounds are summarized in Table 4-20. Concentrations and sample depth do not appear to be correlated and this indicates that the compound is integrated into the sludge, underlying soil, and berm materials. In contrast to the 18 organic compounds detected in surface samples, eight compounds were detected in subsurface samples. Five compounds (anthracene, phenanthrene, fluoranthene, pyrene, and n-nitrosodimethylamine) were detected once in samples from the north edge of the north pond, the west berm, and the exploratory trench dug parallel to the K-65 trench. This indicates that these areas are a possible source for the organic compounds detected in sludge samples.

An investigation trench approximately 275 feet long was excavated parallel to and south of the concrete K-65 slurry line (Figure 4-9) in an effort to locate areas of possible leakage from the slurry line. Field soil radioactivity measurements ranged from 90 cpm to 460 cpm, which were above the background measured each day (60 to 80 cpm). Field measurements did not define soil containing elevated radioactivity where historical leakage from the slurry line containment had occurred. Soil samples from the trench were collected from two locations: one location was selected adjacent to Well 1042 and one location was selected adjacent to Well 1934. Data from these samples are provided in Appendix D in Table D-2C. A summary of selected laboratory analytical results for these soil samples is provided on Table 4-21. A comparison between the data from samples collected within the concrete K-65 slurry line and data from soil outside the slurry line indicates the following:

- Comparison of chromium, nickel, vanadium, and zinc concentrations indicates that these are elevated for slurry line samples. Elevated concentrations for the same metals were detected in soil samples collected adjacent to the slurry line in the investigation trench.
- The highest concentration for total uranium (51.6 µg/g) detected in the concrete K-65 slurry line trench was similar to elevated concentrations in the soil outside of the trench (24.8 µg/g). The background soil concentration for total uranium is 2.54 µg/g.
- The highest activity measured for radium-226 (3.48 pCi/g), thorium-230 (16.23 pCi/g), and uranium-238 (20.4 pCi/g) in samples from the concrete trench were similar to elevated concentrations in the soil outside of the trench. Samples of the soil detected elevated concentrations of radium-226 (5.93 pCi/g), thorium-230 (20.3 pCi/g), and uranium-238 (5.5 pCi/g). Background concentrations for the radioisotopes are 0.780 pCi/g for radium-226, 1.239 pCi/g for thorium-230, and 0.844 pCi/g for uranium-238.

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**TABLE 4-21**  
**SUMMARY OF LABORATORY ANALYSES OF SAMPLES COLLECTED**  
**DURING THE K-65 TRENCH INVESTIGATION**  
**LIME SLUDGE PONDS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Location	Sample	On-Site Total U ( $\mu\text{g/L}$ )	Analyte and Soil Background Concentration								
			(mg/kg)				(pCi/g)			( $\mu\text{g/g}$ )	
			Cr 12.6	Ni 21.9	V 21.72	Zn 52.29	Ra-226 0.780	Th-230 1.239	U-238 0.844	Total U 2.54	Total Th 7.45
Soil Samples From Investigation Trench Adjacent to K-65 Slurry Trench											
Soil Adjacent to Well 1042 (composite 0'-6' deep)	114767		17.8	27.5	42.1	80.2	2.32	20.30	5.50	24.8	13.0
Soil Adjacent to Well 1934 (composite 0'-6' deep)	114776		11	21.1	23.5	55.7	5.93	5.34	3.91	11.5	8.31
Soil and Water Samples From Within The K-65 Slurry Trench											
Water sample from trench	114770	77									
Residue LSP-SS-01	114589		54.2	24.6	39.1	107	3.15	9.79	20.4	51.6	8.63
Residue LSP-SS-02	114591		22.9	16.3	25.1	94.4	3.48	16.23	14.8	45	8.41

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This comparison of sample data indicates that leakage from the trench may be a source of the elevated concentrations of these isotopes in the soil adjacent and south of to the trench.

Composite samples of the lime sludge were collected from eight borings, and TCLP tests were conducted. A summary of the analytical data is provided in Appendix D, Table D-12 and the results are summarized in Table 4-22. Eight samples were collected and tested to determine hazardous waste characteristics by the TCLP method. Five samples indicated the presence of barium and chromium in trace concentrations, but none of the detections exceeded the RCRA standard that defines hazardous waste. The Lime Sludge Ponds are currently classified as Solid Waste Management Units (SWMUs). Results from the TCLP analyses confirm that the materials are not characteristically hazardous. In addition, no trichloroethane was detected in sludge samples, confirming that the wastewater exemption for use of small amounts of solvent on site was applicable.

4.3.3 Surface Water and Sediment

There are no perennial sources of running surface water within the battery limits of the Lime Sludge Ponds. A channelized drainage at the north edge of the battery limits is the only drainage identified in the subunit. Flow to this drainage originates from the road and enters a sewer at the northwest corner of the battery limits. No sediment or surface water samples were collected from the drainage since the data would not be representative of impacts from subunit sources. The North Lime Sludge Pond has a free water surface that changes according to inflow from storm water and water process discharges. When approximately one-half of the pond surface is covered with water, the standing water is pumped to the general sump and treated before discharge. The pond does not have a potential for overflow. One surface water sampling location was identified during Phase II activities within the north pond. Chemical and radiological analytical results for surface water were not compared against background concentrations since there is no background value for surface water. A table of detected constituent concentrations is provided in Appendix D (Table D-9) while a summary of the analytes is presented in Tables 4-23 and 4-24. One surface water sample was collected during Phase I and one was collected during Phase II. Phase I sampling detected 20 metals; no volatile, semivolatile or pesticide/PCB analytes were detected. One Phase II surface water sample detected seven metals (these metals were also detected in Phase I, Aluminum, Arsenic, Boron, Cadmium, Chromium, Cobalt, Copper, Iron, Lead, Manganese, Mercury, Molybdenum, Silver, Vanadium, and Zinc were detected in Phase I samples but not Phase II), Th-230 was the only isotope detected (the Phase I

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**TABLE 4-22**  
**LIME SLUDGE PONDS TCLP RESULTS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)							
			1956	1957	1958	1959	1960	1961	1962	1963
			114858	114836	114822	114813	114733	114746	114609	114763
Arsenic	5.0	1.5	<0.04	<0.04	<0.04	<0.04	<0.050	<0.04	<0.05	<0.04
Barium	100.0	30.0	0.67	0.8	0.39	0.4	0.256	<0.35	0.274	<0.28
Benzene	0.5		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
Cadmium	1.0	0.3	0.005	0.005	<0.005	<0.005	<0.005	0.019	<0.005	<0.005
Carbon Tetrachloride	0.5		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
Chlordane	0.03		<0.006	<0.006	<0.006	<0.006	<0.005	<0.006	<0.0005	<0.006
Chlorobenzene	100.0		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
Chloroform	6.0		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
Chromium	5.0	1.5	0.02	0.02	0.02	0.01	<0.01	0.11	<0.01	0.01
2,4-D	10.0		<0.4	<0.4	<0.4	<0.4	<0.01	<0.4	<0.01	<0.4
1,4-Dichlorobenzene	7.5		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
1,2-Dichloroethane	0.5		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
1,1-Dichloroethene	0.7		<0.025	<0.025	<sup>a</sup>	<0.025	<0.005	<0.025	<0.005	<0.025
2,4-Dinitrotoluene	0.13		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
Endrin	0.02		<0.004	<0.004	<0.004	<0.004	<0.0001	<0.004	<0.0001	<0.004
Heptachlor	0.008		<0.001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.001
Heptachlor epoxide	0.008		<0.001	<0.001	<0.001	<0.001	<0.0001	<0.001	<0.0001	<0.001
Hexachlorobenzene	0.13		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
Hexachlorobutadiene	0.5		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
Hexachloroethane	3.0		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
Lead	5.0	1.5	<0.04	<0.04	<0.04	<0.04	<0.04	0.05	<0.04	<0.04
Lindane	0.4		<0.008	<0.008	<0.008	<0.008	<0.0001	<0.008	<0.0001	<0.008
Mercury	0.2	0.06	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.001	<0.0002	<0.001

See footnote at end of table

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TABLE 4-22  
(Continued)

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)							
			1956	1957	1958	1959	1960	1961	1962	1963
			114858	114836	114822	114813	114733	114746	114609	114763
Methoxychlor	10.0		<0.08	<0.08	<0.08	<0.08	<0.0005	<0.08	<0.0005	<0.08
Nitrobenzene	2.0		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
Pentachlorophenol	100.0		<0.2	<0.2	<0.2	<0.2	<0.1	<0.2	<0.1	<0.2
Pyridine	5.0		<0.4	<0.4	<0.4	<0.4	<0.2	<0.4	<0.2	<0.4
Selenium	1.0	0.3	<0.06	<0.06	<0.06	<0.06	<0.08	<0.06	<0.08	<0.06
Silver	5.0		<0.005	<0.005	<0.005	<0.005	<0.01	0.012	<0.01	<0.005
Tetrachloroethene	0.7		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
Toxaphene	0.5		<0.1	<0.1	<0.1	<0.1	<0.001	<0.1	<0.001	<0.1
2,4,5-TP (Silvex)	1.0		<0.2	<0.2	<0.2	<0.2	<0.0018	<0.2	<0.0018	<0.2
Trichloroethene	0.5		<0.025	<0.025	<0.025	<0.025	<0.005	<0.025	<0.005	<0.025
2,4,5-Trichlorophenol	400.0		<0.2	<0.2	<0.2	<0.2	<0.1	<0.2	<0.1	<0.2
2,4,6-Trichlorophenol	2.0		<0.04	<0.04	<0.04	<0.04	<0.02	<0.04	<0.02	<0.04
Vinyl chloride	0.2		<0.05	<0.05	<0.05	<0.05	<0.01	<0.05	<0.01	<0.05

<sup>a</sup>The sample was not analyzed for the parameter.

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**TABLE 4-23**  
**LIME SLUDGE PONDS**  
**SURFACE WATER<sup>a</sup>**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.000	4	4	.095	.127	4
Antimony		mg/L	.000	2	4	.0333	.0369	2
Arsenic		mg/L	.000	2	4	.0026	.0036	2
Barium		mg/L	.000	4	4	.033	.0607	4
Beryllium		mg/L	.000	0	4	0	0	0
Boron		mg/L	.000	3	3	.211	.359	3
Cadmium		mg/L	.000	4	4	.0037	.0092	4
Calcium		mg/L	.000	4	4	43.3	71	4
Chromium		mg/L	.000	4	4	.0118	.0207	4
Cobalt		mg/L	.000	0	4	0	0	0
Copper		mg/L	.000	0	4	0	0	0
Iron		mg/L	.000	3	4	.0232	.0333	3
Lead		mg/L	.000	1	4	.002	.002	1
Magnesium		mg/L	.000	4	4	24.4	47.8	4
Manganese		mg/L	.000	4	4	.0058	.114	4
Mercury		mg/L	.000	1	4	.001	.001	1
Molybdenum		mg/L	.000	3	4	.0106	.0183	3
Nickel		mg/L	.000	0	4	0	0	0
Potassium		mg/L	.000	4	4	8.54	13.2	4
Selenium		mg/L	.000	0	3	0	0	0
Silicon		mg/L	.000	4	4	.402	1.04	4
Silver		mg/L	.000	3	4	.0107	.0168	3
Sodium		mg/L	.000	4	4	185	299	4
Thallium		mg/L	.000	0	3	0	0	0
Tin		mg/L	.000	0	3	0	0	0
Vanadium		mg/L	.000	1	4	.0102	.0102	1
Zinc		mg/L	.000	3	4	.0083	.193	3
<b>VOLATILE ORGANICS</b>								
1,1,1,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-23  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
1,2,3-Trichloropropane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dibromo-3-chloropropane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dibromoethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Chloro-1,3-butadiene	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
3-Chloropropene	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	1	0	0	0
Acetonitrile	UNFL	ug/L	.000	0	1	0	0	0
Acrolein	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromomethane	UNFL	ug/L	.000	0	1	0	0	0
Ethyl cyanide	UNFL	ug/L	.000	0	1	0	0	0
Ethyl methacrylate	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Iodomethane	UNFL	ug/L	.000	0	1	0	0	0
Isobutyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Methacrylonitrile	UNFL	ug/L	.000	0	1	0	0	0
Methyl methacrylate	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0
Pyridine	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-23  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,4-Dichloro-2-butene	UNFL	ug/L	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4,5-Tetrachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3,5-Trinitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dinitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Naphthoquinone	UNFL	ug/L	.000	0	1	0	0	0
1-Naphthylamine	UNFL	ug/L	.000	0	1	0	0	0
2,3,4,6-Tetrachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2-Acetylaminofluorene	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Naphthylamine	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Picoline	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dimethylbenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Methylcholanthrene	UNFL	ug/L	.000	0	1	0	0	0
3-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0

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TABLE 4-23  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0 0	0
4-Aminobiphenyl	UNFL	ug/L	.000	0	1	0 0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0 0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0 0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0 0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0 0	0
4-Nitroaniline	UNFL	ug/L	.000	0	1	0 0	0
4-Nitrophenol	UNFL	ug/L	.000	0	1	0 0	0
4-Nitroquinoline-1-oxide	UNFL	ug/L	.000	0	1	0 0	0
5-Nitro-o-toluidine	UNFL	ug/L	.000	0	1	0 0	0
7,12-Dimethylbenz(a)anthracene	UNFL	ug/L	.000	0	1	0 0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0 0	0
Acenaphthylene	UNFL	ug/L	.000	0	1	0 0	0
Acetophenone	UNFL	ug/L	.000	0	1	0 0	0
Aniline	UNFL	ug/L	.000	0	1	0 0	0
Anthracene	UNFL	ug/L	.000	0	1	0 0	0
Aramite	UNFL	ug/L	.000	0	1	0 0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0 0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0 0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0 0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0 0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0 0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0 0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0 0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0 0	0
Chrysene	UNFL	ug/L	.000	0	1	0 0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	1	0 0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0 0	0
Diallylate	UNFL	ug/L	.000	0	1	0 0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0 0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0 0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0 0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0 0	0
Diphenylamine	UNFL	ug/L	.000	0	1	0 0	0
Ethyl methanesulfonate	UNFL	ug/L	.000	0	1	0 0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0 0	0
Fluorene	UNFL	ug/L	.000	0	1	0 0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0 0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0 0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0 0	0

See footnote at end of table

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TABLE 4-23  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorophene	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
Isosafrole	UNFL	ug/L	.000	0	1	0	0	0
Methapyrilene	UNFL	ug/L	.000	0	1	0	0	0
Methyl methanesulfonate	UNFL	ug/L	.000	0	1	0	0	0
Methyl parathion	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodi-n-butylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiethylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosomethylethylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosomorpholine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosopiperidine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosopyrrolidine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
O,O,O-Triethylphosphorothioate	UNFL	ug/L	.000	0	1	0	0	0
Parathion	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Pentachloronitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenacetin	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	0	1	0	0	0
Pronamide	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
Safrole	UNFL	ug/L	.000	0	1	0	0	0
Sulfotep	UNFL	ug/L	.000	0	1	0	0	0
Tributyl phosphate	UNFL	ug/L	.000	0	1	0	0	0
a,a-Dimethylphenethylamine	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
o-Toluidine	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	1	0	0	0
p-Dimethylaminoazobenzene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-23  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS</u>								
p-Phenylenediamine	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-T	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-TP (Silvex)	UNFL	ug/L	.000	0	1	0	0	0
2,4-D	UNFL	ug/L	.000	0	1	0	0	0
Dinoseb	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzilate	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Isodrin	UNFL	ug/L	.000	0	1	0	0	0
Kepone	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>MISCELLANEOUS</u>								
Dimethoate	UNFL	ug/L	.000	0	1	0	0	0
Disulfoton	UNFL	ug/L	.000	0	1	0	0	0
Famphur	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-23  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>MISCELLANEOUS (Continued)</u>								
Phorate	UNFL	ug/L	.000	0	1	0	0	0
Tetraethylpyrophosphate	UNFL	ug/L	.000	0	1	0	0	0
Thionazin	UNFL	ug/L	.000	0	1	0	0	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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FEMP-OU02-4 DRAFT  
February 18, 1994

**TABLE 4-24**  
**LIME SLUDGE PONDS**  
**SURFACE WATER<sup>a</sup>**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>METALS</u>								
Aluminum		mg/L	.000	0	1	0	0	0
Antimony		mg/L	.000	1	1	.0052	.0052	1
Arsenic		mg/L	.000	0	1	0	0	0
Barium		mg/L	.000	1	1	.0175	.0175	1
Beryllium		mg/L	.000	0	1	0	0	0
Cadmium		mg/L	.000	0	1	0	0	0
Calcium		mg/L	.000	1	1	17.2	17.2	1
Chromium		mg/L	.000	0	1	0	0	0
Cobalt		mg/L	.000	0	1	0	0	0
Copper		mg/L	.000	0	1	0	0	0
Cyanide		mg/L	.000	0	1	0	0	0
Iron		mg/L	.000	0	1	0	0	0
Lead		mg/L	.000	0	1	0	0	0
Magnesium		mg/L	.000	1	1	17.9	17.9	1
Manganese		mg/L	.000	0	1	0	0	0
Mercury		mg/L	.000	0	1	0	0	0
Molybdenum		mg/L	.000	0	1	0	0	0
Nickel		mg/L	.000	0	1	0	0	0
Potassium		mg/L	.000	1	1	3.93	3.93	1
Selenium		mg/L	.000	0	1	0	0	0
Silicon		mg/L	.000	1	1	.572	.572	1
Silver		mg/L	.000	0	1	0	0	0
Sodium		mg/L	.000	1	1	40.6	40.6	1
Thallium		mg/L	.000	0	1	0	0	0
Vanadium		mg/L	.000	0	1	0	0	0
Zinc		mg/L	.000	0	1	0	0	0
<u>RADIONUCLIDES</u>								
CS-137	UNFL	pCi/L	.000	0	1	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	1	0	0	0
GROSS BETA	UNFL	pCi/L	.000	1	1	4.22	4.22	1
NP-237	UNFL	pCi/L	.000	0	1	0	0	0
PU-238	UNFL	pCi/L	.000	0	1	0	0	0
RA-226	UNFL	pCi/L	.000	0	1	0	0	0
RA-228	UNFL	pCi/L	.000	0	1	0	0	0

See footnote at end of table

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FEMP-OU02-4 DRAFT  
February 18, 1994  
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TABLE 4-24  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RU-106	UNFL	pCi/L	.000	0	1	0	0	0
SR-90	UNFL	pCi/L	.000	0	1	0	0	0
TC-99	UNFL	pCi/L	.000	0	1	0	0	0
TH-228	UNFL	pCi/L	.000	0	1	0	0	0
TH-230	UNFL	pCi/L	.000	1	1	.21	.21	1
TH-232	UNFL	pCi/L	.000	0	1	0	0	0
TH-TOTAL	UNFL	ug/L	.000	0	1	0	0	0
U-234	UNFL	pCi/L	.000	0	1	0	0	0
U-235/236	UNFL	pCi/L	.000	0	1	0	0	0
U-238	UNFL	pCi/L	.000	0	1	0	0	0
U-TOTAL	UNFL	ug/L	.000	0	1	0	0	0
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
<u>VOLATILE ORGANICS (Continued)</u>								
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-24  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	1	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-24  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Carbazole	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	1	1	2	2	1
p-Chloroaniline	UNFL	ug/L	.000	0	1	0	0	0
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-24  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS (Continued)</u>								
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	1	1	63	63	0
Ammonia	UNFL	mg/L	.000	0	1	0	0	0
Chloride	UNFL	mg/L	.000	1	1	72	72	1
Fluoride	UNFL	mg/L	.000	1	1	.11	.11	1
Phenols	UNFL	mg/L	.000	0	1	0	0	0
Sulfate	UNFL	mg/L	.000	1	1	39.3	39.3	1
Sulfide	UNFL	mg/L	.000	0	1	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	1	.17	.17	1
Total Organic Carbon	UNFL	mg/L	.000	1	1	2.24	2.24	1
Total Organic Halides	UNFL	mg/L	.000	1	1	.0228	.0228	1
Total Organic Nitrogen	UNFL	mg/L	.000	1	1	.17	.17	1

See footnote at end of table

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TABLE 4-24  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Maximum	Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>								
Total Phosphorous	UNFL	mg/L	.000	0	1	0	0	0

aFiltered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

3011

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sample was not analyzed for radionuclides), and one organic compound (bis(2-ethylhexyl)phthalate) was detected above background.

4.3.4 Groundwater

Chemical and radiological analytical results from groundwater samples were compared to background concentrations, and a table of the constituents detected above background is provided in Appendix D on Table D-2G through Table D-2I. A summary of the analytes in 1000-series wells is provided in Tables 4-25 and 4-26. Groundwater analytical data from the 1000-series wells were compared to background data from the perched groundwater developed for the site. Phase I sampling, conducted on three 1000-series wells within the battery limits of the subunit, detected eight metals, isotopes of uranium and thorium, and one organic compound phenol at 1 µg/L that exceeded background concentrations. Six 1000-series wells sampled during Phase II detected one metal above background (Antimony was not detected during Phase I, Cadmium, Calcium, Chromium, Magnesium, Manganese, Molybdenum, Sodium, and Zinc were detected in Phase I but not in Phase II), isotopes of five elements (radium-226, neptunium-237, and Strontium-90 were not detected in Phase I), and one organic compound (bis(2-Ethylhexyl) phthalate).

Concentrations of selected analytes detected in samples from 1000-series wells are presented in Table 4-27. Radionuclides detected above background in 1000-series wells are plotted in Figure 4-10. A comparison of concentrations in upgradient Well 1039 and the downgradient wells indicated the following:

- Chloride and sulfate concentrations decrease in the downgradient direction from 360.23 mg/L and 123.4 mg/L (Well 1039) to 47.1 mg/L and 77.0 mg/L (Well 1934), respectively. The chloride and sulfate concentrations in the north pond surface water were 72 mg/L and 39.3 mg/L, respectively (Appendix D-9). The source of elevated chloride concentrations in the upgradient well may be due to the leaching of salt used in salting the road adjacent to the north boundary during the winter. This indicates that precipitative recharge occurs in this area.
- Metals detected in elevated concentrations, both in the sludge and samples of groundwater beneath the ponds (Well 1041) and downgradient (Well 1934), include chromium, copper, beryllium, and vanadium. These data suggest that metals, have leached from the pond sludge and have impacted perched groundwater.
- Total uranium concentration is elevated in downgradient Well 1042 (30.4 µg/L) and Well 1934 (17.5 µg/L) relative to the upgradient Well 1039 (less than 1 µg/L). The increase may be due to impacts from the K-65 slurry line trench (discussed in Section 4.2.3), which is in the flow path between the ponds and the wells.

- Thorium-230 and radium-226 activities are higher in downgradient Well 1934 (6.67 and 1.40 pCi/L, respectively) relative to upgradient Well 1039 (0.251 and <0.183 pCi/L, respectively) and upgradient Well 1041 (1.37 pCi/L and 0.310 pCi/L, respectively). The increase may also be due to impacts from the K-65 slurry line trench.

Groundwater analytical data from the 2000-series wells were compared to background data from the regional aquifer and a summary of the analytes is provided in Tables 4-28A, 4-28B, and 4-29. Phase I sampling on one 2000-series well detected one metal, isotopes of thorium and uranium, and two organic compounds (acetone at 7  $\mu\text{g/L}$  and phenol at 50  $\mu\text{g/L}$ ) that exceeded background concentrations. Phase II sampling of four wells detected three metals (Aluminum, Manganese, and Potassium which were not detected during Phase I), isotopes of three elements (neptunium-237 and plutonium-238 were not detected for Phase I, thorium-238 was detected during Phase I but not Phase II), and one organic compound (Butyl benzyl phthalate). Concentrations of selected radionuclides detected in samples collected from the 2000-series wells during Phase II are shown on Figure 4-11 and presented in Table 4-27. A comparison of concentrations in samples from upgradient and downgradient wells indicates the following:

- Chloride concentrations are similar in upgradient Well 2939 (26.86 mg/L) and downgradient Well 2935 (23 mg/L) and Well 2042 (18.82 mg/L). This indicates that no impacts are present from the Lime Sludge Ponds.
- Isotopes of neptunium and plutonium were detected above background (which was 0.00 pCi/L) in water samples from all of the wells. Isotopes of uranium were detected above background (2.71  $\mu\text{g/L}$ ) in all three downgradient wells (2042, 2935, and 2936). The background value for total uranium (2.92  $\mu\text{g/L}$ ) was exceeded slightly in Well 2042 (3.39  $\mu\text{g/L}$ ) and Well 2935 (2.86  $\mu\text{g/L}$ ). These data do not indicate an impact from the waste unit upon the regional groundwater.

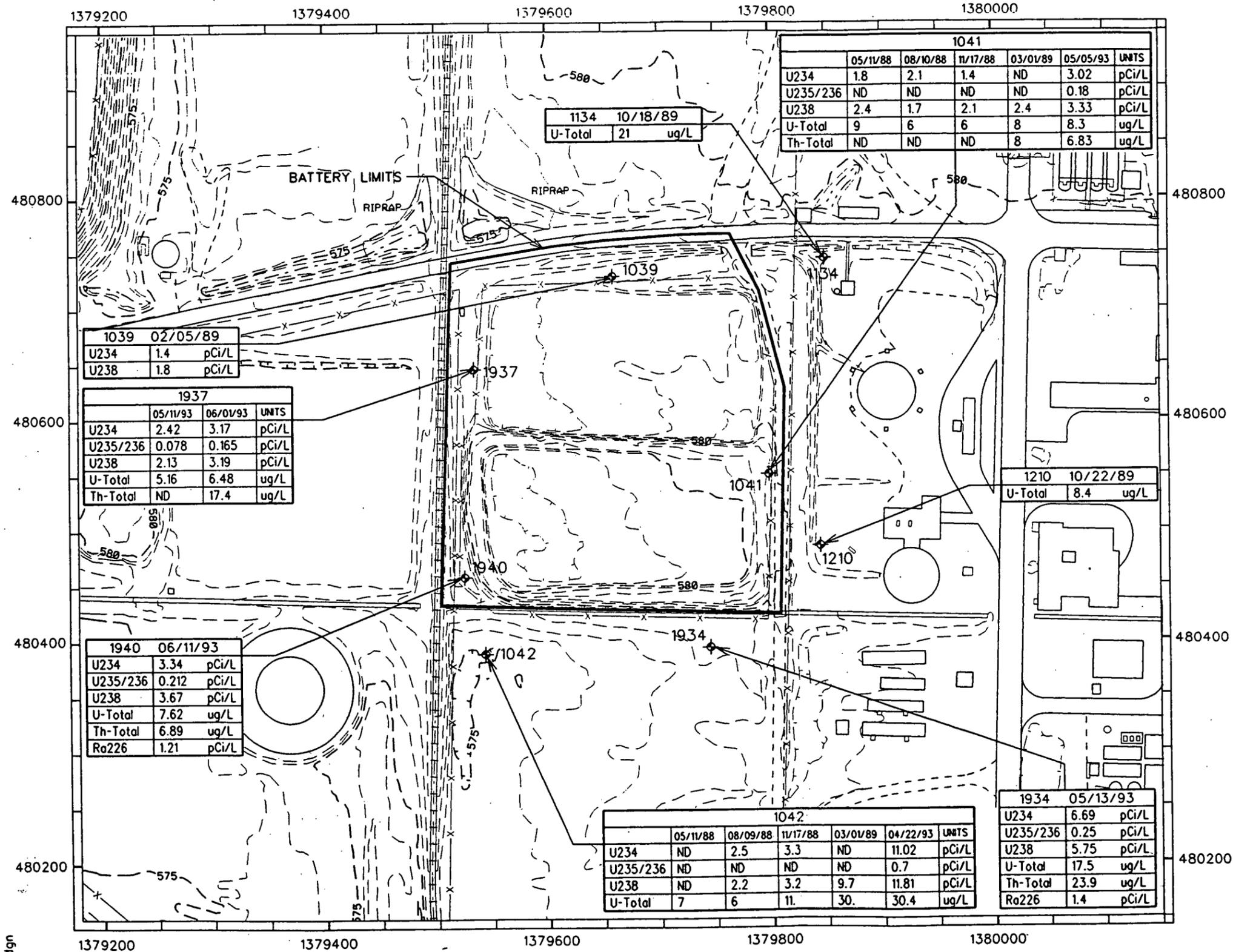
#### 4.3.5 Biota

Impacts of the Lime Sludge Ponds upon biota will be discussed in the Operable Unit 5 Remedial Investigation Report.

#### 4.3.6 Summary

The following conclusions concerning the Lime Sludge Ponds are possible:

- Sludge samples contained trace amounts of organic compounds including six volatile organic and eight semi-volatile compounds. Organic compounds detected in soil were not detected in samples of perched groundwater, indicating that these compounds are not leaching from the sludge.



1041						
	05/11/88	08/10/88	11/17/88	03/01/89	05/05/93	UNITS
U234	1.8	2.1	1.4	ND	3.02	pCi/L
U235/236	ND	ND	ND	ND	0.18	pCi/L
U238	2.4	1.7	2.1	2.4	3.33	pCi/L
U-Total	9	6	6	8	8.3	ug/L
Th-Total	ND	ND	ND	8	6.83	ug/L

1134 10/18/89	
U-Total	21 ug/L

1039 02/05/89		
U234	1.4	pCi/L
U238	1.8	pCi/L

1937			
	05/11/93	06/01/93	UNITS
U234	2.42	3.17	pCi/L
U235/236	0.078	0.165	pCi/L
U238	2.13	3.19	pCi/L
U-Total	5.16	6.48	ug/L
Th-Total	ND	17.4	ug/L

1210 10/22/89	
U-Total	8.4 ug/L

1940 06/11/93		
U234	3.34	pCi/L
U235/236	0.212	pCi/L
U238	3.67	pCi/L
U-Total	7.62	ug/L
Th-Total	6.89	ug/L
Ra226	1.21	pCi/L

1042						
	05/11/88	08/09/88	11/17/88	03/01/89	04/22/93	UNITS
U234	ND	2.5	3.3	ND	11.02	pCi/L
U235/236	ND	ND	ND	ND	0.7	pCi/L
U238	ND	2.2	3.2	9.7	11.81	pCi/L
U-Total	7	6	11	30	30.4	ug/L

1934 05/13/93		
U234	6.69	pCi/L
U235/236	0.25	pCi/L
U238	5.75	pCi/L
U-Total	17.5	ug/L
Th-Total	23.9	ug/L
Ra226	1.4	pCi/L

**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- 1000 MONITORING WELLS

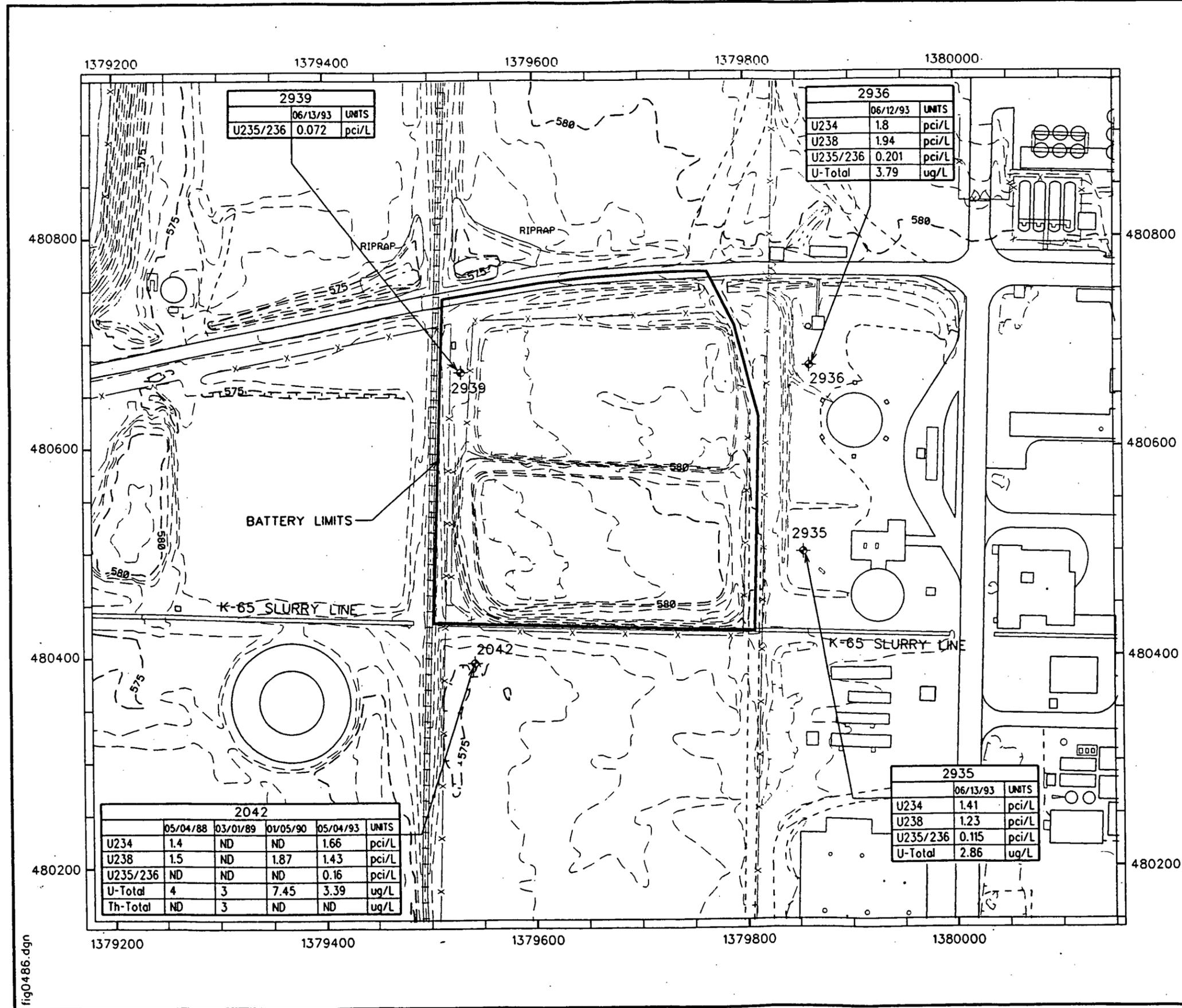
ND = NOT DETECTED ABOVE BACKGROUND CONCENTRATIONS

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

**SCALE (FT)**

**FIGURE 4-10**  
RADIONUCLIDES IN  
1000-SERIES WELLS  
DETECTED ABOVE BACKGROUND  
IN THE LIME SLUDGE PONDS

fig0496.dgn



**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- 2000 MONITORING WELLS

ND=NOT DETECTED ABOVE BACKGROUND

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

**SCALE (FT)**

**FIGURE 4-11**  
**RADIONUCLIDES IN**  
**2000-SERIES WELLS**  
**DETECTED ABOVE BACKGROUND**  
**IN THE LIME SLUDGE PONDS**  
**0441**

fig0486.dgn

**TABLE 4-25**  
**LIME SLUDGE PONDS**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>METALS</u>								
Aluminum		mg/L	.123	0	1	0	0	0
Antimony		mg/L	.000	0	1	0	0	0
Arsenic		mg/L	.122	0	12	0	0	0
Barium		mg/L	.459	11	12	.087	.459	0
Beryllium		mg/L	.002	0	1	0	0	0
Cadmium		mg/L	.007	2	12	.007	.01	1
Calcium		mg/L	125.574	12	12	92.9	274	8
Chromium		mg/L	.035	3	12	.02	.035	1
Cobalt		mg/L	.000	0	1	0	0	0
Copper		mg/L	.030	3	12	.016	.017	0
Iron		mg/L	10.965	11	12	.04	1.8	0
Lead		mg/L	.050	3	12	.002	.004	0
Magnesium		mg/L	49.627	12	12	30.1	109.6	8
Manganese		mg/L	.165	12	12	.029	.986	9
Mercury		mg/L	.004	1	12	.0004	.0004	0
Molybdenum		mg/L	.028	4	12	.02	.03	1
Nickel		mg/L	.026	2	12	.023	.026	0
Potassium		mg/L	29.736	9	12	.48	1.33	0
Selenium		mg/L	.000	0	12	0	0	0
Silver		mg/L	.040	0	12	0	0	0
Sodium		mg/L	49.178	12	12	14	350	4
Thallium		mg/L	.000	0	1	0	0	0
Vanadium		mg/L	.020	0	1	0	0	0
Zinc		mg/L	.032	1	1	.14	.14	1
<u>RADIONUCLIDES</u>								
NP-237	UNFL	pCi/L	.000	0	11	0	0	0
PU-238	UNFL	pCi/L	.000	0	9	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	9	0	0	0
RA-226	UNFL	pCi/L	1.000	1	11	.3	.3	0
RA-228	UNFL	pCi/L	5.200	1	11	3.8	3.8	0
SR-90	UNFL	pCi/L	.000	0	11	0	0	0
TC-99	UNFL	pCi/L	.000	0	11	0	0	0

See footnote at end of table

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**TABLE 4-25  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>								
TH-228	UNFL	pCi/L	1.040	2	11	1.1	1.2	2
TH-230	UNFL	pCi/L	2.000	3	11	1.4	1.6	0
TH-232	UNFL	pCi/L	.000	0	11	0	0	0
TH-TOTAL	UNFL	ug/L	3.000	0	8	0	0	0
U-234	UNFL	pCi/L	1.900	6	9	.5	3.3	2
U-235/236	UNFL	pCi/L	.000	0	11	0	0	0
U-238	UNFL	pCi/L	1.070	8	11	.3	9.7	7
U-TOTAL	UNFL	ug/L	4.000	13	14	1	58	10
<u>VOLATILE ORGANICS</u>								
Phenol	UNFL	ug/L	.000	1	1	50	50	1
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	4.500	5	11	.12	.5	0
Chloride	UNFL	mg/L	110.159	9	10	57.5	1095	6
Fluoride	UNFL	mg/L	1.352	12	12	.16	3.5	3
Nitrate	UNFL	mg/L	.522	4	11	.12	.49	0
Phenols	UNFL	mg/L	.000	7	11	.011	.025	0
Phosphorus	UNFL	mg/L	.223	8	9	.02	.872	3
Sulfate	UNFL	mg/L	141.894	11	11	56	246	2
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	5	9	.103	21	5
Total Organic Halides	UNFL	mg/L	.000	0	5	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	4	10	.103	.7	4

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-26**  
**LIME SLUDGE PONDS**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	0	2	0	0	0
Antimony		mg/L	.038	1	2	.06	.06	1
Arsenic		mg/L	.300	0	4	0	0	0
Barium		mg/L	.413	3	4	.038	.043	0
Beryllium		mg/L	.003	0	2	0	0	0
Cadmium		mg/L	.006	0	4	0	0	0
Calcium		mg/L	135.163	4	4	79.8	120	0
Chromium		mg/L	.042	1	4	.02	.02	0
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.130	0	4	0	0	0
Iron		mg/L	4.000	4	4	.18	.321	0
Lead		mg/L	.029	0	4	0	0	0
Magnesium		mg/L	38.070	4	4	21.91	26	0
Manganese		mg/L	.800	4	4	.11	.233	0
Mercury		mg/L	.001	0	4	0	0	0
Molybdenum		mg/L	.027	2	4	.01	.022	0
Nickel		mg/L	.026	0	4	0	0	0
Potassium		mg/L	3.087	2	4	2.37	2.9	0
Selenium		mg/L	.005	0	4	0	0	0
Silver		mg/L	.023	0	3	0	0	0
Sodium		mg/L	51.918	4	4	10.91	12	0
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.027	0	2	0	0	0
Zinc		mg/L	.105	1	2	.05	.05	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	7	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	2	7	27.12	42.8	2
GROSS BETA	UNFL	pCi/L	.000	2	7	15.3	20.9	2
NP-237	UNFL	pCi/L	.000	2	5	.149	.339	2
PU-238	UNFL	pCi/L	.000	0	7	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	7	0	0	0
RA-226	UNFL	pCi/L	1.000	4	7	.21	1.21	1
RA-228	UNFL	pCi/L	5.200	1	6	3.68	3.68	0

See footnote at end of table

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TABLE 4-26  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RU-106	UNFL	pCi/L	.000	0	7	0	0	0
SR-90	UNFL	pCi/L	.000	1	7	3.45	3.45	1
TC-99	UNFL	pCi/L	.000	0	7	0	0	0
TH-228	UNFL	pCi/L	1.040	3	7	.78	2.37	2
TH-230	UNFL	pCi/L	2.000	4	7	1.29	3.04	2
TH-232	UNFL	pCi/L	.000	3	7	.74	1.91	3
TH-TOTAL	UNFL	ug/L	3.000	3	7	6.83	17.4	3
U-234	UNFL	pCi/L	1.900	7	7	1.81	11.02	6
U-235/236	UNFL	pCi/L	.000	7	7	.076	.7	7
U-238	UNFL	pCi/L	1.070	7	7	1.89	11.81	7
U-TOTAL	UNFL	ug/L	4.000	7	7	4.77	30.4	7
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	6	0	0	0
2-Butanone	UNFL	ug/L	.000	0	6	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	5	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	5	0	0	0
Acetone	UNFL	ug/L	.000	0	4	0	0	0
Benzene	UNFL	ug/L	.000	0	6	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	6	0	0	0
Bromoform	UNFL	ug/L	.000	0	6	0	0	0
Bromomethane	UNFL	ug/L	.000	0	6	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	6	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	5	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
Chloroethane	UNFL	ug/L	.000	0	6	0	0	0
Chloroform	UNFL	ug/L	.000	0	6	0	0	0
Chloromethane	UNFL	ug/L	.000	0	6	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	6	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	6	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	6	0	0	0
Styrene	UNFL	ug/L	.000	0	6	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	6	0	0	0

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See footnote at end of table

TABLE 4-26  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Toluene	UNFL	ug/L	.000	0	6	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	6	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	4	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	6	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	6	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	6	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	6	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	6	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	6	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	6	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	6	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	6	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	6	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	6	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	6	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	6	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	3	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	6	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	6	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	6	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	6	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	3	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	5	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	6	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	6	0	0	0
Anthracene	UNFL	ug/L	.000	0	6	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-26  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(a)pyrene	UNFL	ug/L	.000	0	6	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	6	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	6	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	6	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	4	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	5	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	6	0	0	0
Carbazole	UNFL	ug/L	.000	0	6	0	0	0
Chrysene	UNFL	ug/L	.000	0	6	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	6	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	5	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	6	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	6	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	6	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	6	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	6	0	0	0
Fluorene	UNFL	ug/L	.000	0	6	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	6	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	6	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	6	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	6	0	0	0
Isophorone	UNFL	ug/L	.000	0	6	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	6	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	6	0	0	0
Naphthalene	UNFL	ug/L	.000	0	6	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	6	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	6	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	6	0	0	0
Phenol	UNFL	ug/L	.000	0	6	0	0	0
Pyrene	UNFL	ug/L	.000	0	6	0	0	0
Tributyl phosphate	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	6	0	0	0
bis(2-Chloroethyl) ether	UNFL	ug/L	.000	0	6	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	6	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	2	6	1	2	2
p-Chloroaniline	UNFL	ug/L	.000	0	5	0	0	0

See footnote at end of table

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TABLE 4-26  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	6	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	6	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	6	0	0	0
Aldrin	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	6	0	0	0
Dieldrin	UNFL	ug/L	.000	0	6	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	6	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	6	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	6	0	0	0
Endrin	UNFL	ug/L	.000	0	6	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	6	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	6	0	0	0
Heptachlor	UNFL	ug/L	.000	0	6	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	6	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	6	0	0	0
Toxaphene	UNFL	ug/L	.000	0	6	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	6	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	6	0	0	0
beta-BHC	UNFL	ug/L	.000	0	6	0	0	0
delta-BHC	UNFL	ug/L	.000	0	6	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	6	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	6	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	5	5	245	437.9	0
Alkalinity as CaCO3	UNFL	mg/L	.000	1	1	250	250	0
Ammonia	UNFL	mg/L	4.500	2	6	.14	.15	0
Chloride	UNFL	mg/L	110.159	6	6	44.07	573.8	3
Fluoride	UNFL	mg/L	1.352	6	6	.2	.44	0
Phenols	UNFL	mg/L	.000	0	6	0	0	0
Phosphorus	UNFL	mg/L	.223	1	2	.04	.04	0
Sulfate	UNFL	mg/L	141.894	6	6	57.4	147.5	1
Sulfide	UNFL	mg/L	.000	1	6	1.35	1.35	0

See footnote at end of table

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TABLE 4-26  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>							
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	5	6	.13 .5	5
Total Organic Carbon	UNFL	mg/L	.000	6	6	1.04 1.65	6
Total Organic Halides	UNFL	mg/L	.000	5	6	.0179 .0668	5
Total Organic Nitrogen	UNFL	mg/L	.000	5	6	.13 1.2	5
Total Phosphorous	UNFL	mg/L	.000	4	4	.22 4.13	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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1  
2  
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TABLE 4-27

CONCENTRATIONS OF SELECTED ANALYSIS DETECTED  
 IN GROUNDWATER SAMPLES COLLECTED DURING PHASE II LIME SLUDGE POND  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Location	Sample	Analytes				
		Chloride mg/L	Sulfate mg/L	Thorium-230 pCi/L	Uranium-238 pCi/L	Uranium Total µg/L
<b>1000 SERIES WELLS</b>						
<b>Background Concentrations</b>		110.15	141.89	2	1.07	4
1039. Upgradient of South Lime Sludge Pond	111990 (Unfiltered)	360.23	123.4			
	111990 (Filtered)			0.251	0.416	<1.00
1041. Upgradient of South Lime Sludge Pond	116220 (Unfiltered)	44.07	72.1	1.37	3.33	7.8
	116221 (Filtered)			0.410	2.72	8.3
1934. Downgradient of South Lime Sludge Pond	114620 (Unfiltered)	47.1	77.8	0.308	1.89	4.77
	114622 (Unfiltered)			6.67	5.75	17.5
1937. Downgradient of North Lime Sludge Pond	114617 (Unfiltered)	573.8	57.4	3.014	2.13	5.16
	114782 (Unfiltered)			2.74	3.19	6.48
1940. Downgradient of South Pond	114784 (Filtered)		147.5	0.120	2.58	6.3
	114785 (Unfiltered)			1.29	3.67	7.62
1042. Downgradient of South Pond	110889 (Unfiltered)	88.09	138	0.170	11.81	30.4
Surface Water in North Lime Sludge Pond	114595 (Unfiltered)	68.6	43	0.287	0.285	0.060
	114593 (Unfiltered)	72	39.3	0.210	0.272	1.000

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TABLE 4-27  
(Continued)

Location	Sample	Analytes				
		Chloride mg/L	Sulfate mg/L	Thorium-230 pCi/L	Uranium-238 pCi/L	Uranium Total µg/L
<b>2000 SERIES WELLS</b>						
<b>Background Concentrations</b>		145.04	359.85	1.79	0.90	2.92
2939. Upgradient of Ponds	114924 (Unfiltered)	26.86	106.8	0.186	0.579	1.600
	114924 (Filtered)			0.173	0.592	1.630
2936. Downgradient of North Lime Sludge Pond	114788 (Unfiltered)	27.3	120	0.119	1.940	3.64
2935. Directly downgradient of Lime Ponds	114921 (Unfiltered)	23	118.9	0.192	1.23	2.86
	114921 (Filtered)	N/A	N/A	0.181	1.18	2.59
2042. Side gradient to South Lime Sludge Pond	110989 (Unfiltered)	18.82	130.8	0.25	1.23	2.91
	110990 (Filtered)	N/A	N/A	0.160	1.31	3.1

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**TABLE 4-28A**  
**LIME SLUDGE PONDS**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	0	2	0	0	0
Antimony		mg/L	.038	1	2	.06	.06	1
Arsenic		mg/L	.300	0	4	0	0	0
Barium		mg/L	.413	3	4	.038	.043	0
Beryllium		mg/L	.003	0	2	0	0	0
Cadmium		mg/L	.006	0	4	0	0	0
Calcium		mg/L	135.163	4	4	79.8	120	0
Chromium		mg/L	.042	1	4	.02	.02	0
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.130	0	4	0	0	0
Iron		mg/L	4.000	4	4	.18	.321	0
Lead		mg/L	.029	0	4	0	0	0
Magnesium		mg/L	38.070	4	4	21.91	26	0
Manganese		mg/L	.800	4	4	.11	.233	0
Mercury		mg/L	.001	0	4	0	0	0
Molybdenum		mg/L	.027	2	4	.01	.022	0
Nickel		mg/L	.026	0	4	0	0	0
Potassium		mg/L	3.087	2	4	2.37	2.9	0
Selenium		mg/L	.005	0	4	0	0	0
Silver		mg/L	.023	0	3	0	0	0
Sodium		mg/L	51.918	4	4	10.91	12	0
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.027	0	2	0	0	0
Zinc		mg/L	.105	1	2	.05	.05	0
<b>RADIONUCLIDES</b>								
NP-237	UNFL	pCi/L	.000	0	5	0	0	0
PU-238	UNFL	pCi/L	.000	0	4	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	4	0	0	0
RA-226	UNFL	pCi/L	1.200	0	5	0	0	0
RA-228	UNFL	pCi/L	4.500	0	5	0	0	0
SR-90	UNFL	pCi/L	.000	0	5	0	0	0
TC-99	UNFL	pCi/L	36.000	0	5	0	0	0

See footnote at end of table

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TABLE 4-28A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
TH-228	UNFL	pCi/L	1.520	1	5	1.6	1.6	1
TH-230	UNFL	pCi/L	1.790	1	5	1	1	0
TH-232	UNFL	pCi/L	.000	0	5	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	2	0	0	0
U-234	UNFL	pCi/L	1.900	2	4	1.1	1.4	0
U-235/236	UNFL	pCi/L	.000	0	5	0	0	0
U-238	UNFL	pCi/L	.900	1	5	1.5	1.5	1
U-TOTAL	UNFL	ug/L	2.920	3	3	2	4	2
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	1	1	7	7	1
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-28A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-28A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
Methyl parathion	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Parathion	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	1	1	50	50	1
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	1	0	0	0
<u>PESTICIDES/PCBS</u>								
Azinphosmethyl	UNFL	ug/L	.000	0	1	0	0	0
Demeton	UNFL	ug/L	.000	0	1	0	0	0
Diazinon	UNFL	ug/L	.000	0	1	0	0	0
Ethion	UNFL	ug/L	.000	0	1	0	0	0
Malathion	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	1	4	.3	.3	0
Chloride	UNFL	mg/L	145.065	3	4	18	36.7	0
Fluoride	UNFL	mg/L	.938	4	4	.14	1.2	1
Nitrate	UNFL	mg/L	11.400	3	4	.2	.9	0
Phenols	UNFL	mg/L	.000	0	4	0	0	0
Phosphorus	UNFL	mg/L	.693	2	3	.056	.55	0

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February 18, 1994

See footnote at end of table

TABLE 4-28A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>								
Sulfate	UNFL	mg/L	359.847	4	4	.042	103	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	3	.6	.6	1
Total Organic Halides	UNFL	mg/L	.021	0	1	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.652	2	4	.26	.3	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-28B**  
**LIME SLUDGE PONDS**  
**GROUNDWATER<sup>a</sup> - 4000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	0	1	0	0	0
Antimony		mg/L	.038	0	1	0	0	0
Arsenic		mg/L	.300	1	6	.003	.003	0
Barium		mg/L	.413	6	6	.062	.165	0
Beryllium		mg/L	.003	0	1	0	0	0
Cadmium		mg/L	.006	0	6	0	0	0
Calcium		mg/L	135.163	6	6	95.9	128.9	0
Chromium		mg/L	.042	1	6	.02	.02	0
Cobalt		mg/L	.000	0	1	0	0	0
Copper		mg/L	.130	0	6	0	0	0
Iron		mg/L	4.000	6	6	2.7	5.84	3
Lead		mg/L	.029	0	4	0	0	0
Magnesium		mg/L	38.070	6	6	25	35.5	0
Manganese		mg/L	.800	6	6	.348	.471	0
Mercury		mg/L	.001	0	6	0	0	0
Molybdenum		mg/L	.027	2	6	.0035	.01	0
Nickel		mg/L	.026	1	6	.0162	.0162	0
Potassium		mg/L	3.087	6	6	1.5	4.87	3
Selenium		mg/L	.005	0	5	0	0	0
Silver		mg/L	.023	0	6	0	0	0
Sodium		mg/L	51.918	6	6	14	39.3	0
Thallium		mg/L	.000	0	0	0	0	0
Vanadium		mg/L	.027	0	1	0	0	0
Zinc		mg/L	.105	0	1	0	0	0
<b>RADIONUCLIDES</b>								
NP-237	UNFL	pCi/L	.000	0	5	0	0	0
PU-238	UNFL	pCi/L	.000	0	5	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	5	0	0	0
RA-226	UNFL	pCi/L	1.200	0	3	0	0	0
RA-228	UNFL	pCi/L	4.500	0	5	0	0	0
SR-90	UNFL	pCi/L	.000	0	5	0	0	0
TC-99	UNFL	pCi/L	36.000	0	5	0	0	0

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See footnote at end of table

TABLE 4-28B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
TH-228	UNFL	pCi/L	1.520	0	5	0	0	0
TH-230	UNFL	pCi/L	1.790	0	5	0	0	0
TH-232	UNFL	pCi/L	.000	0	5	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	5	0	0	0
U-234	UNFL	pCi/L	1.900	1	5	1.6	1.6	0
U-235/236	UNFL	pCi/L	.000	0	5	0	0	0
U-238	UNFL	pCi/L	.900	1	5	1	1	1
U-TOTAL	UNFL	ug/L	2.920	0	5	0	0	0
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-28B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-28B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachloropheno1	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Pheno1	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	1	0	0	0
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-28B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS (Continued)</u>								
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	6	6	.44	6.63	3
Chloride	UNFL	mg/L	145.065	5	6	23.1	38.4	0
Fluoride	UNFL	mg/L	.938	6	6	.2	.4	0
Nitrate	UNFL	mg/L	11.400	2	3	.1	.38	0
Phenols	UNFL	mg/L	.000	2	6	.009	.015	0
Phosphorus	UNFL	mg/L	.693	4	5	.031	.18	0
Sulfate	UNFL	mg/L	359.847	6	6	11	182	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	4	4	.58	6.79	4
Total Organic Halides	UNFL	mg/L	.021	1	4	.0135	.0135	0
Total Organic Nitrogen	UNFL	mg/L	.652	4	6	.14	.4	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-29**  
**LIME SLUDGE PONDS**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG					Minimum	Maximum	
<b>METALS</b>								
Aluminum		mg/L	.184	5	8	.0336	.26	1
Antimony		mg/L	.038	0	8	0	0	0
Arsenic		mg/L	.300	3	8	.0011	.0012	0
Barium		mg/L	.413	8	8	.0277	.0698	0
Beryllium		mg/L	.003	0	8	0	0	0
Cadmium		mg/L	.006	0	8	0	0	0
Calcium		mg/L	135.163	8	8	106	118	0
Chromium		mg/L	.042	1	8	.0055	.0055	0
Cobalt		mg/L	.000	0	8	0	0	0
Copper		mg/L	.130	1	8	.0053	.0053	0
Cyanide		mg/L	.000	0	3	0	0	0
Iron		mg/L	4.000	7	8	1.03	2.38	0
Lead		mg/L	.029	0	8	0	0	0
Magnesium		mg/L	38.070	8	8	25.7	27	0
Manganese		mg/L	.800	8	8	.0947	1.29	1
Mercury		mg/L	.001	0	8	0	0	0
Molybdenum		mg/L	.027	3	8	.0071	.0088	0
Nickel		mg/L	.026	0	8	0	0	0
Potassium		mg/L	3.087	2	8	3.1	3.16	2
Selenium		mg/L	.005	0	8	0	0	0
Silicon		mg/L	10.491	8	8	4.28	5.71	0
Silver		mg/L	.023	0	8	0	0	0
Sodium		mg/L	51.918	8	8	13.1	17.9	0
Thallium		mg/L	.000	0	8	0	0	0
Vanadium		mg/L	.027	0	8	0	0	0
Zinc		mg/L	.105	1	8	.0338	.0338	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	5	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	5	0	0	0
GROSS BETA	UNFL	pCi/L	.000	2	5	5.08	5.23	2
NP-237	UNFL	pCi/L	.000	2	4	.1	.52	2
PU-238	UNFL	pCi/L	.000	2	5	.05	.05	2
PU-239/240	UNFL	pCi/L	.000	0	5	0	0	0
RA-226	UNFL	pCi/L	1.200	3	5	.12	.791	0

See footnote at end of table

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TABLE 4-29  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-228	UNFL	pCi/L	4.500	0	5	0	0	0
RU-106	UNFL	pCi/L	.000	0	5	0	0	0
SR-90	UNFL	pCi/L	.000	0	5	0	0	0
TC-99	UNFL	pCi/L	36.000	0	5	0	0	0
TH-228	UNFL	pCi/L	1.520	0	5	0	0	0
TH-230	UNFL	pCi/L	1.790	2	5	.144	.25	0
TH-232	UNFL	pCi/L	.000	0	5	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	5	0	0	0
U-234	UNFL	pCi/L	1.900	2	5	1.33	1.41	0
U-235/236	UNFL	pCi/L	.000	2	5	.076	.16	2
U-238	UNFL	pCi/L	.900	5	5	.579	1.94	4
U-TOTAL	UNFL	ug/L	2.920	5	5	1.63	3.79	2
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	4	0	0	0
2-Butanone	UNFL	ug/L	.000	0	4	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	4	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	4	0	0	0
Benzene	UNFL	ug/L	.000	0	4	0	0	0
Bromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	3	0	0	0
Bromoform	UNFL	ug/L	.000	0	4	0	0	0
Bromomethane	UNFL	ug/L	.000	0	4	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	4	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	4	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
Chloroethane	UNFL	ug/L	.000	0	4	0	0	0
Chloroform	UNFL	ug/L	.000	0	4	0	0	0
Chloromethane	UNFL	ug/L	.000	0	4	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	4	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	4	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	4	0	0	0

See footnote at end of table

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TABLE 4-29  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Styrene	UNFL	ug/L	.000	0	4	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	4	0	0	0
Toluene	UNFL	ug/L	.000	0	4	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	4	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	1	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	4	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	4	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	3	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	4	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	4	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	3	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	4	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	4	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	4	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	4	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	4	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	4	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	4	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	4	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	4	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	4	0	0	0

See footnote at end of table

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**TABLE 4-29  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Anthracene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	3	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	3	4	1	2	3
Carbazole	UNFL	ug/L	.000	0	4	0	0	0
Chrysene	UNFL	ug/L	.000	0	4	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	3	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	4	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Fluorene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	4	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Isophorone	UNFL	ug/L	.000	0	4	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	4	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	3	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	4	0	0	0
Naphthalene	UNFL	ug/L	.000	0	4	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	4	0	0	0
Pentachloropheno1	UNFL	ug/L	.000	0	4	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	4	0	0	0
Phenol	UNFL	ug/L	.000	0	4	0	0	0
Pyrene	UNFL	ug/L	.000	0	4	0	0	0
Tributyl phosphate	UNFL	ug/L	.000	0	3	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	4	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	4	0	0	0

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See footnote at end of table

TABLE 4-29  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	4	0	0	0
Aldrin	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	4	0	0	0
Dieldrin	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	4	0	0	0
Endrin	UNFL	ug/L	.000	0	4	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	4	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	4	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	4	0	0	0
Toxaphene	UNFL	ug/L	.000	0	4	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	4	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
beta-BHC	UNFL	ug/L	.000	0	4	0	0	0
delta-BHC	UNFL	ug/L	.000	0	4	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	4	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	4	4	255.5	332.5	0
Ammonia	UNFL	mg/L	3.240	0	4	0	0	0
Chloride	UNFL	mg/L	145.065	4	4	18.82	27.3	0
Fluoride	UNFL	mg/L	.938	4	4	.13	.17	0
Nitrate	UNFL	mg/L	11.400	2	2	.89	1.46	0
Phenols	UNFL	mg/L	.000	0	4	0	0	0
Sulfate	UNFL	mg/L	359.847	4	4	106.8	130.8	0
Sulfide	UNFL	mg/L	.000	3	4	.51	10.75	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	4	.11	.11	1

See footnote at end of table

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**TABLE 4-29  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>GENERAL CHEMISTRY (Continued)</u>								
Total Organic Carbon	UNFL	mg/L	3.764	0	4	0	0	0
Total Organic Halides	UNFL	mg/L	.021	1	4	.0102	.0102	0
Total Organic Nitrogen	UNFL	mg/L	.652	1	4	.11	.11	0
Total Phosphorous	UNFL	mg/L	.000	3	4	.04	.05	0

\*Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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- Chemical and radiological samples indicate that the sludge, the roadway, and the berm materials have different characteristics and concentrations and are thus distinct waste materials. 1
- Samples collected from sludge and underlying soil indicate that the underlying soil has higher values than the sludge for most constituents. This means that future impacts of the sludge upon the soil are not likely. 2
- Elevated concentrations of uranium and thorium were detected in downgradient perched groundwater wells, but samples collected from the K-65 slurry line trench contained elevated radioisotope activities, and this is believed to be the source for the contamination. 3
- Concentrations of metals were elevated in sludge and in downgradient perched groundwater. This suggests that there has been an impact by metals leaching from the sludge into the perched groundwater. 4
- Samples of regional aquifer groundwater detected uranium above background concentrations in two of three downgradient wells. However, the concentrations are very close to background suggesting that the potential impact of radioisotopes from the Lime Sludge Ponds is minimal. 5
- Samples of regional aquifer groundwater detected slightly elevated concentrations of six metals commonly associated with the soil matrix. These constituents were detected in unfiltered water samples and are possibly a result of slight turbidity prior to acidification during sampling. 6

4.4 INACTIVE FLYASH PILE 7

Analytical results for samples collected from the Inactive Flyash Pile are presented in Appendix E. Sample analyses that detected analytes at concentrations above background (defined in Table 4-1A) will be discussed in this section. Analyte concentrations at or below background will be considered as expected for soil or flyash and will not be discussed further. Geology and hydrogeology of the Inactive Flyash Pile referred to in this section were discussed in more detail in Section 3.4. 8

4.4.1 Volume and Physical Characteristics of the Waste 9

The volume of flyash and waste materials was estimated for the Inactive Flyash Pile and South Field together. The volume for the combined subunits is 216,489 cubic yards. Contours of waste thickness are shown on Figure 4-12. 10

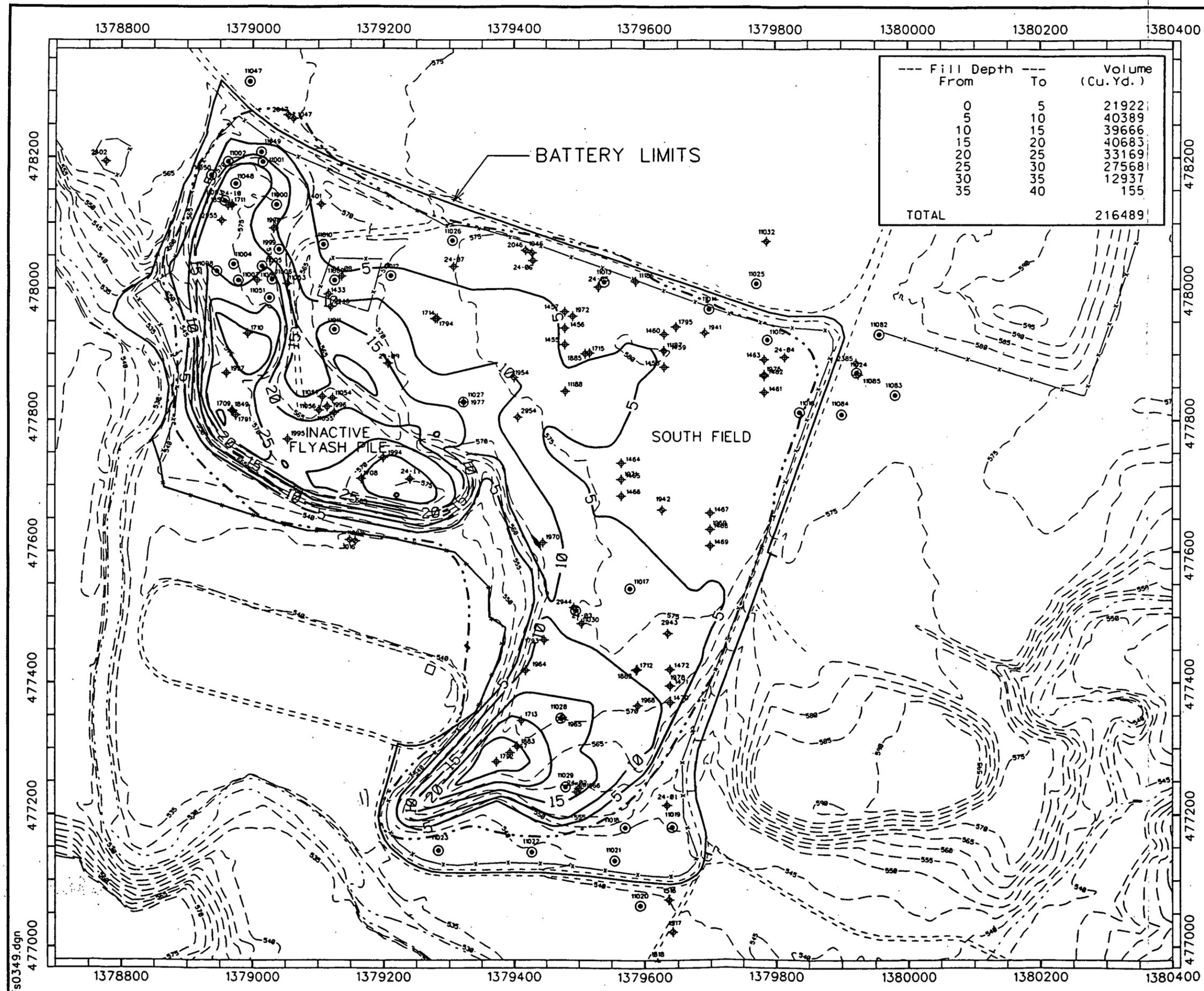
Flyash was originally coal that was burned at the boiler plant and would be expected to contain elevated concentrations of metals and radionuclides when compared to background soil concentrations since coal has elevated concentrations. A discussion of expected concentrations of radionuclides and 11

metals in flyash was provided in Section 4.1.4. Aerial photographs and interviews with workers indicate that the flyash was deposited as in-filling of depressions in the till surface by dump trucks. Flyash was dumped off a steep till embankment near to Paddys Run and thereafter, worked by bulldozers. There were no discernable dumping patterns observed in the aerial photographs, and it appears that dumping occurred at different working faces within the north South Field and Inactive Flyash Pile areas during the 1950s, although the south end of the Inactive Flyash Pile was active during a short period in 1986.

Analyses of subsurface soils collected during Phase II activities were evaluated to determine if correlations existed between detected concentrations of various analytes. The constituents selected were aroclor-1254, arsenic, beryllium, benzo(a)anthracene, benzo(a)pyrene, bis(2-ethylhexyl)phthalate, radium-228, thorium-228, and uranium-238. Radium-228 and thorium-228 varied sympathetically, as did arsenic and beryllium, and benzo(a)anthracene and benzo(a)pyrene. Correlation between these radionuclides, metals, and organic compounds suggests that they were deposited at approximately the same time and place. Poor correlation with other analytes, for example uranium, suggests that the other analytes were deposited over a different time period and in different locations. No other correlations in concentrations were noted. A more detailed comparison of semi-volatile organics in the Solid Waste Landfill (anthracene, phenanthrene, benzo(a)anthracene, benzo(g,h,i)perylene, benzo(k)fluoranthene, fluoranthene, and pyrene) showed that these constituents varied sympathetically. This is consistent with data from the Inactive Flyash Pile and indicates that disposal of similar mixtures of materials, possibly from the same manufacturing areas, were deposited at both locations. The lack of correlation between other organic and radionuclide constituents suggest that they were not co-disposed.

The southern portion of the Inactive Flyash Pile has an approximate 7-foot soil/fill cover with a moderate vegetative cover. The northern portion, as indicated by the soil boring logs, does not have a soil cover. However, the northern portion is covered with moderate vegetation and stands of deciduous trees.

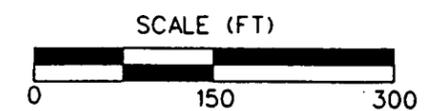
Samples of flyash collected from borings detected dry to moist conditions but never detected water saturated samples. Very moist to wet conditions were detected at the interface of the Inactive Flyash Pile and the native till surface. The highest beta gamma readings were also detected in samples collected from this interface or from underlying sand layers within the glacial till overburden. Soil



**LEGEND**

- ELEVATION CONTOURS
- == ROADS
- STREAM
- DRAINAGE
- FENCE
- ◆ 1000 MONITORING WELLS
- ◆ 2000 MONITORING WELLS
- ◆ SOIL BORING
- ⊙ HYDROPUNCH
- WASTE MATERIAL THICKNESS CONTOUR

NOTE:  
Coordinates are in State  
Planar NAD 1927.  
Surface contours based on  
1992 flyover.



0470  
FIGURE 4-12  
VOLUME OF WASTE  
MATERIAL,  
SOUTH FIELD/  
INACTIVE FLYASH PILE

samples collected from several soil borings drilled in the flyash detected solid waste materials of sludge, concrete, and construction rubble near to the till surface beneath the flyash at Hydropunch™ 11006, 11051, 11055 and in Boring No.1996. Flyash was the major material identified in most of the other subsurface samples collected from the Inactive Flyash Pile.

4.4.2 Surface and Subsurface Media

Chemical and radiological analytical results for surface media were compared to soil background results. A listing of analytes detected above background is provided in Appendix E, Table E-2A. A summary of the analytes in surface media is provided in Table 4-30. Fourteen metals, isotopes of six elements, and twelve organic compounds exceeded background concentrations in samples of the surface media collected during the Phase II field program. Surface soils were not collected for Phase I. Radionuclide data for Phase I are presented on Figure 4-13. Total uranium concentrations were detected at elevated concentrations in all surface soils, ranging from 5.01 microgram per gram (µg/g) to 32.1 µg/g (background concentrations is 3.24 µg/g). Strontium-90 was detected in five of seven surface samples and total thorium was detected at 7.74 µg/g and 21.4 µg/g at IFP-SS-05 and IFP-SS-01, respectively. These data do not suggest a pattern of surface disposal at one location with subsequent surface spreading.

Beryllium and silver were detected in six and five of seven Phase II surface samples, respectively. The metals arsenic, copper, cyanide, selenium, and lead were detected above background in the surface sample IFP-SS-01. This sample also contained the highest values for radium and thorium isotopes. Three volatile organics (trace concentrations of acetone, toluene, and 2-butanone) were detected in surface soil samples. Nine semi-volatile organics (2-methylnaphthalene acenaphthene, acenaphthylene, anthracene, carbazole, dibenzo(a,h)anthracene, fluorene, dibenzofuran, and naphthalene) were detected in sample IFP-SS-07 at the north end of the Inactive Flyash Pile. This indicates that the north area is a potential source of organic compound sediments that are taken off-site by surface erosion, and that the remainder of the surface is covered by relatively clean fill that does not contain organic compounds.

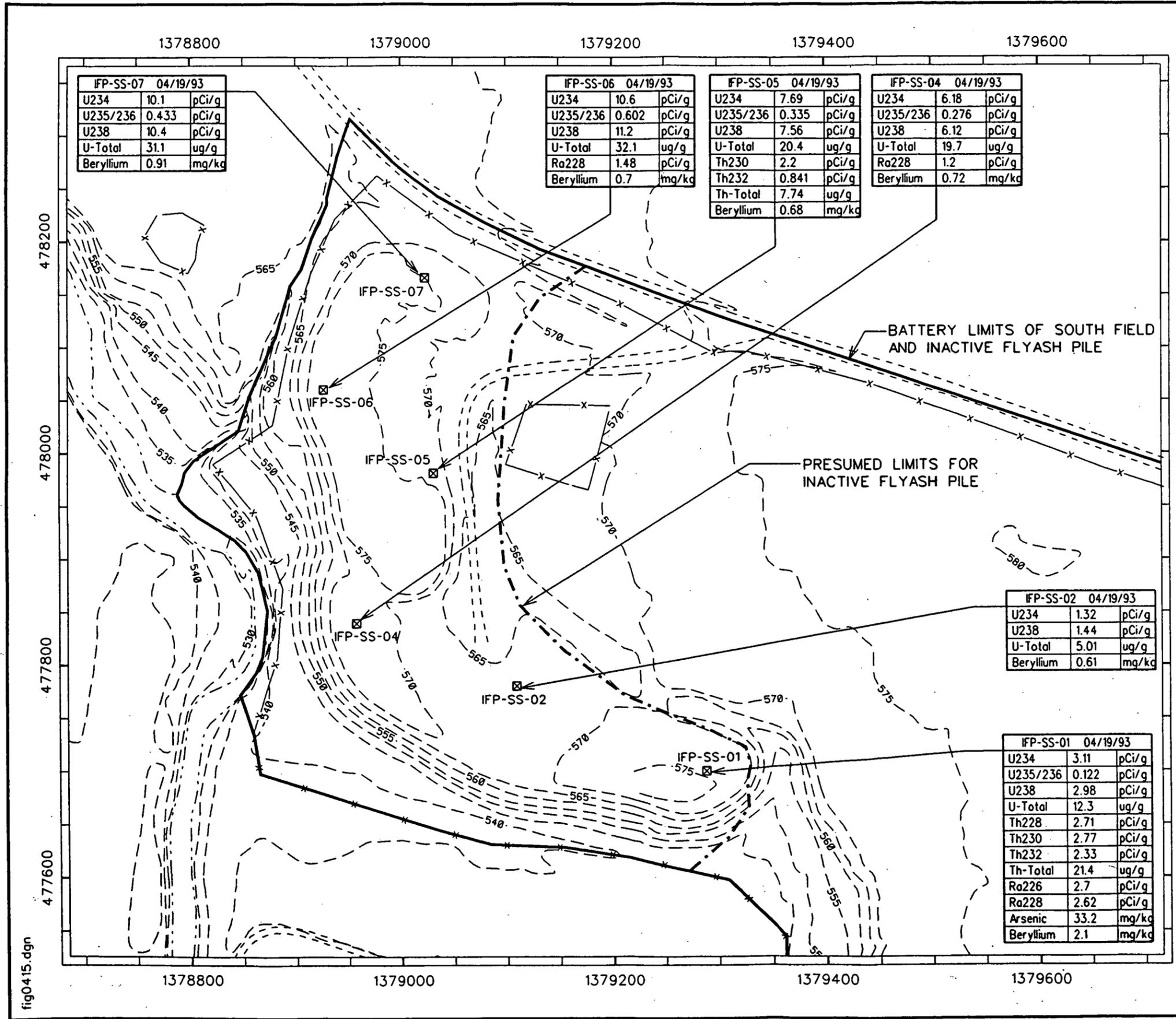
Phase I and Phase II surface soil data were compared to CIS and ES data (Appendices E-4 and E-5). Analytes detected in these preliminary studies were also detected in Phase I and Phase II and within the same order of magnitude.

Chemical and radiological analytical results from subsurface samples were compared against soil background concentrations. A table of the resulting constituent concentrations above background values is provided in Appendix E in Table E-2B and Table E-2C. A summary of the analytes in subsurface soil is presented as Table 4-31 and Table 4-32. Radionuclides and metals of concern are shown on Figure 4-14 (see Volume 2, Oversized Figures). Fifteen metals, isotopes of nine elements, and 24 organic compounds exceeded background concentrations at 11 sample locations from the Inactive Flyash Pile during the Phase I field program. During the Phase II sampling twenty four metals (Calcium, Chromium, Cobalt, Magnesium, Manganese, Nickel, Potassium, Silicon, and Vanadium were not detected for Phase I), isotopes of seven elements (lead-210, and technetium-99 were detected above background for Phase I and not for Phase II), and thirty four organic compounds were detected above background in samples collected from twelve locations (2-Butanone, Chlorobenzene, Chloromethane, Methylene Chloride, Tetrachloroethane, Trichloroethane, 4-Methylphenol, Benao(g,h,i)perylene, Carbazole; Dibenqo(a,h)anthracene, Diethylphthalate, Indeno(1,2,3-cd)pyrene, Isophorone, Phenol, Tributyl phosphate, and alph-Chlordane were detected for Phase II but not Phase I; 2-Hexanone, Carbon disulfide, Styrene, Vinyl Acetate, Benzoic Acid, and Arochlor-1260 were detected for Phase I but not Phase II).

Metals detected above soil background in 40 percent or more of Phase I samples include antimony, arsenic, barium, beryllium, copper, mercury, cyanide, molybdenum, selenium, and silver. If the data are compared to metal concentrations expected for flyash, antimony (three samples), cyanide (ten samples), mercury (one sample), and silver (one sample) are above background concentrations. When Phase II samples are compared to flyash background the following metals are detected above background in 22 samples:

Metal	Number of Sample(s)	Material/Location
copper	2 samples	sludge material at depth of 22 feet
cyanide	8 samples	multiple locations, various depths
lead	2 samples	sludge material at depths of 19 to 24 feet
mercury	3 samples	sludge material at depths of 19 to 24 feet
	1 sample	Boring No. 1997 at depths of 10 to 11 feet
thallium	5 samples	multiple locations, various depths

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**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- SURFACE SAMPLE

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

**SCALE (FT)**

**0473**  
**FIGURE 4-13**  
**RADIONUCLIDES IN**  
**SURFACE SOILS**  
**DETECTED ABOVE BACKGROUND**  
**IN THE INACTIVE FLYASH PILE**

fig0415.dgn

**TABLE 4-30**  
**INACTIVE FLYASH PILE**  
**SURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<b>METALS</b>						
Aluminum	mg/kg	13125.282	7	7	1430 10100	0
Antimony	mg/kg	.000	0	7	0 0	0
Arsenic	mg/kg	11.608	7	7	1.9 33.2	1
Barium	mg/kg	88.500	7	7	7.3 105	2
Beryllium	mg/kg	.600	6	7	.61 2.1	6
Cadmium	mg/kg	.770	1	7	3.1 3.1	1
Calcium	mg/kg	5296.781	7	7	2730 142000	6
Chromium	mg/kg	17.057	7	7	2.5 12.9	0
Cobalt	mg/kg	16.913	7	7	2.9 10.2	0
Copper	mg/kg	15.700	7	7	4.8 41.1	2
Cyanide	mg/kg	.230	3	7	.14 .7	1
Iron	mg/kg	24788.749	7	7	2770 17000	0
Lead	mg/kg	29.575	7	7	3.2 31.3	1
Magnesium	mg/kg	1460.000	7	7	741 55000	6
Manganese	mg/kg	2257.945	7	7	38 1020	0
Mercury	mg/kg	.300	0	7	0 0	0
Molybdenum	mg/kg	.000	3	7	4.8 7.2	3
Nickel	mg/kg	25.145	7	7	5.8 19.7	0
Potassium	mg/kg	1349.530	7	7	221 2030	4
Selenium	mg/kg	.720	1	7	8.2 8.2	1
Silicon	mg/kg	1914.313	7	7	219 1220	0
Silver	mg/kg	.000	5	7	2.8 5	5
Sodium	mg/kg	55.145	7	7	74.5 223	7
Thallium	mg/kg	.580	0	7	0 0	0
Vanadium	mg/kg	33.693	7	7	4.9 32.3	0
Zinc	mg/kg	58.500	7	7	12.6 55.1	0
<b>RADIONUCLIDES</b>						
CS-137	pCi/g	.849	5	7	.0871 .641	0
GROSS ALPHA	pCi/g	.000	6	7	20.1 60.2	6
GROSS BETA	pCi/g	.000	7	7	11.9 43.9	7
NP-237	pCi/g	.000	4	4	.0298 .137	4
PU-238	pCi/g	.000	3	6	.0441 .081	3
PU-239/240	pCi/g	.000	1	6	.0205 .0205	1
RA-226	pCi/g	1.528	7	7	.523 2.7	1
RA-228	pCi/g	1.170	7	7	.415 2.62	3
RU-106	pCi/g	.000	0	7	0 0	0

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TABLE 4-30  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
SR-90	pCi/g	.000	5	7	.525	1.14	5
TC-99	pCi/g	.000	0	7	0	0	0
TH-228	pCi/g	1.519	2	2	.79	2.71	1
TH-230	pCi/g	2.112	2	2	2.2	2.77	2
TH-232	pCi/g	1.469	2	2	.841	2.33	1
TH-TOTAL	mg/kg	10.700	2	2	7.74	21.4	1
U-234	pCi/g	1.319	7	7	.433	10.6	6
U-235/236	pCi/g	.181	7	7	.038	.602	4
U-238	pCi/g	1.270	7	7	.422	11.2	6
U-TOTAL	mg/kg	3.240	7	7	.824	32.1	6
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	7	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	7	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	7	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	7	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	7	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	7	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	7	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	7	0	0	0
2-Butanone	ug/kg	.000	1	7	3	3	1
2-Hexanone	ug/kg	.000	0	7	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	7	0	0	0
Acetone	ug/kg	.000	3	7	2	12	3
Benzene	ug/kg	.000	0	7	0	0	0
Bromodichloromethane	ug/kg	.000	0	7	0	0	0
Bromoform	ug/kg	.000	0	7	0	0	0
Bromomethane	ug/kg	.000	0	7	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	7	0	0	0
Carbon disulfide	ug/kg	.000	0	7	0	0	0
Chlorobenzene	ug/kg	.000	0	7	0	0	0
Chloroethane	ug/kg	.000	0	7	0	0	0
Chloroform	ug/kg	.000	0	7	0	0	0
Chloromethane	ug/kg	.000	0	7	0	0	0
Dibromochloromethane	ug/kg	.000	0	7	0	0	0
Ethylbenzene	ug/kg	.000	0	7	0	0	0
Methylene chloride	ug/kg	.000	0	7	0	0	0
Styrene	ug/kg	.000	0	7	0	0	0
Tetrachloroethene	ug/kg	.000	0	7	0	0	0
Toluene	ug/kg	.000	3	7	3	55	3
Trichloroethene	ug/kg	.000	0	7	0	0	0
Vinyl Acetate	ug/kg	.000	0	7	0	0	0
Vinyl chloride	ug/kg	.000	0	7	0	0	0

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TABLE 4-30  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	7	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	7	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	7	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	7	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	7	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	7	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	7	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	7	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	7	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	7	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	7	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	7	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	7	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	7	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	7	0	0	0
2-Chlorophenol	ug/kg	.000	0	7	0	0	0
2-Methylnaphthalene	ug/kg	.000	1	7	160	160	1
2-Methylphenol	ug/kg	.000	0	7	0	0	0
2-Nitroaniline	ug/kg	.000	0	7	0	0	0
2-Nitrophenol	ug/kg	.000	0	7	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	7	0	0	0
3-Nitroaniline	ug/kg	.000	0	7	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	7	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	7	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	7	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	7	0	0	0
4-Methylphenol	ug/kg	.000	0	7	0	0	0
4-Nitroaniline	ug/kg	.000	0	7	0	0	0
4-Nitrophenol	ug/kg	.000	0	7	0	0	0
Acenaphthene	ug/kg	.000	1	7	460	460	1
Acenaphthylene	ug/kg	.000	1	7	1800	1800	1
Anthracene	ug/kg	.000	1	7	1700	1700	1
Benzo(a)anthracene	ug/kg	.000	0	7	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	7	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	7	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	7	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	7	0	0	0
Benzoic acid	ug/kg	.000	0	7	0	0	0
Benzyl alcohol	ug/kg	.000	0	7	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	7	0	0	0
Carbazole	ug/kg	.000	1	7	510	510	1

7740  
5340

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TABLE 4-30  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Chrysene	ug/kg	.000	0	7	0	0	0
Di-n-butyl phthalate	ug/kg	.000	0	7	0	0	0
Di-n-octyl phthalate	ug/kg	.000	0	7	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	1	7	2200	2200	1
Dibenzofuran	ug/kg	.000	1	7	250	250	1
Diethyl phthalate	ug/kg	.000	0	7	0	0	0
Dimethyl phthalate	ug/kg	.000	0	7	0	0	0
Fluoranthene	ug/kg	.000	0	7	0	0	0
Fluorene	ug/kg	.000	1	7	510	510	1
Hexachlorobenzene	ug/kg	.000	0	7	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	7	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	7	0	0	0
Hexachloroethane	ug/kg	.000	0	7	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	7	0	0	0
Isophorone	ug/kg	.000	0	7	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	7	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	7	0	0	0
Naphthalene	ug/kg	.000	1	7	100	100	1
Nitrobenzene	ug/kg	.000	0	7	0	0	0
Pentachlorophenol	ug/kg	.000	0	7	0	0	0
Phenanthrene	ug/kg	.000	0	7	0	0	0
Phenol	ug/kg	.000	0	7	0	0	0
Pyrene	ug/kg	.000	0	7	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	7	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	7	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	7	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	0	7	0	0	0
p-Chloroaniline	ug/kg	.000	0	7	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	7	0	0	0
4,4'-DDE	ug/kg	.000	0	7	0	0	0
4,4'-DDT	ug/kg	.000	0	7	0	0	0
Aldrin	ug/kg	.000	0	7	0	0	0
Aroclor-1016	ug/kg	.000	0	7	0	0	0
Aroclor-1221	ug/kg	.000	0	7	0	0	0
Aroclor-1232	ug/kg	.000	0	7	0	0	0
Aroclor-1242	ug/kg	.000	0	7	0	0	0
Aroclor-1248	ug/kg	.000	0	7	0	0	0
Aroclor-1254	ug/kg	.000	0	7	0	0	0
Aroclor-1260	ug/kg	.000	0	7	0	0	0
Dieldrin	ug/kg	.000	0	7	0	0	0
Endosulfan II	ug/kg	.000	0	7	0	0	0

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0477

FEMP-OU02-4 DRAFT  
February 18, 1994

TABLE 4-30  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Endosulfan sulfate	ug/kg	.000	0	7	0	0	0
Endosulfan-I	ug/kg	.000	0	7	0	0	0
Endrin	ug/kg	.000	0	7	0	0	0
Endrin aldehyde	ug/kg	.000	0	7	0	0	0
Endrin ketone	ug/kg	.000	0	7	0	0	0
Heptachlor	ug/kg	.000	0	7	0	0	0
Heptachlor epoxide	ug/kg	.000	0	7	0	0	0
Methoxychlor	ug/kg	.000	0	7	0	0	0
Toxaphene	ug/kg	.000	0	7	0	0	0
alpha-BHC	ug/kg	.000	0	7	0	0	0
alpha-Chlordane	ug/kg	.000	0	7	0	0	0
beta-BHC	ug/kg	.000	0	7	0	0	0
delta-BHC	ug/kg	.000	0	7	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	7	0	0	0
gamma-Chlordane	ug/kg	.000	0	7	0	0	0

6740

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PEMP-0002.4 DRAFT  
February 8, 1994  
5120

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**TABLE 4-31**  
**INACTIVE FLYASH PILE**  
**SUBSOIL**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	12	12	2130	9550	0
Antimony	mg/kg	.000	4	8	8.8	16.3	4
Arsenic	mg/kg	9.704	12	12	1.7	74.8	6
Barium	mg/kg	121.064	12	12	13.1	892	8
Beryllium	mg/kg	.620	12	12	.54	6.7	9
Cadmium	mg/kg	.910	9	12	.65	4.1	4
Calcium	mg/kg	150000.000	12	12	2510	123000	0
Chromium	mg/kg	20.953	12	12	5.1	19.6	0
Cobalt	mg/kg	15.929	12	12	5.2	12.1	0
Copper	mg/kg	20.230	12	12	12.1	44.9	9
Cyanide	mg/kg	.170	10	10	.18	1.2	10
Iron	mg/kg	31188.164	12	12	4610	20100	0
Lead	mg/kg	15.780	12	12	6.4	67.1	2
Magnesium	mg/kg	43052.339	12	12	377	25100	0
Manganese	mg/kg	1045.407	12	12	22.7	736	0
Mercury	mg/kg	.290	2	9	.18	.44	1
Molybdenum	mg/kg	.270	12	12	3.2	9.4	12
Nickel	mg/kg	34.747	12	12	9.7	19.6	0
Potassium	mg/kg	2007.519	12	12	456	1430	0
Selenium	mg/kg	.000	9	12	.73	4.1	9
Silver	mg/kg	.000	7	12	2.7	8.3	7
Sodium	mg/kg	227.947	10	12	91.7	294	2
Thallium	mg/kg	.490	3	12	.8	1	3
Vanadium	mg/kg	38.088	12	12	10.7	34.9	0
Zinc	mg/kg	73.158	12	12	9.4	102	1
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	1	19	.2	.2	1
GROSS ALPHA	pCi/g	.000	0		0	0	0
GROSS BETA	pCi/g	.000	0		0	0	0
NP-237	pCi/g	.000	3	18	.6	.78	3
PB-210	pCi/g	.857	10	10	.71	16.8	7
PU-238	pCi/g	.000	1	19	.6	.6	1
PU-239/240	pCi/g	.000	0	16	0	0	0
RA-224	pCi/g	1.019	10	10	1.02	3.49	10
RA-226	pCi/g	1.470	18	19	.4	36	12
RA-228	pCi/g	1.325	16	19	.6	3.13	10

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TABLE 4-31  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>							
RU-106	pCi/g	.000	1	19	1	1	1
SR-90	pCi/g	.560	7	19	.7	4	7
TC-99	pCi/g	.000	2	19	.9	1.5	2
TH-228	pCi/g	1.341	16	18	.79	4.1	12
TH-230	pCi/g	1.897	16	18	.9	54.6	11
TH-232	pCi/g	1.269	15	18	.6	4	9
TH-TOTAL	mg/kg	9.470	16	16	2.79	36.1	11
U-234	pCi/g	1.034	15	18	.7	187	14
U-235	pCi/g	.000	5	10	.57	12.7	0
U-235/236	pCi/g	.142	7	18	.687	18.5	7
U-238	pCi/g	1.122	23	25	.7	191	21
U-TOTAL	mg/kg	2.540	16	19	1.59	873	15
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	9	14	4	170	9
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	5	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	7	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	13	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	13	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	12	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	13	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	7	0	0	0
2-Butanone	ug/kg	.000	0	11	0	0	0
2-Hexanone	ug/kg	.000	1	5	3	3	1
4-Methyl-2-pentanone	ug/kg	.000	2	6	1	2	2
Acetone	ug/kg	.000	5	12	10	190	5
Benzene	ug/kg	.000	0	7	0	0	0
Bromodichloromethane	ug/kg	.000	0	7	0	0	0
Bromoform	ug/kg	.000	0	7	0	0	0
Bromomethane	ug/kg	.000	0	13	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	7	0	0	0
Carbon disulfide	ug/kg	.000	1	13	20	20	1
Chlorobenzene	ug/kg	.000	0	5	0	0	0
Chloroethane	ug/kg	.000	0	13	0	0	0
Chloroform	ug/kg	.000	0	12	0	0	0
Chloromethane	ug/kg	.000	0	13	0	0	0
Dibromochloromethane	ug/kg	.000	0	7	0	0	0
Ethylbenzene	ug/kg	.000	0	5	0	0	0
Methylene chloride	ug/kg	.000	0	13	0	0	0
Styrene	ug/kg	.000	1	6	2	2	1
Tetrachloroethene	ug/kg	.000	0	6	0	0	0
Toluene	ug/kg	.000	6	10	3	110	6
Trichloroethene	ug/kg	.000	0	7	0	0	0

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TABLE 4-31  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Vinyl Acetate	ug/kg	.000	1	8	2	2	1
Vinyl chloride	ug/kg	.000	0	13	0	0	0
Xylenes, Total	ug/kg	.000	0	5	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	7	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	7	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	16	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	16	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	16	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	16	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	16	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	16	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	16	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	16	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	16	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	16	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	16	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	16	0	0	0
2-Chlorophenol	ug/kg	.000	0	16	0	0	0
2-Methylnaphthalene	ug/kg	.000	4	16	50	89	4
2-Methylphenol	ug/kg	.000	0	16	0	0	0
2-Nitroaniline	ug/kg	.000	0	16	0	0	0
2-Nitrophenol	ug/kg	.000	0	16	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	16	0	0	0
3-Nitroaniline	ug/kg	.000	0	16	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	16	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	16	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	16	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	16	0	0	0
4-Methylphenol	ug/kg	.000	0	16	0	0	0
4-Nitroaniline	ug/kg	.000	0	16	0	0	0
4-Nitrophenol	ug/kg	.000	0	16	0	0	0
Acenaphthene	ug/kg	.000	0	16	0	0	0
Acenaphthylene	ug/kg	.000	0	16	0	0	0
Anthracene	ug/kg	.000	1	16	49	49	1
Benzo(a)anthracene	ug/kg	.000	1	16	110	110	1
Benzo(a)pyrene	ug/kg	.000	1	16	130	130	1
Benzo(b)fluoranthene	ug/kg	.000	1	16	360	360	1
Benzo(g,h,i)perylene	ug/kg	.000	0	16	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	1	16	260	260	1
Benzoic acid	ug/kg	.000	2	16	97	150	2

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TABLE 4-31  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Benzyl alcohol	ug/kg	.000	0	16	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	16	0	0	0
Carbazole	ug/kg	.000	0	0	0	0	0
Chrysene	ug/kg	.000	1	16	150	150	1
Di-n-butyl phthalate	ug/kg	.000	1	16	46	46	1
Di-n-octyl phthalate	ug/kg	.000	0	16	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	16	0	0	0
Dibenzofuran	ug/kg	.000	0	16	0	0	0
Diethyl phthalate	ug/kg	.000	0	16	0	0	0
Dimethyl phthalate	ug/kg	.000	0	16	0	0	0
Fluoranthene	ug/kg	.000	1	16	94	94	1
Fluorene	ug/kg	.000	0	16	0	0	0
Hexachlorobenzene	ug/kg	.000	0	16	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	16	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	16	0	0	0
Hexachloroethane	ug/kg	.000	0	16	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	16	0	0	0
Isophorone	ug/kg	.000	0	16	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	16	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	16	0	0	0
Naphthalene	ug/kg	.000	2	16	53	53	2
Nitrobenzene	ug/kg	.000	0	16	0	0	0
Pentachlorophenol	ug/kg	.000	0	16	0	0	0
Phenanthrene	ug/kg	.000	2	16	41	49	2
Phenol	ug/kg	.000	0	16	0	0	0
Pyrene	ug/kg	.000	1	16	120	120	1
bis(2-Chloroethoxy)methane	ug/kg	.000	0	16	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	16	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	16	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	1	16	620	620	1
p-Chloroaniline	ug/kg	.000	0	16	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	12	0	0	0
4,4'-DDE	ug/kg	.000	0	12	0	0	0
4,4'-DDT	ug/kg	.000	0	12	0	0	0
Aldrin	ug/kg	.000	0	12	0	0	0
Aroclor-1016	ug/kg	.000	0	12	0	0	0
Aroclor-1221	ug/kg	.000	0	12	0	0	0
Aroclor-1232	ug/kg	.000	0	12	0	0	0
Aroclor-1242	ug/kg	.000	0	12	0	0	0
Aroclor-1248	ug/kg	.000	0	12	0	0	0
Aroclor-1254	ug/kg	.000	1	12	210	210	1

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**TABLE 4-31**  
**(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Aroclor-1260	ug/kg	.000	1	12	390	390	1
Dieldrin	ug/kg	.000	0	12	0	0	0
Endosulfan II	ug/kg	.000	0	12	0	0	0
Endosulfan sulfate	ug/kg	.000	0	12	0	0	0
Endosulfan-I	ug/kg	.000	0	12	0	0	0
Endrin	ug/kg	.000	0	12	0	0	0
Endrin ketone	ug/kg	.000	0	12	0	0	0
Heptachlor	ug/kg	.000	0	12	0	0	0
Heptachlor epoxide	ug/kg	.000	0	12	0	0	0
Methoxychlor	ug/kg	.000	0	12	0	0	0
Toxaphene	ug/kg	.000	0	12	0	0	0
alpha-BHC	ug/kg	.000	0	12	0	0	0
alpha-Chlordane	ug/kg	.000	0	12	0	0	0
beta-BHC	ug/kg	.000	0	12	0	0	0
delta-BHC	ug/kg	.000	0	12	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	12	0	0	0
gamma-Chlordane	ug/kg	.000	0	12	0	0	0
<u>GENERAL CHEMISTRY</u>							
Total Organic Carbon	mg/kg	.000	6	6	7840	192011	6

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**TABLE 4-32**  
**INACTIVE FLYASH PILE**  
**SUBSOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>METALS</b>							
Aluminum	mg/kg	16277.291	22	22	2260	13900	0
Antimony	mg/kg	.000	2	14	2.1	5.5	2
Arsenic	mg/kg	9.704	22	22	3	81.8	10
Barium	mg/kg	121.064	22	22	8	1080	10
Beryllium	mg/kg	.620	19	22	.31	8.7	17
Cadmium	mg/kg	.910	10	22	.47	1.2	4
Calcium	mg/kg	150000.000	22	22	2990	219000	1
Chromium	mg/kg	20.953	22	22	3.6	34.8	3
Cobalt	mg/kg	15.929	22	22	3	18.2	1
Copper	mg/kg	20.230	21	22	7	258	13
Cyanide	mg/kg	.170	10	21	.13	.84	8
Iron	mg/kg	31188.164	22	22	3430	29800	0
Lead	mg/kg	15.780	22	22	3.3	400	7
Magnesium	mg/kg	43052.339	22	22	512	55900	3
Manganese	mg/kg	1045.407	22	22	23.1	1200	1
Mercury	mg/kg	.290	6	22	.17	1.3	4
Molybdenum	mg/kg	.270	14	22	.72	9.2	14
Nickel	mg/kg	34.747	22	22	8.1	82.3	3
Potassium	mg/kg	2007.519	22	22	474	2900	3
Selenium	mg/kg	.000	9	22	.98	11.1	9
Silicon	mg/kg	1069.496	22	22	474	1250	3
Silver	mg/kg	.000	8	22	.49	9.4	8
Sodium	mg/kg	227.947	22	22	73.4	663	8
Thallium	mg/kg	.490	6	22	.25	3.6	5
Vanadium	mg/kg	38.088	22	22	11.3	53.2	3
Zinc	mg/kg	73.158	20	22	17.7	383	3
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	5	24	.079	.55	5
GROSS ALPHA	pCi/g	.000	24	24	7.81	2030	24
GROSS BETA	pCi/g	.000	24	24	12.41	1810	24
NP-237	pCi/g	.000	20	20	.086	37.3	20
PU-238	pCi/g	.000	18	23	.031	1.85	18
PU-239/240	pCi/g	.000	16	23	.0348	1.77	16
RA-226	pCi/g	1.470	24	24	.56	42.3	15
RA-228	pCi/g	1.325	23	24	.34	3.04	14
RU-106	pCi/g	.000	0	24	0	0	0

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TABLE 4-32  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Maximum	Number of Detects Above Background
<b>RADIONUCLIDES (Continued)</b>							
SR-90	pCi/g	.560	3	24	.26	.86	1
TC-99	pCi/g	.000	0	24	0	0	0
TH-228	pCi/g	1.341	23	23	.308	3.08	11
TH-230	pCi/g	1.897	23	23	.874	121	15
TH-232	pCi/g	1.269	23	23	.264	2.65	12
TH-TOTAL	mg/kg	9.470	23	23	2.41	24.1	14
U-234	pCi/g	1.034	24	24	.49	1380	18
U-235/236	pCi/g	.142	24	24	.0303	68.8	15
U-238	pCi/g	1.122	24	24	.471	1570	18
U-TOTAL	mg/kg	2.540	24	24	2.62	3580	24
<b>VOLATILE ORGANICS</b>							
1,1,1-Trichloroethane	ug/kg	.000	10	30	1	920	10
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	27	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	29	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	30	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	30	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	30	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	30	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	29	0	0	0
2-Butanone	ug/kg	.000	1	30	3	3	1
2-Hexanone	ug/kg	.000	0	28	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	2	28	3	6	2
Acetone	ug/kg	.000	10	30	3	29	10
Benzene	ug/kg	.000	0	29	0	0	0
Bromodichloromethane	ug/kg	.000	0	29	0	0	0
Bromoform	ug/kg	.000	0	29	0	0	0
Bromomethane	ug/kg	.000	0	30	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	29	0	0	0
Carbon disulfide	ug/kg	.000	0	30	0	0	0
Chlorobenzene	ug/kg	.000	1	27	14	14	1
Chloroethane	ug/kg	.000	0	30	0	0	0
Chloroform	ug/kg	.000	0	30	0	0	0
Chloromethane	ug/kg	.000	1	30	52	52	1
Dibromochloromethane	ug/kg	.000	0	29	0	0	0
Ethylbenzene	ug/kg	.000	0	27	0	0	0
Methylene chloride	ug/kg	.000	6	30	53	180	6
Styrene	ug/kg	.000	0	27	0	0	0
Tetrachloroethene	ug/kg	.000	1	27	1	1	1
Toluene	ug/kg	.000	19	29	1	1800	19
Trichloroethene	ug/kg	.000	1	30	2	2	1
Vinyl Acetate	ug/kg	.000	0	22	0	0	0
Vinyl chloride	ug/kg	.000	0	30	0	0	0

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TABLE 4-32  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	27	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	29	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	29	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	31	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	31	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	31	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	31	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	31	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	31	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	31	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	31	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	31	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	31	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	31	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	3	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	31	0	0	0
2-Chlorophenol	ug/kg	.000	0	31	0	0	0
2-Methylnaphthalene	ug/kg	.000	1	31	74	74	1
2-Methylphenol	ug/kg	.000	0	31	0	0	0
2-Nitroaniline	ug/kg	.000	0	31	0	0	0
2-Nitrophenol	ug/kg	.000	0	31	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	31	0	0	0
3-Nitroaniline	ug/kg	.000	0	25	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	31	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	31	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	31	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	31	0	0	0
4-Methylphenol	ug/kg	.000	2	31	10	54	2
4-Nitroaniline	ug/kg	.000	0	28	0	0	0
4-Nitrophenol	ug/kg	.000	0	31	0	0	0
Acenaphthene	ug/kg	.000	0	31	0	0	0
Acenaphthylene	ug/kg	.000	0	31	0	0	0
Anthracene	ug/kg	.000	2	31	3	49	2
Benzo(a)anthracene	ug/kg	.000	4	31	8	130	4
Benzo(a)pyrene	ug/kg	.000	3	31	7	98	3
Benzo(b)fluoranthene	ug/kg	.000	3	31	5	140	3
Benzo(g,h,i)perylene	ug/kg	.000	3	31	4	59	3
Benzo(k)fluoranthene	ug/kg	.000	4	31	6	190	4
Benzoic acid	ug/kg	.000	0	14	0	0	0
Benzyl alcohol	ug/kg	.000	0	12	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	31	0	0	0

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TABLE 4-32  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Carbazole	ug/kg	.000	1	31	1	1	1
Chrysene	ug/kg	.000	4	31	8	150	4
Di-n-butyl phthalate	ug/kg	.000	4	31	43	110	4
Di-n-octyl phthalate	ug/kg	.000	0	31	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	1	31	2	2	1
Dibenzofuran	ug/kg	.000	0	31	0	0	0
Diethyl phthalate	ug/kg	.000	2	31	52	180	2
Dimethyl phthalate	ug/kg	.000	0	31	0	0	0
Fluoranthene	ug/kg	.000	4	31	16	340	4
Fluorene	ug/kg	.000	0	31	0	0	0
Hexachlorobenzene	ug/kg	.000	0	31	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	28	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	31	0	0	0
Hexachloroethane	ug/kg	.000	0	31	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	3	31	4	63	3
Isophorone	ug/kg	.000	1	31	4	4	1
N-Nitroso-di-n-propylamine	ug/kg	.000	0	31	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	31	0	0	0
Naphthalene	ug/kg	.000	1	31	81	81	1
Nitrobenzene	ug/kg	.000	0	31	0	0	0
Pentachlorophenol	ug/kg	.000	0	31	0	0	0
Phenanthrene	ug/kg	.000	5	31	10	280	5
Phenol	ug/kg	.000	1	31	2	2	1
Pyrene	ug/kg	.000	4	31	14	260	4
Tributyl phosphate	ug/kg	.000	2	3	2	200	2
bis(2-Chloroethoxy)methane	ug/kg	.000	0	31	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	31	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	31	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	22	31	2	2800	22
p-Chloroaniline	ug/kg	.000	0	31	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	30	0	0	0
4,4'-DDE	ug/kg	.000	0	30	0	0	0
4,4'-DDT	ug/kg	.000	0	30	0	0	0
Aldrin	ug/kg	.000	0	30	0	0	0
Aroclor-1016	ug/kg	.000	0	31	0	0	0
Aroclor-1221	ug/kg	.000	0	31	0	0	0
Aroclor-1232	ug/kg	.000	0	31	0	0	0
Aroclor-1242	ug/kg	.000	0	31	0	0	0
Aroclor-1248	ug/kg	.000	0	31	0	0	0
Aroclor-1254	ug/kg	.000	3	31	120	570	3

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TABLE 4-32  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Aroclor-1260	ug/kg	.000	0	31	0	0	0
Dieldrin	ug/kg	.000	0	30	0	0	0
Endosulfan II	ug/kg	.000	0	30	0	0	0
Endosulfan sulfate	ug/kg	.000	0	30	0	0	0
Endosulfan-I	ug/kg	.000	0	30	0	0	0
Endrin	ug/kg	.000	0	30	0	0	0
Endrin aldehyde	ug/kg	.000	0	30	0	0	0
Endrin ketone	ug/kg	.000	0	30	0	0	0
Heptachlor	ug/kg	.000	0	30	0	0	0
Heptachlor epoxide	ug/kg	.000	0	30	0	0	0
Methoxychlor	ug/kg	.000	0	30	0	0	0
Toxaphene	ug/kg	.000	0	31	0	0	0
alpha-BHC	ug/kg	.000	0	30	0	0	0
alpha-Chlordane	ug/kg	.000	1	30	3.3	3.3	1
beta-BHC	ug/kg	.000	0	30	0	0	0
delta-BHC	ug/kg	.000	0	30	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	30	0	0	0
gamma-Chlordane	ug/kg	.000	0	30	0	0	0

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Phase II metal samples detected elevated copper, lead, and mercury associated with a sludge material found at 19 to 24 feet depths beneath the flyash. These data indicate that the metals copper, cyanide, mercury, and thallium are possible indicators of waste derived metal contamination in the flyash.

Radionuclides detected above background concentrations in Phase I subsurface samples included the fission products cesium-137 (one sample), ruthenium-106 (one sample), strontium-90 (seven samples), and technetium-99 (two samples). This suggests that fission products were not a significant percentage of the waste material deposited at the Inactive Flyash Pile.

Uranium, thorium, and radium isotopes comprise the major part of the radionuclides detected above background in subsurface samples. Thorium and radium are closely correlated, while uranium does not appear to be closely correlated with thorium. The highest concentration of uranium was detected in samples from a sludge material detected at 20 to 24 foot depths near Hydropunch™ 11006. This depth corresponds to the original till surface and may be the surface upon which 1950s era waste material was deposited. Other samples from this depth detected total uranium; Borings Nos. 1710 (660 µg/g), 11051 (3580 µg/g), and 11052 (294 µg/g) and Hydropunch™ 11006 (1714 µg/g).

Soil boring data indicate that glacial overburden thins and does not extend beneath the far west and southern half of the Inactive Flyash Pile; therefore, waste/fill material sits directly on the Great Miami Aquifer. Concentrations of total uranium in samples collected at the interface of the flyash/fill and underlying till detected the following elevated levels: 873 µg/g (1791 at 27 to 28.5 feet), 68.2 µg/g (1708 at 30 to 31.5 feet), and 50.7 µg/g (1994 at 26 to 27.5 feet). These data indicate that the Inactive Flyash Pile is potentially a source for the uranium contamination in the regional aquifer.

Data for organic compounds detected above background in subsurface soil are provided in Table E-2C in Appendix E and are presented on Figure 4-15 (see Volume 2, Oversized Figures). The most common volatile organic compound detected in Phase I samples was TCA which was detected in 9 of 16 samples throughout the Inactive Flyash Pile and at variable depths. The most common semi-volatile compound was 2-methylnaphthalene, which was detected in 4 of 16 samples. Phase II samples detected TCA in 10 of 30 samples and also detected acetone (10 samples) and toluene (19 samples). Bis(2-Ethylhexyl) phthalate was the most common semivolatile compound and was detected in 22 of 30 samples; 2-methylnaphthalene was detected once in 30 samples.

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Organic compounds detected in subsurface samples from the Inactive Flyash Pile were predominantly semivolatile compounds detected in samples collected from the till/flyash interface in Borings Nos. 11006 and 11051. These sample locations correlate to the highest uranium concentrations in waste samples found in the Inactive Flyash Pile and are related to the sludge like material observed in these borings. The sludge like material was only observed in these two borings and appears to be a very localized material. The pervasive character of trace organic contamination detected elsewhere suggests that the organics within the flyash originated in liquid form and that it was sprayed upon the Inactive Flyash Pile. Aroclor-1254 was detected in five locations in subsurface samples in the Inactive Flyash Pile: at Borings Nos. 1995 (2 feet deep), 1710 (28.5 feet deep), 1711 (18.5 feet deep), 11006 (22.5 feet deep), and 11051 (22 feet deep). Aroclor was detected in trace concentrations and in combination with other organic compounds, suggesting that the PCB was in a mixture when it was disposed of.

Six samples were collected to complete waste characteristic determination TCLP, and the results are presented Table 4-33. No analyses detected concentrations that exceeded the RCRA standard for hazardous waste. Detection limits for heptachlor epoxide exceeded the TCLP regulatory limit; however, this compound was not detected above background in direct analysis of 30 soil samples.

Waste materials were identified from samples collected from four borings in the Inactive Flyash Pile. A summary of selected constituents detected above soil background is presented in Table 4-34 along with background concentrations for soil and flyash. The determination of flyash background concentrations was discussed in Section 4.1.4. The concentration of metals appears elevated in comparison to background soil concentrations. The elevated concentrations of these materials may be due to its association/contact with process material/waste.

Phase I and Phase II subsurface soil data were compared to CIS and ES data (Appendices E-7 and E-8). Analytes detected in these preliminary studies were also detected in Phase I and Phase II and within the same order of magnitude.

A comparison of metals, radionuclides, and organic compounds detected in surface and subsurface soil indicates the following:

- Subsurface concentrations of metals are consistent with background flyash, except for samples collected of visible waste sludge material.

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**TABLE 4-33**  
**CHARACTERISTICS OF WASTE MATERIAL**  
**DETECTED AT THE TILL/FLYASH INTERFACE, INACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Location and Description	Depth Below Ground (ft.)	Copper mg/kg	Lead mg/kg	Nickel mg/kg	Silver mg/kg	Zinc mg/kg	Arsenic mg/kg	Chromium mg/kg	Radium-226 pCi/g	Thorium Total µg/g	Uranium-238 pCi/g	Uranium Total µg/g
Soil Background		20.23	15.78	34.747	0	73.158	9.704	20.953	1.47	9.47	1.122	2.54
Flyash Background		178.88	83.83	89.43	2.34	260.08	61.39	60.36	NA <sup>a</sup>	165	3.13	19
11006, Clayey Sludge (113492)	22.5-24	249	96.6	82.3	8.1	383	6.7	34.8	9.74	10.3	803	1714
11051 (116438) at flyash/till interface	21-22	ANA <sup>c</sup>	ANA	ANA	ANA	ANA	ANA	ANA	37.8	23.1	1570	3580
11051 (116441) at flyash/till interface	22-24	258	400	65.1	9.4	372	49.7	32.1	42.3	16.1	763	2280
11052 (116427) in clay material above Great Miami Aquifer	19-21	92.3	193	54.4	7.9	324	35.5	22	4.06	12.3	115.8	294

<sup>a</sup>NA means data are not available

<sup>b</sup>ND means not detected above background concentrations

<sup>c</sup>ANA means analyte not analyzed

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**TABLE 4-34**  
**INACTIVE FLYASH PILE TCLP RESULTS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)					
			1994	1995	1996	1997	1998	1998
			116295	116114	112081	116216	116074	116075
Arsenic	5.0	1.5	<0.05	rejected	rejected	<0.0633	<0.05	<sup>a</sup>
Barium	100.0	30.0	0.85	<0.913	1.48	1.58	1.07	-
Benzene	0.5		<0.005	<0.005	<0.005	<0.005	-	<0.005
Cadmium	1.0	0.3	<0.005	<0.0021	<0.0021	<0.0021	<0.005	-
Carbon Tetrachloride	0.5		<0.005	<0.005	<0.005	<0.005	-	<0.005
Chlordane	0.03		<0.0005	<0.0014	<0.0014	<0.0014	<0.0005	-
Chlorobenzene	100.0		<0.005	<0.005	<0.005	<0.005	-	<0.005
Chloroform	6.0		<0.005	<0.005	<0.005	<0.005	-	<0.005
Chromium	5.0	1.5	<0.01	<0.0031	<0.0031	<0.0031	<0.01	-
Copper			<0.01	0.002	0.0029	<0.0017	<0.01	-
2,4-D	10.0		<0.01	<0.12	<0.12	<0.12	<0.01	-
1,4-Dichlorobenzene	7.5		<0.02	<0.05	<0.05	<0.05	<0.02	-
1,2-Dichloroethane	0.5		<0.005	<0.005	<0.005	<0.005	-	<0.005
1,1-Dichloroethene	0.7		<0.005	<0.005	<0.005	<0.005	-	<0.005
2,4-Dinitrotoluene	0.13		<0.02	<0.05	<0.05	<0.05	<0.02	-
Endrin	0.02		<0.0001	<0.0006	<0.0006	<0.0006	<0.0001	-
Heptachlor	0.008		<0.0001	<0.0003	<0.0003	<0.0003	<0.0001	-

See footnotes at end of table

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TABLE 4-34  
(Continued)

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)					
			1994	1995	1996	1997	1998	1998
			116295	116114	112081	116216	116074	116075
Heptachlor epoxide	0.008		<0.0001	<0.0083	<0.0083	<0.0083	<0.0001	-
Hexachlorobenzene	0.13		<0.02	<0.05	<0.05	<0.05	<0.02	-
Hexachlorobutadiene	0.5		<0.02	<0.05	<0.05	<0.05	<0.02	-
Hexachloroethane	3.0		<0.02	<0.05	<0.05	<0.05	<0.02	-
Iron			<0.109	0.114	0.007	<0.0158	1.21	-
Lead	5.0	1.5	<0.04	<0.0155	<0.0155	<0.0155	<0.04	-
Lindane	0.4		<0.0001	<0.0004	<0.0004	<0.0004	<0.0001	-
Manganese			<0.102	0.0946	0.105	0.0974	0.432	-
Mercury	0.2	0.06	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	-
Methoxychlor	10.0		<0.0005	<0.018	<0.018	<0.018	<0.0005	-
Nitrobenzene	2.0		<0.02	<0.05	<0.05	<0.05	<0.02	-
Pentachlorophenol	100.0		<0.1	<0.25	<0.25	<0.25	<0.1	-
Pyridine	5.0		<0.2	<0.25	<0.25	<0.25	<0.2	-
Selenium	1.0	0.3	<0.08	rejected	rejected	0.0935	<0.08	-
Silver	5.0		rejected	<0.0022	<0.0022	<0.0022	<0.01	-
Tetrachloroethene	0.7		<0.005	<0.005	<0.005	<0.005	-	<0.005
Toxaphene	0.5		<0.001	<0.024	<0.024	<0.024	<0.001	-
2,4,5-TP (Silvex)	1.0		<0.0018	<0.017	<0.017	<0.017	<0.0018	-
Trichloroethene	0.5		<0.005	<0.005	<0.005	<0.005	-	<0.005
2,4,5-Trichlorophenol	400.0		<0.1	<0.05	<0.05	<0.05	<0.1	-

See footnotes at end of table

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TABLE 4-34  
(Continued)

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)					
			1994	1995	1996	1997	1998	
			116295	116114	112081	116216	116074	116075
2,4,6-Trichlorophenol	2.0		<0.02	<0.05	<0.05	<0.05	<0.02	-
Vinyl chloride	0.2		<0.01	<0.01	<0.01	<0.01	-	<0.01
Zinc			<0.0757	rejected	rejected	rejected	<0.207	-

Note: A box surrounding a number indicates a result or detection limit that is above and EPA or OEPA standard.

<sup>a</sup>The sample was not analyzed for the parameter.

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- Concentrations of organic compounds and radionuclides are significantly higher in subsurface samples. This indicates that surface spillage and leaching is not responsible for observed concentrations, and that past disposal practices are.
- There does not appear to be a single distribution pattern for analytes that defines a boundary of disposal activity on the surface or subsurface.
- When the determination could be made between samples collected in pure flyash and samples taken in fill, it was generally noticed that the flyash samples had lower constituent concentrations than the fill samples.

#### 4.4.3 Surface Water and Sediment

There are no perennial sources of surface water within the battery limits of the Inactive Flyash Pile, so surface water was not present at several of the proposed drainage sampling locations. Surface water samples were collected on an "as-possible" basis after rainstorms. Drainage within a channel at the west side of the flyash pile was observed to flow for several days after significant rain events, and samples were collected at multiple locations to characterize seeps from the Inactive Flyash Pile.

A summary of detected analytes and radionuclides in surface water is provided in Appendix E in Table E-2D and Table E-2E. A summary of the analytes is provided in Table 4-35 and Table 4-36. Locations that were sampled during Phase II field sampling programs are shown on Figure 4-16 (see Volume 2, Oversized Figures). Chemical and radiological analytical results for surface water were not compared to background concentrations since none are developed for surface water. One surface water sample was collected during Phase I at an upstream location in the west drainage channel. Sixteen metals, isotopes of one element (40  $\mu\text{g/L}$  total uranium were detected) and no organic compounds were detected. Metals included cadmium, chromium, lead, mercury, nickel, silver, and vanadium. These metals were also detected in soil samples from the Inactive Flyash Pile. Thirteen metals (Arsenic, Cyanide, Selenium, and Zinc were not detected during Phase I; Cadmium, Chromium, Lead, Mercury, Nickel, Silver, and Vanadium were detected for Phase I but not Phase II), and isotopes of five elements (neptunium-237, plutonium-238, plutonium-239/240, radium-226, thorium-228, thorium-230, and uranium-235/236 were not detected for Phase I), and two organic compounds [toluene at 2  $\mu\text{g/L}$  and bis(2-ethylhexyl)phthalate at 1  $\mu\text{g/L}$ ] were detected in six surface water samples collected during Phase II from the Inactive Flyash Pile. Metals that were detected in surface water samples collected during Phase II from the drainage include arsenic, cyanide, selenium, and zinc. Phase II analyses did not detect the following analytes detected during

**TABLE 4-35**  
**INACTIVE FLYASH PILE**  
**SURFACE WATER\***  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>METALS</u>								
Aluminum		mg/L	.000	1	2	.0764	.0764	1
Antimony		mg/L	.000	0	0	0	0	0
Arsenic		mg/L	.000	0	3	0	0	0
Barium		mg/L	.000	3	3	.0267	.047	3
Beryllium		mg/L	.000	0	0	0	0	0
Cadmium		mg/L	.000	2	3	.0016	.003	2
Calcium		mg/L	.000	3	3	38.3	86.9	3
Chromium		mg/L	.000	1	3	.026	.026	1
Cobalt		mg/L	.000	0	0	0	0	0
Copper		mg/L	.000	0	3	0	0	0
Iron		mg/L	.000	3	3	.024	.284	3
Lead		mg/L	.000	3	3	.006	.0093	3
Magnesium		mg/L	.000	3	3	10.1	20.9	3
Manganese		mg/L	.000	3	3	.009	.0462	3
Mercury		mg/L	.000	2	3	.0003	.0008	2
Molybdenum		mg/L	.000	0	3	0	0	0
Nickel		mg/L	.000	2	3	.008	.025	2
Potassium		mg/L	.000	3	3	1.68	3.03	3
Selenium		mg/L	.000	0	3	0	0	0
Silicon		mg/L	.000	2	2	2.25	4.61	2
Silver		mg/L	.000	1	3	.013	.013	1
Sodium		mg/L	.000	3	3	1.99	9.75	3
Thallium		mg/L	.000	0	0	0	0	0
Vanadium		mg/L	.000	1	2	.013	.013	1
Zinc		mg/L	.000	0	0	0	0	0

See footnote at end of table

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TABLE 4-35  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>RADIONUCLIDES</u>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	0	0	0	0
GROSS BETA	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	2	0	0	0
PU-238	UNFL	pCi/L	.000	0	2	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	2	0	0	0
RA-226	UNFL	pCi/L	.000	0	2	0	0	0
RA-228	UNFL	pCi/L	.000	0	3	0	0	0
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	2	0	0	0
TC-99	UNFL	pCi/L	.000	0	2	0	0	0
TH-228	UNFL	pCi/L	.000	0	2	0	0	0
TH-230	UNFL	pCi/L	.000	0	2	0	0	0
TH-232	UNFL	pCi/L	.000	0	2	0	0	0
TH-TOTAL	UNFL	ug/L	.000	0	1	0	0	0
U-234	UNFL	pCi/L	.000	2	2	2.5	5	2
U-235/236	UNFL	pCi/L	.000	0	2	0	0	0
U-238	UNFL	pCi/L	.000	2	2	2.6	6.8	2
U-TOTAL	UNFL	ug/L	.000	2	2	9	40	2
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	0	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	0	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	0	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	0	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	0	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	0	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	0	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	0	0	0	0
2-Butanone	UNFL	ug/L	.000	0	0	0	0	0

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See footnote at end of table

TABLE 4-35  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
2-Hexanone	UNFL	ug/L	.000	0	0	0 0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	0	0 0	0
Acetone	UNFL	ug/L	.000	0	0	0 0	0
Benzene	UNFL	ug/L	.000	0	0	0 0	0
Bromodichloromethane	UNFL	ug/L	.000	0	0	0 0	0
Bromoform	UNFL	ug/L	.000	0	0	0 0	0
Bromomethane	UNFL	ug/L	.000	0	0	0 0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	0	0 0	0
Carbon disulfide	UNFL	ug/L	.000	0	0	0 0	0
Chlorobenzene	UNFL	ug/L	.000	0	0	0 0	0
Chloroethane	UNFL	ug/L	.000	0	0	0 0	0
Chloroform	UNFL	ug/L	.000	0	0	0 0	0
Chloromethane	UNFL	ug/L	.000	0	0	0 0	0
Dibromochloromethane	UNFL	ug/L	.000	0	0	0 0	0
Ethylbenzene	UNFL	ug/L	.000	0	0	0 0	0
Methylene chloride	UNFL	ug/L	.000	0	0	0 0	0
Styrene	UNFL	ug/L	.000	0	0	0 0	0
Tetrachloroethene	UNFL	ug/L	.000	0	0	0 0	0
Toluene	UNFL	ug/L	.000	0	0	0 0	0
Trichloroethene	UNFL	ug/L	.000	0	0	0 0	0
Vinyl Acetate	UNFL	ug/L	.000	0	0	0 0	0
Vinyl chloride	UNFL	ug/L	.000	0	0	0 0	0
Xylenes, Total	UNFL	ug/L	.000	0	0	0 0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	0	0 0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	0	0 0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	0	0 0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	0	0 0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	0	0 0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	0	0 0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	0	0 0	0

See footnote at end of table

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TABLE 4-35  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	0 0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	0 0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	0 0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	0 0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	0 0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	0 0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	0 0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	0 0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	0 0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	0 0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	0 0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	0 0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	0 0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	0 0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	0 0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	0 0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	0 0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	0 0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	0 0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	0 0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	0 0	0	0
Acenaphthene	UNFL	ug/L	.000	0	0 0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	0 0	0	0
Anthracene	UNFL	ug/L	.000	0	0 0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	0 0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	0 0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	0 0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	0 0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	0 0	0	0
Benzoic acid	UNFL	ug/L	.000	0	0 0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	0 0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	0 0	0	0

See footnote at end of table

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TABLE 4-35  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Chrysene	UNFL	ug/L	.000	0	0 0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	0 0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	0 0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	0 0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	0 0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	0 0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	0 0	0	0
Fluoranthene	UNFL	ug/L	.000	0	0 0	0	0
Fluorene	UNFL	ug/L	.000	0	0 0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	0 0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	0 0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	0 0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	0 0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	0 0	0	0
Isophorone	UNFL	ug/L	.000	0	0 0	0	0
Methyl parathion	UNFL	ug/L	.000	0	1 0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	0 0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	0 0	0	0
Naphthalene	UNFL	ug/L	.000	0	0 0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	0 0	0	0
Parathion	UNFL	ug/L	.000	0	1 0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	0 0	0	0
Phenanthrene	UNFL	ug/L	.000	0	0 0	0	0
Phenol	UNFL	ug/L	.000	0	0 0	0	0
Pyrene	UNFL	ug/L	.000	0	0 0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	0 0	0	0
bis(2-Chloroethyl) ether	UNFL	ug/L	.000	0	0 0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	0 0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	0 0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	0 0	0	0

See footnote at end of table

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**TABLE 4-35  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	UNFL	ug/L	.000	0	0	0 0	0
4,4'-DDE	UNFL	ug/L	.000	0	0	0 0	0
4,4'-DDT	UNFL	ug/L	.000	0	0	0 0	0
Aldrin	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1016	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1221	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1232	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1242	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1248	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1254	UNFL	ug/L	.000	0	0	0 0	0
Aroclor-1260	UNFL	ug/L	.000	0	0	0 0	0
Dieldrin	UNFL	ug/L	.000	0	0	0 0	0
Endosulfan II	UNFL	ug/L	.000	0	0	0 0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	0	0 0	0
Endosulfan-I	UNFL	ug/L	.000	0	0	0 0	0
Endrin	UNFL	ug/L	.000	0	0	0 0	0
Endrin ketone	UNFL	ug/L	.000	0	0	0 0	0
Heptachlor	UNFL	ug/L	.000	0	0	0 0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	0	0 0	0
Methoxychlor	UNFL	ug/L	.000	0	0	0 0	0
Toxaphene	UNFL	ug/L	.000	0	0	0 0	0
alpha-BHC	UNFL	ug/L	.000	0	0	0 0	0
alpha-Chlordane	UNFL	ug/L	.000	0	0	0 0	0
beta-BHC	UNFL	ug/L	.000	0	0	0 0	0
delta-BHC	UNFL	ug/L	.000	0	0	0 0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	0	0 0	0
gamma-Chlordane	UNFL	ug/L	.000	0	0	0 0	0
Azinphosmethyl	UNFL	ug/L	.000	0	1	0 0	0
Demeton	UNFL	ug/L	.000	0	1	0 0	0
Diazinon	UNFL	ug/L	.000	0	1	0 0	0
Disulfoton	UNFL	ug/L	.000	0	1	0 0	0

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See footnote at end of table

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TABLE 4-35  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>PESTICIDES/PCBs (Continued)</u>								
Ethion	UNFL	ug/L	.000	0	1	0	0	0
Malathion	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	.000	2	4	.1626	.452	2
Chloride	UNFL	mg/L	.000	4	4	3.5	19.99	4
Fluoride	UNFL	mg/L	.000	4	4	.18	.3	4
Nitrate	UNFL	mg/L	.000	4	4	.14	12.1	4
Phenols	UNFL	mg/L	.000	1	4	.02	.02	0
Phosphorus	UNFL	mg/L	.000	3	4	.17	.842	3
Sulfate	UNFL	mg/L	.000	3	3	37	57.36	3
Sulfide	UNFL	mg/L	.000	0	1	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	3	3	.347	1.81	3
Total Organic Carbon	UNFL	mg/L	.000	1	2	5.59	5.59	1
Total Organic Halides	UNFL	mg/L	.000	2	3	.01	.0159	2
Total Organic Nitrogen	UNFL	mg/L	.000	4	4	.347	1.36	4

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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HEMP-OU02-4 DRAFT  
February 18, 1994

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**TABLE 4-36**  
**INACTIVE FLYASH PILE**  
**SURFACE WATER\***  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.000	4	6	.0478	.131	4
Antimony		mg/L	.000	0	6	0	0	0
Arsenic		mg/L	.000	1	6	.0014	.0014	1
Barium		mg/L	.000	6	6	.0366	.0661	6
Beryllium		mg/L	.000	0	6	0	0	0
Cadmium		mg/L	.000	0	6	0	0	0
Calcium		mg/L	.000	6	6	82.6	132	6
Chromium		mg/L	.000	0	6	0	0	0
Cobalt		mg/L	.000	0	6	0	0	0
Copper		mg/L	.000	0	6	0	0	0
Cyanide		mg/L	.000	2	4	.001	.0038	2
Iron		mg/L	.000	1	6	.0729	.0729	1
Lead		mg/L	.000	0	6	0	0	0
Magnesium		mg/L	.000	6	6	22.7	45.7	6
Manganese		mg/L	.000	6	6	.0128	.0286	6
Mercury		mg/L	.000	0	6	0	0	0
Molybdenum		mg/L	.000	0	6	0	0	0
Nickel		mg/L	.000	0	6	0	0	0
Potassium		mg/L	.000	6	6	1.74	1.93	6
Selenium		mg/L	.000	1	6	.004	.004	1
Silicon		mg/L	.000	6	6	1.08	7.04	6
Silver		mg/L	.000	0	6	0	0	0
Sodium		mg/L	.000	6	6	2.72	12.8	6
Thallium		mg/L	.000	0	6	0	0	0
Vanadium		mg/L	.000	0	6	0	0	0
Zinc		mg/L	.000	1	6	.0149	.0149	1
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	6	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	2	6	72.9	426	2
GROSS BETA	UNFL	pCi/L	.000	3	6	8.56	172	3
NP-237	UNFL	pCi/L	.000	2	4	.435	.79	2
PU-238	UNFL	pCi/L	.000	2	6	.17	2.91	2
PU-239/240	UNFL	pCi/L	.000	3	6	.2	.266	3

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See footnote at end of table

TABLE 4-36  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-226	UNFL	pCi/L	.000	1	6	.148	.148	1
RA-228	UNFL	pCi/L	.000	0	6	0	0	0
RU-106	UNFL	pCi/L	.000	0	6	0	0	0
SR-90	UNFL	pCi/L	.000	0	6	0	0	0
TC-99	UNFL	pCi/L	.000	0	6	0	0	0
TH-228	UNFL	pCi/L	.000	1	6	.027	.027	1
TH-230	UNFL	pCi/L	.000	5	6	.26	.653	5
TH-232	UNFL	pCi/L	.000	0	6	0	0	0
TH-TOTAL	UNFL	ug/L	.000	0	6	0	0	0
U-234	UNFL	pCi/L	.000	6	6	1.42	265	6
U-235/236	UNFL	pCi/L	.000	3	6	.16	14	3
U-238	UNFL	pCi/L	.000	6	6	1.74	257	6
U-TOTAL	UNFL	ug/L	.000	6	6	4.57	820	6
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	6	0	0	0
2-Butanone	UNFL	ug/L	.000	0	6	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	6	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	6	0	0	0
Acetone	UNFL	ug/L	.000	0	6	0	0	0
Benzene	UNFL	ug/L	.000	0	6	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	6	0	0	0
Bromoform	UNFL	ug/L	.000	0	6	0	0	0
Bromomethane	UNFL	ug/L	.000	0	6	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	6	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	6	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
Chloroethane	UNFL	ug/L	.000	0	6	0	0	0
Chloroform	UNFL	ug/L	.000	0	6	0	0	0
Chloromethane	UNFL	ug/L	.000	0	6	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	6	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-36  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Methylene chloride	UNFL	ug/L	.000	0	6	0	0	0
Styrene	UNFL	ug/L	.000	0	6	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	6	0	0	0
Toluene	UNFL	ug/L	.000	1	6	2	2	1
Trichloroethene	UNFL	ug/L	.000	0	6	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	6	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	6	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	6	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	6	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	6	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	6	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	6	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	6	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	6	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	3	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	6	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	6	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	6	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	6	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	6	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	6	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	6	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	6	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	6	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	6	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	6	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-36  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
4-Nitroaniline	UNFL	ug/L	.000	0	6	0 0	0
4-Nitrophenol	UNFL	ug/L	.000	0	4	0 0	0
Acenaphthene	UNFL	ug/L	.000	0	6	0 0	0
Acenaphthylene	UNFL	ug/L	.000	0	6	0 0	0
Anthracene	UNFL	ug/L	.000	0	6	0 0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	6	0 0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	6	0 0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	6	0 0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	6	0 0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	6	0 0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0 0	0
Benzyl alcohol	UNFL	ug/L	.000	0	6	0 0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	6	0 0	0
Carbazole	UNFL	ug/L	.000	0	6	0 0	0
Chrysene	UNFL	ug/L	.000	0	6	0 0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	6	0 0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	4	0 0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	6	0 0	0
Dibenzofuran	UNFL	ug/L	.000	0	6	0 0	0
Diethyl phthalate	UNFL	ug/L	.000	0	6	0 0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	6	0 0	0
Fluoranthene	UNFL	ug/L	.000	0	6	0 0	0
Fluorene	UNFL	ug/L	.000	0	6	0 0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	6	0 0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	6	0 0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	6	0 0	0
Hexachloroethane	UNFL	ug/L	.000	0	6	0 0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	6	0 0	0
Isophorone	UNFL	ug/L	.000	0	6	0 0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	6	0 0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	3	0 0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	6	0 0	0
Naphthalene	UNFL	ug/L	.000	0	6	0 0	0
Nitrobenzene	UNFL	ug/L	.000	0	6	0 0	0
Pentachlorophenol	UNFL	ug/L	.000	0	6	0 0	0
Phenanthrene	UNFL	ug/L	.000	0	6	0 0	0
Phenol	UNFL	ug/L	.000	0	6	0 0	0
Pyrene	UNFL	ug/L	.000	0	6	0 0	0
Tributyl phosphate	UNFL	ug/L	.000	0	3	0 0	0

See footnote at end of table

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**TABLE 4-36**  
**(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	6	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	6	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	6	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	1	6	1	1	1
p-Chloroaniline	UNFL	ug/L	.000	0	6	0	0	0
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	6	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	6	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	6	0	0	0
Aldrin	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	6	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	6	0	0	0
Dieldrin	UNFL	ug/L	.000	0	6	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	6	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	6	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	6	0	0	0
Endrin	UNFL	ug/L	.000	0	6	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	6	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	6	0	0	0
Heptachlor	UNFL	ug/L	.000	0	6	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	6	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	6	0	0	0
Toxaphene	UNFL	ug/L	.000	0	6	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	6	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	6	0	0	0
beta-BHC	UNFL	ug/L	.000	0	6	0	0	0
delta-BHC	UNFL	ug/L	.000	0	6	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	6	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	6	0	0	0

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See footnote at end of table

TABLE 4-36  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	6	6	195	395	0
Ammonia	UNFL	mg/L	.000	1	5	.13	.13	1
Chloride	UNFL	mg/L	.000	6	6	2.33	25.72	6
Fluoride	UNFL	mg/L	.000	6	6	.19	.39	6
Nitrate	UNFL	mg/L	.000	3	3	.14	1.64	3
Phenols	UNFL	mg/L	.000	0	6	0	0	0
Phosphorus	UNFL	mg/L	.000	2	2	.05	.06	2
Sulfate	UNFL	mg/L	.000	6	6	62.9	133.9	6
Sulfide	UNFL	mg/L	.000	1	6	.57	.57	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	6	6	.18	.9	6
Total Organic Carbon	UNFL	mg/L	.000	6	6	1.98	5.77	6
Total Organic Halides	UNFL	mg/L	.000	1	6	.0106	.0106	1
Total Organic Nitrogen	UNFL	mg/L	.000	5	6	.18	.77	5
Total Phosphorous	UNFL	mg/L	.000	4	4	.03	.2	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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Phase I: chromium, cadmium, lead, mercury, nickel, silver, or vanadium. The CIS and ES sampling programs did not include surface water sampling around the Inactive Flyash Pile.

Total uranium analyses of surface water in the west drainage were used to define the location of possible springs or seeps contributing to drainage from the Inactive Flyash Pile. Data presented in Figure 4-16 suggest that seepage from the west edge of the Inactive Flyash Pile is surfacing in the drainage in at least one location. Total uranium analyses of surface water samples that were collected to locate seeps below the Inactive Flyash Pile are summarized in Table 4-37. One location of observed seepage was sampled at IFP-SW-11 on May 18, 1993, and detected 820 µg/L total uranium. Upstream and downstream concentrations were 23 µg/L (IFP-SW-06) and 910 µg/L (IFP-SW-05), respectively on May 2, 1993. Surface water drainage was traced downstream to where it drained through the bottom of a sandy stream channel. Total uranium in a sample collected slightly upstream of this location was 370 µg/L (IFP-SW-12) on May 18, 1993. Field observations, therefore, indicate that recharge to the regional aquifer occurs by surface water from the west drainage. Analytical data indicate that the recharge water has elevated concentrations of uranium.

Two sediment samples collected during Phase I detected five metals and total uranium in two samples; no organic compounds were detected. Three Phase II sediment samples were collected at the same time and location as surface water samples but at different locations than for Phase I. Analytical data for sediment samples is provided in Appendix E in Table E-2F and Table E-2G. A summary of the analytes is provided in Table 4-38 and Table 4-39. During Phase II four metals (Beryllium was not detected for Phase I; Cadmium and Chromium were detected for Phase I but not Phase II), isotopes of four elements (neptunium-237, plutonium-238, plutonium-239/240, Strontium-90, uranium-234, and uranium-238 were not detected for Phase I), and twenty one organic compounds were detected above background. Beryllium was detected at 1.3 mg/kg, and toluene and acetone were detected in samples from Paddys Run. Five semivolatile organic compounds were detected at trace concentrations in the west drainage. These were detected in the down stream sediment sample from Paddys Run. Four compounds detected in the west drainage and in the downstream sediment sample were not detected in the upstream Paddys Run sample. This fact suggests that the drainage has contributed sediment contaminated with semivolatile organic compounds to Paddys Run.

All of the semivolatile organic compounds, except benzoic acid, that were detected in the upstream Paddys Run sediment sample were detected in the downstream sample. However, an additional nine

**TABLE 4-37**  
**INACTIVE FLYASH PILE**  
**SUMMARY OF DETECTED ANALYTES IN PHASE II**  
**SURFACE WATER AND SEDIMENT SAMPLES**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

**OFF-SITE ANALYSES OF SEDIMENT AND SURFACE WATER**

Location	Description	Sample Number	Collection Date	Analyses					
				Uranium-238	Total-Uranium	Pyrene	bis (2-Ethylhexyl phthalate)	Chrysene	Fluoranthene
IFP-SW-02 IFP-SW-02	West drainage Surface Water	111828 112022	4-26-93 4-30-93	59.7 pCi/L 257 pCi/L	165 µg/L 820 µg/L	ND	ND	ND	ND
IFP-SD-02 IFP-SD-02	Sediment from above location	111812 112021	4-17-93 4-30-93	1.68 pCi/g	12 µg/g 12.3 µg/g		593 µg/g 1200 µg/g		
IFP-SW-03 IFP-SW-03	Paddys Run upstream of West drainage Surface Water	111819 112027	4-21-93 5-01-93	1.74 pCi/L 2.13 pCi/L	5.25 µg/L 5.03 µg/L	ND	ND	ND	ND
IFP-SD-03 IFP-SD-03	Sediment	111813 116219	4-17-93 5-01-93	0.9 pCi/g	4.09 µg/g	47 µg/g	51 µg/g 2200 µg/g		66 µg/g
IFP-SW-04 IFP-SW-04	Paddys Run downstream of West drainage Surface Water	11820 112015	4-21-93 4-29-93	2.26 pCi/L 1.84 pCi/L	5.87 µg/L 4.57 µg/L	ND	ND	ND	ND
IFP-SD-04	Sediment	111815 112017	4-17-93 4-29-93	ND ND	ND 9.9 µg/g	100 µg/g	70 µg/g 700 µg/g	61 µg/g	120 µg/g

**ON-SITE ANALYSES OF TOTAL URANIUM IN SEEPS AND DRAINAGES**

Location	Description	Surface Water Sample Number	Collection Date	Total Uranium µg/L
IFP-SW-02	Collected below seep area (medium flow)	111829	4-26-93	160
IFP-SW-02	Collected below seep (low flow)	112024	4-30-93	830
IFP-SW-03	Collected from Paddys Run upstream of confluence with drainage	111824	4-21-93	6
IFP-SW-03	Collected from Paddys Run upstream of confluence with drainage	112026	5-01-93	5.5
IFP-SW-04	Collected from Paddys Run downstream of confluence with drainage	111822	4-21-93	6
IFP-SW-04	Collected from Paddys Run upstream of confluence with drainage	112019	4-29-93	5
IFP-SW-05	Collected downstream of seep (low flow)	112029	5-02-93	910
IFP-SW-06	Upstream of possible seep from East bank of drainage	112030	5-02-93	23
IFP-SW-06	Upstream of possible seep from East bank of drainage	112031	5-02-93	23
IFP-SW-07	At confluence of North road drainage channel and the East drainage	112032	5-02-93	20
IFP-SW-08	Farthest upstream, collected just below drain culvert under North access road	112033	5-02-93	11
IFP-SW-09	Collected from upstream of seep in drainage channel	112034	5-03-93	81
IFP-SW-10	Collected from mixing zone in drainage adjacent to seep	113491	5-07-93	280
IFP-SW-11	Collected at seep into drainage after recession in drainage after heavy rain	116459	5-18-93	820
IFP-SW-12	Collected at confluence of drainage and Paddys Run above sand unit where drainage recharges to the GMA	116460	5-18-93	370

\*Note: Sample locations shown on Figure 4-17.  
ND = Not detected

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**TABLE 4-38**  
**INACTIVE FLYASH PILE**  
**SEDIMENT**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	1	1	2080	2080	0
Antimony	mg/kg	.000	0		0	0	0
Arsenic	mg/kg	11.608	1	1	2.7	2.7	0
Barium	mg/kg	88.500	1	1	21	21	0
Beryllium	mg/kg	.600	1	1	.5	.5	0
Cadmium	mg/kg	.770	1	1	4.5	4.5	1
Calcium	mg/kg	5296.781	1	1	110000	110000	1
Chromium	mg/kg	17.057	1	1	17.4	17.4	1
Cobalt	mg/kg	16.913	1	1	4.7	4.7	0
Copper	mg/kg	15.700	1	1	11.7	11.7	0
Cyanide	mg/kg	.230	0	1	0	0	0
Iron	mg/kg	24788.749	1	1	5940	5940	0
Lead	mg/kg	29.575	0		0	0	0
Magnesium	mg/kg	1460.000	1	1	26600	26600	1
Manganese	mg/kg	2257.945	1	1	362	362	0
Mercury	mg/kg	.300	0	1	0	0	0
Molybdenum	mg/kg	.000	0	1	0	0	0
Nickel	mg/kg	25.145	1	1	16.4	16.4	0
Potassium	mg/kg	1349.530	1	1	366	366	0
Selenium	mg/kg	.720	0	1	0	0	0
Silver	mg/kg	.000	0	1	0	0	0
Sodium	mg/kg	55.145	1	1	188	188	1
Thallium	mg/kg	.580	0	1	0	0	0
Vanadium	mg/kg	33.693	1	1	13.7	13.7	0
Zinc	mg/kg	58.500	1	1	13.4	13.4	0
<b>RADIONUCLIDES</b>							
GROSS ALPHA	pCi/g	.000	0		0	0	0
GROSS BETA	pCi/g	.000	0		0	0	0
RA-226	pCi/g	1.528	5	5	.4	.885	0
RA-228	pCi/g	1.170	2	5	.69	.901	0
U-TOTAL	mg/kg	3.240	4	5	1	13.9	2
<b>VOLATILE ORGANICS</b>							
1,1,1-Trichloroethane	ug/kg	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	1	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	1	0	0	0

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TABLE 4-38  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
1,1-Dichloroethane	ug/kg	.000	0	1	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	1	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	1	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	1	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	1	0	0	0
2-Butanone	ug/kg	.000	0	1	0	0	0
2-Hexanone	ug/kg	.000	0	1	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	1	0	0	0
Acetone	ug/kg	.000	0	1	0	0	0
Benzene	ug/kg	.000	0	1	0	0	0
Bromodichloromethane	ug/kg	.000	0	1	0	0	0
Bromoform	ug/kg	.000	0	1	0	0	0
Bromomethane	ug/kg	.000	0	1	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	1	0	0	0
Carbon disulfide	ug/kg	.000	0	1	0	0	0
Chlorobenzene	ug/kg	.000	0	1	0	0	0
Chloroethane	ug/kg	.000	0	1	0	0	0
Chloroform	ug/kg	.000	0	1	0	0	0
Chloromethane	ug/kg	.000	0	1	0	0	0
Dibromochloromethane	ug/kg	.000	0	1	0	0	0
Ethylbenzene	ug/kg	.000	0	1	0	0	0
Methylene chloride	ug/kg	.000	0	1	0	0	0
Styrene	ug/kg	.000	0	1	0	0	0
Tetrachloroethene	ug/kg	.000	0	1	0	0	0
Toluene	ug/kg	.000	0	1	0	0	0
Trichloroethene	ug/kg	.000	0	1	0	0	0
Vinyl Acetate	ug/kg	.000	0	1	0	0	0
Vinyl chloride	ug/kg	.000	0	1	0	0	0
Xylenes, Total	ug/kg	.000	0	1	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	1	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	1	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	1	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	1	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	1	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	1	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	1	0	0	0

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TABLE 4-38  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
2,6-Dinitrotoluene	ug/kg	.000	0	1	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	1	0	0	0
2-Chlorophenol	ug/kg	.000	0	1	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	1	0	0	0
2-Methylphenol	ug/kg	.000	0	1	0	0	0
2-Nitroaniline	ug/kg	.000	0	1	0	0	0
2-Nitrophenol	ug/kg	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	1	0	0	0
3-Nitroaniline	ug/kg	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	1	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	1	0	0	0
4-Methylphenol	ug/kg	.000	0	1	0	0	0
4-Nitroaniline	ug/kg	.000	0	1	0	0	0
4-Nitrophenol	ug/kg	.000	0	1	0	0	0
Acenaphthene	ug/kg	.000	0	1	0	0	0
Acenaphthylene	ug/kg	.000	0	1	0	0	0
Anthracene	ug/kg	.000	0	1	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	1	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	1	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	1	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	1	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	1	0	0	0
Benzoic acid	ug/kg	.000	0	1	0	0	0
Benzyl alcohol	ug/kg	.000	0	1	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	1	0	0	0
Chrysene	ug/kg	.000	0	1	0	0	0
Di-n-butyl phthalate	ug/kg	.000	0	1	0	0	0
Di-n-octyl phthalate	ug/kg	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	1	0	0	0
Dibenzofuran	ug/kg	.000	0	1	0	0	0
Diethyl phthalate	ug/kg	.000	0	1	0	0	0
Dimethyl phthalate	ug/kg	.000	0	1	0	0	0
Fluoranthene	ug/kg	.000	0	1	0	0	0
Fluorene	ug/kg	.000	0	1	0	0	0
Hexachlorobenzene	ug/kg	.000	0	1	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	1	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	1	0	0	0
Hexachloroethane	ug/kg	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	1	0	0	0
Isophorone	ug/kg	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	1	0	0	0

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TABLE 4-38  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
N-Nitrosodiphenylamine	ug/kg	.000	0	1	0	0	0
Naphthalene	ug/kg	.000	0	1	0	0	0
Nitrobenzene	ug/kg	.000	0	1	0	0	0
Pentachlorophenol	ug/kg	.000	0	1	0	0	0
Phenanthrene	ug/kg	.000	0	1	0	0	0
Phenol	ug/kg	.000	0	1	0	0	0
Pyrene	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	0	1	0	0	0
p-Chloroaniline	ug/kg	.000	0	1	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	1	0	0	0
4,4'-DDE	ug/kg	.000	0	1	0	0	0
4,4'-DDT	ug/kg	.000	0	1	0	0	0
Aldrin	ug/kg	.000	0	1	0	0	0
Aroclor-1016	ug/kg	.000	0	1	0	0	0
Aroclor-1221	ug/kg	.000	0	1	0	0	0
Aroclor-1232	ug/kg	.000	0	1	0	0	0
Aroclor-1242	ug/kg	.000	0	1	0	0	0
Aroclor-1248	ug/kg	.000	0	1	0	0	0
Aroclor-1254	ug/kg	.000	0	1	0	0	0
Aroclor-1260	ug/kg	.000	0	1	0	0	0
Dieldrin	ug/kg	.000	0	1	0	0	0
Endosulfan II	ug/kg	.000	0	1	0	0	0
Endosulfan sulfate	ug/kg	.000	0	1	0	0	0
Endosulfan-I	ug/kg	.000	0	1	0	0	0
Endrin	ug/kg	.000	0	1	0	0	0
Endrin ketone	ug/kg	.000	0	1	0	0	0
Heptachlor	ug/kg	.000	0	1	0	0	0
Heptachlor epoxide	ug/kg	.000	0	1	0	0	0
Methoxychlor	ug/kg	.000	0	1	0	0	0
Toxaphene	ug/kg	.000	0	1	0	0	0
alpha-BHC	ug/kg	.000	0	1	0	0	0
alpha-Chlordane	ug/kg	.000	0	1	0	0	0
beta-BHC	ug/kg	.000	0	1	0	0	0
delta-BHC	ug/kg	.000	0	1	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	1	0	0	0
gamma-Chlordane	ug/kg	.000	0	1	0	0	0

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**TABLE 4-39**  
**INACTIVE FLYASH PILE**  
**SEDIMENT**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	6	6	1580	5120	0
Antimony	mg/kg	.000	0	5	0	0	0
Arsenic	mg/kg	11.608	6	6	1.7	7.3	0
Barium	mg/kg	88.500	6	6	16.5	50.2	0
Beryllium	mg/kg	.600	1	6	1.2	1.2	1
Cadmium	mg/kg	.770	2	6	.67	.73	0
Calcium	mg/kg	5296.781	6	6	56000	191000	6
Chromium	mg/kg	17.057	6	6	3.7	6.6	0
Cobalt	mg/kg	16.913	6	6	1.8	5.4	0
Copper	mg/kg	15.700	4	6	5	9.5	0
Cyanide	mg/kg	.230	1	6	.16	.16	0
Iron	mg/kg	24788.749	6	6	4260	10300	0
Lead	mg/kg	29.575	6	6	4.1	22.4	0
Magnesium	mg/kg	1460.000	6	6	13500	29800	6
Manganese	mg/kg	2257.945	6	6	253	781	0
Mercury	mg/kg	.300	0	6	0	0	0
Molybdenum	mg/kg	.000	0	6	0	0	0
Nickel	mg/kg	25.145	5	6	4.4	11.7	0
Potassium	mg/kg	1349.530	6	6	253	812	0
Selenium	mg/kg	.720	0	6	0	0	0
Silicon	mg/kg	1914.313	6	6	496	867	0
Silver	mg/kg	.000	0	6	0	0	0
Sodium	mg/kg	55.145	6	6	120	175	6
Thallium	mg/kg	.580	1	6	.52	.52	0
Vanadium	mg/kg	33.693	5	6	10.9	14.1	0
Zinc	mg/kg	58.500	5	6	23.2	41.7	0
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.849	0	4	0	0	0
GROSS ALPHA	pCi/g	.000	4	4	14	16.64	4
GROSS BETA	pCi/g	.000	4	4	16.3	21.44	4
NP-237	pCi/g	.000	3	4	.019	.171	3
PU-238	pCi/g	.000	3	4	.019	.05	3
PU-239/240	pCi/g	.000	2	4	.03	.057	2
RA-226	pCi/g	1.528	4	4	.65	.996	0
RA-228	pCi/g	1.170	4	4	.51	.67	0
RU-106	pCi/g	.000	0	4	0	0	0

100

4-224

0515

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TABLE 4-39  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
SR-90	pCi/g	.000	1	4	.48	.48	1
TC-99	pCi/g	.000	0	4	0	0	0
TH-228	pCi/g	1.519	4	4	.41	.517	0
TH-230	pCi/g	2.112	4	4	.75	1.28	0
TH-232	pCi/g	1.469	4	4	.39	.65	0
TH-TOTAL	mg/kg	10.700	4	4	3.57	5.92	0
U-234	pCi/g	1.319	4	4	.64	1.5	1
U-235/236	pCi/g	.181	4	4	.027	.12	0
U-238	pCi/g	1.270	4	4	.72	1.68	1
U-TOTAL	mg/kg	3.240	4	4	4.09	12.3	4
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	6	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	6	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	6	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	6	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	6	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	6	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	6	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	6	0	0	0
2-Butanone	ug/kg	.000	0	6	0	0	0
2-Hexanone	ug/kg	.000	0	6	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	6	0	0	0
Acetone	ug/kg	.000	2	6	12	22	2
Benzene	ug/kg	.000	0	6	0	0	0
Bromodichloromethane	ug/kg	.000	0	6	0	0	0
Bromoform	ug/kg	.000	0	6	0	0	0
Bromomethane	ug/kg	.000	0	6	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	6	0	0	0
Carbon disulfide	ug/kg	.000	0	6	0	0	0
Chlorobenzene	ug/kg	.000	0	6	0	0	0
Chloroethane	ug/kg	.000	0	6	0	0	0
Chloroform	ug/kg	.000	0	6	0	0	0
Chloromethane	ug/kg	.000	0	6	0	0	0
Dibromochloromethane	ug/kg	.000	0	6	0	0	0
Ethylbenzene	ug/kg	.000	0	6	0	0	0
Methylene chloride	ug/kg	.000	0	6	0	0	0
Styrene	ug/kg	.000	0	6	0	0	0
Tetrachloroethene	ug/kg	.000	0	6	0	0	0
Toluene	ug/kg	.000	1	6	35	35	1
Trichloroethene	ug/kg	.000	0	6	0	0	0
Vinyl Acetate	ug/kg	.000	0	4	0	0	0
Vinyl chloride	ug/kg	.000	0	6	0	0	0

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4-225

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5  
1  
7  
0

TABLE 4-39  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	6	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	6	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	6	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	6	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	6	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	6	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	6	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	6	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	3	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	6	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	6	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	6	0	0	0
2-Chlorophenol	ug/kg	.000	0	6	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	6	0	0	0
2-Methylphenol	ug/kg	.000	0	6	0	0	0
2-Nitroaniline	ug/kg	.000	0	6	0	0	0
2-Nitrophenol	ug/kg	.000	0	6	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	6	0	0	0
3-Nitroaniline	ug/kg	.000	0	6	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	3	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	6	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	6	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	6	0	0	0
4-Methylphenol	ug/kg	.000	2	6	190	310	2
4-Nitroaniline	ug/kg	.000	0	4	0	0	0
4-Nitrophenol	ug/kg	.000	0	5	0	0	0
Acenaphthene	ug/kg	.000	0	6	0	0	0
Acenaphthylene	ug/kg	.000	0	6	0	0	0
Anthracene	ug/kg	.000	1	6	67	67	1
Benzo(a)anthracene	ug/kg	.000	1	6	48	48	1
Benzo(a)pyrene	ug/kg	.000	2	6	9	60	2
Benzo(b)fluoranthene	ug/kg	.000	1	6	39	39	1
Benzo(g,h,i)perylene	ug/kg	.000	2	6	38	130	2
Benzo(k)fluoranthene	ug/kg	.000	1	6	53	53	1
Benzoic acid	ug/kg	.000	1	3	45	45	1
Benzyl alcohol	ug/kg	.000	0	6	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	6	0	0	0
Carbazole	ug/kg	.000	2	6	7	7	2

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0517

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TABLE 4-39  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Chrysene	ug/kg	.000	1	6	61	61	1
Di-n-butyl phthalate	ug/kg	.000	0	6	0	0	0
Di-n-octyl phthalate	ug/kg	.000	2	6	2	7	2
Dibenzo(a,h)anthracene	ug/kg	.000	0	6	0	0	0
Dibenzofuran	ug/kg	.000	0	6	0	0	0
Diethyl phthalate	ug/kg	.000	1	6	14	14	1
Dimethyl phthalate	ug/kg	.000	0	6	0	0	0
Fluoranthene	ug/kg	.000	2	6	66	120	2
Fluorene	ug/kg	.000	1	6	7	7	1
Hexachlorobenzene	ug/kg	.000	0	6	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	4	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	6	0	0	0
Hexachloroethane	ug/kg	.000	0	6	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	1	6	35	35	1
Isophorone	ug/kg	.000	0	6	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	6	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	6	0	0	0
Naphthalene	ug/kg	.000	0	6	0	0	0
Nitrobenzene	ug/kg	.000	0	6	0	0	0
Pentachlorophenol	ug/kg	.000	0	6	0	0	0
Phenanthrene	ug/kg	.000	1	6	67	67	1
Phenol	ug/kg	.000	2	6	24	42	2
Pyrene	ug/kg	.000	2	6	47	100	2
bis(2-Chloroethoxy)methane	ug/kg	.000	0	6	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	6	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	6	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	6	6	51	2200	6
p-Chloroaniline	ug/kg	.000	0	6	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	6	0	0	0
4,4'-DDE	ug/kg	.000	0	6	0	0	0
4,4'-DDT	ug/kg	.000	0	6	0	0	0
Aldrin	ug/kg	.000	0	6	0	0	0
Aroclor-1016	ug/kg	.000	0	6	0	0	0
Aroclor-1221	ug/kg	.000	0	6	0	0	0
Aroclor-1232	ug/kg	.000	0	6	0	0	0
Aroclor-1242	ug/kg	.000	0	6	0	0	0
Aroclor-1248	ug/kg	.000	0	6	0	0	0
Aroclor-1254	ug/kg	.000	0	6	0	0	0
Aroclor-1260	ug/kg	.000	0	6	0	0	0
Dieldrin	ug/kg	.000	0	6	0	0	0
Endosulfan II	ug/kg	.000	0	6	0	0	0

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0518

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TABLE 4-39  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Endosulfan sulfate	ug/kg	.000	0	6	0	0	0
Endosulfan-I	ug/kg	.000	0	6	0	0	0
Endrin	ug/kg	.000	0	6	0	0	0
Endrin aldehyde	ug/kg	.000	0	6	0	0	0
Endrin ketone	ug/kg	.000	0	6	0	0	0
Heptachlor	ug/kg	.000	0	6	0	0	0
Heptachlor epoxide	ug/kg	.000	0	6	0	0	0
Methoxychlor	ug/kg	.000	0	6	0	0	0
Toxaphene	ug/kg	.000	0	6	0	0	0
alpha-BHC	ug/kg	.000	0	6	0	0	0
alpha-Chlordane	ug/kg	.000	0	6	0	0	0
beta-BHC	ug/kg	.000	0	6	0	0	0
delta-BHC	ug/kg	.000	0	6	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	6	0	0	0
gamma-Chlordane	ug/kg	.000	0	6	0	0	0

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0519

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semivolatile compounds were detected in downstream Paddys run sediment samples that were not detected at upstream locations. Only two of these [dimethyl phthalate and indeno(1,2,3-cd)pyrene] were not detected in soil samples from the Inactive Flyash Pile. These data indicate that the Inactive Flyash Pile may be the original source for the nine semivolatile compounds detected in the downstream Paddys Run sediment samples but not detected at upstream locations.

Phase I and Phase II sediment sample data were compared to CIS data (Appendix E-10). Analytes detected in this preliminary study were also detected in Phase I and Phase II and within the same order of magnitude.

Sediment and surface water data for the same sample locations are shown in Table 4-37. A comparison of the data indicate that radionuclides concentration in Paddys Run upstream and downstream of the drainage channel did not detect an impact on April 21, 1993 from the Inactive Flyash Pile.

4.4.4 Groundwater

Monitoring Well 1711 is the only monitoring well completed in the upper perched groundwater zone within the Inactive Flyash Pile. Other wells included in the dataset are completed in the perched zone at the edge of the Inactive Flyash Pile. This is because the perched zone is limited in horizontal extent to the north half of the Inactive Flyash Pile. Wells 1047 and 1711 were sampled during Phase I; however, there was insufficient water in Well 1711 for radionuclide analyses. Ten metals were detected above background in a sample from Well 1711 including cobalt, nickel, and thallium. These metals were also detected at elevated concentrations in flyash. There was insufficient water to collect a sample during Phase II field activities, so upgradient Well 1047 data are discussed below. Groundwater analytical data from Well 1047 was compared to background concentrations for perched water. The analytical data are provided in Appendix E, Table E-2G and Table E-2H. A summary of the number of detected analytes is 1000-series wells is provided in Table 4-40 and Table 4-41. Twelve metals and the isotopes of two elements and no organic compounds were detected in four samples collected during both Phase I and Phase II; no organic compounds were detected.

In order to characterize the perched groundwater system beneath the Inactive Flyash Pile, twelve groundwater samples were collected from 17 Hydropunch™ sample locations. On-site analyses were

**TABLE 4-40**  
**INACTIVE FLYASH PILE**  
**GROUNDWATER - 1000 SERIES\***  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.123	1	2	.0516	.0516	0
Antimony		mg/L	.000	0	2	0	0	0
Arsenic		mg/L	.122	0	4	0	0	0
Barium		mg/L	.459	4	4	.048	.154	0
Beryllium		mg/L	.002	0	2	0	0	0
Cadmium		mg/L	.007	1	4	.009	.009	1
Calcium		mg/L	125.574	4	4	103	233	2
Chromium		mg/L	.035	1	4	.024	.024	0
Cobalt		mg/L	.000	2	2	.0275	.0733	2
Copper		mg/L	.030	1	4	.011	.011	0
Iron		mg/L	10.965	3	4	.066	25.5	2
Lead		mg/L	.050	0	4	0	0	0
Magnesium		mg/L	49.627	4	4	44.3	53.8	2
Manganese		mg/L	.165	4	4	.019	3.85	2
Mercury		mg/L	.004	0	4	0	0	0
Molybdenum		mg/L	.028	2	4	.0878	.147	2
Nickel		mg/L	.026	3	4	.025	2.43	2
Potassium		mg/L	29.736	4	4	2.34	34	1
Selenium		mg/L	.000	0	4	0	0	0
Silicon		mg/L	.000	2	2	19.2	20.1	2
Silver		mg/L	.040	1	4	.012	.012	0
Sodium		mg/L	49.178	4	4	22.3	59.5	1
Thallium		mg/L	.000	2	2	.422	.435	2
Vanadium		mg/L	.020	0	2	0	0	0
Zinc		mg/L	.032	2	2	.0119	.0138	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	2	0	0	0
PU-238	UNFL	pCi/L	.000	0	3	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	3	0	0	0
RA-226	UNFL	pCi/L	1.000	0	3	0	0	0
RA-228	UNFL	pCi/L	5.200	0	3	0	0	0
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	3	0	0	0

See footnote at end of table

FERNALD

4-230

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TABLE 4-40  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>								
TC-99	UNFL	pCi/L	.000	0	3	0	0	0
TH-228	UNFL	pCi/L	1.040	0	3	0	0	0
TH-230	UNFL	pCi/L	2.000	0	3	0	0	0
TH-232	UNFL	pCi/L	.000	0	3	0	0	0
TH-TOTAL	UNFL	ug/L	3.000	1	2	5	5	1
U-234	UNFL	pCi/L	1.900	3	3	3.7	7.4	3
U-235/236	UNFL	pCi/L	.000	0	3	0	0	0
U-238	UNFL	pCi/L	1.070	3	3	2.1	3.2	3
U-TOTAL	UNFL	ug/L	4.000	2	2	6	9	2
<u>GENERAL CHEMISTRY</u>								
Alkalinity as CaCO3	UNFL	mg/L	.000	0	0	0	0	0
Ammonia	UNFL	mg/L	4.500	0	1	0	0	0
Chloride	UNFL	mg/L	110.159	0	1	0	0	0
Fluoride	UNFL	mg/L	1.352	1	1	.8	.8	0
Nitrate	UNFL	mg/L	.522	0	0	0	0	0
Phenols	UNFL	mg/L	.000	0	1	0	0	0
Phosphorus	UNFL	mg/L	.223	1	1	.4	.4	1
Sulfate	UNFL	mg/L	141.894	1	1	180	180	1
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	1	.2	.2	1
Total Organic Halides	UNFL	mg/L	.000	0	2	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	1	1	.2	.2	1

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-41**  
**INACTIVE FLYASH PILE**  
**GROUNDWATER - 1000 SERIES\***  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.123	0	1	0	0	0
Antimony		mg/L	.000	0	1	0	0	0
Arsenic		mg/L	.122	0	1	0	0	0
Barium		mg/L	.459	1	1	.0459	.0459	0
Beryllium		mg/L	.002	0	1	0	0	0
Cadmium		mg/L	.007	0	1	0	0	0
Calcium		mg/L	125.574	1	1	112	112	0
Chromium		mg/L	.035	0	1	0	0	0
Cobalt		mg/L	.000	0	1	0	0	0
Copper		mg/L	.030	0	1	0	0	0
Cyanide		mg/L	.000	0	1	0	0	0
Iron		mg/L	10.965	0	1	0	0	0
Lead		mg/L	.050	0	1	0	0	0
Magnesium		mg/L	49.627	1	1	50.6	50.6	1
Manganese		mg/L	.165	0	1	0	0	0
Mercury		mg/L	.004	0	1	0	0	0
Molybdenum		mg/L	.028	1	1	.0055	.0055	0
Nickel		mg/L	.026	0	1	0	0	0
Potassium		mg/L	29.736	1	1	1.5	1.5	0
Selenium		mg/L	.000	0	1	0	0	0
Silicon		mg/L	.000	1	1	6.22	6.22	1
Silver		mg/L	.040	0	1	0	0	0
Sodium		mg/L	49.178	1	1	40.9	40.9	0
Thallium		mg/L	.000	0	1	0	0	0
Vanadium		mg/L	.020	0	1	0	0	0
Zinc		mg/L	.032	1	1	.0066	.0066	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	1	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	1	0	0	0
GROSS BETA	UNFL	pCi/L	.000	0	1	0	0	0
NP-237	UNFL	pCi/L	.000	0	1	0	0	0
PU-238	UNFL	pCi/L	.000	0	1	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	1	0	0	0

4-232

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See footnote at end of table

TABLE 4-41  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-226	UNFL	pCi/L	1.000	0	1	0	0	0
RA-228	UNFL	pCi/L	5.200	1	1	5.93	5.93	1
RU-106	UNFL	pCi/L	.000	0	1	0	0	0
SR-90	UNFL	pCi/L	.000	0	1	0	0	0
TC-99	UNFL	pCi/L	.000	0	1	0	0	0
TH-228	UNFL	pCi/L	1.040	0	1	0	0	0
TH-230	UNFL	pCi/L	2.000	1	1	.227	.227	0
TH-232	UNFL	pCi/L	.000	0	1	0	0	0
TH-TOTAL	UNFL	ug/L	3.000	0	1	0	0	0
U-234	UNFL	pCi/L	1.900	1	1	2.33	2.33	1
U-235/236	UNFL	pCi/L	.000	0	1	0	0	0
U-238	UNFL	pCi/L	1.070	1	1	1.62	1.62	1
U-TOTAL	UNFL	ug/L	4.000	1	1	5.36	5.36	1
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-41  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	1	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	0	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	0	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-41  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Carbazole	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	0	0	0	0

See footnote at end of table

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TABLE 4-41  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>PESTICIDES/PCBS</b>								
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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used to define the distribution of uranium in perched groundwater at the subunit. These data are presented in Table 4-42 and the locations are shown on Figure 4-23 (see Volume 2, Oversized Figures). Perched water was encountered beneath the north end of the Inactive Flyash Pile but not during attempted sampling in April to May 1993 at the south end of the Inactive Flyash Pile. The extent of saturated conditions in the till were discussed in Section 3.0, and appeared to be limited to the subunit north of Hydropunch™ 11051.

A comparison of total uranium concentrations in soil and water samples collected during the Hydropunch™ activities is presented on Table 4-42 and indicates the following:

- Water samples collected from Hydropunch™ 1999, 11000, 11001, 11002, 11004, 11007, 11048 and 11050 had total uranium ranging from 9.5 µg/L to 6700 µg/L. These Hydropunch™ locations were not associated with waste materials (that is, soil samples from the saturated intervals were less than the detection limit of 11 mg/kg); this suggests that the source for the water contamination was upgradient of the Hydropunch™ locations.
- Water samples from Hydropunch™ 11003 and 11051 had total uranium in water of 720 µg/L and 74 µg/L, while soil samples from the saturated intervals had 378 mg/kg and 1010 mg/kg, respectively. These Hydropunch™ water samples are believed to be associated with waste materials in the perched zone.

Hydropunch™ data suggest that, in the northern portion of Inactive Flyash Pile, perched groundwater is flowing through waste materials containing uranium upgradient from the Hydropunch™ locations. A comparison of the surface water uranium concentrations from the west drainage, downgradient from the identified seepage, and the perched water uranium concentrations indicates that the northern portion of the Inactive Flyash Pile may be the source for the uranium concentrations associated with the seepage.

Four 2000-series wells were sampled during Phase I. Well 1016 is mislabeled and is actually completed in the regional aquifer at the south edge of the Inactive Flyash Pile. The other wells are 2016, 2042, and 2402, which are located on the northeast and southern battery limits. Aluminum, calcium, and chromium were detected above background in Wells 1016 and 2016. Uranium and two organic compounds were detected. The nested Wells 3016 and 4016 were also sampled and detected trace lead, manganese, and uranium. The highest concentrations of total uranium in the 1016-2016-3016 well group in 1989 was 9 µg/g, 22 µg/g, and 7 µg/g, respectively. These data indicate a possible impact from the subunit upon groundwater. Well 2955 was installed in the Inactive Flyash Pile during Phase II. Analytical data from the 2000-series wells were compared to background data

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TABLE 4-42

**SUMMARY OF TOTAL URANIUM IN PERCHED GROUNDWATER  
HYDROPUNCH™ SAMPLES FROM THE INACTIVE FLYASH PILE  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Hydropunch	Sample I.D.	Date Collected	Soil Sample Depth (ft.)	Location	Soil* Total Uranium µg/g	Water Total Uranium µg/L
1999	111922	4/19/93	12-13	Water sample collected from Flyash - till interface 8'-12'	<11	460
11000	11759	4/15/93	16.5-18	Water and soil from silty sand unit within till 13'-15' deep	<11	410
11001	111690	4/13/93	21.5-22	Water collected from silty sand unit in clay till 17'-21' deep	<11	280
11002	116461	5/5/93	16.5	Waste encountered at 13' deep; water collected from waste/till 13'-17' deep	<11	6700
11003	111840	4/17/93	25.5-26	Drilled adjacent to Well 1711, sandy silt unit in till 22'-26' deep	378	720
11004	111855	4/18/93	24-25	Wet sand and gravel unit overlying clay layer 20'-24' deep	<11	29
11005		4/29/93	10.5-11	Dry	165	-
11006		4/26/93	22.5-24	Wet gray clay-like sludge; material, no flow to hydropunch	3300	-
11007	110679	4/21/93	22.5-23	Water may be from clay and sand at 19.5'	<11	9.5
11008		5/2/93	21-21.5	Dry	<11	-
11047	116318	5/16/93		Sand unit within till 8'-12'	-	19
11048	116351	5/25/93	21-22	Sand unit within till 22'-24'	<11	430
11049	116356	5/27/93	11.5-12.5	Silty clay (note: very moist clay from surface to 11.5') 7.5-11.5	<11	77
11050	116454	6/27/93	16-18	Silty fine sand unit in till under Flyash 10.5'-14.5'	<11	370
11051	116437	5/27/93	21-22 22-24 28-30	Waste material at Flyash - till interface; sample collected from 17'-21' deep	1010 1470 <11	- 74 -
11052		5/25/93	19-21 25-27	Clay material beneath Flyash	1000 <11	-
11053		5/21/93	18-26	Great Miami Aquifer Material	<11	-

\*Note: Soil analyses for sample collected from saturated interval tested by hydropunch.

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from the regional aquifer. Analytes detected above background are provided in Appendix E in Table E-2I while a summary of the analytes is provided in Table 4-43 and Table 4-44. Phase II sampling detected aluminum, isotopes of four elements (neptunium-237, plutonium-238, plutonium-259/240, thorium-232, and uranium-235/236 were not detected during Phase I), and three organic compounds (Carbon disulfide and Butyl benzyl phthalate were not detected for Phase I; bis(2-Ethylhexyl)phthalate was detected above back ground for Phase I but not Phase II) that exceeded background values in four samples.

Concentrations of selected analytes detected above background are presented in Table 4-45. A comparison of the concentration of total uranium in upgradient Well 2402 (5.62 µg/L) and downgradient Well 2945 (2070 µg/L) or downgradient Well 2954 (1167 µg/L) indicates that there has been a release of uranium from the subunit to the regional aquifer. Concentrations of uranium in the downgradient wells (see Figure 3-50 for groundwater elevation contours) are similar to those detected in perched groundwater samples collected from the seep (820 µg/L at IFP-SW-10), from the drainage as it infiltrates into the regional aquifer (910 µg/L at IFP-SW-05), and from perched groundwater (6700 µg/L from Hydropunch™ 11002).

Total uranium analysis in Well 2955 (in the north end of the subunit) and Well 2401 (downgradient of 2955 in the South Field) detected 8.19 µg/L and 5.13 µg/L, respectively. These data indicate that there has not been a release of uranium from the subunit in this area to the regional aquifer and suggest that the origin of regional aquifer uranium contamination is southeast of these wells, possibly near to 11051 where 2280 µg/g total uranium was detected in a soil sample at 24 feet deep.

A comparison of the concentration of constituents other than uranium detected in the upgradient and downgradient wells does not identify any constituent that appears to increase in concentration from wells located downgradient of the subunit. This suggests that uranium is the primary constituent in water recharging the regional aquifer beneath the Inactive Flyash Pile.

4.4.5 Biota

Impacts from the Inactive Flyash Pile are not addressed in the Operable Unit 2 RI because it is likely to be remediated. A Site wide Ecological Risk Assessment will be prepared as part of the Operable Unit 5 RI/FS to address area not likely to be remediated.

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**TABLE 4-43A**  
**INACTIVE FLYASH PILE**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	5	8	.113	.374	2
Antimony		mg/L	.038	0	2	0	0	0
Arsenic		mg/L	.300	0	16	0	0	0
Barium		mg/L	.413	14	15	.03	.064	0
Beryllium		mg/L	.003	0	2	0	0	0
Cadmium		mg/L	.006	7	15	.003	.0051	0
Calcium		mg/L	135.163	15	15	19.2	198	2
Chromium		mg/L	.042	8	15	.0138	.127	1
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.130	6	15	.0102	.023	0
Cyanide		mg/L	.000	0	0	0	0	0
Iron		mg/L	4.000	12	15	.02	2.5	0
Lead		mg/L	.029	4	16	.002	.005	0
Magnesium		mg/L	38.070	15	15	18.8	37.9	0
Manganese		mg/L	.800	12	15	.002	.039	0
Mercury		mg/L	.001	3	16	.0002	.0005	0
Molybdenum		mg/L	.027	0	13	0	0	0
Nickel		mg/L	.026	0	13	0	0	0
Potassium		mg/L	3.087	13	16	1.5	2.92	0
Selenium		mg/L	.005	3	16	.0013	.005	0
Silicon		mg/L	10.491	6	6	2.53	4.01	0
Silver		mg/L	.023	1	15	.0102	.0102	0
Sodium		mg/L	51.918	15	15	4.1	17.1	0
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.027	5	8	.0123	.0164	0
Zinc		mg/L	.105	2	2	.027	.034	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	1	0	0	0
NP-237	UNFL	pCi/L	.000	0	8	0	0	0
PU-238	UNFL	pCi/L	.000	0	10	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	10	0	0	0
RA-226	UNFL	pCi/L	1.200	0	7	0	0	0
RA-228	UNFL	pCi/L	4.500	0	10	0	0	0
RU-106	UNFL	pCi/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-43A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
SR-90	UNFL	pCi/L	.000	0	8	0	0	0
TC-99	UNFL	pCi/L	36.000	0	10	0	0	0
TH-228	UNFL	pCi/L	1.520	0	10	0	0	0
TH-230	UNFL	pCi/L	1.790	0	10	0	0	0
TH-232	UNFL	pCi/L	.000	0	10	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	8	0	0	0
U-234	UNFL	pCi/L	1.900	9	10	2.5	7.7	9
U-235/236	UNFL	pCi/L	.000	0	10	0	0	0
U-238	UNFL	pCi/L	.900	9	10	2.6	8	9
U-TOTAL	UNFL	ug/L	2.920	8	8	9	29.4	8
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	1	2	2	2	1
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	2	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	2	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	2	0	0	0
Acetone	UNFL	ug/L	.000	0	2	0	0	0
Benzene	UNFL	ug/L	.000	0	2	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	2	0	0	0
Bromoform	UNFL	ug/L	.000	0	2	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	2	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	2	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	2	0	0	0
Chloroform	UNFL	ug/L	.000	0	2	0	0	0
Chloromethane	UNFL	ug/L	.000	0	2	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	2	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	2	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	2	0	0	0
Styrene	UNFL	ug/L	.000	0	2	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-43A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Toluene	UNFL	ug/L	.000	0	2	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	2	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	2	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	2	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	2	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	2	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	2	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	2	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	2	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	2	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	2	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	2	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	2	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	2	0	0	0
Anthracene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	2	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	2	0	0	0

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See footnote at end of table

TABLE 4-43A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzoic acid	UNFL	ug/L	.000	0	2	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	2	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	2	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	2	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	2	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	2	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	2	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	2	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	2	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	2	0	0	0
Isophorone	UNFL	ug/L	.000	0	2	0	0	0
Methyl parathion	UNFL	ug/L	.000	0	2	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	2	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	2	0	0	0
Naphthalene	UNFL	ug/L	.000	0	2	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	2	0	0	0
Parathion	UNFL	ug/L	.000	0	2	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	2	0	0	0
Phenol	UNFL	ug/L	.000	0	2	0	0	0
Pyrene	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	1	2	4	4	1
p-Chloroaniline	UNFL	ug/L	.000	0	2	0	0	0
<u>PESTICIDES/PCBs</u>								
4,4'-DDD	UNFL	ug/L	.000	0	2	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	2	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-43A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>								
Aroclor-1016	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	2	0	0	0
Dieldrin	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	2	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	2	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	2	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	2	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
Azinphosmethyl	UNFL	ug/L	.000	0	2	0	0	0
Demeton	UNFL	ug/L	.000	0	2	0	0	0
Diazinon	UNFL	ug/L	.000	0	2	0	0	0
Disulfoton	UNFL	ug/L	.000	0	2	0	0	0
Ethion	UNFL	ug/L	.000	0	2	0	0	0
Malathion	UNFL	ug/L	.000	0	2	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	0	12	0	0	0
Chloride	UNFL	mg/L	145.065	12	13	6.8	30	0
Fluoride	UNFL	mg/L	.938	12	13	.1	.77	0
Hexavalent Chromium	UNFL	mg/L	.000	0	2	0	0	0
Nitrate	UNFL	mg/L	11.400	11	13	1.18	5.3	0
Phenols	UNFL	mg/L	.000	3	13	.005	.0546	0
Phosphate	UNFL	mg/L	.000	2	2	.28	.3	0
Phosphorus	UNFL	mg/L	.693	12	12	.03	.758	1
Sulfate	UNFL	mg/L	359.847	12	12	26	146	0

See footnote at end of table

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TABLE 4-43A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects <sup>a</sup>		Number of Detects Above Background
						Minimum	Maximum	
<u>GENERAL CHEMISTRY (Continued)</u>								
Sulfide	UNFL	mg/L	.000	1	6	28.1	28.1	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	5	8	.16	1.2	5
Total Organic Carbon	UNFL	mg/L	3.764	5	7	1.65	3.71	0
Total Organic Halides	UNFL	mg/L	.021	3	11	.01	.07	2
Total Organic Nitrogen	UNFL	mg/L	.652	7	14	.16	.9	1

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-43B**  
**INACTIVE FLYASH PILE**  
**GROUNDWATER\* - 3000 AND 4000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	2	3	.0267	.081	0
Antimony		mg/L	.038	0	0	0	0	0
Arsenic		mg/L	.300	0	9	0	0	0
Barium		mg/L	.413	7	8	.037	.0544	0
Beryllium		mg/L	.003	0	0	0	0	0
Cadmium		mg/L	.006	3	9	.004	.005	0
Calcium		mg/L	135.163	9	9	79.6	109	0
Chromium		mg/L	.042	3	9	.023	.024	0
Cobalt		mg/L	.000	0	0	0	0	0
Copper		mg/L	.130	2	9	.012	.012	0
Iron		mg/L	4.000	5	9	.044	1.56	0
Lead		mg/L	.029	3	6	.0016	.05	1
Magnesium		mg/L	38.070	9	9	20	27.8	0
Manganese		mg/L	.800	8	9	.007	1.02	2
Mercury		mg/L	.001	0	8	0	0	0
Molybdenum		mg/L	.027	1	9	.0035	.0035	0
Nickel		mg/L	.026	0	9	0	0	0
Potassium		mg/L	3.087	8	9	1.2	2.88	0
Selenium		mg/L	.005	1	8	.002	.002	0
Silicon		mg/L	10.491	3	3	3.04	3.36	0
Silver		mg/L	.023	0	8	0	0	0
Sodium		mg/L	51.918	9	9	4.48	13.07	0
Vanadium		mg/L	.027	1	3	.014	.014	0
Zinc		mg/L	.105	0	0	0	0	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	7	0	0	0
PU-238	UNFL	pCi/L	.000	0	7	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	7	0	0	0
RA-226	UNFL	pCi/L	1.200	0	5	0	0	0
RA-228	UNFL	pCi/L	4.500	0	7	0	0	0
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	7	0	0	0
TC-99	UNFL	pCi/L	36.000	0	7	0	0	0

See footnote at end of table

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TABLE 4-43B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
TH-228	UNFL	pCi/L	1.520	1	7	1.4 1.4	0
TH-230	UNFL	pCi/L	1.790	0	7	0 0	0
TH-232	UNFL	pCi/L	.000	0	7	0 0	0
TH-TOTAL	UNFL	ug/L	2.000	0	6	0 0	0
U-234	UNFL	pCi/L	1.900	5	7	3.05 5.3	5
U-235/236	UNFL	pCi/L	.000	0	7	0 0	0
U-238	UNFL	pCi/L	.900	5	7	2.8 4.4	5
U-TOTAL	UNFL	ug/L	2.920	5	7	7 13.4	5
<u>GENERAL CHEMISTRY</u>							
Ammonia	UNFL	mg/L	3.240	2	9	.07 .21	0
Chloride	UNFL	mg/L	145.065	9	9	6.5 25.6	0
Fluoride	UNFL	mg/L	.938	9	9	.1 .74	0
Nitrate	UNFL	mg/L	11.400	7	7	.09 4.9	0
Phenols	UNFL	mg/L	.000	1	7	.011 .011	0
Phosphorus	UNFL	mg/L	.693	6	8	.02 .13	0
Sulfate	UNFL	mg/L	359.847	9	9	48 174	0
Sulfide	UNFL	mg/L	.000	0	1	0 0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	3	4	.14 .202	3
Total Organic Carbon	UNFL	mg/L	3.764	1	2	1.36 1.36	0
Total Organic Halides	UNFL	mg/L	.021	1	6	.016 .016	0
Total Organic Nitrogen	UNFL	mg/L	.652	6	9	.14 1	1

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-44**  
**INACTIVE FLYASH PILE**  
**GROUNDWATER\* - 2000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	2	6	.366	.676	2
Antimony		mg/L	.038	0	6	0	0	0
Arsenic		mg/L	.300	1	6	.0016	.0016	0
Barium		mg/L	.413	6	6	.0457	.0506	0
Beryllium		mg/L	.003	0	6	0	0	0
Cadmium		mg/L	.006	0	6	0	0	0
Calcium		mg/L	135.163	6	6	83.7	98.4	0
Chromium		mg/L	.042	1	6	.0055	.0055	0
Cobalt		mg/L	.000	0	6	0	0	0
Copper		mg/L	.130	0	6	0	0	0
Cyanide		mg/L	.000	0	4	0	0	0
Iron		mg/L	4.000	3	6	.206	2.67	0
Lead		mg/L	.029	2	6	.0013	.0039	0
Magnesium		mg/L	38.070	6	6	23.5	27.4	0
Manganese		mg/L	.800	2	6	.0262	.0677	0
Mercury		mg/L	.001	0	6	0	0	0
Molybdenum		mg/L	.027	0	6	0	0	0
Nickel		mg/L	.026	1	6	.0075	.0075	0
Potassium		mg/L	3.087	6	6	2.26	2.77	0
Selenium		mg/L	.005	0	6	0	0	0
Silicon		mg/L	10.491	6	6	3.3	4.3	0
Silver		mg/L	.023	0	6	0	0	0
Sodium		mg/L	51.918	6	6	8.97	12.9	0
Thallium		mg/L	.000	0	6	0	0	0
Vanadium		mg/L	.027	0	6	0	0	0
Zinc		mg/L	.105	3	6	.0037	.0411	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	3	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	3	3	6.97	9.52	3
GROSS BETA	UNFL	pCi/L	.000	3	3	5.05	9.34	3
NP-237	UNFL	pCi/L	.000	2	3	.28	.71	2
PU-238	UNFL	pCi/L	.000	1	3	.16	.16	1
PU-239/240	UNFL	pCi/L	.000	1	3	.06	.06	1

See footnote at end of table

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TABLE 4-44  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>								
RA-226	UNFL	pCi/L	1.200	2	3	.2	.275	0
RA-228	UNFL	pCi/L	4.500	0	3	0	0	0
RU-106	UNFL	pCi/L	.000	0	3	0	0	0
SR-90	UNFL	pCi/L	.000	0	3	0	0	0
TC-99	UNFL	pCi/L	36.000	0	3	0	0	0
TH-228	UNFL	pCi/L	1.520	0	3	0	0	0
TH-230	UNFL	pCi/L	1.790	3	3	.277	.8	0
TH-232	UNFL	pCi/L	.000	1	3	.14	.14	1
TH-TOTAL	UNFL	ug/L	2.000	1	3	1.27	1.27	0
U-234	UNFL	pCi/L	1.900	3	3	2.17	6.02	3
U-235/236	UNFL	pCi/L	.000	3	3	.15	.698	3
U-238	UNFL	pCi/L	.900	3	3	3.01	6.5	3
U-TOTAL	UNFL	ug/L	2.920	3	3	5.62	17.1	3
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	1	4	1	1	1
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	4	0	0	0
2-Butanone	UNFL	ug/L	.000	0	4	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	4	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	4	0	0	0
Acetone	UNFL	ug/L	.000	0	3	0	0	0
Benzene	UNFL	ug/L	.000	0	4	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	4	0	0	0
Bromoform	UNFL	ug/L	.000	0	4	0	0	0
Bromomethane	UNFL	ug/L	.000	0	4	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	4	0	0	0
Carbon disulfide	UNFL	ug/L	.000	1	4	26	26	1
Chlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
Chloroethane	UNFL	ug/L	.000	0	4	0	0	0
Chloroform	UNFL	ug/L	.000	0	4	0	0	0
Chloromethane	UNFL	ug/L	.000	0	3	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	4	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	4	0	0	0

See footnote at end of table

15010-000

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TABLE 4-44  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Methylene chloride	UNFL	ug/L	.000	0	4	0 0	0
Styrene	UNFL	ug/L	.000	0	4	0 0	0
Tetrachloroethene	UNFL	ug/L	.000	0	4	0 0	0
Toluene	UNFL	ug/L	.000	0	4	0 0	0
Trichloroethene	UNFL	ug/L	.000	0	4	0 0	0
Vinyl Acetate	UNFL	ug/L	.000	0	3	0 0	0
Vinyl chloride	UNFL	ug/L	.000	0	4	0 0	0
Xylenes, Total	UNFL	ug/L	.000	0	4	0 0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0 0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0 0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	4	0 0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	4	0 0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	4	0 0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	4	0 0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	2	0 0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	4	0 0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	4	0 0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	1	0 0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	4	0 0	0
2-Chlorophenol	UNFL	ug/L	.000	0	4	0 0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	4	0 0	0
2-Methylphenol	UNFL	ug/L	.000	0	4	0 0	0
2-Nitroaniline	UNFL	ug/L	.000	0	4	0 0	0
2-Nitrophenol	UNFL	ug/L	.000	0	4	0 0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	4	0 0	0
3-Nitroaniline	UNFL	ug/L	.000	0	4	0 0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	3	0 0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	4	0 0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	4	0 0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	4	0 0	0
4-Methylphenol	UNFL	ug/L	.000	0	4	0 0	0
4-Nitroaniline	UNFL	ug/L	.000	0	3	0 0	0
4-Nitrophenol	UNFL	ug/L	.000	0	2	0 0	0

See footnote at end of table

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TABLE 4-44  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Acenaphthene	UNFL	ug/L	.000	0	4	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	4	0	0	0
Anthracene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	2	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	4	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	1	4	1	1	1
Carbazole	UNFL	ug/L	.000	0	4	0	0	0
Chrysene	UNFL	ug/L	.000	0	4	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	2	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	4	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Fluorene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	4	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Isophorone	UNFL	ug/L	.000	0	4	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	4	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	4	0	0	0
Naphthalene	UNFL	ug/L	.000	0	4	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	4	0	0	0
Pentachloropheno1	UNFL	ug/L	.000	0	4	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	4	0	0	0
Pheno1	UNFL	ug/L	.000	0	4	0	0	0
Pyrene	UNFL	ug/L	.000	0	4	0	0	0
Tributyl phosphate	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	4	0	0	0

See footnote at end of table

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**TABLE 4-44**  
**(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	4	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	3	0	0	0
<u>PESTICIDES/PCBs</u>								
4,4'-DDD	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	4	0	0	0
Aldrin	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	4	0	0	0
Dieldrin	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	4	0	0	0
Endrin	UNFL	ug/L	.000	0	4	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	4	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	4	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	4	0	0	0
Toxaphene	UNFL	ug/L	.000	0	4	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	4	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
beta-BHC	UNFL	ug/L	.000	0	4	0	0	0
delta-BHC	UNFL	ug/L	.000	0	4	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	4	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	3	3	209.9	258	0
Alkalinity as CaCO3	UNFL	mg/L	.000	1	1	224	224	0
Ammonia	UNFL	mg/L	3.240	0	4	0	0	0
Chloride	UNFL	mg/L	145.065	4	4	20.28	29.1	0
Fluoride	UNFL	mg/L	.938	4	4	.2	.28	0

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See footnote at end of table

TABLE 4-44  
(Continued)

Parameter <sup>a</sup>	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>								
Nitrate	UNFL	mg/L	11.400	3	3	1.72	2.46	0
Phenols	UNFL	mg/L	.000	0	4	0	0	0
Phosphorus	UNFL	mg/L	.693	0	1	0	0	0
Sulfate	UNFL	mg/L	359.847	4	4	68.5	84.1	0
Sulfide	UNFL	mg/L	.000	0	4	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	3	4	.12	3.01	3
Total Organic Carbon	UNFL	mg/L	3.764	1	4	1.12	1.12	0
Total Organic Halides	UNFL	mg/L	.021	1	3	.0108	.0108	0
Total Organic Nitrogen	UNFL	mg/L	.652	3	4	.12	2.9	1
Total Phosphorous	UNFL	mg/L	.000	2	3	.06	.14	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-45**  
**CONCENTRATIONS OF SELECTED ANALYTES**  
**FROM 2000 SERIES WELLS DURING PHASE II**  
**INACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Analyte and Concentration							
Well I.D./Location	Total U µg/L	Chloride mg/L	Sulfate mg/L	Alkalinity mg/L	Fluoride mg/L	Bis (2-Ethylhexyl) Phthalate	Butyl Benzylphthalate
2047 - North of Flyash Pile; possible upgradient	9.51	24.48	80.8	NA	0.2	ND	ND
2402 - West of Flyash Pile; upgradient well	5.62	20.28	68.5	209.9	0.28	ND	ND
2955 - Within Flyash Pile; North end	8.19	29.1	72.7	258	0.22	ND	1
2401 - Directly downgradient from North end of Flyash Pile	5.13	23.6	53.5	339	0.20	ND	ND
2945 - Downgradient <sup>a</sup> of central part of Flyash Pile	2670/1820	4.62	69.7	455	0.51	ND	ND
2954 - Downgradient <sup>a</sup> of both 2945 and South of Flyash Pile	1167	20.8	95.4	420	0.09	6	ND
2016 - South of Inactive Flyash Pile; possibly downgradient of South end	17.1	28.35	84.1	245	0.2	ND	ND
Paddys Run (at IFP-SW-03); upstream of out fall of East drainage channel	5.25, 5.03	ND	62.9, 77.4	255, 195	0.2, 0.21	ND	ND

Note: NA means not analyzed.  
ND means not detected.

<sup>a</sup>These wells are located in the South Field

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4.4.6 Summary

Soil, waste material, and water sample data indicate the following about the Inactive Flyash Pile:

- Organic compounds and radionuclides were detected above background for the surface of the Inactive Flyash Pile. These constituents were also found at varied depths in most of the samples, indicating that waste material has been disposed of throughout the operating period of the Inactive Flyash Pile.
- Waste materials identified in samples collected from soil borings in the subunit included localized sludge like material, clay tile drain pipe, wood, nails, wire, construction debris, and flyash. The recovered materials from the borings except the flyash produced elevated field measured radioactivity by an alpha-beta meter. These elevated/readings may be due to the materials having been associated with or in contact with process materials or waste.
- The flyash had generally lower concentrations for constituents than the fill material.
- Identifiable waste materials appear to be resting on or near to the interface of flyash and glacial overburden near the center of the Inactive Flyash Pile.
- Flyash and fill are in contact with the Great Miami Aquifer in the western and southern portions under the Flyash Pile.
- The highest concentrations of Aroclor-1254 and total uranium were found associated with the trace of a buried drainage that existed before the Inactive Flyash Pile was developed.
- The occurrence of uranium in groundwater in the perched groundwater system appears to be related to waste materials buried within the pile or close to it since upgradient Hydropunch™ data (from Hydropunch™ 11047 and 11010) and upgradient Well 1047 data do not detect uranium.
- Seepage in the drainage to the west may be associated with the perched groundwater.
- Contaminated perched groundwater was located in saturated silty sand lenses within the till material beneath the flyash, and in a saturated zone of flyash that was directly above the till surface. This means that a mechanism exists to transport uranium vertically into the Great Miami Aquifer.
- Uranium was not detected in a well completed in the regional aquifer upgradient of the subunit (Well 2402), in a well completed in the north end of the subunit (Well 2955), or in a well completed downgradient of the north part of the subunit (Well 2401). Uranium was detected in two wells downgradient of the central part of the subunit (Well 2945 and Well 2954). This suggests that a source of regional aquifer uranium exists beneath the central part of the Inactive Flyash Pile.

4.5 SOUTH FIELD

Analytical results for samples collected from the South Field are presented in Appendix F. Sample analyses that detected analytes at concentrations above background (defined in Table 4-1A) will be

discussed in this section. Geology and hydrogeology of the South Field referred to in this section were discussed in more detail Section 3.4.

4.5.1 Volume and Physical Characteristics of Waste

Materials in soil samples and trenches in the South Field are comprised of clean fill, construction debris, and radioactive materials mixed with the above materials and the native till. A map showing the estimated thickness of the fill material was presented as Figure 4-12. An estimated volume for the fill and waste materials in the Inactive Flyash Pile and the South Field is 216,489 cubic yards.

A geophysical survey was conducted during Phase II, and 16 trenches were excavated during Phase I and Phase II to locate and sample typical waste materials buried in the South Field. The geophysical survey during Phase II identified ten areas of anomalous electromagnetic readings, and these areas were selected for trenching. The Phase I and Phase II surveys are in agreement with the CIS geophysical survey. Visual observations of the waste materials in the trenches are summarized in Table 4-46 and indicate that a wide range of waste materials were buried in the fill above the till. Samples of soil scraped from the objects were analyzed for metals, radionuclides, and semivolatile compounds. Results of the analyses, shown on Table 4-46, indicate that soil associated with the waste materials contains elevated amounts of metals, radionuclides, and semivolatile compounds. Field screening of dry wipe samples from the surfaces of the waste materials are summarized in Table 4-47; screening data indicate that radioactive contamination is located on the surface and can be removed by wipe sampling.

4.5.2 Surface and Subsurface Soils

Chemical and radiological analytical results from surface samples were compared against soil background concentrations, and a table of the resulting constituent concentrations is provided in Appendix F, Table F-2A. A summary of the analytes are shown in Table 4-48A. Sixteen metals, isotopes of seven elements, and 26 organic compounds exceeded background concentrations in 21 analyses of surface samples collected during the Phase II field program at the South Field. Metals that were detected in over 40 percent of the samples included beryllium (15 samples), copper (12 samples), and silver (20 samples). These metals were widely distributed throughout the South Field and were close to the background limits except for silver, which had a background concentration of 0 mg/kg.

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**TABLE 4-46**  
**SUMMARY OF PHASE II TRENCHING DATA, SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Trench	Waste Types and Description	Field Readings	Analytical Data	
1	Wire, concrete slabs, cinder blocks, flyash, contaminated pipe.  Fluorescent yellow material, wire	up 1500 cpm 15000 cpm  22000 cpm	Sample 113105 Total Uranium 165 µg/kg Total Thorium 28.9 µg/kg Radium-226 1.8 pCi/g Radium-228 3.7 pCi/g Total Uranium (on site) 143 µg/kg	113718 bis(2)ethylhexyl 340 µg/kg Zn 71 mg/kg Aroclor 1254 170 µg/kg Tributyl phosphate 170 µg/kg Fluorethene 140 µg/kg
2	Tar-like material, black construction material, concrete wire Fill/native till interface 12'	25,000 cpm 10,000 cpm 1200 cpm	Sample 113724 Total Uranium = 724 µg/kg Total Thorium = <18 µg/kg Radium-226 12 pCi/g Radium-228 97 pCi/g  Sample 113725 Total Uranium = 34 µg/kg Total Thorium = 3540 µg/kg Radium-9.3 pCi/g Radium-228 85 pCi/g	No analyses
3	Metal pipe construction debris	400 cpm	no samples	
4	Concrete, debris 6' concrete slab 6" thick	3000 cpm	Sample 113722 Zinc = 508 mg/kg Total Uranium = 1170 mg/kg	Benzopyrene = 64 mg/kg Lead = 385 mg/kg bis(2 ethylhexyl)phthalate = 610 mg/kg
	Metal bars, brick	1000 cpm	(on site) Total Uranium = 951 µg/kg	
5	Sheet metal, little debris saturated conditions at 10' Fill/till interface at 6-7'	220 cpm	no samples	
6	Wire, concrete, brick, wood, re-bar, cable, section of trench detected debris in all areas Fill/native till interface at 8-9' deep	80-100 cpm	no samples	
7	Concrete, pipe  Floor drain, metal plate  Demolition debris interface of trench/native till at 9'	5-100 cpm  5000 cpm  500 cpm	no samples	

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TABLE 4-46  
(Continued)

Trench	Waste Types and Description	Field Readings	Analytical Data	
8	concrete sheet metal 6" ID pipe Fill/till interface at 3' deep	600 cpm	no samples	
9	Brick, concrete, wire cinder block small pieces of brick and concrete. Wet at base of fill at till surface (11')	40 cpm	no samples	
10	Native soil at 2', bedding plane of original surface identifiable metal piece 10' x 6' x 1/8" Fill/till interface at 2' deep	4,600 cpm	no samples	

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**TABLE 4-47**  
**SCREENING RESULTS OF WIPE SAMPLES COLLECTED**  
**FROM WASTE MATERIAL IN TRENCHES IN THE SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Material and Description	Sample Number	Activity of Dry Wipe DPM
<b>Trench 1.</b>		
concrete (2' x 1')	T-1-1	15,000
orange stained concrete (0.5' x 0.5')	T-1-2	40,000
insulated wire (5")	T-1-3	10,000
metal (0.5' x 0.3')	T-1-4	30,000
metal (1.4' x	T-1-5	15,000
<b>Trench 2</b>		
metal (3' x 4')	T-2-1	20,000
wood (2" x 4" x 2.5')	T-2-2	25,000
concrete (irregular shapes) connected by rebar	T-2-3	2000-3000
red corrosion on concrete	T-2-4	150,000
wire projecting from concrete	T-2-5	80,000
<b>Trench 4</b>		
crushed metal drum	T-4-1	2,000
pipe (1.75" x 4')	T-4-2	20,000
corrugated metal	T-4-3	2,000
curved metal	T-4-4	30,000
pipe (1" x 6")	T-4-5	10,000
roof tile (4" x 5")	T-4-6	35,000
pipe (2" x 6")	T-4-7	25,000
concrete (3" x 4")	T-4-8	25,000

Note: DPM means Disintegration Per Minute

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**TABLE 4-48A**  
**SOUTH FIELD**  
**SURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>METALS</b>							
Aluminum	mg/kg	13125.282	21	21	7110	16300	2
Antimony	mg/kg	.000	2	10	1.2	1.9	2
Arsenic	mg/kg	11.608	21	21	4.6	9.3	0
Barium	mg/kg	88.500	21	21	55.1	151	5
Beryllium	mg/kg	.600	20	21	.49	1.9	15
Cadmium	mg/kg	.770	0	21	0	0	0
Calcium	mg/kg	5296.781	21	21	12900	140000	21
Chromium	mg/kg	17.057	20	21	8.8	21.5	2
Cobalt	mg/kg	16.913	21	21	3.7	13.9	0
Copper	mg/kg	15.700	21	21	9.3	19.6	12
Cyanide	mg/kg	.230	10	21	.12	.32	1
Iron	mg/kg	24788.749	21	21	12800	20700	0
Lead	mg/kg	29.575	21	21	13.7	46	3
Magnesium	mg/kg	1460.000	21	21	6490	31600	21
Manganese	mg/kg	2257.945	21	21	368	2650	1
Mercury	mg/kg	.300	0	21	0	0	0
Molybdenum	mg/kg	.000	17	21	4	6.2	17
Nickel	mg/kg	25.145	20	21	11.9	22.7	0
Potassium	mg/kg	1349.530	21	21	903	2170	12
Selenium	mg/kg	.720	4	21	.52	.72	0
Silicon	mg/kg	1914.313	21	21	406	1080	0
Silver	mg/kg	.000	20	21	3.2	6.5	20
Sodium	mg/kg	55.145	21	21	69.5	328	21
Thallium	mg/kg	.580	0	21	0	0	0
Vanadium	mg/kg	33.693	21	21	17.8	30.8	0
Zinc	mg/kg	58.500	21	21	33.3	67.8	3

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PEMP-OU02-4 DRAFT  
February 18, 1994

TABLE 4-48A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES</u>							
CS-137	pCi/g	.849	19	21	.089	.836	0
GROSS ALPHA	pCi/g	.000	21	21	18.7	237	21
GROSS BETA	pCi/g	.000	21	21	27.7	113	21
NP-237	pCi/g	.000	13	15	.056	.483	13
PU-238	pCi/g	.000	14	17	.019	.341	14
PU-239/240	pCi/g	.000	13	17	.019	.076	13
RA-226	pCi/g	1.528	21	21	.874	30.8	6
RA-228	pCi/g	1.170	21	21	.917	3.88	9
RU-106	pCi/g	.000	0	21	0	0	0
SR-90	pCi/g	.000	5	21	.16	1	5
TC-99	pCi/g	.000	1	21	142	142	1
TH-228	pCi/g	1.519	16	16	.658	4.41	2
TH-230	pCi/g	2.112	16	16	.117	13.8	6
TH-232	pCi/g	1.469	16	16	.19	3.99	1
TH-TOTAL	mg/kg	10.700	16	16	6.2	36.7	3
U-234	pCi/g	1.319	21	21	2.73	16.3	21
U-235/236	pCi/g	.181	21	21	.149	.887	17
U-238	pCi/g	1.270	21	21	2.87	16.6	21
U-TOTAL	mg/kg	3.240	21	21	1.86	50.6	20
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	21	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	21	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	21	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	21	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	21	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	21	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	21	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	21	0	0	0
2-Butanone	ug/kg	.000	0	21	0	0	0
2-Hexanone	ug/kg	.000	0	21	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	21	0	0	0

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TABLE 4-48A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>VOLATILE ORGANICS (Continued)</u>							
Acetone	ug/kg	.000	5	21	7	68	5
Benzene	ug/kg	.000	0	21	0	0	0
Bromodichloromethane	ug/kg	.000	0	21	0	0	0
Bromoform	ug/kg	.000	0	21	0	0	0
Bromomethane	ug/kg	.000	0	21	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	21	0	0	0
Carbon disulfide	ug/kg	.000	0	21	0	0	0
Chlorobenzene	ug/kg	.000	0	21	0	0	0
Chloroethane	ug/kg	.000	0	21	0	0	0
Chloroform	ug/kg	.000	0	21	0	0	0
Chloromethane	ug/kg	.000	0	17	0	0	0
Dibromochloromethane	ug/kg	.000	0	21	0	0	0
Ethylbenzene	ug/kg	.000	0	21	0	0	0
Methylene chloride	ug/kg	.000	2	21	3	5	2
Styrene	ug/kg	.000	0	21	0	0	0
Tetrachloroethene	ug/kg	.000	0	21	0	0	0
Toluene	ug/kg	.000	0	21	0	0	0
Trichloroethene	ug/kg	.000	0	21	0	0	0
Vinyl Acetate	ug/kg	.000	0	21	0	0	0
Vinyl chloride	ug/kg	.000	0	21	0	0	0
Xylenes, Total	ug/kg	.000	0	21	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	21	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	21	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	21	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	21	0	0	0
1,2-Diphenylhydrazine	ug/kg	.000	0	17	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	21	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	21	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	21	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	21	0	0	0

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TABLE 4-48A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
2,4-Dichlorophenol	ug/kg	.000	0	21	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	21	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	13	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	21	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	21	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	21	0	0	0
2-Chlorophenol	ug/kg	.000	0	21	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	21	0	0	0
2-Methylphenol	ug/kg	.000	0	21	0	0	0
2-Nitroaniline	ug/kg	.000	0	21	0	0	0
2-Nitrophenol	ug/kg	.000	0	21	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	21	0	0	0
3-Nitroaniline	ug/kg	.000	0	21	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	13	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	21	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	21	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	21	0	0	0
4-Methylphenol	ug/kg	.000	0	21	0	0	0
4-Nitroaniline	ug/kg	.000	0	21	0	0	0
4-Nitrophenol	ug/kg	.000	0	18	0	0	0
Acenaphthene	ug/kg	.000	1	20	140	140	1
Acenaphthylene	ug/kg	.000	5	21	55	1200	5
Anthracene	ug/kg	.000	6	21	59	730	6
Benzo(a)anthracene	ug/kg	.000	12	21	44	5500	12
Benzo(a)pyrene	ug/kg	.000	12	21	51	9400	12
Benzo(b)fluoranthene	ug/kg	.000	12	21	46	6200	12
Benzo(g,h,i)perylene	ug/kg	.000	12	21	51	6200	12
Benzo(k)fluoranthene	ug/kg	.000	13	21	49	7300	13
Benzoic acid	ug/kg	.000	10	17	52	270	10
Benzyl alcohol	ug/kg	.000	0	13	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	21	0	0	0

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TABLE 4-48A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Carbazole	ug/kg	.000	3	21	48	170	3
Chrysene	ug/kg	.000	13	21	60	6000	13
Di-n-butyl phthalate	ug/kg	.000	0	21	0	0	0
Di-n-octyl phthalate	ug/kg	.000	0	21	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	7	21	43	1900	7
Dibenzofuran	ug/kg	.000	1	21	130	130	1
Diethyl phthalate	ug/kg	.000	0	21	0	0	0
Dimethyl phthalate	ug/kg	.000	1	21	62	62	1
Fluoranthene	ug/kg	.000	16	21	45	9200	16
Fluorene	ug/kg	.000	1	21	220	220	1
Hexachlorobenzene	ug/kg	.000	0	21	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	21	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	21	0	0	0
Hexachloroethane	ug/kg	.000	0	21	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	10	21	45	6000	10
Isophorone	ug/kg	.000	0	21	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	21	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	17	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	21	0	0	0
Naphthalene	ug/kg	.000	0	21	0	0	0
Nitrobenzene	ug/kg	.000	0	21	0	0	0
Pentachlorophenol	ug/kg	.000	0	21	0	0	0
Phenanthrene	ug/kg	.000	9	21	48	2300	9
Phenol	ug/kg	.000	0	21	0	0	0
Pyrene	ug/kg	.000	13	21	62	8200	13
Tributyl phosphate	ug/kg	.000	0	17	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	21	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	21	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	21	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	19	21	64	110	19
p-Chloroaniline	ug/kg	.000	0	21	0	0	0

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TABLE 4-48A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>PESTICIDES/PCBS</u>							
4,4'-DDD	ug/kg	.000	0	21	0	0	0
4,4'-DDE	ug/kg	.000	0	21	0	0	0
4,4'-DDT	ug/kg	.000	0	21	0	0	0
Aldrin	ug/kg	.000	0	21	0	0	0
Aroclor-1016	ug/kg	.000	0	21	0	0	0
Aroclor-1221	ug/kg	.000	0	21	0	0	0
Aroclor-1232	ug/kg	.000	0	21	0	0	0
Aroclor-1242	ug/kg	.000	0	21	0	0	0
Aroclor-1248	ug/kg	.000	0	21	0	0	0
Aroclor-1254	ug/kg	.000	1	21	89	89	1
Aroclor-1260	ug/kg	.000	2	21	38	52	2
Dieldrin	ug/kg	.000	1	21	9.7	9.7	1
Endosulfan II	ug/kg	.000	0	21	0	0	0
Endosulfan sulfate	ug/kg	.000	0	21	0	0	0
Endosulfan-I	ug/kg	.000	0	21	0	0	0
Endrin	ug/kg	.000	0	21	0	0	0
Endrin aldehyde	ug/kg	.000	0	21	0	0	0
Endrin ketone	ug/kg	.000	1	20	5.9	5.9	1
Heptachlor	ug/kg	.000	0	21	0	0	0
Heptachlor epoxide	ug/kg	.000	0	21	0	0	0
Methoxychlor	ug/kg	.000	0	21	0	0	0
Toxaphene	ug/kg	.000	0	21	0	0	0
alpha-BHC	ug/kg	.000	0	21	0	0	0
alpha-Chlordane	ug/kg	.000	0	21	0	0	0
beta-BHC	ug/kg	.000	0	21	0	0	0
delta-BHC	ug/kg	.000	0	21	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	21	0	0	0
gamma-Chlordane	ug/kg	.000	0	21	0	0	0

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Sample location and radionuclide data collected from surface samples in the South Field are shown on Figure 4-17 (see Volume 2, Oversized Figures). Highest radionuclide activities were detected in two samples (11186 and Boring No. 1972) collected near the north boundary. This location corresponds to the location of waste piles seen in a 1957 aerial photograph of the site. The surface sample 11186 detected the highest activities of radium-226 (30.8 pCi/g) of any surface sample collected from the South Field. The data do not indicate a correlation between thorium, uranium or radium. The distribution of radionuclide concentrations suggests multiple surficial areas elevated concentration which correlate with surface FIDLER scans conducted during the CIS (see Figure F-15A on Page F-15-159). Surface soil data confirm the CIS field data (Table F-4, Appendix F) and indicate that surface dumping occurred adjacent to the north boundary road.

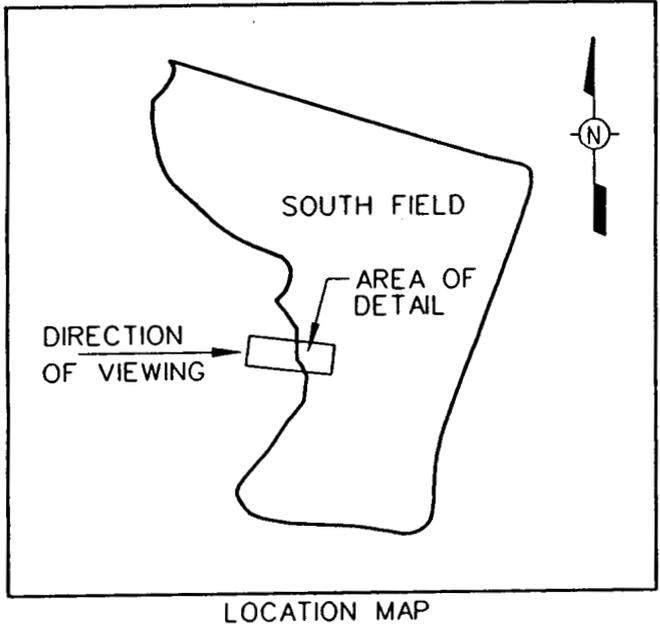
Figure 4-18 (See Volume I, Oversized Figures) identifies the organics in surface samples detected above background in the South Field. The highest concentrations of organic compounds were detected in samples collected from the northern half of the South Field. Some samples have high concentrations of both radionuclides and organics (SF-SS-17 had 28.4 µg/g total uranium and 36,862 µg/kg total SVOCs) while other samples had high activities of radionuclides but relatively low concentrations of organic compounds (1965 had 49 µg/g total uranium and 205 µg/kg total organics). This pattern suggests that the constituents were not consistently disposed of together on the surface of the South Field.

Samples collected for lead analysis at the Firing Range are shown on Figure 4-18A and are presented on Table 4-48B. Analytical data indicate that shallow samples (approximately 0-3 feet deep) have concentrations of lead that range from 408 mg/kg to 2820 mg/kg. Highest concentrations were detected in samples from SP-2 and SP-5, which are aligned with the center of the Firing Range. Concentrations of lead rapidly decrease with distance into the face of the firing range, which corresponds roughly to the depth of samples shown on Table 4-48B. For example, one sample out of five was detected above background at 3 to 4 feet deep. A horizontal boring detected elevated concentrations in a composite sample from 0-5 feet beyond the surface of the firing range (see table on page 267), but below background in deeper samples. The data suggest that lead from bullets was stopped in the soil within 5 feet of the slope that formed the backdrop of the Firing Range.

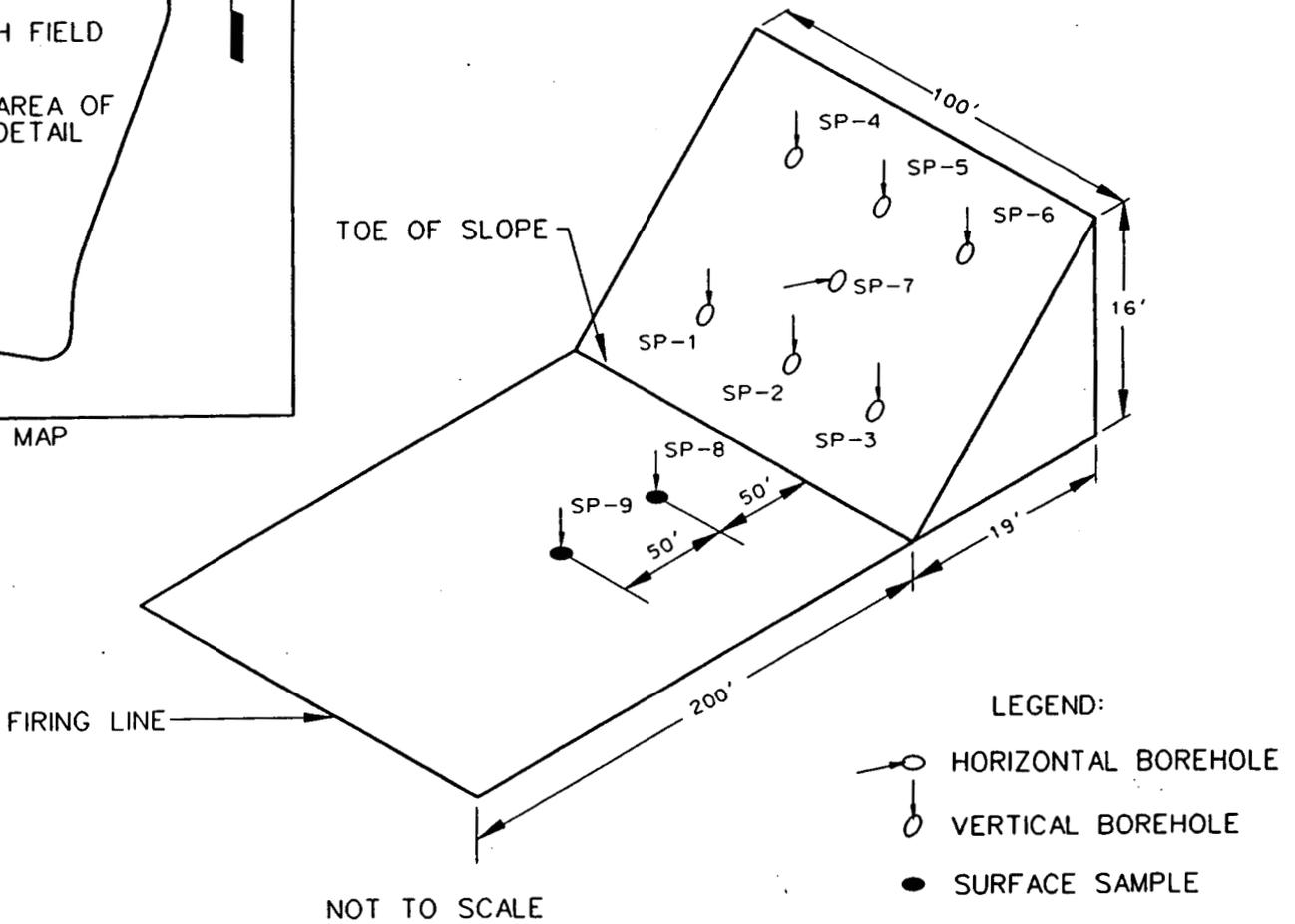
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fig0418.dgn



LOCATION MAP



NOT TO SCALE

LEGEND:

- HORIZONTAL BOREHOLE
- VERTICAL BOREHOLE
- SURFACE SAMPLE

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FIGURE 4-18a  
SUBSURFACE SAMPLING LOCATIONS FOR  
FIRING RANGE REMOVAL SITE EVALUATION

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**TABLE 4-48B**  
**LEAD CONCENTRATIONS IN VERTICAL BORINGS**  
**AT THE FEMP FIRING RANGE**

Depth Interval (ft)	Boring Numbers												
	Background	SP-1		SP-2		SP-3		SP-4		SP-5		SP-6	
		Total (mg/kg)	TCLP (mg/L)										
0.0-0.5	29.5	665	6.9	1250	2.0	123	0.4	63.2	NA	2820	101	64.4	NA
0.5-1.0	15.8	154	1.8	2200	4.8	5.6	NA	7.7	NA	2270	21.2	31.3	NA
1.0-2.0	15.8	6.1	NA	2460	8.8	4.8	NA	11.2	NA	503	1.3	35.7	NA
				1380	9.3			7.0					
2.0-3.0	15.8	6.6	NA	345	1.4	5.1	NA	12.8	NA	204	2.9	17.6	NA
						17.5							
3.0-4.0	15.8	4.9	NA	57.4	NA	4.0	NA	7.9	NA	2.1	NA	NA	NA
4.0-5.0	15.8	5.6	NA	29.6	NA	1.6	NA	7.5	NA	11.6	NA	NA	NA

NA = Not analyzed

Source: Westinghouse Environmental Management Company

Note: Samples sieved with No. 10 sieve to remove lead fragments greater than 2 mm

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Depth (ft)	Background (mg/kg)	Total Lead (mg/kg)	TCLP Lead (mg/L)
0-5	15.78	1020	0.27
5-10	15.78	4.8	NA
10-15	15.78	6.1	NA
15-20	15.78	4.5	NA
20-25	15.78	6.9	NA
25-30	15.78	5.3	NA
30-35	15.78	4.6	NA
35-40	15.78	7.2	NA
40-45	15.78	4.6	NA
45-50	15.78	5.5	NA

NA = Not analyzed  
 Note: Samples sieved with No. 10 sieve to remove lead fragments greater than 2 mm.

Samples collected from subsurface soil borings drilled in the South Field were compared to subsurface soil background concentrations, and a table of the resulting constituent concentrations detected above background is provided in Appendix F, Table F-2B. A summary of the analytes is provided in Table 4-49 and Table 4-50. Seventeen metals, isotopes of nine elements, and 25 organic compounds exceeded background concentrations in sub-surface samples collected during the Phase I program at the South Field. Metals detected in 40 percent of Phase I samples included antimony, beryllium, cadmium, chromium, copper, and silver. Most Phase I samples were collected to a maximum depth of 7.5 feet. These metals were also detected above background in surface soil samples and indicate that metals have been mixed into the upper filled area. Twenty-three metals (Aluminum, Arsenic, Iron, Magnesium, Potassium, Thallium, Vanadium, and Zinc were not detected above background for Phase I; Boron, Cadmium, and Cobalt were detected above background for Phase I but not Phase II), isotopes of seven elements (ruthenium-106 and technetium-99 were detected above background for Phase I but not Phase II), and 30 organic compounds (Carbon disulfide, Toluene, Acenaphthaulene, Benzo(k)flouanthene, Dibenz(a,h,)anthracene, Naphthalene, Tributyl Phosphate, Aroclor-126-, Dieldrin, Endrin ketone, alpha-Chlordane, and gamma-Chlordane were detected above background for the Phase II and not for Phase I; 4-Methyl-2Pentanone, Chloroform, Methylene Chloride, Total Xylenes, Di-n-Octyl phthalate, Diethyl phthalate, Tetrachlorodibenzofuran were detected above background for Phase I but not Phase II). Lead and copper were detected at up to 20 times background (436 mg/kg copper and 385 mg/kg lead) in a sample from Trench 4. Elsewhere, concentrations were near background concentrations. The distribution of metal concentrations suggest

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**TABLE 4-49**  
**SOUTH FIELD**  
**SUBSURFACE SOIL**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>METALS</b>							
Aluminum	mg/kg	16277.291	18	18	4860	13500	0
Antimony	mg/kg	.000	9	12	7.8	29.7	9
Arsenic	mg/kg	9.704	17	18	2.9	8.1	0
Barium	mg/kg	121.064	18	18	52.5	198	4
Beryllium	mg/kg	.620	14	18	.77	1.6	14
Boron	mg/kg	43.204	5	7	17.1	36	0
Cadmium	mg/kg	.910	14	18	.69	4.9	13
Calcium	mg/kg	150000.000	18	18	3720	165000	1
Chromium	mg/kg	20.953	18	18	11	31.9	14
Cobalt	mg/kg	15.929	18	18	8.2	23.2	2
Copper	mg/kg	20.230	18	18	9.7	26.8	7
Cyanide	mg/kg	.170	1	18	2.6	2.6	1
Iron	mg/kg	31188.164	18	18	14900	29200	0
Lead	mg/kg	15.780	18	18	6.8	1140	9
Magnesium	mg/kg	43052.339	18	18	3810	35300	0
Manganese	mg/kg	1045.407	18	18	303	1060	1
Mercury	mg/kg	.290	3	18	.23	.31	1
Molybdenum	mg/kg	.270	12	18	3.4	15.8	12
Nickel	mg/kg	34.747	18	18	17.3	39.5	3
Potassium	mg/kg	2007.519	18	18	548	1920	0
Selenium	mg/kg	.000	0	12	0	0	0
Silicon	mg/kg	1069.496	7	7	636	1530	1
Silver	mg/kg	.000	12	18	1.8	16.2	12
Sodium	mg/kg	227.947	16	18	37.5	522	2
Thallium	mg/kg	.490	2	18	.19	.2	0
Vanadium	mg/kg	38.088	18	18	15.9	34.1	0
Zinc	mg/kg	73.158	18	18	26.9	68.1	0
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	18	71	.2	.2	18
GROSS ALPHA	pCi/g	.000	0		0	0	0
GROSS BETA	pCi/g	.000	0		0	0	0
NP-237	pCi/g	.000	41	104	.6	.6	41
PU-238	pCi/g	.000	41	112	.6	.6	41
PU-239/240	pCi/g	.000	42	112	.6	1.23	42
RA-226	pCi/g	1.470	62	71	.39	15.7	10
RA-228	pCi/g	1.325	55	70	.5	19	11

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TABLE 4-49  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>							
RU-106	pCi/g	.000	17	71	1	1	17
SR-90	pCi/g	.560	46	91	.5	1.91	8
TC-99	pCi/g	.000	43	78	.9	.9	43
TH-228	pCi/g	1.341	97	112	.6	20.3	16
TH-230	pCi/g	1.897	106	112	.6	57.3	26
TH-232	pCi/g	1.269	91	112	.6	17.5	11
TH-TOTAL	mg/kg	9.470	99	103	1.26	158	23
U-234	pCi/g	1.034	96	102	.6	119	64
U-235/236	pCi/g	.142	53	102	.6	20.6	53
U-238	pCi/g	1.122	95	102	.6	131	61
U-TOTAL	mg/kg	2.540	68	74	1	394	54
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	18	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	18	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	18	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	18	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	18	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	18	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	18	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	18	0	0	0
2-Butanone	ug/kg	.000	1	18	42	42	1
2-Hexanone	ug/kg	.000	0	18	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	2	18	1	3	2
Acetone	ug/kg	.000	6	18	5	56	6
Benzene	ug/kg	.000	0	18	0	0	0
Bromodichloromethane	ug/kg	.000	0	18	0	0	0
Bromoform	ug/kg	.000	0	18	0	0	0
Bromomethane	ug/kg	.000	0	17	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	18	0	0	0
Carbon disulfide	ug/kg	.000	0	18	0	0	0
Chlorobenzene	ug/kg	.000	0	18	0	0	0
Chloroethane	ug/kg	.000	0	18	0	0	0
Chloroform	ug/kg	.000	2	18	3	7	2
Chloromethane	ug/kg	.000	0	18	0	0	0
Dibromochloromethane	ug/kg	.000	0	18	0	0	0
Ethylbenzene	ug/kg	.000	0	18	0	0	0
Methylene chloride	ug/kg	.000	3	18	2	57	3
Styrene	ug/kg	.000	0	18	0	0	0
Tetrachloroethene	ug/kg	.000	0	18	0	0	0
Toluene	ug/kg	.000	0	18	0	0	0
Trichloroethene	ug/kg	.000	0	18	0	0	0
Vinyl Acetate	ug/kg	.000	0	18	0	0	0

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TABLE 4-49  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Vinyl chloride	ug/kg	.000	0	18	0	0	0
Xylenes, Total	ug/kg	.000	2	18	1	2	2
cis-1,3-Dichloropropene	ug/kg	.000	0	18	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	18	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	14	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	14	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	14	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	14	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	14	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	14	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	14	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	14	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	14	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	14	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	14	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	14	0	0	0
2-Chlorophenol	ug/kg	.000	0	14	0	0	0
2-Methylnaphthalene	ug/kg	.000	1	15	56	56	1
2-Methylphenol	ug/kg	.000	0	14	0	0	0
2-Nitroaniline	ug/kg	.000	0	14	0	0	0
2-Nitrophenol	ug/kg	.000	0	14	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	14	0	0	0
3-Nitroaniline	ug/kg	.000	0	13	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	14	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	14	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	14	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	14	0	0	0
4-Methylphenol	ug/kg	.000	0	14	0	0	0
4-Nitroaniline	ug/kg	.000	0	14	0	0	0
4-Nitrophenol	ug/kg	.000	0	14	0	0	0
Acenaphthene	ug/kg	.000	0	14	0	0	0
Acenaphthylene	ug/kg	.000	0	14	0	0	0
Anthracene	ug/kg	.000	1	14	58	58	1
Benzo(a)anthracene	ug/kg	.000	5	14	78	270	5
Benzo(a)pyrene	ug/kg	.000	3	14	46	230	3
Benzo(b)fluoranthene	ug/kg	.000	5	14	88	360	5
Benzo(g,h,i)perylene	ug/kg	.000	2	14	45	100	2
Benzo(k)fluoranthene	ug/kg	.000	0	14	0	0	0
Benzoic acid	ug/kg	.000	5	17	47	150	5
Benzyl alcohol	ug/kg	.000	0	14	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	14	0	0	0

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TABLE 4-49  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATLE ORGANICS (Continued)</u>							
Carbazole	ug/kg	.000	0	2	0	0	0
Chrysene	ug/kg	.000	5	14	70	300	5
Di-n-butyl phthalate	ug/kg	.000	1	14	80	80	1
Di-n-octyl phthalate	ug/kg	.000	1	15	210	210	1
Dibenzo(a,h)anthracene	ug/kg	.000	0	14	0	0	0
Dibenzofuran	ug/kg	.000	0	13	0	0	0
Diethyl phthalate	ug/kg	.000	1	15	84	84	1
Dimethyl phthalate	ug/kg	.000	0	14	0	0	0
Fluoranthene	ug/kg	.000	7	15	39	610	7
Fluorene	ug/kg	.000	0	14	0	0	0
Hexachlorobenzene	ug/kg	.000	0	14	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	14	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	14	0	0	0
Hexachloroethane	ug/kg	.000	0	14	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	1	14	84	84	1
Isophorone	ug/kg	.000	0	14	0	0	0
Methyl parathion	ug/kg	.000	0	15	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	14	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	14	0	0	0
Naphthalene	ug/kg	.000	0	14	0	0	0
Nitrobenzene	ug/kg	.000	0	14	0	0	0
O,O,O-Triethylphosphorothioate	ug/kg	.000	0	10	0	0	0
Parathion	ug/kg	.000	0	15	0	0	0
Pentachlorophenol	ug/kg	.000	0	14	0	0	0
Phenanthrene	ug/kg	.000	5	14	93	370	5
Phenol	ug/kg	.000	0	14	0	0	0
Pyrene	ug/kg	.000	10	17	43	500	10
Sulfotep	ug/kg	.000	0	15	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	14	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	14	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	14	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	1	14	40	40	1
p-Chloroaniline	ug/kg	.000	0	14	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	19	0	0	0
4,4'-DDE	ug/kg	.000	0	19	0	0	0
4,4'-DDT	ug/kg	.000	0	19	0	0	0
Aldrin	ug/kg	.000	0	19	0	0	0
Aroclor-1016	ug/kg	.000	0	19	0	0	0
Aroclor-1221	ug/kg	.000	0	19	0	0	0
Aroclor-1232	ug/kg	.000	0	19	0	0	0
Aroclor-1242	ug/kg	.000	0	19	0	0	0
Aroclor-1248	ug/kg	.000	0	19	0	0	0
Aroclor-1254	ug/kg	.000	7	19	32	1100	7

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TABLE 4-49  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Aroclor-1260	ug/kg	.000	0	19	0	0	0
Dieldrin	ug/kg	.000	0	19	0	0	0
Endosulfan II	ug/kg	.000	0	19	0	0	0
Endosulfan sulfate	ug/kg	.000	0	19	0	0	0
Endosulfan-I	ug/kg	.000	0	19	0	0	0
Endrin	ug/kg	.000	0	19	0	0	0
Endrin ketone	ug/kg	.000	0	19	0	0	0
Heptachlor	ug/kg	.000	0	19	0	0	0
Heptachlor epoxide	ug/kg	.000	0	19	0	0	0
Methoxychlor	ug/kg	.000	0	19	0	0	0
Toxaphene	ug/kg	.000	0	19	0	0	0
alpha-BHC	ug/kg	.000	0	19	0	0	0
alpha-Chlordane	ug/kg	.000	0	19	0	0	0
beta-BHC	ug/kg	.000	0	19	0	0	0
delta-BHC	ug/kg	.000	0	19	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	19	0	0	0
gamma-Chlordane	ug/kg	.000	0	19	0	0	0
<u>DIOXIN/FURAN</u>							
1,2,3,4,6,7,8-Heptachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
1,2,3,4,6,7,8-Heptachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
1,2,3,4,7,8,9-Heptachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
1,2,3,4,7,8-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
1,2,3,4,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
1,2,3,6,7,8-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
1,2,3,6,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
1,2,3,7,8,9-Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
1,2,3,7,8,9-Hexachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
1,2,3,7,8-Pentachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
1,2,3,7,8-Pentachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
2,3,4,6,7,8-Hexachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
2,3,4,7,8-Pentachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
2,3,7,8-TCDD	ug/kg	.000	0	10	0	0	0
2,3,7,8-TCDF	ug/kg	.000	0	10	0	0	0
Heptachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
Heptachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
Hexachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
Hexachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
Octachlorodibenzo-p-dioxin	ug/kg	.000	10	10	12	3.6	10
Octachlorodibenzofuran	ug/kg	.000	0	10	0	0	0
Pentachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
Pentachlorodibenzofuran	ug/kg	.000	0	10	0	0	0

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TABLE 4-49  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>DIOXIN/FURAN (Continued)</u>							
Tetrachlorodibenzo-p-dioxin	ug/kg	.000	0	10	0	0	0
Tetrachlorodibenzofuran	ug/kg	.000	1	10	.018	.018	1
<u>PESTICIDES/PCBs</u>							
Demeton	ug/kg	.000	0	8	0	0	0
Diazinon	ug/kg	.000	0	7	0	0	0
Dimethoate	ug/kg	.000	0	15	0	0	0
Disulfoton	ug/kg	.000	0	15	0	0	0
Ethion	ug/kg	.000	0	9	0	0	0
Famphur	ug/kg	.000	0	15	0	0	0
Malathion	ug/kg	.000	0	7	0	0	0
Phorate	ug/kg	.000	0	15	0	0	0
Tetraethylpyrophosphate	ug/kg	.000	0	7	0	0	0
Thionazin	ug/kg	.000	0	16	0	0	0

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**TABLE 4-50**  
**SOUTH FIELD**  
**SUBSURFACE SOIL**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	43	43	2680	22800	5
Antimony	mg/kg	.000	2	37	1.2	1.8	2
Arsenic	mg/kg	9.704	43	43	1.5	14.1	4
Barium	mg/kg	121.064	43	43	12.8	203	5
Beryllium	mg/kg	.620	31	43	.46	2.2	16
Cadmium	mg/kg	.910	0	43	0	0	0
Calcium	mg/kg	150000.000	43	43	1620	252000	3
Chromium	mg/kg	20.953	41	43	5	36.2	2
Cobalt	mg/kg	15.929	38	43	3	14.2	0
Copper	mg/kg	20.230	42	43	8.3	436	14
Cyanide	mg/kg	.170	8	42	.12	.78	4
Iron	mg/kg	31188.164	43	43	7300	44100	6
Lead	mg/kg	15.780	43	43	3.3	385	10
Magnesium	mg/kg	43052.339	43	43	2780	50800	1
Manganese	mg/kg	1045.407	43	43	186	1140	1
Mercury	mg/kg	.290	5	43	.12	.73	1
Molybdenum	mg/kg	.270	31	43	4	17.5	31
Nickel	mg/kg	34.747	39	43	8.8	74.2	3
Potassium	mg/kg	2007.519	43	43	520	2590	5
Selenium	mg/kg	.000	0	43	0	0	0
Silicon	mg/kg	1069.496	43	43	5.5	3370	1
Silver	mg/kg	.000	37	43	2.8	14.1	37
Sodium	mg/kg	227.947	43	43	51.7	294	4
Thallium	mg/kg	.490	3	43	.43	.58	1
Vanadium	mg/kg	38.088	43	43	9.8	47.9	4
Zinc	mg/kg	73.158	43	43	23.5	508	6
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	9	43	.07	.547	9
GROSS ALPHA	pCi/g	.000	41	43	8.72	267	41
GROSS BETA	pCi/g	.000	43	43	13.9	530	43
NP-237	pCi/g	.000	30	37	.0321	6.53	30
PU-238	pCi/g	.000	27	43	.016	.735	27
PU-239/240	pCi/g	.000	15	43	.0147	.083	15
RA-226	pCi/g	1.470	44	45	.6	31.2	10
RA-228	pCi/g	1.325	44	44	.44	675	10
RU-106	pCi/g	.000	0	43	0	0	0

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TABLE 4-50  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
SR-90	pCi/g	.560	21	43	.443	2.39	18
TC-99	pCi/g	.000	0	43	0	0	0
TH-228	pCi/g	1.341	34	32	.33	595	5
TH-230	pCi/g	1.897	34	32	.83	51.6	15
TH-232	pCi/g	1.269	34	32	.33	600	6
TH-TOTAL	mg/kg	9.470	32	32	3	28.9	5
U-234	pCi/g	1.034	44	44	.57	378	33
U-235/236	pCi/g	.142	44	44	.0196	19.7	21
U-238	pCi/g	1.122	44	44	.385	397	31
U-TOTAL	mg/kg	2.540	43	45	1.8	1170	42
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	42	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	42	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	42	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	42	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	42	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	42	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	42	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	42	0	0	0
2-Butanone	ug/kg	.000	4	42	1	11	4
2-Hexanone	ug/kg	.000	0	42	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	42	0	0	0
Acetone	ug/kg	.000	13	42	3	56	13
Benzene	ug/kg	.000	0	42	0	0	0
Bromodichloromethane	ug/kg	.000	0	42	0	0	0
Bromoform	ug/kg	.000	0	42	0	0	0
Bromomethane	ug/kg	.000	0	42	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	42	0	0	0
Carbon disulfide	ug/kg	.000	2	42	2	4	2
Chlorobenzene	ug/kg	.000	0	42	0	0	0
Chloroethane	ug/kg	.000	0	42	0	0	0
Chloroform	ug/kg	.000	0	42	0	0	0
Chloromethane	ug/kg	.000	0	41	0	0	0
Dibromochloromethane	ug/kg	.000	0	42	0	0	0
Ethylbenzene	ug/kg	.000	0	42	0	0	0
Methylene chloride	ug/kg	.000	0	42	0	0	0
Styrene	ug/kg	.000	0	42	0	0	0
Tetrachloroethene	ug/kg	.000	0	42	0	0	0
Toluene	ug/kg	.000	18	42	1	52	18
Trichloroethene	ug/kg	.000	0	42	0	0	0
Vinyl Acetate	ug/kg	.000	0	41	0	0	0
Vinyl chloride	ug/kg	.000	0	42	0	0	0

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TABLE 4-50  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	42	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	42	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	42	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	42	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	42	0	0	0
1,2-Diphenylhydrazine	ug/kg	.000	0	10	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	42	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	42	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	42	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	42	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	42	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	42	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	38	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	42	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	42	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	4	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	42	0	0	0
2-Chlorophenol	ug/kg	.000	0	42	0	0	0
2-Methylnaphthalene	ug/kg	.000	1	42	91	91	1
2-Methylphenol	ug/kg	.000	0	42	0	0	0
2-Nitroaniline	ug/kg	.000	0	42	0	0	0
2-Nitrophenol	ug/kg	.000	0	42	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	42	0	0	0
3-Nitroaniline	ug/kg	.000	0	42	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	22	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	42	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	42	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	42	0	0	0
4-Methylphenol	ug/kg	.000	0	42	0	0	0
4-Nitroaniline	ug/kg	.000	0	30	0	0	0
4-Nitrophenol	ug/kg	.000	0	41	0	0	0
Acenaphthene	ug/kg	.000	0	42	0	0	0
Acenaphthylene	ug/kg	.000	1	42	410	410	1
Anthracene	ug/kg	.000	2	42	62	250	2
Benzo(a)anthracene	ug/kg	.000	5	42	44	1100	5
Benzo(a)pyrene	ug/kg	.000	6	41	3	1800	6
Benzo(b)fluoranthene	ug/kg	.000	4	41	42	1600	4
Benzo(g,h,i)perylene	ug/kg	.000	4	41	52	1200	4
Benzo(k)fluoranthene	ug/kg	.000	5	41	48	1600	5
Benzoic acid	ug/kg	.000	4	38	44	57	4
Benzyl alcohol	ug/kg	.000	0	41	0	0	0

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TABLE 4-50  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Butyl benzyl phthalate	ug/kg	.000	0	42	0	0	0
Carbazole	ug/kg	.000	1	42	51	51	1
Chrysene	ug/kg	.000	5	42	53	1400	5
Di-n-butyl phthalate	ug/kg	.000	1	42	49	49	1
Di-n-octyl phthalate	ug/kg	.000	0	41	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	1	41	440	440	1
Dibenzofuran	ug/kg	.000	0	42	0	0	0
Diethyl phthalate	ug/kg	.000	0	42	0	0	0
Dimethyl phthalate	ug/kg	.000	0	42	0	0	0
Fluoranthene	ug/kg	.000	7	42	83	1800	7
Fluorene	ug/kg	.000	0	42	0	0	0
Hexachlorobenzene	ug/kg	.000	0	42	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	42	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	42	0	0	0
Hexachloroethane	ug/kg	.000	0	42	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	3	41	42	210	3
Isophorone	ug/kg	.000	0	42	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	42	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	14	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	42	0	0	0
Naphthalene	ug/kg	.000	1	42	61	61	1
Nitrobenzene	ug/kg	.000	0	42	0	0	0
Pentachlorophenol	ug/kg	.000	0	42	0	0	0
Phenanthrene	ug/kg	.000	6	42	52	350	6
Phenol	ug/kg	.000	0	42	0	0	0
Pyrene	ug/kg	.000	7	42	44	1400	7
Tributyl phosphate	ug/kg	.000	1	14	170	170	1
bis(2-Chloroethoxy)methane	ug/kg	.000	0	42	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	42	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	42	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	15	41	44	340	15
p-Chloroaniline	ug/kg	.000	0	42	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	43	0	0	0
4,4'-DDE	ug/kg	.000	0	43	0	0	0
4,4'-DDT	ug/kg	.000	0	43	0	0	0
Aldrin	ug/kg	.000	0	43	0	0	0
Aroclor-1016	ug/kg	.000	0	43	0	0	0
Aroclor-1221	ug/kg	.000	0	43	0	0	0
Aroclor-1232	ug/kg	.000	0	43	0	0	0
Aroclor-1242	ug/kg	.000	0	43	0	0	0
Aroclor-1248	ug/kg	.000	0	43	0	0	0

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TABLE 4-50  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Aroclor-1254	ug/kg	.000	12	43	41	430	12
Aroclor-1260	ug/kg	.000	1	43	89	89	1
Dieldrin	ug/kg	.000	1	43	16	16	1
Endosulfan II	ug/kg	.000	0	43	0	0	0
Endosulfan sulfate	ug/kg	.000	0	43	0	0	0
Endosulfan-I	ug/kg	.000	0	43	0	0	0
Endrin	ug/kg	.000	0	43	0	0	0
Endrin aldehyde	ug/kg	.000	0	43	0	0	0
Endrin ketone	ug/kg	.000	1	43	5.3	5.3	1
Heptachlor	ug/kg	.000	0	43	0	0	0
Heptachlor epoxide	ug/kg	.000	0	43	0	0	0
Methoxychlor	ug/kg	.000	0	43	0	0	0
Toxaphene	ug/kg	.000	0	43	0	0	0
alpha-BHC	ug/kg	.000	0	43	0	0	0
alpha-Chlordane	ug/kg	.000	1	43	8	8	1
beta-BHC	ug/kg	.000	0	43	0	0	0
delta-BHC	ug/kg	.000	0	43	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	43	0	0	0
gamma-Chlordane	ug/kg	.000	1	43	7.2	7.2	1

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multiple disposal sites. The trench sample data suggest that lead and copper are waste derived metals within the subsurface soil.

Radionuclide data from sub-surface samples collected from the South Field during Phase I and Phase II are shown on Figure 4-19 (see Volume 2, Oversized Figures). In the north part of the South Field, concentrations of total uranium appear to decrease in samples collected from the native material beneath the fill/till interface. For example, samples from Boring No. 11187 detect concentrations of total uranium that decrease from 228 mg/kg at 5.5 feet deep to 12.3 mg/kg at 10.5 feet deep. Similar trends are observed in total uranium concentrations (in  $\mu\text{g/g}$ ) in other borings sampled in the north part of the South Field: Boring No. 1942 (47.6 at 4 feet, 14.4 at 9 feet), Boring No. 1972 (47.6 at 4 feet, 14.4 at 9 feet) and Boring No. 1977 (35.9 at 10 feet, 3.5 at 18.5 feet). These data indicate that the native material has attenuated vertical movement of uranium.

Phase I and Phase II subsurface soil data were compared to CIS and ES data (Tables F-7 and F-8). Analytes detected in these preliminary studies were also detected in Phase I and Phase II and within the same order of magnitude.

Attenuation of total uranium concentrations with depth in disturbed materials appears to be less than that observed in native till. This is indicated by concentrations detected in samples collected from multiple depths in borings in the south part of the South Field. Samples of total uranium (in  $\mu\text{g/g}$ ) that show little attenuation with depth are seen in Boring No. 1968 (14.9  $\mu\text{g/g}$  at 6.5 feet, 12.2  $\mu\text{g/g}$  at 16.5 feet), Boring No. 1966 (13.9  $\mu\text{g/g}$  at 6.5 feet, 12.6  $\mu\text{g/g}$  at 25 feet) and Boring No. 1967 (15.3  $\mu\text{g/g}$  at 7.5 feet, 9.17  $\mu\text{g/g}$  at 31 feet). Samples from these borings are characteristic of the areas having the deepest fill, and suggest that 1) disturbed fill materials attenuate uranium less than the undisturbed native material or 2) the fill material had higher levels than background soil when they were deposited.

Six shallow trenches were excavated less than five feet deep during Phase I, and 18 samples were collected for full analytical testing from locations 1455 through 1472 (Figure 4-19, See Volume 1, Oversized Figures). Analytical data are presented in Appendix F, Table F-2B. Elevated (greater than five times background) concentrations of cadmium, lead, and silver were detected in samples that also had elevated concentrations of total uranium. Ten trenches were excavated 10 to 12 feet deep during Phase II to investigate anomalous electromagnetic readings and soil samples were collected from three

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of these trenches (Figure 4-19, see Volume I, Oversized Figures). A summary of data obtained from the Phase II trenching activities was provided in Table 4-46 and show data from two samples collected from Trench 2 and Trench 4 for laboratory analyses. A sample from 6 feet deep in Trench 2 (sample 113724) detected 34 mg/kg total uranium and 3540 mg/kg total thorium. This is the most elevated concentration of total thorium detected in a South Field sample. Extensive field screening with other parts of Trench 2 did not detect radioactivity levels as high as those in sample 113724, indicating that the high hit of thorium is localized. The total mass of thorium in Trench 2 was on the order of grams. Concentrations in a sample collected from 0-3 feet deep in Trench 4 (sample 113722) included: total uranium 1170  $\mu\text{g/g}$ ; total thorium 55.8  $\mu\text{g/g}$ ; copper 436 mg/kg; lead 385 mg/kg; vanadium 30.4  $\mu\text{g/g}$ ; and zinc at 508  $\mu\text{g/g}$ . These data indicate that the waste material originated in the production facility and that some of the construction debris in these trenches are probably contaminated as a result of process spillage and leakage prior to deposition in the South Field. Wipe samples indicate that significant radioactive contamination may have transferred to the soil that covers the solid pieces of concrete, wood, and steel. The contaminated materials within these trenches are potential sources of radionuclide contamination to percolating water.

Organic compounds detected in subsurface soil samples from the South Field are presented on Figure 4-20 (see Volume II, Oversized Figures). Highest concentrations of organic compounds were detected in samples collected from the north border of the South Field, and correspond to samples detecting the highest radionuclide concentrations. Semivolatile compounds detected in South Field samples are similar to chemicals detected in samples collected from the Solid Waste Landfill; however, concentrations detected in samples from the Solid Waste Landfill are 100 fold greater than those detected in South Field samples. This suggests that mixtures of waste chemical stocks were sent to the landfill but that much less chemically contaminated materials were sent to the South Field. The distribution of organic compounds indicates that they are pervasive in the surface (Figure 4-20) but that the number of compounds is greatly reduced within the upper four feet of the soil. The following table presents some data from Figure 4-18 and Figure 4-20:

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Boring No.	Depth (ft)	Number of Organic Compounds	Total Organic Concentrations (µg/kg)
11188	0-0.5	15	2416
	5-6	2	45
	10-11	3	59
1977	0-0.5	16	7852
	8.5-10	2	10
	16.5-18.5	3	47
1972	0-0.5	14	69039
	0.5-1	16	12083
	2.5-4	2	17
	7.5-9	1	3
1795	1-1.5	12	2777
	3-4	2	8.6
1968	0-1	10	397
	4.5-6.5	3	71
	15.5-16.5	1	3

These data indicate that in some areas, for example near to Boring No. 1972, the distribution is consistent with surface deposition of a liquid mixture of semivolatile/oily waste.

Uranium-238 data from subsurface data were kriged and the output processed to provide a model of constituent distribution in the South Field and Inactive Flyash Pile. The kriged parameters used are presented below:

Geological Layers	Fill	Till	Great Miami Aquifer
Kriging Method	Point	Block	Block
Variogram Range (ft)	275	750	250
Variogram Sill	226,000	12,400	1.3
Anisotropy detected?	No	No	No
Kriging Search			
X	250	750	250
Y	250	750	250
Z	20	20	20
Number of Samples	136	55	10

Note: Search radius of 50 feet x 50 feet x 10 feet was used in vicinity of sample 67046 (in South Field Great Miami Aquifer)

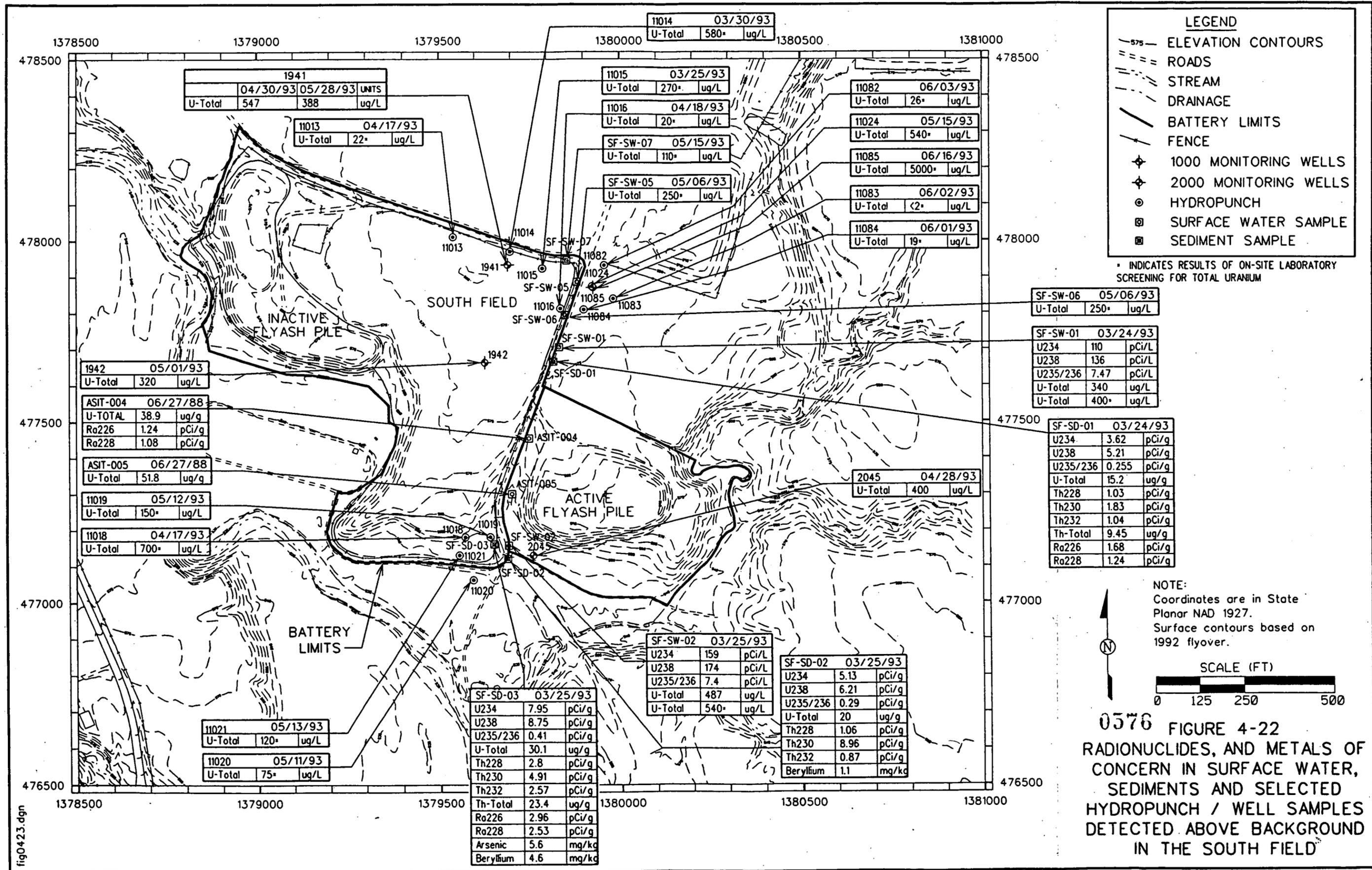
A drawing of a conceptual model for contamination located in three geological cross sections of the South Field is presented as Figure 4-21 (see Volume 2, Oversized Figures). Cross section B-B' cuts through the highest area of contamination detected in the Inactive Flyash and north South Field. The modeling indicates that break-through into the Great Miami Aquifer has been detected by soil samples collected beneath the Inactive Flyash Pile but not beneath the South Field. Modeled breakthrough of uranium-238 into the Great Miami Aquifer is primarily based upon data from Boring No. 1710 (Sample 67046 of 191 pCi/g at 28.5 feet deep). High activities of uranium-238 at this depth correspond to an area where there is no till material overlying the Great Miami Aquifer.

Cross section C-C' shows the relationship between deep soil contamination at the northwest edge of the South Field and the till surface beneath the fill. Contaminated material rests upon a depression which is interpreted to be a pre-construction streambed. The streambed has eroded the glacial overburden, which means contaminated material is in contact with the regional aquifer material.

4.5.3 Surface Water and Sediment

There are no perennial sources of surface water in the South Field subunit. Samples were collected after rain events occurred and when flow was available in a drainage. Chemical and radiological analytical results for surface water were not compared against background concentrations since there are no surface water background data. A table of detected constituent concentrations is provided in Appendix F, Table F-2D while detected analytes above background are shown on Table 4-51. Sample locations are shown on Figure 4-22. No surface water or sediment samples were collected during Phase I in the South Field CIS or ES. Seven metals and uranium were detected in two surface water samples collected during Phase II from the South Field; no organic compounds were detected.

Surface water drainage originating at the northeast corner of the South Field and flowing south along the east boundary of the South Field was observed for extended periods after rain events finished, and two seeps were observed upstream of location SF-SW-01. Total uranium in the drainage is therefore believed to be representative of shallow interflow and potential perched groundwater discharge. Concentrations of total uranium and isotopic uranium in surface water samples collected from the South Field drainages after rain events are presented in Table 4-52. Concentrations of uranium in drainage water ranged from 110  $\mu\text{g/L}$  at the upstream location (SF-SW-07) to 540  $\mu\text{g/L}$  collected from standing water at the farthest downstream location (SF-SW-02) at the southeast corner of the South Field. These values are in approximate agreement with groundwater samples collected from



1941		
04/30/93	05/28/93	UNITS
U-Total	547	388 ug/L

11013	04/17/93
U-Total	22* ug/L

11014	03/30/93
U-Total	580* ug/L

11015	03/25/93
U-Total	270* ug/L

11016	04/18/93
U-Total	20* ug/L

SF-SW-07	05/15/93
U-Total	110* ug/L

SF-SW-05	05/06/93
U-Total	250* ug/L

11082	06/03/93
U-Total	26* ug/L

11024	05/15/93
U-Total	540* ug/L

11085	06/16/93
U-Total	5000* ug/L

11083	06/02/93
U-Total	<2* ug/L

11084	06/01/93
U-Total	19* ug/L

1942	05/01/93
U-Total	320 ug/L

ASIT-004	06/27/88
U-TOTAL	38.9 ug/g
Ra226	1.24 pCi/g
Ra228	1.08 pCi/g

ASIT-005	06/27/88
U-Total	51.8 ug/g

11019	05/12/93
U-Total	150* ug/L

11018	04/17/93
U-Total	700* ug/L

SOUTH FIELD

ACTIVE FLYASH PILE

BATTERY LIMITS

SF-SW-06	05/06/93
U-Total	250* ug/L

SF-SW-01	03/24/93
U234	110 pCi/L
U238	136 pCi/L
U235/236	7.47 pCi/L
U-Total	340 ug/L
U-Total	400* ug/L

SF-SD-01	03/24/93
U234	3.62 pCi/g
U238	5.21 pCi/g
U235/236	0.255 pCi/g
U-Total	15.2 ug/g
Th228	1.03 pCi/g
Th230	1.83 pCi/g
Th232	1.04 pCi/g
Th-Total	9.45 ug/g
Ra226	1.68 pCi/g
Ra228	1.24 pCi/g

2045	04/28/93
U-Total	400 ug/L

SF-SW-02	03/25/93
U234	159 pCi/L
U238	174 pCi/L
U235/236	7.4 pCi/L
U-Total	487 ug/L
U-Total	540* ug/L

SF-SD-02	03/25/93
U234	5.13 pCi/g
U238	6.21 pCi/g
U235/236	0.29 pCi/g
U-Total	20 ug/g
Th228	1.06 pCi/g
Th230	8.96 pCi/g
Th232	0.87 pCi/g
Beryllium	1.1 mg/kd

SF-SD-03	03/25/93
U234	7.95 pCi/g
U238	8.75 pCi/g
U235/236	0.41 pCi/g
U-Total	30.1 ug/g
Th228	2.8 pCi/g
Th230	4.91 pCi/g
Th232	2.57 pCi/g
Th-Total	23.4 ug/g
Ra226	2.96 pCi/g
Ra228	2.53 pCi/g
Arsenic	5.6 mg/kd
Beryllium	4.6 mg/kd

11021	05/13/93
U-Total	120* ug/L

11020	05/11/93
U-Total	75* ug/L

fig0423.dgn

**TABLE 4-51**  
**SOUTH FIELD**  
**SURFACE WATER<sup>a</sup>**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.000	2	2	.178	.183	2
Antimony		mg/L	.000	0	2	0	0	0
Arsenic		mg/L	.000	0	2	0	0	0
Barium		mg/L	.000	2	2	.0497	.0544	2
Beryllium		mg/L	.000	0	2	0	0	0
Cadmium		mg/L	.000	0	2	0	0	0
Calcium		mg/L	.000	2	2	103	109	2
Chromium		mg/L	.000	0	2	0	0	0
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.000	0	2	0	0	0
Cyanide		mg/L	.000	0	2	0	0	0
Iron		mg/L	.000	0	2	0	0	0
Lead		mg/L	.000	0	2	0	0	0
Magnesium		mg/L	.000	2	2	30	38.2	2
Manganese		mg/L	.000	0	2	0	0	0
Mercury		mg/L	.000	0	2	0	0	0
Molybdenum		mg/L	.000	0	2	0	0	0
Nickel		mg/L	.000	0	2	0	0	0
Potassium		mg/L	.000	2	2	1.05	1.27	2
Selenium		mg/L	.000	0	2	0	0	0
Silicon		mg/L	.000	2	2	4.22	5.84	2
Silver		mg/L	.000	0	2	0	0	0
Sodium		mg/L	.000	2	2	4.26	5.05	2
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.000	0	2	0	0	0
Zinc		mg/L	.000	0	2	0	0	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	2	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	2	2	205	224	2
GROSS BETA	UNFL	pCi/L	.000	2	2	97	119	2
NP-237	UNFL	pCi/L	.000	0	2	0	0	0
PU-238	UNFL	pCi/L	.000	0	2	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-51  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-226	UNFL	pCi/L	.000	0	2	0	0	0
RA-228	UNFL	pCi/L	.000	0	2	0	0	0
RU-106	UNFL	pCi/L	.000	0	2	0	0	0
SR-90	UNFL	pCi/L	.000	0	2	0	0	0
TC-99	UNFL	pCi/L	.000	0	2	0	0	0
TH-228	UNFL	pCi/L	.000	0	2	0	0	0
TH-230	UNFL	pCi/L	.000	0	2	0	0	0
TH-232	UNFL	pCi/L	.000	0	2	0	0	0
TH-TOTAL	UNFL	ug/L	.000	0	2	0	0	0
U-234	UNFL	pCi/L	.000	2	2	110	159	2
U-235/236	UNFL	pCi/L	.000	2	2	7.4	7.47	2
U-238	UNFL	pCi/L	.000	2	2	136	174	2
U-TOTAL	UNFL	ug/L	.000	2	2	340	487	2
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	2	0	0	0
2-Butanone	UNFL	ug/L	.000	0	2	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	2	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	2	0	0	0
Acetone	UNFL	ug/L	.000	0	2	0	0	0
Benzene	UNFL	ug/L	.000	0	2	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	2	0	0	0
Bromoform	UNFL	ug/L	.000	0	2	0	0	0
Bromomethane	UNFL	ug/L	.000	0	2	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	2	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	2	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
Chloroethane	UNFL	ug/L	.000	0	2	0	0	0
Chloroform	UNFL	ug/L	.000	0	2	0	0	0
Chloromethane	UNFL	ug/L	.000	0	2	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	2	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-51  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Methylene chloride	UNFL	ug/L	.000	0	2	0 0	0
Styrene	UNFL	ug/L	.000	0	2	0 0	0
Tetrachloroethene	UNFL	ug/L	.000	0	2	0 0	0
Toluene	UNFL	ug/L	.000	0	2	0 0	0
Trichloroethene	UNFL	ug/L	.000	0	2	0 0	0
Vinyl Acetate	UNFL	ug/L	.000	0	2	0 0	0
Vinyl chloride	UNFL	ug/L	.000	0	2	0 0	0
Xylenes, Total	UNFL	ug/L	.000	0	2	0 0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0 0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	2	0 0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	2	0 0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	2	0 0	0
1,2-Diphenylhydrazine	UNFL	ug/L	.000	0	1	0 0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	2	0 0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	2	0 0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	2	0 0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	2	0 0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	2	0 0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	2	0 0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0 0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	2	0 0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	2	0 0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	1	0 0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	2	0 0	0
2-Chlorophenol	UNFL	ug/L	.000	0	2	0 0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	2	0 0	0
2-Methylphenol	UNFL	ug/L	.000	0	2	0 0	0
2-Nitroaniline	UNFL	ug/L	.000	0	2	0 0	0
2-Nitrophenol	UNFL	ug/L	.000	0	2	0 0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	2	0 0	0
3-Nitroaniline	UNFL	ug/L	.000	0	2	0 0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	1	0 0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	2	0 0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	2	0 0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	2	0 0	0
4-Methylphenol	UNFL	ug/L	.000	0	2	0 0	0
4-Nitroaniline	UNFL	ug/L	.000	0	2	0 0	0

See footnote at end of table

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**TABLE 4-51  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<b>SEMIVOLATILE ORGANICS (Continued)</b>							
4-Nitrophenol	UNFL	ug/L	.000	0	2	0 0	0
Acenaphthene	UNFL	ug/L	.000	0	2	0 0	0
Acenaphthylene	UNFL	ug/L	.000	0	2	0 0	0
Anthracene	UNFL	ug/L	.000	0	2	0 0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	2	0 0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	2	0 0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	2	0 0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	2	0 0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	2	0 0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0 0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Carbazole	UNFL	ug/L	.000	0	2	0 0	0
Chrysene	UNFL	ug/L	.000	0	2	0 0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	2	0 0	0
Dibenzofuran	UNFL	ug/L	.000	0	2	0 0	0
Diethyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	2	0 0	0
Fluoranthene	UNFL	ug/L	.000	0	2	0 0	0
Fluorene	UNFL	ug/L	.000	0	2	0 0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	2	0 0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	2	0 0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0 0	0
Hexachloroethane	UNFL	ug/L	.000	0	2	0 0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	2	0 0	0
Isophorone	UNFL	ug/L	.000	0	2	0 0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	2	0 0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	2	0 0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	2	0 0	0
Naphthalene	UNFL	ug/L	.000	0	2	0 0	0
Nitrobenzene	UNFL	ug/L	.000	0	2	0 0	0
Pentachlorophenol	UNFL	ug/L	.000	0	2	0 0	0
Phenanthrene	UNFL	ug/L	.000	0	2	0 0	0
Phenol	UNFL	ug/L	.000	0	2	0 0	0
Pyrene	UNFL	ug/L	.000	0	2	0 0	0
Tributyl phosphate	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	2	0 0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	2	0 0	0

See footnote at end of table

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TABLE 4-51  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	2	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	2	0	0	0
<u>PESTICIDES/PCBs</u>								
4,4'-DDD	UNFL	ug/L	.000	0	2	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	2	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	2	0	0	0
Aldrin	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	2	0	0	0
Dieldrin	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	2	0	0	0
Endrin	UNFL	ug/L	.000	0	2	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	2	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	2	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	2	0	0	0
Toxaphene	UNFL	ug/L	.000	0	2	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	2	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
beta-BHC	UNFL	ug/L	.000	0	2	0	0	0
delta-BHC	UNFL	ug/L	.000	0	2	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	2	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	1	1	355.3	355.3	0
Ammonia	UNFL	mg/L	.000	0	1	0	0	0
Chloride	UNFL	mg/L	.000	1	1	4.4	4.4	1
Fluoride	UNFL	mg/L	.000	1	1	.36	.36	1

See footnote at end of table

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**TABLE 4-51  
 (Continued)**

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>GENERAL CHEMISTRY (Continued)</u>								
Phenols	UNFL	mg/L	.000	0	1	0	0	0
Sulfate	UNFL	mg/L	.000	1	1	87.61	87.61	1
Sulfide	UNFL	mg/L	.000	0	1	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	1	.22	.22	1
Total Organic Carbon	UNFL	mg/L	.000	1	1	2.44	2.44	1
Total Organic Halides	UNFL	mg/L	.000	0	1	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	1	1	.22	.22	1
Total Phosphorous	UNFL	mg/L	.000	1	1	.05	.05	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-52**  
**SUMMARY OF RADIOISOTOPE CONCENTRATION**  
**IN SURFACE DRAINAGE IN THE SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Sample	Data Collected	Activity or Concentration
SF-SW-07 farthest upstream	Sample 113666 collected 5/15/93 On-site analysis:	Total U = 110 µg/L
SF-SW-05 downstream of SW-07	Sample 113489 collected 5/6/93 On-site analysis:	Total U = 160 µg/L
SF-SW-06 downstream of SF-05	Sample 113490 collected 5/6/93 On-site analysis:	Total U = 250 µg/L
SF-SW-01 approximately midway along east side of South Field, downstream of SW-06	Sample 110422* and Sample 110424 collected 3/24/93 On-site analysis:  Off-site analysis:	Total U = 400 µg/L  U-234 = 110 pCi/L U-235/236 = 7.47 pCi/L U-238 = 136 pCi/L Total U = 340 µg/L
SF-SW-02 at southeast corner of South Field and most downstream of locations SW-07 to SW-01	Sample 110432* and Sample 110434 collected 3/25/93 On-site analysis:  Off-site analysis:	Total U = 540 µg/L  U-234 = 159 pCi/L U-235/236 = 7.4 pCi/L U-238 = 174 pCi/L Total U = 487 µg/L
11018 standing water at southeast corner of South Field after period of heavy rain. Sample is representative of accumulated surface drainage from South Field.	Sample 112633 collected 4/17/93 On-site analysis:	Total U = 560 µg/L

\*Analyzed off site for full HSL, Rad.

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the glacial till monitoring Well 1941 (388 µg/L to 547 µg/L) and Well 1942 (320 µg/L) completed at the east side of the South Field. This indicates that the observed drainage is representative of perched groundwater at the east side of the subunit, and that the South Field has an impact upon drainage water.

Sediment samples were collected from the drainages during Phase II, and analytical data were compared to background soil data. A summary table of analytes exceeding background concentrations is provided in Appendix F, Table F-2E. A summary of the number of detected analytes is presented on Table 4-53. Nineteen metals, isotopes of six elements, and 15 organic compounds exceeded the expected background concentrations for surface soil. A comparison with metals detected in the South Field shows that arsenic, beryllium, copper, lead, selenium, silver, and zinc are common to the sediment and soils of the South Field. This means that the source for the sediment may be the South Field; however, all of the metal concentrations are close to background concentrations for flyash.

A comparison of sediment and surface water concentrations for selected constituents detected above background is shown in Table 4-54. Soluble constituents like chloride and fluoride were detected in water samples but not in the sediment. This suggests that the drainage water originated as groundwater because these constituents require relatively long contact time to leach out of geologic materials. Chloride and fluoride are present at trace amounts in precipitation and so a source other than rainfall is indicated. These data support the belief that drainage water samples containing elevated uranium are representative of perched groundwater.

Organic compounds are detected in sediment but not in drainage water, and it may be due to the erosion of surface soil into the drainage. This is because concentrations of organic compounds and metals found in sediment are similar to concentrations found in samples of surface soil at the South Field. Historical aerial photographs of early road construction show material similar in color to surface soil being used to construct roads and drainages.

4.5.4 Groundwater

Groundwater analytical data from the 1000-series wells in the South Field were compared to perched groundwater background concentrations developed for the site. A summary of the analytes detected above background is provided in Appendix F, Table F-2F and Table F-2G. A summary of the number of detected analytes is presented in Table 4-55 and Table 4-56. One upgradient well in the

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**TABLE 4-53**  
**SOUTH FIELD**  
**SEDIMENT**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	3	3	5750	12000	0
Antimony	mg/kg	.000	0	3	0	0	0
Arsenic	mg/kg	11.608	3	3	7.7	75.6	1
Barium	mg/kg	88.500	3	3	52.9	212	2
Beryllium	mg/kg	.600	2	3	1.1	4.6	2
Cadmium	mg/kg	.770	0	3	0	0	0
Calcium	mg/kg	5296.781	3	3	19300	83500	3
Chromium	mg/kg	17.057	3	3	6.8	19.2	1
Cobalt	mg/kg	16.913	3	3	3.7	19.4	1
Copper	mg/kg	15.700	3	3	8	122	2
Cyanide	mg/kg	.230	2	3	.18	.54	1
Iron	mg/kg	24788.749	3	3	10100	22300	0
Lead	mg/kg	29.575	3	3	27	91.5	2
Magnesium	mg/kg	1460.000	3	3	4510	20200	3
Manganese	mg/kg	2257.945	3	3	236	896	0
Mercury	mg/kg	.300	1	3	.19	.19	0
Molybdenum	mg/kg	.000	1	3	6.3	6.3	1
Nickel	mg/kg	25.145	3	3	7.1	36.4	2
Potassium	mg/kg	1349.530	3	3	597	1920	2
Selenium	mg/kg	.720	2	3	.86	5.9	2
Silicon	mg/kg	1914.313	3	3	640	1670	0
Silver	mg/kg	.000	2	3	2.9	6.5	2
Sodium	mg/kg	55.145	3	3	67.1	237	3
Thallium	mg/kg	.580	1	3	4.4	4.4	1
Vanadium	mg/kg	33.693	3	3	15.3	53.6	1
Zinc	mg/kg	58.500	3	3	24.9	118	2
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.849	2	3	.258	.4	0
GROSS ALPHA	pCi/g	.000	3	3	29.1	61.4	3
GROSS BETA	pCi/g	.000	3	3	32.6	58.2	3
NP-237	pCi/g	.000	3	3	.28	.42	3
PU-238	pCi/g	.000	3	3	.057	1.9	3
PU-239/240	pCi/g	.000	2	3	.067	.37	2
RA-226	pCi/g	1.528	3	3	1.57	2.96	3
RA-228	pCi/g	1.170	3	3	.93	2.53	2
RU-106	pCi/g	.000	0	3	0	0	0

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TABLE 4-53  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
SR-90	pCi/g	.000	2	3	.546	1.01	2
TC-99	pCi/g	.000	0	3	0	0	0
TH-228	pCi/g	1.519	3	3	1.03	2.8	1
TH-230	pCi/g	2.112	3	3	1.83	8.96	2
TH-232	pCi/g	1.469	3	3	.87	2.57	1
TH-TOTAL	mg/kg	10.700	3	3	7.93	23.4	1
U-234	pCi/g	1.319	3	3	3.62	7.95	3
U-235/236	pCi/g	.181	3	3	.255	.41	3
U-238	pCi/g	1.270	3	3	5.21	8.75	3
U-TOTAL	mg/kg	3.240	3	3	15.2	30.1	3
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	0	3	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	3	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	3	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	3	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	3	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	3	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	3	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	3	0	0	0
2-Butanone	ug/kg	.000	0	3	0	0	0
2-Hexanone	ug/kg	.000	0	3	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	3	0	0	0
Acetone	ug/kg	.000	0	3	0	0	0
Benzene	ug/kg	.000	0	3	0	0	0
Bromodichloromethane	ug/kg	.000	0	3	0	0	0
Bromoform	ug/kg	.000	0	3	0	0	0
Bromomethane	ug/kg	.000	0	3	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	3	0	0	0
Carbon disulfide	ug/kg	.000	0	3	0	0	0
Chlorobenzene	ug/kg	.000	0	3	0	0	0
Chloroethane	ug/kg	.000	0	3	0	0	0
Chloroform	ug/kg	.000	0	3	0	0	0
Chloromethane	ug/kg	.000	0	3	0	0	0
Dibromochloromethane	ug/kg	.000	0	3	0	0	0
Ethylbenzene	ug/kg	.000	0	3	0	0	0
Methylene chloride	ug/kg	.000	0	3	0	0	0
Styrene	ug/kg	.000	0	3	0	0	0
Tetrachloroethene	ug/kg	.000	0	3	0	0	0
Toluene	ug/kg	.000	1	3	8	8	1
Trichloroethene	ug/kg	.000	0	3	0	0	0
Vinyl Acetate	ug/kg	.000	0	3	0	0	0
Vinyl chloride	ug/kg	.000	0	3	0	0	0

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TABLE 4-53  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	3	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	3	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	3	0	0	0
<u>SEMIVOLITILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	3	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	3	0	0	0
1,2-Diphenylhydrazine	ug/kg	.000	0	3	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	3	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	3	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	3	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	3	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	3	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	3	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	1	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	3	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	3	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	3	0	0	0
2-Chlorophenol	ug/kg	.000	0	3	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	3	0	0	0
2-Methylphenol	ug/kg	.000	0	3	0	0	0
2-Nitroaniline	ug/kg	.000	0	3	0	0	0
2-Nitrophenol	ug/kg	.000	0	3	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	3	0	0	0
3-Nitroaniline	ug/kg	.000	0	3	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	3	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	3	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	3	0	0	0
4-Methylphenol	ug/kg	.000	0	3	0	0	0
4-Nitroaniline	ug/kg	.000	0	3	0	0	0
4-Nitrophenol	ug/kg	.000	0	3	0	0	0
Acenaphthene	ug/kg	.000	0	3	0	0	0
Acenaphthylene	ug/kg	.000	0	3	0	0	0
Anthracene	ug/kg	.000	0	3	0	0	0
Benzo(a)anthracene	ug/kg	.000	1	3	66	66	1
Benzo(a)pyrene	ug/kg	.000	1	2	110	110	1
Benzo(b)fluoranthene	ug/kg	.000	1	2	110	110	1
Benzo(g,h,i)perylene	ug/kg	.000	1	2	120	120	1
Benzo(k)fluoranthene	ug/kg	.000	2	2	74	120	2
Benzoic acid	ug/kg	.000	2	3	99	160	2
Benzyl alcohol	ug/kg	.000	0	3	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	3	0	0	0

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**TABLE 4-53  
(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>SEMIVOLATILE ORGANICS (Continued)</b>							
Carbazole	ug/kg	.000	0	3	0	0	0
Chrysene	ug/kg	.000	3	3	67	110	3
Di-n-butyl phthalate	ug/kg	.000	0	3	0	0	0
Di-n-octyl phthalate	ug/kg	.000	0	2	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	2	0	0	0
Dibenzofuran	ug/kg	.000	0	3	0	0	0
Diethyl phthalate	ug/kg	.000	0	3	0	0	0
Dimethyl phthalate	ug/kg	.000	0	3	0	0	0
Fluoranthene	ug/kg	.000	3	3	74	130	3
Fluorene	ug/kg	.000	0	3	0	0	0
Hexachlorobenzene	ug/kg	.000	0	3	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	3	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	3	0	0	0
Hexachloroethane	ug/kg	.000	0	3	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	1	2	99	99	1
Isophorone	ug/kg	.000	0	3	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	3	0	0	0
Naphthalene	ug/kg	.000	0	3	0	0	0
Nitrobenzene	ug/kg	.000	0	3	0	0	0
Pentachlorophenol	ug/kg	.000	0	3	0	0	0
Phenanthrene	ug/kg	.000	1	3	63	63	1
Phenol	ug/kg	.000	1	3	56	56	1
Pyrene	ug/kg	.000	3	3	71	110	3
Tributyl phosphate	ug/kg	.000	0	3	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	3	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	3	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	3	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	3	3	74	130	3
p-Chloroaniline	ug/kg	.000	0	3	0	0	0
<b>PESTICIDES/PCBs</b>							
4,4'-DDD	ug/kg	.000	0	3	0	0	0
4,4'-DDE	ug/kg	.000	0	3	0	0	0
4,4'-DDT	ug/kg	.000	0	3	0	0	0
Aldrin	ug/kg	.000	0	3	0	0	0
Aroclor-1016	ug/kg	.000	0	3	0	0	0
Aroclor-1221	ug/kg	.000	0	3	0	0	0
Aroclor-1232	ug/kg	.000	0	3	0	0	0
Aroclor-1242	ug/kg	.000	0	3	0	0	0
Aroclor-1248	ug/kg	.000	0	3	0	0	0
Aroclor-1254	ug/kg	.000	1	3	96	96	1

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TABLE 4-53  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Aroclor-1260	ug/kg	.000	0	3	0	0	0
Dieldrin	ug/kg	.000	0	3	0	0	0
Endosulfan II	ug/kg	.000	0	3	0	0	0
Endosulfan sulfate	ug/kg	.000	0	3	0	0	0
Endosulfan-I	ug/kg	.000	0	3	0	0	0
Endrin	ug/kg	.000	0	3	0	0	0
Endrin aldehyde	ug/kg	.000	0	3	0	0	0
Endrin ketone	ug/kg	.000	0	3	0	0	0
Heptachlor	ug/kg	.000	0	3	0	0	0
Heptachlor epoxide	ug/kg	.000	0	3	0	0	0
Methoxychlor	ug/kg	.000	0	3	0	0	0
Toxaphene	ug/kg	.000	0	3	0	0	0
alpha-BHC	ug/kg	.000	0	3	0	0	0
alpha-Chlordane	ug/kg	.000	0	3	0	0	0
beta-BHC	ug/kg	.000	0	3	0	0	0
delta-BHC	ug/kg	.000	0	3	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	3	0	0	0
gamma-Chlordane	ug/kg	.000	0	3	0	0	0

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**TABLE 4-54**  
**SOUTH FIELD**  
**COMPARISON OF CONCENTRATION OF SELECTED CONSTITUENTS**  
**IN SEDIMENT AND SURFACE WATER**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Sample	Sample No.	Constituent	Concentration in Surface Water	Concentration in Sediment	Comment
SF-SW-01	110422	Chloride	3.7 mg/L	ND	Comparison indicates a source in water other than sediment or rainwater. This suggests that the drainage water originates as perched groundwater.
SF-SD-01	110425	Fluoride	0.4 µg/L	ND	
		Total U	340 µg/L	15.2 µg/g	
SF-SW-02	110432	Chloride	4.4 mg/L	ND	
SF-SD-02	110430	Fluoride	0.36 µg/L	ND	
		Total U	340 µg/L	20 µg/g	
SF-SW-01	110422	Fluoranthene	ND	130 µg/kg	Comparison indicates a source in sediment other than surface water. This suggests the sediment was contaminated prior to being deposited in the drainage channel.
SF-SD-01	110425	Phenanthrene	ND	63 µg/kg	
		Pyrene	ND	110 µg/kg	
		Total Th	ND	9.45 µg/kg	
		Zinc	ND	24.9	
SF-SW-02	110432	Benzo(a)anthracene	ND	66 µg/kg	
SF-SD-02	1104360	Chrysene	ND	110 µg/kg	
		Fluorethene	ND	120 µg/kg	
		Phenol	ND	56 µg/kg	
		Pyrene	ND	110 µg/kg	
		Total Th	ND	7.93 µg/kg	

Note: ND = Not Detected

SF-SW-01 and SF-SD-01 were collected on March 24, 1993.  
SF-SW-02 and SF-SD-02 were collected on March 25, 1993.

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**TABLE 4-55**  
**SOUTH FIELD**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.123	0	2	0	0	0
Antimony		mg/L	.000	0	2	0	0	0
Arsenic		mg/L	.122	0	8	0	0	0
Barium		mg/L	.459	6	7	.034	.102	0
Beryllium		mg/L	.002	0	2	0	0	0
Cadmium		mg/L	.007	2	8	.006	.008	1
Calcium		mg/L	125.574	8	8	89	129	2
Chromium		mg/L	.035	2	8	.023	.027	0
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.030	4	8	.013	.0306	1
Cyanide		mg/L	.000	0	2	0	0	0
Iron		mg/L	10.965	2	8	.051	.064	0
Lead		mg/L	.050	1	8	.003	.003	0
Magnesium		mg/L	49.627	8	8	29.5	48.6	0
Manganese		mg/L	.165	7	8	.007	.167	1
Mercury		mg/L	.004	0	8	0	0	0
Molybdenum		mg/L	.028	0	8	0	0	0
Nickel		mg/L	.026	1	8	.024	.024	0
Potassium		mg/L	29.736	8	8	.891	10	0
Selenium		mg/L	.000	1	8	.002	.002	1
Silicon		mg/L	.000	2	2	10.2	10.5	2
Silver		mg/L	.040	1	8	.04	.04	0
Sodium		mg/L	49.178	8	8	5.71	11	0
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.020	0	2	0	0	0
Zinc		mg/L	.032	2	2	.0084	.01	0
<b>RADIONUCLIDES</b>								
NP-237	UNFL	pCi/L	.000	0	6	0	0	0
PU-238	UNFL	pCi/L	.000	0	6	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	6	0	0	0
RA-226	UNFL	pCi/L	1.000	0	4	0	0	0
RA-228	UNFL	pCi/L	5.200	0	4	0	0	0
SR-90	UNFL	pCi/L	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-55  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>RADIONUCLIDES (Continued)</b>								
TC-99	UNFL	pCi/L	.000	0	6	0	0	0
TH-228	UNFL	pCi/L	1.040	1	6	1.1	1.1	1
TH-230	UNFL	pCi/L	2.000	1	6	1	1	0
TH-232	UNFL	pCi/L	.000	0	6	0	0	0
TH-TOTAL	UNFL	ug/L	3.000	0	4	0	0	0
U-234	UNFL	pCi/L	1.900	4	6	2	62.5	4
U-235/236	UNFL	pCi/L	.000	1	6	3.8	3.8	1
U-238	UNFL	pCi/L	1.070	4	6	1.9	79.7	4
U-TOTAL	UNFL	ug/L	4.000	6	6	1	203	4
<b>VOLATILE ORGANICS</b>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-55  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Vinyl Acetate	UNFL	ug/L	.000	0	1	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	4.500	0	6	0	0	0
Chloride	UNFL	mg/L	110.159	4	6	2.7	21	0
Fluoride	UNFL	mg/L	1.352	6	6	.3	.4	0
Nitrate	UNFL	mg/L	.522	3	5	.06	.31	0
Phenols	UNFL	mg/L	.000	3	6	.02	.02	0
Phosphorus	UNFL	mg/L	.223	3	6	.1	.88	2
Sulfate	UNFL	mg/L	141.894	6	6	10	120	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	3	.2	.2	1
Total Organic Halides	UNFL	mg/L	.000	0	5	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	3	5	.1	.5	3

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-56**  
**SOUTH FIELD**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.123	10	13	.0695	184	8
Antimony		mg/L	.000	6	13	.0057	.0141	6
Arsenic		mg/L	.122	5	13	.0053	.0104	0
Barium		mg/L	.459	13	13	.0475	1.14	3
Beryllium		mg/L	.002	3	13	.0037	.0096	3
Cadmium		mg/L	.007	2	13	.0056	.034	1
Calcium		mg/L	125.574	13	13	87.3	1360	7
Chromium		mg/L	.035	7	12	.0046	.196	5
Cobalt		mg/L	.000	5	13	.0246	.116	5
Copper		mg/L	.030	5	13	.0622	.332	5
Cyanide		mg/L	.000	2	6	.0016	.0024	2
Iron		mg/L	10.965	9	13	.0246	370	5
Lead		mg/L	.050	7	13	.0016	.0992	2
Magnesium		mg/L	49.627	13	13	35.5	413	9
Manganese		mg/L	.165	12	13	.0115	6.49	9
Mercury		mg/L	.004	2	13	.00024	.0004	0
Molybdenum		mg/L	.028	5	13	.0309	.108	5
Nickel		mg/L	.026	8	13	.0072	.339	6
Potassium		mg/L	29.736	11	13	.718	27.4	0
Selenium		mg/L	.000	2	13	.0036	.0037	2
Silicon		mg/L	.000	13	13	5.67	102	13
Silver		mg/L	.040	5	13	.018	.0889	2
Sodium		mg/L	49.178	13	13	8.04	16.6	0
Thallium		mg/L	.000	0	13	0	0	0
Vanadium		mg/L	.020	5	12	.103	.376	5
Zinc		mg/L	.032	9	13	.0075	.94	7
<b>RADIONUCLIDES</b>								
CS-137		pCi/L	.000	0	10	0	0	0
GROSS ALPHA		pCi/L	.000	6	9	38	1080	6
GROSS BETA		pCi/L	.000	8	9	8.81	638	8
NP-237		pCi/L	.000	4	8	.22	.48	4
PU-238		pCi/L	.000	4	10	.09	.56	4
PU-239/240		pCi/L	.000	2	10	.12	.193	2

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See footnote at end of table

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TABLE 4-56  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>								
RA-226		pCi/L	1.000	3	7	1.05	1.46	3
RA-228		pCi/L	5.200	0	8	0	0	0
RU-106		pCi/L	.000	0	10	0	0	0
SR-90		pCi/L	.000	2	10	3.05	3.31	2
TC-99		pCi/L	.000	0	10	0	0	0
TH-228		pCi/L	1.040	4	9	1.1	9.87	4
TH-230		pCi/L	2.000	8	9	.11	11.2	3
TH-232		pCi/L	.000	4	9	.938	8.56	4
TH-TOTAL		ug/L	3.000	4	9	8.55	78	4
U-234		pCi/L	1.900	10	10	.54	223	9
U-235/236		pCi/L	.000	8	10	.303	15.7	8
U-238		pCi/L	1.070	10	10	.47	229	8
U-TOTAL		ug/L	4.000	10	10	1.1	573	8
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane		ug/L	.000	0	7	0	0	0
1,1,2,2-Tetrachloroethane		ug/L	.000	0	7	0	0	0
1,1,2-Trichloroethane		ug/L	.000	0	7	0	0	0
1,1-Dichloroethane		ug/L	.000	0	7	0	0	0
1,1-Dichloroethene		ug/L	.000	0	7	0	0	0
1,2-Dichloroethane		ug/L	.000	0	7	0	0	0
1,2-Dichloroethene		ug/L	.000	0	7	0	0	0
1,2-Dichloropropane		ug/L	.000	0	7	0	0	0
2-Butanone		ug/L	.000	0	7	0	0	0
2-Hexanone		ug/L	.000	0	6	0	0	0
4-Methyl-2-pentanone		ug/L	.000	0	6	0	0	0
Acetone		ug/L	.000	1	5	6	6	1
Benzene		ug/L	.000	0	7	0	0	0
Bromodichloromethane		ug/L	.000	0	7	0	0	0
Bromoform		ug/L	.000	0	7	0	0	0
Bromomethane		ug/L	.000	0	7	0	0	0
Carbon Tetrachloride		ug/L	.000	0	7	0	0	0
Carbon disulfide		ug/L	.000	0	6	0	0	0
Chlorobenzene		ug/L	.000	0	7	0	0	0
Chloroethane		ug/L	.000	0	7	0	0	0
Chloroform		ug/L	.000	0	7	0	0	0
Chloromethane		ug/L	.000	0	6	0	0	0
Dibromochloromethane		ug/L	.000	0	7	0	0	0
Ethylbenzene		ug/L	.000	0	7	0	0	0
Methylene chloride		ug/L	.000	0	7	0	0	0

See footnote at end of table

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TABLE 4-56  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Styrene		ug/L	.000	0	7	0 0	0
Tetrachloroethene		ug/L	.000	0	7	0 0	0
Toluene		ug/L	.000	0	7	0 0	0
Trichloroethene		ug/L	.000	0	7	0 0	0
Vinyl Acetate		ug/L	.000	0	4	0 0	0
Vinyl chloride		ug/L	.000	0	7	0 0	0
Xylenes, Total		ug/L	.000	0	7	0 0	0
cis-1,3-Dichloropropene		ug/L	.000	0	7	0 0	0
trans-1,3-Dichloropropene		ug/L	.000	0	7	0 0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene		ug/L	.000	0	7	0 0	0
1,2-Dichlorobenzene		ug/L	.000	0	7	0 0	0
1,3-Dichlorobenzene		ug/L	.000	0	7	0 0	0
1,4-Dichlorobenzene		ug/L	.000	0	7	0 0	0
2,4,5-Trichlorophenol		ug/L	.000	0	7	0 0	0
2,4,6-Trichlorophenol		ug/L	.000	0	7	0 0	0
2,4-Dichlorophenol		ug/L	.000	0	7	0 0	0
2,4-Dimethylphenol		ug/L	.000	0	7	0 0	0
2,4-Dinitrophenol		ug/L	.000	0	3	0 0	0
2,4-Dinitrotoluene		ug/L	.000	0	7	0 0	0
2,6-Dinitrotoluene		ug/L	.000	0	7	0 0	0
2-Benzyl-4-chlorophenol		ug/L	.000	0	3	0 0	0
2-Chloronaphthalene		ug/L	.000	0	7	0 0	0
2-Chlorophenol		ug/L	.000	0	7	0 0	0
2-Methylnaphthalene		ug/L	.000	0	7	0 0	0
2-Methylphenol		ug/L	.000	0	7	0 0	0
2-Nitroaniline		ug/L	.000	0	7	0 0	0
2-Nitrophenol		ug/L	.000	0	7	0 0	0
3,3'-Dichlorobenzidine		ug/L	.000	0	7	0 0	0
3-Nitroaniline		ug/L	.000	0	7	0 0	0
4,6-Dinitro-2-methylphenol		ug/L	.000	0	4	0 0	0
4-Bromophenyl phenyl ether		ug/L	.000	0	7	0 0	0
4-Chloro-3-methylphenol		ug/L	.000	0	7	0 0	0
4-Chlorophenylphenyl ether		ug/L	.000	0	7	0 0	0
4-Methylphenol		ug/L	.000	0	7	0 0	0
4-Nitroaniline		ug/L	.000	0	6	0 0	0
4-Nitrophenol		ug/L	.000	0	5	0 0	0
Acenaphthene		ug/L	.000	0	7	0 0	0

See footnote at end of table

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TABLE 4-56  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Acenaphthylene		ug/L	.000	0	7	0	0	0
Anthracene		ug/L	.000	0	7	0	0	0
Benzo(a)anthracene		ug/L	.000	0	7	0	0	0
Benzo(a)pyrene		ug/L	.000	0	7	0	0	0
Benzo(b)fluoranthene		ug/L	.000	0	7	0	0	0
Benzo(g,h,i)perylene		ug/L	.000	0	7	0	0	0
Benzo(k)fluoranthene		ug/L	.000	0	7	0	0	0
Benzoic acid		ug/L	.000	0	4	0	0	0
Benzyl alcohol		ug/L	.000	0	7	0	0	0
Butyl benzyl phthalate		ug/L	.000	0	7	0	0	0
Carbazole		ug/L	.000	0	7	0	0	0
Chrysene		ug/L	.000	0	7	0	0	0
Di-n-butyl phthalate		ug/L	.000	1	7	4	4	1
Di-n-octyl phthalate		ug/L	.000	0	4	0	0	0
Dibenzo(a,h)anthracene		ug/L	.000	0	7	0	0	0
Dibenzofuran		ug/L	.000	0	7	0	0	0
Diethyl phthalate		ug/L	.000	1	7	1	1	1
Dimethyl phthalate		ug/L	.000	0	7	0	0	0
Fluoranthene		ug/L	.000	0	7	0	0	0
Fluorene		ug/L	.000	0	7	0	0	0
Hexachlorobenzene		ug/L	.000	0	7	0	0	0
Hexachlorobutadiene		ug/L	.000	0	7	0	0	0
Hexachlorocyclopentadiene		ug/L	.000	0	7	0	0	0
Hexachloroethane		ug/L	.000	0	7	0	0	0
Indeno(1,2,3-cd)pyrene		ug/L	.000	0	7	0	0	0
Isophorone		ug/L	.000	0	7	0	0	0
N-Nitroso-di-n-propylamine		ug/L	.000	0	7	0	0	0
N-Nitrosodimethylamine		ug/L	.000	0	3	0	0	0
N-Nitrosodiphenylamine		ug/L	.000	0	7	0	0	0
Naphthalene		ug/L	.000	0	7	0	0	0
Nitrobenzene		ug/L	.000	0	7	0	0	0
Pentachlorophenol		ug/L	.000	0	7	0	0	0
Phenanthrene		ug/L	.000	0	7	0	0	0
Phenol		ug/L	.000	0	7	0	0	0
Pyrene		ug/L	.000	0	7	0	0	0
Tributyl phosphate		ug/L	.000	1	2	1	1	1
bis(2-Chloroethoxy)methane		ug/L	.000	0	7	0	0	0
bis(2-Chloroethyl)ether		ug/L	.000	0	7	0	0	0
bis(2-Chloroisopropyl) ether		ug/L	.000	0	7	0	0	0

See footnote at end of table

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**TABLE 4-56  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
bis(2-Ethylhexyl) phthalate		ug/L	.000	0	7	0 0	0
p-Chloroaniline		ug/L	.000	0	7	0 0	0
<u>PESTICIDES/PCBS</u>							
4,4'-DDD		UG/L	.000	0	7	0 0	0
4,4'-DDE		UG/L	.000	0	7	0 0	0
4,4'-DDT		ug/L	.000	0	7	0 0	0
Aldrin		ug/L	.000	0	7	0 0	0
Aroclor-1016		ug/L	.000	0	7	0 0	0
Aroclor-1221		ug/L	.000	0	7	0 0	0
Aroclor-1232		ug/L	.000	0	7	0 0	0
Aroclor-1242		ug/L	.000	0	7	0 0	0
Aroclor-1248		ug/L	.000	0	7	0 0	0
Aroclor-1254		ug/L	.000	0	7	0 0	0
Aroclor-1260		ug/L	.000	0	7	0 0	0
Dieldrin		ug/L	.000	0	7	0 0	0
Endosulfan II		ug/L	.000	0	7	0 0	0
Endosulfan sulfate		ug/L	.000	0	7	0 0	0
Endosulfan-I		ug/L	.000	0	7	0 0	0
Endrin		ug/L	.000	0	7	0 0	0
Endrin aldehyde		ug/L	.000	0	7	0 0	0
Endrin ketone		ug/L	.000	0	7	0 0	0
Heptachlor		ug/L	.000	0	7	0 0	0
Heptachlor epoxide		ug/L	.000	0	7	0 0	0
Methoxychlor		ug/L	.000	0	7	0 0	0
Toxaphene		ug/L	.000	0	7	0 0	0
alpha-BHC		ug/L	.000	0	7	0 0	0
alpha-Chlordane		ug/L	.000	0	7	0 0	0
beta-BHC		ug/L	.000	0	7	0 0	0
delta-BHC		ug/L	.000	0	7	0 0	0
gamma-BHC (Lindane)		ug/L	.000	0	7	0 0	0
gamma-Chlordane		ug/L	.000	0	7	0 0	0
<u>GENERAL CHEMISTRY</u>							
Alkalinity		mg/L	.000	7	7	349 560	0
Ammonia		mg/L	4.500	5	7	.11 .56	0
Chloride		mg/L	110.159	7	7	2.5 8.89	0
Fluoride		mg/L	1.352	7	7	.23 .64	0
Nitrate		mg/L	.522	3	3	.26 .52	0

See footnote at end of table

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0598

TABLE 4-56  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>								
Phenols		mg/L	.000	0	7	0	0	0
Sulfate		mg/L	141.894	7	7	57.72	203.7	2
Sulfide		mg/L	.000	0	7	0	0	0
Total Kjeldahl Nitrogen		mg/L	.000	6	6	.34	8.43	6
Total Organic Carbon		mg/L	.000	7	7	1.1	3.38	7
Total Organic Halides		mg/L	.000	3	7	.0118	.0206	3
Total Organic Nitrogen		mg/L	.000	7	7	.19	8.02	7
Total Phosphorous		mg/L	.000	7	8	.08	12.11	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

4-308

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5170

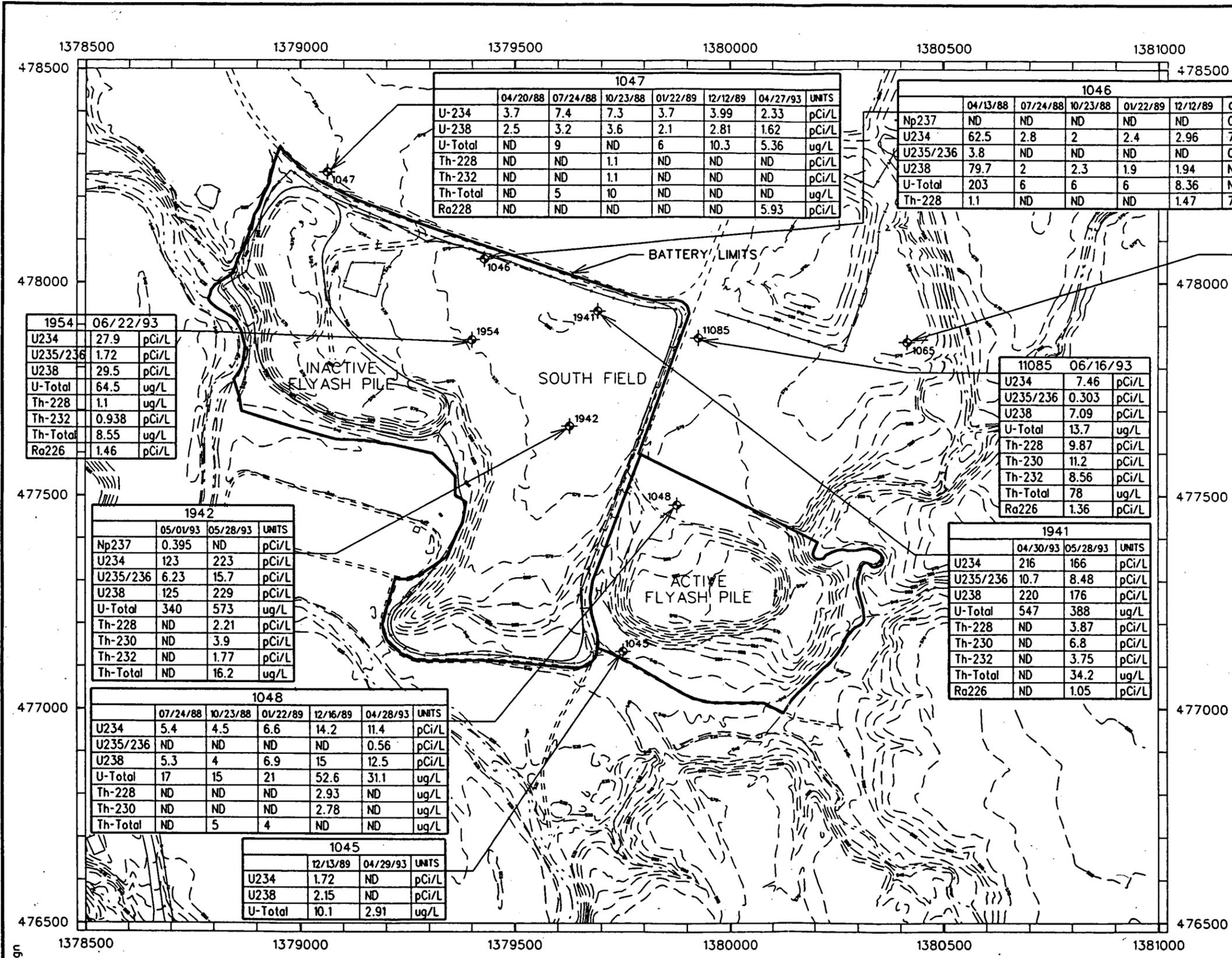
perched aquifer (1046) was sampled during Phase I. Other perched zone wells were sampled during Phase I but these were not within the perched system in the South Field. Three of the wells (1516, 1517, and 1518) monitor the regional aquifer. Phase I sampling detected six metals and isotopes for two elements that exceeded the background concentrations; no organic compounds were detected that exceeded background concentrations. Five additional monitoring wells were installed during Phase II and twelve Hydropunch™ samples were collected in order to define groundwater conditions in the perched aquifer in the South Field. During Phase II, 21 metals (Aluminum Antimony, Barium, Beryllium, Chromium, Cobalt, Cyanide, Iron, Lead, Magnesium, Molybdenum, Nickel, Silver, Vanadium, and Zinc were not detected above background during Phase I), isotopes of six elements (neptunium-237, plutonium-238, plutonium-239/240, Strontium-90, thorium-230, thorium-232, and thorium-total were not detected above background during Phase I), and four organic compounds exceeded background concentrations. Hydropunch™ results are provided in Figure 4-23.

Metals concentrations that exceeded background in 1000-series wells included aluminum, antimony, calcium, magnesium, manganese, silicon, and zinc. Maximum detected concentrations were close to background values except for antimony and silicon which had a background concentration of 0.00 mg/L. This indicates that elevated concentrations of metals detected in subsurface samples are not reflected by significant impacts in perched groundwater.

Radioisotopes detected in groundwater samples collected from the 1000-series wells during Phase I and Phase II are presented on Figure 4-23A. Groundwater in the perched zone is believed to be a continuous unit. Therefore, concentrations of uranium detected in wells located in the perched zone display a concentration gradient in a downstream direction from higher to lower concentrations. Concentration contours of total uranium concentrations detected in samples collected during Phase II are presented on Figure 4-24. Upgradient Well 1047 and Well 1046 detected low concentrations of total uranium, while downgradient Wells 1954, 1942, and 1048 detected elevated concentrations. The distribution of uranium in perched groundwater is controlled by elevated concentrations of uranium in shallow soil samples, by a sand layer identified in South Field soil borings, and by groundwater flow patterns discussed in Section 3.0. Two regions of perched groundwater containing greater than 100 µg/L total uranium are shown on Figure 4-24. One area is at the west side of the subunit near Well 1433 and may originate as leachate from buried waste (Figure 4-21). Waste materials were also encountered while drilling Well 1433 during Phase I at the approximate center of the elevated groundwater concentrations. The second area of elevated total uranium concentration is in

0800

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1047							
	04/20/88	07/24/88	10/23/88	01/22/89	12/12/89	04/27/93	UNITS
U-234	3.7	7.4	7.3	3.7	3.99	2.33	pCi/L
U-238	2.5	3.2	3.6	2.1	2.81	1.62	pCi/L
U-Total	ND	9	ND	6	10.3	5.36	ug/L
Th-228	ND	ND	1.1	ND	ND	ND	pCi/L
Th-232	ND	ND	1.1	ND	ND	ND	pCi/L
Th-Total	ND	5	10	ND	ND	ND	ug/L
Ra228	ND	ND	ND	ND	ND	5.93	pCi/L

1046							
	04/13/88	07/24/88	10/23/88	01/22/89	12/12/89	05/11/93	UNITS
Np237	ND	ND	ND	ND	ND	0.48	pCi/L
U234	62.5	2.8	2	2.4	2.96	7.83	pCi/L
U235/236	3.8	ND	ND	ND	ND	0.479	pCi/L
U238	79.7	2	2.3	1.9	1.94	ND	pCi/L
U-Total	203	6	6	6	8.36	ND	ug/L
Th-228	1.1	ND	ND	ND	1.47	7.91	pCi/L

1065					
	01/22/89	12/13/89	04/05/93	05/04/93	UNITS
Np237	ND	ND	ND	0.22	pCi/L
U234	ND	ND	20.3	ND	pCi/L
U-Total	2	5.33	ND	1.36	ug/L
Th-Total	11	ND	ND	ND	ug/L

1954		
	06/22/93	UNITS
U234	27.9	pCi/L
U235/236	1.72	pCi/L
U238	29.5	pCi/L
U-Total	64.5	ug/L
Th-228	1.1	ug/L
Th-232	0.938	pCi/L
Th-Total	8.55	ug/L
Ra226	1.46	pCi/L

11085		
	06/16/93	UNITS
U234	7.46	pCi/L
U235/236	0.303	pCi/L
U238	7.09	pCi/L
U-Total	13.7	ug/L
Th-228	9.87	pCi/L
Th-230	11.2	pCi/L
Th-232	8.56	pCi/L
Th-Total	78	ug/L
Ra226	1.36	pCi/L

1942			
	05/01/93	05/28/93	UNITS
Np237	0.395	ND	pCi/L
U234	123	223	pCi/L
U235/236	6.23	15.7	pCi/L
U238	125	229	pCi/L
U-Total	340	573	ug/L
Th-228	ND	2.21	pCi/L
Th-230	ND	3.9	pCi/L
Th-232	ND	1.77	pCi/L
Th-Total	ND	16.2	ug/L

1941			
	04/30/93	05/28/93	UNITS
U234	216	166	pCi/L
U235/236	10.7	8.48	pCi/L
U238	220	176	pCi/L
U-Total	547	388	ug/L
Th-228	ND	3.87	pCi/L
Th-230	ND	6.8	pCi/L
Th-232	ND	3.75	pCi/L
Th-Total	ND	34.2	ug/L
Ra226	ND	1.05	pCi/L

1048						
	07/24/88	10/23/88	01/22/89	12/16/89	04/28/93	UNITS
U234	5.4	4.5	6.6	14.2	11.4	pCi/L
U235/236	ND	ND	ND	ND	0.56	pCi/L
U238	5.3	4	6.9	15	12.5	pCi/L
U-Total	17	15	21	52.6	31.1	ug/L
Th-228	ND	ND	ND	2.93	ND	ug/L
Th-230	ND	ND	ND	2.78	ND	ug/L
Th-Total	ND	5	4	ND	ND	ug/L

1045			
	12/13/89	04/29/93	UNITS
U234	1.72	ND	pCi/L
U238	2.15	ND	pCi/L
U-Total	10.1	2.91	ug/L

**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- BATTERY LIMITS
- FENCE
- RAILROAD
- 1000 MONITORING WELLS

ND - NOT DETECTED ABOVE BACKGROUND CONCENTRATIONS

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

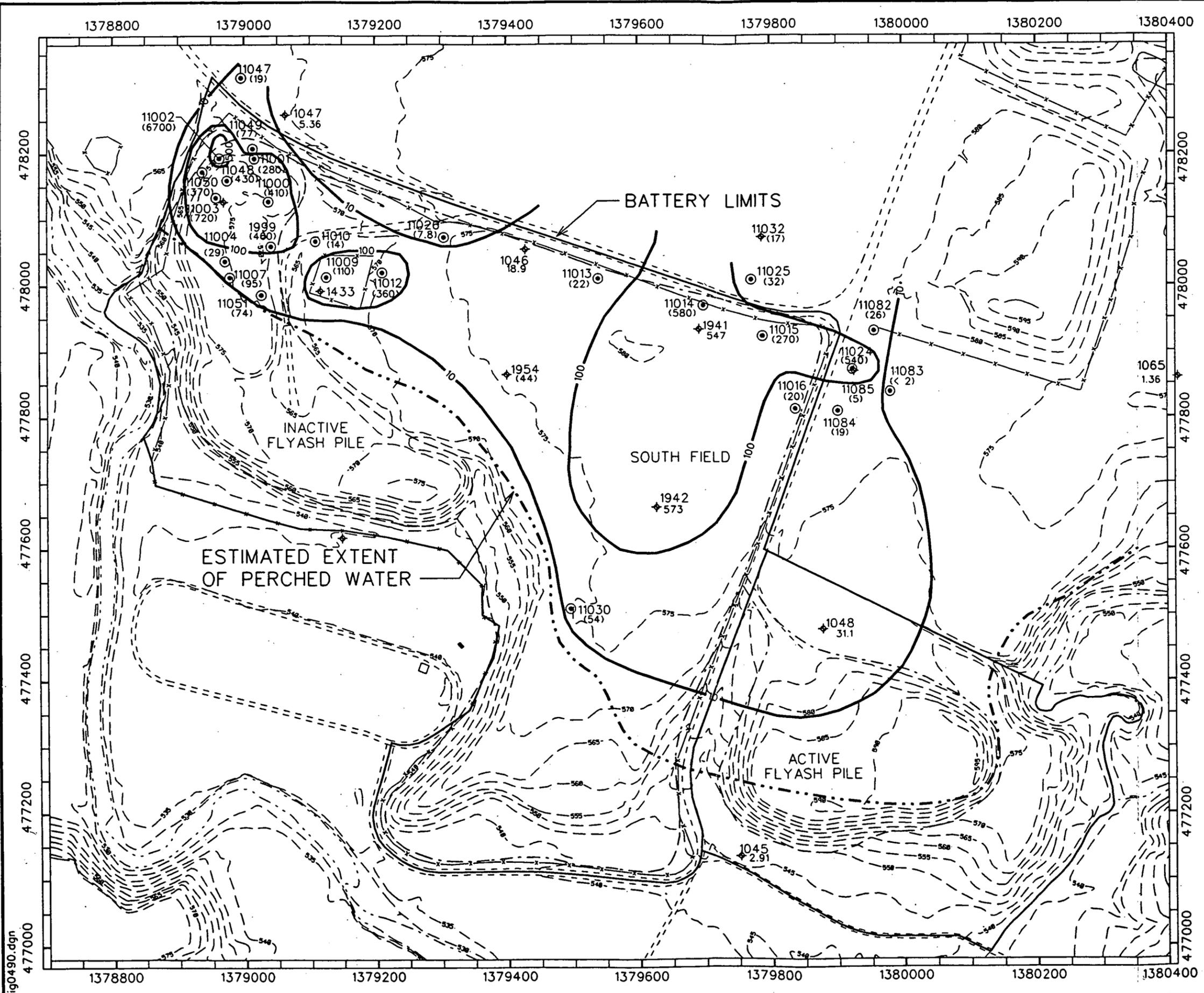
**SCALE (FT)**  
0 125 250 500

**FIGURE 4-23**  
**RADIONUCLIDES IN**  
**1000-SERIES WELLS**  
**DETECTED ABOVE BACKGROUND**  
**IN THE SOUTH FIELD AND**  
**FLYASH PILES**

fig0425.dgn

0501

4-310

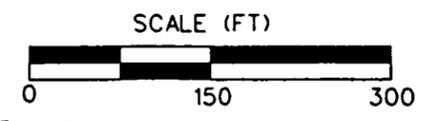


**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- 1000 MONITORING WELLS
- HYDROPUNCH
- (210) ON-SITE SCREENING RESULTS
- CONCENTRATION ISOPACHS

NOTE: Total Uranium Concentrations are in ug/l.  
NOTE: Samples taken from April 1993 to July 1993

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.



0502

**FIGURE 4-24**  
DISTRIBUTION OF  
TOTAL URANIUM IN 1000-SERIES  
WELLS AND HYDROPUNCHES  
DETECTED ABOVE BACKGROUND  
IN THE SOUTH FIELD/  
FLYASH PILES AREA

fig0490.dgn

groundwater at the northeast corner of the subunit. The source for perched groundwater uranium contamination in this area is believed to be waste materials buried or placed on the surface and corresponds to an area of waste piles identified by historical aerial photographs.

Organic compounds detected above background included the following: acetone (6 µg/L), dimethyl phthalate (1 µg/L), and tributyl phosphate (1 µg/L in Well 11032 located north and upgradient of the South Field. Acetone was detected at 6 µg/L in Well 1046 located along the north edge, also upgradient of the South Field. These data do not indicate an impact of organic compounds from the South Field soil on groundwater in the perched aquifer since they are either common laboratory contaminants and/or detected at trace levels.

Groundwater analytical data from the 2000-series wells in the South Field were compared to background data from the regional aquifer, and the data are provided in Appendix F in Table F-2F and Table F-2G. The number of detected analytes is presented in Table 4-57 and Table 4-58. Nine locations surrounding the South Field had 2000-series wells installed during Phase I. Phase I sampling detected 11 metals, uranium, radium, thorium, and seven organic compounds that exceeded background. The concentration of uranium in downgradient wells was elevated with respect to some upgradient wells, but the relationship between possible source areas and regional aquifer wells was not clear. To complete the sampling network, four additional 2000-series wells and eight Hydropunch™ wells were completed in the South Field. Sample data is shown on Figure 4-25 (see Volume 2, Oversized Figures).

Phase II sampling detected six metals (Silicon was not detected above background during Phase I; Cadmium Chromium Molybdenum, Nickel, Selenium, and Vanadium were detected above background for Phase I but not Phase II), isotopes of four elements (neptunium-237, plutonium-238, and thorium-230 were not detected above background for Phase I; radium-226 and thorium-total were detected above background for Phase I but not Phase II), and five organic compounds (Butyl benzyl phthalate and Di-n-butyl phthalate were not detected above background during Phase I; 1,1-Dichloroethane, 1,2,-Dichloroethane, and Diethyl phthalate were detected above background during Phase I but not Phase II). Groundwater samples were collected downgradient of the former Firing Range and analyzed for lead. Results are shown below and the sample locations are shown on Figure 4-25.

5120

**TABLE 4-57A**  
**SOUTH FIELD**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	12	13	.0428	.755	3
Antimony		mg/L	.038	0	2	0	0	0
Arsenic		mg/L	.300	0	22	0	0	0
Barium		mg/L	.413	19	21	.02	.0886	0
Beryllium		mg/L	.003	0	2	0	0	0
Cadmium		mg/L	.006	13	22	.0021	.009	5
Calcium		mg/L	135.163	22	22	81	185	8
Chromium		mg/L	.042	13	20	.0141	.0516	2
Cobalt		mg/L	.000	0	2	0	0	0
Copper		mg/L	.130	8	21	.0102	.026	0
Cyanide		mg/L	.000	0	1	0	0	0
Iron		mg/L	4.000	15	22	.04	1.6	0
Lead		mg/L	.029	7	21	.0034	.009	0
Magnesium		mg/L	38.070	22	22	17.7	58.2	9
Manganese		mg/L	.800	20	22	.002	.517	0
Mercury		mg/L	.001	2	22	.0003	.0004	0
Molybdenum		mg/L	.027	3	21	.008	.049	1
Nickel		mg/L	.026	6	21	.02	.084	3
Potassium		mg/L	3.087	18	21	1.82	4.07	5
Selenium		mg/L	.005	3	22	.003	.006	1
Silicon		mg/L	10.491	11	11	3.12	6.01	0
Silver		mg/L	.023	6	21	.01	.026	1
Sodium		mg/L	51.918	21	22	6.65	16.1	0
Thallium		mg/L	.000	0	2	0	0	0
Vanadium		mg/L	.027	9	13	.0111	.0305	1
Zinc		mg/L	.105	1	2	.034	.034	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	4	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	0	0	0	0
GROSS BETA	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	18	0	0	0
PU-238	UNFL	pCi/L	.000	0	17	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	17	0	0	0

See footnote at end of table

4-313

0504

TABLE 4-57A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>RADIONUCLIDES (Continued)</u>								
RA-226	UNFL	pCi/L	1.200	2	16	1.2	1.4	1
RA-228	UNFL	pCi/L	4.500	0	18	0	0	0
RU-106	UNFL	pCi/L	.000	0	4	0	0	0
SR-90	UNFL	pCi/L	.000	0	16	0	0	0
TC-99	UNFL	pCi/L	36.000	0	18	0	0	0
TH-228	UNFL	pCi/L	1.520	1	18	1.16	1.16	0
TH-230	UNFL	pCi/L	1.790	3	18	1.2	1.78	0
TH-232	UNFL	pCi/L	.000	1	18	1.49	1.49	1
TH-TOTAL	UNFL	ug/L	2.000	1	16	13.5	13.5	1
U-234	UNFL	pCi/L	1.900	17	19	2.6	219	17
U-235/236	UNFL	pCi/L	.000	7	19	1.6	11.5	7
U-238	UNFL	pCi/L	.900	17	19	2.6	231	17
U-TOTAL	UNFL	ug/L	2.920	17	19	3	907	17
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	1	3	5	5	1
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	3	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	3	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	1	3	9	9	1
1,1-Dichloroethene	UNFL	ug/L	.000	0	3	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	3	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	1	3	5	5	1
1,2-Dichloropropane	UNFL	ug/L	.000	0	3	0	0	0
2-Butanone	UNFL	ug/L	.000	0	2	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	3	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	3	0	0	0
Acetone	UNFL	ug/L	.000	2	3	2	5	2
Benzene	UNFL	ug/L	.000	0	3	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	3	0	0	0
Bromoform	UNFL	ug/L	.000	0	3	0	0	0
Bromomethane	UNFL	ug/L	.000	0	3	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	3	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	3	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
Chloroethane	UNFL	ug/L	.000	0	3	0	0	0
Chloroform	UNFL	ug/L	.000	0	3	0	0	0
Chloromethane	UNFL	ug/L	.000	0	3	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	3	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	3	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	3	0	0	0

See footnote at end of table

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TABLE 4-57A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Styrene	UNFL	ug/L	.000	0	3	0	0	0
Tetrachloroethene	UNFL	ug/L	.000	0	3	0	0	0
Toluene	UNFL	ug/L	.000	0	3	0	0	0
Trichloroethene	UNFL	ug/L	.000	1	3	7	7	1
Vinyl Acetate	UNFL	ug/L	.000	0	3	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	3	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	3	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	3	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	3	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	3	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	3	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	3	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	3	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	3	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	3	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	3	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	3	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	3	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	3	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	3	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	3	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	3	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	3	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	3	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	3	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	3	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	3	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	3	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	3	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	3	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	3	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	3	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	3	0	0	0
Anthracene	UNFL	ug/L	.000	0	3	0	0	0

See footnote at end of table

4-315

0506

TABLE 4-57A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(a)anthracene	UNFL	ug/L	.000	0	3	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	3	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	3	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	3	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	3	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	3	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	3	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	3	0	0	0
Chrysene	UNFL	ug/L	.000	0	3	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	3	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	3	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	3	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	3	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	1	3	20	20	1
Dimethyl phthalate	UNFL	ug/L	.000	0	3	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	3	0	0	0
Fluorene	UNFL	ug/L	.000	0	3	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	3	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	3	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	3	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	3	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	3	0	0	0
Isophorone	UNFL	ug/L	.000	0	3	0	0	0
Methyl parathion	UNFL	ug/L	.000	0	2	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	3	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	3	0	0	0
Naphthalene	UNFL	ug/L	.000	0	3	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	3	0	0	0
Parathion	UNFL	ug/L	.000	0	2	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	3	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	3	0	0	0
Phenol	UNFL	ug/L	.000	0	3	0	0	0
Pyrene	UNFL	ug/L	.000	0	3	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	2	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	3	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	3	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	1	3	2	2	1
p-Chloroaniline	UNFL	ug/L	.000	0	3	0	0	0

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See footnote at end of table

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TABLE 4-57A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS</u>								
4,4'-DDD	UNFL	ug/L	.000	0	2	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	2	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	2	0	0	0
Aldrin	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	2	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	2	0	0	0
Dieldrin	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	2	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	2	0	0	0
Endrin	UNFL	ug/L	.000	0	2	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	2	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	2	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	2	0	0	0
Toxaphene	UNFL	ug/L	.000	0	2	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	2	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
beta-BHC	UNFL	ug/L	.000	0	2	0	0	0
delta-BHC	UNFL	ug/L	.000	0	2	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	2	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	2	0	0	0
Azinphosmethyl	UNFL	ug/L	.000	0	2	0	0	0
Demeton	UNFL	ug/L	.000	0	2	0	0	0
Diazinon	UNFL	ug/L	.000	0	2	0	0	0
Disulfoton	UNFL	ug/L	.000	0	2	0	0	0
Ethion	UNFL	ug/L	.000	0	2	0	0	0
Malathion	UNFL	ug/L	.000	0	2	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	2	22	.145	.2	0
Chloride	UNFL	mg/L	145.065	18	20	3	27	0
Fluoride	UNFL	mg/L	.938	14	18	.098	.6	0
Hexavalent Chromium	UNFL	mg/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-57A  
(Continued)

Parameter	FILTER		Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
	FLAG	UNITS				Minimum	Maximum	
<u>GENERAL CHEMISTRY (Continued)</u>								
Nitrate	UNFL	mg/L	11.400	20	23	.1	3.59	0
Phenols	UNFL	mg/L	.000	7	20	.01	.03	0
Phosphate	UNFL	mg/L	.000	1	1	.3	.3	0
Phosphorus	UNFL	mg/L	.693	14	18	.08	1.291	3
Sulfate	UNFL	mg/L	359.847	20	21	49.3	281	0
Sulfide	UNFL	mg/L	.000	3	12	3.52	37.8	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	9	11	.1	1.07	9
Total Organic Carbon	UNFL	mg/L	3.764	7	11	2.83	.62	3
Total Organic Halides	UNFL	mg/L	.021	4	13	.01	1.7	2
Total Organic Nitrogen	UNFL	mg/L	.652	14	22	.1	1.07	2

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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**TABLE 4-57B**  
**SOUTH FIELD**  
**GROUNDWATER<sup>a</sup> - 3000 AND 4000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<b>METALS</b>								
Aluminum		mg/L	.184	6	8	.039	.109	0
Arsenic		mg/L	.300	0	16	0	0	0
Barium		mg/L	.413	14	15	.029	.071	0
Cadmium		mg/L	.006	12	16	.001	.005	0
Calcium		mg/L	135.163	16	16	73.3	109	0
Chromium		mg/L	.042	12	16	.004	.042	0
Copper		mg/L	.130	4	16	.011	.014	0
Cyanide		mg/L	.000	0	0	0	0	0
Iron		mg/L	4.000	10	16	.03	2.51	0
Lead		mg/L	.029	3	13	.003	.0033	0
Magnesium		mg/L	38.070	16	16	18.05	27.8	0
Manganese		mg/L	.800	13	16	.004	1.02	1
Mercury		mg/L	.001	3	16	.0008	.0064	2
Molybdenum		mg/L	.027	1	16	.007	.007	0
Nickel		mg/L	.026	4	16	.005	.03	2
Potassium		mg/L	3.087	15	16	1.28	3.05	0
Selenium		mg/L	.005	3	15	.002	.004	0
Silicon		mg/L	10.491	8	8	1.9	4.24	0
Silver		mg/L	.023	6	15	.0112	.018	0
Sodium		mg/L	51.918	16	16	4.48	13	0
Vanadium		mg/L	.027	4	8	.006	.0174	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	14	0	0	0
PU-238	UNFL	pCi/L	.000	0	14	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	14	0	0	0
RA-226	UNFL	pCi/L	1.200	1	12	2.4	2.4	1
RA-228	UNFL	pCi/L	4.500	0	12	0	0	0
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	15	0	0	0
TC-99	UNFL	pCi/L	36.000	0	15	0	0	0
TH-228	UNFL	pCi/L	1.520	3	16	1.21	2.5	2
TH-230	UNFL	pCi/L	1.790	3	16	1.12	2.21	1

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See footnote at end of table

TABLE 4-57B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
TH-232	UNFL	pCi/L	.000	2	16	1.04	1.1	2
TH-TOTAL	UNFL	ug/L	2.000	2	15	7	9.38	2
U-234	UNFL	pCi/L	1.900	7	15	1.37	17.1	5
U-235/236	UNFL	pCi/L	.000	1	15	1.47	1.47	1
U-238	UNFL	pCi/L	.900	5	15	8.5	16.4	5
U-TOTAL	UNFL	ug/L	2.920	10	15	.793	35.3	8
<u>SEMIVOLATILE ORGANICS</u>								
2-Chloro-N-(2,6-diethylphenyl)-N-(methoxymethyl)	UNFL	ug/L	.000	0	0	0	0	0
6-Chloro-N,N'-diethyl-1,3,5-triazine-2,4-diamine	UNFL	ug/L	.000	0	0	0	0	0
<u>PESTICIDES/PCBS</u>								
2,4,5-TP (Silvex)	UNFL	ug/L	.000	0	0	0	0	0
2,4-D	UNFL	ug/L	.000	0	0	0	0	0
Atrazine	UNFL	ug/L	.000	0	0	0	0	0
Cyanazine	UNFL	ug/L	.000	0	0	0	0	0
Linuron	UNFL	ug/L	.000	0	0	0	0	0
Metribuzin	UNFL	ug/L	.000	0	0	0	0	0
Endrin	UNFL	ug/L	.000	0	0	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	0	0	0	0
Metolachlor	UNFL	ug/L	.000	0	0	0	0	0
Toxaphene	UNFL	ug/L	.000	0	0	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	0	0	0	0
<u>DIOXIN/FURAN</u>								
Carbofuran	UNFL	ug/L	.000	0	0	0	0	0
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	3	15	.108	.21	0
Chemical Oxygen Demand	UNFL	mg/L	.000	0	0	0	0	0
Chloride	UNFL	mg/L	145.065	16	16	6.5	26.7	0
Fluoride	UNFL	mg/L	.938	14	15	.06	.3	0
Nitrate	UNFL	mg/L	11.400	11	13	.1	3.8	0
Phenols	UNFL	mg/L	.000	9	16	.01	.1	0
Phosphorus	UNFL	mg/L	.693	6	11	.124	.67	0
Sulfate	UNFL	mg/L	359.847	14	14	48	106	0
Sulfide	UNFL	mg/L	.000	2	8	.72	2	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	5	6	.1	.29	5
Total Organic Carbon	UNFL	mg/L	3.764	6	7	1.5	4.45	1

See footnote at end of table

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**TABLE 4-57B  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>								
Total Organic Halides	UNFL	mg/L	.021	6	11	.0105	1.1	2
Total Organic Nitrogen	UNFL	mg/L	.652	11	15	0	.31	0
<u>MISCELLANEOUS</u>								
Fonofos	UNFL	ug/L	.000	0	0	0	0	0
Phosphorodithioic acid, O,O- diethyl-s-(((1,1-dimethyl	UNFL	ug/L	.000	0	0	0	0	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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**TABLE 4-58**  
**SOUTH FIELD**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	8	14	.0805	5.11	5
Antimony		mg/L	.038	1	14	.0051	.0051	0
Arsenic		mg/L	.300	5	14	.0012	.0039	0
Barium		mg/L	.413	14	14	.0329	.0961	0
Beryllium		mg/L	.003	1	14	.002	.002	0
Cadmium		mg/L	.006	0	14	0	0	0
Calcium		mg/L	135.163	14	14	83.5	198	7
Chromium		mg/L	.042	2	13	.0052	.0237	0
Cobalt		mg/L	.000	0	14	0	0	0
Copper		mg/L	.130	1	14	.0296	.0296	0
Cyanide		mg/L	.000	0	9	0	0	0
Iron		mg/L	4.000	9	14	.0329	15.1	1
Lead		mg/L	.029	4	14	.0015	.016	0
Magnesium		mg/L	38.070	14	14	20.6	60.2	4
Manganese		mg/L	.800	14	14	.004	.44	0
Mercury		mg/L	.001	0	14	0	0	0
Molybdenum		mg/L	.027	0	14	0	0	0
Nickel		mg/L	.026	2	14	.0042	.0072	0
Potassium		mg/L	3.087	14	14	1.68	4.4	7
Selenium		mg/L	.005	4	14	.0014	.0033	0
Silicon		mg/L	10.491	14	14	3.07	12.8	1
Silver		mg/L	.023	0	14	0	0	0
Sodium		mg/L	51.918	14	14	4.09	12.7	0
Thallium		mg/L	.000	0	14	0	0	0
Vanadium		mg/L	.027	1	13	.0185	.0185	0
Zinc		mg/L	.105	7	14	.0051	.0801	0
<b>RADIONUCLIDES</b>								
CS-137		pCi/L	.000	0	11	0	0	0
GROSS ALPHA		pCi/L	.000	5	11	49.7	1410	5
GROSS BETA		pCi/L	.000	7	11	6.92	520	7
NP-237		pCi/L	.000	6	9	.15	.962	6
PU-238		pCi/L	.000	4	10	.075	.637	4
PU-239/240		pCi/L	.000	0	10	0	0	0

See footnote at end of table

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TABLE 4-58  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-226		pCi/L	1.200	7	11	.13	.536	0
RA-228		pCi/L	4.500	0	11	0	0	0
RU-106		pCi/L	.000	0	11	0	0	0
SR-90		pCi/L	.000	0	11	0	0	0
TC-99		pCi/L	36.000	0	11	0	0	0
TH-228		pCi/L	1.520	0	10	0	0	0
TH-230		pCi/L	1.790	8	10	.186	2.06	1
TH-232		pCi/L	.000	1	10	.044	.044	1
TH-TOTAL		ug/L	2.000	1	9	.398	.398	0
U-234		pCi/L	1.900	10	10	.83	662	6
U-235/236		pCi/L	.000	8	10	.22	31.7	8
U-238		pCi/L	.900	10	10	.76	707	9
U-TOTAL		ug/L	2.920	10	10	1.67	2070	9
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane		ug/L	.000	1	9	1	1	1
1,1,2,2-Tetrachloroethane		ug/L	.000	0	9	0	0	0
1,1,2-Trichloroethane		ug/L	.000	0	9	0	0	0
1,1-Dichloroethane		ug/L	.000	0	9	0	0	0
1,1-Dichloroethene		ug/L	.000	0	9	0	0	0
1,2-Dichloroethane		ug/L	.000	0	9	0	0	0
1,2-Dichloroethene		ug/L	.000	0	9	0	0	0
1,2-Dichloropropane		ug/L	.000	0	9	0	0	0
2-Butanone		ug/L	.000	0	9	0	0	0
2-Hexanone		ug/L	.000	0	9	0	0	0
4-Methyl-2-pentanone		ug/L	.000	0	9	0	0	0
Acetone		ug/L	.000	2	8	3	10	2
Benzene		ug/L	.000	0	9	0	0	0
Bromodichloromethane		ug/L	.000	0	9	0	0	0
Bromoform		ug/L	.000	0	9	0	0	0
Bromomethane		ug/L	.000	0	9	0	0	0
Carbon Tetrachloride		ug/L	.000	0	9	0	0	0
Carbon disulfide		ug/L	.000	0	9	0	0	0
Chlorobenzene		ug/L	.000	0	9	0	0	0
Chloroethane		ug/L	.000	0	9	0	0	0
Chloroform		ug/L	.000	0	9	0	0	0
Chloromethane		ug/L	.000	0	8	0	0	0
Dibromochloromethane		ug/L	.000	0	9	0	0	0
Ethylbenzene		ug/L	.000	0	9	0	0	0
Methylene chloride		ug/L	.000	0	10	0	0	0
Styrene		ug/L	.000	0	9	0	0	0

See footnote at end of table

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TABLE 4-58  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Tetrachloroethene		ug/L	.000	0	9	0	0	0
Toluene		ug/L	.000	0	9	0	0	0
Trichloroethene		ug/L	.000	0	9	0	0	0
Vinyl Acetate		ug/L	.000	0	7	0	0	0
Vinyl chloride		ug/L	.000	0	9	0	0	0
Xylenes, Total		ug/L	.000	0	9	0	0	0
cis-1,3-Dichloropropene		ug/L	.000	0	9	0	0	0
trans-1,3-Dichloropropene		ug/L	.000	0	9	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene		ug/L	.000	0	9	0	0	0
1,2-Dichlorobenzene		ug/L	.000	0	9	0	0	0
1,3-Dichlorobenzene		ug/L	.000	0	9	0	0	0
1,4-Dichlorobenzene		ug/L	.000	0	9	0	0	0
2,4,5-Trichlorophenol		ug/L	.000	0	9	0	0	0
2,4,6-Trichlorophenol		ug/L	.000	0	9	0	0	0
2,4-Dichlorophenol		ug/L	.000	0	9	0	0	0
2,4-Dimethylphenol		ug/L	.000	0	9	0	0	0
2,4-Dinitrophenol		ug/L	.000	0	8	0	0	0
2,4-Dinitrotoluene		ug/L	.000	0	9	0	0	0
2,6-Dinitrotoluene		ug/L	.000	0	9	0	0	0
2-Benzyl-4-chlorophenol		ug/L	.000	0	2	0	0	0
2-Chloronaphthalene		ug/L	.000	0	9	0	0	0
2-Chlorophenol		ug/L	.000	0	9	0	0	0
2-Methylnaphthalene		ug/L	.000	0	9	0	0	0
2-Methylphenol		ug/L	.000	0	9	0	0	0
2-Nitroaniline		ug/L	.000	0	9	0	0	0
2-Nitrophenol		ug/L	.000	0	9	0	0	0
3,3'-Dichlorobenzidine		ug/L	.000	0	9	0	0	0
3-Nitroaniline		ug/L	.000	0	9	0	0	0
4,6-Dinitro-2-methylphenol		ug/L	.000	0	6	0	0	0
4-Bromophenyl phenyl ether		ug/L	.000	0	9	0	0	0
4-Chloro-3-methylphenol		ug/L	.000	0	9	0	0	0
4-Chlorophenylphenyl ether		ug/L	.000	0	9	0	0	0
4-Methylphenol		ug/L	.000	0	9	0	0	0
4-Nitroaniline		ug/L	.000	0	6	0	0	0
4-Nitrophenol		ug/L	.000	0	7	0	0	0
Acenaphthene		ug/L	.000	0	9	0	0	0
Acenaphthylene		ug/L	.000	0	9	0	0	0
Anthracene		ug/L	.000	0	9	0	0	0

See footnote at end of table

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TABLE 4-58  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(a)anthracene		ug/L	.000	0	9	0	0	0
Benzo(a)pyrene		ug/L	.000	0	9	0	0	0
Benzo(b)fluoranthene		ug/L	.000	0	9	0	0	0
Benzo(g,h,i)perylene		ug/L	.000	0	9	0	0	0
Benzo(k)fluoranthene		ug/L	.000	0	9	0	0	0
Benzoic acid		ug/L	.000	0	7	0	0	0
Benzyl alcohol		ug/L	.000	0	8	0	0	0
Butyl benzyl phthalate		ug/L	.000	2	9	1	2	2
Carbazole		ug/L	.000	0	9	0	0	0
Chrysene		ug/L	.000	0	9	0	0	0
Di-n-butyl phthalate		ug/L	.000	2	9	4	5	2
Di-n-octyl phthalate		ug/L	.000	0	8	0	0	0
Dibenzo(a,h)anthracene		ug/L	.000	0	9	0	0	0
Dibenzofuran		ug/L	.000	0	9	0	0	0
Diethyl phthalate		ug/L	.000	0	9	0	0	0
Dimethyl phthalate		ug/L	.000	0	9	0	0	0
Fluoranthene		ug/L	.000	0	9	0	0	0
Fluorene		ug/L	.000	0	9	0	0	0
Hexachlorobenzene		ug/L	.000	0	9	0	0	0
Hexachlorobutadiene		ug/L	.000	0	9	0	0	0
Hexachlorocyclopentadiene		ug/L	.000	0	9	0	0	0
Hexachloroethane		ug/L	.000	0	9	0	0	0
Indeno(1,2,3-cd)pyrene		ug/L	.000	0	9	0	0	0
Isophorone		ug/L	.000	0	9	0	0	0
N-Nitroso-di-n-propylamine		ug/L	.000	0	9	0	0	0
N-Nitrosodimethylamine		ug/L	.000	0	2	0	0	0
N-Nitrosodiphenylamine		ug/L	.000	0	9	0	0	0
Naphthalene		ug/L	.000	0	9	0	0	0
Nitrobenzene		ug/L	.000	0	9	0	0	0
Pentachlorophenol		ug/L	.000	0	9	0	0	0
Phenanthrene		ug/L	.000	0	9	0	0	0
Phenol		ug/L	.000	0	9	0	0	0
Pyrene		ug/L	.000	0	9	0	0	0
Tributyl phosphate		ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane		ug/L	.000	0	9	0	0	0
bis(2-Chloroethyl)ether		ug/L	.000	0	9	0	0	0
bis(2-Chloroisopropyl) ether		ug/L	.000	0	9	0	0	0
bis(2-Ethylhexyl) phthalate		ug/L	.000	3	9	2	6	3
p-Chloroaniline		ug/L	.000	0	8	0	0	0

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See footnote at end of table

TABLE 4-58  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBS</u>								
4,4'-DDD'		ug/L	.000	0	9	0	0	0
4,4'-DDE'		ug/L	.000	0	9	0	0	0
4,4'-DDT'		ug/L	.000	0	9	0	0	0
Aldrin		ug/L	.000	0	9	0	0	0
Aroclor-1016		ug/L	.000	0	9	0	0	0
Aroclor-1221		ug/L	.000	0	9	0	0	0
Aroclor-1232		ug/L	.000	0	9	0	0	0
Aroclor-1242		ug/L	.000	0	9	0	0	0
Aroclor-1248		ug/L	.000	0	9	0	0	0
Aroclor-1254		ug/L	.000	0	9	0	0	0
Aroclor-1260		ug/L	.000	0	9	0	0	0
Dieldrin		ug/L	.000	0	9	0	0	0
Endosulfan II		ug/L	.000	0	9	0	0	0
Endosulfan sulfate		ug/L	.000	0	9	0	0	0
Endosulfan-I		ug/L	.000	0	9	0	0	0
Endrin		ug/L	.000	0	9	0	0	0
Endrin aldehyde		ug/L	.000	0	9	0	0	0
Endrin ketone		ug/L	.000	0	9	0	0	0
Heptachlor		ug/L	.000	0	9	0	0	0
Heptachlor epoxide		ug/L	.000	0	9	0	0	0
Methoxychlor		ug/L	.000	0	9	0	0	0
Toxaphene		ug/L	.000	0	9	0	0	0
alpha-BHC		ug/L	.000	0	9	0	0	0
alpha-Chlordane		ug/L	.000	0	9	0	0	0
beta-BHC		ug/L	.000	0	9	0	0	0
delta-BHC		ug/L	.000	0	9	0	0	0
gamma-BHC (Lindane)		ug/L	.000	0	9	0	0	0
gamma-Chlordane		ug/L	.000	0	9	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity		mg/L	.000	7	7	240	455	0
Alkalinity as CaCO3		mg/L	.000	1	1	370	370	0
Ammonia		mg/L	3.240	1	7	.12	.12	0
Chloride		mg/L	145.065	8	8	4.62	22.89	0
Fluoride		mg/L	.938	8	8	.09	.51	0
Nitrate		mg/L	11.400	7	7	.15	2.04	0
Phenols		mg/L	.000	0	8	0	0	0
Phosphorus		mg/L	.693	2	2	.06	.46	0
Sulfate		mg/L	359.847	8	8	18.6	95.4	0

See footnote at end of table

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TABLE 4-58  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<u>GENERAL CHEMISTRY (Continued)</u>								
Sulfide		mg/L	.000	0	8	0	0	0
Total Kjeldahl Nitrogen		mg/L	.000	7	8	.1	.32	7
Total Organic Carbon		mg/L	3.764	2	8	1.07	1.41	0
Total Organic Halides		mg/L	.021	1	6	.0144	.0144	0
Total Organic Nitrogen		mg/L	.652	6	8	.11	.32	0
Total Phosphorous		mg/L	.000	4	6	.04	.98	0

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available

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See footnote at end of table

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Location	Sample ID	Lead		Groundwater Unit	Sample Type
		Detected Value (µg/L)	Background (µg/L)		
11022	113058	unfiltered 17.9	29	Great Miami Aquifer	Hydropunch™
11023	113062	unfiltered 4.7	29	Great Miami Aquifer	Hydropunch™
11028	113242	unfiltered 35.1	29	Great Miami Aquifer	Hydropunch™
11030	116361	unfiltered 30	50	Perched	Hydropunch™
11030	116362	unfiltered 26.2	50	Perched	Hydropunch™
2944	113866	filtered 2	29	Great Miami Aquifer	2000-Series Well
		unfiltered 16			
2943	113315	unfiltered 2	29	Great Miami Aquifer	2000-Series Well

Groundwater data do not indicate concentrations of lead above background in water samples collected downgradient of the former Firing Range and, therefore, the Firing range does not appear to impact groundwater.

Historical data indicate that Well 2045 (see Appendix G, Table G-2K) has detected total uranium concentrations ranging from 265 µg/L to 462 µg/L since the first sample was analyzed in May 1989. This means that impacts from the South Field are at least four years old. Contours of total uranium concentrations detected in 2000-series wells during Phase II are plotted on Figure 4-26. Several sources potentially exist for the total uranium observed in 2000-series wells. Elevated concentrations detected in 2000-series wells on the west boundary may be related to recharge that occurs beneath the Inactive Flyash Pile and flows to the east beneath the South Field. Recharge mechanisms were discussed in Section 4.3. A plume of total uranium flows downgradient from the Inactive Flyash Pile beneath the South Field and intersects Well 2046 (423 µg/L) before flowing to Well 2385 (98.7 µg/L). The same plume flows from Well 2945 (1820 µg/L), past Well 2954 (1167 µg/L), to Well 2385 (98.7 µg/L).

Uranium contamination detected in Hydropunch™ and well groundwater samples at the southeast part of the South Field (Hydropunch™ 11018, 11019, and 11021, and Well 2045) indicate that the Great Miami Aquifer may receive contaminated groundwater recharge from at least two sources: perched groundwater recharge from the area north of Hydropunch™ location 11028 and contaminated recharge of surface water at the southeast corner of the subunit. Possible contaminated surface water recharge was detected by surface water samples and was discussed in Section 4.4.3. The plume at the southeast corner of the South Field appears to be separated from the plume to the north by a zone of

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less contaminated groundwater that extends from Well 2016 (17 µg/L) to Well 2944 (1.5 µg/L) and Well 2048 (1.3 µg/L). The southeast part of the total uranium plume appears to flow past Well 2045 (364 µg/L), Well 2049 (111 µg/L) and possibly Well 21033 (43.2 µg/L).

4.5.5 Biota

A Site-wide Ecological Risk Assessment will be prepared as part of the Operable Unit 5 RI/FS.

4.5.6 Summary

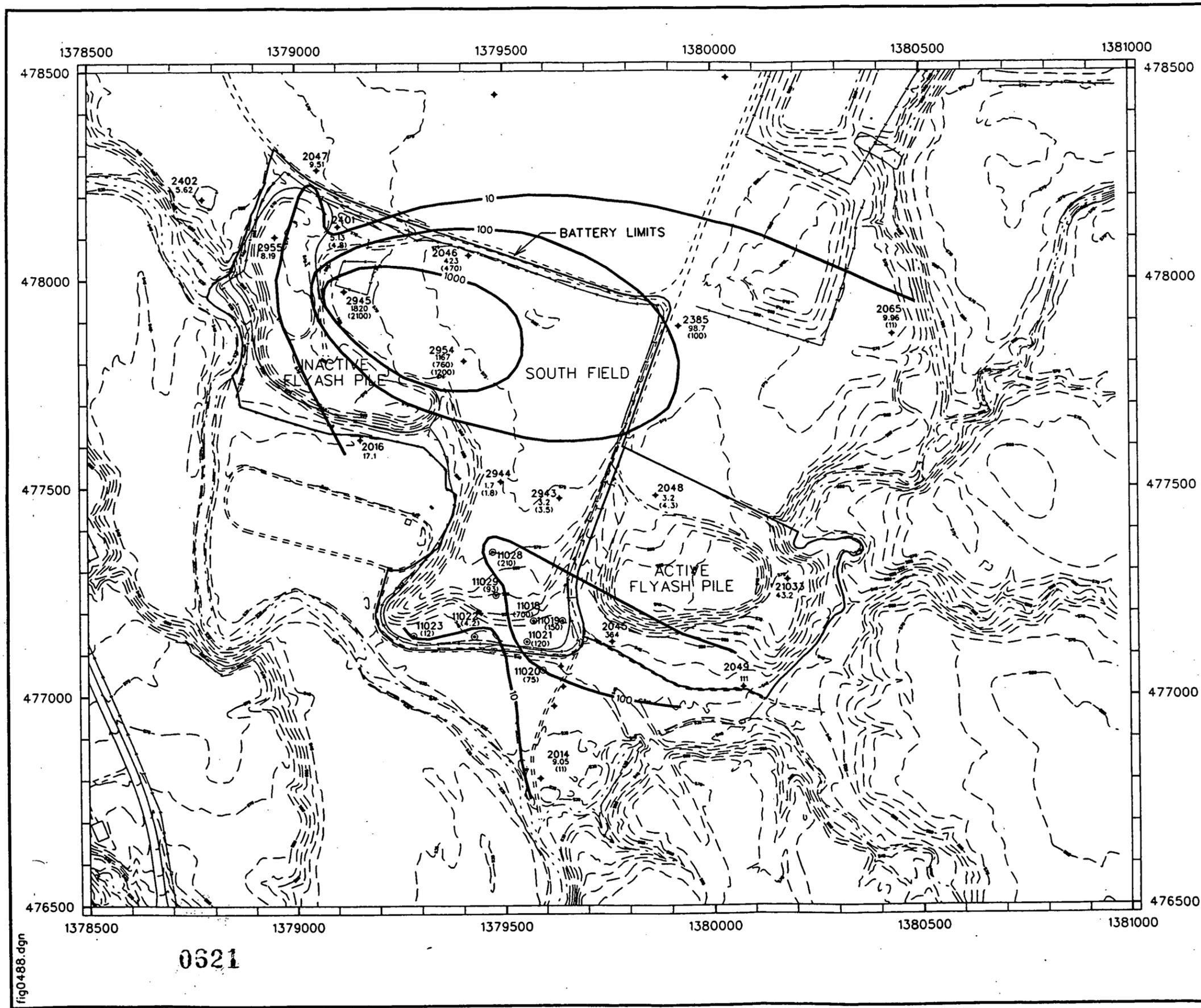
The following conclusions are possible concerning the South Field:

- Twenty-two organic compounds, mostly semivolatile, were detected in soil samples. These compounds are similar to those detected at the Solid Waste Landfill and are distributed over the surface of the subunit. Samples taken at depth indicate the compounds are also detected within the subsurface but concentrations decrease with depth. Organic compounds were detected in perched and regional groundwater at trace levels indicating no significant impact on groundwater.
- Isotopes of nine elements were detected in soil samples. Elevated concentrations of radionuclides are associated with waste material disposed of in the South Field. The concentrations of radionuclides decrease with depth through the fill and glacial till.
- Trenching activities uncovered a variety of waste materials including concrete, steel pipe and sheet steel, wood, and clay tile. Surface wipe samples from some of these materials had a maximum reading of 150,000 dpm suggesting that the contamination is removable, so the materials are potential leaching sources of radionuclides to groundwater.
- Water samples from drainage detected elevated uranium concentrations, indicating that the subunit has impacted surface drainage by seepage. Elevated concentrations of organics were detected in sediment samples, indicating possible migration of contaminated surface soils beyond the subunit battery limits.
- Perched groundwater wells detected elevated uranium concentrations in all samples. This indicates that surface disposal practices and waste trenches have impacted shallow groundwater.
- 2000-series wells detected elevated uranium concentrations downgradient of the Inactive Flyash Pile (Well 2945) and downgradient of the south end of the South Field (Well 2045). This indicates that the subunit has impacted regional groundwater quality.

4.6 ACTIVE FLYASH PILE

Analytical results for samples collected from the Active Flyash Pile are presented in Appendix G. Sample analyses that detected analytes at concentrations above background (defined in Table 4-1A)

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**LEGEND**

- ELEVATION CONTOURS
- ROADS
- STREAM
- DRAINAGE
- FENCE
- 2000 MONITORING WELLS
- HYDROPUNCH
- ON-SITE SCREENING RESULTS

NOTE: Total Uranium Concentrations are in ug/l.  
 NOTE: Data from May 1993.

NOTE:  
 Coordinates are in State Planar NAD 1927.  
 Surface contours based on 1992 flyover.

SCALE (FT)  
 0 125 250 500

**FIGURE 4-26**  
 DISTRIBUTION OF  
 TOTAL URANIUM IN  
 2000-SERIES WELLS  
 DETECTED ABOVE BACKGROUND  
 IN THE SOUTH FIELD/  
 FLYASH PILES AREA

fig0488.dgn  
 0621

will be discussed in this section. Geology and hydrogeology of the Active Flyash Pile referred to in this section were discussed in more detail in Section 3.5.

4.6.1 Volume and Physical Characteristics of Waste Material

The volume of flyash was estimated by means of digitized topographic maps, boring log data, and interpolation by using Intergraph Corporation Microstation PC software. Volume calculations are summarized in Figure 4-27. The volume of flyash in the Active Flyash Pile is calculated to be approximately 64,581 cubic yards

Flyash was generated at the boiler plant by burning coal and was deposited as surface dumping by dump trucks. Aerial photographs indicate that the flyash was deposited upon the original ground surface and thereafter worked by bulldozers into lifts. Samples of flyash collected from borings into the Active Flyash Pile indicate that it contains alternating loose (blow counts ranging from 2 to 10 per 6 inches) to medium dense (blow counts ranging from 11 to 16 per 6 inches) layers.

Samples of flyash collected from borings detected dry to moist conditions but never detected water saturated samples. Very moist to wet conditions were detected at the interface of the Active Flyash Pile and the native till surface. Soil samples collected from soil borings drilled in the flyash detected other waste materials consisting of concrete and construction rubble in the vicinity of Well 1048 north of the flyash pile. Flyash was the only material detected in all other subsurface samples collected from the flyash pile.

4.6.2 Surface and Subsurface Media

Analytical results for flyash (presented in Appendix G, Table G-2) were compared against background flyash concentrations, and soil background concentrations. The summaries of these comparisons are presented in Tables 4-59 through 65.

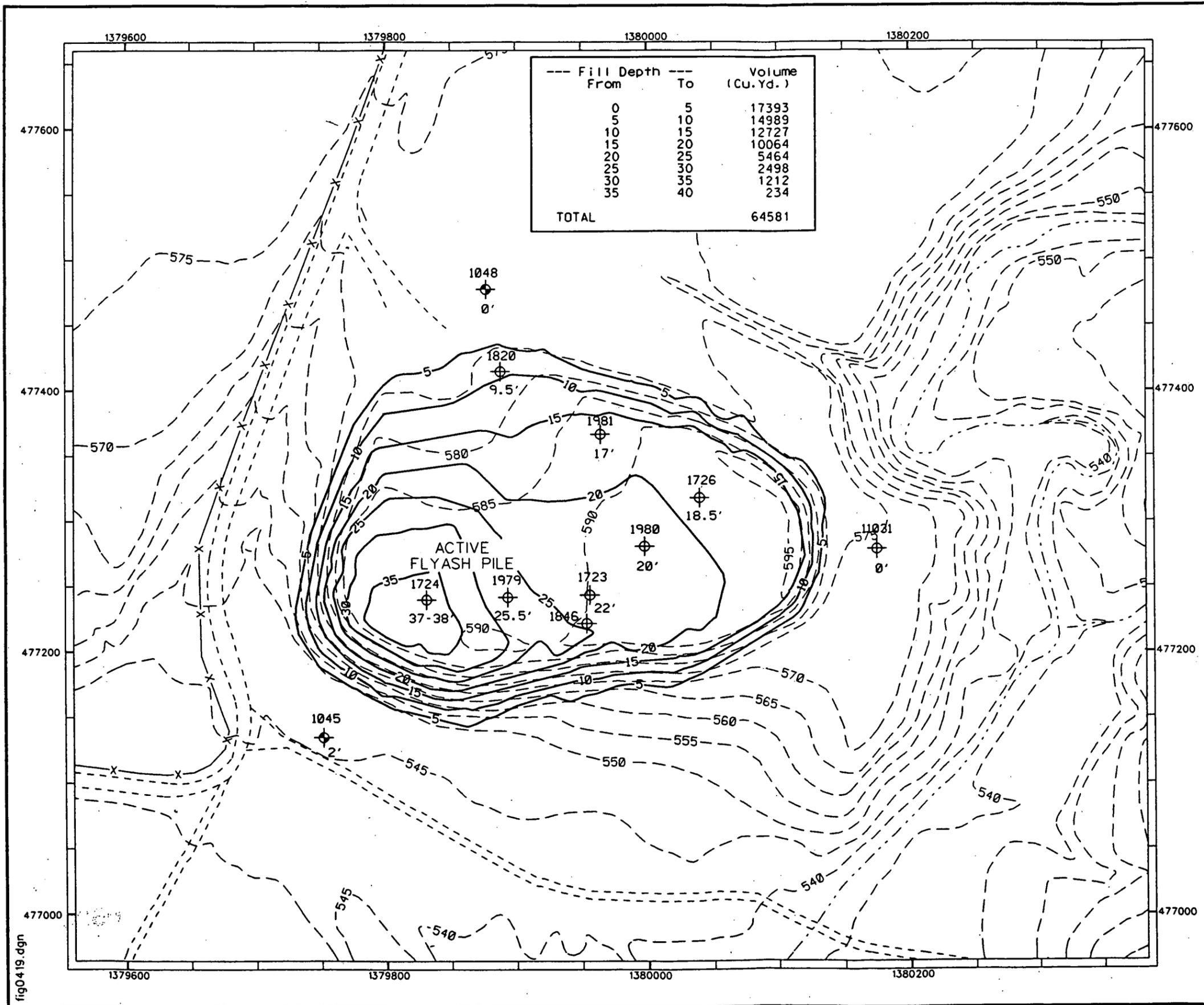
No surface soil samples were collected during Phase I. During Phase II surface soil samples were collected from eight locations within the flyash pile. These results were compared with background flyash and are summarized in Table 4-59. Arsenic was the only metal detected above background (one out of 14 samples analyzed), and no radionuclides were detected above background. Since organic background flyash results were not available, a comparison could not be made. Surface soil samples for the Active Flyash Pile, by visual observation are ash samples and therefore were not

compared to background soil concentrations. Phase II surface soil data was compared to CIS and ES data (Tables G-4 and G-5). Analytes detected in these preliminary studies were also detected in Phase II within the same order of magnitude. Radionuclides, metals of concern, and organics is surface samples that were detected above background are shown on Figure 4-28 (see Volume 2, Oversized Figures).

During Phase I subsurface flyash was collected from four locations and the comparison of the results with background flyash is summarized in Table 4-60A. No metals were detected above background flyash, and isotopes of three elements (radium-226, radium-228, thorium-232, and thorium-total) were detected above background during Phase I. During Phase II subsurface ash was collected from three locations and a comparison of the results with background flyash is summarized in Table 4-60B. No metals were above background flyash concentrations, and one uranium isotope was detected above background (uranium-238 maximum was 7.12 pCi/g; total uranium had a maximum concentration of 22.1 mg/kg). A comparison for organics could not be made since background flyash results for organics did not exist.

A comparison of subsurface ash results to background concentrations for subsurface soil was made for both Phase I and Phase II. The results are summarized in Tables 4-61A and 4-61B. For Phase I sixteen metals, isotopes of six elements, and eleven organics were detected above background soil concentrations. For Phase II fourteen metals (Antimony, Silicon, and Selenium were not detected during Phase I; Aluminum, Chromium, Nickel, and Silver were detected for Phase I but not Phase II), isotopes of six elements (neptunium-237, plutonium-238, and plutonium-239/240 were not detected during Phase I; radium-224 and radium-228 were detected during Phase I but not Phase II), and nine organic compounds (2-Haxanone, Total Xylenes, and Pentachlorophenol were not detected during Phase I; 2-Butanone, Benzene, Carbon Disulfide, Methylene Chloride, 2-Chlorophenol, 2-Methylnapthalene, 4-Chloro-3-Methylphenol, 4-Nitrophenol, Di-n-Octylphthalate, and Phenanthrene were detected above background during Phase I but not Phase II) were detected above soil background.

Subsurface soil samples were collected around and below the flyash pile for Phase I and Phase II. The results were compared to background soil results and are summarized in Tables 4-62 and 4-63. During Phase I ten metals, isotopes of three elements, and one organic compound [bis(2-Ethylhexyl) phthalate] were detected above background. During Phase II eighteen metals, isotopes of five



**LEGEND**

- 575 ELEVATION CONTOURS
- ROADS
- DRAINAGE
- THICKNESS CONTOUR 5-FT INTERVALS
- FENCE
- 1000 MONITORING WELLS 17' DEPTH OF FLYASH
- SOIL BORING 17' DEPTH OF FLYASH

BORINGS USED TO PROVIDE DATA FOR THICKNESS CONTOURS.

NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

SCALE (FT)  
0 80 160

0524

**FIGURE 4-27**  
**THICKNESS OF WASTE MATERIAL**  
**ACTIVE FLYASH PILE**

**TABLE 4-59**  
**ACTIVE FLYASH PILE**  
**SURFACE SOIL<sup>a</sup>**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<b>Metals</b>							
Aluminum	mg/kg	140000.000	14	14	3430	11100	0
Antimony	mg/kg	18.370	7	14	1.5	3.2	0
Arsenic	mg/kg	140.970	14	14	10.4	145	1
Barium	mg/kg	4920.000	14	14	75	349	0
Beryllium	mg/kg	19.890	14	14	1.5	6.4	0
Cadmium	mg/kg	20.640	4	14	.56	.74	0
Calcium	mg/kg	134687.460	14	14	1900	59800	0
Chromium	mg/kg	218.000	14	14	6.9	15.4	0
Cobalt	mg/kg	199.350	14	14	8.9	24.9	0
Copper	mg/kg	382.160	14	14	19.9	94	0
Iron	mg/kg	148364.370	14	14	3940	16500	0
Lead	mg/kg	193.980	14	14	21.6	77.4	0
Magnesium	mg/kg	40000.000	14	14	376	16600	0
Manganese	mg/kg	1610.700	14	14	15.6	463	0
Mercury	mg/kg	.720	6	14	.14	.26	0
Molybdenum	mg/kg	269.590	14	14	1.7	12.5	0
Nickel	mg/kg	215.590	14	14	15.3	54.2	0
Selenium	mg/kg	73.000	11	14	1.9	10.3	0
Silver	mg/kg	14.000	2	14	3.4	4.7	0
Vanadium	mg/kg	390.000	14	14	23	66.3	0
Zinc	mg/kg	677.250	14	14	39.6	94.5	0
<b>Radionuclides</b>							
RA-226	pCi/g	5.250	14	14	1.3	4.61	0
SR-90	pCi/g	4390.000	7	14	.214	4.47	0
TH-232	pCi/g	4.330	14	14	.931	3.74	0
TH-TOTAL	mg/kg	330.000	14	14	8.57	34.1	0
U-238	pCi/g	6.070	14	14	2.88	4.39	0
U-TOTAL	mg/kg	19.000	14	14	7.86	14.8	0

<sup>a</sup>Surface source soil results are compared to ash background concentrations.

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**TABLE 4-60A**  
**ACTIVE FLYASH PILE**  
**SUBSOIL<sup>a</sup> SOURCE (FLYASH)**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	140000.000	8	8	1570	17900	0
Antimony	mg/kg	18.370	0		0	0	0
Arsenic	mg/kg	140.970	8	8	9.1	66.5	0
Barium	mg/kg	4920.000	8	8	56.6	508	0
Beryllium	mg/kg	19.890	8	8	.65	4.6	0
Cadmium	mg/kg	20.640	0	8	0	0	0
Calcium	mg/kg	134687.460	8	8	826	4000	0
Chromium	mg/kg	218.000	8	8	4.4	25.8	0
Cobalt	mg/kg	199.350	7	8	5	18.8	0
Copper	mg/kg	382.160	8	8	24	66.1	0
Iron	mg/kg	148364.370	8	8	2260	31100	0
Lead	mg/kg	193.980	8	8	19.7	61.7	0
Magnesium	mg/kg	40000.000	8	8	150	4380	0
Manganese	mg/kg	1610.700	8	8	8.2	340	0
Mercury	mg/kg	.720	1	8	.16	.16	0
Molybdenum	mg/kg	269.590	8	8	4.3	18.8	0
Nickel	mg/kg	215.590	8	8	6.2	45.7	0
Selenium	mg/kg	73.000	7	8	.85	10.2	0
Silver	mg/kg	14.000	0	8	0	0	0
Vanadium	mg/kg	390.000	8	8	15	40.3	0
Zinc	mg/kg	677.250	8	8	18.9	117	0
<b>Radionuclides</b>							
PB-210	pCi/g	12.500	2	2	1.52	1.63	0
RA-226	pCi/g	5.250	10	10	2.53	6.22	1
RA-228	pCi/g	.000	10	10	2.23	5.32	10
RU-106	pCi/g	.000	0	10	0	0	0
SR-90	pCi/g	4390.000	7	10	1.01	1.53	0
TH-232	pCi/g	4.330	10	10	1.89	5.08	1
TH-TOTAL	mg/kg	330.000	10	10	17	45.8	0
U-238	pCi/g	6.070	12	12	3.15	12.6	7
U-TOTAL	mg/kg	19.000	10	10	9.08	31.3	5

<sup>a</sup>Subsoil source results are compared to ash background concentrations.

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**TABLE 4-60B**  
**ACTIVE FLYASH PILE**  
**SUBSOIL<sup>a</sup> SOURCE (FLYASH)**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>METALS</u>							
Aluminum	mg/kg	140000.000	6	6	3570	7090	0
Antimony	mg/kg	18.370	1	6	2	2	0
Arsenic	mg/kg	140.970	6	6	16.9	87.8	0
Barium	mg/kg	4920.000	6	6	106	385	0
Beryllium	mg/kg	19.890	6	6	2.3	3.9	0
Cadmium	mg/kg	20.640	1	6	.79	.79	0
Calcium	mg/kg	134687.460	6	6	2230	6680	0
Chromium	mg/kg	218.000	6	6	8.4	15.1	0
Cobalt	mg/kg	199.350	6	6	10.7	21.8	0
Copper	mg/kg	382.160	6	6	40	59.8	0
Iron	mg/kg	148364.370	6	6	2480	5310	0
Lead	mg/kg	193.980	6	6	30.3	68.2	0
Magnesium	mg/kg	40000.000	6	6	335	1730	0
Manganese	mg/kg	1610.700	6	6	16.5	107	0
Mercury	mg/kg	.720	1	6	.19	.19	0
Molybdenum	mg/kg	269.590	3	6	5.2	9.7	0
Nickel	mg/kg	215.590	6	6	18.8	34.6	0
Selenium	mg/kg	73.000	5	6	2.5	11.4	0
Silver	mg/kg	14.000	0	6	0	0	0
Vanadium	mg/kg	390.000	6	6	30.5	42.6	0
Zinc	mg/kg	677.250	6	6	23.4	120	0
<u>Radionuclides</u>							
RA-226	pCi/g	5.250	6	6	2.96	4.02	0
SR-90	pCi/g	4390.000	2	6	.65	.705	0
TH-232	pCi/g	4.330	6	6	2.05	3.14	0
TH-TOTAL	mg/kg	330.000	6	6	18.9	28.9	0
U-238	pCi/g	6.070	6	6	3.27	7.12	1
U-TOTAL	mg/kg	19.000	6	6	9.34	22.1	1

<sup>a</sup>Subsoil source results are compared to ash background concentrations.

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**TABLE 4-61A**  
**ACTIVE FLYASH PILE**  
**SUBSURFACE SOIL<sup>a</sup> SOURCE**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	8	8	1570	17900	1
Antimony	mg/kg	.000	0		0	0	0
Arsenic	mg/kg	9.704	8	8	9.1	66.5	7
Barium	mg/kg	121.064	8	8	56.6	508	6
Beryllium	mg/kg	.620	8	8	.65	4.6	8
Cadmium	mg/kg	.910	0	8	0	0	0
Calcium	mg/kg	150000.000	8	8	826	4000	0
Chromium	mg/kg	20.953	8	8	4.4	25.8	1
Cobalt	mg/kg	15.929	7	8	5	18.8	2
Copper	mg/kg	20.230	8	8	24	66.1	8
Cyanide	mg/kg	.170	6	8	.17	.69	5
Iron	mg/kg	31188.164	8	8	2260	31100	0
Lead	mg/kg	15.780	8	8	19.7	61.7	8
Magnesium	mg/kg	43052.339	8	8	150	4380	0
Manganese	mg/kg	1045.407	8	8	8.2	340	0
Mercury	mg/kg	.290	1	8	.16	.16	0
Molybdenum	mg/kg	.270	8	8	4.3	18.8	8
Nickel	mg/kg	34.747	8	8	6.2	45.7	1
Potassium	mg/kg	2007.519	8	8	326	1230	0
Selenium	mg/kg	.000	7	8	.85	10.2	7
Silver	mg/kg	.000	0	8	0	0	0
Sodium	mg/kg	227.947	8	8	92.7	312	2
Thallium	mg/kg	.490	6	8	.96	2.1	6
Vanadium	mg/kg	38.088	8	8	15	40.3	2
Zinc	mg/kg	73.158	8	8	18.9	117	4
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	0	10	0	0	0
GROSS ALPHA	pCi/g	.000	0		0	0	0
GROSS BETA	pCi/g	.000	0		0	0	0
NP-237	pCi/g	.000	0	6	0	0	0
PB-210	pCi/g	.857	2	2	1.52	1.63	2
PU-238	pCi/g	.000	0	10	0	0	0
PU-239/240	pCi/g	.000	0	4	0	0	0
RA-224	pCi/g	1.019	2	2	3.44	3.74	2

See footnote at end of table

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TABLE 4-61A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
RA-226	pCi/g	1.470	10	10	2.53	6.22	10
RA-228	pCi/g	1.325	10	10	2.23	5.32	10
RU-106	pCi/g	.000	0	10	0	0	0
SR-90	pCi/g	.560	7	10	1.01	1.53	7
TC-99	pCi/g	.000	0	8	0	0	0
TH-228	pCi/g	1.341	10	10	2.91	5.79	10
TH-230	pCi/g	1.897	10	10	3	6.08	10
TH-232	pCi/g	1.269	10	10	1.89	5.08	10
TH-TOTAL	mg/kg	9.470	10	10	17	45.8	10
U-234	pCi/g	1.034	10	10	3.08	17.3	10
U-235	pCi/g	.000	1	2	.6	.6	0
U-235/236	pCi/g	.142	2	10	3.42	4.12	2
U-238	pCi/g	1.122	12	12	3.15	12.6	12
U-TOTAL	mg/kg	2.540	10	10	9.08	31.3	10
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	8	9	28	1300	8
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	1	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	1	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	4	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	4	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	4	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	3	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	1	0	0	0
2-Butanone	ug/kg	.000	1	2	4	4	1
2-Hexanone	ug/kg	.000	0	1	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	2	3	11	25	2
Acetone	ug/kg	.000	0	4	0	0	0
Benzene	ug/kg	.000	1	2	2	2	1
Bromodichloromethane	ug/kg	.000	0	1	0	0	0
Bromoform	ug/kg	.000	0	1	0	0	0
Bromomethane	ug/kg	.000	0	4	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	1	0	0	0
Carbon disulfide	ug/kg	.000	1	5	7	7	1
Chlorobenzene	ug/kg	.000	0	1	0	0	0
Chloroethane	ug/kg	.000	0	4	0	0	0
Chloroform	ug/kg	.000	0	4	0	0	0
Chloromethane	ug/kg	.000	0	4	0	0	0
Dibromochloromethane	ug/kg	.000	0	1	0	0	0
Ethylbenzene	ug/kg	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-61A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Methylene chloride	ug/kg	.000	4	6	34	73	4
Styrene	ug/kg	.000	0	1	0	0	0
Tetrachloroethene	ug/kg	.000	0	1	0	0	0
Toluene	ug/kg	.000	5	6	13	130	5
Trichloroethene	ug/kg	.000	0	1	0	0	0
Vinyl Acetate	ug/kg	.000	0	1	0	0	0
Vinyl chloride	ug/kg	.000	0	4	0	0	0
Xylenes, Total	ug/kg	.000	0	1	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	10	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	10	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	10	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	10	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	10	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	10	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	10	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	10	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	10	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	10	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	10	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	10	0	0	0
2-Chlorophenol	ug/kg	.000	1	10	48	48	1
2-Methylnaphthalene	ug/kg	.000	3	10	49	160	3
2-Methylphenol	ug/kg	.000	0	10	0	0	0
2-Nitroaniline	ug/kg	.000	0	10	0	0	0
2-Nitrophenol	ug/kg	.000	0	10	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	10	0	0	0
3-Nitroaniline	ug/kg	.000	0	8	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	10	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	10	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	1	10	58	58	1
4-Chlorophenylphenyl ether	ug/kg	.000	0	10	0	0	0
4-Methylphenol	ug/kg	.000	0	10	0	0	0
4-Nitroaniline	ug/kg	.000	0	10	0	0	0
4-Nitrophenol	ug/kg	.000	1	10	48	48	1
Acenaphthene	ug/kg	.000	0	10	0	0	0
Acenaphthylene	ug/kg	.000	0	10	0	0	0

See footnote at end of table

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TABLE 4-61A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Anthracene	ug/kg	.000	0	10	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	10	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	10	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	10	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	10	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	10	0	0	0
Benzoic acid	ug/kg	.000	4	10	52	73	4
Benzyl alcohol	ug/kg	.000	0	10	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	10	0	0	0
Carbazole	ug/kg	.000	0		0	0	0
Chrysene	ug/kg	.000	0	10	0	0	0
Di-n-butyl phthalate	ug/kg	.000	3	10	47	69	3
Di-n-octyl phthalate	ug/kg	.000	1	10	3000	3000	1
Dibenzo(a,h)anthracene	ug/kg	.000	0	10	0	0	0
Dibenzofuran	ug/kg	.000	0	10	0	0	0
Diethyl phthalate	ug/kg	.000	0	10	0	0	0
Dimethyl phthalate	ug/kg	.000	0	10	0	0	0
Fluoranthene	ug/kg	.000	0	10	0	0	0
Fluorene	ug/kg	.000	0	10	0	0	0
Hexachlorobenzene	ug/kg	.000	0	10	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	10	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	10	0	0	0
Hexachloroethane	ug/kg	.000	0	10	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	10	0	0	0
Isophorone	ug/kg	.000	0	10	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	10	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	10	0	0	0
Naphthalene	ug/kg	.000	2	10	52	82	2
Nitrobenzene	ug/kg	.000	0	10	0	0	0
Pentachlorophenol	ug/kg	.000	0	10	0	0	0
Phenanthrene	ug/kg	.000	3	10	43	72	3
Phenol	ug/kg	.000	1	10	58	58	1
Pyrene	ug/kg	.000	0	10	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	10	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	10	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	10	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	3	10	120	2700	3
p-Chloroaniline	ug/kg	.000	0	10	0	0	0

See footnote at end of table

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TABLE 4-61A  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	8	0	0	0
4,4'-DDE	ug/kg	.000	0	8	0	0	0
4,4'-DDT	ug/kg	.000	0	8	0	0	0
Aldrin	ug/kg	.000	0	8	0	0	0
Aroclor-1016	ug/kg	.000	0	8	0	0	0
Aroclor-1221	ug/kg	.000	0	8	0	0	0
Aroclor-1232	ug/kg	.000	0	8	0	0	0
Aroclor-1242	ug/kg	.000	0	8	0	0	0
Aroclor-1248	ug/kg	.000	0	8	0	0	0
Aroclor-1254	ug/kg	.000	0	8	0	0	0
Aroclor-1260	ug/kg	.000	0	8	0	0	0
Dieldrin	ug/kg	.000	0	8	0	0	0
Endosulfan II	ug/kg	.000	0	8	0	0	0
Endosulfan sulfate	ug/kg	.000	0	8	0	0	0
Endosulfan-I	ug/kg	.000	0	8	0	0	0
Endrin	ug/kg	.000	0	8	0	0	0
Endrin ketone	ug/kg	.000	0	8	0	0	0
Heptachlor	ug/kg	.000	0	8	0	0	0
Heptachlor epoxide	ug/kg	.000	0	8	0	0	0
Methoxychlor	ug/kg	.000	0	8	0	0	0
Toxaphene	ug/kg	.000	0	8	0	0	0
alpha-BHC	ug/kg	.000	0	8	0	0	0
alpha-Chlordane	ug/kg	.000	0	8	0	0	0
beta-BHC	ug/kg	.000	0	8	0	0	0
delta-BHC	ug/kg	.000	0	8	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	8	0	0	0
gamma-Chlordane	ug/kg	.000	0	8	0	0	0
<u>GENERAL CHEMISTRY</u>							
Total Organic Carbon	mg/kg	.000	4	4	63907	420620	4

<sup>a</sup>Flyash subsurface source results are compared to subsurface background concentrations.

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**TABLE 4-61B**  
**ACTIVE FLYASH PILE**  
**SUBSURFACE SOIL<sup>a</sup> SOURCE**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	6	6	3570	7090	0
Antimony	mg/kg	.000	1	6	2	2	1
Arsenic	mg/kg	9.704	6	6	16.9	87.8	6
Barium	mg/kg	121.064	6	6	106	385	5
Beryllium	mg/kg	.620	6	6	2.3	3.9	6
Cadmium	mg/kg	.910	1	6	.79	.79	0
Calcium	mg/kg	150000.000	6	6	2230	6680	0
Chromium	mg/kg	20.953	6	6	8.4	15.1	0
Cobalt	mg/kg	15.929	6	6	10.7	21.8	2
Copper	mg/kg	20.230	6	6	40	59.8	6
Cyanide	mg/kg	.170	2	4	.33	.34	2
Iron	mg/kg	31188.164	6	6	2480	5310	0
Lead	mg/kg	15.780	6	6	30.3	68.2	6
Magnesium	mg/kg	43052.339	6	6	335	1730	0
Manganese	mg/kg	1045.407	6	6	16.5	107	0
Mercury	mg/kg	.290	1	6	.19	.19	0
Molybdenum	mg/kg	.270	3	6	5.2	9.7	3
Nickel	mg/kg	34.747	6	6	18.8	34.6	0
Potassium	mg/kg	2007.519	6	6	601	1230	0
Selenium	mg/kg	.000	5	6	2.5	11.4	5
Silicon	mg/kg	1069.496	6	6	302	964	0
Silver	mg/kg	.000	0	6	0	0	0
Sodium	mg/kg	227.947	6	6	132	231	1
Thallium	mg/kg	.490	6	6	.75	3.1	6
Vanadium	mg/kg	38.088	6	6	30.5	42.6	3
Zinc	mg/kg	73.158	6	6	23.4	120	2
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	0	6	0	0	0
GROSS ALPHA	pCi/g	.000	6	6	35.7	62	6
GROSS BETA	pCi/g	.000	6	6	30.1	45.6	6
NP-237	pCi/g	.000	5	5	.059	.45	5
PU-238	pCi/g	.000	6	6	.062	.47	6
PU-239/240	pCi/g	.000	4	6	.017	.86	4
RA-226	pCi/g	1.470	6	6	2.96	4.02	6

See footnote at end of table

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TABLE 4-61B  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
RA-228	pCi/g	1.325	6	6	2.23	3.69	6
RU-106	pCi/g	.000	0	6	0	0	0
SR-90	pCi/g	.560	2	6	.65	.705	2
TC-99	pCi/g	.000	0	6	0	0	0
TH-228	pCi/g	1.341	6	6	1.8	3.27	6
TH-230	pCi/g	1.897	6	6	2.4	5.52	6
TH-232	pCi/g	1.269	6	6	2.05	3.14	6
TH-TOTAL	mg/kg	9.470	6	6	18.9	28.9	6
U-234	pCi/g	1.034	6	6	3.04	5.02	6
U-235/236	pCi/g	.142	6	6	.12	.326	4
U-238	pCi/g	1.122	6	6	3.27	7.12	6
U-TOTAL	mg/kg	2.540	6	6	9.34	22.1	6
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	3	6	12	740	3
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	2	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	3	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	6	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	6	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	5	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	6	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	3	0	0	0
2-Butanone	ug/kg	.000	0	5	0	0	0
2-Hexanone	ug/kg	.000	1	4	10	10	1
4-Methyl-2-pentanone	ug/kg	.000	0	3	0	0	0
Acetone	ug/kg	.000	1	5	37	37	1
Benzene	ug/kg	.000	0	3	0	0	0
Bromodichloromethane	ug/kg	.000	0	3	0	0	0
Bromoform	ug/kg	.000	0	3	0	0	0
Bromomethane	ug/kg	.000	0	6	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	3	0	0	0
Carbon disulfide	ug/kg	.000	0	6	0	0	0
Chlorobenzene	ug/kg	.000	0	3	0	0	0
Chloroethane	ug/kg	.000	0	6	0	0	0
Chloroform	ug/kg	.000	0	5	0	0	0
Chloromethane	ug/kg	.000	0	6	0	0	0
Dibromochloromethane	ug/kg	.000	0	3	0	0	0
Ethylbenzene	ug/kg	.000	0	3	0	0	0
Methylene chloride	ug/kg	.000	0	6	0	0	0
Styrene	ug/kg	.000	0	3	0	0	0

See footnote at end of table

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TABLE 4-61B  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Tetrachloroethene	ug/kg	.000	0	3	0	0	0
Toluene	ug/kg	.000	5	6	12	440	5
Trichloroethene	ug/kg	.000	0	3	0	0	0
Vinyl Acetate	ug/kg	.000	0	2	0	0	0
Vinyl chloride	ug/kg	.000	0	6	0	0	0
Xylenes, Total	ug/kg	.000	1	3	53	53	1
cis-1,3-Dichloropropene	ug/kg	.000	0	3	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	3	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	6	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	6	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	6	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	6	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	6	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	6	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	6	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	6	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	2	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	6	0	0	0
2-Chlorophenol	ug/kg	.000	0	6	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	6	0	0	0
2-Methylphenol	ug/kg	.000	0	6	0	0	0
2-Nitroaniline	ug/kg	.000	0	6	0	0	0
2-Nitrophenol	ug/kg	.000	0	6	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	6	0	0	0
3-Nitroaniline	ug/kg	.000	0	6	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	6	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	6	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	6	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	6	0	0	0
4-Methylphenol	ug/kg	.000	0	6	0	0	0
4-Nitroaniline	ug/kg	.000	0	6	0	0	0
4-Nitrophenol	ug/kg	.000	0	6	0	0	0
Acenaphthene	ug/kg	.000	0	6	0	0	0
Acenaphthylene	ug/kg	.000	0	6	0	0	0
Anthracene	ug/kg	.000	0	6	0	0	0

See footnote at end of table

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TABLE 4-61B  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Benzo(a)anthracene	ug/kg	.000	0	6	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	6	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	6	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	6	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	6	0	0	0
Benzoic acid	ug/kg	.000	3	6	2	100	3
Benzyl alcohol	ug/kg	.000	0	4	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	6	0	0	0
Carbazole	ug/kg	.000	0	6	0	0	0
Chrysene	ug/kg	.000	0	6	0	0	0
Di-n-butyl phthalate	ug/kg	.000	1	6	86	86	1
Di-n-octyl phthalate	ug/kg	.000	0	6	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	6	0	0	0
Dibenzofuran	ug/kg	.000	0	6	0	0	0
Diethyl phthalate	ug/kg	.000	0	6	0	0	0
Dimethyl phthalate	ug/kg	.000	0	6	0	0	0
Fluoranthene	ug/kg	.000	0	6	0	0	0
Fluorene	ug/kg	.000	0	6	0	0	0
Hexachlorobenzene	ug/kg	.000	0	6	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	6	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	6	0	0	0
Hexachloroethane	ug/kg	.000	0	6	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	6	0	0	0
Isophorone	ug/kg	.000	0	6	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	6	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	6	0	0	0
Naphthalene	ug/kg	.000	0	6	0	0	0
Nitrobenzene	ug/kg	.000	0	6	0	0	0
Pentachlorophenol	ug/kg	.000	1	6	56	56	1
Phenanthrene	ug/kg	.000	0	6	0	0	0
Phenol	ug/kg	.000	0	6	0	0	0
Pyrene	ug/kg	.000	0	6	0	0	0
Tributyl phosphate	ug/kg	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	6	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	6	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	6	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	3	6	48	780	3
p-Chloroaniline	ug/kg	.000	0	6	0	0	0

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See footnote at end of table

TABLE 4-61B  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	6	0	0	0
4,4'-DDE	ug/kg	.000	0	6	0	0	0
4,4'-DDT	ug/kg	.000	0	6	0	0	0
Aldrin	ug/kg	.000	0	6	0	0	0
Aroclor-1016	ug/kg	.000	0	6	0	0	0
Aroclor-1221	ug/kg	.000	0	6	0	0	0
Aroclor-1232	ug/kg	.000	0	6	0	0	0
Aroclor-1242	ug/kg	.000	0	6	0	0	0
Aroclor-1248	ug/kg	.000	0	6	0	0	0
Aroclor-1254	ug/kg	.000	0	6	0	0	0
Aroclor-1260	ug/kg	.000	0	6	0	0	0
Dieldrin	ug/kg	.000	0	6	0	0	0
Endosulfan II	ug/kg	.000	0	6	0	0	0
Endosulfan sulfate	ug/kg	.000	0	6	0	0	0
Endosulfan-I	ug/kg	.000	0	6	0	0	0
Endrin	ug/kg	.000	0	6	0	0	0
Endrin aldehyde	ug/kg	.000	0	6	0	0	0
Endrin ketone	ug/kg	.000	0	6	0	0	0
Heptachlor	ug/kg	.000	0	6	0	0	0
Heptachlor epoxide	ug/kg	.000	0	6	0	0	0
Methoxychlor	ug/kg	.000	0	6	0	0	0
Toxaphene	ug/kg	.000	0	6	0	0	0
alpha-BHC	ug/kg	.000	0	6	0	0	0
alpha-Chlordane	ug/kg	.000	0	6	0	0	0
beta-BHC	ug/kg	.000	0	6	0	0	0
delta-BHC	ug/kg	.000	0	6	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	6	0	0	0
gamma-Chlordane	ug/kg	.000	0	6	0	0	0

<sup>a</sup>Flyah subsurface source results are compared to subsurface background concentrations.

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**TABLE 4-62**  
**ACTIVE FLYASH PILE**  
**SUBSURFACE SOIL NONSOURCE**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<b>METALS</b>							
Aluminum	mg/kg	16277.291	3	3	2440	6360	0
Antimony	mg/kg	.000	3	3	9	31.1	3
Arsenic	mg/kg	9.704	3	3	4.6	9.1	0
Barium	mg/kg	121.064	3	3	16.7	63.6	0
Beryllium	mg/kg	.620	3	3	.47	.75	2
Cadmium	mg/kg	.910	3	3	1.3	5.2	3
Calcium	mg/kg	150000.000	3	3	26200	155000	1
Chromium	mg/kg	20.953	3	3	17.4	26.8	1
Cobalt	mg/kg	15.929	3	3	6.1	10.2	0
Copper	mg/kg	20.230	3	3	14.3	21.3	1
Cyanide	mg/kg	.170	0	3	0	0	0
Iron	mg/kg	31188.164	3	3	9840	16700	0
Lead	mg/kg	15.780	3	3	5.8	11.3	0
Magnesium	mg/kg	43052.339	3	3	9600	37200	0
Manganese	mg/kg	1045.407	3	3	223	523	0
Mercury	mg/kg	.290	0	3	0	0	0
Molybdenum	mg/kg	.270	3	3	8.7	13.2	3
Nickel	mg/kg	34.747	3	3	13.9	25.7	0
Potassium	mg/kg	2007.519	3	3	242	1220	0
Selenium	mg/kg	.000	1	3	2.3	2.3	1
Silver	mg/kg	.000	3	3	6.6	18.5	3
Sodium	mg/kg	227.947	3	3	119	247	1
Thallium	mg/kg	.490	0	3	0	0	0
Vanadium	mg/kg	38.088	3	3	16.8	24	0
Zinc	mg/kg	73.158	3	3	25.3	43	0
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	0	8	0	0	0
NP-237	pCi/g	.000	0	6	0	0	0
PU-238	pCi/g	.000	0	9	0	0	0
PU-239/240	pCi/g	.000	0	7	0	0	0
RA-226	pCi/g	1.470	7	8	.4	1.45	0
RA-228	pCi/g	1.325	6	7	.537	1.2	0
RU-106	pCi/g	.000	0	8	0	0	0
SR-90	pCi/g	.560	5	7	.5	3.61	4
TC-99	pCi/g	.000	0	6	0	0	0
TH-228	pCi/g	1.341	7	9	.813	2.09	3

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TABLE 4-62  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
TH-230	pCi/g	1.897	9	9	.7	1.97	2
TH-232	pCi/g	1.269	7	9	.52	1.2	0
TH-TOTAL	mg/kg	9.470	5	5	3.38	8.71	0
U-234	pCi/g	1.034	7	9	.92	1.27	1
U-235	pCi/g	.000	0		0	0	0
U-235/236	pCi/g	.142	0	9	0	0	0
U-238	pCi/g	1.122	7	9	.754	2.4	2
U-TOTAL	mg/kg	2.540	11	12	2	8	10
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	1	3	25	25	1
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	3	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	3	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	3	0	0	0
1,1-Dichloroethene	ug/kg	.000	1	3	2	2	1
1,2-Dichloroethane	ug/kg	.000	0	3	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	3	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	3	0	0	0
2-Butanone	ug/kg	.000	1	3	3	3	1
2-Hexanone	ug/kg	.000	0	3	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	3	0	0	0
Acetone	ug/kg	.000	0	3	0	0	0
Benzene	ug/kg	.000	0	3	0	0	0
Bromodichloromethane	ug/kg	.000	0	3	0	0	0
Bromoform	ug/kg	.000	0	3	0	0	0
Bromomethane	ug/kg	.000	0	3	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	3	0	0	0
Carbon disulfide	ug/kg	.000	0	3	0	0	0
Chlorobenzene	ug/kg	.000	0	3	0	0	0
Chloroethane	ug/kg	.000	0	3	0	0	0
Chloroform	ug/kg	.000	0	3	0	0	0
Chloromethane	ug/kg	.000	0	3	0	0	0
Dibromochloromethane	ug/kg	.000	0	3	0	0	0
Ethylbenzene	ug/kg	.000	0	3	0	0	0
Methylene chloride	ug/kg	.000	0	3	0	0	0
Styrene	ug/kg	.000	0	3	0	0	0
Tetrachloroethene	ug/kg	.000	0	3	0	0	0
Toluene	ug/kg	.000	0	3	0	0	0
Trichloroethene	ug/kg	.000	0	3	0	0	0
Vinyl Acetate	ug/kg	.000	0	3	0	0	0
Vinyl chloride	ug/kg	.000	0	3	0	0	0
Xylenes, Total	ug/kg	.000	0	3	0	0	0

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TABLE 4-62  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
cis-1,3-Dichloropropene	ug/kg	.000	0	3	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	3	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	3	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	3	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	3	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	3	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	3	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	3	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	3	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	3	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	3	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	3	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	3	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	3	0	0	0
2-Chlorophenol	ug/kg	.000	0	3	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	3	0	0	0
2-Methylphenol	ug/kg	.000	0	3	0	0	0
2-Nitroaniline	ug/kg	.000	0	3	0	0	0
2-Nitrophenol	ug/kg	.000	0	3	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	3	0	0	0
3-Nitroaniline	ug/kg	.000	0	2	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	3	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	3	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	3	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	3	0	0	0
4-Methylphenol	ug/kg	.000	0	3	0	0	0
4-Nitroaniline	ug/kg	.000	0	2	0	0	0
4-Nitrophenol	ug/kg	.000	0	3	0	0	0
Acenaphthene	ug/kg	.000	0	3	0	0	0
Acenaphthylene	ug/kg	.000	0	3	0	0	0
Anthracene	ug/kg	.000	0	3	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	3	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	3	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	3	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	3	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	3	0	0	0
Benzoic acid	ug/kg	.000	0	3	0	0	0
Benzyl alcohol	ug/kg	.000	0	3	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	3	0	0	0
Chrysene	ug/kg	.000	0	3	0	0	0
Di-n-butyl phthalate	ug/kg	.000	0	3	0	0	0

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TABLE 4-62  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Di-n-octyl phthalate	ug/kg	.000	0	3	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	3	0	0	0
Dibenzofuran	ug/kg	.000	0	3	0	0	0
Diethyl phthalate	ug/kg	.000	0	3	0	0	0
Dimethyl phthalate	ug/kg	.000	0	3	0	0	0
Fluoranthene	ug/kg	.000	0	3	0	0	0
Fluorene	ug/kg	.000	0	3	0	0	0
Hexachlorobenzene	ug/kg	.000	0	3	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	3	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	3	0	0	0
Hexachloroethane	ug/kg	.000	0	3	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	3	0	0	0
Isophorone	ug/kg	.000	0	3	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	3	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	3	0	0	0
Naphthalene	ug/kg	.000	0	3	0	0	0
Nitrobenzene	ug/kg	.000	0	3	0	0	0
Pentachlorophenol	ug/kg	.000	0	3	0	0	0
Phenanthrene	ug/kg	.000	0	3	0	0	0
Phenol	ug/kg	.000	0	3	0	0	0
Pyrene	ug/kg	.000	0	3	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	3	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	3	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	3	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	1	3	42	42	1
p-Chloroaniline	ug/kg	.000	0	3	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	3	0	0	0
4,4'-DDE	ug/kg	.000	0	3	0	0	0
4,4'-DDT	ug/kg	.000	0	3	0	0	0
Aldrin	ug/kg	.000	0	3	0	0	0
Aroclor-1016	ug/kg	.000	0	3	0	0	0
Aroclor-1221	ug/kg	.000	0	3	0	0	0
Aroclor-1232	ug/kg	.000	0	3	0	0	0
Aroclor-1242	ug/kg	.000	0	3	0	0	0
Aroclor-1248	ug/kg	.000	0	3	0	0	0
Aroclor-1254	ug/kg	.000	0	3	0	0	0
Aroclor-1260	ug/kg	.000	0	3	0	0	0
Dieldrin	ug/kg	.000	0	3	0	0	0
Endosulfan II	ug/kg	.000	0	3	0	0	0
Endosulfan sulfate	ug/kg	.000	0	3	0	0	0
Endosulfan-I	ug/kg	.000	0	3	0	0	0

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TABLE 4-62  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Endrin	ug/kg	.000	0	3	0	0	0
Endrin ketone	ug/kg	.000	0	3	0	0	0
Heptachlor	ug/kg	.000	0	3	0	0	0
Heptachlor epoxide	ug/kg	.000	0	3	0	0	0
Methoxychlor	ug/kg	.000	0	3	0	0	0
Toxaphene	ug/kg	.000	0	3	0	0	0
alpha-BHC	ug/kg	.000	0	3	0	0	0
alpha-Chlordane	ug/kg	.000	0	3	0	0	0
beta-BHC	ug/kg	.000	0	3	0	0	0
delta-BHC	ug/kg	.000	0	3	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	3	0	0	0
gamma-Chlordane	ug/kg	.000	0	3	0	0	0
<u>GENERAL CHEMISTRY</u>							
Total Organic Carbon	mg/kg	.000	1	1	12331	12331	1

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**TABLE 4-63**  
**ACTIVE FLYASH PILE**  
**SUBSURFACE SOIL NONSOURCE**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	16277.291	6	6	7610	25500	2
Antimony	mg/kg	.000	0	6	0	0	0
Arsenic	mg/kg	9.704	6	6	4.1	18.7	4
Barium	mg/kg	121.064	6	6	62.1	195	2
Beryllium	mg/kg	.620	6	6	.55	1.4	5
Cadmium	mg/kg	.910	4	6	.8	1.2	3
Calcium	mg/kg	150000.000	6	6	5870	106000	0
Chromium	mg/kg	20.953	6	6	11	26.1	2
Cobalt	mg/kg	15.929	6	6	7	13.7	0
Copper	mg/kg	20.230	6	6	14.9	32.3	3
Cyanide	mg/kg	.170	0	4	0	0	0
Iron	mg/kg	31188.164	6	6	15500	44800	2
Lead	mg/kg	15.780	6	6	8.6	31.1	3
Magnesium	mg/kg	43052.339	6	6	4190	25400	0
Manganese	mg/kg	1045.407	6	6	258	1900	2
Mercury	mg/kg	.290	0	6	0	0	0
Molybdenum	mg/kg	.270	4	6	1.3	13.5	4
Nickel	mg/kg	34.747	6	6	16.8	36.7	1
Potassium	mg/kg	2007.519	6	6	935	2380	3
Selenium	mg/kg	.000	1	6	3.7	3.7	1
Silicon	mg/kg	1069.496	6	6	609	1210	1
Silver	mg/kg	.000	2	6	10.7	14.1	2
Sodium	mg/kg	227.947	6	6	128	227	0
Thallium	mg/kg	.490	3	6	.28	.47	0
Vanadium	mg/kg	38.088	6	6	18	64.5	2
Zinc	mg/kg	73.158	6	6	42.7	89.9	1
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.000	0	6	0	0	0
GROSS ALPHA	pCi/g	.000	6	6	9.43	20.3	6
GROSS BETA	pCi/g	.000	6	6	20.7	33.5	6
NP-237	pCi/g	.000	6	6	.052	.4	6
PU-238	pCi/g	.000	3	6	.031	.085	3
PU-239/240	pCi/g	.000	2	6	.027	.06	2
RA-226	pCi/g	1.470	6	6	.912	1.73	1
RA-228	pCi/g	1.325	6	6	.748	1.33	1
RU-106	pCi/g	.000	0	6	0	0	0

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**TABLE 4-63  
(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
SR-90	pCi/g	.560	0	6	0	0	0
TC-99	pCi/g	.000	0	6	0	0	0
TH-228	pCi/g	1.341	6	6	.628	1.37	1
TH-230	pCi/g	1.897	6	6	1.01	3.6	2
TH-232	pCi/g	1.269	6	6	.677	1.35	1
TH-TOTAL	mg/kg	9.470	6	6	6.23	12.4	1
U-234	pCi/g	1.034	6	6	.772	1.01	0
U-235/236	pCi/g	.142	6	6	.03	.069	0
U-238	pCi/g	1.122	6	6	.8	1.21	3
U-TOTAL	mg/kg	2.540	6	6	3.3	4.534	6
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	ug/kg	.000	2	6	4	5600	2
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	5	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	6	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	6	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	6	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	6	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	6	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	6	0	0	0
2-Butanone	ug/kg	.000	0	5	0	0	0
2-Hexanone	ug/kg	.000	0	6	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	6	0	0	0
Acetone	ug/kg	.000	0	4	0	0	0
Benzene	ug/kg	.000	0	6	0	0	0
Bromodichloromethane	ug/kg	.000	0	6	0	0	0
Bromoform	ug/kg	.000	0	6	0	0	0
Bromomethane	ug/kg	.000	0	6	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	6	0	0	0
Carbon disulfide	ug/kg	.000	0	6	0	0	0
Chlorobenzene	ug/kg	.000	0	6	0	0	0
Chloroethane	ug/kg	.000	0	6	0	0	0
Chloroform	ug/kg	.000	0	6	0	0	0
Chloromethane	ug/kg	.000	0	6	0	0	0
Dibromochloromethane	ug/kg	.000	0	6	0	0	0
Ethylbenzene	ug/kg	.000	0	6	0	0	0
Methylene chloride	ug/kg	.000	1	6	25	25	1
Styrene	ug/kg	.000	0	6	0	0	0
Tetrachloroethene	ug/kg	.000	0	6	0	0	0
Toluene	ug/kg	.000	1	6	2	2	1
Trichloroethene	ug/kg	.000	0	6	0	0	0
Vinyl Acetate	ug/kg	.000	0	4	0	0	0
Vinyl chloride	ug/kg	.000	0	6	0	0	0

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TABLE 4-63  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	6	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	6	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	6	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	6	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	6	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	6	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	6	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	6	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	6	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	6	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	6	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	6	0	0	0
2-Benzyl-4-chlorophenol	ug/kg	.000	0	2	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	6	0	0	0
2-Chlorophenol	ug/kg	.000	0	6	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	6	0	0	0
2-Methylphenol	ug/kg	.000	0	6	0	0	0
2-Nitroaniline	ug/kg	.000	0	6	0	0	0
2-Nitrophenol	ug/kg	.000	0	6	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	6	0	0	0
3-Nitroaniline	ug/kg	.000	0	6	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	6	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	6	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	6	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	6	0	0	0
4-Methylphenol	ug/kg	.000	0	6	0	0	0
4-Nitroaniline	ug/kg	.000	0	6	0	0	0
4-Nitrophenol	ug/kg	.000	0	6	0	0	0
Acenaphthene	ug/kg	.000	0	6	0	0	0
Acenaphthylene	ug/kg	.000	0	6	0	0	0
Anthracene	ug/kg	.000	0	6	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	6	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	6	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	6	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	6	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	6	0	0	0
Benzoic acid	ug/kg	.000	1	6	56	56	1
Benzyl alcohol	ug/kg	.000	0	4	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	6	0	0	0

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TABLE 4-63  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Carbazole	ug/kg	.000	0	6	0	0	0
Chrysene	ug/kg	.000	0	6	0	0	0
Di-n-butyl phthalate	ug/kg	.000	0	6	0	0	0
Di-n-octyl phthalate	ug/kg	.000	1	6	46	46	1
Dibenzo(a,h)anthracene	ug/kg	.000	0	6	0	0	0
Dibenzofuran	ug/kg	.000	0	6	0	0	0
Diethyl phthalate	ug/kg	.000	0	6	0	0	0
Dimethyl phthalate	ug/kg	.000	0	6	0	0	0
Fluoranthene	ug/kg	.000	0	6	0	0	0
Fluorene	ug/kg	.000	0	6	0	0	0
Hexachlorobenzene	ug/kg	.000	0	6	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	6	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	6	0	0	0
Hexachloroethane	ug/kg	.000	0	6	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	6	0	0	0
Isophorone	ug/kg	.000	0	6	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	6	0	0	0
N-Nitrosodimethylamine	ug/kg	.000	0	2	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	6	0	0	0
Naphthalene	ug/kg	.000	0	6	0	0	0
Nitrobenzene	ug/kg	.000	0	6	0	0	0
Pentachlorophenol	ug/kg	.000	0	6	0	0	0
Phenanthrene	ug/kg	.000	0	6	0	0	0
Phenol	ug/kg	.000	0	6	0	0	0
Pyrene	ug/kg	.000	0	6	0	0	0
Tributyl phosphate	ug/kg	.000	0	2	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	6	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	6	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	6	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	2	6	98	4200	2
p-Chloroaniline	ug/kg	.000	0	6	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	6	0	0	0
4,4'-DDE	ug/kg	.000	0	6	0	0	0
4,4'-DDT	ug/kg	.000	0	6	0	0	0
Aldrin	ug/kg	.000	0	6	0	0	0
Aroclor-1016	ug/kg	.000	0	6	0	0	0
Aroclor-1221	ug/kg	.000	0	6	0	0	0
Aroclor-1232	ug/kg	.000	0	6	0	0	0
Aroclor-1242	ug/kg	.000	0	6	0	0	0
Aroclor-1248	ug/kg	.000	0	6	0	0	0
Aroclor-1254	ug/kg	.000	0	6	0	0	0

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TABLE 4-63  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Aroclor-1260	ug/kg	.000	0	6	0	0	0
Dieldrin	ug/kg	.000	0	6	0	0	0
Endosulfan II	ug/kg	.000	0	6	0	0	0
Endosulfan sulfate	ug/kg	.000	0	6	0	0	0
Endosulfan-I	ug/kg	.000	0	6	0	0	0
Endrin	ug/kg	.000	0	6	0	0	0
Endrin aldehyde	ug/kg	.000	0	6	0	0	0
Endrin ketone	ug/kg	.000	0	6	0	0	0
Heptachlor	ug/kg	.000	0	6	0	0	0
Heptachlor epoxide	ug/kg	.000	0	6	0	0	0
Methoxychlor	ug/kg	.000	0	6	0	0	0
Toxaphene	ug/kg	.000	0	6	0	0	0
alpha-BHC	ug/kg	.000	0	6	0	0	0
alpha-Chlordane	ug/kg	.000	0	6	0	0	0
beta-BHC	ug/kg	.000	0	6	0	0	0
delta-BHC	ug/kg	.000	0	6	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	6	0	0	0
gamma-Chlordane	ug/kg	.000	0	6	0	0	0

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**TABLE 4-64**  
**ACTIVE FLYASH PILE TCLP RESULTS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)			
			1979	1980	1980	1981
			112093	112131	112146	112168
1,1-Dichloroethene	0.7		<0.005	<0.005	<0.005	<0.005
1,2-Dichloroethane	0.5		<0.005	<0.005	<0.005	<0.005
1,4-Dichlorobenzene	7.5		<0.05	<0.05	<0.05	<0.02
2,4-D	10.0		<0.12	<0.12	<0.12	<0.01
2,4-Dinitrotoluene	0.13		<0.05	<0.05	<0.05	<0.02
2,4,5-TP (Silvex)	1.0		<0.017	<0.017	<0.017	<0.0018
2,4,5-Trichlorophenol	400.0		<0.05	<0.05	<0.05	<0.01
2,4,6-Trichlorophenol	2.0		<0.05	<0.05	<0.05	<0.02
Arsenic	5.0	1.5	rejected	<0.098	<0.0705	<0.05
Barium	100.0	30.0	1.25	0.563	<0.0456	0.299
Benzene	0.5		<0.005	<0.005	<0.005	<0.005
Cadmium	1.0	0.3	<0.0021	<0.0021	<0.0021	<0.005
Carbon Tetrachloride	0.5		<0.005	<0.005	<0.005	<0.005
Chlordane	0.03		<0.0014	<0.0014	<0.0014	<0.0005
Chlorobenzene	100.0		<0.005	<0.005	<0.005	<0.005
Chloroform	6.0		<0.005	<0.005	<0.005	<0.005
Chromium	5.0	1.5	<0.0031	<0.0031	<0.0031	<0.01
Copper			<0.0103	<0.0212	<0.0017	<0.001
Endrin	0.02		<0.0006	<0.0006	<0.0006	<0.0001
Heptachlor	0.008		<0.0003	<0.0003	<0.0003	>0.0001
Heptachlor epoxide	0.008		<0.0083	<0.0083	<0.0083	<0.0001

See footnote at end of table

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TABLE 4-64  
(Continued)

Parameter	RCRA Standard (mg/L)	Ohio Exempt Waste Standard (mg/L)	Location/Sample Number and Result (mg/L)			
			1979	1980	1980	1981
			112093	112131	112146	112168
Hexachlorobenzene	0.13		<0.05	<0.05	<0.05	<0.02
Hexachlorobutadiene	0.5		<0.05	<0.05	<0.05	<0.02
Hexachloroethane	3.0		<0.05	<0.05	<0.05	<0.02
Iron			<0.0019	<0.0514	<0.0255	<0.0557
Lead	5.0	1.5	rejected	<0.0155	<0.0155	<0.04
Lindane	0.4		<0.0004	<0.0004	<0.0004	<0.0001
Manganese			0.0195	0.0688	0.263	0.0131
Mercury	0.2	0.06	<0.0002	<0.0002	<0.0002	<0.0002
Methoxychlor	10.0		<0.018	<0.018	<0.018	<0.0005
Nitrobenzene	2.0		<0.05	<0.05	<0.05	<0.02
Pentachlorophenol	100.0		<0.25	<0.25	<0.25	<0.1
Pyridine	5.0		<0.25	<0.25	<0.25	<0.2
Selenium	1.0	0.3	rejected	<0.0296	<0.0296	<0.08
Silver	5.0		<0.0022	<0.0022	<0.0022	rejected
Tetrachloroethene	0.7		<0.005	<0.005	<0.005	<0.005
Toxaphene	0.5		<0.024	<0.024	<0.024	<0.001
Trichloroethene	0.5		<0.005	<0.005	<0.005	<0.005
Vinyl chloride	0.2		<0.01	<0.01	<0.01	<0.01
Zinc			rejected	1.33	rejected	0.184

Note: A box surrounding a number indicates a result or detection limit that is above an EPA or OEPA standard.

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**TABLE 4-65**  
**ACTIVE FLYASH PILE**  
**SURFACE WATER<sup>a</sup>**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
						Minimum	Maximum	
<b>METALS</b>								
Arsenic		mg/L	.000	1	2	.0455	.0455	1
Barium		mg/L	.000	2	2	.0426	.0633	2
Cadmium		mg/L	.000	0	2	0	0	0
Calcium		mg/L	.000	2	2	73	80.8	2
Chromium		mg/L	.000	2	2	.0155	.0224	2
Copper		mg/L	.000	0	2	0	0	0
Iron		mg/L	.000	2	2	.0475	.262	2
Lead		mg/L	.000	1	2	.0362	.0362	1
Magnesium		mg/L	.000	2	2	155	268	2
Manganese		mg/L	.000	2	2	.0023	.158	2
Mercury		mg/L	.000	2	2	.00022	.00099	2
Molybdenum		mg/L	.000	2	2	.0062	.0183	2
Nickel		mg/L	.000	2	2	.0122	.0149	2
Potassium		mg/L	.000	2	2	2.42	2.42	2
Selenium		mg/L	.000	0	0	0	0	0
Silver		mg/L	.000	0	2	0	0	0
Sodium		mg/L	.000	2	2	69.4	87.8	2
<b>RADIONUCLIDES</b>								
GROSS ALPHA	UNFL	pCi/L	.000	0		0	0	0
GROSS BETA	UNFL	pCi/L	.000	0		0	0	0
RA-226	UNFL	pCi/L	.000	0	2	0	0	0
RA-228	UNFL	pCi/L	.000	0	2	0	0	0
U-TOTAL	UNFL	ug/L	.000	2	2	14	24	2
<b>GENERAL CHEMISTRY</b>								
Ammonia	UNFL	mg/L	.000	2	2	.152	.188	2
Chloride	UNFL	mg/L	.000	2	2	8	15	2
Fluoride	UNFL	mg/L	.000	2	2	.68	.8	2
Nitrate	UNFL	mg/L	.000	2	2	.12	.44	2
Phenols	UNFL	mg/L	.000	0	2	0	0	0
Phosphorus	UNFL	mg/L	.000	2	2	.827	1.1	2
Sulfate	UNFL	mg/L	.000	2	2	253	327	2
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	2	2	1.91	2.03	2
Total Organic Halides	UNFL	mg/L	.000	0	2	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	2	2	1.72	1.88	2

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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elements, and three organic compounds [benzoic acid, Di-n-Octylphthalate, and bis(2-Ethylhexyl) phthalate] were detected above background.

A comparison between surface samples and subsurface samples indicates the following:

- Pyrene, chrysene, benzo (anthracene, pyrene, fluoranthene), and fluoranthene were common to surface samples but were not detected in subsurface samples.
- Benzoic acid, toluene, naphthalene, and bis(2-Ethylhexyl)phthalate were detected in surface and subsurface samples.
- 1,1,1-trichloroethane, 1,1-dichloroethane, chloro-phenols, and xylene were detected in subsurface samples but not in surface samples.
- The concentration of all organics decrease between 10 to 17 feet deep and below the flyash/soil interface. Organics appear to be present at trace amounts throughout the flyash from the surface to about 10 feet deep.

The distribution suggests that the organics were not deposited at a single location with horizontal and vertical migration. A more fitting scenario is deposition of organics in dilute mixtures at several times during construction.

Phase I and Phase II subsurface soil data were compared to CIS and ES data (Table G-7 and G-8). Analytes detected in these preliminary studies were also detected in Phase I and Phase II within the same order of magnitude.

Results of radionuclide concentrations above background are presented on Figure 4-29 (see Volume 2, Oversized Figures). Concentrations of radionuclides are similar between flyash samples collected within the pile and are elevated with respect to soil concentrations. A comparison between the concentration of total uranium in flyash and the concentration in native soil indicates that impacts of the flyash on the soil have been slight if at all. For example, total uranium in Boring No. 1726 flyash (28.1 µg/g at 18.5 feet) is greater than the native soil concentration (3.08 µg/g at 21 feet deep), and flyash in Boring No. 1979 (22.1 µg/g at 22 feet deep) contrasts with the native soil concentration (4.49 µg/g at 27.5 feet deep). Background uranium for subsurface soil is 2.54 µg/g.

Four samples were collected for hazardous waste determination by TCLP analyses. Data from these analyses are provided in Appendix G-12 and are summarized in Table 4-64. Zinc was detected twice

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(Sample 112168 and Sample 112093) and barium was detected once (Sample 112093). None of the concentrations of detected analytes exceeded the RCRA standard defining hazardous waste.

Heptachlor epoxide detection limits exceeded the regulatory limit, but this compound was not detected in samples that were analyzed for total concentrations.

4.6.3 Surface Water and Sediment

There are no perennial sources of surface water within the battery limits of the Active Flyash Pile, and sampling was completed on an as-possible basis when flow was observed. The drainage system within the battery limits of the Active Flyash Pile was altered by to improve drainage during the interval between the Phase I and Phase II sampling events. Present day surface water drainage from the Active Flyash Pile is rapid after rain events, and there was one surface water available for sampling at location (AFP-SW-02) during the Phase II field sampling program. Surface water data are presented on Figure 4-30 (see Volume 2, Oversized Figures).

Analytical results for surface water were not compared against background concentrations since there is no background concentration determined for surface water. Tables of detected constituent concentrations are provided in Appendix G in Table G-2H and Table G-2I. A summary of analytes in surface water samples is presented on Table 4-65 and Table 4-66 and shown on Figure 4-30. Two surface water sampling locations were identified for off-site analyses during Phase I adjacent to the road at the west edge of the Active Flyash Pile. Total uranium was detected in both samples above background, and concentrations fluctuated widely in multiple samples collected over six months as shown below.

Total Uranium in Phase I Surface Water Samples			
Location	Date	Filtered	Total Uranium
ASIT-004 Upstream	March 21, 1989	Yes	318
		Unknown	1692
	November 7, 1989	Unknown	107
		Unknown	98
ASIT-005 Downstream	March 21, 1949	Yes*	1829
		Unknown	499
	November 27, 1989	Unknown	274
		Duplicate	260

\*Possibly mislabeled and is actually unfiltered

TABLE 4-66  
**ACTIVE FLYASH PILE  
 SURFACE WATER<sup>a</sup>  
 PHASE II FIELD INVESTIGATION  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.000	0	1	0	0	0
Antimony		mg/L	.000	0	1	0	0	0
Arsenic		mg/L	.000	1	1	.0054	.0054	1
Barium		mg/L	.000	1	1	.0273	.0273	1
Beryllium		mg/L	.000	0	1	0	0	0
Cadmium		mg/L	.000	0	1	0	0	0
Calcium		mg/L	.000	1	1	43.3	43.3	1
Chromium		mg/L	.000	0	1	0	0	0
Cobalt		mg/L	.000	0	1	0	0	0
Copper		mg/L	.000	0	1	0	0	0
Cyanide		mg/L	.000	0	0	0	0	0
Iron		mg/L	.000	1	1	.0824	.0824	1
Lead		mg/L	.000	0	1	0	0	0
Magnesium		mg/L	.000	1	1	6.91	6.91	1
Manganese		mg/L	.000	1	1	.0053	.0053	1
Mercury		mg/L	.000	0	1	0	0	0
Molybdenum		mg/L	.000	0	1	0	0	0
Nickel		mg/L	.000	0	1	0	0	0
Potassium		mg/L	.000	1	1	4.65	4.65	1
Selenium		mg/L	.000	1	1	.001	.001	1
Silicon		mg/L	.000	1	1	4.12	4.12	1
Silver		mg/L	.000	0	1	0	0	0
Sodium		mg/L	.000	1	1	.795	.795	1
Thallium		mg/L	.000	0	1	0	0	0
Vanadium		mg/L	.000	0	1	0	0	0
Zinc		mg/L	.000	0	1	0	0	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	1	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	1	1	3.9	3.9	1
GROSS BETA	UNFL	pCi/L	.000	1	1	6.22	6.22	1
NP-237	UNFL	pCi/L	.000	1	1	.264	.264	1
PU-238	UNFL	pCi/L	.000	1	1	.108	.108	1
PU-239/240	UNFL	pCi/L	.000	0	1	0	0	0
RA-226	UNFL	pCi/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-66  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-228	UNFL	pCi/L	.000	1	1	1.7	1.7	1
RU-106	UNFL	pCi/L	.000	0	1	0	0	0
SR-90	UNFL	pCi/L	.000	0	1	0	0	0
TC-99	UNFL	pCi/L	.000	0	1	0	0	0
TH-228	UNFL	pCi/L	.000	0	1	0	0	0
TH-230	UNFL	pCi/L	.000	0	1	0	0	0
TH-232	UNFL	pCi/L	.000	0	1	0	0	0
TH-TOTAL	UNFL	ug/L	.000	0	1	0	0	0
U-234	UNFL	pCi/L	.000	1	1	1.5	1.5	1
U-235/236	UNFL	pCi/L	.000	1	1	.102	.102	1
U-238	UNFL	pCi/L	.000	1	1	1.69	1.69	1
U-TOTAL	UNFL	ug/L	.000	1	1	4.18	4.18	1
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	1	0	0	0
2-Butanone	UNFL	ug/L	.000	0	1	0	0	0
2-Hexanone	UNFL	ug/L	.000	0	1	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	1	0	0	0
Acetone	UNFL	ug/L	.000	0	1	0	0	0
Benzene	UNFL	ug/L	.000	0	1	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	1	0	0	0
Bromoform	UNFL	ug/L	.000	0	1	0	0	0
Bromomethane	UNFL	ug/L	.000	0	1	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	1	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	1	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Chloroethane	UNFL	ug/L	.000	0	1	0	0	0
Chloroform	UNFL	ug/L	.000	0	1	0	0	0
Chloromethane	UNFL	ug/L	.000	0	1	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	1	0	0	0
Ethylbenzene	UNFL	ug/L	.000	0	1	0	0	0
Methylene chloride	UNFL	ug/L	.000	0	1	0	0	0
Styrene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-66  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Tetrachloroethene	UNFL	ug/L	.000	0	1	0	0	0
Toluene	UNFL	ug/L	.000	0	1	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	1	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	1	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	1	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	1	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	1	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	1	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	0	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	1	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	1	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	0	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	1	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0

See footnote at end of table

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TABLE 4-66  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Carbazole	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0

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See footnote at end of table

TABLE 4-66  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>								
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity	UNFL	mg/L	.000	1	1	114	114	0
Ammonia	UNFL	mg/L	.000	1	1	.15	.15	1
Chloride	UNFL	mg/L	.000	1	1	1.5	1.5	1
Fluoride	UNFL	mg/L	.000	1	1	.2	.2	1
Nitrate	UNFL	mg/L	.000	0		0	0	0
Phenols	UNFL	mg/L	.000	1	1	.01	.01	0
Sulfate	UNFL	mg/L	.000	1	1	30.4	30.4	1
Sulfide	UNFL	mg/L	.000	1	1	1	1	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	1	.5	.5	1
Total Organic Carbon	UNFL	mg/L	.000	1	1	9.06	9.06	1
Total Organic Halides	UNFL	mg/L	.000	1	1	.021	.021	1
Total Organic Nitrogen	UNFL	mg/L	.000	1	1	.85	.85	1
Total Phosphorous	UNFL	mg/L	.000	1	1	.2	.2	0

\* Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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These data indicate an impact at both the upstream and downstream locations. The origin for the discharge may be the South Field due to the fact that the South Field surface water drained into the ditch where these samples were collected. Concentrations of total uranium are similar in South Field discharge samples from Phase II. The drainage where the Phase I samples were collected has been filled in and a rock-lined channel was constructed beside it at the toe of the Active Flyash Pile.

Nine metals and the isotopes of four elements were detected in one Phase II surface water sample; no organic compounds were detected. These data suggest that organic compounds and metals detected in surface media and sediments are not present in surface water draining the subunit. Surface water data from Phase I and Phase II can not be compared because samples were collected from different drainages. It is believed that concentrations of total uranium in the South Field surface water samples are comparable to Phase I samples collected from a drainage ditch that received surface water from both the South Field and Active Flyash Pile. One Phase II surface water sample detected 4.18 µg/L total uranium, which did not indicate an impact from the Active Flyash Pile.

Two sediment samples were collected during Phase I at the same location nine months earlier. Sample ASIT-004 detected 38.9 mg/kg total uranium and ASIT-005 detected 51.8 mg/kg total uranium at the downstream location. No other constituents were detected above background in Phase I samples. It is believed that these sediment results have been impacted by the South Field because South Field surface water drained through the same ditch during Phase I sampling.

During Phase II field activities, six sediment samples were designated to be sampled. After sampling of the six locations occurred, only one location (AFP-SD-06) was considered a sediment sample. The remaining five locations appeared to be surface soil samples and were combined with Phase II surface soil data discussed in Section 4.6.2. Six metals, isotopes of three elements, and four semivolatile organic compounds were detected above background sediment samples during Phase II sampling. No organics or pesticides/PCBs were detected. A summary of analytes in sediment samples are shown on Table 4-67 and Table 4-68. Detection above background in sediment samples are similar to those for surface and subsurface flyash, indicating that sediments have been impacted by the Active Flyash Pile. Radionuclide measurements in sediments are similar to those measured in surface samples and subsurface samples and suggest that there was no additional source for radionuclides in the drainages besides the flyash material.

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**TABLE 4-67**  
**ACTIVE FLYASH PILE**  
**SEDIMENT**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	0		0	0	0
Antimony	mg/kg	.000	0	1	0	0	0
Arsenic	mg/kg	11.608	0		0	0	0
Barium	mg/kg	88.500	0		0	0	0
Beryllium	mg/kg	.600	0		0	0	0
Cadmium	mg/kg	.770	0	1	0	0	0
Calcium	mg/kg	5296.781	0		0	0	0
Chromium	mg/kg	17.057	0		0	0	0
Cobalt	mg/kg	16.913	0		0	0	0
Copper	mg/kg	15.700	0		0	0	0
Cyanide	mg/kg	.230	0	1	0	0	0
Iron	mg/kg	24788.749	0		0	0	0
Lead	mg/kg	29.575	1	1	12	12	0
Magnesium	mg/kg	1460.000	0		0	0	0
Manganese	mg/kg	2257.945	0		0	0	0
Mercury	mg/kg	.300	0		0	0	0
Molybdenum	mg/kg	.000	0	1	0	0	0
Nickel	mg/kg	25.145	0		0	0	0
Potassium	mg/kg	1349.530	1	1	871	871	0
Selenium	mg/kg	.720	0	1	0	0	0
Silver	mg/kg	.000	0		0	0	0
Sodium	mg/kg	55.145	0		0	0	0
Thallium	mg/kg	.580	0	1	0	0	0
Vanadium	mg/kg	33.693	0		0	0	0
Zinc	mg/kg	58.500	0		0	0	0
<b>RADIONUCLIDES</b>							
GROSS ALPHA	pCi/g	.000	0		0	0	0
GROSS BETA	pCi/g	.000	0		0	0	0
RA-226	pCi/g	1.528	2	2	.637	1.24	0
RA-228	pCi/g	1.170	2	2	.703	1.08	0
U-TOTAL	mg/kg	3.240	4	4	4.53	51.8	4
<b>VOLATILE ORGANICS</b>							
1,1,1-Trichloroethane	ug/kg	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	1	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	1	0	0	0

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**TABLE 4-67  
(Continued)**

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
1,1-Dichloroethane	ug/kg	.000	0	1	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	1	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	1	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	1	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	1	0	0	0
2-Butanone	ug/kg	.000	0	1	0	0	0
2-Hexanone	ug/kg	.000	0	1	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	1	0	0	0
Acetone	ug/kg	.000	0	1	0	0	0
Benzene	ug/kg	.000	0	1	0	0	0
Bromodichloromethane	ug/kg	.000	0	1	0	0	0
Bromoform	ug/kg	.000	0	1	0	0	0
Bromomethane	ug/kg	.000	0	1	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	1	0	0	0
Carbon disulfide	ug/kg	.000	0	1	0	0	0
Chlorobenzene	ug/kg	.000	0	1	0	0	0
Chloroethane	ug/kg	.000	0	1	0	0	0
Chloroform	ug/kg	.000	0	1	0	0	0
Chloromethane	ug/kg	.000	0	1	0	0	0
Dibromochloromethane	ug/kg	.000	0	1	0	0	0
Ethylbenzene	ug/kg	.000	0	1	0	0	0
Methylene chloride	ug/kg	.000	0	1	0	0	0
Styrene	ug/kg	.000	0	1	0	0	0
Tetrachloroethene	ug/kg	.000	0	1	0	0	0
Toluene	ug/kg	.000	0	1	0	0	0
Trichloroethene	ug/kg	.000	0	1	0	0	0
Vinyl Acetate	ug/kg	.000	0	1	0	0	0
Vinyl chloride	ug/kg	.000	0	1	0	0	0
Xylenes, Total	ug/kg	.000	0	1	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	1	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	1	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	1	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	1	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	1	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	1	0	0	0

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TABLE 4-67  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
2,4-Dinitrotoluene	ug/kg	.000	0	1	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	1	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	1	0	0	0
2-Chlorophenol	ug/kg	.000	0	1	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	1	0	0	0
2-Methylphenol	ug/kg	.000	0	1	0	0	0
2-Nitroaniline	ug/kg	.000	0	1	0	0	0
2-Nitrophenol	ug/kg	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	1	0	0	0
3-Nitroaniline	ug/kg	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	1	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	1	0	0	0
4-Methylphenol	ug/kg	.000	0	1	0	0	0
4-Nitroaniline	ug/kg	.000	0	1	0	0	0
4-Nitrophenol	ug/kg	.000	0	1	0	0	0
Acenaphthene	ug/kg	.000	0	1	0	0	0
Acenaphthylene	ug/kg	.000	0	1	0	0	0
Anthracene	ug/kg	.000	0	1	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	1	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	1	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	1	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	1	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	1	0	0	0
Benzoic acid	ug/kg	.000	0	1	0	0	0
Benzyl alcohol	ug/kg	.000	0	1	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	1	0	0	0
Chrysene	ug/kg	.000	0	1	0	0	0
Di-n-butyl phthalate	ug/kg	.000	0	1	0	0	0
Di-n-octyl phthalate	ug/kg	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	1	0	0	0
Dibenzofuran	ug/kg	.000	0	1	0	0	0
Diethyl phthalate	ug/kg	.000	0	1	0	0	0
Dimethyl phthalate	ug/kg	.000	0	1	0	0	0
Fluoranthene	ug/kg	.000	0	1	0	0	0
Fluorene	ug/kg	.000	0	1	0	0	0
Hexachlorobenzene	ug/kg	.000	0	1	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	1	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	1	0	0	0
Hexachloroethane	ug/kg	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	1	0	0	0

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TABLE 4-67  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Isophorone	ug/kg	.000	0	1	0	0	0
Methyl parathion	ug/kg	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	1	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	1	0	0	0
Naphthalene	ug/kg	.000	0	1	0	0	0
Nitrobenzene	ug/kg	.000	0	1	0	0	0
Parathion	ug/kg	.000	0	1	0	0	0
Pentachlorophenol	ug/kg	.000	0	1	0	0	0
Phenanthrene	ug/kg	.000	0	1	0	0	0
Phenol	ug/kg	.000	0	1	0	0	0
Pyrene	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	0	1	0	0	0
p-Chloroaniline	ug/kg	.000	0	1	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	1	0	0	0
4,4'-DDE	ug/kg	.000	0	1	0	0	0
4,4'-DDT	ug/kg	.000	0	1	0	0	0
Aldrin	ug/kg	.000	0	1	0	0	0
Aroclor-1016	ug/kg	.000	0	1	0	0	0
Aroclor-1221	ug/kg	.000	0	1	0	0	0
Aroclor-1232	ug/kg	.000	0	1	0	0	0
Aroclor-1242	ug/kg	.000	0	1	0	0	0
Aroclor-1248	ug/kg	.000	0	1	0	0	0
Aroclor-1254	ug/kg	.000	0	1	0	0	0
Aroclor-1260	ug/kg	.000	0	1	0	0	0
Dieldrin	ug/kg	.000	0	1	0	0	0
Endosulfan II	ug/kg	.000	0	1	0	0	0
Endosulfan sulfate	ug/kg	.000	0	1	0	0	0
Endosulfan-I	ug/kg	.000	0	1	0	0	0
Endrin	ug/kg	.000	0	1	0	0	0
Endrin ketone	ug/kg	.000	0	1	0	0	0
Heptachlor	ug/kg	.000	0	1	0	0	0
Heptachlor epoxide	ug/kg	.000	0	1	0	0	0
Methoxychlor	ug/kg	.000	0	1	0	0	0
Toxaphene	ug/kg	.000	0	1	0	0	0
alpha-BHC	ug/kg	.000	0	1	0	0	0
alpha-Chlordane	ug/kg	.000	0	1	0	0	0
beta-BHC	ug/kg	.000	0	1	0	0	0

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TABLE 4-67  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects		Number of Detects Above Background
					Minimum	Maximum	
<u>PESTICIDES.PCBs (Continued)</u>							
delta-BHC	ug/kg	.000	0	1	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	1	0	0	0
gamma-Chlordane	ug/kg	.000	0	1	0	0	0
Azinphosmethyl	ug/kg	.000	0	1	0	0	0
Demeton	ug/kg	.000	0	1	0	0	0
Diazinon	ug/kg	.000	0	1	0	0	0
Disulfoton	ug/kg	.000	0	1	0	0	0
Ethion	ug/kg	.000	0	1	0	0	0
Malathion	ug/kg	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>							
Ammonia	mg/kg	.000	1	1	50.4	50.4	1
Chloride	mg/kg	.000	1	1	230	230	1
Fluoride	mg/kg	.000	1	1	7.58	7.58	1
Nitrate	mg/kg	.000	1	1	2.76	2.76	1
Phenols	mg/kg	.000	0	1	0	0	0
Phosphorus	mg/kg	.000	1	1	37.4	37.4	1
Sulfate	mg/kg	.000	1	1	697	697	1
Total Organic Nitrogen	mg/kg	.000	1	1	355	355	1

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**TABLE 4-68**  
**ACTIVE FLYASH PILE**  
**SEDIMENT**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

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Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>							
Aluminum	mg/kg	13125.282	1	1	7630	7630	0
Antimony	mg/kg	.000	0	1	0	0	0
Arsenic	mg/kg	11.608	1	1	10.9	10.9	0
Barium	mg/kg	88.500	1	1	71.1	71.1	0
Beryllium	mg/kg	.600	1	1	1.4	1.4	1
Cadmium	mg/kg	.770	1	1	.75	.75	0
Calcium	mg/kg	5296.781	1	1	49200	49200	1
Chromium	mg/kg	17.057	1	1	11.6	11.6	0
Cobalt	mg/kg	16.913	1	1	9.7	9.7	0
Copper	mg/kg	15.700	1	1	22.2	22.2	1
Cyanide	mg/kg	.230	0		0	0	0
Iron	mg/kg	24788.749	1	1	15600	15600	0
Lead	mg/kg	29.575	1	1	15.7	15.7	0
Magnesium	mg/kg	1460.000	1	1	16100	16100	1
Manganese	mg/kg	2257.945	1	1	433	433	0
Mercury	mg/kg	.300	0	1	0	0	0
Molybdenum	mg/kg	.000	1	1	1.7	1.7	1
Nickel	mg/kg	25.145	1	1	18.4	18.4	0
Potassium	mg/kg	1349.530	1	1	1120	1120	0
Selenium	mg/kg	.720	0	1	0	0	0
Silicon	mg/kg	1914.313	1	1	1090	1090	0
Silver	mg/kg	.000	0	1	0	0	0
Sodium	mg/kg	55.145	1	1	140	140	1
Thallium	mg/kg	.580	1	1	.32	.32	0
Vanadium	mg/kg	33.693	1	1	21.5	21.5	0
Zinc	mg/kg	58.500	1	1	53.1	53.1	0
<b>RADIONUCLIDES</b>							
CS-137	pCi/g	.849	1	1	.086	.086	0
GROSS ALPHA	pCi/g	.000	1	1	20.7	20.7	1
GROSS BETA	pCi/g	.000	1	1	31.5	31.5	1
NP-237	pCi/g	.000	1	1	.038	.038	1
PU-238	pCi/g	.000	1	1	.0243	.0243	1
PU-239/240	pCi/g	.000	1	1	.049	.049	1
RA-226	pCi/g	1.528	1	1	1.32	1.32	0
RA-228	pCi/g	1.170	1	1	.908	.908	0
RU-106	pCi/g	.000	0	1	0	0	0

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TABLE 4-68  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>RADIONUCLIDES (Continued)</b>							
SR-90	pCi/g	.000	0	1	0	0	0
TC-99	pCi/g	.000	0	1	0	0	0
TH-228	pCi/g	1.519	1	1	.824	.824	0
TH-230	pCi/g	2.112	1	1	1.47	1.47	0
TH-232	pCi/g	1.469	1	1	.883	.883	0
TH-TOTAL	mg/kg	10.700	1	1	8.04	8.04	0
U-234	pCi/g	1.319	1	1	2.77	2.77	1
U-235/236	pCi/g	.181	1	1	.163	.163	0
U-238	pCi/g	1.270	1	1	2.9	2.9	1
U-TOTAL	mg/kg	3.240	1	1	11.3	11.3	1
<b>VOLATILE ORGANICS</b>							
1,1,1-Trichloroethane	ug/kg	.000	0	1	0	0	0
1,1,2,2-Tetrachloroethane	ug/kg	.000	0	1	0	0	0
1,1,2-Trichloroethane	ug/kg	.000	0	1	0	0	0
1,1-Dichloroethane	ug/kg	.000	0	1	0	0	0
1,1-Dichloroethene	ug/kg	.000	0	1	0	0	0
1,2-Dichloroethane	ug/kg	.000	0	1	0	0	0
1,2-Dichloroethene	ug/kg	.000	0	1	0	0	0
1,2-Dichloropropane	ug/kg	.000	0	1	0	0	0
2-Butanone	ug/kg	.000	0	1	0	0	0
2-Hexanone	ug/kg	.000	0	1	0	0	0
4-Methyl-2-pentanone	ug/kg	.000	0	1	0	0	0
Acetone	ug/kg	.000	0	1	0	0	0
Benzene	ug/kg	.000	0	1	0	0	0
Bromodichloromethane	ug/kg	.000	0	1	0	0	0
Bromoform	ug/kg	.000	0	1	0	0	0
Bromomethane	ug/kg	.000	0	1	0	0	0
Carbon Tetrachloride	ug/kg	.000	0	1	0	0	0
Carbon disulfide	ug/kg	.000	0	1	0	0	0
Chlorobenzene	ug/kg	.000	0	1	0	0	0
Chloroethane	ug/kg	.000	0	1	0	0	0
Chloroform	ug/kg	.000	0	1	0	0	0
Chloromethane	ug/kg	.000	0	1	0	0	0
Dibromochloromethane	ug/kg	.000	0	1	0	0	0
Ethylbenzene	ug/kg	.000	0	1	0	0	0
Methylene chloride	ug/kg	.000	0	1	0	0	0
Styrene	ug/kg	.000	0	1	0	0	0
Tetrachloroethene	ug/kg	.000	0	1	0	0	0
Toluene	ug/kg	.000	0	1	0	0	0
Trichloroethene	ug/kg	.000	0	1	0	0	0
Vinyl chloride	ug/kg	.000	0	1	0	0	0

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TABLE 4-68  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>							
Xylenes, Total	ug/kg	.000	0	1	0	0	0
cis-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
trans-1,3-Dichloropropene	ug/kg	.000	0	1	0	0	0
<u>SEMIVOLATILE ORGANICS</u>							
1,2,4-Trichlorobenzene	ug/kg	.000	0	1	0	0	0
1,2-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
1,3-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
1,4-Dichlorobenzene	ug/kg	.000	0	1	0	0	0
2,4,5-Trichlorophenol	ug/kg	.000	0	1	0	0	0
2,4,6-Trichlorophenol	ug/kg	.000	0	1	0	0	0
2,4-Dichlorophenol	ug/kg	.000	0	1	0	0	0
2,4-Dimethylphenol	ug/kg	.000	0	1	0	0	0
2,4-Dinitrophenol	ug/kg	.000	0	1	0	0	0
2,4-Dinitrotoluene	ug/kg	.000	0	1	0	0	0
2,6-Dinitrotoluene	ug/kg	.000	0	1	0	0	0
2-Chloronaphthalene	ug/kg	.000	0	1	0	0	0
2-Chlorophenol	ug/kg	.000	0	1	0	0	0
2-Methylnaphthalene	ug/kg	.000	0	1	0	0	0
2-Methylphenol	ug/kg	.000	0	1	0	0	0
2-Nitroaniline	ug/kg	.000	0	1	0	0	0
2-Nitrophenol	ug/kg	.000	0	1	0	0	0
3,3'-Dichlorobenzidine	ug/kg	.000	0	1	0	0	0
3-Nitroaniline	ug/kg	.000	0	1	0	0	0
4,6-Dinitro-2-methylphenol	ug/kg	.000	0	1	0	0	0
4-Bromophenyl phenyl ether	ug/kg	.000	0	1	0	0	0
4-Chloro-3-methylphenol	ug/kg	.000	0	1	0	0	0
4-Chlorophenylphenyl ether	ug/kg	.000	0	1	0	0	0
4-Methylphenol	ug/kg	.000	1	1	1700	1700	1
4-Nitroaniline	ug/kg	.000	0	1	0	0	0
4-Nitrophenol	ug/kg	.000	0	1	0	0	0
Acenaphthene	ug/kg	.000	0	1	0	0	0
Acenaphthylene	ug/kg	.000	0	1	0	0	0
Anthracene	ug/kg	.000	0	1	0	0	0
Benzo(a)anthracene	ug/kg	.000	0	1	0	0	0
Benzo(a)pyrene	ug/kg	.000	0	1	0	0	0
Benzo(b)fluoranthene	ug/kg	.000	0	1	0	0	0
Benzo(g,h,i)perylene	ug/kg	.000	0	1	0	0	0
Benzo(k)fluoranthene	ug/kg	.000	0	1	0	0	0
Benzoic acid	ug/kg	.000	1	1	680	680	1
Benzyl alcohol	ug/kg	.000	0	1	0	0	0
Butyl benzyl phthalate	ug/kg	.000	0	1	0	0	0

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TABLE 4-68  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Range of Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>							
Carbazole	ug/kg	.000	0	1	0	0	0
Chrysene	ug/kg	.000	0	1	0	0	0
Di-n-butyl phthalate	ug/kg	.000	1	1	64	64	1
Di-n-octyl phthalate	ug/kg	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	ug/kg	.000	0	1	0	0	0
Dibenzofuran	ug/kg	.000	0	1	0	0	0
Diethyl phthalate	ug/kg	.000	0	1	0	0	0
Dimethyl phthalate	ug/kg	.000	0	1	0	0	0
Fluoranthene	ug/kg	.000	0	1	0	0	0
Fluorene	ug/kg	.000	0	1	0	0	0
Hexachlorobenzene	ug/kg	.000	0	1	0	0	0
Hexachlorobutadiene	ug/kg	.000	0	1	0	0	0
Hexachlorocyclopentadiene	ug/kg	.000	0	1	0	0	0
Hexachloroethane	ug/kg	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	ug/kg	.000	0	1	0	0	0
Isophorone	ug/kg	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	ug/kg	.000	0	1	0	0	0
N-Nitrosodiphenylamine	ug/kg	.000	0	1	0	0	0
Naphthalene	ug/kg	.000	0	1	0	0	0
Nitrobenzene	ug/kg	.000	0	1	0	0	0
Pentachlorophenol	ug/kg	.000	0	1	0	0	0
Phenanthrene	ug/kg	.000	0	1	0	0	0
Phenol	ug/kg	.000	1	1	230	230	1
Pyrene	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	ug/kg	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	ug/kg	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	ug/kg	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	ug/kg	.000	0	1	0	0	0
p-Chloroaniline	ug/kg	.000	0	1	0	0	0
<u>PESTICIDES/PCBs</u>							
4,4'-DDD	ug/kg	.000	0	1	0	0	0
4,4'-DDE	ug/kg	.000	0	1	0	0	0
4,4'-DDT	ug/kg	.000	0	1	0	0	0
Aldrin	ug/kg	.000	0	1	0	0	0
Aroclor-1016	ug/kg	.000	0	1	0	0	0
Aroclor-1221	ug/kg	.000	0	1	0	0	0
Aroclor-1232	ug/kg	.000	0	1	0	0	0
Aroclor-1242	ug/kg	.000	0	1	0	0	0
Aroclor-1248	ug/kg	.000	0	1	0	0	0
Aroclor-1254	ug/kg	.000	0	1	0	0	0
Aroclor-1260	ug/kg	.000	0	1	0	0	0

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TABLE 4-68  
(Continued)

Parameter	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs (Continued)</u>							
Dieldrin	ug/kg	.000	0	1	0	0	0
Endosulfan II	ug/kg	.000	0	1	0	0	0
Endosulfan sulfate	ug/kg	.000	0	1	0	0	0
Endosulfan-I	ug/kg	.000	0	1	0	0	0
Endrin	ug/kg	.000	0	1	0	0	0
Endrin aldehyde	ug/kg	.000	0	1	0	0	0
Endrin ketone	ug/kg	.000	0	1	0	0	0
Heptachlor	ug/kg	.000	0	1	0	0	0
Heptachlor epoxide	ug/kg	.000	0	1	0	0	0
Methoxychlor	ug/kg	.000	0	1	0	0	0
Toxaphene	ug/kg	.000	0	1	0	0	0
alpha-BHC	ug/kg	.000	0	1	0	0	0
alpha-Chlordane	ug/kg	.000	0	1	0	0	0
beta-BHC	ug/kg	.000	0	1	0	0	0
delta-BHC	ug/kg	.000	0	1	0	0	0
gamma-BHC (Lindane)	ug/kg	.000	0	1	0	0	0
gamma-Chlordane	ug/kg	.000	0	1	0	0	0

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4.6.4 Groundwater

Groundwater analytical data from the 1000-series wells were compared to background data developed for perched groundwater. Analytical data are provided in Appendix G as Table G-2L and Table G-2O. The number of detected analytes are provided in Table 4-69 and Table 4-70 and were shown on Figure 4-23a. Groundwater within the perched groundwater system is believed to flow within a sand lens in the glacial overburden, as discussed in Section 3.0 and shown on Figure 3-46. Based upon data generated during Phase II, it is believed that the sand lens thins out beneath the Active Flyash Pile. Thus, the groundwater flow system is continuous from the South Field to the Active Flyash Pile, but it does not exist at the west edge of the pile.

Phase I sampling detected three metals, and isotopes of uranium and total thorium that exceeded the background concentrations. During Phase II six metals (Aluminum, Calcium, Selenium, and Silicon were not detected above background for Phase I; lead was detected above background for Phase I but not Phase II), isotopes of five elements (neptunium-237, plutonium-238, plutonium-239/240, strontium-90, thorium-232, and uranium-235/236 were not detected above background for Phase I), and one organic (2-butanone at 1 µg/L) exceeded background concentrations. Based upon the conceptual model of flow and constituent transport shown on Figure 2-24, groundwater quality near the Active Flyash Pile appears to be impacted by waste disposal activities in the South Field.

Groundwater in the regional aquifer flows toward the east from the South Field to the Active Flyash Pile. Upgradient wells are located west of the Active Flyash Pile (Well 2943), and Well 21033 (constructed during Phase II) is located downgradient. Groundwater analytical data from the 2000-series wells were compared to background data from the regional aquifer and is presented in Tables 4-71 and 4-72. Phase I sampling detected three metals and isotopes of two elements that exceeded background; no organic compounds were analyzed for in Phase I samples. Phase II sampling detected above background four metals (Calcium and Magnesium were not detected above background during Phase I; Chromium was detected above background for Phase I but not Phase II), isotopes of two elements (plutonium-238 was not detected above background during Phase I; thorium-232 and thorium-total were detected above background during Phase I but not Phase II), and two organic compounds (Acetone and Di-n-Butyl phthalate). Available historical uranium isotope and total thorium data are summarized and presented in Table 4-73 for the groundwater wells in the Active Flyash Pile area. Available uranium and thorium concentration data from samples collected since 1988 indicate that these constituents have remained within the same concentration ranges in all wells

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**TABLE 4-69**  
**ACTIVE FLYASH PILE**  
**GROUNDWATER<sup>a</sup> - 1000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Arsenic		mg/L	.122	0	4	0	0	0
Barium		mg/L	.459	3	4	.071	.112	0
Cadmium		mg/L	.007	2	4	.003	.0069	0
Calcium		mg/L	125.574	4	4	51.8	114	0
Chromium		mg/L	.035	1	4	.015	.015	0
Copper		mg/L	.030	1	4	.011	.011	0
Iron		mg/L	10.965	2	4	.061	.153	0
Lead		mg/L	.050	2	4	.004	.06	1
Magnesium		mg/L	49.627	4	4	15.4	80.2	2
Manganese		mg/L	.165	4	4	.003	.187	1
Mercury		mg/L	.004	0	4	0	0	0
Molybdenum		mg/L	.028	0	4	0	0	0
Nickel		mg/L	.026	0	4	0	0	0
Potassium		mg/L	29.736	4	4	1.68	5.43	0
Selenium		mg/L	.000	0	4	0	0	0
Silver		mg/L	.040	0	4	0	0	0
Sodium		mg/L	49.178	4	4	9.85	31	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	2	0	0	0
PU-238	UNFL	pCi/L	.000	0	2	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	2	0	0	0
RA-226	UNFL	pCi/L	1.000	0	2	0	0	0
RA-228	UNFL	pCi/L	5.200	0	2	0	0	0
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	2	0	0	0
TC-99	UNFL	pCi/L	.000	0	2	0	0	0
TH-228	UNFL	pCi/L	1.040	0	2	0	0	0
TH-230	UNFL	pCi/L	2.000	0	2	0	0	0
TH-232	UNFL	pCi/L	.000	0	2	0	0	0
TH-TOTAL	UNFL	ug/L	3.000	1	2	5	5	1
U-234	UNFL	pCi/L	1.900	2	2	4.5	5.4	2
U-235/236	UNFL	pCi/L	.000	0	2	0	0	0

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See footnote at end of table

TABLE 4-69  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
U-238	UNFL	pCi/L	1.070	2	2	4	5.3	2
U-TOTAL	UNFL	ug/L	4.000	2	2	15	17	2
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	4.500	0	4	0	0	0
Chloride	UNFL	mg/L	110.159	3	4	12.5	45.6	0
Fluoride	UNFL	mg/L	1.352	4	4	.19	.5	0
Nitrate	UNFL	mg/L	.522	3	3	.14	.41	0
Phenols	UNFL	mg/L	.000	0	4	0	0	0
Phosphorus	UNFL	mg/L	.223	4	4	.21	.6	2
Sulfate	UNFL	mg/L	141.894	4	4	59	99	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	2	.5	.5	1
Total Organic Halides	UNFL	mg/L	.000	0	3	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.000	2	2	.1	.5	2

<sup>a</sup>Unfiltered metals and filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-70**  
**ACTIVE FLYASH PILE**  
**GROUNDWATER\* - 1000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.123	3	3	.0556	.543	2
Antimony		mg/L	.000	0	3	0	0	0
Arsenic		mg/L	.122	2	3	.0034	.0034	0
Barium		mg/L	.459	3	3	.0481	.201	0
Beryllium		mg/L	.002	0	3	0	0	0
Cadmium		mg/L	.007	0	3	0	0	0
Calcium		mg/L	125.574	3	3	53.4	153	1
Chromium		mg/L	.035	0	3	0	0	0
Cobalt		mg/L	.000	0	3	0	0	0
Copper		mg/L	.030	0	3	0	0	0
Cyanide		mg/L	.000	0	2	0	0	0
Iron		mg/L	10.965	1	3	.958	.958	0
Lead		mg/L	.050	1	3	.0021	.0021	0
Magnesium		mg/L	49.627	3	3	16.3	139	1
Manganese		mg/L	.165	3	3	.0041	.378	1
Mercury		mg/L	.004	0	3	0	0	0
Molybdenum		mg/L	.028	1	3	.0045	.0045	0
Nickel		mg/L	.026	2	3	.0054	.0102	0
Potassium		mg/L	29.736	3	3	1.4	5.98	0
Selenium		mg/L	.000	2	3	.0182	.0195	2
Silicon		mg/L	.000	3	3	10.7	10.8	3
Silver		mg/L	.040	0	3	0	0	0
Sodium		mg/L	49.178	3	3	14.9	28.3	0
Thallium		mg/L	.000	0	3	0	0	0
Vanadium		mg/L	.020	1	3	.0169	.0169	0
Zinc		mg/L	.032	1	3	.0045	.0045	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	2	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	0	2	0	0	0
GROSS BETA	UNFL	pCi/L	.000	2	2	7.35	14.1	2
NP-237	UNFL	pCi/L	.000	1	2	.48	.48	1
PU-238	UNFL	pCi/L	.000	2	2	.122	.17	2
PU-239/240	UNFL	pCi/L	.000	1	2	.2	.2	1

See footnote at end of table

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TABLE 4-70  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
RA-226	UNFL	pCi/L	1.000	0	2	0	0	0
RA-228	UNFL	pCi/L	5.200	0	2	0	0	0
RU-106	UNFL	pCi/L	.000	0	2	0	0	0
SR-90	UNFL	pCi/L	.000	1	2	1.19	1.19	1
TC-99	UNFL	pCi/L	.000	0	2	0	0	0
TH-228	UNFL	pCi/L	1.040	1	2	.13	.13	0
TH-230	UNFL	pCi/L	2.000	1	2	.24	.24	0
TH-232	UNFL	pCi/L	.000	1	2	.032	.032	1
TH-TOTAL	UNFL	ug/L	3.000	1	2	.29	.29	0
U-234	UNFL	pCi/L	1.900	2	2	1.16	11.4	1
U-235/236	UNFL	pCi/L	.000	1	2	.56	.56	1
U-238	UNFL	pCi/L	1.070	2	2	1.19	12.5	2
U-TOTAL	UNFL	ug/L	4.000	2	2	2.91	31.1	1
<u>VOLATILE ORGANICS</u>								
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	2	0	0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	2	0	0	0
2-Butanone	UNFL	ug/L	.000	1	2	1	1	1
2-Hexanone	UNFL	ug/L	.000	0	2	0	0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	2	0	0	0
Acetone	UNFL	ug/L	.000	0	2	0	0	0
Benzene	UNFL	ug/L	.000	0	2	0	0	0
Bromodichloromethane	UNFL	ug/L	.000	0	2	0	0	0
Bromoform	UNFL	ug/L	.000	0	2	0	0	0
Bromomethane	UNFL	ug/L	.000	0	2	0	0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	2	0	0	0
Carbon disulfide	UNFL	ug/L	.000	0	2	0	0	0
Chlorobenzene	UNFL	ug/L	.000	0	2	0	0	0
Chloroethane	UNFL	ug/L	.000	0	2	0	0	0
Chloroform	UNFL	ug/L	.000	0	2	0	0	0
Chloromethane	UNFL	ug/L	.000	0	2	0	0	0
Dibromochloromethane	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-70  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<b>SEMIVOLATILE ORGANICS (Continued)</b>								
Acenaphthylene	UNFL	ug/L	.000	0	1	0	0	0
Anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	1	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	1	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	1	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Carbazole	UNFL	ug/L	.000	0	1	0	0	0
Chrysene	UNFL	ug/L	.000	0	1	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Di-n-octyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	1	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	1	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	1	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	1	0	0	0
Fluorene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	1	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	1	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	1	0	0	0
Isophorone	UNFL	ug/L	.000	0	1	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	1	0	0	0
Naphthalene	UNFL	ug/L	.000	0	1	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	1	0	0	0
Pentachloropheno1	UNFL	ug/L	.000	0	1	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	1	0	0	0
Phenol	UNFL	ug/L	.000	0	1	0	0	0
Pyrene	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	1	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	0	0	0	0

See footnote at end of table

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TABLE 4-70  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>PESTICIDES/PCBs</u>								
4,4'-DDD	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	1	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	1	0	0	0
Aldrin	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	1	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	1	0	0	0
Dieldrin	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	1	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	1	0	0	0
Endrin	UNFL	ug/L	.000	0	1	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	1	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor	UNFL	ug/L	.000	0	1	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	1	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	1	0	0	0
Toxaphene	UNFL	ug/L	.000	0	1	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	1	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
beta-BHC	UNFL	ug/L	.000	0	1	0	0	0
delta-BHC	UNFL	ug/L	.000	0	1	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	1	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	1	0	0	0
<u>GENERAL CHEMISTRY</u>								
Alkalinity as CaCO3	UNFL	mg/L	.000	1	1	790	790	0
Ammonia	UNFL	mg/L	4.500	0	1	0	0	0
Chloride	UNFL	mg/L	110.159	1	1	7.31	7.31	0
Fluoride	UNFL	mg/L	1.352	1	1	.35	.35	0
Nitrate	UNFL	mg/L	.522	0	0	0	0	0
Phenols	UNFL	mg/L	.000	0	1	0	0	0
Phosphorus	UNFL	mg/L	.223	1	1	.08	.08	0
Sulfate	UNFL	mg/L	141.894	1	1	110.4	110.4	0
Sulfide	UNFL	mg/L	.000	0	1	0	0	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	1	1	.23	.23	1

See footnote at end of table

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TABLE 4-70  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>							
Total Organic Carbon	UNFL	mg/L	.000	1	1	2.94 2.94	1
Total Organic Halides	UNFL	mg/L	.000	1	1	62.3 62.3	1
Total Organic Nitrogen	UNFL	mg/L	.000	1	1	.23 .23	1

<sup>a</sup>Filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-71A**  
**ACTIVE FLYASH PILE**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	8	8	.119	.219	1
Arsenic		mg/L	.300	0	15	0	0	0
Barium		mg/L	.413	12	14	.025	.046	0
Cadmium		mg/L	.006	11	15	.0028	.006	0
Calcium		mg/L	135.163	15	15	96.2	124	0
Chromium		mg/L	.042	11	15	.0141	.044	1
Copper		mg/L	.130	7	15	.0102	.017	0
Iron		mg/L	4.000	7	15	.032	.115	0
Lead		mg/L	.029	3	14	.003	.0115	0
Magnesium		mg/L	38.070	15	15	19.77	33.9	0
Manganese		mg/L	.800	12	15	.005	.0145	0
Mercury		mg/L	.001	3	15	.0003	.0006	0
Molybdenum		mg/L	.027	1	15	.008	.008	0
Nickel		mg/L	.026	2	15	.02	.02	0
Potassium		mg/L	3.087	14	15	1.52	3.45	1
Selenium		mg/L	.005	4	14	.002	.005	0
Silicon		mg/L	10.491	8	8	4.46	5.53	0
Silver		mg/L	.023	7	15	.01	.013	0
Sodium		mg/L	51.918	15	15	4.68	17.9	0
Vanadium		mg/L	.027	8	8	.0111	.022	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	2	0	0	0
NP-237	UNFL	pCi/L	.000	0	15	0	0	0
PU-238	UNFL	pCi/L	.000	0	15	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	15	0	0	0
RA-226	UNFL	pCi/L	1.200	1	13	1.19	1.19	0
RA-228	UNFL	pCi/L	4.500	0	15	0	0	0
RU-106	UNFL	pCi/L	.000	0	2	0	0	0
SR-90	UNFL	pCi/L	.000	0	13	0	0	0
TC-99	UNFL	pCi/L	36.000	0	14	0	0	0
TH-228	UNFL	pCi/L	1.520	2	14	1.1	1.5	0
TH-230	UNFL	pCi/L	1.790	1	14	1.2	1.2	0
TH-232	UNFL	pCi/L	.000	2	14	1.05	1.6	2
TH-TOTAL	UNFL	ug/L	2.000	2	13	5	9.47	2

See footnote at end of table

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TABLE 4-71A  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
U-234	UNFL	pCi/L	1.900	11	14	1	104	10
U-235/236	UNFL	pCi/L	.000	7	14	1.4	4.7	7
U-238	UNFL	pCi/L	.900	10	14	2.1	119	10
U-TOTAL	UNFL	ug/L	2.920	12	15	2	462	10
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	0	14	0	0	0
Chloride	UNFL	mg/L	145.065	13	15	4.75	23.7	0
Fluoride	UNFL	mg/L	.938	15	15	.1	.91	0
Nitrate	UNFL	mg/L	11.400	11	12	.685	8.95	0
Phenols	UNFL	mg/L	.000	5	13	.013	.34	0
Phosphorus	UNFL	mg/L	.693	13	14	.1	2.71	6
Sulfate	UNFL	mg/L	359.847	15	15	43.2	70	0
Sulfide	UNFL	mg/L	.000	1	8	37.8	37.8	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	7	9	.231	.725	7
Total Organic Carbon	UNFL	mg/L	3.764	6	8	1.98	2.72	0
Total Organic Halides	UNFL	mg/L	.021	1	9	.01	.01	0
Total Organic Nitrogen	UNFL	mg/L	.652	12	15	.1	1.64	2

<sup>a</sup>Unfiltered metals and filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-71B**  
**ACTIVE FLYASH PILE**  
**GROUNDWATER<sup>a</sup> - 3000 SERIES**  
**PHASE I FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>METALS</u>								
Aluminum	FLTR	mg/L	.184	2	3	.039	.081	0
Arsenic	FLTR	mg/L	.300	0	5	0	0	0
Barium	FLTR	mg/L	.413	5	5	.023	.047	0
Cadmium	FLTR	mg/L	.006	3	5	.001	.003	0
Calcium	FLTR	mg/L	135.163	5	5	53.2	94	0
Chromium	FLTR	mg/L	.042	3	5	.004	.021	0
Copper	FLTR	mg/L	.130	1	5	.01	.01	0
Iron	FLTR	mg/L	4.000	2	5	.087	.15	0
Lead	FLTR	mg/L	.029	0	4	0	0	0
Magnesium	FLTR	mg/L	38.070	5	5	21.9	28.2	0
Manganese	FLTR	mg/L	.800	5	5	.053	.088	0
Mercury	FLTR	mg/L	.001	1	5	.0005	.0005	0
Molybdenum	FLTR	mg/L	.027	2	5	.007	.037	1
Nickel	FLTR	mg/L	.026	1	5	.005	.005	0
Potassium	FLTR	mg/L	3.087	5	5	2.45	4.92	1
Selenium	FLTR	mg/L	.005	0	4	0	0	0
Silicon	FLTR	mg/L	10.491	3	3	1.9	3.98	0
Silver	FLTR	mg/L	.023	1	5	.013	.013	0
Sodium	FLTR	mg/L	51.918	5	5	10.2	34	0
Vanadium	FLTR	mg/L	.027	1	3	.006	.006	0
<u>RADIONUCLIDES</u>								
CS-137	UNFL	pCi/L	.000	0	0	0	0	0
NP-237	UNFL	pCi/L	.000	0	5	0	0	0
PU-238	UNFL	pCi/L	.000	0	5	0	0	0
PU-239/240	UNFL	pCi/L	.000	0	5	0	0	0
RA-226	UNFL	pCi/L	1.200	0	3	0	0	0
RA-228	UNFL	pCi/L	4.500	0	5	0	0	0
RU-106	UNFL	pCi/L	.000	0	0	0	0	0
SR-90	UNFL	pCi/L	.000	0	5	0	0	0
TC-99	UNFL	pCi/L	36.000	0	5	0	0	0
TH-228	UNFL	pCi/L	1.520	0	5	0	0	0
TH-230	UNFL	pCi/L	1.790	0	5	0	0	0
TH-232	UNFL	pCi/L	.000	0	5	0	0	0
TH-TOTAL	UNFL	ug/L	2.000	0	5	0	0	0

See footnote at end of table

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TABLE 4-71B  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>								
U-234	UNFL	pCi/L	1.900	1	5	4.63	4.63	1
U-235/236	UNFL	pCi/L	.000	0	5	0	0	0
U-238	UNFL	pCi/L	.900	1	5	5.06	5.06	1
U-TOTAL	UNFL	ug/L	2.920	2	5	6.02	15.2	2
<u>GENERAL CHEMISTRY</u>								
Ammonia	UNFL	mg/L	3.240	1	5	.2	.2	0
Chloride	UNFL	mg/L	145.065	5	5	12.3	32	0
Fluoride	UNFL	mg/L	.938	5	5	.1	.2	0
Nitrate	UNFL	mg/L	11.400	3	3	.9	1.62	0
Phenols	UNFL	mg/L	.000	3	5	.01	.017	0
Phosphorus	UNFL	mg/L	.693	4	4	.03	.54	0
Sulfate	UNFL	mg/L	359.847	5	5	59.4	115	0
Sulfide	UNFL	mg/L	.000	1	3	2	2	0
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	2	2	.152	.338	2
Total Organic Carbon	UNFL	mg/L	3.764	2	3	1.07	2	0
Total Organic Halides	UNFL	mg/L	.021	1	4	.021	.021	0
Total Organic Nitrogen	UNFL	mg/L	.652	4	5	0	.338	0

<sup>a</sup>Unfiltered metals and filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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FEMP-0U02-4 DRAFT  
February 18, 1994

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**TABLE 4-72**  
**ACTIVE FLYASH PILE**  
**GROUNDWATER<sup>a</sup> - 2000 SERIES**  
**PHASE II FIELD INVESTIGATION**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<b>METALS</b>								
Aluminum		mg/L	.184	2	5	.0959	.35	1
Antimony		mg/L	.038	0	5	0	0	0
Arsenic		mg/L	.300	0	5	0	0	0
Barium		mg/L	.413	5	5	.0443	.101	0
Beryllium		mg/L	.003	0	5	0	0	0
Cadmium		mg/L	.006	0	5	0	0	0
Calcium		mg/L	135.163	5	5	103	173	2
Chromium		mg/L	.042	0	5	0	0	0
Cobalt		mg/L	.000	0	5	0	0	0
Copper		mg/L	.130	0	5	0	0	0
Cyanide		mg/L	.000	0	4	0	0	0
Iron		mg/L	4.000	3	5	.128	.398	0
Lead		mg/L	.029	1	5	.002	.002	0
Magnesium		mg/L	38.070	5	5	27.4	46	2
Manganese		mg/L	.800	3	5	.012	.0827	0
Mercury		mg/L	.001	0	5	0	0	0
Molybdenum		mg/L	.027	0	5	0	0	0
Nickel		mg/L	.026	0	5	0	0	0
Potassium		mg/L	3.087	5	5	2.31	7.46	2
Selenium		mg/L	.005	3	5	.0013	.004	0
Silicon		mg/L	10.491	5	5	4.58	5.99	0
Silver		mg/L	.023	0	5	0	0	0
Sodium		mg/L	51.918	5	5	7.3	16.1	0
Thallium		mg/L	.000	0	5	0	0	0
Vanadium		mg/L	.027	0	5	0	0	0
Zinc		mg/L	.105	2	5	.0068	.0149	0
<b>RADIONUCLIDES</b>								
CS-137	UNFL	pCi/L	.000	0	3	0	0	0
GROSS ALPHA	UNFL	pCi/L	.000	2	3	22.8	59.9	2
GROSS BETA	UNFL	pCi/L	.000	2	3	12.1	25.8	2
NP-237	UNFL	pCi/L	.000	0	2	0	0	0
PU-238	UNFL	pCi/L	.000	1	2	.135	.135	1
PU-239/240	UNFL	pCi/L	.000	0	2	0	0	0
RA-226	UNFL	pCi/L	1.200	1	2	.264	.264	0

See footnote at end of table

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TABLE 4-72  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum	Number of Detects Above Background
<u>RADIONUCLIDES (Continued)</u>							
RA-228	UNFL	pCi/L	4.500	0	2	0 0	0
RU-106	UNFL	pCi/L	.000	0	2	0 0	0
SR-90	UNFL	pCi/L	.000	0	2	0 0	0
TC-99	UNFL	pCi/L	36.000	0	3	0 0	0
TH-228	UNFL	pCi/L	1.520	0	3	0 0	0
TH-230	UNFL	pCi/L	1.790	2	3	.281 1.27	0
TH-232	UNFL	pCi/L	.000	0	3	0 0	0
TH-TOTAL	UNFL	ug/L	2.000	0	3	0 0	0
U-234	UNFL	pCi/L	1.900	3	3	.682 41.5	2
U-235/236	UNFL	pCi/L	.000	2	3	.666 1.86	2
U-238	UNFL	pCi/L	.900	3	3	.338 46.4	2
U-TOTAL	UNFL	ug/L	2.920	2	3	43.2 111	2
<u>VOLATILE ORGANICS</u>							
1,1,1-Trichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1,2,2-Tetrachloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1,2-Trichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1-Dichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,1-Dichloroethene	UNFL	ug/L	.000	0	4	0 0	0
1,2-Dichloroethane	UNFL	ug/L	.000	0	4	0 0	0
1,2-Dichloroethene	UNFL	ug/L	.000	0	4	0 0	0
1,2-Dichloropropane	UNFL	ug/L	.000	0	4	0 0	0
2-Butanone	UNFL	ug/L	.000	0	4	0 0	0
2-Hexanone	UNFL	ug/L	.000	0	3	0 0	0
4-Methyl-2-pentanone	UNFL	ug/L	.000	0	3	0 0	0
Acetone	UNFL	ug/L	.000	1	3	3 3	1
Benzene	UNFL	ug/L	.000	0	4	0 0	0
Bromodichloromethane	UNFL	ug/L	.000	0	4	0 0	0
Bromoform	UNFL	ug/L	.000	0	4	0 0	0
Bromomethane	UNFL	ug/L	.000	0	4	0 0	0
Carbon Tetrachloride	UNFL	ug/L	.000	0	4	0 0	0
Carbon disulfide	UNFL	ug/L	.000	0	3	0 0	0
Chlorobenzene	UNFL	ug/L	.000	0	4	0 0	0
Chloroethane	UNFL	ug/L	.000	0	4	0 0	0
Chloroform	UNFL	ug/L	.000	0	4	0 0	0
Chloromethane	UNFL	ug/L	.000	0	4	0 0	0
Dibromochloromethane	UNFL	ug/L	.000	0	4	0 0	0
Ethylbenzene	UNFL	ug/L	.000	0	4	0 0	0
Methylene chloride	UNFL	ug/L	.000	0	4	0 0	0
Styrene	UNFL	ug/L	.000	0	4	0 0	0

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See footnote at end of table

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**TABLE 4-72  
(Continued)**

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>VOLATILE ORGANICS (Continued)</u>								
Tetrachloroethene	UNFL	ug/L	.000	0	4	0	0	0
Toluene	UNFL	ug/L	.000	0	4	0	0	0
Trichloroethene	UNFL	ug/L	.000	0	4	0	0	0
Vinyl Acetate	UNFL	ug/L	.000	0	3	0	0	0
Vinyl chloride	UNFL	ug/L	.000	0	4	0	0	0
Xylenes, Total	UNFL	ug/L	.000	0	4	0	0	0
cis-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0	0	0
trans-1,3-Dichloropropene	UNFL	ug/L	.000	0	4	0	0	0
<u>SEMIVOLATILE ORGANICS</u>								
1,2,4-Trichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,2-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,3-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
1,4-Dichlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
2,4,5-Trichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4,6-Trichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dichlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dimethylphenol	UNFL	ug/L	.000	0	4	0	0	0
2,4-Dinitrophenol	UNFL	ug/L	.000	0	3	0	0	0
2,4-Dinitrotoluene	UNFL	ug/L	.000	0	4	0	0	0
2,6-Dinitrotoluene	UNFL	ug/L	.000	0	4	0	0	0
2-Benzyl-4-chlorophenol	UNFL	ug/L	.000	0	1	0	0	0
2-Chloronaphthalene	UNFL	ug/L	.000	0	4	0	0	0
2-Chlorophenol	UNFL	ug/L	.000	0	4	0	0	0
2-Methylnaphthalene	UNFL	ug/L	.000	0	4	0	0	0
2-Methylphenol	UNFL	ug/L	.000	0	4	0	0	0
2-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
2-Nitrophenol	UNFL	ug/L	.000	0	4	0	0	0
3,3'-Dichlorobenzidine	UNFL	ug/L	.000	0	4	0	0	0
3-Nitroaniline	UNFL	ug/L	.000	0	4	0	0	0
4,6-Dinitro-2-methylphenol	UNFL	ug/L	.000	0	3	0	0	0
4-Bromophenyl phenyl ether	UNFL	ug/L	.000	0	4	0	0	0
4-Chloro-3-methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Chlorophenylphenyl ether	UNFL	ug/L	.000	0	4	0	0	0
4-Methylphenol	UNFL	ug/L	.000	0	4	0	0	0
4-Nitroaniline	UNFL	ug/L	.000	0	1	0	0	0
4-Nitrophenol	UNFL	ug/L	.000	0	2	0	0	0
Acenaphthene	UNFL	ug/L	.000	0	4	0	0	0
Acenaphthylene	UNFL	ug/L	.000	0	4	0	0	0
Anthracene	UNFL	ug/L	.000	0	4	0	0	0

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See footnote at end of table

TABLE 4-72  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Minimum	Detects Maximum	Number of Detects Above Background
<u>SEMIVOLATILE ORGANICS (Continued)</u>								
Benzo(a)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(a)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(b)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(g,h,i)perylene	UNFL	ug/L	.000	0	4	0	0	0
Benzo(k)fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Benzoic acid	UNFL	ug/L	.000	0	4	0	0	0
Benzyl alcohol	UNFL	ug/L	.000	0	4	0	0	0
Butyl benzyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Carbazole	UNFL	ug/L	.000	0	4	0	0	0
Chrysene	UNFL	ug/L	.000	0	4	0	0	0
Di-n-butyl phthalate	UNFL	ug/L	.000	1	4	19	19	1
Di-n-octyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Dibenzo(a,h)anthracene	UNFL	ug/L	.000	0	4	0	0	0
Dibenzofuran	UNFL	ug/L	.000	0	4	0	0	0
Diethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Dimethyl phthalate	UNFL	ug/L	.000	0	4	0	0	0
Fluoranthene	UNFL	ug/L	.000	0	4	0	0	0
Fluorene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobenzene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorobutadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachlorocyclopentadiene	UNFL	ug/L	.000	0	4	0	0	0
Hexachloroethane	UNFL	ug/L	.000	0	4	0	0	0
Indeno(1,2,3-cd)pyrene	UNFL	ug/L	.000	0	4	0	0	0
Isophorone	UNFL	ug/L	.000	0	4	0	0	0
N-Nitroso-di-n-propylamine	UNFL	ug/L	.000	0	4	0	0	0
N-Nitrosodimethylamine	UNFL	ug/L	.000	0	1	0	0	0
N-Nitrosodiphenylamine	UNFL	ug/L	.000	0	4	0	0	0
Naphthalene	UNFL	ug/L	.000	0	4	0	0	0
Nitrobenzene	UNFL	ug/L	.000	0	4	0	0	0
Pentachlorophenol	UNFL	ug/L	.000	0	4	0	0	0
Phenanthrene	UNFL	ug/L	.000	0	4	0	0	0
Phenol	UNFL	ug/L	.000	0	4	0	0	0
Pyrene	UNFL	ug/L	.000	0	4	0	0	0
Tributyl phosphate	UNFL	ug/L	.000	0	1	0	0	0
bis(2-Chloroethoxy)methane	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroethyl)ether	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Chloroisopropyl) ether	UNFL	ug/L	.000	0	4	0	0	0
bis(2-Ethylhexyl) phthalate	UNFL	ug/L	.000	0	4	0	0	0
p-Chloroaniline	UNFL	ug/L	.000	0	2	0	0	0

See footnote at end of table

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TABLE 4-72  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum	Range of Detects Maximum	Number of Detects Above Background
<b>PESTICIDES/PCBs</b>								
4,4'-DDD	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDE	UNFL	ug/L	.000	0	4	0	0	0
4,4'-DDT	UNFL	ug/L	.000	0	4	0	0	0
Aldrin	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1016	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1221	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1232	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1242	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1248	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1254	UNFL	ug/L	.000	0	4	0	0	0
Aroclor-1260	UNFL	ug/L	.000	0	4	0	0	0
Dieldrin	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan II	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan sulfate	UNFL	ug/L	.000	0	4	0	0	0
Endosulfan-I	UNFL	ug/L	.000	0	4	0	0	0
Endrin	UNFL	ug/L	.000	0	4	0	0	0
Endrin aldehyde	UNFL	ug/L	.000	0	4	0	0	0
Endrin ketone	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor	UNFL	ug/L	.000	0	4	0	0	0
Heptachlor epoxide	UNFL	ug/L	.000	0	4	0	0	0
Methoxychlor	UNFL	ug/L	.000	0	4	0	0	0
Toxaphene	UNFL	ug/L	.000	0	4	0	0	0
alpha-BHC	UNFL	ug/L	.000	0	4	0	0	0
alpha-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
beta-BHC	UNFL	ug/L	.000	0	4	0	0	0
delta-BHC	UNFL	ug/L	.000	0	4	0	0	0
gamma-BHC (Lindane)	UNFL	ug/L	.000	0	4	0	0	0
gamma-Chlordane	UNFL	ug/L	.000	0	4	0	0	0
<b>GENERAL CHEMISTRY</b>								
Alkalinity	UNFL	mg/L	.000	2	2	380	400	0
Alkalinity as CaCO3	UNFL	mg/L	.000	2	2	320	320	0
Ammonia	UNFL	mg/L	3.240	1	4	.12	.12	0
Chloride	UNFL	mg/L	145.065	4	4	9.23	17.2	0
Fluoride	UNFL	mg/L	.938	4	4	.13	.27	0
Nitrate	UNFL	mg/L	11.400	4	4	1.15	1.8	0
Phenols	UNFL	mg/L	.000	0	4	0	0	0
Phosphorus	UNFL	mg/L	.693	2	2	.05	.08	0
Sulfate	UNFL	mg/L	359.847	4	4	49.2	237.5	0
Sulfide	UNFL	mg/L	.000	0	4	0	0	0

See footnote at end of table

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TABLE 4-72  
(Continued)

Parameter	FILTER FLAG	UNITS	Background Concentration	Number of Detects	Number of Analyses	Range of Detects Minimum Maximum		Number of Detects Above Background
<u>GENERAL CHEMISTRY (Continued)</u>								
Total Kjeldahl Nitrogen	UNFL	mg/L	.000	4	4	.12	.16	4
Total Organic Carbon	UNFL	mg/L	3.764	1	4	1.14	1.14	0
Total Organic Halides	UNFL	mg/L	.021	0	3	0	0	0
Total Organic Nitrogen	UNFL	mg/L	.652	3	4	.13	.16	0
Total Phosphorous	UNFL	mg/L	.000	2	2	.07	.12	0

<sup>a</sup>Unfiltered metals and filtered radionuclides, organics, general chemistry, etc. are not included because background concentrations were not available.

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**TABLE 4-73**  
**SUMMARY OF URANIUM ISOTOPES AND**  
**TOTAL THORIUM IN MEDIA IN THE**  
**ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Well Series	Boring No.	Date Sample Taken	Uranium-234 <sup>a</sup> (pCi/L)	Uranium-238 (pCi/L)	Total Uranium (µg/L)	Total Thorium (µg/L)
1000s	1048	07/24/88	5.4 U	5.3 U	17.0 U	-
		10/23/88	4.5 U	4.0 U	15.0 U	5.0 U
		01/22/89	6.6 U	6.9 U	21.0 X	4.0 X
		12/16/89	14.2 U	15.0 X	52.6 X	-
		04/28/93	11.4 U	12.5 U	31.1 U	-
	1045	12/13/89	1.72 X	2.15 X	10.1 X	-
		04/29/93	1.16 U	1.19 U	2.91 U	0.30 U
		04/29/93	-	-	2.47 F	-
		(Soil) 10/07/87	1.0	0.90	-	-
	2000s	21033	06/17/93	13.1 U	16.1 U	43.2 U
06/17/93			12.8 F	15.6 F	41.2 F	-
2049		04/08/88	50.3 U	51.4 U	130.0 U	-
		08/03/88	3.1 U	2.8 U	8.0 U	-
		12/06/88	-	1.0 U	2.0 U	-
		02/07/89	2.3 U	2.1 U	6.0 U	-
		05/10/89	42.9 U	47.5 X	175.0 U	-
		07/30/89	83.2 U	89.9 U	147.0 U	-
		04/03/90	-	-	43.3 U	-
		05/10/93	41.5 U	46.4 U	111.0 U	-
2045		01/23/89	78.9 U	92.3 U	283.0 U	5.0 U
		05/01/89	74.7 U	85.5 U	265.0 U	-
		05/01/89(D)	77.6 U	87.5 U	291.0 U	-
		07/25/89	104.0 U	119.0 U	341.0 U	-
		04/01/90	97.0 U	104.0 U	462.0 U	-

See footnotes at the end of table

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TABLE 4-73  
 (Continued)

Well Series	Boring No.	Date Sample Taken	Uranium-234 <sup>a</sup> (pCi/L)	Uranium-238 (pCi/L)	Total Uranium (μg/L)	Total Thorium (μg/L)
2000s (cont'd)		04/01/90(D)	95.3 U	103.0 U	461.0 U	9.47 U
		04/28/93	131.0 F	144.0 F	364.0 U	-
	(Soil)	12/06/88 (35-36.5)	-	-	2.0	-
	2048	04/01/90	3.4 U	3.02 U	2.07 U	-
		04/27/93	0.68 U	0.34 U	1.0 U	1.03 U
SEDIMENT			pCi/g	pCi/g	mg/kg	mg/kg
	AFP-SD-06	05/13/93	2.77	2.9	11.3	8.04
	AFP-SD-02	05/12/93	4.14	4.39	13.6	8.57
	AFP-SD-04	05/13/93	2.37	3.05	10.2	14.7
	AFP-SD-05	05/13/93	3.25	3.62	12.5	16.5
	AFP-SD-01	05/15/93	3.39	3.42	14.8	22.2
	AFP-SD-03	05/13/93	2.83	3.11	10.7	11.2
	SWAFRSW-02	05/13/93	1.50 U	1.69	4.18 U	-

<sup>a</sup>F = Filtered  
 U = Unfiltered  
 X = Not Known  
 D = Duplicate

Soil samples collected from screened interval at the time of well construction.

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except Well 2049. The concentration of total uranium in this well has ranged from 2  $\mu\text{g/L}$  to 175  $\mu\text{g/L}$  in eight samples collected from 1988 to 1993. This suggests that there may be an influence from the Storm Sewer Outfall Ditch, which flows approximately 50 feet to the east, on Well 2049 due to the recharge of water containing low uranium concentrations to groundwater. Concentrations of total uranium in Well 2045 ranged from 265.5  $\mu\text{g/L}$  to 461.0  $\mu\text{g/L}$  in samples collected from 1988 to 1993. These concentrations are believed to be related to recharge originating upgradient at the south east corner of the South Field subunit. The source of the recharge is discussed in Section 4.5, above. Upgradient Wells 2943 and 2048 detected 1  $\mu\text{g/L}$  and 3  $\mu\text{g/L}$  total uranium, respectively. Downgradient Well 21033 detected 4.12  $\mu\text{g/L}$  total uranium, which suggests that there has been an impact from the subunit on groundwater.

#### 4.6.5 Biota

Impacts from the Active Flyash Pile are not addressed in the Operable Unit 2 RI because it is likely to be remediated. A Site-wide Ecological Risk Assessment will be prepared as part of the Operable Unit 5 RI/FS to address areas not likely to be remediated.

#### 4.6.6 Active Flyash Summary

Data from environmental samples collected from soil and water media in the Active Flyash Pile indicate the following:

- Flyash contains elevated concentrations of metals, radionuclides, and organic compounds when compared to background concentrations for soil. When compared to background for flyash, two metals, five radionuclides, and nine organic compounds exceeded background. However, it should be noted that the FEMP Flyash contains approximately 70 percent bottom ash; therefore, analytical results may be skewed higher.
- Flyash contains elevated concentrations of VOCs when compared to literature derived background concentrations for flyash. This fact suggests that VOCs may have been disposed of as an additional waste material in the subunit.
- Concentrations of organic compounds decrease with depth below 10 feet deep in the flyash pile. This fact suggest that the organic contamination is related to surface activities after the pile was approximately half-way constructed.
- Metals and organic compounds detected in flyash and soil samples were not detected in shallow groundwater. This suggests that these constituents have not impacted groundwater.

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- Chemical and radiological constituents detected in sediment samples are similar to those detected in surface and subsurface flyash samples. This suggests that the origin for sediment in the subunit is the flyash and that there has been an impact from the unit on sediment. 1  
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- The levels of radionuclides in surface flyash, subsurface flyash and sediment appears to vary within a narrow range. This fact suggest that the source for the radionuclides is the flyash. 6  
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- Groundwater in the 2000-series wells has elevated concentrations of radionuclides with respect to background groundwater. The contaminant source is believed to be recharge originating in the South Field. 10  
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## 5.0 CONTAMINANT FATE AND TRANSPORT

This section summarizes the results of fate and transport modeling that was used to simulate constituent movement from the Operable Unit 2 subunits to potential human receptors via the surface water, groundwater, and air migration pathways. Used in conjunction with monitoring data, the models predict constituent concentrations at potential exposure locations when measured constituent concentration data, such as off-site locations and/or future scenarios, are not available. Modeling estimates constituent migration to off-property locations or future exposure predictions by extrapolating from known field data. Conservative assumptions were used to simulate "worst-case" constituent migration scenarios. The modeled future concentrations were based on the unremediated baseline case for the Operable Unit 2 waste areas. The results of the fate and transport models were used in the Operable Unit 2 baseline risk assessment (presented in Appendix B and summarized in Section 6.0) to estimate potential risks to human health.

The technical approach and the methods used to quantitatively predict constituent concentrations for use in the Operable Unit 2 baseline risk assessment are presented as follows:

- A presentation of background information on the environmental setting
- Definition of the conceptual transport models for surface water, groundwater, and air based on a reasonable and conservative depiction of the environmental setting
- Description of the screening processes used to select constituents of potential concern (CPC) for further groundwater modeling
- Overview of the modeling process and discussion of modeling results
- Comparison of modeling results with field data

Radionuclides, metals, and organic constituents found in Operable Unit 2 subunits during RI sampling activities were evaluated for use in the fate and transport modeling process. Based on the sampling analyses, the most prevalent radionuclides within Operable Unit 2 are the isotopes of uranium, radium, thorium, and their progeny, technetium-99, and neptunium-237.

CPCs were identified for each waste subunit in Operable Unit 2 as discussed in the Operable Unit 2 baseline risk assessment (Section 6.0 and Appendix B). Sections 5.1 and 5.2 present the information on migration pathways and contaminant persistence pertinent to Operable Unit 2. Sections 5.3, 5.4,

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and 5.5 present modeling procedures and results for surface water, groundwater, and air pathways, respectively. Detailed descriptions of the technical approaches used for the fate and transport of constituents through the surface water, groundwater, and air pathways are presented in Appendix A.

5.1 POTENTIAL MIGRATION PATHWAYS

The fate and transport evaluation for Operable Unit 2 includes modeling of surface water, groundwater, and air pathways (Figure 5-1):

- Surface water
  - Erosion of contaminated soils and flow of contaminated surface runoff into the Storm Sewer Outfall Ditch and Paddys Run and eventually to the Great Miami River
  - Flow of contaminated seep water to Paddys Run and eventually to the Great Miami River
  - Deposition of airborne contaminated dust directly into surface water
- Groundwater transport
  - Leaching of constituents from the subunits through the vadose zone to underlying groundwater
  - Infiltration of contaminated surface water from the Storm Sewer Outfall Ditch and Paddys Run to the Great Miami Aquifer
  - Leaching of constituents from contaminated sediments in the Storm Sewer Outfall Ditch and Paddys Run to the Great Miami Aquifer
  - Percolation of perched water under the subunits through the vadose zone to the underlying Great Miami Aquifer
  - Lateral migration of perched water to an area where glacial till is not present and then vertical migration to the Great Miami Aquifer
  - Infiltration of contaminated seep water to the Great Miami Aquifer
  - Deposition of airborne contaminated dust onto land and surface water bodies and then leaching to groundwater
- Air emissions
  - Volatilization of organic compounds, wind erosion of contaminated particulate matter
  - Direct release of radon gas

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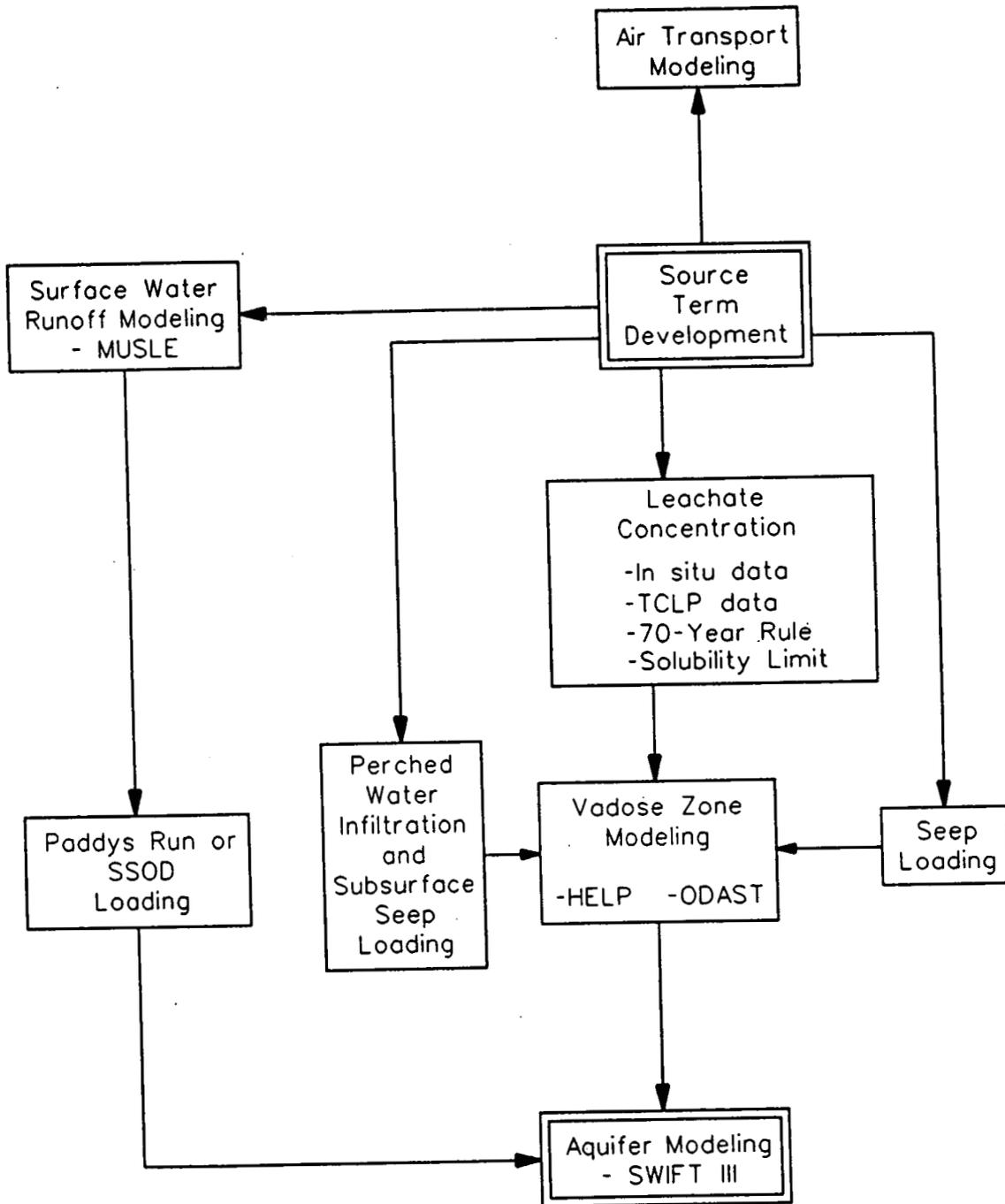


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FIGURE 5-1  
OVERALL FATE AND TRANSPORT MODELING FRAMEWORK

Each of these potential constituent transport pathways is discussed herein. The reader should refer to the baseline risk assessment (Section 6.0 and Appendix B) for detailed information concerning each of these pathways, the associated transport mechanisms, and the impact on environmental media or receptors. Impacts of deposition of airborne contaminated dust and subsequent leaching of constituents were not considered here. Impact of these two mechanisms will be considered under Operable Unit 5 modeling efforts.

5.1.1 Surface Water Pathway

Surface water runoff is a viable transport pathway for subunits in Operable Unit 2 except the Lime Sludge Ponds. Storm water from the Solid Waste Landfill drains to a drainageway which passes through the northern part of the subunit. Runoff flow from the slopes of the Inactive Flyash Pile and South Field drains into Paddys Run. Runoff flow from the Active Flyash Pile drains to the Storm Sewer Outfall Ditch. Surface water is not a viable transport pathway for the Lime Sludge Ponds since the ponds are constructed with berms, which prevent a release of contaminated runoff.

During a rainfall event, soil particles are dislodged by the impact of raindrops and the flow of runoff water across the soil surface. The amount of soil erosion depends on rainfall intensity, ground slope length, ground slope steepness, vegetative cover, and erosion control practices. Constituents adsorbed to soil particles can be desorbed and transported in the runoff water. Constituent transport in runoff water will be presented in the following two forms in Section 5.3:

- Adsorbed to the soil particles, both sediments and suspended particles
- Dissolved in the runoff water

Impact of deposition of airborne contaminated dust on surface water bodies was not considered here.

5.1.2 Groundwater Pathway

Rainfall and surface water runoff infiltrates through the surface of the waste units and percolates through the waste and soil overlying the groundwater. The FEMP is situated above the Great Miami Aquifer, which serves as a principal source of domestic, municipal, and industrial water throughout the region. The Great Miami Aquifer is considered the primary pathway by which constituents released from Operable Unit 2 could be transported to a human receptor. The nine controlling mechanisms for this migration pathway are:

- The leaching of constituents from the soil matrix into the dissolved phase 1
- The percolation of the contaminated leachate to the underlying aquifer 2
- The infiltration of contaminated surface water from the Storm Sewer Outfall Ditch and Paddys Run to the Great Miami Aquifer 3
- The leaching of contaminated sediments in the Storm Sewer Outfall Ditch and Paddys Run to the Great Miami Aquifer 4
- Percolation of perched water under the subunits through the vadose zone to the underlying Great Miami Aquifer 5
- Lateral migration and infiltration of perched water to the Great Miami Aquifer 6
- Infiltration of contaminated seep water to the Great Miami Aquifer 7
- Deposition of airborne contaminated dust onto land and surface water and subsequent leaching and infiltration to the Great Miami Aquifer 8
- The movement of water in the Great Miami Aquifer 9

Impacts of deposition of airborne contaminated dust are not considered here. Impacts of this mechanisms will be considered in the Operable Unit 5 modeling effort. The perched water systems under the Solid Waste Landfill and Lime Sludge Ponds are considered secondary groundwater pathways by which constituents released from Operable Unit 2 subunits could be transported to a human receptor. The three controlling mechanisms for this migration pathway are:

- The leaching of constituents from the soil matrix into the dissolved phase 23
- The percolation of the contaminated leachate to the underlying perched water 24
- The horizontal movement of water in the perched water system 25

The constituent concentrations in leachate reaching groundwater depend on the infiltration rate, the initial concentration, contaminant mass, solubility of the CPC, degradation rate, soil textures, soil hydraulic conductivities, depth to the groundwater, and a number of other chemical- and soil-specific factors. The predicted constituent concentrations in the Great Miami Aquifer were used as the primary basis for the assessment of human exposure by water intake and exposure pathways as discussed in the baseline risk assessment (Section 6.0 and Appendix B). The predicted constituent concentrations in the perched water under the Solid Waste Landfill and Lime Sludge Ponds were also used as the basis for the assessment of human exposure as discussed in the baseline risk assessment.

5.1.3 Air Pathway

Air emissions associated with Operable Unit 2 may involve different types of release mechanisms. During periods of turbulent wind conditions, particles of contaminated surface soil can become suspended in the air and may potentially be subject to inhalation by on- or off-site human receptors. The amount of material that may be suspended depends on wind speed and other site conditions such as soil moisture, particle size, and vegetative cover. Gaseous radon-222 will be emitted from soil and material containing radium-226. Also, if organic compounds are present within the surface soil or exposed waste materials, then volatilization of these compounds may occur. Concentrations of these airborne contaminants at on-site and off-site receptor locations form the basis for the assessment of human exposure by the air pathways, as discussed in Section 6.0.

Wind erosion of contaminated particulate matter was the principal release mechanism for organics, inorganics, and radionuclides found in Operable Unit 2, with one exception. Significant releases of radon-222 gas were estimated for most of the subunits.

5.2 PERSISTENCE OF CONSTITUENTS

The migration of constituents from Operable Unit 2 and their persistence in the environment are a function of both site characteristics and the physical/chemical properties of the constituents. Such properties include water solubility, tendency to transform or degrade (e.g., the compound's half life), and the chemical's affinity for solids or organic matter (partitioning coefficient). These properties and how they affect the constituent's behavior are described below for radionuclides, inorganics, and organics.

5.2.1 Radionuclides

Radionuclides undergo spontaneous transformations that involve the emission of particles and radiant energy. The resulting isotope may also be radioactive and undergo spontaneous decay or may be a stable element that no longer decays. The succession of radioactive decays forms a decay chain, which continues until the resulting element is stable. The decay process occurs by various spontaneous mechanisms. The emissions produced by these decay modes consist of three different types of particles or photons (rays): alpha, beta, and gamma. Two of the more important decay modes are alpha decay and beta decay.

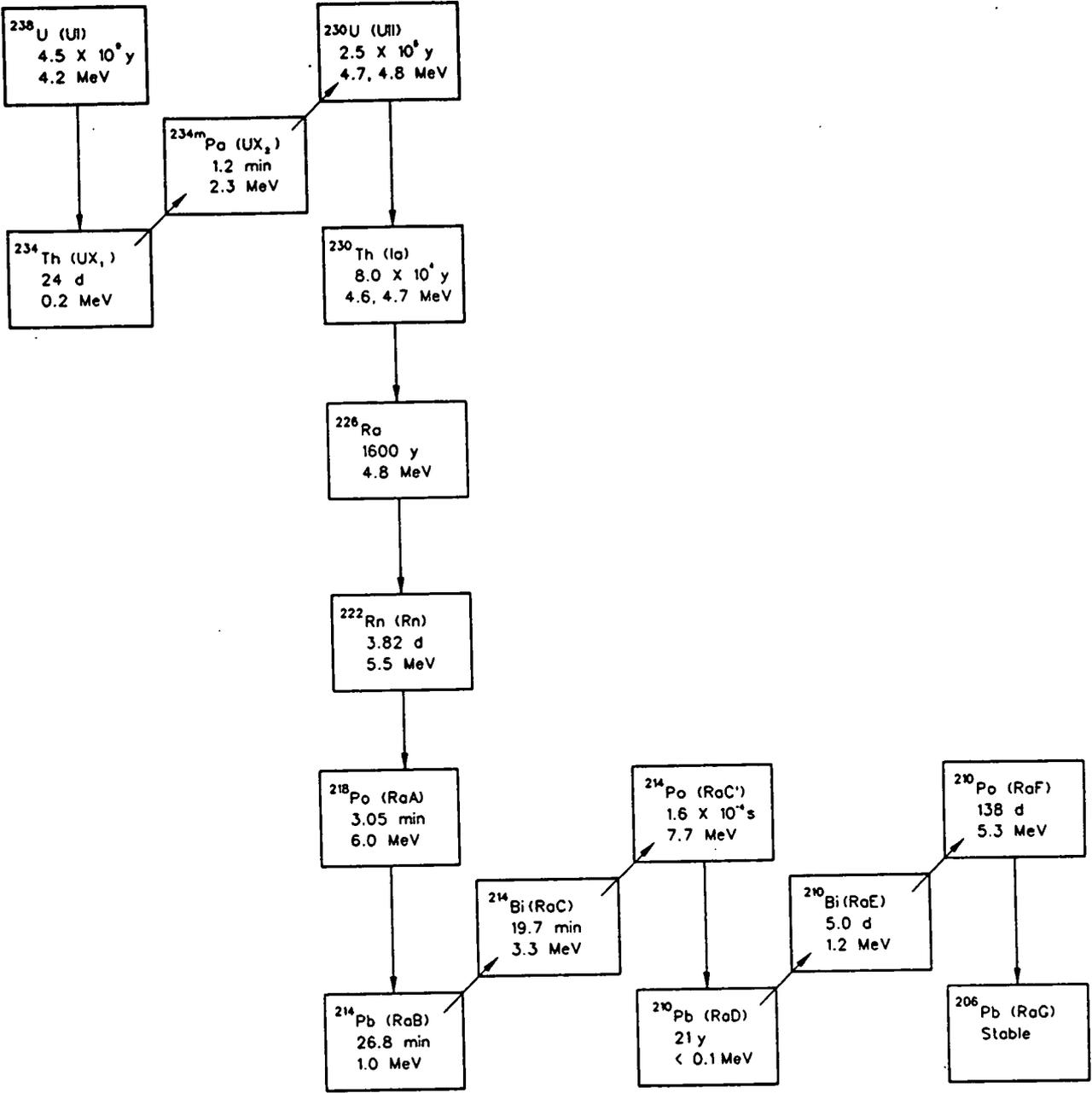
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Alpha decay consists of the emission of an alpha particle from the nucleus of an atom. An alpha particle is composed of two protons and two neutrons, and consequently has a charge of +2. Following radioactive decay by alpha emission, a different element is formed (e.g., radium-226 becomes radon-222) because the number of protons in the nucleus has changed. During beta decay, a neutron is transformed into a proton and electron. The electron is then expelled from the nucleus as a beta particle. The atomic number of the resulting progeny is thus increased by one, and the number of neutrons is decreased by one (e.g. strontium-90 becomes yttrium-90). The atom may be left in an excited state; that is, the atom has excess energy that must be released. This energy can be emitted in several ways, including the formation of a gamma photon (ray) with a discrete energy.

Most of the radioactive materials present at the FEMP originated from natural sources such as pitchblende ore or ore concentrates. The radioactive elements present in these materials belong to three decay series (chain): the uranium-238 (uranium) series, the uranium-235 (actinium) series, and the thorium-232 (thorium) series as shown in Figures 5-2, 5-3, and 5-4, respectively. Stable daughter products are lead-208, lead-207, and lead-206 for uranium, actinium, and thorium series, respectively. If they are not subject to chemical or physical separation, the members of a series attain a state of radioactive equilibrium where the rate of decay of each nuclide is essentially equal to that of the nuclide that heads the series (the parent), leading to constant ratios of activity concentrations among the respective nuclides (parent and daughters or progeny). At the FEMP, radioactive equilibrium between various portions of these three decay chains does not always exist due to processing of ore concentrates prior to arrival at FEMP or as part of the uranium extraction process at FEMP. In addition to chemical processes, physical processes were used to preferentially extract certain isotopes (same element but with differing numbers of neutrons in the nucleus; such as uranium-234, uranium-235, and uranium-238) from materials prior to their use at FEMP (i.e., uranium that has been isotopically separated as part of fuel manufacturing).

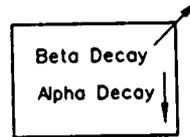
As a result of different chemical processes in various areas of the FEMP, there is a wide variance in the presence or absence of members of the decay chain, member concentration, and isotopic content of wastes within the boundaries of Operable Unit 2. Activity ratios and parent/progeny equilibrium can be used as an indicator of contaminant source.

The half-lives of most of the radionuclides of concern at the FEMP are measured in thousands of years. Exceptions are radium-228 (with a half-life of 5.8 years), thorium-228 (with a half-life of 1.91



**NOTE:**  
1. SOURCE - N.C.R.P., 1987

**LEGEND:**  
<sup>214</sup>Pb (RaB) - MASS SYMBOL  
26.8 min - HALF LIFE  
1.0 MeV - DECAY ENERGY

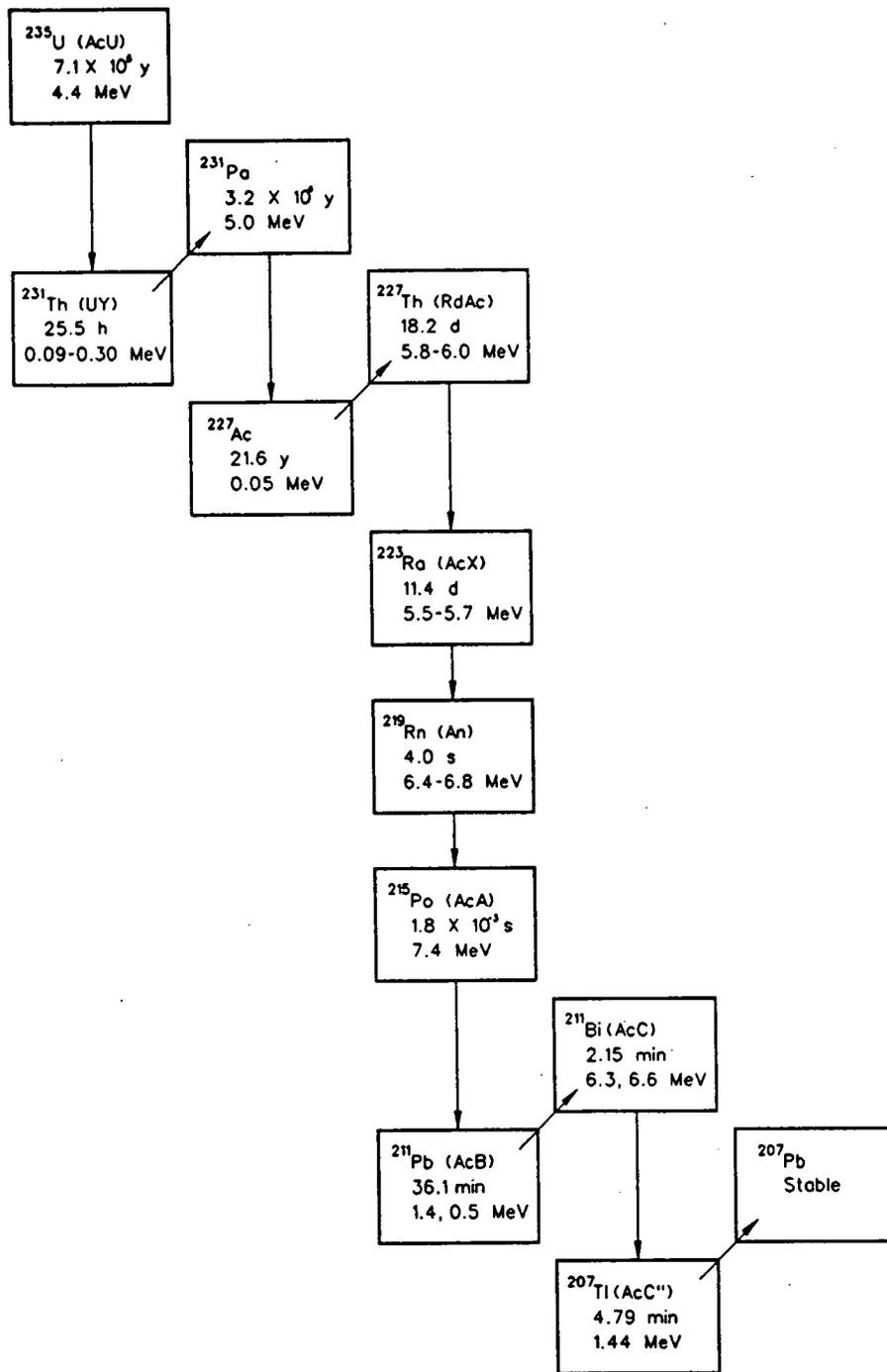


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FIGURE 5-2  
PRINCIPAL DECAY SCHEME OF THE URANIUM SERIES

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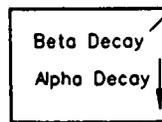


**NOTE:**

1. SOURCE - N.C.R.P., 1987

**LEGEND:**

<sup>211</sup>Pb (AcB) - MASS SYMBOL  
36.1 min - HALF LIFE  
1.4 MeV - DECAY ENERGY

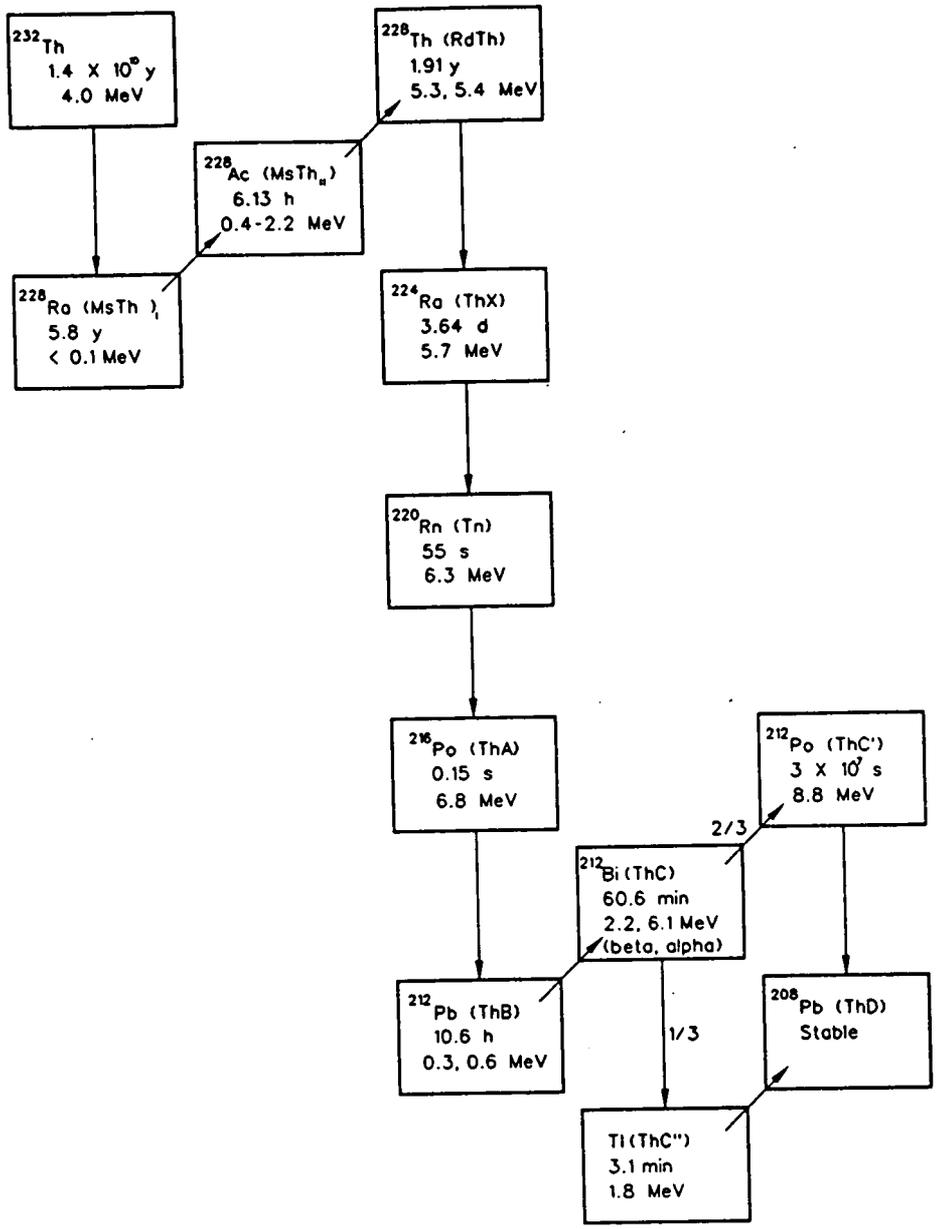


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FIGURE 5-3  
PRINCIPAL DECAY SCHEME OF THE ACTINIUM SERIES

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**NOTE:**

1. SOURCE - N.C.R.P., 1987

**LEGEND:**

$^{212}\text{Pb}$  (ThB) - MASS SYMBOL  
10.6 h - HALF LIFE  
0.6 MeV - DECAY ENERGY

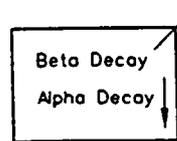


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FIGURE 5-4  
PRINCIPAL DECAY SCHEME OF THE THORIUM SERIES

years), strontium-90 (with a half-life of 29 years), and cesium-137 (with a half-life of 30 years). Furthermore, many geochemical reactions occur that cause constituent movement to be retarded, which is a reduction in the velocity of the constituent movement in a medium. Radionuclide retardation in groundwater transport and their decay constants are discussed in detail in Appendix A.

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5.2.2 Inorganics

Inorganics do not degrade in the environment, but they may undergo speciation, which is a change in chemical form. They may also react with soils or other solid surfaces by ion exchange, adsorption, precipitation, or complexation (combining of two compounds to form a new compound). These processes are affected by Ph, oxidation-reduction conditions, the type and amount of organic matter, clay, and hydrous oxides present. In turn, these factors are affected by the physical and biological properties of the environmental media.

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Chemical speciation has a significant impact on the solubility of inorganic materials and in turn their mobility in the environment. Chemical speciation, however, is very complex and difficult to distinguish in routine laboratory analysis. Generally, the only distinction made in the analysis for inorganics is between total and filterable inorganics in water. The filterable inorganics represent the dissolved fraction, which is the more mobile and bioavailable.

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5.2.3 Organics

Organic contaminants may be degraded in the environment by various processes, including hydrolysis, oxidation/reduction, photolysis, or biodegradation. Degradation rates in various media can vary from minutes to years depending on the chemical and environmental conditions.

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The mobility of an organic compound is affected by its volatility, partitioning between solids and water, water solubility, and concentration. A constituent's water solubility and tendency to adsorb to particles or organic matter correlates with its retardation in groundwater transport. Chemicals with higher water solubilities and lower adsorption coefficients are expected to remain primarily in the dissolved phase and be transported at approximately the same rate as the groundwater flow rate. Chemicals with lower water solubilities and higher adsorption coefficients are expected to remain primarily adsorbed to the surface of the soils and thus, transportation with the groundwater would be very limited and at a much slower rate. Retardation factors in groundwater transport are discussed

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further in Appendix A. A general overview of the relative water solubility, tendency to adsorb to solids, and constituent mobility for different categories of organic constituents is presented as follows:

- Volatile organic compounds
  - High water solubility
  - High volatility
  - Low tendency to adsorb to solids
  - Generally, transport occurs while dissolved in water or in air
  - Operable Unit 2 examples include benzene, 1,2-dichloroethene, 1,1,1-trichloroethane, and toluene
  
- Semivolatile organic compounds
  - Medium to low water solubility
  - Medium volatility
  - Medium to high tendency to adsorb to solids
  - Transport may occur dissolved in water, in air, or adsorbed to soil particles
  - Operable Unit 2 examples include anthracene, chlorobenzene, and di-n-butyl phthalate
  
- Pesticides, PCBs, and dioxins
  - Low water solubility
  - Low volatility
  - High tendency to adsorb to solids
  - Generally, transport occurs while adsorbed to soil particles
  - Operable Unit 2 examples include Aroclor-1254, heptachlorodibenzofuran, and octachlorodibenzo-p-dioxin

5.3 SURFACE WATER MODELING

The modeling approach used to estimate constituent concentrations in surface water and sediments resulting from transport by storm water runoff from Operable Unit 2 is described in this section.

Details regarding the surface water modeling process, as well as modeling uncertainties, are presented in Appendix A-1. Predicting the transport of storm water runoff begins with characterizing the constituents present in the surface soil or waste and uses runoff and partitioning models to quantify the migration of constituents to stream sediments and surface water.

Constituents in surface soil from source areas can be released and transported to surface water via storm water runoff. During a rainfall event, some rainwater infiltrates the soil surface while some runs off the surface as shown in Figure 5-5. The amount of runoff increases with the increase in the clay content and moisture content of the soil, intensity and duration of rainfall, and ground slope steepness. Runoff will decrease with increased vegetative cover or greater ground slope length.

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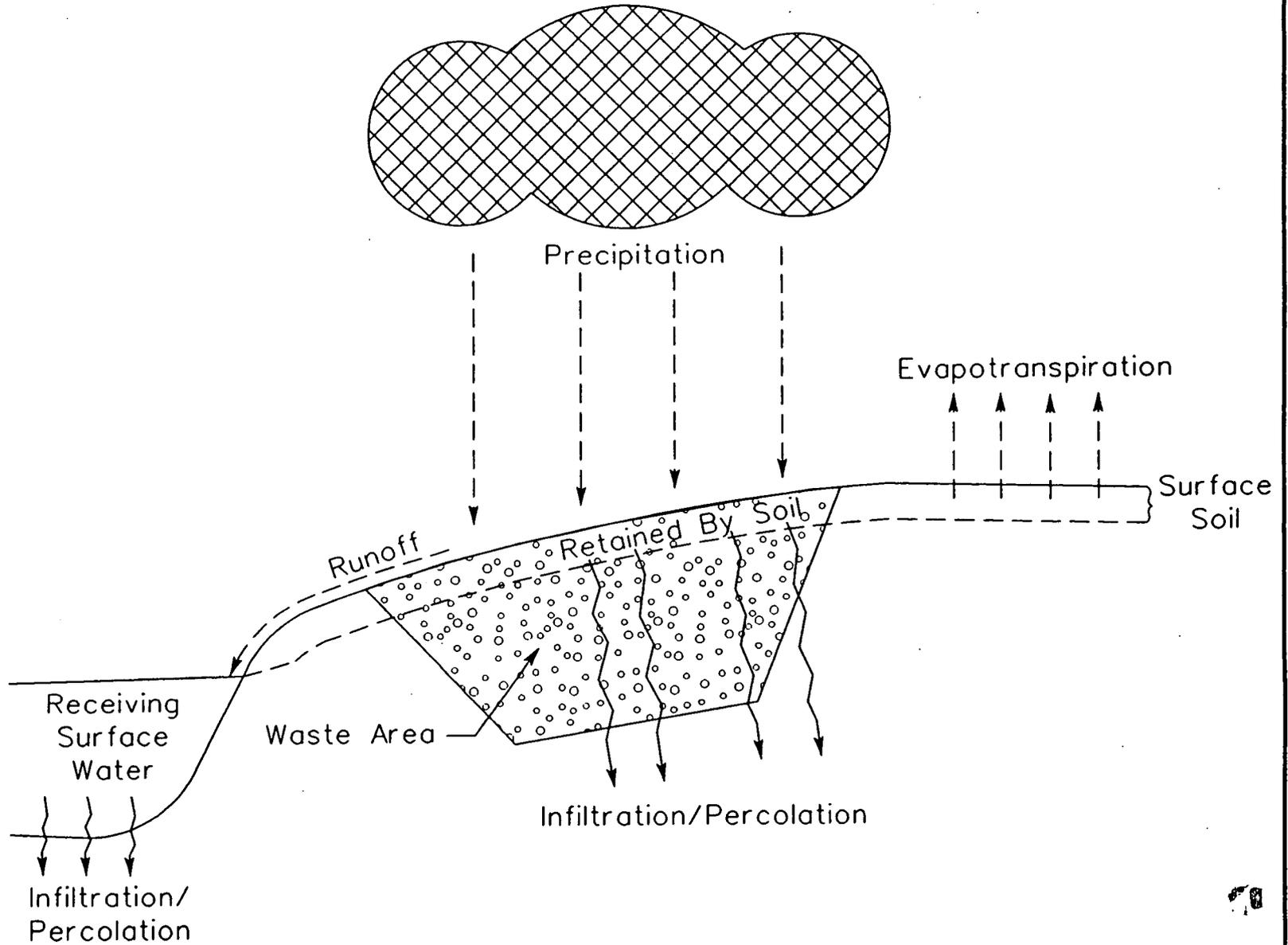


FIGURE 5-5  
CONCEPTUAL MODEL OF SURFACE WATER RUNOFF

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Constituents in the surface soil can be transported via runoff either in the dissolved phase or adsorbed to soil particles. The less soluble a constituent is in water, the more likely it will be adsorbed to soil particles. Because the water solubility of constituents in Operable Unit 2 vary greatly, constituent transport is modeled for both dissolved-phase and adsorbed-phase.

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This section also describes the use of the surface water modeling results to define source terms for groundwater modeling because the bases of Paddys Run and the Storm Sewer Outfall Ditch are in direct contact with the Great Miami Aquifer over a portion of their course.

5.3.1 Conceptual Model

Surface runoff from Operable Unit 2 that reaches the Storm Sewer Outfall Ditch and Paddys Run in response to a rainfall event is a significant potential pathway for constituent migration to surface water. Another pathway for constituent migration to surface water is storm runoff carrying contaminated seep water to the surface water before seep water can infiltrate to the Great Miami Aquifer.

Storm water runoff from the Active Flyash Pile reaches the Storm Sewer Outfall Ditch. As a conservative assumption for the impact on surface water, 44% of constituent mass reaching the Storm Sewer Outfall Ditch was assumed to reach the Paddys Run and eventually to the Great Miami River. However, for groundwater modeling purposes, all CPC mass flowing to the Storm Sewer Outfall Ditch from the Active Flyash Pile is considered to infiltrate the Great Miami Aquifer before reaching Paddys Run because flow in the Storm Sewer Outfall Ditch is very low and the base of the ditch is in direct contact with the Great Miami Aquifer. This is a conservative assumption for surface water source term to the Great Miami Aquifer, for conditions existing before the installation of the FEMP storm water retention basins.

Surface water runoff from the South Field, Inactive Flyash Pile, and Solid Waste Landfill is considered to reach Paddys Run, and in turn, either discharges to the Great Miami River, or infiltrates to the Great Miami Aquifer. The Lime Sludge Ponds were not considered in surface water since berms surrounding the Lime Sludge Ponds are expected to contain the precipitation received during the storm event.

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Contaminated soils in Operable Unit 2 were identified as potentially vulnerable to erosion by storm water. A uniform concentration was assigned for surface soil constituents in each subunit. The constituent concentrations used in this assessment are the upper 95 percent confidence level on the means (UCL) of the surface soil concentrations from the RI. Section 6.0 and Appendix B describe the selection of constituents of potential concern and source concentration terms for surface water modeling.

5.3.2 Technical Approach

The modeling approach used to estimate constituent concentrations in surface water and sediment resulting from transport by surface water runoff is described in this section.

The Modified Universal Soil Loss Equation (MUSLE) model was used to quantify soil migration as referenced in the "Superfund Exposure Assessment Manual" (EPA 1988c). This model employs event-specific runoff volume and flow rate parameters to calculate the soil loss for a single rainfall event and allows evaluation of an event-specific worst-case scenario. The MUSLE model calculates the total mass of soil transported by surface water in a single rainfall event. The volume of runoff was also estimated to determine the amount that stream flow may be increased by a storm event and dissolved contaminant loading.

Additional equations were used to approximate constituent partitioning between soil and water in the runoff flow. These partitioning equations provide an estimate of the constituent concentration dissolved in water runoff and adsorbed to the soil that is carried with the runoff and deposited in the sediment of receiving surface water bodies (Haith 1980; Mills et al. 1982; Mockus 1972).

Local meteorological data were used to obtain estimates of the amount and duration of rainfall at the site. The volume of storm water runoff flowing to Paddys Run was estimated in the surface water runoff modeling using the Soil Conservation Service (SCS) curve method. The storm runoff modeling was based on a single storm event (2.5 inches in 24 hours; Hershfield 1961) resulting in a flow rate in Paddys Run of 4 cubic feet per second (ft<sup>3</sup>/sec) (Dames and Moore 1985a). No flow from upgradient runoff was assumed for the Storm Sewer Outfall Ditch.

Information on the soil types identified in Operable Unit 2 using the U.S. Soil Conservation Service designation is presented in detail in Section 3.0 of this RI report. The types and areal density of

vegetation in Operable Unit 2 were provided by aerial photos, site reconnaissance, and interviews with personnel familiar with the Operable Unit 2 Study Area.

Maximum detected concentrations in the seeps in the Inactive Flyash Pile and South Field and the estimated seep flow rates were also used to define the source term for Paddys Run and the Great Miami River. It was assumed that during the storm event, all seep water will reach Paddys Run. It was estimated that Inactive Flyash seep flow rate during storm event was two gallons per minute (gpm) and the South Field seep flow rate was 10 gpm.

Constituent concentrations in Paddys Run and the Great Miami River were calculated by diluting the dissolved concentrations in storm water runoff or seeps with the flows in the receiving streams. The results from Paddys Run were compared to observed conditions as discussed in Section 5.3.3. Constituent concentrations in the Storm Sewer Outfall Ditch were assumed to be the same as runoff concentrations to simulate a "no-flow" condition upstream of the Active Flyash Pile in the Storm Sewer Outfall Ditch.

An average flow rate of 3,300 ft<sup>3</sup>/sec was used for the Great Miami River based on previous studies (DOE 1993a). To estimate the worst surface water conditions, it was assumed that all flow and all constituent mass in Paddys Run empties into the Great Miami River. To estimate the worst conditions in groundwater due to surface water as a source, it was assumed that 30 percent of constituent mass and flow in Paddys Run infiltrates to the Great Miami River. All constituent mass in the Storm Sewer Outfall Ditch, however, was assumed to infiltrate the Great Miami Aquifer. This accounts for loading due to infiltration of runoff water as well as leaching of sediments.

5.3.3 Screening Procedure for Groundwater CPC from the Surface Water Pathway

Figure 5-6 presents the surface water to groundwater transport modeling diagram. This diagram identifies a screening step used to identify the CPCs in the Great Miami Aquifer from surface water loading. This step consists of comparing predicted constituent concentrations in the Great Miami Aquifer to screening levels. Screening levels have been determined for Operable Unit 2 constituents based on a 10<sup>-7</sup> increased risk for carcinogens and a 0.1 Hazard Index (HI) for non-carcinogens (see Appendix B for the development of screening concentrations levels).

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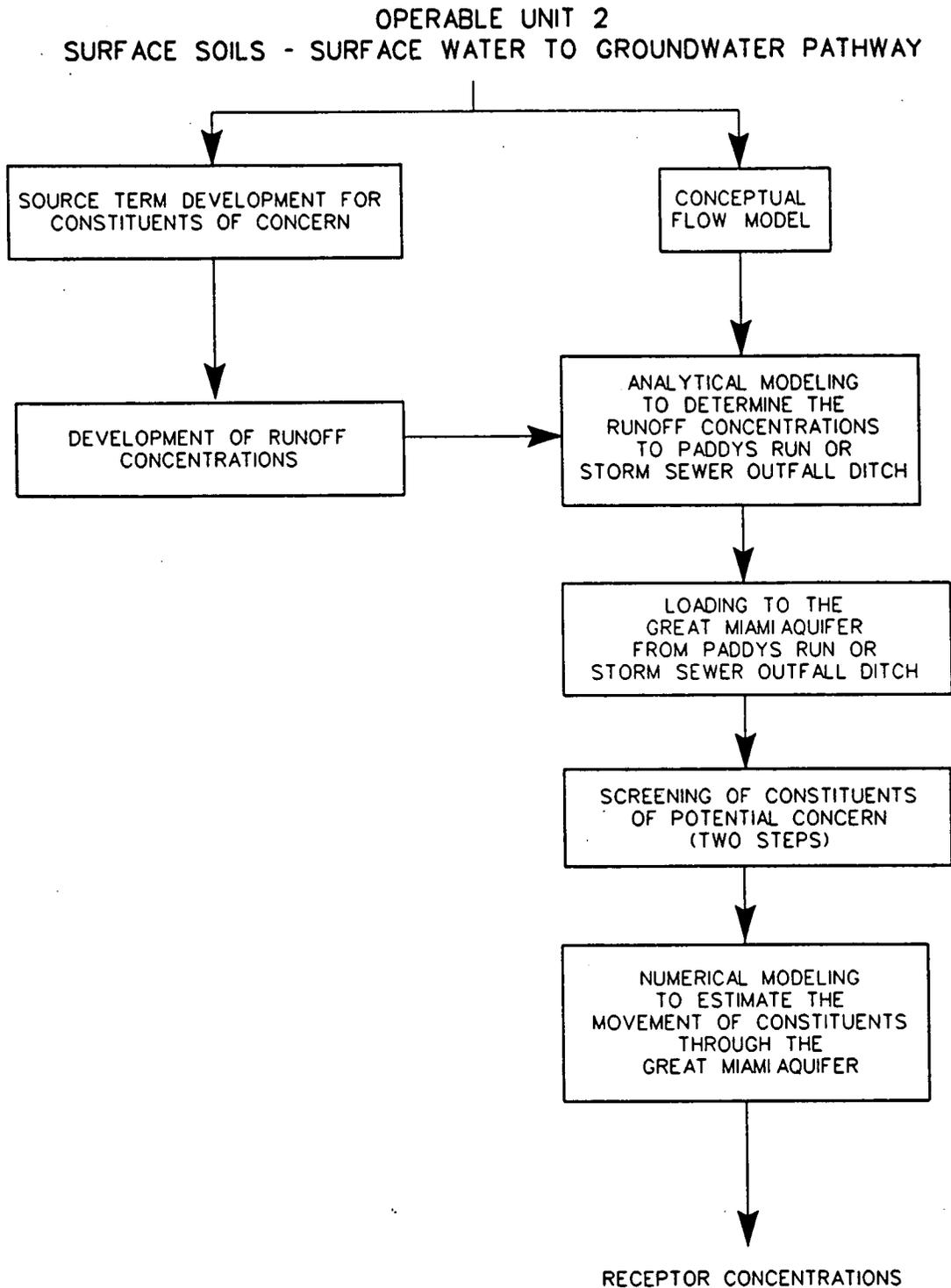


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FIGURE 5-6  
SURFACE WATER TO GROUNDWATER PATHWAY TRANSPORT MODELING DIAGRAM

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The screening step for the Great Miami Aquifer actually consists of two steps. The first two phases compare conservative estimates of Great Miami Aquifer concentrations to the screening levels. If a constituent was still of potential concern after the first two phases, more detailed modeling was performed.

The first step consists of estimating the maximum constituent concentration in the Great Miami Aquifer based on the surface water concentration and dilution in the Great Miami Aquifer resulting only from the width of the streambed (30 feet for Paddys Run and 10 feet for the Storm Sewer Outfall Ditch). Constituents were eliminated from further modeling and screening if their values were below screening levels in the first step.

The second step consists of estimating the constituent concentration in the Great Miami Aquifer by the dilution of the surface water concentration based on the Sandia Waste Isolation Flow and Transport (SWIFT) III model grid of 125 feet by 125 feet. If the predicted diluted groundwater concentrations were below screening levels, detailed modeling was not performed. However, the predicted maximum groundwater concentration predicted in the first step (based on stream width) was reported as the maximum on-site concentrations in the Great Miami Aquifer for that constituent.

5.3.4 Results of Surface Water Modeling

This section presents the results of surface water modeling for each subunit of Operable Unit 2. The predicted maximum Great Miami Aquifer concentrations were compared to risk-based screening criteria which were derived based on a carcinogenic risk of  $1 \times 10^{-7}$  and a non-carcinogenic HI of 0.1.

5.3.4.1 Solid Waste Landfill

Table 5-1 presents the results of surface water modeling for the Solid Waste Landfill based on a single storm event using the MUSLE model. The model results show that the small mass of constituents from the Solid Waste Landfill that partition into the water, combined with a dilution in Paddys Run from a flow of  $4 \text{ ft}^3/\text{sec}$ , results in low surface water concentrations. Radionuclide concentrations in Paddys Run range from a minimum of  $2.8 \times 10^{-6} \text{ pCi/L}$  for plutonium-239/240 to a maximum of  $0.06 \text{ pCi/L}$  for uranium-238. Concentrations in the Great Miami River range from a minimum of  $3.3 \times 10^{-9} \text{ pCi/L}$  for plutonium-239/240 to a maximum of  $3.9 \times 10^{-4} \text{ pCi/L}$  for uranium-234. All inorganics and organics were predicted to remain below  $5 \times 10^{-3} \text{ } \mu\text{g/L}$  in Paddys

**TABLE 5-1**  
**LOADING TO SURFACE WATER FROM**  
**THE SOLID WASTE LANDFILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_I$ (g)	Runoff Effluent Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Surface Water (Paddy's Run) during Storm Event $C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Great Miami River Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Sediment $C_s$ (mg/kg)
<b>INORGANICS</b>							
Arsenic	$2.00 \times 10^{+2}$	$6.67 \times 10^{+0}$	$1.88 \times 10^{+2}$	$8.09 \times 10^{-1}$	$1.91 \times 10^{-3}$	$2.31 \times 10^{-6}$	$6.67 \times 10^{+0}$
Barium	$1.14 \times 10^{+3}$	$9.13 \times 10^{+1}$	$4.53 \times 10^{+2}$	$1.94 \times 10^0$	$4.59 \times 10^{-3}$	$5.54 \times 10^{-6}$	$9.13 \times 10^{+1}$
Beryllium	$1.30 \times 10^{+3}$	$6.98 \times 10^{-1}$	$3.04 \times 10^{-4}$	$1.30 \times 10^{-2}$	$3.08 \times 10^{-5}$	$3.72 \times 10^{-8}$	$6.98 \times 10^{-1}$
Cadmium	$5.00 \times 10^{+2}$	$8.50 \times 10^{-1}$	$9.61 \times 10^{-4}$	$4.12 \times 10^{-2}$	$9.74 \times 10^{-5}$	$1.18 \times 10^{-7}$	$8.50 \times 10^{-1}$
Chromium	$1.50 \times 10^{+3}$	$1.55 \times 10^{+1}$	$5.84 \times 10^{-3}$	$2.51 \times 10^{-1}$	$5.92 \times 10^{-4}$	$7.15 \times 10^{-7}$	$1.55 \times 10^{+1}$
Lead	$3.00 \times 10^{+3}$	$1.90 \times 10^{+1}$	$3.58 \times 10^{-3}$	$1.54 \times 10^{-1}$	$3.63 \times 10^{-4}$	$4.38 \times 10^{-7}$	$1.90 \times 10^{+1}$
Molybdenum	$9.00 \times 10^{+1}$	$5.82 \times 10^{+0}$	$3.65 \times 10^{-2}$	$1.57 \times 10^0$	$3.70 \times 10^{-3}$	$4.47 \times 10^{-6}$	$5.82 \times 10^{+0}$
Nickel	$6.50 \times 10^{+2}$	$1.76 \times 10^{+1}$	$1.53 \times 10^{-2}$	$6.57 \times 10^{-1}$	$1.55 \times 10^{-3}$	$1.87 \times 10^{-6}$	$1.76 \times 10^{+1}$
Vanadium	$1.00 \times 10^{+3}$	$3.36 \times 10^{+1}$	$1.90 \times 10^{-2}$	$8.15 \times 10^{-1}$	$1.93 \times 10^{-3}$	$2.33 \times 10^{-6}$	$3.36 \times 10^{+1}$
Zinc	$2.40 \times 10^{+3}$	$6.13 \times 10^{+1}$	$1.44 \times 10^{-2}$	$6.19 \times 10^{-1}$	$1.46 \times 10^{-3}$	$1.77 \times 10^{-6}$	$6.13 \times 10^{+1}$
<b>ORGANICS</b>							
2-Butanone	$1.19 \times 10^{-2}$	$1.00 \times 10^{-3}$	$5.89 \times 10^{-3}$	$2.53 \times 10^{-1}$	$5.97 \times 10^{-4}$	$7.20 \times 10^{-7}$	$1.24 \times 10^{-4}$
4,4'-DDE	$6.58 \times 10^{+4}$	$1.20 \times 10^{-2}$	$1.03 \times 10^{-7}$	$4.42 \times 10^{-6}$	$1.05 \times 10^{-8}$	$1.26 \times 10^{-11}$	$1.20 \times 10^{-2}$
Acenaphthene	$5.47 \times 10^{+1}$	$1.20 \times 10^{-1}$	$1.24 \times 10^{-3}$	$5.31 \times 10^{-2}$	$1.26 \times 10^{-4}$	$1.52 \times 10^{-7}$	$1.20 \times 10^{-1}$
Acetone	$3.75 \times 10^{-3}$	$5.00 \times 10^{-3}$	$3.22 \times 10^{-2}$	$1.38 \times 10^0$	$3.26 \times 10^{-3}$	$3.94 \times 10^{-6}$	$2.13 \times 10^{-4}$
Anthracene	$1.84 \times 10^{+2}$	$2.30 \times 10^{-1}$	$7.06 \times 10^{-4}$	$3.03 \times 10^{-2}$	$7.16 \times 10^{-5}$	$8.65 \times 10^{-8}$	$2.30 \times 10^{-1}$
Benzo(a)anthracene	$2.63 \times 10^{+3}$	$3.66 \times 10^{-1}$	$7.87 \times 10^{-5}$	$3.38 \times 10^{-3}$	$7.98 \times 10^{-6}$	$9.63 \times 10^{-9}$	$3.66 \times 10^{-1}$
Benzo(a)pyrene	$6.28 \times 10^{+3}$	$3.40 \times 10^{-1}$	$3.06 \times 10^{-5}$	$1.31 \times 10^{-3}$	$3.10 \times 10^{-6}$	$3.75 \times 10^{-9}$	$3.40 \times 10^{-1}$
Benzo(b)fluoranthene	$2.45 \times 10^{+4}$	$7.10 \times 10^{-1}$	$1.64 \times 10^{-5}$	$7.03 \times 10^{-4}$	$1.66 \times 10^{-6}$	$2.01 \times 10^{-9}$	$7.10 \times 10^{-1}$
Benzo(g,h,i)perylene	$2.13 \times 10^{+4}$	$5.00 \times 10^{-1}$	$1.33 \times 10^{-5}$	$5.69 \times 10^{-4}$	$1.35 \times 10^{-6}$	$1.62 \times 10^{-9}$	$5.00 \times 10^{-1}$
Benzo(k)fluoranthene	$4.55 \times 10^{+4}$	$3.85 \times 10^{-1}$	$4.78 \times 10^{-6}$	$2.05 \times 10^{-4}$	$4.85 \times 10^{-7}$	$5.86 \times 10^{-10}$	$3.85 \times 10^{-1}$
Bis-(2-Ethylexyl)phthalate	$1.73 \times 10^{+0}$	$4.80 \times 10^{-2}$	$1.50 \times 10^{-2}$	$6.42 \times 10^{-1}$	$1.52 \times 10^{-3}$	$1.83 \times 10^{-6}$	$4.58 \times 10^{-2}$

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TABLE 5-1  
(Continued)

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_l$ (g)	Runoff Effluent	Concentration in Surface Water (Paddy's Run) during Storm Event	Great Miami River	Concentration in Sediment $C_s$ (mg/kg)
				Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	$C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	
<b>ORGANICS</b> (Continued)							
Bromomethane	$1.02 \times 10^{-1}$	$2.00 \times 10^{-3}$	$6.07 \times 10^{-3}$	$2.61 \times 10^{-1}$	$6.16 \times 10^{-4}$	$7.44 \times 10^{-7}$	$1.10 \times 10^{-3}$
Carbazole	$1.34 \times 10^{+1}$	$7.70 \times 10^{-2}$	$3.23 \times 10^{-3}$	$1.39 \times 10^{-1}$	$3.27 \times 10^{-4}$	$3.95 \times 10^{-7}$	$7.65 \times 10^{-2}$
Chloromethane	$6.25 \times 10^{-3}$	$2.00 \times 10^{-3}$	$1.25 \times 10^{-2}$	$5.37 \times 10^{-1}$	$1.27 \times 10^{-3}$	$1.53 \times 10^{-6}$	$1.38 \times 10^{-4}$
Chrysene	$2.63 \times 10^{+3}$	$4.53 \times 10^{-1}$	$9.74 \times 10^{-5}$	$4.18 \times 10^{-3}$	$9.87 \times 10^{-6}$	$1.19 \times 10^{-8}$	$4.53 \times 10^{-1}$
Di-n-butyl phthalate	$1.04 \times 10^{+3}$	$5.50 \times 10^{-2}$	$2.99 \times 10^{-5}$	$1.28 \times 10^{-3}$	$3.03 \times 10^{-6}$	$3.66 \times 10^{-9}$	$5.50 \times 10^{-2}$
Dibenzo(a,h)anthracene	$6.14 \times 10^{+3}$	$2.00 \times 10^{-1}$	$1.84 \times 10^{-5}$	$7.90 \times 10^{-4}$	$1.87 \times 10^{-6}$	$2.25 \times 10^{-9}$	$2.00 \times 10^{-1}$
Fluoranthene	$1.41 \times 10^{+3}$	$6.91 \times 10^{-1}$	$2.77 \times 10^{-4}$	$1.19 \times 10^{-2}$	$2.81 \times 10^{-5}$	$3.39 \times 10^{-8}$	$6.91 \times 10^{-1}$
Fluorene	$9.87 \times 10^{+1}$	$1.00 \times 10^{-1}$	$5.72 \times 10^{-4}$	$2.46 \times 10^{-2}$	$5.80 \times 10^{-5}$	$7.01 \times 10^{-8}$	$9.99 \times 10^{-2}$
Indeno(1,2,3,cd)pyrene	$3.01 \times 10^{+5}$	$4.80 \times 10^{-1}$	$9.02 \times 10^{-7}$	$3.87 \times 10^{-5}$	$9.14 \times 10^{-8}$	$1.10 \times 10^{-10}$	$4.80 \times 10^{-1}$
Pyrene	$9.93 \times 10^{+2}$	$8.52 \times 10^{-1}$	$4.85 \times 10^{-4}$	$2.08 \times 10^{-2}$	$4.92 \times 10^{-5}$	$5.94 \times 10^{-8}$	$8.52 \times 10^{-1}$
<b>RADIONUCLIDES</b>							
Cesium-137	$1.81 \times 10^{+3}$	$2.97 \times 10^{-9}$	$9.28 \times 10^{-13}$	$3.44 \times 10^{-3}$	$8.14 \times 10^{-6}$	$9.82 \times 10^{-9}$	$2.97 \times 10^{-9}$
Neptunium-237	$5.50 \times 10^{+1}$	$1.69 \times 10^{-3}$	$1.73 \times 10^{-5}$	$5.25 \times 10^{-1}$	$1.24 \times 10^{-3}$	$1.50 \times 10^{-6}$	$1.69 \times 10^{-3}$
Plutonium-238	$1.70 \times 10^{+3}$	$4.51 \times 10^{-8}$	$1.50 \times 10^{-11}$	$1.10 \times 10^{-2}$	$2.60 \times 10^{-5}$	$3.14 \times 10^{-8}$	$4.51 \times 10^{-8}$
Plutonium-239/240	$1.70 \times 10^{+3}$	$1.32 \times 10^{-6}$	$4.39 \times 10^{-10}$	$1.17 \times 10^{-3}$	$2.76 \times 10^{-6}$	$3.34 \times 10^{-9}$	$1.32 \times 10^{-6}$
Radium-226	$6.96 \times 10^{+2}$	$1.41 \times 10^{-6}$	$1.15 \times 10^{-9}$	$4.86 \times 10^{-2}$	$1.15 \times 10^{-4}$	$1.39 \times 10^{-7}$	$1.41 \times 10^{-6}$
Radium-228	$6.96 \times 10^{+2}$	$6.18 \times 10^{-9}$	$5.02 \times 10^{-12}$	$5.85 \times 10^{-2}$	$1.38 \times 10^{-4}$	$1.67 \times 10^{-7}$	$6.18 \times 10^{-9}$
Strontium-90	$1.00 \times 10^{+1}$	$6.97 \times 10^{-9}$	$3.91 \times 10^{-10}$	$2.30 \times 10^{+0}$	$5.43 \times 10^{-3}$	$6.55 \times 10^{-6}$	$6.91 \times 10^{-9}$
Thorium-228	$5.80 \times 10^{+3}$	$1.98 \times 10^{-9}$	$1.93 \times 10^{-13}$	$6.79 \times 10^{-3}$	$1.61 \times 10^{-5}$	$1.94 \times 10^{-8}$	$1.98 \times 10^{-9}$
Thorium-230	$5.80 \times 10^{+3}$	$3.14 \times 10^{-4}$	$3.06 \times 10^{-8}$	$2.71 \times 10^{-2}$	$6.39 \times 10^{-5}$	$7.72 \times 10^{-8}$	$3.14 \times 10^{-4}$
Thorium-232	$5.80 \times 10^{+3}$	$1.37 \times 10^1$	$1.34 \times 10^{-3}$	$6.30 \times 10^{-3}$	$1.49 \times 10^{-5}$	$1.80 \times 10^{-8}$	$1.37 \times 10^{+1}$
Uranium-234	$7.50 \times 10^{+1}$	$6.77 \times 10^{-3}$	$5.10 \times 10^{-5}$	$1.36 \times 10^{+1}$	$3.22 \times 10^{-2}$	$3.88 \times 10^{-4}$	$6.76 \times 10^{-3}$
Uranium-235/236	$7.50 \times 10^{+1}$	$1.31 \times 10^{+0}$	$9.86 \times 10^{-3}$	$9.14 \times 10^{-1}$	$2.16 \times 10^{-3}$	$2.61 \times 10^{-6}$	$1.31 \times 10^{+0}$
Uranium-238	$7.50 \times 10^{+1}$	$2.30 \times 10^{+2}$	$1.73 \times 10^{+0}$	$2.50 \times 10^{+1}$	$5.90 \times 10^{-2}$	$7.12 \times 10^{-5}$	$2.30 \times 10^{+2}$
Uranium-Total (non-RAD)	$7.50 \times 10^{+1}$	$2.25 \times 10^{+2}$	$1.69 \times 10^{+0}$	$7.27 \times 10^{+1}$	$1.72 \times 10^{-1}$	$2.07 \times 10^{-4}$	$2.25 \times 10^{+2}$

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Run and  $6 \times 10^{-6}$   $\mu\text{g/L}$  in the Great Miami River. These concentrations remain only through the duration of the storm.

Modeled sediment concentrations resulting from a single runoff event are comparable to the source term soil concentrations for the Solid Waste Landfill because sediment mixing and desorption in Paddys Run were not considered. For example, the modeled sediment concentration for uranium-238 was 229.7 mg/kg, compared to 230 mg/kg in the soil source term. Sediment concentrations would be expected to decrease following the rainfall event because of dispersion through sediment transport, gradual mixing with sediment from other sources, and leaching of constituents in Paddys Run.

Table 5-2 shows predicted Great Miami Aquifer concentrations due to surface water runoff. Table 5-2 also compares predicted Great Miami Aquifer concentration against the risk-based screening concentrations. As shown in Table 5-2, none of the constituents are above the screening level. Therefore, no constituents were considered for further modeling in the Great Miami Aquifer from the surface water pathway.

5.3.4.2 Lime Sludge Ponds

The Lime Sludge Ponds are contained within soil berms which isolate them from the surrounding soils; therefore, they were not considered a source of contaminants to the surface waters. No surface water pathway modeling was conducted.

5.3.4.3 Inactive Flyash Pile

Table 5-3 presents the results of surface water modeling due to the Inactive Flyash Pile, based upon a designated single storm event using the MUSLE model and loading from seeps in the Inactive Flyash Pile during the storm event. Modeling results show low surface water concentrations in Paddys Run from the Inactive Flyash Pile, usually much less than parts per billion. For radionuclides, concentrations in Paddys Run range from a minimum of a  $2.4 \times 10^{-5}$  pCi/L for cesium-137 to a maximum of 0.66 pCi/L for uranium-238. Concentrations of radionuclides in the Great Miami River range from a low of  $2.8 \times 10^{-8}$  pCi/L for cesium-137 to a high of  $8.0 \times 10^{-4}$  pCi/L for uranium-238. All inorganics and organics were predicted to remain below 0.37  $\mu\text{g/L}$  in Paddys Run and  $4.5 \times 10^{-4}$   $\mu\text{g/L}$  in the Great Miami River. These concentrations remain only through the duration of the storm.

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**TABLE 5-2**  
**LOADING TO THE GREAT MIAMI AQUIFER FROM**  
**PADDY'S RUN AND CPC SCREENING FOR GROUNDWATER MODELING,**  
**SOLID WASTE LANDFILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents	Predicted Maximum Aquifer Concentration $C_{GMA}$ (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	$10^{-7}$ Risk or 0.1 Hazard Index Screening Concentrations (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	Groundwater Modeling Required
<b>INORGANICS</b>			
Arsenic	$1.91 \times 10^{-4}$	$5.00 \times 10^{-3}$	NO
Barium	$4.58 \times 10^{-4}$	$2.60 \times 10^{+2}$	NO
Beryllium	$3.07 \times 10^{-6}$	$2.00 \times 10^{-3}$	NO
Cadmium	$9.71 \times 10^{-6}$	$1.80 \times 10^{-3}$	NO
Chromium	$5.91 \times 10^{-5}$	$1.80 \times 10^{+1}$	NO
Lead	$3.62 \times 10^{-5}$	$1.50 \times 10^0$	NO
Molybdenum	$3.69 \times 10^{-4}$	$1.80 \times 10^{-2}$	NO
Nickel	$1.55 \times 10^{-4}$	$7.30 \times 10^{+1}$	NO
Vanadium	$1.92 \times 10^{-4}$	$2.00 \times 10^{+1}$	NO
Zinc	$1.46 \times 10^{-4}$	$1.10 \times 10^{+3}$	NO
<b>ORGANICS</b>			
2-Butanone	$5.95 \times 10^{-5}$	$2.20 \times 10^{+3}$	NO
4,4'-DDE	$1.04 \times 10^{-9}$	$2.30 \times 10^{-2}$	NO
Acenaphthene	$1.25 \times 10^{-5}$	$2.20 \times 10^{-1}$	NO
Acetone	$3.25 \times 10^{-4}$	$3.70 \times 10^{+2}$	NO
Anthracene	$7.14 \times 10^{-6}$	$1.10 \times 10^{+3}$	NO
Benzo(a)anthracene	$7.95 \times 10^{-7}$	$1.10 \times 10^{-2}$	NO
Benzo(a)pyrene	$3.09 \times 10^{-7}$	$1.10 \times 10^{-3}$	NO
Benzo(b)fluoranthene	$1.66 \times 10^{-7}$	$1.10 \times 10^{-2}$	NO
Benzo(k)fluoranthene	$4.84 \times 10^{-8}$	$1.10 \times 10^{-1}$	NO
Bis-(2-Ethylexy)phthalate	$1.51 \times 10^{-4}$	$4.80 \times 10^{-2}$	NO

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TABLE 5-2  
(Continued)

Constituents	Predicted Maximum Aquifer Concentration $C_{GMA}$ (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	$10^{-7}$ Risk or 0.1 Hazard Index Screening Concentrations (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	Groundwater Modeling Required
<b>ORGANICS (Continued)</b>			
Bromomethane	$6.14 \times 10^{-5}$	$8.70 \times 10^{-1}$	NO
Carbazole	$3.26 \times 10^{-5}$	$4.00 \times 10^{-1}$	NO
Chloromethane	$1.26 \times 10^{-4}$	$1.80 \times 10^{-1}$	NO
Chrysene	$9.84 \times 10^{-7}$	$1.10 \times 10^{+2}$	NO
Di-n-butylphthalate	$3.02 \times 10^{-7}$	$3.70 \times 10^{+2}$	NO
Dibenzo(a,h)anthraene	$1.86 \times 10^{-7}$	$1.10 \times 10^{-3}$	NO
Fluoranthene	$2.80 \times 10^{-6}$	$1.50 \times 10^{+2}$	NO
Fluorene	$5.79 \times 10^{-6}$	$2.20 \times 10^{+2}$	NO
Indeno(1,2,3,cd)pyrene	$9.11 \times 10^{-9}$	$1.10 \times 10^{-2}$	NO
Pyrene	$4.90 \times 10^{-6}$	$1.10 \times 10^{+2}$	NO
<b>RADIONUCLIDES</b>			
Cesium-137	$8.11 \times 10^{-7}$	$1.70 \times 10^{-1}$	NO
Neptunium-237	$1.24 \times 10^{-4}$	$2.20 \times 10^{-2}$	NO
Plutonium-238	$2.59 \times 10^{-6}$	$2.20 \times 10^{-2}$	NO
Plutonium-239/240	$2.76 \times 10^{-5}$	$2.10 \times 10^{+1}$	NO
Radium-226	$1.15 \times 10^{-5}$	$4.00 \times 10^{-2}$	NO
Radium-228	$1.38 \times 10^{-5}$	$4.80 \times 10^{-2}$	NO
Strontium-90	$5.41 \times 10^{-4}$	$1.30 \times 10^{-1}$	NO
Thorium-228	$1.60 \times 10^{-6}$	$8.70 \times 10^{-2}$	NO
Thorium-230	$6.37 \times 10^{-7}$	$3.70 \times 10^{-1}$	NO
Thorium-232	$1.49 \times 10^{-6}$	$4.00 \times 10^{-1}$	NO
Uranium-234	$3.21 \times 10^{-3}$	$3.00 \times 10^{-1}$	NO
Uranium-235/236	$2.15 \times 10^{-5}$	$3.00 \times 10^{-1}$	NO
Uranium-238	$5.88 \times 10^{-3}$	$1.70 \times 10^{-1}$	NO
Uranium-Total (non-RAD)	$1.71 \times 10^{-2}$	$1.00 \times 10^{+1}$	NO

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**TABLE 5-3**  
**LOADING TO SURFACE WATER FROM**  
**THE INACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area		Total Annual Loading to Stream	Runoff Effluent Concentration	Seep Concentration	Concentration in Paddys Run during Storm Event	Great Miami River Concentration	Concentration in Sediment
		Surface Soil $C_i$ (mg/kg)	TI (g)	Ce (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	(pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Cw (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Cgmr (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Cs (mg/kg)	
<b>INORGANICS</b>									
Arsenic	$2.00 \times 10^{+2}$	$3.32 \times 10^{+1}$	$1.14 \times 10^{-1}$	$3.92 \times 10^{+0}$	$1.40 \times 10^{+0}$	$1.31 \times 10^{-2}$	$1.59 \times 10^{-5}$	$3.32 \times 10^{+1}$	
Barium	$2.00 \times 10^{+1}$	$8.57 \times 10^{+1}$	$2.92 \times 10^{+0}$	$1.00 \times 10^{+2}$	$6.61 \times 10^{+1}$	$3.70 \times 10^{-1}$	$4.47 \times 10^{-4}$	$8.50 \times 10^{+1}$	
Beryllium	$2.50 \times 10^{+2}$	$2.27 \times 10^{+0}$	$6.24 \times 10^{-3}$	$2.14 \times 10^{-1}$	ND	$6.32 \times 10^{-4}$	$7.64 \times 10^{-7}$	$2.27 \times 10^{+0}$	
Cadmium	$1.20 \times 10^{+1}$	$3.10 \times 10^{+0}$	$1.75 \times 10^{-1}$	$6.02 \times 10^{+0}$	$1.60 \times 10^{+0}$	$1.95 \times 10^{-2}$	$2.36 \times 10^{-5}$	$3.06 \times 10^{+0}$	
Chromium	$7.00 \times 10^{+1}$	$1.14 \times 10^{+1}$	$1.12 \times 10^{-1}$	$3.84 \times 10^{+0}$	ND	$1.13 \times 10^{-2}$	$1.37 \times 10^{-5}$	$1.14 \times 10^{+1}$	
Copper	$3.50 \times 10^{+1}$	$3.40 \times 10^{+1}$	$6.65 \times 10^{-1}$	$2.28 \times 10^{+1}$	ND	$6.74 \times 10^{-2}$	$8.14 \times 10^{-5}$	$3.38 \times 10^{+1}$	
Lead	$3.80 \times 10^{+1}$	$2.39 \times 10^{+1}$	$4.31 \times 10^{-1}$	$1.48 \times 10^{+1}$	$8.30 \times 10^{+0}$	$5.29 \times 10^{-2}$	$6.40 \times 10^{-5}$	$2.38 \times 10^{+1}$	
Manganese	NA	NA	NA	NA	$4.62 \times 10^{+1}$	$5.15 \times 10^{-2}$	$6.23 \times 10^{-5}$	NA	
Mercury	NA	NA	NA	NA	$8.00 \times 10^{-1}$	$8.91 \times 10^{-4}$	$1.08 \times 10^{-6}$	NA	
Molybdenum	$1.00 \times 10^{+1}$	$7.20 \times 10^{+0}$	$4.87 \times 10^{-1}$	$1.67 \times 10^{+1}$	ND	$4.93 \times 10^{-2}$	$5.96 \times 10^{-5}$	$7.08 \times 10^{+0}$	
Nickel	NA	NA	NA	NA	$8.00 \times 10^{+0}$	$8.91 \times 10^{-3}$	$1.08 \times 10^{-5}$	NA	
Selebium	NA	NA	NA	NA	$4.00 \times 10^{+0}$	$4.46 \times 10^{-3}$	$5.39 \times 10^{-6}$	NA	
Silver	$9.00 \times 10^{+1}$	$4.39 \times 10^{+0}$	$3.35 \times 10^{-2}$	$1.15 \times 10^{+0}$	ND	$3.39 \times 10^{-3}$	$4.10 \times 10^{-6}$	$4.38 \times 10^{+0}$	
<b>ORGANICS</b>									
2-Butanone	$3.29 \times 10^{-3}$	$3.00 \times 10^{-3}$	$1.16 \times 10^{-2}$	$3.99 \times 10^{-1}$	ND	$1.18 \times 10^{-3}$	$1.42 \times 10^{-6}$	$5.56 \times 10^{-5}$	
Acenaphthylene	$1.51 \times 10^{+1}$	$4.60 \times 10^{-1}$	$2.07 \times 10^{-2}$	$7.11 \times 10^{-1}$	ND	$2.10 \times 10^{-3}$	$2.54 \times 10^{-6}$	$4.55 \times 10^{-1}$	
Acetone	$1.04 \times 10^{-3}$	$1.20 \times 10^{-2}$	$4.71 \times 10^{-2}$	$1.62 \times 10^{+0}$	ND	$4.77 \times 10^{-3}$	$5.76 \times 10^{-6}$	$7.12 \times 10^{-5}$	
Anthracene	$5.10 \times 10^{+1}$	$1.70 \times 10^{+0}$	$2.28 \times 10^{-2}$	$7.85 \times 10^{-1}$	ND	$2.32 \times 10^{-3}$	$2.80 \times 10^{-6}$	$1.69 \times 10^{+0}$	
bis(2-Ethylhexyl)phthalate	NA	NA	NA	NA	$1.00 \times 10^{+0}$	$1.11 \times 10^{-3}$	$1.35 \times 10^{-6}$	NA	

See footnotes at end of table

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TABLE 5-3  
(Continued)

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_l$ (g)	Runoff Effluent Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Seep Concentration (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in		
						Paddys Run during Storm Event $C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Great Miami River Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Sediment $C_s$ (mg/kg)
<b>ORGANICS (Continued)</b>								
Carbazole	$3.55 \times 10^{+0}$	$5.10 \times 10^{-1}$	$9.42 \times 10^{-2}$	$3.24 \times 10^{+0}$	ND	$9.54 \times 10^{-3}$	$1.15 \times 10^{-5}$	$4.86 \times 10^{-1}$
Dibenzo(a,h)anthracene	$1.70 \times 10^{+3}$	$2.20 \times 10^{+0}$	$8.90 \times 10^{-4}$	$3.06 \times 10^{-2}$	ND	$9.02 \times 10^{-5}$	$1.09 \times 10^{-7}$	$2.20 \times 10^{+0}$
Fluorene	$2.73 \times 10^{+1}$	$5.10 \times 10^{-1}$	$1.28 \times 10^{-2}$	$4.39 \times 10^{-1}$	ND	$1.29 \times 10^{-3}$	$1.56 \times 10^{-6}$	$5.07 \times 10^{-1}$
Naphthalene	$4.19 \times 10^{+0}$	$1.00 \times 10^{-1}$	$1.58 \times 10^{-2}$	$5.41 \times 10^{-1}$	ND	$1.60 \times 10^{-3}$	$1.93 \times 10^{-6}$	$9.60 \times 10^{-2}$
Toluene	$8.92 \times 10^{-1}$	$5.50 \times 10^{-2}$	$3.55 \times 10^{-2}$	$1.22 \times 10^{+0}$	$2.00 \times 10^{+0}$	$5.82 \times 10^{-3}$	$7.05 \times 10^{-6}$	$4.60 \times 10^{-2}$
<b>RADIONUCLIDES</b>								
Cesium-137	$1.37 \times 10^{+3}$	$5.34 \times 10^{-9}$	$2.68 \times 10^{-12}$	$7.97 \times 10^{-3}$	ND	$2.35 \times 10^{-5}$	$2.84 \times 10^{-8}$	$5.34 \times 10^{-9}$
Neptunium-237	$5.00 \times 10^{+0}$	$1.13 \times 10^{-3}$	$1.50 \times 10^{-4}$	$3.64 \times 10^{+0}$	$7.90 \times 10^{-1}$	$1.16 \times 10^{-2}$	$1.41 \times 10^{-5}$	$1.09 \times 10^{-3}$
Plutonium-238	$1.00 \times 10^{+2}$	$4.74 \times 10^{-9}$	$3.25 \times 10^{-11}$	$1.91 \times 10^{-2}$	$2.91 \times 10^{+0}$	$3.30 \times 10^{-3}$	$3.99 \times 10^{-6}$	$4.73 \times 10^{-9}$
Plutonium-239/240	$1.00 \times 10^{+2}$	$3.38 \times 10^{-7}$	$2.32 \times 10^{-9}$	$4.95 \times 10^{-3}$	$2.00 \times 10^{-1}$	$2.37 \times 10^{-4}$	$2.87 \times 10^{-7}$	$3.37 \times 10^{-7}$
Radium-226	$1.06 \times 10^{+2}$	$2.00 \times 10^{-6}$	$1.30 \times 10^{-8}$	$4.40 \times 10^{-1}$	$1.48 \times 10^{-1}$	$1.46 \times 10^{-3}$	$1.77 \times 10^{-6}$	$2.00 \times 10^{-6}$
Radium-228	$1.06 \times 10^{+2}$	$8.24 \times 10^{-9}$	$5.34 \times 10^{-11}$	$4.99 \times 10^{-1}$	ND	$1.47 \times 10^{-3}$	$1.78 \times 10^{-6}$	$8.23 \times 10^{-9}$
Strontium-90	$1.06 \times 10^{+2}$	$6.35 \times 10^{-9}$	$4.11 \times 10^{-11}$	$1.94 \times 10^{-1}$	ND	$5.71 \times 10^{-4}$	$6.90 \times 10^{-7}$	$6.34 \times 10^{-9}$
Thorium-228	$3.20 \times 10^{+3}$	$3.30 \times 10^{-9}$	$7.09 \times 10^{-13}$	$2.00 \times 10^{-2}$	ND	$5.89 \times 10^{-5}$	$7.12 \times 10^{-8}$	$3.30 \times 10^{-9}$
Thorium-230	$3.20 \times 10^{+3}$	$1.34 \times 10^{-4}$	$2.88 \times 10^{-8}$	$2.04 \times 10^{-2}$	$6.53 \times 10^{-1}$	$7.87 \times 10^{-4}$	$9.53 \times 10^{-7}$	$1.34 \times 10^{-4}$
Thorium-232	$3.20 \times 10^{+3}$	$2.12 \times 10^{+1}$	$4.56 \times 10^{-3}$	$1.72 \times 10^{-2}$	ND	$5.08 \times 10^{-5}$	$6.13 \times 10^{-8}$	$2.12 \times 10^{+1}$
Uranium-234	$1.48 \times 10^{+0}$	$1.39 \times 10^{-3}$	$5.78 \times 10^{-4}$	$1.24 \times 10^{+2}$	$2.65 \times 10^{+2}$	$6.59 \times 10^{-1}$	$7.98 \times 10^{-4}$	$1.24 \times 10^{-3}$
Uranium-235/236	$1.48 \times 10^{+0}$	$1.94 \times 10^{-1}$	$8.07 \times 10^{-2}$	$5.98 \times 10^0$	$1.40 \times 10^{+1}$	$3.32 \times 10^{-2}$	$4.02 \times 10^{-5}$	$1.74 \times 10^{-1}$
Uranium-238	$1.48 \times 10^{+0}$	$2.64 \times 10^{+1}$	$1.10 \times 10^{+1}$	$1.27 \times 10^{+2}$	$2.57 \times 10^{+2}$	$6.60 \times 10^{-1}$	$7.99 \times 10^{-4}$	$2.36 \times 10^{+1}$
Uranium-Total (non-RAD)	$1.48 \times 10^{+0}$	$2.62 \times 10^{+1}$	$1.09 \times 10^{+1}$	$3.74 \times 10^{+2}$	$8.20 \times 10^{+2}$	$2.02 \times 10^{+0}$	$2.44 \times 10^{-3}$	$2.34 \times 10^{+1}$

NA = Not applicable as this constituent was not a constituent of concern for surface soils (see Appendix B).  
ND = Not detected

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Modeled sediment concentrations resulting from a single runoff event are comparable to the source term soil concentrations for the Inactive Flyash Pile because sediment mixing and desorption in Paddys Run were not considered. For example, the modeled uranium-238 sediment concentration was 23.6 mg/kg, compared to 26.4 mg/kg in the surface soil source term. Sediment concentrations would be expected to decrease following the rainfall event because of dispersion through sediment transport, gradual mixing with sediment from other sources, and leaching of constituents in Paddys Run.

Loading from surface runoff to the Great Miami Aquifer from Inactive Flyash Pile and the South Field was combined into one source term because of close proximity of the Inactive Flyash to the South Field and surface runoff from both subunits arriving into Paddys Run at approximately the same location. Contaminant loadings to the Great Miami Aquifer due to surface runoff from the Inactive Flyash and South Field are discussed in Section 5.3.4.4.

5.3.4.4 South Field

Table 5-4 presents the results of surface water modeling from the South Field based on a designated single storm event using the MUSLE model and loading from seeps in the South Field during the storm event. Modeling results showed low surface water concentrations in Paddys Run from the South Field, usually much less than parts per billion. For radionuclides, concentrations in Paddys Run range from a low of  $1.7 \times 10^{-4}$  pCi/L for cesium-137 to a high of 412 pCi/L for technetium-99. Concentrations of radionuclides in the Great Miami River ranged from  $2.1 \times 10^{-7}$  pCi/L for cesium-137 to 0.51 pCi/L for technetium-99. Modeled uranium-238 concentrations were 3.7 pCi/L and  $4.5 \times 10^{-3}$  pCi/L for Paddys Run and the Great Miami River, respectively. All inorganics were predicted to be below 2.4  $\mu\text{g/L}$  in Paddys Run and below  $2.9 \times 10^3 \mu\text{g/L}$  in the Great Miami River. All organics were predicted to be below 0.56  $\mu\text{g/L}$  and  $6.9 \times 10^{-4} \mu\text{g/L}$  in Paddys Run and the Great Miami River, respectively. These concentrations remain only through the duration of the storm.

Modeled sediment concentrations resulting from a single runoff event are comparable to the source term soil concentrations for the South Field because sediment mixing and desorption in Paddys Run were not considered. For example, the modeled uranium-238 sediment concentration was 26.1 mg/kg, compared to 27.7 mg/kg in the soil source term. Sediment concentrations would be expected to decrease following the rainfall event because of dispersion through sediment transport, gradual mixing with sediment from other sources, and leaching of constituents in Paddys Run.

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TABLE 5-4

**LOADING TO SURFACE WATER FROM  
THE SOUTH FIELD  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil Ci (mg/kg)	Total Annual Loading to Stream Tl (g)	Runoff Effluent Concentration Ce (pCi/L RAD) ( $\mu$ g/L non-RAD)	Seep Concentration (pCi/L RAD) ( $\mu$ g/L non-RAD)	Concentration in Paddys Run during Storm Event Cw (pCi/L RAD) ( $\mu$ g/L non-RAD)	Great Miami River	
							Concentration Cgmr (pCi/L RAD) ( $\mu$ g/L non-RAD)	Concentration in Sediment Cs (mg/kg)
<b>INORGANICS</b>								
Antimony	$4.50 \times 10^{+1}$	$1.90 \times 10^{+0}$	$1.97 \times 10^{-1}$	$1.02 \times 10^{-0}$	ND	$1.96 \times 10^{-2}$	$2.41 \times 10^{-5}$	$1.90 \times 10^{+0}$
Arsenic	$2.00 \times 10^{+2}$	$7.27 \times 10^{+0}$	$1.70 \times 10^{-1}$	$8.81 \times 10^{-1}$	ND	$1.69 \times 10^{-2}$	$2.08 \times 10^{-5}$	$7.27 \times 10^{+0}$
Barium	$2.00 \times 10^{+1}$	$9.08 \times 10^{+1}$	$2.11 \times 10^{+1}$	$1.10 \times 10^{+2}$	$5.44 \times 10^{+1}$	$2.41 \times 10^{+0}$	$2.91 \times 10^{-3}$	$9.04 \times 10^{+1}$
Beryllium	$2.50 \times 10^{+2}$	$9.42 \times 10^{-1}$	$1.76 \times 10^{+2}$	$9.14 \times 10^{-2}$	ND	$1.75 \times 10^{-3}$	$2.15 \times 10^{-6}$	$9.42 \times 10^{-1}$
Chromium	$7.00 \times 10^{+1}$	$1.39 \times 10^{+1}$	$9.26 \times 10^{-1}$	$4.81 \times 10^{+0}$	ND	$9.23 \times 10^{-2}$	$1.13 \times 10^{-4}$	$1.39 \times 10^{+1}$
Copper	$3.50 \times 10^{+1}$	$1.66 \times 10^{+1}$	$2.21 \times 10^{+0}$	$1.15 \times 10^{+1}$	ND	$2.20 \times 10^{-1}$	$2.70 \times 10^{-4}$	$1.66 \times 10^{+1}$
Lead	$3.80 \times 10^{+1}$	$2.46 \times 10^{+1}$	$3.02 \times 10^{+0}$	$1.57 \times 10^{+1}$	ND	$3.01 \times 10^{-1}$	$3.69 \times 10^{-4}$	$2.45 \times 10^{+1}$
Molybdenum	$1.00 \times 10^{+1}$	$6.20 \times 10^{+0}$	$2.87 \times 10^{+0}$	$1.49 \times 10^{+1}$	ND	$2.86 \times 10^{-1}$	$3.51 \times 10^{-4}$	$6.14 \times 10^{+0}$
Nickel	$4.00 \times 10^{+2}$	$1.71 \times 10^{+1}$	$2.00 \times 10^{-1}$	$1.04 \times 10^{+0}$	ND	$1.99 \times 10^{-2}$	$2.44 \times 10^{-5}$	$1.71 \times 10^{+1}$
Silver	$9.00 \times 10^{+1}$	$5.38 \times 10^{+0}$	$2.79 \times 10^{-1}$	$1.45 \times 10^{+0}$	ND	$2.78 \times 10^{-2}$	$3.41 \times 10^{-5}$	$5.38 \times 10^{+0}$
Vanadium	$2.00 \times 10^{+2}$	$2.66 \times 10^{+1}$	$6.21 \times 10^{-1}$	$3.22 \times 10^{+0}$	ND	$6.19 \times 10^{-2}$	$7.60 \times 10^{-5}$	$2.66 \times 10^{+1}$
Zinc	$2.00 \times 10^{+2}$	$5.27 \times 10^{+1}$	$1.23 \times 10^{+0}$	$6.39 \times 10^{+0}$	ND	$1.23 \times 10^{-1}$	$1.51 \times 10^{-4}$	$5.27 \times 10^{+1}$
<b>ORGANICS</b>								
Aroclor-1254	$1.95 \times 10^{+3}$	$8.90 \times 10^{-2}$	$2.13 \times 10^{-4}$	$1.11 \times 10^{-3}$	ND	$2.13 \times 10^{-5}$	$2.61 \times 10^{-8}$	$8.90 \times 10^{-2}$
Aroclor-1260	$2.35 \times 10^{+3}$	$5.20 \times 10^{-2}$	$1.03 \times 10^{-4}$	$5.37 \times 10^{-4}$	ND	$1.03 \times 10^{-5}$	$1.27 \times 10^{-8}$	$5.20 \times 10^{-2}$
Dieldrin	$5.75 \times 10^{+0}$	$1.00 \times 10^{-2}$	$8.00 \times 10^{-3}$	$4.15 \times 10^{-2}$	ND	$7.97 \times 10^{-4}$	$9.79 \times 10^{-7}$	$9.85 \times 10^{-3}$
Acenaphthylene	$1.51 \times 10^{+1}$	$1.40 \times 10^{-1}$	$4.30 \times 10^{-2}$	$2.24 \times 10^{-1}$	ND	$4.29 \times 10^{-3}$	$5.27 \times 10^{-6}$	$1.39 \times 10^{-1}$
Anthracene	$5.10 \times 10^{+1}$	$7.30 \times 10^{-1}$	$6.67 \times 10^{-2}$	$3.47 \times 10^{-1}$	ND	$6.65 \times 10^{-3}$	$8.17 \times 10^{-6}$	$7.29 \times 10^{-1}$
Benzo(a)anthracene	$7.28 \times 10^{+2}$	$5.50 \times 10^{+0}$	$3.53 \times 10^{-2}$	$1.83 \times 10^{-1}$	ND	$3.52 \times 10^{-3}$	$4.32 \times 10^{-6}$	$5.50 \times 10^{+0}$

See footnote at end of table

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**TABLE 5-4  
(Continued)**

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_l$ (g)	Runoff Effluent Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Seep Concentration (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Paddys Run during Storm Event $C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Great Miami River	
							Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Sediment $C_s$ (mg/kg)
<b>ORGANICS (Continued)</b>								
Benzo(a)pyrene	$1.74 \times 10^{+3}$	$9.40 \times 10^{+0}$	$2.52 \times 10^{-2}$	$1.31 \times 10^{-1}$	ND	$2.52 \times 10^{-3}$	$3.09 \times 10^{-6}$	$9.40 \times 10^{+0}$
Benzo(b)fluoranthene	$6.77 \times 10^{+3}$	$6.20 \times 10^{+0}$	$4.28 \times 10^{-3}$	$2.22 \times 10^{-2}$	ND	$4.26 \times 10^{-4}$	$5.24 \times 10^{-7}$	$6.20 \times 10^{+0}$
Benzo(k)fluoranthene	$1.26 \times 10^{+4}$	$7.30 \times 10^{+0}$	$2.71 \times 10^{-3}$	$1.41 \times 10^{-2}$	ND	$2.70 \times 10^{-4}$	$3.31 \times 10^{-7}$	$7.30 \times 10^{+0}$
Benzoic Acid	$1.35 \times 10^{-1}$	$2.70 \times 10^{-1}$	$5.59 \times 10^{+0}$	$2.90 \times 10^{+1}$	ND	$5.57 \times 10^{-1}$	$6.85 \times 10^{-4}$	$1.62 \times 10^{-1}$
Carbazole	$3.55 \times 10^{+0}$	$1.70 \times 10^{-1}$	$2.18 \times 10^{-1}$	$1.13 \times 10^{+0}$	ND	$2.17 \times 10^{-2}$	$2.67 \times 10^{-5}$	$1.66 \times 10^{-1}$
Chrysene	$7.28 \times 10^{+2}$	$6.00 \times 10^{+0}$	$3.85 \times 10^{-2}$	$2.00 \times 10^{-1}$	ND	$3.84 \times 10^{-3}$	$4.71 \times 10^{-6}$	$6.00 \times 10^{+0}$
Dibenzo(a,h)anthracene	$1.70 \times 10^{+3}$	$1.90 \times 10^{+0}$	$5.22 \times 10^{-3}$	$2.71 \times 10^{-2}$	ND	$5.20 \times 10^{-4}$	$6.39 \times 10^{-7}$	$1.90 \times 10^{+0}$
Dimethyl phthalate	$2.40 \times 10^{-1}$	$6.20 \times 10^{-2}$	$8.76 \times 10^{-1}$	$4.55 \times 10^{+0}$	ND	$8.73 \times 10^{-2}$	$1.07 \times 10^{-4}$	$4.50 \times 10^{-2}$
Fluoranthene	$3.89 \times 10^{+2}$	$1.85 \times 10^{+0}$	$2.22 \times 10^{-2}$	$1.15 \times 10^{-1}$	ND	$2.21 \times 10^{-3}$	$2.72 \times 10^{-6}$	$1.85 \times 10^{+0}$
Fluorene	$2.73 \times 10^{+1}$	$2.20 \times 10^{-1}$	$3.75 \times 10^{-2}$	$1.95 \times 10^{-1}$	ND	$3.74 \times 10^{-3}$	$4.59 \times 10^{-6}$	$2.19 \times 10^{-1}$
Indeno(1,2,3-cd)pyrene	$8.32 \times 10^{+4}$	$6.00 \times 10^{+0}$	$3.37 \times 10^{-4}$	$1.75 \times 10^{-3}$	ND	$3.36 \times 10^{-5}$	$4.12 \times 10^{-8}$	$6.00 \times 10^{+0}$
Pyrene	$2.75 \times 10^{+2}$	$8.20 \times 10^{+0}$	$1.39 \times 10^{-1}$	$7.23 \times 10^{-1}$	ND	$1.39 \times 10^{-2}$	$1.70 \times 10^{-5}$	$8.20 \times 10^{+0}$
bis(2-Ethylhexyl)phthalate	$1.73 \times 10^{+0}$	$1.10 \times 10^{-1}$	$2.82 \times 10^{-1}$	$1.47 \times 10^{+0}$	ND	$2.81 \times 10^{-2}$	$3.45 \times 10^{-5}$	$1.05 \times 10^{-1}$
Acetone	$1.04 \times 10^{-3}$	$6.80 \times 10^{-2}$	$3.47 \times 10^{+0}$	$1.80 \times 10^{+1}$	ND	$3.46 \times 10^{-1}$	$4.25 \times 10^{-4}$	$7.73 \times 10^{-4}$
Methylene chloride	$3.24 \times 10^{-2}$	$5.00 \times 10^{-3}$	$1.90 \times 10^{-1}$	$9.87 \times 10^{-1}$	ND	$1.89 \times 10^{-2}$	$2.33 \times 10^{-5}$	$1.32 \times 10^{-3}$
<b>RADIONUCLIDES</b>								
Cesium-137	$1.37 \times 10^{+3}$	$5.77 \times 10^{-9}$	$1.97 \times 10^{-11}$	$8.84 \times 10^{-3}$	ND	$1.70 \times 10^{-4}$	$2.08 \times 10^{-7}$	$5.77 \times 10^{-9}$
Neptunium-237	$5.00 \times 10^{+0}$	$3.23 \times 10^{-4}$	$2.96 \times 10^{-4}$	$1.09 \times 10^{+0}$	ND	$2.08 \times 10^{-2}$	$2.56 \times 10^{-5}$	$3.17 \times 10^{-4}$
Plutonium-238	$1.00 \times 10^{+2}$	$7.02 \times 10^{-9}$	$3.28 \times 10^{-10}$	$2.91 \times 10^{-2}$	ND	$5.58 \times 10^{-4}$	$6.86 \times 10^{-7}$	$7.01 \times 10^{-9}$
Plutonium-239/240	$1.00 \times 10^{+2}$	$8.21 \times 10^{-7}$	$3.83 \times 10^{-8}$	$1.24 \times 10^{-2}$	ND	$2.37 \times 10^{-4}$	$2.91 \times 10^{-7}$	$8.20 \times 10^{-7}$
Radium-226	$1.06 \times 10^{+2}$	$3.11 \times 10^{-5}$	$1.37 \times 10^{-6}$	$7.03 \times 10^{+0}$	ND	$1.35 \times 10^{-1}$	$1.66 \times 10^{-4}$	$3.11 \times 10^{-5}$
Radium-228	$1.06 \times 10^{+2}$	$1.43 \times 10^{-8}$	$6.30 \times 10^{-10}$	$8.89 \times 10^{-1}$	ND	$1.71 \times 10^{-2}$	$2.10 \times 10^{-5}$	$1.43 \times 10^{-8}$

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See footnote at end of table

TABLE 5-4  
(Continued)

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_l$ (g)	Runoff Effluent Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Seep Concentration (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Paddys Run during Storm Event $C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Great Miami River	
							Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Sediment $C_s$ (mg/kg)
<b>RADIONUCLIDES</b>								
<b>(Continued)</b>								
Strontium-90	$2.50 \times 10^{+0}$	$7.30 \times 10^{-9}$	$1.32 \times 10^{-8}$	$9.36 \times 10^{+0}$	ND	$1.80 \times 10^{-1}$	$2.21 \times 10^{-4}$	$7.05 \times 10^{-9}$
Technetium-99	$7.00 \times 10^{-2}$	$8.35 \times 10^{-3}$	$2.43 \times 10^{-1}$	$2.15 \times 10^{+4}$	ND	$4.12 \times 10^{+2}$	$5.06 \times 10^{-1}$	$3.64 \times 10^{-3}$
Thorium-228	$3.20 \times 10^{+3}$	$5.38 \times 10^{-9}$	$7.85 \times 10^{-12}$	$3.34 \times 10^{-2}$	ND	$6.42 \times 10^{-4}$	$7.88 \times 10^{-7}$	$5.38 \times 10^{-9}$
Thorium-230	$3.20 \times 10^{+3}$	$6.70 \times 10^{-4}$	$9.78 \times 10^{-7}$	$1.05 \times 10^{-1}$	ND	$2.01 \times 10^{-3}$	$2.47 \times 10^{-6}$	$6.70 \times 10^{-4}$
Thorium-232	$3.20 \times 10^{+3}$	$3.63 \times 10^{+1}$	$5.30 \times 10^{-2}$	$3.03 \times 10^{-2}$	ND	$5.81 \times 10^{-4}$	$7.13 \times 10^{-7}$	$3.63 \times 10^{+1}$
Uranium-234	$1.48 \times 10^{+0}$	$1.39 \times 10^{-3}$	$4.13 \times 10^{-3}$	$1.34 \times 10^{+2}$	$1.59 \times 10^{+2}$	$3.44 \times 10^{+0}$	$4.17 \times 10^{-3}$	$1.31 \times 10^{-3}$
Uranium-235/236	$1.48 \times 10^{+0}$	$1.94 \times 10^{-1}$	$5.77 \times 10^{-1}$	$6.47 \times 10^{+0}$	$7.47 \times 10^{+0}$	$1.66 \times 10^{-1}$	$2.00 \times 10^{-4}$	$1.83 \times 10^{-1}$
Uranium-238	$1.48 \times 10^{+0}$	$2.77 \times 10^{+1}$	$8.24 \times 10^{+1}$	$1.44 \times 10^{+2}$	$1.74 \times 10^{+2}$	$3.72 \times 10^{+0}$	$4.51 \times 10^{-3}$	$2.61 \times 10^{+1}$
Uranium-Total (non-RAD)	$1.48 \times 10^{+0}$	$2.96 \times 10^{+1}$	$8.80 \times 10^{+1}$	$4.57 \times 10^{+2}$	$4.87 \times 10^{+2}$	$1.15 \times 10^{+1}$	$1.39 \times 10^{-2}$	$2.79 \times 10^{+1}$

ND = Not detected

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Table 5-5 shows the predicted Great Miami Aquifer concentrations due to surface water runoff from the Inactive Flyash Pile and South Field. The loading to the Great Miami Aquifer consists of a loading from surface water as well as leaching of sediments. Table 5-5 also compares predicted Great Miami Aquifer concentrations against the risk-based screening concentrations. As shown in Table 5-5, only technetium-99 and uranium isotopes were above the screening levels. The second screening step was not performed since technetium-99 and uranium isotopes were also above screening concentrations from other pathways. A source term loading from the surface water runoff to the Great Miami Aquifer for technetium-99 and uranium isotopes were identified for further groundwater modeling.

5.3.4.5 Active Flyash Pile

Table 5-6 presents the results of surface water modeling from the Active Flyash Pile based on a single storm event using the MUSLE model. The model shows that the mass of constituents that partitions into the water would result in maximum surface water concentrations of 300 µg/L in the Storm Sewer Outfall Ditch (Table 5-6). No dilution of runoff concentration was assumed in the Storm Sewer Outfall Ditch. This is a very conservative assumption, since during the storm event, it is likely that runoff from the east side of the Storm Sewer Outfall Ditch and upgradient of the Active Flyash Pile will also drain into the Storm Sewer Outfall Ditch. The amount of runoff contribution to the Storm Sewer Outfall Ditch from the east side of the Storm Sewer Outfall Ditch is estimated to be the same order of magnitude as the runoff from the Active Flyash Pile. However, for modeling purposes, flow from the east side of Storm Sewer Outfall Ditch during storm event was assumed to be zero. Although most of flow in the Storm Sewer Outfall Ditch infiltrates to the Great Miami Aquifer, it was assumed that 44 percent of the flow reaches Paddys Run.

The predicted concentrations of radionuclides from the Active Flyash Pile into the Storm Sewer Outfall Ditch ranged from 2.0 x 10<sup>-2</sup> µg/L for thorium-232 to 51.4 Pci/L for uranium-234. The only organic above parameter screening concentrations for the surface soil was toluene. The predicted concentration of toluene in the Storm Sewer Outfall Ditch was 2.2 µg/L. For inorganic parameters, the predicted concentrations in the Storm Sewer Outfall Ditch ranged from 4.3 x 10<sup>-2</sup> µg/L for thallium to 297 µg/L for barium.

The predicted concentrations of radionuclides in the Paddys Run range from 2.5 x 10<sup>-4</sup> Pci/L for thorium-232 to 0.64 pCi/L for uranium-234 or uranium-238. Radionuclide concentrations in the

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**TABLE 5-5**  
**LOADING TO THE GREAT MIAMI AQUIFER FROM**  
**PADDY'S RUN AND CPC SCREENING (FIRST STEP) FOR GROUNDWATER MODELING,**  
**INACTIVE FLYASH PILE/SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents	Predicted Maximum Aquifer Concentration C <sub>GMA</sub> (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard	
		Index Screening Concentrations (pCi/L RAD) (μg/L non-RAD)	Groundwater Modeling Required
<b>INORGANICS</b>			
Antimony	5.47 x 10 <sup>-3</sup>	1.50 x 10 <sup>0</sup>	No
Arsenic	7.90 x 10 <sup>-3</sup>	5.00 x 10 <sup>-3</sup>	No
Barium	6.68 x 10 <sup>-1</sup>	2.60 x 10 <sup>+2</sup>	No
Beryllium	6.63 x 10 <sup>-4</sup>	2.00 x 10 <sup>-3</sup>	No
Cadmium	4.89 x 10 <sup>-3</sup>	1.80 x 10 <sup>+0</sup>	No
Chromium	2.89 x 10 <sup>-2</sup>	1.80 x 10 <sup>+1</sup>	No
Copper	8.00 x 10 <sup>-2</sup>	1.40 x 10 <sup>+2</sup>	No
Lead	9.59 x 10 <sup>-2</sup>	1.50 x 10 <sup>0</sup>	No
Molybdenum	9.34 x 10 <sup>-2</sup>	1.80 x 10 <sup>+1</sup>	No
Nickel	5.55 x 10 <sup>-3</sup>	7.30 x 10 <sup>+1</sup>	No
Silver	8.69 x 10 <sup>-3</sup>	1.80 x 10 <sup>+1</sup>	No
Vanadium	1.73 x 10 <sup>-2</sup>	2.00 x 10 <sup>+1</sup>	No
Zinc	3.42 x 10 <sup>-2</sup>	1.10 x 10 <sup>+3</sup>	No
<b>ORGANICS</b>			
2-Butanone	3.25 x 10 <sup>-4</sup>	2.20 x 10 <sup>+3</sup>	No
Acenaphthene	1.78 x 10 <sup>-3</sup>	2.20 x 10 <sup>+2</sup>	No
Acetone	9.78 x 10 <sup>-2</sup>	3.70 x 10 <sup>+2</sup>	No
Anthracene	2.49 x 10 <sup>-3</sup>	1.10 x 10 <sup>+3</sup>	No
Aroclor-1254	5.93 x 10 <sup>-6</sup>	1.00 x 10 <sup>-3</sup>	No
Aroclor-1260	2.87 x 10 <sup>-6</sup>	1.00 x 10 <sup>-3</sup>	No
Benzo(a)anthracene	9.81 x 10 <sup>-4</sup>	1.10 x 10 <sup>-2</sup>	No
Benzo(a)pyrene	7.01 x 10 <sup>-4</sup>	1.10 x 10 <sup>-3</sup>	No
Benzo(b)fluoranthene	1.19 x 10 <sup>-4</sup>	1.10 x 10 <sup>-2</sup>	No
Benzo(k)fluoranthene	7.52 x 10 <sup>-5</sup>	1.10 x 10 <sup>-1</sup>	No
Benzoic Acid	1.55 x 10 <sup>-1</sup>	1.50 x 10 <sup>+4</sup>	No
Bis(2-Ethylhexyl) phthalate	7.85 x 10 <sup>-3</sup>	5.70 x 10 <sup>-1</sup>	No
Carbazole	8.69 x 10 <sup>-3</sup>	4.00 x 10 <sup>-1</sup>	No

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**TABLE 5-5  
(Continued)**

Constituents	Predicted Maximum Aquifer Concentration $C_{GMA}$ (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard	
		Index Screening Concentrations (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	Groundwater Modeling Required
<b>ORGANICS (Continued)</b>			
Chrysene	$1.07 \times 10^{-3}$	$1.10 \times 10^{+2}$	No
Dibenzo(a,h)anthracene	$1.70 \times 10^{-4}$	$1.10 \times 10^{-3}$	No
Dieldrin	$2.22 \times 10^{-4}$	$5.00 \times 10^{-4}$	No
Dimethyl phthalate	$2.44 \times 10^{-2}$	$3.70 \times 10^{+4}$	No
Fluoranthene	$6.17 \times 10^{-4}$	$1.50 \times 10^{+2}$	No
Fluorene	$1.40 \times 10^{-3}$	$2.20 \times 10^{+2}$	No
Indeno(1,2,3-cd)pyrene	$9.36 \times 10^{-6}$	$1.10 \times 10^{-2}$	No
Methylene chloride	$5.28 \times 10^{-3}$	$5.10 \times 10^{-1}$	No
Naphthalene	$4.40 \times 10^{-4}$	$1.50 \times 10^{+2}$	No
Pyrene	$3.87 \times 10^{-3}$	$1.10 \times 10^{+2}$	No
Toluene	$9.91 \times 10^{-4}$	$7.50 \times 10^{+1}$	No
<b>RADIONUCLIDES</b>			
Cesium-137	$5.38 \times 10^{-5}$	$1.70 \times 10^{-1}$	No
Neptunium-237	$8.77 \times 10^{-3}$	$2.20 \times 10^{-2}$	No
Plutonium-238	$1.77 \times 10^{-4}$	$2.21 \times 10^{-2}$	No
Plutonium-239/240	$7.02 \times 10^{-5}$	$2.10 \times 10^{-2}$	No
Radium-226	$3.80 \times 10^{-2}$	$4.00 \times 10^{-2}$	No
Radium-228	$5.17 \times 10^{-3}$	$4.79 \times 10^{-2}$	No
Strontium-90	$5.03 \times 10^{-2}$	$1.30 \times 10^{-1}$	No
Technicium-99	$1.15 \times 10^{+2}$	$2.70 \times 10^{-1}$	Yes
Thorium-228	$1.95 \times 10^{-4}$	$8.70 \times 10^{-2}$	No
Thorium-230	$5.77 \times 10^{-4}$	$3.71 \times 10^{-1}$	No
Thorium-232	$1.76 \times 10^{-4}$	$4.00 \times 10^{-1}$	No
Uranium-234	$8.15 \times 10^{-1}$	$3.00 \times 10^{-1}$	Yes
Uranium-235/236	$3.95 \times 10^{-2}$	$3.00 \times 10^{-1}$	No
Uranium-238	$8.73 \times 10^{-1}$	$1.70 \times 10^{-1}$	Yes
Uranium-Total (non-RAD)	$2.75 \times 10^{+0}$	$1.00 \times 10^{+1}$	No

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**TABLE 5-6**  
**CONTAMINANT LOADING TO SURFACE WATER FROM**  
**THE ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_l$ (g)	Runoff Effluent or Storm Sewer	Concentration in Paddys Run during Storm Event	Great Miami River	Concentration in Sediment
				Outfall Ditch Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	$C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	$C_s$ (mg/kg)
<b>INORGANICS</b>							
Antimony	$4.50 \times 10^{+1}$	$2.10 \times 10^{+0}$	$3.14 \times 10^{-1}$	$1.10 \times 10^{+0}$	$1.37 \times 10^{-2}$	$1.66 \times 10^{-5}$	$2.09 \times 10^{+0}$
Arsenic	$2.00 \times 10^{+2}$	$8.98 \times 10^{+1}$	$3.03 \times 10^{+0}$	$1.06 \times 10^{+1}$	$1.32 \times 10^{-1}$	$1.60 \times 10^{-4}$	$8.97 \times 10^{+1}$
Barium	$2.00 \times 10^{+1}$	$2.54 \times 10^{+2}$	$8.49 \times 10^{+1}$	$2.97 \times 10^{+2}$	$3.72 \times 10^{+0}$	$4.50 \times 10^{-3}$	$2.52 \times 10^{+2}$
Beryllium	$2.50 \times 10^{+2}$	$4.70 \times 10^{+0}$	$1.27 \times 10^{-1}$	$4.44 \times 10^{-1}$	$5.44 \times 10^{-3}$	$6.71 \times 10^{-6}$	$4.70 \times 10^{+0}$
Chromium	$7.00 \times 10^{+1}$	$1.33 \times 10^{+1}$	$1.28 \times 10^{+0}$	$4.48 \times 10^{+0}$	$5.59 \times 10^{-2}$	$6.77 \times 10^{-5}$	$1.33 \times 10^{+1}$
Copper	$3.50 \times 10^{+1}$	$7.38 \times 10^{+1}$	$1.40 \times 10^{+1}$	$4.91 \times 10^{+1}$	$6.13 \times 10^{-1}$	$7.42 \times 10^{-4}$	$7.27 \times 10^{+1}$
Cyanide	$1.85 \times 10^{-2}$	$3.00 \times 10^{-1}$	$1.05 \times 10^{+1}$	$3.68 \times 10^{+1}$	$4.59 \times 10^{-1}$	$5.56 \times 10^{-4}$	$2.88 \times 10^{-2}$
Lead	$3.80 \times 10^{+1}$	$5.54 \times 10^{+1}$	$9.72 \times 10^{+0}$	$3.40 \times 10^{+1}$	$4.25 \times 10^{-1}$	$5.15 \times 10^{-4}$	$5.48 \times 10^{+1}$
Molybdenum	$1.00 \times 10^{+1}$	$8.60 \times 10^{+0}$	$5.70 \times 10^{+0}$	$2.00 \times 10^{+1}$	$2.49 \times 10^{-1}$	$3.02 \times 10^{-4}$	$8.45 \times 10^{+0}$
Nickel	$4.00 \times 10^{+2}$	$4.01 \times 10^{+1}$	$6.76 \times 10^{-1}$	$2.37 \times 10^{+0}$	$2.96 \times 10^{-2}$	$3.58 \times 10^{-5}$	$4.01 \times 10^{+1}$
Selenium	$1.50 \times 10^{+2}$	$5.90 \times 10^{+0}$	$2.65 \times 10^{-1}$	$9.28 \times 10^{-1}$	$1.16 \times 10^{-2}$	$1.40 \times 10^{-5}$	$5.89 \times 10^{+0}$
Thallium	$1.50 \times 10^{+3}$	$2.70 \times 10^{+0}$	$1.21 \times 10^{-2}$	$4.25 \times 10^{-2}$	$5.31 \times 10^{-4}$	$6.43 \times 10^{-7}$	$2.70 \times 10^{+0}$
Vanadium	$2.00 \times 10^{+2}$	$5.02 \times 10^{+1}$	$4.25 \times 10^{-1}$	$1.49 \times 10^{+0}$	$1.86 \times 10^{-2}$	$2.25 \times 10^{-5}$	$1.26 \times 10^{+1}$
Zinc	$2.00 \times 10^{+2}$	$7.83 \times 10^{+1}$	$1.69 \times 10^{+0}$	$5.92 \times 10^{+0}$	$7.40 \times 10^{-2}$	$8.96 \times 10^{-5}$	$5.02 \times 10^{+1}$
<b>ORGANICS</b>							
Toluene	$8.92 \times 10^{-1}$	$1.00 \times 10^{-1}$	$6.33 \times 10^{-1}$	$2.22 \times 10^{+0}$	$2.77 \times 10^{-2}$	$3.35 \times 10^{-5}$	$8.37 \times 10^{-2}$

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**TABLE 5-6  
(Continued)**

Constituent of Potential Concern	Partition Coefficient $K_d$ (mL/g)	Concentration in Waste Area Surface Soil $C_i$ (mg/kg)	Total Annual Loading to Stream $T_l$ (g)	Runoff Effluent or	Concentration in Paddys Run during Storm Event $C_w$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Great Miami River Concentration $C_{gmr}$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )	Concentration in Sediment $C_s$ (mg/kg)
				Storm Sewer Outfall Ditch Concentration $C_e$ (pCi/L RAD) ( $\mu\text{g/L non-RAD}$ )			
<b>RADIONUCLIDES</b>							
Neptunium-237	$5.00 \times 10^{+0}$	$7.80 \times 10^{-3}$	$1.02 \times 10^{-2}$	$2.51 \times 10^{+1}$	$3.14 \times 10^{-1}$	$3.80 \times 10^{-4}$	$7.54 \times 10^{-3}$
Plutonium-238	$1.00 \times 10^{+2}$	$4.09 \times 10^{-8}$	$2.75 \times 10^{-9}$	$1.65 \times 10^{-1}$	$2.06 \times 10^{-3}$	$2.49 \times 10^{-6}$	$4.08 \times 10^{-8}$
Plutonium-239/240	$1.00 \times 10^{+2}$	$4.83 \times 10^{-6}$	$3.25 \times 10^{-7}$	$7.07 \times 10^{-2}$	$8.84 \times 10^{-4}$	$1.07 \times 10^{-6}$	$4.82 \times 10^{-6}$
Radium-226	$1.06 \times 10^{+2}$	$4.65 \times 10^{-6}$	$2.95 \times 10^{-7}$	$1.02 \times 10^{+0}$	$1.28 \times 10^{-2}$	$1.55 \times 10^{-5}$	$4.64 \times 10^{-6}$
Radium-228	$1.06 \times 10^{+2}$	$1.18 \times 10^{-8}$	$7.50 \times 10^{-10}$	$7.14 \times 10^{-1}$	$8.92 \times 10^{-3}$	$1.08 \times 10^{-5}$	$1.18 \times 10^{-8}$
Strontium-90	$1.06 \times 10^{+2}$	$3.28 \times 10^{-8}$	$2.08 \times 10^{-9}$	$1.00 \times 10^{+0}$	$1.25 \times 10^{-2}$	$1.51 \times 10^{-5}$	$3.28 \times 10^{-8}$
Thorium-228	$3.20 \times 10^{+3}$	$4.63 \times 10^{-9}$	$9.76 \times 10^{-12}$	$2.80 \times 10^{-2}$	$3.50 \times 10^{-4}$	$4.23 \times 10^{-7}$	$4.63 \times 10^{-9}$
Thorium-230	$3.20 \times 10^{+3}$	$1.80 \times 10^{-4}$	$3.79 \times 10^{-7}$	$2.74 \times 10^{-2}$	$3.42 \times 10^{-4}$	$4.14 \times 10^{-7}$	$1.80 \times 10^{-4}$
Thorium-232	$3.20 \times 10^{+3}$	$2.45 \times 10^{+1}$	$5.16 \times 10^{-2}$	$1.99 \times 10^{-2}$	$2.48 \times 10^{-4}$	$3.01 \times 10^{-7}$	$2.45 \times 10^{+1}$
Uranium-234	$1.48 \times 10^{+0}$	$5.79 \times 10^{-4}$	$2.36 \times 10^{-3}$	$5.14 \times 10^{+1}$	$6.43 \times 10^{-1}$	$7.78 \times 10^{-4}$	$5.18 \times 10^{-4}$
Uranium-235/236	$1.48 \times 10^{+0}$	$9.26 \times 10^{-2}$	$3.78 \times 10^{-1}$	$2.86 \times 10^{+0}$	$3.57 \times 10^{-2}$	$4.32 \times 10^{-5}$	$8.29 \times 10^{-2}$
Uranium-238	$1.48 \times 10^{+0}$	$1.07 \times 10^{+1}$	$4.36 \times 10^{+1}$	$5.13 \times 10^{+1}$	$6.41 \times 10^{-1}$	$7.77 \times 10^{-4}$	$9.57 \times 10^{+0}$
Uranium-Total (non-RAD)	$1.48 \times 10^{+0}$	$7.83 \times 10^{+1}$	$3.19 \times 10^{+2}$	$1.12 \times 10^{+3}$	$1.40 \times 10^{+1}$	$1.69 \times 10^{-2}$	$7.01 \times 10^{+1}$

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Great Miami River were predicted to range between  $3.0 \times 10^7$  pCi/L for thorium-232 to  $7.8 \times 10^4$  pCi/L for uranium-234 or uranium-238. For inorganics and organics, predicted concentrations in the Paddys Run ranged from  $5.3 \times 10^4$   $\mu\text{g/L}$  for thallium to  $3.7 \mu\text{g/L}$  for barium. Concentrations of all inorganics and organics in the Great Miami River were predicted to remain below  $4.5 \times 10^3$   $\mu\text{g/L}$ . These concentrations remain only through the duration of the storm. When rainfall and runoff cease, no surface water is expected in the Storm Sewer Outfall Ditch.

Table 5-7 compares predicted and observed (filtered) concentrations in the Storm Sewer Outfall Ditch. The model results can only be compared with analytical results from filtered samples. However, due to the small database of filtered surface water samples, Table 5-7 also presents analytical results from unfiltered samples as well as samples which were not labeled filtered or unfiltered. Predicted and observed concentrations are on the same order of magnitude, with the exception of barium, lead, and total uranium. The model predicts more than an order of magnitude of higher concentrations than the observed data for these constituents.

Modeled sediment concentrations resulting from a single runoff event are comparable to the source term soil concentrations for the Active Flyash Pile because sediment mixing was not considered. For example, the modeled uranium-238 sediment concentration was 9.57 mg/kg, compared to 10.7 mg/kg in the soil source term. Sediment concentrations would be expected to decrease following the rainfall event because of dispersion through sediment transport and gradual mixing with sediment from other sources.

Total loading to the Great Miami Aquifer from the Storm Sewer Outfall Ditch (from runoff water as well as sediment leaching) was assumed to equal 100% of dissolved mass reaching the Storm Sewer Outfall Ditch. Since 44 percent of dissolved CPC mass was also assumed to reach Paddys Run, the loading assumption for the Great Miami Aquifer allows up to 44 percent contribution from the leaching of sediments. Table 5-8 shows the predicted maximum Great Miami Aquifer concentrations due to surface water runoff from Active Flyash Pile. Table 5-8 also compares predicted maximum Great Miami Aquifer concentrations against the screening concentrations (first screening step). As shown in Table 5-8, arsenic, beryllium, lead, neptunium-237, radium-226, radium-228, uranium-234, uranium-235/236, uranium-238, and total uranium were predicted to be above screening concentrations. For these constituents, diluted Great Miami Aquifer concentration in full SWIFT cell were predicted and compared against screening concentrations (Table 5-9). During this screening

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**TABLE 5-7**  
**COMPARISON OF MODELED RESULTS TO MEASURED**  
**SURFACE WATER CONCENTRATIONS IN THE**  
**STORM SEWER OUTFALL DITCH**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern <sup>a</sup>	Units	Modeled Concentrations in SSOD <sup>b,c</sup>	Range of Measured Concentrations in SSOD <sup>d</sup>		
			Filtered	Unfiltered	Unknown
<b>RADIONUCLIDES</b>					
Uranium-234	pCi/L	51.4	15.9	- <sup>e</sup>	-
Uranium-238	pCi/L	51.3	15.9	-	-
Total Uranium	µg/L	1120	14-44	14-24	-
<b>INORGANICS</b>					
Barium	µg/L	297	-	-	27.1
Chromium	µg/L	4.48	-	-	7.2
Lead	µg/L	34.0	-	-	2.2

<sup>a</sup>CPC listed only if measured data were available for comparison

<sup>b</sup>Modeled from surface soil sources in the Active Flyash Pile only

<sup>c</sup>SSOD - Storm Sewer Outfall Ditch

<sup>d</sup>Concentrations in samples from locations ASIT-002, ASIT-006, and ASIT-007

<sup>e</sup>Data not available or all were nondetects

**TABLE 5-8**  
**LOADING TO THE GREAT MIAMI AQUIFER FROM THE**  
**STORM SEWER OUTFALL DITCH AND CPC SCREENING (FIRST STEP)**  
**FOR GROUNDWATER MODELING, ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents	Predicted Maximum Aquifer Concentration $C_{GMA}$ (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	$10^{-7}$ Risk or 0.1 Hazard Index Screening Concentrations (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	Groundwater Modeling Required
<b>INORGANICS</b>			
Antimony	$1.21 \times 10^{-1}$	$1.50 \times 10^0$	No
Arsenic	$1.16 \times 10^{+0}$	$5.00 \times 10^{-3}$	Yes
Barium	$3.27 \times 10^{+1}$	$2.60 \times 10^{+2}$	No
Beryllium	$4.87 \times 10^{-2}$	$2.00 \times 10^{-3}$	Yes
Chromium	$4.92 \times 10^{-1}$	$1.80 \times 10^{+1}$	No
Copper	$5.39 \times 10^{+0}$	$1.40 \times 10^{+2}$	No
Cyanide	$4.04 \times 10^{+0}$	$7.30 \times 10^{+1}$	No
Lead	$3.73 \times 10^{+0}$	$1.50 \times 10^0$	Yes
Molybdenum	$2.19 \times 10^{+0}$	$1.80 \times 10^{+1}$	No
Nickel	$2.60 \times 10^{-1}$	$7.30 \times 10^{+1}$	No
Selenium	$1.02 \times 10^{-1}$	$1.80 \times 10^{+1}$	No
Thallium	$4.67 \times 10^{-3}$	$2.60 \times 10^{-1}$	No
Vanadium	$1.63 \times 10^{-1}$	$2.00 \times 10^{+1}$	No
Zinc	$6.51 \times 10^{-1}$	$1.10 \times 10^{+3}$	No
<b>ORGANICS</b>			
Toluene	$2.43 \times 10^{-1}$	$7.50 \times 10^{+1}$	No
<b>RADIONUCLIDES</b>			
Neptunium-237	$2.76 \times 10^{+0}$	$2.20 \times 10^{-2}$	Yes
Plutonium-238	$1.81 \times 10^{-2}$	$2.20 \times 10^{-2}$	No
Plutonium-239/240	$7.77 \times 10^{-3}$	$4.00 \times 10^{-2}$	No
Radium-226	$1.12 \times 10^{-1}$	$4.80 \times 10^{-2}$	Yes
Radium-228	$7.84 \times 10^{-2}$	$4.80 \times 10^{-2}$	Yes

**TABLE 5-8  
(Continued)**

Constituents	Predicted Maximum Aquifer Concentration $C_{GMA}$ (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	$10^{-7}$ Risk or 0.1 Hazard Index Screening Concentrations (pCi/L RAD) ( $\mu\text{g/L}$ non-RAD)	Groundwater Modeling Required
<b>RADIONUCLIDES (Continued)</b>			
Strontium-90	$1.10 \times 10^{-1}$	$1.30 \times 10^{-1}$	No
Thorium-228	$3.08 \times 10^{-3}$	$3.39 \times 10^{-2}$	No
Thorium-230	$3.01 \times 10^{-3}$	$3.70 \times 10^{-1}$	No
Thorium-232	$2.18 \times 10^{-3}$	$4.00 \times 10^{-1}$	No
Uranium-234	$5.65 \times 10^{+0}$	$3.00 \times 10^{+0}$	Yes
Uranium-235/236	$3.14 \times 10^{-1}$	$3.00 \times 10^{-1}$	Yes
Uranium-238	$5.64 \times 10^{+0}$	$1.70 \times 10^{-1}$	Yes
Uranium-Total (non-RAD)	$1.23 \times 10^{+2}$	$1.00 \times 10^{+1}$	Yes

**TABLE 5-9**  
**CPC SCREENING FOR GROUNDWATER MODELING USING FULL SWIFT CELL DILUTION,**  
**ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Units	Surface Water Runoff Concentration	Predicted Diluted GMA Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>RADIONUCLIDES</b>					
Neptunium-237	pCi/L	$2.51 \times 10^{+1}$	$2.45 \times 10^{-1}$	$2.20 \times 10^{-2}$	YES
Radium-226	pCi/L	$1.02 \times 10^{+0}$	$1.00 \times 10^{-2}$	$4.80 \times 10^{-2}$	NO
Radium-228	pCi/L	$7.14 \times 10^{-1}$	$6.98 \times 10^{-3}$	$4.80 \times 10^{-2}$	NO
Uranium-234	pCi/L	$5.14 \times 10^{+1}$	$5.03 \times 10^{-1}$	$3.00 \times 10^{-1}$	YES
Uranium-235/236	pCi/L	$2.86 \times 10^{+0}$	$2.79 \times 10^{-2}$	$3.00 \times 10^{-1}$	NO
Uranium-238	pCi/L	$5.13 \times 10^{+1}$	$5.02 \times 10^{-1}$	$1.70 \times 10^{-1}$	YES
<b>INORGANICS</b>					
Arsenic	$\mu\text{g/L}$	$1.06 \times 10^{+1}$	$1.04 \times 10^{-1}$	$5.00 \times 10^{-3}$	YES
Beryllium	$\mu\text{g/L}$	$4.44 \times 10^{-1}$	$4.34 \times 10^{-3}$	$2.00 \times 10^{-3}$	YES
Lead	$\mu\text{g/L}$	$3.40 \times 10^{+1}$	$3.33 \times 10^{-1}$	$1.50 \times 10^{+0}$	NO
Uranium-Total	$\mu\text{g/L}$	$1.12 \times 10^{+3}$	$1.09 \times 10^{+1}$	$1.00 \times 10^{+1}$	YES

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step, predicted radium-226, radium-228, uranium 235/236, and total uranium and lead concentrations were below the screening concentration (Table 5-9). Therefore, source term loading from the surface water runoff pathway to groundwater for these constituents was not developed. Only arsenic, beryllium, neptunium-237, and uranium isotopes were considered for further groundwater modeling.

Table 5-10 compares model predicted concentrations in the Great Miami Aquifer due to the surface water pathway to concentrations observed in monitoring wells near the Storm Sewer Outfall Ditch. The observed concentration range and predicted concentrations are generally on the same order of magnitude; however, the range of concentrations for uranium isotopes is quite large. This may be caused by upgradient source contributions before installation of the storm water retention basins.

5.3.4.6 Combined Modeling Results

Surface runoff from Solid Waste Landfill, Inactive Flyash Pile, South Field, and Active Flyash Pile reaches Paddys Run. Table 5-11 indicates the MUSLE predicted concentrations for the individual subunits and the combined effects in Paddys Run the Great Miami River. The Paddys Run total surface water concentrations are assumed to be at the confluence of the Storm Sewer Outfall Ditch with Paddys Run. The Great Miami River concentrations are assumed to be at the confluence of Paddys Run with the Great Miami River. The South Field contributes the major portion of concentrations for radionuclides and organics. The Active Flyash Pile contributes the major portion of metals concentrations.

Table 5-12 lists all the CPCs for groundwater from the surface water pathway. No CPCs were identified from the Solid Waste Landfill and Lime Sludge Ponds. Only technetium-99 and uranium isotopes are CPCs from the Inactive Flyash Pile and South Field. The Active Flyash Pile results in three organics and six radionuclides as CPCs. However, only arsenic, beryllium, neptunium-237, and uranium isotopes were CPCs after second screening step and were considered for detailed groundwater modeling.

5.3.5 Uncertainties in the Surface Water Model

The surface water model (like any other model) is a mathematical tool which simplifies the actual situation. Uncertainties in the output from the model are introduced from three primary sources:

- Source Term Uncertainty: Source terms for the modeling were defined based on analytical results from the surface soil samples collected during the RI/FS field investigations. It was assumed that these concentrations are representative of CPC concentrations in the past.

**TABLE 5-10**  
**COMPARISON OF GREAT MIAMI AQUIFER AND MODELED RESULTS**  
**FROM SURFACE RUNOFF PATHWAY, ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern <sup>a</sup>	Units	GMA Wells 2014 and 2049 <sup>b</sup>		Model Predicted GMA Concentration from SSOD Loading <sup>c</sup>
		Minimum	Maximum	
<b>RADIONUCLIDES (Unfiltered)<sup>d</sup></b>				
Neptunium-237	pCi/L	0.48	0.48	2.760
Radium-226	pCi/L	0.17	1.40	0.112
Thorium-228	pCi/L	1.10	1.10	0.003
Thorium-230	pCi/L	0.46	1.20	0.003
Thorium-232	pCi/L	1.60	1.60	0.002
Uranium-234	pCi/L	1.00	83.20	5.650
Uranium-235/236	pCi/L	0.22	1.86	0.314
Uranium-238	pCi/L	2.10	89.90	5.640
<b>INORGANICS (Filtered)</b>				
Barium	µg/L	20.00	42.00	32.65
Copper	µg/L	18.00	18.00	5.39
Chromium	µg/L	25.00	32.00	0.49
Lead	µg/L	6.00	6.00	3.73
Molybdenum	µg/L	49.00	49.00	2.19
Nickel	µg/L	20.00	84.00	0.26
Selenium	µg/L	2.00	3.00	0.10
Vanadium	µg/L	14.00	20.40	0.16

<sup>a</sup>CPC listed only if measured data were available for comparison

<sup>b</sup>These two GMA wells are close to the SSOD

<sup>c</sup>Model predicted concentrations are considered equivalent to filtered samples

<sup>d</sup>Only unfiltered data were available for comparison for radionuclides

GMA - Great Miami Aquifer

SSOD - Storm Sewer Outfall Ditch

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**TABLE 5-11**  
**IMPACT OF ALL OPERABLE UNIT 2 SUBUNITS**  
**ON PADDYS RUN AND THE GREAT MIAMI RIVER**

Constituent of Potential Concern	Unit	Paddys Run Concentration From					Great Miami River Concentration
		Solid Waste Landfill	Inactive Flyash Pile	South Field	Active Flyash Pile	Total	
<b>INORGANICS</b>							
Antimony	µg/L			1.96 x 10 <sup>-2</sup>	1.37 x 10 <sup>-2</sup>	3.33 x 10 <sup>-2</sup>	4.04 x 10 <sup>-5</sup>
Arsenic	µg/L	1.91 x 10 <sup>-3</sup>	1.31 x 10 <sup>-2</sup>	1.69 x 10 <sup>-2</sup>	1.32 x 10 <sup>-1</sup>	1.64 x 10 <sup>-1</sup>	1.99 x 10 <sup>-4</sup>
Barium	µg/L	4.59 x 10 <sup>-3</sup>	3.70 x 10 <sup>-1</sup>	2.41	3.72	6.49	7.86 x 10 <sup>-3</sup>
Beryllium	µg/L	3.04 x 10 <sup>-5</sup>	6.32 x 10 <sup>-4</sup>	1.75 x 10 <sup>-3</sup>	5.54 x 10 <sup>-3</sup>	7.96 x 10 <sup>-3</sup>	9.64 x 10 <sup>-6</sup>
Cadmium	µg/L	9.74 x 10 <sup>-5</sup>	19.5 x 10 <sup>-2</sup>			1.96 x 10 <sup>-2</sup>	2.38 x 10 <sup>-5</sup>
Chromium	µg/L	5.92 x 10 <sup>-4</sup>	1.13 x 10 <sup>-2</sup>	9.23 x 10 <sup>-2</sup>	5.59 x 10 <sup>-2</sup>	1.60 x 10 <sup>-1</sup>	1.94 x 10 <sup>-4</sup>
Copper	µg/L		6.74 x 10 <sup>-2</sup>	2.20 x 10 <sup>-1</sup>	6.13 x 10 <sup>-1</sup>	9.01 x 10 <sup>-1</sup>	1.09 x 10 <sup>-3</sup>
Cyanide	µg/L				4.59 x 10 <sup>-1</sup>	4.59 x 10 <sup>-1</sup>	5.56 x 10 <sup>-4</sup>
Lead	µg/L	3.63 x 10 <sup>-4</sup>	5.29 x 10 <sup>-2</sup>	3.01 x 10 <sup>-1</sup>	4.25 x 10 <sup>-1</sup>	7.79 x 10 <sup>-1</sup>	9.43 x 10 <sup>-4</sup>
Manganese	µg/L		5.15 x 10 <sup>-2</sup>			5.15 x 10 <sup>-2</sup>	6.23 x 10 <sup>-5</sup>
Mercury	µg/L		8.91 x 10 <sup>-4</sup>			8.91 x 10 <sup>-4</sup>	1.08 x 10 <sup>-6</sup>
Molybdenum	µg/L	3.70 x 10 <sup>-3</sup>	4.93 x 10 <sup>-2</sup>	2.86 x 10 <sup>-1</sup>	2.49 x 10 <sup>-1</sup>	5.89 x 10 <sup>-1</sup>	7.12 x 10 <sup>-4</sup>
Nickel	µg/L	1.55 x 10 <sup>-3</sup>	8.91 x 10 <sup>-3</sup>	1.99 x 10 <sup>-2</sup>	2.96 x 10 <sup>-2</sup>	5.99 x 10 <sup>-2</sup>	7.26 x 10 <sup>-5</sup>
Selenium	µg/L		4.46 x 10 <sup>-3</sup>		1.16 x 10 <sup>-2</sup>	1.60 x 10 <sup>-2</sup>	1.94 x 10 <sup>-5</sup>
Silver	µg/L		3.39 x 10 <sup>-3</sup>	2.78 x 10 <sup>-2</sup>		3.12 x 10 <sup>-2</sup>	3.78 x 10 <sup>-5</sup>
Thallium	µg/L				5.31 x 10 <sup>-4</sup>	5.31 x 10 <sup>-4</sup>	6.43 x 10 <sup>-7</sup>
Vanadium	µg/L	1.93 x 10 <sup>-3</sup>		6.19 x 10 <sup>-2</sup>	1.86 x 10 <sup>-2</sup>	8.24 x 10 <sup>-2</sup>	9.97 x 10 <sup>-5</sup>
Zinc	µg/L	1.46 x 10 <sup>-3</sup>		1.23 x 10 <sup>-1</sup>	7.40 x 10 <sup>-2</sup>	1.98 x 10 <sup>-1</sup>	2.40 x 10 <sup>-4</sup>
Total Uranium	µg/L	1.72 x 10 <sup>-1</sup>	2.02	1.15 x 10 <sup>+1</sup>	1.40 x 10 <sup>+1</sup>	2.76 x 10 <sup>+1</sup>	3.34 x 10 <sup>-2</sup>
<b>ORGANICS</b>							
2-Butanone	µg/L	5.97 x 10 <sup>-4</sup>	1.18 x 10 <sup>-3</sup>			1.77 x 10 <sup>-3</sup>	2.15 x 10 <sup>-6</sup>
4,4'-DDE	µg/L	1.04 x 10 <sup>-8</sup>				1.04 x 10 <sup>-8</sup>	1.27 x 10 <sup>-11</sup>
Acenaphthene	µg/L	1.26 x 10 <sup>-4</sup>	2.10 x 10 <sup>-3</sup>			2.22 x 10 <sup>-3</sup>	2.69 x 10 <sup>-6</sup>
Acenaphthylene	µg/L			4.29 x 10 <sup>-3</sup>		4.29 x 10 <sup>-3</sup>	5.19 x 10 <sup>-6</sup>
Acetone	µg/L	3.26 x 10 <sup>-3</sup>	4.77 x 10 <sup>-3</sup>	3.46 x 10 <sup>-1</sup>		3.54 x 10 <sup>-1</sup>	4.28 x 10 <sup>-4</sup>
Anthracene	µg/L	7.16 x 10 <sup>-5</sup>	2.31 x 10 <sup>-3</sup>	6.65 x 10 <sup>-3</sup>		9.04 x 10 <sup>-3</sup>	1.09 x 10 <sup>-5</sup>
Aroclor-1254	µg/L			2.13 x 10 <sup>-5</sup>		2.13 x 10 <sup>-5</sup>	2.57 x 10 <sup>-8</sup>
Aroclor-1260	µg/L			1.03 x 10 <sup>-5</sup>		1.03 x 10 <sup>-5</sup>	1.25 x 10 <sup>-8</sup>
Benzoic Acid	µg/L			5.57 x 10 <sup>-1</sup>		5.57 x 10 <sup>-1</sup>	6.75 x 10 <sup>-4</sup>
Benzo(a)anthracene	µg/L	7.98 x 10 <sup>-6</sup>		3.52 x 10 <sup>-3</sup>		3.52 x 10 <sup>-3</sup>	4.27 x 10 <sup>-6</sup>
Benzo(a)pyrene	µg/L	3.10 x 10 <sup>-6</sup>		2.51 x 10 <sup>-3</sup>		2.52 x 10 <sup>-3</sup>	3.05 x 10 <sup>-6</sup>

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TABLE 5-11  
(Continued)

Constituent of Potential Concern	Unit	Paddys Run Concentration From					Great Miami River Concentration
		Solid Waste Landfill	Inactive Flyash Pile	South Field	Active Flyash Pile	Total	
<b>ORGANICS (Continued)</b>							
Benzo(b)fluoranthene	µg/L	1.66 x 10 <sup>-6</sup>		4.26 x 10 <sup>-4</sup>		4.28 x 10 <sup>-4</sup>	5.18 x 10 <sup>-7</sup>
Benzo(k)fluoranthene	µg/L	4.85 x 10 <sup>-7</sup>		2.70 x 10 <sup>-4</sup>		2.70 x 10 <sup>-4</sup>	3.27 x 10 <sup>-7</sup>
Benzo(g,h,i)perylene	µg/L	1.35 x 10 <sup>-6</sup>				1.35 x 10 <sup>-6</sup>	1.63 x 10 <sup>-9</sup>
bis(2-ethylhexyl)phthalate	µg/L	1.52 x 10 <sup>-3</sup>	1.11 x 10 <sup>-3</sup>	2.81 x 10 <sup>-2</sup>		3.08 x 10 <sup>-2</sup>	3.72 x 10 <sup>-5</sup>
Bromomethane	µg/L	6.16 x 10 <sup>-4</sup>				6.16 x 10 <sup>-4</sup>	7.46 x 10 <sup>-7</sup>
Carbazole	µg/L	3.27 x 10 <sup>-4</sup>	9.54 x 10 <sup>-3</sup>	2.17 x 10 <sup>-2</sup>		3.16 x 10 <sup>-2</sup>	3.83 x 10 <sup>-5</sup>
Chloromethane	µg/L	1.27 x 10 <sup>-3</sup>				1.27 x 10 <sup>-3</sup>	1.54 x 10 <sup>-6</sup>
Chrysene	µg/L	9.87 x 10 <sup>-6</sup>		3.84 x 10 <sup>-3</sup>		3.85 x 10 <sup>-3</sup>	4.66 x 10 <sup>-6</sup>
Di-n-butyl phthalate	µg/L	3.03 x 10 <sup>-6</sup>				3.03 x 10 <sup>-6</sup>	3.67 x 10 <sup>-9</sup>
Dibenzo(a,h)anthracene	µg/L	1.87 x 10 <sup>-6</sup>	9.02 x 10 <sup>-5</sup>	5.20 x 10 <sup>-4</sup>		6.12 x 10 <sup>-4</sup>	7.41 x 10 <sup>-7</sup>
Dieldrin	µg/L			7.97 x 10 <sup>-4</sup>		7.97 x 10 <sup>-4</sup>	9.65 x 10 <sup>-7</sup>
Dimethyl phthalate	µg/L			8.73 x 10 <sup>-2</sup>		8.73 x 10 <sup>-2</sup>	1.06 x 10 <sup>-4</sup>
Fluoranthene	µg/L	2.81 x 10 <sup>-5</sup>		2.21 x 10 <sup>-3</sup>		2.24 x 10 <sup>-3</sup>	2.71 x 10 <sup>-6</sup>
Fluorene	µg/L	5.80 x 10 <sup>-5</sup>	1.29 x 10 <sup>-3</sup>	3.74 x 10 <sup>-3</sup>		5.09 x 10 <sup>-3</sup>	6.16 x 10 <sup>-6</sup>
Ideno(1,2,3-cd)pyrene	µg/L	9.14 x 10 <sup>-8</sup>		3.36 x 10 <sup>-5</sup>		3.37 x 10 <sup>-5</sup>	4.08 x 10 <sup>-8</sup>
Methylene chloride	µg/L			1.89 x 10 <sup>-2</sup>		1.89 x 10 <sup>-2</sup>	2.29 x 10 <sup>-5</sup>
Naphthalene	µg/L		1.60 x 10 <sup>-3</sup>			1.60 x 10 <sup>-3</sup>	1.93 x 10 <sup>-6</sup>
Pyrene	µg/L	4.92 x 10 <sup>-5</sup>		1.39 x 10 <sup>-2</sup>		1.39 x 10 <sup>-2</sup>	1.69 x 10 <sup>-5</sup>
Toluene	µg/L		5.82 x 10 <sup>-3</sup>		2.77 x 10 <sup>-2</sup>	3.35 x 10 <sup>-2</sup>	4.06 x 10 <sup>-5</sup>
<b>RADIONUCLIDES</b>							
Cesium-137	pCi/L	8.13 x 10 <sup>-6</sup>	2.35 x 10 <sup>-3</sup>	1.70 x 10 <sup>-4</sup>		2.01 x 10 <sup>-4</sup>	2.44 x 10 <sup>-7</sup>
Neptunium-237	pCi/L	1.24 x 10 <sup>-3</sup>	1.16 x 10 <sup>-2</sup>	2.08 x 10 <sup>-2</sup>	3.14 x 10 <sup>-1</sup>	3.47 x 10 <sup>-1</sup>	4.20 x 10 <sup>-4</sup>
Plutonium-238	pCi/L	2.60 x 10 <sup>-5</sup>	3.30 x 10 <sup>-3</sup>	5.58 x 10 <sup>-4</sup>	2.06 x 10 <sup>-3</sup>	5.94 x 10 <sup>-3</sup>	7.19 x 10 <sup>-6</sup>
Plutonium-239/240	pCi/L	2.76 x 10 <sup>-6</sup>	2.37 x 10 <sup>-4</sup>	2.37 x 10 <sup>-4</sup>	8.84 x 10 <sup>-4</sup>	1.36 x 10 <sup>-3</sup>	1.65 x 10 <sup>-6</sup>
Radium-226	pCi/L	1.15 x 10 <sup>-4</sup>	1.46 x 10 <sup>-3</sup>	1.35 x 10 <sup>-1</sup>	1.28 x 10 <sup>-2</sup>	1.49 x 10 <sup>-2</sup>	1.81 x 10 <sup>-4</sup>
Radium-228	pCi/L	1.38 x 10 <sup>-4</sup>	1.47 x 10 <sup>-3</sup>	1.71 x 10 <sup>-2</sup>	8.92 x 10 <sup>-3</sup>	2.76 x 10 <sup>-2</sup>	3.34 x 10 <sup>-5</sup>
Strontium-90	pCi/L	5.43 x 10 <sup>-3</sup>	5.71 x 10 <sup>-4</sup>	1.80 x 10 <sup>-1</sup>	1.25 x 10 <sup>-2</sup>	1.98 x 10 <sup>-1</sup>	2.40 x 10 <sup>-4</sup>
Technetium-99	pCi/L			4.12 x 10 <sup>-2</sup>		4.12 x 10 <sup>-2</sup>	4.99 x 10 <sup>-1</sup>
Thorium-228	pCi/L	1.61 x 10 <sup>-5</sup>	5.89 x 10 <sup>-5</sup>	6.42 x 10 <sup>-4</sup>	3.50 x 10 <sup>-4</sup>	1.07 x 10 <sup>-3</sup>	1.29 x 10 <sup>-6</sup>
Thorium-230	pCi/L	6.39 x 10 <sup>-5</sup>	7.87 x 10 <sup>-4</sup>	2.01 x 10 <sup>-3</sup>	3.42 x 10 <sup>-4</sup>	3.20 x 10 <sup>-4</sup>	3.88 x 10 <sup>-6</sup>
Thorium-232	pCi/L	1.49 x 10 <sup>-5</sup>	5.08 x 10 <sup>-5</sup>	5.81 x 10 <sup>-4</sup>	2.48 x 10 <sup>-4</sup>	8.95 x 10 <sup>-4</sup>	1.08 x 10 <sup>-6</sup>
Uranium-234	pCi/L	3.21 x 10 <sup>-2</sup>	6.59 x 10 <sup>-1</sup>	3.44	6.43 x 10 <sup>-1</sup>	4.78	5.78 x 10 <sup>-3</sup>
Uranium-235/236	pCi/L	2.16 x 10 <sup>-3</sup>	3.32 x 10 <sup>-2</sup>	1.66 x 10 <sup>-1</sup>	3.57 x 10 <sup>-1</sup>	2.37 x 10 <sup>-1</sup>	2.87 x 10 <sup>-4</sup>
Uranium-238	pCi/L	5.90 x 10 <sup>-2</sup>	6.60 x 10 <sup>-1</sup>	3.72	6.41 x 10 <sup>-1</sup>	5.08	6.15 x 10 <sup>-3</sup>

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**TABLE 5-12**  
**SUMMARY OF CONSTITUENTS OF CONCERN FOR GROUNDWATER**  
**FROM SURFACE WATER PATHWAY**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern <sup>a</sup>	Units	Model Predicted Maximum GMA <sup>b</sup> Concentration
<b>SOLID WASTE LANDFILL</b>		
None		
<b>LIME SLUDGE PONDS</b>		
None		
<b>SOUTH FIELD/INACTIVE FLYASH PILE</b>		
Technetium-99	pCi/L	115.00
Uranium-234	pCi/L	0.82
Uranium-238	pCi/L	0.87
<b>ACTIVE FLYASH PILE</b>		
Arsenic	µg/L	1.16
Beryllium	µg/L	0.05
Lead <sup>c</sup>	µg/L	3.73
Neptunium-237	pCi/L	2.76
Radium-226 <sup>c</sup>	pCi/L	0.11
Radium-228 <sup>c</sup>	pCi/L	0.08
Uranium-234	pCi/L	5.65
Uranium-235/236 <sup>c</sup>	pCi/L	0.31
Uranium-238	pCi/L	5.64
Uranium-Total <sup>c</sup>	µg/L	123

<sup>a</sup>COC listed only if above screening concentration.

<sup>b</sup>GMA - Great Miami Aquifer.

<sup>c</sup>Radium-226, radium-228, uranium-235/236, total uranium and lead were screened out in the second screening step. Radium-226 and radium-228 were not considered for detailed groundwater modeling as they were below screening levels for all other pathways.

Although CPC concentrations in the past may have exceeded the present concentrations, use of the UCL concentration may counter the uncertainties introduced by using analytical results from the RI/FS field investigation. Use of uniform CPC concentration at UCL also introduces a potential for overestimation of contaminant mass.

- **Input Parameter Uncertainty:** The accuracy of the model prediction is highly dependent on the accuracy of the input parameters. Input parameters such as the SCS runoff curve number, rainfall and runoff factor, soil erodibility factor, slope length and steepness factor, cover factor, etc., are approximate numbers representing the physical characteristics of a given site. The chemical-specific distribution coefficient (Kd) values used to calculate the fraction of contaminants sorbed to soil particles are another source of uncertainty.
- **Modeling Uncertainty:** Any mathematical model representing a physical process tends to be simplified by making approximations and assumptions. The uncertainties in model predictions will increase with increased simplification of the model. Several portions of the surface water model equations consist of empirical equations, which are approximations of actual physical processes.
- **Scenario Uncertainty:** The assumption that each subunit of Operable Unit 2 acts as a point source contamination will introduce some uncertainty in the model predictions. Wherever possible, conservative assumptions were made so that model can predict worst-case conditions.

#### 5.4 GROUNDWATER MODELING

A summary of the fate and transport modeling for the groundwater pathway is presented in the following subsections. Modeling was performed to predict the transport of constituents and to estimate the concentrations of constituents that potential receptors may be exposed to in the future. As part of the initial modeling process, screening of all detected constituents for CPCs was performed to reduce the list of compounds to be carried forward to the detailed modeling process. The screening included comparisons of observed concentrations against various criteria including background concentrations, risk levels, etc., which is described in detail in Appendix A.2 and summarized in Subsection 5.4.2.3.

The migration of water and dissolved constituents from the waste source to the receptor involves flow through both unsaturated (vadose zone) and saturated zones (regional aquifer and perched zones). Flow and solute transport in these zones are affected by the permeability of the media, the hydraulic gradient, and the saturation conditions. Other factors considered were dispersion (mixing) in groundwater, retardation, and biological or radioactive decay. The fate and transport modeling are discussed in detail in Appendix A-2 and are summarized in the following sections.

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The waste areas contained in Operable Unit 2 were assumed to remain in their existing locations and in their current conditions for the purposes of the fate and transport modeling. The extent of the waste areas is described in Section 4.0. The assumptions regarding waste area conditions were made to provide a conservative worst-case estimate of contaminant transport.

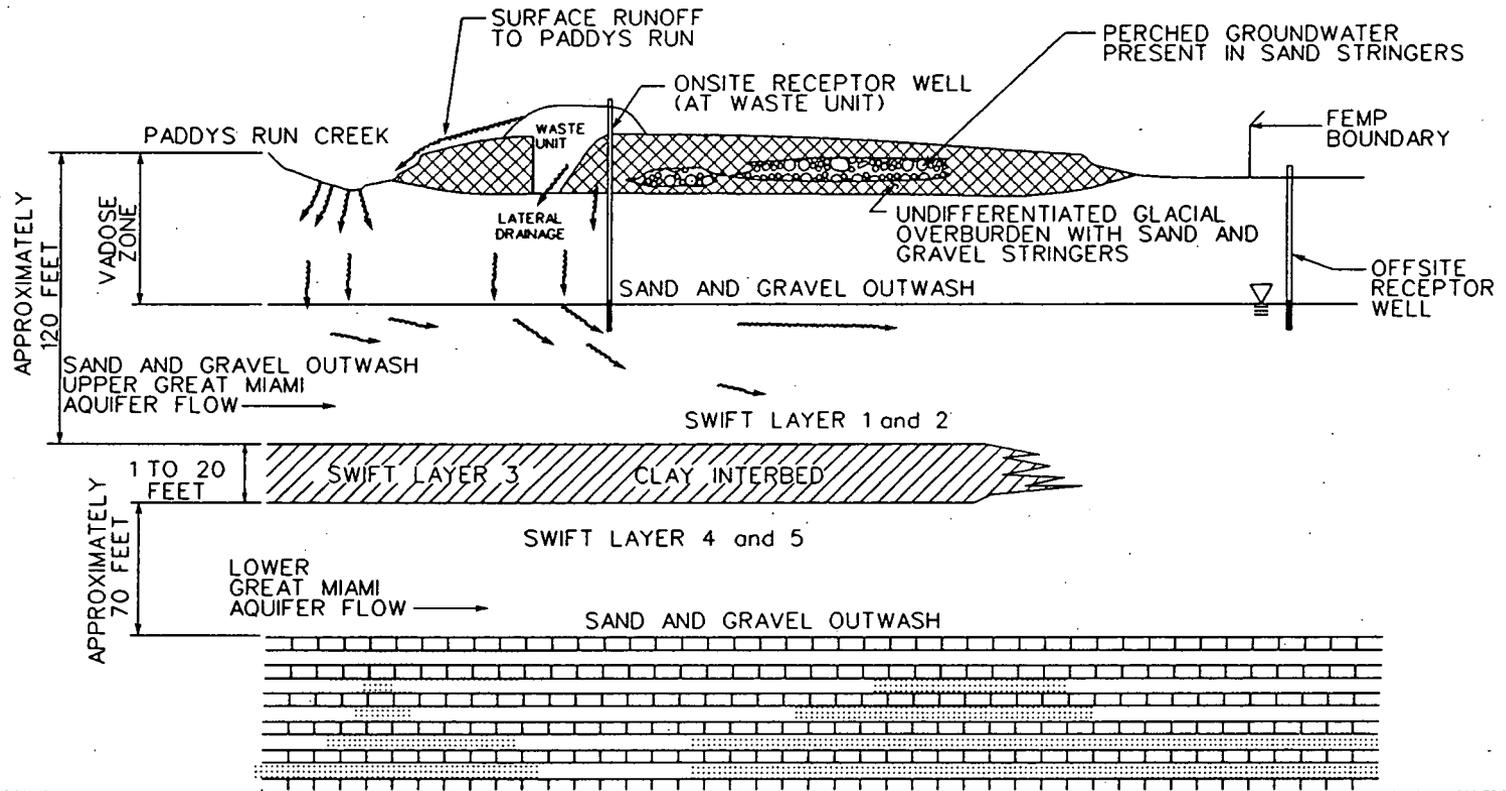
5.4.1 Conceptual Model

Based on characteristics of the material underlying the Operable Unit 2 subunits, a conceptual model was developed for the pathways between the subunit and the Great Miami Aquifer. Five pathways for CPC migration from Operable Unit 2 subunits to the Great Miami Aquifer were identified.

- **VADOSE ZONE PATHWAY:** Migration of CPCs from the waste unit laterally and vertically through the vadose zone to the aquifer was designated as the vadose zone pathway.
- **PERCHED WATER INFILTRATION:** Vertical migration of perched water through the glacial till to the Great Miami Aquifer was designated as the perched water infiltration pathway.
- **PERCHED WATER SUBSURFACE SEEP PATHWAY:** Lateral migration of CPCs occurs when perched water in sand and gravel layers within the glacial overburden come in contact with waste material. Perched water moves laterally in the sand layer until it is intercepted at the sand/gravel and waste interface. At that point, perched water moves along the slope of the waste and till interface until it comes in contact with the unsaturated Great Miami Aquifer. This water containing CPCs then vertically infiltrates to the aquifer.
- **SEEP PATHWAY:** Migration of CPCs from seeps to an area where glacial overburden is not present, and then through the unsaturated portion of the Great Miami Aquifer to the groundwater was designated as the seep pathway.
- **SURFACE WATER PATHWAY:** Migration of CPCs from the surface soils due to storm event runoff to Paddys Run or the Storm Sewer Outfall Ditch, and then vertically to the aquifer was designated as the surface water pathway.

Figure 5-7 shows a generalized picture of contaminant migration at the FEMP. Three primary pathways shown are: vadose zone pathway, surface water pathway, and perched water infiltration pathway. Vertical transport down through the vadose zone to the aquifer and the horizontal transport through the aquifer to the well of a potential human receptor is illustrated in Figure 5-7.

The migration of contaminants from the source to the groundwater begins with the infiltration of rainwater (Figure 5-8). As water percolates through the waste, constituents in the waste are dissolved into the water to form a leachate. Fluids and/or leachate entering from the waste areas migrate first



- LEGEND:
- SHALE WITH INTERBEDDED LIMESTONE SAND
  - CLAY
  - GLACIAL OVERBURDEN
  - SAND & GRAVEL

FIGURE 5-7  
 CONCEPTUAL MODEL OF LOADING TO THE GREAT MIAMI AQUIFER  
 AND CONTAMINANT TRANSPORT BY GROUNDWATER

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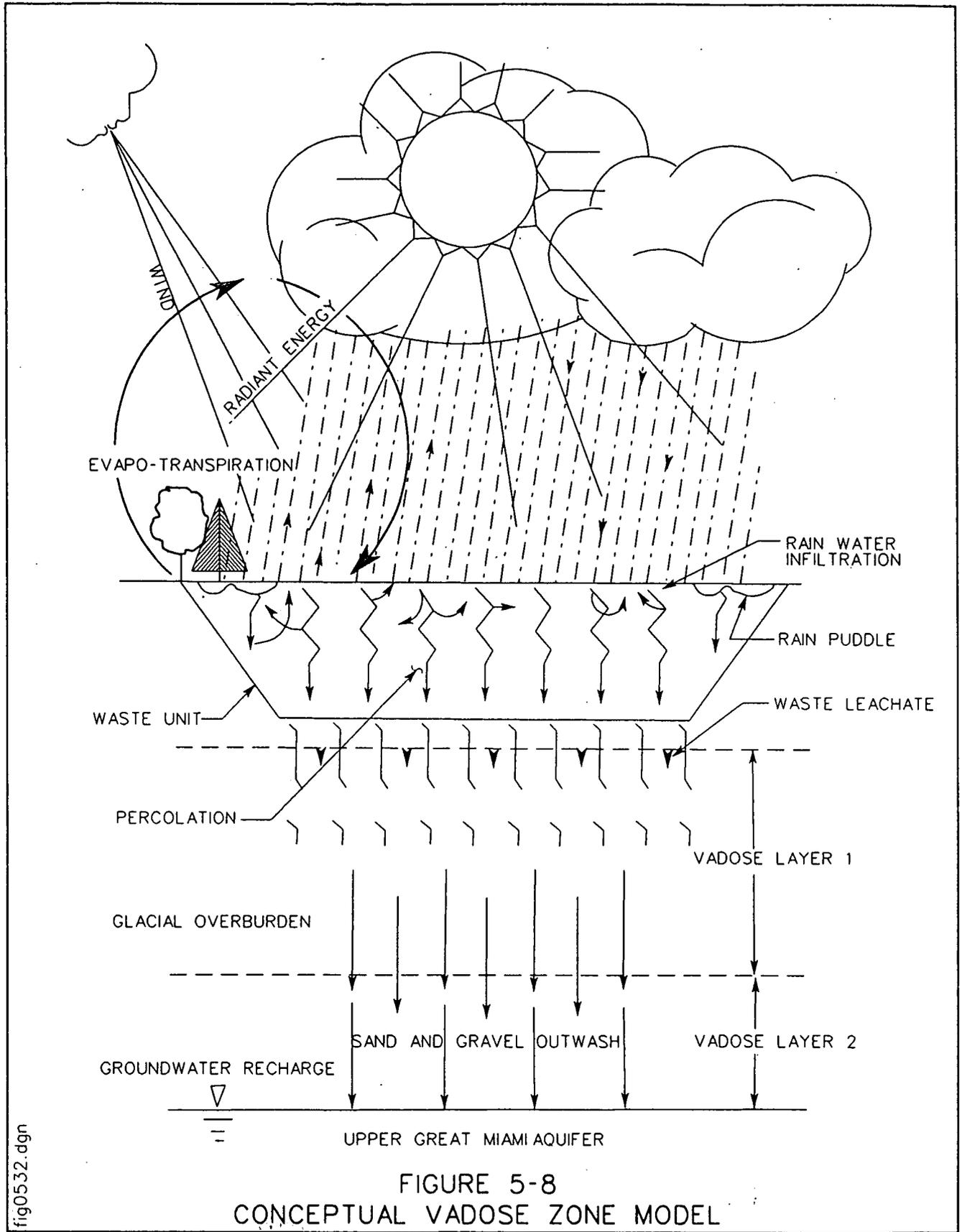


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FIGURE 5-8  
CONCEPTUAL VADOSE ZONE MODEL

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through the unsaturated glacial overburden (if present), then through the unsaturated outwash deposits, and finally into the Great Miami Aquifer. In the South Field, Inactive Flyash Pile, and Active Flyash Pile, part of the waste material is underlain by the glacial overburden, while other parts are underlain by the unsaturated sand and gravel of the Great Miami Aquifer. At these subunits, lateral drainage may take place at the interface of waste and glacial overburden. This lateral drainage then infiltrates through the unsaturated portion of the Great Miami Aquifer where lateral drainage comes in contact with the unsaturated Great Miami Aquifer.

The vadose zone, applicable to all subunits, was modeled as two layers: the glacial overburden underlying the subunits (Layer 1) and the unsaturated portion of the underlying Great Miami Aquifer (Layer 2). Layer 1 soils consist of tills in the glacial overburden. A sequence of fine-grained till deposits interbedded with sand and gravel glaciofluvial stringers forms the glacial overburden at the site. The sand and gravel unit within the glacial overburden was not included in the vadose zone modeling because this layer has much higher permeability and less adsorption potential as compared to clay and silts in glacial overburden. The thickness of till ranges between 0 and 38 feet for the subunits. Beneath the till is the unsaturated sand and gravel outwash layer (Layer 2), which is present beneath all the subunits. The thickness of Layer 2 ranges from 16 to 33 feet.

Another pathway which was applicable to all subunits was perched water infiltration. The conceptual model for the perched water infiltration pathway is similar to that of the vadose zone pathway. This pathway was modeled with two layers. Layer 1 soils consist of till below the perched water zone and Layer 2 soils consist of the unsaturated portion of the Great Miami Aquifer. The thickness of Layer 1 ranged from 2 to 22 feet, and the thickness of Layer 2 ranged from 17 to 33 feet. Constituent mass in the perched water, as well as adsorbed to the sand layer, was considered in the source term for perched water infiltration. The perched water was simulated as an additional source of constituent loading based on the concentration of constituents detected in the 1000-series wells located within the Operable Unit 2 subunits.

Based on characteristics of the material underlying each Operable Unit 2 subunits, a detailed conceptual model is developed for the pathways between each subunit and receptor locations. These more detailed models are developed to account for the variable stratigraphies of the soils of Operable Unit 2 subunits. Areas overlying each SWIFT III grid block in all subunits were modeled separately with individual stratigraphy, constituent type and concentration, and infiltration rate parameters; each constituent was simulated using retardation and decay factors taken from literature studies or site-

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specific data. The waste areas contained in Operable Unit 2 are assumed to remain in their existing locations for the purposes of the baseline fate and transport modeling. The detailed conceptual models are described next.

5.4.1.1 Solid Waste Landfill

Constituent migration pathways applicable to the Solid Waste Landfill were the vadose zone, surface water, and perched water infiltration pathways. Figure 5-9 shows the SWIFT III grid blocks directly beneath the waste at the Solid Waste Landfill and Table 5-13 provides the physical parameters of various layers for each of the blocks modeled. The average thickness of the waste is 8.5 feet. The conceptual model depicting flow in the subsurface soils at the Solid Waste Landfill considers two layers. Layer 1 soils consist of tills, 31 to 38 feet thick. Interbedded sand and gravel stringers within the till, with thicknesses of 0.5 to 6 feet containing perched water, were not considered as a part of Layer 1 of the vadose zone pathway. These sand layers are underlain by 9 to 17 feet of glacial till. Beneath the till layer at the Solid Waste Landfill is the 19 to 25 feet thick unsaturated sand and gravel layer (Layer 2).

5.4.1.2 Lime Sludge Ponds

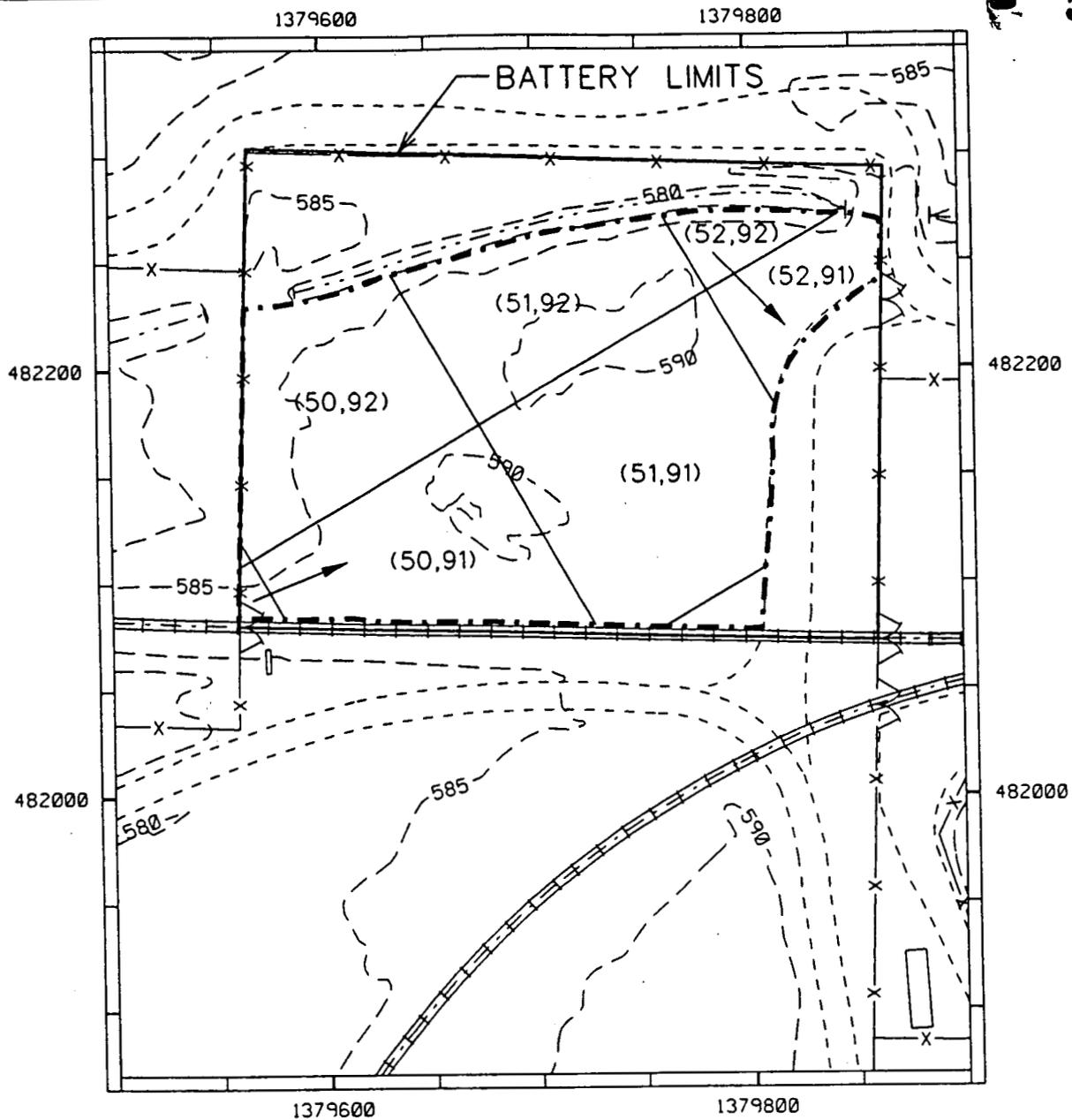
As discussed in Section 5.3, the surface water pathway was not applicable to the Lime Sludge Ponds. Because the Lime Sludge Ponds are underlain by the till everywhere, perched water subsurface seep and seep pathways were not applied to the Lime Sludge Ponds. Figure 5-10 shows the SWIFT III grid blocks directly under the waste at the Lime Sludge Ponds. The hydrostratigraphic units beneath the Lime Sludge Ponds consists of 24 to 35 feet of till (excluding 3 to 6 feet of sand and gravel beds) forming model Layer 1 for the vadose zone pathway, and 16 to 21 feet of buried valley glaciofluvial material forming vadose model Layer 2 (Table 5-14). The base of the ponds is assumed to be located in the unweathered gray tills. Perched water has been observed in the sand and gravel layers under the Lime Sludge Ponds. The thickness of the till below the sand and gravel ranges from 11 to 22 feet (Layer 1 of the perched water vertical infiltration pathway). Only the vadose zone and perched water infiltration pathways were applicable to the Lime Sludge Ponds.

5.4.1.3 Inactive Flyash Pile and South Field

All five constituent migration pathways were applicable to the Inactive Flyash Pile and South Field. The South Field and Inactive Flyash Pile contains the most surface area of any of the Operable Unit 2 subunits (Figure 5-11). The lithology of this area is variable with the southwestern portion containing

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**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- EXTENT OF WASTE
- WASTE FROM CELL IS INCLUDED IN OTHER CELL
- SWIFT MODEL CELL (COLUMN, ROW)

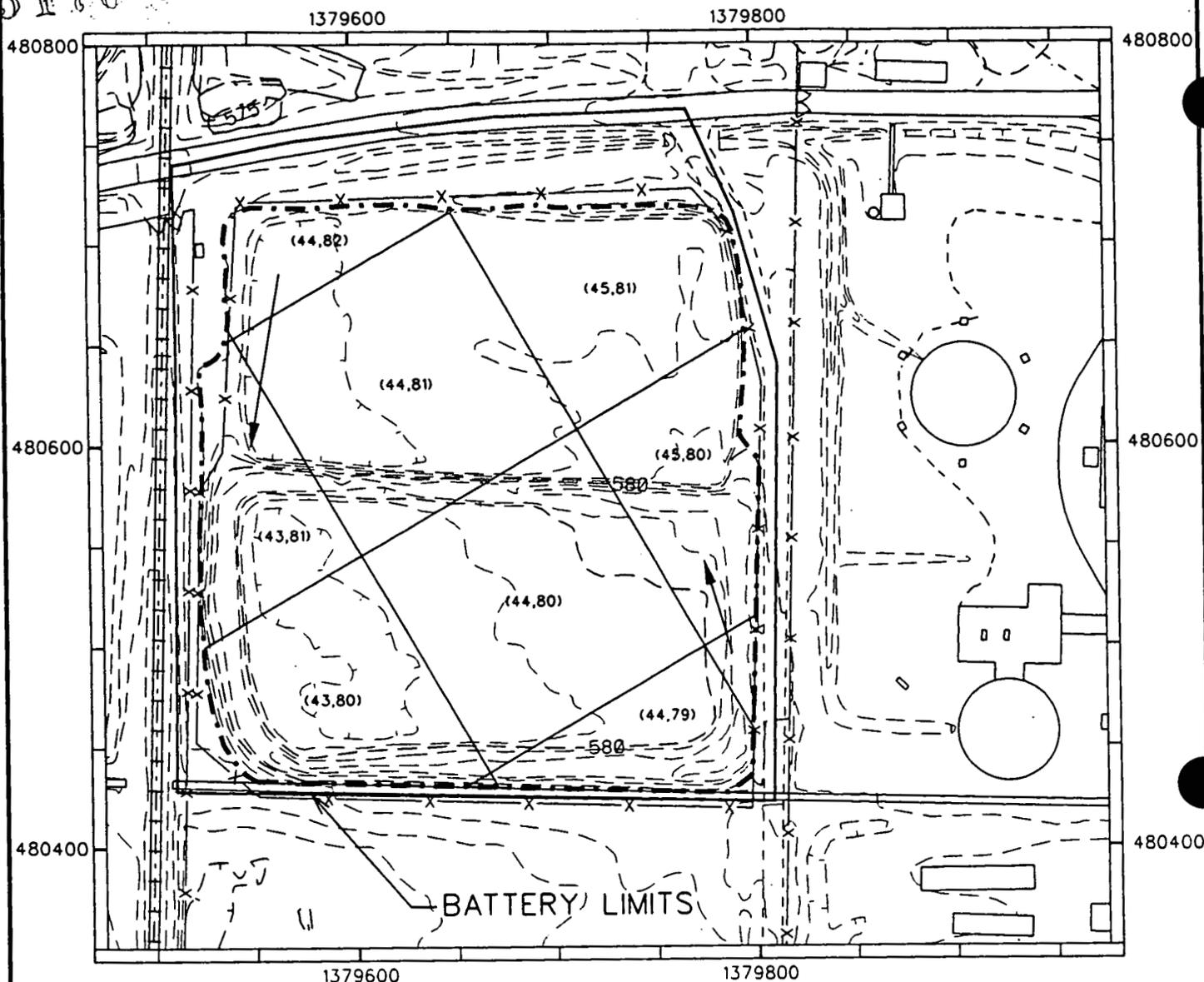
**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

**SCALE (FT)**

**FIGURE 5-9**  
**EXTENT OF WASTE**  
**AND MODELED SWIFT**  
**GRID CELLS,**  
**SOLID WASTE LANDFILL**

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**LEGEND**

- ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- WASTE FROM CELL IS INCLUDED IN OTHER CELL
- EXTENT OF WASTE
- SWIFT MODEL CELL (COLUMN, ROW)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.

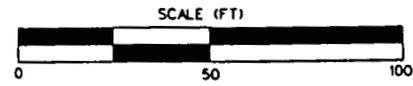


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**FIGURE 5-10**  
**EXTENT OF WASTE AND**  
**MODELED SWIFT GRID CELLS,**  
**LIME SLUDGE PONDS**

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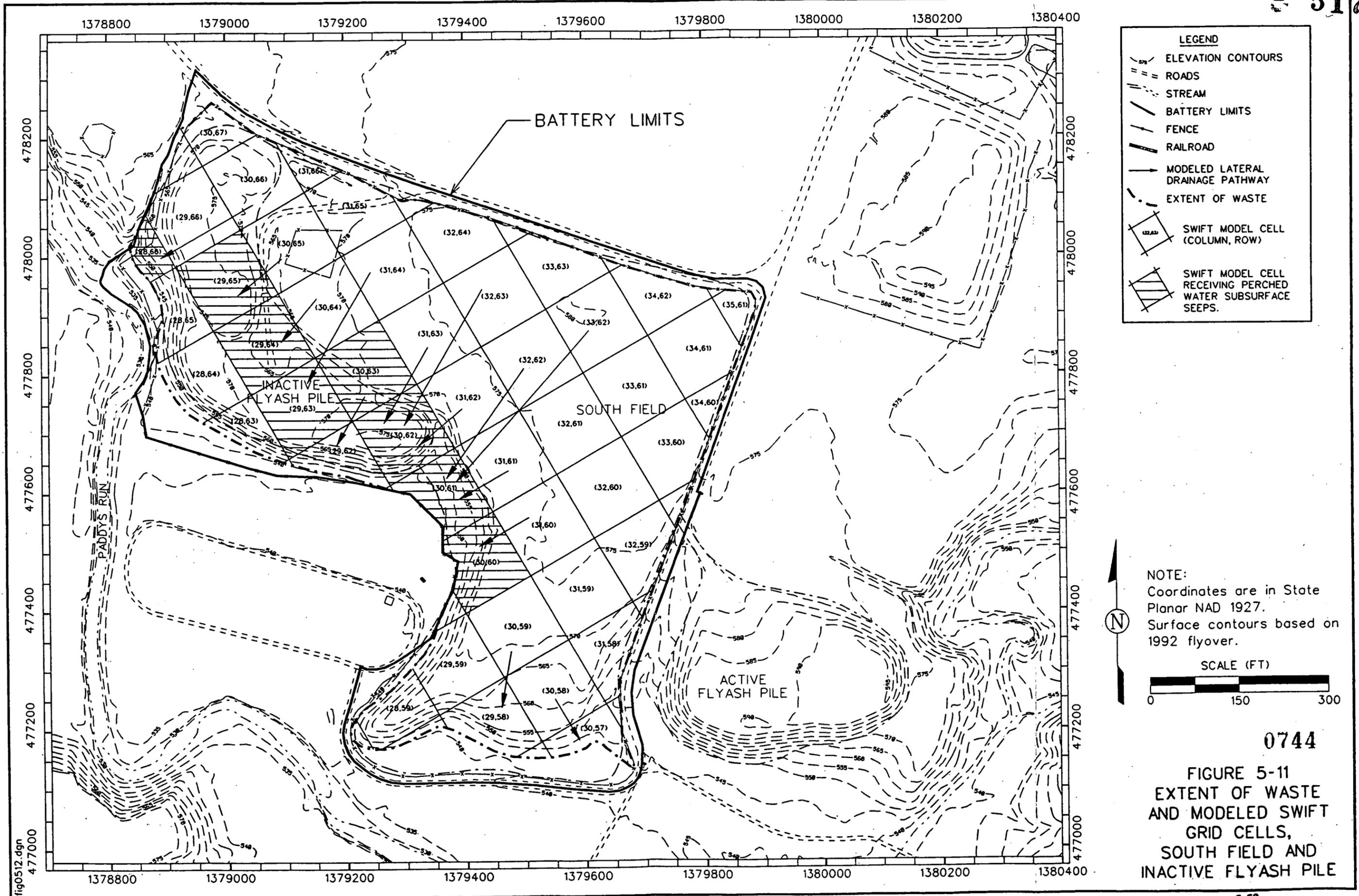
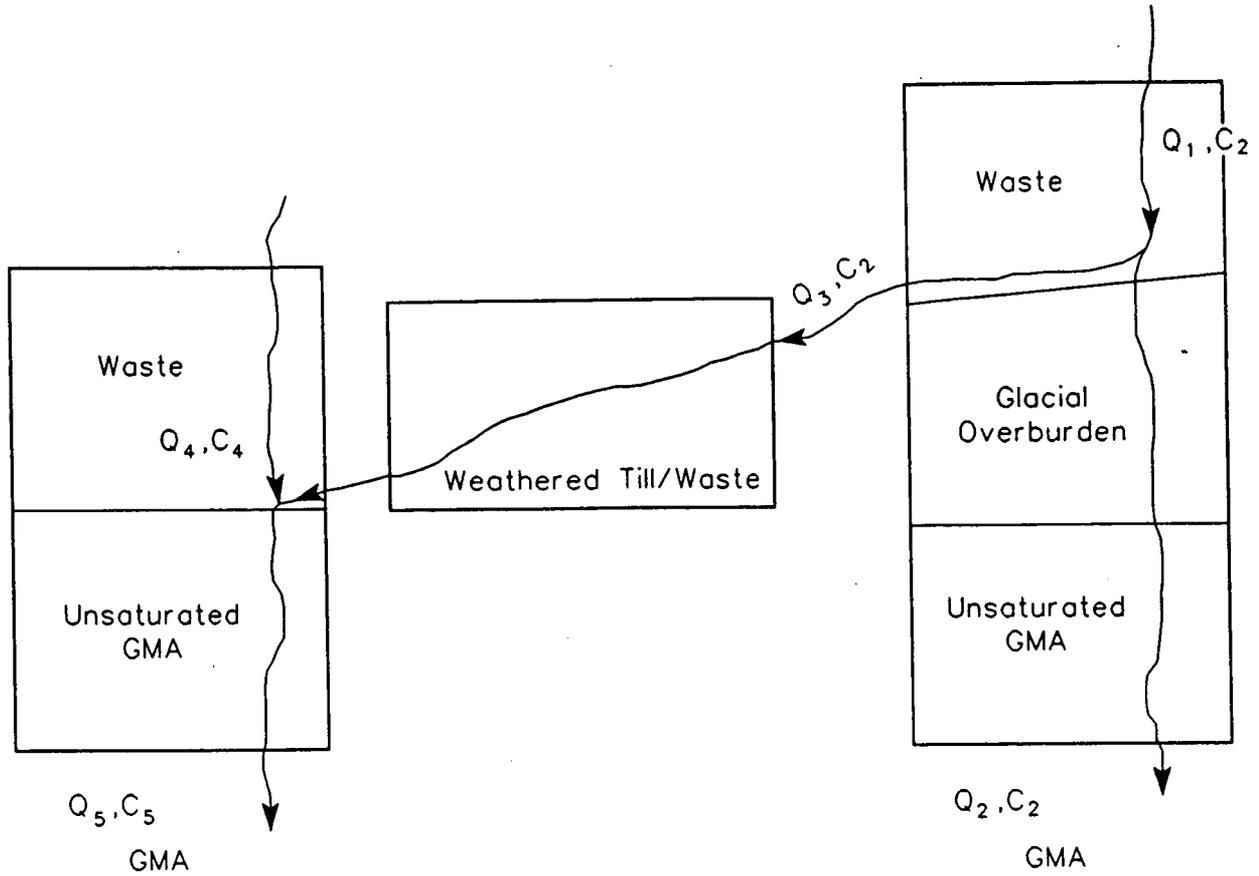


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$$Q_1 = Q_2 + Q_3$$

$$Q_5 = Q_3 + Q_4$$

$$C_5 = \frac{Q_3 C_2 + Q_4 C_4}{Q_3 + Q_4}$$

NOTE:

$C_i$  - CONSTITUENT CONCENTRATION

$Q_i$  - FLOW RATE

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FIGURE 5-12  
CONCEPTUAL MODEL FOR LATERAL DRAINAGE INFILTRATING  
TO THE UNSATURATED GREAT MIAMI AQUIFER

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TABLE 5-14

PHYSICAL PARAMETERS FOR THE SWIFT III GRID CELLS IMPACTED  
BY THE LIME SLUDGE PONDS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Row	Column	Fill or Waste Area (ft <sup>2</sup> )	Fill or Waste		Unsaturated GMA Thickness (ft)	Glacial Overburden Thickness (ft)	Thickness of Till Above the Sand/Gravel (ft)	Thickness of Sand/Gravel In Till (ft)	Thickness of Till Below the Sand/Gravel (ft)	Total Till Thickness (ft)
			Volume (ft <sup>3</sup> )	Thickness (ft)						

ZONE 1 - 2 TO FOUR FEET OF FILL

44	79	5427	15019	2.7	17.7	38.4	15.9	3.6	18.9	34.8
45	80	9163	31863	3.6	19.0	36.3	17.3	5.5	13.5	30.8
43	81	10313	36381	3.9	18.3	35.9	10.3	5.9	19.7	30.0
Zone 1 Average		8288	27754	3.4	18.3	36.8	14.5	5.0	17.4	31.8

ZONE 2 - 6.5 TO 8.5 FEET OF FILL

44	81	15625	100156	6.4	19.7	31.7	11.3	3.8	16.6	27.9
43	80	10322	69238	6.9	16.7	34.9	7.5	5.4	22.0	29.4
45	81	11414	89781	8.5	20.5	29.6	11.9	6.1	11.6	23.6
Zone 2 Average		12454	94969	7.4	20.1	30.7	11.6	5.0	14.1	25.7

ZONE 3 - 9.4 FEET OF FILL

44	80	15625	146931	9.4	18.2	31.3	9.1	3.6	18.6	27.6
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NOTE: GMA = Great Miami Aquifer

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virtually no tills, while the till thicknesses increases to 22 feet towards the northeastern portion of the South Field. The thickness of the unsaturated zone in the Great Miami Aquifer (Layer 2) ranges from 17 to 33 feet (Table 5-15). When leachate from waste arrives at the interface of waste and till, a portion of leachate infiltrates through glacial overburden (till and sand/gravel stringers) and the rest is laterally drained to areas where till does not exist. Figure 5-12 shows the conceptual model for lateral drainage. The area receiving lateral drainage has increased flow. Horizontal travel time is simulated by travel through an equivalent Layer 1 using permeability of waste material. A separate one-dimensional analytical solute transport model (ODAST) run was used for simulating contribution from lateral drainage and was added to the Great Miami Aquifer before screening. Lateral drainage and infiltration through waste were added to calculate total vertical percolation rate and interstitial fluid velocity for the areas receiving lateral drainage from upgradient waste areas.

Perched water has been observed in 0 to 3 feet thick sand and gravel layers in the till. These sand and gravel layers are underlain by 2 to 11 feet thick till layer. Perched water not only represents a source for vertical infiltration, but it also serves as a source for perched water subsurface seeps. Figure 5-13 shows the conceptual model for the perched water subsurface seeps. Sand and gravel layer within the till (containing perched water) comes in contact with the waste in sections of the Inactive Flyash Pile and South Field. Perched water laterally moves in the sand layer until it is intercepted at the sand/gravel and waste contact. At that point, perched water moves along the slope of waste and till interface until it comes in contact with the unsaturated Great Miami Aquifer. The subsurface seep water then vertically infiltrates to the aquifer. Figure 5-11 identifies eight blocks which receive subsurface seep water.

Furthermore, two seeps have been observed adjacent to or in the area of these subunits. One seep exists on the western boundary of the Inactive Flyash Pile, while another was observed on the eastern side of the South Field. Seep water travels on the top of the till until it flows onto the unsaturated sand and gravels of the Great Miami Aquifer. At those locations, seep water infiltrates into the Great Miami Aquifer. These seeps were included as source term for the Great Miami Aquifer.

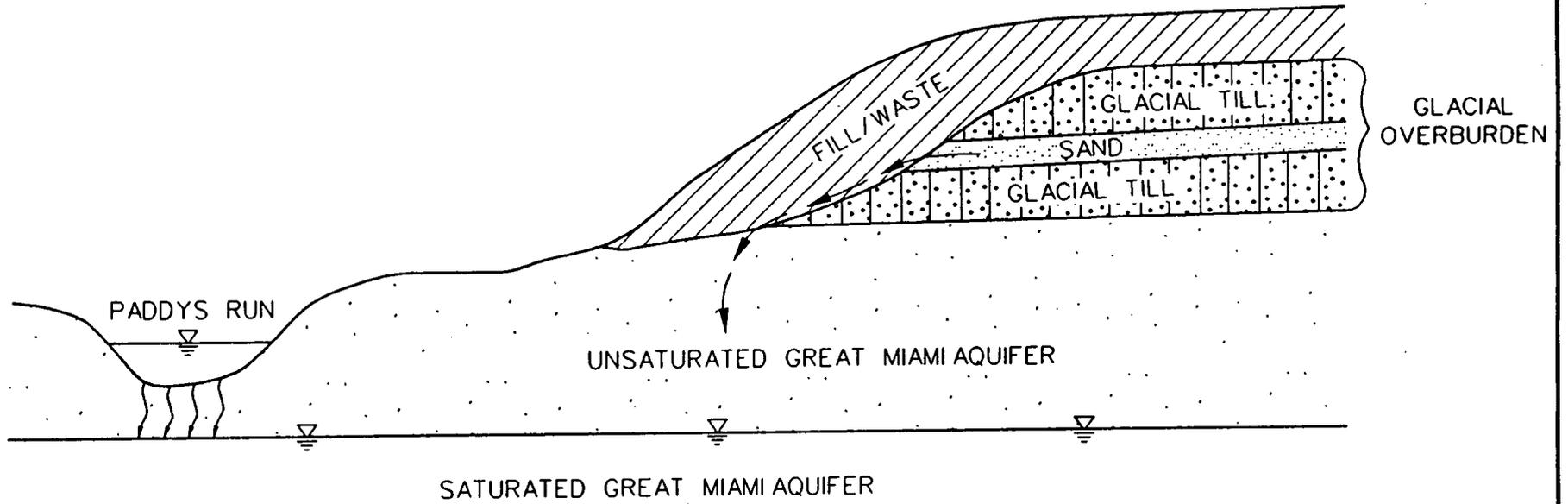
5.4.1.4 Active Flyash Pile

The constituent migration pathways applicable to the Active Flyash Pile were the vadose zone, perched water infiltration, and surface water pathways. Figure 5-14 shows the SWIFT III grid blocks directly under the waste at the Active Flyash Pile. The Active Flyash Pile overlies a variable, 0 to 22

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FIGURE 5-13  
CONCEPTUAL MODEL FOR PERCHED WATER SUBSURFACE SEEPS

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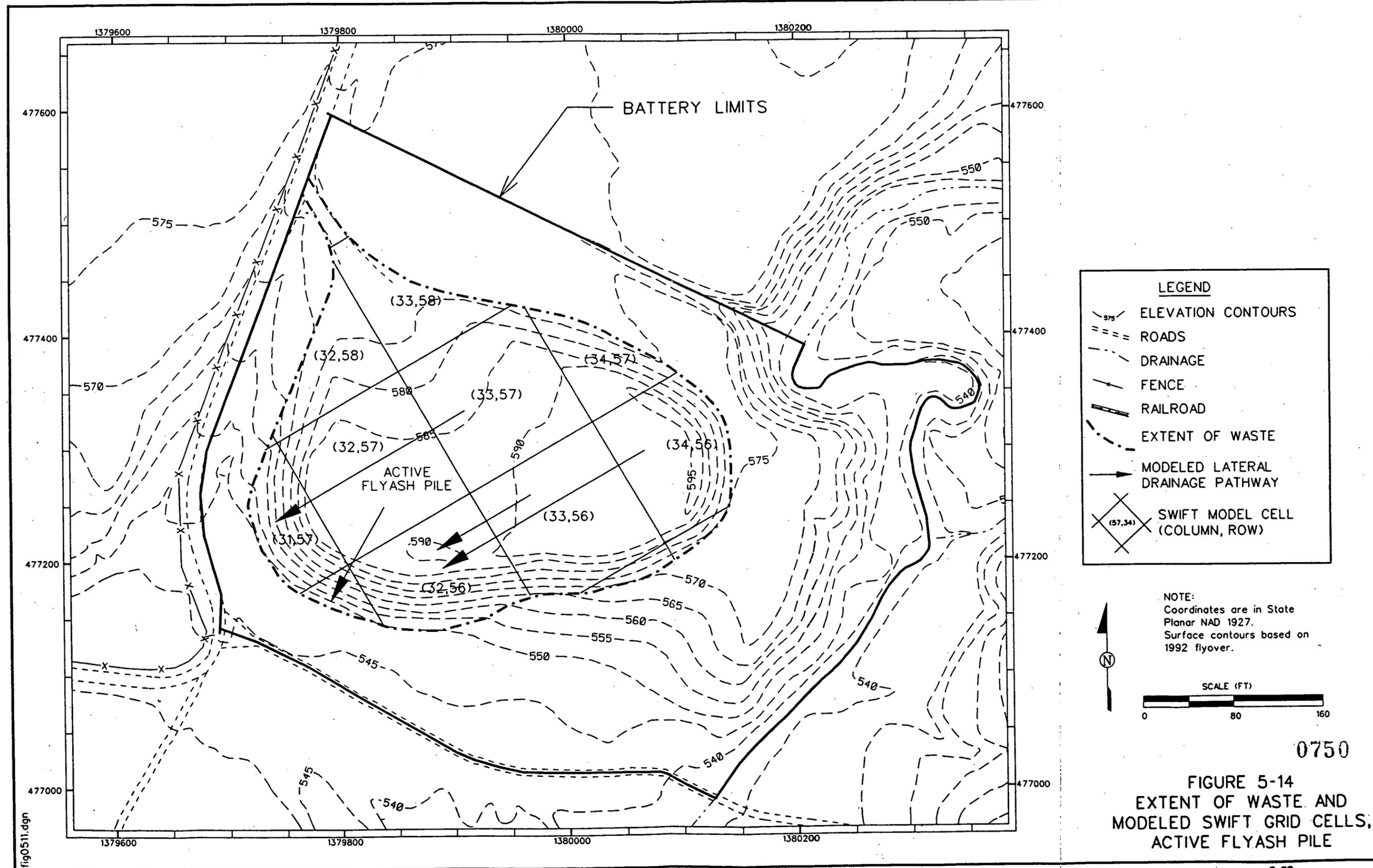


TABLE 5-15

PHYSICAL PARAMETERS FOR THE SWIFT III GRID CELLS IMPACTED  
 BY THE INACTIVE FLYASH PILE AND SOUTH FIELD  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Row	Column	Fill or Waste Area (ft)	Fill or Waste		Unsaturated GMA Thickness (ft)	Glacial Overburden Thickness (ft)	Thickness of Till Above the Sand/Gravel (ft)	Thickness of Sand/Gravel In Till (ft)	Thickness of Till Below the Sand/Gravel (ft)	Total Till Thickness (ft)	Slope at the Base of Fill/Waste (%)
			Volume (ft <sup>3</sup> )	Thickness (ft)							

ZONE 1 - NO SAND, NO TILL, MEDIUM FILL/WASTE

28	59	11720	15938	15.6	16.7	0.0	0.0	0.0	0.0	0.0	
28	63	7029	104463	15.2	18.9	0.0	0.0	0.0	0.0	0.0	
28	65	8907	133369	15.2	19.6	0.0	0.0	0.0	0.0	0.0	
29	62	8869	151588	16.2	18.5	0.0	0.0	0.0	0.0	0.0	
29	64	15625	285594	18.3	25.5	0.0	0.0	0.0	0.0	0.0	
30	62	15625	292094	18.7	24.1	0.0	0.0	0.0	0.0	0.0	
Zone 1 Average		11296	187174	16.5	20.6	0.0	0.0	0.0	0.0	0.0	0.0

ZONE 2 - NO SAND, NO TILL, MAXIMUM FILL/WASTE

28	64	13618	292531	21.3	19.7	0.0	0.0	0.0	0.0	0.0	
29	63	15625	382981	24.5	20.8	0.0	0.0	0.0	0.0	0.0	
Zone 2 Average		14622	337756	22.9	20.2	0.0	0.0	0.0	0.0	0.0	0.0

ZONE 3 - NO SAND, LESS THAN 2 FEET FILL/WASTE

29	60	1392	1706	1.4	25.4	0.0	0.0	0.0	0.0	0.0	
30	57	8444	1006	0.1	21.3	0.0	0.0	0.0	0.0	0.0	
30	61	12342	21281	1.6	24.8	0.0	0.0	0.0	0.0	0.0	
Zone 3 Average		7393	7998	1.0	23.8	0.0	0.0	0.0	0.0	0.0	0.0

See note at end of table

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**TABLE 5-15  
(Continued)**

Row	Column	Fill or Waste Area (ft)	Fill or Waste		Unsaturated GMA Thickness (ft)	Glacial Overburden Thickness (ft)	Thickness of Till Above the Sand/Gravel (ft)	Thickness of Sand/Gravel In Till (ft)	Thickness of Till Below the Sand/Gravel (ft)	Total Till Thickness (ft)	Slope at the Base of Fill/Waste (%)
			Volume (ft <sup>3</sup> )	Thickness (ft)							

**ZONE 4 - NO SAND, LESS THAN 10 FEET FILL/WASTE**

28	66	4480	15288	3.5	21.3	6.0	0.0	0.0	6.0	6.0	
30	60	13981	87850	6.4	29.0	7.0	0.3	0.0	6.7	7.0	
31	58	11040	56950	5.7	29.6	6.0	0.0	0.0	5.9	6.0	
31	59	15625	131675	8.4	31.4	11.8	3.2	0.1	8.6	11.8	
Zone 4 Average		11282	72941	6.0	27.8	7.7	0.0	0.0	7.7	7.7	1.5

**ZONE 5 - NO SAND, LESS THAN 2 FEET TILL, MORE THAN 10 FEET FILL/WASTE**

29	58	12171	137888	11.0	18.2	0.0	0.0	0.0	0.0	0.0	
29	59	14263	297838	20.7	20.2	0.0	0.0	0.0	0.0	0.0	
29	65	15625	398850	25.5	24.8	0.0	0.0	0.0	0.0	0.0	
Zone 5 Average		14020	278192	19.1	21.1	0.0	0.0	0.0	0.0	0.0	8.5

**ZONE 6 - NO SAND, MORE THAN 2 FEET SAND, MORE THAN 10 FEET FILL/WASTE**

30	58	15625	164338	10.5	21.7	7.4	0.0	0.0	7.4	7.4	
30	59	15625	231375	14.8	28.2	6.5	0.0	0.0	6.5	6.5	
30	63	15625	294731	18.9	24.8	3.3	0.0	0.0	3.3	3.3	
30	64	15625	245375	15.7	26.4	4.4	0.0	0.0	4.4	4.4	
Zone 6 Average		15625	233955	15.0	25.3	5.4	0.0	0.0	5.4	5.4	5

**ZONE 7 - NORTHERN PART OF INACTIVE FLYASH PILE**

29	67	3837	13519	3.6	32.5	8.5	3.3	3.0	2.2	5.4	
30	67	6665	55444	8.9	29.7	8.4	1.7	2.7	3.9	5.7	
Zone 7 Average		5251	34481	6	31	8	2	3	3.1	5.5	0.0

See note at end of table

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**TABLE 5-15  
(Continued)**

Row	Column	Fill or Waste Area (ft)	Fill or Waste		Unsaturated GMA Thickness (ft)	Glacial Overburden Thickness (ft)	Thickness of Till Above the Sand/Gravel (ft)	Thickness of Sand/Gravel In Till (ft)	Thickness of Till Below the Sand/Gravel (ft)	Total Till Thickness (ft)	Slope at the Base of Fill/Waste (%)
			Volume (ft <sup>3</sup> )	Thickness (ft)							
<b>ZONE 8</b>											
29	66	15241	227906	15.2	32.0	4.0	0.3	1.4	2.3	2.6	0.0
<b>ZONE 9</b>											
30	65	15625	117675	7.5	27.3	10.1	0.4	0.4	9.2	9.7	4
<b>ZONE 10 - LESS THAN 3 FEET OF TILL ABOVE SAND</b>											
30	66	15429	154863	9.9	28.6	10.3	1.6	1.6	7.1	8.7	
31	61	15625	149431	9.6	30.8	10.8	2.1	1.3	7.4	9.5	
31	62	15625	134256	8.6	30.1	11.5	2.3	0.8	8.4	10.7	
31	63	15625	162263	10.4	29.5	12.2	1.8	0.7	9.7	11.5	
Zone 10 Average		15576	150203	9.6	29.8	11.2	1.9	1.1	8.2	10.1	4
<b>ZONE 11 - LESS THAN 1 FEET OF FILL, MORE THAN 5 FEET OF TILL ABOVE SAND</b>											
31	66	3615	4919	0.9	28.7	18.5	8.3	0.8	9.4	17.7	
34	60	3509	1269	0.3	32.7	22.7	12.8	2.1	7.8	20.6	
35	61	4123	788	0.2	32.2	23.9	12.8	2.0	9.1	21.9	
Zone 11 Average			2325	0.5	31.2	21.7	11.3	1.6	8.8	20.1	0
<b>ZONE 12 - 2-3 FEET OFF FILL, GOOD TILL LAYER ABOVE SAND</b>											
31	65	13612	31419	2.3	28.6	18.0	5.8	1.5	10.7	16.5	
32	64	14238	41544	3.0	29.6	22.0	10.6	1.8	9.6	20.2	
33	59	1860	3688	2.0	33.0	18.3	9.8	1.3	7.2	17.0	
33	60	14234	26344	1.8	32.7	20.4	10.7	2.0	7.7	18.4	
33	61	15625	39369	2.5	31.8	21.7	10.7	1.8	9.2	20.0	
33	63	12928	29019	2.4	30.6	23.5	12.1	1.7	9.6	21.7	

See note at end of table

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**TABLE 5-15  
(Continued)**

Row	Column	Fill or Waste Area (ft)	Fill or Waste		Unsaturated GMA Thickness (ft)	Glacial Overburden Thickness (ft)	Thickness of Till Above the Sand/Gravel (ft)	Thickness of Sand/Gravel In Till (ft)	Thickness of Till Below the Sand/Gravel (ft)	Total Till Thickness (ft)	Slope at the Base of Fill/Waste (%)
			Volume (ft <sup>3</sup> )	Thickness (ft)							

**ZONE 12 - 2-3 FEET OF FILL, GOOD TILL LAYER ABOVE SAND (Continued)**

34	61	15140	39388	2.6	32.1	22.2	11.0	2.0	9.1	20.1	
34	62	10365	26269	2.8	31.5	22.6	11.2	1.7	9.7	20.9	
Zone 12 Average		12250	29630	2.4	31.2	21.1	10.3	1.7	9.1	19.3	0

**ZONE 13 - MORE THAN 4 FEET OF FILL WITH LATERAL DRAINAGE**

31	60	15625	121769	7.8	31.6	14.0	4.1	1.4	8.6	12.7	
31	64	15625	104775	6.7	29.1	15.9	4.5	0.8	10.6	15.1	
32	62	15625	96975	6.2	30.7	18.8	7.3	2.5	9.0	16.3	
32	63	15625	96025	6.2	30.1	19.7	8.4	2.1	9.3	17.6	
33	62	15625	63881	4.1	31.1	21.7	10.3	1.7	9.8	20.1	
Zone 13 Average		15625	96685	6.2	30.5	18.0	6.9	1.7	9.5	16.4	0.9

**ZONE 14 - MORE THAN 4 FEET OF FILL, NO LATERAL DRAINAGE**

32	59	12620	60931	4.9	32.5	14.8	6.3	0.7	7.9	14.1	
32	60	15625	70544	4.5	32.3	17.6	7.6	2.5	7.5	15.1	
32	61	15625	66731	4.3	31.4	18.6	7.7	2.3	8.6	16.3	
Zone 14 Average		14623	66069	4.6	32.1	17.0	7.2	1.8	8.0	15.2	0

NOTE: GMA = Great Miami Aquifer

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feet thick layer of till (Layer 1) for the vadose zone pathway followed immediately by 22 to 33 feet of the unsaturated Great Miami Aquifer layer (Table 5-16). For the purposes of modeling, colluvial material was assumed to have the same properties as the Great Miami Aquifer soils. Lateral drainage of infiltrated leachate was simulated as shown in Figure 5-12. Although no sand/gravel layers were identified under the Active Flyash Pile during field activities, perched water has been observed in monitoring wells installed just north of the Active Flyash Pile. Therefore, a 3-foot perched water layer in the middle of the till layer was used for perched water infiltration pathway simulation.

5.4.2 Technical Approach

This section describes the technical approach used to model groundwater.

5.4.2.1 Source Term Development for Vadose Zone and Groundwater Models

Analytical data for the waste areas were compiled and screened to identify CPCs based on the requirements of the Operable Unit 2 baseline risk assessment (Section 6.0 and Appendix B). A variety of radionuclides, inorganics, and organic compounds are included in the CPC list. Waste area constituent concentrations (as calculated in Appendix B) and their corresponding inventory are presented in Appendix A-2.

Waste constituent concentrations used in the groundwater modeling were the upper 95 percent confidence level on the means of the waste concentrations from the RI/FS subsurface soil or perched water database for Operable Unit 2. For uranium-238, the waste concentration in each block was estimated using kriging. This approach was selected for uranium, since uranium controls the risk from groundwater pathways, to simulate known hot spots identified during field investigations.

All validated uranium-238 analysis from RI/FS Phase I and Phase II field investigations for each subunit were segregated by waste/fill, glacial overburden, and sand/gravel of the Great Miami Aquifer. Uranium-238 concentrations in each 25 x 25 x 2.5 foot block were then estimated using three-dimensional kriging for each media type. Kriging for each medium used analytical results of soil samples from that medium only. Average waste concentrations in each 125 x 125 foot SWIFT III grid cells were then calculated from 25 x 25 x 2.5 foot thick blocks. These concentrations are reported in Section 5.4.3.

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**TABLE 5-16**  
**PHYSICAL PARAMETERS FOR THE SWIFT III GRID CELLS IMPACTED**  
**BY THE ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Row	Column	Fill or Waste Area (ft)	Fill or Waste		Unsaturated GMA Thickness (ft)	Glacial Overburden Thickness (ft)	Slope at the Base of Fill/Waste (%)
			Volume (ft <sup>3</sup> )	Thickness (ft)			
<b>ZONE 1 - CENTRAL PORTION OF THE ACTIVE FLYASH PILE</b>							
32	57	15625	449800	28.8	30.1	5.7	
33	56	15240	319700	21.2	30.8	15.8	
33	57	15595	276300	17.7	31.6	14.9	
34	56	11205	188350	15.9	31.2	22.2	
<b>Zone 1 Average</b>		14416	308538	20.9	30.9	14.7	5
<b>ZONE 2 - NORTHERN SLOPING SURFACE</b>							
32	58	7095	55100	8.0	31.7	12.7	
33	58	7350	42250	5.6	32.6	16.6	
34	57	5885	68700	12.2	32.1	20.0	
<b>Zone 2 Average</b>		6777	55350	8.6	32.1	16.4	0
<b>ZONE 3 - FLYASH DIRECTLY ON THE GREAT MIAMI AQUIFER</b>							
31	56	1625	16100	8.6	22.1	0.0	
31	57	6240	90550	16.1	25.8	0.0	
32	56	11570	246250	20.7	28.3	0.0	
<b>Zone 3 Average</b>		6478	117633	15.1	25.4	0.0	0

NOTE: GMA = Great Miami Aquifer

The source terms for seeps and perched water (infiltration and subsurface seep) pathways were estimated using the following equation:

$$\text{Mass} = (\phi C_w + \rho_b K_d C_w) A b$$

where:

- A = Area of cell (125 x 125 ft<sup>2</sup>)
- b = Average perched water zone thickness
- C<sub>w</sub> = Upper 95 percent confidence level on the means of the perched water concentrations
- K<sub>d</sub> = Distribution coefficient
- φ = Porosity
- ρ<sub>b</sub> = Bulk (dry) density

#### 5.4.2.2 Methods of Estimating Leachate Concentrations

Estimated leachate concentrations were used as initial CPC concentrations in the vadose zone fate and transport model to predict CPC concentrations at the top of the Great Miami Aquifer. Conservative assumptions were used in developing leachate concentrations. All CPC concentrations used as input data in the fate and transport model were constrained by (in order of preference): in situ leachate analyses (Appendix C, Section 4.0), TCLP data (Appendices C through G, Section 4.0), or the EPA 70-year rule (EPA 1988a). See Figure 5-15 for logic in estimating leachate concentrations. Geochemical modeling was not used due to lack of data or large uncertainty associated with leachate concentrations derived from geochemical modeling.

The preferred data for estimating contaminant concentrations in leachate was analyses of in situ leachate. When these data were unavailable, an approach of using the best available TCLP data was followed. When a constituent was detected in in situ leachate or TCLP, the maximum detected concentration was used as leachate concentration. If in situ leachate or TCLP analyses indicated that the compound was not detected, then the concentration of a particular CPC was conservatively estimated as the maximum detection limit value. For CPCs that lack in situ and TCLP data, the EPA 70-year rule calculation was used to estimate their leachate concentration. If the leachate concentration estimated from the EPA 70-year rule exceeds the solubility limit, then the leachate concentration was set to the solubility limit.

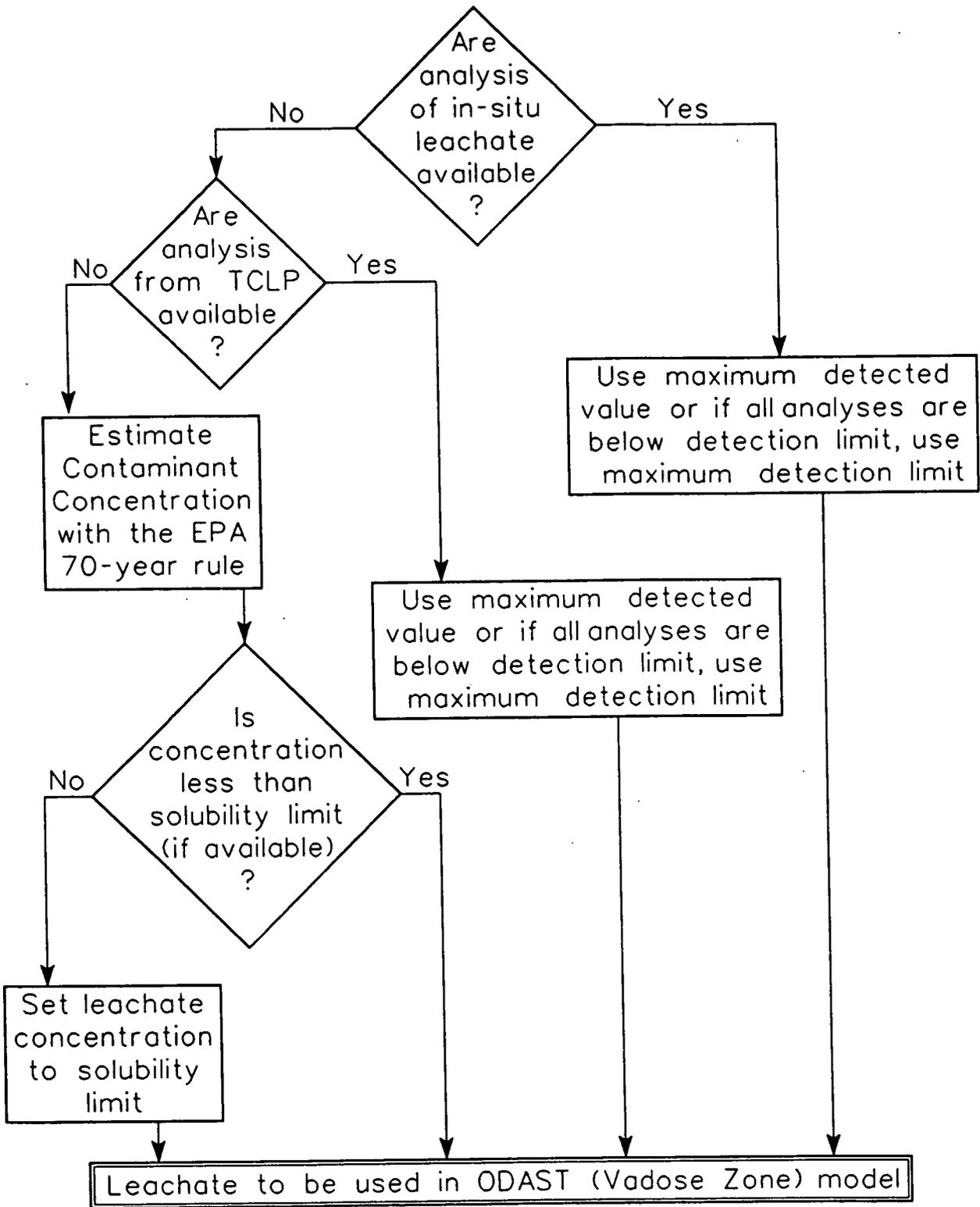


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FIGURE 5-15  
PROCEDURE FOR ESTIMATING LEACHATE CONCENTRATION

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Uncertainties in Estimating Leachate Concentration

As waste composition in Operable Unit 2 subunits is generally heterogeneous, it is possible that in situ leachate concentration may not be a representative value of leachate concentration in each block. Uncertainty is introduced into the estimation of leachate composition whenever in situ leachate analyses are lacking. Figure 5-15 shows the procedure for estimating leachate concentrations. The logic behind using this decision hierarchy is to apply the best available site-specific data to the estimation of leachate compositions. Each successively lower step on this hierarchy represents a more conservative method for estimating CPC concentrations in leachate. For example, the use of TCLP data to estimate leachate composition will probably result in CPC concentrations that are greater than values expected for in situ leachate. The acetic acid leaching used in TCLP procedure results in greater concentrations for many metals in leachate because acetic acid is a more aggressive leaching agent than rainwater. Calculations carried out to estimate CPC concentrations using the EPA 70-year rule will introduce a large conservative uncertainty for all but the most soluble contaminants (e.g., bromide and cesium). The possibility exists to underestimate the contaminant concentration when the EPA 70-year rule is applied to a very soluble constituent. However, the value used for the baseline risk assessment was the maximum predicted concentration for a full 70-year average life span of humans. Even if the leaching time is underestimated by a factor of two to three, peak concentration in the Great Miami Aquifer will occur very early when the concentration of other (less soluble) CPCs is low and risk will still be below the  $10^{-6}$  carcinogenic risk or HI of 1.0, if the very soluble CPC was screened out.

5.4.2.3 Vadose Zone Modeling

Details of the vadose zone modeling is presented in Appendix A.2. Vadose zone modeling was performed by using the leachate concentrations and results of initial screening as inputs into one-dimensional unsaturated flow models to simulate transport through the vadose zone to the Great Miami Aquifer. The ODAST model was used to simulate dispersion, retardation, and decay through unsaturated materials. The Hydrologic Evaluation of Landfill Performance (HELP) model was used to estimate infiltration rates and lateral drainage.

Waste above each SWIFT III grid cell was modeled separately with individual stratigraphy, contaminant type and concentration, and infiltration rate parameters. The conceptual models for the subunits considered the following:

- The contents of waste above individual SWIFT III grid cells
- The presence or absence of standing water in the waste
- The presence/absence of perched water beneath each SWIFT III grid cells
- The average concentration of CPC in perched groundwater
- The identifiable geologic strata beneath the waste areas
- The presence/absence of sand lenses beneath the subunits
- The thickness of each layer in the vadose zone
- The vertical permeability of the layers
- The interstitial fluid velocity through each layer based on saturation
- The dispersion coefficients of each layer
- The partition coefficients for each contaminant in each layer

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The vadose zone was modeled as two layers: the glacial overburden underlying the waste areas (Layer 1) and the unsaturated portion of the underlying Great Miami Aquifer (Layer 2). Layer 1 soils consist of tills in the glacial overburden. A sequence of fine-grained till deposits interbedded with sand and gravel glaciofluvial stringers forms the glacial overburden in Operable Unit 2. The sand and gravel unit within the glacial overburden was not included in the vadose zone modeling because this layer has much higher permeability and less adsorption potential compared to clay and silts in glacial overburden. The thickness of till ranges between 0 and 38 feet for Operable Unit 2 waste areas. Beneath the till is the unsaturated sand and gravel outwash layer (Layer 2), which is present beneath all the waste units. The thickness of Layer 2 ranges from 16 to 33 feet.

The vertical hydraulic conductivity values for Layer 1 were obtained from the geometric average horizontal hydraulic conductivities of 1000-series wells completed in dark gray clay or clayey silt or from maximum permeability measurements conducted on core samples. The vertical hydraulic conductivity for Layer 2 was obtained by dividing the horizontal hydraulic conductivity of the Great Miami Aquifer by 10. The factor of 10 represents a typical horizontal to vertical hydraulic conductivity ratio. The vertical hydraulic conductivity was estimated to be  $1.9 \times 10^{-6}$  to  $1.4 \times 10^{-7}$  cm/s for Layer 1. The vertical hydraulic conductivity of Layer 2 was estimated to be  $1.6 \times 10^{-2}$  cm/s for all of the Operable Unit 2 subunits.

Flow and solute transport through porous media are not only determined by the parameters considered in the conceptual model described above, but they are also affected by the retardation factors and decay rates. These parameters are both chemical- and media-specific. The retardation factors used for all the CPCs in the vadose zone Layers 1 and 2, the radioactive decay constants for radionuclides, and the biodegradation coefficients for the organic constituents are discussed in detail in

Appendix A.2. These retardation factors and decay rates are used in the analytical modeling of the vadose zone and numeric modeling of the Great Miami Aquifer.

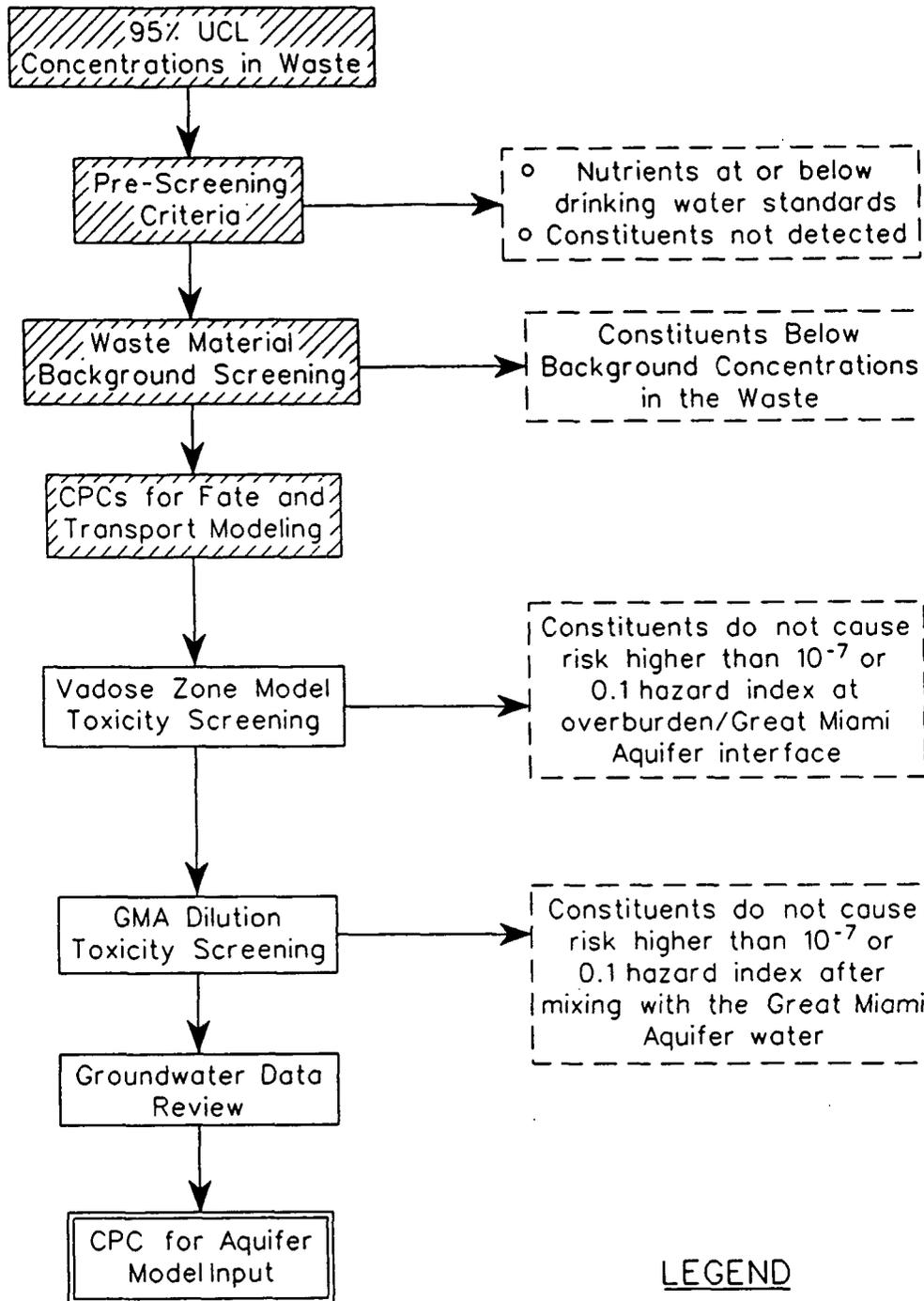
The retardation factor was used to account for those reversible reactions that slow the arrival of a contaminant front, but do not act as a sink. The retardation factor can be expressed as the ratio between the rate of groundwater movement and the rate of contaminant movement. The retardation factors used have been revised from the Risk Assessment Work Plan Addendum (DOE 1992a) based on more conservative assumptions (for transport) of organic content and moisture content (see Table 5-17). The radioactive decay constants and biodegradation coefficients were estimated based on the degradation rates (Howard et al. 1991) using the formulation presented in the Risk Assessment Work Plan Addendum (DOE 1992a).

In the South Field, Inactive Flyash Pile, and Active Flyash Pile, some of the waste material is directly underlain by an unsaturated portion of the Great Miami Aquifer; other waste material is underlain by glacial overburden. When leachate from waste arrives at the interface of waste and glacial overburden, a portion of leachate infiltrates through glacial overburden; the rest of the leachate is laterally drained to areas where glacial overburden does not exist. Figure 5-12 shows the conceptual model for lateral drainage. The area receiving lateral drainage has increased flow. Horizontal travel time is simulated by travel through an equivalent Layer 1 with a permeability of waste material. A separate ODAST run was used before screening for simulating contribution from lateral drainage to the Great Miami Aquifer. Lateral drainage and infiltration through waste were added to calculate the total vertical percolation rate and interstitial fluid velocity for the areas receiving lateral drainage from upgradient waste areas (see Figure 5-12).

5.4.2.4 Screening Procedures

The list of potential CPCs was screened in several ways to eliminate constituents from further analysis that pose insignificant risk. These screening steps were performed because vadose zone and aquifer modeling requires long computational times and allows the analysis to focus on only those constituents that may potentially create significant risks. Figure 5-16 shows the different screening steps. These steps include prescreening, background screening (performed and presented in Section 6.0 and Appendix B), vadose zone output concentration screening, and Great Miami Aquifer dilution screening (presented in detail in Appendix A). Each subunit was treated separately in these

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**LEGEND**

 RI Appendix B Screening  
 RI Appendix A Screening  
 Calculation  
 Screened Out

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FIGURE 5-16  
POTENTIAL CONSTITUENT OF CONCERN SCREENING DIAGRAM

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**TABLE 5-17**  
**MEDIA PARAMETERS FOR VADOSE ZONE MODEL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	Vadose Zone	
	Layer 1 <sup>a</sup>	Layer 2 <sup>b</sup>
<b>SOLID WASTE LANDFILL</b>		
Porosity (%)	41	39
Specific yield (%)	6	25
Bulk density (g/cc)	1.89	1.60
Field capacity (%)	37.1	4.5
Organic content (%)	1.43	0.87
Fines passing less than 200 mesh (%)	70.1	16.5
<b>LIME SLUDGE PONDS</b>		
Porosity (%)	41	39
Specific yield (%)	6	25
Bulk density (g/cc)	1.73	1.60
Field capacity (%)	28	14
Organic content (%)	1.65	0.87
Fines passing less than 200 mesh (%)	70.1	16.5
<b>INACTIVE FLYASH PILE</b>		
Porosity (%)	41	39
Specific yield (%)	6	25
Bulk density (g/cc)	1.85	1.60
Field capacity (%)	37.1	4.5
Organic content (%)	1.69	0.87
Fines passing less than 200 mesh (%)	70.9	16.5

See footnotes at end of table

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**TABLE 5-17  
(Continued)**

Parameter	Vadose Zone	
	Layer 1 <sup>a</sup>	Layer 2 <sup>b</sup>
<b>SOUTH FIELD</b>		
Porosity (%)	41	39
Specific yield (%)	6	25
Bulk density (g/cc)	1.85	1.60
Field capacity (%)	37.1	4.5
Organic content (%)	1.69	0.87
Fines passing less than 200 mesh (%)	70.9	16.5
<b>ACTIVE FLYASH PILE</b>		
Porosity (%)	41	39
Specific yield (%)	6	25
Bulk density (g/cc)	1.850	1.600
Field capacity (%)	37.1	4.5
Organic content (%)	1.89	0.87
Fines passing less than 200 mesh (%)	70.9	16.5

<sup>a</sup>Layer 1 consists of a clay-rich glacial till interbedded with glaciofluvial sand and gravel stringers. However, Layer 1 consists of only glacial till.

<sup>b</sup>Layer 2 consists of unsaturated well-sorted sand and gravel outwash deposits existing above the Great Miami Aquifer.

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screening analyses. These screening steps were applied only to the vadose zone modeling where each block was modeled individually.

If the modeling of a possible CPC through the vadose zone to the Great Miami Aquifer revealed that the peak concentrations of the constituent before or after dilution was below the screening concentration at the point of reaching the Great Miami Aquifer within 1,000 years, further modeling of the constituent was not considered necessary for the human health risk assessment. The CPC concentration capable of producing  $1 \times 10^{-7}$  lifetime cancer risk for carcinogens or the concentration of the 0.1 HI for noncarcinogens was selected to be an appropriate and conservative screening level. If the predicted concentration of a given constituent equals or exceeds the respective screening level concentration after mixing the Great Miami Aquifer, the constituent was included in the aquifer modeling.

5.4.2.5 Great Miami Aquifer Modeling

The calibrated groundwater flow model for the FEMP was developed previously for use in Operable Unit 5. A detailed description of the development, calibration, and verification of the site-wide model is available in the Groundwater Modeling Report, Summary of Model Development, April 1993 (DOE 1993d). The model is based on the SWIFT III model. The modeling approach taken for Operable Unit 2 is described in detail in Appendix A-2. The Operable Unit 2 fate and transport modeling involved incorporating the vadose zone modeling results (for vadose zone, perched water infiltration, perched water subsurface seep, and seep pathways) to determine loading rates (both concentration and volume) to the Great Miami Aquifer from the subunits. In addition, surface water infiltration from the Storm Sewer Outfall Ditch or Paddys Run to the Great Miami Aquifer was used as an additional source term to the model. The model then simulated the transport of constituents away from these source areas. Figure 5-7 presents a conceptual model of fate and transport through groundwater. Dispersion, retardation, and decay were factored into the contaminant transport process. SWIFT III simulations of CPC transport in the Great Miami Aquifer were run up to 1,000 years.

One modeling run was performed for each CPC that remained after the screening processes. The loading from each grid cell impacted by the subunit was entered into the SWIFT III model as a discrete source, making multiple sources for each constituent. Due to the proximity of the Inactive Flyash Pile to the South Field, sources from the Inactive Flyash Pile and South Field were combined

into one SWIFT III run. The modeling runs produced simulations of the aggregate effects of loading from these two subunits for the CPCs.

Only uranium-238 was modeled to reduce computation time for modeling of uranium isotopes. Concentrations of uranium-234, uranium-235/236 were estimated by using site-specific activity ratios for uranium. The uranium at the FEMP is mostly uranium-238 (approximately 91 percent by mass). A discussion of the site-specific activity ratio is provided in Appendix A-2 and Section 5.4.4.

5.4.3 Results of Vadose Zone Modeling and Screening of Contaminants of Potential Concern

5.4.3.1 Solid Waste Landfill

Loading rates to the Great Miami Aquifer were estimated for each CPC for the Operable Unit 2 subunits using ODAST. Loading rates of a constituent from ODAST to the aquifer from a given source vary over time.

5.4.3.1 Solid Waste Landfill

Figure 5-9 shows the areal extent of the waste in the Solid Waste Landfill and the SWIFT III grid blocks impacted by the direct loading from the Solid Waste Landfill. Waste overlying the SWIFT III grid block (49,91) was included with SWIFT III waste overlying grid block (50,91). Similarly, contaminant loadings for SWIFT III grid blocks (52,91) and (52,92) were combined and loaded from the grid block (52,91). Three pathways were considered for the Solid Waste Landfill fate and transport modeling. One of these pathways was surface water pathway. However, no CPCs were identified from this pathway (see Section 5.3.3). Two other pathways were the vadose zone pathway and the perched water infiltration pathway. Table 5-18 lists the CPCs considered for the fate and transport modeling, CPC concentration in the waste, inventory in waste, predicted maximum leachate concentration, predicted maximum concentration from vadose zone Layer 2 from the vadose zone and perched water pathways, and screening concentrations for the Solid Waste Landfill. A summary of screening for CPCs for the Solid Waste Landfill is also included in Table 5-18. Only technetium-99 was found to reach the Great Miami Aquifer above the  $10^7$  lifetime cancer risk level or 0.1 HI level. Great Miami Aquifer dilution screening for technetium-99 was not performed since the ODAST output concentration for technetium-99 was significantly higher than the screening concentration. The predicted increases in CPC concentrations above the background values in the Great Miami Aquifer due to the source term loading from the Solid Waste Landfill were small. Table 5-19

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TABLE 5-18

SOURCE CHARACTERIZATION AND SCREENING SUMMARY FOR CONSTITUENTS OF POTENTIAL CONCERN,  
SOLID WASTE LANDFILL  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD) Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling
<b>RADIONUCLIDES</b>						
Cesium-137	2.89 x 10 <sup>-9</sup>	5.84 x 10 <sup>-2</sup>	2.00 x 10 <sup>+1</sup> ISL	0.0	1.70 x 10 <sup>-1</sup>	No
Lead-210	1.35 x 10 <sup>-8</sup>	2.72 x 10 <sup>-1</sup>	2.79 x 10 <sup>+2</sup> 70-Year	0.0	7.30 x 10 <sup>-3</sup>	No
Neptunium-237	4.98 x 10 <sup>-4</sup>	1.01 x 10 <sup>+4</sup>	1.00 x 10 <sup>+0</sup> ISL	3.42 x 10 <sup>-17</sup>	2.20 x 10 <sup>-2</sup>	No
Plutonium-238	1.92 x 10 <sup>-8</sup>	3.87 x 10 <sup>-1</sup>	1.00 x 10 <sup>+0</sup> ISL	0.0	2.20 x 10 <sup>-2</sup>	No
Plutonium-239/240	1.10 x 10 <sup>-5</sup>	2.21 x 10 <sup>+2</sup>	1.00 x 10 <sup>+0</sup> ISL	0.0	2.10 x 10 <sup>-2</sup>	No
Radium-224	1.35 x 10 <sup>-11</sup>	2.72 x 10 <sup>-4</sup>	7.28 x 10 <sup>+2</sup> 70-Year	0.0	1.30 x 10 <sup>-1</sup>	No
Radium-226	1.57 x 10 <sup>-6</sup>	3.17 x 10 <sup>+1</sup>	1.00 x 10 <sup>+0</sup> ISL	0.0	4.00 x 10 <sup>-2</sup>	No
Radium-228	9.41 x 10 <sup>-9</sup>	1.90 x 10 <sup>-1</sup>	3.00 x 10 <sup>+0</sup> ISL	0.0	4.80 x 10 <sup>-2</sup>	No
Strontium-90	1.15 x 10 <sup>-8</sup>	2.33 x 10 <sup>-1</sup>	5.00 x 10 <sup>+0</sup> ISL	0.0	1.30 x 10 <sup>-1</sup>	No
Technetium-99	2.67 x 10 <sup>-5</sup>	5.39 x 10 <sup>+2</sup>	3.00 x 10 <sup>+1</sup> ISL	2.85 x 10 <sup>+1</sup>	2.70 x 10 <sup>-1</sup>	Yes
Thorium-228	4.13 x 10 <sup>-9</sup>	8.35 x 10 <sup>-2</sup>	1.00 x 10 <sup>+0</sup> ISL	0.0	8.70 x 10 <sup>-2</sup>	No
Thorium-230	5.97 x 10 <sup>-4</sup>	1.21 x 10 <sup>+4</sup>	1.00 x 10 <sup>+0</sup> ISL	0.0	3.70 x 10 <sup>-1</sup>	No
Thorium-232	3.26 x 10 <sup>+1</sup>	6.59 x 10 <sup>+8</sup>	1.00 x 10 <sup>+0</sup> ISL	0.0	4.00 x 10 <sup>-1</sup>	No
Uranium-234	1.56 x 10 <sup>-2</sup>	3.15 x 10 <sup>+5</sup>	9.42 x 10 <sup>+2</sup> ISL	0.0	3.00 x 10 <sup>-1</sup>	No
Uranium-235/236	3.72 x 10 <sup>+0</sup>	7.52 x 10 <sup>+7</sup>	1.05 x 10 <sup>+2</sup> ISL	0.0	3.00 x 10 <sup>-1</sup>	No
Uranium-238		3.39 x 10 <sup>+9</sup>	8.68 x 10 <sup>+2</sup> ISL	0.0	1.70 x 10 <sup>-1</sup>	No
Grid # 52,91	6.01 x 10 <sup>+1</sup>	1.21 x 10 <sup>+8</sup>	8.68 x 10 <sup>+2</sup> ISL			
Grid # 51,90	1.21 x 10 <sup>+2</sup>	2.73 x 10 <sup>+7</sup>	8.68 x 10 <sup>+2</sup> ISL			
Grid # 51,91	2.00 x 10 <sup>+2</sup>	1.26 x 10 <sup>+9</sup>	8.68 x 10 <sup>+2</sup> ISL			
Grid # 51,92	5.36 x 10 <sup>+1</sup>	1.84 x 10 <sup>+8</sup>	8.68 x 10 <sup>+2</sup> ISL			

See footnote at end of table

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**TABLE 5-18  
(Continued)**

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling
<b>RADIONUCLIDES (Continued)</b>							
Grid # 50,91	3.19 x 10 <sup>+2</sup>	1.41 x 10 <sup>+9</sup>	8.68 x 10 <sup>+2</sup>	ISL			
Grid # 50,92	1.02 x 10 <sup>+2</sup>	3.86 x 10 <sup>+8</sup>	8.68 x 10 <sup>+2</sup>	ISL			
Uranium - Total (non-RAD)	1.77 x 10 <sup>+3</sup>	3.58 x 10 <sup>+10</sup>	1.61 x 10 <sup>+3</sup>	mdl-ISL	0.0	1.00 x 10 <sup>-2</sup>	No
<b>ORGANICS</b>							
1,1-Dichloroethane	1.60 x 10 <sup>-2</sup>	3.23 x 10 <sup>+5</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	8.10 x 10 <sup>+1</sup>	No
1,2-Dichloroethene	2.00 x 10 <sup>-3</sup>	4.04 x 10 <sup>+4</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	5.50 x 10 <sup>-0</sup>	No
1,4-Dioxane	1.29 x 10 <sup>+1</sup>	2.61 x 10 <sup>+8</sup>	4.70 x 10 <sup>+1</sup>	mdl-ISL	0.0	7.10 x 10 <sup>-1</sup>	No
2-Butanone	3.00 x 10 <sup>-3</sup>	6.06 x 10 <sup>+4</sup>	3.60 x 10 <sup>+1</sup>	mdl-ISL	0.0	2.20 x 10 <sup>+3</sup>	No
4,4'-DDD	4.00 x 10 <sup>-3</sup>	8.08 x 10 <sup>+4</sup>	2.00 x 10 <sup>-1</sup>	mdl-ISL	0.0	3.30 x 10 <sup>-2</sup>	No
4-Methyl-2-Pentanone	1.00 x 10 <sup>-3</sup>	2.02 x 10 <sup>+4</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.80 x 10 <sup>+2</sup>	No
Acenaphthene	8.40 x 10 <sup>-1</sup>	1.70 x 10 <sup>+7</sup>	8.90 x 10 <sup>+1</sup>	mdl-ISL	0.0	2.20 x 10 <sup>+1</sup>	No
Acetone	3.90 x 10 <sup>-2</sup>	7.88 x 10 <sup>+5</sup>	2.50 x 10 <sup>+1</sup>	mdl-ISL	0.0	3.70 x 10 <sup>+2</sup>	No
Anthracene	1.00 x 10 <sup>-0</sup>	2.02 x 10 <sup>+7</sup>	2.50 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>+3</sup>	No
Aroclor-1254	5.00 x 10 <sup>-2</sup>	1.01 x 10 <sup>+6</sup>	2.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.00 x 10 <sup>-3</sup>	No
Aroclor-1260	8.00 x 10 <sup>-2</sup>	1.62 x 10 <sup>+6</sup>	2.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.00 x 10 <sup>-3</sup>	No
Benzene	3.00 x 10 <sup>-3</sup>	6.06 x 10 <sup>+4</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	3.50 x 10 <sup>-2</sup>	No
Benzo(a)anthracene	7.50 x 10 <sup>+0</sup>	1.52 x 10 <sup>+8</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>-2</sup>	No
Benzo(a)pyrene	8.20 x 10 <sup>+0</sup>	1.66 x 10 <sup>+8</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>-3</sup>	No
Benzo(b)fluoranthene	1.50 x 10 <sup>+0</sup>	3.03 x 10 <sup>+7</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>-2</sup>	No
Benzo(k)fluoranthene	7.40 x 10 <sup>-1</sup>	1.49 x 10 <sup>+7</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>-1</sup>	No
bis(2-Ethylhexyl) phthalate	1.70 x 10 <sup>+0</sup>	3.43 x 10 <sup>+7</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	5.70 x 10 <sup>-1</sup>	No
Carbazole	4.20 x 10 <sup>+0</sup>	8.48 x 10 <sup>+7</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	1.45 x 10 <sup>-3</sup>	4.00 x 10 <sup>-1</sup>	No
Chlorobenzene	2.00 x 10 <sup>-3</sup>	4.04 x 10 <sup>+4</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	3.90 x 10 <sup>-0</sup>	No

See footnote at end of table

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TABLE 5-18  
(Continued)

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling
<b>ORGANICS (Continued)</b>							
Chloromethane	6.00 x 10 <sup>-3</sup>	1.21 x 10 <sup>+5</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.80 x 10 <sup>-1</sup>	No
Chrysene	5.60 x 10 <sup>+0</sup>	1.13 x 10 <sup>+8</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>+2</sup>	No
Di-n-butyl phthalate	7.10 x 10 <sup>-2</sup>	1.43 x 10 <sup>+6</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	3.70 x 10 <sup>+2</sup>	No
Dibenzo(ah)anthracene	2.50 x 10 <sup>-1</sup>	5.05 x 10 <sup>+6</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>-3</sup>	No
Diethyl phthalate	4.50 x 10 <sup>-2</sup>	9.09 x 10 <sup>+5</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	2.90 x 10 <sup>+3</sup>	No
Ethylbenzene	1.50 x 10 <sup>-2</sup>	3.03 x 10 <sup>+5</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.30 x 10 <sup>+2</sup>	No
Fluoranthene	1.20 x 10 <sup>+1</sup>	2.42 x 10 <sup>+8</sup>	1.70 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.50 x 10 <sup>+2</sup>	No
Fluorene	6.40 x 10 <sup>-1</sup>	1.29 x 10 <sup>+7</sup>	6.80 x 10 <sup>+1</sup>	mdl-ISL	0.0	2.20 x 10 <sup>+2</sup>	No
Heptachlorodibenzo-p-dioxin	9.00 x 10 <sup>-4</sup>	1.82 x 10 <sup>+4</sup>	2.40 x 10 <sup>-3</sup>	SOL	0.0	5.30 x 10 <sup>-6</sup>	No
Heptachlorodibenzofuran	2.50 x 10 <sup>-4</sup>	5.05 x 10 <sup>+3</sup>	8.51 x 10 <sup>-2</sup>	70-Year	0.0	5.30 x 10 <sup>-6</sup>	No
Indeno(1,2,3-cd)pyrene	5.50 x 10 <sup>+0</sup>	1.11 x 10 <sup>+8</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>-2</sup>	No
Methylene chloride	6.00 x 10 <sup>-3</sup>	1.21 x 10 <sup>+5</sup>	9.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	5.10 x 10 <sup>-1</sup>	No
Naphthalene	3.20 x 10 <sup>-1</sup>	6.46 x 10 <sup>+6</sup>	3.50 x 10 <sup>+2</sup>	mdl-ISL	0.0	1.50 x 10 <sup>+2</sup>	No
Octachlorodibenzo-p-dioxin	1.30 x 10 <sup>-2</sup>	2.63 x 10 <sup>+5</sup>	4.00 x 10 <sup>-4</sup>	SOL	0.0	5.30 x 10 <sup>-5</sup>	No
Pyrene	1.20 x 10 <sup>+1</sup>	2.42 x 10 <sup>+8</sup>	1.10 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.10 x 10 <sup>+2</sup>	No
Pyridine	3.00 x 10 <sup>-3</sup>	6.06 x 10 <sup>+4</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	3.70 x 10 <sup>-0</sup>	No
Tetrachloroethene	1.00 x 10 <sup>-3</sup>	2.02 x 10 <sup>+4</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.30 x 10 <sup>-1</sup>	No
Toluene	8.00 x 10 <sup>-3</sup>	1.62 x 10 <sup>+5</sup>	5.70 x 10 <sup>+1</sup>	mdl-ISL	0.0	7.50 x 10 <sup>+1</sup>	No
Trichlorofluoromethane	8.40 x 10 <sup>-1</sup>	1.70 x 10 <sup>+7</sup>	1.80 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.00 x 10 <sup>-1</sup>	No
Xylenes, Total	5.40 x 10 <sup>-2</sup>	1.09 x 10 <sup>+6</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.20 x 10 <sup>+3</sup>	No
<b>INORGANICS</b>							
Antimony	2.20 x 10 <sup>+1</sup>	4.44 x 10 <sup>+8</sup>	3.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.50 x 10 <sup>-0</sup>	No

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**TABLE 5-18  
(Continued)**

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling
<b>INORGANICS (Continued)</b>							
Arsenic	1.38 x 10 <sup>+1</sup>	2.79 x 10 <sup>+8</sup>	1.81 x 10 <sup>+1</sup>	mdl-ISL	0.0	5.00 x 10 <sup>-3</sup>	No
Barium	1.08 x 10 <sup>+2</sup>	2.18 x 10 <sup>+9</sup>	1.86 x 10 <sup>+2</sup>	mdl-ISL	0.0	2.60 x 10 <sup>+2</sup>	No
Beryllium	1.08 x 10 <sup>+0</sup>	2.17 x 10 <sup>+7</sup>	2.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	2.00 x 10 <sup>-3</sup>	No
Cadmium	1.69 x 10 <sup>+0</sup>	3.42 x 10 <sup>+7</sup>	5.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.80 x 10 <sup>-0</sup>	No
Chromium	2.01 x 10 <sup>+1</sup>	4.07 x 10 <sup>+8</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.80 x 10 <sup>+1</sup>	No
Copper	2.90 x 10 <sup>+1</sup>	5.86 x 10 <sup>+8</sup>	1.42 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.40 x 10 <sup>+2</sup>	No
Cyanide	5.00 x 10 <sup>-1</sup>	1.01 x 10 <sup>+7</sup>	2.02 x 10 <sup>+1</sup>	mdl-ISL	0.0	7.30 x 10 <sup>+1</sup>	No
Lead	2.83 x 10 <sup>+1</sup>	5.72 x 10 <sup>+8</sup>	1.95 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.50 x 10 <sup>-0</sup>	No
Molybdenum	1.01 x 10 <sup>+1</sup>	2.04 x 10 <sup>+8</sup>	2.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	1.80 x 10 <sup>+1</sup>	No
Selenium	4.80 x 10 <sup>-1</sup>	9.69 x 10 <sup>+6</sup>	2.00 x 10 <sup>-0</sup>	mdl-ISL	0.0	1.80 x 10 <sup>+1</sup>	No
Thallium	6.00 x 10 <sup>-1</sup>	1.21 x 10 <sup>+7</sup>	2.10 x 10 <sup>-0</sup>	mdl-ISL	0.0	2.60 x 10 <sup>-1</sup>	No
Vanadium	2.97 x 10 <sup>+1</sup>	5.99 x 10 <sup>+8</sup>	1.00 x 10 <sup>+1</sup>	mdl-ISL	0.0	2.00 x 10 <sup>+1</sup>	No

<sup>a</sup>Constraint on reported concentration is by In Situ Leachate (ISL), Toxicity Characteristic Leaching Procedure (TCLP), maximum detection limit (MDL), by US EPA 70-year rule (70-Year), or by the Solubility Limit (SOL).

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TABLE 5-19

**COMPARISON OF GREAT MIAMI AQUIFER WATER AND BACKGROUND  
FOR CONSTITUENTS OF POTENTIAL CONCERN IN GROUNDWATER  
SOLID WASTE LANDFILL  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent Potential of Concern	Units	Detects in 2000-Series Well Water Samples					Background		2000-Series Comparable to Background?
		Samples	Hits	Minimum	Maximum	Mean <sup>a</sup>	Minimum	Maximum	
<b>RADIONUCLIDES</b>									
NP-237	pCi/L	16	1	0.32	0.32	0.41	NA	1.10 <sup>c</sup>	Yes
PU-238	pCi/L	19	3	0.05	0.28	0.33	NA	1.00 <sup>c</sup>	Yes
RA-226	pCi/L	17	10	0.22	1.6	0.67	1.10	8.50	Yes
RA-228	pCi/L	17	1	4.30	4.3	1.43	3.10	5.50	Yes
SR-90	pCi/L	19	6	0.75	2.38	2.01	NA	5.00 <sup>c</sup>	Yes
TH-228	pCi/L	19	1	0.03	0.03	0.34	1.20	2.90	Yes
TH-230	pCi/L	19	3	0.31	0.71	0.44	1.20	3.44	Yes
U-234	pCi/L	18	11	0.17	4.74	1.23	1.20	4.20	Yes
U-235/236	pCi/L	19	3	0.05	0.28	0.34	NA	1.30 <sup>c</sup>	Yes
U-238	pCi/L	18	11	0.16	3.69	1.12	0.90	4.40	Yes
<b>INORGANICS</b>									
Arsenic	µg/L	7	2	2.5	2.5	1.1	2.0	550.0	Yes
Chromium	µg/L	7	1	19.8	19.8	7.4	10.0	45.0	Yes
Lead	µg/L	7	3	2.8	4.5	2.0	2.6	140.0	Yes
Manganese	µg/L	7	7	202.0	370.0	286.0	2.0	897.0	Yes
<b>Organics</b>									
bis(2-Ethylhexyl) phthalate	µg/L	11	2	3.0	7.0	4.7	N/A	N/A	No <sup>d</sup>
Hexachlorodibenzofuran	µg/L	3	1	3.8e-04	3.8e-04	3.7e-04	N/A	N/A	Not in waste
Pentachlorodibenzofuran	µg/L	3	1	3.1e-04	3.1e-04	2.7e-04	N/A	N/A	Not in waste
Tetrachlorodibenzofuran	µg/L	3	1	2.2e-04	2.2e-04	2.7e-04	N/A	N/A	Not in waste

<sup>a</sup>Mean calculated by using half of the detection limit for non-detects.

<sup>b</sup>Not detected in background samples. Value reported is minimum detection limit.

<sup>c</sup>Not detected in background samples. Value reported is maximum detection limit.

<sup>d</sup>Not detected in perched water under the solid waste landfill.

NA - Not Available.

compares the background concentration and the field measured concentrations in the Great Miami Aquifer from 2000-series wells in the Solid Waste Landfill. Except for bis(2-Ethylhexyl) phthalate, all other constituents were detected at concentrations comparable to or below the background concentrations in the Great Miami Aquifer. If the source for bis(2-Ethylhexyl) phthalate is the Solid Waste Landfill, then it should have been detected in the perched water as well. However, bis(2-Ethylhexyl) phthalate was not detected in perched water beneath or in the vicinity of the Solid Waste Landfill. Therefore, model results were considered consistent with the observed data as model only predicts increase in concentration over the background value.

As only technetium-99 reached the Great Miami Aquifer above the  $10^{-7}$  risk level or 0.1 HI level, it was selected for modeling in the Great Miami Aquifer. Table 5-20 lists the constituents that survived the various screening processes and was simulated using the SWIFT III model.

In addition to predicting constituent loading to the Great Miami Aquifer, future perched water concentration increases were also predicted using the ODAST. Only one layer was considered. This layer consisted of till above the perched water zone (sand/gravel in the till). The thickness of this layer for various blocks are shown in Table 5-13. CPC waste inventory, CPC concentration in the waste, leachate concentration (all shown in Table 5-18), and physical and chemical parameters were the same as those for the vadose zone modeling to the Great Miami Aquifer.

Table 5-21 shows the predicted perched water concentrations beneath the Solid Waste Landfill and the screening summary. Only technetium-99 and carbazole are predicted to reach the perched water zone above the  $10^{-7}$  lifetime cancer risk level or 0.1 HI level. An increase in CPC concentration above background values in perched water due to source term loading from Solid Waste Landfill were small. Table 5-22 compares the background concentrations and the field measured concentrations in the perched water. Thorium-232, uranium-234, uranium-238, uranium-total, and manganese were observed above background levels. All other CPCs were detected at concentrations comparable to background concentrations. All the high hits for CPCs occur in Well 1952, located southeast of the Solid Waste Landfill and south of railroad.

5.4.3.2 Lime Sludge Ponds

Figure 5-10 shows the aerial extent of the waste in the Lime Sludge Ponds and the SWIFT III grid cells impacted by the direct loading from the Lime Sludge Ponds. Waste overlying the SWIFT III

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**TABLE 5-20**  
**SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN AND**  
**SOURCE PATHWAYS FOR THE SOLID WASTE LANDFILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Source Pathways <sup>a</sup>		
	Solid Waste Landfill Wastes	Perched Groundwater	Paddy's Run Loading from Surface Water Runoff
<b>RADIONUCLIDES</b>			
Technetium-99	Yes	NA <sup>b</sup>	NA

<sup>a</sup>Yes - Indicates concentrations were above screening concentrations from this source pathway

<sup>b</sup>NA - Not Applicable, not present in the perched groundwater or surface water

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**TABLE 5-21**  
**PREDICTED PERCHED WATER CONCENTRATIONS AND SCREENING SUMMARY FOR**  
**CONSTITUENTS OF POTENTIAL CONCERN, SOLID WASTE LANDFILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>RADIONUCLIDES</b>					
Cesium-137	pCi/L	$2.00 \times 10^{+1}$	0.00	$1.70 \times 10^{-1}$	NO
Lead-210	pCi/L	$2.79 \times 10^{+2}$	0.00	$7.30 \times 10^{-3}$	NO
Neptunium-237	pCi/L	$1.00 \times 10^{+0}$	$1.11 \times 10^{-5}$	$2.20 \times 10^{-2}$	NO
Plutonium-238	pCi/L	$1.00 \times 10^{+0}$	0.00	$2.20 \times 10^{-2}$	NO
Plutonium-239/240	pCi/L	$1.00 \times 10^{+0}$	0.00	$2.10 \times 10^{-2}$	NO
Radium-224	pCi/L	$7.28 \times 10^{+2}$	0.00	$1.30 \times 10^{-1}$	NO
Radium-226	pCi/L	$1.00 \times 10^{+0}$	0.00	$4.00 \times 10^{-2}$	NO
Radium-228	pCi/L	$3.00 \times 10^{+0}$	0.00	$4.80 \times 10^{-2}$	NO
Strontium-90	pCi/L	$5.00 \times 10^{+0}$	$1.43 \times 10^{-3}$	$1.30 \times 10^{-1}$	NO
Technetium-99	pCi/L	$3.00 \times 10^{+1}$	$2.89 \times 10^{+1}$	$2.70 \times 10^{-1}$	YES
Thorium-228	pCi/L	$1.00 \times 10^{+0}$	0.00	$8.70 \times 10^{-2}$	NO
Thorium-230	pCi/L	$1.00 \times 10^{+0}$	0.00	$3.70 \times 10^{-1}$	NO
Thorium-232	pCi/L	$1.00 \times 10^{+0}$	0.00	$4.00 \times 10^{-1}$	NO
Uranium-234	pCi/L	$9.42 \times 10^{+2}$	$5.92 \times 10^{-42}$	$3.00 \times 10^{-1}$	NO
Uranium-235/236	pCi/L	$1.05 \times 10^{+2}$	$2.27 \times 10^{-42}$	$3.00 \times 10^{-1}$	NO
Uranium-238	pCi/L	$8.68 \times 10^{+2}$	$5.47 \times 10^{-42}$	$1.70 \times 10^{-1}$	NO
Uranium-Total (non-RAD)	$\mu\text{g/L}$	$1.61 \times 10^{+3}$	$1.02 \times 10^{-41}$	$1.00 \times 10^{+1}$	NO

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TABLE 5-21  
(Continued)

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>ORGANICS</b>					
1,1-Dichlorethane	µg/L	5.00 x 10 <sup>+0</sup>	5.62 x 10 <sup>-4</sup>	8.10 x 10 <sup>+1</sup>	NO
1,2-Dichlorethene	µg/L	5.00 x 10 <sup>+0</sup>	8.66 x 10 <sup>-6</sup>	5.50 x 10 <sup>+0</sup>	NO
1,4-Dioxane	µg/L	4.70 x 10 <sup>+1</sup>	0.00	7.10 x 10 <sup>-1</sup>	NO
2-Butanone	µg/L	3.60 x 10 <sup>+1</sup>	0.00	2.20 x 10 <sup>+3</sup>	NO
4,4'-DDD	µg/L	2.00 x 10 <sup>-1</sup>	0.00	3.30 x 10 <sup>-2</sup>	NO
4-Methyl-2-Pentanone	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.80 x 10 <sup>+2</sup>	NO
Acenaphthene	µg/L	8.90 x 10 <sup>+1</sup>	0.00	2.20 x 10 <sup>+2</sup>	NO
Acetone	µg/L	2.50 x 10 <sup>+1</sup>	0.00	3.70 x 10 <sup>+2</sup>	NO
Anthracene	µg/L	2.50 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>+3</sup>	NO
Aroclor-1254	µg/L	2.00 x 10 <sup>+0</sup>	0.00	1.00 x 10 <sup>-3</sup>	NO
Aroclor-1260	µg/L	2.00 x 10 <sup>+0</sup>	0.00	1.00 x 10 <sup>-3</sup>	NO
Benzene	µg/L	5.00 x 10 <sup>+0</sup>	7.62 x 10 <sup>-6</sup>	3.50 x 10 <sup>-2</sup>	NO
Benzo(a)anthracene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>-2</sup>	NO
Benzo(a)pyrene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>-3</sup>	NO
Benzo(b)fluoranthene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>-2</sup>	NO
Benzo(k)fluoranthene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>-1</sup>	NO
bis(2-Ethylhexyl)phthalate	µg/L	1.00 x 10 <sup>+1</sup>	0.00	5.70 x 10 <sup>-1</sup>	NO
Carbazole	µg/L	1.00 x 10 <sup>+1</sup>	9.61 x 10 <sup>+0</sup>	4.00 x 10 <sup>-1</sup>	YES
Chlorobenzene	µg/L	5.00 x 10 <sup>+0</sup>	0.00	3.90 x 10 <sup>+0</sup>	NO

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TABLE 5-21  
(Continued)

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>ORGANICS (Continued)</b>					
Chloromethane	µg/L	1.00 x 10 <sup>+1</sup>	4.14 x 10 <sup>-7</sup>	1.80 x 10 <sup>-1</sup>	NO
Chrysene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>+2</sup>	NO
Di-N-butyl phthalate	µg/L	1.00 x 10 <sup>+1</sup>	0.00	3.70 x 10 <sup>+2</sup>	NO
Dibenzo(a,h)anthracene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>-3</sup>	NO
Diethyl phthalate	µg/L	1.00 x 10 <sup>+1</sup>	0.00	2.90 x 10 <sup>+3</sup>	NO
Ethylbenzene	µg/L	5.00 x 10 <sup>+0</sup>	0.00	1.30 x 10 <sup>+2</sup>	NO
Fluoranthene	µg/L	1.70 x 10 <sup>+1</sup>	0.00	1.50 x 10 <sup>+2</sup>	NO
Fluorene	µg/L	6.80 x 10 <sup>+1</sup>	0.00	2.20 x 10 <sup>+2</sup>	NO
Heptachlorodibenzo-p-dioxin	µg/L	2.40 x 10 <sup>-3</sup>	0.00	5.30 x 10 <sup>-6</sup>	NO
Heptachlorodibenzofuran	µg/L	8.51 x 10 <sup>-2</sup>	0.00	5.30 x 10 <sup>-6</sup>	NO
Ideno(1,2,3-cd)pyrene	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>-2</sup>	NO
Methylene Chloride	µg/L	9.00 x 10 <sup>+0</sup>	0.00	5.10 x 10 <sup>-1</sup>	NO
Naphthalene	µg/L	3.50 x 10 <sup>+2</sup>	0.00	1.50 x 10 <sup>+2</sup>	NO
Octachlorodibenzo-p-dioxin	µg/L	4.00 x 10 <sup>-4</sup>	0.00	5.30 x 10 <sup>-5</sup>	NO
Pyrene	µg/L	1.10 x 10 <sup>+1</sup>	0.00	1.10 x 10 <sup>+2</sup>	NO
Pyridine	µg/L	1.00 x 10 <sup>+1</sup>	0.00	3.70 x 10 <sup>+0</sup>	NO
Tetrachloroethene	µg/L	5.00 x 10 <sup>+0</sup>	9.72 x 10 <sup>-7</sup>	1.30 x 10 <sup>-1</sup>	NO
Toluene	µg/L	5.70 x 10 <sup>+1</sup>	0.00	7.50 x 10 <sup>+1</sup>	NO

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TABLE 5-21  
(Continued)

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>ORGANICS</b> (Continued)					
Trichlorofluoromethane	µg/L	1.80 x 10 <sup>+1</sup>	2.22 x 10 <sup>-5</sup>	1.00 x 10 <sup>-1</sup>	NO
Xylene	µg/L	5.00 x 10 <sup>+0</sup>	0.00	1.20 x 10 <sup>+3</sup>	NO
<b>INORGANICS</b>					
Antimony	µg/L	3.00 x 10 <sup>+1</sup>	0.00	1.50 x 10 <sup>+0</sup>	NO
Arsenic	µg/L	1.81 x 10 <sup>+1</sup>	0.00	5.00 x 10 <sup>-3</sup>	NO
Barium	µg/L	1.86 x 10 <sup>+2</sup>	0.00	2.60 x 10 <sup>+2</sup>	NO
Beryllium	µg/L	2.00 x 10 <sup>+0</sup>	0.00	2.00 x 10 <sup>-3</sup>	NO
Cadmium	µg/L	5.00 x 10 <sup>+0</sup>	0.00	1.80 x 10 <sup>+0</sup>	NO
Chromium	µg/L	1.00 x 10 <sup>+1</sup>	0.00	1.80 x 10 <sup>+1</sup>	NO
Copper	µg/L	1.42 x 10 <sup>+1</sup>	0.00	1.40 x 10 <sup>+2</sup>	NO
Cyanide	µg/L	2.02 x 10 <sup>+1</sup>	8.37 x 10 <sup>-1</sup>	7.30 x 10 <sup>+1</sup>	NO
Lead	µg/L	1.95 x 10 <sup>+1</sup>	0.00	1.50 x 10 <sup>+0</sup>	NO
Molybdenum	µg/L	2.00 x 10 <sup>+1</sup>	0.00	1.80 x 10 <sup>+1</sup>	NO
Selenium	µg/L	2.00 x 10 <sup>+0</sup>	0.00	1.80 x 10 <sup>+1</sup>	NO
Thallium	µg/L	2.10 x 10 <sup>+0</sup>	0.00	2.60 x 10 <sup>-1</sup>	NO
Vanadium	µg/L	1.00 x 10 <sup>+1</sup>	0.00	2.00 x 10 <sup>+1</sup>	NO

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**TABLE 5-22**  
**COMPARISON OF PERCHED WATER AND BACKGROUND FOR**  
**CONSTITUENTS OF POTENTIAL CONCERN IN PERCHED WATER**  
**FOR THE SOLID WASTE LANDFILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Units	Detects in Perched Water (1000-Series Wells)					Background		Perched Water Comparable to Background?
		Samples	Hits	Minimum	Maximum	Mean <sup>a</sup>	Minimum	Maximum	
<b>RADIONUCLIDES</b>									
NP-237	pCi/L	11	2	0.3	1.94	0.54	0.50 <sup>b</sup>	0.60 <sup>c</sup>	Yes
PU-238	pCi/L	13	3	0.14	0.67	0.32	0.50 <sup>b</sup>	0.50 <sup>c</sup>	Yes
RA-226	pCi/L	13	3	0.19	5.11	0.73	1.00	1.00	Yes
RA-228	pCi/L	13	1	3.72	3.72	1.37	4.50	5.20	Yes
SR-90	pCi/L	12	2	0.90	1.35	1.41	2.50 <sup>b</sup>	2.50 <sup>c</sup>	Yes
TH-228	pCi/L	13	2	0.57	14	1.41	1.04	1.60	Yes
TH-230	pCi/L	13	4	0.26	13.8	1.45	2.00	2.00	Yes
TH-232	pCi/L	13	2	0.65	11.5	1.21	0.50 <sup>b</sup>	0.60 <sup>c</sup>	No
U-234	pCi/L	13	11	1.1	12	3.03	1.06	1.90	No
U-235/236	pCi/L	13	3	0.21	0.43	0.34	0.50 <sup>b</sup>	0.50 <sup>c</sup>	Yes
U-238	pCi/L	13	12	0.67	15.2	3.08	1.07	1.50	No
<b>INORGANICS</b>									
Arsenic	µg/L	6	4	1.1	4.4	1.885	15.0	122.0	Yes
Beryllium	µg/L	6	1	2.2	2.2	0.84	1.0	1.8	Yes
Chromium	µg/L	6	1	58.3	58.3	12	20.0	120.0	Yes
Lead	µg/L	6	2	1	31.4	6.08	2.0	50.0	Yes
Manganese	µg/L	6	6	44.8	1900	517.8	7.0	220.0	No
Molybdenum	µg/L	6	3	14.1	26	11.83	24.0	28.0	Yes
Nickel	µg/L	6	3	4.4	118	34.93	21.0	180.0	Yes
U-TOTAL	µg/L	13	13	2	55.8	8.37	0.8	5.3	No

<sup>a</sup>Mean calculated by using half of the detection limit for non-detects.  
<sup>b</sup>Not detected in background samples. Value reported is minimum detection limit.  
<sup>c</sup>Not detected in background samples. Value reported is maximum detection limit.

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grid block (44,82) was included with the waste overlying the SWIFT III grid block (43,81).  
 Similarly, constituent loadings from SWIFT III grid blocks (45,79) and (45,80) were combined and  
 loaded from the grid block (45,80). Only vadose zone and perched water infiltration pathways were  
 applicable to vadose zone modeling for the Lime Sludge Ponds. Table 5-23 lists the CPCs considered  
 for the fate and transport modeling, CPC concentration in the waste, CPC inventory in the waste,  
 predicted maximum leachate concentration, predicted maximum concentration from vadose zone  
 Layer 2 from all pathways, and screening concentrations for the Lime Sludge Ponds. A summary of  
 screening for constituent of concern for the Lime Sludge Ponds is also included in Table A.2-23.  
 Only technetium-99 was found to reach the Great Miami Aquifer from the Lime Sludge Ponds above  
 the  $10^{-7}$  lifetime cancer risk level or 0.1 HI level. Table 5-24 lists the constituents that survived the  
 various screening processes and were simulated using the SWIFT III model.

The predicted increases in CPC concentrations above the background values in the Great Miami  
 Aquifer due to the source term leading from the Lime Sludge Ponds were small. Table 5-25  
 compares the background concentration and the field measured concentrations in the Great Miami  
 Aquifer. All constituents were detected at concentrations comparable to or below the background  
 concentrations in the Great Miami Aquifer. Therefore, model results were considered consistent with  
 the observed data as model only predicts increase in concentration over the background value.

In addition to predicting constituent loading to the Great Miami Aquifer, future perched water  
 concentration increases were also predicted using the ODAST. Only one layer consisting of till above  
 the perched water zone was considered. Thickness of this layer for various blocks are shown in  
 Table 5-14. CPC waste inventory, CPC concentration in the waste, leachate concentration (all shown  
 in Table 5-23), and physical and chemical parameters are the same as those for the vadose zone  
 modeling to the Great Miami Aquifer.

Table 5-26 shows the predicted perched water concentrations beneath the Lime Sludge Ponds and the  
 screening summary. Neptunium-237, strontium-90, technetium-99, arsenic, and manganese are  
 predicted to reach perched water above the  $10^{-7}$  lifetime cancer risk or 0.1 HI concentration levels.

The predicted increases in CPC concentrations above background in the perched water due to the  
 source term loading from the Lime Sludge Ponds were small. Table 5-27 compares the background  
 concentrations and the field measured concentrations in the perched water beneath or in the vicinity of

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**TABLE 5-23**  
**SOURCE CHARACTERIZATION AND SCREENING SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN**  
**LIME SLUDGE PONDS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (µg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>RADIONUCLIDES</b>							
Cesium-137	1.94 x 10 <sup>-9</sup>	2.04 x 10 <sup>-2</sup>	1.41 x 10 <sup>+1</sup>	70-Year	0.0	1.70 x 10 <sup>-1</sup>	No
Neptunium-237	4.97 x 10 <sup>-4</sup>	5.05 x 10 <sup>+3</sup>	2.84 x 10 <sup>+1</sup>	70-Year	1.19 x 10 <sup>-3</sup>	2.20 x 10 <sup>-2</sup>	No
Plutonium-238	1.22 x 10 <sup>-8</sup>	1.29 x 10 <sup>-1</sup>	1.76 x 10 <sup>+1</sup>	70-Year	0.0	2.21 x 10 <sup>-2</sup>	No
Plutonium-239/240	1.71 x 10 <sup>-6</sup>	1.80 x 10 <sup>+1</sup>	8.91 x 10 <sup>+0</sup>	70-Year	0.0	2.10 x 10 <sup>-2</sup>	No
Radium-226	1.58 x 10 <sup>-6</sup>	1.66 x 10 <sup>+1</sup>	1.31 x 10 <sup>+2</sup>	70-Year	0.0	4.00 x 10 <sup>-2</sup>	No
Radium-228	6.62 x 10 <sup>-9</sup>	6.97 x 10 <sup>-2</sup>	1.51 x 10 <sup>+2</sup>	70-Year	0.0	4.79 x 10 <sup>-2</sup>	No
Strontium-90	6.14 x 10 <sup>-9</sup>	6.47 x 10 <sup>-2</sup>	7.07 x 10 <sup>+1</sup>	70-Year	0.0	1.30 x 10 <sup>-1</sup>	No
Technetium-99	5.24 x 10 <sup>-5</sup>	5.51 x 10 <sup>+2</sup>	7.48 x 10 <sup>+1</sup>	70-Year	6.48 x 10 <sup>+1</sup>	2.70 x 10 <sup>-1</sup>	Yes
Thorium-228	1.88 x 10 <sup>-9</sup>	1.98 x 10 <sup>-2</sup>	1.29 x 10 <sup>+2</sup>	70-Year	0.0	8.69 x 10 <sup>-2</sup>	No
Thorium-230	4.07 x 10 <sup>-4</sup>	4.28 x 10 <sup>+3</sup>	7.05 x 10 <sup>+2</sup>	70-Year	0.0	3.71 x 10 <sup>-1</sup>	No
Thorium-232	9.73 x 10 <sup>+0</sup>	1.02 x 10 <sup>+8</sup>	9.00 x 10 <sup>+1</sup>	70-Year	0.0	4.00 x 10 <sup>-1</sup>	No
Uranium-234	9.94 x 10 <sup>-4</sup>	1.05 x 10 <sup>+4</sup>	5.20 x 10 <sup>+2</sup>	70-Year	2.13 x 10 <sup>-29</sup>	3.00 x 10 <sup>-1</sup>	No
Uranium-235/236	2.01 x 10 <sup>-1</sup>	2.12 x 10 <sup>+6</sup>	3.66 x 10 <sup>+1</sup>	70-Year	1.65 x 10 <sup>-30</sup>	3.00 x 10 <sup>-1</sup>	No
Uranium-238		8.30 x 10 <sup>+7</sup>		70-Year	2.50 x 10 <sup>-29</sup>	1.70 x 10 <sup>-1</sup>	No
Grid #44,79	2.16 x 10 <sup>+1</sup>	6.25 x 10 <sup>+6</sup>	1.85 x 10 <sup>+2</sup>	70-Year			
Grid #45,80	7.63 x 10 <sup>+0</sup>	4.81 x 10 <sup>+6</sup>	2.32 x 10 <sup>+1</sup>	70-Year			
Grid #43,81	2.07 x 10 <sup>+1</sup>	8.57 x 10 <sup>+6</sup>	2.35 x 10 <sup>+2</sup>	70-Year			
Grid #44,81	2.33 x 10 <sup>+0</sup>	4.72 x 10 <sup>+6</sup>	4.28 x 10 <sup>+1</sup>	70-Year			
Grid #43,80	1.59 x 10 <sup>+1</sup>	2.22 x 10 <sup>+7</sup>	4.48 x 10 <sup>+2</sup>	70-Year			
Grid #45,81	5.39 x 10 <sup>+0</sup>	9.53 x 10 <sup>+6</sup>	5.25 x 10 <sup>+2</sup>	70-Year			

See footnote at end of table

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TABLE 5-23  
(Continued)

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>RADIONUCLIDES (Continued)</b>							
Grid #44,80	8.45 x 10 <sup>+0</sup>	6.27 x 10 <sup>+7</sup>	2.40 x 10 <sup>+2</sup>	70-Year			
Uranium - Total (non-RAD)	2.22 x 10 <sup>+1</sup>	2.34 x 10 <sup>+8</sup>	1.87 x 10 <sup>+3</sup>	70-Year	5.78 x 10 <sup>-29</sup>	1.00 x 10 <sup>+1</sup>	No
<b>ORGANICS</b>							
1,1,2-Trichlorotrifluoroethane	2.00 x 10 <sup>-2</sup>	2.11 x 10 <sup>+5</sup>	1.68 x 10 <sup>0</sup>	70-Year	0.0	1.30 x 10 <sup>+2</sup>	No
Acetone	3.80 x 10 <sup>-2</sup>	4.00 x 10 <sup>+5</sup>	3.20 x 10 <sup>0</sup>	70-Year	0.0	3.70 x 10 <sup>+2</sup>	No
Acetonitrile	2.00 x 10 <sup>-1</sup>	2.11 x 10 <sup>+6</sup>	1.68 x 10 <sup>+1</sup>	70-Year	1.52 x 10 <sup>+1</sup>	2.20 x 10 <sup>+1</sup>	No
Acrylonitrile	2.00 x 10 <sup>-1</sup>	2.11 x 10 <sup>+6</sup>	1.68 x 10 <sup>+1</sup>	70-Year	0.0	1.50 x 10 <sup>-2</sup>	No
Anthracene	5.60 x 10 <sup>-2</sup>	5.90 x 10 <sup>+5</sup>	4.71 x 10 <sup>0</sup>	70-Year	0.0	1.10 x 10 <sup>+3</sup>	No
Aroclor-1254	4.30 x 10 <sup>-2</sup>	4.53 x 10 <sup>+5</sup>	3.62 x 10 <sup>0</sup>	70-Year	0.0	1.00 x 10 <sup>-3</sup>	No
Benzo(a)anthracene	1.00 x 10 <sup>-3</sup>	1.05 x 10 <sup>+4</sup>	8.41 x 10 <sup>-2</sup>	70-Year	0.0	1.10 x 10 <sup>-2</sup>	No
Benzo(a)pyrene	1.00 x 10 <sup>-3</sup>	1.05 x 10 <sup>+4</sup>	8.41 x 10 <sup>-2</sup>	70-Year	0.0	1.00 x 10 <sup>-3</sup>	No
Benzo(b)fluoranthene	5.50 x 10 <sup>-2</sup>	5.79 x 10 <sup>+5</sup>	4.63 x 10 <sup>0</sup>	70-Year	0.0	1.10 x 10 <sup>-2</sup>	No
Benzo(k)fluoranthene	2.00 x 10 <sup>-3</sup>	2.11 x 10 <sup>+4</sup>	1.68 x 10 <sup>-1</sup>	70-Year	0.0	1.10 x 10 <sup>-1</sup>	No
bis(2-Ethylhexyl) phthalate	1.70 x 10 <sup>+0</sup>	1.79 x 10 <sup>+7</sup>	1.43 x 10 <sup>+2</sup>	70-Year	0.0	5.70 x 10 <sup>-1</sup>	No
Chrysene	5.70 x 10 <sup>-2</sup>	6.00 x 10 <sup>+5</sup>	4.79 x 10 <sup>0</sup>	70-Year	0.0	1.10 x 10 <sup>+2</sup>	No
Di-n-butyl phthalate	1.20 x 10 <sup>-1</sup>	1.26 x 10 <sup>+6</sup>	1.01 x 10 <sup>+1</sup>	70-Year	0.0	3.70 x 10 <sup>+2</sup>	No
Di-n-octyl phthalate	8.70 x 10 <sup>-2</sup>	9.16 x 10 <sup>+5</sup>	7.32 x 10 <sup>0</sup>	70-Year	0.0	7.30 x 10 <sup>+1</sup>	No
Dibenzo(ah)anthracene	1.10 x 10 <sup>-1</sup>	1.16 x 10 <sup>+6</sup>	9.25 x 10 <sup>0</sup>	70-Year	0.0	1.00 x 10 <sup>-3</sup>	No
Fluoranthene	7.70 x 10 <sup>-2</sup>	8.11 x 10 <sup>+5</sup>	6.48 x 10 <sup>0</sup>	70-Year	0.0	1.50 x 10 <sup>+2</sup>	No
Hexane	2.00 x 10 <sup>-2</sup>	2.11 x 10 <sup>+5</sup>	1.68 x 10 <sup>0</sup>	70-Year	0.0	3.50 x 10 <sup>+1</sup>	No
Indeno(1,2,3-cd)pyrene	2.10 x 10 <sup>-1</sup>	2.21 x 10 <sup>+6</sup>	1.77 x 10 <sup>+1</sup>	70-Year	0.0	1.10 x 10 <sup>-2</sup>	No

See footnote at end of table

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**TABLE 5-23  
(Continued)**

Constituent of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (µg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>ORGANICS (Continued)</b>							
Pyrene	6.40 x 10 <sup>-2</sup>	6.74 x 10 <sup>+5</sup>	5.38 x 10 <sup>0</sup>	70-Year	0.0	1.10 x 10 <sup>+2</sup>	No
Toluene	4.00 x 10 <sup>-3</sup>	4.21 x 10 <sup>+4</sup>	1.00 x 10 <sup>0</sup>	TCLP	0.0	7.50 x 10 <sup>+1</sup>	No
<b>INORGANICS</b>							
Arsenic	6.81 x 10 <sup>+0</sup>	7.18 x 10 <sup>+7</sup>	4.99 x 10 <sup>+2</sup>	TCLP	0.0	5.00 x 10 <sup>-3</sup>	No
Barium	9.63 x 10 <sup>+1</sup>	1.01 x 10 <sup>+9</sup>	8.00 x 10 <sup>+2</sup>	TCLP	0.0	2.60 x 10 <sup>+2</sup>	No
Beryllium	1.27 x 10 <sup>+0</sup>	1.33 x 10 <sup>+7</sup>	1.07 x 10 <sup>+2</sup>	70-Year	0.0	2.00 x 10 <sup>-3</sup>	No
Cadmium	1.31 x 10 <sup>+0</sup>	1.38 x 10 <sup>+7</sup>	4.38 x 10 <sup>+1</sup>	TCLP	0.0	1.80 x 10 <sup>0</sup>	No
Chromium	2.81 x 10 <sup>+1</sup>	2.96 x 10 <sup>+8</sup>	1.11 x 10 <sup>+2</sup>	TCLP	0.0	1.80 x 10 <sup>+1</sup>	No
Copper	2.73 x 10 <sup>+1</sup>	2.88 x 10 <sup>+8</sup>	2.30 x 10 <sup>+3</sup>	70-Year	0.0	1.40 x 10 <sup>+2</sup>	No
Cyanide	8.20 x 10 <sup>-1</sup>	8.64 x 10 <sup>+6</sup>	6.90 x 10 <sup>+1</sup>	70-Year	0.0	7.30 x 10 <sup>+1</sup>	No
Manganese	9.74 x 10 <sup>+2</sup>	1.03 x 10 <sup>+10</sup>	8.19 x 10 <sup>+4</sup>	70-Year	0.0	1.80 x 10 <sup>+1</sup>	No
Mercury	4.40 x 10 <sup>-1</sup>	4.63 x 10 <sup>+6</sup>	2.00 x 10 <sup>-1</sup>	mdl-TCLP	1.97 x 10 <sup>-1</sup>	1.10 x 10 <sup>0</sup>	No

<sup>a</sup>Constraint on reported concentration is by In Situ Leachate (ISL), Toxicity Characteristic Leaching Procedure (TCLP), maximum detection limit (MDL), or by US EPA 70-year rule (70-Year).

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TABLE 5-24

**SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN AND  
SOURCE PATHWAYS FOR THE LIME SLUDGE PONDS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern	Source Pathways <sup>a</sup>	
	Lime Sludge Pond Wastes	Perched Groundwater
<b>RADIONUCLIDES</b>		
Technetium-99	Yes	NA <sup>b</sup>

<sup>a</sup>Yes - Indicates concentrations were above screening concentrations from this source pathway

<sup>b</sup>NA - Not applicable, not present in the perched groundwater

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**TABLE 5-25**  
**COMPARISON OF GREAT MIAMI AQUIFER WATER AND BACKGROUND FOR**  
**CONSTITUENTS OF POTENTIAL CONCERN IN GROUNDWATER**  
**FOR THE LIME SLUDGE PONDS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent of Potential Concern	Units	Detects in 2000-Series Well Water Samples					Background		2000-Series Comparable to Background?
		Samples	Hits	Minimum	Maximum	Mean <sup>a</sup>	Minimum	Maximum	
<b>RADIONUCLIDES</b>									
Neptunium-237	pCi/L	8	3	0.20	0.41	0.37	NA	1.10 <sup>b</sup>	Yes
Plutonium-238	pCi/L	8	3	0.05	0.12	0.23	NA	1.00 <sup>b</sup>	Yes
Radium-226	pCi/L	9	4	0.16	0.79	0.41	1.10	8.50	Yes
Radium-228	pCi/L	9	1	1.54	1.74	1.36	3.10	5.50	Yes
Thorium-228	pCi/L	9	2	0.10	1.60	0.40	1.20	2.90	Yes
Thorium-230	pCi/L	9	4	0.13	1.00	0.40	1.20	3.44	Yes
Uranium-234	pCi/L	8	6	1.10	1.50	1.08	1.20	4.20	Yes
Uranium-235/236	pCi/L	9	4	0.08	0.13	0.27	NA	1.30 <sup>b</sup>	Yes
Uranium-238	pCi/L	9	6	0.58	1.62	1.01	0.90	4.40	Yes
<b>INORGANICS</b>									
Arsenic	µg/L	6	2	1.1	1.2	0.7	2.0	550.0	Yes
Chromium	µg/L	6	1	10.3	10.3	3.6	10.0	45.0	Yes
Manganese	µg/L	6	6	94.7	1685.0	596.8	2.0	897.0	Yes

<sup>a</sup>Means calculated by using half of the detection limit for non-detects.

<sup>b</sup>Not detected in background samples. Value reported is maximum detection limit.

NA = Not Available

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TABLE 5-26

PREDICTED PERCHED WATER CONCENTRATIONS AND SCREENING SUMMARY FOR  
 CONSTITUENTS OF POTENTIAL CONCERN, LIME SLUDGE PONDS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>RADIONUCLIDES</b>					
Cesium-137	pCi/L	1.41 x 10 <sup>+1</sup>	0.0	1.70 x 10 <sup>-1</sup>	NO
Neptunium-237	pCi/L	2.84 x 10 <sup>+1</sup>	5.49 x 10 <sup>+0</sup>	2.20 x 10 <sup>-2</sup>	YES
Plutonium-238	pCi/L	1.76 x 10 <sup>+1</sup>	0.0	2.20 x 10 <sup>-2</sup>	NO
Plutonium-239/240	pCi/L	8.91 x 10 <sup>+0</sup>	0.0	2.10 x 10 <sup>-2</sup>	NO
Radium-226	pCi/L	1.31 x 10 <sup>+2</sup>	0.0	4.00 x 10 <sup>-2</sup>	NO
Radium-228	pCi/L	1.51 x 10 <sup>+2</sup>	0.0	4.80 x 10 <sup>-2</sup>	NO
Strontium-90	pCi/L	7.07 x 10 <sup>+1</sup>	1.91 x 10 <sup>+0</sup>	1.30 x 10 <sup>-1</sup>	YES
Technetium-99	pCi/L	7.48 x 10 <sup>+1</sup>	6.98 x 10 <sup>+1</sup>	2.70 x 10 <sup>-1</sup>	YES
Thorium-228	pCi/L	1.29 x 10 <sup>+2</sup>	0.0	8.70 x 10 <sup>-2</sup>	NO
Thorium-230	pCi/L	7.05 x 10 <sup>+2</sup>	0.0	3.70 x 10 <sup>-1</sup>	NO
Thorium-232	pCi/L	9.00 x 10 <sup>+1</sup>	0.0	4.00 x 10 <sup>-1</sup>	NO
Uranium-234	pCi/L	5.20 x 10 <sup>+2</sup>	2.01 x 10 <sup>-2</sup>	3.00 x 10 <sup>-1</sup>	NO
Uranium-235/236	pCi/L	3.66 x 10 <sup>+1</sup>	1.42 x 10 <sup>-3</sup>	3.00 x 10 <sup>-1</sup>	NO
Uranium-238	pCi/L	6.27 x 10 <sup>+2</sup>	1.64 x 10 <sup>-2</sup>	1.70 x 10 <sup>-1</sup>	NO
Uranium-Total (non-RAD)	µg/L	1.87 x 10 <sup>+3</sup>	7.24 x 10 <sup>-2</sup>	1.00 x 10 <sup>+1</sup>	NO

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TABLE 5-26  
(Continued)

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>ORGANICS</b>					
1,1,2-Trichlorotrifluoroethane	µg/L	1.68 x 10 <sup>+0</sup>	1.66 x 10 <sup>-1</sup>	1.30 x 10 <sup>+2</sup>	NO
Acetone	µg/L	3.20 x 10 <sup>+0</sup>	3.59 x 10 <sup>-8</sup>	3.70 x 10 <sup>+2</sup>	NO
Acetonitrile	µg/L	1.68 x 10 <sup>+1</sup>	1.33 x 10 <sup>+1</sup>	2.20 x 10 <sup>+1</sup>	NO
Acrylonitrile	µg/L	1.68 x 10 <sup>+1</sup>	4.12 x 10 <sup>-5</sup>	1.50 x 10 <sup>-2</sup>	NO
Anthracene	µg/L	4.71 x 10 <sup>+0</sup>	0.0	1.10 x 10 <sup>+3</sup>	NO
Aroclor-1254	µg/L	3.62 x 10 <sup>+0</sup>	0.0	1.00 x 10 <sup>-3</sup>	NO
Benzo(a)anthracene	µg/L	8.41 x 10 <sup>-2</sup>	0.0	1.10 x 10 <sup>-2</sup>	NO
Benzo(a)pyrene	µg/L	8.41 x 10 <sup>-2</sup>	0.0	1.00 x 10 <sup>-3</sup>	NO
Benzo(b)fluoranthene	µg/L	4.63 x 10 <sup>+0</sup>	0.0	1.10 x 10 <sup>-2</sup>	NO
Benzo(k)fluoranthene	µg/L	1.68 x 10 <sup>-1</sup>	0.0	1.10 x 10 <sup>-1</sup>	NO
bis(2-Ethylhexyl)phthalate	µg/L	1.43 x 10 <sup>+2</sup>	0.0	5.70 x 10 <sup>-1</sup>	NO
Chrysene	µg/L	4.79 x 10 <sup>+0</sup>	0.0	1.10 x 10 <sup>+2</sup>	NO
Di-N-butyl phthalate	µg/L	1.01 x 10 <sup>+1</sup>	0.0	3.70 x 10 <sup>+2</sup>	NO
Di-N-octyl phthalate	µg/L	7.32 x 10 <sup>+0</sup>	0.0	7.30 x 10 <sup>+1</sup>	NO
Dibenzo(a,h)anthracene	µg/L	9.25 x 10 <sup>+0</sup>	0.0	1.00 x 10 <sup>-3</sup>	NO
Fluoroanthene	µg/L	6.48 x 10 <sup>+0</sup>	0.0	1.50 x 10 <sup>+2</sup>	NO
Hexane	µg/L	1.68 x 10 <sup>+0</sup>	2.91 x 10 <sup>-1</sup>	3.50 x 10 <sup>+1</sup>	NO
Indeno(1,2,3-cd)pyrene	µg/L	1.77 x 10 <sup>+1</sup>	0.0	1.10 x 10 <sup>-2</sup>	NO

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TABLE 5-26  
(Continued)

Constituent	Units	Maximum Leachate Concentration	Predicted Maximum Perched Water Concentration	Screening Concentration	Predicted Concentration Above Screening Concentration
<b>ORGANICS (Continued)</b>					
Pyrene	µg/L	5.38 x 10 <sup>+0</sup>	0.0	1.10 x 10 <sup>+2</sup>	NO
Toluene	µg/L	1.00 x 10 <sup>+0</sup>	0.0	7.50 x 10 <sup>+1</sup>	NO
<b>INORGANICS</b>					
Arsenic	µg/L	4.99 x 10 <sup>+2</sup>	1.45 x 10 <sup>-2</sup>	5.00 x 10 <sup>-3</sup>	YES
Barium	µg/L	8.00 x 10 <sup>+2</sup>	0.0	2.60 x 10 <sup>+2</sup>	NO
Beryllium	µg/L	1.07 x 10 <sup>+2</sup>	0.0	2.00 x 10 <sup>-3</sup>	NO
Cadmium	µg/L	4.38 x 10 <sup>+1</sup>	0.0	1.80 x 10 <sup>+0</sup>	NO
Chromium	µg/L	1.10 x 10 <sup>+2</sup>	0.0	1.80 x 10 <sup>+1</sup>	NO
Copper	µg/L	2.30 x 10 <sup>+3</sup>	4.69 x 10 <sup>+1</sup>	1.40 x 10 <sup>+2</sup>	NO
Cyanide	µg/L	6.90 x 10 <sup>+1</sup>	1.59 x 10 <sup>+1</sup>	7.30 x 10 <sup>+1</sup>	NO
Manganese	µg/L	8.19 x 10 <sup>+4</sup>	1.94 x 10 <sup>+1</sup>	1.80 x 10 <sup>+1</sup>	YES
Mercury	µg/L	2.00 x 10 <sup>-1</sup>	1.98 x 10 <sup>-1</sup>	1.10 x 10 <sup>+0</sup>	NO

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TABLE 5-27

COMPARISON OF PERCHED WATER AND BACKGROUND FOR  
 POTENTIAL CONSTITUENTS OF CONCERN IN PERCHED WATER  
 FOR THE LIME SLUDGE PONDS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituent of Potential Concern	Units	Detects in Perched Water (1000-Series Well)					Background		Perched Water Comparable to Background?
		Samples	Hits	Minimum	Maximum	Mean <sup>a</sup>	Minimum	Maximum	
<b>RADIONUCLIDES</b>									
Neptunium-237	pCi/L	9	3	0.15	0.08	0.4	0.50 <sup>a</sup>	0.60 <sup>b</sup>	Yes
Radium-226	pCi/L	12	6	0.21	1.4	0.6	1.00	1.00	Yes
Radium-228	pCi/L	12	2	3.68	3.8	3.7	4.50	5.20	Yes
Strontium-90	pCi/L	12	1	3.45	3.5	3.5	2.50 <sup>a</sup>	2.50 <sup>b</sup>	Yes
Thorium-228	pCi/L	14	6	0.78	2.9	1.6	1.04	1.60	Yes
Thorium-230	pCi/L	14	8	0.25	6.7	2.3	2.00	2.00	Yes
Thorium-232	pCi/L	12	4	0.74	2.6	1.5	0.50 <sup>a</sup>	0.60 <sup>b</sup>	No
Uranium-234	pCi/L	16	15	0.39	11.0	3.1	1.06	1.90	No
Uranium-235/236	pCi/L	11	8	0.08	0.7	0.2	0.50 <sup>a</sup>	0.50 <sup>b</sup>	Yes
Uranium-238	pCi/L	18	17	0.30	11.8	3.5	1.07	1.50	No
<b>INORGANICS</b>									
Arsenic	µg/L	10	5	2.2	14	5.9	15.0	122.0	Yes
Barium	µg/L	22	21	78.1	459	201.2	34	459	Yes
Beryllium	µg/L	8	2	1.9	6.8	4.4	1.0	1.8	No
Cadmium	µg/L	6	3	6.2	10	7.7	6	7	Yes
Chromium	µg/L	11	7	12	63.9	30	20.0	12.0	Yes
Lead	µg/L	12	7	2	51.4	14.8	2.0	50.0	Yes
Manganese	µg/L	22	22	29	3060	619.2	7.0	220.0	No
Molybdenum	µg/L	15	8	5.1	30	15	24.0	28.0	Yes
Mercury	µg/L	4	1	0.4	0.4	0.4	0.2	3.7	Yes
Nickel	µg/L	13	9	3.7	108	33.4	21.0	180.0	Yes
Vanadium	µg/L	11	4	27.4	125	54.7	18	19.5	No
Total Uranium	µg/L	22	20	1	58	12.8	0.8	5.3	No
<b>ORGANICS</b>									
bis(2-Ethylhexyl)phthlate	µg/L	3	2	1	2	1.5	0.0	0.0	No

<sup>a</sup>Not detected in background samples. Value reported is minimum detection limit.

<sup>b</sup>Not detected in background samples. Value reported is maximum detection limit.

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the Lime Sludge Ponds. All constituents were detected at concentrations comparable to the background concentrations. Therefore, model results were considered consistent with the observed data.

5.4.3.3 Inactive Flyash Pile/South Field

Figure 5-11 shows the areal extent of the waste in the Inactive Flyash Pile/South Field and the SWIFT III grid cells impacted by direct loading from these subunits. Many SWIFT III grid blocks received lateral drainage. These grid blocks are identified in Figure 5-11. All five pathways discussed in Section 5.4.1 were applicable for these two subunits. For the vadose zone pathway, Table 5-28 shows the CPC concentration in the waste and constituent inventory in the waste. Table 5-28 shows predicted maximum leachate concentration from the vadose zone, perched water infiltration, perched water subsurface seeps, and seep pathways. Table 5-29 shows the flow rates for the seeps and perched water subsurface seeps. While seep flow rates are based on field observations, subsurface seep flow rates were estimated from the perched water hydraulic gradients and hydraulic conductivity of the perched water zone. Concentration and mass loading due to the surface water pathway are discussed in Section 5.3; perched water and seep pathways are discussed in Appendix A-2.

CPCs from these two units were screened together because of the close proximity of the subunits. A summary of screening for CPCs is also included in Table 5-28 for the vadose zone, perched water infiltration, perched water subsurface seeps, and seep pathways. CPCs passing the screening in Table 5-28 were further screened using predicted dilution in the Great Miami Aquifer. Table 5-30 shows the results of the Great Miami Aquifer dilution screening. Table 5-31 lists the constituents that survived the various screening processes and were simulated using the SWIFT III model for the Inactive Flyash Pile and South Field.

Table 5-32 compares the background concentrations and the field measured concentrations in the Great Miami Aquifer. Uranium, bis(2-Ethylhexyl) phthalate, carbon disulfide, and trichloroethane are above background levels. Uranium was simulated using the SWIFT III model. Results of uranium calibration are presented in Section 5.4.4.3. Vadose zone modeling predicted small increase in concentrations for bis(2-Ethylhexyl) phthalate, carbon disulfide, and trichloroethane. Furthermore, the frequency of detection in Great Miami Aquifer for these contaminants was low. Therefore,

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TABLE 5-28

**SOURCE CHARACTERIZATION AND SCREENING SUMMARY FOR CONSTITUENTS OF POTENTIAL CONCERN FOR THE INACTIVE FLYASH PILE AND SOUTH FIELD**

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituents Inventory in the Waste (mg)	Initial Maximum Leachate Concentration		Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
			(pCi/L RAD)	(µg/L non-RAD)			
<b>RADIONUCLIDES</b>							
Cesium-137	2.77 x 10 <sup>-9</sup>	6.13 x 10 <sup>-1</sup>	2.52 x 10 <sup>+2</sup>	70-Year	0.0	1.70 x 10 <sup>-1</sup>	No
Lead-210	7.87 x 10 <sup>-8</sup>	1.74 x 10 <sup>+1</sup>	6.31 x 10 <sup>+3</sup>	70-Year	1.02 x 10 <sup>-15</sup>	7.30 x 10 <sup>-3</sup>	No
Neptunium-237	6.94 x 10 <sup>-4</sup>	1.53 x 10 <sup>+5</sup>	5.13 x 10 <sup>+2</sup>	70-Year	1.73 x 10 <sup>+2</sup>	2.20 x 10 <sup>-2</sup>	Yes
Plutonium-238	1.58 x 10 <sup>-8</sup>	3.49 x 10 <sup>+0</sup>	2.84 x 10 <sup>+2</sup>	70-Year	5.76 x 10 <sup>-4</sup>	2.20 x 10 <sup>-2</sup>	No
Plutonium-239/240	2.09 x 10 <sup>-6</sup>	4.62 x 10 <sup>+2</sup>	1.36 x 10 <sup>+2</sup>	70-Year	0.0	2.10 x 10 <sup>-2</sup>	No
Radium-224	1.97 x 10 <sup>-11</sup>	4.35 x 10 <sup>-3</sup>	3.29 x 10 <sup>+3</sup>	70-Year	0.0	1.30 x 10 <sup>-1</sup>	No
Radium-226	2.95 x 10 <sup>-6</sup>	6.52 x 10 <sup>+2</sup>	3.06 x 10 <sup>+3</sup>	70-Year	1.58 x 10 <sup>-1</sup>	4.00 x 10 <sup>-2</sup>	Yes
Radium-228	6.09 x 10 <sup>-9</sup>	1.35 x 10 <sup>+0</sup>	1.74 x 10 <sup>+3</sup>	70-Year	0.0	4.80 x 10 <sup>-2</sup>	No
Ruthenium-106	3.87 x 10 <sup>-10</sup>	8.55 x 10 <sup>-2</sup>	1.36 x 10 <sup>+3</sup>	70-Year	0.0	5.00 x 10 <sup>-1</sup>	No
Strontium-90	4.09 x 10 <sup>-9</sup>	9.03 x 10 <sup>-1</sup>	5.88 x 10 <sup>+2</sup>	70-Year	6.32 x 10 <sup>+0</sup>	1.30 x 10 <sup>-2</sup>	Yes
Techentium-99	5.29 x 10 <sup>-5</sup>	1.17 x 10 <sup>+4</sup>	9.45 x 10 <sup>+2</sup>	70-Year	7.72 x 10 <sup>+2</sup>	2.70 x 10 <sup>-1</sup>	Yes
Thorium-228	2.03 x 10 <sup>-9</sup>	4.48 x 10 <sup>-1</sup>	1.74 x 10 <sup>+3</sup>	70-Year	0.0	8.70 x 10 <sup>-2</sup>	No
Thorium-230	2.07 x 10 <sup>-4</sup>	4.57 x 10 <sup>+4</sup>	4.48 x 10 <sup>+3</sup>	70-Year	0.0	3.70 x 10 <sup>-1</sup>	No
Thorium-232	1.36 x 10 <sup>+1</sup>	3.00 x 10 <sup>+9</sup>	1.57 x 10 <sup>+3</sup>	70-Year	0.0	4.00 x 10 <sup>-1</sup>	No
Uranium-234	4.62 x 10 <sup>-3</sup>	1.02 x 10 <sup>+6</sup>	3.02 x 10 <sup>+4</sup>	70-Year	1.05 x 10 <sup>+4</sup>	3.00 x 10 <sup>-1</sup>	Yes
Uranium-235/236	9.34 x 10 <sup>-1</sup>	2.06 x 10 <sup>+8</sup>	2.12 x 10 <sup>+3</sup>	70-Year	7.37 x 10 <sup>+2</sup>	3.00 x 10 <sup>-1</sup>	Yes
Uranium-238		1.82 x 10 <sup>+10</sup>			5.44 x 10 <sup>+5</sup>	1.70 x 10 <sup>-1</sup>	Yes
Grid#28,59	1.88 x 10 <sup>+1</sup>	1.41 x 10 <sup>+8</sup>	4.24 x 10 <sup>+3</sup>	70-Year			
Grid#28,63	1.62 x 10 <sup>+2</sup>	4.13 x 10 <sup>+8</sup>	1.72 x 10 <sup>+4</sup>	70-Year			
Grid#28,65	1.28 x 10 <sup>+2</sup>	4.17 x 10 <sup>+8</sup>	1.36 x 10 <sup>+4</sup>	70-Year			
Grid#29,62	3.04 x 10 <sup>+1</sup>	1.12 x 10 <sup>+8</sup>	3.69 x 10 <sup>+3</sup>	70-Year			

See footnote at end of table

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TABLE 5-28  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituents Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>RADIONUCLIDES</b>							
Uranium-238 (Continued)							
Grid#29,64	7.66 x 10 <sup>+1</sup>	5.33 x 10 <sup>+8</sup>	9.89 x 10 <sup>+3</sup>	70-Year			
Grid#30,62	2.18 x 10 <sup>+1</sup>	1.55 x 10 <sup>+8</sup>	2.88 x 10 <sup>+3</sup>	70-Year			
Grid#28,64	3.04 x 10 <sup>+1</sup>	2.17 x 10 <sup>+8</sup>	4.62 x 10 <sup>+3</sup>	70-Year			
Grid#29,63	4.16 x 10 <sup>+1</sup>	3.88 x 10 <sup>+8</sup>	7.21 x 10 <sup>+3</sup>	70-Year			
Grid#29,60	7.85 x 10 <sup>+0</sup>	6.45 x 10 <sup>+5</sup>	6.37 x 10 <sup>+2</sup>	70-Year			
Grid#30,57	1.59 x 10 <sup>+1</sup>	7.69 x 10 <sup>+5</sup>	1.51 x 10 <sup>+2</sup>	70-Year			
Grid#30,61	1.81 x 10 <sup>+1</sup>	1.85 x 10 <sup>+7</sup>	2.06 x 10 <sup>+3</sup>	70-Year			
Grid#28,66	5.34 x 10 <sup>+2</sup>	1.99 x 10 <sup>+8</sup>	3.70 x 10 <sup>+4</sup>	70-Year			
Grid#30,60	1.18 x 10 <sup>+1</sup>	4.99 x 10 <sup>+7</sup>	2.98 x 10 <sup>+3</sup>	70-Year			
Grid#31,58	1.38 x 10 <sup>+1</sup>	3.80 x 10 <sup>+7</sup>	3.03 x 10 <sup>+3</sup>	70-Year			
Grid#31,59	1.38 x 10 <sup>+1</sup>	8.73 x 10 <sup>+7</sup>	4.66 x 10 <sup>+3</sup>	70-Year			
Grid#29,58	1.42 x 10 <sup>+1</sup>	9.45 x 10 <sup>+7</sup>	2.72 x 10 <sup>+3</sup>	70-Year			
Grid#29,59	9.89 x 10 <sup>+0</sup>	1.42 x 10 <sup>+8</sup>	3.49 x 10 <sup>+3</sup>	70-Year			
Grid#29,65	7.30 x 10 <sup>+2</sup>	7.09 x 10 <sup>+9</sup>	1.59 x 10 <sup>+5</sup>	70-Year			
Grid#30,58	1.77 x 10 <sup>+1</sup>	1.40 x 10 <sup>+8</sup>	2.20 x 10 <sup>+3</sup>	70-Year			
Grid#30,59	1.69 x 10 <sup>+1</sup>	1.88 x 10 <sup>+8</sup>	2.96 x 10 <sup>+3</sup>	70-Year			
Grid#30,63	1.45 x 10 <sup>+1</sup>	2.06 x 10 <sup>+8</sup>	3.25 x 10 <sup>+3</sup>	70-Year			
Grid#30,64	4.30 x 10 <sup>+1</sup>	5.08 x 10 <sup>+8</sup>	8.00 x 10 <sup>+3</sup>	70-Year			
Grid#29,67	2.10 x 10 <sup>+1</sup>	6.92 x 10 <sup>+6</sup>	1.27 x 10 <sup>+3</sup>	70-Year			
Grid#30,67	1.46 x 10 <sup>+1</sup>	1.97 x 10 <sup>+7</sup>	2.08 x 10 <sup>+3</sup>	70-Year			
Grid#29,66	3.29 x 10 <sup>+2</sup>	1.83 x 10 <sup>+9</sup>	3.48 x 10 <sup>+4</sup>	70-Year			
Grid#30,65	4.77 x 10 <sup>+2</sup>	2.71 x 10 <sup>+9</sup>	6.37 x 10 <sup>+4</sup>	70-Year			
Grid#30,66	8.25 x 10 <sup>+1</sup>	3.11 x 10 <sup>+8</sup>	6.16 x 10 <sup>+3</sup>	70-Year			

See footnote at end of table

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TABLE 5-28  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituents Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>RADIONUCLIDES</b>							
Uranium-238 (Continued)							
Grid#31,61	2.12 x 10 <sup>+1</sup>	1.53 x 10 <sup>+8</sup>	2.98 x 10 <sup>+3</sup>	70-Year			
Grid#31,62	2.07 x 10 <sup>+1</sup>	1.34 x 10 <sup>+8</sup>	2.62 x 10 <sup>+3</sup>	70-Year			
Grid#31,63	2.11 x 10 <sup>+1</sup>	1.65 x 10 <sup>+8</sup>	3.22 x 10 <sup>+3</sup>	70-Year			
Grid#31,66	2.61 x 10 <sup>+1</sup>	6.19 x 10 <sup>+6</sup>	2.81 x 10 <sup>+3</sup>	70-Year			
Grid#34,60	6.29 x 10 <sup>+1</sup>	3.84 x 10 <sup>+6</sup>	1.80 x 10 <sup>+3</sup>	70-Year			
Grid#35,61	6.29 x 10 <sup>+1</sup>	2.39 x 10 <sup>+6</sup>	1.01 x 10 <sup>+3</sup>	70-Year			
Grid#31,65	2.17 x 10 <sup>+1</sup>	3.28 x 10 <sup>+7</sup>	2.63 x 10 <sup>+3</sup>	70-Year			
Grid#32,64	2.34 x 10 <sup>+1</sup>	4.67 x 10 <sup>+7</sup>	3.92 x 10 <sup>+3</sup>	70-Year			
Grid#33,59	1.61 x 10 <sup>+1</sup>	2.86 x 10 <sup>+6</sup>	1.68 x 10 <sup>+3</sup>	70-Year			
Grid#33,60	8.10 x 10 <sup>+0</sup>	1.03 x 10 <sup>+7</sup>	7.90 x 10 <sup>+2</sup>	70-Year			
Grid#33,61	3.41 x 10 <sup>+1</sup>	6.47 x 10 <sup>+7</sup>	4.53 x 10 <sup>+3</sup>	70-Year			
Grid#33,63	1.01 x 10 <sup>+2</sup>	1.41 x 10 <sup>+8</sup>	1.31 x 10 <sup>+4</sup>	70-Year			
Grid#34,61	6.29 x 10 <sup>+1</sup>	1.19 x 10 <sup>+8</sup>	8.62 x 10 <sup>+3</sup>	70-Year			
Grid#34,62	2.12 x 10 <sup>+2</sup>	2.68 x 10 <sup>+8</sup>	2.92 x 10 <sup>+4</sup>	70-Year			
Grid#31,60	1.32 x 10 <sup>+1</sup>	7.75 x 10 <sup>+7</sup>	2.82 x 10 <sup>+3</sup>	70-Year			
Grid#31,64	2.46 x 10 <sup>+1</sup>	1.24 x 10 <sup>+8</sup>	4.51 x 10 <sup>+3</sup>	70-Year			
Grid#32,60	1.30 x 10 <sup>+1</sup>	4.40 x 10 <sup>+7</sup>	1.60 x 10 <sup>+3</sup>	70-Year			
Grid#32,61	1.07 x 10 <sup>+1</sup>	3.42 x 10 <sup>+7</sup>	1.24 x 10 <sup>+3</sup>	70-Year			
Grid#32,62	2.66 x 10 <sup>+1</sup>	1.24 x 10 <sup>+8</sup>	4.52 x 10 <sup>+3</sup>	70-Year			
Grid#32,63	2.92 x 10 <sup>+1</sup>	1.35 x 10 <sup>+8</sup>	4.90 x 10 <sup>+3</sup>	70-Year			
Grid#33,62	1.60 x 10 <sup>+2</sup>	4.93 x 10 <sup>+8</sup>	1.79 x 10 <sup>+4</sup>	70-Year			
Grid#32,59	1.00 x 10 <sup>+1</sup>	2.95 x 10 <sup>+7</sup>	2.15 x 10 <sup>+3</sup>	70-Year			
Uranium Total (non-RAD)	1.04 x 10 <sup>+2</sup>	2.29 x 10 <sup>+10</sup>	1.09 x 10 <sup>+5</sup>	70-Year	3.79 x 10 <sup>+4</sup>	1.00 x 10 <sup>+1</sup>	Yes

See footnote at end of table

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TABLE 5-28  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituents Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (µg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>ORGANICS</b>							
1,1,1-Trichloroethane	5.00 x 10 <sup>-2</sup>	1.10 x 10 <sup>+7</sup>	5.25 x 10 <sup>+1</sup>	70-Year	3.66 x 10 <sup>-2</sup>	1.30 x 10 <sup>+3</sup>	No
2-Butanone	2.00 x 10 <sup>-3</sup>	4.42 x 10 <sup>+5</sup>	4.00 x 10 <sup>+0</sup>	TCLP	2.64 x 10 <sup>-3</sup>	2.20 x 10 <sup>+3</sup>	No
4-Methyl-2-Pentanone	1.00 x 10 <sup>-3</sup>	2.21 x 10 <sup>+5</sup>	1.05 x 10 <sup>+0</sup>	70-Year	0.0	1.80 x 10 <sup>+2</sup>	No
4-Methylphenol	1.00 x 10 <sup>-1</sup>	2.21 x 10 <sup>+7</sup>	2.00 x 10 <sup>+1</sup>	mdl-TCLP	0.0	1.80 x 10 <sup>+1</sup>	No
Acenaphthylene	4.10 x 10 <sup>-1</sup>	9.06 x 10 <sup>+7</sup>	4.31 x 10 <sup>+2</sup>	70-Year	0.0	2.20 x 10 <sup>+2</sup>	No
Acetone	5.60 x 10 <sup>-2</sup>	1.24 x 10 <sup>+7</sup>	5.88 x 10 <sup>+1</sup>	70-Year	0.0	3.70 x 10 <sup>+2</sup>	No
Anthracene	4.90 x 10 <sup>-2</sup>	1.08 x 10 <sup>+7</sup>	5.15 x 10 <sup>+1</sup>	70-Year	0.0	1.10 x 10 <sup>+3</sup>	No
Aroclor-1254	4.30 x 10 <sup>-1</sup>	9.50 x 10 <sup>+7</sup>	4.52 x 10 <sup>+2</sup>	70-Year	0.0	1.00 x 10 <sup>-3</sup>	No
Aroclor-1260	8.90 x 10 <sup>-2</sup>	1.97 x 10 <sup>+7</sup>	9.35 x 10 <sup>+1</sup>	70-Year	0.0	1.00 x 10 <sup>-3</sup>	No
Benzo(a)anthracene	1.30 x 10 <sup>-1</sup>	2.87 x 10 <sup>+7</sup>	1.37 x 10 <sup>+2</sup>	70-Year	0.0	1.10 x 10 <sup>-2</sup>	No
Benzo(a)pyrene	1.10 x 10 <sup>-1</sup>	2.43 x 10 <sup>+7</sup>	1.16 x 10 <sup>+2</sup>	70-Year	0.0	1.10 x 10 <sup>-3</sup>	No
Benzo(b)fluoranthene	1.40 x 10 <sup>-1</sup>	3.09 x 10 <sup>+7</sup>	1.47 x 10 <sup>+2</sup>	70-Year	0.0	1.10 x 10 <sup>-3</sup>	No
Benzo(k)fluoranthene	8.40 x 10 <sup>-2</sup>	1.86 x 10 <sup>+7</sup>	8.82 x 10 <sup>+1</sup>	70-Year	0.0	1.10 x 10 <sup>-1</sup>	No
Benzoic Acid	5.70 x 10 <sup>-2</sup>	1.26 x 10 <sup>+7</sup>	5.99 x 10 <sup>+1</sup>	70-Year	0.0	1.50 x 10 <sup>+4</sup>	No
bis(2-Ethylhexyl) phthalate	8.60 x 10 <sup>-1</sup>	1.90 x 10 <sup>+8</sup>	9.03 x 10 <sup>+2</sup>	70-Year	4.25 x 10 <sup>-15</sup>	5.70 x 10 <sup>-1</sup>	No
Carbazole	1.00 x 10 <sup>-3</sup>	2.21 x 10 <sup>+5</sup>	1.05 x 10 <sup>+0</sup>	70-Year	5.70 x 10 <sup>-1</sup>	4.00 x 10 <sup>-1</sup>	Yes
Carbon Disulfide	2.00 x 10 <sup>-3</sup>	4.42 x 10 <sup>+5</sup>	2.10 x 10 <sup>+0</sup>	70-Year	9.09 x 10 <sup>-13</sup>	2.10 x 10 <sup>+0</sup>	No
alpha-Chlordane	3.00 x 10 <sup>-3</sup>	6.63 x 10 <sup>+5</sup>	5.00 x 10 <sup>-1</sup>	mdl-TCLP	1.42 x 10 <sup>-4</sup>	6.10 x 10 <sup>-3</sup>	No
gamma-Chlordane	7.00 x 10 <sup>-3</sup>	1.55 x 10 <sup>+6</sup>	5.00 x 10 <sup>-1</sup>	mdl-TCLP	1.51 x 10 <sup>-4</sup>	6.10 x 10 <sup>-3</sup>	No
Chlorobenzene	1.40 x 10 <sup>-2</sup>	3.09 x 10 <sup>+6</sup>	5.00 x 10 <sup>+0</sup>	mdl-TCLP	8.66 x 10 <sup>-9</sup>	3.90 x 10 <sup>+0</sup>	No
Chloroform	3.00 x 10 <sup>-3</sup>	6.63 x 10 <sup>+5</sup>	1.00 x 10 <sup>+0</sup>	TCLP	2.15 x 10 <sup>-6</sup>	2.00 x 10 <sup>-2</sup>	No
Chloromethane	5.20 x 10 <sup>-2</sup>	1.15 x 10 <sup>+7</sup>	5.46 x 10 <sup>+1</sup>	70-Year	7.46 x 10 <sup>-3</sup>	1.80 x 10 <sup>-1</sup>	No
Chrysene	1.50 x 10 <sup>-1</sup>	3.31 x 10 <sup>+7</sup>	1.58 x 10 <sup>+2</sup>	70-Year	0.0	1.10 x 10 <sup>+2</sup>	No
Di-n-butyl phthalate	4.60 x 10 <sup>-2</sup>	1.02 x 10 <sup>+7</sup>	4.83 x 10 <sup>+1</sup>	70-Year	0.0	3.70 x 10 <sup>+2</sup>	No

See footnote at end of table

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TABLE 5-28  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituents Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>ORGANICS (Continued)</b>							
Di-n-octyl phthalate	2.10 x 10 <sup>-1</sup>	4.64 x 10 <sup>+7</sup>	2.21 x 10 <sup>+2</sup>	70-Year	0.0	7.30 x 10 <sup>+1</sup>	No
Dibenzo(ah)anthracene	2.00 x 10 <sup>-3</sup>	4.42 x 10 <sup>+5</sup>	2.10 x 10 <sup>+0</sup>	70-Year	0.0	1.10 x 10 <sup>-3</sup>	No
Dieldrin	1.60 x 10 <sup>-2</sup>	3.53 x 10 <sup>+6</sup>	1.68 x 10 <sup>+1</sup>	70-Year	2.94 x 10 <sup>-9</sup>	5.00 x 10 <sup>-4</sup>	No
Diethyl phthalate	5.20 x 10 <sup>-2</sup>	1.15 x 10 <sup>+7</sup>	5.46 x 10 <sup>+1</sup>	70-Year	0.0	2.90 x 10 <sup>+3</sup>	No
Fluoranthene	2.60 x 10 <sup>-1</sup>	5.74 x 10 <sup>+7</sup>	2.73 x 10 <sup>+2</sup>	70-Year	0.0	1.50 x 10 <sup>+2</sup>	No
Indeno(1,2,3-cd)pyrene	4.60 x 10 <sup>-2</sup>	1.02 x 10 <sup>+7</sup>	4.83 x 10 <sup>+1</sup>	70-Year	0.0	1.10 x 10 <sup>-2</sup>	No
Isophorone	4.00 x 10 <sup>-3</sup>	8.84 x 10 <sup>+5</sup>	4.20 x 10 <sup>+0</sup>	70-Year	0.0	8.40 x 10 <sup>+0</sup>	No
Methylene chloride	5.40 x 10 <sup>-2</sup>	1.19 x 10 <sup>+7</sup>	5.67 x 10 <sup>+1</sup>	70-Year	0.0	5.10 x 10 <sup>-1</sup>	No
Napthalene	5.30 x 10 <sup>-2</sup>	1.17 x 10 <sup>+7</sup>	5.57 x 10 <sup>+1</sup>	70-Year	0.0	1.50 x 10 <sup>+2</sup>	No
Octachlorodibenzo-p-dioxin	4.00 x 10 <sup>-3</sup>	8.84 x 10 <sup>+5</sup>	4.20 x 10 <sup>+0</sup>	70-Year	0.0	5.30 x 10 <sup>-5</sup>	No
Pyrene	2.20 x 10 <sup>-1</sup>	4.86 x 10 <sup>+7</sup>	2.31 x 10 <sup>+2</sup>	70-Year	0.0	1.10 x 10 <sup>+2</sup>	No
Styrene	2.00 x 10 <sup>-3</sup>	4.42 x 10 <sup>+5</sup>	2.10 x 10 <sup>+0</sup>	70-Year	0.0	1.60 x 10 <sup>+2</sup>	No
Tetrachloroethene	1.00 x 10 <sup>-3</sup>	2.21 x 10 <sup>+5</sup>	5.00 x 10 <sup>+0</sup>	mdl-TCLP	1.10 x 10 <sup>-2</sup>	1.30 x 10 <sup>-1</sup>	No
Tetrachlorodibenzofuran	1.80 x 10 <sup>-5</sup>	3.98 x 10 <sup>+3</sup>	1.89 x 10 <sup>-2</sup>	70-Year	0.0	5.30 x 10 <sup>-7</sup>	No
Toluene	1.10 x 10 <sup>-1</sup>	2.43 x 10 <sup>+7</sup>	1.16 x 10 <sup>+2</sup>	70-Year	0.0	7.50 x 10 <sup>+1</sup>	No
Trichloroethene	2.00 x 10 <sup>-3</sup>	4.42 x 10 <sup>+5</sup>	5.00 x 10 <sup>+0</sup>	mdl-TCLP	3.31 x 10 <sup>-2</sup>	1.90 x 10 <sup>-1</sup>	No
Vinyl Acetate	2.00 x 10 <sup>-3</sup>	4.42 x 10 <sup>+5</sup>	2.10 x 10 <sup>+0</sup>	70-Year	9.24 x 10 <sup>-1</sup>	3.70 x 10 <sup>+3</sup>	No
Xylenes, Total	1.00 x 10 <sup>-3</sup>	2.21 x 10 <sup>+5</sup>	1.05 x 10 <sup>+0</sup>	70-Year	0.0	1.20 x 10 <sup>+3</sup>	No
<b>INORGANICS</b>							
Antimony	1.87 x 10 <sup>+1</sup>	4.13 x 10 <sup>+9</sup>	1.96 x 10 <sup>+4</sup>	70-Year	1.27 x 10 <sup>+1</sup>	1.50 x 10 <sup>+0</sup>	Yes
Arsenic	1.21 x 10 <sup>+1</sup>	2.66 x 10 <sup>+9</sup>	4.00 x 10 <sup>+2</sup>	TCLP	1.29 x 10 <sup>-5</sup>	5.00 x 10 <sup>-3</sup>	No
Barium	1.81 x 10 <sup>+2</sup>	4.01 x 10 <sup>+10</sup>	1.91 x 10 <sup>+3</sup>	TCLP	1.21 x 10 <sup>+3</sup>	2.60 x 10 <sup>+2</sup>	Yes

See footnote at end of table

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TABLE 5-28  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituents Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (µg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>INORGANICS (Continued)</b>							
Beryllium	1.44 x 10 <sup>+0</sup>	3.18 x 10 <sup>+8</sup>	1.51 x 10 <sup>+3</sup>	70-Year	0.0	2.00 x 10 <sup>-3</sup>	No
Cadmium	1.22 x 10 <sup>+0</sup>	2.69 x 10 <sup>+8</sup>	1.37 x 10 <sup>+1</sup>	TCLP	1.18 x 10 <sup>+1</sup>	1.80 x 10 <sup>+0</sup>	Yes
Chromium	1.68 x 10 <sup>+1</sup>	3.70 x 10 <sup>+9</sup>	1.00 x 10 <sup>+2</sup>	TCLP	2.52 x 10 <sup>+1</sup>	1.80 x 10 <sup>+1</sup>	Yes
Copper	2.98 x 10 <sup>+1</sup>	6.59 x 10 <sup>+9</sup>	2.90 x 10 <sup>+0</sup>	TCLP	2.70 x 10 <sup>+1</sup>	1.40 x 10 <sup>+2</sup>	No
Cyanide	7.80 x 10 <sup>-1</sup>	1.72 x 10 <sup>+8</sup>	1.00 x 10 <sup>+2</sup>	TCLP	2.24 x 10 <sup>+1</sup>	7.30 x 10 <sup>+1</sup>	No
Lead	2.81 x 10 <sup>+1</sup>	6.20 x 10 <sup>+9</sup>	2.00 x 10 <sup>+2</sup>	TCLP	5.61 x 10 <sup>+1</sup>	1.50 x 10 <sup>+0</sup>	Yes
Manganese	5.25 x 10 <sup>+2</sup>	1.16 x 10 <sup>+11</sup>	4.32 x 10 <sup>+2</sup>	TCLP	3.28 x 10 <sup>+3</sup>	1.80 x 10 <sup>+1</sup>	Yes
Mercury	4.40 x 10 <sup>-1</sup>	9.72 x 10 <sup>+7</sup>	2.00 x 10 <sup>-1</sup>	TCLP	1.99 x 10 <sup>-1</sup>	1.10 x 10 <sup>+0</sup>	No
Molybdenum	6.69 x 10 <sup>+0</sup>	1.48 x 10 <sup>+9</sup>	7.03 x 10 <sup>+3</sup>	70-Year	1.32 x 10 <sup>+3</sup>	1.80 x 10 <sup>+1</sup>	Yes
Nickel	2.35 x 10 <sup>+1</sup>	5.18 x 10 <sup>+9</sup>	2.46 x 10 <sup>+4</sup>	70-Year	0.0	7.30 x 10 <sup>+1</sup>	No
Silver	5.24 x 10 <sup>+0</sup>	1.16 x 10 <sup>+9</sup>	1.00 x 10 <sup>+2</sup>	TCLP	3.25 x 10 <sup>+1</sup>	1.80 x 10 <sup>+1</sup>	Yes
Vanadium	2.77 x 10 <sup>+1</sup>	6.11 x 10 <sup>+9</sup>	2.91 x 10 <sup>+4</sup>	70-Year	0.0	2.00 x 10 <sup>+1</sup>	No

<sup>a</sup>Constraint on reported concentration is by In Situ Leachate (ISL), Toxicity Characteristic Leaching Procedure (TCLP), maximum detection limit (MDL), or by US EPA 70-year rule (70-Year).

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**TABLE 5-29**  
**FLOW RATES FOR SEEPS AND PERCHED WATER SUBSURFACE SEEPS**  
**INACTIVE FLYASH PILE AND SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Grid Cell	Flow Rate	
	Gallons/minute	Inch/year
<b>INACTIVE FLYASH PILE SEEP</b>		
(28,66)	0.35	18.9
<b>SOUTH FIELD SEEP</b>		
(30,57)	0.26	14.0
<b>PERCHED WATER SUBSURFACE SEEP</b>		
(28,66)	0.44	23.6
(29,62)	0.15	8.1
(29,63)	0.45	24.4
(29,64)	0.77	41.8
(29,65)	1.73	93.6
(30,60)	0.20	10.9
(30,61)	0.40	21.7
(30,62)	0.40	21.7

TABLE 5-30

**SCREENING FOR CONSTITUENTS OF POTENTIAL CONCERN AFTER DILUTION IN THE GREAT MIAMI AQUIFER  
FOR THE INACTIVE FLYASH PILE AND SOUTH FIELD  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent	Units	Concentration at the Groundwater Table	Diluted Great Miami Aquifer Concentration	Screening Concentration	Diluted Concentration Exceeds Screening Concentration
<b>RADIONUCLIDES</b>					
Neptunium-237	pCi/L	$1.73 \times 10^{+2}$	$6.25 \times 10^{+0}$	$2.20 \times 10^{-2}$	YES
Radium-226	pCi/L	$1.58 \times 10^{-1}$	$9.14 \times 10^{-2}$	$4.00 \times 10^{-2}$	YES
Strontium-90	pCi/L	$6.32 \times 10^{+0}$	$6.27 \times 10^{-1}$	$1.30 \times 10^{-1}$	YES
Technetium-99	pCi/L	$7.72 \times 10^{+2}$	$2.79 \times 10^{+1}$	$2.70 \times 10^{-1}$	YES
Uranium-234	pCi/L	$1.05 \times 10^{+4}$	$3.79 \times 10^{+2}$	$3.00 \times 10^{-1}$	YES
Uranium-235/236	pCi/L	$7.37 \times 10^{+2}$	$2.66 \times 10^{+1}$	$3.00 \times 10^{-1}$	YES
Uranium-238	pCi/L	$5.44 \times 10^{+5}$	$2.89 \times 10^{+3}$	$1.70 \times 10^{-1}$	YES
Uranium-Total	$\mu\text{g/L}$	$3.79 \times 10^{+4}$	$1.37 \times 10^{+0}$	$1.00 \times 10^{+1}$	YES
<b>ORGANICS</b>					
Carbazole	$\mu\text{g/L}$	$5.70 \times 10^{-1}$	$2.06 \times 10^{-2}$	$4.00 \times 10^{-1}$	NO
<b>INORGANICS</b>					
Antimony	$\mu\text{g/L}$	$1.27 \times 10^{+1}$	$7.32 \times 10^{+0}$	$1.50 \times 10^{+0}$	YES
Barium	$\mu\text{g/L}$	$1.21 \times 10^{+3}$	$1.20 \times 10^{+2}$	$2.60 \times 10^{+2}$	NO
Cadmium	$\mu\text{g/L}$	$1.18 \times 10^{+1}$	$4.86 \times 10^{+0}$	$1.80 \times 10^{+0}$	YES
Chromium	$\mu\text{g/L}$	$2.52 \times 10^{+1}$	$1.46 \times 10^{+1}$	$1.80 \times 10^{+1}$	NO
Lead	$\mu\text{g/L}$	$5.61 \times 10^{+1}$	$3.25 \times 10^{+1}$	$1.50 \times 10^{+0}$	YES
Manganese	$\mu\text{g/L}$	$3.28 \times 10^{+3}$	$1.90 \times 10^{+3}$	$1.80 \times 10^{+1}$	YES
Molybdenum	$\mu\text{g/L}$	$1.32 \times 10^{+3}$	$4.78 \times 10^{+1}$	$1.80 \times 10^{+1}$	YES
Silver	$\mu\text{g/L}$	$3.25 \times 10^{+1}$	$1.88 \times 10^{+1}$	$1.80 \times 10^{+1}$	YES

<sup>a</sup>Diluted Great Miami Aquifer concentration marginally exceeds screening concentration. However, it is expected that maximum concentration in the Great Miami Aquifer will be about an order of magnitude lower and, therefore, silver was not modeled further.

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**TABLE 5-31**  
**SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN AND SOURCE PATHWAYS FOR THE**  
**INACTIVE FLYASH PILE AND SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGMENT PROJECT**

Contaminants of Potential Concern	Source Pathways <sup>a</sup>				
	Inactive Flyash Pile/South Field Waste <sup>b</sup>	Inactive Flyash Pile Seep	South Field Seep	Perched Groundwater Subsurface Seeps in Inactive Flyash Pile/South Field	Paddy's Run Loading from Inactive Flyash Pile/South Field Runoff
<b>RADIONUCLIDES</b>					
Neptunium-237	Yes	Yes	No	Yes	No
Radium-226	Yes	Yes	No	Yes	No
Strontium-90	Yes	No	No	No	No
Technetium-99	Yes	No	No	No	Yes
Uranium-234	Yes	Yes	Yes	Yes	Yes
Uranium-235/236	Yes	Yes	Yes	Yes	Yes
Uranium-238	Yes	Yes	Yes	Yes	Yes
Uranium - Total (non-RAD)	Yes	Yes	Yes	Yes	Yes
<b>INORGANICS</b>					
Antimony	No	No	No	Yes	No
Cadmium	Yes	No	No	Yes	No
Lead	No	No	No	Yes	No
Manganese	No	Yes	No	Yes	No
Molybdenum	Yes	No	No	Yes	No
Silver	No	No	No	Yes <sup>c</sup>	No

<sup>a</sup>"Yes" indicates that predicted CPC concentration was above screening concentration; "No" indicates that the predicted CPC concentration was below screening concentration.

<sup>b</sup>Includes loading from perched groundwater source leakage through till and unsaturated GMA, if applicable.

<sup>c</sup>Not modeled based on diluted GMA concentration being approximately 4 percent greater than the screening concentration. Typical concentration reduction in the GMA is approximately by a factor of 20.

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TABLE 5-32

**COMPARISON OF GREAT MIAMI AQUIFER WATER AND BACKGROUND FOR  
CONSTITUENTS OF POTENTIAL CONCERN IN GROUNDWATER  
SOUTH FIELD, INACTIVE FLYASH PILE, AND ACTIVE FLYASH PILE  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents Potential of Concern	Units	Detects in 2000-Series Well Groundwater Samples				Background		2000-Series Comparable to Background?
		Samples	Hits	Minimum	Maximum	Minimum	Maximum	
<b>RADIONUCLIDES</b>								
NP-237	pCi/L	57	8	0.15	0.962	NA	1.10 <sup>a</sup>	Yes
PU-238	pCi/L	59	7	0.07	0.637	NA	1.00 <sup>a</sup>	Yes
PU-239/240	pCi/L	59	1	0.06	0.06	NA	1.00 <sup>a</sup>	Yes
RA-226	pCi/L	52	14	0.13	1.4	1.10	8.50	Yes
TH-228	pCi/L	60	4	1.10	1.4	1.20	2.90	Yes
TH-230	pCi/L	59	18	0.21	2.06	1.20	3.44	Yes
TH-232	pCi/L	59	5	0.04	1.49	1.20	2.90	Yes
U-234	pCi/L	61	57	0.68	662	1.20	4.20	No
U-235/236	pCi/L	60	28	0.15	31.70	NA	1.30 <sup>a</sup>	No
U-238	pCi/L	60	54	0.338	384	0.90	4.40	No
<b>INORGANICS</b>								
Arsenic	µg/L	16	6	1.2	3.9	2.0	550.0	Yes
Chromium	µg/L	16	3	5.2	23.7	10.0	45.0	Yes
Lead	µg/L	16	7	1.3	16.0	2.6	140.0	Yes
Manganese	µg/L	16	15	4.0	440.0	2.0	897.0	Yes
Vanadium	µg/L	16	3	18.5	30.5	10	25	Yes
U-Total	µg/L	60	56	2.0	2070.0	NA	NA	No <sup>b</sup>
<b>ORGANICS</b>								
bis(2-Ethylhexyl) phthalate	µg/L	22	3	2.0	6.0	N/A	N/A	No
Carbon disulfide	µg/L	22	1	26.0	26.0	N/A	N/A	No
Trichloroethene	µg/L	22	1	7.0	7.0	N/A	N/A	No

<sup>a</sup>Not detected in background samples. Value reported is maximum detection limit.

<sup>b</sup>Perched water concentration is lower then the Great Miami Aquifer concentration.

NA - Not available.

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further calibration for these chemicals was not considered and were not included for SWIFT III modeling.

5.4.3.4 Active Flyash Pile

Figure 5-14 shows the aerial extent of the waste in the Active Flyash Pile and the SWIFT III grid cells impacted by direct loading from this subunit. Three SWIFT III grid cells were modeled to receive lateral drainage from adjacent grid cells' waste (Figure 5-14). Three pathways of CPC migration to the Great Miami Aquifer were modeled from the Active Flyash Pile. These pathways were the vadose zone pathway, perched water infiltration pathway, and surface water pathway. For the vadose zone pathway, Table 5-33 shows CPC concentration in the waste, constituent inventory in the waste, and the maximum predicted leachate concentration. Concentration and mass for the perched water infiltration pathway are discussed in Appendix A-2. Concentration and mass loading due to surface water pathway are discussed in Section 5.3.

A summary of screening for CPCs is also included in Table 5-33 for the vadose zone and perched water infiltration pathways. CPCs passing the screening (Table 5-33) were further screened using predicted dilution in the Great Miami Aquifer. Table 5-34 shows the results of the Great Miami Aquifer dilution. Table 5-35 lists the constituents that survived various screening processes and were simulated using the SWIFT III model for the Active Flyash Pile. Predicted CPC concentrations were not compared to the field analytical results since this subunit is in close proximity and downgradient of the Inactive Flyash Pile and South Field.

5.4.4 Great Miami Aquifer Modeling Results and Discussion

The fate and transport of CPCs contained in the Operable Unit 2 subunits were evaluated to provide a basis for estimating current and future risks posed by Operable Unit 2. The groundwater fate and transport modeling results are summarized in following subsections for the Operable Unit 2's CPCs that will reach the Great Miami Aquifer within 1,000 years. The simulation time period of 1,000 years was selected based on the Risk Assessment Work Plan Addendum (DOE 1992a). Contributions to constituent concentrations from other FEMP sources and background concentrations were not included in the results presented in this section. Constituents concentrations were estimated for both on-site and off-site areas to provide a range of potential exposure scenarios.

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TABLE 5-33

SOURCE CHARACTERIZATION AND SCREENING SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN  
 ACTIVE FLYASH PILE  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration		Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
			(pCi/L RAD)	(μg/L non-RAD) Constraint <sup>a</sup>			
<b>RADIONUCLIDES</b>							
Lead-210	2.13 x 10 <sup>-8</sup>	9.12 x 10 <sup>-1</sup>	1.25 x 10 <sup>+3</sup>	70-Year	2.11 x 10 <sup>-10</sup>	7.30 x 10 <sup>-3</sup>	No
Neptunium-237	6.38 x 10 <sup>-4</sup>	2.73 x 10 <sup>+4</sup>	3.45 x 10 <sup>+2</sup>	70-Year	3.28 x 10 <sup>+1</sup>	2.20 x 10 <sup>-2</sup>	Yes
Plutonium-238	7.19 x 10 <sup>-9</sup>	3.07 x 10 <sup>-1</sup>	9.43 x 10 <sup>+1</sup>	70-Year	6.41 x 10 <sup>-24</sup>	2.20 x 10 <sup>-2</sup>	No
Plutonium-239/240	1.77 x 10 <sup>-6</sup>	7.57 x 10 <sup>+1</sup>	8.43 x 10 <sup>+1</sup>	70-Year	1.40 x 10 <sup>-20</sup>	2.10 x 10 <sup>-2</sup>	No
Radium-224	2.35 x 10 <sup>-11</sup>	1.01 x 10 <sup>-3</sup>	2.87 x 10 <sup>+3</sup>	70-Year	0.0	1.30 x 10 <sup>-1</sup>	No
Radium-226	5.30 x 10 <sup>-6</sup>	2.27 x 10 <sup>+2</sup>	4.02 x 10 <sup>+3</sup>	70-Year	7.74 x 10 <sup>-22</sup>	4.00 x 10 <sup>-2</sup>	No
Radium-228	1.59 x 10 <sup>-8</sup>	6.81 x 10 <sup>-1</sup>	3.32 x 10 <sup>+3</sup>	70-Year	0.0	4.79 x 10 <sup>-2</sup>	No
Strontium-90	7.04 x 10 <sup>-9</sup>	3.01 x 10 <sup>-1</sup>	7.39 x 10 <sup>+2</sup>	70-Year	1.79 x 10 <sup>+1</sup>	1.30 x 10 <sup>-1</sup>	Yes
Thorium-228	7.06 x 10 <sup>-9</sup>	3.02 x 10 <sup>-1</sup>	4.44 x 10 <sup>+3</sup>	70-Year	0.0	8.70 x 10 <sup>-2</sup>	No
Thorium-230	2.78 x 10 <sup>-4</sup>	1.19 x 10 <sup>+4</sup>	4.38 x 10 <sup>+3</sup>	70-Year	0.0	3.70 x 10 <sup>-1</sup>	No
Thorium-232	3.51 x 10 <sup>+1</sup>	1.50 x 10 <sup>+9</sup>	2.96 x 10 <sup>+3</sup>	70-Year	0.0	4.00 x 10 <sup>-1</sup>	No
Uranium-234	1.43 x 10 <sup>-3</sup>	6.12 x 10 <sup>+4</sup>	6.82 x 10 <sup>+3</sup>	70-Year	8.54 x 10 <sup>+2</sup>	3.00 x 10 <sup>-1</sup>	Yes
Uranium-235/236	1.91 x 10 <sup>+0</sup>	8.15 x 10 <sup>+7</sup>	3.16 x 10 <sup>+3</sup>	70-Year	3.95 x 10 <sup>+2</sup>	3.00 x 10 <sup>-1</sup>	Yes
Uranium-238		6.45 x 10 <sup>+8</sup>			4.87 x 10 <sup>+2</sup>	1.70 x 10 <sup>-1</sup>	Yes
Grid #31,56	1.51 x 10 <sup>+1</sup>	6.32 x 10 <sup>+6</sup>	6.78 x 10 <sup>+2</sup>	70-Year			
Grid #31,57	1.51 x 10 <sup>+1</sup>	3.33 x 10 <sup>+7</sup>	9.39 x 10 <sup>+2</sup>	70-Year			
Grid #32,56	1.51 x 10 <sup>+1</sup>	9.13 x 10 <sup>+7</sup>	1.39 x 10 <sup>+3</sup>	70-Year			

See footnote at end of table

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TABLE 5-33  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (µg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>RADIONUCLIDES</b>							
<b>(Continued)</b>							
<b>Uranium-238 (Continued)</b>							
Grid #32,57	1.51 x 10 <sup>+1</sup>	1.64 x 10 <sup>+8</sup>	1.84 x 10 <sup>+3</sup>	70-Year			
Grid #32,58	1.51 x 10 <sup>+1</sup>	1.95 x 10 <sup>+7</sup>	2.50 x 10 <sup>+3</sup>	70-Year			
Grid #33,56	1.51 x 10 <sup>+1</sup>	1.18 x 10 <sup>+8</sup>	1.37 x 10 <sup>+3</sup>	70-Year			
Grid #33,57	1.51 x 10 <sup>+1</sup>	1.03 x 10 <sup>+8</sup>	1.77 x 10 <sup>+3</sup>	70-Year			
Grid #33,58	1.51 x 10 <sup>+1</sup>	1.61 x 10 <sup>+7</sup>	1.97 x 10 <sup>+3</sup>	70-Year			
Grid #34,56	1.51 x 10 <sup>+1</sup>	6.78 x 10 <sup>+7</sup>	1.06 x 10 <sup>+3</sup>	70-Year			
Grid #34,57	1.51 x 10 <sup>+1</sup>	2.53 x 10 <sup>+7</sup>	3.89 x 10 <sup>+3</sup>	70-Year			
Uranium Total (non RAD)	3.00 x 10 <sup>+1</sup>	1.28 x 10 <sup>+9</sup>	2.30 x 10 <sup>+4</sup>	70-Year	2.88 x 10 <sup>+3</sup>	1.00 x 10 <sup>+1</sup>	Yes
<b>ORGANICS</b>							
1,1,1-Trichloroethane	4.55 x 10 <sup>-1</sup>	1.95 x 10 <sup>+7</sup>	3.49 x 10 <sup>+2</sup>	70-Year	1.58 x 10 <sup>+0</sup>	1.30 x 10 <sup>+2</sup>	No
2-Butanone	1.50 x 10 <sup>-2</sup>	6.41 x 10 <sup>+5</sup>	1.00 x 10 <sup>+1</sup>	TCLP	1.90 x 10 <sup>-7</sup>	2.20 x 10 <sup>+3</sup>	No
4-Methyl-2-Pentanone	2.50 x 10 <sup>-2</sup>	1.07 x 10 <sup>+6</sup>	1.92 x 10 <sup>+1</sup>	70-Year	2.82 x 10 <sup>-9</sup>	1.80 x 10 <sup>+2</sup>	No
Acetone	3.70 x 10 <sup>-2</sup>	1.58 x 10 <sup>+6</sup>	2.84 x 10 <sup>+1</sup>	70-Year	2.15 x 10 <sup>-7</sup>	3.70 x 10 <sup>+2</sup>	No
Benzene	2.00 x 10 <sup>-3</sup>	8.55 x 10 <sup>+4</sup>	2.00 x 10 <sup>+1</sup>	mdl-TCLP	1.47 x 10 <sup>-2</sup>	3.50 x 10 <sup>-2</sup>	No
Benzoic Acid	1.00 x 10 <sup>-1</sup>	4.27 x 10 <sup>+6</sup>	7.67 x 10 <sup>+1</sup>	70-Year	0.0	1.50 x 10 <sup>+4</sup>	No
bis(2-Ethylhexyl)phthalate	2.70 x 10 <sup>0</sup>	1.15 x 10 <sup>+8</sup>	2.07 x 10 <sup>+3</sup>	70-Year	2.67 x 10 <sup>-9</sup>	5.70 x 10 <sup>-1</sup>	No
Carbon Disulfide	7.00 x 10 <sup>-3</sup>	2.99 x 10 <sup>+5</sup>	5.37 x 10 <sup>+0</sup>	70-Year	2.13 x 10 <sup>-8</sup>	2.10 x 10 <sup>0</sup>	No

See footnote at end of table

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TABLE 5-33  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (µg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (µg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>ORGANICS (Continued)</b>							
Di-n-butyl phthalate	8.60 x 10 <sup>-2</sup>	3.68 x 10 <sup>+6</sup>	6.59 x 10 <sup>+1</sup>	70-Year	0.0	3.70 x 10 <sup>+2</sup>	No
Methylene Chloride	2.00 x 10 <sup>-1</sup>	8.55 x 10 <sup>+6</sup>	1.53 x 10 <sup>+2</sup>	70-Year	3.64 x 10 <sup>-9</sup>	5.10 x 10 <sup>-1</sup>	No
Naphthalene	8.20 x 10 <sup>-2</sup>	3.51 x 10 <sup>+6</sup>	6.29 x 10 <sup>+1</sup>	70-Year	0.0	1.50 x 10 <sup>+2</sup>	No
Pentachlorophenol	5.60 x 10 <sup>-2</sup>	2.39 x 10 <sup>+6</sup>	1.00 x 10 <sup>+2</sup>	TCLP	0.0	6.60 x 10 <sup>-2</sup>	No
Toluene	2.78 x 10 <sup>-1</sup>	1.19 x 10 <sup>+7</sup>	2.13 x 10 <sup>+2</sup>	70-Year	3.00 x 10 <sup>-10</sup>	7.50 x 10 <sup>+1</sup>	No
Xylenes, Total	5.30 x 10 <sup>-2</sup>	2.27 x 10 <sup>+6</sup>	4.06 x 10 <sup>+1</sup>	70-Year	3.13 x 10 <sup>-13</sup>	1.20 x 10 <sup>+3</sup>	No
<b>INORGANICS</b>							
Arsenic	6.43 x 10 <sup>+1</sup>	2.75 x 10 <sup>+9</sup>	9.80 x 10 <sup>+1</sup>	TCLP	0.0	5.00 x 10 <sup>-3</sup>	No
Barium	3.89 x 10 <sup>+2</sup>	1.66 x 10 <sup>+10</sup>	1.25 x 10 <sup>+3</sup>	TCLP	1.03 x 10 <sup>+3</sup>	2.60 x 10 <sup>+2</sup>	Yes
Beryllium	3.38 x 10 <sup>+0</sup>	1.44 x 10 <sup>+8</sup>	2.59 x 10 <sup>+3</sup>	70-Year	0.0	2.00 x 10 <sup>-3</sup>	No
Cadmium	7.90 x 10 <sup>-1</sup>	3.38 x 10 <sup>+7</sup>	2.62 x 10 <sup>+1</sup>	TCLP	2.31 x 10 <sup>+1</sup>	1.80 x 10 <sup>+0</sup>	Yes
Chromium	1.97 x 10 <sup>+1</sup>	8.42 x 10 <sup>+8</sup>	2.18 x 10 <sup>+2</sup>	TCLP	3.31 x 10 <sup>-6</sup>	1.80 x 10 <sup>+1</sup>	No
Copper	5.35 x 10 <sup>+1</sup>	2.29 x 10 <sup>+9</sup>	2.12 x 10 <sup>+1</sup>	TCLP	2.04 x 10 <sup>+1</sup>	1.40 x 10 <sup>+2</sup>	No
Cyanide	3.27 x 10 <sup>-1</sup>	1.40 x 10 <sup>+7</sup>	2.51 x 10 <sup>+2</sup>	70-Year	1.20 x 10 <sup>+1</sup>	7.30 x 10 <sup>+1</sup>	No
Lead	4.54 x 10 <sup>+1</sup>	1.94 x 10 <sup>+9</sup>	6.04 x 10 <sup>+1</sup>	TCLP	2.87 x 10 <sup>+1</sup>	1.50 x 10 <sup>+0</sup>	Yes
Manganese	3.40 x 10 <sup>+2</sup>	1.45 x 10 <sup>+10</sup>	2.63 x 10 <sup>+2</sup>	TCLP	9.02 x 10 <sup>+0</sup>	1.80 x 10 <sup>+1</sup>	No
Mercury	1.90 x 10 <sup>-1</sup>	8.12 x 10 <sup>+6</sup>	2.00 x 10 <sup>-1</sup>	TCLP	1.98 x 10 <sup>-1</sup>	1.10 x 10 <sup>+0</sup>	No
Molybdenum	1.07 x 10 <sup>+1</sup>	4.56 x 10 <sup>+8</sup>	8.18 x 10 <sup>+3</sup>	70-Year	6.14 x 10 <sup>+2</sup>	1.80 x 10 <sup>+1</sup>	Yes

See footnote at end of table

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TABLE 5-33  
(Continued)

Constituents of Potential Concern	Upper 95% C.I. on Mean Concentration (mg/kg)	Constituent Inventory in the Waste (mg)	Initial Maximum Leachate Concentration (pCi/L RAD) (μg/L non-RAD)	Constraint <sup>a</sup>	Maximum Loading Concentration from ODAST (Vadose Layer 2) (pCi/L RAD) (μg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Concentration (pCi/L RAD) (μg/L non-RAD)	CPC ≥ Screening Concentration and Requires SWIFT Modeling?
<b>INORGANICS (Continued)</b>							
Nickel	2.92 x 10 <sup>+1</sup>	1.25 x 10 <sup>+9</sup>	2.24 x 10 <sup>+4</sup>	70-Year	0.0	7.30 x 10 <sup>+1</sup>	No
Selenium	8.67 x 10 <sup>+0</sup>	3.70 x 10 <sup>+8</sup>	1.10 x 10 <sup>+2</sup>	TCLP	0.0	1.80 x 10 <sup>+1</sup>	No
Thallium	2.08 x 10 <sup>+0</sup>	8.91 x 10 <sup>+7</sup>	1.60 x 10 <sup>+3</sup>	70-Year	0.0	2.60 x 10 <sup>-1</sup>	No
Vanadium	3.74 x 10 <sup>+1</sup>	1.60 x 10 <sup>+9</sup>	2.87 x 10 <sup>+4</sup>	70-Year	0.0	2.00 x 10 <sup>+1</sup>	No

<sup>a</sup>Constraint on reported concentration is by In Situ Leachate (ISL), Toxicity Characteristic Leaching Procedure (TCLP), maximum detection limit (mdl), or by US EPA 70-year rule (70-Year).

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TABLE 5-34

SCREENING FOR CONSTITUENTS OF POTENTIAL CONCERN AFTER DILUTION IN THE GREAT MIAMI AQUIFER  
 FOR THE ACTIVE FLYASH PILE  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituent	Units	Concentration in Vadose Zone at the Groundwater Table	Diluted Great Miami Aquifer Concentration	Screening Concentration	Diluted Concentration Exceeds Screening Concentration
<b>RADIONUCLIDES</b>					
Neptunium-237	pCi/L	$3.28 \times 10^{+1}$	$6.98 \times 10^{+0}$	$2.20 \times 10^{-2}$	YES
Strontium-90	pCi/L	$1.79 \times 10^{+1}$	$3.80 \times 10^{+0}$	$1.30 \times 10^{-1}$	YES
Uranium-234	pCi/L	$8.54 \times 10^{+2}$	$1.28 \times 10^{+2}$	$3.00 \times 10^{-1}$	YES
Uranium-235/236	pCi/L	$3.95 \times 10^{+2}$	$5.92 \times 10^{+1}$	$3.00 \times 10^{-1}$	YES
Uranium-238	pCi/L	$4.87 \times 10^{+2}$	$7.28 \times 10^{+1}$	$1.70 \times 10^{-1}$	YES
Uranium-total(Non-RAD)	pCi/L	$2.88 \times 10^{+3}$	$4.31 \times 10^{+2}$	$1.00 \times 10^{+1}$	YES
<b>INORGANICS</b>					
Barium	$\mu\text{g/L}$	$1.03 \times 10^{+3}$	$2.20 \times 10^{+2}$	$2.60 \times 10^{+2}$	NO
Cadmium	$\mu\text{g/L}$	$2.31 \times 10^{+1}$	$3.45 \times 10^{+0}$	$1.80 \times 10^{+0}$	YES
Lead	$\mu\text{g/L}$	$2.87 \times 10^{+1}$	$6.11 \times 10^{+0}$	$1.50 \times 10^{+0}$	YES
Molybdenum	$\mu\text{g/L}$	$6.14 \times 10^{+2}$	$1.30 \times 10^{+2}$	$1.80 \times 10^{+1}$	YES

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TABLE 5-35

SUMMARY OF CONSTITUENTS OF POTENTIAL CONCERN AND SOURCE PATHWAYS FOR THE  
 ACTIVE FLYASH PILE  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Contaminants of Potential Concern	Source Pathways <sup>a</sup>	
	Infiltration through Active Flyash Pile <sup>b</sup>	SSOD Loading from Active Flyash Pile Runoff
<b>RADIONUCLIDES</b>		
Neptunium-237	Yes	Yes
Radium-226	No	Yes <sup>c</sup>
Radium-228	No	Yes <sup>c</sup>
Strontium-90	Yes	No
Uranium-234	Yes	Yes
Uranium-235/236	Yes	Yes
Uranium-238	Yes	Yes
Uranium Total	Yes	Yes
<b>INORGANICS</b>		
Arsenic	No	Yes
Beryllium	No	Yes
Cadmium	Yes	No
Lead	Yes	Yes
Molybdenum	Yes	No

<sup>a</sup>"Yes" indicates predicted CPC concentration was above screening concentration; "No" indicates that the predicted CPC concentration was below screening concentration

<sup>b</sup>Includes loading from perched groundwater source leakage through till and unsaturated GMA, if applicable

<sup>c</sup>Not modeled based on diluted GMA concentration less than 10<sup>-7</sup> risk or 0.1 Hazard Index screening concentration

5-115  
 0806

5.4.4.1 Solid Waste Landfill

The groundwater fate and transport modeling results are summarized in Table 5-36 for technetium-99, the only CPC that was predicted to reach the Great Miami Aquifer within 1,000 years from the Solid Waste Landfill. The table also presents the arrival time for the CPCs in the aquifer, the maximum loading concentration, the maximum concentrations of the CPC that would be expected in the aquifer within 1,000 years and the time required for the CPC to reach the maximum value. It also presents the predicted maximum concentration at the FEMP boundary due to loading from the Solid Waste Landfill. Screening levels have been developed based on a  $10^{-7}$  lifetime risk of cancer (presented in Appendix B) and provide a basis for understanding the risk to human health from the ingestion of water from the Great Miami Aquifer at the hypothetical receptor location. Contour plots for projected increases in the concentrations of technetium-99, at the time of maximum concentrations (70 years), are shown in Figure 5-17. Figure 5-17 shows that technetium-99 migration is towards the east. At 1,000 years, concentrations of technetium-99 were predicted to be significantly below the screening concentration.

5.4.4.2 Lime Sludge Ponds

The groundwater fate and transport modeling results are summarized in Table 5-37 for technetium-99, the only CPC that was predicted to reach the Great Miami Aquifer within 1,000 years from the Lime Sludge Ponds. The table also presents the arrival time for technetium-99 in the aquifer, the maximum loading concentration, the maximum concentrations of the technetium-99 that would be expected in the aquifer within 1,000 years, and the time required for the constituents to reach the maximum value. It shows that the predicted maximum concentration at the FEMP boundary due to loading from the Lime Sludge Ponds is below the screening level (i.e., off-site impact of Lime Sludge Ponds is negligible). Screening levels have been developed based on a  $10^{-7}$  lifetime risk of cancer (presented in Appendix B) and provide a basis for understanding the risk to human health from the ingestion of water from the Great Miami Aquifer at the hypothetical receptor location. Contour plots for projected increases in the concentrations of technetium-99 at the time of maximum concentrations (40 years) is shown in Figure 5-18. The plot shows the profiles of future increase in concentration as predicted by the SWIFT III model. Figure 5-18 shows that plume migration from the Lime Sludge Ponds is in east-southeasterly direction. At 1,000 years, concentrations of technetium-99 were predicted to be significantly below the screening level.

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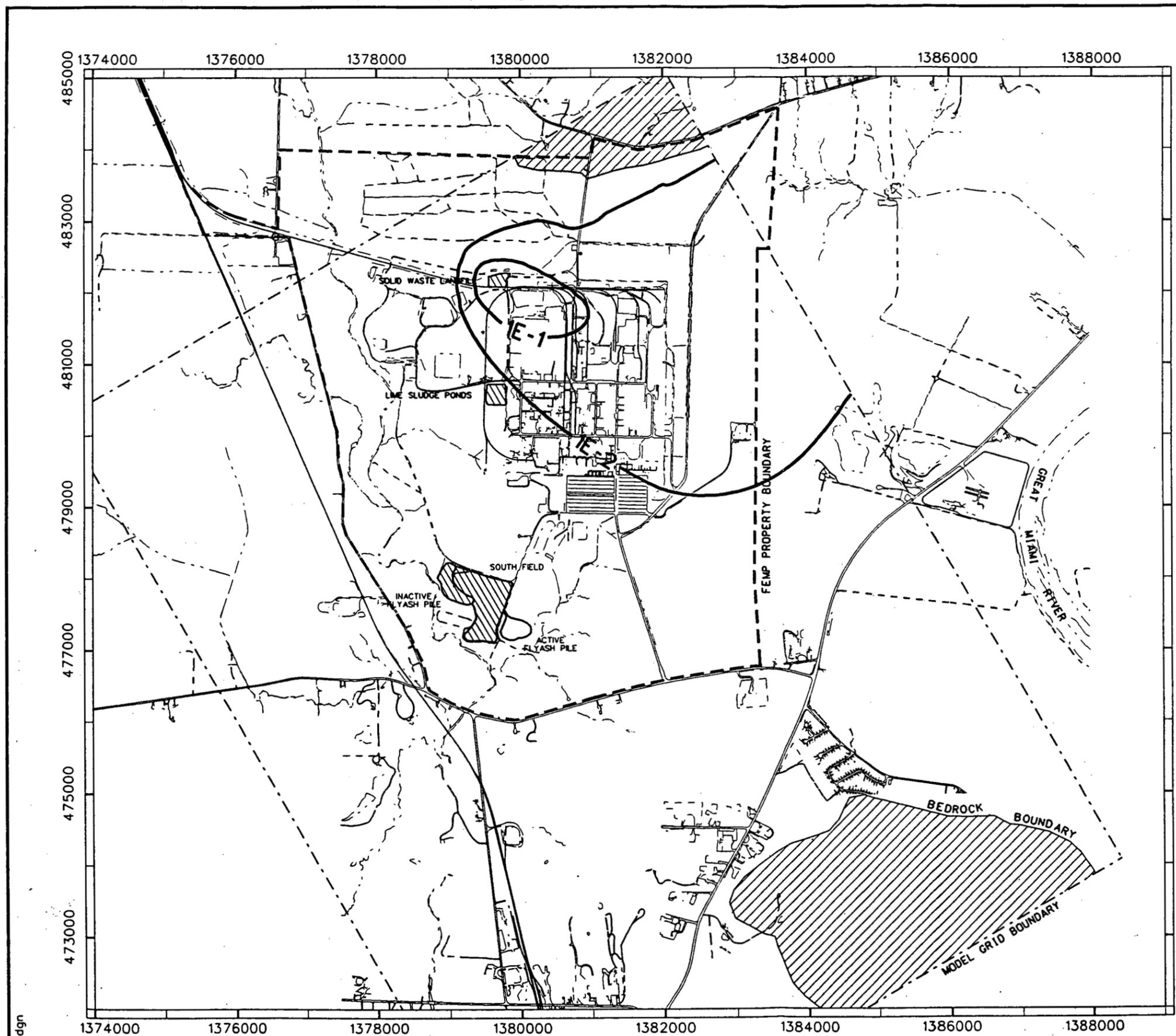
5.4.4.3 Inactive Flyash Pile/South Field

The Operable Unit 2 SWIFT III model was calibrated for uranium-238. Uranium-238 was selected for calibration because of the high detection frequency, very sensitive analytic procedure, projection as a main parameter of concern for risk assessment, and for the determination and modeling of hot spots. Use of uranium at the FEMP site began in the 1950s. Current uranium-238 concentrations in the Great Miami Aquifer in the vicinity of the South Field area were detected as high as 384 pCi/L at Well 2945 in the validated filtered samples and on-site (non-validated) analysis indicated that the total uranium concentration was as high as 2100 µg/L (equivalent to 587 pCi/L of uranium-238).

SWIFT III was first run using a  $K_d$  of 8.4 for uranium (Uranium Partition Coefficient Evaluation Study for Operable Unit 2, 1993) in the Great Miami Aquifer. SWIFT III model results indicated that it will take more than 200 years to reach current concentrations levels in the Great Miami Aquifer. Since uranium breakthrough for the vadose zone pathway for  $K_d$  of 8.4 ml/g does not occur until after 160 years, calibration cannot be done by increasing waste concentration along. Through the calibration process, the  $K_d$  value in the Great Miami Aquifer (and ODAST) was reduced to 1.48 ml/g. At 40 years from placement of waste in the Inactive Flyash Pile and South Field subunits (approximately current conditions), model predicted uranium-238 concentrations in the Great Miami Aquifer to be 134 pCi/L in the grid cell containing the Well 2945 (Figure 5-19). This is considered a good calibration of the model given the limitations that source areas smaller than 125 x 125 feet cannot be assigned. The uranium breakthrough close to the Well 2945 is due to subsurface seeps. Although subsurface seeps do not travel laterally 125 feet on the unsaturated Great Miami Aquifer, model limitations require that subsurface seep mass be loaded uniformly over the full 125 x 125 foot cell. If subsurface seeps infiltrate through a 20- to 50-foot wide area, this can easily result in underestimation of concentration by the model near subsurface seep at 40 years by a factor of 3 to 6. Since overall maximum loading is due to the vadose zone pathway (Figure 5-20), which is uniformly distributed over the full grid cell, the maximum predicted uranium-238 concentrations for the baseline risk assessment are not very sensitive to the above mentioned limitation of the model. The predicted uranium-238 plume shape at 40 years due to loading from the Inactive Flyash Pile and South Field is in general agreement with the field observations.

Figure 5-20 shows the loading of uranium-238 to the Great Miami Aquifer from the Inactive Flyash Pile and South Field. Figure 5-20 shows that uranium-238 reaches the Great Miami Aquifer very early, and loading increases very slowly up to 100 years (main contribution is from perched water

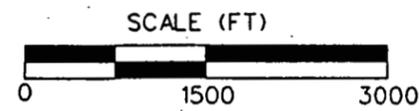
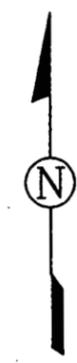
5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- 0.61 — TECHNETIUM-99 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



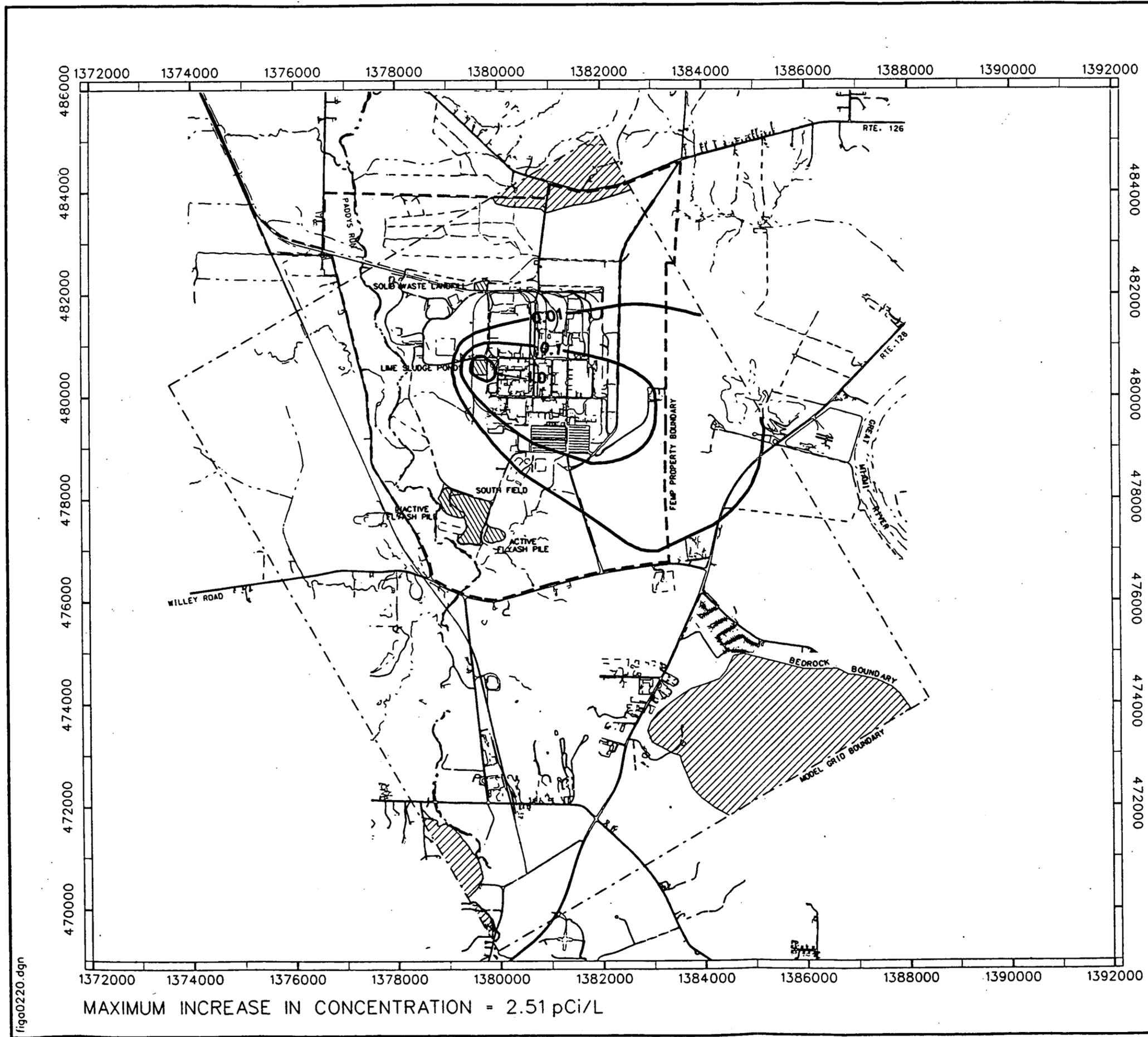
0309

**FIGURE 5-17**  
**PROJECTED INCREASE IN**  
**TECHNETIUM-99 CONCENTRATION**  
**IN GREAT MIAMI AQUIFER AT**  
**70 YEARS DUE TO LOADING**  
**FROM THE SOLID WASTE LANDFILL**

fig0517.dgn

MAXIMUM INCREASE IN CONCENTRATION = 0.61 pCi/L

5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- 10 — TECHNETIUM-99 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentrations not included.

**SCALE (FT)**

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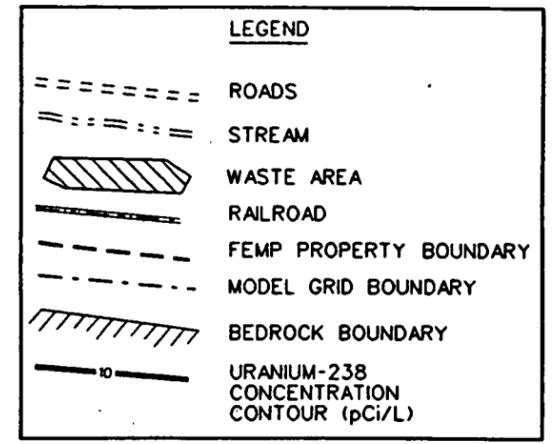
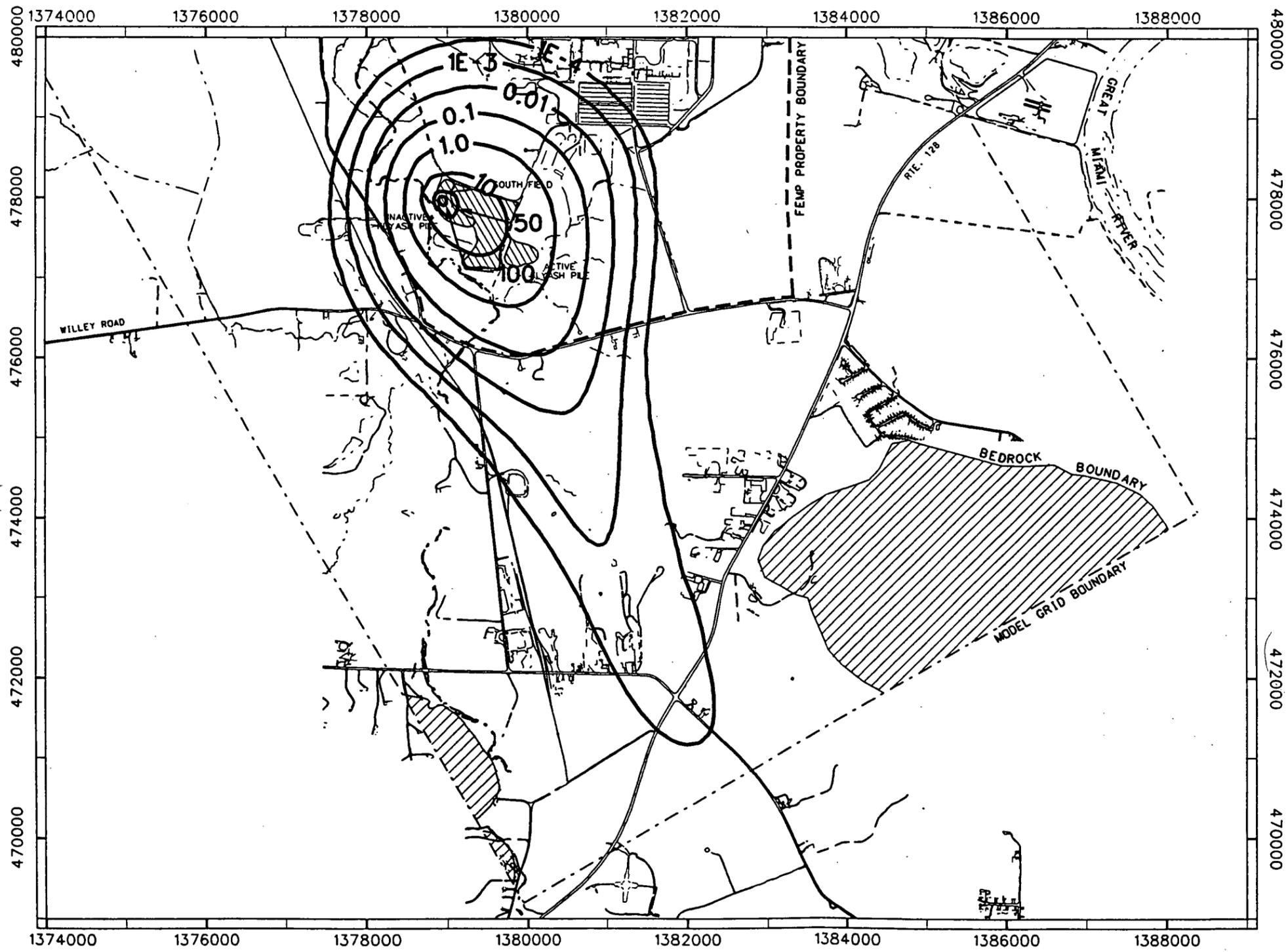
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0310

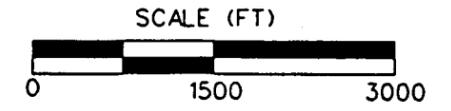
**FIGURE 5-18**  
**PROJECTED INCREASE IN**  
**TECHNETIUM-99 CONCENTRATION IN**  
**GREAT MIAMIAQUIFER AT 40**  
**YEARS DUE TO LOADING FROM**  
**THE LIME SLUDGE PONDS**

fig0220.dgn

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NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



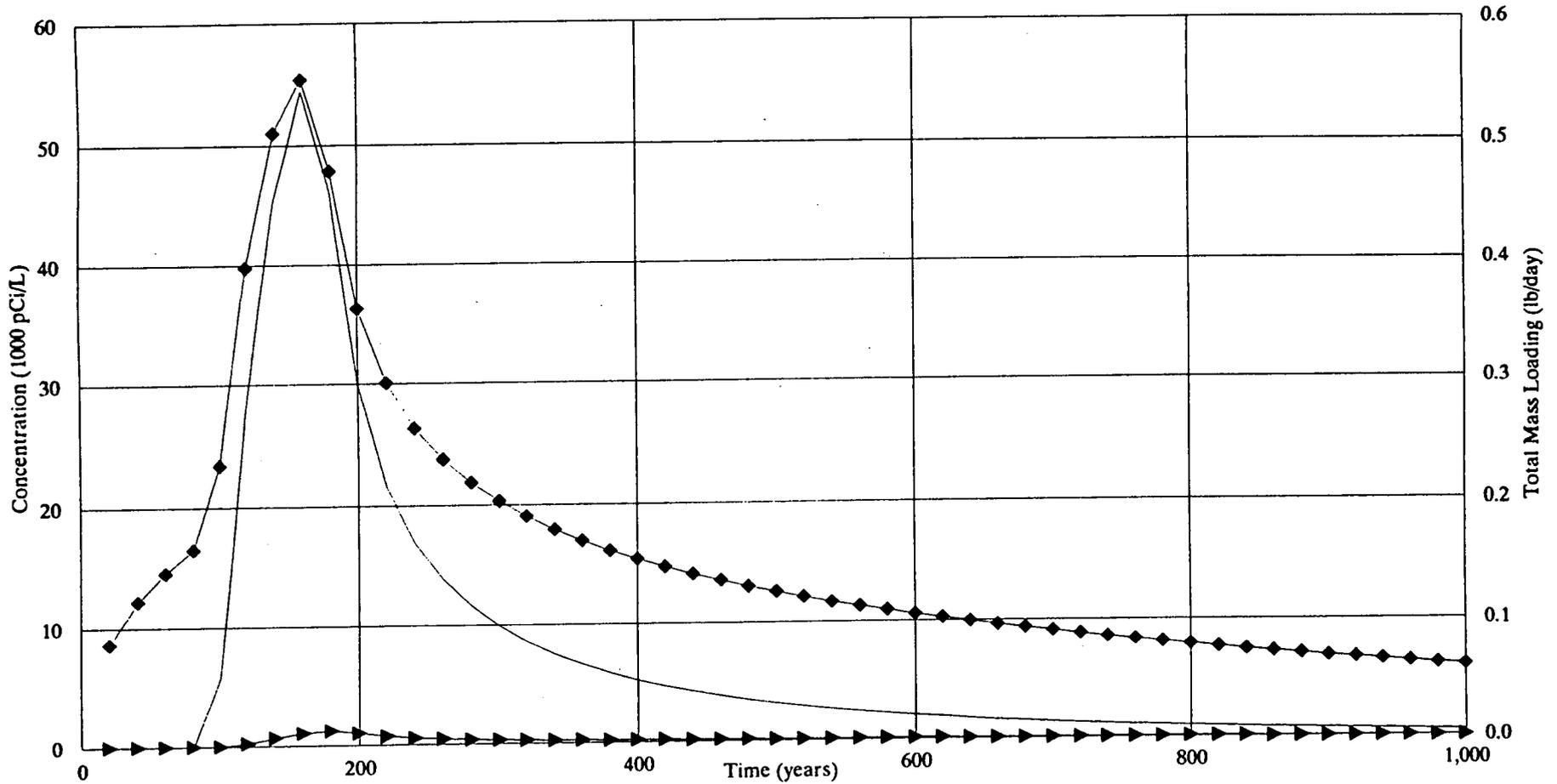
0311

**FIGURE 5-19**  
**PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMI AQUIFER AT 40 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD**

MAXIMUM INCREASE IN CONCENTRATION = 134 pCi/L

fig519.dgn

5-121



Max. Conc. (IFP)    
  Total Mass Loading    
  Max. Conc. (SF)

Maximum Concentration in the Inactive Flyash Pile (54,400 pCi/L) occurs in grid block (29,65)

Maximum Concentration in South Field (1200 pCi/L) occurs in grid block (29,59)

0312

IFP Inactive Flyash Pile  
SF South Field

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FIGURE 5-20. URANIUM-238 LOADING TO THE GREAT MIAMI AQUIFER FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD

**TABLE 5-36**  
**SUMMARY OF SWIFT MODELING RESULTS**  
**FOR THE SOLID WASTE LANDFILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern	Maximum Loading Concentration from ODAST (pCi/L)	Minimum Time of Arrival to the Aquifer (years)	Time of Maximum On-Site Concentration (years)	Maximum On-Site Concentration in the Aquifer (pCi/L)	Time of Maximum Concentration at the FEMP Boundary (years)	Maximum Concentration at the FEMP Boundary (pCi/L)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Levels (pCi/L)
<b>RADIONUCLIDES</b>							
Techneium-99	28.5	10-20	60	0.61	70	0.054	0.27

5-122

5-122

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**TABLE 5-37**  
**SUMMARY OF SWIFT MODELING RESULTS FOR THE**  
**LIME SLUDGE PONDS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern	Maximum Loading Concentration from ODAST (pCi/L)	Minimum Time of Arrival to the Aquifer (years)	Time of Maximum On-Site Concentration (years)	Maximum On-Site Concentration in the Aquifer (pCi/L)	Time of Maximum Concentration at the FEMP Boundary (years)	Maximum Concentration at the FEMP Boundary (pCi/L)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Levels (pCi/L)
<b>RADIONUCLIDES</b>							
Technetium-99	64.8	20-30	40	2.51	40	0.14	0.27

0130

5-123

0314

subsurface seeps) and then rises sharply and reaches a peak at 160 years (due to breakthrough from the vadose zone pathway). Uranium-238 loading then decreases exponentially. Figure 5-20 shows the uranium-238 concentration at the interface of vadose zone Layer 2 (unsaturated Great Miami Aquifer) and saturated Great Miami Aquifer from the vadose zone pathway in grid block (29, 65). It does not show the concentration versus. time history of perched water subsurface seep in the same grid block, which has an early arrival time but a lower peak concentration value.

Figures 5-21, 5-22, and 5-23 show the projected increase in uranium-238 concentrations due to Inactive Flyash Pile and South field at 160, 220, and 1,000 years, respectively. The maximum on-site uranium-238 concentration was predicted to occur at 160 years, while the maximum off-site concentration was predicted to occur at 220 years.

The groundwater fate and transport modeling results for the Inactive Flyash Pile and South Field are summarized in Table 5-38 for the CPCs that will reach the Great Miami Aquifer within 1,000 years from the Inactive Flyash Pile and South Field subunits. The table also presents the arrival time for the CPCs to reach the aquifer, the maximum loading concentration, the maximum concentrations of the CPC that would be expected in the aquifer within 1,000 years, and the time required for the CPC to reach the maximum value. It also presents the predicted maximum concentration at the FEMP boundary due to loading from the Inactive Flyash Pile and South Field subunits. Screening levels are also presented to provide a basis for understanding the risk to human health from the ingestion of water from the Great Miami Aquifer at the hypothetical receptor location. Uranium-238 concentrations are most elevated compared to the screening concentration and may control the overall risk from groundwater pathway (see Section 6.0 and Appendix B). Table 5-39 presents the on-site and off-site concentrations of CPCs at the uranium-238 maximum concentration location and time.

As noted earlier, total uranium, uranium-234, and uranium-235/236 concentrations were estimated from the results of uranium-238 modeling. Figures 5-24 through 5-26 show site-specific relationships between uranium-234 and uranium-238 activity at the Inactive Flyash Pile/South Field/Active Flyash Pile; uranium 235/236 and uranium-238 activity at the Inactive Flyash Pile/South Field/Active Flyash Pile; and uranium-238 and total uranium mass at the Inactive Flyash Pile/South Field, respectively. Following relationships were observed between various uranium forms:

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32

Uranium-234 = 0.91 (Uranium-238)	activity ratio
Uranium-235/236 = 0.048 (Uranium-238)	activity ratio
Uranium-238 = 0.832 (Uranium-total)	mass ratio at Inactive Flyash Pile/South Field

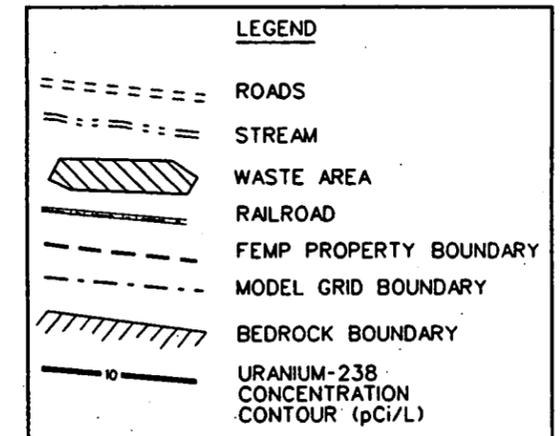
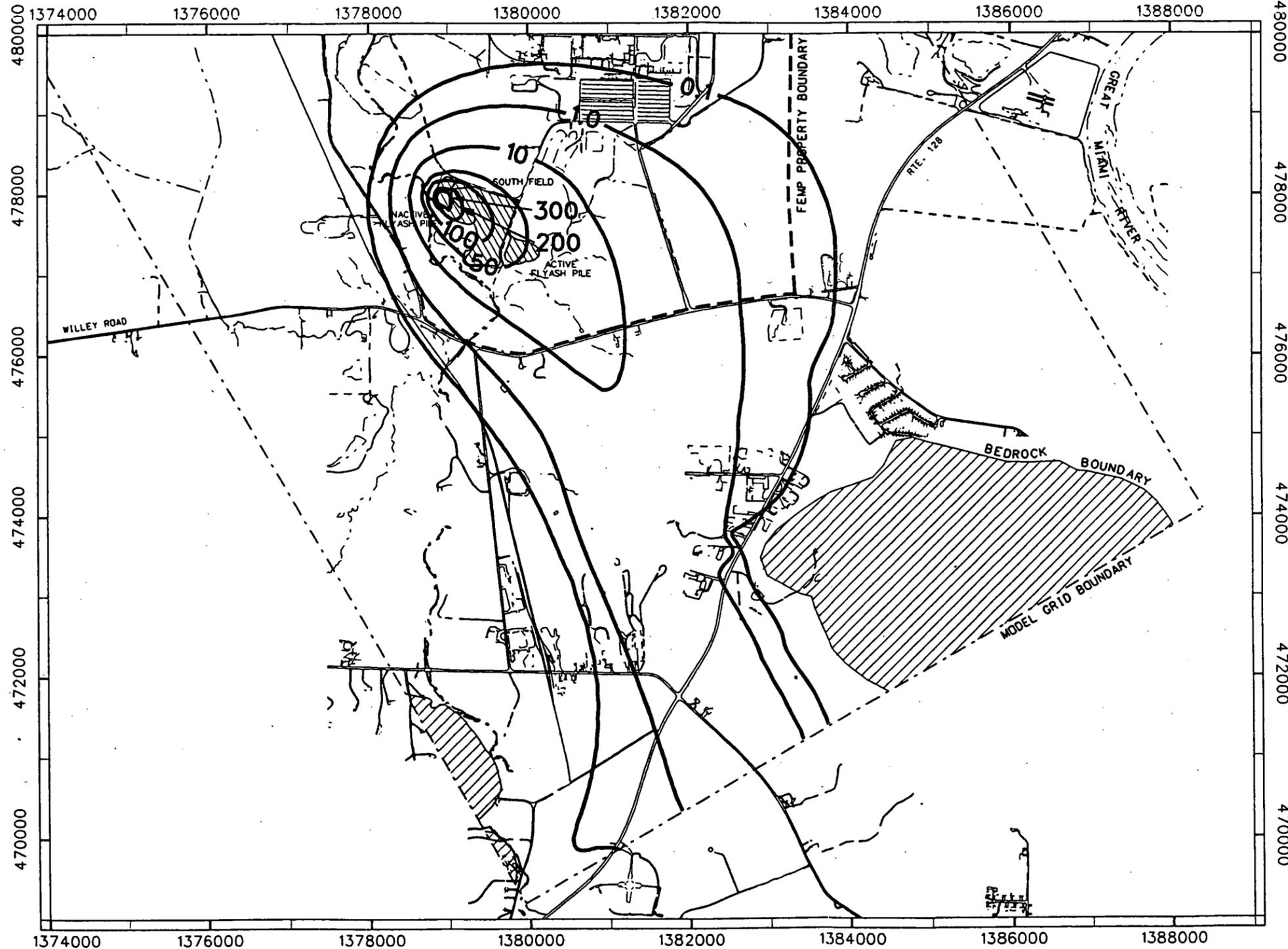
Although these relationships were developed from soil samples, these relationships should apply to uranium concentrations in the groundwater because all uranium isotopes have very long half-lives (greater than 10,000 years) and have similar adsorption properties. These relationships can be used to estimate uranium-234, uranium-235/256, and total uranium concentrations.

Constituents projected to be above screening levels when they reach the Great Miami Aquifer directly beneath the Inactive Flyash Pile and South Field subunits were the uranium isotopes (uranium-234, uranium-235/236, and uranium-238), neptunium-237, radium-226, strontium-90, technetium-99, antimony, cadmium, lead, manganese, and molybdenum. Only uranium isotopes (uranium-234, uranium-235/236, and uranium-238), total uranium, neptunium-237, technetium-99, lead, and manganese were projected to exceed screening levels in the Great Miami Aquifer. Of these CPCs; only uranium isotopes, total uranium, neptunium-237, and technetium-99 were projected to exceed screening levels at the FEMP boundary. Contour plots were made for these CPCs at different time periods and are presented in Appendix A-2 along with the loading curves. Contour plots at the maximum CPC concentration in the Great Miami Aquifer and at 1,000 years are shown in Figures 5-27 through 5-33. As an example, Figure 5-27 depicts a plume of neptunium-237 in groundwater moving towards the southeastern boundary of the FEMP. Contour plots show projected increases in the CPCs' concentrations and do not take into account the background concentrations or contributions from other FEMP sources.

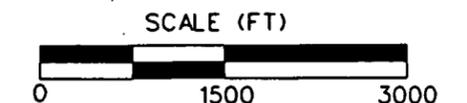
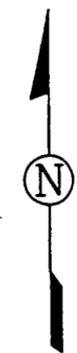
5.4.4.4 Active Flyash Pile

The groundwater fate and transport modeling results are summarized in Table 5-40 for CPCs that will reach the Great Miami Aquifer from the Active Flyash Pile. The table also presents the arrival time for CPCs in the aquifer, the maximum loading concentration, the maximum concentration of the CPC that could be expected in the aquifer within 1,000 years, and the time required for the CPC to reach the maximum value. CPCs projected to be above screening levels as they reach the Great Miami Aquifer directly beneath the Active Flyash Pile were uranium isotopes (uranium-238, uranium-234, and uranium-235/236), total uranium, neptunium-237, strontium-90, arsenic, beryllium, cadmium,

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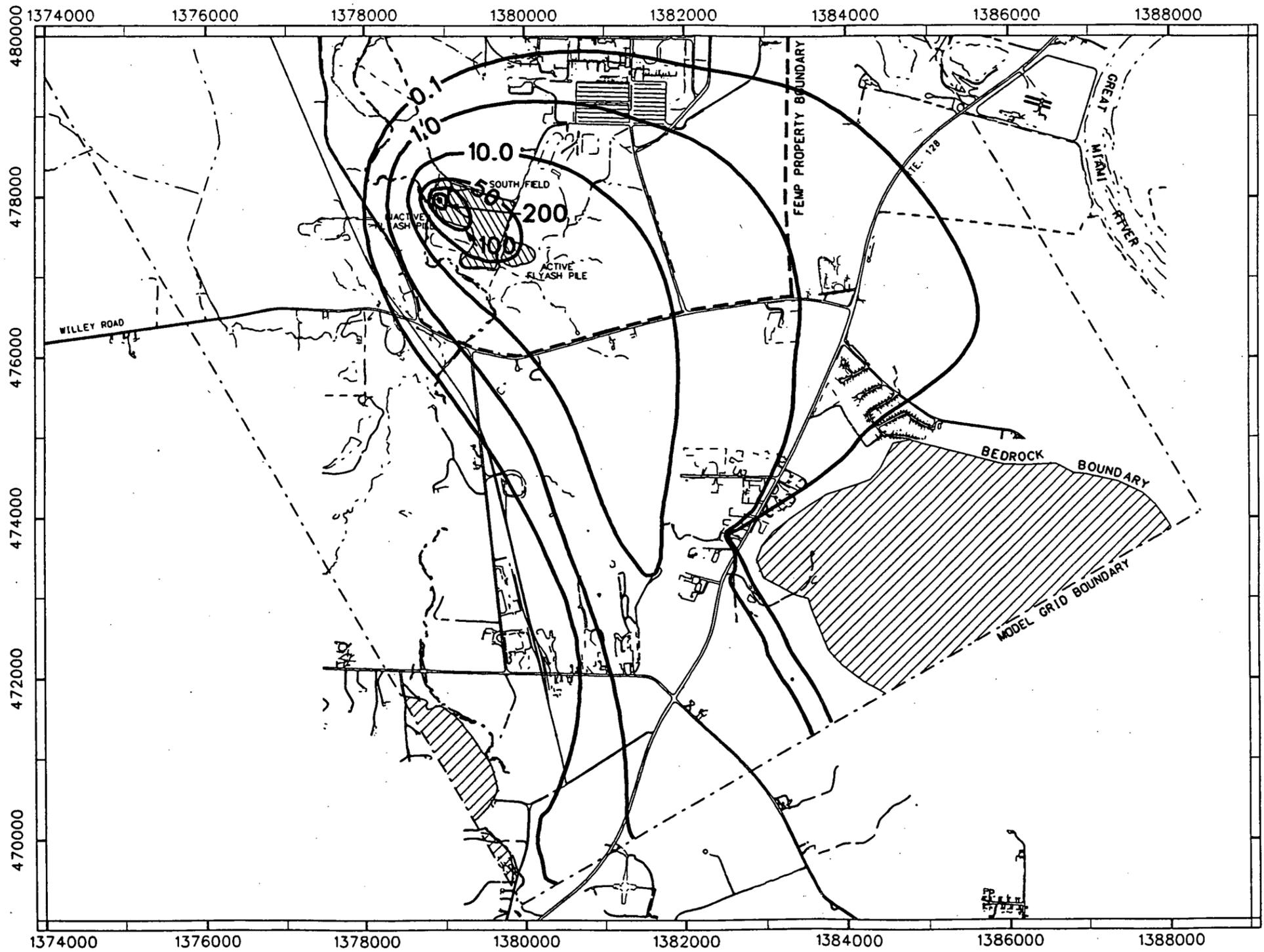
NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



MAXIMUM INCREASE IN CONCENTRATION = 517 pCi/L

0317  
FIGURE 5-21  
PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMI AQUIFER AT 160 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD

5170



**LEGEND**

- ROADS
- STREAM
- WASTE AREA
- RAILROAD
- FEMP PROPERTY BOUNDARY
- MODEL GRID BOUNDARY
- BEDROCK BOUNDARY
- URANIUM-238 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

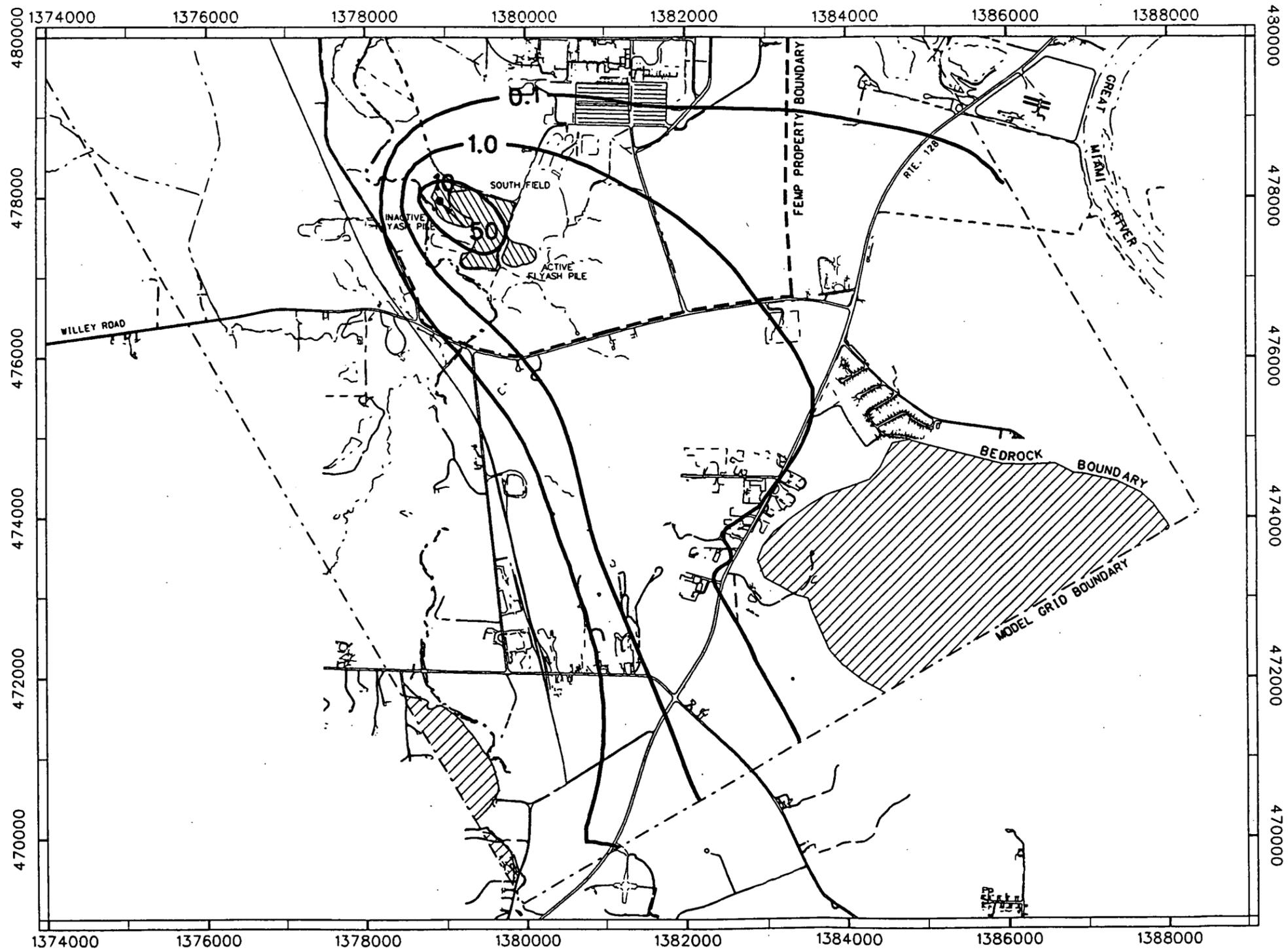
**SCALE (FT)**  
0 1500 3000

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MAXIMUM INCREASE IN CONCENTRATION = 326 pCi/L

0318  
**FIGURE 5-22**  
PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMIAQUIFER AT 220 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD

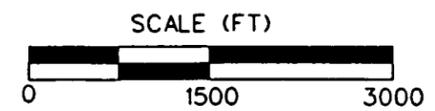
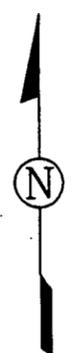
5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- 10 — URANIUM-238 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

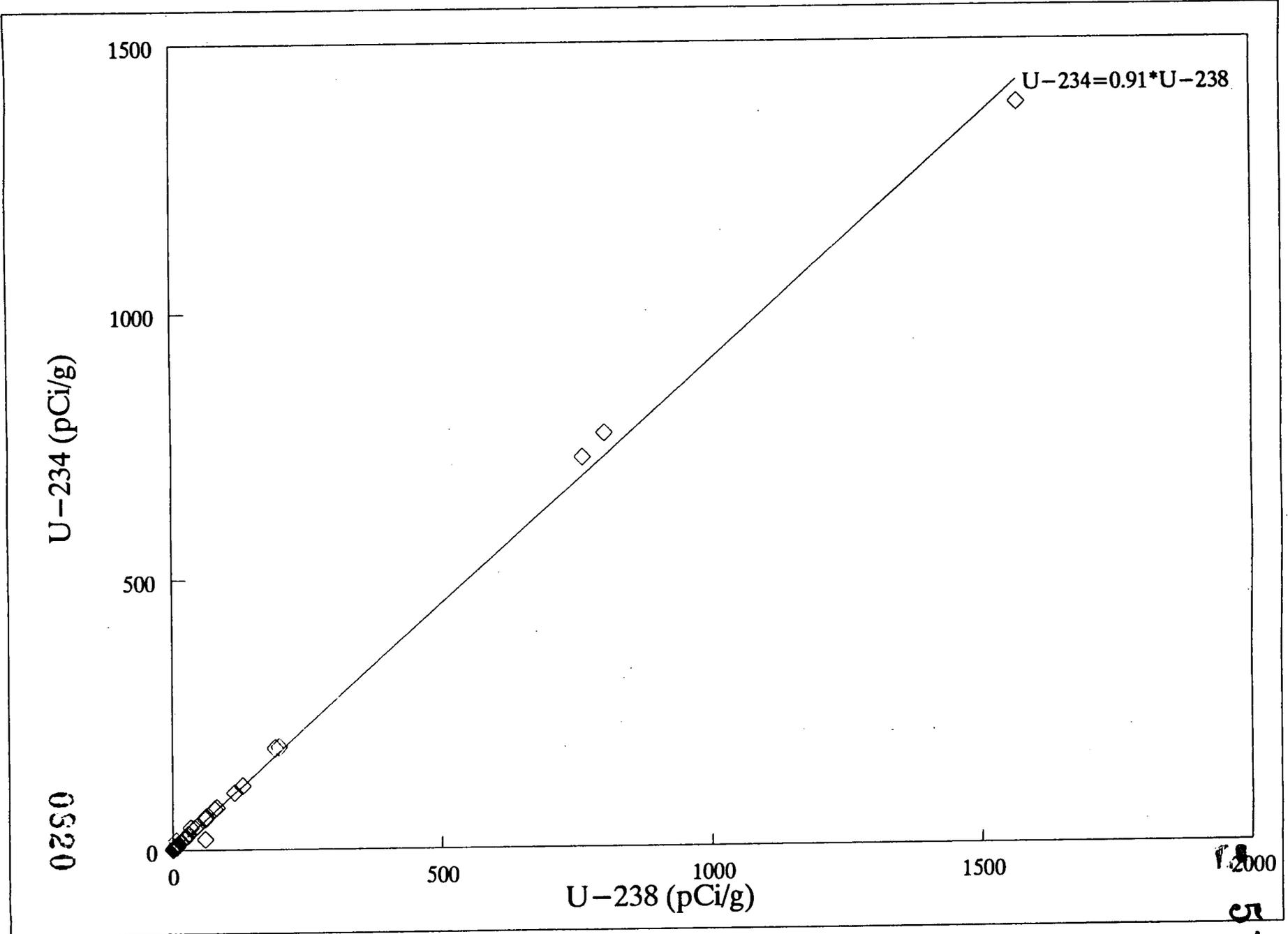


**FIGURE 5-23** 0319  
PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMI AQUIFER AT 1000 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD.

MAXIMUM INCREASE IN CONCENTRATION = 57.4 pCi/L

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5-129



0520

FIGURE 5-24 : U-234 vs. U-238 IN SOIL SAMPLES, SOUTH FIELD & FLYASH PILES

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5-130

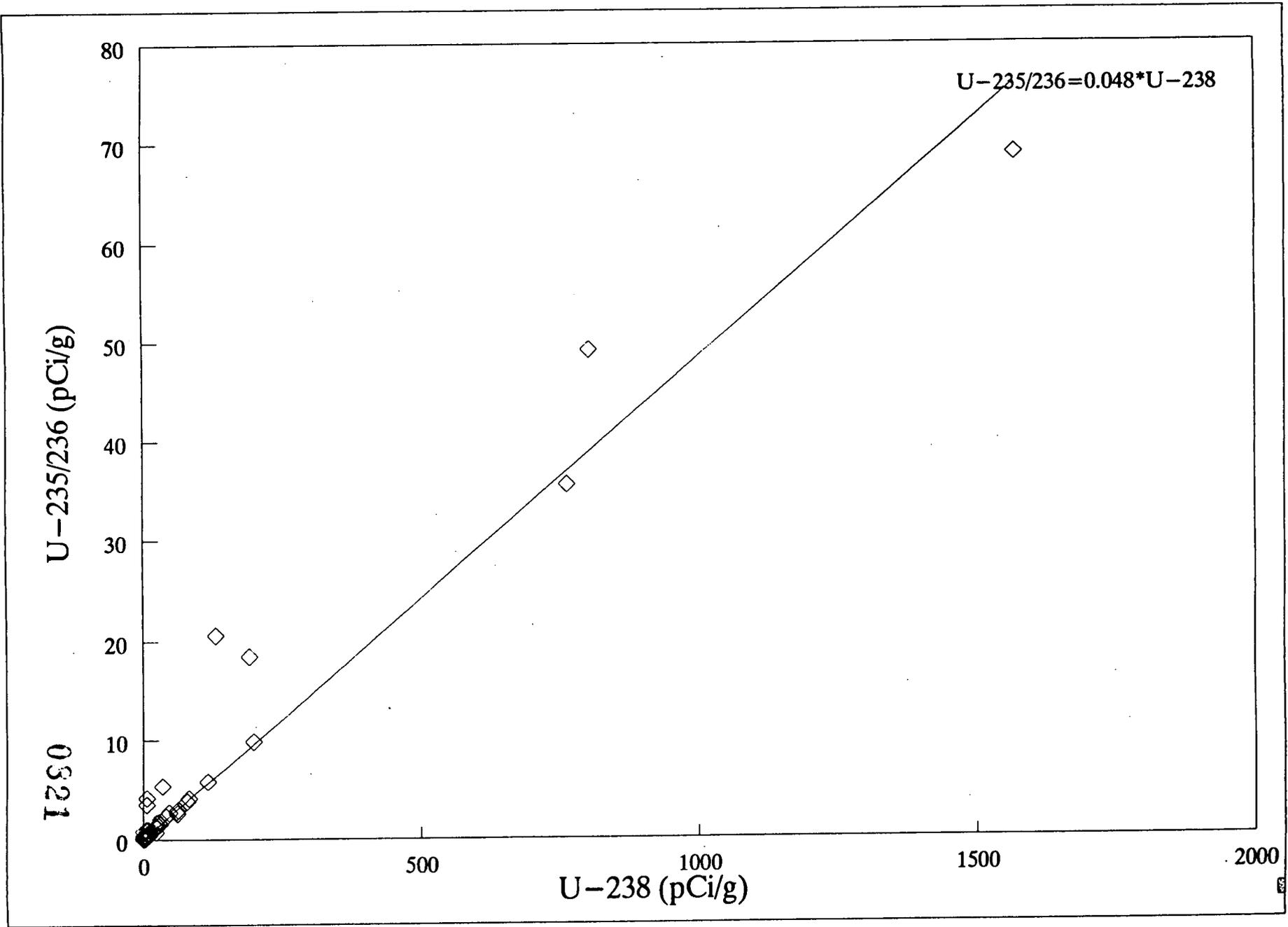


FIGURE 5-25 : U-235/236 vs. U-238 IN SOIL SAMPLES, SOUTH FIELD & FLYASH PILES

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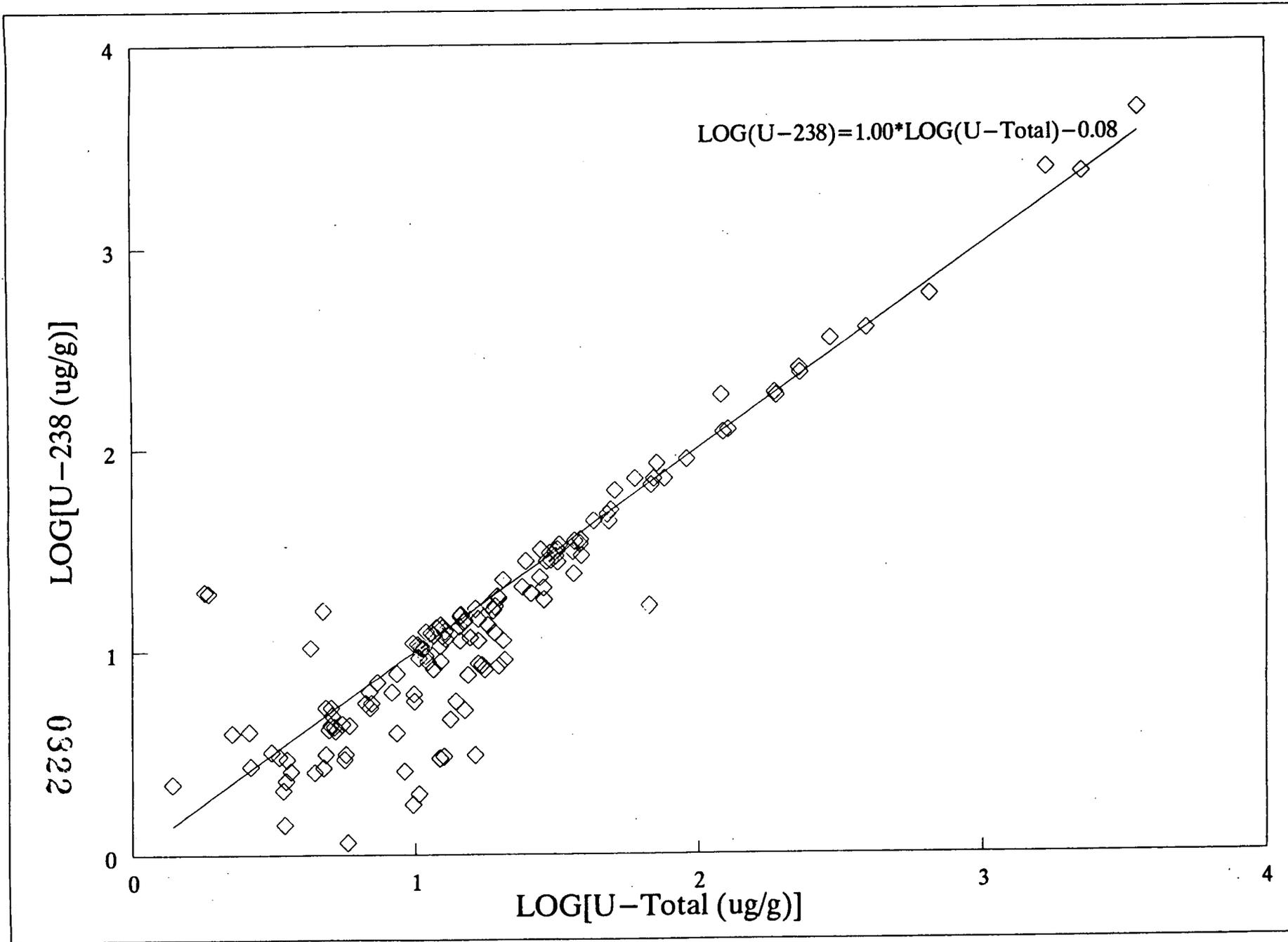
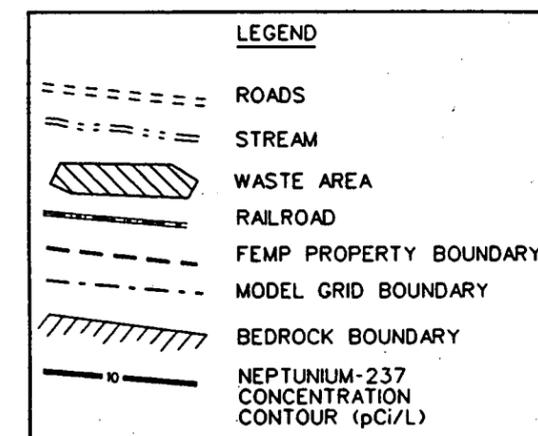
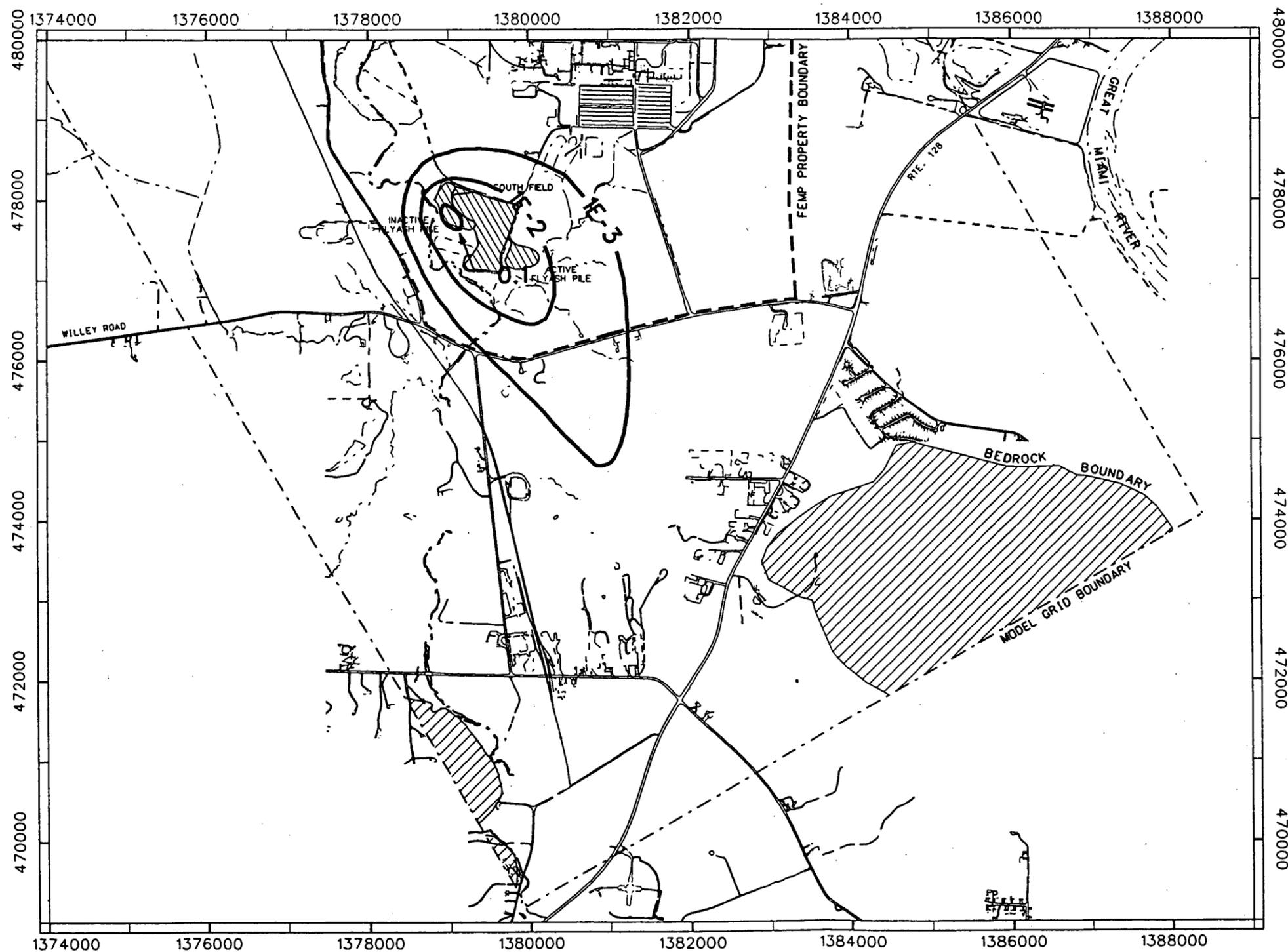
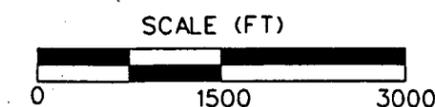
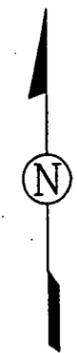


FIGURE 5-26 : U-238 vs. U-TOTAL IN SOIL SAMPLES, SOUTH FIELD & INACTIVE FLYASH PILE

5170



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



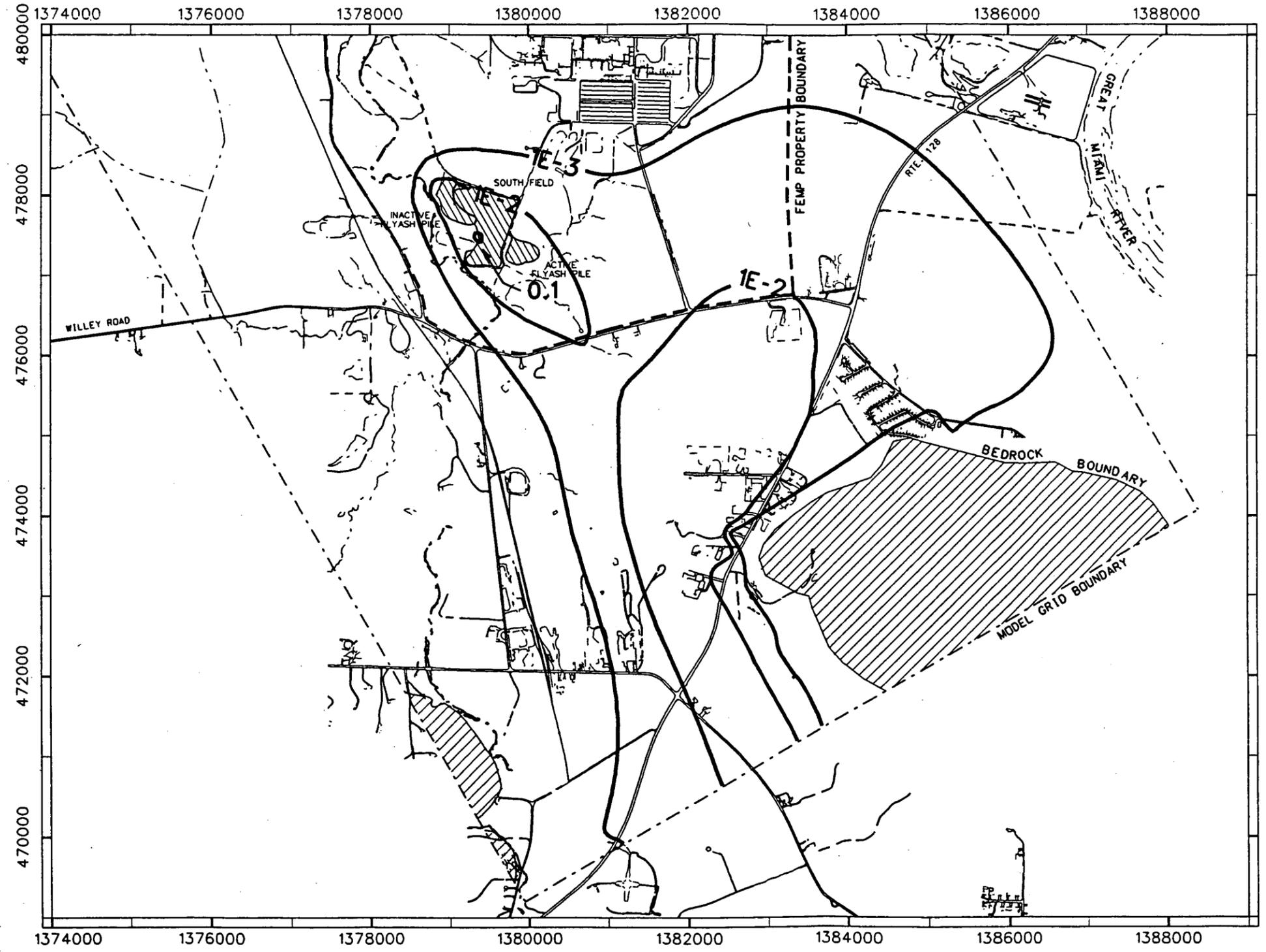
0323

FIGURE 5-27  
PROJECTED INCREASE IN NEPTUNIUM-237 CONCENTRATION IN GREAT MIAMI AQUIFER AT 360 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD.

MAXIMUM INCREASE IN CONCENTRATION = 1.5 pCi/L

fig0524.dgn

5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- 0.1 — NEPTUNIUM-237 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

**SCALE (FT)**

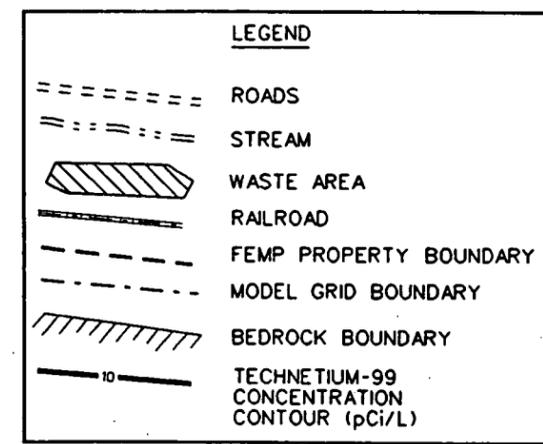
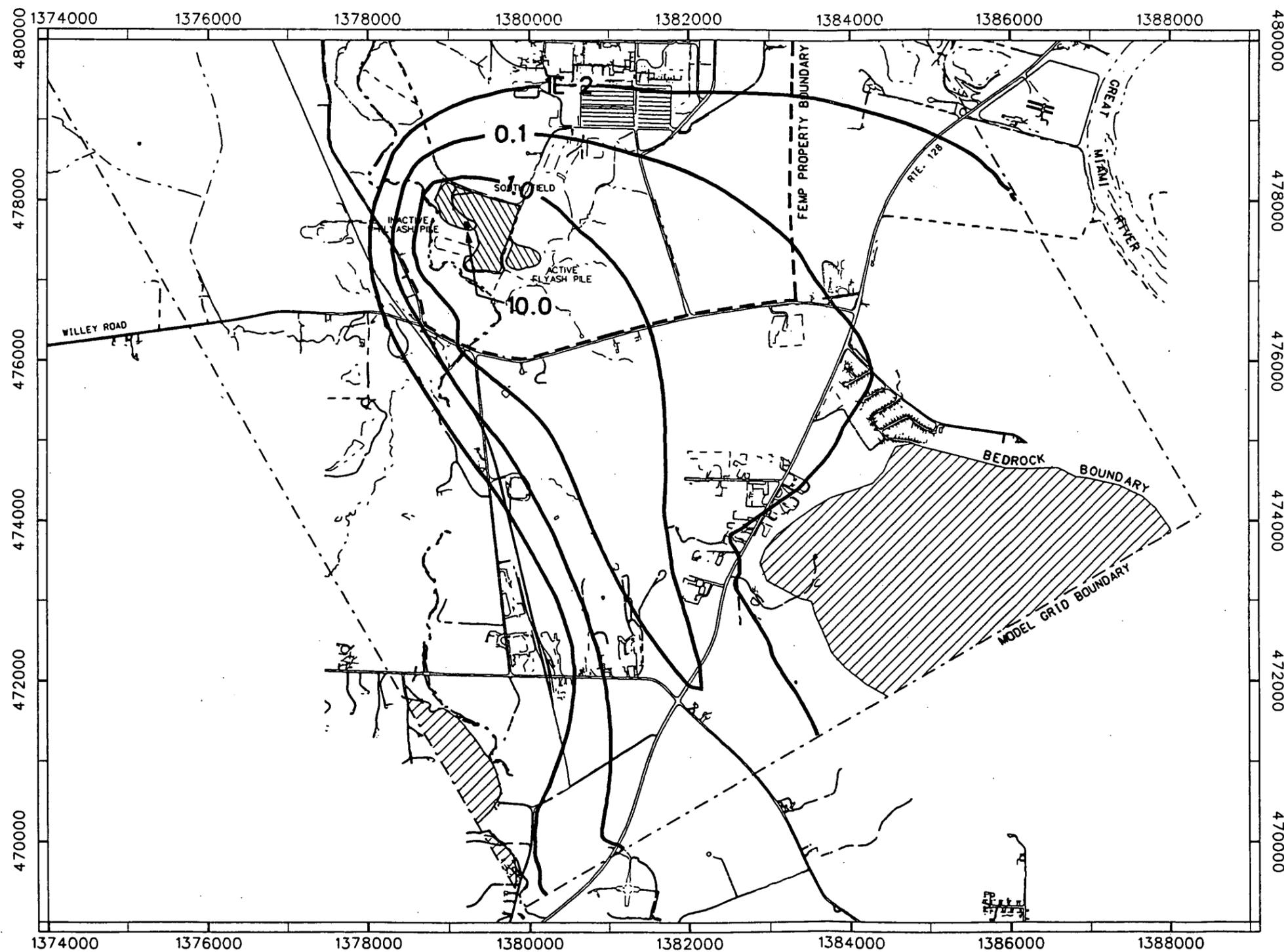
0 1500 3000

**FIGURE 5-28** 0824  
PROJECTED INCREASE IN NEPTUNIUM-237 CONCENTRATION IN GREAT MIAMI AQUIFER AT 1000 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD

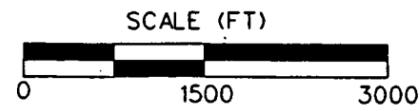
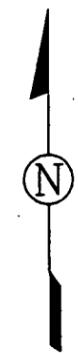
MAXIMUM INCREASE IN CONCENTRATION = 0.13 pCi/L

fig0525.dgn

5170



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

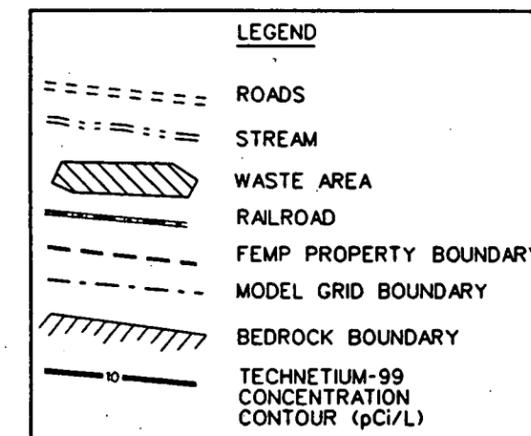
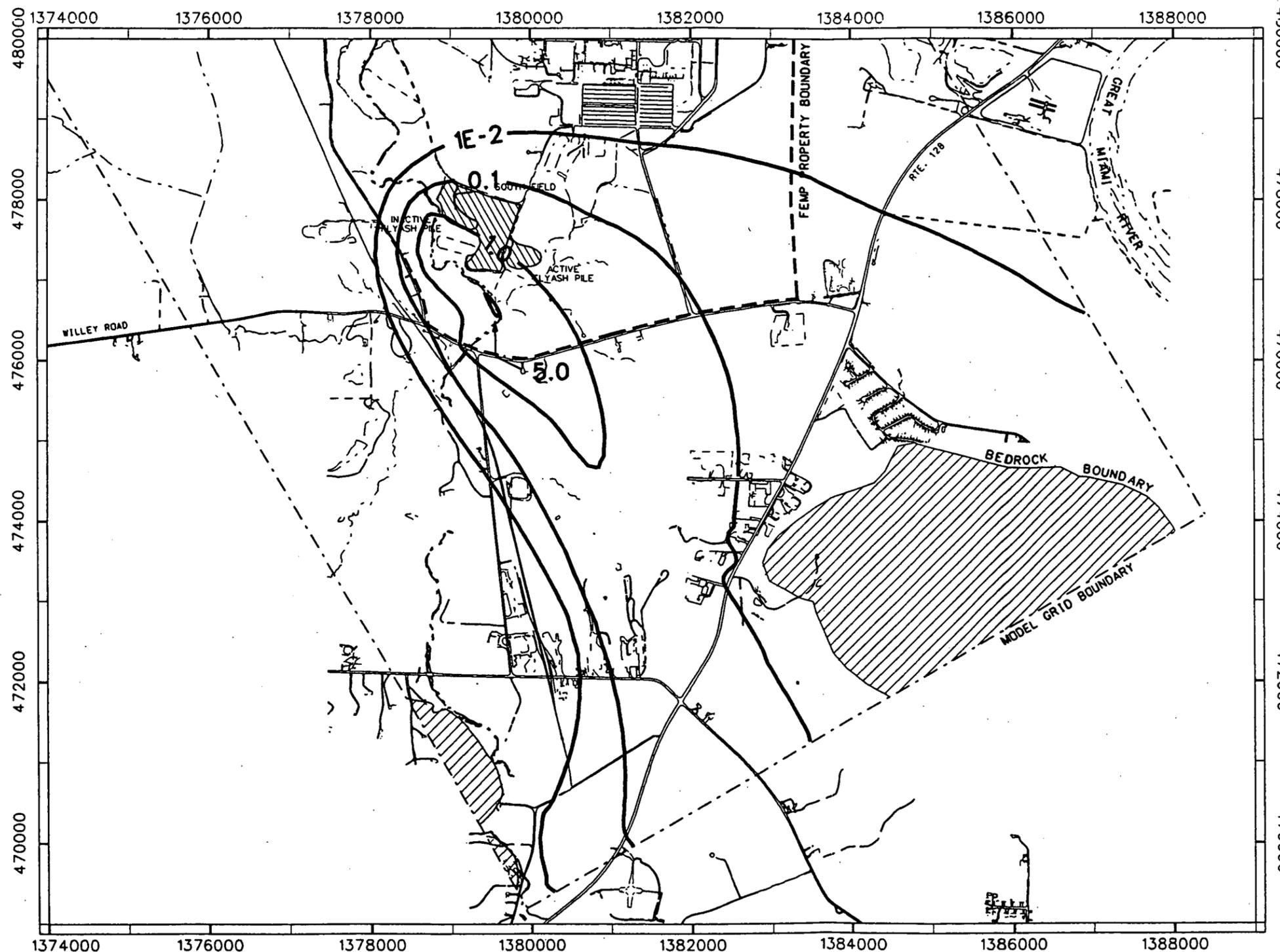


MAXIMUM INCREASE IN CONCENTRATION = 10.3 pCi/L

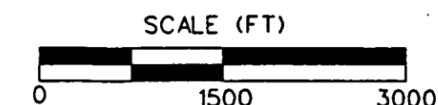
0825  
FIGURE 5-29  
PROJECTED INCREASE IN  
TECHNETIUM-99 CONCENTRATION  
IN GREAT MIAMIAQUIFER AT  
40 YEARS DUE TO LOADING FROM  
THE INACTIVE FLYASH PILE AND  
SOUTH FIELD

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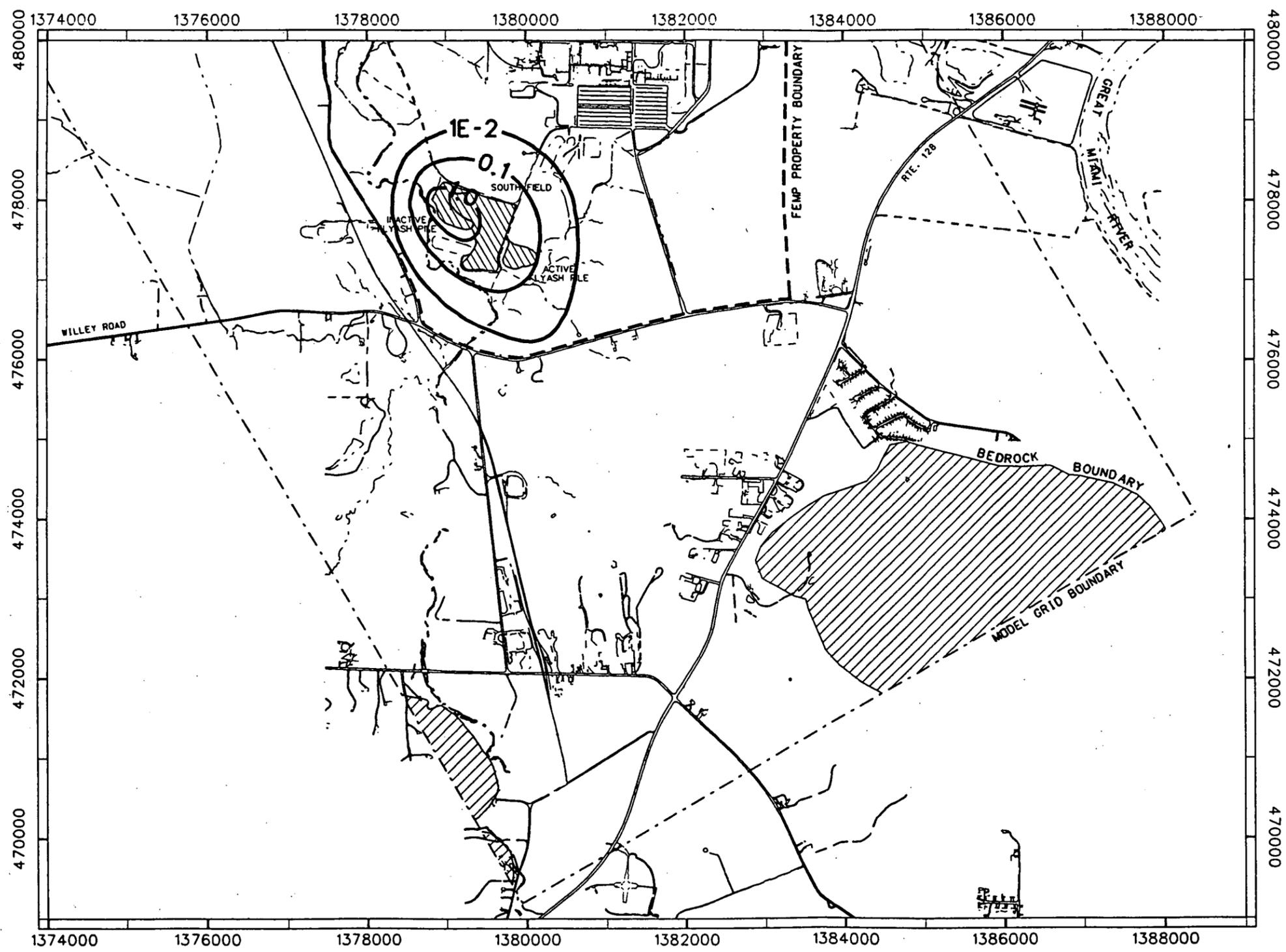
NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



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FIGURE 5-30  
PROJECTED INCREASE IN  
TECHNETIUM-99 CONCENTRATION  
IN GREAT MIAMIAQUIFER AT  
1000 YEARS DUE TO LOADING FROM  
THE INACTIVE FLYASH PILE AND  
SOUTH FIELD

MAXIMUM INCREASE IN CONCENTRATION = 5.4 pCi/L



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- LEAD CONCENTRATION CONTOUR (ug/L)

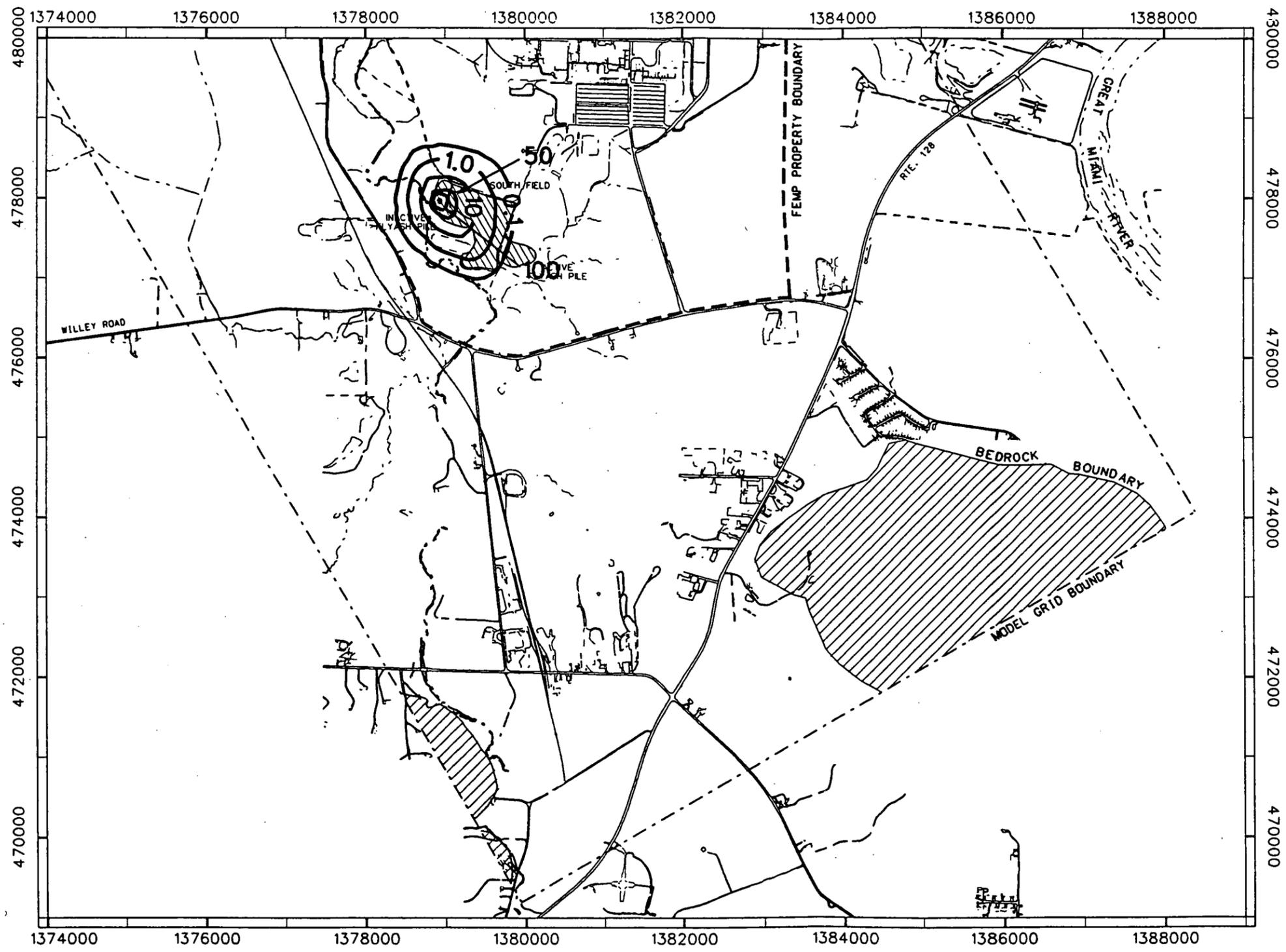
**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

**SCALE (FT)**  
0 1500 3000

**FIGURE 5-31** 0327  
**PROJECTED INCREASE IN LEAD CONCENTRATION IN GREAT MIAMI AQUIFER AT 1000 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD**

MAXIMUM INCREASE IN CONCENTRATION = 4.86 ug/L

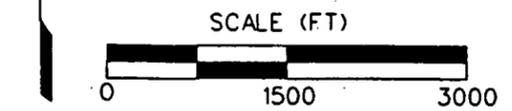
- 5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- MANGANESE CONCENTRATION CONTOUR (ug/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



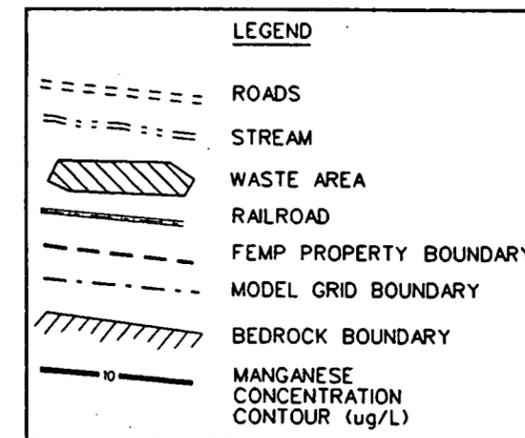
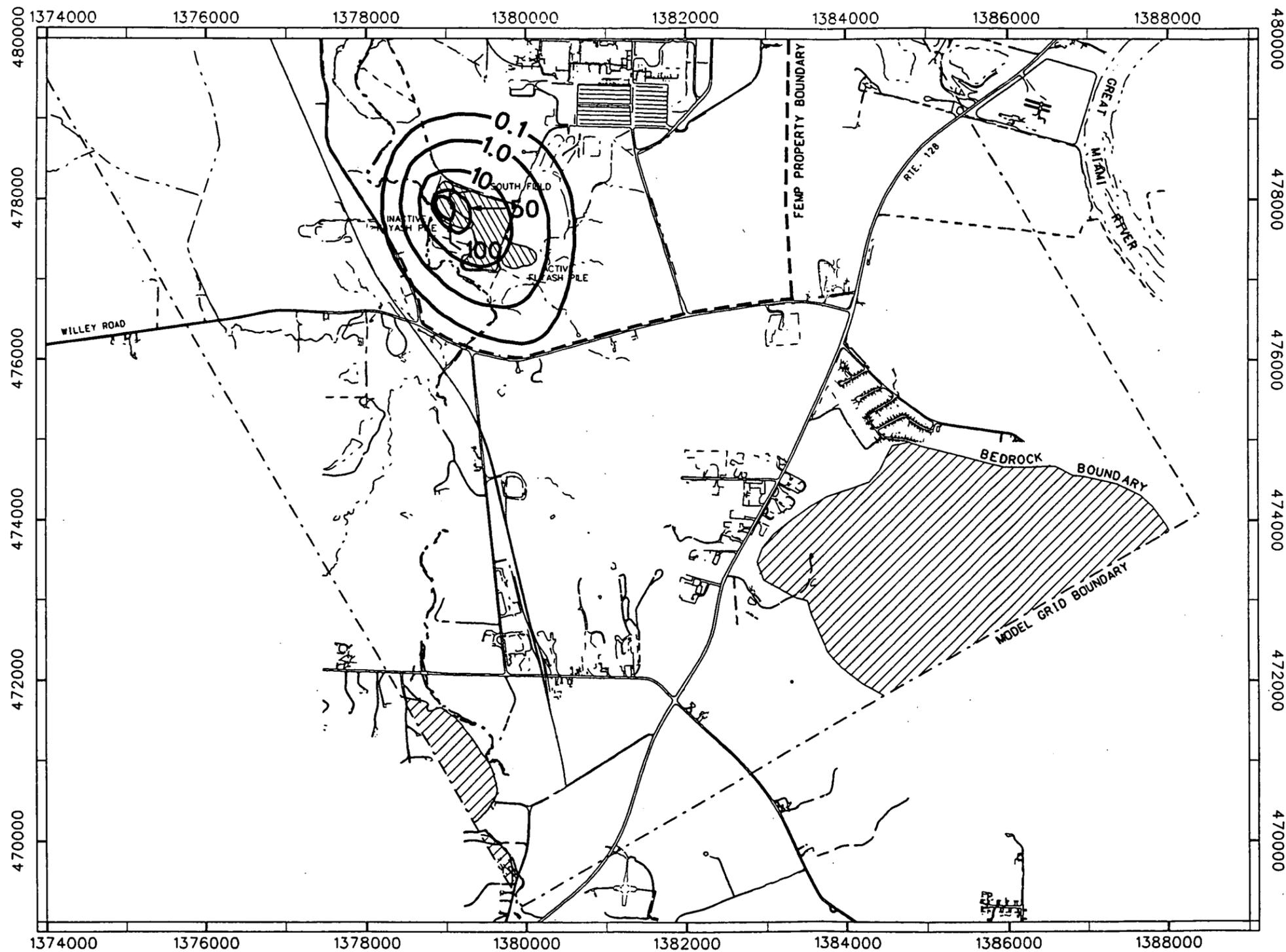
**0328**

**FIGURE 5-32**  
**PROJECTED INCREASE IN MANGANESE CONCENTRATION IN GREAT MIAMI AQUIFER AT 560 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD**

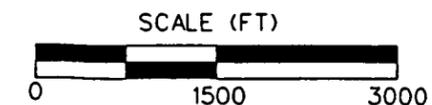
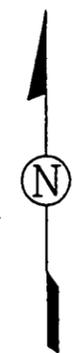
MAXIMUM INCREASE IN CONCENTRATION = 217 ug/L

fig0529.dgn

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NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



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FIGURE 5-33  
PROJECTED INCREASE IN MANGANESE CONCENTRATION IN GREAT MIAMIAQUIFER AT 1000 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE AND SOUTH FIELD

MAXIMUM INCREASE IN CONCENTRATION = 174 ug/L

TABLE 5-38

SUMMARY OF SWIFT MODELING RESULTS FOR THE  
 INACTIVE FLYASH PILE AND SOUTH FIELD  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituents of Potential Concern	Maximum Loading Concentration from ODAST (pCi/L RAD) (µg/L non-RAD)	Minimum Time of Arrival to the Aquifer (years)	Time of Maximum On-Site Concentration (years)	Maximum On-Site Concentration in the Aquifer (pCi/L RAD) (µg/L non-RAD)	Time of Maximum Concentration at the FEMP Boundary (years)	Maximum Concentration at the FEMP Boundary (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Levels (pCi/L RAD) (µg/L non-RAD)
<b>RADIONUCLIDES</b>							
Neptunium-237	1.73 x 10 <sup>+2</sup>	40	360	1.52 x 10 <sup>0</sup>	540	1.40 x 10 <sup>-1</sup>	2.20 x 10 <sup>-2</sup>
Radium-226	1.58 x 10 <sup>-1</sup>	760	1,000	8.90 x 10 <sup>-3</sup>	1,000	1.13 x 10 <sup>-9</sup>	4.00 x 10 <sup>-2</sup>
Strontium-90	6.32 x 10 <sup>0</sup>	60	140	8.54 x 10 <sup>-2</sup>	200	1.85 x 10 <sup>-3</sup>	1.30 x 10 <sup>-1</sup>
Techentium-99	7.72 x 10 <sup>+2</sup>	60	40	1.03 x 10 <sup>+1</sup>	40	2.86 x 10 <sup>0</sup>	2.70 x 10 <sup>-1</sup>
Uranium-234 <sup>a</sup>	.a, b	20	160	4.69 x 10 <sup>+2</sup>	220	2.40 x 10 <sup>+1</sup>	3.00 x 10 <sup>-1</sup>
Uranium-235/236 <sup>a</sup>	.a, b	20	160	2.50 x 10 <sup>+1</sup>	220	1.28 x 10 <sup>0</sup>	3.00 x 10 <sup>-1</sup>
Uranium-238	5.44 x 10 <sup>+5</sup>	20	160	5.17 x 10 <sup>+2</sup>	220	2.65 x 10 <sup>+1</sup>	1.70 x 10 <sup>-1</sup>
Uranium Total - (non-RAD) <sup>a</sup>	.a, b	20	160	1.84 x 10 <sup>+3</sup>	220	9.45 x 10 <sup>+1</sup>	1.00 x 10 <sup>+1</sup>
<b>INORGANICS</b>							
Antimony	1.27 x 10 <sup>+1</sup>	280	530	8.61 x 10 <sup>-1</sup>	1,000	4.60 x 10 <sup>-4</sup>	1.50 x 10 <sup>0</sup>
Cadmium	1.18 x 10 <sup>+1</sup>	60	980	7.51 x 10 <sup>-1</sup>	1,000	7.63 x 10 <sup>-2</sup>	1.80 x 10 <sup>0</sup>
Lead	5.61 x 10 <sup>+1</sup>	200	1,000	4.86 x 10 <sup>0</sup>	1,000	5.94 x 10 <sup>-3</sup>	1.50 x 10 <sup>0</sup>
Manganese	3.28 x 10 <sup>+3</sup>	240	560	2.17 x 10 <sup>+2</sup>	1,000	5.98 x 10 <sup>-2</sup>	1.80 x 10 <sup>+1</sup>
Molybdenum	1.32 x 10 <sup>+3</sup>	60	660	1.34 x 10 <sup>+1</sup>	1,000	1.26 x 10 <sup>0</sup>	1.80 x 10 <sup>+1</sup>

<sup>a</sup>Results for uranium-234, uranium-235/236, and total uranium were established by using appropriate scaling ratios to uranium-238 results.

<sup>b</sup>ODAST results were not used for SWIFT III modeling and therefore not shown in this table.

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**TABLE 5-39**  
**SUMMARY OF SWIFT MODELING RESULTS AT THE TIME AND LOCATION OF THE**  
**U-238 MAXIMUM CONCENTRATION FOR THE INACTIVE FLYASH PILE AND SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern	On-Site Concentration at 160 Years (pCi/L RAD) (µg/L non-RAD)	Concentration at the FEMP Boundary at 220 Years (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Levels (pCi/L RAD) (µg/L non-RAD)
<b>RADIONUCLIDES</b>			
Neptunium-237	3.10 x 10 <sup>-2</sup>	4.58 x 10 <sup>-4</sup>	2.20 x 10 <sup>-2</sup>
Radium-226	0.0	0.0	4.00 x 10 <sup>-2</sup>
Strontium-90	1.12 x 10 <sup>-2</sup>	9.29 x 10 <sup>-4</sup>	1.30 x 10 <sup>-1</sup>
Technetium-99	1.82 x 10 <sup>0</sup>	9.81 x 10 <sup>-1</sup>	2.70 x 10 <sup>-1</sup>
Uranium-234 <sup>a</sup>	4.69 x 10 <sup>+2</sup>	2.40 x 10 <sup>+1</sup>	3.00 x 10 <sup>-1</sup>
Uranium-235/236 <sup>a</sup>	2.50 x 10 <sup>+1</sup>	1.28 x 10 <sup>0</sup>	3.00 x 10 <sup>-1</sup>
Uranium-238	5.17 x 10 <sup>+2</sup>	2.65 x 10 <sup>+1</sup>	1.70 x 10 <sup>-1</sup>
Uranium - Total (non-RAD) <sup>a</sup>	1.84 x 10 <sup>+3</sup>	9.45 x 10 <sup>+1</sup>	01.00 x 10 <sup>+1</sup>
<b>INORGANICS</b>			
Antimony	0.0	0.0	1.50 x 10 <sup>+0</sup>
Cadmium	5.72 x 10 <sup>-1</sup>	2.74 x 10 <sup>-7</sup>	1.80 x 10 <sup>+0</sup>
Lead	1.43 x 10 <sup>+0</sup>	2.05 x 10 <sup>-14</sup>	1.50 x 10 <sup>0</sup>
Manganese	0.0	0.0	1.80 x 10 <sup>+1</sup>
Molybdenum	5.59 x 10 <sup>+0</sup>	1.04 x 10 <sup>-4</sup>	1.80 x 10 <sup>+1</sup>

<sup>a</sup>Uranium-234, uranium-235/236, and total uranium were modeled by applying ratios to uranium-238 results.

lead, and molybdenum. Out of these CPCs, uranium isotopes, neptunium-237, strontium-90, arsenic, lead, and molybdenum were predicted to be above screening levels in the Great Miami Aquifer. Only neptunium-237, uranium isotopes, and total uranium were predicted to be above the 10<sup>-7</sup> cancer risk or 0.1 HI levels at the FEMP boundary.

As noted earlier, total uranium, uranium-234, and uranium-235/236 concentrations were estimated from the results of uranium-238 modeling. Figure 5-34 shows the site-specific relationships between uranium-238 and total uranium at the Active Flyash Pile. Figure 5-34 shows that 91 percent of total uranium mass consists of uranium-238. Relationships of uranium-238 with uranium-234 and uranium-235/236 are shown in Figures 5-24 and 5-25. These relationships were used to estimate uranium-234, uranium-235/236, and total uranium concentrations.

Uranium-238 and neptunium-237 concentrations are significantly elevated compared to the screening concentrations and may control the overall risk from groundwater pathway. Table 5-41 presents on-site and off-site concentrations of CPCs at uranium-238 maximum concentration location and time. Loading curves and contour plots for CPCs at different time periods are presented in Appendix A-2. Contour plots at the maximum CPC concentration in the Great Miami Aquifer and at 1,000 years are shown in Figures 5-35 through 5-43. All concentration contours show a southerly migration from the Active Flyash Pile. Concentrations of strontium-90 and molybdenum at 1,000 years were predicted to be below 10<sup>-7</sup> risk or 0.1 HI level; therefore, no contour plots were produced for these two CPCs at 1,000 years.

5.4.4.5 Combined Impact of All Operable Unit 2 Subunits

Uranium isotopes, neptunium-237, technetium-99, and lead were the only constituents that were CPCs for groundwater from more than one subunit. The Inactive Flyash Pile and South Field are the major contributors of the four CPCs to groundwater. Figures 5-44 through 5-47 show projected increase in concentrations of these CPCs at the time of maximum concentration in the Great Miami Aquifer. These figures present the overall impact of all Operable Unit 2 subunits. A comparison of Figures 5-21 and 5-29 with Figures 5-44 and 5-46 indicates that the point of on-site and off-site maximum concentration for uranium-238 and technetium-99 considering all subunits are almost identical to the point of on-site and off-site maximum concentrations of these parameters due to the South Field and Inactive Flyash Pile. The Figures 5-27 and 5-31 compared to Figures 5-45 and 5-47 indicate that the point of maximum on-site concentrations for neptunium-237 and lead change when considering all

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Operable Unit 2 subunits but the point of maximum off-site concentrations for neptunium-237 and lead do not change significantly.

The assessment of all Operable Unit 2 subunits together does not significantly change the location of the point of maximum concentration for the four constituents, but it does increase the maximum concentration at the maximum point. For other constituents that were CPCs from only one subunit, results are presented in Sections 5.4.4.3 and 5.4.4.4.

5.4.5 Modeling Results of Waste at Background Concentrations

Modeling results presented so far are based on analytical results from soil samples and perched water samples. This section presents results of vadose zone modeling if the waste and perched water were at background concentrations. Selected block(s) in each Operable Unit 2 subunit were modeled using the ODAST to predict loadings to the Great Miami Aquifer. Except for waste perched water concentrations, the technical approach and parameters used in the modeling were the same as presented in Sections 5.4.1 through 5.4.3. Leachate concentrations were estimated using the EPA 70-year rule. Only CPCs present in individual subunits and with non-zero background concentrations were modeled. No background concentrations were available for organic CPCs and were not expected to be present in the background soils and perched water. Therefore, no organic CPCs were modeled. Physical parameters including waste size and infiltration rates were assumed to remain at current conditions.

5.4.5.1 Solid Waste Landfill

Grid cell (51,91), the grid cell with highest waste volume (Table 5-13), was selected for background modeling in the Solid Waste Landfill. Table 5-42 shows the summary of vadose zone modeling results if waste and perched water concentrations were at background levels. Table 5-42 shows that the impact of the Solid Waste Landfill waste at background level is negligible on the Great Miami Aquifer within 1,000 years. Only cyanide was predicted to reach the Great Miami Aquifer at  $1.1 \times 10^{-3} \mu\text{g/L}$  concentration, which is approximately 4 orders of magnitude lower than the  $10^{-7}$  risk or 0.1 HI concentration (Table 5-42).

5.4.5.2 Lime Sludge Ponds

Grid cell (44,81), the grid cell with highest waste volume (Table 5-14), was selected for background modeling in the Lime Sludge Ponds. Table 5-43 shows the summary of vadose zone modeling results

5-143

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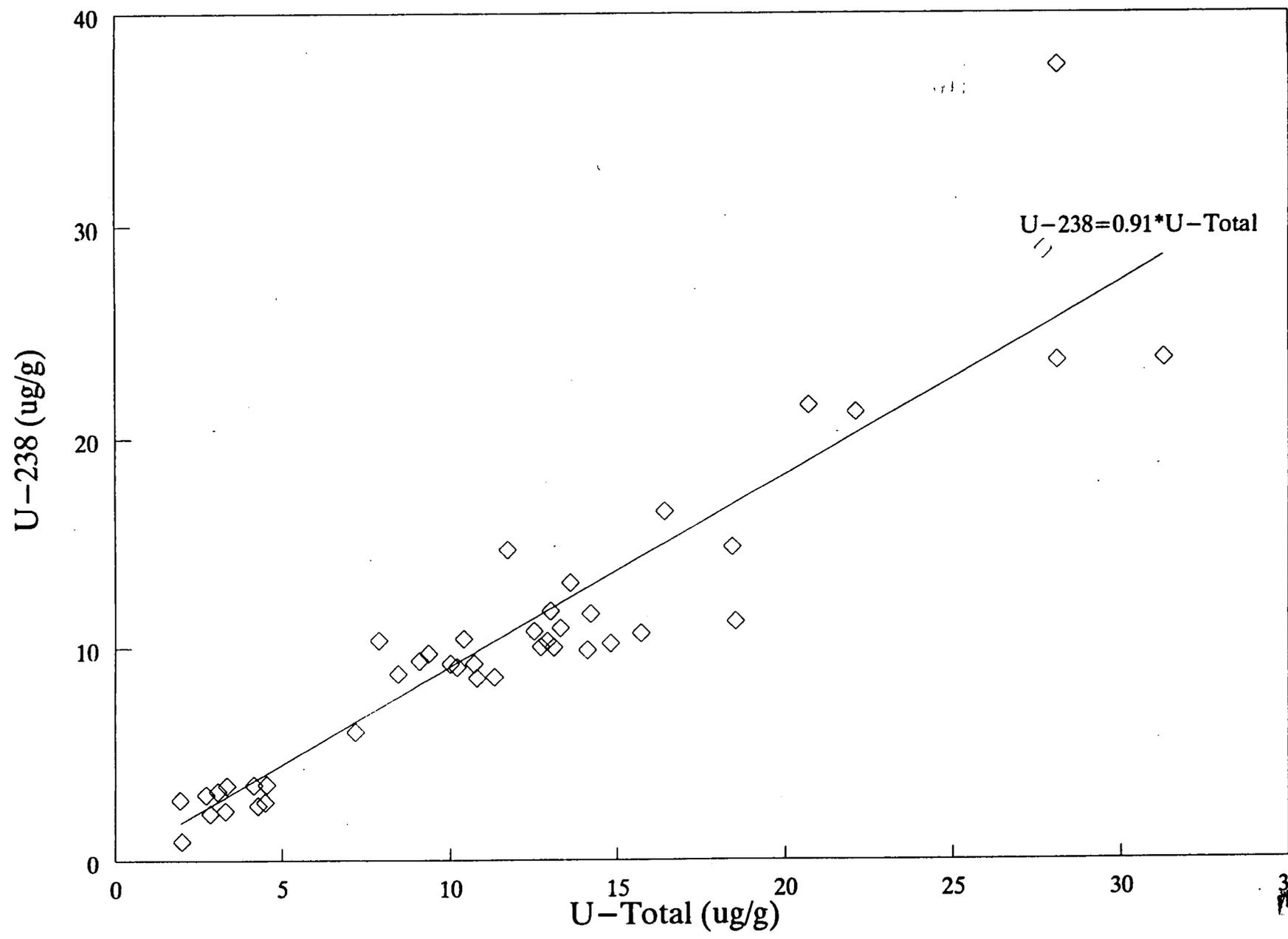
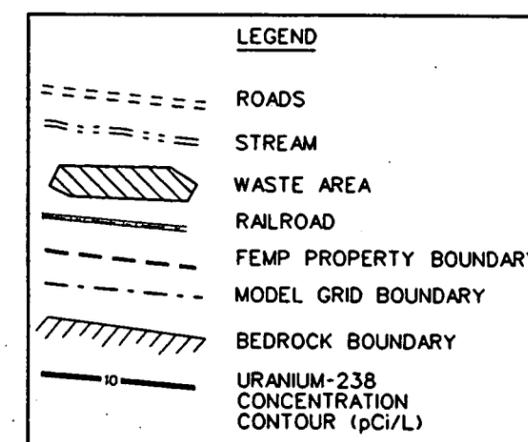
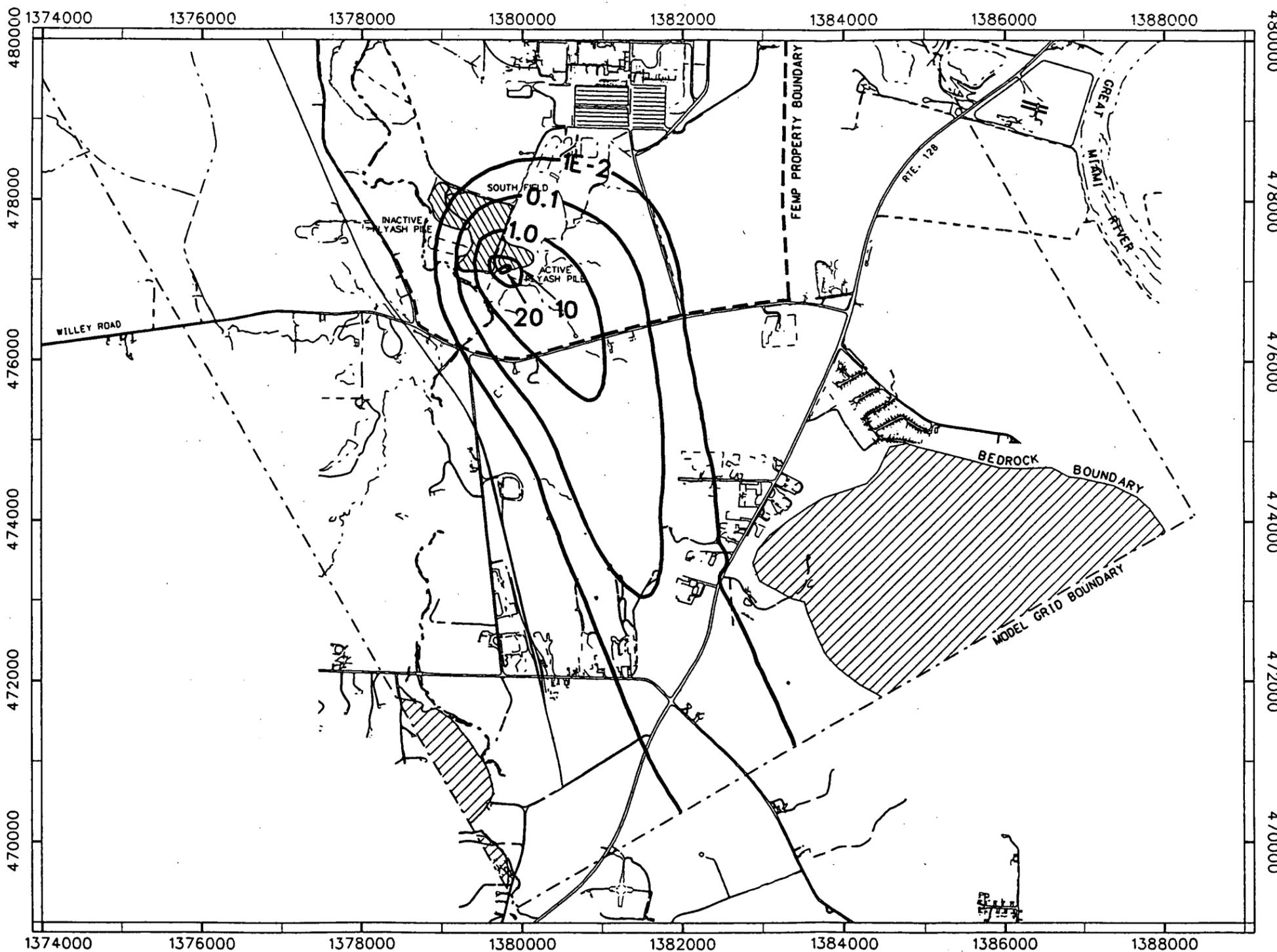
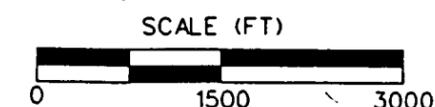


FIGURE 5-34 : U-238 vs. U-TOTAL IN SOIL SAMPLES, ACTIVE FLYASH PILE

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NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

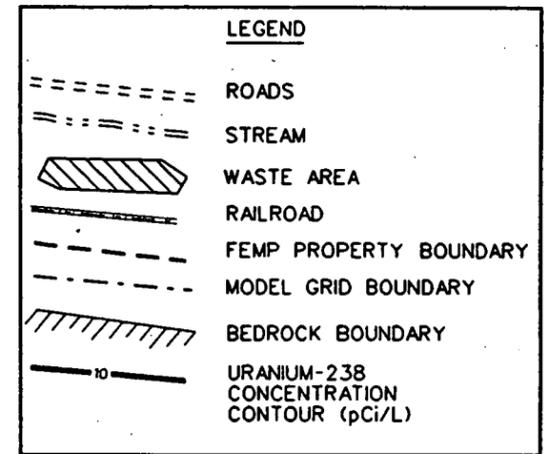
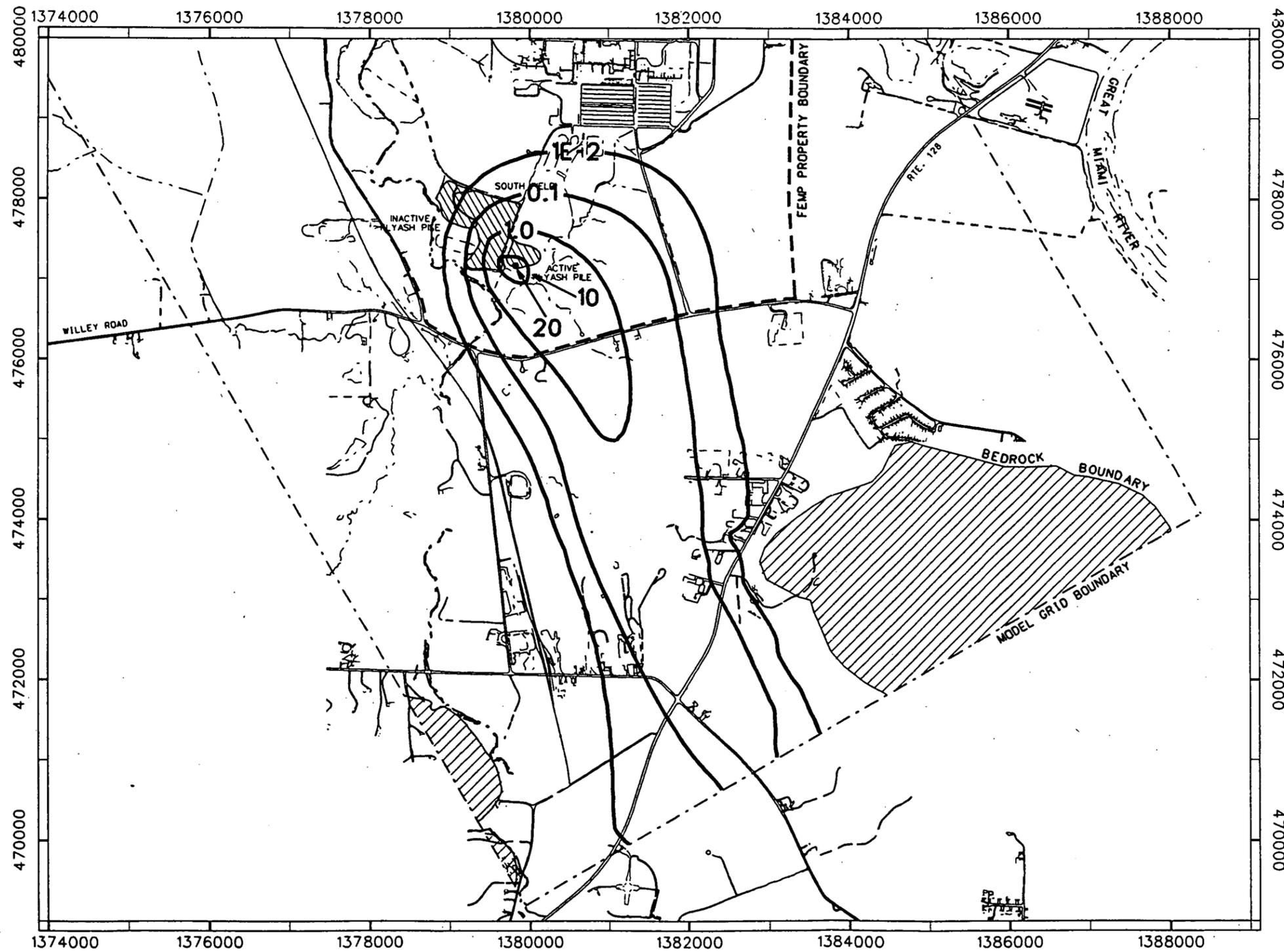


0335

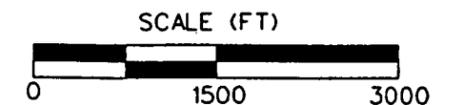
FIGURE 5-35  
PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMI AQUIFER AT 100 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE

MAXIMUM INCREASE IN CONCENTRATION = 21.8 pCi/L

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NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

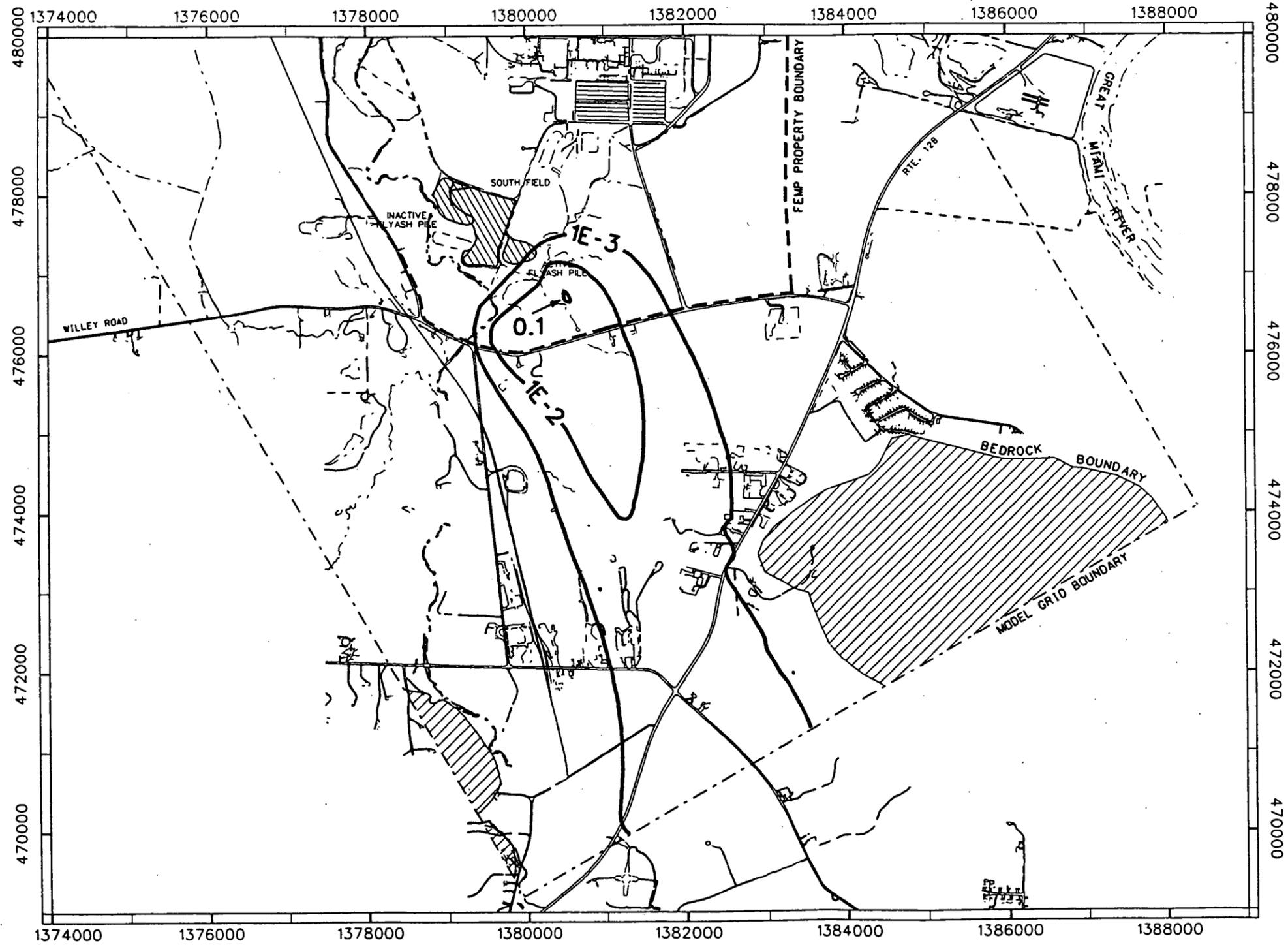


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FIGURE 5-36  
PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMIAQUIFER AT 120 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE

MAXIMUM INCREASE IN CONCENTRATION = 21.4 pCi/L

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**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- 10 — URANIUM-238 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

**SCALE (FT)**

0 1500 3000

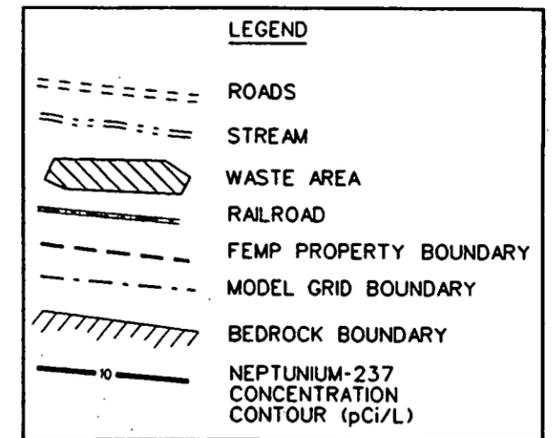
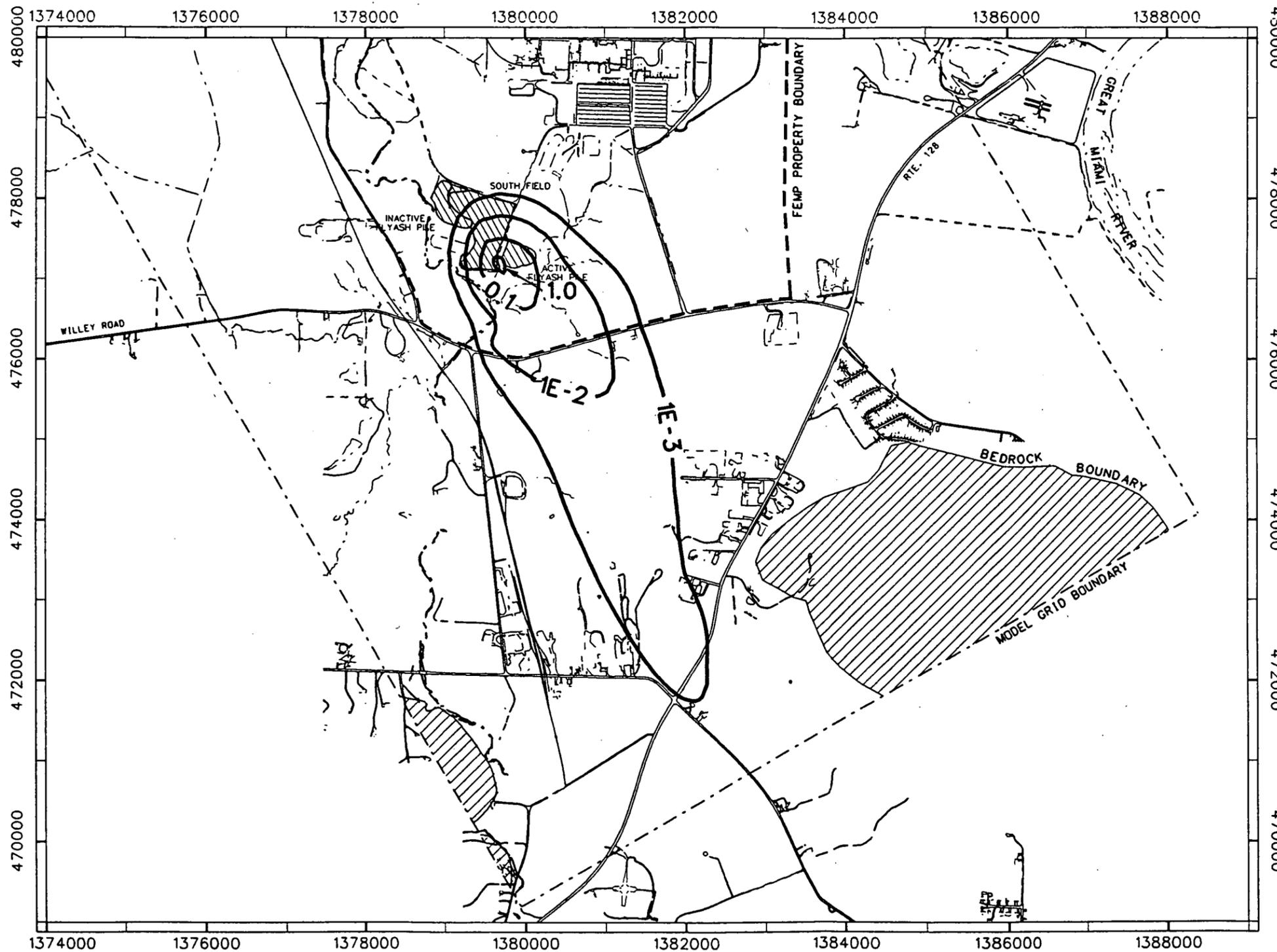
0837

**FIGURE 5-37**  
**PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMI AQUIFER AT 1000 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE**

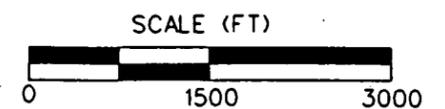
MAXIMUM INCREASE IN CONCENTRATION = 0.11 pCi/L

fig0538.dgn

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NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

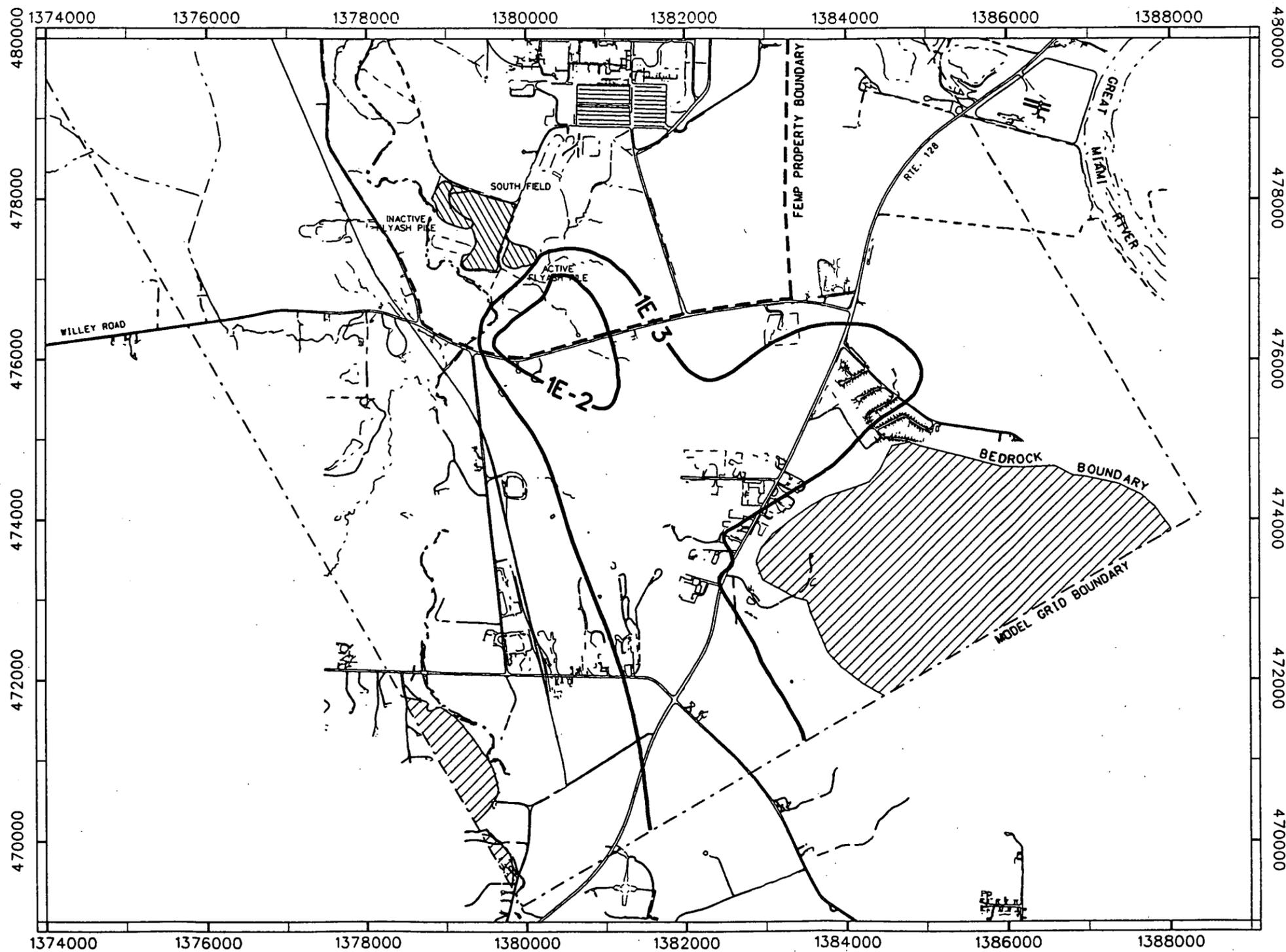


0338

FIGURE 5-38  
PROJECTED INCREASE IN NEPTUNIUM-237 CONCENTRATION IN GREAT MIAMI AQUIFER AT 160 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE

MAXIMUM INCREASE IN CONCENTRATION = 1.52 pCi/L

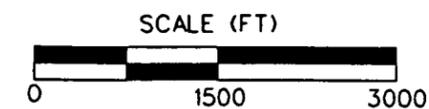
5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- NEPTUNIUM-237 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

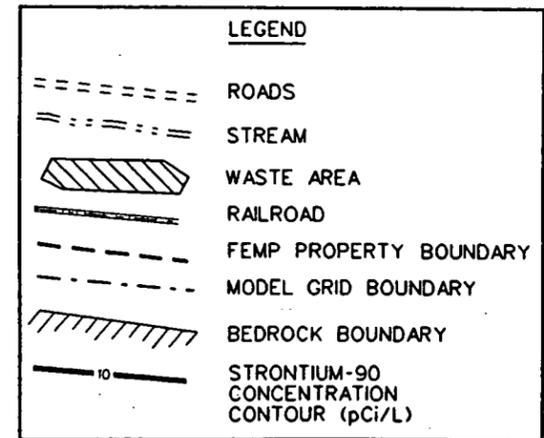
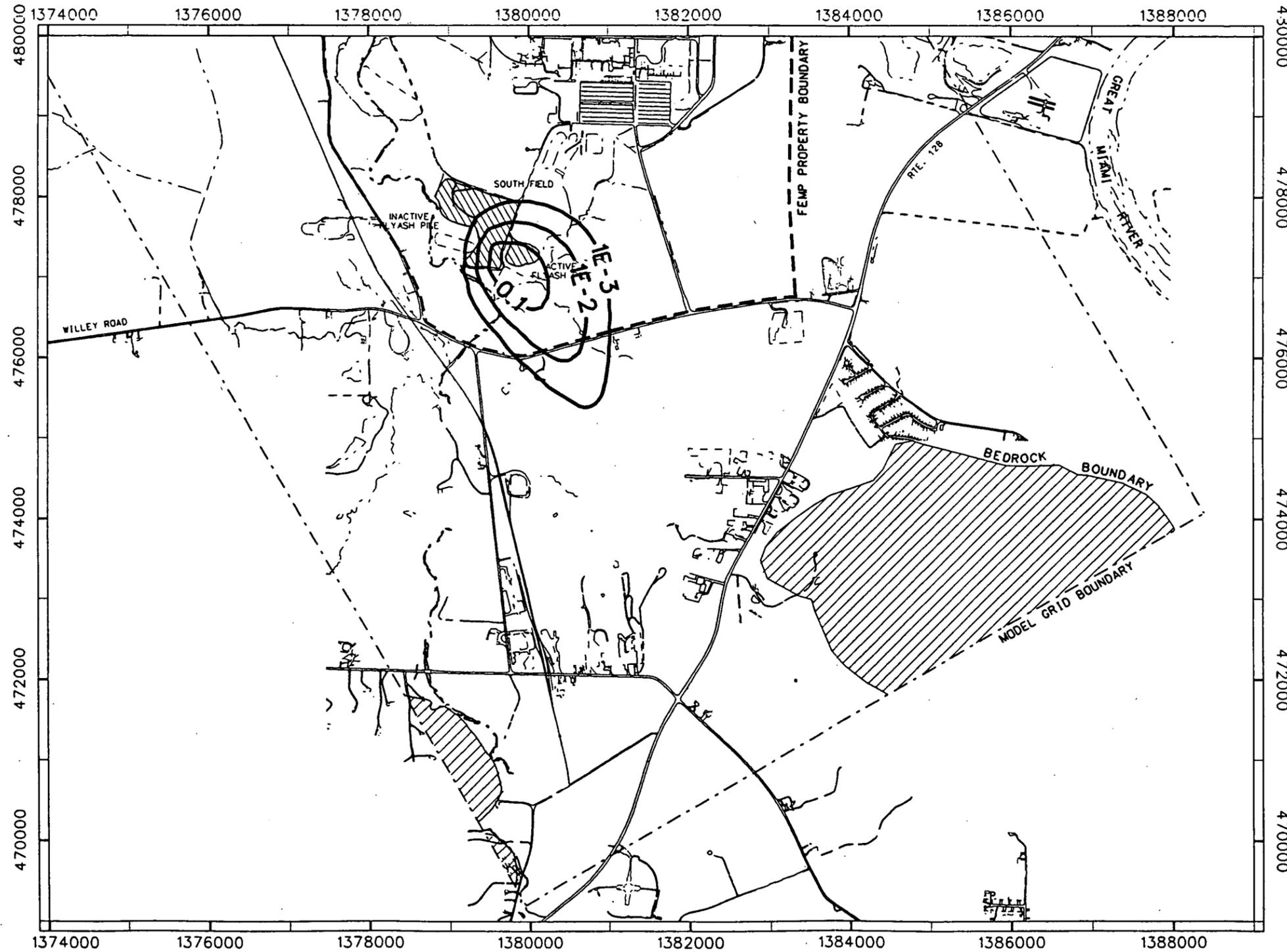


0339

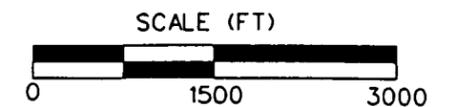
MAXIMUM INCREASE IN CONCENTRATION = 0.054 pCi/L

**FIGURE 5-39**  
PROJECTED INCREASE IN NEPTUNIUM-237 CONCENTRATION IN GREAT MIAMIAQUIFER AT 1000 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE

5170



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

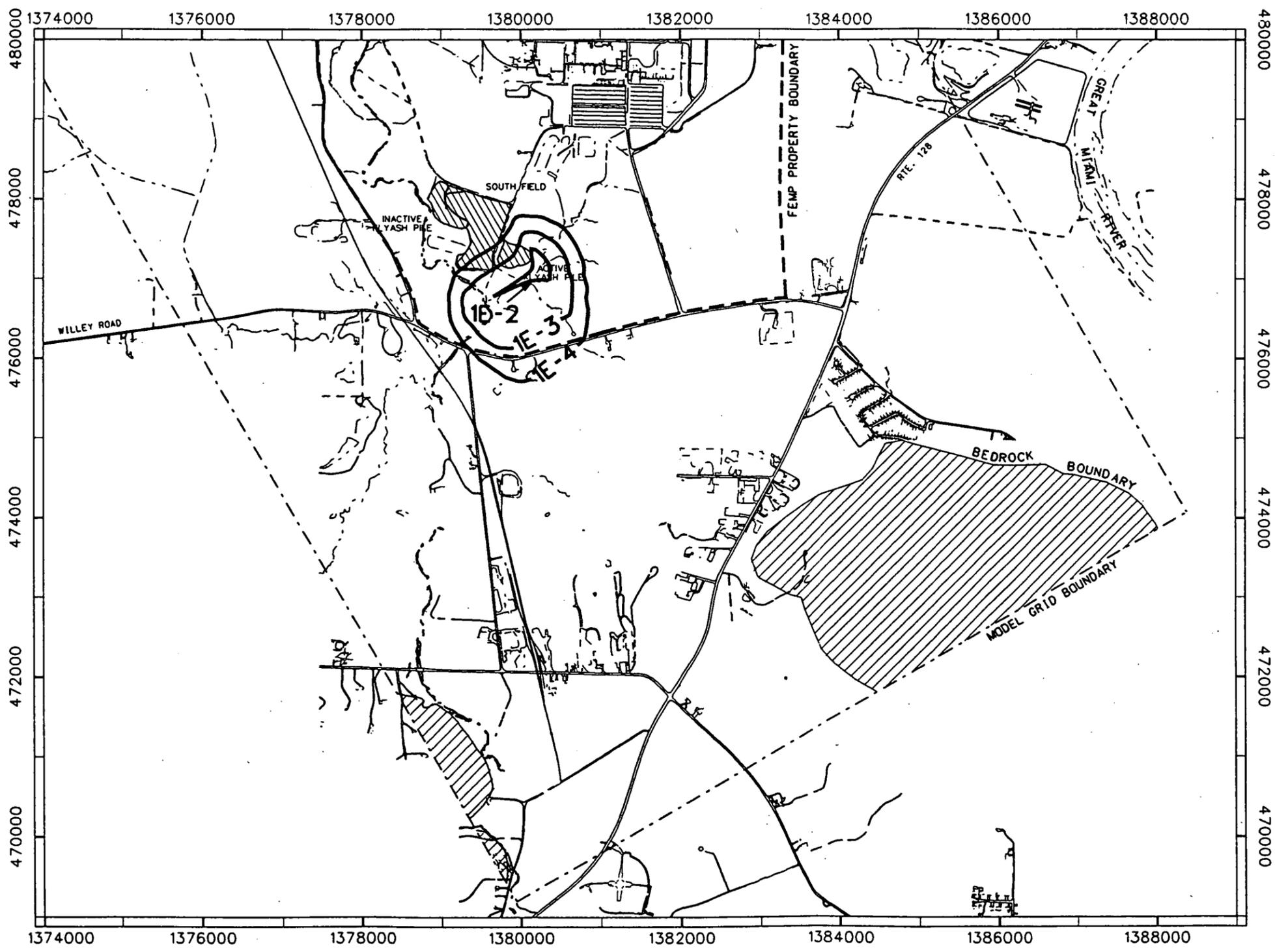


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MAXIMUM INCREASE IN CONCENTRATION = 1.0 pCi/L

FIGURE 5-40  
PROJECTED INCREASE IN STRONTIUM-90 CONCENTRATION IN GREAT MIAMI AQUIFER AT 100 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE

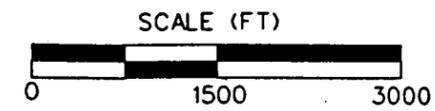
5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- ARSENIC CONCENTRATION CONTOUR (ug/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

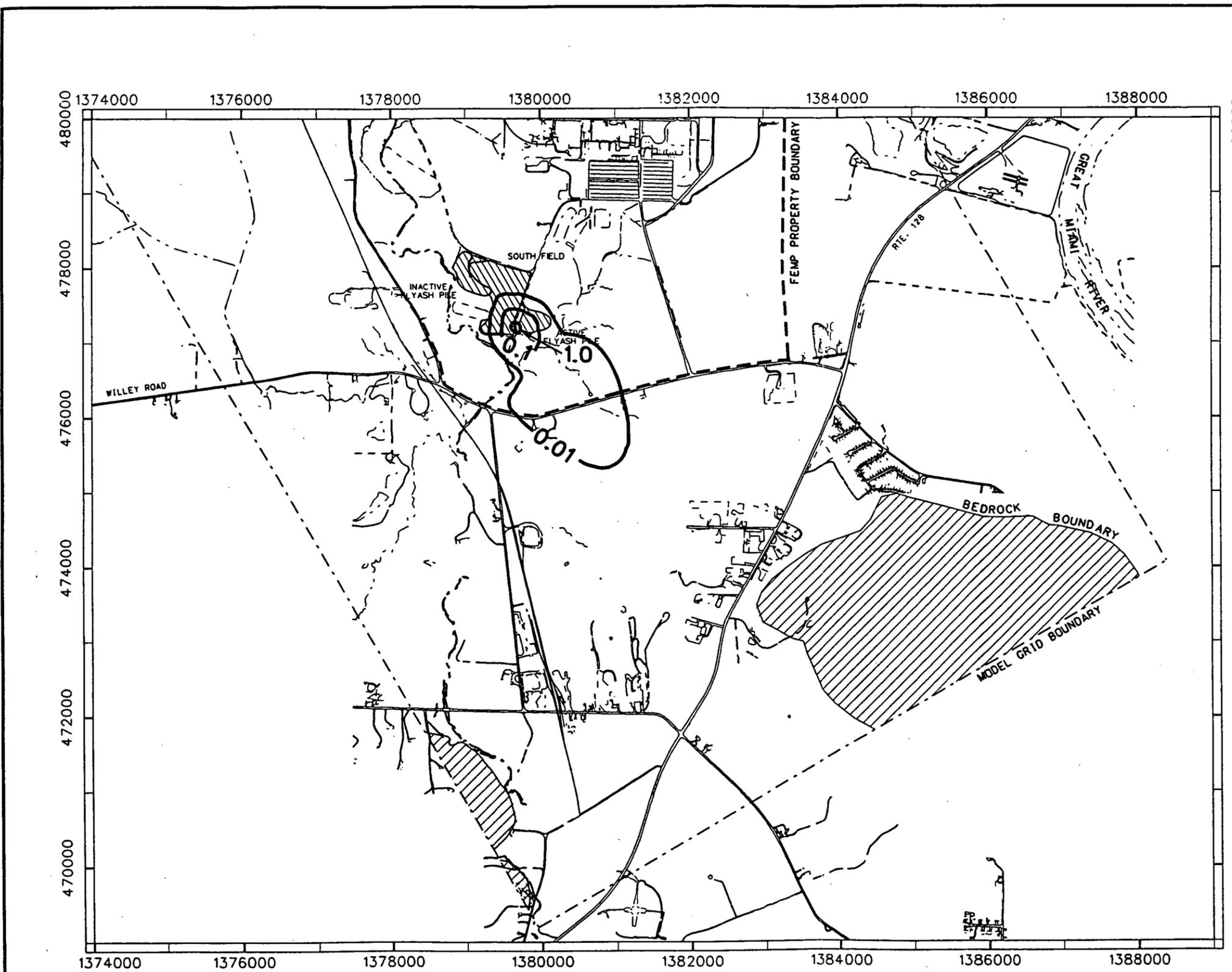


0841

**FIGURE 5-41**  
**PROJECTED INCREASE IN ARSENIC CONCENTRATION IN GREAT MIAMIAQUIFER AT 1000 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE**

MAXIMUM INCREASE IN CONCENTRATION = 0.018 ug/L

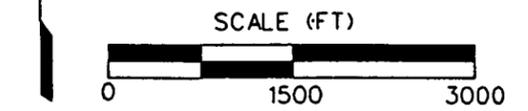
fig0541.dgn



**LEGEND**

- ROADS
- - - - - STREAM
- ▨ WASTE AREA
- RAILROAD
- - - - - FEMP PROPERTY BOUNDARY
- · · · · MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- LEAD CONCENTRATION CONTOUR (ug/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



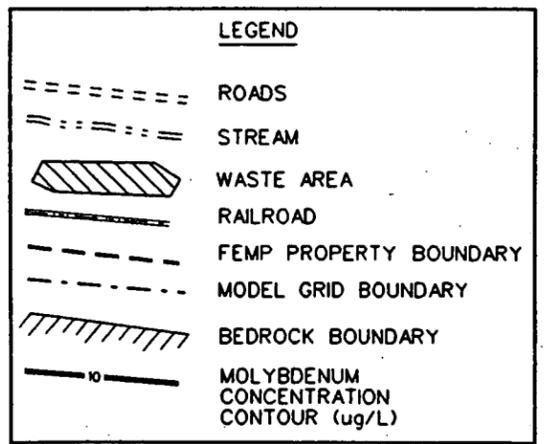
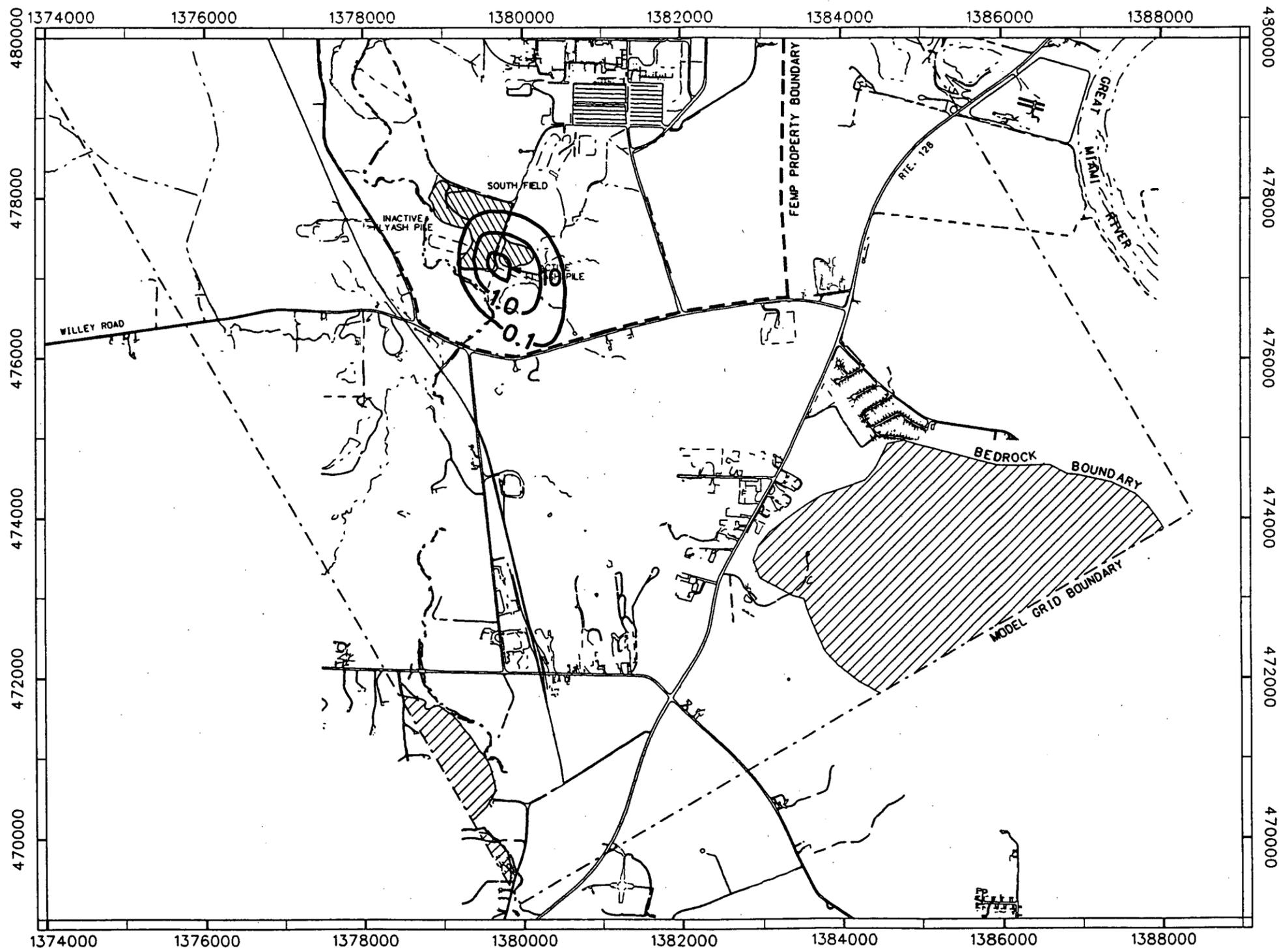
0342

**FIGURE 5-42**  
**PROJECTED INCREASE IN LEAD CONCENTRATION IN GREAT MIAMI AQUIFER AT YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE**

MAXIMUM INCREASE IN CONCENTRATION = 1.6 ug/L

fig0542.dgn

5170



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

SCALE (FT)  
0 1500 3000

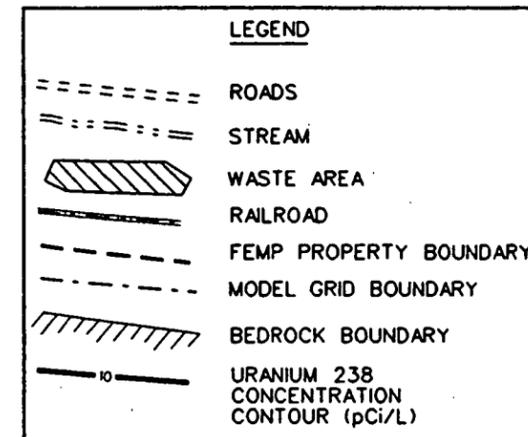
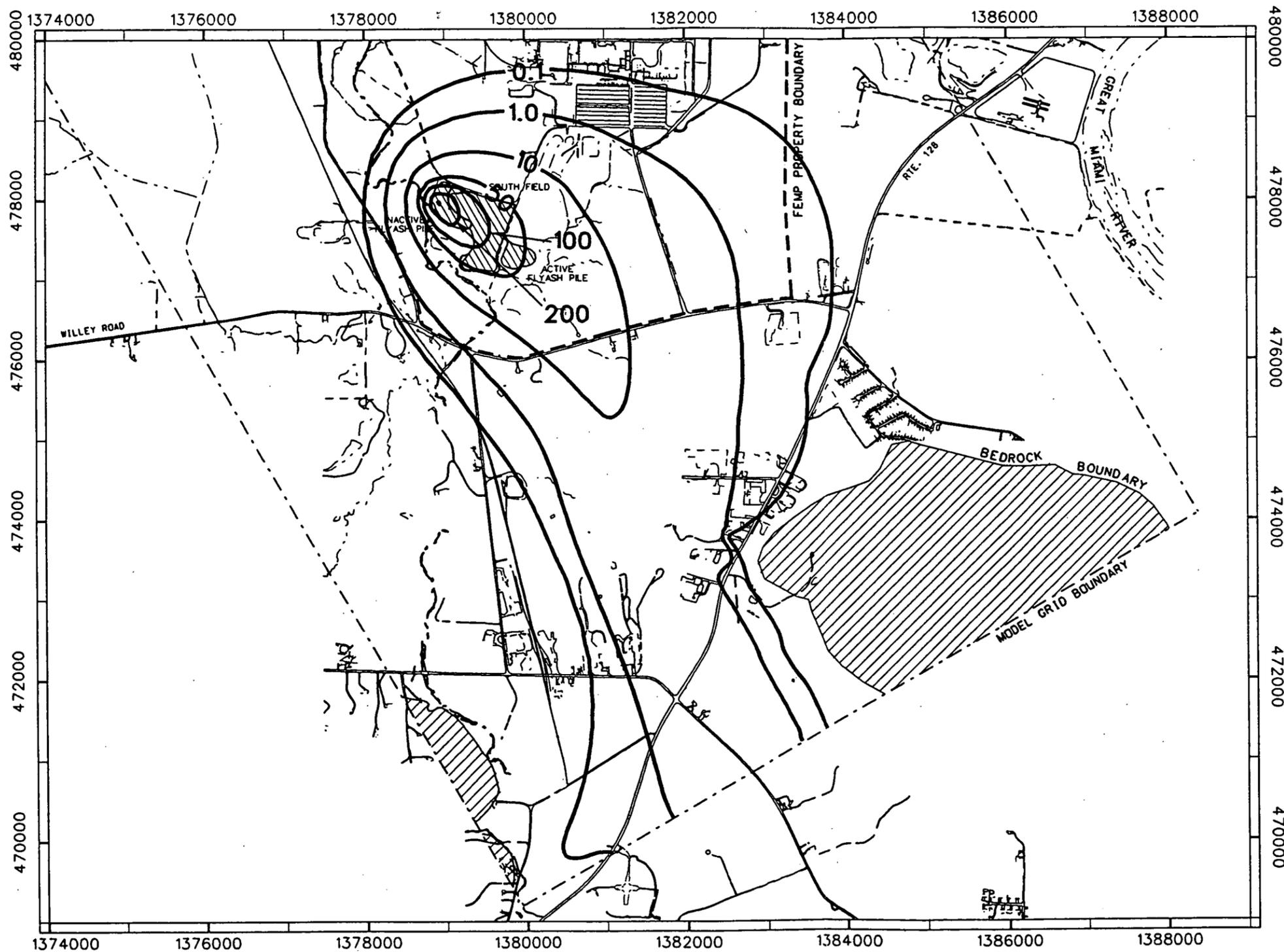
0343

FIGURE 5-43  
PROJECTED INCREASE IN MOLYBDENUM CONCENTRATION IN GREAT MIAMI AQUIFER AT 300 YEARS DUE TO LOADING FROM THE ACTIVE FLYASH PILE

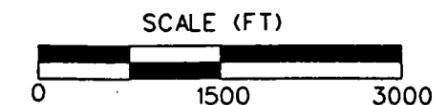
MAXIMUM INCREASE IN CONCENTRATION = 28.0 ug/L

fig0544.dgn

5170



NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

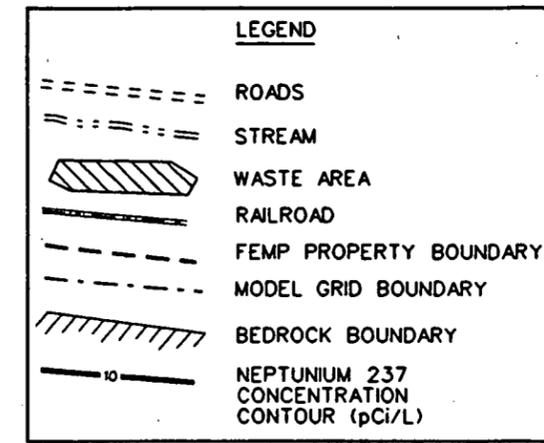
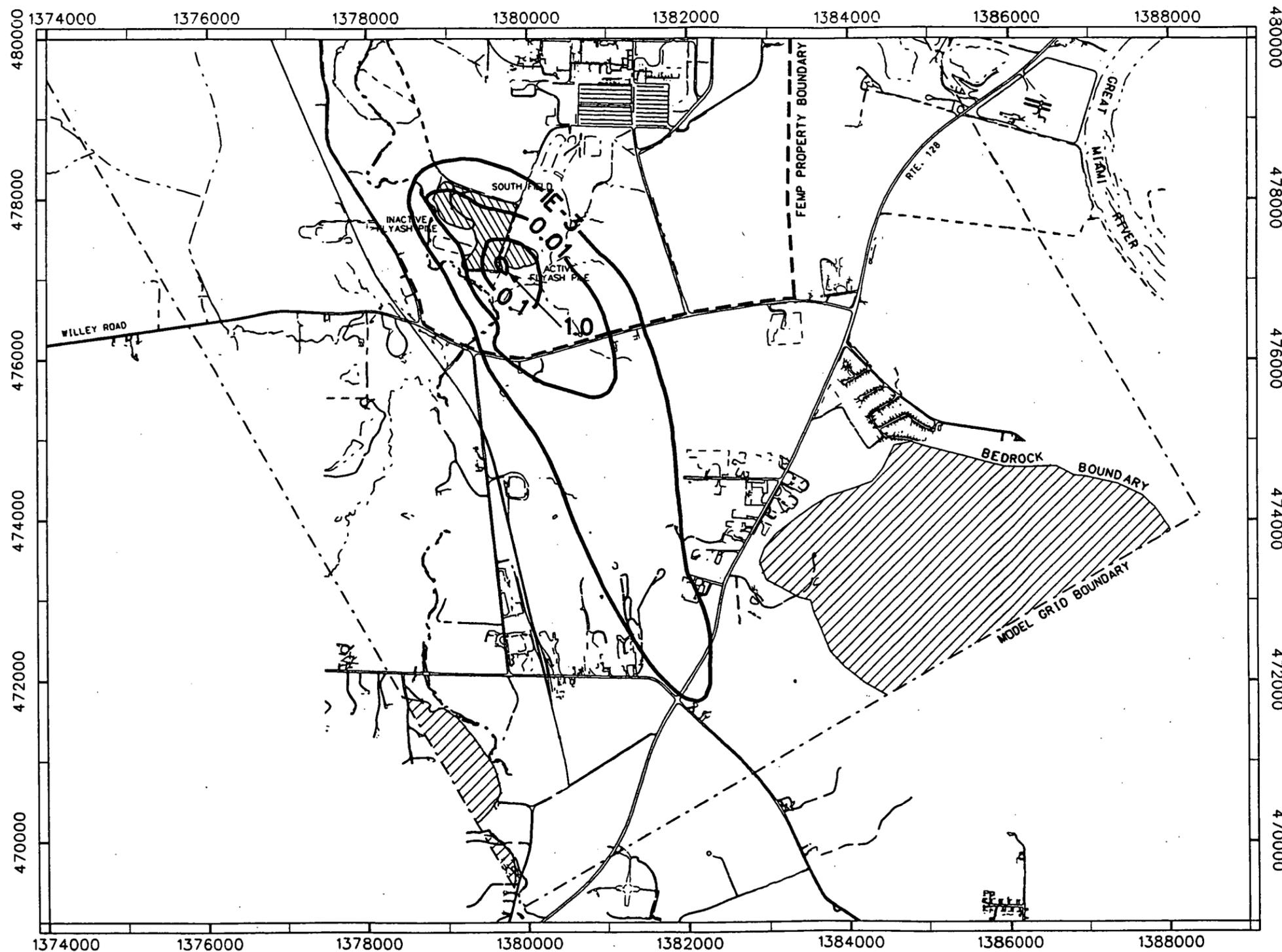


0344

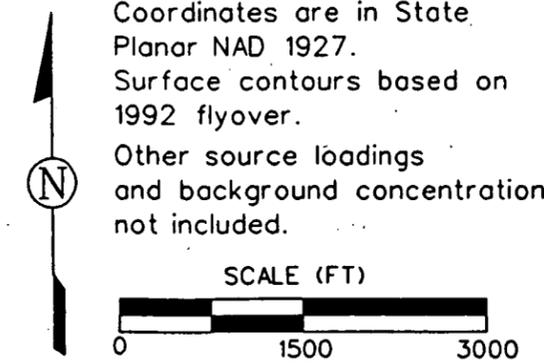
FIGURE 5-44  
PROJECTED INCREASE IN URANIUM-238 CONCENTRATION IN GREAT MIAMI AQUIFER AT 160 YEARS DUE TO LOADING FROM ALL AREA SUBUNITS

MAXIMUM INCREASE IN CONCENTRATION = 517 pCi/L

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NOTE:  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.

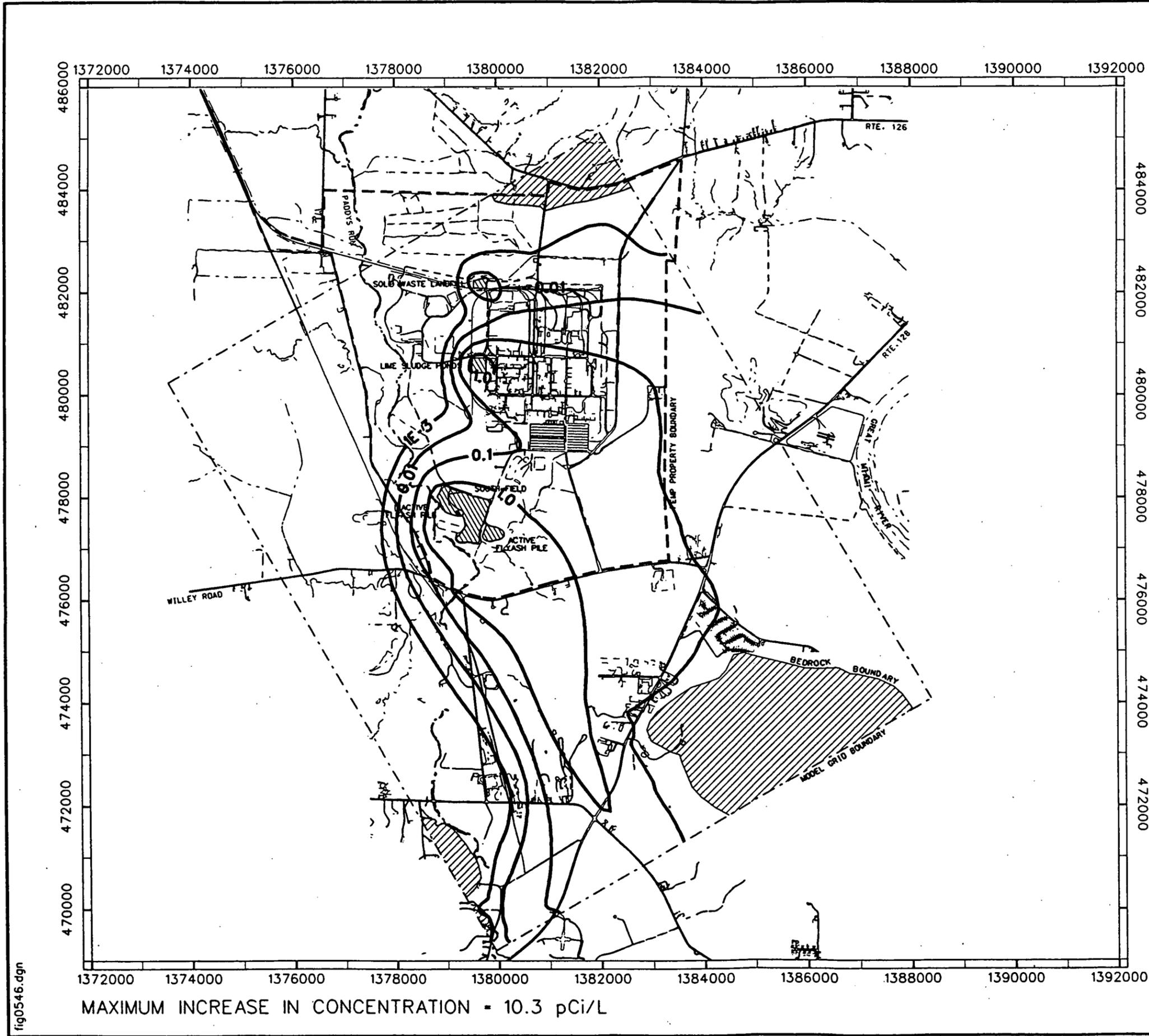


0345

FIGURE 5-45  
PROJECTED INCREASE IN NEPTUNIUM-237 CONCENTRATION IN GREAT MIAMI AQUIFER AT 160 YEARS DUE TO LOADING FROM ALL AREA SUBUNITS

MAXIMUM INCREASE IN CONCENTRATION = 1.5 pCi/L

fig0545.dgn



**LEGEND**

- ROADS
- ... STREAM
- ▨ WASTE AREA
- RAILROAD
- - - FEMP PROPERTY BOUNDARY
- · · MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- 10 — TECHNITIUM-99 CONCENTRATION CONTOUR (pCi/L)

**NOTE:**  
 Coordinates are in State Planar NAD 1927.  
 Surface contours based on 1992 flyover.  
 Other source loadings and background concentrations not included.

**SCALE (FT)**  
 0 2000 4000

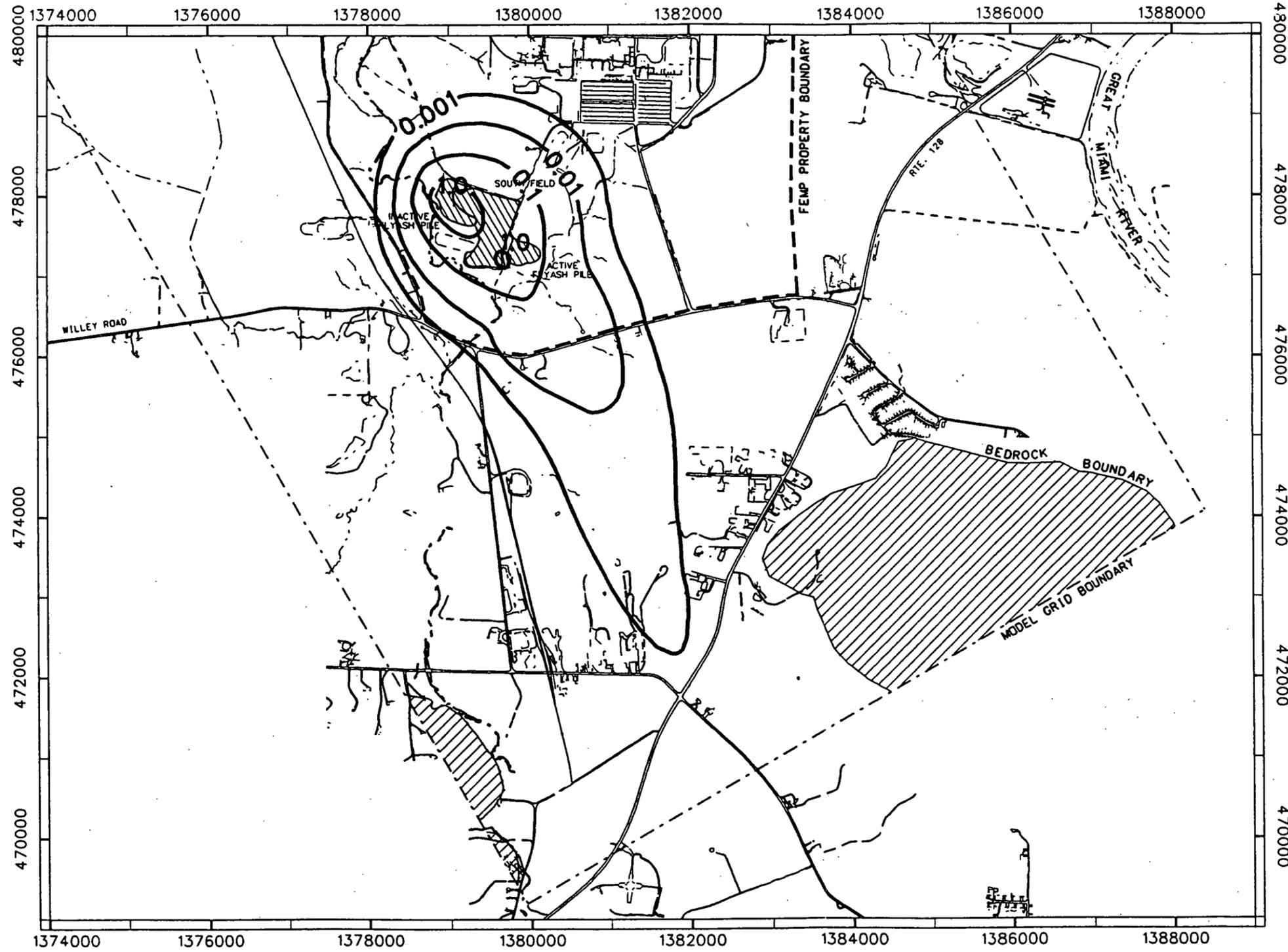
0346

**FIGURE 5-46**  
**PROJECTED INCREASE IN**  
**TECHNETIUM-99 CONCENTRATION**  
**IN GREAT MIAMIAQUIFER AT 40**  
**YEARS DUE TO LOADING FROM**  
**ALL AREA SUBUNITS**

MAXIMUM INCREASE IN CONCENTRATION = 10.3 pCi/L

fig0546.dgn

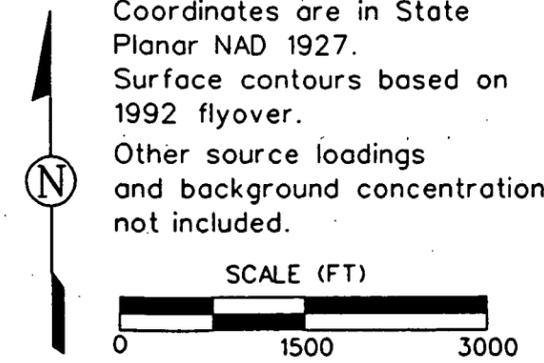
- 5170



**LEGEND**

- ROADS
- STREAM
- ▨ WASTE AREA
- ▬ RAILROAD
- - - FEMP PROPERTY BOUNDARY
- - - MODEL GRID BOUNDARY
- ▨ BEDROCK BOUNDARY
- LEAD CONCENTRATION CONTOUR (ug/L)

**NOTE:**  
Coordinates are in State Planar NAD 1927.  
Surface contours based on 1992 flyover.  
Other source loadings and background concentration not included.



0347

**FIGURE 5-47**  
**PROJECTED INCREASE IN LEAD CONCENTRATION IN GREAT MIAMIAQUIFER AT 1000 YEARS DUE TO LOADING FROM ALL AREA SUBUNITS**

MAXIMUM INCREASE IN CONCENTRATION = 4.9 ug/L

fig0547.dgn

TABLE 5-40

**SUMMARY OF SWIFT MODELING RESULTS FOR THE  
ACTIVE FLYASH PILE  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern	Maximum Loading Concentration from ODAST (pCi/L RAD) (µg/L non-RAD)	Minimum Time of Arrival to the Aquifer (years)	Time of Maximum On-Site Concentration (years)	Maximum On-Site Concentration in the Aquifer (pCi/L RAD) (µg/L non-RAD)	Time of Maximum Concentration at the FEMP Boundary (years)	Maximum Concentration at the FEMP Boundary (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Levels (pCi/L RAD) (µg/L non-RAD)
<b>RADIONUCLIDES</b>							
Neptunium-237	3.28 x 10 <sup>+1</sup>	20	160	1.52 x 10 <sup>+1</sup>	280	1.63 x 10 <sup>-1</sup>	2.20 x 10 <sup>-2</sup>
Radium-226 <sup>c</sup>	NA	0	- <sup>c</sup>	1.13 x 10 <sup>-1</sup>	- <sup>c</sup>	- <sup>c</sup>	4.00 x 10 <sup>-2</sup>
Radium-228 <sup>c</sup>	NA	0	- <sup>c</sup>	7.83 x 10 <sup>-2</sup>	- <sup>c</sup>	- <sup>c</sup>	4.80 x 10 <sup>-2</sup>
Strontium-90	1.79 x 10 <sup>+1</sup>	60	100	1.02 x 10 <sup>0</sup>	160	8.92 x 10 <sup>-2</sup>	1.30 x 10 <sup>-1</sup>
Uranium-234 <sup>a</sup>	-a, b	20	100	1.98 x 10 <sup>+1</sup>	120	2.58 x 10 <sup>0</sup>	3.00 x 10 <sup>-1</sup>
Uranium-235/236 <sup>a</sup>	-a, b	20	100	1.05 x 10 <sup>0</sup>	120	1.38 x 10 <sup>-1</sup>	3.00 x 10 <sup>-1</sup>
Uranium-238	4.87 x 10 <sup>+2</sup>	20	100	2.18 x 10 <sup>+1</sup>	120	2.85 x 10 <sup>0</sup>	1.70 x 10 <sup>-1</sup>
Uranium - Total (non-RAD) <sup>a</sup>	-a, b	20	100	7.76 x 10 <sup>+1</sup>	120	1.02 x 10 <sup>+1</sup>	1.00 x 10 <sup>+1</sup>
<b>INORGANICS</b>							
Arsenic	NA	20	1,000	1.78 x 10 <sup>-2</sup>	1,000	4.55 x 10 <sup>-3</sup>	5.00 x 10 <sup>-3</sup>
Barium <sup>c</sup>	NA	0	- <sup>c</sup>	2.2 x 10 <sup>+2</sup>	- <sup>c</sup>	- <sup>c</sup>	2.60 x 10 <sup>+2</sup>
Beryllium	NA	20	1,000	6.87 x 10 <sup>-4</sup>	1,000	1.77 x 10 <sup>-4</sup>	2.00 x 10 <sup>-3</sup>
Cadmium	2.31 x 10 <sup>+1</sup>	240	380	1.21 x 10 <sup>0</sup>	680	1.10 x 10 <sup>-1</sup>	1.80 x 10 <sup>0</sup>
Lead	2.87 x 10 <sup>+1</sup>	20	1,000	1.64 x 10 <sup>0</sup>	1,000	3.47 x 10 <sup>-2</sup>	1.50 x 10 <sup>0</sup>
Molybdenum	6.14 x 10 <sup>+2</sup>	20	300	2.80 x 10 <sup>+1</sup>	520	2.13 x 10 <sup>+0</sup>	1.80 x 10 <sup>+1</sup>

<sup>a</sup>Uranium-234, uranium-235/236, and total uranium were modeled by applying ratios to uranium-238 results.

<sup>b</sup>ODAST results were not used for SWIFT III modeling and therefore not shown in this table.

<sup>c</sup>Barium, radium-226, and radium-228, were not modeled as concentrations in the Great Miami Aquifer falls below the 10<sup>-7</sup> risk or 0.1 Hazard Index level after mixing in SWIFT III grid cell. Maximum predicted concentration based on the Storm Sewer Outfall Ditch width of 10 feet are reported as maximum on-site concentration.

NA - Not Applicable

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**TABLE 5-41**  
**SUMMARY OF SWIFT MODELING RESULTS AT THE TIME AND LOCATION OF THE**  
**U-238 MAXIMUM CONCENTRATION FOR THE ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION REPORT**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituents of Potential Concern	On-Site Concentration at 100 Years (pCi/L RAD) (µg/L non-RAD)	Concentration at the FEMP Boundary at 120 Years (pCi/L RAD) (µg/L non-RAD)	10 <sup>-7</sup> Risk or 0.1 Hazard Index Screening Levels (pCi/L RAD) (µg/L non-RAD)
<b>RADIONUCLIDES</b>			
Neptunium-237	3.14 x 10 <sup>-4</sup>	2.52 x 10 <sup>-2</sup>	2.20 x 10 <sup>-2</sup>
Radium-226 <sup>b</sup>	-	-	4.00 x 10 <sup>-2</sup>
Radium-228 <sup>b</sup>	-	-	4.80 x 10 <sup>-2</sup>
Strontium-90	5.47 x 10 <sup>-1</sup>	5.19 x 10 <sup>-2</sup>	1.30 x 10 <sup>-1</sup>
Uranium-234 <sup>a</sup>	1.98 x 10 <sup>+1</sup>	2.58 x 10 <sup>0</sup>	3.00 x 10 <sup>-1</sup>
Uranium-235/236 <sup>a</sup>	1.05 x 10 <sup>0</sup>	1.38 x 10 <sup>-1</sup>	3.00 x 10 <sup>-1</sup>
Uranium-238	2.18 x 10 <sup>+1</sup>	2.85 x 10 <sup>0</sup>	1.70 x 10 <sup>-1</sup>
Uranium - Total (non-RAD) <sup>a</sup>	7.76 x 10 <sup>+1</sup>	1.02 x 10 <sup>+1</sup>	1.00 x 10 <sup>+1</sup>
<b>INORGANICS</b>			
Arsenic	4.77 x 10 <sup>-11</sup>	1.93 x 10 <sup>-5</sup>	5.00 x 10 <sup>-3</sup>
Barium <sup>b</sup>	-	-	2.60 x 10 <sup>+2</sup>
Beryllium	4.72 x 10 <sup>-13</sup>	3.80 x 10 <sup>-7</sup>	2.00 x 10 <sup>-3</sup>
Cadmium	0.0	0.0	1.80 x 10 <sup>0</sup>
Lead	2.06 x 10 <sup>-6</sup>	5.82 x 10 <sup>-3</sup>	1.50 x 10 <sup>0</sup>
Molybdenum	0.0	0.0	1.80 x 10 <sup>+1</sup>

<sup>a</sup>Uranium-234, uranium-235/236, and total uranium were modeled by applying ratios to uranium-238 results

<sup>b</sup>Barium, radium-226, and radium-228 were not modeled as concentrations in the Great Miami Aquifer fell below the 10<sup>-7</sup> risk or 0.1 Hazard Index level after mixing in SWIFT III grid cell.

TABLE 5-42

SUMMARY OF VADOSE ZONE MODELING RESULTS IF WASTE AND PERCHED WATER CONCENTRATIONS WERE AT BACKGROUND LEVELS, SOLID WASTE LANDFILL OPERABLE UNIT 2 REMEDIAL INVESTIGATION REPORT FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Constituent	Units for Groundwater Concentration	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) (pCi/g RAD)	Perched Water Background Concentration	Predicted Maximum GMA Concentration	Critical CPC
<b>RADIONUCLIDES</b>						
Lead-210	pCi/L	7.30 x 10 <sup>-3</sup>	5.64 x 10 <sup>-1</sup>	0.00	0.00	NO
Radium-224	pCi/L	1.30 x 10 <sup>-1</sup>	6.62 x 10 <sup>-1</sup>	0.00	0.00	NO
Radium-226	pCi/L	4.00 x 10 <sup>-2</sup>	7.80 x 10 <sup>-1</sup>	1.00 x 10 <sup>+0</sup>	0.00	NO
Radium-228	pCi/L	4.80 x 10 <sup>-2</sup>	8.52 x 10 <sup>-1</sup>	4.50 x 10 <sup>+0</sup>	0.00	NO
Thorium-228	pCi/L	8.70 x 10 <sup>-2</sup>	8.82 x 10 <sup>-1</sup>	1.04 x 10 <sup>+0</sup>	0.00	NO
Thorium-230	pCi/L	3.70 x 10 <sup>-1</sup>	1.24 x 10 <sup>+0</sup>	2.00 x 10 <sup>+0</sup>	0.00	NO
Thorium-232	pCi/L	4.00 x 10 <sup>-1</sup>	8.05 x 10 <sup>-1</sup>	0.00	0.00	NO
Uranium-234	pCi/L	3.00 x 10 <sup>-1</sup>	8.44 x 10 <sup>-1</sup>	1.06 x 10 <sup>+0</sup>	0.00	NO
Uranium-235/236	pCi/L	3.00 x 10 <sup>-1</sup>	7.60 x 10 <sup>-2</sup>	0.00	0.00	NO
Uranium-238	pCi/L	1.70 x 10 <sup>-1</sup>	8.44 x 10 <sup>-1</sup>	1.07 x 10 <sup>+0</sup>	0.00	NO
Total Uranium	µg/L	1.00 x 10 <sup>+1</sup>	2.54 x 10 <sup>+0</sup>	3.22 x 10 <sup>+0</sup>	0.00	NO
<b>INORGANICS</b>						
Arsenic	µg/L	5.00 x 10 <sup>-3</sup>	5.64 x 10 <sup>+0</sup>	1.50 x 10 <sup>+1</sup>	0.00	NO
Barium	µg/L	2.60 x 10 <sup>+2</sup>	6.72 x 10 <sup>+1</sup>	1.12 x 10 <sup>+2</sup>	0.00	NO
Beryllium	µg/L	2.00 x 10 <sup>-3</sup>	4.80 x 10 <sup>-1</sup>	1.80 x 10 <sup>+0</sup>	0.00	NO
Cadmium	µg/L	1.80 x 10 <sup>+0</sup>	4.70 x 10 <sup>-1</sup>	6.00 x 10 <sup>-1</sup>	0.00	NO

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TABLE 5-42  
(Continued)

Constituent	Units for Groundwater Concentration	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) (pCi/g RAD)	Perched Water Background Concentration	Predicted Maximum GMA Concentration	Critical CPC
<b>INORGANICS (Continued)</b>						
Chromium	µg/L	1.80 x 10 <sup>+1</sup>	1.26 x 10 <sup>+1</sup>	2.00 x 10 <sup>+1</sup>	0.00	NO
Copper	µg/L	1.40 x 10 <sup>+2</sup>	1.34 x 10 <sup>+1</sup>	1.30 x 10 <sup>+1</sup>	0.00	NO
Cyanide	µg/L	7.30 x 10 <sup>+1</sup>	1.70 x 10 <sup>-1</sup>	0.00	1.10 x 10 <sup>-3</sup>	NO
Lead	µg/L	1.50 x 10 <sup>+0</sup>	9.52 x 10 <sup>+0</sup>	2.70 x 10 <sup>+0</sup>	0.00	NO
Molybdenum	µg/L	1.80 x 10 <sup>+1</sup>	2.70 x 10 <sup>-1</sup>	2.40 x 10 <sup>+0</sup>	0.00	NO
Thallium	µg/L	2.60 x 10 <sup>-1</sup>	4.90 x 10 <sup>-1</sup>	0.00	0.00	NO
Vanadium	µg/L	2.00 x 10 <sup>+1</sup>	2.17 x 10 <sup>+1</sup>	1.95 x 10 <sup>+1</sup>	0.00	NO

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0.01

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0.51

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TABLE 5-43

**SUMMARY OF VADOSE ZONE MODELING RESULTS IF WASTE AND PERCHED WATER  
CONCENTRATIONS WERE AT BACKGROUND LEVELS, LIME SLUDGE PONDS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION REPORT  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent	Units for Groundwater Concentration	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) pCi/g RAD)	Perched Water Background Concentration	Predicted Maximum GMA Concentration	Critical CPC
<b>RADIONUCLIDES</b>						
Radium-226	pCi/L	$4.00 \times 10^{-2}$	$7.80 \times 10^{-1}$	$1.00 \times 10^{+0}$	0.00	NO
Radium-228	pCi/L	$4.80 \times 10^{-2}$	$8.52 \times 10^{-1}$	$4.50 \times 10^{+0}$	0.00	NO
Strontium-90	pCi/L	$1.30 \times 10^{-1}$	$5.60 \times 10^{-1}$	0.00	0.0	NO
Thorium-228	pCi/L	$8.70 \times 10^{-2}$	$8.82 \times 10^{-1}$	$1.04 \times 10^{+0}$	0.00	NO
Thorium-230	pCi/L	$3.70 \times 10^{-1}$	$1.24 \times 10^{+0}$	$2.00 \times 10^{+0}$	0.00	NO
Thorium-232	pCi/L	$4.00 \times 10^{-1}$	$8.05 \times 10^{-1}$	0.00	0.00	NO
Uranium-234	pCi/L	$3.00 \times 10^{-1}$	$8.44 \times 10^{-1}$	$1.06 \times 10^{+0}$	0.00	NO
Uranium-235/236	pCi/L	$3.00 \times 10^{-1}$	$7.60 \times 10^{-2}$	0.00	0.00	NO
Uranium-238	pCi/L	$1.70 \times 10^{-1}$	$8.44 \times 10^{-1}$	$1.07 \times 10^{+0}$	0.00	NO
Total Uranium	$\mu\text{g/L}$	$1.00 \times 10^{+1}$	$2.54 \times 10^{+0}$	$3.22 \times 10^{+0}$	0.00	NO
<b>INORGANICS</b>						
Arsenic	$\mu\text{g/L}$	$5.00 \times 10^{-3}$	$5.64 \times 10^{+0}$	$1.50 \times 10^{+1}$	0.00	NO
Barium	$\mu\text{g/L}$	$2.60 \times 10^{+2}$	$6.72 \times 10^{-1}$	$1.12 \times 10^{+2}$	0.00	NO
Beryllium	$\mu\text{g/L}$	$2.00 \times 10^{-3}$	$4.80 \times 10^{-1}$	$1.80 \times 10^{+0}$	0.00	NO
Cadmium	$\mu\text{g/L}$	$1.80 \times 10^{+0}$	$4.70 \times 10^{-1}$	$6.00 \times 10^{-1}$	0.00	NO

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TABLE 5-43  
(Continued)

Constituent	Units for Groundwater Concentration	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) pCi/g RAD)	Perched Water Background Concentration	Predicted Maximum GMA Concentration	Critical CPC
<b>INORGANICS (Continued)</b>						
Chromium	µg/L	$1.80 \times 10^{+1}$	$1.26 \times 10^{+1}$	$2.00 \times 10^{+1}$	0.00	NO
Copper	µg/L	$1.40 \times 10^{+2}$	$1.34 \times 10^{+1}$	$1.30 \times 10^{+1}$	0.00	NO
Cyanide	µg/L	$7.30 \times 10^{+1}$	$1.70 \times 10^{+1}$	0.00	$4.20 \times 10^{-2}$	NO
Manganese	µg/L	$1.80 \times 10^{+1}$	$6.21 \times 10^{+2}$	$9.26 \times 10^{+1}$	0.00	NO
Mercury	µg/L	$1.10 \times 10^{+0}$	$2.90 \times 10^{-1}$	$4.00 \times 10^{-1}$	$1.93 \times 10^{-1}$	NO

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if waste and perched water concentrations were at background levels. Table 5-43 shows that the impact of the Lime Sludge Ponds waste at background level is negligible on the Great Miami Aquifer within 1,000 years. Only strontium-90, mercury, and cyanide were predicted to reach the Great Miami Aquifer within 1,000 years at non-zero concentrations. However, all are below the  $10^7$  risk or 0.1 HI concentration (Table 5-43).

#### 5.4.5.3 Inactive Flyash Pile and South Field

Three grid cells were selected for background modeling in the Inactive Flyash Pile and South Field. Grid cell (31,60) represents a typical South Field grid cell where waste is underlain by the glacial till. Only vadose zone and perched water vertical infiltration pathways are applicable to this grid cell. Grid cell (30,61) does not have glacial till beneath the waste. Vadose zone pathways including lateral drainage from other grid cells were simulated for the background modeling. Grid cell (29,65) receives maximum flow of perched water subsurface seeps. This cell also receives lateral drainage. Vadose zone pathways (including lateral drainage) and perched water subsurface seep pathways were modeled for grid cell (29,65). Table 5-44 shows the summary of vadose zone modeling results if waste and perched water concentrations were at background levels. Table 5-44 shows that the impact of the waste at background level is negligible on the Great Miami Aquifer within 1,000 years if waste is underlain by glacial till. However, when waste at background concentrations is left in-place where glacial till is not present, concentrations of certain CPCs exceed screening concentrations based on  $10^7$  risk or 0.1 HI (Table 5-44). In grid cell (30,61), where lateral drainage was simulated, uranium isotopes, total uranium, strontium-90, barium, and cadmium concentrations exceed screening concentrations. In grid cell (29,65), which receives perched water subsurface seep water, uranium isotopes, total uranium, radium-226, strontium-90, cadmium, chromium, lead, manganese, and molybdenum concentrations exceed screening concentrations.

#### 5.4.5.4 Active Flyash Pile

Two grid cells were selected for background modeling in the Active Flyash Pile. Grid cell (32,57) represents a typical Active Flyash Pile grid cell where flyash is underlain by the glacial till. Only vadose zone and perched water vertical infiltration pathways are applicable to this grid cell. Grid cell (32,56) does not have glacial till beneath the flyash. The vadose zone pathway including lateral drainage from other grid cells were simulated for the background modeling. Table 5-45 shows the summary of vadose zone modeling results if flyash and perched water concentrations were at background levels. Table 5-45 shows that the impact of the flyash at background level is negligible

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TABLE 5-44

**SUMMARY OF VADOSE ZONE MODELING RESULTS IF WASTE AND PERCHED WATER CONCENTRATIONS WERE AT BACKGROUND LEVELS, INACTIVE FLYASH PILE AND SOUTH FIELD OPERABLE UNIT 2 REMEDIAL INVESTIGATION REPORT FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent	Units for Groundwater Concentration	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) (pCi/g RAD)	Perched Water Background Concentration	Waste Underlain by Till		Vertical and Lateral Drainage Loading		Vertical and Lateral Drainage and Perched Water Subsurface Seep Loading			
					Predicted Maximum GMA Concentration	Critical CPC	Predicted Maximum GMA Concentration	Critical CPC	Vadose Zone Pathway Concentration	Critical CPC	Perched Water Subsurface Seep Pathway Concentration	Critical CPC
<b>RADIONUCLIDES</b>												
Lead-210	pCi/L	7.30 x 10 <sup>3</sup>	5.64 x 10 <sup>1</sup>	0.0	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Radium-224	pCi/L	1.30 x 10 <sup>1</sup>	6.62 x 10 <sup>1</sup>	0.0	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Radium-226	pCi/L	4.00 x 10 <sup>2</sup>	7.80 x 10 <sup>1</sup>	1.00 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO	6.32 x 10 <sup>-1</sup>	YES
Radium-228	pCi/L	4.80 x 10 <sup>2</sup>	8.52 x 10 <sup>1</sup>	4.50 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Strontium-90	pCi/L	1.30 x 10 <sup>1</sup>	5.60 x 10 <sup>1</sup>	0.0	0.0	NO	8.65 x 10 <sup>-1</sup>	YES	2.07 x 10 <sup>+0</sup>	YES	0.0	NO
Thorium-228	pCi/L	8.70 x 10 <sup>2</sup>	8.82 x 10 <sup>1</sup>	1.04 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Thorium-230	pCi/L	3.70 x 10 <sup>-1</sup>	1.24 x 10 <sup>+0</sup>	2.00 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Thorium-232	pCi/L	4.00 x 10 <sup>-1</sup>	8.05 x 10 <sup>-1</sup>	0.0	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Uranium-234	pCi/L	3.00 x 10 <sup>-1</sup>	8.44 x 10 <sup>-1</sup>	1.06 x 10 <sup>+0</sup>	0.0	NO	1.52 x 10 <sup>-1</sup>	YES	1.87 x 10 <sup>-2</sup>	YES	9.89 x 10 <sup>-1</sup>	YES
Uranium-235/236	pCi/L	3.00 x 10 <sup>-1</sup>	7.60 x 10 <sup>-2</sup>	0.0	0.0	NO	1.37 x 10 <sup>+0</sup>	YES	1.69 x 10 <sup>-1</sup>	YES	0.0	NO
Uranium-238	pCi/L	1.70 x 10 <sup>-1</sup>	8.44 x 10 <sup>-1</sup>	1.07 x 10 <sup>+0</sup>	0.0	NO	1.52 x 10 <sup>-1</sup>	YES	1.87 x 10 <sup>-2</sup>	YES	1.00 x 10 <sup>+0</sup>	YES
Total Uranium	ug/L	1.00 x 10 <sup>-1</sup>	2.54 x 10 <sup>+0</sup>	3.22 x 10 <sup>+0</sup>	0.0	NO	4.57 x 10 <sup>-1</sup>	YES	5.64 x 10 <sup>-2</sup>	YES	3.01 x 10 <sup>+0</sup>	NO
<b>INORGANICS</b>												
Arsenic	ug/L	5.00 x 10 <sup>-3</sup>	5.64 x 10 <sup>+0</sup>	1.50 x 10 <sup>-1</sup>	0.0	NO	0.0	NO	0.0	NO	6.44 x 10 <sup>-5</sup>	NO
Barium	ug/L	2.60 x 10 <sup>-2</sup>	6.72 x 10 <sup>-1</sup>	1.12 x 10 <sup>-2</sup>	0.0	NO	2.95 x 10 <sup>-2</sup>	YES	6.04 x 10 <sup>-1</sup>	NO	1.05 x 10 <sup>-2</sup>	NO
Beryllium	ug/L	2.00 x 10 <sup>-3</sup>	4.80 x 10 <sup>-1</sup>	1.80 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Cadmium	ug/L	1.80 x 10 <sup>+0</sup>	4.70 x 10 <sup>-1</sup>	6.00 x 10 <sup>-1</sup>	0.0	NO	3.68 x 10 <sup>+0</sup>	YES	7.52 x 10 <sup>+0</sup>	YES	5.61 x 10 <sup>-1</sup>	YES
Chromium	ug/L	1.80 x 10 <sup>-1</sup>	1.26 x 10 <sup>-1</sup>	2.00 x 10 <sup>-1</sup>	0.0	NO	0.0	NO	0.0	NO	1.87 x 10 <sup>-1</sup>	YES

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TABLE 5-44  
(Continued)

Constituent	Units for Groundwater Concentration	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) (pCi/g RAD)	Perched Water Background Concentration	Waste Underlain by Till		Vertical and Lateral Drainage Loading		Vertical and Lateral Drainage and Perched Water Subsurface Seep Loading			
					Predicted Maximum GMA Concentration	Critical CPC	Predicted Maximum GMA Concentration	Critical CPC	Vadose Zone Pathway Concentration	Critical CPC	Perched Water Subsurface Seep Pathway Concentration	Critical CPC
<b>INORGANICS</b> (Continued)												
Copper	ug/L	1.40 x 10 <sup>+2</sup>	1.34 x 10 <sup>+1</sup>	1.30 x 10 <sup>+1</sup>	0.0	NO	1.61 x 10 <sup>3</sup>	NO	0.0	NO	1.13 x 10 <sup>+1</sup>	NO
Cyanide	ug/L	7.30 x 10 <sup>+1</sup>	1.70 x 10 <sup>1</sup>	0.0	3.50 x 10 <sup>7</sup>	NO	1.10 x 10 <sup>+0</sup>	NO	7.20 x 10 <sup>+0</sup>	NO	0.0	NO
Lead	ug/L	1.50 x 10 <sup>+0</sup>	9.52 x 10 <sup>+0</sup>	2.70 x 10 <sup>+0</sup>	0.0	NO	8.98 x 10 <sup>-4</sup>	NO	0.0	NO	2.52 x 10 <sup>+0</sup>	YES
Manganese	ug/L	1.80 x 10 <sup>+1</sup>	6.21 x 10 <sup>+2</sup>	9.26 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO	8.08 x 10 <sup>+1</sup>	YES
Mercury	ug/L	1.10 x 10 <sup>+0</sup>	2.90 x 10 <sup>1</sup>	4.00 x 10 <sup>-1</sup>	0.0	NO	1.91 x 10 <sup>1</sup>	NO	1.99 x 10 <sup>-1</sup>	NO	2.39 x 10 <sup>-1</sup>	NO
Molybdenum	ug/L	1.80 x 10 <sup>+1</sup>	2.70 x 10 <sup>1</sup>	2.40 x 10 <sup>+1</sup>	0.0	NO	3.70 x 10 <sup>+0</sup>	NO	3.54 x 10 <sup>+1</sup>	YES	2.21 x 10 <sup>+1</sup>	YES
Nickel	ug/L	7.30 x 10 <sup>+1</sup>	2.19 x 10 <sup>+1</sup>	2.10 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO	0.0	NO
Vanadium	ug/L	2.00 x 10 <sup>+1</sup>	2.17 x 10 <sup>+1</sup>	1.95 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO	5.68 x 10 <sup>-5</sup>	NO

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TABLE 5-45

**SUMMARY OF VADOSE ZONE MODELING RESULTS IF WASTE AND PERCHED WATER  
 CONCENTRATIONS WERE AT BACKGROUND LEVELS, ACTIVE FLYASH PILE  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION REPORT  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Constituent	Units for Groundwater Concentrations	Screening Concentration	Subsurface Soils		Flyash Directly on Unsaturated GMA		Flyash Underlain by Till			
			Background Concentration (mg/kg non-RAD) (pCi/g RAD)	Perched Water Background Concentration	Predicted GMA Concentration	Critical CPC	Vadose Pathway		Perched Water Pathway	
							Predicted GMA Concentration	Critical CPC	Predicted GMA Concentration	Critical CPC
<b>RADIONUCLIDES</b>										
Lead-210	pCi/L	7.30 x 10 <sup>-3</sup>	5.64 x 10 <sup>-1</sup>	0.0	0.0	NO	0.0	NO	0.0	NO
Radium-224	pCi/L	1.30 x 10 <sup>-1</sup>	6.62 x 10 <sup>-1</sup>	0.0	0.0	NO	0.0	NO	0.0	NO
Radium-226	pCi/L	4.00 x 10 <sup>-2</sup>	7.80 x 10 <sup>-1</sup>	1.00 x 10 <sup>+0</sup>	0.00	NO	0.0	NO	0.0	NO
Radium-228	pCi/L	4.80 x 10 <sup>-2</sup>	8.52 x 10 <sup>-1</sup>	4.50 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO
Strontium-90	pCi/L	1.30 x 10 <sup>-1</sup>	5.60 x 10 <sup>-1</sup>	0.0	4.91 x 10 <sup>+0</sup>	YES	1.43 x 10 <sup>-6</sup>	NO	0.0	NO
Thorium-228	pCi/L	8.70 x 10 <sup>-2</sup>	8.82 x 10 <sup>-1</sup>	1.04 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO
Thorium-230	pCi/L	3.70 x 10 <sup>-1</sup>	1.24 x 10 <sup>+0</sup>	2.00 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO
Thorium-232	pCi/L	4.00 x 10 <sup>-1</sup>	8.05 x 10 <sup>-1</sup>	0.0	0.0	NO	0.0	NO	0.0	NO
Uranium-234	pCi/L	3.00 x 10 <sup>-1</sup>	8.44 x 10 <sup>-1</sup>	1.06 x 10 <sup>+0</sup>	7.90 x 10 <sup>+1</sup>	YES	6.72 x 10 <sup>-13</sup>	NO	2.37 x 10 <sup>-4</sup>	NO
Uranium-235/236	pCi/L	3.00 x 10 <sup>-1</sup>	7.60 x 10 <sup>-2</sup>	0.0	7.13 x 10 <sup>+0</sup>	YES	6.07 x 10 <sup>-13</sup>	NO	3.60 x 10 <sup>-5</sup>	NO
Uranium-238	pCi/L	1.70 x 10 <sup>-1</sup>	8.44 x 10 <sup>-1</sup>	1.07 x 10 <sup>+0</sup>	7.93 x 10 <sup>+1</sup>	YES	6.75 x 10 <sup>-13</sup>	NO	2.48 x 10 <sup>-4</sup>	NO
Total Uranium	ug/L	1.00 x 10 <sup>+1</sup>	2.54 x 10 <sup>+0</sup>	3.22 x 10 <sup>-3</sup>	2.38 x 10 <sup>+2</sup>	YES	2.03 x 10 <sup>-12</sup>	NO	1.13 x 10 <sup>-3</sup>	NO
<b>INORGANICS</b>										
Arsenic	ug/L	5.00 x 10 <sup>-3</sup>	5.64 x 10 <sup>+0</sup>	1.50 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO
Barium	ug/L	2.60 x 10 <sup>+2</sup>	6.72 x 10 <sup>+1</sup>	1.12 x 10 <sup>+2</sup>	9.70 x 10 <sup>+2</sup>	YES	0.0	NO	0.0	NO

See footnote at end of table.

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TABLE 5-45  
(Continued)

Constituent	Units for Groundwater Concentrations	Screening Concentration	Subsurface Soils Background Concentration (mg/kg non-RAD) (pCi/g RAD)	Perched Water Background Concentration	Flyash Directly on Unsaturated GMA		Flyash Underlain by Till			
					Predicted GMA Concentration	Critical CPC	Vadose Pathway Predicted GMA Concentration		Perched Water Pathway Predicted GMA Concentration	
<b>INORGANICS (Continued)</b>										
Beryllium	ug/L	2.00 x 10 <sup>-3</sup>	4.80 x 10 <sup>-1</sup>	1.80 x 10 <sup>+0</sup>	0.0	NO	0.0	NO	0.0	NO
Cadmium	ug/L	1.80 x 10 <sup>+0</sup>	4.70 x 10 <sup>-1</sup>	6.00 x 10 <sup>-1</sup>	1.77 x 10 <sup>+1</sup>	YES	0.0	NO	0.0	NO
Chromium	ug/L	1.80 x 10 <sup>+1</sup>	1.26 x 10 <sup>+1</sup>	2.00 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO
Copper	ug/L	1.40 x 10 <sup>+2</sup>	1.34 x 10 <sup>+1</sup>	1.30 x 10 <sup>+1</sup>	1.33 x 10 <sup>-1</sup>	NO	0.0	NO	0.0	NO
Cyanide	ug/L	7.30 x 10 <sup>+1</sup>	1.70 x 10 <sup>-1</sup>	0.0	4.53 x 10 <sup>+0</sup>	NO	8.39 x 10 <sup>-3</sup>	NO	0.0	NO
Lead	ug/L	1.50 x 10 <sup>+0</sup>	9.52 x 10 <sup>+0</sup>	2.70 x 10 <sup>+0</sup>	6.79 x 10 <sup>-3</sup>	NO	0.0	NO	0.0	NO
Manganese	ug/L	1.80 x 10 <sup>+1</sup>	6.21 x 10 <sup>+2</sup>	9.26 x 10 <sup>+1</sup>	1.33 x 10 <sup>-8</sup>	NO	0.0	NO	0.0	NO
Mercury	ug/L	1.10 x 10 <sup>+0</sup>	2.90 x 10 <sup>-1</sup>	4.00 x 10 <sup>-1</sup>	1.98 x 10 <sup>-1</sup>	NO	0.0	NO	0.0	NO
Molybdenum	ug/L	1.80 x 10 <sup>+1</sup>	2.70 x 10 <sup>-1</sup>	2.40 x 10 <sup>+1</sup>	1.40 x 10 <sup>+1</sup>	NO	0.0	NO	0.0	NO
Nickel	ug/L	7.30 x 10 <sup>+1</sup>	2.19 x 10 <sup>+1</sup>	2.10 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO
Thallium	ug/L	2.60 x 10 <sup>-1</sup>	4.90 x 10 <sup>-1</sup>	N/A <sup>a</sup>	0.0	NO	0.0	NO	0.0	NO
Vanadium	ug/L	2.00 x 10 <sup>+1</sup>	2.17 x 10 <sup>+1</sup>	1.95 x 10 <sup>+1</sup>	0.0	NO	0.0	NO	0.0	NO

<sup>a</sup>Not analyzed, assumed to be zero

See footnote at end of table.

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on the Great Miami Aquifer within 1,000 years if flyash is underlain by glacial till. However, when flyash at background concentrations is left in-place where glacial till is not present, concentrations of certain CPCs exceed screening concentrations based on  $10^{-7}$  risk or 0.1 HI (Table 5-45). In grid cell (32,56), where lateral drainage was simulated, uranium isotopes, total uranium, strontium-90, barium, and cadmium concentrations exceed screening concentrations.

5.4.6 Uncertainty Analysis

The groundwater fate and transport modeling performed for Operable Unit 2 is subject to uncertainty and variability due to factors such as the limited compound-specific characterization data, the inability of the models to simulate natural systems with 100 percent accuracy, and the assumptions for future site conditions for the waste units. Of these factors, the assumptions made for the future conditions of the waste units have the most impact on the modeling results. The waste units were all assumed to release contaminants to the environment without future maintenance. This is a worst-case scenario and thus, yields higher contamination levels than would be considered if a vegetative cover or cap was constructed. However, this type of assumption is the primary premise in performing a baseline risk assessment and the most conservative for the purpose of evaluating the risk from the groundwater pathway.

The inherent assumptions built into the models and the assumptions made to develop input parameters for the models also have an impact on the final results. Some general uncertainties associated with modeling can be attributed to the following sources:

- Source terms for the modeling were defined based on analytical results from the soil and water samples collected during the RI/FS field investigations. It was assumed that these concentrations are representative of CPC concentrations in the past. Although CPC concentrations in the past may have exceeded the present concentrations or some hot spots may not have been identified, use of the UCL concentration may counter the uncertainties introduced by using analytical results from the RI/FS field investigation.
- Except for uranium-238, the total mass of each constituent was estimated by multiplying the UCL by the volume of the entire waste area, thus assuming that the UCL concentration is uniformly distributed through the entire source area. This methodology introduces an obvious potential for overestimation of CPC mass.
- The total mass of uranium-238 was estimated from average concentrations in each 125 ft by 125-foot model grid block and the associated volume.
- Uncertainty is introduced into the estimation of leachate compositions even when in situ leachate analysis are available. In situ leachate samples may have missed the highest

leachate concentration in the subunit. Greater uncertainty is introduced when in situ leachate analysis are lacking. The use of TCLP data to estimate leachate composition will probably result in constituent concentrations that are greater than values expected for in situ leachate. As mentioned previously, this occurs due to the enhanced leaching by acetic acid versus rainwater. The possibility of underestimating leachate concentrations from TCLP data also exist if a soil sample used for TCLP analysis does not contain representative concentrations of CPCs. Calculations carried out to estimate contaminant concentrations using the EPA 70-year rule will introduce a large conservative uncertainty for all but the most soluble contaminants (e.g., cesium). The possibility exists to underestimate the constituents concentration when the EPA 70-year rule is applied to very soluble constituents. Even if leaching time is underestimated by a factor of two to three, peak concentration in the Great Miami Aquifer will occur very early, while concentrations of other (less soluble) contaminants is low. Therefore, if a soluble constituent was screened out (all were), risk from these CPCs will still remain below a carcinogenic risk of  $10^{-6}$  and a HI of 1 when peak concentration of risk controlling CPC is predicted in the Great Miami Aquifer.

- The selection of parameters related to the attenuation and retardation of constituents is a major uncertainty in the groundwater fate and transport analysis. The attenuation and retardation factors of every constituent except uranium were determined after an extensive literature search. It should be noted that the actual retardation factors at the FEMP may not follow the assumed literature values, particularly over the long term. Site-specific attenuation and retardation factors were used when available. The use of site-specific values were assumed to result in lower uncertainty than using literature values.
- The organic decay rates at the FEMP were determined after an extensive literature search. The actual decay rates may or may not follow the literature values because of site-specific conditions. The use of site data to determine organic decay rates would result in lower uncertainty than that resulting from the use of literature values.
- Transport through the vadose zone was approximated by using a one-dimensional model and assuming each of the two zones is homogeneous. The unsaturated seepage flow rate is a function of several parameters, such as porosity, residual saturation, and pore size distribution index. Due to the heterogeneous nature of the till, these parameters actually change from location to location and from depth to depth.
- Average properties and uniform loading in a 125 ft by 125 ft model grid block was used even when mass loading may occur through a much smaller area within the grid block. Although this may result in underestimating concentrations in the immediate vicinity of the source covering partial cell, it does not affect concentrations significantly downgradient of the source area.
- The transport models individually made assumptions regarding the fate of individual constituents within source media. However, these models were not combined or linked to consider assumptions made regarding depletion of chemicals from one model and the effect of that assumption on another model (i.e., the leaching models did not consider source depletion from surface water runoff, volatilization, or fugitive emissions, and the surface water runoff models did not consider losses via leaching). Furthermore, the direct exposure pathways to a particular source (i.e., incidental ingestion of surface soil) did not

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consider source depletion by leaching, surface water transport, or air emissions. Consequently, this assumption is considered very conservative.

These uncertainties for modeling are collectively assumed to moderately overestimate the concentrations expected in groundwater.

The following sections discuss uncertainty associated with the different models used in the fate and transport modeling.

5.4.6.1 HELP Model

The HELP model is mainly sensitive to the hydraulic conductivity of the till and waste and moderately sensitive to parameters used to define evapotranspiration and runoff. The majority of water exiting the system is lost through evapotranspiration and runoff. The remaining water becomes the seepage passing through the waste unit. Evapotranspiration is controlled by the plant cover type used. The better the vegetation, the more evapotranspiration and less infiltration takes place. Conservative assumptions were used to underestimate evapotranspiration and overestimate infiltration. For example, the vegetative cover at the Inactive Flyash Pile is excellent, but it was specified as good.

Runoff in the HELP model is controlled by the SCS runoff curve number used, derived from the ground type, vegetation type, and land use. Present conditions were used to define these factors. If future conditions change, available water for seepage could change and thus loading to the aquifer would change. For example, if vegetative cover is removed, runoff will increase, and evapotranspiration will decrease. SCS runoff curve numbers vary between 0 and 100. Table 5-46 shows that infiltration is not very sensitive to the SCS runoff curve numbers.

Uncertainty was also involved in the computation of seepage flow rates for the glacial till and the unsaturated sand and gravel layer. The unsaturated seepage flow rate is a function of the unsaturated hydraulic conductivity dependant on parameters such as porosity, residual saturation, and pore size distribution index. All of these parameters vary in a physical formation matrix and thus, cannot be fully defined for use in a numerical model. A typical HELP run for the Operable Unit 2 subunits had three layers: (1) waste/fill, (2) till, and (3) unsaturated aquifer. Thicknesses, as measured in the field

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TABLE 5-46

SENSITIVITY OF CALCULATED INFILTRATION BY HELP MODEL  
 TO THE SCS RUNOFF CURVE NUMBER  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Subunit	Zone	Base Value of SCS* Runoff Curve Number	Infiltration in Inch/Year		
			(Base -10) SCS Runoff Curve Number	Base SCS Runoff Curve Number	(Base +10) SCS Runoff Curve Number
Solid Waste Landfill	2	58	9.04	9.03	9.00
Lime Sludge Ponds	2	86	14.57	14.57	14.57
Inactive Flyash Pile and South Field	3	61	9.29	9.28	9.27
	5	61	5.81	5.81	5.76
	13	61	2.21	2.21	2.21
Active Flyash Pile	1	86	3.27	3.16	2.46
	3	86	12.84	11.56	5.48

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\*SCS - Soil Conservation Service

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program, were used. A further refinement of these layers is possible. However, zone-by-zone infiltration calculations indicate that further refinement of layers was unwarranted.

The lowest hydraulic conductivity was that of the till layer and it may control the overall infiltration. An increase in till hydraulic conductivity by two orders of magnitude does not cause a significant increase in infiltration (Table 5-47). However, a decrease in hydraulic conductivity of till by an order of magnitude causes significant reduction in infiltration (Table 5-47). It is assumed that infiltration is limited by other factors (i.e., water that is available for seepage).

Table 5-48 shows the effect of an order of magnitude change in waste hydraulic conductivity. The higher the waste hydraulic conductivity, more water infiltrates and less is available for evapotranspiration and runoff and vice versa.

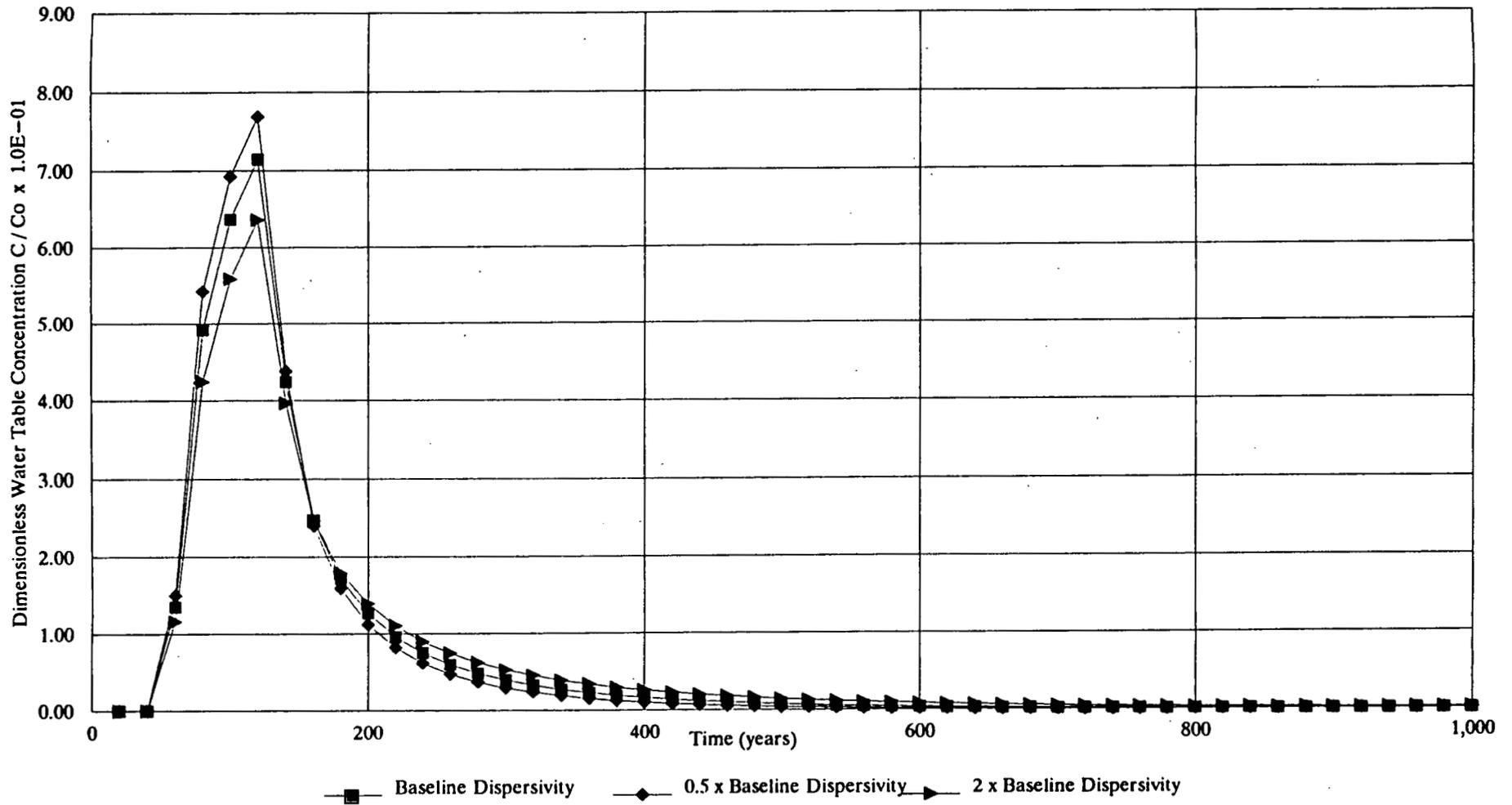
Table 5-49 shows the effect of an order of magnitude variation in the Great Miami Aquifer hydraulic conductivity. Whenever the Great Miami Aquifer is overlain by glacial till, infiltration is not at all sensitive to the hydraulic conductivity of the Great Miami Aquifer. However, when the Great Miami Aquifer is directly overlain by the waste, infiltration is moderately sensitive to the hydraulic conductivity of the Great Miami Aquifer, particularly when waste thickness is less than 2 feet (Zone 3 of Inactive Flyash Pile/South Field in Table 5-49). Otherwise, infiltration is not sensitive to the hydraulic conductivity of the Great Miami Aquifer. Selection of base case parameters used in HELP model runs for vadose zone modeling were such that worst-case infiltrations were predicted. Tables 5-46 through 5-49 indicate that either infiltration is not sensitive to estimated parameters or change in estimated parameters will not significantly increase the infiltration, although a significant decrease in infiltration is possible.

5.4.6.2 ODAST Model

The selection of the longitudinal dispersivity and parameters for biodegradation and retardation of constituents is a major uncertainty in the ODAST model. These parameters were primarily estimated from an extensive literature search. These parameters mainly influence the concentration and time required for the maximum loading to reach the aquifer. Longitudinal dispersivity has a negligible impact on the time for maximum loading to reach the aquifer (Figure 5-48). The maximum loading is moderately sensitive to dispersivity. As dispersivity increases, maximum loading decreases.

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Initial Concentration - 3819.0 ug/l  
Baseline Dispersivity = 0.14

Figure 5-48 - Sensitivity of ODAST Model Results to Dispersivity

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**TABLE 5-47**  
**SENSITIVITY OF CALCULATED INFILTRATION BY HELP MODEL**  
**TO THE HYDRAULIC CONDUCTIVITY OF THE GLACIAL TILL**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Subunit	Zone	Base Value of the Glacial Till Hydraulic Conductivity (cm/sec)	Infiltration in Inch/Year			
			Base/10 Hydraulic Conductivity	Base Hydraulic Conductivity	Base x 10 Hydraulic Conductivity	Base X 100 Hydraulic Conductivity
Solid Waste Landfill	2	1.9 x 10 <sup>-6</sup>	2.88	9.03	9.03	9.03
Lime Sludge Ponds	2	1.9 x 10 <sup>-6</sup>	3.02	14.57	14.58	14.58
Inactive Flyash Pile and South Field	13	1.4 x 10 <sup>-7</sup>	0.23	2.21	8.22	8.27
Active Flyash Pile	1	1.4 x 10 <sup>-7</sup>	0.35	3.16	11.54	11.57

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FEMP-OU02-4 DRAFT  
February 18, 1994

TABLE 5-48

SENSITIVITY OF CALCULATED INFILTRATION BY HELP MODEL  
TO THE HYDRAULIC CONDUCTIVITY OF WASTE/FILL  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Subunit	Zone	Base Value of Waste/Fill Hydraulic Conductivity (cm/sec)	Infiltration in Inch/Year		
			Base/10 Hydraulic Conductivity	Base Hydraulic Conductivity	Base x 10 Hydraulic Conductivity
Solid Waste Landfill	2	$1.1 \times 10^{-4}$	2.30	9.03	10.08
Lime Sludge Ponds	2	$1.0 \times 10^{-3}$	12.01	14.57	15.98
Inactive Flyash Pile and South Field	3	$2.0 \times 10^{-4}$	6.20	9.28	9.63
	5	$2.0 \times 10^{-4}$	1.85	5.81	7.43
	13	$2.0 \times 10^{-4}$	2.15	2.21	2.03
Active Flyash Pile	1	$1.8 \times 10^{-4}$	3.69	3.16	2.13
	3	$1.8 \times 10^{-4}$	5.11	11.56	16.05

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However, concentration at the leading edge and trailing edge of the plume is sensitive to the value of longitudinal dispersivity.

The parameters for retardation influence the time required for the maximum loading to reach the aquifer and the maximum concentration. As retardation factors increase, the maximum concentration decreases with a resulting increase in the time required for the maximum loading to reach the aquifer. (Figures 5-49 and 5-50). Figure 5-49 shows the sensitivity of the Great Miami Aquifer loading to distribution coefficient for the Great Miami Aquifer. Figure 5-50 shows the sensitivity of the Great Miami Aquifer loading to distribution coefficients for glacial till.

Decay rates significantly influence maximum concentrations. As decay rates increase (half-life decrease), the maximum concentrations decrease. Radioactive decay rates are well defined in literature and are applicable to the FEMP. However, biodegradation rates are site-specific. The movement of organic constituents to the Great Miami Aquifer is greatly impeded by high biodegradation rates (low half-lives). Figures 5-51 and 5-52 show the effect of doubling biodegradation half-life on loading to the Great Miami Aquifer when the Great Miami Aquifer is directly overlain by the waste. These figures show the effect that doubling the half-life can result in a 1 to 7 order of magnitude increase in maximum concentration, depending on the half-life itself and other parameters controlling travel time. However, one should note that concentrations are still very small (for example, less than  $10^{-7}$   $\mu\text{g/L}$  in Figure 5-51).

When the decay is combined with high retardation due to adsorption, the constituent concentration in the Great Miami Aquifer is significantly reduced. This is evident in a case where glacial till is present. Figure 5-53 shows that concentrations for bis (2-Ethylhexyl) phthalate remains below  $10^{-41}$   $\mu\text{g/L}$  even when the half-life is increased by a factor of 2.

Retardation parameters for all CPCs, except uranium and the organic decay rates at the FEMP, may not follow the literature values because of site-specific conditions. To be conservative, lowest decay rates and retardation parameters were used in the fate and transport modeling.

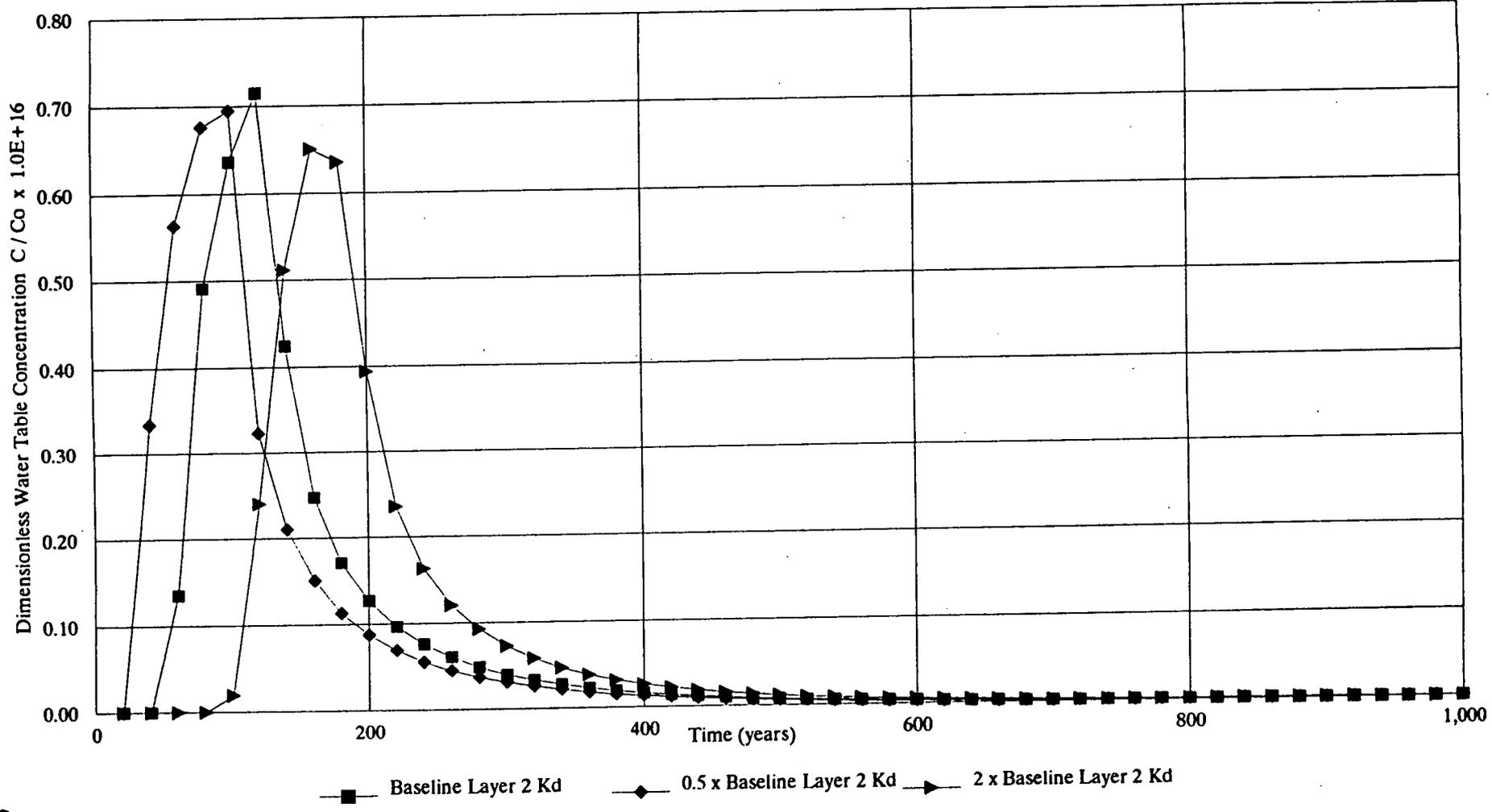
The impact of the Darcy velocity and layer thickness on the models is somewhat limited due to the derivation of the parameters themselves. Layer thicknesses were derived from Operable Unit 2 boring data, which should not vary over a large range within the operable unit. Darcy velocity is a

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Initial Concentration - 3819.0 ug/l  
 Baseline Layer 2 Kd = 1.48 ml/g

Figure 5-49 - Sensitivity of ODAST Model Results to the Great Miami Aquifer Distribution Coefficient for U-238 Inactive Flyash Pile and South Field

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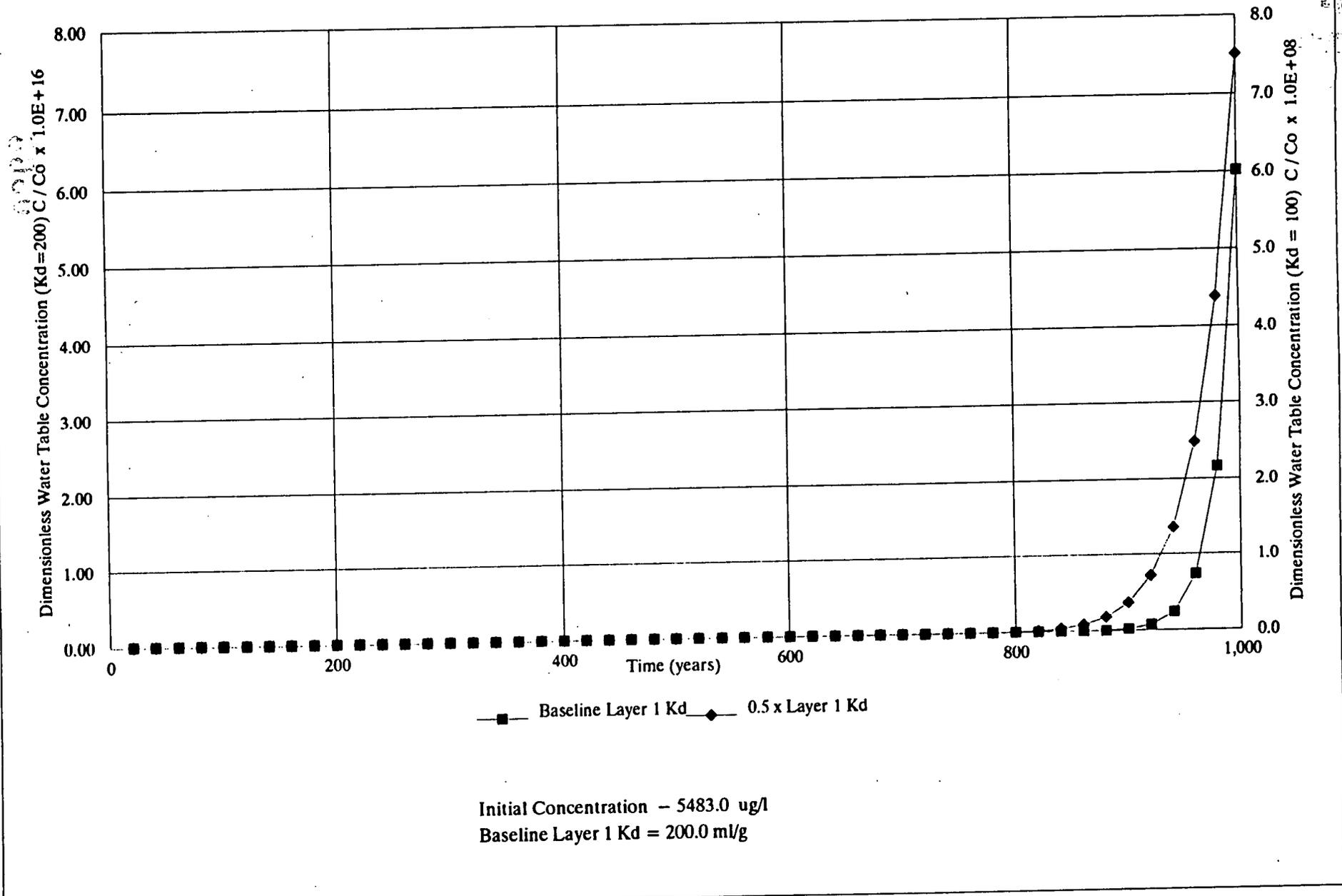
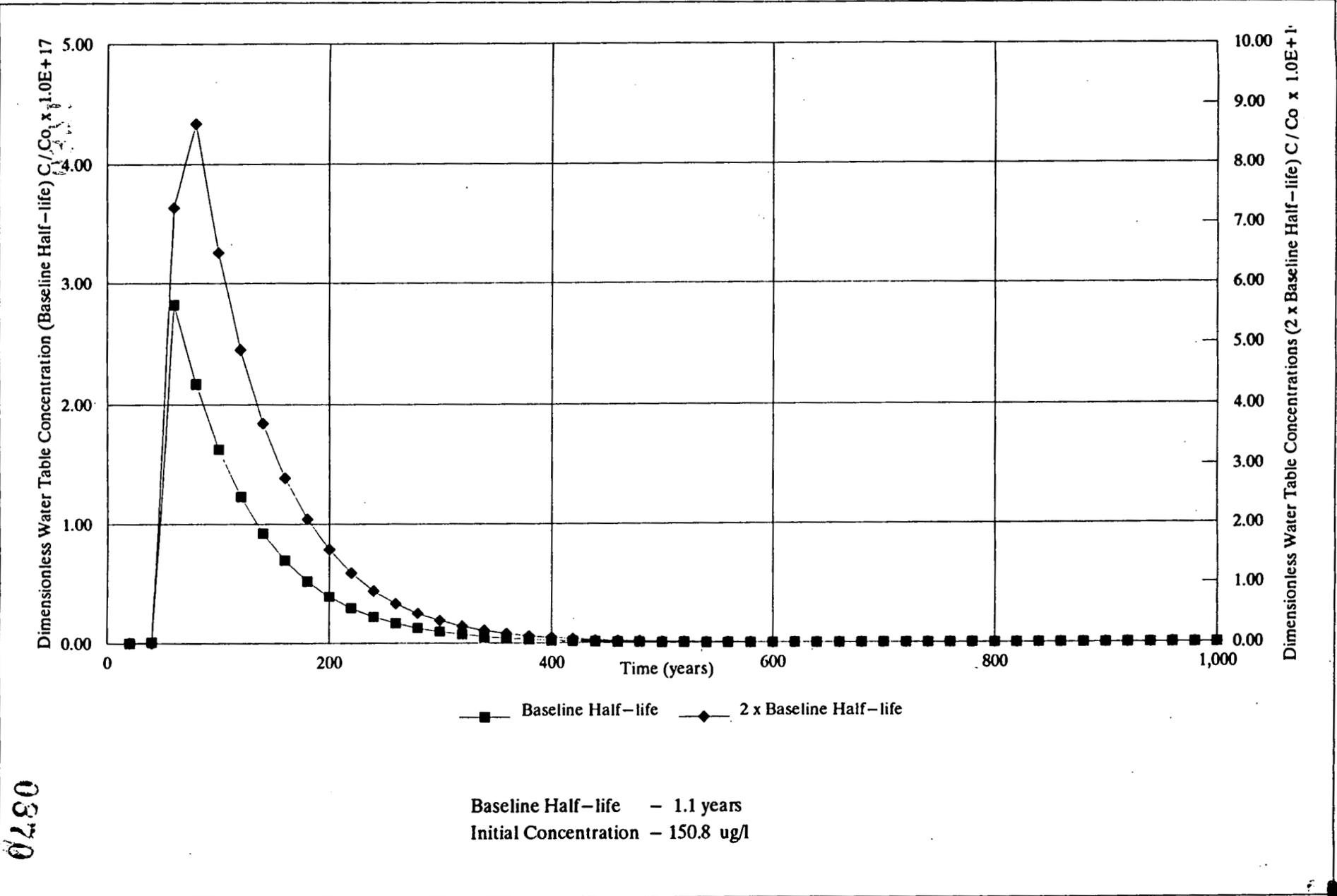


Figure 5-50 - Sensitivity of ODAST Model Results to Glacial Till Distribution Coefficient for Uranium-238, Active Flyash Pile

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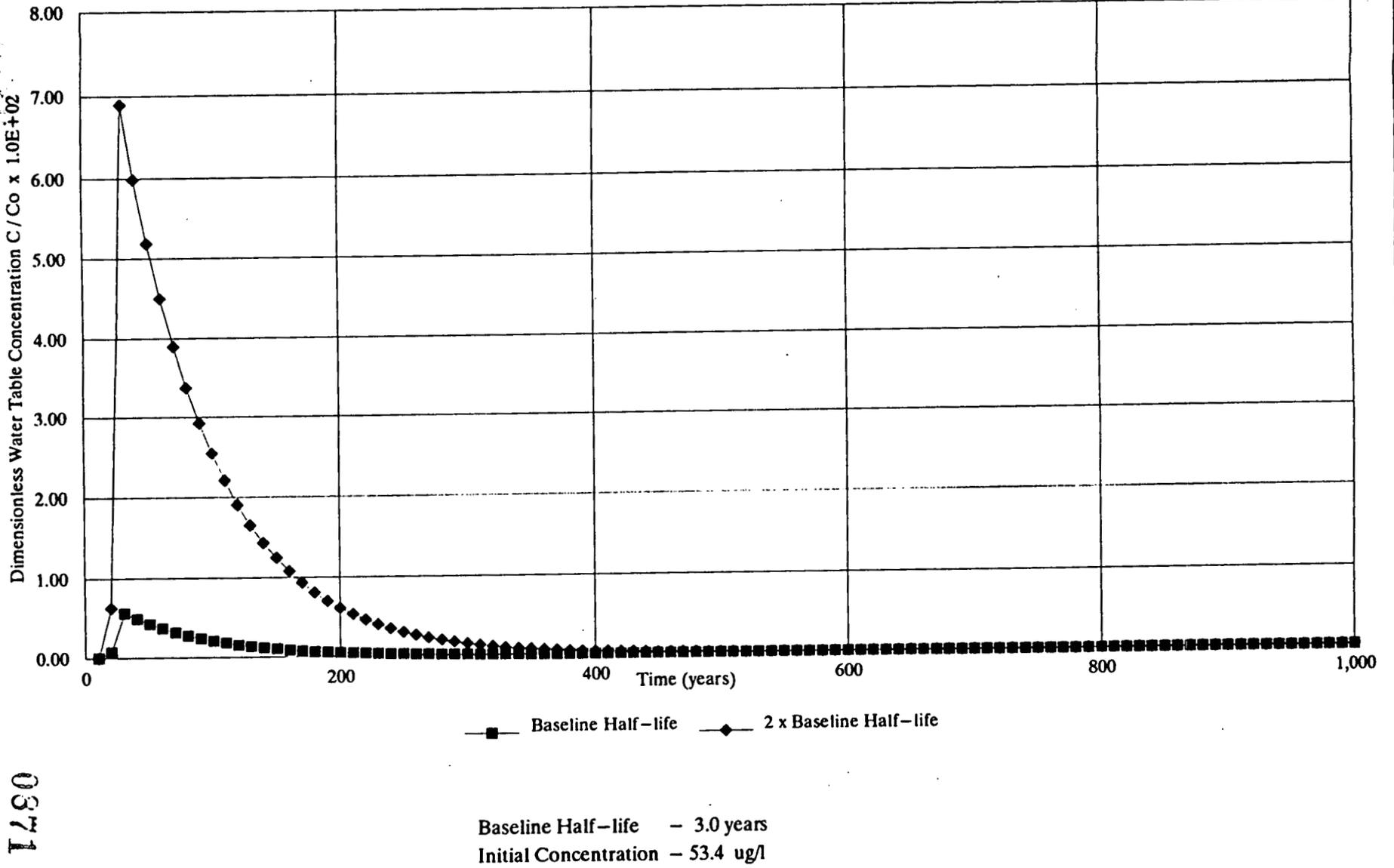


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Figure 5-51 - Sensitivity of ODAST Model Results to Biodegradation Half-life for bis(2-Ethylhexyl) Phthalate Inactive Flyash Pile and South Field

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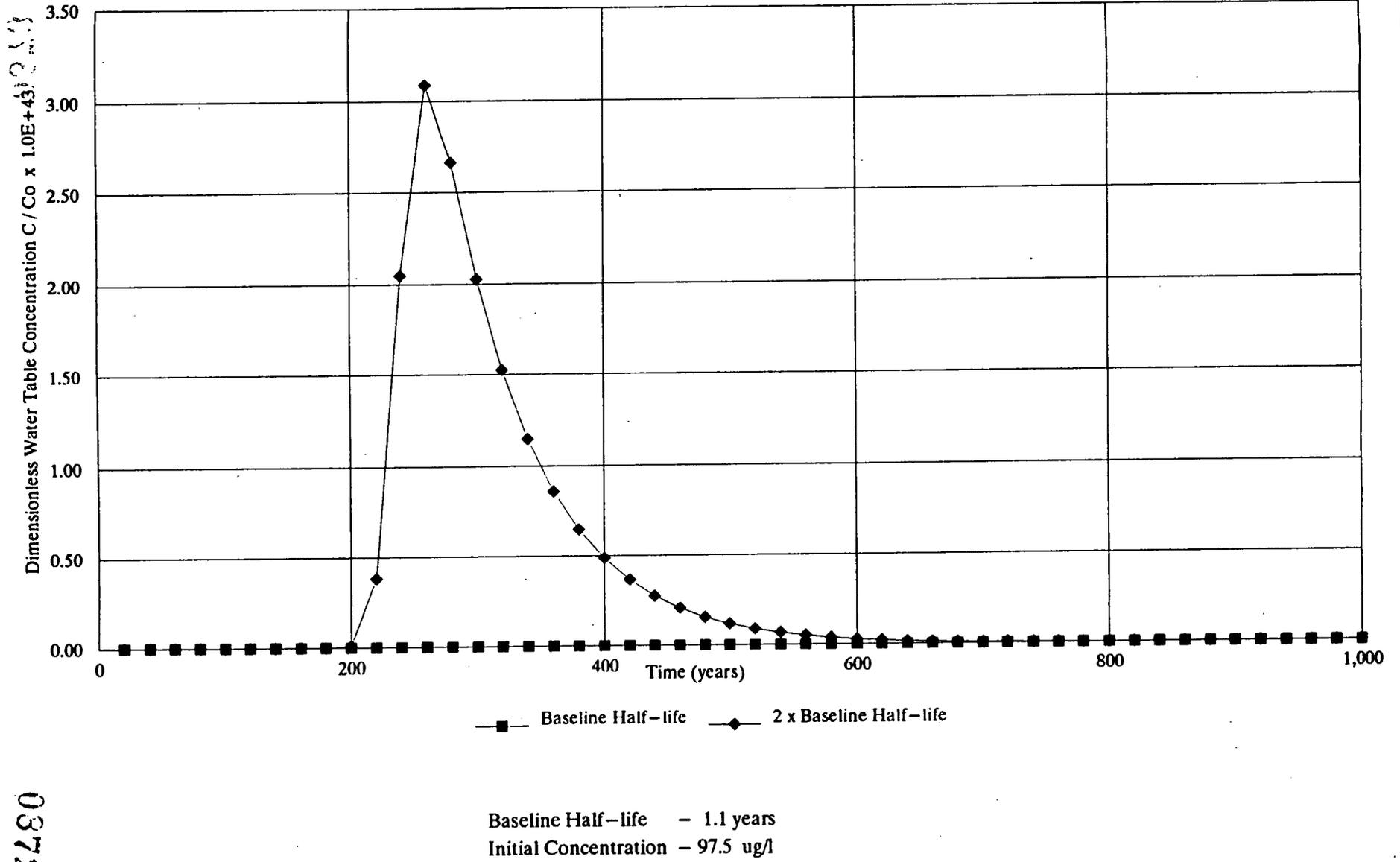
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Figure 5-52 - Sensitivity of ODAST Model to Biodegradation Half-life for 1,1,1-Trichloroethane, Active Fly Ash Pile

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Figure 5-53 - Sensitivity of ODAST Model Results to Biodegradation Half-life for bis(2-Ethylhexyl) Phthalate, Lime Sludge Ponds

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TABLE 5-49

**SENSITIVITY OF CALCULATED INFILTRATION BY HELP MODEL  
TO THE HYDRAULIC CONDUCTIVITY OF THE GREAT MIAMI AQUIFER  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Subunit	Zone	Base Value of the GMA* Hydraulic Conductivity (cm/sec)	Infiltration in Inch/Year		
			Base/10 Hydraulic Conductivity	Base Hydraulic Conductivity	Base x 10 Hydraulic Conductivity
Solid Waste Landfill	2	1.59 x 10 <sup>-2</sup>	9.03	9.03	9.03
Lime Sludge Ponds	2	1.59 x 10 <sup>-2</sup>	14.57	14.57	14.57
Inactive Flyash Pile and South Field	3	1.59 x 10 <sup>-2</sup>	8.59	9.28	10.05
	5	1.59 x 10 <sup>-2</sup>	5.81	5.81	5.81
	13	1.59 x 10 <sup>-2</sup>	2.21	2.21	2.21
Active Flyash Pile	1	1.59 x 10 <sup>-2</sup>	3.16	3.16	3.16
	3	1.59 x 10 <sup>-2</sup>	11.56	11.56	11.56

\*GMA - Great Miami Aquifer

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function of the seepage rate (calculated by the HELP model) and the formation porosity, which is fairly well defined for the media simulated by the models. The sensitivity of seepage rates and the HELP model is discussed in Section 5.4.6.1.

5.4.6.3 SWIFT III Model

Like the vadose zone models, SWIFT is mostly influenced by the solute transport parameters it uses to simulate contaminant movement through the aquifer. Of these, retardation is the least well defined and has the most impact on the fate of contaminants in the groundwater. Calibration of the SWIFT model for uranium was performed as part of the RI/FS process. The SWIFT flow model was calibrated by comparing hydraulic heads calculated by the model against heads measured in numerous monitoring wells throughout the FEMP and surrounding areas. The flow calibration is described in Appendix A-2. The SWIFT solute transport model was calibrated by simulation of uranium transport in the Great Miami Aquifer (IT 1990) over the period of operation at the FEMP. A portion of this calibration involved testing uranium retardation values to determine which value fit historical loading data and present day groundwater concentration data most accurately. Uranium retardation factors below 4 were found to transport uranium too quickly through the system and thus did not match historical data. Retardation factors above 15 were found to not match present day uranium distributions without large aquifer dispersion values, which were felt to be unrealistic. Consequently, a retardation factor of 12 ( $K_d$  of 1.48 mL/g) was found to give the best match for uranium during the modeling process. A  $K_d$  value of 1.48 mL/g for uranium was also found to match the observed data for Operable Unit 2 and was used in uranium fate and transport modeling.

The major parameter affecting solute transport is retardation. Higher retardation factors delay the appearance of a concentration peak at a receptor almost proportionately. Experimental determination of retardation factors for CPCs, which have relatively large source terms and are relatively toxic, is an important factor in reducing uncertainty in solute transport.

5.5 AIR TRANSPORT MODELING

An air transport analysis was conducted for Operable Unit 2 to support the determination of the fate and transport of contaminants in the baseline risk assessment. The objective of the air transport analysis is to estimate the maximum on-site and off-site ambient air concentrations for the current and future emission source terms, which are described in the conceptual model for Operable Unit 2. This section provides an overview of the methodology, input data, and results of the analysis. Appendix A

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contains more detail regarding the technical approach, calculation procedures, and model output associated with the air transport analysis.

The air transport analysis was conducted in accordance with EPA guidelines (EPA 1989e) for air quality dispersion modeling, using on-site data whenever possible. If on-site information was not available, conservative assumptions were made to provide an estimate of the realistic worse case emission from the Operable Unit 2 areas.

Two emission models and an air dispersion model were used to estimate air emissions from each source and to calculate annual average concentrations and deposition rates at the receptor locations. One emission model predicted the quantity of exposed soil that would be resuspended by the wind, and the other emission model estimated the flux of radon-222 gas from soil and waste containing radium-226. The air dispersion model accounted for dispersion and dilution of the contaminants under defined meteorological conditions such as wind speed and direction, atmospheric stability, and mixing height. The primary meteorological parameters used were collected from an on-site meteorological station.

The methodology used to determine the maximum on-site and off-site concentrations included three principal tasks. The first task was to determine the contaminant emission rate for each subunit within Operable Unit 2. Second, calculate downwind contaminant concentrations using representative source emission, meteorological and receptor data, and an EPA-approved air dispersion model. The air dispersion model used in this analysis was the Industrial Source Complex Long Term 2 (ISCLT2) model. Third, model calculations of on-site and off-site concentrations were organized into tabular and graphical summaries for use in the baseline risk assessment.

5.5.1 Emission Source Terms

The conceptual model emission scenarios for the Operable Unit 2 air transport analysis represented two physical configurations of the Operable Unit 2 area. The two configurations examined are a "current" emissions source term for Operable Unit 2 and conservative "future" source term which is represented by an on-site farmer scenario where certain subunits undergo a physical change that affects the subunit emissions.

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For the current emissions source term, the Operable Unit 2 subunit areas are assumed to have the following physical conditions:

- The Solid Waste Landfill, South Sludge Pond, Inactive Flyash Pile, and South Field are assumed to be 85 percent covered by vegetation.
- The North Sludge Pond is assumed to have 10 percent of the surface area covered with water and only 5 percent covered by vegetation. The remaining area of the North Sludge Pond is assumed to be non-vegetated and susceptible to wind erosion; however, much of the surface soil is crusted and thus, has a limited erosion potential.
- The Active Flyash Pile is assumed to have no vegetative cover. However, the pile has limited erosion potential because a dust suppressant is used to control wind erosion and most of the material is composed of large agglomerations of flyash material.

For the future emissions source term, the only changes that occur to the subunit emissions involve the Solid Waste Landfill and the South Field. Both of these subunits are assumed to be used for the farming of crops for human and animal consumption. On an annual basis, these subunits are assumed to have crops for six months of the year to simulate the growing season, while, for the remaining six months of the year, both subunits are assumed to have no vegetation. This land use scenario results in the assumption of a 50 percent vegetation cover factor. This assumption of the crop growing scenario is consistent with local agricultural practices. The emissions for all other Operable Unit 2 subunits remain the same as described above in the current emissions source term.

5.5.2 Air Transport Contaminants

The constituents associated with Operable Unit 2 were identified based on surface soil and waste area material sampling performed during the RI. The upper 95 percent confidence limit on the mean for constituent concentrations in the surface soil and waste area were used in the air dispersion modeling to calculate annual average constituent concentrations in the air for the current and future emission source terms.

A review of the RI database indicated that the Operable Unit 2 waste area materials include organics, inorganics, and radionuclides. The principal sources of constituent emissions were assumed to be associated with the wind erosion of surface soil and evolution of radon-222 from radium-226 decay for each Operable Unit 2 subunit. The volatilization of organics from the surface soils and the waste area materials was evaluated as a possible source in both emission source terms. All of the organic

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compounds found in the RI database for the waste area materials are considered to have relatively low vapor pressures and do not currently represent a significant source term on an annual basis. Also, over time, the volatilization rate for the organics should gradually decrease and not be a significant source for the future. As a result, the volatilization of organics was not considered as a release mechanism for organics; however, particulate transport of organics was modeled.

A complete listing of the surface soil activity levels (pCi/g) for radionuclides and concentrations (mg/kg) for inorganics and organics used in the air transport modeling analysis for the Operable Unit 2 current and future emission source terms are shown in Tables 5-50 through 5-54.

5.5.3 Constituent Emission Rate Estimates

Constituent emissions from the Operable Unit 2 subunit areas were assumed to occur primarily as a result of the wind erosion of surface soil particulate matter. In calculating the wind erosion emission rate for each subunit in this analysis, the constituents were assumed to be part of the particulate. Gaseous radon-222 was assumed to be emitted from soil and material containing radium-226. The concentration or activity level of each constituent within the subunit surface soil was obtained from the RI database. The air transport analysis assumed that the constituent concentration or activity level was uniformly distributed throughout each individual waste area. The methodologies used to calculate wind erosion and gaseous radon emission rates are discussed below. Appendix A provides additional details, examples of particulate matter wind erosion emission rate calculations, and radon-222 emission modeling output.

5.5.3.1 Contaminated Particulate Matter

The methodology used to determine the wind erosion emission rate requires an evaluation of the physical characteristics of each subunit surface area. The physical characteristics that affect wind erosion are the surface soil particle size distribution, vegetative cover, and condition of the surface soil. Information regarding the particle size distribution and modal diameter for each subunit was obtained from Operable Unit 2 surface soil samples.

The technical approach used for estimating particulate emissions due to wind erosion was based on the concept of "threshold friction velocity" (TFV). This approach is recommended by EPA for estimating wind erosion rates from flat soil surfaces at hazardous waste sites (EPA 1985). The approach assumes that a minimum wind speed is required for the resuspension of particulate matter

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TABLE 5-50

**SURFACE SOIL CONTAMINATION ACTIVITY LEVELS  
AND CONCENTRATIONS FOR THE ACTIVE FLYASH PILE  
CURRENT AND FUTURE EMISSION SOURCE TERMS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Contaminant	Current and Future Contamination Parameter
<b>RADIOLOGICAL (pCi/g)</b>	
Neptunium 237	5.5
Plutonium 238	0.7
Plutonium 239/240	0.3
Radium 226	4.6
Radium 228	3.2
Strontium 90	4.5
Thorium 228	3.8
Thorium 230	3.7
Thorium 232	2.7
Uranium 234	3.6
Uranium 235/236	0.2
Uranium 238	3.6
<b>INORGANICS/ORGANICS (mg/kg)</b>	
Arsenic	89.8
Barium	253.9
Beryllium	4.7
Chromium	13.3
Cobalt	18.8
Copper	73.8
Cyanide	0.3
Lead	55.4
Molybdenum	8.6
Nickel	40.1
Selenium	5.9
Thallium	2.7
Toluene	0.1
Vanadium	50.2
Zinc	78.3

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TABLE 5-51

**SURFACE SOIL CONTAMINATION ACTIVITY LEVELS  
AND CONCENTRATIONS FOR THE INACTIVE FLYASH PILE  
CURRENT AND FUTURE EMISSION SOURCE TERMS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Contaminant	Current and Future Contamination Parameter
<b>RADIOLOGICAL (pCi/g)</b>	
Cesium 137	4.62E-01
Neptunium 237	7.97E-01
Plutonium 238	8.10E-02
Plutonium 239/240	2.10E-02
Radium 226	1.98E+00
Radium 228	2.24E+00
Strontium 90	8.70E-01
Thorium 228	2.71E+00
Thorium 230	2.77E+00
Thorium 232	2.33E+00
Uranium 234	8.65E+00
Uranium 235/236	4.20E-01
Uranium 238	8.87E+00
<b>INORGANICS (mg/kg)</b>	
Arsenic	3.32E+01
Beryllium	2.27E+00
Cadmium	3.10E+00
Chromium	1.14E+01
Lead	2.39E+01
<b>ORGANICS(mg/kg)</b>	
Carbazole	5.10E-01
Dibenzo(a,h)anthracene	2.20E+00
<b>OTHER(mg/kg)</b>	
Total Uranium	2.62E+01

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**TABLE 5-52**  
**SURFACE SOIL CONTAMINATION ACTIVITY LEVELS**  
**AND CONCENTRATIONS FOR THE SOUTH FIELD**  
**CURRENT AND FUTURE EMISSION SOURCE TERMS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Contaminant	Current and Future Contamination Parameter
<b>RADIOLOGICAL (pCi/g)</b>	
Cesium 137	4.99E-01
Neptunium 237	2.28E-01
Plutonium 238	1.20E-01
Plutonium 239/240	5.10E-02
Radium 226	3.08E+01
Radium 228	3.88E+00
Strontium 90	1.00E+00
Technecium 99	1.42E+02
Thorium 228	4.41E+00
Thorium 230	1.38E+01
Thorium 232	3.99E+00
Uranium 234	8.66E+00
Uranium 235/236	4.19E-01
Uranium 238	9.31E+00
<b>INORGANICS(mg/kg)</b>	
Arsenic	7.27E+00
Beryllium	9.42E-01
Chromium	1.39E+01
Lead	2.46E+01
<b>ORGANICS(mg/kg)</b>	
Aroclor-1254	8.90E-02
Aroclor-1260	5.20E-02
Dieldrin	1.00E-02
Benzo(a)anthracene	5.50E+00
Benzo(a)pyrene	9.40E+00
Benzo(b)fluoranthene	6.20E+00
Benzo(k)fluoranthene	7.30E+00
Carbazole	1.70E-01
Chrysene	6.00E+00
Dibenzo(a,h)anthracene	1.90E+00
Indeno(1,2,3-cd)pyrene	6.00E+00
bis(2-ethylhexyl)phthalate	1.10E-01
Methylene chloride	5.00E-03
<b>OTHER (mg/kg)</b>	
Total Uranium	2.96E+01

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**TABLE 5-53**  
**SURFACE SOIL CONTAMINATION ACTIVITY LEVELS**  
**AND CONCENTRATIONS FOR THE SOLID WASTE LANDFILL**  
**CURRENT AND FUTURE EMISSION SOURCE TERMS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Contaminant	Current and Future Contamination Parameter
<b>RADIOLOGICAL (pCi/g)</b>	
Cesium 137	2.67E-01
Neptunium 237	1.19E+00
Plutonium 238	7.72E-01
Plutonium 239/240	8.20E-02
Radium 226	1.90E+00
Radium 228	1.68E+00
Strontium 90	9.55E-01
Thorium 228	1.63E+00
Thorium 230	6.48E+00
Thorium 232	1.51E+00
Uranium 234	4.21E+01
Uranium 235/236	2.84E+00
Uranium 238	7.72E+01
<b>INORGANICS (mg/kg)</b>	
Arsenic	6.67E+00
Beryllium	6.98E-01
Cadmium	8.50E-01
Chromium	1.55E+01
Lead	1.90E+01
<b>ORGANICS (mg/kg)</b>	
4,4-DDE	1.20E-02
Benzo(a)anthracene	3.86E-01
Benzo(a)pyrene	3.40E-01
Benzo(b)fluoranthene	7.10E-01
Benzo(k)fluoranthene	8.85E-01
bis(2-ethylhexyl)phthalate	4.80E-02
Carbazole	7.70E-02
Chrysene	4.53E-01
Dibenzo(a,h)anthracene	2.00E-01
Indeno(1,2,3-cd)pyrene	4.80E-01
<b>OTHER (mg/kg)</b>	
Total Uranium	2.25E+02

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**TABLE 5-54**  
**SURFACE SOIL CONTAMINATION ACTIVITY LEVELS**  
**AND CONCENTRATIONS FOR THE NORTH AND SOUTH LIME**  
**SLUDGE POND CURRENT AND FUTURE EMISSION SOURCE TERMS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Contaminant	Current and Future Contamination Parameter
<b>RADIOLOGICAL (pCi/g)</b>	
Cesium 137	7.02E-01
Neptunium 237	7.20E-01
Plutonium 238	5.76E-01
Plutonium 239/240	1.35E-01
Radium 226	1.92E+00
Radium 228	1.64E+00
Strontium 90	7.85E-01
Thorium 228	2.91E+00
Thorium 230	4.48E+01
Thorium 232	1.31E+00
Uranium 234	2.10E+01
Uranium 235/236	1.74E+00
Uranium 238	7.14E+01
<b>INORGANICS (mg/kg)</b>	
Arsenic	7.19E+00
Beryllium	1.52E+00
Cadmium	1.20E+00
Chromium	1.66E+01
Lead	2.76E+01
<b>ORGANICS (mg/kg)</b>	
Aroclor-1254	5.90E+02
Benzo(a)anthracene	9.10E-01
Benzo(a)pyrene	1.10E+00
Benzo(b)fluoranthene	1.00E+00
Benzo(k)fluoranthene	8.00E-01
bis(2-ethylhexyl)phthalate	1.00E+01
Carbazole	1.40E-01
Chrysene	1.10E+00
Dibenzo(a,h)anthracene	3.20E-01
Indeno(1,2,3-cd)pyrene	7.20E-01
<b>OTHER (mg/kg)</b>	
Total Uranium	2.14E+02

from the soil and that the emission rate is a function of two factors, specifically; a) the TFV and b) the erosion potential of the soils. The lower the TFV is, the higher the potential for erosion of the soil by the wind. Depending on the characteristics of the surface soil, an area source can be defined as having either a "limited" or "unlimited" erosion potential.

Various steps are required in the wind erosion emission rate calculation process using the TFV concept. These steps are described in further detail in Appendix A, along with the calculation used to determine the wind erosion emission rate for Operable Unit 2 waste area sources. The Operable Unit 2 subunit areas have a variety of surface covers that include partial water cover, no vegetative cover, and almost complete vegetative cover.

#### 5.5.3.2 Radon-222

Total emissions of radon-222 were calculated from surface and subsurface soil radium-226 concentrations in each Operable Unit 2 subunit. The radon-222 emissions were calculated using the RAECOM model algorithms developed for the NRC (NRC 1984). The model converts radium-226 soil concentrations (in pCi/g) to radon-222 emission fluxes (in pCi/s/m<sup>2</sup>). The basic equations are presented in the Risk Assessment Work Plan Addendum (DOE 1992a). The RAECOM model input parameters and output are presented in Appendix A.

#### 5.5.4 Air Dispersion Modeling

The air transport modeling was conducted using a specific modeling protocol. The objective of the protocol was to use the most representative source area emissions data and on-site meteorological data in an air quality dispersion model to calculate annual average concentrations for all CPCs in the current and future emission scenarios. The modeling protocol is based on EPA modeling guidelines (EPA 1989e and EPA 1986b), the Fernald Particulate Modeling Policy (FERMCO 1993), and a recent site inspection tour of each Operable Unit 2 subunit. All modeling results reported in the air transport analysis are for the worst case annual meteorological period.

A general overview of the modeling protocol is discussed below. The reader is referred to Appendix A for more specific details of model input data and model assumptions.

5.5.4.1 On-Site Meteorological Data

Meteorological and climatological data are required as input for the ISCLT2 dispersion model. This data includes wind speed, wind direction, atmospheric stability, ambient air temperature, and mixing height. The principal source of meteorological data was the on-site FEMP meteorological monitoring system, which was installed in 1986. Other supplementary meteorological and climatological data, not available from the on-site system, was obtained from the National Weather Service (NWS) Office at the Greater Cincinnati-Northern Kentucky International Airport and from the James A. Cox International Airport at Dayton, Ohio. Climatological data regarding the annual average temperature and precipitation was obtained from both the FEMP on-site station and the NWS office at the Greater Cincinnati-Northern Kentucky International Airport. Upper air data, in support of determining mixing heights, was obtained from the James A. Cox International Airport at Dayton, Ohio.

A review of meteorological data measured and recorded at the FEMP monitoring station during the 1987-1992 period indicates that the prevailing wind direction is from the southwest. The on-site meteorological data was processed into a frequency distribution format known as the STability ARray (STAR) format for input into the ISCLT2 model. The STAR data summaries for the five years 1987, 1988, 1989, 1991, and 1992 were used in the air transport modeling analysis. These five annual periods were chosen because they attained the highest data recovery levels since the start of the on-site meteorological monitoring program. The collection efficiency or completeness of the 1990 meteorological parameters was approximately 76 percent (DOE 1993d). Therefore, the 1990 data was not used for dispersion modeling since the collection efficiency was well below the 90 percent EPA guideline (EPA 1987c). The STAR summaries for each annual period are provided in Appendix A. Graphical illustrations of the wind roses for each of the five annual periods are also given in Appendix A.

5.5.4.2 Modeling Approach

The ISCLT2 model was used to calculate annual average concentrations and deposition rates using a number of model options that allow the user to specify the atmospheric conditions of constituent dispersion, the type of emission source, and source emission parameters.

The selection of rural or urban dispersion coefficients for use in the ISCLT2 model was based on a land use analysis conducted previously for the FEMP. The land use types within a three-km radius of Operable Unit 2 were estimated from a review of USGS maps and a site survey of the area. Based

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on the review, no more than 10 percent of the area within a three-km radius of Operable Unit 2 can be classified as industrial, commercial, or compact residential. Therefore, the area was classified as rural for the purpose of dispersion modeling, and rural dispersion coefficients were selected for use in the modeling.

All source emissions were assumed to result from the resuspension of particulate matter due to wind erosion. All Operable Unit 2 source areas were defined as area sources in the model, and emission rates were in the units of grams (g) or pCi per second per square meter.

Because of the large number of constituents that were addressed in this analysis, each subunit area source was modeled using a wind erosion unit emission rate. Individual subunit constituent data from the RI database surface soils was then used in conjunction with the wind erosion unit emission rate dispersion coefficients to calculate specific constituent concentrations at all receptor locations. All maximum constituent concentrations for on-site and off-site receptors are reported for the worst case annual meteorological period. Further detailed information regarding the modeling process can be found in Appendix A.

Receptor Network

The maximum annual constituent concentrations resulting from both the current and future emission scenarios were determined by having the ISCLT2 model calculate concentrations at a number of receptor locations in various directions and distances from the Operable Unit 2 waste areas. Receptor points included locations within and outside the FEMP boundary.

The receptor network for the modeling demonstration consisted of a 4.3 km. x 3.0 km. grid, based on a 50 meter separation between each receptor. This resulted in a total of 5, 246 receptor locations. The origin of the receptor network is located approximately 100 meters west of the northwestern FEMP boundary at State Planar coordinate 482,752.690 ft. north and 1,376,778.760 ft. east. All receptors and area emission sources were assumed to be at the same elevation.

A discrete receptor network was also used to calculate annual average concentrations at sensitive locations. The discrete receptor network included four elementary schools, one middle/high school, and one day nursery identified below:

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- (1) Crosby Elementary School
- (2) Morgan Elementary School
- (3) Elda Elementary School
- (4) St. John Elementary School
- (5) Ross Middle/High School
- (6) Ross County Day Nursery

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Additional information regarding the air transport receptor network, including an illustration of the spatial coverage of the receptor network relative to the FEMP, can be found in Appendix A.

5.5.5 Solid Waste Landfill

Airborne concentrations for constituents resulting from the Solid Waste Landfill are presented in Table 5-55. Annual average concentrations were calculated for both the current and future emission source terms.

For the current emission source term, the maximum annual average concentrations were calculated to occur from the Solid Waste Landfill subunit. The constituents with the highest calculated concentrations are radon-222, uranium-238, lead, and benzo(k)fluoranthene. The respective maximum annual average concentrations for these constituents were  $1.6 \times 10^0$  pCi/m<sup>3</sup>,  $2.31 \times 10^{-4}$  pCi/m<sup>3</sup>,  $5.70 \times 10^{-8}$  mg/m<sup>3</sup>, and  $66 \times 10^{-9}$  mg/m<sup>3</sup>. The maximum annual average concentration for Total Uranium was  $6.76 \times 10^{-7}$  mg/m<sup>3</sup>.

Air transport modeling results for the Solid Waste Landfill future source terms are also shown in Table 5-55. Except for radon-222, these values are generally 1 to 2 orders of magnitude higher than calculated for the current scenario because of the land use assumptions. For the future source term, the Solid Waste Landfill is assumed to be used to grow crops. As in the current emissions source term, the constituents with the highest annual average concentrations on site and off site were radon-222, uranium-238, lead, and benzo(k)fluoranthene; however, the concentration values are higher due to the change in the wind erosion emission rate source term. Maximum annual average concentrations were  $1.60 \times 10^0$  pCi/g,  $7.02 \times 10^{-3}$  pCi/m,  $1.73 \times 10^{-6}$  mg/m<sup>3</sup>, and  $8.05 \times 10^{-8}$  mg/m<sup>3</sup>, respectively. The maximum future source terms concentration of total uranium was calculated to be  $2.05 \times 10^{-5}$ . Radon-222 emission rates and concentrations are the same for the current and future cases since the scenario assumptions do not affect gaseous contaminant emissions.

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TABLE 5-55

**MAXIMUM ANNUAL AIR CONCENTRATIONS RESULTING FROM THE SOLID WASTE  
LANDFILL FOR THE CURRENT AND FUTURE EMISSION SOURCE TERMS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	Current Source Term			Future Source Term		
	Maximum Annual Exposure Point Concentration			Maximum Exposure Point Concentrations		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>	On-Subunit <sup>d</sup>	On-Site <sup>e</sup>	Off-Site <sup>f</sup>
<b>RADIOLOGICAL (pCi/m<sup>3</sup>)</b>						
Cesium 137	8.01E-07	8.01E-07	1.32E-08	2.43E-05	2.43E-05	4.01E-07
Neptunium 237	3.57E-06	3.57E-06	5.87E-08	1.08E-04	1.08E-04	1.78E-06
Plutonium 238	2.32E-06	2.32E-06	3.81E-08	7.03E-05	7.03E-05	1.16E-06
Plutonium 239/240	2.46E-07	2.46E-07	4.05E-09	7.46E-06	7.46E-06	1.23E-07
Radium 226	5.69E-06	5.69E-06	9.37E-08	1.73E-04	1.73E-04	2.85E-06
Radium 228	5.04E-06	5.04E-06	8.30E-08	1.53E-04	1.53E-04	2.52E-06
Radon 222	1.60E+00	1.60E+00	2.63E-02	1.60E+00	1.60E+00	2.63E-02
Strontium 90	2.87E-06	2.87E-06	4.72E-08	8.69E-05	8.69E-05	1.43E-06
Thorium 228	4.88E-06	4.88E-06	8.03E-08	1.48E-04	1.48E-04	2.44E-06
Thorium 230	1.94E-05	1.94E-05	3.20E-07	5.89E-04	5.89E-04	9.71E-06
Thorium 232	4.53E-06	4.53E-06	7.46E-08	1.38E-04	1.38E-04	2.27E-06
Uranium 234	1.26E-04	1.26E-04	2.08E-06	3.83E-03	3.83E-03	6.32E-05
Uranium 235/236	8.51E-06	8.51E-06	1.40E-07	2.58E-04	2.58E-04	4.26E-06
Uranium 238	2.31E-04	2.31E-04	3.81E-06	7.02E-03	7.02E-03	1.16E-04
<b>INORGANICS (mg/m<sup>3</sup>)</b>						
Arsenic	2.00E-08	2.00E-08	3.29E-10	6.07E-07	6.07E-07	1.00E-08
Beryllium	2.09E-09	2.09E-09	3.45E-11	6.35E-08	6.35E-08	1.05E-09
Cadmium	2.55E-09	2.55E-09	4.20E-11	7.74E-08	7.74E-08	1.28E-09
Chromium	4.64E-08	4.64E-08	7.64E-10	1.41E-06	1.41E-06	2.32E-08
Lead	5.70E-08	5.70E-08	9.39E-10	1.73E-06	1.73E-06	2.85E-08

See footnotes at end of table

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TABLE 5-55  
(Continued)

Parameter	Current Source Term			Future Source Term		
	Maximum Annual Exposure Point Concentration			Maximum Exposure Point Concentrations		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>	On-Subunit <sup>d</sup>	On-Site <sup>e</sup>	Off-Site <sup>f</sup>
<b>ORGANICS (mg/m<sup>3</sup>)</b>						
4,4-DDE	3.60E-11	3.60E-11	5.93E-13	1.09E-09	1.09E-09	1.80E-11
Benzo(a)anthracene	1.16E-09	1.16E-09	1.91E-11	3.51E-08	3.51E-08	5.79E-10
Benzo(a)pyrene	1.02E-09	1.02E-09	1.68E-11	3.09E-08	3.09E-08	5.10E-10
Benzo(b)fluoranthene	2.13E-09	2.13E-09	3.51E-11	6.46E-08	6.46E-08	1.07E-09
Benzo(k)fluoranthene	2.66E-09	2.66E-09	4.37E-11	8.05E-08	8.05E-08	1.33E-09
bis(2-Ethylhexyl)phthalate	1.44E-10	1.44E-10	2.37E-12	4.37E-09	4.37E-09	7.20E-11
Carbazole	2.31E-10	2.31E-10	3.80E-12	7.01E-09	7.01E-09	1.16E-10
Chrysene	1.36E-09	1.36E-09	2.24E-11	4.12E-08	4.12E-08	6.80E-10
Dibenzo(a,h)anthracene	6.00E-10	6.00E-10	9.88E-12	1.82E-08	1.82E-08	3.00E-10
Indeno(1,2,3-cd)pyrene	1.44E-09	1.44E-09	2.37E-11	4.37E-08	4.37E-08	7.20E-10
<b>OTHER (mg/m<sup>3</sup>)</b>						
Total Uranium	6.76E-07	6.76E-07	1.11E-08	2.05E-05	2.05E-05	3.38E-07

<sup>a</sup>Within the boundary of the subunit itself, 3.0 ug/m<sup>3</sup>, approximately 30 meters southeast from the center of Solid Waste Landfill.

<sup>b</sup>Between the subunit boundary and the FEMP boundary, 3.0 ug/m<sup>3</sup>, approximately 75 meters east-northeast from the center of Solid Waste Landfill.

<sup>c</sup>At or beyond the FEMP boundary, 0.0494 ug/m<sup>3</sup>, approximately 600 meters north - northeast from the center of the Solid Waste Landfill.

<sup>d</sup>Within the boundary of the subunit itself, 91 ug/m<sup>3</sup>, approximately 30 meters southeast from the center of Solid Waste Landfill.

<sup>e</sup>Between the subunit boundary and the FEMP boundary, 91 ug/m<sup>3</sup>, approximately 75 meters east - northeast from the center of Solid Waste Landfill.

<sup>f</sup>At or beyond the FEMP boundary, 1.5 ug/m<sup>3</sup>, approximately 600 meters north - northeast from the center of the Solid Waste Landfill.

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5.5.6 Lime Sludge Ponds

The results of air transport modeling for the Lime Sludge Ponds are presented in Table 5-56. This table lists the maximum annual average concentrations for the current and future emission source terms. Since the conceptual model assumes no alteration in the physical condition or use of the sludge ponds, there is no change in the source term for the two emission scenarios. The modeling results in Table 5-56 reflect the calculated impact for both sludge ponds.

The constituents with the highest annual average concentrations for the North and South Sludge Ponds were radon-222, uranium-238, lead, and Aroclor-1254. The respective concentrations calculated for each of these constituents were  $3.93 \times 10^{-1}$  pCi/m<sup>3</sup>,  $1.86 \times 10^{-3}$  pCi/m<sup>3</sup>,  $7.17 \times 10^{-7}$  mg/m<sup>3</sup>, and  $1.53 \times 10^{-5}$  mg/m<sup>3</sup>. The maximum annual average concentration for Total Uranium is calculated to be  $5.57 \times 10^{-6}$  mg/m<sup>3</sup>. These maximum concentrations all occurred on the sludge pond subunit.

5.5.7 Inactive Flyash Pile/South Field

The results of the air transport modeling for the Inactive Flyash Pile are presented in Table 5-57 for the current and future emissions source terms. The conceptual model for the Inactive Flyash Pile assumes that the pile remains in the same condition as specified for the current source term and therefore, results in no change for the future source term emissions. Therefore, maximum annual exposure concentrations given in Table 5-57 represent both the current and future emission source terms.

The maximum annual concentrations from the Inactive Flyash Pile occurred approximately 50 meters north-northeast from the center of the pile. This receptor point is situated in the northwestern corner of the South Field subunit. The constituents with the maximum concentrations were radon-222, uranium-238, arsenic, and dibenzo(a,h)anthracene. The respective maximum annual average for these constituents were calculated to be  $4.76 \times 10^0$  pCi/m<sup>3</sup>,  $6.21 \times 10^{-5}$  pCi/m<sup>3</sup>,  $2.32 \times 10^{-7}$  mg/m<sup>3</sup>, and  $1.54 \times 10^{-8}$  mg/m<sup>3</sup>. The maximum annual concentration for total uranium was calculated to be  $1.83 \times 10^{-7}$  mg/m<sup>3</sup>.

5.5.8 South Field

Table 5-58 presents the air transport modeling results for the South Field subunit. The future source term of the conceptual model assumes that the South Field subunit becomes part of a farm and is used to grow crops for human and animal consumption. As a result, the future source term for the South Field increases and results in higher exposure concentrations than the current source term results.

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**TABLE 5-56**

**MAXIMUM ANNUAL AIR CONCENTRATIONS RESULTING FROM  
THE NORTH AND SOUTH LIME SLUDGE PONDS FOR THE  
CURRENT AND FUTURE EMISSION SOURCE TERMS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	Current and Future Source Terms		
	Maximum Annual Exposure Point Concentration		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>
<b>RADIOLOGICAL (pCi/m<sup>3</sup>)</b>			
Cesium 137	1.83E-05	1.05E-05	1.24E-07
Neptunium 237	1.87E-05	1.08E-05	1.28E-07
Plutonium 238	1.50E-05	8.64E-06	1.02E-07
Plutonium 239/240	3.51E-06	2.03E-06	2.39E-08
Radium 226	4.99E-05	2.88E-05	3.40E-07
Radium 228	4.26E-05	2.46E-05	2.90E-07
Radon 222	3.93E-01	3.90E-01	3.02E-02
Strontium 90	2.04E-05	1.18E-05	1.39E-07
Thorium 228	7.57E-05	4.37E-05	5.15E-07
Thorium 230	1.16E-03	6.72E-04	7.93E-06
Thorium 232	3.40E-05	1.96E-05	2.31E-07
Uranium 234	5.46E-04	3.15E-04	3.72E-06
Uranium 235/236	4.53E-05	2.61E-05	3.09E-07
Uranium 238	1.86E-03	1.07E-03	1.26E-05
<b>INORGANICS (mg/m<sup>3</sup>)</b>			
Arsenic	1.87E-07	1.08E-07	1.27E-09
Beryllium	3.95E-08	2.28E-08	2.69E-10
Cadmium	3.12E-08	1.80E-08	2.13E-10
Chromium	4.31E-07	2.49E-07	2.94E-09
Lead	7.17E-07	4.13E-07	4.88E-09
<b>ORGANICS (mg/m<sup>3</sup>)</b>			
Aroclor-1254	1.53E-05	8.85E-06	1.04E-07
Benzo(a)anthracene	2.37E-08	1.37E-08	1.61E-10
Benzo(a)pyrene	2.86E-08	1.65E-08	1.95E-10
Benzo(b)fluoranthene	2.60E-08	1.50E-08	1.77E-10
Benzo(k)fluoranthene	2.08E-08	1.20E-08	1.42E-10
bis(2-Ethylhexyl)phthalate	2.60E-07	1.50E-07	1.77E-09
Carbazole	3.64E-09	2.10E-09	2.48E-11

See footnotes at end of table

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TABLE 5-56  
(Continued)

Parameter	Current and Future Source Terms		
	Maximum Annual Exposure Point Concentration		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>
<b>ORGANICS (mg/m<sup>3</sup>)</b>			
<b>(Continued)</b>			
Chrysene	2.86E-08	1.65E-08	1.95E-10
Dibenzo(a,h)anthracene	8.32E-09	4.80E-09	5.67E-11
Indeno(1,2,3-cd)pyrene	1.87E-08	1.08E-08	1.28E-10
<b>OTHER (mg/m<sup>3</sup>)</b>			
Total Uranium	5.57E-06	3.21E-06	3.80E-08

<sup>a</sup>Within the boundary of the subunit itself, 26 µg/m<sup>3</sup>, approximately 25 meters east - northeast from the center of the Sludge Ponds.

<sup>b</sup>Between the subunit boundary and the FEMP boundary, 15 µg/m<sup>3</sup>, approximately 75 meters east-northeast from the center of the Sludge Ponds.

<sup>c</sup>At or beyond the FEMP boundary, 0.1771 µg/m<sup>3</sup>, approximately 700 meters west - southwest from the center of the Sludge Ponds.

TABLE 5-57

**D**  
**MAXIMUM ANNUAL AIR CONCENTRATIONS RESULTING FROM  
 THE INACTIVE FLYASH PILE FOR THE CURRENT AND  
 FUTURE EMISSION SOURCE TERMS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	Current and Future Source Term		
	Maximum Annual Exposure Point Concentration		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>
<b>RADIOLOGICAL (pCi/m<sup>3</sup>)</b>			
Cesium 137	2.77E-06	3.23E-06	1.66E-07
Neptunium 237	4.78E-06	5.58E-06	2.87E-07
Plutonium 238	4.86E-07	5.67E-07	2.92E-08
Plutonium 239/240	1.26E-07	1.47E-07	7.56E-09
Radium 226	1.19E-05	1.38E-05	7.11E-07
Radium 228	1.35E-05	1.57E-05	8.07E-07
Radon 222	4.08E+00	4.76E+00	2.45E-01
Strontium 90	5.22E-06	6.09E-06	3.13E-07
Thorium 228	1.63E-05	1.90E-05	9.76E-07
Thorium 230	1.66E-05	1.94E-05	9.97E-07
Thorium 232	1.40E-05	1.63E-05	8.39E-07
Uranium 234	5.19E-05	6.05E-05	3.11E-06
Uranium 235/246	2.52E-06	2.94E-06	1.51E-07
Uranium 238	5.32E-05	6.21E-05	3.19E-06
<b>INORGANICS (mg/m<sup>3</sup>)</b>			
Arsenic	1.99E-07	2.32E-07	1.20E-08
Beryllium	1.36E-08	1.59E-08	8.18E-10
Cadmium	1.86E-08	2.17E-08	1.12E-09
Chromium	6.82E-08	7.95E-08	4.09E-09
Lead	1.44E-07	1.68E-07	8.61E-09
<b>ORGANICS (mg/m<sup>3</sup>)</b>			
Carbazole	3.06E-09	3.57E-09	1.84E-10
Dibenzo(a,h)anthracene	1.32E-08	1.54E-08	7.92E-10
<b>OTHER (mg/m<sup>3</sup>)</b>			
Total Uranium	1.57E-07	1.83E-07	9.43E-09

<sup>a</sup>Within the subunit itself, 6.0 ug/m<sup>3</sup>, approximately 25 meters east - southeast of Inactive Flyash Pile center.

<sup>b</sup>Area from subunit boundary to FEMP boundary, 7.0 ug/m<sup>3</sup>, approximately 50 meters north - northeast of Inactive Flyash Pile center.

<sup>c</sup>Area beyond the FEMP boundary, 0.36 ug/m<sup>3</sup>, approximately 250 meters southwest of Inactive Flyash Pile center.

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TABLE 5-58

**MAXIMUM ANNUAL AIR CONCENTRATIONS RESULTING FROM THE  
SOUTH FIELD FOR THE CURRENT AND FUTURE EMISSION SOURCE TERMS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	Current Source Terms			Future Source Terms		
	Maximum Annual Exposure Point Concentration			Maximum Exposure Point Concentrations		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>	On-Subunit <sup>d</sup>	On-Site <sup>e</sup>	Off-Site <sup>f</sup>
<b>RADIOLOGICAL (pCi/m<sup>3</sup>)</b>						
Cesium 137	4.94E-06	4.44E-06	3.65E-07	2.05E-04	1.79E-04	1.30E-05
Neptunium 237	2.26E-06	2.03E-06	1.67E-07	9.35E-05	8.16E-05	5.93E-06
Plutonium 238	1.19E-06	1.07E-06	8.78E-08	4.92E-05	4.30E-05	3.12E-06
Plutonium 239/240	5.05E-07	4.54E-07	3.73E-08	2.09E-05	1.83E-05	1.33E-06
Radium 226	3.05E-04	2.74E-04	2.25E-05	1.26E-02	1.10E-02	8.01E-04
Radium 228	3.84E-05	3.45E-05	2.84E-06	1.59E-03	1.39E-03	1.01E-04
Radon 222	7.74E+01	6.76E+01	4.91E+00	7.74E+01	6.76E+01	4.91E+00
Strontium 90	9.90E-06	8.90E-06	7.32E-07	4.10E-04	3.58E-04	2.60E-05
Technecium 99	1.41E-03	1.26E-03	1.04E-04	5.82E-02	5.08E-02	3.69E-03
Thorium 228	4.37E-05	3.92E-05	3.23E-06	1.81E-03	1.58E-03	1.15E-04
Thorium 230	1.37E-04	1.23E-04	1.01E-05	5.66E-03	4.94E-03	3.59E-04
Thorium 232	3.95E-05	3.55E-05	2.92E-06	1.64E-03	1.43E-03	1.04E-04
Uranium 234	8.57E-05	7.71E-05	6.33E-06	3.55E-03	3.10E-03	2.25E-04
Uranium 235/236	4.15E-06	3.73E-06	3.07E-07	1.72E-04	1.50E-04	1.09E-05
Uranium 238	9.22E-05	8.29E-05	6.81E-06	3.82E-03	3.33E-03	2.42E-04
<b>INORGANICS (mg/m<sup>3</sup>)</b>						
Arsenic	7.20E-08	6.47E-08	5.32E-09	2.98E-06	2.60E-06	1.89E-07
Beryllium	9.33E-09	8.38E-09	6.89E-10	3.86E-07	3.37E-07	2.45E-08
Chromium	1.38E-07	1.24E-07	1.02E-08	5.70E-06	4.98E-06	3.61E-07

See footnotes at end of table

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TABLE 5-58  
(Continued)

Parameter	Current Source Terms			Future Source Terms		
	Maximum Annual Exposure Point Concentration			Maximum Exposure Point Concentrations		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>	On-Subunit <sup>d</sup>	On-Site <sup>e</sup>	Off-Site <sup>f</sup>
Lead	2.43E-07	2.19E-07	1.80E-08	1.01E-05	8.80E-06	6.39E-07
<b>ORGANICS (mg/m<sup>3</sup>)</b>						
Aroclor-1254	8.81E-10	7.92E-10	6.51E-11	3.65E-08	3.19E-08	2.31E-09
Aroclor-1260	5.15E-10	4.63E-10	3.80E-11	2.13E-08	1.86E-08	1.35E-09
Dieldrin	9.90E-11	8.90E-11	7.32E-12	4.10E-09	3.58E-09	2.60E-10
Benzo(a)anthracene	5.45E-08	4.90E-08	4.02E-09	2.26E-06	1.97E-06	1.43E-07
Benzo(a)pyrene	9.31E-08	8.37E-08	6.88E-09	3.85E-06	3.37E-06	2.44E-07
Benzo(b)fluoranthene	6.14E-08	5.52E-08	4.54E-09	2.54E-06	2.22E-06	1.61E-07
Benzo(k)fluoranthene	7.23E-08	6.50E-08	5.34E-09	2.99E-06	2.61E-06	1.90E-07
Carbazole	1.68E-09	1.51E-09	1.24E-10	6.97E-08	6.09E-08	4.42E-09
Chrysene	5.94E-08	5.34E-08	4.39E-09	2.46E-06	2.15E-06	1.56E-07
Dibenzo(a,h)anthracene	1.88E-08	1.69E-08	1.39E-09	7.79E-07	6.80E-07	4.94E-08
Indeno(1,2,3-cd)pyrene	5.94E-08	5.34E-08	4.39E-09	2.46E-06	2.15E-06	1.56E-07
bis(2-ethylhexyl)phthalate	1.09E-09	9.79E-10	8.05E-11	4.51E-08	3.94E-08	2.86E-09
Methylene chloride	4.95E-11	4.45E-11	3.66E-12	2.05E-09	1.79E-09	1.30E-10
<b>OTHER (mg/m<sup>3</sup>)</b>						
Total Uranium	2.93E-07	2.63E-07	2.16E-08	1.21E-05	1.06E-05	7.69E-07

<sup>a</sup>Within the boundary of the subunit itself, 9.9 ug/m<sup>3</sup>, approximately 100 meters northwest from the center of South Field.

<sup>b</sup>Between the subunit boundary and the FEMP boundary, 8.9 ug/m<sup>3</sup>, approximately 125 meters northwest from the center of South Field.

<sup>c</sup>At or beyond the FEMP boundary, 0.7316 ug/m<sup>3</sup>, approximately 350 meters southwest of the center of South Field.

<sup>d</sup>Within the boundary of the subunit itself, 410 ug/m<sup>3</sup>, approximately 100 meters northwest from the center of South Field.

<sup>e</sup>Between the subunit boundary and the FEMP boundary, 358 ug/m<sup>3</sup>, approximately 125 meters northwest from the center of South Field.

<sup>f</sup>At or beyond the FEMP boundary, 26 ug/m<sup>3</sup>, approximately 350 meters southwest of the center of South Field.

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For the current source term, the highest annual average concentrations resulting from the South Field occurred within the boundary of the South Field subunit were for radon-222, technetium-99, lead, and benzo(a)pyrene. The respective concentrations for these contaminants were  $7.74 \times 10^1$  pCi/m<sup>3</sup>,  $1.41 \times 10^{-3}$  pCi/m<sup>3</sup>,  $2.43 \times 10^{-7}$  mg/m<sup>3</sup>, and  $9.31 \times 10^{-8}$  mg/m<sup>3</sup>. The maximum annual concentration for Total Uranium was  $2.93 \times 10^{-7}$  mg/m<sup>3</sup>. The impact calculated from the South Field for the future source term also identified radon-222, technetium-99, lead, and benzo(a)pyrene as having the highest annual average concentrations within the subunit boundary. Except for radon-222, the impacts calculated for the future source terms were generally one order of magnitude higher than for the current source terms. The maximum on-subunit concentrations for radon-222, technetium-99, lead, and benzo(a)pyrene were  $7.74 \times 10^1$  pCi/m<sup>3</sup>,  $5.82 \times 10^{-2}$  pCi/m<sup>3</sup>,  $1.01 \times 10^{-5}$  mg/m<sup>3</sup>, and  $3.85 \times 10^{-6}$  mg/m<sup>3</sup>, respectively. The maximum concentration calculated for total uranium for the future source term was  $1.21 \times 10^{-5}$  mg/m<sup>3</sup>. Radon-222 emission rates and concentrations are the same for the current and future cases since the scenario assumptions do not affect gaseous contaminant emissions.

5.5.9 Active Flyash Pile

The results of the air transport modeling for the Active Flyash Pile current and future emission source terms are presented in Table 5-59. The conceptual model for Operable Unit 2 assumes that the Active Flyash Pile will remain in its present state for the future source term; therefore, the maximum exposure concentrations are the same for the current and future source terms. Table 5-59 lists the maximum annual concentrations for radiological and inorganic constituents associated the Active Flyash Pile.

The calculated highest annual average concentrations of resuspended radionuclides and inorganics contaminants occur within the subunit boundary of the Active Flyash Pile. The highest concentrations were reported for radon, neptunium, and barium. The respective maximum annual on-subunit concentrations for these constituents were calculated to be  $1.81 \times 10^0$  pCi/m<sup>3</sup>,  $5.67 \times 10^{-5}$  pCi/m<sup>3</sup> and  $2.62 \times 10^{-6}$  μg/m<sup>3</sup>. The maximum annual concentration calculated for Total Uranium is  $8.06 \times 10^{-7}$  mg/m<sup>3</sup>.

TABLE 5-59

**MAXIMUM ANNUAL AIR CONCENTRATIONS RESULTING FROM  
THE ACTIVE FLYASH PILE FOR THE CURRENT AND  
FUTURE EMISSION SOURCE TERMS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Parameter	Current and Future Source Terms		
	Maximum Annual Exposure Point Concentration		
	On-Subunit <sup>a</sup>	On-Site <sup>b</sup>	Off-Site <sup>c</sup>
<b>RADIOLOGICAL (pCi/m<sup>3</sup>)</b>			
Neptunium 237	5.67E-05	4.13E-05	4.11E-06
Plutonium 238	7.21E-06	5.25E-06	5.24E-07
Plutonium 239/240	3.09E-06	2.25E-06	2.24E-07
Radium 226	4.74E-05	3.45E-05	3.44E-06
Radium 228	3.30E-05	2.40E-05	2.39E-06
Radon 222	1.81E+00	1.63E+00	1.34E-01
Strontium 90	4.64E-05	3.38E-05	3.37E-06
Thorium 228	3.91E-05	2.85E-05	2.84E-06
Thorium 230	3.81E-05	2.78E-05	2.77E-06
Thorium 232	2.78E-05	2.03E-05	2.02E-06
Uranium 234	3.71E-05	2.70E-05	2.69E-06
Uranium 235/236	2.06E-06	1.50E-06	1.50E-07
Uranium 238	3.71E-05	2.70E-05	2.69E-06
<b>INORGANICS (mg/m<sup>3</sup>)</b>			
Arsenic	9.25E-07	6.74E-07	6.72E-08
Barium	2.62E-06	1.90E-06	1.90E-07
Beryllium	4.84E-08	3.53E-08	3.52E-09
Chromium	1.37E-07	9.98E-08	9.95E-09
Cobalt	1.94E-07	1.41E-07	1.41E-08
Copper	7.60E-07	5.54E-07	5.52E-08
Cyanide	3.09E-09	2.25E-09	2.24E-10
Lead	5.71E-07	4.16E-07	4.14E-08
Molybdenum	8.86E-08	6.45E-08	6.43E-09
Nickel	4.13E-07	3.01E-07	3.00E-08
Selenium	6.08E-08	4.43E-08	4.41E-09
Thallium	2.78E-08	2.03E-08	2.02E-09
Toluene	1.03E-09	7.50E-10	7.48E-11
Vanadium	5.17E-07	3.77E-07	3.75E-08
Zinc	8.06E-07	5.87E-07	5.86E-08

<sup>a</sup>Within the subunit itself, 10.3 ug/m<sup>3</sup>, approximately 20 meters north of Active Flyash Pile center.

<sup>b</sup>Area from subunit boundary to FEMP boundary, 7.5 ug/m<sup>3</sup>, approximately 70 meters north of Active Flyash Pile center.

<sup>c</sup>Area beyond the FEMP boundary, 0.748 ug/m<sup>3</sup>, approximately 430 meters west - southwest of Active Flyash Pile center.

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5.5.10 Combined Modeling Results and Summary

5.5.10.1 Results for Constituents in Wind Blown Particulate Matter

The air quality modeling results in Section 5.5 are presented for each of the individual subunits associated with Operable Unit 2. A review of the modeling results for each subunit in Tables 5-56 through 5-59 indicates that uranium-238 is the particulate-phase constituent that was calculated to have the highest annual average concentrations from the Solid Waste Landfill, the North and South Sludge Ponds, and the Inactive Flyash Pile. The remaining two subunits, the South Field and the Active Flyash Pile, were calculated to produce the highest annual average concentrations for technetium-99 and neptunium-237, respectively.

Of the three constituents identified above, uranium-238 is the most common among the Operable Unit 2 subunits and generally had the highest surface soil activity levels of all radionuclides. Collectively, uranium-238 appears to provide the most measurable impact from Operable Unit 2 on a site-wide basis. The impact from technetium-99 will be more localized and will not provide the cumulative impact of uranium-238 because it is only associated with the South Field subunit.

Although neptunium-237 is also a common radionuclide among the Operable Unit 2 subunits, a comparison of the uranium-238 and neptunium-237 activity levels for each subunit in Tables 5-50 through 5-54 indicates that uranium-238 has much higher activity levels at all subunits, with the exception the Active Flyash Pile. However, the difference in activity levels at the Active Flyash Pile are minimal in comparison the differences between uranium-238 and neptunium-237 at the other subunits. Therefore, uranium-238 is a principal particulate-matter contaminant associated with Operable Unit 2.

The individual subunit model concentration calculations for uranium-238 to all receptors were combined using a specially written computer program to determine the combined impact of uranium-238 from all Operable Unit 2 sources. The concentrations were based on the worst case meteorological period, which was 1989. The results of this calculation procedure were then plotted to show the spatial distribution of uranium-238 annual average concentrations within and beyond the FEMP boundary. The results of this plotting procedure are shown in Figures 5-54 and 5-55 for the current and future emission scenarios. These figures show that the ISCLT2 model calculated the

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highest uranium-238 concentrations resulting from Operable Unit 2 subunits to occur at two distinct on-site locations for both emission scenarios.

#### 5.5.10.2 Results for Gaseous Radon 222

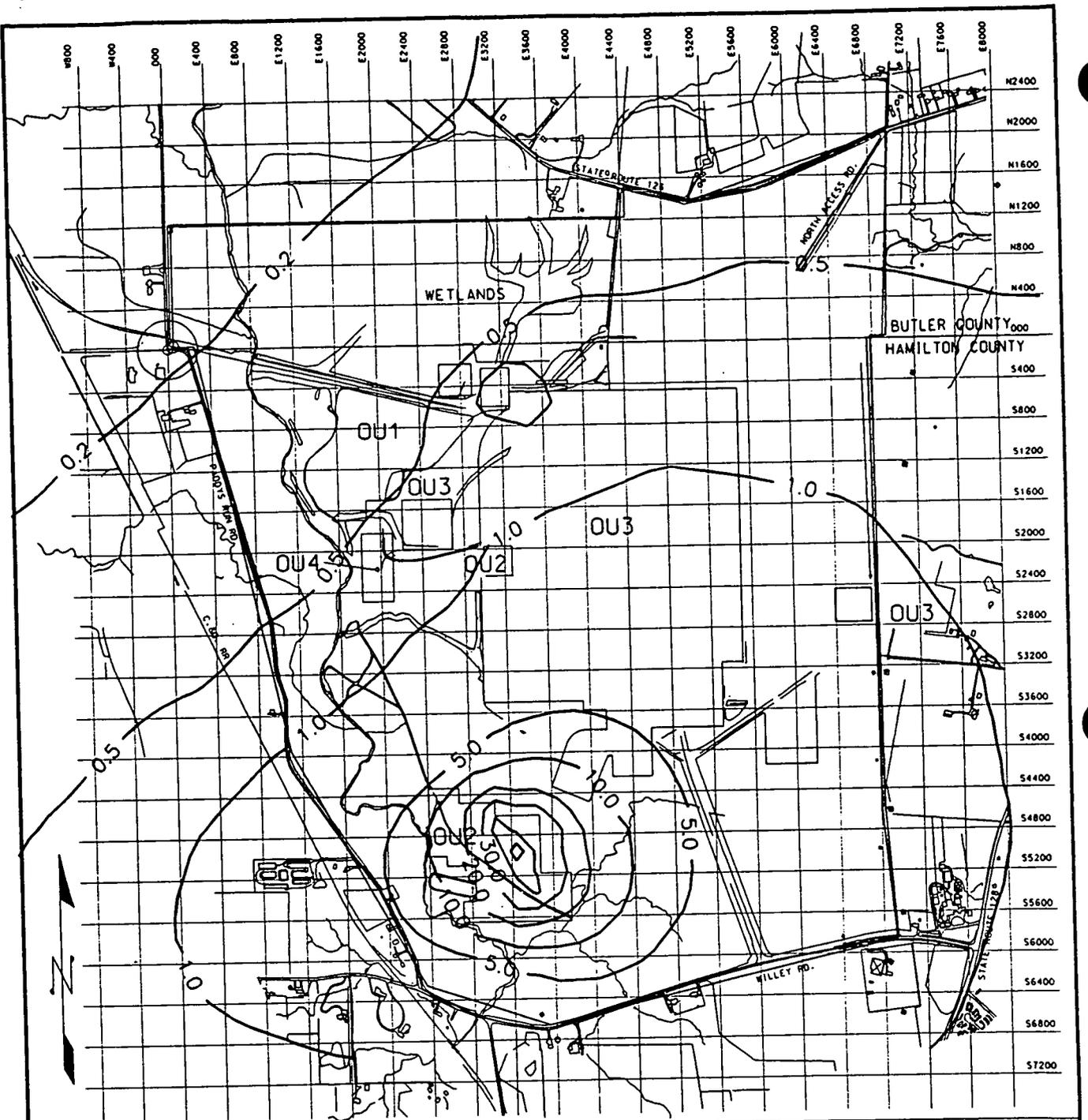
The radionuclide present in Operable Unit 2 with the highest modeled activity concentration in air is radon-222. The graphical presentation of radon-222 air concentrations for Operable Unit 2 (all subunits) is presented in Figure 5-56. The maximum concentration is located over the South Field. This maximum is due to the relatively high surface soil concentration of radium-226 (30.8 pCi/g) in the South Field and subsequent decay of this radium to radon-222. Surface soil radium-226 concentrations in other subunits are one to two orders-of-magnitude below this value.

#### 5.5.11 Uncertainty Analysis

##### 5.5.11.1 Air Quality Modeling

All air transport analysis have some degree of uncertainty due to the approximations or assumptions made primarily for source emissions and model input parameters. To account for these uncertainties, conservative assumptions were made so risks were not underestimated. In addition, uncertainties can be related to the limitations of the air dispersion models, representativeness of the meteorological data, assumptions made in the conceptual model, and the methodologies used to predict the wind erosion emission rate of contaminated particulate matter and gaseous radon emissions.

Uncertainties are inherent in the mathematical model algorithms used to simulate dispersion and transport of air contaminants because no model can provide a perfect simulation of atmospheric physical processes. Dispersion models attempt to estimate the downwind concentration for specific receptor locations and averaging periods. These models attempt to account for different types of atmospheric conditions and other conditions influencing air dispersion. Despite these technical features, the models can still have difficulty calculating contaminant concentrations due to unknown conditions affecting source release and dispersion. Validation studies of model accuracy have shown that models are generally more reliable for long-term averaging periods than for short-term averaging periods and that models are reasonably accurate in estimating the magnitude of highest concentrations within a particular area. However, models can have difficulty predicting observed concentrations for a particular location and time period due to the effects of local topography, spatial and temporal variations in meteorology between the source, and receptor or temporal fluctuations in source



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FIGURE 5-56  
Rn-222 CONCENTRATION IN AIR FROM OU2

emissions. Topography is not expected to be an influencing factor in this analysis because the area modeled is essentially flat. Therefore, a thorough understanding of modeling assumptions and limitations should be known before interpreting model results.

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The conceptual model used in the air transport analysis assumed that all of the subunit areas will have particulate emissions as a result of wind erosion, depending on the physical characteristics of the surface area of subunit. The wind erosion of particulates is basically a function of vegetative cover, wind speed, particle size, the condition of the surface cover, and soil moisture content. For the current emission scenario, the emission potential was based for a large part on a recent site inspection of each subunit and geotechnical data on the size distribution of surface soil for each subunit. The availability of particle size data for each subunit helped to reduce the uncertainty factor in defining the wind erosion potential for each subunit and the calculation of particulate deposition. The EPA recommended predictive model for calculating wind erosion emission rates includes the use of a conservatively low modal diameter in cases of unlimited potential. The lower the modal diameter used in the calculation procedure, the higher the calculated wind erosion emission rate.

In addition, the constituent concentrations used in the dispersion modeling were the 95 percent UCL of the mean for constituents with normal or lognormal distributions. However, for constituents with an undefined distribution, the maximum sampled value was used in the dispersion model. All of these assumptions can lead to conservatively high estimates of the Operable Unit 2 impact from contaminated particulate matter in both the current and future emission scenarios.

Despite the uncertainties discussed herein, the availability of subunit specific data and the conservative approach of estimating input parameters serves to support the representativeness of the air transport analysis and its ability to provide adequate data for the baseline risk assessment.

6.0 BASELINE RISK ASSESSMENT

6.1 INTRODUCTION

This section provides an overview of the methodology, results, summary, and uncertainties associated with the human health baseline risk assessment conducted for Operable Unit 2. The baseline risk assessment is an estimate of the risk to hypothetical receptors potentially exposed to site-related constituents, assuming no remedial actions are taken. The purpose of the baseline risk assessment is to estimate the possible risk to human health from exposure due to the hazardous on-site wastes at Operable Unit 2.

In a baseline risk assessment, information developed during site investigation is used to:

- Determine the constituents of potential concern (CPCs) for Operable Unit 2.
- Assess the potential for constituent transport from Operable Unit 2 sources to potential human exposure points.
- Quantify potential exposures to receptors under current and future land use scenarios.
- Characterize the nature and magnitude of potential risks associated with Operable Unit 2 assuming no remedial action.

Operable Unit 2 contains five subunits for which remedial decisions must be made. In order to facilitate remedial decisions for each independent subunit, risk was quantified separately for each. The specific methodology followed for the risk assessment is consistent across subunits. In addition, risks were quantified for Operable Unit 2 as a whole.

The results of the baseline risk assessment determine the need for remedial action for that subunit; identify specific media and areas for which cleanup is appropriate; present a "baseline" of potential human health risks for the no-action alternative in the subunit FS; and provide criteria for determining cleanup levels. A detailed summary of the methods used and quantitative results of the risk assessment are presented in Appendix B.

The Operable Unit 2 baseline risk assessment addresses only the potential risks associated with waste subunits within the boundaries of Operable Unit 2. It does not consider existing contamination in surface water, sediment, or soil unless it is contained within the boundaries of Operable Unit 2. It

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does not consider existing contamination in groundwater. Risk due to existing contamination outside the boundaries of Operable Unit 2 and in groundwater will be evaluated in the Operable Unit 5 RI. Risks due to groundwater in this and other operable unit baseline risk assessments are based on estimates of future contaminant concentrations, which are based on modeling.

In accordance with an agreement between EPA Region V and DOE, ecological risks are not addressed in this Operable Unit 2 RI report. Baseline ecological risks for the FEMP will be addressed in the Site-Wide Ecological Risk Assessment to be submitted as part of the Operable Unit 5 RI/FS. The Site-Wide Ecological Risk Assessment will address only on-site and off-site areas not likely to be remediated on the basis of human health concerns. The potential impacts to ecological receptors associated with implementation of remedial alternatives within Operable Unit 2 will be considered in the Operable Unit 2 FS.

Section 6.2 summarizes the general methodology used to complete the baseline risk assessment. Section 6.3 summarizes the results of the baseline risk assessment on a subunit-by-subunit basis as well as cumulative Operable Unit 2 risk. Additionally, a summarized comparison of subunit specific risks and Operable Unit 2-wide risks to background is provided. Section 6.4 presents a discussion of associated uncertainties. Detailed discussions and presentations of the risk assessment methodology results and uncertainties are provided in Appendix B.

6.2 METHODOLOGY

The Operable Unit 2 baseline risk assessment was performed in accordance with the FEMP Risk Assessment Work Plan Addendum (DOE 1992a), as well as the refinements and revisions made to the addendum. Some risk assessment procedures described in the addendum were modified as necessary to incorporate new information or new guidance that were unavailable during preparation of the Risk Assessment Work Plan Addendum and to incorporate continued guidance from EPA and OEPA. Differences between the methods described in the Risk Assessment Work Plan Addendum and the methods used for this risk assessment are noted in Appendix B, Section B.2.0.

Figure 6-1 illustrates the general FEMP risk assessment process that was followed for this risk assessment. It generally reflects the four step EPA risk assessment process which involves: (1) identification of CPCs, (2) exposure assessment, (3) toxicity assessment, and (4) risk characterization and uncertainty analysis. The figure reflects the importance of the conceptual site

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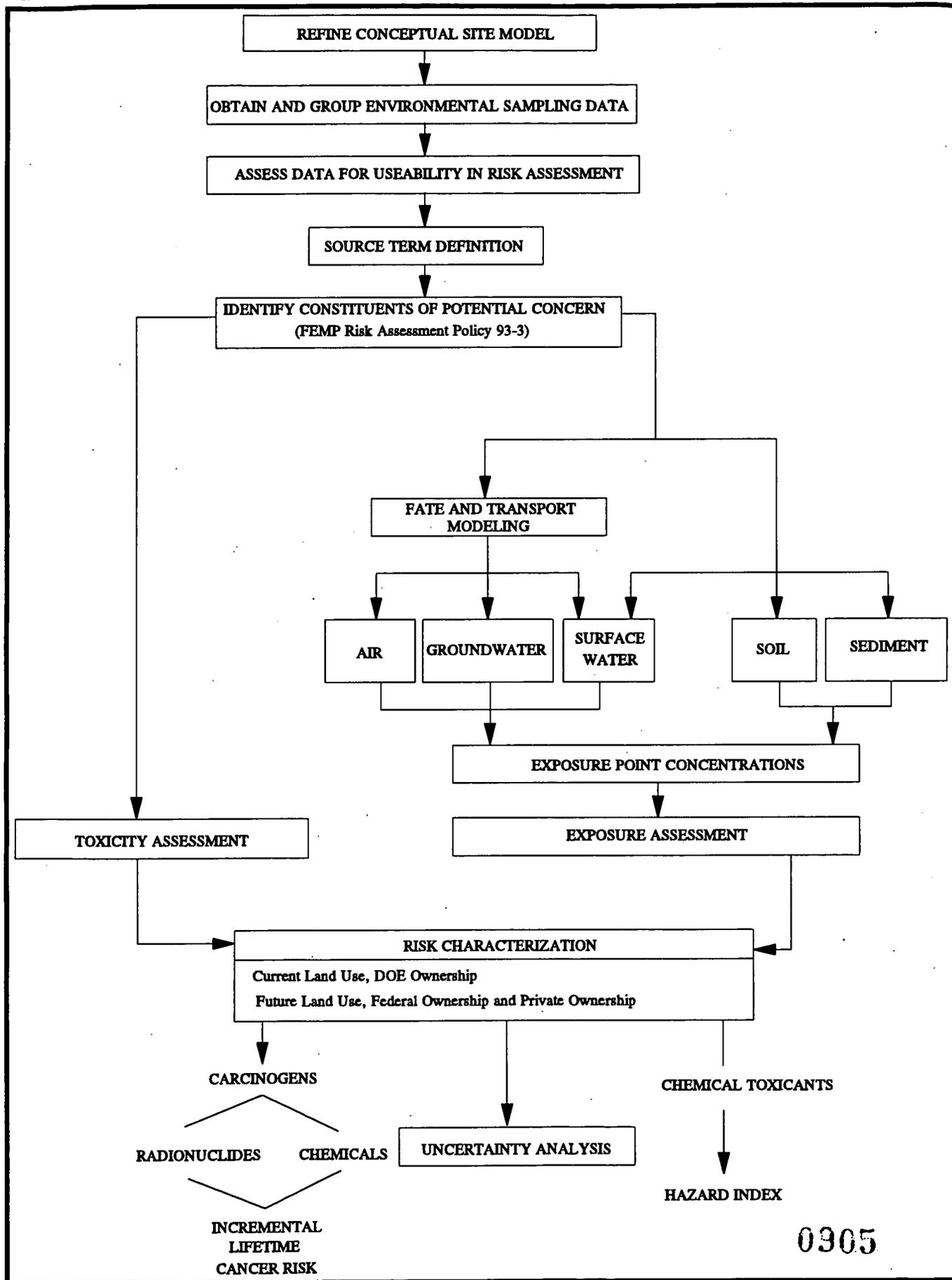


FIGURE 6-1. FEMP RISK ASSESSMENT PROCESS

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model in grouping data and defining exposure pathways. It also reflects the critical dependence of this risk assessment on the results of constituent fate and transport modeling to complete the exposure assessment. The methodology followed for each of the steps highlighted in Figure 6-1 is summarized in the sections below and discussed in detail in Appendix B.

6.2.1 Refine Conceptual Site Model

To assist in appropriately grouping data to identify subunit- and medium-specific CPCs, the general conceptual site model (CSM) for Operable Unit 2 was refined to emphasize the current understanding of constituent migration and potential exposures. The overall purpose of the model is to illustrate and describe: (1) the most current understanding of the sources of constituent within Operable Unit 2, (2) how constituents may be released and transported, (3) impacted and potentially impacted media, and (4) the known and potential human receptors assuming both current and future land use. The CSM clarifies which environmental media and specific human receptors need to be addressed to adequately characterize risk resulting from waste areas within Operable Unit 2. This understanding is critical for the initial grouping of data into subsets relevant to assessing risk so that independent risk-based decisions can be made for each subunit and each medium. Refinement of the CSM is an important first step in completing the risk assessment.

The CSM developed for this Operable Unit 2 baseline risk assessment is shown in Figure 6-2, which shows the five waste areas that are the sources of constituents and the secondary sources (groundwater and soil) impacted by migration of constituents from these source areas. Figure 6-2 is based on the current understanding of constituent migration resulting from RI activities and illustrates the important release mechanisms by which constituents migrate from one medium to another and the contact media potentially encountered by human receptors. It also illustrates the specific current and future human receptors whose contact with impacted media is assessed in this risk assessment. These are the same receptors evaluated in other operable unit baseline risk assessments for the FEMP. The known nature and extent of constituents in environmental media is described in Section 4.0 of this RI; potential future impacted media (i.e., air, groundwater, and surface water) is described in Section 5.0.

6.2.1.1 Land Use

Potential exposures to the environmental media noted on Figure 6-2 are evaluated in the context of three land use configurations: (1) current land use assuming DOE ownership with both access and no access control, (2) future land use assuming federal ownership, and (3) future land use assuming

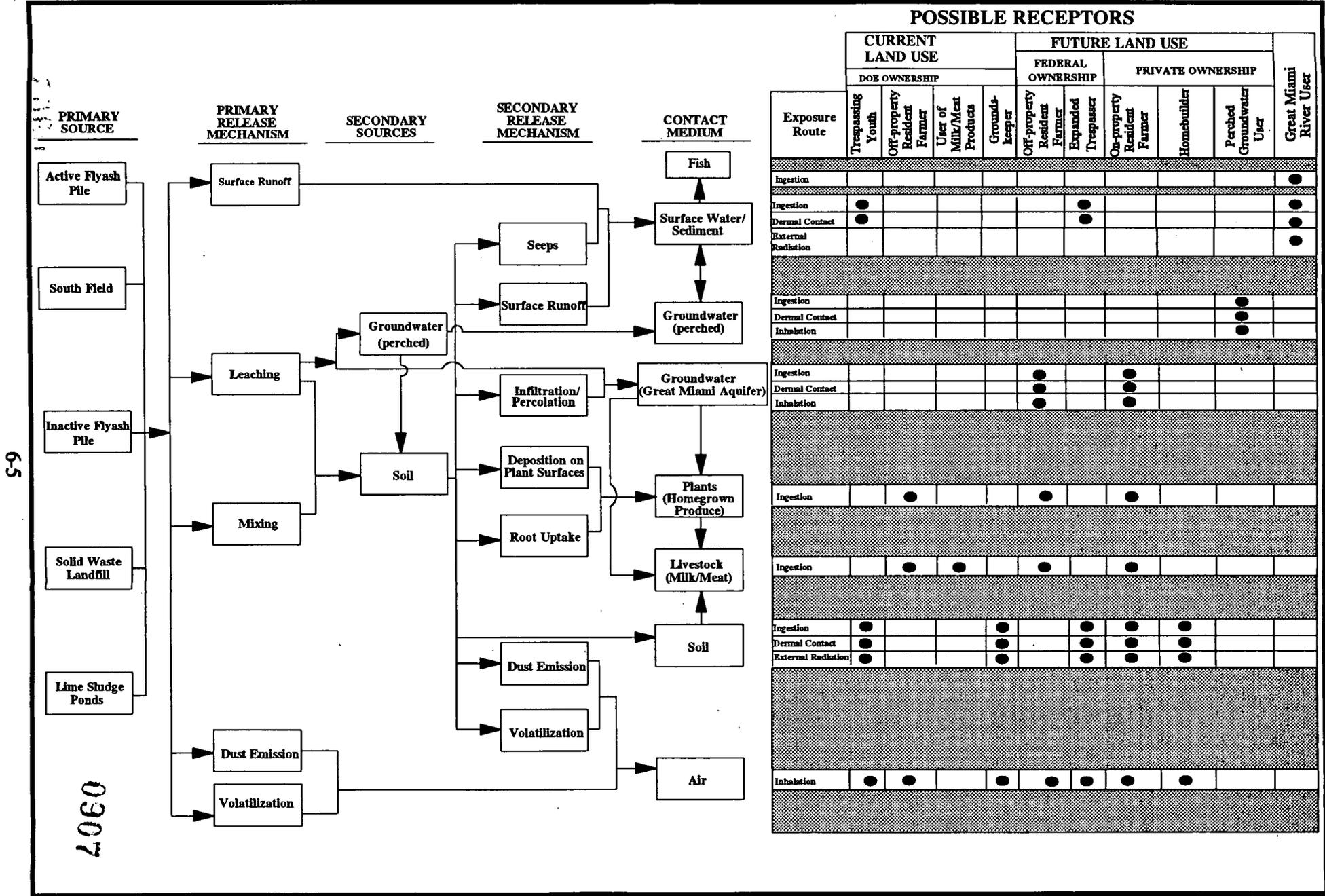


FIGURE 6-2 GENERAL CONCEPTUAL SITE MODEL/OPERABLE UNIT 2

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private ownership. These land use designations reflect the current framework for assessing risk at the FEMP. As indicated in the CSM, current receptors are trespassers, off-property residents, on-property groundskeeper, and users of meat and milk products from livestock grazed on site. Future receptors, assuming federal ownership, are expanded trespassers and off-property residents. Future receptors, assuming private ownership, are on-property farmers, homebuilders, and perched groundwater users. Great Miami River users are future receptors regardless of whether private or federal ownership is assumed. These land use designations and receptor descriptions are further described in the Exposure Assessment, Section B.2.4 of Appendix B.

6.2.1.2 Exposure Scenarios

Land use assumptions and receptors were selected to ensure: (1) that they are consistent with the Risk Assessment Work Plan Addendum, where applicable; (2) that they allow adequate quantification of risk for every contaminated or potentially contaminated medium within each subunit; and (3) that they are consistent with FEMP risk assessment guidelines for exposure scenarios. Table 6-1 summarizes land use and receptor designations utilized to quantify risk in this risk assessment. The rationale for land use designation and scenario selection is presented below.

For current land use assumptions, the FEMP is assumed to remain as it currently exists. In addition, no remedial action is assumed to have been taken beyond what is already accomplished. Existing current land use at and in the vicinity of Operable Unit 2 indicates that receptors most likely to be exposed to constituents on and migrating from Operable Unit 2 waste areas are trespassers who may routinely bypass existing controls and enter the site; off-property farm families who may live in the vicinity of the FEMP property; on-property groundskeeper conducting general maintenance activities not covered under FEMP health and safety and radiation programs; and users of meat and milk products from livestock grazing on the property. As summarized in Table 6-1, current land use with access controls include the following receptors:

- Off-Property Resident Farmer (Adult and Child) - This exposure scenario assumes that a farm family lives immediately adjacent to the FEMP property boundary. Exposure routes include:
  - Inhalation of fugitive dust, VOCs, and gases.
  - Consumption of farm product foodstuffs including vegetables, meat, and milk.
- Trespassing Youth - This exposure scenario considers the risk incurred by a trespassing youth who wanders freely over the site. Exposure routes include:

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TABLE 6-1

EXPOSURE SCENARIOS AND EXPOSURE POINT CONCENTRATIONS  
 OPERABLE UNIT 2 BASELINE RISK ASSESSMENT  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Current Land Use	Receptor	Direct Contact Medium	Route of Exposure	Exposure Point Concentration
Current with Access Controls and without Access Controls (current use of FEMP continues, DOE ownership)	Trespassing Youth	soil	incidental ingestion dermal contact external radiation	surface soil or material within subunit
		air	inhalation    particulates, volatiles, and gases	maximum estimated on-site current concentration derived from air modeling
		surface water	incidental ingestion dermal contact	surface water within subunit
		sediment	incidental ingestion dermal contact external radiation	sediment within subunit
	Off-Property Resident Farmer (adult and child), livestock grazing off-property	air	inhalation    particulates, volatiles, and gases	maximum estimated off-site current concentrations derived from air modeling
		plants (homegrown produce)	ingestion    fruits and vegetables	maximum estimated off-site current concentrations derived from air modeling
		livestock (grazing off-property)	ingestion    milk beef	maximum estimated off-site current concentrations derived from air modeling
	Groundskeeper	air	inhalation    particulates, volatiles and gases	maximum estimated on-site current concentration derived from air modeling
		soil	incidental ingestion, dermal contact, external radiation	surface soil or material within subunit
	User of Meat and Milk Products	livestock (grazing on-property)	ingestion of milk and beef	maximum estimated on-site current concentrations derived from air modeling

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**TABLE 6-1  
(Continued)**

Future Land Use	Receptor	Direct Contact Medium	Route of Exposure		Exposure Point Concentration
Federal Ownership (includes exposure routes that require development time)	Future Off-Property Farmer (adult and child), grazing off-property, groundwater off-property	air	inhalation	particulates, volatiles, and gases	maximum estimated off-site future concentrations derived from air modeling
		plants (homegrown produce)	ingestion	fruits and vegetables	maximum estimated off-site future concentrations derived from air modeling and groundwater modeling
		livestock (grazing at property boundary)	ingestion	milk and beef	maximum estimated off-site future concentrations derived from air modeling and groundwater modeling
		groundwater	ingestion dermal contact inhalation of volatiles released during household use		modelled groundwater concentrations at fenceline when concentration is greatest
	Expanded Trespasser (adult and youth)	air	inhalation	particulates, volatiles, and gases radon	maximum estimated on-site air concentrations derived from air modeling
		soil	incidental ingestion dermal contact external radiation		surface soil within subunit
		surface water	incidental ingestion dermal contact		surface water within subunit
		sediment	ingestion dermal contact external radiation		sediment within subunit
Without Federal Ownership (includes exposure routes that require development time)	Future On-Property Resident Farmer (adult and child), livestock grazing on-property, groundwater on property; will include RME and CT estimates	air	inhalation	particulates, volatiles, gases, and indoor radon radon	maximum estimated on-site future concentrations derived from air modeling; radon estimated from soil radium concentrations
		plants (homegrown produce)	ingestion	fruits and vegetables	maximum estimated on-site future concentrations derived from air modeling

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TABLE 6-1  
(Continued)

Future Land Use	Receptor	Direct Contact Medium	Route of Exposure	Exposure Point Concentration
Without Federal Ownership (includes exposure routes that require development time) (Continued)	Future On-Property Resident Farmer (adult and child), livestock grazing on-property, groundwater on property; will include RME and CT estimates (Continued)	livestock (grazing on property)	ingestion      milk and beef	maximum estimated on-site future concentrations derived from air modeling and groundwater modeling of Great Miami aquifer
		groundwater	ingestion dermal contact inhalation	groundwater concentration in Great Miami aquifer underlying subunit at time when concentration is greatest
		soil	incidental ingestion dermal contact external radiation	surface soil within subunit
Without Federal Ownership (includes exposure routes that require development time)	Future Homebuilder (per OU1)	waste material/subsurface soil	external radiation incidental ingestion dermal contact	subsurface soil within subunit
		air	inhalation      particulates, volatiles, and gases	air concentrations at construction site based on modeling
	Future Perched Groundwater User	perched groundwater directly underlying subunit	ingestion dermal contact inhalation of volatiles released during household use	current groundwater concentration in perched groundwater directly underlying subunit
	Great Miami River User	surface water	ingestion dermal contact	estimated concentrations in Great Miami River
		sediment	ingestion dermal contact external radiation	estimated concentrations in Great Miami River
		fish	ingestion	estimated fish concentrations in Great Miami River

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- Inhalation of fugitive dust, VOCs, and gases.
  - Incidental ingestion of, direct radiation exposure from, and dermal contact with contaminated soils.
  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of and dermal contact with contaminated sediment.
- On- Property Groundskeeper - This exposure scenario considers the risks associated with the on-site maintenance receptor. Exposure pathways include:
    - Inhalation of fugitive dust, VOCs, and gases
    - Incidental ingestion of, dermal contact with, and direct radiation exposure from contaminated soil.

Current land use without access controls include the following receptors:

- Off-Property Resident Farmer (Adult and Child) - This exposure scenario assumes that a farm family lives immediately adjacent to the FEMP property boundary. Exposure routes include:
  - Inhalation of fugitive dust, VOCs, and gases.
  - Consumption of farm product foodstuffs including vegetables, fruit, meat, and milk.
- Trespassing Youth - This exposure scenario considers the risk incurred by a trespassing youth who wanders freely over the site. Exposure routes include:
  - Inhalation of fugitive dust, VOCs, and gases.
  - Incidental ingestion of, direct radiation exposure from, and dermal contact with contaminated soils.
  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of, direct radiation exposure from, and dermal contact with contaminated sediment.
- Users of Meat and Milk Products from Livestock Grazing on the Site - This exposure scenario considers the risks associated with off-property use of animal products produced by cattle currently grazing on Operable Unit 2. Exposure pathways include:
  - Ingestion of beef and milk

Receptors listed in the Risk Assessment Work Plan Addendum not evaluated under current land use assumptions for this risk assessment include:

- Visitor - This scenario is intended to evaluate exposures incurred by the activities of a regular visitor to the FEMP site who is not covered by a health and safety or radiation protection program. An example of this receptor would be a delivery person making regular deliveries to a given building on site. This receptor was not considered applicable, since no visitor would consistently visit the Operable Unit 2 Study Area.

- On-Property Building User - This scenario considers risks from occupancy of an existing on-site building by a hypothetical receptor. This receptor was not considered since no existing habitable structures exist in Operable Unit 2.
- Hunter - this scenario examines risks due to consumption of animal products from wild animals found on the FEMP property. This receptor, as stated in the Risk Assessment Work Plan Addendum, will be evaluated in Operable Unit 5.

To evaluate risk to potential future receptors, it is assumed that the FEMP site will either be retained by the federal government (federal ownership) or will be released for private development (without federal ownership). If it is assumed that the most likely option of the FEMP site under federal ownership is continued restrictive access, therefore, the most likely future receptor might be an expanded trespasser. Potential exposures to an off-property farm family are also evaluated, assuming that the most likely off-site future land use would be agricultural. Specific exposure pathways by which these receptors may be exposed to contaminants on or migrating from Operable Unit 2 source areas are listed in Table 6-1.

As summarized in Table 6-1, future land use receptors, assuming federal ownership, include:

- Expanded Trespasser - This scenario assumes that the same visitor will routinely visit what is now the Operable Unit 2 Study Area after. The expanded trespasser is assumed to wander unrestricted over the entire site. Exposure routes include:
  - Inhalation of fugitive dust, VOCs, and gases.
  - Incidental ingestion of, dermal contact with, and external radiation from contaminated soil.
  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of, dermal contact with, and external radiation sediment.
- Off-Property Resident Farmer (Adult and Child) - This scenario assumes that a farm family lives immediately adjacent to the FEMP property boundary. Exposure routes for this receptor include those listed for the same receptor assuming current land use, in addition to ingestion, dermal contact, and inhalation from groundwater.
- User of the Great Miami River (Adult and Child) - This scenario considers risks to an off-property resident who uses the river for recreational purposes. Exposure routes include:
  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of, dermal contact with, and external radiation from sediment.
  - Ingestion of fish.

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If the FEMP property does not remain under the federal ownership, it is assumed that it will be held in private ownership and developed for agricultural use. As summarized in Table 6-1, future land use receptors, assuming private ownership, include:

- Reasonable Maximum Exposure (RME) On-Property Resident Farmer Receptor (Adult and Child) - This exposure assumes that a farmer resides on the property and conducts agricultural activities. Typical activities may include food and feed production, livestock production, and general farm work. This scenario includes only household use of perched groundwater because the perched groundwater zone would not be sufficient to support agricultural uses. Exposure routes include:
  - Inhalation of fugitive dust, VOCs, and gases.
  - Ingestion of groundwater (separate evaluations for groundwater from the Great Miami Aquifer and for perched groundwater).
  - Dermal contact and inhalation while using groundwater in the home.
  - Consumption of foodstuff grown on the property including vegetables, meat, and milk.
  - Incidental ingestion of, external radiation from, and dermal contact with soil.
  - Inhalation of indoor radon.
  
- Central Tendency (CT) On-Property Resident Farmer Receptor (Adult and Child) - This exposure assumes that a farmer resides on the property and conducts agricultural activities. This exposure is similar to the RME on-property resident farmer with modifications of exposure parameter values to more closely reflect values typical of the CT of exposure. Exposure routes for this receptor include those listed for the RME on-property resident farmer receptor, excluding ingestion of perched groundwater.
  
- Future Home Builder - This exposure scenario involves exposures to workers building residences or other structures within Operable Unit 2. This scenario includes only household use of perched groundwater because the perched groundwater zone would not be sufficient to support agricultural uses. Exposure routes include:
  - Incidental ingestion of, and dermal contact with, and external radiation from soil.
  - Inhalation of fugitive dust, VOCs, and gases.
  
- A Perched Groundwater User - This exposure scenario involves exposures to users of perched groundwater within Operable Unit 2. Exposure routes include:
  - Inhalation and dermal contact while using perched groundwater
  - Ingestion of perched groundwater
  
- User of the Great Miami River (Adult and Child) - This scenario considers risks to an off-property resident who uses the river for recreational purposes. Exposure routes include:
  - Incidental ingestion of and dermal contact with surface water.
  - Incidental ingestion of, dermal contact with, and external radiation from sediment.
  - Ingestion of fish.

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6.2.2 Constituents of Potential Concern (CPCs)

CPCs are defined as those compounds present in environmental media at levels that exceed background and that may present a risk to human health. These are the constituents for which analytical data are available and used for fate and transport modeling and risk characterization throughout baseline risk assessment. Constituents which remain a concern after baseline risks have been calculated become the contaminants of concern (COCs).

The selection of chemical and radionuclide CPCs for Operable Unit 2 is based on data developed in the Operable Unit 2 RI and included a critical review of site data characterizing soils, groundwater, surface water, and sediment within the Operable Unit 2 study areas. Data were collected in accordance with DQOs established in the FEMP QAPP, Sections 2.11 and 2.12 and the Operable Unit 2 Sampling and Analysis Plan (DOE 1993b). The raw data sets on which analyses were performed are presented in Section 4.0 of this RI report and are tabulated in Appendices C through G.

CPCs for this risk assessment were selected using a two-step statistical and toxicological screening process which is described in detail in Appendix B.2.0. In the first step, statistical analyses compared and measured on-site concentrations of each detected constituent to background concentrations of that constituent in the same medium. Constituents whose concentration levels were not statistically significantly greater than background were eliminated from further consideration in the risk assessment. Exceptions to the selection procedure are outlined in Appendix B.2.3 and include all A and B carcinogens and all radionuclides. In the second step, each constituent detected above background in a given medium was compared to conservative, risk-based screening criteria, which were derived from EPA Region III screening values based on a carcinogenic risk of  $1 \times 10^{-7}$  and a noncarcinogenic Hazard Index (HI) of 0.1. Constituents that were present below screening levels were excluded from quantification in the risk assessment. Laboratory contaminants (identified during data validation), essential micronutrients (calcium, magnesium, etc.), and ubiquitous minerals (silica, etc.) were also excluded as CPCs.

Tables 6-2 through 6-6 summarize the Operable Unit 2 CPCs identified by media for each subunit. The detailed results of application of the CPC selection process to each medium within each operable unit subunit are described in Section B.3.0 of Appendix B.

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TABLE 6-2  
CONSTITUENTS OF POTENTIAL CONCERN  
FOR ACTIVE FLYASH PILE

SURFACE SOIL	SUBSURFACE SOIL	SEDIMENT	GROUNDWATER	SURFACE WATER
<i>Radiological Constituents</i>				
NP-237	NP-237	CS-137	NP-237	NP-237
	PB-210	NP-237		
PU-238	PU-237	PU-238	--	PU-238
PU-239/240	PU-239/239	PU-239/240	--	--
	RA-224			
RA-226	RA-226	RA-226	RA-226	--
RA-228	RA-228	RA-228	RA-228	RA-228
SR-90	SR-90	--	--	--
		--	TC-99	--
TH-228	TH-228	TH-228	--	--
TH-230	TH-230	TH-230	--	--
TH-232	TH-232	TH-232	--	--
U-234	U-234	U-234	U234	U-234
U-235/236	U-235/236	U-235/236	U235/236	U-235/236
U-238	U-238	U-238	U238	U-238
<i>Chemical Constituents</i>				
Arsenic	Arsenic	Arsenic	Arsenic	Arsenic
Barium	--	--	--	Barium
Beryllium	Beryllium	Beryllium	Beryllium	--
	Cadmium	Cadmium	Cadmium	--
Chromium	Chromium	Chromium	--	--
Cobalt	Cobalt	Cobalt	--	--
Copper	--	--	--	--
Cyanide	--	--	--	--
Lead	Lead	Lead	Lead	--
--	--	Manganese	--	Manganese
Molybdenum	--	--	Molybdenum	--
Nickel	--	--	--	--
Selenium	--	--	--	Selenium
	TH-TOTAL	TH-TOTAL	--	--
Thallium	--	Thallium	--	--
Toluene	--	--	--	--
	U-TOTAL	U-TOTAL	--	U-TOTAL
Vanadium	--	--	--	--
Zinc	--	--	--	--
	--	Di-n-butyl phthalate	--	--
	1,2-Dichloroethane	--	--	--
	2-Hexanone	--	--	--
	2-Methylnaphthalene	--	--	--
	Benzene	--	--	--
	bis(2-Ethylhexyl) phthalate	--	--	--
	Chloroform	--	--	--
	Methylene chloride	--	--	--
	Pentachlorophenol	--	--	--
	Phenanthrene	--	--	--
	Vinyl chloride	--	--	--

-- = not a CPC in this medium

TABLE 6-3  
CONSTITUENTS OF POTENTIAL CONCERN  
FOR THE SOUTH FIELD

SURFACE SOIL	SEDIMENT	GROUNDWATER	SURFACE WATER
<i>Radiological Constituents</i>			
CS-137	CS-137	--	--
NP-237	NP-237	NP-237	--
PU-238	PU-238	--	--
PU-239	PU-239/240	--	--
RA-226	RA-226	RA-226	--
RA-228	RA-228	RA-228	--
--	RU-106	--	--
SR-90	SR-90	--	--
TC-99	TC-99	TC-99	--
TH-228	TH-228	--	--
TH-230	TH-230	--	--
TH-232	TH-232	--	--
U-234	U-234	U234	U-234
U-235	U-235/236	U235/236	U-235/236
U-238	U-238	U238	U-238
<i>Chemical Constituents</i>			
Arsenic	Arsenic	Arsenic	--
Beryllium	Beryllium	Beryllium	--
Chromium	Chromium	--	--
--	Cobalt	--	--
Lead	Lead	Lead	--
--	Manganese	--	--
--	--	Mercury	--
--	--	Molybdenum	--
TH-TOTAL	TH-TOTAL	--	--
--	Thallium	--	--
U-TOTAL	U-TOTAL	--	U-TOTAL
Acenaphthylene	--	--	--
Benzo(a)anthracene	Benzo(a)anthracene	--	--
Benzo(a)pyrene	Benzo(a)pyrene	--	--
Benzo(b)fluoranthene	Benzo(b)fluoranthene	--	--
Benzo(g,h,i)perylene	Benzo(g,h,i)perylene	--	--
Benzo(k)fluoranthene	Benzo(k)fluoranthene	--	--
bis(2-Ethylhexyl)phthalate	bis(2-Ethylhexyl) phthalate	--	--
Carbazole	--	--	--
Chrysene	Chrysene	--	--
Dibenzo(a,h)anthracene	--	--	--
Dibenzofuran	--	--	--
Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene	--	--
Phenanthrene	Phenanthrene	--	--
Methylene chloride	--	--	--
Aroclor 1254	Aroclor-1254	--	--
Aroclor 1260	--	--	--
Dieldrin	--	--	--
Endrin ketone	--	--	--
--	--	--	--

-- = not a CPC in this medium

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TABLE 6-4  
CONSTITUENTS OF POTENTIAL CONCERN  
FOR THE INACTIVE FLYASH PILE

SURFACE SOIL	SEDIMENT	GROUNDWATER	SURFACE WATER
<i>Radiological Constituents</i>			
CS-137	--	--	--
NP-237	NP-237	NP-237	NP-237
PU-238	PU-238	--	PU-238
PU-239/240	PU-239/240	--	PU-239/240
RA-226	RA-226	--	RA-226
RA-228	RA-228	--	--
SR-90	SR-90	SR-90	--
--	--	TC-99	--
TH-228	TH-228	--	--
TH-230	TH-230	--	TH-230
TH-232	TH-232	--	--
U-234	U-234	U234	U-234
U-235/236	U-235/236	U235/236	U-235/236
U-238	U-238	U238	U-238
<i>Chemical Constituents</i>			
Arsenic	Arsenic	--	Arsenic
Beryllium	--	--	--
Cadmium	--	Cadmium	Cadmium
Chromium	Chromium	--	--
--	Cobalt	--	--
Lead	Lead	--	Lead
--	Manganese	--	--
--	--	--	--
--	--	Molybdenum	--
--	--	--	--
--	Thallium	--	--
U-TOTAL	U-TOTAL	U-TOTAL	U-TOTAL
--	--	--	--
--	--	--	--
--	Benzo(a)pyrene	--	--
--	bis(2-Ethylhexyl)phthalate	--	bis(2-Ethylhexyl) phthalate
Carbazole	--	--	--
Dibenzo(a,h)anthracene	--	--	--
Dibenzofuran	--	--	--
--	--	--	Toluene
--	--	--	--

-- = not a CPC in this medium

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TABLE 6-5

CONSTITUENTS OF POTENTIAL CONCERN  
FOR THE SOLID WASTE LANDFILL

SURFACE SOIL	SEDIMENT	GROUNDWATER	PERCHED GROUNDWATER	SURFACE WATER
<i>Radiological Constituents</i>				
CS-137	--	--	--	--
NP-237	NP-237	--	--	--
PU-238	PU-238	--	--	PU-238
PU-239/240	PU-239/240	--	--	--
RA-226	RA-226	--	--	--
RA-228	RA-228	--	--	--
SR-90	SR-90	--	--	--
--	--	TC-99	TC-99	--
TH-228	TH-228	--	--	--
TH-230	TH-230	--	--	--
TH-232	TH-232	--	--	--
U-234	U-234	--	--	U-234
U-235/236	U-235/236	--	--	U-235/236
U-238	U-238	--	--	U-238
<i>Chemical Constituents</i>				
Arsenic	Arsenic	--	--	--
Beryllium	--	--	--	--
Cadmium	--	--	--	--
Chromium	Chromium	--	--	--
--	Cobalt	--	--	--
Lead	Lead	--	--	--
--	Manganese	--	--	Manganese
--	Silicon	--	--	--
TH-TOTAL	TH-TOTAL	--	--	--
--	Thallium	--	--	--
U-TOTAL	U-TOTAL	--	--	U-TOTAL
4,4'-DDE	--	--	--	--
Benzo(a)anthracene	Benzo(a)anthracene	--	--	--
Benzo(a)pyrene	Benzo(a)pyrene	--	--	--
Benzo(b)fluoranthene	Benzo(b)fluoranthene	--	--	--
Benzo(g,h,i)perylene	Benzo(g,h,i)perylene	--	--	--
Benzo(k)fluoranthene	Benzo(k)fluoranthene	--	--	--
bis(2-Ethylhexyl) phthalate	bis(2-Ethylhexyl) phthalate	--	--	bis(2-Ethylhexyl) phthalate
Carbazole	Carbazole	--	Carbazole	--
Chrysene	Chrysene	--	--	--
Dibenzo(a,h)anthracene	--	--	--	--
Dibenzofuran	--	--	--	--
--	Fluoranthene	--	--	--
Indeno(1,2,3-cd)pyrene	Indeno(1,2,3-cd)pyrene	--	--	--
Phenanthrene	Phenanthrene	--	--	--
--	Pyrene	--	--	--
--	--	--	--	--

-- = not a CPC in this medium

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TABLE 6-6  
CONSTITUENTS OF POTENTIAL CONCERN  
FOR THE LIME SLUDGE PONDS

SURFACE SOIL	GROUNDWATER	PERCHED GROUNDWATER
<i>Radiological Constituents</i>		
CS-137	--	--
NP-237	--	NP-237
PU-238	--	--
PU-239/240	--	--
RA-226	--	--
RA-228	--	--
SR-90	--	SR-90
TC-99	TC-99	TC-99
TH-228	--	--
TH-230	--	--
TH-232	--	--
U-234	--	--
U-235/236	--	--
U-238	--	--
<i>Chemical Constituents</i>		
Arsenic	--	Arsenic
Beryllium	--	--
Cadmium	--	--
Chromium	--	--
Lead	--	--
--	--	Manganese
TH-TOTAL	--	--
U-TOTAL	--	--
Aroclor-1254	--	--
Benzo(a)anthracene	--	--
Benzo(a)pyrene	--	--
Benzo(b)fluoranthene	--	--
Benzo(g,h,i)perylene	--	--
Benzo(k)fluoranthene	--	--
bis(2-Ethylhexyl) phthalate	--	--
Carbazole	--	--
Chrysene	--	--
Dibenzo(a,h)anthracene	--	--
Dibenzofuran	--	--
Indeno(1,2,3-cd)pyrene	--	--
Phenanthrene	--	--

-- = not a CPC in this medium

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6.2.3 Exposure Assessment

The exposure assessment is the determination of the magnitude of contact that a potential receptor may have with site-related CPCs. The general procedure for conducting an exposure assessment involves the following three steps: (1) characterization of the physical setting, (2) identification of exposure pathways, and (3) quantification of exposure.

In the first step, the general physical characteristics of the site and characteristics of potential receptor populations are described. Physical characteristics of the Operable Unit 2 subunits are summarized in detail in Section 3.0 of this RI report.

In the second step, the predominant migration and exposure pathways are identified. Pathways are identified on the basis of specific sources, releases, types, and locations of chemicals at the site; environmental fate of chemical and radioactive constituents; and locations and activities of potentially exposed populations. Section B.2.0 in Appendix B summarizes this information for Operable Unit 2.

The third step, quantification of exposures, involves calculation of estimated intake of contaminants. For each identified receptor, chemicals are calculated in mg/kg per day (mg/kg-day) and for radionuclides in pCi. Equations used to derive intakes are summarized in Section B.2.0 of Appendix B, while the calculated intakes are included in Attachment III of Appendix B.

6.2.3.1 Exposure Point Concentrations

The exposure point concentration is the concentration of a constituent in an environmental medium that may be contacted by a real or hypothetical receptor. It is used in combination with other exposure parameters in intake equations to quantify the actual intake (in mg/kg-day for chemicals and pCi for radionuclides) that a receptor may receive via a specific pathway (e.g., soil, groundwater, etc.,) and route of exposure (e.g., ingestion, inhalation, and dermal contact).

Exposure point concentrations for Operable Unit 2 were determined in different ways, depending on whether exposures were assumed to be current or future and depending on the environmental medium of interest. To be consistent with the concept of the RME scenario required by EPA, an estimate of the highest exposure that can reasonably be expected to occur requires a reasonable maximum estimate of the concentration of each contaminant in each exposure medium. Because of the uncertainty associated with any estimate of exposure point concentrations, the upper 95 percent

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confidence limit on the calculated mean for either a normal or lognormal distribution is the recommended statistic (concentration value) to be constructed from measured contaminant concentration data and used in risk assessments (EPA 1992a). This term is generally called the upper 95 percent confidence limit (UCL). Derivation of the 95 percent UCL for each environmental medium is described in detail in Appendix B, Section B.2.0.

Exposure Point Concentrations for Soil

Exposure point concentrations for direct contact surface soil exposure pathways, under both current and future land use assumptions, are the 95 percent UCLs determined from surface soil data using the process described in the FEMP guidelines for determining CPCs and Appendix B, Section B.2.0.

Exposure Point Concentrations for Groundwater

Current exposures to groundwater at the FEMP will be addressed as part of the Operable Unit 5 RI. Exposure to potential future concentrations of constituents in groundwater from each operable unit are addressed during each operable unit RI baseline risk assessment. Future exposure point concentrations for groundwater are determined from the results of groundwater transport modeling, as described in detail in Section 5.0 and Appendix A.

For assessment of exposures to constituents migrating in groundwater from the South Field and Inactive Flyash Pile, source terms from these two subunits were combined. For assessment of exposures to contaminants migrating from the Active Flyash Pile, Solid Waste Landfill, and Lime Sludge Ponds, independent source terms were derived.

Soil CPCs for each subunit (Inactive Flyash Pile and South Field combined) were subjected to leachate estimations as described in Section 5.4.2.1. CPCs determined to be present in leachate above screening criteria (derived from EPA Region III risk of  $1.0 \times 10^{-7}$  and a HI of 0.1) were then modeled in the vadose zone using the methodology outlined in Section 5.4.2.2. Leachate concentrations are modeled through the vadose zone to the regional aquifer to yield the calculated future concentrations in the aquifer directly underlying the waste area. Concentrations of CPCs determined to be present at this interface at levels above EPA Region III tap water criteria (risk of  $1 \times 10^{-7}$  and a HI of 0.1) were then selected as groundwater CPCs; their concentrations were estimated at specific locations (on-subunit, on-property, and off-property).

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Off-property concentrations of constituents in groundwater were calculated using the regional aquifer model, SWIFT III (Geotrans 1987). The maximum calculated concentrations in the aquifer underlying the Active Flyash Pile; South Field and Inactive Flyash Pile Area (combined); Solid Waste Landfill; and Lime Sludge Ponds were used to estimate on-subunit exposures. The maximum calculation concentrations on-property and at the fenceline were used for exposure point concentrations for on-property and off-property future groundwater exposures. Details of the model and parameters used to calculate future CPC concentrations in the Great Miami Aquifer are presented in Section 5.0. The locations of calculated maximum off-property concentrations of contaminants transported from the waste areas of Operable Unit 2 by groundwater are also shown in Section 5.0.

Exposure Point Concentrations for Surface Water and Sediment

Like groundwater, exposures to current concentrations in surface water and sediment, if present, outside the boundaries of Operable Unit 2 waste areas are to be addressed in the Operable Unit 5 risk assessment. CPC exposure point concentrations for current exposures to surface water and sediment within each subunit were estimated using fate and transport modeling. For future exposures to surface water in Paddys Run and the Great Miami River, fate and transport modeling was used to determine CPC exposure point concentrations. Surface water CPCs included all CPCs selected for surface soil within each subunit. The Modified Universal Soil Loss Equation (MUSLE), a commonly used soil loading model (EPA 1988c), was used to determine if soil runoff, and hence sorbed constituent runoff, would contribute significantly to constituent concentrations in Paddys Run and consequently in the Great Miami River. The source term for this model is the 95 percent UCL surface soil concentrations. The model and modeling results are presented in Section 5.0 and Appendix A.

Exposure Point Concentrations for Air

Operable Unit 2 airborne concentrations of constituents from the individual waste areas were modeled for both current and future conditions at on-subunit, on-property, and off-property locations. The model assumed mass loading (fugitive dust emissions) of surface soil to the air from each waste area and subsequent transport and dispersion of contaminants. The model and parameters for air dispersion are described in Section 5.0. The initial source term for air modeling is the 95 percent UCL soil concentration. The results of air modeling provide the highest annual average air concentrations and deposition rates at each of the specified locations (on-subunit, on-property, off-

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property). This allows for calculation of exposures to constituents being released to air and exposures resulting from ingestion of vegetation on which air particulates are deposited.

6.2.3.2 Intake Equations

The equations and parameter values used in estimating intake are provided in Section B.2.2 of Appendix B. Attachment III of Appendix B presents the calculated intakes by subunit for each current and future receptor, media, and pathway.

6.2.4 Toxicity Assessment

A toxicity assessment examines information concerning the potential effects of exposure to CPCs and summarizes EPA-approved toxicity values. The goal is to provide a quantitative estimate of the relationship between the magnitude and type of exposure and severity or probability of human health effects for each CPC. The toxicity assessment, Section B.2.5 of Appendix B, contains a compilation of toxicity values for CPCs. Summaries of the toxic effects associated with major CPCs are included as toxicity profiles collected in Attachment II, Appendix B.

6.2.5 Risk Characterization

Risk characterization is the final step in the risk assessment process, combining the information developed in the exposure assessment (Section B.2.4) and the toxicity assessment (Section B.2.5). Risk characterization is discussed in detail in Section B.2.6 of Appendix B. The potential of a CPC to cause carcinogenic effects is presented as the incremental lifetime cancer risk (ILCR). Potential noncarcinogenic effects are presented as hazard quotients (HQs) or HIs, as defined in Section B.2.6 of Appendix B.

All site-related risks in the risk assessment are calculated without subtracting the contribution from natural background. In some areas in Operable Unit 2, the concentrations of CPCs are only slightly above background levels. Therefore, it is informative to calculate the risks from background contributions to provide a point of comparison for the site-related risk estimates.

Risks and HIs are calculated for background concentrations of CPCs in soil and groundwater using the same exposure pathways quantitatively evaluated for the RME on-property resident farmer for soil. Exposure point concentrations, which are dependent on the results of air and groundwater modeling, were derived assuming background soil concentrations for the source terms in both

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groundwater and soil modeling. The parameter values used for calculating background intakes are also the same as those used for evaluating subunit-specific risks to the RME on-property resident farmer. Soil concentrations used for background risk and hazard calculations are calculated UCL values for the site-specific background soil sample analytical results.

6.3 RESULTS

This section presents the COCs and results of risks and hazards from each subunit as well as cumulative risk from Operable Unit 2 as a whole. Summary of tables in this section present the total risks and hazards posed to each receptor via the various pathways (e.g., soil, sediment, homegrown produce, etc.). Additionally, summaries of major contributors to risks and hazards by pathways are provided for selected future land use receptors. These receptors include the off-property farmer, expanded trespasser, and on-property farmer (RME). Major contributors to current land use receptors are discussed briefly in this section and are presented in detail in Section B.3.0 of Appendix B.

Summary tables in Appendix B present detailed lists of CPCs contributing risk to specific scenarios and receptors via the various pathways.

6.3.1 Active Flyash Pile

Table 6-7 presents the COCs by media identified for the Active Flyash Pile.

TABLE 6-7  
ACTIVE FLYASH PILE  
CONTAMINANTS OF CONCERN (COCs)

SOIL	
neptunium-237	uranium-235/236
radium-226	uranium-238
radium-226/228	arsenic
thorium-228	beryllium
GROUNDWATER	
uranium-234	uranium-238
PERCHED GROUNDWATER	
no COCs	

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Tables 6-8A and 6-8B summarize total risks and hazards by media, respectively, associated with the Active Flyash Pile for all receptors assuming current land use. Exposure of the trespassing youth and groundskeeper to contaminated soil; exposures of the off-property farmer to homegrown produce; and exposure of the current meat and milk user were associated with carcinogenic risks in the  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-5}$  range. Major contributors to total risk posed to the trespassing youth were from radium-226 (11.55 percent), radium-228 (3.84 percent), and thorium-228 (8.92 percent) in soil via external radiation and from arsenic (3.88 percent) and beryllium (70.59 percent) in soil via dermal contact. Risk to the off-property farmer from ingestion of homegrown produce was due to the estimated uptake of arsenic (66.17 percent) and beryllium (8.43 percent). Exposure of the groundskeeper to contaminated soil was associated with a risk of  $9.2 \times 10^{-5}$ . Exposure to this receptor was mostly from thorium-228 and beryllium which accounted for 18 percent and 63 percent, respectively, of the total risk to this receptor. No exposures resulted in HIs exceeding 1.0.

Tables 6-9A and 6-9B summarize total risks and hazards by media, respectively, associated with the Active Flyash Pile for receptors assuming future land use. Tables 6-10A and 6-10B present the major contributors by media to total risks and hazards, respectively, posed to the selected receptors. The greatest risks associated with the Active Flyash Pile are from direct contact with soil (surface flyash material). Total estimated risks to the expanded trespasser slightly exceeded the  $1.0 \times 10^{-4}$  level due mostly to the estimated presence of beryllium in flyash material which accounted for 87.32 percent of the total risk to this receptor.

Total estimated risk to the off-property farmer exceeded the  $1.0 \times 10^{-6}$  level due mostly to direct exposure to the estimated future concentrations of uranium-234 and uranium-238 and in groundwater which together accounted for about 65 percent of total risk to this receptor. The estimated presence of arsenic in flyash material accounted for another 12 percent of total risk to this receptor due to its estimated deposition on produce.

Total estimated risks to future on-property residents were greatest for the RME farmer. Total risks to this receptor was  $1.9 \times 10^{-3}$  due mostly to the presence of neptunium-237, radium-228, and thorium-228 in surface flyash material which accounted for about 73 percent of total risk to this receptor (equal to  $1.4 \times 10^{-3}$  total radiological risk to soil); and arsenic in surface flyash material which accounted for 21 percent of total risk to this receptor (equal to  $4.0 \times 10^{-4}$  total chemical risk to soil). Risk due to direct contact with contaminants in groundwater accounts for only 2.5 percent of

TABLE 6-8A  
**CURRENT LAND USE  
 ACTIVE FLYASH PILE  
 SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
Total Rad Risk	1.7E-05	8.5E-08	1.5E-09	N/A <sup>a</sup>	2.6E-05
Total Chem Risk	5.1E-05	9.4E-08	8.0E-09	N/A	6.6E-05
<i>Total Risk</i>	6.8E-05	1.8E-07	9.5E-09	N/A	9.2E-05
<b>Surface Water</b>					
Total Rad Risk	9.7E-10	N/A	N/A	N/A	N/A
Total Chem Risk	5.2E-08	N/A	N/A	N/A	N/A
<i>Total Risk</i>	5.3E-08	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
Total Rad Risk	N/A	3.8E-08	2.8E-09	N/A	N/A
Total Chem Risk	N/A	1.3E-06	4.4E-07	N/A	N/A
<i>Total Risk</i>	N/A	1.3E-06	4.4E-07	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
Total Rad Risk	N/A	3.4E-09	6.0E-10	1.0E-07	N/A
Total Chem Risk	N/A	2.1E-07	4.9E-08	6.4E-06	N/A
<i>Total Risk</i>	N/A	2.1E-07	4.9E-08	6.5E-06	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-8B**  
**CURRENT LAND USE**  
**ACTIVE FLYASH PILE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
<i>Total Hazard</i>	1.1E-01	8.8E-05	8.7E-05	N/A <sup>a</sup>	9.9E-02
<b>Surface Water</b>					
<i>Total Hazard</i>	1.1E-03	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	2.6E-03	1.0E-02	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	1.5E-03	5.1E-03	4.7E-02	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-9A**  
**ACTIVE FLYASH PILE**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>							
Total Rad Risk	2.4E-05	8.5E-08	1.5E-09	1.4E-03	1.9E-04	N/A <sup>a</sup>	N/A
Total Chem Risk	2.2E-04	9.4E-08	8.0E-09	4.0E-04	3.9E-04	N/A	N/A
<i>Total Risk</i>	2.4E-04	1.8E-07	9.5E-09	1.8E-03	5.8E-04	N/A	N/A
<b>Sediment</b>							
Total Rad Risk	N/A	N/A	N/A	N/A	N/A	1.8E-05	7.0E-06
Total Chem Risk	N/A	N/A	N/A	N/A	N/A	1.1E-04	5.7E-05
<i>Total Risk</i>	N/A	N/A	N/A	N/A	N/A	1.3E-04	6.5E-05
<b>Groundwater</b>							
Total Rad Risk	N/A	6.4E-06	2.7E-07	4.7E-05	2.0E-06	N/A	N/A
Total Chem Risk	N/A	1.0E-09	2.0E-10	2.4E-15	4.8E-16	N/A	N/A
<i>Total Risk</i>	N/A	6.4E-06	2.7E-07	4.7E-05	2.0E-06	N/A	N/A
<b>Surface Water</b>							
Total Rad Risk	2.47E-08	N/A	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	5.43E-07	N/A	N/A	N/A	N/A	N/A	N/A
<i>Total Risk</i>	5.68E-07	N/A	N/A	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>							
Total Rad Risk	N/A	3.8E-08	2.8E-09	1.2E-06	8.6E-08	N/A	N/A
Total Chem Risk	N/A	1.3E-06	4.4E-07	3.8E-05	1.3E-05	N/A	N/A
<i>Total Risk</i>	N/A	1.3E-06	4.4E-07	4.0E-05	1.3E-05	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
Total Rad Risk	N/A	9.7E-07	7.2E-08	7.1E-06	5.3E-07	N/A	N/A
Total Chem Risk	N/A	1.5E-10	5.1E-08	3.6E-16	1.2E-16	N/A	N/A
<i>Total Risk</i>	N/A	9.7E-07	7.2E-08	7.1E-06	5.3E-07	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
Total Rad Risk	N/A	3.4E-09	6.0E-10	1.0E-07	1.8E-08	N/A	N/A
Total Chem Risk	N/A	2.1E-07	4.9E-08	6.4E-06	1.5E-06	N/A	N/A
<i>Total Risk</i>	N/A	2.1E-07	4.9E-08	6.5E-06	1.5E-06	N/A	N/A
<b>Beef/Milk (Groundwater Affected)</b>							
Total Rad Risk	N/A	1.1E-07	2.0E-08	8.5E-07	1.5E-07	N/A	N/A
Total Chem Risk	N/A	1.4E-11	3.3E-12	3.5E-17	8.2E-18	N/A	N/A
<i>Total Risk</i>	N/A	1.1E-07	2.0E-08	8.5E-07	1.5E-07	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-9B**  
**ACTIVE FLYASH PILE**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>							
<i>Total Hazard</i>	2.8E-01	8.8E-05	8.7E-05	1.0	5.1E+00	N/A <sup>a</sup>	N/A
<b>Sediment</b>							
<i>Total Hazard</i>	N/A	N/A	N/A	N/A	N/A	1.6E-01	2.5E-01
<b>Groundwater</b>							
<i>Total Hazard</i>	N/A	1.1E-01	3.3E-01	8.1E-01	1.8E+00	N/A	N/A
<b>Surface Water</b>							
<i>Total Hazard</i>	5.68E-07	N/A	N/A	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	2.6E-03	1.0E-02	7.8E-02	3.2E-01	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	6.2E-02	2.5E-01	6.6E-13	2.7E-12	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	1.5E-03	5.0E-03	4.6E-02	1.5E-01	N/A	N/A
<b>Beef/Milk (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	5.7E-03	5.6E-02	1.2E-02	1.2E-01	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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TABLE 6-10A

ACTIVE FLYASH PILE  
 SUMMARY OF TOTAL CARCINOGENIC RISK  
 FOR SELECTED FUTURE LAND USE RECEPTORS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	Media	Receptor Risk	% Total Risk	COC <sup>b</sup>		Receptor Risk	% Total Risk	COC		Receptor Risk	% Total Risk	COC
Major Risk Contributors				% Risk of Total	Major Risk Contributors			% Risk of Total	Major Risk Contributors			% Risk of Total
Soil	1.8E-07 <sup>c</sup>	1.95%	- <sup>d</sup>		2.4E-04	99.76%	Ra-226	4.53%	1.8E-03	94.65%	Th-228	46.91%
							Th-228	3.50%			Ra-228	20.26%
							Ra-228	1.51%			Np-237	5.46%
							Beryllium	87.32%			Arsenic	21.21%
							Arsenic	2.48%				
Groundwater	6.4E-06	69.78%	U-238	42.59%	NA <sup>e</sup>	-			4.7E-05	2.49%	U-238	1.58%
			U-234	22.06%							U-234	0.82%
Home Grown Produce (Dust Affected)	1.3E-06	14.22%	Arsenic	12.24%	NA	-			4.0E-05	2.09%	Arsenic	1.80%
											Beryllium	0.23%
Home Grown Produce (Groundwater Affected)	9.7E-07 <sup>c</sup>	10.52%	-		NA	-			7.1E-06	0.38%	U-238	0.24%
											U-234	0.12%
Beef/Milk (Dust Affected)	2.1E-07 <sup>c</sup>	2.33%	-		NA	-			6.5E-06	0.34%	Arsenic	0.32%
ALL MEDIA	9.2E-06				2.4E-04				1.9E-03			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below risk threshold level - provided for comparison purposes

<sup>d</sup>No major risk contributors

<sup>e</sup>NA = not applicable to conceptual model

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**TABLE 6-10B**  
**ACTIVE FLYASH PILE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	Media	Receptor Hazard	% Total Hazard	COC <sup>b</sup>		Receptor Hazard	% Total Hazard	COC		Receptor Hazard	% Total Hazard	COC
Major Hazard Contributors				% Hazard of Total	Major Hazard Contributors			% Hazard of Total	Major Hazard Contributors			% Hazard of Total
Soil	8.8E-05 <sup>c</sup>	0.05%	- <sup>d</sup>		2.8E-01	100%	Arsenic	58.81%	1.0	49.65%	Arsenic	36.41%
							Beryllium	13.87%			Toluene	5.90%
							U-Total	12.60%			Beryllium	3.62%
							Nickel	6.02%				
Groundwater	1.1E-01	55.31%	U-Total	55.30%	NA <sup>e</sup>	-			8.1E-01	38.75%	U-Total	38.75%
Home Grown Produce (Groundwater Affected)	6.2E-02	39.53%	Barium	32.31%	NA	-			6.6E-13 <sup>c</sup>	5.07%	-	
			U-Total	7.23%								
<b>ALL MEDIA</b>	<b>1.9E-01</b>				<b>2.8E-01</b>				<b>2.1</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below hazard threshold level - provided for comparison purposes

<sup>d</sup>No major hazard contributors

<sup>e</sup>NA = not applicable to conceptual model

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total risk (equal to  $4.7 \times 10^{-5}$  total radiological risk in groundwater) to this receptor. Contributions of homegrown and produce and beef and milk to risk for this receptor are negligible.

The only receptors associated with total HIs greater than 1.0 are the future on-property RME farmer and child. Total HI for the farmer is 2.1 due mostly to the presence of arsenic, beryllium, and toluene in surface flyash material which accounted for about 45 percent of total receptor hazard. Total HI for the future on-property child is 8.0, again due mostly to the presence of arsenic, beryllium, and toluene in surface flyash material which accounted for approximately 60 percent of total receptor hazard.

Total estimated risk to future Great Miami River users was greatest for the adult receptor. Total risk to this receptor was  $1.3 \times 10^{-4}$ , due mostly to dermal contact of arsenic and beryllium in sediment which accounted for 25 and 61 percent of total risk to this receptor, respectively. Total HIs for this receptor were less than 1.0. The youth receptor total risk was  $6.5 \times 10^{-5}$  also due mostly to arsenic and beryllium in sediment which accounted for 31 and 58 percent of total risk, respectively. Total hazard for this receptor was less than 1.0.

6.3.2 South Field

Table 6-11 presents the COCs by media identified for the South Field.

**TABLE 6-11**  
**SOUTH FIELD**  
**CONTAMINANTS OF CONCERN (COCs)**

SOIL	
cesium-137	chromium
neptunium-237	Aroclor-1254
radium-226	Aroclor-1260
radium-228	benzo(a)anthracene
thorium-228	benzo(a)pyrene
thorium-230	benzo(b)fluoranthene
thorium-232	benzo(k)fluoranthene
uranium-234	chrysene
uranium-235/236	dibenzo(a,h)anthracene
uranium-238	dieldrin
arsenic	indeno(1,2,3-cd)pyrene
beryllium	
GROUNDWATER	
uranium-234	uranium-238
uranium-235/236	
PERCHED GROUNDWATER	
no COCs	

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Tables 6-12A and 6-12B summarize risks and hazards by media, respectively, associated with the South Field for receptors assuming current land use. Total carcinogenic risk to the trespassing youth was  $8.0 \times 10^{-5}$ . Major contributors to total risk were from radium-228 and thorium-228 via external radiation in soil and sediment which accounted for approximately 21 percent of total receptor risk and exposure to beryllium in soil and sediment which accounted for 70 percent of total receptor risk mainly through the dermal contact route. All total HIs were less than 1.0.

Total estimated risk to the current groundskeeper is  $6.5 \times 10^{-4}$  due primarily to thorium-228 in contaminated soil which accounted for 95 percent of total risk to this receptor. Total HI for this receptor was less than 1.0.

Tables 6-13A and 6-13B summarize risks and hazards by media, respectively, associated with the South Field for receptors assuming future land use. Tables 6-14A and 6-14B present the major contributors by media to total risks and hazards for the three selected receptors. The greatest risk was for the RME on-property farmer, which was  $3.8 \times 10^{-3}$ . Risks associated with groundwater use by this receptor were  $3.9 \times 10^{-4}$  and risks associated with groundwater affected homegrown produce and dust affected beef and milk for this receptor also exceeded  $1.0 \times 10^{-4}$ . The greatest proportion of the risks to the on-property farmer (RME) was attributable to the future estimated concentrations of uranium-234 (9.76 percent) and uranium-238 (18.83 percent) in groundwater, and consequently in irrigated homegrown produce and beef and milk from livestock watered with contaminated groundwater; from the presence of radium-228 (12.46 percent), thorium-228 (27.64 percent), and beryllium (8.74 percent) in surface soil. Risks to all other receptors (off-property farmer and resident child; and on-property resident child) via contact with groundwater, beef and milk, and homegrown produce were in the  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-4}$  range. The greatest hazard to all on- and off-property farm receptors was due to the estimated future presence of uranium-total (85.89 and 87.24 percent, respectively) in groundwater.

Total estimated risk to future Great Miami River users was greatest for the adult receptor. Total risk to this receptor was  $1.1 \times 10^{-4}$  due to benzo(a)pyrene in surface water which accounted for 36 percent of total risk to this receptor. Thorium-230 and beryllium in sediment accounted for 12 and 14 percent of total risk to this receptor, respectively. Total hazard for the adult receptor was less than 1.0.

**TABLE 6-12A**  
**CURRENT LAND USE**  
**SOUTH FIELD**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
Total Rad Risk	1.1E-05	1.4E-07	2.6E-09	N/A <sup>a</sup>	6.3E-04
Total Chem Risk	1.3E-05	3.2E-08	2.7E-09	N/A	1.9E-05
<i>Total Risk</i>	2.4E-05	1.8E-07	5.3E-09	N/A	6.5E-04
<b>Sediment</b>					
Total Rad Risk	7.0E-06	N/A	N/A	N/A	N/A
Total Chem Risk	5.0E-05	N/A	N/A	N/A	N/A
<i>Total Risk</i>	5.7E-05	N/A	N/A	N/A	N/A
<b>Surface Water</b>					
Total Rad Risk	2.2E-08	N/A	N/A	N/A	N/A
Total Chem Risk	<sup>b</sup>	N/A	N/A	N/A	N/A
<i>Total Risk</i>	N/A	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
Total Rad Risk	N/A	2.6E-09	1.9E-10	N/A	N/A
Total Chem Risk	N/A	3.4E-08	1.2E-08	N/A	N/A
<i>Total Risk</i>	N/A	3.7E-08	1.2E-08	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
Total Rad Risk	N/A	7.7E-10	1.3E-10	6.6E-09	N/A
Total Chem Risk	N/A	4.9E-07	2.8E-07	4.2E-06	N/A
<i>Total Risk</i>	N/A	4.9E-07	2.8E-07	4.2E-06	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

<sup>b</sup>No risk greater than the threshold level of  $1 \times 10^{-6}$

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**TABLE 6-12B**  
**CURRENT LAND USE**  
**SOUTH FIELD**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

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Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
<i>Total Hazard</i>	3.5E-02	2.9E-13	2.8E-13	N/A <sup>a</sup>	4.1E-02
<b>Sediment</b>					
<i>Total Hazard</i>	1.1E-01	N/A	N/A	N/A	N/A
<b>Surface Water</b>					
<i>Total Hazard</i>	2.1E-01	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	1.0E-05	4.1E-05	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	1.9E-06	7.7E-06	1.7E-05	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-13A**  
**SOUTH FIELD**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>							
Total Rad Risk	1.7E-05	1.4E-07	2.6E-09	1.7E-03	1.2E-04	N/A <sup>a</sup>	N/A
Total Chem Risk	5.1E-05	3.2E-08	2.7E-09	6.9E-04	1.9E-04	N/A	N/A
<i>Total Risk</i>	6.8E-05	1.8E-07	5.3E-09	2.4E-03	3.1E-04	N/A	N/A
<b>Sediment</b>							
Total Rad Risk	4.9E-06	N/A	N/A	N/A	N/A	2.0E-05	8.1E-06
Total Chem Risk	1.5E-04	N/A	N/A	N/A	N/A	2.0E-05	9.8E-06
<i>Total Risk</i>	1.5E-04	N/A	N/A	N/A	N/A	4.04-05	1.8E-05
<b>Groundwater</b>							
Total Rad Risk	N/A	2.0E-05	8.5E-07	3.9E-04	1.7E-05	N/A	N/A
Total Chem Risk	N/A	<sup>b</sup>	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	2.0E-05	8.5E-07	3.9E-04	1.7E-05	N/A	N/A
<b>Surface Water</b>							
Total Rad Risk	5.7E-07	N/A	N/A	N/A	N/A	1.6E-06	6.5E-07
Total Chem Risk	N/A	N/A	N/A	N/A	N/A	6.9E-05	4.5E-05
<i>Total Risk</i>	5.7E-07	N/A	N/A	N/A	N/A	7.0E-05	4.5E-05
<b>Homegrown Produce (Dust Affected)</b>							
Total Rad Risk	N/A	7.5E-08	5.5E-09	6.2E-07	4.6E-08	N/A	N/A
Total Chem Risk	N/A	9.6E-07	3.3E-07	8.0E-06	2.8E-06	N/A	N/A
<i>Total Risk</i>	N/A	1.0E-06	3.4E-07	8.6E-06	2.8E-06	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
Total Rad Risk	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
Total Chem Risk	-	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
Total Rad Risk	N/A	2.3E-08	3.9E-09	1.9E-07	3.2E-08	N/A	N/A
Total Chem Risk	N/A	1.4E-05	8.0E-06	1.2E-04	6.9E-05	N/A	N/A
<i>Total Risk</i>	N/A	1.4E-05	8.0E-06	1.2E-04	6.9E-05	N/A	N/A

See footnotes at end of table

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TABLE 6-13A  
(Continued)

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Beef/Milk (Groundwater Affected)</b>							
Total Rad Risk	N/A	1.0E-06	1.8E-07	1.9E-05	3.5E-06	N/A	N/A
Total Chem Risk	-	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	1.0E-06	1.8E-07	1.9E-05	3.5E-06	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

<sup>b</sup>No risk great than the threshold level of  $1 \times 10^{-6}$ .

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FEMP-OU02-4 DRAFT  
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**TABLE 6-13B**  
**SOUTH FIELD**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>							
<i>Total Hazard</i>	1.0E-01	2.9E-13	2.8E-13	2.7E-01	7.7E-01	N/A <sup>a</sup>	N/A
<b>Sediment</b>							
<i>Total Hazard</i>	1.5E-01	N/A	N/A	N/A	N/A	2.1E-02	2.6E-02
<b>Groundwater</b>							
<i>Total Hazard</i>	N/A	9.9E-01	2.0E+00	1.9E+01	4.3E+01	N/A	N/A
<b>Surface Water</b>							
<i>Total Hazard</i>	1.3E-01	N/A	N/A	N/A	N/A	2.3E-02	3.7E-02
<b>Homegrown Produce (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	2.9E-04	1.2E-03	2.4E-03	9.7E-03	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	1.3E-01	5.2E-01	2.5E+00	1.0E+01	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	6.9E-05	3.7E-04	6.0E-04	3.2E-03	N/A	N/A
<b>Beef/Milk (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	1.5E-02	1.5E-01	3.0E-01	2.9E+00	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-14A**  
**SOUTH FIELD**  
**SUMMARY OF TOTAL CARCINOGENIC RISK**  
**FOR SELECTED FUTURE LAND USE RECEPTOR**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	Media	Receptor Risk	% Total Risk	COC <sup>b</sup>		Receptor Risk	% Total Risk	COC		Receptor Risk	% Total Risk	COC
Major Risk Contributors				% Risk of Total	Major Risk Contributors			% Risk of Total	Major Risk Contributors			% Risk of Total
Soil	1.8E-07 <sup>c</sup>	0.22%	- <sup>d</sup>		6.8E-05	31.15%	Th-228	4.62%	2.4E-03	62.57%	Th-228	27.64%
							Ra-228	2.01%			Ra-228	12.46%
							Beryllium	19.23%			Beryllium	8.74%
							Aroclor-1254	1.31%			Benzo(a)-pyrene	4.53%
Sediment	NA <sup>e</sup>		-		1.5E-04	68.59%	Th-228	1.43%	NA		-	
							Beryllium	64.85%				
							Arsenic	1.48%				
Groundwater	2.0E-05	69.57%	U-238	44.97%	NA		-		3.9E-04	29.13%	U-238	18.83%
			U-234	23.27%							U-234	9.76%
Home Grown Produce (Dust Affected)	1.0E-06 <sup>c</sup>	1.28%	-		NA		-		8.6E-06	0.23%	Benzo(a)-pyrene	0.11%
Hone Grown Produce (Groundwater Affected)	8.4E-06	10.43%	U-238	6.73%	NA		-		1.6E-04	4.36	U-238	2.82%
			U-234	3.49%							U-234	1.46%
Beef/Milk (Dust Affected)	1.4E-05	17.26%	Indeno(1,2,3-cd)pyrene	13.99%	NA		-		1.2E-04	3.20%	Indeno(1,2,3-cd)pyrene	2.60%
Beef/Milk (Groundwater Affected)	1.0E-06 <sup>c</sup>	1.24%	-		NA		-		1.9E-05	0.51%	U-238	0.33%
											U-234	0.17%
<b>ALL MEDIA</b>	<b>8.1E-05</b>				<b>2.2E-04</b>				<b>3.8E-03</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below risk threshold level - provided for comparison purposes

<sup>d</sup>No major risk contributors

<sup>e</sup>NA = not applicable to conceptual model

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**TABLE 6-14B**  
**SOUTH FIELD**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	COC <sup>b</sup>				COC				COC			
	Media	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors
Soil	2.9E-13 <sup>c</sup>	0.00%	- <sup>d</sup>		1.0E-01	26.07%	U-Total Beryllium Arsenic	21.52% 2.03% 0.99%	2.7E-01	1.23%	U-Total Arsenic	0.80% 0.28%
Sediment	NA <sup>e</sup>		-		1.5E-01	40.45%	Manganese U-Total Beryllium Arsenic	12.61% 11.92% 5.41% 5.33%	NA		-	
Groundwater	9.9E-01	87.24%	U-Total	87.24%	NA		-		1.9E-01	86.19%	U-Total	85.89%
Surface Water	NA		-		1.3E-01	33.48%	U-Total	33.48%	NA		-	
Home Grown Produce (Groundwater Affected)	1.3E-01	11.40%	U-Total	11.40%	NA		-		2.5	11.25%	U-Total	11.23%
Beef/Milk (Groundwater Affected)	1.5E-02 <sup>c</sup>	1.33%	-		NA		-		3.0E-01	1.32%	U-Total	1.31%
<b>ALL MEDIA</b>	<b>1.1E+00</b>				<b>3.8E-01</b>				<b>1.3E+01</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below hazard threshold level - provided for comparison purposes

<sup>d</sup>No major hazard contributors

<sup>e</sup>NA = not applicable to conceptual model

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Total estimated risk to the Great Miami River youth user was  $6.3 \times 10^{-5}$  also due mostly to benzo(a)pyrene in surface water which accounted for 41 percent of total risk to this receptor. Beryllium in sediment contributed another 12 percent to total risk to this receptor. Total HI for this receptor was less than 1.0.

6.3.3 Inactive Flyash Pile

Table 6-15 presents the COCs by media identified for the Inactive Flyash Pile.

**TABLE 6-15**

**INACTIVE FLYASH PILE**

**CONTAMINANTS OF CONCERN (COCs)**

SOIL	
cesium-137	uranium-235/236
neptunium-237	uranium-238
radium-226	arsenic
radium-228	beryllium
thorium-228	dibenzo(a,h)anthracene
uranium-234	
GROUNDWATER	
uranium-234	uranium-238
uranium-235/236	
PERCHED GROUNDWATER	
no COCs	

Tables 6-16A and 6-16B summarize risks and hazards by media, respectively, associated with the Inactive Flyash Pile for receptors assuming current land use. No exposures resulted in HIs exceeding 1.0. Exposures of the trespassing youth to contaminated soils were associated with a total risk of  $3.3 \times 10^{-5}$  due to the presence of radium-228, thorium-228, and beryllium in surface soil, which account for 89 percent of total receptor risk. Total estimated risk to the groundskeeper was  $5.0 \times 10^{-5}$  due primarily to thorium-228 (23 percent of total risk) and beryllium (56 percent of total risk) in soil. Radium-228 in soil contributes 10 percent of total risk. Total HIs did not exceed 1.0.

Tables 6-17A and 6-17B summarize risks and hazards by media, respectively, associated with the Inactive Flyash Pile for receptors assuming future land use. Major contributors by media to total risks and hazards, respectively, posed to the selected receptors are presented in Tables 6-18A and 6-18B. The greatest carcinogenic risk was the risk associated with groundwater use by the RME on-property farmer which slightly exceeded  $1.0 \times 10^{-3}$ . Total risk for this receptor was  $3.2 \times 10^{-3}$  due

**TABLE 6-16A**  
**CURRENT LAND USE**  
**INACTIVE FLYASH PILE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
Total Rad Risk	6.7E-06	4.5E-08	8.2E-10	N/A <sup>a</sup>	1.8E-05
Total Chem Risk	2.5E-05	2.4E-08	2.0E-09	N/A	3.2E-05
<i>Total Risk</i>	3.1E-05	6.9E-08	2.8E-09	N/A	5.0E-05
<b>Sediment</b>					
Total Rad Risk	1.6E-06	N/A	N/A	N/A	N/A
Total Chem Risk	1.6E-07	N/A	N/A	N/A	N/A
<i>Total Risk</i>	1.7E-06	N/A	N/A	N/A	N/A
<b>Surface Water</b>					
Total Rad Risk	3.7E-08	N/A	N/A	N/A	N/A
Total Chem Risk	9.6E-09	N/A	N/A	N/A	N/A
<i>Total Risk</i>	4.6E-08	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
Total Rad Risk	N/A	4.9E-10	3.6E-11	N/A	N/A
Total Chem Risk	N/A	1.4E-08	4.9E-09	N/A	N/A
<i>Total Risk</i>	N/A	1.5E-08	4.9E-09	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
Total Rad Risk	N/A	8.2E-11	1.4E-11	1.1E-09	N/A
Total Chem Risk	N/A	2.3E-09	5.3E-10	3.0E-08	N/A
<i>Total Risk</i>	N/A	2.4E-09	5.4E-10	3.2E-08	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-16B**  
**CURRENT LAND USE**  
**INACTIVE FLYASH PILE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
<i>Total Hazard</i>	5.4E-02	0.0E+00	0.0E+00	N/A <sup>a</sup>	4.5E-02
<b>Sediment</b>					
<i>Total Hazard</i>	3.0E-02	N/A	N/A	N/A	N/A
<b>Surface Water</b>					
<i>Total Hazard</i>	4.0E-02	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	2.6E-05	1.1E-04	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	5.4E-06	2.0E-05	7.2E-05	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-17A**  
**INACTIVE FLYASH PILE**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>							
Total Rad Risk	9.2E-06	4.5E-08	8.2E-10	9.8E-04	7.3E-05	N/A <sup>a</sup>	N/A
Total Chem Risk	1.0E-04	2.4E-08	2.0E-09	9.9E-04	1.9E-04	N/A	N/A
<i>Total Risk</i>	1.1E-04	6.9E-08	2.8E-09	2.0E-03	2.6E-04	N/A	N/A
<b>Sediment</b>							
Total Rad Risk	1.1E-06	N/A	N/A	N/A	N/A	1.9E-05	7.5E-06
Total Chem Risk	2.E-07	N/A	N/A	N/A	N/A	1.0E-06	6.6E-07
<i>Total Risk</i>	1.3E-06	N/A	N/A	N/A	N/A	2.0E-05	8.2E-06
<b>Groundwater</b>							
Total Rad Risk	N/A	5.6E-05	2.4E-06	1.1E-03	4.7E-05	N/A	N/A
Total Chem Risk	N/A	<sup>b</sup>	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	5.6E-05	2.4E-06	1.1E-03	4.7E-05	N/A	N/A
<b>Surface Water</b>							
Total Rad Risk	9.4E-07	N/A	N/A	N/A	N/A	2.7E-08	1.1E-08
Total Chem Risk	1.4E-07	N/A	N/A	N/A	N/A	2.7E-07	6.1E-08
<i>Total Risk</i>	1.1E-06	N/A	N/A	N/A	N/A	3.0E-07	7.2E-08
<b>Homegrown Produce (Dust Affected)</b>							
Total Rad Risk	N/A	4.9E-10	3.6E-11	6.4E-09	4.8E-10	N/A	N/A
Total Chem Risk	N/A	1.4E-08	4.9E-09	1.9E-07	6.5E-08	N/A	N/A
<i>Total Risk</i>	N/A	1.5E-08	4.9E-08	1.9E-07	6.5E-08	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
Total Rad Risk	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	8.4E-06	6.3E-07	1.6E-04	1.2E-05	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
Total Rad Risk	N/A	8.2E-11	1.4E-11	9.9E-10	1.7E-10	N/A	N/A
Total Chem Risk	N/A	2.3E-09	5.3E-10	2.8E-08	6.3E-09	N/A	N/A
<i>Total Risk</i>	N/A	2.4E-09	5.4E-10	2.9E-08	6.5E-09	N/A	N/A

See footnotes at end of table

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**TABLE 6-17A  
(Continued)**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Beef/Milk (Groundwater Affected)</b>							
Total Rad Risk	N/A	9.8E-07	1.8E-07	1.9E-05	3.5E-06	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	9.8E-07	1.8E-07	1.9E-05	3.5E-06	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

<sup>b</sup>No risk greater than the threshold level of  $1 \times 10^{-6}$ .

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**TABLE 6-17B**  
**INACTIVE FLYASH PILE**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>							
<i>Total Hazard</i>	1.4E-01	N/A <sup>a</sup>	N/A	5.4E-01	1.6E+00	N/A	N/A
<b>Sediment</b>							
<i>Total Hazard</i>	4.7E-02	N/A	N/A	N/A	N/A	1.8E-02	2.3E-02
<b>Groundwater</b>							
<i>Total Hazard</i>	N/A	9.9E-01	2.0E+00	1.9E+01	4.3E+01	N/A	N/A
<b>Surface Water</b>							
<i>Total Hazard</i>	2.2E-01	N/A	N/A	N/A	N/A	3.6E-01	1.3E-03
<b>Homegrown Produce (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	2.6E-05	1.1E-04	3.5E-04	1.4E-03	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	2.2E-01	9.0E-01	2.5E+00	1.0E+01	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	5.4E-06	2.0E-05	6.5E-05	2.5E-04	N/A	N/A
<b>Beef/Milk (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	6.3E-02	4.4E-01	3.0E-01	2.9E+00	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-18A**  
**INACTIVE FLYASH PILE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

MEI Receptor:	Federal Ownership								Private Ownership				
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>				
	Media	Receptor Risk	% Total Risk	COC <sup>b</sup>		Receptor Risk	% Total Risk	COC		Receptor Risk	% Total Risk	COC	
				Major Risk Contributors	% Risk of Total			Major Risk Contributors	% Risk of Total			Major Risk Contributors	% Risk of Total
Soil	6.9E-08 <sup>c</sup>	0.11%	- <sup>d</sup>		1.1E-04	97.91%	Th-228	5.13%	2.0E-03	60.54%	Th-228	19.45%	
							Ra-228	2.20%			Ra-228	8.35%	
							Beryllium	87.68%			Beryllium	24.47%	
							Arsenic	1.89%			Arsenic	4.57%	
Sediment	NA <sup>e</sup>		-		1.3E-06	1.16%	-		NA		-		
Groundwater	5.6E-05	85.58%	U-238	55.32%	NA		-		1.1E-03	33.80%	U-238	21.86%	
			U-234	28.63%							U-234	11.33%	
			U-235/236	1.53%									
Surface Water	NA		-		1.1E-06	0.93%	-		NA		-		
Home Grown Produce (Groundwater Affected)	8.4E-06	12.80%	U-238	8.28%	NA		-		1.6E-04	5.06%	U-238	3.27%	
			U-234	4.29%							U-234	1.70%	
											U-235/236	0.09%	
Beef/Milk (Groundwater Affected)	9.8E-07 <sup>c</sup>	1.49%	-		NA		-		1.9E-05	0.59%	U-238	0.38%	
											U-234	0.20%	
<b>ALL MEDIA</b>	<b>6.6E-05</b>				<b>1.2E-04</b>				<b>3.2E-03</b>				

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below risk threshold level- provided for comparison only

<sup>d</sup>No major risk contributors

<sup>e</sup>NA = not applicable to conceptual model

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TABLE 6-18B

INACTIVE FLYASH PILE  
 SUMMARY OF TOTAL NONCARCINOGENIC HAZARD  
 FOR SELECTED FUTURE LAND USE RECEPTORS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Receptor:  Media	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	COC <sup>b</sup>				COC				COC			
	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total
Surface Soil	0.00 <sup>c</sup>		d		1.4E-01	34.49%	U-Total Cadmium Beryllium Arsenic	18.06% 6.41% 4.65% 4.29%	5.4E-01	2.40%	Arsenic U-Total Cadmium	1.24% 0.70% 0.25%
Sediment	NA <sup>e</sup>				4.7E-02	11.55%	U-Total Manganese	5.21% 5.15%	NA			
Groundwater	9.9E-01	77.57%	U-Total	77.57%	NA				19.0	85.16%	U-Total	84.87%
Surface Water	NA				2.2E-01	53.95%	U-Total	53.41%	NA			
Homegrown Produce (Groundwater Affected)	2.2E-01	17.50%	U-Total Molybdenum	10.14% 7.36%	NA				2.5	11.13%	U-Total	11.09%
Beef/Milk (Groundwater Affected)	6.3E-02 <sup>c</sup>	4.93%			NA				3.0E-01	1.31%	U-Total	1.29%
ALL MEDIA	3.4E+00				4.0E-01				2.3E+01			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below hazard threshold level - provided for comparison purposes

<sup>d</sup>No major hazard contributors

<sup>e</sup>NA = not applicable to conceptual model

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mostly to the future estimated concentrations of uranium-234 (11.33 percent) and uranium-238 (21.86 percent) in groundwater and consequently in irrigated produce and beef and milk from livestock watered with contaminated groundwater. Thorium-228 (19.45 percent) and beryllium (24.47 percent) in surface soil also contributed significant risk to this and other on-property receptors. As with the South Field, the greatest hazard to all receptors was due to the estimated presence of uranium-total in groundwater.

Exposures resulting in HIs greater than 1.0 were associated with on- and off-property residents via ingestion of groundwater and homegrown produce contaminated with uranium-total (74.28 and 17.55 percent, respectively).

Total estimated risk to future Great Miami River recreation users was in the  $1.0 \times 10^{-5}$  to  $1.0 \times 10^{-6}$  range. For the adult and youth receptors, thorium-228 and uranium-235/236 in sediment contributed 39 and 32 percent to total risk, respectively. Radium-228 in sediment contributed 17 percent. Total hazard for both receptors was less than 1.0.

6.3.4 Solid Waste Landfill

Table 6-19 presents the COCs by media identified for the Solid Waste Landfill.

**TABLE 6-19**  
**SOLID WASTE LANDFILL**  
**CONTAMINANTS OF CONCERN (COCs)**

SOIL	
cesium-137	uranium-238
neptunium-237	arsenic
radium-226	beryllium
radium-228	chromium
thorium-228	benzo(a)pyrene
thorium-230	benzo(b)fluoranthene
technetium-99	carbazole
plutonium-238	4,4-DDe
uranium-234	dibenzo(a,h)anthracene
uranium-235/236	indeno(1,2,3-cd)pyrene
GROUNDWATER	
no COCs	
PERCHED GROUNDWATER	
technetium-99	
carbazole	

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Tables 6-20A and 6-20B summarize risks and hazards by media, respectively, associated with the Solid Waste Landfill for receptors assuming current land use. Exposure of the trespassing youth to contaminated soil was associated with a total risk slightly greater than  $1.0 \times 10^{-5}$  due to external radiation from radium-228 (14.52 percent) and thorium-228 (24 percent) in soil and sediment and to dermal contact with beryllium (46 percent) in soil. HIs did not exceed 1.0 for any current receptor.

Total risk to the groundskeeper contacting air and soil was  $2.4 \times 10^{-5}$ . Dermal contact with beryllium accounts for 35 percent of total risk. In addition, external radiation from uranium-238, thorium-228, and radium-228 accounts for 10, 29, and 15 percent of total risk, respectively. Total hazard for this receptor did not exceed 1.0.

Tables 6-21A and 6-21B summarize risks and hazards by media, respectively, associated with the Solid Waste Landfill assuming future land use. Tables 6-22A and 6-22B summarize the major contributors to total risk for the off-property farmer, expanded trespasser, and on-property farmer (RME). Total risks barely exceeded  $1.0 \times 10^{-6}$  for future off-property farmer receptors. Risks were mostly due to the estimated presence of the naturally occurring radionuclides uranium-234 and uranium-238 in soil which contributed approximately 66 percent to the total risk. Risks exceeded the  $1.0 \times 10^{-3}$  level for perched groundwater users. This was due mostly to the estimated presence of carbazole in perched groundwater which accounted for 99.9 percent of total risk to this receptor. Risks exceeded  $1.0 \times 10^{-4}$  for the RME on-property farmer and child exposed to arsenic and beryllium in surface soil via dermal contact and ingestion; radium-228, uranium-238, and thorium-228 in surface soil via external radiation. Additional risk to the on-property residents is from ingestion of produce or livestock products estimated to be contaminated with a PAH. These estimates, however, are highly uncertain. Total HIs exceeded 1.0 due mostly to total uranium in soil. This is further discussed in Section B.4.0 of Appendix B.

Total risk to the homebuilder was  $5.1 \times 10^{-6}$  due to the same compounds and exposure pathways contributing risk to the on-property residents. Total HI for this receptor was 1.9 due to the pesticide 4,4-DDE in soil.

Risk to recreational users of the Great Miami River was in the  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-5}$  range. Thorium-228 in sediment accounted for 46 percent of total risk to this receptor. Radium-228 and



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**TABLE 6-20B**  
**CURRENT LAND USE**  
**SOLID WASTE LANDFILL**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
<i>Total Hazard</i>	3.2E-01	N/A <sup>a</sup>	N/A	N/A	1.4E-01
<b>Sediment</b>					
<i>Total Hazard</i>	7.6E-02	N/A	N/A	N/A	N/A
<b>Surface Water</b>					
<i>Total Hazard</i>	1.2E-03	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	4.5E-06	1.8E-05	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	1.0E-06	8.2E-06	6.1E-05	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-21A**  
**SOLID WASTE LANDFILL**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Home-builder	Perched Groundwater User	Perched Groundwater Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>										
Total Rad Risk	9.1E-06	9.8E-07	1.8E-08	8.4E-04	6.0E-05	2.7E-06	N/A <sup>a</sup>	N/A	N/A	N/A
Total Chem Risk	1.7E-07	5.3E-10	4.5E-11	1.5E-05	6.9E-06	1.1E-06	N/A	N/A	N/A	N/A
<i>Total Risk</i>	9.3E-06	9.8E-07	1.8E-08	8.6E-04	6.7E-05	3.9E-06	N/A	N/A	N/A	N/A
<b>Sediment</b>										
Total Rad Risk	1.6E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	9.9E-06	3.9E-06
Total Chem Risk	9.6E-07	N/A	N/A	N/A	N/A	N/A	N/A	N/A	3.2E-07	2.0E-07
<i>Total Risk</i>	2.5E-06	N/A	N/A	N/A	N/A	N/A	N/A	N/A	1.9E-06	8.1E-07
<b>Groundwater</b>										
Total Rad Risk	N/A	0.0E+00	0.0E+00	0.0E+00	0.0E+00	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	<sup>b</sup>	-	-	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	0.0E+00	0.0E+00	0.0E+00	0.0E+00	N/A	N/A	N/A	N/A	N/A
<b>Perched Groundwater</b>										
Total Rad Risk	N/A	N/A	N/A	N/A	N/A	N/A	5.3E-03	1.1E-03	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	N/A	N/A	N/A	N/A	N/A	5.3E-03	1.1E-03	N/A	N/A
<b>Surface Water</b>										
Total Rad Risk	6.8E-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.5E-08	2.2E-08
Total Chem Risk	2.5E-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.0E-11	2.6E-11
<i>Total Risk</i>	9.3E-08	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.5E-08	2.2E-08
<b>Homegrown Produce (Dust Affected)</b>										
Total Rad Risk	N/A	7.3E-09	5.4E-10	5.0E-07	3.7E-08	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	1.2E-07	4.0E-08	8.0E-06	2.8E-06	N/A	N/A	N/A	N/A	N/A
<i>Total Risk</i>	N/A	1.2E-07	4.1E-08	8.5E-06	2.8E-06	N/A	N/A	N/A	N/A	N/A

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TABLE 6-21A  
(Continued)

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Home-builder	Perched Groundwater User	Perched Groundwater Child	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Homegrown Produce (Groundwater Affected)</b>										
Total Rad Risk	N/A	7.4E-10	5.5E-11	8.3E-09	6.2E-10	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	7.4E-10	5.5E-11	8.3E-09	6.2E-10	N/A	N/A	N/A	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>										
Total Rad Risk	N/A	1.3E-09	2.3E-10	7.9E-08	1.4E-08	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	1.5E-07	8.4E-08	9.0E-06	5.1E-06	N/A	N/A	N/A	N/A	N/A
<i>Total Risk</i>	N/A	1.5E-07	8.4E-08	9.0E-06	5.1E-06	N/A	N/A	N/A	N/A	N/A
<b>Beef/Milk (Groundwater Affected)</b>										
Total Rad Risk	N/A	1.2E-09	2.1E-10	1.4E-08	2.3E-09	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	-	-	-	-	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	1.2E-09	2.1E-10	1.4E-08	2.3E-09	N/A	N/A	N/A	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

<sup>b</sup>No risk greater than the threshold level of  $1 \times 10^{-6}$ .

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**TABLE 6-21B**  
**SOLID WASTE LANDFILL**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Home-builder	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>								
<i>Total Risk</i>	6.5E-01	0.0E+00	0.0E+00	1.5E+00	3.3E+00	1.9E+00	N/A <sup>a</sup>	N/A
<b>Sediment</b>								
<i>Total Risk</i>	5.6E-02	N/A	N/A	N/A	N/A	N/A	1.4E-01	1.7E-01
<b>Surface Water</b>								
<i>Total Risk</i>	4.1E-02	N/A	N/A	N/A	N/A	N/A	2.5E-05	4.4E-05
<b>Homegrown Produce (Dust Affected)</b>								
<i>Total Risk</i>	N/A	1.0E-04	4.2E-04	7.2E-03	2.9E-02	N/A	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>								
<i>Total Risk</i>	N/A	2.4E-05	1.9E-04	1.4E-08	1.2E-02	N/A	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-22A**  
**SOLID WASTE LANDFILL**  
**SUMMARY OF TOTAL CARCINOGENIC RISK**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

MEI Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	Media	Receptor Risk	% Total Risk	COC <sup>b</sup>		Receptor Risk	% Total Risk	COC		Receptor Risk	% Total Risk	COC
Major Risk Contributors				% Risk of Total	Major Risk Contributors			% Risk of Total	Major Risk Contributors			% Risk of Total
Soil	9.8E-07 <sup>c</sup>	79.35%	- <sup>d</sup>		9.3E-06	93.98%	Th-228	8.26%	8.6E-04	98.48%	Th-228	32.89%
							U-238	5.47%			Ra-228	17.59%
							Ra-228	4.37%			U-238	14.47%
							Beryllium	71.41%			U-235/236	2.53%
											Beryllium	21.11%
Sediment	NA <sup>e</sup>	-			2.5E-06	5.81%	-		NA		-	
Home Grown Produce (Dust Affected)	1.2E-07 <sup>c</sup>	9.27%	-		NA		-		8.5E-06	0.73%	Arsenic	0.62%
Beef/Milk (Dust Affected)	1.5E-07 <sup>c</sup>	11.24%	-		NA		-		9.0E-06	0.78%	Indeno(1,2,3-cd)pyrene	0.63%
<b>ALL MEDIA</b>	<b>1.3E-06</b>				<b>4.4E-05</b>				<b>1.2E-03</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below risk threshold level - provided for comparison purposes

<sup>d</sup>No major risk contributors

<sup>e</sup>NA = not applicable to conceptual model

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**TABLE 6-22B**  
**SOLID WASTE LANDFILL**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	Media	Receptor Hazard	% Total Hazard	COC <sup>b</sup>		Receptor Hazard	% Total Hazard	COC		Receptor Hazard	% Total Hazard	COC
Major Hazard Contributors				% Hazard of Total	Major Hazard Contributors			% Hazard of Total	Major Hazard Contributors			% Hazard of Total
Soil	0.00 <sup>c</sup>	0.00%	- <sup>d</sup>		6.5E-01	86.96%	U-Total	84.33%	1.5	99.41%	U-Total	92.86%
Sediment	NA <sup>e</sup>		-		5.6E-02	7.58%	U-Total Manganese	4.89% 1.27%	NA		-	
Surface Water	NA		-		4.1E-02	5.46%	Bis(2-ethyl-hexyl)-phthalate U-Total	3.16% 2.10%	NA		-	
Home Grown Produce (Dust Affected)	1.0E-04	81.47%	U-Total Arsenic Chromium	60.10% 17.99% 2.47%	NA		-		7.2E-03	0.48%	U-Total Arsenic	0.36% 0.11%
Beef/Milk (Dust Affected)	2.4E-05	18.53%	U-Total Arsenic Chromium	12.49% 3.19% 2.28%	NA		-		1.4E-03	0.10%	U-Total	0.07%
<b>ALL MEDIA</b>	<b>1.3E-04</b>				<b>7.4E-01</b>				<b>1.5E+00</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below hazard threshold level - provided for comparison purposes

<sup>d</sup>No major hazard contributors

<sup>e</sup>NA = not applicable to conceptual model

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uranium-238 in sediment contributed 25 and 15 percent, respectively. HIs ranged from 1.5 to 3.3 for future on-property receptors due to the presence of uranium-total in soil.

6.3.5 Lime Sludge Ponds

Table 6-23 presents the COCs by media identified for the Lime Sludge Ponds.

**TABLE 6-23**  
**LIME SLUDGE PONDS**  
**CONTAMINANTS OF CONCERN (COCs)**

SOIL	
cesium-137	arsenic
neptunium-237	beryllium
radium-226	chromium
radium-228	Aroclor-1254
thorium-228	benzo(a)pyrene
thorium-230	benzo(b)fluroanthene
uranium-234	dibenzo(a,h)anthracene
uranium-235/236	indeno(1,2,3-cd)pyrene
uranium-238	
GROUNDWATER	
no COCs	
PERCHED GROUNDWATER	
no COCs	

Tables 6-24A and 6-24B summarize risks and hazards by media, respectively, associated with Lime Sludge Pond receptors assuming current land use. Risks to the trespassing youth exceeded  $1.0 \times 10^{-5}$  due to external radiation exposure to surface soil containing radium-228 and thorium-228 and dermal exposure to beryllium and Aroclor-1254 in soil. Total risk to the current groundskeeper exposed to soil was  $4.7 \times 10^{-5}$  due mostly to the presence of thorium-228 accounting for 27 percent of total risk; and dermal contact with beryllium which accounted for 40 percent of total risk. All calculated HIs were below 1.0.

Tables 6-25A and 6-25B summarize risks and hazards by media, respectively, associated with Lime Sludge Pond receptors assuming future land use. Tables 6-26A and 6-26B present the major contributors by media to total risks and hazards for the three selected receptors. Total risks to the on-property RME farmer and resident child exceed  $1.0 \times 10^{-3}$  due primarily to direct contact with surface soil containing radium-228 (10.65 and 7 percent), thorium-228 (36.45 and 24 percent), uranium-238

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**TABLE 6-24A**  
**CURRENT LAND USE**  
**LIME SLUDGE PONDS**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
Total Rad Risk	7.6E-06	1.2E-07	2.2E-09	N/A <sup>a</sup>	2.2E-05
Total Chem Risk	2.0E-05	2.3E-09	2.0E-10	N/A	2.5E-05
<i>Total Risk</i>	2.8E-05	1.2E-07	2.4E-09	N/A	4.7E-05
<b>Sediment</b>					
Total Rad Risk	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	N/A	N/A	N/A	N/A
<i>Total Risk</i>	N/A	N/A	N/A	N/A	N/A
<b>Surface Water</b>					
Total Rad Risk	N/A	N/A	N/A	N/A	N/A
Total Chem Risk	N/A	N/A	N/A	N/A	N/A
<i>Total Risk</i>	N/A	N/A	N/A	N/A	N/A
<b>Homegrown Produce (Dust Affected)</b>					
Total Rad Risk	N/A	6.3E-09	4.7E-10	N/A	N/A
Total Chem Risk	N/A	3.3E-08	1.1E-08	N/A	N/A
<i>Total Risk</i>	N/A	3.9E-08	1.2E-08	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
Total Rad Risk	N/A	1.0E-09	1.8E-10	9.2E-08	N/A
Total Chem Risk	N/A	6.2E-08	3.5E-08	5.4E-06	N/A
<i>Total Risk</i>	N/A	6.3E-08	3.5E-08	5.5E-06	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-24B**  
**CURRENT LAND USE**  
**LIME SLUDGE PONDS**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Trespassing Youth	Off-Property Resident Farmer	Off-Property Resident Child	User of Milk and Meat	Groundskeeper
<b>Soil</b>					
<i>Total Hazard</i>	2.2E-01	0.0E+00	0.0E+00	N/A <sup>a</sup>	1.4E-01
<b>Homegrown Produce (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	9.1E-05	3.2E-05	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	2.1E-05	1.7E-04	1.8E-03	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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TABLE 6-25A  
 LIME SLUDGE PONDS  
 FUTURE LAND USE  
 SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Perched Groundwater User (Adult)	Perched Groundwater User (Child)
<b>Soil</b>							
Total Rad Risk	1.0E-05	1.2E-07	2.2E-09	1.1E-03	8.2E-05	N/A <sup>a</sup>	N/A
Total Chem Risk	8.8E-05	2.3E-09	2.0E-10	7.5E-04	1.2E-04	N/A	N/A
<i>Total Risk</i>	9.8E-05	1.2E-07	2.4E-09	1.9E-03	2.1E-04	N/A	N/A
<b>Groundwater</b>							
Total Rad Risk	N/A	9.1E-09	3.9E-10	1.6E-07	6.9E-09	N/A	N/A
Total Chem Risk	N/A	<sup>b</sup>	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	9.1E-09	3.9E-10	1.6E-07	6.9E-09	N/A	N/A
<b>Perched Groundwater</b>							
Total Rad Risk	N/A	N/A	N/A	N/A	N/A	6.7E-08	2.9E-09
Total Chem Risk	N/A	N/A	N/A	N/A	N/A	7.0E-07	1.4E-07
<i>Total Risk</i>	N/A	N/A	N/A	N/A	N/A	7.0E-07	1.4E-07
<b>Homegrown Produce (Dust Affected)</b>							
Total Rad Risk	N/A	6.3E-09	4.7E-10	5.5E-07	4.1E-08	N/A	N/A
Total Chem Risk	N/A	3.3E-08	1.1E-08	2.9E-06	1.0E-06	N/A	N/A
<i>Total Risk</i>	N/A	3.9E-08	1.2E-08	3.4E-06	1.0E-06	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
Total Rad Risk	N/A	2.6E-09	1.9E-10	4.5E-08	3.3E-09	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	2.6E-09	1.9E-10	4.5E-08	3.3E-09	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
Total Rad Risk	N/A	1.0E-09	1.8E-10	9.2E-08	1.6E-08	N/A	N/A
Total Chem Risk	N/A	6.2E-08	3.5E-08	5.4E-06	3.0E-06	N/A	N/A
<i>Total Risk</i>	N/A	6.3E-08	3.5E-08	5.5E-06	3.1E-06	N/A	N/A

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TABLE 6-25A  
(Continued)

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Perched Groundwater User (Adult)	Perched Groundwater User (Child)
<b>Beef/Milk (Groundwater Affected)</b>							
Total Rad Risk	N/A	3.6E-09	6.0E-10	6.3E-08	1.1E-08	N/A	N/A
Total Chem Risk	N/A	-	-	-	-	N/A	N/A
<i>Total Risk</i>	N/A	3.6E-09	6.0E-10	6.3E-08	1.1E-08	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

<sup>b</sup>No risk greater than the threshold level of  $1 \times 10^{-6}$ .

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**TABLE 6-25B**  
**LIME SLUDGE PONDS**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child	On-Property Resident Farmer (RME)	On-Property Resident Child	Perched Groundwater User (Adult)	Perched Groundwater User (Child)
<b>Soil</b>							
<i>Total Hazard</i>	6.3E-01	0.0E+00	0.0E+00	2.5E-01	1.3E+00	N/A <sup>a</sup>	N/A
<b>Perched Groundwater</b>							
<i>Total Hazard</i>	N/A	N/A	N/A	N/A	N/A	6.0E-03	1.2E-02
<b>Homegrown Produce (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	9.1E-05	3.2E-05	8.0E-03	3.3E-02	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>							
<i>Total Hazard</i>	N/A	1.0E-04	4.2E-04	7.2E-03	2.9E-02	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>							
<i>Total Hazard</i>	N/A	2.1E-05	1.7E-04	1.8E-03	1.5E-02	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-26A**  
**LIME SLUDGE PONDS**  
**SUMMARY OF TOTAL CARCINOGENIC RISK**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor: Media	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	COC <sup>b</sup>				COC				COC			
	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total
Soil	1.2E-07 <sup>c</sup>	51.36%	- <sup>d</sup>		9.8E-05	100%	Th-228 Ra-228 U-238 Beryllium Aroclor-1254	6.52% 1.90% 1.23% 69.15% 19.33%	1.9E-03	99.50%	Th-228 Ra-228 U-238 Cs-137 Beryllium Aroclor-1254	36.45% 10.65% 6.56% 3.14% 28.51% 8.30%
Home Grown Produce (Dust Affected)	3.9E-08 <sup>c</sup>	16.24%	-		NA <sup>e</sup>	-			3.4E-06	0.19%	Arsenic	0.05%
Beef/Milk (Dust Affected)	6.3E-08 <sup>c</sup>	26.05%	-		NA	-			5.5E-06	0.30%	Aroclor-1254 Benzo(a)-pyrene	0.09% 0.09%
<b>ALL MEDIA</b>	<b>2.4E-07</b>				<b>9.8E-05</b>				<b>1.9E-03</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below risk threshold - provided for comparison purposes

<sup>d</sup>No major risk contributors

<sup>e</sup>NA = not applicable to conceptual model

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**TABLE 6-26B**  
**LIME SLUDGE PONDS**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	COC <sup>b</sup>				COC				COC			
Media	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total
Soil	0.00 <sup>c</sup>	0.00%	- <sup>d</sup>		6.3E-01	100%	U-Total Beryllium Cadmium	95.23% 2.00% 1.60%	2.5E-01	96.18%	U-Total Arsenic	68.21% 22.88%
Home Grown Produce (Dust Affected)	9.1E-05	81.30%	U-Total Arsenic	57.56% 19.49%	NA <sup>e</sup>		-		8.0E-03	3.11%	U-Total	2.20%
Beef/Milk (Dust Affected)	2.1E-05	18.70%	U-Total Arsenic Chromium	11.96% 3.46% 2.45%	NA		-		1.8E-03	0.71%	U-Total	0.46%
<b>ALL MEDIA</b>	<b>1.1E-04</b>				<b>6.3E-01</b>				<b>2.6E-01</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below hazard threshold level - provided for comparison purposes

<sup>d</sup>No major hazard contributors

<sup>e</sup>NA = not applicable to conceptual model

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(6.56 and 4.26 percent), beryllium (28.51 and 34 percent), and Aroclor-1254 (8.3 and 11 percent). Total risk to the expanded trespasser exceeded  $1.0 \times 10^{-5}$  due to same compounds as on-property residents. Total HI exceeded 1.0 for the on-property child due to the presence of uranium-total (68.41 percent) in soil. Total risk to the off-property farmer did not exceed the  $1.0 \times 10^{-6}$  threshold risk and hazard was well below 1.0.

6.3.6 Operable Unit 2 Cumulative Risk

Tables 6-27A and 6-27B summarize the risks and hazards by media to future receptors due to the cumulative impact of contaminants present within Operable Unit 2. It is emphasized that the risks and hazards presented are those resulting primarily from the three subunits contributing most to groundwater contamination: the Active Flyash Pile, South Field and Inactive Flyash Pile.

The greatest carcinogenic risk posed was to the RME on-property farmer which had a total risk of  $3.7 \times 10^{-3}$ . Major contributors to risks and hazards for the off-property farmer, expanded trespasser, and on-property farmer (RME) are presented in Tables 6-28A and 6-28B. The major contributor to risk for the on-property receptor is from the presence of thorium-228 (28 percent), radium-228 (12.6 percent), and beryllium (8.84 percent) in soil, and the estimated presence of uranium-238 in groundwater (19 percent).

Total risk to the off-property farmer slightly exceeded  $1.0 \times 10^{-4}$  due primarily to uranium-234 (12 percent) and uranium-238 (23.21 percent) in groundwater, and thorium-228 (8.63 percent), thorium-230 (10 percent), and uranium-238 (12.2 percent) in soil.

Total HIs exceed 1.0 for both the on- and off-property farmers due primarily to the estimated presence of total uranium in groundwater (85.86 and 86.10 percent, respectively).

Total risk to the expanded trespasser was  $6.6 \times 10^{-5}$  due primarily to beryllium and thorium-228 in soil which contributed 64.5 percent and 15.5 percent, respectively. Total HI for this receptor was below 1.0.

6.3.7 Background Risks

All subunit-specific risks in the risk assessment are calculated without accounting for the potential contribution from natural background concentrations of CPCs. In many cases, the concentrations of

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**TABLE 6-27A**  
**OPERABLE UNIT 2-WIDE**  
**FUTURE LAND USE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	On-Property Resident Farmer (RME)	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>					
Total Rad Risk	1.7E-05	7.0E-05	1.7E-03	N/A <sup>a</sup>	N/A
Total Chem Risk	4.7E-05	1.1E-05	6.5E-04	N/A	N/A
<i>Total Risk</i>	6.4E-05	8.1E-05	2.3E-03	N/A	N/A
<b>Groundwater</b>					
Total Rad Risk	N/A	6.0E-05	3.9E-04	N/A	N/A
Total Chem Risk	N/A	6.9E-09	<sup>b</sup>	N/A	N/A
<i>Total Risk</i>	N/A	6.0E-05	3.9E-04	N/A	N/A
<b>Surface Water</b>					
Total Rad Risk	1.8E-06	N/A	N/A	1.3E-04	5.2E-08
Total Chem Risk	5.9E-08	N/A	N/A	7.1E-08	4.6E-08
<i>Total Risk</i>	1.8E-06	N/A	N/A	2.0E-07	9.8E-08
<b>Homegrown Produce (Dust Affected)</b>					
Total Rad Risk	N/A	7.5E-08	6.2E-07	N/A	N/A
Total Chem Risk	N/A	9.6E-07	8.0E-06	N/A	N/A
<i>Total Risk</i>	N/A	1.0E-06	8.0E-06	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>					
Total Rad Risk	N/A	9.0E-06	1.6E-04	N/A	N/A
Total Chem Risk	N/A	9.0E-10	0.0E+00	N/A	N/A
<i>Total Risk</i>	N/A	9.0E-06	1.6E-04	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
Total Rad Risk	N/A	1.1E-06	1.9E-07	N/A	N/A
Total Chem Risk	N/A	8.0E-11	1.2E-04	N/A	N/A
<i>Total Risk</i>	N/A	1.1E-06	1.2E-04	N/A	N/A

See footnotes at end of table

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TABLE 6-27A  
(Continued)

Media	Expanded Trespasser	Off-Property Resident Farmer	On-Property Resident Farmer (RME)	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Beef/Milk (Groundwater Affected)</b>					
Total Rad Risk	N/A	1.1E-06	1.9E-05	N/A	N/A
Total Chem Risk	N/A	8.0E-11	0.0E+00	N/A	N/A
<i>Total Risk</i>	N/A	1.1E-06	1.9E-05	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

<sup>b</sup>No risk greater than the threshold level of  $1 \times 10^{-6}$ .

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**TABLE 6-27B**  
**FUTURE LAND USE**  
**OPERABLE UNIT 2-WIDE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD BY MEDIA**

Media	Expanded Trespasser	Off-Property Resident Farmer	On-Property Resident Farmer (RME)	Great Miami River User (Adult)	Great Miami River User (Youth)
<b>Soil</b>					
<i>Total Hazard</i>	1.0E-01	1.6E-02	2.8E-01	N/A <sup>a</sup>	N/A
<b>Groundwater</b>					
<i>Total Hazard</i>	N/A	1.0E+00	6.7E-02	N/A	N/A
<b>Surface Water</b>					
<i>Total Hazard</i>	7.5E-03	N/A	N/A	4.4E-05	6.7E-05
<b>Homegrown Produce (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	2.9E-04	2.4E-03	N/A	N/A
<b>Homegrown Produce (Groundwater Affected)</b>					
<i>Total Hazard</i>	N/A	1.4E-01	0.0E+00	N/A	N/A
<b>Beef/Milk (Dust Affected)</b>					
<i>Total Hazard</i>	N/A	6.9E-05	6.0E-04	N/A	N/A
<b>Beef/Milk (Groundwater Affected)</b>					
<i>Total Hazard</i>	N/A	1.6E-02	3.0E-01	N/A	N/A

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-28A**  
**OPERABLE UNIT 2 WIDE**  
**SUMMARY OF TOTAL CARCINOGENIC RISK**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	COC <sup>b</sup>				COC				COC			
	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total	Receptor Risk	% Total Risk	Major Risk Contributors	% Risk of Total
Soil	8.1E-05	48.78%	U-238 Th-230 Th-228 U-234 Chromium	12.20% 10.03% 8.63% 5.66% 3.19%	6.4E-05	97.20%	Th-228 Ra-226 Beryllium Benzo(a)pyrene	15.48% 6.75% 64.48% 2.88%	2.3E-03	62.15%	Th-228 Ra-228 Cs-137 Beryllium Benzo(a)pyrene	27.95% 12.60% 1.11% 8.84% 4.58%
Groundwater	6.0E-05	36.11%	U-238 U-234	23.21% 12.03%	NA <sup>c</sup>	- <sup>d</sup>			3.9E-04	29.45%	U-238 U-234	19.04% 9.87%
Surface Water	NA	-			1.8E-06	2.80%	Th-228	2.60%	NA	-		
Homegrown Produce (Dust Affected)	1.0E-06	0.63%	-		NA	-			8.6E-06	0.23%	Benzo(a)pyrene	0.11%
Home Grown Produce (Groundwater Affected)	9.0E-06	5.42%	U-238 U-234	3.48% 1.80%	NA	-			1.6E-04	4.41%	U-238 U-234	2.85% 1.48%
Beef/Milk (Dust Affected)	1.4E-05	8.43%	Indeno(1,2,3-cd)pyrene Benzo(a)pyrene	6.83% 0.81%	NA	-			1.2E-04	3.24%	Indeno(1,2,3-cd)pyrene Benzo(a)pyrene	2.63% 0.31%
Beef/Milk (Groundwater Affected)	1.1E-06	0.64%	-		NA	-			1.9E-05	0.51%	U-238 U-234	0.33% 0.17%
<b>ALL MEDIA</b>	<b>1.7E-04</b>				<b>6.6E-05</b>				<b>3.7E-03</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>NA = not applicable to conceptual model

<sup>d</sup>No major hazard contributors

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**TABLE 6-28B**  
**OPERABLE UNIT 2 WIDE**  
**SUMMARY OF TOTAL NONCARCINOGENIC HAZARD**  
**FOR SELECTED FUTURE LAND USE RECEPTORS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Receptor:	Federal Ownership								Private Ownership			
	Off-Property Resident Farmer				Expanded Trespasser				On-Property Resident Farmer (RME) <sup>a</sup>			
	COC <sup>b</sup>				COC				COC			
	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total	Receptor Hazard	% Total Hazard	Major Hazard Contributors	% Hazard of Total
Soil	1.6E-02 <sup>c</sup>	1.28%	- <sup>d</sup>		1.0E-01	92.99%	U-Total Beryllium	76.59% 7.24%	2.8E-01	1.27%	U-Total	0.80%
Groundwater	1.0	86.12%	U-Total	86.10%	NA <sup>e</sup>	-			6.7E-02	86.16%	U-Total	85.86%
Surface Water	7.5E-03	7.01%	U-Total	6.75%	NA	-			NA	-		
Home Grown Produce (Groundwater Affected)	1.4E-01	11.26%	U-Total	11.25%	NA	-			2.5	11.25%	U-Total	11.22%
Beef/Milk (Groundwater Affected)	1.6E-02	1.31%	U-Total	1.31%	NA	-			3.0E-01	1.32%	U-Total	1.31%
<b>ALL MEDIA</b>	<b>1.2E+00</b>				<b>1.1E-01</b>				<b>2.2E+01</b>			

<sup>a</sup>RME = Reasonable Maximum Exposure

<sup>b</sup>COC = Contaminant of Concern

<sup>c</sup>Below hazard threshold level - provided for comparison purposes

<sup>d</sup>No major hazard contributors

<sup>e</sup>NA = not applicable to conceptual model

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CPCs in soil at Operable Unit 2 waste areas are only slightly above natural background concentrations; however, the risks and HIs for these site-related concentrations are often greater than  $1 \times 10^{-6}$  and 1.0, respectively. Background contributions provide a useful point of comparison for subunit-specific risk estimates.

Therefore, risks and HIs are calculated for the RME on-property future farmer using background concentrations of CPCs in soil and groundwater as direct contact exposure point concentrations where appropriate. Naturally occurring background soil concentrations were also used as the source term for subunit-specific air and groundwater modeling. Exposure assumptions and models used for these background calculations are the same as those used for evaluating subunit-specific risks to the RME on-property resident farmer.

Tables 6-29A through 6-29E present a summary of comparison of subunit-specific risks to the future on-property RME farmer with the risk that would exist to that receptor if naturally occurring CPCs were present at naturally occurring background concentrations. Details of the major contributions to risks are presented in Section B.4.0 of Appendix B. These background comparison tables presented in this section indicate that:

- For the Active Flyash Pile [Table 6-29A], cumulative subunit-specific risk for the future on-property RME farmer is approximately one order of magnitude greater than what it would be if CPCs were present in surface flyash material and groundwater at background concentrations. This is due primarily to elevated (compared to background) levels of neptunium-237, arsenic, and beryllium in surface flyash material; and to estimated elevated levels of neptunium-237, strontium-90, uranium-234, and uranium-238 in groundwater.
- For the South Field [Table 6-29B], cumulative subunit-specific risk for this receptor is also approximately an order of magnitude greater than what it would be if CPCs were present in surface soil and groundwater at background concentrations. This is due primarily to elevated levels of the radionuclides neptunium-237 (which was not detected in background soils), radium-226, thorium-228, thorium-230, uranium-234, uranium-235/236, and uranium-238 in surface soil and to estimated elevated levels of uranium-234, uranium-235/236, and uranium-238 in groundwater. PAHs, Aroclors, and dieldrin, which were not detected in background soil samples, also contributed to risk due to soil for this subunit, but the relative contribution of the radionuclides ( $1.7 \times 10^{-3}$ ) in soil to total risk was greater than it was for these compounds ( $6.9 \times 10^{-4}$ ).
- For the Inactive Flyash Pile [Table 6-29C], cumulative subunit-specific risk for this receptor is also approximately an order of magnitude greater than what it would be if CPCs were present at background levels. This is due primarily to elevated levels of neptunium-237, uranium-238, arsenic, and dibenzo(a,h)anthracene in surface soil, but mostly is due to

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**TABLE 6-29A**  
**COMPARISON SUMMARY OF BACKGROUND RISKS TO ON-SITE RISKS**  
**ACTIVE FLYASH PILE: CARCINOGENS**

<b>Media</b>	<b>On-Property Resident Farmer (RME)</b>	<b>Background</b>
<b>Soil</b>		
Total Radiological Risk	1.4E-03	4.0E-04
Total Chemical Risk	4.0E-04	2.6E-05
<i>Total Risk</i>	1.8E-03	4.3E-04
<b>Groundwater</b>		
Total Radiological Risk	4.7E-05	1.9E-07
Total Chemical Risk	2.4E-15	0.0E+00
<i>Total Risk</i>	4.7E-05	1.9E-07
<b>Homegrown Produce (Dust Affected)</b>		
Total Radiological Risk	1.2E-06	1.5E-07
Total Chemical Risk	3.8E-05	2.7E-09
<i>Total Risk</i>	4.0E-05	1.5E-07
<b>Homegrown Produce (Groundwater Affected)</b>		
Total Radiological Risk	7.1E-06	2.8E-08
Total Chemical Risk	3.6E-16	0.0E+00
<i>Total Risk</i>	7.1E-06	2.8E-08
<b>Beef/Milk (Dust Affected)</b>		
Total Radiological Risk	1.0E-07	2.0E-08
Total Chemical Risk	6.4E-06	4.3E-10
<i>Total Risk</i>	6.5E-06	2.1E-08
<b>Beef/Milk (Groundwater Affected)</b>		
Total Radiological Risk	8.4E-07	8.4E-07
Total Chemical Risk	3.5E-17	3.5E-17
<i>Total Risk</i>	8.4E-07	8.4E-07
<i>All Media</i>	1.9E-03	4.3E-04

**TABLE 6-29B**  
**COMPARISON SUMMARY OF BACKGROUND RISKS TO ON-SITE RISKS**  
**SOUTH FIELD: CARCINOGENS**

<b>Media</b>	<b>On-Property Resident Farmer (RME)</b>	<b>Background</b>
<b>Soil</b>		
Total Radiological Risk	1.6E-03	4.5E-04
Total Chemical Risk	3.6E-04	2.4E-04
<i>Total Risk</i>	2.0E-03	7.0E-04
<b>Groundwater</b>		
Total Radiological Risk	1.1E-03	4.9E-07
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	1.1E-03	4.9E-07
<b>Homegrown Produce (Dust Affected)</b>		
Total Radiological Risk	6.2E-07	3.2E-08
Total Chemical Risk	8.0E-06	8.1E-10
<i>Total Risk</i>	8.6E-06	3.3E-08
<b>Homegrown Produce (Groundwater Affected)</b>		
Total Radiological Risk	1.6E-04	7.4E-08
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	1.6E-04	7.4E-08
<b>Beef/Milk (Dust Affected)</b>		
Total Radiological Risk	1.9E-07	8.9E-09
Total Chemical Risk	1.2E-04	1.3E-10
<i>Total Risk</i>	1.2E-04	9.0E-09
<b>Beef/Milk (Groundwater Affected)</b>		
Total Radiological Risk	1.9E-05	8.7E-09
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	1.9E-05	8.7E-09
<i>All Media</i>	3.8E-03	7.0E-04

TABLE 6-29C  
COMPARISON SUMMARY OF BACKGROUND RISKS TO ON-SITE RISKS  
INACTIVE FLYASH PILE: CARCINOGENS

Media	On-Property Resident Farmer (RME)	Background
<b>Soil</b>		
Total Radiological Risk	9.8E-04	4.4E-04
Total Chemical Risk	9.8E-04	2.3E-04
<i>Total Risk</i>	2.0E-03	6.7E-04
<b>Groundwater</b>		
Total Radiological Risk	1.1E-03	4.9E-07
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	1.1E-03	4.9E-07
<b>Homegrown Produce (Dust Affected)</b>		
Total Radiological Risk	6.4E-09	2.0E-09
Total Chemical Risk	3.5E-04	2.7E-09
<i>Total Risk</i>	3.5E-04	4.7E-09
<b>Homegrown Produce (Groundwater Affected)</b>		
Total Radiological Risk	1.6E-04	7.4E-08
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	1.6E-04	7.4E-08
<b>Beef/Milk (Dust Affected)</b>		
Total Radiological Risk	9.9E-10	4.9E-10
Total Chemical Risk	2.8E-08	4.8E-10
<i>Total Risk</i>	2.9E-08	9.7E-10
<b>Beef/Milk (Groundwater Affected)</b>		
Total Radiological Risk	3.5E-06	8.7E-09
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	3.5E-06	8.7E-09
<i>All Media</i>	3.2E-03	6.8E-04

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**TABLE 6-29D**  
**COMPARISON SUMMARY OF BACKGROUND RISKS TO ON-SITE RISKS**  
**SOLID WASTE LANDFILL: CARCINOGENS**

Media	On-Property Resident Farmer (RME)	Background
<b>Soil</b>		
Total Radiological Risk	8.4E-04	4.3E-04
Total Chemical Risk	3.0E-04	2.3E-04
<i>Total Risk</i>	1.1E-03	6.8E-04
<b>Groundwater</b>		
Total Radiological Risk	3.4E-09	N/A <sup>a</sup>
Total Chemical Risk	0.0E+00	
<i>Total Risk</i>	3.4E-09	
<b>Homegrown Produce (Dust Affected)</b>		
Total Radiological Risk	5.0E-07	5.3E-08
Total Chemical Risk	8.0E-06	6.6E-09
<i>Total Risk</i>	8.5E-06	5.9E-08
<b>Homegrown Produce (Groundwater Affected)</b>		
Total Radiological Risk	8.3E-09	N/A
Total Chemical Risk	0.0E+0000	
<i>Total Risk</i>	8.3E-09	
<b>Beef/Milk (Dust Affected)</b>		
Total Radiological Risk	7.9E-08	1.3E-08
Total Chemical Risk	9.0E-06	1.4E-10
<i>Total Risk</i>	9.0E-06	1.3E-08
<b>Beef/Milk (Groundwater Affected)</b>		
Total Radiological Risk	1.3E-08	N/A
Total Chemical Risk	0.0E+00	
<i>Total Risk</i>	1.3E-08	
<i>All Media</i>	1.2E-03	6.8E-04

<sup>a</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 6-29E**  
**COMPARISON SUMMARY OF BACKGROUND RISKS TO ON-SITE RISKS**  
**LIME SLUDGE PONDS: CARCINOGENS**

Media	On-Property Resident Farmer (RME)	Background
<b>Soil</b>		
Total Radiological Risk	1.1E-03	4.4E-04
Total Chemical Risk	7.5E-04	2.3E-04
<i>Total Risk</i>	1.9E-03	6.7E-04
<b>Perched Groundwater</b>		
Total Radiological Risk	1.6E-07	2.2E-13
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	1.6E-07	2.2E-13
<b>Homegrown Produce (Dust Affected)</b>		
Total Radiological Risk	5.5E-07	5.9E-08
Total Chemical Risk	2.9E-06	1.0E-09
<i>Total Risk</i>	3.4E-06	6.0E-08
<b>Homegrown Produce (Groundwater Affected)</b>		
Total Radiological Risk	4.5E-08	4.6E-14
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	4.5E-08	4.6E-14
<b>Beef/Milk (Dust Affected)</b>		
Total Radiological Risk	9.2E-08	1.5E-08
Total Chemical Risk	5.4E-06	1.7E-10
<i>Total Risk</i>	5.5E-06	1.5E-08
<b>Beef/Milk (Groundwater Affected)</b>		
Total Radiological Risk	6.3E-08	9.1E-15
Total Chemical Risk	0.0E+00	0.0E+00
<i>Total Risk</i>	6.3E-08	9.1E-15
<i>All Media</i>	1.9E-03	6.8E-04

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estimated levels of uranium-234, uranium-235/236, and uranium-238 in groundwater. The risk due to the presence of these radionuclides in groundwater was greater than three orders of magnitude greater than what it would be if these compounds were assumed to be present in groundwater as a result of naturally occurring levels in soils.

- For the Solid Waste Landfill [Table 6-29D], cumulative subunit-specific risk again is about one order of magnitude greater than what it would be if CPCs were present at background levels. This is due primarily to elevated levels of the radionuclides neptunium-237 (which was not detected in background samples), thorium-230, uranium-234, uranium-235/236, and uranium-238 in soil and to the presence of several PAHs in soil which were not detected in background samples.
- For the Lime Sludge Ponds [Table 6-29E], cumulative subunit-specific risk is an order of magnitude greater than what it would be if CPCs were present at background levels. The cumulative risk is primarily due to elevated levels of neptunium-237 (was not detected in background samples), thorium-230, uranium-234, uranium-235/236, and uranium-238 in soil and the presence of several PAHs in soil which were not detected in background samples.

6.3.8 Risks Due to Estimated Ambient Radon Emissions

Tables 6-30A through 6-30E present estimated risks due to inhalation of ambient radon concentrations estimated from detected concentrations of radium-226 in soil according to methodology described in Section 5.0 and Appendix A of this RI report. The risks that would exist if radium-226 were present at these subunits at background concentrations are presented for comparison.

These tables indicate that the only receptor at the Active Flyash Pile, Inactive Flyash Pile, and Solid Waste Landfill that may be at a slightly elevated risk (compared to background) due to ambient concentrations of radon resulting from detected levels of radium-226 is the future on-property RME farmer; and that no receptors at the Lime Sludge Ponds are at risk. This suggests that potential radon emissions from these subunits are not a human health risk concern.

Estimated risks to the future RME farmer due to estimated radon emissions are greatest at the South Field [Table 6-30B] where risks are estimated to range from  $1.2 \times 10^{-5}$  to  $6.0 \times 10^{-5}$  compared to the estimated background risk of  $2.6 \times 10^{-6}$ . Risks to all other receptors at the South Field are in the  $1 \times 10^{-6}$  range or below. This suggests that the concentrations of radium-226 in soil within this subunit may contribute to risk under the future farmer scenario.

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**TABLE 6-30A  
ACTIVE FLYASH PILE  
RISKS DUE TO ESTIMATED RA-222 EMISSION**

Submit				Background		
	Maximum Ra-222 Air Concentration (pCi/m3)*	Intake (pCi)	Risk	Background Ra-222 Air Concentration (pCi/m3)**	Intake (pCi)	Risk
Current Trespassing Youth	1.8E+00	3.7E+03	2.9E-08	3.6E-01	7.4E+02	5.7E-09
Current/Future Off-Property Farmer	1.3E-01	1.6E+04	1.2E-07	2.6E-02	3.0E+03	2.3E-08
Current/Future Off-Property Child	1.3E-01	2.8E+02	2.2E-09	2.6E-02	5.5E+01	4.3E-10
Future Expanded Trespasser (Adult + Child)	1.8E+00	5.9E+03	4.5E-08	3.6E-01	1.2E+03	8.9E-09
Future, RME On-Property Farmer	1.6E+00	1.9E+05	1.5E-06	3.2E-01	3.7E+04	2.9E-07
Future, CT On-Property Farmer	1.6E+00	1.4E+04	1.1E-07	3.2E-01	2.8E+03	2.1E-08
Future On-Property Child	1.6E+00	3.4E+03	2.6E-08	3.2E-01	6.7E+02	5.2E-09

\*Represents the maximum surface soil Ra-226 hit of 4.6 pCi/g.

\*\*Assumes Ra-226 concentration is 1.228 pCi/g in surface soil and 0.78 pCi/g in subsurface soil.

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**TABLE 6-30B  
SOUTH FIELD  
RISKS DUE TO ESTIMATED RA-222 EMISSION**

Submit				Background		
	Maximum Ra-222 Air Concentration (pCi/m3)*	Intake (pCi)	Risk	Background Ra-222 Air Concentration (pCi/m3)**	Intake (pCi)	Risk
Current Trespassing Youth	7.7E+01	1.6E+05	1.2E-06	3.4E+00	7.0E+03	5.4E-08
	1.5E+01	3.1E+04	2.4E-07			
Current/Future Off-Property Farmer	4.9E+00	5.7E+05	4.4E-06	2.2E-01	2.5E+04	1.9E-07
	9.6E-01	1.1E+05	8.6E-07			
Current/Future Off-Property Child	4.9E+00	1.0E+04	7.9E-08	2.2E-01	4.5E+02	3.5E-09
	9.6E-01	2.0E+03	1.6E-08			
Future Expanded Trespasser (Adult + Child)	7.7E+01	7.7E+04	5.9E-07	3.4E+00	1.1E+04	8.5E-08
	1.5E+01	4.9E+04	3.8E-07			
Future, RME On-Property Farmer	6.8E+01	7.8E+06	6.0E-05	3.0E+00	3.4E+05	2.6E-06
	1.3E+01	1.5E+06	1.2E-05			
Future, CT On-Property Farmer	6.8E+01	5.8E+05	4.5E-06	3.0E+00	2.6E+04	2.0E-07
	1.3E+01	1.1E+05	8.8E-07			
Future On-Property Child	6.8E+01	1.4E+05	1.1E-06	3.0E+00	6.2E+03	4.8E-08
	1.3E+01	2.8E+04	2.1E-07			

\*Upper value represents maximum surface soil hit of 30.8 pCi/g in RAECOM model.  
Lower value is mean surface soil concentration of 3.734 pCi/g. Sample distribution is undefined.

\*\*Assumes Ra-226 concentration is 1.228 pCi/g in surface soil and 0.78 pCi/g in subsurface soil.

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TABLE 6-30C  
INACTIVE FLYSASH PILE  
RISKS DUE TO ESTIMATED RA-222 EMISSION

Subunit				Background		
	Maximum Ra-222 Air Concentration (pCi/m3)*	Intake (pCi)	Risk	Background Ra-222 Air Concentration (pCi/m3)**	Intake (pCi)	Risk
Current Trespassing Youth	4.1E+00	8.5E+03	6.5E-08	1.8E+00	3.7E+03	2.9E-08
Current/Future Off-Property Farmer	2.5E-01	2.8E+04	2.2E-07	1.7E-01	2.0E+04	1.5E-07
Current/Future Off-Property Child	2.5E-01	5.1E+02	4.0E-09	1.1E-01	7.5E+02	5.8E-09
Future, Expanded Trespasser (Adult + Child)	4.1E+00	1.3E+04	1.0E-07	1.8E+00	5.8E+03	4.5E-08
Future, RME On-Property Farmer	4.8E+00	5.5E+05	4.2E-06	2.1E+00	2.4E+05	1.9E-06
Future, CT On-Property Farmer	4.8E+00	4.1E+04	3.2E-07	2.1E+00	1.8E+04	1.4E-07
Future, On-Property Child	4.8E+00	1.0E+04	7.7E-08	2.1E+00	4.4E+03	3.4E-08

\*Represents the upper 95 percent confidence interval on the mean Ra-226 soil concentration.

\*\*Assumes Ra-226 concentration is 1.228 pCi/g in surface soil and 0.78 pCi/g in subsurface soil.

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**TABLE 6-30D  
SOLID WASTE LANDFILL  
RISKS DUE TO ESTIMATED RA-222 EMISSION**

Subunit				Background			
	Maximum Ra-222 Air Concentration (pCi/m3)*	Intake (pCi)	Risk	Background Ra-222 Air Concentration (pCi/m3)**	Intake (pCi)	Risk	
Current Trespassing Youth	1.6E+00	3.3E+03	2.6E-08	9.0E-01	1.9E+03	1.4E-08	
Current/Future Off-Property Farmer	2.6E-02	3.0E+03	2.3E-08	1.5E-02	1.7E+03	1.3E-08	
Current/Future Off-Property Child	2.6E-02	5.5E+01	4.3E-10	1.5E-02	3.1E+01	2.4E-10	
Future Expanded Trespasser (Adult + Child)	1.6E+00	5.2E+03	4.0E-08	9.0E-01	2.9E+03	2.3E-08	
Future, RME On-Property Farmer	1.6E+00	1.9E+05	1.4E-06	9.0E-01	1.0E+05	8.1E-07	
Future, CT On-Property Farmer	1.6E+00	1.4E+04	1.1E-07	9.0E-01	7.8E+03	6.0E-08	
Future, On-Property Child	1.6E+00	3.4E+03	2.6E-08	9.0E-01	1.9E+03	1.5E-08	

\*Represents subsurface soil Ra-226 estimate of 1.55 pCi/g.

\*\*Assumes Ra-226 concentration is 1.228 pCi/g in surface soil and 0.78 pCi/g in subsurface soil.

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TABLE 6-30E  
LIME SLUDGE PONDS  
RISKS DUE TO ESTIMATED RA-222 EMISSION

Subunit				Background			
	Maximum Ra-222 Air Concentration (pCi/m3)*	Intake (pCi)	Risk	Background Ra-222 Air Concentration (pCi/m3)**	Intake (pCi)	Risk	
Current Trespassing Youth	3.9E-01	8.1E+02	6.3E-09	1.4E+00	1.0E-11	8.1E-23	
Current/Future Off-Property Farmer	3.0E-03	3.5E+02	2.7E-09	1.0E-02	1.2E+03	9.3E-09	
Current/Future Off-Property Child	3.0E-03	6.3E+00	4.9E-11	1.0E-02	2.2E+01	1.7E-10	
Future Expanded Trespasser (Adult+ Child)	3.9E-01	1.3E+03	9.8E-09	1.4E+00	4.4E+03	3.4E-08	
Future, RME On-Property Farmer	3.9E-01	4.5E+04	3.5E-07	1.4E+00	1.6E+05	1.2E-06	
Future, CT On-Property Farmer	3.9E-01	3.4E+03	2.6E-08	1.4E+00	1.2E+04	9.0E-08	
Future, On-Property Child	3.9E-01	8.2E+02	6.3E-09	1.4E+00	2.8E+03	2.2E-08	

\*Represents upper 95 percent confidence interval on the mean Ra-226 concentration.

\*\*Assumes Ra-226 concentration is 1.228 pCi/g in surface soil and 0.78 pCi/g in subsurface soil.

6.4 UNCERTAINTIES

Sources of uncertainty in the baseline risk assessment are discussed in Section B.4.3. Generally, uncertainty arises wherever imperfect information or understanding exist. In risk assessment, this typically is mitigated by making conservative assumptions for individual parameters. Significant uncertainty results for those particular pathways that required fate and transport modeling to support the assessment of exposure and, therefore, for the homegrown produce and beef and milk pathways. Such uncertainty was generated for the air and groundwater pathways of exposure. The high uncertainty must be recognized in the interpretation of risk from these media. Certain exposure pathways for a particular medium also tend to have higher or lower uncertainty depending on their assumptions. For example, incidental ingestion of soils by residents tends to have significantly less uncertainty than ingestion of fruits and vegetables, and meat and milk raised on contaminated soils. To assess these indirect exposure pathways, assumptions must be made regarding contaminant uptake from soil to plant and plant to livestock that are not required for the soil ingestion pathway. These assumptions contribute significant uncertainty to the risk estimates for these pathways.

The receptor with the highest uncertainty under current land use assumptions is the off-property farmer. The off-property farmer scenario was evaluated based on modeled concentrations for the air pathway and results in high uncertainty. The bioaccumulation of CPCs into meat and milk were modeled, and as a result, provide moderate to high uncertainty for this receptor.

The greatest uncertainty in the Operable Unit 2 risk assessment is associated with the assumptions made to estimate exposure point concentrations in groundwater, air, fruit and vegetables, milk and beef for the future receptors. These receptors include the on-property farmer and resident child, and the off-property farmer and resident child. For the on-property RME farmer and home builder, the highest uncertainty is associated with the assumed future land use and potential exposure pathways. This receptor scenario was included in response to guidance but the likelihood of occurrence within Operable Unit 2 is unknown. Uncertainty associated with the off-property farmer and resident child is primarily the result of surface water, groundwater, and air modeling used to support those scenarios. The modeling assumptions were conservative, therefore; this resulted in conservative estimates for the exposure point concentrations.

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Taken together, the uncertainties identified with site data, exposure parameters, fate and transport, toxicity assessment, and risk characterization are judged to be high (i.e., potential to overestimate risk by two or more orders of magnitude).

6.5 POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

CERCLA §121(d)(2) states that for wastes left on site, remedial actions must comply with federal and state environmental laws that are legally applicable or are relevant and appropriate under the circumstances of the release. Off-site actions must comply only with requirements that are legally applicable.

The definition of Applicable or Relevant and Appropriate Requirements (ARARs) are:

- Applicable Requirements - Cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.
- Relevant and Appropriate Requirements - Cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under federal or state law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site.

EPA has also created another category of requirements known as "to be considered" (TBCs) that include non-promulgated criteria, advisories, and guidance issued by federal or state governments.

Identification of potential ARARs is initiated during scoping and continually refined during site characterization activities, analysis of alternatives and then finalized with the selection of the preferred remedial alternatives.

The EPA document "Overview of ARARs" (Publication 9234.2-03/FS) directs that chemical- and location-specific ARARs be identified early in the process, generally during the site investigation, while action-specific ARARs are usually identified during the detailed analysis of alternatives in the FS. The three types of ARARs are defined as:

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- Chemical-specific ARARs are usually health- or risk- based numerical values or methodologies used to determine acceptable concentrations of chemicals that may be found in or discharged to the environment (e.g., Maximum Contaminant Levels (MCLs) that establish safe levels in drinking water.
- Location-specific ARARs restrict actions or contaminant concentrations in certain environmentally sensitive areas. Examples of areas regulated under various federal laws include floodplains, wetlands, and locations where endangered species or historically significant cultural resources are present.
- Action-specific ARARs are usually technology- or activity-based requirements or limitations on actions or conditions involving special substances.

The initial Operable Unit 2 list of potential ARARs was submitted to EPA and OEPA on October 12, 1990. On February 7, 1991, EPA acknowledged receipt of the potential list and commented that their review would be an iterative process with their final approval at the time of remedy selection.

During the Operable Unit 2 RI, sufficient data has been developed to make initial judgments concerning the COCs in Operable Unit 2 and special location characteristics that may require special protection or action. The Operable Unit 2 pertinent chemical- and location-specific potential ARARs are identified in the following sections.

#### 6.5.1 Potential Chemical-Specific ARARs

The chemical-specific ARARs for the Operable Unit 2 COCs are arranged in this section according to the following categories:

- ARARs and TBC Guidance for Drinking Water and Groundwater
- ARARs and TBC Guidance for Surface Water
- ARARs for Air Emissions
- ARARs and TBC Guidance for Waste Classification
- ARARs and TBC Guidance for Radiation

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6.5.1.1 Potential ARARs and TBC Guidance for Drinking Water and Groundwater

There are no applicable requirements for drinking water or groundwater for Operable Unit 2. The National Contingency Plan (40 CFR §300.430 (e)(2)(i)B-D) states that non-zero Maximum Contaminant Level Goals (MCLGs) and MCLs, are considered to be relevant and appropriate for any aquifer that is a potential drinking water source. The Great Miami Aquifer beneath the Fernald site is considered a potential drinking water source.

If attainment of a non-zero MCLG or MCL is impossible because the background level of the chemical subject to CERCLA authority (e.g., man-made chemical) is higher than that of the MCLG or MCL, attainment of the MCLG or MCL would not be relevant and appropriate [CERCLA Compliance with the CWA and Safe Drinking Water Act (SDWA), Publication 9243.2-06/FS, January 1990].

The relevant and appropriate or TBC (proposed) MCLG and MCL values for the Operable Unit 2 COCs are provided in Table 6-31.

6.5.1.2 Potential ARARs and TBC Guidance for Surface Water and Sediment

CERCLA §121 states that hazardous substances, pollutants, or contaminants left on site at the conclusion of the remedial action shall attain Federal Water Quality Criteria where they are relevant and appropriate under the circumstances of the release or threatened release. CERCLA §121(d)(2) (B)(i) requires this determination to be based on the designated or potential use of the water, the media affected, the purpose of the criteria, and the current information. OEPA has promulgated Water Quality Standards specific to state waters and their actual or potential uses. The designated uses of the Great Miami River and its tributaries are for a warm water aquatic life habitat, agricultural, and industrial water supply and primary contact recreation [Ohio Administrative Code (OAC) 3745-1-21].

The OEPA-promulgated standards are considered potentially applicable for the direct discharge of wastewater generated during a CERCLA action and potentially relevant and appropriate for use in determining clean-up goals for soils or groundwater that is or has the potential to impact the surface waters. The OEPA standards are provided in Table 6-32.

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TABLE 6-31

MCLGs AND MCLs FOR OPERABLE UNIT 2 CONTAMINANTS OF CONCERN

Contaminant of Concern	Requirement	Citation	Remarks
<b>METALS</b>			
Arsenic	0.05 mg/L	40 CFR § 141.11(b)	Promulgated MCL
Beryllium	0.004 mg/L	40 CFR §141.51, §141.62	both MCL and MCLG
Chromium	0.05 mg/L	OAC 3745-81-11	Promulgated MCL
Benzo(a)pyrene	0.0002 mg/L	40 CFR § 141.61	Promulgated MCL
<b>RADIONUCLIDES</b>			
Radium-226	20 pCi/L	56 FR 33050 7/18/91	Proposed MCL
Radium-228	20 pCi/L	56 FR 33050 7/18/91	Proposed MCL
Radium-226 and -228	5 pCi/L	40 CFR §141.15(a)	Promulgated MCL
Uranium-Total	20 µg/L (30 pCi/L)	56 FR 33050 7/18/91	Proposed MCL
Gross alpha particle activity (including Radium-226 ,but excluding Radon and Uranium)	15 pCi/L	40 CFR §141.15(a)	Promulgated MCL; Includes Np-237 and Th-228
Beta and photon radioactivity	4 mrem per year	40 CFR §141.16(a)	Promulgated MCL; Includes Tc-99

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TABLE 6-32

## OEPA WATER QUALITY STANDARDS (OAC 3745-1-07)

Contaminant of Concern	Outside Mixing Zone ( $\mu\text{g/L}$ )			Inside Mixing Zone ( $\mu\text{g/L}$ )	
	Warm Water Habitat Maximum	Habitat Average	Human Health Average	Agriculture Water Supply Average	Warm Water Habitat Maximum
Arsenic	360	190	- <sup>a</sup>	100	1300
Beryllium (total) <sup>b</sup>	520	23	1.17	100	1000
Chromium (total) <sup>b</sup>	1,800	210	3,433,000	100	3,600
Level of Protection (Q-flow) <sup>c</sup>	7Q10	30Q10	Harmonic Mean Flow	Harmonic Mean Flow	-

<sup>a</sup>There is no requirement for this parameter.

<sup>b</sup>Assume a hardness of 100 mg/L as  $\text{CaCO}_3$ .

<sup>c</sup>For example: 7Q10 is the 7 day, 10 year low flow of the receiving stream.

The values provided in the table are the acceptable instream levels. The level of protection is defined as the low flow during which the water quality standards must still be met. Discharge levels are based on the designated level of protection and the upstream concentration of the contaminant of concern. Acceptable discharge levels are governed by the most stringent level based on the protection of the designated uses.

6.5.1.3 Potential ARARs and TBC Guidance for Air Emissions

EPA regulations for National Emission Standards for Hazardous Air Pollutants (NESHAP; 40 CFR §61.92) provide a potentially applicable air emission standard for remedial activities in Operable Unit 2. This regulation limits the effective dose from airborne radionuclide emissions to 10 mrem per person. In addition, radon-222 emissions are limited to 20 pCi/s/m<sup>2</sup> from each Operable Unit 2 source (40 CFR §61.192).

6.5.1.4 Potential ARARs on Waste Classification

To determine the regulatory classification of the wastes in Operable Unit 2, the concentrations of contaminants found in the wastes and soils are compared to the levels defining a regulatory classification. The two waste classifications that are important in defining the Operable Unit 2 wastes are the RCRA Subtitle C Toxicity Characteristic list and the OEPA Nontoxic Policy (OEPA Policy Number 4.07). The COCs with the associated concentration levels for these waste characteristics are listed in Table 6-33.

**TABLE 6-33**  
**WASTE CONCENTRATION STANDARDS**

Parameter	RCRA Toxic Characteristic (mg/L)	Ohio Exempt Waste Standard (30 Times the Ohio Drinking Water Standard) (mg/L)
Arsenic	5.0	1.5
Chromium	5.0	1.5

6.5.1.5 Potential ARARs and TBC Guidance for Radiation

The Nuclear Regulatory Commission (NRC), EPA regulations, and DOE Orders control radiological emissions from all sources to all media. The NRC and EPA regulations are not applicable but may

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be relevant and appropriate to the wastes and remedial activities in Operable Unit 2. While DOE Orders 5400.1 and 5820.2A contain requirements for the control of radiological releases from DOE facilities, these orders are not promulgated and are used as TBC requirements. For the purposes of the Operable Unit 2 assessment of remedial alternatives in the FS, relevant and appropriate NRC and EPA regulations will be supplemented with DOE Order requirements, where the DOE requirements are more stringent. These requirements are outlined in Table 6-34.

6.5.2 Potential Location-Specific ARARs

The RI identifies special characteristics (e.g., presence of wetlands and habitat of endangered species) of the operable unit that allows the identification of statutes and regulatory requirements that may prohibit activities or require the existing conditions to be rectified. While no areas were identified in the Operable Unit 2 battery limits, the final decision whether any statutes are prohibitory or retroactive will be made during the FS. Supplemental investigations have been performed or are currently underway to determine sensitive areas affected by Operable Unit 2 and/or by Operable Unit 2 potential remedial activities. The potential location-specific ARARs identified for Operable Unit 2 are presented in Table 6-35.

6.5.3 Use of ARARs

The potential chemical- and location-specific ARARs identified for Operable Unit 2 will be finalized during the Feasibility Study/Proposed Plan. The action-specific ARARs and additional location-specific ARARs (e.g., siting criteria) will be identified and analyzed in the Feasibility Study/Proposed Plan based on the selection of alternatives. The pertinent chemical-specific ARARs will be used in conjunction with the risk assessment to determine PRG for Operable Unit 2. The ROD will contain the final list of ARARs and remedial goals that will direct the Operable Unit 2 Remedial Design and Remedial Action.

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TABLE 6-34

POTENTIAL RADIATION PROTECTION REQUIREMENTS  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Citation	Requirement																								
Effluent Concentrations 10 CFR §20.106	Radioactive licensed material shall not be possessed, used, or transferred so as to release to an unrestricted area radioactive material in concentrations which exceed the effluent concentration limits provided in this regulation. As an example, specified levels for uranium are provided in the table below. Concentrations may be averaged over a period of not greater than 1 year. <table style="margin-left: auto; margin-right: auto;"> <thead> <tr> <th></th> <th colspan="2" style="text-align: center;">μCi/mL</th> </tr> <tr> <th></th> <th style="text-align: center;">Air</th> <th style="text-align: center;">Water</th> </tr> </thead> <tbody> <tr> <td style="text-align: center;">Uranium-234</td> <td style="text-align: center;"><math>5 \times 10^{-14}</math></td> <td style="text-align: center;"><math>3 \times 10^{-7}</math></td> </tr> <tr> <td style="text-align: center;">Uranium-235</td> <td style="text-align: center;"><math>6 \times 10^{-14}</math></td> <td style="text-align: center;"><math>3 \times 10^{-7}</math></td> </tr> <tr> <td style="text-align: center;">Uranium-236</td> <td style="text-align: center;"><math>6 \times 10^{-14}</math></td> <td style="text-align: center;"><math>3 \times 10^{-7}</math></td> </tr> <tr> <td style="text-align: center;">Uranium-237</td> <td style="text-align: center;"><math>2 \times 10^{-9}</math></td> <td style="text-align: center;"><math>3 \times 10^{-5}</math></td> </tr> <tr> <td style="text-align: center;">Uranium-238</td> <td style="text-align: center;"><math>6 \times 10^{-14}</math></td> <td style="text-align: center;"><math>3 \times 10^{-7}</math></td> </tr> <tr> <td style="text-align: center;">Natural Uranium</td> <td style="text-align: center;"><math>9 \times 10^{-14}</math></td> <td style="text-align: center;"><math>3 \times 10^{-7}</math></td> </tr> </tbody> </table>		μCi/mL			Air	Water	Uranium-234	$5 \times 10^{-14}$	$3 \times 10^{-7}$	Uranium-235	$6 \times 10^{-14}$	$3 \times 10^{-7}$	Uranium-236	$6 \times 10^{-14}$	$3 \times 10^{-7}$	Uranium-237	$2 \times 10^{-9}$	$3 \times 10^{-5}$	Uranium-238	$6 \times 10^{-14}$	$3 \times 10^{-7}$	Natural Uranium	$9 \times 10^{-14}$	$3 \times 10^{-7}$
	μCi/mL																								
	Air	Water																							
Uranium-234	$5 \times 10^{-14}$	$3 \times 10^{-7}$																							
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Uranium-237	$2 \times 10^{-9}$	$3 \times 10^{-5}$																							
Uranium-238	$6 \times 10^{-14}$	$3 \times 10^{-7}$																							
Natural Uranium	$9 \times 10^{-14}$	$3 \times 10^{-7}$																							
Protection of the General Population from Releases of Radioactivity 10 CFR § 61.41	Concentrations of radioactive material which may be released to the general environment in ground water, surface water, air, soil, plants or animals must not result in an annual dose exceeding an equivalent of 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public. Reasonable measures should be made to maintain releases of radioactivity in effluents to the general environment as low as is reasonably achievable (ALARA).																								
Protection of Sedimentation from Effluent DOE Order 5400.5 Chapter II (3)(a)(3)	Liquid process waste streams containing radioactive material in the solid present in the waste stream does not exceed 5 pCi/g above background level of settleable solids for alpha-emitting radionuclides, or 50 pCi/g above background of settleable solids for beta-gamma-emitting radionuclides.																								
Interim Dose Limit for Native Aquatic Animal Organisms DOE Order 5400.5 Chapter II (3)(a)(3)	The absorbed dose to these organisms shall not exceed 1 rad per day from exposure to the radiological material in the liquid wastes discharged to natural water ways.																								

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**TABLE 6-34  
(Continued)**

Citation	Requirement
Basic Dose Limits DOE Order 5400.5 Chapter IV (3)	The exposure of members of the public, to radiation sources as a consequence of all routine DOE activities shall not cause, in a year, an effective dose equivalent greater than 100 mrem. Dose evaluations should reflect realistic exposure conditions, including remedial actions and naturally occurring radionuclides released by DOE processes and operations. If unusual circumstances affect a DOE activity in such a manner that the potential public dose could exceed an effective dose equivalent of 100 mrem in a year, DOE may authorize a temporary increase of the dose limit up to 500 mrem.
Guidelines for Residual Radioactive Material DOE Order 5400.5 Chapter IV (4)(a)	Guidelines for residual concentrations of radionuclides other than thorium and radium shall be derived from the basic dose limits by means of an environmental pathway analysis using specific property data where available. Procedures for these derivations are given in DOE/CH-8901. Residual concentrations of radioactive material in soil are defined as those in excess of background concentrations averaged over an area of 100 m <sup>2</sup> .
Hot Spots DOE Order 5400.5 Chapter IV (4)(a)(1)	If the average concentration in any surface or below surface area less than or equal to 25 m <sup>3</sup> , exceeds the limit or guideline by a factor of $(100/A)^{0.5}$ [where A is the area (in square meters) of the region in which the concentrations are elevated], limits for "hot spots" shall also be developed and applied. Procedures for calculating these hot spots limits, which depend on the extent of the elevated local concentrations, are given in DOE/CH-8901. In addition, reasonable efforts shall be made to remove any source of radionuclide that exceeds 30 times the appropriate limit in the soil, irrespective of the average concentration in the soil.
Generic Guidelines DOE Order 5400.5 Chapter IV (4)(a)(2)	The generic guidelines for residual concentrations of Ra-226, Ra-228, Th-230 and Th-232 are: <ul style="list-style-type: none"> <li>• 5 pCi/g, averaged over the first 15 cm of soil below the surface; and</li> <li>• 15 pCi/g, averaged over 15-cm-thick layers of soil more than 15 cm below the surface.</li> </ul>
External Gamma Radiation DOE Order 5400.5 Chapter IV (4)(c)	External gamma radiation levels on open lands shall comply with the basic limit [dose] and the "as low as reasonably achievable" (ALARA) process, considering appropriate-use scenarios for the area.

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TABLE 6-35

POTENTIAL OPERABLE UNIT 2 LOCATION-SPECIFIC ARARs  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Citation	Requirement	Remarks
Endangered Species and Critical Habitat 50 CFR §17.21, §17.94 50 CFR §402.01 40 CFR §6.302 (h)	All Federal agencies must insure that any action authorized, funded, or carried out by them is not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of the constituent elements essential to the conservation of a listed species within a defined critical habitat.	Baseline Ecological survey conducted by Miami University in 1986 and 1987 found no federal or state endangered species at the Fernald site. The Miami University Study and others have identified suitable habitats for three endangered species.
Antiquity Preservation 16 U.S.C. §431	No person may appropriate, excavate, injure, or destroy any historic or prehistoric ruin or monument, or any object of antiquity situated or controlled by the Government of the United States.	A survey of the Operable Unit 2 areas was performed in March, 1993 and it was determined that it had already been sufficiently disturbed that there would be no requirement to consult the State Historic Preservation Officer (SHPO). Any other proposed areas of disturbance for Operable Unit 2 remedial actions will be surveyed and the SHPO consulted as necessary.
Archaeological Recovery and Preservation 16 U.S.C. §408(a), 16 U.S.C. §470ff(a), 43 CFR Part 7, 40 CFR §6.301 (c)	No person may excavate, remove, damage, or otherwise alter or deface any archaeological resource located on public lands unless such activity is pursuant to a permit.	See above remark.
Safe Drinking Water Act 42 U.S.C. §1424(e)	All Federal financially assisted projects constructed in the area of a sole source aquifer and its principal recharge zone will be subject to EPA's review to insure that these projects are designed and constructed so that they do not create a significant hazard to public health.	53 FR 15876 (May 4, 1988) designated the Buried Valley Aquifer System of the Great Miami/Little Miami River Basins of Southwestern Ohio as a sole or principal source of drinking water.

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TABLE 6-35  
(Continued)

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Citation	Requirement	Remarks
Wetlands Executive Order 11990	Federal agencies must take action to avoid adversely impacting wetlands whenever possible, to minimize wetlands destruction, and to preserve the values of wetlands. 40 CFR §6, Appendix A describes EPA's policy for complying with this order. 10 CFR § 1022 contains DOE regulations implementing the order.	An updated site-wide delineation of Fernald wetlands, performed in accordance with the U.S. Army Corps of Engineers Wetland Delineation Manual, was completed in March 1993. While no wetlands were located in Operable Unit 2, some nearby wetlands may be affected during Operable Unit 2 remedial action.
Floodplains Executive Order 11988	This order requires federal agencies undertaking actions within a floodplain to evaluate the potential the action has for adverse impact on the floodplain. If it is determined that adverse impacts could occur, the effects of the action must be minimized to the extent practical. 10 CFR §1022 contains DOE's regulation implementing the order.	An updated floodplain determination was performed for Paddys Run in October 1993 using the Corps of Engineers' standard HEC2 water surface profile analysis program. The 100 year flood elevations reach the western slope of the Inactive Flyash Pile and the toe of slope of the South Field.

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## 7.0 SUMMARY AND CONCLUSIONS

This section provides a summary of the RI report for Operable Unit 2 and states the major conclusions of the investigation.

### 7.1 FACILITY DESCRIPTION AND RELEVANT HISTORY

The FEMP is a DOE facility located near Fernald, Ohio, which operated from 1952 to 1989 to provide high purity uranium metal products in support of United States defense programs. In 1989, the mission of the facility was changed to one of environmental restoration. Also in 1989, the facility was placed on the National Priorities List ("Superfund List"). The RI/FS for the FEMP is executed according to an Amended Consent Agreement between DOE and the EPA, under authority of CERCLA. OEPA is also participating in the FEMP RI/FS process through direct involvement in review meetings, public meetings, and technical review of project documentation.

The FEMP occupies about 1,050 acres and is located about 17 miles northwest of downtown Cincinnati near Fernald, Ohio, a small farming community. The site lies on the boundary of Hamilton and Butler counties. The primary mission of the FEMP during its 37 years as an operating production facility was to process, refine, and machine high-grade natural uranium ores into high purity uranium metal. The high purity metals were shipped to other DOE or U.S. Department of Defense facilities for use as "feed materials" in the nuclear weapons program. These uranium production activities generated large quantities of waste materials. The storage and disposal of wastes at the site and their potential for impacting human health led to the site being placed on the National Priorities List.

EPA approved the FEMP RI/FS Work Plan in May 1988. The work plan provided the overall technical approach, identified areas to be investigated, and presented the objectives and data evaluation criteria for the planned investigations. The work plan identified 27 specific areas, or units, within the FEMP for investigation. Subsequent evaluations increased the number of units to 39. It soon became apparent that for purposes of effective management, the 39 units should be categorized and grouped. The resultant groupings formed the five operable units of the FEMP. These operable units are:

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- Operable Unit 1 - Waste Pit Area
- Operable Unit 2 - Other Waste Areas
- Operable Unit 3 - Former Production Area
- Operable Unit 4 - Silos 1 through 4
- Operable Unit 5 - Environmental Media

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Operable Unit 2 is comprised of five subunits: (1) Solid Waste Landfill, (2) Lime Sludge Ponds, (3) Active Flyash Pile, (4) Inactive Flyash Pile, and (5) South Field. Large volumes of conventional industrial wastes, assumed to have small amounts of hazardous chemicals and radionuclides, were placed in these subunits during the period of production operations. These subunits are briefly described below.

7.1.1 Solid Waste Landfill

The Solid Waste Landfill is located in the northeast corner of the Waste Storage Area and is a flat, rectangular area of about one acre. The landfill has been inactive since 1986 and is covered with a layer of fill. The operational history of the landfill is not well documented; however, a review of historical site aerial photographs indicates that disposal activities may have occurred as early as 1954. Available documentation and interviews indicate that the landfill was intended to be used for "nonburnable wastes". Field investigations have revealed a variety of waste materials including medical wastes, rubbish, wastes from areas other than the former Production Area, and on-site construction/demolition wastes.

7.1.2 Lime Sludge Ponds

The Lime Sludge Ponds are two (North and South) unlined, rectangular ponds, each measuring approximately 125 by 225 feet, located in the southeast corner of the Waste Storage Area. The sludge is confined by earthen dikes of unknown origin. The operational history of the ponds is well understood based on documentation and process knowledge. Wastes disposed of in the ponds originated from water plant operations, coal pile storm water runoff, and boiler plant blowdown. The South Pond is full, has been inactive since the mid-1960s, and is now overgrown with grasses and shrubs. The North Pond currently remains in use. The west side of the North Pond usually is covered with one to two feet of water, mainly depending on precipitation. The remainder of the pond is dry and sparsely covered with vegetation.

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The waste from water plant operations is generated from a water softening process. About one cubic yard of waste sludge is generated each day and is pumped to Tanks 6 and 7 of the General Sump. Coal pile runoff is treated in a retention basin to settle out the solids, then pumped to Tanks 6 and 7 of the General Sump. The boiler plant blowdown consists of backflush water, generated when the boilers are backflushed to prevent scale buildup. This water is also pumped to Tanks 6 and 7 of the General Sump. Tanks 6 and 7 contain only sludges from these three sources.

Sludge is allowed to accumulate in the tanks for about two weeks. It is then pumped as a slurry to the North Lime Sludge Pond. The bulk of the material comprising the slurry is sludge from the water softening operations. The Lime Sludge Ponds have been operated in this manner since the early 1950s. Based on this process knowledge as well as the results of analytical analysis of the sludge, it appears that the lime sludge is relatively homogenous. The Lime Sludge Ponds are presently classified as SWMUs by OEPA.

7.1.3 Inactive Flyash Pile

The Inactive Flyash Pile is located about 2,000 feet southwest of the former Production Area and covers approximately two acres. Paddys Run forms the western boundary and the South Field lies to the east. The Inactive Flyash Pile and South Field are contiguous and lack a defined physical boundary. In appearance, this subunit resembles a relatively steep hill covered with shrubs and trees. The soil covering the southern half of the Inactive Flyash Pile is of unknown origin.

The operating history of the Inactive Flyash Pile is not well understood. The bulk of the waste material in the pile is reported to be bottom ash and flyash from the facility's boiler plant operations, commonly referred to as flyash. Based on a review of historical aerial photographs, flyash appears to have been taken by truck to an existing slope near Paddys Run and dumped. The photographs indicate that flyash disposal at this subunit had ceased by the mid-1960s. Various other wastes including building rubble, gravel, asphalt, and process waste were also deposited at the Inactive Flyash Pile.

7.1.4 South Field

The South Field is an 11-acre area that lies between the Inactive Flyash Pile and the Active Flyash Pile. A physical boundary with the Inactive Flyash Pile is not distinguishable. Currently, the South Field is relatively flat and is covered with grasses, shrubs, and trees.

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The operational history of the South Field is neither well documented nor understood. It is not an engineered disposal site. A review of historical aerial photographs indicates that disposal may have been initiated in 1954 and continued until the mid-1960s. Disposal appears to have taken place in a random manner. Available documentation indicates that a number of wastes were disposed in the South Field, including construction and demolition materials, flyash, soils that may have been contaminated with low levels of radioactive materials, and possibly process wastes.

7.1.5 Active Flyash Pile

The Active Flyash Pile is bounded to the east and north by the Storm Sewer Outfall Ditch, and is separated from the South Field to the west by an unpaved road. The Active Flyash Pile appears as a large, steep pile of black flyash, and covers about three acres. Wind screens and silt fences have been installed to prevent wind and water erosion, and a crusting agent has been applied to minimize dust. The operational history of the subunit is well understood based on documentation and process knowledge.

Flyash from the site's coal-fired boiler plant was disposed at the Active Flyash Pile from the mid-1960s until December 1992. Flyash presently being generated at the FEMP is disposed at an approved, off-site facility. The waste at the Active Flyash Pile is comprised of about 70 percent bottom ash and 30 percent flyash. Small quantities of unburned coal and rock are present, as is typical of boiler ashes. Previous investigations have discussed the possibility that waste oils, which theoretically could contain PCBs or uranium, might have been applied to the Active Flyash Pile as a dust control measure; however, attempts to document this possibility have not been successful.

7.2 OPERABLE UNIT 2 INVESTIGATIONS

The potential for contamination at Operable Unit 2 subunits has been established through several environmental investigations. The investigations most relied on in this report are the CERCLA RI, the CIS, and the Environmental Survey (ES). The evaluation of the nature and extent of contamination in this report was based primarily on RI data. The CIS and ES primarily were focused on site-wide issues and were not intended to provide a detailed analysis of contamination due to Operable Unit 2 subunits. Data from the CIS was not validated, and therefore, were used only in a supplementary manner and for descriptive purposes. Neither ES nor CIS data were used in fate and transport modeling for the baseline risk assessment.

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The RI field investigations were implemented in two phases (Phase I and Phase II). Phase I investigation activities occurred between 1988 and 1992, and Phase II occurred during 1993. These combined efforts collected over 2,000 samples of environmental media in order to evaluate the potential for contamination. All RI data were validated, and only RI contaminant concentration data were used in the fate and transport modeling for the baseline risk assessment.

The RI data collection was for two specific purposes: (1) to determine the nature and extent of contamination in a manner adequate to determine the future impacts on human health if the site were not to be remediated, and (2) to provide a basis for the development and evaluation of a range of feasible remedial action alternatives. The specific objectives of the RI field investigation were to:

- Characterize the nature and extent of contamination in surface soil, subsurface soil and fill, surface water and sediment, perched water, and the Great Miami Aquifer that could be expected to have been impacted by Operable Unit 2 subunits.
- Characterize specific waste materials, (e.g., lime sludge).
- Provide the data necessary to evaluate the potential for human exposure to contaminants through the air, surface water, groundwater, dermal contact, external radiation, and ingestion pathways.

7.3 PHYSICAL CHARACTERISTICS

The physical characteristics of the site include the natural and man-made factors affecting meteorology, geology, hydrology, and hydrogeology. The prevailing winds at the FEMP are generally from the southwest and west-southwest. The most frequent adverse weather conditions in the region occur from severe thunderstorms and tornados. The annual probability of a tornado occurring per square mile in Ohio is estimated to be 1.25 in 10,000.

The average annual precipitation for the Greater Cincinnati area for the period of 1960 to 1989 was 40.56 inches, and ranged from 27.99 inches in 1963 to 52.76 inches in 1979. The seasons having the most precipitation are spring and early summer; the least precipitation occurs in late summer and fall. The highest 24-hour rainfall event on record, 5.21 inches, occurred in March 1964. The average annual snowfall for the 1960 to 1989 time period was 23.5 inches. The heaviest snowfall usually occurs in January; the maximum monthly snowfall, 31.5 inches, occurred in January 1978. The maximum recorded 24-hour snowfall event, 9.8 inches, occurred in March 1968.

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Maximum elevation at the FEMP is along the northern boundary and is slightly more than 700 feet above MSL. The former Production Area and Waste Storage Area (Operable Units 3 and 1, respectively) are on a relatively flat plain at about 580 feet above MSL. The plain slopes gently from about 600 feet above MSL along the eastern boundary of the FEMP to approximately 550 feet above MSL at Paddys Run. Surface water drainage on the FEMP is generally from east to west toward Paddys Run. The storm water drainage from the former Production Area and the Waste Storage Area is controlled and discharged to the Great Miami River.

Paddys Run originates north of the FEMP and flows intermittently southward along the western boundary of the site. The stream is about 8.8 miles long and drains an area of about 15.8 miles. Flow in Paddys Run is lost to the underlying Great Miami Aquifer in the vicinity of the site. Paddys Run usually flows throughout its entire length between January and May of each year.

The other flowing body of water at the FEMP is the Storm Sewer Outfall Ditch. The drainage area originates east of the former Production Area, and surface flow becomes channeled within a culvert until it reaches the Storm Sewer Outfall Ditch at a point near the parking lot south of the former Production Area. The outfall ditch then flows southwest across the southern portion of the site and enters Paddys Run near the southwestern boundary of the FEMP. Throughout the year, this ditch generally is dry, with flows occurring only during and after precipitation events. Much of the ditch's bottom is composed of sand and gravel, and loss of flow to the underlying aquifer may occur.

The FEMP is situated on an area of glacial overburden deposits; the overburden primarily is composed of till, a dense silty clay that may contain lenses of poorly sorted fine to medium grained sand and gravel, silty sand, and silt. Undisturbed glacial till has relatively low permeability. The thickness of the till varies from 0 to 50 feet on the site, and the till tends to be thicker in the northern part of the site (the Solid Waste Landfill, for example, is sited in thick till) and pinches out completely in the South Field area in the southern part of the site. Areas not covered with till may exhibit higher infiltration rates than those covered with glacial till.

Erratically distributed pockets of sand and gravel within the till contain zones of perched groundwater. Perched groundwater is separated from the underlying aquifer by the surrounding relatively impermeable till materials. Depth to perched groundwater at the FEMP ranges from 1 to 15

feet below ground surface. The depth may fluctuate seasonally by up to 10 feet at a given location, with the highest levels occurring in the early spring and the lowest in the late fall.

The FEMP is sited above a major aquifer system, the Great Miami Aquifer. The Great Miami Aquifer is designated a Sole-Source Drinking Water Aquifer and sustains numerous industrial, municipal, and private drinking water wells. The FEMP includes several areas that probably function as recharge zones to the aquifer including Paddys Run and the Storm Sewer Outfall Ditch.

7.4 PROCESS FOR DETERMINING NATURE AND EXTENT, FATE AND TRANSPORT, AND BASELINE RISK ASSESSMENT

This section summarizes the succession of work performed to determine the Operable Unit 2 COCs and to obtain sufficient information to develop and evaluate remedial alternatives under the Operable Unit 2 FS. This process consists of three major steps: (1) nature and extent, (2) fate and transport, and (3) a baseline risk assessment.

Nature and Extent

The data collected during the RI was analyzed in Section 4.0 to describe the specific constituents and concentration levels found in each environmental media within the Operable Unit 2 battery limits. This analysis included the identification of the horizontal and vertical extent of these constituents within the battery limits of Operable Unit 2.

Fate and Transport

Results of the site physical characteristics, source characteristics, and extent of contamination analyses were combined in the analyses of constituent fate and transport. The observed extent of contamination was used to assist in assessing the transport pathway's rate of migration and the fate of contaminants over the 40 year span from the suspected contaminant release to the time of the RI. A source term was developed for each subunit based on the 95th percent UCL of the mean of the concentration for all constituents except uranium. The source term for uranium was developed through solid block modeling of the RI data. This solid block modeling produced a mean level of uranium present in each subunit based on geostatistical evaluation of the uranium data. A screening procedure was used to identify CPCs for Operable Unit 2. This process eliminated constituents of a source term that were below background levels, of nutrient value, and less than  $1.0 \times 10^{-7}$  potential carcinogenic risk or a HI of less than 0.1 from EPA Region III guidance. Computer modeling, using

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the ISCLT2, HELP, ODAST, and SWIFT models, were used to predict the future concentrations of these CPCs in air, groundwater, and surface water. Groundwater transport was modeled for 1000 years. These simulation models have been approved by EPA and calibrated to site conditions.

Baseline Risk Assessment

An Operable Unit 2 baseline risk assessment was performed to evaluate the current and future potential threat to human health from the Operable Unit 2 subunits in the absence of any remedial actions.

The assessment accomplished the following for each subunit:

- Determination of CPCs for Operable Unit 2.
- Assessment of the potential for and magnitude of constituent transport from Operable Unit 2 sources to potential points of human exposure.
- Quantification of potential exposures to human receptors under current and future land use scenarios.
- Characterization of the nature and magnitude of potential risks associated with Operable Unit 2, assuming there were no remedial action in the future.
- Evaluation of the uncertainty associated with the risk estimations.

The baseline risk assessment results are used to determine the need for remedial action in Operable Unit 2; identify specific media and areas for which cleanup is appropriate; present a baseline of potential risk for the no action alternative in the FS; and provide criteria for determining cleanup levels.

The Operable Unit 2 baseline risk Assessment addresses only potential risks associated with waste subunits within the battery units of Operable Unit 2. It does not consider existing sources or contamination in soil, surface water, and sediment outside the boundaries of Operable Unit 2, nor does it consider groundwater contamination. These risks will be evaluated in the Operable Unit 5 RI. Risks due to groundwater in this and other operable unit risk assessments are based on estimates of future concentrations which are based on modeling. This risk assessment does not consider the potential impacts on flora and fauna (ecological risks). Evaluation of site-wide ecological risks will

take place in the Operable Unit 5 RI/FS; areas likely to be remediated on the basis of human health protection will not be evaluated.

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Operable Unit 2 includes five subunits for which remedial decisions must be made. In order to facilitate the decisions, risk was quantified separately for each subunit. The specific risk assessment methodology followed for the risk assessment was consistent across all subunits as well as for the cumulative risk from Operable Unit 2 that was calculated.

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Potential human exposure to risk is evaluated in the context of three land use scenarios: (1) current land use assuming DOE ownership with both access and no access control, (2) future land use assuming federal ownership, and (3) future land use assuming private ownership. For all scenarios, it is assumed that no additional cleanup of Operable Unit 2 occurs beyond that which already has taken place.

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The postulated human receptors of incremental risk for the current land use scenario include a trespassing youth, off-property residents, and on-property groundskeeper. For the future land use scenario assuming federal ownership, the receptors are expanded trespasser and off-property farmers. For the future land use scenario assuming private ownership, the receptors are on-property farmers, homebuilders (for South Field and Solid Waste Landfill only), and users of "perched" groundwater [isolated bodies of groundwater within the glacial till] (for Solid Waste Landfill and Lime Sludge Ponds only). Recreation users of the Great Miami River are future receptors regardless of whether federal or government ownership is assumed. For the future land use scenarios, the contaminant concentrations at the specific geographical and temporal points of human exposures were determined by the application of approved air dispersion and surface water and groundwater transport computer simulation models.

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Epidemiological evidence indicates that the typical human being has a risk of developing cancer of about one in three, or  $3.3 \times 10^{-1}$ . Federal regulations for the management of waste sites limit the allowable excess risk to any person, resulting from exposure to carcinogenic materials, to one in 10,000 or  $10^{-4}$ . Accordingly, this baseline risk assessment presents the risks due to exposure to carcinogens in terms of ILCR; that is, the additional risk to a given person, given a lifetime of exposure to wastes and impacted media within the Operable Unit 2 battery limits. Hazards due to

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exposure to noncarcinogenic constituent also are evaluated. Noncarcinogenic risks are reported as a HI. HIs of greater than 1.0 or "above unity" indicate a concern for potential health effects.

To ensure that the most sensitive or most exposed individuals in the population are protected, EPA guidance provides for calculation of RME, which is the maximum reasonable exposure a person could receive from the waste site being evaluated. For example, in the Operable Unit 2 future land use scenario having private ownership, the on-property RME farmer (adult and child) builds a home on (where physically feasible) and actively farms the unremediated Operable Unit 2 waste units, and is exposed to the following for each contaminant of potential concern:

- Inhalation of fugitive dust, volatile organic compounds, and gases
- Incidental ingestion, inhalation, and dermal contact while using groundwater (separate evaluations for Great Miami Aquifer and perched groundwater) in the home.
- Consumption of foodstuffs grown on the waste site, including fruits and vegetables, and meat and milk
- Incidental ingestion of, external radiation from, and dermal contact with soil
- Inhalation of indoor radon.

Thus, the RME receptors usually will have the highest estimated risks in a risk assessment. Risk and hazard results are also presented for a CT receptor, whose exposures are thought to be more typical of the average individual in the exposed population. For all subunits, future risks to off-property receptors (with the exception of the expanded trespasser, whose exposures primarily occur on the site) will be the same for federal or private ownership. A summary of results from the risk assessment are presented in Table 7-1 in the following sections. Details of the risk assessment are presented in Appendix B. All site-related risks were calculated without accounting for potential contribution from natural background concentrations of CPCs.

A discussion of this process for each subunit is presented in the following subsections.

7.4.1 Solid Waste Landfill

Trenching and boring activities in the Solid Waste Landfill have determined that cafeteria, laboratory, construction/maintenance, and manufacturing wastes were disposed in the landfill. One waste disposal cell and an evaporation pond were identified in historical photographs and trench

TABLE 7-1

BASELINE RISK ASSESSMENT SUMMARY  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

Waste Subunit	Risk Type <sup>a</sup>	Current Land Use					Future Land Use Assuming Federal Ownership		
		Trespassing Youth	On-Property Groundskeeper	Off-Property Resident Farmer	Off-Property Resident Child	User of Meat and Milk	Expanded Trespasser	Off-Property Resident Farmer	Off-Property Resident Child
Solid Waste Landfill	Carcinogenic	1.6x10 <sup>-5</sup>	2.4x10 <sup>-5</sup>	4.6x10 <sup>-8</sup>	6.2x10 <sup>-9</sup>	3.9x10 <sup>-7</sup>	4.4x10 <sup>-5</sup>	1.3x10 <sup>-6</sup>	1.5x10 <sup>-7</sup>
	Noncarcinogenic	3.9x10 <sup>-1</sup>	1.4x10 <sup>-1</sup>	5.5x10 <sup>-6</sup>	2.6x10 <sup>-5</sup>	6.1x10 <sup>-5</sup>	7.4x10 <sup>-1</sup>	1.3x10 <sup>-4</sup>	6.1x10 <sup>-4</sup>
Lime Sludge Ponds	Carcinogenic	2.8x10 <sup>-5</sup>	4.7x10 <sup>-5</sup>	2.3x10 <sup>-7</sup>	4.9x10 <sup>-8</sup>	5.5x10 <sup>-6</sup>	9.8x10 <sup>-5</sup>	2.4x10 <sup>-7</sup>	5.0x10 <sup>-8</sup>
	Noncarcinogenic	2.1x10 <sup>-1</sup>	1.4x10 <sup>-1</sup>	1.1x10 <sup>-4</sup>	2.0x10 <sup>-4</sup>	1.8x10 <sup>-3</sup>	6.3x10 <sup>-1</sup>	1.1x10 <sup>-4</sup>	2.0x10 <sup>-4</sup>
Inactive Flyash Pile	Carcinogenic	3.3x10 <sup>-5</sup>	5.0x10 <sup>-5</sup>	8.6x10 <sup>-8</sup>	8.3x10 <sup>-9</sup>	3.2x10 <sup>-8</sup>	1.2x10 <sup>-4</sup>	6.6x10 <sup>-5</sup>	3.2x10 <sup>-6</sup>
	Noncarcinogenic	1.2x1 <sup>-1</sup>	4.5x10 <sup>-2</sup>	3.1x10 <sup>-5</sup>	1.3x10 <sup>-4</sup>	7.2x10 <sup>-5</sup>	4.0x10 <sup>-1</sup>	1.3	3.4
South Field	Carcinogenic	8.0x10 <sup>-5</sup>	6.5x10 <sup>-4</sup>	7.0x10 <sup>-7</sup>	3.0x10 <sup>-7</sup>	4.2x10 <sup>-6</sup>	2.2x10 <sup>-4</sup>	8.1x10 <sup>-5</sup>	1.2x10 <sup>-5</sup>
	Noncarcinogenic	3.6x10 <sup>-1</sup>	4.1x10 <sup>-2</sup>	1.2x10 <sup>-5</sup>	4.9x10 <sup>-5</sup>	1.7x10 <sup>-5</sup>	3.8x10 <sup>-1</sup>	1.1	2.7
Active Flyash Pile	Carcinogenic	6.5x10 <sup>-5</sup>	9.2x10 <sup>-5</sup>	1.7x10 <sup>-6</sup>	5.0x10 <sup>-7</sup>	6.5x10 <sup>-6</sup>	2.4x10 <sup>-4</sup>	9.2x10 <sup>-6</sup>	8.7x10 <sup>-7</sup>
	Noncarcinogenic	1.1x10 <sup>-1</sup>	9.9x10 <sup>-2</sup>	4.2x10 <sup>-3</sup>	1.6x10 <sup>-2</sup>	4.7x10 <sup>-2</sup>	2.8x10 <sup>-1</sup>	1.9x10 <sup>-1</sup>	7.1x10 <sup>-1</sup>

See footnotes at end of table

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TABLE 7-1  
(Continued)

Waste Subunit	Risk Type <sup>a</sup>	Future Land Use Assuming Private Ownership							
		On-Property Resident Farmer (RME) <sup>b</sup>	On-Property Resident Farmer (CT) <sup>c</sup>	On-Property Resident Child	Home Builder	Perched Groundwater User	Perched Groundwater Child	Great Miami River User (Adult)	Great Miami River User (Youth)
Solid Waste Landfill	Carcinogenic	1.2x10 <sup>-3</sup>	8.8x10 <sup>-5</sup>	1.2x10 <sup>-4</sup>	5.1x10 <sup>-6</sup>	5.3x10 <sup>-3</sup>	1.1x10 <sup>-3</sup>	1.0x10 <sup>-5</sup>	4.2x10 <sup>-6</sup>
	Noncarcinogenic	1.5	3.0x10 <sup>-1</sup>	3.3	1.9	NA	NA	1.4x10 <sup>-1</sup>	1.7x10 <sup>-1</sup>
Lime Sludge Ponds	Carcinogenic	1.9x10 <sup>-3</sup>	1.7x10 <sup>-4</sup>	2.1x10 <sup>-4</sup>	NA	7.7x10 <sup>-7</sup>	1.4x10 <sup>-7</sup>	N/A	N/A
	Noncarcinogenic	2.6x10 <sup>-1</sup>	1.4x10 <sup>-1</sup>	1.3	NA	6.0x10 <sup>-3</sup>	1.2x10 <sup>-2</sup>	N/A	N/A
Inactive Flyash Pile	Carcinogenic	3.2x10 <sup>-3</sup>	2.7x10 <sup>-4</sup>	3.3x10 <sup>-4</sup>	NA	NA	NA	2.5x10 <sup>-5</sup>	8.2x10 <sup>-6</sup>
	Noncarcinogenic	2.3	1.3	5.8	NA	NA	NA	3.8x10 <sup>-1</sup>	2.4x10 <sup>-2</sup>
South Field	Carcinogenic	3.8x10 <sup>-3</sup>	3.1x10 <sup>-4</sup>	4.5x10 <sup>-4</sup>	2.7x10 <sup>-7</sup>	NA	NA	1.1x10 <sup>-4</sup>	6.3x10 <sup>-5</sup>
	Noncarcinogenic	2.2	1.3	5.7	0.1	NA	NA	4.4x10 <sup>-2</sup>	6.3x10 <sup>-2</sup>
Active Flyash Pile	Carcinogenic	1.9x10 <sup>-3</sup>	1.7x10 <sup>-4</sup>	6.0x10 <sup>-4</sup>	NA	NA	NA	1.3x10 <sup>-4</sup>	6.5x10 <sup>-5</sup>
	Noncarcinogenic	2.1	1.1	8.0	NA	NA	NA	0.2	0.2

<sup>a</sup>The carcinogenic risk value is the Incremental Lifetime Cancer Risk (ILCR) and the noncarcinogenic hazard value is the Hazard Index (HI).

<sup>b</sup>RME = Reasonable Maximum Exposure

<sup>c</sup>CT = Central Tendency

<sup>d</sup>NA = The indicated land use is not applicable to the waste subunit

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observations, but waste was observed in numerous other areas within the battery limits. The depth of waste is generally 10 feet and the maximum depth is the southeastern corner of the landfill of 15 feet.

Nature and Extent

Table 7-2 presents a summary of the nature of COCs for the Solid Waste Landfill determined through the fate and transport modeling and baseline risk assessment processes. Thirteen COCs have been identified for the Solid Waste Landfill that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 3 organic compounds. The table identifies the number of samples detected above background compared to the number of samples in a particular medium.

The extent of COCs in the Solid Waste Landfill is distributed throughout the surface and subsurface fill materials with the maximum levels in the southeastern corner of the landfill. The COCs were also detected in the glacial till beneath the landfill and in the perched groundwater near the southeast corner of the subunit. No impact has been observed on the Great Miami Aquifer. The number of COCs detected in the surface water, sediment, and perched groundwater are fewer than those detected in the surface and subsurface soils.

Fate and Transport

Future maximum on-site and off-site modeled COC concentrations for each media are listed in Table 7-3. The media pathways considered significant for the Solid Waste Landfill as a result of the modeling include air, surface water, groundwater, and perched water. Perched water was modeled under the Solid Waste Landfill because of a potential for household use of the perched water.

Solid Waste Landfill Baseline Risk Assessment

For the current land use scenario, a total carcinogenic risk to a trespassing youth is  $1.6 \times 10^{-5}$  due to external radiation from radium-228 and thorium-228 and dermal contact with beryllium in soil. Total risk to the on-property groundskeeper is within the same order of magnitude as the trespassing youth. Major contributors to risk for this receptor are the same as those to the trespassing youth. HIs are less than 1.0. Off-property farmers have carcinogenic risks on the order of  $10^{-8}$  and HIs of less than 1.0.



TABLE 7-3

MAXIMUM MODELED COC CONCENTRATIONS IN THE<sup>a</sup>  
 SOLID WASTE LANDFILL  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

COC/Phase	Air Maximum Modeled Concentration		Perched Groundwater Maximum Modeled Concentration	Groundwater Maximum Modeled Concentrations			Surface Water Maximum Modeled Concentrations	
	On Site <sup>b</sup>	Off Site <sup>c</sup>	On Site	On Site	Year	Off Site	Year	Paddys Run
Cesium-137	2.43E-05 pCi/m <sup>3</sup>	4.01E-07 pCi/m <sup>3</sup>	0.00 pCi/L	NOT CPC		NOT CPC		8.14E-06 pCi/L
Neptunium-237	1.08E-04 pCi/m <sup>3</sup>	1.78E-06 pCi/m <sup>3</sup>	1.11E-05 pCi/L	NOT CPC		NOT CPC		1.24E-03 pCi/L
Radium-228	1.53E-04 pCi/m <sup>3</sup>	2.52E-06 pCi/m <sup>3</sup>	0.00 pCi/L	NOT CPC		NOT CPC		1.38E-04 pCi/L
Thorium-228	1.48E-04 pCi/m <sup>3</sup>	2.44E-06 pCi/m <sup>3</sup>	0.00 pCi/L	NOT CPC		NOT CPC		1.61E-05 pCi/L
Uranium-234	3.83E-03 pCi/m <sup>3</sup>	6.32E-05 pCi/m <sup>3</sup>	0.00 pCi/L	NOT CPC		NOT CPC		3.22E-02 pCi/L
Uranium-235/236	2.58E-04 pCi/m <sup>3</sup>	4.26E-06 pCi/m <sup>3</sup>	0.00 pCi/L	NOT CPC		NOT CPC		2.16E-03 pCi/L
Uranium-238	7.02E-03 pCi/m <sup>3</sup>	1.16E-04 pCi/m <sup>3</sup>	0.00 pCi/L	NOT CPC		NOT CPC		5.91E-02 pCi/L
Arsenic	6.07E-07 mg/m <sup>3</sup>	1.00E-08 mg/m <sup>3</sup>	0.00 mg/L	NOT CPC		NOT CPC		1.91E-03 mg/L
Beryllium	6.35E-08 mg/m <sup>3</sup>	1.05E-09 mg/m <sup>3</sup>	0.00 mg/L	NOT CPC		NOT CPC		3.08E-05 mg/L
Uranium-Total	2.05E-05 mg/m <sup>3</sup>	3.38E-07 mg/m <sup>3</sup>	0.00 mg/L	NOT CPC		NOT CPC		1.72E-01 mg/L
4,4-DDE	1.09E-09 mg/m <sup>3</sup>	1.80E-11 mg/m <sup>3</sup>	0.00 mg/L	NOT CPC		NOT CPC		1.05E-08 mg/L
Dibenzo(a,h)-anthracene	1.82E-08 mg/m <sup>3</sup>	3.00E-10 mg/m <sup>3</sup>	0.00 mg/L	NOT CPC		NOT CPC		1.87E-06 mg/L
Indeno(1,2,3-cd)pyrene	4.37E-08 mg/m <sup>3</sup>	7.20E-10 mg/m <sup>3</sup>	0.00 mg/L	NOT CPC		NOT CPC		9.14E-08 mg/L
Carbazole	7.01E-09 mg/m <sup>3</sup>	1.16E-10 mg/m <sup>3</sup>	9.61E+00 mg/L	NOT CPC		NOT CPC		3.27E-04 mg/L

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>On site refers to a location on the subunit of concern.

<sup>c</sup>Off site refers to the location at the FEMP fence line.

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For the future land use scenario assuming private ownership, total carcinogenic risk and hazard to the on-property RME farmer are  $1.2 \times 10^{-3}$  and 1.5, respectively. Major contributors to risk for this receptor are from radium-228, uranium-238, and thorium-228 in soil via external radiation and dermal contact with beryllium in soil. Risks exceeded the  $1.0 \times 10^{-4}$  level for perched groundwater users due primarily to the estimated presence of carbazole in perched groundwater.

For the future scenario having federal ownership, the expanded trespasser has a combined carcinogenic risk of  $4.4 \times 10^{-5}$  due mostly to external radiation by radium-228, thorium-228, and uranium-238 and dermal contact with beryllium in soil. Total HI is less than 1.0. Combined carcinogenic risk for off-property farmers range from  $10^{-5}$  to  $10^{-8}$ .

Risk to the recreational users of the Great Miami River is in the  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-5}$  range due mostly to external radiation from thorium-228, radium-228, and uranium-238 in sediment. HIs are below 1.0.

Table 7-4 lists the COCs contributing greater than one percent total medium risk for each medium relating to the future scenarios. Two COCs, carbazole (99.97 percent) and technetium-99 (less than one percent risk contribution), contribute risk to the on-property resident farmer if perched groundwater is used as a household drinking water source. Approximately 86 percent of the total risk to the on-property resident farmer is derived from four COCs: radium-228, thorium-228, uranium-238, and beryllium in soil.

7.4.2 Lime Sludge Ponds

Field investigations of the Lime Sludge Ponds indicate that the sludge within the subunit is homogeneous. Sampling in the berm soils and glacial till beneath the ponds has determined that the soils have higher concentrations of most constituents than the sludge. This means that future impacts from the sludge upon the soil are not likely. Elevated concentrations of uranium and thorium were detected in downgradient perched groundwater wells, but samples collected from the K-65 Trench (outside of Operable Unit 2 boundaries) detected elevated radioisotope activities. The K-65 Trench is believed to be the source for the perched groundwater contamination.

TABLE 7-4

**SOLID WASTE LANDFILL FUTURE LAND USE  
SUMMARY OF COC TOTAL CARCINOGENIC RISK CONTRIBUTIONS<sup>a</sup>  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk	Perched Groundwater User	% Total Medium Risk	% Total Receptor Risk
Soil:												
Cesium-137	b	-	-	-	-	-	2.1E-05	1.88%	1.85%	N/A <sup>c</sup>		
Neptunium-237	-	-	-	-	-	-	2.3E-05	2.00%	1.97%	N/A		
Radium-228	-	-	-	-	-	-	2.0E-04	17.88%	17.60%	N/A		
Thorium-228	-	-	-	-	-	-	3.8E-04	33.42%	32.91%	N/A		
Uranium-234	-	-	-	-	-	-	1.4E-05	1.23%	1.21%	N/A		
Uranium-235/236	-	-	-	-	-	-	2.9E-05	2.57%	2.53%	N/A		
Uranium-238	-	-	-	-	-	-	1.7E-04	14.71%	14.48%	N/A		
Arsenic	-	-	-	-	-	-	3.0E-05	2.67%	2.63%	N/A		
Beryllium	-	-	-	-	-	-	2.4E-04	21.45%	21.12%	N/A		
Perched Groundwater Carbazole	N/A <sup>c</sup>			N/A			N/A			5.3E-03	99.97%	99.97%
Home Grown Produce (Dust Affected)												
Arsenic	-	-	-	-	-	-	7.2E-06	84.78%	0.62%	N/A		
Beef/Milk (Dust Affected)												
Indeno(1,2,3cd)pyrene	-	-	-	-	-	-	7.3E-06	80.95%	0.63%	N/A		
Total Risk	4.4E-05			1.3E-06			1.2E-03			5.3E-03		

<sup>a</sup>COCs listed in table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Pose no risk greater than the threshold level of  $1.0 \times 10^{-6}$ .

<sup>c</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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Nature and Extent

Table 7-5 presents a summary of the nature of COCs within each medium for the Lime Sludge Ponds determined through the fate and transport modeling and baseline risk assessment processes. Seven COCs have been identified for the Lime Sludge Ponds that contribute greater than one percent of the total risk for a medium. These COCs consist of 4 radionuclides, 2 metals, and 1 organic compounds. The table identifies the number of samples detected above background compared to the number of samples in a particular medium.

As described in Section 4.3, the extent of COCs in the Lime Sludge Ponds is limited mostly to the berm soils surrounding the ponds. Beryllium is the only COC that is believed to have originated in the lime sludge. Radionuclides and organics appear to have originated in the surface and berm soils. The COCs were also detected in the perched groundwater downgradient of the subunit, but the source of these contaminants is believed to be the K-65 Trench. No impact has been observed on the Great Miami Aquifer.

Fate and Transport

Future maximum on-site and off-site modeled COC concentrations for each medium are listed in Table 7-6. The media pathways considered significant for the Lime Sludge Ponds as a result of the modeling include the air and groundwater pathways. No surface water pathway exists near the Lime Sludge Ponds and all surface water is contained within the subunit. Perched water was modeled under the Lime Sludge Ponds because of a potential for household use of the perched water.

Baseline Risk Assessment

For the current land use scenario, a total carcinogenic risk to a trespassing youth is  $2.8 \times 10^{-5}$  due primarily to exposure to surface soil containing radium-228 and thorium-228, via external radiation, and to dermal contact with beryllium and Aroclor-1254. Total risk to the current on-property groundskeeper is  $4.7 \times 10^{-5}$  due mostly to the presence of thorium-228 (accounting for 27 percent) and beryllium (accounting for 40 percent) in soil. Total HIs for these receptors were less than 1.0. Carcinogenic risks to off-property residents are on the order of  $10^{-7}$  and the total HI is much less than 1.0.

For the future land use scenario assuming private ownership, the RME farmer has a total risk of  $1.9 \times 10^{-3}$  due almost entirely to the presence of radium-228 (10.65 percent), thorium-228 (36.45

TABLE 7-5

**COCs DETECTED IN THE LIME SLUDGE PONDS<sup>a</sup>  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

COC/Phase	Surface Soil	Subsoil		Surface Water		Sediment		Groundwater 1000-series		Groundwater 2000-series	
	II	I	II	I	II	I	II	I	II	I	II
Cesium-137	1/14 <sup>b</sup>	0/6	11/23	N/A <sup>c</sup>	0/1	N/A	N/A	N/A	0/7	N/A	0/5
Radium-228	7/14	0/6	6/33	N/A	0/1	N/A	N/A	0/11	0/6	0/5	0/5
Thorium-228	4/13	1/6	1/30	N/A	0/1	N/A	N/A	2/11	2/7	1/5	0/5
Uranium-238	12/14	2/6	27/33	N/A	0/1	N/A	N/A	7/11	7/7	1/5	4/5
Arsenic	0/14	0/2	3/33	N/A	0/1	N/A	N/A	0/12	0/4	0/4	0/8
Beryllium	9/14	2/2	17/33	N/A	0/1	N/A	N/A	0/1	0/2	0/2	0/8
Aroclor 1254	3/15	0/2	0/34	0/1	0/1	N/A	N/A	N/A	0/6	N/A	0/4
Benzo(a)pyrene	4/14	0/2	0/34	0/1	0/1	N/A	N/A	N/A	0/6	0/1	0/4

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Number refers to detections above background relative to number of analyses.

<sup>c</sup>N/A indicates not analyzed.

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TABLE 7-6

**MAXIMUM MODELED COC CONCENTRATIONS IN THE<sup>a</sup>  
LIME SLUDGE PONDS  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

COC/Phase	Air Maximum Modeled Concentration		Perched Groundwater Maximum Modeled Concentration	Groundwater Maximum Modeled Concentrations			
	On Site <sup>b</sup>	Off Site <sup>c</sup>	On Site	On Site	Year	Off Site	Year
Cesium-137	1.05E-05 pCi/m <sup>3</sup>	1.24E-07 pCi/m <sup>3</sup>	0.0 pCi/L	NOT CPC		NOT CPC	
Radium-228	2.46E-05 pCi/m <sup>3</sup>	2.90E-07 pCi/m <sup>3</sup>	0.0 pCi/L	NOT CPC		NOT CPC	
Thorium-228	4.37E-05 pCi/m <sup>3</sup>	5.15E-07 pCi/m <sup>3</sup>	0.0 pCi/L	NOT CPC		NOT CPC	
Uranium-238	1.07E-03 pCi/m <sup>3</sup>	1.26E-05 pCi/m <sup>3</sup>	1.64E-02 pCi/L	NOT CPC		NOT CPC	
Arsenic	1.08E-07 mg/m <sup>3</sup>	1.27E-09 mg/m <sup>3</sup>	1.45E-02 mg/L	NOT CPC		NOT CPC	
Beryllium	2.28E-08 mg/m <sup>3</sup>	2.69E-10 mg/m <sup>3</sup>	0.0 mg/L	NOT CPC		NOT CPC	
Aroclor-1254	8.85E-06 mg/m <sup>3</sup>	1.04E-07 mg/m <sup>3</sup>	0.0 mg/L	NOT CPC		NOT CPC	
Benzo(a)pyrene	1.65E-08 mg/m <sup>3</sup>	1.95E-10 mg/m <sup>3</sup>	0.0 mg/L	NOT CPC		NOT CPC	

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>On site refers to a location on the subunit of concern.

<sup>c</sup>Off site refers to the location at the FEMP fenceline.

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percent), uranium-238 (6.56 percent), beryllium (28.51 percent), and Aroclor-1254 (8.3 percent) in soil. Total HI was less than 1.0.

For the future land use scenario with federal ownership, the expanded trespasser has a total risk of  $9.8 \times 10^{-5}$  due to the same compounds as the on-property farmer. HI was less than 1.0. Off-property farmers have carcinogenic risks on the order of  $10^{-7}$  and HI of less than 1.0.

Risks from the Lime Sludge Ponds to the Great Miami River users was not quantified because the Lime Sludge Ponds pose no significant risk.

Table 7-7 lists the COCs contributing greater than one percent total medium risk to receptor of the future scenarios for the Lime Sludge Ponds. No COCs were determined for perched groundwater even if perched groundwater is used for a household drinking water source. Approximately 88 percent of the total risk to the on-property resident farmer is derived from four COCs in soil: radium-228, thorium-228, beryllium, and Aroclor-1254. Pathways contributing to risk include inhalation, ingestion, and dermal contact with soil.

#### 7.4.3 Inactive Flyash Pile

Field investigations of the Inactive Flyash Pile indicate that waste other than flyash were disposed of in the subunit. Organic waste, sludge, clay tile drain pipe, wood, nails, wire, and construction debris were found in addition to flyash. Field measurements with an alpha-beta meter indicated that all materials except for flyash had elevated levels of radioactivity. The identified waste materials appear to be resting on or near the interface between the flyash and the native glacial overburden.

The occurrence of uranium contamination in the perched groundwater appears to be related to waste materials buried within or near this subunit. The perched groundwater appears to discharge through seeps into the Paddys Run drainage channel or directly into the Great Miami Aquifer through regions where the glacial overburden has been eroded. This means that a mechanism exists to transport uranium contamination vertically into the Great Miami Aquifer. Uranium contamination in the Great Miami Aquifer was not detected upgradient or from the northern part of the subunit. Uranium contamination was detected in two wells downgradient from the central part of the subunit. This suggests that a source of uranium contamination to the Great Miami Aquifer exists beneath the central part of the Inactive Flyash Pile.

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**TABLE 7-7**  
**LIME SLUDGE PONDS FUTURE LAND USE**  
**SUMMARY OF COC TOTAL CARCINOGENIC RISK CONTRIBUTIONS<sup>a</sup>**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
Soil:									
Cesium-137	b	-	-	-	-	-	5.8E-05	3.16%	3.14%
Radium-228	1.9E-06	2.12%	2.12%	-	-	-	2.0E-04	10.71%	10.65%
Thorium-228	6.4E-06	7.29%	7.29%	-	-	-	6.8E-04	36.64%	36.45%
Uranium-238	1.2E-06	1.35%	1.35%	-	-	-	1.2E-04	6.59%	6.56%
Arsenic	-	-	-	-	-	-	3.2E-05	1.74%	1.73%
Beryllium	6.0E-05	68.18%	68.18%	-	-	-	5.3E-04	28.65%	28.51%
Aroclor-1254	1.7E-05	19.06%	19.06%	-	-	-	1.5E-04	8.34%	8.30%
Benzo(a)pyrene	-	-	-	-	-	-	2.0E-05	1.07%	1.07%
Home Grown Produce (Dust Affected):									
Arsenic	N/A <sup>c</sup>			-	-	-	1.0E-06	29.36%	0.05%
Beef/Milk (Dust Affected):									
Aroclor-1254	N/A			-	-	-	1.8E-06	31.97%	0.09%
Benzo(a)pyrene	N/A			-	-	-	1.6E-06	29.58%	0.09%
Total Risk	9.8E-05			2.4E-07			1.9E-03		

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Pose no risk greater than the threshold level of  $1.0 \times 10^{-6}$ .

<sup>c</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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Nature and Extent

Table 7-8 presents a summary of the nature of COCs within each medium for the Inactive Flyash Pile determined through the fate and transport modeling and baseline risk assessment processes. Ten COCs have been identified for the Inactive Flyash Pile that contribute greater than one percent of the total risk for a medium. These COCs consist of 8 radionuclides, 2 metals, and 1 organic compound. The table identifies the number of samples detected above background compared to the number of samples in a particular medium.

The extent of COCs in the Inactive Flyash Pile covers most of the surface and subsurface soils, surface water, sediment, and perched water sampled within the subunit. Radionuclides appear to be connected to non-flyash waste such as sludge, wood, and construction debris, whereas organics appear to be intermixed with the flyash, possibly from dust control spraying. The COCs were also detected in the perched groundwater beneath of the subunit. Uranium is the only COC detected in the Great Miami Aquifer downgradient of the subunit.

Fate and Transport

Future maximum on-site and-off site modeled COC concentrations for each medium are listed in Table 7-9. The media pathways considered significant for the Inactive Flyash Pile as a result of the modeling include air, surface water, and groundwater pathways.

Baseline Risk Assessment

Because of the contiguous nature of the Inactive Flyash Pile and South Field, the complexity of the geology and lithology, and the patterns of groundwater flow in the area, it was not possible to completely separate these potential groundwater contaminant sources on other than an arbitrary basis. Therefore, the groundwater modeling for these subunits included simultaneous inputs from the entire area of these combined subunits. Hence, the risk contribution of the groundwater pathway is based on the combined effects of these subunits.

For the current land use scenario, total carcinogenic risks range from slightly greater than  $10^{-5}$  for the trespassing youth to about  $10^{-8}$  for off-property receptors. Total risk to the trespassing youth is  $3.3 \times 10^{-5}$  mostly due to the presence of radium-228, thorium-228, and beryllium in soil which accounted for 89 percent of the total risk. Risk to the on-property groundskeeper are on the same order of

TABLE 7-8

**COCs DETECTED IN THE INACTIVE FLYASH PILE<sup>a</sup>  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

COC/Phase	Surface Soil	Subsoil		Surface Water		Sediment		Groundwater 1000-series		Groundwater 2000-series	
	II	I	II	I	II	I	II	I	II	I	II
Cesium-137	0/7 <sup>b</sup>	1/19	5/24	N/A <sup>c</sup>	0/6	N/A	0/4	N/A	0/1	0/1	0/3
Radium-228	3/7	10/9	14/24	0/3	0/6	0/5	0/4	0/3	1/1	0/10	0/3
Thorium-228	1/2	12/18	11/23	0/2	1/6	N/A	0/4	0/3	0/1	0/10	0/3
Uranium-234	6/7	14/18	18/24	2/2	6/6	N/A	1/4	3/3	1/1	9/10	3/3
Uranium-235/236	4/7	7/18	15/24	0/2	3/6	N/A	0/4	0/3	0/1	0/10	3/3
Uranium-238	6/7	21/25	18/24	2/2	6/6	N/A	1/4	3/3	1/1	9/10	3/3
Arsenic	1/7	6/12	10/22	0/3	1/6	0/1	0/6	0/4	0/1	0/16	0/6
Beryllium	6/7	9/12	17/22	N/A	0/6	0/1	1/6	0/2	0/1	0/2	0/6
Uranium-Total	6/7	15/19	24/24	2/2	6/6	2/5	4/4	2/2	1/1	8/8	3/3
Dibenzo(a,h) anthracene	1/7	0/16	1/31	N/A	0/6	0/1	0/6	N/A	0/1	0/1	0/4

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Number refers to detections above background relative to number of analyses.

<sup>c</sup>N/A signifies not analyzed.

TABLE 7-9

MAXIMUM MODELED COC CONCENTRATIONS IN THE<sup>a</sup>  
 INACTIVE FLYASH PILE  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

COC/Phase	Air Maximum Modeled Concentration		Groundwater Maximum Modeled Concentrations				Surface Water Maximum Modeled Concentrations
	On Site <sup>b</sup>	Off Site <sup>c</sup>	On Site	Year	Off Site	Year	Paddys Run
Cesium-137	3.23E-06 pCi/m <sup>3</sup>	1.66E-07 pCi/m <sup>3</sup>	NOT CPC				2.35E-05 pCi/L
Radium-228	1.57E-05 pCi/m <sup>3</sup>	8.07E-07 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		1.47E-03 pCi/L
Thorium-228	1.90E-05 pCi/m <sup>3</sup>	9.76E-07 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		5.89E-05 pCi/L
Uranium-234	6.05E-05 pCi/m <sup>3</sup>	3.11E-06 pCi/m <sup>3</sup>	4.69E+02 pCi/L	160	2.40E+01 pCi/L	220	6.59E-01 pCi/L
Uranium-235/236	2.94E-06 pCi/m <sup>3</sup>	1.51E-07 pCi/m <sup>3</sup>	2.50E+01 pCi/L	160	1.28E+00 pCi/L	220	3.32E-02 pCi/L
Uranium-238	6.21E-05 pCi/m <sup>3</sup>	3.19E-06 pCi/m <sup>3</sup>	5.17E+02 pCi/L	160	2.65E+01 pCi/L	220	6.60E-01 pCi/L
Arsenic	2.32E-07 mg/m <sup>3</sup>	1.20E-08 mg/m <sup>3</sup>	NOT CPC		NOT CPC		1.31E-02 mg/L
Beryllium	1.59E-09 mg/m <sup>3</sup>	8.18E-10 mg/m <sup>3</sup>	NOT CPC		NOT CPC		6.32E-04 mg/L
Uranium-Total	1.83E-07 mg/m <sup>3</sup>	9.43E-09 mg/m <sup>3</sup>	1.84E+03 mg/L	160	9.45E+01 mg/L	220	2.02E-00 mg/L
Dibenzo(a,h)-anthracene	1.54E-08 mg/m <sup>3</sup>	7.92E-10 mg/m <sup>3</sup>	NOT CPC		NOT CPC		9.02E-05 mg/L

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>On site refers to a location on the subunit of concern.

<sup>c</sup>Off site refers to the location at the FEMP fenceline.

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magnitude as the trespassing youth. Major contributors are also the same as those for the trespassing youth. HIs for all current scenario receptors are less than 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total risk of  $3.2 \times 10^{-3}$  and HI greater than 1.0. The major contributors of risk are thorium-228 and beryllium in soil and uranium-234 and uranium-238 in groundwater and consequently in irrigated produce, and in milk and beef from livestock that are watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. The most significant contributors of the elevated HI are due to total uranium in groundwater and consequently in irrigated produce.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risks of  $1.2 \times 10^{-4}$  and HI of less than 1.0. The off-property farmer has a total risk of  $6.6 \times 10^{-5}$  and a HI of 3.4. The major contributors of risk to the off-property farmer are uranium-234 (28.63 percent) and uranium-238 (55.32 percent) in groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. The major contributors to hazard are from total uranium in groundwater and consequently in irrigated produce, and in milk and beef from cattle that are watered with contaminated groundwater from Inactive Flyash Pile/South Field source area.

Total estimated risk to future Great Miami River users are in the range of  $1.0 \times 10^{-6}$  to  $1.0 \times 10^{-5}$ . For the adult and youth receptors, thorium-228, uranium-235/236, and radium-228 in sediment were the major contributors to total risk. Total HIs are below 1.0.

Table 7-10 lists the COCs which contribute greater than one percent total medium risk to the future scenarios. Approximately 85 percent of the total risk to the on-property resident farmer is derived from five COCs: radium-228, thorium-228, uranium-234, uranium-238, and beryllium. Pathways contributing to risk included inhalation, ingestion, and dermal contact with soil and ingestion of groundwater.

7.4.4 South Field

Test trenches uncovered a range of waste materials including concrete, steel pipe, sheet steel, wood, and clay tile. The results of wipe samples taken from these materials indicate that they represent a potential source of the leaching of radionuclides to groundwater.

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TABLE 7-10

**INACTIVE FLYASH PILE FUTURE LAND USE  
SUMMARY OF COC TOTAL CARCINOGENIC RISK CONTRIBUTIONS<sup>a</sup>  
OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
Soil									
Cesium-137	<sup>b</sup>	-	-	-	-	-	3.8E-05	1.96%	1.18%
Radium-228	2.6E-06	2.52%	2.46%	-	-	-	2.7E-04	13.80%	8.35%
Thorium-228	6.0E-06	5.88%	5.74%	-	-	-	6.3E-04	32.12%	19.45%
Arsenic	2.0E-06	1.93%	1.89%	-	-	-	1.5E-04	7.55%	4.57%
Beryllium	9.0E-05	88.55%	86.37%	-	-	-	7.9E-04	40.42%	24.47%
Dibenzo(a,h)anthracene	-	-	-	-	-	-	4.4E-05	2.24%	1.35%
Sediment									
Radium-228	1.0E-06	44.57%	0.99%	N/A <sup>c</sup>			N/A		
Thorium-228	1.1E-06	46.76%	1.04%	N/A			N/A		
Groundwater									
Uranium-234	N/A			1.9E-05	33.45%	28.63%	3.7E-04	33.52%	11.33%
Uranium-235/236	N/A			1.0E-06	1.78%	1.53%	2.0E-05	1.79%	0.60%
Uranium-238	N/A			3.6E-05	64.64%	55.32%	7.1E-04	64.66%	21.86%
Home Grown Produce (Groundwater Affected)									
Uranium-234	N/A			2.8E-06	33.42%	4.29%	5.5E-05	33.51%	1.70%
Uranium-235	N/A			-	-	-	2.9E-06	1.79%	0.09%
Uranium-238	N/A			5.4E-06	64.71%	8.28%	1.1E-04	64.66%	3.27%
Beef/Milk (Groundwater Affected)									
Uranium-234	N/A			-	-	-	6.4E-06	33.53%	0.20%
Uranium-238	N/A			-	-	-	1.2E-05	64.68%	0.38%
Total Risk	1.2E-04			6.65E-05			3.2E-03		

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Pose no risk greater than the threshold level of  $1.0 \times 10^{-6}$ .

<sup>c</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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Nature and Extent

Table 7-11 presents a summary of the nature of COCs within each medium for the South Field determined through the fate and transport modeling and baseline risk assessment processes. Sixteen COCs have been identified for the South Field that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides, 3 metals, and 7 organic compounds. The table identifies the number of samples detected above background compared to the number of samples in a particular medium.

The extent of COCs in the South Field covers most of the surface and subsurface soils, surface water, sediment, perched groundwater, and groundwater sampled within the subunit. Radionuclides and organics were detected in higher concentrations in the northern portion of the South Field. The COCs were also detected in the perched groundwater beneath the subunit and in the Great Miami Aquifer downgradient of the subunit.

Fate and Transport

Future maximum on-site and off-site modeled COC concentrations for each medium are listed in Table 7-12. The media pathways considered significant for the South Field as a result of the modeling include air, surface water, and groundwater pathways.

Baseline Risk Assessment

For the current land use scenario, total carcinogenic risks range from slightly greater than  $10^{-5}$  for the trespassing youth to about  $10^{-7}$  for off-property receptors. Major contributors to total risk to the trespassing youth are mostly due to radium-228, thorium-228, and beryllium in soil and sediment. Total estimated risk to the on-property groundskeeper is  $6.5 \times 10^{-4}$  due primarily to thorium-228 in soil which accounted for 95 percent of the total risk. HIs for all current receptors are less than 9.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total carcinogenic risk of  $3.8 \times 10^{-3}$  and the resident child has a risk of  $4.5 \times 10^{-4}$ . The on-property RME farmer and resident child have HIs of greater than 1.0. The largest components of risk to the on-property farmers are from thorium-228, radium-228, beryllium, and benzo(a)pyrene in soil, and uranium-234 and uranium-238 in groundwater and consequently in irrigated produce, and in milk and beef from livestock that is watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area. Risks for the on-property RME farmer at the South Field are somewhat

TABLE 7-11

COCs DETECTED IN THE SOUTH FIELD<sup>a</sup>  
 OPERABLE UNIT 2 REMEDIAL INVESTIGATION  
 FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

COC/Phase	Surface Soils	Subsoil		Surface Water	Sediment	Groundwater 1000		Groundwater 2000	
	II	I	II	II	II	I	II	I	II
Radium-226	6/21 <sup>b</sup>	10/71	10/45	0/2	3/3	0/4	3/7	1/16	0/11
Radium-228	9/21	11/70	10/44	0/2	2/3	0/4	0/8	0/18	0/11
Thorium-228	2/16	16/112	5/32	0/2	1/3	1/6	4/9	0/18	0/10
Uranium-234	21/21	64/102	33/44	2/2	3/3	4/6	8/10	7/19	6/10
Uranium-235/236	17/21	53/102	21/44	2/2	3/3	1/6	9/10	7/7	9/10
Uranium-238	21/21	61/102	31/44	2/2	3/3	4/6	8/10	17/19	9/10
Arsenic	0/21	0/18	4/43	0/2	1/3	0/8	0/13	0/19	0/14
Beryllium	15/21	14/18	16/43	0/2	2/3	0/2	3/13	0/2	0/14
Uranium-Total	20/21	54/74	42/45	2/2	3/3	4/6	8/10	17/19	9/10
Benzo(a)pyrene	12/21	3/14	6/41	0/2	1/2	N/A <sup>c</sup>	0/7	0/3	0/9
Benzo(b)fluoranthene	12/21	5/14	4/41	0/2	1/2	N/A	0/7	0/3	0/9
Benzo(k)fluoranthene	12/21	0/14	5/41	0/2	2/2	N/A	0/4	0/3	0/9
Dibenzo(a,h) anthracene	7/21	0/14	1/41	0/2	0/2	N/A	0/7	0/3	0/9
Indeno(1,2,3-cd)pyrene	10/21	1/14	3/41	0/2	1/2	N/A	0/7	0/3	0/9
Aroclor-1254	1/21	7/19	12/43	0/2	1/3	N/A	0/7	0/2	0/9
Archlor 1260	2/21	0/19	1/43	0/2	0/3	N/A	0/7	0/2	0/9

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Number refers to detections above background relative to number of analyses.

<sup>c</sup>N/A signifies not analyzed.

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**TABLE 7-12**  
**MAXIMUM MODELED COC CONCENTRATIONS IN THE<sup>a</sup>**  
**SOUTH FIELD**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

COC/Phase	Air Maximum Modeled Concentration		Groundwater Maximum Modeled Concentrations				Surface Water Maximum Modeled Concentrations
	On Site <sup>b</sup>	Off Site <sup>c</sup>	On Site	Year	Off Site	Year	Paddys Run
Radium-226	1.10E-02 pCi/m <sup>3</sup>	8.01E-04 pCi/m <sup>3</sup>	8.90E-03	1000	1.13E-09	1000	1.35E-01 pCi/L
Radium-228	1.39E-03 pCi/m <sup>3</sup>	1.01E-04 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		1.71E-02 pCi/L
Thorium-228	1.58E-03 pCi/m <sup>3</sup>	1.15E-04 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		6.42E-04 pCi/L
Uranium-234	3.10E-03 pCi/m <sup>3</sup>	2.25E-04 pCi/m <sup>3</sup>	4.69E+02 pCi/L	160	2.40E+01 pCi/L	220	3.44E+00 pCi/L
Uranium-235/236	1.50E-04 pCi/m <sup>3</sup>	1.09E-05 pCi/m <sup>3</sup>	2.50E+01 pCi/L	160	1.28E+00 pCi/L	220	1.66E-01 pCi/L
Uranium-238	3.33E-03 pCi/m <sup>3</sup>	2.42E-04 pCi/m <sup>3</sup>	5.17E+02 pCi/L	160	2.65E+01 pCi/L	220	3.72E+00 pCi/L
Arsenic	2.60E-06 mg/m <sup>3</sup>	1.89E-07 mg/m <sup>3</sup>	NOT CPC		NOT CPC		1.69E-02 mg/L
Beryllium	3.37E-07 mg/m <sup>3</sup>	2.45E-08 mg/m <sup>3</sup>	NOT CPC		NOT CPC		1.75E-03 mg/L
Uranium-Total	1.06E-05 mg/m <sup>3</sup>	7.69E-07 mg/m <sup>3</sup>	1.84E+03 mg/L	160	9.45E+01 mg/L	220	1.15E+01 mg/L
Benzo(a)pyrene	3.37E-06 mg/m <sup>3</sup>	2.44E-07 mg/m <sup>3</sup>	NOT CPC		NOT CPC		2.52E-03 mg/L
Benzo(b)fluoranthene	2.22E-06 mg/m <sup>3</sup>	1.61E-07 mg/m <sup>3</sup>	NOT CPC		NOT CPC		4.26E-04 mg/L
Benzo(k)fluoranthene	2.61E-06 mg/m <sup>3</sup>	1.90E-07 mg/m <sup>3</sup>	NOT CPC		NOT CPC		2.70E-04 mg/L
Dibenzo(a,h)-anthracene	6.80E-07 mg/m <sup>3</sup>	4.94E-08 mg/m <sup>3</sup>	NOT CPC		NOT CPC		5.20E-04 mg/L
Indeno(1,2,3-cd)pyrene	2.15E-06 mg/m <sup>3</sup>	1.56E-07 mg/m <sup>3</sup>	NOT CPC		NOT CPC		3.36E-05 mg/L
Aroclor-1254	3.19E-08 mg/m <sup>3</sup>	2.31E-09 mg/m <sup>3</sup>	NOT CPC		NOT CPC		2.13E-05 mg/L
Aroclor-1260	1.86E-08 mg/m <sup>3</sup>	1.35E-09 mg/m <sup>3</sup>	NOT CPC		NOT CPC		1.24E-05 mg/L

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<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>On site refers to a location on the subunit of concern.

<sup>c</sup>Off site refers to the location at the FEMP fenceline.

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higher than for the Inactive and Active Flyash Piles because it is feasible to build a house on the South Field. Therefore, the South Field RME farmer has higher direct radiation exposures as well as exposure to indoor radon.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of about  $2.2 \times 10^{-4}$  and HI of less than 1.0. The major contributor to risk is from beryllium in sediment and soil (64.85 and 19.23 percent, respectively). Off-property farmers have carcinogenic risks as great as  $10^{-5}$  and HIs of greater than 1.0. The largest component of risk to the off-property farmers is uranium-234, uranium-238, and total uranium in groundwater and consequently in irrigated produce and in milk and beef from livestock that is watered with groundwater contaminated from the combined Inactive Flyash Pile/South Field source area.

Total estimated risk to the Great Miami River adult and youth user is  $1.1 \times 10^{-4}$  and  $6.3 \times 10^{-5}$ , respectively due mostly to benzo(a)pyrene in surface water which accounts for 36 and 41 percent respectively, of the total risk. Thorium-230 and beryllium also contributed to risk.

Table 7-13 lists the COCs which contribute greater than one percent total medium risk. Over 80 percent of the risk to the on-property resident farmer is derived from five COCs: radium-228, thorium-228, uranium-234, uranium-238, and beryllium. Pathways posing risk include inhalation, ingestion, and dermal contact with soil, and ingestion of groundwater.

#### 7.4.5 Active Flyash Pile

The Active Flyash Pile contains only flyash from field observations and historical documentation. Interviews with former processing personnel indicated that organic compounds could have been sprayed on the flyash to reduce dust. The analytical results of the RI field investigation do not support such speculation.

#### Nature and Extent

Table 7-14 presents a summary of the nature of COCs within each medium for the Active Flyash Pile determined through the fate and transport modeling and baseline risk assessment processes. Eight COCs have been identified for the Active Flyash Pile that contribute greater than one percent of the total risk for a medium. These COCs consist of 6 radionuclides and 2 metals. The table identifies

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**TABLE 7-13**  
**SOUTH FIELD FUTURE LAND USE**  
**SUMMARY OF COC CARCINOGENIC RISK CONTRIBUTIONS<sup>a</sup>**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
<b>Soil</b>									
Cesium-137	<sup>b</sup>	-	-	-	-	-	4.1E-05	1.76%	1.10%
Radium-226	-	-	-	-	-	-	3.5E-05	1.51%	0.94%
Radium-228	4.4E-06	7.11%	1.71%	-	-	-	4.7E-04	19.91%	12.46%
Thorium-228	1.0E-05	16.23%	3.91%	-	-	-	1.0E-03	44.17%	27.64%
Uranium-238	-	-	-	-	-	-	3.5E-05	1.49%	0.93%
Arsenic	-	-	-	-	-	-	3.3E-05	1.39%	0.87%
Beryllium	3.7E-05	59.81%	14.42%	-	-	-	3.3E-04	13.97%	8.74%
Benzo(a)pyrene	1.7E-06	2.73%	0.66%	-	-	-	1.7E-04	7.24%	4.53%
Dibenzo(a,h)anthracene	-	-	-	-	-	-	3.8E-05	1.62%	1.02%
Indeno(1,2,3-cd)pyrene	-	-	-	-	-	-	3.0E-05	1.27%	0.79%
Aroclor-1254	2.5E-06	4.06%	0.98%	-	-	-	2.3E-05	0.99%	0.62%
Aroclor-1260	1.5E-06	2.37%	0.57%	-	-	-	1.4E-05	0.58%	0.36%
<b>Sediment</b>									
Radium-228	2.9E-06	1.47%	1.12%	N/A <sup>c</sup>			N/A		
Thorium-228	6.2E-06	3.15%	2.39%	N/A			N/A		
Arsenic	4.4E-06	2.27%	1.72%	N/A			N/A		
Beryllium	1.8E-04	92.80%	70.38%	N/A			N/A		
<b>Groundwater</b>									
Uranium-234	N/A			1.9E-05	33.45%	23.27%	3.7E-04	33.52%	9.76%
Uranium-235/236	N/A			1.0E-06	1.78%	1.24%	2.0E-05	1.79%	0.52%
Uranium-238	N/A			3.6E-05	64.64%	44.97%	7.1E-04	64.66%	18.83%
<b>Home Grown Produce (Dust Affected)</b>									
Benzo(a)pyrene	N/A			-	-	-	4.2E-06	49.05%	0.11%

See footnotes at end of table

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TABLE 7-13  
(Continued)

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
Home Grown Produce (Groundwater Affected)									
Uranium-234	N/A			2.8E-06	33.42%	3.49%	5.5E-05	33.51%	1.46%
Uranium-235/236	N/A			-	-	-	2.9E-06	1.70%	0.08%
Uranium-238	N/A			5.4E-06	64.58%	6.73%	1.1E-04	64.65%	2.82%
Beef/Milk (Dust Affected)									
Benzo(a)pyrene	N/A			1.3E-06	9.67%	1.67%	1.2E-05	9.67%	0.31%
Benzo(b)fluoranthene	N/A			-	-	-	3.7E-06	3.06%	0.10%
Benzo(k)fluoranthene	N/A			-	-	-	3.7E-06	3.10%	0.10%
Dibenzo(a,h)anthracene	N/A			-	-	-	2.6E-06	2.14%	0.07%
Indeno(1,2,3-cd)pyrene	N/A			1.1E-05	81.05%	13.99%	9.8E-05	81.04%	2.60%
Beef/Milk (Groundwater Affected)									
Uranium-234	N/A			-	-	-	6.4E-06	33.45%	0.17%
Uranium-238	N/A			-	-	-	1.2E-05	64.52%	0.33%
Total Risk	2.2E-04			8.1E-05			3.8E-03		

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Pose no risk greater than the threshold level of  $1.0 \times 10^{-6}$ .

<sup>c</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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**TABLE 7-14**  
**COCs DETECTED IN THE ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

COC/Phase	Surface Soil	Flyash Subsurface		Flyash		Subsoil		Surface Water		Sediment		Groundwater 1000 series		Groundwater 2000 series	
	II	I	II	I	II	I	II	I	II	I	II	I	II	I	II
Neptunium-237	6/6 <sup>a</sup>	0/6	5/5	0/6	5/5	0/6	6/6	N/A	1/1	N/A	1/1	0/2	1/2	0/15	0/2
Radium-226	1/14	3/10	0/6	10/10	6/6	0/8	1/6	0/2	0/1	0/2	0/1	0/2	0/2	0/13	0/2
Radium-228	12/14	10/10	6/6	10/10	6/6	0/7	1/6	0/2	1/1	0/2	0/1	0/2	0/2	0/15	0/2
Thorium-228	12/14	10/10	6/6	10/10	6/6	3/9	1/6	N/A	0/1	N/A	0/1	0/2	0/2	0/14	0/3
Uranium-234	14/14	10/10	6/6	10/10	6/6	1/9	0/6	N/A	1/1	N/A	1/1	2/2	1/2	10/14	2/3
Uranium-238	1/14	10/12	1/6	12/12	6/6	2/9	3/6	N/A	1/1	N/A	1/1	2/2	2/2	10/14	2/3
Arsenic	4/14	0/8	0/6	7/8	6/6	0/3	4/6	1/2	1/1	N/A	0/1	0/4	0/3	0/15	0/5
Beryllium	14/14	8/8	6/6	8/8	6/6	2/3	5/6	N/A	0/1	N/A	1/1	N/A	0/3	N/A	0/5

<sup>a</sup>Number refers to detections above background relative to number of analyses.

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the number of samples detected above background compared to the number of samples in a particular medium.

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The extent of COCs in the Active Flyash Pile covers most of the surface and subsurface soils, and sediment within the subunit. The COCs uranium-234, uranium-235/236, and uranium-238 were detected in the Great Miami Aquifer downgradient of the subunit but are probably related to releases from the Inactive Flyash Pile and the South Field.

Fate and Transport

Future maximum on-site and off-site modeled COC concentrations for each medium are listed in Table 7-15. The media pathways considered significant for the Active Flyash Pile as a result of the modeling include air, surface water, and groundwater pathways.

Baseline Risk Assessment

For the current land use scenario, total carcinogenic risk to a trespassing youth is  $6.8 \times 10^{-5}$  due to the presence of radium-226, radium-228, and thorium-228 in soil. Total risk to the groundskeeper is  $9.2 \times 10^{-5}$  due mostly from thorium-228 and beryllium in soil which accounted for 18 and 63 percent, respectively. Carcinogenic risks to off-property residents are on the order of  $10^{-6}$ . The total HIs for all current receptors are below 1.0.

For the future land use scenario assuming private ownership, the on-property RME farmer has a total carcinogenic risks of  $1.9 \times 10^{-3}$  due mostly to the presence of neptunium-237, radium-228, thorium-228, and arsenic in surface flyash material which accounted for approximately 95 percent of the total risk. The HI is less than one.

For the future land use assuming federal ownership, the expanded trespasser has a total carcinogenic risk of  $2.4 \times 10^{-4}$  and HI of less than 1.0. Exposure to the expanded trespasser is primarily due to beryllium (87.32 percent) in flyash material. Off-property farmers have carcinogenic risks greater than  $1.0 \times 10^{-6}$ . Major contributors to this receptor are due to estimated future concentrations of uranium-234 and uranium-238 in groundwater contaminated from the Active Flyash Pile. HIs are less than 1.0.

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**TABLE 7-15**  
**MAXIMUM MODELED COC CONCENTRATIONS<sup>a</sup>**  
**IN THE ACTIVE FLYASH PILE**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

COC/Phase	Air Maximum Modeled Concentration		Groundwater Maximum Modeled Concentrations				Surface Water Maximum Modeled Concentrations
	On Site <sup>b</sup>	Off Site <sup>c</sup>	On Site	Year	Off Site	Year	Storm Sewer Outfall Ditch
Neptunium-237	4.13E-05 pCi/m <sup>3</sup>	4.11E-06 pCi/m <sup>3</sup>	1.52E+01 pCi/L	160	1.63E-01 pCi/L	280	2.51E+01 pCi/L
Radium-226	3.45E-05 pCi/m <sup>3</sup>	3.44E-06 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		1.02E+00 pCi/L
Radium-228	2.4E-05 pCi/m <sup>3</sup>	2.39E-06 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		7.14E-01 pCi/L
Thorium-228	2.85E-05 pCi/m <sup>3</sup>	2.84E-06 pCi/m <sup>3</sup>	NOT CPC		NOT CPC		2.80E-02 pCi/L
Uranium-234	2.7E-05 pCi/m <sup>3</sup>	2.69E-06 pCi/m <sup>3</sup>	1.98E+01 pCi/L	100	2.58E-00 pCi/L	120	5.14E+01 pCi/L
Uranium-238	2.7E-05 pCi/m <sup>3</sup>	2.69E-06 pCi/m <sup>3</sup>	2.18E+01 pCi/L	100	2.85E-00 pCi/L	120	5.13E+01 pCi/L
Arsenic	6.74E-07 mg/m <sup>3</sup>	6.72E-08 mg/m <sup>3</sup>	1.78E-02 mg/L	1000	4.55E-03 mg/L	1000	1.06E+01 mg/L
Beryllium	3.53E-08 mg/m <sup>3</sup>	3.52E-09 mg/m <sup>3</sup>	6.87E-04 mg/L	1000	1.77E-04 mg/L	1000	4.44E-01 mg/L

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>On site refers to a location on the subunit of concern.

<sup>c</sup>Off site refers to the location at the FEMP fenceline.

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Total estimated risks to the Great Miami River adult and youth are  $1.3 \times 10^{-4}$  and  $6.5 \times 10^{-5}$ , respectively. Major contributors of risk to these receptors include arsenic and beryllium in sediment via external radiation. The HIs are less than 1.0.

Table 7-16 lists the COCs which present a greater than one percent total medium risk. Over 85 percent of the risk to the on-property resident farmer is derived from three COCs in soil: radium-228, thorium-228, and arsenic. The pathway which poses the greatest risk to the Active Flyash Pile receptor is dermal contact with soil (surface flyash material).

7.4.6 Operable Unit 2 Cumulative

Cumulative risk posed by Operable Unit 2 was evaluated for impacts to future land uses and receptors.

Fate and Transport

The fate and transport contributions from all of the Operable Unit 2 subunits were evaluated for a combined impact to the surface water, groundwater, and air pathways. The Operable Unit 2-wide surface water assessment determined that the South Field contributed the major portion of radionuclide and organic constituents and the Active flyash Pile contributed the major portion of metals constituents. Cumulative concentrations were determined for the confluence of the Storm Sewer Outfall Ditch with Paddys Run and the confluence of Paddys Run with the Great Miami River.

The combined assessment of groundwater transport determined that the Inactive Flyash Pile and South Field are the major contributors of uranium isotopes, neptunium-237, technetium-99, and lead, which were the only constituents analogous to more than one subunit. The point of maximum on-site and off-site concentrations for the above constituents did not change significantly from that for the South field and Inactive flyash Piles, but the maximum on-site and off-site concentrations increased for the cumulative assessment.

Uranium-238 was the only constituent wide-spread enough to evaluate Operable Unit 2 wide for air modeling. The current source term cumulative maximum on-site concentration location is over the Lime Sludge Ponds and the maximum off-site concentration is over State Route 126 to the northeast of the Lime Sludge Ponds. The future source term maximum on-site concentration lies over the Solid

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**TABLE 7-16**  
**ACTIVE FLYASH PILE FUTURE LAND USE<sup>a</sup>**  
**SUMMARY OF COC TOTAL CARCINOGENIC RISK CONTRIBUTIONS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
Soil									
Neptunium-237	<sup>b</sup>	-	-	-	-	-	1.0E-04	5.77%	5.46%
Radium-226	1.1E-05	5.08%	5.08%	-	-	-	4.7E-06	0.27%	0.25%
Radium-228	3.6E-06	1.69%	1.69%	-	-	-	3.8E-04	21.40%	20.26%
Thorium-228	8.4E-06	3.92%	3.92%	-	-	-	8.9E-04	49.56%	46.91%
Arsenic	5.3E-06	2.49%	2.49%	-	-	-	4.0E-04	22.41%	21.21%
Beryllium	1.8E-04	86.33%	86.26%	-	-	-	-	-	-
Groundwater									
Uranium-234	N/A <sup>c</sup>			2.0E-06	31.60%	22.06%	1.5E-05	32.81%	0.82%
Uranium-238	N/A			3.9E-06	61.03%	42.59%	3.0E-05	63.38%	1.58%
Home Grown Produce (Dust Affected)									
Arsenic	N/A			1.1E-06	86.11%	12.24%	3.4E-05	86.10%	1.80%
Beryllium	N/A			-	-	-	4.4E-06	10.98%	0.23%
Home Grown Produce (Groundwater Affected)									
Uranium-234	N/A			-	-	-	2.3E-06	32.55%	0.12%
Uranium-238	N/A			-	-	-	4.5E-06	62.88%	0.24%
Beef/Milk (Dust Affected)									
Arsenic	N/A			-	-	-	6.1E-06	93.06%	0.32%
Total Risk	2.4E-04			9.2E-06			1.9E-03		

<sup>a</sup>COCs listed in this table are only those contributing greater than one percent total medium risk. total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Pose no risk greater than the threshold level of  $1.0 \times 10^{-6}$ .

<sup>c</sup>N/A signifies that exposure of the receptor to the indicated medium is not applicable.

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Waste Landfill and the maximum off-site concentration is near the maximum concentration point for the current source term.

Baseline Risk Assessment

Future land use receptors were evaluated for cumulative risk from the presence of contaminants within Operable Unit 2. It is emphasized that the risks and hazards presented are those resulting primarily from the three subunits contributing most to groundwater contamination: the Active Flyash Pile, South Field and Inactive Flyash Pile.

The greatest carcinogenic risk posed was to the RME on-property farmer which had a total risk of  $3.7 \times 10^{-3}$ . The major contributors to risk for the on-property receptor is from the presence of thorium-228 (28 percent), radium-228 (12.6 percent), and beryllium (8.84 percent) in soil, and the estimated presence of uranium-238 in groundwater (19 percent).

Total risk to the off-property farmer slightly exceeded  $1.0 \times 10^{-4}$  due primarily to uranium-234 (12 percent) and uranium-238 (23.21 percent) in groundwater, and thorium-228 (8.63 percent), thorium-230 (10 percent), and uranium-238 (12.2 percent) in soil.

Total HIs exceed 1.0 for both the on- and off-property farmers due primarily to the estimated presence of total uranium in groundwater (85.86 and 86.10 percent, respectively).

Total risk to the expanded trespasser was  $6.6 \times 10^{-5}$  due primarily to beryllium and thorium-228 in soil which contributed 64.5 percent and 15.5 percent, respectively. Total HI for this receptor was below 1.0.

Table 7-17 lists the COCs which present a greater than one percent total medium risk to the future receptors. Approximately 68 percent of the total risk to the on-property farmer is attributed from four COCs in soil and groundwater: thorium-228, radium-226, beryllium, and uranium-238.

7.4.7 Risk Assessment Uncertainty

Every quantitative risk assessment is subject to sources of uncertainty. To ensure that risk is not underestimated and that human health is protected, CERCLA guidance and the conventions followed in this report address areas of uncertainty through application of conservative (i.e., protective)

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**TABLE 7-17**  
**OPERABLE UNIT 2-WIDE FUTURE LAND USE<sup>a</sup>**  
**SUMMARY OF COC TOTAL CONTRIBUTIONS**  
**OPERABLE UNIT 2 REMEDIAL INVESTIGATION**  
**FERNALD ENVIRONMENTAL MANAGEMENT PROJECT**

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
<b>Soil</b>									
Cesium-137	b	-	-	-	-	-	4.1E-05	1.79	1.11
Radium-226	-	-	-	-	-	-	4.7E-04	20.27	12.60
Radium-228	4.4E-06	6.94	6.75	3.8E-06	4.74	2.31	-	-	-
Thorium-228	1.0E-05	15.92	15.48	1.4E-05	17.70	8.63	1.0E-03	44.97	27.95
Thorium-230	-	-	-	1.7E-05	20.57	10.03	1.7E-05	0.75	0.47
Thorium-232	-	-	-	4.6E-06	5.75	2.80	4.9E-06	0.21	0.13
Uranium-234	-	-	-	9.4E-06	11.61	5.66	1.0E-05	0.43	0.27
Uranium-238	-	-	-	-	-	-	3.5E-05	1.52	0.95
Arsenic	-	-	-	2.7E-06	3.31	1.61	3.3E-05	1.52	0.94
Berllium	4.2E-05	66.33	64.48	-	-	-	3.3E-04	14.23	8.84
Chromium	-	-	-	5.3E-06	6.55	3.19	5.3E-06	0.23	0.14
Benzo(a)pyrene	1.9E-06	2.96	2.88	1.3E-06	1.65	0.80	1.7E-04	7.37	4.58
Dibenzo(a,h)anthracene	-	-	-	-	-	-	3.8E-05	1.65	1.03
Methylene chloride	-	-	-	-	-	-	3.0E-05	1.29	0.80
<b>Groundwater</b>									
Uranium-234	-	-	-	2.0E-05	33.32	12.03	-	-	-
Uranium-235/236	-	-	-	1.1E-06	1.77	0.64	2.0E-05	1.79	0.53
Uranium-238	-	-	-	3.8E-05	64.28	23.21	7.1E-04	66.44	19.04
<b>Surface Water</b>									
Thorium-228	1.7E-06	92.85	2.60	-	-	-	-	-	-
<b>Homegrown Produce (Dust Affected)</b>									
Benzo(a)pyrene	-	-	-	-	-	-	4.2E-06	49.05	0.11

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See footnotes at end of table

TABLE 7-17  
(Continued)

Medium/ Parameter	Expanded Trespasser	% Total Medium Risk	% Total Receptor Risk	Off-Property Resident Farmer	% Total Medium Risk	% Total Receptor Risk	On-Property Resident Farmer (RME)	% Total Medium Risk	% Total Receptor Risk
Homegrown Produce (Groundwater Affected)									
Uranium-234	-	-	-	3.06E-06	33.27	1.80	5.5E-05	33.51	1.48
Uranium-235	-	-	-	-	-	-	2.9E-06	1.79	0.08
Uranium-238	-	-	-	5.8E-06	64.18	3.48	1.1E-04	64.65	2.85
Beef/Milk (Dust Affected)									
Benzo(a)pyrene	-	-	-	1.3E-06	9.67	0.81	1.2E-05	9.67	0.31
Benzo(b)fluoranthene	-	-	-	-	-	-	3.7E-06	3.06	0.10
Benzo(k)fluoranthene	-	-	-	-	-	-	3.7E-06	3.10	0.10
Dibenzo(a,h)anthracene	-	-	-	-	-	-	2.6E-06	2.14	0.07
Indeno(1,2,3-cd)pyrene	-	-	-	1.1E-05	81.05	6.83	9.8E-05	81.04	2.63
Beef/Milk (Groundwater Affected)									
Uranium-234	-	-	-	-	-	-	6.4E-06	33.45	0.17
Uranium-238	-	-	-	-	-	-	1.2E-05	64.52	0.33
Total Risk									

<sup>a</sup>COCs listed in table are only those contributing greater than one percent total medium risk. Total risk includes the sum of all parameters contributing to risk including those contributing less than one percent.

<sup>b</sup>Pose no risk greater than the threshold level of  $1.0 \times 10^{-6}$ .

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assumptions. The greatest uncertainty associated with the Operable Unit 2 baseline risk assessment is due to the assumptions made to estimate constituent concentrations at the spatial and temporal points of human exposure. Specifically, the exposure point concentrations in groundwater, air, fruit and vegetable produce, beef and milk for human receptors in the future are the most conservatively estimated. All risk and hazard estimates for future on-property residents are subject to uncertainty, and hence conservatism, because the future site ownership and access controls are unknown. Taken together and interactively, the uncertainties identified with site data, exposure parameters, fate and transport, toxicity assessment, and risk characterization are judged to be high, having the potential to overestimate risk by two orders of magnitude or more.

One way to evaluate the degree of conservatism in the risk assessment methodology is to follow the risk estimation protocol, substituting natural background concentrations for the constituents that were found in place of the values actually measured at the waste site. This was done for the Operable Unit 2 land use and human exposure scenarios. The use of background constituent levels in the Operable Unit 2 risk assessment results in total carcinogenic risk for the on-property RME farmer of greater than  $1.0 \times 10^{-4}$ . The major contributors to the total background risk are from thorium-228, radium-228, and beryllium in surface soil. Combined they contribute 85 percent of the total risk.

7.5 DATA LIMITATIONS

This section discusses limitations of the characterization data collected under the Operable Unit 2 RI. The primary objective in characterizing the nature and extent of the contamination was to collect data sufficient to: (1) perform fate and transport modeling/baseline risk assessment and (2) support the development and evaluation of remedial alternatives under the FS for Operable Unit 2.

Characterization activities performed under the Operable Unit 2 RI focused on obtaining the quality and quantity of data necessary to meet the objectives of the RI.

Table 7-18 summarizes recognized data limitations, identifies their significance with respect to achieving the RI objectives, and provides recommended actions to resolve the data limitations. As apparent in Table 7-18, none of the data limitations result in a need for further action to support the Operable Unit 2 RI. However, specific additional data may be necessary to support the Remedial Design based on the preferred remedial alternative identified in the Proposed Plan and selected in the ROD for Operable Unit 2.

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TABLE 7-18

DATA LIMITATIONS AND RECOMMENDED ACTIONS

Data Limitation	Significance to Alternatives Evaluation	Significance to Baseline Risk Assessment	Recommended Action/Justification
<p>There is no assurance that the RI data identified all localized areas that contain elevated constituent concentrations.</p>	<p>The uncertainty in the level of contaminant concentration present in the soil yields uncertainty in the short-term effectiveness for worker health and safety due to air transport of surface soil contaminants during the remedial action. Further, similar uncertainty would result in establishing residual risk for in situ alternatives and volume and cost estimates for ex situ alternatives.</p>	<p>The uncertainty in soil contaminant concentrations yields uncertainty in the input to the fate and transport model for air and surface water and the exposure point concentrations used in risk characterization.</p>	<p>No additional sampling is warranted. Localized areas of elevated contaminant concentrations are anticipated in preparation of the health and safety plans for workers. Further, localized areas of elevated contaminant concentrations are assumed in the evaluation of remedial action alternatives through the use of the UCLs of the mean to represent contaminant concentration.</p> <p>The baseline risk assessment follows EPA guidance by using the 95 percent UCL of the mean as the exposure point concentration. This method is judged by EPA to compensate for any missed "hot spots" during the soils characterization program. Conservatism is also achieved by assuming that the receptor spends long periods of time in the Operable Unit 2 area.</p> <p>Also, substitution of background values for Operable Unit 2 waste concentrations demonstrates the conservatism of the fate and transport and risk assessment calculations in predicting risks of current and future receptors.</p>

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TABLE 7-18  
(Continued)

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Data Limitation	Significance to Alternatives Evaluation	Significance to Baseline Risk Assessment	Recommended Action/Justification
<p>Uncertainty remains regarding the flow of perched groundwater and its interaction with Paddys Run.</p>	<p>None. Remedial alternatives for perched groundwater will be evaluated under Operable Unit 5.</p>	<p>Uncertainty in the fate and transport calculations related to the flow of perched groundwater and its connection to the Great Miami Aquifer. Exposure point concentrations in perched water are biased high through the use of a dilution model. Risk characterization provides an upper bound estimate by assuming direct ingestion of perched water by the hypothetical on-property farmer under the future land use scenario.</p>	<p>No additional sampling is warranted to support the RI. Additional information relative to perched groundwater flow and its connection to the Great Miami Aquifer will be used in evaluating potential remedial actions under Operable Unit 5.</p> <p>While additional perched groundwater data may refine these calculations, its impacts on fate and transport and risk assessment calculations would be insignificant relative to the total risk and evaluation of the need for Operable Unit 2 remedial actions.</p>

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This identification of data limitations and the recommended actions does not discredit the RI results; rather it highlights that the nature and extent of contamination are determined and the risks are calculated for hypothetical receptors using well-defined and strict methods. Refinements of Operable Unit 2 characterization data, exposure assessment models, or risk characterization information could reduce uncertainties in the RI and in the baseline risk assessment methods; however, no benefit toward the remedial design nor remedial action would be gained.

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Characterization activities performed as part of the RI and other site programs successfully characterized the nature and extent of contaminations associated with Operable Unit 2. The Operable Unit 2 baseline risk assessment has succeeded in establishing an upper bound that is sufficient for risk managers to make decisions regarding the need for remedial actions. Based on the results of the investigations and the risk calculations, risks associated with Operable Unit 2 exceeded generally accepted regulatory thresholds, thereby necessitating the implementation of remedial actions. Viable remedial action alternatives will be evaluated in the Operable Unit 2 FS report.

7.6 CONCLUSIONS AND REMEDIAL ACTION OBJECTIVES

7.6.1 Conclusions

This RI presents a detailed understanding of the nature and extent of the contamination of the individual subunits that comprise Operable Unit 2. The contaminant data is used for two major purposes: (1) after the application of rigorous validation and statistical procedures, the data are used to drive the contaminant fate and transport models used in the risk assessment and (2) the types and quantities of contaminants are used in the FS in the screening of appropriate cleanup technologies and the development of specific remedial alternatives. The data collected for the Operable Unit 2 RI are completely adequate for both purposes and no data gaps have been identified.

The Operable Unit 2 baseline risk assessment utilizes a data set in which every data element has been validated for its intended usability. The fate and transport models are approved by EPA and calibrated to the specific site conditions. The risk assessment rigorously follows CERCLA guidance, the approved Risk Assessment Work Plan Addendum, and specific guidance to the FEMP from EPA Region V.

This report concludes that none of the Operable Unit 2 subunits presents a risk to current on-property or off-property receptors above allowable levels, except where access controls are lost and animals would be allowed to graze within the Operable Unit 2 battery limits.

7.6.2 Remedial Action Objectives

The development of the following general remedial action objectives (RAOs) is based only on the results of the baseline risk assessment. The Operable Unit 2 FS will include a consideration of the ARARs for each subunit, and ARARs have the potential to significantly affect the remedial action objectives. For the Operable Unit 2 subunits requiring remedial action, feasible remedial action alternatives will be developed and evaluated in the FS report to be issued for Operable Unit 2.

The remediation of existing contamination in the Great Miami Aquifer is not considered here; remediation of the aquifer is within the scope of the Operable Unit 5 remedial actions. During remediation of Operable Unit 2, contaminated perched water will be controlled to prevent the recontamination of the areas being cleaned up. The treatment or disposal of the perched water will be coordinated with the remedial actions for Operable Unit 5. Also, during the remediation of Operable Unit 2, storm water will be controlled to prevent the spread of contaminants. The treatment or disposal of the storm water will be coordinated with the remedial actions for Operable Unit 5.

The RAOs for all subunits in Operable Unit 2 are to prevent the release or migration of contaminants from waste materials and contaminated soils that could potentially: (1) affect future groundwater users (perched and aquifer) on the site, (2) be harmful as sources of external radiation, (3) prevent the availability of harmful waste materials or contaminated soils for inhalation or ingestion by on-property resident farmers, and (4) prevent the availability of harmful waste materials or contaminated soils for plant uptake, disposition on plants, or ingestion by animals raised for meat and milk products.

The risk assessment shows that in the future assuming federal ownership, in the absence of remediation, the Lime Sludge Ponds present an unacceptable risk for both the on-property receptors and the expanded trespasser.

The risk assessment shows that in the future, in the absence of remediation, the Active Flyash Pile, Inactive Flyash Pile, South Field, and Solid Waste Landfill will present greater than allowable risk to both on- and off-property receptors.

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