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TASK 1 REPORT - DESCRIPTION OF CURRENT SITUATION

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ASI/WMCO
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REPORT

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REMEDIAL INVESTIGATION AND FEASIBILITY STUDY, FEED MATERIALS PRODUCTION CENTER

Fernald, Ohio

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DESCRIPTION OF CURRENT SITUATION

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

REMEDIAL INVESTIGATION
AND
FEASIBILITY STUDY
FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

TASK 1 REPORT:

DESCRIPTION OF CURRENT SITUATION

Prepared For:

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS

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LIST OF ABBREVIATIONS AND ACRONYMS

A list of acronyms used within this document to provide reading ease is presented below:

AEC	-United States Atomic Energy Commission
ASI	-Advanced Sciences, Incorporated
CERCLA	-Comprehensive Environmental Response, Compensation and Liability Act of 1980
CWA	-Clean Water Act
DOE	-United States Department of Energy
DOT	-United States Department of Transportation
EPA	-United States Environmental Protection Agency
FFCA	-Federal Facility Compliance Agreement
FMPC	-Feed Materials Production Center
FS	-Feasibility Study
NLO	-National Lead Company of Ohio, Incorporated
NOAA	-National Oceanic and Atmospheric Administration
NPDES	-National Pollutant Discharge Elimination System
NTS	-Nevada Test Site
OEPA	-Ohio Environmental Protection Agency
ORO	-Oak Ridge Operations
RI	-Remedial Investigation
RMI	-Reactive Metals, Incorporated
SCS	-United States Soil Conservation Service
SOWC	-Southwest Ohio Water Company
USDA	-United States Department of Agriculture
USGS	-United States Geological Survey
WMCO	-Westinghouse Materials Company of Ohio

SECTION 1.0

INTRODUCTION

1.0 INTRODUCTION

The Feed Materials Production Center (FMPC) is a contractor-operated federal facility for the production of high purity uranium metal for the United States Department of Energy (DOE). The FMPC is operated by Westinghouse Materials Company of Ohio (WMCO) under the terms of prime contract number AC05-860R21600 with the DOE. The principal current operations consist of metal fabrication and the processing of accumulated plant residues and miscellaneous feed materials obtained from other DOE sites.

1.1 BASIS FOR CONDUCTING A REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

On March 9, 1985, The United States Environmental Protection Agency (EPA) issued a Notice of Noncompliance letter to DOE, identifying the Agency's major concerns over potential environmental impacts associated with the FMPC's past and present operations. Between April 1985 and July 1986, meetings were held between the DOE and EPA representatives to discuss the issues and steps DOE proposed to take to achieve and maintain compliance.

On July 18, 1986, DOE and EPA entered into a Federal Facility Compliance Agreement (FFCA) pertaining to the FMPC. The FFCA was entered into pursuant to Executive Order 12088 (43CFR47707) to ensure compliance with existing environmental statutes, and implementing regulations. The FFCA is intended to ensure that the environmental impacts associated with past and present activities at the FMPC are thoroughly and adequately investigated, and appropriate remedial response actions taken in accordance with provisions of the Comprehensive Environmental Response, Compensation and Liability Act, of 1980 (CERCLA).

In accordance with the FFCA, a site-wide Remedial Investigation (RI) and Feasibility Study (FS) is being conducted to determine the nature and extent of any release, or threat of release, of hazardous or radioactive substances, pollutants, or contaminants at or from the FMPC and propose remedial actions. The site-wide RI/FS is being conducted pursuant to Section 106 of CERCLA and in conformance with EPA "Guidance on Remedial Investigations Under CERCLA" and the EPA "Guidance on Feasibility Studies Under CERCLA." The RI/FS will be consistent with the guidelines, criteria and considerations set forth in the National Contingency Plan (40CFR300), and the Superfund Amendment Reauthorization Act of 1986.

The FMPC site-wide RI/FS is being performed for DOE by Advanced Sciences, Inc. (ASI) under contract to the Small Business Administration Present WMCO subcontractors are characterizing the FMPC Waste Storage Area and immediately adjacent areas. ASI will study the Production Area and all other potentially affected facilities outside of the Waste Storage Areas. The site-wide RI/FS work plan reflects the activities of DOE, WMCO, and their

subcontractors to satisfy the requirements of the FFCA scope of work for a site-wide RI/FS.

1.2 DEFINITION OF PROBLEM

Presently, a wide variety of chemical and metallurgical processes are utilized at the FMPC to produce uranium metals. Large-scale chemical operations consist of processing enriched uranium scrap residues to produce a uranyl nitrate feed solution. Purified uranyl nitrate solution is concentrated and then denitrated to uranium trioxide (UO_3). UO_3 is reduced to UO_2 and uranium tetrafluoride (UF_4) for reduction to metal. Scrap materials generated in FMPC operations and those received from off site are recycled for reentry into the production process.

As a result of the activities conducted at the facility, both radioactive and nonradioactive wastes are generated. Wastes at the FMPC are stored in on-site pits, silos and drums. In addition, the FMPC is a thorium repository for DOE.

Airborne discharges and liquid effluent result from plant operations. Slightly radioactive particulates generated by manufacturing processes are ventilated through highly efficient bag-type dust collectors and scrubbers. General operations, however, including collector failures, have resulted in releases of uranium to the atmosphere since 1952. Liquid effluent from the production process is sent to a general plant sump for treatment prior to release to the Great Miami River. Untreated storm water runoff from the process is also routinely discharged to the Great Miami River and excess storm flows are periodically discharged to Paddy's Run Creek. In some reaches, Paddy's Run Creek has scoured through the glacial till, and may be in direct communication with the sand and gravel aquifer. This creates a potential for contaminant substances to migrate into the ground water from leaks, spills or surface runoff. The above background levels of uranium detected in three off-site wells may be attributed to off-site uranium through the ground water system.

Identified substance release problems include the following:

- Airborne Uranium Emissions

  Airborne uranium emissions to the environment since 1952 total 132,525 kilograms (kg). Of this amount, more than 97 percent was released prior to 1970 when more efficient control measures were initiated. A total of 123.9 kg of slightly enriched uranium were lost to the atmosphere from Plant 9 operations over an approximate time period from September 1984 to December 1984. The excessive emissions caused no discernible impacts off site; an intensive in-vivo whole body count of Plant 9 workers indicated no significant incorporation of uranium in the lungs. DOE/ORO made reports to the National Response Center and several

State of Ohio health and environmental protection agencies, pursuant to the provisions of CERCLA. A more detailed explanation of this incident is contained in Section 5.1.

- Uranium In Off-Site Wells

  Laboratory analyses of NLO samples (collected since 1981) have indicated that the uranium concentration in the water of three off-site wells may be elevated with respect to wells upgradient from the FMPC. However, these concentrations are below DOE guidelines and the upper limit recommended by the U.S. Public Health Service.

- Surface Runoff

  Storm water runoff flowing into the storm sewer ditch from the production area; and water runoff flowing into Paddy's Run from the waste pit storage area, may be continuing pathways of uranium contamination to surface and ground water from Production and Waste Storage Areas.

1.3 PURPOSE OF THE REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

Within the CERCLA framework, the purpose of the RI is to determine the nature and extent of any release, or threat thereof, of hazardous or radioactive substances, pollutants, or contaminants, and to gather all necessary data to support the FS. The work plan for the RI at the FMPC has been prepared to satisfy the following specific objectives:

- Identify and characterize the possible sources of radiological and chemical contamination;

- Determine the nature and extent of radiological and chemical components in air, soils, sediments, surface water, and ground water media, and characterize their occurrence in aquatic and terrestrial organisms both on and off site;

- Identify the pathways and mechanisms for radiological and chemical constituent migration, conduct public health risk assessments and environmental impact studies;

- Apply appropriate site models or, as necessary, develop and validate site models in order to augment the current understanding of the site environment and to predict future impacts with and without remedial actions in lieu of future observations; and

- Provide necessary information for the identification, evaluation, and selection of the most environmentally and economically acceptable alternatives in the FS.

The Remedial Investigation phase of the site-wide RI/FS will be comprised of eight major tasks:

Task 1 - Description of Current Situation
Task 2 - Work Plan Requirements
Task 3 - Site Investigation
Task 4 - Site Investigation Analysis
Task 5 - Laboratory and Bench-Scale Analysis
Task 6 - Reports
Task 7 - Additional Requirements
Task 8 - Community Relations Support

The Feasibility Study phase of the RI/FS is to develop and evaluate remedial action alternatives and to recommend the remedial actions to be taken to protect the public health, welfare and/or the environment from releases or threatened releases of hazardous or radioactive substances, pollutants or contaminants at or from the FMPC. The Feasibility Study will be comprised of nine tasks:

Task 9 - Description of Current Situation
Task 10 - Work Plan
Task 11 - Development of Alternatives
Task 12 - Initial Screening of Alternatives
Task 13 - Detailed Analysis of Alternatives
Task 14 - Evaluation and Selection of Preferred Alternatives
Task 15 - Draft Feasibility Study Report
Task 16 - Final Feasibility Study Report
Task 17 - Additional Requirements

1.4 SUMMARY OF TASK 1

The Description of Current Situation (Task 1) is an information document prepared from a compilation and review of reports and analytical data pertinent to the FMPC. Data from a site reconnaissance conducted to verify the conditions presented in the preparation of this document are also included.

Important elements of background information and problem definition discussed are:

- Site Background - A summary of the regional site features and historical use of the FMPC;

- Nature and Extent of Problem - A summary of the actual and potential on-facility and off-facility health and environmental effects;

- History of Response Actions - A summary of major studies and corrective actions conducted by local, state, federal, or private parties; and

- Definition of Boundary Conditions - The establishment of site boundary conditions to delineate the area of remedial investigation.

Section 2.0 presents the site background and a discussion of the regional features including location, existing environment, and land use and population. The FMPC production plants and waste management areas, environmental monitoring systems, and process and waste materials are presented in Section 3.0. Section 4.0 summarizes the nature and extent of problems associated with the FMPC. This section provides the basis for future sampling needs discussed in the the Task 2 report, Volume 1, Sampling Plans.

Routine maintenance and monitoring programs, major studies conducted by agencies, private parties, and other technical reports, and resultant corrective actions are presented in Section 5.0. Section 6.0 provides the remedial investigation site boundary condition descriptions and presents the phased approach to the Remediation Investigation.

The Description of Current Situation is based on available information from both site-specific investigations and pertinent regional references. These references are housed at the WMCO Public Reading Room and the Ross, Ohio office of ASI.

SECTION 2.0

SITE BACKGROUND

2.0 SITE BACKGROUND

2.1 REGIONAL LOCATION AND BOUNDARY FEATURES

The FMPC is located in southwestern Ohio near the unincorporated village of Fernald in the Great Miami River Valley (Figure 2.1) Cincinnati is approximately 20 miles to the southeast and Hamilton, Ohio is approximately 10 miles to the northeast. The unincorporated villages of New Baltimore, Ross, and Shandon are within a few miles. The FMPC occupies parts of Sections 30 and 31, Township 3 North, Range 2 East, and parts of Sections, 5, 6, 7 and 8, Township 2 North, Range 2 East.

The FMPC (Figure 2.2) comprises 1050 acres, approximately 850 acres in northern Hamilton County and about 200 acres in adjacent Butler County. The Production Area covers approximately 136 acres in the center of the FMPC. The FMPC is bounded by Ohio Route 126 to the north, an electrical transmission line to the east, Willey Road to the south, and Paddy's Run Road to the west.

2.2 EXISTING ENVIRONMENT

2.2.1 TOPOGRAPHY

The topography and geology of the region surrounding the FMPC have been influenced by Pleistocene glaciation. The FMPC is located in a two- to three-mile wide ancestral river valley, known as the New Haven Trough, which was filled with 200 feet of Pleistocene glacial deposits. Today, the region is influenced by flooding and meandering of the Great Miami River. The FMPC is located on a relatively level terrace approximately 580 feet above sea level. Along the southern and western boundaries, elevations decrease to about 550 feet.

2.2.2 CLIMATE

Data from the Greater Cincinnati International Airport have been used to characterize the climatic regime of the area. Additional windflow data from the Dayton Airport were also incorporated.

The regional climate is defined as continental, with temperatures ranging from an average of 29.0°F in January to 75.5°F in July (NOAA, 1984). The highest temperature recorded from 1950 through 1984 was 102°F in August 1962, and the lowest was -25°F in January 1977. The average days per year with a minimum temperature of 32°F or less is 110 days and the average days with a maximum temperature of 90°F or above is 20 days per year. Frost depth ranges from 30 to 36 inches (Cummings, 1986).

During the winter and spring, frequent weather changes occur in southwestern Ohio as cyclonic storms pass over the area. In the summer, rainfall is produced by thunderstorms originating in the warm moist air which moves northward from the Gulf of Mexico

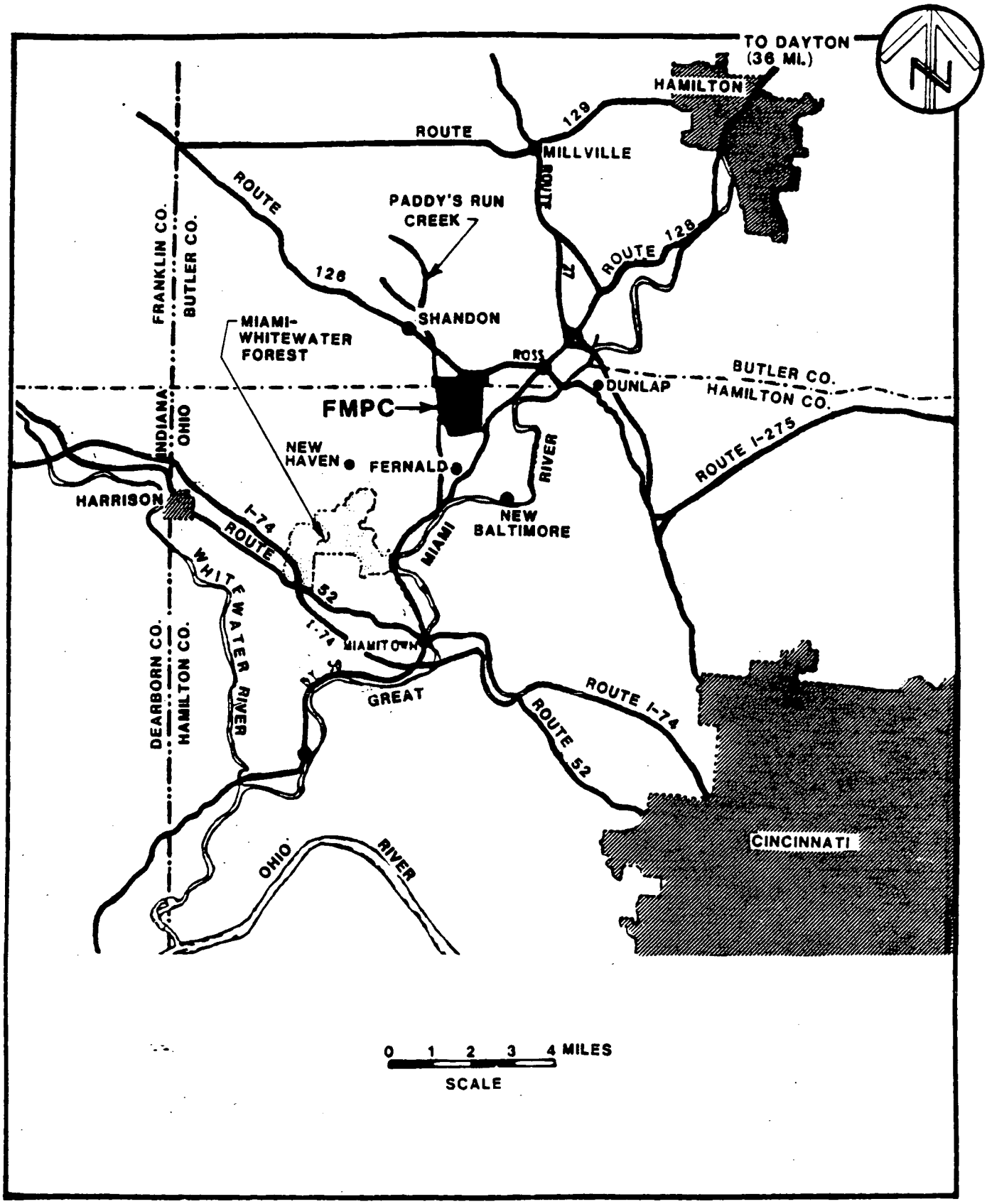


FIGURE 2.1
REGIONAL LOCATION
OF THE FEED MATERIALS PRODUCTION CENTER

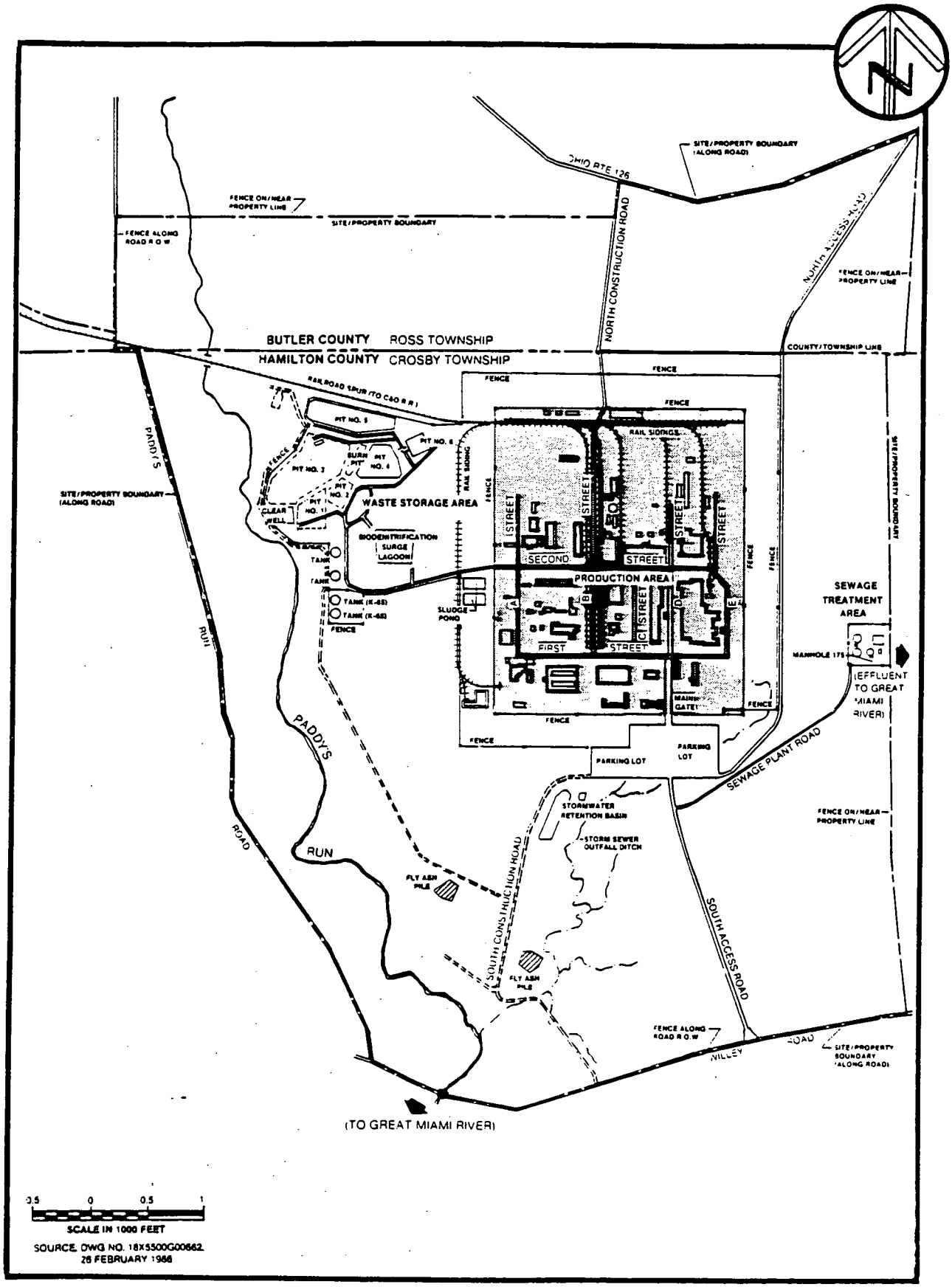


FIGURE 2.2

FEED MATERIALS PRODUCTION CENTER SITE, FERNALD, OHIO

along the Mississippi and Ohio Valleys. Fall is the season of minimum precipitation. Almost all snowfall occurs during the November through April period.

The average annual precipitation for the period 1955 through 1984 was 37.75 inches and ranged from 29.22 to 40.64 inches per year (NOAA, 1984). The highest precipitation occurred during the spring and early summer; precipitation was lowest in late summer and fall. The average annual snowfall for the same period was 24.0 inches with heaviest snowfall in January. Annual snowfall at Hamilton (approximately 10 miles from the FMPC) averaged 15.3 inches over a 29-year period. The Greater Cincinnati area averaged about 24 inches over a 22-year period.

Utilizing data from the Cincinnati and Dayton airports, windflow data for the period 1948 through 1978 indicate that the prevailing winds were from the south-southwest (Figure 2.3). There is a greater component of wind direction from the west and north at Dayton than at the Cincinnati airport. Both data sources are very similar, however, in terms of wind direction and wind speed (Figure 2.3).

Average monthly wind speed for the Greater Cincinnati Airport ranged from 6.7 mph in August to 11.1 mph in March (NOAA, 1984). Highest wind speeds occurred in winter and spring, while the summer and early fall had the lowest wind speeds. Maximum sustained wind speeds (one minute or more) ranged from 32 mph in September 1975, to 46 mph in January and again in April 1985. The strongest winds tend to come from the five wind directions in the west-northwest to south-southwest quadrants.

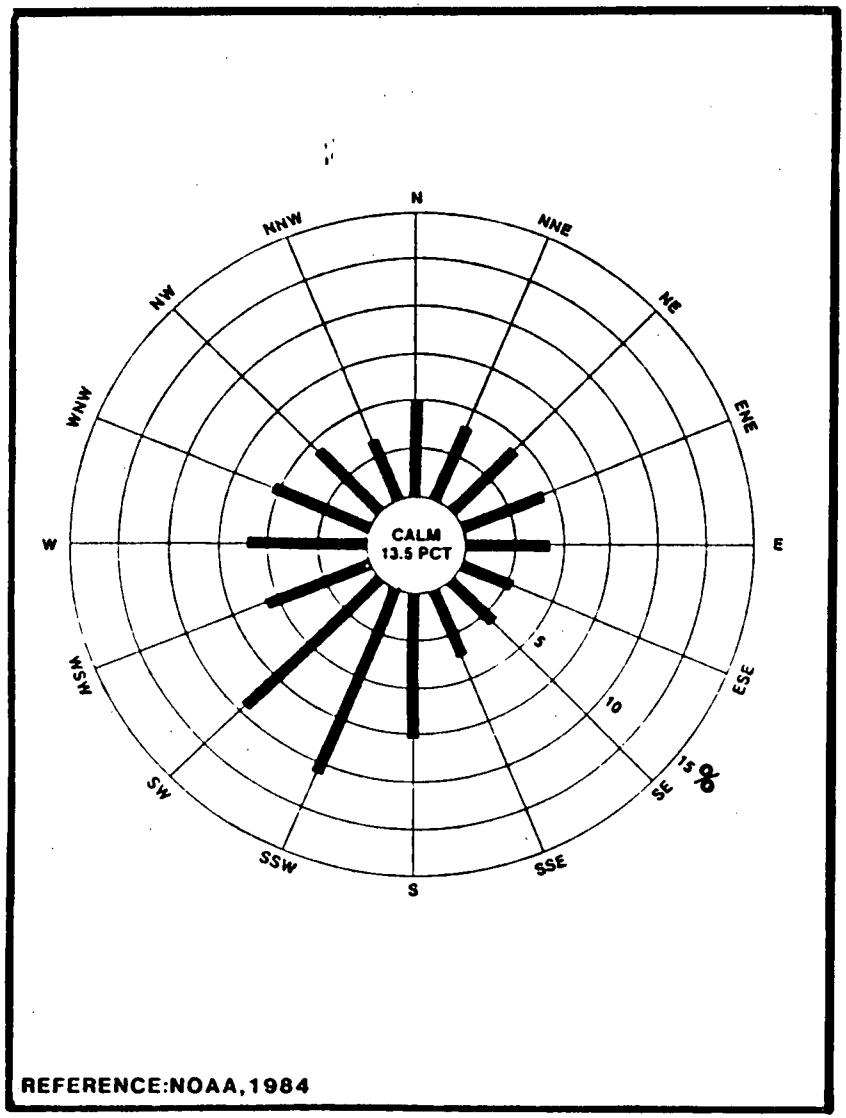
Ohio lies on the eastern edge of the region of maximum tornado frequency. About 90 percent of the tornadoes which are observed in Ohio come from the west-southwest direction. One tornado touched the FMPC on May 10, 1969; however, no damage was reported. Another tornado passed near the northeast boundary of the FMPC on May 13, 1974 but caused no damage.

Heavy fog occurs an average of 20 days per year. These days occur throughout the year with a maximum from September through November and a minimum from April through June.

A meteorological tower has been installed at the FMPC and began operation in mid-1986.

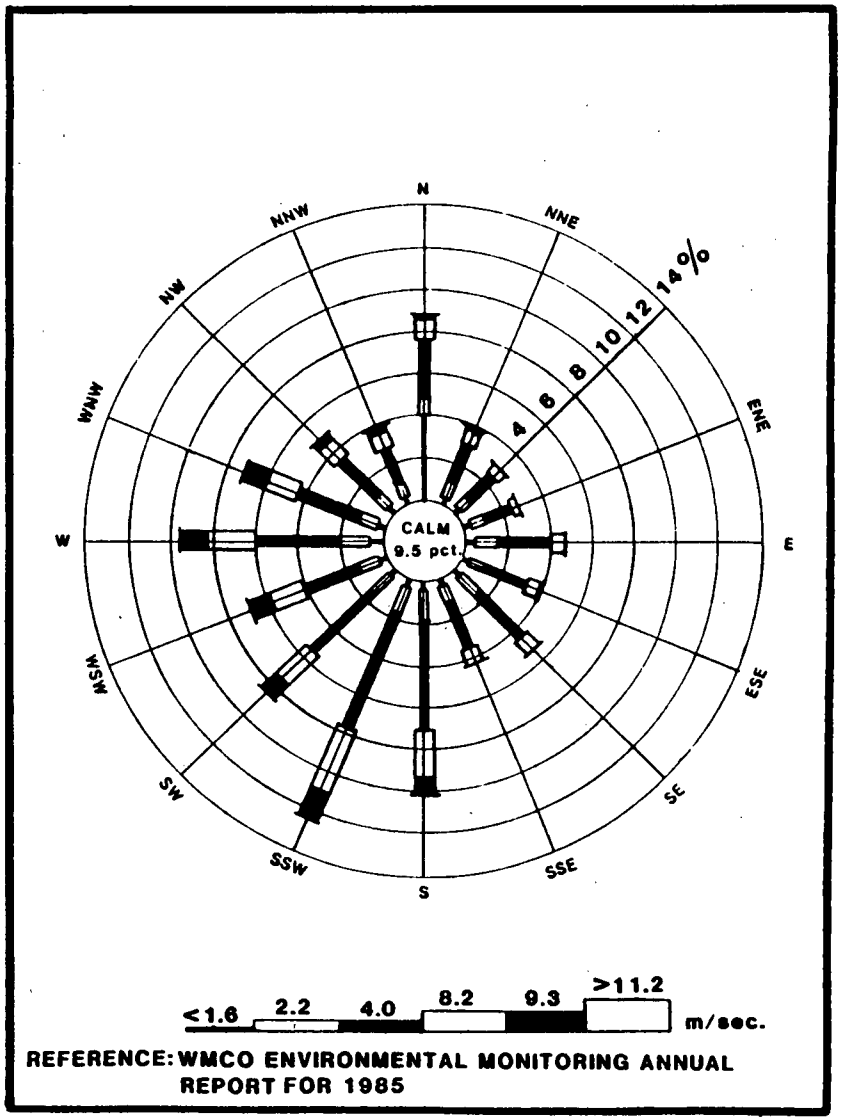
2.2.3 SOILS

Soils in the region were formed from parent materials that were deposited by the action of Wisconsian and Illinoisian glaciers. These materials consist of glacial till, which includes sands, gravels, silt, and clays. Various soils result from different parent materials, variations in relief and



REFERENCE:NOAA,1984

PERCENT FREQUENCY OF WIND DIRECTION FOR THE PERIOD 1948 THROUGH 1978 AT THE GREATER CINCINNATI METROPOLITAN AIRPORT.



REFERENCE: WMCO ENVIRONMENTAL MONITORING ANNUAL REPORT FOR 1985

PERCENT FREQUENCY OF WIND DIRECTION FOR THE PERIOD 1973 THROUGH 1977 AT DAYTON,OHIO.

FIGURE 2.3

drainage, and differences in soil age. In many areas where surficial glacial deposits consist of till or where erosion has occurred, the sand and gravel are at shallow depths.

There are three major soil associations in the vicinity of the FMPC: Russell-Xenia-Wynn, Fincastle-Xenia-Wynn, and Fox-Gennessee. The soils are usually light-colored, acidic, and well-drained. Many of the soils have developed from a wind-blown material (loess), except along present and old river basins where the Fox-Gennessee soils are of glacial till origin. The soils are moderately high in productivity and are frequently used for livestock production and growing cash crops.

Soils at the FMPC site are primarily categorized as Fincastle-Xenia silt loams (Figure 2.4). These soils are light colored, medium acid, and moderately high in productivity when properly managed. Moisture-supplying capacity is moderate as is fertility and organic content. They have formed in 18 to 40 inches (45 to 101 cm) of loess over limey loam till of Wisconsian age. Fincastle soils have poor drainage; and, in areas where these soils are predominant, artificial drainage is required for moderate crop productivity. If artificial drainage is not used, the water table remains high for extended periods in winter and spring. Fincastle-Xenia soils also cover large areas west of the FMPC. Due to development, native soils on site have been convered by paving materials, gravels, and buildings.

Soils along Paddy's Run are categorized as Fox-Gennessee loams. These soils are light colored, high in productivity and moderate in fertility and organic matter. Fox soils are slightly to medium acid, moderate in moisture-supplying capacity, and well drained. They have formed in 24 to 40 inches (60 to 202 cm) of silty materials over sand and gravel on level areas of second bottoms. Gennessee soils occur on first bottoms. These are well drained, high in moisture-supplying capacity, and are subject to flooding.

Soils in a small area on the north side of the site are classed as Russell-Xenia-Wynn. The topography is sloping. These upland soils are light colored and medium acid. The soils have formed in 18 to 40 inches (45 to 101 cm) of wind-blown silty material on limey loam glacial till.

The "Soil Survey of Hamilton County, Ohio" (USDA-SCS) supplies a more detailed listing and description of soil types found in the region.

2.2.4 GEOLOGY

The FMPC is located within the New Haven Trough, a two- to three-mile wide valley formed as a result of Pleistocene glaciation and, subsequently, filled with glacial outwash materials and till (Figure 2.5). Figure 2.6 shows the approximate location of the New Haven Trough with respect to the FMPC.

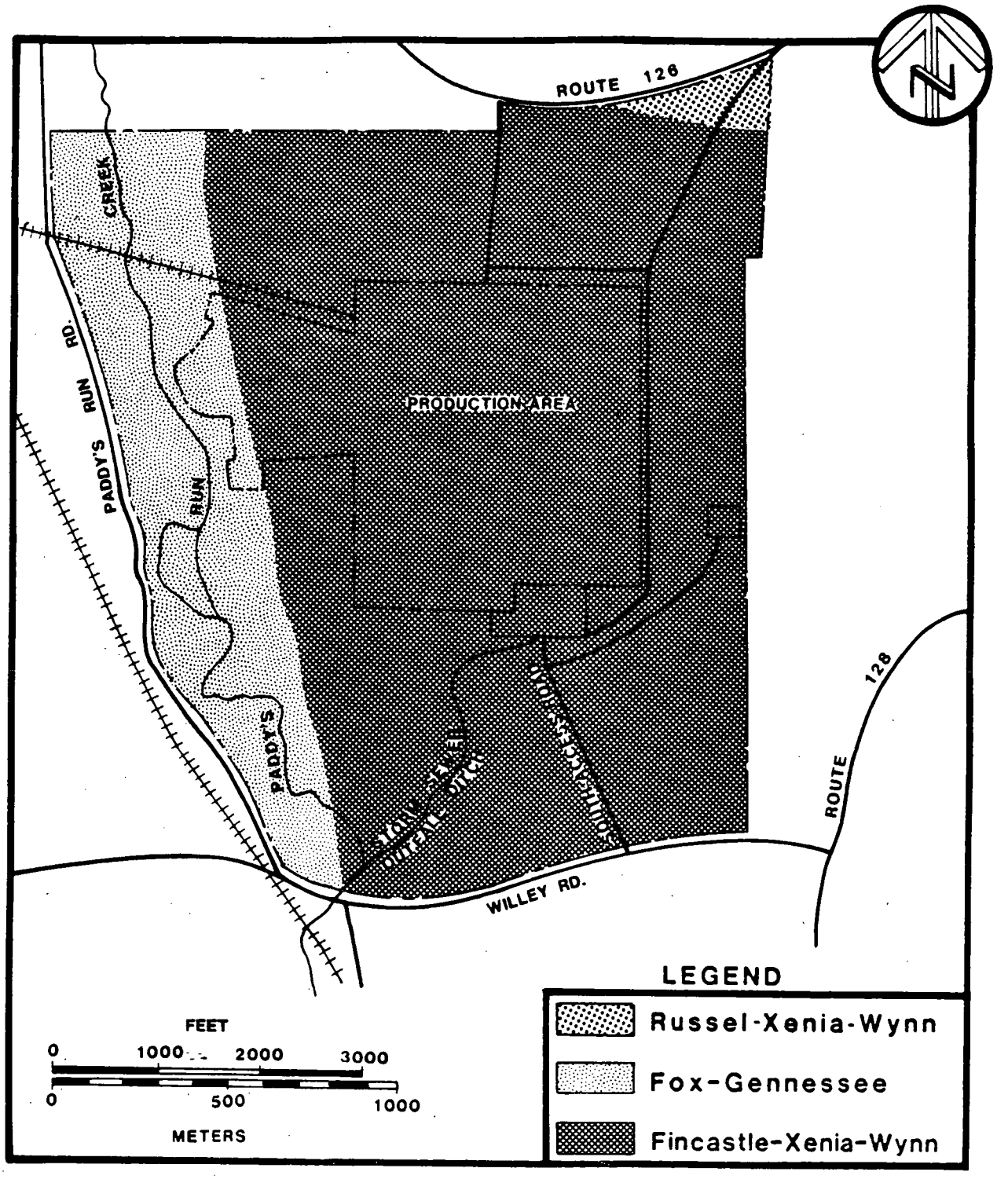


FIGURE 2.4

SOIL ASSOCIATIONS OCCURRING ON THE FMPC (Battelle, 1981)

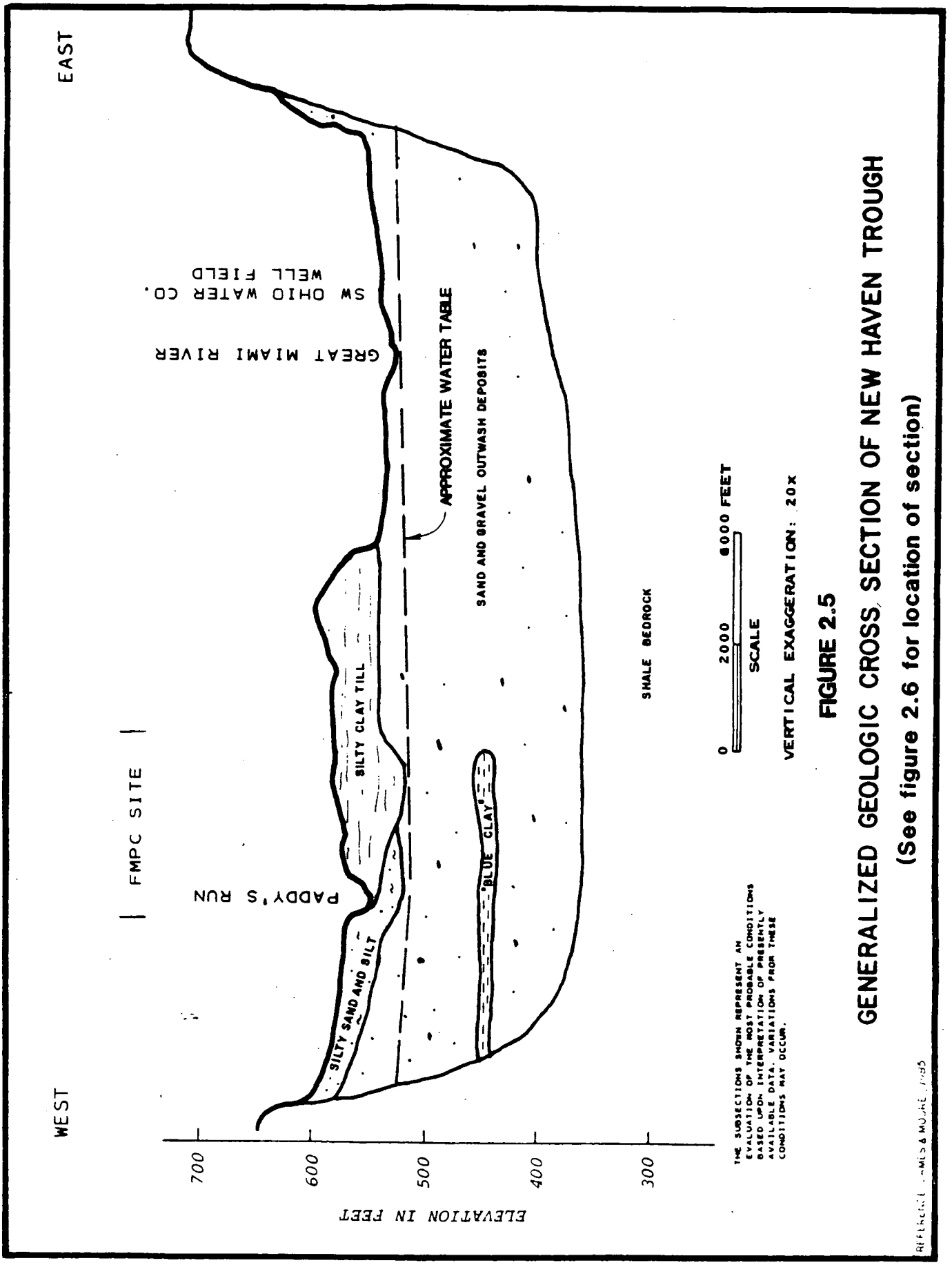


FIGURE 2.5

GENERALIZED GEOLOGIC CROSS SECTION OF NEW HAVEN TROUGH

(See figure 2.6 for location of section)

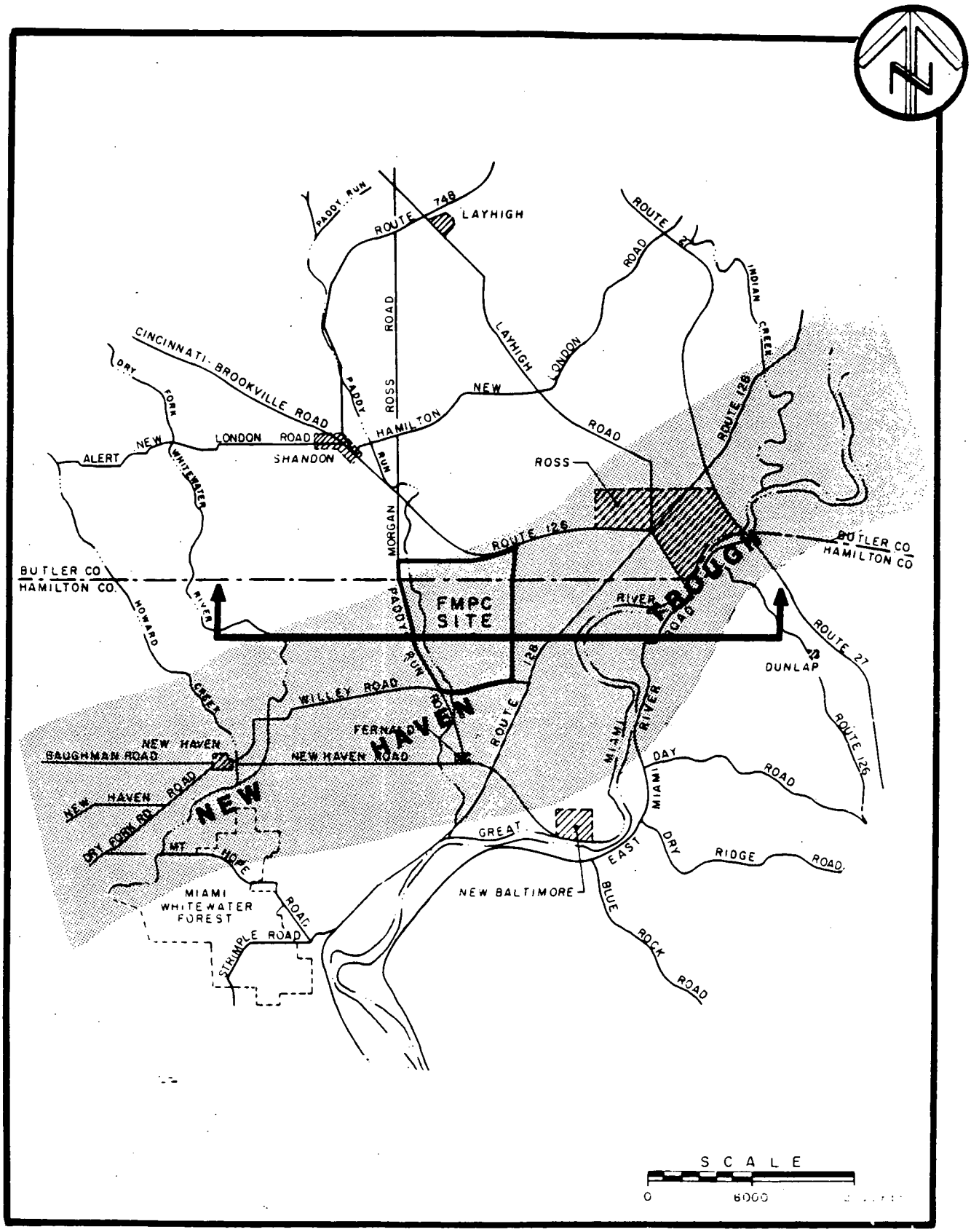


FIGURE 2.6

APPROXIMATE LOCATION OF NEW HAVEN TROUGH (CROSS-SECTION SHOWN ON FIGURE 2.5)

The geological history of the FMPC area is briefly summarized below:

- In Late Ordovician time (approximately 450 million years ago) sediments which would become a predominantly flat-lying shale with thin interbedded limestone were deposited in a shallow sea. This shale (a part of the Cincinnatian Series) is the relatively impermeable bedrock which now underlies the FMPC site area.

- Sometime prior to, or perhaps contemporaneous with, Pleistocene glaciation, a large watercourse (larger than the present-day Great Miami River) cut its channel into this shale bedrock to a level of more than 200 feet below that of the present-day Great Miami River. This approximately two-mile wide channel (called the New Haven Trough) may be an abandoned course of the ancestral Ohio River.

- During subsequent Pleistocene glacial advances and retreats across the site (Illinoisan--approximately 300,000 years to 400,000 years ago and Wisconsian--approximately 100,000 years ago) the New Haven Trough was filled with about 200 feet of glacial sediments. These sediments were deposited by water running from the margins of the glaciers and consisted mainly of well sorted sand and gravel. Deposited on top of these sediments was a blanket of clay-rich relatively impermeable glacial till from a more recent glacial event.

- Erosion by the Great Miami River and its tributaries then removed significant portions of the glacial till and left terrace remnants which stand topographically higher than surrounding bottom lands. The FMPC site lies on top of one of these terrace remnants.

Bedrock underlying the FMPC is comprised of flat lying olive gray shale with thin interbedded limestone. This shale forms the floor and valley of the New Haven Trough and is generally between 60 to more than 200 feet below the land surface in the vicinity of the FMPC. Elevation of the bedrock surface varies from 327 feet south of the Production Area to 400 feet (Figure 2.5) just north of the FMPC (GeoTrans, 1985). The approximate location of the New Haven Trough with respect to the FMPC is shown in Figure 2.6.

Unconformably overlying the shale bedrock is a sequence of sand and gravel glacial outwash material up to 200 feet thick. Underneath parts of the FMPC these gravels are separated by a 10 to 20 feet thick greenish-black silty clay ("blue-clay") at a depth of about 100 to 125 feet below the surface (Spieker, 1968; GeoTrans, 1985). This clay layer, which appears to be discontinuous, is located in the vicinity of the Waste Storage Area and production

wells (Figure 2.5). Dames & Moore (1985) interpreted this clay layer to extend from west of Paddy's Run to east of the production wells. There are insufficient data to determine the southern extent of the clay although it seems to pinch out in the area beneath the storm sewer outfall ditch (Dames & Moore, 1985; GeoTrans, 1985; Spieker, 1968).

Near the surface of the FMPC, overlying the outwash materials is a dense, silty clay, glacial till that varies in composition vertically and laterally. The silty clay till contains lenses of poorly sorted fine- to medium-grained sand and gravel, silty sand and silt with layers of silty clay to the west and south of the FMPC. The till varies in thickness from 20 to 50 feet having a base at an elevation of 540 feet (Dames & Moore, 1985; GeoTrans, 1985; Spieker, 1968).

2.2.5 SEISMOLOGY

The FMPC is located in seismic risk zone 2 (Figure 2.7) which indicates the area could experience moderate earthquake damage. To date, however, no earthquake damage has occurred (Battelle, 1981). Two relatively significant earthquakes occurred in 1937 in the Anna, Ohio area, approximately 70 miles north, with intensities of VII to VIII on the Modified Mercalli Scale. These quakes resulted in cracked walls and fallen chimneys and was felt over an area of approximately 50 miles.

In 1980, a quake measuring 5.1 on the Richter scale occurred in Maysville, Kentucky, along the Ohio River, 60 miles southeast of the Fernald site. This earthquake toppled chimneys in the Cincinnati area (Battelle, 1981).

Eighty earthquakes have occurred in Ohio since 1776. Six of these quakes (all intensity of II on the Modified Mercalli scale) occurred in the Cincinnati area, the last of which occurred in 1937 (Battelle, 1981).

2.2.6 HYDROLOGY

The FMPC is located within the Great Miami River Basin drainage above the river's present day flood plain. Natural drainage from the FMPC to the Great Miami River is primarily from Paddy's Run. This is a stream originating north of the plant and draining southward along the west side of the Waste Storage Area (Figure 2.8) which loses flow to the ground water near Willey Road. Paddy's Run is an ungaged stream that flows primarily between January and May with an estimated discharge ranging between 0.2 and 4.0 cubic feet per second (cfs) (Dames & Moore, 1985).

Additional drainage from the FMPC facility is through the storm Sewer Outfall Ditch which flows south of the Production Area and subsequently drains into Paddy's Run at the facility's southwest corner. Surface runoff from the Waste Storage Area and fly ash piles flows either directly toward Paddy's Run or some of its numerous tributaries.

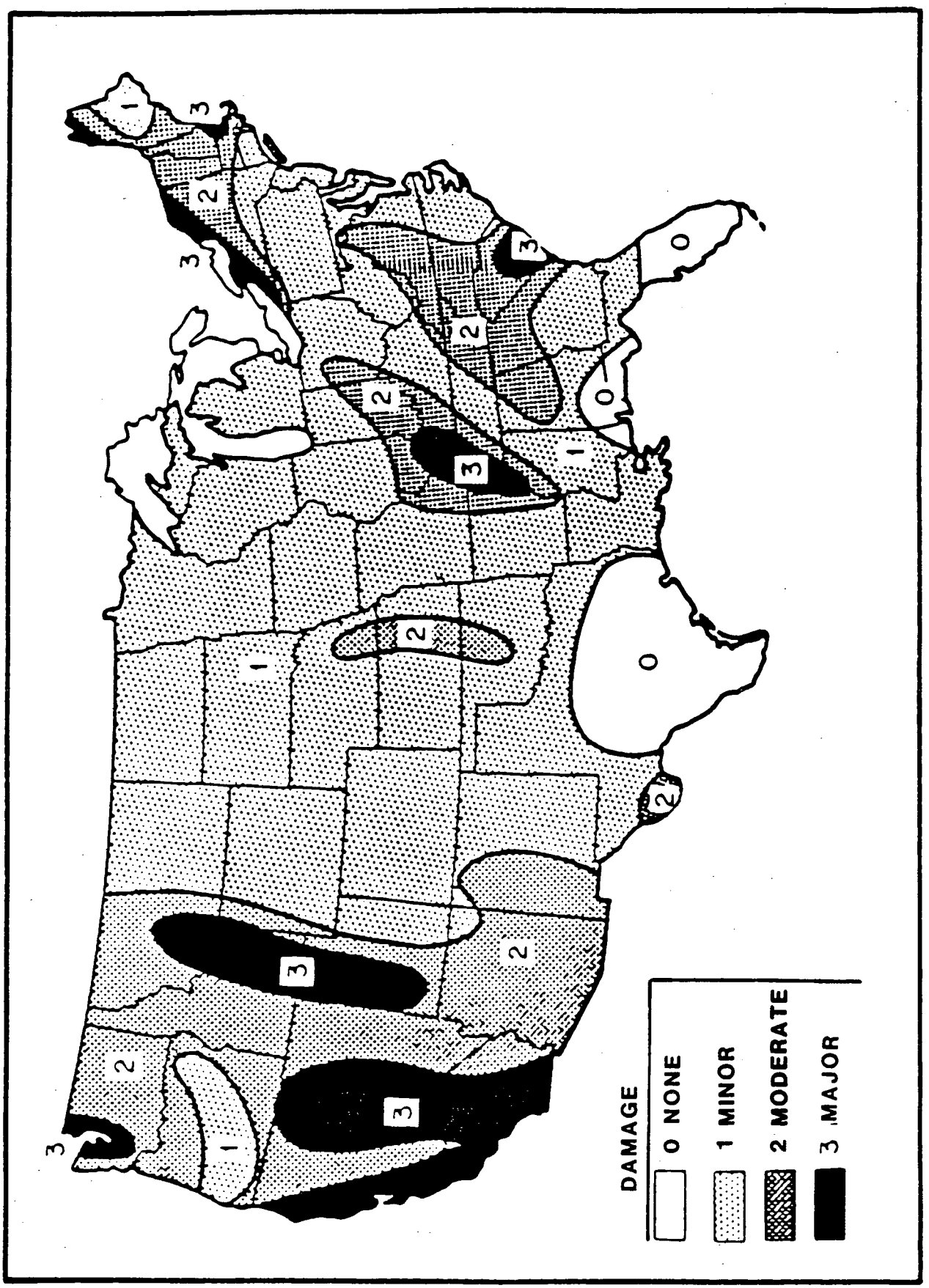


FIGURE 2.7 SEISMIC RISK MAP OF THE UNITED STATES

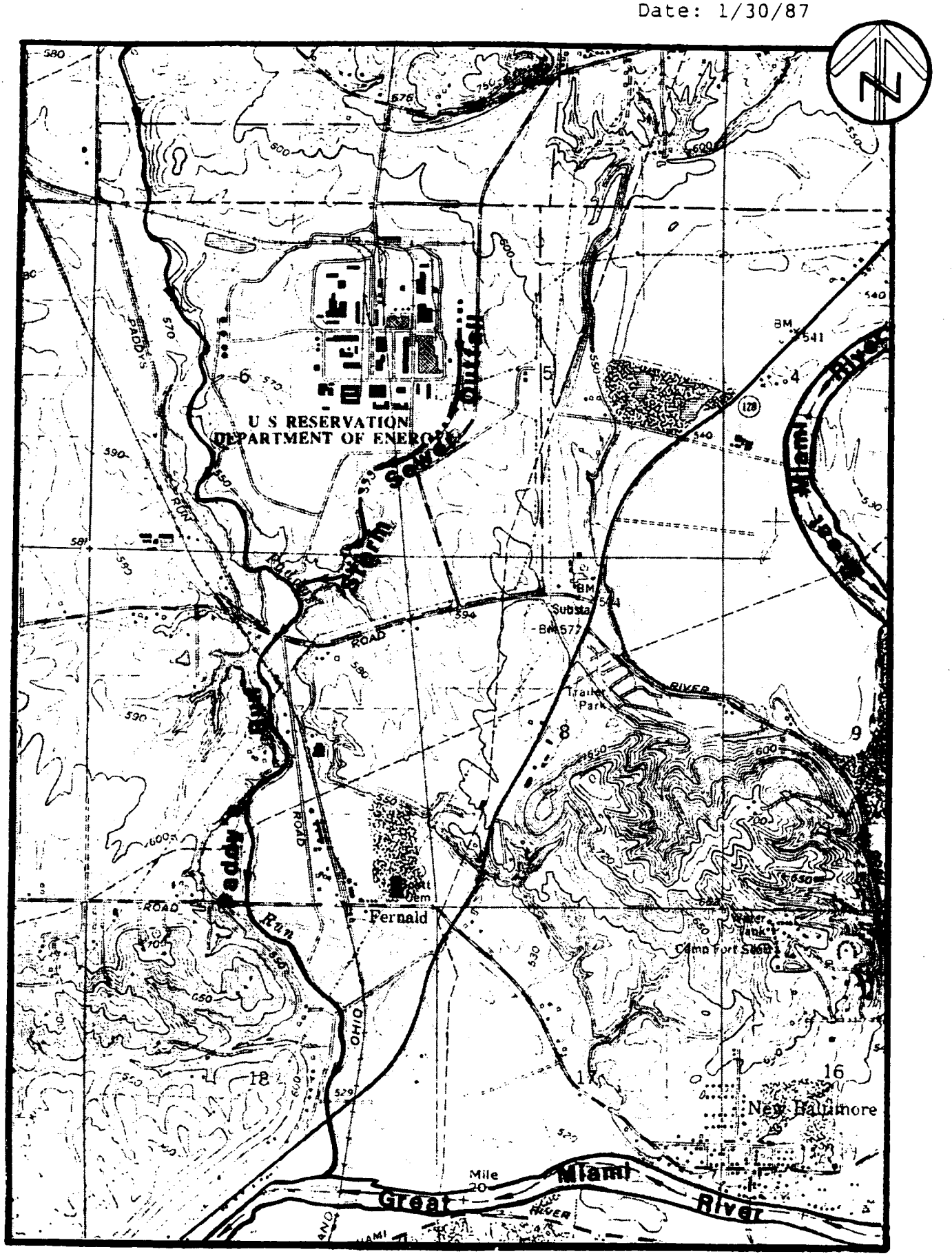


FIGURE 2.8

SURFACE STREAMS- FMPC ENVIRONS

5

2.2.7 HYDROGEOLOGY

2.2.7.1 Ground Water Hydrology

Regional hydrogeologic environments of the buried channel aquifer have been investigated and reported extensively by the USGS. Spieker (1968a) has classified and mapped five major hydrogeologic environments in the Great Miami River Valley. A hydrogeologic environment describes a portion of an aquifer posessing hydrologic and geologic properties that differ from the properties of aquifers in adjacent areas. Of the five hydrogeologic environments in the Great Miami River Valley, four are relevant to a description of hydrogeologic conditions in the vicinity of the FMPC facility (Figure 2.9). Using the notation of Spieker (1968a), these environments are:

- Type I: Sand and Gravel Aquifer. No continuous clay layers are present. Potential for induced stream infiltration exists. The Type I aquifer environment is further divided into a Type I-A-1 aquifer which is 150 to 200 feet or more thick and a Type I-A-2 aquifer which is less than 150 feet thick.

- Type II: Sand and Gravel Aquifer. Types II-A-1, II-A-2, II-B-1, and II-B-2 have been described; however, only Type II-A-2 has been determined to exist in the study area. This environment is less than 150 feet thick and recharge by induced stream infiltration does not occur.

- Type III: Sand and Gravel Aquifer Overlain by Clay. The potential for induced stream infiltration does not exist. The transmissivity and storage properties are highly variable.

- Type V: Shale and Limestone Bedrock Overlain by Till. Relatively impermeable shale and limestone bedrock. Small water supplies are available.

The Type I aquifer environment is found along the floodplain of the Great Miami River to the south and east of the FMPC facility. The lithology of the aquifer consists principally of sand and gravel. Scattered lenses of clay or fine-grained material may exist anywhere in the environment; however, these lenses are not of sufficient thickness or areal extent to act as semiconfining layers or otherwise affect ground water movement. The Type I aquifer may be classed as unconfined with a storage coefficient in the range of 0.2 to 0.25.

The Type II aquifer environment is characterized by 150 to 200 or more feet of sands and gravels with no interstratified clay layers present between soil strata over extensive areas. Recharge by induced stream infiltration does not occur. The coefficient of storage is about 0.2. Large ground water supplies are not

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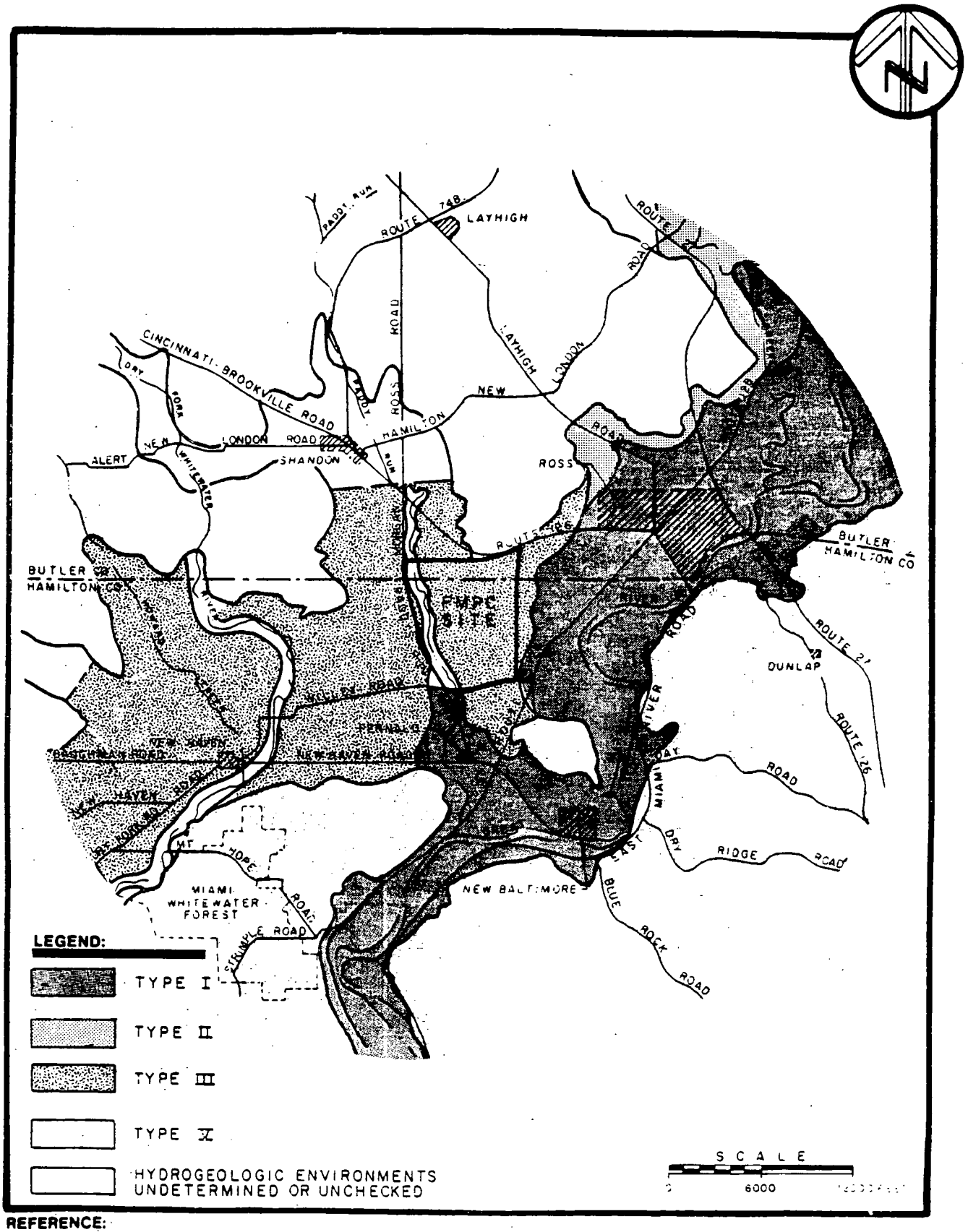

REFERENCE:
I.T. CORP., 1984

FIGURE 2.9
HYDROGEOLOGIC ENVIRONMENTS

generally available from the Type II-A-2 aquifer because of its limited areal extent and proximity to bedrock valley walls.

The Type III aquifer environment is characterized by 50 feet or more of clayey till overlying the main buried channel aquifer. In the region of the FMPC, the buried channel aquifer is divided into an upper and lower part by a semipervious clay layer approximately 10 to 20 feet thick occurring approximately 140 feet below land surface. Hence, the lower aquifer is classed as a semiconfined or leaky confined aquifer. Spieker and Norris (1962) have estimated a coefficient of storage of 0.001 for the lower sand and gravel aquifer.

The Type V hydrogeologic environment includes all of the area outside of the buried channel. These areas are uplands which consist of shale with interbedded limestone bedrock overlain by 50 feet or less of clay-rich till. Large quantities of ground water are not generally transported through this material. Well yields vary widely, generally ranging from zero to ten gallons per minute. Sand and gravel lenses, however, are erratically distributed throughout this material and, in some cases, wells completed in these units may yield up to 50 gallons per minute.

The buried channel aquifer includes numerous interbedded clay or fine-grained lenses. These lenses result in very large variations of aquifer properties on a localized scale. The aquifer may be regarded, however, as homogeneous for the purposes of this study since the hydrogeologic properties of interest occur on a much larger scale than these local variations. On the scale appropriate for characterizing ground water movement in the vicinity of the FMPC, aquifer properties have been previously established by aquifer pumping tests (Spieker, 1968a; Spieker and Norris, 1962; Dove, 1961).

Transmissivity values within the Type I-A-1 aquifer have been reported in the range of 300,000 to 500,000 gallons per day per foot (Spieker, 1968a). Based on an average saturated thickness of 150 feet, the range of horizontal hydraulic conductivity is approximately 270 to 450 feet per day. The Type I-A-2 aquifer would be expected to have similar hydraulic conductivity.

From an aquifer test, Spieker and Norris (1962) estimated the transmissivity of the lower sand and gravel aquifer below the FMPC to be about 140,000 gallons per day per foot. Using a thickness of 70 feet, the estimated horizontal hydraulic conductivity of the lower sand and gravel aquifer is approximately 270 feet per day.

Average annual precipitation at the FMPC for the years 1941 through 1970 was approximately 39 inches (NLO, 1977). Of the total annual precipitation, approximately 57 percent occurs during the spring and summer months. Most precipitation is lost through evapotranspiration during the summer. The remainder is lost through surface runoff or infiltrates to the ground water.

Ground water recharge is low in summer months when evapotranspiration is high. Freezing of the ground also lowers recharge during a portion of the winter. For these reasons, most ground water recharge generally occurs during the months of October, November, March, and April. Average annual recharge has been reported by various authors in the range of 6 inches per year to as high as 21 inches per year for areas not overlain by clay. Average annual recharge within the Type I and Type III hydrogeologic environments has been estimated to be 15 and 6 inches per year, respectively (GeoTrans, 1985; Spieker, 1968a and 1968b). Ground water recharge by induced infiltration is significant along the Great Miami River near the Cincinnati and Southwestern Ohio Water Company (SOWC) well fields. Dove (1961) estimated the average rate of infiltration along the Great Miami River near the SOWC well field to be 240,000 gallons per day per acre of stream bottom.

2.2.7.2 Ground Water Flow

Ground water flow in the buried channel aquifer near the FMPC has been described by various authors. Spieker and Norris (1962) constructed a ground water level elevation contour map using data from 48 wells. They determined that a ground water divide existed along the eastern boundary of the FMPC. From their analyses, they concluded that ground water west of the divide moves from northwest of the facility near Shandon southeastward through the FMPC towards the Great Miami River between New Baltimore and Paddy's Run. These authors did not feel that pumping on-site production wells influenced regional ground water movement.

Sedam (1985) completed a well inventory and water level measurement survey in August 1982. From these measurements, he constructed a water table map of the area surrounding the FMPC. He also showed the north-south ground water divide along the eastern boundary of the FMPC and concluded that ground water moves from north to south across the facility and discharges to the Great Miami River between New Baltimore and Paddy's Run. Sedam shows a cone of depression in the ground water table caused from pumping the plant wells. This pumping cone, as described, would capture a portion of the flow moving across the FMPC.

Dames and Moore (1985) produced a ground water contour map within the FMPC which shows west to east ground water movement which is influenced by the plant pumping. For their off-site ground water quality impact assessment, however, they used Sedam's (1985) evaluation of ground water flow.

GeoTrans (1985) questioned the USGS ground water divide location stating that water level elevations were determined by using surface elevations picked from topographic maps and not determined by an elevation survey and also that more wells were needed along the eastern site boundary. Through a ground water modeling study of the buried channel aquifer near the FMPC, GeoTrans concluded that:

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- A ground water divide exists which trends from southeast to northwest across the south-central portion of the facility;
- Water in the buried channel aquifer near the waste pits will travel east towards the Great Miami River; and
- Water south of the waste pits will travel south and southeasterly towards the Great Miami River.

GeoTrans recommended that additional wells be installed, especially to the east of the Plant Production Area and that a well elevation survey be completed for the area. They also raised the question of vertical ground water gradients and the need for cluster wells to determine the magnitude of the ground water movement. IT Corporation (1986), reviewed existing hydrologic and geologic data in the vicinity of FMPC. A figure was developed (Figure 2-10) showing the direction of ground water flow and aquifer boundaries. The ground water direction and rate of flow direction are controlled by local aquifer properties and topographic relief.

2.2.7.3 Surface Water/Ground Water Interaction

The main surface water drainage channel for the western portion of the site is Paddy's Run, a stream with losing and gaining reaches, which empties into the Great Miami River (Figure 2.8). In addition to drainage to Paddy's Run, a portion of the runoff from the Production Area has been collected and allowed to discharge to the Storm Sewer Outflow Ditch (SSOD). Excess flows in the SSOD is a natural gully that cuts through the south-central to southwest portion of the site (Figure 2.2). The SSOD empties into Paddys Run near Willey Road at the southwestern corner of the FMPC. Additionally, the surface waters infiltrate into the sandy soils and probably recharge the local sand and gravel ground water system.

North of Willey Road, water in Paddy's Run is elevated above the regional water table (GeoTrans, 1985). Somewhere between Willey and New Haven roads, water in Paddy's Run lies below the water table and ground water discharges to Paddy's Run. The exact location where Paddy's Run lies below the water table is seasonal. The location is probably farther south during months when ground water levels are lowest (GeoTrans, 1985).

Dames and Moore (1985) theorized that surface water from Paddy's Run and the SSOD, which contained above background concentrations of uranium, entered the ground water flow regime and that this was the most likely transport pathway by which uranium from the site reached off-site wells immediately south of the FMPC. This indicates that uranium is not being transported offsite from the Waste Pit Storage Area and Production Area via a ground water pathway at concentrations high enough to account for the above background levels in the three off-site wells.

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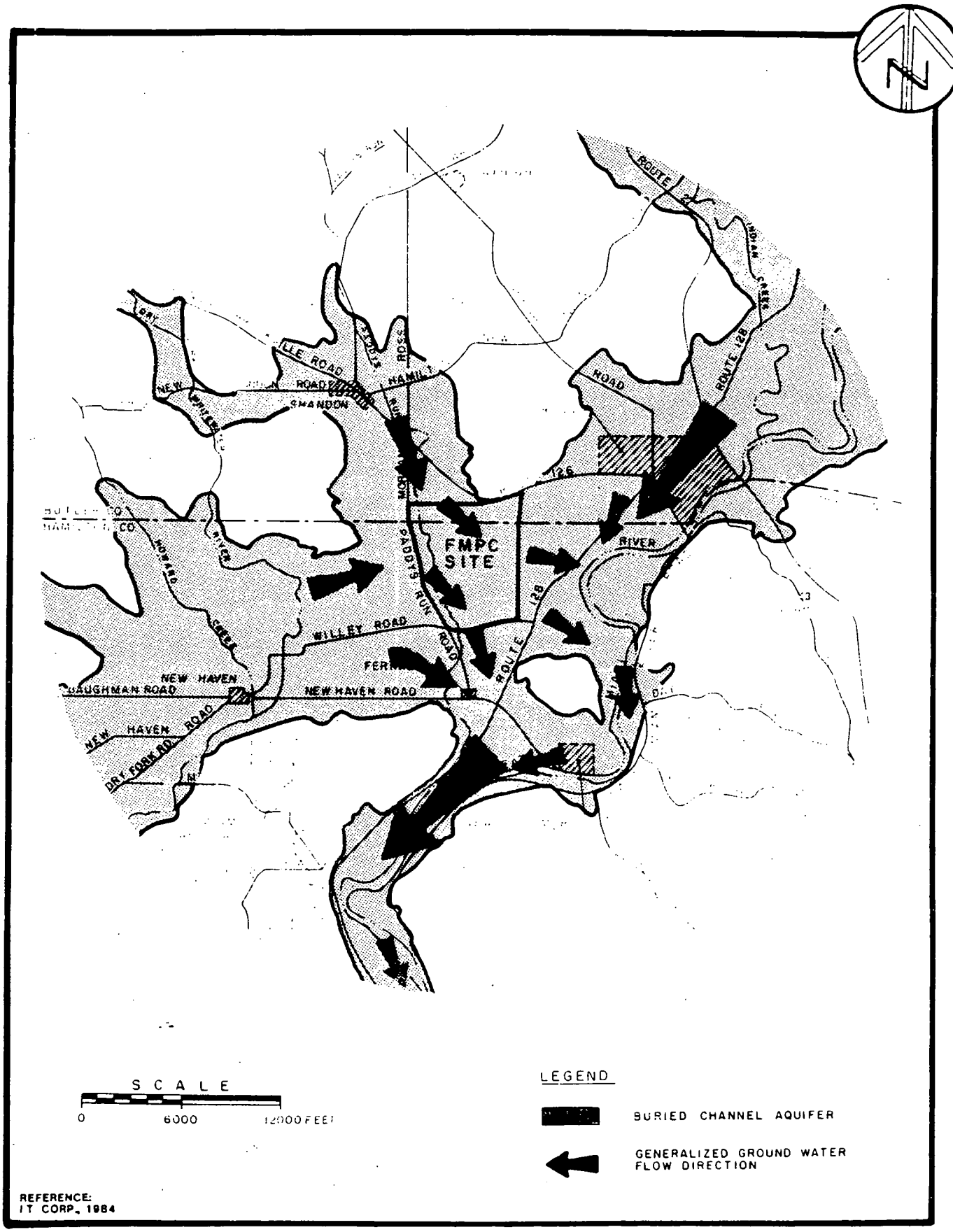

FIGURE 2.10
GENERALIZED GROUNDWATER FLOW IN BURIED CHANNEL AQUIFER

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2.2.7.4 Shallow or Perched Ground Water Conditions

Surficial till at the FMPC consists of silty clay with interbedded sand, gravel, and silty sand lenses. Perched aquifer systems also exist within these units in different areas of the FMPC site. Investigations by Dames and Moore (1985) determined that hydraulic conductivities in the saturated till ranged from 0.2 to 2.5 feet per day. While the exact lateral extent of perched zones within the ground water system below the FMPC has not been established, it is unlikely that these zones provide direct ground water pathways for chemical constituents to reach off-site receptors. However, some of these perched systems may discharge to Paddys Run and to the buried channel aquifer.

2.2.7.5 Ground Water Usage

Ground water is a major source of water supply in the area. Major ground water users have been identified in the study area. These pumping centers are shown in Figure 2.11 and are listed in Table 2.1. The estimated total pumping from these well fields averages over 37 million gallons per day. Additionally, there are many other smaller industrial, commercial, agricultural, and private ground water users in the area.

2.2.8 FLORA AND FAUNA

The background information discussed below presents results from previous investigations. These studies consisted chiefly of literature surveys and site characterization on the FMPC. The studies of Burt (1986) and Lechel (1986) represent unpublished observations. Prior to the FFCA, WMCO contracted for a site-wide study of the biological components of the ecosystem at the FMPC. A map of the biological sampling locations for this study is shown in Figure 2.12. Evaluation of data being collected is expected to result in a more complete understanding of the biota found on the FMPC.

2.2.8.1 Flora

The FMPC is in the transition zone between the beech forests to the north and the mixed deciduous forests of the southern Appalachians. Vegetation outside the fenced, "controlled" area includes mowed pastures, brushy fields, and transition zones to second growth deciduous forests. Within the waste storage area, vegetation is primarily introduced grasses on the covered waste pits and scattered shrubs along small drainages.

Much of the pasture lands are grass and herb dominated habitat with few widely scattered trees. Two mowed fields were planted with conifers in 1972 (NLO, 1986) which are now typically 15 to 25 feet tall (Burt, 1986). Deciduous woods occur principally along Paddy's Run with other wood lots north of the Production Area. These wood lots vary from pole sized trees [3- to 10-inch diameter at breast height (dbh)] to woods dominated by trees with

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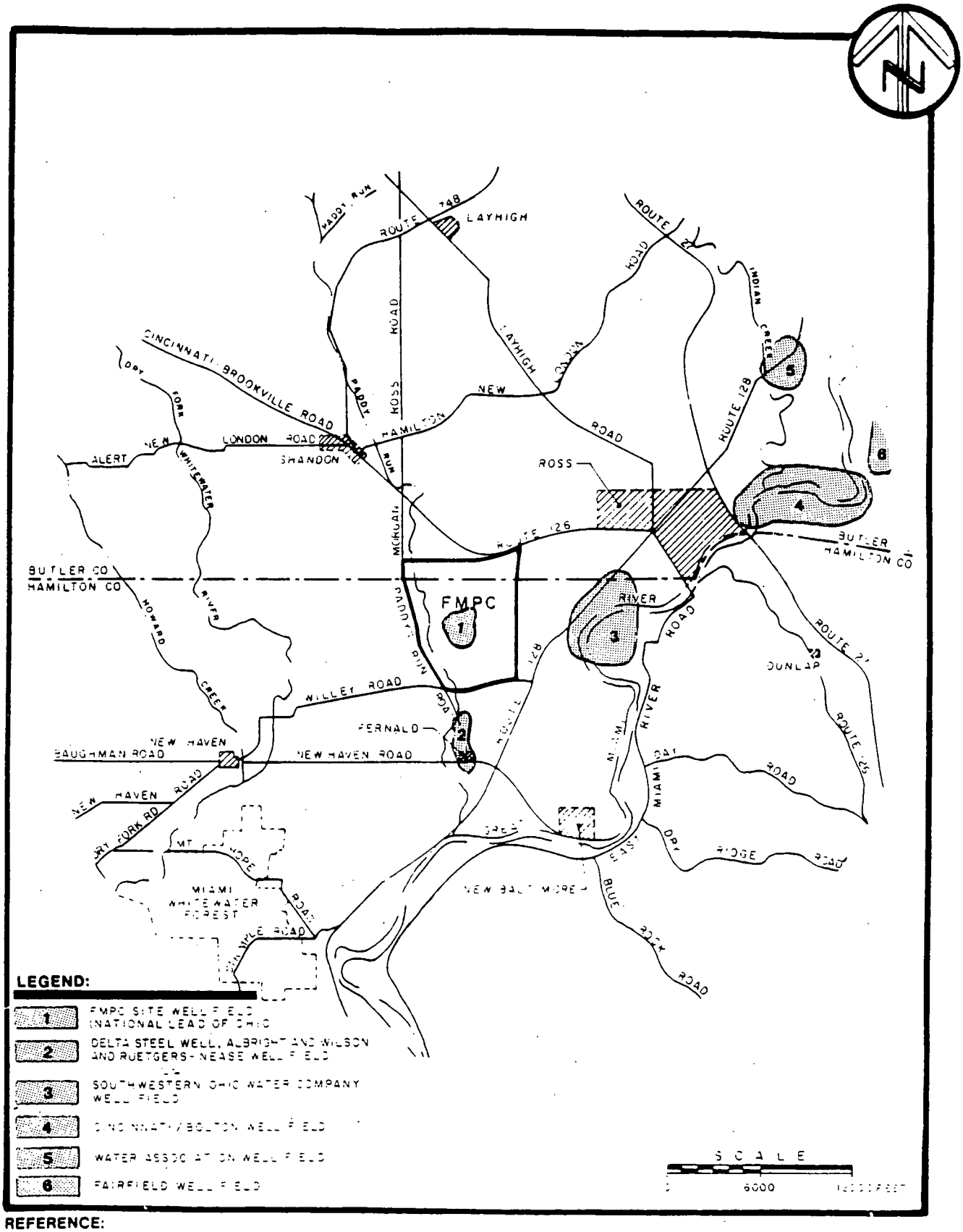

REFERENCE:
I.T. CORP., 1984

FIGURE 2.11
MAJOR GROUND WATER PUMPING AREAS

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TABLE 2.1

MAJOR GROUND WATER PUMPING CENTERS

NAME OF WATER USER	NO. OF TYPE OF WATER SUPPLY	PEOPLE SERVED	AVERAGE WATER USAGE (MDG)[a]
Potable Water			
1. Cincinnati Bolton Plant	Municipal	760,000(b)	15.1
2. Fairfield	Municipal	33,000	1.72(c)
3. National Lead	Noncommunity	800	0.42
4. Water Association	Public	22,000	1.73
Nonpotable Water			
5. Southwestern Ohio Water Company	Industrial	13 Industries	17.38
6. Delta Steel	Industrial	1 factory	Undetermined
7. Albright & Wilson Chemical Co.	Industrial	1 plant	~0.14(d)
8. Ruetgers-Nease Chemical Company	Industrial	1 plant	~0.1(d)

[a]Million gallons per day.

[b]Includes people served from Ohio River water plant (approximately 90 percent).

[c]Well field is only partially in the study area.

[d]Information obtained by IT.

Reference:

1985, The Water Conservation Subdistrict of the Miami Conservancy District, Hydrologic Data for the Hamilton New Baltimore Area 1984.

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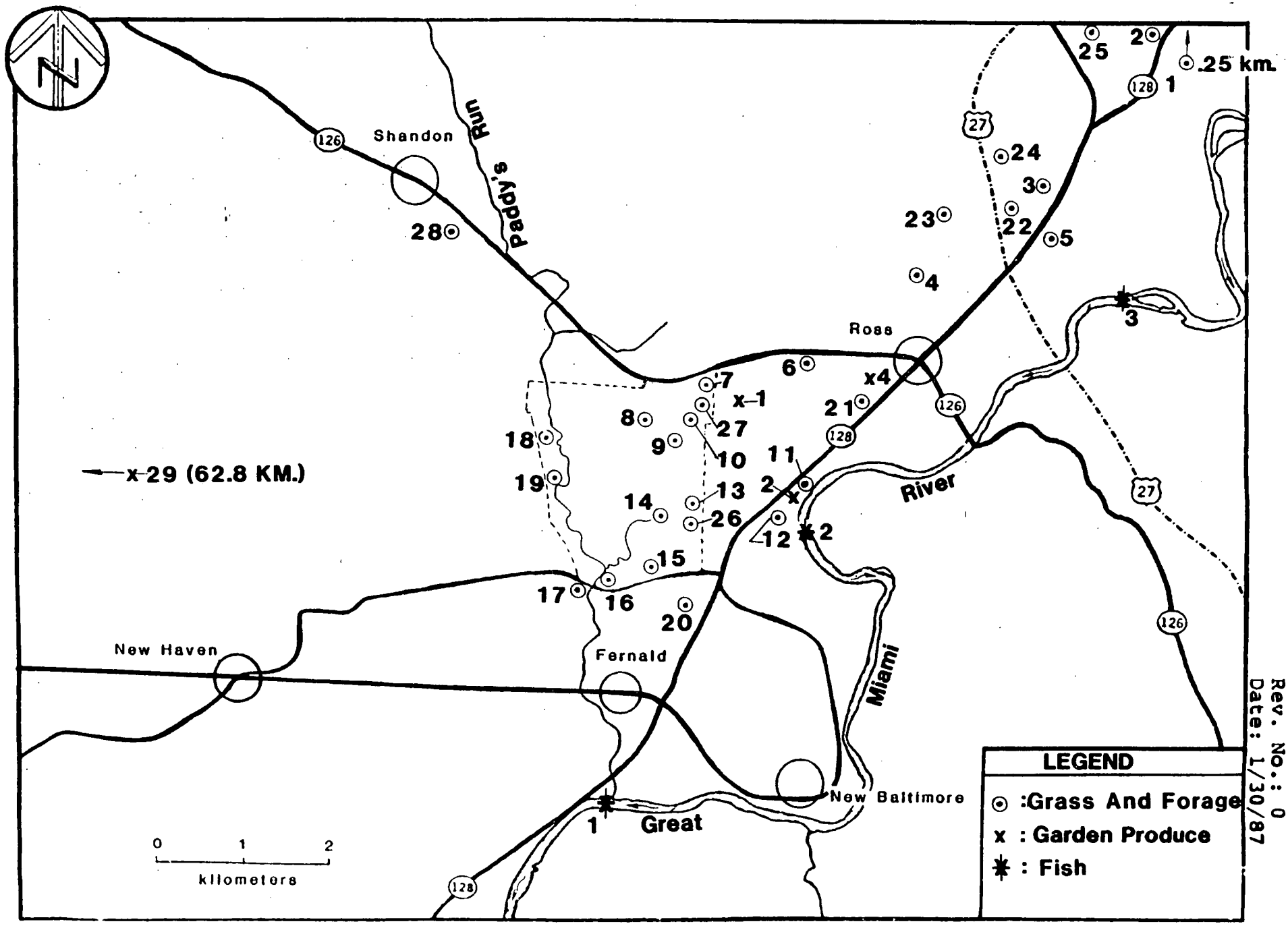

FIGURE 2.12
BIOLOGICAL SAMPLING LOCATIONS

Rev. No.: 0
Date: 1/30/87

ash (Fraxinus americana), sugar maple (Acer saccharum), Sycamore (Platanus occidentalis), and cottonwood (Populus deltoides) becoming more common near Paddy's Run (Burt, 1986). Common understory trees observed were elm and boxelder (Acer negundo). The ground cover was dense, dominated by herbs with scattered clumps of grass. Much of the woodland is undisturbed. Grazed woodland and a large old field habitat occur north of the Production Area. The old field is typically open with clumps of shrubs and small woodland plots interspersed throughout.

Aquatic vegetation occurs principally along drainage ditches near the railroad tracks, and at the western edge of waste pit 3 (Burt, 1986). Common wetland species include sedges (Carex spp.), rushes (Juncus spp.), and cattail (Typha spp.). Two small ponds and scattered wet meadows were also observed during brief field surveys in April 1986 (Burt, 1986). The location, extent and species composition of all wetlands and ponds on the FMPC is not known.

2.2.8.2 Fauna

Few reptile and amphibian species have been recorded on the site. The eastern box turtle (Terrapene carolina) and eastern garter snake (Thamnophis sirtalis) were observed with sign of the snapping turle (Chelydra serpentina) noted along Paddy's Run (Burt, 1986). Frogs of undetermined species were reported from two small ponds. Additional species of reptiles and amphibians are very likely to occur on the FMPC.

Fifty-seven species of birds have been observed (Battelle, 1977; Burt, 1986). Common nesting species in the open pasture were the eastern meadowlark (Sturnella magna), red-winged blackbird (Agelaius phoeniceus), and mourning dove (Zenaida macroura). Common species recorded from the woods were the blue jay (Cyanocitta migratorius), and tufted titmouse (Parus bicolor). Common species in the shrubby fields were the song sparrow (Melospiza melodia), common yellow throat (Geothlypsis trichas) and red-winged blackbird. Breeding bird populations were censused during the summer of 1986.

A total of 41 species of mammals have ranges in the area of Ohio that includes the FMPC (Gottschang, 1981). The common species observed include the white-tailed deer (Odocoileus virginianus), eastern cottontail (Sylvilagus floridanus), fox squirrel (Sciurus niger), eastern chipmunk (Tamias striatus), woodchuck (Marmota monax), and racoon (Procyon lotor). An additional six species have also been observed on the FMPC (Battelle, 1977).

Estimates of deer, rabbit and squirrel populations were made during the 1986 summer field surveys. A trapping system for small mammals was designed; and results for the summer season were obtained in 1986, however, they are not available for this report.

Hunting is not allowed on the FMPC; however, commonly observed and recorded game species include the white-tailed deer, fox squirrel, eastern cottontail, and bobwhite quail (Dolinus virginianus). Scattered waterfowl and woodcock (Philohela minor) were also observed. Deer have larger home ranges that would be expected to extend into the off-site adjacent lands. These animals would be subject to hunting pressure while outside the FMPC. The bobwhite has a much smaller home range and most of the FMPC nesting population probably remain on site. This species is more mobile during the fall and may be subject to hunting outside the FMPC. The mourning dove, while not a game species in Ohio, does nest on the FMPC and is hunted in some states.

Paddy's Run supports at least 23 species of fish (Bauer, et al., 1978; Battelle, 1977). Fish in Paddy's Run and the Great Miami River have been sampled previously during monitoring studies for uranium uptake (WMCO, 1986). Although some game fish have been sampled in Paddy's Run and the Great Miami River, minnows and darters are the dominant fishes and include the emerald shiner (Notropis atherinoides), spotfin shiner (N. spilopterus), rosefin shiner (N. ardens), and the orangethroat darter (Etheostoma spechabile).

2.3 LAND USE, POPULATION AND TRANSPORTATION

2.3.1 LAND USE

The FMPC is located in Hamilton and Butler Counties, parts of which are urbanized. This area is characterized by residential, commercial, and light industrial development along the Great Miami River and highway corridors. The community of Ross lies at the junction of State Routes 126 and 128 about two miles northeast of the FMPC. Areas immediately surrounding the FMPC, however, are primarily rural in nature, characterized by the predominance of agriculture, with some light industry and scattered residences.

Nearby agriculture consists primarily of dairy and beef cattle, and corn and soy bean production. There are three dairy operations within two miles of the FMPC; Knollman, Summe, and Frankenstein. Dairy cattle and beef cattle have grazed for a number of years on land within the confines of the FMPC (Figure 2.13). Truck crops are grown for sale at local produce stands and in nearby communities.

The average farm size for these counties varies from 107 to 147 acres. Since 1975, the average farm size has increased although the total land in farm use has decreased (Priest, 1986). The rural nature of the area has attracted many people who work in metropolitan Cincinnati, but prefer a rural residence on 1 to 2 acres as well as those who maintain "hobby farms of 5 to 10 acres (Bartels, 1986). Land ownership immediately adjacent to the FMPC is presented in Figure 2.14 and Table 2-2.

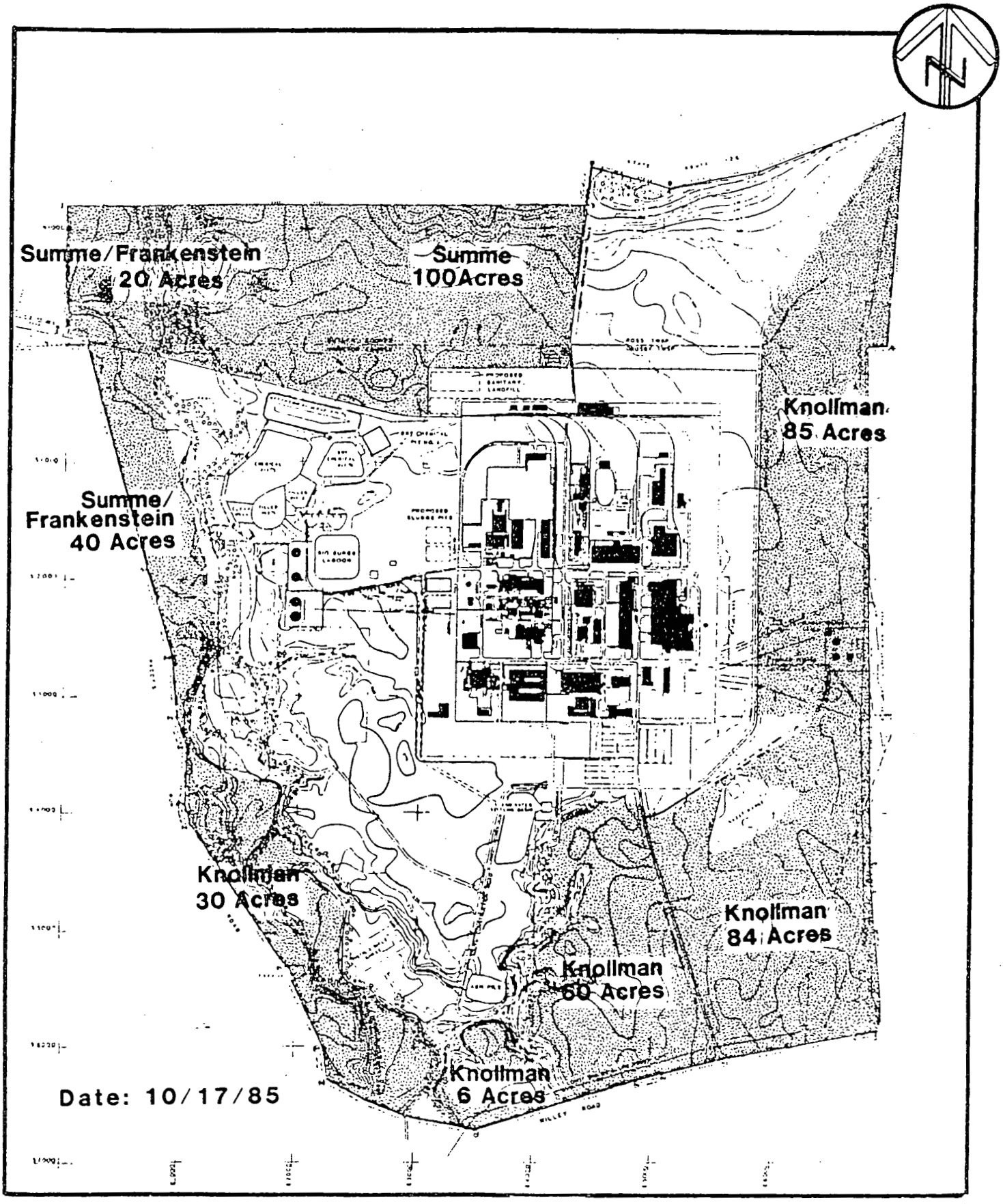

FIGURE 2.13
GRAZING AREAS ON EMPC PROPERTY

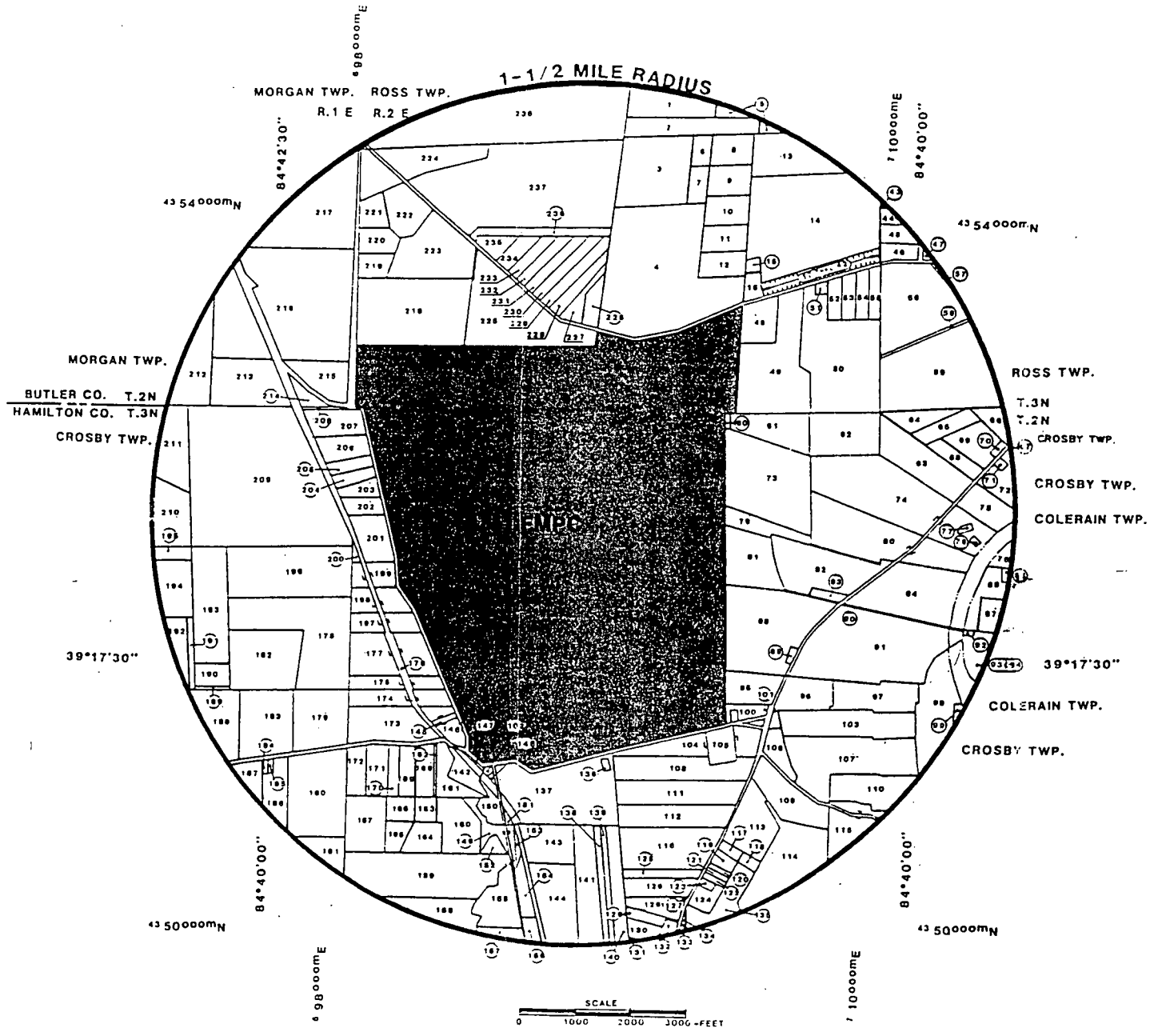

FIGURE 2.14
LAND OWNERSHIP ADJACENT TO THE FMPC

TABLE 2.2
LANDOWNERS IN THE VICINITY OF THE FMPC (1.5 mi. radius)

PARCEL	LAST NAME	FIRST NAME	OWNER NO.
154	Albright & Wilson, Inc.		1
156	Albright & Wilson, Inc.		1
2	Allen	Charles Alvin & Pauline E.	2
5	Allen	Mary K.	3
79	Anglin	John & Sarah	4
115	Atherton	Ralph	5
168	Bernecker	Wm. J. & Marsha A.	6
9	Bill Burkhart, Inc.		7
1	Boehringer	Raymond H. & Audrey L.	8
106	Boyle	Edith et al.	9
113	Boyle	Edith et al.	9
114	Boyle	Edith et al.	9
11	Brater	Henrieta A.	10
32	Brinker	Richard W. Jr. & Diane	11
126	Brockhaus	Stanley A.	12
10	Brown	Richard et al.	13
57	Burwinkle	Leo W.	14
228	Burwinkle	Norbert L. & Anna Marie	15
235	Burwinkle	Norbert L. & Anna Marie	15
62	Burwinkle	Norbert L. & Anna Marie	15
185	Buskirk	Everett W. Jr. & Mary M.	16
186	Buskirk	Matilda	17
208	Butterfield	Curtis B. et al.	18
209	Butterfield	Curtis B. et al.	18
213	Butterfield	Curtis B. et al.	18
215	Butterfield	Curtis B. et al.	18
21	Calhoun	Ronald W. & Sharon L.	19
117	Calvary Baptist Temple of New Baltimore, Inc.		20
118	Calvary Baptist Temple of New Baltimore, Inc.		20
131	Century Farms, Inc.		21
167	Century Farms, Inc.		21
180	Century Farms, Inc.		21
181	Century Farms, Inc.		21
144	Chesapeake Realty Dev. Corp.		22
153	Chesapeake Realty Dev. Corp.		22
155	Chesapeake Realty Dev. Corp.		22
105	Cincinnati Gas & Electric Co.		23
35	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
36	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
37	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
38	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
39	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
40	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
41	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
42	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
230	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
231	Cin. & Ham. Cos. Council Girl Scouts Inc.		24
216	Clawson	Dorothy	25

TABLE 2.2 (continued)

LANDOWNERS IN THE VICINITY OF THE FMPC (1.5 mi. radius)

PARCEL	LAST NAME	FIRST NAME	OWNER NO.
112	Colegate	Milton A.	26
184	Cone	Kenneth W.	27
60	Cone	Wm.	28
169	Cook	Shirley L.	29
225	Courtney	Wanda Lou et al.	30
29	Crain	Harris F. & Opal	31
176	C & O Railroad		32
127	Denier	Howard H. & Zelma T.	33
128	Denier	Howard H. & Zelma T.	33
226	Denney	James Austin & Reva Marie	34
214	DOE/USA		35
224	DOE/USA		35
143	Dooley	Richard E. et al.	36
13	Elliot	Emerson M. et al.	37
52	Engel	James J. & Shirley J.	38
49	Ernst	Donald M. & Lynda L.	39
223	Eschenbrenner	Clayton et al.	40
7	Eschenbrenner	Elma	41
102	Estes	Elizabeth A.	42
147	Estes	Verdie	43
120	Etson	Robert M. & Marian F.	44
121	Etson	Robert M. & Marian F.	44
122	Etson	Robert M. & Marian F.	44
134	Etson	Robert M. & Marian F.	44
146	Farmer	Iona L.	45
19	Fleek	Arnold R. & Carole M.	46
53	Fondong	William H. & Rose F.	47
170	Foxx	Robt & Florence Earnshaw	48
171	Foxx	Robt & Florence Earnshaw	48
217	Francis, John D. & First National Bank of SWOH		49
202	Frankenstein	William	50
203	Frankenstein	William	50
145	Gieringer	Donald Lee	51
163	Gieringer	Donald Lee	51
81	Gieringer	Bernice C. et al.	52
232	Grabel	Ronald C.	53
193	Gray	Geo. W.	54
194	Gray	Geo. W.	54
195	Gray	Geo. W.	54
210	Gray	Geo. W.	54
33	Hafner	Jerome R. & Karen	55
14	Handy	Walker & Florence E.	56
138	Harrison Poured Foundations, Inc.		57
139	Harrison Poured Foundations, Inc.		57
140	Harrison Poured Foundations, Inc.		57
238	Hartkemeyer	Robert & Cynthia Sue	58
220	Hengehold	Fred J. & Dan J.	59
44	Henkel	Otto F. & Jean C.	60
158	Heyob	Miriam	61
30	Hildenbrand	John A.	62
54	Hoffman	Dorothy G. & G. Stephen	63

TABLE 2.2 (continued)
LANDOWNERS IN THE VICINITY OF THE FMPC (1.5 mi. radius)

PARCEL	LAST NAME	FIRST NAME	OWNER NO.
27	Honican	Zella Mae	64
12	Horton	James R. & Donna L.	65
47	Huebner	David J. & Dorothy	66
236	Hughes	Jerome O.	67
129	Jackson	Ralph E. & Susan A.	68
71	Jacobs	Herbert & Norma	69
160	Key Punch Service, Inc.		70
162	Key Punch Service, Inc.		70
164	Key Punch Service, Inc.		70
165	Key Punch Service, Inc.		70
166	Key Punch Service, Inc.		70
133	Kiefer	James C. & Janice M.	71
63	Kissel	Ralph F. & Olga A.	72
65	Kissel	Ralph F. & Olga A.	72
109	Klekamp	Harry G.	73
101	Knollman	Wm. H.	74
136	Knollman	Melvin R. & Margaret J.	75
100	Knollman	Norma & Carol	76
103	Knollman Farm, Inc.		77
104	Knollman Farm, Inc.		77
107	Knollman Farm, Inc.		77
108	Knollman Farm, Inc.		77
110	Knollman Farm, Inc.		77
111	Knollman Farm, Inc.		77
137	Knollman Farm, Inc.		77
148	Knollman Farm, Inc.		77
88	Knollman Farm, Inc.		77
89	Knollman Farm, Inc.		77
90	Knollman Farm, Inc.		77
91	Knollman Farm, Inc.		77
95	Knollman Farm, Inc.		77
96	Knollman Farm, Inc.		77
97	Knollman Farm, Inc.		77
98	Knollman Farm, Inc.		77
99	Knollman Farm, Inc.		77
204	Kohlbrandt	Harry	78
93	Kreuzmann	Barbara M. et al.	79
94	Kreuzmann	Barbara M. et al.	79
34	Laswell	Kenneth E. & Joyce E.	80
142	Lienesch	Frank K.	81
161	Lienesch	Frank K. & Michael E.	82
227	Lindsey	George F. & Adda May	83
233	Lindsey	George F. & Adda May	83
26	Madden	Frank A.	84
20	Marcum	Frank & Betty	85
22	Maxey	Jacob C. & Ocie V.	86
18	McConnell	Jackie D. & Carol J.	87
61	Menges	Cecilia	88
73	Menges	Cecilia	88
234	Menges	Cecilia	88
28	Morse	Stephen F. & Elizabeth M.	89

TABLE 2.2 (continued)
LANDOWNERS IN THE VICINITY OF THE FMPC (1.5 mi. radius)

PARCEL	LAST NAME	FIRST NAME	OWNER NO.
58	Nieman	Anthony J. & Dorothy J.	90
59	Nieman	Anthony J. & Dorothy J.	90
174	Otte Bros., Inc.		91
25	Papet	Lloyd Earl & Beverly Beth	92
48	Pilarczyk	Daniel E. Archbishop Tr.	93
55	Pilarczyk	Daniel E. Archbishop Tr.	93
219	Prewitt	Lloyd	94
229	Prewitt	Lloyd	94
83	Rack	Franklin & Irene	95
116	Ratterman	Thos. J. & Carolyn M.	96
78	Reinke	Jacob H. et al.	97
86	Reinke	Jacob H. et al.	97
69	Renck	Reda K.	98
68	Renck	Rhos. E. & Joyce M.	99
17	Reynolds	Randall L. & Kathy A.	100
173	Rowe	Stanley M. Jr. & Snowden Tr.	101
175	Rowe	Stanley M. Jr. & Snowden Tr.	101
177	Rowe	Stanley M. Jr. & Snowden Tr.	101
178	Rowe	Stanley M. Jr. & Snowden Tr.	101
179	Rowe	Stanley M. Jr. & Snowden Tr.	101
182	Rowe	Stanley M. Jr. & Snowden Tr.	101
183	Rowe	Stanley M. Jr. & Snowden Tr.	101
187	Rowe	Stanley M. Jr. & Snowden Tr.	101
188	Rowe	Stanley M. Jr. & Snowden Tr.	101
189	Rowe	Stanley M. Jr. & Snowden Tr.	101
190	Rowe	Stanley M. Jr. & Snowden Tr.	101
149	Roy	Clarence	102
150	Roy	Agnes	103
151	Roy	Agnes	103
157	R. L. Industries, Inc.		104
207	Schaefer	Franklin G. & Christina K.	105
172	Schiermeir	Wilma B.	106
80	Schmocher	Jos. J. & Dorothy B.	107
125	Schneider	Richard A. & Cynthia J. et al.	108
152	Schneider	Thos. E. & Gertrude N.	109
159	Schneider	Thos. E. & Gertrude N.	109
50	Schradin	John H. & Virginia L.	110
51	Schradin	John H. & Virginia L.	110
16	Schuler	Carroll	111
24	Siekerman	Daniel Gay	112
8	Southwestern Ohio Water Co.		113
67	Southwestern Ohio Water Co.		113
72	Southwestern Ohio Water Co.		113
74	Southwestern Ohio Water Co.		113
75	Southwestern Ohio Water Co.		113
76	Southwestern Ohio Water Co.		113
77	Southwestern Ohio Water Co.		113
85	Southwestern Ohio Water Co.		113
87	Southwestern Ohio Water Co.		113
92	Southwestern Ohio Water Co.		113
84	Stricker	Ralph J. & Nancy	114

TABLE 2.2 (continued)
LANDOWNERS IN THE VICINITY OF THE FMPC (1.5 mi. radius)

PARCEL	LAST NAME	FIRST NAME	OWNER NO.
31	Sunderhaus	Michael A. & Tina K.	115
23	Tarter	Gary D. & Cheryel K.	116
205	Theobald	D. Wayne Jr. & Kim C.	117
206	Theobald	D. Wayne Jr. & Kim C.	117
3	Turner	James R. & Doris W.	118
6	Turner	James R. & Doris W.	118
64	Turner	James R. & Doris W.	118
66	Turner	James R. & Doris W.	118
4	Venice Cemetary Association		119
237	Walther	Joy Elaine	120
222	Walther	Joy Elaine	120
119	Weber	Earl J. Jr. & Margaret T.	121
141	Weber	Earl J. Jr. & Margaret T.	121
82	Welch Sand & Gravel Inc.		122
191	West Homes, Inc.		123
192	West Homes, Inc.		123
196	West Homes, Inc.		123
197	West Homes, Inc.		123
198	West Homes, Inc.		123
199	West Homes, Inc.		123
200	West Homes, Inc.		123
201	West Homes, Inc.		123
211	West Homes, Inc.		123
212	West Homes, Inc.		123
130	Wiesman	Russell & Dorothy	124
132	Wiesman	Russell & Dorothy	124
56	Wright	Ella	125
43	Wurzelbacher	Kenneth J. & Carol A.	126
70	Yolle	Rose A.	127
218	Young	Emily Belle	128
221	Young	Emily Belle	128
45	Young	David M. & Barbara F.	129
46	Young	Jack R. & Edna P.	130
123	Zimmer	Earl Edw. & Marie G.	131
124	Zimmer	Earl Edw. & Marie G.	131
135	Zimmer	Earl Edw. & Marie G.	131
15	Zwissler	Phillip F.	132

Other local land uses include gravel operations along the Great Miami River, industrial facilities (e.g., Delta Steel and a phosphate plant), parks, and primary and secondary transportation corridors. Two commerical gravel extraction operations are located one mile east and two miles southeast of the FMPC, respectively.

Three parks that are used primarily during the summer lie in the vicinity of the FMPC. Camp Ross Trails (1.5 miles northeast) and Camp Fort Scott (2.0 miles southeast) are youth camps operated by the Girl Scouts of America, and the Roman Catholic Archdiocese of Cincinnati, respectively.

The Miami Whitewater Forest, located 5.0 miles southwest of the FMPC, is one of the largest parks in Hamilton County. Approximately 20 percent of the 2,261-acre park is available or may be developed for public use (e.g., golfing, paddle boats). The remainder is dedicated as a wildlife sanctuary (Welsh, 1986). Land use in Butler County is guided by the County Land Use Plan which was adopted in 1983-1984. Morgan Township adjacent to the FMPC within Butler County has zoning ordinances and relies on the County plan to control land uses. Ross Township (containing approximately 200 acres of the 1050 acre FMPC) zones by class, i.e., residential and agricultural (Kosobut, 1986). The area north of the FMPC and south of State Route 126 is zoned for agricultural use (Thiem, 1986).

Hamilton County does not have a county plan; individual townships or municipalities may have their own zoning ordinances (Brienza, 1986). The majority of the FMPC is within Crosby Township which controls land use through zoning. Land immediately south of the FMPC is zoned industrial, and to the east is zoned agricultural. The FMPC existed prior to township zoning and is thus exempted from zoning ordinances (Strunk, 1986).

There are no hospitals or retirement homes within five miles of the FMPC; the closest facilities are located in the cities of Hamilton and Cincinnati which are 10 and 20 miles from the FMPC, respectively. The nearest schools are located in Ross and the Crosby Township School on New Haven Road, both approximately two miles from the FMPC.

2.3.2 POPULATION

Within 50 miles of the FMPC, There is a population of approximately 2,577,000. Hamilton County has a population of about 864,000 and Butler County a population of about 275,000 people (NLO, 1985a).

Most populated areas in the vicinity of the FMPC are unincorporated small towns varying from an estimated population of 30 at Fernald to 3,000 at Ross. Table 2.3 identifies population by sector within a five-mile radius of the FMPC. Table 2.4 shows the population for the towns within this radius.

TABLE 2.3

POPULATION ESTIMATES BY SECTOR
WITHIN A FIVE-MILE RADIUS
OF THE FMPC

Miles From FMPC	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	DISTANCE TOTALS
0-1	13	3	6	3	0	6	6	0	10	16	6	3	0	3	0	13	= 88
1-2	13	10	323	134	19	3	493	13	38	42	48	6	10	10	22	29	= 1,213
2-3	102	90	58	2224	26	118	176	358	58	134	54	38	16	19	294	86	= 3,851
3-4	45	54	61	112	243	218	214	262	192	118	58	669	192	61	102	141	= 2,742
4-5	272	64	41	16	224	368	717	352	371	80	19	224	301	64	93	250	= 3,456
Total	445	221	489	2489	512	713	1606	985	669	390	185	940	519	157	511	519	11,350

Ref: Dames and Moore, n.d.

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TABLE 2.4

POPULATION CENTERS WITHIN A
FIVE-MILE RADIUS OF THE FMPC

POPULATION CENTER	APPROXIMATE DISTANCE	ESTIMATED POPULATION
Fernald	1.75	30
Shandon	2.0	200
Venice (Ross)	2.5	3,000
New Baltimore	2.75	200
New Haven	3.0	200
Dunlap	4.0	100
Harrison	5.0	4,408
Total		8,138

Ref. - NLO, 1977

WMCO employs 1,620 people. About 80 percent of this total work the 8:00 a.m. to 4:30 p.m. shift on weekdays. On weekends, this workforce population is reduced to about 175.

2.3.3 TRANSPORTATION

The regional transportation network is highly developed and is characterized by high-speed, high-capacity interstates (e.g., I-74), and heavy-duty state and county roads. The roads nearby include light-duty secondary roads (e.g., Paddy's Run Road) and medium- and heavy-duty State Routes 126 and 128, respectively. Willey Road is classified as medium-duty. Table 2.5 provides the most recent average daily traffic (ADT) counts for roads near the FMPC (Smith, 1986).

TABLE 2.5

AVERAGE DAILY TRAFFIC

LOCATION	PASSENGER	COMMERCIAL
Intersection routes 126 and 128	6,560	210
Route 128 between Venice and Hamilton County line	4,470	560
Intersection route 128 and Willey Road	4,470	560
Route 128 between Willey Road and New Haven Road	3,570	560
Route 748 at Shandon to Morgan Ross Road	3,260	130

Ref. Smith, 1986

[a]Butler County, 1985; Hamilton County, 1984.

SECTION 3.0

THE FEED MATERIALS PRODUCTION CENTER

3.0 THE FEED MATERIALS PRODUCTION CENTER

3.1 BRIEF HISTORY AND GENERAL DESCRIPTION

The FMPC was constructed and began operations at the Fernald site (Figure 3.1) in the early 1950s. The United States Atomic Energy Commission (AEC), predecessor to the DOE, established this integrated production complex for processing uranium and its compounds from natural uranium ore concentrates for U.S. government needs. Initially, uranium ore concentrates, and, presently, recycled materials, are converted to either uranium oxides or uranium ingots and billets. They are machined or extruded into tubular form for production reactor fuel cores and target fuel element fabrication.

In 1951, NLO, Inc. (formerly National Lead Company of Ohio), entered into contract with the DOE as Operations and Maintenance (O&M) Contractor until January 1, 1986, when the Westinghouse Materials Company of Ohio (WMCO), a wholly-owned subsidiary of Westinghouse Electric Corporation, began contract responsibilities for O&M of the site operations and facilities for a five-year period.

The Pilot Plant was completed in 1951 and was the first operational facility at the FMPC. Following completion of the Pilot Plant, the Metals Fabrication Plant (Plant 6) started up in 1952; the Metals Production Plant (Plant 5), Green Salt Plant (Plant 4), Recovery Plant (Plant 8), Sampling Plant (Plant 1), and Refinery (Plants 2 and 3) began operations in 1953. The Hex Plant (Plant 7) and Special Products Plant were operational in 1954.

All plants except Plants 1, 2, and 3 were expanded during the period from 1954 to 1956 for approximately $60 million. Metal products peaked in 1960 at approximately 10,000 metric tons uranium (MTU) per year. A product decline began in 1964 to a low in 1975 of about 1,230 MTU. During the 1970s, consideration was given to closing the FMPC; therefore, capital improvements and staffing were minimized. In FY 1983 dollars, the average annual operating and capital funds authorized from 1972 through 1979 declined from $27.5 million to $0.7 million. The staffing level, which peaked at 2,891 in 1956, slowly declined over the same period from 662 in 1972 to 538 in 1979. In FY 1981, the FMPC began planning to accommodate increased product requirements. Significantly increased production levels, rapid staff buildup in many areas, and implementation of a major facilities restoration program followed.

From 1953 through 1955, the FMPC refinery processed pitchblende ore from the Belgian Congo. No chemical separation or purification was performed on the ore prior to arrival at the FMPC. Beginning in 1956, the refinery feed consisted of uranium concentrates (yellowcake) from Canada and the United States. The

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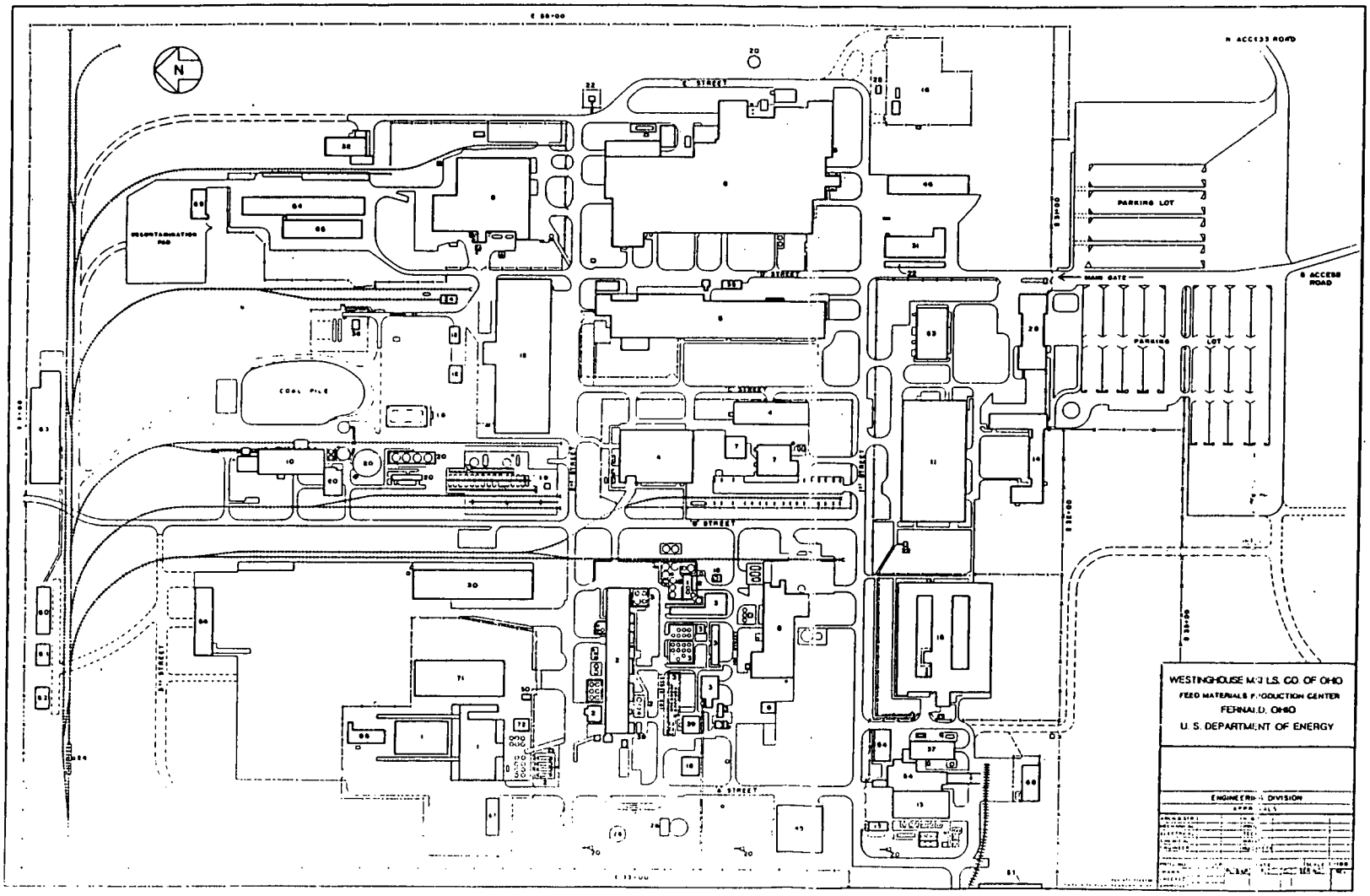
Rev. No.: 0
Date: January 30, 1987



AREA CODE NUMBER	TITLE
00	General
1	Preparation Plant
	Silo Storage (South of Sampling Plant)
2	Ore Refinery Plant
3	Nitric Acid Recovery Plant
4	Green Salt Plant
5	Metals Production Plant
6	Metals Fabricating Plant
7	Building 7
8	Recovery Plant
9	Special Products Plant
10	Boiler Plant
11	Service Building
12	Mechanical Shop & Storeroom
13	Pilot Plant (Wet End)
14	Administration Building
15	Laboratories
16	Main Electric Sub-Station
17	General Area
	Paved Areas (See 74)
18	Water Pollution Control
	Chemical Feed Building
	General Sump
	Biodenitrification Towers
	Surge Lagoon
	Storm Water Retention Basin
19	Metal Tank Farm
20	Water Supply System
	Cooling Tower
	Cooling Tower Pump House
	Elevated Storage Tank - East
	Treated Water Storage Tank
	Chlorine Building (For Water Treatment Area)
	Water Wells
	Reactivator
21	Roads, Sidewalks, Fences, Pits, Etc.
22	Interplant Service & Product Lines
	Gas Meter House
	Lift Station
	Pipe Trestle
	Truck Scale
23	Communication & Alarm System
24	Railroad System
25	Sanitary Sewer System
	Sewage Disposal
	Imhoff Tanks
	Sludge Beds
26	Fire Protection System
	Elevated Water Tower - West
27	Mobile Equipment (Also See 47)
28	Security System - Guard House
30	Chemical Warehouse
31	Engine House - Garage
32	Magnesium Storage
34	K-65 Storage Area
35	Metal Oxide Storage Area
37	Pilot Plant Annex (Dry)
38	Propane Storage
39	Incinerator Plant
40	Waste Management - Solids
44	Temporary Structures (Trailers)
45	Building 45
46	Heavy Equipment Garage
47	Mobile Equipment (Also 27)
51	UF_6 to UF, Reduction Facility II
53	Health, Safety & Production Control Building
54	UF_6 to UF, Reduction Facility I
55	Slag Recycling Plant - East
56	CP Storage Warehouse
60	Quonset Number 1
61	Quonset Number 2
62	Quonset Number 3
63	KC-2 Warehouse
64	Plant 9 Warehouse
65	Plant 5 Warehouse
66	Drum Reconditioning Building
67	Plant 1 Storage Building (No. 1 & No. 2)
68	Pilot Plant Warehouse
69	Decontamination Building
71	General In-Process Storage Warehouse
73	Fire Brigade Training Center
74	Paved Area Storage
75	Site Preparation, Parking Lots

FIGURE 3.1
FMPC PRODUCTION AND ADMINISTRATIVE AREA

58

9

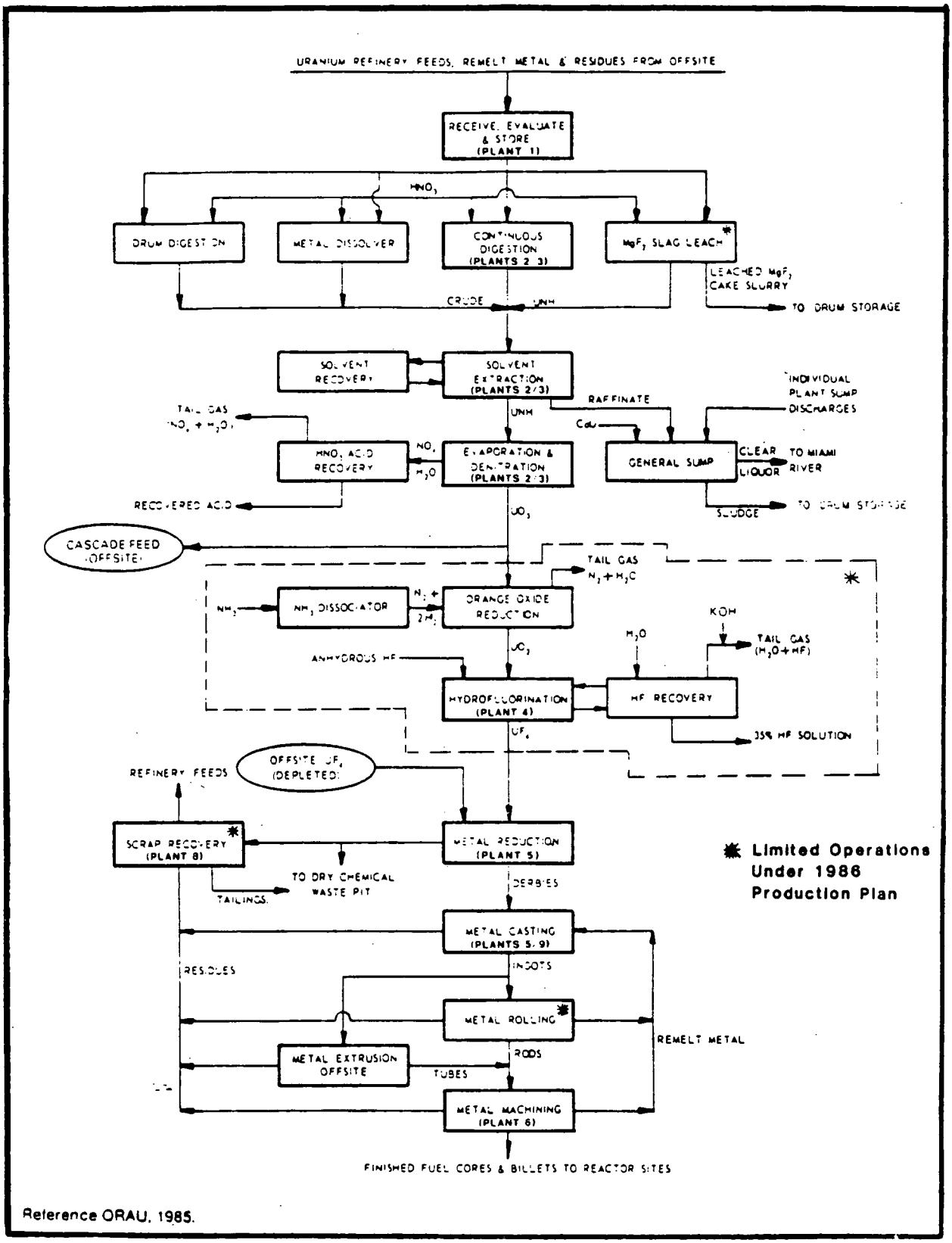
Canadian yellowcake contained higher levels of thorium than the yellowcake from U.S. sources. Canadian concentrates were not processed after 1960.

Pitchblende ore contained all daughter products of the uranium decay chains. In the production of yellowcake most of the uranium daughters have been removed. Radium-226 (Ra-226), a daughter product, remains in the yellowcake in amounts that vary with the process: resin-in-pulp extraction or sulfuric acid leach methods have one-tenth or less Ra-226 than does yellowcake prepared by the carbonate leach process.

Small amounts of thorium were produced at the FMPC on several occasions from 1954 through 1975. Thorium operations were performed in the Metals Fabrication Plant, Recovery Plant, Special Projects Plant, and the Pilot Plant. The FMPC presently serves as the thorium repository for the DOE, maintaining long-term storage facilities for a variety of thorium materials.

No uranium ore is currently being received at the FMPC. The basic process currently performed is the conversion of uranium-containing residues, uranium hexafluoride, and uranium tetrafluoride to uranium metal (Figure 3.2). Uranium received at the FMPC has been through one or more chemical separations at other sites. These separations remove most of the daughter products and formation of new daughters is limited by the long half-life of uranium and the short time span. Most of the production stream metal is cast into ingots for extrusion into tubes on the DOE extrusion press facilities, located at the Reactive Metals, Incorporated facility (RMI), at Ashtabula, Ohio. Some of the extrusions are returned to the FMPC where tube blanks are fabricated into target element cores for DOE reactors. Other extruded material is further processed into fuel billets at RMI. Both fuel cores and target elements are used in government reactors for the production of plutonium.

A variety of chemical and metallurgical processes are utilized at the FMPC for the manufacture of uranium products. During the process of manufacture, other nonuranium chemicals and compounds are utilized. High quality uranium compounds are introduced into the FMPC processes at several points. Impure starting materials are dissolved in nitric acid, the uranium is removed through solvent extraction to yield a solution of uranyl nitrate. Evaporation and heating convert the nitrate solution to uranium trioxide (UO_3) powder. This compound is reduced to uranium dioxide (UO_2) with hydrogen and then converted to uranium tetrafluoride (UF_4) by reaction with anhydrous hydrogen fluoride. Uranium metal is produced by reacting UF_4 and magnesium metal in a refractory-lined reduction vessel. This primary uranium metal is then remelted with scrap uranium metal to yield a purified uranium ingot which is shipped off site for extrusion.



Reference ORAU, 1985.

FIGURE 3.2
SCHEMATIC DIAGRAM OF THE FMPC PROCESS

Enriched (U-235 content increased above 0.71 percent by weight) ingots are extruded into billets and shipped off site; while depleted ingots are extruded into long tubes, sectioned, and machined to final dimensions ("cores") and shipped off site.

Solid waste materials associated with uranium metals production are presently stored on the Plant 1 Pad in steel drums awaiting further processing or off site disposal at approved facilities. These wastes include oils, sludges, contaminated combustibles, filter cake, off spec UF_4 or ThF_4, reject UO_3, etc. The drums sit on an uncontained pad and are inspected on a weekly basis. Contents of deteriorated drums are repackaged. Other waste materials, stored in drums on contained surfaces, include spent degreasing solvents (Pilot Plant Warehouse) and PCB-contaminated material (KC-2 Warehouse).

Large quantities of liquid and solid wastes are generated by operations at the FMPC. Liquid waste streams are treated and discharged in compliance with the terms and conditions of an NPDES permit.

The Waste Storage Area (see Figure 3.3) includes six low-level radioactive waste storage pits, two earthen-bermed concrete silos containing K-65 residues (high specific activity, low-level radium-bearing residues resulting from the pitchblende refining process), one concrete silo containing metal oxides, two lime sludge ponds, a sanitary landfill and all affected adjoining areas. This also includes two fly ash piles, located approximately 3,000 feet SSW of the Waste Storage Area, as well as the burn pit which was situated between Pits 3 and 4. Since 1985, no solid waste materials have been disposed of in the Waste Storage Area.

The following paragraphs provide a more complete discussion of the various processes and operations at the FMPC. Table 3.1 lists the major waste streams generated at the FMPC. Also listed are the specific sources of the stream and the average generation rate.

3.2 CHEMICAL PROCESSING PLANTS

3.2.1 SAMPLING PLANT - PLANT 1

The Sampling Plant with a ground floor area of 22,040 square feet, was completed in 1953. The principal capabilities of the Sampling Plant are to:

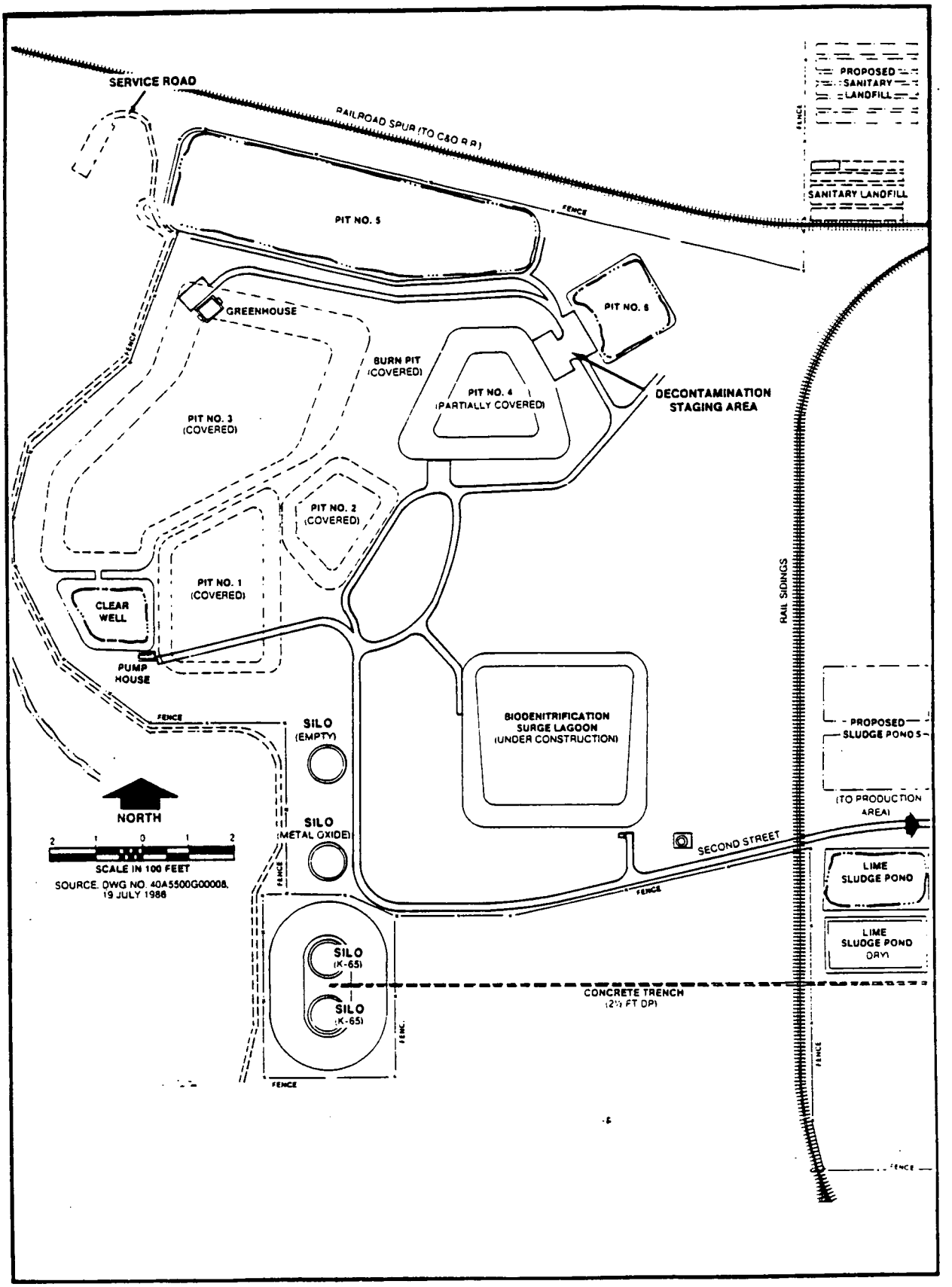


FIGURE 3.3
FMPC WASTE STORAGE AREA

TABLE 3.1

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
002	Neutralized raffinate from general sump	An acidic mixture of magnesium and aluminum nitrates neutralized to pH 11.9 by the addition of caustic and lime filtered to a damp-dry sludge.	2,3	620
001	Slag leach cake	Magnesium fluoride from the reduction operation, acid leached to remove uranium, neutralized with lime, filtered and washed	All Plants	1300
030	Magnesium oxide and magnesium zirconate from crucible clean-out	Dry powders resulting from the clean-out of graphite crucibles.	5	12
065	High fluoride scrap salts and floor sweepings	Magnesium fluoride and uranium fluoride spillage, in dry powdered from.	4, 5, 6	200
066	Low fluoride scrap salts and floor sweepings	Mixed salts and some oxide spillage, with little fluoride content, in dry powdered form.	4, 5, 6, 9	3
069	Non-oily, non-halide wet sump filter cake	Salts and uranium oxides filtered out of the floor drainage system (damp-dry).	All Plants	300
082	Off-specification uranium tetrafluoride (UF_4)	Uranium fluoride, a green, dry homogenous, uniform particle powdered salt which does not meet product specifications.	4	40

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
041 042 068	Sludges from RMI	Oily and non-oily sludges from extrusion.	Off-site	90
020	Contaminated oily Hilco cake	Hydrocarbon cutting oil from machining operations, containing uranium oxide, filtered to a deep-dry sludge; could contain some unoxidized uranium metal fines.	5	2
021	Wet magnesium fluoride (MgF_2), drum residues from decontamination	Damp magnesium fluoride from drum washing operations.	8	30
041	Oily sludges containing high free metal	Similar to FMPC 020 above but does contain unoxidized uranium metal.	5, 6, 9	26
042	Non-oily sludges	Damp dry sludges from clean-up and floor drain sources, containing miscellaneous process salts and oxides.	5, 6, 9	2
046	Non-oily sludge, containing high or low metal	Similar to FMPC 042 but containing unoxidized uranium metal.	5, 6, 9	20
055 056	Uranium metal	Massive metal scrap.	5	115

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
062 135	Dust collector residues containing high fluoride	Magnesium and uranium fluorides similar to FMPC 065	5	430
064	Dust collector residues containing high fluoride pyrophoric	Similar to waste number 15, but containing metallic magnesium and/or uranium fines.	5	0.5
132	Dust collector residues-low fluoride	Uranium oxide fines not containing much uranium fluoride.	5	100
107 110	Non-briquettable chips and turnings	Metallic uranium chips and turnings too small to intermesh in the briquetting operation; may be oily.	5, 6, 9	65
057	Wet crushed magnesium fluoride slag from pot blow-outs	Magnesium fluoride (damp) resulting from furnace failure; chunky material less than 1" in size (top failure).	5	2
077	Dry crushed magnesium fluoride slag from pot blow-outs	Same as FMPC 057 but the magnesium fluoride was not wetted by the cooling water system (bottom failure).	5	2
079	Unfired reduction charges and magnesium fluoride from liner cave-ins.	A mixture of powdered magnesium fluoride, magnesium metal pellets, and uranium fluoride.	5	4

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
019	Contaminated magnesium	Magnesium metal pellets separated from the mixture described in MTC 079	5, 32	2
027	Contaminated conbustibles	Paper, wood, cloth, etc. contaminated with uranium.	All Plants	2
025 028	Contaminated non-combustibles	Scrap sheet metal, broken tools, old wire, control instruments, gages, etc. contaminated with uranium.	All Plants	3
029	Dust collector bags	Wool cloth bags lined with the process salts and uranium oxide fines.	All Plants	2
070 071	Rockwell cleanings and spills	Cleanings from an industrial furnace; uranium oxides, broken fire brick, etc.	5	30
084	Bad reduction-no derby formed	The malfunction of a reduction operation; like MTC 079, however, the reaction may have proceeded to produce some uranium metal.	5	1
119	Solid metal with imbedded steel (RMI)	Uranium metal with steel imbedded	Off-site	1

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
129	Dirty prill (+20 mesh) containing high uranium and magnesium fluoride	Steel pellets used in a cleaning method similar to sandblasting, containing uranium oxide and magesium fluoride larger than 20 mesh screen size.	1, 5	25
131	Partially oxidized metals	Massive uranium metal so badly oxidized as to be unfit for recycle in metal fabrication.	5, 6, 9	2
011	Contaminated soil, bricks, etc.	From plant process area spills, leaks, etc.	All Plants	2
044	Sludges, salt, and chloride	Dry sodium and potassium chlorides (soft powdery form) from molten salt baths (bottom portion) contaminated with uranium.	6, 9	30
060	Furnace solidified chloride salt	Same salt material as FMPC 044 but solidified in a drum as one rock-like block; a minimum of sludge and uranium.	6, 9	50
061	Furnace solidified non-chloride salt	Same as FMPC 060 but salt is sodium and lithium carbonate.	9	10
003	Non-recoverable contaminated trash	Same as FMPC 025/028 but from a different plant area.	All Plants	2

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
014	Sample bottles	Empty glass, plastic, and metal sample bottles which have been rinsed; they are still contaminated.	15	5
008 017 024	Contaminated graphite	Graphite (carbon) molds used in uranium melting and casting operations.	All Plants	20
033	Existing incinerator ash (+20 mesh)	Ash resulting from the combustion of plant trash not contaminated with uranium, coarser than 20 mesh screen size.	39	45
032 059	Existing incinerator ash (-20 mesh)	Same as FMPC 033, but finer than 20 mesh.	39	Included with 033
034	Magnesium fluoride slag	Magnesium fluoride salt in chunky form resulting from the reduction operation, contaminated with uranium.	55	4400
219	Waste uranium metal (spills)	Uranium metal dross resulting from melting operations.	55	35
101	Scrap high temperature uranium oxide (U_3O_8)	Uranium (black) oxide too impure for process use.	5	190
013	Dry cleaning sludges	Perchoroethylene from the plant laundry.	11	2

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
015	Contaminated oil	Miscellaneous vacuum pump, lube, and hydraulic pump oils also contains water-soluble cutting oil.	All Plants	1
022	Contaminated TBP/kerosene	The tributylphosphate/kerosene mixture used in the extraction of pure uranyl nitrate from aqueous feed streams.	2, 3	<1
023	Oily MgF_2	Magnesium fluoride which became oily from leaking hydraulic systems.	5	<1
047	Misc. samples non metallic	Laboratory samples of process materials no longer needed (oxides, fluorides, etc.).	15	<1
058	Calcium fluoride	A salt resulting from the neutralization of a leak from an acid tank, using lime; this is a one-time waste stream.	8	4
080 081	Partially oxidized metal with thorium	Oxidized uranium metal containing some thorium. This is a one-time waste stream from the pilot plant.	13, 37, 54	<1
080	Partially oxidized metal with no thorium	Same as Waste FMPC 080 with no thorium.	Pilot Plant, 54	<1

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
139	Alloyed uranium	One drum containing pieces of uranium alloyed with a very low concentration of titanium and iron.	6	<1
154	U_3O_8 (Black uranium oxide)	Same material as FMPC 055, 056 except that the material is now fully oxidized; this practice is no longer is use.	5, 9	55
157	Reject uranium oxide (UO_3)	Uranium oxide (orange powder) which does not meet process specifications.	2, 3, 4	<1
001	Depleted declad solution	Sodium aluminate solution containing undissolved sludge.	8	<1
003	General waste-process area (33 dumpsters/wk.)	Paper, cardboard, and other combustible material possibly contaminated due to its origin in the process area; in baled form.	All Plants	327
N/A	Wood	Old crates, pallets, skids, etc., possibly contaminated.	N/A	218
N/A	Filters	High efficiency particulate air filters (HEPA); an anticipated waste stream not yet generated.	All Plants	12

70

5

TABLE 3.1
(Continued)

WASTE STREAMS AT THE FMPC

FMPC MATERIAL CODE	WASTE STREAM	WASTE STREAM DESCRIPTION	ORIGIN OF WASTE STREAM (Bldg. No.)	ANNUAL VOLUME (Metric Tons)
N/A	Non-process area general waste (blue area)	Non-contaminated general waste from the plant support areas such as office buildings and maintenance shops; includes waste packing materials.	N/A	61
N/A	Construction materials	Both demolition debris, possibly contaminated, and scraps of new construction materials.	N/A	57
N/A	Cafeteria wastes	Paper plates, napkins , garbage, etc.	Cafeteria	38
N/A	Rubbish "type 1" currently assigned to sanitary landfill	Metal banding, other wire, scrap sheet metal and other non-contaminated non-combustibles.	N/A	30
013	Spent solvent (1,1,1-trichloroethane)	Dirty degreasing solvent arising from the plant maintenance activities.	All Plants	0.5
N/A	Spent Eutectic salts (BaCl, ECl, NaCl)	Waste salts from RMI.	Off-site	22.7
N/A	Spent Solvent (methylene chloride, and perchloroethylene) (from RMI)	Toxic wastes received from an outside supplier (RMI) for disposal.	Off-site	0.6
039	Oily sludges	Water soluble cutting oil, grade SUN #31.	5, 6, 9	

- Ship, receive, sample, and store large amounts of drummed depleted, normal and enriched uranium materials in open and covered storage areas;
- Dry crush, mill, grind, and classify (determine the enrichment) process materials;
- Perform acid digestion of enriched residues assaying up to 20 percent U-235 in geometrically safe equipment (safe diameter concept for process vessels which handle fissionable materials);
- Open unirradiated fuel pins containing enriched uranium dioxide pellets;
- Shred and air clarify scrap copper motor windings;
- Recondition steel drums for reuse and bale deteriorated drums for salvage; and
- Store, certify, and ship low-level radioactive waste materials.

3.2.2 REFINERY - PLANTS 2 AND 3

The Refinery was built in 1953 and has a ground floor area of 36,604 square feet. The principal capabilities of the Refinery are to:

- Digest enriched uranium residues in nitric acid and store blended feed solutions in stainless steel tanks;
- Perform solvent extraction operations with a tributyl phosphate and kerosene mixture in stainless steel, perforated-plate pulse columns and mixer-settler to purify the uranium solution;
- Concentrate pure uranium solution by evaporation and convert to UO_3;
- Recover nitric acid from NO_x discharges from the digestion and denitration operations;
- Recover uranium from internal process waste solutions; and
- Precipitate and recycle uranium contained in aqueous waste streams from the solvent treatment and cleanout operations.

3.2.3 GREEN SALT PLANT - PLANT 4

Operations at the Green Salt Plant began in October 1953. The ground floor area is 26,500 square feet. The principal capabilities of the Green Salt Plant are to:

- Reduce UO_3 to UO_2 with hydrogen. React UO_2 with anhdrous HF to produce uranium tetrafluoride, (UF_4 or green salt), in continuous flow reactor banks designed and staged for gas-solids reactions;

- Package depleted (less than 0.71 percent U-235) UF_4 for metal reduction;

- Operate the tank farm to supply all production plants with bulk quantities of required liquid chemical agents; and

- Manufacture ammonium hydroxide from anhydrous ammonia.

3.2.4 PILOT PLANT

The Pilot Plant was completed during 1952 and currently has a ground floor area of 23,500 square feet. The principal capabilities of the Pilot Plant are:

- Reduction of UF_6 to UF_4 assaying up to 2.5 percent U-235;

- Purification and conversion of thorium nitrate solution to various thorium compounds;

- Miscellaneous operations for shot blasting uranium derby metals and plasma spray coating graphite crucibles; and

- Salt bath heat treating.

3.2.5 SCRAP RECOVERY PLANT - PLANT 8

Plant 8 construction was completed in 1953 and production began in November of that year. The ground floor area of Plant 8 is 25,500 square feet. The principal capabilities of the Scrap Recovery Plant are:

- Roasting various enriched residues to prepare Refinery feed by removing moisture, oil, graphite, and metallic impurities;

- Filtering large volumes of low-level radioactive waste slurries using rotary vacuum, precoat filters; and

- Drum washing operations.

3.2.6 TANK FARM

The tank farm houses 16 storage tanks. Figure 3.4 indicates the capacity of these tanks, the materials and amounts of process materials stored, and the use status of each tank. Information is also shown for additional tanks at Plant 4.

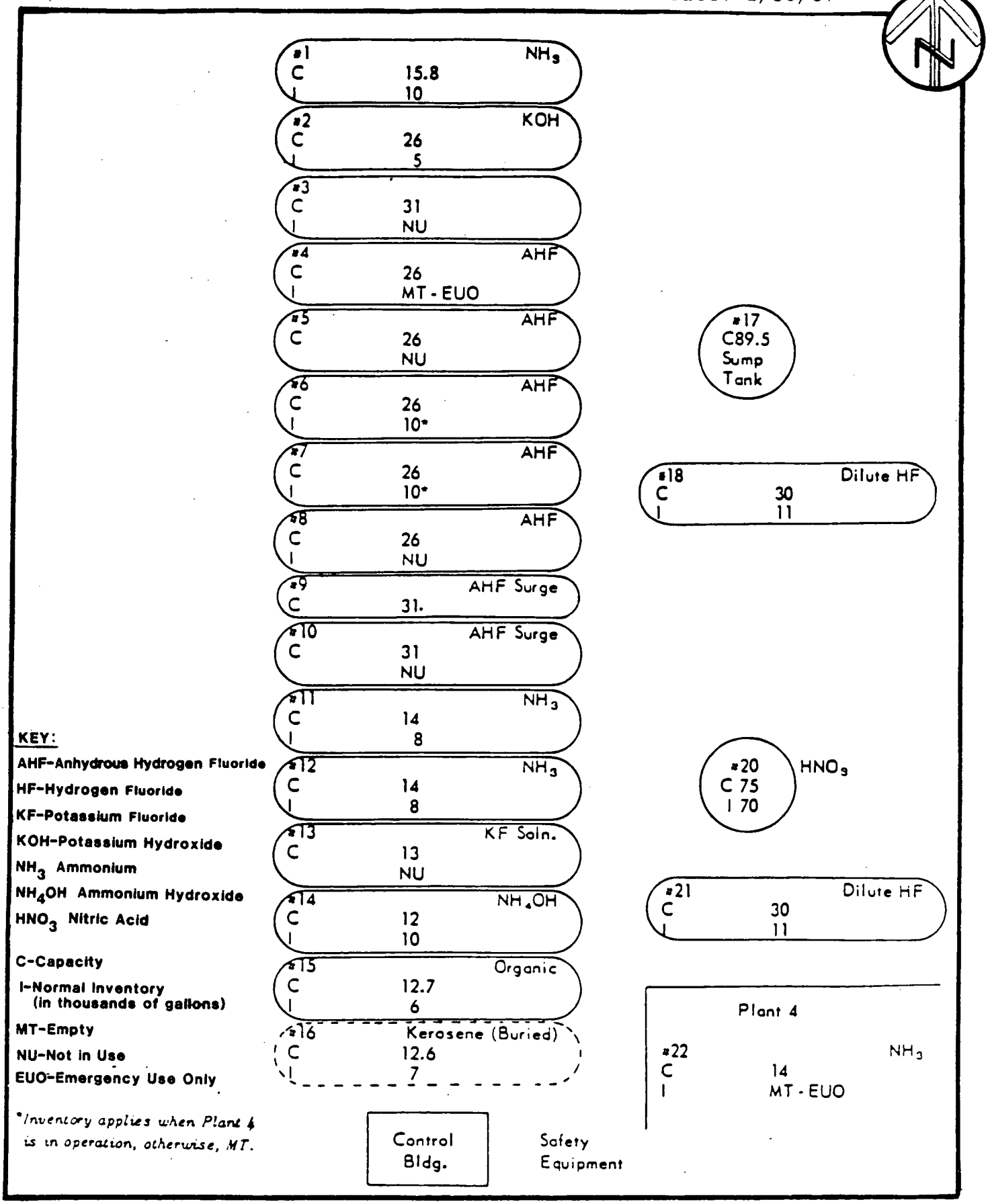


FIGURE 3.4
TANK FARM STORAGE TANKS

3.3 METAL PRODUCTION AND FABRICATION PLANTS

3.3.1 METALS PRODUCTION PLANT - PLANT 5

Construction of this facility was completed in 1953. The ground floor area is 58,620 square feet. The principal capabilities of the Metals Production Plant are to:

- Reduce uranium tetrafluoride with magnesium in electrical resistance furnaces to high-purity uranium derbies;
- Cast depleted uranium derbies needed;
- Machine graphite into needed shapes;
- Mill magnesium fluoride (MgF_2) slag by-product for reuse in lining reduction pots; and
- Crop ingots by sawing.

3.3.2 SPECIAL PRODUCTS PLANT - PLANT 9

Construction of the Special Products Plant was completed in 1954, with a ground floor area of 48,500 square feet. This facility was originally designed and constructed as a thorium metal production plant. Two basic processes, hydrofluoric acid precipitation of thorium fluoride and induction dezincing and melting, were used to produce thorium metal. Improvement in production techniques permitted the eventual development of an oxalate precipitation process capable of producing pure thorium metal (NLO, Inc. n.d. History of the Operation of the FMPC). Thorium is no longer processed in Plant 9. The principal capabilities of the Special Products Plant are to:

- Cast enriched uranium derbies and recycled uranium scrap into large diameter ingots for the N-Reactor;
- Machine as-cast ingots and billets for extrusion;
- Clean depleted uranium derbies in molten salt for off-site shipment;
- Declad copper-zirconium unirradiated fuel cores; and
- Treat decoppered coextrusion sections with dilute HF.

3.3.3 METALS FABRICATION PLANT - PLANT 6

The ground floor area of Plant 6 is 206,260 square feet. The principal capabilities of the Metals Fabrication Plant are to:

- Heat treat all machined ingots for extrusion;

- Blank, heat treat and final machine target elements or fuel cores;
- Perform final inspection for product quality;
- Perform metal pickling and chip briquetting; and
- Provide standby capabilities for rolling as-cast ingots into rods.

3.4 TREATMENT FACILITIES AND DISCHARGE ROUTES

3.4.1 FMPC LIQUID WASTE TREATMENT FACILITIES

Each of the major process areas have individual treatment facilities designed to pretreat liquid wastes that are unique to that particular process step (NLO, 1985d). In these plant treatment units, almost all of the radioactive materials in the wastes can be removed as filter cakes and processed for uranium recovery (NLO, 1985b).

Generally, the plant treatment facilities are simple installations which provide equipment and tankage to collect waste liquors, and adjust the pH to precipitate uranium, and other chemicals. Where oils are present, preliminary steps are taken to break out the oils by acidification and decantation before neutralization and precipitation. Sampling and analysis are performed to assure that uranium content is below preset discard limits. The slurries resulting from the pH adjustments may be filtered in the plant or pumped to the General Sump. If filtered, the clear filtrate is sent to the General Sump. Filter cake, containing recoverable uranium, is held for reprocessing.

The General Sump consists of vertical tanks, pumps, piping, and valves on a contained pad equipped with runoff controls. It is used for the transfer, storage, and discharge of liquid wastes within the complex, and the addition of various reagents and coagulating agents. The controlled pad is equipped with its own sump and drainage trenches to handle any leaks or accidental spills (NLO, 1985b). The General Sump flow design is shown in Figure 3.5. Pretreated liquids are collected at the General Sump where solids are allowed to settle prior to the waste water flowing to Pit 5 and then to the Clear Well for further solids removal. The Clear Well also receives runoff from the general site area.

Effluent from the Clearwell and noncontaminated supernatant from the General Sump are combined with sewage treatment effluent and stormwater runoff and discharged to the Great Miami River through the main effluent line following sampling at the NPDES discharge point.

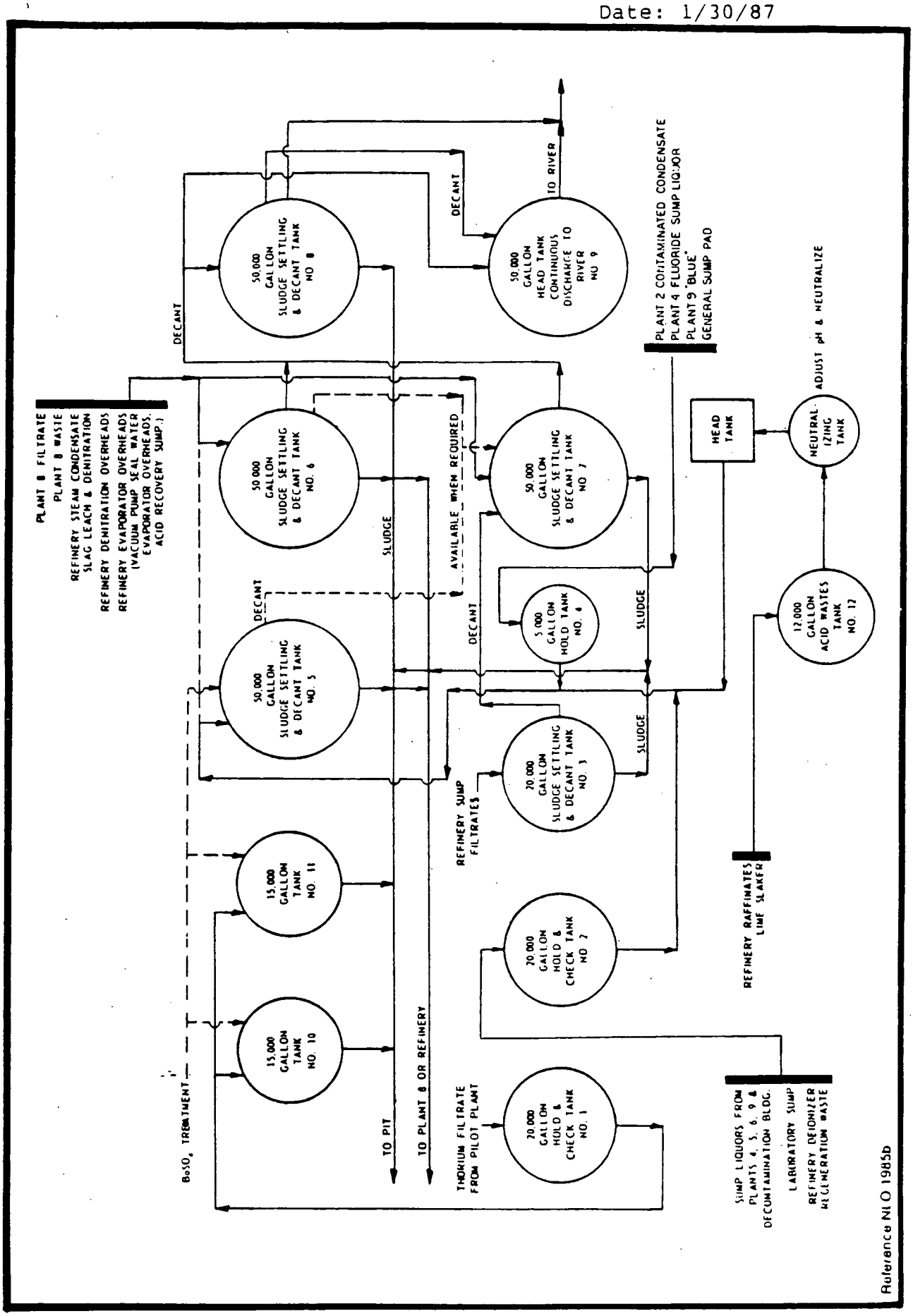


FIGURE 3,5
GENERAL SUMP FLOW DIAGRAM

Figure 3.6 illustrates the liquid waste stream flow and discharge through Manhole 175 and to Paddy's Run via the lift station, as well as the National Pollutant Discharge Elimination System (NPDES) sampling locations.

3.4.2 SANITARY SEWAGE TREATMENT SYSTEM

Sanitary sewage is collected from the Sanitary Sewer System at the Sanitary Lift Station. It is then pumped to the primary settling tank at the Sewage Plant where solids settling takes place. These solids (sludge) are conveyed into the sludge digester. The supernatant or relatively clear water left in the primary settling tanks flows to a trickling filter sump. From the sump, the liquid flows to two trickling filters in series where aerobic bacteria consume the organic matter. Some flow from the trickling filter is recirculated to the trickling filter sump. The remainder flows to a secondary settling tank, where solids from the trickling filters can settle out. The clear water overflows to the ultraviolet disinfection unit, then to Manhole 175, and discharges to the Great Miami River. A biodenitrification facility is being constructed to control the amount of nitrates in the process waste water discharge. A description of this facility is contained in Section 5.2.6 of this document. The sewage plant effluent is analyzed for total solids, total dissolved solids, total suspended solids, volatile solids, pH, total fecal coliform bacteria, alkalinity, total settled solids, and biochemical oxygen demand.

The sewage plant digester anaerobically decomposes the organic material in the sewage sludge. Raw sludge is pumped into the digester and mixes with sludges that have been pumped in previously. A recirculating pump draws the sludge from the bottom of the digester and transfers it through a sludge heater, then returns it to the top of the digester. Methane gas, generated during the sludge digestion process, is either recycled to the sludge heater for use as a fuel or flared to the atmosphere. Weekly analyses are made for total, suspended, dissolved, and volatile solids as well as pH, alkalinity, and volatile acids to constantly monitor the sludge condition. When analytical results dictate, a portion of the digested sludge is pumped to sludge drying beds, where most of the liquid portion percolates through the sand. Liquid flows to the trickling filter sump. Sludges are dried and incinerated. Ashes with recoverable levels of uranium are sent to the recovery plant for processing, while non-recoverable ashes are drummed and stored on site. No hazardous wastes are known to be received at the sanitary sewage treatment plant.

3.4.3 STORM SEWER SYSTEM

The Storm Sewer System collects surface runoff from portions of the Production Area and surrounding terrain. Water in the Storm Sewer System flows by gravity to the storm sewer lift station (Manhole 34). The storm sewer lift station is a pumping station

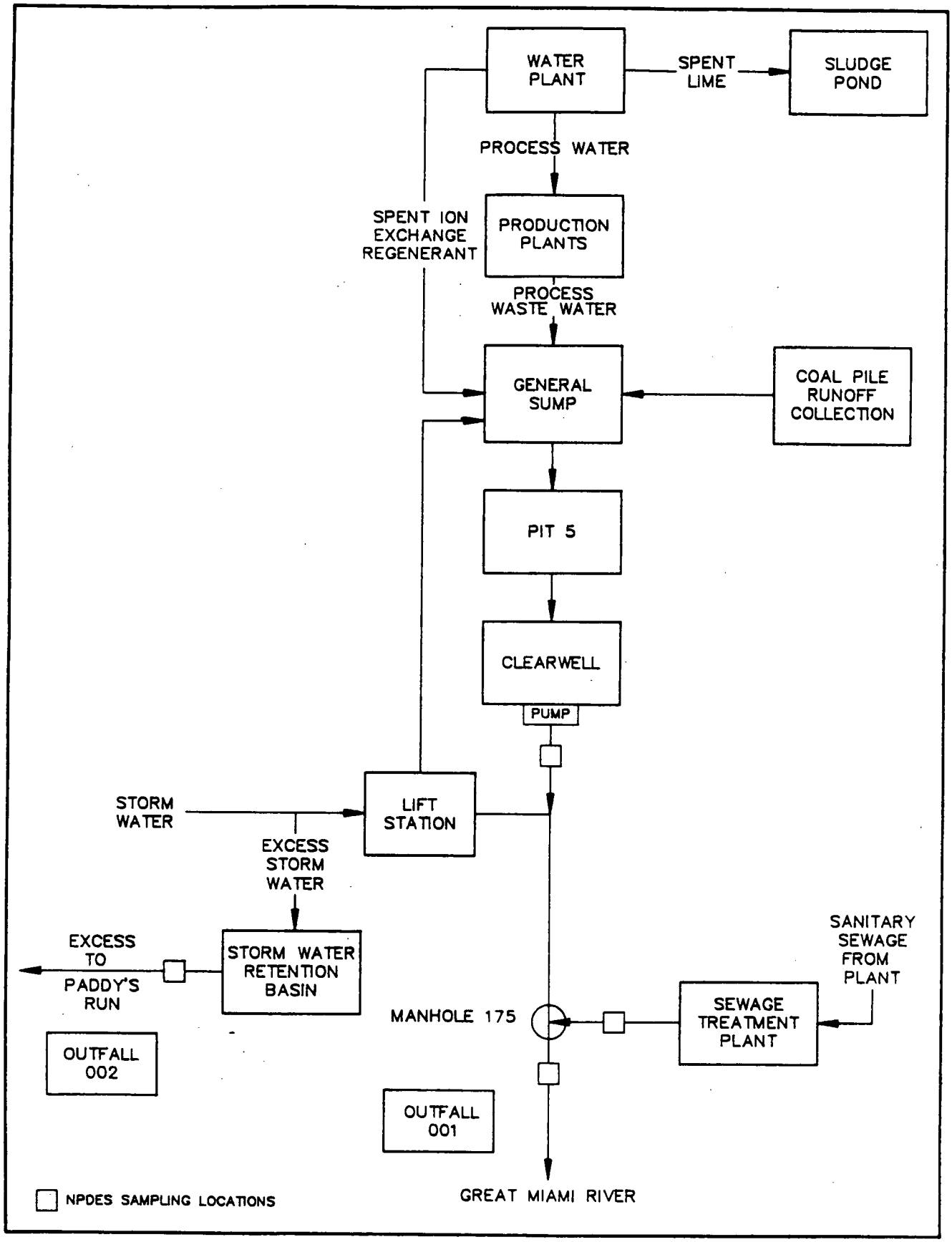


FIGURE 3.6
FMPC LIQUID WASTE STREAMS

for lifting the normal flow in the storm sewer system to the water discharge line that goes to Manhole 175, and the Great Miami River.

Normal storm water flow is directed into the wet well of the lift station by a dam located in the storm sewer outfall. The two lift station pumps are activated by a float control switch, and have a combined capacity of 500 gpm. The lift station also houses instruments that record the flow to Manhole 175, the pH of the flow, and the flow that spills over the dam to the storm sewer retention basin. The instruments are connected to the Water Plant where unusual events can be monitored. Routine inspections are conducted and samples are collected for flow analysis.

During times of heavy precipitation, the flow collected in the storm sewer system will overflow the 14-inch dam and discharge into the 60-inch storm sewer outfall. In the past, the discharge flowed into the storm sewer outfall ditch. This overflow now discharges into the storm water retention basin.

The storm sewer outfall ditch is a narrow and shallow ravine which receives overflow surface water runoff from portions of the production area and surrounding terrain. Radionuclides and other materials originating from the production area have entered the storm sewer system through accidental spills and through surface runoff (H&R, 1986). Under normal conditions, the storm sewer water is combined with the general sump effluent and other plant liquid effluents and is discharged to the Great Miami River. During periods of heavy runoff, excess storm sewer water was discharged directly into the storm sewer outfall ditch which discharges into Paddy's Run. The outfall ditch may be acting as a source and transportation mechanism for above background concentrations of radionuclides in the off-site ground water (H&R, 1986).

The storm sewer outfall now discharges into the newly constructed storm water retention basin. This retention basin is designed to accommodate a 2-year, 24-hour storm event. The basin would be full at about the 12th hour of a 10-year, 24-hour rainfall event (WMCO, 1986a). The basin has a 40-mil liner which is oil and solvent resistant. Two 300-gpm, manually operated pumps can be activated to transfer the flow within the basin to the Storm Sewer System upstream of the lift station outlet. A minimum of two feet of water must be retained in the basin to provide sufficient head pressure for the pumps and maintain the position of the liner. In the event of precipitation in excess of the designed capacity of the retention basin, storm water will overflow into the storm sewer outfall ditch which flows into Paddy's Run. Paddy's Run is a small, intermittent stream with losing and gaining reaches that borders the west boundary of the FMPC and discharges to the Great Miami River approximately 1.5 miles south of the FMPC. The confluence of Paddy's Run with the Great Miami River is approximately 4.5 miles downstream of the effluent line discharge point in the river.

Paddy's Run, which receives runoff from the Waste Storage Area, and uncontained FMPC surfaces, exhibits above background concentrations of radionuclides in isolated areas (NLO, 1986; 1985a; 1984). Paddy's Run has been identified as a potential source of water quality degradation in several off-site wells used for local drinking water supplies (H&R, 1986). Uranium contained in its waters is transported to an area where the less permeable glacial till underlying the stream grades into a more permeable sand and gravel. The surface water percolates into the ground water aquifer near the confluence of Paddy's Run and the storm sewer outfall ditch. In the early 1960s, a portion of Paddy's Run was relocated to prevent it from interfering with the construction of Waste Pit 3. It is not know what effect this has had on ground water movement. Sections 3.8.1 and 3.8.2 discuss discharge limitations and sampling results with respect to NPDES.

3.4.4 AIR TREATMENT SYSTEMS

Most uranium production operations result in the generation of dust, fume, or reaction gases (NLO, 1985d) These operations are conducted in ventilated enclosures and the air is passed through high efficiency dust collectors and scrubbers. The filtered or scrubbed air is exhausted to the atmosphere. Currently, 55 dust collectors are in use. The strategy for air pollution control is based on an Air Emission Master Control Plan which provides direction to achieve full compliance with the Clean Air Act of 1970. Since the mid-1950s, dust collector discharges have been evaluated through continuous stack sampling. Materials deposited in the dust collector bags were incinerated prior to 1979 in the deactivated solid waste incinerator located at the east site boundary. Ashes with recoverable levels of uranium were then sent to the recovery plant while non-recoverable ashes were drummed and stored on site.

3.5 DEACTIVATED PROCESS AND TREATMENT FACILITIES

Four facilities--the Hexafluoride Reduction Plant (Plant 7), the solid waste incinerator at the east site boundary, the graphite burner, and the oil burner have been completely deactivated. Plant 7, however, is still used for storage purposes. The raffinate calciner and Plant 1 silos were also deactivated. Portions of other facilities have also been deactivated, but these facilities continue to operate as described in Section 2.0 of this volume. The rolling mill in Plant 6 is currently on standby and may be removed. The thorium furnace in Plant 6 was operated for a period of time and then removed.

Plant 9 was used for thorium operations up to 1955. The equipment related to this function has mostly been removed.

Equipment was installed at the Pilot Plant to produce and saw thorium derbies. This equipment is deactivated; however, the thorium extraction column and enriched extraction column are placed on standby.

3.5.1 HEXAFLUORIDE REDUCTION PLANT - PLANT 7

Plant 7 was built in 1954 and was designed for the conversion of UF_6 to UF_4 in a gas-gas reaction. The principal capabilities of Plant 7 were:

- Mixing UF_6 gas with hydrogen gas produced by ammonia dissociation;
- Blending and packaging UF_4; and
- Condensing anhydrous liquid HF for storage in the Tank Farm.

Plant 7 was shut down in May 1956, and all equipment inside the building was sold (NLO, Inc. n.d. - History of the Operation of the FMPC). Currently, Plant 7 is used as a general storage facility for empty cans and 10-gallon cans of UF_4.

3.5.2 SOLID WASTE INCINERATOR

The solid waste incinerator is located in the sewage plant enclosure, near Manhole 175, east of the production area. This incinerator was in operation from November 1954 until December 1979. Dust collector bags office paper, production area wood and paper, skids, waste oil, and sludge are examples of the types of material which were burned in this incinerator.

3.5.3 GRAPHITE BURNER

The graphite burner is located on a pad in the vicinity of the coal pile, near the northeast corner of the Production Area. This burner was in operation from November 1965 until September 1984. Scrap graphite from the Metal Production Plants - Plants 5 and 9 was incinerated at this facility.

3.5.4 OIL BURNER

The oil burner is located on a pad in the vicinity of the coal pile, near the northeast corner of the Production Area. This burner was in operation from March 1962 until June 1979. Contaminated liquid organics from production areas that were burned included: used motor oil, hydraulic oil, tributyl phosphate, kerosene or mineral spirits, and small quantities of solvents used in degreasing, e.g., 1,1,1-trichloroethane, trichloroethylene, and perchloroethylene.

3.6 WASTE MANAGEMENT AREAS AND STORAGE UNITS

Wastes at the FMPC include low-level radioactive wastes, mixed wastes (wastes which contain both hazardous or toxic and radioactive wastes), and toxic wastes which result from the uranium production process and operations.

Nine operations plants, support buildings and facilities are used to complete the production process. Waste storage facilities include tanks, silos, inactive shallow pits, and drums. Currently all process wastes which are generated on site are drummed and stored.

Noncombustible solid wastes, including clothing and gloves, generated at the FMPC are boxed or drummed for off-site shipment and disposal at the Nevada Test Site (NTS). The uranium content of these wastes is low and uranium recovery is not feasible. Asbestos-containing wastes generated from maintenance and restoration activities are currently properly packaged, drummed, and stored in a segregated area for final disposition.

Combustible wastes (excluding wood pallets) are currently baled and stored in rented trailers, waiting final disposal. Noncontaminated putrescible wastes (cafeteria scraps) are currently disposed off site at a local sanitary landfill. Wood pallets used in the production area for material handling are currently stored on site, waiting final disposition.

Low-level radioactive wastes resulting from production operations, are processed, packaged, and stored for eventual off-site shipment to NTS for disposal. Currently, the three major process waste streams (raffinate, slag leach filter cake, and magnesium fluoride) are being shipped to NTS for disposal.

The waste storage facilities consist of six waste pits (numbered 1-6), two concrete silos (K-65 silos 1 and 2), two additional concrete silos (metal oxide tanks 3 and 4), a burn pit, the clear well, the sanitary landfill, two lime sludge ponds, and fly ash disposal areas 1 and 2. The six waste pits, four concrete silos, burn pit, sanitary landfill, and lime sludge ponds, are located west of the production facility within the fenced, "controlled" area (Figure 3.3). The fly ash piles and the Southfield Area are located southwest of the Production Area (Figure 2.2).

3.6.1 FERROUS METAL SCRAP PILE

The FMPC currently has approximately 5,000 metric tons of metallic scrap containing above-background levels of uranium. This material is stored on a controlled, curbed pad on the northeast corner of the site. The scrap pile consists primarily of ferrous material with the remainder a mixture of aluminum, stainless steel, copper, brass, and nickel. The scrap includes, but is not limited to, vessels, wiring, cable, duct, pipe, tubing, valves, grating, sheets, plates, and miscellaneous abandoned equipment. Runoff water from the pad is collected in a dedicated sump, and pumped to on-site facilities for recovery and treatment. Some materials at the facility are classified as low level radioactive wastes.

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3.6.2 COPPER SCRAP PILE

Approximately 1,500 tons of mica-coated copper scrap, containing slightly above-background levels of uranium, is stored on an aboveground curbed pad north of Plant 1. A copper shredding system is currently in operation at the FMPC to remove the mica from the recyclable copper. All materials at this location are classified as low level radioactive wastes.

3.6.3 REFINERY STORAGE PAD

The Refinery Storage Pad is currently used to store waste machine oils and oil sludges. At the present time, waste machine oils are not considered as toxic or hazardous waste. The Refinery Storage Pad is a curbed pad. Primarily, waste oils stored at the pad are spent cutting and cooling oils from machinery operations. All runoff waste from the pad is collected, sampled, and recycled for processing, or discharged as required. All material stored at this facility are low-level radioactive wastes. No hazardous wastes are recorded as stored at this facility.

The current FMPC inventory of waste cutting and cooling oils at the Refinery Storage Pad is nine-hundred 55-gallon drums. Approximately one 55-gallon drum of waste oil is generated per day at the FMPC. In addition to the waste oil, 48 drums of oil sludges are stored at the Refinery Storage Pad. The drums stored at the Refinery Storage Pad are in good shape and have just been moved to that pad.

3.6.4 PLANT 1 STORAGE PAD

Low-level radioactive materials are stored on the Plant 1 Pad, located on the northwest corner of the Production Area. All materials are contained in 55- and 30-gallon steel drums awaiting further processing or off-site shipment. Table 3.2 lists the types, number of drums and the weights (lbs.) of wastes stored on Pad 1. A total of 39,275 drums weighing 10,597,533 lbs. was present as of August 12, 1986.

These drums are inspected on a weekly basis. Condition of drums is generally good; however, some deteriorated drums do exist. Contents of the deteriorated drums are repackaged. Drums stored at the Plant 1 Pad will be sampled and analyzed according to the continuing program initiated by WMCO to characterize wastes with respect to RCRA requirements.

3.6.5 PILOT PLANT BULK STORAGE TANKS

The Pilot Plant Hazardous Waste Bulk Storage Area consists of two stainless steel storage tanks, T-5 and T-6. Tank T-5 is 11 feet in diameter, 14 feet high, and has a capacity of 10,000 gallons at a maximum liquid height of 12 feet. Tank T-6 is 11 feet in diameter, 12 feet high, and has a capacity of 8,500 gallons at a

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TABLE 3.2

MATERIALS IN DRUM STORAGE AREA AT PLANT 1 PAD

FMPC MATERIAL CODE	MATERIAL DESCRIPTION	NUMBER OF DRUMS	WEIGHT (lbs)
004	Contaminated steel and equipment off-site receipts only after washing and/or cleaning	28	6,413
011	Contaminated soil, rocks, sand bricks and ceramics to be processed for recovery	200	49,019
013	Contaminated solvent etc. to be be processed for recovery (stencil type of solvent on container)	22	9,286
015	Contaminated oil, insoluble-to burner	2	825
018	Contaminated alumina-soda lime (high Cl)	35	8,206
019	Contaminated magnesium	100	16,310
020	Contaminated Merco-dri and Hilco cake	27	6,417
021	Drum decontamination residues: wet MgF_2	129	63,071
022	Contaminated TBP and/or kerosene mixtures and sludges	4	841
023	Oily MgF_2	1	267
026	Contaminated carbon filter elements	1	145

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TABLE 3.2 (continued)

MATERIALS IN DRUM STORAGE AREA AT PLANT 1 PAD

FMPC MATERIAL CODE	MATERIAL DESCRIPTION	NUMBER OF DRUMS	WEIGHT (lbs)
027	Contaminated burnables: rags, filter cloths, paper, cartridges and contaminated burnable trash	619	32,355
028	Contaminated non-burnables: filter cartridges, asbestos, polyethylene bags, etc.	27	991
029	Dust collector bags	328	19,581
030	Magnesium oxide and magnesium zirconate from crucible cleanout	96	34,756
031	Roasted MgF_2 (Blended with other materials) for slag leach digestion	66	41,710
033	Incinerator cinders - material not passing through grate or screen	1,072	251,821
034	MgF_2 for milling	6,136	3,245,469
037	MgF_2 ground, for slag leach digestion	98	53,959
041	Sludges, oily, for oxidation, high free metal	33	7,686
042	Sludges, cleanout, non-oily, for roasting	26	9,091
043	Sludges, solvent etc. (stencil type of solvent on container)	3	99

TABLE 3.2 (continued)

MATERIALS IN DRUM STORAGE AREA AT PLANT 1 PAD

FMPC MATERIAL CODE	MATERIAL DESCRIPTION	NUMBER OF DRUMS	WEIGHT (lbs)
044	Sludges, salt, soft, chloride (for plant 8 recovery)	85	29,614
045	Sludges, salt, soft, non-chloride	5	2,690
047	Samples, non-metallic, miscellaneous	27	1,545
055	Depleted U metal - not suitable for reactor product streams (not top crops)	345	263,384
056	Depleted U ingot crops (top crops) from primary ingots	669	831,539
057	Wet crushed slag from furnace pot blowouts	31	15,453
058	Contaminated CaF_2 - MgO-for recovery	39	9,259
060	Furnace salt, solidified, chloride (for plant 8 recovery)	160	97,694
061	Furnace salt, solidified, non-chloride	540	145,712
062	Dust collector residues-high fluoride	3,651	1,324,766.5
063	KOH reversion cake	1	86
065	Scrap salts, high fluoride, including floor sweepings	1,396	1,208,030
066	Scrap salts, low fluoride, including floor sweepings	65	16,699
067	Wet sump or filter cake, halide	4	645

TABLE 3.2 (continued)

MATERIALS IN DRUM STORAGE AREA AT PLANT 1 PAD

FMPC MATERIAL CODE	MATERIAL DESCRIPTION	NUMBER OF DRUMS	WEIGHT (lbs)
068	Wet sump or filter cake, oil	59	18,135
069	Wet sump or filter cake, non-oily and non-halide	1162	468,597
070	Rockwell spills	60	39,632
071	Rockwell cleanings	188	90,122
077	Dry crushed slag from furnace pot blowouts	162	101,689
079	Unfired reduction charges plus MgF_2 from liner cave-ins	613	568,599
080	Partially oxidized metal for sorting containing metl- x	1	742
081	Partially oxidized metal for sorting containing no metl-x	4	1,229
082	Off-spec UF_4 or ThF_4	885	217,677
084	Bad reduction (no derby)	1	416
085	U_3O_8 rotexed other than plant 8's own product--not meeting refinery specifications for continuous digestion	2	482
101	Scrap U_3O_8 or ThO_2, high fluoride	1106	505,105
104	Metal spills and extrusion ends: metal high in impurities and spills for HNO_3 metal dissolver	2	631

TABLE 3.2 (continued)

MATERIALS IN DRUM STORAGE AREA AT PLANT 1 PAD

FMPC MATERIAL CODE	MATERIAL DESCRIPTION	NUMBER OF DRUMS	WEIGHT (lbs)
119	Solid metal other than cores, with embedded steel for dissolver feed	12	3,090
125	Unrecycled slag +20 mesh, ball mill product	16	14,880
129	Dirty prill, code 5 derbies, and plant 1 titan mill clean-out, high U content	159	111,161
132	Dust collector residues, low fluoride	558	198,512
134	U_3O_8 for reoxidation	3	351
135	Dust collector residue, high fluoride, greater than 20% assay	67	19,640
137	Miscellaneous material-recovery method to be determined (not for use by individual plants)	19	8,109
139	Uranium alloyed or canned with elements other than aluminum, molybdenum or zirconium	1	600
143	Roasted calcium-precipitated sump and filter cakes	684	176,020
154	U_3O_8 rotexed plant 8 furnace product	489	232,000

TABLE 3.2 (continued)

MATERIALS IN DRUM STORAGE AREA AT PLANT 1 PAD

FMPC MATERIAL CODE	MATERIAL DESCRIPTION	NUMBER OF DRUMS	WEIGHT (lbs)
157	Reject UO_3	2	119
163	Roasted, milled and/or screened ammonium-precipitated sump and filter cakes	63	20,974
VVB-001	Slag leach filter cake, neutralized MgF_2	4580	*
VVB-002	Neutralized Raffinate	11,104	*
VVB-VVC	Depleted sludges from RMI	1202	*
TOTALS		39,275	10,597,533.5

* Weights not available at this time

a Between August 1985 and January 1986, 534 drums or 250,631 pounds of VVB-001 were shipped from the FMPC.

maximum height of 10 feet. The current FMPC inventory of these tanks is 13,000 gallons or 136,874 lbs., of spent degreasing solvents. Annual generation averages approximately 110 gallons (1,300 lbs.) of RMI degreasing solvents (45 percent methylene chloride, 55 percent perchloroethylene) and 110 gallons (1,110 lbs.) of 1,1,1-trichloroethylene.

Both tanks are nonpressurized vessels operating at ambient air temperature. These tanks are not equipped with vapor controls.

The tank storage facility is equipped with a diked storage area having a capacity of approximately 28,000 gallons. This is sufficient to hold the contents of both tanks in case of a leak or accidental spill of liquid waste. The tanks are properly labeled and maintained for safe operation of the tank facility.

3.6.6 PILOT PLANT WAREHOUSE

The Pilot Plant Warehouse is a totally enclosed and roofed warehouse facility with a poured concrete floor and sidewalls. The floor of the warehouse is slightly elevated and the ground is sloped away from the building to prevent any run-on from outside the building due to stormwater.

The storage area for hazardous waste at the Pilot Plant Warehouse is an area seven feet wide by 62 feet long. This facility is equipped with curbed storage areas to contain leaks or accidental spills of wastes. All containers are properly labeled, stacked, and maintained for safe operation of the container storage facility. This facility currently stores waste barium chloride salts received from RMI. These are hazardous wastes without free liquids. One-hundred sixty-seven drums of barium chloride are stored at this facility: 70 drums of barium chloride, 13 drums of trash contaminated with barium chloride, 26 drums of floor sweepings with barium chloride and 58 drums of salt brick.

3.6.7 KC-2 WAREHOUSE

The KC-2 Warehouse container facility is a curbed storage facility. It is seven feet wide by 42 feet long, in Bay No. 5 of the warehouse. It is used for the storage of mixed toxic and co-contaminated waste drums. The warehouse is roofed, with a poured concrete floor, concrete block divided (side) walls, and chain link fence front and back walls. The pad is slightly elevated and the ground is sloped away to prevent any storm water run-on.

The means of secondary containment at the KC-2 Warehouse storage area consists of a concrete pad with curbs. The storage area curb is six inches high and six inches wide. The pad is approximately level over the entire storage area. The pad and the curbs are presently in good condition and free of gaps, holes, or cracks. Concrete is compatible with any of the wastes stored and would not be corroded or weakened if a leak or spill occurred.

The KC-2 Warehouse stores polychlorinated biphenyls (PCBs). Although PCBs are regulated by the Toxic Substance Control Act, (TSCA), some of the PCB wastes at the FMPC also contain uranium and spent degreasing solvents and are classified as mixed wastes. Solvent-still bottoms and sludges, and PCB-containing capacitors are the two PCB contaminated wastes stored at the KC-2 Warehouse.

The current inventory of PCB-still bottoms and sludges is approximately 20,000 lbs. (thirty-seven 55-gallon drums and two 55-gallon drums of absorbent from cleanup operations). In addition, nineteen 55-gallon drums of capacitors, one drum of rags from capacitor cleanup, one drum PCB-containing water (30 gallons) and one drum of laboratory samples are stored at this warehouse.

3.6.8 WASTE PITS

The waste pits consist of Waste Pits 1 through 6, and the burn pit. The waste pits are numbered chronologically in their order of construction. Although the pits no longer receive waste materials, they are referred to as "wet" (3 and 5) or "dry" (1, 2, 4, and 6), depending upon the physical state of the materials which were disposed in the pits. Tables 3.3 and 3.4 describe the characteristics of the Waste Storage Area, and an approximate inventory of stored wastes, respectively. A study is currently characterizing the wastes in the pits (Weston, 1986).

At the Waste Storage area, wastes from dump trucks, dump trailers, and dumpster units, and drummed wastes were emptied directly onto the pit's edge. The materials were then pushed into the pits by either a bulldozer or a drag line scraper (NLO, 1977). Loose radioactive material was washed from bulldozers, drag line scraper, vehicles, dumpsters, and fork trucks with water at the pit. Empty drums were washed in the drum washing facility.

Liquid wastes are transported from the General Sump to the Pits and from the Clear Well to MH-175 via two six-inch diameter pipes (Dames and Moore, n.d.). These pipes leave the Production Area on the west side, enclosed in a concrete trench that is covered with slabs of concrete. The trench extends from the Production Area to the fence of the K-65 silos at which point the pipes turn north and are buried underground. One pipe goes between Pits 2, 3, and 4 to Pit 5, while the other pipe originates at the Clear Well.

On the southern dike of Pit 5, the pipe from the General Sump connects to three berm valves. With these valves, the liquid wastes could be directed from the General Sump to Pit 4 or 5, from either of the two pits to the other, and from either pit back to the General Sump (Dames and Moore, n.d.).

TABLE 3.3

WASTE STORAGE AREA CHARACTERISTICS

FACILITY	FEET (asl)	ESTIMATED BOTTOM ELEVATION LINING/WALLS	PERIOD OF USE[b]
Pit 1	560	1.5-2.0 ft compacted clay[a] or 4 ft clay[b]	1952-1959
Pit 2	570	1.5-2.0 ft compacted clay[a], unknown[b]	1957-1964
Pit 3	548	1.0 ft compacted clay[a,b]	1959-1977 1975-1977
Pit 4	560	1,0 ft compacted clay[a,b]	1960-1986
Pit 5	558	1/16 inch rubberized elastomeric membrane[a,b]	1968-1983
Pit 6	560	Elastomeric membrane[a,b]	1979-1985
K-65 Silos (1, 2)	---	8 inch concrete post stressed with high tensile steel wire, earth embankment[a,b]	1952-1959
Metal Oxide Tank (3)	---	8 inch conrete post stressed with high tensile steel wire[a,b]	1952-1959
Metal Oxide Tank (4)	---	8 inch concrete post stressed with high tensile steel wire[a,b]	Never Used
Burn Pit	Unknown	none	1957-1986
Clear Well	Unknown	clay	1959-Present
Fly Ash Area 1	--	none	Unknown
Fly Ash Area 2	--	none	Unknown-Present

a) from Dames and Moore, n.d.
b) NLO, 1985c

TABLE 3.4 (Continued)

APPROXIMATE WASTE STORAGE INVENTORY

FACILITY	CONTENTS[a,b,c]	ESTIMATED VOLUME (CY)	URANIUM (KG)	URANIUM-235 (KG)	THORIUM (KG)	TOTAL CURIES[b] (CI)
Metal Oxide Tanks (3)	metallic oxides	5,100[a,b]	18,000[a,b]	130[a,c]	unk	23
Burn Pit	pyrophoric and reactive chemicals, oils, combustible wastes	unk[a,b,c]	unk	unk	unk	unk
Clear Well	clear process effluents, surface runoff	unk	unk	unk	unk	unk
Fly Ash Area 1	fly ash, oils	50,000c	1,000[c]	unk	unk	unk
Fly Ash Area 2	fly ash	33,000[c]	unk	unk	unk	unk

a) NLO, 1985c
b) Dames and Moore, n.d.
c) H&R, 1986
unk = unknown

TABLE 3.4

APPROXIMATE WASTE STORAGE INVENTORY

FACILITY	CONTENTS[a,b,c]	ESTIMATED VOLUME (CY)	URANIUM (KG)	URANIUM-235 (KG)	THORIUM (KG)	TOTAL CURIES[b] (CI)
Pit 1	neutralized waste filter cakes, graphite brick scrap, sump liquor & cakes, depleted slag	40,000[a]	52,000[a,c]	370[a,c]	unk	108
Pit 2	neutralized waste filter cakes, graphite, brick scrap, sump liquor & cakes, depleted slag	13,000[a]	1,206,000[a,c]	2,550[a,c]	400[a,c]	35
Pit 3	lime neutralized raffinate concentrate, slag leach residues, filter cakes, fly ash, lime sludge	227,000[b]	129,000[a,c]	1,771[a] 1,010c	400[a,c]	553
Pit 4	process residues, trailer cakes, slurries, raffinates, depleted graphite, non-burnalbe trash, asbestos, barium chloride salt	500,000[a,b]	3,000,371[a] 3,048,087[c]	5,400[a] 5,529[c]	61,700[a] 61,800[c]	233
Pit 5	solids from neutralized raf-finate, slag leach slurry, sump slurry, lime sludge	102,500[a,b]	50,261[a] 50,309[c]	420[a,c]	17,000[a,c]	327
Pit 6	depleted slag, scrap green salt, process residues, filter cake	9,000[a,b]	427,857[a] 843,142[c]	813[a] 1,740[c]	unk	178
K-65 Silos (1, 2)	Australian radium cake, pitch blended processing residues	7,200[a,b]	11,200[a,b]	80[a,c]	unk	17,600

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An additional pipe originated in the tower at the west end of Pit 5 and extended, buried in the dike of Pit 3, to the Clear Well. This pipe transported Pit 5 supernatant to the Clear Well. The other six-inch pipe, which connected the Clear Well and the General Sump, was used to transport Clear Well effluent back to the General Sump (Dames and Moore, n.d.).

Waste Pit 1, constructed in 1952, was excavated into an existing clay lens and was lined with clay excavated from the burn pit (H&R, 1986). The capacity of the waste pit was expanded by the addition of a berm on the west end in 1957 to provide a total capacity of 40,000 cy (Table 3.4). The waste material that was disposed in the waste pit consisted primarily of neutralized waste filter cakes, production plant sump cakes, depleted slag, scrap graphite, contaminated brick, and sump liquor. Although the majority of the wastes were dry solids, decant pipes were constructed through the west berm; these were rarely used (NLO, 1985c). The quantity of uranium disposed in the pit is estimated to be 52,000 kg (114,400 lbs). Waste Pit 1 was closed in 1959, backfilled, and covered with clean fill dirt (NLO, 1985c). Surface water runoff is diverted to the Clear Well prior to its discharge to the Great Miami River.

Waste Pit 2 was constructed in 1957 and was operated from 1957 to 1964 (H&R, 1986). This pit was constructed in a small pond east of Waste Pit 1 and was lined with a compacted clay layer (Dames and Moore, n.d.) (Table 3.3). Waste Pit 2 received primarily dry, low-level radioactive wastes consisting of neutralized waste filter cakes, sump cakes from production plants, depleted slag, scrap graphite, contaminated brick, sump liquor and concentrated raffinate residues (Table 3.3). Similar to Pit 1, decant pipes were located through the west berm. The pit holds approximately 13,000 cy of wastes that contain about 1,206,000 kg (2,653,200 lbs) of uranium and approximately 400 kg (880 lbs) of thorium. The waste pit has been covered with clean fill and graded to provide surface drainage to the Clear Well for subsequent discharge to the Great Miami River.

Waste Pit 3 was constructed in 1959 by excavating into the underlying clay lens and placing a layer of clay along the pit walls (Dames and Moore, n.d.). Waste Pit 3 was operated as a settling basin, from 1959 to 1968, receiving wet waste streams consisting of lime-neutralized waste solution from the FMPC Production Plants (Table 3.3) (H&R, 1986; NLO, 1985c). From 1975 to 1977, the waste pit was used to dispose slag leach residue, filter cakes, fly ash, and lime sludges. The pit contains an estimated 227,000 cy of wastes including 129,000 kg (285,600 lbs) of uranium, and 400 kg (880 lbs) of thorium (Table 3.4). Other constituents are shown in Table 3.5. The pit was retired in 1977 and clean fill was placed over the area. Surface water runoff is diverted to the Clear Well prior to discharge to the Great Miami River.

Waste Pit 4 was constructed in 1960 and was used until May 1986 (Table 3.3). This pit was constructed similar to Pit 3. Waste Pit 4 received process residues, filter cakes, slurries, raffinates, graphite, barium chloride waste sludges (received from RMI from 1981 - 1983), noncombustible trash, and asbestos (H&R, 1986; NLO, 1985c). The pit contains an estimated 563,000 cy, including more than 3 million kg of (6.6 million lbs) uranium and 61,800 kg (135,960 lbs) of thorium (Table 3.4). Pit 4 remains partially uncovered.

Waste Pit 5 was constructed in 1968 and was operated from 1968 to 1983 (Table 3.3) (H&R; 1986; NLO, 1985c). The pit is lined with a 60-mil thick Royal-Seal EPDM Elastomeric Membrane. This liner has had occasional joint failures and tears (NLO, 1985c) which have been repaired. Like Wet Pit 3, this waste pit received liquid waste slurries from the Refinery and the Recovery Plant, including neutralized raffinate settled solids, slag leach slurry, sump slurries, and lime sludge (Table 3.4). The waste volume consists of approximately 102,500 cy, containing 50,309 kg (110,680 lbs) of uranium and 17,000 kg (37,400 lbs) of thorium (H&R, 1986). Other constituents are shown in Table 3.5. Pit 5 now receives only clear decant from the General Sump, filtrate from the Recovery Plant, or nonradioactive slurries, such as blowdown from the Boiler Plant and Water Treatment Plant.

Waste Pit 6 was constructed in 1979 and operated until 1985 (Table 3.3) (H&R, 1986). It was constructed in the same manner as Waste Pit 5 and lined with a similar synthetic liner, although no joint failures or tears have been observed (NLO, 1985c). Noncoarse, nonpyrophoric solid wastes, including green salt, filter cakes, and process residues, containing elevated levels of uranium have been disposed in this pit. Rainfall that is collected in the pit is pumped to Waste Pit 5 for settling and discharge via the Clearwell. The current waste volume is approximately 9,000 cy, which consists of 843,142 kg (1,854,972 lbs) uranium (Table 3.3) (H&R, 1986). The capacity of Waste Pit 6 has not been reached; however, no materials have been added to the pit since April 1985.

The burn pit was first used in 1957 as a site to excavate clay to line Waste Pits 1 and 2 (Table 3.3). The resulting excavation was subsequently used to dispose laboratory chemicals and to burn combustible materials, including pyrophoric and reactive chemicals, oils and other low-level mixed combustible materials (H&R, 1986). The actual inventory of materials or chemicals that was disposed in the burn pit is unknown. The boundaries of the burn pit can no longer be found.

3.6.9 WASTE STORAGE SILOS

The waste storage silos are located south of the waste pit area as shown in Figure 3.3. The four 80-foot diameter silos were constructed with floors of four-inch concrete over an eight-inch layer of gravel containing an underdrain system of a two-inch

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TABLE 3.5

NONRADIOACTIVE, INORGANIC CONSTITUENTS OF WASTE PITS 3 AND 5

CONSTITUENT	PIT 3 MT[a,b]	PIT 5 MT
Ag	<2.55	<0.88
Al	1,530	529
As	65	34
Au	--	--
B	10.2	3.5
Ba	191	66
Be	<2.55	<0.88
Bi	<2.55	<0.88
Ca	46,155	15,967
Cd	<38.25	<13.2
Cl	155	80
Co	<20.4	<7.1
Cr	35.7	12.3
Cu	446.25	154.4
F	12.59	6.49
Fe	5,674	1,963
Hg	--	--
La	<20.4	<7.1
Mg	23,378	8,087
Mn	2,805	970
Mo	2.55	0.88
Na	1,304	672
Ni	76.5	26.5
Pb	153	53
PO_4	171	88
Sb	--	--
Se	--	--
SiO_2	5,100	1,764
Sn	86.7	30
SO_4	788	406
Ti	33.15	11.47
V	15.3	5.3
Zn	<306	<105.9
Zr	102	35.3

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TABLE 3.5 (continued)

NONRADIOACTIVE, INORGANIC CONSTITUENTS OF WASTE PITS 3 AND 5

CONSTITUENT	PIT 3 MT[a,b]	PIT 5 MT
Rare Earths:		
Dy	<15.3	<5.29
Er	<0.09	<0.05
Eu	<5.1	<1.76
Gd	<7.65	<2.65
Ho	<0.06	<0.02
Lu	<0.02	<0.008
Sm	<15.3	<5.29
Tb	<0.06	<0.02
Tm	<0.03	<0.01
Y	7.65	2.65
Yb	<0.60	<0.20

Ref: NLO, 1985c

a)% on dried solids basis of samples from Pit 3, NLO 1969

b)MT = Metric Tons

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slotted pipe draining to a collection tank (NLO, 1985c). Below the gravel is a two-inch layer of asphaltic concrete underlain by 18 inches of compacted clay. The walls are 18 inches thick pre- and post-stressed concrete with a 0.75-inch gunite coating on the exterior. The dome roofs are four-inch-thick reinforced concrete.

Waste raffinate slurries from the processing of pitchblende ore were pumped into Silos 1 and 2 the K-65 silos, allowing the solids to settle. The clarified liquid was then decanted to a treatment facility through valves placed along the 26-foot height of the silo wall. As the depth of solids reached the level of a valve, it was sealed and the next higher valve was used to decant liquids. Settling and decanting were continued in this way until the silos were filled to approximately four feet below the top of the vertical well (NLO, 1985c). Additions to the silos ended in 1955.

The K-65 silos contain approximately 7,200 cy of waste raffinate slurries. More than 11,200 kg (24,640 lbs) of uranium and 1,600 curies of radium are known to be present in the waste materials. Quantities of other metals are also known to be present in the silos (Table 3.6).

In 1964, an earthen embankment was placed around Silos 1 and 2 to provide protection and support, and to minimize gamma emissions. In 1979, all tank openings were sealed to provide total enclosure. The earthen embankment was further enlarged in 1983 to alleviate observed soil erosion on the slopes. Following identification of cracks in the center portion of the domes of the silos, protective covers consisting of prefabricated wood and metal structures, were placed over the domes of Silos 1 and 2 (H&R, 1986). For further discussions of corrective actions taken on the K-65 silos refer to Section 5.0, History of Response Actions.

Approximately 5,100 cy of calcined residues were stored in Silo 3 waiting final disposal. Waste raffinate slurries from refinery operations were dewatered in an evaporator and spray calcined to produce a dry, powder-like waste form. This waste was pneumatically conveyed to the silo. Approximately 18,000 kg (39,600 lbs) of uranium and 15 curies of radium are estimated to be present in the contents of Silo 3. Other metals are known to be present in the stored materials as listed in Table 3.6. Metal Oxide Tank 4 remains empty.

3.6.10 FLY ASH DISPOSAL AREAS

The fly ash disposal areas are located southwest of the Production Area (Figure 2.2). Fly ash resulting from operating the coal-fired boiler plant is loaded into dump trucks and transported to the disposal area (H&R, 1986). The retired pile (Area 1) contains approximately 50,000 cy of fly ash and is sparsely covered with soil and vegetation. About 1,000 kg (2,200

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TABLE 3.6
NONRADIOACTIVE, INORGANIC CONSTITUENTS OF FMPC SILOS

CONSTITUENT	SILOS 1 & 2 (METRIC TON)	SILO 3 (METRIC TON)
Ag	0.176	<0.07
Al	77.	98.67
As	<2.64	
Au	0.44	<0.14
B	1.32	0.70
Ba	6.16	0.70
Be		No Data
Bi		No Data
Ca	342.	144.48
Cd	<0.008	
Cl	0.19	
Co	15.4	8.81
Cr	1.06	1.76
Cu	4.4	8.81
F	0.33	
Fe	105.6	225.52
Hg		
La	7.83	No Data
Mg	110.	229.52
Mn	1.76	17.27
Mo	1.76	2.11
Na	61.6	133.90
Ni	19.8	22.90
Pb	448.8	8.81
PO4		683.62
Sb		<0.53
Se		No Data
SiO2	3,587.	461.62
Sn	0.7	1.41
SO4	No Data	692.08
Ti	6.16	2.11
V	1.85	3.52
Zn	<0.060	
Zr	1.76	
Rare Earths:		
Dy	0.26	<0.11
Er	<0.006	
Eu	<0.001	
Gd	0.35	<0.21
Ho	0.13	<0.11
Lu	<0.002	
Sm	0.42	<0.21
Tb		No Data
Tm	0.07	<0.07
Y	0.35	0.28
Yb	0.05	0.14

Ref: NLO, 1985c

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lbs) of uranium are present from the spreading of oils containing uranium over the fly ash to control dust. The active pile (Area 2) located southeast of the inactive site currently contains approximately 33,000 cy of fly ash. No other wastes, contaminated or noncontaminated, have been added to the active pile.

Underground disposal of construction rubble, containing low levels of radioactivity, occurred in the vicinity of the fly ash disposal area. This repository, known as the Southfield area, is assumed to be encompassed by the area north of and including the fly ash piles (H&R, 1986). Radiological surveys indicate that the soil in this area contains elevated levels of radionuclides.

3.6.11 LIME SLUDGE PONDS

Spent lime from FMPC Water Treatment Plant operations (lime-alum sludges and boiler plant blowdown fly ash) are conveyed to two unlined ponds for storage (Figure 3.3). Each pond is approximately 100 feet by 200 feet by 6 to 8 feet deep with a total volume of 5,000 cubic yards per pond. One pond is completely filled and retired. The other is approximately one-half full. No hazardous materials are recorded as being received at the lime sludge ponds. Material in these ponds is noncontaminated.

3.6.12 SANITARY LANDFILL

The FMPC sanitary landfill is located on a three-acre tract in the northeast corner of the Waste Storage Area (Figure 3.3). The facility is organized into 17 individual cells, five of which are full and out of service. The 12 remaining cells are awaiting issuance of an OEPA Permit to Install. Each cell is estimated to provide approximately 2,080 cubic yards of gross disposal volume. Materials that have been accepted at the facility include: 1) nonburnable, non-radioactive sanitary wastes generated on site (20 cy/wk); and 2) non-radioactive construction related rubble (variable quantity). Small quantities of nonradioactive asbestos are also deposited in the facility in accordance with all applicable federal, state, and local regulations. Leachate from the facility will be collected in each cell and transported to the plant Waste Water Treatment Facility for treatment and discharge under FMPC NPDES permit restrictions. No hazardous wastes are handled at this facility. There is no indication of prior or current releases of hazardous wastes or constituents from this facility.

3.6.13 COAL PILE RUNOFF RETENTION AREA

Stored coal, burned in the coal-fired boiler, is piled on a diked gravel pad that is sloped toward a storm water retention basin which collects any runoff (Figure 3.1). A drainage system was installed underneath the gravel pad in October, 1985, draining water from the pad to the Storm Water Retention Basin. Water

from the Storm Water Retention Basin is pumped to the General Sump where it is analyzed for pH and uranium content.

3.6.14 MISCELLANEOUS WASTES

Miscellaneous drummed wastes (gloves, glass, concrete, etc.) are stored at various locations on the FMPC. Table 3.7 lists the number of drums and their location, as of 21 April 1986. Drums stored at these various locations will be sampled and analyzed according to the continuing program initiated by WMCO to characterize wastes with respect to RCRA requirements.

3.7 PROCESS AND WASTE MATERIALS

3.7.1 STORED INVENTORIES OF IN-PROCESS MATERIALS

Various forms of recycle materials and recoverable residues are stored at the FMPC. These total 223,306 containers of various types having a total net weight of 8,812,745 kgs (19,388,039 lbs). Table 3.8 lists the types of materials and the amounts as of July 31, 1986. A continuous inventory of uranium-containing materials is produced on a monthly basis; therefore, a complete breakdown of these materials is available at the FMPC.

3.7.2 INVENTORY OF OIL AND HAZARDOUS SUBSTANCE STORAGE

Table 3.9 lists the location of oil and hazardous substances stored on site as of July 31, 1986. Containment structures are generally in place around these storage sites, consisting primarily of diked pads.

3.7.3 THORIUM INVENTORY

Thorium operations were performed from 1954 through 1975 and included purifying thorium by solvent extraction, thorium residue processing, conversion of thorium nitrate solution to a storable thoria gel oxide, production of dense thoria, and production of thorium cores. The FMPC serves as the thorium repository for the DOE, maintaining long-term storage facilities for a variety of thorium materials. This thorium is currently not classified as waste.

Table 3.10 shows the present thorium inventory at the FMPC. The thorium is stored in the production areas of the site; and some thorium is located in relatively high traffic areas (Plant 8 silo). The number of drums of thorium and their location are listed in Table 3.11.

The FMPC has implemented interim remedial measures on current inventories of thorium-bearing compounds.

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TABLE 3.7

MISCELLANEOUS DRUMMED WASTES STORED AT THE FMPC
AS OF APRIL 1986

	DRUMS	LOCATION
	1,648	East Building 64
	70	Plant 5, north & south ends
	26	East Building 71
	152	Truck Dock
	101	Plant 2/3 West Pad
	40	Plant 8 West Pad
	396	Laundry and at Fence Area
	15	Pilot Plant
Total	2,448	

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TABLE 3.8

URANIUM INVENTORY (BY CLASS CODE) AS OF JULY 31, 1986

MATERIAL	NO. OF CONTAINERS	WEIGHT (kgs.)
Recoverable Residues 0.72% U-235 - 10% U-235	22,498	537,956.5
Normal Recoverable Residues UO_3, UF_4, Derbies, ingots	47,100	423,156
Recycle Material from Hanford	464	396,433
1.25% U-235, Recoverable Residues Plutonium Off-spec	1,170	276,998.8
0.95% U-235, Scrap and Residue	27,262	342,742.4
UF_4 From Pilot Plant	125	105,086
Depleted UF_4, Depleted Product, Depleted Ingots	124,648	6,730,354
Residues - 10-20% U-235	39	18.3
TOTAL	223,306	8,812,745.0

TABLE 3.9

LOCATION OF OIL AND HAZARDOUS SUBSTANCE STORAGE AT THE FMPC

TYPE	SIZE (GALLONS)	CONTAINMENT SYSTEM
LOCATION-Refinery--Plants 2 and 3		
Oil and Organics		
Kerosene - TBP Mix	2,600	Controlled, diked pad
Kerosene - TBP Mix	2@ 2,250	Controlled, diked pad
Kerosene - TBP Mix	1,050	Controlled, diked pad
Kerosene - TBP Mix	2@ 2,600	Controlled, diked pad
Hazardous Substances		
HNO3	5,076	Controlled, diked pad
HNO3	2@ 30,440	Controlled, diked pad
Raffinate	3,487	Controlled, diked pad
Raffinate	8@ 5,800	Controlled, diked pad
Raffinate	4@ 7,800	Controlled, diked pad
HNO3	5@ 10,000	Controlled, diked pad
HNO3	3,300	Controlled, diked pad
Dilute Ammonia	4,165	Controlled, diked pad
Uranyl Nitrate	2@ 25,000	Controlled, diked pad
Uranyl Nitrate	70,000	Controlled, diked pad
Uranyl Nitrate	3@ 29,000	Controlled, diked pad
Uranyl Nitrate (NE, SE, NW, SW)	6@ 14,200	Controlled, diked pad
Uranyl Nitrate	4@ 30,000	Controlled, diked pad
H2SO4 (Southside)	1,000	Controlled, diked pad
LOCATION-Metals Fabrication Plant--Plant 6		
Oil and Organics		
Soluble Oil Coolant	40,000	Concrete containment dike
Quench Oil (Salt Oil Heat Treating-East	2,000	Concrete containment dike
Oil-Water Wast Residue (Salt Oil Heat Treating-West)(Portable Unit)	1,000	Concrete containment dike

TABLE 3.9 (continued)

LOCATION OF OIL AND HAZARDOUS SUBSTANCE STORAGE AT THE FMPC

TYPE	SIZE (GALLONS)	CONTAINMENT SYSTEM
Hazardous Substances		
HNO3 (Southside)	780	Controlled, diked pad
HNO3 (Eastside)	1,100	Controlled, diked pad
Sodium Hydroxide (NaOH) (Northside)	3,000	Controlled, diked pad
Sodium Hydroxide (NaOH) (Portable Unit)	300	Controlled, diked pad
LOCATION-Scrap Recovery Plant--Plant 8		
NaOH (Northside)	2@ 17,000	Controlled, diked pad
LOCATION-Metals Production Plant--Plant 5		
HNO3 (Ingot Pickling - T-1)	210	Controlled, diked pad
HNO3 (Ingot Pickling - T-6)	2,300	Controlled, diked pad
HNO3 -Uranyl Nitrate Mix (Ingot Pickling - T-5)	950	Controlled, diked pad
LOCATION-Tank Farm		
Oil and Organics		
Tributylphosphate (TBP) (#15)	12,700	Controlled, liner system
Kerosene (Buried) (#16)	12,600	Controlled, liner system
Hazardous Substances		
Ammonia (#1)	15,800	Controlled, liner system
Ammonia (#11 & 12)	2@ 14,000	Controlled, liner system
KOH (#2)	26,000	Controlled, liner system
Hydrofluoric Acid (#4-7)	4@ 26,000	Controlled, liner system
Hydrofluoric Acid (Surge Tank) (#9)	31,000	Controlled, liner system
Dilute Hydrofluoric Acid (#18 & 21)	2@ 30,000	Controlled, liner system
Ammonia Hydroxide (#14)	12,000	Controlled, liner system
HNO3 (#20)	75,000	Controlled, liner system

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TABLE 3.9 (continued)

LOCATION OF OIL AND HAZARDOUS SUBSTANCE STORAGE AT THE FMPC

TYPE	SIZE (GALLONS)	CONTAINMENT SYSTEM
LOCATION-Refinery Sump		
Oil and Organics		
Organics mixed with other water based effluents	2@ 25,000	Controlled, diked pad
Hazardous Substances		
HNO3 (Filter Wash Tank)	600	Controlled, diked pad
LOCATION-Railroad Engine House		
Oil and Organics		
Diesel Fuel (Buried)	12,000	None
LOCATION-Special Products Plant--Plant 9		
Oil and Organics		
Waste Oil (E Sump Tank)	7,833	Concrete containment dike
Cutting Oil (Rapid Borer Facility-NE)	1,885	Concrete containment dike
Waste Oil (W. Sump Tank)	7,833	Controlled, diked pad
Hazardous Substances		
Hydrofluoric Acid (HF) (Westside)	1,000	Controlled, diked pad

TABLE 3.9 (continued)

LOCATION OF OIL AND HAZARDOUS SUBSTANCE STORAGE AT THE FMPC

TYPE	SIZE (GALLONS)	CONTAINMENT SYSTEM
LOCATION-Oil Burner Facility		
Oil and Organics		
Waste Oil (Feed Tank)	400	Controlled, diked pad
Waste Oil & Sludges (Water Separator)	200	Controlled, diked pad
Waste Oil and Sludges	55	Controlled, curbed pad
LOCATION-Maintenance Shops		
Oil and Organics		
Gasoline (Emergency Generator Tank) (Buried)	1,000	None
Diesel Fuel (Portable)	550	None
LOCATION-General Sump		
Hazardous Substances		
Raffinate (Tank 12)	15,000	Controlled, diked pad
LOCATION-Water Treatment		
Hazardous Substances		
Sulfuric Acid	600	Controlled, diked pad
Chlorine	150 lb cylinders	Secondary containment
Sodium Hypochlorite (NaOCl)	200 lb	Secondary containment
Calcium Hypochlorite (CaOCl)	1,500-2,000 lb (3-4 drums)	Secondary containment

TABLE 3.9 (continued)

LOCATION OF OIL AND HAZARDOUS SUBSTANCE STORAGE AT THE FMPC

TYPE	SIZE (GALLONS)	CONTAINMENT SYSTEM
Oil and Organics		
Gasoline (Buried)	2@ 1,500	None
Diesel Fuel (Emergency Generator) (Portable)	550	None
LOCATION-Clearwell Pumphouse		
Oil and Organics		
Gasoline	275	None
LOCATION-Fire Pumphouse		
Oil and Organics		
Diesel Fuel	275	None
LOCATION-No. 3 Well Pumphouse		
Oil and Organics		
Diesel Fuel	500	None
LOCATION-Chemical Waste Pit Area		
Oil and Organics		
Diesel Fuel (Portable)	550	None

TABLE 3.9 (continued)

LOCATION OF OIL AND HAZARDOUS SUBSTANCE STORAGE AT THE FMPC

TYPE	SIZE (GALLONS)	CONTAINMENT SYSTEM
LOCATION-Pilot Plant		
Oil and Organics		
Contaminated Solvent (1,1,1 Trichloroethane) (North Solvent Storage Tank-AX)	2,200	Controlled, diked pad
Contaminated Solvent (1,1,1 Trichloroethane) (South Solvent Storage Tank-CR)	2,200	Controlled, diked pad
Contaminated Solvent (1,1,1 Trichloroethane) (T5)	10,000	Controlled, diked pad
Contaminated Solvent (1,1,1 Trichloroethane) (T6)	8,110	Controlled, diked pad
Hazardous Substances		
Hydrofluoric Acid (HF), Anhydrous (Eastside)	5,000	Controlled, diked pad
Thorium Hold Tank (T2)	7,707	Controlled, diked pad
Thorium Hold Tank (T1)	7,640	Controlled, diked pad
Thorium Hold Tank Emergency Transfer (T3) (Empty)	7,757	Controlled, diked pad
Nitric Acid (NOH3) (010016) Westside	2,400	Controlled, diked pad
Spill Storage Tank (F100) Westside (Empty)	7,833	Controlled, diked pad
Spill Storage Tank (F101) Westside (Empty)	7,833	Controlled, diked pad

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Table 3.10

THORIUM INVENTORY COMPOSITION
(Metric Tons Thorium)

MATERIAL FORM	METRIC TON	LOCATION
ThO_2 Dense (GE-Bettis)	4.3	Bldg. 67, Bldg. 72
ThO_2 Sol Gel	25.9	Bldg. 67
Pilot Plant - WIP	9.2	Pilot Plant Tank #2 & Lab
Impure Thoria Gel	338.3	Pilot Plant Warehouse
Thorium Oxides	174.6	Plant 8 Silo
Thorium Oxalate Cake	1.2	Bldg. 67, Bldg. 72
Thorium Nitrate Crystals	1.2	Bldg. 67
Low-Grade Residues from General Atomic	321.7	Bldg. 65
Offsite Thorium Hydroxide	10.8	Bldg. 67
Offsite Thorium Oxides	74.4	Bldg. 67, Bldg. 72
Thorium Nitrate Solution	0.9	Bldg. 67
ThF_4	0.8	Bldg. 67
Metal	79.9	West Bldg. 65, Bldg. 72, and Bldg. 67
Clad Metal	4.4	West Bldg. 65
Alloyed Metal	3.5	West Bldg. 65, Bldg. 72, and Bldg. 67
Historical Samples	0.5	Bldg. 67, West Bldg. 65
High Grade Residues (>30% Th.)	35.7	Bldg. 67, West Bldg. 65
Low Grade Residues (<30% Th)	0.2	Bldg. 67
TOTAL	1087.5	

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TABLE 3.11

LOCATION AND NUMBER OF THORIUM CONTAINERS

	CONTAINERS	LOCATION
	5,836[a]	Building 65
	1,313[a]	Pilot Plant
	5,882[b]	Building 67
	180[c]	Building 64
Total	13,211	

a) drums

b) approximately 5,500 of these are cans

c) cans

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3.7.4 UNDERGROUND STORAGE TANKS

Eleven underground storage tanks are located on the FMPC. A description of tank location, total capacity, construction material, use status, and presence or absence of a hazardous material is presented in Table 3.12.

3.7.5 COAL PILE

Coal used in the coal-fired boiler is stockpiled in the northwest corner of the Production Area on a gravel pad. The coal is supplied by mining operations located in Kentucky. Current coal inventory is 6,500 tons; however, the normal inventory usually is kept at about 9,500 tons. Runoff from the coal pile is contained as described in Section 3.6.13.

3.8 ENVIRONMENTAL MONITORING

3.8.1 SURFACE WATER MONITORING

An environmental strategy for surface water pollution control has been developed at the FMPC for compliance with requirements of the Clean Water Act (CWA). The strategy uses a combination of state-of-the-art technology and conventional means of pollution control. The objective is compliance with applicable Federal and State of Ohio regulations for the discharge of liquid effluents.

3.8.1.1 Surface Water Monitoring Program

Surface water monitoring samples are taken at six on-site locations to assure effective control of liquid effluents (see Figure 3.7). These sampling locations are at the NPDES outfalls: Manhole 175 (Monitoring Location W-2), the storm sewer overflow to Paddy's Run (Monitoring Location W-6) and the four contributing streams to Manhole 175. Additionally, water samples are collected from three sites on the Great Miami River and two locations on Paddy's Run in order to evaluate the contributions of FMPC operations to off-site contaminant levels.

Daily samples of the individual major wastewater effluents are collected from the General Sump, Clear Well, Sewage Treatment Plant and Storm Sewer System. In addition, a continuous sample is collected from the discharge line after all streams mix together. Samples are analyzed for uranium, alpha and beta radioactivity and several nonradioactive chemicals.

Daily water samples, collected from the Great Miami River upstream and downstream of the FMPC discharge line, are analyzed for uranium, radium, and several nonradioactive chemicals. A weekly grab sample is collected downstream from the mouth of Paddy's Run. Grab samples are also collected weekly from sampling locations in Paddy's Run.

TABLE 3.12

TYPES AND LOCATION OF UNDERGROUND STORAGE TANKS

TANK NUMBER	AGE	LOCATION	TOTAL CAPACITY (GALLON)	CONSTRUCTION MATERIAL	TANK STATUS	SUBSTANCE
1	6	Garage	1,500	Fiberglass	In Use	Fuel
2	6	Garage	1,500	Fiberglass	In Use	Fuel
3	34	Engine House	12,250	Steel	In Use	Fuel
4	34	Truck Dock At Plant 1	3,000	Steel	In Use	Fuel
5	34	Tank Farm At Plant 4	13,525	Steel	In Use	Fuel
6	34	Garage	200	Steel	Not In Use	Waste Oil
7	34	Maintenance Shops Building Change	1,000	Steel	In Use	Fuel
8	34	Plant 9 (Northside)	500	Steel	In Use	Waste Oil
9	34	Garage	1,000	Steel	Not In Use	Fuel
10	34	Garage	1,000	Steel	Not In Use	Fuel
11	34	Garage	3,000	Steel	Not In Use	Fuel

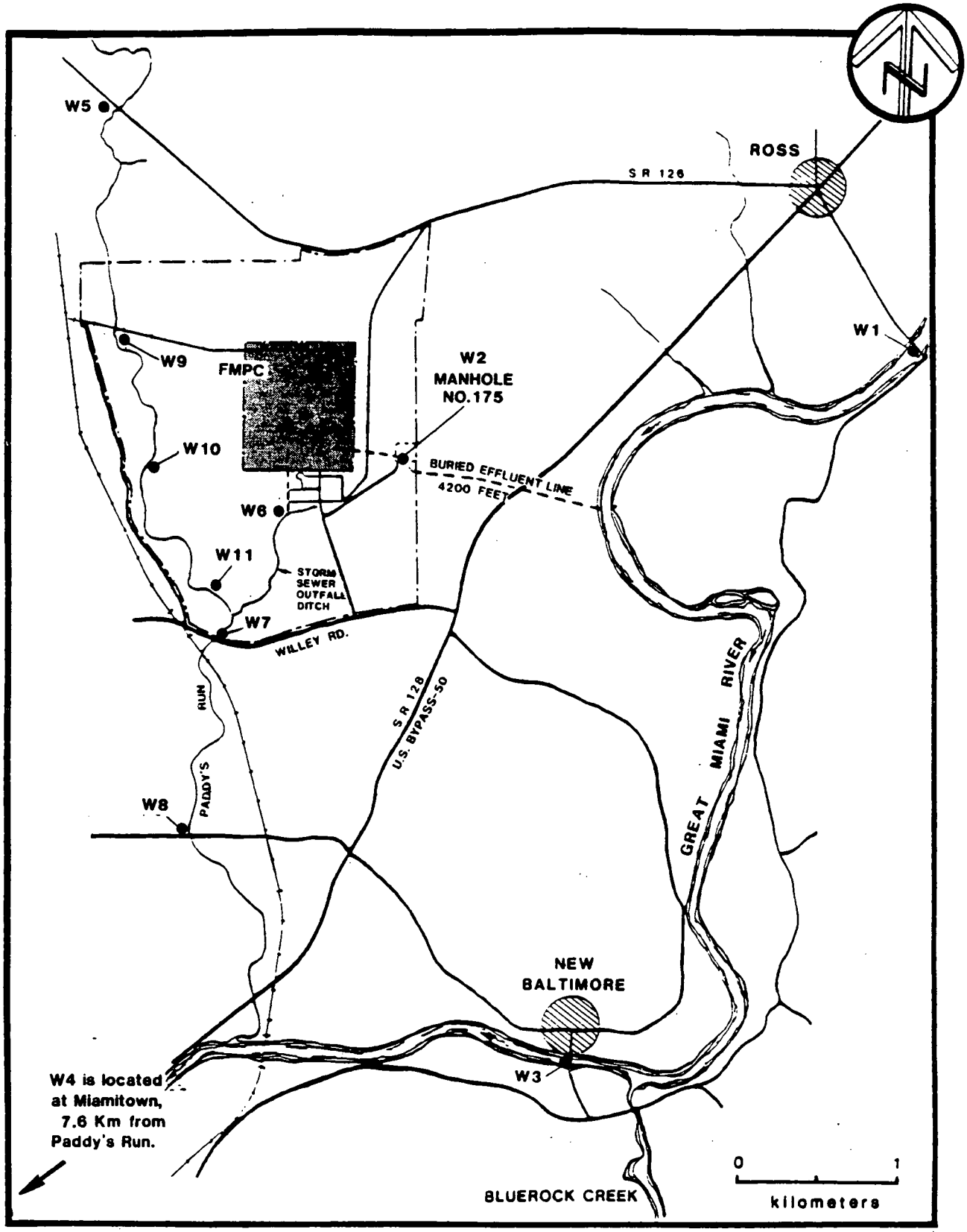

FIGURE 3.7
SURFACE WATER SAMPLING LOCATIONS

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3.8.1.2 Surface Water Monitoring Results

Sampling location W-2 is the final access point prior to discharge to the Great Miami River. Samples are continuously collected in proportion to the flow and composited for a 24-hour period. These samples are analyzed for uranium content and radioactivity due to alpha and beta particles. Table 3.13 lists the average concentrations for 1985 compared to federal guidelines for uncontrolled areas. The highest percent of guideline for any of the radionuclides is that for total uranium (54.5 percent). Table 3.14 summarizes the average concentrations of radionuclides in surface water for the other ten monitoring locations. Although elevated uranium concentrations occur along the on-site location, radionuclides in surface water on the downgradient off-site locations are substantially reduced.

Water quality at the NPDES discharge points is also evaluated for nonradiological parameters. Table 3.15 presents a summary of NPDES data for 1984 and 1985 and percent compliance for each parameter. Those parameters exceeding standard were ammonia and oil and grease--Manhole 175; suspended solids--storm sewer outfall, sewage treatment plant, and combined general sump and clear well; five-day biochemical oxygen demand--sewage treatment plant; and chromium (+6), iron, and copper--combined general sump and clear well. Weekly samples collected at off-site locations W-1, W-3, and W-4 are also analyzed for fluorides, chlorides, and nitrates (Table 3.16).

3.8.2 GROUND WATER MONITORING

3.8.2.1 Ground Water Monitoring Program

There are 41 ground water monitoring wells used to evaluate potential off-site migration of FMPC releases. The on-site wells are monitored quarterly and the off-site wells monthly. Locations of these wells are shown in Figure 3.8. In addition, water samples have been obtained from numerous other wells in the vicinity of the FMPC at various times (Figure 3.9). Quarterly samples from the on-site wells are analyzed for uranium and gross alpha and beta. Monthly samples from off-site wells are analyzed for uranium.

The ground water monitoring program at the FMPC is intended to:

- Characterize the general ground water quality in the area;
- Determine the presence and level of hazardous constituents; and
- Determine the presence and level of radionuclides in ground water.

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TABLE 3.13
RADIONUCLIDES DISCHARGED AT SAMPLING POINT W2

RADIONUCLIDES	TOTAL CURIES	AVERAGE CONCENTRATION[a] pCi/l	% OF GUIDELINES[b]
^{137}Cesium	0.017	15.68	0.08
^{237}Neptunium	0.0002	<0.27	<0.009
^{238}Plutonium	0.00003	0.0082	0.0005
^{239}Plutonium	0.0005	0.23	0.005
^{226}Radium	<0.017	<8.11	<27.0
^{228}Radium	<0.014	<12.86	<42.9
^{106}Ruthenium	0.0005	<1.58	<0.002
^{90}Strontium	0.012	8.39	2.8
^{99}Technetium	18.96	13378.38	4.5
^{232}Thorium	0.0005	<17.73	<0.89
^{234}Uranium	0.34	243.30	6.1
^{235}Uranium	0.018	11.92	0.30
^{236}Uranium	0.021	7.89	0.16
^{238}Uranium	0.39	326.71	54.5
Uranium[c]	0.68	660.84	55.1

(a) Radionuclide concentrations in the plant effluent discharged to the Great Miami River through a buried pipeline, (with the exception of the three radium isotopes, thorium, ruthenium, and uranium) are determined from two six-month composites. An additional 2.6×10^{-2} Curies of uranium was contained in storm sewer overflow discharged into Paddy's Run above sampling point W7.

(b) Guidelines used by FMPC for uranium isotopes and total uranium are more stringent than levels set by 10 CFR Part 20, Appendix B.

(c) From 12 monthly averages assuming total uranium as natural uranium (^{235}U = 0.71% by weight).

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TABLE 3.14

RADIONUCLIDES IN SURFACE WATER

RADIONUCLIDE	SAMPLING POINT[a]	AVERAGE[b]	% of GUIDELINE
Gross α[c]	W1	2.24	7.5
	W3	2.58	8.6
	W4	2.77	9.2
	W5	2.77	5.7
	W7	32.71	109.0
	W8	7.96	26.5
	W9	9.44	31.5
	W10	5.75	19.2
	W11	6.87	22.9
GROSS β[c]	W1	4.91	16.4
	W3	7.49	25.0
	W4	7.17	23.9
	W5	5.85	19.5
	W7	16.71	55.7
	W8	12.61	42.0
	W9	9.53	31.8
	W10	7.61	25.4
	W11	23.81	79.4
^{137}Cesium	W1	<4.05	<0.01
	W3	<4.05	<0.01
	W4	<2.70	<0.01
^{226}Radium	W1	<0.45	<1.5
	W3	<0.45	<1.5
	W4	<0.45	<1.5
	W5	<0.45	<1.5
	W7	<0.45	<1.5
^{228}Radium	W1	<0.45	<1.5
	W3	<0.45	<1.5
	W4	<0.45	<1.5
	W5	<0.45	<1.5
	W7	<0.45	<1.5
^{90}Strontium	W1	<0.81	<0.27
	W3	<1.35	0.45
	W4	1.35	<0.45
^{99}Technetium	W1	1.08	<0.01
	W3	2.97	<0.01
	W4	4.59	<0.01

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TABLE 3.14 (Continued)

RADIONUCLIDES IN SURFACE WATER
(Continued)

RADIONUCLIDE	SAMPLING POINT[a]	AVERAGE[b]	% of GUIDELINE
^{234}Uranium	W1	3.72	0.09
	W3	4.14	0.10
	W4	3.93	0.10
^{235}Uranium	W1	0.16	0.004
	W3	0.18	0.005
	W4	0.17	0.004
^{236}Uranium	W1	0.04	0.001
	W3	0.06	0.001
	W4	0.05	0.001
^{238}Uranium	W1	3.72	0.62
	W3	4.16	0.69
	W4	3.96	0.66
Uranium	W1	1.57	0.1
	W3	.61	0.1
	W4	1.89	0.2
	W5	1.60	0.1
	W7	43.37	3.6
	W8	7.18	0.6
	W9	23.33	1.9
	W10	235.51	19.6
	W11	9.82	0.8

(a) See Figure 3.7

(b) Samples are composited for radium analyses as follows: one-month composites of daily samples from W1 and W3; one-month composites of weekly samples from W4, two-month composites of weekly samples from W5, and one-month composites of all available weekly samples from W7. Semiannual composites were used for those isotopes where two samples are noted.

(c) Gross alpha and gross beta activity values contain activity of uranium and radium in the samples, thus are highly conservative.

TABLE 3.15

SUMMARY OF NPDES DATA FOR THE YEARS 1984-1985

PARAMETER	UNITS	NPDES PERMIT LIMITS Daily Max.	NPDES PERMIT LIMITS Mo. Average	DAILY MINIMUM 1985	DAILY MINIMUM 1984	DAILY MAXIMUM 1985	DAILY MAXIMUM 1984	ANNUAL AVERAGE 1985	ANNUAL AVERAGE 1984	PERCENT COMPLIANCE 1985	PERCENT COMPLIANCE 1984
LOCATION-Discharge 001 (Manhole 175)											
Flow Rate	MG/Day	NA	NA	0.106	0.072	1.131	1.102	0.451	0.576	NA	NA
pH	pH Units	6.5-10.0	6.5-10.0	7.4	7.3	9.1	9.3	NA	NA	100	100
Suspended Solids	mg/L	60	20	<2	<2	26	33	5	8	100	100
Ammonia (N)	kg/Day	43	28	<1	<1	3	46	<1	6	100	98
Oil and Grease	mg/L	15	NA	<5	<5	19	9	<5	5	98	100
Residual Chlorine	mg/L	0.10	NA	<0.02	0.01	0.06	0.08	0.03	0.05	100	100
Nitrate (N)	kg/Day	3180	1590	40	86	1275	2318	370	990	100	98
LOCATION- Discharge 002 (Storm Sewer Outfall)											
Flow Rate	MG/Event	NA	NA	0.007	0.006	0.844	1.00	0.179	0.161	NA	NA
pH	pH Units	6.5-9.0	6.5-9.0	7.5	7.4	8.3	8.5	NA	NA	100	100
Suspended Solids	mg/L	100	30	<2	<2	175	64	15	8	96	100
Oil and Grease	mg/L	15	NA	<5	<5	<5	17	<5	5	100	100
LOCATION- 001A (Sampling of Sewage Treatment Plant)											
Flow Rate	MG/Day	NA	NA	0.035	0.020	0.253	0.246	0.124	0.119	NA	NA
pH	pH Units	6.5-9.0	6.5-9.0	7.2	7.1	7.9	8.3	NA	NA	100	100
BOD, 5-day	mg/L (Kg/Day)	40(10.0)	20(5.0)	1(0.6)	<1(0.1)	27(20.3)	18(6.0)	9(4.4)	7(2.9)	94	100
Suspended Solids	mg/L (Kg/Day)	40(10.0)	20(5.0)	1(0.4)	1(0.3)	27(14.8)	12(8.7)	5(2.5)	4(2.0)	96	100
Fecal Coliform	MPN/100ml	2000	1000	0	1	1000	2000	76	356	100	100
LOCATION- 001B and 001C (Sampling of Combined General Sump and Clearwell)											
Flow Rate	MG/Day	NA	NA	0.000	0.000	0.992	0.312	0.196	0.182	NA	NA
Suspended Solids	kg/Day	12.8	6.2	0.9	0.6	112.4	17.8	6.9	5.1	90	94
Chromium (+6)	kg/Day	0.008	0.004	0.001	0.0003	0.051	0.013	0.005	0.005	79	75
Chromium (Total)	kg/Day	0.102	0.050	0.002	0.003	0.058	0.047	0.012	0.018	100	100
Iron	kg/Day	0.85	0.41	0.01	0.06	1.16	0.66	0.21	0.20	92	98
Nickel	kg/Day	0.256	0.124	0.006	0.003	0.119	0.161	0.033	0.049	100	100
Copper	kg/Day	0.051	0.025	0.005	0.005	0.088	0.104	0.017	0.025	96	86
LOCATION- 001D (Sampling of Lift Station)											
Flow Rate	MG/Day	NA	NA	0.079	0.0	0.694	0.632	0.248	0.249	NA	NA
Suspended Solids	mg/L	100	30	<2	<2	35	73	<5	8	100	100
Oil and Grease	mg/L	15	NA	<5	<5	5	7	<5	<5	100	100

NA = Not Applicable

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TABLE 3.16

ION AND pH LEVELS IN SURFACE WATER

PARAMETER	SAMPLING POINT	NUMBER OF SAMPLES	AVERAGE	% of GUIDELINE	GUIDELINE[a]
	W1	52	0.49	27	
	W3	52	0.50	28	
	W4	52	0.50	28	
	W5	13	0.25	14	
Fluoride	W7	12	0.35	19	1.8 mg/l
	W8	12	0.15	8	
	W9	3	0.17	9	
	W10	2	0.25	14	
	W11	2	0.35	19	
	W1	52	3.57	36	
	W3	52	3.64	36	
	W4	52	3.62	36	
	W5	12	1.68	17	
Nitrate	W7	12	2.01	20	10 mg/l
(as N)	W8	11	0.82	8	
	W9	3	1.47	15	
	W10	2	1.03	10	
	W11	2	2.35	24	
	W1	52	60.1	24	
	W3	52	60.0	24	
	W4	52	60.6	24	
	W5	12	34.2	14	
Chloride	W7	13	21.2	8	250 mg/l
	W8	11	46.2	18	
	W9	3	24.0	10	
	W10	2	14.5	6	
	W11	2	14.5	6	

(a)Ohio EPA standards, Administrative Code Chapter 3745-1

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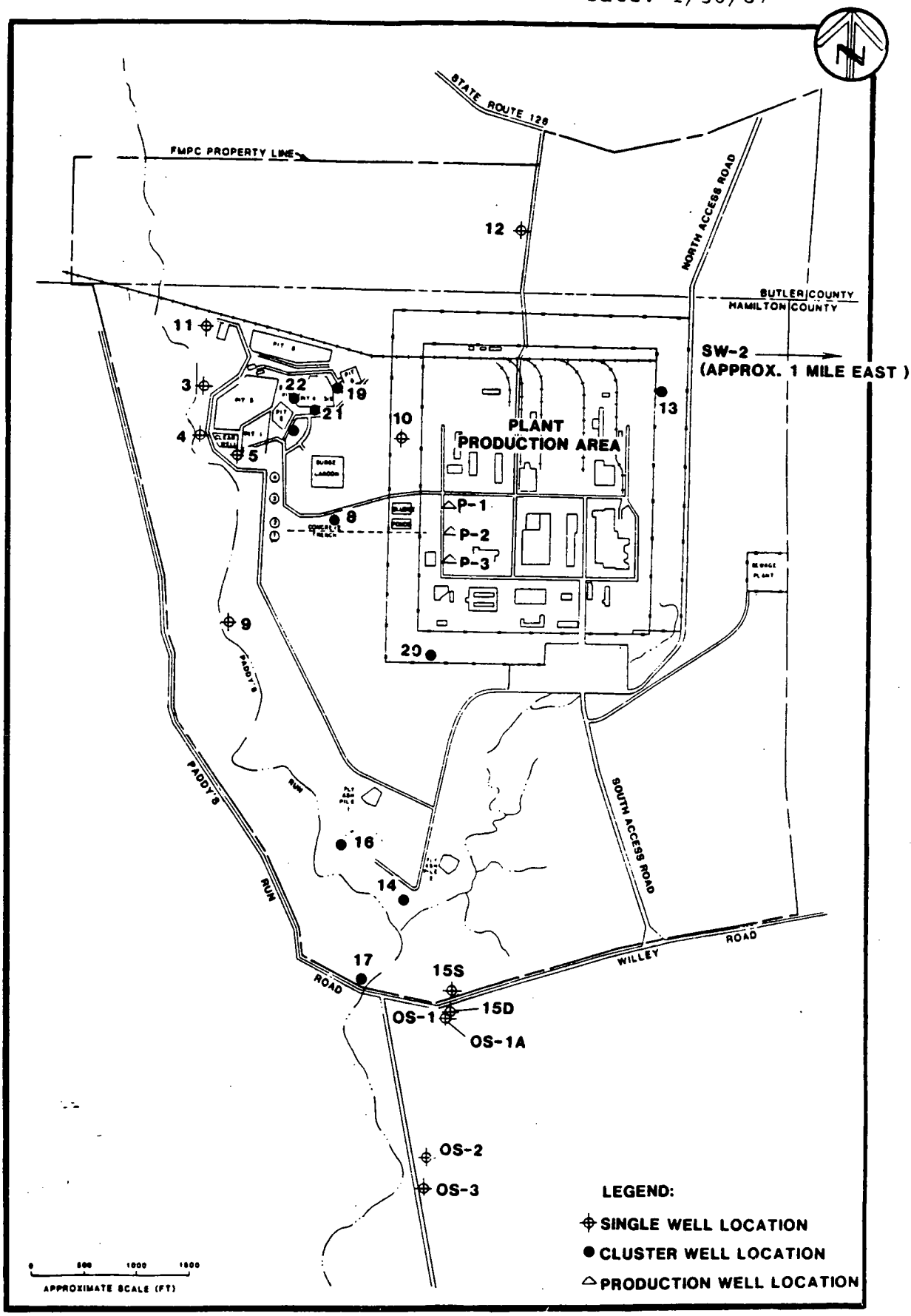

FIGURE 3.8
GROUND WATER MONITORING WELL LOCATIONS

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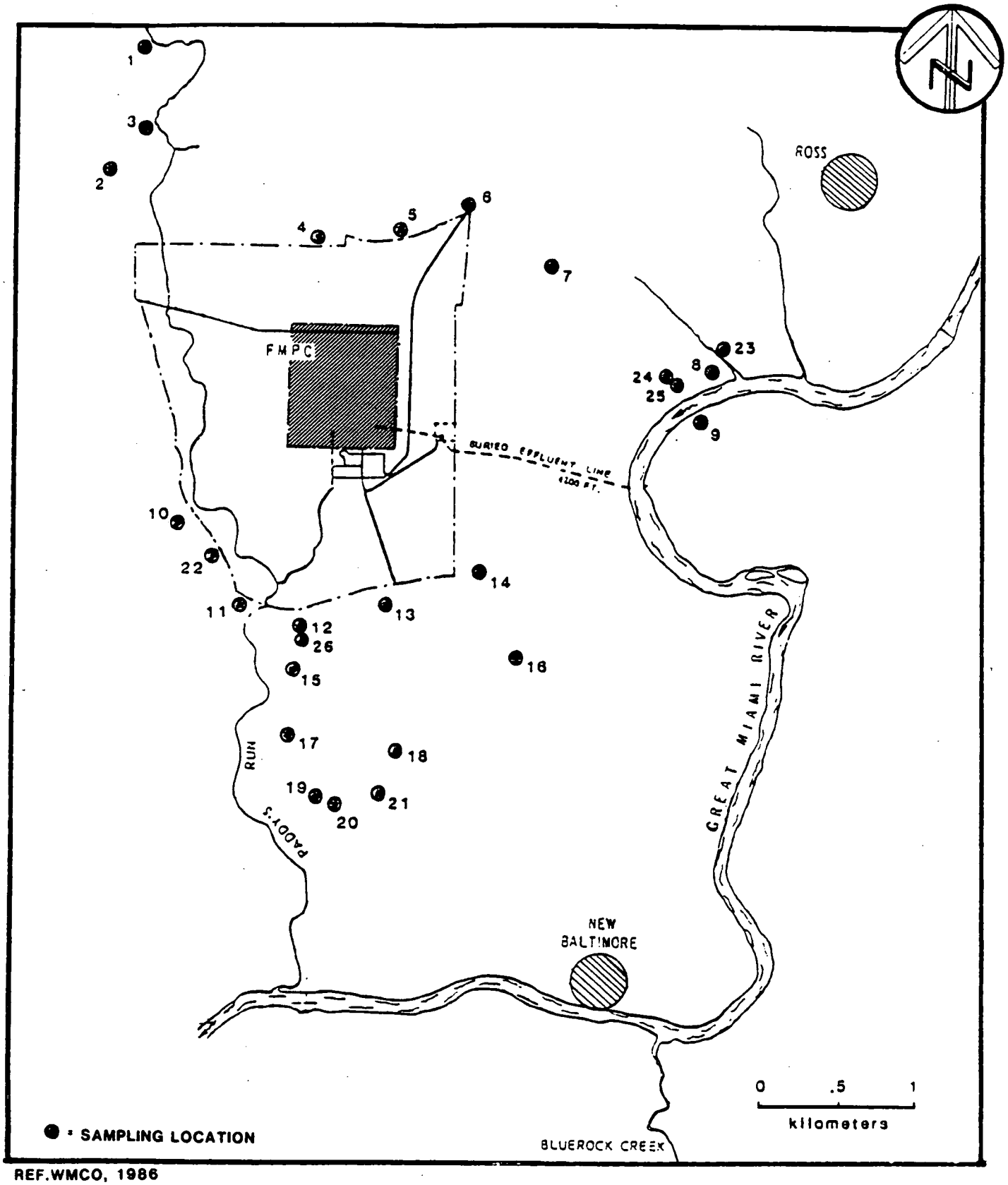

REF.WMCO, 1986

FIGURE 3.9
OFF-SITE MONITORING WELL LOCATIONS

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Present RCRA ground water monitoring consists of collecting water samples from monitor wells and analyzing for 95 specific parameters (Table 3.17). In addition, water levels are measured in each well prior to taking a sample. Because of well construction considerations, water levels are not measured in the on-site production wells, P-1, P-2, and P-3 and the off-site farm well sampling point, OS-1, south of Willey Road (Figure 3.8).

The monitoring wells are completed primarily in the sand and gravel aquifer. Six of the wells are completed in the overlying till. The wells are located both upgradient and downgradient of the Waste Disposal and Production Areas. Well 12, for example, is completed in the till north of the Production Area (upgradient) to determine the background of the shallow till ground water system.

The sand and gravel aquifer north of the FMPC ends abruptly against the till and shale bedrock walls at the New Haven Trough. Consequently, Well SW-2, operated by the Southwestern Ohio Water Company, has been identified as potentially providing a representative background water quality for the sand and gravel aquifer. Although this well is believed to be in a different flow regime, it is likely that water from this source is more representative of natural ground water conditions beneath the FMPC rather than one that is situated closer to the facility but which may be affected by proximity to the till (Dames and Moore, 1986a). The downgradient monitor wells are in the vicinity of various potential contaminant sources that affect or, may in the future affect, ground water quality.

3.8.2.2 Ground Water Monitoring Results

Ground water quality measurements prior to the initiation of the 41-well monitoring program were largely limited to determination of uranium concentrations. Based on 228 samples collected upgradient of the FMPC between 1978 and 1982, the average background concentration for total uranium was 0.8 ug/l (0.5 pCi/l) (Dames and Moore, 1985). Six on-site wells (Table 3.18) and 13 off-site wells (Table 3-19) have measured levels in excess of the background. The highest levels have been measured in three off-site wells, OS-1, OS-2, OS-3 (Figure 3.8) south of the facility to the east of Paddy's Run. The highest on-site uranium concentrations in ground water have been found in Wells 1, 8, and 10 on the downgradient (easterly) side of the Waste Disposal Area and Wells 3, 4, and 5 somewhat upgradient of the Waste Disposal Area and east of Paddy's Run.

The ground water monitoring program, which is part of the RCRA monitoring compliance effort, consists of monitoring on a quarterly basis. The second round of this program was completed during May, 1986 (Dames and Moore, 1986). The findings from the first two rounds of sampling are summarized below.

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TABLE 3.17

GROUND WATER PARAMETERS TO BE ANALYZED

A. For General Water Quality[a]

1. Chloride
2. Iron
3. Manganese
4. Phenols
5. Sodium
6. Sulfate

B. For Indicators of Contamination (Quadruplicate Analysis)[a]

1. pH
2. Specific Conductance
3. Total Organic Carbon (TOC)
4. Total Organic Halogen (TOX)

C. For Drinking Water Suitability[a]

1. Arsenic
2. Barium
3. Cadmium
4. Chromium - Hexavalent
   - Total
5. Fluoride
6. Lead
7. Mercury
8. Nitrate
9. Selenium
10. Silver
11. Gross Alpha
12. Gross Beta
13. Radium
14. Endrin
15. Lindane
16. Methoxychlor
17. Toxaphene
18. 2,4-D
19. 2,4,5-TP
20. Coliform Bacteria

D. Site Specific Parameters[b]

1. Nickel
2. Cyanide
3. Copper
4. Zinc
5. Magnesium
6. Calcium
7. Phosphorus
8. Chlorobenzene
9. Chlorodibromomethane
10. Chloroethane
11. 2-Chloroethylvinyl
12. Chloroform
13. Dichlorobromomethane
14. Dichlorofluoromethane
15. Total Dissolved Solids (TDS)
16. Total Potassium
17. Chemical Oxygen Demand (COD)
18. Perchloroethylene
19. cis-1,2-Dichloroethylene
20. Tributylphosphate
21. Acrolein
22. Acrylonitrile
23. Benzene
24. bis-(chloromethyl)-Ether
25. Bromoform
26. Bromodichloromethane
27. Bromomethane
28. Carbon tetrachloride
29. Chloromethane
30. 1,2 Dichlorobenzene
31. 1,3 Dichlorobenzene
32. 1,4 Dichlorobenzene

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Table 3.17 (Continued)

GROUND WATER PARAMETERS TO BE ANALYZED

33. 1,1-Dichloroethane
34. 1,2-Dichloroethane
35. 1,1-Dichloroethylene
36. 1,2-Dichloropropane
37. 1,2-Dichloropropylene
38. Ethylbenzene
39. Methylbromide
40. Methylchloride
41. trans-1,2 Dichloro-ethylene
42. 1,3-Dichloropropene
43. 1,1,2,2-Tetrachloroethane
44. Tetrachloroethylene
45. Toluene
46. 1,1,1-Trichloroethane
47. 1,1,2-Trichloroethane
48. Trichloroethylene
49. Trichlorofluoromethane
50. Vinyl Chloride

E. Radionuclide[b]

1. Total Uranium
2. Isotopic Uranium
3. Radium 226
4. Radium 228
5. Technetium 99
6. Thorium 228
7. Thorium 230
8. Throium 232
9. Cesium 137
10. Strontium 90
11. Ruthenium 106
12. Neptunium 237
13. Plutonium 238
14. Plutonium 239
15. Plutonium 240

F. Schedule - Quarterly for one (1) year, semiannual thereafter (or as necessary according to regulations).

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a)Required for RCRA and analyzed for each sample.

b)Not required for RCRA, but also analyzed for each sample.

TABLE 3.18

URANIUM IN ON-SITE WELL WATER

Sampling Point[a]	Concentration Average pCi/ℓ	% of Standard[b]
P1	0.25	0.02
P2	0.30	0.03
P3	0.15	0.01
T1S	6.89	0.57
1D	0.19	0.02
3	1.76	0.15
4	5.52	0.46
5	2.49	0.21
8S	0.59	0.05
8D	0.24	0.02
9	0.90	0.07
10	13.88	1.16
11	0.15	0.01

a) See Figure 3.8

b) Guidelines used by FMPC for uranium are more stringent than levels set by 10 CFR Part 20, Appendix B, Concentration in A.2 and water above natural background.

Source: WMCO, 1986.

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TABLE 3.19

URANIUM IN OFF-SITE WELL WATER

Sampling Point[a]	Concentration Average pCi/ℓ	% of Standard[b]
1	0.30	0.02
2	NS(3)	NS
3	0.23	0.02
4	1.08	0.09
5	1.31	0.11
6	1.37	0.11
7	0.95	0.08
8	0.53	0.04
9	0.99	0.08
10	0.38	0.03
11	0.81	0.07
12	140.00	11.67
13	0.44	0.04
14	0.73	0.06
15	204.27	17.02
16	0.67	0.06
17	31.15	2.60
18	0.29	0.02
19	0.20	0.02
20	0.16	0.01
21	0.29	0.02
22	0.76	0.06
23	0.55	0.05
24	0.32	0.03
25	0.27	0.02
26	0.24	0.02

a)See Figure 3.9.

b)Guidelines used by FMPC for uranium are more stringent than levels set by 10 CFR Part 20, Appendix B, Concentrations in Air and Water Above Natural Background.

(3)NS = Not sampled at homeowner's request.

Source: WMCO, 1986.

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The 41-well monitoring program can be divided into two groupings: 1) a till well monitoring system; and 2) the sand and gravel aquifer monitoring system. The latter is further subdivided as to well location either within or outside the Plant Production Area.

Till Ground Water Quality

- No VOC's or pesticide/herbicide have been detected in the till water-bearing zone.

- No radionuclides above background have not been detected in Well 12 (up gradient). Wells 20 (southwest of production area) and OS-1a (off site) are slightly above background. Wells 19, 21, and 22 continue to show gross alpha, gross beta and radium concentrations in excess of U.S. EPA drinking water standards.

- Wells OS-1a, 20, and 22 show high coliform levels.

- Till water quality is generally high in iron, manganese and total dissolved solids (TDS).

- Elevated chloride (Well MW-19TP) and sulfate (Wells MW-19TP, MW-21TP, and MW-22TP) may indicate contamination due to waste disposal activities.

Sand and Gravel Aquifer Water Quality-Production Area

- No VOCs or pesticides/herbicides were detected in 12 out of the 14 wells monitored. A concentration of 4.4 ppb of trichloroethene was detected in MW-4 and 4.06 ppb of 2,4-D and 0.694 ppb of 2,4,5-TP Silvex were detected in MW-8s. Both the 2,4,-D and 2,4,5-TP Silvex concentrations were below EPA Primary Drinking Water Standards of 10 ppb. This is the first time that these parameters have been detected in these wells and conclusions cannot be reached at this time as to the significance of these concentrations. These wells will continue to be monitored for these parameters.

- Wells 10, 13d, 19d, 22s indicate slightly elevated gross beta activities (5.3 pCi/l to 73 pCi/l). In addition, Wells 19s and 21s reported high activities at gross alpha, gross beta and radium. Wells 1s, 3, 4, 5, 10, 13s, 13d, 19s, 19d, 21s, and 22s have uranium levels above background (1.1 to 32 ug/l).

- Wells 1d, 4, and 8s show elevated levels of coliform.

- Manganese and phenols exceed recommended standards in 10 of the 14 sand and gravel aquifer wells inside the production area. However, the upgradient well, SW-2 also exceeds these standards. These elevated levels may be reflective of regional water quality.

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- Wells 19s, 19d, 21s, and 22s show elevated TDS levels. TDS concentrations in Well MW-5 exceeded recommended standards for the first time in the second round of sampling.

- Wells 19s, 21s, 22s show nitrate levels in excess at U.S. EPA Primary Drinking Water Standards.

- The production wells contain low levels of uranium. Well P-1 has a reported uranium concentration of 0.4 ug/l, and Wells P-2 and P-3 show levels of 0.2 ug/l.

Sand and Gravel Aquifer Water Quality - Outside Production Area

- VOCs have been detected only in Well 15s. This was first noted in the second round of the quarterly sampling program (Dames and Moore, 1986b).

- Elevated coliforms have been detected in Well 9.

- In 5 of the 18 wells (11, 17d, 20s, SW-2, 15d) uranium concentrations are comparable to background levels. The highest uranium concentrations continue to be found in the three off site wells, OS-1, OS-2 and OS-3, south of the FMPC.

- Manganese and/or phenols exceed secondary and recommended drinking water standards on 14 of the 18 wells. As the background Well SW-2 is also high in these two parameters, they are probably reflective of the regional water quality.

The general ground water quality in the vicinity of the FMPC can be summarized as follows:

- Widespread VOC, pesticide/herbicide, and heavy metal contamination is not present in the ground water at the FMPC (Dames and Moore, 1986b).

- Radiological and nonradiological contaminants appear to be localized in the waste disposal area from Pit 4 and may be migrating outward (Dames and Moore 1986).

- Radiological constituents above background occur in portions of the ground water system in the vicinity of the FMPC.

3.8.3 AIR MONITORING SYSTEMS

3.8.3.1 Air Monitoring Program

Most uranium production operations involve the generation of dust, fume or reaction gases. These operations are conducted in

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ventilated enclosures and the air is passed through dust collectors or scrubbers. The filtered or scrubbed air is exhausted to the atmosphere. Over 90 dust collectors have been used at the FMPC and currently 55 are in use. Since the mid-1950s, dust collector discharges have been determined through continuous stack sampling. Each stack has a sampling system which consists of a centerline probe, a pleated filter and a vacuum source. The vacuum is adjusted for isokinetic sampling. Filters are regularly changed and analyzed for uranium (NLO, 1985d).

Stack sampling was originally undertaken to show there was a need for close attention to dust collector operations. Minor problems with sampling rates and sample vacuum supply may have affected the accuracy of discharge estimates for some of the sources. Stack flow rates were determined for the initial adjustment of sampler vacuum, but were not rechecked unless there was reason to suspect a significant flow rate change might have occurred. Vacuum lines were occasionally found disconnected or the vacuum pump was turned off (NLO, 1985d). During the uranium hexafluoride process operation in Plant 7, (from 1954 to 1956) the centerline probes were occasionally plugged. These problems have received attention and no longer exist because of changes made over the years. The dust collector uranium discharges, which have produced the major part of the potential off-site releases, were monitored through continuous stack sampling. NLO developed the sampler in the early 1950s and experience has indicated that these units have given good data on uranium discharges.

Before a sampler is installed, a traverse of the stack is made to determine the total air flow and velocity profile. The sampler is installed with the probe in the stack centerline. The filter holder is attached to a vacuum source which is adjusted to provide an isokinetic sampling rate. A cellulose pleated filter is used to collect particulates; filter diameter is four inches and the effective filtering area is 77 square inches. Until recently, new filters were numbered and weighed. After removal from the sampler, they were weighed and an aliquot of the collected dust was removed, weighed and analyzed for uranium. This procedure provided the percent of uranium in the dust and the total dust and total uranium on the filter. Knowledge of the probe diameter and duct diameter permitted a calculation to obtain total dust discharge and total uranium. As of December 1984, all filters are changed at least once each month. The filters are dissolved in acid and analyzed for uranium.

Continuous air sampling is carried out at nine locations on or near the plant boundary as shown in Figure 3.10. There are also three additional locations off site with monitors currently in operation. One additional off-site station will be operational in 1987. These four off-site stations are shown in Figure 3.11. Air is drawn at one cubic meter per minute through an 8-inch by 10-inch filter which is changed weekly. The filter and

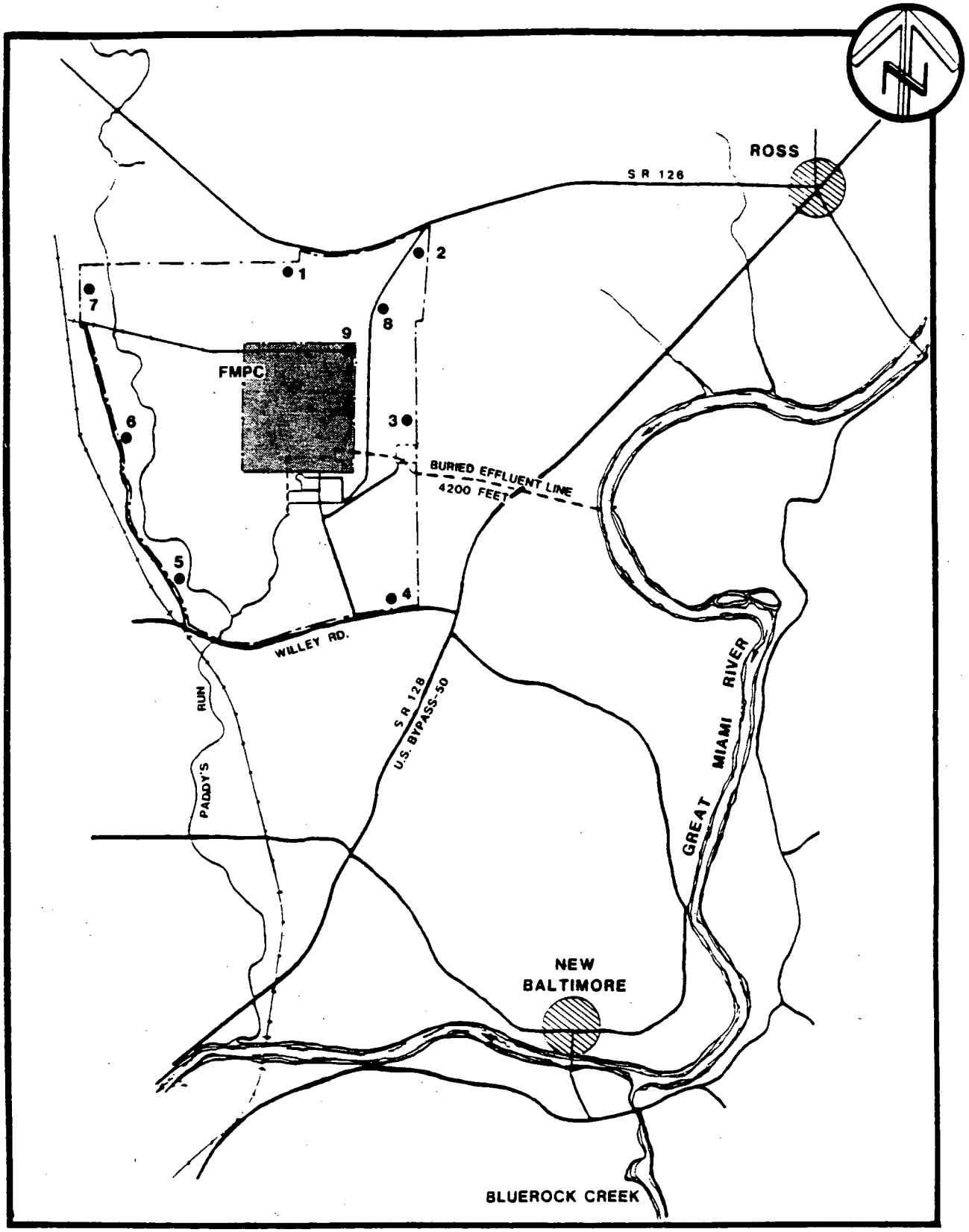

FIGURE 3.10
ON-SITE AIR MONITORING LOCATIONS

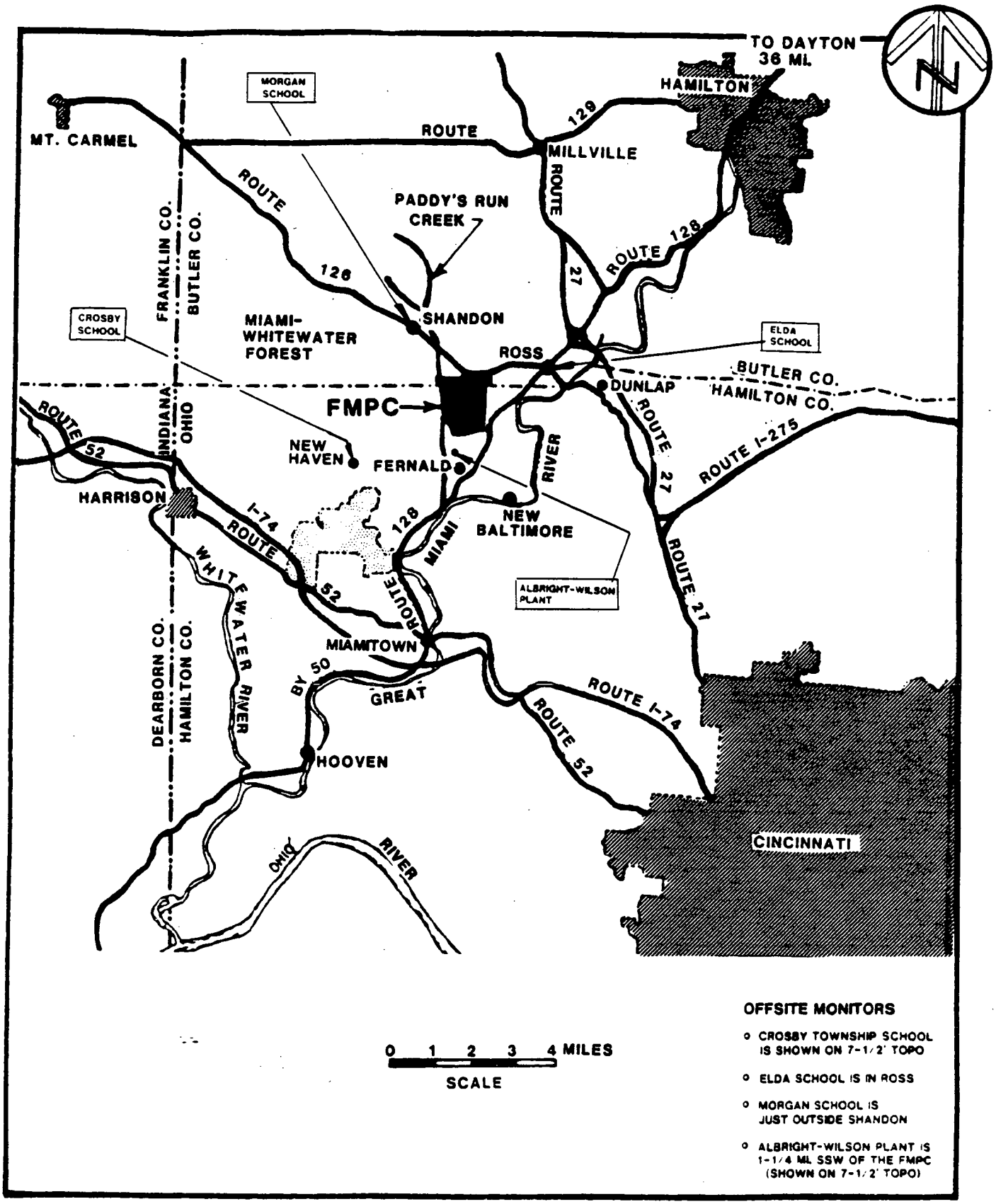

FIGURE 3.11

OFFSITE AIR QUALITY MONITORING STATIONS

its dust load are dissolved in nitric acid and the resulting solution is analyzed for uranium and radioactivity. The remaining solution is held to provide a long-term composite for the determination of other radionuclides such as thorium isotopes and transuranics. Boundary air sampling results are reported in an annual Environmental Monitoring Report.
Since 1981, commercial samplers have been used to measure radon at the plant boundary air sampling stations and three off-site locations. The devices are left in position for a calendar quarter and then returned to the manufacturer for readout.

3.8.3.2 Air Monitoring Results

Uranium has been discharged from 110 stacks during the 34-year period of 1951 through 1984. Emissions have totaled approximately 133,000 kg (NLO 1986). Emissions of uranium were highest in 1955, totaling approximately 34,000 kg, which is about nine times greater than the average annual uranium emissions for the 34-year period (Table 3.20). To arrive at uranium emissions for those periods when stack emission data were not available, reasonable estimates were made. Most of these estimates were made by extrapolating from periods when emissions were measured or they were derived from measured production-discharge ratios applied to periods for which only production data were available. This procedure probably over estimated actual emissions as conservative assumptions were used. The emissions for 1955 were estimated by use of these procedures.

Although 24-hour total suspended particulates (TSP) measurements were not recorded, weekly measurements from 1973 through 1985 indicated that the highest annual TSP concentrations ranged from 31 to 60 $\mu g/m^3$ (NLO 1986; 1984; 1983; 1981;1980; 1979; 1978; 1977; 1976; 1975; 1974) (Table 3.21). These μg averages were less than the Federal annual standard of 60 $\mu g/m^3$ (EPA, 1984). None of the average annual concentrations exceeded or equalled the present Federal and state primary standard of 75 $\mu g/m^3$ (EPA, 1984; OEPA, 1980). Monitoring results are presented for only seven of the monitoring stations; the remaining stations became operational in 1986.

Although TSP concentrations have been less than the standards, the annual averages, taken at the site boundary, are probably an overestimate as most of the monitoring stations (except BS3) are located near roads where vehicular traffic generates dust (Figure 3.10). Station BS4 had the highest maximum weekly concentrations in five of the 11-year monitoring period and the highest average annual concentration in seven of the 11-year monitoring period. This site is located on the edge of Willey Road which has relatively high vehicle traffic when compared to other roads around the FMPC. The significance of dust generated by traffic is confirmed by the consistently low TSP concentrations measured at BS1 and BS2 which are located downward of the prevailing southwesterlies, but slightly off State Route 126 and the north access road, respectively.

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TABLE 3.20

TOTAL AIRBORNE URANIUM EMISSIONS

YEAR	DUST[a] COLLECTORS	WET SCRUBBERS[b]	NON PRODUCTION[c]	TOTAL
(1986 Jan-July)	8	9		17
1985	50	25		75
1984	323	38	17	378
1983	115	58	8	181
1982	234	37	9	280
1981	569	10	8	587
1980	248	11	8	267
1979	62	--	93	155
1978	117	--	105	222
1977	87	--	105	192
1976	64	--	105	169
1975	213	--	105	318
1974	130	--	105	235
1973	352	39	105	496
1972	509	--	105	614
1971	126	541	105	772
1970	717	666	105	1,488
1969	647	3,123	128	3,898
1968	1,421	3,082	152	4,655
1967	983	1,790	152	2,925
1966	776	926	152	1,854
1965	1,089	5,810	146	7,045
1964	2,243	2,865	145	5,253
1963	3,720	2,171	145	6,036
1962	2,126	2,304	138	4,568
1961	1,027	2,371	118	3,516
1960	2,151	2,604	118	4,873
1959	2,909	2,100	118	5,127
1958	3,745	1,650	118	5,513
1957	6,352	1,575	118	8,045

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TABLE 3.20

TOTAL AIRBORNE URANIUM EMISSIONS

YEAR	DUST[a] COLLECTORS	WET SCRUBBERS[b]	NON PRODUCTION[c]	TOTAL
1956	10,292	1,442	118	11,852
1955	32,965	948	118	34,031
1954	14,677	217	15	14,909
1953	1,363	--	--	1,363
1952	493	--	--	493
1951	123	--	--	123
TOTALS	93,026	36,412	3,087	132,525

Ref: 1986 (Nov.) History of FMPC Radionuclide Discharges; Boback, M. W., D. A. Fleming, T. A. Dugan, R. W. Keys, and R. B. Grant Feed Materials Production Center, NLO, Inc. Cincinnati, Ohio.

a) Dust collector data based on calender year

b) Wet scrubber data based on fiscal year

c) Emmissions from the graphite and oil burners, and waste incinerators

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TABLE 3.21

AVERAGE ANNUAL TSP CONCENTRATIONS AT THE FMPC (micrograms per cubic meter)

Year/ Concentration	Sampling Station[a,b]						
	BS1	BS2	BS3	BS4	BS5	BS6	BS7
1973							
Concentration	48	52	52	58	54	52	--
% of standard[c]	80	87	87	97	90	87	--
1974							
Concentration	52	53	46	58	54	52	--
% of standard	87	88	77	97	90	87	--
1975							
Concentration	48	55	52	53	60	51	--
% of standard	80	91	86	88	100	85	--
1976							
Concentration	48	49	48	59	51	53	--
% of standard	80	82	80	98	85	88	--
1977							
Concentration	46	45	47	53	49	48	--
% of standard	77	75	78	88	82	80	--
1978							
Concentration	47	52	47	52	48	53	--
% of standard	72	80	72	80	74	82	--
1979							
Concentration	48	42	34	47	42	43	--
% of standard	80	70	57	78	70	72	--

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TABLE 3.21 continued)

AVERAGE ANNUAL TSP CONCENTRATIONS AT THE FMPC (micrograms per cubic meter)

Year/ Concentration	Sampling Station[a,b]						
	BS1	BS2	BS3	BS4	BS5	BS6	BS7
1980							
Concentration	33	42	31	48	37	38	--
% of standard	63	70	52	80	62	63	--
1982							
Concentration	42	38	44	45	46	43	40
% of standard	56	51	59	60	61	57	53
1983							
Concentration	36	37	38	42	37	41	39
% of standard	48	49	51	56	49	55	52
1985							
Concentration	31	32	35	40	37	37	36
% of standard	41	43	47	53	49	49	48

Ref: NLO, 1986; 1984; 1983; 1981; 1980; 1979; 1978; 1977; 1976; 1975; 1974; EPA, 1984; OEPA, 1980

[a] Location of sampling stations shown on Figure 2.4

[b] Six air sampling stations were in operation from 1973-1980; seven were used from 1982-1985

[c] Annual primary standard was 60 micrograms per cubic meter through 1980 and 75 micrograms per cubic meter since 1982

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TABLE 3.22

MAXIMUM AND MINIMUM URANIUM CONCENTRATIONS AT THE FMPC (pCi/l x 10^{-5})

Year	Sampling Station	Maximum Concentration	Minimum Concentration[a]
1973	BS6	4.58	--[b]
1974	BS1	3.42	0.04
1975	BS3	5.77	0.09
1976	BS1	7.08	0.08
1977	BS1	3.40	0.0003
1978	BS3	8.80	0.0006
1979	BS3	23.00	0.0003
1980	BS3	2.30	0.0003
1982	BS1	3.80	0.0004
1983	BS3	25.00	0.0003
1984	BS3	18.79	0.0023
1985	BS1	3.12	0.0001

Ref: NLO 1986; 1985a; 1984; 1983; 1981; 1980; 1979; 1978; 1977; 1976; 1975; 1974

a) Sampling stations for minimum concentrations may be different from sampling station for maximum concentrations.

b) Below detection limits

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Maximum annual concentrations of airborne uranium were highest at perimeter monitoring stations BS1 and BS3 (Table 3.22). These sites are located north and east of the FMPC and are downwind of the prevailing southwesterlies. The highest average annual uranium concentrations were recorded 10 of 12 years at station BS3 and two of 12 years at station BS1 (Table 3.23). The lowest concentrations were consistently recorded at station BS4, BS5, and BS6 which are upwind of the prevailing wind direction. Average annual concentrations, measured at the site boundary, have never exceeded one percent of the applicable DOE guideline.

Gross alpha radioactivity was measured from 1973 through 1982 and gross beta was measured from 1973 through 1985. As with airborne uranium, average annual gross alpha and gross beta measurements were usually highest at BS3 and BS1 (8 of 9 years), and BS3 (9 of 12 years), respectively (Table 3.24). All averages were within applicable standards.

Thorium concentrations in particulate samples were determined from 1973 through 1980; thorium isotopes were not analyzed separately until 1982. Total thorium levels were low at all air monitoring stations (Table 3.25). In all cases, the values were less than 0.001 percent of standard.

In 1982-1985, thorium-228, and -232 were measured; thorium-230 was included in 1984. The measured levels of thorium isotopes were very low and never reached more than 0.2 percent of the applicable standard (Table 3.26).

Airborne neptunium-237, and plutonium-238 and -239 concentrations were determined annually from 1982 through 1985. These radionuclides occurred in very small quantities, and never reached more than 0.09 percent, 0.02 percent, and 0.02 percent of the applicable standards, respectively (DOE Order 5480.1A, Attachment XI-I, Table II) (NLO, 1986; 1985a; 1984; 1983).

The remaining airborne radionuclides, plutonium-241, cesium-137, radium-226, radium-228, ruthenium-106, strontium-90, and technetium-99 were measured only in 1985 (NLO, 1986). Levels of these radionuclides were very low and account for only a small fraction of a percent of the applicable standards.

Radon levels were measured routinely from 1982 through 1985 at seven on-site perimeter locations (BS1-BS7) and at two off-site locations (ENE, WSW) (Table 3.27). The annual average radon values for the on-site stations ranged between 0.28 and 1.07 pCi/l. Off-site values ranged between 0.36 and 0.84 pCi/l.

Analysis of the average annual radon-222 concentrations indicated that on-site sampling sites BS5, BS6, and BS7 generally had the highest levels (Table 3.27). These are locations that are closest to the K65 silos and waste pits. All annual levels reported were below the standard. The highest average annual level was reported from station BS7 in 1982. In addition to the

TABLE 3.23

AVERAGE ANNUAL URANIUM CONCENTRATIONS
MEASURED AT THE FMPC (pCi/l x 10^{-5})

Year/ Concentration	Sampling Station BS1	BS2	BS3	BS4	BS5	BS6	BS7
1973							
Concentration	1.07	0.85	1.19	0.32	0.34	0.87	--
% of guideline[a]	0.5	0.4	0.6	0.2	0.2	0.4	--
1974							
Concentration	1.09	0.85	0.84	0.24	0.35	0.58	--
% of guideline	0.5	0.4	0.4	0.1	0.2	0.3	--
1975							
Concentration	1.24	1.09	1.34	0.37	0.43	0.87	--
% of guideline	0.6	0.5	0.7	0.2	0.2	0.4	--
1976							
Concentration	0.93	0.62	0.97	0.30	0.30	0.49	--
% of guideline	0.5	0.3	0.5	0.2	0.2	0.2	--
1977							
Concentration	0.56	0.41	0.64	0.20	0.25	0.25	--
% of guideline	0.3	0.2	0.3	0.1	0.1	0.1	--
1978							
Concentration	0.39	0.42	1.40	0.44	0.50	0.34	--
% of guideline	0.2	0.2	0.7	0.2	0.3	0.2	--
1979							
Concentration	0.67	0.55	0.96	0.41	0.54	0.47	--
% of guideline	0.3	0.3	0.5	0.2	0.3	0.2	--

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TABLE 3.23 (continued)

AVERAGE ANNUAL URANIUM CONCENTRATIONS
MEASURED AT THE FMPC (pCi/l x 10^{-5})

Year/ Concentration	Sampling Station BS1	BS2	BS3	BS4	BS5	BS6	BS7
1980							
Concentration	0.21	0.18	0.23	0.17	0.15	0.20	--
% of guideline	0.1	0.1	0.1	0.1	0.1	0.1	--
1982							
Concentration	0.77	0.42	0.70	0.21	0.35	0.39	0.22
% of guideline	0.3	0.2	0.3	0.1	0.2	0.2	0.1
1983							
Concentration	2.20	1.40	2.50	0.89	0.98	1.10	0.48
% of guideline	0.5	0.3	0.6	0.2	0.2	0.3	0.1
1984							
Concentration	1.03	0.92	1.36	0.35	0.40	0.63	0.30
% of guideline	0.5	0.5	0.7	0.2	0.2	0.3	0.2
1985							
Concentration	0.30	0.31	0.56	0.21	0.22	0.25	0.11
% of guideline	0.2	0.2	0.3	0.1	0.1	0.1	0.1

Ref: NLO, 1986; 1985a; 1984; 1983; 1981; 1980; 1979; 1978; 1977; 1976; 1975; 1974

a) Guideline was $2x10^{-3}$ pCi/l for 1973-1980, $4x10^{-3}$ pCi/l for 1982 and 1983, and $2.0x10^{-3}$ pCi/l in 1984 and 1985; 1973-1980 guidelines from DOE manual, Chapter 0524, Annex A, Table II: 1982-1985 guidelines from DOE Order 5480.1A, Attachment XI-1, Table II.

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TABLE 3.24

AVERAGE ANNUAL GROSS ALPHA AND GROSS BETA (pCi/lx10)

Year/ Concentration	Sampling Station													
	BS1		BS2		BS3		BS4		BS5		BS6		BS7	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1973[a]														
Concentration	1.13	2.70	0.94	2.65	2.37	3.54	0.35	2.35	0.38	2.32	0.94	3.35	--	--
% Guidelines	0.06	0.003	0.5	0.003	1.2	0.004	0.2	0.002	0.2	0.002	0.5	0.003	--	--
1974														
Concentration	1.22	5.87	0.93	5.16	0.92	5.45	0.28	5.91	0.36	6.29	0.65	6.56	--	--
% Guidelines	0.6	0.06	0.5	0.05	0.5	0.05	0.1	0.06	0.2	0.06	0.3	0.06	--	--
1975														
Concentration	1.28	4.10	1.21	4.14	1.41	4.84	0.40	3.74	0.48	4.60	0.90	4.58	--	--
% Guidelines	0.6	0.04	0.6	0.04	0.7	0.05	0.2	0.04	0.2	0.05	0.5	0.04	--	--
1976														
Contentration	1.28	4.10	1.21	4.14	1.41	4.84	0.40	3.74	0.48	4.60	0.90	4.58	--	--
% Guidelines	0.5	0.03	0.3	0.03	0.5	0.04	0.2	0.03	0.2	0.03	0.3	0.04	--	--
1977														
Concentration	0.81	6.80	0.45	5.80	0.72	6.90	0.25	6.20	0.28	6.70	0.30	6.90	--	--
% of Standard	0.4	0.07	0.2	0.06	0.4	0.07	0.1	0.06	0.1	0.07	0.2	0.07	--	--
1978														
Concentration	0.36	4.80	0.39	5.20	0.80	6.90	0.26	4.60	0.89	5.50	0.43	5.40	--	--
% of Standard	0.2	0.05	0.2	0.05	0.4	0.07	0.1	0.05	0.4	0.06	0.2	0.05	--	--
1979														
Concentration	0.63	2.50	0.39	1.90	0.97	2.50	0.47	2.00	0.52	2.20	0.47	2.40	--	--
% of Standard	0.3	0.02	0.2	0.02	0.5	0.03	0.2	0.02	0.3	0.02	0.2	0.02	--	--
1980														
Concentration	0.20	2.20	0.16	1.80	0.21	1.90	0.16	1.90	0.14	1.90	0.19	2.00	--	--
% of Standard	0.1	0.02	0.1	0.02	0.1	0.02	0.1	0.02	0.1	0.02	0.1	0.02	--	--
1982														
Concentration	0.79	8.70	0.44	6.00	0.83	9.80	0.26	3.60	0.48	6.70	0.40	5.60	0.20	3.60
% of Standard	0.4	0.09	0.2	0.06	0.4	0.10	0.1	0.04	0.2	0.07	0.2	0.07	0.1	0.04

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TABLE 3.24 continued

AVERAGE ANNUAL GROSS ALPHA AND GROSS BETA (pCi/lx10)

Year/ Concentration	Sampling Station													
	BS1		BS2		BS3		BS4		BS5		BS6		BS7	
	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta	Alpha	Beta
1983[b]														
Concentration		5.60		4.10		5.70		2.80		3.10		3.70		3.20
% of Standard		0.06		0.04		0.06		0.03		0.03		0.04		0.03
1984														
Concentration		4.91		4.56		6.38		2.60		2.88		3.39		2.46
% of Standard		0.05		0.05		0.06		0.03		0.03		0.03		0.02
1985														
Concentration		1.89		2.08		2.64		1.79		1.86		1.94		1.66
% of Standard		0.02		0.02		0.03		0.02		0.02		0.02		0.02

Ref: NLO, 1986; 1985; 1984; 1983; 1981; 1980; 1979; 1978; 1977; 1976; 1974

[a]Gross alpha measurements discontinued beginning in 1983. 1973 through 1980 guidelines from DOE manual, Chapter 0524, Annex A, Table II; 1982 through 1985 guidelines from DOE Order 5480.1A, Attachment XI-1, Table II.

[b]Gross alpha measurements discontinued beginning in 1983.

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TABLE 3.25

THORIUM CONCENTRATIONS
AT THE FMPC (pCi/l x 10^{-5})[a]

Year/ Concentration	Sampling Station					
	BS1	BS2	BS3	BS4	BS5	BS6
1973 Concentration[b]	0.002	0.002	0.002	0.002	0.002	0.002
1974 Concentration	0.002	0.002	0.002	0.001	0.002	0.002
1975 Concentration	0.002	0.004	0.002	0.002	0.003	0.002
1976 Concentration	0.003	0.004	0.003	0.003	0.002	0.003
1977 Concentration	0.003	0.003	0.004	0.003	0.002	0.003
1978 Concentration	0.003	0.003	0.003	0.002	0.001	0.002
1979 Concentration	0.003	0.003	0.004	0.003	0.003	0.004
1980 Concentration	0.0002	0.0006	0.0005	0.0005	0.0003	0.0005

Ref: NLO, 1981; 1980; 1979; 1978; 1977; 1976; 1975; 1974

[a] One composite sample of the weekly samples was analyzed for thorium each year.

[b] Percent of standard less than 0.001%; Standard was 1×10^{-3} pCi/l. Standard from DOE Manual, Chapter 0524, Annex A, Table II.

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TABLE 3.26

THORIUM ISOTOPE LEVELS MEASURED
AT THE FMPC (pCi/l x 10^{-5})

Year/ Isotope	Sampling Station BS1	BS2	BS3	BS4	BS5	SB6	BS7
1982							
Thorium-228							
Conc.	0.0064	0.0037	0.0079	0.0032	0.0034	0.0039	0.0019
% Guideline	0.03	0.02	0.04	0.02	0.02	0.02	0.01
Thorium-232							
Conc.	0.0024	0.0021	0.0048	0.0020	0.0019	0.0021	0.0012
% Guideline	--	--	--	--	--	--	--
1983							
Thorium-228							
Conc.	0.0048	0.0041	0.0093	0.0026	0.0040	0.0027	0.0014
% Standard	0.02	0.02	0.05	0.01	0.02	0.01	0.01
Thorium-232							
Conc.	0.0061	0.0039	0.0014	0.0051	0.0043	0.0019	
% Standard	--	--	--	--	--	--	
1984							
Thorium-228							
Conc.	0.0024	0.0031	0.0051	0.0013	0.0017	0.0024	0.0026
% Standard	0.01	0.01	0.03	0.01	0.01	0.01	0.01
Thorium-230							
Conc.	0.0495	0.0559	0.0746	0.0155	0.0321	0.0406	0.0532
% Standard	0.20	0.02	0.02	0.05	0.10	0.10	0.20
Thorium-232							
Conc.	0.0015	0.0018	0.0028	0.0009	0.0011	0.0015	0.0016
% Standard[a]	--	--	--	--	--	--	--
1985							
Thorium-228							
Conc.	0.0014	0.0011	0.0026	0.0021	0.0032	0.0018	0.0023
% Standard	0.01	0.01	0.01	0.01	0.02	0.01	0.01
Thorium-230							
Conc.	0.0152	0.0077	0.0261	0.0135	0.0195	0.0121	0.0083
% Standard	0.05	0.03	0.09	0.05	0.07	0.04	0.03
Thorium-232							
Conc.	0.0010	0.0009	0.0014	0.0012	0.0014	0.0013	0.0011
% Standard	--	--	--	--	--	--	--

Ref: NLO, 1986; 1985a; 1984; 1983
a) Percent of standard less than 0.01%

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TABLE 3.27

AVERAGE ANNUAL RADON GAS LEVELS
MEASURED ON-SITE AND OFF-SITE AT THE FMPC
(Concentrations in pCi/l)

Year/ Concentration[a]	Sampling Station On-Site BS1	BS2	BS3	BS4	BS5	BS6	BS7	Off-Site ENE	WSW
1982									
Concentration	0.79	0.91	0.66	0.90	0.94	1.01	1.07	0.56	0.66
% of standard	26	30	22	30	31	34	36	19	22
1983									
Concentration	0.65	0.77	0.76	0.65	1.05	0.82	0.91	0.77	0.61
% of standard	22	26	25	22	35	27	30	26	20
1984									
Concentration	0.92	0.80	0.84	0.59	0.97	0.58	0.71	0.84	0.36
% of standard	28	25	26	18	30	18	22	26	11
1985									
Concentration	0.81	0.82	0.28	0.56	0.80	1.06	1.01	0.59	0.37
% of standard	25	25	9	17	25	33	31	18	11

Ref: NLO, 1985a; 1984; 1983

a) DOE Order 5480.1A, Attachment XI-1, Table II, Concentration Guide for Radon 222 = 3 pCi/l.

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3.8.4 BIOLOGICAL RESOURCES MONITORING

3.8.4.1 Biological Resources Monitoring Program

Environmental monitoring of selected vegetation, garden produce, milk and fish was conducted at the FMPC during 1985 (WMCO) and 1984 (NLO, Inc.). The majority of samples was collected to the northeast of the site, in the direction of prevailing winds (Figure 2.11). Various intermittent monitoring studies have been conducted at the FMPC since the 1950s.

Each vegetation sample consisted of all above-ground plant material clipped near ground level from a 0.5 m diameter circular quadrat. The vegetation samples were analyzed for uranium and fluoride.

Six replicate samples of potatoes were collected from four farms and gardens in the vicinity of the FMPC (Figure 2.11). Twelve replicate samples were collected from distant locations in Indiana and were used as a comparison for background levels of uranium. Potatoes were analyzed for uranium concentration.

Milk produced by cows grazing on the FMPC and adjacent pasture land was monitored three times in 1985 for uranium. A similar sample was collected concurrently from a remote site 29-30 km southeast of the FMPC for comparison purposes.

Fish were collected from three reaches of the Great Miami River (Figure 2.11) in September, 1985. A total of 252 fish representing 25 species was taken: 52 from sampling station one, 41 from station two, and 159 from station three. The fish from each location were placed in plastic bags, packed in ice, and then scaled and prepared as for human consumption (heads and entrails removed, and filleted if total weight was above 800-900 grams). These fish were analyzed for uranium concentration.

3.8.4.2 Biological Resources Monitoring Results

Vegetation samples collected primarily to the northeast of the FMPC were analyzed for uranium and fluoride uptake (Table 3-28). Soils were analyzed for uranium content only. Ohio has no fluoride standard; however, fluoride concentrations were about 7 percent of the Kentucky standard of 80 ppm. A positive correlation was found between uranium concentrations within soil samples and corresponding grass samples (Table 3.29). Generally, uranium concentrations in vegetation decreased with distance from the FMPC. The highest uranium concentration for vegetation (2.34 pCi/g) and soil (64.32 pCi/g) occurred at sampling location 10 which is 0.8 km from the center of the FMPC production area.

Potato samples were collected and analyzed for uranium content (Table 3.30). Peels from potatoes at sample station number one (Figure 2.9) contained greater uranium concentrations than

TABLE 3.28

URANIUM AND FLUORIDE IN GRASS AND OTHER FORAGE (1)

Sampling Point (2)	Distance (km) From FMPC (3)	URANIUM CONCENTRATION pCi/g Dry Wt. (4)	URANIUM CONCENTRATION 95% C.L. (5)	FLUORIDE CONCENTRATION ppm	FLUORIDE CONCENTRATION % of Standard (6)
1	10.5	0.09 (0.003)	NA(7)	3.0	3.8
2	8.7	0.10 (0.004)	±0.10	5.1	6.4
3	6.2	0.12 (0.005)	NA	14.0	17.5
4	4.1	0.25 (0.009)	±0.05	5.8	7.3
5	5.3	0.15 (0.006)	NA	3.3	4.1
6	2.3	0.54 (0.020)	±0.08	6.0	7.5
7	1.4	1.40 (0.052)	±0.01	6.5	8.1
8	0.7	0.88 (0.033)	±0.01	5.6	7.0
9	0.9	1.57 (0.058)	±0.53	8.4	10.5
10	0.8	2.34 (0.086)	±0.38	11.5	14.4
11	1.9	0.65 (0.024)	±0.07	11.1	13.9
12	1.9	0.31 (0.012)	±0.44	4.1	5.1
13	1.0	1.63 (0.060)	±0.64	6.9	8.6
14	0.7	1.50 (0.055)	±0.32	5.7	7.1
15	1.3	0.37 (0.014)	±0.53	5.9	7.4
16	1.5	0.31 (0.012)	±0.34	3.5	4.4
17	1.6	0.26 (0.010)	±0.02	4.0	5.0
18	1.2	0.67 (0.025)	±0.10	6.2	7.8
19	1.0	0.02 (0.001)	±0.007	<2.4	<3.0
20	0.9	0.18 (0.007)	±0.03	6.2	7.8
21	2.7	0.40 (0.015)	±0.04	6.8	8.5
22	7.0	0.05 (0.002)	±0.01	4.7	5.9
23	8.0	0.03 (0.001)	±0.01	<2.4	<3.0
24	8.1	0.08 (0.003)	±0.01	<2.4	<3.0
25	8.5	0.04 (0.002)	±0.01	5.9	7.4
26	0.8	0.38 (0.014)	±0.02	<2.4	<3.0
27	1.0	0.20 (0.008)	±0.01	<2.4	<3.0
28	4.0	0.26 (0.010)	±0.14	6.5	8.1
29(8)	62.8	0.25 (0.010)	±0.81	2.5	2.0

Footnotes:

(1) The plant material analyzed was primarily brome grass (Bromus spp.), but some samples contained species from the following genera: Allium, Daucus, Hordeum, Medicago, Melilotus, Poa, Secale, and Triticum.

(2) See Figure 3.11

(3) For the purpose ot this table, the center of the production area was used for distance measurements.

(4) Bq/g in parentheses.

(5) C.L. = $\pm 2\sigma$.

(6) No Ohio standard established; Kentucky standard of 80 ppm was used.

(7) Not Applicable.

(8) Control samples collected from a farm in Indiana.

Reference: WMCO 1986

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TABLE 3.29

COMPARISON OF URANIUM CONCENTRATIONS IN GRASS AND SOILS AT PARALLEL SAMPLING LOCATIONS

Sampling Location (1)	Distance (km) From FMPC (2)	GRASS pCi/g Dry Wt. (3)	GRASS 95% C.L. (4)	SOIL pCi/g Dry Wt. (3)	SOIL 95% C.L. (4)
1	0.5	0.02(0.0008)	0.007	1.25 (0.05)	0.55
2	8.7	0.10(0.004)	0.10	1.22 (0.05)	0.14
3	6.2	0.12(0.005)	NA(5)	1.90 (0.07)	0.14
4	4.1	0.25(0.009)	0.05	1.96 (0.07)	0.14
5	5.3	0.15(0.006)	NA	1.29 (0.05)	0.14
6	2.3	0.54(0.020)	0.08	5.69 (0.21)	0.27
7	1.4	1.40(0.052)	0.01	14.22 (0.53)	0.68
8	0.7	0.88(0.033)	0.01	18.96 (0.70)	0.68
9	0.9	1.57(0.058)	0.53	16.93 (0.63)	0.68
10	0.8	2.34(0.086)	0.38	64.32 (2.38)	3.39
11	1.9	0.65(0.024)	0.07	2.84 (0.11)	0.14
12	1.9	0.31(0.012)	0.44	1.08 (0.04)	0.14
13	1.0	1.63(0.060)	0.64	31.14 (1.15)	1.35
14	0.7	1.50(0.055)	0.32	17.60 (0.65)	1.35
15	1.0	0.37(0.014)	0.53	5.75 (0.21)	0.27
16	1.5	0.31(0.012)	0.34	3.25 (0.12)	0.14
17	1.6	0.26(0.010)	0.02	4.27 (0.16)	0.20
18	1.2	0.67(0.025)	0.10	5.08 (0.19)	0.27
19	0.9	0.18(0.007)	0.03	3.11 (0.12)	0.14
20	2.7	0.40(0.015)	0.04	2.23 (0.08)	0.14
21	4.0	0.26(0.010)	0.14	2.57 (0.10)	0.14

Footnotes:

(1) See Figure 3.11

(2) For the purpose of this table, the center of the production area was used for distance measurements.

(3) Bq/g in parentheses

(4) C.L. = $\pm 2\sigma$

(5) NA = Not Applicable

REFERENCE: WMCO, 1986

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TABLE 3.30

URANIUM CONCENTRATION IN GARDEN PRODUCE: POTATOES

Sampling[a] Point	Number of Samples	Minimum	Maximum	Average[b]	95%[c] C.L.
		Concentration in Peels (pCi/g dry wt.)			
1	6	0.90	1.22	1.02(0.038)	1.0
2	6	0.22	0.65	0.29(0.011)	1.1
3	6	0.32	0.75	0.43(0.016)	1.0
4	6	0.19	0.37	0.25(0.0093)	1.0
Control[d]	12	0.14	0.34	0.26(0.0096)	1.0
		Concentration in Flesh (pCi/g dry wt.)			
1	6	0.0019	0.0066	0.0030(0.00011)	1.1
2	6	0.0033	0.013	0.0063(0.00023)	1.1
3	6	0.0055	0.011	0.0089(0.00033)	1.0
4	6	0.0033	0.011	0.0062(0.00023)	1.1
Control[d]	12	0.00048	0.011	0.0054(0.00020)	1.3

Footnotes:

a) See Figure 3.11
b) Bq/g in parentheses
c) C.L.=Average Concentration x: value shown. Derived from log-transformed data.
d) Control samples were collected from two remote sites in Indiana.

Reference: WMCO, 1986.

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potatoes sampled off site in Indiana. A maximum uranium concentration of 1.22 pCi/g was recorded from this sample, while a maximum control sample contained 0.34 pCi/g uranium.

No detectable quantity of uranium was present in milk samples taken adjacent to the FMPC (Table 3.31).

Fish populations sampled within the Great Miami River near the FMPC were considered healthy. Uranium concentrations were slightly higher in fish captured at the confluence of Paddy's Run and the FMPC outfall to the Great Miami River than in fish captured upstream (Table 3.32). However, there were no significant differences in mean uranium concentrations between fish species fish collected at different sampling locations (WMCO, 1986).

In addition to the ongoing monitoring systems, Battelle (1981) performed health effects calculations for persons consuming significant quantities of locally-grown vegetables. The average concentration of uranium found in vegetables (at this time) grown near the FMPC was 0.016 mg/g wet weight. They assumed that a resident would consume an average of one-half pound (0.22 Kg) per day of fresh or home-canned vegetables, and that 1.3 mg of uranium would be ingested each day. From the calculation, Battelle calculated the 50-year dose commitments presented in Table 3.33.

3.8.5 SOIL MONITORING

3.8.5.1 Soil Monitoring Program

Since the early 1950s, the FMPC has been collecting annual soil samples as part of the FMPC Environmental Monitoring Program. Annual reports summarizing the results of the monitoring program have indicated releases of radiological and nonradiological substances.

Prior to 1984, soil samples were collected at seven air sample locations along the site boundary to observe possible contributions from stack effluents (Figure 3.10). In 1984 and 1985, the soil sampling program was expanded to include 15 locations, all of which were along the site boundary or off site (Figure 3.12). In addition, various special samples were taken; 104 off site in 1984 to construct a map showing uranium concentrations in the top 5 centimeters of soil near the old solid waste incinerator; and 21 taken in 1985 correspond to grass sampling sites, ten of which were on site and three of which are along the site boundary. In general, these soil samples were analyzed only for uranium concentrations. The exception is 1984; 25 of the 105 special samples were analyzed for Pu-239/240, Np 237, Tc 99, Th 228, Th 230, and Th 232.

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TABLE 3.31

URANIUM IN MILK

Sampling Location[a]	Number of Samples	Average Concentration[b] ug/l	pCi/l[c]	Standard
1	3	<1.0	<0.68(0.025)	d
2	3	<1.0	<0.68(0.025)	d

a)Sampling locations: 1=dairy farm adjacent to the FMPC
2=dairy farm in Kentucky approximately 29 km southeast of the FMPC
b)All analyses for both sites yielded the same results; i.e., <1 ug/l
c)Bq/l in parentheses
d)No standards have been established

Reference: WMCO, 1986.

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TABLE 3.32

URANIUM CONCENTRATION IN FISH

Family[b]	Number of Samples	Concentration[c] (pCi/g) Minimum	Maximum	Average[d]	95% C.L.[e]
		Sampling Point[a] - 1 (Paddy's Run)			
1	9	0.067	0.286	0.095(0.0035)	0.749
2	2	0.106	0.153	0.107(0.0046)	6.121
3	4	0.089	0.128	0.100(0.0037)	1.246
4	2	0.213	0.280	0.244(0.0090)	0.712
Total	17	0.067	0.280	0.109(0.0040)	0.523
		Sampling Point[a] - 2 (Buried Effluent Line)			
1	6	0.064	0.286	0.156(0.0056)	1.125
2	6	0.086	0.153	0.118(0.0044)	0.871
3	1	0.083	0.083	0.083(0.0031)	ND[f]
4	2	0.234	0.344	0.284(0.0105)	7.370
5	6	0.141	0.254	0.187(0.0069)	0.900
Total	21	0.064	0.344	0.156(0.0058)	0.477
		Sampling Point[a] - 3 (Upstream)			
1	1	0.057	0.057	0.057(0.0021)	ND[f]
2	2	0.073	0.081	0.077(0.0028)	6.412
3	4	0.039	0.118	0.066(0.0024)	1.678
4	9	0.060	0.173	0.104(0.0038)	0.712
Total	16	0.039	0.173	0.086(0.0032)	0.535

a) See Figure 3.11
b) Family: 1 = Cyprinidae (carp)
2 = Catastomidae (carpsucker, redhorse)
3 = Centrarchidae, Sciaenidae (bass, sunfish, drum)
4 = Clupeidae (gizzard shad)
5 = Ictaluridae (catfish)
c) All concentrations in pCi(U)/g ash; wet weight: ash weight ratio = 31:1
d) Bq/g in parentheses
e) C.L. = Average Concentration x: the value shown. Derived from log-transformed data
f) ND = Not Determined
Reference: WMCO, 1986.

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TABLE 3.33

FIFTY-YEAR DOSE COMMITMENTS PER YEAR OF CONSUMPTION OF RADIONUCLIDES IN LOCALLY GROWN VEGETABLES

Target Organ	Dose (mrem)
Total body	0.04
Bone	0.7
Kidney	0.02
G.I. Tract	0.05

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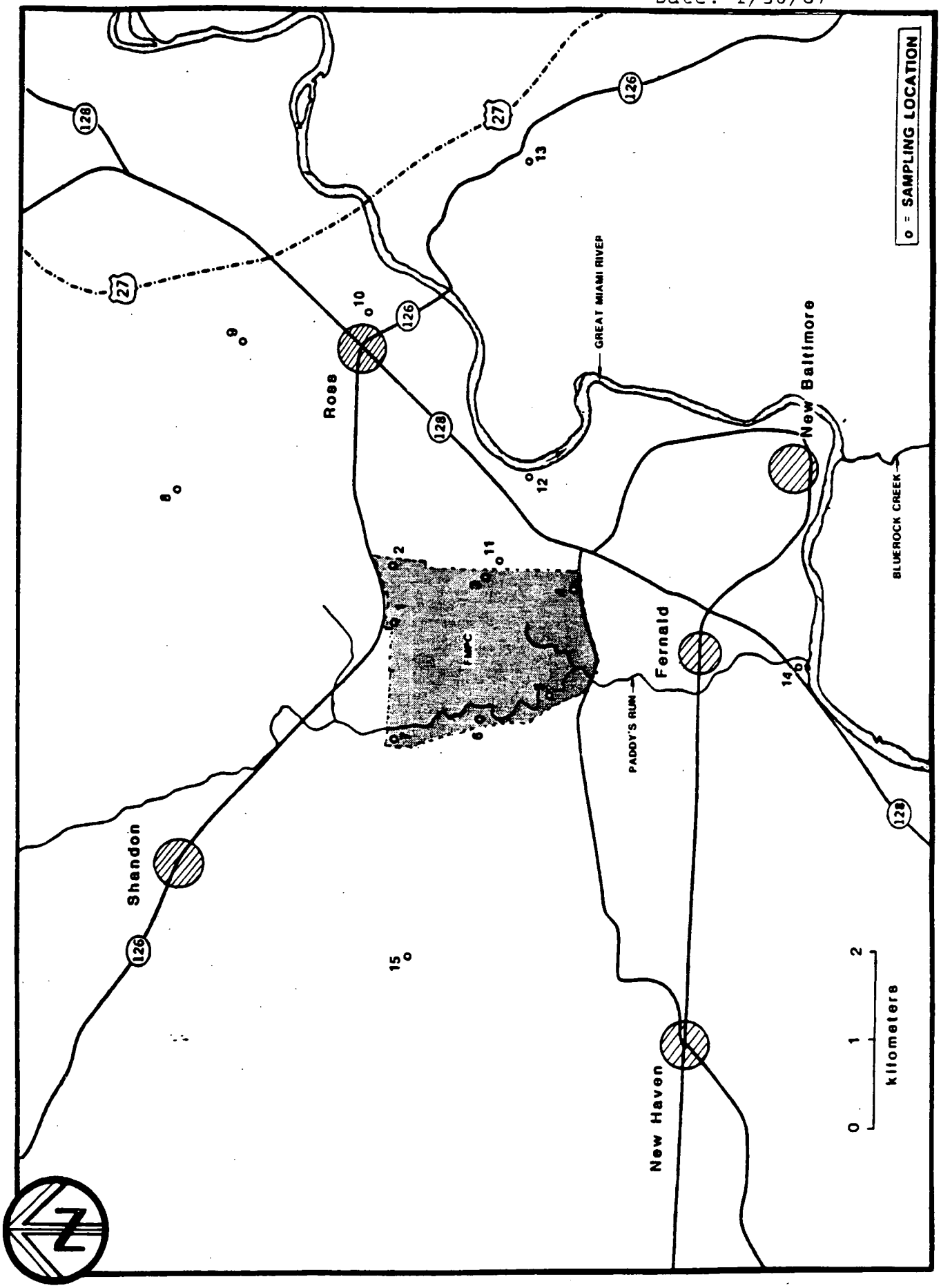

FIGURE 3.12
SOIL SAMPLING LOCATIONS

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3.8.5.2 Soil Monitoring Results

The sampling results indicate that the concentration of uranium in soils for all but one location were below 35 pCi/g, (the reference level FMPC uses for acceptance of decontaminated areas NLO, 1985a). One sample location, near the site of the old solid waste incinerator, showed concentrations of uranium in soil ranging from 38.88 - 54.22 pCi/g. These results are reported in the annual environmental monitoring reports NLCO-2028 and FMPC-2047 (Table 3.34). Soils were analyzed for uranium concentrations only since analyses for other radionuclides in 1984 revealed small or undetectable concentrations.

3.9 MINOR EVENTS AND INCIDENCES AT THE FMPC

During the course of various production processes at the FMPC, numerous minor events such as fume releases and material spills occur. Table 3.35 summarizes the minor events, unusual occurrences, and incidents which occur at the FMPC. The most significant of these include uranium dust releases, furnace blowouts, magnesium flashes, green salt and magnesium fluoride spills, and various fume releases including hydrogen fluoride.

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TABLE 3.34

Comparison of Uranium in Routine
Soil Samples for 1984 and 1985

Sampling Point (1)	Concentration (2) (pCi/g dry wt.)			
	1984 (3)	1985	±2σ (4)	% of (5) Guideline
1	6.35(0.24)	4.35(0.16)	1.74	12.4
2	8.98(0.33)	1.95(0.07)	0.82	5.6
3 (6)	54.22(2.01)	35.88(1.33)	14.5	102.5
4	7.45(0.28)	3.05(0.11)	1.26	8.7
5	9.09(0.34)	2.88(0.11)	1.20	8.5
6	4.46(0.17)	1.25(0.05)	0.55	3.6
7	3.41(0.13)	0.42(0.02)	0.21	1.2
8	2.48(0.09)	0.43(0.02)	0.30	1.2
9	3.94(0.15)	1.71(0.06)	0.28	4.9
10	2.94(0.11)	0.42(0.02)	0.21	1.2
11	16.54(0.61)	14.15(0.52)	0.73	40.4
12	2.12(0.08)	0.67(0.02)	0.21	1.9
13	3.81(0.14)	0.44(0.02)	6.04	1.3
14	2.19(0.08)	0.61(0.02)	0.21	1.7
15	7.73(0.29)	0.35(0.01)	0.17	1.0

Footnotes:

(1) See FIGURE 3.12

(2) Bq/g in Parentheses.

(3) See 1984 Environmental Monitoring Report.

(4) Applies to analytical uncertainty for 1985 value.

(5) Value of 35 pCi/g used as guideline for these calculations.

(6) This location is on site near an out of service incinerator.

TABLE 3.35

REPORTS OF MINOR EVENTS, UNUSUAL OCCURRENCES, AND INCIDENTS AT THE FMPC

EVENT	NUMBER OF OCCURRENCES	LOCATION	COMMENTS
Dust Collectors and Stack Loss	238	Pilot Plant; Plant 4; Plant 8; Plant 1; Plant 5; Plant 9; Plant 2/3; Plant 6	Minor events reports for dust collectors and stack loss primarily include dust loss, soiled stack samples, or filter changes. Loose bags result in most of the dust releases reported.
Fume Release:			
AHF	4	Pilot Plant; Plant 4	Releases occurred during off-loading of chemical and in delivery line leaks.
ANH_3	4	Plant 4; Plant 8	Releases occurred during off-loading of chemical and in delivery line leaks.
DHF	5	Plant 4	Releases occurred during loading and off-loading of chemical and in delivery line leaks.
HF	36	Pilot Plant; Plant 4; Plant 9; Bldg. 14	Releases occurred during off-loading of chemical and in delivery line leaks.
NOX	2	Plant 2/3	Releases during production.
Enriched UF_4	1	Pilot Plant	Approximately 1 ounce released during production.
UF_6	14	Pilot Plant Technical Div. Lab.	Releases occurred during production.
Green Salt Spill	45	Pilot Plant; Plant 4, Plant 5 Plant 8	Spills occurred during loading, off-loading, and mixing of charges, primarily.
Magnesium Flouride Spill and Dust	26	Plant 2/3; Plant 5; Pit 6; Bldg. 55	Generated during production and in waste disposal in Pit 6.
NPDES Parameters Exceeded:			
BOD	3	Water Plant; Sewage Plant Effluent 001A	BOD levels tend to increase in cold winter months.
Cr^{+6}	31	Water Plant; K-65 Clearwell; General Sump; Outfall 001 B & C	Exceedences generally occur during heavy precipitation events.
Cu	10	General Sump; K-65 Clearwell	
Fe	4	General Sump; K-65 Clearwell; Outfall 001 B & C	
Oil and Grease	1	Outfall 002	
Nitrate N	1		
NH_3	1		
TSS	11	Sewage Plant Effluent; General Sump; K-65 Clearwell; Outfall 001 B & C	Exceedences occur during heavy precipitation events.

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TABLE 3.35 (Continued)

REPORTS OF MINOR EVENTS, UNUSUAL OCCURENCES, AND INCIDENTS REPORTED AT THE FMPC

EVENT	NUMBER OF OCCURRENCES	LOCATION	COMMENTS
pH Readings:			
High	3	Plant 2/3	Spillage creates high pH readings at manholes.
Low	6	Plant 2/3	Spillage creates low pH readings at manholes.
Oil Spill or Residual Oil	14	Pilot Plant; Plant 2/3; Roadway; Building Pad	A variety of oil spill or residual oil on surfaces is reported in this category.
Rockwell Furnace:			
Bottom Blowout	121	Plant 5	Blowouts occur relatively frequently, usually with release of smoke.
Top Blowout	68	Plant 5	Blowouts occur relatively frequently, usually with release of smoke.
Magnesium Flash	565	Plant 2/3; Plant 4; Plant 5; Plant 8	Smoke and fumes are generally released when flashes occur on a frequent basis.
Tank Overflows	15	Plant 2/3; Plant 4 Plant 8	Various incidents where storage tanks have been allowed to overfill prior to discharge.
Thorium Spill	1	Pilot Plant	Spill of a two-gallon container.
Uranium:			
Dust	121	Plant 5	Dust escapes from a variety of sources, generally minor releases from baghouses.
Fire	13	Plant 2/3; Plant 4 Plant 5; Plant 8	Various derby fires and reports of burning drums of chips.
Leak	9	Plant 2/3; Plant 4	Generally from deteriorated drums.
Intake	1	Plant 5	Possible intake of depleted UF_4 by employee.
Spill	4	Plant 2/3; Plant 6; Roadway	Primarily uranium metal.
Other	4	Biodenitrification Consturction Site	Elevated Uranium reading in river water samples.
Other:			
Dust Emissions	4		Emissions that do not include uranium compounds.
Fire	1		Fire in non-radioactive materials.
Leakage	15	Numerous Sites	Non-radioactive leaks from production area.
Spill	8	Numerous Sites	Chemical spills - materials that are not radioactive.
Release	4	Drain System	Materials released into the General Sump, Clearwell, and effluent treatment system.
Other Minor Events	20	Numerous Sites	Several types of events.

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SECTION 4.0

NATURE AND EXTENT OF PROBLEM

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4.0 NATURE AND EXTENT OF PROBLEM

4.1 INTRODUCTION

The potential public health and environmental problems associated with the FMPC have received widespread publicity in recent years. This publicity has resulted primarily from three incidents of environmental contamination that could be closely tied to public health threats. These included: (1) the loss of approximately 124 kilograms of slightly enriched uranium to the atmosphere from Plant 9 operations between mid-September and December 6, 1984; (2) the observation in 1985 of elevated uranium concentrations in ground water in off-site wells to the south of the FMPC; and (3) the report that a sample of potato peels grown in a nearby field had a statistically greater uranium concentration than potatoes grown elsewhere.

The nature of these three events illustrates the complexity of the public health and environmental problems resulting from past and present operations at the FMPC. Consider the following:

- Each event involved a different environmental media, these being air, ground water, and soil/vegetation, respectively.

- The air emissions involved an active facility, whereas the off-site ground water problem may have its source in environmental releases from inactive, closed waste storage units. The uranium found in the potato peels could have originated in atmospheric deposition from both past and present operations.

- The atmospheric release was an episodic event, whereas the atmospheric deposition to soils represents a cumulative effect over the life of the facility. The off-site migration of uranium in ground water could be the result of either a long-term release from waste storage areas, or an episodic release associated with contaminated storm water runoff overflowing into the storm water outfall ditch.

- The air emissions have a single and direct pathway to human receptors, whereas the potential contamination of foodstuffs involves a staged pathway involving air release, soil contamination, and plant uptake before human ingestion becomes a concern. The source and pathway for ground water contamination have not yet been fully resolved.

Two approaches will be used in this section to define the nature and extent of the problem just illustrated. The first is in the context of a CERCLA investigation through a source-pathway-receptor framework. The second is a media-by-media summary of

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the problem, since it is the environmental media that are monitored to quantitatively define the nature and extent of contamination that poses a threat, or potential threat, to public health and the environment.

4.2 SOURCES, PATHWAYS, AND RECEPTORS

Each element of the FMPC and surrounding environs has been designated as either a potential source of environmental contamination, an environmental pathway of contaminant migration, or a potential contaminant receptor. The relationship between sources and on-site and off-site pathways is illustrated in Figure 4.1. The "dots" shown under "Potential Source" indicate which FMPC sources may contribute radioactive or chemical constituents to on-site environmental media, treatment facilities or discharge routes identified in the middle column. The latter elements, which represent the initial on-site contaminant receptors, also serve as the physical pathways by which contaminants can potentially be released to off-site environments. The entries on the right indicate the specific pathways that potentially link on-site contamination to off-site environmental receptors.

The off-site environmental receptors can serve as pathways to the point of exposure for human receptors. The specific pathways that are related to each of the public exposure pathways are illustrated in Figure 4.2. For example, contaminants entering Paddy's Run or the Great Miami River could reach a human receptor via direct contact with contaminated surface water or sediments.

4.2.1 POTENTIAL SOURCES OF ENVIRONMENTAL CONTAMINATION

Public health or environmental problems associated with environmental contamination at the FMPC can be ultimately tied back to a contaminant source at either the Production Area or a waste storage area (Figure 4.1). The potential sources of contaminants within the Production Area include a variety of active facility operations, temporary or long-term waste storage units, and abandoned facilities that once handled or produced hazardous materials. The waste storage areas represent various types of engineered disposal facilities ranging from silo structures to open ponds, and from below-grade pits to aboveground landfills. Descriptions of each of the individual potential sources identified in Figure 4.1 have been provided in Section 3.0.

4.2.2 ON-SITE PATHWAYS (ENVIRONMENTAL RECEPTORS)

Many hazardous waste problems involve a known single source and pathway of contamination, with the primary focus of study being the quantification of the public health and environmental problems at receptor locations. The 1984 release of enriched uranium from Plant 9 operations to the atmosphere is an example of such a scenario. In the case of the FMPC as a whole, however,

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POTENTIAL SOURCES																ONSITE RECEPTORS AND PATHWAYS	OFFSITE PATHWAYS (ENVIRONMENTAL RECEPTORS)				
WASTE STORAGE AREAS								PRODUCTION AREA													
CLEARWELL	WASTE PITS	BURN PIT	LIME SLUDGE PONDS	FLY ASH PILES	K-65 SILOS	METAL OXIDE TANKS	SANITARY LANDFILL	AIR EMMISSIONS	THORIUM INVENTORY	STORED WASTE INVENTORY	UNDERGROUND STORAGE TANKS	METAL WASTE STORAGE AREAS	IN-PROCESS MATERIALS	CURRENTLY GENERATED WASTES	ABANDONED FACILITIES		PADDY'S RUN	GREAT MIAMI RIVER	FLORA AND FAUNA	REGIONAL AQUIFER	ATMOSPHERE
	●			●				●	●	●		●	●	●	●	STORMWATER SYSTEM	●		●	●	
●	●	●	●	●			●	●	●	●		●	●	●	●	SURFACE DRAINAGEWAYS	●		●	●	
●	●								●	●			●	●	●	MAIN EFFLUENT LINE		●		●	
	●	●	●	●	●	●	●		●	●	●		●	●	●	GROUNDWATER BELOW THE FMPC	●	●		●	
	●	●		●	●		●	●	●	●		●	●	●	●	SURFACE SOILS			●	●	●
	●			●	●		●	●	●	●		●	●	●	●	LOCAL ATMOSPHERE				●	
●	●	●	●	●	●	●	●				●		●		●	SUBSURFACE SOILS				●	

FIGURE 4.1
POTENTIAL EXPOSURE PATHWAYS TO OFFSITE ENVIRONMENTAL RECEPTORS

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OFFSITE PATHWAYS					POTENTIAL EXPOSURE PATHWAYS TO THE PUBLIC
PADDY'S RUN	GREAT MIAMI RIVER	FLORA AND FAUNA	REGIONAL AQUIFER	ATMOSPHERE	
●	●			●	DIRECT CONTACT
				●	INHALATION
●	●	●	●		INGESTION
●	●			●	DIRECT RADIATION

FIGURE 4.2
POTENTIAL EXPOSURE PATHWAYS TO THE PUBLIC

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the problem definition for purposes of developing responsive remedial actions cannot concentrate solely on the off-site receptors and whether or not an imminent or substantial endangerment exists. A second key problem to be addressed is how the contaminants arrived at the receptor such that individual sources can be identified, current and future risks can be evaluated, and appropriate remedial actions can be developed and analyzed. The analysis of on-site pathways is important to characterize the current and potential public health and environmental problems at the FMPC. Because on-site pathways also represent environmental receptors, a pathway analysis becomes more important in the problem definition. Each potential pathway for on-site contaminant movement at the FMPC is addressed in the following sections.

4.2.2.1 Storm Water System

Radionuclides and other contaminants originating from the Production Area have entered the storm sewer system through accidental spills and through surface runoff. Under normal conditions, the storm water runoff is combined with the general sump effluent and other plant liquid effluents and is discharged to the Great Miami River. During periods of heavy runoff, excess storm water has been discharged directly into a storm water outfall ditch. This ditch is a narrow and shallow ravine that flows southwest from the Production Area and discharges into Paddy's Run. This overflow condition is now controlled by an equalization basin.

Contaminated storm water in this ditch could have infiltrated the till and possibly recharged the underlying sand and gravel aquifer. This could represent a pathway for contaminants originating in the Production Area to enter a southern flowing ground water system. An evaluation and understanding of this potential pathway could be important to any remedial action program to control sources of offsite ground water contamination to the south.

4.2.2.2 Surface Drainageways

Several drainageways that exist within and adjacent to the waste storage area and Production Area serve as a transport system for surface water runoff from the waste storage areas to Paddy's Run and off site. Such a drainage system is also a potential source of ground water contamination. Runoff that is collected and discharged directly to the soil may contain radioactive or other hazardous contaminants that can infiltrate into the underlying aquifer.

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4.2.2.3 Main Effluent Line

The FMPC main effluent line traverses the entire site in an easterly direction. The line originates at the clear well near the western border of the site below Waste Pit 3, and conveys clarified process waste stream effluent eastward to a point of discharge at the Great Miami River. As it traverses the Production Area, storm water enters through a tie-in with the storm water collection system. The effluent line exits the FMPC near the sewage treatment plant, at which point (Manhole 175), treated effluent from the sewage treatment plant also enters the discharge line.

This line carries all of the wastewater leaving the FMPC; a leak any place in the line could become a local source of ground water contamination. Furthermore, the trench carring the line could act as a conduit carrying cntaminated ground water across the site. Leakage at the clear well could also contribute contaminants to Paddy's Run, and in turn to southern ground water zones as a consequence of recharge from Paddy's Run. An important issue associated with the effluent line is the possibility that it could carry contaminants across a potential ground water divide near the Production Area. Additionally, the potential exists that the discharge from this line is within the zone of influence of the Southwest Ohio Water Company (SOWC) well.

4.2.2.4 Ground Water Below the FMPC

The importance of on-site ground water is its role as both a receptor of contaminants from a variety of FMPC sources and a pathway for contaminant migration to off-site areas. The use of ground water at the FMPC is for production water and on-site drinking water. This water, which is pumped from the sand and gravel aquifer below the blue-clay stratum, has not exhibited contamination. More details on the ground water system as a potential pathway are provided in Section 4.3.1.

4.2.2.5 Surface Soils

Most of the radiological contamination of surface soils at the FMPC is the result of deposition of airborne emissions over the life of the plant. Exceptions would include spill areas or zones contiguous to waste storage units or near production facilities. As a result, the contamination of soils is expected to be dispersed and variable. A summary of the available data base on soils is provided in Section 4.3.3.

4.2.2.6 Subsurface Soils

The contamination of subsurface soils would be the result of deposition of airborne emissions, spills or line leaks, or surface water transport along drainageways to low spots within the FMPC. Subsurface soil contamination would be expected to be

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dispersed and variable, but principally associated with waste storage areas and drainageways.

4.2.2.7 Local Atmosphere

Emissions of particulates and gaseous material from the FMPC plants, treatment facilities, waste management areas, and storage units can be categorized as releases from the Production Area facilities from point sources (stacks); and fugitive releases of material deposited on buildings or soil surfaces by previous releases. Ventilation systems within the production area collect gases and airborne particulates from over 400 individual operations or pieces of equipment. These ventilation systems are vented to the atmosphere through dust collectors to control total emissions from the plant. Emission sources with a potential for releasing radionuclides are provided with stack samplers to determine the magnitude of releases. Uranium, thorium, and associated daughter products are the primary radioactive emissions from these stacks. The principal non-radioactive emissions are particulates, nitrogen oxides, and sulfur oxides.

4.2.3 OFF-SITE PATHWAYS (ENVIRONMENTAL RECEPTORS)

Many of the source-pathway-receptor scenarios associated with the FMPC cannot be completed without a consideration of the off-site pathways identified in Figures 4.1 and 4.2. The off-site pathways, which are in themselves environmental receptors, represent either an extension of an on-site pathway (e.g., the regional aquifer or ambient atmosphere) or a new, intermediate pathway to a final receptor (e.g., the Great Miami River). Each is discussed below.

4.2.3.1 Paddy's Run

Natural drainage from large portions of the FMPC is to Paddy's Run. This waterway represents both a principal environmental pathway and an important environmental receptor. The contaminants can enter Paddy's Run via surface water drainageways, surface infiltration, and ground water discharge. The Great Miami River is the most evident receptor of contaminants transported via Paddy's Run. Impacts on aquatic environments and the potential for human contact with contaminated organisms, water and sediments in Paddy's Run represent secondary pathway-receptor scenarios.

Paddy's Run is also a potential pathway for contaminant transport to the regional aquifer if radionuclides and/or hazardous chemicals enter the stream from surface drainages or ground water discharge and then infiltrate through the streambed. The scenario of ground water - surface water - groundwater transport could be important to the explanation of southern ground water contamination, particularly if a ground water divide exists on the FMPC site near the waste storage area.

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4.2.3.2 Great Miami River

The Great Miami River represents the ultimate receptor of surface water drainage and localized ground water discharges from the site, and is both an important pathway and an important receptor of environmental releases from the FMPC. The three principal pathways of contaminant transport to the Great Miami River are Paddy's Run, the main effluent line from the plant through Manhole 175, and ground water discharge.

The aquatic ecosystem of the river is a potentially impacted receptor of contaminants in the river. In addition, the river represents a mechanism for downstream transport of dissolved and suspended contaminants. This increases the possible exposure to humans either by direct contact or by ingestion of contaminated fish flesh.

4.2.3.3 Flora and Fauna

The flora and fauna of the FMPC have not been extensively studied, although surveys are underway. Some native and introduced species are of importance to the RI/FS for two principal reasons. The first is the potential impact of radionuclide and chemical releases on both the organisms and their environment. A second concern is the potential for biomagnification via the food chain, with fish, and some game species representing upper levels of the food chain and direct food sources to the public.

4.2.3.4 Regional Aquifer

The regional ground water aquifer serves as a pathway to downgradient receptors (as addressed below). As a receptor, the principal issue associated with the regional aquifer is the potential degradation of the ground water as a natural resource and its relationship to established ground water quality standards. Numerous potable and industrial water supply wells are located in the immediate vicinity and downgradient of the FMPC. The largest withdrawal is associated with the SOWC wells located along the western shoreline of the Great Miami River immediately to the east of the FMPC. The water withdrawn from these wells is piped for use as industrial process water.

From a public health standpoint, the private potable water supply wells to the south and possibly to the east of the FMPC represent a concern. Private wells to the south of the FMPC have been observed to have elevated levels of uranium. None of these wells are used as a potable water supply, however.

4.2.3.5 Atmosphere

The ambient air can potentially receive contaminated particulate and gaseous emissions from numerous sources throughout the FMPC. Atmospheric transport of contaminants is not constrained

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by physical boundaries, and thus a 360-degree impact area can potentially result. In addition, the uptake of airborne contaminants via inhalation is a passive occurrence to which the entire receptor population is potentially exposed. An offshoot of such an exposure pattern to radiological contaminants is the importance of cumulative doses over the lifetime of an exposed individual.

Within 50 miles of the FMPC, there is a population of approximately 2,577,000. Hamilton County supports a population of about 864,000, and Butler County a population of about 275,000. Most populated areas in the vicinity of the FMPC are unincorporated small towns varying from an estimated population of 30 at Fernald to 3,000 at Ross.

4.2.4 POTENTIAL EXPOSURE PATHWAYS TO THE PUBLIC

A completed pathway to a human receptor requires a mode of exposure. Four types of exposure modes have been identified in association with the FMPC, as described in the following sections.

4.2.4.1 Direct Contact

The direct contact exposure mode is associated primarily with potential contact with contaminated soils, sediments, and surface waters at off-site locations. This scenario is not considered to represent a principal public health issue, however. The subsequent use of available and new data in a comprehensive risk assessment will test this hypothesis.

4.2.4.2 Inhalation

The inhalation exposure mode is directly related to atmospheric emissions and pathway transport that have been addressed in previous sections. The quantification of cumulative doses and anticipated future doses to offsite populations will be a principal objective of the RI. Much of this determination may be based on existing data and the results of other completed and ongoing studies, as appropriate.

4.2.4.3 Ingestion

Potential health impacts associated with an ingestion exposure mode have five principal components:

- The ingestion of ground water;
- The ingestion of crops grown on FMPC or adjacent areas;
- The ingestion of milk products or meat from livestock grazing on FMPC property or neighboring environs;

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- The ingestion of fish collected from Paddy's Run or the Great Miami River;

- The hunting and ingestion of game animals.

Previous investigations have addressed these issues. The scope of the RI will be sufficient to collect data necessary for the eventual determination of dose and risk in the risk assessment task.

4.2.4.4 Direct Radiation Exposure

Exposure through direct radiation is more likely in the Production Area work place than at off-site locations. Worker health and safety procedures at the FMPC are in place to monitor and control potential threats to personnel. This includes strict operating procedures in the metals fabrication buildings, posting areas or restricting access where potential health and safety could be jeopardized, personnel training, and medical surveillance. The focus of the RI will be on any potential effects on off-site populations living near radiation sources.

4.3 AFFECTED ENVIRONMENTAL MEDIA

4.3.1 GROUND WATER INVESTIGATION RESULTS

Based on 228 samples collected upgradient of the FMPC between 1978 and 1982, Dames and Moore (1985) determined the average background concentration for uranium in ground water in the vicinity of the FMPC to be approximately 0.5 pCi/l (0.8 ug/l). Based on this value, ground water monitoring data collected to date indicates three areas within and adjacent to the FMPC that have uranium levels exceeding background. These include areas within the waste storage area and just to the northwest and south of this area; an off-site area to the south of the FMPC and east of Paddy's Run; and an area surrounding the SOWC's well near the Great Miami River to the east of the site.

The on-site uranium contamination near the waste storage areas was first detected in six wells by Dames and Moore in 1985. Ongoing quarterly monitoring in support of RCRA compliance continues to indicate elevated uranium concentrations at this location, although the levels of contamination and the observed locations have not remained consistent (Dames and Moore, 1986). Monitoring over a longer time period will be necessary to establish meaningful trends.

Off-site uranium levels in excess of background were also observed by Dames and Moore in 1985 in 13 wells to the south of the FMPC boundary. A 1986 study by IT Corporation found elevated levels in off-site wells in the same area, with two wells exhibiting concentrations of 144 pCi/l and 185 pCi/l, respectively. The RCRA monitoring program continues to document elevated uranium concentrations to the south, but again the

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locations and levels of uranium are not consistent from one quarter to the next.

A single observation of a 1.22 pCi/l uranium level in the SOWC well (IT, 1986) is difficult to interpret in terms of site-related contamination. Not only is the observed value close to background, but it is less than the value of 6.8 pCi/l considered as background in the nearby Great Miami River. Since considerable volumes of river water may be induced into the SOWC well by the pumping stresses, the FMPC may not be the only or principal source of uranium observed in the SOWC well.

IT Corporation (1986) compared the off-site areas that exhibit elevated uranium concentrations with a theoretical potential impact area. The impact area was based on calculations of the maximum distance of ground water movement that would have occurred during a 35-year site operations period, using hydrogeologic and geochemical settings developed by IT from available data. This analytically determined distance envelops both off-site areas which have been observed to have elevated uranium levels.

Although off-site uranium contamination has been observed, monitoring data collected to date do not show evidence of an organic contamination problem in the ground water underlying the FMPC. During IT's 1986 study, five on-site and four off-site ground water samples were analyzed for the presence of organic compounds listed in EPA's Hazardous Substances List (HSL). No compounds were detected in any of the samples at or above the minimum detection level required by EPA. The quarterly RCRA monitoring program also tests for volatile organics and pesticides/herbicides at 42 on-site and off-site wells in both the till and the sand and gravel aquifers. Several values slightly above the analytical detection limit have been observed, but both the compound(s) detected and the location(s) of the affected well(s) have varied from quarter to quarter. The RCRA program will continue to analyze ground water samples for organics on a quarterly or semi-annual basis, and a comparative data base will eventually be developed to allow for a more definitive trend analysis.

The till material is the unit most likely to be contaminated by direct contact with wastes and by surface water infiltrating through waste areas and adjacent contaminated soils. The perched aquifer systems that exist within the till can consequently be degraded by radiological and chemical constituents, as exhibited by elevated levels of uranium found in wells near Pit 4 during the Dames and Moore and RCRA monitoring programs. While it is unlikely that these shallow aquifer systems provide direct ground water pathways for contaminants to reach off-site receptors, they can provide the intermediate source of contaminant release to the underlying sand and gravel aquifer.

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The sand and gravel outwash deposits which underlie the glacial till are less hydrologically complex than the till. These deposits are, however, more extensive and represent a regional-scale buried channel aquifer which is being used as a water supply. Previous sampling of existing wells indicates contamination in this aquifer in the area immediately downgradient of the waste pit area. Off-site wells to the south of the FMPC have also exhibited elevated levels of uranium in this zone. The upper sand and gravel aquifer can, therefore, be considered to be the principal pathway for off-site ground water contamination.

The observation of a slightly elevated level of uranium in the SOWC well underscores the potential importance of an easterly flow component to contaminant pathways from the Production Area and waste storage areas. Through a ground water modeling study of the buried channel aquifer near the FMPC, GeoTrans (1985) concluded that a ground water divide exists which trends from southeast to northwest across the south-central portion of the facility, and that water in the buried channel aquifer near the waste pits will travel east towards the Great Miami River. The 1986 work by IT supported the concept of an eastward flow component.

The evaluation of both the water quality data and the associated public health and environmental risks requires that the concentrations found in the ground water samples be compared to levels expected in ground water not influenced by the facility operations. This, in turn, requires establishing background concentrations for various chemical constituents. An average background uranium concentration of 0.5 pCi/l was computed by Dames and Moore (1985). However, the data used to compute this value had a large variance, and uranium levels such as the 1.22 pCi/l observed in the SOWC well cannot at this time be conclusively considered to exceed background levels.

4.3.2 AIR INVESTIGATION RESULTS

Routine or accidental releases of hazardous or radioactive substances to the atmosphere will be transported and deposited downwind of the point or area of release. The nature and extent of these emissions of hazardous or radioactive materials to the atmosphere due to current or past operations at the FMPC can be quantified from the historic inventories of radionuclide emissions (Boback, 1986), ambient air quality data from the FMPC monitoring network (NLO and WMCO Annual Environmental Monitoring Reports, 1960-1985), soil samples taken at approximately 300 locations around the FMPC site, and by the results of atmospheric dispersion modeling.

Uranium emissions from the FMPC totaled approximately 136,000 kg during the period 1951 through 1984, an average of 3,900 kg per year. A total of 75 kg of uranium was emitted to the atmosphere in 1985 (FMPC-2047), indicating a decrease in air emissions in

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recent years due to the implementation of control devices. The majority of these releases were made through control device stacks equipped with continuous samplers to measure particulate emissions. Data from the stack samplers was used in determining emissions from the various sources within the FMPC (Boback, 1986).

Radon-222 is released from two silos (K-65 storage tanks) containing pitchblende residues. Estimated emissions of radon-222 from the K-65 tanks is 60 curies per year (Boback, 1986). Section 3.0 discusses an intensive survey conducted from September 1984 to February 1985 to assess radon releases from the K-65 silos.

Wastes containing asbestos have been disposed in the sanitary landfill, in Pit 4, and in steel drums, as discussed in Section 3.0. Emissions of this material from Pit 4 and the steel drums is unlikely. Pit 4 is inactive and the entire pit is expected to be completely covered in the near future. However, fugitive emissions from the sanitary landfill are possible and will be dependent on climatic conditions and earthmoving activities in the landfill. There is no record of any observation of visible emissions of asbestos from either the sanitary landfill or Pit 4.

Ambient particulate monitors (high volume samplers) and passive radon monitors (track-etch film detectors) are located in nine on-site plant perimeter monitoring stations and three off-site stations (Crosby School, Elda School, and the Albright Wilson Plant). A fourth monitoring station at the Morgan School near the town of Shandon is expected to be operational by mid-1987. The current monitoring network meets appropriate DOE guidelines for ambient monitoring networks. The monitoring stations both on-site and off-site are located so that releases of radon or particulate matter have a high probability of being detected (Kornegay and Sharp, undated). Annual average uranium concentrations, as derived from the particulate matter collected by the high volume samplers, are well below applicable DOE guidelines. Similarly, ambient radon concentrations have also been below applicable DOE guidelines during the period of monitoring.

IT Corporation (IT, 1986) conducted a dispersion modeling study to assess the air quality impacts due to uranium emissions from the FMPC. Average annual uranium concentrations were predicted over a 34-year period (1951 to 1984) by use of the Industrial Source Complex Long Term Model (ISCLT), a U.S. EPA guideline model (U.S. EPA, 1986). An annual average uranium emission rate for the 34-year period, along with meteorological data from the Greater Cincinnati Airport, were used as model inputs. Results of the modeling verified measured concentrations at the boundary monitoring station. Furthermore, the model predicted concentrations were also well below applicable DOE guidelines. Predicted concentrations were compared to measured annual concentrations averaged over a 12-year period at monitoring

stations BS1 through BS7. This comparison resulted in a correlation coefficient of 0.97 which is significant at the 5 percent level. This degree of correlation indicates that the available emission inventory (emission rates, stack parameters, and particle size distributions) adequately describes the source term and that the meteorological data is representative of the dispersion climatology in the vicinity of Fernald.

The Oak Ridge National Laboratory (ORNL) is currently performing a dispersion modeling study to assess the impact of releases of radioactive material from the FMPC which have taken place on an annual basis during the period 1951 through 1984. The study results will include concentration, deposition, and population dose within 50 miles of the FMPC. This retrospective modeling study will be used to assess the impact of these historic emissions on the local community.

4.3.3 SURFACE SOIL INVESTIGATION RESULTS

Prior to 1984, soil samples were collected at seven air sample locations along the site boundary to observe possible contributions from stack effluents. In 1984 and 1985, the soil sampling program was expanded to include 15 locations, all of which were either along the site boundary or off site. In addition, the following special samples were taken: 104 off-site samples in 1984 near the old solid waste incinerator; and 21 samples in 1985 to correspond to grass sampling sites. In general, these soil samples were analyzed only for uranium concentrations. The exception was 1984, in which 25 of the 105 special samples were analyzed for Pu-239, Pu-240, Np-237, Tc-99, Th-228, Th-230, and Th-232. The sampling results indicate that the concentration of uranium in soils for all but one location were below 35 pCi/g (a reference point FMPC uses for acceptance of decontaminated areas). One sample location, near the site of the old solid waste incinerator, showed concentrations of uranium in soil ranging from 38.9-68.5 pCi/g. Concentrations of the other radionuclides were small or undetectable. These results are reported in the annual environmental monitoring reports NLCO-2028 and FMPC-2047.

Two special studies have been initiated by WMCO contractors that have or are currently generating surface soil sampling data. One off-site study was conducted to assess, within a five-mile radius of the FMPC site, the potential impacts to the general public from exposure to airborne radionuclides and surface soils deposition. Another on-site study is currently underway to characterize soil contamination within the FMPC waste storage area.

The off-site study involved obtaining over 900-near surface soil samples collected at over 300 sample locations. The bulk of the sampling was conducted off site with fewer than 10 samples collected on site. No samples were taken inside the Production Area or waste storage areas. In addition, as part of this

sampling program, a statistically designed comparison was made between surface soil sampling results from the study and the results of a previous study conducted by NLO, Inc. in 1984. The results showed that 1984 soil sampling data is directly comparable to the data taken during the off-site study.

The on-site study involves a characterization of the FMPC waste storage area, and is intended to identify and quantify the areal and vertical extent of radioactive and chemical contamination of soils. This study is establishing a permanent, reusable grid system, on 100-foot centers, throughout the waste storage area which will be tied to the existing FMPC coordinate system. Surface soil samples are to be taken and analyzed for a wide range of radionuclides and chemical contaminants listed on EPA's HSL.

In summary, data on surface soil contamination has been collected primarily near the boundary of the FMPC site and off site. With the exception of 12 samples collected in 1984, uranium was the sole parameter of analysis. The data in these reports suggest that deposition of uranium in surface soils appears to be through the air pathway, and could represent a potential hazard to human health and the environment. Current data are adequate to describe off-site surface soil uranium contamination, but not adequate to characterize on-site contamination of soils by radionuclides or hazardous chemicals.

4.3.4 SURFACE WATER AND SEDIMENT INVESTIGATION RESULTS

Surface water samples have been collected since 1954 at several locations on the FMPC and the Great Miami River to determine the effect of effluents on river water quality. At the Venice Bridge, weekly samples are collected for background analysis. A weekly downstream sample is collected at New Baltimore. In addition, a daily composite sample is analyzed from the waste line at Manhole 175. All samples are analyzed for uranium, alpha and beta radioactivity, radium-226, radium-228, chloride, fluoride, nitrate, filterable solids, and pH. In 1976, additional downstream samples at Miamitown were collected weekly to assess the effect of intermittent discharges of storm water from Paddy's Run on water quality. During this period, additional radioactive isotopes were analyzed in the effluent line. These included Technetium-99, Neptunium-237, Plutonium-238 and 239, Ruthenium-106, and Cesium-137.

The monitoring program was further expanded in 1979 to include weekly samples from three locations in Paddy's Run. The storm sewer overflow drainage ditch was also included as a sampling location whenever water was available.

The concentrations of uranium in Great Miami River samples downstream of the effluent line have generally been at levels similar to or less than upstream levels. Other parameters, both radioactive and nonradioactive, showed similar patterns

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suggesting that the contribution of these elements from the FMPC to the river system is small when compared to the river flow volume and upstream mass loading of the same contaminants.

Water samples from Paddy's Run consistently showed elevated levels of uranium and gross alpha activity in samples collected from on site and downstream of the site when compared with off-site upstream samples. Concentrations of Radium-226, Radium-228 and gross beta activity were more variable among the three sampling sites. Nonradioactive parameters did not display any clear trends that would indicate site-related problems.

Other drainages have been observed in various parts of the facility that, during precipitation events, receive overland flow and discharge directly into Paddy's Run. These have never been sampled for the analysis of radiologic parameters.

River sediments have been collected at seven locations in the Great Miami River since 1975. Five sampling points are located from 50 feet to 4.7 miles downstream from the FMPC outfall. Two upstream locations, up to 3.7 miles from the outfall, have also been sampled. Once a year, river bank samples are collected from the top two inches near the water line. Only that portion passing a 50-mesh screen is analyzed for uranium.

In 1983, Technetium-99 was analyzed in one upstream and three downstream samples. In addition, five sediment sampling locations were selected along Paddy's Run and seven locations were selected in the storm sewer outfall ditch. All sampling was done semi-annually.

Over the ten-year period of sediment analysis in the Great Miami River, all uranium levels downstream of the outfall were similar to the upstream levels. Technetium was detected at levels near the detection limit only at the downstream sampling location nearest the outfall.

Uranium concentrations in on-site sediment varied greatly in both space and time. The temporal variation is most likely due to the flushing action of seasonal rainfall. In addition, the spatial variation observed may result from the variation in distance of flow before water percolates into the sand and gravel. This is a function of precipitation quantity and duration as well as the distribution of sediment grain sizes and geotechnical properties.

There was some evidence of elevated levels of Technetium in the storm sewer outfall ditch while other areas, including those off site, were similar to one another. Off-site samples, both upstream and downstream of the facility, contained low levels of uranium that may be indicative of background concentrations.

Other drainageways and potential sediment traps such as culverts and manholes have not been sampled to date.

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4.3.5 BIOLOGICAL RESOURCES INVESTIGATION RESULTS

During 1984 and 1985, the environmental monitoring program at the FMPC was expanded to include the collection and analysis of fish, vegetation, produce, and agricultural products for uranium and fluoride (NLCO-2028; FMPC-2047). Elevated levels of both parameters were found. The data suggest that the highest concentrations of uranium occur in soils and vegetation found in the prevailing wind direction (NE). There was also positive correlation between soil uranium content and vegetation uranium content, indicating that air deposition is the pathway for uranium to soil and vegetation. Values ranged from 0.09 to 7.09 pCi/g dry weight in 1984, and 0.02 to 2.34 pCi/g dry weight in 1985.

Potatoes were selected for analysis as a human food chain component. Potato peels and flesh were analyzed for uranium content in 1984 and 1985 from locally grown stock and from a control location approximately 25 miles to the west of the FMPC. Observed values for potato peels ranged from 0.068 to 0.366 pCi/g dry weight in 1984, and from 0.19 to 1.22 pCi/g dry weight in 1985. Peels concentrate uranium to a greater extent than flesh.

In October 1984 and September 1985, fish were collected from three locations on the Great Miami River. A total of 90 fish were analyzed for the two years. The number of fish per sample location ranged from 11 to 21. Analyses were performed by species and a mean was calculated for the station. Station 1 was just below the confluence of Paddy's Run with the Great Miami River; Station 2 was at the main effluent line discharge into the river; and Station 3 was approximately 2.9 river miles upstream from Station 2. Average uranium content in fish flesh at Station 1 was 0.242 pCi/g in 1984 and 0.109 pCi/g in 1985. Station 2 uranium content averaged 0.299 pCi/g in 1984 and 0.156 pCi/g in 1985. Station 3 averages were 0.331 pCi/g and 0.086 pCi/g in 1984 and 1985, respectively. Station 3, upstream from the effluent outfall, had lower mean uranium levels than the other two stations.

Milk produced by cows grazing on the FMPC and adjacent land was collected and analyzed from two sampling locations. No detectable quantity of uranium was present in samples from the two locations for 1984 or 1985.

4.3.6 RADIATION INVESTIGATION RESULTS

Radioactive materials have been used and stored at the FMPC since operations first began in the early 1950s. These materials emit direct radiation into the surrounding environment. Direct radiation measurements were performed in 1976 and 1985 at the FMPC site and its immediate environment by EG&G Energy Measurements, Inc, using the Aerial Measuring System (AMS). The results of these studies indicate that external radiation levels

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at the site boundary, and for much of the site, are not significantly above background levels for the area.

Direct radiation measurements made at the site boundary by WMCO, using thermoluminescent dosimeters, support the conclusion that external radiation levels are at or near background levels for the area.

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SECTION 5.0

HISTORY OF RESPONSE ACTIONS

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5.0 HISTORY OF RESPONSE ACTIONS

5.1 MAJOR STUDIES

Several major studies of the FMPC site have been undertaken by NLO and WMCO in past years. Other studies are currently underway, but are not presented here unless a final report has been issued.

5.1.1 DAMES AND MOORE, 1985. DEPARTMENT OF ENERGY FEED MATERIALS PRODUCTION CENTER, GROUND WATER TASK C REPORT

This section summarizes the Ground Water Task C Report as well as the Results of Round 1 and Round 2 Ground Water Sampling, Feed Materials Production Center, Fernald, Ohio prepared by Dames and Moore (1986).

The Task C Report identifies the sources of above-ground concentrations of uranium which have been detected in three off-site wells. These wells are downgradient of the FMPC.

This Report presents:

- Field and laboratory data collected during the drilling aquifer testing, and water sampling tasks of this project;
- Evaluation of site geologic and hydrogeologic conditions based on recently collected and previously published data;
- The basis for the identification of sources for the above-background concentrations of uranium in the three off-site wells;
- The identification of sources for above-ground concentrations of uranium in the three off-site wells; and
- Recommended short- and long-term alternative actions to reduce the contribution of uranium to ground water and/or to mitigate its potential impacts.

VOLUME I - ROUND 1 SAMPLING 1985 -1986

The first round of RCRA ground water monitoring included sampling in three phases with different wells being sampled during each phase. Sampling for Phase I included four shallow wells which were sampled in August 1985. Sampling for Phase 2 included seven wells in the sand and gravel aquifer, performed in December 1985. Sampling for Phase 3 included a total of 32 on- and off-site wells performed in January 1986.

Elevated levels of several metals, anions and cations were noted in several on-site wells.

VOLUME II - ROUND 2 SAMPLING 1986

The second round of RCRA ground water monitoring included sampling of 41 monitoring and water supply wells at the FMPC and vicinity.

Based upon review of the current analytical data, the following conclusions were made regarding ground water quality underlying and in the vicinity of the FMPC:

- Widespread VOC, pesticide/herbicide and heavy metal contamination is not present in the ground water at the FMPC. Although isolated occurrences of low concentrations of coumpounds have been detected, they are not indicative of widespread ground water degradation.

- The distribution of radiological and nonradiological constituents around Pit 4 appears to be localized but may be moving outward. The Waste Storage Area RI/FS currently in progress will help decide as to the most effective way to remediate this situation.

- The Plant Production wells and off-site monitoring/supply wells have not been influenced by leaching from Pit 4.

- Ground water sampling must be continued on a regular basis to confirm the above conclusions.

5.1.2 GEOTRANS, 1985. PRELIMINARY CHARACTERIZATION OF THE GROUND WATER FLOW SYSTEM NEAR THE FEED MATERIALS PRODUCTION CENTER, GREAT MIAMI RIVER VALLEY FILL AQUIFER, FERNALD, OHIO

GeoTrans (1985) questioned the USGS (Sedan, 1985) ground water divide locations stating that the water level elevations were determined by using surface elevations picked from topographic maps and not determined by an elevation survey. GeoTrans also stated that more wells were needed along the eastern site boundary to characterize ground water flow. Through a ground water modeling study of the buried channel aquifer near the FMPC, GeoTrans concluded that:

- There exists a ground water divide which trends from southeast to northwest across the south-central portion of the facility;

- Water in the buried channel aquifer near the waste pits will travel east towards the Great Miami River; and

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- Water south of the waste pits will travel south and southeasterly towards the Great Miami River.

GeoTrans recommended that additional wells be installed, especially to the east of the plant production area and that a well elevation survey be completed for the area. They also raised the question of vertical ground water gradients and the need for cluster wells to determine the magnitude of the ground water movement.

5.1.3 NLO, 1985. HISTORY OF FMPC RADIONUCLIDE DISCHARGE AND WMCO, 1986, REVISION.

This report presents information on the discharge of radionuclides from the Feed Materials Production Center during the 34 years of FMPC operations, from 1951 through 1984. Discharges to both air and water have occurred, but airborne releases are emphasized in the report because inhalation is an important potential exposure route for most off-site residents in the FMPC area. Industrial waste water from the site enters the Great Miami River via the main effluent line. Best estimates were made when sampling data were not available to provide a complete history. Therefore, for those periods when stack emission data were not available, reasonable estimates were made. Most of these estimates were made by extrapolating from periods when emissions were measured or they were derived from measured production - discharge ratios applied to periods for which only production data were available. The inventory includes stack parameters, building dimensions, and site plans depicting the locations of various emission sources.

A summary of the data compiled in these reports is presented below:

- Air Emissions - Most of the calculated potential dose from FMPC operations is due to uranium; however, daughter products, fission products, and transuranic nuclides have been emitted. Over 34 years, uranium was discharged from 110 stacks, with the emissions totaling approximately 120,000 kg.

- Wastewater Discharge - Over 33 years, uranium was discharged to the Great Miami River with an estimated discharge totaling 74,308 kg. Thorium discharge data have been collected since 1969. The estimated thorium discharged to the Great Miami River is 367 kg. Eight- to 24-year records are available concerning curies discharged for Sr-90, Tc-99, Ru-106, Cs-137, Ra-226, Ra-228, Np-237, Pu-238, and Pu-239/240.

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- Ground Water Discharge - Twenty-two off-site wells are routinely sampled. Three of these wells have above background uranium concentrations. These wells are no longer used as drinking water sources.

- Radon - 222 Source Term - The estimated source term for Radon-222 flux, for both K-65 silos under the present storage conditions, is 60 Curies per year. Dispersion code calculations predict that this flux will add an average of 0.006 pCi/L to the radon-222 concentrations at the nearest residence. The increase is about 2.5 percent of the natural background Rn-222 concentration in the Cincinnati area. Appendix 1 - WMCO, 1986, is a report which discusses the source term derivation and the concentration and dose calculations. To be conservative in the source term derivation, the amount of Ra-226 in the silos was assumed to be 1760 curies instead of the previously-used estimate of 1652 curies.

5.1.4 INCIDENT INVESTIGATION BOARD, 1984. INVESTIGATION OF SEPTEMBER - DECEMBER 1984 PLANT 9 EXCESSIVE URANIUM EMISSIONS: FEED MATERIALS PRODUCTION CENTER.

As a result of an excessive release of slightly enriched uranium from the FMPC Plant 9 dust collection system during September to December 1984, a type B investigation was initiated in accordance with DOE Order 5484-1. The investigation board was charged with assessing the situation and determining causal factors which contributed significantly to the release.

The board assembled facts and findings by conducting interviews, inspecting plant facilities, consulting with a team of baghouse experts, and conducting physical tests on site. Based upon these investigative techniques, judgements of needs were prepared. The results of the investigation are summarized as follows:

On December 7, 1984, NLO, Inc., the contract manager of the FMPC, reported to DOE/ORO that there had been an excessive and unanticipated amount of uranium emissions to the air. The loss occurred from the Plant 9 operations from approximately mid-September to December 6, 1984.

DOE/ORO made reports to the National Response Center and several State of Ohio health and environmental protection agencies, pursuant to the provisions of CERCLA on December 7, 1984. The loss totaled 123.9 kilograms of slightly enriched uranium. The excessive emissions caused no discernable impacts off site.

During the incident, stack samples and radiation detectors indicated that the dust collector system was not operating

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properly. Upon inspection of the baghouse from a limited viewing point, FMPC personnel saw no excessive uranium dust. The stack samples and radiation detector readings were therefore ignored and the plant continued to operate. The evidence indicates a loose bag, which was unobserved, allowed excessive emissions of uranium to occur.

Following discovery of the defective bag, area bags were installed in the baghouse. Baghouses are now routinely monitored and maintained.

5.1.5 MOUND, 1985. RADON AND RADON FLUX MEASUREMENTS AT THE FEED MATERIALS PRODUCTION CENTER, FERNALD, OHIO

This study was conducted from September 1984 to February 1985 and was designed to assess the radon releases near the two K-65 silos. Seventeen radon monitors were established with most located inside the Waste Storage Area. Radon flux from the two K-65 silos also was measured at 24 locations on K-65 Silos 1 and 2.

The average radon concentrations at the 17 monitors ranged from 0.24 to 5.1 pCi/l (Mound, 1985). The maximum concentrations were found near the tanks while the minimum levels were along the eastern perimeter of the FMPC. Contours of equal radon concentrations indicate that the 3.0 pCi/l levels are generally confined to the Waste Storage Area while the 1.0 pCi/l levels extend into the Production Area.

Radon flux values ranged from 13 pCi/m^2/sec to 3 x 10^7 pCi/m^2/sec on Silo 2 and from 30 pCi/m^2/sec to 1.4 x 10^7 pCi/m^2/sec on Silo 1 (Mound, 1985). The highest levels occur near cracks in the tank domes.

5.1.6 WMCO, 1986. RCRA DETERMINATIONS FOR FMPC WASTE STREAMS

In July 1986, WMCO initiated a program to characterize drummed wastes with respect to RCRA requirements. The first effort in this program was to inventory all wastes generated at the FMPC and to determine which waste streams or drummed wastes met requirements of 40CFR261 to be classified as RCRA wastes. From this effort six wastes were classified as "hazardous" and 44 others lacked sufficient analytical information to make a nonhazardous determination. A priority ranking of these remaining wastes was prepared in order of importance, and a detailed stored waste inventory sampling program is being prepared. This sampling and analysis program for stored wastes and waste streams is a continuing program of RCRA waste determination initiated under FFCA guidance.

5.1.7 EG&G, 1985. AERIAL RADIOLOGICAL SURVEY

An aerial radiological survey was conducted over a 70-square kilometer (27 sq. mi.) area centered around the FMPC site. The survey was conducted between April 24-27, 1985.

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Following interpretation, the highest exposure rates determined in excess of 0.35 milliroentgens per hour were measured directly over the Production Area. This radiation was determined to be due to the presence of radionuclides present during normal plant operations. For the remaining portion of the survey area, the inferred radiation exposure rates, which varied from 6 to 12 microroentgens per hour, were thought to be naturally occurring potassium, uranium, thorium, and daughter products. The reported exposure rate values include arc estimated cosmic ray contribution of 3.7 microroentgens per hour.

Measurements taken by field crews on the ground, coinciding with the overflight were compared to the aerial interpretation. The exposure rate values obtained from these measurements supported the aerial survey results. Soil sample results indicated several areas just outside the site boundary with slightly elevated amounts of U-238. The levels were below the detection limits of the aerial systems, however.

An area directly west of the storage silos showed apparent above-background activity. This area was symmetrical in shape when the contours were prepared, suggesting that the elevated levels were caused by "Shine" from materials stored on site in the silos and not to actual off-site contamination.

A detailed comparison of the 1985 aerial survey data with a previous survey conducted in 1976 showed no significant change in any area outside the FMPC boundary.

5.1.8 BATTELLE, 1981. ENVIRONMENTAL REPORT, FEED MATERIALS PRODUCTION CENTER

This report provides a description of the FMPC, operated by NLO, the environment in which it is located, and the actual and potential impacts of the operations upon the environment in which its is located.

5.1.9 ORNL, 1986 DRAFT. REVIEWS OF RADIOLOGICAL DATA FOR THE K-65 STORAGE SILOS AT THE FEED MATERIALS PRODUCTION CENTER, FERNALD, OHIO.

This report is a review of all available environmental radiological data relevant to the K-65 storage silos. The two pathways for radiation exposure to site occupants and off-site residents from K-65 silos are direct gamma radiation exposure from the silos resulting from gamma-emitting products of the radium decay chain and radon gas and products emitted from the silos. Outdoor background levels of radon for this area range from 0.26 to 0.29 pCi/L and average about 0.28 pCi/L. Concentrations of radon at the facility perimeter average 0.55 pCi/L on the west and 0.42 pCi/L on the east. Radon levels at the nearest off-site residence average 0.78 pCi/L. These levels are two to three times the background level, are attributable to the K-65 silos, and are a significant source of radon to the

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local environment. These levels, however, are well below the current DOE guidelines of 3.0 pCi/L above background. Direct gamma radiation falls off rapidly with distance from the K-65 silos. Monitoring data around the permiter of the FMPC is within normal background levels (average of 9 μR/h) except for locations along Paddy's Run. A maximum average value of 22 μR/h was recorded at the monitor closest to the K-65 silos. This corresponds to 193 mR/y (continuous exposure) and may exceed 100 mrem/y. This report also reviews the methodology, procedures, and calibration documentation; the proposed radon monitoring plan; and ORNL gamma exposure rate measurements. Additional monitoring stations for radon are recommended.

5.2 CORRECTIVE ACTIONS

Corrective actions have been conducted at the FMPC to correct, alleviate, or mitigate potential environmental releases. These corrective actions include exterior surface repairs to the two K-65 silos due to exterior surface deterioration; interim surface water runoff control for landfill Pit 4; repair of Pit 5 liner tears; providing protective pumping schemes; relocating Paddy's Run; and construction of a biodenitrification surge lagoon.

5.2.1 K-65 SILOS REMEDIATION

The two K-65 silos, located on the west side of the FMPC, were constructed in 1955. The silos are used for storage of radium bearing residues, a byproduct of uranium ore processing. The silos are of cylindrical concrete construction, 80 feet in diameter and approximately 27 feet high. The silo domes were originally designed to be four inches thick at the center, tapering to eight inches at the dome wall edge.

The walls were post-tensioned, reinforced with 0.162-inch diameter wire stressed to 140,000 pounds per square inch (psi). These post-tensioning wires were covered by a 3/4-inch thick gunite coating. The maximum allowable soil pressure was 4,000 pounds per square foot (psf).

The silos were designed to be loaded with metal oxides in slurry form at a maximum rate of 8,000 gallons per day. The radioactive residues were allowed to settle and the water was decanted, leaving sludge with a density of 100 pounds per cubic foot (pcf) and angle of repose of 0 degrees. The maximum allowable height of solid material was 23 feet and the water level was limited to a maximum height of 25 feet.

In 1963, the silos were showing signs of exterior surface deterioration. Large areas of spalling occurred in the exterior surface gunite coating, particularly on the north silo, leaving post-tensioning wires exposed to weather. Subsequently, patches of the wires became severely corroded and broken. Various options were investigated as remedial actions for the silos.

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Repairs began in 1964 by first chipping away all loose gunite material and then patching the surface with a 3/4-inch coat of cement mortar. After the gunite was repaired and a waterproofing sealant was applied to the external silo walls, an earth embankment was built to the top of the wall on a one and one-half to one (1-1/2:1) slope (horizontal:vertical). The earthen embankment was to provide relief from tensile stress within the walls by counterbalancing the load from the internal contents, since the broken wires were not replaced. A soil was chosen with roughly the same density (125 pcf) as the contents of the silos (100 pcf).

In subsequent years, problems with soil erosion on the silo embankment were frequent. The eroded areas were repaired, but with heavy rains, the problem reoccurred. In 1983, the embankment was enlarged to achieve a 3:1 slope. No further evidence of large scale erosion has occurred (Camargo Associates, Limited, 1986).

Protective covers of refabricated wood and metal were placed over the center portions of the domes of Silos 1 and 2 in early 1986 after cracks were found. Attempts have been made to apply sealant to some of the dome areas, but this has not been completed to date.

5.2.2 WASTE PIT 4 RUNOFF COLLECTION

Pit 4 occupies an area of approximately 2.5 acres, located in the northwest portion of the facility between Pit 6 and Pit 3. This pit was used to dispose of solid waste from the processing facility. Pit 4 is not currently active and has been partially backfilled, graded, and covered with fill material. Pit 4 is known to have received an EP toxic hazardous waste (barium) and is currently being studied to determine whether the site contains hazardous waste as defined by RCRA.

In accordance with the FFCA, a surface runoff collection plan was initiated in July 1986 to collect runoff from the active portions of the landfill as required by RCRA 40CFR 265.302(b).

The adopted surface water design features are as follows:

1. Run-on Controls: There are two run-on controls in place at Pit 4. They consist of:

    - A series of drainage ditches which divert run-on along the east and south sides of the pit. These ditches prevent run-on of surface flow from adjacent access roads, from Pit 6 and from undeveloped land to the south of Pit 4. The ditches will convey the peak flow from a 25-year, 24-hour storm event.

    - An approximately four-foot high earthern berm located along the north and west sides of Pit 4. This berm

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prevents run-on to Pit 4 from the eastern sides of Pits 3 and 5.

2. Runoff Controls: There are three runoff controls in place at Pit 4. They consist of:

   - An internal drainage system formed by placement of waste and cover material to minimize ponding with Pit 4. If ponding does occur, standing water is pumped to Pit 5 or 6 for inclusion in the FMPC wastewater treatment flows. The system will control, contain, and convey the peak flows and total runoff from the 25-year, 24-hour storm event.

   - A two-foot perimeter berm around the landfill located to convey, contain, and treat surface water. The perimeter containment berm is located to contain runoff from the northwest corner of the landfill where runoff from inside the pit boundary occurs. The berm location and design is based on the "worst case" assumption that the area within the berm is impervious and where all rainfall within this drainage area is collected inside the berm.

   - A sump and portable sump pump to convey collected surface water flow from within the perimeter berm drainage area to either Pit 5 or the Dry Residue Pit No. 6 for inclusion in the FMPC wastewater treatment flows.

A storm water containment strategy has been adopted for the disturbed landfill area. The existing topography effectively drains to a sump located in the southwest corner of the landfill. In addition, in areas that are not internally drained within the landfill, potentially contaminated surface water runoff from the disturbed area will be controlled and contained by the external berm and a sump pump.

5.2.3 REPAIRS OF LINER TEARS

Minor joint failures have occurred in the liner of Pit 5 in the past. These have been repaired and all waste pit liners are now inspected on a weekly basis.

5.2.4 PROTECTIVE PUMPING SCHEMES

Six shallow ground water wells were installed in the waste pit area in the early 1960s. Well 1S was pumped continuously at a flow rate of approximately 100 gal/min until June 1984. Discharge was, at various times, to Paddy's Run, the Clear Well, and the wastewater line that empties into Manhole 175. The pumping was an attempt to control migration of shallow ground water away from the Waste Pit Area. Well 2S was damaged and subsequently closed. Wells 3S, 4S, and 5S were pumped for one month at a time on an intermittent basis. Well 6S was dry.

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5.2.5 RELOCATION OF PADDY'S RUN

In the early 1960s, a portion of Paddy's Run was relocated approximately 60 to 80 feet to the west to prevent it from interfering with the construction of Waste Pit 3. In the early 1970s a portion of Paddy's Run, south of the Waste Storage Area, was straightened to improve drainage.

5.2.6 CONSTRUCTION OF BIODENITRIFICATION FACILITY

A biodenitrification facility is being added to reduce the amount of nitrates in the waste water discharged to the Great Miami River, response to recent and more stringent NPDES nitrate limits. Process waste water with unacceptable levels of nitrates will also be routed to the biodenitrification facility.

Construction of the biodenitrification demonstration facility was completed in 1986. Elements of the biodenitrification process are currently being evaluated. Methods for identifying species of denitrifying bacteria are being studied to determine the most rapid and accurate techniques for future analyses. Fermentation equipment, ion and gas chromatographs, and additional laboratory equipment have been ordered so that data for performing bacterial reaction studies may be collected. These data will be used to anticipate and aid in the solution of future problems encountered in the biodenitrification unit.

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SECTION 6.0

DEFINITION OF BOUNDARY

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6.0 DEFINITION OF BOUNDARY

6.1 REMEDIAL INVESTIGATION SITE BOUNDARY CONDITIONS

The areal extent of site-related contaminant migration beyond the FMPC boundaries must be known to characterize the actual or potential impact of FMPC releases to the surrounding population and the environment. A review of existing information has been used to establish RI site investigation boundaries for the sampling discussed in the Task 2 Report, Volume 1 - Sampling Plan. This includes:

- Radiological measurements
- Surface soils
- Ground water
- Subsurface soils
- Surface water and sediments; and
- Biological resources

Radiological measurements will be taken principally within the FMPC boundaries (Figure 6.1) as described in the Radiological Measurements Sampling Plan. Previous direct radiation measurements performed at the site and the immediate surrounding vicinity indicate that external radiation levels at the site boundaries are at or near background levels for the area. The on-site measurements will be used to develop concentration contours for direct radiation levels, and in conjunction with the soil sampling plan, to locate anomalies that may be present.

Extensive surface soil sampling has been performed outside of the FMPC boundaries as part of the Environmental Monitoring Program and by IT Corporation (1986). These data will be used in support of the RI/FS effort. Little data are available inside the boundaries where radioactive material was actually processed and stored. Therefore, the surface soil sampling efforts will be concentrated within the FMPC boundaries at locations that have previously shown elevated direct radiation levels in the Radiological Measurement program. In addition, a limited number of soil samples will be taken in agricultural areas to coincide with biological sampling. The boundaries of the surface soil study are shown in Figure 6.2.

The limits of the proposed Ground Water Sampling program are shown in Figure 6.3. Various studies by Dames & Moore (1985), GeoTrans (1985) and Sedam (1985) indicate that a ground water divide exists at the FMPC; however, its location which affects the direction of ground water contamination migration has been disputed. The areal boundaries of the study have been established based upon available off-site ground water analyses, water level data, aquifer boundary maps, other hydrologic data, geochemical data and calculations of the possible rate and distance of ground water movement from the site. The blue clay layer will serve as the vertical boundary of the study. This

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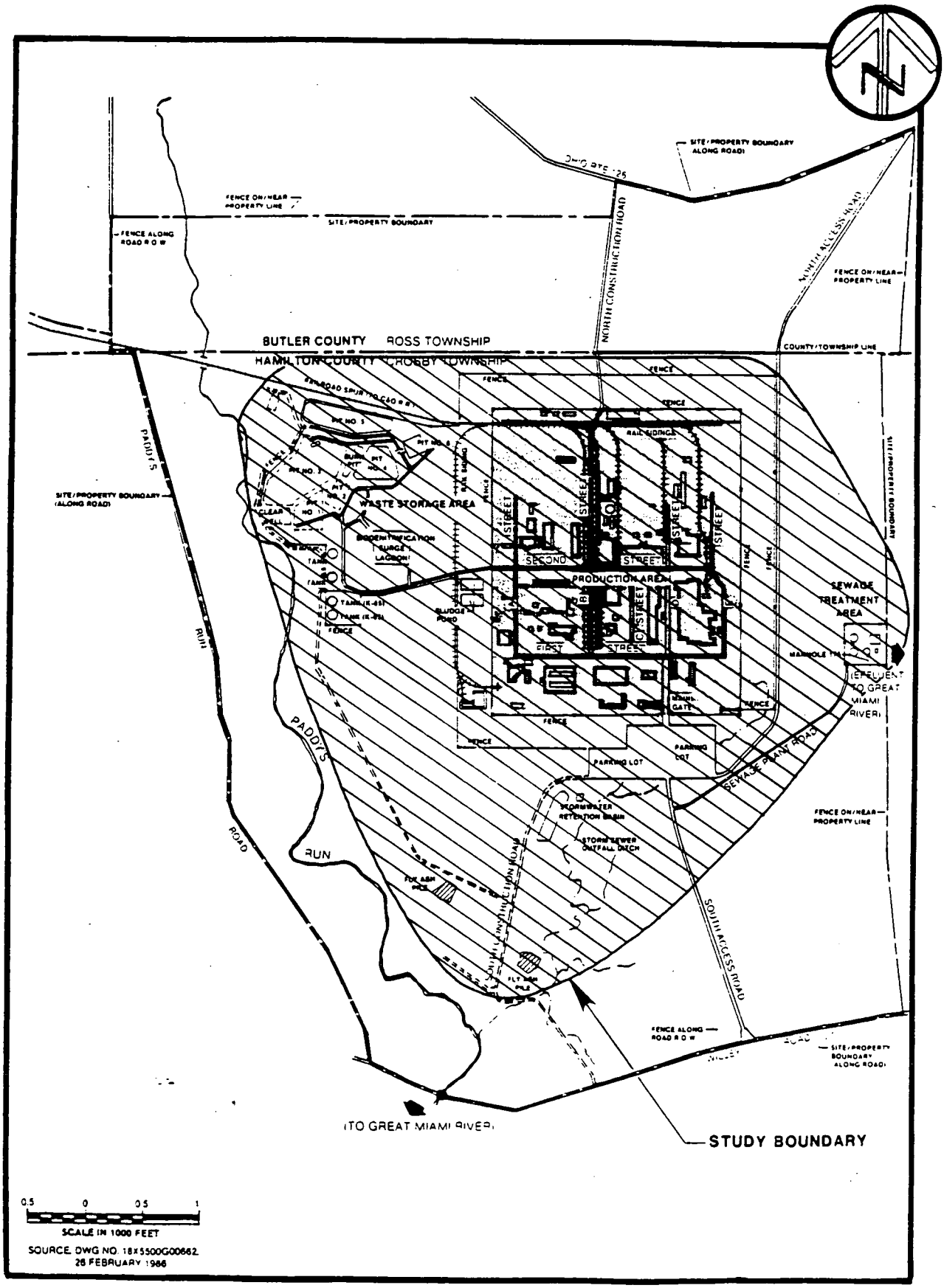

FIGURE 6.1

STUDY BOUNDARY FOR RADIATION MEASUREMENTS PLAN

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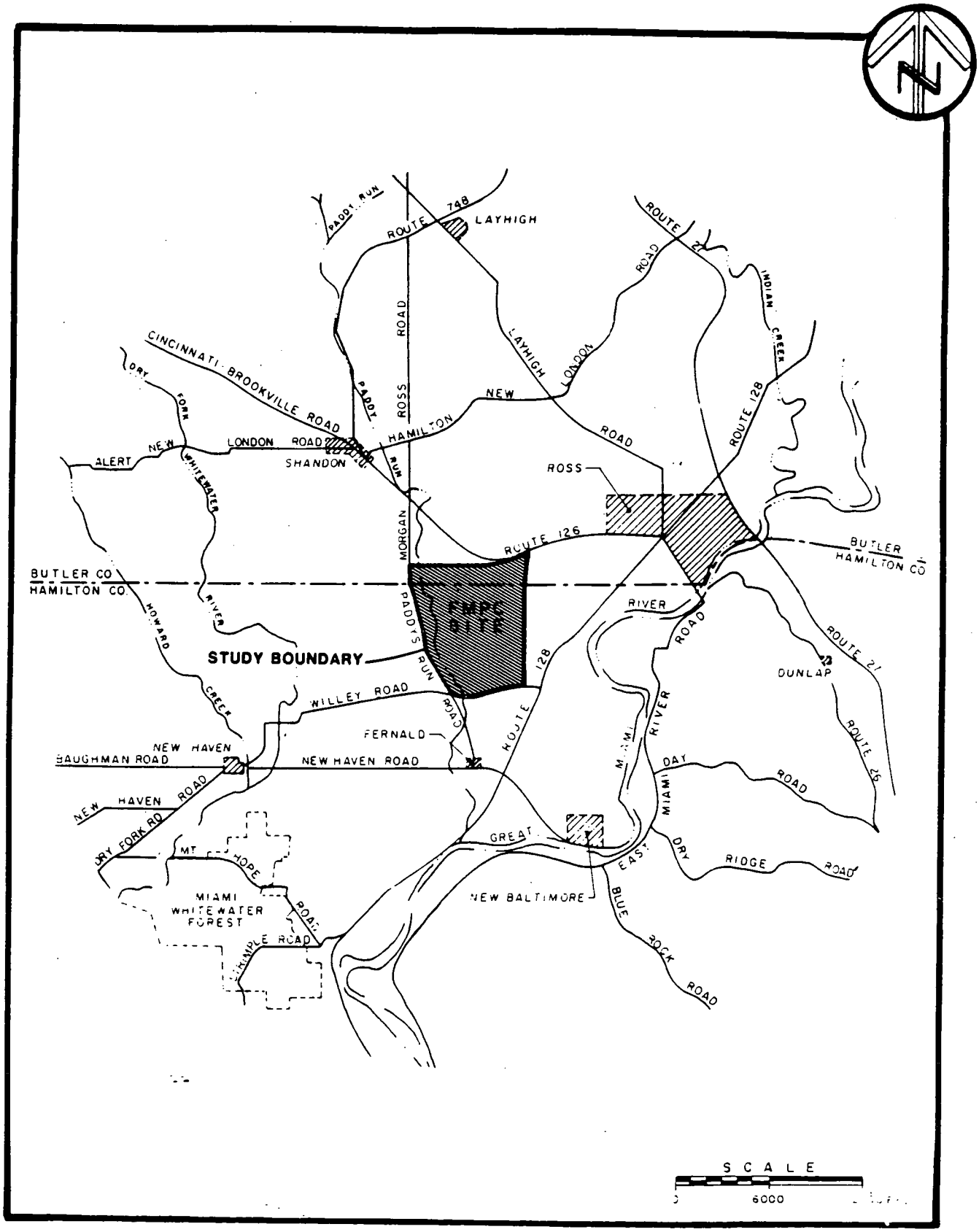

FIGURE 6.2
STUDY BOUNDARY FOR SOIL SAMPLING PLAN

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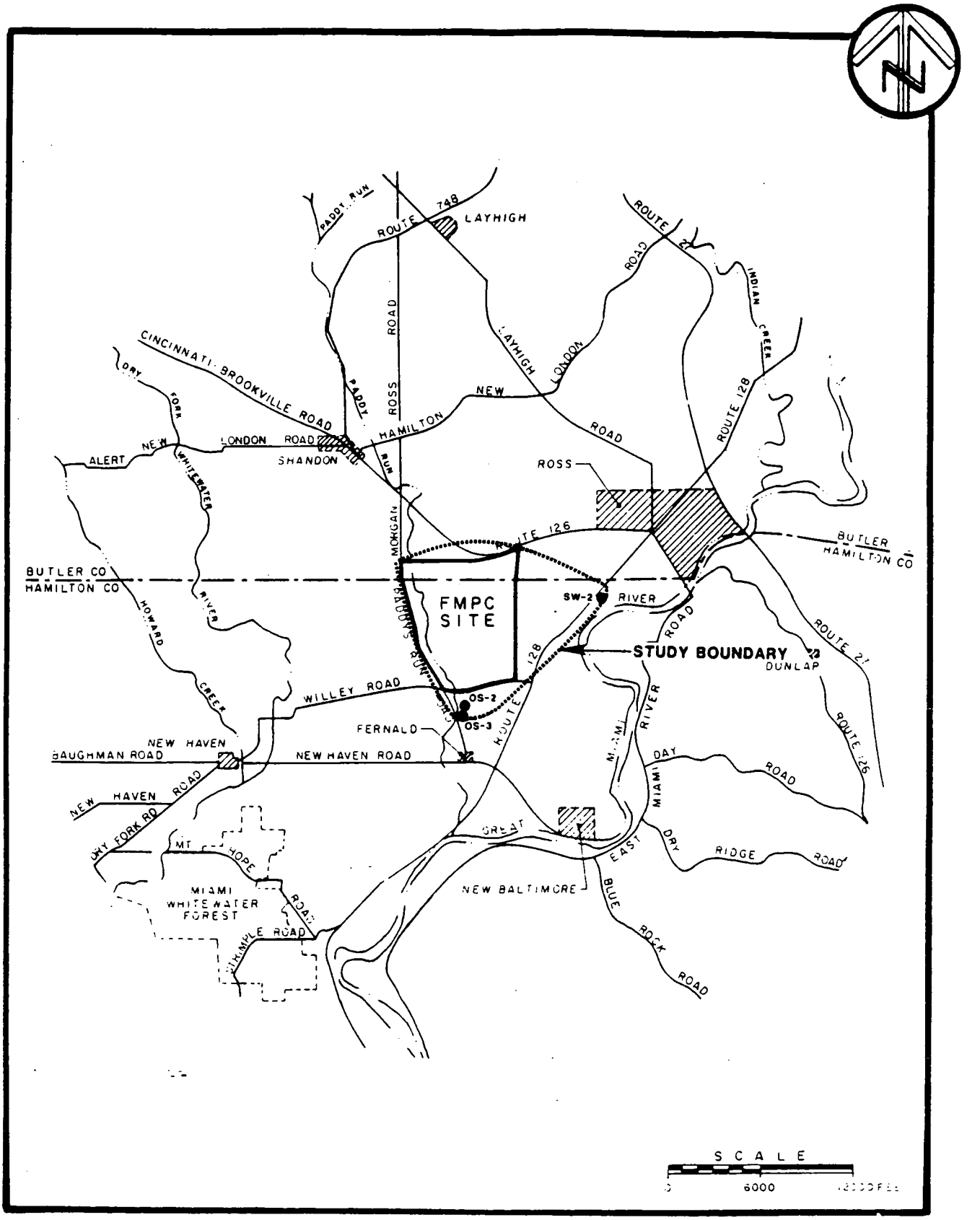

FIGURE 6.3
STUDY BOUNDARY FOR GROUNDWATER SAMPLING PLAN

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unit appears to serve as a semi-pervious barrier beneath the site. This is evidenced by the absence of contamination in deep wells located south of the site. In addition, by limiting the number of deep wells to an as needed basis, the integrity of the blue clay layer will be preserved.

The Subsurface Soil Sampling program will coincide with the locations of new wells installed as part of the ground water program. It is felt that sufficient definition of the extent of subsurface contamination at the site can be achieved by selectively analyzing soils from the 42 borings associated with the monitoring wells. In addition, 12 borings located in the vicinity of the waste pits will provide information in areas where wastes are stored, and there is an increased potential for subsurface contamination.

Surface water and sediment sampling will occur along drainages on the FMPC, along Paddy's Run and the Great Miami River. Historical data indicate that surface waters and sediments in the Great Miami River are not contaminated based on the analyses of limited radiological and non-radiological parameters. Paddy's Run, which receives surface runoff from the site and may recharge the sand and gravel aquifer shows evidence of elevated levels of uranium in on-site and downstream locations. The boundaries of the surface water and sediment survey have been placed to verify our present understanding of the extent of known contamination and, by analyzing additional parameters, to determine if further investigation is required. The boundaries of this study, as depicted on Figure 6.4, consist of the width of the stream, river, and drainages.

The study boundaries of Biological Resources Sampling plan are illustrated in Figure 6.5. On-site sampling will be conducted to confirm current FMPC monitoring results of forage samples and to establish levels of contaminant uptake and assimilation in vegetation and wildlife species which are important in the human food chain. FMPC monitoring studies indicate there are elevated levels of uranium in some off-site produce. Data suggest that the highest levels of uranium occur in soils and produce found in the prevailing wind direction. Therefore, agricultural products will be sampled in this area. Current monitoring indicates elevated levels of uranium in fish from locations in the Great Miami River and Paddy's Run. The boundary for fish and benthicmacroinvertebrates was selected to confirm the results of the current monitoring program.

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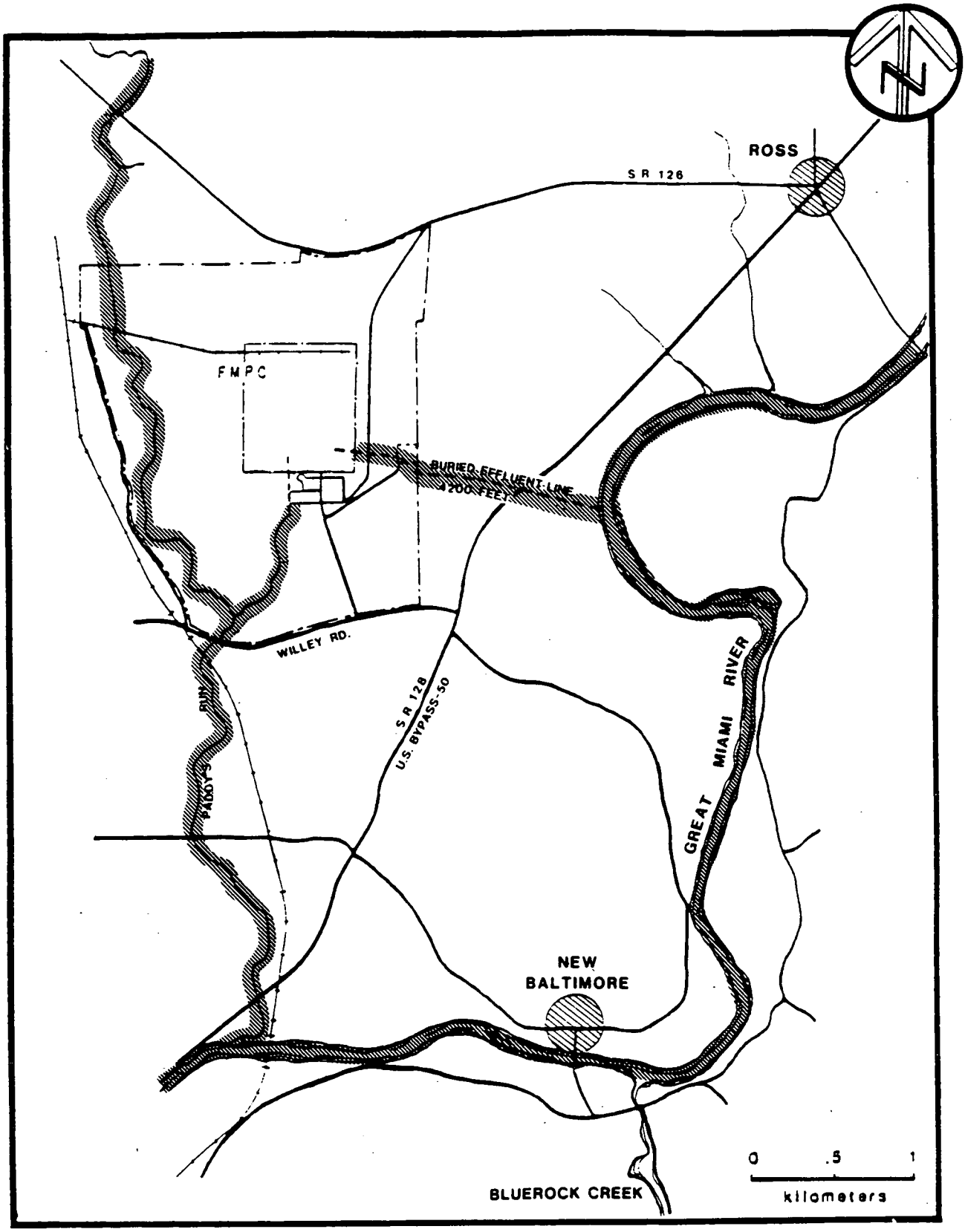

FIGURE 6.4
STUDY BOUNDARY FOR SEDIMENT AND SURFACE WATER SAMPLING PLAN

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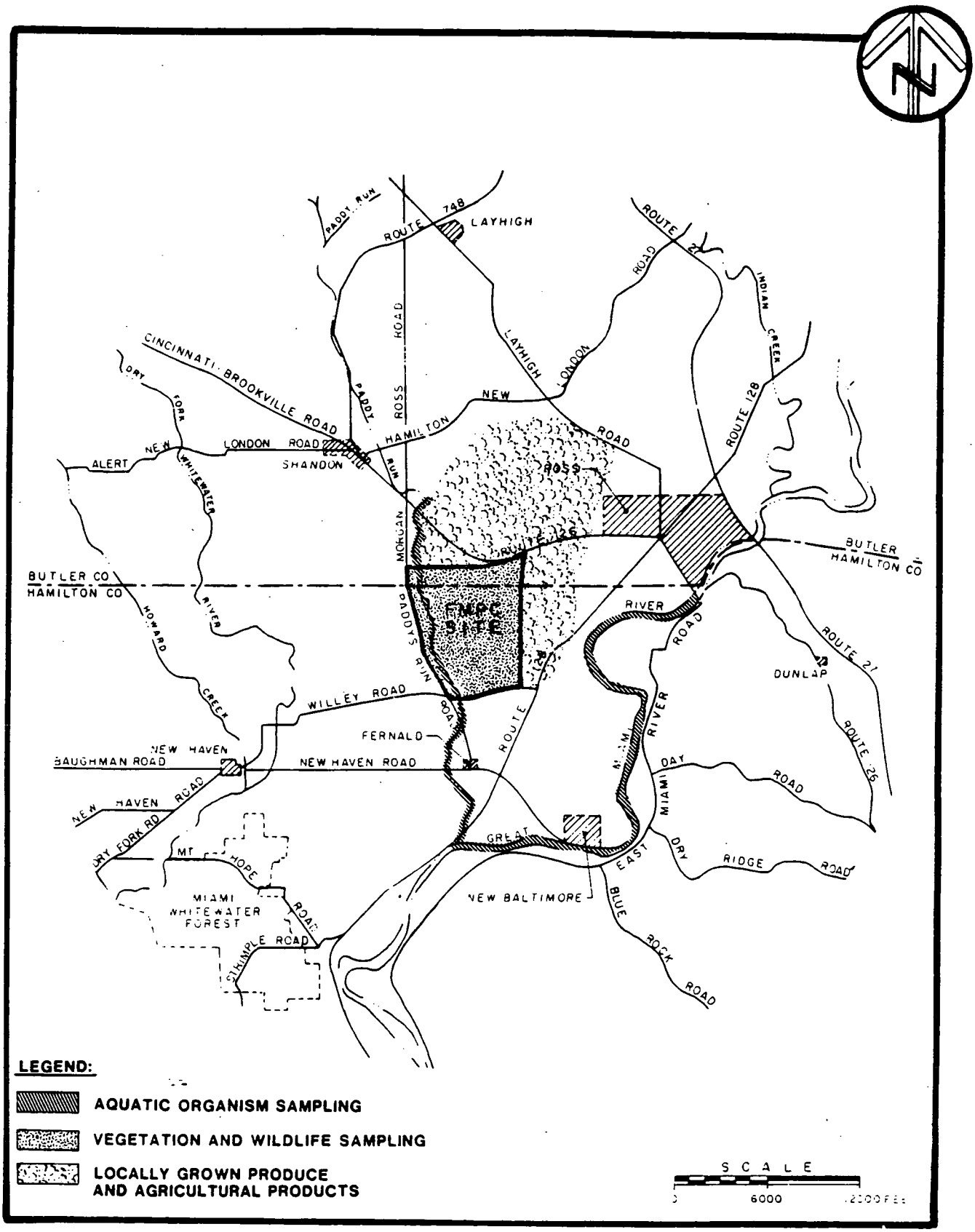

FIGURE 6.5
STUDY BOUNDARIES FOR BIOLOGICAL RESOURCES SAMPLING PLAN

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