G-000-107.5

60

ENVIRONMENTAL REPORT FEED MATERIALS PRODUCTION CENTER FERNALD, OHIO JANUARY, 1981

01/31/81

BATTELLE/NLO
140
REPORT

ENVIRONMENTAL REPORT

FEED MATERIALS PRODUCTION CENTER

Fernald, Ohio

January, 1981

United States Department of Energy

FINAL REPORT

ENVIRONMENTAL REPORT
of the
FEED MATERIALS PRODUCTION CENTER

to

NLO, Inc.

January 31, 1981

BATTELLE
Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

SUMMARY

PURPOSE

The purpose of this environmental report is to describe the Feed Materials Production Center (FMPC), operated by The National Lead Company of Ohio (NLO, Inc.), the environment in which it is located, and the actual and potential impacts of the FMPC's operations upon the environment in which it is located.

OPERATIONS

The primary work of the FMPC is the production of purified uranium metal and compounds from a variety of feed materials for use at other U.S. Department of Energy (DOE) sites. The facility operates as an integrated facility where a series of physical, chemical, and metallurgical processes are used. Solid wastes and wastes from treated liquid effluents are placed in chemical storage pits on the FMPC site. After treatment to remove virtually all the radioactive materials in the wastes, the liquid effluents are discharged into the Great Miami River. Continuous monitoring of the effluents, air, ground water, and River is conducted to assure control of potential contaminants and compliance with government regulations on pollutant discharges.

Future plans call for intermittent refinery operations and a continued low level of other operations.

EXISTING ENVIRONMENT

The FMPC is located in rural southwestern Ohio, about 20 miles northwest of downtown Cincinnati. The facility is located on a 1,050 acre site, of which 136 acres is occupied by the plant.

The climate is characterized by temperatures ranging generally from summer highs in the mid 80's °F to winter lows in the low 20's °F.

Precipitation averages about 37 inches, with snowfall averaging about 20 inches. Winds prevail from the south-southwest.

Bed rock of the area is Ordovician shales and limestone overlain with Pleistocene glacial deposits. Many ground water aquifers exist in the glacial deposits. The location is not an area of major seismic risk.

Farming is the major industry surrounding the FMPC plant; manufacturing is the major industry in the surrounding region. The FMPC currently employs about 600 people.

Several archaeological and historical features are located within a 3 mile radius of the facility. Soils on the site are of glacial origin and moderately high in productivity; however, they support little natural vegetation except along an intermittent creek and in small woodlots. Much of the site is either grazed or mowed. Animal life is primarily that of open areas or edges. Biota in the creek on the site is indicative of good water quality but the Great Miami River, adjacent to the FMPC, generally supports only pollution-tolerant species.

Air and water pollutants from the FMPC are currently meeting all governmental regulations except occasionally for suspended solids from surface runoff in the storm sewer outfall. Effluent radionuclide concentrations are well below DOE limits.

POTENTIAL ENVIRONMENTAL IMPACTS

There will not be any significant construction at the FMPC to result in impacts. All non-radioactive effluents are in or near compliance with appropriate regulations and all radioactive effluents are in compliance. As a result of current management policies, FMPC operations have no significant impact upon the surrounding area.

The most serious accident that could occur on the site which would affect the surrounding areas would be a release of anhydrous hydrogen fluoride or ammonia. Any effects beyond the plant boundary would likely be temporary. Any accident involving radioactive compounds would not likely have significant offsite impacts because of the nature of the compounds at the FMPC.

60

COORDINATION WITH GOVERNMENT PLANS

The areas surrounding the FMPC facility are not zoned for land use. The FMPC cooperates with governmental plans to control environmental pollutants in air and water and hazardous wastes.

A decommissioning plan is being established which will define the decontamination and associated work necessary to make the area suitable for restricted and unrestricted uses.

TABLE OF CONTENTS

	Page
1. DESCRIPTION OF THE FACILITIES	1-1
1.1 Plant Facilities	1-1
1.1.1 Location	1-1
1.1.2 Plant Layout	1-1
1.2 Operations	1-6
1.2.1 Current Operations	1-6
1.2.2 Future Plans	1-26
2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT	2-1
2.1 Characterization of the General Area	2-1
2.1.1 Climatology	2-1
2.1.2 Seismology	2-9
2.1.3 Geology	2-10
2.1.4 Hydrology	2-15
2.1.5 Demography and Land Use	2-22
2.1.6 Archeology and Historical Features	2-28
2.1.7 Ecology	2-29
2.2 Characterization of the Plant Site	2-32
2.2.1 Air Quality	2-32
2.2.2 Water Quality	2-35
2.2.3 Radiation Levels	2-38
2.2.4 Ecology	2-43
2.2.5 Socioeconomic Effects, Local Communities	2-52

TABLE OF CONTENTS
(Continued)

	Page
3.0 POTENTIAL ENVIRONMENTAL IMPACTS	3-1
3.1 Construction	3-1
3.2 Operations Impacts	3-1
3.2.1 Non-Radioactive Releases	3-1
3.2.2 Radioactive Releases	3-2
3.3 Accidents	3-2
4. COORDINATION WITH FEDERAL, STATE, LOCAL OR REGIONAL PLANS	4-1
4.1 Current Operations	4-1
4.2 Decommissioning	4-1
REFERENCES	5-1
APPENDICES	
APPENDIX A, ECOLOGY	A-1
REFERENCES FOR APPENDIX A	A-20
APPENDIX B, WATER QUALITY	B-1
REFERENCES FOR APPENDIX B	B-8
APPENDIX C, RADIATION LEVELS	C-1
REFERENCES FOR APPENDIX C	C-10

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES

TABLE 2-1. NORMAL TEMPERATURE AT CINCINNATI'S ABBE OBSERVATORY (1941-1970) 2-3

TABLE 2-2. PRECIPITATION MEASURED AT THE FMPC, 1960-1979 (WATER EQUIVALENT INCHES) 2-4

TABLE 2-3. MAXIMUM MONTHLY SNOWFALLS AT THE ABBE OBSERVATORY (1915-1978) 2-7

TABLE 2-4. PERCENTAGE OF OCCURRENCE OF WIND SPEED CLASSES (GREATER CINCINNATI AIRPORT 1951-1960) 2-8

TABLE 2-5. POPULATION AND LOCATION OF TOWNS AND CITIES NEAR FMPC 2-23

TABLE 2-6. COUNTY POPULATION CHANGE, 1970-1977 2-24

TABLE 2-7. GENERAL CATEGORIES OF EMPLOYMENT HAMILTON AND BUTLER COUNTIES, OHIO 1977 2-26

TABLE 2-8. AGRICULTURAL EVALUATION OF SOILS IN THE VICINITY OF THE FMPC PLANT 2-30

TABLE 2-9. AMBIENT CONCENTRATIONS OF NON-RADIOACTIVE CONTAMINANTS AT THE FMPC BOUNDARY, 1977-1979 . . . 2-34

TABLE 2-10. APPLICABLE STANDARDS FOR POTENTIAL WATER POLLUTANTS IN RECEIVING WATERS AND EFFLUENT DISCHARGES 2-36

TABLE 2-11. SUMMARY OF 1979 EXPOSURE DATA 2-41

TABLE OF CONTENTS (Continued)

Page

APPENDICES

LIST OF TABLES

TABLE A-1.	TREE AND SHRUB SPECIES RECORDED ON THE FMPC SITE	A-2
TABLE A-2.	HERBACEOUS VEGETATION RECORDED ON THE FMPC SITE, JULY 1977	A-3
TABLE A-3.	MAMMALS WHOSE RANGE INCLUDES THE FEED MATERIALS PRODUCTION CENTER	A-4
TABLE A-4.	BIRDS OF SOUTHWESTERN OHIO	A-6
TABLE A-5.	AVIAN SUMMER ROADSIDE SURVEY DATA FROM THE SITE PERIMETER COMPARED TO ABUNDANCE OF SPECIES IN SOUTHWESTERN OHIO	A-9
TABLE A-6.	HABITAT TRANSECT DATA FROM THE SITE PROPERTY COMPARED TO ABUNDANCE IN SIMILAR SOUTHWESTERN OHIO HABITATS	A-10
TABLE A-7.	REPTILES WHOSE RANGE INCLUDES THE FEED MATERIALS PRODUCTION CENTER	A-12
TABLE A-8.	AMPHIBIANS WHOSE RANGE INCLUDES THE FEED MATERIALS PRODUCTION CENTER	A-13
TABLE A-9.	BENTHIC MACROINVERTEBRATES (NUMBER/FT^2) COLLECTED FROM PADDY'S RUN IN THE VICINITY OF THE FMPC FACILITY, JULY, 1977	A-14
TABLE A-10.	BENTHIC MACROINVERTEBRATES (NUMBER/FT^2) COLLECTED FROM THE GREATER MIAMI RIVER WITH A SURBER SAMPLER IN THE VICINITY OF THE FMPC PROCESS WATER DISCHARGE, JULY 6, 1977	A-16
TABLE A-11.	RELATIVE ABUNDANCE OF FISH SPECIES COLLECTED FROM PADDY'S RUN AT THE FMPC FACILITY, JULY 6, 1977	A-18
TABLE A-12.	FISH SPECIES COLLECTED UPSTREAM AND DOWNSTREAM OF THE FMPC FACILITY DISCHARGE TO THE GREAT MIAMI RIVER, JULY 6-7, 1977	A-19

TABLE OF CONTENTS (Continued)

Page

LIST OF TABLES IN APPENDICES (continued)

TABLE B-1. 1979 WATER QUALITY IN THE GREAT MIAMI RIVER NEAR MIAMISBURG, OHIO B-2

TABLE B-2. WATER QUALITY IN THE GREAT MIAMI RIVER AT NEW BALTIMORE, OHIO--1979 . . . . B-3

TABLE B-3. NON-RADIOACTIVE CONTAMINANTS IN WATER B-4

TABLE B-4. HYDROGEN ION CONCENTRATION B-5

TABLE B-5. 1979 NPDES SUMMARY B-6

TABLE B-6. SEWAGE TREATMENT PLANT DATA, 1979 . . . . B-7

TABLE C-1. RADIOACTIVE CONTAMINANTS IN AIR--1978 . . . . C-2

TABLE C-3. RADIOACTIVE CONTAMINANTS IN WATER--1978 . . . . . . C-4

TABLE C-4. RADIOACTIVE CONTAMINANTS IN WATER--1979 . . . . . . C-5

TABLE C-5. RADIONUCLIDES DISCHARGED VIA SAMPLING POINT W2--1979 . . . . . . C-6

TABLE C-6. URANIUM IN MIAMI RIVER SEDIMENT C-7

TABLE C-7. URANIUM IN SOIL C-8

TABLE C-8. URANIUM CONCENTRATION IN SOIL VS DEPTH C-9

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES

FIGURE 1-1. AERIAL VIEW OF THE FEED MATERIALS PRODUCTION CENTER 1-2

FIGURE 1-2. AREA MAP 1-3

FIGURE 1-3. FMPC AND SURROUNDING AREA 1-4

FIGURE 1-4. FEED MATERIALS PRODUCTION CENTER ENVIRONMENTAL FEATURES 1-5

FIGURE 1-5. FMPC PRODUCTION AREA 1-7

FIGURE 1-6. SCHEMATIC DIAGRAM OF THE FMPC PROCESS 1-8

FIGURE 1-7. WASTE TREATMENT AND STORAGE LOCATIONS 1-14

FIGURE 1-8. LIQUID WASTE FLOW DIAGRAM 1-16

FIGURE 1-9. GENERAL SUMP FLOW DIAGRAM 1-18

FIGURE 1-10. AIR AND WATER SAMPLING LOCATIONS 1-23

FIGURE 1-11. TEST WELL AND PRODUCTION WELL LOCATIONS 1-25

FIGURE 1-12. PROJECTED DELIVERIES OF URANIUM 1-27

FIGURE 2-1. WIND DIRECTION AND SPEED OCCURRENCES 2-6

FIGURE 2-2. SEISMIC RISK MAP OF THE UNITED STATES 2-11

FIGURE 2-3. GEOLOGIC MAP AND CROSS SECTION OF OHIO 2-12

FIGURE 2-4. GEOLOGICAL FEATURES OF THE FMPC AREA 2-13

FIGURE 2-5. TOPOGRAPHY OF THE FMPC AREA AND THE MIAMI VALLEY 2-14

FIGURE 2-6. SURFACE STREAMS -- FMPC ENVIRONS 2-16

FIGURE 2-7. LIQUID WASTE STREAMS 2-18

60

TABLE OF CONTENTS (Continued)

Page

LIST OF FIGURES (Continued)

FIGURE 2-8. GEOLOGIC SECTION OF THE U.S. DEPARTMENT OF ENERGY AND THE SOUTHWESTERN OHIO WATER COMPANY WELL FIELDS 2-19

FIGURE 2-9. VERTICAL SECTION THROUGH DEEP WELLS ON PLANT SITE 2-21

FIGURE 2-10. SOIL ASSOCIATIONS OCCURRING ON THE FMPC PLANT SITE 2-44

FIGURE 2-11. VEGETATION TYPES OCCURRING ON THE FMPC PLANT SITE 2-45

FIGURE 2-12. AQUATIC BIOTA SAMPLING LOCATIONS IN THE VICINITY OF THE FMPC PLANT SITE 2-50

1. DESCRIPTION OF THE FACILITIES

1.1 Plant Facilities

1.1.1 Location

The Feed Materials Production Center (FMPC) is an industrial facility owned by the United States Department of Energy (DOE) and operated by NLO, Inc. It is located in a rural area (Figure 1-1) of southwestern Ohio, near Fernald, on a 1,050 acre (425 ha) site about 10 miles (16 km) northwest of Cincinnati and 8 miles (13 km) southwest of Hamilton (Figures 1-2 and 1-3). The plant facility occupies 136 acres (55 ha) in the center of the site. The site is bounded on the south by Willey Road, on the west by Paddy's Run Road, on the north by farm land and State Route 126, and on the east by a dairy farm (Figure 1-4). Most of the site, including all of the production and waste storage areas, is in Hamilton County, Crosby Township. Approximately 200 acres (91 ha), mostly grass cover with some shrub and hardwood areas, are in Butler County, Ross Township.

1.1.2 Plant Layout

The 136 acre (55 ha) production center was completed in 1954. It consists of eight separate plants, support building and facilities (administration, personnel and security, service, and health and safety buildings, boiler plant, garages, water supply system, laboratory, and warehouses) and wastes treatment and storage facilities (sump, wet and dry chemical storage pits and tanks). Figure 1-1 shows the plant layout. The waste storage facilities are located on the west side of the plant (see Figure 1-4) and consist of tanks used for storage of refinery residues and wet and dry chemical pits. Four chemical pits are currently in use; the others have been filled to capacity, covered with earth, packed, and re-seeded.

60

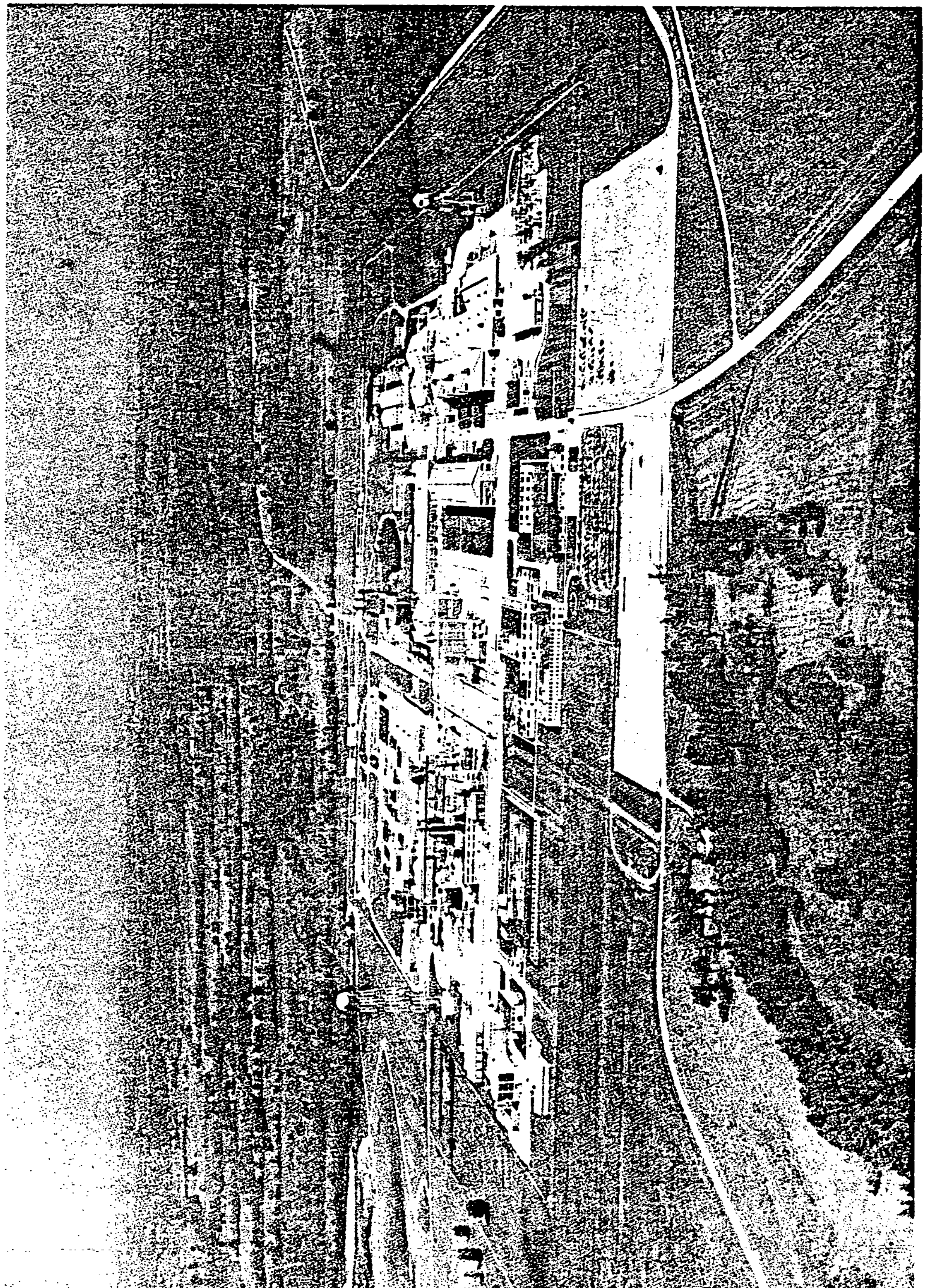


FIGURE 1-1. AERIAL VIEW OF THE FEED MATERIALS PRODUCTION CENTER

14

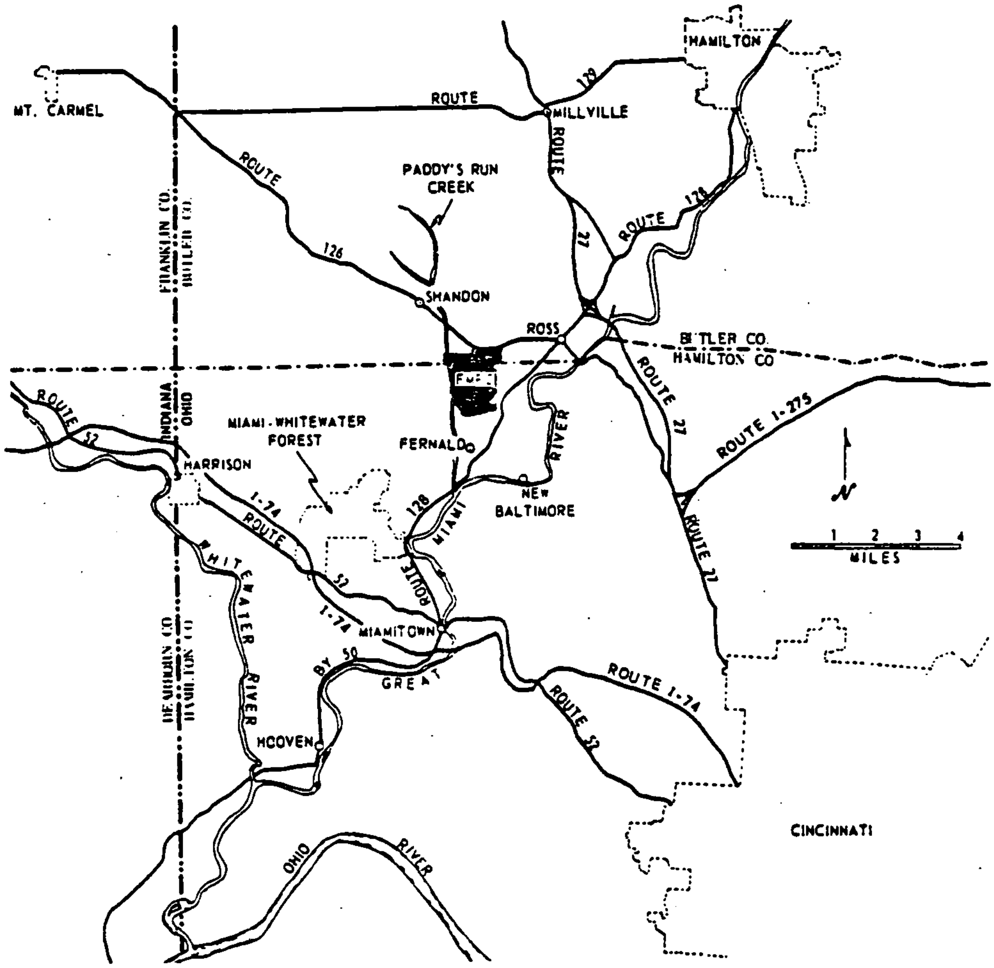


FIGURE 1-2. AREA MAP

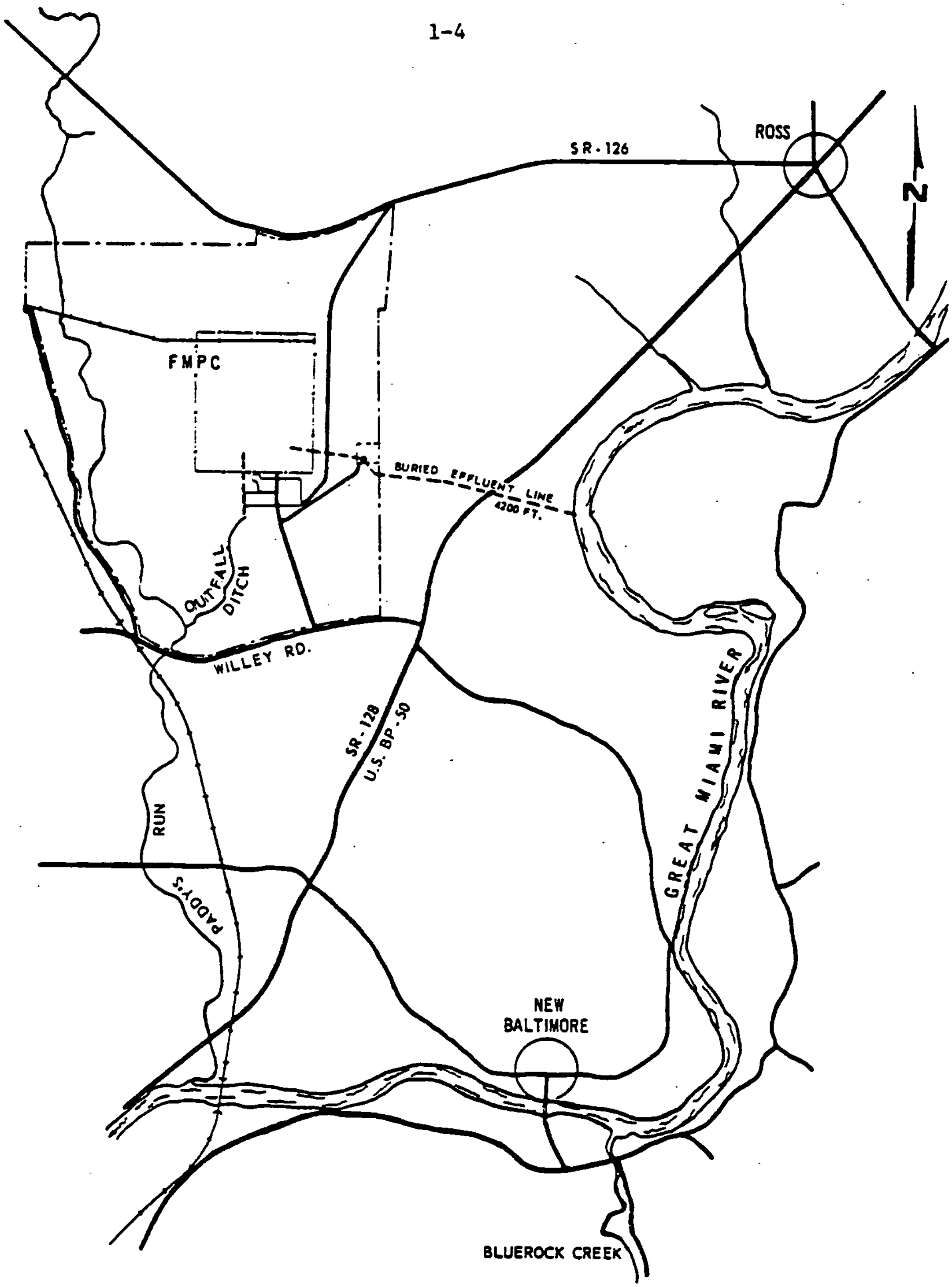


FIGURE 1-3. FMPC AND SURROUNDING AREA

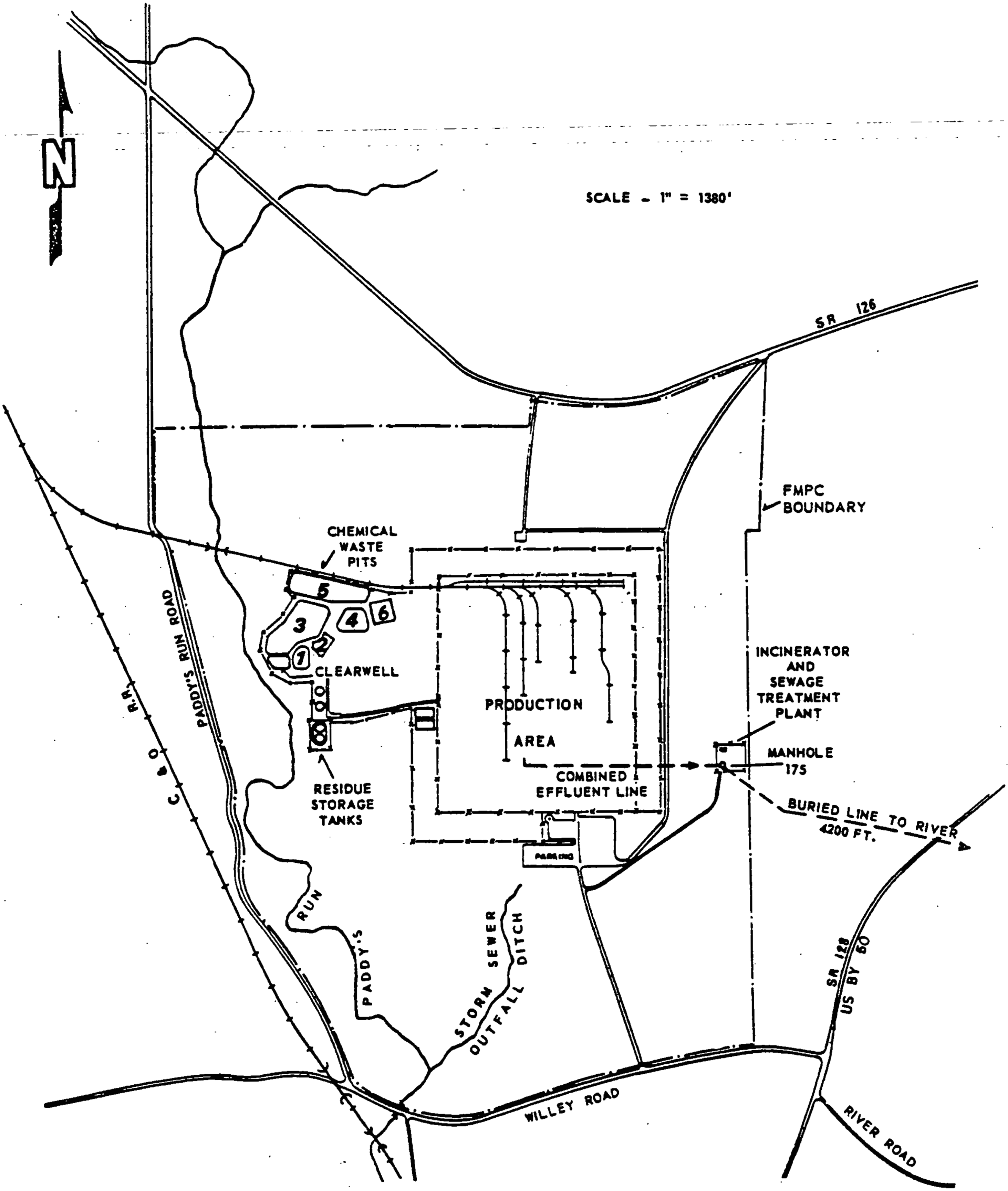


FIGURE 1-4. FEED MATERIALS PRODUCTION CENTER ENVIRONMENTAL FEATURES

1.2 Operations

1.2.1 Current Operations

The primary work of the Feed Materials Production Center has been the production of purified uranium metal and compounds for use at other DOE sites. A small amount of thorium processing has also been done. Principal current uranium operations comprise metals fabrication with periodic small campaigns to process accumulated plant residues and miscellaneous feed materials from other sites.

1.2.1.1 Production Operations. The FMPC has the capability to convert a variety of feeds to pure uranium chemicals and metal (Figure 1-5). Precise material accountability controls are maintained. Strict quality control is enforced throughout the operation in order to guarantee that the finished product will always meet the high standards required in the atomic energy industry. An abridged description of operation and technology associated with each of the major plants involved in production is presented below(1). A flow chart of the FMPC production processes and major waste streams is shown in Figure 1-6.

1.2.1.1.1 Sampling Plant. The Sampling Plant operations are important adjuncts in the support of other plant and project functions. Weighing and sampling of incoming feed materials establish the nuclear materials accountability base.

A Safe Geometry Digestion System provides the FMPC with a capability of safely processing enriched materials containing up to 10 percent ^{235}U.

Other possible operations carried out by the Sampling Plant include: opening of fuel rods containing enriched uranium dioxide pellets and powders; the reclamation of uranium values from cleaning solvents by distillation and recovering of the solvents for reuse; the reconditioning of steel drums for use throughout the project; and the storage of waste materials, recycle materials, and uranium bearing concentrates.

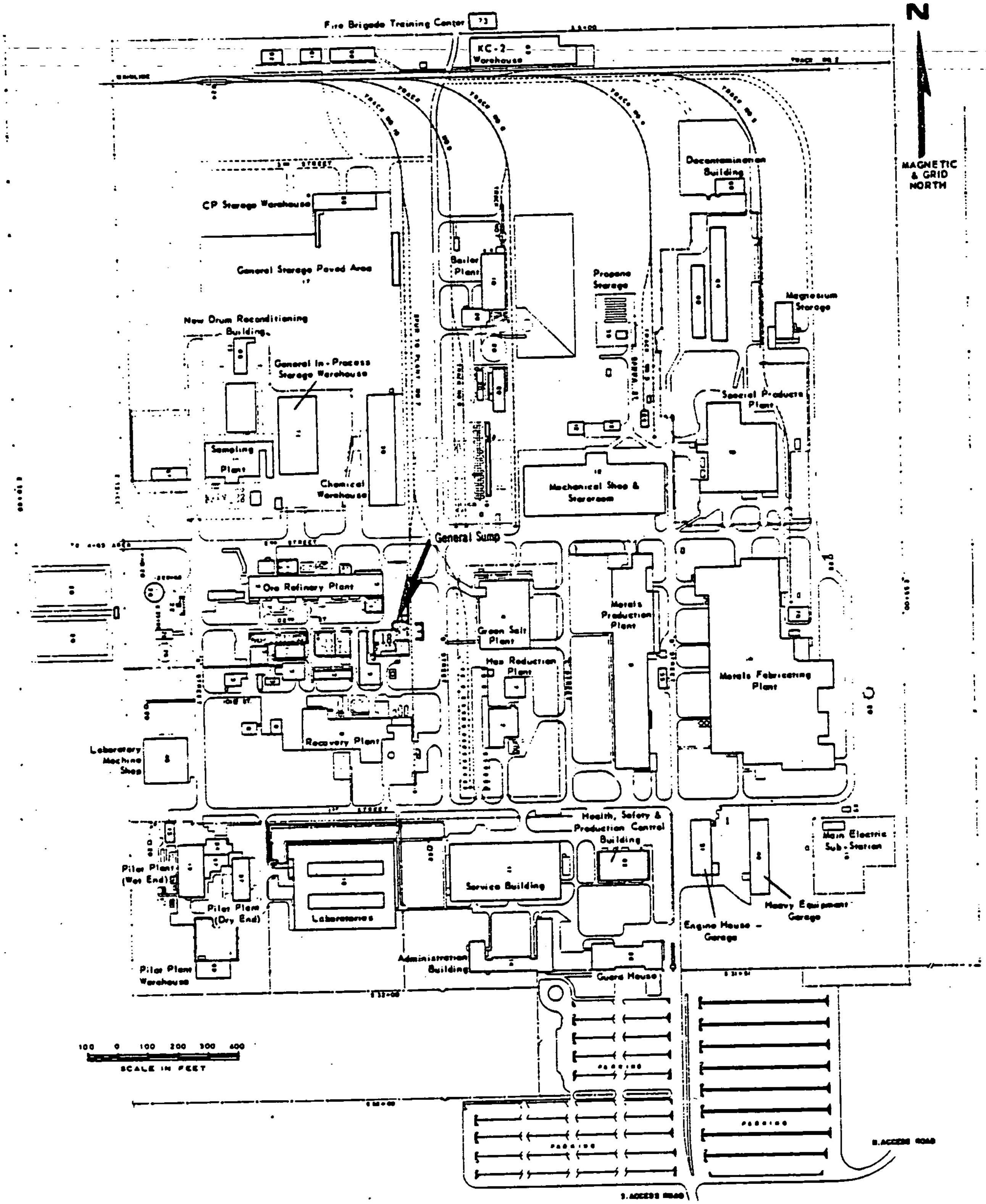


FIGURE 1-5. FMPC PRODUCTION AREA

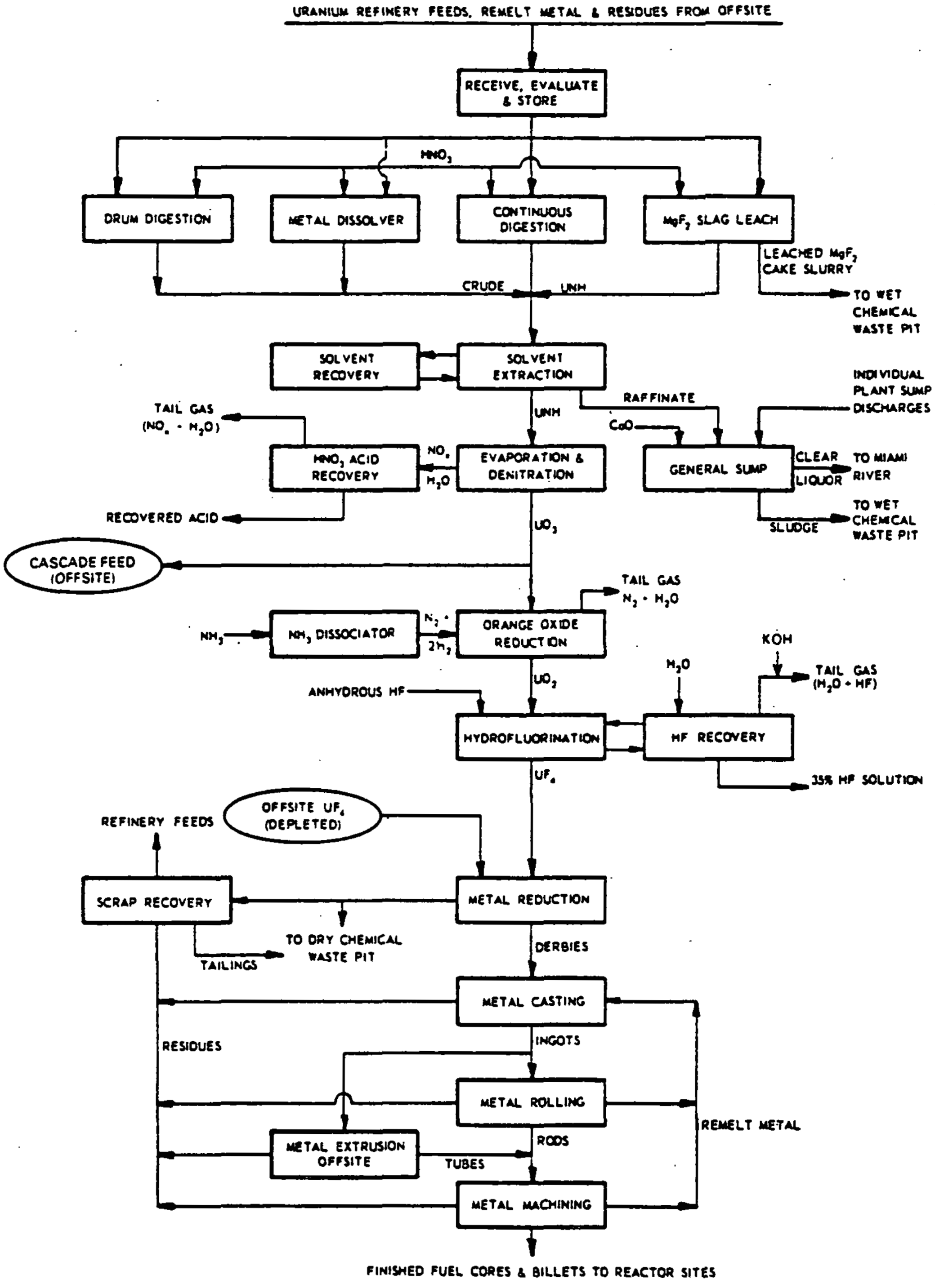


FIGURE 1-6. SCHEMATIC DIAGRAM OF THE FMPC PROCESS
(Some operations limited under present production program)

1.2.1.1.2 Refinery. Uranium trioxide (orange oxide), UO_3, is produced in three steps: digestion, extraction, and denitration.

Feed materials from various sources are fed into tanks for digestion in nitric acid after sampling and analysis. The resulting slurry consists of acid insolubles and a solution of impure uranyl nitrate and excess nitric acid. The slurry is then pumped to the extraction system. Low-grade uranium slurries require filtration and evaporation prior to extraction.

In the primary extraction column of the Refinery, the aqueous feed slurry is brought into contact with an organic solvent--a mixture of tributyl phosphate and kerosene. The organic solvent selectively extracts the uranium; most of the nitric acid and impurities are left behind in the aqueous raffinate. A raffinate mixer-settler may be used in series with the primary extraction column to further reduce the uranium content of the aqueous waste stream leaving the primary extraction column.

Additional purification of the uranium contained in the extract stream is achieved by scrubbing with a small counterflow of water in the compound primary extraction column. The aqueous stream from the scrubbing operation combines with the aqueous feed in the primary extraction column. The purified uranyl nitrate is recovered from the organic solvent stream by re-extraction with deionized water in stripping columns. In the absence of nitric acid, the uranyl nitrate contained in the solvent is preferentially attracted to the water. After treatment with a sodium carbonate solution for removal of degradation products, the stripped solvent stream is recycled to the primary extraction column. The aqueous uranyl nitrate product is sampled and analyzed to assure conformance with specifications.

In the denitration process, aqueous uranyl nitrate at about 100 g/L U is concentrated by evaporation and boildown to approximately 1200-1300 g/L. It is then calcined batchwise in denitration pots to yield uranium trioxide, the end product of the refinery operations. The UO_3 product is packaged and may be retained for further processing or shipped to other DOE sites.

The Nitric Acid Recovery Plant operates in conjunction with the Refinery to recover nitric acid from the off-gases generated in the refinery processes. Nitric acid is recovered from the exhaust gas streams in the digestion and denitration areas and from several other minor sources. This acid is returned to the digestion area of the Refinery for reuse.

Uranium contained in aqueous waste streams from the solvent treatment and cleanout operations is precipitated with magnesia, sodium hydroxide, or calcium oxide. Extraction raffinate and other low-level uranium wastes are precipitated and neutralized with lime before being discharged to settling ponds.

1.2.1.1.3 Green Salt Plant. Uranium trioxide is converted to uranium dioxide, UO_2, in the Green Salt Plant by reduction with hydrogen. The UO_2 is then converted to uranium tetrafluoride, UF_4, or green salt, in a reaction with anhydrous hydrogen fluoride.

Uranium trioxide is fed to stainless steel fluidized bed reactors which are heated in the range of 985-1100°F (530-593°C). Dissociated ammonia enters the bottom of the reactors through a gas diffuser. The hydrogen and nitrogen hold the UO_3 powder in suspension in a fluidized bed. Partially converted UO_3 overflows from the first fluid bed reactor into the second where the reaction with hydrogen is completed.

Hydrofluorination takes place in groups of three heated horizontal ribbon-screw reactors, arranged in vertical stacks. Each reactor tube is 16 in. in diameter and 20 ft in length (0.40 x 6.1 m). Uranium dioxide enters at one end of the top reactor and is conveyed slowly to the other end and stirred by a power-driven ribbon screw. The operating temperature is progressively higher for each reactor, starting at about 300°F (150°C) at the first and ranging up to 1200°F (650°C) at the third. Anhydrous hydrogen fluoride gas enters at the discharge end of the bottom reactor and flows countercurrent to the uranium dioxide up through the three reactors.

Excess hydrogen fluoride is vented from the top reactor, filtered, and condensed to a dilute hydrogen fluoride solution (ranging from 20 to 35 percent HF).

The uranium tetrafluoride product is weighed, blended, sampled for chemical analysis, and packaged in 10-gallon (38-liter) cans.

1.2.1.1.4 Metals Production Plant. Uranium metal is produced from uranium tetrafluoride in a thermite-type reaction with magnesium metal. This reduction takes place in a closed steel reduction pot which is lined with packed magnesium fluoride slag. Uranium tetrafluoride and magnesium granules are blended and charged into the slag-lined pot. The pot is capped with slag, sealed, and heated in a resistance furnace at temperatures up to 1500°F (815°C) until the contents react spontaneously. At this point, internal temperatures of the pot may reach up to 3000°F (1650°C). About 5 minutes after this reaction, the pot is removed, cooled, and the uranium mass, called a derby, is separated, cleaned, weighed (approximately 335 lbs or 152 kg) and transferred to the casting area. The slag from the pot liner is milled for reuse as liner material.

In the casting process, cleaned derbies and scrap uranium metal are put into a graphite crucible. The loaded crucible is placed in a vacuum induction furnace and heated for about 95 minutes to approximately 2700°F (1480°C). A shear plug in the bottom of the crucible is then broken to permit the molten metal to flow into a heated graphite mold located directly under the crucible. After cooling, the mold is removed from the ingot, cleaned, and readied for reuse.

Ingots destined for extrusion are sampled and cropped (i.e., a piece is sawed from the top section of the ingot to remove shrinkage cavities and impurities).

Ingot sizes range from 8 to 10 in. (20-25 cm) in diameter, from 23 to 40 in. (58-102 cm) in length, and weigh up to 1400 lbs (635 kg).

1.2.1.1.5 Metals Fabrication Plant. Ingots made for extrusion are heat-treated in a molten salt bath in the Metals Fabrication Plant before shipment to an off-site extrusion facility. The metal is returned to the plant as extruded tubes approximately 10 feet (3.0 m) in length. These tubes are cut into 8-inch (20.3 cm) lengths on a cut-off lathe. Further processing consists of: heat-treating in molten salt and quenching in oil, and reaming; reduction of the outside diameter; and machining of each end face on a multi-station transfer machine. The finished tubular cores are cleaned and inspected for surface defects, dimensional accuracy and grain size before packaging for shipment to another DOE site.

Uranium ingots can be converted to solid fuel element cores in the Rolling Mill and Machining Area of the Metals Fabrication Plant. The ingots are first heated in a molten salt bath to the required fabrication temperature and then reduced to round rods approximately 1-1 1/2 in. (3.8 cm) in diameter by a series of rolling operations. The rods are air-cooled, conveyed through a rod straightener, weighed, and inspected.

In the Machining Area, the rods are cut into blanks, heat-treated and machined to final size. The machined cores are stamped for identification, degreased, pickled in nitric acid, rinsed, and inspected for surface defects, dimensional accuracy, and grain size.

1.2.1.1.6 Recovery Plant. Uranium recycle materials for process operations at FMPC and elsewhere are sorted, calcined, screened, milled, and blended as necessary. Recycled materials containing metallics, oil, and graphite must be roasted (calcined) to oxidize these components. Several furnaces are used for this purpose: a rotary kiln, three multiple-hearth vertical furnaces, and two small single-hearth furnaces.

Uranium recycle materials of differing ^{235}U enrichments must be kept segregated throughout the process and while in storage.

1.2.1.1.7 Pilot Plant. This unit of the FMPC production complex has a wide range of chemical-metallurgical process equipment for smaller quantities of uranium or thorium products. It is principally used for handling enriched uranium feed materials containing up to 10 percent ^{235}U. Safe geometry solvent extraction columns are used for uranium purification.

The Pilot Plant is also utilized for the infrequent processing of thorium. The plant can produce purified thorium nitrate, thorium oxalate, thorium metal, and thoria gel (hydrated oxide). Thorium processing includes a complete solvent-extraction refining system, a multi-tank system for precipitation, several filters, an oven-drying system, atmospheric furnaces for dehydration and metal reduction, vacuum furnaces for dezincing, and all auxiliary systems, including milling, dust collection, and sawing.

Equipment not used for thorium processing is available for such operations as metallic shot preparation, plasma-spraying in inert atmosphere, salt-bath heat-treating, and high-temperature gas-solid reaction (reduction of UF_6 to UF_4).

1.2.1.1.8 Special Products Plant. Operations in this plant involve processing uranium metal pieces larger in size than those processed in the Metals Production and Metals Fabrication plants. Ingot sizes range from 11 to 13 in (28-33 cm) in diameter and weigh up to 1925 lbs (873 kg).

A decladding operation (Zirnlo process) is also performed in this plant. Reject fuel elements from the cladding operation of reactor sites are processed to remove the jacket materials that encase the uranium metal fuel elements. The clad elements are immersed in a solution of hydrofluoric acid to dissolve the jacket and the unaffected uranium metal cores are recovered for reuse.

1.2.1.2 Waste Management. Wastes at the FMPC plant include sanitary sewage and solid and liquid radioactive wastes from the various production plants. Wastes generated are treated and stored on-site or discharged after treatment to remove contaminants. Treatment and storage locations are shown in Figure 1-7.

1.2.1.2.1 Solid Wastes. There are four principal types of solid wastes generated at the present time at FMPC which are discarded to dry chemical storage pits (Pits 4 and 6). These include:

(a) Depleted uranium residues--Process residues of depleted uranium (0.142 - 0.40 percent ^{235}U) that are not suitable for remelt or containing uranium values in amounts not economical for recovery. These include filter cake and sludges from neutralized wastes.

(b) Low grade thorium residues--Process residues that similarly cannot be economically processed for recovery of thorium values.

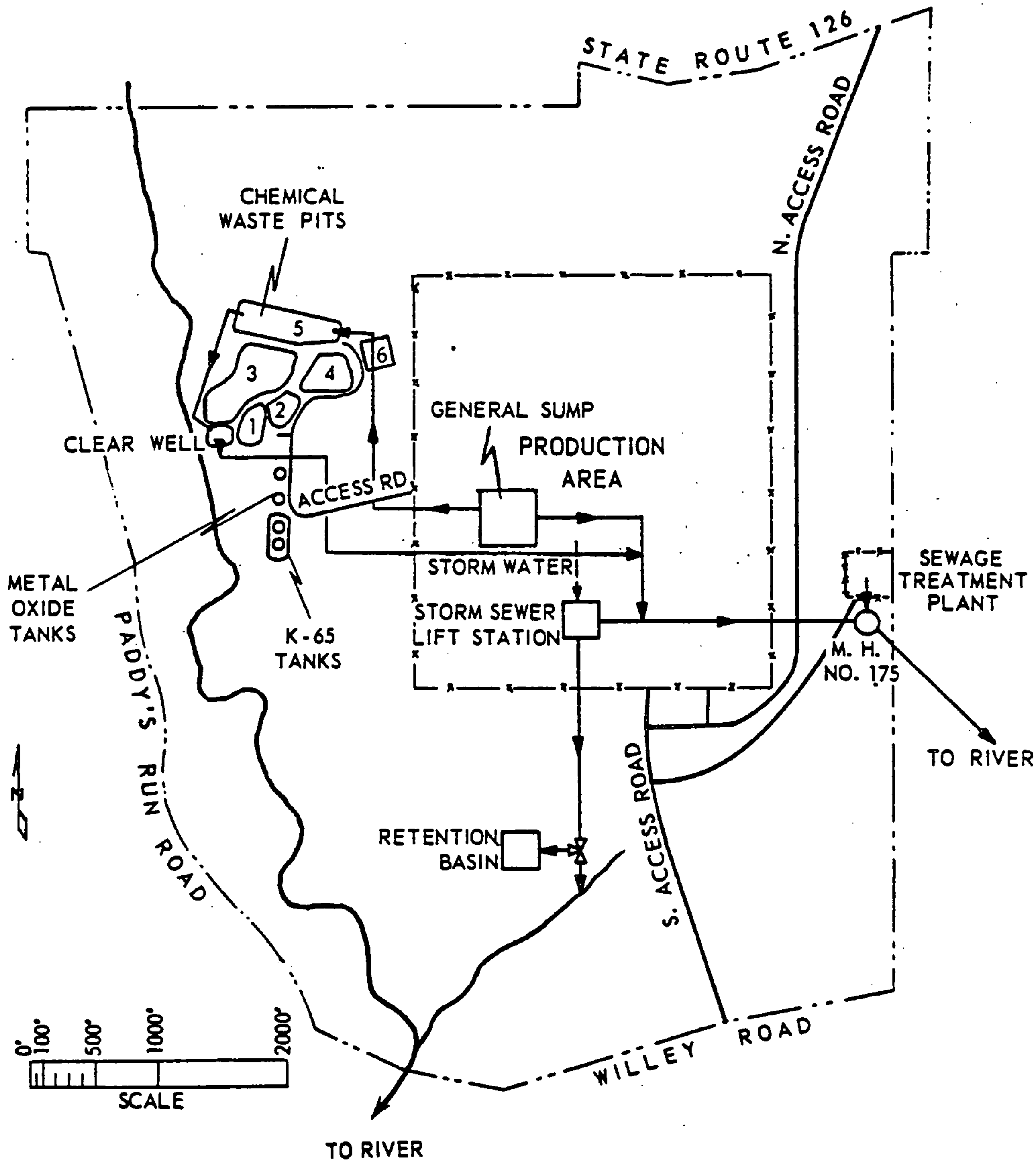


FIGURE 1-7. WASTE TREATMENT AND STORAGE LOCATIONS

(c) Contaminated ceramics--Slightly contaminated refractories discarded from production electric furnaces during repairs.

(d) General refuse--Various types of trash, generally non-combustible, which, through incidental contact with radioactive substances, have become slightly contaminated, but at a level above that allowed for unconditional release.

Pit 4 is a large basin lined with 1.5-2.0 ft (0.5-0.6 m) of impervious clay. It is partially filled and is used principally for the storage of large dry waste solids. Pit 6 is lined with an impermeable elastomeric membrane and is used for storage of fine materials.

Before storage all of these wastes are reviewed to determine that they (1) are insoluble, (2) do not present a fire hazard, and (3) do not include organic liquids which possibly present a water pollution problem.

Contaminated combustible residues, sewage sludge, graphite, and oils are treated as process residues and incinerated in various facilities. The uranium values are recovered from the generated ash in the Recovery Plant or the Refinery.

Pits 1 and 2 are essentially "inground" facilities which are used for solid waste storage. They were constructed by digging a large basin and then lining the walls with 1.5 to 2.0 ft (0.5-0.6 m) of impervious clay. Maximum depths were 17 feet (5 m) and 13 ft (4 m) respectively. Both pits have been filled, covered with clean, uncontaminated fill, and graded to provide surface drainage away from the pits.

1.2.1.2.2 Liquid Wastes. Liquid wastes are generated to some degree in every operation at the FMPC. All of the major process areas have individual treatment facilities capable of pretreating the liquid wastes that are peculiar to that particular process step (Figure 1-8). Virtually all of the radioactive materials in the wastes are removed in these facilities.

Generally, these plant treatment facilities are simple installations which provide equipment and tankage to collect waste liquors, adjust

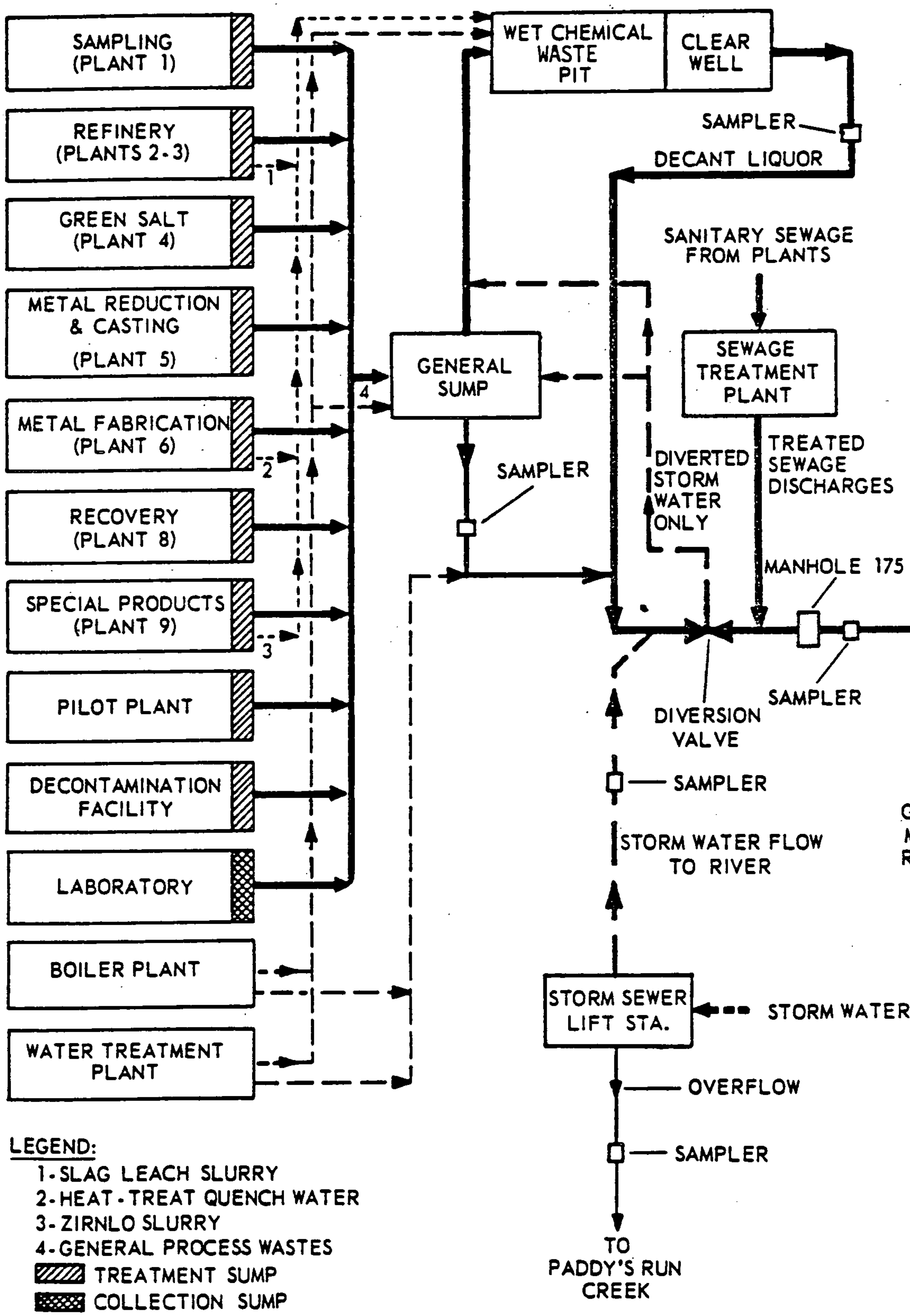


FIGURE 1-8. LIQUID WASTE FLOW DIAGRAM

the pH for precipitation of uranium, and to filter the resultant slurry. Where oils are present, preliminary steps are taken to break out the oils by acidification and decantation before neutralization and precipitation. After sampling and analysis is performed to ascertain that uranium content is within pre-set allowable discard limits, the filtrate is pumped to the General Sump and filter cake is sent to the Refinery or the Recovery Plant as a process residue.

When thorium is processed in the Pilot Plant, after neutralization the waste liquors are treated with barium carbonate and aluminum sulfate before filtration in order to reduce ^{228}Ra activity in the filtrate. Because of its higher ^{228}Ra content, raffinate from the thorium extraction process is segregated from other thorium liquid wastes and subjected to a double $BaCO_3$-$Al_2(SO_4)_3$ treatment and filtration before the resultant filtrate is pumped to the General Sump.

Physically, the General Sump is a collection of vertical tanks of various sizes, pumps, piping, and valves established on a controlled pad. It is designed to facilitate the storage and transfer of liquid wastes within the tankage complex and the discharge therefrom, and the addition of various reagents and coagulation aids (Figure 1-9). Provisions have been made for ease of sampling, both grab and continuous. The pad is equipped with its own sump and drainage trenches to handle any leaks or accidental spills.

The process wastes from the various production plants and service facilities are received at the General Sump, checked for uranium or thorium content, and segregated or selectively combined as required. If certain waste exceeds discard specifications, it is neutralized, precipitated, and filtered, and the filter cake is held for recovery of uranium or thorium values. Thorium wastes, if present, are segregated, again co-precipitated with barium carbonate and aluminum sulfate to further reduce ^{228}Ra activity and then pumped to the Wet Chemical Storage Pit (Pit 5). All acidic wastes are adjusted for pH to obtain a maximum precipitation of radioactive material. Thereafter, these wastes are pumped to Pit 5. Other wastes are settled and decanted in successive steps prior to discharge of the supernatant liquor to the river. The settled sludges are also transferred to Pit 5.

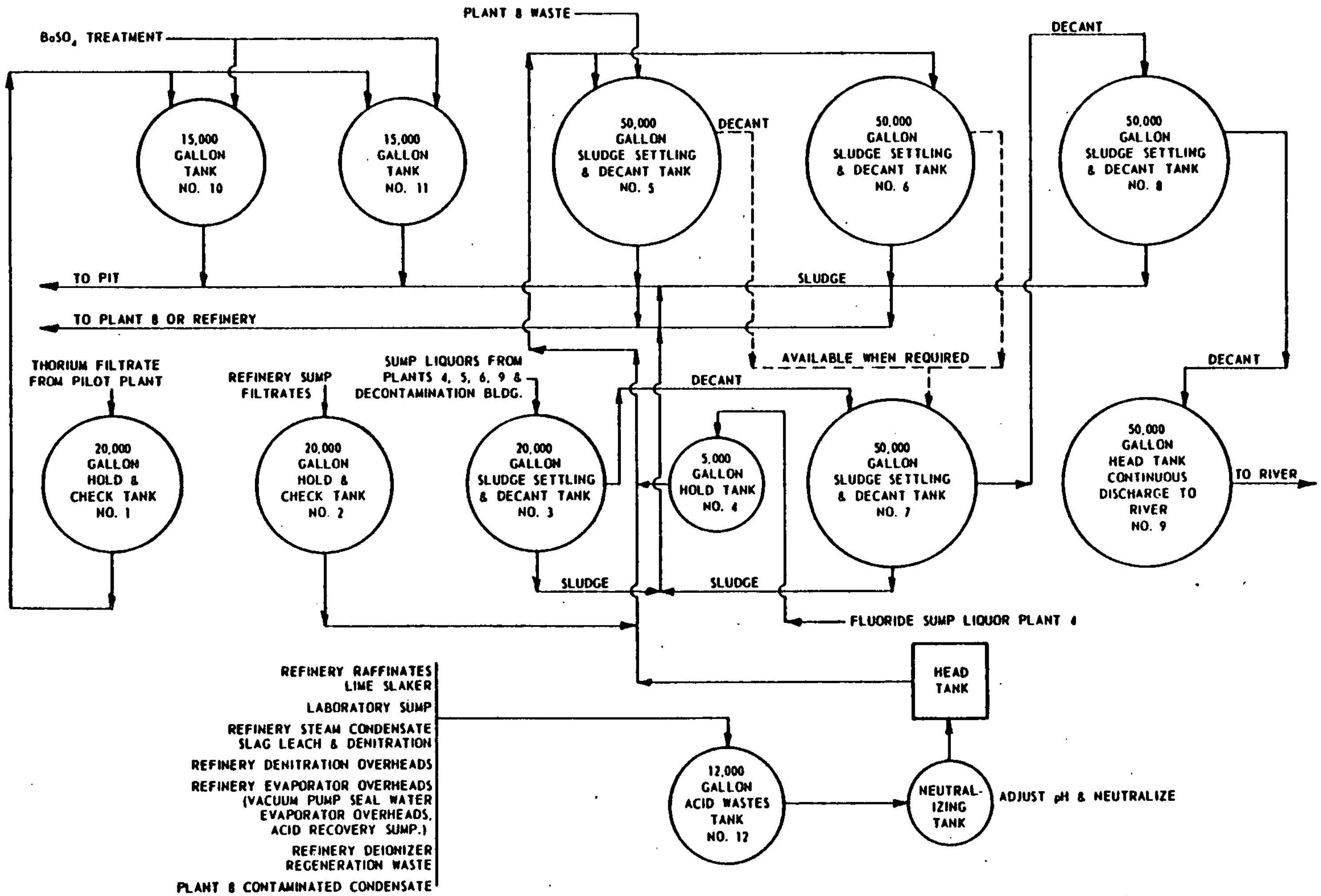


FIGURE 1-9. GENERAL SUMP FLOW DIAGRAM
(Not all processes are continuous)

All liquid wastes, before discharge from the General Sump to the Wet Chemical Storage Pit or to the Miami River, are sampled. The samples are analyzed to ascertain concentrations and total content of radioactive materials.

All liquid wastes discharged to Pit 5 enter at the eastern or smaller end of the basin. The large volume of the pit, in addition to providing settling time for solids in the effluent as received, also allows time for slow interaction of effluents and additional precipitation and settling. The solids, which contain almost all of the uranium, thorium, and radioactivity remaining in the waste, settle out and remain in the pit for long-term storage. The supernatant liquor, practically solids free, overflows through an effluent control tower near the western end of the pit into a clearwell from which it is sampled and then pumped to the Miami River.

The major portion of FMPC's liquid process wastes is routed through the General Sump to Pit 5. However, there are three process waste streams which are routed directly to the pit. They are: Zirnlo slurry, heat-treat quench water, and slag leach slurry. These streams are produced in minor quantities and radioactivity in all three streams is effectively controlled by settling in Pit 5 without processing at the General Sump.

Two pits have been used for storage of wet chemicals; these are Pits 3 and 5. Pit 3 was constructed at the west end of the storage area plateau. Dirt removed during the excavation was used to form the pit west wall. The dirt was placed in 6- to 8-inch (15-20 cm) layers and compacted with sheepsfoot rollers. A natural layer of impervious clay formed the pit bottom. After the excavation, the pit walls were covered with a thick clay layer. Maximum depth of the pit was 24 feet (7.3 m) from the pit bottom to the top of the embankment. Capacity of Pit 3 was 225,600 cubic yards (172,500 m^3); the surface area was 6.80 acres (2.75 ha).

Pit 3 has been filled with respect to its capacity to function as a settling basin and has been partially covered with clean fill. The remaining capacity is being filled with magnesium fluoride slag from Plant 5, dirt, and cinders. When all space has been filled, the covering will be completed and the surface graded and seeded to control run-off and erosion.

Pit 5 is a settling basin, lined with a rubberized elastomeric membrane that is highly resistant to acids, alkalis, and oxygenated solvents. The pit has a capacity of 115,000 cubic yards (87,800 m^3) and a surface area of about 3.6 acres (1.5 ha). It was constructed to replace Pit 3. The pit is 25 feet (7.6 m) deep and the top of the pit embankment is about 10 feet (3 m) above the surrounding ground surface. Neutralized waste enters the east end and the clear supernate is discharged through an overflow tower at the west end. From the tower, the liquid flows by gravity to the Pit 3 clearwell where it is sampled and pumped for offsite discharge.

There are two additional facilities used at the FMPC for the long-term storage of wastes: two K-65 Tanks and two Metal Oxide Tanks. These tanks are of cylindrical concrete construction, 80 feet (24.4 m) in diameter and approximately 27 feet (8 m) high. The capacity of the individual tanks is 125,000 cubic feet (3,540 m^3). The tank walls are of concrete, 8 inches (20 cm) thick. The walls are post-stressed with high tensile steel wire and the wires protected by a 0.75 inch (1.9 cm) grout coating. In 1964, the two K-65 tanks were protected by enclosing them with an earth embankment.

The K-65 tanks were used for the storage of Refinery residues that resulted from the processing of pitchblende ores. These residues or tailings contain ^{226}Ra. Pitchblende ore processing at the FMPC was discontinued in 1959; however, the residues resulting from this work remain in storage. Other similar residues were sent to the FMPC from other sites and are stored in the K-65 tanks. The K-65 wastes are the property of the African Metals Corporation and are stored at the FMPC under a lease contract (that expires in 1983), which prohibits abandonment by the lessee.

One of the metal oxide tanks contains similar tailings or residues from Refinery operations at FMPC. However, these residues are the result of processing of non-pitchblende ore concentrates and contain only the trace of radium not removed in the concentrate process. These metal oxides are owned by DOE. The other metal oxide tank is empty.

The sanitary waste collection and treatment system is a completely separate system from the process waste system. These wastes by virtue of their natural separation from the actual production effort do not normally contain significant amounts of uranium. However, uranium contamination does occur through the plant laundry and showers. Normal treatment of the sanitary sewage in the Sewage Treatment Plant removes much of the uranium which is captured in the sewage sludge. The sludge is incinerated and the uranium recovered from the ash in the Recovery Plant or Refinery.

The storm water system is basically designed to be uranium-free; however, it is possible for uranium to enter the Storm Sewer System through surface water runoff from the plant area. No treatment facility as such is provided for the storm water, but control and recovery of uranium washed or spilled into the Storm Sewer System is possible to a major degree through diversion facilities.

To effectively control quality of all effluents, repeated sampling and sample analysis is employed at each treatment step or junction of liquid waste streams. Before discharge of the treated effluent from the generating plant to the General Sump, samples are taken and analyzed to establish that the effluent meets the pre-set discard limits. The process waste effluents are again sampled and checked on receipt at the General Sump. The sampling and analysis is repeated before discharge of the effluent from the General Sump and again upon discharge from the Clearwell at the Chemical Waste Pit.

Samples of other waste streams are similarly taken and analyzed before the wastes are sent directly to the Chemical Waste Pit. The Storm Sewer Lift Station is equipped with recording flowmeters and automatic proportional samplers to provide data on storm sewer system flow. One unit measures and samples the flow being pumped to the Miami River through Manhole 175 (see Figure 1-4). The second unit is automatically activated whenever there is an overflow to Paddy's Run Creek and provides samples and measurement of these flows. From the sample analyses and flow data, any discharges of radioactive materials through the storm sewer system can be measured.

Manhole 175 is the final junction point of the major waste streams. This facility is equipped with a recording pH meter, a flowmeter utilizing a Parshall flume, a temperature recorder, and an automatic proportional sampler. At this location, the discharge flow to the Miami River is continuously measured and a continous sample is collected for analyses.

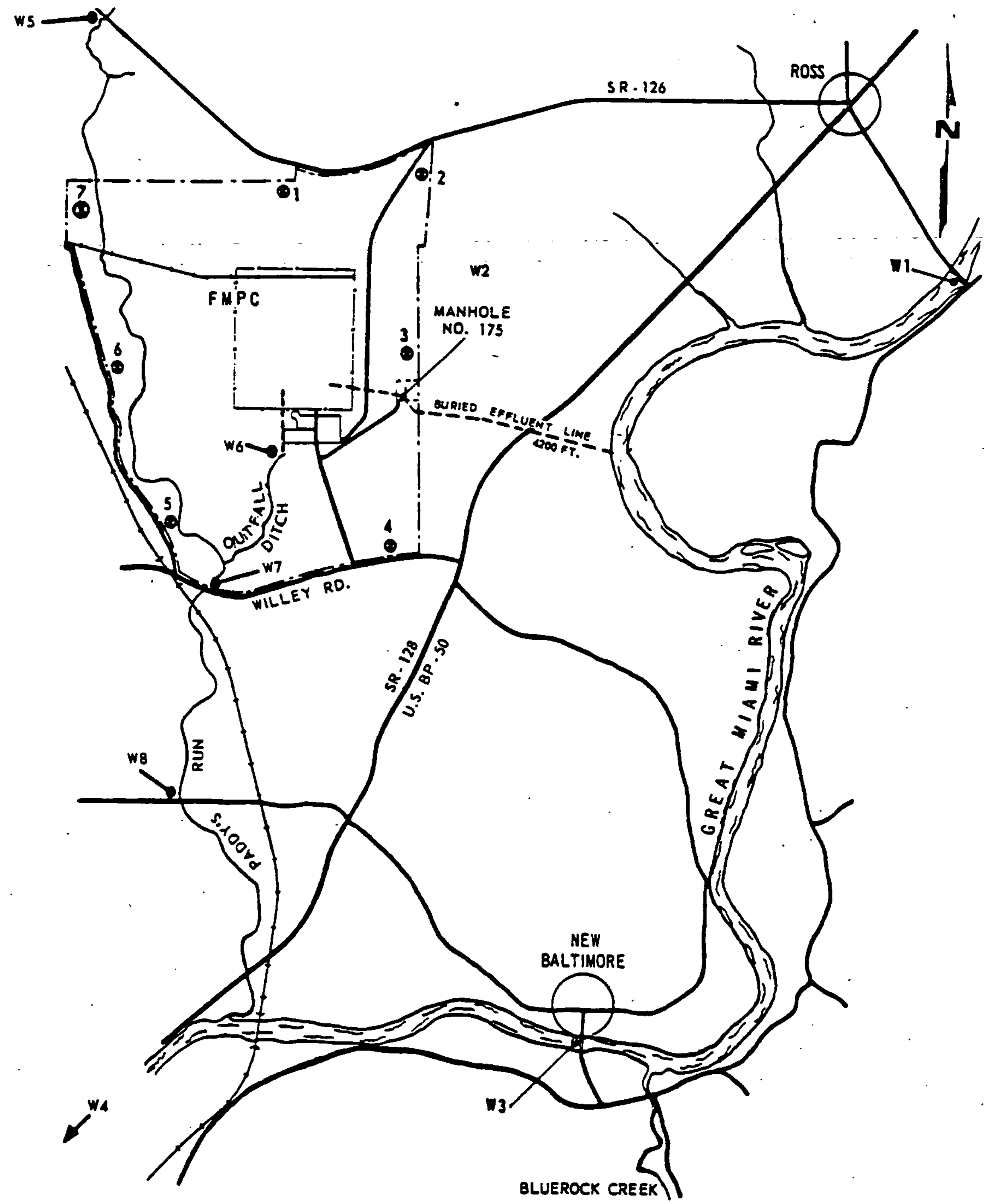
In addition to this on-site monitoring, an off-site monitoring program is conducted to determine the effect of FMPC releases on the quality of the Miami River. The sampling locations that are used in implementing this program are shown in Figure 1-10. Point 1 is located upstream from the point of the FMPC discharge into the Miami River. Weekly samples are taken at this point to give an indication of the quality of the water approaching the FMPC discharge. Point 2 is the continuous sampler at Manhole 175. Points 3 and 4 are located downstream from the FMPC discharge point. A grab sample is collected at Point 3 and weekly composites are analyzed; a weekly grab sample is collected at Point 4. Sample comparisons from upstream and downstream provide an effective means of noting the effect of FMPC discharge on the river.

Data compiled with respect to discharge of chemicals and radionuclides to the Miami River are summarized and published as part of the annual monitoring reports.

Test wells have been drilled around the waste pits to permit monitoring of ground water in the area. The locations of these wells are shown in Figure 1-11. Wells are sampled on a quarterly basis to furnish an indication of the condition of the pit liners. This sampling frequency exceeds the U.S. EPA requirements.

In addition to test well samples, surface water in Paddy's Run is sampled and analyzed weekly. In addition, grab samples of surface water in the pit area are obtained on a random basis and analyzed for radioactivity, NO_3, and chloride. Any unusual concentrations would be investigated.

1.2.1.2.3 Airborne Wastes. Conversion of impure uranium and thorium compounds to reactor-grade feed materials involves operations which generate radioactive dust, nuisance dusts, and corrosive mists or reaction products. Ventilation and air cleaning systems such as bag collectors, electrostatic precipitators, and scrubbing towers are used to confine this



W4 is located at Miamitown, 4.7 miles from Paddy's Run.

⊕ BOUNDARY AIR SAMPLING STATIONS.

W1-W8 - WATER SAMPLING LOCATIONS

SCALE: 1" = 3055'

FIGURE 1-10. AIR AND WATER SAMPLING LOCATIONS air and remove airborne contaminants, including valuable material which is returned to the production processes. The filtered or scrubbed air is exhausted to the atmosphere. Sampling of these stack exhausts is maintained on a continuous schedule to determine the operating condition of the air cleaning systems and to measure the quantities of materials not being collected by the systems.

Steam plant emissions are currently being reduced by purchasing low-sulfur (1.0 percent or less) coal and by the use of electrostatic precipitators.

The FMPC solid waste incinerator is used for the destruction of combustible trash, paper, wood, etc. It is equipped with two gas-fired afterburners to aid in attaining a goal of +1080°F (582°C) temperature in the stack gases. During steady state operations with the 1080°F (582°C) temperature developed, particulate emissions from the incinerator operation are minimized.

Samples of particulate matter in air are continuously collected at seven permanent sampling stations located on the project's outer boundary (see Figure 1-10). At each boundary station, air is drawn at a rate of about one cubic meter per minute through an 8 x 10 inch (20 x 25 cm) filter which is changed weekly. Filters are weighed before use and then reweighed after changing to obtain the weight of collected dust. After reweighing, the filter and its collection of dust are dissolved in acid and the solutions are analyzed for uranium and alpha and beta radioactivity. Counting is done about seven days after the end of the collection period. After these analyses are completed the remaining solution is held to provide a long-term composite for thorium analyses. Frequent thorium analyses are not considered necessary because of the small amount of thorium processed and the low concentration of thorium found in the boundary samples. Because of the low concentrations, analysis of annual composites for each station is considered adequate. All air monitoring data is summarized and published in annual monitoring reports.

1.2.1.3 Utilities. During calendar year 1979, the FMPC consumed 22,669,000 KWH of electricity, 2,451,000 cubic feet (69,360 m^3) of natural

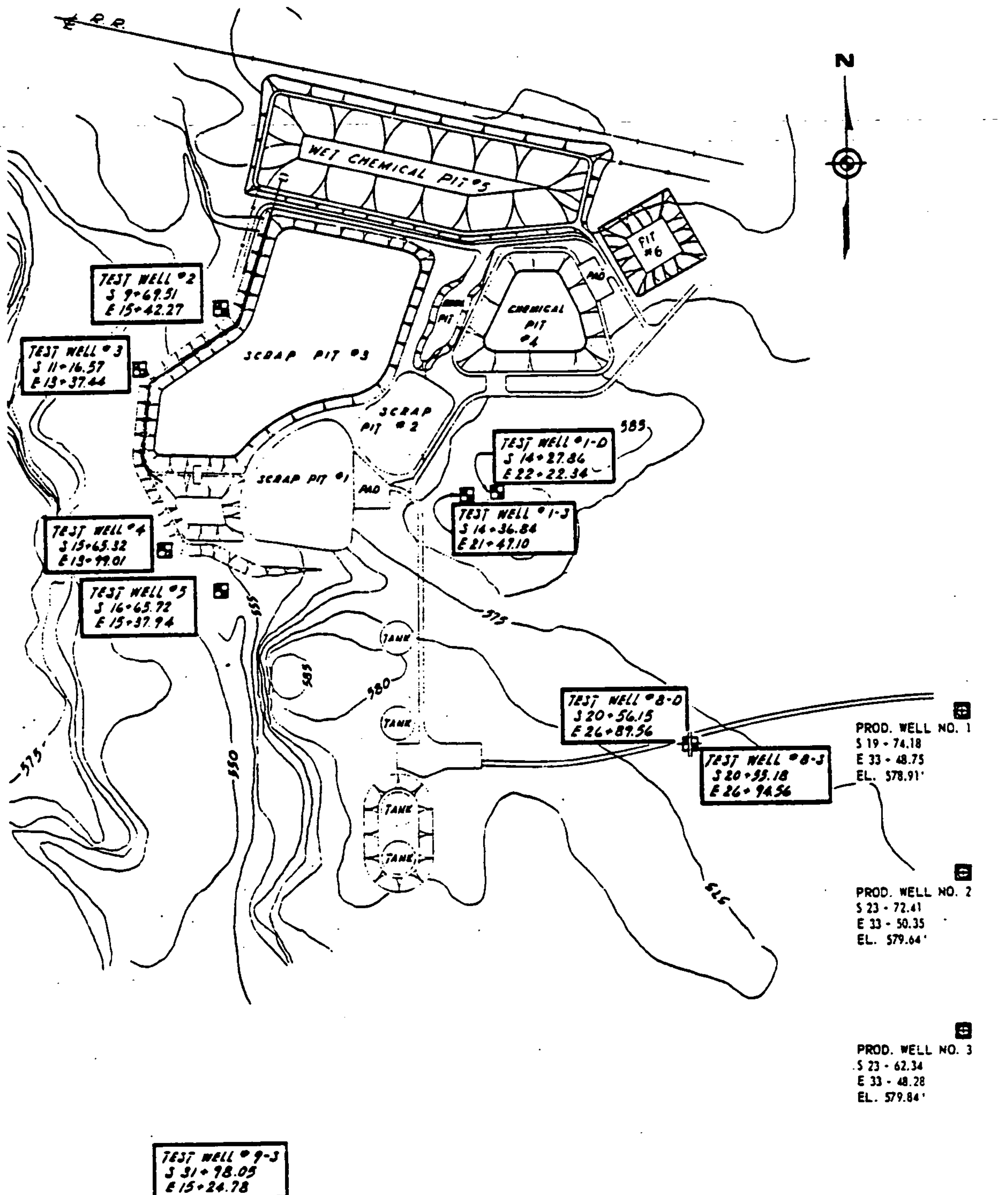


FIGURE 1-11. TEST WELL AND PRODUCTION WELL LOCATIONS

gas, 21,087 tons (19,126 tonnes) of low sulfur coal, and 99,351,000 gallons (376,040 m^3) of water from wells on the site. The FMPC discharged 218,091,000 gallons (825,475 m^3) of treated effluent and storm water to the Great Miami River[2].

1.2.2 Future Plans

Formal plans prepared by DOE for operations at the FMPC extend through 1992. Although operations at the plant will probably continue past 1992, no formal projections for those activities have been prepared and no drastic differences in requirements are expected, beyond those shown in major case studies.

Future production plans at the FMPC are illustrated in terms of projected uranium deliveries (for major products) in Figure 1-12. As shown in the graphs, FMPC operations are planned to supply materials for the New Production Reactor (NPR) at the DOE-Richland Operations site, for the Savannah River Plant (SRP), for the Y-12 Plant in Oak Ridge, Tennessee, and the Rocky Flats Plant, Golden, Colorado. The prospects of increased work for the NPR, SRP, and Y-12 will involve increased utilization of the metal area facilities, the Refinery and/or the smaller scale operation capabilities of the Pilot Plant.

Other program activities planned for the FMPC through 1992 include:

1. Small intermittent or sequential mode Refinery campaigns to produce slightly enriched UO_3 for NPR or normal UO_3 for the cascades.
2. Intermittent utilization of otherwise idle FMPC production areas to augment other DOE or inter-agency efforts (i.e., DOE and DOD) for cost reduction programs or R&D.
3. Air, water, and solid waste pollution abatement programs for compliance with applicable standards.

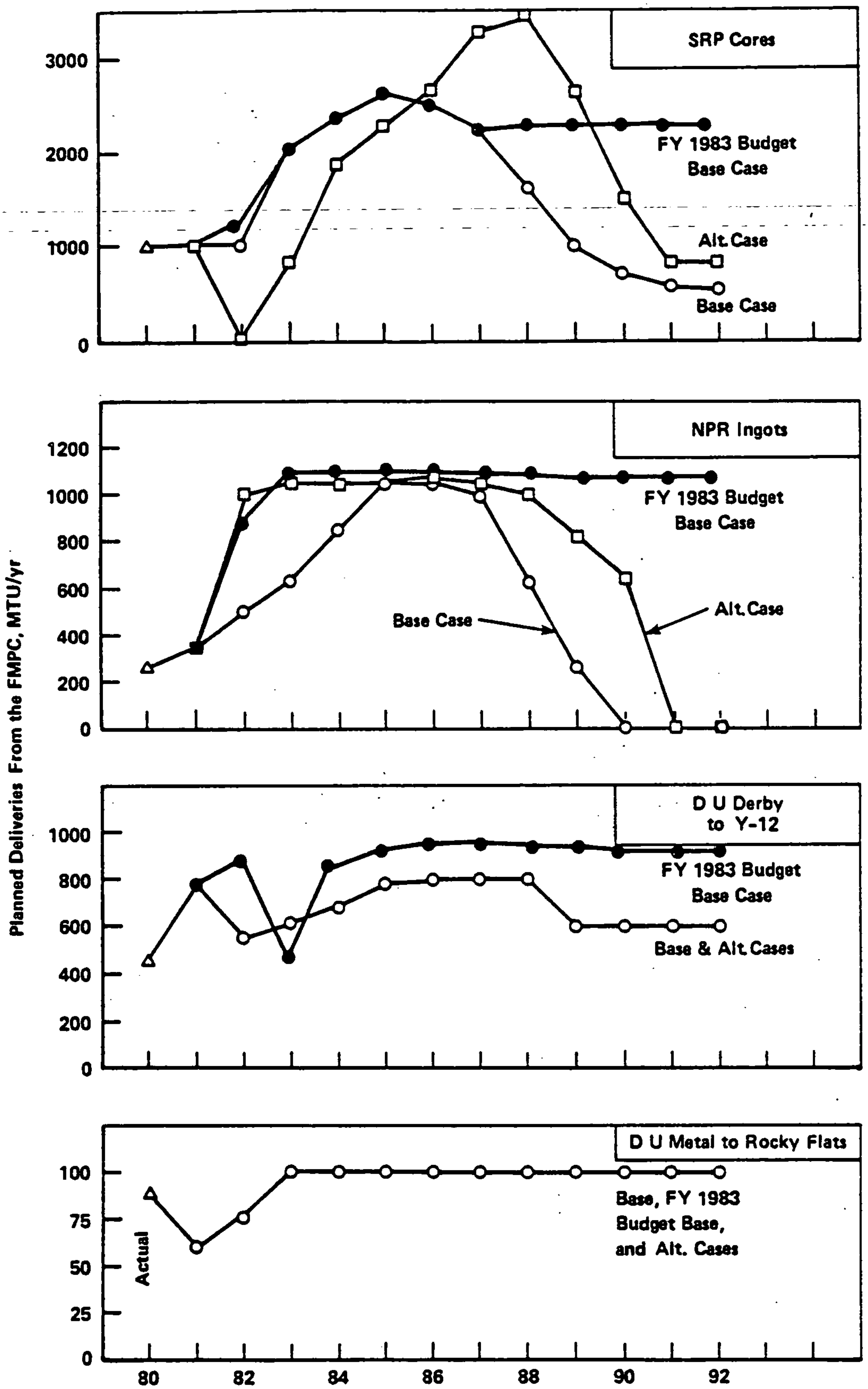


FIGURE 1-12. PROJECTED DELIVERIES OF URANIUM

2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT

2.1 Characterization of the General Area

2.1.1 Climatology

Comprehensive weather observations are made by the National Weather Service at the Abbe Observatory[3] in Cincinnati about 15 miles (24 km) to the south of FMPC and at the Greater Cincinnati Airport[4] about 17 miles (27 km) to the south of the FMPC on the plateau above the Kentucky bank of the Ohio River. Data on temperature, precipitation, and snowfall are also available from regular measurements made at cooperative weather observer stations in Hamilton, Ohio[5], about 10 miles (16 km) from FMPC[6]. Precipitation and wind are routinely recorded at the Feed Materials Production Center itself. Since the Greater Cincinnati Airport is in a suburban and rural area, its climate is more comparable to the FMPC climate than is that of the Abbe Observatory so the airport measurements will generally be used in this discussion unless the parameters are measured at Hamilton or FMPC.

The climate of southwestern Ohio is continental characterized by a wide range of temperatures from winter to summer. Average daily temperatures are in the 70's°F (low 20's°C) in June, July, and August, and in the low 30's°F (around 0°C) in December through February. The length of the frost-free period is about 190 days, extending from mid-April to late October. The probability of a temperature less than 0°F (-18°C) occurring at the FMPC is about 70 percent in any year[6].

During the winter and spring, frequent changes in the weather occur in southwestern Ohio as cyclonic storms pass over the area. In the summer the rainfall is produced by thunderstorms originating in the warm moist air which moves northward from the Gulf of Mexico along the Mississippi and Ohio valleys. The fall season is a period of minimum rainfall. There is an average of 185 days during the year when eight-tenths or more of the sky is covered by clouds[4]. The period of maximum cloudiness begins in November and continues through April. These are also the months when almost all of the snow falls.

2.1.1.1 Temperature. Average temperatures at Hamilton over a 29-year period ranged from 33.1°F (0.6°C) in January to 76.3°F (24.6°C) in July. Over a comparable period at the Greater Cincinnati Airport, these average temperatures were 31.6°F (-0.2°C) and 75.4°F (24.1°C). Normal daily fluctuations in the winter months are from the low 20's°F (around -15°C) to the low 40's°F (around 5°C), while during the summer months the range is from the low 60's°F (mid-teen°C) to the mid-80's°F (around 30°C). Average daily maximum, minimum, and monthly normal temperatures for the 1941-1970 period at Abbe Observatory are shown in Table 2-1. Monthly means are stable from June through August and December through February with sharp increases between March and June and decreases between September and December.

Over the period 1961-1979 at the Greater Cincinnati Airport, the highest temperature recorded was 102°F (38.9°C) in August, 1962. The record low there was -25°F (-31.7°C) on January 18, 1977[7].

Based on the 10 years from 1951 to 1960, Hamilton had an average of 115 days per year when temperatures reached 32°F (0°C) or below. During the same period, there was an average of 38 days per year when temperatures equaled or exceeded 90°F (32.2°C).

2.1.1.2 Precipitation. Over the 20 years from 1960 to 1979, the average annual precipitation measured at the FMPC was 37.75 inches (95.9 cm)[7] (Table 2-2). Other long term averages are 39.54 inches (100.4 cm), the 30-year climatological normal for Cincinnati[5], and 39.80 inches (101.1 cm), the climatological normal for Hamilton. At the FMPC the annual precipitation has ranged from 29.22 inches (74.2 cm) in 1963 to 47.72 inches (121.2 cm) in 1973. Monthly totals were a minimum of 0.04 inches (0.1 cm) during March, 1962, and a maximum of 11.15 inches (28.3 cm) during March, 1964. A large amount of this maximum fell on a single day that month when the record 24-hour rainfall of 5.21 inches (13.2 cm) was measured at the Greater Cincinnati Airport[4].

TABLE 2-1. NORMAL TEMPERATURES AT CINCINNATI'S ABBE OBSERVATORY (1941-1970)

Month	Daily Maximum (degrees F)	Daily Minimum (degrees F)	Monthly Mean (degrees F)
January	39.8	24.3	32.1
February	42.9	25.8	34.4
March	52.2	33.5	42.9
April	65.5	44.6	55.1
May	75.2	53.6	64.4
June	83.6	62.5	73.1
July	86.6	65.8	76.2
August	86.0	64.1	75.1
September	79.8	57.0	68.4
October	68.8	46.7	57.8
November	53.0	36.2	44.6
December	41.8	27.1	34.4
Year	64.6	45.1	54.9

TABLE 2-2. PRECIPITATION MEASURED AT THE FMPC, 1960-1979 (WATER EQUIVALENT INCHES)

Year	Total Precipitation	Monthly Records	
		Maximum	Minimum
1960	30.76	6.04 June	0.55 March
1961	45.69	8.75 July	1.32 January
1962	33.45	6.63 July	0.57 April
1963	29.22	9.78 March	0.04 October
1964	41.52	11.15 March	0.67 October
1965	38.63	6.56 September	0.82 May
1966	35.89	4.83 April	0.78 October
1967	33.07	5.86 May	0.44 January
1968	39.81	10.36 May	0.30 February
1969	34.17	5.26 September	0.91 March
1970	34.31	5.20 April	0.98 January
1971	32.86	4.35 September	1.11 April
1972	38.68	5.49 April	1.08 February
1973	47.72	7.61 July	1.07 February
1974	43.63	7.09 August	1.03 October
1975	40.89	5.65 March	1.50 July
1976	29.56	5.59 August	0.41 December
1977	40.48	6.09 December	1.18 February
1978	39.21	5.80 June	0.19 February
1979	45.44	7.37 September	1.10 March
Average	37.75		

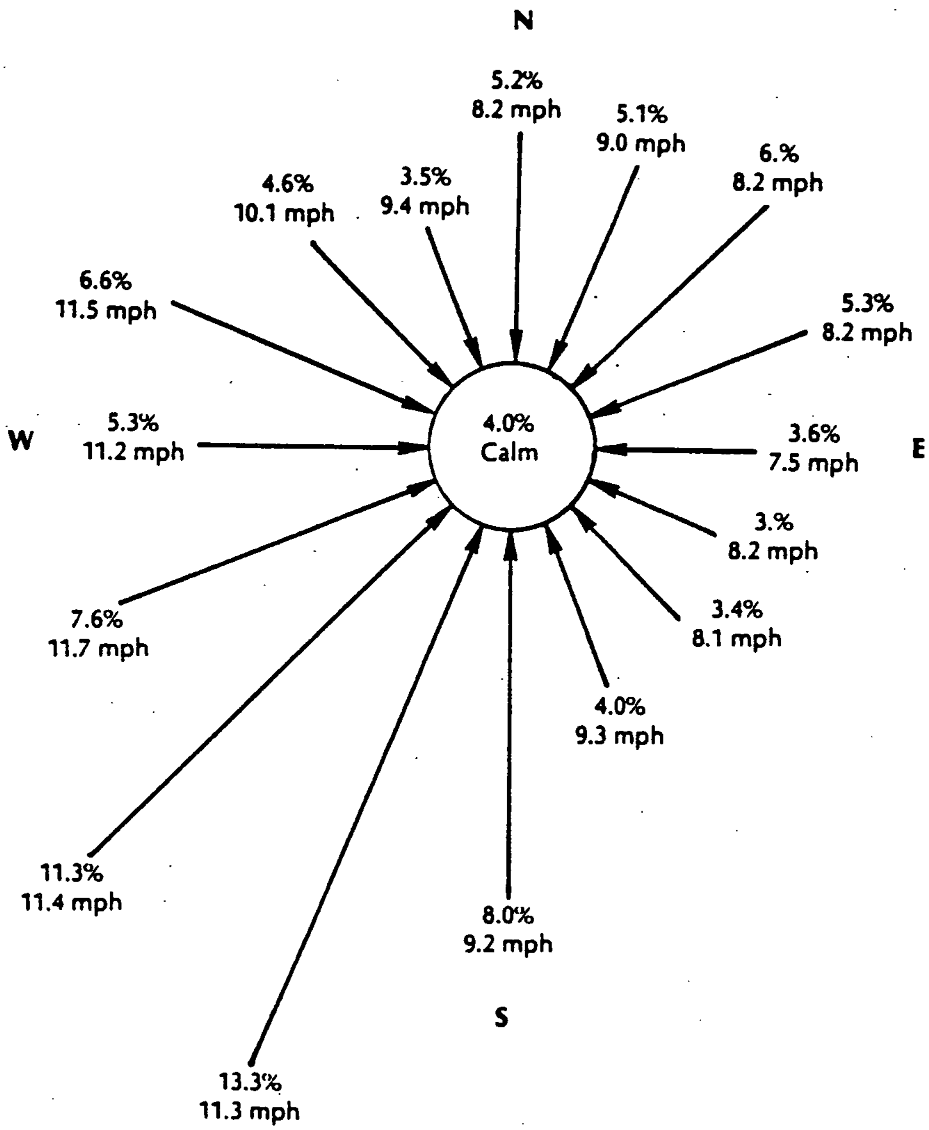
There is an average of 44 days with thunderstorms each year in southwestern Ohio and 30 of these thundershower days occur between May and August[4]. In urban Cincinnati (the Abbe Observatory), the number of annual thunderstorm days is 50.

Heavy fog is observed an average of 20 days per year on the hilltops above the Ohio River (Greater Cincinnati Airport). These days are rather evenly distributed throughout the year with a slight maximum in September-November and a slight minimum in April-June. The occurrence of heavy fog in the valleys of the Ohio River and its tributaries is markedly more frequent than on the hilltops because of the cooler temperatures caused by the combination of nighttime drainage winds or relatively cool summertime water temperatures and the source of water vapor provided by the rivers themselves. River valleys delineated by fog are a common sight for travelers driving through or flying over the Cincinnati area in early morning hours.

Annual snowfall at Hamilton averaged 15.3 inches (38.8 cm) over a 29-year period. At the Abbe Observatory, the 39-year average (1935-1974) was 18.9 inches (48.0 cm) and at the Greater Cincinnati Airport there was a 24.6 (62.5 cm) average measured during a 32 year period. The maximum monthly snowfall totals for the Abbe Observatory are presented in Table 2-3.

2.1.1.3 Winds. At the Greater Cincinnati Airport, prevailing winds are from the south-southwest for all 12 months of the year. Average monthly speeds range from 6.7 mph (10.8 kph) in August to 11.2 mph (18.0 kph) in March. Channelling of air flow and surface friction in the valleys reduce the wind speed and direct the air flow along the valleys. A wind rose showing the wind direction frequencies and the average wind speeds from each direction at the airport is presented in Figure 2-1.

The maximum wind velocity recorded at the airport was 40 mph (64.4 kph) from the SSW. It has been observed five times in 12 years: February, 1967; April, 1970; January, 1971; June, 1971; and December, 1973. Wind records from the FMPC list wind gusts in excess of 50 mph (80.5 kph) for 11 occasions between 1960 and 1976 with gusts to 60 mph (96.6 kph) twice [7]. Table 2-4 shows the percentage of occurrence of various wind speed ranges measured at the Greater Cincinnati Airport [8].



BASED ON HOURLY SURFACE WIND OBSERVATIONS TAKEN AT GREATER CINCINNATI AIRPORT FROM 1951- 1960.

FIGURE 2-1. WIND DIRECTION AND SPEED OCCURRENCES

TABLE 2-3. MAXIMUM MONTHLY SNOWFALLS AT THE ABBE OBSERVATORY (1915 - 1978)

Month	Maximum Snowfall (inches)	Year of Occurrence
October	4.7	1925
November	10.2	1966
December	16.3	1917
January	20.2	1918
February	14.6	1971
March	13.0	1937
April	5.2	1920
May	Trace	Several Years

TABLE 2-4. PERCENTAGE OF OCCURRENCE OF WIND SPEED CLASSES (GREATER CINCINNATI AIRPORT 1951-1960)

Range (miles per hour)	Frequency (percent)
0-3	10.8
4-7	26.6
8-12	35.6
13-18	22.3
19-24	3.9
25-31	0.7
32-38	0.1
39 and above	0.0

2.1.1.4 Tornadoes. Ohio lies on the eastern edge of the land of maximum tornado frequency, the centerline of which extends from northern Texas to southwestern Iowa. Tornadoes may approach a location from any direction, but about 90 percent come from the west through southwest. Tornadoes usually move at a speed of about 40 mph (64.4 kph), a very slow rate compared with the rotary speed of winds within the tornado which are estimated to sometimes exceed 200 mph (322 kph).

During the 20-year period from 1953 to 1972, there were 235 tornadoes that struck Ohio. Peak months were April (47 tornadoes), May (47), June (36), and July (34) when 70 percent of the tornadoes occurred[9]. During the period 1900 - 1978, 15 tornadoes were observed in Hamilton County and eleven were seen in Butler County. During the 23-year period from 1953-1975, Ohio averaged about 13 tornadoes annually. In these years a total of eight tornadoes were observed in Hamilton County and seven in Butler County.

Only one tornado is known to have touched the FMPC; this occurred May 10, 1969. There was no damage to the FMPC property. A tornado passed near the northeast boundary on May 13, 1973, but caused no damage to the FMPC.

2.1.2 Seismology

A study of the past seismic activity in Ohio reveals that it is not a major seismic risk area. However, there is a small region in west-central Ohio, near the town of Anna, that has experienced damaging shocks in the past. The two largest shocks that are recorded occurred on March 2 and 9, 1937, and the shocks were felt over a distance of 48 to 55 miles, respectively.[10] During the period 1776 to 1980, approximately 80 earthquakes were recorded in Ohio and six of these occurred in the Cincinnati area. (All six occurred between the years 1925 and 1937 and were of low intensity, III-Modified Mercalli Scale, 1956 revision.) Although the 1937 events in the Anna area were larger, VII and VIII, the Anna area is located far enough north of Cincinnati that only a mild shock was felt there.[10] On July 27, 1980, there was an earthquake centered in Maysville, Kentucky, about 65 miles (105 km) woutheast of FMPC. The earthquake measured 5.1 on the Richter scale.[11] Because of the seismic activity in the area, this portion of Ohio is included in a seismic risk category of 2 (Figure 2.2).[12] A seismic risk category of 2 is an area where moderate earthquake damage can occur. The two largest recorded events in the Anna area, those in 1937, caused damage such as toppled chimneys and cracked walls[10]; the Maysville earthquake toppled chimneys in the Cincinnati area[11]. No earthquake damage has occurred at the FMPC.

2.1.3 Geology

The bedrock in much of southwestern Ohio consists of indurated shales and limestones of Upper Ordovician Age (Figure 2-3).[13] These sediments were deposited in a shallow sea which inundated much of the central part of the United States. The land masses during this period were far to the east, which accounts for the fine grained nature of the sedimentary deposits.

Pleistocene glacial deposits unconformably overlie the Ordovician rocks. In southwestern Ohio, these glacial deposits are associated with the two youngest of the three continental ice sheets that have advanced over portions of Ohio in the past million years. The last two ice advances, the Illinoian and the Wisconsin, chronologically, contributed great quantities of debris to the area, filling in old river and stream channels, which caused a pronounced softening of the topographic relief. The area is marked by broad flat plains, rolling surfaces along glacial moraines, and by low well rounded hills of bedrock which protrude through the glacial debris[14] (Figures 2-4).

Prior to glaciation southwestern Ohio was drained by the Hamilton River which incised a broad river valley. Later this valley was occupied by the Cincinnati River during the advance and retreat of the Kansas ice sheet. (This advance did not extend into southwestern Ohio.) The debris from later advances, the Illinoian and Wisconsin, was deposited in this ancestral river valley to form the extensive groundwater aquifer of the New Haven Trough (Figure 2-5). The glacial deposits in the trough average 2 miles (3.2 km) in width and about 150-200 feet (46-61 m) in depth. When the ice receded from the area, glacial drift deposits filled it to a height of more than 200 feet (61 m) above the limestone and shale valley floor. Most of the surface

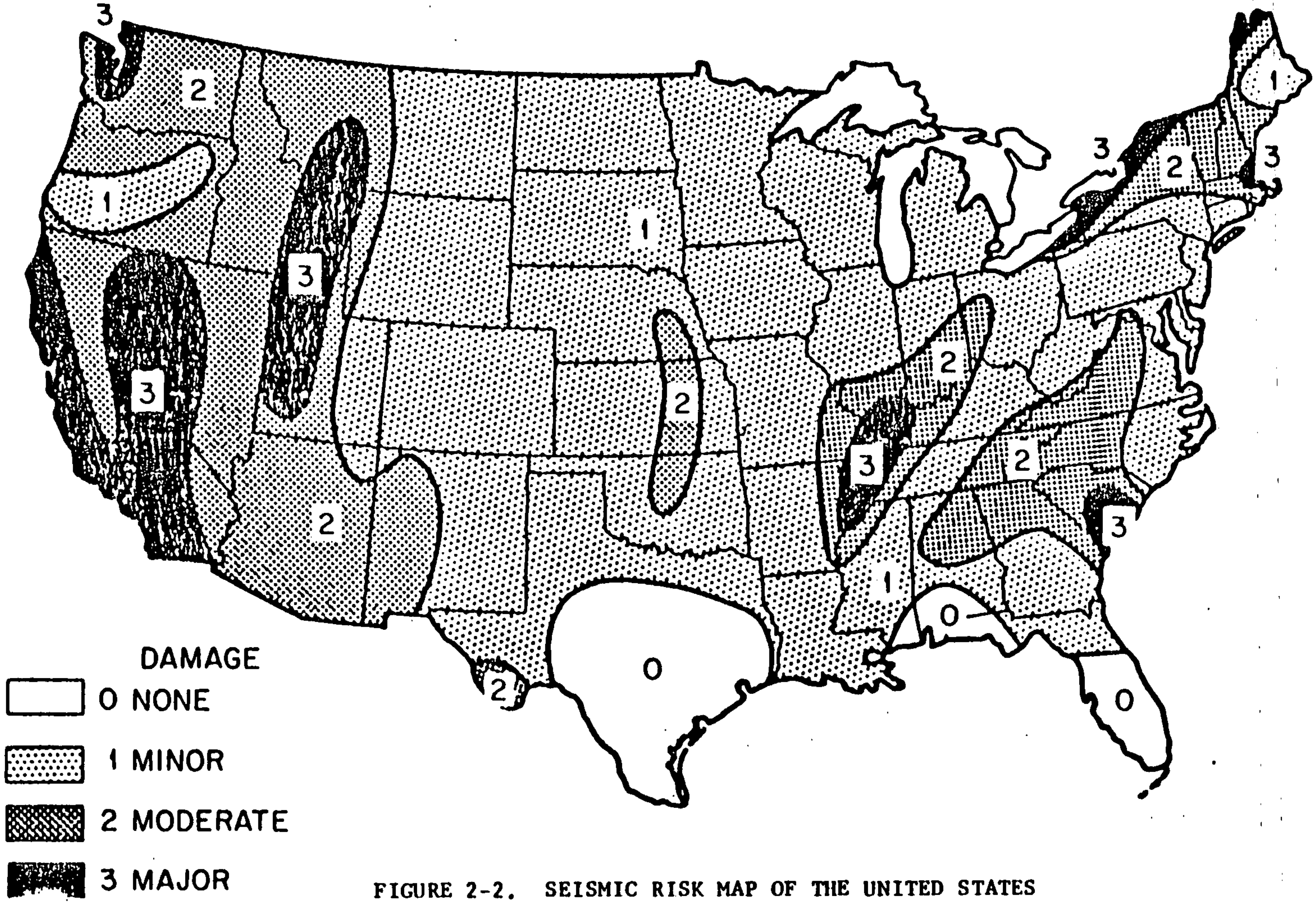


FIGURE 2-2. SEISMIC RISK MAP OF THE UNITED STATES

60

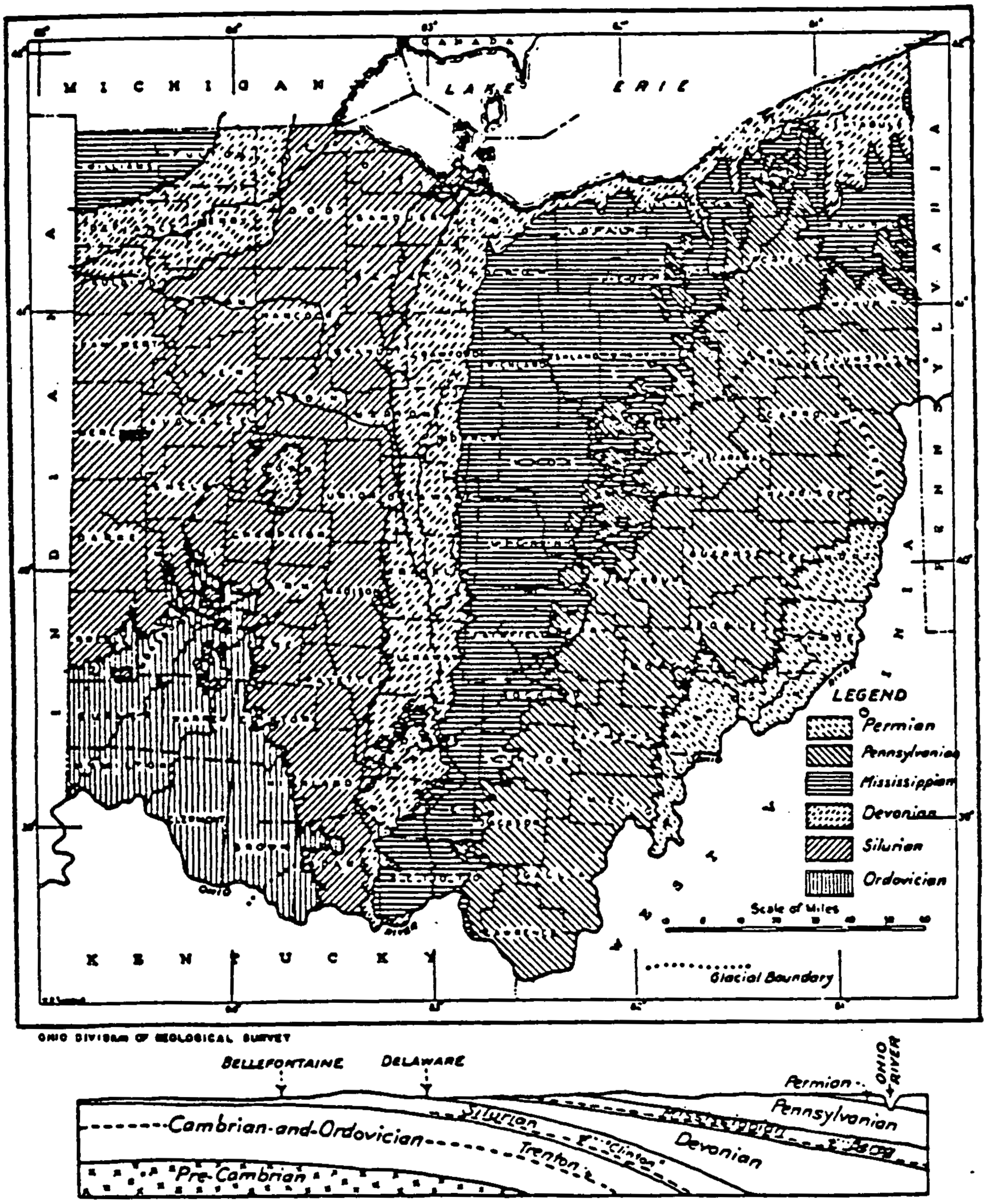


FIGURE 2-3. GEOLOGIC MAP AND CROSS SECTION OF OHIO

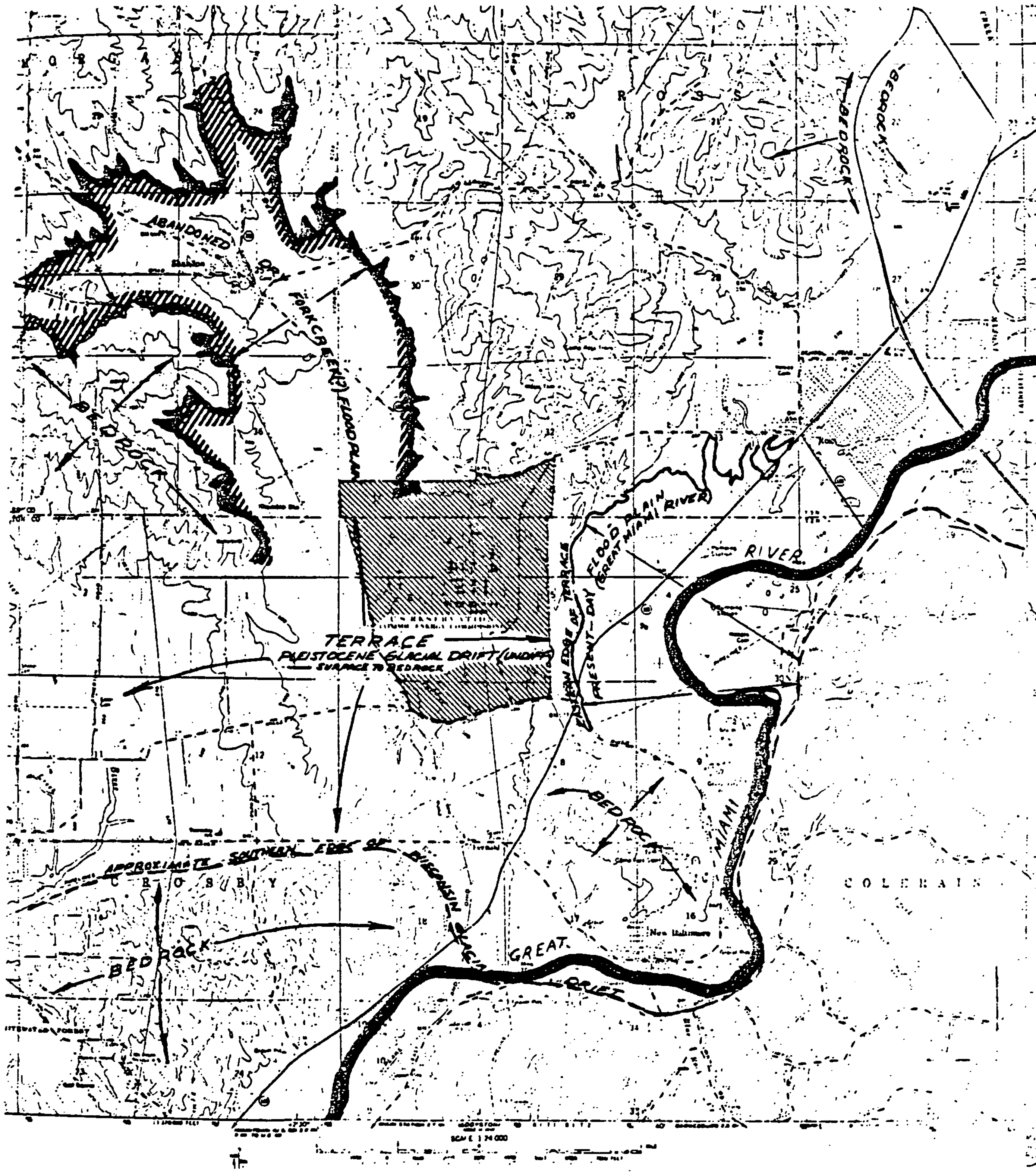


FIGURE 2-4. GEOLOGICAL FEATURES OF THE FMPC AREA
Defines Terrace Edge

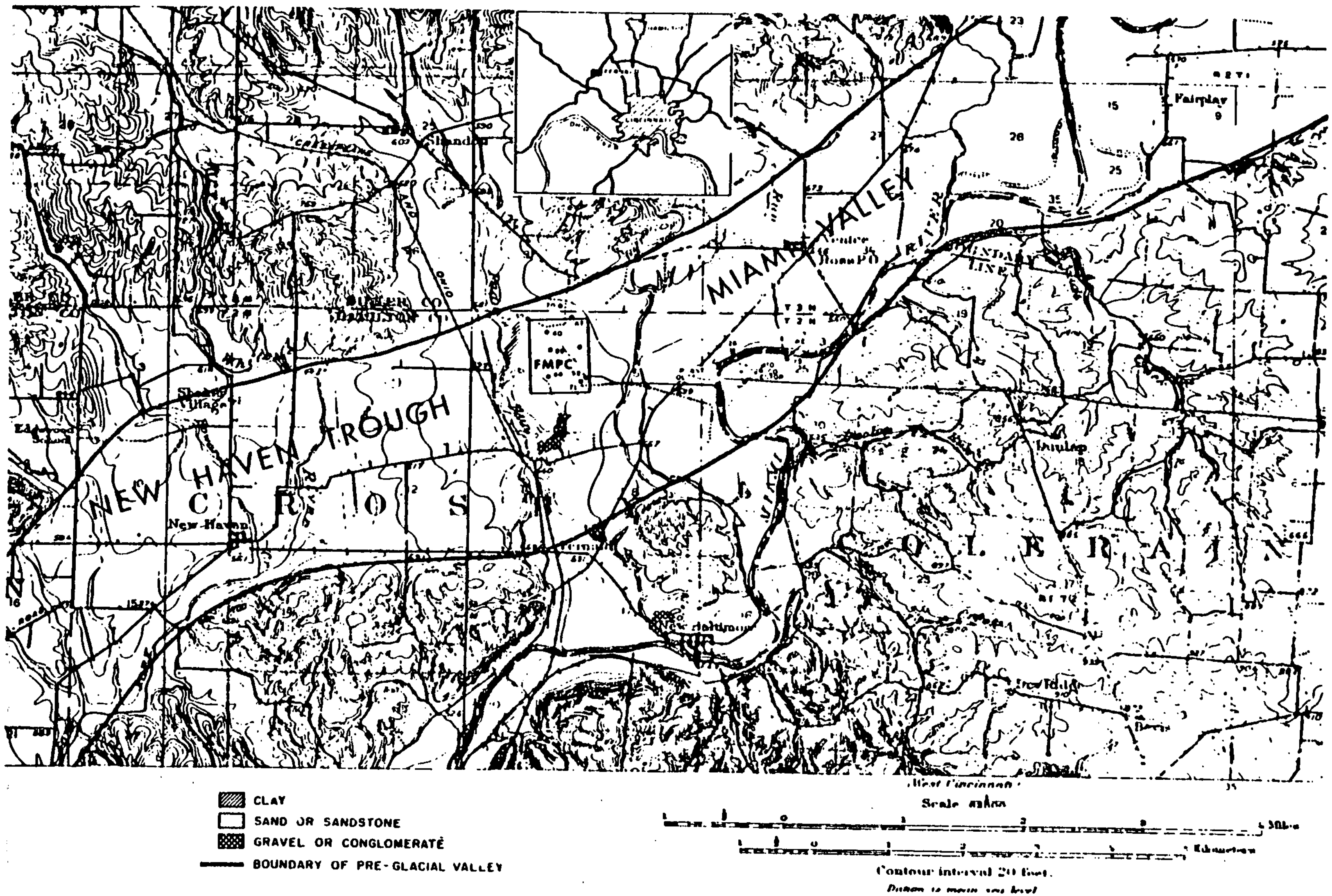
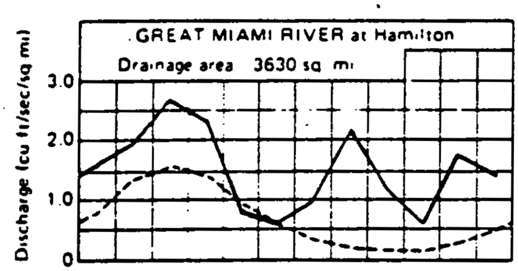


FIGURE 2-5. TOPOGRAPHY OF THE FMPC AREA AND THE MIAMI VALLEY

deposits accumulated during the last glacial advance, the Wisconsin. Recent erosion by the Miami River and its tributaries has removed substantial portions of the glacial fill, leaving terrace remnants standing higher than the adjacent bottom lands.

2.1.4 Hydrology

2.1.4.1 Surface Water. The FMPC is located in the Great Miami River Basin. Natural drainage of the site is to Paddy's Run, a tributary of the Great Miami River (Figure 2-6). Paddy's Run is an ungaged stream. However, mean discharge of gaged streams in Butler and Hamilton counties ranges between 11.7 and 13.3 inches (29.7-33.8 cm) per year[15] (0.86 to 0.98 cfs/mi^2 or 0.008-0.009 $m^3/sec/km^2$ of area drained). Monthly discharge data for the Great Miami River is shown below[16].



——————— 1979

- - - - - - - - - Normal (1941-1970)

Paddy's Run is just west of FMPC's six chemical waste storage pits. Location of the pits is shown in Figure 1-7; the status of the pits is as follows:

60

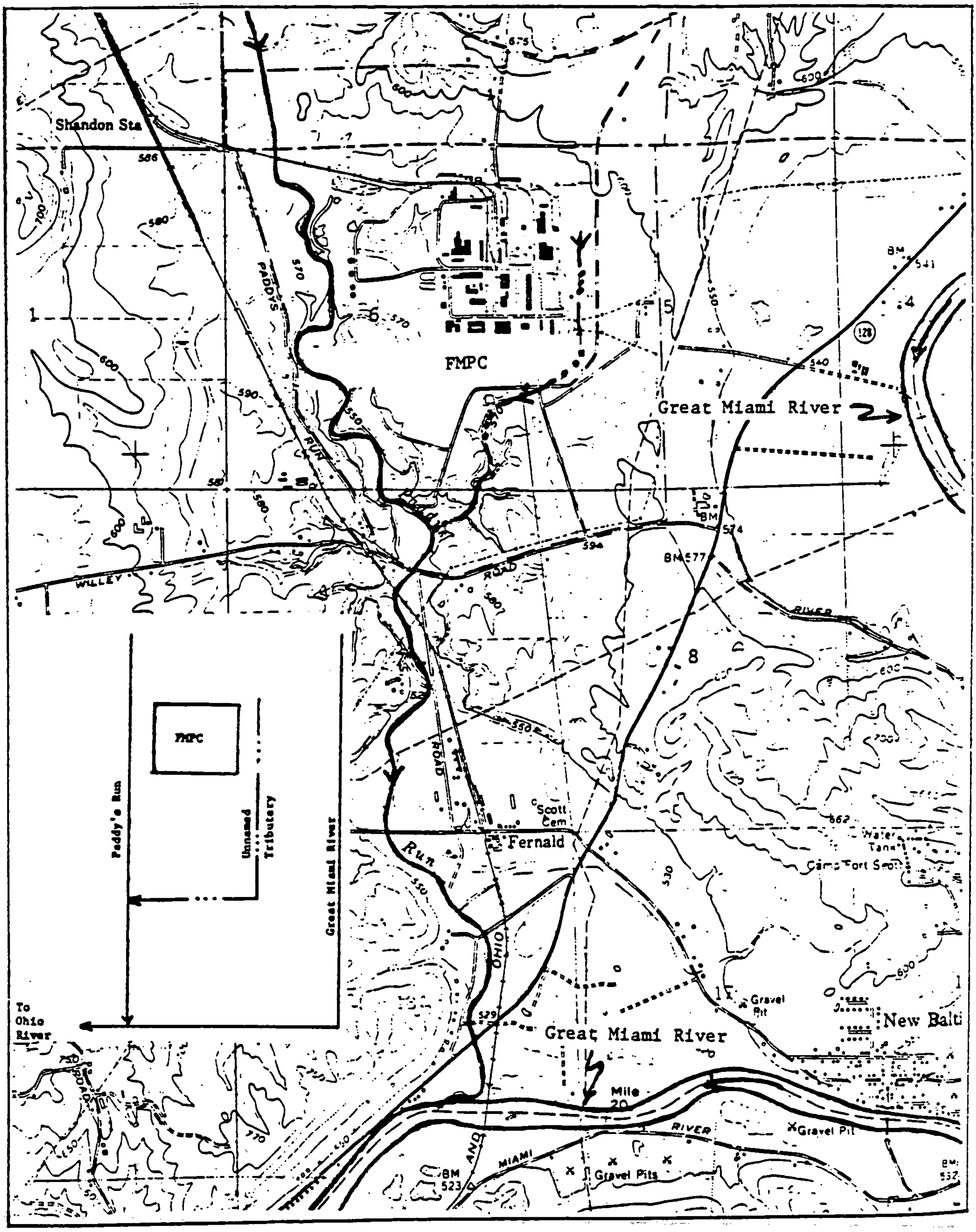


FIGURE 2-6. SURFACE STREAMS -- FMPC ENVIRONS

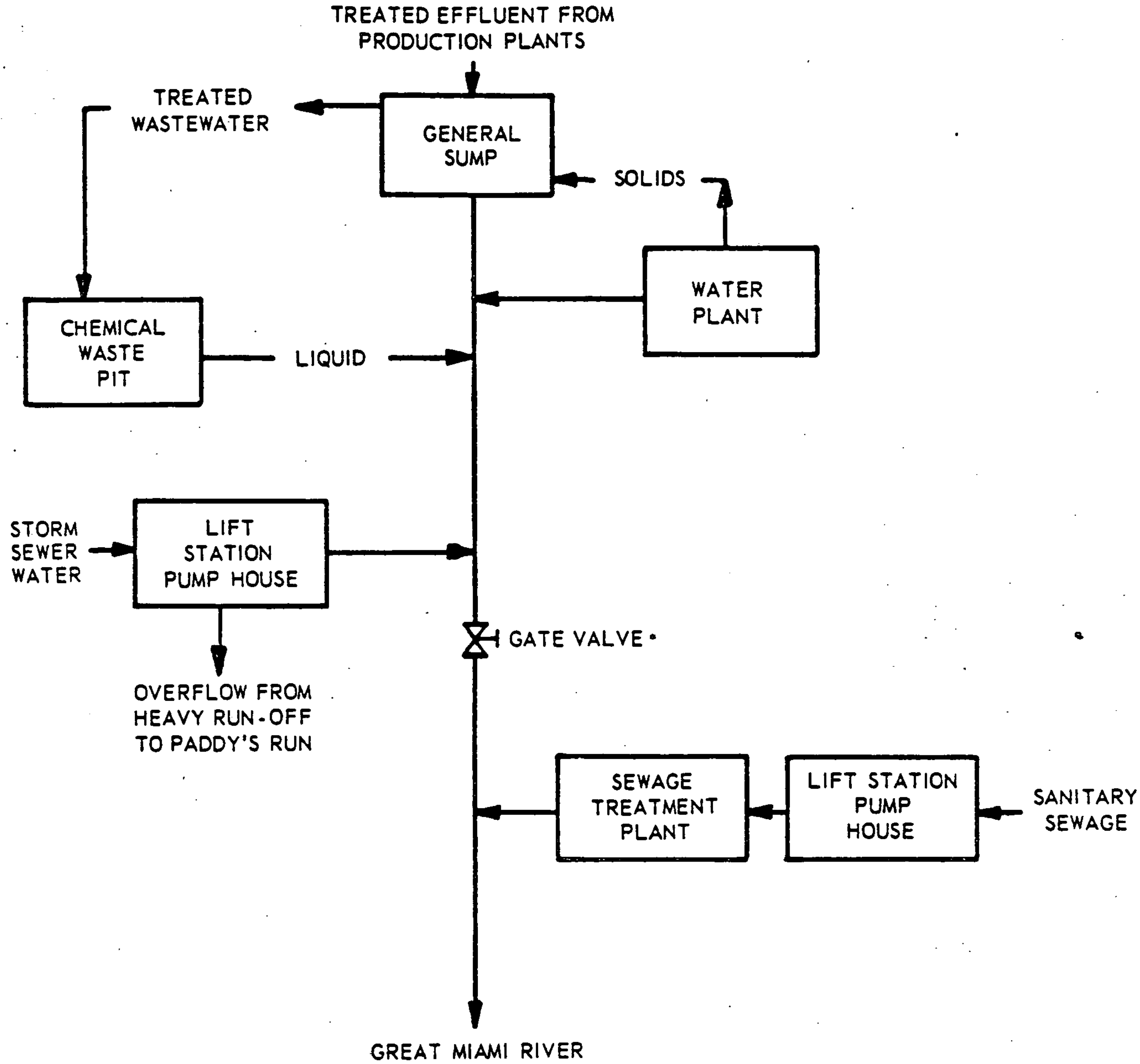
Pit No.	Pit Type	Pit Volume Cubic Yards	Status
1	Dry	40,000	Filled & covered
2	Dry	13,000	Filled & covered
3	Wet	226,500	99% Filled - Being covered
4	Dry	53,000	93% Filled
5	Wet	115,000	95% Filled
6	Dry	16,000	10% Filled

The waste storage pits are lined with clay or a rubber membrane There have not been any weather or runoff conditions that have led to erosion near the base of west slope of the waste storage area since the FMPC began operations.(7)

Liquid wastes have been generated to some degree in every operation at FMPC. Treated process effluents, sewage treatment plant effluents, and storm sewer water are discharged to Great Miami River (Figure 2-7).

2.1.4.2 Ground Water. The underlying sediments at the FMPC site are unconsolidated glacial drift which essentially fill the New Haven Trough. The upper 50 feet (15 m) is composed of a clay-rich till which may be a remnant of a large glacial moraine. Beneath the till is about 150 feet (46 m) of sand and gravel which fills the buried preglacial river valley. In the FMPC area, the sand and gravel deposits are divided into two units by a clay layer that is about 10 to 20 feet (3-6 m) thick. The top of this clay is about 125 feet (38 m) below the land surface.(7) Figure 1-8 shows the location of some of the test and production wells at the FMPC site and Figure 2-8 shows an idealized west-east cross section through the valley fill.

The surface deposits at the site contain sufficient clay to render them nearly impervious to infiltration. However, in some areas, sand and gravel deposits extend to the surface. Aquifer tests in the lower sand and gravel layer yield a coefficient of permeability of 2,000 gallons per square foot (81.5 m^3/m^2) per day and the clay layer between the sand and gravel units has a coefficient of permeability of about 3 gallons per square foot (0.1 m^3/m^2) per day. Thus, in some locations, the clay layer provides a confining unit for the lower sand and gravel aquifer.



•Storm sewer water can be diverted to the Chemical Waste Pit or the General Sump by first halting the pumping from both locations and then closing the gate valve.

FIGURE 2-7. LIQUID WASTE STREAMS

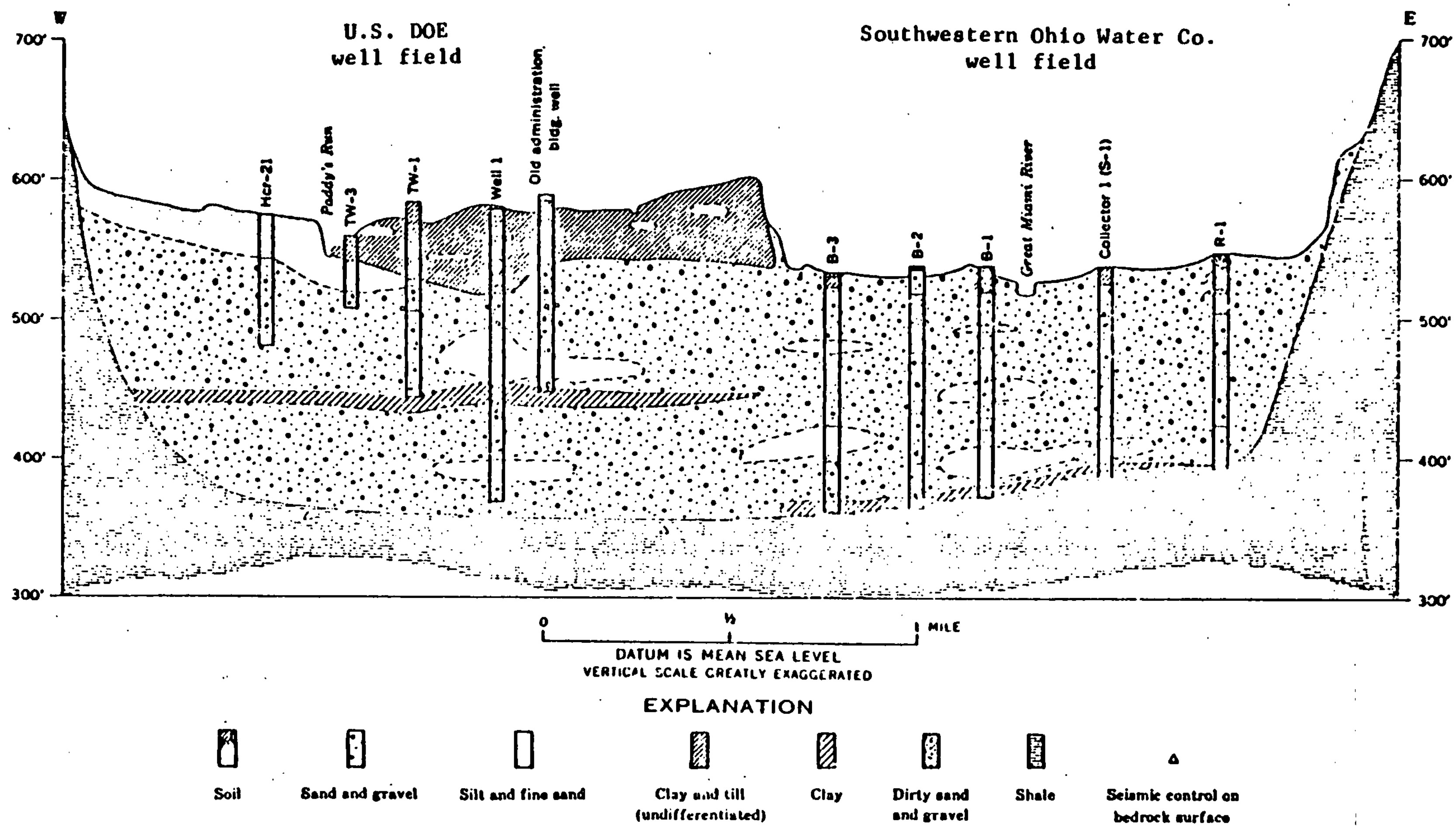


FIGURE 2-8. GEOLOGIC SECTION OF THE U.S. DEPARTMENT OF ENERGY AND THE SOUTHWESTERN OHIO WATER COMPANY WELL FIELDS

Test borings for foundation design, well drilling, and waste pit excavation at the FMPC site show the existance of many ground-water aquifers in the glacial deposits. Some of these are quite localized and result primarily from infiltration of precipitation that is trapped by underlying clay units. A more detailed cross section of the glacial deposits encountered in deep wells is shown in Figure 2-9. The two major aquifers, the upper and lower sand and gravel units, are about 50 and 70 feet (15 and 21 m) thick, respectively (Figure 2-9). The blue clay layer that separates these gravel deposits is sufficiently impervious that water in the lower sand and gravel unit is under considerable hydrostatic head. The water in the upper aquifer, above the blue clay layer, is under normal hydrostatic conditions and is recharged locally from infiltration of precipitation through the surface clay deposits. The static water levels in Test Wells 2, 3, 4, and 5, located on the west side of the waste disposal area, are higher than the water level in Test Well 1 on the east side of the disposal area (Figure 1-8). This indicates that the shallow ground water is moving in an easterly direction toward the main production wells (Figure 1-11).[7]

The deep aquifer (artesian in the FMPC site) is undoubtedly supplied with water from a large recharge area and is not greatly affected by local precipitation. On the average, 200,000 gallons (760 m^3) per day are withdrawn from this aquifer by the FMPC production wells.

The static water level in the production wells (into the lower aquifer) and in the well of the "old Administration Building" (into the upper aquifer) are approximately the same (Figures 2-8 and 2-9). This indicates that the lower and upper sand and gravel aquifers are interconnected in this area. Chemical analyses of water samples from both deep and shallow wells are similar which is a further indication of direct interchange between the aquifers at this location.[7]

The physical characteristics of the sand and gravel deposits in the New Haven Trough (Miami Valley) give rise to ground-water resources which are of tremendous potential economic value. At the present time, only limited use is being made of ground water in the FMPC area, but increased industrial use will undoubtedly occur in the future. Because of the interconnected nature of shallow and deep aquifers in the FMPC area, there is a potential for contamination of a valuable ground-water resource from waste disposal activities at the FMPC. However, no ground-water

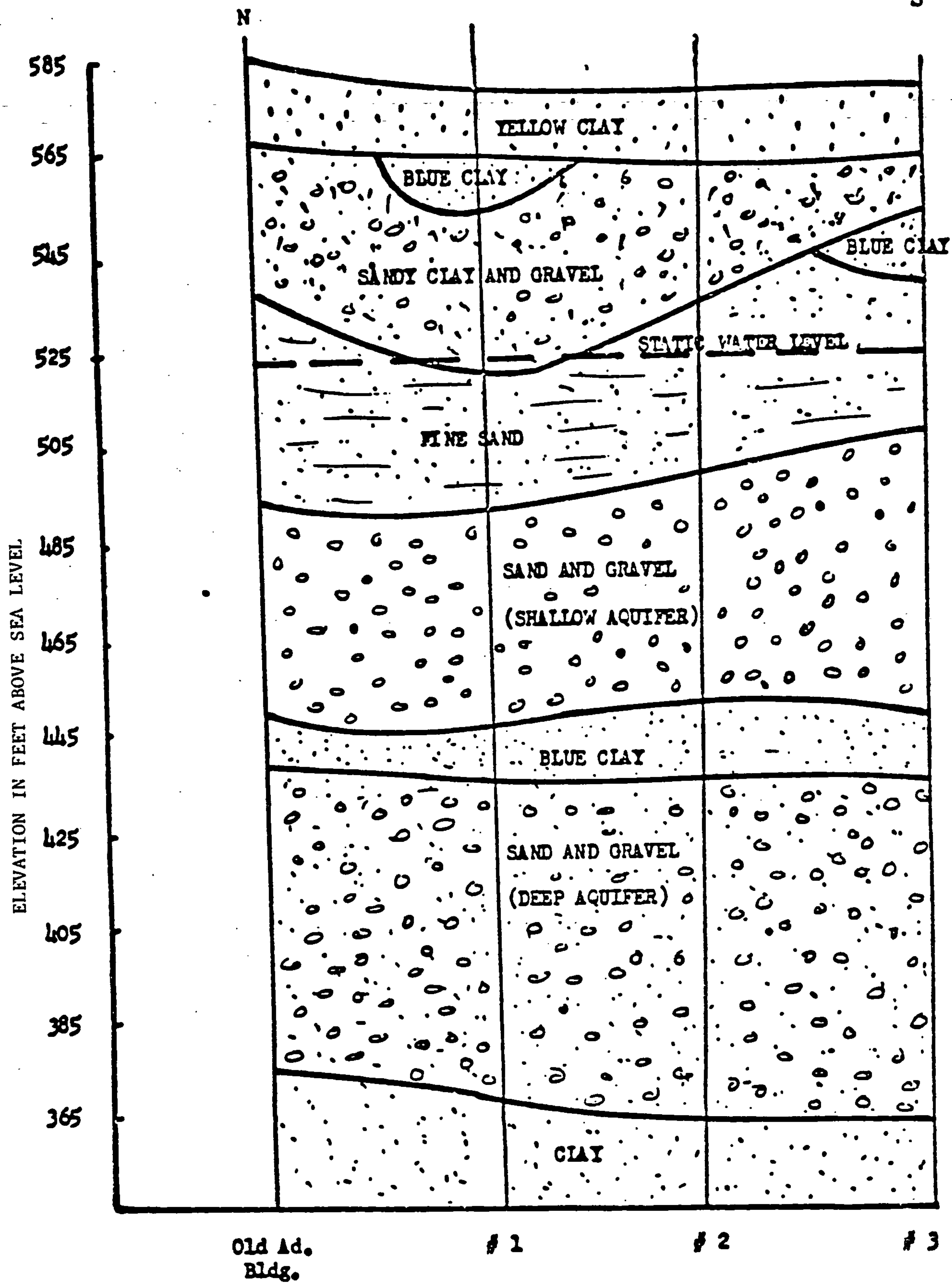


FIGURE 2-9. VERTICAL SECTION THROUGH DEEP WELLS ON PLANT SITE

60

contamination of the deep aquifer has been observed and the upper clay layers are believed to form a sufficient barrier to migration of pollutants into the deeper sand and gravel aquifers.[7]

2.1.5 Demography and Land Use

The Feed Materials Production Center is located in northwestern Hamilton County and southwestern Butler County near Fernald, Ohio, approximately 20 miles (32 km) northwest of downtown Cincinnati (see Figure 1-2).

In 1977, Hamilton County had an estimated population of 883,739; Butler County had an estimated population of 250,479[17]. Hamilton County is primarily urban (96.0%), with a rural nonfarm population of 3.6% and a rural farm population of 0.4%; while 77.4% of Butler County's residents are classified as urban, 19.1% are rural nonfarm and 3.5% are rural farm residences. Both counties have a higher percentage of urban residents than the state, which has an urban population of approximately 75%[18].

The land surrounding the FMPC is primarily used for agriculture. There are approximately 35 residences near the north side of the project; the majority of these are in a subdivision to the northeast. There are also ten scattered residences and one small business in the remaining adjacent areas and a trailer park is located about 1-1/2 miles (2.4 km) southeast of the waste storage area. Fernald and New Baltimore in Hamilton County and Shandon and Ross in Butler County are the communities closest to the plant site. The locations and populations of the towns and cities in the area are shown in Table 2-5.

Between 1960 and 1970, the two counties experienced population increases, with Hamilton County increasing by 6.8% and Butler County by 13.6%; the State's population increased by 9.8% during this same time period[19]. However, from 1970 to 1977, the growth slowed, with Hamilton County experiencing a 4.6% decrease, and Butler County increasing by 10.7%[17]; the state increased by 0.4%[19]. Table 2-6 shows the changes in population for the two counties from 1970 to 1977.

TABLE 2-5. POPULATION AND LOCATION OF TOWNS AND CITIES NEAR FMPC

Town or City	Approximate Distance from FMPC to Nearest Edge (Miles)	Estimated Population
Fernald	1-3-1/4	30
Shandon	2	200
Ross	2-1/2	1,661[a]
New Baltimore	2-3/4	200
New Haven	3	200
Dunlap	4	100
Harrison	5	5,405[b]
Miamitown	6	700[a]
Groesbeck	7	6,000[a]
Forest Park	7	19,864[b]
Fairfield	8	25,747[b]
Hamilton	8	66,712[b]
Mt. Healthy	8-1/2	7,246[b]
Cincinnati	9	403,363[b]
Cheviot	10	9,845[b]

(a) 1970 Census.

(b) 1977 Estimate, Reference (17)

TABLE 2-6. COUNTY POPULATION CHANGE, 1970 to 1977[a]

County	1970 (Census)	1977 (Estimate)	Change, 1970 to 1975	
			Number	Percent
Hamilton	925,944	883,339	- 42,605	- 4.6
Butler	226,207	250,479	24,272	10.7

(a) Source: Reference (17)

In 1970, the median age for Hamilton County residents was 28.3 years, while Butler County's residents were slightly younger with a median age of 25.5 years; the median age for Ohio was 27.9 years. There were slightly more females than males in both counties: 52.5% in Hamilton County; 51.1% in Butler County. Hamilton County residents aged 25 and over had a median educational attainment of 12.0 years; Butler County's residents had a median of 11.7 years of education; the median for the State is 12.1 years[20]. The estimated per capita income in 1974 was $4863 for Hamilton County (an increase of 43.5% from 1969) and $4538 for Butler County (an increase of 46.0% from 1969)[21].

Hamilton County contained 1,619 manufacturing establishments in 1977, with the manufacture of equipment for the transportation industry (e.g., motor vehicle and aircraft) being the major industry. Butler County contains 220 manufacturing establishments, with the production of paper and allied products leading in number of employees in the county[22]. The general categories of employment for the two counties are shown in Table 2-7. The average weekly earnings for all industries in 1979 was $278.48 for Hamilton County and $287.31 for Butler County, compared to $266.84 for the State.[23]

Hamilton and Butler Counties have a considerable amount of industrial activity, as indicated above; however, farming is one of the major economic activities of the rural area surrounding the plant site. Dairy farming, raising of beef cattle and crops such as sweet corn, grain corn, soybeans, and wheat predominate in the area. Truck crops are widely grown and sold at local produce stands and in nearby urban markets.

In 1976, Hamilton County had 470 farms, with an average size of 100 acres (40 ha); Butler County had 1200 farms, averaging 152 acres (61 ha) in size.[24] Between 1974 and 1979, the number of farms decreased by 16% in Hamilton County, and decreased by 19% in Butler County. The number of farms with sales of $2500 and over increased in both counties during 1969-1974: Hamilton County +29%; Butler County +5%. The State experienced a decrease of 12% in the total number of farms, but a 5% increase in the number of farms with sales of $2500 and over[25].

Although the area around the FMPC is rural, Hamilton and Butler Counties are not among the State's leading agricultural counties. For 1979, in cash receipts from the nine major agricultural commodities, Hamilton

TABLE 2-7. GENERAL CATEGORIES OF EMPLOYMENT HAMILTON AND BUTLER COUNTIES, OHIO, 1977(a,b)

	Number of Employees for Week Including March 12, 1977	
	Hamilton County	Butler County
Total Number of Employees	402,091	65,632
Agricultural Services	603	84
Mining	378	140
Contract Construction	15,294	3,480
Manufacturing	141,521	31,466
Transportation and Other Public Utilities	25,309	2,199
Wholesale Trade	35,229	3,029
Retail Trade	71,090	11,362
Finance, Insurance, and Real Estate	26,214	4,102
Services	86,220	9,705

(a) Source: Reference (22).

(b) Excludes government employees, railroad employees, and self-employed.

County was among the top 10 of Ohio's 88 counties in only one commodity: greenhouse and nursery products. The county ranked sixth with receipts of 7.6 million dollars from this farm activity. Butler County was not ranked among the top 10 counties in any of the nine major commodities[26]. Grain corn is the major crop in both counties with regard to total acreage. In 1976, the acreage used was 7,500 acres (3040 ha) in Hamilton County and 54,500 acres (22,070 ha) in Butler County, with an average yield of 96.5 bushels per acre (8.3 m^3/ha). The average yield in Ohio was 101 bushels per acre (8.7 m^3/ha)[24].

The nearest Hamilton County park is the Miami Whitewater Forest located approximately five miles (8.0 km) southwest of the plant site in northwest Hamilton County. The park contains 2031 acres (823 ha) in a natural state for wildlife sanctuaries. The park is well-known for its while-tail deer, predatory birds, and rare plantlife; it also has extensive recreational facilities for the public. Other recreational areas near the plant site include Fort Scott Camps, owned by the Archdiocese of Cincinnati, two miles southeast of the FMPC; and Camp Ross Trails, owned and operated by the Girl Scouts of America, approximately two miles northeast of the plant. The latter campgrounds have historical importance because of Indian earth works preserved there.

The area of Hamilton County is 414 square miles (1073 km^2); Butler County is slightly larger with an area of 471 square miles (1221 km^2). Hamilton County had a population density of 2230 people per square mile (860/km^2) in 1977; Butler County had 480 people per square mile (185/km^2), compared to the State which had a population density of 260 (100 km^2)[19].

According to studies of the Great Miami River Basin area, the basin's population was projected to grow by about 50% from 1960 to 1980, and 100% from 1960 to 2000[27]. It is anticipated that manufacturing productivity will increase at twice the rate of population growth. The studies that forecast this growth were centered around the industrial area between Dayton and Hamilton. Because of the lack of industry in the vicinity, growth in the FMPC area will be much less than that expected for the upstream urban areas. Up to the year 2000, growth in the area from New Baltimore to the Ohio River is expected to be low. Based on these studies and expectations, it appears reasonable to conclude that land availability in the FMPC area will not become critical during the next several decades.

2.1.6 Archeology and Historical Features[7]

Four prehistoric Indian sites listed in the National Register of Historic Places are located within a three-mile radius of the FMPC. The "Adena Circle" and "Demoret Mount" are located on the grounds of Camp Ross Trails two miles (2.2 km) northeast of the plant and are being preserved by the camp owners. The "Colerain work" is a fortification or sacred enclosure surrounding about 95 acres (38.5 ha) in a large horseshoe of the Great Miami River, about one mile (0.6 km) east of the plant. The parapet of these ancient remains is fairly well preserved and in places is 8-10 feet (2.4-3.0 m) high. Nearby, overlooking the Colerain site, is the "Dunlap work", a site with prehistoric origins which is believed to have had later use as well.

The Miami Purchase Association is an independent local historical society which acts as the Southwestern Ohio Regional Preservation Office for the Ohio Historical Society. Records maintained by this local group do not indicate that the area occupied by the FMPC contains any known sites of archaeological importance. A complete archaeological survey of the Paddy's Run area was planned for 1979.

The old village of Whitewater, more commonly known as "Shakers' Town" is situated on the Dry Fork of the Whitewater, in Crosby Township approximately five miles (8.0 km) west of the plant site. It had its origin about the year 1820, with the United Society of Believers, commonly called "Shakers". Originally, this society engaged in some manufacturing and in the raising of garden seeds, but later turned exclusively to farming and expanded their holdings from forty acres to twelve hundred acres in only a few years. They replaced their first log cabins with brick structures which are presently privately owned and well kept landmarks.

The town of New Baltimore, located 2.5 miles (4.0 km) from the plant site, played a role in Civil War history. General John Hunt Morgan and a party of approximately 225 men raided the farm area adjacent to New Baltimore in July, 1863. They stopped at a blacksmith shop operated by Mathias Raisch and forced him to shoe some of Morgan's horses.

The old Raisch farmstead on Flick Road, 1 mi (1.6 km) south of New Baltimore, remains intact. Following his raid, Morgan burned the New Baltimore bridge to delay his pursuers.

Old Fort Dunlap or Colerain Village is located about 2 mi (3.2 km) to the east of this site and on the opposite bank of the Great Miami River. This village and small fort were founded in 1790 by John Dunlap, an immigrant from Colerain in the north of Ireland. Fort Dunlap is principally memorable as the scene of the fiercest and longest sustained Indian attack recorded in Hamilton County. The garrison suffered severe losses and the fort was damaged by fire. The continuous siege lasted more than 24 hours before the Indians retreated. Stone monuments have been erected in that area to mark the location of the old fort.

2.1.7 Ecology

2.1.7.1 Terrestrial Ecosystems. Soils in the region of the FMPC plant have formed in parent materials that were deposited either by the action of Wisconsin and Illinois glaciers or wind action. These materials consist mainly of glacial till but also include sand and gravel and glacial lake and silt clays. The various soils are a result of different parent materials, variations in relief and drainage, and differences in soil age. In many areas where the till consists of the deposits or where severe erosion has occurred, the underlying bedrock is at shallow depths[28,29].

There are four major soil associations in the vicinity of the FMPC plant; these are Russel-Xenia-Wynn, Fincastle-Xenia-Wynn, Rossmoyne-Cincinnati-Edenton-Fairmont, and Fox-Genessee. The soils are usually light-colored, acidic, and well-drained. Most of the soils have resulted from wind-blown material, except along present and old river basins where the Fox-Genessee association soils are of glacial till origin. The soils are moderately high in productivity and are frequently used for cash crops and livestock production[28,29]. Table 2-8 presents an agricultural evaluation of the more common soils in the vicinity of the FMPC plant.

The natural vegetation occurring in the region when the early settlers first came to the area was characterized as the Western Mesophytic Forest Region; the FMPC site lies within the Illinoian Glaciation area of

TABLE 2-8. AGRICULTURAL EVALUATION OF SOILS IN THE VICINITY OF THE FMPC PLANT

Soil	Yield Potential								Truck Crop Suitability
	Corn		Soybean		Wheat		Hay		
	(bu/ac)	(m^3/ha)	(bu/ac)	(m^3/ha)	(bu/ac)	(m^3/ha)	(ton/ac	(ton/ha)	
Russell	105	9.0	36	3.1	40	3.4	4.5	10.1	Good
Xenia	105	9.0	36	3.1	40	3.4	4.5	10.1	Good
Wynn	95	8.2	30	2.6	35	3.0	3.5	7.8	Very Poor
Fincastle	105	9.0	40	3.4	40	3.4	4.0	9.0	Fair
Fox	120	10.3	35	3.0	45	3.9	5.0	11.2	Good
Genessee	130	11.2	50	4.3	55	4.7	6.0	13.4	Good

Source: Reference (7)

this region[30]. There are very few remnants of the virgin forests in existence today and none in the local area. The present-day secondary forests of the region are characterized by a mosaic of forest types; there is no single climax species. The region has a wide variety of upland forest types and alluvial swamps[31]. The southern sweetgum is frequently the dominant species in developmental forest stages. Drier slopes may display remnants of oak-ash-maple forests and have a luxurious herbaceous layer. American beech may form approximately 50 percent of the forest canopy with tuliptree, sugar maple, basswood, black walnut, and white ash as subdominants[30].

Mammal populations in the area are typical of those in southwestern Ohio where the land is generally open and subjected to agricultural practices. A list of species whose range includes the region is presented in Appendix A. The more common species in the area include short-tailed shrew, various bats, fox squirrel, eastern chipmunk, woodchuck, white-footed mouse, house mouse, eastern cottontail, red fox, raccoon, opossum, and white-tailed deer.

Avian populations in the region are diverse and continually changing. About 250 species may be seen in one or more seasons in southwestern Ohio (Appendix A)[32]. During the breeding season, the season of greatest stability in bird populations, there are records of 100 and 99 species nesting in Butler and Hamilton counties, respectively. Some of the most abundant species in the region are mallard, rock dove (pigeon), mourning dove, common flicker, barn swallow, bluejay, tufted titmouse, American robin, starling, yellow-rumped warbler, indigo bunting, house sparrow, and song sparrow[32].

Reptiles and amphibians are also common to the region. There are approximately 27 species of each group whose ranges inclued the area (Appendix A). These fauna are most common in and near aquatic habitats or areas with ground cover (e.g., shrubs and trees). They occur less frequently in areas with high human disturbance, such as business, industrial and urban residential areas. Some of the more common species in the region are painted turtle, box turtle, eastern garter snake, black rat snake, two-lined salamander, American toad, and northern leopard frog.

2.1.7.2 Aquatic Ecosystems. Aquatic invertebrate populations in the Great Miami River are characteristic of those of stressed streams. Benthos, from approximately Dayton, Ohio (upriver), to the confluence with the Ohio River is characterized by species which are considered pollution-tolerant(33). Further upriver, above Dayton, pollution-intolerant species are much more common.

Fish population in the lower portions of the Great Miami River contain low proportions of sport and pollution intolerant species(34). Sport fishes are principally sunfish species while the rough and forage fishes are mainly carp, goldfish, and shiners.

2.2 Characterization of the Plant Site

2.2.1 Air Quality

Air contaminants at the FMPC can be divided into two groups: non-radioactive and radioactive. Non-radioactive contaminants emitted during FMPC operations are primarily particulates (including fluorides and carbonates), sulfur dioxide, and nitrogen oxides. Although not included in this list of emissions, concentrations of oxidants and aldehydes have been monitored at the boundary of the FMPC for one season. The radioactive contaminant parameters for which determinations have been made at the boundary include uranium, thorium, gross alpha activity, and gross beta activity.

For environmental monitoring purposes, the DOE criteria for air in uncontrolled areas are used as standards. At the FMPC, these criteria for offsite or ambient air are compared with samples taken at the plant boundaries. Plant boundary samples are also used in determining compliance with ambient standards for the non-radioactive contaminants. For these pollutants, the air standards used are those established by the Ohio Environmental Protection Agency (OEPA).

Results of monitoring done during the years 1977 through 1979 have shown that the ambient concentrations for both non-radioactive and radioactive contaminants have been within the standards.

2.2.1.1 Particulates. The concentrations of total suspended particulates measured at six stations around the boundary of the FMPC are presented in Table 2-9. Location of these stations is shown in Figure 1-10. Particulate measurements are taken every week for a sampling period of one week. No annual average concentration in years 1977-1979 equaled the annual ambient standard of 60 $\mu g/m^3$ (35,36,37). In 1980, the standard was changed to 75 $\mu g/m^3$. Concentrations at the stations were relatively consistent over the three years with no decreasing or increasing trends. The FMPC contribution to ambient air particulate matter cannot be assessed from the data. Except for the monitoring station at BS3, all these boundary stations are located near roads where traffic dust is generated. Moreover, BS4, BS5, and BS6 are located near fields where periodic farming activities produce high dust levels.

2.2.1.2 Nitrogen Dioxide. Measurements of NO_2 concentration were made at boundary site BS2 between 1974 and 1977. This site is located to the northeast of the plant site and is thus downwind of the production operations where oxides of nitrogen are emitted. Samples were taken periodically throughout the years for 24-hour periods. Average concentration ranged from 22-44 $\mu g/m^3$ (35,38,39,40); the OEPA annual ambient standard is 100 $\mu g/m^3$. Nitrogen dioxide concentrations are no longer measured.

2.2.1.3 Sulfur Dioxide. Steam is generated at the FMPC facility by combustion of coal. Low-sulfur coal is being burned in the steam plant (37). Measurements of this pollutant were made at sampling site BS2 during 1974 (1) for the City of Cincinnati as a check on ambient SO_2 levels in a rural environment. These were 24-hour samples made primarily in the first quarter of that year. The average 20 samples was 23 $\mu g/m^3$ which was about one-third the OEPA annual ambient standard of 60 $\mu g/m^3$. A maximum 24-hour concentration of 100 $\mu g/m^3$ was measured and this is also well within the 24-hour standard of 365 $\mu g/m^3$.

TABLE 2-9. AMBIENT CONCENTRATIONS OF NON-RADIOACTIVE CONTAMINANTS AT THE FMPC BOUNDARY, 1977-1979[a]

		Individual Samples 1977-1979		Annual Averages						
				1977		1978		1979		Standard (Annual Ambient)
Contaminant	Sampling Point	Maximum (μg/m³)	Minimum (μg/m³)	No. of Samples	Avg. Conc. (μg/m³)	No. of Samples	Avg. Conc. (μg/m³)	No. of Samples	Avg. Conc. (μg/m³)	(μg/m³)
Particulates	BS 1	164	21	52	46	52	47	48	49	60
	BS 2	105	22	52	45	52	52	49	42	
	BS 3	106	19	51	47	52	47	49	34	
	BS 4	110	15	52	53	52	52	49	47	
	BS 5	106	12	52	49	51	48	49	42	
	BS 6	115	10	51	49	52	53	46	43	

[a] Source: References (35), (36), and (37)

60

74

2.2.2 Water Quality

Liquid discharge from the site consist of treated process and sanitary effluents and storm water. A permit to discharge liquid effluents, has been issued to the FMPC by the U.S. Environmental Protection Agency. The permit was issued under the National Pollutant Discharge Elimination System (NPDES) and it contains maximum and average limits for 18 parameters at four plant locations. Schedules for sampling are specified and results are reported to the EPA on a quarterly basis. The limits shown in Table 2-10 became effective in 1980.

2.2.2.1 Regional Water Quality. Regional water quality is indicated in Appendix B, Tables B-1 and B-2 which lists data for 1979 obtained by the U.S. Geological Service at their water quality monitoring stations on the Great Miami River at Miamisburg, Ohio, about 35 miles (56 km) upstream of FMPC, and at New Baltimore which is approximately 3.5 river miles (5.6 km) downstream from FMPC. The station at New Baltimore is a National Stream-Quality Accounting Network (NASQAN) station[43]. The major water quality problem stems from low dissolved oxygen and ammonia toxicity as a result of municipal and industrial waste discharges. Plant nutrients are in a concentration range which may promote excessive algal growth. Heavy metals do not appear to be a significant factor in the water column. The hard water, high alkalinity characteristics of the Miami, would result in the precipitation of heavy metals. Sedimentation would then occur in pools and scouring would take place during storm flows.

Fish surveys and benthic studies have been conducted on the Great Miami River and its tributaries by the Miami Conservancy District[44]. Most of the work has been done in the upper reaches where the pollution load is greatest. Results show that the fish population and game-fish species decrease sharply in the Dayton area and then remain stable, at the reduced level, from that point to the backwater pool at the junction with the Ohio River.

2.2.2.2 Monitoring Activity. Water samples are collected at several points to determine the effect of the FMPC effluent upon the river.

TABLE 2-10. APPLICABLE STANDARDS FOR POTENTIAL WATER POLLUTANTS IN RECEIVING WATERS AND EFFLUENT DISCHARGES

	Federal or Ohio[a]		DOE[b]	NPDES	
	Drinking Water	All Waters		Daily Average	Daily Maximum
Radionuclides (μCi/L)[c]					
Cesium - 137			2×10^{-5}		
Neptunium - 237			3×10^{-6}		
Plutonium - 238			5×10^{-6}		
Radium - 226	5×10^{-6}		5×10^{-6}		
Radium - 228			3×10^{-8}		
Ruthenium - 106			3×10^{-8}		
Strontium - 90			1×10^{-5}		
Technetium - 99			3×10^{-7}		
Thorium			3×10^{-4}		
Uranium			1×10^{-6}		
Gross Alpha Activity	15×10^{-6}		2×10^{-5}		
Gross Beta Activity (mrem/yr)	4				
Non-Radioactive Parameters (mg/L)[d]					
Total Suspended Solids				20(e,f), 30(h,j)	60(e), 40(f), 100(h,j)
Total Suspended Solids (kg/da)				5(f), 6.2(g)	10(f), 12.8(g)
Nitrate (N) (kg/da)				1590(e), 62(i)	3180(e), 124(i)
Ammonia (N) (kg/da)				28(e), 12(i)	43(e), 18(i)
Oil and Grease				--	15(e,h,i)
Total Residual Chlorine					0.10(e)
BOD, 5-day				20(f)	40(f)
BOD (kg/da)				5(f)	10(f)
Chromium (+6) (kg/da)				0.004(g)	0.008(g)
Chromium (total) (kg/da)				0.050(g)	0.102(g)
Iron (kg/da)				0.41(g)	0.85(g)
Nickel (kg/da)				0.124(g)	0.256(g)
Copper (kg/da)				0.025(g)	0.051(g)
pH				--	10(e), 9(f,j)
Fecal Coliform (#/100 mL)	1				
Cadmium		0.012			
Lead		0.03			
Mercury		0.00005/.0002			
Cyanide		0.025			
Dissolved Oxygen		4.0			

(a) Source: Reference (41)
(b) Source: Reference (42)
(c) Values in microcuries/liter except as noted
(d) Values in milligrams/liter except as noted
(e) Total discharge, Manhole 175
(f) Sanitary treatment plant
(g) General sump and Clearwell combined
(h) Stormsewer lift station
(i) Bioreactor
(j) Storm water overflow

Locations are shown in Figure 1-10. At point W1, upstream from the effluent discharge, a daily grab sample is collected. At the final access point on the waste line, W2, a Parshal Flume type water sampler continuously collects a sample which is proportional to the total flow. Twenty-four-hour samples from this point are collected daily for analyses. Results of these analyses, combined with river flow measurements, are used to calculate the average contaminant concentrations added to the river at point W2. At point W3, downstream on the river from the discharge point, 24-hour samples are collected by a continuous sampler. Point W4 is at Miamitown, 4.7 mi (7.5 km) downstream from the mouth of Paddy's Run. Grab samples are collected weekly at this point. Paddy's Run is a small stream which flows along the site's west edge and joins the Miami River about 2 miles (3.2 km) away from the FMPC southern boundary. Surface runoff from rain falling on the production area can be intercepted near the south end of the project and pumped into the Miami River through the same effluent line bearing normal process wastes. The initial portion of all rainfall, which is potentially contaminated from the process operations, is diverted in this manner. During periods of heavy runoff, excess water in the storm sewer system overflows to a drainage ditch which discharges into Paddy's Run. Under normal conditions, all water reaching the storm sewer lift station is pumped to the line which leads to the Miami River. It is unlikely that the intermittent flow of storm water would have any effect on river water quality since it contains no process water discharges.

Operations at the FMPC do not cause any state standard for non-radioactive contaminants to be exceeded in the river. The contaminants listed in Appendix B, Table B-3, were selected for analysis and reporting because of the possibility of adding to the river concentrations greater than 1 percent of the applicable state standards. Appendix B, Table B-4, contains a summary of pH data.

2.2.2.2.1 NPDES Compliance. Compliance with NPDES limitations during 1979 is summarized in Appendix B, Table B-5. Currently, FMPC is in compliance with most NPDES limitations in effect at MH-175. Two chloride violations were due to precipitation runoff carrying dissolved road salt applied to the roads in winter. Suspended solids violations were due to runoff carrying soil into the clearwell. The effect, if any, on the river has not been determined. FMPC was in compliance with all other NPDES permit conditions.

2.2.2.2.2 Sewage Plant Effluent. Effluent from the FMPC sewage treatment plant is combined with other effluents at MH-175. Prior to discharge from the treatment plant, however, the effluent is carefully monitored and sampled to determine efficiency of operation and compliance with all applicable standards. The comparison in Appendix B, Table B-6, shows that FMPC sewage treatment effluent far surpasses the requirements, in all parameters, of the federal EPA secondary treatment regulations (40 CFR 133.102).

2.2.3 Radiation Levels

2.2.3.1 Air. The operations which convert impure uranium and thorium compounds to reactor-grade feed materials generate radioactive dust. Air cleaning systems filter and scrub the air from these operations and then exhaust the cleaned air to the atmosphere. The particulate samples collected each week by the six samplers at the FMPC boundaries are analyzed for uranium and for alpha and beta radioactivity. A total composite is analyzed once annually for thorium. Appendix Tables C-1 and C-2 present the complete results of these analyses for 1977 through 1979. The maximum average airborne uranium concentrations at the six stations was 0.7 percent of the DOE standard for offsite areas during 1977-1979. The maximum average thorium, gross alpha and gross beta concentrations were 0.004, 0.5, and 0.07 percent of the DOE standards, respectively.

Methods are being investigated for determining the concentration of radon-222 at the site boundary. Preliminary sampling indicates concentrations up to 0.6 picocuries per liter (pCi/L). A long-term average may be about 0.3 pCi/L, which is 10% of the DOE limit for uncontrolled areas. The naturally-occurring background concentration of radon-222 in this region is about 0.1 pCi/L.

2.2.3.2 Water. Samples collected from the Great Miami River for water quality analyses (Section 2.2.2.2) are also used in analyses for radionuclides. As shown in Appendix C, Tables C-3, C-4, and C-5, radium was the radionuclide present at the greatest percentage of the specified limits.[42] Radium-226 and radium-228, combined from the FMPC amounted to 0.02 percent of the limit for water in uncontrolled areas. There is no known downstream use of the River as a potable water supply.

The addition of gross alpha and gross beta radioactivity to the River during 1977-1979 was not detectable. Gross alpha and gross beta show an increase downstream in Paddy's Run but are below DOE standards for uncontrolled waters.

Sediment samples were collected from the banks of the Miami River and analyzed for uranium to determine if material was accumulating below the site outfall. Sediment from the river bank, near the water line, was collected by scraping up the top 2 inches. Only the portion passing a 50-mesh screen was analyzed. The results of sediment sampling, given in Appendix C, Table C-6, do not indicate any buildup of uranium along the edge of the water where settling might be expected to occur. Most of the uranium present in the site effluent is soluble, probably existing as a carbonate complex. Periodic flooding, which is severe enough to cause channel alteration and bank erosion, scours the river bed and banks and prevents any long-term sediment accumulation.

2.2.3.3 Soil. Soil samples are collected annually near the six boundary air sampling stations (Figure 1-10) to check for uranium from stack effluents. Each sample consists of six cores 2 cm in diameter and 10 cm deep. Results of analyses are published in annual monitoring reports and are summarized in Appendix C, Table C-7. The concentrations in the soil samples are above the normal concentration of uranium in the local area (1-4 μg/g)[40]; however, there are no standards for comparison. There are no hazards associated with the increased concentrations caused by the FMPC. External radiation from uranium is slight and the exposure contribution from the boundary concentration would be considerably less than one percent of the Radiation Protection Standard for people in uncontrolled areas.

Uranium deposited on the ground will slowly be solubilized and transported as surface water percolates through the soil. The rate of movement depends on many factors, including the amount of precipitation, uranium compounds involved, soil carbonate content, and the amount of organic material in the soil. The amount of movement in an undisturbed location near boundary sampling station No. 3 (see Figure 1-10) is shown in Appendix C, Table C-8. Surface deposition began about 25 years ago and peaked about 15-20 years ago. It appears that the vertical movement of uranium through the soil has been about 0.5 inch (1.3 cm) per year.

2.2.3.4 Radiation Dose Estimates. During 1976, the highest average concentration of airborne uranium found at the FMPC site boundary was 9.6×10^{-15} μCi/ml, at boundary station BS-3 (see Figure 1-10). The radiation dose to the lungs which would have been received from this concentration was calculated using a methodology based on transport and uptake models[45]. This method yields a 50-year dose commitment of 7.3 mrems, assuming the year-long inhalation of airborne uranium at a concentration of 9.6×10^{-15} μCi/ml. Thorium, at an average concentration of 4.4×10^{-17} μCi/ml adds 0.5 mrem to the 50-year lung dose commitment. Exposure data for 1979 is summarized in Table 2-11.

The Great Miami River is not used as a source of drinking water but calculations of 50-year dose commitments were made assuming an individual took water from a location downstream from the FMPC discharge point. A daily intake of 2.2 liters (2 quarts) per day was assumed.[45] This intake for a full year would result in a 50-year dose commitment of 0.3 mrem to the bone and 0.03 mrem to the total body.

Throughout 1979, gamma radiation at the six boundary sampling stations was measured with thermoluminescent dosimeters which were changed and processed every three months. (Results are given in Appendix C, Table C-1.) The maximum annual average, 0.015 mrem/hr, was measured at BS-6. Background radiation in the general area around the FMPC is about 0.009-0.010 mrem/hr, as indicated by the data for BS-2 and BS-4, which are both located about 4000 feet (about 1220 m) away from the nearest production or storage building. If 0.009 mrem/hr at BS-6 was due to FMPC operations, the maximum annual dose at the boundary would have been 0.052 rem. This is 10 percent of the DOEM-0524 limit for a dose to individuals at points of maximum probable exposure[42].

The residence closest to the center of the production area is located near boundary station BS-1. The average uranium concentration at this station during 1979 was 6.7×10^{-15} μCi/ml. Diffusion equation calculations[37] yield an average uranium concentration, and assuming an occupancy time factor of 80 percent, an annual whole body dose of 8 mrem was calculated. This is 1.6 percent of the standard[37].

TABLE 2-11. SUMMARY OF 1979 EXPOSURE DATA

Type of Exposure	Dose Estimate	% of Standard	Radiation Protection Standard (a)
"Maximum potential" dose due to direct radiation from FMPC operations.	0.052 Rem	10	0.5 Rem
"Maximum indiviual" whole-body dose due to direct radiation from FMPC operations.	0.008 Rem	1.6	0.5 Rem
"Population group" 50-year whole-body dose commitment from airborne uranium and thorium.	0.00003 Rem	0.02	0.17 Rem
"80-km" 50-year whole-body dose commitment from airborne uranium and thorium.	3.6 person-Rem	–	–

(a) Source: Reference (42)

River water is not used as a drinking water supply but it is possible for the residents to have an additional uranium intake if they consume a significant quantity of locally-grown vegetables. The average concentration of uranium found in vegetables grown near the FMPC is 0.016 micrograms per gram wet weight. Assuming that a resident would consume an average of one-half pound (0.22 kg) per day of fresh or home-canned vegetables, an ingestion of 1.3 mg would result. The following 50-year dose commitments were calculated for this intake:

Reference Organ	Dose, mrems
Total body	0.04
Bone	0.7
Kidney	0.02
G.I. Tract	0.05

The community of Ross, Ohio, is located about 2.5 miles (4.0 km) from the center of the FMPC production area. Because of distance and wind direction frequency, boundary station BS-3 is the sampling location which would give the best indication of contaminants moving towards Ross. Starting with the concentrations at BS-3, diffusion equation calculations give average concentrations at Ross of 1.55×10^{-15} μCi/ml and 0.71×10^{-17} μCi/mL for uranium and thorium respectively. If a time occupancy factor of 80 percent is assumed, the calculated 50-year dose commitments for the Ross population group are:

Organ	Dose, mrem
Lung	1.0
Kidney	0.5
Bone	0.3
Total Body	0.03

The total population within an 80-km radius of the FMPC is 2.5 million. The total 50-year whole body dose commitment due to airborne uranium and thorium for this group is 3.6 person-rem. For this same population, the whole body dose due to natural radiation is 200,000 person-rem per year[37].

2.2.4 Ecology

2.2.4.1 Terrestrial Ecology.

2.2.4.1.1 Soils. Soils at the FMPC site are primarily categorized as Fincastle-Xenia silt loams (Figure 2-10)[28]. 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 18-40 inches (45-101 cm) of loess over limy loam till of Wisconsin age. Fincastle soils have poor drainage; and, in areas where this soils is 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 cover large areas west of the FMPC.

Soils along Paddy's Run are categorized as Fox-Genessee 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 24-40 inches (60-101 cm) of silty materials over sand and gravel on level areas of second bottoms. Genessee soils occur on first bottoms. These are well drained, high in moisture-supplying capacity, and are subject to flooding[28].

Soils in a small area on the north side of the site are classed as Russell-Xenia-Wynn[29]. The topography is sloping. These upland soils are light colored and medium acid. The soils have formed in 18-40 inches (45-101 cm) of wind-blown silty material on limy loam glacial till.

2.2.4.1.2 Flora. Vegetation growing on the site is typical of that normally occurring in this region under similar land-use practices. Four major vegetational communities occur on the FMPC site (Figure 2-11); these are grazed areas (pasture) along the east, south and north sides, mowed area along the northeast portions, wooded areas along the stream beds and on the north side and forb-shrub area near Paddy's Run and in the northwest portion. Herbaceous vegetation in the mowed and pasture areas is similar in composition, with fescue being the dominant species. As a result

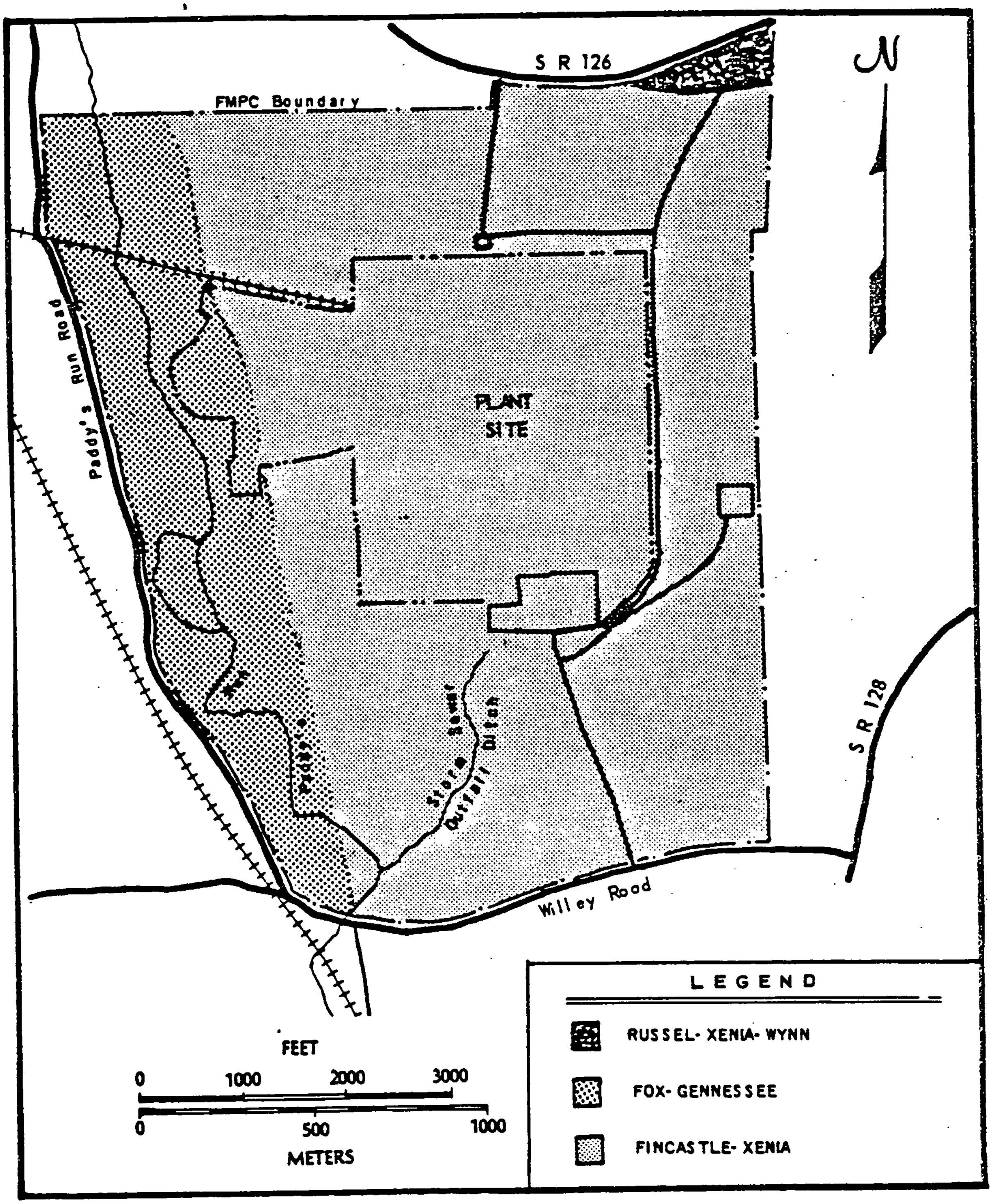


FIGURE 2-10. SOIL ASSOCIATIONS OCCURRING ON THE FMPC PLANT SITE

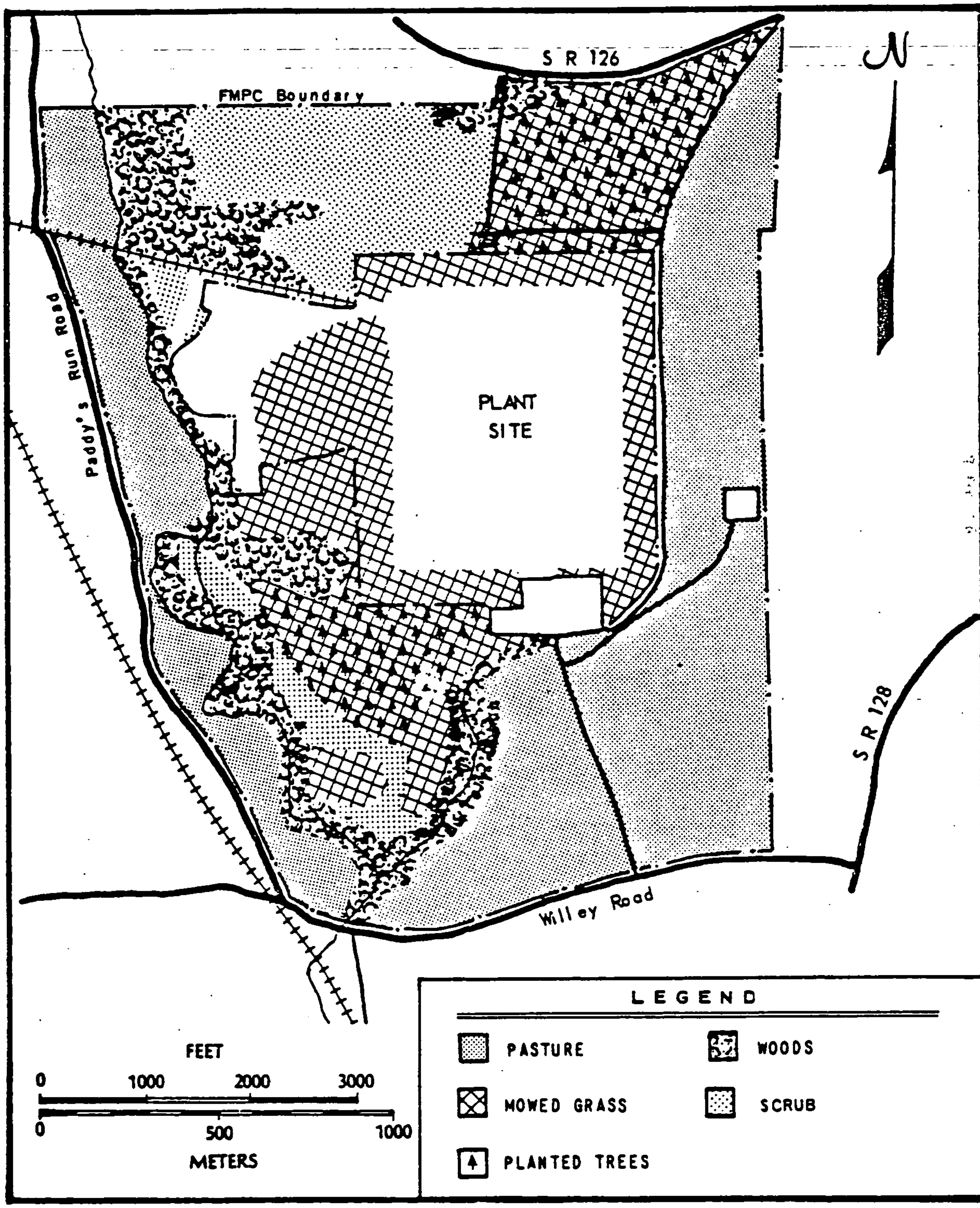


FIGURE 2-11. VEGETATION TYPES OCCURRING ON THE FMPC PLANT SITE

of grazing, the vegetation in the pasture area is normally maintained at a lower height and plant density is reduced. Scattered trees occur in the grazed areas. The mowed vegetation in the central portion of the site is more dense than in the pasture due to less compaction. Portions of the mowed areas outside the inner fence were planted with approximately 131,000 tree seedlings in 1972; white pine, Austrian pine, and Norway spruce were used[7]. Grass is mowed to reduce competition among the seedlings, most of which are two feet (60 cm) or less tall.

Shrub areas have as common woody species black locust, box-elder, white ash, black cherry, and dogwood; other woody species present are listed in Appendix A, Table A-1. Common forbs in these areas are goldenrod, Queen Anne's Lace, thistle, and teasel. A partial list of the herbaceous species growing on the site is presented in Appendix A, Table A-2.

Woodlands are of two types on the site: upland and riparian. Upland woods are generally dominated by white ash which commonly has the largest individuals. With the exception of the woods in the northeast portion of the site, most woodlands have very few large trees, i.e., greater than 15 inches (38 cm). Most of the upland woods are dominated by trees with 3-8 inches (8-20 cm) size class and have numerous species. Other common tree species in the uplands are black and sugar maples, black locust, black walnut, and Kentucky coffee tree.

Riparian woods occur in a narrow band along Paddy's Run and the storm sewer ditch. The dominant and most abundant species in this woodland type is the sycamore. Cottonwood is the second most abundant species. Other common species present include black willow, black locust, and boxelder.

The vegetation occurring on the FMPC site is typical of the Western Mesophytic forest region as typified by second growth forest dominance of sycamore and white ash. The small woodlots with open area and maintained grasslands are also typical of the region.

2.2.4.1.3 Fauna. Mammal populations at the Feed Materials Production Center are typical of those in southwestern Ohio where the land is generally open and subjected to agricultural practices. The most common species of native mammals on the site include white-tailed deer, eastern cottontail, fox squirrel, eastern chipmunk, woodchuck, and raccoon[47]. A list of mammal species observed on the site is indicated in Appendix A,

Table A-3. Most of the populations of native mammals are centered around the areas with trees and shrubs. These areas provide cover and denning areas for species which often range into other habitats during foraging activities. Deer, cottontail and woodchuck in particular use the grassy areas for feeding. The deer population level in the area is low and is typical of this region of Ohio(48); a regional exception is the Miami Whitewater Forest, a Hamilton County, Ohio, park 5 miles (8 km) southwest of the site, which serves as a wildlife sanctuary. Rabbit populations on the site are similar to those expected in the surrounding area but may be slightly lower due to extensive mowing or grazing over much of the site. Average density is probably slightly less than one per acre (two per hectare)(49). Squirrels and chipmunks are found primarily in association with the woody vegetation. Southwestern Ohio is part of the primary range of fox squirrels in Ohio and they are common in the wooded areas of the site; gray squirrel populations are low in this region except in urban areas(50). Raccoon and skunk are mainly in the wooded areas and along the streams but will range into the open fields in search of insects, fruits and other items for food.

Several species of small mammals occur on the site. Species expected to be common are white-footed mice in wooded and shrub areas and meadow voles in the mowed areas. Other species anticipated are the short-tailed shrew, prairie deer mouse, and meadow jumping mouse. Several species of bats can be expected to forage over the site and some may roost in trees on the site.

Livestock is pastured on approximately 325 acres (131 ha) of the site. Most of the site used for pasture is grazed by dairy cattle except for one small area on the northwest portion which is grazed by about 20 beef cattle. Average annual milk production from the cattle pastured on the site is about 18,500 pounds/cow (8,400 kg/cow). This is considerably higher than the average for either Hamilton or Butler counties where the averages were 11,000 pounds/cow (4,987 kg/cow) and 12,280 pounds/cow (4,475 kg/cow), respectively(51).

Bird populations in the area of the FMPC site are diverse and species change seasonally (Appendix A, Table A-4). A total of 50 different species have been recorded during summer surveys on the FMPC site, including 39 during breeding bird surveys (Appendix A, Tables A-5 and A-6). Species judged to be very common based on the number observed during the roadside survey were the American robin, house sparrow, eastern meadowlark, and indigo bunting. Three species, the chimney swift, common flicker, and common grackle, were considerably less numerous than expected based on their relative abundance in the Hamilton County Part District[32].

Surveys indicated the most numerous birds associated with each of the four habitat types. The most abundant species recorded on grazed pasture transects were starlings and eastern meadowlarks. Grasshopper sparrows and eastern meadowlarks were the most prominent species in the weedy fields planted with small conifers. Fields overgrown with weeds, shrubs, and young trees supported relatively high numbers of gray catbirds, American goldfinch, and field sparrows. The mature riparian woods along Paddy's Run provided habitat for the greatest number of species[30]. The starling was by far the most numerous species in this riparian habitat, but the woods along the stream also had fair numbers of common crows, cardinals, and indigo buntings.

One species, the grasshopper sparrow, was much more numerous in the weed-and-small-conifer transects than expected based on the abundance of that species in the Hamilton County, Ohio, Park District[32]. This species has shown recent decreases in populations throughout the state[52].

A few orchard orioles were observed in the weed-shrub-tree transects. This species is considered rare in Ohio[52] but is reportedly fairly common in the Hamilton County Park District[32].

Reptile and amphibian populations on the site appear to be low due to grazing or mowing of much of the area. Most of these animals present will occur primarily in the woods, along the stream and the small pond on the south wide. The only herpetiles observed were the box turtle near a wooded area and tadpoles in a small pond. Few turtles, except the box turtle, or salamanders are to be expected because of the dry upland habitat and the intermittent nature of the streams on site. Turtles are present in the Great Miami River. Species of amphibians one may expect to encounter on the site include American toad, Fowler's toad, spring peeper, green frog, leopard frog and pickerel frog; snakes expected to be present include the black snake, eastern garter snake, and northern water snake (Appendix A, Tables A-7 and A-8).

2.2.4.2 Aquatic Ecosystems.

2.2.4.2.1 Benthic Macroinvertebrates. A total of 19 species of benthic organisms have been collected from the upstream portion of Paddy's Run (Figure 2-12), Appendix A, Table A-9, an intermittent stream on the west side of the site[41]. Most of the stream bed on the plant property is usually dry. The dominant organism was a caddisfly larva, Cheumatopsyche sp. Relatively large numbers of caddisflies, Hydropsyche sp. and Chimarra sp., were also present in the collections. The remainder of the samples were comprised of mainly six species of midge larvae, a mayfly larva, Baetis sp., two types of water beetles, and a species of crayfish. Species diversities, calculated according to the Shannon-Weaver index, were not very high. These values fall within the range indicative of intermediate stream quality[33].

Invertebrates have also been sampled in the Great Miami River upstream and downstream from the plant outfall (see Figure 2-13). The samples were collected over three types of substrate[47]. The riffle areas in the river support lush growths of aquatic macrophytes. Samples were also collected over Cladophora beds and over sand-gravel at all three locations. A third sample area was over one of several available plant types--Potamogeton crispus (curly pondweed), Potamogeton sp. (another type of pondweed), and Myriophyllum sp. (water milfoil).

In all cases, samples taken over the plant-covered substrates contained larger numbers of individuals (Appendix A, Table A-10). Potamogeton spp. and Myriophyllum sp. appeared to support slightly more organisms than did the Cladophora.

Collections made upstream and downstream of the plant outfall appeared very similar in numbers of species, species composition, and species diversity. A total of 19 species were collected. Thirteen species were collected upstream of the plant outfall; 18 species were collected

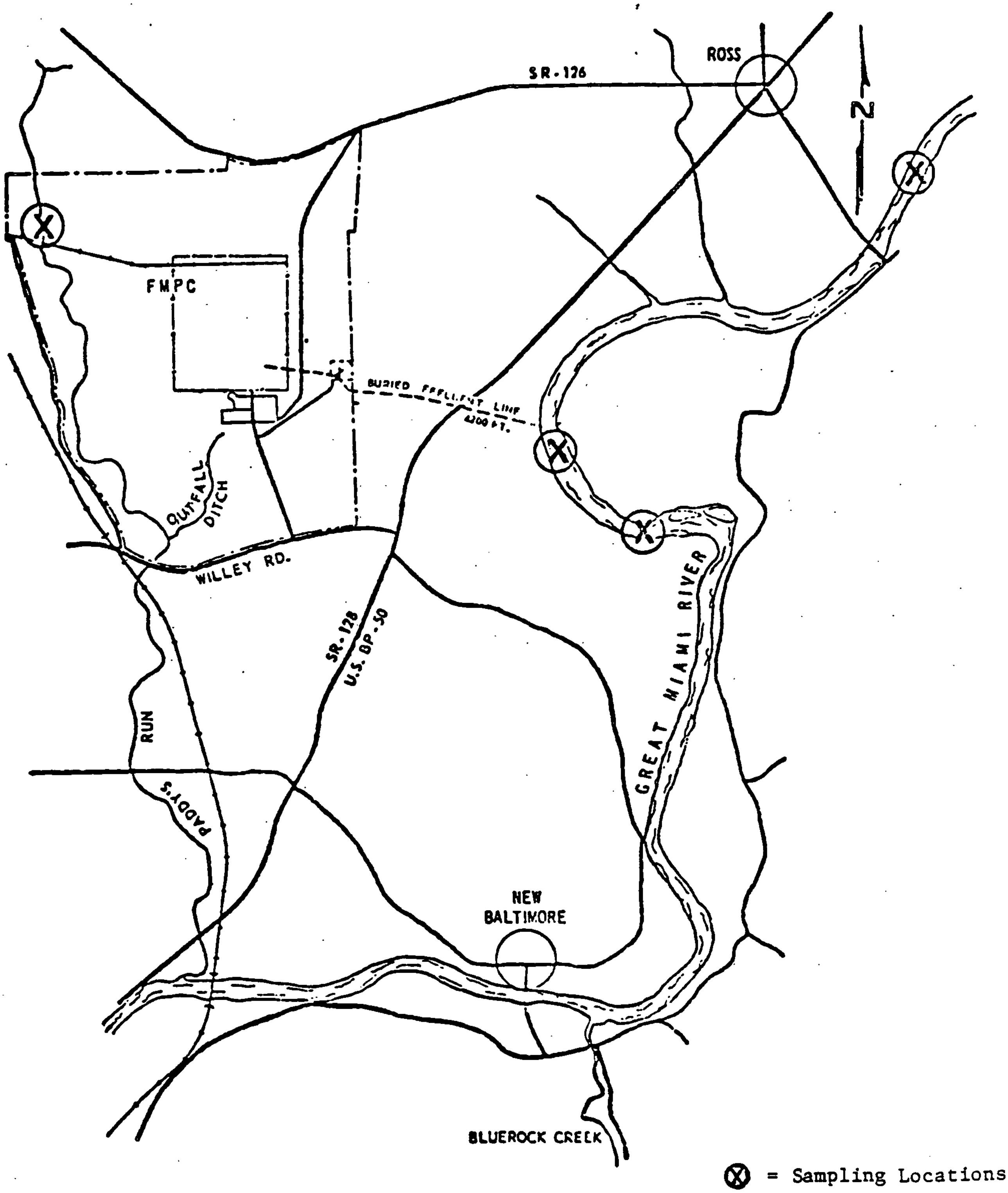


FIGURE 2-12. AQUATIC BIOTA SAMPLING LOCATIONS IN THE VICINITY OF THE FMPC PLANT SITE

downstream. The dominant organisms in all collections were caddisfly and midge larvae. Five species were collected downstream which were not found upstream. However, these organisms were collected in very small numbers.

Species diversities at both upstream and downstream locations are within ranges indicative of intermediate to good biological quality(53).

2.2.4.2.2 Fish. Fish collections from Paddy's Run contained a total of nine species of fish(47). A list of these species and their relative abundance is presented in Appendix A, Table A-11. The two dominant species, creek chub and orangethroat darter, occurred in large numbers. The presence of large numbers of fish and the occurrence of a variety of species indicates that Paddy's Run is a fairly clean water stream. The presence of grazing cattle may alter stream morphology somewhat and add excessive nutrients; however, these conditions do not appear to affect the fish populations in this area of the stream.

Fish collections from the Great Miami River near the FMPC outfall contained 16 species; 14 were collected upstream and 15 downstream. A list of the fish species collected is presented in Appendix A, Table A-12. The river carpsucker was found upstream but not downstream; however, only two specimens were collected. Similarly, the two species (longnose gar and orangethroat darter) collected downstream and not upstream were each represented by a single specimen(47).

Fish populations in both these areas were quite similar. The spotfin shiner was the dominant forage fish in upstream and downstream areas. The green sunfish and bluegill were the only sport fish collected but occurred in both zones sampled.

While similar species and numbers of fishes were collected above and below the plant discharge, the near total absence of darters (a clean water riffle species) and sport fish (bass, catfish, bullhead and sunfish) indicates the Great Miami River has been environmentally stressed. The large, wide riffle areas should be inhabited by several darter species(54). The turbid water and siltation over the bottom substrates may have an adverse effect on darter populations in this area. The lack of cover, such as dead trees, brush, rock outages, and undercut banks, may partially explain the absence of sport fish in this area.

2.2.4.3 Threatened and Endangered Species. No species of vegetation included on the proposed federal list of endangered or threatened plants[55] is known to exist on the FMPC site. Current land practices on the site (e.g., grazing and mowing) will act to reduce the likelihood of any occurring.

Three species of mammals classified as endangered by the Ohio[56] and the United States[57] governments have ranges which include the FMPC site. These are the bobcat, river otter, and Indiana bat. All three are listed by Ohio; only the Indiana bat is on the U.S. endangered list. Neither the otter or the bobcat is to be expected in the region due to lack of suitable habitat. There is a slight possibility that the bat may at some time pass over the site during migratory or feeding activities. There are not suitable locations on the site for the bats to use as roosting or resting areas as they require caves.

No federal or state threatened or endangered bird species were observed on the site during the two days of surveys in June. In fact, habitats available on the property are not suitable as breeding or over-wintering habitat for any of the federally threatened or endangered bird species known to occur in Ohio. Although only remotely possible, one or more of the seven species of birds considered endangered in Ohio[56] could stop briefly on the property during migration. One of these seven species, the upland sandpiper, is a bird of open pastures that has been rarely seen during the summer in the Hamilton County Park District[32] and could possibly occur in the pasture on the site.

No threatened or endangered species of fish on either the federal[57] or state[56] lists are known or expected to occur on the FMPC site or in the local stretches of the Great Miami River due to the intermittent nature of Paddy's Run and to degraded state of the river.

2.2.5 Socioeconomic Effects, Local Communities

The FMPC is a major employer in the area, providing jobs for 572 employees. As of September, 1980, employment records showed 182 professional and administrative personnel, 257 production and related personnel, 90 technical and clerical personnel, and 43 service personnel, for a total of 572. The total plant payroll for 1979 was $9,408,793.

In 1979, orders were placed with over 600 local business firms and manufacturers. The value of local orders exceeds 2.4 million dollars annually. The total value of orders placed is over 6.7 million dollars annually.

FMPC employees participate in community services with contributions to United Appeal of nearly $20,200 in 1979, with other contributions by direct individual donations. The plant sponsors Junior Achievement (Hamilton, Ohio) with three NLCO employee counselors.

The impact of the FMPC on local communities is summarized below:

(a) The plant provides employment for 572 people

(b) The total annual payroll for 1979 was 9.4 million dollars

(c) Orders were placed with over 600 local business firms in 1979, totaling approximately 2.4 million dollars.

(d) The company and its employees made donations of money and manpower to local service and charitable organizations.

There are two large consolidated public school systems in the near vicinity of the plant site. The Ross Local School District has four schools, about four miles to the northeast. Total enrollment is 2700. The Southwest Local School District has seven schools to the south and west of the plant. The total enrollment of these schools in 1979-1980 was 3100. Because the FMPC is a government-owned facility, no land taxes are paid to the counties. However, local school boards do receive funds from government based on the number of "federally-connected pupils" in relation to the plant.

3.0 POTENTIAL ENVIRONMENTAL IMPACTS

This section considers the potential impacts of the FMPC plant on the environs. Construction activities, effluents, and potential accidents are discussed.

3.1 Construction

No construction is currently taking place at the FMPC plant that has potential for significant environmental impact and no major construction activity is currently being planned.

3.2 Operations Impacts

3.2.1 Non-Radioactive Releases

The levels of all the airborne contaminants are below the applicable state standards at the FMPC boundary (see Table 2-9). Particulate emissions from the steam plant stack are controlled by electrostatic precipitators. Sulfur dioxide levels are currently being controlled by burning low sulfur coal.

Liquid effluents transport several organic and inorganic compounds beyond the boundaries of the FMPC. These originate in the production plants, sanitary sewage and surface water runoff. A list of monitored parameters and their 1979 concentrations is shown in Appendix B, Table B-5. The suspended solid levels in the storm sewer outfall may occasionally be high during periods of heavy rainfall when surface runoff transports soil particles into the sewers. FMPC operations do not cause any standards to be exceeded in the river.

As a result of the current waste management policies at the FMPC, operations of the plant have no significant impacts upon the surrounding area.

3.2.2 Radioactive Releases

Radionuclides are released from the plant in both air and water. The air contaminants are thorium and uranium in particulates which escape from the plant. All buildings are ventilated and the air filtered before discharge; the filters have an efficiency greater than 99 percent. Concentrations of these elements are less than one percent of the standard and results of analyses for alpha and beta radioactivity in 1979 are presented in Appendix C, Table C-3.

Liquid effluents contain traces of 11 radionuclides (see Appendix C, Table C-5). These come from the various plants effluents, particles washed into the sewage systems from laundry and cleaning procedures; surface runoff transports some particulates into the storm sewer system while other small amounts may enter the local streams. Quantities entering the streams and stream levels are well below the minimum levels for unrestricted public use and are expected to remain so.

3.3 Accidents

Volatile radioactive compounds are not used or produced at the FMPC and it is not likely that an accident involving radionuclides would have any significant offsite consequences.

In a worst case accident, an accidental release of hydrogen fluoride could produce offsite concentrations high enough to cause some effect in humans. The effects offsite would depend on the release rate and the total quantity released. It is likely that offsite concentrations would not exceed a level which could be tolerated for a short period[58]. Vegetation in the immediate release area could be adversely affected. A transient effect would be expected if a release resulted in a high fluoride concentration being discharged to the Great Miami River. However, facilities for spill prevention and flow diversion would provide good control of leaked chemicals. Plant emergency procedures exist to control such an accident and plans to minimize exposure and damage have been established.

4. COORDINATION WITH FEDERAL, STATE, LOCAL OR REGIONAL PLANS

4.1 Current Operations

The land areas of Hamilton and Butler counties where the FMPC plant is located is not presently zoned so there are no land-use plans and no restrictions on land use exist in the immediate vicinity. The nearby urban areas of Cincinnati and Hamilton do have land-use restrictions but they do not extend to the rural FMPC site.

Federal and state air and water pollution control guidelines encompass the FMPC plant and its emissions and effluents along with DOE guidelines for radioactive discharges and EPA regulations of hazardous wastes. The FMPC cooperates to the fullest extent possible in complying with the various agencies' plans for reducing environmental pollutants.

4.2 Decommissioning

In response to recent public and Congressional interest in the decommissioning of nuclear facilities in general, a DOE-wide decontamination/decommissioning planning system is being established. As an initial step, a comprehensive data base on all DOE-owned contaminated sites is being prepared. After completion of the data base, specific decommissioning plans will be developed for each site with first priority given to those which are now considered to be excess, followed by those which are expected to become excess in the near future. Lower priority will be given to facilities such as FMPC which are not expected to become excess for a significant period of time.

The decommissioning plan will quantify the decontamination and associated work required to render the site suitable for both restricted and unrestricted uses. Prior to actual decommissioning, the plan will be reviewed on the basis of the proposed use or disposition of the site and revised accordingly. In addition, any significant change in the activities at the site or any transfer of the property to the private sector would require preparation of an Environmental Assessment in accordance with the National Environmental Policy Act. This Assessment would specifically address the decontamination work to be performed, the levels of contamination expected to remain and the effects of this residual contamination on the future usefulness of the site. The results of this Assessment would be utilized to determine the need for preparation of an Environmental Impact Statement for the proposed action.

5.0 REFERENCES

(1) Savage, F.N., editor, "Uranium Feed Materials Production Center", National Lead Company of Ohio, Cincinnati, Ohio, 26 p. Undated.

(2) Pennak, A.F., Director of Engineering, National Lead Company of Ohio, Personal Communication, September, 1977.

(3) U.S. Department of Commerce, Environmental Data Service, "Local Climatology Data--Annual Summary with Comparative Data, 1969, Cincinnati, Ohio--Abbe Observatory", 4 p., 1970.

(4) U.S. Department of Commerce, Environmental Data Service, "Local Climatology Data--Annual Summary with Comparative Data, 1969, Cincinnati, Ohio--Greater Cincinnati Airport", 4 p., 1970.

(5) U.S. Department of Commerce, Weather Bureau, "Climatology of the United States No. 86-29, Decennial Census of United States Climate--Summary for 1951 through 1960--Ohio", 77 p., 1964.

(6) Miller, M.E., and C.R. Weaver, "Extreme Monthly and Annual Temperatures in Ohio", Ohio Agricultural Research and Development Center, Wooster, Ohio, Research Bulletin 1041, 35 p., 1970.

(7) National Lead Company of Ohio, "Study of Radioactive Waste Storage Area at the Feed Materials Production Center", U.S. ERDA Report, NLCO-1143 (Special), 76 p., 1977.

(8) U.S. Department of Commerce, Weather Bureau, "Climatography of the United States No. 82-33--Decennial Census of United States Climate--Summary of Hourly Observations--Cincinnati, Ohio", 16 p., 1963.

(9) Davis, J.M., "Ohio Tornado Facts", Unpublished manuscript by State Climatologist for Ohio, 12 p., 1979.

(10) Bradley, E.A., S.J. Bennet, and T.S. Bennett, "Earthquake History of Ohio", Bulletin of Seismology Society of American, Vol. 55, No.4, pp.745-752, 1965.

(11) The Cincinnati Enquirer, July 28, 1980.

(12) Algermissen, S.T., "Seismic Risk Studies in the United States", U.S. Department of Commerce, Environmental Science Service Administration, 20 p., 1969.

(13) Wright, J., "Economic Geography of Ohio", Ohio Department of Natural Resources, Division of Geological Survey, Bulletin 50, 1953.

(14) Stout, W., K. Versteeg, and G.R. Lamb, "Geology of Water in Ohio", Geological Survey of Ohio, Bulletin 44, 1943.

(15) Ohio Department of Natural Resources, Division of Water, "Flow Duration of Ohio Streams Based on Gaging Station Records Through 1965", Bulletin 42, 1968.

(16) Ohio Department of Natural Resources, Division of Water, Monthly Water Inventory Report for Ohio, December, 1976.

(17) U.S. Bureau of the Census, "Current Population Reports, Population Estimates and Projections", Series P-25, No 848, November, 1979.

(18) U.S. Bureau of the Census, "General Social and Economic Characteristics, Ohio, 1970", April, 1972.

(19) U.S. Bureau of the Census, "County and City Data Book, 1977", 1978.

(20) U.S. Bureau of the Census, "County and City Data Book, 1972", Statistical Abstract Supplement, 1973.

(21) U.S. Bureau of the Census, "Current Population Reports, Population Estimates and Projections", Series p-25, No. 683, May, 1977.

(22) U.S. Bureau of the Census, "County Business Patterns, 1974", 1975.

(23) Ohio Bureau of Employment Services, "Labor Market Information, 1979", 1980.

(24) Ohio Crop Reporting Service, "Ohio Agricultural Statistics, 1979", May, 1980.

(25) U.S. Bureau of the Census, "1974 Census of Agriculture, Preliminary Report", 1976.

(26) Ohio Agricultural Research and Development Center, "1979 Ohio Farm Income", Dept. Series ESO 757, October, 1980.

(27) The Miami Conservation District, "Water Quality Report" prepared by Roy F. Weston, Inc., undated.

(28) Ohio Department of Natural Resources, "General Soil Map of Hamilton County", 2 p., 1966.

(29) Ohio Depatment of Natural Resources, "General Soil Map of Butler County", 2 p., 1969.

(30) Braun, E.L., Deciduous Forests of Eastern North America, Hafner Press, New York, New York, 546 p., 1950.

(31) Wharton, M.E., and R.W. Barbour, Trees and Shrubs of Kentucky, The University Press of Kentucky, Lexington, Kentucky, 582 p., 1973.

(32) Austin, G.R., and D.A. Imbrogno, "Birds of the Hamilton County Park District", The Board of Park Commissioners, Hamilton County Park District, Cincinnati, Ohio 52 p., 1976.

(33) Conn, C.C., "Biological Survey of the Great Miami River", The Miami Conservancy District, Dayton, Ohio, 50 p., 1973.

(34) The Miami Conservancy District, Regional Water Qualtiy Management Program - Fish Survey of the Miami River", Tech. Note 4, Dayton, Ohio. 9 p., 1969.

(35) Boback, M.W., K.N. Ross, and D.A. Fuchs,"Feed Materials Production Center Environmental Monitoring Annual Report for 1977", National Lead Company of Ohio, U.S. DOE Report NLCO-1151 (Special), 31 p., 1978.

(36) Boback, M.W. and K.N. Ross, "Feed Materials Production Center Environmental Monitoring Annual Report for 1978", National Lead Company of Ohio, U.S. DOE Report NLCO-1159 (Special), 32 p., 1979.

(37) Boback, M.W. and K.N. Ross, "Feed Materials Production Center Environmental Monitoring Annual Report for 1979", National Lead Company of Ohio, U.S. DOE Report NLCO-1164 (Special), 34 p., 1980.

(38) National Lead Company of Ohio, "Feed Materials Production Center Environmental Monitoring Annual Report for 1974", U.S. ERDA Report NLCO-1117 (Special), 29 p., 1975.

(39) National Lead Company of Ohio, "Feed Materials Production Center Environmental Monitoring Annual Report for 1975", U.S. ERDA Report, NLCO-1133 (Special), 30 p., 1976.

(40) Boback, M.W., K.N. Ross, and D.A. Fuchs, "Feed Materials Production Center Environmental Monitoring Annual Report for 1976", National Lead Company of Ohio, U.S. ERDA Report (Special), 34 p., 1977.

(41) Ohio Environmental Protection Agency, "Regulation EP-1 Water Quality Standards", January, 1975.

(42) U.S. Department of Energy "DOE Manual Chapter 0524, Standards for Radiation Protection", March 1977.

(43) U.S. Department of the Interior, Geological Survey, "Water Resources Data for Ohio, Vol. 1, Ohio River Basin Water Year 1979", Water Data Report OH-79-1, 1980.

(44) The Miami Conservancy District, "Water Quality Management Report for the Period Ending June 30, 1969", Dayton, Ohio, 1969.

(45) Killough, G.G., and L.R. McKay, "A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment", U.S. ERDA Report ORNL-4942, 1976.

(46) Slade, D.H., "Meteorology and Atomic Energy - 1968", U.S. AEC Report, 1968.

(47) Pomeroy, S.E., T.L. Anderson, M.A. Eischen, J.M Stilwell, and D.A. Tolle, "Final Report on Ecological Assessment of the Feed Materials Production Center, Cincinnati, Ohio, to National Lead Company of Ohio", Battelle's Columbus Laboratories, Columbus, Ohio, various paging, 1977.

(48) Ohio Department of Natural Resources, Division of Wildlife, "White-tailed Deer in Ohio", Publication 101, 2 p., 1971.

(49) Ohio Department of Natural Resources, Division of Wildlife, "Cotton-tail Rabbit in Ohio", Publication 93, 2 p., 1968.

(50) Ohio Department of Natural Resources, Division of Wildlife, "Squirrels in Ohio", Publication 95, 2 p., 1968.

60

(51) Evans, M., U.S. Department of Agriculture, Statistical Reporting Service, Columbus, Ohio, Personal Communication, June, 1977.

(52) Smith, H.G., R.K. Burnard, E.E. Good, and J.M. Keener, "Rare and Endangered Vertebrates of Ohio", Ohio Journal of Science, Vol. 73, No. 5, pp. 257-271.

(53) Wilhm, J.L., "Range of Diversity Index in Benthic Macroinvertebrate Populations", Journal of Water Pollution Control Federation, Vol. 42. pp.221-223, 1970.

(54) Trautman, M.B., The Fishes of Ohio. The Ohio State University Press, Columbus, Ohio 683 p., 1957.

(55) U.S. Department of the Interior, Fish and Wildlife Service, "Endangered and Threatened Species - Plants", Federal Register, Vol. 41, No. 117, pp. 24524-24572.

(56) Ohio Department of Natural Resources, Division of Wildlife, "Endangered Wild Animals in Ohio", Publication 316, 3 p., 1974.

(57) U.S. Department of the Interior, Fish and Wildlife Service, "Republication of Lists of Endangered and Threatened Species and Correction of Technical Errors in Final Rules", Fed. Reg. 45, No. 99, pp. 33768-33781, 1980.

(58) "Portsmouth Gaseous Diffusion Plant Site, Final Environmental Impact Statement", U.S. ERDA Report ERDA-1555, Vol.1, p. 4-62, May, 1977.

102

APPENDIX A

ECOLOGY

APPENDIX A

TABLE A-1. TREE AND SHRUB SPECIES RECORDED ON THE FMPC SITE[a]

Common Name	Scientific Name
White Pine	Pinus strobus
Austrian Pine	Pinus nigra
Norway Spruce	Picea excelsa
Eastern Red Cedar	Juniperus virginiana
Black Willow	Salix nigra
Cottonwood	Populus deltoides
Black Walnut	Juglans nigra
Shagbark Hickory	Carya ovata
Pignut Hickory	Carya glabra
Gray Birch	Betula populifolia
Chinkapin Oak	Quercus muehlenbergii
White Oak	Quercus alba
Swamp White Oak	Quercus michauxii
Northern Red Oak	Quercus rubra
Shumard Oak	Quercus shumardii
Shingle Oak	Quercus imbricaria
American Elm	Ulmus americana
Slippery Elm	Ulmus rubra
Rock Elm	Ulmus thomasii
Hackberry	Celtis occidentalis
Pawpaw	Asimina triloba
American Sycamore	Platanus occidentalis
Black Cherry	Prunus serotina
Eastern Redbud	Cercis canadensis
Kentucky Coffee Tree	Gymnocladus dioicus
Honey Locust	Gleditsia triacanthos
Black Locust	Robinia pseudoacacia
Ailanthus	Ailanthus altissima
Sumac	Rhus sp.
Sugar Maple	Acer saccharum
Black Maple	Acer nigrum
Silver Maple	Acer saccharinum
Boxelder	Acer negundo
Buckeye	Aesculus sp.
Gray-stemmed Dogwood	Cornus racemosa
Roughleaf Dogwood	Cornus drummondii
White Ash	Fraxinus americana

[a] Source: Reference 1.

TABLE A-2. HERBACEOUS VEGETATION RECORDED ON THE FMPC SITE, JULY 1977[(a)]

Common Name	Scientific Name
Fescue	Festuca sp.
Asparagus	Asparagus officinalis
Curly Dock	Rumex crispus
Pigweed	Chenopodium sp.
Pokeweed	Phytolacca americana
Blackberry	Rubus sp.
Red Clover	Trifolium pratense
Poison Ivy	Rhus radicanus
Grape	Vitis rotundifolia
Queen Anne's Lace	Daucus carota
Golden Alexander	Taenidia integerrima
Cow Parsnip	Heracleum lanatum
Milkweed	Asclepias sp.
Morning Glory	Ipomoea purpurea
Plantain	Plantago sp.
Elderberry	Sambucus canadensis
Teasil	Dipsacus sylvestris
Ragweed	Ambrosia artemisiifolia
Chicory	Cichorium intybus
Thistle	Carduus sp.
Joe-pye-weed	Eupatorium sp.
Daisy Fleabane	Erigeron annuus
Goldenrod	Solidago sp.
Compass Plant	Silphinium laciniatum
Black-eyed Susan	Rudbeckia hirta

(a) Source: Reference 1.

TABLE A-3. MAMMALS WHOSE RANGE INCLUDES THE FEED MATERIALS PRODUCTION CENTER[a]

Opossum[b]	*Didelphis virginiana*
Masked shrew	*Sorex cinereus*
Short-tailed shrew	*Blarina brevicauda*
Least shrew	*Cryptotis parva*
Eastern mole	*Scalopus aquaticus*
Little brown myotis	*Myotis lucifugus*
Keen's myotis	*Myotis keenii*
Indiana myotis[c,d]	*Myotis sodalis*
Silver-haired bat	*Lasionycteris noctivagaus*
Eastern pipistrelle	*Pipistrellus subflavus*
Big brown bat	*Eptesicus fuscus*
Red bat	*Lasiurus borealis*
Hoary bat	*Lasiurus cinereus*
Evening bat	*Nycticeius humeralis*
Eastern cottontail[b]	*Sylvilagus floridanus*
Eastern chipmunk[b]	*Tamias striatus*
Woodchuck[b]	*Marmota monax*
Gray squirrel[b]	*Sciurus carolinensis*
Fox squirrel[b]	*Sciurus niger*
Southern flying squirrel	*Glaucomys volans*
Beaver	*Castor canadensis*
Eastern harvest mouse	*Reithrodontomys humulis*
Prairie deer mouse	*Peromyscus maniculatus bairdii*
White-footed mouse	*Peromyscus leucopus*
Meadow vole	*Microtus pennsylvanicus*
Prairie vole	*Microtus ochrogaster*
Pine vole	*Microtus pinetorum*
Muskrat[b]	*Ondatra zibethicus*
Southern bog lemming	*Synaptomys cooperi*
House mouse	*Mus musculus*

TABLE A-3. (Continued)

Norway rat	*Rattus norvegicus*
Meadow jumping mouse	*Zapus hudsonius*
Red fox[(b)]	*Vulpes vulpes*
Gray fox	*Uracyon cineroargenteus*
Raccoon[(b)]	*Procyon lotor*
Long-tailed weasel	*Mustela frenata*
Mink[(b)]	*Mustela vison*
Striped skunk[(b)]	*Mephitis mephitis*
River otter[(c)]	*Lontra canadensis*
Bobcat[(c)]	*Lynx rufus*
White-tailed deer[(b)]	*Odocoileus virginianus*

(a) Sources: References 1, 2, 3, and 4.

(b) Observed on the site.

(c) Listed as Endangered by State of Ohio.

(d) Listed as Endangered by U.S. Fish and Wildlife.

TABLE A-4. BIRDS OF SOUTHWESTERN OHIO

Common Loon	Black Vulture
Red-throated Loon	Goshawk
Holboell's Grebe	Sharp-shinned Hawk
Horned Grebe	Cooper's Hawk
Pied-billed Grebe	Red-tailed Hawk
White Pelican	Red-shouldered Hawk
Double-crested Cormorant	Broad-winged Hawk
Great Blue Heron	Rough-legged Hawk
Great Egret	Golden Eagle
Snowy Egret	Bald Eagle
Little Blue Heron	Marsh Hawk
Green Heron	Osprey
Black-crowned Night Heron	Peregrine Falcon
Yellow-crowned Night Heron	Merlin
American Bittern	American Kestrel
Least Bittern	Ruffed Grouse
Mute Swan	Bob-white
Whistling Swan	Ring-necked Pheasant
Canada Goose	Sandhill Crane
American Brant	King Rail
White-fronted Goose	Virginia Rail
Snow Goose	Sora
Mallard	Florida Gallinule
Black Duck	American Coot
Gadwall	Piping Plover
Pintail	Semipalmated Plover
Green-winged Teal	Killdeer
Blue-winged Teal	Golden Plover
American Wigeon	Black-bellied Plover
Northern Shoveller	Ruddy Turnstone
Wood Duck	American Woodcock
Redhead	Common Snipe
Ring-necked Duck	Upland Plover
Canvasback	Spotted Sandpiper
Greater Scaup Duck	Solitary Sandpiper
Lesser Scaup Duck	Greater Yellowlegs
American Goldeneye	Lesser Yellowlegs
Bufflehead	Pectoral Sandpiper
Oldsquaw	White-rumped Sandpiper
White-winged Scoter	Baird's Sandpiper
Ruddy Duck	Least Sandpiper
Hooded Merganser	Red-backed Sandpiper
American Merganser	Eastern Dowitcher
Red-breasted Merganser	Stilt Sandpiper
Turkey Vulture	Semiplamated Sandpiper

TABLE A-4. (Continued)

Western Sandpiper	Bank Swallow
Buff-breasted Sandpiper	Rough-winged Swallow
Herring Gull	Barn Swallow
Ring-billed Gull	Cliff Swallow
Bonaparte's Gull	Purple Martin
Forster's Tern	Blue Jay
Common Tern	Crow
Least Tern	Carolina Chickadee
Caspian Tern	Tufted Titmouse
Black Tern	White-breasted Nuthatch
Rock Dove	Red-breasted Nuthatch
Mourning Dove	Brown Creeper
Yellow-billed Cuckoo	House Wren
Black-billed Cuckoo	Winter Wren
Barn Owl	Bewick's Wren
Screech Owl	Carolina Wren
Great Horned Owl	Long-billed Marsh Wren
Snowy Owl	Short-billed Marsh Wren
Barred Owl	Mockingbird
Long-eared Owl	Gray Catbird
Short-eared Owl	Brown Thrasher
Saw-whet Owl	American Robin
Whip-poor-will	Wood Thrush
Nighthawk	Hermit Thrush
Chimney Swift	Swainson's Thrush
Ruby-throated Hummingbird	Gray-cheeked Thrush
Belted Kingfisher	Veery
Common Flicker	Bluebird
Pileated Woodpecker	Blue-gray Gnatcatcher
Red-bellied Woodpecker	Golden-crowned Kinglet
Red-headed Woodpecker	Ruby-crowned Kinglet
Yellow-bellied Sapsucker	American Pipit
Hairy Woodpecker	Cedar Waxwing
Downy Woodpecker	Loggerhead Shrike
Eastern Kingbird	Starling
Crested Flycatcher	White-eyed Vireo
Phoebe	Yellow-throated Vireo
Yellow-bellied Flycatcher	Blue-headed Vireo
Acadian Flycatcher	Red-eyed Vireo
Alder Flycatcher	Philadelphia Vireo
Least Flycatcher	Warbling Vireo
Wood Pewee	Black and White Warbler
Olive-sided Flycatcher	Prothonotary Warbler
Horned Lark	Worm-eating Warbler
Tree Swallow	Golden-winged Warbler

TABLE A-4. (Continued)

Blue-winged Warbler	Red-winged Blackbird
Tennessee Warbler	Orchard Oriole
Orange-crowned Warbler	Northern Oriole
Nashville Warbler	Rusty Blackbird
Northern Parula Warbler	Common Grackle
Yellow Warbler	Cowbird
Magnolia Warbler	Scarlet Tanager
Cape May Warbler	Summer Tanager
Black-throated Blue Warbler	Cardinal
Yellow-rumped Warbler	Rose-breasted Grosbeak
Black-throated Green Warbler	Indigo Bunting
Cerulean Warbler	Dickcissel
Blackburnian Warbler	Evening Grosbeak
Yellow-throated Warbler	Purple Finch
Chestnut-sided Warbler	Common Redpoll
Bay-breasted Warbler	Pine Siskin
Black-poll Warbler	Goldfinch
Pine Warbler	Red Crossbill
Prairie Warbler	White-winged Crossbill
Palm Warbler	Rufous-sided Towhee
Ovenbird	Savannah Sparrow
Northern Water-thrush	Grasshopper Sparrow
Louisiana Water-thrush	Henslow's Sparrow
Kentucky Warbler	Vesper Sparrow
Connecticut Warbler	Bachman's Sparrow
Mourning Warbler	Dark-eyed Junco
Northern Yellow-throat	Tree Sparrow
Yellow-breasted Chat	Chipping Sparrow
Hooded Warbler	Field Sparrow
Wilson's Warbler	White-crowned Sparrow
Canada Warbler	White-throated Sparrow
American Redstart	Fox Sparrow
House Sparrow	Lincoln's Sparrow
Bobolink	Swamp Sparrow
Eastern Meadowlark	Song Sparrow
Western Meadowlark	Snow Bunting
Yellow-headed Blackbird	

TABLE A-5. AVIAN SUMMER ROADSIDE SURVEY DATA FROM THE SITE PERIMETER COMPARED TO ABUNDANCE OF SPECIES IN SOUTHWESTERN OHIO

Common Name	Roadside Survey[a]	Southwestern Ohio (summer)[b]
Red-tailed Hawk	Uncommon	Fairly Common
Bobwhite	Common	Common
Killdeer	Fairly Common	Common
Mourning Dove	Common	Very Common
Yellow-billed Cuckoo	Uncommon	Fairly Common
Common Nighthawk	Uncommon	Common
Chimney Swift	Rare	Very Common
Common Flicker	Uncommon	Very Common
Red-bellied Woodpecker	Uncommon	Common
Downy Woodpecker	Uncommon	Common
Eastern Wood Pewee	Uncommon	Common
Blue Jay	Fairly Common	Very Common
Common Crow	Fairly Common	Very Common
American Robin	Very Common	Very Common
Starling	Fairly Common	Very Common
Common Yellowthroat	Uncommon	Common
House Sparrow	Very Common	Very Common
Eastern Meadowlark	Very Common	Very Common
Red-winged Blackbird	Fairly Common	Very Common
Common Grackle	Uncommon	Very Common
Cardinal	Fairly Common	Very Common
Indigo Bunting	Very Common	Very Common
American Goldfinch	Fairly Common	Very Common
Rufous-sided Towhee	Common	Common
Field Sparrow	Fairly Common	Very Common
Song Sparrow	Common	Very Common

(a) Source: Reference 1.

(b) Source: Reference 5.

TABLE A-6. HABITAT TRANSECT DATA FROM THE SITE PROPERTY[(a)] COMPARED TO ABUNDANCE IN SIMILAR SOUTHWESTERN OHIO HABITATS[(b)]

Common Name	Grazed Pasture		Weeds & Small Conifers		Weed-Shrub-Tree		Mature Riparian Woods	
	Site[(a)]	SW[(b)] Ohio	Site[(a)]	SW[(b)] Ohio	Site[(a)]	SW[(b)] Ohio	Site[(a)]	SW[(b)] Ohio
Green Heron	--	--	--	--	--	--	U	C
Red-tailed Hawk	U	FC	--	FC	--	--	U	FC
Bobwhite	--	C	FC	C	--	C	U	C
Mourning Dove	FC	VC	--	VC	U	VC	C	VC
Yellow-billed Cuckoo	--	--	--	--	--	FC	FC	FC
Chimney Swift	--	VC	--	VC	FC	VC	--	--
Belted Kingfisher	--	--	--	--	--	--	FC	FC
Common Flicker	--	--	--	--	U	VC	FC	VC
Red-bellied Woodpecker	--	--	--	--	U	C	U	C
Downy Woodpecker	--	--	--	--	U	C	C	C
Eastern Wood Pewee	--	--	--	--	--	--	C	C
Rough-winged Swallow	--	U	U	U	--	--	C	U
Barn Swallow	--	VC	FC	VC	--	--	--	VC
Blue Jay	--	--	--	--	--	--	C	VC
Common Crow	--	VC	--	VC	--	--	C	VC
Carolina Chickadee	--	--	--	--	C	VC	C	VC
Tufted Titmouse	--	--	--	--	--	VC	C	VC
Mockingbird	--	--	--	--	U	C	--	--
Gray Catbird	--	--	--	--	VC	A	--	--
American Robin	--	VC	--	--	C	VC	FC	VC
Wood Thrush	--	--	--	--	--	--	C	C
Blue-gray Gnatcatcher	--	--	--	--	U	C	--	C
Starling	VC	VC	U	VC	--	VC	VC	VC
Red-eyed Vireo	--	--	--	--	--	--	FC	VC
Common Yellowthroat	--	--	--	--	FC	C	--	--
Yellow-breasted Chat	--	--	--	--	FC	C	--	--
Eastern Meadowlark	VC	VC	VC	VC	--	--	U	--

TABLE A-6. (Continued)

Common Name	Grazed Pasture		Weeds & Small Conifers		Weed-Shrub-Tree		Mature Riparian Woods	
	Site[a]	SW[b] Ohio	Site[a]	SW[b] Ohio	Site[a]	SW[b] Ohio	Site[a]	SW[b] Ohio
Red-winged Blackbird	--	VC	C	VC	--	VC	U	VC
Orchard Oriole	--	--	--	--	FC	FC	--	FC
Brown-headed Cowbird	--	--	--	--	C	VC	FC	VC
Scarlet Tanager	--	--	--	--	--	--	U	FC
Cardinal	--	--	--	--	FC	VC	C	VC
Indigo Bunting	--	--	--	--	FC	VC	C	VC
American Goldfinch	--	VC	U	VC	C	VC	U	VC
Rufous-sided Towhee	--	--	--	--	FC	C	FC	C
Savannah Sparrow	FC	VR	U	VR	--	--	--	--
Grasshopper Sparrow	--	VR	VC	VR	--	--	--	--
Field Sparrow	--	VC	--	VC	C	VC	--	--
Song Sparrow	--	VC	U	VC	C	VC	U	VC

[a] Source: Reference 1.

[b] Summertime abundance in the Hamilton County Parks (5) were VR = Very Rare U = Uncommon, FC = Fairly Common, C = Common, and VC = Very Common. Habitat association(s) includes both feeding and nesting habitats.

TABLE A-7. REPTILES WHOSE RANGE INCLUDES THE FEED MATERIALS PRODUCTION CENTER[a]

Common snapping turtle	Chelydra serpentina
Stinkpot	Sternotherus odoratus
Map turtle	Graptemys geographica
Midland painted turtle	Chrysemys picta
Box turtle	Terrapene carolina
Smooth softshell	Trionyx muticus
Spiny softshell	Trionyx spiniferus
Northern Fence Lizard	Sceloporus undulatus
Five-lined skink	Eumeces faciatus
Broad-headed skink	Eumeces laticeps
Northern water snake	Natrix sipedon
Queen snake	Natrix septemvittata
Eastern garter snake	Thamnophis sirtalis
Eastern ribbon snake	Thamnophis sauritus
Northern brown snake	Storeaia dekayi dekayi
Midland brown snake	Storeaia dekayi wrightorum
Eastern hognose	Heterodon platyrhinos
Midwest worm snake	Carphophis amoenus
Northern ringneck snake	Diadophis punctatus
Rough green snake	Opheodrys aestivus
Smooth green snake	Opheodrys vernalis
Black racer	Coluber constrictor constrictor
Blue racer	Coluber constricter foxi
Black rat snake	Elaphe obsoleta
Eastern milk snake	Lampropeltis triangulum
Eastern earth snake	Virginia valeriae
Copperhead	Agkistrodon contrortrix

Sources: References 6 and 7.

TABLE A-8. AMPHIBIANS WHOSE RANGE INCLUDES THE FEED MATERIALS PRODUCTION CENTER

Mudpuppy	Necturus maculosus
Red-spotted newt	Notophthalmus viridescens
Small-mouthed salamander	Ambystoma texanum
Eastern tiger salamander	Ambystoma tigrinum
Jefferson salamander	Ambystoma jeffersonianum
Silvery salamander	Ambystoma platineum
Spotted salamander	Ambystoma maculatum
Marbled salamander	Ambystoma opacum
Dusky salamander	Desmognathus fuscus
Slimy slamander	Plethodon glutinosus
Ravine salamander	Plethodon richmondi
Redbacked salamander	Plethodon cinereus
Four-toed salamander	Hemidactylium scutatum
Two-lined salamander	Eurycea bislineata
Long-tailed salamander	Eurycea longicauda
Cave salamander	Eurycea lucifuga
American toad	Bufo americanus
Fowler's toad	Bufo woodhousei
Spring peeper	Hyla crucifer
Gray treefrog	Hyla versicolor; H. chrysocelis
Western chorus frog	Pseudacris triseriata
Blanchard's cricket frog	Acris crepitans
Green frog	Rana clamitans
Bullfrog	Rana catesbeiana
Northern leopard frog	Rana pipens
Pickerel frog	Rana palustris
Wood frog	Rana sylvatica

Sources: References 6 and 7.

TABLE A-9. BENTHIC MACROINVERTEBRATES (NUMBER/FT^2) COLLECTED FROM PADDY'S RUN IN THE VICNITY OF THE FMPC FACILITY, JULY, 1977[a]

	1	2	3
DIPTERA			
Chironomidae			
Micropsectra sp.	7	2	2
Microtendipes sp.	3	3	8
Polypedilum sp.	6	3	8
Cricotopus sp.	3	1	4
Pentaneura sp.	-	1	2
Chironomus (*Dicrotendipes*) sp.	-	-	2
Tipulidae			
Hexatoma sp.	2	2	8
Empididae			
sp.	3	3	-
EPHEMEROPTERA			
Baetidae			
Baetis sp.	5	8	8
TRICHOPTERA			
Hydropsychidae			
Hydropsyche sp.	88	91	80
Cheumatopsyche sp.	260	135	320
Helicopsychidae			
Helicopsyche sp.	4	4	14
Hydroptilidae			
Agraylea sp.	-	3	6
Philoptamidae			
Chimarra sp.	14	17	74
COLEOPTERA			
Elmidae			
Stenelmis sp.	12	8	30
Psephenidae			
Psephenus herricki	1	-	-
HEMIPTERA			
Veliidae			
Microvelia sp.	-	-	2

TABLE A-9. (Continued)

	1	2	3
PELECYPODA			
Sphaeriidae			
Sphaerium sp.	1	-	-
DECAPODA			
Astacidae			
Orconectes sp.	1	-	2
Total Number of Individuals	410	281	570
Total Number of Species	15	14	16
Species Diversity	1.80	2.10	2.21

(a) Source: Reference 1.

TABLE A-10. BENTHIC MACROINVERTEBRATES (NUMBER/FT^2) COLLECTED FROM THE GREATER MIAMI RIVER WITH A SURBER SAMPLER IN THE VICINITY OF THE FMPC PROCESS WATER DISCHARGE, JULY 6, 1977[(a)]

	Upstream			Downstream 0.5 mi.			Downstream 1.0 mi.		
	1[(b)]	2[(c)]	3[(d)]	1[(b)]	2[(c)]	3[(d)]	1[(b)]	2[(c)]	3[(d)]
DIPTERA									
Chironomidae									
Polypedilum sp.	1	72	24	-	32	112	8	64	72
Cricotopus sp.	2	124	48	-	24	32	16	108	104
Pentaneura sp.	9	80	88	32	160	144	24	68	32
Psectrocladius sp.	-	-	-	-	-	-	-	32	8
Simuliidae									
Simulium sp.	-	8	192	8	8	112	8	-	176
Empididae									
sp.	-	-	-	-	-	-	-	-	8
EPHEMEROPTERA									
Baetidae									
Baetis sp.	13	188	176	240	88	-	16	12	16
Caenis sp.	-	-	-	-	-	-	-	4	-
TRICHOPTERA									
Hydropsychidae									
Hydropsyche sp.	41	80	120	160	400	464	124	156	168
Cheumatopsyche sp.	6	12	32	8	-	16	8	-	-
Pupae	50	-	160	24	64	16	24	16	56
Hydroptilidae									
Agraylea sp.	-	4	-	-	16	-	-	32	-
COLEOPTERA									
Elmidae									
Stenelimis sp.	-	-	-	-	8	-	4	-	-

TABLE A-10. (Continued)

	Upstream			Downstream 0.5 mi.			Downstream 1.0 mi.		
	1[b]	2[c]	3[d]	1[b]	2[c]	3[d]	1[b]	2[c]	3[d]
PELECYPODA									
Sphaeriidae									
<u>Sphaerium</u> sp.	-	-	-	40	8	-	-	20	40
GASTROPODA									
Physidae									
<u>Physa</u> sp.	1	4	-	-	-	16	-	20	8
Ancylidae									
<u>Ferrissia</u> sp.	-	-	-	8	-	-	-	-	8
DECAPODA									
Astacidae									
<u>Orconectes</u> sp.	-	2	1	-	-	-	-	-	-
OLIGOCHAETA									
sp.	4	28	48	40	-	-	-	20	24
HIRUDINEA (Leeches)									
sp.	-	-	8	40	24	32	4	4	-
Total Number of Individuals	127	602	897	600	832	944	236	556	720
Total Number of Species	9	11	11	10	11	9	10	13	13
Species Diversity	2.23	2.66	2.93	2.48	2.37	2.28	2.38	3.06	3.01

(a) Source: Reference 1.

(b) No vegetation over substrate.

(c) <u>Cladophora</u> sp. covering substrate.

(d) Aquatic macrophyte covering substrate.

TABLE A-11. RELATIVE ABUNDANCE OF FISH SPECIES COLLECTED FROM PADDY'S RUN AT THE FMPC FACILITY, JULY 6, 1977[a]

Species	Relative Abundance
Semotilus atromaculatus, Creek chub	Dominant
Notropis chrysocephalus, Striped shiner	Common
Pimephales notatus, Bluntnose minnow	Sparse
Ericymba buccata, Silverjaw minnow	Sparse
Campostoma anomalum, Stoneroller minnow	Common
Catostomus commersoni, White sucker	Sparse
Etheostoma nigrum, Johnny darter	Sparse
Etheostoma flabellare, Barred fantail darter	Common
Etheostoma spectabile, Orangethoat darter	Dominant

[a] Source: Reference 1.

TABLE A-12. FISH SPECIES COLLECTED UPSTREAM AND DOWNSTREAM OF THE FMPC FACILITY DISCHARGE TO THE GREAT MIAMI RIVER, JULY 6-7, 1977[a]

	Upstream	Downstream
Lepisosteus osseus, Longnose gar	X	X
Dorosoma cepedianum, Gizzard Shad	X	X
Alosa chrysochloris, Skipjack herring	X	X
Carpiodes cyprinus, Quillback carpsucker	X	X
Carpiodes carpio, River carpsucker	X	
Cyprinus carpio, Carp	X	X
Carassius auratus, Goldfish	X	X
Semotilus atromaculatus, Creek chub	X	X
Notropis chrysocephalus, Striped shiner	X	X
Notropis spilopterus, Spotfin shiner	X	X
Notropis atherinoides, Emerald shiner	X	X
Notropis stramineus, Sand shiner	X	X
Campostoma anomalum, Stoneroller minnow	X	X
Lepomis cyanellus, Green sunfish	X	X
Lepomis macrochirus, Bluegill	X	X
Etheostoma spectabile, Orangethroat darter		X

[a] Source: Reference 1.

60

REFERENCES

(1) Pomeroy, S. E., T. L. Anderson, M. A. Eischen, J. M. Stilwell, and D. A. Tolle, "Final Report on Ecological Assessment at the Feed Materials Production Center, Cincinnati, Ohio, to National Lead Company of Ohio", Battelle's Columbus Laboratories, Columbus, Ohio, various paging, 1977.

(2) Barbour, R. W., and W. H. Davis, Mammals of Kentucky, The University Press of Kentucky, Lexington, Kentucky, 322 p., 1974.

(3) Burt, W. H., and R. P. Grossenheider, A Field Guide to the Mammals, 3rd ed., Houghton Mifflin Co., Boston, Massachusetts, 289 p., 1976.

(4) National Lead Company of Ohio, "Study of Radioactive Waste Storage Area at the Feed Materials Production Center", NLCO-1143 (special), Cincinnati, Ohio, 76 p., 1977.

(5) Austin, G. R., and D. A. Imbrogno, "Birds of the Hamilton County Park District", The Board of Park Commissioners, Hamilton County Park District, Cincinnati, Ohio, 52 p., 1976.

(6) Conant, R., A Field Guide to Reptiles and Amphibians of Eastern and Central North America, 2nd ed., Houghton Mifflin Company, Boston, Massachusetts, 429 p., 1975.

(7) Nixon, C. M., D. A. Watts, and J. M. Keener, "Non-game Species--Amphibians and Reptiles", Ohio Department of Natural Resources, Division of Wildlife, Inservice publication 71, 18 p., 1972.

122

APPENDIX B

WATER QUALITY

60

TABLE B-1. 1979 WATER QUALITY IN THE GREAT MIAMI RIVER NEAR MIAMISBURG, OHIO[a]

	Maximum	Minimum
Specific Conductance (µmho/cm^2)	1270	270
pH (SU)	9.1	7.0
Water Temperature (°C)	31.0	0.0
Dissolved Oxygen (mg/L)	16.1	2.9

(a) Source: Reference (1).

TABLE B-2. WATER QUALITY IN THE GREAT MIAMI RIVER AT NEW BALTIMORE, OHIO--1979[(a)]

Parameter	Maximum	Minimum
Specific Conductance (μmho/cm^2)	1030	261
pH(SU)	9.1	2.3 7.3
Water Temperature (°C)	30.0	0.0
Dissolved Oxygen	18.9	3.6
Hardness, as $CaCO_3$	420	220
Alkalinity	260	160
Chloride	90	22
Fluoride	0.8	0.2
Dissolved Solids	544	252
Ammonia	2.4	0.75
Nitrogen, Total	9.1	3.6
Nitrogen, Nitrate	40	16
Phosphorus, Total	0.70	0.18
Arsenic	0.003	0.001
Barium	0.1	0.1
Cadmium	0.004	0.000
Chromium	0.03	0.002
Copper	0.02	0.002
Iron	0.5	0.000
Lead	0.039	0.003
Mercury	<0.0005	<0.0005
Selenium	0.001	0.000
Silver	0.002	0.000
Zinc	0.05	0.01

(a) Source: Reference (1)
(b) All values in mg/L except as noted.

126

60

TABLE B-3. NON-RADIOACTIVE CONTAMINANTS IN WATER[a]

Contaminant	Sampling Point[b]	Year	Number of Samples	Max. Conc. (mg/L)	Min. Conc. (mg/L)	Avg. Conc. (mg/L)	Standard[c] (mg/L)
Fluoride	W1	1977	51	1.2	0.3	0.5	2.0
		1978	50	1.3	0.3	0.8	
		1979	52	1.0	0.2	0.4	
	W3	1977	51	1.0	0.3	0.5	
		1978	52	1.2	0.3	0.8	
		1979	52	0.7	0.2	0.4	
	W4	1977	51	1.1	0.3	0.5	
		1978	49	1.2	0.3	0.7	
		1979	52	0.7	0.2	0.4	
	W5	1979	12	0.3	0.2	0.2	
	W7	1979	11	0.3	0.2	0.2	
Nitrate Nitrogen	W1	1977	51	7.0	1.5	3.7	22
		1978	50	30	6	14	
		1979	52	6.0	2.2	3.4	
	W3	1977	51	7.2	1.6	4.0	
		1978	52	158	11	22	
		1979	52	5.9	2.0	3.5	
	W4	1977	51	7.2	1.3	3.6	
		1978	49	105	8	18	
		1979	52	5.8	2.2	3.4	
	W5	1979	12	15	5.2	8.8	
	W6	1979	12	18	4.1	9.2	
Chloride	W1	1979	52	108	17	45	250
	W3	1979	52	117	18	45	
	W4	1979	52	123	17	45	
	W5	1979	12	32	11	23	
	W7	1979	12	24	10	19	

(a) Source: References (2),(3), and (4).
(b) See Figure 1-10.
(c) Ohio EPA, Water Quality Standards, Administrative Code 3745-1.

TABLE B-4. HYDROGEN ION CONCENTRATION[a]

Sampling Point[b]	Year	Number of Samples	pH Range	Standard[c]
W1	1977	50	7.5-8.7	6.5-9.0
	1978	52	7.0-8.3	
	1979	52	7.5-8.3	
W3	1977	52	7.5-8.4	
	1978	51	7.0-8.6	
	1979	52	7.3-8.6	
W4	1977	49	7.4-8.9	
	1978	51	7.0-8.6	
	1979	52	7.4-8.6	
W5	1979	12	6.9-8.1	
W7	1979	12	6.9-8.3	

(a) Sources: References (2), (3), and (4).
(b) See Figure 1-10
(c) Ohio EPA Water Quality Standards, Administrative Code 3745-1.

TABLE B-5. 1979 NPDES SUMMARY[a]

Location	Parameter	Daily Maximum mg/L(b)	Daily Average mg/L(b)	Compliance With Permit Limits, %
Manhole - 175	Residual chlorine	0.5	–	100
	Dissolved solids	12000	6000	100
	Nitrate (N)	2000	900	100
	Ammonia (N)	200	75	100
	Chloride	350	290	99
	Fluoride	10	6	100
	Chromium	0.10	0.05	100
	Iron	3.0	1.2	100
	Oil & Grease	15	–	100
	Flow, MGD	0.9	–	100
	pH	6.5 – 10.0	–	100
Pit Clearwell	Suspended solids	40	20	99
Sewage Treatment Plant Effluent	5-Day BOD	40	20	100
	Suspended solids	40	20	100
	Fecal Coliform bacteria (No. per 100 ml.)	400	200	100
Storm Sewer Outfall	Suspended solids	100	30	100
	Oil & Grease	40	20	100
	pH	6.5 – 8.5	–	100

(a) Source: Reference (4).
(b) Values in mg/L except pH(SU) and Fecal Coliform (No./100mL).

TABLE B-6. SEWAGE TREATMENT PLANT DATA, 1979[a]

Parameter	EPA Standard	FMPC Data
Suspended Solids		
30-day average	≤ 30 mg/L	1-7 mg/L (b)
Maximum in any 7 days	≤ 45 mg/L	12 mg/L (c)
Solids reduction achieved	≥ 85%	90% (3)
B.O.D. (5-day)		
30-day average	≤ 30 mg/L	< 1-9 mg/L (b)
Maximum in any 7 days	≤ 45 mg/L	12 mg/L (c)
B.O.D. reduction achieved	≥ 85%	94% (d)
Fecal Coliform		
30-day average	≤ 200 per 100 mL	< 1-30 per 100 mL (b)
Maximum in any 7 days	≤ 400 per 100 mL	200 per 100 mL (c)
pH	6.0 – 9.0	6.2 – 8.8 (e)

(a) Source: Reference (4).
(b) Range of monthly averages for the year.
(c) Maximum 7-day concentration.
(d) Reduction determined from analysis of Sewage Treatment Plant influent and effluent samples.
(e) Range of daily pH measurements.

60

REFERENCES

(1) U.S. Department of the Interior, Geological Survey, "Water Resources Data for Ohio, Vol. 1, Ohio River Basin Water Year 1979", Water Data, Report OH-79-1, 1980.

(2) Boback, M.W., K.N. Ross, and D.A. Fuchs,"Feed Materials Production Center Environmental Monitoring Annual Report for 1977", National Lead Company of Ohio, U.S. DOE Report NLCO-1151 (Special), 31 p., 1978.

(3) Boback, M.W. and K.N. Ross, "Feed Materials Production Center Environmental Monitoring Annual Report for 1978", National Lead Company of Ohio, U.S. DOE Report NLCO-1159 (Special), 32 p., 1979.

(4) Boback, M. W. and K.N. Ross, "Feed Materials Production Center Environmental Monitoring Annual Report for 1979", National Lead Company of Ohio, U.S. DOE Report NLCO-1164 (Special) 34 p., 1980.

130

APPENDIX C

RADIATION LEVELS

TABLE C-1. RADIOACTIVE CONTAMINANTS IN AIR--1978[(a)]

Contaminant	Sampling Point (b)	Number of Samples	Max. Conc. Found		Min. Conc. Found		Average Concentration				Detection Level	Standard (c) µCi/ml
			µg/m³	µCi/ml	µg/m³	µCi/ml	µg/m³	µCi/ml	% of Standard	95% Confidence Level		
Uranium	BS1	52	0.092	3.1×10^{-14}	0.001	3×10^{-16}	0.011	3.9×10^{-15}	0.2	$\pm 1.4 \times 10^{-15}$ µCi/ml	2×10^{-16} µCi/ml	2×10^{-12}
	BS2	52	0.115	3.9×10^{-14}	0.001	3×10^{-16}	0.012	4.2×10^{-15}	0.2			
	BS3	52	0.260	8.8×10^{-14}	0.002	6×10^{-16}	0.004	1.4×10^{-14}	0.7			
	BS4	52	0.038	1.3×10^{-14}	0.001	3×10^{-16}	0.013	4.4×10^{-15}	0.2			
	BS5	51	0.136	4.6×10^{-14}	0.001	1×10^{-16}	0.015	5.0×10^{-15}	0.3			
	BS6	52	0.136	4.6×10^{-14}	0.001	2×10^{-16}	0.010	3.1×10^{-15}	0.2			
Thorium	BS1	1 (d)	NA (e)	NA	NA	NA	2.5×10^{-4}	2.8×10^{-17}	0.003	$\pm 1 \times 10^{-17}$ µCi/ml	1×10^{-17} µCi/ml	1×10^{-12}
	BS2	1					2.2×10^{-4}	2.5×10^{-17}	0.002			
	BS3	1					2.8×10^{-4}	3.1×10^{-17}	0.003			
	BS4	1					1.3×10^{-4}	1.5×10^{-17}	0.002			
	BS5	1					1.2×10^{-4}	1.4×10^{-17}	0.001			
	BS6	1					1.7×10^{-4}	1.9×10^{-17}	0.002			
Gross Alpha Radioactivity	BS1	52	NA	2.8×10^{-14}	NA	3×10^{-16}	NA	3.6×10^{-15}	0.2	$\pm 1.4 \times 10^{-15}$ µCi/ml	1×10^{-16} µCi/ml	2×10^{-12}
	BS2	52		3.2×10^{-14}		5×10^{-16}		3.9×10^{-15}	0.2			
	BS3	52		8.4×10^{-14}		4×10^{-16}		8.0×10^{-15}	0.4			
	BS4	52		1.5×10^{-14}		4×10^{-16}		2.6×10^{-15}	0.1			
	BS5	51		1.8×10^{-13}		1×10^{-16}		8.9×10^{-15}	0.4			
	BS6	52		4.9×10^{-14}		3×10^{-16}		4.3×10^{-15}	0.2			
Gross Beta Radioactivity	BS1	52	NA	5.7×10^{-13}	NA	1.4×10^{-14}	NA	4.8×10^{-14}	0.05	$\pm 6 \times 10^{-15}$ µCi/ml	1×10^{-16} µCi/ml	1×10^{-10}
	BS2	52		4.3×10^{-13}		1.5×10^{-14}		5.2×10^{-14}	0.05			
	BS3	52		6.0×10^{-13}		1.6×10^{-14}		6.9×10^{-14}	0.07			
	BS4	52		4.8×10^{-13}		1.5×10^{-14}		4.6×10^{-14}	0.05			
	BS5	51		4.0×10^{-13}		1.7×10^{-14}		5.5×10^{-14}	0.06			
	BS6	52		3.7×10^{-13}		1.2×10^{-14}		5.4×10^{-14}	0.05			

(a) Source: Reference (a) 1.
(b) See sampling locations shown in Figure 1-10.
(c) DOE Manual Chapter 0524, Annex A.
(d) Each sample is a composite of 51 or 52 weekly samples.
(e) Not applicable.

TABLE C-2. RADIOACTIVE CONTAMINANTS IN AIR--1979[a]

Contaminant	Sampling Point (b)	Number of Samples	Maximum Conc. Found µg/m³	Maximum Conc. Found µCi/mL	Minimum Conc. Found µg/m³	Minimum Conc. Found µCi/mL	Average Concentration Found µg/m³	Average Concentration Found µCi/mL	Average Concentration Found % of Standard	Average Concentration Found 95% Confidence Level	Detection Level	Standard (c)
Uranium	BS1	48	0.24	8.2×10^{-14}	0.002	6×10^{-18}	0.020	6.7×10^{-15}	0.3	$\pm 1.4 \times 10^{-15}$ µCi/mL	2×10^{-16} µCi/mL	2×10^{-12} µCi/mL
	BS2	49	0.12	4.0×10^{-14}	0.001	3×10^{-18}	0.016	5.5×10^{-15}	0.3			
	BS3	49	0.68	2.3×10^{-13}	0.002	6×10^{-18}	0.028	9.6×10^{-15}	0.5			
	BS4	49	0.22	7.5×10^{-14}	0.001	2×10^{-18}	0.012	4.1×10^{-15}	0.2			
	BS5	49	0.35	1.2×10^{-13}	0.001	3×10^{-18}	0.016	5.4×10^{-15}	0.3			
	BS6	46	0.24	8.1×10^{-14}	0.001	3×10^{-18}	0.014	4.7×10^{-15}	0.2			
Thorium	BS1	1 (d)	NA (e)	NA	NA	NA	2.4×10^{-4}	2.7×10^{-17}	0.003	$\pm 1 \times 10^{-17}$ µCi/mL	1×10^{-17} µCi/mL	1×10^{-12} µCi/mL
	BS2	1					2.3×10^{-4}	2.6×10^{-17}	0.003			
	BS3	1					3.9×10^{-4}	4.4×10^{-17}	0.004			
	BS4	1					2.9×10^{-4}	3.3×10^{-17}	0.003			
	BS5	1					2.5×10^{-4}	2.8×10^{-17}	0.003			
	BS6	1					3.2×10^{-4}	3.6×10^{-17}	0.003			
Gross Alpha Radioactivity	BS1	48	NA	7.6×10^{-14}	NA	4×10^{-16}	NA	6.3×10^{-15}	0.3	$\pm 1.4 \times 10^{-15}$ µCi/mL	1×10^{-16} µCi/mL	2×10^{-12} µCi/mL
	BS2	49		3.9×10^{-14}		3×10^{-16}		3.9×10^{-15}	0.2			
	BS3	49		2.2×10^{-13}		8×10^{-16}		9.7×10^{-15}	0.5			
	BS4	49		6.6×10^{-14}		4×10^{-16}		4.7×10^{-15}	0.2			
	BS5	49		1.1×10^{-13}		2×10^{-16}		5.2×10^{-15}	0.3			
	BS6	46		7.8×10^{-14}		2×10^{-16}		4.7×10^{-15}	0.2			
Gross Beta Radioactivity	BS1	48	NA	1.1×10^{-13}	NA	8.9×10^{-15}	NA	2.5×10^{-14}	0.02	$\pm 6 \times 10^{-15}$ µCi/mL	1×10^{-16} µCi/mL	1×10^{-10} µCi/mL
	BS2	49		5.9×10^{-14}		6.2×10^{-15}		1.9×10^{-14}	0.02			
	BS3	49		2.1×10^{-13}		7.3×10^{-15}		2.5×10^{-14}	0.03			
	BS4	49		7.8×10^{-14}		7.9×10^{-15}		2.0×10^{-14}	0.02			
	BS5	49		1.1×10^{-13}		8.0×10^{-15}		2.2×10^{-14}	0.02			
	BS6	46		1.1×10^{-13}		1.0×10^{-14}		2.4×10^{-14}	0.02			

(a) Source: Reference (2).
(b) See sampling locations shown in Figure 1-10.
(c) DOE Manual Chapter 0524, Annex A.
(d) Each sample is a composite of 46-49 weekly samples
(e) Not applicable

TABLE C-3. RADIOACTIVE CONTAMINANTS IN WATER--1978[(a)]

Contaminant	Sampling Point (b)	Number of Samples	Max. Conc. Found mg/l	Max. Conc. Found µCi/ml	Min. Conc. Found mg/l	Min. Conc. Found µCi/ml	Average Concentration Found mg/l	Average Concentration Found µCi/ml	Average Concentration Found % of Standard	Average Concentration Found 95% Confidence Limits	Detection Level µCi/ml	Standard µCi/ml (c)
Uranium	W1	50	0.010	0.34×10^{-8}	0.001	0.34×10^{-8}	0.005	0.17×10^{-8}	0.008	$\pm 0.7 \times 10^{-8}$ µCi/ml	0.34×10^{-8}	2×10^{-5}
	W3	51	0.010	0.34×10^{-8}	0.001	0.34×10^{-8}	0.005	0.17×10^{-8}	0.008			
	W4	51	0.009	0.30×10^{-8}	0.002	0.68×10^{-8}	0.006	0.20×10^{-8}	0.010			
Radium-226	W1	12 (d)	NA (e)	4.5×10^{-10}	NA	4.5×10^{-10}	NA	$< 4.5 \times 10^{-10}$	< 1.5	$\pm 4.5 \times 10^{-10}$ µCi/ml	4.5×10^{-10}	3×10^{-8}
	W3	12		4.5×10^{-10}		4.5×10^{-10}		$< 4.5 \times 10^{-10}$	< 1.5			
	W4	12		4.5×10^{-10}		$< 4.5 \times 10^{-10}$		$< 4.5 \times 10^{-10}$	< 1.5			
Radium-228	W1	12 (d)	NA	4.5×10^{-10}	NA	$< 4.5 \times 10^{-10}$	NA	$< 4.5 \times 10^{-10}$	< 1.5	$\pm 4.5 \times 10^{-10}$ µCi/ml	4.5×10^{-10}	3×10^{-8}
	W3	12		4.5×10^{-10}		$< 4.5 \times 10^{-10}$		$< 4.5 \times 10^{-10}$	< 1.5			
	W4	12		9.0×10^{-10}		$< 4.5 \times 10^{-10}$		$< 4.5 \times 10^{-10}$	< 1.5			
Gross Alpha	W1	51	NA	0.4×10^{-8}	NA	$< 0.9 \times 10^{-9}$	NA	$< 2.7 \times 10^{-9}$	< 9	$\pm 0.8 \times 10^{-9}$ µCi/ml	0.9×10^{-9}	3×10^{-8}
	W3	50		0.4×10^{-8}		$< 0.9 \times 10^{-9}$		$< 2.7 \times 10^{-9}$	< 9			
	W4	51		0.4×10^{-8}		$< 0.9 \times 10^{-9}$		$< 2.7 \times 10^{-9}$	< 9			
Gross Beta	W1	51	NA	6.3×10^{-8}	NA	0.4×10^{-8}	NA	2.2×10^{-8}	73	$\pm 0.3 \times 10^{-8}$ µCi/ml	0.2×10^{-8}	3×10^{-8}
	W3	50		6.3×10^{-8}		0.4×10^{-8}		1.8×10^{-8}	60			
	W4	51		4.0×10^{-8}		0.4×10^{-8}		1.4×10^{-8}	47			

(a) Source: Reference (1).
(b) See sampling locations shown in Figure 1-10.
(c) DOE Manual Chapter 0524, Annex A.
(d) Each sample was a one-month composite of daily samples (W1 and W3) or or of samples collected once each week (W4).
(e) Not applicable.

60

TABLE C-4. RADIOACTIVE CONTAMINANTS IN WATER--1979 (a)

Contaminant	Sampling Point (b)	Number of Samples	Maximum Conc. Found mg/l	Maximum Conc. Found μCi/mL	Minimum Conc. Found mg/l	Minimum Conc. Found μCi/mL	Average Concentration Found mg/l	Average Concentration Found μCi/mL	Average Concentration Found % of Standard	Average Concentration Found 95% Confidence Limits	Detection Level μCi/mL	Standard μCi/mL (c)
Uranium	W1	52	0.009	3.0×10^{-9}	0.001	3.4×10^{-10}	0.004	1.4×10^{-9}	0.007	$\pm 0.7 \times 10^{-9}$ μCi/mL	3.4×10^{-10}	2×10^{-5}
	W3	52	0.009	3.0×10^{-9}	0.001	3.4×10^{-10}	0.004	1.4×10^{-9}	0.007			
	W4	52	0.008	2.7×10^{-9}	0.001	3.4×10^{-10}	0.004	1.4×10^{-9}	0.007			
	W5	52	0.030	1.0×10^{-8}	0.001	0.3×10^{-9}	0.004	1.4×10^{-9}	0.007			
	W7	29	0.052	1.8×10^{-8}	0.009	3.0×10^{-9}	0.016	5.4×10^{-9}	0.027			
	W8	25	0.024	0.8×10^{-8}	0.003	1.0×10^{-9}	0.012	4.1×10^{-9}	0.020			
Radium-226	W1	12 (d)	NA (e)	4.5×10^{-10}	NA	4.5×10^{-10}	NA	4.5×10^{-10}	1.5	$\pm 4.5 \times 10^{-10}$ μCi/mL	4.5×10^{-10}	3×10^{-8}
	W3	12		4.5×10^{-10}		4.5×10^{-10}		4.5×10^{-10}	1.5			
	W4	12		4.5×10^{-10}		4.5×10^{-10}		4.5×10^{-10}	1.5			
Radium-228	W1	12 (d)	NA	9.0×10^{-10}	NA	4.5×10^{-10}	NA	4.9×10^{-10}	1.6	$\pm 4.5 \times 10^{-10}$ μCi/mL	4.5×10^{-10}	3×10^{-8}
	W3	12		4.5×10^{-10}		4.5×10^{-10}		4.5×10^{-10}	1.5			
	W4	12		9.0×10^{-10}		4.5×10^{-10}		4.9×10^{-10}	1.6			
Gross Alpha	W1	52	NA	4.5×10^{-9}	NA	0.9×10^{-9}	NA	2.2×10^{-9}	7	$\pm 0.8 \times 10^{-9}$ μCi/mL	0.9×10^{-9}	3×10^{-8}
	W3	52		4.5×10^{-9}		0.9×10^{-9}		1.8×10^{-9}	6			
	W4	52		4.0×10^{-9}		0.9×10^{-9}		2.2×10^{-9}	7			
	W5	52		2.0×10^{-8}		0.9×10^{-9}		3.6×10^{-9}	12			
	W7	29		3.5×10^{-8}		4.5×10^{-9}		1.0×10^{-8}	33			
	W8	25		2.2×10^{-8}		2.2×10^{-9}		8.6×10^{-9}	29			
Gross Beta	W1	52	NA	4.0×10^{-8}	NA	0.4×10^{-9}	NA	1.4×10^{-8}	47	$\pm 0.3 \times 10^{-8}$ μCi/mL	0.2×10^{-9}	3×10^{-8}
	W3	52		3.6×10^{-8}		0.4×10^{-9}		0.9×10^{-8}	30			
	W4	52		2.7×10^{-8}		0.4×10^{-9}		0.9×10^{-8}	30			
	W5	52		9.0×10^{-8}		4.5×10^{-9}		1.8×10^{-8}	60			
	W7	29		4.5×10^{-8}		4.5×10^{-9}		1.4×10^{-8}	47			
	W8	25		7.7×10^{-8}		4.5×10^{-9}		2.7×10^{-8}	90			

(a) Source: Reference (2).
(b) See sampling locations shown in Figure 1-10.
(c) DOE Manual Chapter 0524, Annex A.
(d) Each sample was a one-month composite of daily samples (W1 and W3) or of samples collected once each week (W4).
(e) Not applicable.

TABLE C-5. RADIONUCLIDES DISCHARGED VIA SAMPLING POINT W2--1979[a,b]

Radionuclide	Total Curies	Average Conc. Found µCi/mL	Average Conc. Found % of Standard	Standard(c) µCi/mL
Cesium-137	6.1×10^{-3}	8.0×10^{-9}	0.04	2×10^{-5}
Neptunium-237	1.9×10^{-4}	2.5×10^{-10}	0.008	3×10^{-6}
Plutonium-238	1.0×10^{-5}	1.3×10^{-11}	<0.001	5×10^{-6}
Plutonium-239	2.9×10^{-5}	3.8×10^{-11}	<0.001	5×10^{-6}
Radium-226	7.8×10^{-4}	1.0×10^{-9}	3.3	3×10^{-8}
Radium-228	9.3×10^{-3}	1.2×10^{-8}	40	3×10^{-8}
Ruthenium-106	1.8×10^{-3}	2.4×10^{-9}	0.02	1×10^{-5}
Strontium-90	3.2×10^{-3}	4.2×10^{-9}	1.4	3×10^{-7}
Technetium-99	3.4	4.5×10^{-6}	1.5	3×10^{-4}
Thorium	7.6×10^{-4}	1.0×10^{-9}	0.1	1×10^{-6}
Uranium	3.8×10^{-1}	5.0×10^{-7}	2.5	2×10^{-5}

(a) Source: Reference (2).

(b) Radionuclides in the plant effluent which is discharged to the Great Miami River through a buried pipeline. An additional 2.3×10^{-2} Curie of uranium was contained in the storm sewer overflow discharged into a ditch at sampling point W6. The ditch empties into Paddy's Run above sampling point W7.

(c) DOE Manual Chapter 0524, Annex A, Table II, Concentration Guides for Water in Uncontrolled Areas. These Guides are for water such as the Great Miami River and are not meant to be applied to the plant effluent. They are listed here for comparison purposes.

TABLE C-6. URANIUM IN MIAMI RIVER SEDIMENT[a]

Distance from FMPC Outfall	Uranium Concentration[b]				Detection Level
	1978		1979		
	μg/g	μCi/g	μg/g	μCi/g	
Upstream					
3.7 miles	2.8	0.9×10^{-6}	2.0	0.7×10^{-6}	0.5 μg/g
1.5 miles	2.6	0.9×10^{-6}	2.8	0.9×10^{-6}	
Downstream					
50 Feet	5.4	1.8×10^{-6}	4.2	1.4×10^{-6}	
0.8 mile	2.9	1.0×10^{-6}	2.4	0.8×10^{-6}	
3.3 miles	1.6	0.5×10^{-6}	1.8	0.6×10^{-6}	0.5 μg/g
4.5 miles[c]	1.6	0.5×10^{-6}	1.8	0.6×10^{-6}	
4.7 miles[d]	6.3	2.1×10^{-6}	2.6	0.9×10^{-6}	

(a) Sources: References (1) and (2).
(b) Results on dry basis.
(c) Upstream of mouth of Paddy's Run.
(d) Downstream of mouth of Paddy's Run.

TABLE C-7. URANIUM IN SOIL[a]

Sampling Point[c]	Uranium Concentration[b] 1978		1979		Detection Level
	μg/g	μCi/g	μg/g	μCi/g	
BS1	23	7.8×10^{-6}	12	4.0×10^{-6}	
BS2	21	7.1×10^{-6}	17	5.7×10^{-6}	
BS3	102	3.4×10^{-5}	110	3.7×10^{-5}	
BS4	11	3.7×10^{-6}	11	3.7×10^{-6}	0.5 μg/g
BS5	16	5.4×10^{-6}	11	3.7×10^{-6}	
BS6	11	3.7×10^{-6}	14	4.7×10^{-6}	

(a) Source: References (1) and (2).
(b) Results on dry basis.
(c) See sampling locations shown in Figure 1-10.

TABLE C-8. URANIUM CONCENTRATION IN SOIL VS. DEPTH[(a)]

Soil depth, inches	Uranium μg/g[(b)]
0-2	125
3-4	62
5-6	20
7-8	10
9-10	5.2
11-12	3.5

(a) Source: Reference (3).
(b) Results on a dry weight basis.

REFERENCES

(1) Boback, M.W. and K.N. Ross, "Feed Materials Production Center Environmental Monitoring Annual Report for 1978", National Lead Company of Ohio, U.S. Department of Energy Report NLCO-1159 (Special) 32 p., 1979.

(2) Boback, M.W. and K.N. Ross, "Feed Materials Production Center Environmental Monitoring Annual Report for 1979", National Lead Company of Ohio, U.S. Department of Energy Report NLCO-1160 (Special) 34 p., 1980.

(3) Boback, M.W., K.N. Ross, and D.A. Fuchs, "Feed Materials Production Center Environmental Monitoring Report for 1976", National Lead Company of Ohio, U.S. ERDA Report NLCO-1142 (Special) 34 p., 1977.