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Environmental Survey
Preliminary Report

Feed Materials Production Center
Fernald, Ohio

March 1987

MASTER

PREFACE TO
THE DEPARTMENT OF ENERGY
FEED MATERIALS PRODUCTION CENTER
ENVIRONMENTAL SURVEY PRELIMINARY REPORT

This report contains the preliminary findings based on the first phase of an environmental survey at the Department of Energy (DOE) Feed Materials Production Center (FMPC), located at Fernald, Ohio. The survey is being conducted by DOE's Office of Environment, Safety and Health.

The FMPC survey is a portion of the larger, comprehensive DOE Environmental Survey encompassing all major operating facilities of DOE. The DOE Environmental Survey is one of a series of initiatives announced on September 18, 1985, by Secretary of Energy John S. Herrington, to strengthen the environmental, safety, and health programs and activities within DOE. The purpose of the Environmental Survey is to identify, via a "no fault" baseline survey of all the Department's major operating facilities, environmental problems, and areas of environmental risk. The identified problem areas will be prioritized on a Department-wide basis in order of importance in 1988.

The findings in this report are subject to modification based on the results from the sampling and analysis phase of the survey. The findings are also subject to modification based on comments from the Oak Ridge Operations Office concerning the technical accuracy of the findings. The modified preliminary findings and any other appropriate changes will be incorporated into an Interim Report. The Interim Report will serve as the site-specific source for environmental information generated by the Survey, and ultimately as the primary source of information for the DOE-wide prioritization of environmental problems in the final Survey report.

March 1987
Washington, D.C.

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EXECUTIVE SUMMARY

Introduction

This report presents the preliminary findings from the first phase of the environmental survey of the United States Department of Energy (DOE) Feed Materials Production Center (FMPC), conducted June 16 through 27, 1986.

The survey is being conducted by an interdisciplinary team of environmental specialists, led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. Individual team components are being supplied by a private contractor. The objective of the survey is to identify environmental problems and areas of environmental risk associated with the FMPC. The survey covers all environmental media and all areas of environmental regulation. It is being performed in accordance with the DOE Environmental Survey Manual. This phase of the survey involves the review of existing site environmental data, observations of the operations carried on at FMPC, and interviews with site personnel.

The survey team developed a Sampling and Analysis Plan to assist in further assessing certain of the environmental problems identified during its onsite activities. The Sampling and Analysis Plan will be executed by a DOE National Laboratory or a support contractor. When completed, the results will be incorporated into the FMPC Environmental Survey Interim Report. The Interim Report will reflect the final determinations of the FMPC survey.

Site Description

The FMPC occupies a 1,050 acre site located near Fernald, Ohio, approximately 20 miles northwest of Cincinnati. The FMPC is operated by the Westinghouse Materials Company of Ohio, under contract with DOE. The primary function of the FMPC is production of purified uranium metal and compounds, from various feed materials, for use at other DOE facilities. Its mission is critical to the national defense effort.

A wide variety of hazardous and radioactive wastes are generated by FMPC activities. The accumulated releases of these wastes into the environment over the last 35 years of operation have resulted in contamination of air, soil, surface water, and groundwater. The site management has initiated a number of ongoing remedial actions intended to address these conditions.

Summary of Findings

The major preliminary findings of the environmental survey of the FMPC site are:

- Degradation of onsite and offsite ground-water quality exists and potential health risks may be increased if the ground water is used as a source of drinking water;

- Operations are suspected of generating hazardous wastes which have not been previously identified as hazardous wastes, potentially resulting in the improper treatment, storage, handling or disposal of these wastes;

- Radon releases from the K-65 silos may result in pulmonary doses which exceed the risk-based inhalation dose guideline established by U.S. EPA for other radionuclides;

- Ground-water flow patterns are not completely identified, resulting in uncertainty over potential contaminant migration pathways; and

- The consistency and accuracy of environmental monitoring data may be inadequate because there are no formal sampling and analysis quality assurance practices and procedures.

Overall Conclusions

The survey found no environmental problems at the FMPC site that represent an immediate threat to human life. The environmental problems identified at FMPC by the survey do confirm that the site is affected by a number of substantial and chronic environmental concerns. These problems vary in terms of their magnitude and risk, as described in this report. Although the sampling and analysis performed by the FMPC survey will assist in further identifying environmental problems at the site, a complete understanding of the significance of some of the environmental problems identified requires a level of study and characterization that is beyond the scope of the survey. Response actions currently underway or planned at the site will contribute toward meeting this requirement.

Transmittal of Results

The findings of the environmental survey of the FMPC site were shared with the DOE Oak Ridge Operations Office, the DOE Site Manager for FMPC, and the site contractor, at the survey close-out briefing held June 27, 1986. By letter of July 2, 1986, the Operations Office directed the site contractor to develop an action plan to address the identified problems. Those problems that involve extended studies and multi-year budget commitments will be the subject of the Environmental Survey final report and the DOE-wide prioritization.

Within the Office of Environment, Safety and Health, the Office of Environmental Guidance and Compliance has immediate responsibility for monitoring environmental compliance and the status of the FMPC survey findings. The Office of Environmental Audit will continue to assess the environmental problems through the program of systematic environmental audits that will be initiated toward the conclusion of the DOE Environmental Survey in 1988.

1.0 INTRODUCTION

The purpose of this report is to present the preliminary findings made during the environmental survey, conducted June 16 through 27, 1986, at the United States Department of Energy's (DOE) Feed Materials Production Center (FMPC) in Fernald, Ohio (Figure 1-1). As a preliminary report, the contents are subject to revisions, in the Interim Report, based on Oak Ridge Operations Office review and comments concerning the technical accuracy, the results of the sampling and analysis phase of the survey, and other information that may come to the survey team's attention prior to issuance of the Interim Report. The FMPC is currently operated for DOE by the Westinghouse Materials Company of Ohio (WMCO).

The FMPC survey is part of the larger, comprehensive, DOE Environmental Survey effort announced by Secretary John S. Herrington on September 18, 1985. The purpose of the Environmental Survey is to identify, via a "no fault" baseline survey of all the Department's major operating facilities, existing environmental problems and areas of environmental risk. In 1988, the identified problem areas will be prioritized on a Department-wide basis in order of importance. The prioritization will enable DOE to more effectively address environmental problems and allocate the resources necessary to correct these problems. Because the survey is "no fault" and is not an "audit," it is not designed to identify specific isolated incidents of noncompliance or to analyze environmental management practices. Such incidents and/or management practices are, however, used in the survey as a means of identifying existing and potential environmental problems and risk.

The FMPC environmental survey is being conducted by an interdisciplinary team of environmental specialists led and managed by the Office of Environment, Safety and Health's Office of Environmental Audit. A complete list of survey participants and their affiliations is included in Appendix A.

The survey team focused on all environmental media, using Federal, state, and local environmental statutes and regulations, accepted industry practices, and professional judgment, to make the preliminary findings included in this report. The team carried out its activities in accordance with the guidance and protocols in the DOE Environmental Survey Manual. Substantial use of existing information and of interviews with knowledgeable field office and site-contractor personnel accounted for a large part of the onsite effort. A summary of the site-specific survey activities is presented in Appendix B, and the Survey Plan is presented in Appendix C.

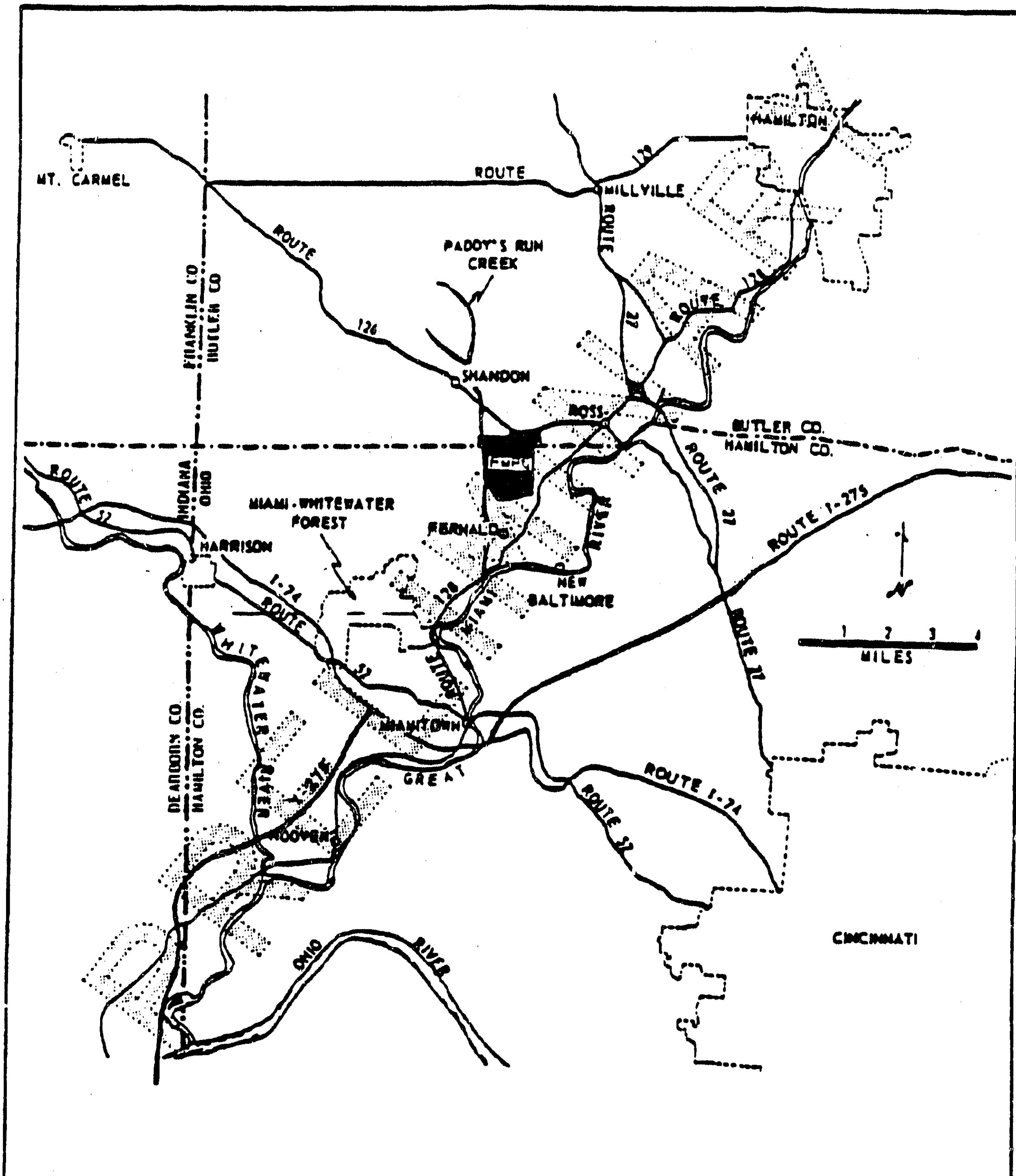


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FERNALD AREA MAP **FIGURE 1 - 1**

The preliminary survey findings, in the form of existing environmental problems and risks, are presented in Sections 3.0 and 4.0. Section 3.0 includes those findings that pertain to a specific environmental medium (e.g., air or soil) whereas Section 4.0 includes those that are non-media-specific (e.g., waste management, direct radiation, and quality assurance). Because the findings are highly varied in terms of magnitude, risk, and characterization, and consequently require different levels of management attention and response, they are further subdivided into four categories within Sections 3.0 and 4.0.

The criteria for placing a finding into one of the four categories is as follows:

- Category I findings are those environmental problems where the potential risk is highest; the confidence in the finding, based on the information available, is the strongest; and the appropriate response to the finding is the most restrictive in terms of alternatives. Therefore, Category I findings include only those which, based upon the information available to the team leader, involve immediate life-threatening situations. In these situations, response or remedial action by the Operations Office to rectify the situation must be taken immediately.

- Category II findings are those environmental problems where the risk is high but where the definition of risk is broader than in Category I. The information available to the team leader is adequate to identify the problem but may be insufficient to fully characterize it. Finally, in this category, most discretion is available to the Operations Office and Program Office in terms of an appropriate response; however, the need for that response is such that management should not wait for the completion of the entire Survey to respond. Therefore, unlike Category I findings, a sufficient near-term response by the Operations Office may include further characterization prior to taking action to rectify the situation. Situations that constitute Category II findings include

    - Multiple or continuing exceedances, past or present, of a health-based standard in air, water, and soil or at a location where there is immediate potential for human exposure or a one-time exceedance where residual impacts pose an immediate potential for human exposure.

    - The evidence indicates that a health-based standard may be exceeded as discussed in the above criteria within the time-frame of the Survey.

- Evidence that there is great likelihood for an unplanned release due to, for example, the condition or design of pollution abatement or monitoring equipment or other environmental management practices.

- Noncompliance with significant regulatory procedures (i.e., those substantive technical regulatory procedures, designed to directly or indirectly minimize or prevent risks, such as inadequate monitoring or failure to obtain required permits).

- Category III findings are those environmental problems where the most broad definition of risk is used. As in Category II, the information available to the team leader may not be sufficient to fully characterize the problem. Under this category, the range of alternatives available for response, and the corresponding time-frames for response, are the greatest. Environmental problems included within this category will typically require lengthy investigation and remediation phases, and multi-year budget commitments. These problems will be included in the DOE-wide prioritization effort to ensure that DOE's resources are used most effectively. Situations that constitute Category III findings include

  - The existence of pollutants or hazardous materials in the air, water, groundwater, or soil resulting from DOE operations that pose or may pose a hazard to human health or the environment.

  - The existence of conditions at a DOE facility that pose or may pose a hazard to human health or the environment.

In general, the levels of pollutants or materials that constitute a hazard or potential for hazard are those that exceed some Federal, state, or local regulations for release of, contamination by, or exposure to such pollutants or materials. However, in some cases, the Survey may determine that the presence of some nonregulated material is in a concentration that presents sufficient concern for local populations or the environment to be included as an environmental problem. Likewise, the presence of regulated materials in concentrations below those established by regulatory authorities that present a potential for hazard or concern may be classified as an environmental problem.

Conditions that pose or may pose a hazard are generally those which are violations of regulations or requirements (e.g., improper storage of hazardous chemicals in unsafe tanks). Such conditions present a potential hazardous threat to the health and the environment and should be identified as an environmental problem. Additionally, potentially hazardous conditions are those where the likelihood of the occurrence of release is high. In general, however, conditions that meet regulatory or other requirements, where such exist, should not present a potential hazard and will not be identified as an environmental problem. The definition of the term environmental problem is broad and flexible to allow for the wide variability among the DOE sites and operations. Therefore, a good deal of professional judgment must be applied to the identification of environmental problems.

- Category IV findings include instances of administrative noncompliance and management practices that are indirectly related to environmental risk, but are not appropriate for inclusion in Categories I-III. Such findings can be based upon any level of information available to the team leader, including direct observations by the team members. Findings in this category are generally expected to lend themselves to relatively simple, straightforward resolution without further evaluation or analysis. These findings, although not part of the DOE-wide prioritization effort, will be passed along to the Operations Office and appropriate Program Office for their appropriate action. The survey team leader should request and receive a memorandum from the Operations Office as to their intentions concerning these findings.

Based on the professional judgment of the team leader, the findings within categories are arranged in order of relative significance. Comparing the relative significance of one finding to another, either between categories within a section or within categories between sections, is neither appropriate nor valid. The categorization and listing of findings in order of significance within this report is only the first step in a multi-step iterative process to prioritize DOE's problems.

The next phase of the FMPC survey is sampling and analysis (S&A). Argonne National Laboratory (ANL), the S&A team for FMPC, began taking samples in September 1986. Prior to sampling, an S&A Plan is prepared by DOE and ANL in accordance with the protocols in the DOE Environmental Survey Manual. The S&A Plan is designed to fill existing data gaps or weaknesses. The results generated by the S&A effort are used to assist the survey team in further defining the existence and extent of environmental problems and risk identified during the survey.

An Interim Report is prepared 6 to 8 weeks after the completion of the S&A effort. The Interim Report incorporates the results of the S&A effort as well as any changes or comments resulting from the review of the Preliminary Report. Based on the S&A results, the preliminary findings and observations made during the onsite survey may be modified, deleted, or moved within or between categories. The Interim Report will serve as the site-specific source for information generated by the Survey, and ultimately as the site-specific source of information for the DOE-wide prioritization of environmental problems in the final Survey report.

It is clear that certain of the findings and observations contained in this report, especially those in Category II, can and should be addressed in the near-term (i.e., prior to the DOE-wide prioritization effort). It is also clear that the findings and observations in this report are highly varied in terms of magnitude, risks, and characterization. Consequently, the priority, magnitude, and timeliness of near-term responses require careful planning to ensure appropriate and effective action. The information in this Preliminary Report will assist the Oak Ridge Operations Office in the planning of these near-term responses.

2.0 GENERAL SITE INFORMATION

2.1 Site Setting

The Feed Materials Production Center (FMPC) is situated in the southwestern corner of Ohio, approximately 20 miles northwest of the city of Cincinnati, as depicted in Figure 1-1. The plant occupies approximately 136 acres of the total 1,050-acre site owned and controlled by the Department of Energy.

Generally, the area surrounding the plant is rural in nature, with a number of farms surrounding the site. Suburban development is evidenced by recent housing subdivisions and light industrial expansion in the area. Population centers within 5 miles of the site are Fernald (30 people), Shandon (200), Ross (1,700), New Baltimore (200), New Haven (200), Dunlap (100), and Harrison (5,400) (DOE/Battelle, 1981). The population distribution in the surrounding area is summarized below (Aas, et al., 1986):

Distance (miles) from FMPC	Population
0-5	10,850
5-10	277,859
10-20	875,153
20-50	1,413,126

The FMPC site is located in both Hamilton and Butler Counties. Hamilton County had an estimated population of 883,739 people in 1977, whereas Butler County had significantly fewer people--250,479 (DOE/Battelle, 1981). Hamilton County is 414 square miles in area and Butler County is slightly larger at 471 square miles. Hence, the population density in Hamilton County is about 4 times greater than in Butler County. Population changes in the area are modest. Between 1960 and 1970 the two counties experienced population increases, with Hamilton County increasing by 6.8 percent and Butler County by 13.6 percent, whereas the overall population in the State of Ohio increased by 9.8 percent. From 1970 to 1977, the growth slowed, with Hamilton County experiencing a 4.6 percent decrease and Butler County increasing by 10.7 percent while the State increased by 0.4 percent.

It was estimated that the population in the industrial area of the two counties (the Great Miami River Basin area) would increase by about 50 percent from 1960 to 1980 and 100 percent from 1960 to 2000 (DOE/Battelle 1981). Because of limited industrial use in the immediate vicinity, growth near FMPC is expected to be much less than that expected for other areas of these counties. It appears reasonable to conclude that land availability in the FMPC area will not become critical during the next several decades.

The percentage of urban dwellers is high in both counties--96 percent in Hamilton and 77 percent in Butler. Although there is a substantial manufacturing/industrial operation in Hamilton and Butler Counties, farming is also a major economic activity. Dairy and beef farming and raising grain crops, such as sweet and grain corn, soybeans, and wheat, are the primary agricultural activities. Recent years (1974-1979) have seen a 15 to 20 percent decrease in the number of farms in these counties, with an attendant increase in the sales from each farm. This trend reflects a nationwide loss of farmland to urban development and a consolidation of farms for higher productivity.

Land use patterns in the vicinity of FMPC are not expected to change dramatically in the near future. Farmland will decrease and light industrial and residential land use will increase moderately.

The climate in the vicinity of the FMPC is classified as continental, with wide variations in temperatures from winter to summer. Historically, average monthly temperatures range from a low of 32°F in January to a high of 76°F in July.

During the winter and spring, frequent changes in weather occur as cyclonic storms pass over the area. The fall is the season of minimum rainfall. The average annual precipitation measured at FMPC is about 38 inches (DOE/Battelle, 1981), which is comparable to data from Cincinnati and Hamilton (39.8 inches). In recent years, precipitation at FMPC has ranged from 29.2 inches to 47.7 inches. Annual snowfall at Hamilton averages 15 inches, while averages of 24 inches are recorded at the Greater Cincinnati Airport.

Western Ohio lies in an area of moderate tornado frequency. Between 1953 and 1973, Ohio averaged about 13 tornados annually. During that time, eight tornados were observed in Hamilton County and seven in Butler County. Only one tornado is known to have touched FMPC; this occurred May 10, 1969. No damage to FMPC property occurred.

The two types of vegetation that dominate the site are pasture grasses and pine trees. The site is extensively used for pasture by local farmers. About 325 acres of the site are in pasture grasses, primarily leased for dairy cattle (DOE/Battelle, 1981). Large areas of the site, to the north and south of the production areas, have been planted with pine trees, which are presently 10 to 20 feet tall.

2.2 Overview of Major Site Operations

The FMPC produces uranium products that are cast and machined to various physical forms containing a specified concentration of uranium-235. Most of the metallic uranium produced, when cast into ingots, is center-drilled, surface-machined, and sent to DOE extrusion press facilities at the RMI Extrusion Plant in Ashtabula, Ohio. RMI processes some extrusions into fuel billets, whereas other extrusions are returned to the FMPC for heat treatment and fabrication into target fuel cores for DOE reactors. Some derby metal is cast at the FMPC into billets for further processing at the Rocky Flats Plant, Colorado.

The FMPC production process begins at the Sampling Plant (Plant 1), where uranium ore concentrates and recycled materials generated within the FMPC are weighed and sampled to determine their radioactive content. Slags and process residues are reduced in particle size by a ring-roller mill. Materials containing high levels of uranium-235 are digested in a Safe Geometry Digestion System designed to eliminate the accumulation of a critical mass. Plant 1 also manages the largest drum storage lot on site.

The Refinery (Plants 2 and 3) converts ore concentrates and recycled materials into uranium trioxide. These feed materials are initially digested by nitric acid to produce a slurry containing solids, nitric acid, and uranyl nitrate. Uranium is extracted from the slurry by a mixed organic solvent. The remaining nitric acid and impurities (raffinate) are processed to recover more uranium, and the uranium-containing aqueous stream is recycled to the digestion process. Uranium is extracted from the solvent by pure water. The aqueous solution of uranyl nitrate is concentrated by evaporation, then calcined in denitration pots to produce uranium trioxide.

In the Green Salt Plant (Plant 4), uranium trioxide is reduced to uranium dioxide by hydrogen in a fluidized bed reactor. The fluidized bed is formed by hydrogen and nitrogen obtained by the dissociation of ammonia. This hydrogen-nitrogen mixture, which is fed into the bottom of the reactor, holds the uranium trioxide powder in suspension. The uranium dioxide produced in this reaction is reacted with hydrogen fluoride in a series of reaction tubes, each at a higher temperature than the previous one. The uranium dioxide and hydrogen fluoride flow countercurrent to each other in the reaction tubes. Uranium tetrafluoride (UF_4) is the reaction product.

Uranium tetrafluoride is reduced with magnesium in the Metal Production Plant (Plant 5) to form a solid uranium metal called a derby. Uranium tetrafluoride is placed in a magnesium fluoride slag-lined reduction pot containing magnesium granules. The pot is heated for 3 to 4 hours until a spontaneous reaction occurs to produce uranium metal. Some derbies are melted in a graphite crucible and poured into a mold to produce an ingot.

Ingots are processed into fuel element cores in the Metal Fabrication Plant (Plant 6). They are center-drilled, heat-treated in a molten salt bath, inspected, and shipped to RMI for extrusion. Extruded tubes are returned from the RMI facility for cropping and finish machining to produce fuel elements. Ingots are treated in a molten salt bath, rolled to round rods, cut, heat-treated, and machined to specified sizes.

The Scrap Recovery Plant (Plant 8) processes uranium-containing materials from the FMPC and other DOE sites to remove contaminants prior to recycling to the refinery. Depending upon the material and the contaminants, they may be washed, filtered, or roasted to oxidize metals, oil, and graphite contaminants. Particle-size screening, milling, crushing, and drying operations are also involved.

The Pilot Plant has a wide range of equipment for processing gases, solids, and liquids that contain uranium. Operations vary depending upon materials available and product demand. Uranium metal is recovered from aluminum-clad fuel cores by dissolution of the aluminum cladding and aluminum-silicon bonding material. Enriched uranium-containing materials are roasted to oxidize contaminants prior to being recycled in the enriched digestion system of the sampling plant. Autoclaves and tube reactors convert uranium hexafluoride to uranium tetrafluoride. Although FMPC does not currently process thorium materials, the Pilot Plant has the capability to convert thorium nitrate solutions into thorium compounds or metals. This process involves, as necessary, solvent extraction, precipitation, filtering, oven drying, furnace dehydration, furnace reduction, and zinc removal in vacuum furnaces. The plant also has facilities for miscellaneous operations, such as shot-blast cleaning of derbies and salt-bath heat treating.

The Special Products Plant (Plant 9) processes metal solids too large to be handled in the metal production and fabricating plants. Induction furnaces cast large-diameter enriched ingots for nuclear reactors. Derbies are produced in vacuum induction furnaces. Enriched and depleted ingots are machined to standard sizes. The Zirnlo chemical process is used to remove the zircoloy-2 jacket and copper coating from reject fuel elements. Copper is removed by dilute nitric acid and the zircoloy-2 jacket is removed by dilute hydrofluoric acid. The metal cores are recycled to the casting operation.

2.3 State/Federal Concerns

Representatives of the survey team met with the U.S. Environmental Protection Agency (EPA) and the State of Ohio environmental agencies on May 6, 1986, at the FMPC site as part of the pre-survey site visit. At this meeting, the survey team representatives asked the Federal and state representatives to identify and discuss their environmental concerns about the FMPC site so that these concerns could be reviewed during the DOE survey effort. Their concerns are summarized below:

- Storm water discharges to Paddy's Run/sediment contamination in Paddy's Run.
- Ground water contamination on and off site.
- K-65 Silos.
- Waste Pits 1 through 6.
- Tank farm.
- Operation and maintenance of air pollution equipment.
- Ground water movement toward the Great Miami River.
- Potential for releases from the new UF_6 to UF_4 Reduction Facility.
- Uranium contamination of cistern near State Route 126.
- Long-term effects of air releases on water and soil.

The FMPC site has been the subject of continuing negotiations with EPA since 1985, regarding environmental compliance concerns. An agreement between DOE and EPA was concluded shortly after the onsite survey was performed. The survey team was informed of the technical content of this agreement during the investigation. The text of the Federal Facility Compliance Agreement (FFCA) is included in Appendix D for reference.

3.0 MEDIA-SPECIFIC SURVEY FINDINGS AND OBSERVATIONS

3.1 Air

3.1.1 Background Environmental Information

Wind roses for the Cincinnati and Dayton airports are similar and probably representative of wind speed and direction at Fernald. Prevailing winds at the Dayton airport are from the south-southwest throughout the year, as shown on Figure 3-1.

Air quality in the area of FMPC is good. While portions of Hamilton and Butler counties are non-attainment areas for total suspended particulates, the area surrounding FMPC has an attainment atus. Both Hamilton and Butler Counties are attainment areas for sulfur dioxide. Both counties, however, are non-attainment areas with respect to photochemical oxidants.

Background concentrations of total suspended particulates (annual geometric mean) for 1983 were reported to be 80 $\mu g/m^3$ and 61 $\mu g/m^3$ for Hamilton and Butler Counties, respectively (Ohio EPA, 1985). Sulfur dioxide concentrations (annual arithmetic mean) were 37 $\mu g/m^3$ and 31 $\mu g/m^3$ for Hamilton and Butler Counties, respectively. Nitrogen dioxides were reported for Hamilton County only at 68 $\mu g/m^3$ (annual arithmetic mean).

Background gross beta, plutonium (Pu), and uranium (U) in the air were recorded at Columbus, Ohio (EPA, 1985a) as follows:

Parameter	Concentration (picoCurie per liter - pCi/l)
Gross Beta	1×10^{-5}
Pu-238	8×10^{-10}
Pu-239	3×10^{-10}
U-234	4.05×10^{-8}
U-235	7×10^{-10}
U-238	3.83×10^{-8}

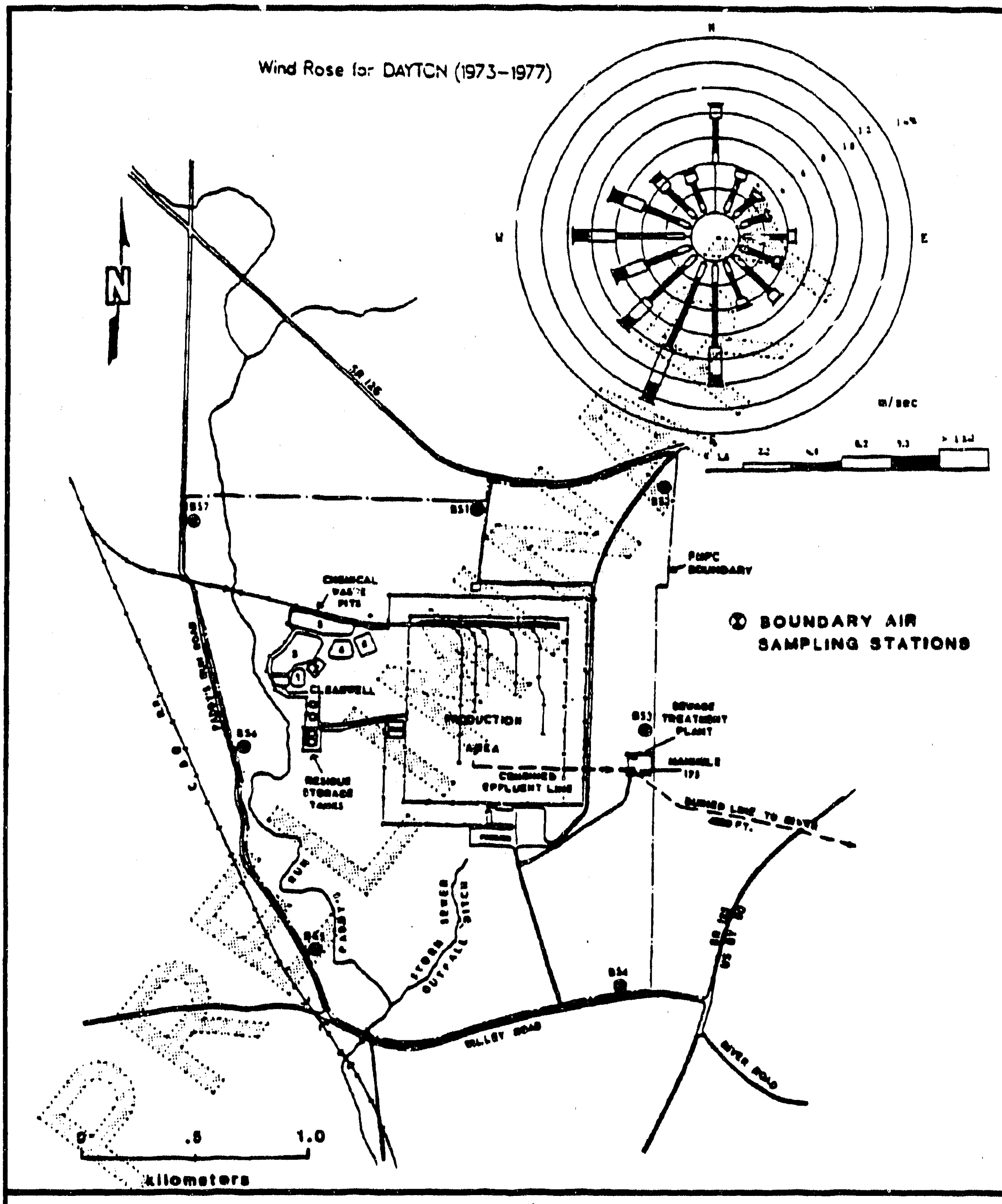


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FIGURE 3-1

DAYTON WIND ROSE AND FMPC BOUNDARY AIR MONITORING STATIONS

3.1.2 General Description of Pollution Sources/Controls

Any discussion of air emissions, controls, and problems at FMPC is complicated by the large number of production processes with their attendant sources and stacks. There are approximately 430 process-emission sources at FMPC and 109 emission point sources (stacks and vents). Control equipment has been installed at most point sources. These controls consist primarily of fabric filters, with a small number of electrostatic precipitators, venturi scrubbers, and high-efficiency particulate (HEPA) filters. .

Particulates are the predominant emission from the site as a result of the handling of the production feed materials, the conversion process to metal, and the grinding/milling of metal into various product forms. The particulate emissions are of special concern because of their uranium and other radionuclide constituents. Large quantities of magnesium fluoride are also produced. FMPC emits smaller amounts of nitrogen oxides (NO_x) from the substantial nitric acid operations on the site. Small amounts of kerosene and hydrogen fluoride (HF) are also generated by uranium refining processes. The kerosene emissions are attributable to the tributyl phosphate and kerosene mixture used in Plant 2/3 to recover uranium from the uranyl nitrate solution. Trace amounts of hydrogen fluoride emissions result from the Plant 4 operations and the conversion of uranium hexafluoride (UF_6) to uranium tetrafluoride (UF_4) in the Pilot Plant.

A steam plant with four boilers also operates on the FMPC site to provide steam for the production processes. Emissions from these coal-fired boilers include particulates, sulfur dioxide, and nitrogen oxide. An electrostatic precipitator is used to control emissions from the steam plant. Only two of the boilers (No. 1 and No. 3) are currently operational. Both boilers were tested during 1985 and met the State of Ohio discharge standards for particulates. Sulfur dioxide emissions are controlled by using coal that contains 1 percent or less sulfur (Aas, et al., 1986).

FMPC categorizes 15 sources as "major" since these account for over 90 percent of the uranium-containing particulate emissions in most years. Table 3-1 shows a breakdown of "major" uranium sources in 1984 (Spenceley, 1985).

TABLE 3-1

MAJOR URANIUM AIR EMISSION SOURCES
FMPC - FERNALD, OHIO

Discharge Number	Plant Number	Emission Source	Control System	1984 Emissions (Pounds Uranium)	Cumulative % of Total Emissions
G9N1	9	Remelt Furnace	Fabric Filter	374.1	47.3
G4-2	4	Packaging	Fabric Filter	66.8	55.7
G5-261	5	Crucible Burnout	Fabric Filter	65.0	64.0
8-RKS	8	Rotary Kiln	Scrubber	63.7	72.0
G5-55	5	Storage	Fabric Filter	34.2	76.3
G5-259	5	Crucible Burnout	Fabric Filter	33.1	80.5
1-SLY	1	Cutting/ Milling	HEPA Filter	19.4	83.0
G5-260	5	Casting	Fabric Filter	18.5	85.3
8-OFS-1	8	Oxidation Furnace	Scrubber	11.5	86.8
G5-251	5	Blending	Fabric Filter	11.0	88.2
G4-5	4	Packaging	Fabric Filter	9.3	89.3
G4-14	4	Packaging	Fabric Filter	7.9	90.3
8-035	8	Oxidation Furnace	Fabric Filter	7.9	91.3
G5-254	5	Breakout	Fabric Filter	6.6	92.2
8-024	8	Muffle Furnace	Fabric Filter	6.0	92.9
All Others	-	--	--	56.0	100
Total	-	--	--	791*	100

* Not including unmonitored sources.

Standard operating procedures (SOPs) have been developed at FMPC to limit discharge of uranium-containing particulates. As of May 1986, more than half of the point sources (59) were sampled for particulate uranium by drawing a continuous fraction of the effluent flow through a pleated filter (called the "side stream filter" method). In addition, 22 of the stacks with the highest potential for uranium releases are equipped with radiation alarms. The alarms are pancake-type detectors mounted adjacent to the sampling filter and connected to alarm count rate meters. The intent of the alarm system is to detect any release of a small, arbitrarily chosen quantity (0.1 kilogram or more) of uranium. The meters are connected to both local audible and visual alarms and to the central alarm system in the security office.

The sampling filters are changed monthly in most stacks, or two times per week in selected stacks. The filters are changed more frequently if soiling of the filters is noticed or if the alarm indicates a greater-than-anticipated load.

Not only are point sources a concern for air emissions at FMPC, but also fugitive emissions. Fugitive emissions can be categorized as one of two types at the FMPC site: current emissions and resuspension of past emissions. Current fugitive emissions are those that escape from the process buildings through doors, windows, and exhaust fans that are not considered point sources/stacks. These emissions are primarily particulates and fumes from leaks in piping and tanks in the uranium processing operations. Additionally, fugitive emissions result from the fly ash piles, landfill, waste pits, tank farms, and waste drums on the site. Uranium has been historically deposited on roadways, fields, and storage areas of the plant from spills, accidents, and air emissions, as discussed in the following paragraphs. These uranium particles can be resuspended in the air and become an added source of fugitive emissions.

Historical uranium air emissions from the FMPC have contaminated soils on and near the site. The historical airborne releases are important, therefore, not only because of their direct air-quality impact, but also because the uranium-bearing particulates are a source of soil contamination (see Section 3.2.2) and, through leaching, a source of ground-water contamination (see Section 3.4.2).

Based on the activity mean aerodynamic diameter (AMAD) of particulates measured in 15 stacks (Spenceley, Undated), most of the airborne particles released to the atmosphere will be deposited on the ground within 1.5 kilometers of the source. The actual distribution depends on the source emission characteristics and meteorology, but a major portion of the historic airborne releases has likely deposited within the site boundary. The high levels of contamination found in soils around the decommissioned incinerator at the waste water treatment plant are indicative of a source that has experienced downwash while in operation. Aerodynamic downwash of plumes from many of the stacks and vents is likely to be a concern in the process area. Resulting soil contamination poses a potential problem because these soils are a source of fugitive emissions that may contribute to offsite doses from the inhalation and ingestion pathways as well as surface and ground-water contamination.

In 34 years of operation, FMPC has released an estimated 96,000 kilograms (kg) of uranium to the atmosphere (DOE, February 6, 1985). As shown in Figure 3-2, the major contribution to the total airborne releases occurred prior to 1970. One third of the total airborne releases occurred during 2 years of operation: 1955 (21,000 kg uranium) and 1956 (9,500 kg uranium) (Boback, 1986). From 1957 through 1969, uranium releases to the atmosphere averaged approximately 4,500 kg per year, with a maximum of about 7,500 kg in 1964, and a minimum of 1,388 kg in 1969. This reduction in airborne emissions reflects the improved control technology at the facility, reduced levels of uranium production, and shutdown of certain processes. Since 1970, uranium releases have averaged less than 2,000 kg per year.

In the period from January 1983 through May 1986, releases have totaled 660 kg uranium, which is an annual average of less than 200 kg per year. The following table provides a plant-by-plant summary of the reported uranium emissions to the atmosphere from FMPC during that period:

Source	Uranium Air Emissions (kg)				
	1983	1984	1985	1986(1)	Total
Plant 1	6.4	12.1	1.1	0.0	19.6
Plant 2/3	0.0	4.3	14.6	0.0	18.9
Plant 4	42.9	39.6	10.2	9.0	101.7
Plant 5	41.4	83.9	12.4	3.0	140.7
Plant 6	0.0	1.0	0.0	0.0	1.0
Plant 8	82.1(2)	76.8(2)	27.3	7.8	194
Plant 9	0.0	170.9(3)	2.2	0.6	173.7
Pilot Plant	0.0	2.8	6.5	9.8(4)	19.1
Total	172.8	391.4	74.3	30.2	668.7

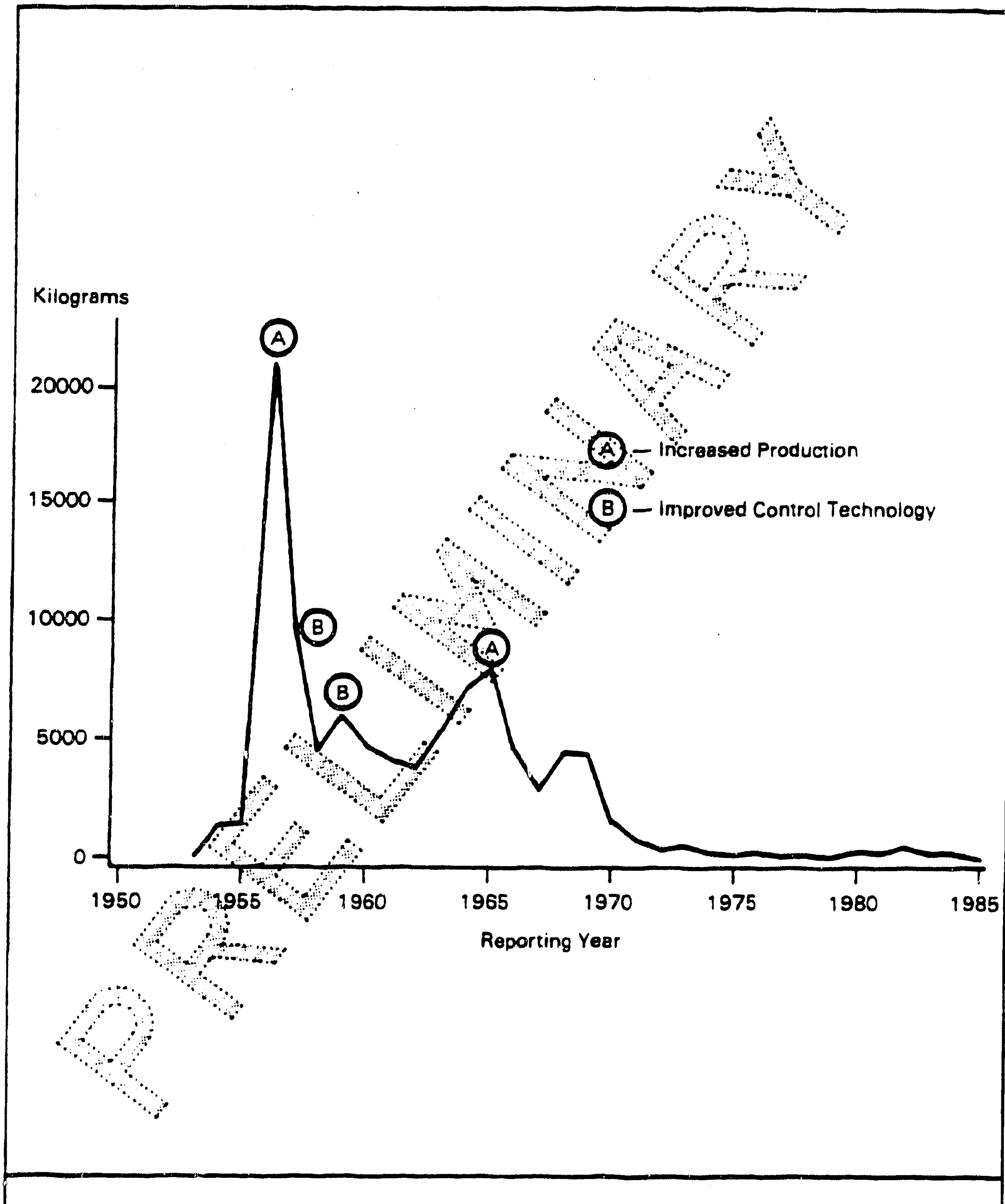
Notes:

(1) For period January through May 1986.

(2) Assumes that the difference between annual emission and reported sources is the Plant 8 rotary kiln and furnaces.

(3) Includes accidental release from the G9NI-1039 baghouse (160 kg).

(4) Includes accidental release of January 1986 (9.2 kg) (see Appendix F).



ANNUAL RELEASES OF URANIUM TO THE AIR FROM THE FEED MATERIALS PRODUCTION CENTER **FIGURE 3 - 2**

Even including the accidental releases of 1984 (Plant 9) and January 1986 (Pilot Plant), there is a clear trend showing improved control of the particulate emissions. Based on these emissions data for the past 3-1/2 years of operation (with no known accidental releases), Plants 4, 5, and 8 contributed about 62 percent of all uranium-bearing particulate emissions. A comparison of historical stack emissions to ambient air monitoring data is presented in Appendix E.

FMPC SOPs developed to limit particulate uranium discharges include administrative controls instituted in all process baghouse filters directed at the timely detection of failures, to avoid a repetition of the 1984 accidental release from the G9N1-1039 (Plant 9) baghouse. Appendix F provides information concerning the 1984 accidental release to the atmosphere at FMPC. These SOPs include a daily visual inspection of the baghouse for signs of failure and hourly checks and recording of the differential pressure across the baghouse. In some facilities, such as G9N1-1039, a high-efficiency particulate (HEPA) filter has been installed downstream of the baghouse. Based on the 1985 and 1986 emissions data, these measures have been effective in reducing the airborne releases of uranium-bearing particulates.

As noted above, control of radioactive releases at FMPC shows continuing improvement. However, in 1984 (partially as a result of the accidental release from September to December 1984), FMPC would have exceeded USEPA's February 1985 air emissions standards for uranium (40 CFR 61) by 33 percent. The 1984 releases resulted in FMPC having the highest dose to the public (as calculated from the monitors along the plant boundary) of any DOE plant (GAO, December 1985).

The contamination of soils (that subsequently become a fugitive air emissions source) by past operational practices at FMPC is not confined to radioactive materials. Lead shot has been used in the Plant 1 drum shot blaster, and the historical emissions from this facility are considered not only a potential source of lead soil contamination, but also a fugitive air source. Similarly, the concentration levels of asbestos found in landfill water samples (10^6 fibers per liter) suggests that the contamination of landfill soils is also a potential concern as a fugitive air emission source of a regulated hazardous air pollutant.

Radon-222 is a naturally-occurring isotope produced from the decay of radium-226. Radon, through its particulate daughters, has been known to be a causative agent for lung cancer where it is present in high concentrations such as in uranium mines. More recently, increasing concern has been expressed at the possible health hazards associated with exposures to lower levels of radon over a long period of time. These lower levels, elevated over the average outdoor ambient value of about 0.2 pCi/l, arise in homes and buildings sealed from normal atmospheric dilution for energy conservation. Other recognized sources of radon exposure to the general public include uranium mill tailings piles, phosphate deposits and processing plants, and old radium operations. At FMPC, the primary sources of radon are the K-65 storage silos, which contain approximately 1,652 grams of radium-226.

There are many sources of airborne radionuclides at FMPC that are also important sources of direct radiation. These include the K-65 Silos (the most significant source of radon), scrap piles, rubble piles, abandoned drums, and burial sites, each of which is a source of airborne particulate matter. These are described in Section 4.3.2.

As previously described, all of the major air emission sources and many of the minor sources are monitored by the "side stream filter" procedure. Some of the minor sources are estimated. In Plant 8 wet scrubbers are used to control particulate emissions from the rotary kiln, the oxidation No. 1 furnace, the oxidation No. 2 furnace, and the box furnace. The particulate emissions from these furnaces are not directly monitored, but, instead, are determined from an empirical relationship and the reported hours of operation. These emission factors are

Activity	Emission Factor (grams U/hour)
Rotary Kiln	20.4
Oxidation No. 1 Furnace	7.84
Oxidation No. 2 Furnace	7.84
Box Furnace	1.47

Documentation supporting these emission factors could not be located. Trial burn tests performed by Martin Marietta on the rotary kiln and the box furnace did not involve sampling downstream of the wet scrubbers to determine their collection efficiency. However, in 1985, operation of the kiln and furnaces in Plant 8 was calculated to contribute 23.3 kg (or about 30 percent) of the reported total air emissions of uranium.

3.1.3 Environmental Monitoring Program

This section discusses the air quality monitoring performed at FMPC. Basically, air monitoring is conducted for particulates (including radioactive constituents), radon, and thoron.

Particulates and Radionuclides

FMPC operates seven air monitoring stations located around the perimeter of the site (see Figure 3-1 for locations). High-volume particulate samples are located at these stations and samples are collected on pre-weighed filter paper on a weekly basis. Particulate concentrations are measured by weighing the filters; then the filters are dissolved in acid and the solutions are analyzed for uranium and beta activity. Composites of these weekly solutions are used to analyze for other radionuclides on an annual basis. In 1985, concentrations reported for cesium, neptunium, plutonium, radium, ruthenium, strontium, technetium, and thorium at the boundary air stations were extremely low (Aas, et al., 1986).

The minimum, maximum, and average concentrations of particulates, uranium, and beta activity are summarized on Table 3-2.

FMPC does not monitor for NO_x, SO_2, or fluorides because these parameters are not major emission problems at the site.

The Southwestern Ohio Air Pollution Control Agency has recently agreed to operate FMPC air-monitoring stations at two schools (Crosby and Elder) north of FMPC to monitor air-quality data.

Radon Monitoring

The FMPC routinely measures radon as part of the environmental monitoring program (Table 3-3). The commercially-available Track-Etch® method (Terradex Corporation, Walnut Creek, California) is used to measure radon. A detector is deployed at each location for approximately 3 months. Until 1985, background levels of radon were determined at seven site boundary stations and two offsite stations. In 1985, six new locations were added to the program, primarily to help determine the extent of the radon problem near the K-65 silos. Six additional locations near the K-65 silos were added to the program in 1986.

Between 1982 and 1986, the overall average boundary station radon concentrations ranged from 0.62 to 0.94 pCi/l. The maximum boundary station annual average was 1.097 pCi/l from station BS7 in 1982. The overall average offsite concentrations ranged from 0.66 to 0.81 pCi/l. The highest radon concentrations were obtained near the K-65 silos. The station designated K-65 (top) had an average radon concentration of approximately 99 pCi/l.

TABLE 3-2

PARTICULATES, URANIUM, AND GROSS BETA ACTIVITY AT FMPC (1985)[1]
FMPC - FERNALD, OHIO

Sampling Location	Number of Samples	Particulates (ug/m³)			Uranium (pCi/l x 10^{-5})			Beta Activity (pCi/l x 10^{-5})		
		Minimum	Maximum	Average	Minimum	Maximum	Average	Minimum	Maximum	Average
BS1	53	17	56	31.0	0.013	3.117	0.296	0.81	4.14	1.89
BS2	53	13	57	31.5	0.058	2.629	0.311	1.05	6.07	2.08
BS3	52	16	59	34.9	0.057	2.709	0.557	0.95	6.14	2.64
BS4	53	19	69	40.2	0.044	1.042	0.213	0.96	5.46	2.64
BS5	53	18	82	36.9	0.027	1.892	0.221	0.90	11.94	1.86
BS6	53	12	67	37.3	0.035	1.264	0.247	0.82	9.82	1.94
BS7	53	16	63	35.7	0.011	0.506	0.111	0.79	9.91	1.66

(1)The following guidelines are useful for comparison:

a. Uranium = 2.0×10^{-3} pCi/l as stated in guidelines more stringent than levels set by 10 CFR Part 20, Appendix B
b. Gross β = 1.0×10^{-1} pCi/l as stated in 10 CFR Part 20, Appendix B
c. Particulates = 60 ug/m³ (annual geometric mean) as stated in 10 CFR Part 50, National Ambient Air Quality Standards

TABLE 3-3

RADON STATIONS AND AVERAGE RESULTS FOR THE FMPC MONITORING PROGRAM
FMPC - FERNALD, OHIO

Station	Annual Average (pCi/l)					
	1982	1983	1984	1985	1986 (1)	Average ± 2σ
BS1	0.79	0.65	0.92	0.81	0.14	0.66 ± 0.61
BS2	0.91	0.77	0.80	0.82	0.61	0.78 ± 0.22
BS3	0.66	0.76	0.84	0.28	1.04	0.72 ± 0.56
BS4	0.90	0.65	0.59	0.56	0.40	0.62 ± 0.36
BS5	0.94	1.05	0.97	0.80	0.18	0.79 ± 0.70
BS6	1.01	0.82	0.58	1.06	0.81	0.86 ± 0.38
BS7	1.07	0.91	0.72	1.01	0.98	0.94 ± 0.27
OS1 (8 mi ENE)	0.56	0.77	0.84	0.59	1.29	0.81 ± 0.59
OS2 (5 mi WSW)	0.66	0.61	0.36	0.37	1.29	0.66 ± 0.76
K-65 (Top)	–	–	–	123.85	74.10	98.98 ± 70.36
K-65 (NW fence)	–	–	–	7.73	5.58	6.66 ± 3.04
K-65 (NW fence)	–	–	–	1.78	1.93	1.86 ± 0.21
K-65 (SE fence)	–	–	–	1.51	4.85	3.18 ± 4.72
N metal oxide tower	–	–	–	1.12	0.47	0.80 ± 0.92
W water tower	–	–	–	0.75	1.98	1.37 ± 1.74
K-65 (fence W of S tank)	–	–	–	–	7.54	–
K-65 (fence W of N tank)	–	–	–	–	8.59	–
K-65 (NE rail of S tank)	–	–	–	–	49.81	–
K-65 (fence E of N tank)	–	–	–	–	11.19	–
K-65 (SW fence)	–	–	–	–	5.98	–
K-65 (fence E of S tank)	–	–	–	–	7.54	–

(1) First-quarter results only.

Thoron Monitoring

With the presence of thorium compounds in storage at FMPC, there is the potential for offsite exposure from thoron gas (radon-220) and daughter products. Thoron appears halfway down the thorium decay chain. Thorium-228 ($T_{1/2}$ = 1.9 years) decays to radium-224 ($T_{1/2}$ = 3.7 days), which in turn decays to thoron ($T_{1/2}$ = 55.6 seconds). Monitoring of thoron near the thorium storage areas is warranted, since thoron decay products pose health risks similar to radon decay products. Monitoring of thoron off site is also necessary to ascertain thoron background activities.

At the time of the survey, FMPC was measuring thoron at two locations, but analytical results were not yet available.

The Track-Etch® method is also used to measure thoron. Two Track-Etch® detectors, each mounted inside a plastic cup with different semipermeable membranes, are deployed at each station for approximately 3 months. The first detector discriminates against thoron while permitting radon to enter the cup, and the second detector permits both radon and thoron to enter the cup. The thoron activity is determined from the difference between the activities of the two detectors.

3.1.4 Findings and Observations

3.1.4.1 Category I

None

3.1.4.2 Category II

1. Radon Releases. Radon releases from the K-65 silos may result in a pulmonary dose that exceeds the risk-based inhalation dose guidelines established by U.S. EPA for other radionuclides.

   This dose was estimated from measurements of radon activity by FMPC programs using Track-Etch® detectors. The measurement of 0.5 pCi/l above background at the site boundary was extrapolated to the Paddy's Run Road residence, assuming that the concentration decreases in proportion to the square of the distance from the source.

A calculation was made to estimate the bronchial-pulmonary dose rate from the inhalation of radon daughter products to a person living near Air Station BS6 on Paddy's Run Road. This is the closest residence to the K-65 storage tanks. The average radon-222 activity, used for the background subtraction, averaged 0.48 pCi/l. The above-background activity at BS6, therefore, was approximately 0.5 pCi/l. Because this location is about 0.4 miles from Station BS6, the activity of radon at the house is assumed to be 0.25 pCi/l, about a factor of 2 less than 0.5 pCi/l. According to NRC Regulatory Guide 3.51, the indoor dose from a concentration of 1 pCi/m^3 outdoors is 0.625 millirem/yr. Therefore, with an outdoor concentration of 0.25 pCi/l (or 250 pCi/m^3) at the house on Paddy's Run Road, the indoor dose becomes 156 millirem/yr to an individual residing at the house.

This dose would be in excess of the 75 millirem guideline (40 CFR 61) for a dose from gaseous effluents from DOE facilities. This guideline specifically states that the rule does not apply to radon. However, in the rationale for the guideline, the following explanation is offered: ". . . available information suggests that the DOE facilities that are covered by this standard are likely only to have relatively small total quantities of materials containing radium-224 and radium-226, the sources of radon-220 and radon-222, respectively. The quantities of these materials will be much smaller than uranium mill tailings piles, for example. In practice, EPA expects DOE will seal up all significant sources of radon emissions to air or take other appropriate control action as part of their (As Low As Reasonably Achievable) ALARA Program" (EPA, 1985).

Sampling by Argonne National Laboratory (ANL) is being performed to better define the impact at Paddy's Run Road.

2. <u>Fugitive Uranium Releases</u>. There are numerous sources of fugitive airborne emissions of uranium-containing particulates at FMPC based on observations made during the survey. These fugitive emissions could cause adverse environmental impacts to offsite receptors.

Contaminated soils can become airborne from road traffic and/or wind erosion. Fugitive emissions from the fly-ash piles, especially the inactive fly-ash pile, which had been treated with contaminated oils as a dust suppressant, are of major concern. The concrete pad between Pits 4 and 5 and the dried-out areas observed in various waste pits are potential fugitive sources of airborne uranium. Obviously all plant roadways and other paved areas are fugitive sources of airborne particulates.

Soil samples being collected by ANL will provide data to quantify the potential effects of fugitive sources of uranium-containing particulates.

3. Perchloroethylene Emissions. Uncontrolled emissions of perchloroethylene, a toxic air pollutant, from the dry-cleaning facility present both an onsite and a potential offsite hazard.

Because of its toxic nature, USEPA has announced that it intends to list perchloroethylene as a toxic air pollutant. The studies to develop concentration limits and emission control technology are now in progress. In anticipation of this occurrence, the survey team estimated that the amount vented to the atmosphere between July 1985 and June 1986 was about 21,000 pounds, compared to a permit limit of 2,475 pounds per year. This quantity was estimated by assuming that 90 percent of the 23,800 pounds purchased annually (July 1985 to June 1986) became airborne.

4. Plant 5 Fugitive Emissions. Uncontrolled emissions from Plant 5 are a source of fugitive uranium-containing emissions at FMPC.

A total of 207 magnesium flashes and 23 blowouts occurred in the area of the Plant 5 Rockwell furnaces during the first 3-1/2 months of 1986. These events released uranium-bearing particulates into the building air, which were then released to the outside environment through the building ventilation system. These events are considered to be a potentially important source of unmonitored and uncontrolled emissions at FMPC.

5. Lead Contamination. Lead contamination of the site soils could be the result of the past use of lead in the Plant 1 shot blaster. These soils can be resuspended and provide a continuing source of airborne concentrations of lead at the site.

Lead is a toxic metal for which air quality standards have been established. Standards may not be violated by this resuspension, but the lead will add to the body dose already received from other sources and may possibly result in long-term health effects.

ANL is analyzing the lead content in a number of soil samples in order to estimate the potential extent of this problem.

6. Plants 6 and 9 Emissions. Uncontrolled emissions of uranium-containing particulates occur from Plants 6 and 9 because the electrostatic precipitator (ESP) units are not functional.

These units, the principal control for particulate emissions from various machining operations, have not, according to site personnel, operated for many years. The Plant 9 unit had a coarse fiberglass curtain that could remove the larger particulates. The Plant 6 units (not inspected) presumably have similar screens that appear to originally have served to keep the larger particles from the ESPs. These screens would not be expected to be very efficient for the removal of smaller particles.

These emission sources are minor. (As discussed in Section 3.1.2, the 15 "major" sources account for 90 percent of the uranium emissions.) The stacks at Plants 6 and 9 are sampled continuously. Only one Minor Events Report, required when a sampler detects more than 0.1 kg. of uranium in one month, has ever been filed for these sources.

ANL is collecting samples to more precisely determine the quantities of particulate emissions released.

7. Potential Tank Farm Releases. The accidental release of toxic and corrosive vapors from the Tank Farm presents a potential for both an onsite or offsite environmental hazard. The age and outdated design of the equipment in use at the Tank Farm have led to equipment failure and subsequent spills of hazardous materials (DuPont, 1985).

   During the survey, a small uncontrolled, continuous release of hydrogen fluoride was observed in the piping from an out-of-service tank (Tank 4). There are large quantities of anhydrous hydrogen fluoride and anhydrous ammonia handled and stored at the Tank Farm; these could be released as toxic and corrosive vapors. Normal load-in operations, accidents, and/or major storage tank failures could result in offsite concentrations that exceed generally-accepted, short-term exposure limits. (See Section 4.2, Toxic and Chemical Materials, for additional information.)

8. Potential Thorium Releases. Thorium storage at the FMPC was assessed to present a potentially significant air pollution hazard. Potential release of airborne materials from thorium storage facilities under various accident scenarios would present both onsite and offsite hazards.

   The Plant 8 thorium storage silo and its supporting tower are overstressed and could fail if subjected to high winds or an earthquake, according to information provided by FMPC personnel during the survey. Storage at the Pilot Plant warehouse presents a similar hazard from the 55-gallon drums stacked with plywood sheets between layers. Some of the drums are leaning and could fall and rupture. Thorium storage and the direct radiation hazard is discussed in greater detail in Section 4.3.2.

3.1.4.3 Category III

1. Uncontrolled Uranium Stack Emissions. There are a number of unmonitored, uncontrolled uranium particulate emission points at FMPC. These sources can result in high doses to offsite residents.

   Visible plumes, indicative of poor control of particulate emissions, sometimes occur during operation of the box furnace at Plant 8. Four Plant 8 processes--the rotary kiln, the two oxidation furnaces, and the box furnaces--account for an estimated annual release of 23.3 kg of uranium. These uncontrolled releases could reach nearby residents and thereby contribute to their body doses.

2. Pulmonary Doses. Uranium releases from the facility result in higher pulmonary doses to the offsite population than those from other DOE facilities.

   Maximum pulmonary doses were estimated by the survey team from the ambient air concentrations measured at the site boundary over a 4-year period. Doses ranged from 5.6 millirem/year in 1985 to 25.1 millirem/year in 1983. If nonuranium radionuclides are included in the calculations, doses will increase by about 10 percent. Although these levels are higher than at most DOE facilities, they are still below the 75 millirem guideline for the inhalation pathway.

3.1.4.4 Category IV

1. Uranium Detection Limit. No detection limit for uranium calculated by the "side stream filter method" has been established, although a 0.05 kg value is used. This practice may result in an underestimation of the amount of uranium released.

   Many of the calculated values for individual filters are less than 0.05 kg. The practice is to report any value less than 0.05 kg as 0.0. With 10 filter changes in a month, the reported value is still considered 0.0 kg, even though the total uranium released could be as high as 0.5 kg.

2. Air Monitoring Data. Interpretation of the ambient air monitoring data from 1982, 1984, and 1985 could result in either an underestimation or an overestimation (by a factor of two) in the reported uranium emissions. Modeled offsite doses are directly proportional to the annual uranium emissions, and hence the predicted inhalation pathway doses are considered to have the same uncertainty factor.

   This problem is further compounded by the source emission characteristics used in the AIRDOS-EPA dispersion model. Different source characteristics were used in modeling 1985 emissions. The 1985 model used an effluent velocity of 53.5 m/sec, which is considered to be inappropriate because of rain caps on many of the stacks. The difference in source characterization between 1984 and 1985 is of concern because it also affects the predicted maximum dose by an estimated factor of two.

3. Stack Sampling. Non-isokinetic stack sampling heads may result in the selective collection of larger particles and hence a bias in the sample results.

   Based on a review of testing data, the survey team has concluded that the sampling heads fabricated on site are probably not isokinetic (i.e., the sample velocity is not equal to the velocity of the stack air). The velocity differences could bias the data.

4. Sample Flow Rates. Drift in sample flow rates results in inaccurate estimates of the fraction of the total released uranium that is actually sampled.

   The conversion of sampled uranium to released uranium requires an accurate estimate of the fraction of the total released uranium sampled. At FMPC this is accomplished by quarterly, or sometimes less frequent, measurements of velocity in the stack and sample lines. The survey team observed drift in sample flow rates that, although corrected either hourly or by shift, results in inaccuracies in this estimate.

5. Thoron Monitoring Methods. Inappropriate methods are in use for determination of thoron at FMPC. This could result in underestimation of thoron releases.

   As mentioned in Section 3.1.3, the Track-Etch® method is used to monitor radon and is also used to determine thoron. At each station, two Track-Etch® detectors, each mounted in a plastic cup, with different semi-permeable membranes, are deployed. One detector, with a membrane that discriminates against thoron while permitting radon to pass, is used to measure radon. The second detector, with a membrane that allows both radon and thoron to enter the cup, is used to measure radon plus thoron. Thoron is determined from the difference in activity measurements.

Conversations with the Staff Physicist at Terradex Corporation (supplier of the Track-Etch® detector) indicate that the detector is not applicable for precise determination of thoron. Terradex does not quote sensitivities for thoron as it does for radon. In the opinion of the Terradex representative, using two measurements to derive the thoron activities only compounds the potential errors involved.

3.2 Soil

3.2.1 Background Environmental Information

Soils at the FMPC are derived from the glacial sediments. The soils have been mapped as Fincastle-Xenia silt loams. Along the western edge of the site, near Paddy's Run, these soils grade into the Fox-Gennessee silt loams and, at the northeast corner, grade into the Russell-Xenia silt loams.

The predominant soils at FMPC are the Fincastle-Xenia, although these soils have been extensively modified in the production area through excavation and grading, import of fill materials and road gravels, and the paving of roads and parking areas. These native soils are light colored, with medium acidity and moderately high productivity for agricultural purposes (USDA-SCS, 1982). Drainage of these soils is considered poor.

The Fox-Gennessee soils found along Paddy's Run are light colored high in agricultural productivity, with medium acidity (USDA-SCS, 1982). These soils are considered to be well drained but subject to flooding.

Data provided by Myrick, et al. (1983) indicates background surface soil concentrations in Ohio to be as follows:

Radionuclide	Activity (pCi/g)
Ra-226	1.5 (dry weight)
U-238	1.4 (dry weight)
Th-232	1.0 (dry weight)

These radionuclides are naturally occurring members of the uranium and thorium decay chains. The concentrations can be useful when making comparisons to existing surface soil concentrations of these radionuclides in the area surrounding FMPC.

Vegetation and milk samples are collected as indicators of radionuclide contamination of soils. All vegetation samples are washed prior to analysis; therefore, radionuclide concentrations are indicative of plant uptake, not deposition on the plant surface.

Pasture grass samples collected 62.8 km (39 miles) from FMPC had an average total uranium activity of 0.25 pCi/g (dry weight) in 1985 (Aas et al., 1986). Samples of potatoes collected in Indiana in 1985 were used for background comparisons. According to Aas et al. (1986), total uranium from the control stations averaged 0.26 pCi/g (dry weight) for the peels and 0.0054 pCi/g (dry weight) for the flesh.

Milk samples from a dairy in Kentucky approximately 29 km (18 miles) from FMPC had an average total uranium activity of less than 0.68 pCi/l (Aas et al., 1986). According to EPA (1985b), milk samples collected in Cincinnati had the following activities:

Radionuclide	Activity (pCi/l)
Cs-137	3 ±7
Ba-140	5 ±9
I-131	3 ±7

3.2.2 General Description of Pollution Sources/Controls

The airborne uranium released from FMPC has deposited on the soil both on the site and off the site. The primary sources of these releases are discussed in detail in Section 3.1.2. The surface-deposited uranium poses a potential offsite hazard because it can become resuspended in the air or absorbed by vegetation through the roots. The uranium can then be directly inhaled or ingested by humans or ingested indirectly by consuming milk produced by cows that have been feeding on contaminated vegetation.

Uranium found in the soils is primarily the result of past emissions from the FMPC metal production operations. Quantities of uranium released during normal operations were historically much greater than current releases, because of better controls and operational procedures. Additionally, uncontrolled releases or accidents have also been a problem in the past. The characteristics of the uranium particulates released and their aerodynamics indicate that a high percentage have been deposited on local soils in the immediate vicinity of the plant.

Soils contaminated with uranium from air emissions can also serve as a source of stream sediment contamination as a result of overland wash, stream convection, settling, and resuspension mechanisms.

3.2.3 Environmental Monitoring Program

The FMPC environmental monitoring program for soils includes not only the sampling of soil but also vegetation and milk samples because potential contaminants in these media would be derived from contamination of the soil. Uptake of contaminants from the soil by vegetation and cows (milk products) is a potential dose pathway to the surrounding population.

3.2.3.1 Soil

FMPC collects soil samples on an annual basis. Each soil sample is made up of a composite of nine cores, which are 2 centimeters (cm) in diameter and 5 cm deep. The cores are taken from the top layer of the soil profile. From 1982 to 1985, uranium was the primary constituent measured in soil samples collected as part of the FMPC environmental monitoring program. Originally, seven soil monitoring stations were located near the air sampling stations in 1982. Eight additional locations were added to the monitoring program in 1983, bringing the total to 15. Soil sampling locations are presented in Figures 3-3 and 3-4. Table 3-4 compares the uranium concentrations between 1982 and 1985. The overall average uranium activity ranged from 1.6 pCi/g (dry) to 41.0 pCi/g (dry). According to Myrick, et al. (1983), the typical background activity of uranium in soils in Ohio is 1.4 pCi/g (dry). In 1984, samples from 25 soil sampling locations were analyzed for non-uranium isotopes. These isotopes included neptunium-237; plutonium-238, 239, and 240; technetium-99; and thorium-238, 230, and 232. Only the thorium isotopes were positively detected. The overall range of thorium

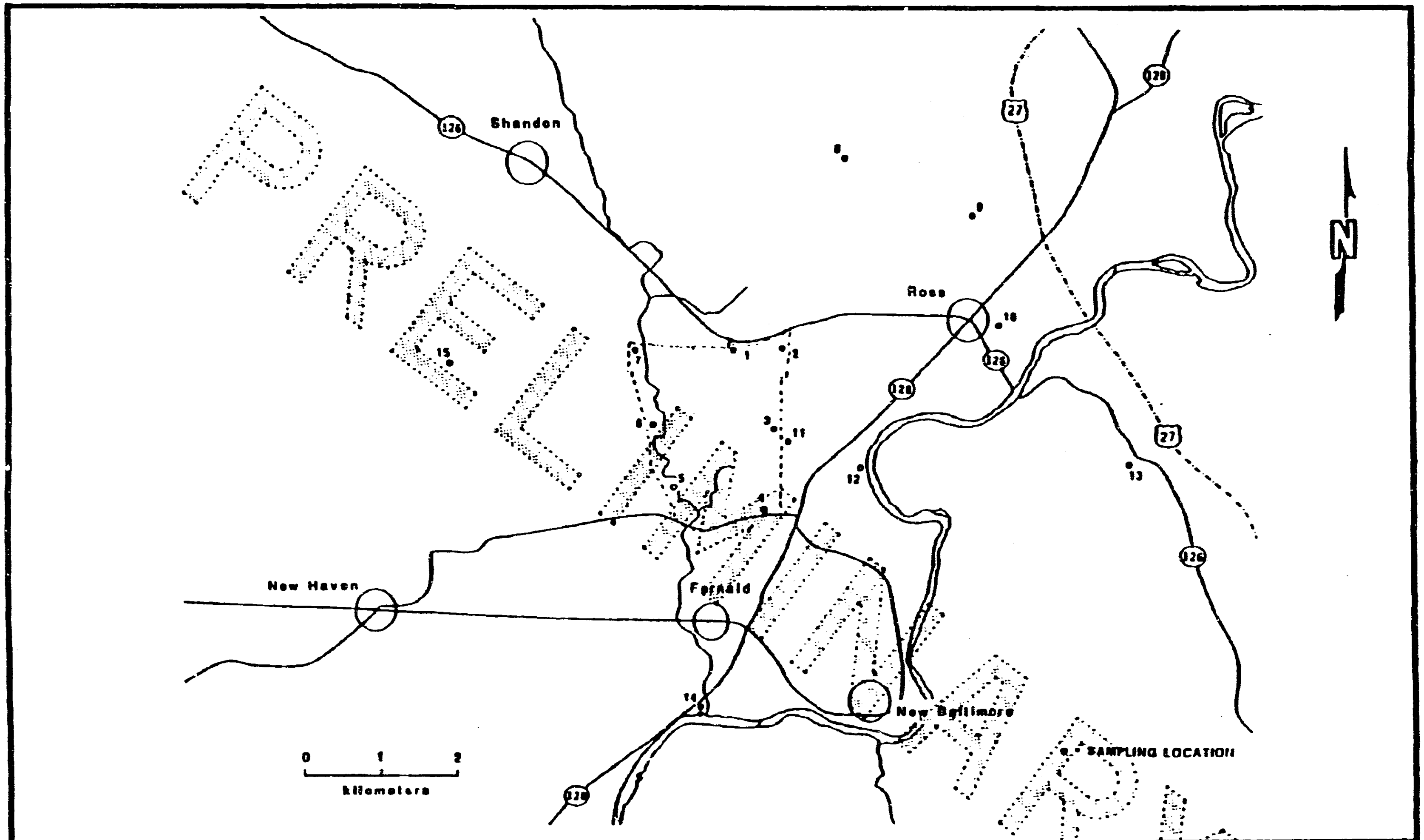


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FIGURE 3-3

ROUTINE SOIL SAMPLING LOCATIONS

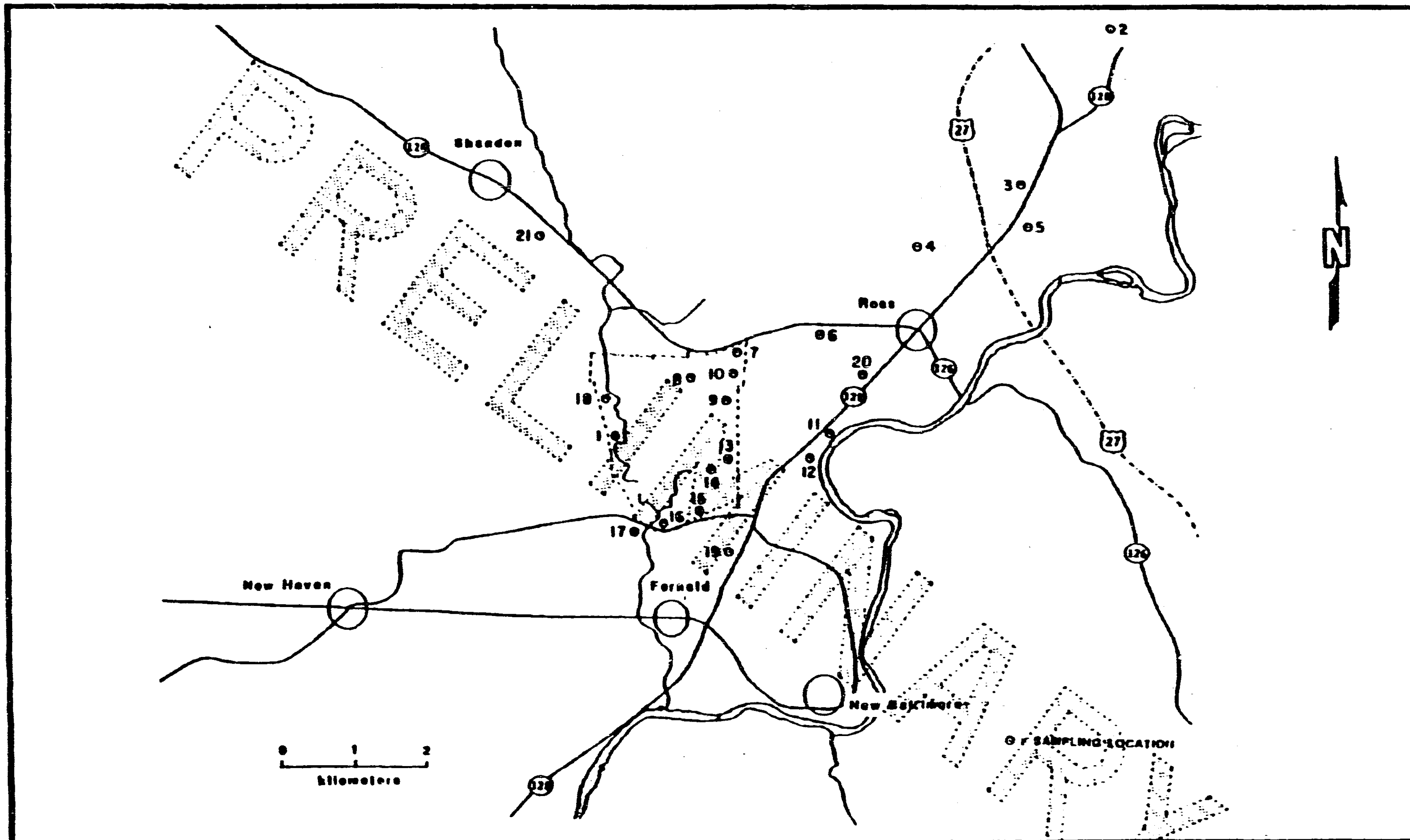


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FIGURE 3-4

LOCATIONS OF PARALLEL SOIL AND GRASS SAMPLING

TABLE 3-4

URANIUM IN SOIL, 1982 - 1985
FMPC - FERNALD, OHIO

Sampling Station	Annual Average (pCi/g)				
	1982	1983	1984	1985	Average ± 2σ
1	3.7	9.5	9.3	4.4	6.7 ± 6.2
2	3.7	13	9.0	2.0	6.9 ± 10.1
3	21	53	54.2	35.9	41.0 ± 31.5
4	1.5	4.7	7.5	3.1	4.2 ± 5.1
5	2.7	6.1	9.1	2.9	5.2 ± 6.1
6	3.1	8.8	4.5	1.3	4.4 ± 6.4
7	1.3	2.7	3.4	0.4	2.0 ± 2.7
8	–	2.0	2.5	0.4	1.6 ± 2.2
9	–	2.7	3.9	1.7	2.8 ± 2.2
10	–	3.3	2.9	0.4	2.2 ± 3.1
11	–	16	16.5	14.2	15.6 ± 2.4
12	–	2.5	2.1	0.7	1.8 ± 1.9
13	–	2.4	3.8	0.4	2.2 ± 3.4
14	–	2.5	2.2	0.6	1.8 ± 2.0
15	–	2.4	7.7	0.4	3.5 ± 7.5

activities was 0.4 pCi/g to 2.0 pCi/g. These values compare well with the average background thorium activity in soil of 1.0 pCi/g (dry) for Ohio (Myrick, et al., 1983).

3.2.3.2 Vegetation

Annual uranium measurements in vegetation (grass, foliage, potatoes) were begun in 1984. Grass and other foliage were analyzed for uranium at 20 locations in 1984 and 29 locations in 1985. These locations are identified in Figure 3-5. Each vegetation sample is a composite of a number of subsamples in order to provide approximately 500 grams (wet weight) total. Each subsample consisted of all above-ground plant material from a 0.5 m diameter circular quadrant. All samples were washed prior to analysis.

In 1984, the uranium concentrations in grass and other foliage ranged from 0.09 pCi/g (dry) at Station 1 (10.5 km from FMPC) to 7.09 pCi/g (dry) at Station 10 (0.8 km from FMPC). In 1985, the uranium concentrations ranged from 0.02 pCi/g (dry) at Station 19 (1.0 km from FMPC) to 2.34 pCi/g (dry) at Station 10 (0.8 km from FMPC). As indicated in Section 3.2.1, the average uranium concentration for FMPC control stations was 0.25 pCi/g (dry) in 1985.

Concentrations of uranium in potatoes in both peels and flesh were measured at six locations in 1984 and at five locations in 1985. These locations are identified in Figure 3-6. The average uranium concentrations (peels) in 1984 ranged from 0.08 pCi/g (dry) at Station 4 to 0.19 pCi/g (dry) at Station 2. In 1985, the average uranium concentrations (peels) ranged from 0.25 pCi/g (dry) at Station 4 to 1.02 pCi/g (dry) at Station 1. The average uranium concentrations in the flesh part of the potatoes were two orders of magnitude lower in both years (less than 0.009 pCi/g [dry]). According to Aas, et al. (1986), the total uranium concentration from potatoes collected in Indiana (control station) averaged 0.26 pCi/g (dry) for the peels and 0.0054 pCi/g (dry) for the flesh in 1985.

3.2.3.3 Milk

Milk produced by cows grazing on FMPC and adjacent pasture land was monitored three times in 1985. The FMPC 1985 Environmental Monitoring Report indicates that the concentration of total uranium in milk is less than 0.68 pCi/l. This result was obtained at both the indicator and the control station. The survey team estimated this concentration of uranium in milk would yield an insignificant dose (bone surface) of 2.49 x 10^{-2} millirem/year to the maximally-exposed individual.

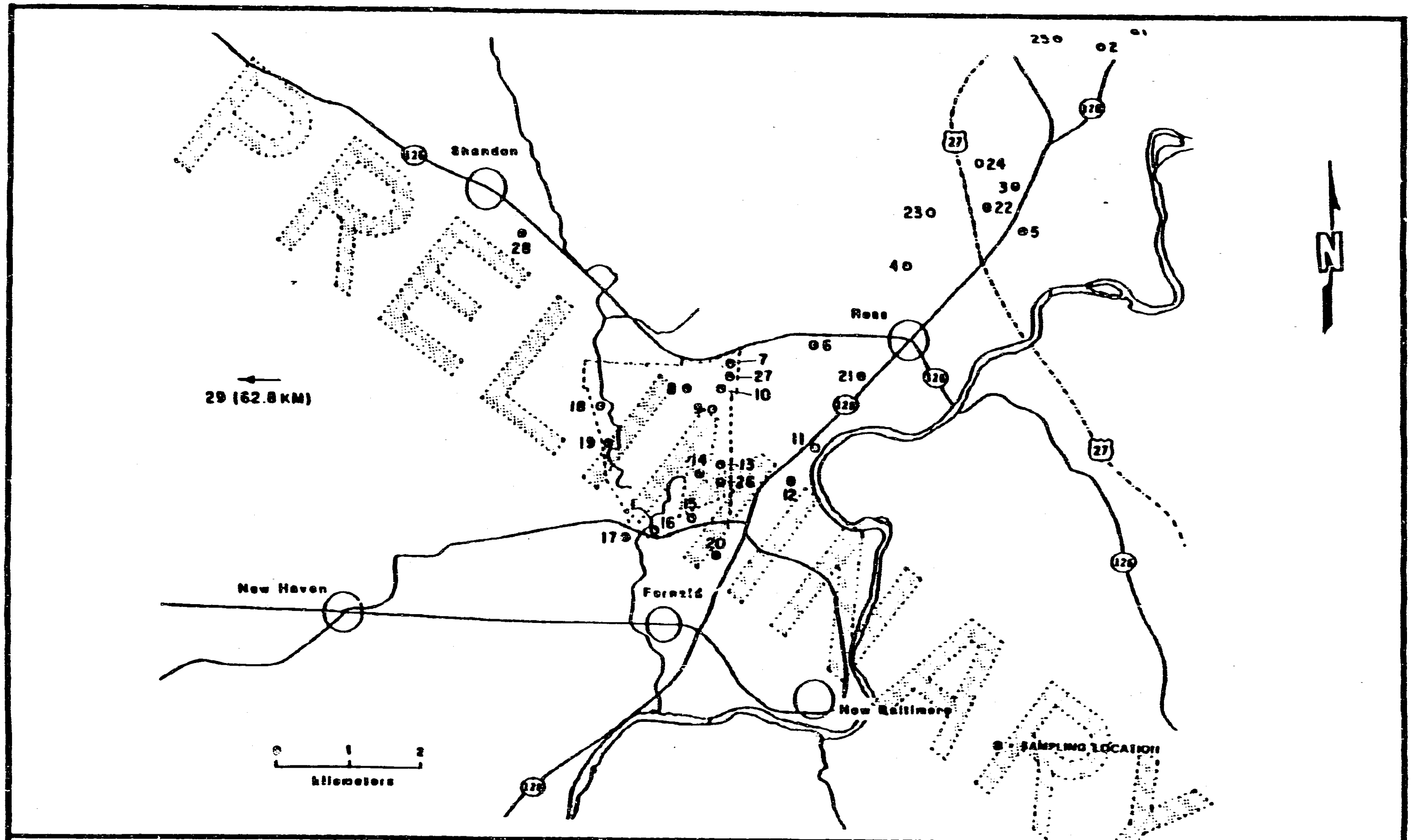


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FIGURE 3-5

GRASS AND FORAGE SAMPLING LOCATIONS

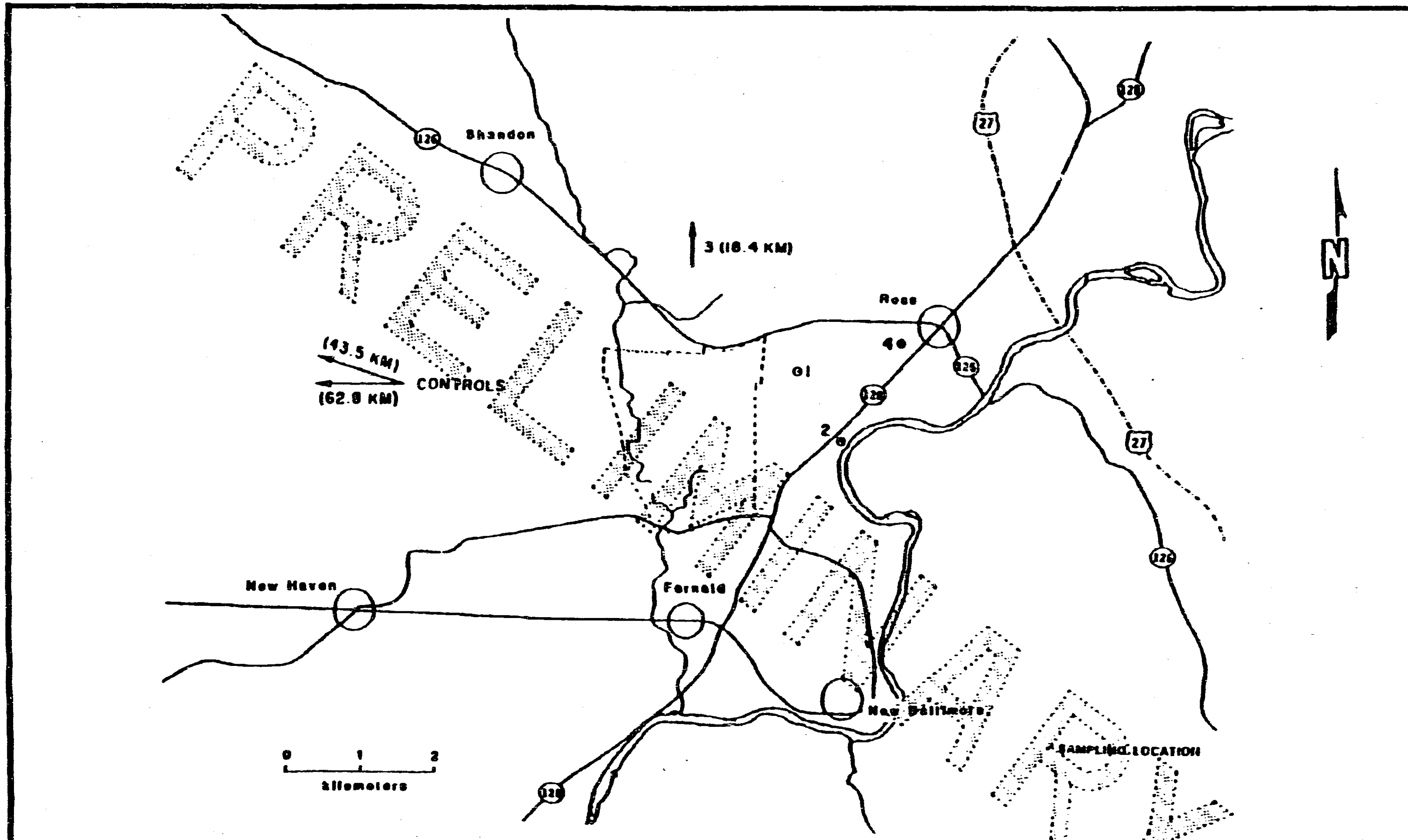


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FIGURE 3 - 6

SAMPLING LOCATIONS FOR GARDEN PRODUCE

3.2.4 Findings and Observations

3.2.4.1 Category I

None

3.2.4.2 Category II

1. Non-Uranium Radionuclides. Potential problems may exist if non-uranium radionuclides are present in the soils or vegetation. The presence of non-uranium radionuclide contaminants is not known because soil samples are currently only analyzed for total uranium. The dose to the maximally exposed individual from ingestion of vegetation containing uranium, explained in Category III, could increase as a result of these non-uranium isotopes. Analytical parameters of concern include

   - Uranium-235
   - Radium-226,228
   - Thorium-232
   - Plutonium-238, 239
   - Neptunium-237
   - Technetium-99
   - Cesium-137

   Survey sampling will be conducted by ANL to determine if non-uranium radionuclides are present in the soil.

3.2.4.3 Category III

1. Soil Contamination. Soil on the FMPC facility has been contaminated with uranium by past releases from the production operations on the site. The contaminated soil may potentially be resuspended in the air, to be transported off the site as a fugitive emission, and contribute to groundwater and surface-water contamination. Uptake of this contamination by vegetation is also a concern.

   Although emissions of uranium from point sources may have been significantly reduced in recent years, a large quantity of uranium exists on soils within the facility boundary from past deposition.

   The FMPC soil sampling program concentrates on offsite locations.

ANL will take soil and dust samples from onsite roadways and paved areas in the production area to better identify this problem.

2. Offsite Doses. Uranium contents of soils at FMPC have reached levels whereby contributions are made to offsite doses. This is not consistent with the DOE philosophy of keeping levels of radiation and doses to the public as low as reasonably achievable (ALARA).

   DOE uses a level of 35 pCi/g (dry) in remedial action programs for acceptance of decontaminated areas. This same value is used at FMPC to define the level at which offsite soils are considered contaminated. Several of the soil monitoring stations at FMPC exceed or approach this limit. Station 3 in Figure 3-3 and Stations 0 and 13 in Figure 3-4 had concentrations of total uranium in 1985 of 36, 64, and 31 pCi/g (dry), respectively.

   Using the 35 pCi/g level of total uranium in soil to estimate the corresponding concentration of uranium in edible plant tissue, the dose to the maximally exposed individual from consumption of that plant tissue was calculated by the survey team to be 6.9 millirem/year. This exposure route is only one component of an air pathway dose and yet represents about 15 percent of the guideline limit of 75 millirem/year. In addition, 6.9 millirem/year is about 1 to 2 orders of magnitude larger than the ingestion dose from all radionuclides attributed to most commercial nuclear facilities.

3.2.4.4 Category IV

None

3.3 Surface Water

3.3.1 Background Environmental Information

Natural surface-water bodies in the area of the FMPC are Paddy's Run and the Great Miami River. As shown in Figure 3-7, Paddy's Run flows in a southerly direction just inside the western boundary of the FMPC. The Great Miami River flows in a southerly direction east of FMPC and intersects with Paddy's Run approximately 3 km south of the site. The Great Miami River joins the Ohio River farther downstream.

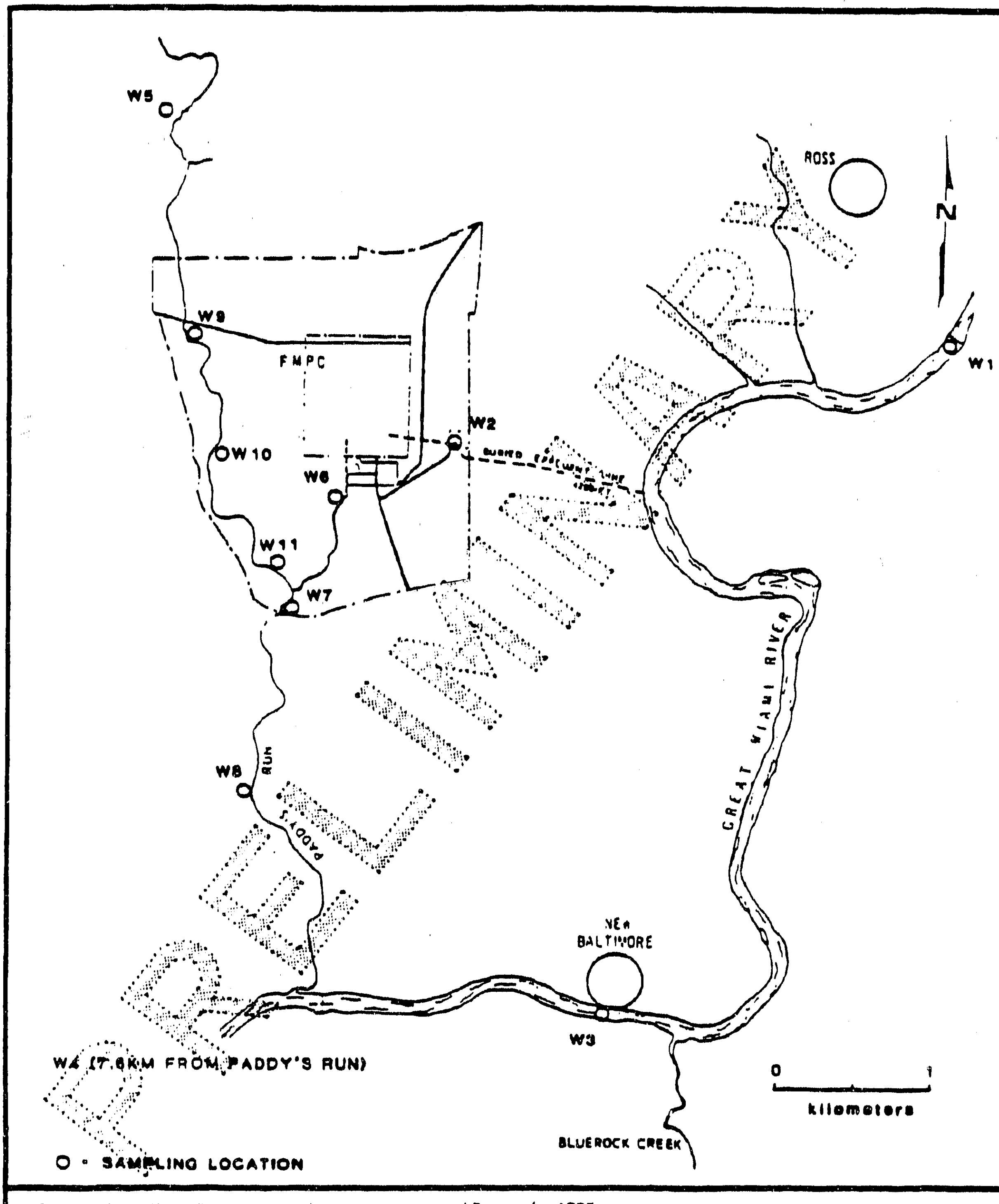


FIGURE FROM: FMPC Environmental Monitoring Annual Report for 1985

FIGURE 3-7

SURFACE WATER SAMPLING LOCATIONS

The intermittent nature of Paddy's Run restricts its use for many purposes. Because of industrial and municipal wastes introduced from upstream communities such as Dayton, Middletown, and Hamilton, the Great Miami River is not extensively used for recreational purposes. There are no known potable water users of the river downstream from FMPC.

The U.S. Geological Survey (USGS) has operated a sampling station on the Great Miami River at New Baltimore, Ohio, since 1966. Data extracted from USGS (1980) for the Water Year 1979 (October 1978 through September 1979) are presented in Table 3-5.

In addition to the total organic carbon data provided in Table 3-5, the USGS analyzed for pesticides in both the water and bottom material at the New Baltimore location. One sample of the bottom material contained 0.6 mg/l of dieldrin. No other pesticides were detected in these samples. Background analytical data on other organic compounds were not obtained.

Average surface-water radionuclide activities and inorganic ion concentrations for Paddy's Run and the Great Miami River upstream of FMPC, provided by Aas, et al. (1986), are as follows:

Analyte	Upstream Paddy's Run	Upstream Great Miami River
Gross Alpha	2.77 pCi/l	2.24 pCi/l
Gross Beta	5.85 pCi/l	4.91 pCi/l
Technetium-99	--	1.08 pCi/l
Uranium-234	--	3.72* pCi/l
Uranium-235	--	0.16* pCi/l
Uranium-238	--	3.72* pCi/l
Total Uranium	1.60 pCi/l	1.57* pCi/l
Fluoride	0.25 mg/l	0.49 mg/l
Nitrate (as N)	1.68 mg/l	3.57 mg/l
Chloride	34.2 mg/l	60.1 mg/l

* Isotope concentration is the average of 2 samples, while total is the average of 52 samples.

According to Aas et al. (1986), upstream sediment samples from the Great Miami River have an average total uranium activity of 1.1 pCi/g (dry weight), and the total uranium activity of fish samples collected upstream of FMPC on the Great Miami River averaged 0.086 pCi/g (ash weight) in 1985.

TABLE 3-5

USGS DATA FOR WATER YEAR 1979
GREAT MIAMI RIVER AT NEW BALTIMORE, OHIO
FMPC - FERNALD, OHIO

	Maximum	Minimum
Flow, CFS	37,000	575
Conductivity, µmhos	1,030	261
pH, SU	9.1	7.3
Temp, °C	30.0	0.0
D.O., mg/l	18.9	3.6
Turbidity, NTU	85	3
Fecal Coliform, cols/100 ml	22,000	480
Calcium, mg/l	110	53
Magnesium, mg/l	38	19
Sodium, mg/l	56	10
Alkalinity, mg/l as $CaCo_3$	240	140
Total organic carbon, mg/l	17	3
Sulfate, mg/l	120	36
Chloride, mg/l	90	22
Fluoride, mg/l	0.8	0.2
Solids, dissolved mg/l	599	297
Sediments, suspended mg/l	808	8
Barium, (total) µg/l	100	100
Chromium, (total) µg/l	30	10
Copper, (total) µg/l	29	8
Iron, (total) µg/l	9,000	1,000
Lead, (total) µg/l	66	41
Manganese, µg/l	160	60
Mercury, (total) µg/l	<0.5	<0.5
Zinc (total), µg/l	80	60

Source: USGS, 1980

The FMPC site is at a sufficiently high elevation that flooding of neither Paddy's Run nor the Great Miami River would have an impact.

3.3.2 General Description of Pollution Sources/Controls

This section presents a description of plant processes and potential pollution sources for the water media. Figure 3-8 shows the major water treatment systems and outfalls from the FMPC site.

3.3.2.1 Water Treatment Plant and Boiler House

Water for use in the FMPC plant is obtained from one of three production wells. Aluminum sulfate and lime are added to the water for softening. Two clarifiers are available for settling the sludge formed in this process. The clarified water overflows to a clear well where it is pumped through sand filters for polishing before transfer to a 750,000-gallon, covered storage tank. Separate pumping systems are used to route water from this storage tank to the sanitary water system and to the process water system.

The sludge from the water treatment plant, coal pile runoff water, boiler blowdown, and other boiler house waters is sent alternately to Tanks 6 or 7 at the General Sump. When a tank is full, lime is added, the contents are mixed, and the sludge is allowed to settle. The clear supernatant is decanted to Tank 9 where it is held until tested for uranium and pH prior to discharge through Manhole 175 (Outfall 001) to the Great Miami River. The water from Tank 9 is sampled as Outfall 001B for the NPDES monitoring program.

3.3.2.2 Sewage Treatment Plant

Sanitary wastes from the plant are collected in a separate sewer system for delivery to the sewage treatment plant. Sanitary sewage passes through a bar screen and comminuter, then through two primary settling tanks operated in parallel. The effluent from the primary settling tanks passes over two trickling filters operated in series; one acts as a roughing filter and the other as a polishing filter. The water then passes through the secondary settling basins, the old chlorine contact chamber, and the ultra-violet (UV) light disinfecting unit before going to Manhole 175 for discharge from the site. Chlorine is not used on a regular basis but is available if the UV system is not operating properly.

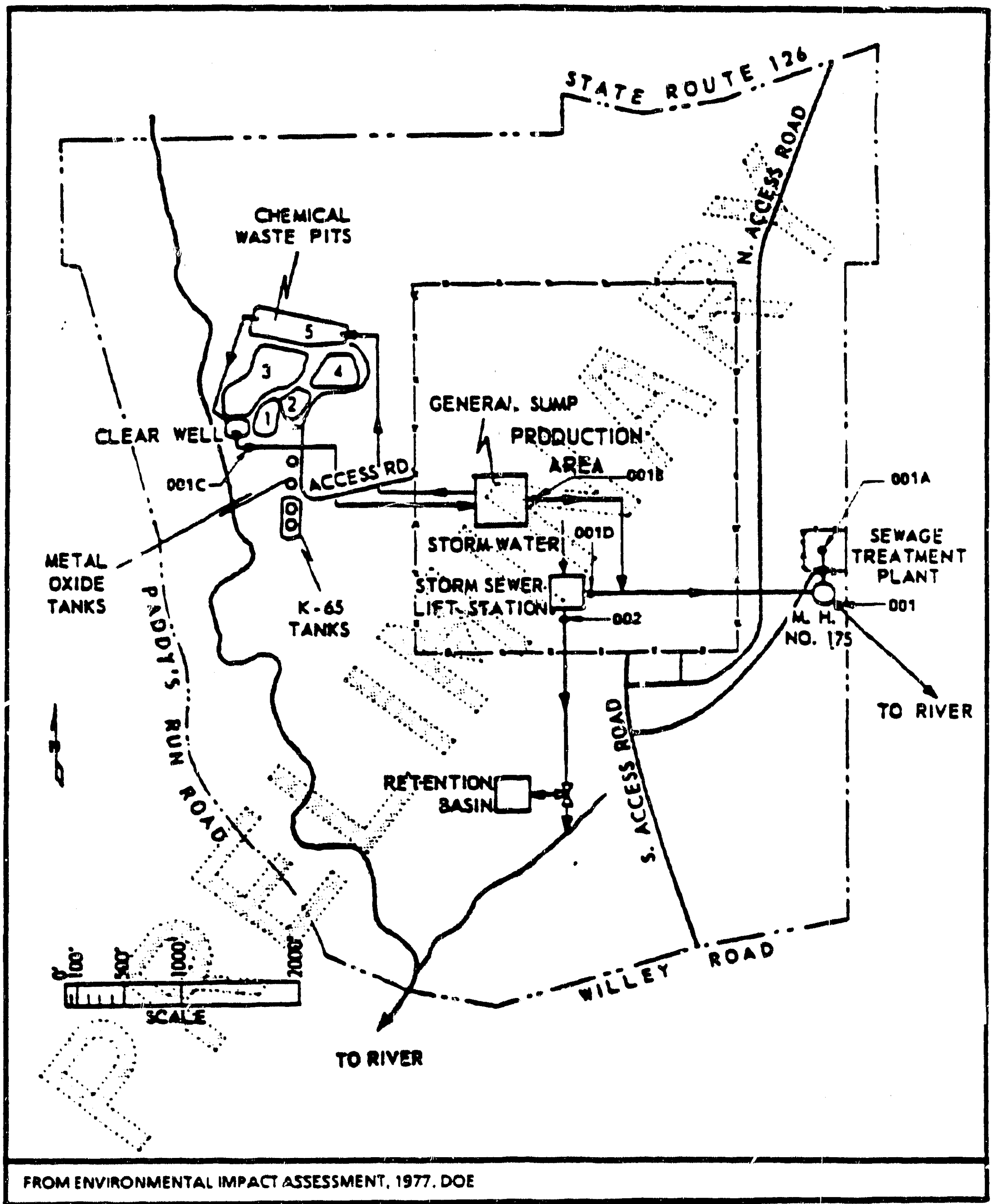


FIGURE 3-8

NPDES SAMPLING LOCATIONS

The settled sludges and skimmings from the settling basins are placed into an anaerobic digester. Once a year the sludge is removed from the digester and placed on sludge drying beds. The filtrate from the sludge drying beds is returned to the system through the trickling filters. The solids are sent to Plant 1 for analysis, then to Plant 8 for incineration. The sewage treatment plant effluent is monitored at Outfall 001A prior to combining with other plant flows at Manhole 175 for discharge through Outfall 001.

3.3.2.3 Plant Process Water Discharges Through the Clear Well

All aqueous wastes from the process areas of the plant are eventually discharged from the General Sump to Pit 5 and thence to the Clear Well.

Plant 1 - Water that collects in the sump in the mill area is pumped to an elevated 5,000-gallon tank. About once a month, this tank is emptied into dumpsters for transport to the Plant 9 sump. The plant operator sends sump water from the Plant 1 hydraulic drum compactor to the oil burner if it "looks oily" or to Plant 8 if it "does not appear oily."

Plant 2/3 - Waste raffinate from the refinery is pumped to Tank 12 for treatment, whereas all other liquid discharges go to the refinery sump. Organics in the refinery sump are pumped to the spent solvent storage tanks. About once a year the spent solvent is filtered and transferred to the clean solvent storage tanks. The process solvent is recovered by treatment with sodium carbonate to neutralize the acid, then centrifuged to separate the water from the solids. The solvent is reacidified and returned to the process. The wastewater is then sent to the Plant 2/3 sump for treatment prior to being sent to either Tank 1 or 3 at the General Sump.

Plant 4 - Spent liquid from the potassium hydroxide scrubbers, leaks and washdown water from the hydrogen fluoride area, and hopper wash water go to the process sump. These liquids are neutralized with lime prior to being sent to the Plant 8 sump for treatment.

Plant 5 - Cutting oils and any waters that drain into floor sumps are lifted by steam ejectors into a 6,000-gallon tank. Approximately three to four times a week this tank is pumped to Plant 6 for treatment.

Plant 6 - The only treatment system that is regularly used to remove oil from wastewaters is located at this plant. Nonacidic and oily wastes from Plants 5, 6, and 9 are collected in a 40,000-gallon receiving tank. A 6,000-gallon tank receives acidic wastes. The wastes from these tanks are blended in a 4,000 gallon tank and additional acid is added, if needed, to effect separation of the water and oil. The oil is decanted into drums and sent to the Plant 9 pad for storage before disposal. The water goes to another 4,000 gallon tank where it is neutralized with sodium hydroxide and then filtered through a plate and frame filter before being sent to Tank 2 at the General Sump. The filter cake is taken to Plant 8 for processing in one of the furnaces.

Plant 8 -This plant contains several different types of furnaces that are used to either dry sludges prior to packaging in drums for disposal, or to oxidize sludges prior to further processing in other portions of the FMPC. Liquids received at Plant 8 from Plants 1, 4, and 9; Building 12; the Pilot Plant; and from the Plant 8 sump are pumped into tanks for neutralization with lime. The neutralized slurry is filtered on vacuum filters, and the cake is drummed for further processing in Plant 8. The filtrate is sent to Tanks 10 or 11 at the General Sump if the uranium and copper values are within prescribed limits, or returned to the Plant 8 neutralization process if these limits are exceeded. The vacuum filters at Plant 8 are also used to dewater the slurry received from Tank 5 at the General Sump.

Plant 9 - Oily wastes from the machining area are transported to Plant 6 for treatment. Spent hydrofluoric acid is neutralized with lime to pH 8 and transported in a dumpster to Plant 8 for further treatment. Spent nitric acid from the Zirnlo decladding process is taken to Plant 2/3 for use in that process. This acid stream is the source of copper in the raffinate waste. Floor drains that collect non-oily wastes are pumped to the Plant 9 treatment sump. The treated solution is dumped to Tank 2 at the General Sump.

Pilot Plant - The sump water from this area is pumped into one of two holding tanks. The contents of these holding tanks are pumped to either Plant 8 or to the General Sump, depending upon the uranium content of the solution. The Pilot Plant barium chloride treatment operations are a potential source of hazardous or mixed waste contamination of Plant 8 and the General Sump. As a result of screening the waste drum contents to remove foreign matter, barium chloride salt may be released to the floor drains. The barium then goes to the Pilot Plant sump (usually Tank F-100), which is pumped to Plant 8 or to the General Sump.

Building 12 (Maintenance Shop) - The maintenance shop generates two potentially hazardous liquid waste streams. Spent 1,1,1-trichloroethane generated in degreasing is transported to the storage tanks at the Pilot Plant. The paint shop also generates paint-spray booth wastewater, which is discharged to liquid dumpsters and transported to the Plant 8 liquid sump for processing.

Decontamination Pad - Waste acid from the cleaning operation at this location is transported by dumpster to the refinery because of copper concentrations in the acid that may adversely affect operations at the General Sump. Process wastewaters are neutralized with lime and pumped to the General Sump. Precipitation falling onto the outside storage pad flows to the storm sewer system.

Tank Farm - The FMPC generates dilute hydrogen fluoride from operations in Plant 4 and the Pilot Plant. It is stored for sale in Tanks 18 and 21 and in railcars at the tank farm. Tank 18 is rubber-lined, but the contents have leaked onto the gravel layer below the tank in the past. The grading under Tank 18 does not direct all leakage to the Tank Farm Sump.

Waters collected in the Tank Farm Sump are neutralized with lime before being placed in Tank 17 adjacent to the sump. When this tank is full and the contents analyzed, it is pumped to Tank 2 at the General Sump. Spilled material and rain-water runoff that is not collected in the Tank Farm Sump flow into the storm sewer system. There is a valved drain line from the sump to a storm sewer manhole just north of the sump. Spills from Tanks 1, 2, and 3 as well as overflow from the sump could enter this manhole. However, Tank 3 is not used, and Tank 1 contains anhydrous NH_3 that would vaporize. Tank 2 is used to store KOH. Potential leaks from railcars on the west tracks at the tank farm, as well as potential leaks on the east side of the east tracks, would go to storm sewers and not to the sump.

Laboratory - The main laboratory generates waste solvents and spent chemical solutions that are collected in carboys in individual laboratory rooms and accumulated in 55-gallon drums outside of the main laboratory building. The main laboratory generates an estimated 4 drums of waste quarterly. Liquid wastes poured into sinks and drains at the laboratory are collected in a stainless-steel sump prior to being pumped to Tank 2 at the General Sump for treatment.

General Sump - The General Sump receives the liquid wastes from the processing areas of the plant, as described above. It consists of 12 tanks of various sizes used to collect, hold, neutralize, and settle the wastewaters. The operation of Tanks 6, 7, and 9 has been previously discussed in Section 3.3.2.1. Tanks 1 and 3 receive the filtrate from the refinery (Plant 2/3) sump. Tank 2 collects the waters from sumps at Plant 6 (which received the wastes from Plant 5), Plant 9, the Pilot Plant, the decontamination pad, the tank farm, and the laboratory. Tank 8 is normally empty and is used to receive up to 50,000 gallons of diverted stormwater in case of a spill. It can also be used to receive water from the production plants in emergencies. Tanks 10 and 11 are used to receive the filtrate from vacuum filters at Plant 8. Wastes collected in these six tanks are treated with lime, the precipitate is allowed to settle, and the clear liquid is decanted to Pit 5. Tank 12 receives the raffinate from the refinery and lime is added for neutralization. The waters collected on the pad at the General Sump are collected in Tank 4. These waters and the neutralized raffinate from Tank 12 are transferred to Tank 5 for further neutralization, if necessary. The contents of Tank 5 are then pumped to Plant 8.

The clear liquid sent to Pit 5 overflows after further settling to the Clear Well located south of abandoned Pit 3. The water from the Clear Well is pumped to Manhole 175 for discharge to the river through Outfall 001 and is monitored at the Clear Well pumphouse as Outfall 001C.

3.3.2.4 Storm Sewer System

The normal surface-water flow from the site is directed to Paddy's Run. The storm sewer outfall ditch originates in the northeast corner of the site and flows south to Paddy's Run. This ditch picks up storm-water flow from the east side of the site, outside the fence, as well as excess storm water from the fenced portion of the plant that is released through Outfall 002.

Stormwater runoff and spills outside the buildings within the fenced area are collected by the storm sewer system. Normal flow in the storm sewer is collected at a lift station and pumped to Manhole 175 for discharge into the Great Miami River. The lift station discharge is monitored as Outfall 001D. During storm events when the flow exceeds the capacity of the lift station, the excess storm water overflows through Outfall 002 to the stormwater ditch that flows into Paddy's Run south of the plant.

In addition to the stormwater runoff, the storm sewer system also receives ground-water infiltration and other waters from the process area. As described in the ground-water Section 3.4.4.2, a 1986 study of flows in the storm sewer indicated that 109 million gallons of ground water is entering the storm sewer per year. Analysis of waters in the sewer attributed to ground-water infiltration showed concentrations of uranium ranging from 0.14 to 4.06 mg/l. Background levels in the ground water in this area are estimated to be in the range of 0.0014 to 0.038 mg/l. Similar uranium concentrations (0.08 to 4.19 mg/l) were found in those extraneous waters in the storm sewer identified as being process/production related. The contamination of the storm sewer from all these sources can later translate into contamination of the surface waters at the storm sewer discharge points (the Great Miami River through Outfall 001 and the storm sewer outfall ditch and Paddy's Run through Outfall 002).

However, surface water samples taken in the Great Miami River show that there was no significant impact on this stream for the parameters measured (gross alpha, gross beta, cesium 137, radium-226, strontium-90, technetium-99, uranium-234, uranium-235, uranium-236, uranium-238, total uranium, F^-, NO_3-N, and Cl^-). Technetium-99 was the only parameter that varied by more than a factor of 2 between the upstream and downstream samples taken in 1985, and it only varied from an average of 1.08 pCi/l at the upstream point to an average of 4.59 pCi/l at the point farthest downstream.

The surface-water samples from Paddy's Run reflect different results. While the fluorides, nitrates, and chlorides were not affected by the uncontrolled discharges from the site, the gross alpha, gross beta, and the uranium results indicated significant increases in these parameters. The averages of the gross alpha and the uranium results varied by an order of magnitude (10x) between the upstream point and the point just downstream of the confluence of Paddy's Run with the storm sewer outfall ditch.

The storm sewer system is being upgraded by the installation of a retention pond. This pond will receive and hold waters that currently discharge to Paddy's Run through the storm sewer outfall. These waters will be pumped for discharge through Outfall 001 to the Great Miami River. These waters include the stormwater lift station overflow and the discharges from the storm sewers south of First Street that tie into the discharge line below the lift station. The pond will also provide containment capacity in the event of a spill into the storm sewer system. The stormwater in the retention pond will also be able to be returned to the general sump for treatment, if needed.

3.3.3 Environmental Monitoring Program

3.3.3.1 NPDES Monitoring

There are six NPDES monitoring locations on site. Outfall 001 is sampled once a week at Manhole 175. An automatic flow, proportional, continuous sampler is used to collect a composite over a 24-hour period. The sample is refrigerated while it is being composited. The parameters measured at this location are pH, suspended solids (TSS), ammonia as nitrogen (NH_3-N), oil and grease (O&G), residual chlorine (Cl_2) (summer only), and nitrate as nitrogen(NO_3-N).

There are four streams contributing flows to Outfall 001 that are also monitored as NPDES sample points--the sewage treatment plant (Outfall 001A), the General Sump (Outfall 001B), the Clear Well (Outfall 001C), and the stormwater lift station (Outfall 001D). The discharge from the sewage treatment plant is sampled at the discharge from the UV disinfecting unit. This point is designated

Outfall 001A. Parameters measured here are pH, BOD_5, TSS, and fecal coliform bacteria (summer months only).

For NPDES reporting and discharge limitations, the results of samples collected at the General Sump and the Clear Well are combined. The General Sump sample, designated Outfall 001B, is collected from the discharge of Tank 9. The Clear Well sample, Outfall 001C, is collected from the Clear Well pump discharge. The Clear Well receives the final liquid waste discharge from the process areas of the plant. The parameters measured at these two points are total suspended solids (TSS), hexavalent chromium (Cr^{+6}), total chromium (Cr), iron (Fe), nickel (Ni), and copper (Cu). After the separate samples are analyzed, the results are added together to give the total amount (expressed in kilograms per day) of each of the parameters discharged from these two sources.

The discharge of the stormwater lift station is monitored for TSS and oil and grease (O&G) for reporting as Outfall 001D in the NPDES discharge monitoring reports.

The sixth NPDES monitoring point is the stormwater lift station overflow, Outfall 002. It is sampled at the same point as the stormwater lift station but only at times when the lift station is overflowing to Paddy's Run.

3.3.3.2 Surface-Water Monitoring

Surface-water samples are collected weekly at three points in the Great Miami River: one upstream of the plant, one downstream of Outfall 001, and the third downstream of the confluence of Paddy's Run with the river. These samples are analyzed for U, gross alpha, gross beta, fluoride (F^-), NO_3-N, chloride (Cl^-), and pH. These same parameters have historically been monitored at two of three points in Paddy's Run. One point is upstream of the plant site, and the other point is either just downstream of the confluence of the storm sewer ditch with Paddy's Run or at a point approximately halfway between this point and the Great Miami River. The sample is taken at this latter site only if there is no flow at the site just downstream of the confluence of the two streams.

In October 1985, three additional sampling points were added in Paddy's Run. These points are located just downstream of the railroad bridge, just upstream of the confluence of Paddy's Run and the stormwater outfall ditch, and approximately halfway between the other two sampling points. Grab samples are collected at these surface water sampling points.

3.3.3.3 Fish Monitoring

Fish sampling was conducted at three locations on the Great Miami River in 1984 and 1985 by the University of Cincinnati. One location is upstream of FMPC and the other is near the confluence of Paddy's Run and the Great Miami River. Average concentrations of uranium in 1984 ranged from 0.24 pCi/g (ash) to 0.33 pCi/g (ash), with the higher concentrations found upstream. In 1985, the uranium concentrations ranged from 0.09 pCi/g (ash) to 0.16 pCi/g (ash). Higher concentrations in 1985 were found at the third location near the outfall of the buried effluent line.

3.3.3.4 Sediment Monitoring

During the survey, observations were made of the sediment sampling procedure on Paddy's Run and the outfall ditch. On June 25, 1986, 6 of the 27 sediment stations were sampled. Although the sample collector was unaware of the existence of a sampling procedure, he did follow a sound technique, was consistent from one station to the next, and decontaminated the sampling equipment between stations.

Sediment sampling on Paddy's Run was conducted in 1983, 1984, and 1985 at 7, 14, and 27 stations, respectively. It is difficult to make comparisons among the years, since station numbers and descriptions were not consistent from year to year.

The highest concentrations of uranium in all years were observed along the outfall ditch and at the confluence of the outfall ditch and Paddy's Run. In 1983, uranium concentrations ranged from 1.7 pCi/g (dry) upstream on Paddy's Run to 910 pCi/g (dry) near the mid-point of the outfall ditch. In 1984, uranium concentrations ranged from 2.3 pCi/g (dry) upstream on Paddy's Run to 296.5 pCi/g (dry) near the confluence of Paddy's Run and the outfall ditch. Concentrations of uranium in 1985 ranged from 0.6 pCi/g (dry) upstream on Paddy's Run to 46.2 pCi/g (dry) near the confluence of Paddy's Run and the outfall ditch.

Technetium-99 was also measured at selected locations along Paddy's Run and the outfall ditch. It is not known how the selection process is conducted; however, different stations were monitored for technetium-99 in each of the 3 years. Maximum technetium-99 concentrations were found along the outfall ditch and near the confluence of Paddy's Run and the outfall ditch. Maximum concentrations were 17 pCi/g (dry) and 30 pCi/g (dry) in 1983 and 1984, respectively. In 1985, technetium-99 concentrations did not exceed 6.9 pCi/g (dry).

Uranium and technetium-99 were also measured at locations upstream and downstream on the Great Miami River. Generally, concentrations of uranium and technetium-99 in the Great Miami River sediments were much lower than those observed in Paddy's Run and the outfall ditch. The maximum uranium concentration (3.1 pCi/g [dry]) was observed 50 feet downstream of FMPC in 1983. The maximum technetium-99 concentration (4.9 pCi/g [dry]) was observed at the same location in 1985. Once again, it is difficult to make comparisons, since different station numbers were used in each of the four sample years (1982 to 1985).

3.3.4 Findings and Observations

3.3.4.1 Category I

None

3.3.4.2 Category II

1. Contaminated Recharge of Ground Water. Contaminated surface water in Paddy's Run and the storm sewer outfall ditch is a source of contamination of the offsite ground water.

   The 1985 Dames and Moore ground-water study identifies Paddy's Run and the storm sewer outfall ditch as the principal source of uranium in offsite wells in the sand and gravel aquifer. Because contaminated surface waters in these locations pass over recharge areas for the sand and gravel aquifer, uranium contamination is transmitted to the groundwater. Additional details concerning the potential impact to the ground water are provided in Finding 1, Section 3.4.4.2.

2. Potential PCB Discharges. It is possible that PCBs have entered the environment through surface runoft, if they are present in the current or past inventory of waste oils stored behind the liquid incinerator. A substantial inventory of waste oil drums (approximately 1000) has been stored outdoors on an unprotected concrete pad. The chemical constituents of these waste oils have not been identified and could potentially contain PCBs. More detailed data on this problem is presented in Finding 1 in Section 4.2.2.3.

   ANL is sampling the waste oils and the trough around the perimeter that contains oily waste for PCB content.

3. Potential Solvent Releases. The Hazardous Substance List (HSL) contaminants, 1,1,1-trichloroethane and perchloroethylene, are not monitored in the effluents, although they are used in large quantities throughout the plant. Significant concentrations of these solvents could be potentially released in the wastewater without detection because no monitoring is performed for these parameters.

The proposed Federal Facility Compliance Agreement will require monitoring for these substances on a monthly basis at Outfalls 001, 001B, and 001C. Since large quantities of perchloroethylene are used in the laundry, it could be possible for this material to enter the sanitary sewer system, which is monitored at 001A.

ANL is analyzing for these contaminants during the sampling and analysis phase of the survey.

3.3.4.3 Category III

1. Uranium Contamination of Paddy's Run. Uranium is entering Paddy's Run through uncontrolled storm-water ditches originating on the plant site. The fact that contaminated storm water in these ditches is not controlled or treated causes offsite release of uranium.

Sampling along Paddy's Run, instituted in late 1985, indicates that several ditches on the west side of FMPC are sources of uranium entering this stream. The average total uranium concentration in the surface water samples taken during 1985 is shown in Table 3-6. The sample locations are identified in Figure 3-7. The ditches from the plant site that discharge into Paddy's Run are described in the following paragraphs.

One ditch runs in a southerly direction along the security fence on the east side of the plant and is the beginning of the storm sewer outfall ditch. Most of the waters entering this ditch before it reaches the southwest corner of the fenced area are from areas outside the fence. Materials spilled just inside the fence, or south and east of the transformer pad, could also flow into this ditch. However, the storm sewer system has several catch basins on the east side of E Street that would pick up the majority of the runoff from inside the fence in this area. This ditch passes under the parking lot east of the south access road where it picks up runoff from some catch basins in the parking lot. Just east of the point where the waters from the stormwater outfall (002) enter the ditch, there is a 16-inch-diameter steel pipe that drips water into the ditch. According to print 22X5500P00537, this former drainage line from the General

TABLE 3-6

AVERAGE TOTAL URANIUM CONCENTRATIONS IN SURFACE WATER SAMPLES FMPC - FERNALD, OHIO

Sample Point	Uranium (pCi/l)
W1	1.57
W2	660.8
W3	1.61
W4	1.89
W5	1.60
W7	43.37
W8	7.18
W9	23.33
W10	235.51
W11	9.82

Sump and Plant 6 has been rerouted to the storm sewer outfall. Plant personnel state that the end of the line at Plant 6 and the General Sump is plugged and buried.

Outside the southwest corner of the new Pilot Plant building, inside the fence, is a depression that collects runoff waters and discharges to Paddy's Run through an 8-inch steel pipe under the road. Just north of the new Pilot Plant building, adjacent to the fence, there is a broken tile-field discharge line. Water collected in this tile-field system drains to the ditch leading to Paddy's Run. Approximately midway between these two points is another discharge to the ditch leading to Paddy's Run. No pipe was observed, although flow was evident on the quiescent water surface in the ditch adjacent to the west side of the road.

The uncontrolled runoff ditch with the greatest potential for polluting Paddy's Run is the ditch that crosses the western fence line, just south of the Clear Well. This ditch has a flapper-type valve that can be closed to block the discharge to Paddy's Run in the event of a spill or other known source of contamination. This ditch drains much of the area west of A Street, including the pit area south and east of Pits 3, 4, and 6. The drainage from the area between Pit 5 and Pits 3 and 4 flows westward in a depression along the southern edge of Pit 5 and then across the road and down a depression to Paddy's Run.

Two other ditches from the plant site enter Paddy's Run just south and north of the railroad trestle. These ditches run west from the plant site, parallel to the railroad. The southern ditch picks up seeps from the north face of Pit 5 and the area between Pit 6 and the railroad. The northern ditch gathers water from the area used for a landfill, as well as surface drainage outside the fence on the northern side of the plant. Spills or contaminated runoff from the fire training area north of the plant flow into this ditch.

2. Exfiltration in Main Discharge Line. The 4,200-foot-long discharge line from Outfall 001 to the Great Miami River may be a source of offsite ground-water contamination. Exfiltration from this 30-year-old line may have occurred and, if so, would contaminate the ground water.

   This line is located in sand and gravel deposits that would allow any leaks to readily enter the ground water.

3. Ground-water Contamination of Storm Sewers. The storm sewer system is being infiltrated by contaminated ground water. Ground water seeping into the storm sewer system provides a conduit for transport of uranium off the FMPC site.

The 1986 Dames and Moore ground-water study showed that 109 million gallons per year of ground water containing uranium at 100 to 4,000 times background levels is entering the storm sewer in the production area of the plant. This contamination is in addition to that normally associated with the storm sewer due to runoff from the drum storage areas during storm events. A more detailed discussion of the ground-water contamination of the storm sewer system is presented in "Hydrogeology," Section 3.4.4.2, Finding 2.

3.3.4.4 <u>Category IV</u>

1. <u>Hexavalent Chromium Discharges</u>. Hexavalent chromium (Cr^{+6}) is periodically discharged by FMPC to the Great Miami River in amounts that exceed the NPDES permit limit.

   The Cr^{+6} NPDES limitation for the combined General Sump and Clear Well sampling points was out of compliance 21 percent of the time in 1985 and 25 percent in 1984 (NLO, 1985). This limit is determined by adding the mass loading in kilograms per day (kg/day) of Cr^{+6} discharged at the General Sump (sampling point 001B) to the kg/day of Cr + 6 discharged at the Clear Well (sampling point 001C). The limits are 0.008 kg/day daily maximum and 0.004 kg/day monthly average. A review of the data indicates that the amount of Cr + 6 in the Clear Well effluent is usually an order of magnitude greater than the amount of Cr + 6 in the General Sump discharge. However, since the major portion of the water treated in the General Sump is discharged through Pit 5 to the Clear Well rather than at the General Sump discharge point, and tests for Cr + 6 are not run on these discharges to Pit 5, it is not known whether the Cr + 6 comes from the General Sump or from waste pit leachate that is entering the Clear Well.

2. <u>Cyanide Discharges</u>. Cyanide in excess of the Ohio water quality standard of 0.025 mg/l was reported in the Form 2-C analyses submitted with the NPDES Permit renewal application.

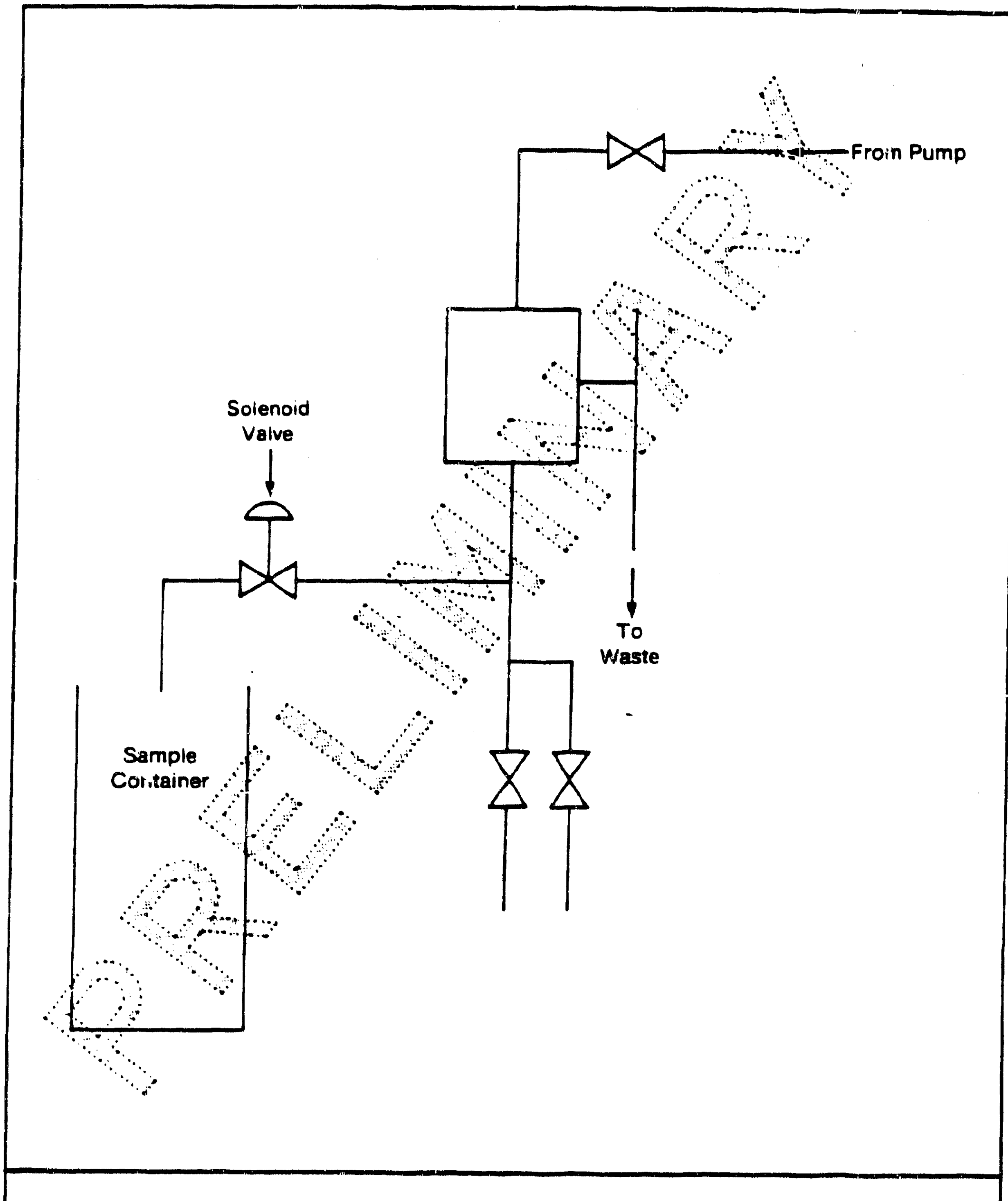
   These cyanide (CN-) concentrations were 0.042 mg/l at 001, 0.10 mg/l at 001B, and 0.08 mg/l at 001C. No uses of cyanides, other than as a laboratory reagent, were uncovered during the survey.

3. <u>Unrepresentative Sampling</u>. The analytical results for insoluble materials (including TSS, O&G, and uranium) at 001 and the uranium results at 001D and 002 are unreliable because the samples are not truly representative of the stream being measured.

- Filtered Samples. The filter at Outfall 001 removes some of the insoluble materials before the sample is taken. The sample pump at Outfall 001 (the main discharge from the plant) has a filter on the suction side to prevent particles of sand or grit from entering and damaging the pump or the solenoid sampling valves. Although several nail holes were punched in the filter "in order to provide a representative sample," the results obtained at this location for insoluble contaminants, since May 1979 when the pump was installed, cannot be considered accurate.

- Sampling System Configuration. The physical configuration of the sample piping at Outfall 001 causes suspended particulates in the sample to potentially differ from the discharge concentration. In addition to the inaccuracies caused by the filter at Outfall 001, the configuration at the sampling system downstream of the pump can also introduce errors. As shown in Figure 3-9, the continuous flow from the pump enters the top of a larger-diameter pipe, which acts as a constant head tank. When the solenoid valve is closed, the head tank continuously overflows out the side offtake to waste. Since particulate matter tends to continue in the direction in which it is moving, the concentration of particulate matter in the bottom of the head tank will tend to become greater than is actually present in the stream being sampled. On the other hand, since there is no flow out of the bottom of the head tank unless the solenoid is open, the particulate matter tends to settle onto the bottom of the head tank and into the line below the offtake to the sample container. This would have the effect of making the water delivered to the sample container lower in suspended particulates than the actual wastewater.

- Sample Points with Strainers. The composite samples collected at sample points 001D and 002 pass through strainers ahead of the solenoid valves prior to entering the collection tanks. Particulate uranium present in these streams could be removed from the sample by these strainers. The total suspended solids (TSS) or oil and grease (O&G) results of the NPDES sample for these locations are not affected because they are collected as grab samples from a continuously flowing line that does not pass through a strainer. However, the composite samples for uranium could be affected if uranium is removed.



SAMPLING ARRANGEMENT AT OUTFALL 001 **FIGURE 3-9**

3.4 Hydrogeology

3.4.1 Background Environmental Information

This section presents background information on the general aspects of the FMPC ground-water regime. The following subsections discuss regional geology and hydrogeology as they relate to the site.

3.4.1.1 Geology

The FMPC lies atop an ancient river valley that has been infilled by glacial outwash. The valley is approximately 2 miles wide and was cut into Ordovician age limestone and shale by an ancient river during pre-Pleistocene and/or Pleistocene times. The limestone and shale bedrock occurs at a depth of approximately 200 feet beneath the surface of the FMPC. A 150- to 200-foot-thick layer of glacial outwash, consisting of sands and gravels, immediately overlies the bedrock.

Overlying the glacial outwash and extending to the surface is a clayey till, which is typically 20 to 50 feet thick in the FMPC site area. The till, thought to be the remnants of a glacial moraine, is generally clayey but is known to contain sand and gravel.

The configuration of the infilled river valley is shown in Figure 3-10. (The infilled valley is known as the "New Haven Trough.") A conceptual geologic cross section of the New Haven Trough in the vicinity of the FMPC is included as Figure 3-11.

3.4.1.2 Hydrogeology

Ground water occurs in all of the geologic materials described in the previous section. Of the three geologic units described (bedrock, glacial outwash deposits, and glacial till), only the glacial outwash deposits constitute a major aquifer in the FMPC area. The bedrock is not considered to be a reliable water supply because of its reportedly low hydraulic conductivity. The glacial till is reported to contain perched water above the main aquifer within the glacial outwash deposits.

The glacial outwash deposits within the New Haven Trough are part of the major buried valley, which extends from Dayton, Ohio, to about 15 miles west of Cincinnati, Ohio. The aquifer associated with these deposits has been characterized as one of the most productive sources of ground water in the midwestern United States. Typically, the ground water occurs at a depth of 30 to 50 feet below

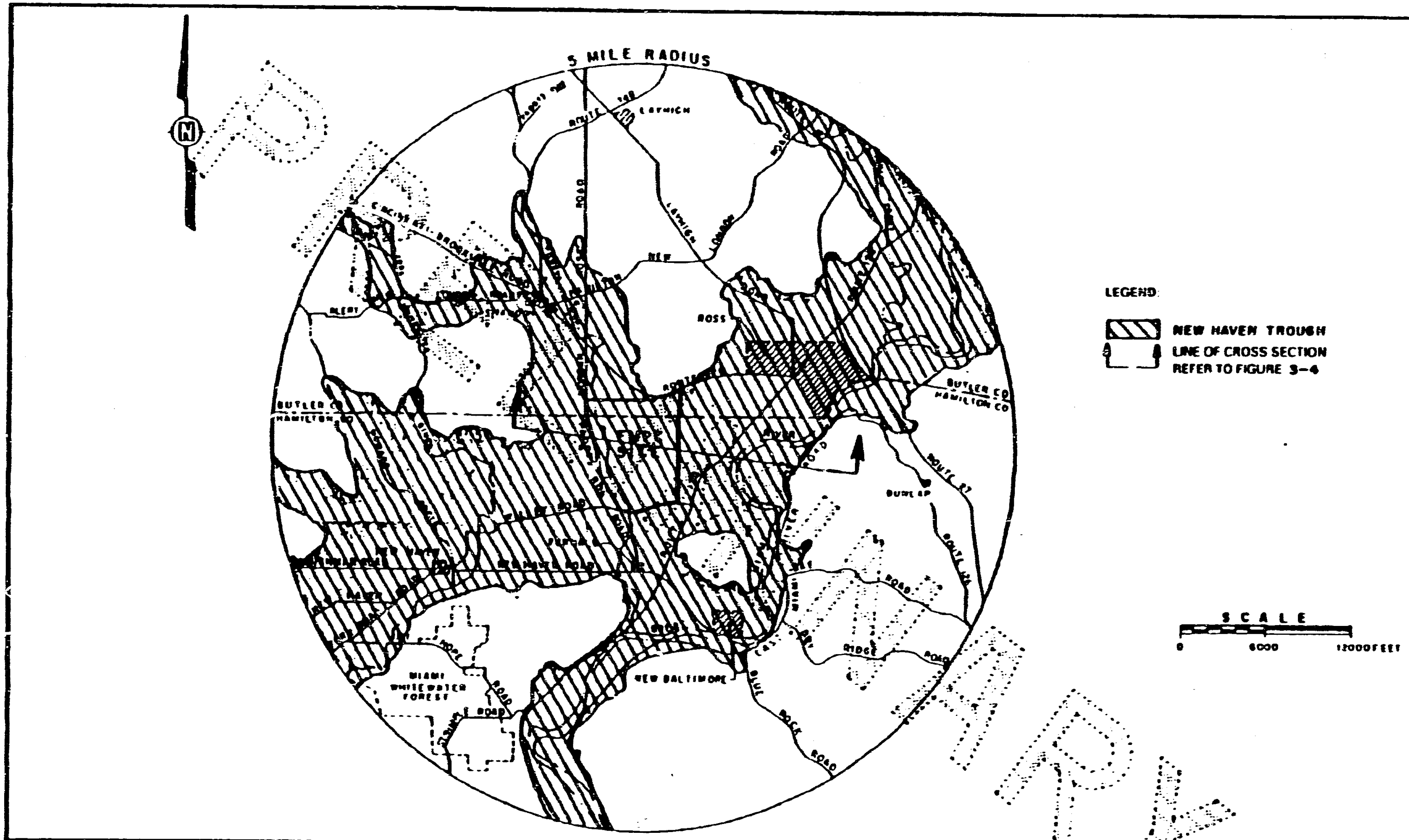


Figure From International Technology Corporation, May 1986

FIGURE 3 - 10

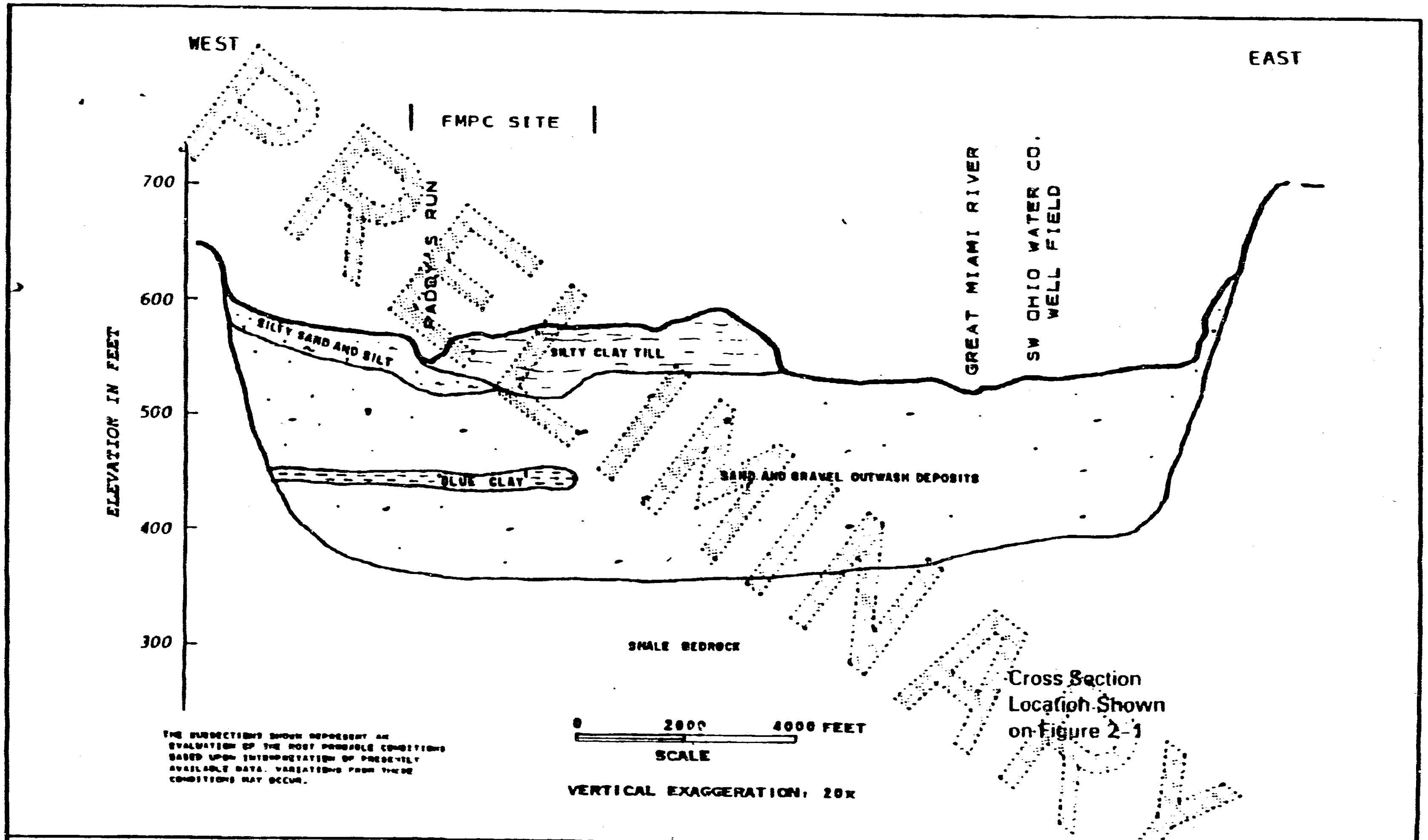


Figure From: Groundwater Study Task C Report, Dames & Moore, 1985

GENERALIZED GEOLOGIC CROSS SECTION OF NEW HAVEN TROUGH

FIGURE 3-11

the ground surface within the trough. Individual wells within the buried valley have reported yields as high as 3,000 gallons per minute (gpm).

In the site vicinity, the buried valley (or sand and gravel) aquifer is hydraulically separated into upper and lower units by a blue clay layer (see Figure 3-11). The blue clay layer is approximately 10 to 20 feet thick.

Ground-water flow within the buried valley aquifer beneath the FMPC is thought to originate north and west of the site and flow to the south and east. A depiction of the generalized ground-water flow is included as Figure 3-12. Flow of the perched ground water within the till at the FMPC is poorly understood. However, it is postulated that shallow-perched water flow along the western site boundary is toward Paddy's Run. Flow is also likely, but not proven, to occur vertically downward from the perched ground water into the buried valley aquifer.

Use of the buried valley aquifer in the vicinity of FMPC is estimated to be in excess of 37 million gallons per day (mgd). Major ground-water users are shown on Figure 3-13. In addition, most local residences and industries use ground water for their potable supplies.

3.4.1.3 Regional Ground-water Quality

Spieker (1968) indicates that the lower Great Miami River valley has a calcium bicarbonate type ground water. The water is usually hard, with total dissolved solids ranging between 300 and 600 mg/l. Nitrate, phenols, and detergents were noted by Spieker (1968) as constituents contaminating some of the local ground-water supplies, although the level and extent of contamination was considered minor. Contamination was most evident where pumping had drawn surface water into the aquifer. Other contamination was linked to agricultural application of fertilizers and improperly constructed septic tanks.

3.4.2 General Description of Pollution Sources/Controls

Sources of ground-water pollution at FMPC consist of various known and unknown releases of contaminants (over time) to other media. These releases subsequently affect ground water.

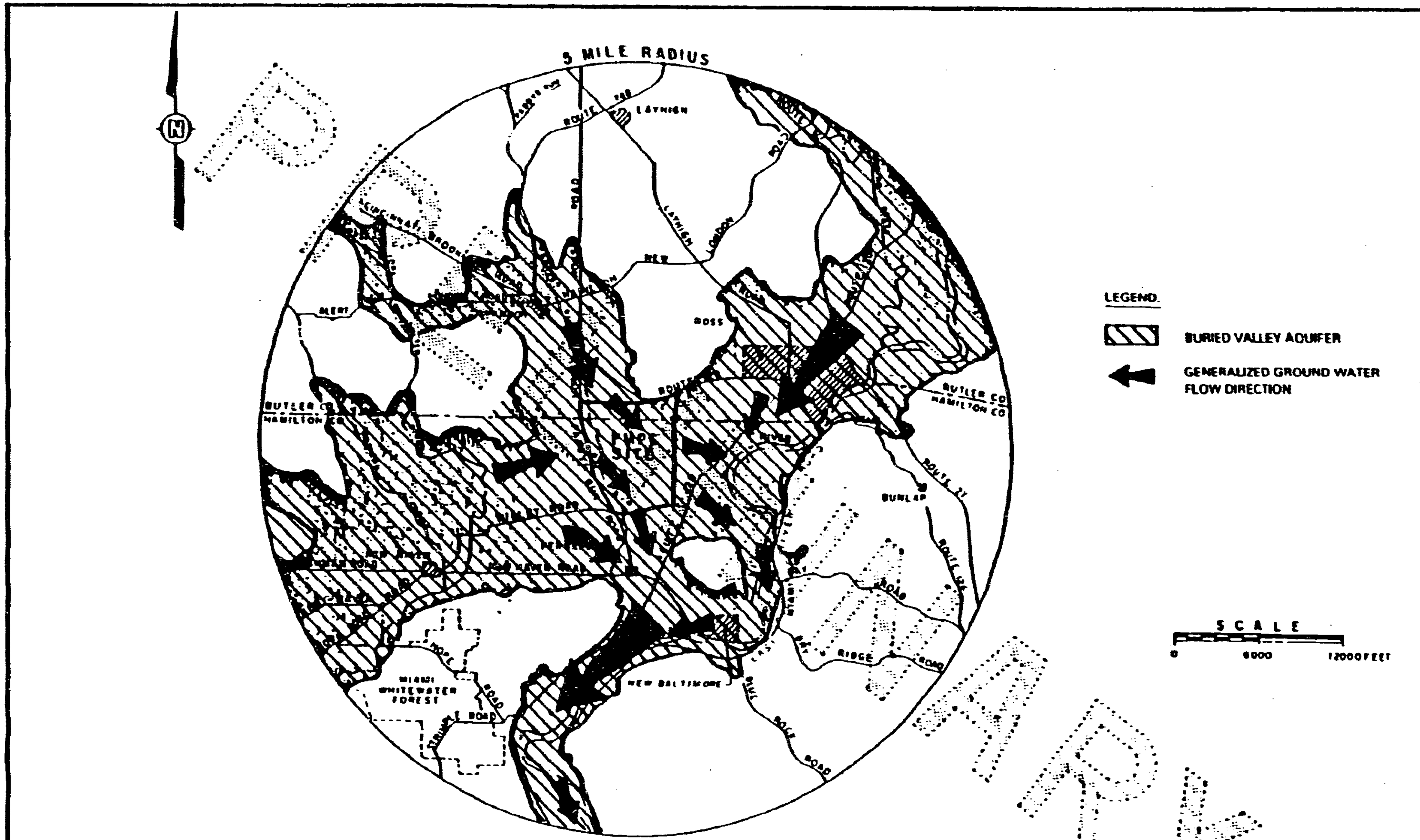


Figure From: International Technology Corporation, May 1986

FIGURE 3 - 12

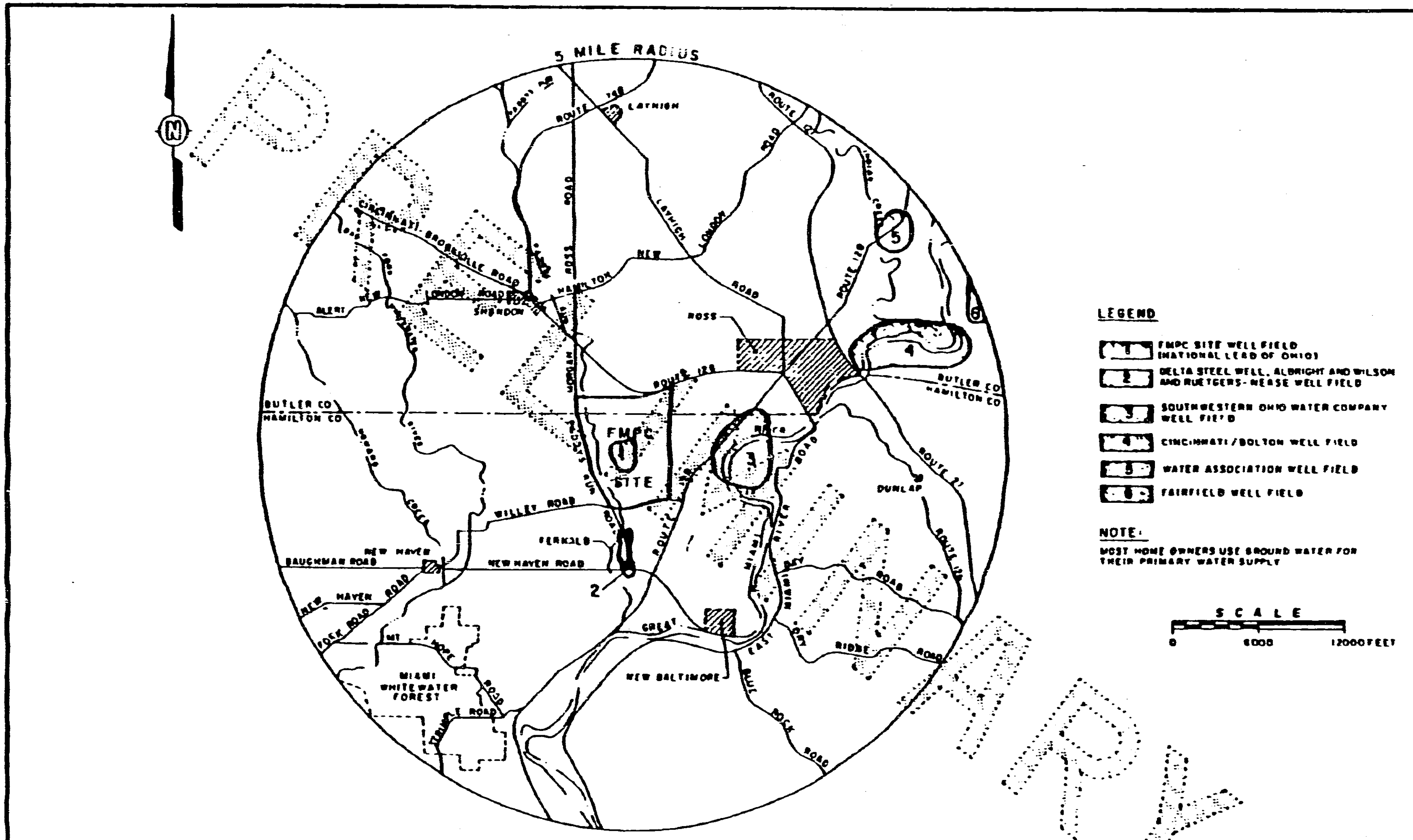


Figure From. International Technology Corporation, May 1986

FIGURE 3-13

In general, the major sources of ground-water contamination at the FMPC Site can be identified as follows:

- The production area.
- The waste pits.
- Surface water discharges from the production area through the storm sewer outfall ditch to Paddy's Run.

The production area is a source of contaminants because of the use and release of chemicals and radioactive materials in the production operations. Storage of contaminated production materials on porous soils, spills/accidents, and process releases of surface water and airborne contaminants have caused a build-up of pollutants in the soil and ground water in the production area. This build-up acts as a source for continuing release of pollutants to the ground water.

The waste pits are a known burial ground for various hazardous and radioactive wastes since the early 1950s. The inventory of wastes mixed in these pits has not been carefully tracked and has not been easy to accurately re-create. Engineering designs used for the construction of these pits, trenches, and landfills do not meet the current criteria for containment of pollutants. Thus, releases from this waste management area probably represent the single most concentrated impact to ground-water quality.

Surface-water discharges from the storm-water system in the production area are primarily a concern because of the uranium and other related radioactive particles washed from the site during storm events.

Other sources of ground-water pollution are less important individually but contribute significantly as a group (e.g., fly ash piles, rubble piles, etc).

3.4.3 Environmental Monitoring Program

This section presents a summary of the FMPC monitoring program and the results of this program (environmental monitoring data). The following subsections discuss

- The ground-water monitoring program, which includes well location and construction; sampling frequency, procedures, and monitoring parameters; and sample analysis and quality assurance.

- The results of the monitoring program, which includes a discussion of ground-water quality for the perched and the sand-and-gravel aquifer both on and off site.

3.4.3.1 FMPC Monitoring Program

Well Location

The ground-water monitoring program at FMPC consists of 37 onsite wells and 25 offsite wells, as shown on Figures 3-14 and 3-15. The majority of these wells monitor the sand and gravel aquifer and only five wells monitor the perched aquifer within the glacial till. A summary of the total monitoring system is included in Table 3-7, which depicts the number of wells and the associated aquifer monitored.

The majority of onsite wells are used for monitoring only. The offsite wells are typically used for domestic or industrial water supplies by private parties. Initial monitoring wells (called "test wells" by FMPC) in the sand and gravel aquifer were installed in 1959 and 1965 in the waste pit area. The three onsite production wells were installed in 1951 in the lower sand-and-gravel aquifer. Additional onsite monitoring wells were installed in 1984 and 1985.

Well Construction

The site test wells installed in 1959 and 1965 are constructed of steel casing of various sizes ranging from 4 to 8 inches. Screens are of steel or brass construction and lengths of screen vary. Lead was used as a seal between the steel casing and brass screen on some wells. Construction details are not complete for all of these wells. Construction logs for two wells installed in 1951 are available, but the locations of both wells are unknown.

The onsite production wells were constructed in 1951. Each well has an outer steel casing 38 inches in diameter set into the blue clay, which separates the upper and lower sand-and-gravel aquifer. The inner casing is steel, 26 inches in diameter, and extends into the lower sand-and-gravel aquifer. Twenty-foot screens were installed in each well.

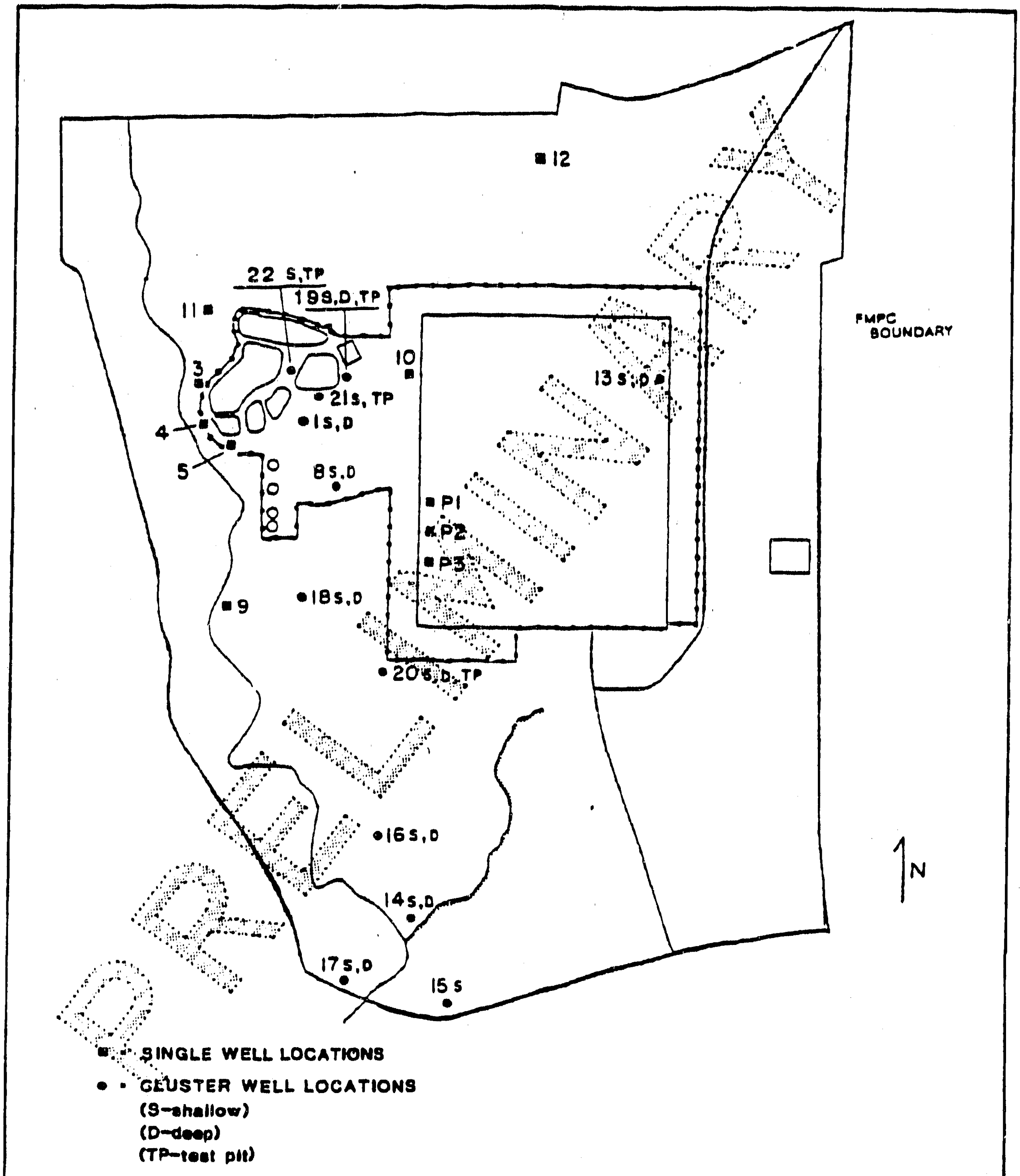


Figure From: Feed Materials Production Center Environmental Monitoring Annual Report for 1985

FMPC ONSITE PRODUCTION AND TEST WELL LOCATIONS **FIGURE 3-14**

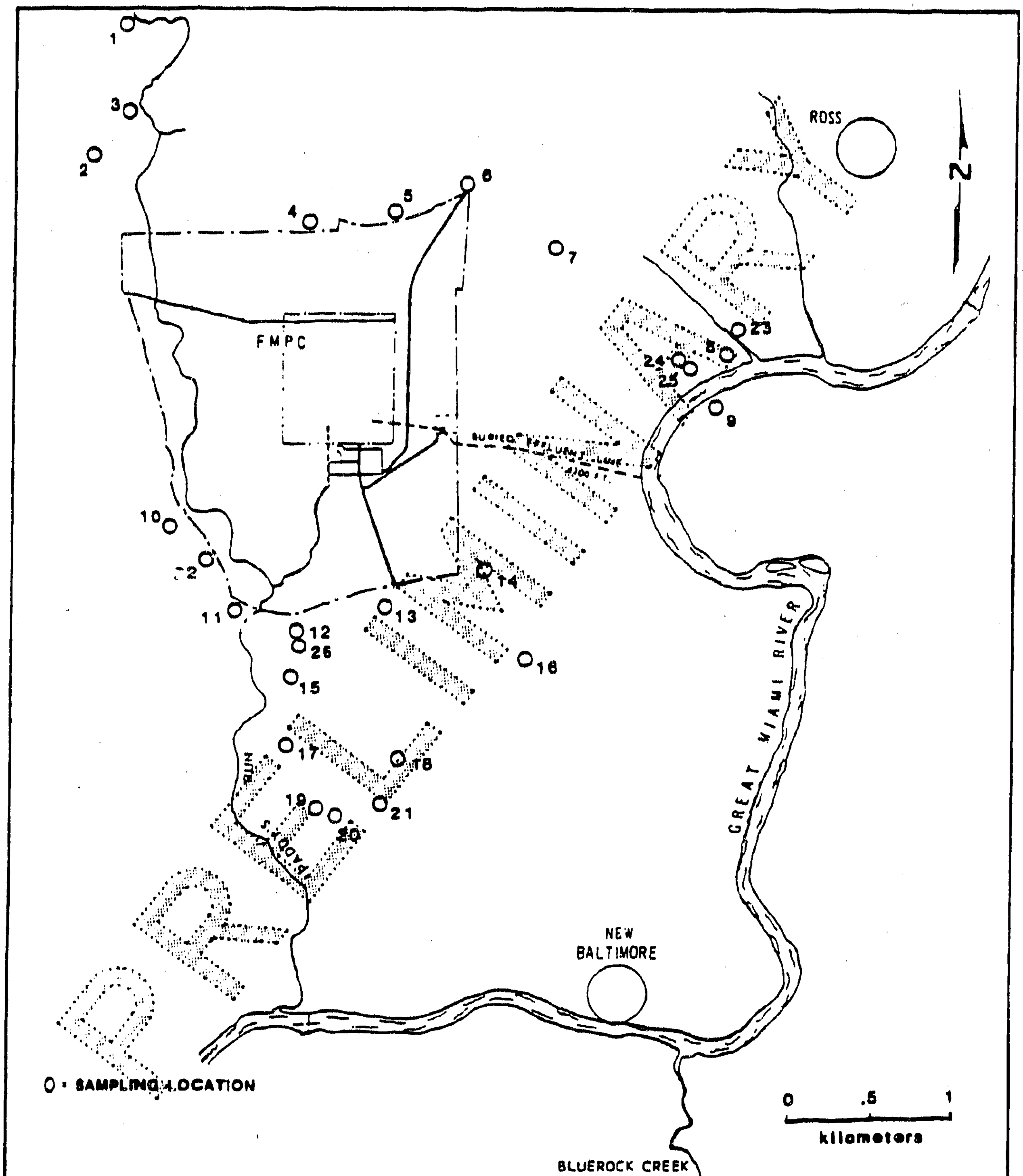


Figure From: Feed Materials Production Center Environmental Monitoring Annual Report for 1985

OFFSITE MONITORING WELL LOCATIONS **FIGURE 3 - 15**

TABLE 3-7

SUMMARY OF MONITORING SYSTEM,
TOTAL GROUND-WATER MONITORING WELLS BY AQUIFER
FMPC - FERNALD, OHIO

ONSITE MONITORING WELLS

Number of Wells	Aquifer Monitored
5	Glacial till
17	Upper sand + gravel
14	Lower sand + gravel
1	Bedrock

OFFSITE MONITORING WELLS

Number of Wells	Aquifer Monitored
25	Sand + gravel*

* 64 percent of wells have no geologic log

The monitoring wells installed in 1984 and 1985 are all constructed of 4-inch-diameter PVC. One well is constructed of 6-inch-diameter steel with stainless screen. Screen lengths vary from 5 to 15 feet in length. Screened intervals are sealed by a bentonite layer placed in the annulus above the screen.

Offsite wells used for monitoring are of varying construction. The majority of the offsite wells currently sampled have no construction documentation.

<u>Sampling Frequency, Procedures, and Monitored Parameters</u>

Table 3-8 presents a summary of the well-sampling frequencies and the chemical parameters analyzed during each sampling interval. The chemical parameters are presented, where applicable, in Tables 3-8a, b, and c. The monthly sampling by the FMPC wastewater treatment plant (WTP) personnel generates data for onsite use only. This sampling, begun in 1965, is the longest continuous sampling effort for ground water at the site.

Monthly sampling of offsite wells is conducted by FMPC Environmental Safety and Health (ES&H) personnel. This sampling effort was begun in late 1981 in response to the discovery by Ohio EPA of elevated radionuclide levels in ground water in offsite wells. The analytical data obtained from this sampling effort are used as part of the overall environmental monitoring program to assess possible effects of FMPC operations on the local environment.

The quarterly sampling is conducted primarily by contractor personnel hired by FMPC to perform the sampling. ES&H personnel give direction and assistance to the contractor. This sampling effort was begun in 1985 as part of RCRA ground-water monitoring at FMPC for Waste Pit No. 4. Although only four wells, one upgradient and three downgradient of the waste pit, are included as part of the RCRA Part B permit submittal by FMPC, a total of 40 wells are sampled. This program is currently under review for possible expansion to include other offsite wells. At present, however, a second round of samples have been taken and two more rounds are planned to provide four quarters of data. These data are intended to help characterize the chemical constituents in ground water on site and fulfill regulatory requirements in the waste pit area.

Sampling procedures and protocol were observed during the survey effort. Collection of samples was observed during a typical monthly sampling event performed by WTP personnel and a typical RCRA quarterly sampling event performed by ES&H personnel. Selected groundwater samples were also obtained by the survey team for analysis by Argonne National Laboratories. A total of 10 wells (1S,

TABLE 3-8

SUMMARY OF MONITORING SYSTEM
SAMPLING FREQUENCY AND CHEMICAL ANALYTICAL PARAMETERS

Wells	Total Number of Wells	Sampling Interval	Sampled By(1)	Analytical Parameters
1S, 1D, 3, 4, 5, 8S, 8D, 9, 10, 11, P-1, P-2, P-3	13	Monthly	WTP	See Table 3-7a
All offsite	25	Monthly	ES&H	Uranium
1S, 1D, 3, 4, 5, 8S, 8D, 9, 10, 11, P-1, P-2, P-3	13	Quarterly (as part of monthly collection)	WTP	See Table 3-7b
All on site (35) and 6 off site	41	Quarterly	Contractor	See Table 3-7c

(1) WTP = Water Treatment Plant personnel
ES&H = Environmental Safety and Health personnel
Contractor = Outside groundwater sampling consultant

TABLE 3-8a

MONTHLY WTP ANALYTICAL PARAMETERS[2]

pH	Fluoride
Specific conductance	Uranium
Nitrate	Alkalinity
Iron	Calcium hardness
Chloride	Magnesium hardness
Sulfate	

[2]Not reported except for uranium

TABLE 3-8b
QUARTERLY WTP ANALYTICAL PARAMETERS

Uranium	Nitrate
Gross alpha	Sulfate
Gross beta	pH
Chloride	

TABLE 3-8c

QUARTERLY CONTRACTOR ANALYTICAL PARAMETERS

Chloride	Sulfate
Iron	pH
Manganese	Specific Conductance
Phenols	TOC
Sodium	TOX
Arsenic	Gross alpha
Barium	Gross beta
Cadmium	Radium
Chromium (total)	Endrin
Chromium (hexavalent)	Lindane
Fluoride	Methoxychlor
Lead	Toxaphene
Mercury	2,4-D
Nitrate	2,4,5-TP Silvex
Selenium	Coliform bacteria
Silver	Chlorobenzene
Nickel	Chlorodibromomethane
Cyanide	Chloroethane
Copper	2-Chloroethyl vinyl ether
Zinc	Chloroform
Magnesium	Dichlorobromomethane
Calcium	Dichlorodifluoromethane
Phosphorus	1,1-Dichloroethane
Total dissolved solids	1,2-Dichloroethylene
Total potassium	1,1-Dichloroethylene
COD	1,2-Dichloropropane
Perchloroethylene	1,2-Dichloropropylene
cis-1,2-Dichloroethylene	Ethylbenzene
Tributylphosphate	Methyl bromide

TABLE 3-8c
QUARTERLY CONTRACTOR ANALYTICAL PARAMETERS
PAGE TWO

Acrolein	Methylchloride
Acrylonitrile	trans-1,2-Dichloroethylene
Benzene	1,3-Dichloropropene
Bis(chloromethyl)ether	1,1,2,2-Tetrachloroethane
Bromoform	Tetrachloroethylene
Bromodichloromethane	Toluene
Bromomethane	1,1,1-Trichloroethane
Carbon tetrachloride	1,1,2-Trichloroethane
Chloromethane	Trichloroethylene
1,2-Dichlorobenzene	Trichlorofluoromethane
1,3-Dichlorobenzene	Vinyl chloride
1,4-Dichlorobenzene	Cesium 137
Potassium 40	Strontium 90
Total uranium	Ruthenium 106
Radium 226	Neptunium 237
Radium 228	Plutonium 238
Technetium 99	Plutonium 239
Thorium 228	Plutonium 240
Thorium 230	
Thorium 232	

1D, 3, 4, 5, 8S, 8D, 10, 11, and P-1) were sampled by WTP personnel. Three wells (14S, 16D, and HKS [Offsite Well 12]) were sampled by ES&H personnel.

The monthly sampling of onsite wells is performed by obtaining water samples from the discharge lines of pumps dedicated to each well. Pumps have variable capacities ranging from tens of gallons per minute (gpm) to a rated 700 gpm in the production wells.

The RCRA ground-water sampling includes the older test wells and production wells installed prior to 1965, selected offsite wells (four), and the newer monitoring wells installed in 1984 and 1985. The survey effort observed the sampling of two of the newer PVC wells and an offsite domestic well.

Each well has a dedicated pump, which is typically left in the well. Samples are obtained from the pump discharge line at the surface after purging. Purging volumes are calculated based on casing volumes. Samples for volatiles are obtained by using stainless-steel bailers. In general, the RCRA sampling program follows EPA-established protocols for chain-of-custody, field measurements, and sample handling.

During the survey team visit, ground-water samples were obtained from five wells. Wells 5 and P-1 were sampled by WTP personnel, and wells 14S, 16D, and 12 (HKS) were sampled by ES&H personnel. Analyses were performed by Argonne National Laboratories (ANL). A comparison between these results and results of the WTP laboratory and the 1985 RCRA results is included on Table 3-9.

There is general agreement between the ANL results and the 1985 RCRA parameters. However, some radionuclides evident in 14S, 16D, and 12 were not evident previously. Significantly higher levels of gross alpha and beta were also found in wells 16D and 12 by ANL.

<u>Sample Analysis</u>

At present, three separate laboratories are conducting the analyses of ground-water samples for FMPC. Table 3-10 summarizes the sampling events and the associated laboratory responsible for each event.

3.4.3.2 <u>Environmental Monitoring Data</u>

Ground-water monitoring results of FMPC, although not formally documented in the Environmental Monitoring Report until 1983, date back to the 1960s. Records obtained from monthly monitoring

TABLE 3-9

COMPARISON OF ANL MONITORING RESULTS TO SITE DATA FOR 5 SAMPLED WELLS
FMPC - FERNALD, OHIO

Parameter/Unit	Well P-1		Well T-5		Well 14S		Well 16D		Well 12	
	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA
pH	7.75	7.45	7.60	7.36	7.91	8.1	7.88	7.54	7.81	7.48
Conductivity umho/cm	488	835	650	620	510	420	475	520	460	491
Uranium ug/l	<1	0.6(1)	4.6	4.2(1)	27.2	120(1)	10.2	31(1)	249	300(1)
Fluoride ppm	0.24	0.18	0.24	0.24	0.28	1.1	0.24	0.16	0.54	300
Chloride ppm	36.4	36	14.4	17	20.6	19	18.2	20	20.3	0.46
NO_3 ppm	<0.5	<0.02	<0.5	0.09	4.2	0.89	11.9	2.36	12.5	19
NO_2 ppm	<0.3	NA	<0.3	N/A	<0.3	NA	<0.3	NA	<0.3	2.55
SO_4 ppm	102	16	68	82	59	70	50	60	53	NA
Alkalinity meq or mg $CaCO_3$/l	353	NA	311	NA	216	NA	220	NA	212	54
Calcium Hardness meq or mg $CaCO_3$/l	278	NA	248	NA	194	NA	203	NA	192	NA
Magnesium Hardness meq or mg $CaCO_3$/l	112	NA	104	NA	78	NA	84	NA	79	NA
Ag ppm	<0.02	<0.03	<0.02	<0.03	<0.02	<0.03	<0.03	<0.03	<0.02	NA
Al ppm	<0.1	NA	<0.1	NA	0.3	NA	0.3	NA	0.22	<0.03
Ba ppm	0.16	<0.2	0.07	<0.2	0.03	<0.2	<.02	<0.02	0.03	NA
Be ppm	<0.005	NA	<0.005	NA	<0.005	NA	<0.005	NA	<0.005	<0.2
Ca ppm	111.5	116	99.2	115	77.5	241	81.1	81.8	76.85	NA
Co ppm	<0.02	NA	<0.02	NA	<0.02	NA	<0.02	NA	<0.02	67.8

TABLE 3-9
COMPARISON OF ANL MONITORING RESULTS TO SITE DATA FOR 5 SAMPLED WELLS
FMPC - FERNALD, OHIO
PAGE TWO

Parameter/Unit	Well P-1		Well T-5		Well 14S		Well 16D		Well 12	
	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA
Cr ppm	0.03	<0.005	0.02	<0.005	<0.02	0.159	<0.02	<0.005	0.02	NA
Cu ppm	0.04	<0.025	0.03	<0.025	0.04	0.289	0.04	<0.025	<0.05	<0.005
Fe ppm	4.92	5.31	1.87	1.82	0.22	37.2	0.29	0.123	0.02	<0.025
Cd ppm	<0.02	<0.002	<0.02	<0.002	<0.02	0.005	<0.02	<0.002	<0.02	0.05
Mg ppm	27.1	33.9	25.2	25.5	18.9	44.3	20.4	20.7	19.2	<0.002
Mn ppm	0.41	NA	0.59	NA	0.09	0.451	0.02	<0.02	<0.01	18.9
Mo ppm	<0.05	NA	<0.05	NA	<0.05	NA	<00.5	NA	<00.5	<0.02
Na ppm	27.0	26.6	9.18	12.8	11.20	10.4	9.96	11.1	13.50	NA
Ni ppm	<0.02	<0.005	<0.02	<0.005	<0.02	0.027	<0.02	<0.005	<0.02	11.2
Pb ppm	<0.1	<0.005	<0.1	0.09	<0.1	<0.1	<0.1	<0.005	<0.1	<0.005
Sn ppm	<0.1	NA	<0.1	NA	<0.1	NA	<0.1	NA	<0.1	NA
Sr ppm	1.48	NA	0.32	NA	0.24	NA	0.16	NA	0.17	NA
Tl ppm	<0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA	<0.01	NA
V ppm	<0.05	NA	<0.05	NA	<0.05	NA	<0.05	NA	<0.05	NA
Zn ppm	<0.01	<0.02	<0.01	<0.025	<0.01	0.166	<0.01	<0.025	0.04	0.109
Zr ppm	<0.02	NA	<0.02	NA	<0.02	NA	<0.02	NA	<0.02	NA
Gross alpha (pCi/l)	NA	<15.0	NA		<2	47	900 ± 90	<15.0	500 ± 50	<15.0

TABLE 3-9
COMPARISON OF ANL MONITORING RESULTS TO SITE DATA FOR 5 SAMPLED WELLS
FMPC - FERNALD, OHIO
PAGE THREE

Parameter/Unit	Well P-1		Well T-5		Well 14S		Well 16D		Well 14S	
	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA	June 1986 ANL	1985 RCRA
Gross beta (pCi/l)	NA	<5.0	NA	12	<20	46	21 ± 4x10³	<5.0	44 ± 9x10³	28
Cesium-137(pCi/l)	NA	(2)	NA	(2)	6 ± 3	12	<3	(2)	3 ± 2	(2)
Radium-226 (pCi/l)	NA	(2)	NA	(2)	68 ± 20	<10	31 ± 15	<5.0	45 ± 15	<5.0
Bismuth-214 (pCi/l)	NA	(2)	NA	(2)	73 ± 22	NA	<17	(2)	78 ± 23	(2)
Thorium-228 (pCi/l)	NA	(2)	NA	(2)	150 ± 60	<5	<49	(2)	<49	(2)
Potassium-40 (pCi/l)	NA	(2)	NA	(2)	<75	<10	<75	(2)	<75	(2)
TDS ppm	NA	420	NA	396	370	436	390	356	750	304
COD ppm	NA	<10	NA	<10	13	32	13	21	32	<10
TOC ppm	NA	<1	NA	<1	3.2,2.4	4	2 7.2.0	<1	10.9,11.1	<1
TOX ppb	NA	12.8	NA	<10	0.009,0.007	NA	0.013,0.010	28.5	-	32
Phenol ppm	NA	0.008	NA	<0.005	<0.005	0.015	0.013	0.009	-	0

Notes:
NA - Not Analyzed
(1) - Data from Dames and Moore, 1985
(2) - Rad scan <5.0

TABLE 3-10

LABORATORIES RESPONSIBLE FOR ANALYSIS OF GROUND WATER
FMPC - FERNALD, OHIO

Sampling Event	Sampled By	Analyzed By
Monthly onsite	WTP	WTP (onsite)
Monthly offsite	ES&H	Bioassay lab (onsite)
Quarterly onsite	WTP	WTP/Bioassay (onsite)
Quarterly RCRA	Contractor/ES&H	Contractor-Howard Labs

data in the test wells extend back to 1965, and consultants' reports from as early as 1960 provide additional data. Sampling from 1983 provides further data. A summary of the monitoring data is provided in Appendix G. This summary presents an historical perspective on the ground-water contamination at FMPC.

3.4.4 Findings and Observations

3.4.4.1 Category I

None

3.4.4.2 Category II

1. Uranium Contamination of the Sand and Gravel Aquifer--Onsite and offsite ground water is degraded, and potential health risks may be increased if the ground water is used as a source of drinking water. The contaminated areas are located:

   - Along the western side of the site.
   - South of the site in private wells.
   - Possibly east and southeast of the site.

   The 1985 Dames and Moore study identified a large area of uranium contamination in the sand and gravel aquifer (see Figure 3-16). The area included the entire western site boundary parallel to Paddy's Run, and areas south of the site. Uranium concentrations mapped in Figure 3-16 are shown at levels above 0.001 mg/l. Background uranium concentration was considered to be 0.0008 mg/l.

   The Dames and Moore study verified the occurrence of uranium at elevated levels (in fact, the highest levels found in any sampled well) in ground water in three offsite water supply wells south of the site. These wells (offsite wells 12, 15, and 17) had average 1985 ground-water uranium concentrations of 140.00, 204.27, and 31.15 pCi/l respectively. None of these wells are currently used for potable water because of the uranium contamination.

   The sources of the ground-water contamination identified by Dames and Moore included the waste pit area and the production area. The highest contamination of uranium that occurred in the offsite wells was attributed to the downward infiltration of contaminated surface

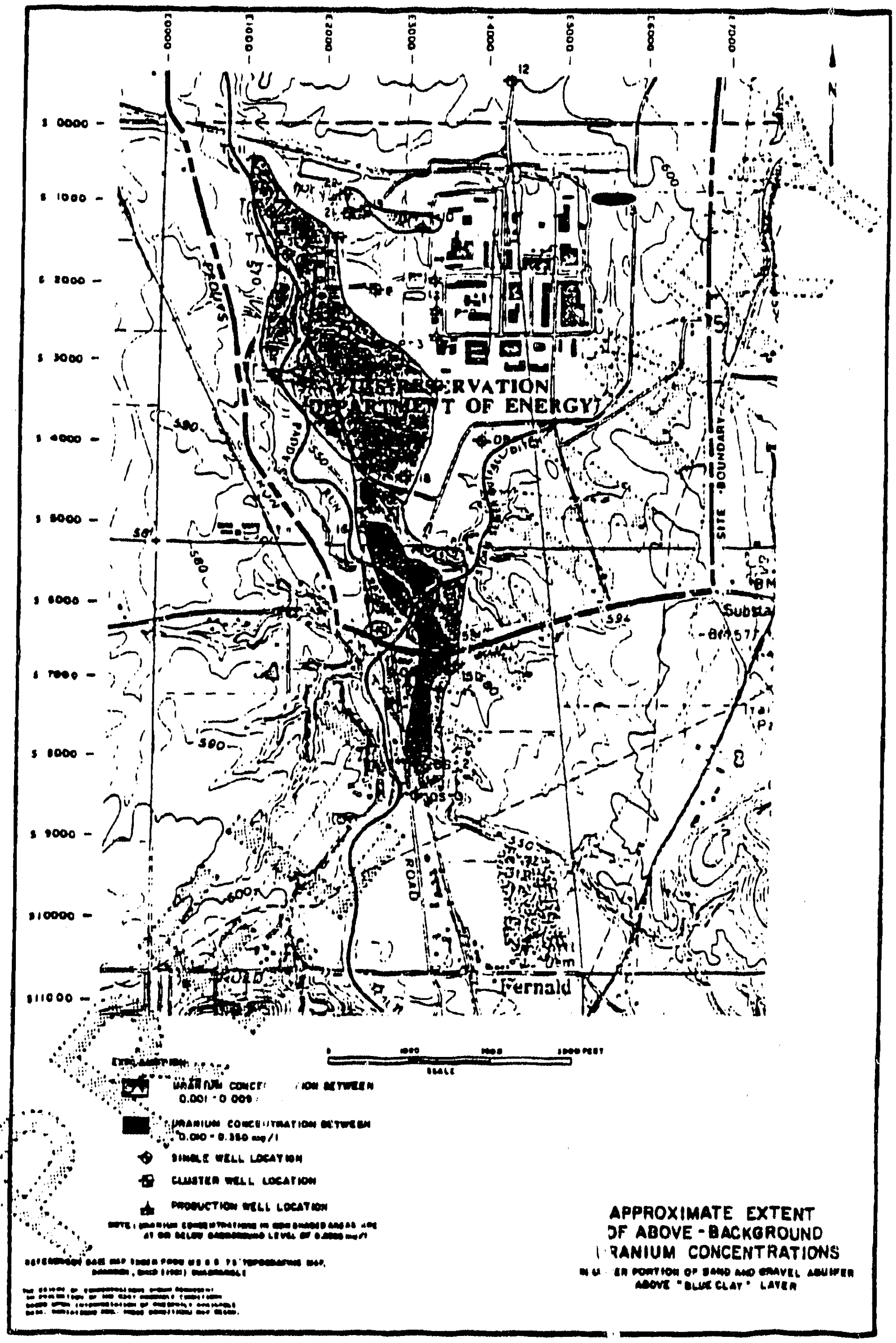


Figure From: Groundwater Study Task C Report, Dames & Moore, 1985

APPROXIMATE EXTENT OF ABOVE-BACKGROUND URANIUM CONCENTRATIONS **FIGURE 3 - 16**

water derived from Paddy's Run and the Storm Sewer Outfall Ditch into the sand and gravel aquifer.

Potential uranium contamination east and southeast of the site has been preliminarily identified by a 1986 study by IT Corporation (see Figure 3-17). The basis for these preliminary findings is uranium levels in groundwater samples above background concentrations.

2. <u>Contamination in Perched Ground Water</u>. Shallow (perched) ground water within the till has been contaminated in the following areas:

- The waste pit area.
- The production area.
- The area west and slightly south of the production area.

In the waste-pit area ground water has been contaminated by both radionuclides, sulfate, and possibly by metallic ions such as barium and chromium. In fact, a total of 32 parameters were found at higher levels than background in ground water in the three shallow wells around Waste Pit 4. Uranium concentrations in ground water from these wells ranged between 0.29 and 2.19 mg/l. Gross alpha and gross beta ranged from 43 to 1370 pCi/l and from 94 to 1,340 pCi/l, respectively.

Although no shallow wells exist within the production area, a 1986 study by Dames and Moore indicates that the ground water is contaminated by uranium at levels 200 to 4,000 times background concentrations. Samples were taken in the production area storm sewers that intercept the shallow ground water. A flow balance performed during this study estimated that 109.4 million gallons per year of ground water infiltrates the storm sewers at reported uranium concentrations of between 0.14 and 4.06 mg/l.

Well TP-20 southwest of the production area and a spring west of the production area exhibit uranium concentrations in the shallow ground water above background levels. The spring, which is south of the K-65 silos and flows into Paddy's Run, has a reported uranium concentration of 1.88 mg/l. The ground water from Well TP-20 exhibited an above-background uranium concentration of 0.0410 mg/l in 1985. Gross beta was 77 pCi/l.

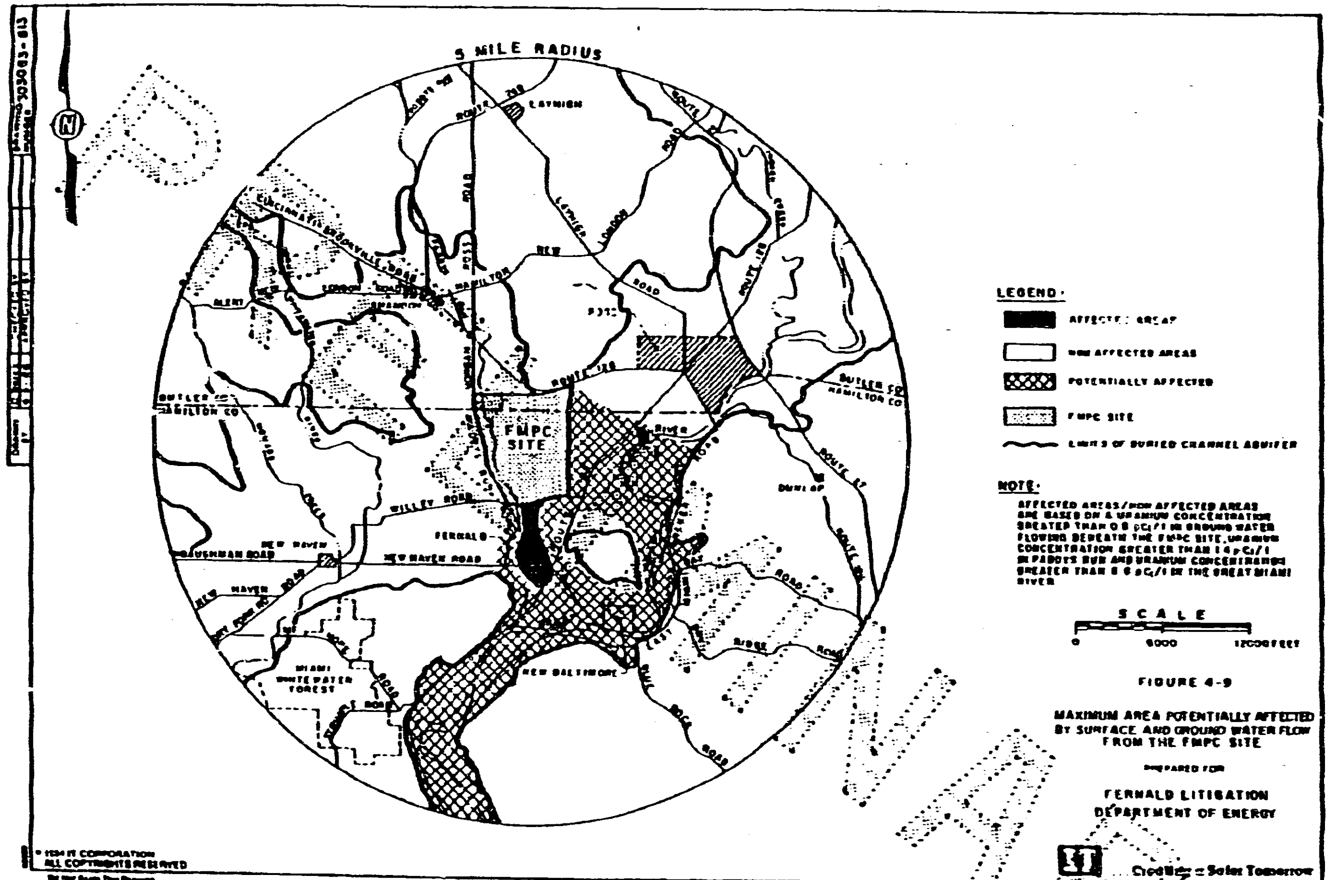


Figure From: Feed Materials Production Center Environmental Monitoring Annual Report for 1985

MAXIMUM AREA POTENTIALLY AFFECTED BY SURFACE AND GROUND WATER FLOW FROM THE FMPC SITE

FIGURE 3-17

3. Chemical Contamination in Sand and Gravel Aquifer. Ground water in the sand and gravel aquifer on site is contaminated by constituents other than uranium. Historically, chlorides, nitrates and sulfates have been detected above drinking water standards in the ground water.

For example, on May 15, 1965, use of Production Well 1 (P-1), installed in the lower sand-and-gravel aquifer, stopped as a result of contamination. In June and July 1960, chloride levels in Well 1S ranged between 17 and 27 mg/l and nitrate levels ranged between <0.1 and 5.2 mg/l. Significant levels of contaminants were also discovered in Well 7. By May 1965, Well 1S ground water had a chloride level of 300 mg/l, nitrates of 500 mg/l, and sulfates of 169 mg/l. In October 1965, Well 7 contained 1,430 mg/l of chloride, 4,800 mg/l of nitrate, and 746 mg/l of sulfate. These levels exceed present drinking water standards and are far in excess of general background levels.

4. Offsite Use of Contaminated Ground Water. Uranium-contaminated ground water is being used or has the potential to be used in two offsite wells.

The shallow well at the Knollman Farm (offsite well 12) has an outdoor spigot which is not secured and allows for unrestricted access. There is a potential for human or animal exposure because of this condition. Additionally, offsite well 15 is being used to supply process water for a local industry. Although no longer used as a potable supply, treatment of the water for industrial purposes generates uranium-contaminated sludges, which much be specially disposed by the facility.

A review of the tabular data from the WTP laboratory indicates that the ground water contaminants in many of the test production wells have increased substantially in the past. A brief summary is included below:

- P-1 shows a steady increase in chloride to more than 200 mg/l by 1970. These levels slowly declined, but in 1984 the nitrate concentration in this well exceeded the National Primary Drinking Water Standards twice.

- Well P-2 shows increases in chloride concentration to greater than 250 mg/l (drinking water standard) in 1969 and 1970. Levels declined to less than 20 mg/l by 1980.

- Wells 9 and 8S have also shown significant increases in contaminants since 1965.

- TOAB well (The Old Administration Building) has shown substantial increases in groundwater contaminants. An example of contaminant levels in mg/l is shown in the following table:

Date	Chloride	Nitrate	Sulfide
1/69	8	1.3	2
4/71	614	10.9	313
4/73	763	2.0	497
4/75	433	12.7	329

Radionuclide data were not available in the tabulated data for these wells. However, for comparison, the 1985 levels in TW-10 for chlorides, nitrates, and sulfates were 76, 155.6, and 470 mg/l, respectively, and the uranium concentration was 13.88 pCi/l. Sulfate, nitrate, gross alpha, and possibly gross beta levels were all above National Primary Drinking Water Standards (NPDWS).

3.4.4.3 Category III

1. Ground-Water Flow Patterns. Ground-water flow patterns are not completely characterized, resulting in uncertainty over potential contaminant migration pathways. The ground-water flow regime has not been adequately characterized in either of the following:

- The shallow (perched) aquifer.
- The sand and gravel aquifer.

Although a 1986 study by Dames and Moore indicates that substantial quantities of shallow groundwater exist in the production area, no shallow wells exist within the production area. Therefore, the horizontal and vertical extent and flow regime of this zone remains uncharacterized. This lack of data is significant in light of the fact that the Dames and Moore study indicates that these waters are contaminated.

The shallow groundwater regime has only been investigated in the vicinity of Waste Pit 4 by three wells. No other wells are installed in the shallow ground water in the waste pit area. Only one shallow well (TP-20) exists outside the waste pit area. Springs or seeps likely to be associated with the shallow ground water have not been fully characterized or identified on or off site.

A component of flow (which could allow for movement of contaminants toward the east) in the sand and gravel aquifer has been postulated by Ohio EPA's consultant, Geotrans. One known component of flow is toward the south. The computer modeling effort by Geotrans suggests that a groundwater divide may exist beneath the production area. Only two monitoring wells exist in the production area, a number which is insufficient to provide the data necessary to resolve this issue.

2. <u>Ground-water Data Base Gaps</u>. Significant data gaps have been identified in the FMPC ground-water program which limit the complete understanding of the impacts of FMPC operations on the ground-water environment. These gaps include the following:

- The lack of ground-water chemistry data within and east of the production area.
- The lack of a data base on predominantly nonradiologic ground-water parameters in offsite wells.
- The lack of a complete offsite well inventory to identify all potential receptors.
- The lack of a definitive explanation of the radioactive potassium-40 concentrations in ground water in offsite Wells 19 and 20.

No monitoring wells exist within the production area in the shallow ground water ,and only two exist in the upper sand-and-gravel aquifer. No information from wells is available immediately southeast or east of the production area. Therefore, only extremely limited information exists.

Twenty-five wells are monitored off site. However, only three of these wells are analyzed for parameters other than nitrate and uranium. Parameters other than uranium and nitrate have been identified in the groundwater in onsite wells. This lack of data in offsite wells could result in the failure to identify the occurrence or lack thereof of site ground-water contaminants. Along these lines, a complete inventory of all potential offsite well users has not been performed. Potential receptors could be missed.

Offsite Wells 19 and 20 (Figure 3-15) have reported gross beta concentrations in groundwater potentially in excess of the NPDWS. According to site personnel these gross beta levels have been attributed to potassium-40 and are considered to be non-site related. However, potassium-40 has been found in onsite ground water (associated with the waste pits). A definitive document and/or set of data is not available to substantiate the site's finding.

3.4.4.4 Category IV

1. Ground-water Sampling Program. The validity of ground-water contaminant data collected at the FMPC is in question because of

- Well construction of older test wells.
- Sampling procedures.
- Well placement.
- Well security and maintenance.

Analytical results from ground-water samples taken from the old test wells (constructed in 1959 and 1965) may be affected by the well construction materials. According to the construction details, some of these wells contain brass screens and lead seals. Steel casings are also in direct contact with the ground water.

Sampling procedures used in the monthly sampling of the production wells and older test wells have the potential to further affect analytical results and generate questionable environmental data. This potential arises from

- Allowing sample bottles to be left in the sun for hours after sample collection.
- Using non-laboratory-prepared sample bottles.
- Collecting "stagnant" water from improperly purged wells.
- Allowing surface contamination of bottles.
- Lack of "hygiene" in the use of water-level measuring devices.

Sampling of Well 14S for the RCRA program resulted in the placement of a submersible pump directly on the ground surface. This procedure has the potential to introduce surface contamination into the well.

Wells 1S and 5 have become contaminated with oil as a result of leakage from the surface-mounted pumps. The oil is several inches thick in Well 15. In addition, Wells 1D, 4, 8S and 8D are open to the atmosphere, a factor which could allow airborne contaminants or small objects to enter the wells. The old test wells are also not secured against tampering.

Upgradient Well 12 used for the RCRA sampling program in the waste pit area does not provide data on ground-water quality parameters for either the shallow (till) ground water or the ground water in the sand and gravel aquifer. Well 12 is screened primarily within the bedrock. As a result, upgradient groundwater quality has not been established for the program.

4.0 NON-MEDIA-SPECIFIC FINDINGS AND OBSERVATIONS

4.1 Waste Management

4.1.1 General Description of Pollution Sources/Controls

This section describes the waste sources at the FMPC by category: hazardous, mixed (hazardous and radioactive), radioactive, and nonhazardous. The largest portion of the waste streams from FMPC of concern in this report contain potential mixed wastes.

4.1.1.1 Hazardous Waste

The majority of hazardous waste generated at FMPC is suspected of being mixed with radioactive waste. The only strictly hazardous waste stream identified in the FMPC Resource Conservation and Recovery Act (RCRA) Part B permit application is 50 pounds per year of out-of-date chemicals from the main laboratory. The suspected additional hazardous/mixed waste streams will be discussed in the mixed waste section below.

4.1.1.2 Mixed (Radioactive and Hazardous) Waste

The FMPC RCRA Part B permit application for the management of hazardous/mixed waste reported three mixed waste storage facilities (the KC-2 Warehouse, the Pilot Plant Warehouse, and the Pilot Plant 10,000 gallon tanks); one treatment process (the Pilot Plant treatment operation that converts soluble $BaCl_2$ to insoluble $BaSO_4$); and one landfill (Pit 4).

Table 4-1 depicts the hazardous/mixed waste stream management information expressed in the most recent modification to the RCRA Part B permit application. Waste generation points; waste storage, treatment, and disposal points; and waste types and quantities are included in this table.

The following paragraphs describe specific potential mixed waste stream from each major process building at the FMPC site.

Plant 1 - The Sampling Plant. Water from the spray curtain in the paint booth on the drum reconditioning line is transferred to a dumpster and hauled to the Plant 8 sump for disposal as needed. The water may contain lead-based paint, lacquer, and solvent wastes that may be hazardous. In addition, xylene, a listed hazardous waste generated in this operation, is placed in

TABLE 4-1

FMPC RCRA PART B HAZARDOUS/MIXED WASTE MANAGEMENT INFORMATION
FMPC - FERNALD, OHIO

Waste Generation	Waste Storage	Waste Treatment	Disposal	Waste Type	Rate
Maintenance Shop - Building 12 Plant 6 National Electric Coil Corp - Louisville, Kentucky	2 stainless-steel 10,000 gallon tanks at Pilot Plant 13,000 gallon in storage		Ultimate disposal at Oak Ridge National Lab (K-25) Incinerator	1,1,1-trichloroethane, mineral spirits, PCBs <250 ppm uranium (mixed waste)	110 gal/yr
National Electric Coil Corp - Louisville, Kentucky - distilled to still bottom in Plant 1 still	Stored in drums in KC-2 warehouse 24,000 lbs in storage	Distilled to still bottoms	As above	1,1,1-trichloroethane and PCB still bottoms with <250 ppm uranium (mixed waste)	No longer generated
RMI - Ashtabula, Ohio (heat treatment of DOE uranium metals)	Stored in drums at Pilot Plant Warehouse	Treated in Pilot Plant Treatment System		Barium chloride salt (55% $BaCl_2$, 25% NaCl, 20% KCl contains uranium mixed)	Approximately 50,000 lb/yr
Main Laboratory			Sold to commercial recycler or offsite TSD facility*	Excess or outdated lab chemicals (RCRA wastes)	Approximately 50 lb/yr
RMI - Ashtabula, Ohio	2 stainless-steel 10,000 gallon tanks at Pilot Plant		Ultimate disposal at Oak Ridge incinerator	Degreasing solvents 45% methylene chloride, 50% perchloroethylene, <1% uranium (mixed waste)	13,000 lb/yr
RMI - Ashtabula, Ohio	KC-2 Warehouse		Ultimate disposal in Oak Ridge incinerator	Pump station oil and lathe coolant containing lead	4,000 lb/yr

* As stated in the RCRA Part B permit. No further information is provided.

55-gallon drums and transported to either the Plant 1 pad or to Plant 8. Plant 1 has a hydraulic drum compactor that has occasionally leaked to the compactor sump. The compactor sump water has been sent to the oil burner if it "looked oily" or to Plant 8 if it "did not appear oily." The fluid has not been tested for PCBs.

The Plant 1 drum reconditioning unit may be the source of a low quantity of hazardous waste. The peelable paint that lines the paint-spray booth may be lead-based or have chromium pigments. The peelable paint is periodically removed and placed in drums for transport to either Plant 1 for storage or Plant 8 for burning.

Plant 1 has a large drum storage pad that is suspected of being used to store hazardous and radioactive mixed waste.

A solvent still, which is used to reduce the volume of large quantities of 1,1,1-trichloroethane contaminated with PCBs from past operations at the RMI facility in Ashtabula, Ohio, is located in Plant 1. The still bottoms from that operation have been removed and are now in storage at the KC-2 warehouse. The still is not currently in use.

<u>Plant 2/3 - The Refinery</u>. The Refinery waste includes solids from the continual regeneration of the kerosene/tributyl phosphate (TBP) mixture in the solvent treatment system. Solid waste is removed from the solvent by centrifuges on the second level of the plant. The solids are drummed and sent to Plant 8 for uranium recovery. In addition, frame filters in the hot raffinate building of the refinery complex are used annually for solvent cleaning. This activity generates approximately ten drums of solids that are sent to Plant 8 for recovery. Both centrifuge and frame filter solids are suspected of containing barium, a toxic metal. Standard Operating Procedure No. 2-C-202 entitled "Filtration and Evaporation" states that $BaCO_3$ is introduced in the refinery process for radium control. The quantity of $BaCO_3$ used is unclear, but the FMPC Chemical Warehouse has more than 20 tons of $BaCO_3$ in storage (purchased in 1979), and records indicate that the refinery withdrew 5,750 pounds from storage in May 1986.

Plant 2/3 produces raffinate that, when neutralized at the General Sump, is the third largest low-level waste stream at FMPC. The material was subjected to the EP toxicity test and was not found to be hazardous. Neutralized raffinate is now packaged at Plant 8 for shipment to the Nevada Test Site (NTS), but none has been shipped to date.

The waste oil burner and solid waste incinerator, which were deactivated in early 1986, are located in a building outside of Plant 2/3. The waste oil burner was combusting a number of process liquid wastes including Plant 6 wastewater system decant oil, plant oily sump water, waste solvents, and other waste cutting oils. These and similar liquid wastes are now stored in barrels on a concrete storage pad adjacent to the oil burner.

Plants 5, 6, and 9. Individual maintenance shops that use 1,1,1-trichloroethane primarily for degreasing of equipment are located in these plants. These activities generate approximately 9 drums of waste 1,1,1-trichloroethane per year. This hazardous waste is accumulated in 55-gallon drums and sent to the Plant 1 storage pad or the Pilot Plant hazardous waste storage tanks.

Plant 6. The only treatment system that is regularly used to remove oil from wastewaters is located at this plant. Nonacidic and oily wastes from Plants 5, 6, and 9 are collected, blended, and separated into water and oil fractions. The oil is decanted into drums that are sent to the Plant 2/3 pad for storage. The water is filtered through a plate and frame filter. The filter cake is taken to Plant 8 for processing in one of the furnaces.

Plant 8 - Scrap Recovery Plant. Plant 8 generates solid wastes from Eimco and Oliver filters and from the box furnace, muffle furnace, oxidation furnace Nos. 1 and 2, rotary kiln, and calciner. Wastes from the filters are packaged in 55-gallon drums and sent to Plant 1. The Plant 8 filters process wastes from Plants 1, 2/3, 4, 9, the Pilot Plant, and other buildings including those from the General Sump that have been processed through the Plant 8 treatment tanks. The filter cake contains uranium but may also be contaminated with hazardous materials from other processes. Similarly, feed materials to the Plant 8 furnaces may contain hazardous wastes. Feed materials to all furnaces will be tested to determine toxicity.

Plant 9. Non-oily wastes from Plant 9 processing are collected in floor drains and pumped to the Plant 9 treatment sump. There the wastes are pumped through a filter press until the solution is clear.

The Pilot Plant. The Pilot Plant warehouse contains storage space for drums of hazardous waste and thorium. The hazardous barium chloride waste is generated at the RMI Extrusion Plant in Ashtabula, Ohio. These hazardous wastes are from the processing of FMPC materials, and FMPC has contractually agreed to accept the wastes. FMPC receives shipments from RMI several times per year. These shipments are manifested and the drums are properly marked. The drums are stacked on pallets on a cement slab curbed on three sides. The fourth side is composed of a wooden plank that allows a forklift to enter the slab.

The Pilot Plant contains a hazardous waste treatment system that transforms the soluble barium chloride to the insoluble barium sulfate solid. This system was a prototype to prove the feasibility of the process and must undergo modifications prior to its continued use. The barium sulfate produced from the system is packaged in 55-gallon drums and sent to Plant 1 for assay. As a result of screening the waste drum contents to remove foreign matter prior to the treatment operation, barium chloride salt may be released to the floor drains. If this type of release should occur, then barium would go to the Pilot Plant sump (usually Tank F-100), which is pumped to Plant 8 or the General Sump, depending on the uranium content of the solution.

The Pilot Plant stores liquid hazardous wastes in two 10,000-gallon tanks (Tanks T5 and T6). The records of tank inventory maintained at the Pilot Plant identify these wastes as either contaminated solvents or contaminated oil. These tanks are sampled after each loading for percent carbon, hydrogen, chloride, fluoride, sulfur, phosphate, 1,1,1-trichloroethane, iron, sodium, and pH. The FMPC Part B RCRA permit application identifies this liquid waste as waste 1,1,1-trichloroethane. The FMPC hazardous waste management plan states that this material is also contaminated with PCB. The Part B permit application indicates that the maintenance shop, garage, and paint shops are the sources of these materials. In addition, liquid wastes generated in the early 1980s by the National Electric Coil Corporation (NEC) in Louisville, Kentucky may also contain these contaminants.

The Pilot Plant tank T3 is marked as a hazardous waste tank. Records show that it contains unspecified waste liquid.

Building 12 (Maintenance Shop). The maintenance shop generates two potentially hazardous liquid waste streams. Spent 1,1,1-trichloroethane generated in degreasing is transported to the storage tanks at the Pilot Plant and is a waste stream described in the RCRA Part B permit application. The paint shop also generates paint-spray booth wastewater that is discharged to liquid dumpsters and transported to the Plant 8 liquid sump for processing.

The Laundry. The FMPC laundry produces a solid waste from its perchloroethylene filtering system. Perchloroethylene is used as a dry-cleaning agent for protective garments used at FMPC. The dirty solvent is processed through a diatomaceous earth/clay filter media to remove impurities. The spent filter media is laden with perchloroethylene and is packaged in 55-gallon drums that are taken to Plant 1. The laundry generates approximately one 55-gallon drum per week.

Laboratory. The main laboratory generates waste solvents and spent chemical solutions that are collected in carboys in individual laboratory rooms and accumulated in 55-gallon drums outside of the main laboratory building. The main laboratory generates an estimated 4 drums of waste quarterly. There were 12 drums of waste solvent stored on a grassy area directly behind the building at the time of the survey. There are plans to construct a concrete storage pad outside the main laboratory to provide a more secure storage area for the waste solvent drums. The waste drums are transported to Plant 8 for processing.

Liquid wastes poured into sinks and drains at the laboratory are collected in a stainless-steel sump prior to being pumped to Tank 2 at the General Sump for treatment. The main laboratory sump is occasionally drained, and the accumulated sludge is packaged in 55-gallon drums for transport to Plant 1.

Pits 5 and 6. Rainwater that has accumulated on top of Pit 4 has been pumped to Pits 5 and 6; no testing has been performed to determine whether the water has been contaminated by hazardous wastes in Pit 4.

Other Solid Waste Streams. FMPC generates miscellaneous solid waste from a number of plants and activities. These wastes are stored in centralized areas awaiting further processing or disposition. Any large pieces of contaminated scrap metal are sent to the scrap metal storage pile behind the decontamination building (Building 69). The material on the pile has extended beyond the asphalt pad, which serves at its base. The pile contains approximately 8,000 tons of contaminated iron and steel. Runoff from the pad goes to the stormwater system and onto the ground beyond the pad. A pad outside Building 64 that stores metal, ceramics, machinery, and other items is not in current use. While some of the material is not waste, there appear to be contaminated burnables stored on this pad as well as miscellaneous drums. The Plant 1 storage pad contains a large inventory (1,350 tons) of contaminated, scrap copper, motor windings stored in a pile, and runoff from this pile flows to the stormwater system.

4.1.1.3 Radioactive Waste

The majority of the solid wastes generated at FMPC are low-level radioactive wastes (LLW). The three largest categories of LLW are depleted magnesium fluoride (MgF_2) slag, slag-leach filter cake, and neutralized raffinate. Depleted MgF_2 slag produced in Plant 5 was deposited in Pits 1, 2, and 6 in the past. It is now drummed and stored on the Plant 1 pad or packaged for delivery to NTS.

Slag-leach filter cake produced in Plant 8 from the Eimco and Oliver filters was formerly deposited in Pits 1, 2, and 6. Neutralized raffinate is produced in the Refinery (Plant 2/3), treated in the General Sump, and pumped to Plant 8 where solids are removed by rotary vacuum filtration. The neutralized raffinate was previously deposited in Pits 3 and 5. FMPC produces approximately 48 drums of depleted MgF_2 slag, 27 drums of slag-leach filter cake, and 9 drums of neutralized raffinate daily. The majority of the waste is now drummed and stored on the Plant 1 storage pad. Other high-volume LLW streams include air pollution dust collector residues, scrap salts, and wet filter cakes. Table 4-2 depicts the 1986 estimated daily generation rate of all FMPC LLW streams. The major chemical components of the waste are oxides and nitrates of copper, aluminum, iron, calcium, and uranium in various oxidation states; magnesium fluoride; and traces of free magnesium.

The FMPC generates burnable LLW waste streams from the process area. These wastes are composed of decant oils from the Plant 6 wastewater treatment operations, contaminated wood, filters, and other general wastes. Table 4-3 depicts the quantities of burnable LLW generated.

The storage of LLW and recoverable uranium-bearing process material is the responsibility of Plant 1. The Plant 1 storage pad is a U-shaped cement slab behind Plant 1. The Plant 1 pad currently has an inventory of nearly 35,000 drums scheduled for eventual disposal. The oldest drums on the pad are approximately 10 years old. Plant 1 personnel re-drum leaking drums and drums in poor condition. The continual increase in the number of drums in the past years had made adequate spacing and access for inspection or maintenance difficult. The concrete pad is cracked and crumbled, with vegetation growing through in places. Runoff from the pad is collected by the stormwater sewer, but also drains to cracks and openings. All drums examined were marked with the FMPC drum identification system numbers. The numbering system identifies the source of the waste by plant, section of the plant, date of generation, and uranium enrichment level. The drum inventory documentation is computerized, and Plant 1 personnel can identify the storage location of specific drum lot numbers. Each drum arriving at Plant 1 is assayed for uranium content, but no hazardous waste tests are performed. As a result, it is likely that the Plant 1 pad is storing hazardous or mixed wastes. A survey of the pad found drums of newly-arrived spent perchloroethylene awaiting storage, yet there was no record in the computer data base of this or any perchloroethylene waste shipments stored at the Plant 1 pad. FMPC has not included the Plant 1 storage in the RCRA Part B permit.

Approximately 2,500 other radioactive waste drums are stored at other locations throughout the FMPC facility. These drums contain miscellaneous wastes such as contaminated gloves, glass, and concrete. Table 4-4 identifies the location of these drums.

TABLE 4-2
1986 PRODUCTION ESTIMATE OF LOW-LEVEL WASTE
FMPC - FERNALD, OHIO

Waste Stream	Drums/Day
Depleted MgF_2	48
Slag Leach Filter Cake, Enriched and Normal	27
Neutralized Raffinate	9
Dust Collector Residues, Depleted	5
Scrap Salts, High Fluoride	3
Wet Filter Cakes (Non-oily, Non-halide)	3
General Sump Sludge	2
Scrap U_3O_8, High Fluorides	1.3
RMI Residues	1.0
Off-Spec. UF_4	0.7
Non-Briquettable Chips and Turnings for Oxidation	0.7
Furnace Solidified Salts, Non-chloride	0.44
Incinerator Ash	0.44
Furnace Solidified Salts, Chloride	0.19
Rockwell Cleanings and Spills	0.19
Dry Crushed Slag from Pot Blowout	0.13
MgF_2 plus 20 Mesh (Including Dirty Drill)	0.13
Unfired Reduction Charges and MgF_2 from Liner Cave-ins	0.13
MgO & Mg Zirconate from Crucible Cleanout	0.03
Nonburnable Contaminated Trash	0.03
Metal Spills and Extruder Ends High-Impurity Metal	0.01
Contaminated Bricks, Soil, Gravel, Ceramics	0.01
Partially Oxidized Metal Oxidation Feed	0.01
Bad Reduction (No Derby)	0.01
Contaminated Mg	0.01
Solid Metal with Imbedded Steel Other than Cores	0.006
Contaminated Non-Burnable Filter Cartridges, Asbestos, Etc.	0.006
Glass Sample Bottles	0.004
Samples from Lab	0.003
TOTAL DRUMS PER DAY	**99**

TABLE 4-3

LOW-LEVEL WASTE ESTIMATE
CURRENT OPERATIONS
FMPC - FERNALD, OHIO

Based on 50 weeks per year

Waste Stream (Burnable)	Rank	t/Yr	Lbs/Yr	Lbs/Day	Ft^3/Yr	Drums/Yr
General Waste - Process Area (33 Dumpster Loads/Week)	1	327	791,000	2,260	175,800	27,050(1)
Wood	2	218	480,000	2,400	32,000	4,000 Units
Oils - Plant 6 Decanting	3	57	126,000	360	2,100	300(2)
Filters(3)	4	12	27,000	N/A	4,500	695(1)

(1) Based on packing rate at 6.5 ft^3/drum
(2) Based on packing rate at 7.0 ft^3/drum
(3) Based on 1 bag change/yr for 75 units

*Source: Adapted from S. K. Scheel, September 1985, Preliminary Feasibility Report - FMPC Contaminated Waste Incinerator Facility.

TABLE 4-4

LOCATION OF WASTE DRUMS (GLOVES, GLASS, CONCRETE, ETC.) FMPC - FERNALD, OHIO

Drums	Location
1,548	East Building 64
70	Plant 5, North and South Ends
26	East Building 71
152	Truck Dock
101	Plant 2/3 West Pad
40	Plant 8 West Pad
396	Laundry and at Fence Area
15	Pilot Plant

In addition, there are 13,211 drums or cans of thorium stored in Building 65, the Pilot Plant Warehouse, Building 64, and Building 67. Almost 22,000 drums containing recoverable quantities of uranium are located on the Plant 1 storage pad awaiting processing.

Plant 5 generates depleted MgF_2 slag, which is the largest single waste stream at FMPC constituting 49 percent weight of the total waste. The waste from the MgF_2 pot liner recycle mill is packaged in drums and sent to the Plant 1 pad for storage until disposal at NTS.

Plant 5 also produces scrap solids from the derby top-cropping operation. The uranium scrap is high in impurities but has occasionally been sent to a National Lead Corporation facility in Albany, New York. The scrap depleted crops are packaged in boxes for storage. Any enriched uranium derby top-crops are returned to the refinery for uranium recovery.

The solids from the cutting, milling, and treatment operations in Plant 6 are directed either to a briquetting operation or to the Plant 6 wastewater treatment system. The briquetting operation receives metal solids from cut-off lathes and cross transfermatic mills, then crushes, pickles, and presses the solids into briquettes that are recycled to casting operations.

4.1.1.4 Nonhazardous Waste

FMPC also produces noncontaminated wastes from process and nonprocess areas. These waste streams are composed of construction materials, cafeteria waste, packaging materials, and similar burnable materials, as well as nonburnable rubbish assigned to the onsite sanitary landfill. Tables 4-5 and 4-6 respectively depict the quantities of noncontaminated burnable and nonburnable waste generated.

4.1.1.5 Offsite Disposal

Since 1985, FMPC instituted a system to reduce the amount of LLW stored on site by offsite disposal. To reduce the volume of waste stored on site, FMPC developed a waste certification program to inspect and test waste packages for transport to a DOE disposal area at the NTS. All waste packages shipped to NTS must meet waste acceptance criteria including limitations on external radiation, surface contamination, free liquids, respirable particles, criticality, and absence of hazardous wastes. NTS requires that RCRA EP toxicity tests must be performed (FMPC tests semiannually) on wastes sent to NTS. NTS has stated it will not accept mixed wastes or hazardous wastes from FMPC. The FMPC

TABLE 4-5

NONCONTAMINATED BURNABLE WASTE ESTIMATE
CURRENT OPERATIONS
FMPC - FERNALD, OHIO

Based on 50 weeks per year

Waste Stream (Burnable)	Rank	t/Yr	Lbs/Yr	Lbs/Day	Ft³/Yr	Drums/Yr
Non-Process Area General Waste (Blue Area)	1	61	135,000	386	18,000	2,770(1)
Construction Materials	2	57	125,000	500	15,625	2,404(1)
Cafeteria Waste	3	38	82,500	330	18,350	3,825(1)
Other Non-Process Area Packaging Materials	4	18	40,000	160	6,670	N/A

(1) Based on packing rate at 6.5 ft³/drum

*Source: Adapted from S. K. Scheel, September 1985, Preliminary Feasibility Report - FMPC Contaminated Waste Incinerator Facility.

TABLE 4-6

NONCONTAMINATED NONBURNABLE WASTE ESTIMATE
CURRENT OPERATIONS
FMPC - FERNALD, OHIO

Based on 50 weeks per year

Waste Stream (Nonburnable)	Mt/Yr	Lbs/Yr	Lbs/Day	Ft^3/Yr	Drums/Yr
Rubbish, Type "1," currently assigned to Sanitary Landfill	30	66,000	264	13,200	2,030(1)

(1) Based on packing rate at 6.5 ft^3/drum

*Source: Adapted from S. K. Scheel, September, 1985, Preliminary Feasibility Report FMPC Contaminated Waste Incinerator Facility.

waste certification program is the forerunner of the Low Level Waste Packaging and Shipment System (LLWPSS). The LLWPSS is a system to reduce in size, dry, stabilize, and drum all FMPC LLW for shipment to NTS. The LLWPSS would upgrade present Plant 8 equipment, add new structures and equipment, and provide an offsite disposal alternative for waste previously deposited in the FMPC pits.

The majority of waste sent to NTS is newly generated waste. By mid-1986, FMPC had shipped 4,191 drums of waste, but only 83 boxes were used as an overpack to transport old drums. Older drums require more time to package and certify.

Very little hazardous, radioactive, and mixed wastes were sent off site to other facilities prior to 1985. Examples of previous shipments are listed below:

- PCB-contaminated wastes shipped to the CECOS facility in Ohio.

- One shipment of radioactively contaminated scrap metal sent to the Oak Ridge facility—the scrap had an uranium concentration above specification and also contained asbestos.

- Two shipments of radium sources—one sent to USEPA's Eastern Environmental Radiation Facility in Montgomery, Alabama, and one sent to Beatty, Nevada.

- A limited number of shipments of contaminated process residues sent to the Maxie Flats facility in Kentucky during the late 1950s and early 1960s.

Radioactively-contaminated waste shipped off site is managed by the FMPC Nuclear Materials Group. This group prepares nuclear material shipping orders and transportation manifests, and conducts analysis of waste to determine levels of radioactivity and hazardous characteristics (e.g., EP toxicity). The transportation group prepares the shipping documents and loads the wastes. Both groups are involved in waste packaging and keep copies of the forms.

4.1.2 Findings and Observations

4.1.2.1 Category I

None

4.1.2.2 Category II

1. Unidentified Hazardous/Mixed Waste Streams. Operations are suspected of generating hazardous wastes that have not been previously identified as hazardous wastes, resulting in the improper treatment, storage, handling, or disposal of these wastes.

   The environmental survey found that FMPC is generating hazardous and mixed waste streams not previously identified. The result is that some facilities are not permitted (and do not have interim status) under RCRA and are operated without the control, monitoring, and operating practices normally associated with such facilities to prevent the release of hazardous constituents. These wastes are eventually stored on the Plant 1 pad or are treated in Plant 8. In either case, there is a potential for unmonitored release of hazardous substances from these facilities.

   The FMPC RCRA Part B permit application for the management of hazardous and mixed waste, prepared by FMPC in 1986, identifies three onsite sources of such waste – the maintenance shop, Plant 6, and the main laboratory. The survey found 32 additional waste streams and activities not identified in the Part B permit application that may be generating or managing hazardous/mixed waste. The 32 suspected waste streams or activities are summarized in Table 4-7.

   It is suspected that FMPC may have three additional storage facilities (Plant 1 pad, Plant 2/3 waste oil pad, and the Plant 8 pad); seven additional treatment/incinerator facilities; and three facilities in the waste pit area (Pit 5, Pit 6, and the Clear Well) that may have received hazardous waste either directly or through the General Sump wastewater flow system.

   ANL is sampling these waste streams to determine the constituents in these wastes. The specific analytical requirements for each waste stream are detailed in Table 4-7.

2. Hazardous Constituents in LLWPSS Feed Streams. The inclusion of many of the 32 mixed wastes streams, identified in Finding 1 above, in the planned FMPC Low-Level Waste Processing and Shipping System (LLWPSS) may cause hazardous constituents to be improperly released to the environments. Proposed designs for this treatment unit may not be suitable to handle hazardous constituents. Furthermore, hazardous contaminants in these wastes make them unsuitable for acceptance by NTS.

TABLE 4-7

SUSPECTED HAZARDOUS/MIXED WASTE STREAM OR ACTIVITY
FMPC - FERNALD, OHIO

Waste Stream/Activity	Suspected Problem	Sampling and Analysis Needs
Plant 1 storage pad waste drums	Storage of mixed or hazardous waste	Identify process area hazardous/mixed wastes and determine if stored on pad
Plant 1 spray booth wastewater	May be a hazardous waste	Analyze for toxicity and volatiles
Plant 1 waste xylene	Definitely a hazardous waste	Test for xylene
Plant 1 peelable paint waste	May be a hazardous waste	Analyze for EP toxicity and ignitability
Plant 1 drum reconditioner, air emissions	Shot used in barrel blaster may have contained lead	Sample soil around exhaust for lead contamination
Plant 1 drum compactor, sump water and sludge	May be a hazardous/mixed waste and contain PCB	Sample sludge and test for PCB and EP toxicity
Plant 2/3 centrifuge solids	May be a hazardous/mixed waste	Test for EP toxicity and volatiles
Plant 2/3 hot raffinate building, filter press solids	May be a hazardous/mixed waste	Test for EP toxicity and volatiles

TABLE 4-7
SUSPECTED HAZARDOUS/MIXED WASTE STREAM OR ACTIVITY
FMPC - FERNALD, OHIO
PAGE TWO

Waste Stream/Activity	Suspected Problem	Sampling and Analysis Needs
Plant 2/3 tank bottoms	May be a hazardous/ mixed waste	Test for EP toxicity and volatiles
Plant 2/3 neutralized raffinate	This material has been tested by EP toxic test and is not hazardous, but should be tested with proposed new EPA TCLP procedures.	TCLP
Plant 2/3 waste oil storage pad	Older drums may contain hazardous waste, visible leakers on pad, oil draining to sump around pad and to Plant 2/3 sump	Test for EP toxicity and volatiles
Plant 5 MgF_2	This material has been tested by EP toxic test and is not hazardous, but should be tested with proposed new EPA TCLP procedures.	TCLP
Plant 6 filter solids from wastewater treatment system	May be a hazardous/ mixed waste	EP toxicity and volatiles
Plant 6 oil decant from oil/water separator	May be a hazardous/ mixed waste	EP toxicity and volatiles

TABLE 4-7
SUSPECTED HAZARDOUS/MIXED WASTE STREAM OR ACTIVITY
FMPC - FERNALD, OHIO
PAGE THREE

Waste Stream/Activity	Suspected Problem	Sampling and Analysis Needs
Plant 8 wastewater treatment solids from: filters Oxidation 1 furnace Oxidation 2 furnace Rotary Kiln Calciner Box Furnace Drum Washer	It is suspected that any of these facilities could be treating hazardous/mixed waste	Feed materials and ash will be EP toxicity and volatile scan tested
Oil Burner	May have burned hazardous waste	-
Plant 9 filter solids	May be a hazardous/mixed waste	EP toxicity and volatiles
Pilot Plant barium chloride treatment facility area sump	Barium chloride may be released to sump upon screening of drum contents to remove foreign matter	EP toxicity
Pilot Plant, hazardous waste tank (#T3)	Contains hazardous waste	EP toxicity and volatiles
Laundry perchloroethylene regeneration system, waste filter material	Definitely a hazardous/mixed waste	Perchloroethylene
Main laboratory sump	Sump sludge is periodically removed and packaged in drums	EP toxic, volatile scan
Main laboratory waste solvent storage area	Drums stored outdoors on grassy area (unlabelled)	EP toxicity and volatiles

TABLE 4-7
SUSPECTED HAZARDOUS/MIXED WASTE STREAM OR ACTIVITY
FMPC - FERNALD, OHIO
PAGE FOUR

Waste Stream/Activity	Suspected Problem	Sampling and Analysis Needs
Pit 4	Known hazardous waste in pit, barium detected in ground water at levels above background	Corings and sampling of impounded water on surface for EP toxicity volatiles
Pit 5	Contamination by hazardous/mixed waste from process or other management activities	Representative sampling of sediment and liquid
Pit 6	Contamination by hazardous/mixed waste from process or other management activities	Representative sampling of sediment and liquid
Clear Well	Contamination by hazardous/mixed waste from process or other management activities	Representative sampling of sediment and liquid
Abandoned waste oil tank	Any remaining liquid or sludge may be hazardous	EP toxicity

The LLWPSS depends heavily upon existing and upgraded Plant 8 facilities to process the low-level radioactive waste to a form suitable for shipment off site. All Plant 8 filters, tanks, and combustion units that are suspected of treating hazardous waste in the past continue to do so. Furthermore, several proposed LLWPSS process streams are suspected of containing undetected hazardous waste constituents. Significant schedule delays and equipment modification in the LLWPSS could result if Plant 8 facilities were required to obtain hazardous waste incinerator permits. In addition, NTS waste acceptance criteria could not be met if FMPC LLW were found to contain hazardous waste. This would result in a need to find alternative disposal options for such waste.

3. <u>Waste Drum Deterioration</u>. An inventory of old radioactive waste drums is stored outdoors on the Plant 1 pad, and their deteriorating condition increases the potential for spills and releases to occur.

   FMPC could currently ship more waste to NTS, but the lack of manpower to certify that shipments meet acceptance criteria has slowed the process. The majority of waste sent to NTS is newly generated waste because it requires less time for packaging and certification than older drums on the Plant 1 storage pad. However, the removal of older drums from the pad would reduce the potential for drum failure. By mid-1986, FMPC had shipped 4,191 drums of waste, but only 83 boxes were used as overpack to transport old drums.

4. <u>Hazardous Waste Tracking System</u>. Hazardous pollutants may have been unknowingly released to the environment at FMPC because wastes have not been fully characterized prior to treatment, storage or disposal. FMPC has not established a program for onsite analysis, tracking, and control of hazardous/mixed waste. Thus, hazardous waste have not always been properly directed to treatment, storage, and disposal facilities that are appropriate and/or approved for these wastes.

   Lack of a comprehensive hazardous/mixed waste stream characterization and tracking system for onsite movement and handling is a major cause of the uncertainty pertaining to hazardous/mixed waste generation on site. FMPC rigorously analyzes waste material for uranium content and tracks shipments through the Nuclear Materials Balance System. However, there is no system to analyze and track hazardous or mixed wastes. For example, there was no record of perchloroethylene waste being stored at the Plant 1 pad, although 12 drums of this waste were located during the environmental survey.

In the past, waste has been directed to the pit area simply by sending a truck to dump the waste. This lack of any internal manifest system that would rigidly control the disposal of waste has resulted in a variety of materials being deposited in all pits despite certain attempts to segregate waste materials to specific pits.

Lack of manifests also makes it difficult to ascertain the exact characteristics and quantities of wastes processed and disposed at various facilities on site.

4.1.2.3 Category III

None

4.1.2.4 Category IV

1. Scrap Metal Pile Runoff. Runoff from precipitation falling on the contaminated material in the scrap pile has the potential to carry surface contamination to the stormwater system and drain onto the ground beyond the pad.

   The material on the scrap metal storage pile behind the decontamination building has extended beyond the asphalt pad which serves as its base. The pile contains approximately 8,000 tons of radioactively-contaminated iron and steel.

2. Waste Oil Burner Permit. The waste oil burner, shut down in early 1986, had burned waste oil and other ignitable liquids. The facility may be required to submit a closure plan for the unit if waste oil or other input materials are determined to be a hazardous waste. EPA is currently studying waste oil for listing as a hazardous waste.

3. Uncontrolled Waste Drum Storage. The waste solvent drums (12 drums) located on the grassy area behind the main laboratory did not have accumulation start-dates on their labels so it was not possible to verify the length of storage at this location. Long-term storage at this location has the potential for discharges to the surrounding soils as there are no records of regular inspection of the drums in the area. There are plans to build a concrete storage pad to provide more secure storage for these drums.

4. Onsite Waste Accumulation. The storage of solid waste may exacerbate the crowded waste storage conditions on site. FMPC has closed its sanitary landfill and its solid waste incinerator.

It is currently compacting and storing its nonputrescible solid waste. FMPC has applied to the Ohio EPA for approval to expand its present sanitary landfill, but Ohio has not yet acted upon the application. FMPC is planning to acquire a large-capacity, volume-reduction unit to supplement its capabilities.

5. Waste Drum Inspection. Drums of hazardous waste stored in the Pilot Plant Warehouse are not inspected weekly as is required by RCRA requirements (40 CFR 265.174). Inspection logs maintained in the Pilot Plant indicate inspection at 2- to 3-week intervals or longer. The drums are in good condition, in an area that is enclosed by curbing. There was no evidence of current leakage.

4.2 Toxic and Chemical Materials

4.2.1 General Description of Pollution Sources/Controls

The FMPC facility handles a number of toxic and hazardous materials (e.g., magnesium, 1,1,1-trichloroethane, xylene, etc.). The Stores Department is responsible for the procurement and initial storage and distribution of these materials. Secondary storage sites are under the management of various end-users on the site. Large bulk shipments of chemicals are delivered directly to the Tank Farm.

4.2.1.1 Toxics Management

The majority of chemicals used on the site are purchased through the Stores Department. Thus, Stores has initial control over the storage and use of the chemicals. A recently-installed (approximately May 1986) computerized inventory system, known as MMCS (Maintenance Management Control System), is used to track the quantities of chemicals, spare parts, and materials in the Stores Department. This system does not, however, track chemicals to the actual user. It allows materials designated as hazardous to be so identified in the printout of the inventory. Currently, no controls exist to limit the access of employees who have not been properly trained or do not need the materials in the normal course of their work from obtaining these chemicals. The Industrial Hygiene and Safety Department prepared the list of hazardous materials identified in the MMCS system. These substances were selected for tracking because of potential industrial hygiene and/or environmental concerns. Material Safety Data Sheets (MSDS) are available for many of these substances to ensure proper handling and use of appropriate protective equipment by the employees.

The materials stored in the Stores Department were observed to be kept in dry, secure facilities with minimal chance of spills or accidents.

4.2.1.2 Tank Farm Facility

The FMPC tank farm facility handles and stores anhydrous hydrogen fluoride (AHF), anhydrous ammonia (ANH_3), aqueous hydrofluoric acid (HF), aqueous nitric acid (HNO_3), tributyl phosphate (TBP), and kerosene. The following table lists the tanks, material stored, storage capacity, and the operational condition.

Tank No.	Chemical Stored	Capacity (Gallons)	Operational Status
1	NH_3	15,801	Backup tank
2	KOH	26,000	In service
3	HF	31,000	Out of service
4	AHF	26,000	Out of service
5	AHF	26,000	In service
6	AHF	26,000	In service
7	AHF	26,000	Out of service
8	AHF	26,000	Out of service
9	AHF	31,000	Vapor surge tank
10	AHF	31,000	Out of service
11	ANH_3	14,000	In service
12	ANH_3	14,000	In service
13	HF	13,000	Out of service
14	NH_4OH	12,000	In service
15	TBP	12,700	In service
16	Kerosene	12,600	In service
17	Wastes	89,500	Sump tank
18	HF	30,000	In service
20	HNO_3	75,000	In service
21	HF	30,000	Out of service

The tank farm has rail car and truck loading facilities to handle chemical deliveries. Under present plant operations, deliveries include about 80,000 lbs of AHF by rail and one tanker truck of ANH_3 every 2 weeks. Four tanker trucks of HNO_3 are delivered weekly, and one tanker truck of potassium hydroxide (KOH) is received every few months. Since Plant 2/3 has not been in operation for some time, there have not been any recent deliveries of TBP or kerosene.

Large volumes of dilute or spent HF are received by pipeline and dumpsters from the process plants for storage at the tank farm. The spent acid is sampled for total U, uranium-235, and HF before shipment by truck from the site for commercial recovery of the acid.

The tank farm is underlain by a natural clay, and is designed to drain spills of chemicals to a collection basin near the sump tank (Tank 17). Lime is used to neutralize the acid solutions in the collection basin before being pumped to the sump tank for storage and eventually to the General Sump for disposal.

The tank farm equipment (i.e., tanks, pumps, pipelines) has been in use for many years. A new tank farm has been proposed to replace the existing equipment.

4.2.1.3 Polychlorinated Biphenyls (PCBs)

Liquids and equipment contaminated with PCBs have been identified on the FMPC plant site in the calendar year 1983 and 1984 P reports. These reports discuss in-service and stored PCB items, as well as disposal performed within the last calendar year.

Records show that the major transformers on the site have been tested for PCBs and are not contaminated with PCBs (Cornett, 1982). A sampling program was also undertaken to analyze all open fluids (i.e., kerosene, TBP, and hydraulic, cutting, and lubricating oils), and the results showed all concentrations of PCBs below regulatory limits.

During the survey, an inspection of selected PCB capacitors in Plant 5 showed that the capacitors located in open, accessible areas were clearly marked with PCB warning signs. The capacitors located in inaccessible areas did not have PCB signs, although they contained PCBs.

Four new capacitors containing PCBs are currently in the Stores Inventory (Hertel, 1986). The site is, however, actively replacing capacitors containing PCBs with PCB-free capacitors in the plant (e.g., Plant 5, new Rockwell furnaces).

Waste PCBs are stored in the KC-2 warehouse, where approximately 62 drums of equipment and still bottoms contaminated with PCBs are maintained. These drums are in a covered warehouse with proper diking, and no signs of leaking or spills are evident. These drums are inspected weekly, and there is little chance that environmental contamination could result.

4.2.1.4 Magnesium

The magnesium storage building handles magnesium used in the process of producing uranium metals. Magnesium is received at this building, repackaged into new containers, and stored prior to use. The potential for a fire when the magnesium is exposed to water has been considered in the design of the storage building and the operations. There is little concern for release of magnesium from the storage building because of these precautions.

4.2.1.5 Pesticides

Pesticides are not currently being applied by site personnel. The site does not have personnel licensed for pesticide management and has decided to cease application of pesticides by plant personnel. An outside contractor will be retained to perform these duties in the future.

Because site personnel applied pesticides in the past, there is a small stockpile of pesticides on the site that are in storage. It is planned that most of these chemicals will be used by the outside contractor when such a contract is awarded. The site does not plan to order any additional pesticides.

The pesticides inventory is stored under lock and key in a dry, indoor area of the Maintenance Shop. The particularly potent pesticides, which have been banned from use, are present in small quantities and are kept in a locked cabinet in the secured area. Dry materials are kept off the floors to avoid absorbing moisture, and liquid containers showed no evidence of leaking. Past practices do not show evidence of releases to the environment. Discussions with maintenance personnel indicate that empty drums were triple-rinsed before disposal, and paper bags and cardboard containers were wrapped in plastic and burned at the incinerator.

4.2.1.6 Asbestos

The FMPC production buildings were constructed largely with asbestos-containing materials. The building exteriors are made of "transite" siding and roofing, and many interior surfaces and pipes were covered with asbestos insulation. Remodeling, replacement, and maintenance of the buildings has generated a continual stream of asbestos waste that has been disposed on the site.

The procedures for removal, handling, and disposal of asbestos of the FMPC facility were reviewed by the survey team with the Industrial Hygiene Department and are adequate. Work permits are issued for asbestos removal projects that specify special handling, removal, and disposal requirements. Although disposal volumes are specified in the work permit, there appear to be no controls or checks on how much asbestos actually goes to the landfill.

Waste Pits 1, 2, 3, 4, and 6 are primary candidates for containing radioactively-contaminated asbestos. Asbestos disposal in Pits 4 and 6 has been confirmed through survey team interviews with the FMPC staff. For the most part, this disposal (Pits 4 and 6) was accomplished in accordance with EPA NESHAPs regulations for double bagging of asbestos. Disposal in the other pits has not been verified but is suspected. Asbestos materials in these pits are probably not double bagged.

Disposal of nonradioactively contaminated asbestos was documented to have occurred in the sanitary landfill. Both double-bagged and bulk quantities of asbestos were placed in the landfill. The final cover has not beed placed on this sanitary landfill.

Disposal of asbestos prior to the implementation of specific handling and disposal regulations for National Emission Standards for Hazardous Air Pollutants (NESHAPs) could also have occurred in the inactive fly ash pile/south field and the numerous suspected construction debris locations around the site.

4.2.2 Findings and Observations

4.2.2.1 Category I

None

4.2.2.2 Category II

1. Potential Releases from Tank Farm. The physical condition of the existing FMPC tank farm creates a high potential for releases and spills of hazardous chemicals that may create an offsite air quality impact.

   The quantities of anhydrous hydrogen fluoride and anhydrous ammonia handled and stored at the tank farm are sufficient to pose a potential serious onsite and offsite risk during a major accidental release of these materials either during loading operations or from failure of the pressure tanks. The survey team estimated that a continuous AHF leak of only 22.6 lbs/hr can cause air concentrations at the site boundary of 2.0 mg/m^3 from the initial puff of vapor released by the event. These estimated air concentration levels are considered to be in excess of short-term exposure limits used to assess risk to the general public.

   The July 25, 1985 DuPont evaluation report on the existing tank farm cited numerous problems related to the design and management control of the facility. These findings were critical of process design features, which were assessed to be "primitive" or "substandard" even by design criteria in effect at the time the facility was installed. The major conclusions of this report were as follows:

   - The process design of transferring liquids by (nitrogen) gas overpressure rather than pumps is considered poor practice. In addition, the design of the piping, because it is unduly complicated, leaves too many components susceptible to developing leaks.

   - The horizontal pressure tanks have too many penetrations, and critical shutoff valves are not readily accessible at the tank nozzle for isolation of leaks in the piping system.

   - The practice of operating the AHF emergency transfer pumps dry for monthly tests can cause damage to the seals and result in leaks when the pumps are needed.

The survey team observed that these same conditions still exist and could therefore lead to an increased potential for releases and spills at this location.

The tank farm has experienced a failure of the manhole cover seal on Tank 21 with the attendant release of dilute HF. The failure was serious and symptomatic of potential problems at the facility. Since this event involved a dilute HF rather than an AHF storage tank, it did not constitute a serious offsite threat. The contents of the leaking tank were transferred to two rail tanker cars currently located on a railroad spur line on an embankment at the eastern side of the facility.

The AHF storage tanks have a manifold vent system for pressure relief to the AHF vapor surge tank (Tank 9). There are two pressure-relief rupture disks on each tank and one on the vapor collection system manifold that are designed to blow out in the event of an overpressurization in the system. The process design also allows the AHF tanks to be manually vented by the operator, a process which can induce a pressure surge in the manifold upstream of the rupture disk. During previous manual venting operations at the tank farm, the manifold line rupture disk has, in some instances, blown out, with the attendant release of HF vapors to the atmosphere.

2. <u>Tank Farm Spill Containment</u>. The spill containment system in the tank farm has inadequate capacity to handle a major spill and thus could potentially result in an overflow condition to the storm drains and offsite locations.

The tank farm has a tile field to drain chemical spills to a collection basin, where collected liquid chemicals are neutralized and pumped from the collection basin to the 89,500-gallon sump tank (Tank 17). The total retention capacity of the tile field and collection basin is unknown, but the survey team estimates that the collection basin is clearly inadequate to hold the volume of a major chemical spill at the facility. The pumps used to transfer liquids from the collection basin to the sump tank are located at ground level, and they may be susceptible to failure in the event of a catastrophic tank failure. The tank farm rail and truck load-out facilities are outside the tile field, and any spills occurring at these facilities would be uncontained and would run off into the storm drain system.

3. <u>Offsite PCB Disposal</u>. Disposal of PCB wastes by offsite contractors may be causing environmental problems, and FMPC personnel have no evidence concerning how or where these wastes are disposed.

FMPC has disposed of PCBs at two sites operated by CECOS and ENSCO. However, the bills of lading for these two disposal firms do not indicate the specific disposal facility. No manifests were returned from the shippers that can positively identify the sites where disposal occurred. This situation could provide a potential liability for DOE in the future because the specific disposal site is not identified. FMPC files indicate the CECOS operation is a landfill, whereas other references show an incinerator.

Additionally, no records are on file that show that FMPC employees inspected the ENSCO or CECOS disposal facilities to ensure proper disposal. There is no documentation to show whether these firms were reviewed to ensure they were approved by state and Federal agencies or had current permits to operate.

4. Potential Releases of Asbestos. Asbestos materials may be transported off the site by air and surface-water media from the waste pits and the sanitary landfill.

The lack of an engineered cover on the Waste Pits and the Sanitary Landfill provides the opportunity for asbestos-bearing waste materials to be exposed to the environment and become a potential airborne pollutant.

The inactive pits have been operationally, but not physically, closed with a final engineered cover. The lack of a final cover allows erosion, storm water, and burrowing animals to intrude into the waste zone, potentially exposing asbestos fiber, which could then become airborne to the atmosphere. Storm-water control for the waste pit area consists of pumping accumulated water to Pit 6 and the Clear Well, which eventually is discharged to the Miami River. Entrainment of asbestos fibers into stormwater and process water in Pit 6 could allow transport of the asbestos off the FMPC Site. Uncontrolled stormwater from the pits could also be entering Paddy's Run.

Similarly, because a final cover is lacking on the Sanitary Landfill, the opportunity is provided for release of asbestos to the environment. FMPC personnel conducted limited sampling at these locations for asbestos and confirmed the presence (10^6 fibers/liter) in some samples. Additional sampling is being performed by ANL as part of the survey effort.

4.2.2.3 Category III

1. PCB Testing of Waste Oils. Release of PCBs to the soil, surface water, and/or ground water may have already occurred or could occur in the future if the waste oils in storage at the liquid incinerator are found to contain PCBs.

An extensive waste-oil inventory is stored on a pad behind the recently closed liquid incinerator. These drums, approximately 1,000 in number, have not been tested for PCBs. They are stored on an open pad with several observed and potential leaking drums. The surrounding runoff control trough contains oils and oily sludges, which are evidence of past releases. Should any of these drums contain PCBs there is a potential that they would be released from leaking drums to the soil, surface water, and/or ground water.

Sampling of several of these containers is being undertaken by ANL as part of the survey effort.

4.2.2.4 Category IV

1. Identification of PCB Equipment. PCB equipment in service at FMPC may not be adequately identified; thus, potential spills, fires, and accidents cannot be properly handled.

The FMPC facility does not have an accurate inventory of PCB equipment in service. Past inventory records are suspect based on a recent estimate of 2,100 PCB capacitors. The lack of a complete inventory severely hinders maintenance, fire response, and disposal estimates.

Estimates of PCB equipment in use at the site were included in the annual PCB reports for 1983 and 1984, but the small quantities contained in those reports were contradicted by a more recent estimate that indicates the following much larger totals (Boback, 1986):

Type of Capacitors	Quantity in Service	Notes
Large	2,000	> 1.36 kilograms liquid
Small	100	< 1.36 kilograms liquid (not regulated)
Total	2,100	

Currently, these figures are only rough estimates; no detailed listing of the location, size, and type of equipment could be located during the survey to support this estimate. Thus, determining the equipment containing PCBs during the survey was difficult.

Several capacitors in Plant 5 were observed to be unmarked for PCBs, although maintenance personnel remembered PCB signs previously posted at these locations. No explanation was provided as to why these capacitors were no longer marked as PCBs. Leaks and routine maintenance of these capacitors may not be properly handled if warning signs are not posted.

2. <u>PCB Equipment Replacements</u>. Several PCB capacitors are in the Stores Department as replacements or spares. In other areas of the plant PCB capacitors are being replaced with non-PCB models. Continued storage of these PCB capacitors may cause problems due to deterioration of the metal bodies and potential leaks.

3. <u>Onsite Pesticide Storage</u>. Continued onsite storage of pesticides that are no longer being applied by site personnel poses a potential environmental danger through the deterioration of the containers, possible theft, and/or misuse of these chemicals. Several types of pesticides that are currently banned from use are included.

4. <u>Tank Farm Operating Procedures</u>. A potential release of used chemicals to the storm water drains may occur in the tank farm area because of inadequate procedures relating to how these materials are stored.

Containers of liquid materials (e.g., acid wastes stored for recycling) were stored outside the 'break line' in the tank farm area and, thus, if spilled would not be contained by the spill collection system. There is no standard operating procedure directing that these types of containers be stored within the "break line", and continued storage in this manner could lead to an uncontained spill.

The tank farm tile field does not collect spills in the entire storage area of the facility. There is a "break line" on the site outside of which any chemical spills would be uncontained and would run off into the storm drain system, rather than be directed to the collection basin. Two dumpsters filled with acid wastes from the process plants were situated outside the "break line." In addition, an empty tanker truck available for emergency storage, as well as the two railroad tankers in use for the temporary storage of the dilute HF from Tank 21, were located outside the "break line." The location of liquid storage containers outside the tile field "break line" is recognized by facility personnel to be contrary to good management practice. No standard operating procedure is in place to govern the placement of temporary storage tanks or dumpsters within the tile field area, nor is the "break line" clearly delineated at the facility.

5. Release of HF Vapors at Tank Farm. HF vapors are being released in small quantities from an out-of-service AHF tank at the FMPC tank farm.

During the environmental survey an uncontrolled, small, continuous release of vapor was observed in the vicinity of a flange on the discharge nozzle of Tank 4. This tank is used to store AHF, but it is presently out of service. The location of the leak appeared to be from the flange upstream of the tank's discharge valve, which would account for the inability to isolate and repair the problem. The observed, released HF vapors are likely from residual AHF in the bottom of the tank and/or sludge in the tank and discharge nozzle.

4.3 Direct Radiation

Direct external radiation is defined as exposure to gamma photons, x-rays, and beta particles coming from radioactive material outside the body. This does not include radiation from ingested or inhaled radioactivity. The effects of radioactive particles in the soil, water, or air have been previously described under the appropriate media in Section 3.0 of this report.

4.3.1 Background Environmental Information

According to Oakley (1972), the total external dose rate to an individual in the Cincinnati area was estimated to be 66.5 millirem/year. This includes 36.3 millirem/year from cosmic rays (excluding the neutron component) and 30.2 millirem/year from terrestrial sources. The total compares relatively well with the FMPC estimates of background external exposure. The background external dose rate in 1985, according to Aas, et al. (1986), was estimated to be 78 millirem/year. The aerial radiological survey for FMPC, conducted in April 1985, measured typical background external exposures of 9 microR/hour, or 78.8 mR/year. One roentgen (R) is equivalent to one rem, if a quality factor of one is assumed. It should be noted that Oakley (1972) also estimated an exposure of 18 millirem/year from internal emitters. This was excluded from the total, since FMPC measurements were for external exposure only.

4.3.2 General Description of Pollution Sources/Controls

There are several major identifiable sources of direct radiation on the FMPC site, including the uranium feed materials and metal inventories, the K-65 silos, thorium storage, and various scrap and rubble piles. These sources are described in more detail in the following paragraphs.

4.3.2.1 Uranium Feed Materials

The in-process uranium feed materials, uranium scrap, and finished metal inventories scattered throughout the production area contribute to the direct radiation on the site. Feed materials are primarily found in the Pilot Plant, Plants 2/3, and Plant 4. Uranium metals and scrap materials are heavily concentrated in Plants 5, 6, 8, and 9.

4.3.2.2 Silos 3 and 4 (Cold Metal Oxide Silos)

Silo 3 is used to store dewatered, calcined raffinate waste. This waste was generated from 1952 to 1959 when the FMPC refinery was processing ore concentrates. It contains oxides of the metals that were present as impurities in the ore concentrate. The waste contains approximately 18,000 kg of uranium (0.72 percent uranium-235) and traces of radium not removed in the concentrate process. A breakdown of the contents of Silo 3 is provided in Table 4-8. Based on the waste and its volume, the silo is not a significant source of radon or gamma radiation. Gross measurements of radioactivity in the field are not accurate because of the silo's proximity to the K-65 silos and their impacts on instrument readings.

Silo 4 has never been used and remains empty.

The silos were constructed on-grade with floors of 4-inch-thick reinforced concrete. The walls are 8-inch-thick, pre- and post-stressed concrete with 3/4-inch gunite coating on the exterior. The domed roofs are 4-inch-thick reinforced concrete. Each silo has a total capacity of 13,900 cubic feet. Silo 3 is filled to capacity.

4.3.2.3 K-65 Silos

Silos 1 and 2 contain refinery residues (K-65) that resulted from the processing of pitchblende ores from South Africa. The K-65 material is a radioactive solid residue resulting from the acid digestion of pitchblende. It is insoluble in nitric acid and consists mostly of siliceous matter. The radioactivity

TABLE 4-8

CONTENTS OF FMPC SILOS
(METRIC TONS)
FMPC - FERNALD, OHIO

Constituent	Silo 1 & 2	Silo 3
Ag	0.176	<0.07
Al	77.	98.67
As	<2.64	
Au	0.44	<0.14
B	1.32	0.70
Ba	6.16	0.70
Be		No Data
Bi		No Data
Ca	342	144.18
Cd	<0.008	
Cl	0.19	
Co	15.4	8.81
Cr	1.06	1.76
Cu	4.4	8.81
F	0.33	
Fe	105.6	225.52
Hg		
La	7.83	No Data
Mg	110.	229.52
Mn	1.76	17.27
Mo	1.76	2.11
Na	61.6	133.90
Ni	19.8	22.90
Pb	448.8	8.81
PO_4		683.62

TABLE 4-8
CONTENTS OF FMPC SILOS
(METRIC TONS)
FMPC - FERNALD, OHIO
PAGE TWO

Constituent	Silo 1 & 2	Silo 3
Sb		<0.53
Se		No Data
SiO_2	3,587.	461.62
Sn	0.7	1.41
SO_4	No Data	692.08
Ti	6.16	2.11
V	1.85	3.52
Zn	<0.060	
Zr	1.76	
Rare Earths:		
Dy	0.26	<0.11
Er	<0.006	
Eu	<0.001	
Gd	0.35	<0.21
Ho	0.13	<0.11
Lu	<0.002	
Sm	0.42	<0.21
Tb		No Data
Tm	0.07	<0.07
Y	0.35	0.28
Yb	0.05	0.14

Source: Advanced Sciences, 1986

of the material is caused by the presence of radium. The K-65 silos also contain other insoluble metallic compounds.

An estimate of the materials stored in Silos 1 and 2 is provided in Table 4-8.

The silos were constructed on-grade with floors of 4-inch concrete over an 8-inch layer of gravel containing an underdrain system of 2-inch slotted pipe draining to a collection tank. Below the gravel is a 2-inch layer of asphaltic concrete underlain by 18 inches of compacted impervious clay. The walls are 18 inches thick pre- and post-stressed concrete with a 3/4 inch gunite coating on the exterior. The domed roofs are 4-inch-thick reinforced concrete.

In 1964 the walls of the silos were covered with an earthen embankment to provide long-term protection and support and to minimize gamma radiation levels in the area of the silos. In 1979 all tank openings were sealed with gaskets; however, some radon still migrates to the outside.

Radiation flux values on the north and south K-65 tanks in a recent study ranged from approximately 13 $pCi/m^2/sec$ and 30 $pCi/m^2/sec$ respectively to 1.4×10^7 $pCi/m^2/sec$. In general, the values found on intact concrete were lower than values obtained at nearby locations having obvious cracks and fissures. The magnitude of the flux values found on what appeared to be intact concrete suggests that small cracks and fissures not apparent to the eye may be present.

A 1985 structural analysis of the concrete silos noted that the top 5 percent of the tank dome needed to be strengthened. According to FMPC, new structural covers were installed in January 1986. The tank domes are currently being sealed with several layers of flexible synthetic rubber to prevent rain from seeping into the tanks. This should also reduce the amount of radon that seeps from the tanks.

4.3.2.4 Thorium

The FMPC is the national repository for thorium. The term thorium, as used here, refers to a variety of materials containing thorium-232 and its daughter radionuclides. These materials are highly radioactive and can pose a hazard from both direct external radiation and internal exposures. About 1,000 metric tons (2.4 million pounds) of thorium materials are stored on site. Table 4-9 presents a summary of the inventory of these materials.

TABLE 4-9

FMPC THORIUM INVENTORY
FMPC - FERNALD, OHIO

	Metric Tons	Location
ThO_2 Dense	4.3	Bldg. 67, Bldg. 72
ThO_2 Sol Gel	25.9	Bldg.67
Thorium Nitrate	8.8	Pilot Plant Tank #2
Misc. Scrap & Lab Samples	.4	Pilot Plant Lab
Impure Thoria Gel	338.3	Pilot Plant Warehouse
Thorium Oxides in Plant 8 Silo	174.6	Plant 8 Silo
Thorium Oxalate Cake	1.2	Bldg. 67, Bldg. 72
Thorium Nitrate Crystals	1.2	Bldg. 67
Impure Thoria Feed	321.7	Bldg. 65
Offsite Thorium Hydroxide	10.8	Bldg. 67
Offsite Thorium Oxides	74.4	Bldg. 67, Bldg. 72
Thorium Nitrate Solution	0.9	Bldg. 67
ThF_4	0.8	Bldg. 67
Metal	79.9	West Bldg. 65, Bldg. 72, Bldg. 67
Clad Metal	4.4	West Bldg. 65
Alloyed Metal	3.5	West Bldg. 65, Bldg. 67, Bldg. 72
Material Held for Historical Purposes	0.5	Bldg. 67, West Bldg. 65
High Grade Residues (>30% Th)	5.7	Bldg. 67, West Bldg. 65
Low Grade Residues (<30% Th)	0.2	Bldg. 72
TOTAL	**1057.5**	

The materials are stored in a variety of containers including a silo, bins, tanks, 55-gallon drums, and "cans." The structural stability of the storage systems and containers varies from good to very poor.

The site operators have recognized that present storage practices could represent significant environmental hazards. A thorium task force, made up of managers and technical personnel, has been established to evaluate these hazards and evaluate alternative handling options. In addition, the site has performed and is performing engineering evaluations of the Plant 8 silos and bins.

4.3.2.5 Scrap Piles

The scrap piles contain a variety of contaminated scrap materials, including ferrous scrap metal (5,000 tons), copper (1,500 tons), and wood (1,000 tons). The scrap is stored outdoors primarily in two locations. The metallic scrap is contaminated with uranium and other radionuclides, which contribute to the direct external exposures.

Plans are being made for the removal of this scrap. The metal scrap will be shredded and packaged for recycling or for offsite disposal. The wood will be prepared and transferred to Oak Ridge, Tennessee, for incineration. These measures appear adequate to eliminate the potential environmental risk posed by the scrap storage piles.

4.3.2.6 Rubble Piles, Abandoned Drums, and Burial Sites

In several locations throughout the FMPC there are rubble piles and abandoned drums that may be sources of offsite contamination. Some of the rubble piles emit radiation.

4.3.3 Environmental Monitoring Program

As discussed in Section 4.3.1, the normal or background levels of external radiation at FMPC are about 80 millirem/year (9 microrem/hour). The FMPC staff and others measure external radiation levels on and near the site as follows:

- Eleven continuously operated thermoluminescent dosimeter (TLD) stations yield quarterly data.
- Measurements are made with a pressurized ion chamber at the 11 TLD stations.
- EG&G performed aerial surveys in 1978 and 1985.

Results of these measurements are generally consistent. The two aerial surveys yielded similar results and confirmed the results of the TLD measurements.

The TLD system is the primary method for measuring offsite direct radiation, and the results are reported in the Annual Environmental Monitoring Report. The other measurements have supplemented this program and have generally confirmed the TLD results.

The locations of the seven fencepost TLD locations are well suited in relation to the major sources of direct radiation. The TLDs, supplied by Teledyne Isotopes, Inc., are of an appropriate type for environmental monitoring. Additional stations, especially near the K-65 silos (the most important source of direct radiation), near the residence southwest of the silos, and at a background station upwind and greater than 5 miles from the site have been considered.

The data reported in the 1985 Annual Environmental Monitoring Report indicated a quarterly direct exposure rate ranked from 8.24 to 19.10 microrem/hour. On an average annual basis, the rates ranged from 94 to 148 millirem/year. The highest measured direct exposure rate at an offsite residence was 103 millirem/year and, at a fence-post location, 148 millirem/year.

4.3.4 Findings and Observations

4.3.4.1 Category I

None

4.3.4.2 Category II

1. Offsite Direct Radiation Levels. Radioactive materials stored at FMPC result in external radiation levels on and near the site being higher than normal (referred to as background).

   The sources of these higher-than-background levels, in approximate order of importance, are

   - K-65 silos.
   - Thorium-bearing materials stored on site.
   - Previously released and dispersed radioactive materials.
   - Other stored material (scrap, rubble, abandoned drums, burial sites).

Based on the measurements made by FMPC personnel, it is estimated that the highest offsite exposure at a nearby residence is about 12 microrem/hour. This means that the FMPC is contributing about 3 microrem/hour or 26 millirem/year. Assuming a conservative residential shielding factor of 0.7 (USNRC, 1977), a person living at this residence would receive an external exposure of 18 millirem/year above normal background. Assuming a background external dose rate of 78 millirems/year (Aas, et al, 1986), this exposure would represent an additional burden of approximately 23 percent above background levels in the area of FMPC.

2. <u>K-65 Exposure Levels</u>. There is an increased potential for unnecessary human exposure to direct radiation at the K-65 silos because the area is not posted with "high radiation hazard" signs.

   External radiation levels at the fence around the base of the K-65 silos are about 500 microrem/hour. The public can gain access to this point. A construction worker was observed during the survey, sitting on a bulldozer near this point waiting for a gate to be opened. Security personnel have found members of the public in this area and have escorted them off site. Relatively short exposure times in this area (40 hours/year) can result in an exposure similar to that discussed above for residents.

4.3.4.3 Category III

None

4.3.4.4 Category IV

None

4.4 Quality Assurance

This section of the report reviews the procedures for the collection and analysis of environmental data with particular concern focused on the ability to identify the quality of the data. Quality assurance is discussed by technical area (i.e., air, radiation, hydrogeology, etc.). Two components of quality assurance are discussed in this section: field sampling/monitoring and laboratory analysis.

4.4.1 General Description of Data Handling Procedures

4.4.1.1 Surface Water

Sampling for NPDES, process wastewater, and stormwater were conducted with generally acceptable sampling techniques at the FMPC facility. Chain-of-custody procedures were being used by the samplers during the survey. Because this program had just recently been initiated; however, there was insufficient time to determine its effectiveness.

Sediment sampling of Paddy's Run was observed on the site during the survey, and it was conducted in accordance to the written procedures. The site personnel who collected the samples appeared to be well trained.

Analytical work associated with wastewater treatment operations is conducted by the Water Treatment Laboratory, NPDES samples are analyzed at the Bioassay Laboratory, and process sumps are analyzed at the Analytical Laboratory. The quality assurance program observed at these laboratories is summarized in Section 4.4.1.6, Laboratory Analysis.

4.4.1.2 Ground Water

Sampling of the RCRA wells follows acceptable procedures, except for very minor details. Training records are not available, and written procedures are not kept in a sampling manual. Chain-of-custody procedures are followed.

Sampling of the onsite and offsite wells for nonregulatory data collection does not generally follow accepted sampling procedures. The personnel used to conduct this sampling do not appear to have been properly trained, and training records are not available. Written sampling procedures are minimal and were not consulted during the observation of the sampling. No field logs were maintained to record sample identification numbers and site conditions. Chain-of-custody forms are not routinely employed.

Ground-water samples are analyzed in the Water Treatment and Bioassay Laboratories on the site. The RCRA samples are sent to Howard Laboratory, an offsite contractor. Howard Laboratory has a written quality assurance program. FMPC sends spikes and references to Howard for comparison of results but does not perform any formal QA checks or audits of the Howard Laboratory.

The quality assurance observations for the Water Treatment and Bioassay laboratories are summarized in Section 4.4.1.6, Laboratory Analysis.

4.4.1.3 Air

The sample collection of the boundary air stations is governed by a written procedure, and the technician observed during the survey had received verbal training. No chain-of-custody forms were used for the boundary air station samples.

Procedures for conditioning and weighing the filters for the boundary air stations are not written, and the training has been by word of mouth.

The boundary air station particulate samples are analyzed in the Bioassay Laboratory, and pertinent quality assurance observations for this laboratory are contained in Section 4.4.1.6, Laboratory Analysis.

4.4.1.4 Soil/Vegetation/Milk

Several offsite analytical laboratories are used to conduct analyses of vegetation, soil, and milk samples. EAL Corporation has an extensive quality assurance program for its laboratory operations. Copies of the Oak Ridge National Laboratory (ORNL) and Northern Kentucky Environmental quality assurance manuals were not available on site for review. Chain-of-custody forms do not appear to be routinely used for offsite laboratory samples. Quality assurance for offsite laboratories consists of occasional analysis of spikes and references. There is no formal QA program to check or audit these laboratories.

The Bioassay Laboratory coordinates all the analytical work (on and off site) for soil, vegetation, and milk samples, and the quality assurance program for the Bioassay Laboratory is presented in Section 4.4.1.6, Laboratory Analysis.

4.4.1.5 Direct Radiation

The thermoluminescent dosimeters (TLD) constitute the direct radiation monitoring program at the FMPC site. The procedures observed for collection of these devices were in accordance with acceptable methods.

The TLDs are analyzed in the Bioassay Laboratory and the radon and thoron samples are sent off site. Observations for the Bioassay Laboratory are detailed in Section 4.4.1.6, Laboratory Analysis.

4.4.1.6 Laboratory Analysis

There are three onsite laboratories at FMPC that perform analysis of environmental samples. The Water Treatment Laboratory is responsible for sampling at the General Sump, Clear Well, Waste Pits, and storm drains to determine if the effluent streams have been treated sufficiently prior to release to the environment. This sampling program is designed to assist in optimally operating FMPC's water and wastewater treatment facilities. The Bioassay Laboratory is responsible for all environmental compliance samples (i.e., air, surface water, ground water, and soil sampling). Where regulatory standards must be met, the Bioassay Laboratory is responsible for analyzing and reporting results against these standards. The Bioassay Laboratory also performs the analytical work for all TLDs on the site. Contract work to offsite analytical laboratories for specialized analyses, such as low-level radiation, vegetation, and milk samples, are coordinated through the Bioassay Laboratory. The Analytical Laboratory performs the analysis of wastewaters from each of the process buildings, which indicates whether the wastewaters have been sufficiently pretreated prior to release to the General Sump.

The Analytical Laboratory Quality Assurance Section (ALQA) has the lead responsibility for quality assurance for all three laboratories. Quality assurance procedures are observed by each of the onsite laboratories to varying degrees because each laboratory falls under a different management organization. Spikes, splits (recycle), and standards are sent to the other onsite laboratories by the Analytical Laboratory, and the results are tabulated on a quarterly basis and reported back to the performing laboratory group. The Analytical Laboratory makes use of USEPA, Environmental Measurements Laboratory (EML), and other outside sources for reference standards, and participates in interlaboratory comparisons. An expansion of the existing proficiency testing program is being considered by ALQA through participation in a trace metals program offered by Analytical Products Group (APG).

ALQA reports the results of the quality control program through several documents. A bimonthly quality control report is prepared for each of the three environmental laboratories, citing the number of samples submitted, type of samples, and the estimate of bias (Russell, 1986). Both control and recycle (duplicate) samples are evaluated. A quarterly report is prepared for each laboratory group summarizing the number of quality assurance samples that have been analyzed for each sample type (ALQA, 1986a). Controls, recycle, and reference samples are included in this report.

Periodically, ALQA issues a report showing the total number of QA samples that fall outside the control limits (ALQA, 1986b). This document is being expanded to report the reason for out-of-control results and the corrective action taken.

ALQA has initiated a program to update all the analytical procedures used on the FMPC site and standardize their format. The format has been approved and several example procedures have been completed, but the effort has not been fully implemented.

The Water Treatment Laboratory maintains legible laboratory notebooks, has equipment calibrated on schedule, runs standard reference curves on a daily basis, and uses the manufacturer's laboratory procedures for analytical instrumentation operations. Training records for the analysts and approved analytical procedures for that laboratory were not available.

The Bioassay Laboratory maintains legible laboratory notebooks, but some information is recorded on loose scraps of paper. Spikes, splits, and reference samples are run in the laboratory, and the analytical equipment is calibrated on a pre-set schedule. Some laboratory procedures are written and approved, but variations to these procedures are often made in practice. Training records for the analysts could not be found.

The Analytical Laboratory uses laboratory notebooks for analysts and completes analysis of spikes, splits, and reference standards on a routine basis. Equipment calibration records are well organized in the analytical laboratories visited. Training records that show academic degrees and instrument courses are kept by supervisors. Written laboratory procedures are incomplete, but those that do exist are readily available on the laboratory bench for the analyst. A standard format for analytical procedures has been recommended but not fully implemented. Data recording and manipulations are regularly checked and approved by the supervisor. Laboratory records for analytical results are well organized so that tracking of samples through the system can be easily performed.

4.4.2 Findings and Observations

4.4.2.1 Category I

None

4.4.2.2 Category II

1. Environmental Sampling. The consistency and accuracy of environmental monitoring data may be inadequate because there are no formal sampling and analysis quality assurance practices and procedures.

There is no QA plan addressing the collection of environmental samples at the FMPC site. Thus, a number of documentation, training, and data-checking problems are evident in the monitoring program. Field logbooks and/or sample sheets are not routinely and uniformly used on the site to record field observations during sampling (i.e., weather conditions, sample numbers, sampling locations, and deviations from procedures). This condition can lead to problems in interpreting anomalous data. Training records for sampling personnel do not exist. Training of samplers is verbal, with no record of who performed the training, when it was completed, and whether refresher sessions have been held. No observations were made during the survey to indicate any checking by supervisors of data entry or computations made by the sampling technicians.

Sampling procedures were incomplete, not dated, and/or not signed and approved. There was no sampling manual that contained all the procedures, identified specific sampling locations, and specified sampling frequency. In one case, the procedure for sampling the boundary air stations was not included in the loose-leaf notebook that served as the reference copy of procedures located in the technician's office. Ground-water monitoring is conducted both correctly and incorrectly on the FMPC site. Ground-water samples taken for RCRA compliance purposes are in accordance with acceptable procedures. Other ground-water sampling efforts do not follow these procedures, a factor which may lead to potential cross-contamination of samples, lack of proper preservation, and little documentation of sampling conditions.

Without a sampling manual, formal training, and a quality assurance program, FMPC staff cannot verify that samples were collected according to procedures, were collected at the proper location, or were properly handled and preserved. Effects of weather, variations from sampling procedures, and production operation cycles cannot be assessed in interpreting the data because field logbooks are not uniformly maintained.

2. Laboratory Analysis of Environmental Data. The quality of the laboratory analysis of environmental samples from FMPC cannot be assessed because of the lack of a formal and

approved quality assurance (QA) program. Incomplete and outdated laboratory procedures and protocols also add to the uncertainty about the consistency and comparability of laboratory data.

A formal QA program for those FMPC laboratories involved with environmental data analysis does not exist. Elements of quality assurance are evident in each of the laboratories to varying degrees, but no written manual has been prepared or approved. These laboratories do perform calibrations of instruments, run standardized reference samples, and complete maintenance on instruments. Without a QA manual, however, there is little standardization between laboratories, and documentation of training is minimal.

The site contractor has a quality assurance program for production efforts, but these policies have not been extended to the laboratories. The laboratories have a separate quality assurance program, but QA plans have not been developed and no audits have been conducted.

A number of environmental samples are sent to offsite analytical laboratories, and specific quality assurance requirements for these laboratories are not usually specified. The QA requirements for offsite laboratories are basically left to the discretion of the offsite contractors. At times, performance tests have been specified by FMPC on reference samples. Because the FMPC laboratories do not have a formal QA program, there is no point of reference that can be used in contracting with offsite laboratories to indicate the minimum quality assurance program that is acceptable. QA plans for several offsite laboratories were reviewed and found to be comprehensive, but QA plans for all the offsite laboratories were not available at FMPC for review. There were no records or recollections by staff personnel of FMPC audits of offsite laboratories.

The Analytical Laboratory has the most complete set of analytical procedures, and copies of these procedures are readily available to the analysts at their laboratory benches. But even these procedures have been acknowledged by site personnel to be incomplete. Procedures in the Water Treatment and Bioassay Laboratories are basically referenced directly from textbooks or instrument manufacturer's literature. For the most part, these procedures have not been rewritten to reflect the specific physical and operational conditions that exist in the Water Treatment and Bioassay Laboratories. In the case of preparing boundary air station particulate filters for laboratory analysis, the analyst reported that no written procedures existed and training was performed verbally.

4.4.2.3 Category III

None

4.4.2.4 Category IV

1. Sample Chain-of-Custody. Chain-of-custody procedures are not being maintained on all environmental samples.

   A new program has been recently implemented for chain-of-custody, but is being primarily implemented on surface- and ground-water samples. Samples sent to offsite laboratories do not usually have chain-of-custody records.

2. Environmental Data Checking and Review. Data generated by sampling and analytical personnel was not always checked and approved by supervisors. This practice can lead to propagation of errors from data entry and computation.

   The Analytical Laboratory was the only laboratory where all data results were consistently checked by supervisors. The Bioassay and Water Treatment Laboratories did not have records to indicate this level of data verification. The data recorded by environmental sampling personnel were not checked.

3. Personnel Training Documentation. Documentation of training for sampling and analytical personnel was incomplete.

   Training of all environmental sampling personnel is verbal with no written documentation. Because of vacations, personnel turnover, and rotation of duties, the same people do not always collect the same environmental samples. There were no written records to indicate personnel used for these tasks understood the procedures, where the samples should be collected, how they should be handled and preserved, and how often samples should be taken.

Similarly, in the laboratories, training records were incomplete or did not exist. The Analytical Laboratory supervisors maintained records on academic degrees and courses attended by their employees. No records were available for personnel from the Water Treatment and Bioassay Laboratories.

4.5 Inactive Waste Disposal and Contamination Sites

4.5.1 General Description of Pollution Sources/Controls

The FMPC contains several areas that could be sources of offsite environmental contamination and could pose a public health risk. The areas include the following:

- Waste disposal pits.
- Sanitary landfill.
- Rubble piles, abandoned drums, and burial sites.
- Scrap piles and abandoned equipment.
- Inactive fly-ash pile.
- Underground storage tanks.
- Fire-fighting training area.

The waste disposal pits consist of Waste Pits 1 through 6, the burn pit, and the Clear Well. The pits are numbered chronologically according to their order of construction. Only Pit 5 and the Clear Well are still in use. Characteristics of the pits, including their waste contents, are summarized below and in Table 4-10. Refer to Figure 4-1 for a layout of the waste disposal pits. Remedial investigations and feasibility studies are planned to be conducted at FMPC to characterize impacts and risks and to develop remedial action alternatives.

An estimate of the contents of Pits 3 and 5 has been made by FMPC and is presented in Table 4-11. The most current estimate of the radioactive content of the waste management storage/disposal facilities is presented in Table 4-12.

Pit 1 was excavated into an existing clay lens and lined with clay excavated from the burn pit (H&R, April 28, 1986). It was expanded in 1957 when excavated spoil material from the construction of Pit 2 was used to build up the berm an extra 5 feet on the west side (WMCO, June 16, 1986). The majority of the wastes disposed in this pit were dry solids. Decant water from the K-65 silos also was

TABLE 4-10

CHARACTERISTICS OF WASTE DISPOSAL PITS[a]
FMPC - FERNALD, OHIO

Pit	Lining	Volume (Cubic Yards)	Contents	Period of Use	Status
Pit 1	Clay	40,000	Neutralized waste filter cakes, graphite, brick scrap, sump liquor and cakes, depleted slag	1952-1959	Retired, covered
Pit 2	Compacted clay	13,000	Neutralized waste filter cakes, graphite, brick scrap, sump liquor and cakes, depleted slag	1957-1964	Retired, covered
Pit 3	Compacted clay	227,000	Lime neutralized raffinate concentrate, slag leach residues, filter cakes, fly ash, lime sludge	1959-1968 1975-1977	Retired, covered
Pit 4	Compacted clay	50,000	Process residues, trailer cakes, slurries, raffinates, depleted graphite, nonburnable trash, asbestos, barium chloride salt	1960-1986	Inactive, partially covered
Pit 5	1/6 inch rubberized elastomeric membrane	102,500	Depleted slag, scrap green salt, process residues, filter cakes	1968-Present	Active, near capacity
Pit 6	Elastomeric membrane	9,000	Solids from neutralized raffinate, slag leach slurry, sump slurry, lime sludge	1979-1985	Inactive, 70% full
Burn Pit	Natural clay	Unknown	Pyrophoric and reactive chemicals, oils, combustible wastes	1957-1986	Retired, covered
Clear Well, Wet	Clay	Unknown	Clear process effluents, surface runoff	1959-Present	Active

[a] Weston, 1986

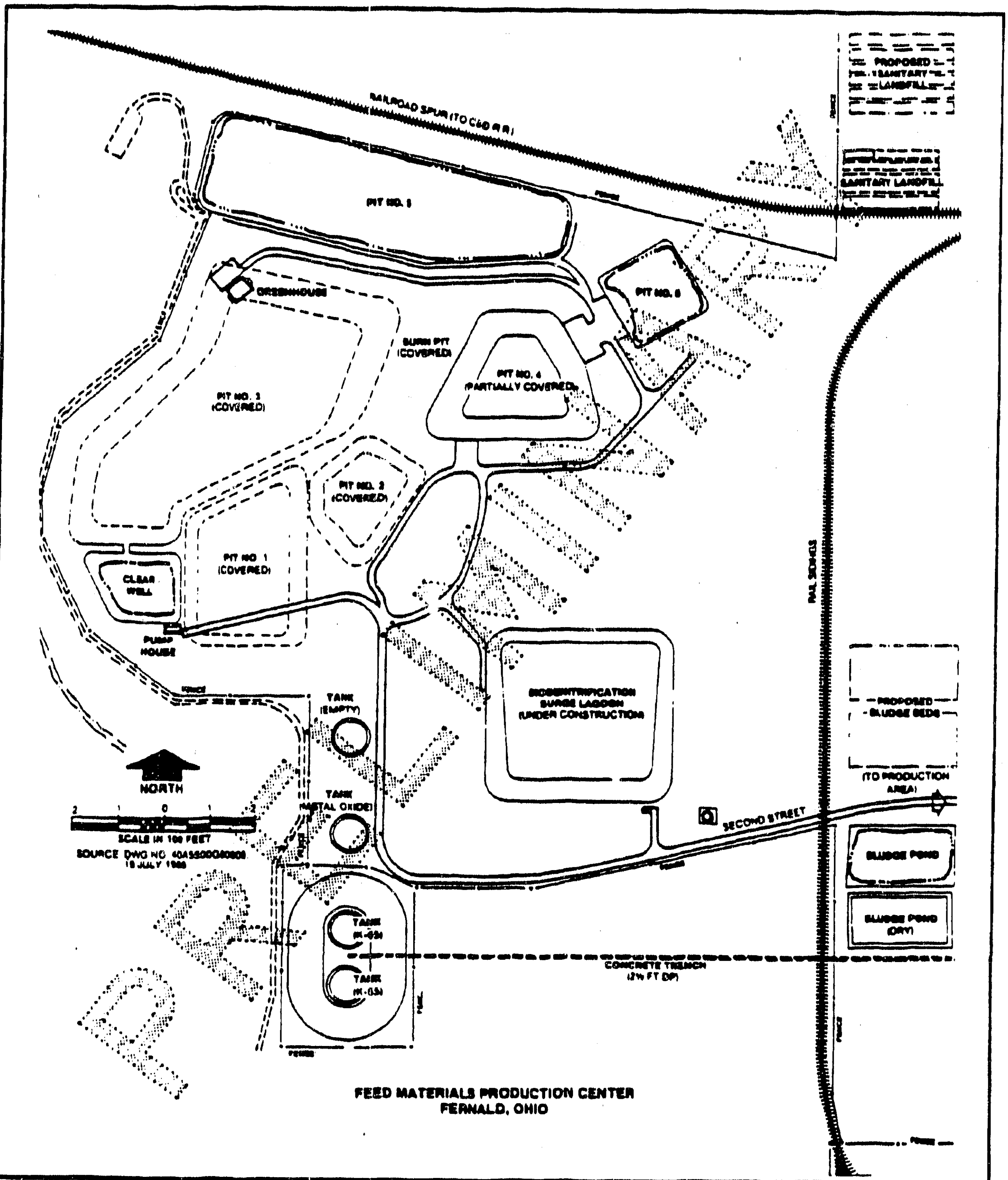


Figure From: Weston, 1986

PRELIMINARY MAP OF THE STORAGE AREA WEST SIDE MIDDLE OF SITE **FIGURE 4-1**

TABLE 4-11

CONTENTS OF FMPC WASTE PITS 3 AND 5
FMPC - FERNALD, OHIO

Constituent	PIT 3		PIT 5	
	% Z[a]	Metric Ton	% Z[b]	Metric Ton
Ag	<0.001	<2.55	--[c]	<0.88
Al	0.6	1,530	--	529
As	0.0655	65	--	34
Au	--	--	--	--
B	0.004	10.2	--	3.5
Ba	0.075	191	--	66
Be	<0.001	<2.55	--	<0.88
Bi	<0.001	<2.55	--	<0.88
Ca	18.1	46,155	--	15,967
Cd	<0.015	<38.25	--	<13.2
Cl	0.517	155	--	80
Co	<0.008	<20.4	--	<7.1
Cr	0.014	35.7	--	12.3
Cu	0.175	446.25	--	154.4
F	0.042	12.59	--	6.49
Fe	2.225	5,674	--	1,963
Hg	--	--	--	--
La	<0.008	<20.4	--	<7.1
Mg	9.168	23,378	--	8,087
Mn	1.1	2,805	--	970
Mo	0.001	2.55	--	0.88
Na	4.35	1,304	--	672
Ni	0.03	76.5	--	26.5
Pb	0.06	153	--	53

TABLE 4-11
CONTENTS OF FMPC WASTE PITS 3 AND 5
FMPC - FERNALD, OHIO
PAGE TWO

Constituent	PIT 3		PIT 5	
	% Z[a]	Metric Ton	% Z[b]	Metric Ton
PO	0.57	171	--	88
Sb	--	--	--	--
Se	--	--	--	--
SiO	2.0	5,100	--	1,764
Sn	0.034	86.7	--	30
SO	2.63	788	--	406
Ti	0.013	33.15	--	11.47
V	0.006	15.3	--	5.3
Zn	<0.12	<306	--	<105.9
Zr	0.04	102	--	35.3
Rare Earths:				
Dy	<0.006	<15.3	--	<5.29
Er	<0.0003	<0.09	--	<0.05
Eu	<0.002	<5.1	--	<1.76
Gd	<0.003	<7.65	--	<2.65
Ho	<0.0002	<0.06	--	<0.02
Lu	<0.00008	<0.02	--	<0.008
Sm	<0.006	<15.3	--	<5.29
Tb	<0.0002	<0.06	--	<0.02
Tm	<0.0001	<0.03	--	<0.01
Y	<0.003	7.65	--	2.65
Yb	<0.002	<0.60	--	<0.20

Source: Advanced Sciences, 1986

a 1% on dried solids basis of samples from Pit 3, NLO 1969
b Calculations for Pit 5 based upon percentages used for Pit 3
c (no data)

TABLE 4-12

RADIOACTIVE CONTENT OF FMPC WASTE STORAGE/DISPOSAL FACILITIES
FMPC - FERNALD, OHIO

Facility	Contents	Uranium (Kg)	Uranium-235 (Kg)	Thorium (Kg)	Total Curies (Ci)
Pit 1	neutralized waste filter cakes, graphite, brick scrap, sump liquor & cakes, depleted slag	52,000	370	unknown	108
Pit 2	neutralized waste filter cakes, graphite, brick scrap, sump liquor & cakes, depleted slag	1,206,000	2,550	400	35
Pit 3	lime neutralized raffinate concentrate, slag leach residues, filter cakes, fly ash, lime sludge	129,000	1,771 1,010	400	553
Pit 4	process residues, trailer cakes, slurries, raffinates, depleted graphite, non-burnable trash, asbestos, barium chloride salt	3,050,371 3,048,087	5,400 5,529	61,700 61,800	233
Pit 5	solids from neutralized raffinate, slag leach slurry, sump slurry, lime sludge	50,261 50,309	420	17,000	327
Pit 6	depleted slag, scrap green salt, process residues, filter cake	427,857 843,142	813 1,740	unknown	178
K-65 Silos (1, 2)	radium cake, pitchblende processing residues	11,200	80	unknown	17,600
Metal Oxide Tanks (3)	metalli: oxides	18,000	130	unknown	23

TABLE 4-12
RADIOACTIVE CONTENT OF FMPC WASTE STORAGE/DISPOSAL FACILITIES
FMPC - FERNALD, OHIO
PAGE TWO

Facility	Contents	Uranium (Kg)	Uranium-235 (Kg)	Thorium (Kg)	Total Curies (Ci)
Burn Pit	pyrophoric and reactive chemicals, oils, combustible wastes	unknown	unknown	unknown	unknown
Clear Well	clear process effluents, surface runoff	unknown	unknown	unknown	unknown
Fly Ash Area 1	fly ash, oils	1,000	unknown	unknown	unknown
Fly Ash Area 2	fly ash	unknown	unknown	unknown	unknown

disposed in this pit. During 1958 and 1959, Pit 1 was used as a Clear Well for Pit 2 (WMCO, June 16, 1986).

Pit 2, like Pit 1, was constructed in a small pond. This pit received primarily dry, low-level radioactive wastes as well as some decant water from the K-65 silos. During 1958 and 1959, it was necessary to use Pit 2 for the disposal of neutralized, concentrated refinery raffinate residues because the drying equipment available could not process all of the raffinate output. The remaining capacity of Pit 1 was used as a Clear Well for the effluents going to the Great Miami River (WMCO, June 16, 1986).

Pit 3 was constructed by excavating into the underlying clay lens and by placing a layer of clay along the pit walls. This pit was operated as a settling basin from 1959 to 1968, receiving wet waste streams (i.e., lime-neutralized, radioactive raffinate concentrate) and discharging to the existing Clear Well. In 1965, the pit capacity was expanded by adding 2 feet of additional clay material to the top of the pit walls. From 1975 to 1977 the pit was used to dispose of a variety of dry radioactive solids (WMCO, June 16, 1986). Pit 3 also received storm water pumped from the sump draining the area around the K-65 silos.

The Burn Pit was originally excavated to provide clay to line Pits 1 and 2. The Burn Pit was subsequently used to dispose laboratory chemicals and to burn combustible materials, including pyrophoric and reactive chemicals, oils, and other low-level contaminated combustible materials (H&R, April 28, 1986). The actual inventory of materials or chemicals disposed in the Burn Pit is unknown. Although reported as having been backfilled (H&R, April 28, 1986), the boundaries of the Burn Pit are no longer discernible from uncovered Pit 4 (Weston, 1986).

Pit 4 was constructed in 1960 with a 1-foot clay process liner. The pit was in continuous operation until it ceased to accept process waste in early 1985; it continued to receive contaminated construction debris, asbestos, and garbage until May 1986. Pit 4 has received a variety of process and construction wastes, including hazardous and mixed wastes. Wastes include uranium, thorium, barium, solvents (e.g., 1,1,1-trichloroethane, perchloroethylene, and xylene), lead-based or chromium-containing paints, oils with a variety of additives, graphite, asbestos, process trash, and construction rubble and debris. In addition, exposed wastes in Pit 4 have been covered with contaminated soil from the old fire pond. It is estimated that Pit 4 contains 3,000,000 kilograms of uranium and 61,700 kilograms of thorium.

Pit 5 was built to replace Pit 3 and was constructed by cut and fill, using the excavated material to build a dike, extending the pit approximately 10 feet above grade. It is lined with 60-mil-thick Royal-

Seal EPDM Elastomeric Membrane (WMCO, June 16, 1986). The pit received liquid waste slurries until mid-1983, and now receives filtered waste streams. Process effluent containing suspended solids flows across the pit and is discharged to the Clear Well. The discharge was tested and found to be nonhazardous, based on the EP toxicity test.

Pit 6 was constructed in the same fashion as Pit 5, with a 60-mil EPDM hydroseal liner from American Hydrotech (WMCO, June 16, 1986). The pit received both solid and liquid wastes until early 1985. Collected rainfall is pumped to Pit 5 for discharge via the Clear Well. No tears in the lining or joint failures have been observed (Weston, 1986).

Details on the potential impacts of these facilities are presented in the following section.

4.5.2 Findings and Observations

4.5.2.1 Category I

None

4.5.2.2 Category II

1. Potential Leakage from Underground Storage Tanks. Underground storage tanks at FMPC are a possible source of ground-water contamination because of age, construction materials, and materials stored in the tanks.

   A total of nine metal tanks have been in service for approximately 34 years. These tanks contain gasoline, diesel, kerosene, waste oil, and recycled cutting oil. Four are abandoned and it is not known whether they contain any material. None have ever been protected against corrosion, and none were pressure tested after installation. No leak detection or tank-specific ground-water monitoring program is in place. The age of the tanks, together with the lack of protection and testing, makes them suspect as sources of ground-water contamination. FMPC currently plans to remove the abandoned tanks before closure plans are required (i.e., November 1987).

2. Inactive Fly-Ash Pile. The inactive fly-ash pile could be a source of offsite chemical and radioactive contamination.

The pile was contaminated in the past as a result of spreading PCB-contaminated waste oil to control dust. The pile also contains approximately 1,000 kilograms of uranium (H&R, 1986). Uranium and PCBs may be carried via storm water to Paddy's Run and the storm sewer outfall ditch. In addition, airborne dust from the pile may have a radioactive component.

ANL is sampling the inactive fly-ash pile to determine its chemical and radioactive content.

3. Fire-Fighting Training Area. The fire-fighting training area may be contaminated with oil, including the soil around the tank and the water in the trough. Depending on the extent of contamination, the area may serve as a source for migrating contaminants.

Used oils from the FMPC operation were stored at the location and used for practice fires for the site fire-protection personnel. No analysis of the waste oil was performed, and potential hazardous and/or radioactive constituents could have been present. These oils may have leaked, spilled, or been applied to soils at that site.

ANL is sampling soils in the area to determine the presence of contaminants.

4.5.2.3 Category III

1. Contaminant Releases from Waste Pits. The FMPC waste disposal pits are a potential source of uranium, sulfate, barium, chromium, and other chemical contamination of the ground water in the western and southern areas on and off site. The sand and gravel aquifer in the western area of the site has been found to contain uranium at concentrations of 80 times background levels.

The area covering Pits 1, 2, and 3 and the burn pit is not graded to allow all storm-water drainage to be directed to the Clear Well, thereby causing runoff to enter Paddy's Run. Paddy's Run has been identified as a source of downward migration of pollutants into the sand and gravel aquifer in that area of the site (Dames and Moore, 1985). Pits 1, 2, and 3 and the burn pit are potential sources of uranium, thorium, nitrates, sulfates, and organic contaminants because of the historic operations and wastes directed to these areas (see Table 4-10).

Pit 4 is a source of contamination of the shallow water regime in the waste pit area. As discussed in the the section on hydrology (Section 3.4), sampling of shallow wells around Pit 4 has revealed 32 parameters at concentrations above background in the perched ground-water region. No other wells monitor the shallow-water aquifer in the waste pit area. The flow regime within the shallow-water aquifer has not been adequately characterized, but the presence of contamination around Pit 4 is a potential source of onsite and offsite ground-water contamination.

The lining of Pit 5 has torn, and lining joints have failed (Weston, 1986). The lining near the influent line, on the east site, is covered by dirt and vegetation and the vegetation may have breached the lining. Pollutants from the pit may be entering the ground water beneath the pit and contributing to elevated levels of contaminants detected in the shallow water regime.

Solids are accumulating in Pit 5 and dredging may be needed in the near future to prevent overflow. The pit received liquid waste slurries until mid-1983 and now receives filtered waste streams. Process effluent containing suspended solids flows across the pit and is discharged to the Clear Well via an outflow valve.

However, a review of records found during the environmental survey indicates that suspended solids may be accumulating in the pit at a rate of approximately 9,000 pounds for each 400,000 gallons discharged to the pit or at a rate of 1,300 pounds per day (i.e., 2,700 mg/l dissolved solids; 400,000 gallon/week; 7 days/week). This rate of disposal indicates that Pit 5 continues to handle process wastes and is continuing to be filled with solids despite filtering.

Pit 5 may have received barium-containing materials from Pit 4 through the practice of pumping accumulated rainwater on top of the uncovered Pit 4 to Pit 5 via a portable pump. The presence of hazardous waste could signify that the pit is a hazardous waste surface impoundment requiring compliance with RCRA requirements.

Pit 6 may have received hazardous wastes as a result of the FMPC practice of pumping accumulated rainwater from Pit 4 (known to contain hazardous waste) to Pits 5 and 6. Pit 6 has not been observed to have torn lining joints as has Pit 5.

Pits will be tested under the Federal Facility Compliance Agreement to characterize the waste contaminants that could migrate in water.

2. Contamination from the Sanitary Landfill. The sanitary landfill may be a possible source of ground-water and surface-water contamination, since it may have received quantities of asbestos-containing rubble.

A sample of water taken during the environmental survey from standing water on the surface of the landfill contained a very high count of asbestos fibers. In addition, the landfill may contain radionuclide-contaminated materials, including construction rubble and soil used to cover exposed wastes.

The sanitary landfill was used for the disposal of cafeteria wastes, rubbish, and other wastes from non-process areas. The existing cells are filled to capacity, and FMPC stopped using the landfill in early 1986. Limited data on wastes disposed at the landfill and the hydrogeology of the site do not permit a detailed assessment of the landfill's potential environmental impacts and public health risks. However, the landfill has the potential to contribute to ground-water contamination on and off site.

ANL is sampling soils at the sanitary landfill to determine the presence of any surface contaminants.

3. Uranium Releases from the Clear Well. The Clear Well has likely received uranium-bearing solids from process effluent flow-through from Pit 5 and potentially can be releasing uranium to the ground water by migration through cracks and fissures in the clay liner. No estimates of volume or mass of solids in the Clear Well are available. The Clear Well has also received runoff from the waste pit area since 1959 when it was constructed. Uranium and other runoff-derived contaminants could seep through discontinuities in the clay lining of the Clear Well. This loss of uranium and other constituents may add to contaminants within the perched ground-water of the area.

Sampling will be performed by ANL on the Clear Well Sediments to determine the concentration of pollutants.

4. Rubble Piles, Abandoned Drums, and Burial Sites. In several locations throughout the FMPC there are rubble piles and abandoned drums that may be sources contributing to onsite and offsite radioactive and chemical contamination.

Some of the rubble piles emit radiation and may contain asbestos-contaminated building debris. The abandoned drums and the surrounding areas may contain hazardous substances. There are also areas that may have been burial sites for radioactive, hazardous, and mixed wastes. One suspected area is known as the South Field, which is located directly north of the inactive fly ash disposal area. Radiological surveys indicate that the soil in this area contains elevated levels of radionuclides. In addition, contaminated soils have been removed from some contaminated areas and disposed of elsewhere. One example involved the use of uranium-contaminated soil from the old fire pond to cover exposed wastes in Pit 4. The locations of rubble piles, abandoned drums, and possible burial sites are shown in Figure 4-2.

Soil samples are being taken by ANL from these areas to assess contamination levels.

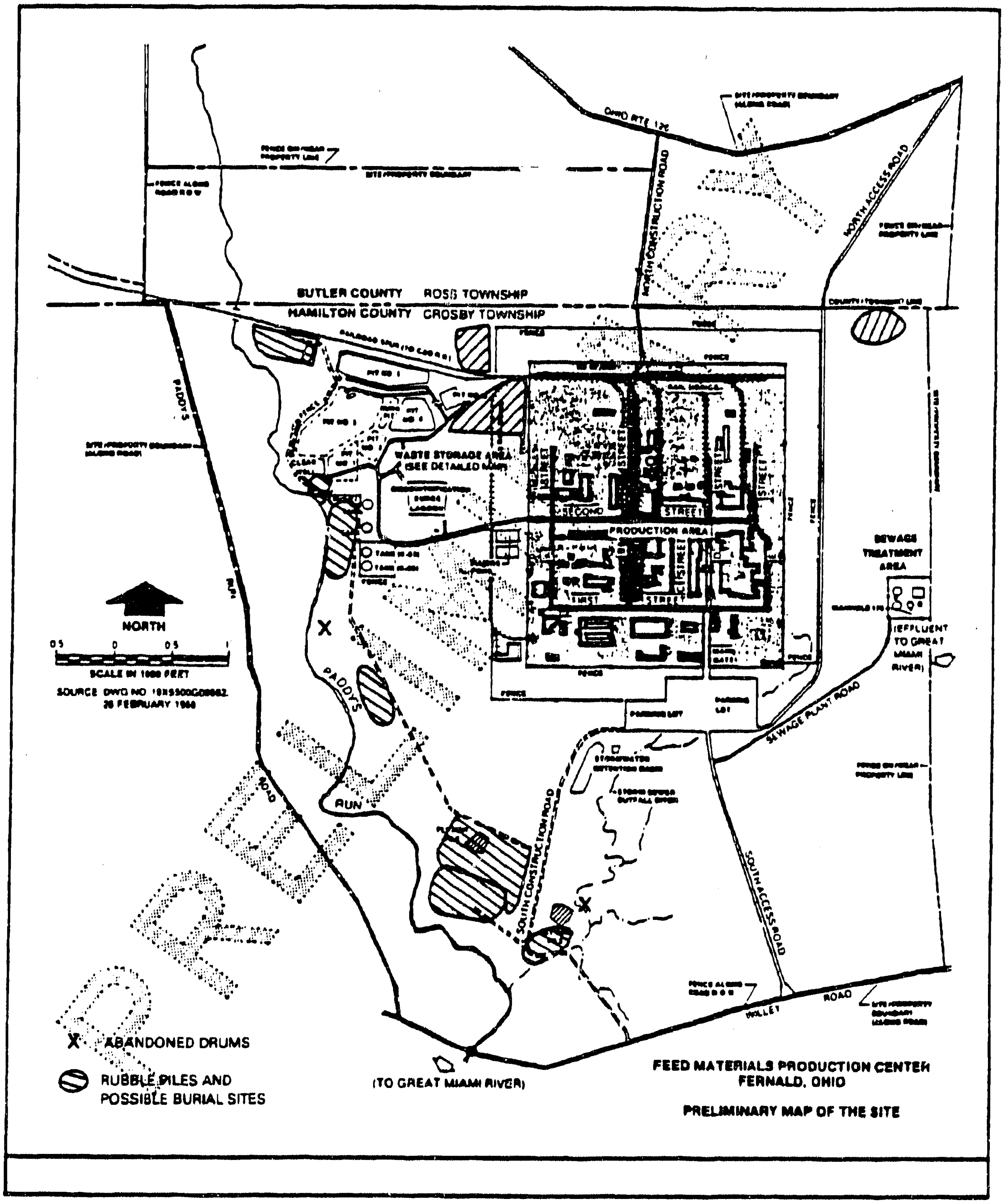
5. <u>Scrap Piles and Abandoned Equipment</u>. Scrap piles and abandoned equipment at FMPC are potential sources of radioactive contamination via ground-water and surface-water pathways from these sources.

The scrap piles contain a variety of contaminated scrap meterials, including ferrous scrap metal (5,000 tons), copper (1,500 tons), and wood (1,000 tons). The scrap is stored outdoors, primarily in two locations. The metallic scrap is contaminated with uranium and other radionuclides that contribute to the direct external exposures off site. The wood is contaminated primarily with uranium, which could be a source of fugitive emissions if left uncontrolled. It is also possible that these sources contribute to liquid release through stormwater runoff. Some of the material extends beyond the pads that drain to the sewer system, and some runoff could drain to surface waters. It is not possible to estimate the contribution of these sources to offsite exposures.

Plans are being made for the removal of this scrap. Present planning is for the metal scrap to be shredded and packaged for recycling or for offsite disposal. Also, the wood will be prepared and transferred to Oak Ridge, Tennessee, for incineration.

A large quantity of abandoned equipment and piping is found on site, including the following:

- Process equipment.
- The deactivated incinerator near the wastewater treatment plant.
- The deactivated graphite and oil burners.



LOCATIONS OF RUBBLE PILES, ABANDONED DRUMS, AND POSSIBLE BURIAL SITES

FIGURE 4-2

- Half of the tanks at the tank farm.
- Four underground storage tanks (see section pertaining to underground storage tanks).
- Two above-ground tanks east of Pits 2 and 3.
- One above-ground storage tank on the west side of the refinery.
- Ore hoppers in Plant 1.
- Dust collectors.

Much of this equipment is abandoned in place, especially in Buildings 1, 2, 3, and 4 and in the Pilot Plant. Some equipment was removed and put in storage areas or added to the scrap piles. Much of the abandoned piping is difficult to locate because there are no complete records on pipe location since as-built drawings generally were not updated. This equipment has the potential to become a future environmental problem because it contains radioactive (uranium) and organic contaminants (waste oils) and has not yet been properly decontaminated or decommissioned.

ANL is sampling soils in the area to determine the presence of contaminants.

4.5.2.5 Category IV

None

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APPENDIX A
SURVEY PARTICIPANTS

FMPC SURVEY PARTICIPANTS
JUNE 16-27, 1986

DOE

Team Leader:	R. Scott
Assistant Team Leader:	C. Grundler
Operations Office Representative:	V. Fayne

NUS

Coordinator:	W. Smith
QA/Toxics:	M. Malloy
Surface Water:	R. Tarbert
Air:	J. Crist
	H. Firstenberg
Radiation:	D. Dougherty
	C. Yates
Waste Management:	P. Alexandro
Inactive Waste Sites:	G. Kelly
Hydrogeology:	D. Riddle

APPENDIX B
SITE-SPECIFIC SURVEY ACTIVITIES

B.1 Pre-Survey Preparation

The DOE Office of Environmental Audit, Assistant Secretary for Environment, Safety, and Health, selected a survey team for the Feed Materials Production Center (FMPC) site in Fernald, Ohio in March 1986. The site is operated for DOE by the Westinghouse Materials Company of Ohio (WMCO). Mr. Randal Scott was designated the DOE Team Leader, and Mr. Christopher Grundler, the Assistant Team Leader. Mr. Vincent Fayne was identified as the Oak Ridge Operations Office representative. The remainder of the team was composed of contractor specialists from the NUS Corporation and ICF Corporation.

Survey team members began reviewing FMPC general environmental documents and reports in April 1986. Messrs. Scott, Grundler, Smith, Malloy and Terry Surles (Argonne National Laboratory) conducted a pre-survey site visit on May 5 and 6, 1986 to gain familiarization with key DOE and Westinghouse personnel and the site. They toured the facility and completed a cursory review of the data generated in response to an information request of April 8, 1986. The request listed environmental information of interest to the survey team for planning purposes. The survey team intensively reviewed the information generated during the pre-survey visit, and on May 20 through 22, 1986, prepared a survey plan for the FMPC Site. This plan discussed the specific approach to the survey for each of the technical disciplines and included a proposed schedule of activities for onsite activities. The survey plan was transmitted through the Oak Ridge Operations Office to Westinghouse during the week of May 26, 1986.

B.2 Onsite Activities

The onsite portion of the survey was conducted during the period of June 16-27, 1986. The opening meeting held on June 16, 1986 at the site was attended by representatives from DOE Headquarters, the Oak Ridge Operations Office, Westinghouse Materials Company of Ohio, NUS Corporation, and ICF Corporation. Discussions during this meeting centered on the purpose of the survey, logistics at FMPC, and an introduction of the key personnel involved.

During the survey, team members reviewed file materials, permits and applications, background studies, engineering drawings, accident reports, and operating logbooks. The production process was thoroughly analyzed to identify existing and potential pollutants. Site operations and monitoring procedures were observed. Extensive interviews were conducted with plant personnel regarding environmental controls, operations, monitoring and analysis, past operations, regulatory permits, and waste management.

Daily meetings of the survey team members were held to report observations and compare findings. A representative from the environmental management group of Westinghouse met daily with the DOE Team Leader, Assistant Team Leader, and the NUS Coordinator to arrange for specific site personnel and facilities to be available, as needed, on the following day.

The survey team members identified further sampling and analysis (S&A) requirements necessary to complete the survey effort. The S&A requirements were discussed by the team on June 26, 1986, and the request was transmitted to Argonne National Laboratory for review. Argonne was designated by DOE to provide a sampling team for FMPC and to perform the laboratory analytical services.

A site closeout briefing was held on June 27, 1986, where the DOE Team Leader presented the preliminary observations of the survey team. These observations were classified as preliminary, because additional research and, in some cases, additional field sampling were required to positively confirm the observations.

B.3 Sampling and Analysis

Argonne National Laboratory (ANL) will perform the sampling and analysis portion of the survey. ANL evaluated the sampling requests made by the survey team and determined sampling and analysis logistics, costs, and schedules. The sampling plan prepared by ANL includes a quality assurance plan and a health and safety plan. The sampling plan was completed during mid-July 1986 and the sampling team began work at the site during September 1986.

B.4 Report Preparation

A Preliminary Report for FMPC will be prepared to summarize the findings from the onsite survey effort. This report will be provided to the Oak Ridge Operations Office and the FMPC contractor for review. The findings presented in the Preliminary Report are considered preliminary until comments are received and S&A results are available. At that time, the comments and S&A results will be evaluated and an interim report will be prepared.

APPENDIX C
SURVEY PLAN

ENVIRONMENTAL SURVEY
FEED MATERIALS PRODUCTION CENTER
JUNE 16-27, 1986
FERNALD, OHIO

1.0 INTRODUCTION

The Environmental Survey is a one time baseline inventory of existing environmental problems and environmental risks at DOE operating facilities. The Survey will be conducted in accordance with the principles and procedures contained in the Draft Environmental Survey Manual distributed on May 16, 1986.

The survey is an internal management tool to aid the Secretary and Under Secretary in allocating resources for maintaining aggressive environmental programs and for mitigating environmental problems at DOE facilities.

2.0 SURVEY IMPLEMENTATION

The Survey will be managed by the Team Leader, Randal Scott and the Assistant Team Leader, Christopher Grundler. Vincent Fayne will serve as the Oak Ridge Operations Office Representative on the survey team. Technical support will be provided by NUS Corporation personnel as follows:

William Smith	NUS Coordinator/Air Quality
Michael Malloy	QA/TSCA
Richard Tarbert	Surface Water
Henry Firstenberg	Air
David Dougherty	Radiation
Carl Yates	Radiation
Patrick Radigan	RCRA/Rad Waste
Peter Alexandro	RCRA/CERCLA
Gerard Kelly	CERCLA
Douglas Riddle	Hydrogeology

2.1 Pre Survey Activities

Survey Team members began reviewing FMPC general environmental documents and reports in April, 1986. Messrs. Scott, Grundler, Smith, Malloy and Terry Surles (Argonne National Laboratory) conducted a pre-survey site visit on May 5 and 6, 1986 to gain a familiarization with key DOE and Westinghouse personnel and the site itself. They toured the facility and completed a cursory review of data that were generated in response to a memorandum of April 8, 1986. The memorandum documented the visit and listed environmental information of interest to the Survey Team for survey planning purposes.

This Survey Plan will be transmitted to the FMPC at least two weeks prior to the survey.

2.2 On Site Activities

The survey will be conducted from June 16, 1986 through June 27, 1986. The Agenda will be as shown in Table 1, with modifications as appropriate to minimize disruption of site activities and to enhance survey efficiency and effectiveness.

Interviews and consultations will be conducted with environmental, safety, operations, waste management, purchasing and warehousing personnel, among others, in the course of the survey.

2.3 Sampling and Analysis

Based on available site environmental information and the results of the survey activities on site, the sampling and analysis (S&A) phase of the survey process will be implemented 2-4 weeks after completion of the survey. This effort will have a 2-10 week duration and will be conducted by DOE Laboratories. Results of the S&A effort will be transmitted to the Survey Team Leader.

Table I

Fernald On-Site Survey Agenda

Day	CERCLA - Site Agenda	RCRA - Site Agenda	Hydrogeology
Week 1			
Monday	Opening Meeting, Orientation, Facility Tour	Opening Meeting, Orientation, Facility Tour	Opening Meeting, Orientation, Facility Tour
Tuesday	Field/Perimeter Tour (drums, buried waste, rubble piles, etc.)	Field/Detailed Process Tour	Field/Observe Well Sampling Procedures
Wednesday	Office/File Review and Interviews	Office/File Review	Field/Continue Tuesday Activities Chain-of-Custody, Lab Procedures
Thursday	Field/Pit Area Site Visit Office/Documentation Review	Field/Pit Area Site Visit Office/Documentation Review	Office/Review of Sampling Documentation
Friday	Field/Storage and Treatment Facility Tour/Releases Inspection	Field/Storage and Treatment Facility Tour	Office/Meet with Environmental Monitoring Personnel
Week 2			
Monday	Office/File Review and Interviews	Office/Documentation Review	Field/Visit Potential Source Areas, Off-Site Reconnaissance
Tuesday	Field/Followup Field Survey	Office/Document Review/RAD Area Follow-Up	Field/Continue Monday Activities
Wednesday	Office/Technical Area Coordination (i.e., RCRA, CERCLA, Hydrogeology, Radiation	Office/Technical Area Coord. (RCRA/CERCLA/HYDRO/RAD)	Field/Reconnaissance On-Site Office/Coordinate With RCRA, CERCLA, RAD
Thursday	Sampling and Analysis Planning/Tech. Coord.	Sampling and Analysis Plan/Tech. Coord.	Coordinate With Other Technical Areas and Sampling Analysis Plan
Friday	S&A Planning/Close Out Meeting at 10:00 a.m.	Sampling and Analysis Plan/Close Out Meeting at 10:00 a.m.	Finalize Sampling and Analysis Plan/Close Out Meeting at 10:00 a.m.

Table I
Fernald On-Site Survey Agenda (Continued)

	Surface Water	QA-TSCA	RAD	AIR
WEEK 1				
Monday	Opening meeting, orientation, facility tour	Opening meeting, orientation, facility tour	Opening meeting, orientation, facility tour	Opening meeting, orientation facility tour
Tuesday	Field/Walk through process areas to confirm or identify potential or actual discharges	Field/PCBs facilities Office/PCB Field/tour laboratory	Office/AM-Data review/gaseous release points will be divided into 6 groups Field/PM-Group 1 gaseous release points	Office/Data review
Wed.	Same as Tuesday	Field/Environmental sampling	Field/AM-Group 2 & 3 gaseous release points Field/PM-Group 4 & 5 gaseous release points	Field/Plant emissions
Thurs.	Office/Review SOPS for operations & maint. of sampling, monitor. & treat. facilities	Office/Review toxic substances mgmt. program	Field/AM-Liquid release points Office/PM-Data review (Group 6 gaseous release points handled under Air on Thur., Fri., & Mon.)	Field/Plant emissions (Group 1)
Friday	Field/Perimeter Tour	Office/Asbestos inventory Field/Asbestos facilities	Office/AM-rechecks Field/PM-laboratory	Field/Plant emissions (Group 1)
WEEK 2				
Monday	Field/Water treatment plant; sewer monitoring; general sump; sludge pits; clear well; sewage plant.	Field/Laboratory data management, lab procedures	Field/Laboratory	Field/Plant emissions (Group 1)
Tuesday	AM Field/Continue Monday's Activities PM Office/Review data	Office/QA environ. sampling; review toxic usage inventory	Field/Envir. monitor. program (Air)	Field/Ambient Air Laboratory
Wed.	Field/Observe surface water and NPDES sampling	Office/Develop sampling plan and review data	Field/Environmental monitoring program (Water)	Office/Data review
Thurs.	Office/Sampling Plan	Office/Sampling plan	Office/Sampling Plan (Dose Assessment)	Office/Sampling plan
Friday	Office/Open; close-out meeting at 10:00 a.m.	Office/Open; close out meeting at 10:00 a.m.	Office/Open; close out meeting at 10:00 a.m.	Office/Open; close out

2.4 Conclusions and Reporting on the Survey

A close out briefing will be conducted as noted on the agenda to describe the general conclusions of the site activities. Within 4 weeks of the on-site survey team visit, a Draft Survey Report will be developed. Within 4 weeks of the availability of the analytical results from the sampling and analysis phase of the survey, an Interim Survey Report will be completed.

3.0 QUALITY ASSURANCE

3.1 Issue Identification

The quality assurance review of the environmental program will be primarily directed to the evaluation of site sampling and analytical capabilities. The intent will be to verify and review the quality assurance procedures for obtaining process/effluent and environmental samples, performing the analytical work to identify the concentration of pollutants, and the handling and reporting of data. All aspects of the quality assurance program relating to environmental management of the Fernald site will be reviewed, including operator training; equipment and instrument calibration/maintenance; precision and accuracy studies; blank, split, and spiked sample analyses; sample handling and chain of custody procedures; data reduction and validation; data reporting and documentation; and calculation and logbook reviews.

The procedures for sampling and analysis will be monitored to ensure proper implementation and conformance to regulatory agency requirements. Quality assurance plans will be reviewed for the sampling and analytical activities, as well as any internal QA audits that have been completed.

The QA programs currently in force in the Fernald Laboratories, as administered by DOE through the Environmental Measurements Labortory (EML) and EPA will be evaluated. QA procedures imposed on any outside sampling or analytical laboratories will also be reviewed in this study effort.

3.2 Records Required

During the site visit, the following records/documents will be reviewed:

- Analytical Laboratory and Environmental Sampling Quality Assurance Plans (Environmental and Waste Management Divisions)
- QA Audits of Laboratory and Sampling Program
- Bimonthly QA Reports for the Fernald Laboratories
- Laboratory and Sampling procedures manuals
- DOE (EML) and EPA QA results for prepared analytical samples
- Operator training records (laboratory and sampling)
- Instrument maintenance and calibration records (laboratory and sampling)
- Laboratory and sampling calculations and workbooks
- Precision and Accuracy studies

4.0 SURFACE WATER/DRINKING WATER

4.1 Issue Identification

The preliminary review of the information presented for Fernald indicates that it is typical of other DOE facilities. In the past, attention has been primarily directed toward the identification of radiological releases and very litle information is available on other pollutants. Except for some water quality parameters in receiving streams, the only other non-radionuclide analyses generally available are those required by the NPDES permit.

Compliance for Cr^{+6}, Fe, TSS and Cu at the combined general sump/clearwell sampling point appear to have deteriorated from 100% in 1982 to 79%-96% in 1985, although the overall compliance remains at approximately 98%. Tetrachloroethylene and 1,1,1-trichloroethane are used in the plant but the only analyses of these materials in the discharge from the plant are those required for the submittal of the application for renewal of the NPDES permit. One report states that other toxic organics are used onsite and are not monitored but does not identify them. These issues and the reports of possible unpermitted discharges to Paddy's Run from storm drainage ditches to the north and west of the plant will be investigated during the site visit. This will be accomplished by reviewing SOPs for the operation and maintenance of sampling and treatment equipment, then following through by looking at records, interviewing personnel, and observing procedures to determine how they are followed. A walk through of the plant area will be made to identify all liquid waste streams from plant processes and discharges from the plant property.

4.2 Records Required

Records that may be reviewed during the visit to obtain information include:

- o Analytical data used for preparation of the NPDES monitoring reports
- o NPDES discharge monitoring reports for the period 1980 - present
- o Records of drinking water quality
- o Operators log books and reports for treatment plant operations
- o Sampling log books
- o Treatment plant and monitoring equipment maintenance records and/or logs

- Procedures for the operation and/or maintenance of treatment and monitoring equipment

- SPCC plan and records of implementation.

5.0 AIR

5.1 Issue Identification

The nonradioactive air related issues involve an assessment of the plant-wide air emissions, emission control and monitoring, and the acquisition and processing of ambient air quality data. Areas of particular interest are the process emissions of particulates, nitrogen oxides, hydrogen fluoride and organics, and the emissions of sulfur dioxide from fuel burning equipment. In addition, there will be some emphasis on operational and procedural practices associated with the control equipment, and fugitive sources of emissions and mitigative procedures for fugitive sources.

The general approach to the survey will involve a review of existing air permits, pending air permit applications, operating procedures, and the physical inspection of the processes and control equipment. The survey will attempt to relate the air contaminants from different processes in the plant, evaluate the existing control equipment for the air contaminants, and assess the potential serious environmental problems from the emissions.

The ambient air monitoring system assessment will involve inspection of the ambient samplers, review of documentation applicable to data acquisition, review of calibration procedures, data validation, and processing. The primary emphasis will be an assessment of the use of these data to characterize the environmental impact of plant operation and the defensibility of these data.

5.2 Records Required

- Air permits (Registrations, Installation and Operation)

- Source and source emissions inventories
- Supporting calculations, stack tests, etc.
- Descriptive documentation on add-on emission controls
- Operating procedures for processes and control equipment
- Correspondence between regulatory agencies: air-related
- Reports on accidental releases
- Ambient air monitoring program procedures
  - Duty observer
  - Calibration procedures and records
  - Laboratory procedures and quality assurance
  - Ambient air monitoring data

6.0 RADIOLOGICAL

6.1 Issue Identification

Three radiological issues have been identified for the Fernald FMPC survey. They are as follows: (1) atmospheric releases and impacts, (2) ground and surface water contamination and (3) radon emissions. Evaluation of these issues for the purpose of identifying environmental problems will be accomplished through observations of equipment to control atmospheric and liquid releases, observations of the monitoring of effluents and observations of the environmental monitoring program. Dose assessment methodology will also be evaluated.

Particular attention will be paid to the potential radon problem near the silos and the release of non-uranium radionuclides (e.g. transuranics and radium) to the atmosphere and surface and ground water. Also, unanticipated releases and the site response to those releases will be evaluated.

6.2 Records Required

The records required for review include the following:

- o Meteorological data forming basis of siting air samplers
- o Hydrological data forming basis of siting surface and groundwater monitoring
- o Land use, demographic surveys forming basis for any other sample types
- o Impact assessment methodologies
- o Evidence of availability of regulatory bases, or key referenced documents cited in procedures (e.g., ANSI standards, EPA regulations, etc.)
- o DOE orders, field supplements, facility directives covering quality assurance activities
- o Procedure and forms indices
- o Examples of forms cited in procedures
- o Field and Laboratory calibration records
- o Laboratory QA records
- o Effluent monitoring calibration records
- o Raw data from effluent and environmental monitoring
- o Accident reports and data

7.0 TOXIC SUBSTANCES

7.1 Issue Identification

The toxic substances review will include all raw materials and process-related chemicals used on the Fernald site. Use, handling, and disposal of Polychlorinated Biphenyls (PCBs), asbestos, and pesticides will be within the scope of this effort.

All toxic substances purchased, used, or manufactured on the site will be evaluated. Tracking, control, and management of these substances will be reviewed. Records of usage will be evaluated to determine the potential for entering effluent streams.

The inventory of PCB contaminated electrical equipment in use at the facility will be determined. The condition of this equipment, its potential for leakage, and the quantity of contaminated fluids will be identified. Obsolete or used PCB items and contaminated items in storage will be inspected for proper container/packaging, adequate storage protection requirements, and inventory controls. Disposal practices will be reviewed for current and past inventories to determine the method of disposal and location of disposal sites. Procedures for PCB analysis, removal, handling, and disposal will be reviewed.

Asbestos insulation in Fernald buildings will be identified and projects for modification/removal will be reviewed. Asbestos procedures for modification/removal, handling, and disposal will be investigated. Disposal practices, both on and off site, will be reviewed to determine disposal methods and locations of disposal sites.

Pesticides usage on the site will be reviewed including personnel training, application records, and storage and disposal practices.

7.2 Records Required

The following records/documents regarding toxic substances should be available for review during the site visit:

- Toxic substances labeling and tracking system
- Procedures for handling, control, and management of toxic substances
- Inventory of toxic substances and purchasing records
- Inventory of current PCB-contaminated electrical equipment
- Storage records of PCB items
- Disposal records for PCB items
- PCB handling, storage, and disposal procedures
- Locations of buildings containing asbestos
- Asbestos disposal records, including method and location of disposal
- Asbestos handling, removal, and disposal procedures
- Pesticide training, handling, storage, and disposal records
- Standard operating procedures for pesticides

8.0 HAZARDOUS/RADIOACTIVE WASTE

8.1 Issue Identification

The hazardous waste review will place emphasis on those facilities seeking hazardous waste permit approval and on the identification of hazardous waste management activities that have potential for an adverse enviromental effect. Pit 4 is a known area of concern as it manages hazardous waste and a permit application has been submitted for its continued use. The survey review will confirm that Fernald hazardous waste management activities are administered to prevent unauthorized releases. Personnel training and emergency response plans will be reviewed for completeness. Pit 4 activities will be examined to assure correction of any deficiencies for waste analysis, contingency, closure , and operating records. In addition, any operating and permitting deficiencies for hazardous waste storage facilities will be defined. The identification of solid waste management units (SWMU) is required by RCRA and is important in delineating sources of environmental contamination. The hazardous waste review will be coordinated with CERCLA and hydrologic investigations to help identify possible releases from such SWMUs. Fernald will be examined to determine hazardous waste generation points and the characterization of existing and, to the extent possible, past hazardous waste disposal practices. Waste storage practices in underground tanks and waste oil burning practices will also be examined. In addition, the storage of thorium and the handling and disposal of radioactive wastes in pits and other techniques will be included in the review of waste management activities. Solid waste disposal operations will be evaluated to ensure that all hazardous and radiological constituents have been identified and are properly managed. All radioactive waste treatment, storage, and disposal facilities will be reviewed.

8.2 Records Required

The following records will be reviewed on site:

- o Part B permit application
- o 3016 inventory
- o Part A application and 3010 notification
- o Inspection documentation, (state and federal)
- o Groundwater monitoring, sampling and analytical documentation
- o Groundwater quality assessment documentation
- o Release notification or occurrence documentation
- o Waste inventory documentation
- o Enforcement action documentation
- o Groundwater monitoring system construction documentation
- o Internal facility inspection documentation

9.0 INACTIVE WASTE SITES/RELEASES (CERCLA)

9.1 Issue Identification

The survey will attempt to identify environmental problems and potential risks associated with the handling, storage and disposal of hazardous substances at the Fernald facility. The survey will focus on current and future risks related to the following:

- o Past land disposal practices;
- o Past spills/releases;
- o Current waste management practices; and
- o Potential for future spills/releases

All facilities that have handled or are currently handling hazardous, mixed and low-level radioactive wastes will be inspected and assessed. These facilities include the waste pits (#1, 2, 3, 5 and 6), the four silos, drum storage sites, thorium storage facilities, fly ash piles, and landfills. These facilities will be evaluated in terms of the materials that they contain, the integrity of the facilities, past and potential releases of hazardous substances.

9.2 Records Required

The following records will be reviewed at the site:

- o Waste management plans (old and current)
- o SOPs regarding management of hazardous substances, disposal areas and storage areas
- o Hazardous substances inventories
- o Listing of areas used for hazardous substances use, storage, receiving and shipping, and disposal
- o Historical files on past operations and processes, substances used, and methods of handling and disposal
- o Files on past off-site waste handling and disposal
- o Records of facility expansion and building rubble disposal
- o Descriptions and notifications of inactive waste sites and potential areas of contamination

- o Descriptions and notification of spills/releases
- o Descriptions of corrective actions
- o Description of all waste management facilities, including buried tanks and structures (e.g., design, materials used, details on liners used in waste pits)
- o On-going studies, including:
  - Weston RI/FS work plan
  - Study plans to identify contaminated surplus facilities; and
  - Groundwater studies (e.g., Dames & Moore and Geraghty & Miller work)

10.0 HYDROGEOLOGY

10.1 Issue Identification

The preliminary review of documentation on the FMPC site indicates that a great deal of previous work has been conducted in the area of groundwater assessments. Previous studies have not resolved questions of potential contaminants other than radionuclides and the nature of the groundwater flow regime in some areas around the site. Recent and on-going studies have recognized these shortcomings and have begun to address them. The issues to be dealt with during the survey include a determination of the status of those recent and on-going studies. While some potential contaminant source areas, such as the waste pits and Paddy's Run, have been investigated in the past, a number of potential source areas need further study. These include the flyash disposal areas, coal piles, underground storage tanks, storage ponds, and the south field area.

A general review of data collection efforts that have taken place will be required to verify the value of previous studies. This will include a review of sampling procedures, chain of custody and QA/QC procedures, compatability of data from various sources (USGS, OEPA, FMPC, Consultants), and monitoring parameters. The reliability and placement of wells used for groundwater monitoring will be examined. To assess the potential for regional impact from groundwater contamination, principal users of groundwater, as well as domestic users, need to be identified.

10.2 Records Required

Records and documents to be reviewed include the following:

- o New and recent work and work plans
- o Well sampling procedures
- o Sampling schedules
- o Monitoring parameters
- o Monitoring data and results
- o General groundwater sampling QA/QC and lab.
- o Well installation reports, boring logs
- o Air photos (historic)
- o Historic topography, records, etc.
- o Groundwater sections of pertinent documents (e.g. RCRA permits, FUSRAP cleanups, etc.)

APPENDIX D
FEDERAL FACILITIES COMPLIANCE AGREEMENT

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION V

UNITED STATES DEPARTMENT OF ENERGY AND UNITED STATES ENVIRONMENTAL PROTECTION AGENCY	)))))))	FEDERAL FACILITY COMPLIANCE AGREEMENT Docket No. ____________

The United States Environmental Protection Agency (U.S. EPA) and the United States Department of Energy (U.S. DOE) are the parties to this agreement which is entered into pursuant to Executive Order 12088, October 13, 1978 (43 F.R. 47707). This Agreement pertains to U.S. DOE's Feed Material Production Center (FMPC) in Fernald, Ohio. The Office of Management and Budget (OMB) and the United States Department of Justice (DOJ) will take cognizance of this agreement pursuant to their respective duties to ensure compliance with the environmental laws under Executive Order 12088 and the particular statutes addressed herein.

SCOPE

1. This agreement is entered into by the parties to ensure compliance by U.S. DOE, Oak Ridge Operations, Oak Ridge, Tennessee, with existing environmental statutes, and implementing regulations, including the Clean Air Act (CAA), as amended 42 U.S.C. 7401 *et seq.*, the Resource Conservation and Recovery Act (RCRA), as amended, 42

U.S.C. 6901 et seq, and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), 42 U.S.C. 9601 et seq., at FMPC. The Agreement is further intended to ensure that the environmental impacts associated with past and present activities at the FMPC are thoroughly and adequately investigated, and appropriate remedial response action taken, as contemplated by the Comprehensive Environmental Response, Compensation & Liability Act, of 1980, and regulations promulgated thereunder. The Agreement does not address compliance, or the lack thereof, by U.S. DOE's FMPC with the Clean Water Act, 33 U.S.C. 1251 et seq.

2. This Agreement shall apply to U.S. DOE, its officers, successors in office, agents, employees, contractors, and subsequent owners and all operators of FMPC in Fernald, Ohio. U.S. DOE agrees to give notice of this compliance agreement to any subsequent owner and/or operator prior to the transfer of ownership or the obligation of a new contractor/operator and shall simultaneously notify U.S. EPA of any such change or transfer.

AUTHORITIES

The duties of U.S. DOE to operate its facilities in compliance with enacted environmental statutes are prescribed in Section 118 of the Clean Air Act, 42 U.S.C. 7417; Section 6001 of RCRA, 42 U.S.C. 6961, and Section 107(g) of CERCLA, 42 U.S.C. 9607(g). Executive Order 12088 was promulgated to ensure federal compliance with applicable pollution control standards. This agreement contains a "plan" as described in Section 1-601 of Executive Order 12088 to enable U.S. DOE to achieve and maintain compliance with applicable environmental standards. This Agreement is further entered into pursuant to U.S. EPA's responsibilities under Executive Order 12316 and U.S. DOE's authority under the Atomic Energy Act, as amended, 42 U.S.C. 2011, et seq. The parties agree to meet their responsibilities under the authorities recited herein.

FINDINGS OF FACT

1. FMPC is an industrial facility owned by the U.S. Government and operated for the U.S. DOE under a management contract with Westinghouse Materials Co. of Ohio (WMCO). The facility commenced operations in 1952. Between the years 1952 and 1986, FMPC was operated by National Lead of Ohio, Inc. (NLO), under contract with U.S. DOE. The facility is located approximately twenty miles northwest of downtown Cincinnati, Ohio. FMPC operations cover approximately 136 acres in the center of a 1050 acres site. Several rural communities lie within a one to three mile radius of the plant.

2. The primary function of the FMPC is the production of metallic uranium fuel elements and target cores and other uranium products for use in production reactors operated for the U.S. DOE. In prior years, small amounts of thorium were also processed. As a result of these processes the plant has generated both radioactive and non-radioactive hazardous waste. The principal

radionuclides present in waste materials handled at FMPC include Uranium-238 (U-238), U-235, and thorium-232 (Th-232) with their respective decay chains. Plutonium and fission products may also be present in the wastes. The principal non-radioactive hazardous wastes known to be generated at the FMPC are halogenated solvents, primarily 1,1,1-trichloroethane. The facility also stores radioactively contaminated polychlorinated biphenyls (PCBs). Detailed chemical and radiological analyses are necessary at the facility to determine the nature and extent of wastes generated, handled, treated, stored and disposed of at the FMPC.

3. Waste storage and disposal areas at FMPC include six on-site waste pits and lagoons containing both radioactive and nonradioactive hazardous substances; two silos containing approximately 1700 curies of radium and other radioactive waste ("K-65 silos"); metal structures and other containers containing a total of approximately 1,100 metric tons of thorium; and a 10,000 gallons hazardous waste container storage area. The 61 drums of radioactively contaminated PCBs in the container storage area presently satisfy the requirements of the Toxic Substances Control Act (TSCA), 15 U.S.C. 2601 <u>et seq</u>.

4. Plants 1 through 6, 8, 9 and the Pilot Plant at FMPC contain emission points subject to Ohio Pollution Control Regulations AP-3-07 (recodified Ohio Administrative Code (OAC) 3745-17-07), AP-3-11 (recodified OAC 3745-17-10) and AP-3-12 (recodified OAC-3745-17-11) concerning the limitations of visible and particulate emissions. These provisions are part of the

applicable State Implementation Plan (SIP), approved by U.S. EPA on April 15, 1974. The regulations are enforceable by both the State of Ohio and the Federal government.

5. Airborne uranium, radon gas and radon decay product releases at FMPC have resulted from plant operations. Radioactive dust generated by manufacturing processes at FMPC are captured by bag-type dust collectors. Operations, including collector failures, have resulted in estimated releases of approximately 215,000 pounds of uranium to the air. Radium-bearing wastes are stored in two silos that are structurally unsound and are leaking radon and radon decay products to the environment. Up to 500 metric tons of thorium compounds are stored in a metal structure that is currently structurally unsound. Failure of the structure would release radioactive thorium compounds into the environment at levels that could be harmful to the surrounding communities.

6. Liquid effluent from the uranium metal production processes is generated and sent to the general sump for treatment prior to release to the Great Miami River. Untreated stormwater run-off from the process areas is routinely discharged to the Great Miami River and the overflow is periodically discharged to Paddy's Run Creek. Paddy's Run Creek is a small receiving stream upgradient to underground drinking water sources. Available evidence indicates that discharges to Paddy's Run Creek have contributed to the contamination of underground water supplies.

7. In December, 1981, elevated radioactivity was detected in three private wells located downgradient from FMPC. In February, 1982, following confirmation of preliminary sample results, the Ohio Department of Health and the landowners were notified of the elevated readings. This information was released to the general public in a FMPC Environmental Monitoring Annual Report in 1983.

8. As a result of the aforementioned releases, the Regional Administrator of U.S. EPA, Region V, has determined that releases and threatened releases of hazardous substances including radioactive materials, may present an imminent and substantial endangerment to the public health, welfare and the environment, requiring remedial response activities. U.S. DOE neither admits nor denies this determination; however, it does commit to undertaking the Work outlined in this Agreement without contest.

9. On March 9, 1985, U.S. EPA issued a Notice of Noncompliance letter to U.S. DOE identifying the Agency's major concerns over the environmental impacts associated with FMPC's past and present operations. U.S. DOE responded to this letter on June 14, 1985.

10. Between April, 1985, and July, 1986, conferences were held between the U.S. DOE and U.S. EPA representatives to discuss the violations and adverse environmental impacts and steps U.S. DOE proposed to take to achieve and maintain compliance.

COMMITMENT OF THE PARTIES

1. U.S. DOE and U.S. EPA hereby agree that U.S. DOE shall conduct a Remedial Investigation/ Feasibility Study and implement Initial Remedial Measures, in accordance with guidelines under CERCLA, to determine the nature and extent of contamination both on and off the FMPC site. The investigation shall be consistent with applicable EPA guidance documents.

2. It is further agreed that U.S. DOE shall undertake the activities described below, within the stated time frames, to bring FMPC into compliance with, and maintain compliance with, the Clean Air Act and RCRA.

COMPLIANCE PLAN

COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION AND LIABILITY ACT

1. Initial Remedial Measures

Pursuant to Section 106 of CERCLA, 42 U.S.C. 9606, and 40 CFR 300.63, U.S. DOE shall undertake the following initial remedial measures to limit the exposure or threat of exposure of radioactive emissions, including radon gas and radon decay products, to the public health and the environment:

A. U.S. DOE shall develop effective operation and maintenance procedures and work practices to control radioactive emissions, including radon gas and radon decay products, from production materials and onsite wastes to maintain all exposures As Low As Reasonably Achievable (ALARA). Within sixty (60) days of the effective date of this agreement, U.S. DOE shall implement effective operation and maintenance procedures and work practices for the control of radioactive emissions, including radon gas and radon decay product emissions. Progress reports shall be provided to U.S. EPA quarterly.

B. Within thirty (30) days of the effective date of this Compliance Agreement, U.S. DOE shall develop and provide U.S. EPA with a plan and implementation schedule for the following initial remedial measures: 1) interim control of radioactive emissions, including radon gas and radon decay product emissions from the K-65 silos and thorium compounds storage structures; 2) interim controls to ensure the structural integrity of the two K-65 silos, and the thorium compounds storage structures; 3) a radon and radon decay product monitoring program for the fence line and off-site environs; and 4) measures to be undertaken in the event of unplanned releases from the K-65 silos and thorium compounds storage structures to the environment.

C. U.S. DOE shall implement the plan for interim controls described in subparagraph B above, upon approval of the plan by U.S. EPA in accordance with the approved implementation schedule. The interim controls shall be maintained until such time as a long-term plan for the radium-bearing wastes and thorium compounds is developed, approved and implemented pursuant to the Remedial Investigation/Feasibility Study process discussed below.

D. The State of Ohio shall be given an opportunity to review and comment upon reports developed by U.S. DOE under this subsection.

2. Remedial Investigation/ Feasibility Study

Pursuant to Section 106 of CERCLA, 42 U.S.C. 9606, which addresses imminent and substantial endangerment to public health or welfare or the environment, and the regulations promulgated thereunder, U.S. DOE shall conduct a Remedial Investigation and Feasibility Study (RI/FS).

A. All RI/FS work shall be conducted in conformance with U.S. EPA "Guidance on Remedial Investigations under CERCLA", dated May, 1985, and the U.S. EPA "Guidance on Feasibility Studies under CERCLA", dated April, 1985, and shall be consistent with the guidelines and criteria and considerations set forth in the National Contingency Plan, 40 CFR Part 300, as amended.

B. Attachment I to this Agreement provides a Scope of Work (SOW) for the completion of the RI and FS. The SOW is incorporated into and made a part of this Agreement.

C. Within forty-five (45) days of the effective date of this Compliance Agreement, U.S. DOE will provide analytical results for laboratory certification as required by SOW Task 7b. In the event of any disapproval of certification by U.S. EPA, U.S. EPA may require that U.S. DOE either select another laboratory for laboratory certification, or allow the original test company to analyze a second round of blanks. Ten (10) days will be allowed for the analysis of a second round of test blanks by either the new or original laboratory.

D. Within ninety (90) calendar days of the effective date of this Agreement, U.S. DOE shall submit to U.S. EPA a work plan for a complete Remedial Investigation and Feasibility Study (RI/FS Work Plan) to determine the nature and extent of any release or threatened release of hazardous chemical and/or radiological substances pollutants or contaminants into the environment at or from FMPC. The RI/FS Work Plan shall be based upon the SOW provided in Attachment I and developed in accordance with the U.S. EPA RI/FS guidance documents which have been provided to U.S. DOE.

E. After receipt of the RI/FS Work Plan, U.S. EPA shall evaluate it and specify in writing to U.S. DOE both deficiencies and any U.S. EPA recommended modifications. Within forty-five (45) calendar days of the receipt of U.S. EPA notification of a RI/FS Work Plan disapproval, U.S. DOE shall amend and submit a revised plan to U.S. EPA. In the event subsequent disapproval of the RI/FS Work Plan cannot be resolved by informal means, the dispute resolution process described in the Agreement shall be used.

F. U.S. DOE shall implement the tasks detailed in the RI/FS Work Plan as approved by U.S. EPA. The fully approved RI/FS Work Plan shall be incorporated into and made a part of this Compliance Agreement, and shall be included as Attachment II. The tasks in the RI/FS Work Plan shall be conducted in accordance with the standards, specifications, and schedules contained in the approved RI/FS Work Plan.

G. U.S. DOE shall prepare draft and final RI and FS reports as provided in the attached SOW in accordance with the approved time schedule.

H. The final RI and FS studies, including recommended remedial alternatives, shall be made available to the public for review and comment for a twenty-one (21) day public comment period. After public comment, U.S. EPA shall prepare a Record of Decision (ROD) incorporating comments received during the public comment period, and identifying the selected remedial alternative. U.S. DOE shall implement the remedial action alternatives identified in the ROD. This work shall be conducted in accordance with applicable U.S. EPA guidance documents and the standards, specifications and implementation schedules specified by U.S. EPA.

I. The State of Ohio shall be given an opportunity to review and comment upon reports developed by U.S. DOE pursuant to the Remedial Investigation/Feasibility Study process, and shall be consulted during the selection of remedial alternatives to be carried out at FMPC.

J. Upon completion of the work described in subparagraph H. above, U.S. DOE shall provide U.S. EPA with written notification of its completion. U.S. EPA shall evaluate the remedial action taken by U.S. DOE and notify U.S. DOE in writing of the adequacy of the required cleanup. If the actions taken are inadequate, U.S. EPA shall specify, in writing, both deficiencies and the steps necessary to complete the remedial action. Within forty-five (45) calendar days of receipt of U.S. EPA notification, U.S. DOE shall implement the necessary remedial action. Any disputes that cannot be resolved by informal process will be handled according to the dispute resolution process contained in this Agreement.

K. U.S. EPA and U.S. DOE agree that actions undertaken by U.S. DOE pursuant to this section of the Agreement, establish a course of action, which, based on present information, is reasonable and necessary and consistent with the National Contingency Plan.

L. To the extent the RI/FS is conducted consistent with the provisions of this Agreement, following the completion of the RI/FS and upon written request by U.S. DOE, U.S. EPA will respond in writing within ninety (90) days of the request, that in the opinion of U.S. EPA, the Work was performed consistent with the National Contingency Plan and any cleanup remedy selected by U.S. EPA is the most appropriate remedy to protect the public health, safety and the environment consistent with the National Contingency Plan.

3. Reports and Recordkeeping

A. All submittals made to U.S. EPA and RI/FS work performed by U.S. DOE are subject to the review, modification and approval of U.S. EPA. U.S. EPA retains the right to amend reports, perform additional work, and to conduct the RI/FS if U.S. EPA decides any of the above are necessary.

B. U.S. DOE shall provide monthly written progress reports to U.S. EPA as described in Scope of Work (SOW) Task 7.

C. In addition to the monthly progress reports, U.S. DOE shall submit the plans and reports to U.S. EPA as required in the SOW, in accordance with the schedule contained in the approved RI/FS Work Plan.

D. Within thirty (30) days of receipt of any written notice of disapproval from U.S. EPA of such plans or reports, U.S. DOE shall submit a revised plan or report to U.S. EPA incorporating the required modifications or additions.

E. Documents and other notices required to be submitted pursuant to this Agreement, shall be sent by certified mail to the following addresses, or to such other addresses as U.S. DOE or U.S. EPA may hereafter designate in writing:

1. Documents to be submitted to U.S. EPA should be sent to:

United States Environmental Protection Agency
Region V
Hazardous Waste Enforcement Branch, 5HE-12
230 South Dearborn Street
Chicago, Illinois 60604
Attention: RCRA Enforcement Section

2. Documents to be submitted to U.S. DOE should be sent to:

U.S. Department of Energy
Oak Ridge Operations
Environmental Protection Division
P.O. Box E
Oak Ridge, Tennessee 37830

4. Designated Project Coordinators

A. The designated Project Coordinators for CERCLA activities are:

James A. Reafsnyder
U.S. DOE

Stephen Clough
U.S. EPA

B. To the maximum extent possible, communications between U.S. DOE and U.S. EPA and all documents, including reports, agreements, and other correspondence, concerning the activities performed pursuant to the terms and conditions of this section of the Agreement, shall be directed through the Project Coordinators.

C. U.S. EPA and U.S. DOE have the right to change their respective Project Coordinators. Such a change shall be accomplished by notifying the other party in writing.

CLEAN AIR ACT

A. U.S. DOE shall comply with the radionuclides emission standard promulgated at 40 CFR 61.92. Airborne concentrations of radionuclides shall not exceed those amounts that cause a whole body dose equivalent of 25 millirem (mrem) per year and 75 mrem per year to the critical organ of any member of the public.

B. To ensure compliance with emission standards promulgated at 40 CFR Part 61, U.S. DOE shall establish monitors, install emission controls and develop administrative controls to ensure (1) their proper operation and (2) correct collection and analytical methodology. Within thirty (30) days of the effective date of this Agreement, the following work shall be completed with progress reports quarterly:

1. Install real-time alarm monitors to monitor radionuclides on all major emission points.

2. Establish and implement administrative controls for real-time alarm monitors to ensure that any unplanned release will be detected immediately and dealt with in 24 hours.

3. Establish and implement air sample collection and analysis procedures along with a quality assurance plan to monitor radionuclides on all emission points with a potential for release of radionuclides to the air.

4. Establish a schedule for installation of emission controls and annual progress reports on the replacement of control devices.

C. U.S. DOE shall comply with the reporting provisions contained at 40 CFR 61.94(c).

D. Commencing in 1986, and each year thereafter, U.S. DOE shall provide U.S. EPA with (1) a yearly particulate matter stack-testing schedule for that year of all air pollution control devices using U.S. EPA method 5 procedures and (2) the stack test results forty-five (45) days after testing is completed. Stack test results shall report the actual quantities of emissions. The results shall be included in the quarterly reports required by Subparagraph E. Particulate catch shall also be analyzed for radionuclides and isotopic concentrations reported. U.S. DOE shall provide U.S. EPA with twenty (20) days advance notice of any change in the stack-testing schedule.

E. U.S. DOE shall maintain records of monthly particulate matter emissions and shall provide U.S. EPA with quarterly reports of such emissions.

F. Within sixty (60) days of the effective date of this Compliance Agreement, U.S. DOE shall provide U.S. EPA with a list of all environmental air monitoring equipment, including their location, and the operation and maintenance (O&M) program designed to maintain the monitors at peak efficiency.

G. Within ninety (90) days of the effective date of this Compliance Agreement, U.S. DOE shall develop and provide U.S. EPA with an O&M program for air pollution control devices.

H. Reports required to be submitted to U.S. EPA as a requirement of NESHAPS shall be sent to U.S. EPA, Assistant Administrator for Air and Radiation (ANR-443), 401 M Street, S.W., Washington, D.C. 20460. Copies of the reports shall also be sent to U.S. EPA, Region V.

RESOURCE CONSERVATION AND RECOVERY ACT

A. Within thirty (30) days of the effective date of this Compliance Agreement, U.S. DOE shall achieve compliance with interim status regulations at all areas subject to control under RCRA. For purposes of this Agreement, the "mixed wastes" located at FMPC are subject to RCRA regulation. For purposes of this Agreement, at FMPC, the term "mixed wastes" shall apply to hazardous waste that is mixed with source, special nuclear and byproduct material. Pursuant to the RCRA interim status regulations, U.S. DOE shall:

1. Conduct a hazardous waste determination on all

waste streams generated at the facility that were previously untested, pursuant to 40 CFR 262.11.

2. Commence a hazardous waste analysis program to determine the physical and chemical characteristics of the materials in the landfill and going to the incinerator at the FMPC in accordance with the RCRA regulations, 40 CFR 265.13. The radiological characteristics of the materials shall also be determined and results submitted to U.S. EPA.

3. Update the operating records to include: the description and quantity of waste stored onsite, a map showing the location and quantity of waste disposed of onsite, the EPA Hazardous Waste Code and physical state of all waste treated, stored or disposed of, and a description of the method(s) used to treat, store, or dispose of any hazardous waste pursuant to 40 CFR 265.73 and 265.309.

4. Include the printed full name and signature of the person receiving hazardous waste and the date it is received on the manifests pursuant to 40 CFR 265.71.

5. Update the facility closure plan to reflect the year the facility expects to begin closure pursuant to 40 CFR 265.112.

6. Collect run-off from the active portions of the landfill as required by 40 CFR 265.302(b);

7. Prepare and maintain onsite a written outline for a groundwater quality assessment program pursuant to 40 CFR 265.93(a).

B. Within ninety (90) days of the effective date of this Compliance Agreement, U.S. DOE shall submit to U.S. EPA for approval a detailed groundwater monitoring plan for the landfill (waste pit #4) pursuant to 40 CFR 265.90 and 265.91. This plan may be combined with the CERCLA groundwater monitoring plan described in the Remedial Investigation Study (CERCLA, Section 2). In addition to the requirements of CERCLA, Section 2., the RCRA groundwater monitoring plan should provide the following information:

1. A determination of groundwater flow at the RCRA regulated units, that specifies both horizontal and vertical components. A potentiometric map should display groundwater flow in this area.

2. A detailed map providing the location of all RCRA monitoring wells. This map should also designate the location of cross sections constructed from well information.

3. The specifications for the design and construction of all RCRA wells to be included in the monitoring system. This description should include well depth, screen length, casing materials, etc.

4. A list of the parameters to be monitored. If the waste inventory of all the pits and impoundments is not completed,

all Appendix VIII constituents should be monitored. U.S. DOE may petition U.S. EPA to delete a constituent if documentation can be provided to U.S. EPA indicating that a specific waste was not handled in the past. This list of parameters should include radionuclides.

5. A sampling and analysis plan that meets the requirements of 40 CFR § 265.92.

C. Within sixty (60) days of completion of the Waste Characterization Study at the waste pit area, DOE shall:

1. Develop a closure plan for the landfill pursuant to 40 CFR 265.112.

2. Develop a post-closure plan for the landfill pursuant to 40 CFR 265.118.

<u>RADIATION DISCHARGE INFORMATION</u>

A. Within thirty (30) days of the effective date of this Agreement, U.S. DOE shall provide U.S. EPA with its existing comprehensive offsite environmental monitoring program and an associated quality assurance plan for FMPC, and any revisions to the plan, for review and comment. At a minimum, the environmental monitoring program shall include the maintaining of liquid discharge monitors and administrative controls to ensure (1) their proper operation and (2) correct collection and analytical methodology. The following work shall be continued:

1. Maintain continuous liquid discharge sample collectors

at all discharge points, monitor and report results quarterly to U.S. EPA, Ohio EPA, and Ohio Department of Public Health.

2. Maintain administrative controls for liquid discharges sufficient to identify and deal with any unplanned release within 24 hours.

3. Maintain sample collection analysis procedures along with a quality assurance plan for liquid samples.

B. For the purposes of this Compliance Agreement, data reported to the U.S. EPA shall be radionuclide specific except for uranium which may be reported as total uranium.

FUNDING

U.S. DOE's performance of the commitments under this Agreement are subject to the availability of appropriated funds for such purposes. If appropriated funds are not available to fulfill requirements of the Agreement U.S. EPA reserves the right to initiate such action as it deems appropriate to the extent permitted by law.

REPORTING REQUIREMENTS

A. Unless otherwise specified, U.S. DOE shall submit required documents, notices and reports to the following address:

Chief, Environmental Review Branch
U.S. Environmental Protection Agency
John C. Kluczynski Federal Building, 5ME-16
230 South Dearborn Street
Chicago, Illinois 60604

B. Monthly progress reports identifying steps taken toward achieving compliance with the requirements contained herein shall be submitted to U.S. EPA. Monthly reports shall be submitted by the twentieth (20) day following the end of each month.

C. U.S. EPA may need varying amounts of time to comment on the various documents required to be submitted by U.S. DOE to U.S. EPA for review and comment or approval. U.S. EPA will respond within thirty (30) days of receipt of submittals unless more time is required.

DISPUTE RESOLUTION

Failure to comply with the terms of this Compliance Agreement shall be considered a violation and shall result in the initiation of the conflict resolution procedures of Section 1-602 of Executive Order No. 12088. Unless U.S. DOE demonstrates that such failure to comply was justified and a new schedule is agreed upon, the Regional Administrator will refer the matter to the U.S. EPA, Office of External Affairs (OEA) for resolution of the dispute with U.S. DOE's Headquarter Office. In the event that a resolution is not reached between OEA and the parent Agency of the non-complying facility, the Administrator of U.S. EPA will request the Director of the Office of Management and Budget to resolve the conflict pursuant to Section 1-602 of Executive Order 12088." As provided in Section 1-604 of Executive Order No. 12088, such conflict resolution procedures are in addition to, not in lieu of, other procedures, including sanctions, for the enforcement of applicable pollution control standards.

OTHER APPLICABLE LAWS AND REGULATIONS

All actions required to be taken by U.S. DOE pursuant to this Agreement shall be undertaken in accordance with the requirements of all other applicable local, state, and Federal laws and regulations unless an exception from such requirement is specifically provided in this Agreement.

RESERVATION OF RIGHTS

U.S. DOE neither admits nor denies any findings of fact or conclusions of law contained in this Compliance Agreement. Nothing herein is intended to affect the rights or liabilities of nonparties to this Agreement.

EFFECTIVE DATE AND SUBSEQUENT MODIFICATIONS

1. The effective date of this Agreement shall be the date on which it is signed by U.S. EPA.

2. Modifications to this Agreement may be requested by U.S. EPA or U.S. DOE. All such modifications shall be by mutual agreement of U.S. EPA and U.S. DOE. Such amendments shall be in writing and shall have as the effective date, that date on which such amendments are signed by U.S. EPA, and shall become an integral part of this Compliance Agreement.

3. Any reports, plans, specifications, schedules, and attachments required by this Agreement are, upon approval by U.S. EPA, incorporated into this Agreement.

4. No informal advice, guidance, suggestions, or comments by U.S. EPA regarding reports, plans, specifications, schedules, and any other writing submitted by the U.S. DOE will be construed as relieving U.S. DOE of its obligation to obtain such formal approval as may be required by this Agreement.

5. Upon demonstration of compliance by U.S. DOE with this Agreement, there will be a continuing obligation to comply with applicable permit and other requirements under the relevant statutes.

IT IS SO AGREED:

By: [signature]
U.S. Department of Energy

July 18th, 1986
DATE:

By: Valdas V. Adamkus
U.S. Environmental Protection Agency

July 18th, 1986
DATE:

ATTACHMENT I

SCOPE OF WORK FOR A REMEDIAL INVESTIGATION 6/30/86

AT FEED MATERIALS PRODUCTION CENTER

PURPOSE

The purpose of this Remedial Investigation is to determine the nature and extent of any release, or threat thereof, of hazardous or radioactive substances, pollutants, or contaminants at or from the Feed Materials Production Center, and to gather all necessary data to support the Feasibility Study. The Contractor will furnish all personnel, materials, and services necessary for, or incidental to, performing the Remedial Investigation at Feed Materials Production Center.

DEFINITIONS

a. Facility - refers to the Feed Materials Production Center (FMPC).

b. Site - refers to FMPC and all areas where hazardous or radioactive substances, pollutants, or contaminants have been deposited, stored, disposed of, or placed or otherwise come to be located.

c. Waste Management Area - refers to any continguous land structures, other appurtenances and improvement on the land used for storage, treatment, disposal, collection, radioactive source separation, transfer, processing, resource recovery, incineration, or conservation of any chemical or radioactive material. It includes any unit at the FMPC facility from which contaminants might migrate, irrespective of whether the units were intended for the management of radioactive and/or hazardous waste.

d. Production Area - refers to any device that yields a radioactive or hazardous substance.

SCOPE

The Remedial Investigation shall consist of eight tasks:

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

TASK 1 - DESCRIPTION OF CURRENT SITUATION

The Contractor will outline the purpose for the Remedial Investigation and describe the background information pertinent to the Facility and its problems.

The data gathered during any previous investigations or inspections and other relevant data should be used.

a. Site Background

The Contractor will prepare a summary of the regional location, pertinent area boundary features, general site physiography, hydrogeology, and historical use of the Facility for the treatment, storage and disposal of both hazardous and radioactive materials.

This summary shall at a minimum include:

1. Maps depicting the following:

   A. The general geographic location;

   B. All existing and former Waste Management and Production Areas.

   C. Feed Materials Production Center property lines and any adjacent property lines with the owners of all adjacent property clearly indicated; and

   D. All known past and present product and waste underground tanks or lines.

2. Details on past product and waste spills including date, volume, nature, location, and cleanup activities.

3. A description of current operations at each Waste Management and Production Area including a history of the unit's function and all of the wastes processed or disposed at the unit. Include the waste constituents processed or disposed, the time frames of operation, and quantities handled during those time frames.

4. A description of each Waste Management and Production Unit including engineering drawings, foundation materials of construction, dimensions, capacity and ancillary systems: include location, design, construction, and descriptions of all groundwater monitoring systems. If the Waste Management or Production Area is not in use, describe the methods utilized to close the facility and all construction related to closure.

b. Nature and Extent of Problem.

Prepare a summary of the actual and potential off-facility and on-facility health and environmental effects. This summary shall include: the types, physical states, and amounts of hazardous wastes/hazardous substances and radioactive materials; the existance and condition of drums, tanks, landfills, surface ponding, and other containers; affected media and pathways of exposure; and contaminated releases such as air releases, leachate, and runoff. Include discussion of the population in the area potentially affected by release of contaminants from the Facility.

Describe any reports of human or animal illness that may be related to the Facility. Emphasis should be placed upon describing the threat or potential threat to public health and the environment.

c. History of Response Actions.

Prepare a summary of any previous response actions conducted by either local, State, Federal, or private parties, including inspections and other technical reports, and their results. A list of reference documents and their location should be included. The scope of the remedial investigation should be developed to address the problems and questions that have resulted from previous work at the site.

d. Site Visit.

Conduct an initial site visit to become familiar with site topography, access routes, and proximity of receptors to possible contamination and collect data for preparation of the site safety plan. The visit should be used to verify the site information developed in this Task.

e. Define Boundary Conditions.

Establish site boundary conditions to delineate the area of remedial investigation. The boundary conditions shall be set so that subsequent investigations will cover the contaminated media in sufficient detail to support the following activities, e.g. feasibility study. Boundary conditions will also be used to identify boundaries for site access control and site security. Site boundaries shall encompass all areas of contamination (i.e. groundwater, soil), both on and off FMPC.

TASK 2 - WORK PLAN REQUIREMENTS

The consultant shall conduct preliminary work necessary to scope and conduct the site remedial investigation and feasibility study. This shall include the development and submittal of a detailed work plan to U.S. EPA for review and approval outlining data needs for characterizing the site and for support of the feasibility study. The work plan shall include an outline of proposed investigation activities, a time schedule for accomplishing the tasks identified in the SOW, and personnel and equipment requirements. The work plan shall also include a sampling plan indicating rationales for sampling activities, location, quantity, and frequency of sampling, sampling and analysis methods, constituents for analysis, and quality assurance procedures. In addition to these general sampling plan elements, other requirements will be identified in the following subtasks as they apply:

a. Sampling Plans.

The Contractor will prepare detailed Sampling Plans to address each of the Site Investigation activities.

1. The objective of the Sampling Plan is to:

A. Provide specific guidance for all field work;

B. Provide a mechanism for planning and approving site activities;

C. Provide a basis for estimating costs of field efforts;

D. Ensure that sampling activities are limited to those that are necessary and sufficient; and

E. Provide a common point of reference for all parties to ensure comparability and compatibility between all activities performed at the site.

2. A Sampling Plan should discuss the following items:

A. Investigation objectives;

B. Parameters of interest;

C. Number of each sample type for each matrix;

D. Locations of samples;

E. Justification for sample type and location;

F. Collection methods;

G. Sample number and frequency;

H. Analytical procedures (refer to Quality Assurance Project Plan);

I. Operational plan and schedule;

J. Differentiation between samples that will be analyzed in the field (on-site) and those that will be sent to a laboratory;

K. Sampling Logistics Plan including:

(1) Identification of team members;

(2) Documentation procedures;

(3) Field equipment listing;

(4) Sampling order; and

(5) Decontamination procedures.

L. Monitor well and piezometer construction materials and techniques; and

M. Quality control to assure samples are not contaminated as specified in Subpart d below.

b. <u>Health and Safety Plan</u>.

The Contractor will prepare a site Health and Safety Plan.

1. Major elements of the Health and Safety Plan will include:

   A. Site description including availability of resources such as roads, water supply, electricity and telephone service;

   B. Hazard evaluation;

   C. Monitoring requirements;

   D. Levels of protection;

   E. Work limitations;

   F. Authorized personnel;

   G. Decontamination; and

   H. Emergency information.

2. The Site Health and Safety Plan must be consistent with:

   A. Interim Standard Operating Safety Procedures;

   B. Section III(C)(6) of CERCLA;

   C. EPA Order 1440.1 - Respiratory Protection;

   D. EPA Order 1440.3 - Health and Safety Requirements for Employees engaged in Field Activities;

   E. EPA Occupational Health and Safety Manual;

   F. EPA Interim Standard Operating Safety Guide (September, 1982);

   G. OSHA regulations in 29 CFR 1910 - 1926;

   H. Other EPA guidance as provided; and

   I. Site conditions.

c. <u>Chain of Custody</u>. Any field sampling collection and analyses conducted shall be documented in accordance with chain-of-custody procedures as provided by U.S. EPA. The Contractor shall prepare and submit as part of the work plan a description of the chain-of-custody procedures to be used.

d. Quality Assurance Project Plan. The Contractor will prepare a Quality Assurance Project Plan (QAPP). The QAPP will be prepared in accordance with "Interim Guidelines and Specifications for Preparing Quality Assurance Project Plans" (QAMS-005/80, U.S. EPA, December, 1980), and the requirements of U.S. EPA's Contract Laboratory Program. The QAPP should be prepared as soon as possible to allow adequate time for possible review and revision.

1. The goals of the QAPP are:

   A. To ensure that the procedures used will not detract from the quality of results; and

   B. To ensure that all activities, findings and results follow an approved plan and are documented.

2. Specifically, the QAPP must address the following items and issues:

   A. Title page with provision for approval signatures;

   B. Table of contents;

   C. Project description;

   D. Project organization and responsibility;

   E. QA objectives for measurement data in terms of precision, accuracy, completeness, representativeness, detection limits, and comparability;

   F. Sampling procedures;

   G. Sample custody;

   H. Calibration procedures and frequency;

   I. Analytical procedures;

   J. Data reduction, validation and reporting;

   K. Internal quality control checks and frequency;

   L. Performance and systems audits and frequency;

   M. Preventative maintenance procedures and schedules;

   N. Specific routine procedures to be used to assess data precision;

   O. Remedial action;

   P. Quality assurance reports; and

   Q. Turnaround time.

d. Permitting Requirements Plan.

The Contractor will prepare a plan addressing the procedures to be employed if tasks required in the RI will require permitting action by any governmental authority.

e. Pre-Investigation Evaluation.

Prior to starting any remedial investigations, the Contractor shall assess the site conditions to identify potential remedial technologies applicable to the site and associated data needed to evaluate alternatives based on these technologies for feasibility studies. A report shall be prepared for U.S. EPA review identifying broad categories of remedial technologies that may be applicable to the site and data needs.

TASK 3 - SITE INVESTIGATION

The Contractor will conduct those investigations necessary to characterize the site and its actual or potential hazard to human health and environment. The investigations should result in data of adequate technical content to support the development and evaluation of remedial alternatives during the Feasibility Study. Investigation activities will focus on problem definition and data to support the screening of remedial technologies, alternative development and screening, and detailed evaluation of alternatives.

The site investigation activities will follow the plans set forth in Task 2. All sample analyses will be conducted at laboratories following EPA protocols or their equivalents. Strict chain-of-custody procedures will be followed and all samples will be located on a site map.

a. Hazardous Analyses Program

A sampling and analysis program to characterize the radiological, physical, and chemical characteristics of all materials of interest at the Facility will be completed. The materials of interest will at a minimum include:

1. Materials (waste and product) stored above or below ground in tanks, containers, lagoons, piles or other structures;

2. Materials generated at the Facility and disposed of off-site;

3. Materials treated or disposed of on the facility; and

4. All materials emitted, discharged, released or potentially released into the environment.

b. Hydrogeologic Investigation

The Contractor shall conduct a program to evaluate hydrogeologic conditions at the site. This program shall provide the following information:

1. A description of the regional geologic and hydrogeologic characteristics in the vicinity, including:

   A. regional stratigraphy: description of strata including strike and dip, identification of stratigraphic contacts, petrographic analysis;

   B. structural geology: description of local and regional structural features (e.g., folding, faulting, tilting, jointing, etc.);

   C. depositional history;

   D. regional groundwater flow patterns; and

   E. identification and characterization of areas of recharge and discharge.

2. An analysis of any topographic features that might influence the groundwater flow system (Note that stereoscopic analysis of aerial photographs should aid in this analysis).

3. A classification and description of the hydrogeologic properties of all the hydrogeologic units found at the site based on continuous bore hole samples (i.e., the aquifers and any intervening saturated and unsaturated units), including:

   A. hydraulic conductivity and effective porosity based upon laboratory and field data;

   B. lithology, grain size, sorting, degree of cementation;

   C. an interpretation of hydraulic interconnections between saturated zones; and

   D. the soil's attenuation capacity and mechanisms.

4. Using a topographic map or aerial photograph as a base, submit maps of structural geology and at least four hydrogeologic cross sections showing the extent (depth, thickness, lateral extent) of all hydrogeologic units within the scope of the RI, identifying:

   A. sand and gravel deposits in unconsolidated deposits;

   B. zones of fracturing or channeling in consolidated or unconsolidated deposits;

   C. zones of higher permeability or lower permeability that might direct or restrict the flow of contaminants;

   D. perched aquifers;

E. the uppermost aquifer (includes all water-bearing zones above the first confining layer that may serve as a pathway for contaminant migration including perched zones of saturation); and

F. zones of contaminated leaching, accumulation, and unaffected horizons for those contaminants whose movement is controlled by mechanisms of adsorption and/or mechanical filtering. These profiles should be based on continuous bore hole sampling and representative analysis.

5. A description of water level or fluid pressure monitoring including:

A. water-level contour and/or potentiometric maps;

B. hydrologic cross sections showing vertical gradients;

C. an interpretation of the flow system, including the vertical and horizontal components of flow; and

D. an interpretation of any change in hydraulic gradients due, for instance, to tidal or seasonal influences.

6. An interpretation of man-made influences that may affect the hydrogeology of the site, identifying:

A. local water-supply and production wells with an approximate schedule of pumping; and

B. man-made hydraulic structures (pipelines, french drains, ditches).

7. Preparation of chemical and radiological concentration isopleth maps which extend off the FMPC as necessary to identify areas of contaminant transport. The map should reflect discrete depth intervals.

c. Groundwater Quality Investigation

The Contractor shall conduct a Groundwater Quality Investigation to characterize any plumes of contamination at the site utilizing monitor wells constructed of teflon or stainless steel 316. This investigation shall at a minimum provide the following information:

1. A description of the horizontal and vertical extent of any immiscible or dissolved plume(s) originating from the facility;

2. The horizontal and vertical direction of contamination movement;

3. The current speed of contaminant movement;

4. The maximum concentration of Contract Laboratory Program List (CLP) constituents and radiological contaminants in the plume(s);

5. An evaluation of factors influencing the plume movement;

6. An extrapolation of future contaminant movement; and

7. Identification of the source(s) of groundwater contamination.

d. Soils and Sediments Investigation

The Contractor shall conduct a program to determine the location and extent of contamination of surface and subsurface soils. This process may overlap with certain aspects of the hydrogeologic study (e.g., characteristics of soil strata are relevant to both the transport of contaminants by groundwater and to the location of contaminants in the soil; cores from groundwater monitoring wells may serve as soil samples). A survey of existing data on soils and sediments may be useful. The horizontal and vertical extent of contaminated soils and sediments should be determined. Information on local background levels, degree of hazard, location of samples, techniques utilized, and methods of analysis should be included. The investigation should identify the locations and probable quantities of subsurface wastes, such as buried drums, old spill areas, inactive surface impoundments or landfills. Geophysical methods may be used to supplement sampling results. This investigation should include a study of soil contamination off the FMPC from both airborne and surface water releases.

e. Surface Water Investigation

Conduct a program to determine the extent of contamination of surface water. This process may overlap with the soils and sediments investigation; data from river sediments sampled may be relevant to surface water quality. A survey of existing data on surface water flow quantity and quality may be a useful first step, particularly information on local background levels, location and frequency of samples, sampling techniques, and method of analysis. This program shall also evaluate the impacts of the contaminants on the floral and faunal communities in the surface water, sediments, and any adjacent wetlands. This investigation should include:

1. Retrospectively computing doses to the population along the Great Miami River and Paddy's Run Creek from discharges to surface water for each each year of plant operation. Report for each year, doses to maximally exposed individuals and, for the Great Miami River, to the nearest population center downstream, New Baltimore. Report the integral population dose from the Great Miami River discharge point to the nearest population center downstream for each year; and

2. Performance of radiological analyses on the sediments in the Great Miami River from each discharge point downstream 2 kilometers. Radiological analyses on soils from the banks shall be made. Radionuclides shall be identified isotropically and compared to measured background concentrations.

f. Air Investigation

Conduct a program to determine the extent of atmospheric contamination. The program should address the tendency of substances (identified through the Hazardous Analyses Program, Task 3.a) to enter the atmosphere, local wind patterns, and the degree of hazard. This investigation should include a detailed and comprehensive study of radiological impacts associated with past operations and should include:

1. Retropectively computing inhalation doses to the offsite population within 2, 5, 10, and 50 mile radii of the FMPC due to airborne releases for each year of plant operation. Report doses to the population in each ring and doses to maximally exposed individuals for each year.

2. Retrospectively computing the deposition of radioactive materials in areas within 2 and 5 mile radii of the FMPC due to airborne releases for each year of plant operation and give the integral deposition for each year. Report deposition and compute resulting whole body and organ doses. Verify the computations through direct measurement of soils and sediments performed in Subpart e.

g. Off-Facility Water Supply Investigation

Conduct a program consisting of regular sampling and analysis of off-facility downgradient private water supply wells and downwind cistern supplies for any contaminants having the potential for movement off of the FMPC. The program should identify the contaminants of concern and include proposed criteria for comparison of results.

TASK 4 - SITE INVESTIGATION ANALYSIS

The Contractor will prepare a thorough analysis and summary of all site investigations and their results. The objective of this task will be to ensure that the investigation data are sufficient in quality (e.g., QA/QC procedures have been followed) and quantity to support the Feasibility Study.

a. Data Analysis

The Contractor will analyze all site investigation data and develop a summary of the type and extent of contamination at the site. The summary will describe the extent of contamination (qualitative/quantitative) in relation to background levels indicative for the area.

b. Exposure (Risk) Assessment

For the detailed listing of radionuclides, and inorganic and organic constituents determined to be present during the Site Investigation (Task 3), the Contractor shall evaluate the risk to life forms encountering these contaminants. The following items will be discussed for each contaminant:

1. Environmental Fate and Transport:

   A. physical, chemical, and radiological properties;

   B. chemical transformations; and

   C. fate and transport.

2. Toxicological Properties:

   A. metabolism;

   B. acute toxicity;

   C. subacute and chronic toxicity;

   D. carcinogenicity;

   E. mutagenicity;

   F. teratogenicity/reproductive effects;

   G. other health effects;

   H. epidemiological evidence; and

   I. aquatic species toxicity, environmental improvement.

3. Risk Assessment and Impact Evaluation:

   A. carcinogenic risk;

   B. probability of noncarcinogenic human health effects;

   C. nonhuman species risk assessment; and

   D. conclusions.

4. Demographic Profile of Population at Risk:

   The analysis should discuss the degree to which either on-facility control or off-facility measures are required to significantly mitigate the threat to public health, welfare or the environment. If the results of the investigation indicate that no threat or potential threat exists, a recommendation to stop the remedial response should be made.

C. Application to Preliminary Technologies

The Contractor will analyze the results of the site investigations in relation to the potential remedial technologies applicable to the site. Data supporting or rejecting types of corrective action technologies, compatibility of wastes and construction materials, and other conclusions should be presented.

d. Groundwater Protection Standards

The Contractor shall develop Groundwater Protection Standards for all of the CLP constituents found in the groundwater during the Site Investigation (Task 3).

1. The Groundwater Protection Standards shall consist of:

   A. for any constituents listed in Table 1 of 40 CFR 264.94, the respective value given in that table if the background level of that constituent is below the value given in Table 1; or

   B. the background level of that constituent in the groundwater; or

   C. a U.S. EPA aproved Alternate Concentration Limit.

2. Alternate Concentration Limits (ACL's) may be developed by the Contractor and submitted to the U.S. EPA for approval. For any proposed ACL's the Contractor shall include a justification based upon the criteria set forth in 40 CFR 264.94(b).

3. Within forty-five (45) days of receipt of any proposed ACL's, the U.S. EPA shall notify the United States Department of Energy (U.S. DOE) in writing of approval, disapproval or modifications. The U.S. EPA shall specify in writing the reason(s) for any disapproval or modification.

4. Within twenty (20) days of receipt of the U.S. EPA's notification of disapproval of any proposed ACL, the U.S. DOE shall amend and submit to the U.S. EPA revised ACL's.

TASK 5 - LABORATORY AND BENCH-SCALE STUDIES

The Contractor shall conduct laboratory and/or bench scale studies to determine the applicability of remedial technologies to site conditions and problems. Analyze the technologies, based on literature review, vendor contracts, and past experience to determine the testing requirements.

A testing plan identifying the type(s) and goal(s) of the study(ies), the level of effort needed, and data management and interpretation guidelines shall be developed and submitted to U.S. EPA for review and approval.

Upon completion of the testing, evaluate the testing results to assess the technologies with respect to the site-specific questions identified in the test plan. Scale up those technologies selected based on testing results.

Prepare a report summarizing the testing program and its results, both positive and negative.

TASK 6 - REPORTS

The Contractor shall prepare a Remedial Investigation Report to present Tasks 1-7. The Remedial Investigation Report will be developed in draft form for U.S. EPA review and approval. A public meeting may be held to discuss the Draft. The Remedial Investigation will be developed in final format incorporating all comments received on the Draft Remedial Investigation Report.

Five (5) copies of both the Draft and Final Remedial Investigation Reports will be provided by the Contractor to U.S EPA.

TASK 7 - ADDITIONAL REQUIREMENTS

a. Reporting Requirements.

Monthly Technical Progress Reports developed by the Contractor should be submitted to U.S. EPA. For each on-going work assignment, the Contractor shall submit progress reports with the following elements:

1. Identification of site and activity.
2. Status of work at the site and progress toward achieving compliance with the Agreement.
3. Percentage of completion.
4. Difficulties encountered during the reporting period.
5. Actions being taken to rectify problems.
6. Changes in personnel.
7. All results of sampling tests and all other data received by U.S. DOE.
8. A summary of all plans and procedures completed during the past month as well as any activities scheduled for the next month.

The monthly progress report will list target and actual completion dates for each activity including project completion and provide an explanation of any deviation from the milestones in the work plan schedule.

b. Laboratory Certification

In addition to QAPP development, the Contractor will be required to pass a laboratory performance audit prior to performing any task after Task 1 if a certified CLP laboratory is not used. The audit will include analysis of the following performance evaluation samples.

Sample Type	Performance Evaluation Sample	# of Samples	U.S. EPA Analysis Procedure
Organic	Base/Neutrals	2	625
Organic	Acids	1	625
Organic	PCB's	2	608 or 625
Organic	Aromatic Purgeables*	1	602
Organic	Halogenated Purgeables*	1	601
Organic	GC/MS Purgeables	1	624

*Methods 601 and 602 are not essential if Contractor proposed analyzing all purgeables by GC/MS (method 624).

Sample Type	Performance Evaluation Sample	# of Samples	U.S. EPA Analysis Procedure
Inorganic	Metals	1	
Inorganic	Minerals	1	
Inorganic	Nutrients	2	
Inorganic	CN	1	
Inorganic	COD/BOD	1	

The Contractor is expected to qualify as well as quantify the parameters of interest. The results shall include all supporting data as required for a QAPP as specified by U.S. EPA and described when samples are forwarded to the laboratory.

An on-site laboratory visit will be performed by an U.S. EPA Quality Assurance Officer to verify compliance with required analysis procedures.

TASK 8 - COMMUNITY RELATIONS SUPPORT

The U.S. DOE will act as lead agent for the implementation of community relations activities. The Contractor will provide support to U.S. DOE staff as required for community relations activities. Community relations activities performed by the U.S. DOE will be consistent with:

a. Superfund community relations policy, as stated in "Guidance for Implementing the Superfund Program", and

b. "Community Relations in Superfund-a-Handbook".

SCOPE OF WORK FOR A FEASIBILITY STUDY

FEED MATERIALS PRODUCTION CENTER

PURPOSE

The purpose of this Feasibility Study is to develop and evaluate remedial action alternatives and to recommend the remedial action(s) to be taken to protect the public health, or welfare, or the environment from releases, or threatened releases of hazardous or radioactive substances, pollutants or contaminants at or from the Feed Materials Production Center. The Contractor will furnish the necessary personnel, materials, and services necessary to prepare the remedial action feasibility study, except as otherwise specified.

DEFINITIONS

a. Facility - refers to the Feed Materials Production Center (FMPC).

b. Site - refers to FMPC and all areas where hazardous or radioactive substances, pollutants, or contaminants have been deposited, stored, disposed of, or placed or otherwise come to be located.

SCOPE

The Feasibility Study consists of nine tasks:

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

TASK 9 - DESCRIPTION OF CURRENT SITUATION

Information on the site's background, the nature and extent of the problem, and the previous response activities presented in Task 1 of the Remedial Investigation may be incorporated by reference. Any changes to the original project scope described in the Task 1 description should be discussed and justified based on the results of the remedial investigation.

Following the summary of the current situation, a site-specific statement of the purpose for the response, based on the results of the Remedial Investigation, should be presented. The statement of purpose should identify the actual or potential exposure pathways that should be addressed by remedial alternatives.

TASK 10 - WORK PLAN

A work plan that includes a technical approach, personnel requirements, and schedules shall be submitted to the U.S. EPA for review and approval for the proposed feasibility study.

TASK 11 - DEVELOPMENT OF ALTERNATIVES

Based on the results of the Remedial Investigation, the Contractor will develop a limited number of alternatives for source control, off-facility remedial action or on-facility remedial action, based on the objectives established for the remedial action and the scoping decision.

a. Establishment of Remedial Response Objectives.

The Contractor in conjunction with the U.S. EPA will establish site-specific objectives for the remedial action. These objectives shall be based on public health and environmental concerns, scoping decisions, information gathered during the Remedial Investigation, EPA interim guidance, and the requirements of any other applicable Federal statutes including 40 CFR 300.68. At a minimum, all remedial actions concerning groundwater must be consistent with, and as stringent as, those required under 40 CFR 264.100.

b. Identification of Remedial Technologies.

Based on the remedial response objectives established above and the statement of purpose identified in Task 9 identify appropriate remedial technologies as a basis for the development of remedial alternatives. These technologies shall be identified on a media-specific basis, although consideration should be given to the interrelationship of the media. The technologies should be able to meet the response objectives. The list of potential remedial technologies developed in Tasks 2e and Task 4c shall be considered a master list of applicable technologies and shall be screened based on site conditions, waste characteristics, and technical requirements, to eliminate or modify those technologies that may prove extremely difficult to implement, will require unreasonable time periods to implement, or will rely on insufficiently developed technology.

c. Identification of Remedial Alternatives.

The Contractor will develop appropriate remedial technologies, response objectives, and other appropriate considerations into a comprehensive, site-specific approach. Alternatives developed should include the following (as appropriate):

- Alternatives for treatment or disposal off the FMPC as appropriate

- Alternatives which attain applicable and/or relevant Federal public health or environmental standards

- Alternatives which exceed applicable and/or relevant public health or environmental standards.

- No action

There may be overlap among the alternatives developed. Further, alternatives outside of these categories may also be developed. The alternatives shall be developed in close consultation with the U.S. EPA. Document the rationale for excluding any technologies in Task 2e in the development of alternatives.

TASK 12: INITIAL SCREENING OF ALTERNATIVES

The alternatives developed in Task 11 will be screened by the Contractor and U.S. EPA to eliminate alternatives that are clearly not feasible or appropriate prior to undertaking detailed evaluations of the remaining alternatives.

a. Considerations to be Used in Initial Screening.

Three broad considerations must be used as a basis for the initial screening: cost, effects of the alternative, and acceptable engineering practices. More specifically, the following factors must be considered:

1. Cost. An alternative whose cost far exceeds that of other alternatives may be eliminated from recommendation. Total cost will include the cost of implementing the alternative and the cost of operation and maintenance.

   The cost screening will be conducted only after the environmental and public health screenings have been performed.

2. Environmental effects. Alternatives posing significant adverse environmental effects will be eliminated. Significant adverse environmental effects shall include but not limited to failure to meet the Groundwater Protection Standards both on and off the BMPC.

3. Environmental protection. Only those alternatives that satisfy the remedial action objectives and contribute substantially to the protection of public health, welfare, or the environment shall be considered further. Source control alternatives shall achieve adequate control of source materials. On and off-facility alternatives shall minimize or mitigate the threat of harm to public health, welfare, or the environment.

4. Implementability and reliability. Alternatives that may prove extremely difficult to implement, will not achieve the remedial action objectives in a reasonable time period, or rely on unproven technology, will be eliminated.

TASK 13 - DETAILED ANALYSIS OF ALTERNATIVES

The Contractor will evaluate the alternatives that pass through the Initial Screening in Task 12. Alternative evaluation will be preceded by detailed development of the remaining alternatives.

a. Technical Analysis

The Technical Analysis will at a minimum:

1. Describe appropriate treatment, storage, and disposal technologies;

2. Discuss how the alternative does (or does not) comply with specific requirements of other environmental programs. When an alternative does not comply, discuss how the alternative prevents or minimizes the migration of wastes and public health or environmental impacts and describe special design needs that could be implemented to achieve compliance;

3. Outline operation, maintenance, and monitoring requirements of the remedy;

4. Identify and review potential off the FMPC facilities to ensure compliance with applicable RCRA and other EPA environmental program requirements, both current and proposed. Potential disposal facilities should be evaluated to determine whether off the FMPC management-of-site-wastes-could-result-in-a-potential for a future release from the disposal facility;

5. Identify temporary storage requirements, off the FMPC disposal needs, and transportation plans;

6. Describe whether the alternative results in permanent treatment or destruction of the wastes, and, if not, the potential for future release to the environment;

7. Outline safety requirements for remedial implementation (including both on-facility and off-facility health and safety considerations);

8. Describe how the alternative could be phased into individual operable units. The description should include a discussion of how various operable units of the total remedy could be implemented individually or in groups, resulting in significant improvement to the environment or savings in cost;

9. Describe how the alternative could be segmented into areas to allow implementation in differing phases; and

10. Describe the special engineering requirements of the remedy or site preparation considerations.

b. Environmental Assessment

The Contractor will perform an Environmental Assessment (EA) for each alternative. The EA should focus on the site problems and pathways of contamination actually addressed by each alternative. The EA for each alternative will include, at a minimum, an evaluation of beneficial effects of the response, adverse effects of the response, and an analysis of measures to mitigate adverse effects. The no-action alternative will be fully evaluated to describe the current site situation and anticipated environmental conditions if no actions are taken. The no-action alternative will serve as the baseline for the analysis.

c. Public Health Analysis

Each alternative will be assessed in terms of the extent to which it mitigates long-term exposure to any residual contamination and protects public health both during and after completion of the remedial action. The assessment will describe the levels and characterizations of contaminants on-site, potential exposure routes, and potentially affected population. The effect of "no-action" should be described in terms of short-term effects (e.g., lagoon failure), long-term exposure to hazardous substances, and resulting public health impacts. Each remedial alternative will be evaluated to determine the level of exposure to contaminants and the reduction over time. The relative reduction in public health impacts for each alternative will be compared to the no-action level. For management of migration measures, the relative reduction of impact will be determined by comparing residual levels of each alternative with existing criteria, standards, or guidelines acceptable to EPA. For source control measures or when the criteria, standards, or guidelines are not available, the comparison should be based on the relative effectiveness of technologies. The no-action alternative will serve as the baseline for the analysis.

d. Institutional Analysis

Each alternative will be evaluated based on relevant institutional needs. Specifically, regulatory requirements, permits, community relations, and participatory agency coordination will be assessed.

e. Cost Analysis

Evaluate the cost of each remedial action alternative (and for each phase or segment of the alternative). The cost will be presented as a present worth cost and will include the total cost of implementing the alternative and the annual operating and maintenance costs. Both monetary costs and associated non-monetary costs will be included. A distribution of costs over time will be provided.

TASK 14 - EVALUATION AND SELECTION OF PREFERRED ALTERNATIVE

The U.S. EPA shall review the results of the detailed analysis of alternatives prepared under Task 13 and select the preferred alternative. The lowest cost alternative that is technologically feasible and reliable and which effectively mitigates and minimizes damage to and provides adequate protection of public health, welfare, or the environment will be considered the preferred alternative.

The following considerations shall be used as the basis for selecting the cost-effective alternative:

a. Reliability. Alternatives that minimize or eliminate the potential for release of hazardous substances into the environment will be considered more reliable than other alternatives. For example, recycling of wastes and off-site incineration would be considered more reliable than land disposal. Institutional concerns such as management requirements can also be considered as reliability factors.

b. Implementability. The requirements for implementing the alternatives will be considered, including phasing alternatives into operable units and segmenting alternatives into project areas on the site. The requirements for permits, zoning restrictions, rights of way and public acceptance are also examples of factors to be considered.

c. Effects of the Alternative. The alternative posing the greatest improvement to (and least negative impact on) public health, welfare, and environment will be favored.

d. Safety Requirements. The alternatives with the lowest adverse safety impacts and associated costs will be favored.

e. Present Worth of Total Cost. The net present value of capital and operation and maintenance cost of the proposed alternative must be presented.

TASK 15 - DRAFT FEASIBILITY STUDY REPORT

The Contractor will prepare and submit to U.S. EPA, a Draft Feasibility Study Report presenting the results of Tasks 9 through 14 and recommending a remedial action alternative. Five (5) copies of the preliminary report will be provided by the Contractor.

TASK 16 - FINAL FEASIBILITY STUDY REPORT

The Contractor will prepare a Final Feasibility Study Report for submission to U.S. EPA, taking into account comments received from the Agency and the State of Ohio. Five (5) copies will be provided by the Contractor.

TASK 17 - ADDITIONAL REQUIREMENTS

Reporting and Community Relations Support requirements, as described in Task 8 of the Remedial Investigation scope of work, will be required for the Feasibility Study as well. The Feasibility Study Reports will address the need and the applicability of long term monitoring at the facility.

APPENDIX E

COMPARISON OF AMBIENT AIR MONITORING DATA WITH STACK EMISSIONS

APPENDIX E

Comparison of Ambient Air Monitoring Data with Stack Emissions

During the time between 1982 and 1985, the highest annual average ambient air concentrations of uranium were measured in 1983, although the reported stack emissions were only 172.8 kg. (about one-half of that reported for 1982 or 1984). The measured air concentrations of uranium were elevated at all site boundary stations for that year. This observation suggests that actual uranium emissions for that year may have been substantially higher than reported or that the measurement system is inaccurate.

FMPC operates seven high-volume, particulate monitoring stations, located on the site boundary. The data collected and reported (Boback, 1986; Cornett, 1982; Hertel, 1986) from these monitoring stations indicate an annual average total suspended particulate (TSP) concentration between 35.4 ± 3.3 (1985) and 42.6 ± 2.8 $\mu g/m^3$ (1982). These annual TSP concentrations were within the primary ambient air quality standard of 75 $\mu g/m^3$. The standard deviations of the annual TSP concentration from the different locations suggest, at best, a secondary effect of wind direction and distance from the process area. Although data from a limited period have been examined, the data were surprisingly homogeneous in character. The southeastern boundary station (BS4) measures at or near the highest TSP concentration levels, whereas the northeast boundary station (BS2) measures at or near the lowest TSP concentration levels. The range between the maximum and minimum annual average concentrations was found to be 7 $\mu g/m^3$ (1982), 6 $\mu g/m^3$ (1983), and 9 $\mu g/m^3$ (1985).

A meaningful comparison cannot be made between the measured TSP concentrations and the secondary ambient air quality standard, since the latter applies to a 24-hour average, whereas the measured values correspond to a 1-week averaging period. Greater variations were observed in the maximum weekly average TSP concentrations, but the variations between monitoring locations were less than might be expected with a major particulate emission source in the vicinity. In view of these observations and the anticipated meteorology, it appears that the monitoring stations were measuring a nearly homogeneous background of airborne particulates.

A somewhat different picture emerges with the airborne uranium concentration levels measured at the monitoring stations. The annual average air concentrations of uranium reported for the past 4 years were as follows:

Monitoring Station	Airborne Uranium Concentration (10^{-5} pCi/l)			
	1982	1983	1984	1985
BS1	0.77	2.1	1.03	0.296
BS2	0.42	1.4	0.92	0.311
BS3	0.70	2.5	1.36	0.557
BS4	0.21	0.89	0.35	0.213
BS5	0.35	0.98	0.40	0.221
BS6	0.39	1.1	0.63	0.241
BS7	0.22	0.48	0.30	0.111

Unlike the measured TSP concentrations, the uranium content in the airborne particulates provides a tracer of FMPC operations. The highest levels of uranium were observed at the east (BS3) and north (BS1) boundary stations. These were the two monitoring stations closest to the process area. The northeastern station (BS2) generally ranked third. The BS2 station was downwind of the predominant wind direction anticipated for the site, but about 350 to 400 meters farther than the BS1 station from the center of the production area. The northwestern monitoring station (BS7) generally measured the lowest airborne uranium concentrations because it was the monitor farthest from the production area and has a wind direction with an expected low frequency of occurrence.

Based on these monitoring data the highest inhalation dose would be expected to occur on the eastern site boundary. The estimated pulmonary doses at this location were as follows:

Year	Pulmonary Dose (millirem/yr)	Air Emissions (kg uranium/yr)	Dose/Quantity (D/Q) (millirem/kg uranium)
1982	7.0	358.9	0.0195
1983	25.1	172.8	0.1450
1984	13.7	391.4	0.0350
1985	5.6	75.3	0.0710

The reported plant-wide, annual uranium air emissions have also been presented to emphasize the anomalously-high pulmonary dose obtained from the 1983 data. The last column in this table presents the site boundary pulmonary dose per kilogram of uranium discharged to the atmosphere (D/Q). This parameter is generally considered to be a measure of the dispersive characteristics of the atmosphere, where larger values of D/Q are associated with less dilution of the air emissions.

The annual variations in the meteorology are usually not a primary cause of large variations in annual average concentrations. With a constant emission rate, the year-to-year variation in meteorology may produce a 10 to 20 percent change in the concentrations at a monitoring station. Dramatic temporal variations in the emission rate can produce results analogous to those observed at the BS2 monitoring station as well as at other monitoring stations in the air monitoring network. However, the air monitoring data did not indicate this to be the case. When the D/Q values from all monitoring stations were compared, there was a consistency found in the year-to-year data reported for all the monitoring stations; that is, the 1983 D/Q values relative to those observed in 1985 give 2.101 ± 0.198 for all the monitoring stations. In other words, the 1983 D/Q values are an average of 2.101 times those measured in 1985 with a standard deviation of 0.198 (9.4 percent). The same process yields 6.506 ± 1.278 (± 19.6 percent) and 4.440 ± 0.892 (± 20.0 percent) when the 1983 data were compared to the 1982 and 1984 data, respectively. In effect, while there was some station-to-station variability in the data from each monitoring station, all the monitoring stations showed an average systematic difference from year to year. The standard deviations about this average were in the range expected from variations in annual meteorology.

Although it is difficult to specifically identify the actual cause of the systemic bias in the monitoring data from one year to the next, it is clear that the bias seems to affect all the monitoring stations in the same manner. This observation does not depend on the accuracy of the monitoring data, since the analysis depends on the relative data collected at all monitoring stations in 1 year and the general trends at each monitoring station over 4 years. A possible cause of the year-to-year systematic differences in the monitoring data is the general air emissions from the FMPC production area. If the 1983 data are set aside, the 1982, 1984, and 1985 monitoring data suggest an uncertainty of ± 100 percent in the inhalation dose. The 1983 data suggest either (1) a possible unaccounted-for air release of uranium at the facility, (2) a fugitive source of uranium emissions in the production area, or (3) a problem associated with the laboratory techniques during this year. It should be stressed that these are tentative explanations which appear to provide an explanation for the monitoring data.

APPENDIX F

RECENT ACCIDENTAL RELEASE
(JANUARY 1986)

APPENDIX F

Recent Accidental Release (January 1986)

The UF_6 to UF_4 reduction facility is located in the FMPC Pilot Plant near the southwest corner of the plant site. The facility receives UF_6 from offsite in large cylinders. The cylinders are heated with steam to convert the UF_6 to a gas. The gaseous UF_6 is mixed with disassociated ammonia at the head of a 20-foot-long reaction vessel. The two vessels, each about 15 inches in diameter and 20 feet long are mounted vertically. Operating temperatures in the vessel vary from one end of the vessel to the other and with time. At the temperature of the vessel (nominally 1,200°F), the UF_6 is reduced to UF_4. The UF_4 (commonly referred to as green salt) is collected at the bottom of the reaction vessel and packaged for use at Plant 5.

The major by-products of the reaction include hydrogen fluoride (HF), nitrogen, and small amounts of hydrogen. The HF is recovered in a complex system that includes refrigeration and liquid scrubbing. The recovered HF is sold commercially to an offsite contractor. The nitrogen and hydrogen are vented to the atmosphere.

Under normal operating conditions, uranium can be released from the green salt packaging operation. The operation is vented through a fabric filter to the atmosphere. The effluent is sampled continuously for uranium. In 1985, 6.5 kg of uranium were released from this source, which was about 9 percent of the total airborne uranium released site-wide.

On January 19, 1986, reaction vessel 2, used for the conversion of UF_6 to UF_4 in the FMPC Pilot Plant, failed. The failure consisted of a 17.5-cm crack located approximately 39 cm from the top of the vessel, resulting in a release of process gases.

An investigation of the vessel failure was conducted by a DOE Incident Investigation Board. The board assembled the facts concerning the incident, analyzed the facts, identified the probable cause, and provided their judgment as to needs for the safe operation of the facility. The findings and recommendations of the board were published in June 1986 (DOE, June 1986). The survey team believes that once the recommendations of the board are implemented, the probability of another such release of uranium from this facility will be minimized. The survey team observed that some of the recommended corrective actions had already been implemented. The remaining actions will be implemented shortly.

The board attempted to estimate the quantity of these releases since no monitoring data were available. The estimates were based on known input rates for UF_6 and disassociated ammonia to the vessel and assumed fractional releases to various parts of the facility. A description of the board's calculations can be found in Appendix 4 of their report.

The board concluded that a maximum of 9.7 kg of uranium and 3.3 kg of HF were released. The survey team believes that while the estimate is probably conservative, the release could have been higher than this estimate due to inaccuracies in the assumptions made. This is especially true in the assumption that 6 minutes passed from the initial failure to shutdown of the UF_6 flow to the vessel. Nonetheless, the estimate is the best available data and is adequate for use in evaluating impacts of the incident.

The uranium release was about 13 percent of the annual airborne release from all sources at the site in 1985 (75 kg). However, two facts make the offsite transport of the material less likely than typical releases from the site. First, the release was not filtered and therefore particles would be of a larger size and mass and would fall out and deposit on the ground more readily. Secondly, UF_6 reacts in the moist air forming large, massive particles that also readily fall out.

The survey team has conservatively estimated the hypothetical dose of a person standing at the western edge of the site as the cloud of uranium from this incident passed by. This estimate was made using a puff model with meteorological conditions reported at the time (winds from the west at 10 mph) and ICRP-30 dose models. The average uranium concentration was estimated as 3.73 mg/m^3 and the time of passage about 1.5 minutes. The resulting bone dose was 2.2 millirem, which is about 25 percent of the highest predicted organ dose for all airborne uranium releases from the site for 1985.

The predicted concentration of HF was 1.3 mg/m^3, which is more than one-half of the air concentration limit suggested by the American Conference of Industrial Hygienists.

APPENDIX G
SUMMARY OF GROUND-WATER MONITORING DATA AT FMPC

Ground-water resources in the area of FMPC have been the subject of a number of investigations over the last 30 years. These investigations and their results have not always been tied together. This section of the report summarizes the major ground-water studies and the primary results in a chronological order. This summary is intended to show the extent of ground-water contamination at FMPC and identify the specific pollutants of concern.

Glacial Till (Perched Aquifer) On Site

Most of the data associated with the saturated portion of the glacial till is the result of recent studies and sampling. Even so, the data base is minimal. The following information chronologically summarizes the pertinent data and studies.

1. The potential for ground-water contamination in general was recognized in 1955 and 1961 (Theis, 1955, and Eye, 1961). The 1961 Eye report included a large sampling program of site soils, ground water, and surface waters. Samples taken of water from site excavations at this time showed high concentrations of chlorides, nitrates, fluorides, and uranium (all typical site-related constituents). Table G-1 is reproduced from the Eye report as is Figure G-1 (Eye, 1961, Table VI and Figure 4).

   Note on Table G-1 that shallow ground water in 1959 at the K-65 ditch contained significant uranium (16.7 parts per million [ppm]) and nitrate (1273 ppm). Water obtained from excavations for Pit 4 and west of Plant 1 exhibited concentrations of uranium at 120 ppm and 2.14 ppm respectively. The soil sample analyses for uranium in the production area gave evidence of widespread surface contamination (Figure G-1). This surface contamination was, according to Eye, "... indicative only of the fact that process materials can be dissolved and carried into the ground water. The high fluoride, nitrate, chloride and uranium levels found in the seepage water in ditches and excavations also support this conclusion."

   Eye's conclusions included the following statement: "Analysis of water samples collected from trenches and excavations throughout the plant site show that production chemicals are finding their way into the subsurface waters of the plant." Eye also indicated that the storm drainage system should be investigated to ascertain whether it presented a possible pollution potential to Paddy's Run during storm flow. The results of the 1985 Dames and Moore study indicate that the discharge from the storm sewer system (to the storm sewer outfall ditch and

TABLE G-1

ANALYSIS OF MISCELLANEOUS WATER SAMPLES COLLECTED ON FMPC SITE

Date	Sample Location	NO_3^- (ppm)	Cl^- (ppm)	F^- (ppm)	U (ppm)
9/22/60	Storm sewer line from technical lab	1,328	1,217	38	8.9
9/03/60	Elevated tower trench	66	25	0.5	8.0
9/28/60	Fire line trench	--	28	0.5	5.5
9/28/60	Fire line trench	--	490	3.0	1.3
9/30/60	Ditch N. of Pit #3	1.0	22	1.2	1.1
6/24/60	Puddle north side of Plant #3	443	8,125	56	41.5
6/26/60	MH-123 from Plant #8	7	100	23	2.0
7/17/60	Overflow from slop tank Plant 8	490	66,400	2,500	14
7/20/60	Water into MH-23	1,230	330	280	9.5
7/15/60	New elevated tower excavation	19	61	15	1.3
7/18/60	Retaining wall east of tank farm	--	88	10,000	275
6/29/60	Ground W. of Pit #5	5	27	4.8	12
7/23/60	MH east of Plant #6	4	18	10	70
7/18/60	Hole at A and 2nd Streets	2.2	--	5.4	18.5
8/03/60	Catch basin-storm sewer outfall	18	62	8.6	9.9
7/21/60	Test hole-N. tech. lab	1	17	2.3	7.5
7/26/60	Waste line from pilot plant	--	340	--	64.5
2/05/60	Water from storage pad	16	8	4.5	4.9
2/05/60	Water from storage pad	16	16.5	3.5	6.9
2/18/60	Drainage ditch by #5 test well	51	1,600	9.8	0.32
4/11/60	To storm sewer from tank	293	9,250	85	0.65
6/08/60	Excavation for Pit #4	14	30	12.4	120
6/28/60	Water to storm sewer from Plant 8	11	110	8.3	3.95
6/28/60	To storm sewer from Plant 6	2	5,000	--	30.3
6/29/60	Thick fluid at MH-117	18	33	240	86,750
6/31/60	Leakage from tank #F3E7	5,977	82	49	144
6/07/60	Water at MH-166	8,245	63	7.3	12.4
2/26/59	Overflow from K-65 trench	1,107	--	--	29.1
6/29/60	Surface water from Plant 8	20	188	6	8.5

TABLE G-1
ANALYSIS OF MISCELLANEOUS WATER SAMPLES
COLLECTED ON FMPC SITE
PAGE TWO

Date	Sample Location	NO_3^- ppm	Cl^- ppm	F^- ppm	U ppm
2/08/59	Groundwater in ditch at K-65	1,273	–	7.4	16.7
2/22/59	Creek behind Pilot Plant	1,107	–	–	22.3
2/04/59	Surface water to MH Plant 8	60	37	9.8	98
2/04/59	From pit at RR track	102	40	5.6	837
2/19/59	To storm sewer at General Sump	184	21,000	2,220	32
2/11/59	Barrel loading pad - B street	22	6	1.5	25.2
2/18/60	Plant 8 line break at Test Well 1	498	19,000	170	56.5
4/13/60	To storm sewer from Tank Farm sump	24	1,500	800	1.55
7/22/60	To CB-93 from garden hose	11	150	2.8	4.75
4/11/59	Excavation west of Plant 1	0.59	–	1.2	2.14
4/22/59	Creek behind Pilot Plant	1,107	–	–	22.3

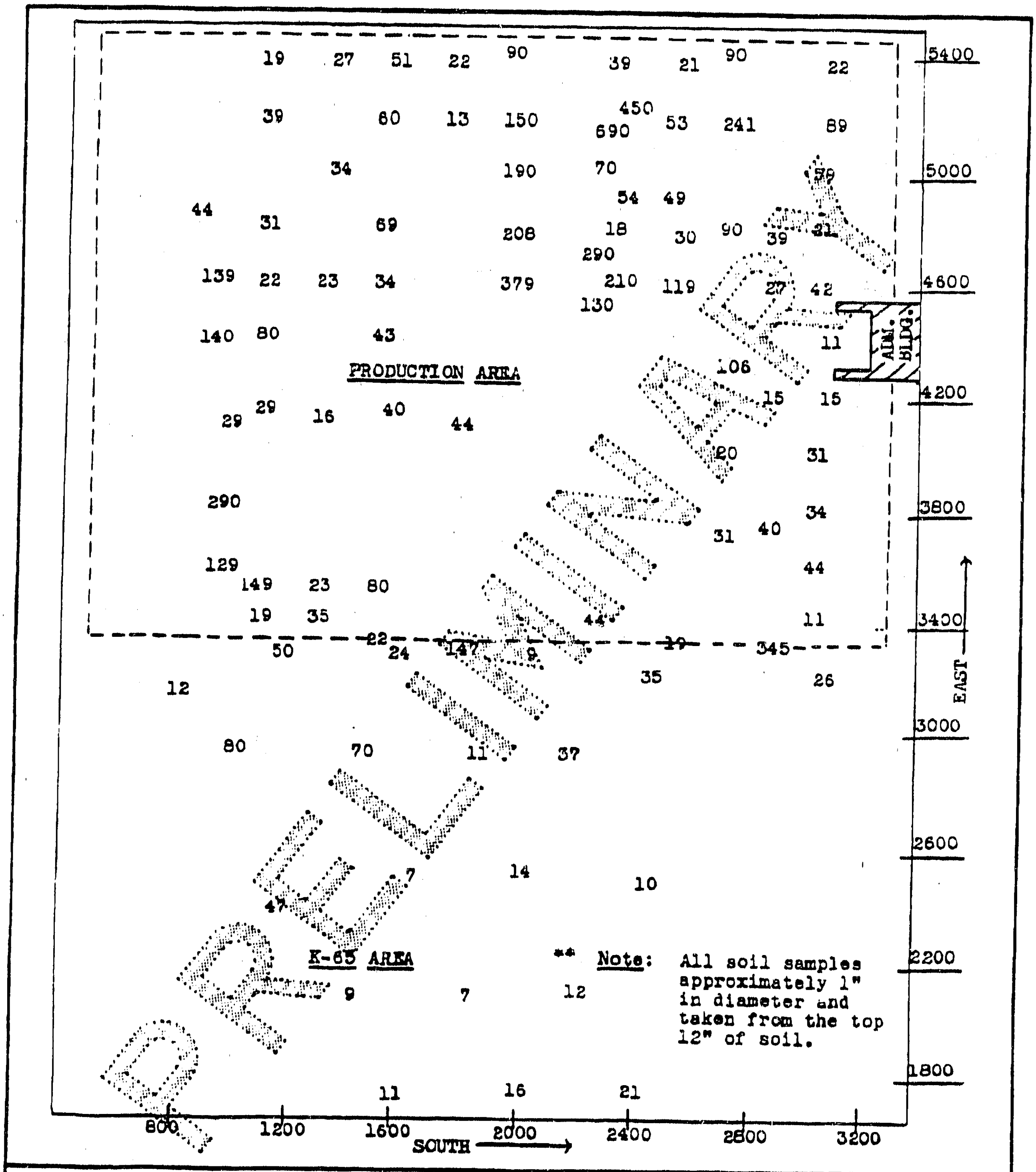

Figure From: Report on Ground Water Pollution Potential in the Feed Materials Production Center Operated by the National Lead Company of Ohio, by J. D. Eye

URANIUM CONTENT OF SOIL SAMPLES FROM PLANT SITE (TOTAL URANIUM IN PPM U)**

FIGURE G-1

subsequently to Paddy's Run) is one of the suspected sources of contaminants in the sand and gravel aquifer.

2. A 1969 NLO report to the FMPC manager on aquifer contamination control indicated that action should be taken to check for potential underground uranium sources as a result of uranium levels in the storm sewer.

3. A 1972 report to the FMPC manager indicated that nitrate was 201 mg/l and uranium 4.7 mg/l in the tile drain west of the pilot plant. This report further states that this area ". . .always has a high nitrate content. . ." and these levels are ". . .very high for groundwater. . . ."

4. The 1985 data from three shallow wells installed in the glacial till by Dames and Moore for the FMPC indicate that a significant impact has occurred in the waste pit area on the ground water contained in the till. These wells, installed adjacent to Pit 4, are part of the proposed RCRA ground-water monitoring system. Well 12 provides an upgradient sampling point for background water quality.

   A comparison of upgradient ground-water chemistry concentrations (Well 12) to concentrations above background in the downgradient wells (TP-19, TP-21, and TP-22) is included as Table G-2. A total of 32 parameters were at levels higher than background in the downgradient wells. Of particular note is the presence of uranium at concentrations ranging between 0.29 and 2.10 mg/l; gross alpha between 43 and 1,370 pCi/l; and gross beta between 94 and 1,340 pCi/l. Barium is relatively higher downgradient, as is sulfate in TP-19 and TP-22 and chloride in TP-19.

   An additional shallow well (TP-20) south of the production area had an above-background uranium concentration in 1985 of 0.0410 mg/l and a gross beta of 77 pCi/l.

5. A 1986 study of infiltration/inflow of the storm sewer system indicated that a substantial quantity of ground water (presumably in the glacial till) was infiltrating the storm sewer system. A flow balance estimated that 109.4 million gallons per year was derived from infiltrating ground water. Samples of the infiltrating ground water (in the storm sewer) exhibited uranium concentrations of between 0.14 to 4.06 mg/l (well above background). Samples of process/production-related water in the storm sewers yielded uranium concentrations ranging from 0.08 to 4.19 mg/l. No analyses were performed for other parameters.

TABLE G-2

CONCENTRATIONS OF CHEMICAL CONSTITUENTS GREATER THAN BACKGROUND IN WASTE PIT AREA (RCRA WELLS ONLY)

Parameter	Background MW-12	TP-19	TP-21	TP-22
Chloride (ppm)	109	459	–	Trace
Iron (ppm)	18.1	–	58.4	–
Manganese (ppm)	0.216	2.75	3.77	2.01
Phenols (ppm)	0.019	0.049	–	–
Sulfate (ppm)	72	575	–	850
Barium (ppm)	<0.2	0.308	0.863	0.363
Calcium (ppm)	53	372	415	154
Chromium (ppm)	0.055	–	0.08	–
Copper (ppm)	<0.055	–	0.074	–
Magnesium (ppm)	12.3	12.8	18.3	–
Nickel (ppm)	0.06	–	0.137	–
Nitrates (ppm)	<0.02	<0.02	<0.02	0.06
Lead (ppm)	0.320	–	–	–
Phosphorus (ppm)	0.26	–	–	1.15
Zinc (ppm)	0.081	–	0.240	–
TDS (ppm)	660	2,540	936	2,240
COD (ppm)	17.0	–	–	44
Sp. cond. (µmhos/cm)	880	2,350	1,000	1,950
TOC (ppm)	< 1.00	4.00	4.00	6.5
TOX (ppb)	< 10.00	80.25	–	–
Gross beta (pCi/l)	30	94	250	1,340
Gross alpha (pCi/l)	–	43	230	1,370
Potassium 40 (pCi/l)	–	–	15	75
Radium-228 (pCi/l)	–	–	12	75
Thorium 232 (pCi/l)	–	–	–	88
Cesium 137 (pCi/l)	–	22	48	115
Strontium 90 (pCi/l)	–	–	14	28
Ruthenium 106 (pCi/l)	–	–	15	80

TABLE G-2
CONCENTRATIONS OF CHEMICAL CONSTITUENTS
GREATER THAN BACKGROUND IN WASTE PIT AREA
(RCRA WELLS ONLY)
PAGE TWO

Parameter	Background MW-12	TP-19	TP-21	TP-22
Neptunium 237 (pCi/l)	–	–	14	50
Benzene (ppb)	14.8	–	–	–
Xylene (ppb)	11.8	–	–	–
1,1-dichloroethane (ppb)	ND	3.4	–	–
Methylene chloride (ppb)	ND	Trace	–	–
Uranium (ppm)	0.0000	0.29	1.50	2.10

– = Equal to or less than background level

The survey team estimated the uranium load to the storm sewers by taking an average concentration of uranium in the storm sewer of 2.4 mg/l and multiplying by the volume of water. This estimate shows a uranium loading of 2.73 kg/day or 995 kg/year. These values do not appear unrealistic with regard to uranium loading, considering that production area losses to the storm sewer have historically exceeded 454 kg per month of uranium.

6. A water sample taken by the survey team and ES&H personnel of water flowing in the spring south of the K-65 silos was analyzed for uranium by the Bioassay Laboratory at FMPC in June 1986. The concentration was 1.88 mg/l. Another sample taken in a spring southwest of the production area yielded a uranium concentration of 0.0045 mg/l, which is above background levels.

Sand and Gravel Aquifer On Site

The sand and gravel aquifer is divided into an upper and lower zone at the FMPC, which are separated by a blue clay layer. This layer does not extend off-site for any great distance, and thus the aquifer is not divided off site. The aquifer is not discussed separately as upper and lower but rather as an entire unit with specific reference to the zone, where appropriate.

Data on the sand and gravel aquifer have been gathered since 1960, when Dr. Eye first became involved as a consultant at the FMPC. A relatively continuous set of data exists from the mid-1960s to today for the older site wells within the sand and gravel aquifer. As a result, the data base is considerably better than the one for the glacial till. The following information represents a chronologic summary of the data for the aquifer.

1. As previously presented in Item 1 under Glacial Till, the potential for ground-water contamination was recognized over 30 years ago at the FMPC by both the USGS (Theis, 1955) and a private consultant (Eye, 1961). The gross contamination of soils and water reported by Eye gives a clearer understanding of some of the subsequent ground-water problems encountered at the site.

   In January of 1961, Eye observed that there was ". . .definitely some leakage from Pit 3 into Pit 5 test well because the chloride and nitrate content of samples from this well is much higher than from other wells in the plant." Number 5 test well (Well 5) is screened in the upper sand and gravel aquifer. Number 5 test well ground water exhibited chloride contents generally between 500 and 800 mg/l and nitrates generally between 500 and 1200 mg/l. These values were significantly greater than those of any ground-water samples from the production wells or the old administration building (TOAB) well (P-1, P-2, P-3, or TOAB), which had chloride ranges between 8 and 22 mg/l and nitrate between <0.1 and 1.6 mg/l. These data are based on 32 samples from each well in June and July 1960.

Eye also noted that although pollution entering the upper sand-and-gravel aquifer would flow at a low velocity toward the production wells and it would take many years to reach them, many years of pumping would be required to eliminate the accumulated contaminants.

2. At the suggestion of the U.S. Geological Survey (USGS), Well 1S, a well installed in the upper sand-and-gravel aquifer began pumping continuously in January 1965. The purpose of this pumping was to help contain the ground-water contamination in the waste pit area. Discharge of the pumped water was initially directed to the Pit 3 Clear Well but in later years was directed to Paddy's Run. Conversation with site personnel indicated that this practice continued for approximately 20 years but was stopped within the last few years.

3. On May 15, 1965, use of production well 1 (P-1), installed in the lower sand-and-gravel aquifer, stopped as a result of contamination. In June and July 1960, chloride levels in Well 1S ranged between 17 and 27 mg/l and nitrate levels ranged between <0.1 and 6.2 mg/l. Significant levels of contaminants were also discovered in Well 7. By May 1965, Well 1S ground water had a chloride level of 300 mg/l, nitrates of 500 mg/l, and sulfates of 169 mg/l. In October 1965, Well 7 contained 1,430 mg/l of chloride, 4,800 mg/l of nitrate, and 746 mg/l of sulfate. These levels exceed present drinking water standards and are far in excess of general background levels.

4. A review of the tabular data from the WTP laboratory indicates that the ground-water contaminants in many of the test and production wells have increased substantially in the past. A brief summary is included below:

- P-1 shows a steady increase in chloride to more than 200 mg/l by 1970. These levels slowly declined, but in 1984 the nitrate concentration in this well exceeded the National Primary Drinking Water Regulations (NPDWR) twice.

- Well P-2 shows increases in chloride concentration to greater than 250 mg/l (drinking water standard) in 1969 and 1970. Levels declined to less than 20 mg/l by 1980.

- Wells 9 and 8S have also shown significant increases in contaminants since 1965.

- TOAB well has shown substantial increases in groundwater contaminants. An example of contaminant levels in (mg/l) is shown in the following table:

Date	Chloride	Nitrate	Sulfate
1/69	8	1.3	2
4/71	614	10.9	313
4/73	763	2.0	497
4/75	433	12.7	329

Radionuclide data were not available in the tabulated data for these wells. However, for comparison, the 1985 levels in TW-10 for chlorides, nitrates, and sulfates were 76, 155.6, and 470 mg/l, respectively, and the uranium concentration was 13.88 pCi/l. Sulfate, nitrate, gross alpha, and possibly gross beta levels were all above NPDWR or National Secondary Drinking Water Regulations (NSDWR).

5. In response to indications of elevated levels of radionuclides in offsite ground water (by Ohio EPA), a study of uranium contamination in the sand and gravel aquifer was begun in 1984. Above-background concentrations of uranium were found in 24 onsite wells in the upper sand-and-gravel aquifer (Dames and Moore, July 1985a). Table G-3 and Figure G-2 are extracted from this report. Figure G-2 shows the above-background uranium plume extending along the western site boundary from the waste pit area progressing generally toward the south (more or less parallel to ground-water flow) off site.

6. Following the first round of RCRA sampling in 1985, a report was issued to the FMPC by its consultant (Dames and Moore, October 1985a) on the sand and gravel aquifer. The report was the first in a series of reports on the sand and gravel aquifer. This report concluded that there was clear indication of waste pit area influence on the sand and gravel aquifer. Dames and Moore, as part of its RCRA monitoring program, developed two tables (reproduced here as Tables G-4 and G-5) which identified both "possibly elevated constituents" and detectable metals in the sand and gravel aquifer.

TABLE G-3

ABOVE-BACKGROUND CONCENTRATIONS OF URANIUM IN GROUND-WATER SAMPLES FROM ONSITE WELLS IN THE SAND AND GRAVEL AQUIFER (FROM DAMES AND MOORE, JULY 1985a)

Well Number	Screened Zone	Value* (U in mg/l)
MW 1S	B	0.009
MW 3	B	0.002
MW 4	B	0.009
MW 5	B	0.004
MW 9	B	0.002
MW 10	B	0.019
MW 11	B	0.004
MW 13S	A	0.015
MW 13D	B	0.010
MW 14S	A	0.120
MW 14D	B	0.140
MW 15S	A	0.140
MW 15D	B	0.002
MW 16S	A	0.031
MW 16D	B	0.025
MW 17S	A	0.003
MW 17D	B	0.002
MW 18S	A	0.002
MW 18D	B	0.003

TABLE G-3
ABOVE-BACKGROUND CONCENTRATIONS OF URANIUM IN GROUND-WATER SAMPLES FROM ONSITE WELLS IN THE SAND AND GRAVEL AQUIFER (FROM DAMES AND MOORE, 1985a)
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Well Number	Screened Zone	Value* (U in mg/l)
MW 19S	A	0.002
MW 19D	B	0.024
MW 20D	B	0.002
MW 21S	A	0.014
MW 22S	A	0.015

A. Screened above blue clay layer in upper part of upper sand and gravel aquifer.

B Screened above blue clay layer in lower part of upper sand and gravel aquifer.

Samples taken March 1985 by Dames & Moore

Background ranges from 0.0001 mg/l to 0.0027 mg/l. Average value of 0.0008 mg/l was used for statistical comparisons.

* DOE Guideline for uranium in water released in uncontrolled areas = 1.8 mg/l.

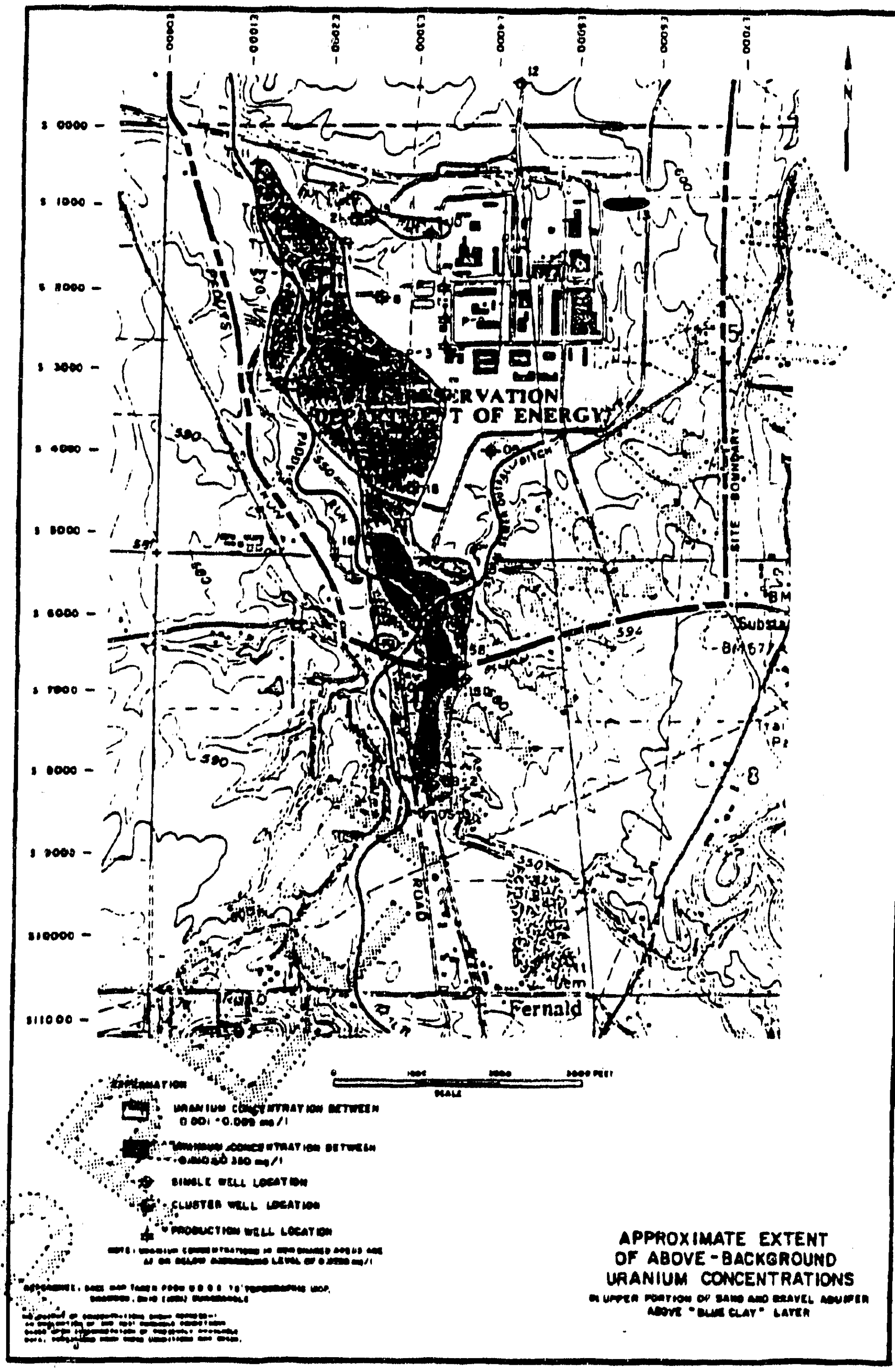

Figure From: Groundwater Study Task C Report, Dames & Moore, 1985

APPROXIMATE EXTENT OF ABOVE-BACKGROUND URANIUM CONCENTRATIONS **FIGURE G - 2**

TABLE G-4

POSSIBLY ELEVATED CONSTITUENTS IN SAND AND GRAVEL WELLS
(All Results in ppm Except As Noted)

	1D	10	13D	14S	19D	19S
Chloride	–	–	–	–	–	–
Iron	61.8	–	–	–	–	–
Manganese	–	5.5	–	–	3.73	–
Phenols	–	–	–	0.015	–	–
Sodium	–	162	–	–	–	180
Sulfate	–	470	300	–	440	–
Calcium	–	1,232	–	–	–	–
Fluoride	–	–	–	1.1	–	1.06
Nitrates	–	155.6	–	–	–	25.04
TDS	–	2,540	–	–	–	–
COD	84	20	–	32	–	–
pH-lab (1) (2)	–	–	6.97	–	6.83	–
Conductivity (1)(3)	–	2,400	1,250	–	1,600	1,000
TOC (1)	5	4	–	4	–	–

(1) Average of four measurements
(2) Standard pH units
(3) Units in μmhos/cm

TABLE G-5

METALS DETECTED IN 7 OR FEWER SAND AND GRAVEL WELLS

	Well Number								
	1D	10	14S	14D	18S	19S	20S	OS-1	OS-2
Cadmium		●	●		●	●			
Chromium (Total)	●	●	●		●	●	●		
Copper	●		●		●	●			
Cyanide						●			
Lead	●		●	●	●	●			
Nickel	●	●	●	●	●	●			
Zinc	●	●	●		●	●		●	●

1. All measured concentrations are below EPA limits except the value of lead in well MW-14S and chromium in wells MW-14S, 18S, and 19S.

7. A review of the 1986 RCRA monitoring data for the sand and gravel aquifer indicates that 9 onsite wells exceeded the maximum contaminant levels (MCLs) as found in the NPDWR or NSDWR for at least one parameter (excluding coliforms). Table G-6 presents these data.

Although many wells shown on Table G-6 exhibit significant coliform counts, the FMPC ES&H staff indicates that these results arose from bailers that had been stored wet and thus were subject to bacterial growth.

Rock Aquifer On Site

Only one onsite well monitors the ground water from the limestone and shale bedrock. Well MW-12 exhibited Primary Drinking Water Standards (PDWS) exceedences for chromium and lead (see Table G-6). Benzene and xylene were also detected, but a sampling error was thought to have created these levels. Additional samples have been taken in this well but the analytical results were not available during the survey team's visit.

Glacial Till Off Site

No data are available for ground-water quality within the glacial till off site. This is partially because the areal extent of the till is limited and because very few wells use this zone for production purposes. The only reasonably consistent data base for the till is at the "Old Cone House" (TCH) well, located northeast of the production area but still on site. This well had been monitored since 1966 and was abandoned as a monitoring point in 1985. The data on ground water for the period show exceedences of the NPDWR or NSDWR MCLs for both sulfate and nitrate throughout the sampled years. Average 1984 uranium concentration in the TCH well was 6.43 pCi/l. This level is above background for the sand and gravel aquifer and was higher than any average uranium concentration for onsite wells in 1984.

Sand and Gravel Aquifer Off Site

Elevated levels of gross beta and gross alpha activity were found in four offsite wells by the Ohio EPA in November 1981. Subsequently, FMPC began sampling offsite wells. The summary of this sampling effort follows.

TABLE G-6

SUMMARY OF 1985 SAMPLING PARAMETERS EXCEEDING PRIMARY AND SECONDARY STANDARDS IN SAND AND GRAVEL AQUIFER

Primary Standard	1D	4	5	8S	9	10	12	14D	14S	18S	19S	21S	22S	OS-2	OS-3	13D	19D
Chromium/0.05							.055		.159	.147	.133						
Nitrates/10.0						155.6					25.04	39.3	42				
Lead/0.05							.320		.1		.072						
Gross Beta/30						33.79 (avg)	78		46	44	1250	400	78		42		
Gross Alpha/15						15.77 (avg)	18		47	21	36						
Radium 226 + 228/5											70 (228)						
Coliform/1	190K	380	17	36	24	140,000		110	2,220	3,550	197			40			
Other Selected Parameters																	
Chloride/250																300	440
Sulfate/250						470											
Other Radionuclides Above MW-12 Background																	
Potassium 40											40						
Thorium 232											80						
Cesium 137											110						
Strontium 90											24						
Ruthenium 106											75						
Neptunium 237																	

1. Sampling of offsite wells by FMPC (14 wells in 1981) and the USGS in 1982 revealed three offsite wells with uranium concentrations above background. The levels are shown in the following table and are compared to the onsite production well P-3.

FMPC Well Number	Corresponding USGS Well Number	Uranium Concentration in µg/l
12 (HKS)	H-108	250
15 (DS)	H-111	430
17 (AW)	H-121	46
P-3	H-130	<0.8

The USGS study sampled approximately 33 wells and defined an area of approximately 100 acres south of the FMPC where uranium levels were elevated.

2. Sampling of the offsite wells was continued by FMPC and, in 1984, Dames and Moore began a study to assess the sources and distribution of uranium south of the site. The results of this study indicated that above-background uranium concentrations in ground water occurred along the entire western boundary of the site, parallel to Paddy's Run, extending from the waste pit area south to the three affected offsite wells (Figure G-2). Elevated uranium levels also occurred east of the waste pits in the upper sand-and-gravel aquifer.

The Dames and Moore study suspected that the primary source of offsite uranium contamination was the storm sewer outfall ditch south of the site and Paddy's Run, which had received uranium-bearing storm sewer flows for many years. These waters could infiltrate the upper sand-and-gravel aquifer where the material was exposed near the surface (i.e., where the "blanket" of lower permeability glacial till did not occur). Potential sources for the storm sewer outfall ditch and Paddy's Run were originally considered to be the waste pits, the production area, and the fly-ash disposal areas.

3. By 1985, offsite Well 12 was replaced by a deeper well drilled by FMPC, and bottled water was used in place of the other two offsite wells (15 and 17).

4. A 1985 report and groundwater model by Geotrans developed for the Ohio EPA indicated that an additional component of flow may exist to the east of the FMPC in the sand and gravel aquifer. This would result in a groundwater divide on site and could indicate the potential for movement of contaminants from the site to the east (Geotrans, Inc., September 30, 1985).

5. Recent work by IT Corporation for the DOE on site has included the addition of wells to the east and southeast of the site. Although specific contaminant data from this work is not yet available, preliminary indications are that the area south of the site and the Southwestern Ohio Water Collection System area east of the site have been affected by FMPC. Additionally, the buried valley or sand and gravel aquifer east and south of the site has been potentially affected.

6. Three offsite wells, OS-1, OS-2, and OS-3 (12, 15, and 17), were included in the 1985 RCRA sampling. Gross alpha and beta activity were above NPDWR MCLs in OS-2.

<u>Bedrock Off Site</u>

No bedrock wells are believed to be monitored downgradient of the site.

APPENDIX H

CHEMICAL SYMBOLS, ABBREVIATIONS, AND ACRONYMS

AHF	- Anhydrous Hydrogen Fluoride
AMAD	- Activity Mean Aerodynamic Diameter
ANL	- Argonne National Laboratory
ANH_3	- Anhydrous Ammonia
ALARA	- As Low As Reasonably Achievable
BaCl	- Barium Chloride
$BaCO_3$	- Barium Carbonate
CERCLA	- Comprehensive Environmental Response, Compensation, and Liability Act
$CaCO_3$	- Calcium Carbonate
CB	- Catch Basin
CFS	- Cubic Feet per Second
Cl^-	- Chloride
Cl_2	- Chlorine
CFR	- Code of Federal Regulations
CN	- Cyanide
Cols	- Colonies
Cond	- Conductivity
Cr	- Chrome
Cu	- Copper
DO	- Dissolved Oxygen
DOE	- Department of Energy
EP Toxicity	- Extraction Procedure Toxicity
ES&H	- Environmental Safety and Health
F^-	- Fluoride
F_2	- Fluorine
Fe	- Iron
FFCA	- Federal Facilities Compliance Agreement
FMPC	- Feed Materials Production Center
Ft^3/Yr	- Cubic Feet per Year
GPM	- Gallons per Minute
HEPA	- High Efficiency Particulate Filter
HF	- Hydrogen Fluoride
HNO_3	- Nitric Acid
HSL	- Hazardous Substance List
KCl	- Potassium Chloride
Kg	- Kilogram
Km	- Kilometer
KOH	- Potassium Hydroxide
l	- Liter
Lb	- Pounds
LLW	- Low Level Waste (Radioactive)
LLWPSS	- Low Level Waste Packaging and Shipping System

m	- Meter
MCL	- Maximum Contaminant Level
mgd	- Million Gallons per Day
MgF_2	- Magnesium Fluoride
mg	- Milligram
MH	- Manhole
ml	- Milliliter
MMCS	- Maintenance Management Control System
μmhos	- Micro mhos
MSDS	- Material Safety Data Sheet
NaCl	- Sodium Chloride
NEC	- National Electric Coil
NESHAPS	- National Emissions Standards for Hazardous Air Pollutants
NH_3	- Ammonia
Ni	- Nickel
NLO	- National Lead of Ohio
NO_3-N	- Nitrate Nitrogen
NO_x	- Nitrogen Oxides
NPDES	- National Pollutant Discharge Elimination System
NPDWS	- National Primary Drinking Water Standards
NSDWS	- National Secondary Drinking Water Standards
NTS	- Nevada Test Site
NTU	- Nephelometric Turbidity Unit
O&G	- Oil and Grease
ORNL	- Oak Ridge National Laboratory
ORO	- Oak Ridge Operations Office
PCB	- Polychlorinated Biphenyls
pCi	- picoCuries
PDWS	- Primary Drinking Water Standards
ppb	- Parts per Billion
ppm	- Parts per Million
R	- Roentgen
Rad	- Unit of Radiation Dose
RCRA	- Resource Conservation and Recovery Act
Rem	- Roentgen Equivalent Man
FI/FS	- Remedial Investigation/Feasibility Study
S&A	- Sampling and Analysis
SO_2	- Sulfur Dioxide
SOPs	- Standard Operating Procedures
SWMU	- Solid Waste Management Units
SU	- Standard Units
T1/2	- Half Life
TBP	- Tributyl Phosphate
TCE	- 1,1,1 Trichlorethane
TCH	- The Old Cone House
TCLP	- Toxic Constituents Leach Procedure
TLD	- Thermoluminescent Dosimeter
TOAB	- The Old Administration Building

TP	- Test Pit
TSD	- Treatment, Storage, and Disposal
TSS	- Total Suspended Solids
t/Yr	- Metric Ton/Year (1000 kg/year)
UF_4	- Uranium Tetrafluoride
UF_6	- Uranium Hexafluoride
UO_3	- Uranium Trioxide
USAEC	- United States Atomic Energy Commission
USEPA	- United States Environmental Protection Agency
USGS	- United States Geological Survey
WMCO	- Westinghouse Materials Company of Ohio
WTP	- Wastewater Treatment Plant

APPENDIX I
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