72

G-000-107.10

ENVIRONMENTAL PROGRAM REVIEW OF THE FEED MATERIALS PRODUCTION CENTER , FERNALD, OHIO
OCTOBER 1985

10/31/85

ORAU/DOE-ORO
142
REPORT

G-000-0072

[redacted]

Prepared by
Oak Ridge Associated Universities

Prepared for
Safety and Environmental Control Division:
Oak Ridge Operations Office

U.S. Department of Energy

ENVIRONMENTAL PROGRAM REVIEW

OF THE

FEED MATERIALS PRODUCTION CENTER

FERNALD, OHIO

Radiological Site Assessment Program
Manpower Education, Research, and Training Division

FINAL REPORT

OCTOBER 1985

G-000-106.48
72

ENVIRONMENTAL PROGRAM REVIEW OF THE FEED MATERIALS PRODUCTION CENTER FERNALD, OHIO

Prepared by

Radiological Site Assessment Program
Manpower Education, Research, and Training Division
Oak Ridge Associated Universities
Oak Ridge, Tennessee 37831-0117

Under Contract
DE-AC05-76OR00033
U.S. Department of Energy

FINAL REPORT

OCTOBER 1985

72

TABLE OF CONTENTS

		Page
List of Figures		iii
List of Tables		iv
1.0	Executive Summary	1
2.0	Introduction	20
	2.1 Purpose and Scope	20
	2.2 Background and History	21
	2.3 Site Description	23
3.0	Organizational Structure and Staffing	29
	3.1 Organization	29
	3.2 Staffing	32
4.0	Air Monitoring Program	34
	4.1 General Description	34
	4.2 Stack Monitoring	35
	4.3 Ambient Air Monitoring	44
	4.4 Meteorological Data	49
	4.5 Compliance	51
5.0	Water Treatment and Monitoring	53
	5.1 General Description	53
	5.2 Liquid Monitoring Program	56
	5.3 Compliance	65
6.0	Groundwater Monitoring Program	66
	6.1 General Description	66
	6.2 Monitoring Program	66
7.0	Monitoring Program for Soil, Sediment, Vegetation, and Other Environmental Media	81
	7.1 Soil Sampling	81
	7.2 Sediment Sampling	87
	7.3 Vegetation Sampling	92
	7.4 Direct Radiation Measurement	96
	7.5 Other Environmental Sampling	98

3

Page

8.0 Waste Management 100

8.1 General Description of FMPC Wastes 100
8.2 Waste Management Activities 103
8.3 Waste Management Area Inspections 106

9.0 Analytical Procedures 108

10.0 Data Handling and Analysis 110

11.0 Quality Assurance Program 112

12.0 Dose Assessment 114

13.0 Emergency Preparedness 116

Appendices

Appendix A: Biographical Sketches of Review Panel Members

Appendix B: Scope of Work, Environmental Program Review, Feed Materials Production Center

Appendix C: Review Schedule

Appendix D: Personnel Contacted During Review

Appendix E: Documents Reviewed

LIST OF FIGURES

		Page
FIGURE 2-1:	Summary of Major FMPC Processes	22
FIGURE 2-2:	Map of Southwestern Ohio Indicating the Location of the Feed Materials Production Center	24
FIGURE 2-3:	Map of the FMPC Production Area	25
FIGURE 2-4:	Feed Materials Production Center Plant Layout	26
FIGURE 3-1:	Organizational Chart of the FMPC	30
FIGURE 4-1:	Locations of Perimeter Particulate Air and Radon Monitoring Stations	45
FIGURE 5-1:	Water Sampling Locations	55
FIGURE 6-1:	Locations of Onsite Production and Monitoring Wells	68
FIGURE 6-2:	Locations of Offsite Monitoring Wells	69
FIGURE 7-1:	Routine Soil Sampling Locations During 1984	82
FIGURE 7-2:	Sediment Sampling Locations	88
FIGURE 7-3:	Locations of Grass and Forage Sampling Butler County	94
FIGURE 7-4:	Locations of Grass and Forage Sampling Hamilton County	95
FIGURE 8-1:	Map Indicating Locations of FMPC Waste Areas	101

LIST OF TABLES

		Page
TABLE 1-1:	Summary of Recommendations and Suggested Priorities	13
TABLE 2-1:	Population Distribution in the Vicinity of the FMPC	28
TABLE 4-1:	Radionuclide Concentrations in Air Samples from Perimeter Monitoring Stations	48
TABLE 4-2:	Radon Concentrations at Perimeter Monitoring Stations	50
TABLE 5-1:	Radionuclides in Surface Water	61
TABLE 5-2:	Radionuclides in Water Discharged at the Great Miami River	62
TABLE 5-3:	Ion and pH levels in Surface Water	63
TABLE 5-4:	Summary of NPDES Data for 1984	64
TABLE 6-1:	Uranium in Onsite Well Water	72
TABLE 6-2:	Gross Alpha Activity in Onsite Well Water	73
TABLE 6-3:	Gross Beta Activity in Onsite Well Water	74
TABLE 6-4:	pH and Chloride in Onsite Well Water	75
TABLE 6-5:	Nitrate and Sulfate in Onsite Well Water	76
TABLE 6-6:	Uranium in Offsite Well Water	77
TABLE 6-7:	Nitrate in Offsite Well Water	78
TABLE 7-1:	Uranium Concentrations in Perimeter Soil Samples	84
TABLE 7-2:	Radionuclide Concentrations in Perimeter Soil Samples from the FMPC Area	86
TABLE 7-3:	Uranium and Technetium-99 Concentrations in Great Miami River Sediments	90
TABLE 7-4:	Uranium and Technetium-99 Concentrations in Sediments from Paddy's Run and Associated Drainage Ditches	91
TABLE 7-5:	Concentrations of Uranium and Fluorides in Grass and Forage Samples	97
TABLE 8-1:	Summary of Radioactive Wastes in Pits and Silos	102

1.0 EXECUTIVE SUMMARY

An evaluation of the program for monitoring radioactive and nonradioactive contaminants in effluents and the environment of the Feed Materials Production Center (FMPC) in Fernald, Ohio was conducted April 15-19, 1985. This evaluation included a review and assessment of the monitoring programs, procedures, equipment, and compliance with applicable federal and state regulations. No conditions or activities which pose an imminent threat to public health and safety were noted. Data developed by the FMPC indicate general compliance with current applicable Department of Energy (DOE) and Ohio environmental protection regulations. Some minor regulatory deficiencies were identified, but there was no evidence of serious violations. A few areas, notably air emissions and groundwater contamination, have potential for significant environmental impact and regulatory difficulties in the near future. Additional data are needed to thoroughly evaluate the current status of these areas, predict future conditions, and determine practicable options for remediation. In several other areas of monitoring, more and/or improved data should be developed to confirm an acceptable level of environmental protection.

While state-of-the-art or high-technology approaches and equipment may not be appropriate for all FMPC operations, control and monitoring activities must be consistent with regulatory requirements, and should be in accordance with methods of "accepted good practice" for comparable industries and DOE's ALARA (as low as reasonably achievable) philosophy. With respect to these criteria, some aspects of monitoring procedures, documentation, and quality assurance are deficient. Present effluent control systems are based on technologies of the 1950's and 1960's. Portions of these systems are in need of upgrading or replacement to assure that environmental health and safety will continue to be acceptable and that emissions will continue to satisfy applicable regulations and limits. Waste management practices are being upgraded, but some previous and current disposal and storage activities have resulted in surface water and groundwater contamination. Ultimate impacts from the past waste management activities must be assessed and, if necessary, mitigating measures implemented.

The FMPC staff has recognized many of the deficiencies and potential problem areas and has already initiated steps for further evaluation and/or improvements. It was apparent from the discussions and document reviews during this evaluation that current deficiencies in effluent control systems and management activities relative to environmental protection are a result of previous attitudes within FMPC and DOE that production is the first priority. While emphasizing product quality, cost, and schedule, insufficient consideration was given to other areas, including environmental protection. A more balanced approach to complete facility management must be achieved, and DOE must provide assistance to the FMPC in the form of technical guidance and funding support to correct current deficiencies and assure an effective environmental management program.

The remainder of this Section summarizes findings and recommendations of this review as related to specific program areas. Further information is to be found in the body of this report (Section 3 through 13). It should be noted that certain of the recommendations provide only one suggested approach and that there may be alternative approaches which would also be acceptable. Table 1-1 summarizes the recommendations from the body of the report according to categories of short-term and long-term priorities.

Organizational Structure and Staffing

The overall plant organizational structure results in a fragmentation of the responsibilities for the environmental management program into three major organizational units. As a result of this structure, there is no single focal point for program leadership and direction. Also, responsibilities are not clearly defined in some program areas. This lack of common line-organization responsibility inhibits open communication. As a result, field operations personnel are not being adequately instructed in monitoring and sampling procedures (criteria, equipment, and techniques), and there is a lack of current information, available at the supervisory level, concerning equipment condition and performance, selection of monitoring locations, and recent changes in plant activities and facilities.

Although the Health, Safety, and Environment (HS&E) Division has a direct line to the plant management, in the past this Division has not been directly

involved in decisions and actions with potential impact on the environmental program. It appears that plant management is taking steps to correct this situation.

Within the HS&E Division a new position of Environmental Group Director has been created. This new position will bring the waste management and environmental monitoring functions under the same line responsibility; however, some aspects of the environmental program will remain under a separate responsibility within the Power Plant and Utilities Group. The Environmental Group Director position has not yet been filled; there are also vacancies in several other professional level and technical level positions. FMPC is actively recruiting personnel for these vacant positions. The Health, Safety, and Environment Division presently has professional level personnel with educational backgrounds and work experience in environmental and effluent monitoring. Discussions with the staff indicated that most possessed good general knowledge; however, in-depth expertise in stack, air, surface water, groundwater, and terrestrial monitoring procedures are lacking.

There appears to be limited knowledge within the environmental staff as to the various feed stocks used in the plant and the design and operating parameters of effluent control systems. This is due, in part, to a lack of regular communication between personnel in the environmental management program and those responsible for production, plant design, maintenance, and engineering activities. Another factor is the lack of complete engineering information available on the varied equipment and operations within the plant. In many of the areas of deficiency noted by the reviewers, the HS&E staff appeared to be uninformed of existing situations and conditions and unaware that there were potential problems.

The overall HS&E staffing shortage has restricted participation of environmental personnel in outside training programs to the extent necessary to remain abreast of the rapidly developing field of environmental regulations, monitoring, and control. It does not appear that NLO, Inc. or DOE's Oak Ridge Operations Office (DOE/ORO) has, in the past, strongly encouraged outside training or communications with other DOE contractor organizations. This problem of staff shortage is compounded by a large amount of the staff's effort being devoted to multiple audits, appraisals, and

evaluations by outside groups as a consequence of recent environmental concerns and problems. The impact of this redirection of effort on the status of the routine program deserves consideration.

While there are individuals who demonstrated concern, initiative, and a positive attitude toward their duties and overall program objectives, it is apparent that the previous lack of management concern and financial support for environmental matters and the recent "crash" program of evaluations and fixes has had a demoralizing effect on certain members of the HS&E staff. Some displayed a defeatist attitude about ever improving conditions and were resistant to suggestions for changes. Others appeared to have little drive and initiative; their approach appears to be to wait until someone else tells them exactly what to do. Before this organizational unit can return to full effectiveness, some individual attitudes will need to be adjusted and staff motivation will have to be improved.

Air Monitoring Program

There are approximately 430 air-emission sources throughout the FMPC plant. Of these, the major sources originate from the uranium production operations. Sixty-eight dry dust collectors (baghouses) exhaust these operations. In addition to the dry collectors there are approximately 10 systems equipped with wet scrubbers for control of radioactive particulates and gases (UF_6) and chemical fumes, vapors, or gases, e.g. HF and NO_x. Other sources include such operations as individual analytical laboratory hoods, roof and wall vent fans, fugitive emissions, a coal-fired steam plant, a dry cleaning facility, and solid and liquid waste incinerators for non-hazardous wastes. Most sources have not been adequately characterized.

Routine sampling for particulate uranium releases is performed on the 68 baghouse stacks. Although data from this monitoring is used to develop a total source term for calculating doses to offsite personnel, the major use of stack monitoring is to estimate the total quantity of uranium released through exhaust discharges; results are primarily used for purposes of materials accountability. Limited grab sampling has also been performed on some wet scrubber system discharges and the steam plant stack; there is a continuous

monitor for oxides of nitrogen in the nitric acid recovery tower stack. Monitoring is not conducted on the other emission sources.

The present stack sampling methodology appears generally adequate; however, the sampling equipment and application of the methodology have many deficiencies, which make the adequacy and accuracy of the data questionable. Significant changes in the equipment and procedures are required. Requirements for sampling additional systems for radiological and nonradiological contaminant emissions must be determined. Also, additional information regarding the total source term, particle size distributions, lung solubility classifications, and other radionuclides present as contaminants is necessary for calculations of population doses from air emissions.

Air monitoring is performed at 7 locations on the plant perimeter. The uranium and radon concentrations measured at these locations indicate compliance with DOE 5480.1A guidelines. Equipment and procedures are generally adequate; however, the sample locations were selected without a thorough evaluation of the local meteorology. It is therefore possible that these samples may not be truly representative of concentrations at and beyond the plant perimeter. The Oak Ridge National Laboratory (ORNL) Energy Systems Group is performing a modeling study relative to siting of additional samplers. Sampling for fluorides (total and UF_6) is also recommended at the perimeter and offsite locations.

There are no offsite ambient air monitoring stations; FMPC is proposing to install at least 2 stations - one at the Cosby Township School (upwind) and one at the Ross School (downwind) during 1985. The ORNL study will suggest additional sites for offsite monitors. There is no equipment or procedure for offsite monitoring over extended time intervals in the event of large accidental releases and during emergency situations.

The FMPC does not presently have onsite meteorological monitoring capability. There is an active project to install a monitoring system. Delays have been experienced in obtaining readout telemetry instrumentation and software. Completion is not anticipated until FY 86.

Permit applications for all air emission sources have not been completed; comparisons with Ohio Environmental Protection Agency (OEPA) limitations are therefore not possible. The steam plant stack has been surveyed and determined to be in compliance with OEPA regulations. Concentrations of total suspended particulates, measured at the perimeter fence are in compliance with State of Ohio guidelines.

Water Treatment and Monitoring

The equipment and procedures for treatment and monitoring of wastewater effluent are generally adequate and satisfy current standards. However, procedures for collection of liquid effluent and other surface water samples and for assuring proper quality assurance practices in handling samples are not documented.

Sampling is performed at six onsite locations to assure effective control of liquid effluents. These sampling locations are at the two National Pollution Discharge Elimination System (NPDES) outfalls (Manhole 175 and the Storm Sewer overflow to Paddy's Run) and the four contributing streams to Manhole 175. Routine sampling of the effluent indicates very few exceedances of the NPDES permit limits and compliance with DOE Order 5480.1A. Water samples are also collected from three locations in the Great Miami River and three locations in Paddy's Run. Flow metering devices (flumes and weirs) at the outfalls are not regularly inspected or calibrated.

Surface flow and stormwater runoff at the FMPC site has not been adequately characterized. During a brief tour of the waste pit area, several surface drainage systems, which are not being controlled or monitored, were noted. Also, during field inspections, a flow was observed in the overflow outfall to Paddy's Run, although weather conditions were not such that overflow would be expected. This suggests subsurface seepage into the discharge pipe or leakage around the weir system. Discussions with sampling personnel revealed that during the summer months, there is little or no flow in the southern portion of Paddy's Run. These individuals indicated that the stream goes underground a short distance south of the waste pit area. This should be investigated as a possible contributor to the groundwater contamination south of the plant.

Potential liquid waste stream pollutants which are not currently monitored include heavy and trace metals, toxic organics, kerosene, perchloroethylene, and 1,1,1-trichloroethane.

The FMPC has several major liquid waste control or treatment projects under construction. These projects include a biodenitrification treatment system, a diversion system for coal-pile runoff, and a stormwater runoff retention basin. Completion of these projects is expected in 1986. The FMPC has developed a Spill Prevention Control and Countermeasure Plan which appears adequate.

Groundwater Monitoring Program

There are 13 onsite and 21 offsite groundwater monitoring wells and three onsite production wells, which are routinely monitored. Procedures for groundwater monitoring have not yet been finalized; the draft procedures reviewed are incomplete.

There are three groundwater systems beneath the FMPC. These systems are presently being characterized by Dames and Moore. Waste disposal/storage areas are situated within or on the surficial till; this groundwater unit thus has the greater potential for contamination. None of the existing wells monitor this layer, but four of the newly installed Dames and Moore wells are in this groundwater system. Three of these wells, located around waste pit 4, contained the highest groundwater uranium concentrations during the Dames and Moore study.

Potential sources of contaminant release to groundwater at the FMPC include the six waste pits, the burn pit, the clearwell, the K-65 silos, the metal oxide tanks, the scrap metal piles, the fly ash piles, the sanitary landfill, and runoff from the plant production area. The present well monitoring system is inadequate to properly monitor the individual contribution from each of these potential sources. In addition, the condition of the thirteen older onsite wells is questionable, relative to their continued use for regulatory purposes.

Sampling results indicate elevated uranium concentrations in onsite wells, near the waste pit area and in three offsite wells, south of the FMPC site. Although the concentrations were significantly above typical background levels, they remain within DOE 5480.1A and OEPA guidelines. Radionuclide analysis has been limited to uranium; analyses for other potential radionuclide contaminants are recommended.

Other Environmental Monitoring Programs

Procedures have been prepared for monitoring soil, sediment, and vegetation; however, these procedures lack certain information and do not accurately describe the monitoring program as currently being conducted. Routine sampling has identified uranium contamination in soil and sediment both onsite and offsite. Additional sampling and adherence to standard methods is required to thoroughly characterize the contamination, help identify sources, and permit evaluation of trends. No significant levels of other radionuclides have been identified in the soil or sediment, although a thorough analysis for all potential radionuclides has not been performed on sediment samples. Neither soil or sediment have been analyzed for nonradioactive contaminants such as metals and organics.

Onsite grass and forage samples contain low levels of uranium and fluorides. Produce (potatoes) from the plant vicinity did not contain detectable concentrations of uranium above background levels. Above-ground produce crops are also recommended for analysis for potential air deposition.

Direct radiation levels at the plant perimeter are typical of background levels, with the exception of the area nearest the K-65 residue storage towers. Levels at that location average about 20-30% higher than background, but are still well within the DOE guidelines for radiation in uncontrolled areas.

Milk and fish sampling have not identified evidence of uranium contamination due to FMPC activities. These sampling programs, which do not have document procedures, and other sampling programs, which are being considered, should be carefully evaluated to determine if they are warranted.

Waste Management

Previous FMPC activities have generated a large quantity of miscellaneous wastes including general noncontaminated scrap and refuse, contaminated and noncontaminated metal scrap, waste oils, low level radioactive waste, RCRA hazardous wastes, co-contaminated and mixed wastes, sewage treatment plant sludge, and flyash from the steam plant. Most of this waste has been retained onsite. There are six shallow pits (three of which are soil covered) which have been used for disposal of wastes contaminated with uranium. In addition, there are four silos (two containing K-65 radium bearing residues), two flyash piles (one partially covered), numerous piles of metal scrap, a sanitary landfill, construction rubble and debris, and hazardous RCRA waste from the RMI facility in Ashtabula, Ohio. Also, the FMPC has been designated as the DOE thorium storage center and a large quantity of thorium feed-material and products is stored on the site. Ultimate disposition of this material has not been determined.

Contaminated waste oil and noncontaminated combustibles are incinerated onsite. Toxic co-contaminated wastes, such as PCB wastes, are segregated and packaged for storage.

Waste management activities are well documented, although responsibilities for various aspects of these activities are not specifically delineated. Wastes previously placed in the pits and silos were characterized only in generic terms and no specific analyses are available.

The status of the current waste pit areas does not satisfy the requirements of DOE Order 5820.2; there is uranium contamination of the groundwater in the vicinity of the waste disposal areas.

The technique used for covering pits 1, 2, and 3 may have been inappropriate since the covering was not impermeable to water. The FMPC is engaged in programs to characterize the waste area, determine (and hopefully mitigate) the mechanisms of groundwater contamination, and evaluate options for ultimate disposition of the wastes. These studies are expected to be completed in 1986.

Inspections of the waste areas revealed conditions which could compromise the integrity of waste control and provide mechanisms for migration of contaminants to the environment. Immediate correction of these deficiencies has been recommended.

Analytical Procedures

Analytical procedures for effluent and environmental samples are generally the accepted methods recommended by EPA or DOE. Most have been reproduced directly from literature or reference manuals, without an attempt to adapt the documented procedure to the specific lab where it is being used. Several Bioassay Lab procedures have not been documented, and some other procedures are in various stages of preparation.

Two procedures which should be modified are the specific ion electrode method for NPDES nitrate analysis at less than 2 mg/l (not approved for this application by EPA or OEPA); and the acidification and storage of water samples for uranium analysis without first filtering to remove suspended solids.

Data Handling and Analysis

The HS&E staff is developing computer capabilities for storage and analysis of effluent and environmental monitoring data. Many of the data reductions and computations are still performed by "hand", promoting the chance of arithmetic errors.

Data are generated by several organizational units; not all data are provided to HS&E, and the form of the data that is maintained and provided differs, depending upon its source. Some of the monitoring and sampling data developed by FMPC laboratories and outside laboratories do not include uncertainties. Uncertainties presented with data are primarily based on statistical confidence limits associated with radiometric counting and do not include propogated errors from all activities, which introduce errors.

Development of standard procedures for data handling and analysis and designation of an individual responsible for coordinating data management would eliminate many of the deficiencies.

Quality Assurance Program

Laboratory quality assurance procedures appear generally adequate, although improved documentation of training and qualification is needed. Laboratories are maintaining good quality control records and performance on known QA samples is good. The percentage of quality control analyses should be increased to at least 10% of the total analyses performed.

Quality assurance provisions should be incorporated into field sampling and monitoring procedures, particularly the stack sampling procedures. Chain of custody for field samples is weak. There is no documented HS&E guidance regarding review and acceptance (or rejection) of monitoring and analytical data.

Dose Assessment

AIRDOS/DARTAB calculations by ORNL predict that the maximally exposed individual will receive a dose equivalent commitment of 1.8 mrem, whole body, and 100 mrem, pulmonary tissue from 1984 air emissions. These values are well within the current DOE guidelines of 500 mrem total body and 1500 to other organs (DOE Order 5480.1A). However, the calculated doses are based on a questionable source term and other parameters which have not been verified. Meteorological data used for the model may also not be appropriate. It is anticipated that planned improvements to air emission controls and the use of better defined input parameters will assure that EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) guideline is satisfied within the specified time frame.

Annual dose equivalent commitments calculated for drinking water from three offsite wells, which have been identified as containing uranium contamination, predicated values ranged up to 89 mrem effective dose and 1204 mrem to the bone endosteum. Calculated doses from intake of Great Miami River water, produce, milk, and fish are negligible.

Contributions from potential radiological contaminants other than uranium have not been included in dose calculations.

Emergency Preparedness

The FMPC has an ongoing emergency preparedness program for protection of workers, facilities, and the environment. Potential emergencies have been identified and evaluated, and some response capabilities are in place. Periodic training and drill are conducted.

Procedures for monitoring airborne particulate and gaseous contaminants in the vicinity of the plant during emergency situations involving uranium, HF, or ammonia releases are needed. Appropriate portable sampling and/or monitoring equipment should be obtained and personnel trained in its use.

TABLE 1-1

SUMMARY OF RECOMMENDATIONS AND SUGGESTED PRIORITIES

SHORT TERM PRIORITY (To be Accomplished Within Approximately One Year)

1. Complete the staffing upgrade by filling the position of the Director of the Environmental Group and other professional and technical vacancies. Concentrate on obtaining personnel with expertise in air and stack monitoring and groundwater monitoring.

2. Restructure the effluent and environmental monitoring program to place the primary responsibility for all monitoring within the HS&E Division. Document these environmental program responsibilities.

3. Management must demonstrate strong support of the Health, Safety, and Environment Division and assure direct involvement of this division in all FMPC activities which may have environmental impacts. The HS&E Division must become more aggressive in identifying deficiencies and recommending and initiating improvements in environmental areas.

4. Increase communications within HS&E and between HS&E and other organizational units to develop a thorough understanding of plant operations and equipment and the onsite and offsite physical environment.

5. Provide opportunities and encourage the staff to regularly participate in meetings, workshops, and short courses relative to environmental and effluent monitoring and control.

6. Pursue programs for improving staff motivation and attitude and developing espirit de corps within the HS&E Division.

7. Change the major theme of the stack monitoring program from materials accountability to environmental protection and regulatory compliance. Perform calculations in terms of concentrations.

8. Implement a program of routine (annual suggested) stack velocity measurements at emission sampling locations.

9. Conduct studies to document the performance of single point sampling in FMPC stacks, relative to providing representative sampling.

10. Initiate improvements to the stack sampling systems presently in use. Upgrades should begin with ventilation systems historically noted to be major contributors to plant air emissions. Recommended changes include:

    a. replacement of present probes with stainless steel probes meeting ANSI and EPA design recommendations.

    b. use of leak-free oil-less or modified lubricated vacuum pumps.

    c. relocation of flow gauges to the discharge side of the pumps.

d. replacement of filter holder with a transparent model.

e. replacement of pleated filters with glass fiber or cellulose membrane filters having collection efficiencies >99% for 0.3 μm particles.

f. leak test all sampling systems.

11. Implement a program for routine (semiannual) inspection of sampling probes.

12. Replace and analyze all stack samples on a minimum frequency of weekly.

13. Protect breakthrough monitors from tampering. Develop a standard for setting monitor alarm points. Provide flashing lights or amplified sound to assure that alarms are noted. Require that the count rate meter records are provided to HS&E personnel responsible for stack monitoring.

14. Assure that the NO_x monitor in the nitric acid recovery tower is operating properly and is calibrated. The HS&E Division should assume responsibility for routine monitoring of this and any other air emissions sources currently not under their cognizance.

15. Develop action levels and incorporate these into stack monitoring procedures.

16. Perform analyses on composite samples from several major emission sources for other radionuclides, known to be present in FMPC uranium feed stocks. Based on the results of these analyses, determine whether these other radionuclides contribute significantly to calculated population doses, and if periodic measurement of these radionuclides is warranted.

17. Conduct particle size determinations on samples from major emission sources. Also determine lung solubility classifications for composites of samples from major emission sources.

18. Proceed with plans to locate sampling stations at the two school sites. Also, evaluate current sampler locations and additional offsite sampler locations recommended by the ORNL modeling report.

19. Provide flow recording devices and elapsed timers on the high-volume samplers for perimeter and offsite monitoring.

20. Develop equipment and procedures for sampling potential hazardous contaminants other than particulate uranium in critical perimeter and offsite locations. Both routine (continuous) sampling and emergency sampling capabilities should be available. It is recommended that routine sampling be conducted for uranium fluoride and total fluorides carbonate treated filters would be acceptable sampling media. Procedures should also be developed for ambient sampling of NH_3OH and NO_x for use on an intermittent basis and under conditions of release incidents and emergencies.

21. Establish a requirement for sampler calibration and maintenance. Six months appears to be a reasonable interval.

22. Complete applications for OEPA air discharge permits.

23. Complete compliance testing for the solid waste incinerator stack.

24. Continue with plans for improvements to air emissions control systems. Implement improvements on historically significant emission sources.

25. Develop detailed procedures for sampling liquid effluents and surface water sources. Procedures should require recording of pertinent field data such as weather conditions, temperature, sample appearance, odor, and other comments.

26. Implement a program for periodic inspection, maintenance, and calibration of flow metering devices (flumes and weirs). Identify the source of flow from the stormwater overflow discharge.

27. Initiate regular maintenance and calibration schedules for NPDES sampling equipment.

28. Identify and characterize all sources of surface runoff from the plant site. Initiate programs for sampling water and sediment from these sources.

29. Increase the number of surface water sampling points on Paddy's Run. It is suggested that 4 to 6 additional samples be routinely collected in the vicinity of the waste pits, K-65 silos, and flyash piles.

30. Investigate the possibility that the subsurface portion of Paddy's Run contributes to the groundwater contamination problem.

31. Perform analyses on several daily and composite samples from all effluent sampling locations for additional potential pollutants which might be suspected of being present at the plant. These should include heavy metals listed in 40 CFR 122, Appendix D, Table III; trace metals listed in Table IV of the same regulation; and toxic organics. Based on the results of these analyses, determine the need for further sampling and analyses.

32. Groundwater sampling procedures should be finalized and documented. Consolidate groundwater monitoring responsibilities in one group and provide an individual with a background in such monitoring. Implement changes to make sampling procedures similar for onsite and offsite wells. Determine appropriate well-evacuation volumes.

33. Determine the physical condition of existing wells; repair or recondition as appropriate. Wells which are substandard should be removed from service and plugged (grouted).

34. Provide additional onsite wells to completely characterize the local hydrology and evaluate sources, migration pathways, and trends. These

wells should be placed in the surficial till, which is the critical zone for uranium groundwater contamination at FMPC.

a. Place sufficient wells around each source area to enable determination of its individual effect on groundwater quality.

b. Use screened wells downgradient to allow determination of gross contaminant movement via a plume. It is advantageous to screen these wells over the entire distance of the aquifer to ensure that a leachate plume is not passing beneath the well system.

c. Use wells placed directly upon the waste area. These wells provide the best indication of what is happening as groundwater passes a source.

d. Use well clusters which permit monitoring of all three groundwater zones.

35. Parameters such as pH, conductivity, temperature, and dissolved oxygen can be readily monitored during well evacuation and serve as excellent indicators of sample stability, especially if well depths are not known, and thus adequate evacuation volumes cannot be estimated. Such monitoring provides valuable data regarding gross groundwater quality, such as the presence of acids, organics, etc. A portable pH/conductivity meter should be purchased and used during sample collection, particularly for those onsite wells that are old and for which the depths are not known, in addition to all the offsite wells. A sampling form like that used by Dames and Moore should be adopted.

36. Conduct additional analyses of groundwater samples for other radionuclides (Np-237, Th-228, Th-232, Ra-226, Ra-228, Pu-238, Pu-239/240, Ru-106, Sr-90, Cs-137, and Tc-99) known to be present in materials processed, stored, or disposed of at the FMPC. Also monitor for heavy and trace metals and volatile and non-volatile organics. Based on these results, determine the need for routine measurement of these parameters.

37. Revise soil, sediment, and vegetation sampling procedures to reflect current routine sampling locations and to address matters of parallel vegetation/soil sampling; improved sampling equipment cleaning techniques (or use of separate collection equipment at each location); personnel training, including documentation; expanded radionuclide analyses; and recording of pertinent site and sample information. Develop procedures for sampling milk, fish, and other media and for monitoring direct radiation.

38. Conduct a thorough survey of uranium soil contamination in the environment surrounding the FMPC.

39. Establish a program for routine soil sampling within the plant area. A minimum of 20 sampling locations is suggested. Locations should include areas of heavy traffic, storm runoff pathways, and some relatively undisturbed regions.

40. Analyze a representative selection of soils with elevated uranium concentrations for nonradiological contaminants. Analyses should include heavy and trace metals, known to be present in materials at the FMPC. Based on results determine if these parameters should be routinely evaluated.

41. Conduct sampling of other drainage ditches to measure levels of uranium in sediments. Based on results determine if these should be added as routine sampling locations.

42. Complete planned actions to identify sampling locations and to revise sediment sampling techniques.

43. Collect one set of sediment samples annually from the flow channel of the Great Miami River.

44. Analyze a selection of sediment with elevated uranium concentration for other radionuclides (i.e. transuranics, thorium, radium, and fission products), known to be present in contaminants in FMPC materials. Also conduct analyses for organics and heavy and trace metals. Decide on need for routine analyses for these parameters, based on results of initial screening tests.

45. Ground crops such as potato tubers are of questionable value by themselves. Above ground crops are also indicators of deposition. It may be useful to investigate the use of soybeans, because they possess good air intercept qualities and are widely cultivated in this region, thus providing numerous potential sampling sites.

46. Re-examine the need for sampling fish and other organisms currently being considered. If such an evaluation or a preliminary screening study indicates that these sampling program would provide useful data, then proceed with their implementation; otherwise document the evaluations and concentrate efforts on aspects of the environmental and effluent monitoring program which are in greater need of attention.

47. Proceed with plans to perform physical, chemical, and radiological characterization of wastes, presently stored/disposed of in silos and pits.

48. Identify potential onsite sources of uranium release to shallow groundwater and apply appropriate control measures.

49. Continue activities necessary to achieve compliance with DOE Orders 5480.2 and 5820.2.

50. Evaluate current status of waste disposal areas, relative to leachate levels and liner integrity. Initiate temporary steps to achieve hydrologic isolation while permanent stabilization techniques are being developed. Take corrective measures to eliminate conditions which are detrimental to the continued integrity of waste storage and disposal areas (Section 8.3). Develop criteria for maintenance of such areas and initiate routine inspections to identify and correct potential problems.

51. Develop and implement a compliance monitoring plan for waste areas.

52. Obtain the necessary permits for disposal areas identified as having received hazardous wastes and for the proposed new sanitary landfill site.

53. Establish background levels for relevant contaminants listed in Appendix VIII of RCRA regulation, 40 CFR 261.

54. Work with DOE to obtain a decision regarding the ultimate fate of the thorium currently stored at the FMPC.

55. Apply, per 40 CFR 136, for approval of the specific ion electrode method for NPDES nitrate analysis. An alternative would be use the approved cadmium reduction/colormetric method.

56. Filter water samples intended for uranium analyses before addition of nitric acid for preservation. The solids on the filter can be analyzed separately if there is concern for total (suspended plus dissolved) uranium.

57. Complete documentation of all FMPC laboratory procedures. These procedures should be "tailored" to meet the conditions of the specific laboratories in which they are being used.

58. Request analytical groups to provide uncertainties (total propogated errors) and detection sensitivities with all reported data.

59. Consider the recommendations of EPA 520/1-80-012 "Upgrading Environmental Radiation Data" concerning uncertainties, significant figures, and use of zero and negative values.

60. Assign a member of the HS&E staff the responsibility for data coordination.

61. Develop and document procedures for data generation, storage, and management. Such procedures should include a rational for data analysis, describing statistical packages and trend analysis procedures.

62. Increase computer capability. A minimum should be a dedicated personal computer with appropriate data management and analysis software packages. Several such packages are Systat, Statpac, and Open Access.

63. Develop QA plans covering data handling and analysis, data acceptance, chain of custody, training, and field sampling procedures.

64. Increase the frequency of internal QA/QC samples to a minimum of 10% for all analytical work.

65. Assure that new analytical procedures are routed directly to QA/QC coordinator for review and comment.

66. Include quality control samples (spikes and blanks) with samples sent to outside laboratories for analysis.

67. Evaluate dose contributions for other potential radiological contaminants in air, surface water, and groundwater.

LONG-TERM PRIORITY (May Require In Excess of One Year to Accomplish)

1. Identify and characterize all potential sources of radiological and nonradiological air contaminants. Based on this information conduct short term sampling of those emissions not presently monitored. Use these results to determine what additional routine stack monitoring is required.

2. Perform a survey to compile current information on exhaust ventilation system design and operating parameters.

3. Complete upgrades to the stack sampling system (see item 10 under Short-Term Priority Recommendations).

4. After ventilation system and sampling system improvements, generate a data base to determine if additional breakthrough monitors are needed.

5. Install 2 to 4 additional offsite air monitors based on recommendations of the ORNL modeling and FMPC evaluations.

6. Complete installation, calibration, and testing of the FMPC meteorological station and initiate accumulation of site specific meteorological data.

7. Continue improvements and upgrades on air emissions control system.

8. Complete characterization of wastes presently stored/disposed of in pits and silos.

9. Implement actions to control, reduce, or eliminate sources of groundwater contamination in the environment of the FMPC.

10. Develop and implement site stabilization and closure plans for all waste areas, consistent with requirements of DOE order 5820.2. Evaluate needs for leachate removal and prevention of introduction of water following closure.

2.0 INTRODUCTION

2.1 Purpose and Scope

At the request of the U.S. Department of Energy's Oak Ridge Operations Office (DOE/ORO), Oak Ridge Associated Universities (ORAU) organized and directed a review of the effluent and environmental monitoring program at the Feed Materials Production Center (FMPC) in Fernald, Ohio. This review was conducted April 15-19, 1985, by a five-person panel consisting of the following individuals:

J.D. Berger - ORAU; Oak Ridge, Tennessee
C.S. Gist - ORAU; Oak Ridge, Tennessee
C.M. Morrow - Independent Consultant; Oak Ridge, Tennessee
D.J. Niederkorn - Q Source Engineering; Miamisburg, Ohio
D.T. Robinson - Pollution Control Science; Miamisburg, Ohio

These panel members were selected on the basis of their educational backgrounds, experience in various aspects of effluent and environmental monitoring, and familiarity with applicable regulations and standards or generally accepted industry practices. Biographical sketches of the panel members are provided in Appendix A. Vincent Fayne of the DOE/OR Environmental Protection Branch participated in the review as an observer and facilitator.

The review was a comprehensive technical assessment of the FMPC program for monitoring contaminant levels in plant effluents and the environment. Appendix B contains the scope of work issued by DOE/OR for this review. Included in the review were the plant's organizational structure and staffing as related to environmental activities; waste management programs; sampling methodologies, equipment, and procedures; analytical techniques; quality assurance; and computational and data processing methods. Compliance with applicable environmental protection regulations was also evaluated.

The Argonne National Laboratory document, Internal Environmental Protection Audits: A Suggested Guide for U.S. Department of Energy Facilities, (ANL/EES-TM-237), August 1983, was used to guide the review process. Information was obtained through a combination of discussions with FMPC staff members; field inspections of effluent release points, sampling equipment, analytical facilities, and waste storage sites; and review of documents. The review schedule is presented in Appendix C; Appendices D and E are listings of FMPC staff contacted and documents reviewed, respectively.

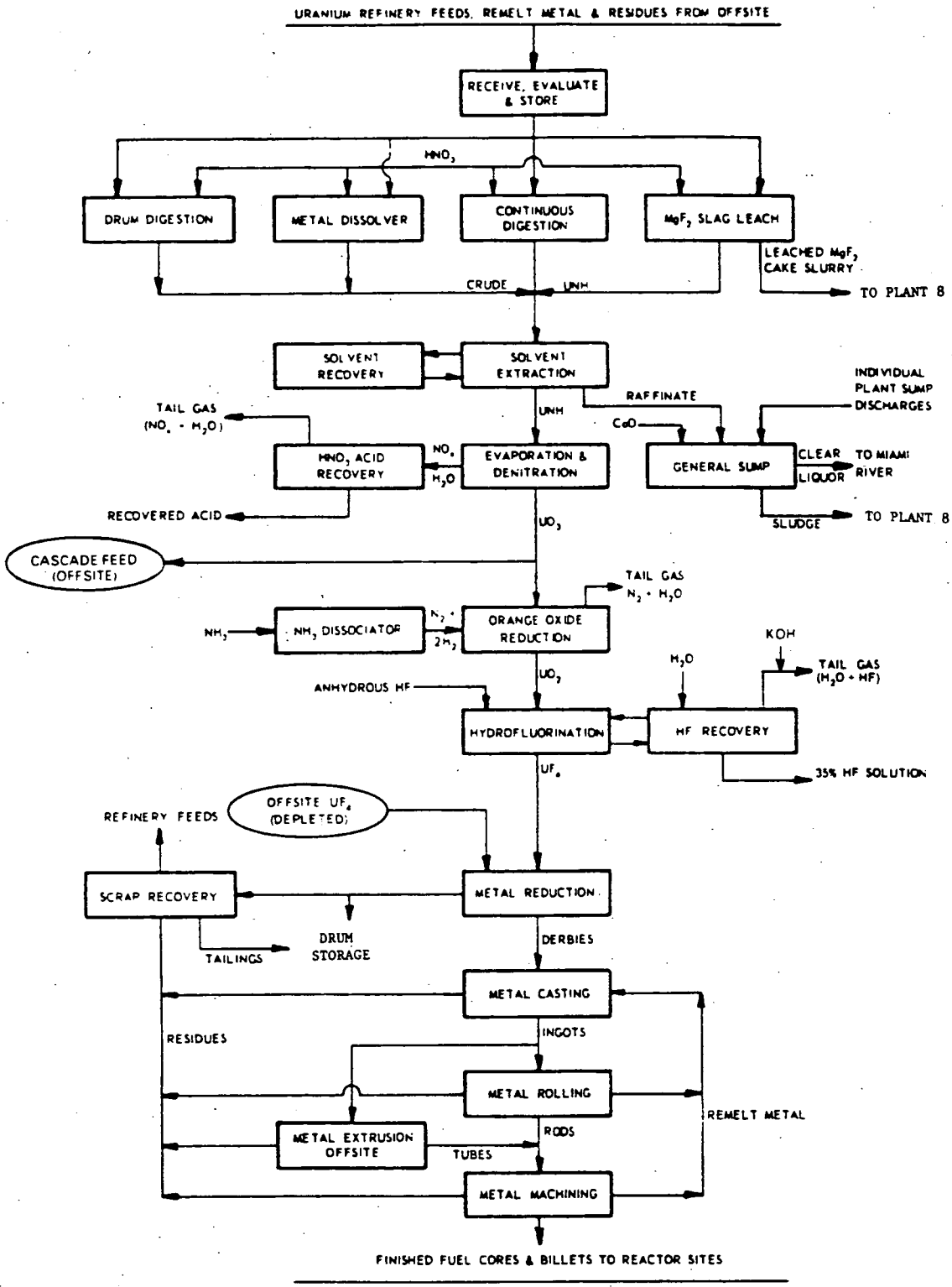
Items of concern, noted during the review, were brought to the immediate attention of plant personnel. A brief close out presentation was made by C. Gist on the afternoon of April 19, identifying those areas where major deficiencies or potential problems were felt to exist.

2.2 Background and History

The Feed Materials Production Center (FMPC) is located in a rural area of southwestern Ohio, near the community of Fernald. The plant is operated by NLO, Inc., a subsidiary of NL Industries (formerly the National Lead Company) under contract DE-AC05-76OR01156 with the U.S. Department of Energy. Oak Ridge Operations Office of the Department of Energy has the responsibility for administration of this contract.

The FMPC was originally constructed in 1954 to produce high purity uranium-metal in various physical forms and isotopic assays. Most of the production stream metal is cast into ingots, for eventual fabrication into fuel cores for production reactors at the Hanford Reservation near Richland, Washington, and the Savannah River Plant near Aiken, South Carolina. A wide variety of chemical and metallurgical process steps are utilized; Figure 2-1 is a schematic of the FMPC processes. U-235 enrichments in raw materials range up to approximately 20%; however, the maximum product enrichment is 1.25% and the average product is slightly depleted. A small amount of thorium processing was also performed in the past, but present thorium activities are limited

FIGURE 2-1
Summary of Major FMPC Processes



(Adapted From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

to storage. Small quantities of fission products (Sr-90, Cs-137, and Tc-99) and transuranics are also possible in some plant effluents and wastes as a consequence of processing some recycled fuel.

Facilities and procedures available for the control, treatment, storage, and monitoring of effluents and wastes are described in greater detail in the various sections of this report, the January 1981 Environmental Report, and the Site Development and Facilities Utilization Plan, NLCO-2012.

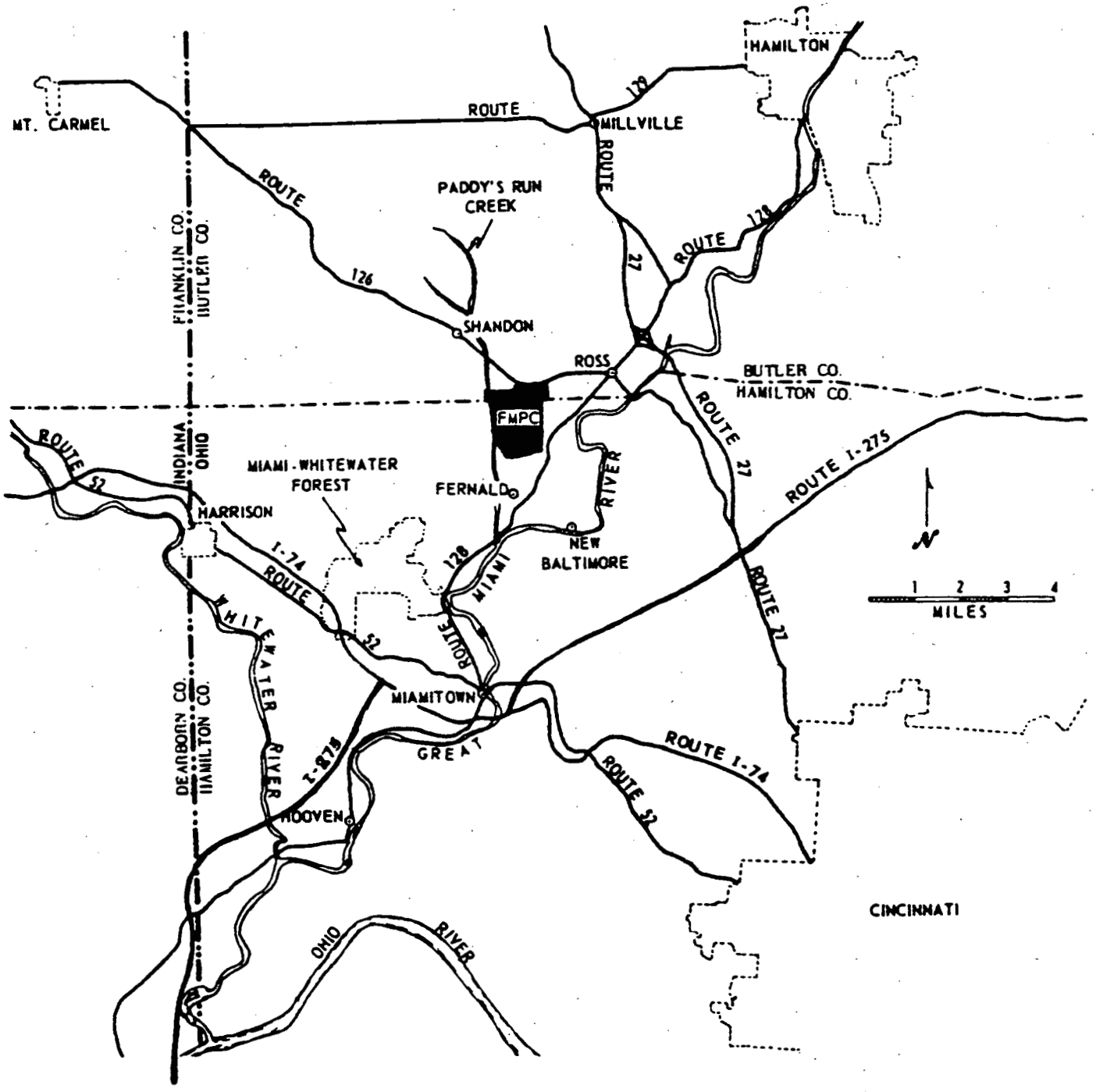
2.3 Site Description

The Feed Materials Production Center is located near Fernald, Ohio, in Butler and Hamilton Counties, approximately 16 km northwest of Cincinnati and 13 km southwest of Hamilton (see Figure 2-2). The site occupies a total of 425 ha, bounded on the south by Willey Road, on the west by Paddy's Run Road, on the north by farm land and State Route 126, and on the east by a dairy farm (see Figure 2-3). Production facilities occupy 55 ha in the center of the site. All of the production and waste storage areas are within Hamilton county.

The FMPC consists of eight separate operations plants, support buildings and facilities, and waste treatment and storage facilities. Figure 2-4 is a diagram of the plant layout. Waste storage facilities are located on the west side of the plant and include tanks (silos) and both active and inactive (covered) shallow pits.

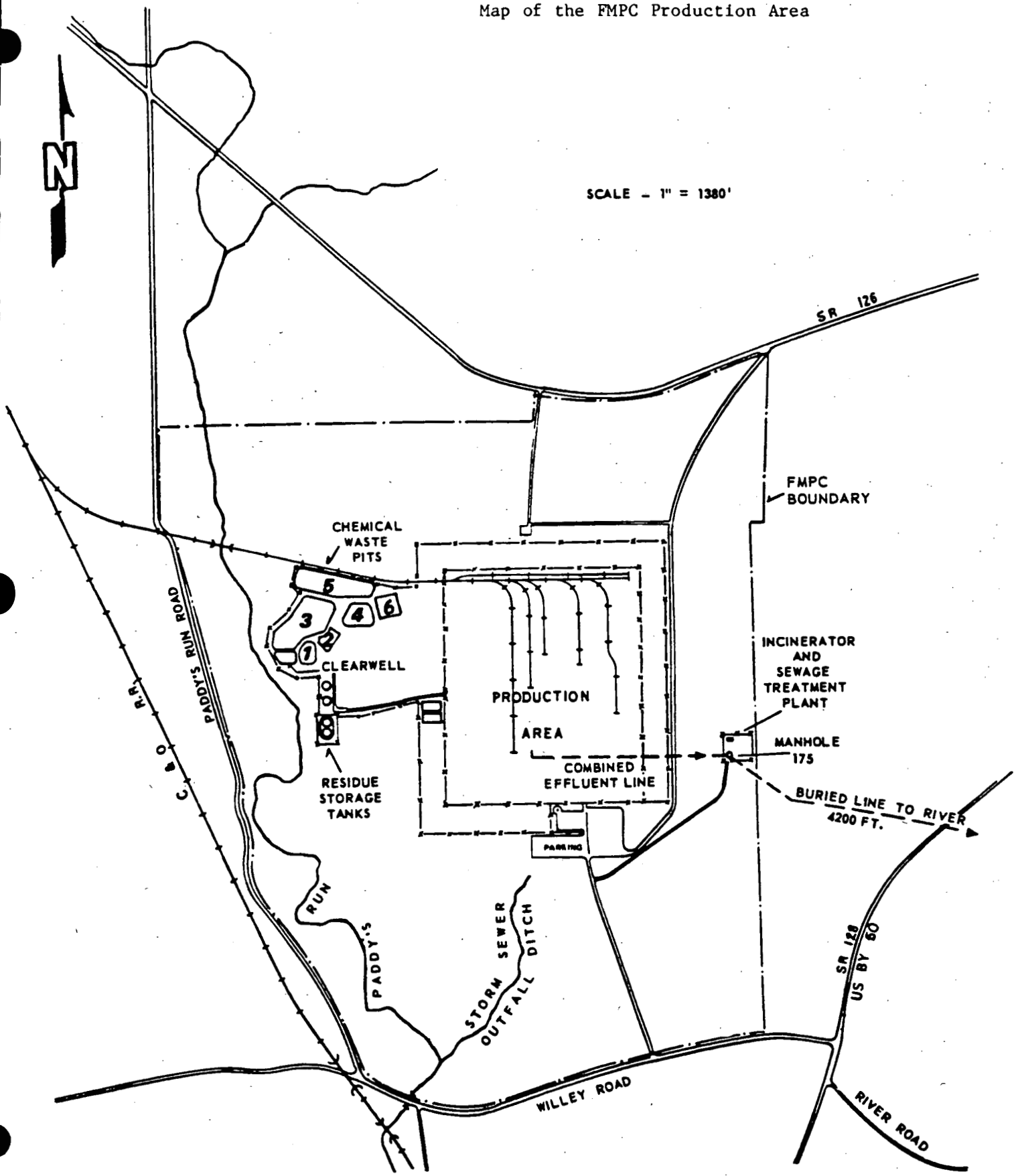
The site is located on an elevated plain approximately 177 m above sea level. Topography is generally level; the land rises to 213 m at the northern boundary and slopes downward (168 m) to Paddy's Run on the west. The FMPC is situated in the Great Miami River Basin. Natural surface drainage of the site is to Paddy's Run, an ephemeral stream discharging to the Great Miami River. The river valley contains unconsolidated glacial drift deposits to a depth of 46-61 m. Most of the glacial drift is covered by approximately 15 m of clay-rich till, which restricts infiltration of surface water; however, there are

FIGURE 2-2
Map of Southwestern Ohio Indicating the Location of the Feed Materials Production Center



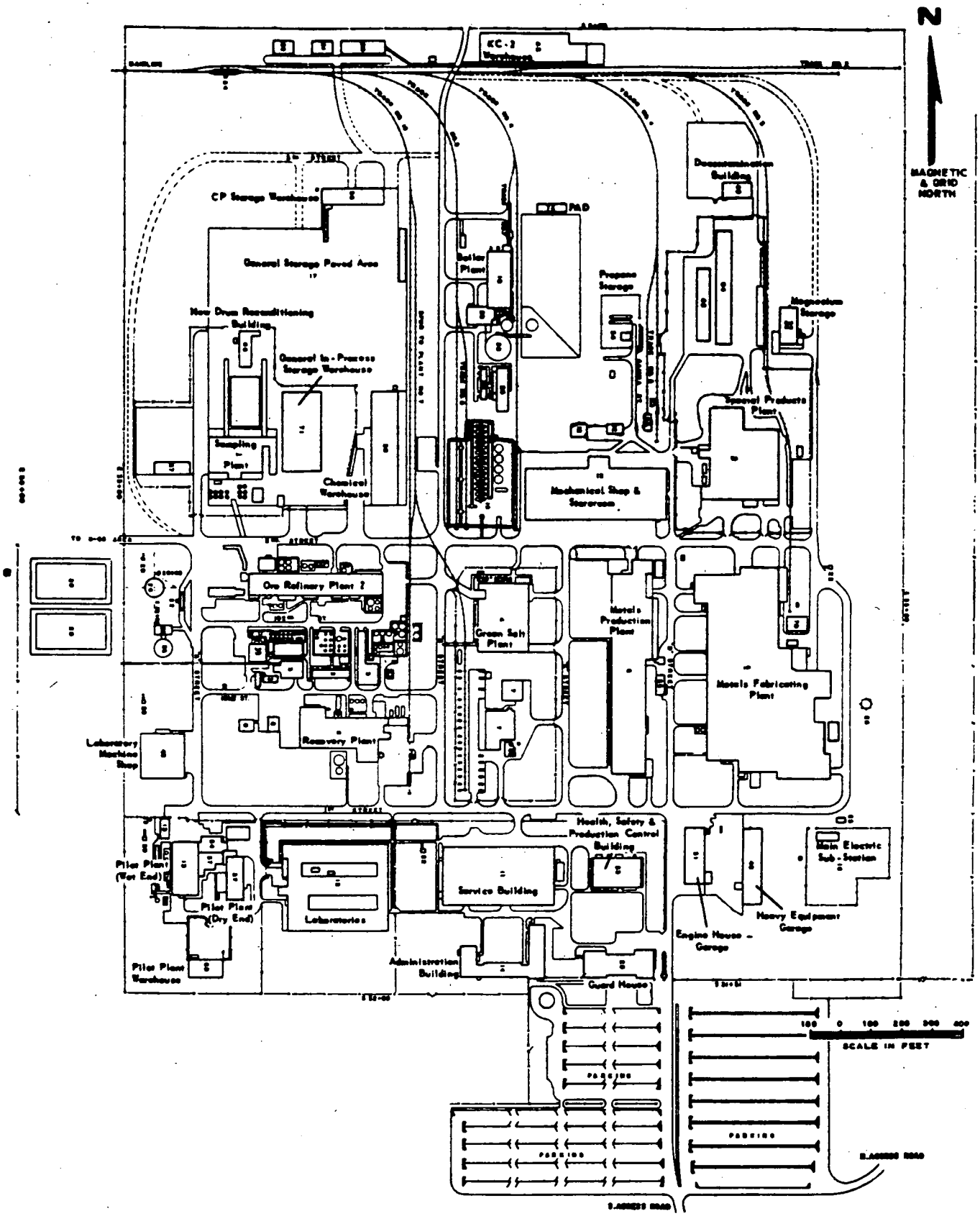
(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

FIGURE 2-3
Map of the FMPC Production Area



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

FIGURE 2-4
Feed Materials Production Center Plant Layout



regions where sand and gravel deposits extend to the surface. In the area of the FMPC, a thin clay layer, about 38 m below the surface, divides the sand and gravel deposits into two layers. These two layers form two separate major aquifers; the upper aquifer moves in a southeasterly direction and is recharged locally from infiltration; the lower aquifer is artesian in nature and is not greatly influenced by local surface water and precipitation.

The average daily temperature ranges from 0° C in the winter months to the low 20°'s C in summer months. Average annual precipitation is approximately 96 cm. Prevailing winds are from the south-southwest with average monthly speeds ranging from 10.8 kph to 18.0 kph.

The FMPC is located in a rural area surrounded largely by farm land and dairy pasture land. The immediate area is sparsely populated; however, the small communities of Fernald, New Baltimore, Ross, and Shandon are within 5 km of the plant. A 1981 study by Dames and Moore indicated only 88 people living within 1-6 km of the site and approximately 11,000 people within 8 km. Table 2-1 is a summary of the population distribution within 80 km. The nearest residence to FMPC has been identified as being on State Route 126, immediately north of the site boundary.

TABLE 2-1
Population Distribution in the Vicinity of the FMPC

Compass Sector	Estimated Population (1)			
	0 - 8 km (0 - 5 mi)	8 - 16 km (5 - 10 mi)	16 - 32 km (10 - 20 mi)	32 - 80 km (20 - 50 mi)
N	445	3,395	6,743	29,597
NNE	221	18,959	12,805	148,079
NE	489	32,001	36,705	557,783
ENE	2,489	25,760	29,830	55,078
E	512	40,770	70,762	85,240
ESE	713	54,533	150,630	107,365
SE	1,606	36,467	247,846	118,490
SSE	985	28,932	207,202	51,946
S	669	19,214	53,673	39,116
SSW	390	4,217	10,614	21,987
SW	185	2,957	13,066	16,574
WSW	440	4,961	3,930	19,199
W	519	1,765	3,292	31,629
WNW	157	1,361	5,211	21,605
NW	511	1,433	1,802	37,945
NNW	519	1,134	21,042	71,493
Totals	10,850	277,859	875,153	1,413,126

Total in all sectors: 2,576,988

Footnote:

(1) Based on "Report of Findings, Population Studies for DOE Feed Materials Production Center, Near Fernald, Ohio, for NLO, Inc.", May 18, 1981.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

3.0 ORGANIZATIONAL STRUCTURE AND STAFFING

3.1 Organization

Figure 3-1 shows the organizational structure of the NLO Feed Materials Production Center. Management and operation are under the direction of R.M. Spenceley. R.B. Weidner is the director of Health, Safety, and Environment (HS&E); this group reports to the Plant Manager through the Director of the Environmental Group (a position currently vacant). In addition to the Health, Safety, and Environment Division, organizations with environmental control and monitoring responsibilities are Waste Management (presently part of the Technical Group but planned for transfer to the Environmental Group); Power Plant and Utilities, which reports to the Assistant Plant Manager; and the Technical Group's Analytical Department, which performs laboratory analyses of some environmental and effluent samples. The responsibility for the FMPC Quality Assurance/Quality Control (QA/QC) Program is also located within the Technical Group; QA/QC for all plant analytical activities is being assumed by the Analytical Department.

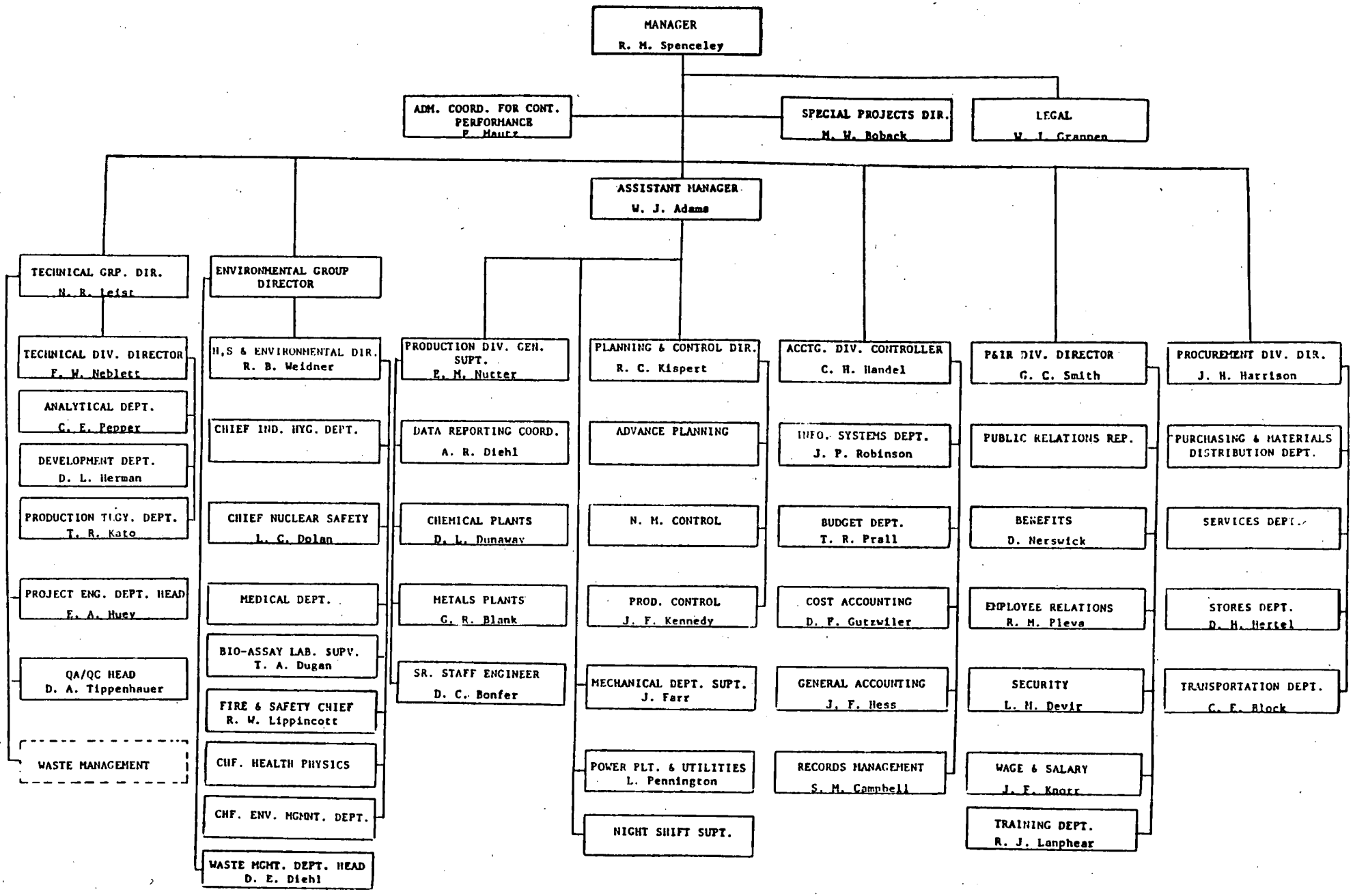
Findings

- The structure of the environmental program is fragmented, involving groups in three major organizational units. As a result of this structure, there is no single focal point for program leadership and direction. Responsibilities are not clearly defined in some program areas.

- A new position of Environmental Group Director has been created but is not filled. This new position will bring the waste management and environmental monitoring functions under the same line responsibility; however, some aspects of the environmental program will remain under a separate responsibility within the Power Plant and Utilities group.

- Waste Management has responsibilities for treatment and disposal of wastes and preparation of necessary federal and state permit

FIGURE 1
Organizational Chart of the FMPC



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

applications. Power Plant and Utilities operates the water treatment, sewage treatment, and steam plants; that department also conducts sampling of effluents from these activities.

- Separation of organizational responsibilities for sampling (or monitoring) and sample analysis is a frequently encountered situation. This separation is usually preferrable, because the question of bias is avoided and the independence of the analytical program is assured. There appears to be good communication between the analytical and organization and the rest of the environmental program. Also, the environmental monitoring staff indicates acceptable response and prioritization of sample analysis.

- Thorough exchange of information and direction is inhibited by the lack of a common responsible line organization contact. As a result, all field operations personnel are not being adequately instructed in control and sampling methods and regulatory requirements.

- Field monitoring and sampling personnel are not communicating adequately with their supervisors. This is evidenced by the lack of current information, available at the supervisory level, concerning equipment condition and performance, selection of monitoring locations, and recent changes in plant activities and facilities.

- There appears to be limited knowledge within the environmental staff as to the various feed stocks used in the plant and the design and operating parameters of effluent control systems. This is due to a large extent to a lack of regular communication between personnel in the environmental program and those responsible for production and plant design and engineering activities.

Recommendations

The position of the Director of the Environmental Group should be filled as soon as possible. Responsibilities for effluent and environmental

sampling (or at a minimum, overview of this sampling), presently performed by the Power Plant and Utilities group, should be reassigned to the environmental monitoring organization. All responsibilities within the environmental program should be documented.

Management must demonstrate strong support of the Health, Safety, and Environment Division and assure direct involvement of this division in all FMPC activities which may have environmental impacts.

Increased communications within HS&E and between HS&E and other organizational units are necessary to develop a thorough understanding of plant operations and equipment and the onsite and offsite physical environment.

3.2 Staffing

Findings

- The Health, Safety, and Environmental Division has professional level personnel with educational backgrounds and work experience in environmental and effluent monitoring. Discussions with the staff indicated that most possessed good general knowledge; however, in-depth expertise in stack, air, surface water, ground water, and terrestrial monitoring procedures are lacking.

- Several professional level staff vacancies, including the Director of the Environmental Group, are vacant. There are also vacant technician level positions. FMPC is actively recruiting personnel for these vacant positions.

- The lack of staffing has inhibited participation of environmental personnel in outside training programs to the extent necessary to remain up-to-date with the rapidly developing field of environmental regulations, monitoring, and control. It does not appear that in the past NLO, Inc. or DOE/ORO has strongly encouraged outside training and communications with other DOE contractor organizations.

- Several longer-term staff members indicated previous lack of management concern and financial support for environmental control and monitoring activities. As a result some of these individuals appear demoralized and have developed a defeatist attitude; they are apathetic, display a lack of drive and initiative, and are suspicious of and resistant to suggestions for program changes.

Recommendations

Continue recruitment with intentions of filling the vacant positions with qualified personnel as quickly as possible. Attempts should be made to obtain personnel with expertise in monitoring practices for effluent and environmental media.

Provide opportunities and encourage the staff to regularly participate in meetings, workshops, and short courses relative to environmental and effluent monitoring and control.

Programs for improving staff motivation and attitude and developing espirit de corps within the HS&E Division should be pursued.

4.0 AIR MONITORING PROGRAM

4.1 General Description

There are approximately 430 air-emission sources throughout the FMPC plant. Of these, the major sources originate from the uranium production operations. Sixty-eight dry dust collectors (baghouses) exhaust these operations. In addition to the dry collectors there are approximately 10 systems (the Health, Safety, and Environment staff was not able to identify the exact number) equipped with wet scrubbers for control of radioactive particulates and gases (UF_6) and chemical fumes, vapors, or gases, e.g. HF and NO_x. Other sources include such operations as individual analytical laboratory hoods, roof and wall vent fans, fugitive emissions, a coal-fired steam plant, a dry cleaning facility, and solid and liquid waste incinerators for non-hazardous wastes.

Routine sampling for particulate uranium releases is performed on the 68 baghouse stacks. Limited grab sampling has also been performed on some wet scrubber system discharges and the power plant stack; there is a continuous monitor for oxides of nitrogen in the nitric acid recovery tower stack. Monitoring is not conducted on the other emission sources.

Sampling of baghouse stacks is conducted using single nozzle probes. Samples are withdrawn (usually from the stack centerline) at varying rates to approximate isokinetic flows, and particulates are collected on pleated, glass-fiber filters. Sampling is continuous during ventilation system operation. Eight of the filter holders, on systems with higher potentials for uranium releases, are equipped with "breakthrough" radiation monitors. Filters are inspected weekly and replaced if a "significant" quantity of material is observed on the filter; otherwise the filter is left in place and replaced on a monthly schedule. Filters are analyzed for total uranium content, and results are reported in units of total grams of material released during the sampling period. Although data from this monitoring is used to develop a total source term for calculating doses to offsite personnel, the major use of the stack monitoring results has been for materials accountability.

There are seven high-volume air samplers located around the plant perimeter fence. These samples operate continuously at approximately 1 m^3/min; filters are replaced weekly and analyzed for total suspended particulates and uranium. Results of these perimeter monitors are used to demonstrate compliance with federal and state regulations. Installation of offsite stations for air monitoring are planned during 1985.

Radon levels are monitored at the perimeter fence by HS&E and at 17 locations throughout the site by Mound Laboratories.

4.2 Stack Monitoring

4.2.1 Monitoring Program

Findings

- There is a documented procedure for stack monitoring - IH&R Procedure 1.4 (Revised 1/1/85) "Stack Sampler Inspection and Filter Change Procedure".

- Stack monitoring was originally initiated (about 30 years ago) for the purpose of determining losses of uranium for material accountability inventories. Monitoring results are still reported in units of grams of uranium released, primarily for accountability purposes.

- Discussions with the Health, Safety, and Environment staff, identified a lack of in-depth familiarity with the ventilation systems, production operations, and stack monitoring equipment. This group does not include a staff member with expertise in stack monitoring techniques.

- There are 68 dry dust collector (baghouse) stacks for production areas. All of these stacks are monitored during their operations. Although not all samplers are interlocked to assure operation when dust collectors are running. In addition to the dry collectors,

there are approximately 10 systems equipped with wet scrubbers (pickling, kilns, furnaces, nitric acid recovery, etc.), numerous small stacks such as discharges from laboratory hoods, roof and wall vents, and fugitive emission sources. None of these air emission sources are routinely monitored. Grab sampling of some of these air streams has revealed the presence of acid gases (NO_x and HF). H_2 was detected in explosive concentrations in the UF_6-->UF_4 pilot plant stack. Other potential contaminants include organics (gasoline, kerosene, general solvents, perchloroethylene), UF_6, and NH_3. Failure to monitor these other sources appears due to a lack of concern that these sources are significant contributors, a lack of interest in releases other than uranium, and/or a lack of knowledge regarding sampling procedures.

- Much of the currently available information on ventilation system design and performance was developed during the 1960's by the Engineering Department. An update of this survey is anticipated in the near future. Dwyer pitot tubes and inclined manometers are available for stack velocity measurement. However, there is no requirement for periodic measurement of stack velocities for recalculation of isokinetic flow rates.

Recommendations

The major theme of the monitoring program should be changed from one of materials accountability to one of environmental protection and regulatory compliance.

The Health, Safety, and Environment staff should include a member with expertise in monitoring air emissions. Also the staff should thoroughly acquaint themselves with plant operations, emissions control equipment, and stack monitoring equipment and procedures used at FMPC. A thorough characterization of FMPC emission sources should be performed to identify all release points with potential for discharge of significant concentrations of radioactive and non-radioactive contaminants.

Sampling of these sources should be conducted to determine the concentrations and, if levels exceed the DOE guideline concentrations for unrestricted areas (order 5480.1A), or Ohio Environmental Protection Agency (OEPA) discharge limits, a program for routine monitoring of these sources should be implemented.

A resurvey of exhaust ventilation system design and operating parameters should be completed. A program for routine stack velocity measurement should be initiated; a minimum frequency of annual measurement is recommended.

4.2.2 Sampling Equipment and Procedures

Findings

- Stack sampling is conducted using single point stack probes designed by FMPC. These probes are fabricated from copper tubing with a brass 1/4" ID inlet nozzle. Sampled particulates are collected on 4" diameter staplex Model TFA-S pleated filters, housed in an FMPC designed holder. Vacuum is provided by small, carbon-vane pumps and flow rate is monitored using rotameters located near the sampler controls.

- The brass fitting on the sampling probe nozzle is such that the air flow pattern into the probe will not be smooth and undisturbed; the tip design is not consistent with EPA recommendations (40CFR61). The standard probe design has recently been changed to elminate the brass fitting and shape the probe nozzle to a razor edge. FMPC personnel indicated that this new-type probe has been installed in three stacks; the one "new" probe inspected was without the brass fitting, but also had not been machined to have the razor-edged nozzle inlet.

- The single point sampling probe is not in accordance with the recommendations of 40CFR61 or ANSI 13.1, "Guide to Sampling Airborne Radioactive Material in Nuclear Facilities". Recent dye testing has indicated good agreement between FMPC sampling systems

and EPA Method 5 procedures; however, data is limited and is insufficient proof that the single point sample is representative of the average stack discharge.

- There is no procedure for periodic inspection of stack probes; some have not been checked since initial installation - up to 30 years ago.

- FMPC personnel have no data concerning the performance characteristics of the filter media being used in stack samplers.

- Sampler locations observed are generally in sections of duct where disturbances would not be of concern. Most were at least 8 duct diameters downstream and at least 2 duct diameters upstream of the nearest disturbances.

- Flow rates to achieve isokinetic sampling are based on stack velocities, measured, in some cases, as many as 20 years ago.

- Flow rate measurements are with a rotameter, located between the filter and the pump and calibrated against a wet test meter.

- There is no standard procedure for rotameter calibration. The type of flowmeter (hand held with 2 to 5 lpm divisions) prevents accurate flow calibration.

- Flow rates indicated on system rotameters are checked and adjusted, if necessary, during each weekly inspection. Review of record forms indicated large changes in the flow rates during the time between inspections. In some cases the rate decreased by a factor of about 4; some data indicates an increase in sampling rate by a factor of about 2.5. There is no internal requirement for replacement of filters based on changes in flow rates. The actual measured sample volume is not being determined and used in the emission calculations; this probably introduces large errors in the calculated discharges.

- Filters are inspected weekly and replacement and analysis of the filter is based on the technician's judgment that greater than 1 g of material has accumulated on the filter. Otherwise, the filter is left in the holder and sampling continues for another week. The procedure requires that each filter be replaced at least monthly. A review of records indicates that a monthly replacement has been performed on all operating sampling systems during 1985.

- Eight of the filter holders have been equipped with thin-window "pancake" GM detectors to monitor gross radioactive material filter breakthrough. These probes read out on Ludlum count rate meters. The meters have alarm settings, but there is not a standard for setting the alarm points. Alarms require shutdown of the generation systems. Also, alarms cannot be heard in the noisy environments where most meters are located. Production personnel record meter readings hourly, but the data are not provided to the Health, Safety, and Environment Division.

- Auburn Triboflow direct indicators are being installed in some stacks to indicate dust levels. This is new equipment and its performance has not yet been completely evaluated.

- A subcontractor has performed compliance monitoring of the steam plant stack; monitoring of the solid waste incinerator stack is expected during 1985.

- There is a Dupont Photometric NO_x analyzer for the nitric acid recovery tower. The Technical Division is responsible for monitoring this stack - use of the data is not known by HS&E personnel. The last check date indicated was ?/1982 (not legible); the last calibration date was 10/13/80. The readout chart recorder does not agree with the meter reading.

- Four sampling systems were inspected. These were on stacks G4-14 and G4-15 (Building 4); the South Buffalo stack (Building 2/3); and stack 2 on the UF_6 to UF_4 conversion pilot plant. The following deficiencies were noted:

a. All probes inspected were partially clogged with material and the nozzles were damaged (mostly due to the corrosive nature of the stack gases). The probe in G4-15 was the newer design (no brass fitting), however the probe had not been machined to a razor-edge. This particular probe was partially crimped at the 90° bend and was bent so that it was not perpendicular to the line of flow.

b. The prescribed sampling rate (per monitoring personnel) on G4-14 was 14 l/m; however the rotameter setting was 150 ft^3/h (7.07 l/m).

c. A leak test of the sampler on G4-15 indicated that the system continued to have a flow of about 1/2 the indicated rate when the intake nozzle was blocked. FMPC personnel stated that they have been experiencing many problems with system leakage.

d. On the South Buffalo stack the filter was wet. This filter was not secured by the filter-holder gasket, allowing a significant leakage path around the collecting media.

e. The location of the flow indicator (rotameter) for the South Buffalo stack was not known by HS&E personnel accompanying the inspectors; there is no flow indicating device on the pilot plant stack-2 sampler.

f. Stack G4-14 has a GM breakthrough monitor. The reading was 2600 cpm with an alarm setting of 50,000 cpm. Readouts were being recorded hourly. When tested, the alarm was barely audible above the ambient noise level. The monitor was not protected from tampering by facility personnel.

Recommendations

Collect data to document the representativeness of single point sampling in FMPC emission systems. If necessary, modify probes for multipoint sampling in accordance with 40CFR61 and ANSI 13.1 guidance.

Replace all stack sampling probes with stainless steel units meeting the ANSI and EPA design recommendations. Initiate a program for regular (semiannual) probe inspections.

Use only leak-free oil-less pumps or lubricated pumps modified in accordance with APTD-0581, "Construction Details of Isokinetic Source-Sampling Equipment".

Relocate flowmeters (rotameters) to the discharge side of sampling pumps. Test all sampling lines and components to locate and correct system leakage. Redetermine flow rates to achieve isokinetic sampling and adjust rotameters accordingly. Initiate use of actual flow volume in stack sampling calculations. Develop procedures for calibration of rotameters. Obtain a "standard" rotameter which is accurate and readable to better than $\pm$ 5%.

Replace the current filter holder with a clear plastic or glass unit to permit easy visual inspection. Replace present pleated filters with high efficiency glass fiber or cellulose membrane filters, capable of collecting >99% of particulates exceeding 0.3 μm in diameter.

Replace and analyze all stack sampling media on a minimum frequency of weekly.

Protect breakthrough monitors from tampering. Develop a standard for setting monitor alarm points. Provide flashing lights or amplified sound to assure that alarms are noted. Require that the count rate meter records are provided to HS&E personnel responsible for stack monitoring.

After ventilation system and sampling system improvements, generate a data base to determine if additional breakthrough monitors are needed.

Assure that the NO_x monitor in the nitric acid recovery tower is operating properly and is calibrated. The HS&E Division should assume routine monitoring responsibility for this and any other air emissions sources, for which it is not currently responsible.

4.2.3 Stack Sample Analysis and Data

Findings

- Stack sampling filters are analyzed by the Analytical Department of the Technical Group. Analysis is by colorimetry for total uranium. Results are reported to Health, Safety, and Environment in units of milligrams of material on the filter.

- Uranium contents of filters are multiplied by a factor, which is the ratio of the area of the duct to the area of the sampling probe, to provide an estimate of the total grams of uranium discharged over the sampling period. This information is used primarily for materials accountability purposes and to indicate failures in emission control systems. No calculations of emission concentrations are made for comparison with guideline levels, normal operations, or action limits.

- Monthly reports of baghouse stack discharges are prepared by the Health, Safety, and Environment Division. An annual summary of all discharges is also prepared.

- Reports do not include information regarding uncertainties in the data or minimum detectable quantities. The minimum reported quantity is 0.1 kg of uranium (total stack discharge).

- No action levels have been established for discharges from various stacks.

- Radionuclides other than uranium are not measured in stack emissions.

- Particle size distributions and lung solubility classifications of stack emissions have not been determined. FMPC plans to conduct particle size studies on 15 stacks during late CY 85.

- A review of several monthly stack discharge reports identified release during sampling periods ranging from 0.1 kg to 22.4 kg. Total annual 1984 air emissions from the FMPC was estimated as 376 kg. For comparison, the total 1981, 1982, and 1983 releases were 347, 340, and 164 kg, respectively.

- An estimate of releases through wet scrubber system is performed for materials accountability purposes. This estimate is based on measurements of uranium in scrubber solutions and residues and scrubber removal efficiencies. These removal efficiencies were determined when systems were initially installed (20-30 years ago) and have not been recently validated.

Recommendations

Initiate calculations of stack emissions in units of concentration for comparison with guidelines and to enable comparison of different control system performances. Include uncertainties and minimum detection levels with data.

Develop action levels and incorporate these into stack monitoring procedures.

Perform analyses on composite samples from several major emission sources for other radionuclides, known to be present in FMPC uranium feed stocks. Based on the results of these analyses, determine whether these other radionuclides contribute significantly to calculated population doses, and if periodic measurement of these radionuclides is warranted.

Conduct particle size determinations on samples from major emission sources. Also determine lung solubility classifications for composites of samples from major emission sources.

4.3 Ambient Air Monitoring

4.3.1 Sampling Program, Equipment, and Procedures

Findings

- EM Procedure 4.6 (Draft - April 10, 1985) "Collection of Routine Environmental High Volume Air Samples" describes the procedures and equipment for ambient air monitoring. This procedure appears sufficiently detailed and comprehensive for the activities as presently being performed.

- Sampler locations are indicated on Figure 4-1. The samplers are General Metal Works, Model GMWL-2000. Particulate samples are collected weekly (168 hr. operation) on 8" x 10" microsorban filters. Sampling rates are nominally 1 m^3/min. This general methodology appears adequate for particulate sampling.

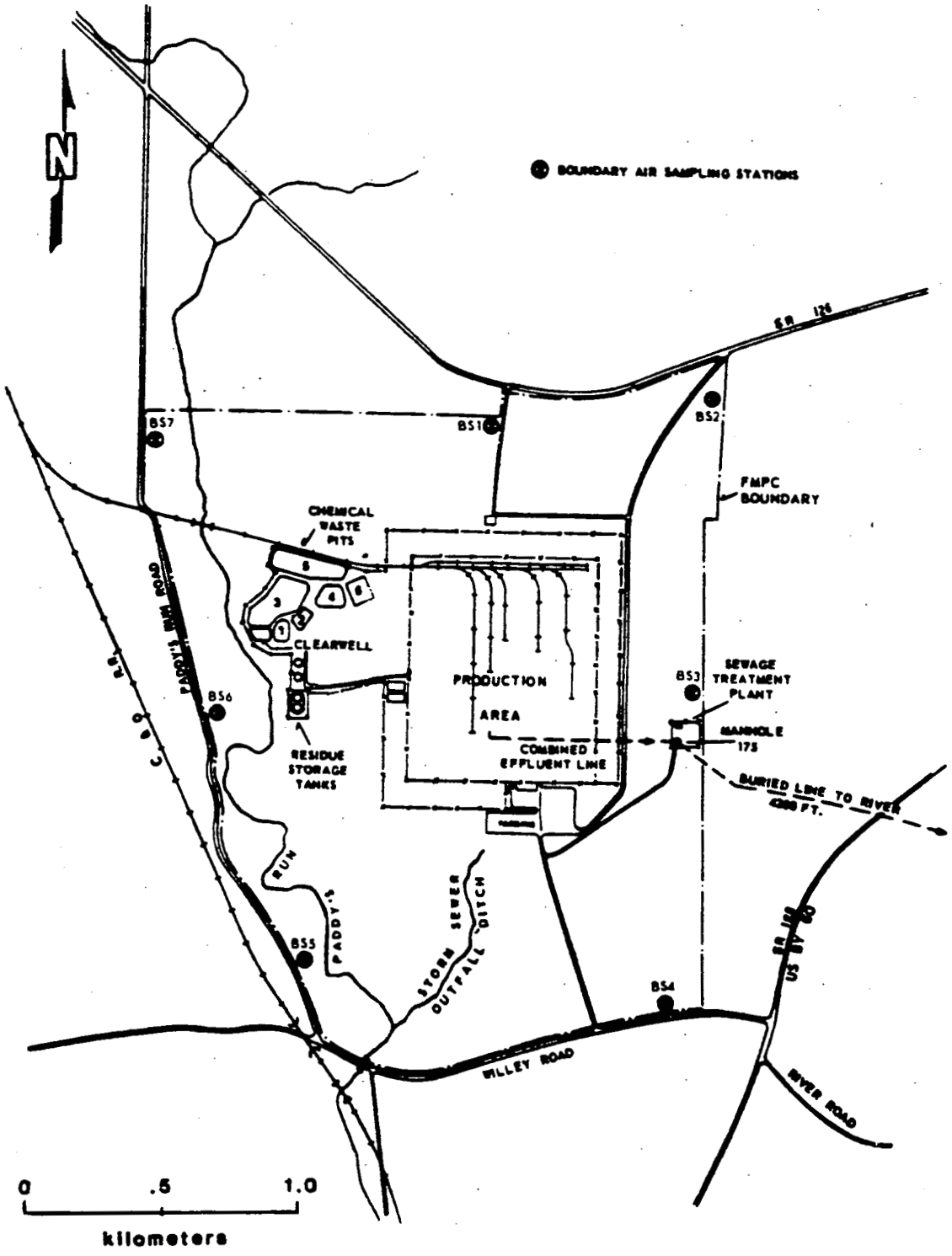
- Radon monitoring is conducted by FMPC at each of the perimeter stations using passive monitors (Terradex - track etch). Mound Laboratories is also conducting radon monitoring study using PERM units at 17 locations on the site. The FMPC monitors are processed quarterly; Mound Laboratory monitors are processed weekly.

- Samplers were sited to provide coverage surrounding the plant. Modeling was not utilized to confirm the appropriateness of the sampler locations.

- There are no offsite ambient air monitoring stations; FMPC is proposing to install at least 2 stations - one at the Cosby Township School (upwind) and one at the Ross School (downwind) during 1985.

- At DOE/OR's request, ORAU has contracted with the ORNL Energy Systems group to perform a modeling study relative to siting of samplers for ambient air monitoring. The results of this study will be provided under separate cover.

FIGURE 4-1
Locations of Perimeter Particulate Air and
Radon Monitoring Stations



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

- The samplers are protected by a small (about 1.5 x 1.5 m) cyclone fence enclosures, which are kept locked to prevent tampering.

- Sample flow rates are checked using a "standard" rotameter at the start and finish of the sampling period. A review of sample log forms indicated little loading effect over the sampling period. However, the sample rates were slightly higher than the normal 1 m^3/min. level. The form for 4/9/85 indicated rates ranging from 1.2 to 1.4 m^3/min.

- There is no flowmeter or chart on the sampler to indicate sampler performance. The samplers are equipped with timers to record the actual operating time. Each sampler station is equipped with a warning light, visible from the patrol road, which becomes illuminated when the sampler pumps cease operation.

- Samplers are returned to HS&E for maintenance and calibration, at approximately 6 month intervals. There is no established frequency for maintenance and calibration.

- Sampler station 3 was inspected during the review; a cursory viewing of station 4 was also conducted. Equipment was in good condition and operating properly. No deficiencies were observed.

- The FMPC has Drager colorimetric monitoring tubes for monitoring air concentrations of hazardous chemicals used at the plant. There is no equipment or procedure for offsite monitoring over extended time intervals in event of large accidental releases and during emergency situations.

Recommendations

Proceed with plans to locate sampling stations at the two school sites. Also, evaluate current sampler locations and establish 2 to 4 additional offsite sampler locations based on recommendations of the ORNL modeling report.

Provide flow recording devices and elapsed timers on the high volume samplers.

Develop equipment and procedures for sampling potential hazardous contaminants other than particulate uranium at critical perimeter and offsite locations. Both routine (continuous) sampling and emergency sampling capabilities should be available. It is recommended that routine sampling be conducted for uranium fluoride and total fluorides. Procedures should also be developed for ambient sampling of NH_3OH and NO_x for use on an intermittent basis and under conditions of release incidents and emergencies. Action levels and notification requirements should be incorporated into these procedures.

Establish a requirement for sampler calibration and maintenance. Six months appears to be a reasonable interval.

4.3.2 Perimeter Air Sampling Analysis and Data

Findings

- Filters are returned to the HS&E Bioassay Department for analysis. The initial analysis involves desicating (drying) and weighing to determine weight of total suspended particulates (TSP). The filter is then ashed and dissolved for total uranium and gross beta activity analyses.

- Procedures are described in an undated document, "Analyses of Boundary Air Filter Samples", prepared by the Bioassay Department.

- A portion of each solution is retained and composited annually for analysis for Np-237, Pu-238, Pu-239/240, Th-228, and Th-232 by Oak Ridge National Laboratory.

- Table 4-1 presents the sampling results for 1984. These results indicate concentrations of uranium, gross beta, and other radionuclides were well within the applicable DOE order 5480.1A

TABLE 4-1
Radionuclide Concentrations in Air Samples from
Perimeter Monitoring Stations

Routinely Monitored Radionuclides

Sampling Point (1)	Number of Samples	Uranium ($pCi/L \times 10^{-3}$) Maximum	Minimum	Average	95% (2) C. L.	% of Guideline	Gross β Activity (4) ($pCi/L \times 10^{-3}$) Maximum	Minimum	Average	95% (2) C. L.	% of Guideline
BS1	53	12.52	0.03	1.03	1.35		34.52	0.96	4.91	1.24	
BS2	53	4.57	0.04	0.92	1.29		29.68	1.17	4.56	1.22	
BS3	53	18.79	0.23	1.36	1.30		104.16	1.42	6.38	1.28	
BS4	53	1.45	0.05	0.35	1.25	(3)	10.54	0.92	2.60	1.16	(3)
BS5	53	3.73	0.03	0.40	1.32		27.28	1.15	2.88	1.18	
BS6	53	4.31	0.04	0.63	1.32		68.28	1.14	3.39	1.21	
BS7	53	1.78	0.05	0.30	1.29		14.29	0.51	2.46	1.18	

Other Radionuclides
($pCi/L \times 10^{-3} \pm 2\sigma$)

Sampling Point (1)	Number of Samples	^{237}Neptunium Level	% of Guideline	^{238}Plutonium Level	% of Guideline	^{239,240}Plutonium Level	% of Guideline	^{228}Thorium Level	% of Guideline	^{230}Thorium Level	% of Guideline	^{232}Thorium Level	% of Guideline
BS1		8.31 ± 0.5		2.21 ± 0.4		42.09 ± 3.2		24.20 ± 2.1		494.51 ± 10.5		14.73 ± 2.1	
BS2		6.80 ± 0.4		3.95 ± 0.8		35.11 ± 3.3		30.72 ± 2.2		559.57 ± 11.0		17.56 ± 1.1	
BS3		10.71 ± 0.6		2.65 ± 0.7		55.38 ± 6.0		50.56 ± 2.4		746.44 ± 12.0		27.69 ± 2.4	
BS4	(5)	2.27 ± 0.2	(3)	0.97 ± 0.2	(3)	16.54 ± 1.0	(3)	13.44 ± 1.0	(3)	155.08 ± 10.3	(3)	9.41 ± 1.0	(3)
BS5		2.79 ± 0.3		1.07 ± 0.4		20.39 ± 2.1		17.17 ± 1.1		321.91 ± 10.7		10.73 ± 1.1	
BS6		4.83 ± 0.4		2.30 ± 0.4		28.53 ± 2.2		24.14 ± 2.2		406.07 ± 11.0		15.36 ± 1.1	
BS7		1.81 ± 0.2		1.70 ± 0.5		20.37 ± 2.3		26.03 ± 2.3		531.83 ± 11.3		15.84 ± 2.3	

Footnotes:

(1) See Figure 4-1

(2) C. L. = Average Concentration ×+ the value shown. Derived from log-transformed data; $= t_{(0.05,\,40)} S_{\bar{x}}$.

(3) The following guidelines were established by DOE Order 5480.1A, Attachment XI-1, Table II (Note 3c for gross β), insoluble particles in air, and were in effect during 1984:

Uranium	2.0×10^{-2} pCi/L	^{239,240}Plutonium	1.0×10^{-3} pCi/L
Gross β	1.0×10^{-1} pCi/L	^{228}Thorium	2.0×10^{-4} pCi/L
^{237}Neptunium	4.0×10^{-3} pCi/L	^{230}Thorium	3.0×10^{-4} pCi/L
^{238}Plutonium	1.0×10^{-3} pCi/L	^{232}Thorium	1.0×10^{-3} pCi/L

The NESHAP Limits promulgated in 1985 relate to body and organ dose, however, and are addressed elsewhere in the text of this report as well as in Table 23.

(4) Includes Uranium activity, thus highly conservative.

(5) A composite of 53 weekly samples.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

guidelines. Highest concentrations of all radioactive contaminants were measured at station BS3, directly east of the production area.

- Radon monitoring results from 1984 FMPC monitoring are presented in Table 4-2. Concentrations are within DOE guidelines. The Mound Laboratories radon monitoring study, initiated in late 1984, has not yet provided sufficient data for comparison of Mound and FMPC results or long-term average concentrations. Initial Mound results indicate above background concentrations near the K-65 residue silos, ranging up to 5.1 pCi/l, but background levels at the plant perimeter fence in the downwind direction.

Recommendation - None

4.4 Meteorological Data

Findings

- The FMPC does not presently have onsite meteorological monitoring capability. Previous annual wind speed and direction data is obtained from the Cincinnati Airport. This station is located in Covington, Kentucky, on the other side of the Ohio River, south of the site; the appropriateness of meteorological data from that station is questionable.

- The Cincinnati Airport data does not include upper atmosphere information from which to determine stability conditions.

- Meteorological data, including upper atmospheric conditions, is available from the Wright Patterson Airforce Base in Dayton, Ohio. This data would probably more correctly represent the conditions at the FMPC.

- The FMPC has an active project to provide site specific meteorological information. A tower has been installed, but is not yet operational due to a lack of readout telemetry instrumentation and software. Also, the system does not have redundancy provisions

TABLE 4-2
Radon Concentrations at Perimeter Monitoring Stations

Location	Number of Samples	Concentration (pCi/L)					Normal Background Level
		Maximum	Minimum	Average	95% (2) C. L.	% of Guideline	
Onsite (1)							
BS1	4	1.03	0.81	0.917	1.20	(3)	0.20 - 0.35 pCi/L
BS2	4	1.08	0.41	0.801	1.86		
BS3	4	1.11	0.61	0.843	1.41		
BS4	4	0.73	0.48	0.591	1.37		
BS5	4	1.34	0.71	0.970	1.64		
BS6	8	1.55	0.28	0.584	1.35		
BS7	4	1.34	0.42	0.717	2.11		
Offsite							
8 mi. ENE	4	2.19	0.29	0.836	3.72	(3)	
5 mi. WSW	4	0.59	0.19	0.357	1.91		

Footnotes:

(1) See Figure 4-1

(2) C. L. = Average Concentration ×÷ the value shown. Derived from log-transformed data; $= t_{0.05,40} S_{\bar{x}}$.

(3) DOE Order 5480.1A, Attachment XI - 1, Table II, established a guideline level of 3 pCi/L above background, but see Footnote (3), Table 1.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

for backup monitoring. The ORNL Energy Systems group has been asked by DOE/ORO to provide assistance to the FMPC in completion of this meteorological station. Completion is not anticipated until FY 86.

Recommendations

Complete installation, calibration, and testing of the FMPC meteorological station and initiate accumulation of site specific meteorological data.

4.5 Compliance

Findings

- The FMPC is in the process of preparing OEPA Permit applications for air emission sources. Applications for about 1/4 of the sources have been submitted to DOE/OR thus far. Delay in completing the permits is due largely to a lack of thorough information regarding many of the sources.

- Because no OEPA air permits have been issued, it is not possible to evaluate compliance with permit limitations.

- The steam plant stack has been surveyed by a subcontractor and determined to be in compliance with OEPA regulations. Compliance testing of the solid waste incinerator is anticipated in 1985.

- Concentrations of total suspended particulates and radionuclides, measured at the perimeter fence are in compliance with State of Ohio and DOE guidelines for exposures to the general public.

- Calculations by ORNL, based on 1984 emissions data and using the EPA-specified AIRDOS and DARTAB computer codes, have predicted that the maximally exposed offsite individual would have received dose equivalent commitments 1.8 mrem, total body, and 100 mrem, pulmonary tissue (critical organ). These levels indicate that

doses to the public as a result of 1984 FMPC air emissions were well below the DOE 5480.1A criteria. Improvements to emissions control systems which are anticipated during 1985 should assure that offsite doses comply with NESHAP limits.

- The adequacy and accuracy of some stack emission data is questionable. While improved and expanded emission monitoring may result in a larger source term, use of actual data on particle size distribution and lung solubility will likely tend to reduce population dose levels.

Recommendations

Complete application for OEPA air discharge permits.

Complete compliance testing for the solid waste incinerator stack.

Continue with plans for improvements to air emissions control systems.

5.0 WATER TREATMENT AND MONITORING

5.1 General Description

Virtually all operations at the FMPC generate liquid wastes to some extent. Each major operation area includes facilities for collection and pretreatment of process liquids. This pretreatment is generally limited to precipitation and filtration of uranium and preliminary reduction of oil content. After sampling to determine if uranium content is within preset limits, the filtrate is pumped to the General Sump and filter cake is sent to the Refinery or the Recovery Plant as a process residue.

The General Sump is a system of vertical, open-top tanks of various sizes with associated pumps, piping, and valves. At the General Sump, liquid wastes are sampled for uranium content. If content levels permit, the liquid is discharged; otherwise, the waste is neutralized, precipitated, and filtered. Acidic wastes are adjusted for pH to increase precipitation of radioactive material, then pumped to waste Pit 5; raffinate is sent to Plant 8. Other wastes are settled and decanted in successive steps prior to discharge of the supernatant liquor to the Great Miami River; the settled sludges are also transferred to Plant 8.

Pit 5 was used as a settling basin with a surface area of about 1.5 ha. This pit is now full of sediment and is no longer functioning as a settling basin. Liquid wastes enter the east end and discharge through an overflow tower at the west end. From the tower, the liquid flows by gravity to the Clearwell, where it is sampled and pumped for offsite discharge.

The sanitary waste collection and treatment system is a completely separate system from the process waste system. This waste, by virtue of its natural separation from the actual production effort does not normally contain a significant amount of uranium. However, uranium contamination does occur through discharges from the plant laundry and showers. The Sewage Treatment Plant consists of a two-stage trickling filter and an ultraviolet disinfection system. Treatment Plant sludge

is potentially contaminated with uranium. Liquid effluent from the Sewage Treatment Plant is sampled before release for offsite discharge.

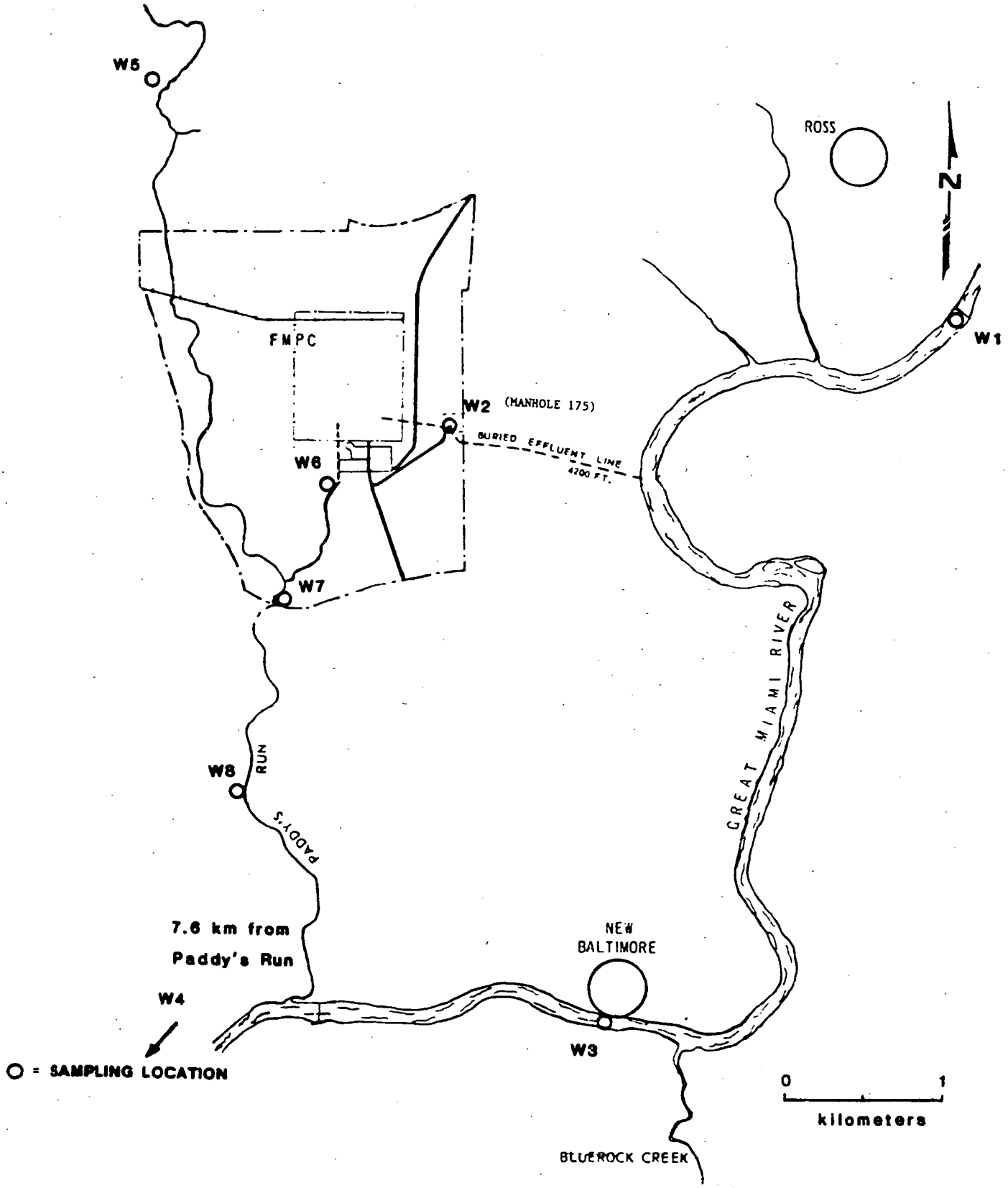
Storm water drainage is collected at the Storm Lift Station, where it is sampled and pumped to the effluent discharge point. Some contamination of this stream is possible through surface runoff. No routine treatment is provided for storm water; control of spills into the Storm Sewer System is achieved through diversion facilities. The capacity of the Storm Sewer Lift Station is limited and during moderate and high precipitation, excess water overflows to a ditch, which then empties into Paddy's Run. A sampling system is automatically activated to assure monitoring and metering of this overflow.

Manhole 175 is the junction point for the waste stream from the General Pump, Clearwell, Sewage Treatment Plant and Storm Sewer Lift Station. This facility is equipped with a recording pH meter, a flowmeter utilizing a Parshall flume, a temperature recorder, and an automatic proportional sampler. At this location, the discharge flow to the Miami River is continuously measured and a continuous sample is collected for analysis.

Sampling is performed at six onsite locations to assure effective control of liquid effluents. These sampling locations are at the two NPDES outfalls (Manhole 175 and the Storm Sewer overflow to Paddy's Run) and the four contributing streams to Manhole 175. Water samples are also collected from three locations in the Great Miami River and three locations in Paddy's Run, to evaluate contributions of FMPC operations to contaminant levels in these bodies of water. These sampling locations are indicated on Figure 5-1.

The FMPC has several major liquid waste control or treatment projects under construction. These projects include a biodenitrification treatment system, a diversion system for coal-pile runoff, and a stormwater runoff retention basin. Completion of these projects is expected in 1986.

FIGURE 5-1
Water Sampling Locations



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

5.2 Liquid Monitoring Program

5.2.1 Sampling Procedures and Equipment

Findings

- Procedures for collection of liquid effluent and other surface water samples and for assuring proper quality assurance practices in handling samples have not been developed.

- Power Plant and Utilities collects liquid effluent samples.

- At Manhole 175, (NPDES outfall 001), the Clearwell, and the Storm Sewer Lift Station flow proportional sampling is performed continuously. Twenty-four hour samples are collected daily for analysis.

- Proportional sampling is performed continuously at NPDES outfall 002 (the Storm Sewer Lift Station overflow) during those periods when overflow is occurring.

- Grab sampling is performed for NPDES purposes at the secondary settling basin outfall of the Sewage Treatment Plant.

- Daily grab samples are obtained from the Great Miami River, upstream and downstream of the main effluent discharge, and a weekly grab sample is collected from this river, downstream of the mouth of Paddy's Run.

- Grab samples are collected weekly from sampling locations in Paddy's Run.

- Flow metering at the main outfall utilizes a Parshall flume. This flume is not regularly inspected or calibrated. The weir on the Storm Sewer Lift Station overflow is also not inspected or calibrated. During field inspections, a flow was observed in the overflow outfall to Paddy's Run, although weather conditions were

not such that overflow would be expected. This suggests subsurface seepage into the discharge pipe or leakage around the weir system.

- NPDES sampling equipment appeared adequate though cumbersome. Samplers are equipped with refrigerated collection containers to satisfy NPDES sample preservation requirements.

- Proportional samplers are not on a regular maintenance and calibration program.

- Surface and stormwater runoff at the FMPC site has not been adequately characterized. During a brief tour of the pit area, northwest of the site, several surface drainage systems, which are not being controlled or monitored, were noted. These include:

  a. a drainage system north of the production area running from the area around the present and proposed sanitary landfills west to Paddy's Run. This ditch runs just north of Pit 5, parallel to the railroad tracks.

  b. a drainage system that begins in the production area and runs west through the pit area, entering Paddy's Run near the Clearwell. This source should be investigated since, by strict interpretation of 40 CFR Part 122 and the Ohio NPDES Regulations, this drainage could be classified as a permittable point source.

  c. a gully draining to Paddy's Run between the Clearwell and Pit 5. The site topographical map indicates a continuous berm in this area.

  d. a large ditch running west along the south edge of the parking lot into the storm water overflow ditch. Several pipes of unknown origin were observed entering this ditch.

  e. also, visual evidence of surface runoff was observed at several locations around the active flyash storage pile. The inactive

flyash pile may also be a source of runoff contamination; however, this pile was not thoroughly inspected during the review.

- Discussions with sampling personnel revealed that during the summer months there is little or no flow in the southern portion of Paddy's Run. These individuals indicated that the stream goes underground a short distance south of the waste pit area. This may be a significant contributing factor to groundwater contamination south of the FMPC site.

Recommendations

Develop detailed procedures for sampling liquid effluents and surface water sources. Procedures should require recording of pertinent field data such as weather conditions, temperature, sample appearance, odor, and other comments.

Implement a program for periodic inspection, maintenance, and calibration of flow metering devices (flumes and weirs). Identify the source of flow from the stormwater overflow discharge.

Initiate regular maintenance and calibration schedules for NPDES sampling equipment.

Investigate the possibility that the subsurface portion of Paddy's Run contributes to the groundwater contamination problem.

Identify and characterize all sources of surface runoff from the plant site. Initiate programs for sampling water and sediment from these sources. Increase the number of surface water sampling points from Paddy's Run. It is suggested that 4 to 6 additional samples be routinely collected in the vicinity of the waste pits.

5.2.2 Sample Analysis and Data

Findings

- Daily samples from the main NPDES outfall (Manhole 175) are analyzed for uranium, gross alpha and beta activity, and pH; one sample per week is analyzed for chloride, nitrate, fluoride, and other NPDES parameters. Monthly composites of daily samples are analyzed for Ra-226, Ra-228, Ru-106, and thorium. Long term (annual) composites are analyzed for other radionuclides such as transuranics and selected fission products.

- A minimum of 1 sample per week from each of the three river sampling locations is analyzed for uranium, gross alpha and beta activity, chloride, nitrate, fluoride, non-filterable solids and pH. Monthly composites are analyzed for Ra-226 and Ra-228.

- Weekly samples from Paddy's Run are analyzed for uranium, gross alpha and beta activity and pH. Chloride, fluoride, and nitrate analyses are performed on one sample each month. Radium analyses are performed on bi-monthly composites from samples upstream of the site and, when available, on monthly composites of samples from the juncture of Paddy's Run with the storm drainage ditch.

- Analyses for uranium, Ra-226, Ra-228, Ru-106, Th-232, gross alpha, gross beta, pH, chloride, fluoride, nitrate, and dissolved solids are performed by the Bioassay Laboratory of the Heath, Safety, and Environment Division. Power Plant and Utilities perform analyses for BOD, suspended solids, fecal coliform, and bacteria in Sewage Treatment Plant effluent. The Analytical Laboratory of the Technical Groups conducts analyses for ammonia, copper, nickel, chromium, iron, oil and grease. Oak Ridge National Laboratory performs analyses for Np-237, Pu-239/240, Pu-238, Sr-90, Cs-137 and Tc-99.

- NPDES analyses are usually performed within 8 hours of sample collection.

- All analytical procedures are documented and appear adequate. One exception is the procedure for nitrate analysis at levels greater than 2 mg O_3-N/l; this procedure is not approved by EPA and OEPA (refer to section 9).

- Reviews of FMPC operations, discussions with plant personnel, and observations during plant inspection tours identified a potential for liquid waste stream pollutants, which are not currently being monitored. These include:

  a. heavy metals and trace metals (e.g. from the coal flyash pile).

  b. toxic organics - in particular the volatile, base/neutral, and acid fractions of the priority pollutant list.

  c. kerosene from the primary extraction process in Plant 2/3.

  d. general cleaning/degreasing solvents such a perchloroethylene (site laundry) and 1,1,1-trichloroethane. Low concentrations (4 ppb and 1.2 ppb, respectively) of these two solvents were detected in Manhole 175 in the recent analysis for a new NPDES permit application.

- Results of 1984 sampling are presented in Tables 5-1 through 5-4. These results demonstrate that, with minor exceptions, monitored effluents were well within the standards established by DOE order 5480.1A and OEPA.

Recommendations

Perform analyses on several daily and composite samples from all effluent sampling locations for additional potential pollutants which might be suspected of being present at the plant. These should include heavy metals listed in 40 CFR 122, Appendix D, Table III; trace metals listed in Table IV of the same regulation; and toxic organics. Based on the results of these analyses, determine the need for futher sampling and analyses.

TABLE 5-1
Radionuclides in Surface Water

Radionuclide	Sampling Point (1)	Number of Samples (2)	Concentration (pCi/L) Maximum	Minimum	Average	95% (3) C. L.	% of Guideline	Guideline pCi/L (4)
Gross α (5)	W1	52	8.11	0.90	2.25	1.11	7.5	30
	W3	52	9.91	0.90	2.66	1.12	8.9	
	W4	52	11.71	1.35	2.79	1.11	9.3	
	W5	52	5.41	0.45	1.80	1.17	6.0	
	W7	26	127.93	6.31	13.96	1.37	46.5	
	W8	26	65.77	4.95	9.28	1.25	30.9	
Gross β (5)	W1	52	8.56	2.25	4.86	1.08	16.2	30
	W3	52	54.50	3.15	10.23	1.18	34.1	
	W4	52	46.40	2.70	9.73	1.20	32.4	
	W5	52	10.81	0.90	4.64	1.13	15.5	
	W7	26	46.85	<6.31	<10.86	1.25	<36.2	
	W8	26	50.45	<7.21	<16.94	1.23	<56.5	
^{137}Cesium	W1	1			<1.89		<0.01	20,000
	W3	1			<1.62		<0.01	
	W4	1			<1.62		<0.01	
^{226}Radium	W1	12	0.45	<0.45	<0.45	1.00	<1.5	30
	W3	12	0.45	<0.45	<0.45	1.00	<1.5	
	W4	12	0.45	<0.45	<0.45	1.00	<1.5	
	W5	6	0.45	<0.45	<0.45	1.00	<1.5	
	W7	9	0.45	<0.45	<0.45	1.00	<1.5	
^{228}Radium	W1	12	0.45	<0.45	<0.45	1.00	<1.5	30
	W3	12	0.45	<0.45	<0.45	1.00	<1.5	
	W4	12	0.45	<0.45	<0.45	1.00	<1.5	
	W5	6	0.90	<0.45	<0.57	1.46	<1.9	
	W7	9	0.90	<0.45	<0.49	1.19	<1.6	
^{90}Strontium	W1	1			0.43	±1.27 (6)	0.14	300
	W3	1			1.57	±1.89	0.52	
	W4	1			1.51	±2.14	0.50	
^{99}Technetium	W1	1			1351.35	±27.03	0.45	300,000
	W3	1			14.32	±3.24	<0.01	
	W4	1			12.43	±3.24	<0.01	
^{234}Uranium	W1	1			2.16	±0.24	0.05	4,000
	W3	1			1.22	±0.16	0.03	
	W4	1			1.32	±0.16	0.03	
^{235}Uranium	W1	1			0.30	±0.14	0.008	4,000
	W3	1			<0.27		<0.007	
	W4	1			<0.27		<0.007	
^{238}Uranium	W1	1			0.30	±0.14	0.006	5,000
	W3	1			<0.27		<0.005	
	W4	1			<0.27		<0.005	
^{238}Uranium	W1	1			2.51	±0.24	0.42	600
	W3	1			2.14	±0.24	0.36	
	W4	1			1.68	±0.16	0.28	
Uranium (7)	W1	52	25.73	0.68	1.62	1.19	0.14	1,200
	W3	52	16.25	0.68	1.62	1.14	0.14	
	W4	52	18.97	0.68	1.62	1.14	0.14	
	W5	52	6.77	0.68	1.35	1.15	0.11	
	W7	26	168.57	5.42	15.44	1.41	1.29	
	W8	26	65.67	3.39	9.48	1.28	0.79	

Footnotes:
(1) See Figure 5-1
(2) Samples are composited for radium analyses as follows: one-month composites of daily samples from W1 and W3; one-month composites of weekly samples from W4, two-month composites of weekly samples from W5, and one-month composites of all available weekly samples from W7. An annual composite was used for those isotopes where only a single sample is noted.
(3) C. L. = Average ×÷ the value shown. Derived from log-transformed data; = $t_{0.05,\,40}\,S_{\bar{x}}$.
(4) DOE Order 5480.1A, Attachment XI-1, Table II (Note 2 for Gross α and Gross β). Guidelines listed are for soluble isotopes.
(5) Gross α and Gross β activity values contain activity of uranium and radium in the samples, thus are highly conservative.
(6) Counting uncertainties at 95% C. L. (^{137}Cesium includes an additional 6% intrinsic uncertainty). This applies to all values preceded by ±.
(7) Normal background levels of uranium in local surface waters range between 1.4 and 2.8 pCi/L.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 5-2
Radionuclides in Water Discharged at the Great Miami River

Radionuclide (1)	Total Curies	Concentration (pCi/L)					Guideline pCi/L (4)
		Maximum	Minimum	Average	95% (2) C. L.	% of Guideline	
^{137}Cesium	0.017	21.89	20.00	20.92	±3.77	0.005	4×10^6
^{237}Neptunium	0.0002	0.25	0.10	0.16	±0.04	<0.001	9×10^4
^{239}Plutonium	0.00003	0.035	0.030	0.032	±0.02	<0.0001	1×10^5
$^{239, 240}$Plutonium	0.00005	0.089	0.018	0.040	±0.01	<0.0001	1×10^5
^{226}Radium	<0.017	81.08	<0.45	<14.48	1.75 (3)	<3.62	4×10^3
^{228}Radium	<0.014	68.02	<0.45	<9.23	1.87 (3)	<1.15	8×10^3
^{106}Ruthenium	0.0005	1.53	0.23	0.50	1.48 (3)	<0.001	4×10^5
^{90}Strontium	0.012	19.19	10.27	14.04	±4.01	0.14	1×10^4
^{99}Technetium	18.96	29729.73	16756.76	22319.81	±854.67	2.23	1×10^6
^{232}Thorium	0.0005	1.08	0.32	0.56	1.28 (3)	0.001	5×10^4
^{234}Uranium	0.34	432.43	405.41	418.70	±81.08	0.42	1×10^6
^{235}Uranium	0.018	23.51	20.54	21.98	±6.76	0.02	1×10^5
^{236}Uranium	0.021	32.43	20.00	25.47	±11.47	0.03	1×10^6
^{238}Uranium	0.39	540.54	432.43	483.47	±81.08	2.42	2×10^4
Uranium (5)	0.68	1333.69	352.04	663.31	1.35 (3)	1.66	4×10^4

Footnotes:

(1) Radionuclides in the plant effluent which is discharged to the Great Miami River through a buried pipeline, (with the exception of the two radium isotopes, ruthenium, and uranium) from two 6-month composites. An additional 3.8×10^{-2} Curies of uranium was contained in storm sewer overflow discharged into Paddy's Run above sampling point W7.

(2) Counting uncertainties at 95% C. L. (^{137}Cesium includes an additional 6% intrinsic uncertainty) unless otherwise specified.

(3) C. L. = Average Concentration ×+ value shown. Derived from log-transformed data and = $t_{(0.05,n)} S_{\bar{x}}$.

(4) DOE Order 5480.1A, Attachment XI-1, Table II, Concentration Guides for Water in Controlled Areas. Guidelines for soluble isotopes are listed.

(5) From average monthly concentration data.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 5-3
Ion and pH levels in Surface Water

Parameter	Sampling Point (1)	Number Of Samples	Concentration (mg/L)					Guideline (3)
			Maximum	Minimum	Average	95% C. L. (2)	% of Guideline	
Fluoride	W1	52	1.0	0.2	0.44	1.11	22	2.0 mg/L
	W3	52	1.0	0.3	0.45	1.10	23	
	W4	52	1.1	0.2	0.45	1.12	23	
	W5	12	0.5	0.1	0.23	1.26	12	
	W7	12	0.6	0.2	0.26	1.24	13	
	W8	12	0.4	0.1	0.17	1.32	9	
Nitrogen (in nitrate ions)	W1	52	8.8	2.3	4.27	1.09	19	22 mg/L
	W3	52	9.0	2.2	4.36	1.10	20	
	W4	52	8.9	2.1	4.39	1.10	20	
	W5	12	4.3	0.9	2.64	1.34	12	
	W7	11	4.9	0.6	2.13	1.49	10	
	W8	12	4.0	0.1	0.39	2.47	11	
Chloride	W1	52	145	17	54.6	1.12	22	250 mg/L
	W3	52	97	17	54.3	1.12	22	
	W4	52	99	17	55.1	1.12	22	
	W5	12	46	14	29.9	1.25	12	
	W7	12	135	14	25.1	1.41	10	
	W8	12	168	21	38.4	1.43	15	
pH (4)	W1	52	9.0	7.9	(5)	(5)	(5)	6.5 - 9.0
	W3	52	9.1	7.9				
	W4	52	9.2	7.3				
	W5	52	8.2	7.5				
	W7	26	8.4	7.6				
	W8	26	8.3	7.5				

Footnotes:

(1) See Figure 5-1

(2) C. L. = Average Concentration ×+ value shown. Derived from log-transformed data and = $t_{(a.m.en)} S_{\bar{x}}$.

(3) Ohio EPA Water Quality Standards, Administrative Code Chapter 3745-1.

(4) pH is reported in standard units.

(5) Not applicable.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 5-4
Summary of NPDES Data for 1984

Parameter	Units	Number Of Samples	Minimum	Maximum	Annual Average	NPDES Permit Limits		Percent Compliance
						Daily Maximum	Monthly Average	
Discharge 001 (MH175)								
Flow rate	MGD	Continuous	0.072	1.102	0.576	NA	NA	NA
pH	pH Units	Daily Grab	7.3	9.3	NA	Range = 6.5 to 10.0		100
Suspended Solids	mg/L*	53	<2	33	8	60	20	100
Ammonia (as N)	kg/day	53	<1	46	6	43	28	98
Oil & Grease (mg/L)	mg/L.	53	<5	9	5	15	NA	100
Residual Chlorine	mg/L	25[b]	0.01	0.08	0.05	0.10	NA	100
Nitrate (as N)	kg/day	53	86	2318	990	3180	1590	98
Discharge 002 (Storm Sewer Outfall)								
Flow rate	MG/Event	Continuous	0.006	1.00[a]	0.161	NA	NA	NA
pH	pH Units	Grab/Event	7.4	8.5	NA	Range = 6.5 to 9.0		100
Suspended Solids	mg/L*	98	<2	64	8	100	30	100
Oil & Grease	mg/L	98	<5	17	5	15	NA	100
Sampling Location 001A (Sewage Treament Plant)								
Flow rate	MGD	Continuous	0.020	0.246	0.119	NA	NA	NA
pH	pH Units	Daily Grab	7.1	8.3	NA	Range = 6.5 to 9.0		100
BOD_5	mg/L* (kg/day)	53	<1(0.1)	18(6.0)	7(2.9)	40(10.0)	20(5.0)	100
Suspended Solids	mg/L* (kg/day)	53	1(0.3)	12(8.7)	4(2.0)	40(10.0)	20(5.0)	100
Fecal Coliform	MPN/100ml*	29[b]	1[c]	2000	356	2000	1000	100
Sampling Locations 001B & C (Combined General Sump & Clearwell)								
Flow rate	MGD	Continuous	0.0	0.312	0.182	NA	NA	NA
Suspended Solids	kg/day	53	0.6	17.8	5.1	12.8	6.2	94
Chromium (+6)	kg/day	53	0.0003	0.013	0.005	0.008	0.004	75
Chromium (total)	kg/day	53	0.003	0.047	0.018	0.102	0.050	100
Iron	kg/day	53	0.06	0.66	0.20	0.85	0.41	98
Nickel	kg/day	53	0.003	0.161	0.049	0.256	0.124	100
Copper	kg/day	53	0.005	0.104	0.025	0.051	0.025	86
Sampling Location 001D (Lift Station)								
Flow rate	MGD	Continuous	0.0	0.632	0.249	NA	NA	NA
Suspended Solids	mg/L	53	<2	73	8	100	30	100
Oil & Grease	mg/L	53	<5	7	<5	15	NA	100

Footnotes:

NA = Not applicable.

* = Flow-weighted averages.

[a] Estimated during an extreme storm event.

[b] Monitoring not required during winter months.

[c] Occurred subsequent to installation of the ultraviolet disinfection system.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

5.3 Compliance

Findings

- Radionuclide concentrations in monitored effluents and surface waters are consistently within the DOE guidelines of 5480.1A for uncontrolled areas (see Tables 5-1 and 5-2). Uranium and technetium-99 are the principle radionuclides in the main effluent discharge.

- Effluents are generally in compliance with NPDES limits. Occassional minor (up to several times the limit) exceedances occur; these are primarily for parameters of suspended solids, chromium (+6), and copper (see Table 5-4).

- The biodenitrification facility, presently under construction to reduce nitrate concentrations in process effluent, will possibly produce higher ammonia levels in effluents. This might require permitted limits at Manhole 175 to be re-evaluated.

- A Spill Prevention Control and Countermeasure Plan (dated June 5, 1978) has been developed. This Plan was recently (April 1985) revised and is currently being reviewed prior to implementation. This plan appears adequate for the FMPC operations.

Recommendations - None

6.0 GROUNDWATER MONITORING PROGRAM

6.1 General Description

- There are three groundwater systems beneath the FMPC. These are:

  1) the surficial till layer, approximately 15 to 18 meters thick, which contains pockets of perched water and sand and gravel lenses.

  2) the shallow sand and gravel aquifer, occurring at 18 to 27 meters; this is the water table.

  3) the deep sand and gravel aquifer, occurring at 40 to 45 meters; this is a major regional aquifer, separated from the shallower aquifer by a 3 to 5 meter layer of blue clay.

  The three systems are somewhat interconnected by several sand and gravel lenses and a semi-continuous blue clay layer. The general direction of groundwater movement is south. There are 13 onsite and 21 offsite groundwater monitoring wells and three production wells onsite. Onsite wells are monitored quarterly; offsite wells are monitored monthly. Elevated concentrations of uranium are present in three downgradient offsite wells. A study by Dames and Moore was initiated during 1984 to identify the origin of this contamination and to recommend possible mitigating measures. This study has been completed and implementation of remedial measures is expected during FY 86.

6.2 Monitoring Program

Findings

- There are 13 onsite and 21 offsite groundwater monitoring wells, which are used for routine monitoring at FMPC. There are also three production wells onsite. The onsite wells are monitored

quarterly and the offsite wells, monthly. Locations of the wells are shown on Figures 6-1 and 6-2.

- Onsite groundwater sampling is conducted by Power Plant and Utilities; HS&E collects offsite samples. Neither group includes personnel with backgrounds in groundwater monitoring.

- Groundwater sampling procedures are described in draft Procedure 4.6 (April 1, 1985). This procedure addresses sampling of onsite wells only. No procedure for offsite well sampling could be provided by the HS&E staff.

- The draft onsite sampling procedure does not address purging of wells, parameters to be monitored during collection, data forms, sample chain of custody, or training of sampling personnel.

- Little information is available as to how these wells were installed and whether they were sealed, adequately cased, or developed. They are open to the atmosphere, which greatly affects chemical composition. In addition, they may be serving as routes for contaminant migration, if they were improperly placed, or if the integrity of the bentonite seals has been compromised.

- The surficial till is the critical zone for groundwater monitoring for the following reasons:

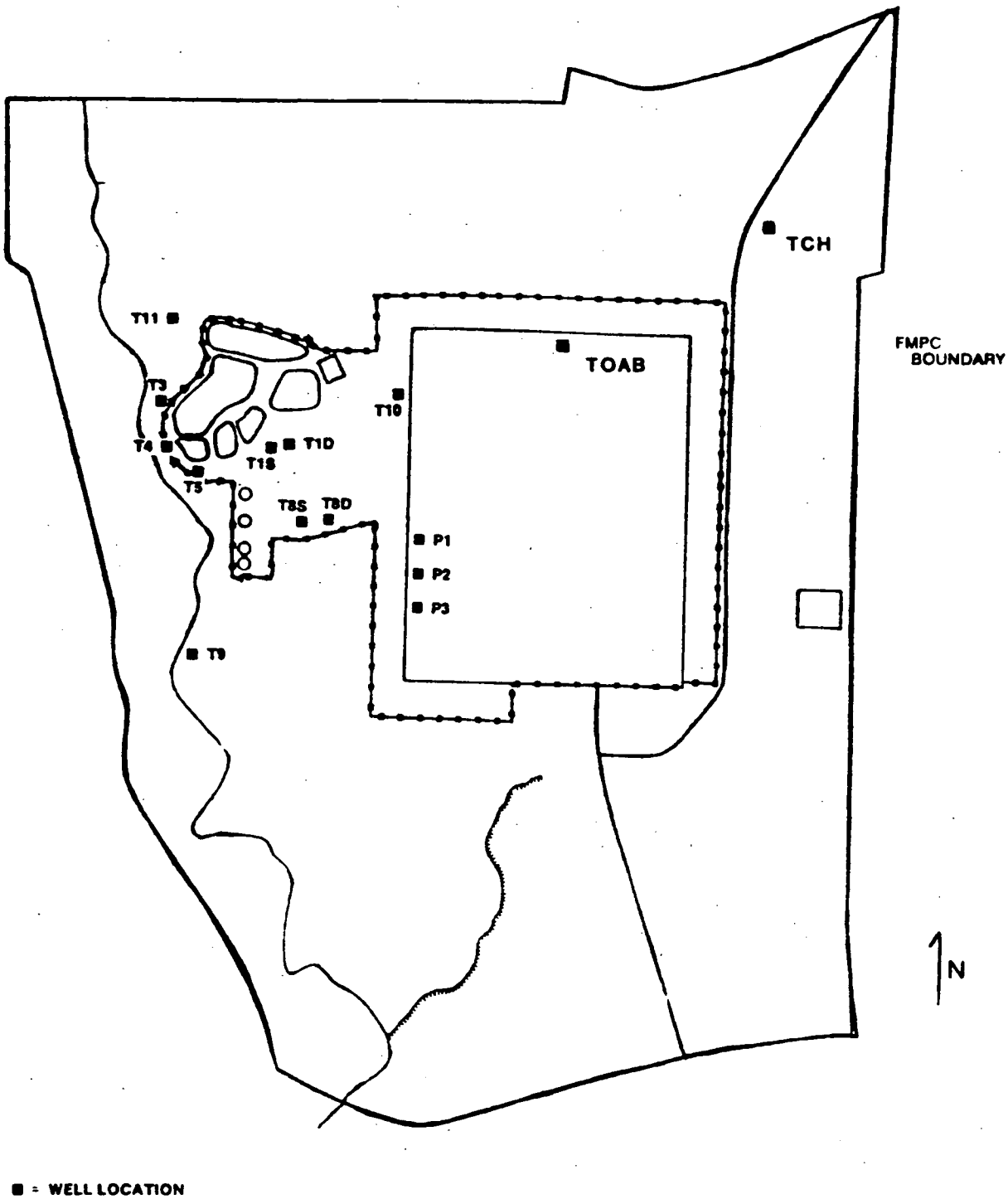
  a. All FMPC disposal/storage units occur within or on this unit.

  b. Leachate released from source areas will initially migrate within this layer.

  c. The surficial till unit can provide local discharge of contaminated groundwater to surface streams.

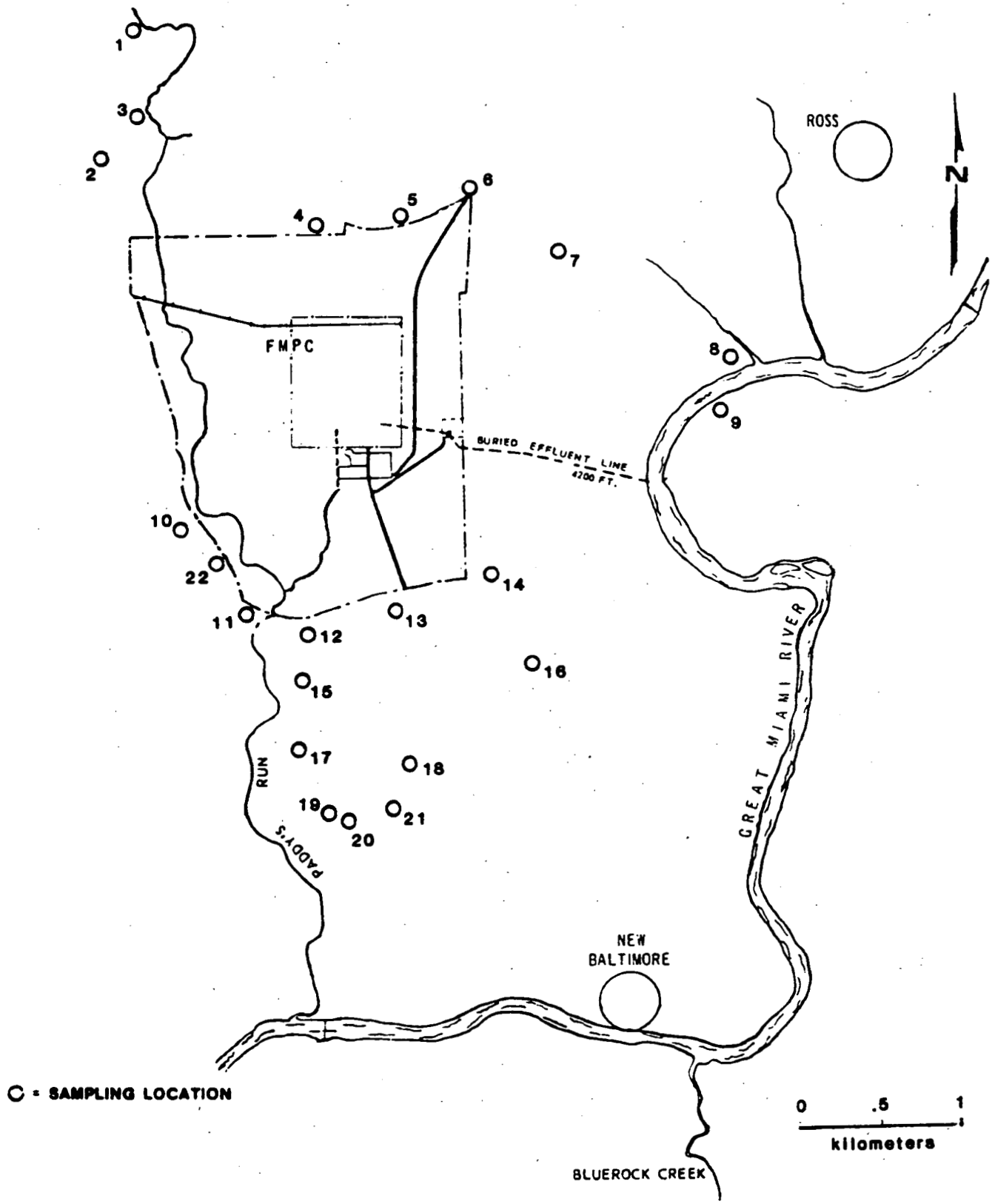
  d. Boring logs indicate that the surficial till unit is hydrologically connected to the shallow sand and gravel aquifer, where above-background uranium levels have been observed.

FIGURE 6-1
Locations of Onsite Production and Monitoring Wells



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

FIGURE 6-2
Locations of Offsite Monitoring Wells



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

None of the 13 onsite and 21 offsite wells, used for routine monitoring, sample the surficial till. Hydrogeologic properties of the till such as hydraulic conductivity, infiltration rate, groundwater flow direction and velocity have not been established.

- Potential sources of contaminant release to groundwater at the FMPC include the six waste pits, the burn pit, the clearwell, the K-65 tanks, the metal oxide silos, the scrap metal piles, the flyash piles, the sanitary landfill, leaking transfer lines, and runoff from the plant production area.

- The existing number of monitoring wells and their respective placements are inadequate to properly monitor each potential source for its individual contribution to groundwater contamination. Each of the above sources should have a minimum of one upgradient and three downgradient wells to properly characterize that source's effect on groundwater. Some potential sources do not have any wells that can serve such an individual purpose. The inability to determine the impact that a particular disposal/storage area has on groundwater precludes the ability to apply effective/timely remedial actions.

- Sampling is performed by both dedicated pumps and hand bailers. Special cleaning procedures for preventing cross-contamination during bailing are not documented.

- Well evacuation (purge) volumes are based on the Theis and Jacobs equation for pump test data. This equation assumes that all water pumped during a test comes from the aquifer and none comes from storage within the well casing; it is therefore not appropriate for application to small, low-yielding wells such as the monitoring wells at FMPC.

- Onsite well samples are analyzed for uranium, gross alpha and gross beta activity, pH, chloride, nitrate, and sulfate. Results for

1984 samples are presented in Table 6-1 through 6-5. Many above-background concentrations of uranium and nitrate have been observed in the wells that monitor the shallow sand and gravel aquifer. The highest radioactivity levels were noted in wells T8D and T10. Well TOAB had the highest chloride levels and well T10 had the highest nitrate and sulfate concentrations.

- Offsite wells are analyzed for uranium and nitrate only. Exceptions are wells 8 and 9 which are also analyzed for Ra-226 and Ra-228. Tables 6-6 and 6-7 present offsite well data for 1984. Wells 12, 15, and 17 contained the highest uranium concentrations. The maximum was 247.11 pCi/l in well 15. Nitrate concentration was highest in well 5. Both uranium and nitrate concentrations were within DOE 5480.1A and OEPA guidelines.

Recommendations

Determine the physical condition of existing wells; repair or recondition as appropriate. Wells which are substandard should be removed from service and plugged (grouted).

Provide additional onsite wells to completely characterize the local hydrology and evaluate sources, migration pathways, and trends. These wells should be placed in the surficial till, which is the critical zone for initial release of uranium contaminated groundwater at the FMPC. These wells should enable characterization of the character, extent, rate and direction of movement of groundwater contamination in the surficial till.

a. Place sufficient wells around each source area to enable determination of its individual effect on groundwater quality.

b. Use screened wells downgradient to allow determination of gross contaminant movement via a plume. It is advantageous to screen these wells over the entire distance of the aquifer to ensure that a leachate plume is not passing under the well system.

TABLE 6-1
Uranium in Onsite Well Water

Sampling Point (1)	Number of Samples	Concentration (pCi/L)				
		Maximum	Minimum	Average	95% (2) C. L.	% of (3) Standard
P1	4	0.54	0.20	0.34	1.93	0.03
P2	4	0.74	0.20	0.34	2.43	0.03
P3	4	0.27	0.14	0.14	1.74	0.01
T1S	2	6.09	5.28	5.69	1.90	0.47
T1D	4	1.22	0.20	0.34	3.84	0.03
T3	4	2.17	1.76	1.90	1.15	0.16
T4	3	5.15	4.60	4.87	1.15	0.41
T5	3	2.50	2.44	2.44	1.03	0.20
T8S	4	0.95	0.54	0.61	1.53	0.05
T8D	3	30.47 (4)	0.14	1.15	1.3×10^8	0.10
T9	4	0.95	0.54	0.81	1.51	0.07
T10	2	15.16	1.29	4.40	6.4×10^6	0.37
T11	4	1.35	0.20	0.54	3.80	0.05
TOAB	4	5.42	0.47	1.83	5.43	0.15
TCH	4	8.19	5.48	6.43	1.34	0.54

Footnotes:
(1) See Figure 6-1
(2) C. L. = Average Concentration ×÷ the value shown. Derived from log-transformed data; $= t_{0.05,df} S_{\bar{x}}$.
(3) 1200 pCi/L per DOE Order 5480.1A, Attachment XI-1, Table II is the standard for uncontrolled waters and does not apply to on-site well water. Used for reference purposes only.
(4) Dip sample; bucket may have been contaminated.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 6-2
Gross Alpha Activity in Onsite Well Water

Sampling Point (1)	Number of Samples	Concentration (pCi/L) (2)				
		Maximum	Minimum	Average	95% (3) C. L.	% of (4) Standard
P1	4	2.70	2.25	2.36	1.16	7.9
P2	4	1.35	0.45	0.93	2.28	3.1
P3	4	0.90	0.45	0.76	1.74	2.5
T1S	2	7.66	7.66	7.66	1.00	25.5
T1D	4	2.25	0.45	1.05	2.95	3.5
T3	4	4.96	2.70	3.38	1.58	11.3
T4	3	4.96	4.05	4.49	1.28	15.0
T5	3	4.05	3.15	3.58	1.37	11.9
T8S	4	2.70	1.35	1.96	1.60	6.5
T8D	3	23.42 (5)	<3.15	<7.15	13.60	<23.8
T9	4	2.70	2.25	2.58	1.15	8.6
T10	2	24.32	21.17	22.69	2.42	75.6
T11	4	2.25	<0.90	<1.49	1.88	<5.0
TOAB	4	<4.05	<2.25	<2.73	1.55	<9.1
TCH	4	8.56	1.04	4.84	5.75	16.1

Footnotes:

(1) See Figure 6-1

(2) Includes activity due to Uranium (see Table 20A), thus results are conservative.

(3) C. L. = Average Concentration X+ the value shown. Derived from log-transformed data; = $t_{n.m.\alpha} S_{\bar{x}}$.

(4) 30 pCi/L per DOE Order 5480.1A, Attachment XI-1, Table II is the standard for uncontrolled waters and does not apply to on-site wells. Used for reference purposes only.

(5) Dip sample; bucket may have been contaminated.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 6-3
Gross Beta Activity in Onsite Well Water

Sampling Point (1)	Number of Samples	Concentration (pCi/L) (2)				
		Maximum	Minimum	Average	95% (3) C. L.	% of (4) Standard
P1	4	4.95	4.05	4.49	1.14	15.0
P2	4	3.15	1.35	1.99	2.04	6.6
P3	4	3.15	1.80	2.32	1.44	7.7
T1S	2	22.97	11.26	16.24	92.70	54.1
T1D	4	2.25	0.90	1.42	3.66	4.7
T3	4	5.86	4.50	5.27	1.19	17.6
T4	3	6.76	5.86	6.30	1.19	21.0
T5	3	7.21	4.95	5.78	1.63	19.3
T8S	4	4.05	2.70	3.34	1.32	11.1
T8D	3	29.73 (5)	0.90	3.31	1.2×10^2	11.0
T9	4	4.95	3.60	4.02	1.27	13.4
T10	2	38.74	32.43	35.45	3.09	118.2
T11	4	3.60	2.25	2.65	1.53	8.8
TOAB	4	32.43	19.37	26.54	1.43	88.5
TCH	4	15.77	4.95	7.19	2.32	24.0

Footnotes:
(1) See Figure 6-1
(2) Includes activity due to Uranium (see Table 20A), thus results are conservative.
(3) C. L. = Average Concentration ×÷ the value shown. Derived from log-transformed data; $= t_{0.05,40} S_{\bar{x}}$.
(4) 30 pCi/L per DOE Order 5480.1A, Attachment XI-1, Table II is the standard for uncontrolled waters and does not apply to on-site wells. Used for reference purposes only.
(5) Dip sample; bucket may have been contaminated.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 6-4
pH and Chloride in Onsite Well Water

Sampling Point (1)	Number of Samples	pH		Chloride (mg/L)				
		Maximum	Minimum	Maximum	Minimum	Average	95% (3) C. L.	% of (4) Standard
P1	4	7.6	7.5	44	39	41.2	1.09	16.5
P2	4	7.6	7.5	19	17	18.0	1.07	7.2
P3	4	7.6	7.4	13	12	12.7	1.07	5.1
T1S	2	7.5	7.3	23	18	20.3	4.75	8.1
T1D	4	7.8	7.4	22	20	21.2	1.08	8.5
T3	4	7.5	7.4	23	20	21.5	1.10	8.6
T4	3	7.5	7.4	27	20	22.8	1.46	9.1
T5	3	7.4	7.3	21	19	20.0	1.13	8.0
T8S	4	7.6	7.4	21	19	20.2	1.08	8.1
T8D	3	7.7	7.4	12	8	10.5	1.79	4.2
T9	4	7.8	7.5	24	19	21.4	1.19	8.6
T10	2	6.8	6.8	79	74	76.5	1.51	30.6
T11	4	8.6	7.5	21	17	19.2	1.16	7.7
TOAB	4	8.5	7.0	577	540	559.8	1.05	223.9
TCH	4 (5)	7.5	7.1	57	4	22.8	42.4	9.1

Footnotes:
(1) See Figure 6-1
(2) C. L. = $\pm 2\sigma$.
(3) C. L. = Average ×+ the value shown. Derived from log-transformed data; = $t_{n.s.}$ as $S_{\bar{x}}$.
(4) 250 mg/L per Ohio EPA Rule 3745-82-02, Secondary Maximum Contaminant Levels.
(5) Only 3 for Chloride.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 6-5
Nitrate and Sulfate in Onsite Well Water

Sampling Point (1)	Number of Samples	Nitrate Nitrogen (mg/L)					Sulfate (mg/L)				
		Maximum	Minimum	Average	95% (2) C. L.	% of (3) Standard	Maximum	Minimum	Average	95% (2) C. L.	% of (4) Standard
P1	4	1.40	<0.11	<0.48	5.31	<4.8	97	64	79.0	1.35	31.6
P2	4	<0.11	<0.11	<0.11	1.00	<1.1	142	9	18.4	8.74	7.4
P3	4	<0.11	<0.11	<0.11	1.00	<1.1	45	40	42.2	1.09	16.9
T1S	2	1.67	<0.11	<0.43	2.7×10^7	<4.3	80	79	79.5	1.08	31.8
T1D	4	<0.11	<0.11	<0.11	1.00	<1.1	17	2	8.1	4.87	3.2
T3	4	<0.11	<0.11	<0.11	1.00	<1.1	101	92	97.7	1.07	39.1
T4	3	4.25	2.71	3.23	1.82	32.3	68	62	65.3	1.12	26.1
T5	3	<0.11	<0.11	<0.11	1.00	<1.1	91	80	83.5	1.20	33.4
T8S	4	<0.11	<0.11	<0.11	1.00	<1.1	75	53	65.5	1.27	26.2
T8D	3	0.68	<0.11	<0.21	13.07	<2.1	12	2	6.0	10.92	2.4
T9	4	1.78	<0.11	<0.49	9.77	<4.9	81	71	74.9	1.10	30.0
T10	2	234.93	26.90	79.50	9.5×10^5	795.0(5)	769	723	745.6	1.48	298.2 (5)
T11	4	1.22	<0.11	<0.36	8.52	<3.6	95	5	43.0	9.82	17.2
TOAB	4	0.11	<0.11	<0.11	1.00	<1.1	663	563	608.0	1.12	243.2 (5)
TCH	4	7.93	0.72	2.28	4.75	22.8	252	28	132.4	5.27	53.0

Footnotes:
(1) See Figure 6-1
(2) C. L. = Average ×÷ the value shown. Derived from log-transformed data; = $t_{0.05, df} S_{\bar{x}}$.
(3) 10 mg/L per Ohio EPA Rule 3745-81-11, Maximum Contaminant Levels for Inorganic Chemicals.
(4) 250 mg/L per Ohio EPA Rule 3745-82-02, Secondary Maximum Contaminant Levels.
(5) Standards apply only to drinking water, and thus only to wells P1, P2 and P3. Used for reference purposes only on others.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 6-6
Uranium in Offsite Well Water

Sampling Point (1)	Number of Samples	Concentration (pCi/L)				
		Maximum	Minimum	Average	95% (2) C. L.	% of (3) Standard
1	12	0.54	0.20	0.34	1.24	0.03
2	9	0.54	0.14	0.27	1.46	0.02
3	10	0.47	0.20	0.34	1.26	0.03
4	10	1.42	1.02	1.29	1.08	0.11
5	11	1.76	1.29	1.42	1.07	0.12
6	12	1.62	0.81	1.29	1.16	0.11
7	11	1.15	0.74	0.95	1.08	0.08
8	12	0.81	0.47	0.54	1.10	0.05
9	12	1.02	0.54	0.81	1.10	0.07
10	12	0.47	0.27	0.34	1.10	0.03
11	7	0.88	0.54	0.68	1.19	0.06
12	11	182.79	128.63	165.19	1.07	13.77
13	12	0.41	0.34	0.41	1.06	0.03
14	12	0.81	0.68	0.74	1.03	0.06
15	12	247.11	193.62	219.85	1.06	18.28
16	11	0.81	0.20	0.41	1.38	0.03
17	11	46.04	30.47	36.29	1.08	3.02
18	11	0.41	0.20	0.34	1.17	0.03
19	12	0.34	0.07	0.20	1.38	0.02
20	10	0.47	0.07	0.20	1.48	0.02
21	12	0.34	0.20	0.27	1.10	0.02
22	9	0.88	0.61	0.74	1.11	0.06

Footnotes:
(1) See Figure 6-2
(2) C. L. = Average Concentration ×÷ value shown. Derived from log-transformed data; = $t_{0.05,\,40}\,S_{\bar{x}}$.
(3) 1200 pCi/L per DOE Order 5480.1A, Attachment XI-1, Table II.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 6-7
Nitrate in Offsite Well Water

Sampling Location (1)	Number of Samples	Concentration (mg/L)				
		Maximum	Minimum	Average	95% (2) C. L.	% of (3) Standard
1	12	<0.11	<0.11	<0.11	1.00	<1.1
2	9	0.18	<0.11	<0.12	1.13	<1.2
3	10	<0.11	<0.11	<0.11	1.00	<1.1
4	10	1.67	0.63	1.15	1.21	11.5
5	11	16.47	1.31	7.83	1.87	78.3
6	12	8.18	1.27	3.70	1.51	37.0
7	11	<0.11	<0.11	<0.11	1.00	<1.1
8	11	3.66	1.08	2.04	1.34	20.4
9	11	3.43	1.49	2.53	1.18	25.3
10	12	<0.11	<0.11	<0.11	1.00	<1.1
11	7	4.18	1.17	3.24	1.53	32.4
12	11	2.73	1.22	1.95	1.21	19.5
13	12	2.06	1.27	1.62	1.11	16.2
14	12	4.50	1.36	2.98	1.26	29.8
15	12	3.84	1.87	2.65	1.16	26.5
16	11	0.16	<0.11	<0.12	1.08	<1.2
17	11	0.32	<0.11	<0.13	1.26	<1.3
18	11	<0.11	<0.11	<0.11	1.00	<1.1
19	12	<0.11	<0.11	<0.11	1.00	<1.1
20	10	1.27	<0.11	<0.25	1.86	<2.5
21	12	<0.11	<0.11	<0.11	1.00	<1.1
22	9	1.69	<0.11	<0.68	2.37	<6.8

Footnotes:
(1) See Figure 6-2
(2) C. L. = Average Concentration ×÷ value shown. Derived from log-transformed data; = $t_{n-1, \alpha/2}$ $S_{\bar{x}}$.
(3) 10 mg/L per Ohio EPA Rule 3745-81-11, Maximum Contaminant Levels for Inorganic Chemicals.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

c. Use wells placed directly upon the waste area to allow observation of water level fluctuations. These wells provide the bestindication of what is happening as groundwater passes a source.

d. Use well clusters which permit monitoring of all three groundwater zones.

e. Determine hydrologic characteristics such as transmissivity, specific yield, porosity, permeability, and hydraulic conductivity. These characteristics will enable determination of the rate of movement of groundwater in the surficial till and deeper zones.

Groundwater sampling procedures should be finalized and documented. Consolidate groundwater monitoring responsibilities in one group and provide an individual with a background in such monitoring. Implement changes to make sampling procedures similar for onsite and offsite wells.

Re-evaluate the use of the Theis and Jacobs equation for determining well-evacuation volumes. Papadopulos and Cooper have an equation, describing discharge from a pumped well, which considers water removed from casing storage and may therefore be more appropriate for monitoring well application.

Parameters such as pH, conductivity, temperature, and dissolved oxygen are readily monitored during well evacuation and serve as excellent indicators of sample stability, especially if well depths are not known, and thus adequate volumes for evacuation cannot be estimated. Such monitoring provides valuable data regarding gross groundwater quality, such as the presence of acids, organics, etc. A portable pH/conductivity meter should be purchased and used during sample collection, particularly for those onsite wells that are old and for which the depths are not known, in addition to all the offsite wells. A sampling form like that used by Dames and Moore should be adopted, to encourage recording of such pertinent information as water level, well

evacuation methodology, field tests, time, sample identification, and sample physical appearance and odor.

Conduct additional analyses of groundwater samples for other radionuclides (Np-237, Th-228, Th-232, Ra-226, Ra-228, Pu-238, Pu-239/240, Ru-106, Sr-90, Cs-137, and Tc-99) known to be present in materials processed, stored, or disposed of at the FMPC. Also monitor for heavy and trace metals and volatile and non-volatile organics. Based on these results, determine the need for routine measurement of these parameters.

7.0 MONITORING PROGRAM FOR SOIL, SEDIMENT, VEGETATION, AND OTHER ENVIRONMENTAL MEDIA

7.1 Soil Sampling

Findings

- Soil sampling procedures are documented in IH&R Procedure 4.1 (January 12, 1981).

- The above procedure specifies routine annual samples only from the vicinity of the perimeter air monitoring stations. However, routine sampling locations have been increased to semi-annually and to include six offsite locations. Routine sampling locations for 1984 are indicated on Figure 7-1.

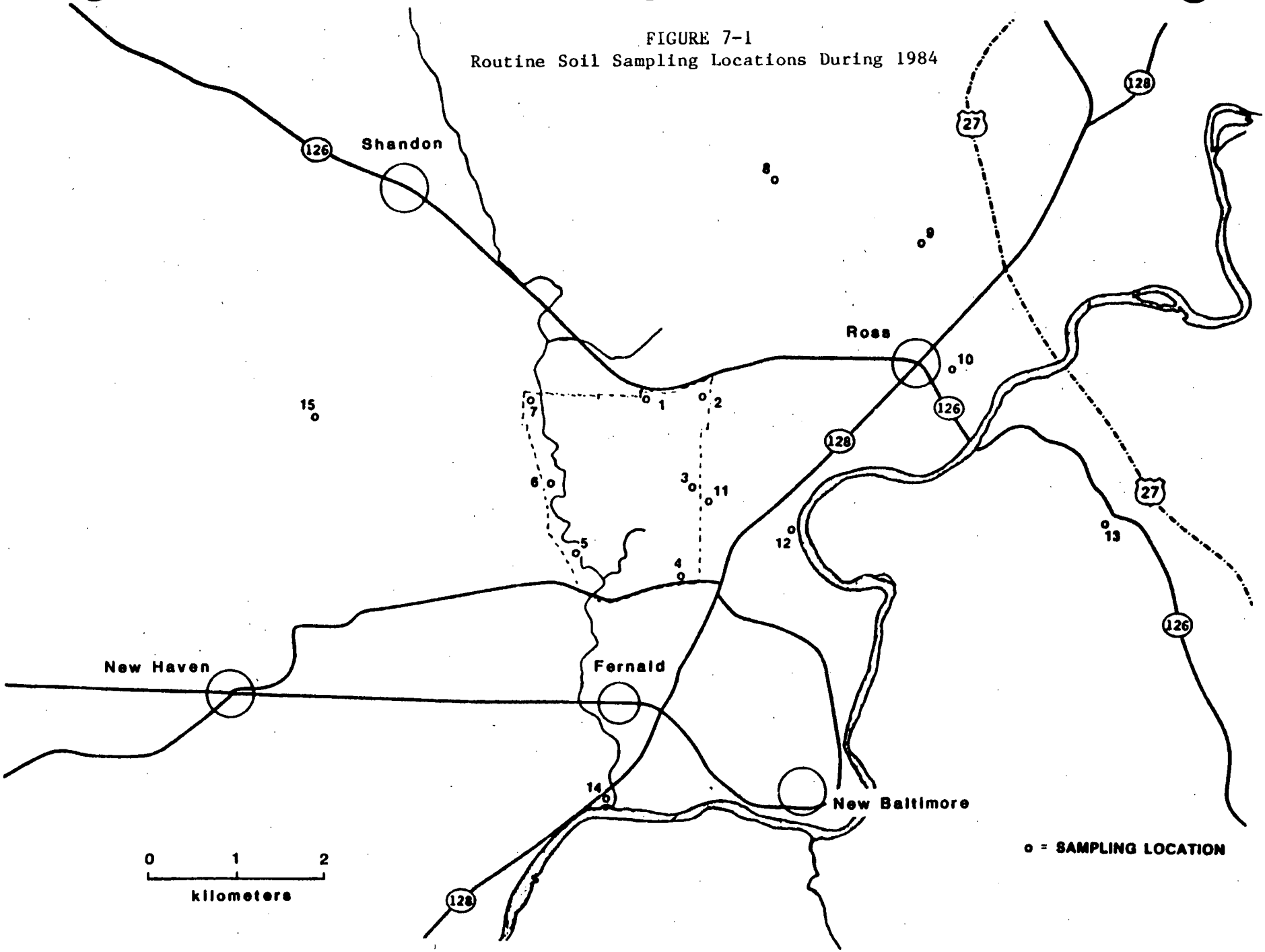
- Additional samples are collected, as considered necessary, to assist in evaluating deposition of contaminants. During 1984, additional sampling was performed both on and off the FMPC property. Sufficient data is not available to thoroughly characterize offsite contamination levels.

- Sampling is performed using a 2.1 cm diameter stainless steel coring tube. Samples are to 5 cm deep. Nine cores are obtained (the procedure indicates 6 cores) at approximately 1.5 m a part at each sampling location and these cores are composited to form the sample.

- The procedure does not provide guidance concerning removal of vegetation before sampling or elimination of the vegetation from the sample prior to analysis.

- Information regarding exact location of sampling; conditions of the sampling sites; type of soil obtained; physical characteristics, e.g. odor and color; ground cover; etc., is not recorded. This information may be helpful in explaining unanticipated or atypical results.

FIGURE 7-1
Routine Soil Sampling Locations During 1984



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

- Training of personnel in soil sampling techniques is not documented.

- The procedure does not specify collection of soil samples to correspond to all vegetation sampling locations. This is necessary to help determine the source of vegetation contamination, i.e. uptake from soil, external rain - splash contamination or airborne deposition.

- The sampler is field cleaned between samples by scraping off residual soil and wiping with a clean cloth or paper towel. This cleaning technique is inadequate to prevent cross contamination. Thorough cleaning of the sampler is performed after all sampling has been completed.

- Sampling of soils within the plant area has identified significant and widely fluctuating uranium concentrations. Such information can help identify potential storm runoff and resuspension problems and trends in onsite surface contamination. However, there are no existing procedures requiring routine in-plant soil sampling at the FMPC.

- Soil samples are analyzed by EAL in California. The procedure specifies only uranium analyses, although additional radionuclides, known to be present as contaminants in FMPC materials, were also determined in selected samples collected in 1984. Soils are not analyzed for nonradiological contaminates.

- Uranium concentrations in 1984 soil samples from near the perimeter monitoring stations ranged from 2.01 to 68.5 pCi/g (see Table 7-1). The highest concentration was in the sample from location 3, directly east of the site and in the vicinity of an out of service incinerator. For comparison, background uranium concentrations in soil from this area are typically on the order of 1 to 3 pCi/g of total uranium.

TABLE 7-1
Uranium Concentrations in Perimeter Soil Samples

Sampling Point (1)	Concentration (pCi/g dry wt.)					
	August	95% (2) C. L.	% of Guideline	December	95% (2) C. L.	% of (3) Guideline
1	8.32	±0.41	23.8	10.22	±0.55	29.2
2	10.64	±0.54	30.4	7.31	±0.33	20.9
3	68.50	±3.46	195.7 (4)	39.94	±1.70	114.1 (4)
4	8.32	±0.34	23.8	6.57	±0.34	18.8
5	5.37	±0.54	15.3	12.80	±0.62	36.6
6	7.36	±0.41	21.0	1.56	±0.23	4.5
7	3.29	±0.34	9.4	3.52	±0.26	10.1
8	3.06	±0.14	8.7	1.90	±0.26	5.4
9	3.74	±0.20	10.7	4.13	±0.26	11.8
10	2.01	±0.14	5.7	3.86	±0.24	11.0
11	13.78	±0.68	39.4	19.29	±0.80	55.1
12	1.80	±0.14	5.1	2.44	±0.24	7.0
13	6.54	±0.34	18.7	1.08	±0.16	3.1
14	2.07	±0.14	5.9	2.30	±0.18	6.6
15	13.22	±1.39	37.8	2.23	±0.16	6.4

Footnotes:

(1) See Figure 7-1

(2) C. L. = 2σ.

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

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

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

- DOE guidelines for residual uranium soil contamination at formerly utilized sites being decontaminated for release for unrestricted use are developed on a site specific basis. The Nuclear Regulatory Commission has a guideline for total natural or depleted uranium in soil of 35 pCi/g. Offsite soils in an area directly east of the old incinerator exceed the NRC guidelines.

- Analyses for other radionuclides (refer to Table 7-2) indicated no detectable transuranics, thorium within the range of typical background levels, and a maximum level of 4.0 pCi/g of Tc-99 (approximately 85% of the samples analyzed contained no detectable Tc-99 contamination).

Recommendations

Revise sampling procedures to reflect current routine sampling locations and to address matters of parallel vegetation/soil sampling; improved sampling equipment cleaning techniques (or use of separate collection equipment at each location); personnel training, including documentation; expanded radionuclide analyses; recording of pertinent site and sample information; and guidance on removal of vegetation when sampling.

Conduct a thorough survey of uranium contamination in the environment surrounding the FMPC.

Establish a program for routine sampling within the plant area. A minimum of 20 sampling locations is suggested. Locations should include areas of heavy traffic, storm runoff pathways, and some relatively undisturbed regions.

Analyze a representative selection of soils with elevated uranium concentrations for nonradiological contaminants. Analyses should include heavy and trace metals, known to be present in materials at the FMPC. Based on results determine if these parameters should be routinely evaluated.

TABLE 7-2
Radionuclide Concentrations in Perimeter
Soil Samples from the FMPC Area

Sampling Location	Radionuclide (pCi/g ± 2σ)							
	^{237}Neptunium	^{238}Plutonium	^{239,240}Plutonium	^{99}Technetium	^{230}Thorium	^{232}Thorium	^{228}Thorium	Uranium
1	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.3	0.7 ± 0.1	1.1 ± 0.1	0.8 ± 0.1	1.4 ± 0.1
2	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.6	0.9 ± 0.2	1.0 ± 0.2	1.0 ± 0.2	2.6 ± 0.1
3	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.5	1.2 ± 0.1	1.4 ± 0.1	1.2 ± 0.1	2.8 ± 0.1
4	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.06	0.0 ± 0.6	0.9 ± 0.1	1.0 ± 0.1	0.9 ± 0.1	1.9 ± 0.1
5	0.0 ± 0.4	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.5	1.1 ± 0.1	1.5 ± 0.1	1.2 ± 0.1	10.5 ± 0.5
6	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	1.3 ± 0.2	1.8 ± 0.2	1.7 ± 0.2	5.9 ± 0.3
7	0.0 ± 0.2	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.5	0.8 ± 0.1	1.2 ± 0.1	1.1 ± 0.1	7.7 ± 0.4
8	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	0.6 ± 0.2	1.5 ± 0.2	0.9 ± 0.2	3.2 ± 0.3
9	0.0 ± 0.2	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.6	0.8 ± 0.1	1.1 ± 0.1	0.8 ± 0.1	7.3 ± 0.3
10	0.0 ± 0.3	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.6	1.0 ± 0.1	1.4 ± 0.1	1.0 ± 0.1	8.9 ± 0.5
11	0.0 ± 0.3	0.0 ± 0.05	0.0 ± 0.06	0.0 ± 0.6	0.9 ± 0.1	1.3 ± 0.1	0.8 ± 0.1	10.8 ± 0.5
12	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.8	1.1 ± 0.1	1.4 ± 0.1	1.2 ± 0.1	5.7 ± 0.3
13	0.0 ± 0.2	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	1.1 ± 0.1	1.2 ± 0.1	1.0 ± 0.1	2.8 ± 0.1
14	0.0 ± 0.3	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.6	1.0 ± 0.1	1.3 ± 0.1	1.0 ± 0.1	7.1 ± 0.3
15	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	1.0 ± 0.1	1.3 ± 0.1	1.0 ± 0.1	3.4 ± 0.2
16	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	1.1 ± 0.1	1.2 ± 0.1	1.1 ± 0.1	11.8 ± 0.6
17	0.0 ± 0.2	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 1.0	0.8 ± 0.1	1.0 ± 0.1	0.7 ± 0.1	2.4 ± 0.1
18	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.8 ± 0.7	1.6 ± 0.2	2.0 ± 0.3	1.5 ± 0.2	3.3 ± 0.1
19	0.0 ± 0.4	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	0.6 ± 0.1	1.1 ± 0.1	0.7 ± 0.1	3.7 ± 0.2
20	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	4.0 ± 0.6	1.1 ± 0.1	1.4 ± 0.1	1.1 ± 0.1	2.5 ± 0.1
21	0.0 ± 0.2	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.4	0.8 ± 0.1	1.2 ± 0.1	0.9 ± 0.1	4.8 ± 0.3
22	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.5	0.3 ± 0.1	0.4 ± 0.1	0.4 ± 0.1	3.5 ± 0.2
23	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.05	0.0 ± 0.5	0.8 ± 0.1	1.5 ± 0.1	0.8 ± 0.1	2.3 ± 0.1
24	0.0 ± 0.4	0.0 ± 0.06	0.0 ± 0.05	3.8 ± 0.5	1.2 ± 0.1	1.3 ± 0.1	1.1 ± 0.1	1.4 ± 0.1
25	0.0 ± 0.1	0.0 ± 0.05	0.0 ± 0.07	1.8 ± 0.8	1.6 ± 0.1	1.0 ± 0.1	1.7 ± 0.1	3.7 ± 0.2

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

7.2 Sediment Sampling

Findings

- Sediment sampling procedures are documented in IH&R Procedure 4.3 (March 30, 1981) and IH&R Procedure 4.4 (April 20, 1981). The former is for sampling the Great Miami River; the latter is for Paddy's Run and the Storm Sewer Outfall.

- Sampling procedures do not specify the frequency of sampling. In 1984, samples were collected semi-annually.

- Through 1984, samples were not collected from the same area at the prescribed sampling locations. This can result in wide variations in the deposited sediments and prevents evaluation of trends. The HS&E staff has recognized this deficiency and plans to erect markers to define sampling locations.

- The procedures identify seven sediment sampling locations in the Great Miami River and seven in Paddy's Run and associated ditches. In 1984, samples were obtained at the seven river locations and at 14 locations on the Paddy's Run drainage system (see Figure 7-2).

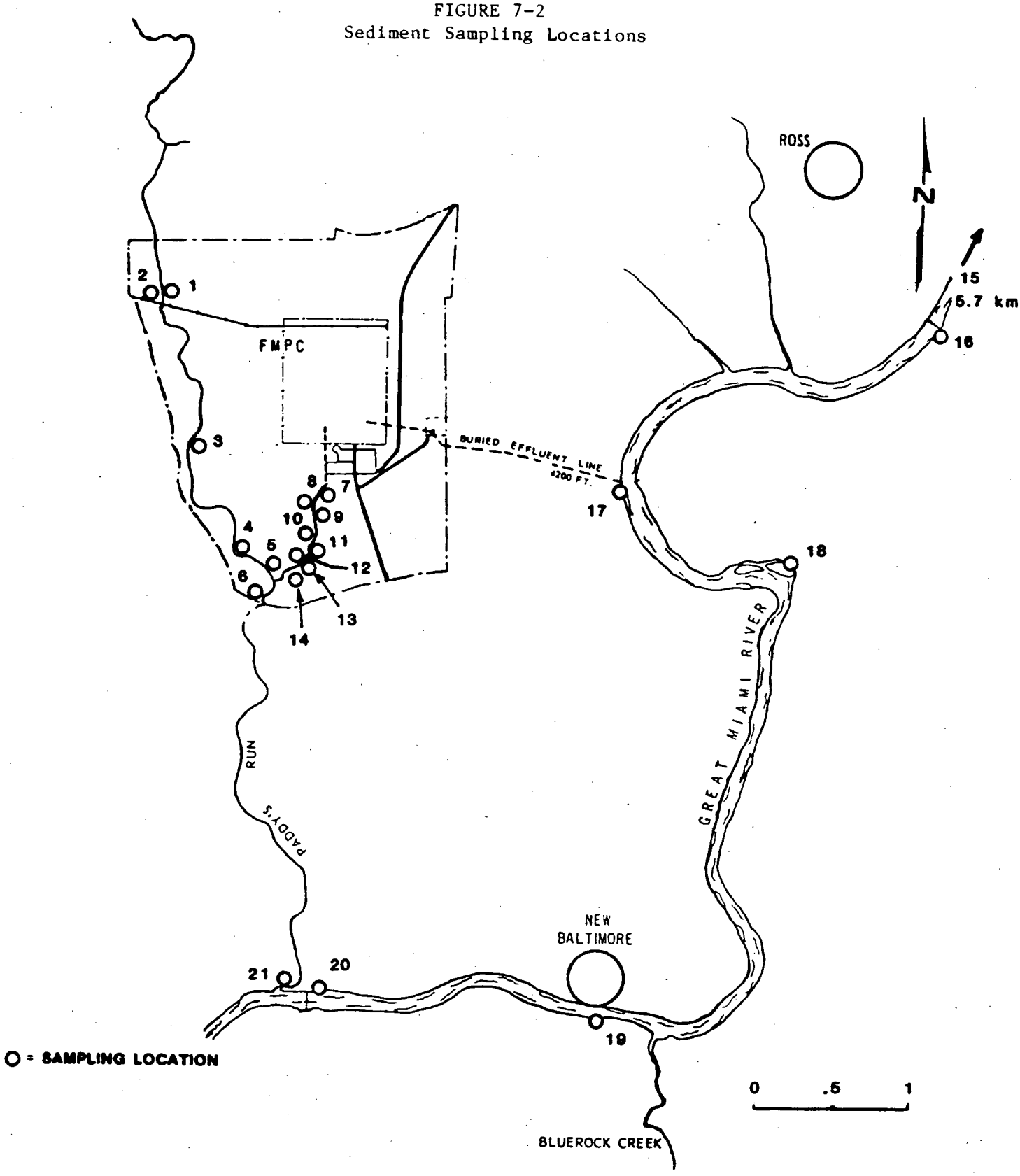
- Procedures address the handling of nonsediment (stones, twigs, artifacts, etc.) collected during sampling. As with soil sampling techniques, the procedure for cleaning the sampling equipment between samples is inadequate to prevent cross contamination.

- Trowels or spatulas are used for sediment sample collection. These techniques result in loss of the smaller particle size sediments. The HS&E staff is reviewing other possible methods of sediment collection.

- Training in sediment sampling procedures is not documented.

- All particle size classifications are being analyzed together. This can yield misleading data relative to trends in sediment

FIGURE 7-2
Sediment Sampling Locations



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

levels. The HS&E staff recognizes this limitation and plans to separate particle sizes for future analyses.

- Samples are being obtained only from the accessible banks along the Great Miami River; no samples are obtained from the main channel, into which the plant effluent is discharged.

- Sediments are not collected from the section of Paddy's Run between the FMPC boundary and the Great Miami River. This area has not been characterized for contamination, although data indicates elevated uranium levels in Paddy's Run sediments at the plant boundary.

- During a plant tour, many drainage ditches, leading from the plant site into Paddy's Run, were noted. Because of surface contamination on the plant site, these ditches have a potential for contamination by storm runoff. However, only one of these ditches - the one north of the railroad bridge - is routinely checked for sediment contamination.

- Sediment samples are analyzed by EAL. Although the procedures specify only uranium analysis; selected samples are also analyzed for Tc-99 because this radionuclide was identified at low concentrations in 1983 samples. Sediments are not analyzed for other radionuclides or nonradioactive contaminants.

- Uranium concentrations measured in 1984 sediment samples from the Great Miami River ranged from less than detectable to 2.96 pCi/g (Table 7-3). These are in the range of typical uranium background levels. No pattern of concentration was observed relative to the sampling location with respect to the effluent discharge point. Technetium-99 levels ranged from less than detectable to 1.3 pCi/g.

- Sediment samples from Paddy's Run and the associated drainage ditches ranged from 1.09 to 296.53 pCi/g of uranium (see Table 7-4). The highest level was from sampling location 6 at the plant boundary on Willey Road. Technetium-99 levels in selected

TABLE 7-3
Uranium and Technetium-99 Concentrations in
Great Miami River Sediments

Sampling Point (1)	Distance From FMPC Effluent Outfall	Uranium Concentration		^{99}Technetium Concentration	
		pCi/g (2)	95% C. L. (3)	pCi/g (2)	95% C. L. (3)
	Upstream				
15	5.9 km	2.62	±0.28		
16	2.4 km	0.00	±0.42	0.00	±0.4
	Downstream				
17	0.015 km	2.64	±0.34	1.30	±0.2
18	1.3 km	0.00	±0.42		
19	5.3 km	1.86	±0.22	0.80	±0.2
20	7.2 km	2.96	±0.34		
21	7.5 km	1.36	±0.20	0.00	±0.2

Footnotes:

(1) See Figure 7-2

(2) Dry weight.

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

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984).

TABLE 7-4
Uranium and Technetium-99 Concentrations in Sediments from Paddy's Run and Associated Drainage Ditches

Radionuclide	Sampling Point (1)	Concentration (pCi/g dry wt.)			
		May (2)	95% C. L.	August (3)	95% (4) C. L.
Uranium	1	2.30	±0.35 (5)	0.89	±0.07
	2	2.71	±0.41	1.09	±0.07
	3	5.96	±0.89	14.41	±0.68
	4	4.54	±0.68	1.30	±0.14
	5	42.31	±6.35	15.71	±0.68
	6	296.53	±44.48	9.00	±0.68
	7	42.85	±6.43	4.66	±0.21
	8	123.21	±18.48	22.78	±1.38
	9	168.57	±25.29	19.11	±0.68
	10	185.50	±27.83	125.81	±6.15
	11	214.61	±32.19	2.82	±0.14
	12	141.49	±21.22	32.81	±1.37
	13	18.69	±2.80	69.41	±3.44
	14	20.11	±3.02	45.15	±2.05
^{99}Technetium (6)	1	0.70	±0.2 (4)		
	6	30.0	±2.0		
	7	4.3	±0.2		
	11	16.0	±0.6		

Footnotes:
(1) See Figure 7-2
(2) Analysis by FMPC Bioassay Lab.
(3) Analysis by commercial laboratory.
(4) C. L. = ±2σ.
(5) C. L. = ±15% (equipment specification).
(6) ^{99}Tc samples consisted of a composite of May and August material.

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984).

samples ranged from 0.70 to 30.0 pCi/g. It should be noted that large variations were observed between samples collected in May and August 1984. These differences may be due to natural scouring by water flow or may be the result of sampling at different locations.

Recommendations

Conduct sampling of other drainage ditches to measure levels of uranium in sediments. Based on results, determine if these should be added as routine sampling locations.

Complete planned actions to identify sampling locations and to revise sediment sampling techniques.

Collect one set of sediment samples annually from the flow channel of the Great Miami River.

Implement improved procedures for cleaning equipment between samples.

Analyze a selection of sediments with elevated uranium concentrations for other radionuclides (i.e. transuranics, thorium, radium, and fission products), known to be present in contaminants in FMPC materials. Also conduct analyses for organics and heavy and trace metals. Decide on the need for routine analyses for these parameters based on results of initial screening tests.

Revise sampling procedures, accordingly, to incorporate current sampling procedures, training, sample locations, and analyses performed.

7.3 Vegetation Sampling

Finding

- Vegetation sampling procedures are documented in IH&R Procedure 4.2 (February 11, 1981). This procedure addresses only grass sampling.

- The above procedure does not specify the frequency of sampling or the locations to be sampled. The practice has been to collect samples near the perimeter air monitoring stations, at locations corresponding to the perimeter soil sampling points. Repeat sampling is not performed at the same locations, thus restricting use of data for trend analysis. There is no guidance for selection of control sample sites.

- During 1984, 20 samples of grass and forage were obtained from the FMPC and surrounding area (see Figures 7-3 and 7-4). Five samples of produce (potatoes) were also obtained from local residents' gardens. There is no documented procedure for produce sampling. Soil was not collected from the produce and forage sampling locations.

- Grass and forage sampling is performed by clipping the vegetation with large shears (scissors) from locations within a 1.5 m x 3.0 m area. Clippings from within the area are composited to form the sample.

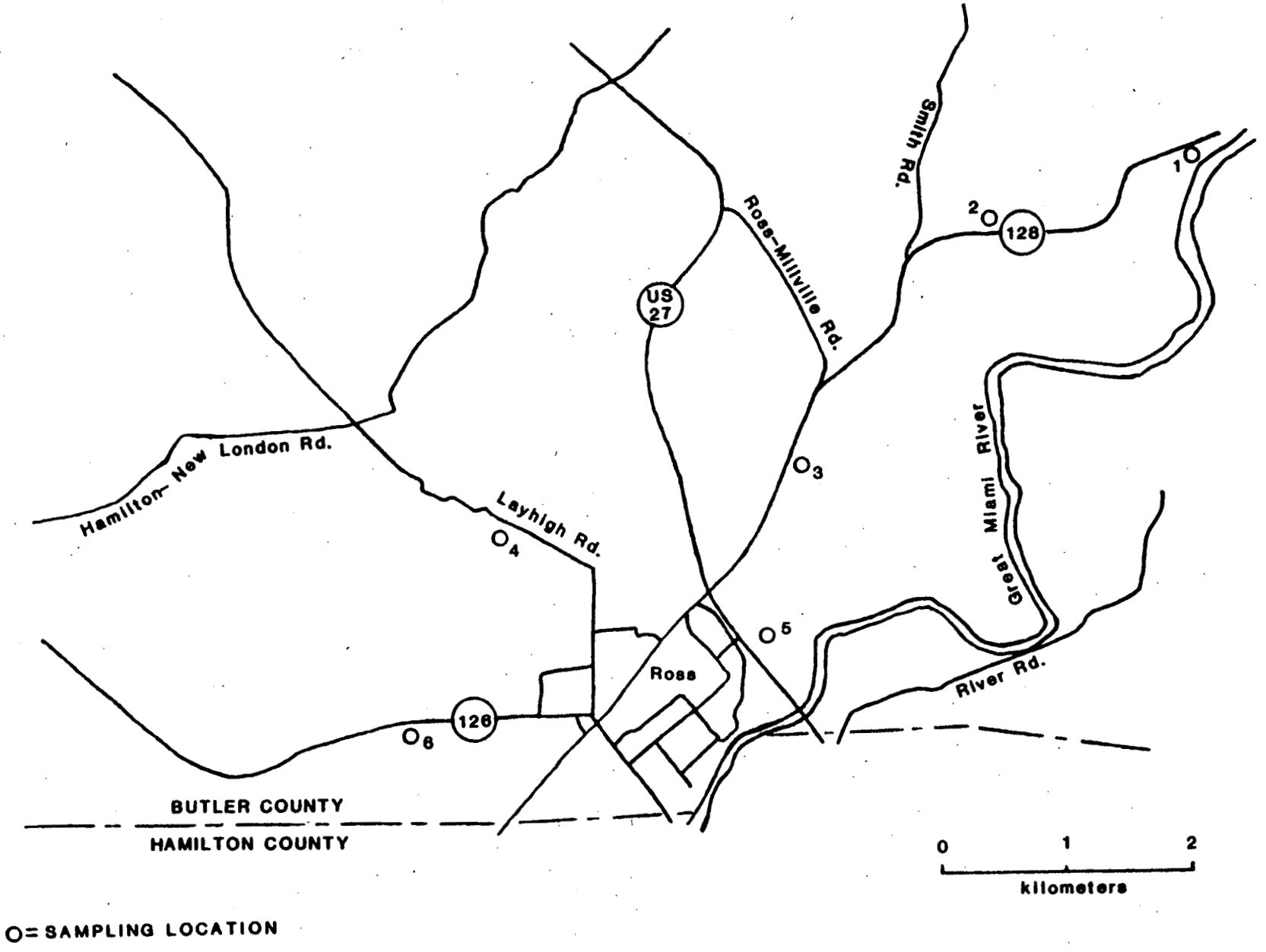
- The procedure does not specify collection of soil samples to correspond to all vegetation sampling locations. This is necessary to help determine the source of vegetation contamination, i.e. uptake from soil, external rain-splash contamination or airborne deposition.

- The shears are field cleaned between samples by wiping with a clean cloth or paper towel. This cleaning technique is inadequate to prevent cross contamination. Thorough cleaning of the sampler is performed after all sampling has been completed.

- Training of personnel in vegetation sampling techniques is not documented.

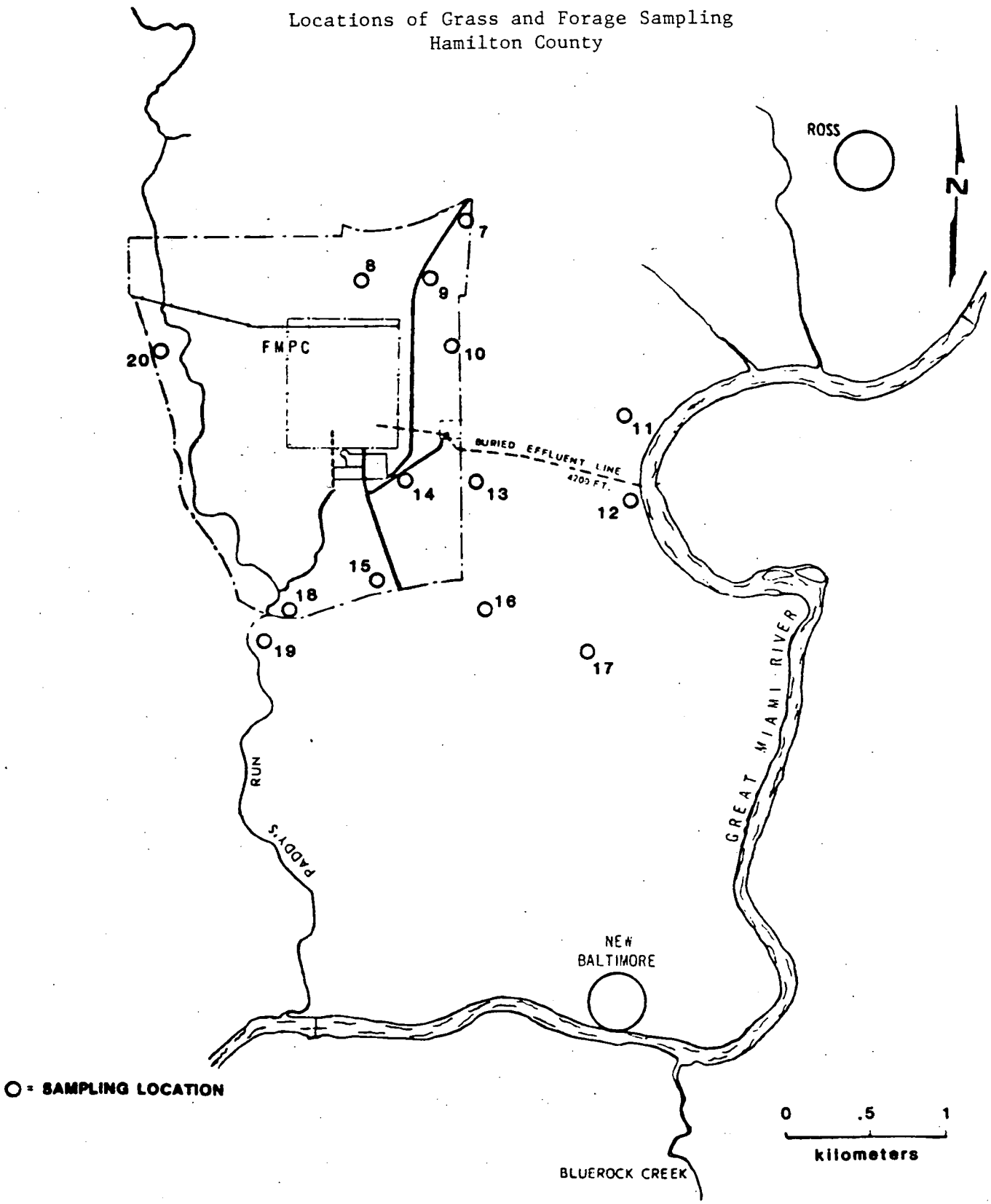
- Grass and forage samples are analyzed for uranium and fluoride concentrations. Uranium concentrations in 1984 samples ranged from 0.09 to 7.09 pCi/g dry weight; fluorides ranged from 6.3 to

FIGURE 7-3
Locations of Grass and Forage Sampling
Butler County



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

FIGURE 7-4
Locations of Grass and Forage Sampling
Hamilton County



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

19.5 ppm. Highest concentrations of both uranium and fluoride were onsite, east of the production area (see Table 7-5).

- Analyses for uranium in potato peels and flesh indicated from 0.068 to 0.366 pCi/g in the peels and <0.002 to 0.028 pCi/g in the flesh. For comparison the control sample contained uranium from 0.052 to 0.267 pCi/g in peels and <0.003 to 0.009 pCi/g in flesh.

Recommendations

Implement improved procedures for cleaning equipment between samples.

When collecting vegetation samples, collect parallel soil samples (at sample place and time). Ground crops such as potato tubers are of questionable value by themselves. Above ground crops are also indicators of deposition. It may be useful to investigate the use of soybeans, because they possess good air intercept qualities and are widely cultivated in this region, thus providing numerous potential sampling sites.

Revise sampling procedures, accordingly, to incorporate current sampling procedures, training, and sample locations (including control samples).

7.4 Direct Radiation Measurement

Findings

- Direct radiation levels are continuously measured at the perimeter air monitoring stations using thermoluminescent dosimeters. Processing of these dosimeters is on a quaterly basis. There is no HS&E procedure documenting this activity.

- Results of 1984 measurements indicated average perimeter radiation exposure rates ranging from 9.7 to 15.5 μR/h. The maximum levels were measured at station BS6 which is the nearest station to the K-65 storage tanks. Levels at other stations did not differ from typical background radiation in this area.

TABLE 7-5
Concentrations of Uranium and Fluorides in Grass and Forage Samples

Sampling Point (2)	Distance (km) From FMPC (3)	Uranium Concentration		Fluoride Concentration	
		pCi/g (4)	95% C. L. (5)	ppm (4)	% of Standard (6)
1	10.5	0.09	±0.01	6.7	8.4
2	8.7	0.14	±0.01	9.8	12.3
3	6.2	0.27	±0.02	9.2	11.5
4	4.1	0.48	±0.03	7.5	9.4
5	5.3	0.33	±0.01	10.2	12.8
6	2.3	1.12	±0.06	8.7	10.9
7	1.4	4.33	±0.22	7.8	9.8
8	0.7	4.59	±0.21	10.5	13.1
9	0.9	5.06	±0.22	9.8	12.3
10	0.8	7.09	±0.30	13.1	16.4
11	1.9	0.56	±0.03	8.1	10.1
12	1.9	1.24	±0.06	6.3	7.9
13	1.0	1.09	±0.06	9.1	11.4
14	0.7	6.67	±0.36	19.5	24.4
15	1.3	0.66	±0.03	11.9	14.9
16	1.7	0.44	±0.03	9.7	12.1
17	2.2	0.32	±0.02	6.6	8.3
18	1.5	1.78	±0.14	10.4	13.0
19	1.6	1.06	±0.05	6.4	8.0
20	1.2	3.20	±0.15	12.8	16.0

Footnotes:

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

(2) See Figure 7-3

(3) For the purposes of this table only, the center of the production area (Figure 2) was used for distance measurements.

(4) Dry weight.

(5) C. L. = ±2s.

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

(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

Recommendations - None

7.5 Other Environmental Sampling

Findings

- Milk is collected quarterly from cows which are pastured on the FMPC property; analysis is for uranium. Milk samples collected during 1984 did not contain detectable concentrations of uranium (<0.68 pCi/l).

- A fish sampling study was initiated in 1984. Samples were collected from the Great Miami River at the FMPC outfall and upstream and downstream of the outfall. Gizzard shad was the predominant species sampled, although a total of 18 different species were collected. Edible portions of the fish were analyzed for uranium. Analysis of fish samples indicated concentrations ranging from 0.067 to 0.777 pCi/g, wet weight. Evaluation of data by FMPC identified no significant differences between species or sampling locations, relative to uranium concentrations.

- Procedures for milk and fish sampling are not documented.

- The HS&E staff is considering sampling of additional media such as small mammals, birds, and macroinvertebrates. On the basis of the fish sampling results and the low levels of contamination identified in the environment of the FMPC, the usefulness of these programs would appear questionable.

Recommendations

Reexamine the need for sampling fish and other organisms currently being considered. If such an evaluation or a preliminary screening study indicates that these sampling programs would provide useful data, then

proceed with their implementation; otherwise document the evaluations and concentrate efforts on aspects of the environmental and effluent monitoring program which are in greater need of attention.

Develop documented procedures for all sampling programs currently in use.

8.0 WASTE MANAGEMENT

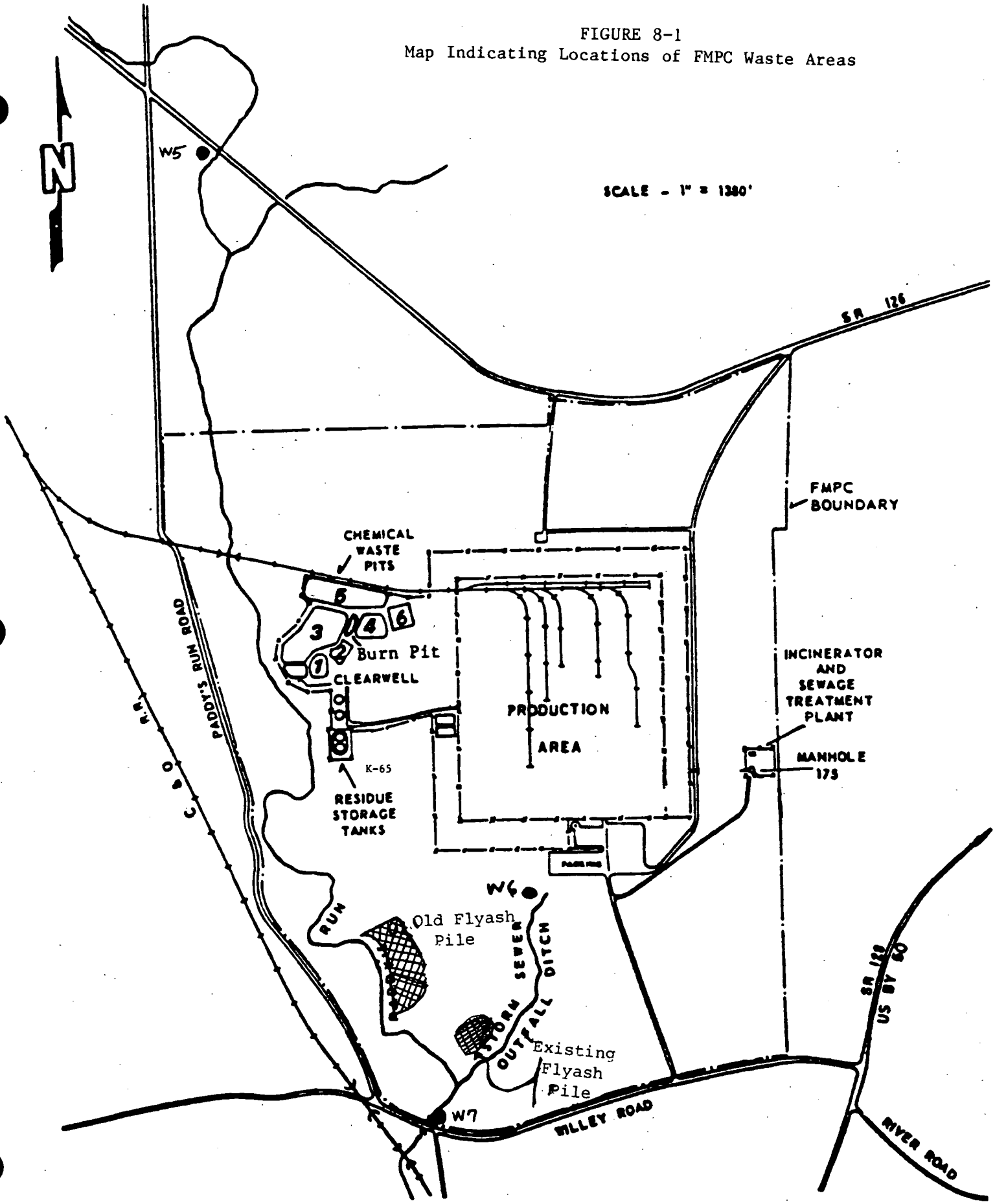
8.1 General Description of FMPC Wastes

Waste management activities at the FMPC are concerned with a variety of hazardous and nonhazardous wastes. Included in these wastes are general noncontaminated scrap and refuse, contaminated and noncontaminated metal scrap, waste oils, low level radioactive waste, RCRA hazardous wastes, co-contaminated and mixed wastes, sewage treatment plant sludge, and fly ash from the steam plant. Wastes currently on the FMPC site are estimated to total about 3.5×10^5 m^3. Since 1952, solid wastes contaminated with low concentrations of natural or depleted uranium have been placed in shallow pits. There are six pits; three (1, 2, and 3) have been filled and covered, the other three are near capacity. Waste contributions to the uncovered pits have ceased because of groundwater contamination. In addition to these six pits there are four silos. Two of these contain radium residues (K-65) from processing of Afrimet uranium ores. One of the silos contains metal oxides with low level radium contamination. The fourth silo is empty. Flyash has been disposed of at two locations toward the south of the property. The older flyash pile is inactive and has been partially covered; the other pile is still used for disposal of ash from the steam plant boilers. Locations of these waste areas are indicated on Figure 8-1 and a summary of the volumes and radioactivity contents is presented in Table 8-1.

All radioactive waste is low-level waste; no high level or transuranic wastes are generated or handled at the FMPC. Uranium waste is depleted or natural. Enriched uranium waste is recycled for recovery.

Other stored wastes include metal scrap (some is contaminated - some is not), in several different piles throughout the production area; refuse, which is disposed of in an onsite sanitary landfill; about 4.8×10^4 liters of 1,1,1-trichoroethane (awaiting incineration at the proposed Oak Ridge incinerator site); 3.2×10^3 kg of spent barium chloride salt and 1.7×10^3 liters of methylene chloride/perchloroethylene degreaser from the RMI plant in Ashtabula, Ohio; and an unestimated

FIGURE 8-1
Map Indicating Locations of FMPC Waste Areas



(From Feed Materials Production Center Environmental Monitoring Annual Report 1984)

TABLE 8-1
Summary of Radioactive Wastes in Pits and Silos

STRUCTURE	WASTE QUANTITY (MT)	URANIUM (KG)	U-235 (KG)	THORIUM (KG)	RADIUM-226 (Ci)
PIT 1	40,500	52,000	370	-	UNAVAILABLE
PIT 2	13,000	1,206,000	2,550	400	UNAVAILABLE
PIT 3	255,000	129,000	1,010	400	19
PIT 4	64,800	2,992,000	5,420	61,700	-
PIT 5	87,300	50,200	420	17,100	118
PIT 6	5,300	272,400	580	-	-
SILO 1 & 2	8,800	11,200	80	-	1,652
SILO 3	3,500	18,000	130	-	15
TOTALS	478,200	4,730,800	10,560	79,600	1,804

*(AS STORED, THROUGH AUGUST 1983)

(From "Hazardous Waste and Radioactive Mixed Waste Management Plan", U.S. DOE Feed Materials Production Center, May 26, 1984)

quantity of construction rubble and debris. Plans for disposition of construction rubble and debris have not been established.

The FMPC has been designated as the DOE thorium storage center and about 1050 metric tons of thorium feed material and products are stored on the site.

Contaminated waste oil is incinerated on site. Toxic co-contaminated wastes, such as PCB wastes, are segregated and packaged for storage.

8.2 Waste Management Activities

Findings

- Responsibility for coordinating waste management is assigned to the Waste Management Department.

- There are no written delineations of activities related to waste and management.

- Waste management practices are well documented in several manuals and reports. These include:

  a. Feed Materials Production Center Radioactive Waste Management Plan, NLCO-1100 (Rev. 5), March 19, 1984;

  b. FMPC Standard Operating Procedures Manual;

  c. FMPC Manufacturing Standards Manual;

  d. Implementation Plan for DOE Order 5820.2 (draft), August 1984;

  e. Hazardous Waste and Radioactive Mixed Waste Management Plan, May 26, 1984;

  f. FMPC Contingency Plan for RCRA Hazardous Waste, NLCO-2027 (draft) March 1985;

g. Standard Operating Procedure for On-Site Shipment and Discard of Depleted Uranium Materials, NLCO-1021 (Rev. 3).

- Analyses to characterize current wastes are performed prior to placing them into storage. Procedures are described in documents e. and g. above. However, characterization of wastes previously placed in pits was generic and does not provide a thorough analysis of specific contents.

- NLO, Inc. considers the surface impoundments and pits to be storage areas and not permanent disposal areas. It has been the contention of NLO, Inc. that DOE Order 5820.2 applies only to disposal of radioactive waste and is therefore not applicable to waste management activities at the FMPC. This is contradicted by records of DOE's Solid Waste Information Management System (SWIMS), which indicate the waste has been disposed of. Regardless of whether this is storage or disposal, the FMPC activities are still subject to requirements of 5820.2 for surveillance and institutional control and for compliance with the radioactivity concentration guidelines of DOE Order 5840.1A for areas beyond the site boundary.

- The current status of the waste pit area does not satisfy requirements of DOE Order 5820.2 for isolation during all phases of management. This is evidenced by the contamination of shallow groundwater in the vicinity of the waste pit area.

- Existing waste areas that have been "retired" have been simply covered with earth and vegetation. With the exception of the silos, other storage areas are uncovered.

- The placement of soil over the chemical waste pits as a retirement technique was particularly inappropriate. The pits were clay lined, which provides for a "bathtub" effect - an impermeable bottom which retains water and a permeable top which allows water to enter. Water may be actually accummulating in the pits to such a high level that it spills over. Plans are being developed for stabilization of the waste pits.

- Contaminants could be hydrologically transported from the active flyash pile by surface water runoff or infiltration into groundwater. The small area of uncovered waste on the "inactive" flyash pile could also be a source of contamination of runoff and groundwater.

- The suitability and conditions of the thorium storage building and containers are questionable from a continuing environmental health and safety standpoint. A decision should be made by DOE regarding the ultimate fate of the thorium at the FMPC so that disposal or long term storage can be pursued.

- Because of groundwater uranium contamination in the waste pit area and downgradient offsite, use of the pits has been discontinued. The FMPC plans to process and ship future wastes to an approved DOE low-level waste disposal site.

- Various alternatives for the wastes presently onsite are being explored. Before options can be evaluated a thorough characterization of these wastes will be necessary. The FMPC plans to have such a characterization performed in FY 86.

- The current sanitary landfill is almost full. Permitting for a proposed new landfill site is still pending with OEPA. (The current landfill has not been permitted.)

- NLO, Inc. had initially assumed that DOE-owned and contractor-operated facilities were not subject to the EPA regulations for hazardous waste. Requirements for compliance with these RCRA regulations of 40 CFR 260-267 are mandatory for DOE facilities. NLO, Inc. has developed and is implementing plans to attain compliance.

Recommendations

Responsibilities for all aspects of waste management should be delineated.

Proceed with plans to perform physical and chemical characterization of wastes presently stored/disposed of in silos and pits.

Evaluate the status of waste disposal areas. Such an evaluation should include measurement of leachate levels and determination of liner integrity. Identify potential onsite sources of uranium releases to shallow groundwater.

Develop and implement site stabilization and closure plans for all waste areas, consistent with requirements of DOE Order 5820.2. Initiate steps to achieve hydrologic isolation of waste using temporary measures while more permanent stabilization techniques are being developed.

Obtain the necessary permits for disposal areas identified as containing hazardous wastes and the proposed new sanitary landfill site.

Establish background levels for relevant contaminants listed in Appendix VIII of RCRA regulations, 40 CFR 261.

Develop a compliance monitoring plan for waste areas.

Work with DOE to obtain a decision regarding the ultimate fate of the thorium currently stored at the FMPC.

Continue activities necessary to achieve compliance with DOE Orders 5480.2 and 5820.2.

8.3 Waste Management Area Inspections

Findings

- A visit to the active flyash pile revealed significant fugitive emissions. Visual inspection of the pile's sloped sides revealed runoff of the solid material was occurring. The site is directly above the confluence of Paddy's Run Creek and the Storm Sewer Outfall Ditch. The inactive flyash pile has evidence of the recent addition of waste on top of the cover.

- Several small scrub trees were observed to be growing on top of the soil covering the K-65 tanks. Possible root damage to the structure or root uptake of radionuclides should be avoided by periodic maintenance activities.

- Contaminated scrap metals are piled directly on the ground surface. Runoff from this area may be contaminating surface and groundwater.

- Pit 4 had large areas of standing water on the surface when visited. Uncovered rubble and assorted debris were also on the surface.

- Pit 5 had grasses growing all around the outside edges, as well as numerous small scrub trees on the bermed areas; these trees have the potential to puncture the membrane liner. There was significant visible degradation of the liner where it was above the ground surface. Sludge was contained in the pit up to approximately one foot beneath the pit freeboard and a major portion of plant effluent was being directed through the pit and into the Clearwell.

- The sanitary landfill had several piles of trash lying loose on the surface. Daily cut and cover is not practiced.

Recommendations

Take corrective measures to eliminate conditions such as those noted above, which are detrimental to the continued integrity of waste storage and disposal areas. Develop criteria for maintenance of such areas and initiate routine inspections to identify and correct potential problems.

9.0 ANALYTICAL PROCEDURES

Findings

- Analytical procedures of FMPC laboratories are generally the standard (reference) methods recommended by EPA or DOE's Environmental Measurement Laboratory. One exception noted was the use of the specific ion electrode rather than brucine sulfate method for NPDES nitrate analyses when concentrations exceed 2 mg/l. The specific ion electrode method has not been approved by EPA or OEPA for this analysis.

- Water samples collected for uranium analysis are not filtered prior to acidifying to a pH of <2 with nitric acid. The eventual analysis for dissolved uranium is therefore actually for a combination of the initially dissolved uranium plus that fraction of the undissolved uranium which was solublized from particulates by the nitric acid preservative. Depending upon the chemical form of the uranium in the suspended particulates and the length of time between acidifying and analysis, this method could result in over estimating the concentration of dissolved uranium in water.

- Many of the procedures in use by FMPC laboratories have been reproduced directly from literature or reference manuals. No attempt has been made to adapt the documented procedure to the specific lab where it is being used.

- Several Bioassay Lab procedures, for example gross alpha in water and Ru-106, have not been documented. Some other procedures are in various stages of preparation.

Recommendations

The FMPC laboratory should apply, per 40 CFR 136, for approval of the specific ion electrode method for NPDES nitrate analysis. An alternative would be to use the approved cadmium reduction/colormetric method.

Filter water samples, intended for uranium analysis before addition of nitric acid for preservation. The solids on the filter can be analyzed separately if there is concern for total (suspended plus dissolved) uranium.

Complete documentation of all FMPC laboratory procedures. These procedures should be "tailored" to meet the conditions of the specific laboratories in which they are being used.

10.0 DATA HANDLING AND ANALYSIS

Findings

- Some of the monitoring and sampling data developed by FMPC laboratories and outside laboratories do not include uncertainties.

- Confidence limits presented with data are primarily based on statistical uncertainties associated with radiometric counting and do not include propogated errors from flow measurement, weighing, calibration, recoveries, and similar operations which introduce overall analytical uncertainties.

- Data are scattered throughout several operational groups, restricting their ready accessibility and interpretation. There is no individual responsible for coordinating data management.

- There are no procedures documenting data handling and analysis.

- Much of the observed data reduction was performed by hand, promoting the possibility of computational errors. In one case an error of nine orders of magnitude was noted in a group of calculations.

- The HS&E staff is developing a computer data base for environmental and effluent data and has initiated use of standard techniques for inspection of data distributions and trend analyses. A computer system, dedicated to the storage and processing of environmental monitoring data, is not yet available.

Recommendations

Request analytical groups to provide uncertainties (total propogated errors) and detection sensitivities with all reported data.

Consider the recommendations of EPA 520/1-80-012 "Upgrading Environmental Radiation Data" concerning uncertainties, significant figures, and use of zero and negative values.

Assign a member of the HS&E staff the responsibility for data coordination.

Develop and document procedures for data generation, storage, and management. Such procedures should include a rationale for data analysis, describing statistical packages and trend analysis procedures.

Increase computer capability. A minimum should be a dedicated personal computer with appropriate data management and analysis software packages.

11.0 QUALITY ASSURANCE PROGRAM

Findings

- The Analytical Laboratory is assuming the quality assurance (QA) responsibility for all FMPC laboratories.

- Samples to outside analytical laboratories are not accompanied by spikes and blanks.

- The FMPC participates in the DOE Quality Assurance Program, conducted by the Environmental Measurements Laboratory (EML). Results of analyses of EML uranium samples during 1984 were reviewed and noted to be in good agreement. The HS&E staff has calculated the FMPC analyses to average within ± 14% of the EML values.

- Quality control samples from EPA are analyzed as part of the QA program for NPDES parameters. Results have been within the value range provided by EPA.

- QA procedures have not been developed for data handling and analysis.

- Criteria for review and acceptance (or rejection) of effluent and environmental monitoring data has not been developed.

- There are no QA procedures for field sampling and monitoring activities or chain of custody for field samples.

- Training and qualifications of laboratory personnel is being performed and documented. However, better QA documentation is required for sampling procedures and personnel training to perform the sampling procedures. This training documentation should include the education and/or experience required, how it is determined when the individual is qualified to perform the procedure, who makes this determination (person authorized to "sign

off" for the procedures), the date the determination is made, and requirements and procedures for periodic training and/or requalification.

- Analysis of matrix spikes and duplicates should be increased. A minimum of 10% of the samples for NPDES parameters (except BOD) should be QA/QC samples.

- The Analytical Laboratory QA/QC coordinator has not been receiving copies of some new procedure documents for review.

- The FMPC has developed a Quality Assurance Program Manual NLCO-1104 (Revision 5), May 1982.

Recommendations

Develop QA plans covering data handling, analysis, review and acceptance; chain of custody; training, and field sampling procedures.

Increase the frequency of internal QA/QC samples to a minimum of 10% for all analytical work.

Assure that new analytical procedures are routed directly to the QA/QC coordinator for review and comment.

Include quality control samples (spikes and blanks) with samples sent to outside laboratories for analysis.

12.0 DOSE ASSESSMENT

Findings

- Oak Ridge National Laboratory has calculated the predicted committed dose equivalent to the maximally exposed individual and the 80 km population due to FMPC air emissions during 1984. The AIRDOS-EPA and DARTAB computer codes were used for the calculations with input parameters of 0.265 Ci of uranium released, lung solubility classification of 20% W and 80% Y, 1.0 μm particle size, average stack height of 13.4 m, stack velocity of zero (due to raincaps), and meteorological data from the Dayton, Ohio airport.

- AIRDOS/DARTAB results predict 70 year dose equivalent commitments to the maximally exposed individual of 1.8 mrem, whole body and 100 mrem, pulmonary tissue, from 1984 uranium air emissions. These are well within the current DOE guidelines of 500 mrem total body and 1500 to other organs.

- Planned improvements to air emission control systems are expected to assure compliance with the NESHAP guideline during CY 85.

- The 70 year population dose equivalent commitment from uranium emission was estimated as 370 person-rem. For comparison, natural background would be expected to deliver 275,000 person-rem to the same population group.

- Although the Great Miami River is not used as a drinking water source, dose equivalent commitment from effluent discharges to this river were calculated. Using a worst case scenario, the maximum individual commitment was estimated as 0.01 mrem to the bone surface (the critical organ for soluble uranium in water).

- Dose equivalent commitments (70 year) were calculated for drinking water from three offsite wells, which have been identified as containing uranium contamination. The predicted values ranged

from 14.6 to 89 mrem effective whole body dose and from 199 to 1204 mrem to the bone endosteum.

- Based on the lack of significant difference between background (control) samples and fish, potatoes, forage, and milk from the FMPC area, it would appear that the population doses from these sources are negligible.

- Contributions from potential radiological contaminants other than uranium have not been included in the dose calculations.

Recommendations

Evaluate dose contributions from other potential radiological contaminants in air, surface water, and groundwater.

13.0 EMERGENCY PREPAREDNESS

Findings

- The FMPC has an ongoing emergency preparedness program, with emergency plans and procedures documented in an Emergency Preparedness Manual, and conducts coordinated emergency drills.

- Emergency preparedness planning is performed by the Nuclear Safety staff of the FMPC Health, Safety, and Environment Division.

- Potential emergencies - both radiological and nonradiological - have been identified and their consequences evaluated. Emergencies which could have significant impacts on the environment are major fires, and a large release of HF, UF_6, or anhydrous ammonia from storage tanks.

- Battelle Memorial Institute (Columbus, Ohio) has conducted a hazards assessment of the FMPC and predicts the annual probability of a major accident as 10^{-7} and a minor accident as 10^{-4} to 10^{-3}.

- Emergency procedures for HF, UF_6, and anhydrous ammonia are adopted from those used by the Paducah Gaseous Diffusion Plant.

- There is an onsite fire brigade and medical response team. Training has also been provided by FMPC for local emergency response personnel. Four small hospitals plus the University of Cincinnati Hospital are prepared to handle accident victims from the FMPC. The University of Cincinnati Hospital has a comprehensive radiation emergency response capability.

- The FMPC has portable detectors for HF and ammonia - primarily for onsite use. Capabilities for extended term offsite environmental monitoring for radiological and nonradiological contaminants are not available.

- As part of the spill control plan a continuous pH monitor and alarm has been installed in the storm sewer. This enables liquid spills to be diverted to holdup facilities. Installation of an oil and grease monitor is also being considered.

Recommendations

The FMPC should develop procedures for monitoring particulate and gaseous contaminants in the vicinity of the plant during emergency situations involving uranium, HF, or ammonia releases. Appropriate portable sampling and/or monitoring equipment should be obtained and personnel trained in its use. Action levels and public notification procedures for offsite air contamination should be developed.

APPENDIX A

BIOGRAPHICAL SKETCHES OF REVIEW PANEL MEMBERS

BIOGRAPHICAL SKETCH

James D. Berger
Oak Ridge Associated Universities
Oak Ridge, Tennessee

Manager, Radiological Site Assessment Program at ORAU from 1980 to present. Main duties include technical assistance to DOE and NRC in areas of radiological environmental surveys and evaluation of effluent and environmental monitoring programs. Prior positions at ORAU include Department Head, Health and Safety Office, 1975 to 1980; Radiation and Chemical Safety Officer, 1970 to 1975; and health physicist, 1967 to 1970. Also, Health Physics Team Leader for the ORAU Radiation Emergency Assistance Center from 1975 to 1985. Additional professional experience as industrial hygienist at Bettis Atomic Power Laboratory, 1963 to 1966, and instrument development physicist with the Bureau of Radiological Health, 1960 to 1963.

Education

B.S. in Physics from Bowling Green State University, [redacted]
M.S. in Radiological Health from Northwestern University, [redacted]

Professional Society Affiliations

Health Physics Society
American Industrial Hygiene Association

Certified by American Board of Health Physics

Publications

Author or co-author of approximately 10 published reports, guidebooks, and book chapters in various areas of health physics.

Author of numerous unpublished (internal use only) reports describing findings or results of technical assistance for DOE and NRC.

BIOGRAPHICAL SKETCH

Clayton S. Gist
Oak Ridge Associated Universities
Oak Ridge, Tennessee

Director, Off-site Environmental Monitoring Program and Coordinator of the Field Sampling Program at ORAU. Additional professional experience include former director of biological studies, project manager and systems ecologist for CDM/Limnetics; taught Statistical Methods for Desert Biome Modeling Group and Department of Applied Statistical and Computer Science with Utah State University; Site Modeler for University of Georgia. Areas of expertise include environmental impact of energy development; role insects play in ecosystem nutrient cycling; ecosystem chemical cycling; radioecology, tropical ecology.

Education

B.S. in Zoology from Brigham Young University, [redacted]
M.S. in Radiation Biology from Colorado State University, [redacted]
Ph.D. in Entomology-Ecology from University of Georgia, [redacted].

Professional Society Affiliations

Registered Professional Entomologist
Certified Senior Ecologist

Publications

Publications authored or co-authored include areas of entomology, geology and geochemistry, terrestrial monitoring programs for coal mine reclamation, environmental evaluations and disposal site envaluations.

BIOGRAPHICAL SKETCH

Charlene M. Morrow
Consultant
Oak Ridge, Tennessee

Currently self-employed as an environmental engineer. Prior work experience includes environmental engineer with Evaluation Research Corporation, research assistant for the University of Tennessee in the Ecology and Civil Engineering Departments and for the University of Arkansas in the Soil Physics Department. Areas of technical expertise include environmental engineering, water and wastewater treatment systems, radioactive and hazardous waste management, groundwater contamination, and environmental regulations.

Education

B.S. in Environmental Science from University of Arkansas, [redacted].
M.S. in Environmental Engineering from the University of Tennessee, [redacted].

Publications

Publications authored or co-authored include approximately 10 publications on site stabilization, low-level waste management and water managment.

BIOGRAPHICAL SKETCH

Donald J. Niederkorn
Q-Source Engineering, Inc.
Miamisburg, Ohio

Manager, Environmental Sciences at Q-Source Engineering, Inc. Prior positions include Environmental Specialist with Bruce Menkel and Associates, Inc., Air Pollution Control Specialist with the Regional Air Pollution Control Agency of Dayton, Ohio; and Bio-Environmental Engineering Section with the United States Air Force. Main areas of expertise are environmental engineering, having been responsible for the management of environmental affairs for numerous clients, sample collection and process evaluation of air and water pollution control systems.

Education

A.S. in Engineering Electronics from Sinclair College [redacted]
Attended Electrical-Mechanical Engineering Program at the University of Dayton.

Professional Affiliations

American Industrial Hygiene Association
Air Pollution Control Association

BIOGRAPHICAL SKETCH

David T. Robinson
Pollution Control Science, Inc.
Miamisburg, Ohio

Manager, laboratory Services, responsible for the Laboratory Quality Control program and assuring continued laboratory approval by the Ohio EPA and accreditation by the American Industrial Hygiene and Safety Association. Main areas of expertise include air and water monitoring, laboratory procedures, computer programming, gas chromatography, atomic absorption spectrophotometry, UV/Visible spectrometry, total organic carbon by NDIR, NMR spectroscopy, IR spectroscopy, high vacuum systems, inert atmosphere synthesis, polarimetry, and phase contrast microscopy of asbestos fiber, noise radiation, and other industrial hygience measurements.

Education

B.S. in Chemistry from University of Michigan, [redacted]

Professional Affiliations

American Council of Industrial Laboratories
Air Pollution Control Association

Publications

Authored or co-authored publications in the area of air pollution monitoring.

APPENDIX B

SCOPE OF WORK
ENVIRONMENTAL PROGRAM REVIEW
FEED MATERIALS PRODUCTION CENTER

SCOPE OF WORK

ENVIRONMENTAL PROGRAM REVIEW

FEED MATERIALS PRODUCTION CENTER

I. Effluent and Environmental Monitoring

Conduct a comprehensive technical review of the effluent and environmental monitoring programs for radioactive and non-radioactive effluents to air, water and land. Determine the degree of compliance with applicable codes, standards and regulations and "good professional practice", as they apply to effluent and environmental monitoring systems. Evaluation of control equipment should be made only to the extent that the effluent and environmental monitoring review indicates a problem (control equipment which may cause a problem should be noted). This effort should include an educative component, i.e., where procedures at the Feed Materials Production Center (FMPC) can be improved. NLO, Inc., should be given advice to that effect during the contractor's review.

Areas to be addressed include, but are not limited to:

A. Sampling

1. locations (representativeness)
2. frequency
3. methodology
4. parameter
5. equipment utilized

B. Analyses

1. data analysis and statistical treatment
2. equipment

C. Results

1. calculational methods and computer programs
2. data reduction
3. interpretation
4. trend analyses

D. Quality Assurance, Quality Control and Reliability

1. equipment procurement and testing

E. Policy and Procedures

1. training
2. knowledge of regulatory requirements

F. Records and Reporting

The following components of the environmental monitoring review should include, but not be limited to, the following:

A. Soil and vegetation sampling (radionuclides and chemical releases)

B. Sediment sampling

C. Ambient air monitoring and modeling

1. Source Characterization Studies

D. Surface and groundwater monitoring/sampling

E. Radiation dose and contaminant level estimates

F. Continuous monitoring for emergency detection

G. Landfill operations

For the above, assurance is needed on the appropriateness of the monitoring locations, frequencies, methodology, equipment, procedures, data reduction, interpretation, trend analyses, quality assurance, quality control, reliability, records and reporting.

II. Coordination

The effort will involve coordination with the following organizations:

A. NLO, Inc.

B. State of Ohio

C. Environmental Protection Division, DOE-HQ

D. Defense Programs, DOE-HQ and DOE-ORO

E. Environmental Protection Branch, DOE-ORO (Vincent Fayne - contact)

Initiate as soon as possible after February 1, 1985.

Project to be concluded by May 1, 1985.

III. Products

A. Periodic summary reports with recommendations

B. Detailed report with overall program recommendations

IV. Manpower Requirements

A. 400 - 500 manhours

B. Personnel to be selected by consultant

Please modify the scope of work for the Feed Materials Production Center to reflect the changes to section D. Quality Assurance, Quality Control,, Reliability, and Maintainability

D. Quality Assurance, Quality Control, Reliability, and Maintainability

1. Verify inclusion in an overall contractor quality assurance program. Assess the adequacy of the quality assurance elements being used.

2. Assess the reliability of the existing systems. Review failure rates. Examine the need for redundancy and backup.

3. Assess the use or feasibility of statistical methods to demonstrate that measurement systems are in a state of control relative to design standards.

4. Affirm that activities affecting quality including procurement, receiving, storing, installing, maintenance, testing, repairing, modifying and operating contribute to satisfactory performance in service.

5. Verify the measurement accuracy of all systems that are used for the purpose of quantifying releases.

6. Examine random and systematic error estimates.

APPENDIX C

REVIEW SCHEDULE

REVIEW SCHEDULE
April 15 - 19, 1985

April 15

8:00 - 8:30	Introductory Remarks
8:30 - 11:30	General Review of FMPC Operations and Environmental Control Program
1:00 - 2:00	Soil, Sediment, and Vegetation Sampling Program
2:00 - 2:30	Emergency Plans and Procedures
2:30 - 4:00	Air Emissions Sources
4:00 - 4:30	Panel Discussions and Summary

April 16

8:00 - 8:30	Panel Planning Session
8:30 - 10:00	Stack Monitoring Systems and Procedures
10:00 - 11:30	Field Inspection of Stack Sampling Equipment
1:00 - 2:30	Waste Water Systems and Monitoring
2:30 - 4:30	Field Inspection of Water Sampling Equipment

April 17

8:00 - 8:30	Panel Planning Session
8:30 - 10:00	Waste Management and Ground Water Monitoring Procedures
10:00 - 11:30	Field Inspection of Waste Sites and Monitoring Wells
1:00 - 2:30	Bioassay Laboratory Procedures; Quality Assurance/Quality Control
2:30 - 4:30	Technical Laboratory Procedures; Quality Assurance/Quality Control

April 18

8:00 - 8:30	Panel Planning Session
8:30 - 11:30	Field Inspection of Perimeter and off-site Sampling Locations and Liquid Effluent Discharge Streams
1:00 - 4:30	Review of Miscellaneous Information

April 19

8:00 - 10:00	Panel Discussion and Summary of Findings
10:00 - 11:00	Review Closeout with NLO, Inc. and DOE personnel

APPENDIX D

PERSONNEL CONTACTED DURING REVIEW

PERSONNEL CONTACTED DURING REVIEW

Administration

Weldon Adams

Health, Safety, and Environment

Linda Dolan
Tom Dugan
Chuck Facemire
Don Flemming
Bill Hayes
Dave Jones
Keith Ross
Bob Weidner

Waste Management

Dennis Carr
Don Deihl
Tim Poff

Power Plant and Utilities

Leroy Pennington
Bill Weisman

Analytical Laboratory (Technical Group)

Charles Pepper
Laverne Russel

APPENDIX E

DOCUMENTS REVIEWED

DOCUMENTS REVIEWED

Environmental Report, Feed Materials Production Center, Battelle Columbus Laboratories, January 1981.

Site Development and Facilities Utilization Plan, NLCO - 2012, NLO, Inc., April 1984.

Task Force Report on Review of Operations at the Feed Materials Production Center (FMPC), DOE/ORO, June 1984.

FMPC Options Study for Management of Radioactive Waste, NLO, Inc., and Science Applications, Inc., August 1983.

Feed Materials Production Center Environmental Monitoring Annual Reports - 1979, 1980, 1981, 1982, 1983, 1984.

An Aerial Radiological Survey of the Area Surrounding the Feed Materials Production Center, EGG-1183-1680, EG&G, June 1979.

Fernald Assessment Task Force, Review of FMPC Operations and Key Improvement Items, NLO, Inc., May 1984.

Feed Materials Production Center Graphic Overview System.

Letter, W.D. Cottrell (ORNL) to D.R. Brown (DOE/ORO), Radon Monitoring at the Department of Energy's Feed Materials Production Center, Fernald, Ohio, April 11, 1985.

Groundwater Study, Task A - Draft, Dames and Moore, September 1984.

Groundwater Study, Task B - Work Plan (Revision #1), Dames and Moore, November 28, 1984.

Groundwater Study, Task C Report (Draft), Dames and Moore, May 1985.

Letter, F.C. Kornegay (ORNL) to V. Fayne (DOE/ORO), Discussions with EPA Region 5, March 29, 1985.

Elemental Constituents of FMPC Pits and Silos, T.A. Poff, C.E. Pepper, B. Gessiness, February 21, 1985.

Letter, D.B. Howard (DOE/ORO) to R.E. Erickson (DOE/HQ), Response to Headquarters Request for Information, January 11, 1985.

Letter, W.J. Adams (NLO) to M.R. Theisen (DOE/ORO) Meteorological Systems at the Feed Materials Production Center, February 20, 1985.

Letter, R.M. Spenceley (NLO) to M.R. Theisen (DOE/ORO), Application for NPDES Permit, August 24, 1984.

Feed Materials Production Center (FMPC) Waste Storage Pit Area and K-65 Storage Silo Environmental Characterization Plan (Draft), ORNL, March 1985.

Emergency Preparedness Manual (various sections dated 3/83-3/84).

Miscellaneous Environmental Sampling Procedures

Miscellaneous Bioassay Department Procedures.

Miscellaneous stack traverse data sheets and calculations (2/6/84 and 2/6/85).

Miscellaneous control and recycle data and charts (3/85).

Quality Assurance Program, Health and Safety Division (no date).

Results of analyses for DOE's EML/QAP samples.

Occurrence of Uranium in Ground Water in the Vicinity of the U.S. Department of Energy Feed Materials Production Center, Fernald, Ohio, U.S. Geologic Survey, 1984.

Final Safety Analysis Report for the FMPC Task Form, (NLCO-1191), NLO, Inc., July 1983.

FMPC Contingency Plan for RCRA Hazardous Waste (NLCO-2027), NLO, Inc., March 1985.

Implementation Plan for DOE Order 5820.2 - Feed Materials Production Center, August 1984.

Hazardous Waste and Radioactive Mixed Waste Management Plan - U.S. DOE Feed Materials Production Center, May 26, 1984.

Feed Materials Production Center Oil and Hazardous Substances Spill Prevention Control and Counter Measure Plan (Draft), NLCO-1111 Rev. 2, April 1985.