6402

G-000-307 .25

H&R TECHNICAL ASSOCIATES, INC., FEED MATERIALS PRODUCTION CENTER INSTALLATION ASSESSMENT - (USED AS A REFERENCE IN OU1 & OU5 RI REPORTS AND OU1 FS REPORT)

04/28/86

FMPC-2049
WMCO
250
REPORT

6402

DRAFT

FMPC-2049
Special
UC-11

FEED MATERIALS PRODUCTION CENTER

INSTALLATION ASSESSMENT

by:

R. R. Ferguson, D. J. Georgopoulos,

and

A. H. Hansen

H&R TECHNICAL ASSOCIATES, INC.
575 OAK RIDGE TURNPIKE
OAK RIDGE, TENNESSEE 37830

April 28, 1986

WESTINGHOUSE MATERIALS COMPANY OF OHIO
P.O. BOX 398704
CINCINNATI, OHIO 45239

Prepared for:

U.S. Department of Energy
Weapons Division of Oak Ridge Operations
Contract DE-AC05-860R21600

Approved: Louis C. Bogar

Louis C. Bogar
Vice President and Manager
Environment, Safety and Health

Approved: W A Weinreich

William A. Weinreich
Vice President and Technical
Director

000001

NOTICE

TABLE OF CONTENTS

LIST OF TABLES AND FIGURES

TABLES

FIGURES

FOREWORD

This Installation Assessment has been prepared to meet the Phase I requirements outlined in the Department of Energy (DOE) Order 5480.14. The document presents a cursory evaluation of historical disposal practices at the Feed Materials Production Center (FMPC) and includes an assessment of the relative hazards posed by the various waste sites. Significant discussions were held with FMPC personnel prior to and during development of the Phase I report in an effort to identify the sites that are specifically applicable to consideration under DOE Order 5480.14. Those sites that are included in this evaluation include the following:

1) Waste Pit Storage Area
2) Waste Storage Silos 1 and 2
3) Waste Storage Silo 3
4) Fly-ash Disposal Areas
5) Deactivated Incinerator
6) Storm Sewer Outfall Ditch
7) Paddy's Run
8) Copper Scrap Pile
9) Sanitary Landfill

Several other sites were considered for evaluation in Phase 1 but were ultimately excluded from the assessment or deemed inapplicable to the Order. These sites are described further in the following paragraphs:

Production Area - Releases to the environment (primarily air and soil) have been detected that are directly associated with past and continuing operations at the facility. The frequency and magnitude of occurrence of these releases ultimately defines the FMPC production area as one of the major sources of environmental degradation associated with the facility. Based on interpretation of the overall mission of DOE Order 5480.14, it does not appear that this issue should be addressed in the Installation Assessment. Specific plants within the facility already taken out of service and those planned to be taken out of service should ultimately be managed under the Surplus Facilities Management Program or similar program, which may be specifically excluded from the requirements of DOE Order 5480.14.

Deactivated Oil Burner - This facility was not included in the assessment because only limited data concerning the site could be identified and because any releases from the facility would probably have affected soils and surfaces located within the Production Area. Accordingly, this facility could also possibly come under the scrutiny of other DOE sponsored remedial action programs.

Lime Sludge Ponds - According to FMPC documents, no hazardous materials were discharged to these ponds.

Waste Oil Storage Pad and Oil Burner - The regulatory status of the used oils stored at the Waste Oil Storage Pad and burned in the FMPC oil burner is currently undefined because of recently published proposed rules under the Resource Conservation and Recovery Act (RCRA) (November 29, 1985 and March 10, 1986 Federal Register citations). The Waste Oil Storage Pad is likely to be regulated under RCRA at some point in the future. It does not appear that the regulations governing burning of waste fuel and used oil in boilers and industrial furnaces are applicable to the oil burner facility. However, depending on the final promulgation of rules and regulations governing the management and disposal of used oils, the burner could also feasibly become a RCRA facility. Since RCRA facilities are excluded from DOE Order 5480.14, these facilities were not considered in this assessment.

Plant 1 Storage Pad - This facility is used for interim storage of low-level radioactive materials derived from or used in FMPC processing operations. Since it is an active facility and is regulated by DOE orders governing the handling of radioactive materials, the site was not included in this assessment.

Ferrous Metal Scrap Pile - This facility is used for storage of scrap iron and other metals containing elevated levels of uranium. Since it is also an active facility, the site has not been included in this assessment.

The priority rankings presented in this document were prepared in strict accordance with the guidelines and procedures outlined in the Hazard Ranking System (HRS) and the Modified Hazard Ranking System (mHRS) manuals. Because of limited data availability, numerous assumptions and estimations were required in order to complete the hazard rankings. Some of these assumptions and estimations can be substantiated simply through continued identification of obscure data. Others may require additional field investigations and sampling for confirmation.

The terms "hazardous substances" or "hazardous constituents", as referred to in this document, are defined as follows: (1) any substance designated pursuant to section 311 (b)(2)(A) of the Federal Water Pollution Control Act; (2) any element, compound, mixture, solution, or substance designated pursuant to Section 102 of the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); (3) any hazardous waste having the characteristics identified under or listed pursuant to section 3001 of the Solid Waste Disposal Act; (4) any toxic pollutant listed under section 307(a) of the Federal Water Pollution Control Act; (5) any hazardous air pollutant listed under section 112 of the Clean Air Act; (6) any imminently hazardous chemical substance or mixture with respect to which the Administrator of the Environmental Protection Agency (EPA) has taken action pursuant to section 7 of the Toxic Substances Control Act; and (7) toxic radionuclides.

Finally, English units have generally been used in this report, simply because these units correspond to the units generally referenced in the HRS manual. However, metric units have been used to represent the mass of wastes present because of the scoring format presented in the mHRS protocol.

1.0 Executive Summary

1.1 Introduction

The Department of Energy (DOE) has issued DOE Order 5480.14 which defines how the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) program is to be implemented at all DOE installations.

The program is implemented in five phases. These are: 1) Phase I -Installation Assessment; 2) Phase II - Confirmation; 3) Phase III - Engineering Assessment; 4) Phase IV - Remedial Action; and 5) Phase V - Compliance and Verification.

This report satisfies the requirements of the Phase I Installation Assessment. The purpose of the Installation Assessment is 1) to identify the inactive hazardous waste management sites that may pose an undue risk to health, safety, and the environment as a result of migration of hazardous substances; and 2) to make an initial evaluation of the threat posed by these sites. The Order requires that the Hazard Ranking System (HRS), as defined in 40 CFR Part 300, Appendix A, be used to rank the hazardous waste management sites. If both hazardous and radioactive wastes have been deposited at the site, the Modified Hazard Ranking System (mHRS) developed by Hawlay and Napier at Pacific Northwest Laboratory (Ref. 20) is to be used. Once the sites have been ranked by either of the ranking systems, recommendations and conclusions regarding the need for further site characterization activities and possible remedial actions can be formulated.

This report presents an assessment of nine waste management sites at the Feed Materials Production Center (FMPC). In order to perform the evaluation, records and reports regarding waste storage or disposal activities were researched. Interviews were also conducted with FMPC personnel having direct knowledge of the waste management activities at these sites. These data provided an understanding of the types and quantities of wastes deposited at each location as well as some indication of the extent of the contamination at each site. For many of the sites, a significant amount of detailed information regarding waste practices, types and quantities was available; however, for other sites, very limited data were identified.

1.2 Conclusions

The mHRS methodology was used for all nine sites. Table 1-1 summarizes the results of applying the methodology to these sites. The number of primary importance on this table is the weighted migration score, S_m (See Appendix B for documentation of all scores). In the private sector, this score has been used as the basis for deciding whether a site should be listed on the National Priorities List (NPL) under CERCLA. As currently formulated, a migration score of 28.5 or greater would result in listing the site on the NPL. Although Federal facilities recently became eligible for inclusion on the NPL, these facilities are not eligible for Superfund-financed responses. By inspection of the Table, it can be seen that both the Waste Storage Silos and the Waste Pit Storage Area received a rating high enough for consideration for inclusion on the NPL.

Table 1-1 Relative Ranking of the FMPC CERCLA Sites

Site	Air Route (S_a)	Surface Water Route (S_{sw})	Ground Water Route (S_{gw})	Migration Score (S_m)	Fire and Explosion Mode (S_{fe})	Direct Contact Mode (S_{dc})
Waste Pit Storage Area	53.85	29.10	51.02	46.1	NA	0
Waste Storage Silos 1 and 2	53.85	7.11	11.34	32.1	NA	0
Paddy's Run	0	21.26	43.25	27.8	NA	25.0
Storm Sewer Outfall Ditch	0	21.26	43.25	27.8	NA	25.0
Fly-Ash Disposal Area	0	9.45	25.95	16.0	NA	25.0
Deactivated Incinerator	0	6.61	19.88	12.1	NA	25.0
Waste Storage Silo 3	0	6.46	10.20	7.0	NA	0
Copper Scrap Pile	0	0	11.60	6.7	NA	0
Sanitary Landfill	0	0	0	0	NA	0

NA - Not Applicable

It should be recognized that the mHRS methodology assigns a maximum possible score whenever above-background levels of hazardous constituents have actually been detected. As a result, those sites having documented evidence of above-background levels of ground and surface water contaminants or air releases ultimately receive higher scores than those sites for which no monitoring data exist. Thus, in many respects, if a site is relatively well characterized at this stage of the CERCLA implementation program, it could receive a higher score than another site which might pose a greater environmental threat but which is ranked lower as a result of limited or nonexistent data. Both chemically hazardous and radioactive materials are suspected of being disposed of at the FMPC sites. However, the radioactive wastes appear to be much better characterized than the chemically hazardous wastes. Generally, the chemical toxicity threat resulted in a higher score than the radiological threat.

The only nonzero air route scores were for the Waste Storage Silos (1 and 2) and the Waste Pit Storage Areas, where localized air monitoring programs have previously been instituted. No air data directly attributable to the other sites were identified. The ground water scores for all nonzero sites were elevated due to the close proximity of ground water withdrawal wells to the FMPC site. All scores were derived through a strict application of the guidelines and instructions associated with the HRS and mHRS user's manuals. The surface water scores were reduced relative to the ground water scores because of the limited use of streams in the area.

The assessment yielded the following recommendations which upon implementation should lessen the uncertainties associated with the hazard ranking:

1) Expand surface water monitoring programs to include monitoring at specific waste management sites. Surface waters discharging from the FMPC facility have been well characterized, specifically at and below the confluence of Paddy's Run and the Storm Sewer Outfall Ditch. However, the actual contributions of specific waste sites to the overall surface water contamination have not been sufficiently characterized. In particular, additional sampling efforts should probably be conducted in the vicinity of the Waste Pit Storage Area, the Waste Storage Silos, and the Fly-ash Disposal Areas.

2) Continue site characterization activities at the Waste Pit Storage Area and the Waste Storage Silos. These sites scored sufficiently high to be considered for inclusion on the NPL.

3) Based on the results of continuing site characterization activities, the need for additional background data should be evaluated. This data might include air monitoring data from surrounding areas not influenced by FMPC operations and upgradient surface water and ground water monitoring data.

A Characterization and Investigation Study has recently been initiated by Westinghouse Materials Company of Ohio (WMCO). This investigative study is being conducted in a manner similar to the Environmental Protection Agency's (EPA) remedial investigation/feasibility study program under CERCLA.

2.0 Introduction

2.1 Background

The FMPC is owned by the U.S. DOE and operated by WMCO. It is located in a rural area of southwestern Ohio on a 1,050 acre site near Fernald, about 20 miles northwest of Cincinnati and 8 miles southwest of Hamilton (See Figure 2-1). The plant facility occupies about 136 acres in the center of the site. The site is bounded on the south by Willey Road, on the west by Paddy's Run Road, on the north by farm land and State Route 126, and on the east by a dairy farm (See Figure 2-2).

The FMPC was completed in 1954 and consists of eight separate production plants, support buildings and facilities (e.g., administration, personnel and security, service, boiler plant, laboratory, etc.), and waste treatment and storage facilities (e.g., sump, sewage treatment plant, chemical storage pits and silos).

The primary mission of the FMPC is the production of purified uranium metal and uranium compounds for use at other DOE sites. A small amount of thorium processing has also been conducted. The facility has the capability of converting a variety of feeds to pure uranium metal and compounds. The principal current operations consist of metal fabrication with periodic small campaigns to process accumulated plant residues and miscellaneous feed materials obtained from other DOE sites. A flow chart of the FMPC production process is shown in Figure 2-3.

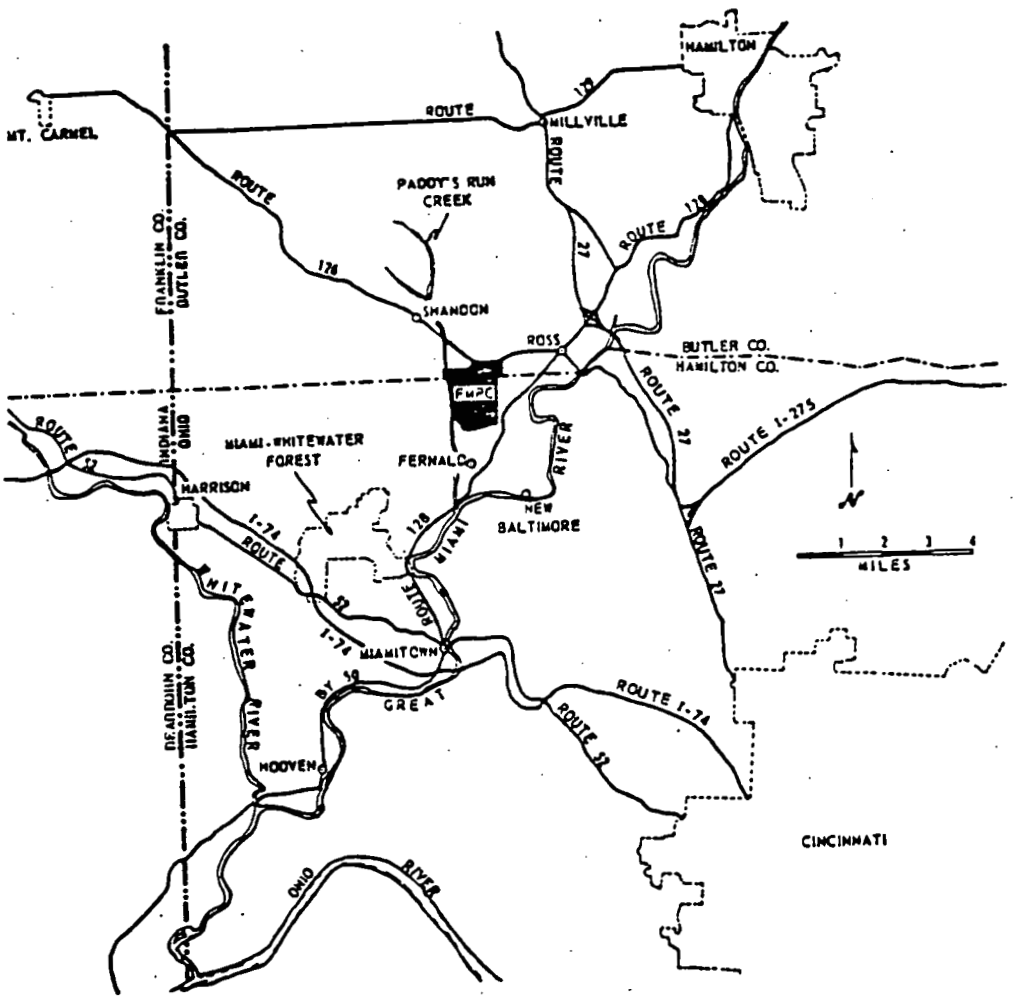


FIGURE 2-1. AREA MAP
(Source: Ref. 17)

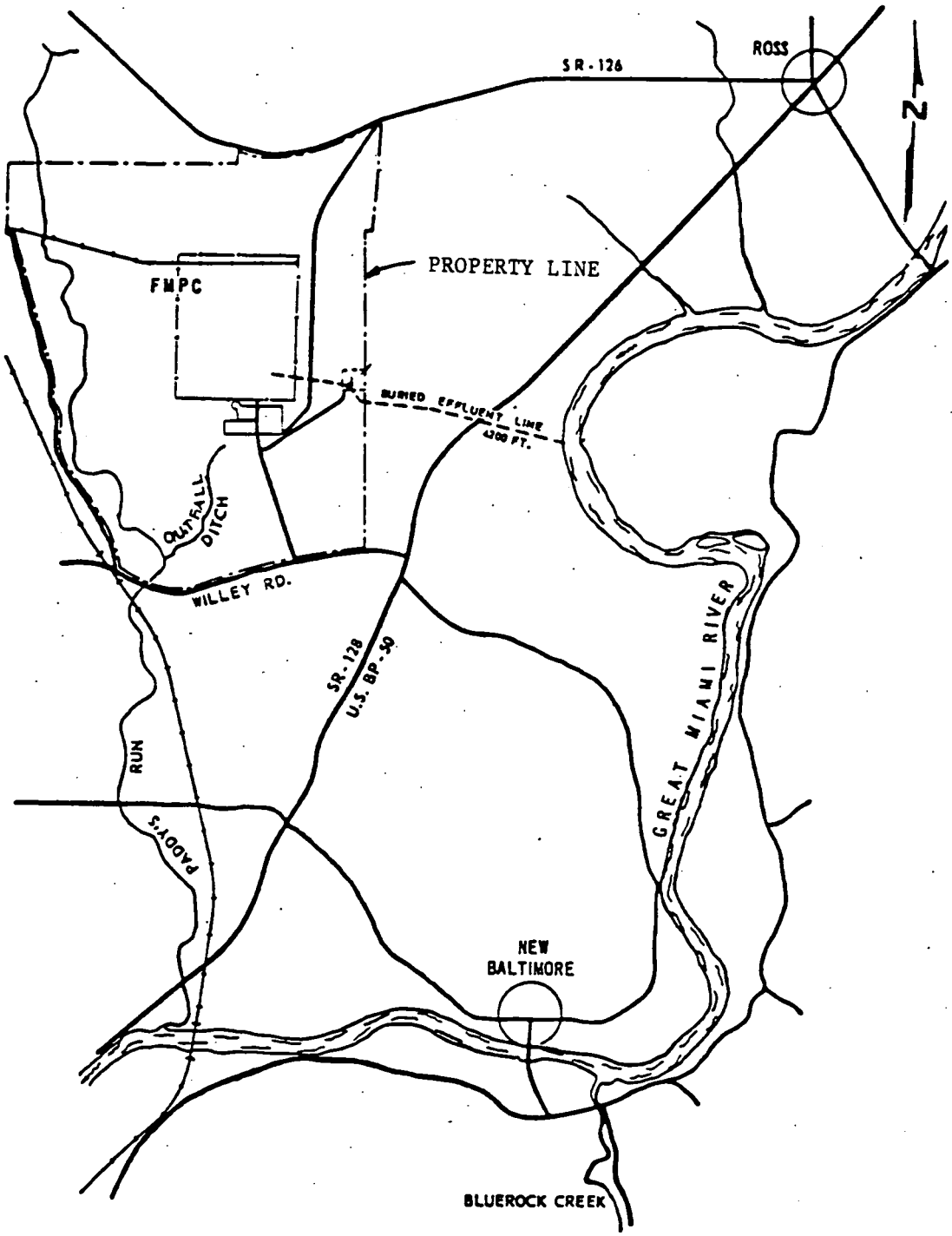


FIGURE 2-2. FMPC AND SURROUNDING AREA

(Source: Ref. 11)

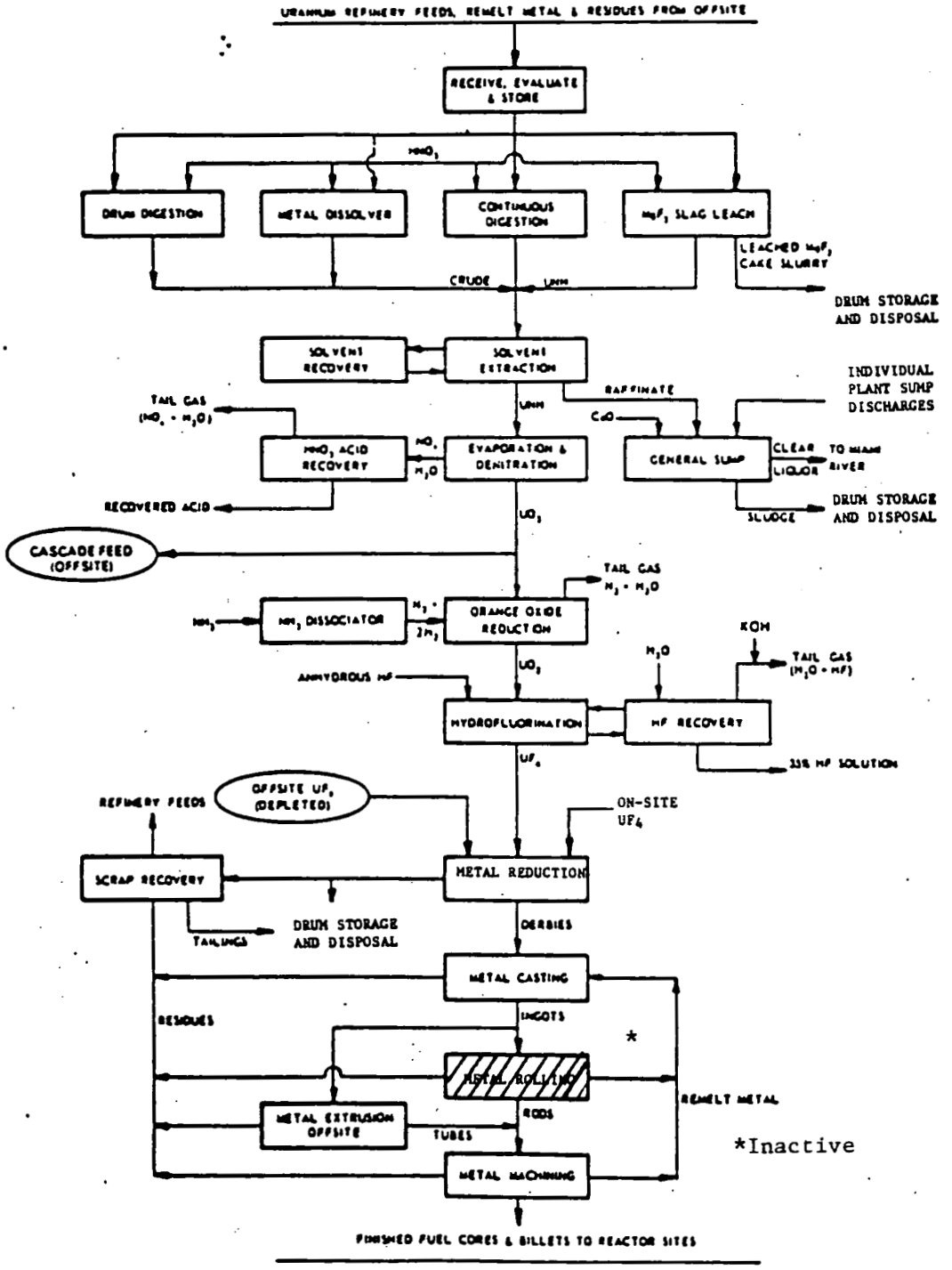


FIGURE 2-3. SCHEMATIC DIAGRAM OF THE FMPC PROCESS

(Source: Ref. 11)

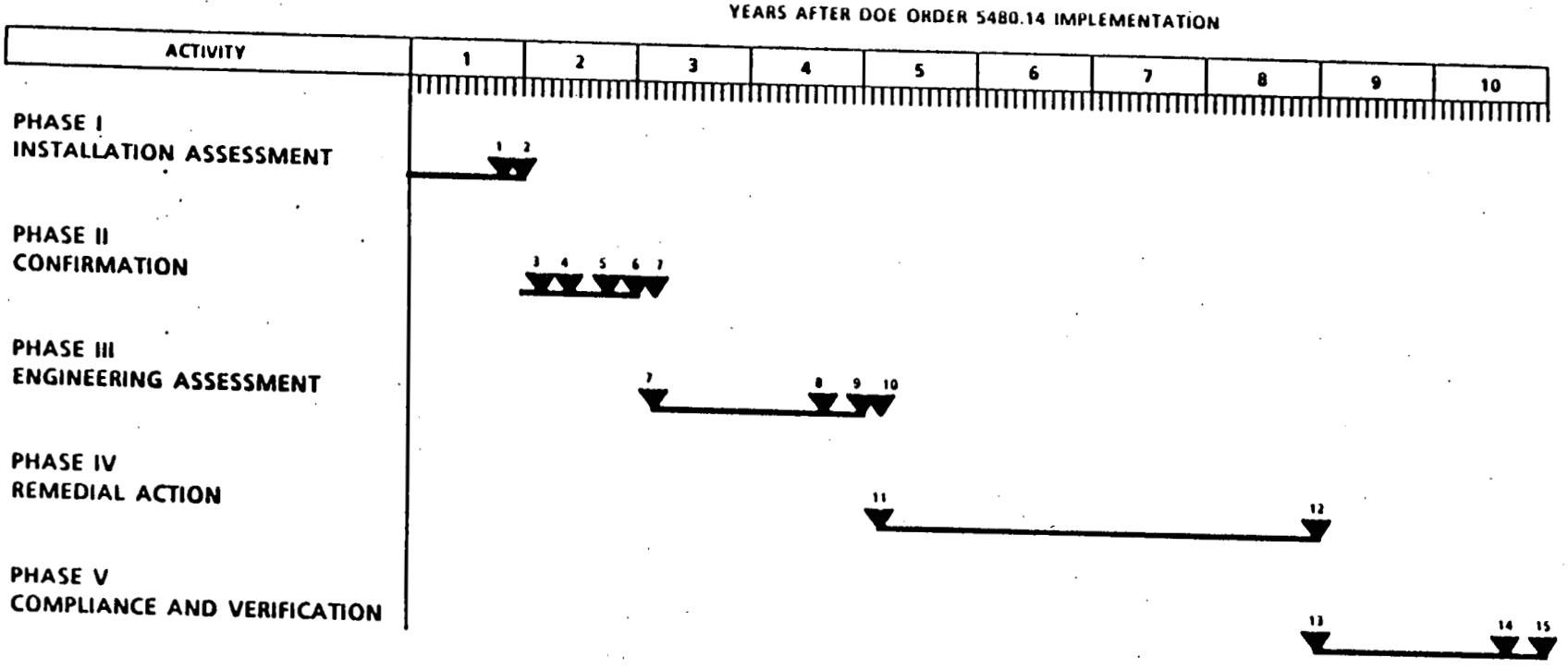
2.2 Purpose, Authority and Scope

DOE-owned facilities which have previously been used for treatment, storage, or disposal of hazardous substances must comply with the provisions of the CERCLA program. As mandated by DOE Order 5480.14, the DOE CERCLA program is performed in five distinct phases in order to identify and evaluate inactive hazardous waste management sites on DOE installations and to effect any necessary remedial actions to improve the control of hazardous substance migration from these sites. The Order is not applicable to sites addressed in other DOE remedial action programs.

This report represents the first phase of the DOE CERCLA program for the FMPC. The purpose of the first phase is to evaluate the site history and records, and to locate and identify those inactive hazardous and mixed (i.e., both hazardous and radioactive) waste management sites that may pose a risk to health, safety, and the environment. The report provides a limited prioritized ranking of the inactive waste management sites according to their potential for causing health or safety problems or environmental damage.

2.3 Methodology

The five phases of the DOE CERCLA program include the Installation Assessment (Phase I), Confirmation (Phase II), an Engineering Assessment (Phase III), Remedial Action (Phase IV), and Compliance and Verification (Phase V). Figure 2-4 provides the overall implementation schedule of DOE Order 5480.14, which became effective on April 26, 1985.



Notes:

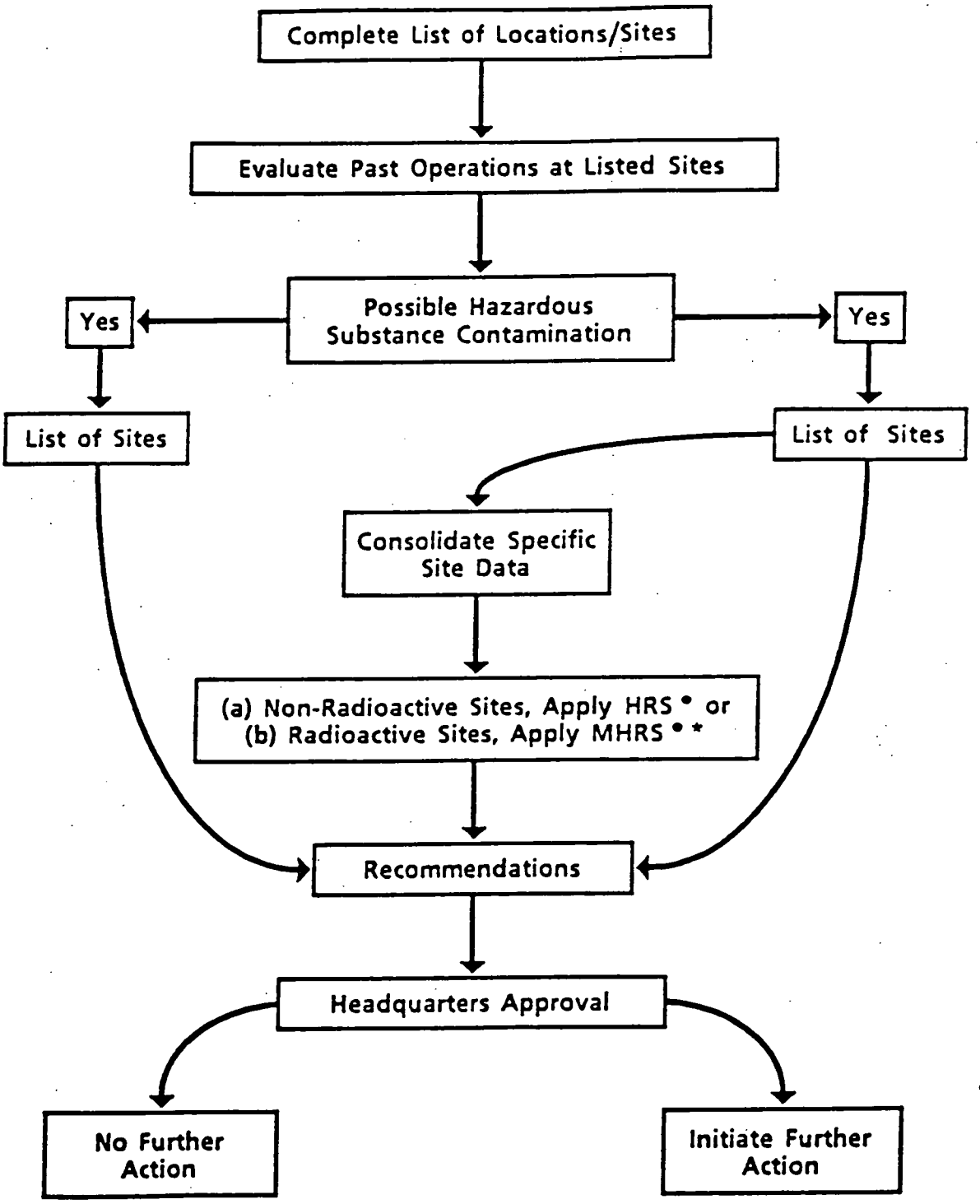
1. Submit Installation Assessment to DOE-ORO.
2. DOE-ORO approves Installation Assessment and authorizes initiation of Confirmation Phase.
3. Submit monitoring plan to DOE-ORO for approval.
4. DOE-ORO approval of monitoring plan; initiate site characterization activities.
5. Begin Phase II report preparation.
6. Submit Phase II Confirmation Report to DOE-ORO for approval.
7. Receive DOE-ORO approval of Confirmation Report; initiate Engineering Assessment activities.
8. Begin preparation of NEPA documentation
9. Submit Engineering Assessment to DOE-ORO for approval.
10. Receive DOE-ORO approval of preferred Remedial Action and notice to proceed.
11. Initiate Remedial Action activities.
12. Complete Remedial Action activities.
13. Initiate Compliance Report.
14. Submit Compliance Report to DOE-ORO for approval.
15. Receive DOE-ORO approval of Compliance Report.

Figure 2-4 CERCLA Program Implementation Schedule

It should be recognized that the schedule presented on Figure 2-4 is that mandated by the Order. Actual compliance with the Order may require a longer or shorter time period, depending on the nature of the specific remedial actions and the availability of resources.

As shown in Figure 2-5, the Phase I effort is intended to identify, locate, and prioritize those past waste management sites that pose a potential hazard to health or the environment. These hazards may be a result of migration of contaminants to the air or to surface and ground waters. In this phase, it is only determined whether a particular site may be considered to present a significant hazard relative to other sites. The HRS model identified in 40 CFR Part 300, Appendix A, and DOE's mHRS for sites containing radionuclides are to be used to rank the sites on a relative basis.

The Phase II effort is intended to identify and quantify, through environmental investigations, the presence of hazardous substances at inactive waste management sites that may pose an undue risk to health, safety, and the environment. During this phase, environmental monitoring plans are developed based upon the recommendations of the Phase I report. These plans should include cost estimates for all associated field activities. A detailed site characterization is then conducted and includes sampling, analytical measurements, and modeling to confirm the presence or extent of above-background levels of hazardous constituents. The final Phase II effort will include development of a set of specific recommendations describing the need for remediation activities and will include a more in-depth reiteration



• Hazard Ranking System
• • Modified Hazard Ranking System

Figure 2-5. Installation Assessment Methodology

PI-H&R-8-8-85

of the hazard ranking system analysis based on the additional data obtained during site investigations.

Phase III is the engineering assessment phase. During this phase, a plan for remedial action is prepared. This plan evaluates alternative technologies for stabilizing the site to control the migration of hazardous substances or decontaminating the inactive waste management site. In Phase III, remedial action criteria are established, alternative approaches for achieving these criteria are established, and alternative remedial action technologies are identified and evaluated. A remedial action project schedule and cost estimate are developed and the appropriate NEPA documentation is prepared.

Phase IV is the remedial action phase in which the remedial measures recommended in Phase III are finalized and implemented.

The final phase, Phase V, is a compliance and verification phase in which the remedial action documentation is prepared and ongoing monitoring requirements are established. The compliance report contains a detailed description of the actual work completed, what was accomplished, a documentation of independent verification measures, and finally, a discussion of any agreements between other Federal, state, or local agencies.

3.0 Installation Description

3.1 Site Specific Descriptions

This report considers nine potential CERCLA sites for ranking at the FMPC facility. The methodology for determining which sites would be ranked was based on the requirements specified in the DOE Order 5480.14. Specific sites which were not included in this document include the Plant 1 Storage Pad, the Oil Burner, the Deactivated Oil Burner, the Waste Oil Storage Pad, the Lime Sludge Pits, the Production Area, the Ferrous Metal Scrap Pile, and any satellite plant storage areas.

The following is a description of the CERCLA sites identified at this time. The types and quantities of materials deposited at each site are provided where possible.

3.1.1 Waste Pit Storage Area (Ref. 2, 6, 8, 12, 13)

The Waste Pit Storage Area consists of seven areas: Waste Pits 1, 2, 3, 5, 6, the Burn Pit, and the Clearwell. Waste Pit 4 is regulated under the Resource Conservation and Recovery Act (RCRA) and is thus excluded from the requirements of DOE Order 5480.14. The facilities are numbered in chronological order based on the order in which they were constructed. The facilities are further identified as "dry" or "wet" based on the physical state of the waste materials that were placed in the pits. Figure 3-1 shows the location of the facilities.

Waste Pit 1 was the first area to be constructed (1952) and used in the waste storage area. The "in-ground" facility was excavated into

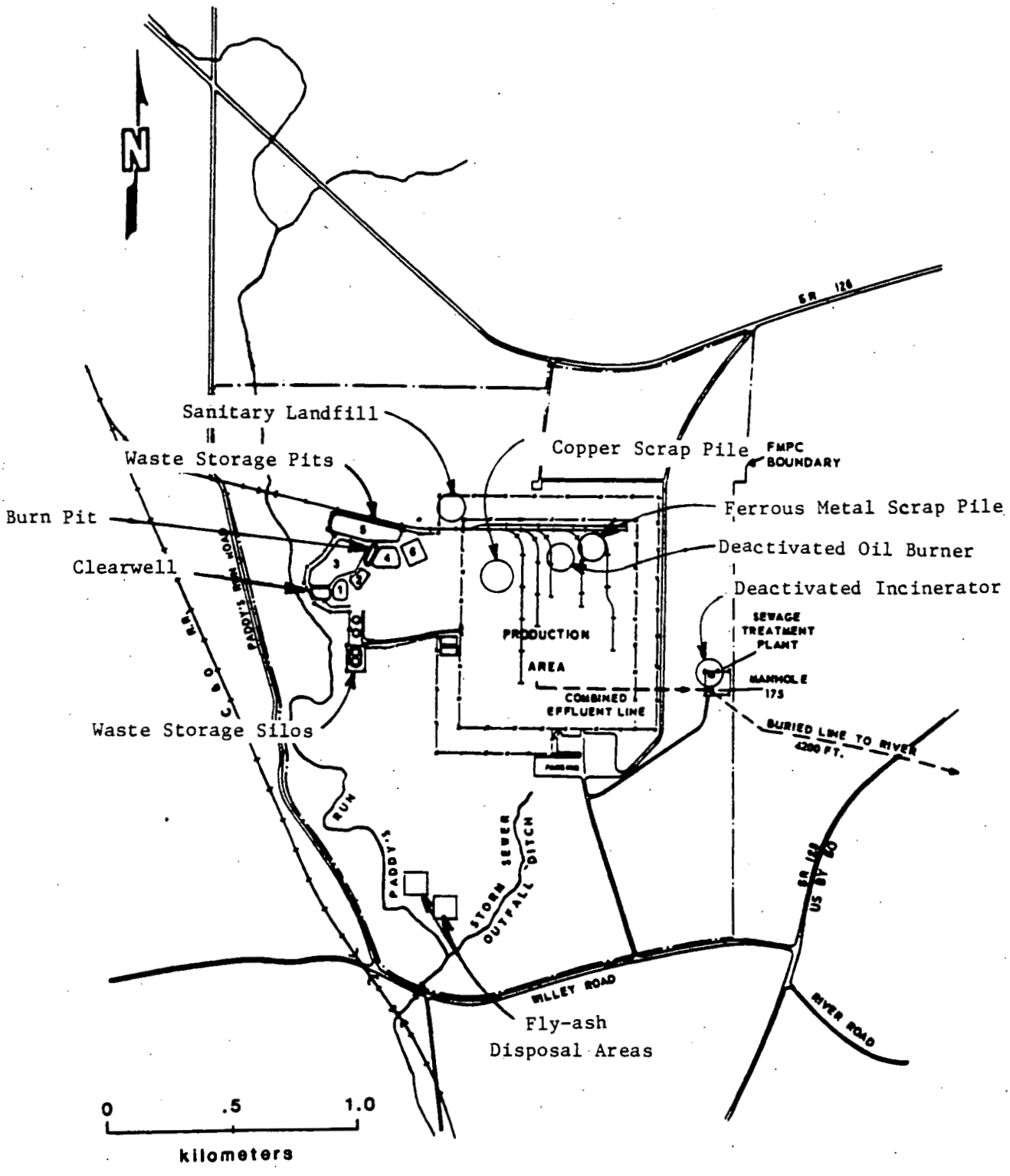


Figure 3-1. Disposal Site Location Map
(Source: Ref. 15)

the existing "blue clay" layer and is reported to have been lined with an additional 4 feet of clay excavated from the Burn Pit area. The capacity of the waste pit was expanded in 1957 to provide a total capacity of 40,000 yd^3 (Ref. 13). The waste material that was disposed of in the waste pit consisted primarily of neutralized waste filter cake, production plant sump cake, depleted slag, scrap graphite, contaminated brick, and sump liquor. The majority of wastes were reported to be dry solids. The quantity of uranium reported to be disposed of in the pit is 52,000 kg (Ref. 2). Waste Pit 1 was closed in 1959 and reportedly backfilled and covered with clean fill dirt. Surface water runoff is diverted to the Clearwell prior to discharge to the Great Miami River.

Waste Pit 2 was constructed in 1957 and was operated as a waste storage site from 1957 to 1964. It was constructed in the location of a small pond east of Waste Pit 1 and was reportedly lined with a compacted blue clay layer. Waste Pit 2 received primarily dry, low-level radioactive wastes consisting of neutralized waste filter cake, sump cake, depleted slag, contaminated brick, some sump liquor and concentrated raffinate residues. The pit contains approximately 13,000 yd^3 (Ref. 13) of wastes. It is estimated that about 1,206,000 kg of uranium and approximately 400 kg of thorium were disposed of at this site (Ref. 2). The waste pit has subsequently been retired and reportedly covered with clean, uncontaminated fill and graded to provide surface drainage to the Clearwell for subsequent discharge to the Great Miami River.

Waste Pit 3 was constructed in 1959 in the western end of the waste storage area. It was constructed by excavating a basin into the underlying blue clay and placing a layer of blue clay along the pit walls. Waste Pit 3 was operated as a settling basin from 1959 to 1968 receiving wet waste streams consisting of lime-neutralized radioactive raffinate concentrate. From 1975 to 1977, the waste pit was again used to dispose of low level radioactive waste solids in order to fill the site to capacity. These wastes consisted of slag leach residue, filter cake, fly-ash, and lime sludge. The pit contains 277,000 yd^3 of wastes (Ref. 13), including 129,000 kg of uranium, 400 kg of thorium, and 19 Ci of radium-226 (Ref. 2). The area was retired in 1977 and clean fill was placed over the contaminated waste site. Surface water runoff is diverted to the Clearwell prior to discharge to the Great Miami River.

Waste Pit 5 was constructed in 1968 and was operated from 1968 to 1983. The pit is lined with a 60 mil thick Royal-Seal EPDM Elastomeric Membrane. The waste pit was designed to receive low level radioactive liquid waste slurries pumped from the Refinery and Plant 8. Low-level radioactive wastes that had been disposed of in Pit 5 consisted of neutralized raffinate settled solids, slag leach slurry, sump slurries, and lime sludge. The current waste volume consists of approximately 102,500 yd^3 (Ref. 13), containing 50,249 kg of uranium, 17,000 kg of thorium, and 118 Ci of radium-226 (Ref. 2).

Waste Pit 6 was constructed in 1979 and operated as an active site until 1985. It was constructed in the same manner as Waste Pit 5 and lined with a similar synthetic liner. Non-coarse, non-pyrophoric solids wastes containing elevated levels of uranium have been disposed

of in the pit. Rainfall that is collected in the pit is pumped to Waste Pit 5 for discharge and settling via the Clearwell. The current waste volume is approximately 9,000 cubic yards (Ref. 13), consisting of 843,142 kg uranium (Ref. 2). The capacity of Waste Pit 6 has not been reached; however, the site is currently inactive.

The Burn Pit was constructed in 1957 as a site to excavate blue clay needed to line Waste Pits 1 and 2. The pit was subsequently used to dispose of laboratory chemicals and to burn combustible materials. Interviews with plant personnel indicate that pyrophoric and reactive chemicals were disposed of at the site along with oils and other low-level contaminated combustible materials. The actual inventory of materials or chemicals that was disposed of in the Burn Pit is unknown. It has since been backfilled and covered with clean soil.

The Clearwell receives surface runoff from the waste pit area as well as some flow-through liquids from other waste pits. It is used as a final settling basin prior to discharge to the Great Miami River via the FMPC National Pollutant Discharge Elimination System (NPDES) discharge point (currently under negotiation). It is anticipated that a significant amount of uranium-bearing settled solids is contained in the basin; however, no volume or mass estimates are available.

3.1.2 Waste Storage Silos (Ref. 2, 6, 8, 12, 13)

The Waste Storage Silos are located south of the waste pit area as shown on Figure 3-1. Storage activities at the 4 silos were completed in 1959 after seven years of operation. The 80-foot diameter silos are constructed with 4-inch concrete floors with 8-inch thick pre- and

post-stressed concrete walls (personal interview with FMPC technical personnel). Silo 4 was never used to store waste materials.

Silos 1 and 2 (K-65 silos) contain over 7,200 yd^3 (Ref. 12) of residues resulting from the processing of pitchblende ores. The waste residue contains 11,200 kg (Ref. 12) of uranium, as well as radium and trace amounts of precious and heavy metals. In 1964, the walls of the silos were covered with an earthen embankment to provide protection and support and to minimize gamma radiation emissions.

In 1979, all tank openings were sealed to provide total enclosure of the waste residues. The earthen embankment was further enlarged in 1983 to alleviate observed soil erosion on the slopes. Following identification of cracks in the center portion of the domes of the silos, protective covers consisting of prefabricated wood and metal structures and synthetic liners were placed over the domes of Silos 1 and 2.

Silo 3 was designed in a similar fashion to Silos 1 and 2. It contains over 5,100 yd^3 (Ref. 8) of calcined residues. The dry waste residues resulted from the dewatering process of the waste raffinate slurries. The calcined residues stored in the silo contain approximately 18,000 kg uranium (Ref. 2), some metal oxides, heavy metals, and trace amounts of radium. Due to the source of the residue, radon or gamma radiation does not present a significant source problem.

3.1.3 Paddy's Run (Ref. 4, 5, 17)

Paddy's Run is a small, ephemeral stream bordering the west boundary of the facility and discharging to the Great Miami River

Approximately 2 miles south of the FMPC (See Figure 3-1). The site receives runoff from portions of the waste pit storage area, the silo area, and other potentially contaminated surface areas. Paddy's Run has been identified as a potential source of water quality degradation in several off-site wells used for local drinking water supplies. Uranium contained in the waters of this stream is apparently transported to an area where the less permeable glacial till underlying the stream grades into a more permeable sand and gravel. The surface water apparently percolates into the ground water aquifer near the confluence of Paddy's Run and the Storm Sewer Outfall Ditch.

3.1.4 Storm Sewer Outfall Ditch (Ref. 4, 5)

The Storm Sewer Outfall Ditch is a narrow and shallow ravine which receives overflow surface water runoff from portions of the Production Area and surrounding terrain (See Figure 3-1). It is possible for radionuclides and other materials originating from the process area to enter the storm sewer system through accidental spills or through surface runoff. Under normal conditions, the storm sewer water is combined with the general sump effluent and other plant liquid effluents and discharged to the Great Miami River. During periods of heavy runoff, excess storm sewer water is discharged directly into the Storm Sewer Outfall Ditch which discharges into Paddy's Run. Since flow in Paddy's Run is intermittent during periods of prolonged dryness and it serves as a surface runoff collection source for the area, it may also serve as a recharge zone for ground water. The stream and the outfall ditch may be acting as a source and transportation mechanism

for above background concentrations of radionuclides in the offsite ground water.

3.1.5 Fly-ash Disposal Areas

The Fly-ash Disposal Areas are located in the southwest corner of the reservation (See Figure 3-1). Fly-ash resulting from the Production Area coal fired boiler plant is loaded into dump trucks and transported to the disposal area. The inactive, retired pile contains approximately 50,000 yd^3 of fly-ash (Ref. 13) and is sparsely covered with soil and vegetation. It is reported to contain 1,000 kg of uranium (Ref. 4) from the spreading of oils containing radionuclides over the pile to control dust during dry periods. The active pile located southeast of the inactive site currently contains approximately 33,000 yd^3 of fly-ash (Ref. 13).

Due to the close proximity of their respective locations, the area known as the Southfield is assumed to be encompassed by the areas including the fly-ash piles. The Southfield area is believed to be directly north of the inactive fly-ash pile. This area, though not documented, was believed to be the repository for below-ground disposal of construction rubble containing low levels of radioactivity. Radiological surveys indicate that the soil in this area contains elevated levels of radionuclides although the source has not been identified.

3.1.6 Deactivated Incinerator (Ref. 17)

The Deactivated Incinerator is located on the east side of the

plant adjacent to the Sewage Treatment Plant and Manhole 175 (See Figure 3-1). The incinerator was originally used to burn combustible materials suspected of containing elevated levels of radionuclides until it was placed in inactive status in 1979 when an upgraded combustible material incinerator was constructed. In addition, interviewed FMPC personnel indicated that waste oils of undefined composition were probably burned at this site. The incinerator is being considered in this investigation because of the evidence of elevated levels of uranium in the soil which is apparently attributed to the incinerator stack emissions. Detailed stack emission data from the incinerator are not available to substantiate this speculation.

3.1.7 Copper Scrap Pile

The Copper Scrap Pile consists of approximately 1,500 tons of mica-coated copper scrap containing elevated levels of uranium (Ref. 13). The scrap is stored on an above-ground, concrete pad at the Plant 1 Storage Pad (See Figure 3-1). The scrap is stored at this site for subsequent shredding for removal of the mica from the copper.

3.1.8 Sanitary Landfill (Ref. 13)

The Sanitary Landfill was used in the past for disposal of non-hazardous solid waste and refuse generated during normal FMPC operations. The facility is reported to have received small quantities of nonradioactive asbestos. The landfill is presently inactive but is anticipated to be expanded following permitting by the Ohio Environmental Protection Agency (OEPA).

4.0 Environmental Summary

4.1 Meteorology (Condensed from Ref. 11)

The climate of southwestern Ohio is continental, characterized by a wide range of temperatures from winter to summer. Average daily temperatures range from 70°F. in the summer to the low thirties in the winter months. The frost-free period is approximately 190 days and extends from mid-April to late October. There is a 70% chance that temperatures less than 0°F. will occur at the FMPC in any year. Over a 30-year period at the Greater Cincinnati Airport, the highest temperature recorded was 102°F. in August 1962. The record low was minus 25°F. on January 18, 1977.

During the winter and spring, frequent changes in the weather occur in southwestern Ohio as cyclonic storms pass over the area. In the summer, rainfall is produced by the thunderstorms originating in the warm moist air which moves northward from the Gulf of Mexico along the Mississippi and Ohio valleys. The fall season is the period of minimum rainfall. There is an average of 185 days during the year when 80% or more of the sky is covered by clouds. The period of maximum cloudiness begins in November and continues through April. These are also the months when almost all snowfall occurs.

The average annual precipitation measured at the FMPC in the seventeen year period between 1960 and 1976 was 37.05 inches. The annual precipitation has ranged from a minimum of 29.22 inches in 1963 to a maximum of 47.72 inches in 1973. Monthly totals ranged from a minimum of 0.04 inches in March 1962 to a maximum of 11.15 inches

during March of 1964. The maximum 24 hour rainfall as measured at the Greater Cincinnati Airport was 5.21 inches. There is an average of 44 days with thundershowers each year in southwestern Ohio with 30 of these thundershower days occurring between May and August.

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

Annual snowfall at Hamilton, which is approximately ten miles from the FMPC, averaged 15.3 inches over a 29 year period. The Greater Cincinnati Airport averaged about 24 inches over a 22 year period.

Prevailing winds at the Greater Cincinnati Airport are from the south-southwest for all twelve months of the year. Average monthly windspeeds range from 6.7 mph in August to 11.2 mph in March. A condensed wind rose for the airport is shown in Figure 4-1. Wind records at the FMPC indicate gusts greater than 60 mph have occurred on two occasions.

Ohio lies on the eastern edge of the region of maximum tornado frequency. About 90% of the tornados observed in Ohio come from the west-southwest direction. Only one tornado, which occurred May 10, 1969, is known to have been encountered at the FMPC. There was no damage to FMPC property.

4.2 Geology, Seismology, and Soils (Condensed from Ref. 15)

4.2.1 Geology

The bedrock in much of southwestern Ohio consists of indurated shales and limestones of the Upper Ordovician Age (See Figure 4-2).

BASED ON HOURLY SURFACE WIND OBSERVATIONS TAKEN AT GREATER CINCINNATI AIRPORT.

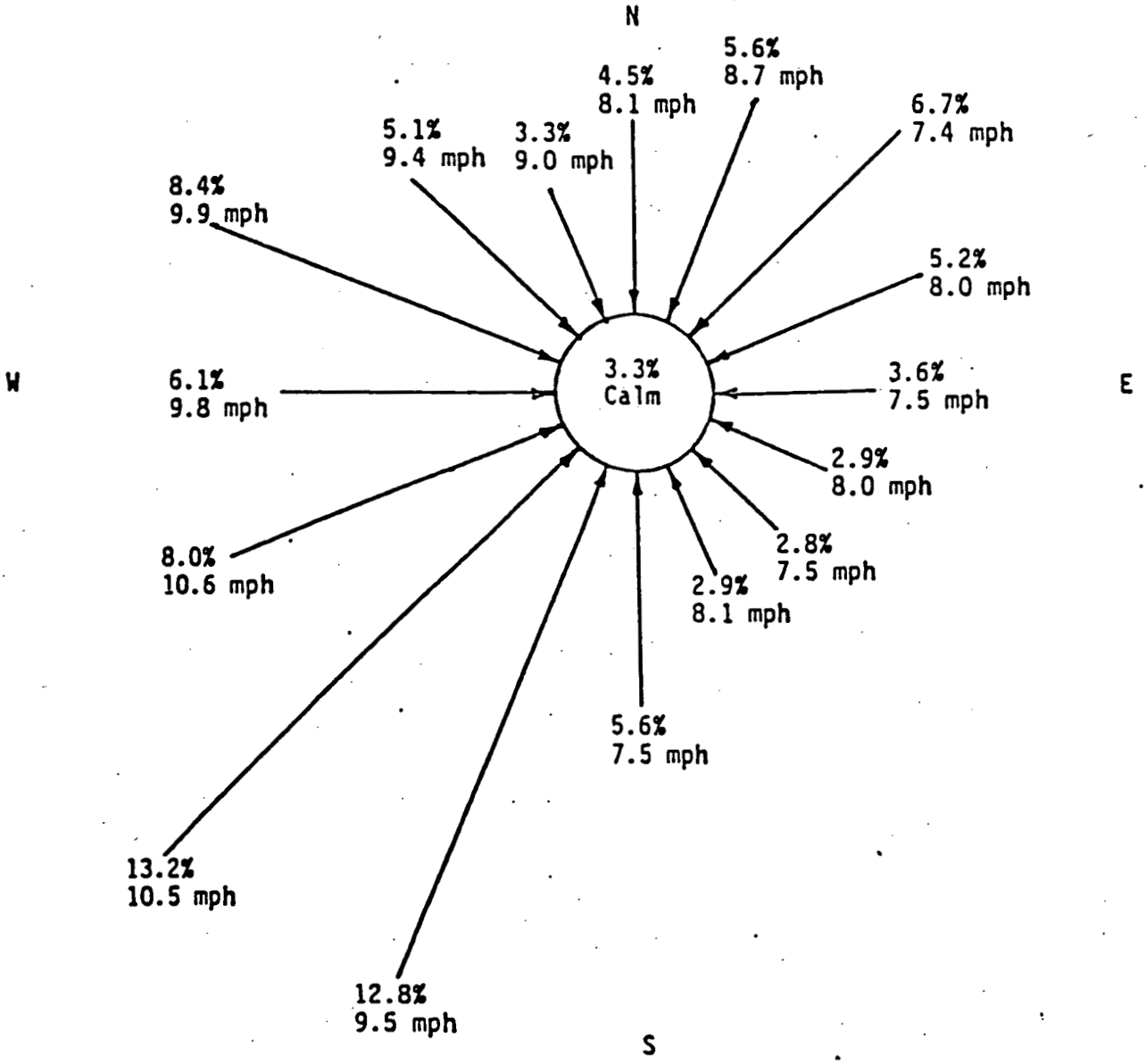


Figure 4-1. Wind Direction and Speed Occurrences

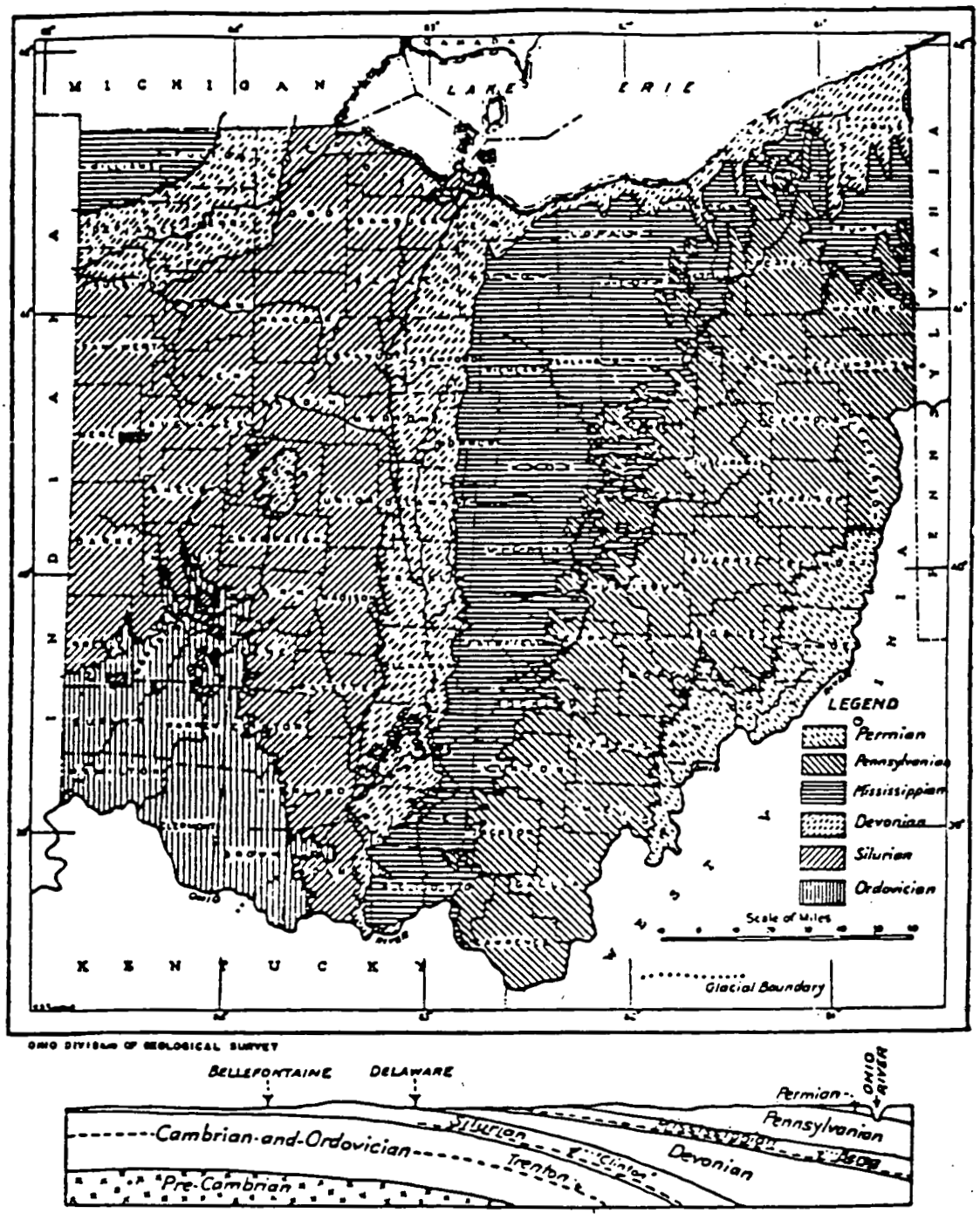


FIGURE 4-2. GEOLOGIC MAP AND CROSS SECTION OF OHIO
(Source: Ref. 11)

These sediments were deposited in a shallow sea which inundated much of the central part of the United States. The land masses during this period were situated far to the east which accounts for the fine gained nature of the sedimentary deposits.

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

Prior to glaciation, during the Teays stage, southwestern Ohio was drained by the Hamilton River, which incised a broad river valley. Later, this valley was occupied by the Cincinnati River during the advance and retreat of the Kansan ice sheet, which did not extend into southwestern Ohio. The debris from later advances, the Illinoian and Wisconsin, was deposited in this ancestral river valley to form the extensive ground water aquifer of the New Haven Trough (See Figure 4-3). The glacial deposits in the trough average 2 miles in width and about 150 to 200 feet in depth. When the ice receded from the area, glacial drift deposits filled it to a height of more than 200 feet above the limestone and shale valley floor. Most of the surface deposits accumulated during the last glacial advance, the Wisconsin.

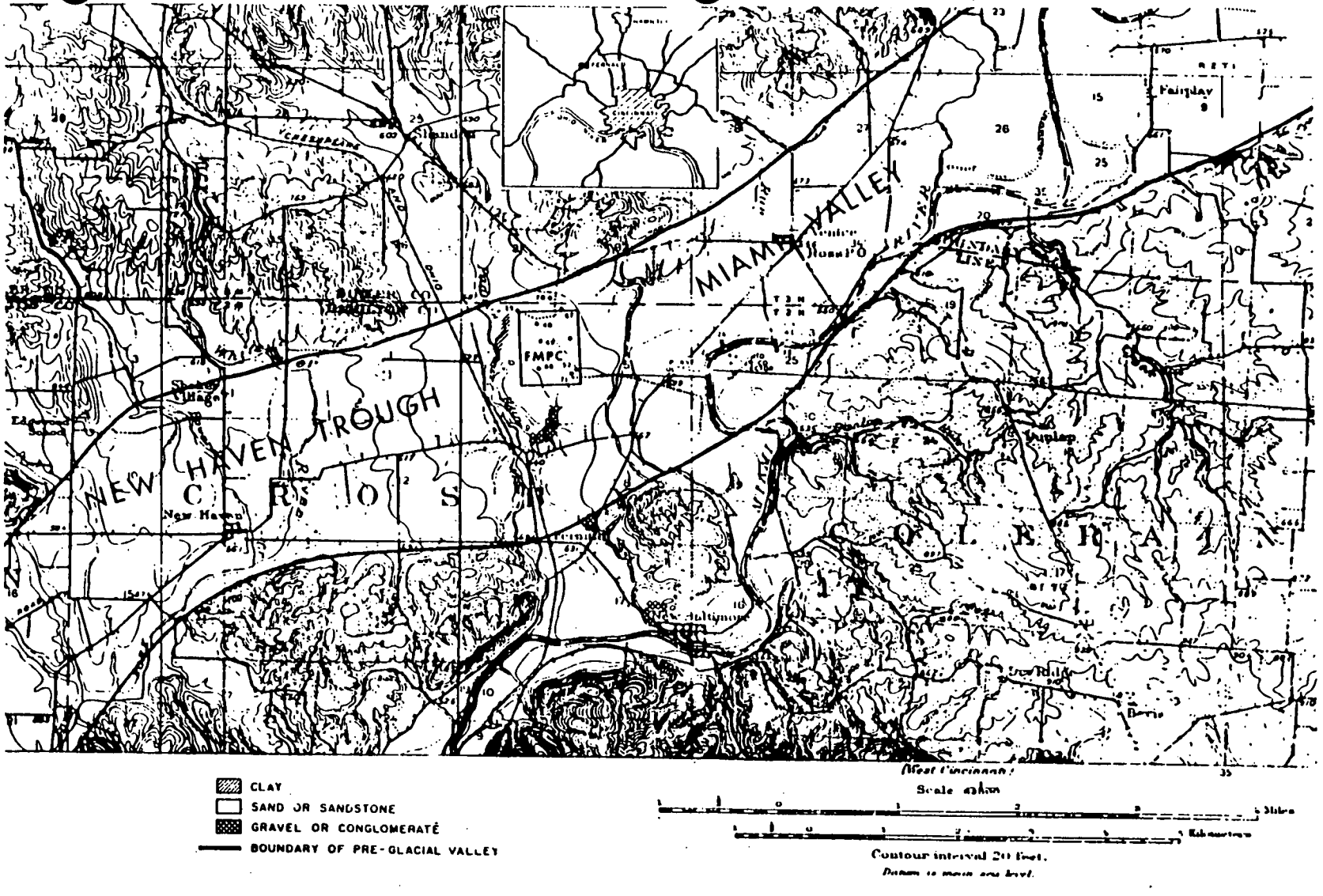


FIGURE 4-3. TOPOGRAPHY OF THE FMPC AREA AND THE MIAMI VALLEY
(Source: Ref. 11)

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

4.2.2 Seismology

A study of the past seismic activity in Ohio reveals that it is not a major seismic risk area. However, there is a small region in west-central Ohio, near the town of Anna, that has experienced damaging shocks in the past. The two largest shocks that are recorded occurred on March 2 and 9, 1973, and the shocks were felt over a distance of 48 and 55 miles, respectively. From 1776 to 1964, 78 earthquakes were recorded in Ohio. Six of these occurred in the Cincinnati area between the years 1925 and 1937. All six earthquakes were of low intensity (i.e., an intensity of II on the Modified Mercalli scale). Although the 1937 events in the Anna area were larger, VII and VIII respectively on the Modified Mercalli scale, the Anna area is located far enough north of Cincinnati that only a mild shock was felt in Cincinnati. There has been no seismic activity in the area local to the FMPC (i.e., the Cincinnati area) since 1937. Because of the seismic activity in the Anna area, this portion of Ohio is included in a seismic risk category of 2. This category represents an area where moderate earthquake damage could occur.

4.2.3 Soils (Ref. 11, 17)

Soils in the region of the FMPC have formed in parent materials that were deposited either by the action of Wisconsin and Illinois

glaciers or wind action. These materials consist mainly of glacial till but also include sand and gravel and glacial lake and silt clays. The various soils are a result of different parent materials, variations in relief and drainage, and differences in soil age. In many areas where the till consists of the deposits or where severe erosion has occurred, the underlying bedrock is at shallow depths.

There are four major soil associations in the vicinity of the FMPC; these are Russell-Xenia-Wynn, Fincastle-Xenia-Wynn, Rossmoyne-Cincinnati-Edenton-Fairmont, and Fox-Gennessee. The soils are usually light-colored, acidic, and well-drained. Most of the soils have resulted from wind-blown material, except along present and old river basins where the Fox-Gennessee soils are of glacial till origin. The soils are moderately high in productivity and are frequently used for cash crops and for livestock production.

Soil samples were collected twice during 1985 from each of fifteen on-site and off-site locations. Table 4-1 summarizes the results of these analyses. The sampling locations are shown in Figure 4-4. As shown in Table 4-1, samples taken from sampling point 3 near the eastern plant boundary exhibit elevated levels of uranium. This relatively high level is probably due to the former operation of the incinerator adjacent to the sewage treatment plant.

Sediment samples are collected semi-annually from selected locations along the Great Miami River, Paddy's Run, and the Storm Sewer Outfall Ditch. Sediment sampling locations are shown in Figure 4-5. Table 4-2 provides the results of the 1985 sediment sampling program. As shown in Table 4-2, the uranium concentrations in on-site sediments

TABLE 4-1. Uranium in Routine 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	196.7 (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 4-4.

(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.

(Source: Ref. 17)

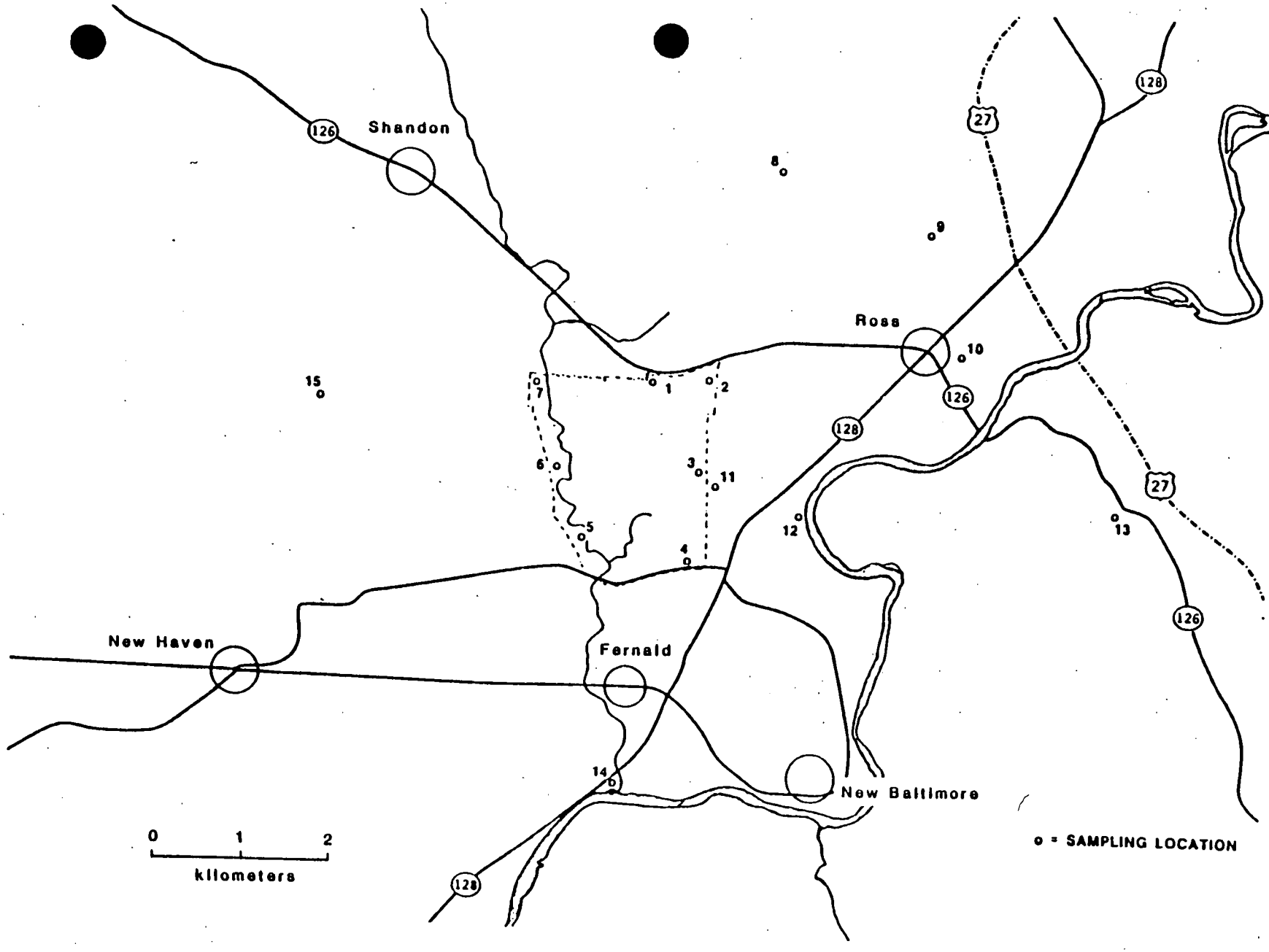


Figure 4-4. Routine Soil Sampling Locations
(Source: Ref. 17)

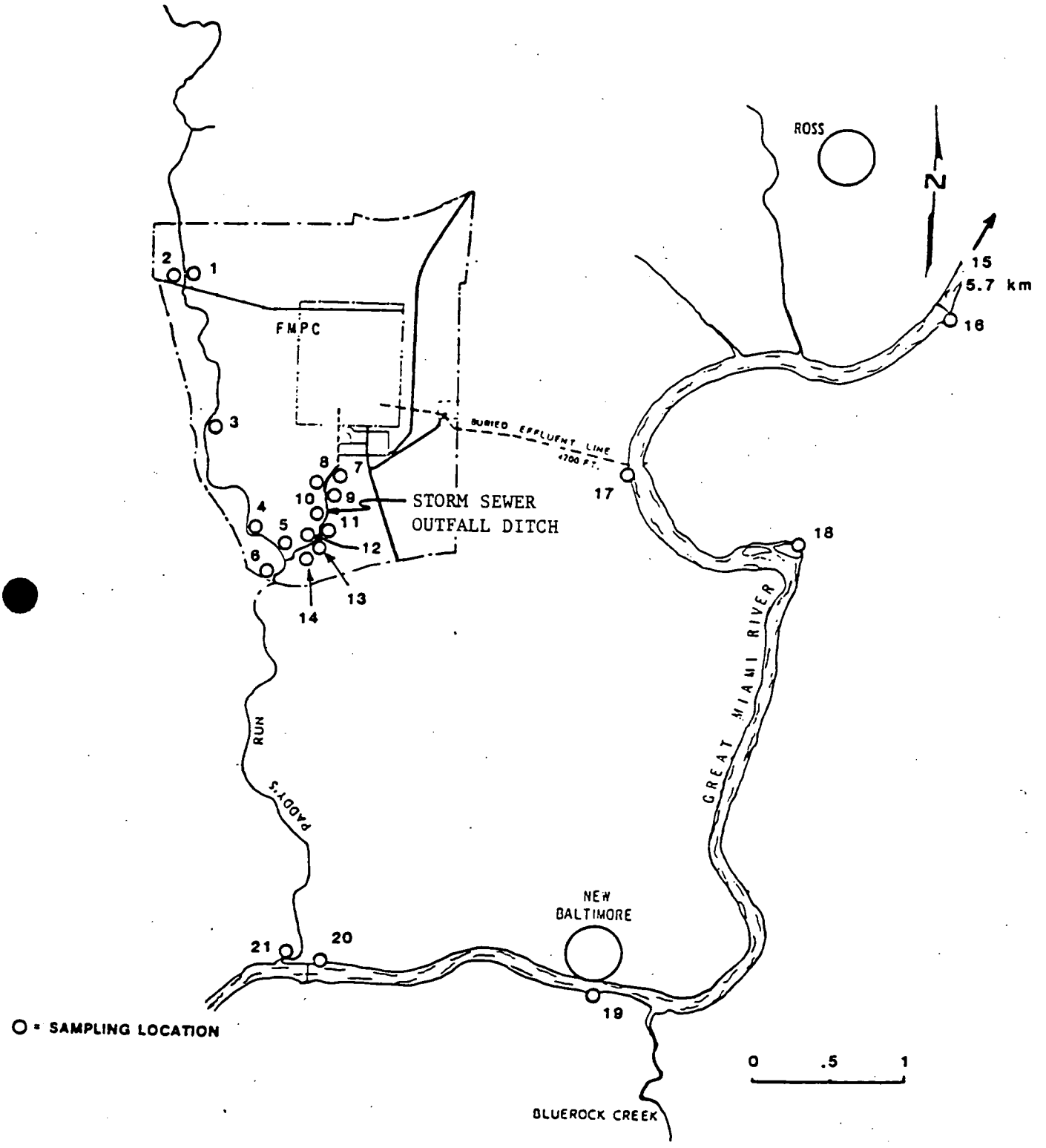


FIGURE 4-5. Sediment Sampling Locations

(Source: Ref. 17)

TABLE 4-2. Uranium and Technetium in On-site Sediment

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 4-5.

(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.

(Source: Ref. 17)

vary greatly both in space and time. The temporal variation is likely due to the flushing action of seasonal rainfall. The spatial variations observed are more difficult to explain. In those cases relating to the variation observed in the Storm Sewer Outfall Ditch (Sampling points 7 through 14), much of the variation is probably due to the variation in the flow distance before the water percolated downward into the sand and gravel.

Uranium concentrations in the sediment samples collected from off-site locations, as shown in Table 4-3, are indicative of background levels commonly found in the area. As has been the case in prior years, there are no significant differences between sediment samples taken from upstream and those taken from downstream locations.

4.3 Hydrology and Hydrogeology

4.3.1 Surface Water Hydrology (Condensed from Ref. 15)

The FMPC is located in the Great Miami River Basin. Natural drainage of the site is to Paddy's Run, a tributary of the Great Miami River. As shown in Figure 4-6, Paddy's Run originates near the plant and flows south on the west side of the waste storage area. Flow in Paddy's Run is intermittent and is sustained only during the period from January to May, ranging from 0.2 to 4.0 cubic feet per second. Over the remainder of the year, it may be considered a dry stream bed with occasional flash flows of a few hours duration following heavy rains.

Although Paddy's Run has overflown its banks on numerous occasions, it is far enough below the general site level that flooding

TABLE 4-3. Radionuclides 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 4-5

(2) Dry weight.

(3) C. L. = ±2σ.

(Source: Ref. 17)

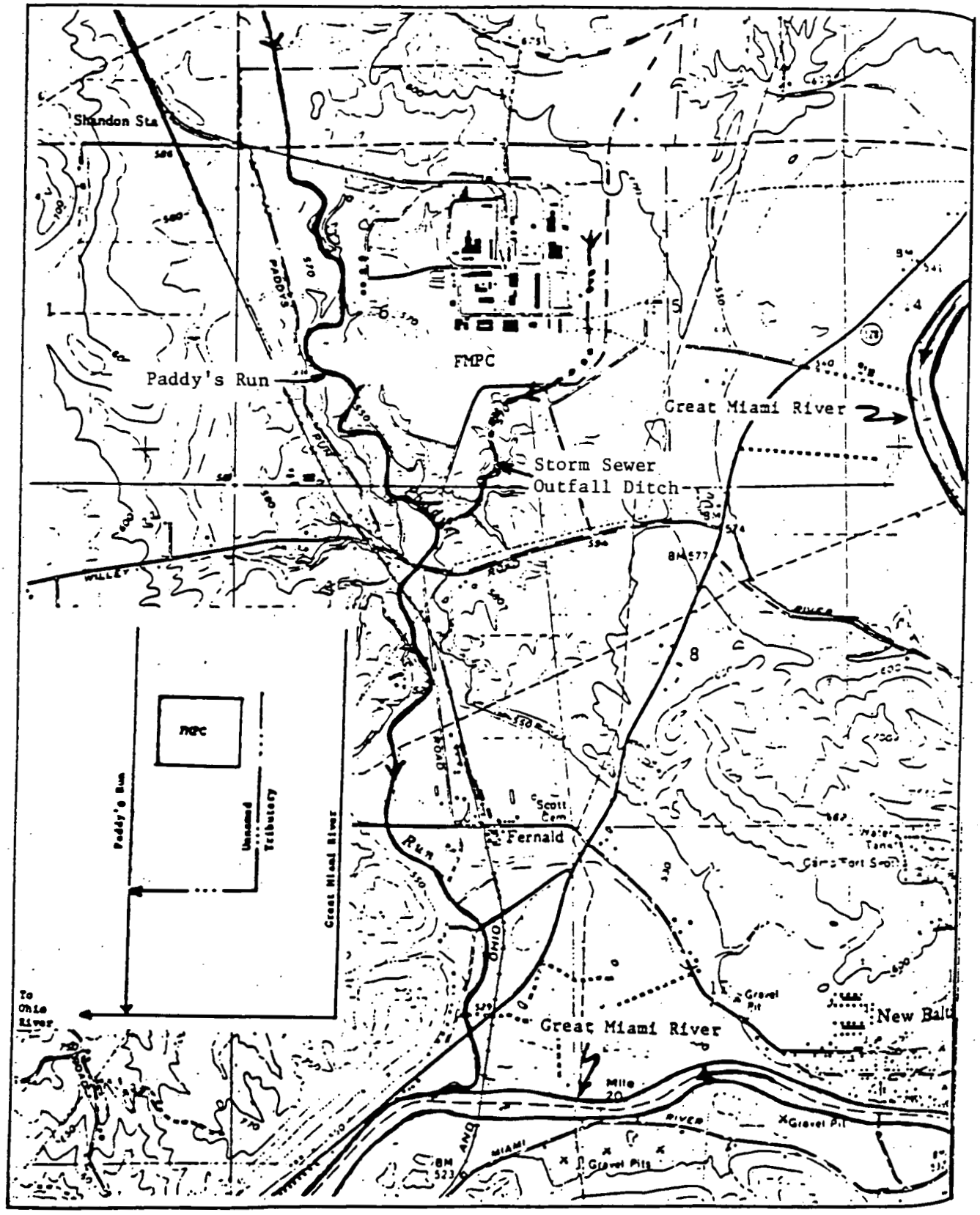


Figure 4-6. SURFACE STREAMS -- FMPC ENVIRONS

(Source: Ref. 11)

is inconsequential. Similarly, flooding of the Great Miami River does not reach the FMPC.

4.3.2 Ground Water Hydrology (Condensed from Ref. 5)

The bedrock underlying the FMPC consists of a predominantly flat-lying, grayish olive shale with interbedded thin limestone layers. The bedrock surface slopes generally to the northwest and forms the floor and walls of the New Haven Trough as well as the hills rising above the glacial till north and south of the valley. In these upland areas, the shale bedrock is overlain by up to 60 feet of glacial till. At Well 12, located north of the FMPC Production Area as shown in Figure 4-7, the shale is within approximately 65 feet of the land surface. To the south, along Paddy's Run Road and near the center of the New Haven Trough, shale was encountered in Well 15 (see Figure 4-7) at a depth of approximately 214 feet below the land surface. Shales of this type generally have low hydraulic conductivities (0.003 ft/day to 0.00003 ft/day). Water occurs primarily in joints and cracks in the shale which have an irregular distribution. Transmissivity of the shale is usually too low to provide a reliable supply of water for domestic or agricultural purposes.

As shown in Figure 4-8, a sequence of highly permeable sand and gravel outwash deposits laid down by the meltwaters of receding continental ice sheets unconformably overlay the shale bedrock. These outwash deposits generally consist of an unconsolidated medium to coarse grained olive brown, 200 foot thick layer of sand and gravel which is overlain by till. A 10 to 20 foot thick layer of greenish-

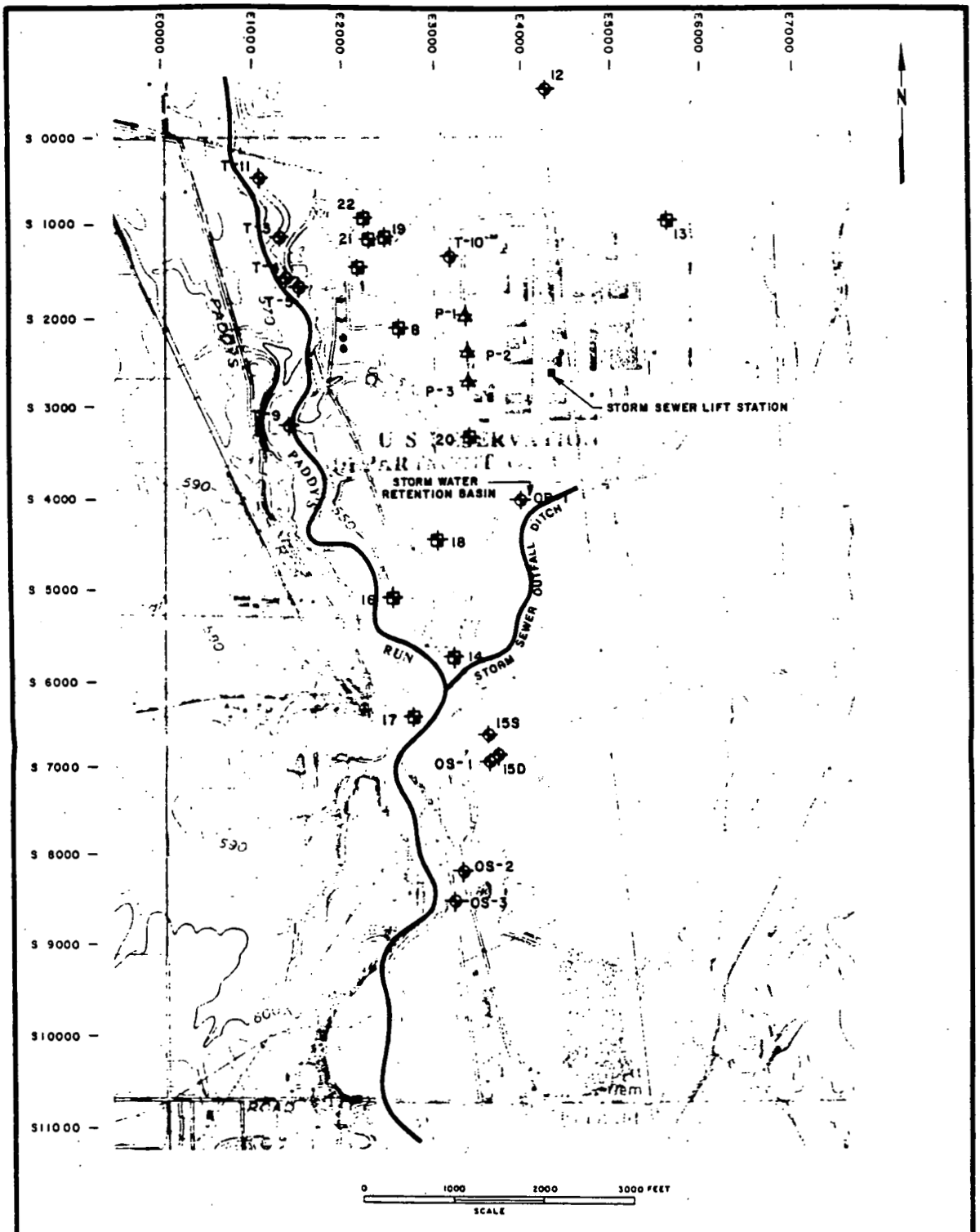


Figure 4-7. Monitoring Well Locations

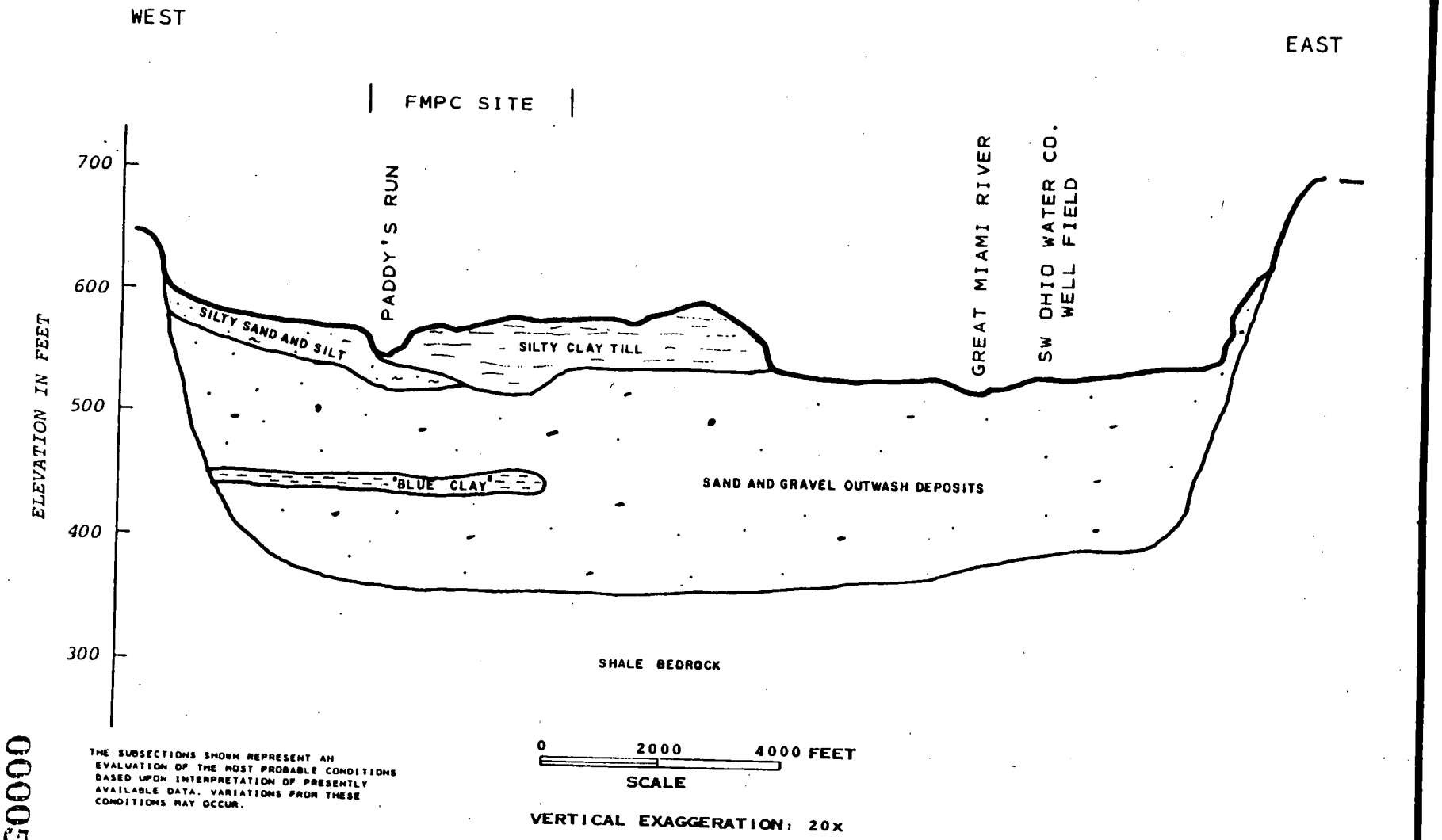


FIGURE 4-8. **GENERALIZED GEOLOGIC CROSS SECTION OF NEW HAVEN TROUGH**

(Source: Ref. 5)

DAMES & MOORE

250000

6402

black silty clay, which is also known as "blue clay", occurs approximately 100 to 125 feet below grade in some areas.

Hydrogeologically, the sand and gravel above and below the "blue clay" layer acts as a single unit. The "blue clay" layer is not sufficiently extensive to act as an aquitard, and no significant head differences exist between wells completed above and below this layer.

The hydraulic conductivity of the "blue clay" has been estimated to be above 0.4 ft/day. The discontinuous distribution of the "blue clay", as well as lateral variations in its thickness and consistency, apparently allow it to transmit water between two sand layers despite its relatively low permeability.

Transmissivities and hydraulic conductivities for the sand and gravel have been measured and are reported to range from 35,000 gpd/ft to 300,000 gpd/ft and 270 ft/day to 370 ft/day, respectively. Average hydraulic gradients for the area measured by the United States Geological Survey (USGS) from water level measurements made in August 1982 were calculated to range from 0.001 ft/ft to 0.005 ft/ft. Thus, the rate of ground water movement was calculated to range between 1.1 ft/day and 9.3 ft/day.

Water in the sand and gravel aquifer occurs approximately 60 to 90 feet below the land surface depending upon the surface elevation and the thickness of till. The upper 20 to 30 feet of the sand and gravel deposits are not saturated.

At the surface of the site and overlying the sand and gravel outwash deposit is a 20 to 50 foot thick layer of glacial till composed of a dense, olive-gray silty clay. The till varies in texture and

composition both laterally and vertically and contains lenses of poorly sorted, fine to medium grained sand and gravel. The base of the till occurs at about elevation 540 mean sea level and overlies the sand and gravel outwash deposits.

To the west and south of the site, the silty clay till laterally grades into a sequence of silty sand and silt with some layers of silty clay. The silty clay till remains continuous to the north and east of the site and directly overlies the bedrock in this area. In the lower reaches of Paddy's Run and the Storm Sewer Outfall Ditch, the silty clay till has been eroded away and the underlying sand and gravel are exposed.

A saturated zone occurs within the silty clay till approximately 4 to 9 feet below the surface in some areas of the FMPC site. The saturated zone was encountered in five shallow wells (test pits) and is probably recharged by precipitation. This saturated zone may be present because of vertical variations of composition and texture of the till, or near-surface weathering or desiccation induced fracturing of the till itself. Hydraulic conductivities of this saturated zone have been measured to be 0.2 ft/day to 2.5 ft/day with associated transmissivites of 3.5 gpd/ft to 150 gpd/ft.

4.4 Air and Water Quality (Condensed from Ref. 11, 17)

4.4.1 Air Quality

Air contaminants at the FMPC can be divided into two groups: non-radioactive and radioactive. The non-radioactive contaminants emitted during FMPC operations are primarily particulates, sulfur dioxide, and oxides of nitrogen. The radioactive parameters measured are uranium,

thorium, transuranic radionuclides, gross alpha activity and gross beta activity.

For air monitoring purposes, the FMPC has used the DOE criteria for air in uncontrolled areas as standards. These criteria are compared with samples taken at the plant boundaries via a network of seven air monitoring stations as shown in Figure 4-9. Plant boundary samples are also used for determining compliance with ambient standards for the non-radioactive contaminants. For these pollutants, the applicable air standards are taken to be those established by the EPA.

The concentrations of total suspended particulates measured at air monitoring stations BS1 through BS6 are also shown in Table 4-4 for the years 1977 through 1979. Particulate measurements were taken every week for a sampling period of one week. As shown in the Table, the annual average concentration in these years was below the standard of 60 $\mu g/m^3$. It should be noted that the FMPC contribution to ambient air particulate matter cannot be assessed accurately from this data because all boundary air monitoring stations, except for BS-3, are located near roads where traffic dust is generated. Monitoring stations BS4, BS5, and BS6 are also located near fields where periodic agricultural activities produce high dust levels. Measurements of nitrogen dioxide concentration were made at monitoring station BS2 for the years 1974 through 1977. This monitoring station is located downwind of the production operations that emit nitrogen oxides. Samples were taken periodically throughout the year for 24-hour periods. Average

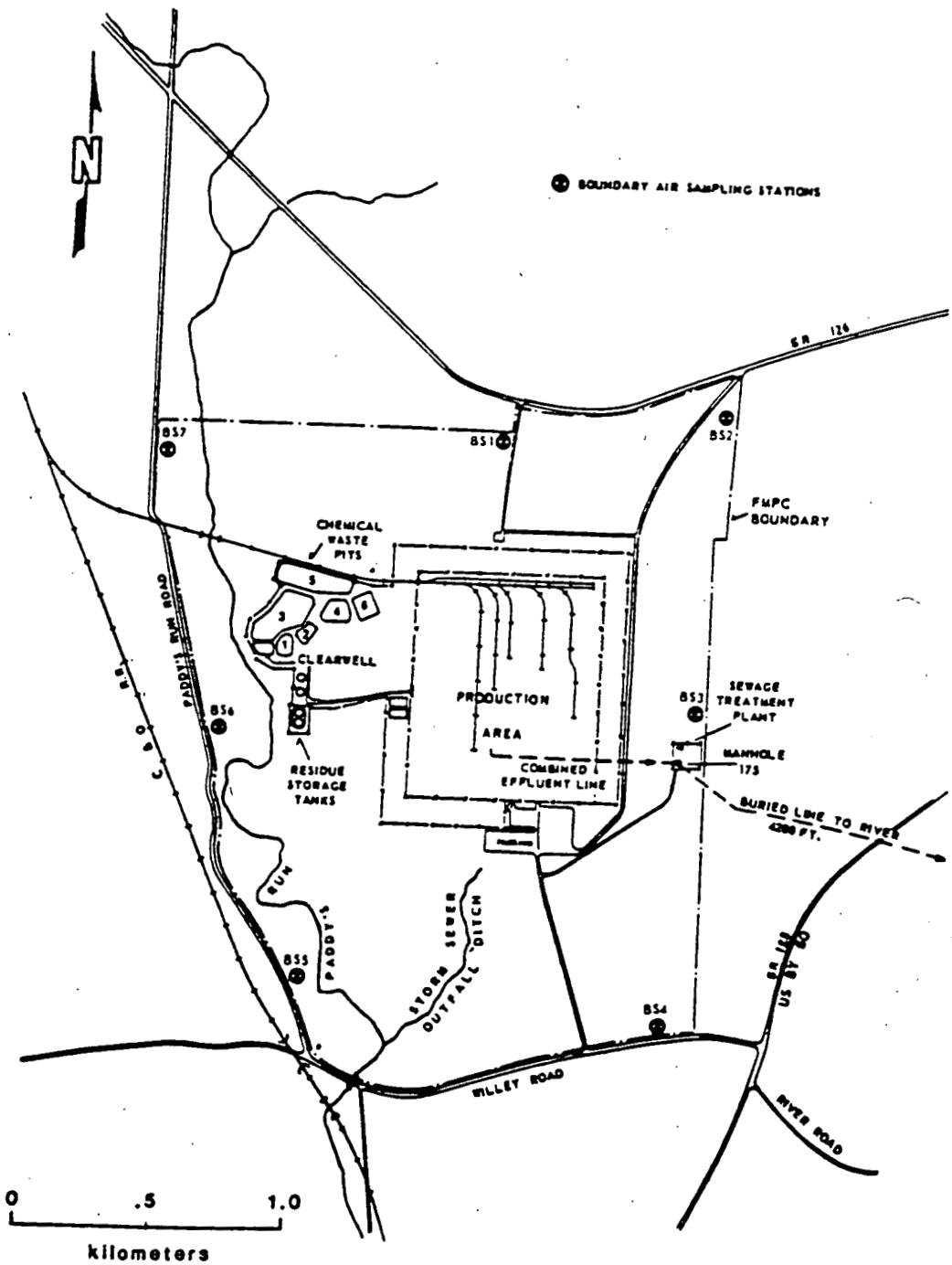


FIGURE 4-9 · **FMPC Site Map and Boundary Air Station Locations**
(Source: Ref. 17)

TABLE 4-4 AMBIENT CONCENTRATIONS OF NON-RADIOACTIVE CONTAMINANTS AT THE FMPC BOUNDARY, 1977-1979

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

(Source: Ref. 11)

concentrations ranged from 22 to 44 $\mu g/m^3$. These measurements were well below the OEPA standard of 100 $\mu g/m^3$. Nitrogen dioxide concentrations are no longer measured.

Sulfur dioxide is emitted at the FMPC as a result of coal combustion at the steam plant. SO_2 measurements were made in the first quarter of 1974. The average of the 20 samples taken was 23 $\mu g/m^3$, which is about one-third the OEPA standard of 60 $\mu g/m^3$. A maximum 24-hour concentration of 100 $\mu g/m^3$ was measured, and this was also well within the OEPA standard of 365 $\mu g/m^3$.

Weekly samples are also taken for radiological monitoring purposes. The air stations are monitored weekly for gross alpha and gross beta activity and for uranium. Annual composites from each monitoring station are analyzed for thorium and transuranic compounds. The average airborne concentrations for 1985 are summarized in Table 4-5. A comparison was made between data obtained in 1983 and that obtained in 1984. No significant differences were noted in uranium levels between the two years; however, beta activity at sampling stations BS-2 and BS-3 was significantly higher in 1984 than in 1983. This difference was probably due to elevated levels of ^{234}Pa and ^{234}Th released in connection with the accidental stack losses in November and December 1984 (Ref 17). Since releases of radon-222 from the K-65 silos were suspected, measurement of ambient air radon-222 concentrations was added to the air monitoring program in 1980. Results of this monitoring program are shown in Table 4-6. Although it

TABLE 4-5. Radionuclides in Air

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	1.46	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 ± 0.6		20.37 ± 2.3		26.03 ± 2.3		531.83 ± 11.3		15.84 ± 2.3	

Footnotes:

(1) See Figure 4-9

(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^{-3} pCi/L	^{239,240}Plutonium	1.0×10^{-5} 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^{-5} 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.

(Source: Ref. 17)

TABLE 4-6. ^{222}Radon In Ambient Air

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		
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	(3)	0.20 - 0.35 pCi/L
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 4-7

(2) C. L. = Average Concentration ×÷ the value shown. Derived from log-transformed data; = $t_{95\%,n} S_{\bar{x}}$.

(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.

(Source: Ref. 17)

is known that radon is emanating from the K-65 tanks, concentrations at the boundary monitoring stations are not significantly different from the off-site monitoring locations. None exceeded the DOE limit of 3 pCi/l for uncontrolled areas.

4.4.2 Water Quality

Liquid discharges from the site consist of treated process and sanitary effluents and storm water. A permit to discharge liquid effluents had been issued under the NPDES by the U.S. EPA. The permit contained maximum and average limits for eighteen parameters at four locations. These limits are shown in Table 4-7. A new permit with more stringent levels is currently under negotiation.

Samples are taken on a specified schedule and are reported quarterly. FMPC operations have not caused any state standard for non-radioactive contaminants to be exceeded in the river. The contaminants listed in Table 4-7 were selected for analysis and reporting because of the possibility of adding greater than one percent of the applicable state standards to the river concentrations.

Samples taken from the Miami River for water quality analyses are also used in analyses for radionuclides. Analyses for 1979 indicate that radium-226 and radium-228 amounted to 0.02 percent of the limit for water in an uncontrolled area. The addition of gross alpha and gross beta radioactivity to the Miami River during 1977 through 1979 was not detectable. Gross alpha and gross beta radioactivity show an increase downstream in Paddy's Run but are below DOE standards for uncontrolled waters.

TABLE 4-7 APPLICABLE STANDARDS FOR POTENTIAL WATER POLLUTANTS IN RECEIVING WATERS AND EFFLUENT DISCHARGES

	Federal or Ohio			
	Drinking Water	All Waters	DOE	NPDES
Radionuclides (μCi/L)[a]				
Cesium - 137			2×10^{-5}	
Neptunium - 237			3×10^{-6}	
Plutonium - 238			5×10^{-6}	
Radium - 226	5×10^{-6}		5×10^{-6}	
Radium - 228			3×10^{-8}	
Ruthenium - 106			3×10^{-8}	
Strontium - 90			1×10^{-5}	
Technetium - 99			3×10^{-7}	
Thorium			3×10^{-4}	
Uranium			1×10^{-6}	
Gross Alpha Activity	15×10^{-6}		2×10^{-5}	
Gross Beta Activity (mrem/yr)	4			
Non-Radioactive Parameters (mg/L)[b]			Daily Average	Daily Maximum
Total Suspended Solids			$20^{(c,d)}$, $30^{(f,h)}$	$60^{(c)}$, $40^{(d)}$, $100^{(f,h)}$
Total Suspended Solids (kg/da)			$5^{(d)}$, $6.2^{(e)}$	$10^{(d)}$, $12.8^{(e)}$
Nitrate (N) (kg/da)			$1590^{(c)}$, $62^{(h)}$	$3180^{(c)}$, $124^{(h)}$
Ammonia (N) (kg/da)			$28^{(c)}$, $12^{(h)}$	$43^{(c)}$, $18^{(h)}$
Oil and Grease				$15^{(c,e,h)}$
Total Residual Chlorine				$0.10^{(c)}$

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

(Source: Ref. 11)

TABLE 4-7 (CON'T) APPLICABLE STANDARDS FOR POTE. .AL WATER POLLUTANTS IN RECEIVING WATERS AND EFFLUENT DISCHARGES

	Federal or Ohio		DOE	NPDES	
	Drinking Water	All Waters		Daily Average	Daily Maximum
BOD, 5-day				20(d)	40(d)
BOD (kg/da)				5(d)	10(d)
Chromium (+6) (kg/da)				0.004(e)	0.008(e)
Chromium (total) (kg/da)				0.050(e)	0.102(e)
Iron (kg/da)				0.41(e)	0.85(e)
Nickel (kg/da)				0.124(e)	0.256(e)
Copper (kg/da)				0.025(e)	0.051(e)
pH				---	10(e), 9(d,h)
Fecal Coliform (#/100 mL)	1				
Cadmium		0.012			
Lead		0.03			
Mercury		0.00005/.0002			
Cyanide		0.025			
Dissolved Oxygen		4.0			

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

(Source: Ref. 11)

There is no known downstream use of the Miami River as a potable water supply.

4.5 Environmentally Sensitive Conditions

4.5.1 Endangered Species (Condensed from Ref. 19)

No species of vegetation included on the proposed Federal list of endangered or threatened plants are known to exist on the FMPC site. Current land practices on the site (e.g., grazing and mowing) act to reduce the likelihood of any occurring.

Three species of mammals classified as endangered by state and Federal governments have ranges which include the FMPC site. These are the bobcat, the river otter, and the Indiana bat. All these are listed by Ohio; however, only the Indiana bat is on the U.S. endangered species list. Neither the otter nor the bobcat is to be expected in the region due to a lack of suitable habitat. There is a slight possibility that the bat may, at some time, pass over the site during migratory or feeding activities. There are no suitable locations on the site for the bats to use as roosting or resting areas since they require caves.

No Federal or state threatened or endangered bird species were observed on the site during a two day survey in June 1977. Furthermore, habitats available on the property are not suitable for breeding or overwintering for any of the Federally threatened or endangered bird species known to occur in Ohio. Although only remotely possible, one or more of the seven species of birds considered endangered in Ohio could stop briefly on the property during migration.

One of the seven species, the upland sandpiper, is a bird of open pastures that has been rarely seen during the summer in the Hamilton County Park District and could possibly occur in the pastures on the site.

No threatened or endangered species of fish on either the Federal or state lists are known or expected to occur on the FMPC site or in the local stretches of the Miami River due to the intermittent nature of Paddy's Run and to the degraded state of the River. Therefore, for the purposes of this analysis, it is assumed that there are no endangered species routinely present within the area of concern.

5.0 Results

As required by DOE Order 5480.14, the potential CERCLA sites at the FMPC have been evaluated using the mHRS. This methodology, which is described below, is used to provide a uniform evaluation of the environmental threat posed by a potentially hazardous site. Prior to presenting the findings for each site, a brief discussion of the mHRS methodology is provided for perspective.

5.1 Modified Hazard Ranking System Methodology

DOE Order 5480.14 requires that installation assessments of inactive hazardous waste management sites that may pose an undue risk to health, safety, and the environment be completed within one year of the implementation date of the Order, or by April 26, 1986. The Order mandates that the methodology described as the HRS in 40 CFR Part 300, Appendix A be used for sites containing only hazardous materials and that the mHRS (Ref. 20) be used for sites containing both hazardous and radioactive waste. These prescribed methodologies allow uniform evaluations of the hazards presented by a facility relative to those presented by another facility. However, since above-background levels of radiation have been detected at most of the FMPC sites evaluated, the mHRS was used exclusively in this assessment.

The mHRS methodology assigns three hazard mode scores to a facility: 1) S_m, which reflects the potential for harm to humans or the environment as a result of contaminant migrations from the facility via air, ground water, or surface water routes; 2) S_{fe}, which assesses the

potential for harm from substances that could cause fires or explode; and 3) S_{dc}, which reflects the potential for harm from direct contact with the hazardous and/or radioactive materials at the facility. The score for each hazard mode is obtained by considering a set of factors that characterizes the potential of the facility to cause harm (e.g., waste characteristics, containment, land use, etc.). The likelihood of individuals and sensitive environments being adversely affected by the facility is also considered in the calculation of the scores for all three hazard modes. Thus, if it could be demonstrated that population or sensitive environments were not likely to be adversely affected, the hazard mode scores were reduced substantially since the environmental threat would be reduced.

Each contributing factor to a hazard mode score is assigned a numerical value according to prescribed guidelines. The national ranking of facilities for remedial action is based primarily on the total migration mode (S_m) score. A total S_m score of 28.5 would currently result in the facility being listed on the NPL (40 CFR Part 300, Appendix A). Federal facilities have recently become eligible for inclusion on the NPL; however, they still would not be eligible for fund financed remediations. The rating scores from the fire and explosion and direct contact modes are used to identify facilities requiring emergency attention.

It should be noted that neither the HRS nor the mHRS provides estimates of the probability or magnitude of harm to humans or the environment due to exposure to these sites. As stated previously, the methodology is simply a procedure for evaluating the potential threat

to humans and the environment posed by one facility relative to another.

5.2 Findings

The goal of the Installation Assessment is to identify sites where there is a potential for environmental degradation as a result of past waste management activities and to assess the likelihood of contaminant migration from these sites. The findings for each site, as presented in the following text, are based upon: 1) a search of the available literature regarding the sites and the items disposed of at each site; 2) interviews with FMPC personnel having direct knowledge of the waste management activities at each site; and 3) to a limited extent, the results of air, surface, and ground water monitoring programs. The results of applying the mHRS to each site are summarized in Table 5-1. The annotated mHRS worksheets are provided in Appendix B.

The air route score was determined to be zero for all but the Waste Pit Storage Area and Waste Storage Silos 1 and 2. A nonzero air route score is possible only if airborne releases in excess of background levels have actually been measured. With the exception of the plant boundary air monitoring program, air monitoring efforts have only been conducted in the vicinity of the Waste Pit Storage Area and the Waste Storage Silos 1 and 2.

Ground water degradation is the major environmental consequence that has been observed at many of the sites. These scores are exacerbated by the fact that the ground water within a mile of the site is used as a drinking water source.

Table 5-1 Relative Ranking of the FMPC CERCLA Sites

Site	Air Route (S_a)	Surface Water Route (S_{sw})	Ground Water Route (S_{gw})	Migration Score (S_m)	Fire and Explosion Mode (S_{fe})	Direct Contact Mode (S_{dc})
Waste Pit Storage Area	53.85	29.10	51.02	46.1	NA	0
Waste Storage Silos 1 and 2	53.85	7.11	11.34	32.1	NA	0
Paddy's Run	0	21.26	43.25	27.8	NA	25.0
Storm Sewer Outfall Ditch	0	21.26	43.25	27.8	NA	25.0
Fly-Ash Disposal Area	0	9.45	25.95	16.0	NA	25.0
Deactivated Incinerator	0	6.61	19.88	12.1	NA	25.0
Waste Storage Silo 3	0	6.46	10.20	7.0	NA	0
Copper Scrap Pile	0	0	11.60	6.7	NA	0
Sanitary Landfill	0	0	0	0	NA	0

NA - Not Applicable

The sites having the higher surface water scores (i.e., greater than 20) generally had direct evidence of releases that could be attributable to those sites. There is also evidence that the sites contributing to the water quality degradation of Paddy's Run are also contributing to the elevated uranium levels detected in the off-site wells.

The methodology produces a non-zero score for the fire and explosion mode only if a fire marshall has certified that the facility presents a significant fire or explosion threat or if such a threat (e.g., observable fires or high combustible gas levels) has actually been detected. Due to burning uranium chips, the Waste Pit Storage Area is the only site that has exhibited any fire and explosion threat in the past. According to FMPC operating personnel, uranium chips are no longer placed in the pits. Accordingly, none of the sites are considered hazardous in terms of fire and explosion threats in their current undisturbed states.

The direct contact mode scores are nonzero for Paddy's Run, the soils exhibiting elevated levels of uranium associated with the Deactivated Incinerator, the Storm Sewer Outfall Ditch, and the Fly-ash Disposal areas. These sites all have areas of potential contact outside the controlled access area of the FMPC plant proper and in accordance with the methodology, are considered accessible to the general public.

5.2.1 Waste Pit Storage Area

The air, surface water, and ground water monitoring programs

conducted in the vicinity of the waste pits all resulted in detection of above-background levels of uranium; therefore, the Waste Pit Storage Area received the maximum observed release score under the mHRS methodology. Because of the low activity of the radioactive materials stored in the Waste Storage Area, the chemical threat is greater than the radiological threat for both the surface and ground water route scores. However, the radiological threat is greater for the air route. Because of the limited containment features of the storage area and because of the three nonzero route scores, the Waste Pit Storage Area scored significantly higher than any of the other FMPC sites.

5.2.2 Waste Storage Silos 1 and 2

This site received one of the highest rankings because of its nonzero air route score. A local air monitoring program specific to this site had detected a peak radon gas level of almost 2,600 pCi/l in the vicinity of the storage silos. This was also the only site in which a greater threat due to radionuclides rather than chemical constituents was observed.

The surface and ground water migration scores were reduced somewhat because of the concrete containment structures housing the wastes. Although uranium has been detected in wells located near the silos, the absence of significant radium levels appears to indicate that the uranium is derived from sources other than the silos.

5.2.3 Paddy's Run

Above-background levels of uranium have been detected in ground and surface waters associated with Paddy's Run. The route scores are not as high as those of the Waste Pits and the Waste Silos because the quantity of hazardous material located in Paddy's Run is not as great. Similarly, because there is a lesser quantity of radionuclides present, the chemical threat is greater than the radiological threat.

Since portions of Paddy's Run are located outside the perimeter security fencing, there is a nonzero direct contact score. The score is elevated because Paddy's Run sediments, which probably contain above-background levels of uranium in some areas, can be readily contacted, especially during dry periods.

5.2.4 Storm Sewer Outfall Ditch

As in the case of the three sites discussed previously, there have been observed releases to ground and surface waters that can be attributed to the Storm Sewer Outfall Ditch. The amount of uranium that has been discharged to the outfall ditch and the amount that is contained in the stream sediments are somewhat questionable. As was the case for Paddy's Run, the chemical threat exceeds the radiological threat. The direct contact route was scored nonzero since the site is not located within the fenced, controlled access area.

5.2.5 Fly-ash Disposal Area

The principal contributor to the overall migration route score is the ground water route score. This is primarily due to the close

roximity of an off-site well to the disposal areas. There have been no observed releases by any migration mode. The direct contact route is scored as nonzero since the areas are not located within the fenced, controlled access area.

5.2.6 Deactivated Incinerator

There have been no direct releases observed for any mode. The primary threat posed by the Deactivated Incinerator site is potential ground water degradation due to the presence of elevated levels of uranium. Much of the uranium detected apparently resulted from deposition of the incinerator exhaust in the vicinity of the incinerator site. Also, since the soils exhibiting elevated levels of uranium extend beyond the plant boundary, the direct contact mode is nonzero.

5.2.7 Waste Storage Silo 3

Waste Storage Silo 3 scored significantly lower than the K-65 silos because of the amount of radium present in the wastes and the absence of detected air releases. The ground and surface water route scores are lower than the same scores for many of the other sites primarily because of the absence of observed releases and because of the form of containment.

5.2.8 Copper Scrap Pile

The surface water route for the Copper Scrap Pile is scored zero due to the routing of surface runoff to the Great Miami River. The

overall threat is due to the limited ground water migration potential of the chemically toxic uranium.

5.2.9 Sanitary Landfill

Asbestos is the only hazardous substance reported to have been disposed of in the Sanitary Landfill. This material was reportedly bagged for disposal and is presently covered over with soil. The air migration route was scored zero since no air data have been collected. Since the hazard posed by this material is primarily respiratory related, and the air route is the only appropriate means of migration, the overall migration score was assigned zero. The site apparently never received any wastes capable of presenting a fire and explosion threat. Finally, since the wastes have been covered over with soil and the site is within the confines of the FMPC controlled access area, the direct contact score is also zero. (Note: Since this site was assigned zero scores for all routes, annotated worksheets are not included in Appendix B.)

6.0 Conclusions

The mHRS evaluations indicate that the primary threat to the environment posed by the potential FMPC CERCLA sites appears to be the degradation of off-site ground water quality. Studies that have been completed to date indicate that this degradation is primarily a result of surface water recharge to the ground water aquifer supplying water to these wells. Application of the generic mHRS methodology to the FMPC site also results in identification of subsurface contaminant migration as a potential threat to human health and the environment. Moreover, the methodology indicates that the primary health threat is typically due to the chemical toxicity of the hazardous substances involved rather than the radiological toxicity.

The results of the relative site rankings are shown in Table 5-1. Basically, the two most critical sites identified by the ranking methodology are presently the subject of a recently initiated detailed site characterization similar to a typical remedial investigation/ feasibility study. Remediation activities at the Waste Pit Storage Area should result in significant improvements of the water quality of Paddy's Run. Other on-going activities, such as completion of the FMPC storm water retention basin, should improve the overall environmental quality of the Storm Sewer Outfall Ditch. These three sites and Waste Storage Silos 1 and 2 ranked significantly higher than the remaining sites at the FMPC and will be further characterized during the remedial investigation.

Specific recommendations that should further substantiate the hazard rankings include the following:

1) Expand surface water monitoring programs to include monitoring at specific waste management sites. Surface waters discharging from the FMPC facility have been well characterized, specifically at and below the confluence of Paddy's Run and the Storm Sewer Outfall Ditch. However, the actual contributions of specific waste sites to the overall surface water contamination have not been sufficiently characterized. In particular, additional sampling efforts should probably be conducted in the vicinity of the Waste Pit Storage Area, the Waste Storage Silos, and the Fly-ash Disposal Areas.

2) Continue site characterization activities at the Waste Pit Storage Area and the Waste Storage Silos. These sites scored sufficiently high to be considered for inclusion on the NPL.

3) Based on the results of continuing site characterization activities, the need for additional background data should be evaluated. This data might include air monitoring data from surrounding areas not influenced by FMPC operations and upgradient surface water and ground water monitoring data.

A Characterization and Investigation Study has recently been initiated by WMCO. This investigative study is being conducted in a manner similar to the EPA remedial investigation/feasibility study program under CERCLA.

7.0 References

1. Poff, T. A., "Task Force for Characterization of Wet Waste Pit Storage", June 20, 1985.

2. "Waste Storage Inventory", Memo from B. Gessiness, WMCO:EH (MCA): B6: 86-011, January 9, 1986.

3. "Feed Materials Production Center - Fernald, Ohio Graphic Overview System", 1981.

4. Dames and Moore, "Ground Water Study - Task A Report", October 1985.

5. Dames and Moore, "Ground Water Study - Task C Report", July 1985.

6. Drawing "Ground Water Monitoring Well Locations", Series #00662, February 25, 1986.

7. "Environmental Report - Feed Materials Production Center", Battelle, January 31, 1985.

8. Memo from T. A. Poff, "FMPC Waste Inventory".

9. Diehl, Donald E., "Request for Proposal No. S-1174".

10. Sax, N. I., "Dangerous Properties of Industrial Materials", Fourth Edition.

11. "Environmental Report - Feed Materials Production Center", January, 1981.

12. Poff, T. A., "Waste Storage Pits and Silo".

13. "Information Regarding Potential Release from Solid Waste Management Units", U.S. DOE - Feed Materials Production Center, March 10, 1986.

14. "Rainfall Frequency Atlas of the United States", U.S. Department of Agriculture, Soil Conservation Service, January, 1963.

15. Dames and Moore, "Final Safety Analysis Report, FMPC Waste Storage Area", 1982.

16. Climatic Atlas of the United States, U.S. Department of Commerce, Reprinted 1983.

17. Facemire, C.F., Jones, D.L., and Keys, R.W., "Feed Materials Production Center Environmental Monitoring Annual Report for 1984", July 15, 1985.

18. "Preliminary FMPC Environmental, Safety, and Health Management Plan", NLO, Inc., November, 1985.

19. Battelle Columbus Laboratories, "Ecological Assessment at the Feed Materials Production Center", September 30, 1977.

20. Hawlay, K.A., and Napier, B.A., "A Ranking System for Sites with Mixed Radioactive and Hazardous Wastes", February, 1985.

21. Fleming, D.A., and Ross, K.N., "Feed Materials Production Center Environmental Monitoring Report for 1983", August, 1984.

22. Fleming, D.A., "Air Samples Collected at Pit 6 Slag Dumping", WMCO: EH(IH): 86: 0038, April 16, 1986.

APPENDIX A

R. RANDOLPH FERGUSON

Education

M.E., 1984, University of Tennessee, Environmental Engineering

B.S., 1980, University of Tennessee, Civil Engineering

Positions Held

H&R Technical Associates, Inc.
Environmental Engineer

MCI Consulting Engineers, Inc.
Project Engineer

Experience

Assistant Project Manager for development of RCRA Part B permit applications for seven mixed hazardous and radioactive waste surface impoundments. Prepared Section 3019 (1984 RCRA Amendments) Exposure Assessments for the seven surface impoundments.

Assisted in development of closure and ground water monitoring plans for thirty-seven underground storage tanks containing mixed hazardous and radioactive wastes.

Developed a comparison of requirements for remedial actions at mixed waste surface impoundments as regulated under RCRA vs. CERCLA.

Developed a generic closure/remedial action plan for implementation at mixed hazardous and radioactive waste surface impoundments, burial grounds, and landfarms. Closure plan included an assessment of all regulatory constraints imposed through the authorities of RCRA, CERCLA, OSHA, TSCA, the Clean Water Act, the Clean Air Act, and applicable DOE Orders.

Project Manager for development of RCRA Part B permit application for a hazardous waste drum storage facility.

Task leader for development of RCRA closure plans for hazardous waste surface impoundments (9), bulk chemical storage tanks (4), landfill (1) and drum storage facilities (3).

Task leader for RCRA Part B process plan descriptions for nine hazardous waste surface impoundments.

Prepared evaluation of site closure alternatives for disposal of drummed sludges expected to be contaminated with low-level radionuclides, heavy metals, and nitrates. Assessment included an evaluation of disposal requirements necessitated by state hazardous and solid waste laws and DOE orders.

Developed remedial action priorities at a DOE facility in accordance with 40 CFR 300, Appendix A (Hazardous Ranking System) and where applicable, DOE's proposed Modified Hazard Ranking System. An "Installation Assessment" was prepared in accordance with DOE Order 5480.14 for thirteen mixed waste disposal sites.

Project Manager for the preparation of design and permit documents for closure of five disposal sites at the Oak Ridge Y-12, X-10, and K-25 facilities (three contractors' disposal areas, asbestos disposal area and beryllium oxide disposal area).

Design Engineer for conceptual layouts for sanitary, demolition and low-level waste disposal areas at the Oak Ridge X-10 and K-25 facilities.

Prepared a remedial action plan for and active municipal landfill in Bradley County, Tennessee. Plan included provisions for surface stabilization and reduction of leachate generation.

Project Manager for the preparation of a ground water assessment plan for a hazardous waste surface impoundment.

Design and Field Engineer for development and implementation of closure plans for an industrial landfill and surface impoundments at a baghouse dust disposal site.

Developed construction plans and permit documents for two industrial landfills and five industrial landfill closures at a munitions manufacturing facility.

Design Engineer responsible for preparing construction plans and permit doouments for a 1,200 tons per day sanitary landfill for metropolitan Davidson County and Nashville, Tennessee.

Design Engineer for over thirty disposal facility construction and operation plans and/or closure plans for municipalities and industries located in Tennessee, Mississippi and Colorado.

Related Publications

"RCRA Part B Permit Application for Oak Ridge National Laboratory," presented to Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee, August, 1985 (Co-author).

"Exposure Information Report for Oak Ridge National Laboratory," presented to Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee, August, 1985.

"Generic Implementation Plan for Clean Closure of Co-contaminated Waste Disposal Sites," presented to Martin Marietta Energy Systems, Inc., Oak Ridge, Tennessee, July, 1985.

"RCRA Part B Permit Application for Boeing Engineering Company Southeast, Inc.", Oak Ridge, Tennessee, February, 1985 (Co-author).

"Ground Water Assessment Plan for Boeing Engineering Company Southeast, Inc.", Oak Ridge, Tennessee, December, 1984.

"Contractor Disposal Area Closure for K-25 Plant," presented to Martin Marietta Energy Systems, Inc. Oak Ridge, Tennessee, July, 1984.

"RCRA Part B Permit Application for True Temper Sports, Inc.," Amory, Mississippi, June, 1984 (Co-author)

Beryllium Oxide Disposal Area Closure for Y-12 Plant," presented to Union Carbide Corporation-Nuclear Division, Oak Ridge, Tennessee, February, 1984.

"Landfill Closure/Post Closure Plans for U.S. Pipe and Foundry Company," Chattanooga, Tennessee, February, 1984.

"RCRA Part B Permit Application of Diversified Systems, Inc.,"Athens, Tennessee, February, 1984 (Co-author).

"Asbestos Disposal Area Closure for Y-12 Plant," presented to Union Carbide Corporation-Nuclear Division, Oak Ridge, Tennessee, November, 1983.

"Bradley County Landfill Remedial Action Plan," Cleveland, Tennessee, November 1983.

"Conceptual Layout co Demolition, Asbestos, and Laboratory Animal Disposal Area for X-10 Plant," presented to Union Carbide Corporation-Nuclear Division, Oak Ridge, Tennessee, September, 1983.

"Contractor Disposal Area Closure for Y-12 Plant," presented to Union Carbide Corporation - Nuclear Division, Oak Ridge, Tennessee, June 1983.

"Landfill Closure Plan for Vertac Chemical Corporation," Vicksburg, Mississippi, February, 1983 (Co-author).

"Closure of a Baghouse Dust Disposal Area in Karst Geologic Area," Proceedings, ASCE Environmental Division Annual Conference, Minneapolis, Minnesota, July, 1982, (Co-author).

"Landfill Construction, Operation and Closure plans for 7 Solid Waste Disposal Sites for Holston Army Ammunition Plant," presented to Holston Defense Corporation, Kingsport, Tennessee, May, 1982.

"Sanitary Landfill Site selection, Design and Operation to Minimize Impact Upon Groundwater Resources," 1981 AWRA Conference, Atlanta, Georgia, October 1981, (Co-author).

Professional Societies

National Society of Professional Engineers

Tennessee Society of Professional Engineers

Tau Beta Pi

Miscellaneous

Registered Professional Engineer - Tennessee, Alabama, Washington (pending)

Selected "Outstanding Young Engineer of the Year", 1985, by Knoxville Chapter of Tennessee Society of Professional Engineers.

Active Q-clearance

ANN H. HANSEN

Education

D.Sc., 1985, Florida Southern College, Natural Sciences

M.S., 1974, Carnegie-Mellon University, Nuclear Engineering

M.S., 1972, Virginia Polytechnic Institute and State University, Physics

B.S., 1970, Florida Southern College, Mathematics and Physics

Positions Held

H&R Technical Associates, Inc.
Co-founder and President

Science Applications, Inc.
Manager, Systems Safety Division

U.S. Department of Energy
Operations Analyst, Oak Ridge Operations Office

U.S. Energy Research and Development Administration
Licensing Engineer, Clinch River Breeder Reactor Plant Project
Safety Engineer, Clinch River Breeder Reactor Plant Project

Experience

Principal Investigator for preparation of Phase I Installation Assessment for mixed hazardous and radioactive waste sites in accordance with DOE ORder 5480.14.

Member of Senior Technical Advisory Committee for the Bear Creek Valley Environmental Impact Statement.

Principal Investigator for the safety critique of the Atomic Vapor Laser Isotope Separation process.

Principal Investigator for the preparation of Spill Prevention Control and Countermeasure Plans and contingency, training, and waste characteristic plans for RCRA Part B permit applications.

Principal Investigator for an assessment of the hazards associated with disposal of incompatible wastes at a hazardous and radioactive wastes disposal sites.

Assisted in the development of remedial actions for a hazardous and radioactive waste disposal site.

Principal Investigator for the development of performance documentation checklists for uranium casting and associated operations.

Principal Investigator for the development of systems design documentation for a fuel recycle facility.

Principal Investigator for the Final Safety Analysis Report for the Gas Centrifuge Enrichment Plant which was developed in accordance with the NRC Regulatory Guide 3.25.

Principal Investigator for analysis of criticality alarm instrumentation test data and development of a delayed neutron critical event accident code.

Principal Investigator for the development of credible accident scenarios and their subsequent analysis, and the identification of potential safety systems for existing Y-12 Wet Chemistry and Uranium Parts Manufacturing facilities.

Performed criticality safety analysis of a UF_6 product cold trap.

Defined the minimum accident of concern and evaluated the adequacy of the existing gaseous diffusion plant radiation protection system.

Performed hazards analyses for gas centrifuge uranium enrichment facilities and storage of oil in salt dome operations.

Assisted in the development of a model to predict overall system reliability and availability during all phases of oil storage operation.

Principal Investigator in providing systems analysis support to the Centrifuge Plant Demonstration Facility operations and engineering staffs through the development of System Design Descriptions for each major system of the facility and through performance of system design reviews.

Performed a risk assessment of transportation accidents for spent fuel shipping casks.

Performed economics analyses of various uranium enrichment technologies including gaseous diffusion, gas centrifuge, and advanced isotope separation.

Coordinator of the Preliminary Safety Analysis Report for the Clinch River Breeder Reactor Plant Project. This effort involved the development of responses to inquiries by NRC staff, updating the PSAR to reflect design changes and being a liaison between CRBRP Project and the NRC staff.

Selected Publications and Technical Reports

"Installation Assessment for the Y-12 Plant CERCLA Sites," with others, Y/TS-114, August, 1985.

"Spill Prevention Control and Countermeasure Plan," with others, H&R 250-1, August, 1985.

"Y-12 Accident Analysis Committee Review Reports:
- Accident Analysis for the Enriched Uranium Parts Manufacturing Facilities," with others, H&R 220-15, February, 1984.
- O-Wing Rolling and Forming Operations," with others, H&R 220-October, 1983.
- Special Processing Operations," with others, H&R 220-13, October, 1983.
- M-Wing Machining Operations," with others, H&R 220-12, October, 1983.
- E-Wing Casting Operations," with others, H&R 220-10, October, 1983.
- Safety Analysis of Buildings 9206 and 9212 Systems," with others, H&R 81-1, August, 1981.

"An Assessment of the Hazards from Mixing Incompatible Wastes in the Bear Creek Waste Disposal Area," H&R 242-1, April, 1984.

"Safety Studies for the Feed and Withdrawal Building of the Gas Centrifuge Enrichment Plant," with others, H&R 226-1, April, 1983.

"SLOPLS: A Code to Determine Criticality Accident Characteristics," with others, H&R 224-3, May, 1983.

"Breeder Reprocessing Engineering Test: Functional Criteria and Preliminary Conceptual Design Descriptions," with R. J. Robinette, ORNL/Sub-8341X-10/1, June, 1983.

"Hazards Analysis Report for the
- Combustible Waste Processing Facility (U)," with others, Y-ENG/SA 516, February, 1982.

"Criticality Safety Analysis of the 16-inch GCEP Product Cold Trap," with others, H&R 82-1, February, 1982.

"Providing a Reliable Source of Nuclear Fuel for the 80's: An Overview of Uranium Enrichment Technologies" paper delivered at the 9th Annual WATTec Energy Conference and Exhibition, February 24, 1982, Knoxville, Tennessee.

"An Assessment of the Minimum Criticality Accident of Concern," with others, H&R 82-2, April, 1982.

"Manpower Requirements and Supply of Magnetic Fusion Energy," with M. G. Finn and P. A. Harr, Transactions of the American Nuclear Society 1982 Summer Meeting, p. 36f.

"Final Safety Analysis Report for the
- Centrifuge Verification Test Facility (U)," with others, K/D-5234, July, 1982.
- Systems Interface Test Facility (U)," with others, K/D-5241, September, 1982.
- Technology Test Facility (U)," with others, KH-7503, September, 1980.
- Control of Effluents and Pollutants Project (U)," with others, Y/SE-20, January, 1982.
- Gunite Sludge Removal Project," with others, SAI-OR-147-017, December, 1979.

"Safety Studies of the GCEP Process and Feed Withdrawal Buildings (U)," with others, K/D SAR 4 DF2, July, 1982.

"Use of Source and Special Nuclear Materials at BECSI Centrifuge Manufacturing Facility," with others, H&R 225-1, November, 1982.

"Accident Assessment of the HF Scrubber Systems for Buildings 9206 and 9212, with others, H&R 81-2, September, 1981.

"Preliminary Safety Analysis Report for the
- Operational Test Facility, (U)," with others, KH-7499, May, 1980.
- Centrifuge Verification Test Facility (U)," with others, KH-7498, September, 1980.
- MLIS Withdrawal System," with others, SAI-OR-147-036, February, 1980.

"Twelve volumes of "System Design Descriptions for the Centrifuge Plant Demonstration Facility," with others, July, 1980.

"An Assessment of the Transportation Risk for Spent Fuel and Partitioned Transmutation Wastes," with others, SAI-OR-147-79-01, February, 1979.

"Design Verification Machine Test Plans, Group 3 (U)," with others, KH-6030, September, 1979.

"Review of Selected Design Items for the CPDF Master Control Unit," with others, OR-016-79, November, 1978.

"Preliminary Review of Selected Design Items for the CPDF Withdrawal System (U)," with others, KH-6017, November, 1978.

"Qualitative Systems Analysis of Selected CPDF Systems, eight volumes, with others, August, 1978.

"Effects of Cross-Linking on Reliability of Plant Protection Systems," with A. A. Husseiny, Transactions of the American Nuclear Society 1974 Winter Meeting, p. 334.

"Design of a Partial Shutdown System," with A. A. Husseiny, Transactions of the American Nuclear Society 1974 Winter Meeting, p. 334.

"Reliability Analysis of LMFBR Plan Protection Systems," with A. A. Husseiny, Transactions of the American Nuclear Society 1974 Winter Meeting, p. 234f.

Professional Societies

Tennessee Society of Professional Engineers, Oak Ridge Chapter President, Oak Ridge Chapter, 1984

National Society of Professional Engineers

Society of Women Engineers

American Nuclear Society

American Society of Engineering Management

Miscellaneous

Q Clearance

Registered Professional Engineer, State of Tennessee

Member, WATTec Energy Conference and Exhibition Board of Directors

Member, Oak Ridge Chamber of Commerce Board of Directors

Member, State of Tennessee Air Pollution Control Board

Member, Board of Directors 39th International Science and Engineering Fair

National Society of Professional Engineers Young Engineer of the Year Award - 1982

DEMETRIUS J. GEORGOPOULOS

Education

B.S., 1981, Clarkson College of Technology, Chemical Engineering

Positions Held

H&R Technical Associates, Inc.
Staff Engineer

Presearch, Inc.
Systems Engineer

Goodyear Atomic Corporation
Production Engineer

Experience

Currently preparing operator training documentation for site operation of heavy equipment at hazardous waste disposal sites.

Prepared operator training documentation for the handling and delivery of hazardous materials. Also prepared a job safety analysis for the hazardous materials handling to identify hazardous operations and propose equipment or operation modifications.

Prepared management information documentation for the initial phase of the operator training program in accordance with the Hazardous Communication Standard.

Prepared an operator training program for the Y-12 Materials Department.

Supervised the development of an integrated data base system for the Advanced Gas Centrifuge Enrichment Program to collect, structure, and prepare outputs from data supplied by the program contractors.

Performed various stress and structural analyses on composite and alloy structures.

Performed a technical analysis on potential causes and probable solutions to component dampening system viscosity variation problems.

Analyzed system design and operating procedures documentation to review failure modes and effects criteria to determine the effect human mis-operation can have on the system reliability and availability. This also included an analysis of the effect a mis-operation may have on the equipment and personnel safety.

Reviewed and revised contractor facility designs to improve process operation and facility layout of plantwide utility systems.

Reviewed and revised contractor facility designs to provide a functional operational instrumentation and control system. Supervised the contractor testing, installation, and functional checkout of the complete I/C system.

Performed a human factors engineering analysis on several system control panels and recommended design modification necessary to prevent potentially hazardous mis-operations.

Prepared and initiated individual utility systems start-up test and operating procedure.

Prepared and presented several performance based training program packages for hourly and supervisory personnel.

Prepared and implemented a utility systems Integrated Systems Test Procedures, the function of which was to test the actual operating characteristics of the system to correlated with the design requirements.

Performed supervisory responsibilities as Utilities System Start-up Team Leader. Responsibilities included allocating task assignments, planning and coordinating test procedures, and contractor liaison.

Prepared operating procedures for plantwide cooling water system.

Selected Publications and Technical Reports

Job Safety Analysis for HF Handling and Delivery, March 1986

Training Manual for Heavy Equipment Operation, March 1986

Performance Documentation Checklists for Heavy Equipment Operation, March 1986

Performance Documentation Checklists for HF Handling and Delivery, February 1986

Performance Documentation Checklist for Machine Coolant Process Operations, with others, February 1986

"Hazardous communication Program - Pesticide Application Training" with others, November 1985

"Y-12 Materials Department Hazardous Communication Training Program", with others, September 1985

"First Train Rise due to Instrument Air Ruptures External to the Process Building", with others, LU4-E42-050, August 1984

"GCEP Rise Analysis for First Train Start-Up: Summary of Phase 3", with others, NU4-E42-010, September 1984

"Tower Cooling Water System - Functional Checkout Test Procedure", with others, January 1983

"Tower Cooling Water System - Integrated System Test Procedure", with others, February 1983

"Tower Cooling Water System - Start-Up Test Procedure", with others, December 1982.

Professional Societies

Tennessee Society of Professional Engineers

National Society of Professional Engineers

American Institute of Chemical Engineers

Miscellaneous

Q-clearance

Registered Engineer in Training, State of Tennessee

APPENDIX B

WASTE PIT STORAGE AREA

AIR ROUTE

1. Observed Release

   o Above background uranium and fluoride concentrations have been detected in air in the vicinity of the Waste Pit Storage Area (Ref. 22). Although specific air data are not available, asbestos is also believed to have been placed in the storage area. Assign 45

2. Waste Characteristics

   a. Chemical

      o Reactivity - Uranium chips are spontaneously combustible under normal conditions but are not capable of detonation or explosions. Assign 2

      o Compatibility - No known incompatible materials have been mixed together at the burial grounds. Assign 0

      o Toxicity - Uranium is considered toxic. Assign 3

      o Hazardous Waste Quantity - More than 2,500 tons (highest value referenced in HRS user's manual) of hazardous materials have been disposed of at the site (Ref. 1, 2). Assign 8

b. Radioactive

- o A maximum of approximately 2,200 pCi/m^3 of uranium (Group A radionuclide) has been measured adjacent to the waste pits during unloading operations (calculated from information obtained from Ref. 22). Assign 20

The total for Line 2 is:

Chemical: 2 + 3(3) + 8 = 19

Radioactive: 20

3. Targets

- o The population within a 4-mile radius according to the 1970 census is approximately 7,800 people (Ref. 3). Assign 18

- o The distance to the nearest sensitive environment is greater than one mile. Assign 0

- o Agricultural lands are located within 1/4 mile of the site. Assign 3

The total for Line 3 = 18 + 2(0) + 3 = 21

4. The total for Line 4 is:

Chemical: 45 x 19 x 21 = 17,955

Radioactive: 45 x 20 x 21 = 18,900

5. The total for Line 5 is: (18,900/35,100) x 100 = 53.85

SURFACE WATER ROUTE

1. Observed Release

o Monitoring of surface water runoff has revealed the presence of above-background levels of uranium downgradient of the waste pit storage area. A portion of the runoff water is routed into the Clearwell where it is later discharged to the Great Miami River. Surface runoff from portions of the waste pit area probably drains directly into Paddy's Run (Ref. 5). Assign 45

4. Waste Characteristics

a. Chemical

o Based on employee interviews and review of pertinent records, heavy metals, magnesium fluorides, construction rubble, metal nitrates, asbestos, silicon, radionuclides and a variety of other chemicals were disposed of at the site. Much of this material is both toxic and persistent (Ref. 10, 11). Assign 18

o The quantity of uranium and thorium alone disposed of at the site is in excess of 2,500 tons, which is the highest value referenced in the HRS user's manual (Ref. 1, 2). Assign 8

b. Radioactive

- Surface water radionuclide data specific to the waste pits consists of random sampling for uranium within minor drainways and channels leading eventually to the Clearwell or Paddy's Run. The maximum observed concentration in waters bypassing the Clearwell and discharging to Paddy's Run was reported as 11.0 mg/l or 7.7×10^3 pCi/l Group D radionuclides (estimated from information contained in Ref. 5). Assign 11

- The maximum potential release of radionuclides to surface waters is estimated at 15.2 pCi/l (estimated from data obtained from Ref. 2). Assign 3

The total for Line 4 is:

Chemical: 18 + 8 = 26

Radioactive: 11

5. Targets

- The water from Paddy's Run has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation purposes is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

Chemical: 45 x 26 x 16 = 18,720

Radioactive: 45 x 11 x 16 = 7,920

7. The total for Line 7 = (18,720/64,350) x 100 = 29.1

GROUND WATER ROUTE

1. Observed Release

o Above-background levels of uranium have been observed in wells immediately adjacent to the facility (Ref. 5). Assign 45

4. Waste Characteristics

a. Chemical

o Based on employee interviews and review of pertinent records, heavy metals, magnesium fluorides, construction rubble, metal nitrates, asbestos, silicon, radionuclides and a variety of other chemicals were disposed of at the site. Much of this material is both toxic and persistent (Ref. 10, 11). Assign 18

o The quantity of uranium and thorium alone disposed of at the site is in excess of 2,500 tons, which is the highest value referenced in the HRS user's manual (Ref. 1, 2). Assign 8

b. Radioactive

o Uranium has been detected in monitoring wells associated with the waste storage pits. Maximum gross alpha measurements of 7.66 pCi/l (Group A radionuclides) and gross beta measurements of 22.97 pCi/l (Group B radionuclides) have been recorded (Ref. 17). Assign 11

- The maximum potential concentration of ground waters by uranium is estimated to be 3.2×10^4 pCi/l (estimated from data obtained from Ref. 2). Assign 15

The total for Line 4 is:

Chemical: 18 + 8 = 26

Radioactive: 15

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is between 2,000 feet and 1 mile and the population potentially served within 3 miles of the site is within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 5). Assign 16

The total for Line 5 = 3(3) + 16(1) = 25

6. The total for Line 6 is:

Chemical: 45 x 26 x 25 = 29,250

Radioactive: 45 x 15 x 25 = 16,875

7. The total for Line 7 = (29,250/57,330) x 100 = 51.02

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where:

S_{gw} = ground water score = 51.02

S_{sw} = surface water score = 29.1

S_{air} = air score = 53.85

S_m = 46.1

FIRE AND EXPLOSION

Although significant fire and explosion threats probably existed during previous operations in the waste pits, no significant hazards are expected from current limited disposal activities. Therefore, the Fire and Explosion route is not applicable.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o The waste pit area is completely surrounded by a limited access security fence. Assign 0

Since Lines 1 and 2 are zero, Line 7 is also zero.

Waste Pit Storage Area

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	5.1
Date and Location:	8/13/82: Sampling adjacent to pit 6 during unloading operation				
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5.					
If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 (2) 3	1		3	
Toxicity	0 1 2 (3)	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive	0 2 5 8 12 16 (20)	1		20	
Total Waste Characteristics Score		2a.	19	20	
		2b.	20		
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 (18) 21 24 27 30	1		30	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Land Use	0 1 2 (3)	1		3	
Total Targets Score			21	39	
4 Multiply 1 X 2 X 3		Chemical	17,955	35,100	
		Radioactive	18,900		
5 Divide Line 4 by 35,100 and Multiply by 100		$S_a^r = S_a^c =$	53.85		

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
Total Route Characteristics Score				15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive					
1. Maximum Observed	0 1 3 7 (11) 15 21 26	1		26	
2. Maximum Potential	0 1 (3) 7 11 15 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	26 11	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	18,720	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	7,920		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw}$	29.10	

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
Total Route Characteristics Score				15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive					
1. Maximum Observed	0 1 3 7 (11) 15 21 26	1		26	
2. Maximum Potential	0 1 3 7 11 (15) 21 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 4b.	26 15	26	
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 (16) 18 20 24 30 32 35 40	1		40	
Total Targets Score			25	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	29,250	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	16,875		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = S^c_{gw} = 51.02$		

Waste Pit Storage Area

	S	S^2
Groundwater Route Score (S_{gw})	51.02	2,603.04
Surface Water Route Score (S_{sw})	29.1	846.81
Air Route Score (S_a)	53.85	2,899.82
$S_{gw}^2 + S_{sw}^2 + S_a^2$		6,349.67
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		79.68
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		46.1

WORKSHEET FOR COMPUTING S_M

Waste Pit Storage Area

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
Waste Quantities					
a. Chemical					
Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal		2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			$S^r_{FE} = S^c_{FE} =$ NA		

Waste Pit Storage Area

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.		15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
Total Targets Score				32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical		21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive			
7 Divide Line 6 by 21,600 and Multiply by 100		$S^r_{DC} = S^c_{DC} =$	0.00		

WASTE STORAGE SILOS 1 AND 2

AIR ROUTE

1. Observed Release

   o Above-background radon concentrations have been detected in the K-65 silo area (Silos 1 and 2). Assign 45

2. Waste Characteristics

   a. Chemical

      o Reactivity - Pitchblende and uranium oxides are unstable but do not detonate spontaneously in an explosive reaction. Assign 1

      o Incompatibility - No known incompatible substances have been mixed together. Assign 0

      o Toxicity - Pitchblende and uranium oxides are toxic. Assign 3

      o Hazardous Waste Quantity - More than 2,500 tons (highest value referenced in HRS user's manual) of wastes have been stored (Ref. 2). Assign 8

b. Radioactivity

- Almost 2,600 pCi/l of radon (Group A radionuclides) have been measured in the vicinity of the silos (Ref. 15). Assign 20

The total for Line 2 is:

Chemical: 1 + 3(3) + 8 = 18

Radioactive: 20

3. Targets

- The population within a 4-mile radius according to the 1970 census is approximately 7,800 people (Ref. 3). Assign 18

- The distance to the nearest sensitive environment is greater than one mile. Assign 0

- Agricultural lands are located within 1/4 mile of the facility. Assign 3

The total for Line 3 = 18 + 2(0) + 3 = 21

4. The total for Line 4 is:

Chemical: 45 x 18 x 21 = 17,010

Radioactive: 45 x 20 x 21 = 18,900

5. The total for Line 5 is (18,900/35,100) x 100 = 53.85

SURFACE WATER ROUTE

1. Observed Release

   o Monitoring of localized surface water runoff does not reveal contamination that can be attributed to the waste storage silos. Assign 0

2. Route Characteristics

   o The facility slope and average slope of the intervening terrain generally fall within the 5-8% and less than 3% ranges, respectively, as referenced in the HRS user's manual. Assign 0

   o The average 1-yr, 24-hr rainfall = 2.5 inches (Ref. 14). Assign 2

   o The distance to the nearest surface water (Paddy's Run) is less than 1,000 feet. Assign 3

   o The physical state of the wastes is represented by unstabliized solids. Assign 1

The total for Line 2 = 0 + 2 + 3(2) + 1 = 9

3. Containment

o The silos can be considered a sealed container with a potentially unsound liner. Assign 1

4. Waste Characteristics

a. Chemical

o Uranium and radium have been stored in the silos (Ref. 2, 8). These compounds are toxic and highly persistent. Assign 18

o Over 9,600 tons of wastes have been deposited in the silos (Ref. 2). Assign 8

b. Radioactive

o Surface runoff samples specific to the silos have not been collected. Assign 0

o The maximum potential release is calculated to be approximately 15.7 pCi/l (estimated from data obtained in Ref. 2) of Group A radionuclides. Assign 15

The total for Line 4 is:

Chemical: 18 + 8 = 26

Radioactive: 15

5. Targets

- The water from Paddy's Run has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation purposes is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

Chemical: 9 x 1 x 26 x 16 = 3,744

Radioactive: 9 x 1 x 15 x 16 = 2,160

7. The total for Line 7 = (3,744/64,350) x 100 = 5.82

GROUND WATER ROUTE

1. Observed Release

   o Ground water degradation cannot be directly attributed to the silos. Assign 0

2. Route Characteristics

   o The depth to the aquifer of concern generally falls within the range of 21 to 75 feet referenced in the HRS user's manual (Ref. 5). Assign 2

   o The net precipitation is 38 inches annual rainfall less 34 inches annual evaporation = 4 inches (Ref. 16). Assign 1

   o The permeability of the unsaturated zone generally falls within the range of 10^{-3} cm/sec to 10^{-5} cm/sec (Ref. 5). Assign 2

   o The physical state of the wastes is represented by a wet residue. Assign 3

The total for Line 2 = 2(2) + 1 + 2 + 3 = 10

3. Containment

o The silos can be considered a sealed container with a potentially unsound liner. Assign 1

4. Waste Characteristics

a. Chemical

o Uranium and radium have been stored in the silos (Ref. 2, 8). These compounds are both toxic and persistent. Assign 18

o Over 9,600 tons of wastes have been deposited in the silos (Ref. 2). Assign 8

b. Radioactive

o Ground water monitoring efforts have not detected contamination directly attributable to the silos. Assign 0

o The maximum potential release has been estimated at 33,000 pCi/l of radium (estimated from data obtained from Ref. 2). Assign 26

The total for Line 4 is:

Chemical: 18 + 8 = 26

Radioactive: 26

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is between 2,000 feet and 1 mile and the population potentially served within 3 miles of the site is within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 5). Assign 16

The total for Line 5 = 3(3) + 16(1) = 25

6. The total for Line 6 is:

Chemical: 10 x 1 x 26 x 25 = 6.500

Radioactive: 10 x 1 x 26 x 25 = 6.500

7. The total for Line 7 = (6,500/57,330) x 100 = 11.34

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where:

S_{gw} = ground water score = 11.34

S_{sw} = surface water score = 5.82

S_{air} = air score = 53.85

S_m = 32.00

FIRE AND EXPLOSION

No significant fire and explosion threat has been identified for the waste silos; therefore, the Fire and Explosion route is not applicable.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o The waste storage silos are completely surrounded by a limited access security fence. Assign 0

Since Lines 1 and 2 are zero, Line 7 is also zero.

Waste Storage Silos 1 and 2

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5.					
If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 (1) 2 3	1		3	
Toxicity	0 1 2 (3)	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive	0 2 5 8 12 16 (20)	1		20	
Total Waste Characteristics Score		2a.	18	20	
		2b.	20		
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 (18) 21 24 27 30	1		30	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Land Use	0 1 2 (3)	1		3	
Total Targets Score			21	39	
4 Multiply 1 X 2 X 3		Chemical	17,010	35,100	
		Radioactive	18,900		
5 Divide Line 4 by 35,100 and Multiply by 100		$S_a^r = S_a^c = 53.85$			

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	(0) 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1		3	
Distance to Nearest Surface Water	0 1 2 (3)	2		6	
Physical State	0 1 2 (3)	1		3	
Total Route Characteristics Score			11	15	
3 Containment	0 (1) 2 3	1	1	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	0 1 3 7 11 (15) 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	26 15	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	4,576	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	2,640		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw} =$ 7.11		

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 (2) 3	2		6	
Net Precipitation	0 (1) 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1		3	
Physical State	0 1 2 (3)	1		3	
Total Route Characteristics Score			10	15	
3 Containment	0 (1) 2 3	1		3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	0 1 3 7 11 15 21 (26)	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 4b.	26 26	26	
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 / 12 (16) 18 20 / 24 30 32 35 40	1		40	
Total Targets Score			25	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	6,500	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	6,500		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = S^c_{gw} = 11.34$		

Waste Storage Silos 1 and 2

	S	S^2
Groundwater Route Score (S_{gw})	11.34	128.60
Surface Water Route Score (S_{sw})	7.11	50.55
Air Route Score (S_a)	53.85	2,899.82
$S_{gw}^2 + S_{sw}^2 + S_a^2$		3,078.97
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		55.49
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		32.1

WORKSHEET FOR COMPUTING S_M

Waste Storage Silos 1 and 2

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
Waste Quantities					
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal	2a. / 2b.			20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3	Chemical / Radioactive			1,440	
5 Divide Line 4 by 1,440 and Multiply by 100	S^r_{FE} = S^c_{FE} = NA				

Waste Storage Silos 1 and 2

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.		15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
Total Targets Score				32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical		21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive			
7 Divide Line 6 by 21,600 and Multiply by 100			$S^r_{DC} = S^c_{DC} = 0.0$		

PADDY'S RUN

AIR ROUTE

1. Observed Release

   o Air quality data specific to Paddy's Run have not been identified. Therefore, Line 1 = 0 and S_a = 0.

SURFACE WATER ROUTE

1. Observed Release

o Monitoring of stream waters and sediment within Paddy's Run has revealed the presence of above-background levels of uranium (Ref. 5). Assign 45

4. Waste Characteristics

a. Chemical

o Uranium that is present in the drainage channel is both toxic and persistent (Ref. 10). Assign 18

o Estimates of the total quantity of uranium released to Paddy's Run are not available. The quantity is assumed to be represented by the 1-10 ton range referenced in the HRS user's manual. Assign 1

b. Radioactive

o Surface water radionuclide data taken from Paddy's Run yielded a depleted uranium concentration of 41 pCi/l, Group D radionuclides (estimated from information contained in Ref. 4). Assign 3

- The potential release of uranium to surface waters is estimated at 2 x 10^{-2} pCi/l, Group D radionuclides (estimated from information obtained from Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 3

5. Targets

- The water from Paddy's Run has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation purposes is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

Chemical: 45 x 19 x 16 = 13,680

Radioactive: 45 x 3 x 16 = 2,160

7. The total for Line 7 = (13,680/64,350) x 100 = 21.26

GROUND WATER ROUTE

1. Observed Release

o Above-background levels of uranium have been observed in wells located near Paddy's Run (Ref. 5). Assign 45

4. Waste Characteristics

a. Chemical

o Uranium that is present in the drainage channel is both toxic and persistent (Ref. 10). Assign 18

o Estimates of the total quantity of uranium released to Paddy's Run are not available. The quantity is assumed to be represented by the 1-10 ton range referenced in the HRS user's manual. Assign 1

b. Radioactive

o Uranium has been detected in monitoring wells located near Paddy's Run. Maximum uranium measurements of 6.4 pCi/l (Group D radionuclides) have been observed (estimated from information contained in Ref. 5). Assign 1

o The maximum potential concentration of uranium in ground waters is estimated to be 8.2×10^{-1} pCi/l, Group D radionuclides (estimated from information obtained from Ref. 5). Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 1

5. Targets

o Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

o The distance to the nearest well is less than 2,000 feet and the population potentially served within 3 miles of the site is probably within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 15). Assign 20

The total for Line 5 = 3(3) + 20(1) = 29

6. The total for Line 6 is:

Chemical: 45 x 19 x 29 = 24,795

Radioactive: 45 x 1 x 29 = 1,305

7. The total for Line 7 = (24,795/57,330) x 100 = 43.2

TOTAL MIGRATION SCORE - S_m

$$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$$

Where: S_{gw} = ground water score = 43.2

S_{sw} = surface water score = 21.26

S_{air} = air score = 0.00

S_m = 27.8

FIRE AND EXPLOSION

There are no significant fire or explosion threats known to be associated with this site. Accordingly, the Fire and Explosion mode is not applicable.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o Paddy's Run flows for a distance of approximately two miles after leaving the FMPC controlled access area before discharging into the Great Miami River. Assign 3

3. Containment

   o The waters and sediments of Paddy's Run can be easily contacted. Assign 15

4. Waste Characteristics

   a. Chemical

      o The uranium and heavy metals disposed of at this site are toxic. Assign 3

   b. Radioactive

      o The concentration of radionuclides over the accessible reach of Paddy's Run was estimated to be approximately 1×10^{-6} Ci/m^3 (estimated from information obtained from Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 3(5) = 15

Radioactive: 0

5. Targets

- The population within a one-mile radius of Paddy's Run, including the working population of the plant, probably falls within the 101-1000 range referenced in the HRS users's manual. Assign 2

- The distance to the nearest critical habitat is greater than 1 mile. Assign 0

The total for Line 5 = 2(4) + 0 = 8

6. The total for Line 6 is:

Chemical: 3 x 15 x 15 x 8 = 5,400

Radioactive: 3 x 15 x 0 x 8 = 0

7. Line 7 = (5,400/21,600) x 100 = 25.0

Paddy's Run

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1		45	5.1

Date and Location:

Sampling Protocol:

If Line 1 is 0, the S_a = 0. Enter on Line 5.
If Line 1 is 45, Then Proceed to Line 2.

2 Waste Characteristics												5.2
a. Chemical												
Reactivity and Incompatibility	0	1	2	3						1	3	
Toxicity	0	1	2	3						3	9	
Hazardous Waste Quantity	0	1	2	3	4	5	6	7	8	1	8	
b. Radioactive	0	2	5	8	12	16	20			1	20	

Total Waste Characteristics Score	2a. / 2b.		20	

3 Targets										5.3
Population Within 4-Mile Radius	0	9	12	15	18	21	24	27	30	1	30	
Distance to Sensitive Environment	0	1	2	3						2	6	
Land Use	0	1	2	3						1	3	

Total Targets Score		39	

4 Multiply 1 X 2 X 3	Chemical / Radioactive	35,100	

5 Divide Line 4 by 35,100 and Multiply by 100 $S_a^r = S_a^c =$ 0.00

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
Total Route Characteristics Score				15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	0 1 (3) 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	19 3	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	13,680	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	2,160		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw}$	21.26	

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 (45)	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
Total Route Characteristics Score				15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 14 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	0 (1) 3 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a.	19	26	
		4b.	1		
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 (20) 24 30 32 35 40	1		40	
Total Targets Score			29	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	24,795	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	1,305		
7 Divide Line 6 by 57,330 and Multiply by 100		$S^r_{gw} = S^c_{gw} =$	43.2		

Paddy's Run

	S	S^2
Groundwater Route Score (S_{gw})	43.2	1,866.24
Surface Water Route Score (S_{sw})	21.26	451.99
Air Route Score (S_a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$		2,318.23
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		48.15
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		27.8

WORKSHEET FOR COMPUTING S_M

Paddy's Run

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
Waste Quantities					
a. Chemical					
Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score (2a + Subtotal, 2b + Subtotal)		2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100		S^r_{FE} = S^c_{FE} = NA			

Paddy's Run

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.		15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.	15 0	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 (2) 3 4 5	4		20	
Distance to a Critical Habitat	(0) 1 2 3	4		12	
Total Targets Score			8	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	5,400	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100		$S^r_{DC} = S^c_{DC} =$	25.0		

STORM SEWER OUTFALL DITCH

AIR ROUTE

1. Observed Release

   o Air quality data specific to the Storm Sewer Outfall Ditch have not been identified. Therefore, Line 1 = 0 and S_a = 0.

SURFACE WATER ROUTE

1. Observed Release

o Monitoring of stream waters and sediment within the Storm Sewer Outfall Ditch has revealed the presence of above background levels of uranium (Ref. 5). Assign 45

4. Waste Characteristics

a. Chemical

o Uranium that is present in the drainage control channel is both toxic and persistent (Ref. 10). Assign 18

o The quantity of uranium released to the Storm Sewer Outfall Ditch is unknown. The total is assumed to be within the 1-10 ton range referenced in the HRS user's manual. Assign 1

b. Radioactive

o Surface water radionuclide data specific to the Storm Sewer Outfall Ditch have indicated the presence of uranium. The maximum observed concentration in the 1985 sampling effort was 0.3 mg/l. Earlier sampling and analysis programs detected concentrations as high as 3.8 mg/l (Ref. 5). This corresponds to a maximum observed average activity of about 2,660 pCi/l of uranium, Group D radionuclide. Assign 11

- The maximum potential release of Group D radionuclides to surface waters is estimated as 1.6 pCi/l (estimated from information obtained from Ref. 5). Assign 1

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 11

5. Targets

- The water from Paddy's Run has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation purposes is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

   Chemical: 45 x 19 x 16 = 13,680

   Radioactive: 45 x 11 x 16 = 7,920

7. The total for Line 7 = (13,680/64,350) x 100 = 21.26

GROUND WATER ROUTE

1. Observed Release

o Above-background levels of uranium have been observed in wells located near the Storm Sewer Outfall Ditch (Ref. 5). Assign 45

4. Waste Characteristics

a. Chemical

o Uranium that is present in the drainage channel is both toxic and persistent (Ref. 10). Assign 18

o Estimates of the total quantity of uranium released to Paddy's Run are not available. The quantity is assumed to be represented by the 1-10 ton range referenced in the HRS user's manual. Assign 1

b. Radioactive

o Uranium that can be attributed to the Storm Sewer Outfall Ditch has been detected at concentrations ranging from 7 pCi/l to 245 pCi/l (Ref. 5). Assign 7

o The maximum potential concentration of uranium in ground waters is estimated to be 11.9 pCi/l, Group D radionuclides (estimated from information obtained from Ref. 5). Assign 3

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 7

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is less than 2,000 feet and the population potentially served within 3 miles of the site is probably within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 15). Assign 20

The total for Line 5 = 3(3) + 20(1) = 29

6. The total for Line 6 is:

Chemical: 45 x 19 x 29 = 24,795

Radioactive: 45 x 7 x 29 = 9,135

7. The total for Line 7 = (24,795/57,330) x 100 = 43.2

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where: S_{gw} = ground water score = 43.2

S_{sw} = surface water score = 21.26

S_{air} = air score = 0.00

S_m = 27.8

FIRE AND EXPLOSION

There are no significant fire or explosion threats known to be associated with this site. Accordingly, the Fire and Explosion mode is not applicable to this site.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o Although the Storm Sewer Outfall Ditch is located entirely within the FMPC reservation, it is not within the confines of the fenced, controlled access area. Assign 3

3. Containment

   o The waters and sediments of the Storm Sewer Outfall Ditch can be easily contacted. Assign 15

4. Waste Characteristics

   a. Chemical

      o The uranium and heavy metals disposed of at this site are toxic. Assign 3

   b. Radioactive

      o The concentration of radionuclides over the total accessible reach of the Storm Sewer Outfall Ditch was estimated to be approximately 6×10^{-4} Ci/m^3 (estimated from information obtained from Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 3(5) = 15

Radioactive: 0

5. Targets

o The population within a one-mile radius of the Storm Sewer Outfall Ditch, including the working population of the plant, probably falls within the 101-1000 range referenced in the HRS user's manual. Assign 2

o The distance to the nearest critical habitat is greater than 1 mile. Assign 0

The total for Line 5 = 2(4) + 0 = 8

6. The total for Line 6 is:

Chemical: 3 x 15 x 15 x 8 = 5,400

Radioactive: 3 x 15 x 0 x 8 = 0

7. Line 7 = (5,400/21,600) x 100 = 25.0

Storm Sewer Outfall Ditch

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5.					
If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 / 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100		$S_a^r = S_a^c =$	0.00		

Storm Sewer Outfall Ditch

6402

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 **(45)**	1	45	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	0 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 2 3	1		3	
Distance to Nearest Surface Water	0 1 2 3	2		6	
Physical State	0 1 2 3	1		3	
Total Route Characteristics Score				15	
3 Containment	0 1 2 3	1		3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 **(18)**	1		18	
Hazardous Waste Quantity	0 **(1)** 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	0 1 3 7 **(11)** 15 21 26	1		26	
2. Maximum Potential	0 **(1)** 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	19 11	26	
5 Targets					4.5
Surface Water Use	0 1 **(2)** 3	3		9	
Distance to Sensitive Environment	**(0)** 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 **(10)** 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	13,680 7,920	64,350	
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw}$ 21.26		

000154

Storm Sewer Outfall Ditch

6402

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	0 **(45)**	1	45	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 2 3	2		6	
Net Precipitation	0 1 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 2 3	1		3	
Physical State	0 1 2 3	1		3	
Total Route Characteristics Score				15	
3 Containment	0 1 2 3	1		3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 14 **(18)**	1		18	
Hazardous Waste Quantity	0 **(1)** 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	0 1 3 **(7)** 11 15 21 26	1		26	
2. Maximum Potential	0 1 **(3)** 7 11 15 21 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 19 4b. 7		26	
5 Targets					3.5
Ground Water Use	0 1 2 **(3)**	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 **(20)** 24 30 32 35 40	1		40	
Total Targets Score			29	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	24,795	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	9,135		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^c_{gw} = S^c_{gw} =$ 43.25		

000155

Storm Sewer Outfall Ditch

	S	S^2
Groundwater Route Score (S_{gw})	43.2	1,866.24
Surface Water Route Score (S_{sw})	21.26	451.99
Air Route Score (S_a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$		2,318.23
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		48.15
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		27.80

WORKSHEET FOR COMPUTING S_M

Storm Sewer Outfall Ditch

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
Waste Quantities					
a. Chemical					
Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal		2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			$S^r_{FE} = S^c_{FE} =$ NA		

Storm Sewer Outfall Ditch

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.		15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.	15 0	15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 (2) 3 4 5	4		20	
Distance to a Critical Habitat	(0) 1 2 3	4		12	
Total Targets Score			8	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	5,400	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100		$S^r_{DC} = S^c_{DC} =$	25.0		

FLY-ASH DISPOSAL AREAS

AIR ROUTE

1. Observed Release

   o Although airborne particulates are known to have been discharged from the Fly-ash Disposal Areas during dry periods, there are no site-specific data referencing air releases. Therefore, Line 1 = 0 and S_a = 0.

SURFACE WATER ROUTE

1. Observed Release

   - Surface water runoff directly from the fly-ash sites has not been monitored. Assign 0

2. Route Characteristics

   - The facility slope and average slope of the intervening terrain generally fall within the 5-8% and less than 3% ranges, respectively, as referenced in the HRS user's manual. Assign 0

   - The average 1-yr, 24-hr rainfall = 2.5 inches (Ref. 14). Assign 2

   - The distance to the nearest surface water (Paddy's Run) is less than 1,000 feet (Ref. 6). Assign 3

   - The physical state of the wastes is represented by powder or fine material. Assign 2

   Total for Line 2 = 0 + 2 + 3(2) + 2 = 10

3. Containment

   - The majority of the disposal area is not covered and surface water diversion systems are potentially unsound. Assign 2

4. Waste Characteristics

a. Chemical

- Natural uranium, as well as uranium originating from waste oils applied to the site for dust control, is present in the Fly-ash Disposal Areas (Ref. 18). Small concentrations of heavy metals typically present in coal fly-ash are also probably present. These materials are both toxic and persistent. Assign 18

- The quantity of uranium estimated to be present in the disposal areas is 1,000 kilograms (Ref. 4). Assign 1

b. Radioactive

- Surface runoff samples specific to the Fly-ash Disposal Areas have not been collected. Assign 0

- The potential release of Group D radionuclides to surface waters is estimated at 8.4×10^{-1} pCi/l (estimated from data obtained in Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 0

5. Targets

- The water from Paddy's Run has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation purposes is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

Chemical: 10 x 2 x 19 x 16 = 6,080

Radioactive: 10 x 2 x 0 x 16 = 0

7. The total for Line 7 = (6,080/64,350) x 100 = 9.45

GROUND WATER ROUTE

1. Observed Release

   o No direct evidence of ground water contamination due to the fly-ash areas has been identified. Assign 0

2. Route Characteristics

   o The depth to the aquifer of concern generally falls within the range of 21 to 75 feet (Ref. 5). Assign 2

   o The net precipitation is 38 inches annual rainfall less 34 inches annual evaporation = 4 inches (Ref. 16). Assign 1

   o The permeability of the unsaturated zone generally falls within the range of 10^{-3} cm/sec to 10^{-5} cm/sec (Ref. 5). Assign 2

   o The physical state of the wastes is represented by powder or fine materials. Assign 2

   The total for Line 2 = 2(2) + 1 + 2 + 2 = 9

3. Containment

   o The facility is considered a landfill with no liner and no runoff controls. Assign 3

4. Waste Characteristics

a. Chemical

- Natural uranium, as well as uranium originating from waste oils applied to the site for dust control, is present in the Fly-ash Disposal Area (Ref. 18). Small concentrations of heavy metals typically present in coal fly-ash are also probably present. These materials are both toxic and persistent. Assign 18

- The quantity of uranium estimated to be present in the disposal areas is 1,000 kilograms (Ref. 4). Assign 1

b. Radioactive

- Ground water samples specific to the Fly-ash Disposal Areas have not been collected. Assign 0

- The maximum potential concentration of uranium in ground waters by Group D radionuclides is estimated to be 14 pCi/l (estimated from data obtained in Ref. 4). Assign 3

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 3

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is less than 2,000 feet and the population potentially served within 3 miles of the site probably falls within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 5). Assign 20

  The total for Line 5 = 3(3) + 20(1) = 29

6. The total for Line 6 is:

   Chemical: 9 x 3 x 19 x 29 = 14,877

   Radioactive: 9 x 3 x 3 x 29 = 2,349

7. The total for Line 7 = (14,877/57,330) x 100 = 25.95

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where:

S_{gw} - ground water score = 25.95

S_{sw} - surface water score = 9.45

S_{air} - air score = 0.00

S_m = 16.0

FIRE AND EXPLOSION

There are no significant fire or explosion threats known to exist at this site. Accordingly, the Fire and Explosion mode is not applicable to this site.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o Although the Fly-ash Disposal Area is located entirely within the FMPC reservation, it is not within the confines of the fenced, controlled access area. Assign 3

3. Containment

   o The fly-ash present at the disposal area can be easily contacted. Assign 15

4. Waste Characteristics

   a. Chemical

      o The uranium and heavy metals disposed of at this site are toxic. Assign 3

   b. Radioactive

      o The concentration of radionuclides over the accessible reach of the Fly-ash Disposal Area was estimated to be in the range of 1×10^{-6} Ci/m^3 (estimated from information obtained from Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 3(5) = 15

Radioactive: 0

5. Targets

- The population within a one-mile radius of the Fly-ash Disposal Area including the working population of the plant, probably falls within the 101-1000 range referenced in the HRS user's manual. Assign 2

- The distance to the nearest critical habitat is greater than 1 mile. Assign 0

The total for Line 5 = 2(4) + 0 = 8

6. The total for Line 6 is:

Chemical: 3 x 15 x 15 x 8 = 5,400

Radioactive: 3 x 15 x 0 x 8 = 0

7. Line 7 = (5,400/21,600) x 100 = 25.0

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5.					
If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 / 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100		$S_a^r = S_a^c =$ 0.00			

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	(0) 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1		3	
Distance to Nearest Surface Water	0 1 2 (3)	2		6	
Physical State	0 1 (2) 3	1		3	
Total Route Characteristics Score			10	15	
3 Containment	0 1 (2) 3	1	2	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score		4a.	19	26	
Largest of 4a, b1 or b2		4b.	0		
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	6,080	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 64,350 and Multiply by 100		$S^r_{sw} = S^c_{sw}$	9.45		

Ground Water Route Work Sheet

6402

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1

If Observed Release is Given a Value of 45, Proceed to Line 4

If Observed Release is Given a Value of 0, Proceed to Line 2

2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 (2) 3	2		6	
Net Precipitation	0 (1) 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1		3	
Physical State	0 1 (2) 3	1		3	
Total Route Characteristics Score			9	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 14 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	0 1 (3) 7 11 15 21 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 19 4b. 3		26	
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 16 18 (20) 24 30 32 35 40	1		40	
Total Targets Score			29	49	

6 If Line 1 is 45, Multiply 1 X 4 X 5	Chemical	14,877	57,330
If Line 1 is 0, Multiply 2 X 3 X 4 X 5	Radioactive	2,349	

7 Divide Line 6 by 57,330 and Multiply by 100 $S^r_{gw} = S^c_{gw} =$ 25.95

Fly-Ash Disposal Area

	S	S^2
Groundwater Route Score (S_{gw})	25.95	673.40
Surface Water Route Score (S_{sw})	9.45	89.30
Air Route Score (S_a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$		762.71
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		27.61
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		16.0

WORKSHEET FOR COMPUTING S_M

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
Waste Quantities					
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score (2a + Subtotal, 2b + Subtotal)		2a.		20	
		2b.			
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical		1,440	
		Radioactive			
5 Divide Line 4 by 1,440 and Multiply by 100		$S^r_{FE} = S^c_{FE} =$	NA		

Fly-ash Disposal Area

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.		15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a.	15	15	
		4b.	0		
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 (2) 3 4 5	4		20	
Distance to a Critical Habitat	(0) 1 2 3	4		12	
Total Targets Score			8	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	5,400	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100		$S^r_{DC} = S^c_{DC} =$	25.0		

DEACTIVATED INCINERATOR

AIR ROUTE

1. Observed Release

   o Air quality degradation probably occurred and was possibly monitored during past operation of the incinerator. However, these data would not apply to this ranking. Other more current air quality data specific to the Deactivated Incinerator have not been identified. Therefore, $S_a = 0$.

SURFACE WATER ROUTE

1. Observed Release

   o Surface water runoff specific to the Deactivated Incinerator area has not been sampled. Assign 0

2. Route Characteristics

   o The facility slope and average slope of the intervening terrain generally are less than 3%. Assign 0

   o The average 1-yr, 24-hour rainfall = 2.5 inches (Ref. 14). Assign 2

   o The distance to the nearest surface water (Storm Sewer Outfall Ditch) is between 1,000 ft. and one mile (Ref. 6). Assign 2

   o The physical state of the wastes is assumed to be unstabilized solids. Assign 1

   The total for Line 2 = 0 + 2 + 2(2) + 1 = 7

3. Containment

   o Although this site does not fit into any of the categories listed in the HRS user's manual, it is best represented by an uncovered waste pile with potentially unsound diversion or containment systems. Assign 2

4. Waste Characteristics

a. Chemical

- Analyses of soil samples obtained from an area located near the incinerator indicate that the major hazardous constituent of concern associated with this site is uranium. Uranium is considered both toxic and persistent. Assign 18

- Detailed estimates of the total quantity of uranium present in the soils located near the incinerator are not available. In order to assign a nonzero score, the lowest range referenced in the HRS user's manual was selected (1-10 tons). Assign 1

b. Radioactive

- Surface water samples specific to the incinerator area have not been collected. Assign 0

- Detailed estimates of the mass of uranium present in the soils are not available. Regardless, the chemical hazard is expected to exceed the hazard posed by radionuclides. Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 0

5. Targets

- The water from Paddy's Run, which the outfall ditch discharges into, has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

Chemical: 7 x 2 x 19 x 16 = 4,256

Radioactive: 7 x 2 x 0 x 16 = 0

7. The total for Line 7 = (4,256/64,350) x 100 = 6.61

GROUND WATER ROUTE

1. Observed Release

o No direct evidence of ground water contamination due to this facility has been identified. Assign 0

2. Route Characteristics

o The depth to the aquifer of concern generally falls within the range of 21 to 75 feet (Ref. 5). Assign 2

o The net precipitation is 38 inches annual rainfall less 34 inches annual evaporation = 4 inches. (Ref. 16). Assign 1

o The permeability of the unsaturated zone generally falls within the range of 10^{-3} cm/sec to 10^{-5} cm/sec (Ref. 5). Assign 2

o The physical state of the wastes is assumed to be unstabilized solids. Assign 1

The total for Line 2 = 2(2) + 1 + 2 + 1 = 8

3. Containment

o Although the site does not fall into any specific HRS user's manual category, it can best be represented by and uncovered waste pile with no liner. Assign 3

4. Waste Characteristics

a. Chemical

- Analyses of soil samples obtained from an area located near the incinerator indicate that the major hazardous constituent of concern associated with this site is uranium. Uranium is considered both toxic and persistent. Assign 18

- The waste quantity was estimated previously to fall within the 1-10 ton range referenced in the HRS user's manual. Assign 1

b. Radioactive

- Ground water samples specific to the incinerator area have not been collected. Assign 0

- Detailed estimates of the mass of uranium present in the soils are not available. Regardless, the chemical hazard is expected to exceed the hazard posed by radionuclides. Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 0

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is between 2,000 feet and 1 mile and the population potentially served within 3 miles of the site is probably within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 15). Assign 16

The total for Line 5 = 3(3) + 16(1) = 25

6. The total for Line 6 is:

Chemical: 8 x 3 x 19 x 25 = 11,400

Radioactive: 8 x 3 x 0 x 25 = 0

7. The total for Line 7 = (11,400/57,330) x 100 = 19.88

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where:

S_{gw} = ground water score = 19.88

S_{sw} = surface water score = 6.61

S_{air} = air score = 0.00

S_m = 12.11

FIRE AND EXPLOSION

There are no significant fire or explosion threats known to exist at this site. Accordingly, the fire and explosion mode is not applicable to this site.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o Soils containing above-background levels of uranium are located outside of the FMPC controlled access area. Assign 3

3. Containment

   o The hazardous constituents are located within surface soils. Assign 15

4. Waste Characteristics

   a. Chemical

      o The uranium present at this site is toxic. Assign 3

   The total for Line 4.a = 3(5) = 15

   b. Radioactive

      o Detailed estimates of the mass of uranium present in the soils are not available. Regardless, the chemical hazard is expected to exceed the hazard posed by radionuclides. Assign 0

The total for Line 4 is:

Chemical: 3 x 5 = 15

Radioactive: 0

5. Targets

- The population within a one-mile radius of the incinerator area, including the working population of the plant, probably falls within the 101-1000 range referenced in the HRS users's manual. Assign 2

- The distance to the nearest critical habitat is greater than 1 mile. Assign 0

The total for Line 5 = 2(4) + 0 = 8

6. The total for Line 6 is:

Chemical: 3 x 15 x 15 x 8 = 5,400

Radioactive: 3 x 15 x 0 x 8 = 0

7. Line 7 = (5,400/21,600) x 100 = 25.0

Deactivated Incinerator

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100		$S_a^r = S_a^c = 0.00$			

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	(0) 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1		3	
Distance to Nearest Surface Water	0 1 (2) 3	2		6	
Physical State	0 (1) 2 3	1		3	
Total Route Characteristics Score			7	15	
3 Containment	0 1 (2) 3	1	2	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	19 0	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	4,256	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw}$	6.61	

Ground Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 (2) 3	2		6	
Net Precipitation	0 (1) 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1		3	
Physical State	0 (1) 2 3	1		3	
Total Route Characteristics Score			8	15	
3 Containment	0 1 2 (3)	1	3	3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 14 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 4b.	19 0	26	
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 (16) 18 20 24 30 32 35 40	1		40	
Total Targets Score			25	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	11,400	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = S^c_{gw} = 19.88$		

Deactivated Incinerator

	S	S^2
Groundwater Route Score (S_{gw})	19.88	395.21
Surface Water Route Score (S_{sw})	6.61	43.69
Air Route Score (S_a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$		438.90
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		20.95
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		12.11

WORKSHEET FOR COMPUTING S_M

Deactivated Incinerator

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
Waste Quantities					
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score: 2a + Subtotal, 2b + Subtotal		2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100		$S^r_{FE} = S^c_{FE} =$ NA			

Deactivated Incinerator .

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	0 1 2 (3)	1	3	3	8.2
3 Containment	0 (15)	1	15	15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 (3)	5 a.		15	
b. Radioactive	(0) 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a.	15	15	
		4b.	0		
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 (2) 3 4 5	4		20	
Distance to a Critical Habitat	(0) 1 2 3	4		12	
Total Targets Score			8	32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	5,400	21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 21,600 and Multiply by 100		$S^r_{DC} = S^c_{DC} =$	25.0		

WASTE STORAGE SILO 3

AIR ROUTE

1. Observed Release

   o Air releases directly attributable to Silo 3 have not been detected. Therefore Line 1 = 0 and S_a = 0.

SURFACE WATER ROUTE

1. Observed Release

   o Monitoring of localized surface water runoff does not reveal contamination that can be attributed to the waste storage silo. Assign 0

2. Route Characteristics

   o The facility slope and average slope of the intervening terrain generally fall within the 5-8% and less than 3% ranges, respectively, as referenced in the HRS user's manual. Assign 0

   o The average 1-yr, 24-hr rainfall = 2.5 inches (Ref. 14). Assign 2

   o The distance to the nearest surface water (Paddy's Run) is less than 1,000 feet (Ref. 6). Assign 3

   o The physical state of the wastes is represented by powder or fine materials. Assign 2

The total for Line 2 = 0 + 2 + 3(2) + 2 = 10

3. Containment

o The silo can be considered a sealed container with a potentially unsound liner. Assign 1

4. Waste Characteristics

a. Chemical

o Metal oxides and uranium containing trace amounts of radium have been stored in the silo (Ref. 2, 8). These compounds are toxic and persistent. Assign 18

o Approximately 3,800 tons of wastes have been deposited in the silo (Ref. 2). Assign 8

b. Radioactive

o Surface runoff samples specific to the silo have not been collected. Assign 0

o The maximum potential release is calculated to be approximately 0.14 pCi/l (estimated from data obtained in Ref. 2) of Group A radionuclides. Assign 7

The total for Line 4 is:

Chemical: 18 + 8 = 26

Radioactive: 7

5. Targets

- The water from Paddy's Run has been reported to be used for irrigation and grazing purposes within 3 miles of the site (based on personal interview with FMPC personnel). Assign 2

- No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- Since the use of Paddy's Run for irrigation purposes is reported to be minimal, the population which may be served within 3 miles downstream probably falls within the 1-100 range referenced in the HRS user's manual (converted to population using 1.5 persons per acre of land irrigated). Assign 10

The total for Line 5 = 2(3) + 0 + 10 = 16

6. The total for Line 6 is:

Chemical: 10 x 1 x 26 x 16 = 4,160

Radioactive: 10 x 1 x 7 x 16 = 1,120

7. The total for Line 7 = (4,160/64,350) x 100 = 6.46

GROUND WATER ROUTE

1. Observed Release

   o Ground water degradation cannot be directly attributed to Silo 3. Assign 0

2. Route Characteristics

   o The depth to the aquifer of concern generally falls within the range of 21 to 75 feet referenced in the HRS user's manual (Ref. 5). Assign 2

   o The net precipitation is 38 inches annual rainfall less 34 inches annual evaporation = 4 inches (Ref. 16). Assign 1

   o The permeability of the unsaturated zone generally falls within the range of 10^{-3} cm/sec to 10^{-5} cm/sec (Ref. 5). Assign 2

   o The physical state of the wastes is represented by powder or fine material. Assign 2

   The total for Line 2 = 2(2) + 1 + 2 + 2 = 9

3. Containment

   o The silo can be considered a sealed container in sound condition with a potentially unsound liner. Assign 1

4. Waste Characteristics

a. Chemical

- Metal oxides and uranium with trace amounts of radium have been stored in the silo (Ref. 2, 8). These compounds are both toxic and persistent. Assign 18

- Approximately 3,800 tons of wastes have been deposited in the silo (Ref. 2). Assign 8

b. Radioactive

- Ground water monitoring efforts have not detected contamination directly attributable to Silo 3. Assign 0

- The maximum potential release has been estimated at 300 pCi/l of radium (estimated from data obtained from Ref. 2). Assign 21

The total for Line 4 is:

Chemical: 18 + 8 = 26

Radioactive: 21

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is between 2,000 feet and 1 mile and the population potentially served within 3 miles of the site is within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 5). Assign 16

The total for Line 5 = 3(3) + 16(1) = 25

6. The total for Line 6 is:

Chemical: 9 x 1 x 26 x 25 = 5,850

Radioactive: 9 x 1 x 21 x 25 = 4,725

7. The total for Line 7 = (5,850/57,330) x 100 = 10.20

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where:

S_{gw} = ground water score = 10.20

S_{sw} = surface water score = 6.46

S_{air} = air score = 0.00

S_m = 6.98

FIRE AND EXPLOSION

No significant fire and explosion threat has been identified for the waste silo; therefore, the Fire and Explosion route is not applicable.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o Silo 3 is completely surrounded by a limited access security fence. Assign 0

Since Lines 1 and 2 are zero, Line 7 is also zero.

Waste Storage Silo 3

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1
Date and Location:					
Sampling Protocol:					
If Line 1 is 0, the S_a = 0. Enter on Line 5. If Line 1 is 45, Then Proceed to Line 2.					
2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1		3	
Toxicity	0 1 2 3	3		9	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 2 5 8 12 16 20	1		20	
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 21 24 27 30	1		30	
Distance to Sensitive Environment	0 1 2 3	2		6	
Land Use	0 1 2 3	1		3	
Total Targets Score				39	
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100			$S_a^r = S_a^c =$ 0.00		

Surface Water Route Work Sheet

6402

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	(0) 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1		3	
Distance to Nearest Surface Water	0 1 2 (3)	2		6	
Physical State	0 1 (2) 3	1		3	
Total Route Characteristics Score			10	15	
3 Containment	0 (1) 2 3	1	1	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	0 1 3 (7) 11 15 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	26 7	26	
5 Targets					4.5
Surface Water Use	0 1 (2) 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	0 4 6 8 (10) 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			16	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	4,160	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	1,120		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw}$	6.46	

Ground Water Route Work Sheet

6402

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 (2) 3	2		6	
Net Precipitation	0 (1) 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1		3	
Physical State	0 1 (2) 3	1		3	
Total Route Characteristics Score			9	15	
3 Containment	0 (1) 2 3	1	1	3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 (8)	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	0 1 3 7 11 15 (21) 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 4b.	26 21	26	
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 (16) 18 20 24 30 32 35 40	1		40	
Total Targets Score			25	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	5,850	57,330	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	4,725		
7 Divide Line 6 by 57,330 and Multiply by 100			$S^r_{gw} = S^c_{gw} =$ 10.20		

Waste Storage Silo 3

	S	S^2
Groundwater Route Score (S_{gw})	10.20	104.04
Surface Water Route Score (S_{sw})	6.46	41.73
Air Route Score (S_a)	0.00	0.00
$S_{gw}^2 + S_{sw}^2 + S_a^2$		145.77
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		12.07
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		6.98

WORKSHEET FOR COMPUTING S_M

Waste Storage Silo 3

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
		Subtotal		12	
Waste Quantities					
a. Chemical					
Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score 2a + Subtotal, 2b + Subtotal		2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			S^r_{FE} = S^c_{FE} = NA		

Waste Storage Silo 3

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.		15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
Total Targets Score				32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical		21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive			
7 Divide Line 6 by 21,600 and Multiply by 100			$S^r_{DC} = S^c_{DC} =$ 0.00		

COPPER SCRAP PILE

AIR ROUTE

1. Observed Release

   o Air quality data specific to the Copper Scrap Pile have not been identified. Therefore, Line 1 = 0 and S_a = 0.

SURFACE WATER ROUTE

1. Observed Release

   o Surface water runoff from the Copper Scrap Pile has not been monitored. Assign 0

2. Route Characteristics

   o The facility slope and average slope of the intervening terrain appear to be less than 3%. Assign 0

   o The average 1-yr, 24-hr rainfall = 2.5 inches (Ref. 14). Assign 2

   o The distance to the nearest surface water via the plant discharge to the Great Miami River is between 1 and 2 miles. Assign 1

   o The wastes are considered consolidated and stabilized solids. Assign 0

   Total for Line 2 = 0 + 2 + 1(2) + 0 = 4

3. Containment

   o The site is considered an uncovered waste pile with an inadequate diversion or containment system. Assign 2

4. Waste Characteristics

a. Chemical

- The waste materials stored at this site consist of mica-coated copper scrap containing above-background levels of uranium (Ref. 13). Uranium is considered both toxic and persistent. Assign 18

- Assuming that the average uranium concentration in the copper metal is similar to that of the Ferrous Metal Scrap Pile, the quantity of uranium present at the site can be estimated at less than 10 kilograms (Ref. 4). Since other heavy metals are possibly present, the lowest range referenced in the HRS user's manual was selected (1-10 tons). Assign 1

b. Radioactive

- Surface runoff samples specific to the Copper Scrap Pile have not been collected. Assign 0

- The maximum potential release of radionuclides to surface waters is estimated to be 5.7×10^{-3} pCi/l (estimated from information contained in Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 0

5. Targets

- o There are no known uses of water from the Great Miami River for human consumption (Ref. 17). Assign 0

- o No wetlands or endangered species are expected to be located within 1 mile of the site (Ref. 13). Assign 0

- o The population which may be served within 3 miles downstream is zero. Assign 0

The total for Line 5 = 0

6. The total for Line 6 is:

Chemical: 4 x 2 x 19 x 0 = 0

Radioactive: 4 x 2 x 0 x 0 = 0

7. The total for Line 7 = 0.00

GROUND WATER ROUTE

1. Observed Release

   o No direct evidence of ground water contamination due to the Copper Scrap Pile has been identified. Assign 0

2. Route Characteristics

   o The depth to the aquifer of concern generally falls within the range of 21 to 75 feet (Ref. 5). Assign 2

   o The net precipitation is 38 inches annual rainfall less 34 inches annual evaporation = 4 inches (Ref. 16). Assign 1

   o The permeability of the unsaturated zone generally falls within the range of 10^{-3} cm/sec to 10^{-5} cm/sec (Ref. 5). Assign 2

   o The wastes are considered to be consolidated and stabilized solids. Assign 0

   The total for Line 2 = 2(2) + 1 + 2 + 0 = 7

3. Containment

   o The site is considered an uncovered waste pile with potentially inadequate diversion and collection systems (Ref. 13). Assign 2

4. Waste Characteristics

a. Chemical

- The waste materials stored at this site consist of mica-coated copper scrap containing above-background levels of uranium (Ref. 13). Uranium is considered both toxic and persistent. Assign 18

- Assuming that the average uranium concentration in the copper metal is similar to that of the Ferrous Metal Scrap Pile, the quantity of uranium present at the site can be estimated at less than 10 kilograms (Ref. 4). Since other heavy metals are possibly present, the lowest range referenced in the HRS user's manual was selected (1-10 tons). Assign 1

b. Radioactive

- Groundwater samples specific to the Copper Scrap Pile have not been collected. Assign 0

- The potential contamination of ground waters by Group D radionuclides is estimated to be 4.2×10^{-2} pCi/l (estimated from information contained in Ref. 4). Assign 0

The total for Line 4 is:

Chemical: 18 + 1 = 19

Radioactive: 0

5. Targets

- Ground water within three miles of the site is used as the primary drinking water supply. Assign 3

- The distance to the nearest well is between 2,000 feet and 1 mile and the population potentially served within 3 miles of the site is within the 101-1000 range referenced in the HRS user's manual (Ref. 3, 5). Assign 16

The total for Line 5 = 3(3) + 16 = 25

6. The total for Line 6 is:

Chemical: 7 x 2 x 19 x 25 = 6,650

Radioactive: 7 x 2 x 0 x 25 = 0

7. The total for Line 7 = (6,650/57,330) x 100 = 11.60

TOTAL MIGRATION SCORE - S_m

$S_m = (S^2_{gw} + S^2_{sw} + S^2_{air})^{1/2}/1.73$

Where: S_{gw} = ground water score = 11.60

S_{sw} = surface water score = 0.00

S_{air} = air score = 0.00

S_m = 6.71

FIRE AND EXPLOSION

There are no known significant fire or explosion threats associated with this facility. Accordingly, the fire and explosion mode is not applicable to this site.

DIRECT CONTACT

1. Observed Incidents

   o No information indicating that contact with hazardous substances at this facility has caused injury, illness, or death to humans, domestic animals, or wild animals. Assign 0

2. Accessibility

   o The Copper Scrap Pile is contained within the confines of the controlled access plant facility. Assign 0

Since Lines 1 and 2 are zero, Line 7 is also zero.

Copper Scrap Pile

Air Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multiplier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	5.1

Date and Location:

Sampling Protocol:

If Line 1 is 0, the S_a = 0. Enter on Line 5.
If Line 1 is 45, Then Proceed to Line 2.

2 Waste Characteristics					5.2
a. Chemical					
Reactivity and Incompatibility	0 1 2 3	1	3		
Toxicity	0 1 2 3	3	9		
Hazardous Waste Quantity	0 1 2 3 4 5 6 7 8	1	8		
b. Radioactive	0 2 5 8 12 16 20	1	20		
Total Waste Characteristics Score		2a. / 2b.		20	
3 Targets					5.3
Population Within 4-Mile Radius	0 9 12 15 18 / 21 24 27 30	1	30		
Distance to Sensitive Environment	0 1 2 3	2	6		
Land Use	0 1 2 3	1	3		
Total Targets Score			39		
4 Multiply 1 X 2 X 3		Chemical / Radioactive		35,100	
5 Divide Line 4 by 35,100 and Multiply by 100		$S_a^r = S_a^c = 0.0$			

Surface Water Route Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	4.1
If Observed Release is Given a Value of 45, Proceed to Line 4					
If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					4.2
Facility Slope and Intervening Terrain	(0) 1 2 3	1		3	
1-yr. 24-hr. Rainfall	0 1 (2) 3	1		3	
Distance to Nearest Surface Water	0 (1) 2 3	2		6	
Physical State	(0) 1 2 3	1		3	
Total Route Characteristics Score			4	15	
3 Containment	0 1 (2) 3	1	2	3	4.3
4 Waste Characteristics					4.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 15 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score Largest of 4a, b1 or b2		4a. 4b.	19 0	26	
5 Targets					4.5
Surface Water Use	(0) 1 2 3	3		9	
Distance to Sensitive Environment	(0) 1 2 3	2		6	
Population Served / Distance to Water Intake Downstream	(0) 4 6 8 10 12 16 18 20 24 30 32 35 40	1		40	
Total Targets Score			0	55	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical	0	64,350	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive	0		
7 Divide Line 6 by 64,350 and Multiply by 100			$S^r_{sw} = S^c_{sw}$	0.0	

Ground Water Route Work Sheet 6402

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Release	(0) 45	1	0	45	3.1
If Observed Release is Given a Value of 45, Proceed to Line 4 If Observed Release is Given a Value of 0, Proceed to Line 2					
2 Route Characteristics					3.2
Depth to Aquifer of Concern	0 1 (2) 3	2		6	
Net Precipitation	0 (1) 2 3	1		3	
Permeability of the Unsaturated Zone	0 1 (2) 3	1		3	
Physical State	(0) 1 2 3	1		3	
Total Route Characteristics Score			7	15	
3 Containment	0 1 (2) 3	1	2	3	3.3
4 Waste Characteristics					3.4
a. Chemical					
Toxicity / Persistence	0 3 6 9 12 14 (18)	1		18	
Hazardous Waste Quantity	0 (1) 2 3 4 5 6 7 8	1		8	
b. Radioactive					
1. Maximum Observed	(0) 1 3 7 11 15 21 26	1		26	
2. Maximum Potential	(0) 1 3 7 11 15 21 26	1		26	
Total Waste Characteristics Score (Largest of 4a, b1 or b2)		4a. 4b.	19 0	26	
5 Targets					3.5
Ground Water Use	0 1 2 (3)	3		9	
Distance to Nearest Well / Population Served	0 4 6 8 10 12 (16) 18 20 24 30 32 35 40	1		40	
Total Targets Score			25	49	
6 If Line 1 is 45, Multiply 1 X 4 X 5 If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Chemical Radioactive	6,650 0	57,330	
7 Divide Line 6 by 57,330 and Multiply by 100		$S^r_{gw} = S^c_{gw} =$	11.6		

Copper Scrap Pile

	S	S^2
Groundwater Route Score (S_{gw})	11.6	134.56
Surface Water Route Score (S_{sw})	0.0	0.0
Air Route Score (S_a)	0.0	0.0
$S_{gw}^2 + S_{sw}^2 + S_a^2$		134.56
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2}$		11.6
$\sqrt{S_{gw}^2 + S_{sw}^2 + S_a^2} / 1.73 = S_M =$		6.7

WORKSHEET FOR COMPUTING S_M

Copper Scrap Pile

Fire and Explosion Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Containment	1 3	1		3	7.1
2 Waste Characteristics					7.2
Direct Evidence	0 3	1		3	
Ignitability	0 1 2 3	1		3	
Reactivity	0 1 2 3	1		3	
Incompatibility	0 1 2 3	1		3	
	Subtotal			12	
Waste Quantities					
a. Chemical Hazardous Waste	0 1 2 3 4 5 6 7 8	1		8	
b. Radioactive	0 1 2 3 5 6 8	1		8	
Total Waste Characteristics Score (2a + Subtotal, 2b + Subtotal)		2a. 2b.		20	
3 Targets					7.3
Distance to Nearest Population	0 1 2 3 4 5	1		5	
Distance to Nearest Building	0 1 2 3	1		3	
Distance to Sensitive Environment	0 1 2 3	1		3	
Land Use	0 1 2 3	1		3	
Population Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Buildings Within 2-Mile Radius	0 1 2 3 4 5	1		5	
Total Targets Score				24	
4 Multiply 1 X 2 X 3		Chemical Radioactive		1,440	
5 Divide Line 4 by 1,440 and Multiply by 100			$S^r_{FE} = S^c_{FE} =$ NA		

Copper Scrap Pile

Direct Contact Work Sheet

Rating Factor	Assigned Value (Circle One)	Multi-plier	Score	Max. Score	Ref. (Section)
1 Observed Incident	(0) 45	1	0	45	8.1
If Line 1 is 45, Proceed to Line 4 If Line 1 is 0, Proceed to Line 2					
2 Accessibility	(0) 1 2 3	1	0	3	8.2
3 Containment	0 15	1		15	8.3
4 Waste Characteristics					8.4
a. Chemical Toxicity	0 1 2 3	5 a.		15	
b. Radioactive	0 1 2 4 6 9 12 15	1 b.		15	
Total Waste Characteristics Score		4a. 4b.		15	
5 Targets					8.5
Population Within a 1-Mile Radius	0 1 2 3 4 5	4		20	
Distance to a Critical Habitat	0 1 2 3	4		12	
Total Targets Score				32	
6 If Line 1 is 45, Multiply 1 X 4 X 5		Chemical		21,600	
If Line 1 is 0, Multiply 2 X 3 X 4 X 5		Radioactive			
7 Divide Line 6 by 21,600 and Multiply by 100			$S^r_{DC} = S^c_{DC} =$ 0.0		

APPENDIX C - ACRONYMS

CERCLA - Comprehensive Environmental Response, Compensation, and Liability Act

DOE - Department of Energy

EPA - Environmental Protection Agency

FMPC - Feed Materials Production Center

HRS - Hazard Ranking System

mHRS - Modified Hazard Ranking System

NPDES - National Pollutant Discharge Elimination System

NPL - National Priorities List

OEPA - Ohio Environmental Protection Agency

RCRA - Resource Conservation and Recovery Act

WMCO - Westinghouse Materials Company of Ohio