441

G-000-107.26

DRAFT ENVIRONMENTAL IMPACT STATEMENT FEED MATERIALS PRODUCTION CENTER RENOVATION AND SITE EVALUATION MAY 1990

05/01/90

DOE/EIS-0142 D
DOE-FMPC
604
REPORT

~~G-038-107.3~~ 441

DOE/EIS-0142 D

Draft
Environmental Impact Statement

Feed Materials Production Center Renovation and Site Evaluation

May 1990
United States Department of Energy

441

DOE/EIS-0142 D

Draft
Environmental Impact Statement

Feed Materials Production Center Renovation and Site Evaluation

CAUTION

This document has not been given final patent clearance and is for internal use only. If this document is to be given public release, it must be cleared through the site Technical Information Office which will see that the proper patent and technical information reviews are completed in accordance with Energy Systems Policy.

May 1990
United States Department of Energy

2

COVER SHEET

A. Lead Agency: U.S. Department of Energy (DOE)

B. Title: Draft Environmental Impact Statement—Feed Materials Production Center: Renovation and Site Evaluation (DOE/EIS-0142 D)

C. Contact: For additional copies or further information, please contact

Mr. Raymond J. Hansen
DOE Feed Materials Production Center Site Office
P. O. Box 398705
Cincinnati, Ohio 45239-8705
Telephone: (513) 738-6357

For information on the DOE National Environmental Policy Act of 1969 (NEPA) process, please contact

Ms. Carol M. Borgstrom, Director
Office of NEPA Project Assistance
1000 Independence Ave., S.W.
Washington, D.C. 20585
Telephone: (202) 586-4600

D. Abstract:

The U.S. Department of Energy (DOE) is completing 161 renovation projects and proposes to conduct an additional 82 projects at the Feed Materials Production Center located near Fernald, Ohio. DOE is also considering cessation of metal production (in which 49 projects would be completed) as an alternative to the proposed action. Renovation is intended to (1) improve environmental, safety, and health conditions and production reliability; (2) enhance management of Resource Conservation and Recovery Act hazardous and radioactive waste materials; and (3) restore production to a level that will meet future national defense needs except under the cessation of metal production alternative. Under separate activities, DOE also intends to remediate areas that have been contaminated by past operations. This Draft Environmental Impact Statement evaluates the impacts resulting from the remedial action sites as they currently exist but defers evaluation of specific remedial action to the Feasibility Study of the Remedial Investigation/ Feasibility Study (RI/FS) process. Most of the environmental benefits of plant renovation are realized in the present situation alternative. Further major reductions in off-site radiological doses to the public will be the result of site remediation, which is to be addressed in separate RI/FS-NEPA documentation.

E. Comments: Comments on the Draft Environmental Impact Statement are to be submitted to DOE not later than 45 days after the Notice of Availability is published in the *Federal Register.*

F. Designation: Draft EIS (DEIS)

TABLE OF CONTENTS

	Page
COVER SHEET	iii
TABLE OF CONTENTS	v
LIST OF FIGURES	xiii
LIST OF TABLES	xvii
EXECUTIVE SUMMARY	xxiii
ABBREVIATIONS, ACRONYMS, AND INITIALISMS	xxxi
1. PURPOSE OF AND NEED FOR THE PROPOSED ACTION	1-1
1.1 PURPOSE AND NEED	1-1
1.2 BACKGROUND	1-1
1.2.1 FMPC Operations	1-1
1.2.2 Renovation	1-2
1.2.3 Remedial Action	1-3
1.3 SCOPE OF THIS EIS	1-3
1.4 REFERENCES	1-5
2. ALTERNATIVES INCLUDING THE PROPOSED ACTION	2-1
2.1 OVERVIEW OF FMPC OPERATION	2-1
2.1.1 Process Summary	2-1
2.1.2 Waste Management	2-5
2.1.2.1 Atmospheric emissions	2-5
2.1.2.2 Liquid wastes	2-5
2.1.2.3 Solid waste	2-8
2.1.3 Thorium Management	2-10
2.2 ALTERNATIVES	2-12
2.2.1 Present Situation (No Action) Alternative	2-12
2.2.2 Proposed Action Alternative	2-14
2.2.3 Cessation of Metal Production Alternative	2-14
2.2.4 Relocation Alternative	2-14
2.3 OVERVIEW OF RENOVATION AND REMEDIAL ACTION PROJECTS	2-18
2.3.1 Renovation	2-18
2.3.1.1 Atmospheric emission control	2-21
2.3.1.2 Liquid effluent control	2-23
2.3.2 Directed Actions	2-24
2.3.3 Overview of Remedial Action Activities	2-26
2.3.3.1 On-site remedial action sites	2-26
2.3.3.2 Off-site remedial action sites	2-29
2.4 COMPARISON OF ENVIRONMENTAL IMPACTS OF MAJOR ALTERNATIVES	2-31
2.4.1 Present Situation (No Action)	2-31
2.4.2 Proposed Action	2-37
2.4.3 Cessation of Metal Production Alternative	2-37
2.5 REFERENCES	2-38

3. AFFECTED ENVIRONMENT 3-1
3.1 INTRODUCTION 3-1
3.2 SOCIOECONOMICS 3-4
3.2.1 Population and Demography 3-4
3.2.1.1 Population 3-4
3.2.1.2 Residences of FMPC employees 3-4
3.2.2 Employment and Income 3-8
3.2.3 Schools 3-8
3.2.4 Infrastructure and Emergency Response 3-9
3.2.4.1 Utilities 3-9
3.2.4.2 Fire and police 3-9
3.2.4.3 Commercial transportation 3-9
3.2.4.4 Emergency response 3-10
3.2.5 Traffic 3-11
3.2.6 Noise 3-11
3.2.7 Historical Resources 3-13
3.3 WASTE MANAGEMENT AND TRANSPORTATION 3-13
3.4 METEOROLOGY AND NONRADIOLOGICAL AIR QUALITY 3-14
3.4.1 Regional Climatology 3-14
3.4.2 Local Meteorology 3-15
3.4.3 Nonradiological Air Quality 3-17
3.4.3.1 Comparison of monitoring data and air quality standards 3-17
3.4.3.2 Regional and FMPC emissions data 3-20
3.4.3.3 Impacts from FMPC 3-20
3.5 GEOLOGY 3-22
3.5.1 Overview of FMPC Site Geology 3-22
3.5.1.1 Paleozoic rock 3-22
3.5.1.2 Pleistocene/Holocene sediments 3-24
3.5.2 Potential Effluent Subsurface Pathways to the Great Miami Aquifer 3-24
3.5.3 Soils on the FMPC Site 3-35
3.5.4 Earthquake Risk 3-36
3.6 HYDROLOGY AND WATER QUALITY 3-39
3.6.1 Surface Water Hydrology 3-39
3.6.1.1 Paddy's Run 3-41
3.6.1.2 Flooding 3-42
3.6.2 Surface Water Quality and Sediments 3-42
3.6.2.1 Great Miami River 3-42
3.6.2.2 Paddy's Run 3-48
3.6.3 Groundwater Hydrology 3-50
3.6.3.1 Great Miami Aquifer 3-50
3.6.3.2 Shallow groundwater 3-53
3.6.4 Groundwater Quality 3-53
3.6.4.1 Background 3-53
3.6.4.2 Great Miami Aquifer contamination 3-56
3.7 ECOLOGY 3-61
3.7.1 Terrestrial Ecology 3-61
3.7.1.1 Vegetation 3-61
3.7.1.2 Fauna 3-67
3.7.1.3 Endangered species 3-69

3.7.2 Aquatic Ecology 3-69
3.8 RADIOLOGICAL BACKGROUND 3-78
3.8.1 Environmental Sampling 3-78
3.8.1.1 Air pathway 3-78
3.8.1.2 Water pathway 3-83
3.8.2 Dose 3-88
3.8.2.1 Methods 3-88
3.8.2.2 Dose calculations 3-93
3.8.3 Risk Calculation 3-95
3.9 WORKER EXPOSURE TO HAZARDOUS SUBSTANCES 3-97
3.9.1 Radiation Exposure Limits 3-97
3.9.2 Worker Radiological Monitoring and Training 3-100
3.9.3 NIOSH Radiological and Chemical Evaluation and Findings 3-103
3.9.3.1 NIOSH survey results 3-103
3.9.3.2 NIOSH recommendations and FMPC responses 3-105
3.9.4 Additional Radiation and Chemical Exposure Reduction Activities 3-105
3.10 REFERENCES 3-112

4. ENVIRONMENTAL IMPACTS 4-1
4.1 PRESENT SITUATION 4-1
4.1.1 Impacts on Air Quality 4-1
4.1.1.1 Construction 4-1
4.1.1.2 Operation 4-2
4.1.2 Impacts on Water Resources 4-5
4.1.2.1 Surface water quality 4-5
4.1.2.2 Groundwater quality 4-13
4.1.3 Ecology 4-15
4.1.3.1 Terrestrial 4-15
4.1.3.2 Aquatic 4-17
4.1.4 Radiological Impacts to the Public 4-20
4.1.4.1 General public and maximally exposed individual 4-20
4.1.4.2 Off-site agricultural impact 4-24
4.1.4.3 Limited individual 4-24
4.1.4.4 Risk calculation 4-25
4.1.5 Worker Radiation and Chemical Exposure 4-25
4.1.6 Waste Management 4-25
4.1.6.1 Operational wastes 4-25
4.1.6.2 Backlog wastes 4-31
4.1.6.3 Construction rubble 4-33
4.1.6.4 Waste transport impacts 4-38
4.1.7 Socioeconomics 4-41
4.1.7.1 Population and demography 4-42
4.1.7.2 Regional employment and income 4-42
4.1.7.3 Schools 4-43
4.1.7.4 Infrastructure 4-44
4.1.7.5 Traffic 4-44
4.1.8 Summary 4-44
4.2 PROPOSED ACTION 4-45

6

4.2.1 Air Quality 4-45
4.2.1.1 Construction 4-45
4.2.1.2 Operation 4-46
4.2.2 Impacts on water resources 4-46
4.2.2.1 Surface waters 4-46
4.2.2.2 Groundwater quality impacts 4-53
4.2.3 Ecology 4-53
4.2.3.1 Terrestrial 4-53
4.2.3.2 Aquatic 4-53
4.2.4 Radiological Impacts to Public 4-57
4.2.4.1 General population and maximally exposed individual 4-57
4.2.4.2 Off-site agricultural impact 4-57
4.2.4.3 K-65 silos impacts 4-61
4.2.4.4 Risk calculation 4-61
4.2.5 Worker Radiation and Chemical Exposure 4-61
4.2.6 Waste Management 4-61
4.2.6.1 Operational wastes 4-65
4.2.6.2 Backlog wastes 4-65
4.2.6.3 Construction rubble 4-65
4.2.6.4 Transportation 4-67
4.2.7 Socioeconomics 4-68
4.2.7.1 Population and demography 4-68
4.2.7.2 Regional employment and income 4-68
4.2.7.3 Schools 4-69
4.2.7.4 Traffic 4-69
4.2.8 Summary 4-69
4.3 CESSATION OF METAL PRODUCTION ALTERNATIVE 4-70
4.3.1 Air Quality 4-70
4.3.1.1 Construction 4-70
4.3.1.2 Operation 4-70
4.3.2 Impacts on Water Resources 4-70
4.3.2.1 Surface waters 4-70
4.3.2.2 Groundwater quality impacts 4-73
4.3.3 Ecology 4-74
4.3.3.1 Terrestrial 4-74
4.3.3.2 Aquatic 4-74
4.3.4 Radiological Impacts to Public 4-75
4.3.4.1 General population and maximally exposed individual 4-75
4.3.4.2 Off-site agricultural impact 4-79
4.3.4.3 K-65 silos impacts 4-79
4.3.4.4 Risk calculation 4-79
4.3.5 Worker Radiation and Chemical Exposure 4-81
4.3.6 Waste Management 4-81
4.3.6.1 Operational wastes 4-81
4.3.6.2 Backlog wastes 4-81
4.3.6.3 Construction rubble 4-84
4.3.6.4 Transportation 4-84
4.3.7 Socioeconomics 4-84
4.3.7.1 Population and demography 4-84
4.3.7.2 Regional employment and income 4-85

4.3.7.3 Schools 4-85
4.3.7.4 Traffic 4-85
4.3.8 Summary 4-85
4.4 REMEDIAL ACTIONS 4-86
4.4.1 Scope of Remedial Actions at FMPC 4-86
4.4.2 Potential Effects of Key Remedial Action Sites . . 4-86
4.4.2.1 K-65 silos 4-86
4.4.2.2 Waste pit area and the eastern groundwater plume 4-87
4.4.2.3 Southern groundwater plume 4-89
4.5 ACCIDENTS 4-89
4.5.1 Transportation 4-89
4.5.2 Ecology 4-94
4.5.2.1 Terrestrial 4-94
4.5.2.2 Surface waters/aquatic 4-95
4.5.3 Air Quality 4-95
4.5.4 Hydrology and Water Quality 4-98
4.5.4.1 Stormwater Retention Basin (SWRB) 4-98
4.5.4.2 Biodenitrification Surge Lagoon (BSL) . . 4-98
4.6 MONITORING AND MITIGATION 4-98
4.7 CUMULATIVE IMPACTS 4-102
4.8 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS 4-108
4.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES . . 4-109
4.10 SHORT-TERM AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT . 4-109
4.11 REFERENCES 4-109

5. LIST OF PREPARERS 5-1

GLOSSARY GL-1

DISTRIBUTION LIST DL-1

APPENDIX A. PROPOSED ACTION, PRESENT SITUATION (NO ACTION), AND CESSATION OF METAL PRODUCTION ALTERNATIVE PROJECT LISTS A-1
A.1 INTRODUCTION A-1

APPENDIX B. AN OVERVIEW OF THE FEED MATERIALS PRODUCTION CENTER . . B-1
B.1 PRINCIPAL PRODUCTS B-1
B.2 THE PRODUCTION PROCESS B-1
B.3 PLANT-BY-PLANT PROCESS FLOW B-4
B.3.1 Plant 1: The Sampling Plant B-4
B.3.2 Plant 2/3: The Refinery B-6
B.3.3 Plant 4: The Green Salt Plant B-8
B.3.4 Pilot Plant: The UF_6 to UF_4 Reduction Plant B-10
B.3.5 Plant 5: The Metals Production Plant B-10
B.3.6 Plant 9: The Special Products Plant B-14
B.3.7 Plant 6: The Metals Fabrication Plant B-14
B.3.8 Plant 8: The Scrap Recovery Plant B-16

APPENDIX C. DESCRIPTIONS OF REMEDIAL ACTION SITES C-1
C.1 DEACTIVATED PROCESS AND TREATMENT FACILITIES C-1
C.1.1 Hexafluoride Reduction Plant (Plant 7) C-1

8

441

C.1.2 Solid Waste Incinerator C-1
C.1.3 Graphite Burner C-1
C.1.4 Oil Burner C-1
C.1.5 Barium Chloride Waste Salt Treatment Facility . . . C-2
C.1.6 Trane Liquid Hazardous Waste Incinerator Unit . . . C-2
C.1.7 Underground Storage Tanks C-3
C.2 WASTE MANAGEMENT AREAS AND STORAGE UNITS C-3
C.2.1 Ferrous Metal Scrap Pile C-3
C.2.2 Copper Scrap Pile C-3
C.2.3 Waste Pits C-3
C.2.3.1 Waste Pit 1 . . . . . C-8
C.2.3.2 Waste Pit 2 . . . . . C-8
C.2.3.3 Waste Pit 3 . . . . . C-9
C.2.3.4 Waste Pit 4 . . . . . C-9
C.2.3.5 Waste Pit 5 . . . . . C-9
C.2.3.6 Waste Pit 6 . . . . . C-12
C.2.3.7 Burn Pit C-12
C.2.3.8 Clear Well C-12
C.2.4 Waste Storage Silos C-12
C.2.4.1 K-65 Silos C-12
C.2.4.2 Metal Oxide Silo No. 3 . . . . . C-13
C.2.5 Retired Fly Ash Pile 1 . . . . . C-13
C.2.6 Southfield Area C-13
C.2.7 Lime Sludge Ponds C-13
C.2.8 Paddy's Run On-Site C-15
C.2.9 Perched Groundwater On-Site C-15
C.2.10 Contaminated Surface Soils-On-Site C-15
C.2.11 Stormwater Drainage Ditch C-15
C.2.12 Surface Drainageways C-15
C.3 OFF-SITE REMEDIAL ACTION SITES C-16
C.3.1 Great Miami River C-16
C.3.2 Great Miami Aquifer C-16
C.3.3 Paddy's Run Off-Site C-16
C.3.4 Perched Groundwater Off-Site C-17
C.3.5 Contaminated Surface Soils-Off-Site C-17
C.4 REFERENCES C-17

APPENDIX D. SOCIOECONOMIC DATA AND METHODS D-1
D.1 DESCRIPTION OF KEY ECONOMIC DATA D-1
D.2 METHOD FOR ESTIMATING REGIONAL ECONOMIC AND EMPLOYMENT IMPACTS D-1
D.3 DESCRIPTION OF EMPLOYMENT DISPERSION ANALYSIS D-2
D.4 DESCRIPTION OF TRAFFIC ASSESSMENT D-2
D.5 REFERENCES D-4

APPENDIX E. HAZARD EVALUATION OF WASTE PITS E-1

APPENDIX F. GEOHYDROLOGY F-1
F.1 SUMMARY F-1
F.2 CONCEPTS FROM GROUNDWATER HYDROLOGY RELATED TO AN ENVIRONMENTAL IMPACT EVALUATION OF THE FMPC F-1
F.2.1 Darcy's Law F-1

9

F.2.2 Hydraulic Conductivity F-2
F.2.3 Porosity F-3
F.2.4 Presence of Unsaturated Zones F-3
F.2.5 Location of Groundwater Divides F-4
F.2.6 Geochemical Considerations F-5
F.2.7 Hydrodynamic Dispersion F-9
F.3 MATHEMATICAL ANALYSIS OF THE CONTAMINANT-DISPERSION PROCESS DOWNGRADIENT OF THE STORM SEWER OUTFALL DITCH . . . F-10
F.4 DETERMINATION OF THE INDEPENDENT PARAMETERS REQUIRED BY THE SOLUTE TRANSPORT MODEL F-25
F.5 REFERENCES F-31

APPENDIX G. AIR QUALITY/METEOROLOGY G-1
G.1 DISPERSION MODELING METHODOLOGY AND MODEL INPUT DATA FOR NON-RADIOLOGICAL EMISSIONS G-1
G.2 METEOROLOGICAL INPUT DATA FOR RADIOLOGICAL AND NON-RADIOLOGICAL DISPERSION MODELING G-7
G.2.1 Selection of Meteorological Input Data G-7
G.2.2 Comparison of FMPC and Greater Cincinnati Airport Wind Data G-7
G.3 DETAILED CLIMATIC DATA SUMMARY G-11
G.4 AIR QUALITY IMPACTS OF MAJOR CHEMICAL SPILLS G-11
G.4.1 Selection of Scenarios and Dispersion Model G-11
G.4.2 HF Analysis G-13
G.4.3 NH_3 Analysis G-13
G.5 REFERENCES G-16

APPENDIX H. MAJOR RENOVATION PROJECTS AFFECTING THE ENVIRONMENT . . H-1
H.1 AIR EMISSION CONTROL PROJECTS H-1
H.1.1 Introduction H-1
H.1.2 Plant 8 Scrubbers H-2
H.1.3 NO_x Scrubbers H-2
H.1.4 Derby Breakout H-3
H.1.5 Titan Milling System H-4
H.1.6 Nitric Acid Recovery H-4
H.1.7 Packaging System Stations H-4
H.1.8 Tank Farm H-5
H.2 ADVANCED WASTERWATER TREATMENT FACILITY H-5
H.2.1 Pretreatment H-7
H.2.2 Carbon Adsorption H-7
H.2.3 Ion Exchange H-7
H.2.4 Reverse Osmosis H-7
H.2.5 Technological Alternatives H-7
H.3 DENITRIFICATION OF FMPC WASTEWATER H-9
H.3.1 Description of the FMPC Denitrification Facility . . H-9
H.3.2 Technological Alternatives H-11
H.3.2.1 Ion Exchange H-12
H.3.2.2 Reverse Osmosis H-12
H.3.2.3 Electrodialysis H-12
H.3.2.4 Bipolar Electroreduction H-13
H.3.2.5 Drying and Calcination (Including Plasma) . H-13
H.3.2.6 Conversion to Fertilizer H-14

441

H.3.2.7 Summary H-14

APPENDIX I. FMPC'S NEPA AND ENVIRONMENTAL DOCUMENTS I-1

APPENDIX J. CONSULTATION WITH AGENCIES J-1

APPENDIX K. SUMMARY AND ANALYSIS OF PUBLIC SCOPING COMMENTS K-1
K.1 SCOPING PROCESS K-1
K.2 DISCUSSION OF PUBLIC SCOPING COMMENTS K-1

APPENDIX L. FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS L-1
L.1 INTERAGENCY AGREEMENTS L-1
L.1.1 Memorandum of Understanding Among DOE, U.S. EPA, and OEPA for Preparation of the FMPC Renovation and Remedial Action EIS L-1
L.1.2 Federal Facility Compliance Agreement L-1
L.1.3 OEPA Director's Findings and Orders L-1
L.1.4 Consent Decree Between State of Ohio and DOE L-2
L.2 SUMMARY OF ENVIRONMENTAL REVIEW REQUIREMENTS L-2
L.2.1 National Environmental Policy Act of 1969 . . . . . L-2
L.2.2 Executive Order 12088: Federal Compliance with Pollution Control Standards L-3
L.2.3 DOE Orders for Environmental, Safety, and Health Protection L-3
L.2.4 Atomic Energy Act of 1954 . . . . . L-3
L.2.5 Hazardous Waste Regulations L-4
L.2.5.1 Comprehensive Environmental Response, Compensation, and Liability Act L-4
L.2.5.2 Resource Conservation and Recovery Act and Hazardous and Solid Waste Amendments . L-4
L.2.5.3 State of Ohio Hazardous Waste Rules L-6
L.2.6 Water Quality Regulations L-6
L.2.6.1 Federal Safe Drinking Water Act and Amendments L-6
L.2.6.2 State of Ohio Water Quality Regulations . . L-6
L.2.7 Air Quality Regulations L-7
L.2.7.1 Clean Air Act (CAA) and Amendments L-7
L.2.7.2 State of Ohio Air Quality Regulations . . . L-7
L.3 FMPC ENVIRONMENTAL COMPLIANCE PLAN L-8
L.4 REFERENCES L-8

11

LIST OF FIGURES

		Page
2.1-1	Feed Materials Production Center site map	2-2
2.1-2	Perspective drawing of the Feed Materials Production Center waste pit and production areas	2-3
2.1-3	Feed Materials Production Center process flow block diagram	2-4
2.1-4	Feed Materials Production Center liquid waste stream flow diagram in 1988	2-7
2.1-5	Feed Materials Production Center waste storage area	2-9
2.3-1	Map of the Feed Materials Production Center showing the location of major new facilities that will be completed under the present situation and are part of the proposed action and cessation of metal production alternatives	2-22
2.3-2	Map of the Feed Materials Production Center showing the location of major remedial action sites	2-30
3.1-1	Area in the vicinity of the Feed Materials Production Center	3-2
3.1-2	Land use map for the Feed Materials Production Center	3-3
3.2-1	Cincinnati-Hamilton Consolidated Metropolitan Statistical Area	3-5
3.2-2	Highway service for Feed Materials Production Center	3-12
3.4-1	Fernald Feed Materials Production Center wind rose for 10-m level, Dec. 16, 1987-Dec. 16, 1988	3-16
3.4-2	Air monitoring stations in the FMPC vicinity	3-19
3.5-1	The Great Miami Aquifer (New Haven Trough) and major pumping centers in the vicinity of the Feed Materials Production Center	3-25
3.5-2	New Haven Trough and the vertical cross section A'A through the Great Miami Aquifer	3-26
3.5-3	Schematic north-to-south vertical section BB' of Fig. 3.5-1 of bedrock and Pleistocene and Holocene sediments from the FMPC production area to the southern boundary of FMPC	3-27
3.5-4	Schematic cross section of Pleistocene strata at the Stormwater Retention Basin and Storm Sewer Outfall Ditch and Paddy's Run generally south of the production area	3-30
3.5-5	Topographic map (1959) of Paddy's Run and its tributaries from Pit 5 to 500 ft south of the silos	3-31
3.5-6	Two possible foundation conditions beneath the Clear Well and Waste Pit 3 and potential pathways of effluent from the pits to groundwater	3-32
3.5-7	Groundwater well locations at the Feed Materials Production Center	3-34
3.5-8	Soils map of the Feed Materials Production Center site	3-35
3.5-9	Location of moderate and large earthquakes recorded within 320 km (200 miles) of the Feed Materials Production Center during the past 200 years	3-37
3.6-1	The Great Miami River watershed in the vicinity of the Feed Materials Production Center	3-40

441

3.6-2 100-year floodplain within the Feed Materials Production Center site 3-43
3.6-3 Major surface waters and surface water sampling locations in the vicinity of the Feed Materials Production Center . 3-44
3.6-4 Sediment sampling locations in the FMPC vicinity in 1985 . 3-49
3.6-5 Major groundwater pumping centers within an 8-km (5-mile) radius of the Feed Materials Production Center 3-51
3.6-6 Groundwater flow directions in the Great Miami Aquifer in the vicinity of the Feed Materials Production Center . . . 3-54
3.6-7 Water table map in the vicinity of the Feed Materials Production Center measured between March 29 and April 11, 1986 3-55
3.6-8 Locations of background wells MW-12, GT-3, B-3, and D in the Great Miami Aquifer near the Feed Materials Production Center 3-57
3.6-9 Generalized areas of contamination in the Great Miami Aquifer in the vicinity of the Feed Materials Production Center 3-59
3.6-10 Mass of uranium discharged to Storm Sewer Outfall Ditch as a function of time 3-62
3.7-1 Vegetation types occurring on the Feed Materials Production Center site 3-66
3.8-1 Routine soil sampling locations at the Feed Materials Production Center 3-80
3.8-2 Parallel soil and vegetation and associated soil sampling locations at the Feed Materials Production Center 3-81
3.8-3 Sampling locations for farm and garden produce and associated soils surrounding the Feed Materials Production Center 3-82
3.8-4 Off-site monitoring well locations at the Feed Materials Production Center 3-84
3.8-5 Surface water sampling locations in the vicinity of the Feed Materials Production Center in 1987 3-85
3.8-6 Sediment sampling locations in the vicinity of the Feed Materials Production Center in 1987 3-87
3.8-7 Exposure pathway to humans (not exclusive to FMPC) . . . 3-89
4.1-1 Approximate extent of the Great Miami Aquifer contamination in the vicinity of the Feed Materials Production Center 4-14
4.1-2 Feed Materials Production Center construction-waste storage areas 4-35
4.1-3 Location of proposed temporary storage (IS-3) of containerized low-level waste construction rubble 4-37
4.4-1 Concentration of uranium in wells completed in the lower portion of the Great Miami Aquifer in 3000-series monitoring wells on and near the Feed Materials Production Center site in 1988 4-90
4.4-2 Concentration of uranium in wells completed in the upper portion of the Great Miami Aquifer in 2000-series monitoring wells in 1988 4-91
4.4-3 Southern groundwater plume centerline and location of uranium-contaminated off-site wells in the vicinity of the Feed Materials Production Center 4-92

13

4.5-1	Simulation of maximum groundwater uranium concentration at the Feed Materials Production Center plant boundary assuming leakage through one Stormwater Retention Basin at arbitrary future date and assuming negligible background concentration	4-99
A.1	Perspective drawing of the Feed Materials Production Center waste pit and production areas	A-2
B.1	The role of the Feed Materials Production Center in U.S. Department of Energy programs	B-2
B.2	The production process at the Feed Materials Production Center	B-3
B.3	The plant-by-plant process flow	B-5
B.4	Digestion, extraction, and denitration of uranium to produce orange oxide (UO_3)	B-7
B.5	Converting UO_3 to UF_4	B-9
B.6	Reducing UF_6 to UF_4	B-11
B.7	Uranium metal production	B-12
B.8	Metals fabrication process flow	B-15
F.1	Eh-pH equilibrium diagram for the $U-O_2$ - H_2O-CO_2 system at 25°C, 1 atm, and a partial pressure of CO_2 at $10^{-3.4}$ atm .	F-8
F.2	Contaminant transport from a point source into a one-dimensional, plane parallel alluvial aquifer	F-13
F.3	Mathematical representation of the discharge per unit time of containment into the Storm Sewer Outfall Ditch	F-15
F.4	Step function representation of the time history of discharge rate into the Storm Sewer Outfall Ditch	F-17
F.5	Flow chart of computational procedure	F-23
F.6	Plan view south of the Feed Materials Production Center showing equivalent point source location along Storm Sewer Outfall Ditch, plume centerline, and contaminated off-site wells	F-26
F.7	Cross section through Great Miami Aquifer south of the Feed Materials Production Center showing installation details of contaminated off-site wells	F-27
G.1	Greater Cincinnati Airport wind rose for 6.1-m (20-ft) level, August 5, 1986-April 22, 1987	G-8
G.2	Fernald Feed Materials Production Center wind rose for 10-m level, August 5, 1986-April 22, 1987	G-9
G.3	Polar receptor grid for atmospheric dispersion calculations	G-10
H.1	Advanced Wastewater Treatment Facility projected process flow treatment scheme	H-6

LIST OF TABLES

		Page
2.1-1	Thorium inventory composition	2-11
2.2-1	Salient characteristics of the proposed action, present situation, and cessation of metal production alternatives	2-13
2.2-2	Summary of impacts for the three relocation subalternatives	2-15
2.3-1	Summary of principal renovation activities for the present situation, proposed action, and cessation of metal production renovation activities that are expected to reduce impacts on the environment	2-19
2.3-2	On-site Remedial Action Sites at the Feed Materials Production Center	2-27
2.4-1	Actions associated with each alternative considered in the Feed Materials Production Center Environmental Impact Statement	2-32
2.4-2	Summary of impacts of the proposed action and major alternatives for Feed Materials Production Center renovation	2-33
3.2-1	Estimated populations of Ohio cities and towns in the vicinity of the Feed Materials Production Center	3-6
3.2-2	Percentage of FMPC employment by county	3-7
3.4-1	Maximum 1985 air pollutant concentrations near Feed Materials Production Center and in the southwest Ohio region	3-18
3.4-2	Nonradiological operational air emissions during 1985	3-21
3.4-3	Predicted ambient air quality impacts from FMPC operations for 1985	3-23
3.5-1	Qualitative comparison of permeabilities of Pleistocene and Holocene sediments at the Feed Materials Production Center	3-28
3.5-2	Peak ground accelerations for given return periods and the maximum expected regional and local earthquakes at the Feed Materials Production Center	3-38
3.6-1	Summary of 1985 wastewater contaminant discharges at the Feed Materials Production Center	3-46
3.6-2	Comparison of average 1985 radionuclide concentrations released to the Great Miami River buried effluent line and DOE liquid release limits	3-47
3.6-3	Average usage of groundwater pumped from the Great Miami Aquifer	3-52
3.6-4	Water quality parameters for background wells near the Feed Materials Production Center	3-58
3.6-5	Historical record of uranium discharges that have entered the Storm Sewer Outfall Ditch from the Feed Materials Production Center Storm Sewer System	3-63

441

LIST OF TABLES (continued)

3.6-6 Average annual uranium concentrations measured in the Great Miami Aquifer groundwater at three off-site locations south of the Feed Materials Production Center where maximum levels of contamination have been observed 3-65

3.7-1 Fluoride and uranium concentrations in vegetation at the FMPC site, 1984-87 3-68

3.7-2 Approximations of annual dose to invertebrates and fish exposed to 1985 radionuclide concentrations as measured in the Great Miami River downstream of the FMPC outfall 3-74

3.7-3 Comparison of total dose estimates for aquatic organisms with proposed DOE limit and range of published background doses 3-76

3.7-4 Approximations of annual dose to invertebrates and fish exposed to 1985 radionuclide concentrations in Paddy's Run 3-77

3.8-1 Estimates of uranium air emissions for 1985, 1986, and 1987 3-94

3.8-2 Annual radiation doses resulting from 1985, 1986, and 1987 FMPC operations 3-96

3.8-3 Annual cancer risks associated with annual effective total-body doses resulting from 1985 Feed Materials Production Center operation 3-98

3.9-1 Annual radiation dose limits set by Westinghouse Materials Company of Ohio for occupational exposure at the Feed Materials Production Center 3-99

3.9-2 Summary of Feed Materials Production Center employee whole-body radiation exposures measured by the U.S. Department of Energy mobile van system 3-101

3.9-3 Concentration of uranium for Feed Materials Production Center worker urine analysis in Plants 5 and 9, 1985 and 1986 3-102

3.9-4 National Institute for Occupational Safety and Health recommendations and FMPC worker protection activities . . 3-106

4.1-1 Nonradiological operational air emissions for 1985 and for the present situation alternative 4-3

4.1-2 Predicted ambient air quality impacts from FMPC operations for 1985 and maximum achievable production levels for renovation alternatives 4-4

4.1-3 Comparison of annual Feed Materials Production Center wastewater flow and pollutants discharged to the Great Miami River (Station 001) and to Paddy's Run (Station 002) for the present situation alternative and 1985 4-6

4.1-4 Comparison of average annual nonradioactive releases anticipated under the present situation with National Pollutant Discharge Elimination System permit limits and state standards 4-9

16

LIST OF TABLES (continued)

4.1-5 Present situation alternative: comparison of radionuclide releases to the Great Miami River with DOE liquid release limits 4-11

4.1-6 Present situation alternative: predicted annual releases of radionuclides and resulting dose rates to aquatic organisms in the Great Miami River 4-18

4.1-7 Estimates of uranium air emissions for the present situation and 1985 4-21

4.1-8 Annual radiation doses to the general population and the maximally exposed individual resulting from FMPC operation in the present situation and 1985 4-22

4.1-9 Annual cancer risks associated with annual radiation doses projected to result from present situation Feed Materials Production Center operation 4-26

4.1-10 Waste management impacts summary, present situation alternative 4-27

4.1-11 Production of operational wastes generated by or shipped to the Feed Materials Production Center for FY 1985-FY 1988 4-29

4.1-12 Backlog wastes inventory at the Feed Materials Production Center 4-32

4.1-13 Estimated types and quantities of construction rubble generated at the Feed Materials Production Center for present situation (cumulative) 4-34

4.2-1 Comparison of annual Feed Materials Production Center wastewater and pollutant discharges to the Great Miami River (Station 001) and to Paddy's Run (Station 002) for the proposed action and present situation alternatives . 4-47

4.2-2 Comparison of annual average nonradioactive pollutant releases under the proposed action with NPDES permit limits and state standards 4-50

4.2-3 Proposed action: comparison of predicted radionuclide releases to the Great Miami River with U.S. Department of Energy liquid release limits 4-52

4.2-4 Proposed action: predicted annual releases of radionuclides and resulting dose rates to aquatic organisms in the Great Miami River 4-55

4.2-5 Estimates of uranium air emissions for Feed Materials Production Center for the proposed action and the present situation alternatives 4-58

4.2-6 Annual radiation doses to the general population and the maximally exposed individual resulting from Feed Materials Production Center operation under the proposed action and present situation alternatives . . . 4-59

4.2-7 Annual cancer risks associated with radiation doses projected to result from Feed Materials Production Center operation after completion of the proposed action 4-62

441

LIST OF TABLES (continued)

4.2-8	Comparison of waste management impacts at the Feed Materials Production Center for the present situation and proposed action alternatives	4-63
4.2-9	Estimated types and incremental quantities of construction rubble generated at FMPC for the proposed action	4-66
4.3-1	Nonradiological operational air emissions for the present situation/proposed action and for the cessation of metal production alternative	4-71
4.3-2	Estimates of uranium air emissions for Feed Materials Production Center for the cessation of metal production alternative, the proposed action, and the present situation alternatives	4-76
4.3-3	Annual radiation doses to the general population and the maximally exposed individual resulting from Feed Materials Production Center operation under the cessation of metal production alternative, the proposed action, and present situation alternatives	4-77
4.3-4	Annual cancer risks associated with radiation doses projected to result from Feed Materials Production Center operation after completion of the cessation of metal production alternative	4-80
4.3-5	Comparison of waste management impacts at the Feed Materials Production Center for the present situation, proposed action, and cessation of metal production alternatives .	4-82
4.4-1	Comparison of off-site effective total-body doses to the maximally exposed individual for major Feed Materials Production Center remedial action sites	4-88
4.5-1	Selected accident scenarios and associated consequences for the Feed Materials Production Center pre-renovation operation	4-97
4.7-1	Environmental impacts resulting from operations and remedial action sites at the Feed Materials Production Center, Fernald, Ohio	4-103
A.1	Major projects affecting source terms for the present action alternative	A-3
A.2	Major projects affecting source terms for the proposed action alternative	A-7
A.3	Cessation of metal production alternative	A-9
A.4	Present situation alternative renovation projects sorted by location (projects started before 10/89) . . .	A-10
A.5	Proposed action renovation projects sorted by location (projects started after 10/89)	A-17
A.6	Cessation of metal production projects (sorted by location)	A-21
A.7	FMPC renovation projects descriptions	A-24
A.8	Renovation project numbers and names, construction dates, facility numbers, and NEPA document numbers . . .	A-40
C.1	Characteristics and locations of underground storage tanks	C-4
C.2	Waste storage area characteristics	C-5
C.3	Approximate waste storage inventory	C-6

18

LIST OF TABLES (continued)

C.4	Nonradioactive, inorganic constituents of Waste Pits 3 and 5	C-10
C.5	Nonradioactive, inorganic constituents of FMPC silos	C-14
E.1	Materials detected in waste pits and incorporated in hazard analysis	E-3
E.2	Cumulative hazard level in waste pits at the FMPC, Fernald, Ohio	E-5
E.3	Relative hazard of inorganic materials	E-6
F.1	Distribution coefficient for uranium leachate measured for groundwater transport through the Minford silts of southern Ohio	F-6
F.2	Roots of the Legendre Polynominal P_4 and the weight factors for four-point, Gauss Legendre quadruature	F-20
F.3	Bulk density of unconsolidated deposits as a function of porosity	F-24
F.4	Values of independent parameters used to predict the plume downgradient of the Storm Sewer Outfall Ditch	F-30
G.1	Typical U.S. EPA Industrial Source Complex Short Term model input data for Feed Materials Production Center air quality analysis	G-3
G.2	U.S. EPA Industrial Source Complex Short-Term source input data used to model Feed Materials Production Center air pollutant emission sources	G-6
G.3	Summary of climatological data recorded at the Cincinnati Airport, Boone County, Kentucky (1947-1977)	G-12
G.4	Maximum ten-min HF concentrations predicted by Air Force Chemical Dispersion Model	G-14
G.5	Maximum 1-min NH_3 concentrations predicted by Air Force Chemical Dispersion Model	G-15
K.1	Analysis of verbal comments made at the September 3, 1986, scoping meeting	K-3
K.2	Analysis of verbal comments made at the September 22, 1986, scoping meeting	K-5
K.3	Analysis of written comments submitted for the records of the scoping meetings	K-12

EXECUTIVE SUMMARY

This Draft Environmental Impact Statement (DEIS) is issued by the U.S. Department of Energy (DOE) in accordance with the National Environmental Policy Act (NEPA) as implemented by the regulations promulgated by the Council on Environmental Quality (40 CFR, Pts. 1500-1508, November 1978) and DOE's guidelines (45 FR 20695, March 28, 1980, as amended). A notice of intent was published for this EIS on August 14, 1986, and public scoping meetings to determine the major issues and scope of the DEIS were held on September 3 and 22, 1986. DOE has prepared this DEIS to provide environmental input to the decision on the proposal to complete the renovation of the Feed Materials Production Center (FMPC), located near Fernald, Ohio. After considering all comments on this DEIS, DOE will issue a final EIS (FEIS). DOE will then issue a Record of Decision stating the Department's decision regarding this proposal and identifying all alternatives considered no sooner than 30 days after issuance of the FEIS.

To maintain a viable production facility and to enhance environmental, health, and safety conditions, DOE is implementing renovation activities that are based on project-specific environmental evaluations; the evaluations of projects were documented on 166 Fact Sheets (Appendix I) and two environmental assessments.

DOE is completing 161 renovation projects including 9 directed actions and proposes to conduct an additional 82 renovation projects at FMPC. The basic process at this plant is the conversion of uranium-containing residues and uranium compounds to uranium metal for use in DOE's defense programs. These renovation projects are intended to (1) improve environmental, safety, and health conditions and production reliability; (2) enhance management of Resource Conservation and Recovery Act hazardous and radioactive waste materials; and (3) except for the cessation of metal production alternative, restore production to a level that will meet future national defense needs. Under separate activities approved by the U.S. Environmental Protection Agency (EPA), DOE intends also to clean up areas that have been contaminated by past operations. These separate activities are Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) removal and remediation actions. Throughout this DEIS, the phrase "remedial action" is used for both "removal" and "remedial action" as defined in CERCLA. Key areas of concern are silos containing residues from processing pitchblende ore that are emitting radon and gamma radiation, and waste pits that were used for solid and liquid waste storage. These waste pits are suspected of being responsible for an eastward-moving plume of contaminated groundwater and a southward-moving plume that has moved past the plant boundary toward the community of Fernald. This DEIS evaluates the impacts resulting from the remedial action sites as they currently exist but defers evaluation of specific remedial action to the remedial investigation/feasibility study (RI/FS) process. Future remedial actions may require additional evaluations under NEPA. It is DOE policy to integrate the NEPA process into the RI/FS. As future remedial actions are evaluated for FMPC, the need for additional NEPA documentation will be

assessed, and the NEPA requirements will be integrated into the RI/FS as needed.

Ongoing and proposed renovation is plantwide. Some projects have decreased the amount of uranium that is released from exhaust stacks, decreased contaminated runoff that enters the surface waters and groundwaters, decreased nitrates in the plant liquid effluents, and decreased worker exposure during some maintenance procedures (see Table S-1).

This DEIS evaluates the following alternatives: (1) the present situation at FMPC, which assumes the completion of the 161 renovation projects including nine directed activities begun prior to September 30, 1989, but assumes no further action (no action alternative); (2) completion of an additional 82 renovation projects to begin after the Record of Decision (ROD) is issued (proposed action); (3) cessation of metal production followed by termination of residue processing 8-10 years later but including 49 renovation projects (cessation of metal production alternative); and (4) relocation of FMPC operations, which is briefly analyzed, although an in-depth evaluation is not possible because no specific locations have been identified.

Key areas of concern that are evaluated include air quality, water resources, ecology, radiological impacts, worker radiation and chemical exposure, waste management, and socioeconomics. A comparison of environmental impacts associated with prerenovation (1985), present situation (predominantly 1985-89), proposed action (renovation projects after 1989), and cessation alternative (after 1989) demonstrates trends for each of the key areas of concern and identifies the contributions of plant operations and remedial action sites to these impacts.

Nonradiological Effects

Air quality. Before renovation began in 1985, pollutant levels in emissions were below the national ambient air quality standards. Production activities are assumed to increase for the present situation and proposed action; thus, general increase in emissions (but still below standards) would occur for both these alternatives. Cessation of metal production would result in decreases of SO_x, NO_x, CO, and particulate matter because the boiler plant would reduce operations. In the past, hydrogen fluoride (HF) concentrations were high enough to cause concern that damage to vegetation and adverse effects on cattle might occur. Monitoring to detect potential damage would occur under the present situation and proposed action alternative. HF emissions occurring under the cessation of metal production alternative would be less than 15% of the present situation and proposed action emissions and would not be a concern.

Water resources. The present situation alternative would result in a tenfold increase in biochemical oxygen demand and total suspended solids discharged to the Great Miami River compared to 1985, primarily because of operation of a new facility designed to reduce nitrates to meet national pollution discharge limits. The advanced wastewater treatment facility

Table S-1. Summary of principal renovation activities for the present situation (PS), proposed action (PA), and cessation of metal production alternative (CA) renovation activities that are expected to reduce impacts on the environment

Renovation Activity	Plant/on-site location (alternative)	Purpose
Refurbish or replace existing dust collectors, install new high-efficiency particulate air filters	1 (PS, PA, CA) 2/3 (PS, PA, CA) 4 (PS, PA) 5 (PS, PA) 6 (PS, PA) 9 (PS, PA)	Reduce stack emissions of particulates, primarily uranium; reduce worker exposure during filter changeout and back-up system for main collectors
Tank Farm	Near center of production area (PS)	Reduce hydrogen fluoride and nitric acid air emissions and potential major accidental release of nonradiological pollutants
Upgrade process wastewater treatment	Plant 8 (PS, PA) Plant 2/3 (PS, PA) Plant 6 (PS, PA) General Sump (PS, PA, CA)	Increase capacity and improve process control to more effectively reduce concentration of uranium in Feed Materials Production Center effluent
Install Biodenitrification Surge Lagoon (BSL) and BSL liner upgrade	West of production area (PS)	Provides holding capacity and final solids settling basin for liquid wastes from the General Sump and runoff from the waste pit and waste pit perimeter (Clear Well flow will be directed to the BSL)

Table S-1. (continued)

Renovation Activity	Plant/on-site location (alternative)	Purpose
Install Biodenitrification Facility (BDN), including a high-nitrate wastewater holding tank, a four-tower BDN system, and a BDN effluent treatment system	West of Plants 2/3 and 8 (PS)	Reduce concentration of nitrates from liquid waste stream. BDN effluent treatment facility will treat total suspended solids and biochemical oxygen demand for these waste streams
Stormwater Retention Basins	South of production area adjacent to south parking lot and Storm Sewer Outfall Ditch (PS)	Provide collection of production area runoff from storm sewers for a 10-year, 24-h storm event
Install Advanced Waste Water Treatment System and Water Recycle and Reuse	Sanitary waste treatment area (near Manhole 175) (PA, CA)	Remove radionuclides and hexavalent chromium for compliance with U.S. Environmental Agency-National Pollutant Discharge Elimination System effluent limitations prior to release to the Great Miami River. Capability to recycle the effluent as a process water supply if it meets process water standards

proposed for completion at the end of 1992, under the proposed action and cessation alternative, is designed to reduce these pollutants to best-available-technology limits.

Ecology. No known adverse aquatic or terrestrial impacts result from plant operations or remedial action sites, and none are predicted to occur for any of the alternatives. Stressed aquatic communities have been identified to reside in Paddy's Run. Evaluation of contaminant levels and flow patterns indicate that any stress probably results from periods of extremely low flow. This naturally occurring flow pattern is unaffected by any of the alternatives. Fluoride levels in vegetation both on- and off-site are within the range naturally occurring in plants. Compared to 1985, HF emissions would increase by about 10% under the proposed action and present situation but would decrease by 85% for the cessation of metal production alternative. Changes in fluoride concentrations in vegetation are expected to reflect changes in HF emissions.

Socioeconomics. Employment at FMPC is currently about 1120 people (present situation) and will not change significantly under either the proposed action or the cessation of metal production alternative. Employment and personal income represent only 1% of that in the three-county region surrounding FMPC. Thus, FMPC has little effect on the regional or local economics.

Radiological Effects[1]

Air Quality. The effective total-body dose to off-site individuals is the result of effluents from operations and remedial action sites. In 1985, the annual dose to the maximally exposed individual was 10.4 mrem (operation) and 81 mrem (remedial action sites). In the present situation, plant operation contributes 1.1 mrem and remedial action sites contribute 57 mrem to the maximally exposed individual. There is no appreciable decline of this dose in the future for either the proposed action or the cessation of metal production alternative because the K-65 silos are responsible for 98% of the dose to this individual. The total dose of 58 mrem attributable to FMPC operations and remedial action sites results in 7.3 chances in 1 million that a maximally exposed person would contract fatal cancer. The 58-mrem dose is in addition to the background dose of 300 mrem, which results in 38 chances in 1 million of contracting fatal cancer.

---

[1]On December 20, 1989, the National Research Council's Committee on the BEIR issued a report on the health effects of exposure to low levels of ionizing radiation (BEIR-V). This report includes information and analyses from the BEIR-IV report that are appropriate for cancer and genetic risk assessment, along with the delayed health effects that are induced by low linear energy transfer (LET) radiations such as x-rays and gamma radiation. DOE is examining the BEIR-V report to evaluate the extent to which it may affect the estimation of risks in this Draft EIS. The results of this evaluation will be included and assessed in the Final EIS.

Surface water. Beta activity increased from 5.2-pCi/L background levels in the Great Miami River to a high of 16 pCi/L downstream of the FMPC in 1987, probably because of increased levels of Tc-99. The advanced wastewater treatment project that would be done for the proposed action and cessation of metal production alternative should decrease contamination entering the river. Uranium-contaminated stormwater runoff that is discharged to Paddy's Run from the production area, has largely been eliminated. Runoff outside the production area, such as around the waste pits, continues to pollute that stream and will be addressed by the RI/FS program. Above-background levels of uranium were found only in Paddy's Run: 235 and 6.8 pCi/L in 1985 and 1987, respectively, compared with background levels of 1.0 pCi/L. If Paddy's Run had been used as a drinking water source in 1987, the dose to the user would have been 1.3 mrem.

Groundwater. Surface water runoff infiltration into the Great Miami Aquifer has resulted in a southward-moving plume of uranium-contaminated water. The average uranium concentration in the three off-site wells found to be contaminated has remained near 200 pCi/L since 1985[1]. Although these wells are not used as sources of drinking water, a dose of 38 mrem/year would result if an individual were to drink 2 L/day for a year of water from these wells. The zone of maximum contamination is believed to have passed by these wells. Contaminated water leaking from the waste pits has resulted in an eastward-moving plume that is still within the site boundary. This plume poses no immediate threat to public health. Plant operation under any alternative does not affect this plume. The exact locations of the plumes and their associated impacts are being addressed as part of the RI/FS process.

Soils. Soil contamination results from the deposition of airborne uranium and is limited mainly to on-site locations. Uranium emissions would greatly decrease from the 1985 levels (315 kg) under the present situation (65 kg), proposed action (50 kg) and cessation (34 kg) alternatives. Five of the twenty-five off-site sampling locations had uranium levels above background in 1987. The highest concentration was 14 pCi/g, compared with a 4.5-pCi/g background level. The maximum dose from eating produce grown in gardens sampled near FMPC is 0.008 mrem/year. Contaminated soils on-site will be addressed by the RI/FS activity.

Ecology. There are no known adverse effects on terrestrial or aquatic communities due to radioactive contamination. In 1985, maximum levels of uranium in terrestrial vegetation ranged from 1.2 pCi/g on-site to 0.47 pCi/g off-site. Background levels are about 0.1 pCi/g. In 1987, both on-site and off-site maximum levels were 0.43 pCi/g. These levels are not expected to decrease significantly in the future under any alternative. Levels would probably decrease only as a result of remedial actions.

---

[1]Since completion of the analyses for this Draft EIS, new data have become available on the extent of groundwater contamination. These new data will be appropriately addressed in the Final EIS and will be considered as part of the RI/FS process.

Radiological and chemical exposure of workers. National Institute for Occupational Safety and Health studies have indicated that there is a general need for better housekeeping in the work areas of FMPC, but no chemical or radiological exposure standards have been found to be exceeded. DOE goals regarding exposure are based on the as-low-as-reasonably-achievable concept, and 57 projects designed to achieve these goals have been completed since 1985. Forty-two projects to decrease worker exposure are included in the proposed action, 25 of which are part of the cessation of metal production alternative. Good quantification of worker exposure is needed to verify that these goals are being met.

Waste management. In the past, some wastes were placed in the pits and silos at FMPC and some were incinerated. Today, all wastes are packaged for future disposal or for shipping to off-site disposal at the Nevada Test Site (NTS) or to the Toxic Substances Control Act incinerator at the Oak Ridge Gaseous Diffusion Plant in Tennessee. Approximately 550 truck shipments/year for five years are needed to remove all backlogged construction and operational waste for the present situation alternative. The proposed action increases those shipment needs to about 700 per year, and the cessation of metal production decreases shipments to about 400 per year. The maximum exposure of a truck driver during a trip to NTS has been measured to be 11 mrem. An accident that exposes a worker to contamination for two hours during cleanup is projected to result in a dose of ~5 mrem. These levels are 4% and 1%, respectively, of the radiation received from natural background sources per year.

Conclusion

In conclusion, 243 renovation projects are completed, initiated, or proposed for FMPC. Because the 161 renovation projects that comprise the present situation are largely directed at obvious and immediate concerns, most of the benefits (reduction of actual or potential exposure) to be derived by the public from these projects will be realized upon completion of these projects. Worker health and safety will benefit from the proposed action scheduled to begin after issuance of the ROD. Forty-two of the proposed action renovation projects are designed to improve worker health and safety. Twenty-five of these projects are included in the cessation of metal production alternative. In addition, the proposed advanced wastewater treatment system will reduce contaminants in the effluent released to the Great Miami River by a factor of about 10. Radiological impacts from the present situation, proposed action and cessation of metal production alternatives are similar. Remedial action sites are responsible for 98% of the off-site radiological dose to the maximally exposed individual; thus, remedial action projects have good potential for additional benefit. Primary sources of off-site dose or potential dose are the K-65 silos, the southward-moving plume, and the waste pits. The RI/FS process will define specific EPA-approved actions to clean up contaminated sites and other contamination resulting from past operations.

ABBREVIATIONS, ACRONYMS, AND INITIALISMS

ADC	administrative dose control
AEA	Atomic Energy Act of 1954
AEC	Atomic Energy Commission
ALARA	as low as reasonably achievable
AMS	air monitoring station
AWWT	Advanced Wastewater Treatment
BAT	best available technology
BDN	Biodenitrification Facility
BMP	Best Management Practices
BOD	biochemical oxygen demand
BSL	Biodenitrification Surge Lagoon
CA	Cessation Alternative
CAA	Clean Air Act of 1970 (Amendments of 1977)
CEQ	Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CFR	*Code of Federal Regulations*
CMSA	Consolidated Metropolitan Statistical Area
CWA	Clean Water Act of 1977
DE	drum equivalent
DEIS	Draft Environmental Impact Statement
DOE	U.S. Department of Energy
DOT	U.S. Department of Transportation
EA	environmental assessment
EIS	environmental impact statement
EPA	U.S. Environmental Protection Agency
ERA	Environmental Remedial Action project
ES&H	environmental safety and health
FEIS	Final Environmental Impact Statement
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
FR	*Federal Register*
FWS	U.S. Fish and Wildlife Service
GMA	Great Miami Aquifer
HEPA	high-efficiency particulate air
HF	Hydrogen fluoride
HSWA	Hazardous and Solid Waste Amendments of 1984
ICRP	International Council for Radiation Protection
IS	interim site
ISCST	Industrial Source Complex, Short-Term
LLW	low-level (radioactive) waste
MEE	maximum expected earthquake
MOU	Memorandum of Understanding
NAAQS	National Ambient Air Quality Standards
NCRP	National Council on Radiation Protection and Measurements
NEC	National Electric Coil
NEPA	National Environmental Policy Act of 1969
NESHAP	National Emission Standards for Hazardous Air Pollutants
NIOSH	National Institute for Occupational Safety and Health

NPDES	National Pollutant Discharge Elimination System
NRC	U.S. Nuclear Regulatory Commission
NTS	Nevada Test Site
ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
ORAU	Oak Ridge Associated Universities
ORGDP	Oak Ridge Gaseous Diffusion Plant
OSHA	Occupational Safety and Health Administration
PA	Proposed Action Alternative
PCB	polychlorinated biphenyl
PGA	peak ground acceleration
PS	Present Situation Alternative
RACT	reasonably available control technology
RCRA	Resource Conservation and Recovery Act of 1976
RI/FS	Remedial Investigation/Feasibility Study
RM	river mile
RMI	Reactive Metals, Inc.
ROD	Record of Decision
SARA	Superfund Amendments and Reauthorization Act of 1986
SCS	Soil Conservation Service (USDA)
SDWAA	Safe Drinking Water Act Amendments
SIP	Ohio State Implementation Plan
SSE	safe shutdown earthquake
SSOD	Storm Sewer Outfall Ditch
SWOAPCA	Southwestern Ohio Air Pollution Control Agency
SWRB	Stormwater Retention Basin
TLD	thermoluminescent dosimeter
TSCA	Toxic Substances Control Act of 1976
TSP	total suspended particles
TSS	total suspended solids
WMCO	Westinghouse Materials Company of Ohio
WPASRC	Waste Pit Area Stormwater Runoff Control

CHAPTER 1

PURPOSE OF AND NEED FOR THE PROPOSED ACTION

The U.S. Department of Energy (DOE) is completing 161 renovation projects, which include 9 directed actions, and proposes to conduct an additional 82 renovation projects at the Feed Materials Production Center (FMPC) located near Fernald, Ohio, approximately 32 km (20 miles) northwest of Cincinnati. This document evaluates the environmental impact of this proposal and three alternative actions and also reviews the potential environmental consequences of the principal remedial action sites as they currently exist. FMPC is a DOE-owned manufacturing facility developed in 1951 for the production of uranium metal used in U.S. defense programs. The potential environmental consequences of the proposed action and each alternative are evaluated in this Environmental Impact Statement (EIS), which has been prepared pursuant to the National Environmental Policy Act (NEPA) of 1969 (Pub. L. 91-190).

1.1 PURPOSE AND NEED

The mission at FMPC is to fabricate uranium metal for use at other DOE installations, but FMPC operations before 1980 also involved thorium processing. Peak production levels occurred in 1960 but declined through the 1970s to a point at which DOE considered closing the facility. During the decline, capital expenditures for maintenance and improvements decreased. However, from 1982 through 1987, the demand for uranium metal increased; and DOE began planning and implementing renovation projects to meet environmental health and safety goals and to enable FMPC to meet projected uranium metal demands of the defense program through the year 2000. Uranium metal production has been temporarily suspended at FMPC.

The proposed action is intended to improve environmental, safety, and health conditions; restore production capacity to a level that will meet future national defense needs; and enhance management of hazardous and radioactive wastes. Under separate EPA-directed activities, DOE intends to remediate areas that have been contaminated by past operations.

1.2 BACKGROUND

1.2.1 FMPC Operations

FMPC is located on a 429-ha (1050-acre) rural site. Eight production buildings and various support buildings (including administration, security, services, and utilities) occupy about 55 ha (136 acres) in the central portion of the site. Other on-site structures include sumps, a sewage treatment plant, waste chemical storage pits, and waste storage silos. A detailed description of the production facilities is provided in

Chap. 2, and Appendix B gives an overview of the production processes at FMPC.

Operations at FMPC generate hazardous and nonhazardous forms of solid wastes, liquid effluents, and atmospheric emissions. Past FMPC operations have resulted in environmental contamination, the significance of which is evaluated in this EIS. In November and December 1984, public attention was drawn to FMPC operations, in particular to environmental and occupational health and safety conditions, following the release of 120-170 kg (265-375 lb) of uranium to the atmosphere by a malfunctioning air emissions control system. In response to public concern, DOE issued a report on the historical uranium releases from FMPC (Boback et al. 1986), which also offered recommendations for operational procedure changes and pollution control improvements. Additional reviews of environmental and occupational health and safety conditions at FMPC followed (ORAU 1985; GAO 1985).

In addition, the following state and federal agency interactions with DOE have resulted in the need for some immediate environment, safety, and health improvements:

1. In July 1986, DOE and Region V of the U.S. Environmental Protection Agency (EPA) signed a Federal Facility Compliance Agreement (FFCA) (EPA 1986). The FFCA addresses environmental protection activities at FMPC pursuant to the Clean Air Act and the Resource Conservation and Recovery Act, as well as remedial actions to be undertaken pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). Currently, a new CERCLA 120 Federal Facilities Agreement is being negotiated between DOE and Region V of the U.S. EPA to amend the CERCLA activities in the preexisting FFCA.

2. In June 1987, Director's Findings and Orders were issued by the Ohio Environmental Protection Agency (OEPA) regarding facility effluents (OEPA 1987).

3. A consent decree was negotiated between Ohio and DOE regarding FMPC hazardous waste and the control of FMPC wastewater and runoff (Ohio 1988). This consent decree was signed in December 1988. With the signing of the consent decree, the Director's Findings and Orders became a part of the consent decree.

1.2.2 Renovation

To maintain a viable production facility and to enhance environmental, health, and safety conditions, DOE is implementing renovation activities that are based on project-specific environmental evaluations; the evaluations of major projects were documented on 166 Fact Sheets (Appendix I) and two environmental assessments (EAs). Two EAs were prepared for the thorium handling project (Project 146) and the construction and operation of the Decontamination and Decommissioning Facility (Project 147).

Planning for the renovation of FMPC started in 1982, and the design activities began in 1983. By August 1989, 224 renovation projects (Appendix A) were identified. By September 30, 1989, 161 of these were initiated or completed to address immediate concerns and to respond to directives from environmental regulators. The proposed action is to complete the remaining 82 projects. Finally, the cessation of metal production alternative involves completion of 49 renovation projects and termination of metals production. The initiation of these projects will not begin until the Record of Decision (ROD) for this EIS is issued.

1.2.3 Remedial Action

Some remedial actions have been completed at the FMPC site, but most remedial action will occur after the sitewide Remedial Investigation/Feasibility Study (RI/FS) has been implemented in accordance with the terms of the FFCA between DOE and EPA. In general, the RI consists of (1) collecting and analyzing existing data, determining whether emergency removal of contamination is necessary, and developing a work plan and a community relations plan and (2) preparing a site characterization study that consists of field data collection and evaluation. The FS identifies technology and process options, develops alternative remedial actions, and selects those alternatives that are most promising. EPA will decide which remedial actions will be implemented under the RI/FS process. The selected alternatives will be published in a separate ROD.

Remedial actions will occur sitewide and possibly off-site following the recommendations in the feasibility study and published in the RI/FS ROD. It is anticipated that most remediation will occur in the waste storage areas located in the northwest part of the site. The work plan for the RI/FS was approved by EPA in May 1988. The schedule for completion of the RI/FS and the ROD is under negotiation. After the RI/FS ROD is made, the Environmental Remedial Action Project will implement specific remedial actions at FMPC; the duration of the Environmental Remedial Action Project is expected to be about 15 to 20 years. Future remedial actions may require additional evaluations under NEPA. It is DOE policy to integrate the NEPA process into the RI/FS. As future remedial actions are evaluated for FMPC, the need for additional NEPA documentation will be assessed, and the NEPA requirements will be integrated into the RI/FS as needed.

1.3 SCOPE OF THIS EIS

This EIS provides an analysis of the environmental impacts of 82 proposed FMPC renovation projects to improve environmental, health, and safety conditions associated with operation of the facility. This EIS also evaluates the present situation in which 161 projects are completed and reviews the potential environmental consequences of the principal remedial action sites as they currently exist. Although the level of future production is uncertain, this EIS places an upper bound on potential impacts due to operation by assuming that FMPC will operate at the "maximum production capability," which is estimated to be about 8.1×10^6 kg/year (8.9×10^3 tons/year) of uranium metal. Finally, this EIS examines the

effects of a cessation alternative in which 49 renovation projects are completed and metal production is terminated.

Public scoping meetings were held on September 3 and 22, 1986, at the Crosby Township School. Appendix K summarizes the comments raised during the scoping process. Major issues raised were (1) radiation doses to the general public and workers; (2) chemical exposure effects to the general public, workers, and ecological resources; (3) exposure pathways, including surface water, groundwater, air, and direct radiation; (4) socioeconomic impacts associated with traffic, expenditures, and cultural resources; (5) monitoring and mitigation; and (6) cumulative impacts.

Scoping helped determine the alternatives considered in this EIS. The various alternatives summarized here are discussed in detail in Chap. 2.

Present Situation—No Action

The present situation alternative consists of 161 renovation projects that include 9 directed actions that were initiated prior to September 30, 1989. This alternative is considered the no action alternative since these renovation projects will be completed or begun prior to the ROD for this EIS and no further projects will be undertaken after September 30, 1989. Potential environmental consequences of the principal remedial action sites as they currently exist are evaluated in this alternative and in Sect. 4.4. Impacts of the present situation alternative are discussed in Sect. 4.1.

Proposed Action

The proposed action consists of 82 renovation projects that would begin after the ROD for this EIS is issued. The proposed action would restore the capacity of the plant to a level that will meet future national defense needs, reduce radiological and nonradiological exposures to workers and the public, and minimize the environmental impact of plant operation. Remedial action required to correct existing environmental problems would also be performed. Impacts caused by completing the planned renovation are assessed in Sect. 4.2. Impacts of remedial action sites are assessed in Sect. 4.4.

Cessation of Metal Production Alternative

The cessation alternative would result in the cessation of uranium metal production in Plants 5, 6, 9, and the Pilot Plant. Activity in Plant 4 would cease after the receipt of UF4 from Paducah is completed. Plant 2/3 (Refinery), Plant 1 (Sampling Plant) and Plant 8 (Scrap Recovery Plant) operations would continue for eight to ten years in order to extract uranium from stored residues. Other plant operations necessary to support site environmental clean up and remedial activities would also continue until the clean up is complete (15 to 20 years). Renovation projects (49) would be completed to support the residue processing and remedial action activities. These include operation of the Biodenitrification Facility,

the General Sump, the Advanced Waste Water Treatment Facility (a proposed project), the Stormwater Retention Basin, and the Boiler Plant.

Relocation

The relocation alternative would involve relocating production activities within the existing FMPC site, relocating to one or more existing DOE sites, or relocating to a new DOE site. No further renovations to existing FMPC facilities would occur if relocation were selected. The environmental consequences of these subalternatives are discussed in Chap. 2.

1.4 REFERENCES

Boback, M. W., D. A. Fleming, T. A. Dugan, R. W. Keys, and R. B. Grant 1986. History of FMPC Radionuclide Discharges, FMPC-2058, November 1986.

EPA (U.S. Environmental Protection Agency, Region V) 1986. Federal Facility Compliance Agreement (for the U.S. Department of Energy's Feed Materials Production Center in Fernald, Ohio).

GAO (U.S. General Accounting Office) 1985. Environment and Workers Could be Better Protected at Ohio Defense Plants, GAO/RCED-86-61, U.S. Government Printing Office.

OEPA (Ohio Environmental Protection Agency) 1987. Director's Findings and Orders for the Feed Materials Production Center, Ohio Environmental Protection Agency Director's Journal, June 26, 1987.

Ohio (State of Ohio) December 2, 1988. Consent Decree Between Plaintiff State of Ohio and Defendant Department of Energy, Civil Action No. C-196-0217.

ORAU (Oak Ridge Associated Universities) 1985. Environmental Program Review of the Feed Materials Production Center, Fernald, Ohio, Oak Ridge, Tenn.

CHAPTER 2
ALTERNATIVES INCLUDING THE PROPOSED ACTION

Chapter 2 presents descriptions of the proposed action and alternatives, followed by a summary and comparison of the environmental impacts. The proposed action and alternatives are summarized in Sect. 2.2 and are described in detail in Sect. 2.3. A summary comparison of impacts among the alternative actions is given in Sect. 2.4. An overview of the FMPC operation is provided in the following section.

2.1 OVERVIEW OF FMPC OPERATION

This section provides a brief description of FMPC facilities and operations as they existed in October 1985 and major changes in facilities and operations through September 1989. October 1985 was the earliest completion date of one of approximately 10 projects begun prior to that date (Project 324*). Process operations, facility interrelationships, and areas of concern are briefly outlined, while methods of control and management of gaseous, liquid, and solid wastes are discussed in more detail.

2.1.1 Process Summary

The Production Area at FMPC is within a fenced area near the center of the site, as shown in Fig. 2.1-1. The locations of the major production buildings and utility services are shown in Fig. 2.1-2. The relationship of the processes in these buildings (plants) and a detailed discussion of FMPC operations are given in Appendix B.

The basic process performed at FMPC (Fig. 2.1-3) is the conversion of uranium-containing residues and uranium compounds to uranium metal. Producing uranium metal requires a series of chemical and metallurgical conversions that occur in eight specialized on-site chemical and metal plants. The basic uranium compound necessary for the production of uranium metal is uranium tetrafluoride (UF_4, commonly called green salt). This compound is produced in the FMPC chemical plants from uranium-bearing oxides or the conversion of uranium hexafluoride (UF_6) to UF_4. In the Metals Production Plant (Plant 5), UF_4 is converted to uranium metal derbies, and some of the derbies are melted to form ingots. In the Special Products Plant (Plant 9) special oversized ingots are cast from derbies and recycled metal, and ingots are machined into billets. From Plant 9 the uranium ingots and billets go to Plant 6 (Metal Fabrication Plant) where billets are heat treated for off-site extrusion. Final machining, inspection, and shipping of the finished products are then performed.

---

*Appendix A includes a list and description of renovation projects.

ORNL-DWG 88-12386R8

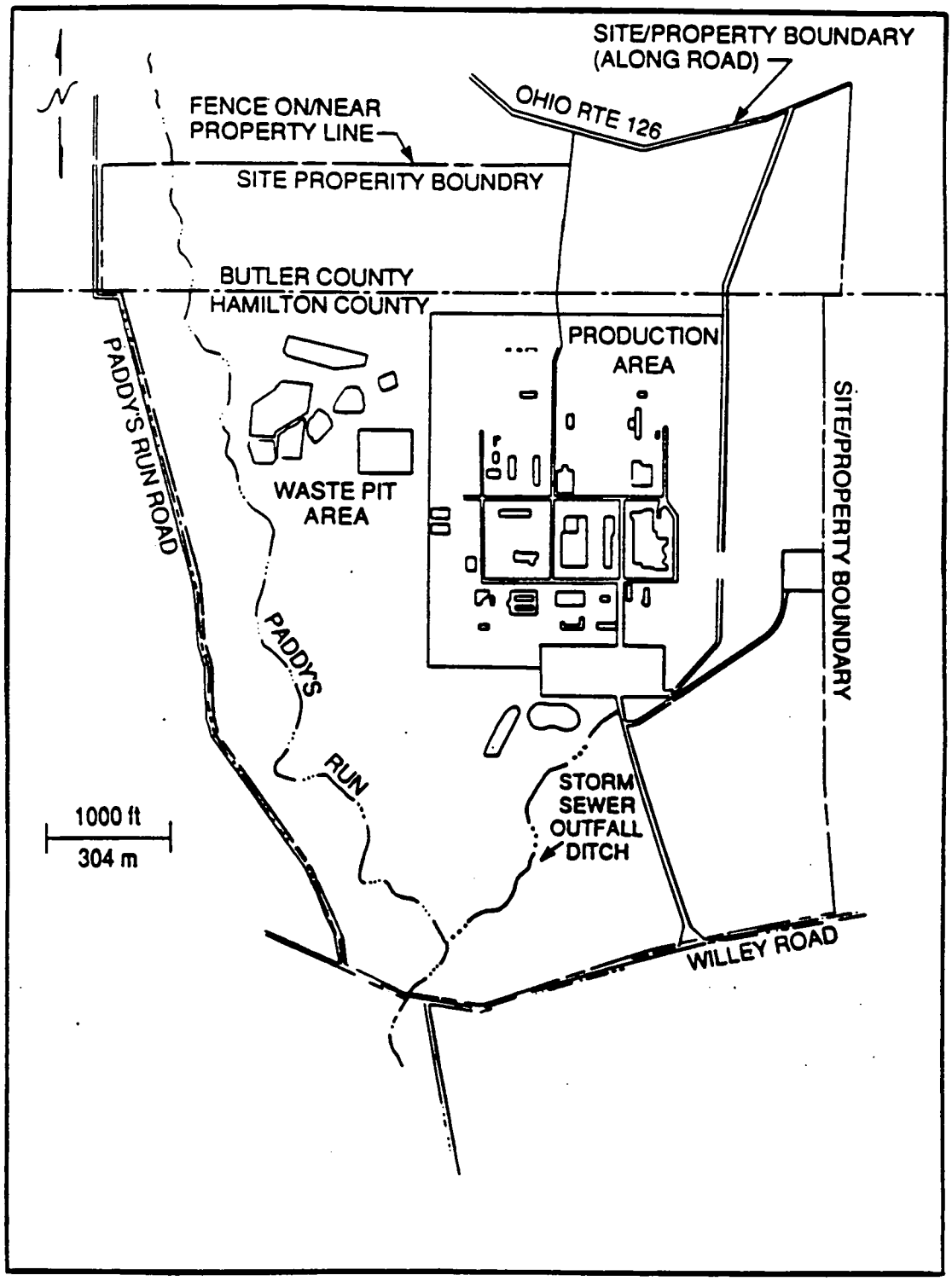
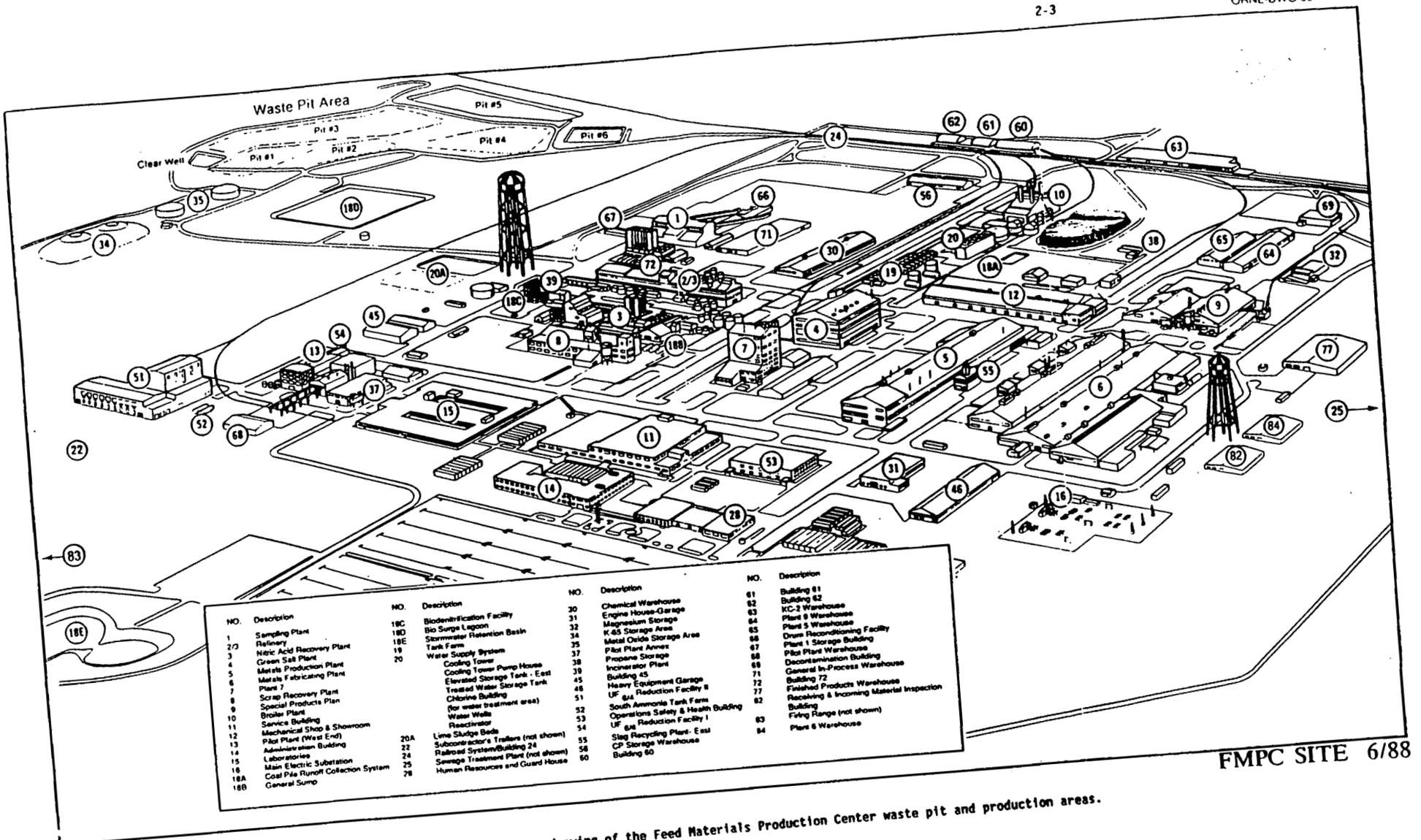


Fig. 2.1-1. Feed Materials Production Center site map.

ORNL-DWG 89-7594R



NO.	Description
1	Sampling Plant
2/3	Refinery
3	Nitric Acid Recovery Plant
4	Green Salt Plant
5	Metals Production Plant
6	Metals Fabricating Plant
7	Plant 7
8	Scrap Recovery Plant
9	Special Products Plan
10	Broiler Plant
11	Service Building
12	Mechanical Shop & Showroom
13	Pilot Plant (West End)
14	Administration Building
15	Laboratories
16	Main Electric Substation
18A	Coal Pile Runoff Collection System
18B	General Sump
18C	Biodenitrification Facility
18D	Bio Surge Lagoon
18E	Stormwater Retention Basin
19	Tank Farm
20	Water Supply System
	Cooling Tower
	Cooling Tower Pump House
	Elevated Storage Tank - East
	Treated Water Storage Tank
	Chlorine Building (for water treatment area)
	Water Wells
	Reservoir
20A	Lime Sludge Beds
22	Subcontractor's Trailers (not shown)
24	Railroad System/Building 24
25	Sewage Treatment Plant (not shown)
28	Human Resources and Guard House
30	Chemical Warehouse
31	Engine House-Garage
32	Magnesium Storage
34	K-65 Storage Area
35	Metal Oxide Storage Area
37	Pilot Plant Annex
38	Propane Storage
39	Incinerator Plant
45	Building 45
46	Heavy Equipment Garage
51	UF6/4 Reduction Facility II
52	South Ammonia Tank Farm
53	Operations Safety & Health Building
54	UF6/6 Reduction Facility I
55	Slag Recycling Plant- East
56	CP Storage Warehouse
60	Building 60
61	Building 61
62	Building 62
63	KC-2 Warehouse
64	Plant 8 Warehouse
65	Plant 5 Warehouse
66	Drum Reconditioning Facility
67	Plant 1 Storage Building
68	Pilot Plant Warehouse
69	Decontamination Building
71	General In-Process Warehouse
72	Building 72
77	Finished Products Warehouse
82	Receiving & Incoming Material Inspection Building
83	Firing Range (not shown)
84	Plant 6 Warehouse

Fig. 2.1-2. Perspective drawing of the Feed Materials Production Center waste pit and production areas.

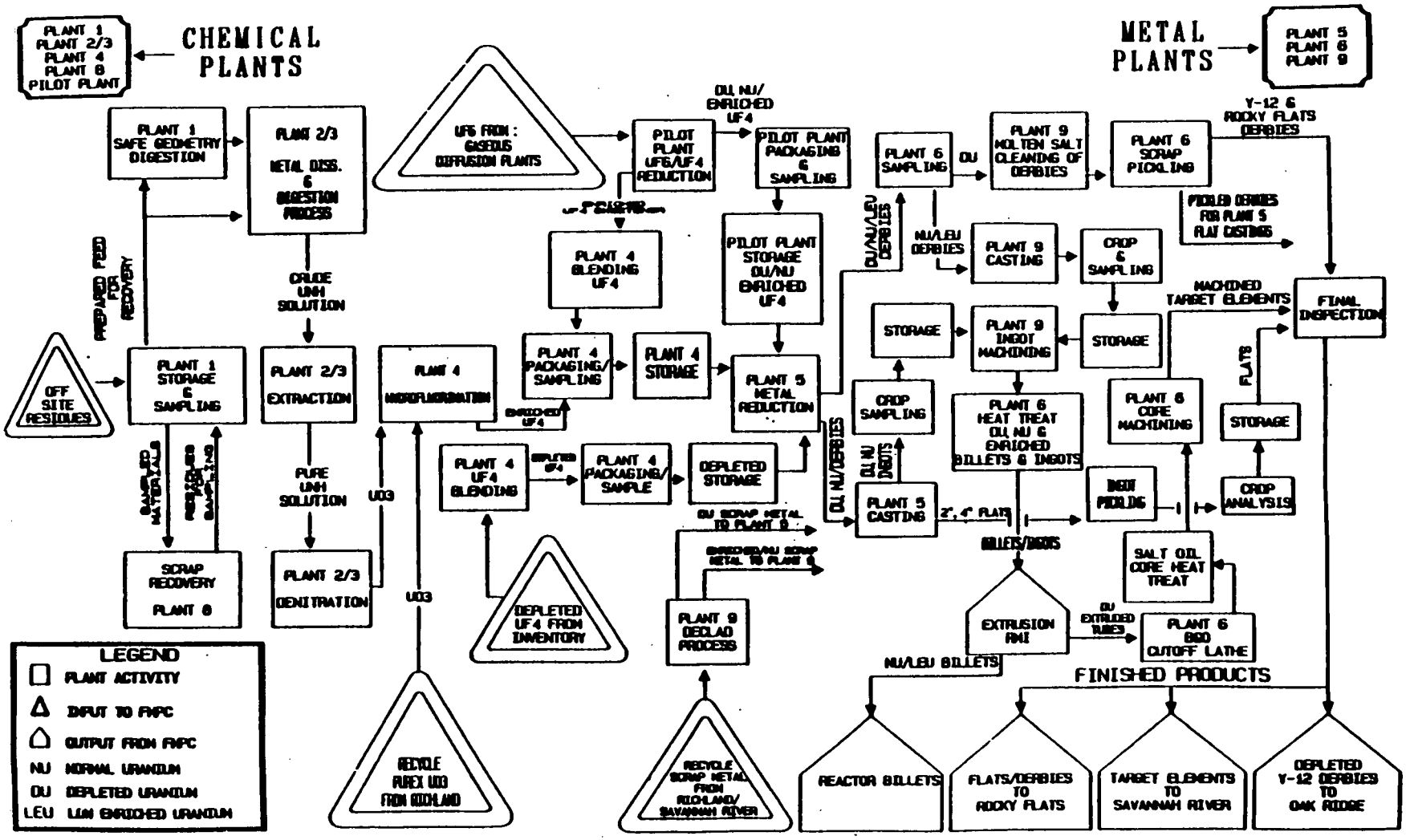


Fig. 2.1-3. Feed Materials Production Center process flow block diagram.

The finished uranium metal production is then shipped, as needed, to Rocky Flats, Colorado; Savannah River, South Carolina; Oak Ridge, Tennessee; and Hanford, Washington, for use in DOE's national defense programs.

2.1.2 Waste Management

Virtually all gaseous, liquid, and solid wastes at FMPC originate within the production area. These wastes and their control are examined in the following sections.

2.1.2.1 Atmospheric emissions

Uranium production operations produce dust particles and gases. These operations are conducted in ventilated enclosures or buildings. Exhaust air is passed through dust collectors or scrubbers and released to the atmosphere through stacks. Fifty-five dust collectors were available for use in October 1985, but much of this equipment was old, unreliable, or not capable of satisfying current technological standards. Many of these dust collectors were replaced by September 30, 1989. Since the mid-1950s, dust collector discharges have been evaluated through continuous stack sampling, although it was determined in July-August 1988 that some vents and stacks have not been monitored for uranium. Stack samplers and monitors, as well as off-site monitors, help determine whether releases result in violation of environmental standards and whether mitigative measures are needed at the production facility.

The 1984 failure of the Plant 9 (Special Products Plant) dust collector prompted a review of FMPC dust collector operating procedures. Improved dust collector operations procedures in 1985 reduced the amount of airborne radionuclide emissions (Sect. 4.1.4). Since 1985, projects replacing dust collecting and air handling equipment have been initiated to further reduce these emissions (Appendix A).

Several FMPC operations involve the use of hazardous fluids such as nitric acid (HNO_3), hydrogen fluoride (HF), and ammonia (NH_3). Fumes from these operations are generally controlled by being collected in aqueous scrubber devices. An example of a renovation project addressing fumes is the Scrap Pickling and Handling Facility at Plant 6 (Project 40). In addition, operations at the tank farm where hazardous fluids are stored lacked the emission controls to prevent releases of these vapors during filling or purging of the storage tanks. The renovation of the tank farm is to be completed under the present situation alternative (Project 38.)

2.1.2.2 Liquid wastes

Liquid wastes generated at FMPC consist of process wastewater, sanitary sewage, and stormwater runoff. Process wastewaters are produced in virtually all the production areas (or plants) discussed in Appendix B. Within the plant are individual treatment facilities capable of pretreating the process liquid wastes. In these plant treatment units, a large amount of the uranium compounds dissolved in the liquid wastes is precipitated and removed as sludge or filter cake, which, in turn, can be recycled through

the facilities for uranium recovery or dried in Plant 8, drummed, and shipped off-site for disposal. Disposal of the final filter cake is discussed in Sect. 2.1.2.3. The filtrate is then sent to the General Sump (Fig. 2.1-4).

The General Sump is a collection of various sizes of vertical tanks and pumps, piping, and valves designed for treatment of the liquid wastes. This facility is built on a concrete pad with curbs for spill and rainfall containment. Process wastewater is received at the General Sump in separate batch volumes from the production plants or service facilities, checked for suspended solids content, and segregated or combined as required. If a particular liquid volume does not meet the specifications for suspended solids, it is sent to Plant 8 for solids recovery and returned to the General Sump. Various reagents and coagulation aids can be added to the liquid wastes in the tanks as necessary to promote the precipitation of other soluble materials. These precipitates are collected and disposed of with other solid wastes (Sect. 2.1.2.3).

Waste slurries, including neutralized refinery raffinate, General Sump slurry, and slag leach slurry, are sent to Plant 8 for filtering on rotary vacuum filters. The filtrate is pumped back to the General Sump for subsequent discharge to the Great Miami River in accordance with the National Pollutant Discharge Elimination System (NPDES) permit and DOE regulations. Disposal of the filter cake as a solid waste is discussed in Sect. 2.1.2.3.

In 1985, treated effluent was discharged to the Wet Chemical Waste Pit (No. 5) in the waste pit area (Fig. 2.1-2). This pit provided the holdup time for chemical neutralization and additional settling of solids. The supernatant liquid was collected in the Clear Well and discharged to the Great Miami River. Pit 5 was taken out of service in 1987. In previous years, Pit 3 was also used to contain effluent from the General Sump. In 1977, Pit 3 was taken out of use and covered with soil. Wet waste pits 3 and 5 have been identified among the remedial action sites being characterized in the Remedial Investigation/Feasibility Study (RI/FS) process (see Sect. 2.3.2 and Appendix C). Pit 5 is still uncovered and exposed to the weather.

Sanitary sewage from the Sanitary Sewer System and process waste water from the Biodenitrification Facility is pumped to the Sewage Treatment Plant for treatment. The Sewage Treatment Plant effluent is analyzed for total suspended solids (TSS), pH, total fecal coliform bacteria, residual chlorine, and biochemical oxygen demand (BOD) in compliance with the terms and conditions of the NPDES permit. This effluent is discharged to the Great Miami River by way of Manhole 175 (Fig. 2.1-4).

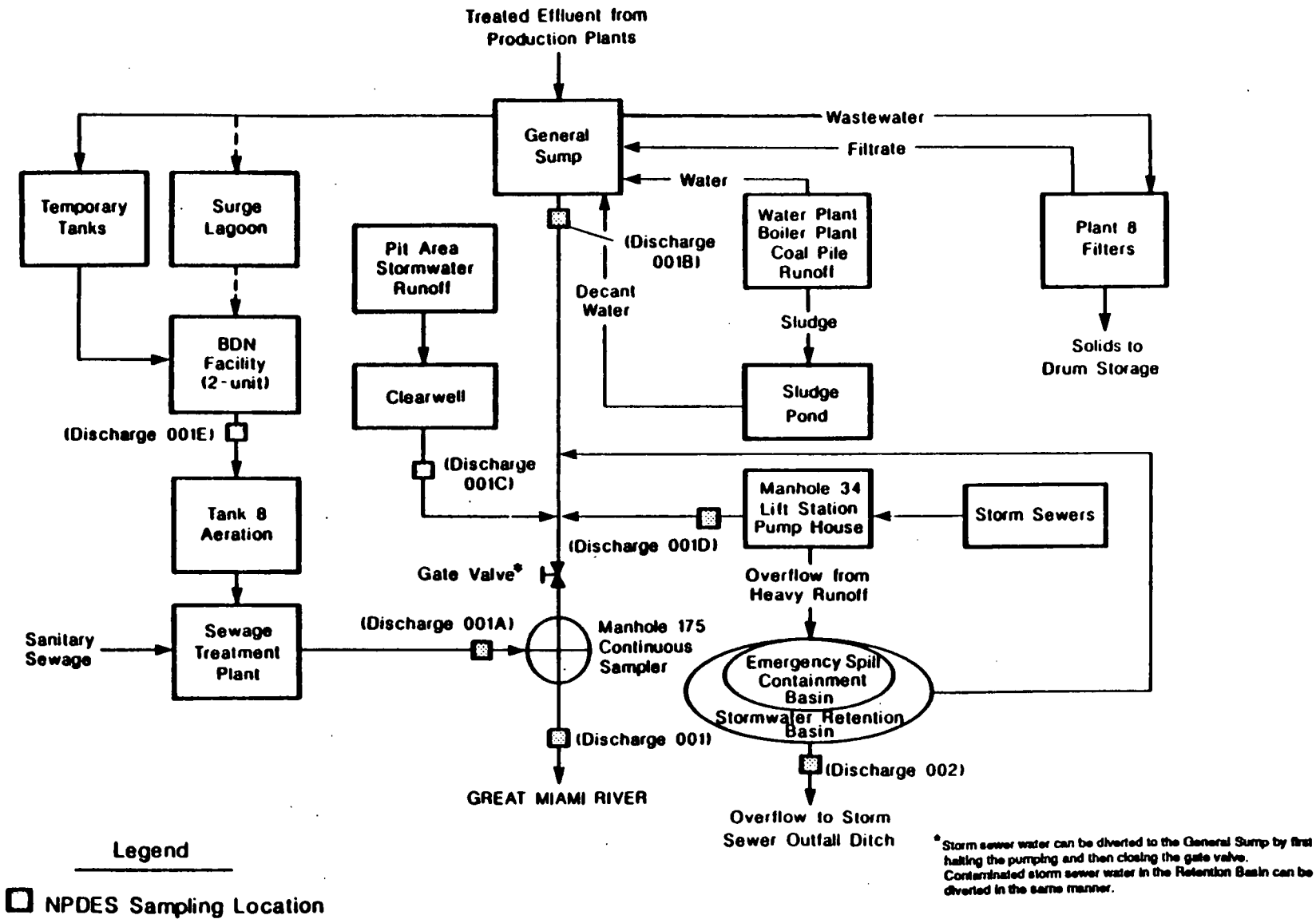


Fig. 2.1-4. Feed Materials Production Center liquid waste stream flow diagram in 1988.

The FMPC storm sewer system collects surface runoff, which contains uranium from portions of the Production Area and surrounding terrain. In 1987, a Biodenitrification Facility was placed on-line to remove nitrates from process wastewaters. Under normal conditions, the storm sewer water drains to Manhole 34 and is pumped by the Storm Sewer Pumping Station to Manhole 175, where it is combined with other plant effluents for discharge to the Great Miami River. Prior to November 1986, during times of heavy precipitation, stormwater runoff bypassed the Storm Sewer Pumping Station and was discharged to the Storm Sewer Outfall Ditch (SSOD), where the contaminated runoff entered the groundwater or flowed into Paddy's Run (see Sect. 3.6). In 1986, a 6.5-million-gal Stormwater Retention Basin (SWRB) was built to intercept this runoff, settle the solids, and pump the effluent to Manhole 175. In 1988, an expansion to the existing Stormwater Retention Basin (an additional capacity of 4.5 million gal) was completed to increase the capability of the basin to contain runoff from a 10-year/24-h storm event.

Much of the runoff from the waste pit area is collected in the Clear Well, after which it is pumped to the Great Miami River via Manhole 175. However, some of the runoff from the waste pit area flows directly into Paddy's Run.

Wastewater from the FMPC water treatment facility and the steam plant (boiler) and the decant from the coal pile runoff collection basin are sent to the General Sump (Fig. 2.1-4) for treatment before discharge.

2.1.2.3 Solid waste

The FMPC production processes generate solid waste that must be treated, stored, and ultimately disposed. These wastes can be grouped into four categories: low-level radioactive waste (LLW), hazardous waste, mixed (radioactive and chemically hazardous) waste, and conventional industrial waste.

LLW generated at FMPC includes wet filter cake and neutralized raffinate sludge from pretreatment of process waste streams (discussed in Sect. 2.1.2.2) dry slag, ash, metallic uranium fines, dust collector filters, and miscellaneous trash containing above-background levels of uranium. The major chemical components of FMPC LLW are metal oxides; nitrates of copper, aluminum, and iron; calcium oxide; uranium metal and several uranium oxides; magnesium fluoride; and magnesium metal.

The uranium content of the various waste streams varies from ~0.05% uranium in solids in the neutralized refinery raffinate sludge and slag leach filter cake to 80-100% uranium in discarded metal and uranium oxides. The isotopic percentage of U-235 is 0.2-1.1% in waste materials containing above-background levels of uranium.

Before early 1985, most of the FMPC process solid waste was disposed of in dry on-site pits—nos. 1, 2, 4, and 6 in Fig. 2.1-5 (See Appendix C).

ORNL-DWG 88-12384R2

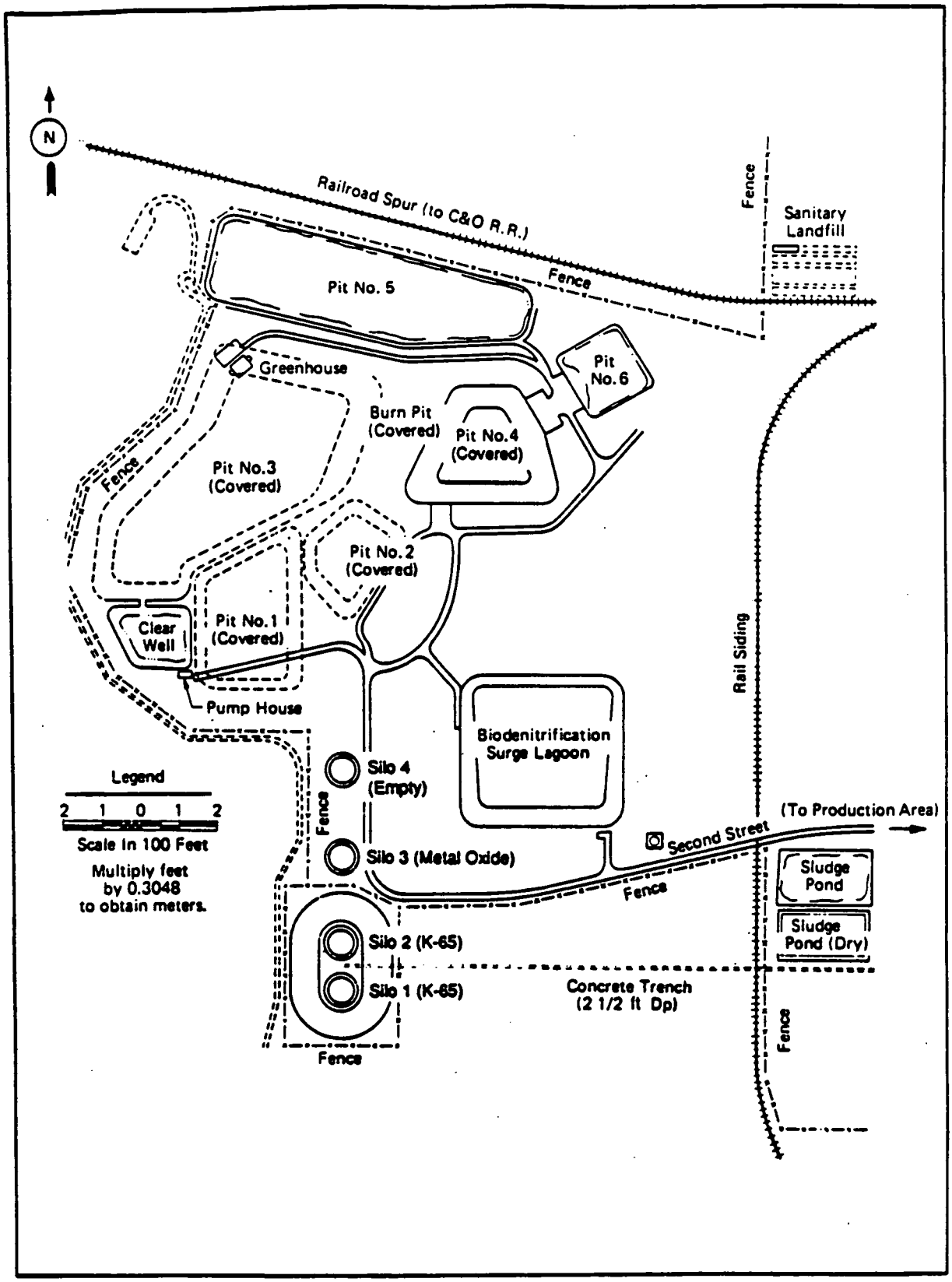


Fig. 2.1-5. Feed Materials Production Center waste storage area.

Pit 6 was the last operating dry pit and was closed in 1986. Pits 1 and 2 have been covered. An interim cover has been placed over Pit 4 pending final closure. Pit 6 is still open and subject to weather conditions. Since 1985, LLW has been packaged in drums, boxes, or other appropriate containers approved by DOE and the U.S. Department of Transportation. The wastes are either shipped off-site for disposal or stored in warehouses or on pads unprotected from the weather for later shipment. Shipment of LLW to the Nevada Test Site (NTS) was begun in 1985. The impacts of up to 320 truck shipments of these wastes per year were evaluated in DOE/EA-0260 (DOE 1985). Subsequently, a DOE Action Description Memorandum (ADM) and an approved memorandum to file (DOE 1987a) was prepared addressing the increase in shipments from 320 to 1600 per year. A summary of the impacts of LLW transport is provided in Sect. 4.1.6.4.

Hazardous and mixed radioactive/hazardous waste materials are being packaged and either stored on-site until final disposition is determined or shipped off-site for disposal. The principal off-site shipment of hazardous chemicals involves the transportation of oils and solvents contaminated with PCBs to the Oak Ridge Gaseous Diffusion Plant (ORGDP) incinerator at Oak Ridge, Tennessee. Transportation impacts from shipping these types of wastes from DOE sites to the ORGDP incinerator were evaluated in DOE/EIS-0084 (DOE 1982).

After it is monitored, conventional nonradioactive, nonhazardous industrial solid waste is disposed of at nearby municipal waste disposal facilities.

Uranium trioxide (UO_3) is a key feed material for the production of uranium metal. This material is shipped from Hanford, Washington, to FMPC. If uranium metal production declines at FMPC and UO_3 is not converted to metal, the amount of UO_3 stored at FMPC may significantly increase. Therefore, these materials will be properly managed in order to minimize potential worker exposure and to prevent an accumulation of a material that could be considered a waste material in the future.

2.1.3 Thorium management

Since 1972, FMPC has served as the DOE storage site for thorium. Approximately 1100 metric tons of thorium residues are stored at several locations on the FMPC site (Table 2.1-1). Thorium in the Plant 8 silo and bins had the potential for release of thorium during a catastrophic failure. The thorium-filled silo and bins were also the source of worker exposure to gamma radiation. Removing and packaging the thorium in the Plant 8 silo and bins (Project 146) eliminated these hazards and was evaluated in an Environmental Assessment (DOE 1988).

Two hundred twelve deteriorated drums of thorium were stored outdoors. These drums of thorium presented a hazard of thorium releases to the environment and ignition of combustible thorium metal. All 212 deteriorated drums will be overpacked (Project 177). This project was evaluated in a NEPA checklist (DOE 1988). This project will eliminate the hazard posed by the deteriorated drums.

Table 2.1-1. Thorium inventory composition (metric tons thorium)

Material form	Metric ton	Location
ThO_2 dense (GE-Bettis)	4.3	Bldg. 67
ThO_2 sol gel	25.9	Bldg. 67
Pilot Plant - WIP	9.2	Pilot Plant Tank #2 & Lab
Impure thoria gel	338.3	Pilot Plant Warehouse
Thorium oxides	174.6	Bldg. 60
Thorium oxalate cake	1.2	Bldg. 67
Thorium nitrate crystals	1.2	Bldg. 67
Low-grade residues from general atomic	321.7	Bldg. 65
Off-site thorium hydroxide	10.8	Bldg. 67
Off-site thorium oxides	74.4	Bldg. 67
Thorium nitrate solution	0.9	Bldg. 67
ThF_4	0.8	Bldg. 67
Metal	79.9	West Bldg. 65 and Bldg. 67
Clad metal	4.4	West Bldg. 65
Alloyed metal	3.5	West Bldg. 65 and Bldg. 67
Historical samples	0.5	Bldg. 67, West Bldg. 65
High-grade residues (>30% Th)	35.7	Bldg. 67, West Bldg. 65
Low grade residues (<30% Th)	0.2	Bldg. 67
TOTAL	1087.5	

A third thorium project is the overpacking and on-site storage of 8800 drum-equivalents of thorium residues. These thorium materials, along with all other thorium residues, are now stored in on-site warehouses. Final disposition of thorium materials has not been determined.

2.2 ALTERNATIVES

Four alternatives are considered in this EIS:

1. the present situation (no action) alternative,
2. the proposed action alternative,
3. the cessation of metal production alternative, and
4. the relocation alternative.

These four alternatives differ in the extent to which the production and waste management facilities would be renovated. All the alternatives would involve metal production at maximum capacity except the cessation alternative, under which metal production would cease. The salient characteristics of the proposed action, present situation, and cessation of metal production alternatives are summarized in Table 2.2-1. The relocation alternative is presented in Sect. 2.2.4.

No decisions on remedial actions will result from this EIS. Remedial actions are being selected through the RI/FS process and are subject to approval by the EPA. Separate RI/FS-NEPA documentation will be written to address environmental impacts from future FMPC site remediation.

2.2.1 Present Situation (No Action) Alternative

The present situation alternative consists of 161 renovation projects including 9 directed actions that were started before September 30, 1989 (Appendix A, Table A.5). Many of these projects have been completed, and the remainder of the renovation projects are scheduled to be started before the EIS Record of Decision is completed. No further projects will be initiated under this alternative. Therefore, this alternative is essentially the no action alternative. Twenty-five of these projects account for most of the environmental benefits of the present situation alternative (Appendix A, Table A.1). Four of these projects reduce conventional nonradiological air emissions, 14 projects reduce uranium emissions to the atmosphere, 1 directed remedial action project reduces radon emissions, and 6 projects reduce discharges of water pollutants. The remaining projects are designed primarily to improve plant reliability and worker health and safety.

Table 2.2-1. Salient characteristics of the proposed action, present situation, and cessation of metal production alternatives

Characteristic	Alternatives		
	Present situation (no action)	Proposed action	Cessation of metal production
Renovation begins	May 1984 (Project 324)[a]	After issuance of Record of Decision (ROD)	After isssuance of ROD[b]
Renovation complete	June 1991 (Project 69)[a]	Dec. 1996 (Project 226) or later[a]	Dec. 1996 (Project 226) or later[a]
Number of renovation projects	161	82[c] projects	49[c,d]
Maximum production capacity	8.1×10^6 kg (8900 tons)/ year uranium	8.1×10^6 kg (8900 tons)/ year uranium	No uranium metal

[a]See Appendix A. Not all projects have completion dates.

[b]Not before October 1989.

[c]These projects are separate from the 161 present situation renovation projects.

[d]These projects are 49 of 82 in the proposed action.

2.2.2 Proposed Action Alternative

The proposed action alternative consists of 82 renovation projects (Appendix A, Table A.2) that are planned to begin after the ROD for this EIS is issued. Four of these projects account for most of the environmental and public health benefits of the proposed action. One is a water pollution control project, and the other 3 are uranium air emission control projects. The remaining 78 projects are designed primarily to improve plant reliability and worker health and safety. Remedial actions required to correct existing environmental problems would also be performed.

2.2.3 Cessation of Metal Production Alternative

The cessation alternative would result in the cessation of uranium metal production in Plants 5, 6, 9, and the Pilot Plant. Activity in Plant 4 would cease after the receipt of UF4 from Paducah is completed. Plant 2/3 (Refinery), Plant 1 (Sampling Plant) and Plant 8 (Scrap Recovery Plant) operations would continue for eight to ten years in order to extract uranium from uranium containing residues. Other plant operations necessary to support site environmental cleanup and remedial activities would also continue until the cleanup is complete (15 to 20 years). Renovation projects (49) would be completed to support the residue processing and remedial action activities. These projects are a subset of the 82 proposed action projects. These include operation of the Biodenitrification Facility, the General Sump, the Advanced Waste Water Treatment Facility (a proposed project), the Stormwater Retention Basin, and the Boiler Plant.

One of the 49 projects, the water pollution control project, accounts for most of the environmental and public health benefits of renovation projects under this alternative. The remaining projects are designed to improve facility reliability and worker health and safety in the residue processing areas. Remedial actions required to correct existing environmental problems would also be performed.

2.2.4 Relocation Alternative

An alternative to renovation of existing facilities is relocation of the activities conducted at FMPC. This alternative could involve (1) rebuilding production facilities already existing on the FMPC site, (2) relocating production activity to uranium production facilities existing at one or more other DOE sites, or (3) constructing replacement facilities at an undeveloped DOE site. A screening assessment of these subalternatives is given (Table 2.2-2). Separate NEPA documentation will be written if the relocation alternative becomes a viable alternative. In any case, the necessary remedial actions expected for the proposed alternative at the FMPC site would still be conducted by the FMPC RI/FS process.

Relocation Subalternative 1: New facilities would be built on land available within the existing FMPC site, and the existing production

Table 2.2-2 Summary of impacts for the three relocation subalternatives

	Relocation on the present site (Subalternative 1)	Relocation to another DOE site (Subalternative 2)	Relocation to a new site (Subalternative 3)
Air quality	Designed to meet standards	Designed to meet standards	Designed to meet standards
Surface water	Designed to meet standards	Designed to meet standards	Designed to meet standards
Groundwater	Designed to minimize groundwater impacts	Designed to minimize groundwater impacts	Designed to minimize groundwater impacts
Aquatic and terrestrial ecology	Same as present situation (Sect. 2.4)	Located to avoid adverse impact	Located to avoid adverse impact
Radiological dose	Same as present situation (Sect. 2.4)	Major radiation dose sources from FMPC remedial action sites (e.g. K-65 silos and waste pit fugitives) not present at new site Designed to meet standards	Major radiation dose source from FMPC remedial action sites (e.g. K-65 silo and waste pit fugitives) not present at new site Designed to meet standards
Worker health and safety	State-of-the-art facility minimizes adverse impacts to workers	Same as on site	Same as on site
Waste	Construction rubble from FMPC decommissioning much greater than proposed action Process waste similar to present situation; waste from decommissioning existing production facility added to waste stream; future waste from decommissioning new facility must be disposed of	Construction rubble from FMPC decommissioning much greater than proposed action Process waste similar to present situation; waste from new facility will be added to existing waste streams; waste from decommissioning the existing facility and the new facility must be disposed of by DOE	Construction from FMPC decommissioning much greater than proposed action Process waste similar to present situation; however, there is no backlog waste or existing process waste streams at new facility, however, these waste as well as waste from decommissioning the existing and the new facility will have to be disposed of by DOE

Table 2.2-2 (continued)

	Relocation on the present site (Subalternative 1)	Relocation to another DOE site (Subalternative 2)	Relocation to a new site (Subalternative 3)
Transportation	Greater number of waste shipments as a result of FMPC decommissioning	Greater number of waste shipments as a result of FMPC decommissioning	Greater number of waste shipments as a result of FMPC decommissioning
	About 200 shipments per year from process waste	About 200 shipments per year from process waste	About 200 shipments per year from process waste
Socioeconomics	Short-term increase in expenditures over proposed action	Dependent on size of community	Dependent on size of community
	Short-term increase in traffic impacts over proposed action	Site specific analysis required	Site specific analysis required

facilities would be removed. Sufficient land exists at the current FMPC site to rebuild the production facilities and associated support facilities (WMCO 1987); however, it is improbable that new facilities would be allowed to be built over the aquifer existing beneath the site. The new facilities would employ state-of-the-art equipment for controlling air emissions and wastewater effluents from packaging and handling solid wastes, and for minimizing worker exposure. Waste treatment would be in accordance with current environmental regulations, and about 200 shipments per year are anticipated for process waste. This option would, however, produce significantly more solid waste than would the proposed action because of demolition of the existing facilities and future demolition of the new facilities. Detailed evaluation of the impacts of decommissioning the existing facilities would be provided in separate NEPA documentation. Employment and expenditures in the immediate area and region would not change except for some increase during the construction phase.

Relocation Subalternative 2: FMPC functions would be moved to existing facilities at other previously developed DOE sites. The principal effects of this alternative in the immediate FMPC area would be reduced employment and financial activities as well as elimination of gaseous, liquid, and solid wastes from FMPC operation. There would be similar but opposite changes at the selected DOE sites. However, it is not likely that all FMPC activities could be transferred to other DOE sites. At least as much waste would probably be generated as that generated at a new facility (200 shipments of process waste per year).

Local employment would be reduced by about 1000 workers and direct expenditures would be reduced by about $57 million if FMPC operations were relocated from the existing FMPC site. Including secondary socioeconomic factors, the regional impact would be less than 0.5% of the regional socioeconomic base. This negative economic impact of closing FMPC would be within the normal fluctuations of economic activity in the Cincinnati-Hamilton region. A mitigating factor not considered in this analysis of plant closure is the economic benefits that would result from decommissioning FMPC. Impacts of decommissioning the FMPC facilities would be addressed in separate NEPA documentation.

Relocation Subalternative 3: FMPC would be rebuilt on an undeveloped (i.e., "greenfield") site. No such site has been identified; however, it would probably be an undeveloped portion of an existing DOE site. The plant would be identical to the one considered in Relocation Subalternative 1. State-of-the-art production processes and equipment would be used, as well as state-of-the-art pollution control equipment. The environmental impacts should be less than those for Relocation Subalternative 1 because of the opportunity to establish more restrictive siting criteria than possible at the FMPC site. The waste impacts would likely be less than those associated with Relocation Subalternative 2 because a new facility with state-of-the-art technologies would be more effective than existing DOE uranium production facilities in minimizing the production of wastes. With the use of an existing DOE reservation, it is not expected that the economic impacts at the new location would be significant, because the existing socioeconomic infrastructure should be

able to absorb the increased employment. The same adverse socioeconomic impacts on the region surrounding the FMPC site would be observed as associated with Relocation Subalternative 2. It is assumed that the RI/FS process would be completed at FMPC and that separate NEPA documents would be required for both the new production site and for the decontamination and decommissioning of the existing site.

In general, the primary benefits gained by relocation are improved worker health and safety conditions if a new plant is built. Relocation to a new site would probably eliminate the possibility of any contaminants entering a major aquifer. In comparison, emissions from a new site would be similar to those from a fully renovated FMPC facility—a new facility built at any location would have to be decommissioned in the future, thus adding a large amount of additional waste to be disposed of. Furthermore, relocation may not be physically possible, because no existing DOE site has the uranium production capability of FMPC. Relocation to an area on the existing FMPC reservation is probably not possible, because it is unlikely that a new facility would be allowed to be built over the aquifer beneath FMPC. Thus, it is concluded, on balance, that the relocation alternatives are not viable options and that it would not be reasonable to discuss them further in this document. If the relocation alternative ever became viable, separate NEPA documentation would be written.

2.3 OVERVIEW OF RENOVATION AND REMEDIAL ACTION PROJECTS

Approximately 240 renovation projects and 9 directed actions have been planned. One hundred and sixty-one renovation projects (Appendix A), including 9 directed actions (Sect. 4.4) that would be completed or started by September 30, 1989, constitute the present situation alternative. These projects and activities were initiated as a result of immediate concerns for the effects of plant emissions to the environment, worker health and safety, and plant reliability. They also respond to directives from federal and state regulatory agencies. Eighty-two additional projects constitute the proposed alternative, and 49 of these projects constitute the cessation of metal production alternative (Appendix A). An overview of the major projects completed or planned is given here. A detailed listing of all projects is given in Appendix A. Project identification numbers given in this section are defined in Appendix A.

2.3.1 Renovation

The renovation projects for all alternatives are intended to (1) improve environmental and worker safety and health conditions and production reliability, (2) enhance management of hazardous and radioactive waste materials, and (3) except for the cessation of metal production alternative, restore production capacity to a level that will meet future national defense needs. Renovation projects, concentrated primarily in or adjacent to the production area of the FMPC site, are planned to be completed by the mid-1990s.

Table 2.3-1 presents a brief list of the renovation projects that have the greatest potential for environmental impact (positive or negative)

Table 2.3-1. Summary of principal renovation activities for the present situation (PS), proposed action (PA), and cessation of metal production (CA) renovation activities that are expected to reduce impacts on the environment

Resource category	Renovation activity	Plants/on-site location (alternative)	Purpose
Air	Refurbish or replace existing dust collectors; install new high efficiency particulate air (HEPA) filters (PS, PA)	1 (PS, PA, CA) 2/3 (PS, PA, CA) 4 (PS, PA) 5 (PS, PA) 6 (PS, PS) 9 (PS, PA)	Reduce stack emissions of particulates, primarily uranium; reduce worker exposure during filter changeout, and provide a backup system for main collectors
	Tank Farm (PS)	Near center of production area (PS)	Reduce HF and HNO_3 air emissions and potential major accidental release of nonradiological pollutants
Water	Upgrade process wastewater treatment (PS, PA)	Plant 8 (PS, PA) Plant 2/3 (PS, PA) Plant 6 (PS, PA) General Sump (PS, PA, CA)	Increase capacity and improve process control to more effectively reduce concentration of uranium in FMPC effluent
	Install Biodenitrification Surge Lagoon (BSL) and BSL liner upgrade (PS)	West of production area (PS)	Provide holding capacity and final solids settling basin for liquid wastes from the General Sump and runoff from the waste pit and waste pit perimeter (Clear Well flow to be directed to the BSL)

Table 2.3-1 (continued)

Resource category	Renovation activity	Plants/on-site location (alternative)	Purpose
Water	Install Biodenitrification Facility (BDN), including a high nitrate wastewater holding tank, a four-tower BDN system, and a BDN effluent treatment system	West of Plants 2/3 and 8 (PS)	Reduce concentration of nitrates from liquid waste stream. BDN effluent treatment facility will treat TSS and BOD for these waste streams
	Stormwater Retention Basins	South of production area adjacent to south parking lot and Storm Sewer Outfall Ditch (SSOD) (PS)	Provide collection of production area runoff from storm sewers for a 10-year, 24-h storm event
	Install Advanced Waste Water Treatment (AWWT) and Water Recycle and Reuse	Sanitary waste treatment area (near Manhole 175) (PA, SA)	Remove radiounuclides and hexavalent chromium for compliance with DOE and NPDES effluent limitations prior to release to the Great Miami River. Provide capability to recycle the effluent as a process water supply if it meets process water standards

to natural resources such as air, groundwater, surface water, aquatic ecology, and terrestrial ecology. Figure 2.1-3 shows the location of existing facilities, and Fig. 2.3-1 shows the location of major new facilities. Short descriptions of all of these projects are in Appendix A, Table A.7. All present situation and proposed action and cessation alternative projects are listed in Appendix A, Tables A.4, A.5, and A.6 respectively. These tables also note for each project whether air quality, water quality, or worker health are affected.

2.3.1.1 Atmospheric emission control

All nonradiological and most significant radiological air emission control projects will be completed under the present situation alternative. Most of the air emission projects involve refurbishment or replacement of dust collectors for many separate internal operations or facilities within the plant buildings. High-efficiency particulate air (HEPA) filter equipment will be installed in the ventilation system for equipment at the production facilities where the greatest amount of fine uranium-bearing particulates are likely to be produced. The source terms for stack emissions of uranium and other emissions to the atmosphere are based principally on a combination of engineering specifications for the equipment expected to be used and from the monitoring data from existing generation rates. Installation of a new dust collector system, including a HEPA filter, in the Special Products Plant (Plant 9) was completed in 1987 (Project 205) to replace a system that failed in late 1984 and caused a major atmospheric release of uranium. Many of the other projects for replacement of dust collectors have also been initiated. Installation of 15 stack monitors and alarms connected to the Security Communications Center was completed in 1986 (Project 176) to provide immediate local and remote alarms in the event of a dust collector malfunction.

Replacement of the chemical storage facilities (Tank Farm) (Project 38) began in 1987 with the relocation of anhydrous ammonia, kerosene, and tributyl phosphate storage tanks. The first phase of this project was completed in early 1988. Construction of the new main Tank Farm includes state-of-the-art ammonia- and acid-unloading stations, containment dikes, vapor collection with scrubbers to control vapor loss to the atmosphere, and a sump area for treatment of rainwater collected in the diked area. Major improvements include substantial reductions in emission of vapors (NH_3, HNO_3, and HF) during filling or purging of storage tanks and reduction of the possibility of catastrophic failure. Installation of remote controls for process requirements reduces worker exposure to the hazards of working at the Tank Farm.

Air quality is monitored at several locations surrounding FMPC. Two high-volume air monitoring stations were added in 1986 (Projects 9 and 66) to the existing seven stations located along the site boundary. In 1987, four additional monitoring stations were added at off-site locations to sample air. An expanded radon monitoring program was initiated, and radon-sensitive monitoring devices were installed at both the fence surrounding the K-65 silos and at the FMPC site boundary in each of the 16 cardinal-compass directions.

DWG 88-12386R

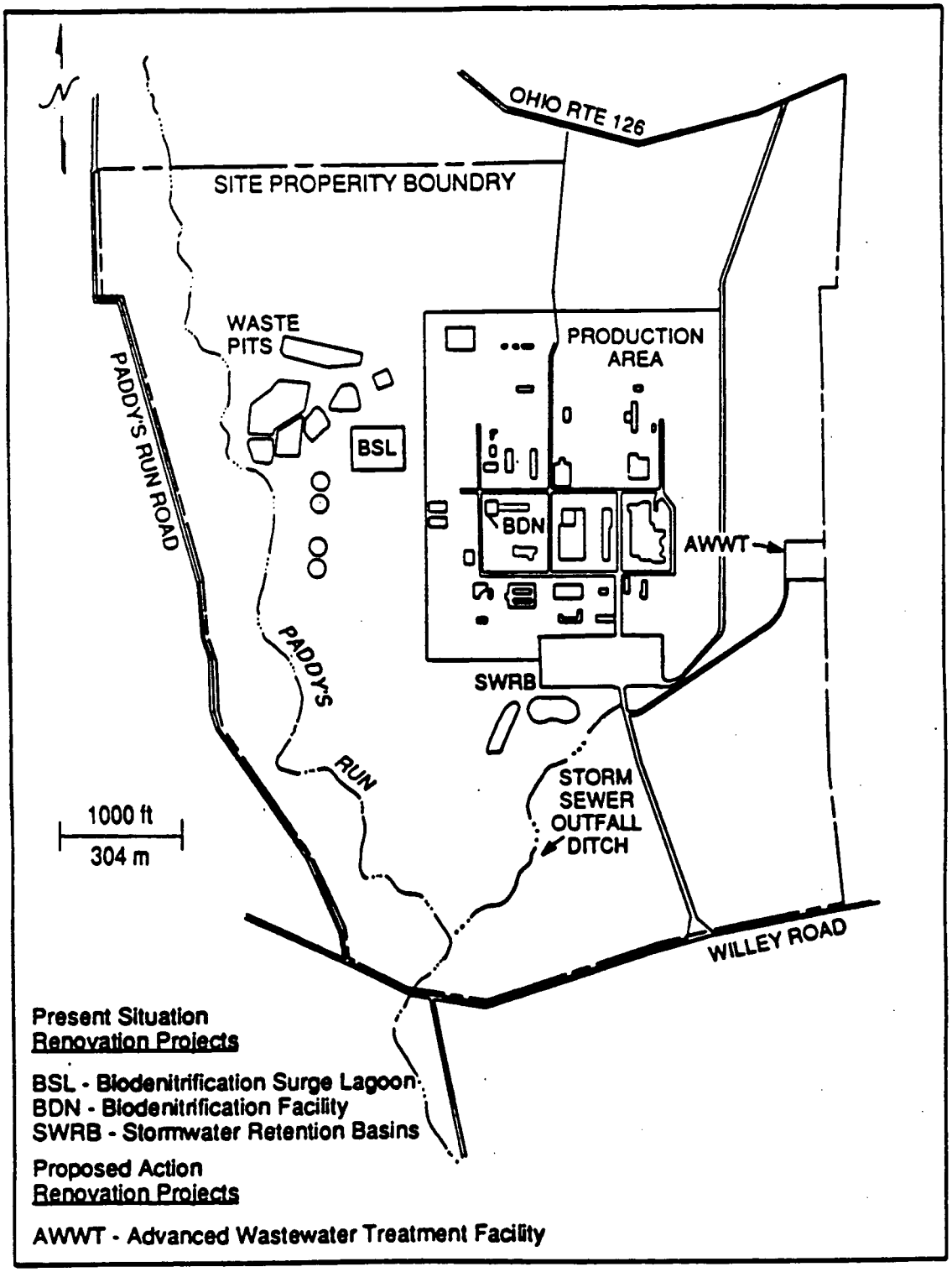


Fig. 2.3-1. Map of the Feed Materials Production Center showing the location of major new facilities that will be completed under the present situation and are part of the proposed action and cessation of metal production alternatives.

2.3.1.2 Liquid effluent control

These specific plant process waste control projects are all part of the present situation alternative, except for the Advanced Wastewater Treatment facility, which is both a proposed action and a cessation alternative project. These projects include

1. Increased capacity and improved process control at the General Sump and Plant 8 sump (Appendix A, Table A.7, Projects 52 and 61). Reduced worker exposure to radiation is also a major benefit of these projects.

2. Replacement of wastewater collection and treatment systems within other production buildings, such as the Refinery (Appendix A, Table A.7, Project 53) and the Metals Fabrication Plant (Plant 6).

3. Improved nitric acid recovery from Plant 2/3 raffinate (Appendix A, Table A.7, Project 72).

4. Building of the Advanced Wastewater Treatment (AWWT) Facility under the proposed action and cessation alternatives (Project 143).

Projects that provide for improved control and reduced discharge of effluents to the Great Miami River include the Biodenitrification Surge Lagoon (BSL), the Biodenitrification (BDN) Facility and the proposed Advanced Wastewater Treatment (AWWT) Facility at Manhole 175 (Fig. 2.3-1.) The Biodenitrification Surge Lagoon, located between the waste pits and the Production Area (Fig. 2.3-1), replaces Pit 5 as a settling/flow equalization basin for liquid process waste. As part of the Biodenitrification Facility, a high-nitrate holding tank for wastewaters with high-nitrate concentrations will be provided. This tank will allow for blending of nitrates to the Biodenitrification Facility system for optimum treatment. The Biodenitrification Surge Lagoon was first placed on line in February 1987 (Project 243). After leaks were discovered in the inner Biodenitrification Surge Lagoon liner, a project was initiated to replace the liner. All leachate was collected in the underdrains and pumped back into the Biodenitrification Surge Lagoon. No leakage through the bentonite liner was found. Temporary tanks were installed to replace the Biodenitrification Surge Lagoon function while the Biodenitrification Surge Lagoon was cleaned out and the liner replaced (Project 249). The new liner was installed in December 1988, as required by the Director's Findings and Orders.

The Biodenitrification Facility (Project 24) is designed to treat nitrate-containing liquid wastes that are received from the Biodenitrification Surge Lagoon and high-nitrate holding tank. This facility consists of four towers containing biological material that reacts with the nitrates in liquid waste passing through the facility. When completed in 1989, the treated liquid wastes will be discharged to a Biodenitrification Facility Effluent Treatment Plant for removal of BOD and TSS. The operation of the effluent treatment facility reduces the amount

of liquid flow and loading through the Sewage Treatment Plant, thus allowing the facility to more effectively treat sanitary wastewater.

A variety of projects are included to reduce the amount of contaminated rainwater runoff from solid waste storage areas. For the present situation, these projects include the repair of concrete storage pads with the added provision of curbs. The proposed action projects include enclosing or sheltering of the storage areas from rainfall (Project 138).

A major project to collect and treat runoff has been completed. The SWRBs, consisting of two basins (Projects 242 and 247) located near the southwest corner of the South Parking Lot and the upper end of the Storm Sewer Outfall Ditch (Fig. 2.1-1), receive overflow from the Manhole 34 Lift Station Pump House (Fig. 2.1-4). The first basin of the SWRB, completed in 1986 with a capacity of 24,000 m^3 (19 acre-ft), can hold the Lift Station overflow during a 24-h rainfall event of 6.4 cm (2.5 in). The second basin, completed in December 1988, increased the holding capacity to 40,000 m^3 (32 acre-ft) and can contain the Lift Station overflow from a 24-h rainfall of 10 cm (4.1 in.), which is expected about once every 10 years (10 year/24-h storm event). These basins will not contain a 48-h rainfall of this magnitude.

Proposed action renovation Project 143 has four elements, of which the AWWT facility project is the most important. The other three elements in project 143 are Worker Recycle and Reuse, Process and Storm Water Runoff Control, and Waste Pit Area Stormwater Runoff Control. The AWWT facility will be installed near Manhole 175 to treat the total wastewater stream before discharge to the Great Miami River. The AWWT facility is intended to provide a higher degree of removal of radionuclides and hexavalent chromium and to ensure compliance with the latest DOE and National Pollutant Discharge Elimination System (NPDES) discharge limits. Appendix H summarizes the technologies being considered for this facility. The Waste Pit Area Stormwater Runoff Control project is a CERCLA removal action and will be covered under separate RI/FS and NEPA documentation. Although it is an element of Project 143, it is not part of the proposed action for this EIS.

2.3.2 Directed Actions

Several actions have been taken since 1985 in response to directions from state and federal regulatory agencies. These actions are based primarily on the need to alleviate immediate concerns about the environment and public and worker health.

Major projects undertaken at FMPC pursuant to directed actions between 1985 and 1989 include

- structural improvements to the thorium silo (Project 325),
- structural improvements to and sealing of K-65 silos to reduce radon emissions (Project 263),

- construction of a Stormwater Retention Basin to contain a 10-year, 24-h rainfall event to reduce discharges of runoff to Paddy's Run (Project 242),
- closure of Barium Chloride Treatment Facility (Project 326),
- interim closure of Pit 4 (Project 271),
- repackaging of bulk thorium from silos and bins (Project 146),
- investigation and remediation of coal pile runoff (Project 241), and
- Biodenitrification Surge Lagoon upgrade (Project 249).

The K-65 Silos are hazardous primarily because of radon emissions. In 1987, pursuant to the Federal Facility Compliance Agreement, the first phase of the project to reduce radon emissions (K-65 Interim Stabilization Project 263) was completed. Construction of the radon treatment system was completed in November 1987, and the system was successfully operated to reduce radon levels during renovation activities. The external application of foam to the silos, completed in December 1987, provided weather protection, insulation, improvement of the structural integrity of the silos, and reduction of radon emissions. Measurement of the pressure and temperature differentials between the insides of the silos were completed for input to the structural analysis. As part of the RI/FS process, internal video monitoring of the silos was completed in early 1988 to determine the condition of the silo domes, walls, and residues.

To collect production area stormwater runoff, two SWRBs were built with a combined storage capacity of 40,000 m^3 (32 acre-ft), the second being a directed action. This capacity is sufficient to contain a 24-h, 10-cm (4.1-in.) rainfall event, which is expected to occur once in 10 years. The installation of these basins significantly reduces the amount of contaminated runoff reaching Paddy's Run and the Great Miami Aquifer.

Directed actions also included activities to comply with RCRA. These activities include (1) closure of the Barium Chloride Waste Salt Treatment Facility and (2) interim closure of Waste Pit 4 (Project 271) to retard the infiltration of water. All activities will be completed in compliance with RCRA or other applicable regulations.

The interim closure of Waste Pit 4 was accomplished by installing clay and synthetic liners. This action does not constitute final remediation of this pit. Final remediation of this site will be assessed in the FMPC RI/FS process.

Another project removed thorium from the Plant 8 silos and bins (Project 146). This project reduced the potential for release of thorium during a catastrophic failure of these storage structures and reduced

worker exposure to gamma radiation. The thorium material is stored in on-site warehouses. Its final disposition has not been determined.

Two projects undertaken to reduce potential surface and groundwater contamination were the investigation and remediation of coal pile runoff and upgrading the liners in the Biodenitrification Surge Lagoon to control leakage.

2.3.3 Overview of Remedial Action Activities

DOE proposes to carry out all remedial actions necessary to comply with the determinations of EPA on the basis of interim findings and on the RI/FS evaluations. Most remedial action projects will be evaluated in the feasibility study as part of the ongoing RI/FS process (Sect. 1.1). A number of steps performed during the RI/FS, including identification of technology and process options, will lead to the formulation of these projects. Detailed analysis of remedial actions and alternatives will be completed under the RI/FS. This EIS evaluates potential environmental consequences of FMPC remediation sites as they currently exist.

Potential remedial action sites have been identified both on and off the FMPC site. The remedial action sites include facilities contaminated with radioactive or hazardous materials and general areas that are contaminated from releases of these materials to the environment over many years of operation. These sites are targeted for detailed evaluation during the RI/FS process. The principal adverse impacts associated with these contaminated areas are discussed in Sect. 4.5.

Throughout this DEIS the phrase "remedial action" is used for both "removal" and "remedial action" as defined in CERCLA. Four CERCLA "removal" actions that will be undertaken involve

- contaminated water pooled beneath Plant 6 and other facilities,
- south plume groundwater,
- waste-pit area stormwater runoff control, and
- K-65 silos.

2.3.3.1 On-site remedial action sites

A brief summary of the waste materials associated with about twenty remedial action sites and five general areas identified on-site is provided in Table 2.3-2. Two of the sites, K-65 silos and waste pit 4, have been the subject of directed actions (Sect. 2.3.2). More details are given in Appendix C.

Table 2.3-2. On-site Remedial Action Sites at the Feed Materials Production Center

Name	Type of waste	Quantity (yd^3)
	Surface and near-surface contaminated material locations	
Waste Pit 1	Uranium-contaminated waste	40,000
Waste Pit 2	Uranium-, thorium-contaminated waste	13,000
Waste Pit 3	Uranium-, thorium-contaminated waste	227,000
Waste Pit 4	Uranium-, thorium-contaminated waste	500,000
Waste Pit 5	Uranium-, thorium-contaminated waste	102,500
Waste Pit 6	Uranium-contaminated waste	9,000
Burn pit	[a]	[a]
Clear Well	[a]	[a]
Fly Ash area 1	Fly ash, oils, uranium	50,000
Southfield area	[a]	[a]
Perched groundwater[b]	[a]	[a]
Paddy's Run	Uranium	[a]
Storm Sewer Outfall Ditch	Uranium	[a]

Table 2.3-2 (continued)

Name	Type of waste	Quantity (yd^3)
	Surface and near-surface contaminated material locations	
Contaminated surface soil	Uranium	[a]
Surface drainageways	Uranium	[a]
	Contaminated structures and facilities	
K-65 silos (Nos. 1 & 2)	Uranium-, radium-contaminated waste	7,200
Metal oxide tanks (No. 3)	Uranium-contaminated waste	5,100
Solid waste incinerator	[a]	[a]
Graphite burner	[a]	[a]
Oil burner	[a]	[a]
Kelly solid waste incinerator	[a]	[a]

[a]Currently being determined under the RI/FS.

[b]Water located between the ground surface and the main aquifer is separated from the aquifer by a relativly impermeable layer.

The Waste Pits, the Burn Pit, and the Clear Well are located in the northwestern side of the waste storage area (Fig. 2.1-5). The Waste Pits are no longer in use. Waste Pit 1, 2, 4, and 6 were mostly used for disposal of dry radioactive waste. These four waste pits contain over 5 million kg (11 million lb) of uranium (Appendix C). Waste Pits 3 and 5 were used for treatment of liquid wastes. They contain less than 200,000 kg (440,000 lb) of uranium. The Burn Pit was used to burn materials, including pyrophoric and reactive chemicals, oils, and other combustible low-level radioactive material. Use of the Burn Pit was discontinued in 1986. The Clear Well has been used as a collection and settling basin for liquid overflow from Pit 5 and for runoff from nearby pits; since shutdown of the process flow to Pit 5 in early 1987, use of the Clear Well has been limited to collecting surface stormwater runoff from the waste pit area.

Fly Ash Pile 1, containing fly ash from the on-site coal-fired boiler plant, is located southwest of the Production Area (Fig. 2.3-2). It is not in use and in the past has been sprayed with oils (contaminated with uranium) to control dust. Fly Ash Pile 2 is currently in use and not a remedial action site (not shown in Fig. 2.3-2). The Southfield Area, located at the northern edge of Fly Ash Pile 1, was used to dispose of uranium-contaminated construction rubble.

Paddy's Run, the SSOD, and other surface drainageways are remedial action sites because they are likely to have been contaminated by runoff from the Production Area or the Waste Pit Area as a result of previous waste management procedures and control. Similarly, past activities have contributed to contamination of surface soils on parts of the site with uranium at above-background levels. The perched aquifer and the Great Miami Aquifer beneath the site (Sect. 3.6.4) have been identified with above-background concentrations of uranium and other contaminants, a result of leakage from the waste pits or leaching of contaminants from overlying soils.

The silos (Figs. 2.1-5 and 2.3-2) are major inactive waste storage structures at FMPC. The K-65 silos (1 and 2) hold waste residues from the processing of pitchblende ore. Metal Oxide Tank 3 (Silo 3) contains calcined waste from past refinery operations. Silo 4 is empty. The final four sites listed in Table 2.3-2 are inactive facilities located in the Production Area (Appendix C).

2.3.3.2 Off-site remedial action sites

Five potential off-site remedial action areas have been identified to date in the initial investigation for the RI/FS (DOE 1987b). The Great Miami Aquifer (GMA) beneath FMPC contains plumes of uranium contamination from the waste pits toward the east and from the Storm Sewer Outfall Ditch and surface runoff toward the south. A description of these plumes is provided in Sect. 3.6.4. Sediments in Paddy's Run have been slightly contaminated beyond the FMPC boundaries. Soils in several off-site locations have been contaminated by plant air emissions, and off-site

ORNL-DWG 88-12386R7

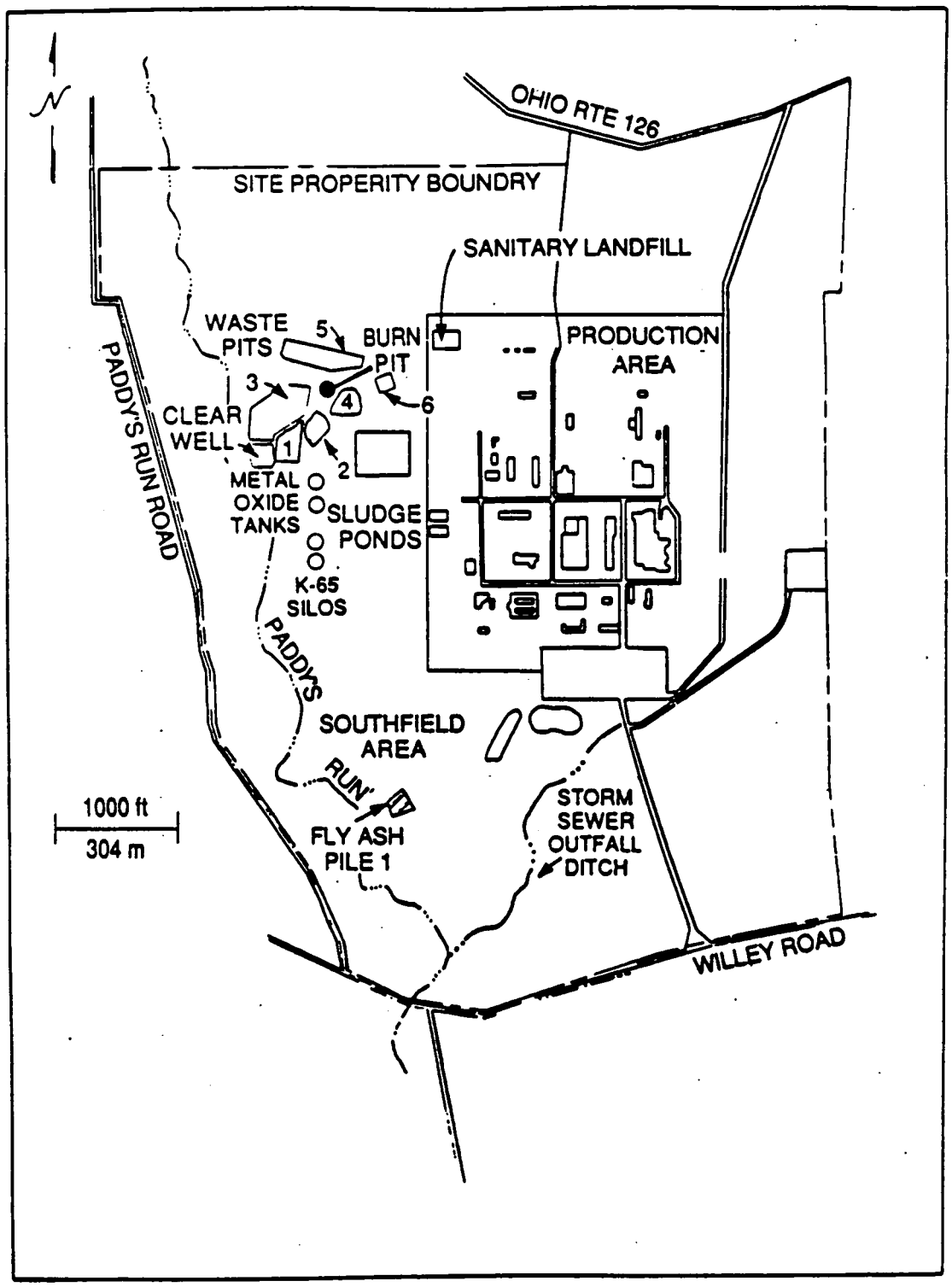


Fig. 2.3-2. Map of the Feed Materials Production Center showing the location of major remedial action sites.

perched groundwater may have been contaminated as a result of plant air emissions or seepage from the waste pits or SSOD. Treated process, sewage, and stormwater runoff effluents released to the Great Miami River may have contributed to contamination of river sediments, particularly near the outfall.

2.4 COMPARISON OF ENVIRONMENTAL IMPACTS OF MAJOR ALTERNATIVES

Alternatives include present situation (no action alternative), proposed action, cessation of metal production, and relocation. A comparison of the actions associated with each alternative and environmental impacts of these alternatives are presented in Tables 2.4-1 and 2.4-2 respectively.

2.4.1 Present Situation (No Action)

This alternative encompasses all renovations started between 1984 and September 30, 1989. It is assumed that renovations started during this time would be completed and the plant would be run at maximum capability.

This alternative results in significant positive impacts and few adverse impacts (Sect. 4.1). The following major areas of concern pertaining to the operation of FMPC are addressed by this alternative: (1) reduction of hydrogen fluoride levels in the air to acceptable levels, (2) reduction of the potential for accidents at the tank farm, (3) elimination of a major source of contamination to groundwater resulting in a southern plume (Production Area surface runoff), (4) reduction of the potential for collapse of the roofs of the K-65 waste storage silos, (5) reduction of the potential for accidental releases of thorium and reduction of worker exposure to gamma radiation through repackaging of the thorium inventory, (6) reduction of uranium emissions from the stacks by a factor of 3.6 from 1985 emissions, (7) reduction of radon emissions from the K-65 silos by one-third, and (8) reduction of nitrate discharges to the Great Miami River.

The calculated effective total-body radiological dose to the maximally exposed individual from air, surface water, and fish ingestion pathways is ~58 mrem/year as compared with ~85 mrem in the 1985 reference year. A conservative (upper limit) estimate of risk to an adult exposed to 1 mrem is about 0.12 chances in 1 million of contracting a lethal cancer. This can be compared with a natural background dose level of approximately 300 mrem/year. If the radon and direct gamma from the K-65 silos is eliminated, the maximum dose would be ~3.6 mrem/year. Eliminating uranium emissions from the waste pit area would further reduce maximum dose to ~2.9 mrem/year.

Radionuclide discharges to the Great Miami River could increase over 1985 because the present situation alternative assumes that the plant will operate at maximum production. Also under the present situation, greater quantities of surface runoff from the production area are diverted to the Great Miami River. Analyses indicate that DOE radionuclide limits could be

Table 2.4-1. Actions associated with each alternative considered in the Feed Materials Production Center Environmental Impact Statement

Alternative	Action			
	49[a] renovation projects	82[a] renovation projects	161[b] renovation projects	Operate at maximum capability[c]
Present situation (no action)			X	X
Proposed action		X	•	X
Cessation of metal production alternative	X		•	

[a]Projects begun on or after Oct. 1, 1989.

[b]Each cessation of metal production alternative project is also a proposed action project.

[c]Projects begun before Oct. 1, 1989.

[d]Maximum production capability is estimated to be 8084 x 10^3 kg/year (8900 tons/year) of uranium.

•Present situation projects are common to all alternatives.

Table 2.4-2. Summary of impacts of the proposed action and major alternatives for Feed Materials Production Center renovation[a]

Present situation	Proposed action	Cessation of metal production
	Air Quality	
Meets standard for particulates during construction activities	Same as present situation	Same as present situation
Insignificant off-site impact due to nonradiological air emissions (e.g., NO_x, SO_2, CO) during operation	Same as present situation	Same as present situation
Reduced possibility of major tank farm accident releasing toxic gases	Same as present situation	Same as present situation
	Surface Water	
No significant impact due to renovation construction activities	Same as present situation	Same as present situation
National Pollutant Discharge Elimination System (NPDES) permit limits exceeded for total suspended solids (TSS), biochemical oxygen demand (BOD), NO_3, Cr^{6+}, and fecal coliform bacteria, but new permit levels to be negotiated or contaminant concentration to be reduced to meet limits	NPDES permit exceeded for BOD; at NPDES limit for NO_3 and TSS, but new permit levels to be negotiated or contaminant concentration to be reduced to meet limits. Best available technology is in place.	Same as proposed action

Table 2.4-2 (continued)

Present situation	Proposed action	Cessation of metal production
Meets all state of Ohio river standards	Same as present situation	Same as present situation
Individual radionuclide releases are met for proposed U.S. Department of Energy (DOE) Order 5400.xx	Same as present situation	Same as present situation
Sum of radionuclides limit for proposed DOE Order 5400.xx exceeded	Sum of radionuclides limit for proposed DOE Order 5400.xx met	Same as proposed action
	Decrease in surface runoff to Paddy's Run from Waste Pit Area due to improved surface water runoff control	Same as proposed action
	Groundwater	
Stormwater Retention Basins (SWRBs) eliminate the major source for southern plume	Same as present situation	Same as present situation
	Aquatic and Terrestrial Ecology	
No adverse impacts during operation or construction activities	Same as present situation	Same as present situation
	Radiological dose	
Maximally exposed individual, if exposed to combination of possible doses, would receive an effective total-body dose of	Same as present situation	Same as present situation

Table 2.4-2 (continued)

Present situation	Proposed action	Cessation of metal production
58 mrem/year; 7.3 chances in 1 million of contracting fatal cancer. Maximum dose does not exceed regulatory limits		
	Worker Health and Safety	
No known industrial standard exceeded for uranium exposure. However, improved information needed to better quantify worker exposure	Same as present situation	Same as present situation
About 59 projects implemented to improve worker health and safety; data to quantify actual exposures or accident risks are absent	About 47 projects, in addition to present situation projects, undertaken to improve worker health and safety; data to quantify actual exposures or accidental risks are absent	About 26 projects, in addition to present situation projects, undertaken to improve worker health and safety; data to quantify actual exposures or accidental risks are absent
	Waste	
10,000 tons scrap metal backlog	10,000 tons scrap metal backlog	10,000 ton scrap metal backlog
20 tons hazardous waste (PCBs)	20 tons hazardous waste (PCBs)	20 tons hazardous waste (PCBs)
430 tons backlog mixed waste	430 tons backlog mixed waste	430 tons backlog mixed waste
117,000 drum equivalents low-level waste (LLW) backlog	117,000 drum equivalents LLW backlog	117,000 drum equivalents LLW backlog
15,000 tons contaminated construction rubble	26,000 tons contaminated construction rubble	17,000 tons contaminated construction rubble

Table 2.4-2 (continued)

Present situation	Proposed action	Cessation of metal production
20,500 tons noncontaminated construction rubble	34,000 tons noncontaminated construction rubble	23,500 tons noncontaminated construction rubble
About 11,000 tons/year process waste (LLW)	Abpit 11,000 tons/year process waste (LLW)	About 2,200 tons/year process waste (LLW)
	Transportation	
About 550 waste shipments/year are anticipated; this is less than the 1600 shipment/year limit	About 700 waste shipments/year	About 400 waste shipments/year
Total construction rubble will require ~150 shipments	Total construction rubble will require ~1,000 shipments	Total construction rubble will require ~1,000 shipments.
Process wastes make up ~200 shipments/year	Same as present situation	Process wastes will make up ~30 shipments/year
	Socioeconomics	
No significant socioeconomic impacts on income, schools, and employment	Same as present situation	Same as present situation
Feed Materials Production Center (FMPC) to provide 1.5% of personal income to three-county region	FMPC to provide 1.1% of personal income in three-county area	FMPC to provide 1.0% of personal income in three-county area
Potential traffic impacts at two intersections	Same as present situation	Smaller impacts than present situation

[a]Remedial actions to be conducted at FMPC will be covered by separate Remedial Investigation/Feasibility Study-National Environmental Policy Act (RI/FS-NEPA) documentation.

exceeded. Therefore, radionuclide discharges will have to be monitored and decreased if limits approach DOE release limits.

Under the present situation alternative, the current NPDES permit levels could be exceeded for total suspended solids, biological oxygen demand, nitrates, hexavalent chromium (Cr^{+6}), and fecal coliform bacteria. DOE and EPA are renegotiating NPDES limits to reflect the best available wastewater treatment technology proposed for FMPC. DOE will not tolerate the exceedance of NPDES limits that are finally set. State of Ohio water quality standards for nonradiological discharges (OEPA 1986), which are applied after mixing has occurred, are met.

Worker health and safety conditions have improved since 1985 as a result of the completion of 58 projects specifically designed for this purpose. Potential for accidental releases to the public due to transportation accidents involving waste shipments increased because of the increase of waste shipments. However, no accidental releases of contaminants to the public due to waste shipments have occurred to date. In addition, U.S. Department of Transportation-approved shipping containers reduce the potential for releases should an accident occur during transport.

2.4.2 Proposed Action

The proposed action would further reduce the contaminant level in discharges to the Great Miami River as compared with the contaminant level in the present situation alternative. The current NPDES permit levels for BOD would still be exceeded. DOE and EPA are currently renegotiating NPDES limits to reflect the best available wastewater treatment technology proposed for FMPC. DOE will not tolerate exceedance of the NPDES limits that are finally set. All radionuclide releases to the river would meet DOE standards. Worker health and safety will be further improved as a result of about 42 projects designed for that purpose. The calculated effective total-body radiological dose to the public from air, surface water, and fish ingestion pathways is ~58 mrem/year. A conservative estimate of risk to an adult exposed to ~58 mrem is about 7.3 chances in 1 million of contracting a lethal cancer. If the radon and direct gamma from the K-65 silos is eliminated, the maximum dose would be ~2.9 mrem/year. Eliminating uranium emissions from the Waste Pit Area would further reduce maximum doses to ~2.2 mrem/year. These doses are essentially the same as those for the present situation alternative. All remedial action activities are planned for completion under EPA direction, as stated in the present situation alternative.

2.4.3 Cessation of Metal Production Alternative

The cessation alternative would reduce discharges to the Great Miami River about the same amount as the proposed action alternative, but the current NPDES permit levels for BOD could still be exceeded. DOE and EPA are currently renegotiating NPDES limits to reflect the best available wastewater treatment technology proposed for FMPC. DOE will not tolerate the exceedance of the NPDES limits that are finally set. Worker health and

safety would continue to be improved as a result of projects designed for that purpose. The calculated effective total-body radiological dose from air, surface water, and fish ingestion pathways is 57 mrem/year. If the radon and direct gamma from the K-65 silos is eliminated, the maximum dose would be 1.6 mrem/year. Eliminating uranium emissions from the Waste Pit Area would further reduce the maximum dose to 0.9 mrem/year. These doses are lower than those for the present situation and proposed action alternatives because atmospheric emissions of uranium would be reduced by this alternative. The maximum dose is not reduced further because building exhausts and unmonitored processes that will not be affected by any alternative release an estimated 15 kg/year (34 lb/year.). If these emissions were stopped after residue processing is complete, these doses to the public would be eliminated.

2.5 REFERENCES

DOE (U.S. Department of Energy) 1982. Incineration Facility for Radioactively Contaminated Polychlorinated Biphenyls and Other Wastes (as amended), DOE/EIS-0084, June 1982.

DOE (Department of Energy) 1985. Environmental Assessment of the Proposed Low-Level Waste Processing and Shipment System, DOE/EA-0260, May 1985.

DOE (U.S. Department of Energy) 1987a. Memorandum to File from Richard L. Egli and William R. Bibb, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, Tenn., to Joe La Grone, Manager, U.S. Department of Energy, Oak Ridge Operations, NEPA No. 9989, August 12, 1987.

DOE (U.S. Department of Energy) 1987b. Remedial Investigation and Feasibility Study, Feed Materials Production Center, Fernald, Ohio, Task 1 Report: Description of Current Situation, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, Tenn.

DOE (U.S. Department of Energy) 1988. Thorium Handling Environmental Assessment, Feed Materials Production Center, Fernald, Ohio, DOE/EA-0338, January 1988.

OEPA (Ohio Environmental Protection Agency) 1986. State of Ohio Water Quality Standards, Chapter 3745-1 of the Administrative Code, Ohio Environmental Protection Agency Division of Water Quality Monitoring and Assessment, Columbus, Ohio, effective July 28, 1986.

WMCO (Westinghouse Materials Company of Ohio) 1987. FMPC 1993 Long Range Plan, Westinghouse Materials Company of Ohio, Fernald, Ohio.

CHAPTER 3

AFFECTED ENVIRONMENT

A detailed description of the natural and social environment of the region around the FMPC site is presented in this chapter. The major environmental issues considered in this chapter relate to the site, socioeconomics, meteorology and air quality, geology, hydrology and water quality, ecology, and radiological background. Assessments of the way that FMPC operations affected environmental resources during the mid-1980s are presented so that pre-renovation conditions can be compared with the present situation alternative and with the anticipated future conditions under the proposed action alternative. Environmental conditions in the local area are given the major emphasis because FMPC operation is anticipated to have its greatest effect nearby. However, for factors that result in far-field effects (e.g., socioeconomics), environmental conditions for a larger region including the Cincinnati Metropolitan Statistical Area are provided.

3.1 INTRODUCTION

FMPC is located in rural southwestern Ohio near the unincorporated village of Fernald in the Great Miami River valley (Fig. 3.1-1). Cincinnati is approximately 15 km (9 miles) to the southeast and Hamilton, Ohio, is approximately 16 km (10 miles) to the northeast. The unincorporated villages of New Baltimore, Ross, and Shandon are within a few miles of FMPC.

FMPC (Fig. 3.1-2) comprises 425 ha (1050 acres) [approximately 344 ha (850 acres) in northern Hamilton County and about 81 ha (200 acres) in southern Butler County] and is generally bounded by Ohio Route 126 to the north, a dairy farm to the east, Willey Road to the south, and Paddy's Run Road to the west. The Production Area covers approximately 55 ha (136 acres) at the central portion of the FMPC site. Surrounding this core of buildings (Fig. 3.1-2) is a buffer consisting of leased grazing land, reforested land, and unused land (WMCO 1987d). Paddy's Run, a small creek, flows south-southeast within the western edge of the FMPC site.

The principal land use near the FMPC is agriculture. Several heavy industries and residential areas are also located near FMPC. Heavy industries, such as Miami Valley Ready-Mix, Delta Steel, Albright Wilson, and Rutgers-Neese, are located just south of FMPC. Residential areas include a scattering of residences near FMPC and a larger number of residences in the unincorporated villages of Fernald, New Baltimore, Ross, and Shandon.

ORNL-DWG 88-12932R3

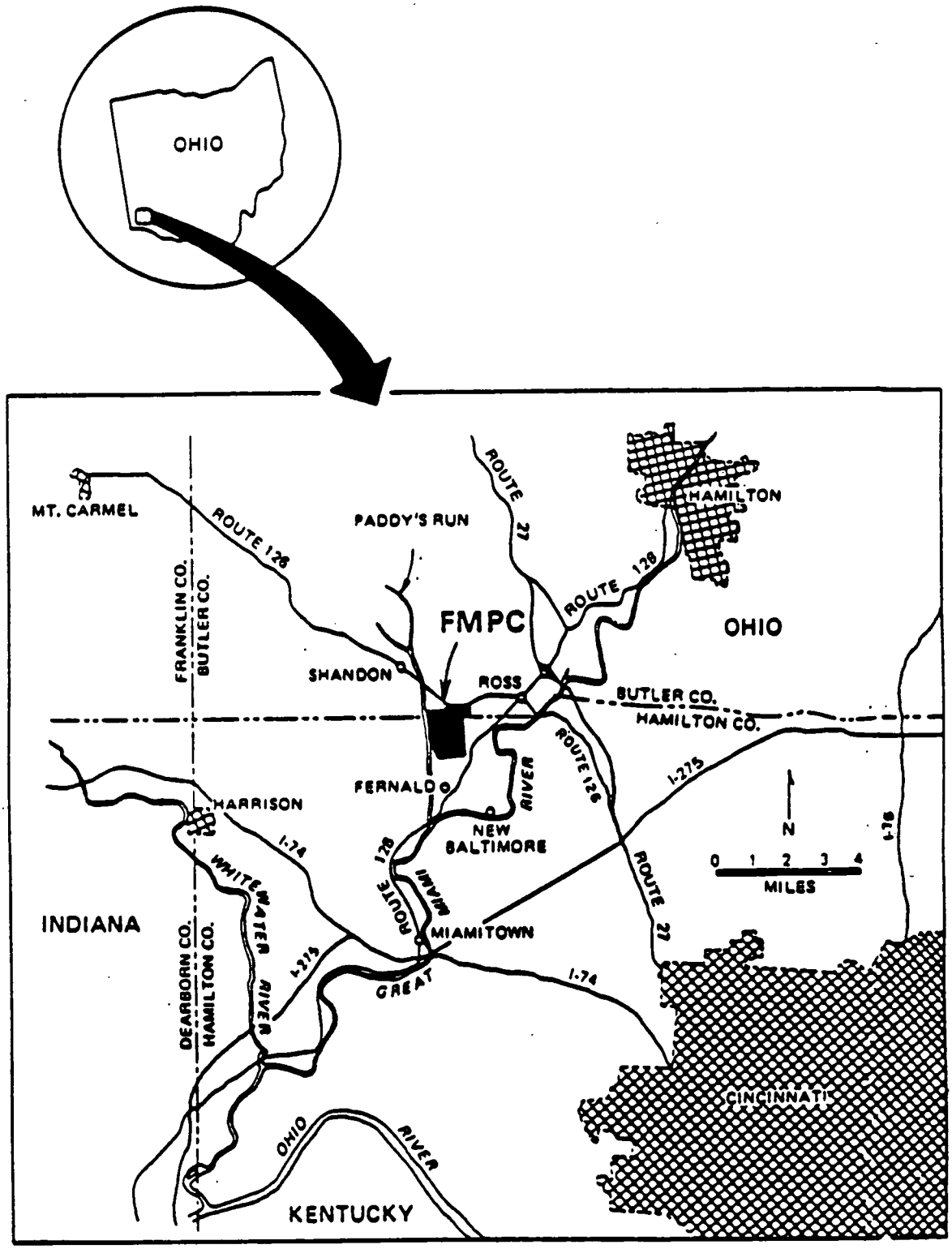


Fig. 3.1-1. Area in the vicinity of the Feed Materials Production Center.

ORNL-DWG 88M-17145R

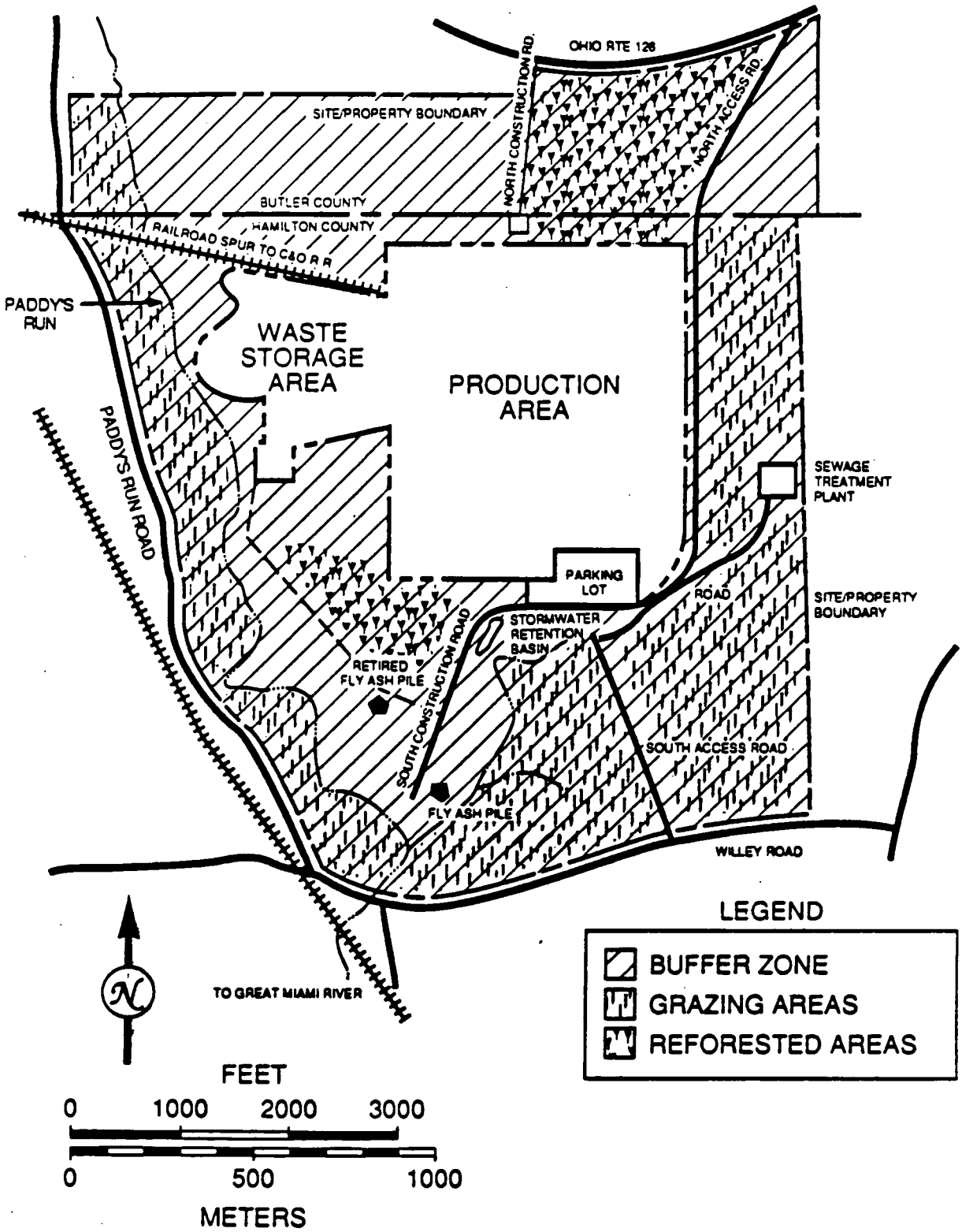


Fig. 3.1-2. Land use map for the Feed Materials Production Center.

3.2 SOCIOECONOMICS

3.2.1 Population and Demography

3.2.1.1 Population

FMPC is located in the Cincinnati-Hamilton (Ohio-Kentucky-Indiana) Consolidated Metropolitan Statistical Area (CMSA), which has a 1984 population of 1.7 million (USBC 1986). The CMSA includes Butler, Clermont, Hamilton, and Warren counties in Ohio; Boone, Campbell, and Kenton counties in northern Kentucky; and Dearborn County in southeastern Indiana (Fig. 3.2-1).

The population of cities and towns within approximately 16 km (10 miles) of the site is given in Table 3.2-1. The regional population distribution is dominated by Cincinnati and its suburbs to the southeast of FMPC beginning about 8 km (5 miles) away. The population density within 8 km (5 miles) is fairly uniform. Other significant localized populations are the town of Ross to the east-northeast and nearby towns of Fernald and New Baltimore to the south (Fig. 3.1-1). Both the urban complex of Hamilton and Fairfield about 16-32 km (10-20 miles) to the northeast and the urban growth along U.S. Highways 27 and 127 greatly influence the population distribution. The population density within an 8-km (5-mile) radius of the FMPC is less than one-half of the statewide average and is significantly lower than population densities for Butler and Hamilton counties; thus, the rural character of the vicinity is emphasized.

The overall population in Hamilton and Butler counties is projected to be fairly constant through the year 2000. Within an 8-km (5-mile) radius of the plant, population growth is projected to increase less than 10% for the period from 1980 to 2000 (Ohio-Kentucky-Indiana Regional Council of Governments 1987). This projection implies a population increase of fewer than 1100 persons during the period from 1980 to 2000.

The incomes of individuals in the vicinity of FMPC were slightly above the area average in 1980. The projected low rate of population growth in the area suggests that characteristics of the local population will tend to be the same in the near future. However, because this rural area is near a large metropolitan area, characteristics can be influenced by socioeconomic changes (such as industrial expansion) and by demographic mobility.

3.2.1.2 Residences of FMPC employees

FMPC plant employees in 1986 were widely dispersed (see Appendix D), coming from Ohio, Indiana, and Kentucky (Table 3.2-2). Employment records indicate that about 71% of the employees reside in urban areas, including the Ohio communities of Cincinnati (35%); Hamilton (15%); Harrison (8%); and Fairfield (8%), as well as Lawrenceburg, Indiana (5%). The other 29% are widely dispersed; their home addresses show over 100 postal ZIP codes.

ORNL DWG 88-12597R

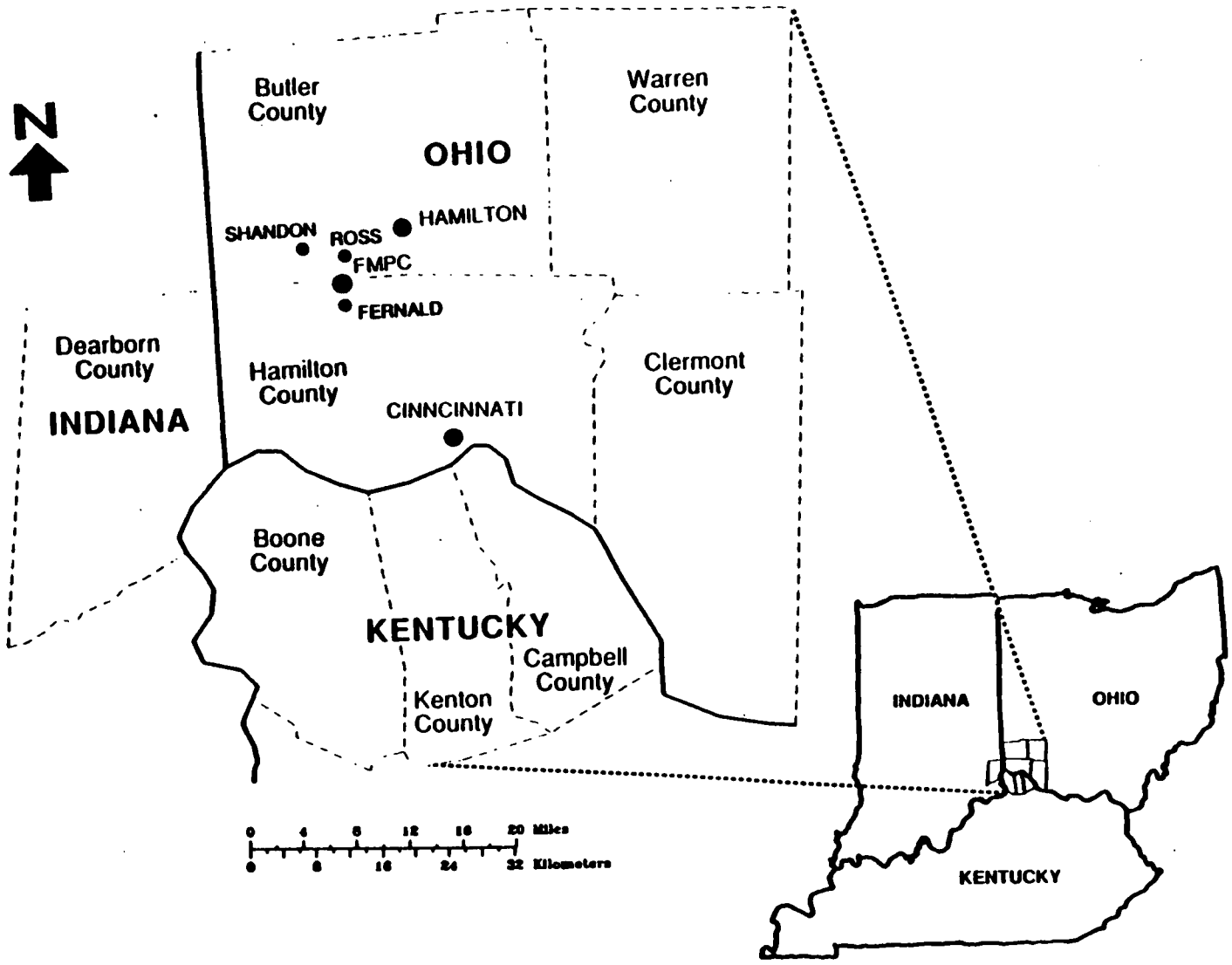


Fig. 3.2-1. Cincinnati-Hamilton Consolidated Metropolitan Statistical Area.

Table 3.2-1. Estimated populations of Ohio cities and towns in the vicinity of the Feed Materials Production Center

Town or city	Distance from FMPC boundary (km)	Distance from FMPC boundary (miles)	Estimated population
Fernald	0.5	0.3	30
Shandon	3.2	2	200
Ross	4.0	2.5	1,661
New Baltimore	4.5	2.8	200
New Haven	4.8	3	200
Dunlap	6.4	4	100
Harrison	8.0	5	5,855
Miamitown	9.7	6	700
Groesbeck	11.3	7	7,400
Forest Park	11.3	7	18,675
Fairfield	12.9	8	30,777
Hamilton	12.9	8	63,189
Mt. Healthy	13.7	8.5	7,562
Cincinnati	14.5	9	385,457
Cheviot	16.0	10	9,888

Sources: Rand McNally 1984; Battelle 1981.

Table 3.2-2. Percentage of FMPC employment by county

State	County	Percentage of employees
Kentucky		
	Boone	0.6%
	Campbell	0.6%
	Gallatin	0.1%
	Kenton	0.9%
	Total Kentucky	2.2%
Indiana		
	Dearborn	12.0%
	Decatur	0.1%
	Fayette	0.1%
	Franklin	1.5%
	Ohio	0.6%
	Ripley	3.0%
	Switzerland	0.1%
	Union	0.3%
	Total Indiana	17.7%
Ohio		
	Butler	31.4%
	Clermont	1.7%
	Clinton	0.3%
	Hamilton[a]	45.4%
	Preble	0.1%
	Warren	1.2%
	Total Ohio	80.1%

[a]Includes employees who live in the city of Cincinnati.

Source: Reynolds 1987.

In 1986 about 40 residents of Ross, or 2.4% of the town's population, worked at FMPC. This was the highest percentage of FMPC employees that could be identified for any nearby community (see Appendix D.3).

3.2.2 Employment and Income

Employment and income in Butler and Hamilton counties have been strongly related to the manufacturing sector. For the two-county area in 1983, manufacturing accounted for more than 30% of employment and 40% of income. The next most important sector, services, accounted for approximately 25% of employment and 19% of income. Income from and employment in agriculture and mining are relatively insignificant.

In July 1986, Hamilton County had a total work force of 449,600 and 6.1% unemployment. Butler County had a work force of 123,000 and unemployment of 7.3%. These unemployment rates were somewhat lower than the overall rate of 7.8% for Ohio. However, Butler County's rate was somewhat higher than the average rate of unemployment for the United States, which was 7.0% (OBES 1986).

Economic activity in the immediate vicinity around the FMPC site is largely agricultural, including dairy farming and landscaping/nursery activities. However, employment and income for the area immediately surrounding FMPC is (and will continue to be) strongly linked to employment and income trends in the Cincinnati metropolitan area.

Employment at FMPC increased from about 600 in 1980 to about 1600 in 1987 and declined to about 1200 in 1989. The 1200 employees represent less than 0.3% of combined employment in Hamilton and Butler counties. With average employee compensation in 1985 of about $33,000, the FMPC payroll represented less than 0.3% of the combined personal income in the two counties. When secondary income and employment effects are considered, FMPC accounted for less than 0.5% of income and employment in the two counties. Thus, FMPC employment and payroll in 1985 did not represent a significant part of the regional economy.

3.2.3 Schools

The following schools, with 1987-88 school year enrollments, are included within the Southwest Local School District of Hamilton County: Crosby Elementary, 379; Harrison Junior High School, 569; Harrison Senior High School, 1071; Harrison Elementary, 941; Elizabethtown, 136; Hooven, 201; Miamitown Elementary, 213; Christ Centered School, 136 (1985-86); and St. John the Baptist, 487 (1985-86).

The following schools, with 1987-88 enrollments, are included within the Ross Local School District of Butler County: Ross High School, 832; Elda Elementary, 597; Ross Middle School, 716; and Morgan Elementary, 558. All of these schools are within approximately 5 km (3 miles) of the plant, the closest being Elda Elementary on State Route 128.

The lack of concentration of FMPC employees in any particular community (see Sect. 3.2.1) indicates that no concentrations of students with parents working at FMPC exist within any particular school or school system. Staff for the Crosby Township School District indicated that they received no Community Impact Funds (Pub L. 81-874) for FMPC students. During the 1987-88 school year, 5 students (1.3%) out of a total enrollment of 379 in Crosby Elementary School (the school in Hamilton County nearest the FMPC facility) had at least one parent working at FMPC. The Ross School District (with the exception of Morgan Elementary) has experienced steady or declining enrollment during the late 1980s.

3.2.4 Infrastructure and Emergency Response

3.2.4.1 Utilities

FMPC does not depend much on the local infrastructure. Gas and electricity are purchased from Cincinnati Gas and Electric, and water is pumped from on-site production wells. Domestic sewage is treated at the FMPC sewage plant; treatment with two trickling filters and a closed digester for aerobic and nonaerobic treatments, is followed by ultraviolet disinfection. The resulting effluent is discharged to the Great Miami River.

Much of the FMPC solid waste is generated as a by-product of production processes. After monitoring, the noncontaminated sanitary waste (nonprocess area trash) is shipped to a local sanitary landfill for disposal. All hazardous and radioactive wastes are either stored on-site or shipped beyond the local area for disposal.

3.2.4.2 Fire and police

The New Baltimore, Ross Township, and Colerain Township fire departments have mutual-aid fire-fighting agreements with FMPC. The community fire departments in New Baltimore to the southeast and Ross Township to the northeast are volunteer organizations. Colerain Township to the south has a professional fire department with equipment and fire fighting capability. However, in case of a call for aid from FMPC, the Ross Township fire department is more likely to be called on because of its proximity to FMPC. The Ross Township department has one 5000-gal tanker and three engines. The fire fighting capabilities at FMPC include seven full-time inspectors and numerous FMPC employee volunteers. There are two fire department engines with 1000-gal pumpers, one engine with a 3500-gal pumper, and two ambulances. In-plant fire fighting depends on FMPC employee volunteers; therefore, its fire fighting capability varies with the time of day and week. The surrounding communities of Ross and Crosby townships mainly depend on Butler and Hamilton County police departments for local police protection.

3.2.4.3 Commercial transportation

The nearest major commercial airport is the Greater Cincinnati International Airport located just off Interstate 275 in Boone County

Kentucky. FMPC is linked to the CSX Railroad System for freight transportation. Most freight, however, is transported by truck.

3.2.4.4 Emergency response

FMPC uses and stores toxic chemicals such as anhydrous hydrogen fluoride (AHF) that constitute a potential hazard to plant employees and the surrounding residents. To deal with this risk, contingency plans have been prepared for emergency evacuation of on-site personnel and off-site citizens who could be at risk.

Emergency response procedures are either in existence or being developed within Butler and Hamilton Counties by local civil defense planners. Planning is coordinated for Hamilton County, Butler County, Ohio Disaster Service Agency, and Westinghouse Materials Company of Ohio. A task force with members from FMPC, DOE, the State of Ohio, Hamilton and Butler counties, and several local communities is responsible for developing exercises based on plausible scenarios involving the local community and FMPC emergency response personnel. Full-scale exercises were held on April 25, 1987, and June 24, 1989, to test the response to a mock emergency at FMPC (Richardson 1987).

Butler and Hamilton counties have made extensive plans for evacuation in case of an emergency at FMPC that might jeopardize off-site individuals (BCDSA 1985, BCDSA 1986, and HCDSA 1986). Zones have been established for the purpose of planning and response. One zone, defined by local roads, extends approximately 3.5 km (2 miles) from the center of the FMPC site and is called the Two-mile Intermediate Notification Zone. A siren system at FMPC was installed in 1987-88 to alert citizens within this zone to take shelter in an emergency. Ross, Fernald, and New Baltimore are included within this two-mile zone. This zone is not subdivided, and all persons within this two-mile zone would receive information in case a protective action is recommended from the FMPC Joint Public Information Center. The center disseminates information to the public via the news media and telephone.

The Five-mile Planning Zone extends from the boundary of the Two-mile Immediate Notification Zone with an approximate 8-km (5-mile) radius from the center of the FMPC. This zone is generally defined by local roads. This zone is subdivided by township boundaries into districts to facilitate planning, notification, response, and protective actions. Residents of the various sectors in this zone would be notified based on the most appropriate information for their sector.

Various types of training related to the need for emergency response are offered through the Butler County Civil Defense Office. Organizations involved in this training effort include the Ohio Disaster Services Agency, the Ohio Department of Health, FMPC, the Federal Emergency Management Agency, DOE, OEPA, and the Ohio fire marshal.

Organizational responsibilities are defined in the Butler County Emergency Response Plan for (1) local, state, and federal governments;

(2) FMPC; and (3) organizations such as the American Red Cross, hospitals, and rescue squads that normally provide service to the area. FMPC's responsibility is to notify the appropriate local authorities promptly in the event of a hazardous materials incident and to provide incident-related information about proposed responses (BCDSA 1986). The Emergency Response Plan includes (1) notification and warning methods and procedures, (2) emergency response support and resources, (3) release of public information, and (4) emergency communications (BCDSA 1986).

3.2.5 Traffic

The most commonly used access to the FMPC parking lot is the South Access Road connecting Willey Road to the employee parking lot (Fig. 3.2-2). Willey Road intersects State Road 128 about 4 km (2.5 miles) south of the intersection of State Highway 128 and State Highway 126 in Ross. The North Access Road intersects State Road 126 about 2.5 km (1.5 miles) west of the Ross intersection.

The intersection of State Highway 128 with State Highway 126 in the town of Ross (see Fig. 3.2-2) is particularly critical with respect to analysis of traffic because the most direct access from the FMPC parking lot to the cities of Hamilton and Fairfield is through that intersection. This intersection also handles traffic bound to Cincinnati via State Highway 126 or U.S. Highway 27 to Interstate 275. The intersection has a traffic signal. It was well within its capacity during peak traffic hours in 1985.

State Highway 128 also provides an important southwest route for commuters to and from FMPC. The intersection of Willey Road and State Highway 128 is busy during morning and evening hours. The traffic peaks tend to be from 7 to 8 a.m. and from 4:30 to 5:30 p.m., when most regular FMPC employees arrive and depart. Most of the construction craft workers at the FMPC site work 10-h shifts for 4-d weeks. These craft workers arrive at FMPC between 6 and 7 a.m. and leave between 5 and 6 p.m. Thus, most of the construction craft workers do not affect the peak traffic periods. In general, traffic had short to average delays in 1985 during the afternoon as workers left FMPC.

Delivery of materials and shipment of product or solid wastes involve relatively small numbers of vehicles, spaced more uniformly during the day. These vehicles do not contribute to traffic-related problems.

3.2.6 Noise

The noise level associated with the production of uranium metal at FMPC is similar to noise levels at other metal processing facilities of its size. There is currently no noise level data available that allows for the quantification of off-site noise impacts. However, a noise impact study is to be performed at FMPC. (Sect. 4.6).

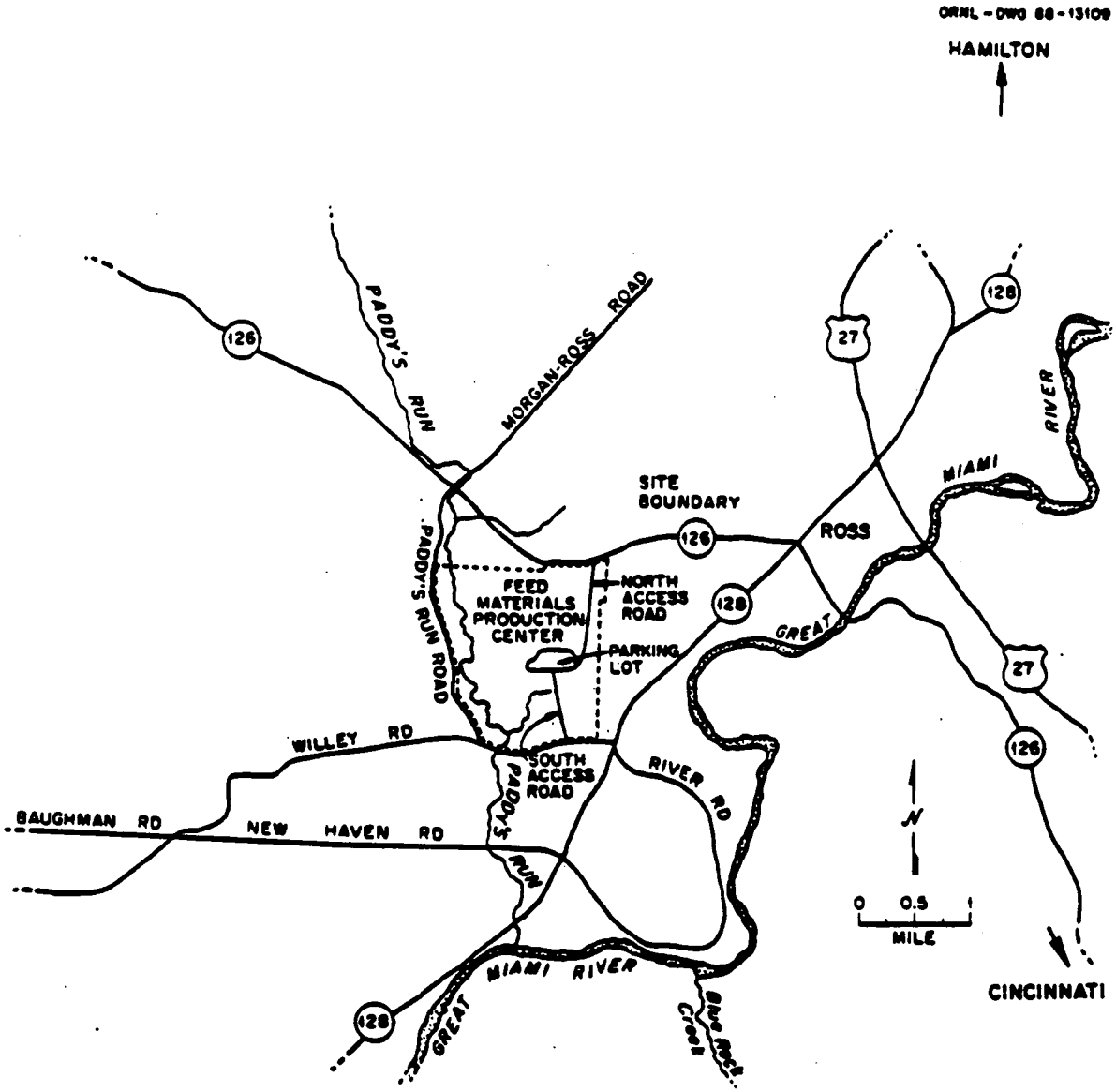


Fig. 3.2-2. Highway service for Feed Materials Production Center.

3.2.7 Historical Resources

The area surrounding the FMPC site contains several sites of historical interest. The National Register of Historic Places lists four prehistoric Indian sites within a 4.8-km (3-mile) radius. These include the Adena Circle, the Demoret Mound, the Colerain work, and the Dunlap work. The Colerain work is situated approximately 1 mile east of the plant. There are several other sites of historic interest within 8 km (5 miles) of the plant. However, the State Historical Preservation Officer reports that there are no known sites of archaeological significance on the FMPC site (DOE 1977; Luce 1987).

3.3 WASTE MANAGEMENT AND TRANSPORTATION

Wastes at FMPC can be grouped into four categories: low-level radioactive waste (LLW), hazardous waste, mixed (radioactive and hazardous) waste, and conventional industrial waste. These wastes are discussed in Sect. 2.1.2. Transportation is a key element in FMPC LLW management. Shipment of LLW to NTS is a large component of overall transportation activity. Shipments have been increasing in frequency since they began in 1985.

LLW consists primarily of materials generated during the production of uranium metal and materials (e.g., scrap wooden pallets, scrap metal, trash) and construction rubble that have become contaminated as a result of contact with uranium. LLW falls into two categories: wastes generated by current activities (current operational wastes) and wastes generated by past activities that are in storage awaiting disposition (backlog waste). Section 4.2.6 provides more details on the types of waste generated at FMPC and their processing and future disposition.

Most LLW at FMPC will be shipped to NTS for disposal. The NTS requires that LLW be dry before being packed into drums. No hazardous substances regulated under the Resource Conservation and Recovery Act of 1976 (RCRA) may be included.

Packaging and shipping operations are conducted in compliance with all applicable U.S. Department of Transportation (DOT) regulations (49 CFR Pts. 173 and 177). On average, each drum of waste material has 27 kg (59.4 lb) of uranium (DOE 1985) or 0.018 curie (Ci) on the basis of a specific activity of 6.77×10^{-7} Ci/g (10 CFR Pt. 20). However, drums with waste containing only natural or enriched uranium hold ~150 g (0.33 lb) of uranium ($\sim 0.1 \times 10^{-3}$ Ci), and drums with only depleted uranium in the waste hold an average of 90 kg (200 lb) of uranium (43×10^{-3} Ci), on the basis of adjusted specific activities.

Before being shipped, filled drums are washed, dried, examined for removable external radioactivity, and monitored for radiation levels. After compliance with DOT limits is ensured and results are recorded, the drums are available for loading. The wastes are shipped in closed trailers owned and operated by commercial carriers. Radiation levels for all loads

of waste drums are well within applicable DOT limits (49 CFR Pts. 173 and 177). Radiation levels associated with FMPC LLW shipments have been measured (DOE 1985). Contact radiation levels on the drums ranged from 0.7 mR/h for drums with small amounts of enriched uranium to ~5 mR/h for drums with significant amounts of depleted uranium. Radiation levels at 1 m (3 ft) from the drums ranged from 0.5 to 1.5 mR/h. These levels are similar to those for drums of U_3O_8 after uranium mill processing (DOE 1985). Measured levels in the truck cab after loading an enclosed trailer averaged ~0.5 mR/h for trailer-to-cab separations of ~1 m (~3 ft) and less than 0.3 mR/h for a separation of 2 m (7 ft) (DOE 1985).

Consistent with DOT regulations for highway transport (49 CFR Pt. 177), typically the shortest route along the interstate highway system is followed to minimize travel time and distance while taking advantage of the quality of interstate highways. The usual route for shipment to NTS is State Highway 128 south to Interstate 74, west to the Interstate 465 bypass around Indianapolis, then west on Interstate 70 to its terminus in Utah, utilizing the bypasses around the cities of St. Louis and Kansas City. The remaining segment consists of Interstate 15 to Las Vegas, Nevada, and U.S. Highway 95 to NTS.

This route is 3273 km (2034 miles) long, with mileage by highway type as follows: interstate routes, 3065 km (1905 miles); U.S. routes, 169 km (105 miles); state routes, 29 km (18 miles); and local routes, 9.8 km (6 miles). Three general categories of population density are encountered on the route: urban, 3861 persons/km^2; suburban, 719 persons/km^2; and rural, 6 persons/km^2. The route from FMPC to NTS is about 5% urban, 5% suburban, and 90% rural (DOE 1985).

At NTS, trucks are directed to the designated area(s) for LLW disposal, and the drums are off-loaded and placed into deep trenches. The impacts of LLW disposal at NTS have been addressed in a Final Environmental Impact Statement for the site (ERDA 1977). In 1982, the LLW inventory at NTS was about 125,000 m^3, which represented about 6% of its capacity. Since 1985, shipments from FMPC added about 3-5%/year to the 1982 volume (DOE 1985).

3.4 METEOROLOGY AND NONRADIOLOGICAL AIR QUALITY

3.4.1 Regional Climatology

The climate of the southwestern Ohio region can be characterized as continental, with a wide range in temperature and moisture during the year. Summers are warm and humid, while winters are moderately cold. Spring is characterized by sharp periodic temperature fluctuations and plentiful precipitation, whereas cooler and drier weather prevails for much of autumn. Severe weather usually occurs during the spring and summer in the form of thunderstorms and occasionally as tornadoes. Based on data provided by Thom (1963), the calculated probability of a tornado hitting any given project in the FMPC vicinity is 0.00092 per year. Thus, any given point in the FMPC vicinity can be expected to be hit by a tornado once in about every 1199 years on average.

Table G-3 (Appendix G) displays climatological data recorded at the Greater Cincinnati Airport. Average temperatures at the Greater Cincinnati Airport range from -1.7°C (29°F) in January to 24.4°C (76°F) in July. There are typically 21 d/year when temperatures surpass 32°C (90°F) and 27 d/year when the temperature does not rise above freezing [0°C (32°F)]. The average annual precipitation (including melted snowfall) is 102 cm (40 in.), and the average annual snowfall is 61 cm (24 in.). Average monthly wind speeds range from 3.1 m/s (7 mph) in August to 4.9 m/s (11 mph) in March.

3.4.2 Local Meteorology

Meteorological conditions at the FMPC site are typical of conditions throughout the southwestern Ohio region, but wind direction may be influenced by the local terrain. The facility is situated in a valley which is oriented in the west-southwest/east-northeast axis through which the Great Miami River flows to the west-southwest. Gently rolling hills immediately surround the site, and larger hills, 50 m (164 ft) high, form the boundaries of the valley. The minimum distance from the site to these larger hills is approximately 0.8 km (0.5 mile) to the north and 2 km (1.2 miles) to the south-southeast.

Data collection from a meteorological tower erected in the southwestern part of the FMPC site began in August 1986. Lightning affected the meteorological monitoring system operation in 1987 and resulted in a loss of data for most of June through August 1987. A wind rose for December 16, 1987, through December 16, 1988 [data from the 10-m (33-ft) level on the FMPC meteorological tower] is shown in Fig. 3.4-1. Approximately 87% of the possible data for this 1-year period were available and are represented in Fig. 3.4-1. This wind rose shows that prevailing winds at FMPC are from the westerly and southwesterly directions.

Because a complete year of on-site data was not available, Greater Cincinnati Airport data were selected for the nonradiological air quality impact analysis. The Greater Cincinnati Airport was considered the best available alternative due to its proximity [27 km (16.2 miles) south of FMPC]. A comparison of Greater Cincinnati Airport and FMPC meteorological data is given in Appendix G. Data collected over 1 year were considered sufficient because the modeling results showed that maximum pollutant contributions were far below levels that would cause the NAAQS to be exceeded (see Sect. 3.4.3.1).

Although the wind direction and wind speed distributions at the Greater Cincinnati Airport are somewhat different than those at FMPC (probably because of terrain effects), the differences are not expected to have a large effect on maximum predicted pollutant concentrations, particularly for shorter averaging periods.

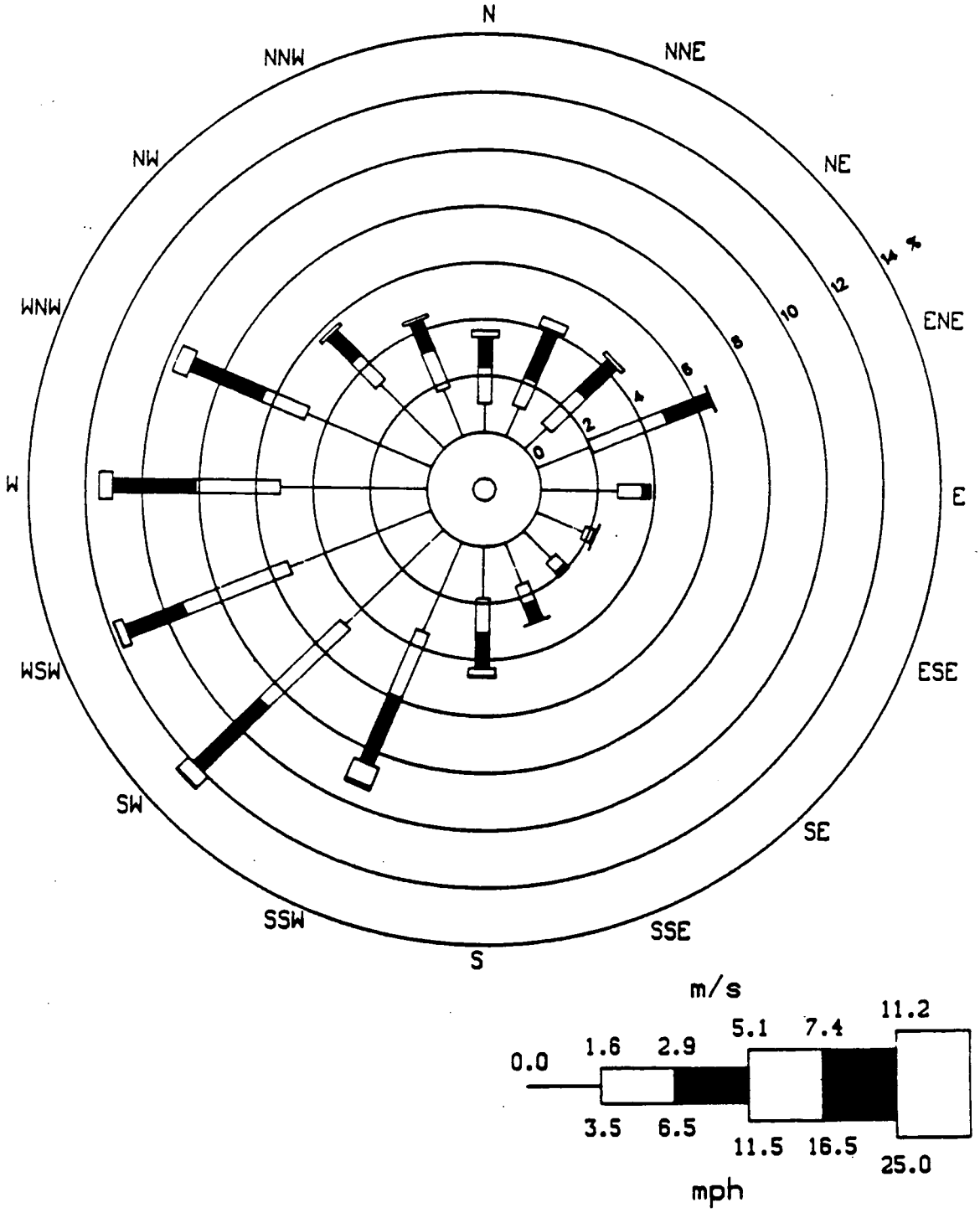


Fig. 3.4-1. Fernald Feed Materials Production Center wind rose for 10-m level, Dec. 16, 1987-Dec. 16, 1988. Approximately 87% of the possible observations are represented.

3.4.3 Nonradiological Air Quality

Pre-renovation (1985) data are presented in this section to allow comparisons among pre-renovation, the present situation, and the proposed action.

3.4.3.1 Comparison of monitoring data and air quality standards

FMPC is located in a four-county area (Hamilton, Butler, Warren, and Clermont counties) under the air quality responsibility of the Southwestern Ohio Air Pollution Control Agency (SWOAPCA). The SWOAPCA has adopted verbatim the National Ambient Air Quality Standards (NAAQS) with no additional state or local ambient air quality standards. The NAAQS apply to the following criteria pollutants: PM-10 (particulate matter less than 10 μm in diameter) since July 31, 1987 (EPA 1987b) [total suspended particulates (TSP) prior to July 31, 1987]; sulfur dioxide (SO_2); nitrogen dioxide (NO_2); carbon monoxide (CO); ozone (O_3); and lead (Pb). The region is currently considered by EPA to be in compliance with all NAAQS except for O_3 and CO, for which it is in nonattainment status (40 CFR Pt. 81.336). Occasional air pollution episodes in southwestern Ohio are usually the result of stagnant air associated with a stationary high pressure system. Low surface wind speeds and a temperature inversion (air temperature increasing with height in the atmosphere) combine to produce a "lid" over the area, dramatically reducing the dispersion of pollutants. Most air pollution episodes occur during late summer and early autumn.

A summary of pre-renovation (1985) air quality monitoring data from FMPC and SWOAPCA sites is shown in Table 3.4-1. The only criteria pollutant monitored in the immediate FMPC vicinity in 1985 was TSP. The TSP values shown in Table 3.4-1 are the maximum values at any of the FMPC monitoring sites operated in 1985 (WMCO 1986). TSP has been monitored at several sites near the facility for a number of years, primarily to collect samples for radiological analyses. The current TSP monitoring sites in the immediate FMPC vicinity are shown in Fig. 3.4-2. Only the boundary monitors (1-7) were operating in 1985, and TSP data from these sites are represented in Table 3.4-1. The 1985 data show that TSP levels around the facility were well below the NAAQS for TSP that were in effect at that time. The TSP values in 1985 were also below the PM-10 NAAQS that are now in effect. Because PM-10 is by definition a fraction of TSP, it is obvious that in 1985 the FMPC vicinity would have been in compliance with the PM-10 NAAQS had they been in force at that time.

SWOAPCA 1985 air quality data for the four-county southwest Ohio region indicated compliance with all NAAQS. The SWOAPCA data in Table 3.4-1 show the maximum concentrations measured at the pollutant monitor closest to the FMPC site (SWOAPCA 1985). Although these data may not be representative of background (non-FMPC) contributions in the FMPC area, they are considered to be conservative estimates of the background. One reason for this is that the SWOAPCA monitors are generally closer to or within cities with a greater concentration of pollutant sources. Also, there are no other large pollutant sources within several kilometers of FMPC.

Table 3.4-1. Maximum 1985 air pollutant concentrations near Feed Materials Production Center and in the southwest Ohio region

Monitor operator	Pollutant	Averaging time	Monitoring location[a] Direction	Distance (km)	Maximum concentration ($\mu g/m^3$)	NAAQS[b] ($\mu g/m^3$)
FMPC	TSP	24-h	SW	1.0	82	150
		annual	SSE	1.0	40[c]	75[d]
SWOAPCA	SO_2	3-h	S	10	681[e]	1,300[f]
		24-h	S	10	252	365[f]
		Annual	S	10	34	80
SWOAPCA	NO_2	Annual	SE	22	55	100
SWOAPCA	O_3	1-h	S	10	274[g]	235[h]
SWOAPCA	CO	1-h	S	10	3,800	40,000
		8-h			i	10,000

[a]Relative to the FMPC production area.

[b]PM-10 NAAQS of 150 $\mu g/m^3$ (24-h) and 50 $\mu g/m^3$ (annual) replaced the TSP NAAQS effective July 31, 1987.

[c]Annual average (arithmetic mean).

[d]Annual geometric mean.

[e]1-h value, used as a conservative estimate of maximum 3-h value.

[f]Not to be exceeded more than once per year.

[g]The second highest 1-h O_3 concentration at this site was 216 $\mu g/m^3$. Therefore, no violation of the NAAQS occurred.

[h]Not to be exceeded on more than 1 d/year.

[i]8-h CO data not provided by SWOAPCA. However, concentration will be less than the maximum 1-h concentration.

ORNL-DWG 89-6407

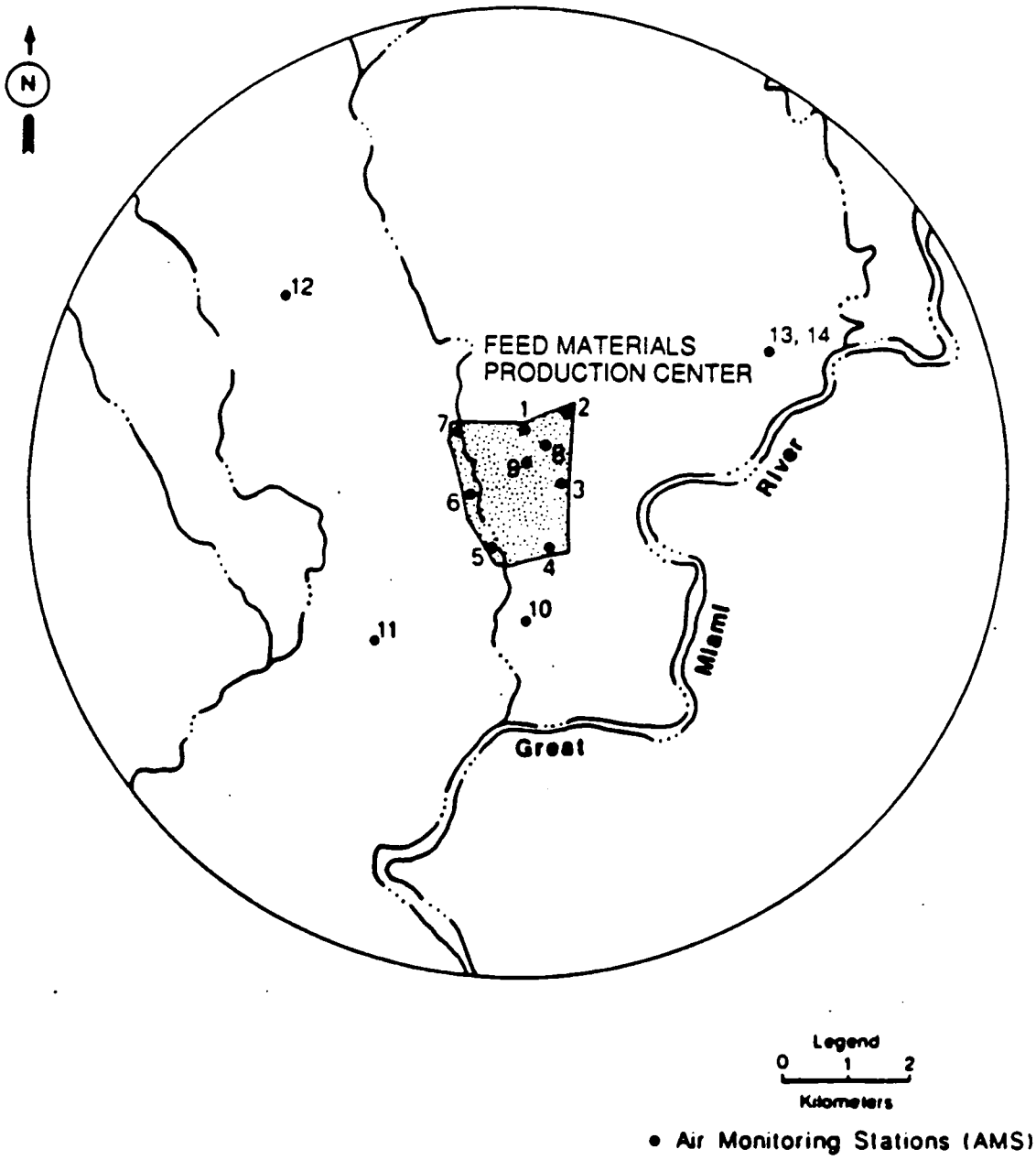


Fig. 3.4-2. Air monitoring stations in the FMPC vicinity. Stations 1-7 operated in 1985.

3.4.3.2 Regional and FMPC emissions data

The combined emissions from all sources other than FMPC with emissions of more than 227 metric tons/year (250 tons/year) of any criteria pollutant in Hamilton and Butler counties during calendar year 1985 were as follows (OEPA 1988):

	kg/year	lb/year
Particulate matter	6,443,000	14,204,000
Sulfur dioxide (SO_2)	114,306,000	251,998,000
Nitrogen oxide (NO_x) [as nitrogen dioxide (NO_2)]	30,508,000	67,258,000
Hydrocarbons	17,420,000	38,404,000
Carbon monoxide (CO)	25,368,000	55,926,000

Comparing these data with the 1985 FMPC emissions data (Table 3.4-2), it is evident that nonradiological FMPC emissions were less than 1% of any pollutants of regional emissions in 1985. No data are available regarding regional emissions of hydrogen fluoride (HF) from sources other than FMPC.

3.4.3.3 Impacts from FMPC

The air quality impacts of FMPC emissions were estimated using the Industrial Source Complex, Short-Term (ISCST) dispersion model (EPA 1987a). The ISCST model uses a straight-line Gaussian plume formulation of pollutant dispersion based on hourly averaged meteorological data read in sequence. This model was selected because it is suitable for the source type (i.e., multiple emission points in a facility with potential plume downwash effects), it is reasonably suited to the terrain around FMPC, and it is an EPA-approved model for air quality permitting applications.

Reported source strengths (Table 3.4-2), primarily from stacks, were used as input to the model. Because source data were provided on a plant-by-plant basis, all stack heights, diameters, and exit velocities were averaged for a given plant. Model technical options and stack data are listed and discussed in Appendix G.

The model calculations were made using May 1986-April 1987 Greater Cincinnati Airport surface and Dayton upper-air meteorological data. Concentrations of pollutants from FMPC were calculated at five distances, 750 were through 2000 m (~2461 ft through ~6562 ft) from Plant 4 and 10 compass-degree intervals around Plant 4. The location at which pollutant concentrations from FMPC were calculated are shown in Appendix G (Fig. G.3). The maximum concentrations were found to occur at the two smallest distances, 750 m (2460 ft) or 1000 m (3280 ft).

The quality of the input data affects the reliability of the predictions of pollutant levels presented here. On-site data from FMPC were not used because data for a complete year were not available. The consequences of using off-site wind data are discussed in Appendix G. The

Table 3.4-2. Nonradiological operational air emissions during 1985

Pollutant	Source	1985 emissions (kg)	1985 emissions (lb)
NO_x	Plant 2/3	2,146	4,731
	Plant 6	54,431	119,997
	Plant 9	4,398	9,675
	Boiler Plant	163,843	360,458
	Total	224,467	494,861
SO_2	Boiler Plant	318,830	702,893
PM[a]	Boiler Plant	12,526	27,615
CO	Plant 8	340	750
	Boiler Plant	58,394	128,735
	Total	58,734	129,485
HF	Plant 4	0.5	1.2
	Plant 8	227	500
	Pilot Plant	235	517
	Tank Farm	998	2,200
	Total	1,460	3,218
HNO_3	Tank Farm	3,792	8,360

[a]Assumes particulate matter (PM) control of 99%. The PM emissions are total suspended particulate matter emissions rather than the PM-10 fraction.

emission rates of nonradioactive air pollutants were determined using standard EPA emission factors (EPA 1985), stack test data, and engineering calculations along with process flow data.

Predicted FMPC impacts to ambient air quality are shown in Table 3.4-3 for 1985. FMPC contributions were below levels that could cause the NAAQS to be exceeded. The maximum predicted 24-h HF concentrations were above standards that have been established by other states. However, the maximum predicted HF concentrations are considered upper limits because the modeling procedure did not account for deposition or chemical reactions which might substantially reduce HF concentrations.

3.5 GEOLOGY

This section discusses local Paleozoic strata (sedimentary rocks), unconsolidated Pleistocene and Holocene sediments and soils, and historical earthquake activity. An understanding of geology coupled with hydrology is required in order to analyze the impact of controlled or accidental releases of contaminants to the surface and subsurface hydrologic systems. Local and regional aquifers (permeable, water-bearing sediments and sedimentary rocks that are capable of yielding significant quantities of water to a well) and aquitards (intervening layers of low permeability that restrict the flow of groundwater between aquifers and between the surface and an aquifer) are identified in terms of their vertical and horizontal positions within unconsolidated Pleistocene and Holocene sediments and Paleozoic rock lying beneath the FMPC area. Details of aquifer characteristics and groundwater resources, as well as their interactions with surface water, are discussed in detail in Sect. 3.6.

3.5.1 Overview of FMPC Site Geology

3.5.1.1 Paleozoic rock

Strata in the FMPC region are relatively old Paleozoic shales (fine-grained rocks that have low permeability and are rich in clay and silt-sized particles) interbedded with limestone (primarily calcium carbonate, which has an unpredictable permeability because of its tendency to dissolve in water where fractures are present) (Swinford and Brockman 1989). Several formations are described by Swinford. These formations are (in descending order) the Point Pleasant Formation [~75 m (~250 ft) thick], the Kope Formation [~85 m (280 ft) thick], and the Fairview Formation [~15 m (~50 ft) thick]. The Kope Formation is approximately 70% shale and 30% limestone, with individual shale beds ranging up to 1 m (3 ft) thick and limestone beds generally less than 0.2 m (0.5 ft) thick, whereas strata immediately above and below the Kope are about evenly divided between shale and limestone. Immediately underlying the above strata is Trenton Limestone, which is ~12 m (~39 ft) thick. Massive carbonates of the Black River Group (several undifferentiated formations lumped together) are ~150 m (~490 ft) thick and lie beneath the Trenton Limestone.

Very limited groundwater resources are available in these bedrock units. Only the Trenton Limestone yields significant quantities of water,

Table 3.4-3. Predicted ambient air quality impacts from FMPC operations for 1985

Pollutant	NAAQS[a] minus background[b] ($\mu g/m^3$)	Modeled FMPC contribution ($\mu g/m^3$)
NO_2		
Annual	45	5
PM-10		
Annual	10	0.1
24 h	68	1.1
CO		
8 h	6,200	8
1 h	36,200	16
SO_2		
Annual	46	3
24 h	113	29
3 h	619	53
HF		
Annual	c	0.28
24 h	c,d	5

[a]The more stringent of either the primary or secondary NAAQS was used. Refer to 40 CFR Pt. 50 for more details on the NAAQS. This column provides a conservative indicator of the available air quality resource.

[b]Background levels for pollutants other than HF and PM-10 were obtained from SWOAPCA (1985) using data (Table 3.4-1) from air monitoring stations located closest to the FMPC. Since no ambient air HF data are available for FMPC and vicinity, a value of 0 $\mu g/m^3$ was assumed for background. TSP data from the FMPC vicinity were used as a conservative measure of background PM-10.

[c]No applicable federal or state of Ohio standard.

[d]Although Ohio does not have an ambient air quality standard for HF, a number of other states have established 24-h HF standards ranging from ~1 to 3 $\mu g/m^3$.

but its quality is degraded by naturally occurring hydrocarbons. Other strata are too deeply buried and too saline to be considered groundwater resources. The Trenton Limestone aquifer is hydrologically isolated from shallower aquifers.

3.5.1.2 Pleistocene/Holocene sediments

Pleistocene and Holocene sediments overlie bedrock (described above). These sediments comprise the Great Miami Aquifer (GMA), one of the most productive aquifers in the Midwest and a prolific producer of high-quality municipal water in Butler and Hamilton Counties, Ohio (Sect. 3.6). The areal extent of the Great Miami Aquifer is limited to the New Haven Trough, as shown in Fig. 3.5-1. The FMPC site, waste storage and production areas, Paddy's Run, the Storm Sewer Outfall Ditch (SSOD), and major groundwater pumping centers are also shown in Fig. 3.5-1.

The vertical extent of the Great Miami Aquifer and overlying sediments is illustrated in Figs. 3.5-2 and 3.5-3 (west-east and north-south profile views, respectively, from FMPC to the Great Miami River). These figures are compiled mainly from data provided by Brockman (1986), supplemented by Spieker (1968) and Lerch, Hale, and Lemaster (1982). The FMPC production area and waste pits are on the upland till plain on the left (north) side of Fig. 3.5-3, the Great Miami River is beyond the right (south) side, and the Storm Sewer Outfall Ditch and SWRB are near the right side of the figure. Pleistocene sediments in ascending order above the trough's floor are (1) glacial outwash (alluvium deposited by a meltwater stream beyond a glacier's margin), (2) glacial till (deposited as the glacier advanced over previously deposited outwash), (3) lakebed sediments (deposited in glacial meltwater dammed between thick deposits of glacial till and the retreating glacier), and (4) minor amounts of loess (windblown silt). Holocene alluvium (modern stream sediments) and colluvium (slope-wash sediments and landslide debris) were deposited in the beds and sidewalls respectively of the Storm Sewer Outfall Ditch and the Great Miami River. As shown in Fig. 3.5-3, Holocene soils formed in place on a wide variety of Pleistocene and Holocene parent materials. Contacts (boundaries) between Pleistocene sediments are rarely distinguishable at the surface because they are generally covered by Holocene sediments and soils.

The Pleistocene and Holocene sediments of the New Haven Trough are up to 91 m (300 ft) thick, and the trough is 3-5 km (2-3 miles) wide (Spieker 1968). Glacial outwash deposits of the Great Miami Aquifer are by far the thickest [up to 76 m (250 ft)]. Lumped together, the overlying glacial till, lakebed sediments, and Holocene alluvium are up to 15 m (50 ft) thick.

3.5.2 Potential Effluent Subsurface Pathways to the Great Miami Aquifer

Among the Pleistocene and Holocene sediments, only glacial till is generally considered to be capable of restricting groundwater flow between the surface and the Great Miami Aquifer. Table 3.5-1 provides a qualitative comparison of permeabilities of Pleistocene and Holocene

ORNL-DWG 88-14214R2

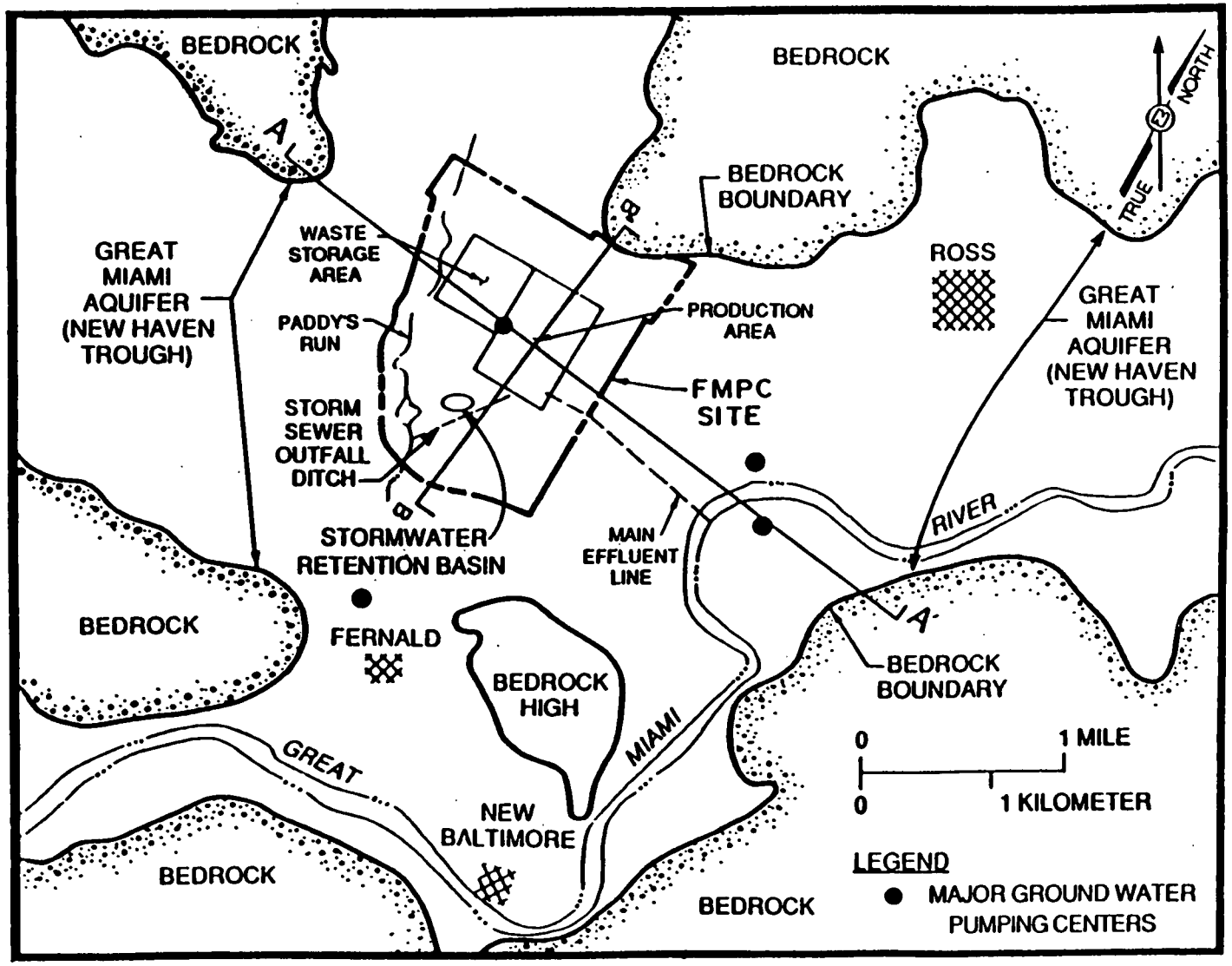


Fig. 3.5-1. The Great Miami Aquifer (New Haven Trough) and major pumping centers in the vicinity of the Feed Materials Production Center [adapted from IT (1986)].

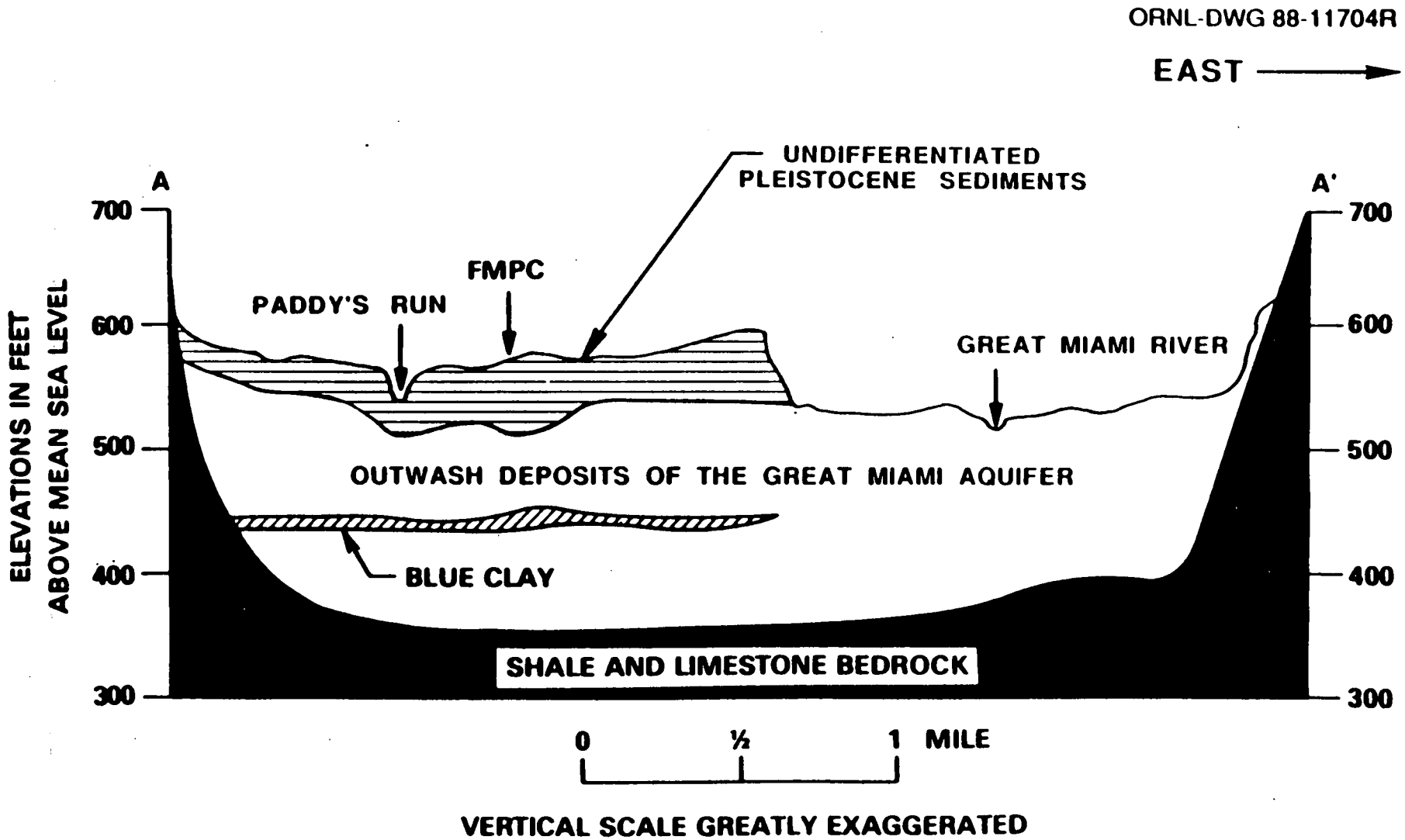


Fig. 3.5-2. New Haven Trough and the vertical cross section A'A (location shown in Fig. 3.5-1) through the Great Miami Aquifer [adapted from Spieker (1968)].

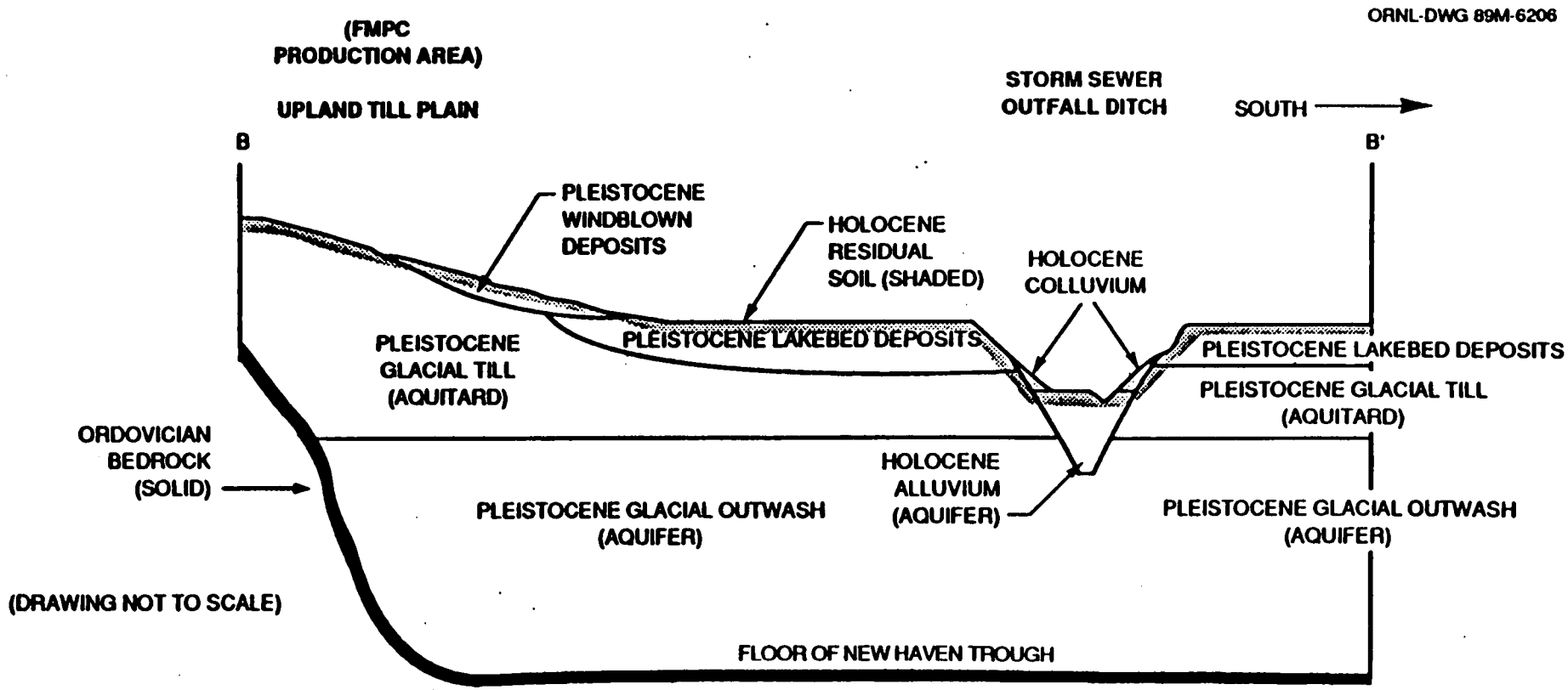


Fig. 3.5-3. Schematic north-to-south vertical section BB′ of Fig. 3.5-1 of bedrock and Pleistocene and Holocene sediments from the FMPC production area to the southern boundary of FMPC. Sources: Brockman 1986, Spieker 1968, and Lerch, Hale, and Lemaster 1982.

Table 3.5-1. Qualitative comparison of permeabilities of Pleistocene and Holocene sediments at the Feed Materials Producton Center

Age	Type of sediment	Stratigraphic position with respect to glacial till	Permeability
Holocene	Gravel and sand	Overlies Pleistocene	High
Pleistocene	Lake bed silt	Above	Low
	Melt water channel sands[a] (perched aquifer)	Above and possibly within	Moderate
	Glacial till (aquitard)	--	Very low
	Outwash deposits[b] (Great Miami Aquifer)	Beneath	High

[a]There is a possiblity that meltwater channels of sand exist within the glacial till and at the interface of the glacial till and lakebed silts. These channels could provide a horizontal pathway for groundwater within the glacial till.

[b]The Great Miami Aquifer (GMA) is laterally and vertically continuous. Where overlying Pleistocene sediments have been eroded, this aquifer is directly in contact with the Holocene gravel and sand or exposed to the surface. These eroded areas would allow direct recharge of the GMA.

sediments at FMPC. Locations where glacial till is absent or thin and weathered are potential vertical pathways of impounded surface water to the Great Miami Aquifer. Where glacial till is thick and continuous,horizontal subsurface pathways along the contact between lakebed sediments and glacial till are more likely.

A number of sites have been identified where glacial till may be absent or thin and weathered. In descending order from the land surface, Pleistocene sediments (loess, lakebed sediments, glacial till, and the uppermost glacial outwash deposits) are successively eroded away, removed by excavation, or penetrated by well drilling. Glacial till is only partially penetrated or left completely in place by shallow stream erosion, shallow excavations during construction, and primitive hand-dug farm wells. However, deep erosion and excavations, modern but pre-FMPC farm wells, and FMPC test holes, and monitor wells, have completely penetrated through the glacial till to the underlying glacial outwash deposits of the Great Miami Aquifer.

Figure 3.5-4 illustrates sites generally south of the production area where erosion and excavations are known to have penetrated below glacial till and on the southwest side of FMPC, the Storm Sewer Outfall Ditch, and the SWRB (Fig. 3.5-1.) Arrows in this figure illustrate both horizontal and vertical pathways. These arrows also identify the general locations of groundwater discharge (springs and seeps on creek banks) and recharge areas (Paddy's Run and its tributaries where glacial till is absent or thin and weathered). Another site excavated beneath glacial till (Fig. 3.5-5) is a gravel pit in Paddy's Run southwest of the silos.

The presence and condition of glacial till is uncertain where deep excavations for the Clear Well and Waste Pit 3 crossed a tributary to Paddy's Run. Figure 3.5-5 is a topographic map of the area as it appeared in 1959 (City of Cincinnati 1959). These excavations were to within 1 m (3 ft) of the projected base [166 m (545 ft)] of glacial till. However, it is possible that the remaining glacial till had been eroded from the bottom of the tributary underlying these excavations during repeated major flood events (i.e., 100-year floods and less frequent but higher-intensity storms) since the end of Pleistocene time (~10,000 years ago). Following each such flood event, the channel may have been partially backfilled with Holocene alluvium, as illustrated in Fig. 3.5-6. Hypothesis 1 in this figure illustrates a leaking liner with plant effluent contained by glacial till. Hypothesis 2 illustrates leaking effluent reaching glacial outwash of the Great Miami Aquifer through a vertical pathway in Holocene alluvium. Isolated areas where glacial till has been breached by erosion would be significant vertical pathways to the Great Miami Aquifer. However, foundation conditions at the Clear Well and Waste Pits 1-3 are not understood well enough at present to determine whether significant vertical pathways exist beneath them. The foundation conditions under Pit 5 are also uncertain. A test well drilled in this area in 1963 (prior to construction of Pit 5) apparently did not encounter glacial till before penetrating the Great Miami Aquifer. The presence of glacial till beneath Pit 5 has been neither confirmed nor contradicted by recent drilling. The locations of FMPC groundwater monitor wells as of 1986 are shown in

ORNL-DWG 88-11098R

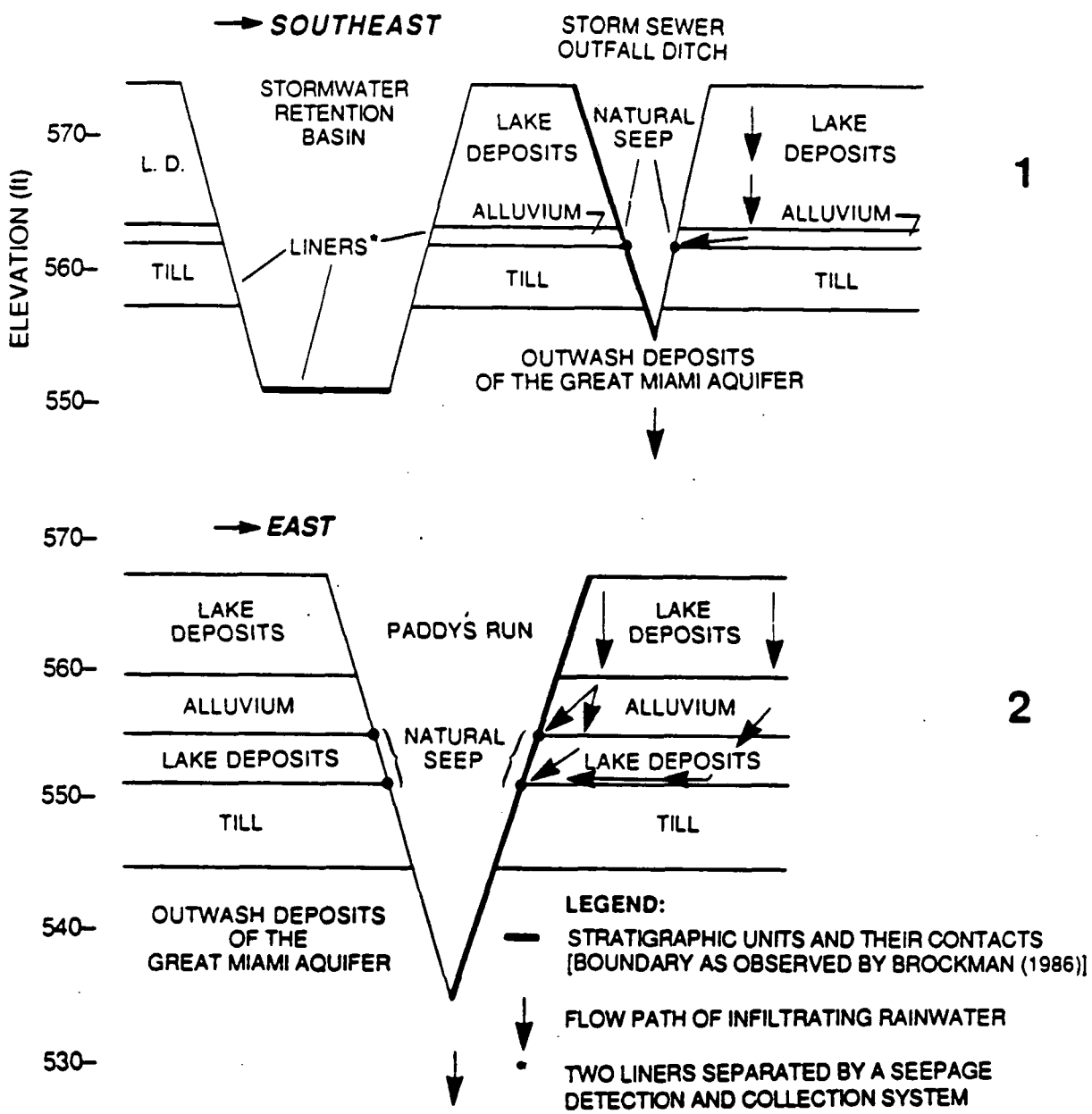


Fig. 3.5-4. Schematic cross section of Pleistocene strata at the Stormwater Retention Basin and Storm Sewer Outfall Ditch (1) and Paddy's Run generally south of the production area (2).

ORNL-DWG 88-112054R1

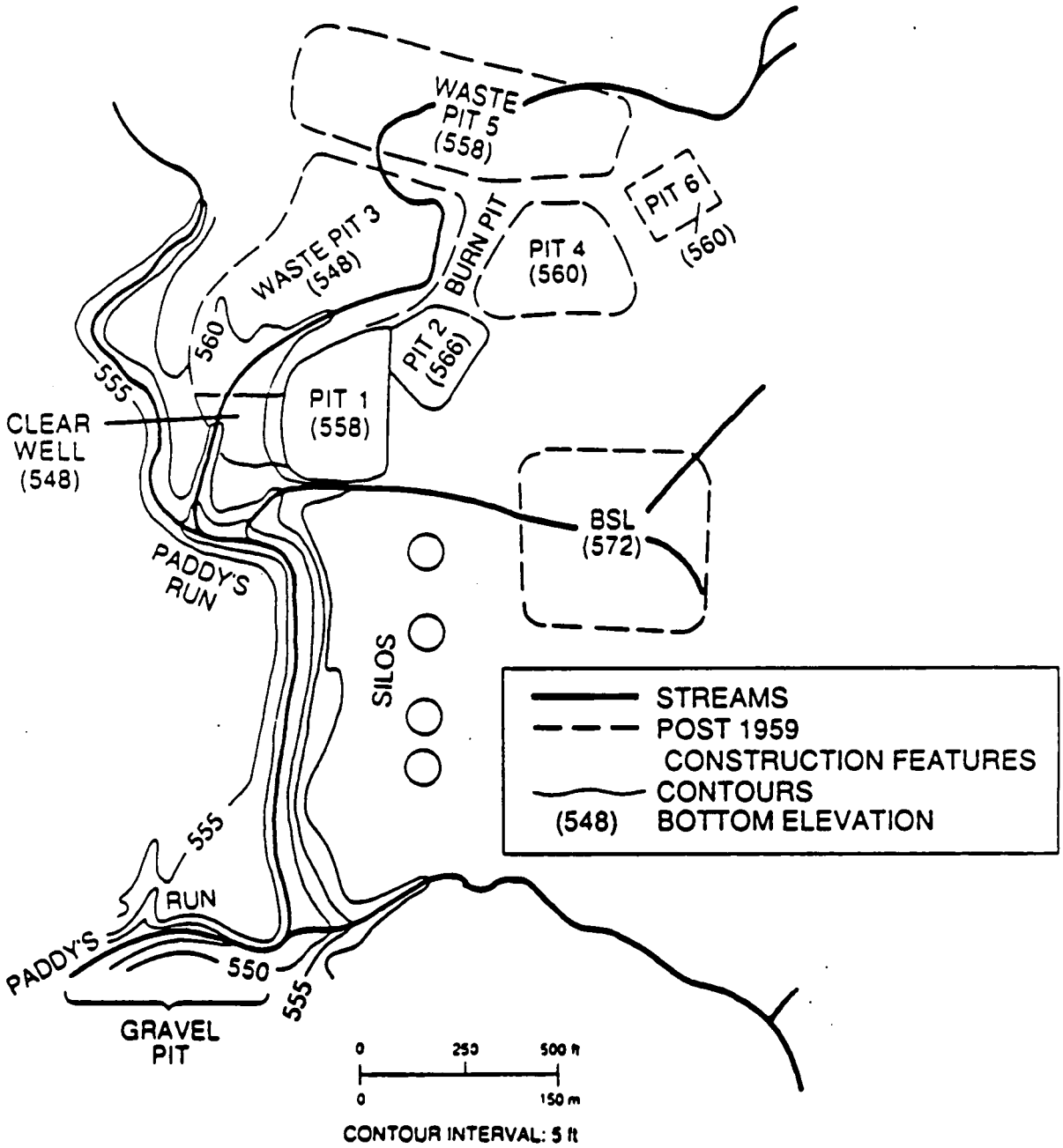


Fig. 3.5-5. Topographic map (1959) of Paddy's Run and its tributaries from Pit 5 to 500 ft south of the silos. *Source:* Modified after city of Cincinnati vs Hamilton County metropolitan topographic sheet no. 132 (1959) under direction of the Division of Engineering of the city of Cincinnati.

ORNL-DWG 87-14191

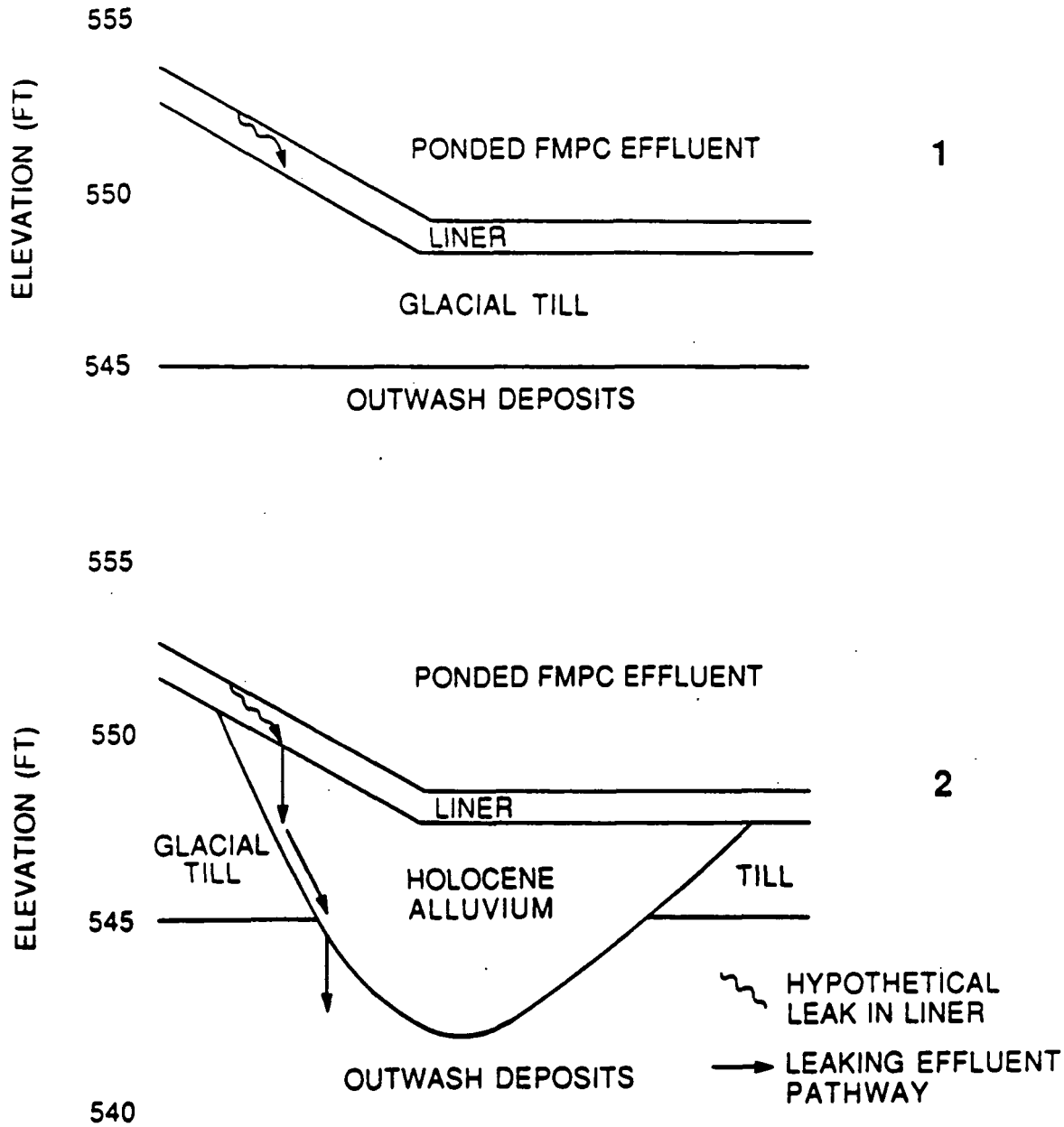


Fig. 3.5-6. Two possible foundation conditions beneath the Clear Well and Waste Pit 3 and potential pathways of effluent from the pits to groundwater (Hypothesis 1 - Effluent leak contained by glacial till; Hypothesis 2 - Effluent leak transmitted through Holocene alluvium to outwash deposits of the Great Miami Aquifer). Foundation conditions at the Clear Well and Waste Pits 1-3 are not well enough understood or present to determine whether or not they leak significantly.

Fig. 3.5-7 (WMCO 1987a). The locations of abandoned deep farm wells are uncertain. There may also be a number of deep FMPC foundation borings at unknown locations.

Containment of effluents depends on the quality of construction of waste pits as well as construction and abandonment procedures for nearby wells. Construction and logging methods for abandoned farm wells and early FMPC wells are uncertain; pathways to the Great Miami Aquifer could exist if poorly completed or improperly abandoned wells are located near leaking waste pits. Liners of the older FMPC waste pits are not of current construction and would not have been approved under current EPA-RCRA standards for hazardous waste impoundments. The deeply excavated older FMPC waste pits were constructed across the tributary to Paddy's Run (the Clear Well and Pit 3). These pits are the most likely contributors of contaminants to the Great Miami Aquifer, possibly by one or more of the pathways described previously. The appearance of contaminants in nearby (on-site) monitor wells shortly after Waste Pit 3 was placed in service supports this interpretation (ACCR 1965-85). Facilities with state-of-the-art liners and shallow excavations [e.g., the Biodenitrification Surge Lagoon (BSL)] are least likely contributors of contaminants to the Great Miami Aquifer.

3.5.3 Soils on the FMPC Site

Soils with agricultural drain tile are of interest because of the potential for horizontal movement of contaminated water at shallow depth [~1 m (3 ft) beneath the surface]. This is particularly true for the Fincastle and Henshaw soils (Fig. 3.5-8), which are considered to be prime farmland (Lerch 1980 and 1982). The use of agricultural drain tile by former landowners is believed to have been extensive. All drain tile at FMPC was installed before the U.S. Department of Agriculture's Soil Conservation Service (SCS) was established; therefore, no records of installation are available. However, the significance of the presence of agricultural drain tile is uncertain. A few damaged segments may remain partly intact. Several drain tile outlets in tributaries to Paddy's Run are still recognizable (Knollman 1987). Currently no data are available regarding drainage or contaminants from these outlets.

Only the two principal soils on the higher ground of the FMPC site (Fig. 3.5-8), the Fincastle silt loam (both disturbed and undisturbed by urbanization) and the Henshaw silt loam, are discussed here. Fincastle soils are developed on glacial till of the upland till plain where the FMPC production area and waste pits are located, and Henshaw soils are developed on lakebed sediments where the SWRB is located (Fig. 3.5-8). Both soils are poorly drained, due in part to the nearly flat slopes on which they lie and the presence of a clay-rich subsoil beneath the topsoil. The soils are drained by open ditches, drain tile, or natural gullies. Both topsoils are loose and dark brown. With increasing depth, the subsoil changes into a dense clay loam that forms a partial barrier to the downward flow of surface water. However, this barrier has probably been destroyed wherever construction activities have occurred in the northern one-third of the FMPC

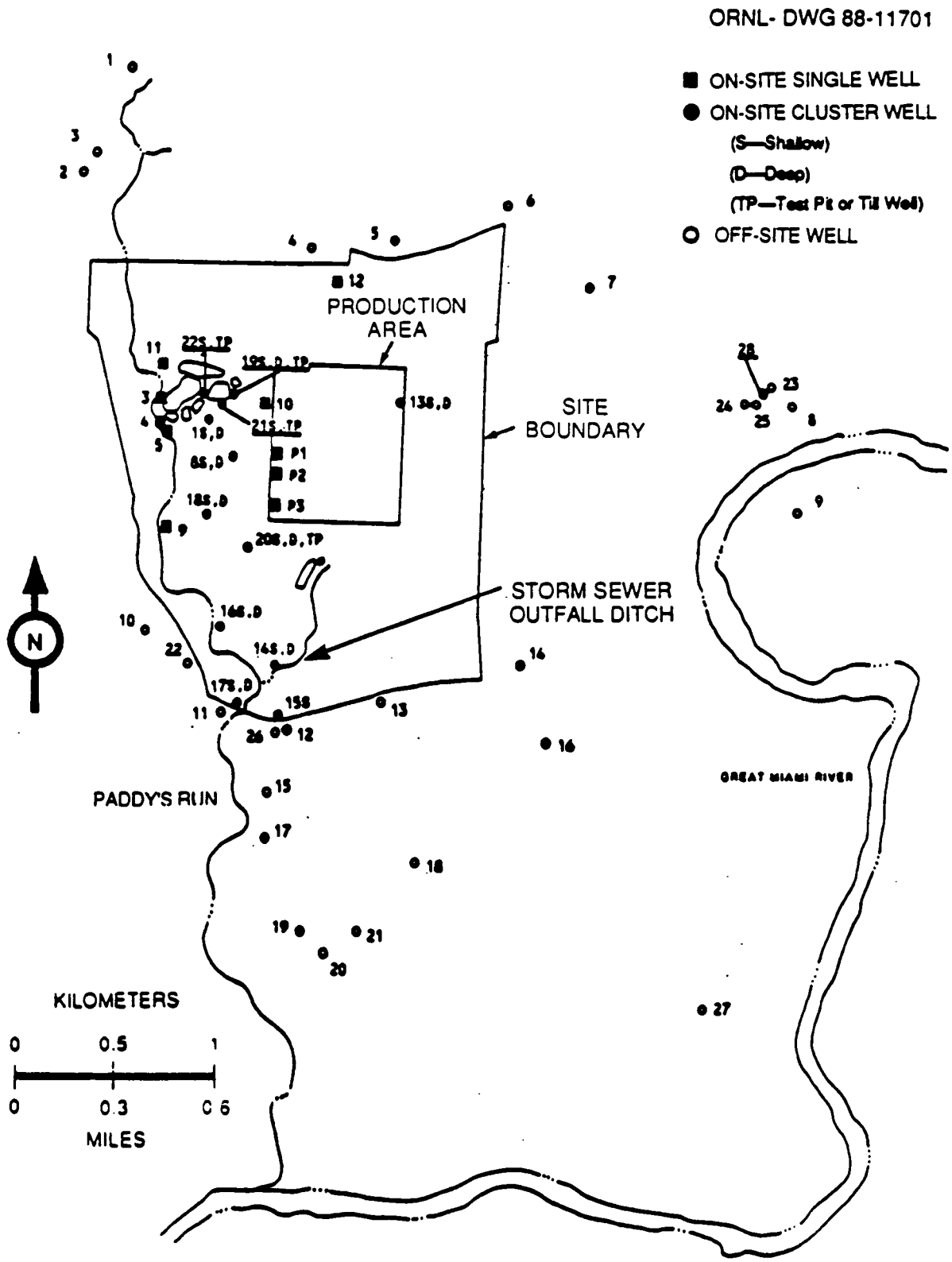


Fig. 3.5-7. Groundwater well locations at the Feed Materials Production Center (WMCO 1987a).

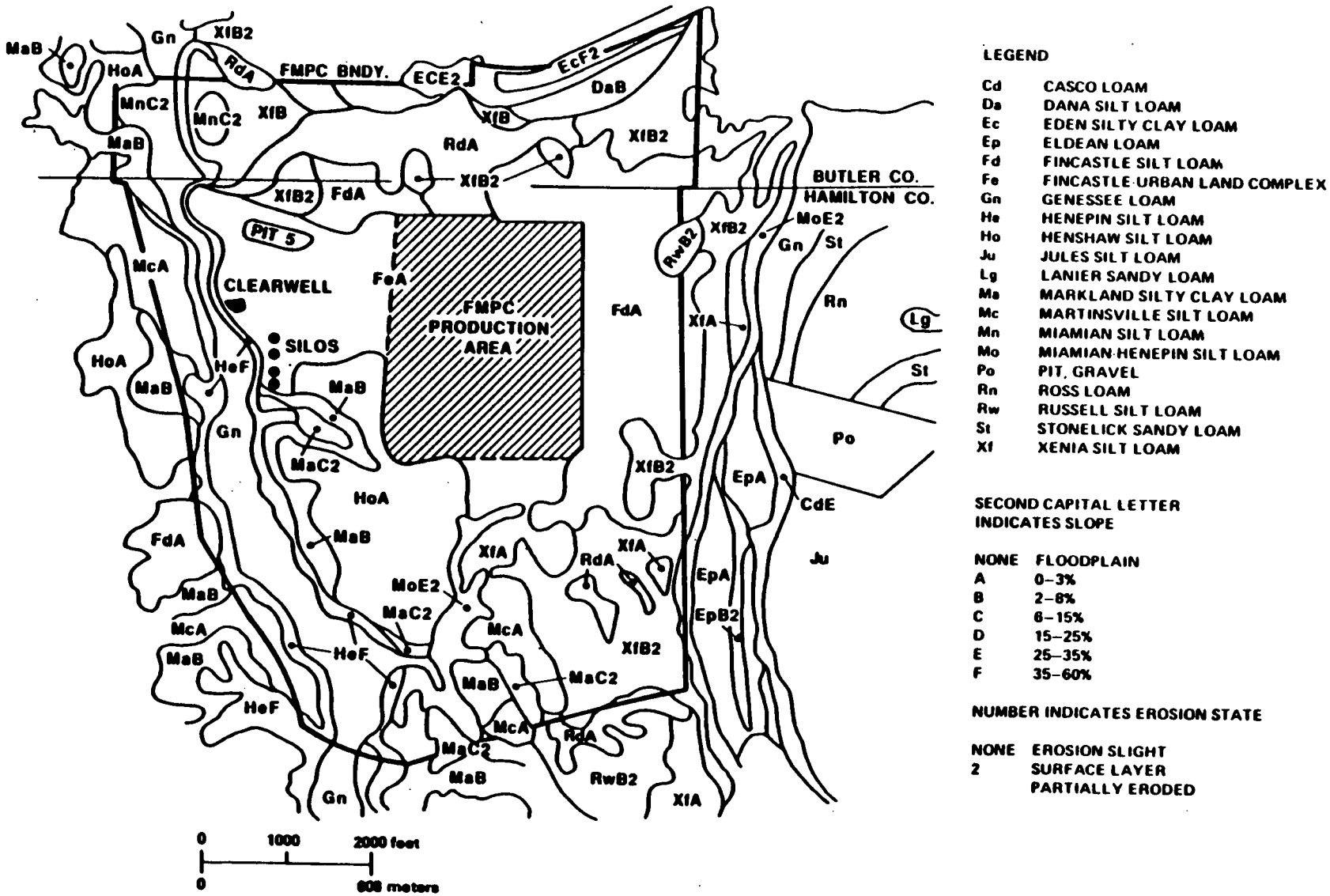


Fig. 3.5-8. Soils map of the Feed Materials Production Center site.
Source: modified after Lerch, Hale, and Lemaster (1980) and Lerch, Hale, and Lemaster (1982).

site. Where this destroyed barrier has not been paved over, stormwater infiltration is increased.

3.5.4 Earthquake Risk

Major earthquakes have the potential for causing accidental releases of contaminants to the environment wherever facilities such as FMPC are located. All such facilities must be designed and constructed to shut down safely in the event of intense ground shaking or soil liquefaction induced by major (strong-motion) earthquakes. These facilities must be sited away from areas where there is a risk of surface rupture along an active fault.

The risk of surface rupture can be dismissed at FMPC. Nuttli (1981) states that strong-motion earthquakes are seldom, if ever, accompanied by surface rupture in the eastern United States. Furthermore, there are apparently no significant Paleozoic faults in the region surrounding FMPC (Swinford and Brockman 1989). The base of the glacial till is unfaulted (Brockman 1986).

Liquefaction and intensity of ground shaking depend on foundation conditions as well as the size of an earthquake. The following discussion identifies the safe shutdown earthquakes (SSE) and associated peak ground acceleration [(PGA) a measure of the intensity of ground shaking] for moderately hazardous facilities located on rock or firm soil. Unusual foundation conditions at FMPC that could amplify PGAs or create a potential for liquefaction are also discussed.

FMPC lies in an area of moderate seismic activity (seismic zone 2 of Algermissen 1969). Fig. 3.5-9 is a map of the region displaying the epicenters of strong and moderately strong earthquakes that have occurred within 320 km (200 miles) of FMPC (NOAA 1987) during the past 200 years. Thenhaus' (1983) seismic source zones of the central interior United States are also displayed on Fig. 3.5-9, denoted by two-digit numbers (55-63). The maximum expected earthquake would occur at the closest approach of seismic source zones 55-56 to FMPC or the maximum expected earthquake within 10 km (6.2 miles) of FMPC in seismic source zone 63.

Table 3.5-2 provides PGAs as decimal fractions of the earth's gravitational acceleration (g) for various return periods at FMPC. The return period is a measure of the likelihood of an earthquake exceeding a given PGA [e.g., Coats and Murray (1984) estimate that earthquake ground motion will exceed a PGA of 0.06 g at least once in 100 years]. All DOE general purpose facilities may be designed to withstand a 500-year return period PGA of 0.10 g, but all new or renovated moderately hazardous facilities at FMPC are required by DOE Order 6430.1A (DOE 1988) to be shut down safely in the event of a 1000-year return period PGA of 0.12 g at FMPC. The PGAs at FMPC for the maximum expected regional and local earthquakes are 0.20 g and 0.18 g (target and star symbols, respectively, in Fig. 3.5-9). The return periods for these ground motions are highly uncertain (~10,000 ± 5000 years).

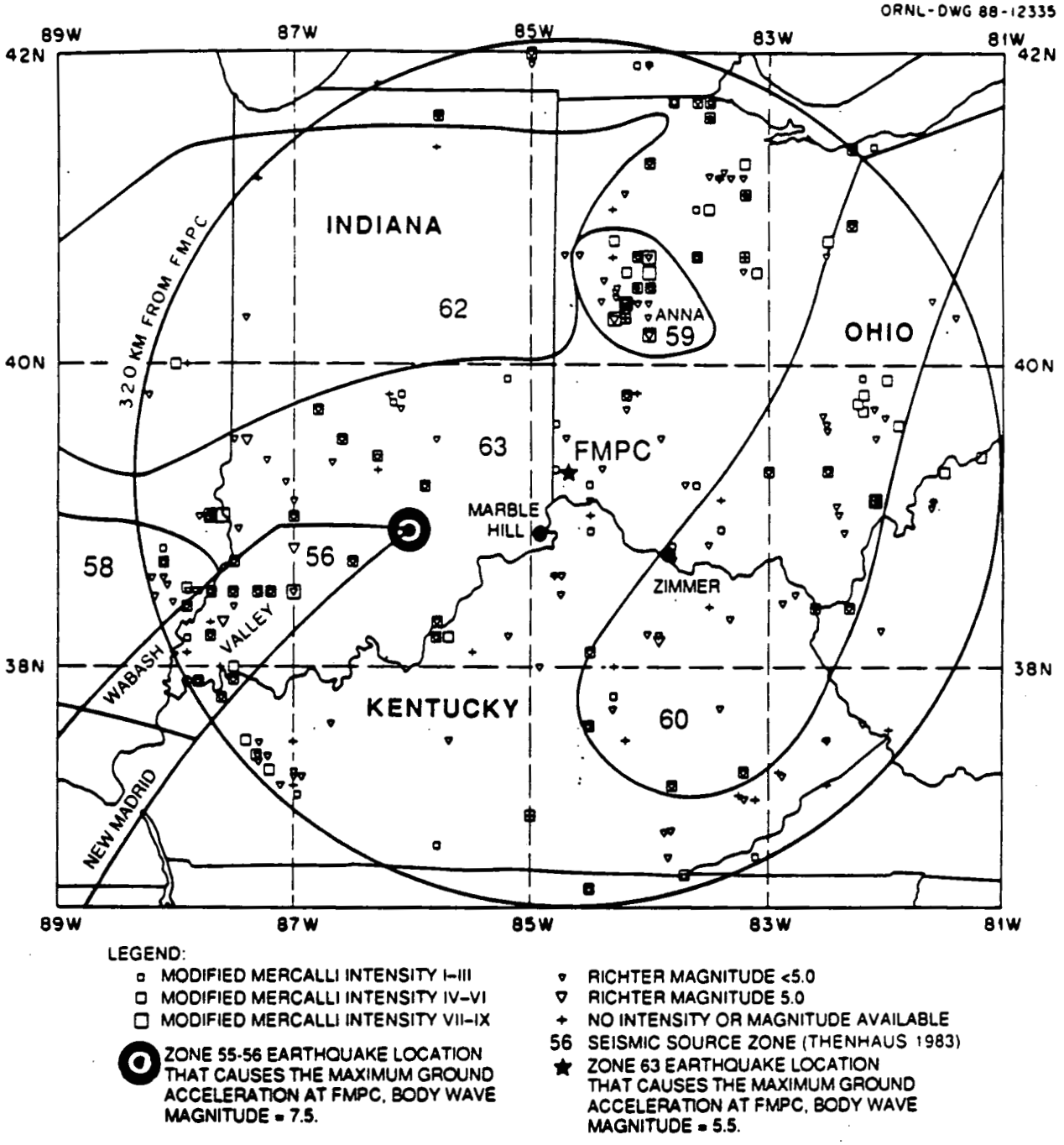


Fig. 3.5-9. Location of moderate and large earthquakes recorded within 320 km (200 miles) of the Feed Materials Production Center during the past 200 years. Source: NOAA 1987.

Table 3.5-2. Peak ground accelerations for given return periods and the maximum expected regional and local earthquakes at the Feed Materials Production Center

Return Period (years)	Peak ground accelerations (g)
100	0.06[a]
500	0.10[a]
1000 (SSE)[b]	0.12[a]
MEE[c] (regional)	0.20[d]
MEE (local)	0.18[d]

[a]*Source:* Coats and Murray 1984; Beavers, Manrod, and Stoddart 1982.

[b]Safe shutdown earthquake (SSE) for facilities such as FMPC (DOE 1988).

[c]MEE is the maximum expected earthquake. The return period for these ground motions are highly uncertain (~10,000 ± 5,000 years).

[d]Based on Campbell 1981 and Fig. 3.5-9.

The PGA estimates in Table 3.5-2 are based on the assumption that the facilities are built on rock or firm, cohesive ground. Facilities built on relatively cohesionless soils may experience more severe ground accelerations or may fail by liquefaction (a physical state wherein the soil behaves as though it were a liquid and thus fails to support a load placed upon it). FMPC production area facilities are generally sited on glacial till, which has no liquefaction potential. Outside the production area, however, several of the waste pits constructed along a tributary to Paddy's Run (Sect. 3.5.2) may be underlain by soft Holocene alluvium. Liquefaction potential of the alluvium is uncertain. Standard penetrometer tests and grain-size distribution analyses would be needed to determine whether these sediments are sensitive to liquefaction.

Ground motion amplification may also be a concern at FMPC. All facilities at FMPC are sited above thick glacial outwash sand and gravel of the New Haven Trough. This may cause the amplification of PGAs above the estimates provided in Table 3.5-2. DOE Order 6430.1A requires that all of the previously discussed unusual foundation conditions be taken into consideration in designing and renovating facilities.

3.6 HYDROLOGY AND WATER QUALITY

This section describes current surface water and groundwater conditions in the vicinity of FMPC. Additional information is found on groundwater in Appendix F.

3.6.1 Surface Water Hydrology

FMPC lies within the watershed of the Great Miami River, which flows within 1.2 km (0.75 mile) of the eastern boundary of the site on its way to the Ohio River, approximately 39 river kilometers [24 river miles (RM)] to the southwest (see Fig. 3.6-1). The FMPC site drains primarily west and south to Paddy's Run, a small, first-order stream that typically flows throughout its length only during the months of January through May (Dames and Moore, Inc. 1985). During summer and fall, the entire flow in Paddy's Run often seeps into the Great Miami Aquifer downstream of the K-65 silos, resulting in no surface flow south of FMPC. From the site's southern boundary, Paddy's Run extends south approximately 2.9 km (1.8 miles) to the Great Miami River.

The Great Miami River drainage basin above FMPC has an area of 9850 km^2 (3800 $mile^2$). The Great Miami River in the vicinity of FMPC averages about 1 m (3 ft) in depth and 40-120 m (130-390 ft) in width with a broad floodplain.

Upstream from FMPC, five Miami Conservancy District retarding basins have assisted in the flow regulation of the Great Miami River since 1920 (Spieker 1968). Storage is controlled by ungated outlets at each dam (COE 1967). Average discharge at the nearest U.S. Geological Survey gauging station at Hamilton for 1931-1986 is 93.6 m^3/s (3205 cfs). The average maximum and minimum discharges have been 3060 m^3/s (108,000 cfs) and 4.4 m^3/s (155 cfs) respectively. The baseflow (that is, the sustained

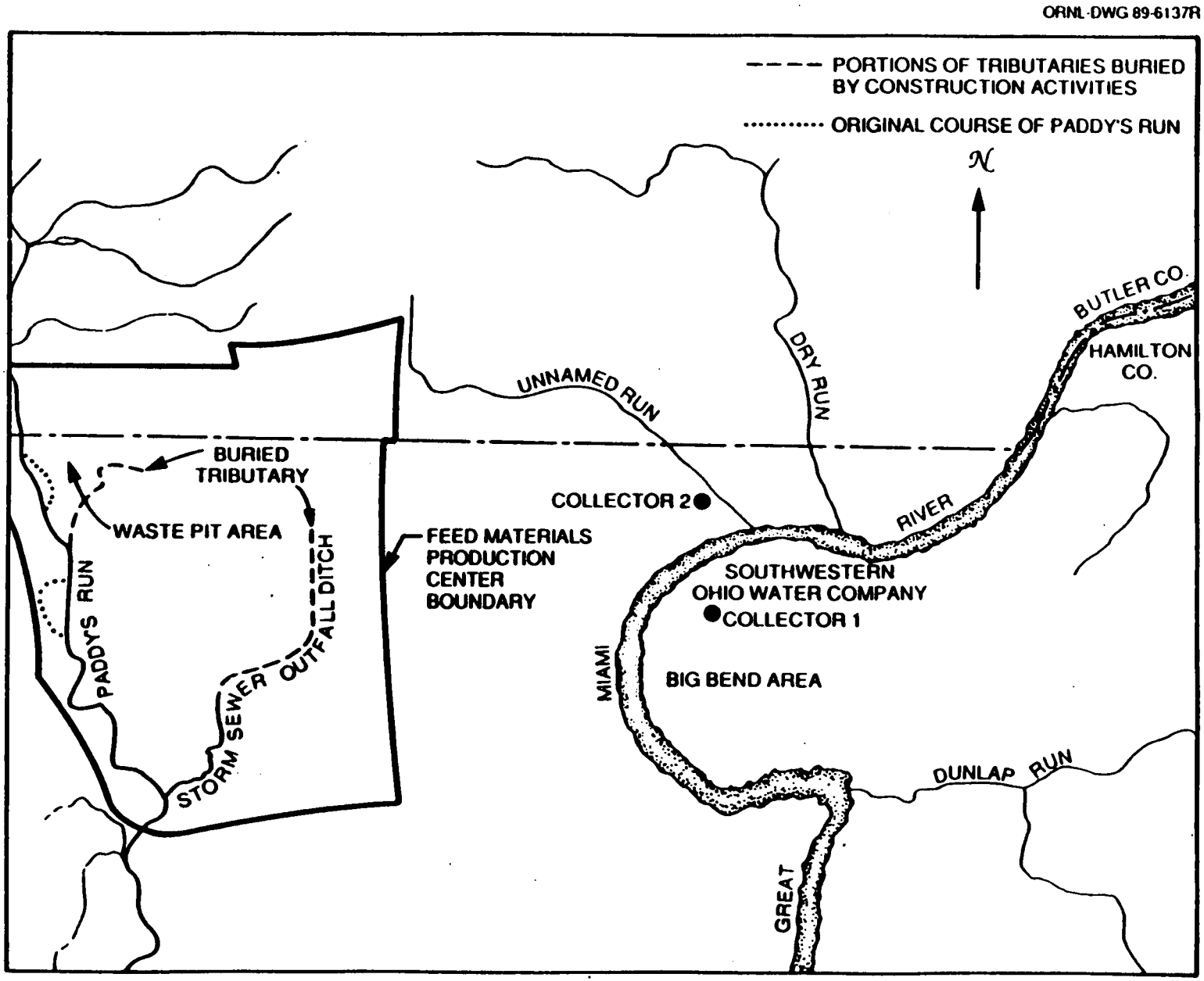


Fig. 3.6-1. The Great Miami River watershed in the vicinity of the Feed Materials Production Center [adapted from Dove (1961)].

dry-weather flow) of the Great Miami River is maintained primarily by groundwater seepage in the northern portion of the watershed(Spieker 1968). The river's baseflow at Hamilton is 13.9 m^3/s (490 cfs) (Spieker 1968). Since the river is the major recharge source for the Great Miami Aquifer, this baseflow ensures that adequate quantities of water are available to replenish the aquifer.

3.6.1.1 Paddy's Run

Paddy's Run flows in a north-to-south direction along the western edge of the FMPC reservation boundary before joining the Great Miami River south of the plant. Paddy's Run is an extremely steep-sided stream that has cut to depths of 6.1 m (20 ft) or more through the glacial till and lacustrine deposits on which FMPC is built. The Pleistocene glacial outwash, the geologic formation through which the Great Miami Aquifer flows (Sect. 3.5.1.2), is exposed in the streambed of Paddy's Run between the K-65 silos and its junction with the Great Miami River.

Flow in Paddy's Run follows two pathways. Between January and May, flow is generally continuous all the way to the Great Miami River. During these months, the flow typically ranges from 0.006 m^3/s (0.2 cfs) to 0.1 m^3/s (4 cfs) (Dames and Moore, Inc. 1985). Between June and December, flow north of the K-65 silos is reduced to a trickle. During this time of year there is usually no flow in Paddy's Run south of the K-65 silos. The flow disappears into the Great Miami Aquifer below the K-65 silos because at that point the streambed penetrates the relatively impermeable glacial till and permits surface flow to enter the underlying Pleistocene outwash deposits and the Great Miami Aquifer.

The course of Paddy's Run has been changed twice in recent times. In 1961 and 1962 the stream was redirected away from the waste pit area (Fig. 3.6-1). A stretch of Paddy's Run south of the K-65 silos was straightened in 1970 to prevent erosion from undermining Paddy's Run Road (WMCO 1987b). In addition, a tributary of Paddy's Run that passed through the waste pit area was buried during the construction of several waste pits.

The Storm Sewer Outfall Ditch, an important tributary of Paddy's Run, begins at the southwestern edge of the parking lot and extends past the SWRB to its confluence with Paddy's Run near the southern boundary of the FMPC site. The upper reaches of this intermittent stream were buried during construction at the plant. As the name suggests, the Storm Sewer Outfall Ditch has been the point of discharge for the Storm Sewer System since FMPC was constructed. Currently, the SWRB intercepts discharges from the Storm Sewer System, and the Storm Sewer Outfall Ditch receives stormwater from the FMPC process area only when the SWRB overflows. The single SWRB has overflowed four times between 1986 and January 1989. In January 1989 a second SWRB was completed (Sect. 4.1). These two basins are designed with enough capacity to capture a 10-year, 24-h rainfall event. Storms occurring within few days of each other and delivering a total cumulative rainfall of greater than the 10.4 cm (4.1 in.) of rain that the

basins are designed to contain will cause overflows. Such multiple storms occur every 2 to 3 years at FMPC.

3.6.1.2 Flooding

FMPC is built on an upland till plain above the Great Miami River floodplain. Figure 3.6-2 shows the 100-year floodplain areas of the FMPC as determined by the U.S. Geological Survey (USGS 1973). Figure 3.6-2 shows that the waste pit area might be affected by flooding. Since the flood-prone areas shown in Fig. 3.6-2 were identified, however, the waste pit area has been changed in such a way that flooding appears unlikely. The sides of the Clear Well and Pit 3 have been built up to an elevation of 176 m (578 ft), which is above the floodplain elevations. Paddy's Run has been straightened and diked so that it is farther west from the pits. Flooding of the waste pits area appears to require a flood larger than the 100-year flood.

3.6.2 Surface Water Quality and Sediments

Under the state of Ohio's Water Quality Standards, both Paddy's Run and the Great Miami River in the vicinity of FMPC are designated for use as warmwater aquatic life habitat, agricultural and industrial water supplies, and for primary contact recreation (suitable for full-body contact). Neither stream is designated for use as a public water supply. The following descriptions of water quality are based primarily on data published in the FMPC Environmental Monitoring Report for 1986 (WMCO 1987a). This allows a comparison among conditions prior to renovations (1985), after some renovations (present situation alternative, Sect. 4.1) and after future actions (Sects. 4.2 and 4.3).

3.6.2.1 Great Miami River

The Great Miami River has a long history of water quality problems related to municipal sewage and industrial outfalls, especially low dissolved oxygen, thermal discharges, and high levels of ammonia and nitrates. Several upstream facilities (e.g., the Mound Laboratory near Miamisburg, Ohio) may release small amounts of radionuclides to the river. Urban and industrial areas associated with the cities of Dayton, Middletown, and Hamilton-Fairfield are the principal contributors of pollutants. Hamilton-Fairfield lies only about 15 km (9 miles) upstream of FMPC. Agricultural practices in the watershed have also contributed to problems related to nutrient enrichment, increased suspended solids, and lowered dissolved oxygen. FMPC discharges treated process wastewater, sewage treatment plant effluent, and stormwater to the Great Miami River through a buried effluent pipeline at RM 24.3. During heavy rainfalls, or sequential rainfalls, stormwater occasionally overflows the SWRBs to Paddy's Run, which discharges into the river at RM 19.6 (see Fig. 3.6-3).

These discharges are regulated by a National Pollutant Discharge Elimination System (NPDES) permit administered by OEPA. The NPDES permit expired in 1985; however, FMPC is now operating under an administrative

ORNL-DWG 88-12386R3

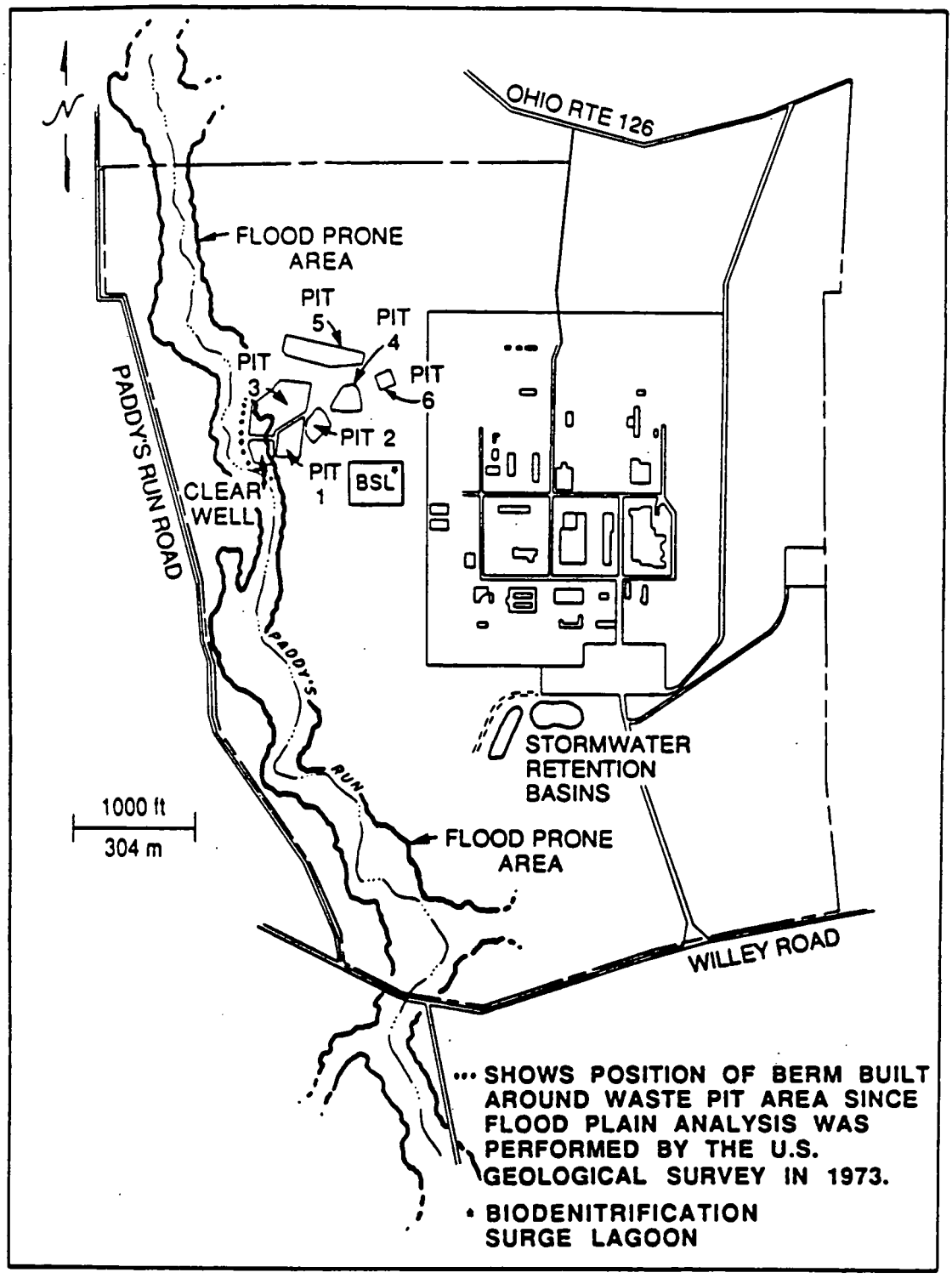


Fig. 3.6-2. 100-year floodplain within the Feed Materials Production Center site (USGS 1973).

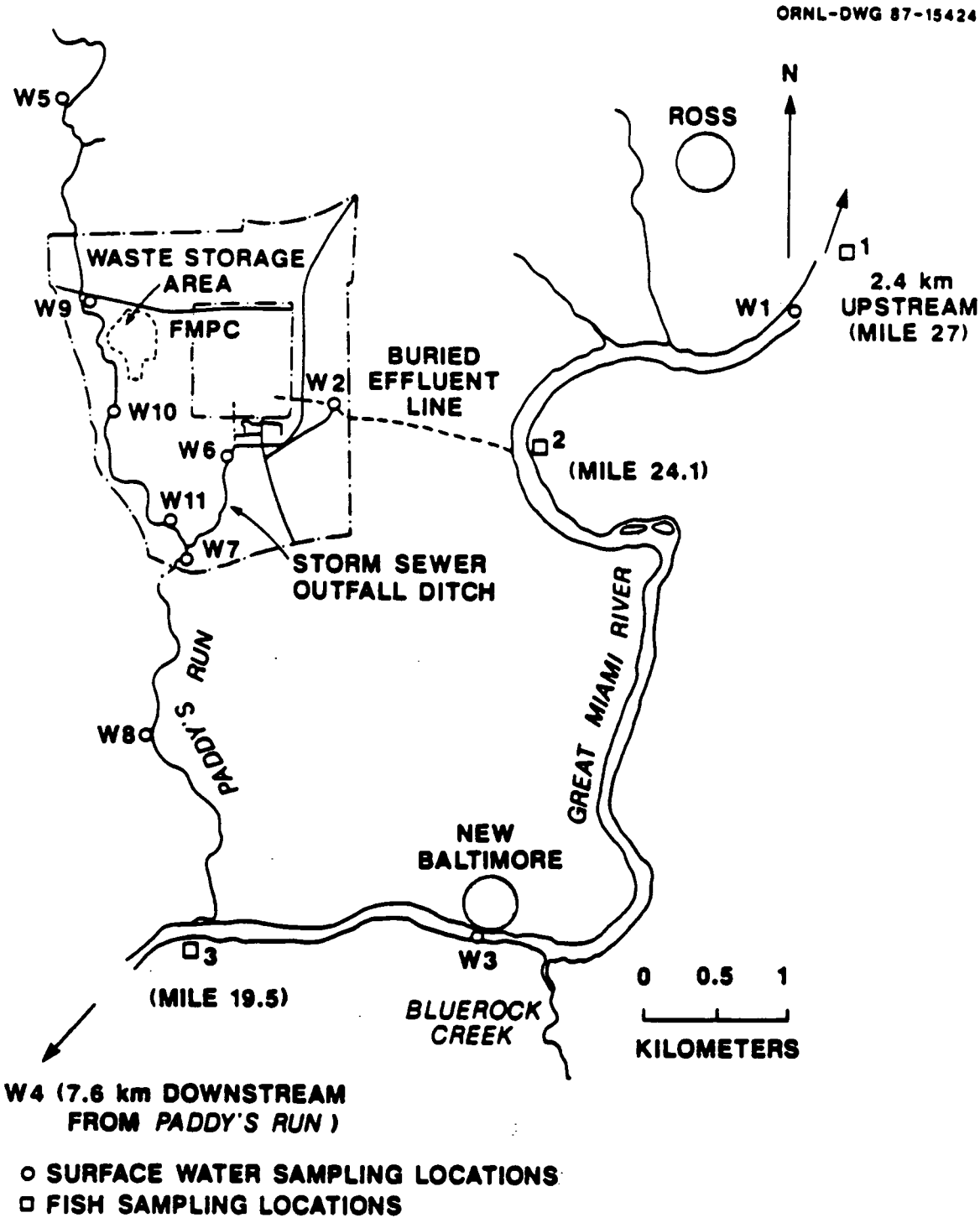


Fig. 3.6-3. Major surface waters and surface water sampling locations in the vicinity of the Feed Materials Production Center.

extension of the permit. FMPC sent an NPDES permit renewal application to OEPA in August 1988. FMPC continues to operate under the old permit and, according to the terms of the Consent Decree, until OEPA issues a new permit. DOE and EPA are currently renegotiating NPDES limits to reflect the best available wastewater treatment technology proposed for FMPC. During 1985, some samples of FMPC effluents discharged through the buried pipeline (WMCO 1986) exceeded permit limits for hexavalent chromium (21% of samples), iron (8%), copper (4%), 5-d BOD (6%), suspended solids (4%), and oil and grease (2%). During 1986, samples exceeded the permit levels for hexavalent chromium (6% of samples), 5-d BOD (6%), and suspended solids (8%).

During 1985, several radionuclide concentrations (especially technetium) in water and sediment of the Great Miami River were slightly higher 5 km (3 miles) downstream of FMPC wastewater outfall W3, than at the upstream sampling station W1 (Fig. 3.6-3) (WMCO 1986). All measurements of radionuclide concentrations in the Great Miami River in the vicinity of FMPC remained well below levels considered harmful to aquatic life, as shown in Sect. 3.7.2. However, neither the level of radionuclides in the river between the outfall and station W3, nor the efficacy of mixing of effluent in the river has been characterized. Concentrations of radionuclides and other contaminants in the 5-km reach between the outfall and station W3 could be higher than the concentrations reported for W3. Therefore, a well-designed monitoring program directed at contaminant concentrations in water and sediment between the outfall and W3 is needed to better characterize the mixing zone.

Runoff from several areas at the FMPC site, especially the waste pit storage area in the northwest part of the site, indirectly contributes (e.g., via Paddy's Run) to the contaminant loading of the final effluent to the Great Miami River (Table 3.6-1). The discharge of radionuclides to surface water is not regulated by the NPDES permit but is regulated under draft DOE Order 5480.xx.

The average annual effluent concentrations of individual radionuclides in 1985 ranged from 0.00016% (Pu-238) to 54% (U-238) of DOE's release concentration limits for waters beyond DOE control (Table 3.6-2). On a daily basis, however, total activities from uranium in the effluent have ranged as high as 3300 pCi/L (Bogar 1987), well in excess of the proposed DOE limit of 550 pCi/L for total activity from uranium. Although the average effluent concentrations for all individual radionuclides were below DOE's release limits, the combination of radionuclides exceeds DOE's effluent limits. The uranium-234 and U-238 are the principal radionuclides that cause the effluent to exceed DOE's limits (Table 3.6-2).*

Information on other contaminants that may have been discharged to area surface waters by FMPC facilities (e.g., lead and other toxic metals, PCBs, toxic organic compounds, and asbestos) is limited to the data

---

*The sum of ratios rule states that the sum of the ratios for each radionuclide (the concentration of the individual radionuclides over their maximum permissible concentrations) should not exceed 1.0.

Table 3.6-1. Summary of 1985 wastewater contaminant discharges at the Feed Materials Production Center

Pollutant[a]	Manhole 175 (001)	Stormwater overflow[b] (002)
Flow, MG	164.6	35.8
pH	7.4-9.1	
TSS, kg	3,119	2,035
BOD, kg	1,606	
NO_3 as N, kg	135,050	
NH_3 as N, kg	183	
O&G, kg	524	136
Res. chlorine, kg	18.7	
F. Coliform, mpn/100 mL	2,500	
Cr^{6+}, kg	2.2	
Cr, total kg	5.1	
Fe, kg	94.9	
Ni, kg	12.0	
Cu, kg	6.2	
Uranium, kg	605.6	81.4
Uranium Ci (total)	0.41	0.055
U-234, Ci	0.15	
U-235, Ci	0.0074	
U-236,Ci	0.0049	
U-238, Ci	0.2	
Cs-137, Ci	0.0097	
Np-237, Ci	<0.00017	
Pu-238, Ci	0.000005	
Pu-239/240, Ci	0.000015	
Ra-226, Ci	<0.0051	
Ra-228, Ci	<0.008	
Ru-106, Ci	<0.0010	
Sr-90, Ci	0.0052	
Tc-99, Ci	8.3	
Th-232, Ci	<0.011	

[a]MG = millions of gallons,
TSS = total suspended solids,
BOD = 5-day biochemical oxygen demand,
O&G = oil and grease, and
mpn = most probable number.

[b]Only the parameters with values given below are monitored. The Stormwater Retention Basin was not built at this time.

Table 3.6-2. Comparison of average 1985 radionuclide concentrations released to the Great Miami River buried effluent line and DOE liquid release limits

Isotope	Average annual effluent conc.[a] (pCi/L)	Proposed release limit (5400.xx)[b] (pCi/L)	Ratio[c]
Sr-90	8.39	1,000	0.00839
Tc-99	13,400	100,000	0.134
Ru-106	<1.58	6,000	<0.000263
Cs-137	15.7	3,000	0.00523
Ra-226	<8.11	100	<0.081100
Ra-228	<12.9	100	<0.129
Th-232	<17.7	50	<0.355
U-234	243	500	0.487
U-235	11.9	600	0.0199
U-236	7.89	500	0.0158
U-238	326	600	0.545
Np-237	<0.27	30	<0.0090
Pu-238	0.0082	40	0.00021
Pu-239/240	0.023	30	0.00077
Sum of ratios[d]			1.26-1.79[e]

[a]*Source*: WMCO 1986

[b]*Source*: DOE Draft Order 5400.xx, Radiation Protection of the Public and the Environment, March 18, 1988. FMPC is working toward complying with these limits.

[c]Effluent concentration/release limit

[d]The sum of ratios rule is defined in proposed DOE Order 5400.xx. The rule states that the sum of the ratios (the concentration of individual radionuclides released in effluent divided by individual radionuclide release limits) should not exceed 1.0.

[e]Lower value calculated on the basis that radionuclides not detected are not present; higher value calculated on the basis that radionuclides not detected are present at the detection limit.

generated by one sampling effort in 1988 (WMCO 1988c). However, this effort did not analyze for hexavalent chromium, asbestos, or PCBs at detection levels approximating the state criteria for protection of aquatic life. Although these data show that NPDES-permitted discharges occasionally exceed limits for BOD, total suspended solids, fecal coliforms, copper, iron, and nitrate, none of the priority pollutants in the final discharges to area waters were measured at levels known to be toxic to aquatic life.

Water quality standards for fecal coliforms, total iron, total copper, ammonia-nitrogen, and phenols at RM 21.4 of the Great Miami River (3 RM downstream of FMPC outfall) were exceeded at least once during a 1982 OEPA study. Higher-than-normal flows during the study may have caused higher-than-usual fecal coliforms, dissolved oxygen, and total iron concentrations; they also may have caused lower-than-usual temperature and concentrations of ammonia-nitrogen and certain other pollutants. Sediments have been sampled (see Fig. 3.6-4), and concentrations for phenols, phosphates, nitrates, and for each of eight heavy metals were lower at RM 20.6 (below the FMPC outfall) than at RM 30.4 (above the outfall) during the OEPA study (OEPA 1982). During droughts, surface water use in the reach from FMPC to the mouth of the Great Miami River is limited to occasional irrigation of 100-125 acres of corn at the dairy farm south of and immediately adjacent to the plant (Hamilton County Extension Agent 1986).

3.6.2.2 Paddy's Run

Paddy's Run has been subject to water pollution from several sources, including soil erosion, crop fertilization, feedlot runoff (Bauer, Branson, and Colwell 1978) as well as contaminated runoff and groundwater seepage from FMPC. In 1985, stormwater runoff entered Paddy's Run directly from FMPC waste pit areas (Fig. 3.6-3), fly ash piles, and from overflow of the Storm Sewer Lift Station (WMCO 1986). Only four storm events have led to stormwater discharges to the Storm Sewer Outfall Ditch since the SWRB was put into service in 1986 (Sect. 4.2.5). Contamination of Paddy's Run by FMPC is evidenced by elevated levels of uranium, technetium, and other radionuclides in surface waters and sediments of Paddy's Run on and downstream of the FMPC site. At Sampling Station W10, located in Paddy's Run immediately south of the waste pit area (Fig. 3.6-3), uranium concentrations in surface water ranged up to 1830 pCi/L in 1985 (WMCO 1986).

In 1985, uranium concentrations in sediments of Paddy's Run ranged from background levels of 0.5 pCi/g (dry weight) at Station 26 just upstream of the waste pit area to 46.2 pCi/g at Station 17 downstream of the waste pits (WMCO 1986). In all, nine of the sediment sampling stations in Paddy's Run (Stations 10, 11, 12, 13, 14, 16, 17, 19, and 21 in Fig. 3.6-4) exhibited uranium concentrations in excess of DOE's limit proposed in Draft Order 5400.xx of 5 pCi/g for alpha-emitting radionuclides in the suspended solids of effluents released to natural waterways (DOE 1987). Technetium in Paddy's Run sediments was also evident from the 1985 data, but levels were below DOE's proposed limit of 50 pCi/g for

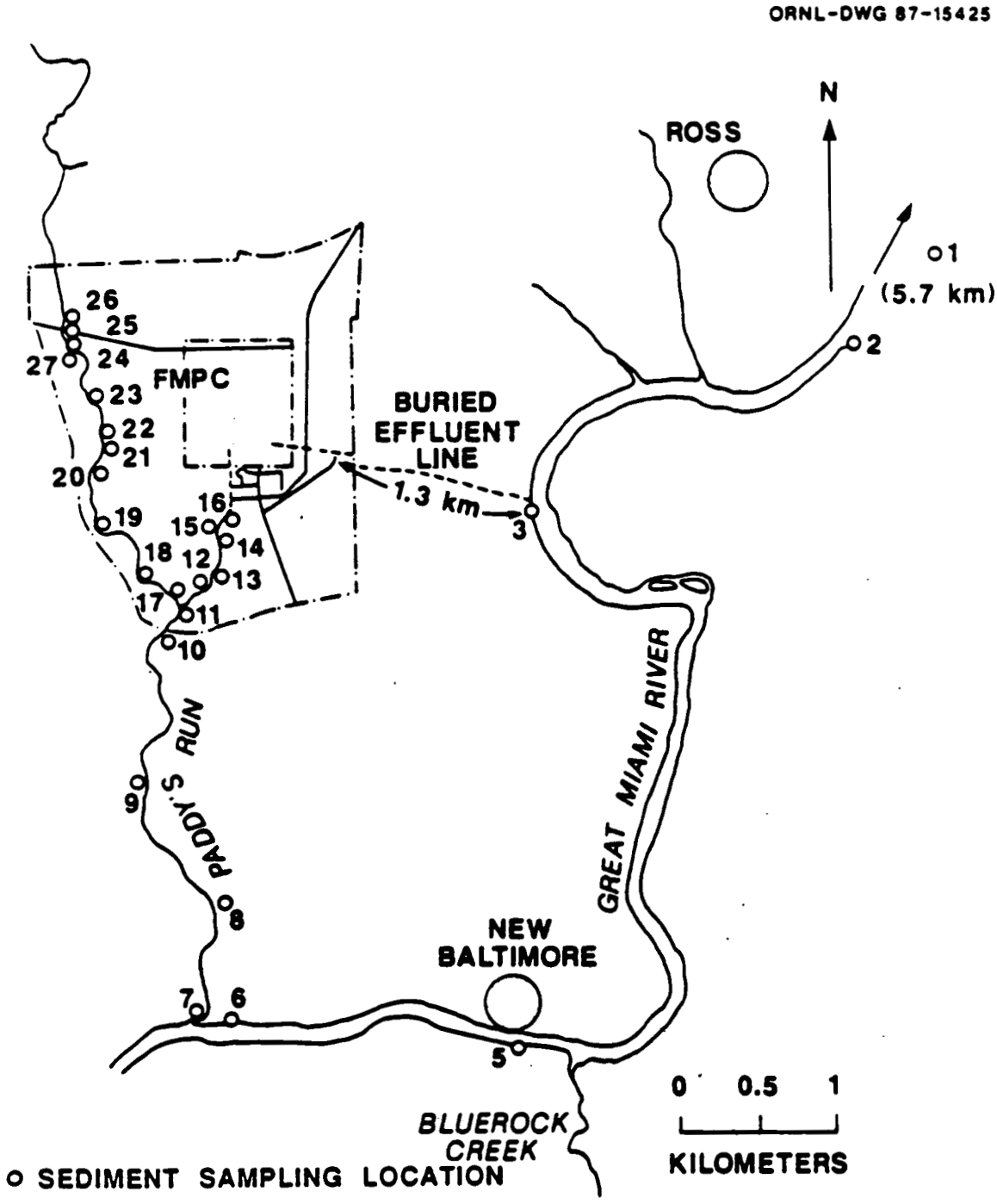


Fig. 3.6-4. Sediment sampling locations in the FMPC vicinity in 1985.

solids (in effluents) bearing beta- and/or gamma-emitting radionuclides (DOE 1987a). Uranium and technetium in sediments in the Great Miami River are also higher below the confluence of Paddy's Run than at the areas just downstream of the effluent outfall (2.6 pCi/g vs 0.5-0.8 pCi/g for uranium and 4.9 pCi/g vs 0.0 pCi/g for technetium). However, these levels are below the proposed beta-gamma limit of 50 pCi/g for suspended solids.

Except for fluoride, chloride, nitrate, and pH (none of which exceeded Ohio Water Quality Standards during 1985), nonradiological contaminants (e.g., lead, PCBs, organic halogens, and asbestos) in Paddy's Run have not been characterized.

3.6.3 Groundwater Hydrology

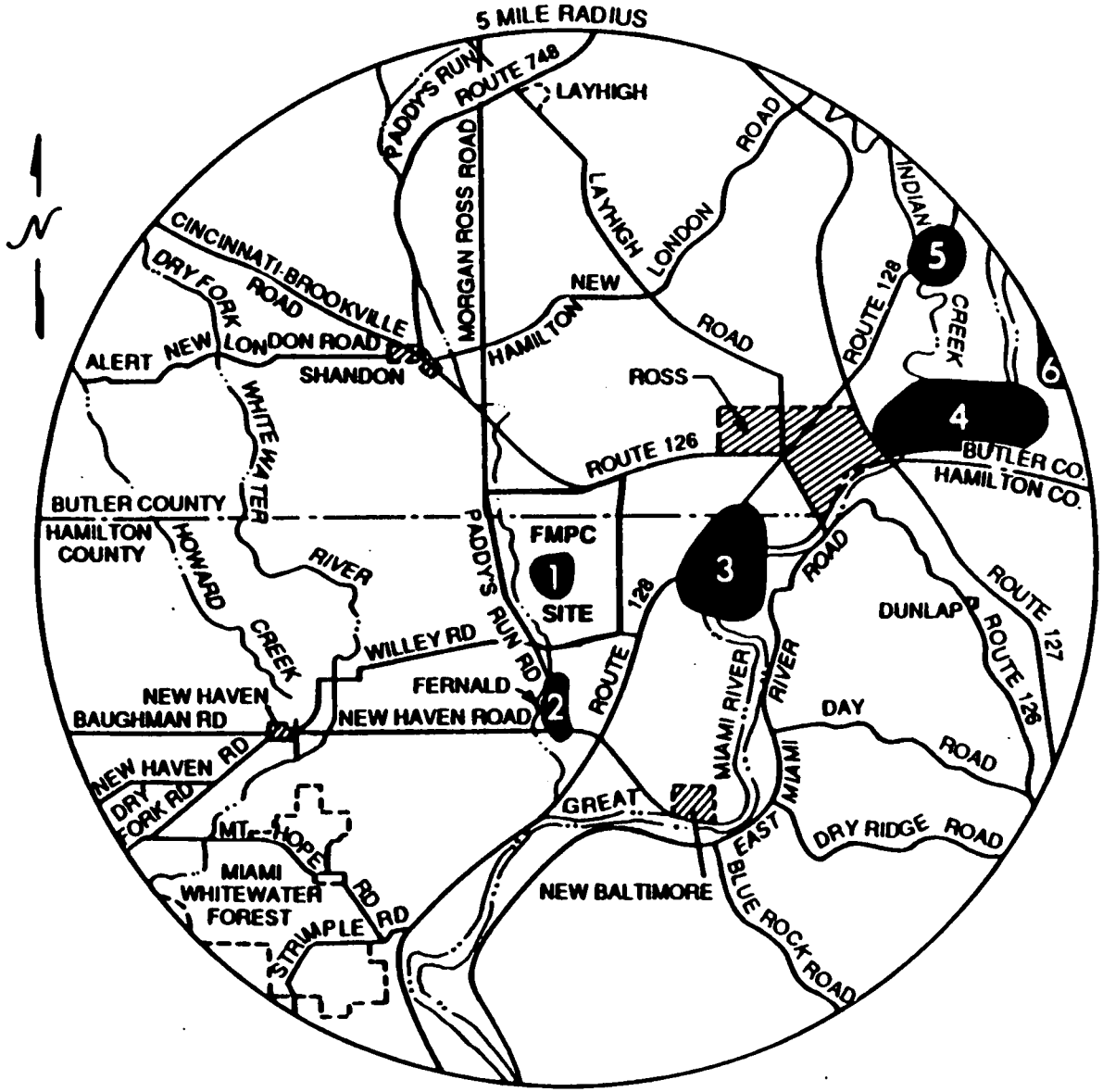
FMPC is built upon relatively impermeable glacial deposits which, in turn, overlay a thick and permeable layer of alluvium which is host to the Great Miami Aquifer (see Sect. 3.5.1.2). The Great Miami Aquifer is one of the most productive aquifers in the Midwest and serves as a major source of domestic, industrial, and municipal water for southwestern Ohio. In a recent Federal Register notice (53 FR 25870, July 8, 1988), EPA classified the Great Miami Aquifer as a sole source drinking water supply.

The Buried Valley Aquifer System (which includes the Great Miami Aquifer) of the Great Miami and Little Miami River Basins of Southwestern Ohio, has been designated as a sole source aquifer. This requires that no commitment for federal financial assistance may be entered into for any project that the EPA administrator determines may contaminate the aquifer system to create a hazard to public health. Commitments for federal financial assistance may be entered into to plan or design projects to assure that the aquifer will not be contaminated. This designation does not affect activities at FMPC since no activities are associated with commitments of federal financial assistance. However, the designation of the Great Miami Aquifer as a sole source aquifer could result in the development of a sole source aquifer demonstration program by the state of Ohio, subject to the approval of EPA. Such a demonstration program may include requirements designed to maintain the existing underground drinking water quality or improve quality if prevailing conditions fail to meet federal or state drinking water quality standards. Additionally, implementation of pollution-abatement measures may be required if they are deemed to be appropriate.

3.6.3.1 Great Miami Aquifer

Major Great Miami Aquifer groundwater pumping centers are shown in Fig. 3.6-5, and average individual pumping rates are listed in Table 3.6-3. There are many other smaller industrial, commercial, agricultural, and private groundwater users in the area. Total pumpage from the well fields listed in Table 3.6-3 exceeds 140,000 m^3/d (37,000,000 gal/d). Groundwater withdrawn from the Great Miami Aquifer by the Southwestern Ohio Water Company is piped to the heavily industrialized Mill Creek Valley north of Cincinnati. The Cincinnati Bolton Plant provides drinking water to the city of Cincinnati, particularly the northwestern part of Hamilton County which is one of the primary directions of expansion in the metropolitan

ORNL-DWG 89-6136



1	FEED MATERIALS PRODUCTION CENTER SITE WELL FIELD
2	DELTA STEEL WELL, ALBRIGHT AND WILSON, AND RUETGERS-NEASE WELL FIELD
3	SOUTHWESTERN OHIO WATER COMPANY WELL FIELD
4	CINCINNATI/BOLTON WELL FIELD
5	WATER ASSOCIATION WELL FIELD
6	FAIRFIELD WELL FIELD

NOTES

MOST HOMEOWNERS USE GROUNDWATER FOR THEIR PRIMARY WATER SUPPLY.

AREAS 1, 2, AND 3 ARE INDUSTRIAL WATER SUPPLIES, WHILE THE OTHERS ARE USED AT LEAST PARTIALLY BY THE PUBLIC FOR DRINKING WATER.

0 6,000 12,000 FEET

Fig. 3.6-5. Major groundwater pumping centers within an 8-km (5-mile) radius of the Feed Materials Production Center [adapted from IT (1986)].

Table 3.6-3. Average usage of groundwater pumped from the Great Miami Aquifer

Name of user	Water supply type	Number of people served	Average water usage [m^3/d (Mgd)[a]]
Cincinnati Bolton Plant[b]	Municipal	760,000[c]	57,200 (15.1)
Fairfield[d]	Municipal	33,000	6,520 (1.72)
Feed Materials Production Center	Industrial	800[e]	1,600 (0.42)
Water Association	Public	22,000	6,550 (1.73)
Southwest Ohio Water Company[f]	Industrial	13 industries	65,830 (17.38)
Delta Steel	Industrial	1 factory	Undetermined
Albright & Wilson Chemical Company	Industrial	1 plant	530 (0.14)
Ruetgers-Nease Chemical Company	Industrial	1 plant	400 (0.1)

[a]Million gallons per day.

[b]This well field has an installed capacity of 152,000 m^3/d (40 Mgd). Pumpage at this higher capacity usually occurs only during the summer months (Spieker 1968a).

[c]Includes people served from Ohio River water plant (approximately 90%).

[d]Well field is located only partially within an 8-km (5-mile) radius of FMPC.

[e]Since 1985 the number of employees at FMPC has nearly doubled. The value quoted in this table is an approximate 1985 baseline.

[f]This well field has an installed capacity of 114,000 m^3/d (30 Mgd) (Starkey et al. 1962).

Sources: IT 1986, MCD 1985, Starkey 1962, and Spieker 1968a.

area. Total groundwater consumption in the lower Great Miami River valley below Dayton doubled between the beginning of World War II and 1964 and is expected to double again by the year 2000 (Spieker 1968b).

The principal flow of groundwater in the Great Miami Aquifer is in a southwesterly direction from Hamilton to New Baltimore and then towards Miamitown and Hooven following the course of the Great Miami River (Fig. 3.6-6). Secondary flows of groundwater join the main course of the Great Miami Aquifer from the north and west in the vicinity of FMPC. Great Miami Aquifer groundwater flows in the vicinity of the FMPC are complex. A water table map for the Great Miami Aquifer is shown in Fig. 3.6-7. Groundwater flows from regions of higher head (elevation) to lower heads perpendicular to the water table contours. Figure 3.6-7 shows that groundwater flows east from the waste pit area beneath the Production Area towards the Southwestern Ohio Water Company. South of the K-65 silos, groundwater flows in a southerly direction toward Fernald.

Three localized water table depressions (indicated by closed shapes with inward-pointing lines) are shown on Fig. 3.6-7. These depressions are the result of groundwater withdrawals at FMPC and two Southwestern Ohio Water Company collectors. An important groundwater recharge area is located near the midpoint of the western FMPC boundary (identified on Fig. 3.6-7 where the 526-ft line bows eastward under the FMPC boundary). Paddy's Run breaches the impermeable glacial till in the locale, allowing the upstream flow from the creek to infiltrate into the Great Miami Aquifer, usually leaving the lower reaches of the streambed dry.

3.6.3.2 Shallow groundwater

Groundwater is also found in the relatively impermeable glacial and lake deposits on which FMPC is built. Most rainfall on the FMPC site runs off or is evaporated out of the soil. About 6 in./year of rainwater is added to the groundwater perched at the site. Very little water seeps through the impermeable materials to the Great Miami Aquifer except where wells, excavations or natural erosion have penetrated into the alluvium of the Great Miami Aquifer. It appears that most of this perched groundwater flows westward within 1.2-4 m (4-13 ft) of the land surface to Paddy's Run, where it surfaces as seeps and contributes to the creek's streamflow. Current knowledge does not allow precise predictions of groundwater movement in the perched aquifer. Natural variations in this aquifer cause lateral flows to be concentrated in certain areas. Wells, ponds, pits, and an agricultural drain tile system, the characteristics of which are unknown in most cases, have complicated the picture even further.

3.6.4 Groundwater Quality

3.6.4.1 Background

Ambient water quality in the Great Miami Aquifer is generally excellent. The groundwater is classified as hard and has total dissolved solids in the range of 300 to 1100 mg/L. Trace metal concentrations are low, and radionuclide levels are well below levels of concern.

ORNL-DWG 87-16021

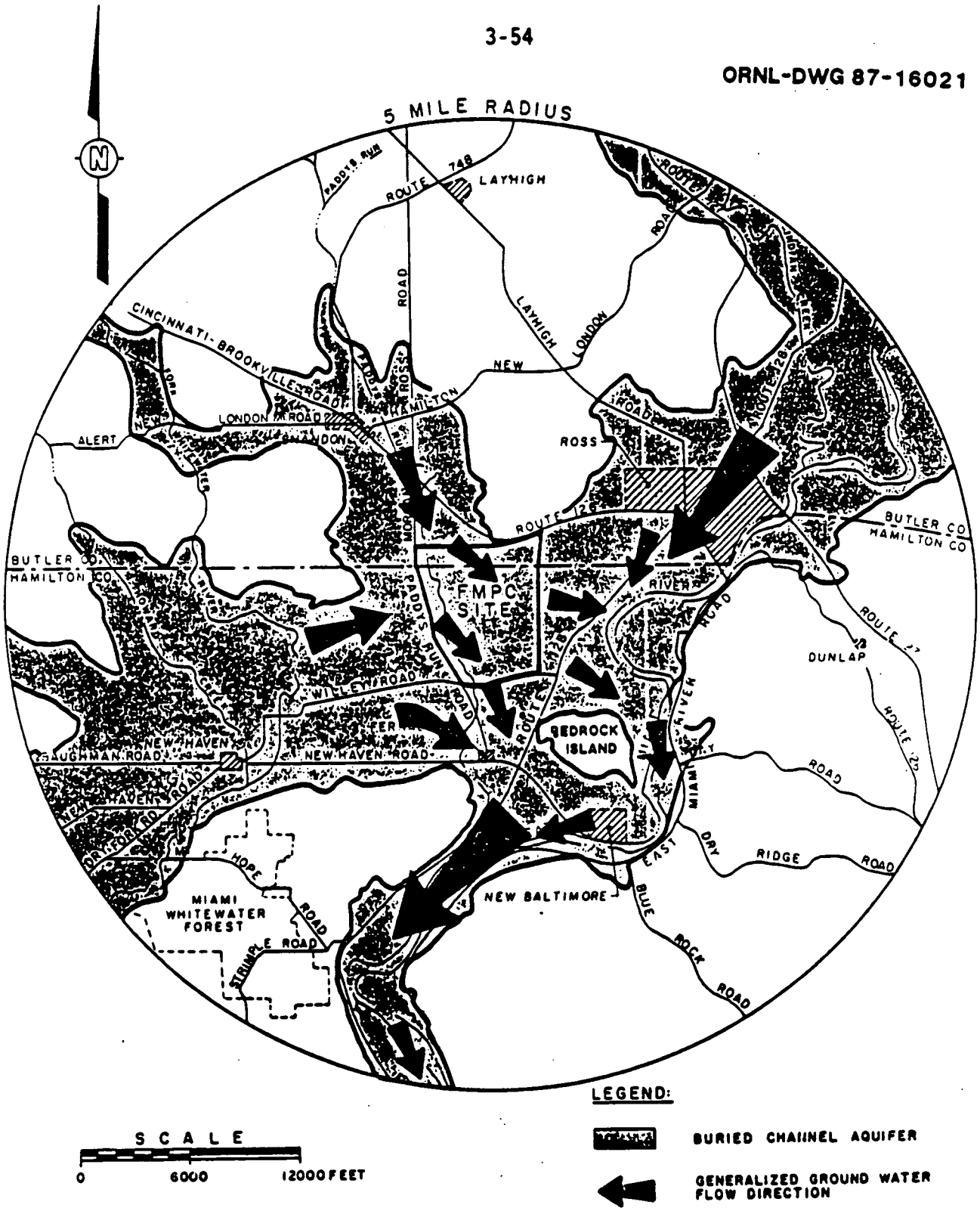


Fig. 3.6-6. Groundwater flow directions in the Great Miami Aquifer in the vicinity of the Feed Materials Production Center [adapted from IT (1986)].

ORNL-DWG 88-11702

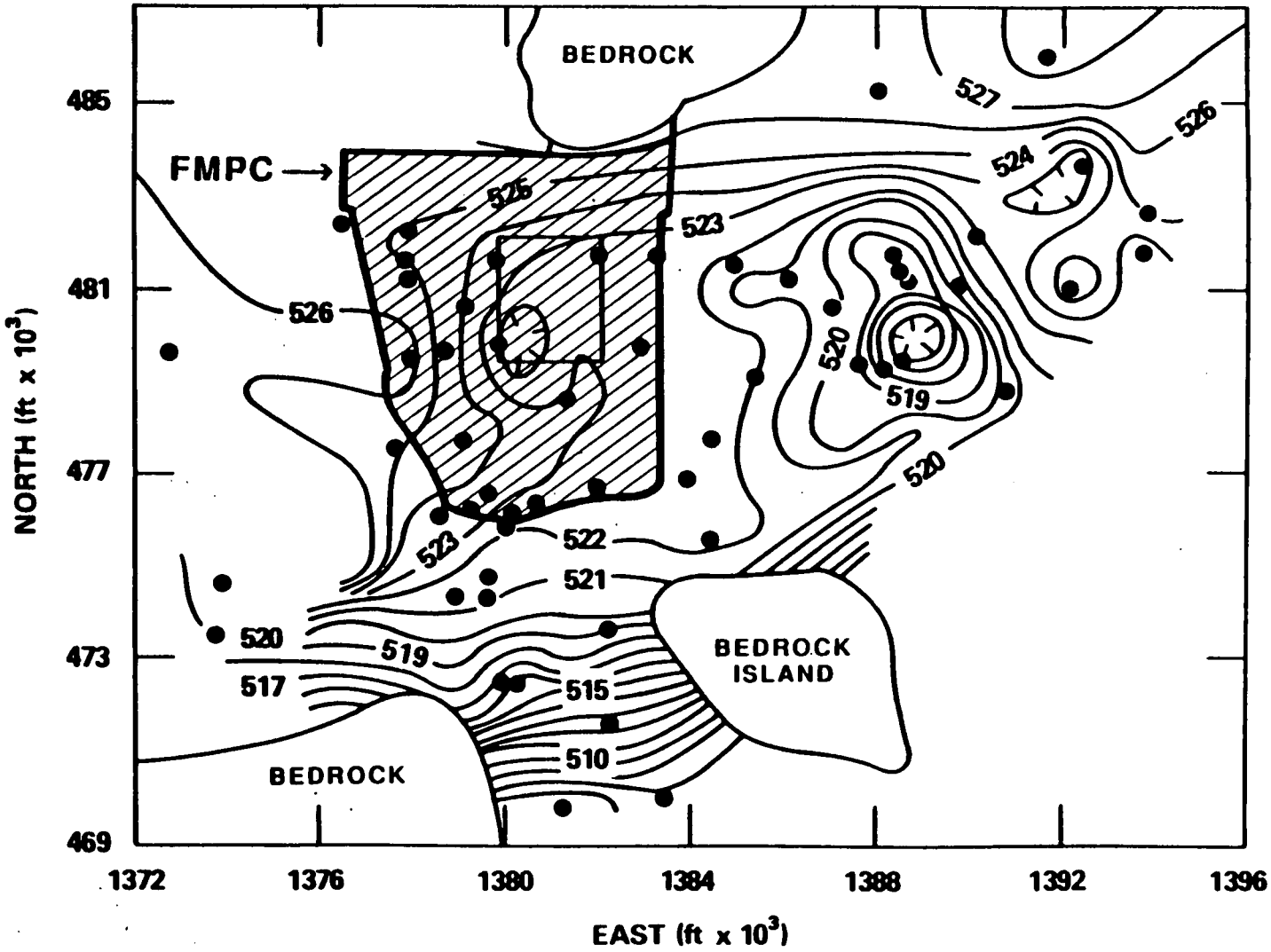


Fig. 3.6-7. Water table map in the vicinity of the Feed Materials Production Center measured between March 29 and April 11, 1986 (axes specified in state planar coordinates, well locations indicated by dots, and water level contours measured in feet above mean sea level. Source: Clement (1987).

Figure 3.6-8 shows the location of several groundwater wells within the vicinity of FMPC. Table 3.6-4 lists water quality parameters measured at several of these background wells (B-3, GT-3, D, and MW-12) and applicable water quality standards.

Well MW-12 samples groundwater perched in the glacial till that lies over the Great Miami Aquifer in the FMPC vicinity (Fig. 3.6-8). Well MW-12 is upgradient of FMPC activities; thus, it should be a good indicator of the natural quality of water in this formation. However, the concentration of some minerals in the water may be elevated because MW-12 is quite close to the bedrock. As shown in Table 3.6-4, the constituents of this water are not much different from water from the background wells B-3 and GT-3, and production well D screened in the Great Miami Aquifer.

3.6.4.2 Great Miami Aquifer contamination

Two plumes of contaminated groundwater containing dissolved natural uranium in the Great Miami Aquifer appear to be emanating from FMPC (WMCO 1987a). Figure 3.6-9 displays the regions of contamination originating under the FMPC. The current status and expected behavior of these contaminated areas are described in subsequent sections.

Eastern groundwater plume

The northern contaminated area indicated on Fig. 3.6-9 is an eastward- moving plume that appears to have originated in the waste pit area (Fig. 3.1-2). The level of uranium in groundwater under FMPC depends on the depth of the groundwater. At the deepest levels of the aquifer, uranium concentrations are very low, on the order of 0.1 µg/L. In the groundwater immediately above the blue clay layer (Fig. 3.5-2), the level is 1-2 µg/L. The eastward-moving plume is currently characterized by maximum uranium concentrations in the Great Miami Aquifer immediately beneath the pits (above the blue clay layer) of about 80 µg/L, about 100 times background concentrations.* At approximately 330 m (1000 ft), 660 m (2000 ft), and 1600 m (5000 ft) east of the pits, corresponding concentrations are 50, 10, and 0.1 µg/L respectively. The maximum uranium concentrations in the plume are more than twice those in DOE Draft Order 5400.xx, which sets a drinking water standard for natural uranium of 36 µg/L.** Elevated concentrations of sulfate, nitrate, chloride, magnesium, and manganese are also present in the plume.

---

*Based on the background concentration of 0.8 µg/L determined by Dames & Moore, Inc. (1985), using sampling and statistical methods.

**This limit is based on a 4-mrem/year dose from radionuclides introduced to the groundwater by DOE activities. The 36 µg/L is based on the assumption that the isotopic composition of the uranium is equivalent to that of natural uranium. If DOE's activities have introduced other radionuclides, less uranium is allowed.

ORNL-DWG 88-12379

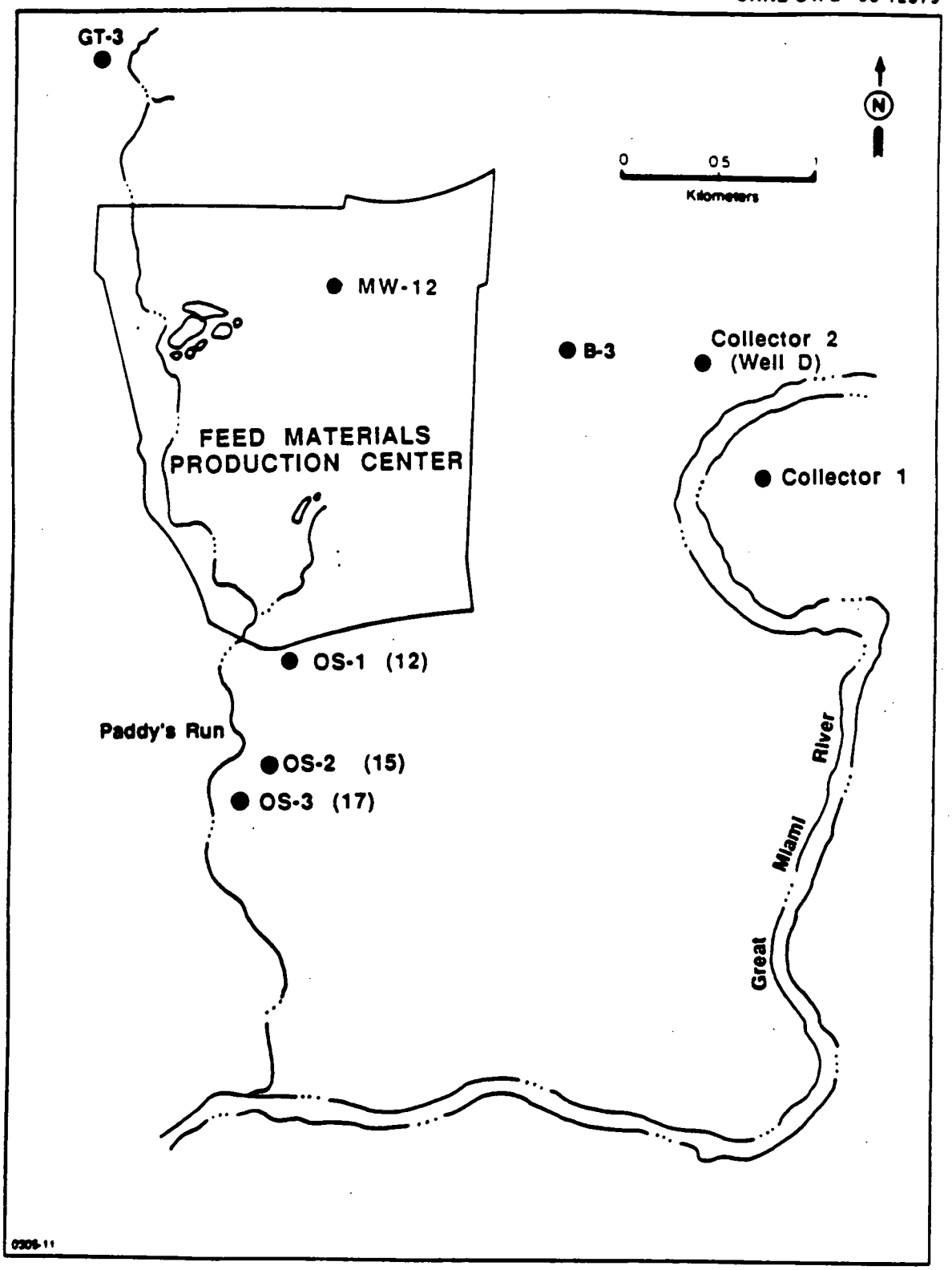


Fig. 3.6-8. Locations of background wells MW-12, GT-3, B-3, and D (which is Southwestern Ohio Water Company collector number 2) in the Great Miami Aquifer near the Feed Materials Production Center [adapted from GeoTrans (1985) and Dove (1961)].

Table 3.6-4. Water quality parameters for background wells near the Feed Materials Production Center (mg/L except as indicated)

Dissolved constituent	Great Miami Aquifer Wells B-3[a]	GT-3[b]	D[c]	Glacial Till Well MW-12[d]	Water Quality Standard[e]
Iron	3.1	4.14	0.08	0.618	0.3
Manganese	0.28	25.4	0.38	<0.020	0.05
Calcium	5.9	79	110	21.9	
Magnesium	22			7.3	
Sodium	16	43		191	
Potassium	5.0	1.5		11.1	
Bicarbonate	116				
Sulfate	0.6	10	79.9	8.0	250
Chloride	36	73	36	100	250
Fluoride	0.2	0.37	0.30	1.05	1.8
Nitrate (NO_3)	0.1				44
Ammonia (as N)		5.12			
Nitrite (NO_2)					
Phenols (as C_6H_5OH)				<0.005	0.001
Total dissolved solids	144	428		672	500
Hardness (as $CaCO_3$)	105		350		
Noncarbonate hardness	16				
Alkalinity (as $CaCO_3$)		317			
Arsenic		0.019		<0.005	0.05
Barium		0.3		<0.2	1.0
Copper		0.08		<0.025	1.0
Lead		0.018		<0.005	0.05
Zinc		0.26		<0.025	5.0
Phosphorus		0.18		0.03	
pH	8.4		7.6	7.74	
Gross beta, pCi/L		5.0		10.9	30[f]
Gross alpha, pCi/L		3.0		3.46	15[f]
Uranium total, pCi/L		0.0		0.0046	24[g]

[a]Dove 1961.

[b]GeoTrans 1985.

[c]Walker 1986.

[d]WMCO 1987a.

[e]Surface water quality standards for public water supplies, State of Ohio. Chapter 3745-1 of the Ohio Administrative Code.

[f]Taken from 40 CFR Pt 141, National Interim Primary Drinking Water Regulations - Subpart B - Maximum Contaminant Levels, July 1, 1984.

[g]Draft DOE Order 5400.3 limits, assuming the entire drinking water dose is natural uranium.

ORNL-DWG 88-11700

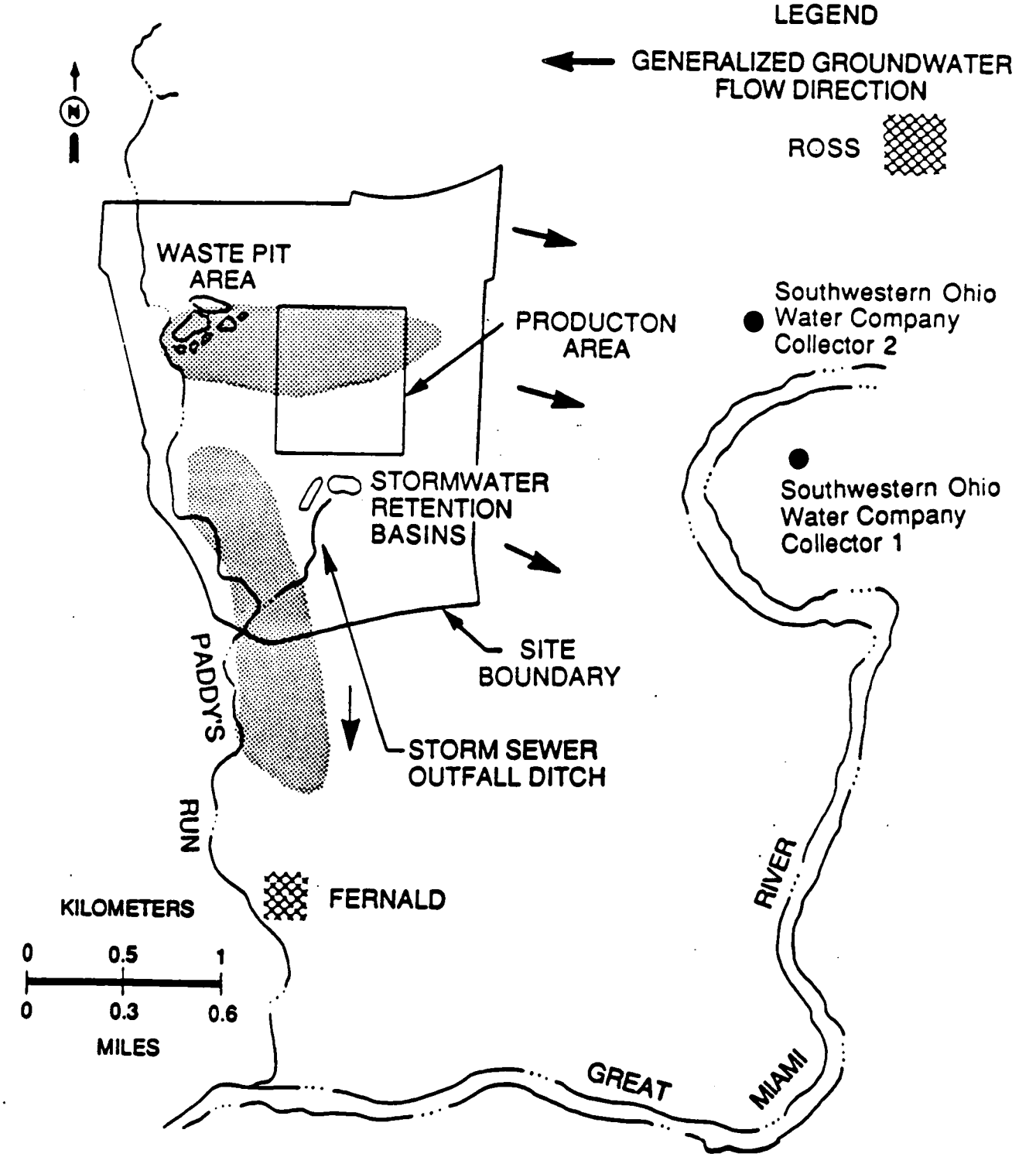


Fig. 3.6-9. Generalized areas of contamination in the Great Miami Aquifer in the vicinity of the Feed Materials Production Center. Shaded regions indicate the approximate extent of major areas where above-background concentrations of uranium, sulfate, nitrate, chloride, magnesium, or manganese have been measured in groundwater samples (WMCO 1987a).

Although groundwater under this part of FMPC appears to be moving eastward at an average rate of 91 m (300 ft) per year, two phenomena may be affecting the migration of dissolved uranium in solution. Various minerals in the aquifer (and to an even greater extent in the overlaying glacial till and lacustrine sediments) have a capacity to adsorb contaminants such as uranium. Downgradient concentrations are reduced, retarding the easterly migration of the plume. Preliminary estimates indicate that the dissolved uranium is migrating at a velocity one-third that of the groundwater. The other phenomenon is the fact that groundwater flow under FMPC is not strictly horizontal. The three FMPC production wells, P1, P2, and P3, draw approximately 1,900 m^3/d (500,000 gal/d) of water from deep in the Great Miami Aquifer (below the blue clay layer). Groundwater sampling data indicate that the plume is moving downward in the waste pit area as well as eastward. The 400-series monitoring wells draw water from near the bottom of the aquifer. The 200-series monitoring wells sample water near the top of the aquifer, and the 300-series monitoring wells sample water from the middle depths of the aquifer above the blue clay layer (Fig. 3.5-2). Uranium concentrations sampled in the shallow 200-series wells are typically 1-4 μg/L, but the deeper 300-series wells show higher concentrations of 10-40 μg/L (WMCO 1988b, Tables 35 and 40).

The actual location of the plume centerline is not known, so the maximum uranium concentration may be higher than that reported here. Isolated measurements of higher uranium concentrations have been reported. These may be the result of measurement errors or they may be indicative of peak plume concentrations. Although other pits cannot be ruled out, Pit 3 is considered the major source of this contamination in the eastward-moving groundwater plume.

Southern groundwater plume

The second contaminated area of the Great Miami Aquifer (Fig. 3.6-9) is believed to consist of two plumes, merging to form one plume moving off-site. One plume originates where Paddy's Run breaches the till (Paddy's Run plume), and the other originates where the Storm Sewer Outfall Ditch breaches the till near its confluence with Paddy's Run (Storm Sewer Outfall Ditch plume).

Paddy's Run plume. Shortly after Pit 3 was put into service, high levels of dissolved uranium in groundwater were detected in the Great Miami Aquifer beneath the waste pits. To avoid contamination of the FMPC water supply well, a well southeast of Pit 2 was pumped continuously at a rate of 380 m^3/d (70 gpm) from 1965 through 1980. The contaminated groundwater was discharged to Paddy's Run (ACCR 1965-85; Brataas 1986) and flowed until the streambed penetrated the glacial till and the water seeped through to the Great Miami Aquifer. Stormwater runoff from the pit area continues to add contaminated water to this plume (WMCO 1988b), which is moving southward at a rate of about 91 m/year (300 ft/year). The effects of adsorption also retard movement of this plume. Groundwater in this locale is migrating southward three times faster than the contaminant plume. The Paddy's Run plume is not well characterized because there are few wells in the area.

Storm Sewer Outfall Ditch (SSOD) plume. The FMPC production area storm sewers drain to the Manhole 34 Lift Station Pump House. Stormwater is pumped from Manhole 34 to the NPDES discharge point on the Great Miami River. Before October 1986, when stormwater exceeded the capacity of the Manhole 34 Lift Station, overflow ran into the Storm Sewer Outfall Ditch. Since October 1986, Lift Station overflow discharges into an SWRB. This SWRB's capacity is sufficient to contain production area runoff from 6.4 cm (2.5 in.) of rain falling in 24 h, which is expected to occur every 2 years on the average. A second SWRB was completed in December 1988. The combined capacities of these two basins [40,000 m^3 (32 acre-ft)] is sufficient to contain a 24-h, 10-cm (4.1-in.) rainfall, expected to occur once in 10 years. Larger precipitation events and sequential precipitation events have caused the combined SWRB facility to overflow into the Storm Sewer Outfall Ditch. The SWRB impacts are discussed in Sect. 4.1.2.2.

Figure 3.6-10 shows a histogram of the estimated annual uranium discharges to the Storm Sewer Outfall Ditch between 1956 and 1984. The data and analysis required to construct the histogram are summarized in Table 3.6-5. The figure and table are largely based on the observation reported by Starkey et al. (1962) that approximately one-fifth of the discharge entering the Storm Sewer System entered the Storm Sewer Outfall Ditch. These discharges into the Storm Sewer Outfall Ditch are believed to have been the main source of uranium contamination measured at off-site wells south of FMPC. Wells OS-1, OS-2, and OS-3 (Fig. 3.6-8) had levels of uranium contamination (Table 3.6-6) that were 2 to 10 times higher than the drinking water standards of 36 μg/L proposed by DOE.

3.7 ECOLOGY

3.7.1 Terrestrial Ecology

3.7.1.1 Vegetation

The region of the FMPC site is a transition area between mixed mesophytic forests (those growing in moderately moist soil) to the east and oak-hickory forests to the west. Because of local variability in underlying rock, the region is characterized by a variety of forest types rather than by a single climax type (Braun 1950).

Mixed mesophytic forests are frequent in dissected terrain near rivers, whereas flatter land may support swamp forests or beech-maple forests (Braun 1950). The natural vegetation that characterized the region before settlement has been largely eliminated, and no remnants of virgin forests are near the site (Pomeroy et al. 1977). Most relatively level land in areas surrounding the site is in cropland and pasture, whereas forests in various stages of secondary succession occur primarily in areas of relatively rough terrain, as shown by a USGS topographic map with green forest overprint (Shandon Quadrangle).

Vegetation on the site (Fig. 3.7-1) consists of grass, scrub growth, mature woods, and plantations of pine and spruce planted in 1972. Grassy

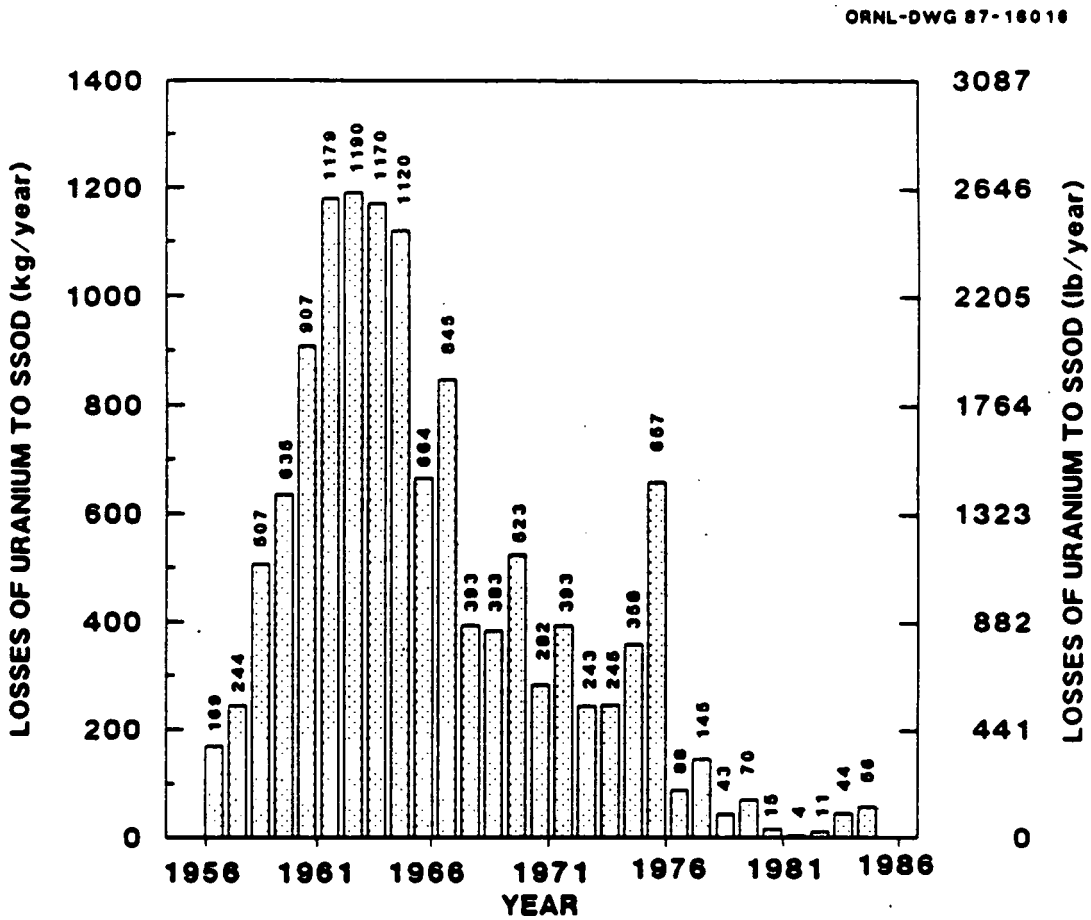


Fig. 3.6-10. Mass of uranium discharged to Storm Sewer Outfall Ditch as a function of time.

Table 3.6-5. Historical record of uranium discharges that have entered the Storm Sewer Outfall Ditch (SSOD) from the Feed Materials Production Center (FMPC) Storm Sewer System (SSS)

Year	Loss of uranium to SSS (lb)	Loss of uranium to SSS (kg)	Loss[a] of uranium to SSOD (lb)	Loss[a] of uranium to SSOD (kg)	Percentage of uranium lost to SSOD (%)
1956	1,800[b]	816		169	20.7
1957	2,600[b]	1,179		244	20.7
1958	5,400[b]	2,449		507	20.7
1959	6,300[b]	2,857	1,400[b]	635	22.2[c]
1960	11,200[b]	5,079	2,000[b]	907	17.9[c]
1961	11,800[b]	5,351	2,600[b]	1,179	22.0[c]
1962	>7,070[d]			1,190[e]	
1963	>7,070[d]			1,170[e]	
1964	>7,070[d]			1,120[e]	
1965	7,070[g]	3,206		664	20.7
1966	>9,000[g]	4,082		845	20.7
1967	4,190[g]	1,900		393	20.7
1968	4,080[g]	1,850		383	20.7
1969	5,570[g]	2,526		523	20.7
1970	3,000[g]	1,361		282	20.7
1971	4,184[g]	1,898		393	20.7
1972	2,584[g]	1,172		243	20.7
1973	2,605[g]	1,181		245	20.7
1974	1,464[g,h]	664		137	20.7
1974[f]	488[g,h]	221	488	221	100
1975[f]	≈1,200[g]	544	1,200	544[i]	100
1975[j]	≈1,200[g]	544		113[i]	20.7
1976[k]				88[m]	
1977				145[m]	
1978				43[m]	
1979				70[m]	
1980				15[m]	
1981				4[m]	
1982				11[m]	
1983				44[m]	
1984				56[m]	

[a]The total mass of uranium discharged into the SSOD during the 29-year period of record from 1956 to 1984 was 12,583 kg (27,746 lb). The annual average for this period of record was 434 kg/year (957 lb/year).

[b]These values were reported by Starkey et al. (1962).

Table 3.6-5 (continued)

[c]The three recorded losses to the SSOD reported by Starkey et al. (1962) are approximately one-fifth of the total loss of uranium through the SSS between 1959 and 1961. These three values are the basis for most of the losses to the SSOD quoted in this tabulation. The average of the three values is 20.7%

[d]No data is available between 1962 and 1964. Production peaked at the FMPC during this time period and it is assumed that the losses to the SSS exceeded the losses reported for 1965.

[e]These interpolated values were estimated graphically.

[f]All stormwater (100%) was diverted from the SSS into the SSOD during the last quarter of 1974 and the first half of 1975 (ACCR 1965-1985).

[g]These values were estimated from information contained in the Aquifer Contamination Control Reports (ACCR 1965-1985).

[h]The total loss to the SSS reported for 1974 is 885 kg (1,952 lb) (ACCR 1965-1985). One-fourth of this total is assumed to have entered the SSOD directly (100%) during the last quarter of 1974.

[i]The total discharge entering the SSOD in 1975 reported by Dames and Moore (1985) was 375 kg (827 lb). The total quoted in this tabulation for 1975, which is 657 kg (1,449 lb), was obtained from the Aquifer Contamination Control Reports (ACCR 1965-1985). This higher value is assumed to be correct.

[j]The SSS was returned to normal operating conditions (20.7%) during the second half of 1975.

[k]No annual losses from the SSS into the SSOD were reported after 1975 in the Aquifer Contamination Control Reports (ACCR 1965-1985).

[m]These values were obtained from the study performed by Dames and Moore (1985).

Sources: Starkey 1962, ACCR 1965-85, and Dames and Moore 1985.

Table 3.6-6. Average annual uranium concentrations measured in Great Miami Aquifer groundwater at three off-site locations south of the Feed Materials Production Center where maximum levels of contamination have been observed

Year	Wells[a] OS-1 (12) (μg/L)	OS-2 (15) (μg/L)	OS-3 (17) (μg/L)	Source
1981	190	320	050	Sedam 1984
1982	250	470	070	Dames & Moore 1985
1983	260	430	060	Dames & Moore 1985
1984	250	330	050	Dames & Moore 1985
1985	210	310	050	WMCO 1986
1986	220	290	050	WMCO 1987a
1987	300	300	060	WMCO 1988b

[a]See Table 4.6, Dames & Moore (1985). Wells OS-1, OS-2, and OS-3 are Dames & Moore (1985) nomenclature; Wells 12, 15, and 17 are FMPC Environmental Monitoring Reports (WMCO 1986, WMCO 1987a, WMCO 1988b) nomenclature.

ORNL-DWG 88-8289

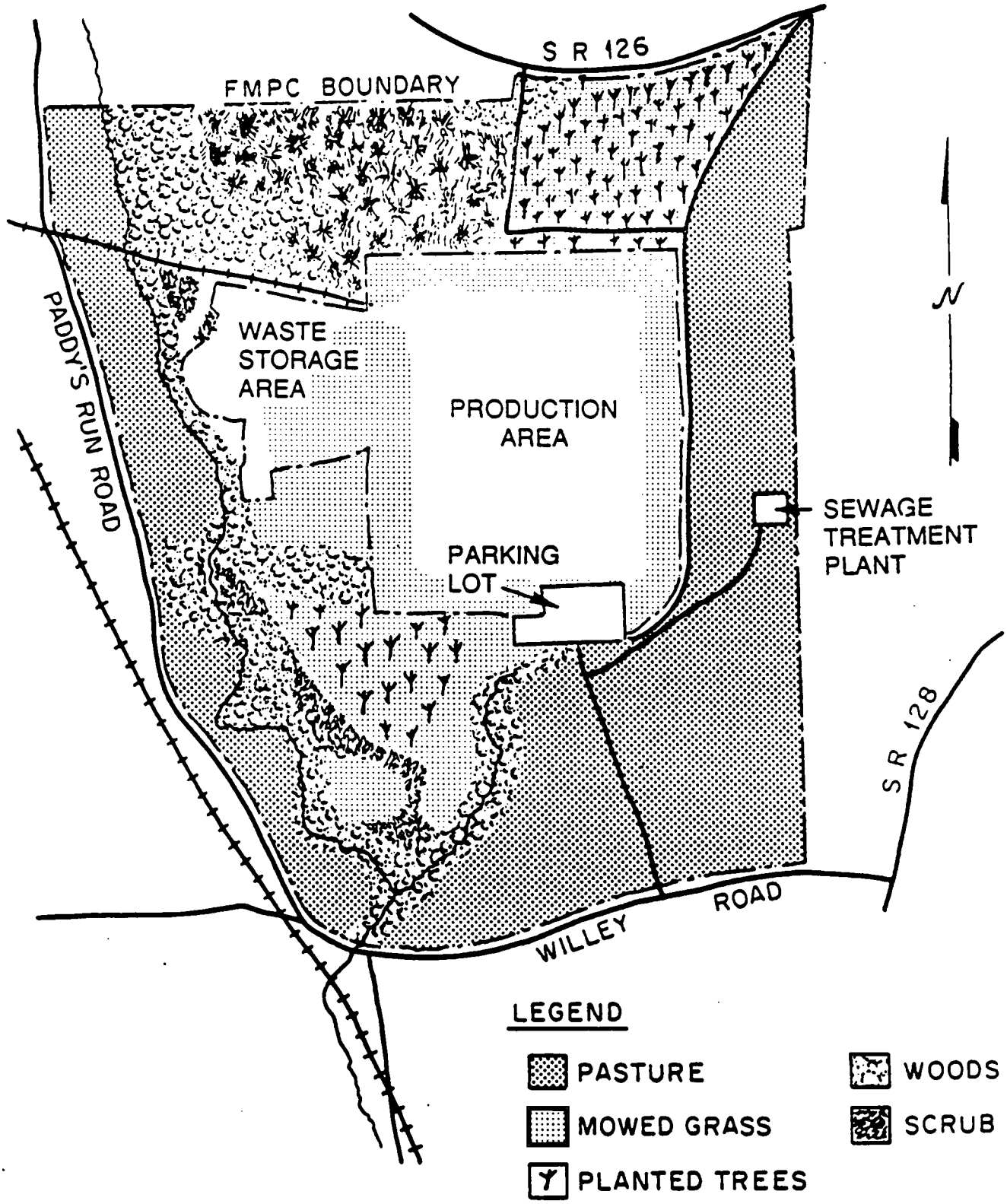


Fig. 3.7-1. Vegetation types occurring on the Feed Materials Production Center site.

areas are mowed and/or grazed and are dominated by red fescue (Osborne et al. 1987). An area of scrub northwest of the main facilities is an old field dominated by forbs, grasses, and small trees of black locust, box-elder, white ash, black cherry, and dogwood (Pomeroy et al. 1977).

Riparian woods occur along Paddy's Run, which parallels the western boundary of the site, and along the Storm Sewer Outfall Ditch south of the main plant area. These woods are dominated by cottonwood, American elm, hackberry, box-elder, and Ohio buckeye (Osborne et al. 1987). Two stands of upland woods that adjoin the northern boundary of the site (Fig. 3.7-1) are dominated by white ash, shellbark hickory, and other common species including sugar maple, black locust, shingle oak, American elm, hackberry, and American sycamore (Osborne et al. 1987; Pomeroy et al. 1977). The western stand is relatively young, while the eastern stand is mature and dominated by large white ash trees (Pomeroy et al. 1977).

Airborne substances released by FMPC that could potentially affect terrestrial biota include fluoride and uranium. Fluoride and uranium concentrations in vegetation were sampled at 20-28 stations both on and off the site from 1984 to 1987 (NLO 1985; WMCO 1986, 1988, 1989). Off-site sampling was primarily to the east and northeast of the plant facilities in the direction of the prevailing winds. In these areas, average fluoride levels appear to show a decreasing trend from 1984 to 1987 (Table 3.7-1). No trend for higher fluoride levels near the site was evident in the sampling data. All average fluoride levels were within the range of levels naturally occurring in most plants in remote areas distant from industrial facilities [i.e., 2-20 μg/g dry weight (NRC 1971)]. Uranium concentrations in vegetation, as indicated by the sampling data, showed a decreasing trend with increasing distance from FMPC (Table 3.7-1). Average dry weight concentrations in the eastern half of the site, which were higher than those off the site, ranged from 0.64 μg/g (0.43 pCi/g) in 1987 to 7.07 μg/g (4.71 pCi/g) in 1984. Average concentrations at 2 to 10 km (1.2 to 6.2 miles) northeast of the site ranged from 0.15 (0.10 pCi/g) μg/g in 1985 to 0.58 μg/g (0.39 pCi/g) in 1984. The concentration of uranium in vascular plants growing in areas without elevated levels of uranium in soil has usually been reported to be less than 0.06 μg/g (0.04 pCi/g) (Bowen 1979).

3.7.1.2 Fauna

FMPC is located within the geographic ranges of 27 species of amphibians, 25 species of reptiles (Conant 1975), 150 species of birds that nest in the region (Cook 1969), and 65 species of mammals (Simpson 1964). Most of these species, however, are not resident on or near the FMPC site because this area does not contain many of their specific habitat types. In addition, the ecology of this region has been greatly disturbed by the clearing of habitats for pasture and croplands, which support relatively few wildlife species and only low population levels (Castrale 1985; Wooley, Best, and Clark 1985). Forests that covered extensive areas before settlement are now greatly fragmented and, as a result, are less suitable for some wildlife species (Lynch and Whigham 1984; Wilcove 1985).

Table 3.7-1. Fluoride and uranium concentrations in vegetation (μg/g dry weight) at the FMPC site, 1984-87[a]

Sampling station	1984			1985			1986			1987		
	No. of stations	Fluoride	Uranium	No. of stations	Fluoride	Uranium	No. of stations	Fluoride	Uranium	No. of stations	Fluoride	Uranium
Western boundary of site	3	9.9	3.01	4	4.0	0.47	2	5.2	0.59	3	3.7	0.32
Eastern half of site	6	12.1	7.07	8	6.2	1.85	7	5.5	2.93	7	4.0	0.64
Within 2 km east of site	5	8.0	1.09	4	7.0	0.71	4	5.8	0.43	4	4.4	0.62
2-10 km NE of site	6	8.7	0.58	9	5.2	0.15	4	5.2	0.19	4	6.1	0.21
Other stations	0	--	--	3	6.2	0.40	3	4.6	0.16	2	3.8	0.35

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

Sources: NLO 1985; WMCO 1986, 1987a.

Many wildlife species are common in the habitats located on the site, but none of these habitats appears to be unique or unusually important. Riparian and upland hardwood forests on the site support more species than the old field/scrub and the young plantations, which support more species than do the grass fields (Osborne et al. 1987). A survey in the summer of 1986 resulted in observations of 83 species of birds and about 10 species of mammals (Osborne et al. 1987). Species typical of certain habitat types include the following:

Hardwood forests	Fox squirrel, white-footed mouse, yellow-billed cuckoo, great crested flycatcher, scarlet tanager, red-eyed vireo, tufted titmouse, and downy woodpecker.
Young plantations	Indigo bunting, willow flycatcher, field sparrow, meadow vole, grasshopper sparrow, and eastern meadowlark.

Other species on the site usually occur in more than one habitat type and include red-tailed hawk, yellow-shafted flicker, common crow, several species of bats, white-tailed deer, eastern cottontail, raccoon, red fox, woodchuck, and striped skunk. These species often forage in open areas but depend on shrubby or forested areas for cover, denning, and nesting.

3.7.1.3 Endangered species

The FMPC site is located within the geographic ranges of several species listed as threatened or endangered by the U.S. Fish and Wildlife Service (FWS), including the endangered Indiana bat, bald eagle, peregrine falcon, and the threatened northern wild monkshood (an herb) (FWS 1986). The Indiana bat hibernates in caves during the winter and raises its young in streamside forests and other habitats during the summer (Harvey 1975; Humphrey, Richter, and Cope 1977). Thus, Indiana bats could possibly occur in the riparian woods and nearby habitats on the FMPC site where bat surveys have not been conducted. The bat would not occur, however, in the plant area in which renovation and remedial action projects will take place (Kroonemeyer 1987). None of the several caves that have been designated as critical habitat for this bat is located in Ohio (50 CFR Pt. 17.95). The bald eagle and peregrine falcon do not nest in the counties surrounding the FMPC site but could occur in the area as rare transients along the Great Miami River and other relatively large water bodies. No habitat on or near the site is suitable for these species. Northern wild monkshood occurs in northeastern Ohio but not near the FMPC site (McCance and Burns 1984). The Cooper's hawk, previously listed as threatened by the state of Ohio (ODNR May 1987), has been observed during the winter and summer in the FMPC pine plantations and probably nests there (Osborne et al. 1987).

3.7.2 Aquatic Ecology

The Great Miami River in the vicinity of FMPC ranges from about 40 m (130 ft) to about 120 m (390 ft) in width and averages about 1 m (3 ft) in depth. The floodplain is often much wider. Long, wide pools or runs

alternate with riffle areas varying widely in length, width, and depth. Shoreline trees are few and provide little shade. The substrate consists primarily of cobble, pebbles, sand, and silt, with some detritus, boulders, and rubble (OEPA 1982; Pomeroy et al. 1977). At the nearest USGS gauging station approximately 15 km (9 miles) upstream of the site, the flow averaged 93.6 m^3/s (3305 cfs) for the period 1931-1986 (USGS 1987). The maximum and minimum average daily discharges since the 1922 construction of nine dams and retarding basins upstream were 3060 m^3/s (108,000 cfs) and 4.4 m^3/s (155 cfs) respectively.

Paddy's Run consists of riffles and pools up to 20 m (66 ft) long, 3 m (10 ft) wide, and 1 m (3 ft) deep over a substrate of rubble, cobble, gravel, and some silt. Trees such as oak, sycamore, locust, maple, and hackberry partially shade the stream (Pomeroy et al. 1977). Paddy's Run is not gauged, but estimates of instantaneous discharge when it does exhibit surface flow (Dames and Moore, Inc. 1985) have ranged from 0.006 m^3/s (0.2 cfs) to 0.11 m^3/s (4.0 cfs). For a more detailed discussion of surface water hydrology, see Sect. 3.6.1.

Biological studies of the Great Miami River and Paddy's Run performed in the 1970s are summarized in Pomeroy et al. (1977) and DOE (1977). At that time the numbers and diversity of species of fish and invertebrates in flowing reaches of Paddy's Run were indicative of fairly good water quality above FMPC. At least 23 species of fish, dominated by creek chubs (Semotilus atromaculatus) and other minnows as well as orangethroat darters (Etheostoma spectabile) have been collected from Paddy's Run. Bauer et al. (1978) reported that 17 fish species and 4 families upstream of FMPC dropped to only four species and one family (Cyprinidae) immediately below FMPC. In this stream reach, infiltration of water into the underlying aquifer results in a dry streambed during much of the year. This periodic loss of water could greatly affect the fish species composition when water is present, due to such factors as habitat alteration and food availability. Thus, it is probably impossible to determine the effects of contaminants on fish species diversity from these conditions. Past stream "straightening" and mining for gravel and sand probably also contributed to this reduction in species richness. A limited investigation of aquatic invertebrates in Paddy's Run during the same study suggested the same reduction in species richness below FMPC; again, this is an area of reduced flows due to the loss of water to the groundwater. A 1977 collection of benthic macroinvertebrates from Paddy's Run yielded 17 species among 11 families of aquatic insects (Pomeroy et al. 1977).

More recently, Osborne et al. (1988) conducted a biological and ecological site characterization of the FMPC site that included Paddy's Run. This study yielded 20 fish species (mostly minnows and darters) and more than 50 taxa of benthic macroinvertebrates (dominated by chironomids) from Paddy's Run. According to the authors of this study, species richness and diversity for both fish and benthic invertebrates generally were lowest at sampling stations where contamination by radionuclides was reported to be highest. Osborne et al. also reported that electrophoretic analyses of genetic material in both mayflies and fish show significant differences in population genetic structure between communities upstream of FMPC influence

and communities within the reach receiving FMPC runoff and possibly contaminated groundwater discharge to the stream.

Osborne et al. conclude that entry of FMPC-generated contaminants has stressed fish and benthic communities in Paddy's Run. This conclusion, however, does not take into account other factors that may explain community differences among different sites in Paddy's Run. These factors include the intermittent nature of the stream adjacent to and downstream of FMPC (mentioned earlier), natural differences in substrate and other habitat characteristics, past physical disturbances such as agricultural runoff, a small chemical plant, and a steel plant. Moreover, elsewhere in their report and in contradiction to the inadequately supported conclusion that FMPC releases have stressed aquatic communities, Osborne et al. acknowledge the potential effects of these unrelated factors (as well as shortcomings in the design and execution of the study), on their findings. Although FMPC releases, runoff, or groundwater recharge may have had adverse effects on aquatic communities of Paddy's Run, none of the studies of Paddy's Run to date is adequate for demonstrating cause and effect.

The warmwater aquatic communities of the Great Miami River tend to be dominated by species noted for their tolerance of moderate levels of pollution. Carp (Cyprinus carpio), for example, contributed nearly 22% of the total numbers and 70% of the total weight of all fish collected by electrofishing during OEPA's comprehensive study (OEPA 1982) of the lower 150 km (93 miles) of the river. Gizzard shad (Dorosoma cepedianum) contributed 14% of the total numbers and 5% of the total weight collected. Pomeroy et al. (1977) reported few sport fishes (primarily sunfishes, family Centrarchidae) and other pollution-intolerant species from the river in the vicinity of FMPC. Only one species of darter, a small member of the perch family which generally requires good water quality, was collected from riffle areas near the facility. It should be noted, however, that the kinds of cover (undercut banks, brush, dead trees, and rock outcroppings) favored by many sport fishes (e.g., bass and catfish) are rare in this reach of the Great Miami River.

In the 19-km (12-mile) reach of the Great Miami River below the FMPC outfall, gizzard shad were most numerous, followed by carp, several sunfishes, shiners (Cyprinidae), catfishes (Ictaluridae), and suckers (Catostomidae). Based on several measures of community abundance and diversity that OEPA (1982) applied to fish sampling data for the lower 150 km (93 miles), the river reach from near the FMPC effluent outfall to well below the mouth of Paddy's Run appears to support one of the healthiest fish communities in the lower 150 km (93 miles). Only 2 of the 11 study reaches (both well above the influence of most industrial and municipal discharges) exhibited a better combination of abundance and diversity indices. OEPA (1982) concluded that the entire "lower mainstream is capable of supporting a healthy and diverse fish fauna typical of large river systems." The reach downstream of FMPC was assigned a rating of "good" (on a scale of "poor-fair-good-exceptional") on the basis of its fish abundance and diversity indices.

In 1985, electroshocking at the three fish sampling stations (Fig. 3.6-3) indicated that length-to-weight ratios (one indication of fish condition or "health") were similar at each location. Species diversity was reported to be highest at station 2, adjacent to the FMPC outfall (WMCO 1986).

Macroinvertebrate data, though not as quantitative as the fish data, generally support the assignment of a "good" rating (for a large, organically enriched warmwater river) to this reach of the river (OEPA 1982). Many macroinvertebrates in the reach downstream of FMPC were associated with abundant beds of Cladophora (an alga) and stands of aquatic macrophytes including pondweed (Potamogeton spp.) and water milfoil (Myriophyllum sp.) (Pomeroy et al. 1977) .

Endangered species

No federally designated threatened or endangered species are known or expected to reside in Paddy's Run based on the current known ranges of these species (Kroonemeyer 1987). The Ohio Heritage Program of the Ohio Department of Natural Resources (ODNR) has identified two state-listed endangered species that have been collected in recent years from the lower Great Miami River: the tonguetied minnow, Exoglossum laurae, and the bigeye shiner, Notropis boops (ODNR March 23, 1987).

The historical range of the tonguetied minnow is known to include three separate drainages of the upper and middle Ohio River Basin, one of which is the Great Miami River system (ODNR March 23, 1987). Except for one report of this fish from a site 12.3 km upstream of the FMPC outfall, all records indicate that the tonguetied minnow in Ohio is limited to the upper Great Miami River and its tributaries. It is therefore unlikely to be affected in any way by the FMPC.

The bigeye shiner has been collected at the confluence of the Great Miami River and Paddy's Run as well as in other river systems in Ohio. The known range of this fish extends from western Pennsylvania south to below Tennessee and west to Kansas and Oklahoma. This fish prefers clear streams with abundant aquatic vegetation and substrates of clean sand, gravel, or rock. Conversely, turbidity and siltation (which are present to a moderate degree in the Great Miami River) are principal hazards to local populations. As long as sediment input to, or sediment mobilization in, Paddy's Run is reasonably low, current activities at FMPC are unlikely to measurably affect any local populations of the bigeye shiner that may exist in the river. (See dose calculations for fish in the following paragraphs.)

Dose calculations for 1985

Based on the available data, radiological doses to aquatic organisms residing in the Great Miami River and Paddy's Run in 1985 were estimated at less than 6% of the DOE proposed limit of 1 rad/d for the protection of aquatic populations (DOE 1987). The following analysis supporting this conclusion is based primarily on data published in the Feed Materials

Production Center Environmental Monitoring Annual Report for 1985 (WMCO 1986).

To approximate the annual radiation dose to fish and invertebrates in waters downstream of the FMPC outfall in the Great Miami River, generally conservative dose factors compiled by Killough and McKay (1976) were applied to the highest average concentrations of individual radionuclides for downstream water and sediment sampling locations during 1985, as reported in Table 5 of the Feed Materials Production Center Environmental Monitoring Report for 1985 (WMCO 1986). For organisms assumed to lie continuously on the surface of the sediments, dose from radionuclides in the sediments was estimated by applying Killough and McKay's dose factors to measured sediment concentrations. Other radionuclides (e.g., several isotopes of thorium) that could have possibly contributed significantly to the total dose may have been present, but no assumptions regarding their identities or concentrations and the resulting dose rates for the 1985 baseline year can be made in the absence of data. The results are shown in Table 3.7-2. From this table it is evident that most of the radiation dose to aquatic organisms from the listed radionuclides is from internal exposure to ingested or otherwise absorbed radionuclides.

Four radionuclides, U-238, U-234, Ra-226, and Ra-228, contributed more than 96% of the total dose absorbed by the exposed animals (Ra-226 and Ra-228 are assumed to be present at the detection limits). The total annual dose for invertebrates and fish in the water column exposed to all reported radionuclides was less than 1100 mrad/year and 170 mrad/year respectively. An animal living all year on the river bottom may have received up to an additional 200 mrad/year from exposure to uranium and technetium in the sediments. Data for the 1985 baseline year are lacking on other radionuclides that may be in the sediments. However, recently obtained sediment concentrations for Pu-238, Pu 239/240, Ra-228, Ra-226, Th-230, Th-232, and Th-228 indicate that animals residing on the sediments would have been exposed to less than 90 mrad/year due to these radionuclides.

The doses contributed by Ra-226 and Ra-228 in the river may have represented natural background levels (for purposes of this analysis, river concentrations of 0.45 pCi/L were assumed for Ra-226 and Ra-228 because neither was detected above the detection limits of 0.45 pCi/L). Assuming complete mixing in the river, the levels reported for the FMPC effluent (< 13 pCi/L Ra-226 and < 8.1 pCi/L Ra-228 at a mean effluent flow of 20 L/s) would have yielded no more than 0.006 pCi/L Ra-226 and 0.004 pCi/L Ra-228. These figures further assume the record low flow of the Great Miami River (4400 L/s). According to EPA (1986), the average population-weighted concentrations of Ra-226 and Ra-228 in U.S. community water supplies (including groundwater) range from 0.3 to 0.8 pCi/L and 0.4 to 1.0 pCi/L respectively. The lower values are probably more representative of surface waters and are comparable to the maximum level (< 0.45) reported for the river in 1985.

Table 3.7-2. Approximations of annual dose[a] to invertebrates and fish exposed to 1985 radionuclide concentrations as measured in the Great Miami River downstream of the FMPC outfall

	Average concentration[b]	Invertebrates			Fish		
		Internal dose (mrad/yr)	External dose (mrad/yr)	Sum (mrad/yr)	Internal dose (mrad/yr)	External dose (mrad/yr)	Sum (mrad/yr)
	Water (pCi/L)						
Sr-90	1.35	2.8	0.014	2.8	0.14	0.014	0.15
Tc-99	4.59	0.040	0.0041	0.044	0.12	0.0041	0.12
Cs-137	<4.05	<4.5	<0.049	<4.5	<18	<0.049	<18
Ra-226	<0.45	<230	<0.00011	<230	<45	<0.00011	<45
Ra-228	<0.45	<150	<0.00007	<150	<30	<0.00007	<30
U-234	4.14	380	0.00066	380	38	0.00066	38
U-235	0.18	15	0.00097	15	1.5	0.00097	1.5
U-236	0.06	5.3	0.000008	5.3	0.53	0.000008	0.53
U-238	4.16	330	0.31	330	33	0.31	33
Total dose - Water		<1100	<0.38	<1100	<170	<0.38	<170
	Sediment (pCi/g)						
Tc-99	89		110	110		110	110
Total U	2.6		96	96		96	96
Total dose - Water and sediment				<1300			<380

[a]Based on application of dose factors compiled by Killough and McKay (1976) to measured concentrations in water and sediment.

[b]At sampling stations exhibiting highest levels of contamination by a given contaminant.

The maximum reported values for total uranium at 8.5 pCi/L and Tc-99 at 4.6 pCi/L, on the other hand, occurred at concentrations above reported background concentrations for U.S. water supplies [0.3-2.0 pCi/L (EPA 1986) and 0.0 pCi/L respectively], although uranium concentrations upstream of the FMPC outfall were about the same as those downstream of the outfall (WMCO 1986). This could mean that uranium from FMPC is entering the river via the effluent outfall as well as by other pathways (e.g., atmospheric fallout), or that most of the uranium measured in the river has a source upstream unrelated to FMPC, or that natural uranium-bearing strata in the region have contributed to higher-than-usual background concentrations of uranium. Total annual doses to biota in the Great Miami River 5 km (3 miles) or more downstream of the FMPC outfall as a result of the listed radionuclides were estimated at less than 1.3 rad/year for invertebrates and less than 0.380 rad/year for fish. Although several times the lowest reported natural background dose rates for freshwater organisms (Table 3.7-3), these dose rates represent only 0.4% (invertebrates) and 0.1% (fish) of DOE's proposed limit of 1 rad/d (DOE 1987), a dose rate generally believed safe for populations of sensitive aquatic organisms (IAEA 1976; National Research Council of Canada 1983). Exposures nearer the outfall were probably higher, but still likely to be well below 1 rad/d.

Uranium concentrations in fish muscle collected from the Great Miami River averaged 0.11 pCi/g (ash weight) at fish collecting station 1 (Fig. 3.6-3), 4.7 km above the FMPC outfall; 0.16 pCi/g at station 2 immediately downstream of the outfall; and 0.09 pCi/g at station 3, 7.4 km downstream of the outfall (mouth of Paddy's Run). Although the differences among sites are not statistically significant (WMCO 1986), these data do suggest that FMPC could be a contributor to total fish body burdens of uranium in the vicinity of the outfall. Nevertheless, these levels are not out of line with published background concentrations of natural uranium isotopes in fish (0.022-0.21 pCi/g, ash weight) (IAEA 1976).

Dose rates for aquatic organisms residing in the most contaminated locations of Paddy's Run were potentially much higher (Table 3.7-4). As discussed earlier, Osborne et al. (1988) concluded that FMPC-generated contaminants have stressed fish and benthic communities in Paddy's Run, based on the excessive dominance of the benthos by chironomids and the differences in population genetic structure between upstream and downstream populations of mayflies and fish.

Other factors, however, including the intermittent nature of the stream in the contaminated areas and certain deficiencies in the Osborne study, compromise the certainty of that conclusion. The dose estimates presented in Table 3.7-3 for measured levels of uranium and technetium show that doses to invertebrates and fish were only 5.7% and 1.0% respectively of DOE's proposed limit of 1 rad/d for the protection of aquatic populations. Although other radionuclides for which data are unavailable were undoubtedly present in Paddy's Run in 1985, data from later monitoring programs indicate that all of these unmonitored radionuclides together are probably less important as contributors to total dose than uranium and technetium (WMCO 1987a; WMCO 1988b).

Table 3.7-3. Comparison of total dose estimates for aquatic organisms with proposed DOE limit[a] and range of published background doses[b]

	Total dose (rad/year)	Proposed limit (rad/year)	Ratio dose: limit[a]	Background[b] (rad/year)	Ratio dose: background
			Great Miami River		
Invertebrates	1.3	365	0.0036	0.081-0.70[c]	16-1.9
Fish	0.38	365	0.0010	0.082-0.70	4.6-0.54
			Paddy's Run		
Invertebrates	21	365	0.056	0.081-0.70[c]	260-30
Fish	3.8	365	0.010	0.082-0.70	46-5.4

[a]*Source:* DOE 1987.

[b]The background dose includes natural sources and fallout. *Source:* IAEA 1976.

[c]Dose from internal activity was assumed to be equivalent to that for fish.

Table 3.7-4. Approximations of annual dose[a] to invertebrates and fish exposed to 1985 radionuclide concentrations in Paddy's Run

		Invertebrates			Fish		
	Average concentration[b]	Internal dose (mrad/yr)	External dose (mrad/yr)	Sum (mrad/yr)	Internal dose (mrad/yr)	External dose (mrad/yr)	Sum (mrad/yr)
	Water (pCi/L)						
Tc-99	NA[c]	~0.06	~0.006	~0.07	~0.17	~0.006	~0.18
Total U	236	18800	17	18800	1880	17	1900
	Sediment (pCi/g)						
Tc-99	190		150	150		150	150
Total U	46.2		1710	1710		1710	1710
Total dose (water and sediment)				20700			3780

[a]Based on application of dose factors compiled by Killough and McKay (1976) to measured concentrations in water and sediment.

[b]At sampling stations exhibiting highest levels of contamination by a given contaminant.

[c]No data available. The Tc-99 concentration in water used to calculate dose estimates derives from application of the distribution coefficient (K_d) for distribution of Tc-99 between water and sediment of the Great Miami River to that in Paddy's Run.

Finally, the amounts by which estimated doses to invertebrates and fish in the most contaminated areas of the stream exceeded published natural background values are presented in Table 3.7-3. The dose estimates were from 30 to 260 times reported background doses for invertebrates and from 5 to 46 times reported background for fish.

3.8 RADIOLOGICAL BACKGROUND

Radiological dose estimates are obtained by using a combination of modeling and monitoring data. This section presents the results of both monitoring and modeling and discusses the results in relationship to dose. Where possible, 1985, 1986, and 1987 data are discussed to show trends.

3.8.1 Environmental Sampling

3.8.1.1 Air pathway

Air sampling

Air samples were collected weekly in 1987 by taking filters from 14 high-volume air monitoring stations (AMSs), 9 on-site and 5 off-site (Fig. 3-4.2). Several of these have been added in the last 3 years in response to comments in an Oak Ridge Associated Universities (ORAU) study (1985) that more air monitoring was needed. Two on-site stations were added in the production area (AMSs 8 and 9) in 1986, three off-site in 1986 (AMSs 10, 11, and 13), one in 1987 (AMS 12), and one in 1988 (AMS 14, at the same location as AMS 13 but on the roof of the school rather than at ground level). Uranium concentrations, gross beta activity, and TSP are monitored weekly at these stations; an annual composite sample is monitored for trace radionuclide levels (including Sr-90, Tc-99, Ru-106, Cs-137, Ra-226, Ra-228, Th-228, Th-230, Th-232, Np-237, Pu-238, Pu-239, Pu-240, and Pu-241 in addition to the uranium isotopes). All trace radionuclides were measured, in 1987 (WMCO 1988a), at less than 1% of proposed DOE Draft Order 5400.xx guidelines. Neither the air sampling data nor the stack on-site monitors provide measurements of particle size distribution.

A 1985 FMPC study (Boback et al. 1986) showed that an average particle size of 5-6 μm was emitted from the stacks. However, in this EIS a size of 1 μm is assumed for dose calculations in the absence of confirmatory data. The dose would be overestimated by a factor of ~3 if the actual particle size is 5-6 μm. This overestimate occurs because small particles stay suspended in the air and are retained in the deep lung longer.

Radon measurements are made quarterly at the regular AMS and, as of 1987, at 16 additional fenceline locations, 18 on-site locations, 3 residences near the west boundary, and 2 distant (farther than 20 km or 12 miles) background locations (WMCO 1988a). Radon levels vary with season, wind velocity, and humidity and other meteorological variables. Problems in quantifying this normal variability at FMPC are exacerbated by an apparent considerable variability in the measurements and variability between stations at background locations.

Soil sampling

Routine annual soil samples were taken in 1985, 1986, and 1987. The uranium concentrations generally increased during that time, so 1987 data are given as the maximum concentration observed. In 1987 (WMCO 1988b) soils from 7 on-site (boundary) locations and 7 of 11 off-site locations were analyzed for total uranium concentrations (Fig. 3.8-1). The samples were taken at two depths, 1-5 cm (0.4-2 in.) and 5-10 cm (2-4 in.) and consist of ten cores about 2 cm (0.8 in.) in diameter. In 1986 and 1987, annual soil samples were also taken in parallel with vegetation samples and in 1987 with farm and garden produce. In 1987, these samples were from 9 on-site and 11 off-site locations (Fig. 3.8-2). Samples taken in parallel with garden produce from 9 off-site locations were analyzed for uranium (Fig. 3.8-3). Thus, in 1987, soil samples were taken from a total of 16 on-site and 25 off-site locations. The background levels cited for Ohio are 0.6 to 2.2 pCi/g U-238 or about double those values (1.2 to 4.4 pCi/g) for total uranium (WMCO 1988a). Most of the on-site locations had uranium levels above the 4.4 pCi/g upper value for background. In 1986, no off-site soil samples were above background. In 1985 and 1987, only one of the routine off-site soil samples appeared to be above background (14.2 and 8.3 pCi/g for 1985 and 1987 respectively, location 11, Fig. 3.8-1), but two off-site samples in the vegetation study and two from the produce study were above the upper end of the background range in 1987. Vegetation soil samples at locations 7 and 18 (Fig. 3.8-2) had 6.1 and 6.5 pCi/g respectively. Produce soil samples in location 3 and 5 (Fig. 3.8-3) had 5.5 and 7.7 pCi/g respectively.

Farm/garden produce sampling

Radionuclides that occur naturally or are deposited on the soil may be taken up by plants and animals and may ultimately find their way into human food sources. To monitor produce grown in areas surrounding FMPC and at remote distances, samples of vegetables, soil, and fertilizer from area farms and gardens (Fig. 3.8-3) were analyzed for uranium in 1986 and 1987. Results of soil analyses are given in the preceding section.

Significantly different concentrations of uranium did not appear among produce groups. The highest levels of uranium were sampled in 1986. One sample was 0.2 pCi/g, which was an order of magnitude below the soil concentration; fertilizers used at that site contained 121 pCi/g. Natural background is 1.2-4.4 pCi/g. In most cases the uranium concentration in or on the produce was 2-3 orders of magnitude less than background concentrations of uranium in the soil, and no produce sampled showed significant levels of contamination. The impacts of ingesting this produce are evaluated in Sect. 3.8.2. A number of vegetables analyzed exhibited no measurable uranium concentrations. There was no association among uranium concentrations, distance from FMPC, vegetable type, or farm from which vegetables came (Christiansen 1988).

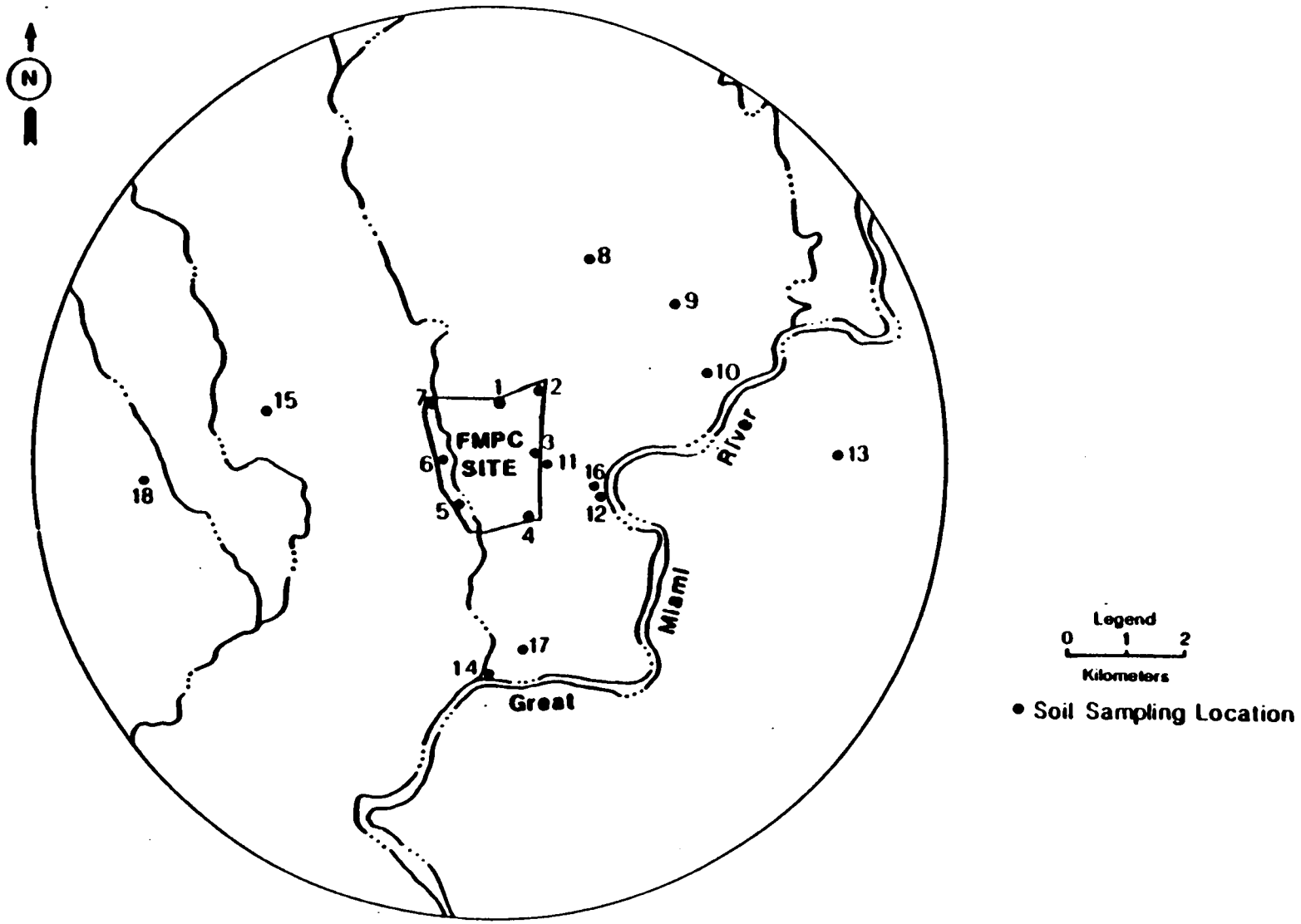


Fig. 3.8-1. Routine soil sampling locations at the Feed Materials Production Center (WMCO 1988d).

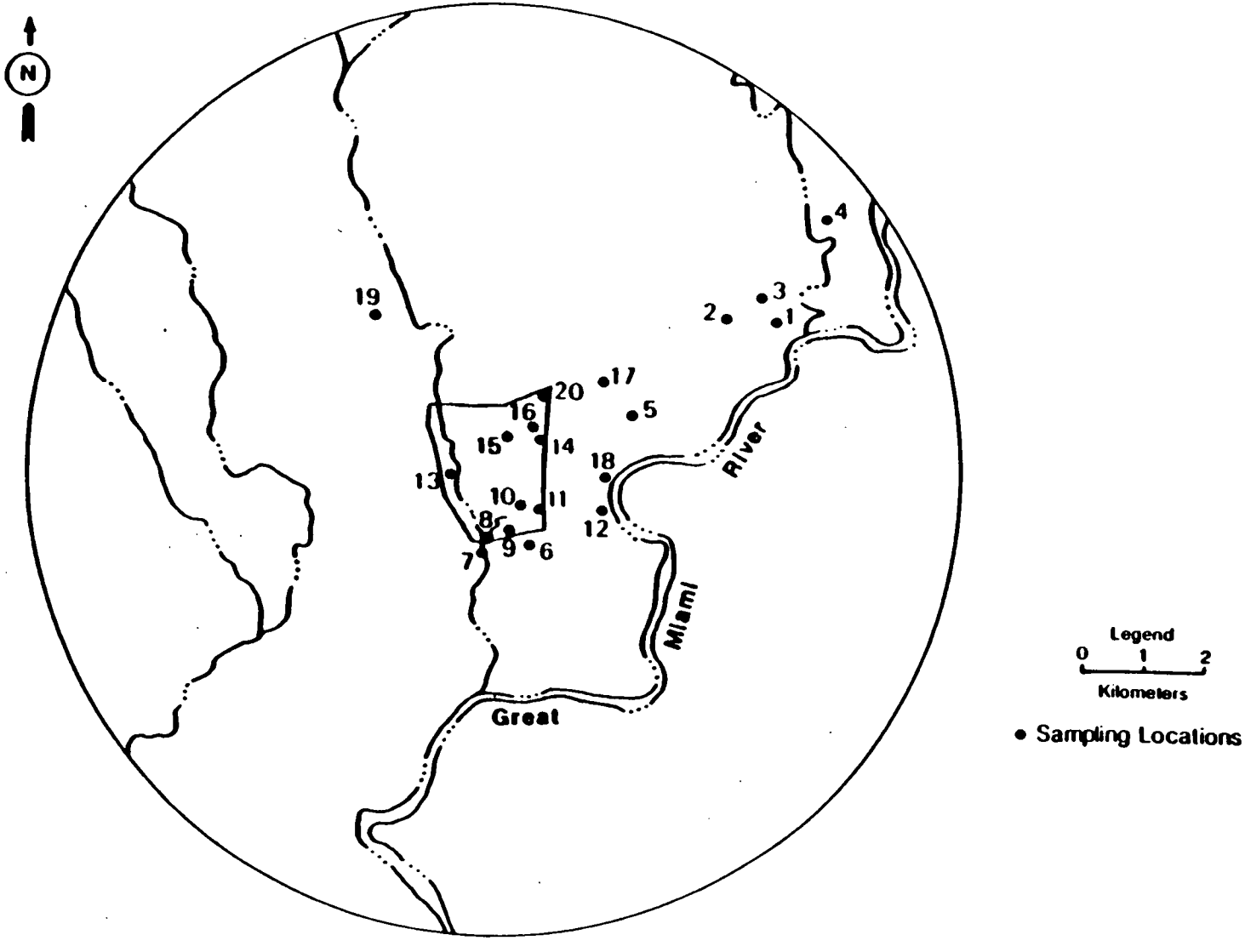


Fig. 3.8-2. Parallel soil and vegetation and associated soil sampling locations at the Feed Materials Production Center.

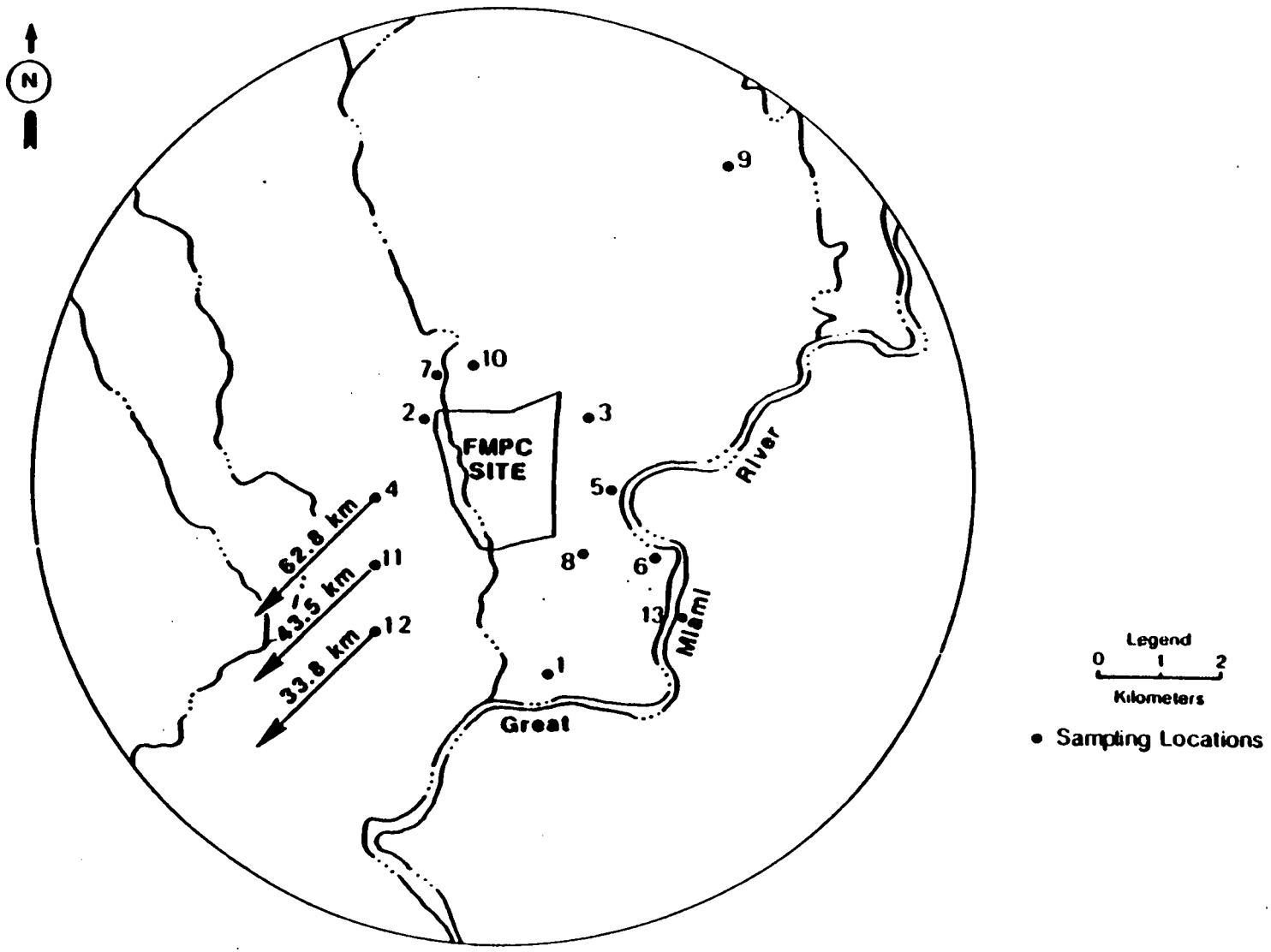


Fig. 3.8-3. Sampling locations for farm and garden produce and associated soils surrounding the Feed Materials Production Center.

Milk sampling

In 1987, the milk produced by cows grazing on FMPC land adjacent to the site and in Indiana about 30 km (19 miles) northwest of FMPC was sampled monthly. The levels of uranium present in the samples from each location were consistently less than the FMPC laboratory's minimum detectable range of < 0.7 pCi/L; levels did not vary between the two locations (Christiansen 1988).

3.8.1.2 Water pathway

Groundwater sampling

The FMPC wells were sampled for 1985, 1986, and 1987 as part of several environmental monitoring programs. In 1987, 28 off-site wells belonging to individuals and companies in the vicinity of FMPC and 13 on-site wells were sampled monthly for radiological parameters (Fig. 3.8-4). The sampling was performed according to guidelines set forth by EPA and RCRA regulations (40 CFR 265).

The average uranium concentrations in the samples collected for all years, except wells 12, 15, and 17 (OS-1, OS-2, and OS-3) were within the range considered natural background for uranium content in groundwater. In 1987, the highest concentrations in these wells were 278, 223, and 75 pCi/L respectively (Christiansen 1988, Table 23). The concentration of 278 pCi/L is the highest sample concentration ever recorded for an off-site well; however, the average concentration for the year was 204 pCi/L. No clear trends are evident in the majority of the off-site wells. Natural background levels for uranium in groundwater in most areas in the United States range from 0.68 to 6.8 pCi/L (WMCO 1989).

Surface water and sediment sampling

Surface water samples were taken in 1985, 1986, and 1987. In 1987 four on-site and five off-site locations were sampled (Fig. 3.8-5) (WMCO 1988a). Three off-site locations were on the Great Miami River where grab samples were taken weekly and analyzed for total uranium concentration, gross alpha and gross beta levels, pH, and ions. Semiannual composites of river samples were analyzed for other heavy elements such as cesium and strontium, (WMCO 1988a, Table 25, pp. A-32 and A-33). One-month composites were analyzed for radium. Comparisons of gross alpha and beta were made for 1985, 1986, and 1987. In addition to slight increases in total uranium, gross beta increased markedly at the Great Miami River stations downstream of the FMPC liquid effluent line to the river. Upstream, the yearly average gross beta level for 1985-1987 did not exceed 5.2 pCi/L; at the downstream points in 1985 and 1986 the average values ranged from 5.5 to 7.8 pCi/L. In 1987, the two downstream values were 12 and 16 pCi/L. This increase may be due to increased release of Tc-99 from the FMPC; however, the concentrations were far below the draft DOE Draft Order 5400.xx standard. The total uranium concentration at sampling point 001 (the final access point to the effluent line to the Great Miami River) was

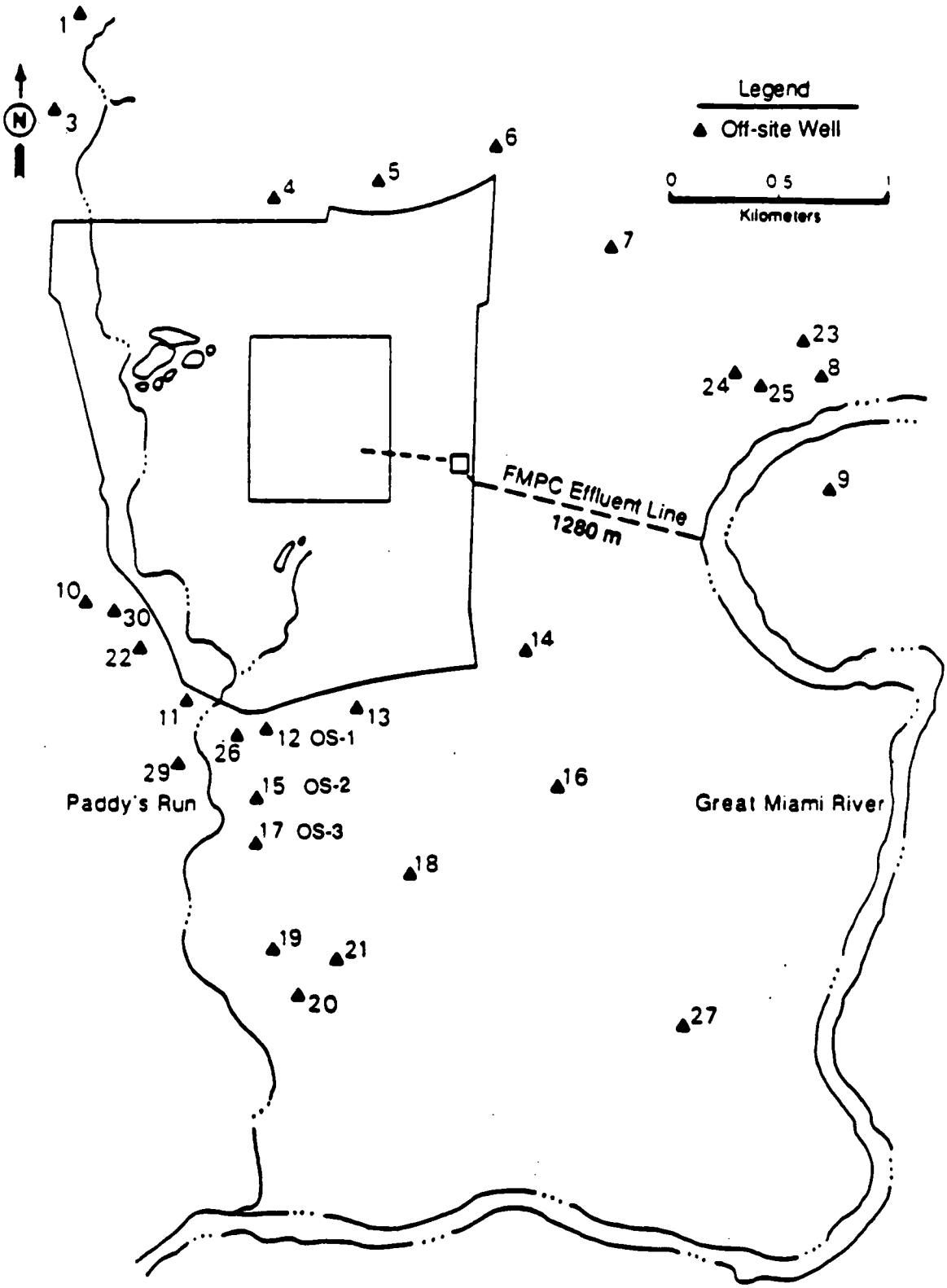


Fig. 3.8-4. Off-site monitoring well locations at the Feed Materials Production Center (WMCO 1988d).

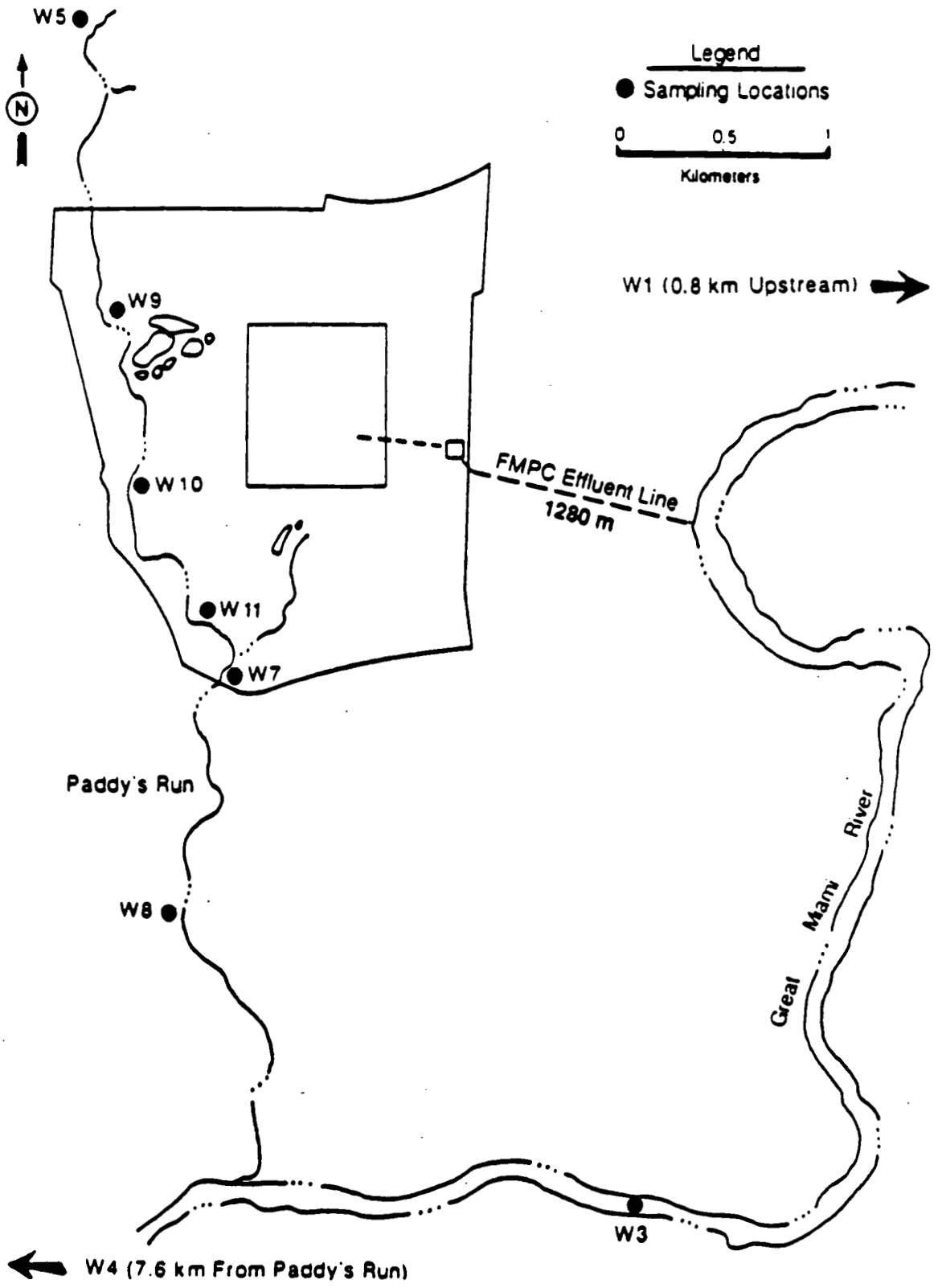


Fig. 3.8-5. Surface water sampling locations in the vicinity of the Feed Materials Production Center in 1987.

120% of the DOE standard in draft DOE Draft Order 5400.xx (WMCO 1988a, Table 27). The total amount of uranium discharged into the river increased 54% in 1987 compared to 1986.

Other on- and off-site locations were on Paddy's Run; weekly grab samples were collected at those sites and analyzed for total uranium concentration, gross alpha and beta levels, and pH. Uranium levels were elevated at some on-site locations on Paddy's Run; the average values in 1987 ranged from 1.7 to 6.8 pCi/L and background was 1.0 to 1.2 pCi/L. Levels of total uranium at the Paddy's Run sampling points decreased greatly in 1987 from 1985 levels. In 1985, on-site uranium levels ranged from to 9.8 to 235.5 pCi/L.

In 1987, sediment samples were taken from 9 sites on the Great Miami River and 51 sites on Paddy's Run and the Storm Sewer Outfall Ditch (Fig. 3.8-6) (WMCO 1988b). This was an increase of 11 sites over 1986 sediment sampling. The frequency of collection was not specified. The samples were analyzed for Tc-99 and isotopes of U, Th, Ra, and Pu, but not for total uranium. No difference was seen upstream versus downstream of the effluent line to the Great Miami River (WMCO 1988b). Paddy's Run sediments were at background. Above-background levels of uranium, thorium, and radium were seen only in sediments of the storm-sewer outfall ditch, unlike previous years when Paddy's Run sediments near the storm-sewer outfall were also elevated.

Fish sampling

Fish have been collected in the Great Miami River since 1984 with the aid of a fisheries research team from the University of Cincinnati (Christiansen 1988). In 1987, the date of the latest available data, electroshocking resulted in the collection of 229 fish representing 19 species: 51 from sampling location 1, 56 from location 2, and 122 from location 3 (Fig. 3.6-3). A total of 61 fish from all three locations were initially placed in plastic bags and packed in ice, then later scaled and the heads and entrails removed. A fish was filleted if its total weight was greater than 800-900 g (~2 lb). The fillets were then frozen, packed in dry ice, and shipped to an independent test laboratory for analysis along with the fish that were not filleted.

A University of Cincinnati study determined that the fish populations in the Great Miami River have not changed appreciably since 1984. The same types of fish were collected in the same types of habitats in the river. Some river habitats changed from 1984 to 1987 because of gravel quarrying and removal of the dam at sampling location 3. University of Cincinnati scientists suggest that populations of fish throughout the river between 1984 and 1986 were healthy (Christiansen 1988).

The overall uranium concentrations in fish collected in 1987 were statistically lower than the average for fish collected in 1984, 1985, and 1986. In 1987, average uranium concentrations in fish were lowest at the FMPC discharge point to the Great Miami River and not significantly different upstream or downstream from the FMPC outfall to the Great Miami

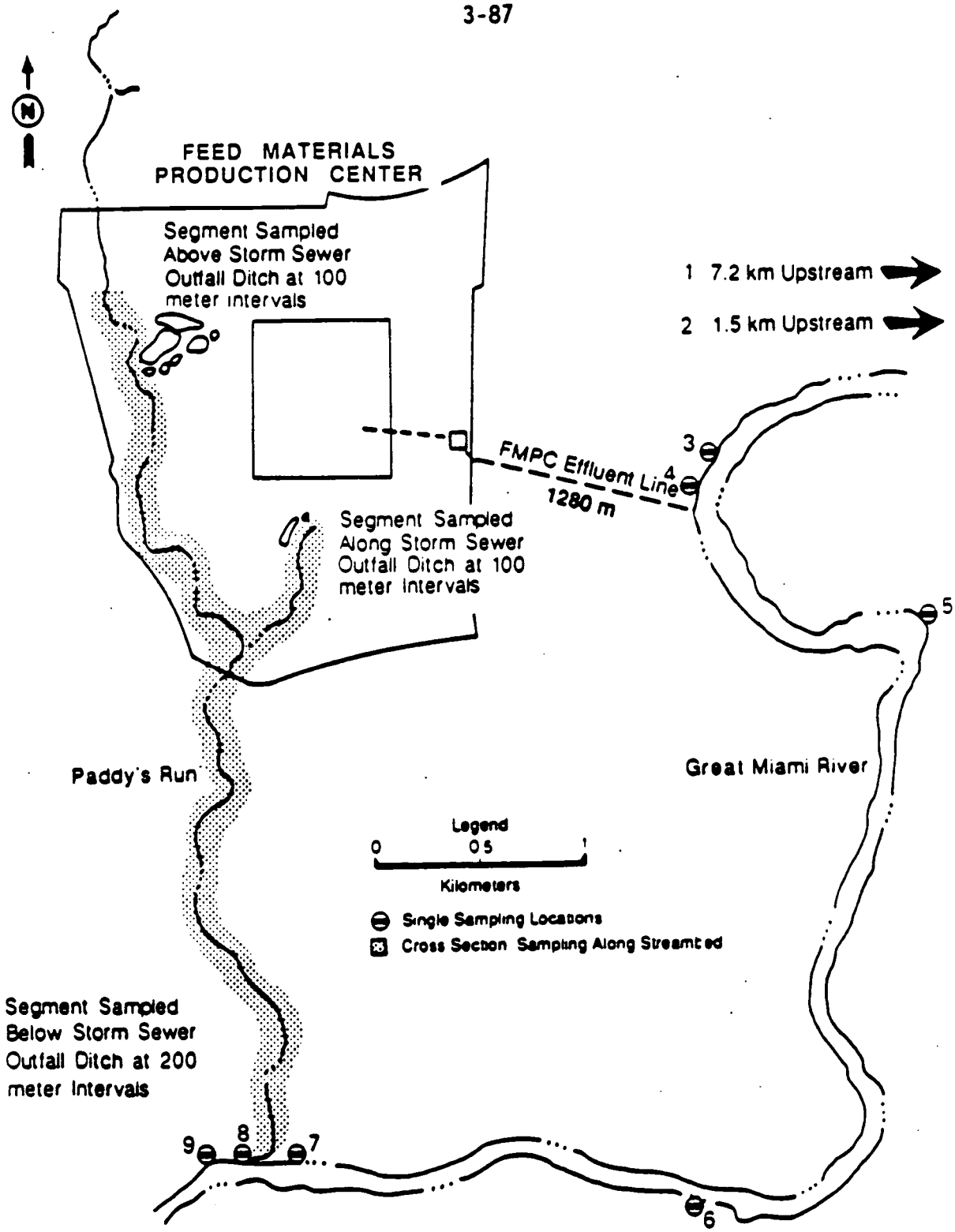


Fig. 3.8-6. Sediment sampling locations in the vicinity of the Feed Materials Production Center in 1987.

River; the concentrations are therefore considered to be natural background levels (WMCO 1987a).

3.8.2 Dose

3.8.2.1 Methods

When site-specific information is not available, conservative assumptions are used that tend to maximize the dose (e.g., in calculating doses from atmospheric releases, it is assumed that the individual is exposed to contaminated air and ground surfaces for 100% of the time without shielding). Further, it is assumed that all food consumed is grown at the location of dose calculations. FMPC site meteorological data were used to perform dose calculations.

The AIRDOS-EPA (Moore 1979) computer program was used to estimate radiation doses to the nearest off-site individual and to the human population within 80 km (50 miles) of FMPC.

Five potential pathways for radiation exposure from nuclides are presented schematically in Fig. 3.8-7. External doses result from the overhead plume, immersion in contaminated air, submersion in contaminated water, exposure to contaminated ground surfaces, and direct gamma radiation from the K-65 silos. Internal doses result from inhalation of contaminated air and ingestion of contaminated food and water. Doses to humans are estimated for the total body and various organs accounting for all five significant pathways. Radioactive materials introduced into the body by inhalation and ingestion pathways (internal exposure) continue to irradiate the body until they are removed by processes of metabolism and radioactive decay. Thus, the dose calculated for an adult individual for 1 year of radionuclide intake represents the total dose to be received integrated over the next 50 years (assumed remaining lifetime) as a result of that 1 year's intake (i.e., a 50-year dose commitment). In this EIS, all internal radiation dose equivalents are expressed as 50-year dose commitments.

Airborne releases

The AIRDOS-EPA computer code (Moore et al. 1979) is used to calculate the dose commitments resulting from atmospheric releases of radionuclides from FMPC for this EIS and for the FMPC Environmental Monitoring Reports (WMCO 1988b; WMCO 1986). The AIRDOS-EPA computer code is designed to estimate (1) radionuclide concentrations in air; (2) rates of deposition on ground surfaces; (3) ground surface concentrations; and (4) intake rates via inhalation of air and ingestion of meat, milk, and vegetables. The code uses this information to calculate the potential dose commitment over the next 50 years for selected individuals in the area and the doses to the population living within an 80-km radius of the facility.

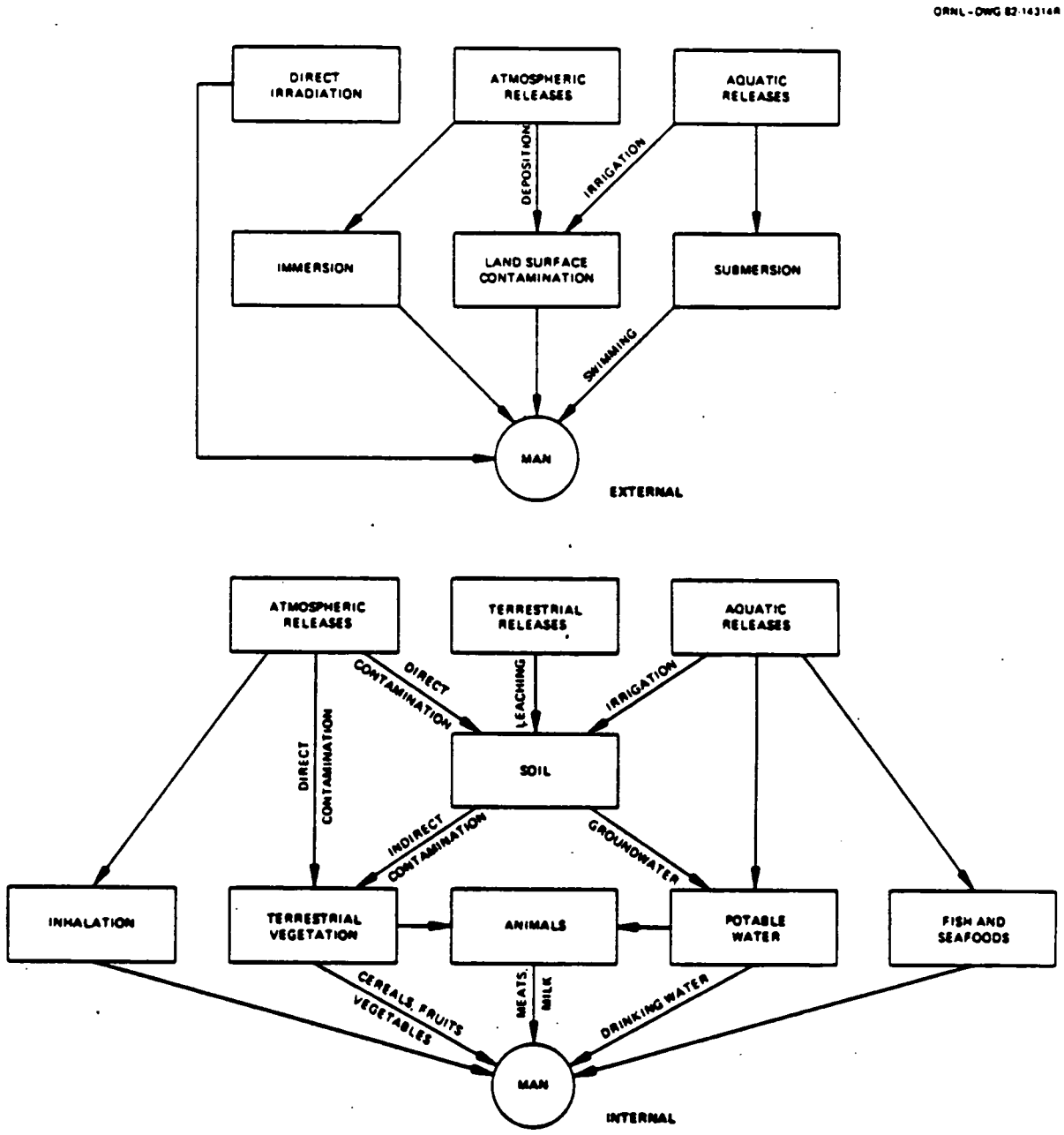


Fig. 3.8-7. Exposure pathway to humans (not exclusive to FMPC).

The following data were used for the computer calculations:

1. Particle size was assumed to be 1 μm.

2. All radiological emissions were modeled as if emanating from an area source of 337-m (1100-ft) diameter and 20-m (66-ft) height.

3. Meteorological data for 1988 from the site were used.

4. The 1980 census was the source of demographic data [2,576,988 persons within 80 km (50 miles) of FMPC]. The population distribution is presented in Table 6 in WMCO (1988b).

5. The calculations assumed that the UO_3 gulping process involved 0.94% U-235, which was 91.8% lung clearance class D (soluble) and 8.2% lung clearance class W (moderately soluble). The remainder of uranium airborne emissions were considered to be 0.5% U-235 of Y lung clearance class (insoluble).

6. For radionuclides other than uranium, a weighted average of the ratio of uranium to other radionuclides as given in Boback (1986) was used.

7. Dose conversion factors are 50-year committed doses.

Radionuclides contained in the airborne effluent are dispersed both horizontally and vertically as the plume is blown downwind. The AIRDOS-EPA computer code uses an atmospheric transport model to estimate the annual average ground-level concentration of each radionuclide as a function of direction and distance from the release. Meteorological data required as input into the code include annual average frequencies of wind direction and atmospheric stability, annual average wind speed for each wind direction/stability combination, and the annual average atmospheric mixing layer depth, air temperature, and rainfall rate. Required source input data include the radionuclide, radionuclide emission rate in curies per year, and height of emissions for point and area sources. Also required for point sources with plume rise are the stack gas exit velocity, the stack inside diameter, and the stack heat release rate. The deposition and gravitational settling velocities (dry deposition) and the scavenging coefficient (wet deposition) are required input for each radionuclide in order to calculate total deposition amounts. The AIRDOS-EPA atmospheric dispersion and deposition algorithms are described in Moore et al. (1979).

The average modeled concentration of radionuclides in air at ground level is used to estimate the external dose from gamma radiation to an individual. The air concentration at each location is also used to estimate the internal dose by inhalation. The dose conversion factor used to convert exposure to each radionuclide to total body and organ dose includes contributions from radioactive daughters after intake into the body. Fifty-year dose equivalent calculations based on standards established by ICRP Reports 26 and 30 are taken from Dunning (1981).

Rates of deposition on ground surfaces are used to estimate the external dose resulting from gamma radiation emanating from contaminated ground surfaces. Radionuclide concentrations in meat, milk, and vegetables consumed by humans are estimated with the AIRDOS-EPA computer code by coupling the output of the atmospheric transport model with NRC Regulatory Guide 1.109 (NRC 1977) terrestrial food chain models. These regulatory guide models base organ dose calculations on nuclide concentrations in and on vegetation; the concentrations depend on rates of deposition of the nuclides on the ground and plant surfaces. The radioactive material accumulates in vegetation as a result of deposition on the plant foliage and root uptake of radioactivity from the soil. The concentration of radionuclides in meat and milk depends on the contamination level of the local feed and water consumed by an animal. Ingestion doses resulting from deposition of radionuclides on cropland and pasture are estimated separately for vegetables, meat, and milk. The terrestrial models are used to estimate the steady-state concentrations of radionuclides in these types of foods for continuous deposition on the land. A range of about one to two orders of magnitude above the average value for most parameters can be expected (NCRP 1984). The use of conservative assumptions in the terrestrial model results in predictions that tend to overestimate the concentrations in terrestrial foods and, consequently, dose to humans.

Site-specific monitoring, carried out annually, is discussed in Sect. 3.8.1. One major purpose of taking these measurements is to make sure that modeling and calculational procedures do not underestimate doses. Transfer coefficients for radionuclides used in these calculations are found in Dunning (1981).

The estimated radiation doses presented in this section are for the years 1985, 1986, and 1987. Projected radiation doses to the public from FMPC are presented in Chap. 4. Estimated radiation doses for earlier years of FMPC operations are available in a report by IT Corporation (1989). The doses estimated by IT are similar to those presented in this section, but the IT assumptions and data are slightly different because of the different nature of these studies. The IT report is a historical assessment (1951-84) of FMPC radiological emissions. This EIS uses 1980 census population data, whereas IT used 1970 census population data because of its historical orientation. This EIS uses FMPC site-specific wind data because a recent data base for this information has been compiled (Appendix G). The IT report, however, had to use Cincinnati Airport wind data because there is no historical FMPC site-specific data. This EIS uses standards established by ICRP Reports 26 and 30 (Dunning 1981) to estimate cancer risk from radiation exposure. The RADRISK computer code was used by IT to estimate the cancer risk from radiation exposure. The RADRISK method is used by EPA, but the approach used in the EIS is used by most other specialists because of its simplicity and accuracy. For a common data, set, the two methods are expected to give the same results.

Maximum individual dose

The maximum individual dose is based on the effluent plume concentration at the point of maximum exposure and is estimated for the

nearest maximally exposed resident 976 m (3200 ft) east-southeast of FMPC (Plant 4). The exposed individual is assumed to reside continuously at the location without benefit of shielding, and the location is assumed to be the point of origin for all food consumed. All dose estimates are for adults. Estimates of doses are made for the total body and for several reference organs.

The National Emission Standards for Hazardous Air Pollutants (NESHAP) are applicable to radionuclide air emissions from DOE facilities, including FMPC (40 CFR Pt. 61, Subpart H). The standards for radionuclides are 25 mrem annual whole-body dose to an individual and 75 mrem to any organ of that individual. The dose contribution of radon and its daughter products is not included in NESHAP regulations.

Aquatic dose

Radiation exposures to the public resulting from effluent discharges of water from FMPC are required to meet the federal standard defined in Radiation Protection of the Public and the Environment (DOE 1987). The standard for prolonged radiation exposure to the maximally exposed individual is 100-mrem effective dose equivalent, but no organ can receive more than 5 rem/year.

The individual dose from liquid effluents in 1985 was calculated using average measured concentrations of radionuclides in the Great Miami River (Table 29 in WMCO 1986). It was assumed that an individual drinks 2 L/d (2.1 qt/d) of water and eats 21 kg (46 lb) of fish per year.

Radon dose

Radon monitoring data collected at the fence perimeter and the background stations are highly variable. The 1987 data have a standard deviation that is 100% of the mean, making them of little value for estimating doses. The 1988 data have a 40% variation, but measurements of radon at both near-site and off-site background stations exceed the measurements at the fence perimeter. Therefore, these radon monitoring data are not very useful in evaluating the dose to off-site individuals.

Uranium dose

Air monitoring data were taken from the 1985 monitoring report (WMCO 1986) for the monitoring station (BS3) nearest the maximally exposed individual on the east. This station is on the fenceline directly east of the FMPC site, and the average levels of almost all radionuclides were highest at that station. The effective total-body dose, lung dose, and dose to bone surface were calculated by summing the doses from nine of the monitored isotopes. Values for uranium isotopes were not given, so levels of U-234, U-235, and U-238 were estimated from the value for total uranium by using the level of enrichment and percentages of each isotope supplied by WMCO. The amount inhaled and total doses were calculated using the same

assumptions regarding particle size and solubility used in the AIRDOS calculations.

In addition to the uranium isotopes, the values for Pu-238, Pu-239, Pu-240 and Pu-241, Th-228, Th-230, and Th-232 were included in the dose calculation.

Direct gamma dose

The direct external gamma radiation dose from the K-65 silos was calculated from the measured exposure rate at the nearest residence (to the west of the silos). The direct gamma radiation measurement was made with a calibrated pressured ionization chamber (WMCO 1988b, Table 3).

Population dose

The total collective dose from airborne particulates received by the population of 2,570,000 persons who live within 80 km (50 miles) of FMPC is estimated using AIRDOS-EPA by summing individual internal dose estimates for the five significant pathways illustrated in Fig. 3.8-1 within the population. The data are then combined with the calculated ground-level radionuclide concentrations in air and the rate of deposition on the ground and water surfaces for each radionuclide at the designated distances and directions from the release point. The doses to humans for each direction and distance are estimated for the total body and various organs for the five significant pathways.

3.8.2.2 Dose calculations

Airborne releases of uranium from FMPC operations for 1985, 1986, and 1987 are given in Table 3.8-1 and are used in the AIRDOS code to estimate doses in this section.

Individual dose

Maximum individual 1985, 1986, and 1987 doses from uranium (and thorium) emissions for a person residing off-site, as calculated by AIRDOS modeling, are given in Table 3.8-2. Between 89 and 100% of these doses are due to inhalation of radionuclides in air. Uranium accounts for about 75% of the effective total-body dose and 84% of the dose to lungs. Thorium radionuclides account for 18% and 13%, respectively, of the dose to total body and lung. In 1985, the total-body dose (11.9 mrem) from uranium air emissions was less than the 25-mrem NESHAP standard (40 CFR PT. 61), but the highest organ dose (87 mrem to lung) exceeded the NESHAP 75-mrem organ dose limit. In 1986 and 1987, these doses were about the same as those in 1985. The average annual effective dose equivalent to an individual in the United States from natural background radiation is approximately 300 mrem, the majority of which is from radon and its decay products (200 mrem) (NCRP 1987). The maximum individual dose from FMPC operations is small compared with the natural background radiation dose.

Table 3.8-1. Estimates of uranium air emissions[a] for 1985, 1986, and 1987

Emission point (plant)	1985 (kg)	1985 (lb)	1986 (kg)	1986 (lb)	1987 (kg)	1987 (lb)
			Monitored operational emissions			
1	2.1	4.7	0.0	0.0	0.2	0.4
2/3	7.5	16.5	0.0	0.0	0.2	0.4
4	19.6	43.2	5.4	11.8	2.0	4.4
5	23.9	52.5	15.8	34.7	4.4	9.8
6	0.0	0.0	0.0	0.0	0.3	0.6
8	32.3	71.0	16.6	36.5	34.4	75.7
9	4.2	9.3	3.5	7.6	0.2	0.4
Pilot Plant	12.5	27.5	2.2	4.9	0.7	1.5
Incinerator	19.2	42.3	18.8	41.4	0.0	0.0
Subtotal	121	267	62	137	42	93
			Unmonitored operational emissions[b]			
UO_3 gulping	130	286.6	0[c]	0[c]	200	440.9
Laboratory hoods	2	4.4	2	4.4	2	4.4
Building exhausts	4	8.8	4	8.8	2	4.4
Other unmonitored processes	6	13.2	6	13.2	5	11.0
Non-routine events	12	26.5	16	35.3	10	22.0
Subtotal	154	340	28	62	219	483
			Remedial action site emissions[d]			
Waste pit fugitives	40	88.1	40	88.1	41	90.3
Total	315	694	130	287	302	666

[a]It is assumed that the ratio of uranium released from stack emissions to other radionuclides remains the same for all scenarios (Boback et al. 1986). Therefore, uranium accounts for 75% of the effective total-body dose and 80% of the dose to lungs. Thorium radionuclides account for 18% and 13% of the total-body and lung doses respectively.

[b]Data are unavailable for these emission points. An ongoing re-evaluation of all emissions is being conducted to supply missing data and to ensure accuracy of all source terms.

[c]Process not operated during 1986.

[d]Engineering estimates.

Source: Brettschneider May 12, 1989

The doses calculated by the AIRDOS code for the FMPC site are conservative. As mentioned previously, if the particle size averages 5-6 μm instead of the assumed 1 μm, the doses are overestimated by a factor of ~3.

Doses calculated using 1985 monitoring data at AMS 3 (Fig. 3.4-2) are about one-fourth of those calculated by AIRDOS for the maximally exposed individual east of the site. Monitoring data indicate a dose of 2.6 mrem/year versus AIRDOS calculations of 12 mrem/year. The dose would be expected to be even less at the distance of the maximally exposed individual 30 m (97 ft) east of the site. If background values had been available to subtract from the monitoring data, the difference would have been still greater. A difference of a factor of three or so is considered good agreement with the model; the results show that the model is not underestimating the dose to the maximally exposed individual.

The individual dose from liquid effluents was calculated using average measured concentrations of radionuclides in the Great Miami River during 1985 (Table 5, WMCO 1986). It was assumed that an individual drinks 2 L/d (2.2 qt/d) of water and eats 21 kg/year (46 lb/year) of fish. Estimated effective total-body doses are 0.14 mrem/year from ingestion of water and 0.01 mrem/year from ingestion of fish.

In addition, a nearby off-site individual receives a radiation dose from radon released primarily from the K-65 silos but also from other sources in the production facility. Assuming a release of 1083 Ci/year and using 1988 meteorological data for the FMPC site, the average annual FMPC-derived concentration calculated by AIRDOS would be 0.23 pCi/L for the maximally exposed individual for radon west of the FMPC boundary. The corresponding effective whole-body dose for an adult is 70.5 mrem/year, which may be added to 4.9 mrem/year estimated for airborne emissions from normal operation and 9.5 mrem/year dose for direct gamma radiation from the K-65 silos for a total dose of 85 mrem/year. The radon concentrations attenuate very rapidly with distance and are negligible beyond about 0.8 km (0.5 miles) from the source. Also, the direct gamma dose drops off rapidly.

Population dose

The estimated doses from atmospheric particulate emissions to the 2,570,000 persons who live within 80 km (50 miles) of FMPC are 250, 185, and 169 person-rem for 1985, 1986, and 1987 airborne releases respectively (Table 3.8-2). This may be compared with the 771,000 person-rem that this population would be expected to receive annually from background radiation (300 mrem/year per person).

3.8.3 Risk Calculation

To put the above doses calculated for a maximally exposed individual in 1985 into better perspective, it is useful to estimate the excess annual risk of incurring a fatal cancer experienced by an individual at the estimated doses. The dose for the aquatic pathway (Great Miami River

Table 3.8-2. Annual radiation doses resulting from 1985, 1986, and 1987 FMPC operations[a]

	1985	1986	1987
Population dose to individuals within 80 km of FMPC			
FMPC emissions	250 person-rem	185 person-rem	169 person-rem
Maximally exposed individual: East			
Operations			
Uranium air emissions	10.4	7.4	6.5
Remedial action sites			
Waste pit area uranium air emissions	1.5	1.5	1.5
K-65 Silos radon	27.1	27.1	27.1
Total	39	36	35
Maximally exposed individual: West			
Operations			
Uranium air emissions	4.3	3.0	2.7
Remedial action sites			
Waste pit area uranium air emissions	0.6	0.6	0.6
K-65 Silos radon	70.5	70.5	70.5
K-65 Silos direct gamma	9.5	9.5	9.5
Total	85	84	83
Off-site agricultural doses	0.03	0.01	0.03
Water Pathway			
Great Miami River[b]	0.15	0.31	0.17
Off-site wells[c]	38	36	38
Paddy's Run[b]	1.3	<1.3	<1.3

[a]All doses are effective total-body doses in mrem/year except where noted. The ratio of uranium to other radionuclides is assumed to remain the same as that found in Boback 1985; therefore, thorium accounts for 18% and 13% of effective total-body and lung doses respectively.

[b]Assuming that an individual eats 21 kg (46 lb) fish/year and drinks 2 L/d (2.2 qt/d) of water.

[c]These doses resulted from the highest annual average concentrations found in off-site wells (WMCO 1986, 1987a, 1988b); however, these contaminated wells are not used for drinking water.

drinking water and fish) of 0.15 mrem and the dose for ingesting vegetables of 0.03 were so small they were not included in the risk assessment. The estimated risks are shown in Table 3.8-3. For 1985, the effective total-body dose to the maximally exposed adult on the west of the FMPC site from air emissions and direct gamma exposure is estimated to be 85 mrem/year. The standard (conservative) estimate for risk of fatal cancer is 1.25×10^{-4} cancers per rem of exposure to any radiation (ICRP 1977). Thus, a conservative (upper limit) estimate of risk to an adult exposed to 85 mrem is about 1×10^{-5} or 1 chance in 100,000 of contracting a lethal cancer. If this same maximally exposed individual had also drunk water from the most contaminated off-site well (not used for drinking water) and eaten fish from the Great Miami River, the additional dose received would have been ~38 mrem. Therefore, the total possible annual dose is 123 mrem, with an annual risk increment of 15×10^{-6}. Since people do not drink water from the contaminated well, a more realistic maximum dose is 85 mrem/year, 1×10^{-5} chances of fatal cancer per year of exposure. The International Council for Radiation Protection (ICRP) has suggested 10^{-6} to 10^{-5} as an acceptable range for risk incurred annually by inadvertent exposure to nonnatural radiation (ICRP 1977).

The water and sediment in Paddy's Run contain low-level radionuclide contamination. Therefore, there is a potential, but not probable, source of exposure to radiation for an off-site individual. Using measured radionuclide concentrations in sediment (Table 17) and water (Table 5) given in the 1985 Environmental Monitoring Annual Report (WMCO 1986), the following radiation doses were estimated. An adult individual drinking 730 L (193 gal) of water and eating 21 kg (46 lb) of fish per year would receive an effective total-body dose of 1.7 mrem. In the unlikely event that a child were to ingest 1 kg (2 lb) of sediment over a period of 1 year, the resultant effective total-body dose would be 10.4 mrem (Cristy 1986). It should be emphasized that Paddy's Run is not a source of drinking water or a recreational site.

3.9 WORKER EXPOSURE TO HAZARDOUS SUBSTANCES

3.9.1 Radiation Exposure Limits

FMPC, like all DOE facilities, has adopted a policy intended to reduce occupational radiation exposure to as low as reasonably achievable (ALARA) levels. WMCO has set the administrative dose controls (ADCs) for workers listed in Table 3.9-1. The ADCs are used for controlling occupational radiation exposure (excluding radiation received as a result of medical or dental exams). WMCO has established its ADCs at levels well below the DOE limits to ensure ALARA personnel exposure.

The WMCO ADCs, established for both internal and external exposures, are consistent with the requirements of federal agencies such as EPA, NRC, and the Occupational Safety and Health Administration (OSHA); they are also consistent with the recommendations of scientific organizations such as the National Council on Radiation Protection and Measurements (NCRP). The limit for the occupational whole-body dose can purposely be exceeded only in the event of an unusual situation, and exceeding the limit must be

Table 3.8-3. Annual cancer risks associated with annual effective total-body doses resulting from 1985 Feed Materials Production Center operation

	Dose[a] (mrem)	Annual cancer risk
Maximally exposed individual: East		
Operations		
Uranium air emissions	10.4	1.3×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions	1.5	0.2×10^{-6}
K-65 Silos radon	27.1	3.4×10^{-6}
Total[b]	39	4.9×10^{-6}
Maximally exposed individual: West		
Operations		
Uranium air emissions	4.3	0.5×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions	0.6	0.1×10^{-6}
K-65 Silos radon	70.5	8.8×10^{-6}
K-65 Silos direct gamma	9.5	1.2×10^{-6}
Total[b]	85	1.0×10^{-5}
Background		
Natural	100[c]	13×10^{-6}
Indoor radon background	200[c]	25×10^{-6}
Total[b]	300	38×10^{-6}

[a]Effective total-body dose from the particulate atmospheric emissions includes dose from inhalation of air; immersion in contaminated air; ingestion of meat, milk, and vegetables grown at the site; and exposure to deposition on ground.

[b]Totals may not add due to independent rounding.

[c]*Source:* NCRP 1987.

Table 3.9-1. Annual radiation dose limits set by Westinghouse Materials Company of Ohio for occupational exposure at the Feed Materials Production Center[a]

	Annual limit (mrem)	
	Westinghouse Materials Company of Ohio ADC[b]	DOE[c]
Whole body	3,000	5,000[d]
Lens of eye	9,000	15,000
All other organs	30,000	50,000

[a]*Source*: WMCO 1989, p. 2-2.

[b]Administrative dose controls (ADCs).

[c]Dose equivalent or committed dose equivalent. Occupational radiation exposure limits per DOE Order 5480.11; radiation exposure limits to the general public per Draft DOE Order 5400.xx.

[d]Limited to a lifetime effective dose equivalent of 1×10^5 mrem.

approved by the Emergency Duty Officer. A permanent radiological exposure record is kept for all employees except temporary workers and subcontractors.

3.9.2 Worker Radiological Monitoring and Training

The Feed Materials Production Center Radiation Control Manual (WMCO 1989) sets forth programs to inform workers of and protect them from radioactive exposures. A major part of this program involves the use of various personnel monitoring devices to determine exposures. Thermoluminescent dosimeters (TLDs), which are used to measure external radiation, are normally read on a monthly basis; however, they can be read more frequently when warranted.

Until January 1989, the DOE mobile in vivo monitor was used to measure the amount of uranium in employees' lungs. Workers are required to have lung counts every 1-4 years, depending on their job descriptions. Results of whole body monitoring for 1981-86 are given in Table 3.9-2. These whole body exposures were measured by the DOE mobile in vivo monitor. As noted in Sect. 3.9.3, the National Institute for Occupational Safety and Health (NIOSH) questioned the accuracy of this monitor at low exposure levels.

Urine analyses for uranium are performed annually for all FMPC workers and additionally when there is some reason to suspect an unusual exposure to uranium. Prior to August 1986, a uranium concentration of 40 g/L in the urine was the action level. At this point workers were required to have daily urine samples taken until the uranium concentration dropped below 40 μg/L for three consecutive days. Since August 1986 the action level for uranium in the urine has been 15 μg/L. At this level workers are required to give daily urine samples until the concentration falls below 15 μg/L. At 25-μg/L uranium concentrations, workers are restricted to certain jobs until the uranium concentration falls below 15 μg/L. At uranium concentrations above 35 μg/L, workers are removed from the production area until the concentration falls below 15 μg/L. Table 3.9-3 gives 1985 and 1986 urinalysis data for workers in Plants 5 and 9.

In addition to personnel monitoring, FMPC has initiated air sampling in every plant. The air sample data are accumulated and averaged over a 1-month period, and the results are posted on the bulletin board to inform the workers of the air quality.

Radiological controls are necessary at FMPC in areas where radioactive materials are handled and where personnel or potentially contaminated materials may be located. The major sources of radioactive contamination and radiation exposure are in the uranium processing and inspection areas of the facility. The most prevalent types of radiation at FMPC are alpha and beta radiation from uranium and gamma radiation from thorium.

Since 1986, WMCO has implemented a Radiation Worker Training program. This 8-h course covers radioactivity, types of radiation, radiation

Table 3.9-2. Summary of Feed Materials Production Center employee whole-body radiation exposures measured by the U.S. Department of Energy mobile van system

Dose range (mrem)	Number of individuals					
	1981	1982	1983	1984	1985	1986
None	156	0	5	14	21	15
<100	329	37	54	69	135	100
100-249	83	54	91	122	142	168
250-499	86	97	131	150	200	204
500-749	27	40	26	50	39	87
750-999	13	19	2	14	2	9
1000-1999	7	15	1	0	0	0
Total	701	262	310	419	539	583

Source: Saylor 1989.

Table 3.9-3. Concentration of uranium for Feed Materials Production Center worker urine analysis in Plants 5 and 9, 1985 and 1986

	Total number of samples taken		
Year	Number of samples <15 μg/L	Number of samples between 15 and 25 μg/L	Number of samples >25 μg/L
1985	3595	80	70
1986	3084	33	7

Source: Saylor 1989.

protection, radiation effects, radiation protection equipment, contamination, dosimetry, and company and personnel responsibilities. All radiation workers must take this course and pass a written exam with a minimum score of 80%.

Radiological requirements implemented by WMCO to ensure adequate control include

- control of external radiation exposure to personnel by means of personnel monitoring, area monitoring, shielding, and planning and execution of radiological work;
- control of internal radiation exposure to personnel by containing contamination, using anti-contamination clothing (Anti-C Clothing) and respiratory protection, and establishing areas and levels for control of surface contamination;
- control of radioactive wastes;
- decontamination of radioactively contaminated material;
- implementation of procedures for receiving, transferring, storing, and shipping radioactive materials; and
- training of personnel in sound radiological work practices.

3.9.3 NIOSH Radiological and Chemical Evaluation and Findings

The NIOSH Hazard Evaluations and Technical Assistance Branch conducts field investigations of possible health hazards in the workplace. These investigations are conducted following a written request from any employee or an employee's authorized representative to determine whether any substance normally found in the place of employment has potentially toxic effects in the concentrations used or found. NIOSH has completed several studies at FMPC.

3.9.3.1 NIOSH survey results

The first of the NIOSH studies was requested by the Director of Health, state of Ohio, on behalf of the FMPC workers to assess the potential health effects of a 1984 uranium release at FMPC (NIOSH 1987a). Approximately 122.5-167.8 kg (270-370 lb) of uranium oxide was accidentally released from dust collectors in Plant 9 between November 16 and December 7, 1984. To assess the extent of uranium exposure and potential health effects of the accidental releases, all workers (approximately 100) from Plant 9 were monitored for whole-body uranium burden. The results of testing Plant 9 workers by the DOE mobile radiological monitoring van indicate that none of the workers had uranium content in the lungs greater than the DOE maximum permissible limit (NIOSH understood this limit to be 15 mrem/year to the lungs). Additional testing with permanent, more sensitive monitoring systems was recommended and carried out for a subset of workers in order to check the validity of the DOE mobile van results.

The results of both tests revealed that the uranium in the lungs of the workers was significantly less than the maximum permitted by DOE (combined amounts of U-235 and U-238 which would give a 15-mrem/year dose to the lungs).

Based on a review of all the monitoring results, NIOSH concluded that the releases of uranium at FMPC between November 16 and December 7, 1984, did not result in excessive uranium body contents for the workers. NIOSH also concluded that DOE's mobile monitoring van is not sensitive enough to be more than a screening system because its minimum detection limit is too high. However, NIOSH concluded that the mobile van is accurate enough to ensure that workers' maximum permissible lung burdens have not been exceeded.

A second NIOSH study (NIOSH 1987b) involved 146 of 208 (70%) of the eligible long-term FMPC employees. NIOSH collected medical and occupational history questionnaires, urine and blood tests for several indicators of renal function and damage, chest X-rays, pulmonary function tests, and determinations of uranium concentration in post-shift urine samples for each participating employee. Company personnel records and urine uranium monitoring data were used to construct work and exposure histories.

The study demonstrated some associations between respiratory effects (lung capacity) and the uranium exposure index, even after accounting for cigarette smoking. Shortness of breath was not associated with the uranium exposure but was significantly associated with self-reported uranium exposure incidents. Neither chronic cough nor chronic bronchitis was associated with any of the indicators of uranium exposure. None of the 130 X-rays showed increased interstitial markings suggestive of pneumoconiosis. Renal effects evaluation gives no indication of uranium exposure. This apparent lack of any exposure-related renal effects, however, may have been attributable to limitations of the study.

At the request of the International Association of Machinists and Aerospace Workers, NIOSH assessed chemical and radiological exposure at FMPC (NIOSH 1988). NIOSH initiated its investigation during the first week of December 1987. The plant site samples were chosen based on the union's concerns about chemical and radiological exposures in certain areas. NIOSH monitored the air at specific workstations in the Sampling Plant (Plant 1), the Refinery Plants (Plants 2 and 3), the Green Salt Plant (Plant 4), the Metals Productions Plant (Plant 9), and the Pilot Plant. NIOSH monitored the air for particulates and gaseous fluorides, nitric acid, nitrogen dioxide, hydrofluoric acid, ammonia, and oil mist. NIOSH also collected airborne radionuclide samples and surveyed for radiological surface contamination.

NIOSH air samples revealed that nitrogen dioxide (at Plant 6 chip pickling tank operators' station) was the only substance to exceed applicable occupational health criteria (1.9 mg/m^3 compared with the 1.8 mg/m^3 NIOSH-recommended exposure level as a 10-h time-weighted average). Concentrations of all other chemicals (except possibly total

fluorides, for which results were not available) were less than 25% of their respective most stringent occupational exposure criteria. NIOSH found ventilation systems to be operating satisfactorily. However, certain mechanical and work practice deficiencies were observed.

General area air samples did not show concentrations in excess of DOE-derived concentration guides for occupational exposure to airborne radioactive contaminants. However, many surfaces had high levels of radioactive contamination. Plants 2/3 and 4 had removable surface contamination levels five or more times the limits in the Feed Materials Production Center Radiation Control Manual (5000 disintegrations per minute per 100 cm^2 of surface area for production areas). Westinghouse Materials Company of Ohio Radiation Control Manual limits were exceeded many places within the plants (NIOSH 1988).

Future NIOSH activities will include (1) environmental evaluation of various exposures at FMPC and (2) epidemiological analysis of employee urine uranium monitoring data with the NIOSH renal test results to determine if there is an association between renal effects and past uranium exposure. These activities have not been scheduled.

3.9.3.2 NIOSH recommendations and FMPC responses

Based on its findings, NIOSH made several specific recommendations for reducing workers' radiological and chemical exposure at FMPC. The recommendations and DOE and WMCO actions related to the recommendations are summarized on Table 3.9-4. WMCO has been responsive to a number of the recommendations. One of the most notable FMPC actions is the construction of a new, state-of-the-art in vivo monitoring facility at FMPC, project 272 on the list in Appendix A. This facility uses liquid nitrogen-cooled germanium radiation detectors in a low-background-radiation chamber to detect low levels of radiation in workers' bodies. WMCO has also submitted a contamination control plan to DOE, instituted various training programs, and issued Radiological Control and Hazard Communications Standard Manuals. However, WMCO has not responded to January 1987 NIOSH recommendations 2, 4, and 7 or to the July 1987 NIOSH recommendations.

In response to the March 1987 NIOSH recommendations, DOE has assigned an independent environment and health person to FMPC for FY 1989. The WMCO contamination control plan is in the DOE approval process.

3.9.4 Additional Radiation and Chemical Exposure Reduction Activities

During the years 1985-88 WMCO has made many improvements in FMPC operations to reduce workers' exposure to radiation and chemicals. Many of these are physical improvements included in the projects list (Appendix A). A substantial number of the improvements are administrative, which can be as important as physical improvements. The major improvements made by WMCO

Table 3.9-4. National Institute for Occupational Safety and Health (NIOSH) recommendations and FMPC worker protection activities

NIOSH Recommendation	FMPC Actions
January 1987[a]	
1. FMPC should construct a permanent state-of-the-art in vivo facility at or near the plant.	FMPC has constructed and is now operating a permanent in vivo monitoring facility at FMPC.
2. The in vivo assay program should be revised	This is being conducted.
o Lung counting for uranium should be performed for all workers semiannually.	
o Routine urinalysis or fecal analysis should be performed as appropriate.	
o A formal in vivo monitoring protocol should be developed and implemented to determine whether an individual worker's exposure is below regulatory and administrative limits and whether the worker's exposure is kept as low as practicable.	
3. Better communication is needed between health physics and industrial hygiene personnel and workers. Health and safety personnel should hold informative presentations and discussions for workers at regular intervals.	WMCO has initiated various training programs.
4. WMCO should ensure employees' protection against discrimination for testimony or proceedings related to health and safety at FMPC.	Under consideration.

Table 3.9-4 (continued)

NIOSH Recommendation	FMPC Actions
5. WMCO should provide more radiation safety training courses for all workers, including supervisors.	WMCO has initiated various training programs.
6. All measurement and monitoring techniques used by the Health and Safety Division should have DOE- and WMCO-approved standard operating procedures.	WMCO issued the Feed Materials Production Center Hazard Communications Standard Manual in 1987 and the Feed Materials Production Center Radiation Control Manual in 1989.
7. Reevaluate the need for respiratory protection for machinists working with uranium ingots.	Under consideration.
July 1987[b]	
1. The medical monitoring program for workers exposed to uranium should include annual assessments of pulmonary and renal function.	Under consideration.
2. Pulmonary function tests should be performed using standardized procedures.	Under consideration.
3. Renal function tests should include a) glucose, pH, protein, occult blood, and microscopic urine analysis; b) serum creatine concentrations with creatine clearance; and c) some measure of renal tubular function.	Under consideration.
4. Anyone with an abnormal test result or a larger decrease in pulmonary or renal function than expected by age alone should have an appropriate medical examination.	Under consideration.

Table 3.9-4 (continued)

NIOSH Recommendation	FMPC Actions
5. A medical monitoring program should be available to anyone exposed to asbestos.	Under consideration
March 7, 1988[c]	April 7, 1988[d]
1. A major contamination cleanup effort is needed, with attention and enforcement from DOE.	WMCO has o submitted a contamination control plan to DOE. o established a contamination control plan implementation task force. The task force was to identify all areas where controls and anticontamination clothing were required and to have barriers installed for all these areas. The areas were identified in March and April 1988, and the barriers were installed from May through November 1988[e]. o initiated development of job classification, High Level Cleaner, to provide decontamination and cleaning of elevated building structures.
	July 14, 1988[e]
2. An experienced on-site DOE health physicist/industrial hygienist should be assigned to FMPC and given appropriate administrative authority to complete this task.	o DOE assigned an independent environmental and health person to FMPC in FY 1989.
	April 7, 1988[d]
3. Smoking, eating, and drinking in the counting room should be terminated, as required by the WMCO Radiation Control Manual.	The counting room has been properly posted as a "Radioactive Materials Area. Eating, Smoking, Drinking are not permitted."

Table 3.9-4 (continued)

NIOSH Recommendation	FMPC Actions
4. Workers should store their respirators in a clean location when not in use.	Increased audits of respirator use and storage in the production area have been initiated. A new respirator audit form was introduced, to provide supervisors with immediate feedback. Respirator storage and use guidelines were sent to all supervisors participating in the Respirator Protection Program. Employees are given training in proper respirator practices during periodic training classes. WMCO plans to begin a special training course on proper respirator practices for FMPC supervisors.
5. Additional air monitoring should be conducted by WMCO because the chip pickling tank operator was exposed to NO_2 concentrations. near the NIOSH-recommended exposure limit.	WMCO conducted additional air sampling March 15-25, 1988. Samples were submitted for analysis to determine worker exposure and general area contaminant concentrations.
6. Airborne dust from the drum lidding operation should be controlled by using the existing local exhaust ventilation (LEV) system.	Design of modifications to the existing LEV systems were undergoing plant review prior to final design on April 17, 1988.
7. Correct ventilation problems of #1 green salt drums station in Plant 4.	WMCO investigated the problem and committed to correct it. WMCO also committed to evaluate the efficacy of the repair.
8. Workers should close the access doors when capping pots to ensure maximum removal of airborne particles.	WMCO instructed workers to comply with "Keep Closed" signs posted on the pot access doors to the capping stations in Plant 5. WMCO plans to emphasize compliance by Plant 5 supervision. Operational Safety and Health Department personnel are to check this practice during periodic walk-through sessions.

Table 3.9-4 (continued)

NIOSH Recommendation	FMPC Actions
9. Air velocity in the exhaust ducts in the graphite machining department (Plant 5) needs to be increased to prevent graphite chips from settling in the hood, reducing air flows.	WMCO reviewed these operations and committed to increasing air velocity in the exhaust ducts by installing dampers to allow the closing of ducts that service machines that are not in use.

[a]*Source:* NIOSH 1987a.

[b]*Source:* NIOSH 1987b.

[c]*Source:* NIOSH 1988.

[d]*Source:* Christiansen 1988.

[e]*Source:* Cooley 1990.

[f]*Source:* Reafsnyder 1988.

to reduce worker exposure to radiation and chemicals are listed here:

1985

- Modified dust collector systems to improve ventilation for operators' work areas.
- Installed alpha counters to provide additional monitoring for worker safety and to prevent contamination.
- Installed a dust suppressant system to reduce operator exposure to contaminated dust.
- Upgraded fire protection equipment and systems plantwide.

1986

- Significantly increased professional staff and enhanced health and safety programs to better comply with DOE requirements.
- Installed an evacuation alarm system in the laboratory for personnel safety.
- Initiated a major effort to prepare and rewrite Standard Operating Procedures and manuals.
- Set up an environmental safety and health (ES&H) document review program to ensure that all standard operating procedures and facilities designs met ES&H rules and regulations as well as accepted good nuclear industry practices.

1987

- Initiated various programs to reduce worker radiation exposure including training programs and improved handling procedures. Radiation exposure was reduced from 10% to 46% in areas of some production plants.
- Established on-site Emergency Operations Center. Restructured the Emergency Preparedness Section and added personnel; completed a full-scale emergency drill to improve the site's ability to respond to emergencies.
- Installed an outdoor warning system consisting of one siren on-site and seven at various locations within a 2-mile radius of the plant.
- Initiated the Five-Alive program to improve production while enhancing the health and safety of personnel.

- Issued the Feed Materials Production Center Radiation Control Manual, updated in 1989.
- Issued the Feed Materials Production Center Hazard Communications Standard written program manual.
- Completed an upgrade of the Radiation Detection Alarm system.
- Upgraded and added nuclear accident dosimeters in all production facilities.
- Installed an automatic shutoff valve to prevent facility damage and/or personnel injury in the event of a propane pipeline rupture.
- Completed railroad track repairs to avoid potential injury or chemical release as a result of a derailment.

1988

- Began construction of an addition to the Environment, Safety, and Health Building to provide additional laboratory facilities.
- Installed an in vivo monitoring chamber in the Environment, Safety, and Health Building addition to provide improved capability for monitoring employee exposure.
- Initiated three-zone concept of contamination control.
- Began construction of three warehouses for finished products and materials in process to further reduce employee exposure.
- Installed additional shielding and implemented materials handling procedural changes to reduce employee exposure.
- Added three sirens to the outdoor warning system to address coverage problems identified in regular testing program.
- Began construction of a new Receiving and Incoming Materials Inspection Area to reduce vehicular traffic within the process area and prevent the possible contamination of delivery vehicles moving through the process area.

3.10 REFERENCES

ACCR (Aquifer Contamination Control Reports) 1965-85. Prepared by R. H. Starkey, 1965-69; M. W. Boback, 1970-81; R. B. Weidner, 1982-84; and C. F. Facemire, 1985.

Algermissen, S. T. 1969. "Seismic Risk Studies in the United States," pp. 1-10 in Proceedings of the Fourth World Conference on Earthquake Engineering, Chilean Assn. for Seismology and Earthquake Engineering, Santiago, Chile.

Battelle 1981. Environmental Report of the FMPC to NLO, Inc., Battelle Columbus Laboratories, Columbus, Ohio, January 31, 1981.

Bauer, B. H., B. A. Branson, and S. T. Colwell 1978. "Fishes of Paddy's Run Creek and the Dry Fork of the Whitewater River, Southwestern Ohio." Ohio J. Sci. 78(3): 144-48.

BCDSA (Butler County Civil Defense Disaster Services Agency) November 1985. "Ross and Morgan Townships Evacuation Plan--Feed Materials Production Plant, Fernald Ohio."

BCDSA (Butler County Civil Defense Disaster Services Agency) August 1986. "Hazardous Materials Emergency Response Plan--FMPC."

Beavers, J. E., W. E. Manrod, and W. C. Stoddart 1982. Recommended Seismic Hazard Levels for the Oak Ridge, Tennessee; Paducah, Kentucky; Fernald, Ohio; and Portsmouth, Ohio, Department of Energy Reservations, K/BD-1025/R1, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Boback, M. W., D. A. Fleming, T. A. Dugan, R. W. Keys, and R. B. Grant 1986. History of FMPC Radionuclide Discharges, FMPC-2058, November 1986.

Bogar, L. C. June 21, 1988. Westinghouse Materials Company of Ohio, Cincinnati, letter report WMCO:SR:88-0048 to J. A. Reafsnyder, U.S. Department of Energy, Fernald, Ohio.

Bowen, H. J. M. 1979. Environmental Chemistry of the Elements, Academic Press, New York.

Brataas, A. Oct. 19, 1986. "Pit Liner Failed Twice, Tears Let Waste into Underground Water," The Cincinnati Enquirer, pp. A-1 and A-20.

Braun, E. L. 1950. Deciduous Forests of Eastern North America, The Free Press, New York.

Brettschneider, D. J. Oct. 14, 1988. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):88-422(EISTF-43)] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Brettschneider, D. J. Jan 11, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):89-011] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Brettschneider, D. J. May 12, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:LWE:89-027(EISTF-98)] to E. J. Powell, U.S. Department of Energy.

Brockman, C. S. 1986. "Glacial Geologic Mapping in Hamilton County, Ohio," Ohio Department of Natural Resources, Division of Geological Survey, Columbus, Ohio.

Campbell, K. W. 1981. "A Ground Motion Model for the Central United States Based on Near-Source Acceleration Data," in Proceedings of Earthquakes and Earthquake Engineering: the Eastern United States, ed. J. Beavers, Ann Arbor Science Publishers, Inc., Ann Arbor, Mich.

Castrale, S. 1985. "Responses of wildlife to various tillage conditions," Trans. N. Amer. Wildl. and Natur. Resour. Conf. 50.

Christiansen, H. D. 1988. Westinghouse Materials Company of Ohio, letter [WMCO:OSH(IH):88:035] to J. A. Reafsnyder, U.S. Department of Energy, Cincinnati, April 7, 1988.

City of Cincinnati 1959. "Metropolitan Topographic Sheet No. 132," Cincinnati Division of Engineering, Cincinnati, Ohio.

Clement, S. 1987. Westinghouse Materials Company of Ohio Open File Data, 3 pp. of tabulated information. This data set of water table elevations measured between March 29 and April 11, 1986, includes the results of recently surveyed well reference elevations.

Coats, D. W., and R. C. Murray 1984. Natural Phenomena Hazards Modeling Project: Seismic Hazard Models for Department of Energy Sites. UCRL-53582, Rev. 1, Lawrence Livermore National Laboratory, Livermore, Calif., p. 10.

COE (U.S. Army Corps of Engineers) 1967. Flood Control in the Ohio River Basin Appendix M Ohio River Basin Comprehensive Survey Volume XIV, U.S. Army Engineer Division, Ohio River Corps of Engineers, Cincinnati, Ohio.

Conant, R. 1975. A Field Guide to Reptiles and Amphibians of Eastern and Central North America, Houghton Mifflin Co., Boston.

Cooley, G. M. 1990. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO: IRS&T(RE):90-061] to D. J. Brettschneider, Westinghouse Materials Company of Ohio, Cincinnati, April 10, 1990.

Cristy, M., Leggett, R. W., Dunning, D. E., Jr., and Eckerman, K. F. 1986. Relative Age-Specific Radiation Dose Commitment Factors for Major Radionuclides Released from Nuclear Fuel Facilities, NUREG/CR-4628 (ORNL/TM-9890), Oak Ridge National Laboratory, Oak Ridge, Tenn.

Cook, R. E. 1969. "Variation in Species Density of North American Birds", Systematic Zoology 18:63-84.

Dames and Moore, Inc. 1985. Department of Energy Feed Materials Production Center, Ground Water Task C Report, prepared for National Lead of Ohio, Inc., Cincinnati, Ohio.

DOE (U.S. Department of Energy) 1977. Environmental Impact Assessment: Feed Materials Production Center, Fernald, Ohio.

DOE (U.S. Department of Energy) 1985. Environmental Assessment of the Proposed Low-Level Waste Processing and Shipment System, Feed Materials Production Center, Fernald, Ohio, DOE/EA-0260.

DOE (U.S. Department of Energy) 1987. DOE Draft Order 5400.xx: Radiation Protection of the Public and the Environment.

DOE (U.S. Department of Energy) 1988. General Design Criteria, DOE 6430.1A, U.S. Department of Energy, Washington, D.C.

Dove, G. D. 1961. A Hydrologic Study of the Valley-Fill Deposits in the Venice Area, Ohio, Technical Report Number 4, State of Ohio Department of Natural Resources, Division of Water, Columbus, Ohio.

Dunning. D. E., Jr., S. R. Bernard, P. J. Walsh, T. G. Killough, and J. C. Pleasant, 1981. Estimates of Internal Dose Equivalent to 22 Target Organs for Radionuclides Occurring in Routine Releases from Nuclear Fuel-Cycle Facilities, Vol. 3, ORNL/NUREG/TM-190-V3, Oak Ridge National Laboratory, Oak Ridge, Tenn.

EPA (U.S. Environmental Protection Agency) 1985. Compilation of Air Pollution Emission Factors, Volume I: Stationary, Point, and Area Sources (Fourth Edition), USEPA Publication No. AP-42, U.S. Environmental Protection Agency, Research Triangle Park, N.C.

EPA (U.S.Environmental Protection Agency) 1986. Water Pollution Control; National Primary Drinking Water Regulations; Radionuclides, 51 FR 34836-34862.

EPA (U.S. Environmental Protection Agency) 1987a. Industrial Source Complex (ISC) Dispersion Model User's Guide, Second Edition (Revised), Volumes 1 and 2, EPA Publication No. EPA-450/4-88-002a and 002b, U.S. Environmental Protection Agency, Research Triangle Park, N.C.

EPA (U.S. Environmental Protection Agency) 1987b. "Revisions to the National Ambient Air Quality Standards for Particulate Matter, "Fed. Regist. 52 (1261), 24634, 24684-85 (July 1, 1987).

ERDA (U.S. Energy Research and Development Administration) 1977. Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada, ERDA 1551, U.S. Energy Research and Development Administration (now U.S. Department of Energy), September 1977.

FWS (U.S. Fish and Wildlife Service) 1986. Endangered and threatened wildlife and plants. 50 CFR Pts. 17.11 and 17.12.

GeoTrans, Inc. September 30, 1985. Preliminary Characterization of the Groundwater Flow System Near the Feed Materials Production Center, Great Miami River Valley-Fill Aquifer, Fernald, Ohio, Columbus, Ohio.

Hamilton County Extension Agent 1986. Telephone communication from George Cummings, Hamilton County Extension Agent, to G. K. Eddlemon, Oak Ridge National Laboratory, Oak Ridge, Tenn., Dec. 16, 1986.

Harvey, M. J. 1975. "Endangered Chiroptera of the southeastern United States," Proc. Ann. Conf. Southeastern Association of Game and Fish Commissioners 29:429-33.

HCSDA (Hamilton County Civil Defense Disaster Services Agency) 1986. "Interim Response Plan for a Hazardous Materials Emergency at the Feed Materials Production Center."

Humphrey, S. R., A. R. Richter, and J. B. Cope 1977. "Summer Habitat and Ecology of the Endangered Indiana Bat, Myotis sodalis," J. Mammalogy 58:334-46.

IAEA (International Atomic Energy Agency) 1976. Effects of Ionizing Radiation on Aquatic Organisms and Ecosystems, Tech. Reports Series 172, International Atomic Energy Agency, Vienna, Va.

ICRP (International Commission on Radiological Protection) 1977. Recommendations of the International Commission on Radiological Protection, ICRP Publication 26, Pergamon Press, Oxford. Reprinted (with additions) 1987.

IT (International Technology Corporation) 1986. Final Interim Report, Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC, Fernald, Ohio. Report and Data Package prepared by IT Corporation for the U.S. Department of Energy, Oak Ridge Operations, in support of the Fernald litigation.

IT (International Technology Corporation) 1989. Draft Assessment of Radiation Dose and Cancer Risk for Emissions from 1951 through 1984, Project No. 303063, IT Corporation, Knoxville, Tenn.

Killough, G. G., and L. R. McKay 1976. A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment, ORNL-4992, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Knollman, B. 1987, Fernald, Ohio, resident and land owner, personal communication with W. P. Staub, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Kroonemeyer, K. E. (U.S. Fish and Wildlife Service) 1987. U.S. Fish and Wildlife Service, Columbus office, letter to J. A. Reafsnyder (U.S. Department of Energy), April 23, 1987.

Lerch, N. K., W. F. Hale, and D. D. Lemaster 1980. "Soil Survey of Butler County, Ohio." U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Ohio Department of Natural Resources, Division of Lands and Soil; and Ohio Agricultural Research and Development Center, Columbus, Ohio.

Lerch, N. K., W. F. Hale, and D. D. Lemaster 1982. "Soil Survey of Hamilton County, Ohio," U.S. Department of Agriculture, Soil Conservation Service, in cooperation with Ohio Department of Natural Resources, Division of Lands and Soil; and Ohio Agricultural Research and Development Center, Columbus, Ohio.

Luce, W. R. 1987. Ohio State Historic Preservation Officer, letter to J. W. Van Dyke, Oak Ridge National Laboratory, Oak Ridge, Tenn. February 18, 1984.

Lynch, J. F., and D. F. Whigham 1984. "Effects of Forest Fragmentation on Breeding Bird communities in Maryland, USA," Biological Conservation 28:287-324.

MCD (Miami Conservancy District) 1985. Hydrologic Data for the Hamilton-New Baltimore area 1984. The Water Conservation Subdistrict of the Miami Conservancy District.

McCance, R. M., Jr., and J. F. Burns (eds.) 1984. Ohio Endangered and Threatened Vascular Plants. Department of Natural Resources, Columbus, Ohio.

McKeown, F. A., D. P. Russ, and P. C. Thenhaus 1983. "Central Interior Seismic Source Zones--Summary of Workshop Convened June 10-11, 1980," pp. 19-24 in Summary of Workshops Concerning Regional Seismic Source Zones of Parts of the Conterminous United States Convened by the U.S. Geological Survey 1979-80, Golden, Colorado, U.S.Geological Survey Circular 898, Denver, Colo.

Moore, R. E., C. F. Baes, L. M. McDowell-Boyer, A. P. Watson, F. O. Hoffman, J. C. Pleasant and C. W. Miller, 1979. AIRDOS-EPA: A Computerized Methodology for Estimating Environmental Concentrations and Dose to Man from Airborne Releases of Radionuclides, ORNL-5532, Oak Ridge National Laboratory, Oak Ridge, Tenn.

National Research Council of Canada 1983. Radioactivity in the Canadian Aquatic Environment, NRCC 19250, Ottawa, Canada.

NCRP (National Council on Radiation Protection and Measurements) 1984. Radiological Assessment: Predicting the Transport, Bioaccumulation, and Uptake by Man of Radionuclides Released to the Environment, NCRP Report 76, Washington, D.C.

NCRP (National Council on Radiation Protection and Measurements) 1987. Ionizing radiation exposure of the population of the United States, NRCP Report 93, Bethesda, Md.

NIOSH (National Institute for Occupational Safety and Health) 1987a. Health Hazard Evaluation Report, HETA 85-111-1770.

NIOSH (National Institute for Occupational Safety and Health) 1987b. Report of Medical Study, HETA 83-144.

NIOSH (National Institute for Occupational Safety and Health) 1988. Letter from J. M. Biano and C. E. Mass, NIOSH, to Bruce Boswell, Westinghouse Materials Company of Ohio, HETA 83-144, March 7, 1988.

NLO 1985. Feed Materials Production Center Environmental Monitoring Annual Report for 1984, NLO, Inc., Cincinnati.

NOAA (National Oceanographic and Atmospheric Administration) 1987. Earthquake computerized data file, National Oceanographic and Atmospheric Administration, National Geophysical Data Center, Boulder, Colo.

National Research Council 1971. Fluorides, National Academy of Sciences, Washington, D.C.

NRC (U.S. Nuclear Regulatory Commission) 1977. Calculation of Annual Dose to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluation Compliance with 10 CFR Part 50, Appendix I, Revision 1, Regulatory Guide 1.109, Office of Standards Development.

Nuttli, O. C. 1981. "Similarities and Differences between Western and Eastern United States Earthquakes, and their Consequences for Earthquake Engineering." pp. 25-51 in Preceedings of Earthquakes and Earthquake Engineering-Eastern United States, Vol. 1, ed. J. E. Beavers, Arbor Science Publishers, Ann Arbor, Mich.

OBES (Ohio Bureau of Employment Services) 1986. Ohio Labor Market Information, Labor Force Estimates July 1986, Ohio Bureau of Employment Services, Columbus, Ohio.

ODNR (Ohio Department of National Resources) May 1987. Ohio's Endangered Wild Animals, Publication 361(R487), Columbus, Ohio.

ODNR (Ohio Department of Natural Resources) Mar. 23, 1987. Letter from P. D. Jones, Ohio Department of Natural Resources, Division of Natural Areas and Preserves, to G. K. Eddlemon, Oak Ridge National Laboratory, Oak Ridge, Tenn.

OEPA (Ohio Environmental Protection Agency) 1982. Comprehensive Water Quality Report for the Lower Mainstem of the Great Miami River (River Mile 92.5-0.9) Montgomery, Warren, Butler, and Hamilton Counties, Ohio: Final Draft. Div. Wastewater Poll. Control, Columbus, Ohio.

OEPA (Ohio Environmental Protection Agency) 1988. Printout of 1985 major sources of air pollution in Hamilton and Butler Counties, Ohio, Ohio Environmental Protection Agency, Columbus, Ohio.

Ohio-Kentucky-Indiana Regional Council of Governments 1987. Data on population and household projections for transportation zones, 1980-2000. Generated Feb. 4, 1987, Cincinnati.

ORAU (Oak Ridge Associated University) 1985. Environmental Program Review of the Feed Materials Production Center, Fernald, Ohio, Oak Ridge, Tenn.

Osborne, D. R., S. I. Guttman, C. F. Facemire, and R. H. Sperger 1987. Biological and Ecological Site Characterization of the Feed Materials Production Center: Summer 1986 through Winter 1987. Draft Final Report and Addenda to Westinghouse Materials Company of Ohio. Department of Zoology, Miami University, Oxford, Ohio, Jan. 31-Aug. 14, 1987.

Osborne, D. R., S. I. Guttman, C. F. Facemire, and R. H. Sperger 1988. Biological and Ecological Site Characterization of the Feed Materials Production Center: June 1986 through June 1987. Draft Executive Summary to Westinghouse Materials Company of Ohio. Department of Zoology, Miami University, Oxford, Ohio, May 31, 1988.

Pomeroy, S. E., T. L. Anderson, J. M. Stilwell, and D. A. Tolle 1977. Final Report on Ecological Assessment at the Feed Materials Production Center, Cincinnati, Ohio, Battelle Columbus Laboratories, Columbus, Ohio.

Rand McNally 1984. 1984 Road Atlas, Rand McNally and Co., Chicago, Ill.

Reafsnyder, J. A. 1988. Department of Energy, Oak Ridge, Tenn., letter (DOE-1157-88) to J. M. Boiano, Department of Health and Human Services, National Institute for Occupational Safety and Health, July 14, 1988.

Reynolds, A. C. 1987. Westinghouse Materials Company of Ohio, letter to J. A. Reafsnyder, Site Manager, U.S. Department of Energy, Aug. 20, 1987.

Richardson, P. 1987. "FMPC Is Ready for an Emergency," Journal-News, Hamilton and Fairfield, Ohio, August 30, 1987,

Saylor, R. E. 1989. Oak Ridge National Laboratory, Oak Ridge, Tenn., letter to Andrew C. Bassett, U.S. Department of Energy, Oak Ridge Operations, Oak Ridge, Tenn., Feb. 10, 1989.

Sedam, Alan C. 1984. Occurrence of Uranium in Ground Water in the Vicinity of the U.S. Department of Energy Feed Materials Production Center, Fernald, Ohio, U.S. Geological Survey Administrative Report DOE/OR/20998-T1, Columbus, Ohio.

Simpson, G. G. 1964. "Species Density of North American Recent Mammals," Systematic Zoology 12:57-73.

Spieker, Andrew M. 1968. Ground-Water Hydrology and Geology of the Lower Great Miami River Valley Ohio, U.S. Geological Survey Professional Paper 605-A, U.S. Government Printing Office.

Spieker, Andrew M. 1968a. Effect of Increased Pumping of Ground Water in the Fairfield-New Baltimore Area, Ohio--A Prediction by Analog-Model Study, U.S. Geological Survey Professional Paper 605-C. U.S. Government Printing Office.

Spieker, Andrew M. 1968b. Future Development of the Ground Water Resource in the Lower Great Miami River Valley, Ohio--Problems and Alternative Solutions. U.S. Geological Survey Professional Paper 605-D. U.S. Government Printing Office.

Starkey, R. H., C. Watson, R. C. Coates, E. B. Riestenberg, and J. W. Robinson 1962. Report of FMPC Ground Contamination Study Committee, National Lead Company of Ohio, Cincinnati.

SWOAPCA (Southwest Ohio Air Pollution Control Agency) 1985. 1985 Air Quality Data, Southwest Ohio Air Pollution Control Agency, Technical Services Section, Cincinnati, Ohio.

Swinford, M. and C. S. Brockman, February 1989. Ohio Department of Natural Resource, Division of Geological Survey, Columbus, Ohio, letter to W. P. Staub, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Thom, H. C. S. 1963. "Tornado Probabilities", Monthly Weather Review, October-December, 730-36

USBC (U.S. Bureau of the Census) 1986. State and Metropolitan Area Data Book, 1986, U.S. Government Printing Office.

USGS (U.S. Department of the Interior, Geological Survey) 1973. Map of Flood-Prone Areas, Shandon Quadrangle, Ohio. Prepared in Cooperation with the U.S. Department of Housing and Urban Development, Federal Insurance Administration.

USGS (U.S. Geological Survey) 1987. Water Resources Data for Ohio: Volume 1, USGS Water-Data Report OH-86-1. USGS Water Resources Division, Columbus, Ohio.

Walker, A. C. 1986. Ground-Water Resources of Hamilton County. Map available from the Ohio Department of Natural Resources, Division of Water.

Wilcove, D. S. 1985. "Nest Predation in Forest Tracts and the Decline of Migratory Songbirds," Ecology 66:1211-14.

WMCO (Westinghouse Materials Company of Ohio) 1986. Feed Materials Production Center Environmental Monitoring Annual Report for 1985, FMPC-2047, Westinghouse Materials Co. of Ohio, Cincinnati, May 30, 1986

WMCO (Westinghouse Materials Company of Ohio) April 30, 1987a. Feed Materials Production Center Environmental Monitoring Annual Report for 1986. FMPC-2076, Special, UC-41, Westinghouse Materials Company of Ohio, Cincinnati, Ohio.

WMCO (Westinghouse Materials Company of Ohio) January 27, 1987b. Letter (WMCO:WM:87-036) from R. E. Watts to L. C. Bogar, containing Report on History of Paddy's Run and Surrounding Area.

WMCO (Westinghouse Materials Company of Ohio) March 9, 1987c. Letter (WMCO:TD:87-111) from W. A. Weinreich to J. A. Reafsnyder, U.S. Department of Energy, Cincinnati, Report on Stormwater Runoff Sampling in the Waste Pit Area.

WMCO (Westinghouse Materials Company of Ohio) March 11, 1987d. 1987 FMPC Development and Facilities Utilization Plan, prepared by Strategic Planning and Reporting, C.L. Oldenettel, Cincinnati, Ohio.

WMCO (Westinghouse Materials Company of Ohio) 1988a. Environment, Safety, Health and Waste Management Plan, Westinghouse Materials Company of Ohio, Cincinnati, April 15, 1988.

WMCO (Westinghouse Materials Company of Ohio) April 30, 1988b. Feed Materials Production Center Environmental Monitoring Annual Report for 1987. FMPC-2135, Special, UC-41, Westinghouse Materials Company of Ohio, Cincinnati.

WMCO (Westinghouse Materials Company of Ohio) Oct. 19, 1988c. Letter WMCO:SR(WR):88-451 EIS TF-47, from D. J. Brettschneider, Westinghouse Materials Company of Ohio, to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn., containing August 1988 NPDES sampling results.

WMCO (Westinghouse Materials Company of Ohio) September 1989. Feed Materials Production Center Radiation Control Manual, FMPC-2084, Rev. 1, Feed Materials Production Center, Fernald, Ohio.

Wooley, J. B., Jr., L. B. Best, and W. R. Clark 1985. "Impacts of No-till Cropping on Upland Wildlife," Trans. N. Amer. Wildl. and Natur. Resour. Conf. 50:157-68.

CHAPTER 4
ENVIRONMENTAL IMPACTS

The environmental impacts of renovation and operation of FMPC are described in this chapter. In addition, environmental impacts of directed actions that have taken place to reduce impacts of prior operation are provided. Descriptions of renovation projects for the present situation, proposed action, cessation of metal production alternatives, and potential future remedial action (which would apply to each alternative) are presented in this chapter. Impacts associated with air quality, water resources, ecology, public exposure to radiation, worker health and safety, waste management, and socioeconomics will be discussed. Projects that comprise the present situation and proposed action are referred to by their project number and are described in Appendix A.

4.1 PRESENT SITUATION

Impacts of construction and operation related to 161 renovation projects, which includes 9 directed actions initiated before September 30, 1989, will be discussed and analyzed. It is assumed for this alternative that the plant will operate at maximum production capability.

4.1.1 Impacts on Air Quality

4.1.1.1 Construction

Construction activity generates dust (particulate matter). PM-10 (particulate matter less than 10 μm in diameter) is the only National Ambient Air Quality Standards (NAAQS) criteria pollutant of special concern because of the construction activities. The U.S. Environmental Protection Agency (EPA) has estimated an average total suspended particulate matter (TSP), which includes PM-10, emission factor of 1.2 tons/acre-month of land disturbed by heavy construction activities (EPA 1985). A recent EPA report (EPA 1988) provides estimates of PM-10:TSP ratios for construction activities, based on measurements 50 m downwind of construction areas. The average PM-10:TSP ratios for various earthmoving operations ranged from 0.22 to 0.27. To be conservative, an average PM-10:TSP ratio of 0.3 was assumed for FMPC construction activities associated with ongoing renovations. This results in estimated emissions of 1.8 tons/month of PM-10 for the 20,230 m^2 (5 acres) to be disturbed by all renovation activities.

The EPA Industrial Source Complex, Short-Term (ISCST) dispersion model (EPA 1987) was used to estimate the increased atmospheric PM-10 loading using the above emission rate and making the conservative assumption that the source of emissions was 1000 m^2 (10,760 ft^2) of total area located at the center of the FMPC production area. Meteorological data, receptor data, and model technical options for this model run were

consistent with those used to evaluate operational emissions (see Appendix G).

The maximum predicted increase in 24-h PM-10 levels from all FMPC renovation activities is 38 $\mu g/m^3$. When added to the maximum background 24-h PM-10 concentration (82 $\mu g/m^3$), the total PM-10 level is 120 $\mu g/m^3$ compared with 24-h PM-10 NAAQS of 150 $\mu g/m^3$. Besides being temporary, the predicted 24-h PM-10 values are quite conservative for the following reasons: (1) all construction areas were assumed to be active at the same time, (2) many sources were combined into a single area source, (3) the maximum background concentration was assumed to coincide in time with the maximum modeled concentration, and (4) removal of plume PM-10 by gravitational settling and deposition was not taken into account.

The maximum predicted increase in annual PM-10 concentration from construction activities was 3 $\mu g/m^3$. When added to the maximum annual background PM-10 concentration of 40 $\mu g/m^3$, this yields a total annual PM-10 concentration of 43 $\mu g/m^3$. This is below the annual PM-10 NAAQS of 50 $\mu g/m^3$. As with the predicted 24-h PM-10 concentrations, the predicted annual PM-10 concentrations are expected to be quite conservative.

Other emissions associated with construction would emanate from various earthmoving and other equipment engines. The pollutants emitted would be NO_x, SO_2, hydrocarbons (which are precursors in the formation of ozone), CO and PM-10. The amounts of these emissions would be very small compared with the amounts of construction-related dust emissions. The off-site impacts of these emissions would be insignificant.

4.1.1.2 Operation

The installation of NO_x scrubbers (Project 59) and the newly built tank farm acid supply systems (Project 38) resulted in reduced nonradiological operational air emissions of NO_x, HNO_3, and HF. The predicted impacts of present situation alternative emissions (Table 4.1-1) were modeled using the ISCST model (Appendix G). The maximum predicted concentrations at or beyond the FMPC boundary are generally well below NAAQS (Table 4.1-2). Ohio has no HF standard. However, the maximum predicted 24-h HF concentration is slightly above the most stringent standard established by any other state. The emissions of SO_2, CO, and PM-10 from the boiler plant would not be directly affected by the renovation projects. Increased production, however, would result in increased use of coal in the steam plant. This increase is reflected in increased emissions of pollutants (Table 4.1-1). Because the boiler size and fuel sulfur content would not increase, the facility would not be subject to New Source Review under Prevention of Significant Deterioration Regulations (40 CFR Pt. 52.21).

Table 4.1-1. Nonradiological operational air emissions for 1985 and for the present situation alternative[a]

Pollutant	Source	1985 kg	1985 (lb)	Present Situation kg	Present Situation (lb)
NO_x	Plant 2/3	2,146	(4,731)	42	(93)
	Plant 6	54,430	(119,997)	1,621	(3,573)
	Plant 9	4,389	(9,675)	83	(183)
	Boiler Plant	163,501	(360,458)	268,142	(591,151)
	Total	224,465	(494,861)	269,887	(595,000)
SO_2	Boiler Plant	318,827	(702,893)	522,876	(1,152,745)
PM	Boiler Plant	12,526	(27,615)	20,543	(45,289)
CO	Plant 8	340	(750)	19	(41)
	Boiler Plant	58,393	(128,735)	95,765	(211,125)
	Total	58,733	(129,485)	95,783	(211,166)
HF	Plant 4	0.5	(1.2)	1.4	(3)
	Plant 8	227	(500)	3.2	(7)
	Pilot Plant	235	(517)	1,417	(3,125)
	Tank Farm	998	(2,200)	210	(464)
	Total	1,460	(3,218)	1,614	(3,559)
HNO_3	Tank Farm	3,792	(8,360)	139	(306)

[a]Emissions will be the same for the present situation and the proposed action alternatives. Assumes the facility is operating at maximum production capacity.

Source: Brettschneider, Oct. 14, 1988.

Table 4.1-2. Predicted ambient air quality impacts from FMPC operations for 1985 and maximum achievable production levels for renovation alternatives

Pollutant	NAAQS[a] minus background[b] ($\mu g/m^3$)	1985 ($\mu g/m^3$)	Present situation/ proposed action[c,d] ($\mu g/m^3$)
NO_2			
Annual	45	5	3
PM-10			
Annual	10	0.1	0.2
24 h	68	1.1	1.8
CO			
8 h	6,200	8	14
1 h	36,200	16	27
SO_2			
Annual	46	3	5
24 h	113	29	47
3 h	619	53	87
HF			
Annual	e	0.28	0.12
24 h	f	5	1.2

[a]The more stringent of either the primary or secondary NAAQS was used. Refer to 40 CFR Pt. 50 for more details on the NAAQS. This column provides a conservative indicator of the available air quality resource.

[b]Background levels for pollutants other than HF and PM-10 were obtained from SWOAPCA (1985) using data from air monitoring stations located closest to the FMPC. Since no ambient air HF data are available for the FMPC and vicinity, a value of 0 $\mu g/m^3$ was used for background. TSP data from the FMPC vicinity were used as a conservative measure of PM-10 background.

[c]Renovation impacts are the same for each present situation and proposed action alternative.

[d]Predicted pollutant concentrations assume that the facility operates at maximum production capacity rather than the lower 1985 rate. This results in higher predicted concentrations for some pollutants.

[e]No applicable standard.

[f]Although Ohio does not have an ambient air quality standard for HF, a number of other states have established 24-h HF standards ranging from approximately 1-3 $\mu g/m^3$.

4.1.2 Impacts on Water Resources

4.1.2.1 Surface water quality

Construction

Before renovation began, normal stormwater runoff from the plant production area (the area associated with the majority of renovation projects) was collected in the Storm Sewer System. Generally the runoff was monitored for suspended solids and oil and grease at the Storm Sewer Lift Station, then pumped to Manhole 175 and discharged to the Great Miami River. During heavy rains, the runoff greater than the Storm Sewer Lift Station pump capacity flowed into the Storm Sewer Outfall Ditch (SSOD) and subsequently into Paddy's Run. An early renovation project was the construction of one Storm Water Retention Basin (SWRB) in October 1986. A second basin was completed in December 1988. Water collected in these SWRBs is settled, and the decant is sent to the effluent discharge pipeline to the Great Miami River except after spills, in which case contaminated water is sent to the General Sump for treatment. Consequently, the small spills which occur during construction in the Production Area are contained and treated within the facility's boundaries as long as runoff does not exceed the capacity of the SWRBs.

Operation

Renovation projects affecting surface water quality involve enhancement of wastewater and stormwater monitoring, collection, and treatment facilities that should allow for more efficient removal of contaminants currently discharged to the Great Miami River and Paddy's Run. The most important water quality projects are the Biodenitrification Facility (BDN) and the SWRBs. Under the present situation alternative, release rates of most contaminants to the Great Miami River are greater than those reported for 1985 because the plant is assumed to be operating at maximum production capacity (Table 4.1-3). Due largely to the installation of the BDN, which was built to reduce nitrate concentrations in the effluents to levels that would meet NPDES permit requirements, suspended solids, biochemical oxygen demand (BOD), and ammonia, in particular, show increases by factors of nearly eleven, eight, and seven over baseline, respectively, while nitrate releases decrease by a factor of almost three. Other radioactive and nonradioactive contaminants show increases by a factor of about 2.5 or less. Discharges to Paddy's Run via the SWRB overflow, on the other hand, show substantial decreases in releases of contaminants for which source terms are available. However, runoff entering Paddy's Run from uncontrolled areas may contain about 180 kg (~400 lb) of uranium per year (Brettschneider February 1989).

The estimated annual volumetric discharge to the Great Miami River at maximum production (Table 4.1-3) is about twice the estimated flow in 1985. Much of the increase in annual flow results from processing runoff from the production area, which previously was discharged to Paddy's Run during heavy rains.

Table 4.1-3. Comparison of annual Feed Materials Production Center wastewater flow and pollutants discharged to the Great Miami River (Station 001) and to Paddy's Run (Station 002) for the present situation alternative and 1985

Discharge Point	Pollutant[a]	1985 discharges	Present situation[b]
Manhole 175 (001)	Flow, MG	164.4	327.5
	pH	7.4-9.1	7.2-9
	TSS, kg	3,119	33,017
	BOD, kg	1,606	12,288
	NO_3 as N, kg	135,050	41,925
	NH_3 as N, kg	183	1,270
	O&G, kg	624	1,815
	Res. chlorine, kg	18.7	19
	F. coliform, mpn/100 mL	2,500	2,500
	Cr+6, kg	2.2	4
	Cr, total kg	5.1	9.1
	Fe, kg	95	114
	Ni, kg	12	18.1
	Cu, kg	6.2	9.1
	Uranium, kg	606	1,260
	U, total Ci	0.41	0.85
	U-234, Ci	0.15	0.39
	U-235, Ci	0.0074	0.0164
	U-236, Ci	0.0049	0.016
	U-238, Ci	0.2	0.43
	Cs-137, Ci	0.0097	0.015
	Np-237, Ci	<0.00017	0.00031
	Pu-238, Ci	0.000005	0.000008
	Pu-239/240, Ci	0.000015	0.000024
	Ra-226, Ci	<0.0051	0.0066
	Ra-228, Ci	<0.008	0.0098
	Ru-106, Ci	<0.0010	0.0016
	Sr-90, Ci	0.0052	0.0082
	Tc-99, Ci	8.3	13.3
	Th-232, Ci	<0.011	0.0005
Stormwater Retention Basin overflow (002)	Flow, MG	35.8	0.3
	TSS, kg	2,035	57
	O&G, kg	136	1
	Uranium, kg	81.4	0.9
	U, total Ci	0.055	0.00043

Table 4.1-3 (continued)

Source: Brettschneider Oct. 14, 1988.

[a]MG = millions of gallons,
TSS = total suspended solids,
BOD = 5-day biochemical oxygen demand,
O&G = oil and grease, and
mpn = most probable number.

[b]Based on the estimated maximum production level.
[c]In 1985, the Stormwater Retention Basin did not exist, and the Storm Sewer Outfall Ditch was used.

ASSUMPTIONS:

1. Only external discharge points are considered as source terms. Internal points such as 001B/C are factored for total contribution to MH-175.
   Discharges 001 and 002 are the only point sources for water emissions.
2. Averages for 1985 were used as more representative of true conditions than individual months.
3. Present situation assumptions: four-tower biodenitrification facility (BDN) with effluent treatment, two-chambered stormwater retention basin (SWRB). 1987 numbers were used as basis, since one SWRB and a two-tower BDN were on line. 1987 flow was adjusted upward to account for low rainfall that year. 1987/88 overflow flows were adjusted for operation of a second SWRB (ten-year rainfall event capacity rather than two-year). Assumed Sanitary Treatment Plant will produce 7.5 kg/d biochemical oxygen demand (BOD) (1750 people) and BDN effluent treatment will produce 17 kg/d (30 mg/L); stormwater will add 5 kg/d (1.19 mg/L). The NO_3 concentration at MH-175 will be 20 mg/L (70 kg/d). Stormwater collected in the Clear Well (CW) will be processed at the BDN. The average 1987 NO_3 at MH-175 was 90 kg/d; 22 kg/d was contributed by the CW. When these nitrates are treated at the BDN, the total nitrates at MH-175 will be 70 kg/d.
   In 1990 the total of 81 kg/d of TSS at MH-175 will be supplied as follows: 3 kg/d, General Sump/Clear Well; 17 kg/d, BDN; 54 kg/d, stormwater; 7 kg/d, sanitary wastewater.
4. Sump renovation projects will not increase treatment efficiencies for metals removal, because current equipment will be replaced and not substantially changed. Metals contributions from the GS/CW in 1987 were slightly more than doubled for 1990 estimate. (1987 metals numbers were lower than 1985 numbers.)
5. Remedial activities were not considered in these calculations because they are not yet well enough defined.
6. Process wastewater contributed 40% of the total flow at MH-175 in 1985 and will contribute 19% of the total in 1990 and 17% in 1992+, as additional stormwater is collected.

Table 4.1-4 compares expected annual average release rates of nonradioactive contaminants to area surface waters with National Pollutant Discharge Elimination System (NPDES) permit limits and state water quality standards for warmwater streams where applicable. Note that several of the NPDES limits are for internal plant discharges (e.g., the sanitary treatment plant discharge) upstream of Manhole 175, which discharges to the Great Miami River. For this analysis, it was assumed that these permit limits could be applied to the final discharge to the river, even though contributions are made from other internal discharges. From this table it is evident that the discharge to the Great Miami River could exceed existing NPDES permit limits for suspended solids, BOD, nitrate, hexavalent chromium, fecal coliform bacteria, and possibly copper (at their respective permitted discharge points; see notes to Table 4.1-4). Since the current NPDES permit has expired, a new permit is being negotiated. DOE is committed to compliance with the new permit limits. All other listed contaminants are below existing NPDES limits. After mixing in the Great Miami River, all listed contaminants attributable to FMPC appear in concentrations that are well below the state's water quality standards for this river, even at the record low flow of only 4,430 L/s. Under average flow conditions (93,600 L/s), contaminant concentrations attributed to FMPC would be further reduced by a factor of 21.

In May 1988 FMPC effluents were sampled for nearly 150 other contaminants, including trace elements and organic compounds (WMCO 1988c). In most cases only three samples were collected. Concentrations of most substances were below limits of detection, but maximum reported daily levels of iron and nickel exceeded NPDES permit limits. Concentrations of neither metal approach the state water quality standards after dilution in the river. These data are not comparable to the concentrations in Table 4.1-4 because the table presents predictions for maximum production and FMPC was operating below maximum production during July 1987.

No individual radionuclide for which release rates and concentration source terms are available is released to the Great Miami River at concentrations in excess of release limits, set forth in DOE Draft Order 5400.xx (Table 4.1-5). However, taken together, the radionuclides exceed DOE release limits. Under the proposed limits, U-232, U-233, U-234, and U-238 are most important. Furthermore, it should be noted that on a given day, concentrations of one or more individual uranium isotopes may exceed DOE limits, as has already occurred on several occasions since 1985 (WMCO 1988b). DOE Draft Order 5400.xx will require use of the best technology economically achievable to reduce effluent concentrations to acceptable levels. Finally, although the listed radionuclides probably contribute most of the radioactivity released to surface waters, other unmonitored radionuclides may also be present in the discharge.

The completion of two SWRBs (in October 1986 and December 1988) significantly reduced surface runoff from the plant area to Paddy's Run and the Great Miami Aquifer (GMA). The two SWRBs are designed to contain runoff from a 24-h storm of magnitude expected to occur no more than once in 10 years. Larger and sequential precipitation events cause the SWRBs to overflow into the storm sewer outfall ditch. As described in Sect. 3.6.4,

Table 4.1-4. Comparison of average annual nonradioactive releases anticipated under the present situation with National Pollutant Discharge Elimination System permit limits and state standards

	Estimated average releases (kg/d)	Estimated average releases (mg/L)	NPDES limit[a]	River concentration after mixing[b] (mg/L)	Ohio standard[c] (mg/L)
To Great Miami River					
Water	3.4×10^6 L/d				
pH	7.2 - 9.0		6.5-9.0		6.5-9.0
TSS[d]	90.4	26.6	20 mg/L	0.24	
BOD[e]	33.7	9.9	5[f] kg/d	0.088	
$N\text{-}NO_3$ as N	115	33.8	62[g] kg/d	0.30	10
$N\text{-}NH_3$ as N	3.48	1.0	12[g] kg/d	0.0089	≥0.10
O&G[h]	4.97	1.5	15 mg/L[n]	0.013	No sheen
Res. Cl	0.052	0.015	0.10 mg/L[n]	0.00013	0.002
F. Coliform	2500[m]		1000[f,m]	2.21[m]	1000[m]
Cr^{+6}	0.011	0.0032	0.004[i] kg/d	0.000029	0.010
Cr total	0.025	0.0073	0.050[i] kg/d	0.000065	
Fe	0.312	0.092	0.41[i] kg/d	0.00082	1.0
Ni	0.050	0.015	0.124[i] kg/d	0.00013	≥0.167
Cu	0.025	0.0073	0.025[i] kg/d	0.000065	0.017
To Paddy's Run[j]					
Water	1.4×10^6 L/year				
TSS	k	50[n]	100 mg/L[n]	k	
O&G	k	0.88[n]	15 mg/L[n]	k	No sheen

Source: Brettschneider Oct. 14, 1988.

[a]Permit No. OH 009580, 30-d average unless otherwise noted.

[b]Attributable to FMPC releases; assumes the record minimum river flow of 4430 L/s through mixing.

[c]*Source:* OEPA 1986.

[d]Total suspended solids.

[e]5-day Biochemical oxygen demand.

Table 4.1-4 (continued)

---

[f]Effluent from sanitary treatment plant (001A).

[g]Effluent from bioreactor (001E).

[h]Oil and grease.

[i]Combined loading of general sump (001B) and Clear Well (001C).

[j]Via Storm Sewer Outfall Ditch.

[k]Intermittent discharge (only when Stormwater Retention Basins overflow).

[m]Most probable number of Colonies/100 mL.

[n]Daily maximum.

Table 4.1-5. Present situation alternative: comparison of radionuclide releases to the Great Miami River with DOE liquid release limits

Isotope	Average annual effluent concentration[a] (pCi/L)	Release limit (5400.xx)[b] (pCi/L)	Ratio[c]
Sr-90	8	1,000	0.00800
Tc-99	13,000	100,000	0.130
Ru-106	1.6	6,000	0.00027
Cs-137	15	3,000	0.00500
Ra-226	6	100	0.0600
Ra-228	9	100	0.0900
Th-228	<0.5	400	<0.00125
Th-232	2	50	0.0400
Th-230	<0.6	300	<0.00200
U-232	<60[d]	100	<0.600
U-233	130	500	0.260
U-234	320	500	0.640
U-235	14	600	0.0233
U-236	13	500	0.0260
U-238	320	600	0.533
Np-237	<0.3	30	<0.0100
Pu-238	0.0082	40	0.000210
Pu-239/240	0.023	30	0.000767
SUM OF RATIOS			1.82-2.43[e]

[a]*Source:* Brettschneider Oct. 14, 1988.

[b]*Source:* DOE Draft Order 5400.xx. Radiation Protection of the Public and the Environment, March 18, 1988. FMPC is working toward complying with these limits.

[c]Effluent concentration/release limit.

[d]Past value reported by WMCO; present concentration is unknown, but probably less than past values (Eddlemon 1989).

[e]Lower value calculated on the basis that radionuclides not detected are not present; higher value calculated on the basis that radionuclides not detected are present at the detection limit.

an overflow of the single basin SWRB in December 1986 resulted in the discharge of uranium concentrations as high as 1.1 mg/L (~760 pCi/L) and averaging 0.73 mg/L (~490 pCi/L), which exceeds DOE Draft Order 5400.xx Derived Concentration Guides of 500-600 pCi/L for uranium isotopes. Maximum TSS in the storm water runoff overflow was about 50% of the daily maximum limit specified in the NPDES limit. The second SWRB reduces the probability of an overflow of production area runoff to Paddy's Run. The water collected in the SWRBs is normally discharged to the Great Miami River along with the process water.

Monitoring data for 1987 for surface water quality in Paddy's Run (WMCO 1988b) show a substantial drop in uranium contamination at the sampling stations registering the highest concentrations during the 1985 baseline year (WMCO 1986a). Uranium concentrations at stations W7, W9, and W10, for example, averaged 43, 23, and 236 pCi/L, respectively, during 1985, but only 5.8, 1.7, and 6.8 pCi/L, respectively, during 1987. Even these much-reduced concentrations, however, are still higher than the 1.0-pCi/L average measured for station W5 upstream of the FMPC. Gross alpha and beta concentrations at the contaminated stations also decreased from 1985 to 1987, but the decrease was not as marked as the decrease in uranium concentrations. None of the four nonradiological parameters for which data are available (fluoride, nitrate, chloride, and pH) show significant changes between 1985 and 1987; neither are their levels cause for concern.

The FMPC process wastewater and the runoff from the waste pit area and controlled runoff areas of the production area contain uranium that passes through the Biodenitrification Facility. This uranium may be partially removed in the sewage treatment plant (ending up in the sludge), with the remainder showing up in the wastewater discharge to Manhole 175. This uranium, along with uranium not settled out in the SWRB, is subsequently discharged to the Great Miami River.

In conclusion, under the present situation alternative, the FMPC would exceed NPDES permit limits on discharges to the Great Miami River at maximum production, especially for suspended solids, BOD, nitrate, fecal coliforms, hexavalent chromium, and possibly copper. However, DOE is renegotiating the NPDES permit with EPA and is committed to operating FMPC in such a manner as to meet all permit requirements regardless of which alternative is selected. Dilution by the river will reduce concentrations of the contaminants from FMPC to well below state water quality standards (OEPA 1986). On average, individual radionuclides will not exceed DOE limits, but total radioactivity from all radionuclides together could exceed limits (i.e., the cumulative concentrations of radionuclides in the effluent could exceed DOE limits). Monitoring will be designed to ensure that discharge limits are not exceeded (Sect. 4.6). Discharges to Paddy's Run via the Storm Sewer Outfall Ditch will be considerably reduced by the SWRBs, but concentrations of suspended solids will temporarily exceed the current NPDES permit limit if the SWRBs overflow.

4.1.2.2 Groundwater quality

Groundwater quality has been most affected by three sources of contaminants. These are surface runoff to the Storm Sewer Outfall Ditch and Paddy's Run, overflow from SWRBs to the Storm Sewer Outfall Ditch and the water leaking out of the waste pits. In all cases, contaminated water reached the aquifer through breaches in the glacial till (Sect. 3.6.4).

Southern Groundwater Plume

The SWRBs completed in 1988 will reduce future contamination of the Great Miami Aquifer (Fig. 4.1-1) by intercepting the contaminated water that would have entered the Storm Sewer Outfall Ditch. The two SWRBs are double-lined, seepage recovery-type ponds. It is normal for liners to leak slightly, and the SWRB liners are estimated to introduce about 1.4 kg/year (3.1 lb/year) of uranium into the Great Miami Aquifer. Annual uranium discharges to the Storm Sewer Outfall Ditch during previous years could have been several hundred times greater than current uranium leakage to the Great Miami Aquifer from the SWRB (Fig. 3.6-10). These releases have contributed to the southern plume, which is a remedial action site and is described in Sect. 4.4.2.3.

While the SWRBs will reduce stormwater discharges to the Storm Sewer Outfall Ditch, they will not eliminate them. The SWRBs are large enough to contain the production area stormwater runoff of ~24-h rains, which have recurrence intervals of 10 years [about 10.4 cm (4.1 in.)]. However, two or more smaller storms occurring within a few days during which more than 10.4 cm (4.1 in.) of rainfall will also cause the SWRBs to overflow. Sequential storms that cause the SWRBs to overflow are expected to occur every 2 or 3 years. When the single SWRB overflowed in October 1986, about 5.5 kg (12 lb) of uranium was discharged to the Storm Sewer Outfall Ditch. These discharges are believed to contribute to the south plume. A monitoring well immediately south of the SWRBs will be installed to determine the need for mitigative action following any inadvertent overflows.

Eastern Groundwater Plume

The contaminated waste pit area (Fig. 4.1-1) appears to be the source for an eastward-moving plume. All of the pits have been removed from service since 1986. Status of the eastern plume and remediation of the waste pit area are discussed in Sect. 4.4.2.2.

The Biodenitrification Surge Lagoon (BSL), a renovation project that is part of the new wastewater treatment systems, was installed to replace Pit 5 as a liquid effluent settling basin. The lagoon is a settling pond with a triple liner (two flexible membrane liners and a bentonite layer). Seepage through the primary membrane accumulates above the secondary bentonite layer, from which it is discharged by gravity to a sump and pumped back into the Biodenitrification Surge Lagoon. These liners plus the underdrain system, as well as the impermeable layer of till that the

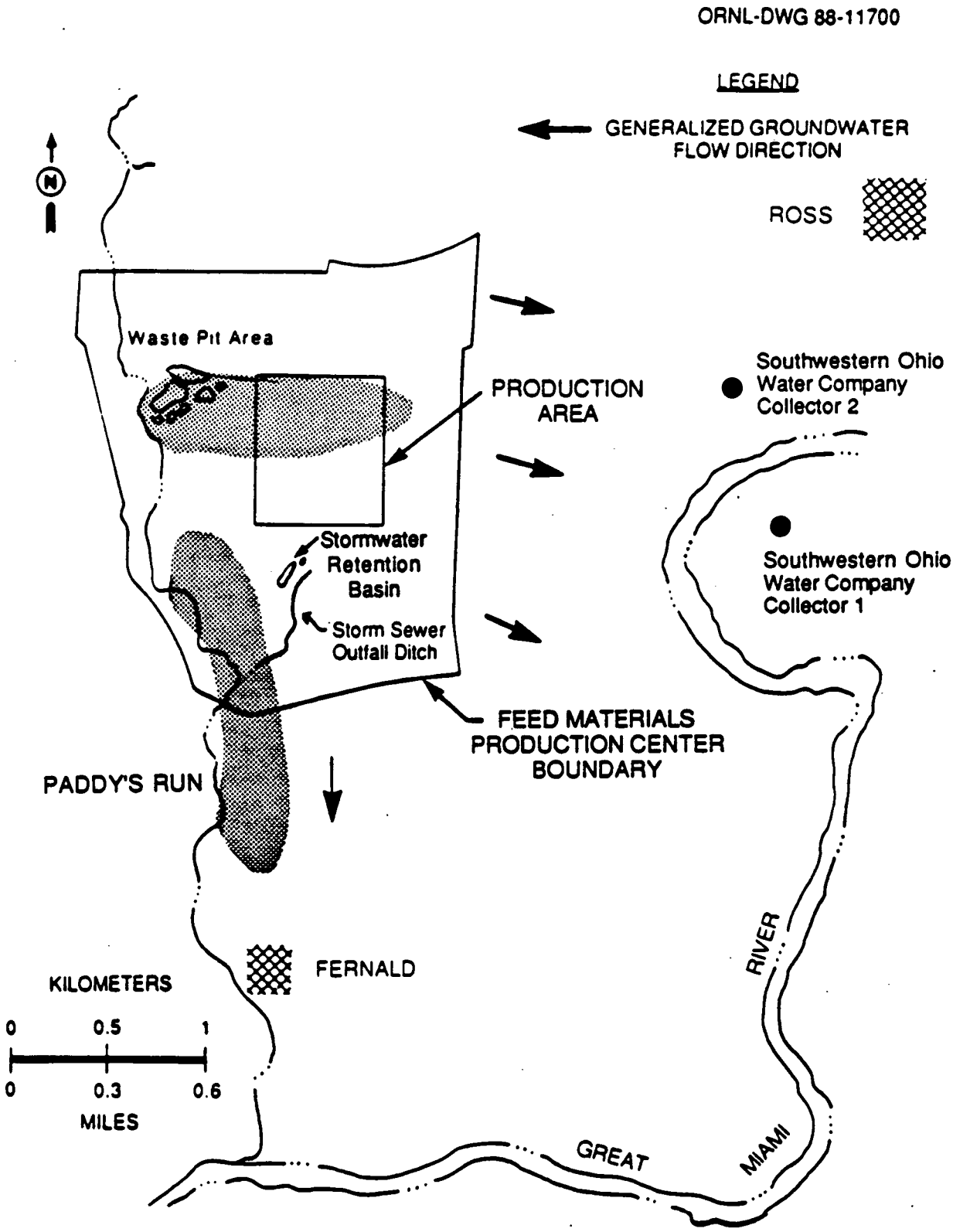


Fig. 4.1-1. Approximate extent of the Great Miami Aquifer contamination in the vicinity of the Feed Materials Production Center. *Source:* WMCO 1987.

lagoon is built on, probably eliminate the Biodenitrification Surge Lagoon as a source of contamination for the groundwater.

Stormwater Runoff

The present situation does not include total control of runoff from the site including the waste pit area. This runoff may contain 180 kg (400 lb) of uranium/year (Brettschneider Feb. 3, 1989.) Thus, Paddy's Run would continue to be subject to contamination from runoff, resulting in continued contamination of the southern groundwater plume zone due to seepage from Paddy's Run. In 1987, the uranium concentration in Paddy's Run was an average concentration of 6.8 pCi/L compared with background concentrations of 1 pCi/L.

4.1.3 Ecology

4.1.3.1 Terrestrial

Construction

The present situation alternative has had no significant construction impacts on terrestrial biota and will not cause any such impacts in the future. This alternative involves construction activities located primarily within or adjacent to the production area, where ecological resources are limited. Therefore, no significant clearing of plant communities or loss of wildlife habitat is associated with the construction activities for this alternative. Also, no significant impacts on terrestrial biota due to fugitive dust or emissions from construction vehicles are a consequence of this alternative.

Operation

With regard to terrestrial biota, the only significant issue involved in normal operation under the present situation alternative is the possible effect of uranium and fluoride emissions to the atmosphere. Historical emissions from FMPC are not known to have had adverse effects on vegetation, wildlife, or livestock. Other emissions, which are subject to NAAQS, include nitrogen oxides, sulfur dioxide, particulates, carbon monoxide, and photochemical oxidants. Future emissions of these substances would not be great enough to significantly affect air quality (Sect. 4.1.1.2) and would thus not be expected to adversely affect terrestrial biota.

Particulates containing uranium are emitted from the FMPC facilities and dispersed by winds, but they eventually settle to earth. Very high concentrations of uranium in vegetation and soils can have toxic effects on animals that ingest it. However, uranium concentrations observed in vegetation at the FMPC site (e.g., 7 ppm average on the site in 1984; see Sect. 3.7.1.1) are far below levels that have been shown to be harmful (NRC 1980). Concentrations of uranium up to a few hundred parts per million in the diet appear to be safe for mammalian wildlife and domestic animals. According to the National Research Council (NRC 1980), "except

for an inadvertent direct contamination of livestock diets or feed ingredients with a uranium compound, uranium toxicosis does not appear to be a practical problem."

The present situation renovation projects, in combination with changes in stack filter operation and maintenance in 1985 through 1989 (Sect. 3.8), will culminate in a reduction of atmospheric uranium emissions to about 21% of the 1985 emissions (Sect. 4.1.4). The decreased emissions are expected to result in decreased concentrations of uranium in soils and vegetation surrounding the FMPC site. Considering that uranium concentrations in vegetation prior to renovation were already below harmful levels, uranium emissions after renovation should have no adverse effects on wildlife or livestock.

Emissions of hydrogen fluoride at industrial installations can result in high accumulations of fluorides in vegetation, death or reduced productivity of plants, and fluorosis in grazing animals (NRC 1971; Shupe et al. 1984; Gilbert 1985). With the present situation alternative, it is estimated that the atmospheric concentrations of fluoride at the site boundary would be no higher than an annual average of 0.12 $\mu g/m^3$ or a 24-h average of 1.2 $\mu g/m^3$ (Table 4.1-2). Such concentrations would be unlikely to cause visible damage to plant leaves or reduced productivity of relatively sensitive plants such as conifers, sorghum, gladiolus, corn, and tomato. Lichens, however, are extremely sensitive and could possibly be affected (NRC 1971; Shupe et al. 1984; Perkins and Millar 1987).

Adverse effects on plant productivity usually require slightly higher fluoride concentrations than those causing visible leaf damage. Thus, the absence of leaf damage usually indicates no effect on productivity. No surveys for visible damage to sensitive species have been done at FMPC. To identify the need for corrective action at the FMPC facilities if vegetation is adversely affected by fluorides, surveys for visible damage to leaves of conifers, corn, and lichens would be conducted monthly during the growing season (March-September). These surveys would use recognized methods (MacLean 1982; Shupe et al. 1984) and would be conducted for at least two growing seasons.

Fluoride concentrations in herbage for grazing animals are not expected to increase in the future, because HF emissions from FMPC will not increase. Concentrations of fluorides in herbage within 2 km (1.2 miles) east of the site center in the direction of the prevailing winds averaged 10.2 ppm in 1984, 6.5 ppm in 1985, and 5.6 ppm in 1986, and 4.1 in 1987 (Table 3.7-1, Sect. 3.7.1.1). Concentrations 2-10 km (1.2-6.2 miles) northeast of the site, also in the direction of the prevailing wind, were 8.7 ppm in 1984, 5.2 ppm in 1985, 5.2 ppm in 1986, and 6.1 in 1987. These concentrations are within the range of fluoride concentrations reported in plants growing in areas remote from industrial facilities; most such plants have fluoride levels between 0.1 and 20 ppm dry weight, which would not affect grazing animals (Shupe et al. 1984; NRC 1971). If fluoride concentrations in vegetation at the site reached 30-50 ppm, adverse effects could occur on dairy cattle, which are among the livestock most sensitive to fluoride. Such effects could include discoloration of teeth and, in

severe cases, lameness due to skeletal weakness induced by excess fluoride in bones. To ensure that cattle and other grazing animals would not be affected, fluoride concentrations in herbage would continue to be monitored at appropriate locations around FMPC, and action would be taken to reduce emissions in the unlikely event that fluoride concentrations in vegetation reached 15 ppm.

No threatened or endangered plants or animals are known to occur on or near the FMPC (Sect. 3.7.1.3). Therefore, no effects on threatened or endangered species are expected.

4.1.3.2 Aquatic

Construction

Small spills and suspended solids in runoff would be contained and treated within the facility's boundaries as long as runoff does not exceed the capacity of the SWRBs. Therefore, adverse effects of construction on aquatic ecosystems are expected to be slight to non-existent. If stormwater overflows the SWRBs during renovation, adverse but short-term effects of increased contaminant and TSS levels on the aquatic communities in the lower reach of Paddy's Run are possible, but fairly rapid recovery would be expected.

Operation

Beyond a reasonable mixing zone, as described in the Ohio Water Quality Standard (OEPA 1986), contaminant concentrations from FMPC discharges would not exceed state water quality standards nor would they be likely to adversely affect aquatic life, even under record low river flow conditions (Table 4.1-3). The estimated total internal radiation doses absorbed by fish (0.11 rads/year) and invertebrates (1.0 rads/year) attributable to FMPC releases to the Great Miami River under the present situation alternative are shown in Table 4.1-6. These doses are only small fractions of the proposed DOE Draft Order 5400.xx limit of 365 rad/year (1 rad/d) for the protection of aquatic populations. DOE's proposed limit is consistent with the level of radiation exposure below which many researchers in biological effects of radiation believe aquatic populations will not be significantly affected (Blaylock 1989; Trabalka 1988; National Research Council of Canada 1983). Even immersion of aquatic organisms in undiluted effluent would result in absorbed doses (130 rads/year for invertebrates and 13 rads/year for fish) below the proposed DOE limit.

This analysis indicates that contaminants examined here will not substantially affect resident aquatic communities of the Great Miami River. Decreased pollutant loading of Paddy's Run (from the baseline level) will benefit its aquatic communities. Other potentially hazardous contaminants, however, possibly occur in FMPC effluents (e.g., U-232, Pb-210, Ac-227, hexavalent chromium, asbestos, and other contaminants that received only limited monitoring during July 1988). While such contaminants are unlikely to discharge to surface waters in quantities hazardous to aquatic life or to man, a measure of uncertainty necessarily qualifies this assessment

Table 4.1-6. Present situation alternative: predicted annual releases of radionuclides and resulting dose rates to aquatic organisms in the Great Miami River

	Release rate (Ci/yr)	Effluent concentration[a] (pCi/L)	River concentration[b] (pCi/L)	Internal dose[c] at point of discharge		Internal dose[c] after complete mixing	
				Inverts. (rads/yr)	Fish (rads/yr)	Inverts. (rads/yr)	Fish (rads/yr)
Ra-226	0.0066	6.0	0.047	3.1	0.60	0.024	0.0047
Ra-228	0.0098	8.9	0.07	3.2	0.62	0.025	0.0049
Th-228[d]	0.00051	0.46	0.0036	1.0	0.060	0.0080	0.00047
Th-230[d]	0.00062	0.56	0.0044	0.25	0.015	0.0020	0.00012
Th-232[e]	0.00051	0.46	0.0036	1.0	0.06	0.0080	0.00047
U-232[f]	0.067	61	0.48	31	3.1	0.25	0.025
U-233[f]	0.23	210	1.6	20	1.9	0.15	0.015
U-234	0.39	350	2.8	32	3.2	0.26	0.026
U-235	0.016	14	0.11	1.2	0.12	0.0098	0.00098
U-236	0.016	14	0.11	1.3	0.13	0.010	0.0010
U-238	0.43	390	3.1	31	3.1	0.25	0.025
Sr-90	0.0082	7.4	0.059	0.016	0.00074	0.00012	0.0000059
Tc-99	13	12,000	95	0.11	0.31	0.00084	0.0025
Ru-106	0.0016	1.4	0.011	0.011	0.00038	0.000090	0.0000030

Table 4.1-6 (continued)

	Release rate (Ci/yr)	Effluent concentration[a] (pCi/L)	River concentration[b] (pCi/L)	Internal dose[c] at point of discharge Inverts. (rads/yr)	Internal dose[c] at point of discharge Fish (rads/yr)	Internal dose[c] after complete mixing Inverts. (rads/yr)	Internal dose[c] after complete mixing Fish (rads/yr)
Cs-137	0.015	14	0.11	0.015	0.060	0.00012	0.00047
Np-237	0.00031	0.28	0.0022	0.10	0.0026	0.00082	0.000020
Pu-238	0.0000080	0.0072	0.000057	0.00080	0.0027	0.0000063	0.000021
Pu 239/240	0.000024	0.022	0.00017	0.0021	0.0076	0.000017	0.000060
Total	14	13,000	100	130	13	1.0	0.11
		Proposed limit[g]		365	365	365	365

[a]Source terms for theoretical maximum annual average concentrations in discharge to Great Miami River in 1990 as provided by D. J. Brettschneider (Oct. 14, 1988).

[b]Assumes an effluent discharge of 35.1 L/s and a record minimum river flow of 4400 L/s.

[c]Based on application of dose factors compiled by Killough and McKay (1976) to predicted concentrations in water.

[d]Source terms for Th-228 and -230 were not provided. Effluent concentration estimates used here are based on the assumption that relative concentrations of the three thorium isotopes in the effluent reflect concentrations measured in 1987 samples of river sediments.

[e]Internal dose factors for Th-232 were assumed to be equivalent to highest estimates available for a thorium isotope (Th-228).

[f]U-232 may no longer be present in plant discharges. U-232 and -233 source terms are based on engineering estimates (Eddlemon March 15, 1989).

[g]Expressed in proposed DOE Draft Order 5400.xx as 1 rad/d.

until existing and future effluents and the streams receiving them are more thoroughly characterized.

No federally designated threatened or endangered species are known to reside in either Paddy's Run or the Great Miami River. Two state-listed endangered minnows have been collected from the Great Miami River in the vicinity of the FMPC (see Sect. 3.7.2). Both species (the tonguetied minnow and the bigeye shiner) occur in other river systems. The known range of the tonguetied minnow in the Great Miami River does not extend closer than about 12 km (~7 miles) upstream of the FMPC outfall and is therefore unaffected by FMPC. The bigeye shiner has been collected from the confluence of the river and Paddy's Run. No adverse effects on any populations that may still exist are expected if turbidity and siltation from FMPC-related activities are adequately controlled.

In conclusion, the present situation alternative is unlikely to result in substantial adverse effects on aquatic communities of the Great Miami River and probably benefits aquatic communities of Paddy's Run relative to baseline conditions. A measure of uncertainty remains concerning the presence and importance of other pollutants that may occur in the effluents but for which data are either lacking or are very limited. These pollutants will be the subject of analysis under the proposed action.

4.1.4 Radiological Impacts to the Public

The present situation alternative results in annual atmospheric emissions of uranium at maximum production capability that are approximately 21% of the 1985 pre-renovation emission levels (Table 4.1-7). This reduction is due to the improved air filtering and scrubbing systems. Due to an absence of more recent data, thorium and other radionuclides are assumed to be emitted in the same proportion to uranium as in 1985 (Boback et al. 1986). Therefore, thorium accounts for 18 and 13% of the effective total-body and lung doses respectively. This assumption may not be valid, however, since thorium has not been processed at FMPC since about 1980. Further sampling of the stacks is needed to establish a more accurate composition of effluent gases and particulates (see Sect. 4.6). The methodology for assessing radiological doses is described in Sect. 3.8.

4.1.4.1 General public and maximally exposed individual

Table 4.1-8 presents estimates of the annual radiation dose from FMPC uranium air emissions to the 2.6 million people within 80 km (50 miles) of FMPC. The present situation alternative emissions result in a population dose ~70% smaller than the 1985 uranium emissions. In either case, the population dose is a small fraction of the background dose.

Table 4.1-8 presents maximally exposed individual dose estimates for the east and west sides of the site. A person at the east perimeter of the site would receive the maximum radiation exposure contributed by atmospheric uranium emissions generated by operation. A person on the west site perimeter would receive the maximum dose contributed by radon and

Table 4.1-7. Estimates of uranium air emissions[a] for the present situation and 1985

Emission point (plant)	1985 kg	1985 lb	Present situation[b] kg	Present situation[b] lb
	Monitored operational emissions			
1	2.1	4.6	0.2	0.4
2/3	7.5	16.5	6.6	14.6
4	19.6	43.2	11.9	26.2
5	23.9	52.7	3.3	7.3
6	0.0	0.0	3.0	6.6
8	32.8	72.3	1.4	3.1
9	4.2	9.3	0.9	2.0
Pilot Plant	12.5	27.6	1.5	3.3
Incinerator	19.2	42.3	0.0	0.0
Subtotal	121	267	29	64
	Unmonitored operational emissions[c]			
UO_3 gulping	130	286.6	0.7	1.5
Laboratory hoods	2	4.4	3.1	6.8
Building exhausts	4	8.8	9.3	20.5
Other unmonitored processes	6	13.2	9.5	20.9
Non-routine events	12	26.5	[d]	[d]
Subtotal	154	340	23	51
	Remedial action site emissions[c]			
Waste pit fugitives[e]	40	88	13	29
Total	315	694	65	143

[a]It is assumed that the ratio of uranium released from stack emissions to other radionuclides remains the same for all scenarios (Boback et al. 1986).

[b]Assumes maximum FMPC production capacity.

[c]Engineering estimates.

[d]Nonroutine events can not be projected for future operations.

[e]Remedial actions may reduce emissions (see Sect. 4.3).

Source: Brettschneider July 14, 1989.

Table 4.1-8. Annual radiation doses[a] to the general population and the maximally exposed individual resulting from FMPC operation in the present situation and 1985

	1985 (mrem/year)	Present situation[b] (mrem/year)
Population dose to individuals within 80 km of FMPC		
Total FMPC uranium emissions	250 person-rem	76 person-rem
Maximally exposed individual: East		
Operations		
Uranium air emissions	10.4	2.9
Remedial action sites		
Waste pit area uranium air emissions	1.5	0.7
K-65 Silos radon[c]	27.1	18.1
Total	39	22
Maximally exposed individual: West		
Operations		
Uranium air emissions	4.3	1.1
Remedial action sites		
Waste pit area uranium air emissions	0.6	0.3
K-65 Silos radon	70.5	47.2
K-65 Silos direct gamma	9.5	9.5
Total	85	58
Water Pathway		
Great Miami River	0.15	0.15[d]
Paddy's Run	1.3	1.3[d]
Off-site wells[e]	38	38[f]

[a]All doses are effective total-body doses in mrem/year except where noted. The ratio of uranium to other radionuclides is assumed to remain the same as that found in Boback 1986; therefore, thorium accounts for 18% and 13% of effective total-body and lung doses respectively.

Table 4.1-8 (continued)

---

[b]Remedial actions may further reduce dose, however, the size of the reduction cannot be estimated until specific remedial actions are identified (see Sect. 4.3).

[c]In 1988 emissions were reduced by 33% because of silo dome maintenance. For this analysis it is assumed that further remedial action of the silo has not been performed. Remedial action could reduce the dose from this source.

[d]Dose expected to remain near 1985 levels because of residual contamination.

[e]This dose resulted from the highest annual average concentration found in off-site wells (WMCO 1986a, Table 11); however, these contaminated wells are not used for drinking water.

[f]Doses are expected to remain near 1985 doses or decline as uranium contamination declines.

gamma radiation produced by the K-65 silos. Thus, 2.9 mrem/year for uranium air emissions at the eastern plant boundary is the maximum exposurecaused by FMPC operations. Adding radionuclide exposures from remedial action sites increases the dose to a person at the eastern boundary to 22 mrem/year for the present situation alternative. On the western FMPC boundary an individual's dose caused by FMPC operators is 1.1 mrem/year. Adding radiation exposure from remedial action sites increases the dose to a person at the western boundary to 58 mrem/year.

4.1.4.2 Off-site agricultural impact

Emissions of radioactivity to the atmosphere from routine operations pose no significant impact to off-site agricultural areas or to persons eating agricultural products. The dose received via the food chain is estimated to be 0.01 mrem to an individual. This pathway includes ingestion of vegetables, meat, and milk and represents ~0.3% of the total dose received by an off-site individual. Present situation alternative doses received via the food chain will be about one-third those estimated for the 1985 baseline year (Table 4.1-8).

4.1.4.3 Limited individual

The limited individual is a hypothetical person who uses surface water or contaminated well water as his sole drinking water source and consumes 21 kg (46 lb) of fish from the Great Miami River.

Radon from K-65 Silos

Remedial action to inhibit the release of radioactive radon from the K-65 silos occurred in late 1987. As a result, the pre-renovation (1985) dose of 70.5 mrem/year (total-body) to the maximally exposed off-site individual has been reduced to 47.2 mrem/year (Table 4.1-8).

Great Miami River

Doses to individuals from drinking river water and eating fish from the river could increase slightly from the 1985 pre-renovation dose of 0.15 mrem because uranium discharges are predicted to double for maximum operation in the present situation (Table 4.1-2). However, drinking water from the Great Miami River contributes only 0.06 mrem to the 0.15 aquatic pathway dose, and fish contamination is near background levels that are not expected to increase.

Off-Site Wells

Only three off-site wells are known to be contaminated with uranium. Water from these wells is used for industrial purposes. However, if humans drank 2.2 L/d of this water, they would receive the 38 mrem/year dose indicated in Table 4.1-8. Contamination of the groundwater is expected to decline because the SWRBs (Projects 242 and 247) have eliminated a significant source of groundwater contamination.

4.1.4.4 Risk calculation

Doses predicted for the maximally exposed individual in the present situation alternative are converted to increased annual risk above background of contracting fatal cancer. Doses for the aquatic pathway (Great Miami River drinking water and fish) and the agricultural pathway were so small that they were not included in the analysis. Estimates of risk are shown in Table 4.1-9. The total-body dose to the maximally exposed individual (west of FMPC) is 58 mrem/year. A conservative (upper limit) estimate of the fatal cancer risk increase to an adult exposed to 58 mrem is about 7.3 chances in one million. The International Council for Radiation Protection (ICRP) has suggested 10^{-6} to 10^{-5} as an acceptable range for annual risk incurred inadvertently by exposure to nonnatural radiation (ICRP 1977). Remedial action sites, not FMPC operations, are the source of most of the dose and, therefore, are a cause of most of the risk.

4.1.5 Worker Radiation and Chemical Exposure

Four general areas regarding worker radiation exposure are targeted for corrective action. These are containment of radioactive and toxic materials, control of external radiation exposure, improved workplace monitoring, and improved medical monitoring. In addition, studies by NIOSH are providing an evaluation of worker radiation and chemical exposure. Present situation includes about 57 projects (Appendix A.4) that are expected to reduce exposure of plant personnel to both radioactive and hazardous materials. An improved personnel monitoring program would allow for a quantification of the positive impacts of these efforts (Sect. 4.6). These worker health and safety projects will occur throughout the site.

4.1.6 Waste Management

Four categories of waste are generated by FMPC operations: low-level radioactive waste (LLW), chemically hazardous [Resource Conservation and Recovery Act of 1976 (RCRA) and Toxic Substances Control Act of 1976 (TSCA) definitions] waste, mixed (LLW and hazardous) waste, and conventional (nonradioactive, nonhazardous) industrial waste. In addition, a large backlog of radioactive and hazardous production wastes is stored at FMPC. The renovation activities have also contributed to FMPC waste primarily as construction rubble. The impacts of managing current and backlog wastes and the construction rubble are described in Sects. 4.1.6.1, 4.1.6.2, and 4.1.6.3 respectively. The impacts of transportation to off-site disposal locations is discussed in Sect. 4.1.6.4. Waste management impacts for the present situation alternative are summarized in Table 4.1-10.

4.1.6.1 Operational wastes

The historical annual amounts of wastes in the four categories produced at FMPC are given in Table 4.1-11. The amount of waste produced in the future will vary with production level. Waste management procedures for these operational wastes are described here.

Table 4.1-9. Annual cancer risks associated with annual radiation doses projected to result from present situation Feed Materials Production Center operation[a]

	Annual dose[b] (mrem)	Incremental cancer risk
Maximally exposed individual: East		
Operations		
Uranium air emissions[c]	2.9	0.3×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions[c]	0.7	0.09×10^{-8}
K-65 Silos radon	18.1	2.3×10^{-6}
TOTAL[d]	21.7	2.7×10^{-6}
Maximally exposed individual: West		
Operations		
Uranium air emissions[c]	1.1	0.1×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions[c]	0.3	0.04×10^{-6}
K-65 Silos radon	47.2	5.9×10^{-6}
K-65 Silos direct gamma	9.5	1.2×10^{-6}
TOTAL[d]	58	7.2×10^{-6}
Background		
Natural[e]	100	$13. \times 10^{-6}$
Background indoor radon[e]	200	$25. \times 10^{-6}$
TOTAL[d]	300	$38. \times 10^{-6}$

[a]Remedial actions may reduce dose; however, this cannot be defined until specific remedial actions are identified (see Sect. 4.3).

[b]Effective total-body dose.

[c]Effective total-body dose from uranium air emissions includes dose from inhalation of air; immersion in contaminated air; ingestion of meat, milk, and vegetables grown at the site; and exposure to deposition on ground.

[d]Totals may not add due to independent rounding.

[e]*Source:* NCRP 1987

Table 4.1-10. Waste management impacts summary, present situation alternative

Operational waste	Backlog waste	Construction waste
Low-level radioactive waste (LLW)		
Low-level radioactive waste is packaged and shipped to Nevada Test Site (NTS). Impacts associated with about 200 shipments per year to NTS are minor	About 200 shipments of backlog LLW are sent to NTS each year	LLW construction wastes are being packaged for shipment to NTS. More than adequate on-site storage space is available while wastes await shipment
Hazardous waste		
Hazardous waste (except $BaCl_2$ waste) is shipped to Oak Ridge Gasseous Diffusion Plant (ORGDP) for destruction in the Toxic Substances Control Act (TSCA) incinerator. Storage and shipment impacts are negligible. $BaCl_2$ wastes are being stored at Feed Materials Production Center (FMPC) while disposal plans are being developed	Backlog hazardous wastes (except $BaCl_2$ waste) are being shipped to ORGDP for storage and incineration in the TSCA incinerator. $BaCl_2$ wastes are stored at FMPC while disposal plans are being developed	Asbestos is being packaged for shipment to NTS as if it were LLW. More than adequate on-site storage space is available
Mixed waste		
Mixed wastes (except $BaCl_2$ waste) are shipped to ORGDP for destruction in the TSCA incinerator. Storage and shipment impacts are negligible	Mixed wastes are being stored at FMPC while disposal plans are being formulated	None

Table 4.1-10 (continued)

Operational waste	Backlog waste	Construction waste
	Conventional industrial waste	
Conventional industrial waste is stored on-site or sent off-site to a commercial landfill. Adequate on-site and off-site disposal areas are available	None	Uncontaminated trash is sent to off-site commercial landfills. Sand, gravel, concrete, and asphalt will be stored on-site. Plentiful space is available
	Transportation	
Sum of all LLW waste shipments is less than 1600 shipments per year to NTS. Impacts of 1600 shipments per year to NTS are the following: negligible radiological impacts to the public, minor radiological impacts to truck drivers who drive fewer than 25 trips per year, and fewer than 6 traffic accidents per year	Sum of all LLW waste shipments is less than 1600 shipments per year to NTS. Impacts of 1600 shipments year to NTS are the following: negligible radiological impacts to the public, minor radiological impacts to truck drivers who drive fewer than 25 trips per year, and fewer than 6 traffic accidents per year	Sum of all LLW waste shipments is less than 1600 shipments per year to NTS. Impacts of 1600 shipments per year to NTS are the following: negligible radiological impacts to the public, minor radiological impacts to truck drivers who drive fewer than 25 trips per year, and fewer than 6 traffic accidents per year

Table 4.1-11. Production of operational wastes generated[a] by or shipped to the Feed Materials Production Center for FY 1985-FY 1988

Type of waste	Annual production rate			
	FY 1985	FY 1986	FY 1987	FY 1988
Low-level[b]	236,991 ft^3	187,699 ft^3	235,548 ft^3	230,004 ft^3
Mixed (radioactive and hazardous)	0	0	610.8 ft^3	7,828 ft^3
Mixed waste generated at RMI and NEC, stored at FMPC	735.2 ft^3	747.4 ft^3	860.3 ft^3	518 ft^3
Mixed waste (oil) generated at FMPC and shipped off-site for disposal	0	0	926.4 ft^3	3,919 ft^3
Mixed waste treated at FMPC and shipped off-site for disposal	0	205.9 ft^3	0	0
PCB (contaminated)	13.96 ft^3	2.25 ft^3	.83 ft^3	15 ft^3
Hazardous (uncontaminated)	515 ft^3	757.4 ft^3	191.2 ft^3	0
PCB (uncontaminated)	1.59 ft^3	2.80 ft^3	0	10 ft^3
PCB (uncontaminated) generated at FMPC and shipped off-site for disposal	0	1.98 ft^3	2.28 ft^3	34 ft
Conventional (sanitary)	0[c]	0[c]	63,800 ft^3	203,632 ft^3

[a]Does not include construction rubble. The amount of waste to be generated in the future is expected to remain about the same, varying with production level. These quantities are based on materials logged into the waste management system during the specified year.

[b]To convert cubic feet of low-level waste to tons multiply by 0.045. (Assumes waste is dry and ready for shipment.)

[c]Prior to FY 1987 this material had been treated as contaminated waste. Beginning in FY 1987, a program was initiated to segregate noncontaminated waste from contaminated waste.

Source: Weinreich Jan. 29, 1988; Saylor Oct. 4, 1989.

Low-level Radioactive Waste

LLW process residues are the largest FMPC solid waste stream and include uranium-contaminated magnesium fluoride slag, neutralized raffinates, and dewatered sump sludge. Several new waste streams will be generated as a result of renovation projects completed by 1989. These include the sludges from the Biodenitrification Surge Lagoon and the SWRB. These sludges are expected to be contaminated with small concentrations of uranium and will be classified as LLW. Sewage treatment sludge is now dried and temporarily stored-on site before final disposition. Previously, sewage sludge was incinerated and the uranium content was recovered from the ashes.

Most of the currently generated LLW including contaminated process area trash is shipped off-site to the Nevada Test Site (NTS) for disposal. A segregation procedure and an active waste minimization program were initiated in 1985 and are now in place to reduce the quantity of contaminated trash. Sludges from the Biodenitrification Surge Lagoon and SWRBs will be drummed and stored on-site pending shipment to NTS.

Hazardous Waste

Currently generated hazardous wastes are principally solvents. These solvents are added to the bulk storage tanks located at the FMPC. Spent solvent generated at Reactive Metals, Inc. (RMI) and 1,1,1-trichloroethane from degreasing operations at National Electric Coil (NEC) are also stored in the spent solvent tanks. The solvents from NEC were generated during decontamination activities in the 1970s and are no longer being shipped to the FMPC.

Much of the hazardous waste is shipped to the Oak Ridge Gaseous Diffusion Plant (ORGDP) for interim storage. These wastes will be eliminated in the ORGDP TSCA incinerator, which was designed in accordance with TSCA and RCRA regulatory requirements. This incinerator is currently undergoing testing prior to being given operational status. Shipments of drummed hazardous wastes to ORGDP have already filled the allotted storage space of 1,000 drum equivalents. The 13,000 gal in the FMPC spent solvent tanks can be shipped to ORGDP storage tanks when the TSCA incinerator begins operation. Historically these wastes have been incinerated on-site. Thus, the impacts of emissions from the local incinerator have been eliminated.

Mixed Waste

Mixed waste generated by current operations consists primarily of uranium-contaminated barium chloride (BaCl) from RMI and uranium-contaminated waste oils. Most of the FMPC mixed waste is shipped to the ORGDP for interim storage prior to combustion in the TSCA incinerator. Previously, waste oils had been incinerated on-site at the FMPC incinerator. In FY 1987, 184 drum equivalents of mixed waste were shipped to ORGDP, and in FY 1988, 606 additional drum equivalents were shipped.

Shipments of drummed oils and solvents to ORGDP will continue until the allotted FMPC storage space of 1000 drum equivalents is used. Oils and solids containing $BaCl_2$ salt continue to be shipped from RMI to FMPC for temporary storage. There are currently no facilities for disposal of this material. Prior to 1985, the $BaCl_2$ wastes had been placed in Pit 4. An area has since been constructed in the KC-2 warehouse to store these mixed wastes prior to their disposition.

Conventional Industrial Waste

Conventional industrial waste consists of nonprocess trash, boiler plant waste, spent lime sludges, and sewage treatment plant sludges. Boiler fly ash is deposited on Fly Ash Pile 2 at the southwest corner of the plant. The surface of the fly ash piles is treated to minimize wind blown dust, and the ash will eventually be covered to inhibit erosion. Boiler blowdown water and coal pile runoff are routed to a retention pond. After settling of solids, the pond water is sent through the plant wastewater treatment systems to ensure compliance with NPDES permit conditions before release to the Great Miami River. The sludge from these ponds will be periodically removed and dried and then either burned with the coal, disposed of in a commercial landfill, or drummed for disposal with hazardous waste if necessary. Calcium carbonate sludge from drinking water softening operations is currently accumulated in lime sludge beds at the western side of the production area. These beds are nearly full, and options for permanent disposition of the lime sludge are being studied as part of the remedial action process.

4.1.6.2 Backlog wastes

Table 4.1-12 lists the types of backlog wastes stored at FMPC. The backlog materials from past operations include the four types of waste that are currently generated at FMPC, plus scrap metal.

About 94,000 drum equivalents (assumed to be 55 gal or 7.35 ft^3 of backlog LLW) are stored on the FMPC site. This quantity includes process residues and scrap metals noted in Table 4.1-12. The 8400 tons of ferrous scrap metal consist of refuse, usable ferrous metal, and usable nonferrous metal. The refuse, which includes a quantity of asbestos, will be disposed of as LLW. Approximately 20 tons of hazardous wastes governed under RCRA and TSCA are stored on the FMPC site. Some of this volume consists of about six capacitors containing polychlorinated biphenyls (PCBs) in the KC-2 warehouse. These capacitors are being shipped to ORGDP for destruction in the TSCA incinerator. The remaining hazardous waste is being shipped to ORGDP for storage. Construction of additional space for storage of RCRA wastes at FMPC is part of the proposed action (Sect. 4.2). Until a DOE-wide decision is made about the final disposition of mixed waste, $BaCl_2$, and oils and solids contaminated with $BaCl_2$ continue to be shipped to FMPC from RMI for storage.

Capacitors removed from service at FMPC containing PCBs and articles used in their handling (rags, clothes, and gloves) are stored in drums in a curbed storage area within the KC-2 warehouse. Approximately 20,000 lb of

Table 4.1-12. Backlog wastes inventory at the Feed Materials Production Center

Description	Quantity[a] FY 1986	FY 1987	FY 1988	FY 1989
Scrap metal				
Ferrous	5,600	5,600	6,720	8,000
Copper	1,570	1,570	1,570	1,570
Hazardous waste				
PCB-contaminated materials[b]	10	10	9	20
Mixed waste				
1,1,1-trichloroethane (spent solvents) contaminated with uranium and PCBs[c]	69	72	76	79
Uranium-contaminated $BaCl_2$[d]	59	59	75[e]	100
Contaminated cutting and cooling oils	75	175	147	250
Conventional industrial waste				
Boiler plant wastes	2,500	2,500	2,500	2,500
Spent lime sludge	7,000 yd^3	8,000 yd^3	9,000 yd^3	10,000 yd^3
Low-level waste[f]	101,000 DE[g]	91,540 DE	77,600 DE	94,200 DE
Process residue	23,000 DE	22,892 DE	22,375 DE	23,140 DE

[a]Units are tons except for low-level waste and spent lime sludge.

[b]Includes PCB-contaminated sludges from the bottoms of tanks used to store solvents.

[c]Includes solvents for degreasing operations at NEC in Louisville, Kentucky, during the 1970s. (These solvents are no longer being shipped to the Feed Materials Production Center.)

[d]Includes $BaCl_2$ contained in waste pits.

[e]$BaCl_2$ from Reactive Metals, Inc.

[f]Low-level waste includes process residues, contaminated scrap metal, and other waste.

[g]Units are in drum equivalents (DE). One DE is assumed to be 55 gal, or 7.35 ft^3.

1,1,1-trichloroethane distillation residues and sludges are also currently stored in the KC-2 warehouse. These wastes, contaminated with uranium and PCBs, were generated as a result of distilling the National Electric Coil waste to reclaim the solvent.

Plans for disposal of the mixed waste backlog have not been formulated. Some of these wastes may be incinerated at the ORGDP TSCA incinerator.

4.1.6.3 Construction rubble

The total estimated quantity of construction rubble generated from October 1, 1984 through September 30, 1989, is 13,901,787 lb (Bogar 1988). Approximately 57% of the total is uncontaminated rubble, about 42% is contaminated with low levels of radioactivity, and less than 1% is asbestos. Table 4.1-13 summarizes this information.

Uncontaminated construction rubble

The total weight of uncontaminated rubble is estimated to be composed of approximately 62% soil and gravel, 18% salable equipment and metal (actually not a waste requiring disposal area), 15% concrete and asphalt, and 5% clean refuse. The contaminated rubble is estimated to be composed of approximately 71% soil and gravel, 21% concrete and asphalt, 6% metal and equipment, 1% wood, and a small amount of miscellaneous trash.

Only uncontaminated soil, gravel, concrete, and asphalt will be retained on-site; the remaining uncontaminated construction rubble (e.g., wood) will be sent off-site to a nearby municipal landfill for disposal. The largest components of uncontaminated rubble are soil and gravel. As much sand and gravel as possible will be used for backfill at renovation projects and for other activities. If none of the soil and gravel were reused for backfill, then a total volume of ~42,000 ft^3 would require disposal (at an assumed density of 117 lb/ft^3). Soil and gravel are currently stored near the northwest corner of the site, as shown in Fig. 4.1-2. If only the current storage area were used for storing soil generated by current situation projects, then a pile averaging ~3 ft in height covering the 15,000-ft^2 area would be formed. Clearly, adequate storage area is available. When the area is full, it will be seeded to further reduce the potential for environmental impacts such as erosion. The area for soil storage is neither a remedial action site nor the site of any planned renovation activities.

Concrete and asphalt are the second largest uncontaminated construction waste components by volume. This waste is stored in an area adjacent to the soil stockpile shown in Fig. 4.1-2. The uncontaminated concrete and asphalt would be retained on-site pending final disposition. In case all concrete and asphalt rubble estimated to be generated under the present situation alternative (1,188,493 lb or ~12000 ft^3 using an assumed overall average density of 100 lb/ft^3) were stored on-site in the current area (~12,000 ft^2), then a pile averaging ~1 ft high would be created.

Table 4.1-13. Estimated types and quantities of construction rubble generated at the Feed Materials Production Center for present situation (cumulative)[a]

Type	Estimated cumulative quantity from 10/1/84 through 9/1/88 (lb)	Estimated cumulative quantity through 9/30/89 (lb)
Contaminated (low-level radioactivity)	1,850,950	5,952,799
Uncontaminated	2,507,971	7,923,285
Asbestos	25,703	25,703[b]
Total	4,384,624	13,901,787[b]

[a]No action would result in no further renovation and no additional generation of rubble.

[b]FY 1988 data on asbestos not available. Assumes no new asbestos generated after 9/1/88 and before 10/1/89.

Source: Bogar 1988. Some values have been changed to reflect fiscal years rather than calendar years.

ORNL-DWG 89-6183

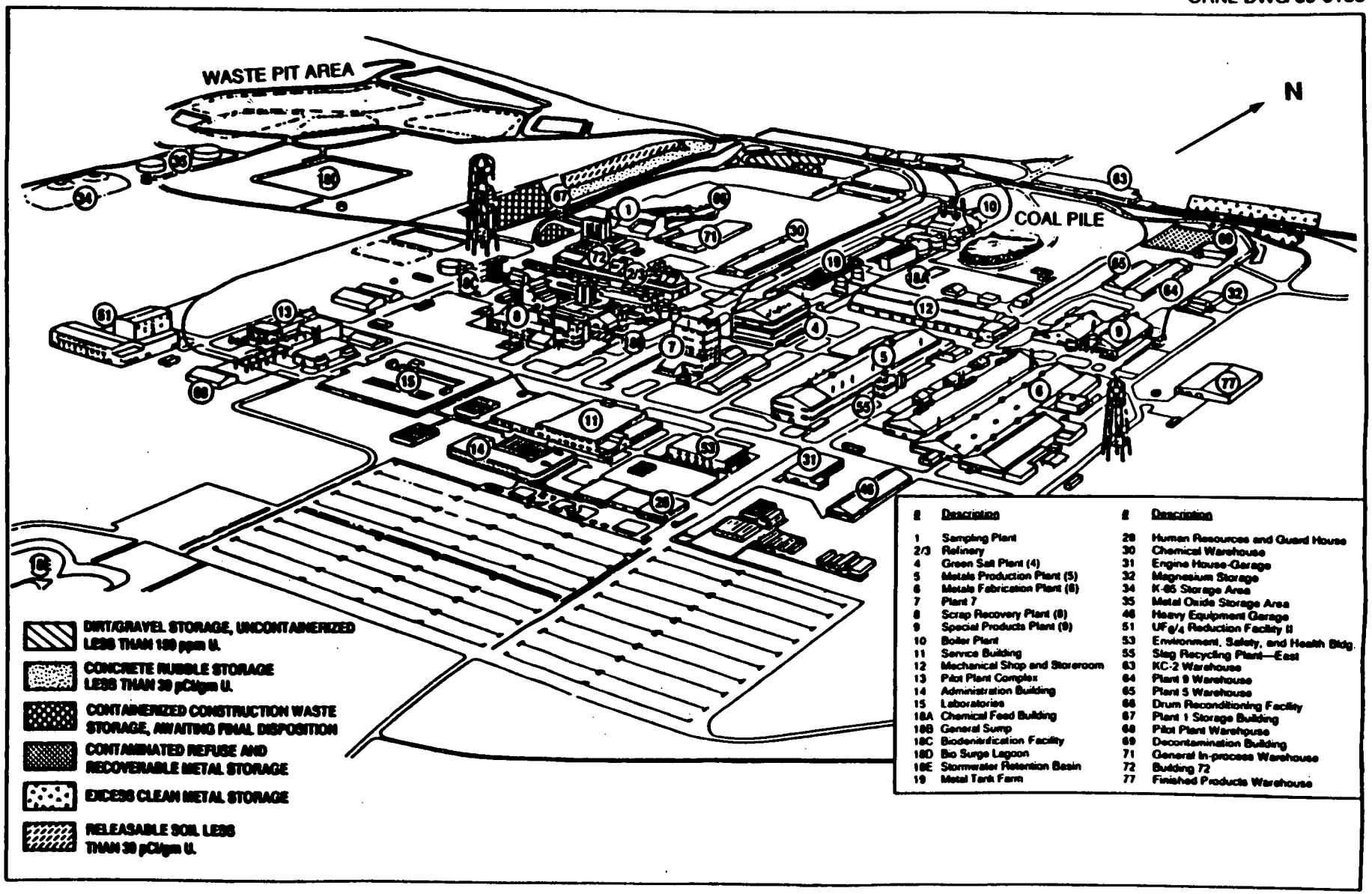


Fig. 4.1-2. Feed Materials Production Center construction-waste storage areas.

No potential conflicts with other renovation or remedial action activities are apparent.

The remaining uncontaminated waste (about 23%) will be surveyed to ensure that it is uncontaminated and will be either stored on-site (as in the case of clean metal) or shipped off-site for disposal. No significant adverse environmental or operational impacts are anticipated from disposal of uncontaminated rubble under the present situation alternative.

Contaminated rubble

About 42% of the total construction rubble generated by the present situation is expected to be LLW because it is contaminated with low levels of radioactivity. Contaminated construction rubble is segregated by waste type and packaged for off-site shipment to NTS for disposal. FMPC anticipates approximately 400 shipments/year for FY 1989. Under the present situation alternative it is assumed that only renovation activities begun by September 30, 1989, are completed. The total contaminated rubble (31,000,000 lb) estimated to be generated by projects begun before September 30, 1989, would require approximately 800 shipments to NTS (Bogar 1988). The anticipated 800 shipments are well within the 1600 shipments/year that NTS has agreed to accept from FMPC. Potential transportation impacts from 1600 shipments/year are evaluated in the following section.

Containerized construction rubble (LLW) is currently stored on the ground and unsheltered in the western portion of the site north of the water tower (Fig. 4.1-2). These steel containers, which are called six packs, were originally designed to overpack six 55-gal drums for shipping. The area now used for storage of containerized waste is targeted for future construction under the present situation alternative. Consequently, additional area on the site will be needed for future storage of containers of low-level contaminated construction rubble. Interim Site (IS) IS-3 (Fig. 4.1-3) has been measured at about 284,000 ft^2 (Bogar 1988) and has been selected as a temporary storage site. Available storage at Site IS-3 could hold more than 16,500 containers, or about 2,060 shipments. This area is more than adequate for temporary storage of the projected 150 shipments of contaminated construction rubble generated under the present situation.

Storage of contaminated construction rubble in steel containers will help minimize impacts from direct radiation, inhalation, or other potential pathways. The dose rate at the surface of the containers is limited by U.S. Department of Transportation regulations (see Sect. 4.1.6.4) so that no significant adverse effects to workers or the public would result. Exposure by other pathways is extremely unlikely because the wastes are in containers. Thus, no significant adverse environmental impacts should result from contaminated construction rubble storage. To help ensure that no impacts occur, regular inspections of the containers will be made (Sect. 4.6)

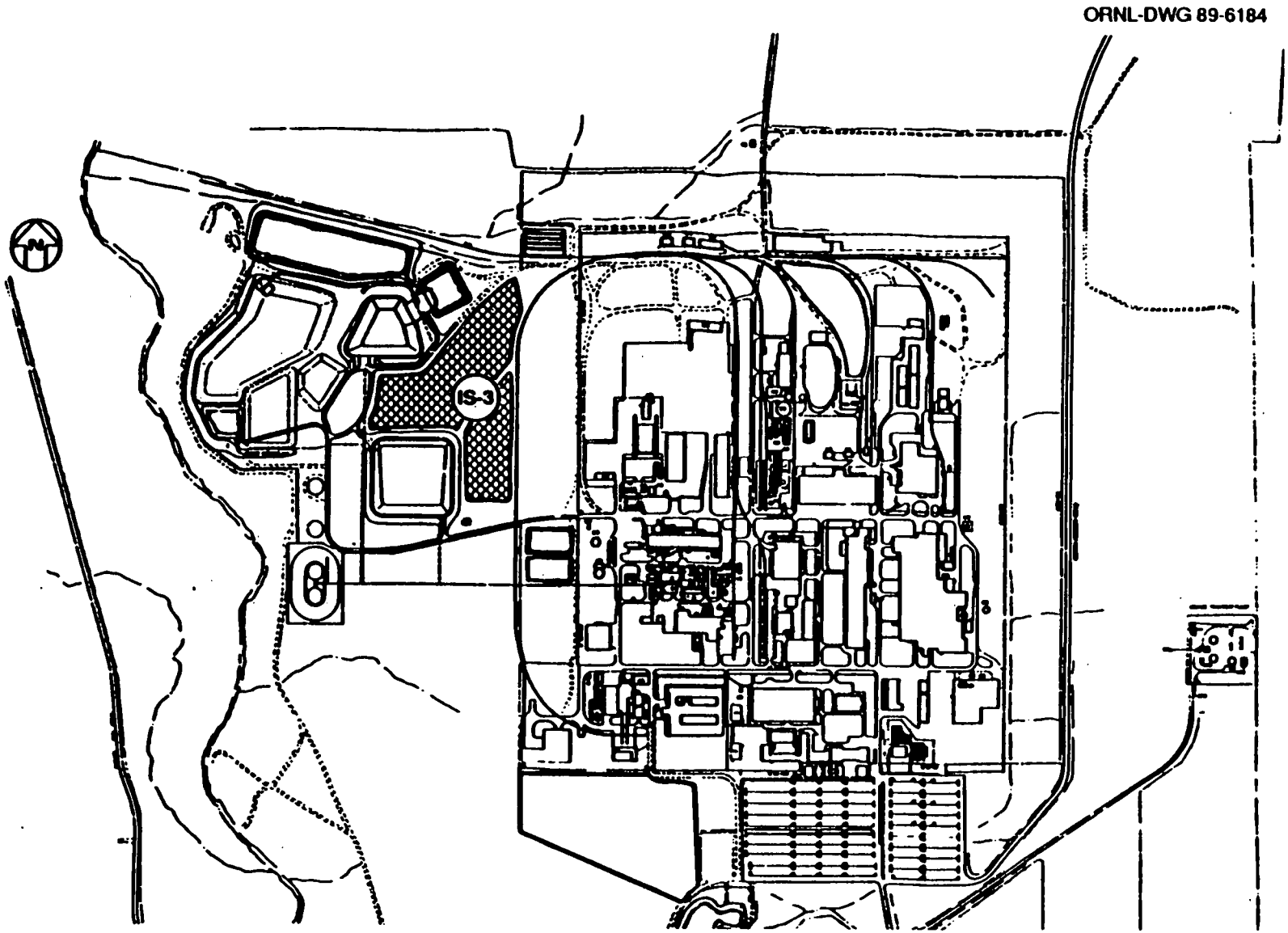


Fig. 4.1-3. Location of proposed temporary storage (IS-3) of containerized low-level waste construction rubble.

Scrap metal

Scrap metal generated as a result of the present situation is added to the inventory and is stored on a controlled runoff pad in the northeast corner of the site. Scrap metal for which decontamination is economically feasible will be recycled as part of DOE's Scrap Reclamation Program. Private companies interested in the metal have taken samples to determine if decontaminating the metal is economically feasible. If the results are positive, interested vendors will bid to take title to all or part of the FMPC scrap inventory. They will then decontaminate the scrap and return it to the private sector. This action will be analyzed under separate NEPA documentation.

Asbestos

Asbestos poses a potential health threat, primarily through inhalation. It is regulated as a hazardous air pollutant under 40 CFR Pt. 61 and by regulations controlling occupational exposure, which in part require handling and packaging of waste asbestos to minimize air emissions. Through September 1, 1988, approximately 25,703 lb of waste asbestos was generated as construction rubble at the FMPC (Weinreich 1988). All FMPC asbestos waste is packaged in accordance with regulations (40 CFR Pt. 61), labeled, stored on pads while awaiting shipment, and shipped to NTS for disposal under the umbrella of 1600 shipments annually (Schneider, Grumski, and Dicken 1988). FMPC made no shipments of asbestos to NTS until FY 1988. In the first 10 months of FY 1988, FMPC shipped 349,000 lb of asbestos and asbestos contaminated waste to NTS.

Temporary storage, transportation, and disposal of asbestos as described previously should result in no adverse environmental effects. Wetting friable asbestos and sealing it in leakproof containers as required by 40 CFR Pt. 61 greatly reduces the probability of exposure through inhalation, which is a principal exposure pathway. Drums of asbestos awaiting shipment represent very little hazard for air or water contamination. Transportation of asbestos to NTS with the LLW should not result in adverse effects under normal or accident conditions (Sect. 4.2.6.4). Disposal of the asbestos at NTS is accomplished in accordance with environmental regulatory requirements and the environmental impact statement (EIS) prepared for NTS (ERDA 1977).

4.1.6.4 Waste transport impacts

NTS has agreed to accept up to 1600 shipments/year of LLW from FMPC. In FYs 1986, 1987, and 1988 the numbers of shipments of LLW from FMPC to NTS were 137, 337, and 445 respectively. For FY 1989, 816 waste shipments are anticipated, including 216 shipments of current waste, 200 shipments of backlog waste, and 400 shipments of construction rubble (WMCO 1988a).

Under the present situation alternative, there would be no increase in FMPC waste shipments to NTS. With no further renovation, approximately 392 shipments are anticipated for FY 1990 and approximately 356 shipments

for FY 1991 (WMCO 1988a). For FYs 1992-1994, waste shipments would drop to 223 per year because shipment of the backlogged waste is to be completed at the end of FY 1991. Potential impacts from FMPC waste transportation to NTS are described here.

Normal Transport

Packaging and shipping the FMPC LLW waste to NTS at a rate of 1600 shipments per year in accordance with all applicable regulatory requirements should not result in significant adverse effects. External radiation from the waste packages and truck trailers must comply with Department of Transportation (DOT) limits established to allow safe transportation of radioactive materials (49 CFR Pts. 173 and 177). External radiation levels for a single drum are 0.7-5 mR/h at the surface and 0.5-1.5 mR/h at a distance of 1 m (DOE 1985). Drums of DOT specification 17H with plastic linings are used: they comply with DOT requirements, have been tested in accordance with DOT regulations, and are approved for shipment as Type A packaging. These 17H drums provide adequate containment for normal transport conditions.

Transportation of the FMPC wastes will result in radiation exposures to persons passed along the transportation route, persons handling the drums, and drivers of the vehicles carrying the waste. Radiation doses associated with transportation of U_3O_8 (natural uranium) (NUREG 1977) can be used as an upper limit for doses associated with transportation of drums of FMPC wastes, which are similar in radiation level to drums of U_3O_8 (DOE 1985).

Radiation exposures to persons along the transportation route will be negligible when compared with exposures associated with natural background radiation. Calculations for truck transportation of 40 drums of U_3O_8 over a route that is 5% urban (3861 persons/km^2), 5% suburban (719 persons/km^2), and 90% rural (6 persons/km^2) indicate a radiation dose of 1.6×10^{-4} person-rem/km per shipment (NUREG 1977). Because the activity levels of those for drums of U_3O_8 are higher than drums of FMPC waste, radiation exposure from a 60-drum truckload of FMPC waste would not be any greater than exposure from a 40-drum load of U_3O_8. Each FMPC waste shipment travels 3273 km en route to NTS and results in a cumulative radiation dose of no more than 0.52 person-mrem. Sixteen hundred shipments per year would result in a cumulative dose of not more than 840 person-mrem/year to the persons along the route. This combined radiation exposure to the many thousands of people living along the route is negligible compared with the exposure to the same population group from the natural background dose rate of 300 mrem/year per person (Sect. 3.8.2.2).

Individual exposures to persons along the route should also be negligible. The dose rate to an individual at 50 m from the truck (an assumed probable distance of a nearest person) would be less than 0.1 mrem/h for a few seconds each time a truck passed (based on radiation measurements taken at FMPC for trucks loaded with wastes--see Sect. 3.3). Therefore, the dose to an individual living along the route would be expected to be less than 1 mrem/year as a result of 1600 trucks per year

passing a given location. Occupants of other vehicles could be near one of these trucks for several minutes, but because they are only randomly expected to be near one of the trucks, their annual dose would also be expected to be less than 1 mrem/year.

During transportation, the direct radiation dose received by the handlers is minimized by a maximum permissible radiation level at the external surface of the containers of 200 mrem/h (DOT regulations). Based upon measurements, the FMPC waste drums and other containers have surface radiation levels of 1-5 mrem/h (DOE 1985). Because the trucks are fully loaded and probably locked, the containers are not handled between FMPC and NTS.

The dose rates to the drivers are limited by the DOT dose rate limit of 2 mrem/h in the truck cab and by the low probability that any one driver would make a large number of repeat trips from FMPC to NTS. Two drivers per truck are used to transport the FMPC wastes; the actual time that they are in the truck cab during the trip to NTS is estimated to be 45 h (DOE 1985). The average dose rate in the cab of a truck loaded with FMPC wastes has been measured at 0.4 mrem/h. Consequently, the total dose to each driver for the 45-h trip is ~18 mrem. Drivers usually do not return immediately to FMPC with empty trucks to pick up more waste. They are often sent to other locations in the western United States to pick up commodities to be shipped to the Cincinnati area. Given this additional activity, a round trip is assumed to last about two weeks and a two-person crew would make approximately 24 FMPC waste trips to NTS per year. Therefore, drivers might receive doses of 432 mrem/year, which is less than, but close to, the 500-mrem/year dose permitted by DOE regulations for unmonitored individuals in uncontrolled areas (DOE 1987). This is a conservative estimate in that it assumes that the drivers are dedicated to FMPC waste shipments. In reality, in large commercial trucking firms' drivers are likely to be rotated among clients, thereby reducing the chances that any one driver would always be assigned to hauling FMPC LLW shipments.

To ensure compliance with DOE Draft Order 5400.xx, a simple dose tracking system was implemented at FMPC. A log was kept of drivers' names for each of the trips to NTS (Christensen 1988). Of 259 dosimeters issued over 9 months, only 28 recorded exposures above the 5-mrem detection limit. The maximum exposure for a single trip was 11 mrem, and the highest exposure to any individual driver during the 9 months was 13 mrem. This system showed that drivers did not approach their dose limits, and therefore the system has been discontinued.

Accidents

Accidents resulting in the release of radioactive materials could occur during waste transport. The accident probability for trucks carrying drums of radioactive solid waste is 1.06×10^{-6} accidents per kilometer (DOE 1985). Transport of 1600 FMPC waste shipments per year to NTS (3273 km per trip) is expected to result in 5 or 6 accidents per year. Only about half (3) of these accidents would be expected to result in a

release of radioactive material (DOE 1985). Because of the low probability of truck accidents, it is unlikely that any individual or group of individuals would be exposed more than one time to accidental releases of these materials. Potential effects from an accident can be estimated by evaluating a conservative scenario.

A worst-case accident scenario is that 10% of the contents of one truckload of wastes with drums containing 30% depleted uranium (i.e., 0.25 Ci) would be spilled over 100 m^2 of surface (road or ground) in an accident. The resultant surface contamination level would be 2.5×10^{-3} Ci/m^2. External radiation exposure levels at 1 m above such a surface would be 1.5×10^{-2} mR/h, which is not significant in terms of direct radiation exposure.

Internal exposure via resuspension of uranium into the air would be a more significant problem than would external exposure. If it is assumed that 10^{-5} of the spilled uranium is initially resuspended to a 1-m (3-ft) height above the contaminated area and that virtually immediate dispersion increases the affected area by a factor of 100, then a level of 2.5×10^{-10} Ci/m^3 would be present over an area of 10,000 m^2 (DOE 1985). Inhalation of dust containing this concentration for 1 h by truck crews, emergency personnel, or onlookers would result in individual total-body doses of ~2.6 mrem and doses to the lungs of ~180 mrem, assuming that suspended particles are 0.3 μm in diameter. This total-body dose is equivalent to <1% of a year's natural radiation exposure, and it is also less than EPA Protective Action Guidelines for evacuation in the event of a nuclear accident (i.e., predicted levels are not high enough to warrant evacuation). Because individuals are unlikely to be involved in such accidents more than once in their lives and because the doses are estimated to be a small percentage of background levels, the potential impacts are not significant.

Resuspended particulate matter in the air over the accident site would be further dispersed and diluted in the atmosphere as the plume moves away from the site. The extent of this dispersion would be dependent upon meteorological conditions at the time of the accident. Thus, with increasing time after an accident, individual exposures would become lower.

4.1.7 Socioeconomics

The present situation alternative estimates of socioeconomic impacts are based on the maximum potential levels of expenditure for plant operations, renovations, and remedial actions that were projected in early 1988. Production was, however, significantly curtailed in late 1988 with accompanying reductions in operating employment. Therefore, impacts presented in this section provide an upper bound on the socioeconomic impacts.

The potential socioeconomic impacts have been considered from two perspectives: (1) the local area including individual communities and government units near the FMPC facility and (2) a regional area defined by Butler and Hamilton Counties in Ohio and Dearborn County in Indiana, where

most of the workers will reside and material expenditures are expected to take place (see Appendix D.2).

4.1.7.1 Population and demography

The direct incremental employment for the present situation alternative at FMPC is projected to reach its maximum of about 700 in 1989, and the incremental employment in 1990 for operation at maximum production is approximately 1400. Thus, the combined incremental employment for 1990 is about 2100. Operating employment would be approximately 10% higher in 1991, but employment for renovations will decrease rapidly. Some communities in the region, especially those near the facility, may experience an increase in population as a result of this employment increase, although most of the people hired in connection with the renovations will already reside within commuting distance and will not choose to relocate. For instance, most employees hired for construction projects are hired through local craft unions which (in the Cincinnati-Hamilton metropolitan area) have had sufficient manpower since the early 1980s. Construction-associated jobs would be temporary, and construction workers generally do not relocate to be closer to jobs that are within 50 miles of their homes. Therefore, most newly hired construction workers are unlikely to affect local populations.

Increases in population are more likely from increases in permanent employment as a result of changes in FMPC operations. An analysis of where FMPC employees lived in 1986 (see Appendix D.3) indicated that there has been no significant concentration of FMPC employees in any one community. It seems likely that settlement patterns for new FMPC employees will be similar to patterns associated with baseline conditions. No changes have occurred in local communities or transportation networks as a result of recent FMPC activities to indicate that residential distributions would differ from past patterns.

To test the potential impact on local populations from FMPC employment increases, the effect on the nearby town of Ross was assumed to receive the highest proportional increase of new employment. Based on a 1986 listing of FMPC employees by ZIP code, Ross contained the highest ratio of FMPC employees to total community population. In 1986 approximately 40 FMPC employees, representing about 3% of the total FMPC work force, lived in Ross. These 40 employees represented approximately 2.4% of the town's population of almost 1700. If 3% of the new FMPC employees reside in Ross, then an average annual increase of less than 1% of the Ross population would occur from 1985 to 1989. This would not be a significant impact on the community's population. Other communities should experience even less impact on population because a smaller percentage of FMPC employees live there.

4.1.7.2 Regional employment and income

The effects discussed in this section result from FMPC expenditures in the region. To place some perspective on the effects being reported, FMPC's expenditures in 1985 of $96 million induced an estimated regional

effect of approximately 0.5% of the combined incomes of Butler, Hamilton, and Dearborn counties. FMPC operations in 1985 induced an estimated regional employment effect of approximately 0.4% of the combined employment in the three counties. FMPC expenditures represent purchases of labor for construction and operations and non-labor items such as equipment and materials. To the extent that these expenditures increase over the expenditures in FY 1985 they will result in direct increases of employment and income for the region. In addition, respending by FMPC operating employees and construction laborers will generate secondary employment, income, and expenditures within the region.

The area in the immediate vicinity of the plant may experience some minor positive impacts in terms of increased expenditures for labor and materials. Local businesses such as restaurants and hardware suppliers may gain financially from increased expenditures at FMPC. Some building materials such as gravel may be purchased nearby. However, the area in the immediate vicinity of the FMPC plant is generally rural and lacks the core of commercial establishments and population to attract a major share of expenditures. The effects from increased employment and income should be widely spread throughout the greater Cincinnati and Hamilton metropolitan area if current settlement patterns continue.

The three-county area including Hamilton and Butler Counties in Ohio and Dearborn County in Indiana should experience most of the regional expenditure impacts from the projects at FMPC (see Appendix D.2). Approximately 89% of FMPC expenditures for labor in 1987 went to persons residing within these three counties, and most of the wages and salaries for work on the renovation projects are expected to be paid to employees within this three-county area. Furthermore, much of the standard material and equipment required for construction and renovation activities at FMPC will be supplied from within this area as well.

The estimated increase in direct and indirect employment (about 4000 jobs) and income (approximately $170 million) will be spread throughout the regional economy. Although total employment and income values are quite large, no significant socioeconomic impacts are expected because the effects will be widely spread over a very large existing regional economy. The estimated increase in employment for the maximum employment year of 1989 is approximately 0.8% of the total civilian labor force in Hamilton, Butler, and Dearborn counties in 1985. The maximum estimated income impact of $170 million is approximately 1.0% of the personal income for these three counties in 1985. These economic effects will be positive impacts but not unusual in terms of annual fluctuations. After peaking from 1989 through 1991, economic impacts will be reduced as expenditures for renovation decrease rapidly.

4.1.7.3 Schools

Any effects on public schools will be related to changes in local community populations. Since no significant population changes in local communities are expected, there will be no impact on schools.

The Crosby Elementary School, which was discussed in Sect. 3.2.3, is probably typical of nearby schools with students some of whose parents are employed at FMPC. At Crosby Elementary, 1.3% of the students (5 students out of 379) had a parent working at FMPC in 1985. Even if this percentage doubled because of increased FMPC employment by 1989, it is highly unlikely that the additional 5 students would cause any significant impact. Changes in student enrollment induced by the present situation would be only a small part of the total change in a typical year.

4.1.7.4 Infrastructure

Since most of FMPC's basic infrastructure requirements such as water, sewage treatment, steam, and waste disposal are satisfied internally, renovation activities and/or changes in operating levels per se will not affect off-site infrastructure. Potential effects on off-site infrastructure are associated with significant changes in community populations. Since no significant impacts on community populations are expected (see Sect. 4.2.7.1), there should be no significant impacts on community infrastructure.

4.1.7.5 Traffic

The increase in both construction and operation employment will increase traffic on roads leading to the FMPC plant (Fig. 3.2-2). The main impacts will be evident at the intersection of State Routes 126 and 128 in Ross during the morning and evening rush hours and at the intersection of Willey Road and State Route 128 as traffic exits the plant in the afternoon.

Potential problems with increased rush hour traffic would be related almost entirely to increased operations. Construction employment will have little effect because most of the crafts personnel working on renovations will be on 4-d/week, 10-h/d schedules, which will allow them to avoid the peak traffic hours. Since operations and operating employment for 1989 have been reduced to levels typical of 1985-86, the most significant effects would have occurred in 1988. An analysis of highway capacity (see Appendix D) and estimated traffic increases for 1988 indicated that the Ross intersection was still below its critical capacity at that time. The intersection of Willey Road and State Route 128 should continue to experience the short to average delays that were typical of the traffic levels in 1985 and 1986. Traffic impacts at other locations should be less significant because of the increasing distance from FMPC.

4.1.8 Summary

This alternative encompasses all renovations started between 1984 and September 30, 1989. It is assumed that renovations started during this time would be completed and the plant would be run at maximum capability.

This alternative results in significant positive impacts and few adverse impacts. The following major areas of concern pertaining to the operation of FMPC have been addressed (1) reduction of hydrogen fluoride

levels in the air to acceptable levels, (2) reduction of the potential for accidents at the tank farm, (3) elimination of a major source of contamination to groundwater resulting in a southern plume (Production Area surface runoff), (4) reduction of the potential for the collapse of the roofs of the K-65 waste storage silos, (5) reduction of the potential for accidental releases of thorium and reduction of worker exposure to gamma radiation through repackaging of the thorium inventory, (6) reduction of uranium emissions from the stacks by a factor of 6.3 from 1985 emissions, and (7) reduction of radon emissions from the K-65 silos by one-third.

The calculated effective total-body radiological dose to the maximally exposed individual from air, surface water, and fish ingestion pathways is ~58 mrem/year as compared with 85 mrem in the 1985 reference year. This can be compared with a natural background dose level of approximately 300 mrem/year. After the radon and direct gamma from the K-65 silos is eliminated, the maximum dose should be ~3.6 mrem/year. Eliminating uranium emissions from the waste pit area would further reduce maximum dose to ~2.9 mrem/year. Radionuclide wastewater discharges could increase over 1985 because the present situation alternative assumes that the plant will operate at maximum production and that under the present greater quantity of surface runoff from the production area are diverted to the Great Miami River. Analysis indicate that DOE radionuclide limits could be exceeded. Therefore, radionuclide discharges will have to be monitored, and mitigation taken, if limits approach DOE release limits. Because the existing NPDES permit levels could also be exceeded for total suspended solids, biological oxygen demand, nitrates, and hexavalent chromium (Cr^{+6}), new limits will have to be negotiated or mitigation implemented to reduce the concentrations of these contaminants. However, state of Ohio water quality standards (OEPA 1986), which are applied after water has mixed, are met.

Worker health and safety conditions are improved since 1985 as a result of the completion of 57 projects specifically designed for this purpose. Potential for accidental releases to the public due to transportation accidents involving waste shipments increased because of the increase in waste shipments. However, no accidental releases of contaminants to the public due to waste shipments have occurred to date.

4.2 PROPOSED ACTION

4.2.1 Air Quality

4.2.1.1 Construction

The additional proposed action renovation activities to be started after the EIS Record of Decision is completed, are expected to involve less activity outside building confinement and thus to create less disturbance to the site area than was the case for the renovations already completed. Therefore, air quality impacts from construction for renovation activities beyond 1989 are expected to be less than those of the present situation alternative [i.e. projects completed through 1989 (see Sect. 4.1.4.1)]. Because impacts were within standards for the present situation

alternative, no dispersion modeling analysis was conducted for air quality impacts from construction of the proposed action.

4.2.1.2 Operation

The emissions of SO_2, CO, and particulate matter from the boiler plant will not be changed as a result of the proposed action renovation. Because the boiler size and the fuel sulfur content would not increase, the facility would not be subject to New Source Review under Prevention of Significant Deterioration Regulations (40 CFR Pt. 52.21).

Predicted air quality impacts for the proposed action are the same as under the present situation alternative (Sect. 4.1.1, Table 4.1-2) because no additional major renovation projects affecting nonradiological air emissions are planned. Under normal operations, the concentrations of air pollutants for the proposed action would be well below NAAQS for criteria pollutants. Maximum predicted HF levels for the proposed action are near the lower end of the range of levels regulated by other states and are below site-specific limits prescribed by the Ohio State Air Quality permit (pending).

4.2.2 Impacts on water resources

4.2.2.1 Surface waters

Construction. Most proposed action renovation construction activities will take place within the FMPC industrial area. Within this area, runoff from building roofs, uncontrolled storage pads, and open areas collects in the Storm Sewer System. From there it goes to Manhole 34 where it is either monitored and discharged to the Great Miami River or, for periods of heavy rains, diverted to the SWRBs. After particulates are allowed to settle in the SWRBs, the stormwater is pumped to the force main near Manhole 34 for monitoring and discharge to Manhole 175 (Sect. 2.1.2). The two retention basins together are designed to contain runoff from a 24-h storm of a magnitude expected to occur on the average of once in 10 years. If stormwater overflows the SWRBs during renovation, adverse but short-term effects of increased contaminants and TSS levels on the lower reach of Paddy's Run are possible, however fairly rapid recovery would be expected.

Operation. Completion and operation of the proposed action will be beneficial as indicated by the comparison of contaminant discharge rates for the proposed action and present situation alternatives (Table 4.2-1). Some of the proposed projects involve expansion or enhancement of wastewater monitoring, collection, storage, and treatment procedures and facilities that should allow for more efficient removal of contaminants currently discharged to Paddy's Run and the Great Miami River. Two important renovation projects, the SWRBs and the Biodenitrification Facility, were completed under the present situation alternative (Sect. 4.1.2).

Table 4.2-1. Comparison of annual Feed Materials Production Center wastewater and pollutant discharges to the Great Miami River (Station 001) and to Paddy's Run (Station 002) for the proposed action and present situation alternative

Emission point	Pollutant[a]	Present situation[b]	Proposed action[b]
Manhole 175 (001)	Flow, MG	327.5	418.7
	pH	7.2-9	7.2-9
	TSS, kg	33,017	7,669
	BOD, kg	12,288	7,669
	$N\text{-}NO_3$, kg	41,925	22,687
	$N\text{-}NH_3$, kg	1,270	454
	O&G, kg	1,815	23
	Res. chlorine, kg	19	0
	F. coliform, mpn/100 mL	2,500	250
	Cr^{+6}, kg	4	0.4
	Cr, total kg	9.1	0.9
	Fe, kg	114	11.4
	Ni, kg	18.1	1.8
	Cu, kg	9.1	0.9
	Uranium, kg	1,260	126
	U, total Ci	0.85	0.085
	U-234, Ci	0.39	0.039
	U-235, Ci	0.0164	0.0016
	U-236, Ci	0.016	0.0016
	U-238, Ci	0.4	0.04
	Cs-137, Ci	0.015	0.0015
	Np-237, Ci	0.00031	0.000031
	Pu-238, Ci	0.000008	0.0000008
	Pu-239/240, Ci	0.000024	0.000002
	Ra-226, Ci	0.0066	0.00066
	Ra-228, Ci	0.0098	0.00098
	Ru-106, Ci	0.0016	0.0002
	Sr-90, Ci	0.0082	0.0008
	Tc-99, Ci	13.3	1.3
	Th-232, Ci	0.0005	0.00005
Stormwater Retention Basin overflow (002)	Flow, MG	0.3	0.3
	TSS, kg	57	57
	O&G, kg	1	1
	Uranium, kg	0.9	0.9
	U, total Ci	0.00043	0.00043

Source: Brettschneider Oct. 14, 1988.

Table 4.2-1 (continued)

[a]MG = millions of gallons,
TSS = total suspended solids,
BOD = biochemical oxygen demand,
O&G = oil and grease, and
mpn = most probable number.

[b]Based on the estimated maximum production level.

ASSUMPTIONS:

1. Only external discharge points are considered as source terms. Internal points such as 001B/C are factored for total contribution to MH-175. Discharges 001 and 002 are the only point sources for water emissions.
2. Averages for 1985 were used as more representative of true conditions than individual months.
3. Present situation assumptions: four-tower biodenitrification facility (BDN) with effluent treatment, two-chambered stormwater retention basin (SWRB). 1987 numbers were used as basis, since one SWRB and a two-tower BDN were on line. 1987 flow was adjusted upward to account for low rainfall that year. 1987/88 overflow flows were adjusted for operation of a second SWRB (ten-year rainfall event capacity rather than two-year). Assumed Sanitary Treatment Plant will produce 7.5 kg/d biochemical oxygen demand (BOD) (1750 people) and BDN effluent treatment will produce 17 kg/d (30 mg/L); stormwater will add 5 kg/d (1.19 mg/L). The NO_3 concentration at MH-175 will be 20 mg/L (70 kg/d). Stormwater collected in the Clear Well (CW) will be processed at the BDN. The average 1987 NO_3 at MH-175 was 90 kg/d; 22 kg/d was contributed by the CW. When these nitrates are treated at the BDN, the total nitrates at MH-175 will be 70 kg/d. In 1990 the total of 81 kg/d of TSS at MH-175 will be supplied as follows: 3 kg/d, GS/CW; 17 kg/d, BDN; 54 kg/d, stormwater; 7 kg/d, sanitary wastewater.
4. Proposed action assumptions: four-tower BDN with effluent treatment, advanced wastewater (AWW) treatment at MH-175. AWW treatment will be assumed to remove 90% of metals, O&G, and fecal coliform at MH-175. Significant amounts of BOD and TSS will also be removed by AWW treatment.
5. Sump renovation projects will not increase treatment efficiencies for metals removal, because current equipment will be replaced and not substantially changed. Metals contributions from the GS/CW in 1987 were slightly more than doubled for 1990 est. (1987 metals numbers were lower than 1985 numbers.)
6. Remedial activities were not considered in these calculations because they are not yet well enough defined.
7. Process wastewater contributed 40% of the total flow at MH-175 in 1985 and will contribute 19% of the total in 1990 and 17% in 1992+, as additional stormwater is collected.

A major proposed action projects is the advanced treatment of wastewater. The Advanced Wastewater Treatment (AWWT) Facility will be designed to treat stormwater and process effluents (to be discharged to the river) for removal of contaminants by sedimentation, filtration, granular activated carbon adsorption, ion exchange, and reverse osmosis. The AWWT Facility is expected to remove at least 90% of metals, radionuclides, oil and grease, and fecal coliforms and to lower significantly the amounts of BOD and suspended solids in the final effluent. The Biodenitrification Facility will substantially reduce nitrate discharges but will increase discharges of BOD, ammonia, and suspended solids.

Table 4.2-2 compares expected annual average Manhole 175 release rates of nonradioactive contaminants to the Great Miami River under the proposed action with NPDES permit limits and state water quality standards for warmwater streams. Note that several NPDES limits are for internal plant discharges (e.g., the sanitary treatment plant discharge) upstream of the Manhole 175 discharge to the Great Miami River. For this analysis, it was assumed that these permit limits could be applied to the final discharge to the river. Based on the information used in this analysis, the discharge to the Great Miami River could exceed existing NPDES permit limits for BOD and possibly nitrate at their respective permitted discharge points (see Table 4.2-2, footnotes i, j, and n). However, the current NPDES permit has expired and a new permit is being negotiated. DOE is committed to meeting all discharge limits. All other listed contaminants would occur at levels below NPDES limits. After mixing in the Great Miami River, concentrations of all listed contaminants attributable to FMPC will be far below the state water quality standards for the river as well, even at the record low flow of only 4430 L/s. Average river flow conditions (93,600 L/s) would further reduce contaminant concentrations attributable to FMPC by a factor of about 20.

None of the individual radionuclides for which information is available would be released to the Great Miami River at concentrations in excess of release limits set forth in DOE Draft Order 5400.xx (Table 4.2-3). Similarly, the cumulative radioactivity of all these radionuclides will not exceed DOE limits if AWWT works as planned. The AWWT will be designed such that the additive impact of all these radionuclides will not exceed DOE Draft Order 5400.xx limits. Although the listed radionuclides probably contribute most of the radioactivity released to surface waters, other, unmonitored radionuclides may also be present in the discharge.

Discharges to Paddy's Run via the SWRB overflow will show substantial decreases in levels of contaminants for which information is available, but concentrations of suspended solids will probably temporarily exceed the current NPDES permit limit during these infrequent events.

In conclusion, under the proposed action FMPC will release substantially lower quantities of most contaminants, but BOD and nitrates could exceed NPDES permit limits on discharges to the river. DOE will have

Table 4.2-2. Comparison of average annual nonradioactive pollutant releases under the proposed action with NPDES permit limits and state standards

	Estimated average releases[a] (kg/d)	(mg/L)	NPDES limit[b]	River concentration after mixing[c] (mg/L)	Ohio standard[d] (mg/L)
			To Great Miami River		
Water	3.4×10^6 L/d				
pH	7.2-9.0		6.5-9.0		6.5-9.0
7TSS[e]	21.0	5.56	20 mg/L	0.049	
BOD[f]	21.0	5.56	5[g] kg/d	0.049	
$N\text{-}NO_3$	62.2	14.4	62[h] kg/d	0.13	10
$N\text{-}NH_3$	1.24	0.287	12[h] kg/d	0.0026	$\geq$0.10
O&G[j]	0.063	0.015	15 mg/L	0.00013	no sheen
Res. Cl	0	0	0.10 mg/L	0	0.002
F. Coliform	250[k]		1000[k,g]	2.21[k]	1000[k]
Cr^{6+}	0.0011	0.00025	0.004[m] kg/d	2.2×10^{-6}	0.010
Cr total	0.0025	0.00057	0.050[g] kg/d	5.1×10^{-6}	
Fe	0.031	0.0072	0.41[m] kg/d	6.4×10^{-5}	1.0
Ni	0.0049	0.0011	0.124[m] kg/d	9.8×10^{-6}	$\geq$0.167
Cu	0.0025	0.00057	0.025[m] kg/d	5.1×10^{-6}	0.007
			To Paddy's Run[n]		
TSS	[p]	50	30 mg/L	[p]	
O&G	[p]	0.88	15 mg/L	[p]	no sheen

[a]*Source:* Brettschneider Oct. 14, 1988.

[b]*Source:* National Pollution Discharge Elimination System (refer to Reafsnyder Aug. 1, 1988).

[c]Attributable to FMPC releases; assumes the record minimum river flow of 4430 L/s and thorough mixing.

[d]*Source:* OEPA 1986.

[e]Total suspended solids.

Table 4.2-2 (continued)

---

[f]5-day biochemical oxygen demand.

[g]Effluent from sanitary treatment plant (001A).

[h]Effluent from bioreactor (001E).

[j]Oil and grease

[k]Colonies /100 ml.

[m]Combined loading of general sump (001B) and Clear Well (001C).

[n]Via Storm Sewer Outfall Ditch.

[p]Data unavailable.

Table 4.2-3. Proposed action: comparison of predicted radionuclide releases to the Great Miami River with U.S. Department of Energy liquid release limits

Isotope	Average annual effluent concentration[a] (pCi/L)	Release limit (5400.xx)[b] (pCi/L)	Ratio[c]
Sr-90	0.8	1,000	0.00080
Tc-99	1,300	100,000	0.013
Ru-106	0.16	6,000	2.75E-5
Cs-137	1.5	3,000	0.00050
Ra-226	0.6	100	0.0060
Ra-228	0.9	100	0.0090
Th-228	<0.05	400	<0.00013
Th-232	0.05	50	0.0010
Th-230	<0.06	300	<0.00020
U-232	<6.0[d]	100	<0.060
U-233	13	500	0.026
U-234	32	500	0.064
U-235	1.4	600	0.0023
U-236	1.3	500	0.0026
U-238	32	600	0.053
Np-237	<0.03	30	<0.0010
Pu-238	0.00082	40	2.1E-5
Pu-239/240	0.0023	30	7.7E-5
SUM OF RATIOS			0.18-0.24[e]

[a]*Source:* Brettschneider, D. J. October 14, 1988. These source terms are based on the assumption that the proposed Advanced Wastewater Treatment Facility will remove 90% of each radionuclide.

[b]DOE Draft Order 5400.xx. Radiation Protection of the Public and the Environment, March 18, 1988. When this order is finalized, DOE will have to comply with these generally much lower limits.

[c]Ratio of effluent concentration to release limit.

[d]Past value reported by WMCO; percent concentration is unknown, but probably less than past values (Eddlemon 1989).

[e]Lower value calculated on the basis that radionuclides not detected are present at the detection limit.

in place best available technoloy and has committed itself to comply with the pollutant limits prescribed in the NPDES permit currently under negotiation. The river's dilutive capacity will reduce concentrations of the contaminants attributable to FMPC to well below state water quality standards. Neither individual radionuclides nor total radioactivity on average will exceed DOE's proposed limits. The infrequent discharge to Paddy's Run via the Storm Sewer Outfall Ditch will be considerably improved over baseline conditions, although suspended solids may occasionally exceed the NPDES permit limit.

Control of runoff of the soils that are contaminated with uranium and other materials from the waste pit area is needed and planned as a remedial action project. During and after heavy rain some of these contaminants are washed into Paddy's Run although the quantity of these contaminants has not been measured. Cessation of contaminated runoff would benefit Paddy's Run by reducing uranium input.

4.2.2.2 Groundwater quality impacts

The groundwater impacts for the proposed action should be slightly reduced from those of the present situation because renovations in Plants 2/3 and 4 and the Pilot Plant will reduce uranium emissions to the atmosphere by ~16 kg/year (see Sect. 4.2.4). Therefore, less uranium should enter Paddy's Run and subsequently the Great Miami Aquifer as a result of reducing uranium atmospheric emissions from the renovation of the above plants.

4.2.3 Ecology

4.2.3.1 Terrestrial

Expected uranium emissions of 3 kg/year (82 lb/year) are 35% lower than emission levels of the present situation alternative (Sect. 4.2.4). Since the existing levels of uranium in vegetation due to prior operations are below those shown to be harmful to animals (Sect. 4.1.3.1), no adverse impacts are anticipated. Emissions of fluorides for the proposed action are expected to be about the same as the present situation and are not expected to result in adverse environmental impact (Sect. 4.1.3.1). However, an HF monitoring program will be conducted to observe visible damage to foliage of sensitive plant species and to monitor fluoride concentrations in herbage for livestock and wildlife (Sect. 4.1.3.1).

4.2.3.2 Aquatic

Construction

Runoff from the production area, the area of most renovation projects, would be contained and treated before being discharged to the Great Miami River as long as runoff does not exceed the capacity in the SWRBs. Containment of this runoff would eliminate most or all adverse effects from runoff on aquatic ecosystems. Adverse but short-term effects of increased contaminant and TSS levels on the aquatic communities in the

lower reach of Paddy's Run are possible if stormwater overflows the retention basin system; however, a fairly rapid recovery would be expected.

Operation

The proposed action would result in substantial reductions in the discharge of contaminants to the Great Miami River from the present situation alternative (Sect. 4.2.2.1). Water quality in the river would improve slightly. Beyond a reasonable mixing zone or that area in which effluent is being mixed with river water, contaminant concentrations attributable to the FMPC discharge would not exceed state water quality standards (Table 4.2-2), nor would they be likely to adversely affect aquatic life, even under record low river flow conditions.

The analysis in Table 4.2-4 shows that the estimated total internal radiation doses absorbed by fish (0.01 rad/year) and invertebrates (0.1 rad/year) attributable to FMPC releases to the Great Miami River would be only about one-tenth the doses calculated for these organisms under the present situation alternative. Furthermore, these doses would represent only 0.00390% (fish) and 0.03% (invertebrates) of the proposed DOE Draft Order 5400.xx limit of 365 rads/year (1 rad/d) for the protection of aquatic populations. DOE's proposed limit is consistent with the level of radiation exposure below which many researchers in biological effects of radiation believe aquatic populations would not be significantly affected (Blaylock 1989; Trabalka 1988; National Research Council of Canada 1983). Even immersion of aquatic organisms in undiluted effluent would result in absorbed doses (13 rads/year for invertebrates and 1.3 rads/year for fish) substantially below the proposed limit in DOE Draft Order 5400.xx.

This analysis indicates that contaminants examined here would not affect resident aquatic communities of the Great Miami River and that decreased pollutant loading of Paddy's Run (from the baseline level) would benefit aquatic communities. However, other potentially hazardous contaminants could occur in FMPC effluents (e.g., U-232, Pb-210, Ac-227, hexavalent chromium, and asbestos). These other contaminants have received only limited monitoring thus far. Therefore, quantification of these and other possible contaminants will be required as part of the environmental monitoring program (Sect. 4.6).

No federally designated threatened or endangered species are known to reside in either Paddy's Run or the Great Miami River. Two state-listed endangered minnows have been collected from the Great Miami River in the vicinity of the FMPC (see Sect. 3.7.2). Both species (the tonguetied minnow and the bigeye shiner) occur in other river systems. The known range of the tonguetied minnow in the Great Miami River does not extend closer than about 12 km (~7.5 mi) upstream of the FMPC outfall and is therefore unaffected by FMPC. The bigeye shiner has been collected from the confluence of the river and Paddy's Run. No adverse effects on any populations that may still exist are expected if turbidity and siltation from FMPC-related activities are adequately controlled.

Table 4.2-4. Proposed action: predicted annual releases of radionuclides and resulting dose rates to aquatic organisms in the Great Miami River

Isotope	Release rate (Ci/yr)	Effluent concentration[a] (pCi/L)	River concentration[b] (pCi/L)	Internal dose[c] at point of discharge		Internal dose[c] after complete mixing	
				Inverts. (rads/yr)	Fish (rads/yr)	Inverts. (rads/yr)	Fish (rads/yr)
Ra-226	0.00066	0.54	0.0047	0.28	0.054	0.0024	0.00047
Ra-228	0.00098	0.79	0.0070	0.28	0.055	0.0025	0.00049
Th-228[d]	0.000051	0.041	0.00036	0.090	0.0053	0.00080	0.000047
Th-230[d]	0.000062	0.050	0.00044	0.023	0.0014	0.00020	0.000012
Th-232[e]	0.000051	0.041	0.00036	0.090	0.0054	0.00080	0.000047
U-232[f]	0.0067	5.4	0.048	2.8	0.28	0.025	0.0025
U-233[f]	0.023	19	0.16	1.8	0.17	0.015	0.0015
U-234	0.039	31	0.28	2.9	0.29	0.026	0.0026
U-235	0.0016	1.2	0.011	0.11	0.011	0.00098	0.000098
U-236	0.0016	1.2	0.011	0.12	0.012	0.0010	0.00010
U-238	0.043	35	0.31	2.8	0.28	0.025	0.0025
Sr-90	0.00082	0.66	0.0059	0.0014	0.000067	0.000012	0.00000059
Tc-99	1.3	1100	9.5	0.0099	0.028	0.000084	0.00025
Ru-106	0.00016	0.12	0.0011	0.00099	0.000034	0.0000090	0.00000030

Table 4.2-4 (continued)

Isotope	Release rate (Ci/yr)	Effluent concentration[a] (pCi/L)	River concentration[b] (pCi/L)	Internal dose[c] at point of discharge		Internal dose[c] after complete mixing	
				Inverts. (rads/yr)	Fish (rads/yr)	Inverts. (rads/yr)	Fish (rads/yr)
Cs-137	0.0015	1.2	0.011	0.0014	0.0054	0.000012	0.000047
Np-237	0.000031	0.025	0.00022	0.0090	0.00023	0.000082	0.0000020
Pu-238	0.00000080	0.00064	0.0000057	0.000072	0.00024	0.00000063	0.0000021
Pu-239/240	0.0000024	0.0020	0.00007	0.00019	0.00068	0.0000017	0.000006
Total	1.4	1200	10	11.0	1.2	0.10	0.011
		Proposed limit[g]		365	365	365	365

[a]Source terms for theoretical maximum annual average concentrations in discharge to the Great Miami River in 1990 as provided by D. J. Brettschneider (October 14, 1988).

[b]Assumes an effluent discharge of 39.4 L/s and a record minimum river flow of 4400 L/s.

[c]Based on application of dose factors compiled by Killough and McKay (1976) to predicted concentrations in water.

[d]Source terms for Th-228 and -230 were not provided. Effluent concentration estimates used here are based on the assumption that relative concentrations of the three thorium isotopes in the effluent reflect concentrations measured in 1987 samples of river sediments.

[e]Internal dose factors for Th-232 were assumed to be equivalent to highest estimates available for a thorium isotope (Th-228).

[f]U-232 may no longer be present in plant discharges. U-232 and U-233 source terms are based on Clements Sept. 15, 1987.

[g]Expressed in proposed DOE Order 5400.xx as 1 rad/d.

In conclusion, the proposed action would be likely to improve water quality of the Great Miami River slightly, thereby benefitting aquatic communities in the river. The existing NPDES permit limit for BOD would continue to be exceeded at least occasionally, but no adverse effects would be anticipated. A small measure of uncertainty remains concerning the presence and importance of other effluents for which data are either lacking or are very limited.

4.2.4 Radiological Impacts to Public

There is little difference between radiation exposure resulting from the present situation and the proposed action because most projects that affect radiological releases due to operation are completed under the present situation alternative.

For the proposed action, expected emissions of uranium are 50 kg/year (110 lb/year) (Table 4.2-5). The impacts of the uranium emissions and the associated thorium release are discussed in the following sections.

4.2.4.1 General population and maximally exposed individual

Table 4.2-6 presents estimates of the annual radiation dose from FMPC uranium air emissions to the 2.6 million people within 80 km (50 miles) of FMPC. The proposed action alternative emissions result is a population dose - 22% smaller than the present situation alternative uranium emissions. In either case, the population dose is a small fraction of the background dose.

Table 4.2-6 presents maximally exposed individual dose estimates for the east and west sides of the site. A person at the east perimeter of the site would receive the maximum radiation exposure contributed by atmospheric uranium emissions generated by operation. A person on the west side perimeter would receive the maximum dose contributed by radon and gamma radiation produced by the K-65 silos. Thus, 2.2 mrem/year for uranium air emissions at the eastern plant boundary is the maximum exposure caused by FMPC operations. Adding radionuclide exposures from remedial action sites increases the dose to a person at the eastern boundary to 21 mrem/year for the present situation alternative. On the western FMPC boundary, an individual's dose caused by FMPC operations is 0.8 mrem/year. Adding radiation exposure from remedial action sites increases the dose to a person at the western boundary to 58 mrem/year.

4.2.4.2 Off-site agricultural impact

Radiation doses to off-site persons from uranium and thorium in the food chain would be about 0.2% of the maximum off-site dose. The estimated 0.008 mrem/year (Table 4.2-6) would be from eating vegetables, meat, and milk. Inhalation of radionuclides would continue to be the exposure route for over 99% of the individual dose.

Table 4.2-5. Estimates of uranium air emissions[a] for Feed Materials Production Center for the proposed action and the present situation alternatives

Emission point (plant)	Present situation[b] kg	Present situation[b] lb	Proposed action[b] kg	Proposed action[b] lb
	Monitored operational emissions			
1	0.2	0.4	0.1	0.3
2/3	6.6	14.6	0.2	0.5
4	11.9	26.1	11.9	26.1
5	3.3	7.2	3.3	7.2
6	3.0	6.6	[c]	[c]
8	1.4	3.0	1.1	2.4
9	0.9	1.9	0.04	0.1
Pilot Plant	1.5	3.4	0.3	0.6
Incinerator	0.0	0.0	0.0	0.0
Subtotal	29	63	17	37
	Unmonitored operational emissions[d]			
UO_3 gulping process	0.7	1.5	0.7	1.5
Laboratory hoods	3.1	6.8	0.1	0.2
Building exhausts	9.3	20.5	9.3	20.5
Other unmonitored processes	9.5	20.9	9.5	20.9
Subtotal	23	50	20	43
	Remedial action site emissions[d]			
Waste pit fugitives[e]	13	28	13	28
Total	65	141	50	108

[a]It is assumed that the ratio of uranium to other radiouncludes released from stack emissions remains the same for all alternatives (Boback et al. 1986).

[b]Assumes maximum FMPC production capacity.

[c]Less than 0.02 kg/year (0.05 lb/year).

[d]Engineering estimates.

[e]Remedial actions may reduce emissions (see Sect. 4.3).

Source: Brettschneider July 14, 1989.

Table 4.2-6. Annual radiation doses[a] to the general population and the maximally exposed individual resulting from Feed Materials Production Center operation under the proposed action and present situation alternatives

	Present situation[b]	Proposed action[b]
Dose to population within 80 km of FMPC		
Total FMPC uranium emissions	76 person-rem	59 person-rem
Maximally exposed individual: East		
Operations		
Uranium air emissions	2.9	2.2
Remedial action sites		
Waste pit area uranium air emissions	0.7	0.7
K-65 Silos radon[c]	18.1	18.1
Total	22	21
Maximally exposed individual: West		
Operations		
Uranium air emissions	1.1	0.8
Remedial action sites		
Waste pit area uranium air emissions	0.3	0.3
K-65 Silos radon[c]	47.2	47.2
K-65 direct gamma	9.5	9.5
Total	58	58
Water Pathway		
Great Miami River	0.15[d]	0.15[d]
Paddy's Run	1.3[d]	1.3[d]
Off-site wells[e]	38[f]	38[f]

[a]All doses are effective total-body doses in mrem/year except where noted. It is assumed that the ratio of uranium to other radionuclides remains the same as that found in 1985 (Boback 1986); therefore, thorium accounts for 18% and 13% of effective total-body and lung doses respectively.

Table 4.2-6 (continued)

---

[b]Remedial actions may reduce dose; however, the size of the reduction cannot be estimated until specific remedial actions are identified (see Sect. 4.3).

[c]In 1988, emissions were reduced by 33% because of silo dome maintenance. For this analysis it is assumed that further remedial action of the silo has not been performed. Remedial action could reduce the dose from this source.

[d]Dose expected to remain near 1985 levels because of residual contamination.

[e]This dose resulted from the highest annual average concentration found in off-site wells (WMCO 1986a, Table 11); however, these contaminated wells are not used for drinking water.

[f]Dose is expected to decrease if SWRB is primary source of contamination.

4.2.4.3 K-65 silos impacts

The K-65 silos are the major source of radon and gamma emission at FMPC. Table 4.2-6 assumes that radon emissions are the same as those in the present situation and that no further remedial actions will occur. The maximally exposed individual to the west of FMPC would continue to receive a total-body inhalation dose of 47.2 mrem/year and a direct external gamma dose of 9.5 mrem/year from the K-65 silos. See Sect. 4.4 for a more detailed description of the K-65 silos.

4.2.4.4 Risk calculation

Doses predicted for the maximally exposed individual in the proposed action alternative are converted to an excess annual risk of incurring fatal cancer (Table 4.2-7). The effective total-body dose to the maximally exposed individual (west of FMPC) is 58 mrem/year. A conservative (upper limit) estimate of risk to an adult exposed to 58 mrem is about 7.3 chances in 1,000,000 of contracting a fatal cancer. This risk is the same as the present situation alternative risk. The proposed action and present situation alternatives have the same radiological risk because most projects that affect major source terms would be completed under the present situation. Remedial action will address the release of radon from the K-65 silos, contaminated water in off-site wells, wind-blown contaminants from the waste pits, and direct gamma radiation from the K-65 silos.

4.2.5 Worker Radiation and Chemical Exposure

Four general areas regarding worker radiation exposure are targeted for corrective action. These areas are containment of radioactive and toxic materials, control of external radiation exposure, improved workplace monitoring, and improved medical monitoring. In addition, studies by NIOSH are providing an evaluation of worker radiation and chemical exposure. The proposed action includes about 60 projects (Appendix A, Table A.5) not included in the present situation that would be expected to result in further reduction in exposure of plant personnel both to radioactive and to hazardous materials. An improved personnel monitoring program should allow for a quantification of the positive impacts of these efforts. These worker health and safety projects would occur throughout the site, but 25% of them would occur in the metals and fabricating plant (Plant 6).

4.2.6 Waste Management

Waste materials are produced during operations and by renovation activities. Past activities have resulted in an accumulation of backlog wastes. This section describes waste management and waste transportation activities associated with the proposed action. Table 4.2-8 summarizes the waste management impacts of the proposed action and the current situation alternatives.

Table 4.2-7. Annual cancer risks associated with radiation doses projected to result from Feed Materials Production Center operation after completion of the proposed action[a]

	Annual dose[b] (mrem)	Annual cancer risk
Maximally exposed individual: East		
Operations		
Uranium air emissions[c]	1.9	0.2×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions[c]	0.7	0.09×10^{-6}
K-65 Silos radon	18.1	2.3×10^{-6}
Total[d]	21	2.6×10^{-6}
Maximally exposed individual: West		
Operations		
Uranium air emissions[c]	0.8	0.1×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions[c]	0.3	0.04×10^{-6}
K-65 Silos radon	47.2	5.9×10^{-6}
K-65 Silos direct gamma	9.5	1.2×10^{-6}
Total[d]	58	1.2×10^{-6}
Background		
Natural[e]	100	$13. \times 10^{-6}$
Background indoor radon[e]	200	$25. \times 10^{-6}$
Total[d]	300	$38. \times 10^{-6}$

[a]Remedial actions may reduce dose; however, magnitude of reduction cannot be determined until specific remedial actions are identified (see Sect. 4.3).

[b]Effective total-body dose.

[c]Dose from uranium air emissions includes doses from inhalation of air, immersion in contaminated air, ingestion of meat, milk and produce grown near the site, and exposure to deposition on ground.

[d]Totals may not add due to independent rounding.

[e]*Source:* NCRP 1987.

Table 4.2-8. Comparison of waste management impacts at the Feed Materials Production Center for the present situation and proposed action alternatives

Waste type	Present situation	Proposed action[a]
Low-level radioactive waste (LLW)	Operations: 230,000 ft^3/year ~200 shipments/year to NTS Backlog: 94,000 drum equivalents ~1,600 shipments to NTS Construction: 3,000 tons ~150 shipments to NTS Total: 1,750 shipments to NTS plus 200 shipments/year to NTS	Operations: 230,000 ft^3/year; ~200 shipments/year to NTS Backlog: 94,000 drum equivalents ~1,600 shipments to NTS Construction: 19,500 tons ~1,000 shipments to NTS Total: 2,600 shipments to NTS plus 200 shipments/year to NTS
Hazardous wastes	Operations: 44 ft^3/year (6 drum equivalents), shipped to ORGDP TSCA incinerator Backlog: 100 drum equivalents (1-2 shipments) will be shipped to ORGDP TSCA incinerator Construction: 60 drum equivalents (1 shipment) of asbestos, to be shipped to NTS Total: ~3 shipments/year to ORGDP and NTS	Operations: 44 ft^3/year, (6 drum equivalents) shipped to ORGDP TSCA incinerator Backlog: 100 drum equivalents (1-2 shipments) will be shipped to ORGDP TSCA incinerator Construction: 60 drum equivalents (1 shipment) of asbestos, to be shipped to NTS Total: ~3 shipments/year to ORGDP and NTS
Mixed waste	Operations: 4,000 ft^3/year (11 shipments to ORGDP) plus 70 drum equivalents of $BaCL_2$ waste from RMI stored at FMPC Backlog: 2,000 drum equivalents Excludes 160 drum equivalents of $BaCl_2$ in Pit 4 Construction: None	Operations: 4,000 ft^3/year (11 shipments to ORGDP) plus 70 drum equivalents/year of $BaCl_2$ wastes from RMI stored at FMPC Backlog: 2,000 drum equivalents Excludes 160 drum equivalents of $BaCl_2$ in Pit 4 Construction: None

Table 4.2-8 (continued)

Waste type	Present situation	Proposed action[a]
Mixed waste (cont'd)	Total: 11 shipments/year to ORGDP, 2,000 drum equivalents backlog less what is shipped to ORGDP plus 70 drum equivalents/year from RMI	Total: 11 shipments/year to ORGDP, 2,000 drum equivalents backlog less what is shipped to ORGDP plus 70 drum equivalents/year from RMI
Summary (LLW, hazardous and mixed waste	Total of ~2,750 LLW shipments to NTS over 5 years (FY 90-FY 94). Average ~550 shipments/year	Total of ~3,600 LLW shipments to NTS over 5 years (FY 90-FY 94). Average ~700 shipments/year
	Total of ~70 shipments of hazardous and mixed waste to ORGDP over 5 years. Average of 14 shipments/year	Total of ~70 shipments of hazardous and mixed waste to ORGDP over 5 years. Average 14 shipments/year
Conventional industrial waste	Operations: 200,000 ft^3/year. Some stored on-site and some shipped off-site to commercial landfill	Operations: 200,000 ft^3/year. Some stored on-site and some shipped off-site to commercial landfill
	Backlog: ~300,000 ft^3	Backlog: ~300,000 ft^3
	Construction: 8 million lb (80,000 ft^3) on-site disposal	Construction: 51 million lb (~510,000 ft^3) on-site disposal
	Total: 380,000 ft^3 plus 200,000 ft^3/year production waste	Total: 800,000 ft^3 plus 200,000 ft^3/year production waste

[a]Proposed action includes waste from present situation.

4.2.6.1 Operational wastes

Generation of operational wastes after the proposed action would not be expected to differ significantly from the present situation alternative. The principal differences would occur as a result of (1) increased uranium dust collection at the production facilities and (2) increased sludge production from wastewater treatment at AWWT. Based on the reduction in pollutants in the wastewater released to the Great Miami River (Table 4.1-3), the annual sludge production at AWWT would weigh 50,000 kg (110,000 lb), about 150 drum equivalents. The increased uranium dust collected would weigh about 17 kg/year (36 lb/year). These waste represent about a 1.5% increase over present situation.

4.2.6.2 Backlog wastes

The quantity of backlog wastes will continue to decline (same as present situation alternative) as off-site shipments continue to reduce the inventory. Shipments of backlog waste will be made regardless of the alternative. For FY 1990, quantities of backlog wastes are estimated as follows (Brettschneider Dec. 1, 1988):

Waste types	FY 1990 Quantity (drum equivalents)
Low-level waste	54,200
Process residue	23,140
Mixed Waste (assumed density of 50 lb/ft^3)	1,700
Conventional Industrial	
Boiler plant	2,500
Spent lime	10,000

The above quantities represent no change over FY 1989 levels.

4.2.6.3 Construction rubble

Completion of renovation beyond October 1, 1989, is estimated to generate an additional 35 x 10^6 kg (76 x 10^6 lb) of rubble, of which about 57% would be uncontaminated (Table 4.2-9) (Bogar 1988). The general types of impacts discussed under present situation alternative (Sect. 4.1.6.3) are also relevant here. Potential impacts from waste transportation for the proposed action are described in Sect. 4.2.6.4.

Uncontaminated construction rubble

The composition of the uncontaminated rubble is expected to be 62% soil and gravel, 18% resalable metal and equipment, 15% concrete and

Table 4.2-9. Estimated types and incremental quantities of construction rubble generated at FMPC for the proposed action[a]

Type of rubble	Incremental waste quantity due to completion of renovation[a] kg x 10^6	(lb x 10^6)
Contaminated (low-level radioactivity)	15	(33)
Uncontaminated	20	(43)
Total	35	(76)

[a]Estimated waste quantities that would be generated in addition to those given in Table 4.2-6, through 9/30/92 (i.e., estimated waste quantity generated 10/1/1989 through 9/30/1992).

Source: Bogar Oct. 3, 1988. Percentages of contaminated and uncontaminated rubble are based on data collected for the first 147 projects that were implemented.

asphalt, and 5% clean refuse. Potential impacts of interest, discussed in Sect. 4.1.6.3, are availability of land for rubble storage, environmental effects from storing the rubble, and effects of rubble storage on renovation and remedial action activities.

Soil and gravel represent the largest fraction of the uncontaminated rubble (26,890,648 lb). As a worst case, all of this rubble is assumed to be stored on site in the area currently used for this purpose (Fig. 4.1-2). The total volume (including current situation renovations sand and gravel) would be about 271,715 ft^3. Storing this in the existing area of about 15,000 ft^2 would create a pile averaging about 18 ft deep. Concrete and asphalt from additional renovation, when combined with that stored from the present situation alternative, would produce a volume of about 76,943 ft^3 (assuming average density of 100 lb/ft^3). If all concrete and asphalt were stored in the existing area (12,000 ft^2), then a pile averaging about 6 ft deep would be created. Impacts should not be significant with planned erosion controls. No adverse operational effects are anticipated from management of the uncontaminated rubble, because the rubble stockpile areas would not be located on either renovation or remedial action sites. The principal waste management effect of completing the renovation would be to increase the height of the rubble.

Contaminated construction rubble

About 42% of the total additional rubble from completing renovation is expected to be contaminated with low levels of radioactivity. Contaminated construction rubble is segregated by waste type and packaged for off-site shipment to NTS for disposal. This additional quantity of contaminated rubble would be 15×10^6 kg (33×10^6 lb).

Potential on-site effects of generating contaminated rubble can be evaluated by assuming that none of the waste is sent off-site and is stored at area IS-3 (Fig. 4.1-3). Temporary storage area IS-3 has enough space to store about 2065 shipments of rubble, which is more than adequate (see Sect. 4.2.6.4).

Environmental impacts of storing the contaminated rubble on-site would not be significant. Contaminated construction rubble would be stored in the same steel containers used for shipment. The dose rate of the container surface is limited by the U.S. Department of Transportation regulations (Sect. 4.1.6.4) so no significant dose to workers or the public would result. Exposure by other pathways is extremely unlikely because the wastes are sealed in containers.

4.2.6.4 Transportation

Under the proposed action, the number of LLW shipments from FMPC to NTS would increase by about 100 shipments annually for a total of about 800 shipments per year for 5 years due to the contaminated construction rubble generated by the renovation activities. The total number of shipments anticipated under the proposed action is shown in the waste disposal forecast given in Table 4.2-8 (WMCO 1988a).

The potential environmental impact of 800 shipments per year is small. Routine shipments result in a maximum dose to the driver of 11 mrem per trip (Section 4.1.6.4). In addition, two to three accidents per year could also occur. If contaminants are released, individuals in the immediate area (e.g., clean-up crews or drivers) could receive a whole-body dose of 2.6 mrem/h per individual (Section 4.1.6.4). Therefore, if an accident takes 2 h to clean up, a worker could receive 5 mrem. This dose is about 1.8% of annual background dose and 0.5% of the occupational dose standard.

4.2.7 Socioeconomics

The proposed action alternative entails additional expenditures and employment at FMPC as a result of extending the renovation to other parts of the operations. The employment and expenditures for material and equipment would extend the induced secondary employment, income, and expenditure effects discussed in Sect. 4.1.7 in the regional economy for several years beyond 1989.

Although production was significantly curtailed in late 1988 with an accompanying reduction in operating employment and expenditures, the following analyses are based on the employment and expenditure estimates assuming that all of the renovation projects listed in Appendix A, Table A.5, would be completed in the early 1990s and that production would be maintained at near the maximum capability. Therefore, these analyses provide an upper bound on the impacts of the proposed action.

4.2.7.1 Population and demography

The direct incremental employment for the proposed action alternative at FMPC is projected to reach its maximum of about 2200 in 1991. Maximum operating employment may vary up or down in subsequent years, but employment for renovations would decrease rapidly. The additional peak employment for the proposed action alternative would be only about 10% more than the increase anticipated for the peak employment for the present situation alternative (see Sect. 4.1.6). A 10% increase in employment compared with the present situation alternative would not materially change the significance of this employment on the local population or infrastructure.

4.2.7.2 Regional employment and income

The increase in direct and secondary income would be spread throughout the regional economy. Although estimates of total regional income values are quite large, no significant socioeconomic impacts would be expected because the effects would be spread over a very large existing regional economy. The estimated increase in combined direct and secondary employment for the maximum employment year of 1991 would be approximately 1% of the total civilian labor force in Hamilton, Butler, and Dearborn counties in 1985. The maximum estimated income impact of almost $240 million would be slightly over 1% of the personal income for these

three counties in 1985. These economic effects would be positive impacts but not unusual in terms of annual fluctuations. After peaking, the economic impacts would be reduced as expenditures for renovation decrease rapidly.

4.2.7.3 Schools

Any effects on public schools would be related to changes in local community populations. The small additional employment increase for the proposed action alternative would have an insignificant impact on the local schools.

4.2.7.4 Traffic

The proposed action alternative would extend the duration of impacts on traffic into the early 1990s. The maximum impact would occur in 1991. Traffic would increase at the intersection of State Routes 126 and 128 in Ross by about 800 vehicles during the morning and afternoon peaks. This could place the intersection near its capacity level, with traffic flow characterized by intermittent vehicular delays (see Appendix D). About 85% of the increase in rush hour traffic leading to these problems would be due to increased operations because many of the crafts personnel working on renovations would be on a 4 d/week, 10 h/d schedule, which would allow them to avoid the peak traffic hours.

Increased employment, especially in 1991, would result in greater traffic impacts at the intersection of Willey Road and State Route 128 during the afternoon as workers leave FMPC. These impacts principally affect FMPC operations employees (because construction workers have a later quitting time), and long delays are anticipated. Traffic impacts at other area intersections would be less significant because of increasing distance from FMPC or less use by employees.

Since the adverse impacts of increased traffic would be related to employee arrival and departure, the impacts could be diminished or perhaps mitigated with staggered work times designed to shift arrivals and departures to nonpeak hours. Other potential alternatives for mitigating traffic impacts could include adding lanes of traffic at the intersection in Ross or placing a traffic signal at the intersection of State Route 128 and Willey Road.

4.2.8 Summary

The proposed action would reduce discharges to the Great Miami River from the present situation, but the current NPDES permit levels for BOD would still be exceeded. DOE and EPA are currently renegotiating NPDES limits to reflect the best available wastewater treatment technology proposed for FMPC. DOE will not allow the NPDES limits that are finally set to be exceeded. All radionuclide releases to the river would meet DOE standards. Worker health and safety will continue to be improved as a result of 42 projects designed for that purpose. The calculated effective total-body radiological dose from air, surface water, and fish ingestion

pathways is 58 mrem/year. After the radon and direct gamma from the K-65 silos is eliminated, the maximum dose should be ~2.9 mrem/year. Eliminating uranium emissions from the Waste Pit Area would further reduce maximum doses to ~2.2 mrem/year. These doses are essentially the same as those for the present situation alternative.

4.3 CESSATION OF METAL PRODUCTION ALTERNATIVE

4.3.1 Air Quality

4.3.1.1 Construction

Renovation that would be completed under the cessation alternative would result in less construction activity outside of enclosed buildings than was the case for renovations completed under either the present situation or proposed action alternatives. Construction activity under the cessation alternative would generate some fugitive dust and other minor emissions from equipment exhaust, but the amounts of these emissions would be less than for the other alternative renovations (Sect. 4.1.1.1). Since the air quality impacts from the present situation alternative were within standards, the air quality impacts of construction associated with the cessation of metals production alternative would also be within standards.

4.3.1.2 Operation

Operational air pollutant emissions for the metals production cessation alternative would be less than those resulting from the present situation and the proposed action alternatives (Table 4.3-1) because this alternative would include shutdown of plants 4, 6, 9, and the pilot plant. Emissions of NO_x and HF from the facility would thereby be substantially reduced. Also, the boiler plant would operate less under the cessation alternative, reducing emissions of SO_2, NO_x, PM-10 and CO. Because the air quality impacts for the other alternatives would be well below NAAQS for criteria pollutants (Sect. 4.1.1), no additional dispersion modeling analyses were performed for the cessation of metals production alternative.

4.3.2 Impacts on Water Resources

4.3.2.1 Surface waters

Construction. Most construction related to the cessation alternative activities would take place within the FMPC industrial area. Within this area, runoff from building roofs, uncontrolled storage pads, and open areas collects in the Storm Sewer System. From there runoff flows to Manhole 34, where it is either monitored or discharged to the Great Miami River or, for periods of heavy rains, diverted to the SWRBs. After particulates are allowed to settle in the SWRBs, the stormwater is pumped to the force main near Manhole 34 for monitoring and discharge to Manhole 175 (Sect. 2.1.2). The two retention basins together are designed to contain runoff from a 24-h storm of a magnitude expected to occur on the average of once in 10 years. If stormwater overflows the SWRBs during renovation and cleaning operations, adverse but short-term effects of increased contaminants and

Table 4.3-1. Nonradiological operational air emissions for the present situation/proposed action[a] and for the cessation of metal production alternative

Pollutant	Source	Present situation[a] kg	Present situation[a] lb	Cessation alternative kg	Cessation alternative lb
NO_x	Plant 2/3	42	93	42	93
	Plant 6	1,621	3,573	0	0
	Plant 9	83	183	0	0
	Boiler Plant	268,142	591,151	163,501	360,458
	Total	269,887	595,000	163,543	360,551
SO_2	Boiler Plant	522,876	1,152,745	318,827	702,893
PM	Boiler Plant	20,543	45,289	12,526	27,615
CO	Plant 8	19	41	19	41
	Boiler Plant	95,765	211,125	58,393	128,735
	Total	95,783	211,166	58,412	128,776
HF	Plant 4	1.4	3	0	0
	Plant 8	3.2	7	3.2	7
	Pilot Plant	1,417	3,125	0	0
	Tank Farm	210	464	210	464
	Total	1,614	3,559	214	471
HNO_3	Tank Farm	139	306	139	306

[a]Emissions will be the same for the present situation and the proposed action alternatives. Assumes the facility is operating at maximum production capacity.

Source: Brettschneider July 14, 1989.

TSS levels on the lower reach of Paddy's Run are possible; however, fairly rapid recovery would be expected.

Operation. Operation under the cessation alternative would have largely the same beneficial effects on liquid effluent quality predicted for the proposed action (i.e., a substantially improved effluent compared with the present situation alternative). Moreover, cessation of metal production may slightly reduce the discharge of certain contaminants such as uranium to levels below those predicted for the proposed action. The extent of this reduction is not known, but most of the contaminants in the effluents are from sources other than metal production facilities.

Some of the proposed projects involve expansion or enhancement of wastewater monitoring, collection, storage, as well as treatment procedures and facilities that should allow for more efficient removal of contaminants currently discharged to the Great Miami River. Two important renovation projects, the SWRBs and the Biodenitrification Facility, were completed under the present situation alternative (Sect. 4.1.2).

The major cessation alternative project (also a proposed action project) is the wastewater treatment improvements project, which includes advanced treatment of wastewater. A CERCLA remedial action includes collection and treatment of waste pit area runoff. The AWWT will be designed to treat stormwater and process effluents (to be discharged to the river) for removal of contaminants by sedimentation, filtration, granular activated carbon adsorption, ion exchange, and reverse osmosis. The AWWT Facility is expected to remove at least 90% of metals, radionuclides, oil and grease, and fecal coliforms, and to lower significantly the amounts of BOD and suspended solids in the final effluent. The Biodenitrification Facility, a current situation project, will have substantially reduced nitrate discharges but will have increased discharges of BOD, ammonia, and suspended solids.

Expected annual average Manhole 175 release rates of nonradioactive contaminants to the Great Miami River under the proposed action alternative are compared with NPDES permit limits and state water quality standards for warmwater streams in Table 4.2-2. Pollutant releases under the cessation alternative are expected to be equivalent to, or slightly lower than, the estimated releases shown in Table 4.2-2 for the proposed action. For this reason, the release estimates shown in Table 4.2-2 are used in this analysis as well. Note that several NPDES limits are for internal plant discharges (e.g., the sanitary treatment plant discharge) upstream of the Manhole 175 discharge to the Great Miami River. For this analysis, it was assumed that these permit limits could be applied to the final discharge to the river. Based on the information used in this analysis, the discharge to the Great Miami River could exceed existing NPDES permit limits for BOD and possibly nitrate at their respective permitted discharge points (see Table 4.2.2, footnotes i, j, and n). However, the current NPDES permit has expired, and a new permit is being negotiated. DOE is committed to meeting all discharge limits. All other listed contaminants would occur at levels below NPDES limits. After mixing in the Great Miami River, concentrations of all listed contaminants attributable to FMPC would be far below the

state water quality standards for the river, even at the record low flow of only 4430 L/s. Average river flow conditions (93,600 L/s) would further reduce contaminant concentrations attributable to FMPC by a factor of about 20.

None of the individual radionuclides for which information is available would be released to the Great Miami River at concentrations in excess of release limits set forth in DOE Draft Order 5400.xx (Table 4.2-3). The AWWT would be designed such that the additive impact of all these radionuclides would not exceed DOE Draft Order 5400.xx limits. Although the listed radionuclides probably contribute most of the radioactivity released to surface waters, other unmonitored radionuclides may also be present in the discharge.

Discharges to Paddy's Run via the SWRB overflow would show substantial decreases in levels of contaminants for which information is available, but concentrations of suspended solids would probably temporarily exceed the current NPDES permit limit during these infrequent events.

In conclusion, under the cessation alternative FMPC would release substantially lower quantities of most contaminants as compared with the present situation alternative, but BOD and nitrates could exceed NPDES permit limits on discharges to the river. NPDES limits would be met either by reducing contaminant levels or renegotiating higher limits. Neither individual radionuclides nor total radioactivity on average would exceed DOE's proposed limits. The infrequent discharge to Paddy's Run via the Storm Sewer Retention Basin overflow would be considerably improved over baseline conditions, although suspended solids may occasionally exceed the NPDES permit limit.

Control of runoff of the soils that are contaminated with uranium and other materials from the waste pit area is needed. During and after heavy rain some of these contaminants are washed into Paddy's Run, although the quantity of these contaminants has not been measured. Interception, treatment, and diversion to the Great Miami River of contaminated runoff would benefit Paddy's Run by reducing the input of uranium and other contaminants.

4.3.2.2 Groundwater quality impacts

The groundwater impacts for the cessation alternative should be slightly reduced from those of the present situation because shutdown of uranium production would reduce uranium emissions to the atmosphere ~31 kg/year (~68 lb/year) (see Sect. 4.3.4). Therefore, less uranium should enter Paddy's Run and subsequently the Great Miami Aquifer as a result of reducing atmospheric emissions of uranium.

4.3.3 Ecology

4.3.3.1 Terrestrial

Expected uranium emissions of 34 kg/year (74 lb/year) are lower than emission levels of the present situation alternatives (Sect. 4.3.4). Since the existing levels of uranium in vegetation due to prior operations are below those shown to be harmful to animals (Sect. 4.1.3.1), no adverse impacts are anticipated. Emissions of fluorides for the cessation alternative are expected to be less than those for the present situation and proposed action alternative and are not expected to result in adverse environmental impacts (Sect. 4.1.3.1).

4.3.3.2 Aquatic

Construction. Runoff from the production area, where most renovation and cessation activities would be performed, would be contained and treated before being discharged to the Great Miami River as long as runoff does not exceed the capacity in the SWRBs. Containment of this runoff would eliminate most or all adverse effects from runoff on aquatic ecosystems. Adverse but short-term effects of increased contaminant and TSS levels on the aquatic communities in the lower reach of Paddy's Run are possible if stormwater overflows the retention basin system; however, a fairly rapid recovery would be expected. Best waste management practices would be used to contain runoff.

Operation. The cessation alternative would result in substantial reductions in the discharge of contaminants to the Great Miami River from levels of the present situation alternative (Sect. 4.3.2.1). Water quality in the river would improve slightly. Beyond a reasonable mixing zone (that area in which effluent is being mixed with river water), contaminant concentrations attributable to the FMPC discharge would not exceed state water quality standards (Table 4.2-2), nor would they be likely to adversely affect aquatic life, even under record low river flow conditions.

Pollutant releases under the cessation alternative would be expected to be equivalent to, or slightly lower than, the estimated releases for the proposed action (Sect. 4.3.2.1). For this reason, the dose estimates for aquatic organisms under the proposed action set forth in Table 4.2-4 are used in this analysis as well. Table 4.2-4 shows that the estimated total internal radiation doses absorbed by fish (0.01 rad/year) and invertebrates (0.1 rad/year) attributable to FMPC releases to the Great Miami River would be only about one-tenth the doses calculated for these organisms under the present situation alternative. Furthermore, these doses would represent only 0.003% (fish) and 0.03% (invertebrates) of the proposed DOE Draft Order 5400.xx limit of 365 rads/year (1 rad/d) for the protection of aquatic populations. DOE's proposed limit is consistent with the level of radiation exposure below which many researchers in biological effects of radiation believe aquatic populations would not be significantly affected (Blaylock 1979; Trabalka 1988; National Research Council of Canada 1983). Even immersion of aquatic organisms in undiluted effluent would result in

absorbed doses (13 rads/year for invertebrates and 1.3 rads/year for fish) substantially below the proposed limit in DOE Draft Order 5400.xx.

This analysis indicates that contaminants examined here would not affect resident aquatic communities of the Great Miami River and that decreased pollutant loading of Paddy's Run (from the baseline level) would benefit aquatic communities. However, other potentially hazardous contaminants that could occur in FMPC effluents (e.g., U-232, Pb-210, Ac-227, hexavalent chromium, and asbestos) have received only limited monitoring thus far. Therefore, these and other possible contaminants will be monitored as part of the environmental monitoring program (Sect. 4.6).

No federally designated threatened or endangered species are known to inhabit either Paddy's Run or the Great Miami River. Two state-listed endangered minnows have been collected from the Great Miami River in the vicinity of FMPC (see Sect. 3.7.2). Both species (the tonguetied minnow and the bigeye shiner) occur in other river systems. The known range of the tonguetied minnow in the Great Miami River does not extend closer than about 12 km (~7.5 mi) upstream of the FMPC outfall and is therefore unaffected by FMPC. The bigeye shiner has been collected from the confluence of the river and Paddy's Run. No adverse effects on any populations that may still exist are expected if turbidity and siltation from FMPC-related activities are adequately controlled.

In conclusion, the cessation alternative would be likely to improve water quality of the Great Miami River slightly, thereby benefitting aquatic communities in the river. The existing NPDES permit for BOD could continue to be exceeded at least occasionally, but no adverse ecological effects would be anticipated. A small measure of uncertainty remains concerning the presence and importance of other effluents for which data are either lacking or are very limited.

4.3.4 Radiological Impacts to Public

There are only small differences between radiation exposures resulting from the cessation alternative, the present situation, and the proposed action because the projects that most reduce operational releases of radionuclides were under the present situation alternative and because the biggest part of the dose to the nearest exposed individuals is from remedial action sites.

For the cessation alternative, expected emissions of uranium are 34 kg/year (74 lb/year) (Table 4.3-2). The impacts of the uranium emissions and the associated thorium release are discussed in the following sections.

4.3.4.1 General population and maximally exposed individual

Table 4.3-3 presents estimates of the annual radiation dose from FMPC uranium air emissions to the 2.6 million people within 80 km (50 miles) of FMPC. The cessation alternative emissions result in a population dose ~54% smaller than the dose from present situation alternative uranium

Table 4.3-2. Estimates of uranium air emissions[a] for Feed Materials Production Center for the cessation of metal production alternative, the proposed action, and the present situation alternatives

Emission point (plant)	Present situation		Proposed action[b]		Cessation alternative	
	kg	lb	kg	lb	kg	lb
			Monitored operational emissions			
1	0.2	0.4	0.1	0.3	0.1	0.3
2/3	6.6	14.6	0.2	0.5	0.2	0.5
4	11.9	26.1	11.9	26.1	0.0	0.0
5	3.3	7.2	3.3	7.2	0.0	0.0
6	3.0	6.6	[c]	[c]	0.0	0.0
8	1.4	3.0	1.1	2.4	1.1	2.4
9	0.9	1.9	0.04	0.1	0.0	0.0
Pilot Plant	1.5	3.4	0.3	0.6	0.0	0.0
Incinerator	0.0	0.0	0.0	0.0	0.0	0.0
Subtotal	29	63	17	37	1.4	3.2
			Unmonitored operational emissions[d]			
UO_3 gulping process	0.7	1.5	0.7	1.5	0.7	1.5
Laboratory hoods	3.1	6.8	0.1	0.2	0.1	0.2
Building exhausts	9.3	20.5	9.3	20.5	9.3	20.5
Other unmonitored processes	9.5	20.9	9.5	20.9	5.2	11.4
Subtotal	23	50	20	43	15	34
			Remedial action site emissions[d]			
Waste pit fugitives[e]	13	28	13	28	13	28
Total	65	141	50	108	30	65

[a]It is assumed that the ratio of uranium to other radiouncludes released from stack emissions remains the same for all alternatives (Boback et al. 1986).

[b]Assumes maximum FMPC production capacity.

[c]Less than 0.02 kg/year (0.05 lb/year).

[d]Engineering estimates.

[e]Remedial actions may reduce emissions (see Sect. 4.3).

Source: Brettschneider May 12, 1989; Saylor Oct. 4, 1989.

Table 4.3-3. Annual radiation doses[a] to the general population and the maximally exposed individual resulting from Feed Materials Production Center operation under the cessation of metal production alternative, the proposed action, and present situation alternatives

	Present situation[b]	Proposed action[b]	Cessation alternative[b]
Dose to population within 80 km of FMPC			
Total FMPC uranium emissions	76 person-rem	59 person-rem	35 person-rem
Maximally exposed individual: East			
Operations			
Uranium air emissions	2.9	2.2	0.9
Remedial action sites			
Waste pit area uranium air emissions	0.7	0.7	0.7
K-65 Silos radon[c]	18.1	18.1	18.1
Total	22	21	20
Maximally exposed individual: West			
Operations			
Uranium air emissions	1.1	0.8	0.4
Remedial action sites			
Waste pit area uranium air emissions	0.3	0.3	0.3
K-65 Silos radon[c]	47.2	47.2	47.2
K-65 direct gamma	9.5	9.5	9.5
Total	58	58	57
Water Pathway			
Great Miami River	0.15[d]	0.15[d]	0.15[d]
Paddy's Run	1.3[d]	1.3[d]	1.3[d]
Off-site wells[e]	38[f]	38[f]	38[f]

[a]All doses are effective total-body doses in mrem/year except where noted. It is assumed that the ratio of uranium to other radionuclides remains

Table 4.3-3 (continued)

the same as that found in 1985 (Boback 1986); therefore, thorium accounts for 18% and 13% of effective total-body and lung doses respectively.

[b]Remedial actions may reduce dose; however, the size of the reduction cannot be estimated until specific remedial actions are identified (see Sect. 4.3).

[c]In 1988 emissions were reduced by 33% because of silo dome maintenance. For this analysis it is assumed that further remedial action of the silo has not been performed. Remedial action could reduce the dose from this source.

[d]Dose expected to remain near 1985 levels because of residual contamination.

[e]This dose resulted from the highest annual average concentration found in off-site wells (WMCO 1986a, Table 11); however, these contaminated wells are not used for drinking water.

[f]Dose is expected to decrease if the Storm Water Retention Basin is the primary source of contamination.

emissions. In either case, the population dose is a small fraction of the background dose.

Table 4.3-3 presents estimates of the dose to the maximally exposed individual for the east and west sides of the site. A person at the east perimeter of the site would receive the maximum radiation exposure contributed by atmospheric uranium emissions generated by operation. A person on the west perimeter would receive the maximum dose contributed by radon and gamma radiation produced by the K-65 silos. Thus 0.9 mrem/year for uranium air emissions at the eastern plant boundary is the maximum exposure attributable to FMPC operations after shutdown. Adding radionuclide exposures from remedial action sites increases the dose to a person at the eastern boundary to 20 mrem/year for the cessation alternative. On the western FMPC boundary, an individual's dose caused by FMPC operations after shutdown is 0.4 mrem/year. Adding radiation exposure from remedial action sites increases the dose to a person at the western boundary to 57 mrem/year.

4.3.4.2 Off-site agricultural impact

Radiation doses to off-site persons from uranium and thorium in the food chain would be ~0.2% of the maximum off-site dose. The estimated 0.002 mrem/year would be from eating vegetables, meat, and milk. Inhalation of radionuclides would continue to be the exposure route for over 99% of the individual dose.

4.3.4.3 K-65 silos impacts

The K-65 silos are the major source of radon and gamma emission at FMPC. Table 4.3-3 assumes that radon emissions are the same as those in the present situation and that no further remedial actions will occur. The maximally exposed individual to the west of FMPC would continue to receive a total-body inhalation dose of 47.2 mrem/year and a direct external gamma dose of 9.5 mrem/year from the K-65 silos. Sect. 4.4 gives a more detailed description of the K-65 silos.

4.3.4.4 Risk calculation

Doses predicted for the maximally exposed individual under the cessation alternative are converted to an excess annual risk of incurring fatal cancer (Table 4.3-4). The effective total-body dose to the maximally exposed individual (west of FMPC) is 57 mrem/year. A conservative (upper limit) estimate of risk to an adult exposed to 57 mrem is about 7.2 chances in 1,000,000 of contracting fatal cancer. This risk is the same as the present situation alternative risk. The cessation, proposed action, and present situation alternatives carry about the same radiological risks because most projects that affect major source terms would be completed under the present situation and because most of the radiological risk comes from the remedial action sites, not operations. Remedial action will address the release of radon from the K-65 silos, contaminated water in off-site wells, wind-blown contaminants from the waste pits, and direct gamma radiation from the K-65 silos.

Table 4.3-4. Annual cancer risks associated with radiation doses projected to result from Feed Materials Production Center operation after completion of the cessation of metal production alternative[a]

	Annual dose[b] (mrem)	Annual cancer risk
Maximally exposed individual: East		
Operations		
Uranium air emissions[c]	0.9	0.1×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions[c]	0.7	0.1×10^{-6}
K-65 Silos radon	18.1	2.3×10^{-6}
Total[d]	20	2.5×10^{-6}
Maximally exposed individual: West		
Operations		
Uranium air emissions[c]	0.4	0.05×10^{-6}
Remedial action sites		
Waste pit area uranium air emissions[c]	0.3	0.04×10^{-6}
K-65 Silos radon	47.2	5.9×10^{-6}
K-65 Silos direct gamma	9.5	1.2×10^{-6}
Total[d]	58	7.2×10^{-6}
Background		
Natural[e]	100	$13. \times 10^{-6}$
Background indoor radon[e]	200	$25. \times 10^{-6}$
Total[d]	300	$38. \times 10^{-6}$

[a]Remedial actions may reduce dose; however, magnitude of reduction cannot be determined until specific remedial actions are identified (see Sect. 4.3).

[b]Effective total-body dose.

[c]Dose from uranium air emissions includes doses from inhalation of air, immersion in contaminated air, ingestion of meat, milk and produce grown near the site, and exposure to deposition on ground.

[d]Totals may not add due to independent rounding.

[e]*Source:* NCRP 1987.

4.3.5 Worker Radiation and Chemical Exposure

Four general areas affecting worker radiation exposure are targeted for corrective action: (1) containment of radioactive and toxic materials, (2) control of external radiation exposure, (3) improved workplace monitoring, (4) and improved medical monitoring. In addition, studies by NIOSH are providing an evaluation of worker radiation and chemical exposure. The cessation alternative would be expected to result in further reduction in exposure of plant personnel both to radioactive and to hazardous materials. An improved personnel monitoring program should allow for a quantification of the positive impacts of these efforts. Worker health and safety projects would occur throughout the site during and after the transition of the facility to no metal production. Some activities (e.g. cleaning furnaces) that would take place as a result of a decision to shut down are a part of the normal maintenance program. Changing to a safe shutdown configuration is not expected to result in different exposure scenarios from those incurred durng normal operation and maintenance.

4.3.6 Waste Management

Waste materials are generated during operations and by renovation activities. In addition, past activities have resulted in an accumulation of backlog wastes. This section describes waste management and transportation activities associated with the cessation alternative. Table 4.3-5 summarizes the waste management impacts of the cessation alternative, the proposed action, and the present situation alternative.

4.3.6.1 Operational wastes

Generation of operational wastes after cessation would be expected to be substantially less than under either the proposed action or the present situation alternatives. The reduced waste generation would result from reduced production of uranium metals. However, waste generation would not be expected to stop because Plant 2/3 and the Biodenitrification Facility would continue processing residues. Waste management facilities, such as the AWWT and the Stormwater Retention Basin, would also continue to operate and generate solid waste. The amount of waste that would be generated by these activities is not known but would be substantially less than under the other alternatives.

4.3.6.2 Backlog wastes

As is the situation with the other alternatives, the quantity of backlog waste would continue to decline under the cessation alternative as off-site shipments continue to reduce the inventory. See Sect. 4.2.6.2 for details.

000275

Table 4.3-5. Comparison of waste management impacts at the Feed Materials Production Center (FMPC) for the present situation, proposed action, and cessation of metal production alternatives

Waste source	Present situation	Proposed action[a]	Cessation of metal production alternative
		Low-level radioactive waste (LLW)	
Operations:	230,000 ft^3/year ~200 shipments/year to NTS[b]	230,000 ft^3/year ~200 shipments/year to NTS	45,000 ft^3/year ~30 shipments/year to NTS
Backlog:	94,000 drum equivalents ~1,600 shipments to NTS	94,000 drum equivalents ~1,600 shipments to NTS	94,000 drum equivalents ~1,600 shipments to NTS
Construction:	31,000,000 lb ~800 shipments to NTS	52,000,000 lb ~1,300 shipments to NTS	35,000,000 lb ~900 shipments to NTS
Total:	~2,400 shipments to NTS plus 200 operational waste shipments/year to NTS	~2,900 shipments to NTS plus 200 operational waste shipments/year to NTS	~2,500 shipments to NTS plus ~30 operational waste shipments per year to NTS
		Hazardous wastes	
Operations:	44 ft^3/year (6 drum equivalents) shipped to ORGDP[b] TSCA[b] incinerator	44 ft^3/year (6 drum equivalents) shipped to ORGDP[b] TSCA incinerator	13 ft^3/year (2 drum equivalents) shipped to ORGDP TSCA incinerator
Backlog:	100 drum equivalents (1-2 shipments) will be shipped to ORGDP TSCA incinerator	100 drum equivalents (1-2 shipments) will be shipped to ORGDP TSCA incinerator	100 drum equivalents (1-2 shipments) will be shipped to ORGDP TSCA incinerator
Construction:	60 drum equivalents (1 shipment) of asbestos, to be shipped to NTS	60 drum equivalents (1 shipment) of asbestos, to be shipped to NTS	60 drum equivalents (1 shipment) of asbestos, to be shipped to NTS
Total:	~3 shipments/year to ORGDP and NTS	~3 shipments/year to ORGDP and NTS	~3 shipments/year to ORGDP and NTS
		Mixed waste	
Operations:	4,000 ft^3/year (11 shipments to ORGDP) plus 70 drum equivalents of $BaCl_2$ waste from RMI[b] stored at FMPC	4,000 ft^3/year (11 shipments to ORGDP) plus 70 drum equivalents/year of $BaCl_2$ wastes from RMI stored at FMPC	1,300 ft^3/year (4 shipments to ORGDP) plus 70 drum equivalents/year of $BaCl_2$ wastes from RMI stored at FMPC

F-0441

Table 4.3-5 (continued)

Waste source	Present situation	Proposed action[a]	Cessation of metal production alternative
	Mixed waste (continued)		
Backlog:	2,000 drum equivalents Excludes 160 drum equivalents of $BaCl_2$ in Pit 4	2,000 drum equivalents Excludes 160 drum equivalents of $BaCl_2$ in Pit 4	2,000 drum equivalents Excludes 160 drum equivalents of $BaCl_2$ in Pit 4
Construction:	None	None	None
Total:	11 shipments/year to ORGDP. 2,000 drum equivalents backlog less what is shipped to ORGDP plus 70 drum equivalents/year from RMI	11 shipments/year to ORGDP. 2,000 drum equivalents backlog less what is shipped to ORGDP plus 70 drum equivalents/year from RMI	4 shipments/year to ORGDP. 2,000 drum equivalents backlog less what is shipped to ORGDP plus 70 drum equivalents/year from RMI
	Summary for low-level, hazardous and mixed wastes		
	Total of ~3,400 LLW shipments to NTS over 5 years (FY 90-FY 94). Average ~700 shipments/year	Total of ~3,900 LLW shipments to NTS over 5 years (FY 90-FY 94). Average ~800 shipments/year	Total of ~2,700 LLW shipments to NTS over 5 years (FY 90-FY 94). Average ~500 shipments/year
	Total of ~70 shipments of hazardous and mixed waste to ORGDP over 5 years. Average of 14 shipments/year	Total of ~70 shipments of hazardous and mixed waste to ORGDP over 5 years. Average 14 shipments/year	Total of ~35 shipments of hazardous and mixed waste to ORGDP over 5 years. Average of 7 shipments/year
	Conventional industrial waste		
Operations:	200,000 ft^3/year. Some stored on-site and some shipped off-site to commercial landfill	200,000 ft^3/year. Some stored on-site and some shipped off-site to commercial landfill	60,000 ft^3/year. Some stored on-site and some shipped off-site to commercial landfill
Backlog:	~300,000 ft^3	~300,000 ft^3	~300,000 ft^3
Construction:	~41,000,000 lb (410,000 ft^3) on-site disposal	~68,000,000 lb (~680,000 ft^3) on-site disposal	~47,000,000 lb (~470,000 ft^3) on-site disposal
Total:	~700,000 ft^3 plus 200,000 ft^3/year production waste	~1,000,000 ft^3 plus 200,000 ft^3/year production waste	~800,000 ft^3 plus unknown annual amount of production waste

[a]Includes waste from present situation.

[b]NTS = Nevada Test Site; ORGDP = Oak Ridge Gaseous Diffusion Plant; TSCA = Toxic Substances Control Act of 1976; RMI = Reactive Metals, Inc.

E-0441

000275

4.3.6.3 Construction rubble

The cessation alternative involves the same renovation projects as the present situation alternative, with the addition of 49 additional projects including the wastewater treatment improvement projects (Project 143). Consequently, essentially the same amount of construction rubble would be generated under the cessation alternative as under the present situation alternative. The quantities of construction rubble generated are summarized on Table 4.3-5. The characteristics of the rubble and plans for disposal are described in Sect. 4.1.6.3.

4.3.6.4 Transportation

Under the cessation alternative, the number of LLW shipments from FMPC to NTS would about 400 shipments estimated for the present situation alternative because less operational waste would be generated. After 5 years (circa 1994), waste shipments to NTS would drop to less than 200/year. The 2500 shipments anticipated are somewhat less than the 2900 LLW shipments anticipated for the present situation alternative, as shown in Table 4.3-5.

The potential environmental impact of ~500 shipments per year is small. Routine shipments result in a maximum dose to the driver of 11 mrem per trip (Sect. 4.1.6.4). Two or three accidents per year in which radioactive materials are released would be expected. If contaminants are released, individuals in the immediate area (e.g., clean-up crews or drivers) could receive a whole-body dose of 2.6 mrem/h per individual (Sect. 4.1.6.4). If cleanup after an accident takes 2 h, a worker could receive ~5 mrem. This dose is ~1.8% of the annual background dose and 0.5% of the occupational dose standard.

4.3.7 Socioeconomics

The cessation alternative entails decreased expenditures and employment after 1989 as a result of curtailment of the renovation and operation activities at FMPC. However, because of significant expenditures for remedial actions, regional income and employment associated with FMPC would remain approximately the same as or somewhat higher than 1985 levels. The largest socioeconomic impact in this alternative would occur as a result of the reduction of regional employment and personal income of 0.4% and 0.5% respectively from 1989 to 1990.

4.3.7.1 Population and demography

Direct employment would be reduced to about 900 from 1989 to 1990. This would lower direct employment at FMPC by ~36% for 1989, but the effect would be reduced to ~20% as expenditures on remedial actions increased in 1991 and 1992. This decrease in employment would not have a significant effect on the local population.

4.3.7.2 Regional employment and income

The decrease in direct and secondary income would be spread throughout the regional economy. The estimated decrease in regional combined direct and secondary employment from 1989 to 1990 would be -0.6%. Income for the region would decrease by -0.7% which would have a negative effect on the regional economy. The significance of this impact would depend on the prevailing economic conditions. In June 1989 unemployment was 6.2% in Butler County and 4.8% in Hamilton County. These relatively low rates of unemployment suggest that the regional economy would be able to absorb some of the unemployment induced by the FMPC shutdown. More significant impacts could be expected if unemployment levels increase from their current levels.

4.3.7.3 Schools

Any effects on public schools would be related to changes in local community populations. The small decrease in employment resulting from the shutdown would not have an appreciable effect on any local schools.

4.3.7.4 Traffic

The cessation alternative would result in smaller traffic impacts than in FY 1987 when employment at FMPC was highest. Following the trend of reduced employment for operations, peak hour traffic at the intersection of State Routes 126 and 128 would continue to decline through 1995. A similar trend would take place at the intersection of Willey Road and State Route 128.

4.3.8 Summary

The cessation alternative would reduce discharges to the Great Miami River about the same amount as the proposed action alternative, but the current NPDES permit levels for BOD could still be exceeded. DOE and EPA are currently renegotiating NPDES limits to reflect the best available wastewater treatment technology proposed for FMPC. DOE will not tolerate exceeding of the NPDES limits that are finally set. Emissions of NO_x, SO_2, CO and particulates are decreased by about 40% from the present situation and are well below NAAQS for criteria pollutants. Product shipments would be eliminated or greatly reduced, thus removing possibilities for transportation accidents and reducing potential worker exposure in producing uranium metal. All radionuclide releases to the river would meet DOE standards. Worker health and safety will continue to be improved as a result of about 25 projects designed for that purpose. Uranium air emissions due to operations of the plant are reduced about 54% from the present situation. The calculated effective total-body radiological dose from air, surface water, and fish ingestion pathways is 57 mrem/year. After the radon and direct gamma from the K-65 silos is eliminated, the maximum dose should be -1.6 mrem/year. Eliminating uranium emissions from the Waste Pit Area would further reduce maximum doses to -0.9 mrem/year. These doses are lower than those for the present situation and proposed

action alternatives because atmospheric emissions of uranium would be reduced by this alternative.

4.4 REMEDIAL ACTIONS

The remedial actions being planned will be carried out under the FMPC RI/FS. The RI phase is a systematic, comprehensive investigation of environmental and public health problems associated with past facility operations. The FS phase evaluates corrective and mitigative actions for the environmental problems identified in the RI phase. EPA will approve the remedial actions to be performed.

4.4.1 Scope of Remedial Actions at FMPC

The distinction between remedial actions and plant renovations is sometimes unclear. However, renovations are generally needed for safe and efficient plant operations, while remedial actions are needed to correct environmental problems resulting from past operations. Some renovation projects such as the SWRBs have corrected the primary cause of environmental problems such as the south groundwater plume. The remedial action program will address the need to clean up the plume itself.

The purpose of this section is to indicate the magnitude of three major environmental problems and the potential benefit to be gained if major sources of contamination could be eliminated by remedial action. Over 20 sites on and around FMPC may need remedial action. They are listed in Table 2.3-2 and Sect. 2.3.3 and are briefly described in Appendix C. Three remedial action sites currently appear to be of primary concern: the K-65 silos and the associated radon and gamma emissions, the waste pit area and the contamination that appears to be entering the Great Miami Aquifer beneath it, and the plume of uranium contamination south of the FMPC boundary. Some of the other remedial action sites include the streambeds of Paddy's Run and the Storm Sewer Outfall Ditch, the retired flyash pile and the southfield area, the metal oxide silo, the thorium inventory, the sanitary landfill, underground storage tanks, and the lime sludge ponds. Other smaller or limited contaminated areas fill out the list of sites and facilities that may need remedial action.

4.4.2 Potential Effects of Key Remedial Action Sites

The two primary concerns (K-65 silos and south groundwater plume) are believed to constitute the most immediate potential environmental hazards. The third area of concern, the east groundwater plume, is contained within the FMPC site.

4.4.2.1 K-65 silos

The K-65 silos contain waste from the Manhattan Project, the World War II program to produce the first atomic bombs. The silos contain about 8,800 metric tons (9,700 tons) of uranium ore tailings. These residues contain about 11,000 kg (24,000 lb) of uranium and high concentrations of

radium and other uranium decay products as well as many other metals (Appendix C). Most of these decay products are radioactive.

The two hazards associated with the silos are the release of radioactive radon gas (and direct gamma radiation) and the possible failure of the silos. The silos were built of reinforced concrete in 1952, but weathering and internal corrosion have weakened the silos in the intervening years. Since 1964, the sides and tops of the silos have been reinforced several times, and currently the sides are protected by an earthen embankment, and the tops are covered by a waterproof membrane and a foam coating. Catastrophic failure of the silos is now believed to be extremely unlikely but is assessed in Sect. 4.5.

The radium in the silos produces radon-222. Because it is a gas, radon readily escapes the silos and disperses off-site. Radon is radioactive and has a half-life of 3.8 d. Radon decays into a chain of seven radionuclides (daughter products) which finally decay into nonradioactive lead. Inhaled daughter products contribute most of the radiation exposure from radon. Microscopic particles containing these daughter products can become attached to lung tissue and in large enough concentrations could possibly cause lung cancer. The K-65 silos are the largest source of FMPC radon emissions.

These emissions and their associated doses would continue indefinitely if some action to eliminate or attenuate the radon is not taken. In 1985, the radon from these silos resulted in a dose to the maximally exposed individual of about 70.5 mrem/year (Table 4.4-1). As a result of the project (Project 263) to reinforce the silo dome, the dose dropped to 47.2 mrem/year in 1988. No further action is assumed to result in a return to the 70.5-mrem/year dose due to deterioration of the dome. Removal of the silo contents with appropriate packaging and off-site disposal would eliminate the radon and gamma doses.

4.4.2.2 Waste pit area and the eastern groundwater plume

The waste pits have been in operation for almost 40 years, and the groundwater beneath these pits has been contaminated with uranium. Water leaking from the pits has resulted in this contamination. The waste pits have a wide range of permeability. Water that enters pits 1, 2, and 3 leaks out of their bottoms or sides. Waste Pit 4 apparently has very thick glacial till in the walls and bottom; much of the water which enters this pit is believed to leak over the tops of the sides and into shallow surface till, through which it migrates to Paddy's Run or the Great Miami Aquifer. Waste Pits 5 and 6 are intermediate in permeability. During dry weather, the water levels decline as water evaporates or seeps through their elastomer liners. In the past during wet weather periods, Pit 4 may have filled above the top of its clay liners and leaked into the surface till. However, since 1986 the surface water in Pit 4 has been pumped to Pit 6 and eventually goes through treatment and is discharged to the Great Miami Aquifer. All pits except 5 and 6 have been filled and Pit 4 will have an interim cap when project No. 271 (Appendix A, Table A.7) is completed.

Table 4.4-1. Comparison of off-site effective total-body doses to the maximally exposed individual for major Feed Materials Production Center remedial action sites

Sites	Doses (mrem/year) 1985	1989
Air pathway		
K-65 Silos radon[a]	70.5	47.2
K-65 Silos direct gamma[a]	9.5	9.5
Waste pit fugitives	1.5	0.7[b]
Water pathways		
East plume at site boundary	c	c
South plume at site boundary	~100	~100
Paddy's Run	1.3	1.3[d]
Great Miami River	0.15	0.15[d]

[a]Assumes K-65 silo is major FMPC source.

[b]Capping pit 4 reduces fugitive emission.

[c]A level approaching background.

[d]Near-term surface water doses expected to remain near 1985 dose values.

Preliminary remedial investigation data indicate that in 1988 the plume had its highest concentrations of uranium (25 μg/L) near the waste pits and concentrations above background levels (<1 μg/L) extending to the eastern boundary of the production area (Figs. 4.4-1 and 4.4-2). None of the uranium values, however, exceeds the DOE drinking water limit of 36 μg/L.

The waste pits contribute to off-site doses as a result of airborne particulates. Wind erosion of the pit contents and contaminated soils results in annual doses to the maximally exposed individual of 0.7 mrem/year (Table 4.4-1). Capping of the pits, stabilization of the contents, or removal of the wastes would eliminate this off-site dose.

4.4.2.3 Southern groundwater plume

The groundwater contamination model described in Appendix F was used to estimate uranium concentrations in the Great Miami Aquifer at Fernald. The measured uranium concentrations south of the FMPC (Table 3.6-6 and Fig. 4.4-2) are consistent with model predictions, but the accuracy of the model predictions at greater distances is unknown. Although current information does not permit an accurate assessment of the problem, groundwater monitoring wells are being installed in the RI/FS program that will help assess the current extent of the plume. The estimated plume centerline is shown in Fig. 4.4-3.

As the plume approaches the Great Miami River it will merge with another part of the Great Miami Aquifer (Fig. 3.6-6). The behavior of the plume at and beyond this point has not been modeled. If monitoring wells show high uranium concentrations in the vicinity of Fernald, additional wells may be needed to determine how far the plume has migrated. The RI/FS program includes a proposed project to build a hydraulic barrier south of FMPC and north of the village of Fernald. This hydraulic barrier would be designed to intercept the contaminated plume migrating southward from FMPC. One proposal is to pump flow from the hydraulic barrier to Manhole 175, the existing National Pollutant Discharge Elimination System (NPDES) discharge monitoring point for FMPC. The flow would be monitored and discharged to the Great Miami River. Another alternative would be to treat the water before discharge. This directed remedial action and all alternatives will be presented in another NEPA document.

4.5 ACCIDENTS

4.5.1 Transportation

During transportation of low-level radioactive materials a release of radioactive materials is possible should an accident occur. The estimated probabilities of occurrence and associated consequences are of interest. In DOE/EA-0260 DOE 1985, it was assumed that the accident probability for trucks carrying solid waste is 1.06×10^{-6} accidents per kilometer, which results in about 1.1 accidents per year for 320 shipments annually to NTS. Assuming that only 50% of these accidents would result in the release of

ORNL-DWG 89-6892

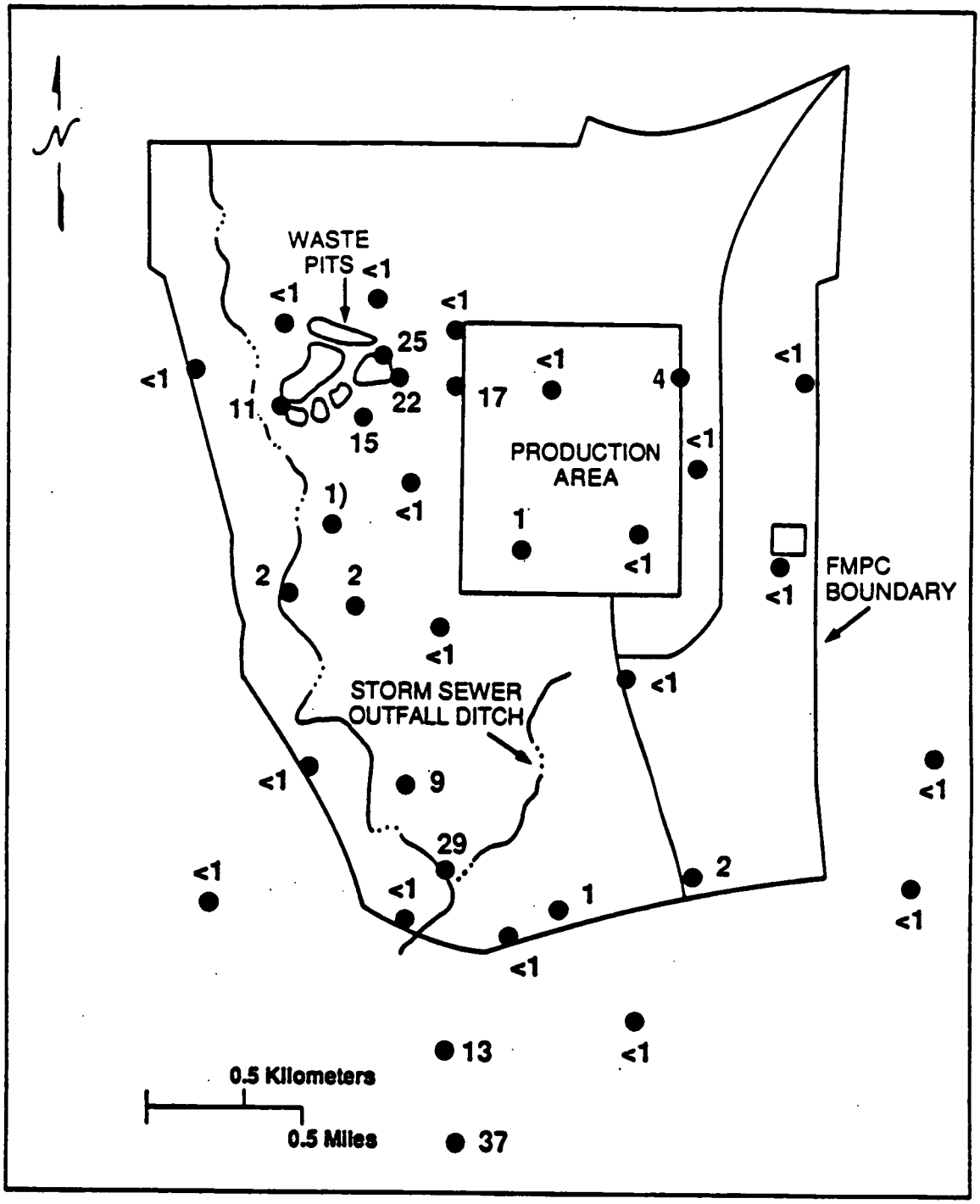


Fig. 4.4-1. Concentration of uranium (μgL) in wells completed in the lower portion of the Great Miami Aquifer in 3000-series monitoring wells on and near the Feed Materials Production Center site in 1988. Note: To convert uranium concentrations from μg/L to pCi/L, multiply by 1.5. *Source:* preliminary findings of the RI/FS program at the Feed Materials Production Center.

ORNL-DWG 89-6891

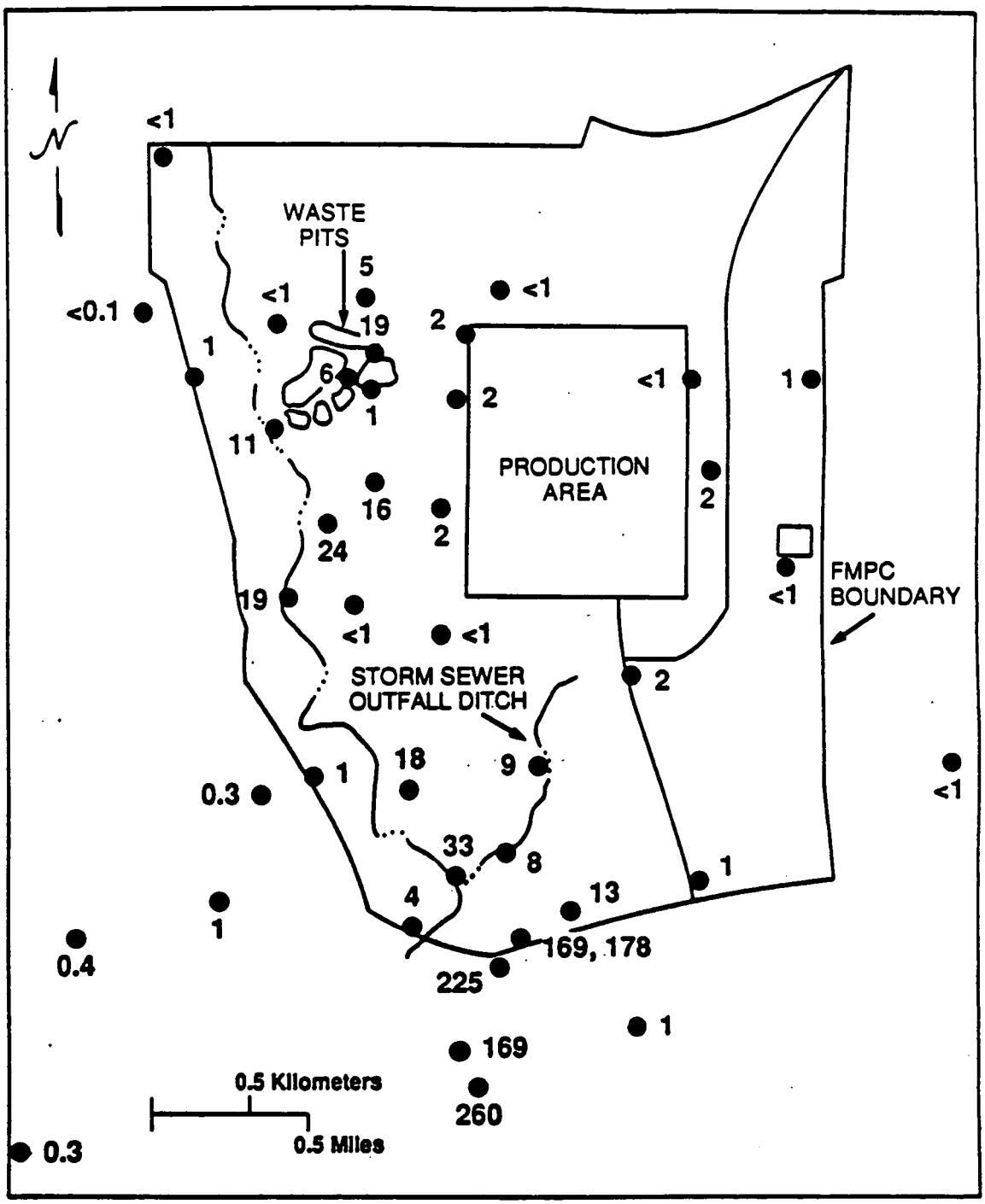


Fig. 4.4-2. Concentration of uranium (μg/L) in wells completed in the upper portion of the Great Miami Aquifer in 2000-series monitoring wells in 1988. Note: To convert uranium concentrations from μg/L to pCi/L, multiply by 1.5. *Source:* preliminary findings of the RI/FS program at the Feed Materials Production Center.

ORNL-DWG 88-12386R7

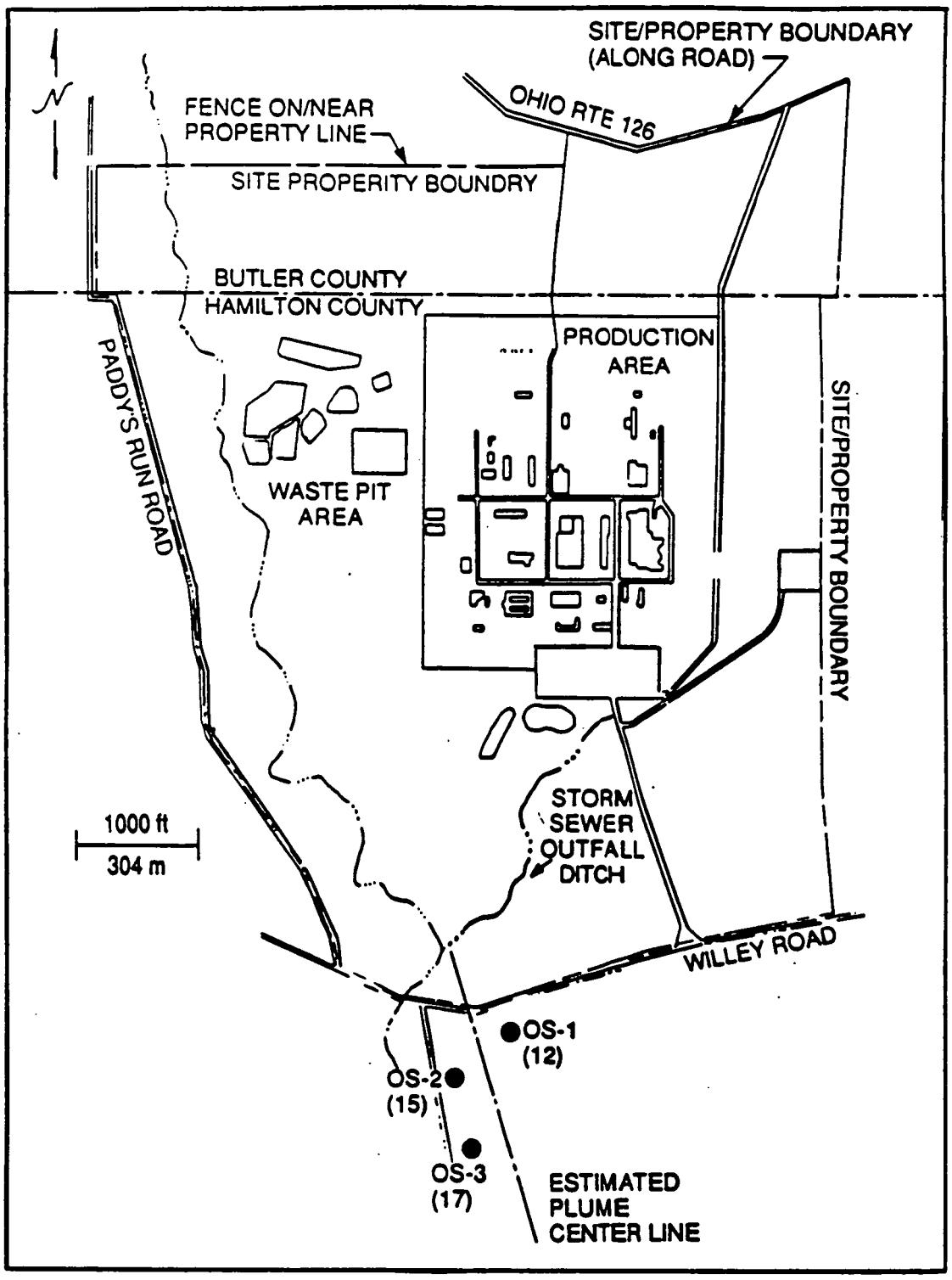


Fig. 4.4-3. Southern groundwater plume centerline and location of uranium-contaminated off-site wells in the vicinity of the Feed Materials Production Center.

radioactive material, the estimated accident rate with accompanying release would be 0.5 accident per year (for total trip mileage). The worst-case scenario evaluated in DOE/EA-0260 for an accident with drum rupture assumed that 10% of the contents of a truckload of drums of waste containing 30% depleted uranium was spilled over 100 m^2, with about 0.25 Ci released. The resultant surface contamination would be 2.5×10^{-3} Ci/m^2, and direct radiation exposure at 1 m would be about 1.5×10^{-2} mrem/h. Inhalation of resuspended uranium from such an accident would result in a total-body dose of 2.6 mrem and a dose to lungs of 180 mrem to exposed individuals. These doses are equivalent to less than two years' normal background radiation exposure and are not significant. They are also less than EPA Protective Action Guidelines for evacuation in the event of a nuclear accident. A fivefold increase in shipments (i.e., from 320 to 1600) would result in an estimated accident probability of 2.5 accidents per year (total trip mileage), but the consequences of this accident would not change from those postulated in DOE/EA-0260. Because of this low probability of truck accidents, it is considered unlikely that any individual or group of individuals would be exposed more than one time to accidental releases of these low-level radioactive materials.

An accident involving a truck carrying LLW in the FMPC vicinity (i.e., on local roads before reaching the interstate) is of interest (primarily because of the proximity of homes, businesses, and a school) and was not specifically evaluated in the prior NEPA documentation cited previously. Using the truck accident probability of 1.06×10^{-6} accidents per truck-km (given in DOE/EA-0260 for trucks carrying radioactive material) and assuming that half of the accidents result in a release (DOE 1985) and that 16 km (10 miles) of local roads are traveled, then the estimated accident probability is less than 0.01 per year. The consequences of an accident scenario of this type are given in the preceding paragraph.

In the case of a rail accident there is a greater probability of fire than in truck accidents due to flammables being transported by train. In an accident involving fire and release of radioactivity, the probabilities would be about 1.5×10^{-10} accidents per railcar mile (DOE 1985). This would result in an accident probability of 3×10^{-4} accidents per year. Assuming that a rail car holds twice as many drums of waste as a truck holds and that all accident conditions assumed for trucks (DOE 1985) applied to railcars, then the inhalation of resuspended uranium would produce doses roughly twice those predicated previously for truck accidents. The increased doses from rail accidents are also less than doses in EPA protective action guidelines for evacuation. Impacts to the public would be greater in the more populated areas than in areas with low population density. These impacts would be about 5 mrem/h to persons in the immediate vicinity of the site (e.g., emergency personnel). Occupational dose limits are set at 5000 mrem/year.

Cessation of metal production would result in no shipments of product being made to RMI in Ashtabula, Ohio, or Y-12 in Oak Ridge, Tennessee. The probability of accidents involving a truck carrying product is less than one per year. The cessation alternative would eliminate this accident probability.

4.5.2 Ecology

4.5.2.1 Terrestrial

High, short-term concentrations of atmospheric NH_3 and fluorides possibly resulting from accidents at the FMPC site could adversely affect plants and animals. Ammonia at 1- to 2-mg/m^3 concentrations reduces the productivity of sensitive plants. The Occupational Safety and Health Administration short-term exposure limit for humans is 40 mg/m^3, and the concentration that is immediately dangerous to life and health for humans is 600 mg/m^3.

The primary effects of high atmospheric NH_3 concentrations on plants are foliar damage and occasional damage to fruit (NRC 1979). Following foliar damage, individual plants usually recover and continue normal growth. For animals, NH_3 is an irritant that in very high concentrations could damage the skin, eyes, mucous membrane of the upper respiratory tract, and lungs (NRC 1979; EPA 1981). Such damage could occur to animals near a sudden, accidental release of a large quantity of NH_3 at the FMPC site. The NH_3 would probably dissipate in less than 1 h and after that would no longer be a threat to livestock or wildlife.

Acute exposures of animals to very high concentrations of atmospheric HF following an accident can cause intense irritation of the eyes and respiratory tract and, in the extreme, can result in skin burns and respiratory failure (NRC 1971; NUREG 1986). Concentrations high enough to cause respiratory failure in livestock and most animals would probably not occur in areas farther than a few hundred yards downwind from the accident release point. An accidental release of this magnitude would probably cause some damage to plants near the release point and would result in elevated levels of fluorides in foliar tissues. Any significant accidental release of fluoride would be followed by monitoring of fluoride levels in vegetation and affected livestock.

Because of tank farm renovations, improved material handling methods, and improved process design, the present situation and proposed action alternatives would reduce the likelihood of accidental releases of NH_3 and fluorides. An accidental release of uranium would be unlikely to have acute or chronic effects on plants or animals. Any such release would be followed immediately by monitoring of vegetation and livestock for uranium levels.

4.5.2.2 Surface waters/aquatic

Under the pre-renovation conditions, the tank farm directly north of Plant 4 consisted of severely deteriorated components, most of which were at least 30 years old. AHF, dilute HF, KOH, and anhydrous NH_3 were stored there in large quantities in tanks and in railroad cars parked adjacent to the facility. Some potential leaks and spills may not have been contained and could have entered the Storm Sewer System. Renovation of the tank farm in the present situation alternative greatly reduces (1) the probability of accidental releases and (2) the probability of accidental releases entering the Storm Sewer System untreated.

The potential severity of major spills underscores the importance of (1) using great care in waste removal and transport operations, including using secondary means for containment of spills where possible; (2) maintaining a spill and emergency response team that is alert and well trained, staffed, and equipped; and (3) using adequate packaging for wastes to be transported and stored elsewhere.

The severity of impacts of waste removal and transportation accidents on aquatic communities would vary with the conditions described in the preceding discussion of surface water impacts of accidents.

4.5.3 Air Quality

Available data are inadequate to quantify potential accidents for FMPC site operation after renovation and remediation. However, the frequency and consequences of accidents are expected to be less than those for pre-renovation site operation. Therefore, this section presents a summary of potential major pre-renovation accidents to set an upper boundary on the frequency and consequences of accidents that could be expected from post-renovation plant operation.

For the renovation projects, the installation of new pipes, tanks, dust collectors, furnaces, and other equipment should reduce the probability of catastrophic failure resulting from metal fatigue and other weaknesses of old equipment. For the remedial action projects, directed actions (i.e., structural stabilization of K-65 silos domes) would help reduce the probabilities of air releases from accidents until the final remedial action is implemented. The final remedial action should have a large effect on the air quality consequences of an accident by stabilizing or removing the source term (e.g., remediation of the K-65 silos).

Available safety reports and assessments (mainly pre-renovation) were reviewed to select a sample of accident scenarios to summarize. In accordance with Council on Environmental Quality (CEQ) regulations and guidance that direct EISs to focus on significant issues, accidents with potentially serious consequences and/or high probabilities of occurrence were given priority. Thus, the summary of pre-renovation accidents and consequences emphasizes the event or events from a given safety report with the greatest potential risk. If a number of events were associated with equally rated risks, the event with the greatest potential impact

(regardless of probability of occurrence) was included. The rationale for this latter decision is included in a CEQ discussion of analyzing low-probability/high-consequence events in an EIS (CEQ 1986). Some safety reports and studies contained only general qualitative information on the probabilities of occurrence and associated consequences of potential accidents. These data were not included in the summary because it was not possible to gauge the accident probabilities or associated consequences.

Table 4.5-1 summarizes eight pre-renovation accident scenarios and their probabilities of occurrence and consequences. Five FMPC facilities are represented: Plant 4, the K-65 silos, the Tank Farm, Plant 1, and the elevated bins and silos used for thorium storage at Plant 8. Four of the accidents involve the release of radioactive material, and four involve the release of hazardous chemicals. The predominant exposure pathway in all cases was postulated to be atmospheric release and subsequent inhalation, but air quality is not the only important concern. For example, as described in preceding sections of this chapter, radionuclides emitted to the air can enter surface waters and groundwater in the FMPC vicinity, thereby providing additional exposure possibilities. Thus, other potential impacts not summarized in the table may also be important.

A number of the accidents summarized in the table, especially those involving chemical releases, have potentially serious consequences. Under the worst-case meteorological conditions, the predicted off-site HF concentration for the pre-renovation Tank Farm HF accident is classified as being lethal for exposure periods greater than ~2 min. The maximum predicted off-site concentration from the Plant 4 HF release is classified as lethal for exposures greater than ~10 min (Davis, Denning, and Zienlenbach 1983). The predicted NH_3 concentration for the Tank Farm accident is classified as fatal for exposure on the order of minutes at distances up to 7 km downwind (Davis, Denning and Zienlenbach 1983). In any of these cases, individuals exposed to the releases would make every effort to flee when the ambient levels exceeded the odor thresholds [2 mg/m^3 for HF and 4 mg/m^3 for NH_3 (Davis, Denning, and Zienlenbach 1983)]. However, a nonambulatory individual would be at severe health risk. Thus, although the probability of the occurrence of these accidents is estimated to be low, the consequences are serious.

The predicted consequences of the remaining pre-renovation accidents are estimated not to be serious. The predicted consequences of the nitric acid release are well within levels established to protect worker health; thus, they should not adversely affect public health, either. For radiological impacts, the predicted dose of 0.74 mrem from the baghouse fire is much less than the 75-mrem/year standard (40 CFR Pt. 61) and is also less than the EPA-recommended Protective Action Guideline of 5 to 25 rem for evacuation purposes in the event of a nuclear release (EPA 1980). The predicted total-body dose from the silo dome collapse is about 1.6 times that of the annual average dose from radon to U.S. citizens guideline of 1 to 5 rem (whole body). Predicted impacts for the criticality accident at Plant 1 are also below guidelines and standards. In summary, the consequences of the chemical releases listed are generally more serious than those of the radiological releases. Given that this is a

Table 4.5-1. Selected accident scenarios and associated consequences for the Feed Materials Production Center pre-renovation operation

Accident description	Release	Estimated probability of annual occurrence (P)	Predicted consequences	Reference
Dust collector fire in Plant 4	50 kg U over 1 h	$10^{-3} \leq P < 10^{-2}$	0.74-mrem bone dose off-site	WMCO 1986a
Liquid anhydrous hydrogen floride (AHF) spill at Plant 4	Initial release of 95 lb of HF over 1 min; 132 lb/min of HF for steady state	$10^{-2} \leq P < 10^{-1}$	427-mg/m^3 HF max. instantaneous (1 s) concentration; 4-mg/m^3 steady-state concentration	WMCO 1986a
Complete collapse of K-65 domes	6,000 Ci/year Rn-222	$P < 10^{-4}$	331-mrem/year dose, nearest resident most probable wind direction	Grumski 1987
AHF release from Tank Farm (major pipe break during campaign)	95,000 lb of HF over 17 min	$10^{-4} < P \leq 10^{-2}$	3035-mg/m^3 concentration at 2 km downwind, F stability	Appendix G
NH_3 release from Tank Farm (catastrophic tank failure)	45,000 lb of NH_3 instantaenously	$10^{-4} < P \leq 10^{-2}$	3290-mg/m^3 concentration at 7 km downwind, F stability	Appendix G
Criticality accident at Plant 1	10^{17} fissions, uranium oxide powder	$10^{-3} \leq P < 10^{-2}$	2000-mrem thyroid dose, 10-mrem whole body dose (2 h after accident)	WMCO 1986b
Vent release of nitric acid vapor at Plant 1	7 lb HNO_3	$10^{-2} \leq P < 10^{-1}$	50- to 180-μg/m^3 concentration	WMCO 1986b
Thorium release from collapse of elevated silos and bins	9,500 lb of thorium (~4 Ci)	Not available	<500-mrem whole body dose, <1500-mrem dose other organs	O'Donnell 1986

0441

000290

worst case analysis and that many of these potential accidents are already mitigated through renovation and directed actions (e.g., K-65 dome reinforcement, plant 8 bins and silos emptied, and renovation of tank farm), a complete safety analysis is needed to determine realistic probabilities, consequences, and mitigation for potential accidents.

4.5.4 Hydrology and Water Quality

4.5.4.1 Stormwater Retention Basin (SWRB)

A postulated accident for the SWRB was defined to be a 2-week event in which a single basin has a torn elastomer liner. This accident would allow direct hydraulic communication between the water stored in the basin and the water contained in the collection system. The clay liner would then be subject to the basin hydrostatic head.

Figure 4.5-1 shows the predicted groundwater uranium concentration at the FMPC plant boundary along the plume centerline at the top of the aquifer, the point of maximum off-site groundwater contamination. The total release for the 2-week event has been conservatively assumed to enter the Great Miami Aquifer instantaneously at the equivalent point source location. If the initial uranium concentration in groundwater were negligible, the maximum off-site groundwater uranium concentration would be 4 μg/L, which is below the DOE recommended drinking water standard of 36 μg/L (DOE 1987).

4.5.4.2 Biodenitrification Surge Lagoon (BSL)

The Biodenitrification Surge Lagoon's liners and collection system may eventually fail. In such an event, contaminated water could emerge at the surface or escape horizontally through channel sands within the glacial till and lacustrine sediments on which the Biodenitrification Surge Lagoon was constructed. Eventually, seepage may reach the Great Miami Aquifer by recharge along Paddy's Run. Therefore, it would be necessary to maintain a monitor well in the till downgradient of the Biodenitrification Surge Lagoon and to monitor local surface drainages. Failure to discover leaks in the secondary liners or failure to take appropriate remedial action may lead to an unacceptable impact on the Great Miami Aquifer.

4.6 MONITORING AND MITIGATION

The following are monitoring and mitigation recommendations that DOE shall implement.

Terrestrial ecology

- An HF monitoring program shall be conducted to observe for damage to foliage of sensitive plant species and to monitor fluoride concentrations in herbage for livestock and wildlife (Sect. 4.1.3.1).

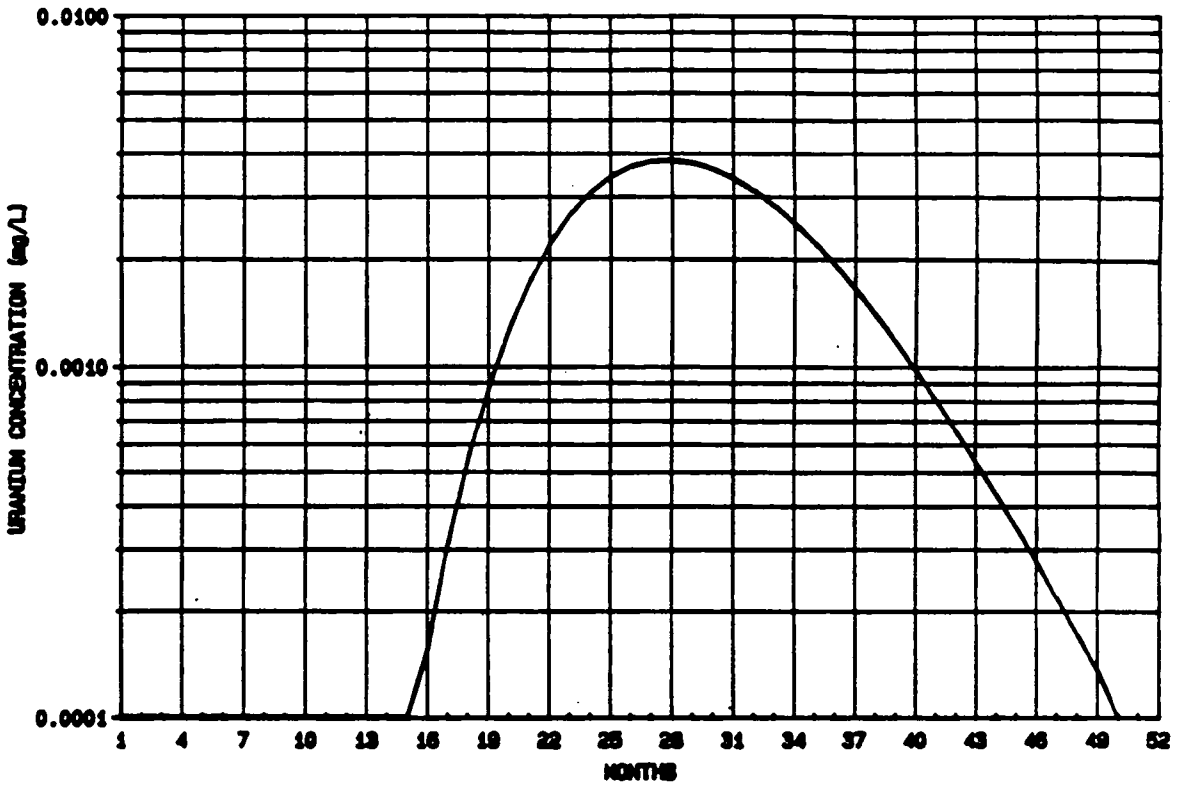


Fig. 4.5-1. Simulation of maximum groundwater uranium concentration at the Feed Materials Production Center plant boundary assuming leakage through one Stormwater Retention Basin at arbitrary future date and assuming negligible background concentration.

Surface water/aquatic ecology

The following measures for monitoring and mitigation shall be undertaken to protect local surface waters and their aquatic communities:

- Plant production shall not exceed a level that would cause NPDES limits to be exceeded.
- One or more monitoring stations shall be added to the Great Miami River between the MH-175 outfall and the confluence of Paddy's Run to better characterize areas affected by the mixing zone.
- Sediments and water of Paddy's Run and the Great Miami River shall be monitored for other radionuclides in addition to uranium and technetium (including specific isotopes) and for nonradioactive but potentially toxic contaminants that may enter this stream. Discrete monitoring stations that are clearly upstream of areas affected by FMPC shall be included. Monitoring stations at appropriate locations shall be added between the effluent outfall in the Great Miami River and existing downstream locations (including locations downstream of but near the outfall and confluence of Paddy's Run with the river).
- Monitor on a routine basis the final effluent at MH-175 and the storm sewer overflow for potentially toxic inorganic and organic contaminants that can reasonably be expected to enter these waste streams (e.g., PCBs, asbestos, and hazardous constituents on the RCRA list).
- Monitoring of effluents shall be designed to ensure that radionuclide discharge limits are not exceeded.
- Depending on surface water monitoring results, fish and sediments will be collected and analyzed for the contaminants mentioned previously as appropriate.
- Appropriate measures shall be taken to ensure containment and proper disposal of contaminants encountered during renovation and cleaning operations (e.g., during cleaning of Plant 4, 5, 6, and 9 facilities under the shut-down alternative).

Air Quality

- If TSP levels increase above the PM-10 NAAQS, PM-10 monitoring and appropriate mitigative action will be taken to ensure that facility continues to comply with PM-10 NAAQS.

Hydrology and Groundwater Quality

- A suitable monitoring system shall be installed surrounding each SWRB and in the Storm Sewer Outfall Ditch to determine whether any contamination enters the Great Miami Aquifer through basin leakage or overflow.

- A single downgradient monitoring well shall be installed in the glacial till near the Biodenitrification Surge Lagoon to ensure that it is not leaking.

Radiological

The following measures for monitoring and mitigative measures shall be undertaken to improve on-site and off-site radiological dose assessment.

- Radiological emission quantities from all sources will be re-evaluated to ensure accuracy of source terms.

- Routine measurements of both particle size distribution and solubility of major radionuclides contributing to dose shall be made.

- The locations of background radon monitoring stations shall be reevaluated. Radon measurements shall be improved so they can be used to evaluate radon exposure and can be compared to modeled results.

- The location of soil, vegetation, and produce sampling protocol shall be reevaluated on the bases of present population distribution and new on-site meteorology.

- Unmonitored sources, including waste pits, shall be reevaluated to provide better characterization and quantification of fugitive emissions.

- The sampling protocol for garden produce shall be reevaluated. Greater emphasis shall be placed on root vegetables and leafy, low-growing edible vegetables and also on obtaining comparable specimens at all sites.

Worker Health and Safety

- Worker exposure to chemical and radiological exposure shall be better quantified so ALARA goals can be evaluated.

General

- A noise impact study shall be undertaken to determine the impact of noise from FMPC operations.

- Safety analyses shall be performed for plant operations.

o Regular inspection of waste storage containers shall be made.

4.7 CUMULATIVE IMPACTS

Cumulative impacts associated with the proposed action are evaluated with respect to the recent past, present, and anticipated future conditions of the FMPC site and surrounding area. Impacts on the following key resources are evaluated: (1) air quality, (2) surface water, (3) sediments, (4) aquatic ecology, (5) groundwater, (6) soils, and (7) terrestrial ecology. The impacts of plant operation and remedial action sites on these resources are summarized in Table 4.7-1.

Table 4.7-1 displays environmental impacts of both plant operation and remedial action sites. FMPC environmental impacts before renovation began (past impacts) are represented by 1985 conditions. FMPC impacts after the present situation alternative projects are complete (present impacts) are described in the present situation columns. Impacts of FMPC operations after completion of the proposed action projects (future impacts) are described in the proposed action columns. Whenever possible, incremental impacts are given by comparing impacts to background conditions. Both on-site and off-site impacts are discussed to demonstrate the geographical extent of FMPC impacts.

Air

Radiological emissions resulting from stored waste (K-65 Silos and waste pits) are, by far, the largest source of dose to individuals. Dose to the maximally exposed individual could be reduced by a factor of ~40 by remedial actions that eliminate these sources. Doses associated with remedial action sites and plant operations add about 19% and 0.5%, respectively, to the dose received from background radiation by the maximally exposed individual. The FMPC emissions are responsible for an increase of less than 0.03% in regional dose [80-km (50-mile) radius]. Nonradiological emissions meet NAAQS for both alternatives.

Surface Water

The only known impact of FMPC on surface water is due to radionuclides (predominantly uranium) in Paddy's Run and Tc-99 in the Great Miami River. Effluents from the Storm Sewer Outfall Ditch were probably responsible for most uranium contamination (235 pCi/L) in Paddy's Run in 1985. Since then, there has been much lower uranium contamination (6.8 pCi/L), probably because of surface runoff from the waste pit area. Renovation projects to contain and treat waste pit runoff should lower contamination in Paddy's Run to near background. Contaminated water in Paddy's Run does not measurably affect water quality in the Great Miami River at the sampling station 4.6 km (2.8 miles) downstream of the confluence of Paddy's Run. In 1987, a downstream average value of 16 pCi/L was measured for gross beta, compared with 5.2-pCi/L background. Drinking water and eating fish from this river, however, would result in a dose of only 0.15 mrem/year. Thus, the cumulative effect of FMPC on surface water

Table 4.7-1 Environmental impacts resulting from operations and remedial action sites at the Feed Materials Production Center, Fernald, Ohio

	1985		Present situation		Proposed action		Cessation Alternative	
	Operation	Remedial action sites	Operation	Remedial action sites	Operation	Remedial action sites	Operation	Remedial action sites
RADIOLOGICAL EFFECTS								
Air								
Maximally exposed individual (mrem)								
West	4.3 (Background = 300)	81	1.1	57	0.8	57	0.4	57
East	10.4 (Background = 300)	29	2.9	19	2.2	19	0.9	19
80-km population dose (person-rem)	218 (Background = 257,000)	32	61	15	44	15	20	15
Surface water (Uranium)								
Paddy's Run (pCi/L)	Highest $\bar{X}$ = 235 (Background = 1.4)	Some contamination attributed to runoff from waste pit area but not quantified	Highest $\bar{X}$ = 6.8 in 1987 (Background = 1.0)	About 180 kg/year (400 lb/year) of uranium is in surface runoff	Water quality should continue to improve as sources of contamination are eliminated		Same as proposed action	
Great Miami River (pCi/L)	Highest $\bar{X}$ = 1.6 (Background = 1.2)	NA	Highest $\bar{X}$ = 1.7 (Background = 1.2)		Advanced Wastewater Treatment Facility will reduce radionuclide discharges by 90%		Same as or lower than proposed action	
Sediment (uranium contamination)								
Paddy's Run (pCi/g)	Highest $\bar{X}$ = 46.2 (Background = 0.5)		Highest $\bar{X}$ = 22 (Background = 0.43)		Not expected to increase over present situation		Not expected to increase over present situation	
Great Miami River (pCi/g)	Highest $\bar{X}$ = 2.6 (Background = 1.3)		Highest $\bar{X}$ = 0.59 (Background = 0.59)		Same as present situation		Same as present situation	
Groundwater								
South plume		Highest $\bar{X}$ = 204 μg/L Dose = 38 mrem (Background <1 μg/L		Concentration should decrease to near background		Same as present situation		Same as present situation
East plume		(Highest $\bar{X}$ = 24 μg/L) (Background <1 μg/L)		Highest concentration in 1988 was 17 μg/L (background = 1 μg/L) Concentration depends on remedial action		Same as present situation		Same as present situation

0441

Table 4.7-1 (continued)

	1985		Present situation		Proposed action		Cessation Alternative	
	Operation	Remedial action sites	Operation	Remedial action sites	Operation	Remedial action sites	Operation	Remedial action sites
Soils								
Routine	One off-site location was 14.2 pCi/g (Background = 1.2-4.5 pCi/g)		One off-site location was 8.3 pCi/g in 1987 (Background = 1.2-4.5 pCi/g)		Soil contamination is mainly limited to on-site locations. Off-site dose from eating the vegetables is calculated to be 0.008 mrem/year, which is considered background.		Same as proposed action	
Vegetation	One off-site location was 5.75 pCi/g (Background = 1.2-4.5 pCi/g)		Two off-site locations 6.1 and 6.5 pCi/g in 1987 (Background = 1.2-4.5 pCi/g)		Same as present situation		Same as present situation	
Produce	Dose from produce grown in soils = 0.03 mrem/year		Dose from produce grown near FMPC is 0.01 mrem/year		Same as present situation		Same as present situation	
Aquatic ecology								
Paddy's Run	3.8 rad/year to fish; no known adverse effects		Concentration (uranium in sediment and water reduced and expected to continue to decrease)			Same as present situation		Same as present situation
Great Miami River	0.38 rad/year to fish; no known adverse effects		No known adverse effects		No known adverse effects		No known adverse effects	
Terrestrial ecology	Maximum average uranium concentrations ranged from 1.2 pCi/g on-site to 0.47 pCi/g off-site		Maximum average uranium concentration on- and off-site was 0.43 pCi/g in 1987		Uranium levels not expected to change from the present situation		Uranium levels not expected to change from the present situation	
	No effect on plants or animals		No effect on plants or animals		No effect on plants or animals		No effect on plants or animals	
Worker health and safety	Health and safety projects begun to initiate ALARA goals		About 58 projects completed designed for worker health and safety. NIOSH studies show no limits exceeded but general improvement in cleanliness needed	Potential for K-65 silo collapse greatly reduced. RI/FS directed action planned for remediation	About 42 projects designed to further ALARA goals	Same as present situation	About 25 projects designed to further ALARA goals	Same as present situation
Waste management	Solid waste disposed of on-site in pits and incinerated. Liquid waste placed in Pit 5.		Disposal on-site discontinued. All waste shipped off-site or stored on-site. Backlog waste inventory eliminated by 1994. ~700 shipments of waste/year to NTS/ORGDP	Remedial action sites identified and directed actions completed to eliminate some source terms	Same as present situation, but ~800 shipments/year to NTS/ORGDP	Same as present situation	Same as present situation but ~500 shipments/year to NTS/ORGDP	Same as present situation

E-0441

7620000

Table 4.7-1 (continued)

	1985		Present situation		Proposed action		Cessation Alternative	
	Operation	Remedial action sites	Operation	Remedial action sites	Operation	Remedial action sites	Operation	Remedial action sites
NONRADIOLOGICAL EFFECTS								
Air	Below NAAQS emission standards 24-h HF exceeds standards for other states		General increase due to maximum production assumption Below NAAQS emission standards, meet 24-h HF standards for other states		Same as present situation		Emissions of NAAQS criteria pollutants ~40% less than present situation because of metals production cessation	
Surface water								
Great Miami River								
BOD TSS NO_3	1,600 kg/year 3,100 kg/year 135,000 kg/year		12,000 kg/year 33,000 kg/year 42,000 kg/year		7,700 kg/year 7,700 kg/year 23,000 kg/year		Same as or slightly lower than proposed action	
Paddy's Run	34 million gal of production area surface water discharged		Discharge reduced by a factor of 100 over 1985		Same as present situation		Same as present situation	
Aquatic ecology								
Paddy's Run	Fish population may be stressed due to low flows or contamination		Same as in 1985		Same as 1985		Same as 1985	
Great Miami River	No effect		Same as in 1985		Same as 1985		Same as 1985	
Terrestrial ecology								
	All fluoride levels within range naturally occurring in plants		Fluoride levels lower than 1985 HF to be monitored in plants		Same as present situation		Same as present situation	
GENERAL EFFECTS								
Socioeconomics	0.4% of regional employment 0.5% of regional personal income		1.2% of regional employment 1.5% of regional personal income		0.9% of regional employment 1.1% of regional personal		0.8% of regional employment 1.0% of personal income	

--0441

000293

quality appears to be limited to the vicinity of FMPC except for gross beta.

Sediment

Sediment can be a good indicator of long-term accumulations of contaminants. In 1985, uranium at some locations within Paddy's Run sediment exceeded background by almost two orders of magnitude (100 times). The Great Miami River sediments downstream of the FMPC outfall were less than two times background. By 1987, the uranium contamination in Paddy's Run and the Great Miami River were near background levels. This dramatic lowering of contamination levels in Paddy's Run is thought to result from a combination of two factors: the installation of the Stormwater Retention Basin that intercepted the main source of contamination before reaching Paddy's Run and a flushing of the sediments through natural streamflows. It is estimated that in the unlikely event that a child were to ingest 1 kg (2.2 lb) of sediment during 1985, the resultant dose would have been 10 mrem. Current levels of contamination would result in a dose much less than 1 mrem/year.

Groundwater

Apparently, contaminated groundwater originating within the FMPC boundary has moved off-site in only the southern direction, toward the town of Fernald. Concentrations in the two off-site wells, where contamination has been measured, have been about 200 pCi/L in 1984-87. This water would yield a dose of 38 mrem/year if used as a source of drinking water. Contaminated wells are not currently used as drinking water supplies. The extent of groundwater contamination shall be defined by the RI/FS Program. Because a principal source of uranium contamination is now greatly reduced, dilution within the aquifer should lower these concentrations as the plume moves southward.. Further evaluation of the potential effect of this contamination cannot be made until the size, location, and rate of movement of the plume are better defined.

Another contaminated groundwater plume has been identified that is moving eastward from the Waste Pit Area. This plume has current concentrations of uranium up to 25 pCi/L. Remedial action shall address this problem.

Soils

Soils, like sediments, can be a good indicator of long-term accumulations of contaminants. The sampling of soils has indicated very few off-site locations where uranium is above background levels. In 1985-87, 5 of 35 off-site locations sampled had uranium concentrations above background. One of these locations is adjacent to the FMPC trash incinerator. The other four had a maximum concentration of 7.7 pCi/g, compared with a background of between 1.2 and 4.4 pCi/g. It can generally be concluded that deposition of uranium from FMPC operation has mainly accumulated within the site boundary. Uranium concentrations in these soils inside the boundary shall be reduced to approved EPA limits.

Aquatic Ecology

There are no known effects of FMPC operation on aquatic communities. There are some differences in communities in Paddy's Run upstream and downstream of FMPC that may be attributed to environmental stress related to the FMPC, but the origin of the stress could be the periodic loss of flow in the creek when water enters the Great Miami Aquifer, among other factors. In 1987, the return of the sediments to near background conditions with respect to uranium and the improvement in water quality indicates that any stress caused by FMPC could be largely eliminated. There is no indication of an effect by FMPC on aquatic populations in the Great Miami River.

Terrestrial Ecology

Fluorides and uranium emissions are the primary contaminants that might affect vegetation in the vicinity of FMPC. All fluoride levels were within the range of levels naturally occurring in most plants in remote areas distant from industrial facilities. Uranium was elevated in vegetation within the FMPC boundary [0.6 to 7.07 ppm (0.4 to 4.7 pCi/g)] between 1984 and 1985 and was slightly elevated off-site [0.15 to 0.58 ppm (0.1 to 0.39 pCi/g)], as compared with background levels of about 0.17 ppm (0.11 pCi/g). After 1985, concentrations decreased to a 1987 maximum of about 1.5 ppm (1 pCi/g) for on-site locations and ranged from 0.03 to 1.5 ppm (0.02 to 1 pCi/g) off-site. These levels are not harmful to plants or to animals that eat these plants. The influence of FMPC emissions, although slight, may be seen within about 4 km (2.5 miles) of the plant, where levels of uranium are raised from a background of 0.15 to 0.35 ppm (0.1 to 0.13 pCi/g).

Worker Health and Safety

No adverse effects on worker health have been detected. NIOSH has found no instance of worker radiation exposure limits. However, NIOSH has found plant conditions that do not meet current levels of individual hygiene and has made specific recommendations for reducing worker exposure to chemical and radiological hazards. WMCO and DOE have begun to implement the NIOSH recommendations to keep worker radiation and chemical hazard exposure as low as reasonably achievable (ALARA). Fifty-seven present situation, and 42 proposed action projects, 25 of which are part of the cessation alternative, are intended to improve worker health and safety conditions. NIOSH is expected to continue to monitor industrial hygiene at FMPC.

Summary

The differences between the renovation-related impacts of the present situation and those of the proposed action would be a small reduction in radiological dose, a reduction of some nonradiological pollutants in the Great Miami River, and an improvement in worker health and safety conditions. Compared with the proposed action, the cessation alternative

leads to a slight reduction in radiation doses to the public and small reductions in wastewater discharges and solid waste generation. FMPC effluents have a limited effect on the area surrounding the plant. Radon emissions are probably not detectable 0.8 km (0.5 mile) from the source, and atmospheric uranium emissions are estimated to potentially affect an area about 3.2 km (2 miles) from FMPC. The only pollutant that can be measured in the Great Miami River 4.6 km (2.8 miles) below FMPC is gross beta, and Paddy's Run sediments are returning to background levels for uranium.

The largest impacts of FMPC on the environment are the results of past waste disposal practices. These resulting wastes represent a cumulative source of contamination from many years of operation. The K-65 silos are a source of gamma and radon emissions to individuals near the FMPC boundary. Second, there is a southward-moving contaminated groundwater plume that moved past the plant boundary towards the community of Fernald. Last, there is an on-site eastward-moving contaminated groundwater plume originating from the waste pit area that could affect off-site areas in the future.

4.8 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

Because one of the main goals of the proposed action is to improve the environment, both on-site and off-site, few adverse impacts would result from this action. The cessation of metal production alternative will also improve the environment because of renovation projects and reduction of operational emissions.

The unavoidable adverse impacts of the proposed action and the cessation alternative include potential exposure of workers to chemical and radiological contaminants due to renovation and directed remedial action activities. Waste from construction would also be generated and should be prepared for storage or disposal.

Under the present situation alternative, the water quality would decrease over that of 1985 because of increases in TSS, uranium, and BOD and would improve because of fewer nitrates. However, FMPC would be operated to meet existing standards. Waste water discharges would have no adverse environmental effects. All other potential impacts in this alternative are considered to be improvements over pre-renovation conditions.

Under the proposed action and cessation alternatives, there would be a net increase in water effluent quality discharged to the Great Miami River. BOD is the only parameter that would exceed the current NPDES permit limit, even though there would be no adverse environmental effect. FMPC would, however, be operated to meet existing standards.

4.9 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

The materials, labor, and capital required for construction of the proposed action would be an irretrievable commitment of resources. Because renovation activities would occur on the FMPC site, an existing industrial complex, there would be no change in the use or aesthetic qualities of the land. Analysis concluded that standard construction practices would ensure no loss of riparian communities and wildlife populations. The clean-up of on- and off-site contamination shall be addressed in a separate FMPC RI/FS-NEPA document.

4.10 SHORT-TERM AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

The proposed action, cessation, and present situation alternatives would have minimal effects on short-term productivity because no additional on-site resources would be used. However, in the long term, the potential remediation of groundwater could result in drinking water standards' being met for a small portion of the Great Miami Aquifer south of the site. Improved water quality would increase the potential use of this portion of the aquifer. Remedial action of the waste pits and eastward-moving plume would help preserve the long-term potential use of the groundwater affected by that contamination. The increased future production at FMPC would result in the use of more raw materials, including uranium, NH_3, and construction materials. Increased use of these resources is not considered an adverse environmental impact.

4.11 REFERENCES

Blaylock, B. G. 1989. Research staff, Oak Ridge National Laboratory, personal memorandum to G. K. Eddlemon, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Boback, M. W., D. A. Fleming, T. A. Dugan, R. W. Keyes, R. B. Grant 1986. History of FMPC Radionuclide Discharges, FMPC-2058, Westinghouse Materials Company of Ohio, Cincinnati

Bogar, L. C. Oct. 3, 1988. Westinghouse Materials Company of Ohio, Cincinnati, letter report [WMCO:SR(IA):88-0520] to J. A. Reafsnyder, U.S. Department of Energy, Cincinnati, FMPC Construction Rubble Report.

Brettschneider, D. J. Oct. 14, 1988. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):88-422(EISTF-43)] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Brettschneider, D. J. Dec. 1, 1988. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):88-525] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Brettschneider, D. J. Jan. 11, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):89-011] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Brettschneider, D. J. Feb. 3, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):89-071] to L. C. Bogar, Westinghouse Material Company of Ohio, Cincinnati.

Brettschneider, D. J. May 12, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:LWE:89-027(EISTF-98)] to E. J. Powell, U.S. Department of Energy, May 12, 1989.

Brettschneider, D. J. July 14, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:LWE:89-068 (EISTF:89-105)] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Brettschneider, D. J. Sept. 28, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter (WMCO:LWE:89-126 to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

CEQ (Council on Environmental Quality) 1986. Federal Register 51(80), 15618-26 (April 25, 1986).

Christiansen, H. D. 1988. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:OSH (ODI)): 88-131], to J. A. Reafsnyder, Department of Energy, Cincinnati, NTS Truck Drivers Radiation Exposure.

Davis, T. C., R. S. Denning, and W. J. Zienlenbach 1983. Final Safety Analysis Report for the FMPC Tank Farm, NLCO-1191 Special, Westinghouse Materials Company of Ohio, Cincinnati.

DOE (U. S. Department of Energy) 1985. Environmental Assessment of the Proposed Low-Level Waste Processing and Shipment System, DOE/EA-0260, May 1985.

DOE (U.S. Department of Energy) 1987. DOE Draft Order 5400.xx: Radiation Protection of the Public and the Environment, March 31, 1987.

Eddlemon, G. K. March 15, 1989. Oak Ridge National Laboratory, Oak Ridge, Tenn., letter to D. J. Brettschneider, Westinghouse Materials Company of Ohio, Cincinnati.

EPA (U.S. Environmental Protection Agency) 1980. Manual of Protective Action Guides and Protective Actions for Nuclear Accidents, EPA 520/1-75-001, June 1980.

EPA (U.S. Environmental Protection Agency) 1981. Ammonia Health Effects, EPA 460/3-81-027, Midwest Research Institute, Kansas City, Mo.

EPA (U.S. Environmental Protection Agency) 1985. Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources, 4th Ed., GPO Order No. 055-000-0025107, EPA Publication No. AP-42, Research Triangle Park, N.C.

EPA (U.S. Environmental Protection Agency) 1987. Industrial Source Complex (ISC) Dispersion Model User's Guide, Second Edition (Revised), Volumes 1 and 2, EPA Publication No. EPA-450/4-88-002a and 002b. U.S. Environmental Protection Agency, Research Triangle Park, N.C.

ERDA (U.S. Energy Research and Development Administration) 1977. Final Environmental Impact Statement, Nevada Test Site, Nye County, Nevada, ERDA 1551, September 1977.

Gilbert, O. L. 1985. "Environmental Effects of Airborne Fluorides from Aluminium Smelting at Invergordon, Scotland 1971-83, "Environmental Pollution (Series A) 39:293-302

Grumski, J. T. 1987. Feasibility Investigation for Control of Radon Emission from the K-65 Silos, Draft, July 10, 1987, Westinghouse Materials Company of Ohio, Cincinnati, Ohio.

ICRP (International Commission on Radiological Protection) 1977. Annals of the ICRP: Recommendations of the International Commission on Radiological Protection, ICRP 26, Pergamon Press, Oxford, New York, Frankfurt.

Killough, G. G., and L. R. McKay 1976. A Methodology for Calculating Radiation Doses from Radioactivity Released to the Environment, ORNL-4992, Oak Ridge National Laboratory, Oak Ridge, Tenn.

MacLean, D. C. 1982. "Vegetation Surveys to Evaluate Fluoride Effects on Plants," pp. 153-56 in F. Murray, ed., Fluoride Emissions: Their Monitoring and Effects on Vegetation and Ecosystems, Academic Press, New York

National Research Council of Canada 1983. Radioactivity in the Canadian Aquatic Environment, NRCC 19250, Ottawa.

NCRP (National Commission for Radiation Protection) 1984. Evaluation of Occupational and Environmental Exposures to Radon Daughters in the United States, NCRP Report No. 78, Bethesda, Md.

NCRP (National Commission on Radiation Protection and Measurements) 1987. Ionizing Radiation Exposure of the Population of the United States, NRCP Report No. 93, Bethesda, Md.

NRC (National Research Council) 1971. Fluorides, National Academy of Sciences.

NRC (National Research Council) 1979. Ammonia, University Park Press, Baltimore.

NRC (National Research Council) 1980. "Florine" and "Uranium," pp. 184-226 and 525-33 in Mineral Tolerance of Domestic Animals, National Academy of Sciences.

NUREG (U.S. Nuclear Regulatory Commission) 1977. Final Environmental Impact Statement on the Transportation of Radioactive Material by Air and Other Modes, NUREG-0170, Vol. 1, December 1977.

NUREG (U.S. Nuclear Regulatory Commission) 1986. Assessment of the Public Health Impacts from the Accidental Release of UF_6 at the Sequoyah Fuels Corporation Facility at Gore, Oklahoma, NUREG-1189, Washington, D.C.

O'Donnell, F. R. June 19, 1986. Martin Marietta Energy Systems, Oak Ridge, Tenn., internal correspondence, memorandum to L. J. Mezga, Preliminary Assessment of Doses from the Plant 8 Silo at the Feed Materials Production Center.

OEPA (Ohio Environmental Protection Agency) 1986. State of Ohio Water Quality Standards, Chapter 3745-1 of the "Administrative Code, Ohio Environmental Protection Agency Division of Water Quality Monitoring and Assessment, Columbus, Ohio, Effective July 28, 1986."

Perkins, D. F., and R. O. Millar 1987. "Effects of Airborne Fluoride Emissions near an Aluminum Works in Wales: Part 1—Corticolous Lichens Growing on Broadleaved Trees." Environ. Pollut. 47:63-78.

Reafsnyder, J. A. Aug. 1, 1988. Department of Energy, Oak Ridge Operations, Oak Ridge, Tenn., letter (DOE-1244-88) to T. A. Winston, Ohio Environmental Protection Agency, Dayton, Ohio.

Saylor, R. E. Oct. 4, 1989. Oak Ridge National Laboratory, Oak Ridge, Tenn., letter to D. J. Brettschneider, Westinghouse Materials Company of Ohio, Cincinnati.

Schneider, W. S., J. T. Grumski, and D. Dicken 1988. Westinghouse Materials Company of Ohio, memorandum to S. J. Clements, Westinghouse Materials Company of Ohio, Aug. 30, 1988.

Shupe, J. L., A. E. Olson, H. B. Peterson, and J. B. Low 1984. "Fluoride Toxicosis in Wild Ungulates." J. Am. Vet. Med. Assoc. 185:1295-1300.

SWOAPCA (Southwest Ohio Air Pollution Control Agency) 1985. 1985 Air Quality Data, Southwest Ohio Air Pollution Control Agency, Technical Services Section, Cincinnati

Trabalka, J. R. 1988. Research staff, Oak Ridge National Laboratory, Oak Ridge, Tenn., personal memorandum to G. K. Eddlemon, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Weinreich, W. A. Jan. 29, 1988. Westinghouse Materials Company of Ohio, letter (WMCO:TD:88-049) to J. A. Reafsnyder, U.S. Department of Energy, Cincinnati, "Feed Materials Production Center Waste Generation Data for FY 1984 through FY 1987."

WMCO (Westinghouse Materials Company of Ohio) 1986a. Feed Materials Production Center Environmental Monitoring Annual Report for 1985, FMPC-2047, Cincinnati.

WMCO (Westinghouse Materials Company of Ohio) 1986b. Feed Materials Production Center, Plant 4 Safety Study, Cincinnati.

WMCO (Westinghouse Materials Company of Ohio) April 30, 1987. Feed Materials Production Center Environmental Monitoring Annual Report for 1986, FMPC-2076, Special, UC-41, Cincinnati.

WMCO (Westinghouse Materials Company of Ohio) 1988a. Environment, Safety, Health and Waste Management Plan, FMPC-2114, Cincinnati.

WMCO (Westinghouse Materials Company of Ohio) April 30, 1988b. Feed Materials Production Center Environmental Monitoring Annual Report for 1987, FMPC-2135, Special, UC-41, Cincinnati.

WMCO (Westinghouse Materials Company of Ohio) Dec. 21, 1988c. Letter WMCO:SR(WR):88-564, from D. J. Brettschneider, Westinghouse Materials Company of Ohio, to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn., containing August 1988 NPDES sampling results.

CHAPTER 5

LIST OF PREPARERS

NAME	Gail L. Anderson
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.A., English, The University of Nebraska; M.A., Linguistics, The University of Nebraska; Technical Writing and Editing Specialization, The University of Tennessee
EXPERIENCE AND TECHNICAL SPECIALTY	Ten years. Editing and writing technical documents.
EIS RESPONSIBILITY	Editing and coordination

NAME	Clay E. Easterly
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	Ph.D., Physics (minor in health physics), The University of Tennessee
EXPERIENCE AND TECHNICAL SPECIALTY	Seventeen years. Health risk assessment and environmental impact analysis
EIS RESPONSIBILITY	Assessments of occupational exposure, chemical hazards of waste pits, risk calculations, and environmental monitoring.

NAME	Gerald K. Eddlemon
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.S., Zoology, The University of Tennessee, Knoxville; M.S., Zoology, The University of Tennessee, Knoxville.

EXPERIENCE AND TECHNICAL SPECIALTY	Fourteen years. Aquatic ecology; water quality; transport, fate, and effects of pollutants in aquatic systems; environmental auditing.
EIS RESPONSIBILITY	Authored sections on aquatic ecology and surface water quality in Chaps. 3 and 4.
NAME	D. B. Hunsaker, Jr.
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.S., Chemistry, University of Wisconsin-Whitewater; M.S., Analytical Chemistry, Wayne State University; Ph.D., Environmental Science and Engineering, University of California-Los Angeles.
EXPERIENCE AND TECHNICAL SPECIALTY	Twelve years. Statistical analyses of air quality data, air quality model evaluation, air quality impact assessment/permit applications, air quality planning, emission inventory compilation, analysis of regulations on energy technologies, environmental impact assessment.
EIS RESPONSIBILITY	Authored transportation and waste management section.
NAME	Robert O. Johnson
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.S., Mechanical Engineering, University of Evansville, 1972; M.S., Mechanical Engineering, Purdue University, 1975; Ph.D., Engineering Science & Mechanics, University of Tennessee, 1984.
EXPERIENCE AND TECHNICAL SPECIALTY	Fourteen years. Mathematical formulation and solution of problems in the areas of fluid mechanics, thermodynamics, heat and mass transfer, and vibrations.
EIS RESPONSIBILITY	Author or coauthor of surface water hydrology and groundwater sections in Chaps. 3 and 4. Author of geohydrology appendices.

NAME	Roger L. Kroodsma
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.A., Biology, Hope College, Holland, Michigan; M.S., Zoology, North Dakota State University; Ph.D., Zoology, North Dakota State University, Fargo.
EXPERIENCE AND TECHNICAL SPECIALTY	Eighteen years. Wildlife biology, terrestrial ecology, hydrogen fluoride effects. Certified Wildlife Biologist.
EIS RESPONSIBILITY	Terrestrial ecology--effects of uranium and hydrogen fluoride on wildlife, livestock, and vegetation.

NAME	Edward J. Liebsch
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.A., Earth Science, St. Cloud State University; M.S., Meteorology, Pennsylvania State University
EXPERIENCE AND TECHNICAL SPECIALTY	Eight years. Meteorology, air quality, and air pollution dispersion modeling.
EIS RESPONSIBILITY	Author of meteorology and nonradiological air quality.

NAME	Lance N. McCold
AFFILIATION	Oak Ridge National Laboratory
EDUCATION AND	B.S., Physics, Oregon State University; M.S., Mechanical Engineering, Oregon State University.
EXPERIENCE AND TECHNICAL SPECIALTY	Eleven years. Water resources, hydrology, waste management, energy conservation; laboratory and field experimental techniques; analytical and computer analyses.
EIS RESPONSIBILITY	Remedial actions.

NAME	Richard B. McLean
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.A., Biology; Ph.D., Marine Biology, Florida State University.
EXPERIENCE AND TECHNICAL SPECIALTY	Fourteen years. Environmental impact analysis and analysis and research. Emphasis on impacts related to uranium fuel cycle.
EIS RESPONSIBILITY	Program management.
NAME	Nancy B. Munro
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.S., Biology, Capital University; Ph.D., Mammalian Physiology, University of Kentucky
EXPERIENCE AND	Nine years. Environmental toxicology and quantitative health risk analysis
EIS RESPONSIBILITY	Evaluation of the routine off-site monitoring activities at FMPC and estimates of quantitative health risks.
NAME	Richard E. Saylor
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.S., Geology, State University of New York, B.S., Industrial Engineering, University of Tennessee; M.S., Environmental Studies, University of Rochester.
EXPERIENCE AND TECHNICAL SPECIALTY	Nine years. Environmental impact analysis and project management.
EIS RESPONSIBILITY	Project leader.
NAME	William P. Staub
AFFILIATION	Oak Ridge National Laboratory

EDUCATION	B.S., Geological Engineering, Washington University, St. Louis; M.S., Geology, Washington University, St. Louis; Ph.D., Geotechnical Engineering, Iowa State University.
EXPERIENCE AND TECHNICAL SPECIALTY	Twelve years. Uranium mill tailings stabilization, seismic risk analysis, groundwater impact analysis.
EIS RESPONSIBILITY	Author of geological assessments.
NAME	James W. Van Dyke
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	M.S. Economics, Colorado State University.
EXPERIENCE AND TECHNICAL SPECIALTY	Eleven years. Socioeconomics, need for electric power, and benefit-cost analysis.
EIS RESPONSIBILITY	Socioeconomic impacts, including land use and cultural and historical resources.
NAME	J. P. Witherspoon
AFFILIATION	Oak Ridge National Laboratory
EDUCATION	B.S., M.S., Biology, Emory University; Ph.D., Plant Ecology, The University of Tennessee.
EXPERIENCE TECHNICAL SPECIALTY	Twenty-six years. Radioecology and environmental radioactivity and dosimetry.
EIS RESPONSIBILITY	Radiological impacts sections.

GLOSSARY

acre-ft—A unit of area equal to 43,560 ft^3 (1234 m^3).

air pathway—See "pathway."

air sampling—The collection and analysis of air samples for detection or measurement of substances.

air-quality standards—The prescribed level of pollutants in the outside air that cannot be exceeded legally during a specified time in a specified area.

AIRDOS-EPA computer code—A computer code designed to estimate (1) radionuclide concentrations in air; (2) rates of deposition on ground surfaces; (3) ground surface concentrations; and (4) intake rates via inhalation of air and ingestion of meat, milk, and vegetables.

alluvium—The loose materials such as rock fragments or organic materials that are eroded, transported, and deposited by streams.

ambient air—The surrounding atmosphere, usually the outside air, as it exists around people, plants, and structures. (It is not the air in immediate proximity to emission sources.)

aquatic pathway—see "pathway."

aquifer—A saturated geologic unit that can transmit significant quantities of water under ordinary hydraulic gradients; the water can be pumped to the surface through a well, or it can emerge naturally as a spring.

aquitard—A less permeable bed in a stratigraphic sequence.

atmosphere—The layer of air surrounding the earth.

backfill—Material such as stone, clean rubble, or soil that is used to refill an excavation.

background exposure—See "exposure to radiation."

backlog wastes—Wastes that have accumulated on site from past operations.

bedrock—Any solid rock exposed at the earth's surface or overlain by unconsolidated surface material such as soil, gravel, or sand.

biochemical oxygen demand (BOD)—A measure of the amount of oxygen consumed in the biological processes that break down organic material in water; the greater the amount of organic waste, the greater the BOD.

biodenitrification—Use of microbes to remove nitrates from wastewater.

biological dose—The radiation dose absorbed in biological material (measured in rem).

British thermal unit (Btu)—A unit of heat; the quantity of heat required to raise the temperature of 1 lb of water by 1 degree Fahrenheit. One Btu equals 1055 joules (or 252 calories).

carcinogenic—Capable of producing or inducing cancer.

carcinogen—An agent capable of producing or inducing cancer.

Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA)—Established National Priority List of abandoned hazardous waste sites ("Superfund").

condensate—Liquid water obtained by cooling the steam produced in an evaporator system; also, any liquid obtained by cooling saturated vapor.

consent decree—A consent judgment by a court invoking equitable remedies.

contaminant—Any undesired physical, chemical, biological, or radiological substance or matter in water or soil.

curie (Ci)—A unit of radioactivity equal to 3.7×10^{10} (37 billion) disintegrations per second; also a quantity of any nuclide or mixture of nuclides having 1 Ci of radioactivity.

current operational wastes—Wastes generated by operation of the Feed Materials Production Center, consisting of wastes from production processes and wastes produced by support activities. Wastes from construction and from past operations are not current operational wastes.

daughter—A nuclide formed by the radioactive decay of another nuclide, which is called the parent.

decant—To pour from one container into another.

decommissioning—The process of removing a facility or area from operation or decontaminating and/or disposing of it or placing it in a condition of standby with appropriate controls and safeguards.

decontamination (radioactive)—The removal of radioactive contaminants from surfaces of equipment by cleaning or washing with chemicals, by wet abrasive blasting, or by chemical processing.

demography—The study of the characteristics of human populations (e.g., size, growth, density, distribution, and vital statistics).

depleted uranium—Uranium having a smaller percentage of uranium-235 than the 0.7% found in natural uranium.

derby—A large, usually cylindrical piece of primary metal.

detection limit—The minimum quantity or concentration that an instrument or analytical procedure can detect.

detritus—Loose material (e.g., rock fragments or organic particles) that result directly from disintegration.

directed remedial actions—Remedial actions performed at FMPC in response to U.S. Environmental Protection Agency or Ohio Environmental Protection Agency directions.

Director's Findings and Orders—Findings and orders issued by the Ohio Environmental Protection Agency regarding facility effluents.

disposal—Placement of wastes in a facility such that the wastes remain isolated from the environment permanently or until decay has progressed to a point at which releases pose no threat or hazard.

dose —See "radiological dose."

dose (radiation) rate—The radiation dose delivered per unit time (e.g., mrem per year).

dose commitment—The dose an organ or tissue would receive during a specified period of time (e.g., 50-100 years) as a result of intake (as by ingestion or inhalation) of one or more radionuclides from a 1-year release.

dose equivalent—The product of the absorbed dose from ionizing radiation and the factors that account for differences in biological effectiveness due to the type of radiation and its distribution in the body; it is measured in rem (roentgen equivalent man).

dosimeter—A small device carried by a radiation worker that measures radiation dose (e.g., film badge or ionization chamber).

ecology—The science dealing with the relationship of all living things with each other and with the environment.

effluent—A liquid waste, discharged into the environment, usually into surface streams.

electrofishing—A collection technique (sometimes called electroshocking) in which electric shock is used to stun fish that pass through the field.

electroshocking—See "electrofishing."

emission standards—Legally enforceable limits on the quantities or kinds of air contaminants that might be emitted into the atmosphere.

enriched uranium—Uranium having a larger percentage of uranium-235 than the 0.7% found in natural uranium.

environmental impact statement (EIS)—A document prepared pursuant to Section 102(2)(c) of the National Environmental Policy Act (NEPA) of 1969 for a major federal action significantly affecting the quality of the human environment.

epicenter—A point on the surface of the earth that is directly above the seismic focus of an earthquake and where the earthquake vibrations reach first.

fault—A fracture or a zone of fractures within a rock formation along which vertical, horizontal, or transverse slippage has occurred in the past.

fecal coliform bacteria—Organisms associated with the intestines of warm-blooded animals; commonly used to indicate the presence of fecal material and the potential presence of organisms capable of causing human disease.

filter cake—A concentrated solid or semisolid material that is separated from a liquid and remains on the filter after pressure filtration.

filtrate—The portion of material subjected to filtration that passes through the filter.

fines—Particles smaller than average in a mixture of particles varying in size.

flood, 100-year—A flood level that is expected to occur once every 100 years.

floodplain—A plain bordering a river, subject to flooding.

fly ash—The component of coal that results from the combustion of coal and is the finely divided mineral residue that is typically collected from boiler stack gases by electrostatic precipitator or mechanical collection devices.

geology—The science that deals with the earth: the materials, processes, environments, and history of the planet, especially the lithosphere (solid part), including the rocks, their formation and structure.

glacial outwash—Sand and gravel transported away from a glacier by streams of meltwater and either deposited as a floodplain along a preexisting valley bottom or broadcast over a preexisting plain

glacial till—See "till."

green salt—Uranium tetrafluoride.

gross beta activity—The total radioactivity due to beta particle emission as inferred from measurements on a dry sample.

ground motion amplification—Refers to situations in which soil-structure interactions may lead to ground motions that are significantly higher than the ground motions that would be predicted if a structure were built on rock.

groundwater—The supply of water under the earth's surface in an aquifer.

half-life—The time taken by certain materials to lose half their strength. For example, the half-life of DDT is 15 years, while the half-life of radium is 1580 years.

hazardous waste—Any waste or combination of wastes that pose a substantial present or potential hazard to human health or living organisms because such wastes are nondegradable or persistent in nature, because they can be biologically magnified, or because they may otherwise cause or tend to cause detrimental cumulative effects.

high-efficiency particulate air (HEPA) filter—A type of filter designed to remove 99.9% of the particulates as small as 0.3 micron in diameter from a flowing air stream.

high-level waste—High-level liquid waste or the products from the solidification of high-level liquid waste or irradiated fuel elements, if discarded without reprocessing.

histogram—A graphical representation of a distribution function by means of rectangles whose widths represent intervals by means of rectangles into which the range of observed values is divided and whose heights represent the number of observations occurring in each interval.

Holocene—An epoch of geologic time from 10,000 years ago (the end of the Pleistocene period) to the present time.

hydrocarbons—Organic compounds consisting primarily of hydrogen and carbon; emitted in automotive exhaust and from the incomplete combustion of fossil fuels such as coal.

hydrology—The science dealing with the properties, distribution, and circulation of natural water systems.

inadvertent exposure—Unintentional exposure, as to a person performing normal activities who is unknowingly exposed to radiation.

industrial waste—The waste generated by industrial processes and manufacturing.

ingot—A solid metal casting suitable for remelting or working.

interim storage (waste)—Temporary storage of drums, sealed canisters, or other containers containing immobilized hazardous or radioactive wastes in a shielded or unshielded storage facility until transfer to a federal repository or other permanent disposal/storage facility.

isotope—An atom of a chemical element with a specific atomic number and atomic weight; isotopes of the same element have the same number of protons but different numbers of neutrons. See 'nuclide.'

lacustrine—Belonging to or produced by lakes.

leachate—Any liquid, including any suspended components in the liquid, that has percolated through or drained from hazardous waste.

leaching—The process whereby a soluble component of a solid or mixture of solids is extracted as a result of percolation of a liquid around and through the solid.

limited individual—A hypothetical person exposed to a defined set of conditions, such as drinking water from a specific well or water supply.

liquefaction—Changing a solid into a liquid form or a solid with liquid-like flow properties.

loess—A fine-grained, chalky silt or clay, thought to be a deposit of wind-blown dust.

low-level (radioactive) waste—Radioactive waste not classified as high-level waste, transuranic waste, spent nuclear fuel, or byproduct material.

macrophyte—A microscopic plant, especially one in an aquatic habitat.

maximally exposed individual—The person who receives the highest dose from a given exposure.

mesophytic—Referring to a land plant that requires moderate amounts of moisture for optimal growth.

mixed waste—Waste that is both radioactive and chemically hazardous.

mixing zone—An area of a water body contiguous to a treated or untreated wastewater discharge. The mixing zone should be considered a place where wastewater and receiving water mix and not as a place where wastes are treated.

natural radiation; natural radioactivity—Background radiation: cosmic, soil, rocks.

natural uranium—Uranium with its nuclides present in proportion to their natural abundances. Natural uranium consists of 99.27% U-238, 0.72% U-235, 0.0055% U-234, and smaller proportions of other nuclides.

NO_x—Refers to the oxides of nitrogen, primarily NO and NO_2. These are often produced in the combustion of fossil fuels. In high concentrations, they constitute an air pollution problem.

nuclide—An atomic nucleus specified by its atomic weight, atomic number, and energy state; a radionuclide is a radioactive nuclide.

100-year flood—See "flood, 100-year."

outfall—The place where an effluent is discharged into receiving waters.

overpack—The process of packing one container into another.

Paleocene—An epoch of geologic time extending from the end of the cretaceous period (65 million years ago) to the beginning of the Eocene period (55 million years ago).

Paleozoic—The era of geologic time from the end of the Precambrian (600 million years before the present) until the beginning of the Mesozoic era (225 million years before the present).

particulates—Solid particles small enough to become airborne.

pathway—The route by which contaminants travel, resulting in exposure to living organisms.

penetrometer—An instrument that measures the penetrating power of a beam of X rays or other penetrating radiation.

perched—A water-bearing area of small lateral dimensions lying above a more extensive aquifer.

permeability—Ability of water to flow through porous rock or soil.

person-rem—The radiation dose commitment to a given population; the sum of the individual doses received by a population segment.

photochemical oxidant—Air pollutants formed by the action of sunlight on oxides of nitrogen and hydrocarbons.

Pleistocene—Epoch of geologic time of the quaternary period, between Pliocene (1.8 million years ago) and Holocene (10,000 years ago). Also known as the Ice Age.

plume—The elongated pattern of contaminated air or water originating at a point-source emission, such as a smokestack or a hazardous waste disposal site.

process waste—Waste produced by the production processes at the Feed Materials Production Center.

radiation absorbed dose (rad)—The basic unit of absorbed dose equal to the absorption of 0.01 joule per kilogram of absorbing material.

radioisotopes—Nuclides of the same element (same number of protons in their nuclei) that differ in the number of neutrons and that spontaneously emit particles of electromagnetic radiation.

radiological dose—The energy imparted to matter by ionizing radiation. The unit of absorbed dose is the rad, which is equal to 0.01 joule per kilogram of irradiated material in any medium.

radionuclide—A nuclide (species of atom) that exhibits radioactivity.

raffinate—In solvent refining, the portion of the treated liquid mixture that remains undissolved and is not removed by the selective solvent.

reagent—A substance used in a chemical reaction to detect, measure, or produce other substances.

remedial action—A process that is carried out in order to clean up contaminated areas to acceptable levels.

remediation—The act or process of remedying.

rem—A measurement of radiation by biological effect on human tissue (acronym for roentgen equivalent man).

Resource Conservation and Recovery Act (RCRA)—Federal legislation that regulates the transport, treatment, and disposal of solid and hazardous wastes.

riparian—Of, on, or pertaining to the bank of a river, a pond, or small lake.

risk—The chance or probability of a loss or hazard (e.g., cancer).

roentgen (R)—A unit of exposure to ionizing radiation equal to or producing 1 coulomb of charge per cubic meter of air.

safe-shutdown earthquake—The maximum earthquake for which a facility is designed to safely shut down.

scrubber—An air pollution control device that uses a liquid spray to remove pollutants from a gas stream by absorption or chemical reaction.

sedimentation—The settling of excess soil and mineral solids of small particle size contained in water.

sediment—Material that settles to the bottom of a liquid.

seismicity—The tendency for the occurrence of earthquakes.

seismic—Pertaining to any earth vibration, especially an earthquake.

shale—A fissile rock (i.e., a rock that is capable of being split), composed of laminated layers of claylike, fine-grained sediments.

siltation—The process of becoming choked, filled, covered, or obstructed with silt or mud.

site characterization—A study that identifies key physical and ecological characteristics of a defined geographical area.

slag—The more or less completely fused and vitrified matter separated during the reduction of a metal from its ore.

sludge—The precipitated solids (primarily oxides and hydroxides) that settle to the bottom of the vessels containing liquid wastes.

slurry—A watery mixture of insoluble matter that results from some pollution control techniques.

standard deviation—A statistic used as a measure of dispersion in a distribution, the square root of the arithmetic average of the square of the deviations from the mean.

storage (waste)—Retention of radioactive or hazardous waste in a man-made containment such as a drum, tank, or vault in a manner that permits retrieval, as distinguished from disposal, which implies no retrieval.

strata—Geologic formations containing a number of beds or layers of rock of the same kind of material.

stratigraphy—Division of geology dealing with the definition and description of rocks and soil, both major and minor natural divisions.

sump—A depression or tank that catches liquid runoff for drainage or disposal.

supernatant liquid—The liquid remaining above a layer of settleable solids after the solids have collected at the bottom of a vessel.

surface water—Water on the earth's surface, as distinguished from groundwater.

till—Glacial drift composed of an unconsolidated, heterogeneous mixture of clay, sand, gravel, and boulders.

total suspended particulates (TSP)—The concentration of particulates in suspension in the air irrespective of the nature, source, or size of the particulates.

total-body radiological dose—The dose that the total body receives from exposure to radiation.

toxicity—The quality or degree of being poisonous or harmful to plant or animal life.

turbidity—Hazy air due to the presence of particles and pollutants; a similar cloudy condition in water due to suspended silt or organic matter.

unconsolidated—Loosely arranged or unstratified sediment.

DISTRIBUTION OF THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

UNITED STATES CONGRESS

UNITED STATES SENATE

The Honorable John Glenn

The Honorable Mitch McConnell

The Honorable Howard M. Metzenbaum

The Honorable Quentin N. Burdick, Chairman, Committee on Environment and Public Works

The Honorable John H. Chafee, Ranking Minority Member, Committee on Environment and Public Works

The Honorable Pete V. Domenici, Ranking Minority Member, Subcommittee on Energy Research and Development, Committee on Energy and Natural Resources

The Honorable J. James Exon, Chairman, Subcommittee on Strategic Forces and Nuclear Deterrence, Committee on Armed Services

The Honorable Wendell H. Ford, Chairman, Subcommittee on Energy, Research and Develpoment

The Honorable Wendell H. Ford, Committee on Energy and Natural Resources

The Honorable John Glenn, Chairman, Committee on Governmental Affairs

The Honorable Mark O. Hatfield, Ranking Minority Member, Subcommittee on Energy and Water Development, Committee on Appropriations

The Honorable J. Bennett Johnston, Chairman, Committee on Energy and Natural Resources

The Honorable J. Bennett Johnston, Chairman, Subcommittee on Energy and Water Development, Committee on Appropriations

The Honorable James A. McClure, Ranking Minority Member, Committee on Energy and Natural Resources

The Honorable Sam Nunn, Chairman, Committee on Armed Services

The Honorable William V. Roth, Jr., Ranking Minority Member, Committee on Governmental Affairs

The Honorable Strom Thurmond, Ranking Minority Member, Subcommittee on Strategic Forces and Nuclear Deterrence, Committee on Armed Services

The Honorable John W. Warner, Ranking Minority Member, Committee on Armed Services

UNITED STATES HOUSE OF REPRESENTATIVES

The Honorable Willis D. Gradison, Jr.

The Honorable Thomas A. Luken

The Honorable Donald E. Lukens

The Honorable Mitch McConnell

The Honorable Bob McEwen

The Honorable Howard M. Metzenbaum

The Honorable Les Aspin, Chairman, Subcommittee on Procurement and Military Nuclear Systems

The Honorable Les Aspin, Chairman, Committee on Armed Services

The Honorable Tom Bevill, Chairman, Subcommittee on Energy and Water Development, Committee on Appropriations

The Honorable Thomas J. Bliley, Jr., Ranking Minority Member, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce

The Honorable William F. Clinger, Jr., Ranking Minority Member, Subcommittee on Environment, Energy and Natural Resources, Committee on Government Operations

The Honorable Jim Courter, Ranking Minority Member, Subcommittee on Procurement and Military Nuclear Systems, Committee on Armed Services

The Honorable William L. Dickinson, Ranking Minority Member, Committee on Armed Services

The Honorable John D. Dingell, Chairman, Committee on Energy and Commerce; Chairman, Subcommittee on Oversight and Investigations, Committee on Energy and Commerce

The Honorable James V. Hansen, Ranking Minority Member, Subcommittee on Energy and the Environment, Committee on Interior and Insular Affairs

The Honorable Jon Kyl, Ranking Minority Member, Department of Energy Defense Nuclear Facilities Panel

The Honorable Jon Kyl, Committee on Armed Services

The Honorable Norman F. Lent, Ranking Minority Member, Committee on Energy and Commerce

DL-3

The Honorable Thomas A. Luken, Chairman, Subcommittee on Transportation and Hazardous Materials, Committee on Energy and Commerce

The Honorable Carlos J. Moorhead, Ranking Minority Member, Subcommittee on Energy and Power, Committee on Energy and Commerce

The Honorable John T. Myers, Ranking Minority Member, Subcommittee on Energy and Water Development, Committee on Appropriations

The Honorable Robert A. Roe, Chairman, Committee on Science, Space, and Technology

The Honorable James H. Scheuer, Chairman, Subcommittee on Natural Resources, Agriculture Research and Environment, Committee on Science, Space, and Technology

The Honorable Claudine Schneider, Ranking Minority Member, Subcommittee on Natural Resources, Agriculture Research and Environment, Committee on Science, Space and Technology

The Honorable Philip R. Sharp, Chairman, Subcommittee on Energy and Power, Committee on Energy and Commerce

The Honorable John M. Spratt, Jr., Chairman, Department of Energy Defense Nuclear Facilities Panel

The Honorable Mike Synar, Chairman, Subcommittee on Environment, Energy, and Natural Resources, Committee on Government Operations

The Honorable Morris K. Udall, Chairman, Committee on Interior and Insular Affairs

The Honorable Morris K. Udall, Chairman, Subcommittee on Energy and the Environment

The Honorable Robert S. Walker, Ranking Minority Member, Committee on Science, Space, and Technology

The Honorable Bob Whittaker, Ranking Minority Member, Subcommittee on Transportation and Hazardous Materials, Committee on Energy and Commerce

The Honorable Don Young, Ranking Minority Member, Committee on Interior and Insular Affairs

DL-4

FEDERAL AGENCIES

Advisory Council on Historic Preservation, Robert D. Bush, Executive Director

Council on Environmental Quality, Dinah Bear, General Counsel

Department of Defense, Christina Ramsey, Deputy Director; Environmental Planning

Department of Health and Human Services, David E. Clapp, Office of the Director; Center for Environmental Health and Injury Control; Centers for Disease Control

Department of the Interior, John H. Farrell, Acting Director, Environmental Project Review Office

Department of the Interior, Shelia M. Huff, Regional Environmental Officer, North Central Region

Department of Labor, Hugh Conway, Director, Office of Regulatory Analysis; Occupational Safety and Health Administration

Environmental Protection Agency, Richard Sanderson, Director, Office of Federal Activities

Environmental Protection Agency, Region 5, Bill Frantz, Environmental Review Coordinator

Environmental Protection Agency, Region 5, Bill Constantelos, Catherine McCord

Office of Management and Budget, Robert Fairweather, Chief, Environmental Branch

U.S. Army Corps of Engineers, District, Louisville; Attention: CEORL-PD-R

U.S. Fish and Wildlife Service, Richard M. Smith, Research Director

U.S. Fish and Wildlife Serivce, Region 3, James C. Gritman, Twin Cities Regional Office

STATE OFFICIALS/AGENCIES/ORGANIZATIONS

GOVERNORS

Honorable Evan Bayh, Indiana

Honorable Richard H. Bryan, Nevada

DL-5

Honorable Richard Celeste, Ohio

Honorable Wallace G. Wilkinson, Kentucky

AGENCIES/ORGANIZATIONS

Federal Environmental Protection Agency, Dayton, Ohio

Kentucky State Clearinghouse, Robert Leonard, State Single Point of Contact

Ohio State Clearinghouse, Larry Weaver, State Single Point of Contact, State/Federal Funds Coordinator, Office of Budget and Management

Ohio State EPA, DEPNM, Columbus, Ohio

Ohio State EPA, Richard Shank, Columbus, Ohio

Ohio Environmental Protection Agency, Dayton, Ohio

Ohio Environmental Protection Agency, Graham Mitchell, Dayton, Ohio

Ohio Environmental Protection Agency, Jackson Township, Williamsburg, Ohio

Nevada Office of Community Services, John Walker, Clearinghouse Coordinator

LOCAL OFFICIALS

Honorable Charles J. Luken, Mayor, Cincinnati, Ohio
Assistant City Solicitor, Mr. Donald Lewis, Cincinnati, Ohio

BUTLER COUNTY COMMISSIONERS

Honorable Courtney Combs, Hamilton, Ohio

Honorable Cale Logsdon, Hamilton, Ohio

Honorable Edward Shelton, Hamilton, Ohio

HAMILTON COUNTY COMMISSIONERS

Honorable Joseph M. DeCourcy, Cincinnati, Ohio

Honorable Robert A. Taft II, Cincinnati, Ohio

BUTLER COUNTY TRUSTEES, MORGAN TOWNSHIP

Honorable Charlotte Lahmann, Clerk, Okeana, Ohio

Honorable Karl Dillhoff, Okeana, Ohio

Honorable Robert Copeland, Okeana, Ohio

Honorable Gary Colegate, Okeana, Ohio

BUTLER COUNTY TRUSTEES, ROSS TOWNSHIP

Honorable James M. Brown, Clerk, Hamilton, Ohio

Honorable Thomas Willsey, Jr., Hamilton, Ohio

Honorable Donald H. Thiem, Hamilton, Ohio

Honorable David M.

HAMILTON COUNTY TRUSTEES, COLERAIN TOWNSHIP

Honorable Patricia Clancy, Cincinnati, Ohio

Honorable David Gully, Administrator, Cincinnati, Ohio

Honorable Kathy Mohr, Clerk, Cincinnati, Ohio

Honorable John Schwierling, Cincinnati, Ohio

Honorable Joseph Wolterman, Cincinnati, Ohio

HAMILTON COUNTY TRUSTEES, CROSBY TOWNSHIP

Honorable James Miller, Harrison, Ohio

Honorable Gary Storer, Harrison, Ohio

Honorable Warren Strunk, Harrison, Ohio

Honorable Doris Turner, Clerk, Harrison, Ohio

NON-FEDERAL AGENCIES/ORGANIZATIONS/ENVIRONMENTAL GROUPS

Cincinnati Department of Health, Thomas Rotte

Environmental Defense Fund, Inc., c/o Melinda Kassen, Boulder, Colorado

FRESH, Fernald Residents for Environmental Safety and Health, c/o Lisa Crawford, Harrison, Ohio

League of Women Voters of Cincinnati, Cincinnati, Ohio

League of Women Voters of the U.S., Washington, DC

Natural Resources Defense Council, Inc., Washington, DC

Sierra Club, Cincinnati, Ohio

DL-7

Sierra Club, Miami Chapter, c/o Allen Feibelman, Cincinnati, Ohio

Sierra Club Radioactive Waste Campaign, c/o Marvin Resnikoff, Staff Scientist, New York, New York

WMCO-FMPC Advisory Committee

Howard E. Ayer, Kettering Laboratory, Cincinnati, Ohio

Sandy Butterfield, Hamilton, Ohio

Norman Cohen, Ph.D., New York University Medical Center, Institute of Environmental Medicine, Tuxedo Park, New York

Allen Feibelman, Cincinnati, Ohio

Errol Frank, Ph.D., Southwest Local School District, Harrison, Ohio

Gareth E. Gilbert, Ph.D., Ohio State University, Department of Botany, Columbus, Ohio

Gerda B. McFarland, Hamilton, Ohio

George Murray, Vice President, Project Management, Clean Sites, Inc., Alexandria, Virginia

Edward B. Silberstein, Ph.D., Professor of Radiology and Medicine, University of Cincinnati Medical Center, Cincinnati, Ohio

APPENDIX A

PROPOSED ACTION, PRESENT SITUATION (NO ACTION), AND CESSATION OF METAL PRODUCTION ALTERNATIVE PROJECT LISTS

APPENDIX A

PROPOSED ACTION, PRESENT SITUATION (NO ACTION), AND CESSATION OF METAL PRODUCTION ALTERNATIVE PROJECT LISTS

A.1 INTRODUCTION

Renovation of the Feed Materials Production Center (FMPC) involves many projects in nearly every part of the facility. Whereas Chapter 2 describes the proposed action and the present situation (no action) alternatives in summary fashion, this appendix supplies many of the details.

Figure A.1 is a map of the major FMPC facilities. The lists of projects that make up this appendix use the names and numbers in Fig. A.1 to identify project locations.

Renovation of the FMPC involves about 243 individual projects that will reduce air and/or water pollution, improve protection of worker health and safety, and improve productivity. Many projects serve more than one of these purposes. Tables A.1-A.8 describe the renovation projects, identify the resources the affected by the projects, and highlight the projects with the predominant environmental effects.

Table A.1 describes the present situation (no action) renovation and interim remedial action projects that have the predominant influences on air and water pollution. Construction of these current situation projects has already begun, and many of these projects have been completed. Tables A.2 and A.3 describe the proposed action and cessation of metal production alternative renovation projects that have the predominant effect on the air and water. The project and facility numbers listed in Tables A.1, A.2, and A.3 can be used to find additional project details in the subsequent tables.

Tables A.4, A.5, and A.6 list all present situation (no action), proposed action, and cessation of metal production alternative projects respectively. Along with the list of projects, Tables A.4, A.5, and A.6 identify the resources (air quality, water quality, and worker health) that will be affected by the individual projects. Some projects affect none of these resources but serve only to improve FMPC productivity.

Table A.7 gives a brief narrative description of each renovation project. Table A.8 lists planned construction dates, facility numbers, and environmental documentation numbers, where appropriate. Both Tables A.7 and A.8 list the projects by project number.

ORNL-DWG 89-7594R

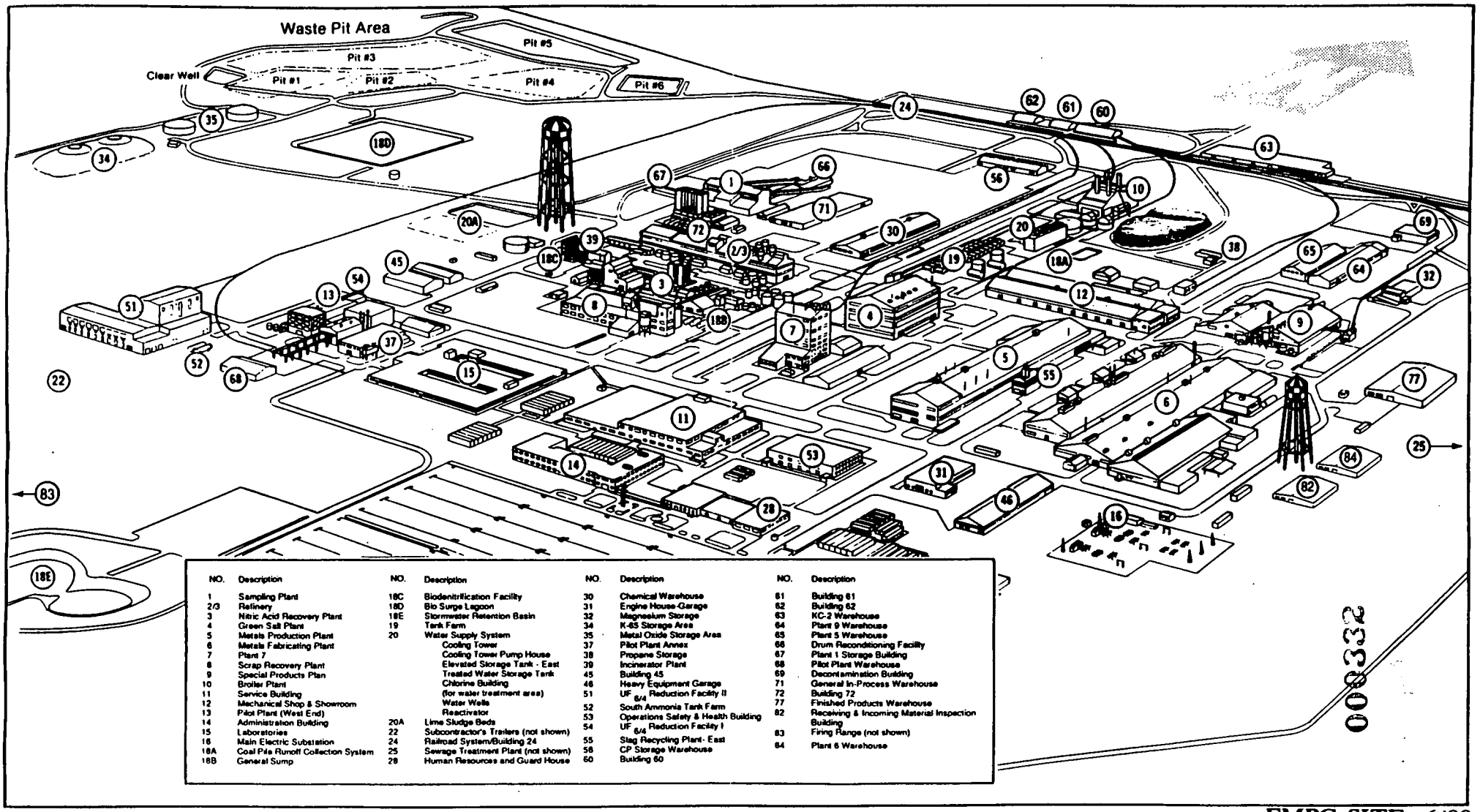


Fig. A.1. Perspective drawing of the Feed Materials Production Center waste pit and production areas.

=-0441

000332

Table A.1. Major projects affecting source terms for the present situation alternative

Project number	Facility number	Project description
		Nonradiological air emission control projects
38	4	TANK FARM: The renovated Tank Farm will be capable of receiving, storing, and distributing various flammable, toxic, and corrosive chemicals in a safe and efficient manner. All Tank Farm operations will be controllable from a remote control center.
59	6	NO_x SCRUBBER: Remove the nitric oxides from the exhaust air streams in the present scrap and chip pickling processes. A scrubber system will reduce NOx emissions to below regulatory standards.
78	8	ROTARY FURNACE: Install a new Rotary Furnace to replace existing oxidation and box furnaces.
36	8	REPLACE ROTARY KILN: The new rotary kiln must be capable of drying, roasting, or oxidizing up to 1,000 lb/hour of various process residues. Also included in this subproject are new feeders, packaging stations, dust collectors, filters, and scrubbers.
		Water pollution control projects
61	8	PLANT 8 SUMP: Improve wastewater treatment processes thereby facilitating compliance with environmental regulations. Increased capacity, improved process control and reduced operator exposure will result from this project.
324	18A	WATER POLLUTION CONTROL - COAL PILE RUN-OFF: Collection and subsequent treatment of run-off water from the coal pile. Includes construction of a run-off catch basin to be used for settling and treatment of the run-off water.
14	18C	WATER POLLUTION CONTROL PHASE II - BIODENTRIFICATION FACILITY UPGRADE: Improve waste handling and operate all four bio-reactor towers.

Table A.1 (continued)

Project number	Facility number	Project description
243	18C	WPC PHASE I BIOREACTORS: Installation of four bio-reactor towers, Biodenitrification Surge Lagoon (BSL) and demonstration test utilizing two of bio-reactor towers.
242	18E	STORMWATER COLLECTION BASIN: A 6.5 million gallon stormwater retention basin was constructed to collect and settle stormwater run-off from the process area.
247	18E	STORMWATER RETENTION BASIN EXPANSION: The stormwater retention basin will be enlarged to hold a ten year, twenty-four hour storm event (4.3 million gallons).
		Uranium air emissions control projects
82	2/3	DUST COLLECTOR G1-856: Dust Collector G1-856 and its associated equipment shall be replaced by a new system.
51	5	WEST SLAG MILLING: Provide a dedicated facility for processing slag which will eliminate the need to convert the existing facility in Plant 55 from enriched to depleted milling, and also provide the flexibility of simultaneous processing of both enriched and depleted slag.
57	5	WEST DERBY BREAKOUT: Replace present system of breaking slag with a custom-built Derby slag separator.
58	5	MATERIAL HANDLING: Reduce human exposure to uranium compounds in Plant 5 by replacing Dust Collectors G5-249 and G5-250 for the west side F-Machines with a new cartridge dust collector module and HEPA filters.
87	5	DUST COLLECTOR G5-A-100: Replace existing dust collector and its associated hoods and ducting for three ingot saws, a mold reconditioning station and a separation booth, and replace the vacuum system.

Table A.1 (continued)

Project number	Facility number	Project description
88	5	DUST COLLECTOR G5-247 AND G5-248: Dust Collector G5-247 and G5-248 will be demolished and replaced with a new collection system.
195	5	REPLACE DUST COLLECTOR G5-251: Involves replacing existing dust collector on the east side of Plant 5 near the F machines to reduce uranium emissions to the atmosphere.
196	5	REPLACE DUST COLLECTOR G5-253: Involves replacing existing dust collector on the east side of Plant 5 near the F machines to reduce uranium emissions to the atmosphere.
59	6	NO_x SCRUBBER: Remove the nitric oxides from the exhaust air streams in the present scrap and chip pickling processes. A scrubber system will reduce NO_x emissions to below regulatory standards.
36	8	REPLACE ROTARY KILN: The new rotary kiln must be capable of drying, roasting, or oxidizing up to 1,000 lb/hour of various process residues. Also included in this subproject are new feeders, packaging stations, dust collectors, filters, and scrubbers.
37	8	DRUM RECONDITIONING: The new Drum Reconditioning Facility will be capable of washing drums (plus lid and lock ring). The drum straightener and painting system will be capable of processing or handling 35 drums per hour. Each system will be capable of handling 55 gallon, 30 gallon, or 10 gallon drums with minimal manual rearrangement/adjustment of equipment.
78	8	ROTARY FURNACE: Install a new Rotary Furnace to replace existing oxidation and box furnaces.

Table A.1 (continued)

Project number	Facility number	Project description
89	8	DUST COLLECTOR G43-27 AND G43-29: Dust Collector G43-27 (Primary Calciner) and Dust Collector G43-29 (Rotex Screening) shall be demolished and replaced with a new collection system.
205	9	REPLACE AIR FILTRATION SYSTEM: This project involves the replacement of the air filtration system in Plant 9 to reduce uranium emissions into the atmosphere.
274	55	REPLACE G55-E-100 DUST COLLECTOR: Involves the replacement of G55-E-100 dust collector in Plant 55 to reduce uranium emissions to the atmosphere.
		Radon air emissions control projects
263	34	K-65 SILO INTERIM STABILIZATION: Involves stabilization of silo structures and installation of a radon containment system that is used during maintenance activities only.

Table A.2. Major projects affecting source terms for the proposed action alternative

Project number	Facility number	Project description
		Nonradiological air emission control projects
None		None
		Water pollution control projects
143	PW	WASTEWATER TREATMENT IMPROVEMENTS - PLANTWIDE: This project is made up of four sub-projects: Advanced Wastewater Treatment (AWWT) Facility, Water Recycle and Reuse, Process and Storm Water Runoff Control, and Waste Pit Area Stormwater Runoff Control. An Advanced Wastewater Treatment Facility will be installed at MH. 175 to remove radionuclides and hexavalent chrome from FMPC wastewater. A water recycle system will be installed for use as process water. The waste pit area stormwater runoff control project is a CERCLA removal action and will be covered under separate RI/FS and NEPA documentation. Although it is an element of project 143, it is not part of the proposed action for this EIS.
		Uranium air emissions control projects
39	5	FILTRATION SYSTEM DC: Replace Dust Collector G5-250 and G5-251, east remelt separation. Involves the installation of a cartridge type filtration with HEPA secondary filter to reduce uranium emissions to the atmosphere.
81	2/3	DUST COLLECTOR G2-104: Dust Collector G2-104 and its associated equipment will be replaced by a new system.
90	9	DUST COLLECTOR G42-615, DERBY SALT CLEANING: Demolish existing dust collector and replace with a new collection system.
91	54	DUST COLLECTORS G1 AND G2: The dust collectors and associated ductwork shall be demolished and replaced with new ductwork and vacuum system piping, tied in with the house system, and routed to a new filter system.

Table A.2 (continued)

Project number	Facility number	Project description
188	4	REPLACE DUST COLLECTOR G4-14 #1 PACKING STATION: involves the removal of existing air filtration equipment and the installation of a HEPA filter at Plant 4 to reduce uranium emissions to the atomsphere.
287	6	NEW FILTER SYSTEM: North, middle, and south Electrostatic Precipitators shall be removed and its previous suppliers exhausted to a new filter system.
—	—	DUST COLLECTOR 8-021, 8-024 AND G8-57.
—	—	DUST COLLECTOR G6-93A

Radon air emissions control projects

Radon air emission control projects will be defined during the Remedial Investigation and Feasibility Study.

Table A.3. Cessation of metal production alternative

Project number	Facility number	Project description
		Nonradiological air emission control projects
None		None
		Water pollution control projects
143	PW	WASTEWATER TREATMENT IMPROVEMENTS - PLANTWIDE: This project is made up of four sub-projects: Advanced Wastewater Treatment (AWWT) Facility, Water Recycle and Reuse, Process and Storm Water Runoff Control, and Waste Pit Area Stormwater Runoff Control. An Advanced Wastewater Treatment Facility will be installed at MH. 175 to remove radionuclides and hexavalent chrome from FMPC wastewater. A water recycle system will be installed for use as process water. The waste pit area stormwater runoff control project is a CERCLA removal action and will be covered under separate RI/FS and NEPA documentation. Although it is an element of project 143, it is not part of the proposed action for this EIS.
		Uranium air emissions control projects
		None
		Radon air emissions control projects
		Radon air emission control projects will be defined during the Remedial Investigation and Feasibility Study.

Table A.4. Present situation alternative renovation projects sorted by location (projects started before 10/89)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Unspecified			
147	DECONTAMINATION & DECOMMISSIONING FACILITY	X		X
167	RECEIVING INCOMING MATERIAL INSPECTION AREA (RIMIA)			
	Off-site			
66	OFFSITE AIR MONITORS			
	Waste Pits			
271	INTERIM CLOSURE FOR PIT 4		X	
319	NW ELECTRICAL SUBSTATION			
	Plantwide (PW)			
9	AIR MONITORING STATIONS	X		
28	REPLACEMENT OF CONDENSATE RETURN			X
29	REPLACE PLANT SCALES (1985)			
49	ROOF REPAIR BLDG 2,3 & 53			
50	GUARD RAIL			
62	MISCELLANEOUS OFFICES			
63	ENVIRONMENTAL EFFLUENT MEASURMENT SAMPLING UPGRADE		X	
64	TRAILER MODIF & LAB			
65	IDENTIFICATION OF PIPING			X
75	CRANE/RAILWAY MODERNIZATION			X
142	LEAKPROOF DIKES: PLANTWIDE		X	
160	LAUNDRY HANDLING BUILDING 11, 15, 53			
162	INTERPLANT MOVEMENT OF MATERIAL			X
173	FIRE TRUCK PLANTWIDE			
174	FIRE ALARM SYSTEM			X
175	PLANTWIDE LIGHTING UPGRADE			
176	RADIATION DETECTION ALARM UPGRADE			X
180	PORTABLE OFFICES			
186	PLANTWIDE PIPING REPLACEMENT AHF		X	
248	MONITORING WELL IMPROVEMENTS			
253	EMERGENCY WARNING SYSTEM			X
254	COMMUNICATIONS SYSTEMS UPGRADE			
255	UPGRADE SECURITY PHASE 2			
258	UPGRADE SECURITY PERIMETER FENCE			
265	ASBESTOS REMOVAL	X		X
269	WASTE SEGREGATION PROGRAM			

Table A.4 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
270	DRUMMED/METALLIC THORIUM REPACKAGING	X		X
279	PARKING LOT IMPROVEMENTS			
280	PLANTWIDE CONCRETE REPAIR			
281	REPAIR ASPHALT PAVED AREAS			
318	METALS SEGREGATION PROGRAM			
326	BARIUM CHLORIDE TREATMENT FACILITY CLOSURE			
	Plant 1 Sampling Plant			
7	CONTROLLING SURFACE WATER ON PLANT 1 STORAGE PAD		X	
80	REPLACE DUST COLLECTOR G2-6042 A&B PLT 1	X		
155	PLANT 1 MATERIAL HANDLING SYSTEM			X
179	TITAN MILL CYCLONE & DUCT WORK			
181	MAINTENANCE SHOP THAW TUNNEL			
215	STORAGE RACKS - ENRICHED NUCLEAR MATERIALS		X	
	Plant 2/3 Refinery			
32	METAL DISSOLVER		X	
82	DUST COLLECTOR G1-856	X		
118	WET PROCESS EXHAUST-SCRUBBING SYSTEM EXHAUST MOD.	X		X
	Plant 3 Nitric Acid Recovery Plant			
33	UO_3 GULPING		X	
182	NAR PAD TOWER CONCRETE	X		
	Plant 4 Green Salt Plant			
38	TANK FARM PROJECT	X	X	X
54	NITROGEN SYSTEM			
69	UF_4 PACKAGING STATION 1	X		X
283	T-HOPPER TURNER MAINTENANCE FACILITY		X	
	Plant 5 Metals Production Plant			
2	INSPECTION AND PACKAGING STATION			
3	ENCLOSE SAWS AND LATHES (PLANTS 5 & 9)	X		X
35	F MACHINES WEST			X
41	ELECTRICAL SUBSTATION	X	X	
42	MODIFICATIONS OF REMELT FURNACES (1-4)			

Table A.4 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
46	INGOT SEPARATION BOOTH AND MOLD COATING	X		X
51	WEST SLAG MILLING	X		X
57	WEST DERBY BREAKOUT	X		X
58	MATERIAL HANDLING INC: REPLACE DUST COLL 249 & 250	X		X
77	"F" MACHINE PARTICULATE CONTAINMENT SYSTEM	X		X
87	DUST COLLECTOR G5A-100 VENTILATION UPGRADE	X		X
88	DUST COLLECTOR G5-247 AND G5-248	X		
120	PLT 5 SAW SHARPENING & MAINT SHOP VENTILATION UPGRADE	X		X
157	JOLTER & ROCKWELL HOIST, & ETC. (PLANT 5)			X
169	SMOKE DETECTION SYSTEM UPGRADE (PLANT 5 & BLDG 71)			X
190	INGOT CLEAN ACID PICKLING	X	X	X
191	COLD SAW	X		
195	REPLACE DUST COLLECTOR G5-251	X		
196	REPLACE DUST COLLECTOR G5-253	X		
198	UPGRADE ROCKWELL FURNACE MONORAIL PLANT 5			
199	MODIFICATIONS OF REMELT FURNACES (5-8)			
	Plant 6 Metals Fabricating Plant			
34	PLANT 6 SUMP		X	X
40	SCRAP PICKLING & HANDLING FACILITY	X	X	
44	ULTRASONIC TESTING FACILITY			
45	MOLD DRYING OVENS			
59	PLANT 6 NO_x SCRUBBER (DESTRUCTORS)	X		X
149	STORAGE BUILDING, RCRA WASTES		X	X
203	DEEP HOLE DRILLING			X
204	INGOT OD LATHE	X		X
206	INGOT CRANE			X
277	CENTRIFUGES			
	Plant 8 Scrap Recovery Plant			
36	REPLACE ROTARY KILN	X		X
37	DRUM RECONDITIONI NG	X		X
55	PLANT 8 ELEVATOR			

Table A.4 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
61	PLANT 8 SUMP	X	X	X
67	CRUSHER SYSTEM	X		X
78	ROTARY FURNACE	X		X
89	DUST COLLECTOR G43-27 AND G43-29	X		
137	CONTROLLED STORAGE PAD WEST OF PLANT 8		X	
139	COVERED STORAGE PAD EAST OF PLANT 8		X	
146	THORIUM REMOVAL/HANDLING SYSTEM	X		X
150	RCRA WASTES WAREHOUSE (PLANT 8 WAREHOUSE)		X	X
325	STRUCTURAL IMPROVEMENTS TO THE THORIUM SILO	X	X	
	Plant 9 Special Products Plant			
3	ENCLOSE SAWS AND LATHES	X		X
70	MODERNIZATION OF NuSAL HEAT TREATMENT FURNACE	X		X
151	PLANT 9 WAREHOUSE - NORTH		X	X
205	REPLACE AIR FILTRATION SYSTEM (PLANT 5 AND 9)	X		
	Building 10 Boiler Plant			
163	MAINTENANCE AREA BOILER PLANT			X
216	REPLACE INSTRUMENT BOILERS 1 & 3			
218	REPAIR OBSOLETE BOILER CONTROL	X		
219	REPLACE ASH CONVEYOR - BOILER PLANT			
220	VACUUM SYSTEM BOILER PLT			X
	Building 11 Services Building			
96	CAFETERIA HVAC BLDG 11			
164	LOCKER ROOM UPGRADE/LAUNDRY UPGRADE PHASE II		X	
221	LAUNDRY MACHINES & DISHWASHER REPLACEMENT			
222	LOCKER ROOM UPGRADE (PHASE 1)		X	
223	CAFETERIA CEILING			
224	RESPIRATOR WASHING SYSTEM		X	
	Building 12 Mechanical Shop and Storeroom			
161	REPLACE EXISTING 1/2 TON CHAIN W/ 1.5 TON HOIST			
225	RADIO REPAIR SHOP RELOCATION			

Table A.4 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Building 13 Pilot Plant (wet end)			
153	GREENSALT PILOT PLANT		X	X
	Building Plant 14 Administration Building			
227	REPLACE HVAC UNITS - S.E. WING ADMIN. BLDG			
228	REPLACE HVAC UNITS - N.E. WING ADMIN. BLDG			
229	PRESIDENT'S OFFICE COMPLEX ADM BLDG			
231	ADMIN BLDG 2ND FLOOR EAST - DOE OFFICE			
232	OFFICE RENOVATIONS TO ADMIN BLDG			
233	COMPUTER AIDED DESIGN SUPPORT SYSTEM			
234	OFFICE RENOVATIONS			
236	ADMIN BLDG OFFICE RENOVATIONS			
237	SINGLE PLY ROOF ADMIN			
238	INTERIM EMERGENCY OPERATING CENTER			
	Building 15 Laboratories			
48	LAB/OFFICE MODIFICATIONS			
239	EVACUATION ALARM - LAB BUILDING			X
315	BULK ARGON FACILITY			X
316	FUME HOOD REPL - E47 & N19			X
317	FUME HOOD REPL - N5			X
	Area 18			
14	WATER POLLUTION CONTROL PHASEII-BIODENITRIFICATION FACILITY UPGRADE		X	
52	GENERAL SUMP	X	X	X
53	REFINERY SUMP	X		X
242	STORM WATER COLLECTION BASIN		X	
243	WPC PHASE I BIOREACTORS		X	
245	FENCING RETENTION BASIN			
247	STORMWATER RETENTION BASIN EXPANSION		X	
249	SURGE LAGOON LINER REPLACEMENT		X	
324	WATER POLLUTION CONTROL - COAL PILE RUN-OFF		X	

Table A.4 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Area 20 Water Supply System			
71	WATER TREATMENT PLANT			
250	REPLACE SEALWATER HEADER			
251	COOLING TOWER RENOVATIONS			
	Area 22			
252	UTILITY MODIFICATIONS SE TRAILERS			
	Facility 24 Railroad System			
256	RAILROAD REPAIR 1987			
	Facility 25			
6	ULTRAVIOLET SYSTEM		X	
	Building 28 Human Resources and Guard House			
257	HUMAN RESOURCES BUILDING EXPANSION			
259	MAIN GATE VEHICLE TRAP			
	Building 30 Chemical Warehouse			
266	CHEMICAL WAREHOUSE - REFURBISH BLDG 30			
	Building Plant 31 Enginehouse-Garage			
261	UPGRADE GARAGE FACILITY			
	Area 34 K-65 Storage Area			
262	K-65 SILO'S CC TV MONITORING SYSTEM			
263	K-65 SILO INTERIM STABILIZATION	X		X
	Area 38 Propane Storage			
264	PROPANE SHUTOFF VALVES			
	Building 53 Operations Safety & Health Building			
166	EXPAND ES&H BLDG			
272	IN-VIVO MONITORING FACILITY			X
	Building 54 UF 6/4 Reduction Facility I			
273	PILOT PLANT	X		X
	Plant 55 Slag Recycling Plant-East			
274	PLANT 55 DC G55-E-100	X		
275	REPLACE SLAG CONVEYOR			
	Building 60			
276	NEW SLAB			

Table A.4 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Building 64 Plant 9 Warehouse			
171	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 64			X
177	THORIUM OVERPACKING AND ONSITE INTERIM STORAGE (212)	X		
	Building 69 Decontamination Building			
278	EXT. CONCRETE PAD AND FENCE			
	Building 71 General In-Process Warehouse			
169	SMOKE DETECTION SYSTEM UPGRADE (PLANT 5 AND BUILDING 71)			X
	Building Plant 77 Finished Products Warehouse			
47	FINISHED PRODUCT WAREHOUSE (4A)			X

Table A.5. Proposed action renovation projects sorted by location (projects to be started after the ROD)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Unspecified			
8	SHREDDER/COMPACTOR FACILITY CONSTRUCTION			
10	WASTE CONTAINERS	X	X	X
11	WASTE REPACKAGING SYSTEM	X	X	X
15	NORTH ACCESS ROAD UPGRADE CONSTRUCTION	X	X	X
148	WASTE HANDLING FACILITY		X	
	Plant Wide (PW)			
5	POWER FEEDER REPLACEMENT			
27	SITE UTILITIES UPGRADE			
138	CONTROLLED STORAGE PADS PLANTWIDE		X	
143	WASTE WATER TREATMENT IMPROVEMENTS		X	
144	STORM SEWER IMPROVEMENTS		X	
226	SCRAP METAL MANAGEMENT			
	Plant 1 Sampling Plant			
135	COVERED CONTROL STORAGE PAD PLANT 1		X	
310	DUST COLLECTOR - PLANT 1	X		
321	LLW TRUCK DOCK UPGRADE	X	X	
	Plant 2/3 Refinery			
81	DUST COLLECTOR G2-104	X		
92	BUILDING HEATING & VENTILATION SYSTEM	X		X
285	STORAGE BUILDING - SOUTH PLANT 2			X
	Plant 3 Nitric Acid Recovery Plant			
72	IMPROVE NITRIC ACID RECOVERY	X		X
295	RAFFINATE EVAPORATOR			
311	EVAPORATOR FLASH CHAMBER			X
	Plant 4 Green Salt Plant			
188	DUST COLLECTOR REPLACEMENT #1 PACKAGING STATION	X		
313	EAST BRIDGE CRANE - PLANT 4			
	Plant 5 Metals Production Plant			
39	FILTRATION SYSTEM DC	X		
43	MOLD HAND FAC INC: INGOT COOL MOLD CLEAN	X		X
93	HEATING & VENTILATING SYSTEM PLANT 5	X		
136	CONTROLLED COVERED STORAGE PAD PLANT 5		X	

Table A.5 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
194	INGOT COOLING BOOTH	X		X
200	CRUCIBLE ENLARGEMENT			
282	REDUCTION FURNACES VENT - PLANT 5	X		X
284	FURNACE POT COOLERS	X		X
294	INGOT SAW - PLANT 5 - (#2)	X		
296	DRUM STATION FOR BURN-OUT - PLANT 5	X		
300	INGOT/CORE MARKING SYS			X
309	HILCO UNIT UPGRADE			X
314	DC - E.S. COOL BTH/FURN REP - PLANT 5	X		
	Plant 6 Metals Fabricating Plant			
94	HEATING & VENTILATING SYSTEM UPGRADE PLANT 6	X		X
121	FLAT MACHINING AREA VENTILATION UPGRADE	X		X
132	CHIP BRIQUETTING PRESS & CONVEYOR VENTILATION UPGRADE	X		X
133	SALT OIL TREATMENT ROOM VENTILATION UPGRADE PLANT 6	X		X
158	MATERIAL HANDLING PLANT 6			X
287	NEW FILTER SYSTEM	X		X
293	INGOT LATHE-REWORK CENTER	X		
304	CORE PICKLING SYS - PLANT 6	X		
305	MILLING MACH - PLANT 6 TOOL	X		
312	UNIVERSAL MACHINING CENTER	X		
	Plant 8 Scrap Recovery Plant			
306	ROTEX SCREEN - PLANT 8			X
	Plant 9 Special Products Plant			
90	VENTILATION UPGRADE DUST COLLECTOR G42-615	X		
207	INGOT COLD SAW PLANT 9	X		
292	INGOT LATHE-CROP, END FACE (#2)	X		
301	INGOT CUTTING EQUIP (4)	X		
307	CUT-OFF SAW			X
	Building 10 Boiler Plant			
159	JIB & HOIST BUILDING 10			
217	GAS FIRED BOILER #2	X		
	Building 12 Mechanical Shop & Storeroom			
97	HEATING & VENTILATING BLDG 12			
286	MAINTENANCE WAREHOUSE			X

Table A.5 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Building 13 Pilot Plant (Wet End)			
168	FIRE PROTECTION IMPROVEMENT: PILOT PLANT			X
	Building 14 Administration Building			
170	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 14			X
240	UPGRADE HIGH VACUUM SYSTEM-LAB	X		
	Building 15 Laboratories			
165	EXPAN OF ANALY FACILITY			X
288	FUME HOOD REPLACMENT			X
302	FUME HOOD			X
308	FUME HOOD REPLACEMENT			X
	Area 18			
241	COAL STORAGE FACILITY ENVIRONMENTAL UPGRADE		X	
	Area 18D Bio Surge Lagoon			
19	SURGE LAGOON PIPING REPLACEMENT			
	Area 20 Water Supply Lagoon			
99	HVAC SYSTEM BLDG 20	X		
	Facility 24 Railroad System			
100	HEATING BLDG 24	X		X
	Building 25			
101	HEATING & VENTILATING SYSTEM BLDG 25A	X		X
102	HEATING & VENTILATING SYSTEM BLDG 25C	X		X
	Building 28 Human Resources & Guard House			
103	AIR CONDITIONING SYSTEM BLDG 28	X		X
	Building 30 Chemical Warehouse			
126	HEATING & VENTILATING SYSTEM BLDG 30	X		X
152	STORAGE WAREHOUSE UPGRADE BUILDING 30		X	
	Building 31 Engine House-Garage			
105	HEATING & VENTILATING SYSTEM BLDG 31	X		X

Table A.5 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Plant 39 Incinerator Plant			
109	HEATING & VENTILATING SYSTEM BLDG 39	X		X
	Building 46 Heavy Equipment Garage			
111	HEATING & VENTILATING SYSTEM BLDG 46	X		X
	Building 54 UF 6/4 Reduction Facility I			
91	UPGRADE DUST COLL G1 & G2 BUILDING 54	X		
112	UPGRADE HEATING & VENTILATION BLDG 54	X		X
134	UF_6-UF_4 FIRE RETARD. EXH. SYS. (TO BE COORD WITH UF_6)	X		X
	Plant 55 Slag Recycling Plant-East			
113	HEATING & VENTILATING UPGRADE BLDG 55	X		X
	Building 56 CP Storage Warehouse			
114	HEATING & VENTILATING SYSTEM BLDG 56	X		X
	Building 64 Plant 9 Warehouse			
154	STORAGE WAREHOUSE UPGRADE BLDG 64 & 65		X	
	Building 65 Plant 4 Warehouse			
154	STORAGE WAREHOUSE UPGRADE BLDG 64 & 65		X	
172	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 65			X
	Building 71 General In-Process Warehouse			
4	TRUCK DOCK SHELTER			

Table A.6. Cessation of metal production projects (sorted by location)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Unspecified			
8	SHREDDER/COMPACTOR FACILITY CONSTRUCTION			
10	WASTE CONTAINERS	X	X	X
11	WASTE REPACKAGING SYSTEM	X	X	X
15	NORTH ACCESS ROAD UPGRADE CONSTRUCTION	X	X	X
148	WASTE HANDLING FACILITY		X	
	Plant Wide (PW)			
5	POWER FEEDER REPLACEMENT			
27	SITE UTILITIES UPGRADE			
138	CONTROLLED STORAGE PADS PLANTWIDE		X	
143	WASTE WATER TREATMENT IMPROVEMENTS		X	
144	STORM SEWER IMPROVEMENTS		X	
226	SCRAP METAL MANAGEMENT			
	Plant 1 Sampling Plant			
135	COVERED CONTROL STORAGE PAD PLANT 1		X	
310	DUST COLLECTOR - PLANT 1	X		
321	LLW TRUCK DOCK UPGRADE	X	X	
	Plant 2/3 Refinery			
81	DUST COLLECTOR G2-104	X		
92	BUILDING HEATING & VENTILATION SYSTEM	X		X
285	STORAGE BUILDING - SOUTH PLANT 2			X
	Plant 3 Nitric Acid Recovery Plant			
72	IMPROVE NITRIC ACID RECOVERY	X		X
295	RAFFINATE EVAPORATOR			
311	EVAPORATOR FLASH CHAMBER			X
	Plant 5 Metals Production Plant			
93	HEATING & VENTILATING SYSTEM PLANT 5	X		
136	CONTROLLED COVERED STORAGE PAD PLANT 5		X	
194	INGOT COOLING BOOTH	X		X
282	REDUCTION FURNACES VENT - PLANT 5	X		
294	INGOT SAW - PLANT 5 - (#2)	X		
	Plant 8 Scrap Recovery Plant			
306	ROTEX SCREEN - PLANT 8			X

Table A.6 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Building 10 Boiler Plant			
159	JIB & HOIST BUILDING 10			
285	STORAGE BUILDING - SOUTH PLANT 2			X
	Building 12 Mechanical Shop & Storeroom			
97	HEATING & VENTILATING BLDG 12			
286	MAINTENANCE WAREHOUSE			X
	Building 14 Administration Building			
170	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 14			X
	Building 15 Laboratories			
165	EXPAN OF ANALY FACILITY			X
288	FUME HOOD REPLACMENT			X
302	FUME HOOD			X
308	FUME HOOD REPLACEMENT			X
	Area 18			
241	COAL STORAGE FACILITY ENVIRONMENTAL UPGRADE		X	
	Area 18D Bio Surge Lagoon			
19	SURGE LAGOON PIPING REPLACEMENT			
	Area 20 Water Supply Lagoon			
99	HVAC SYSTEM BLDG 20	X		
	Facility 24 Railroad System			
100	HEATING BLDG 24	X		X
	Building 25			
101	HEATING & VENTILATING SYSTEM BLDG 25A	X		X
102	HEATING & VENTILATING SYSTEM BLDG 25C	X		X
	Building 28 Human Resources & Guard House			
103	AIR CONDITIONING SYSTEM BLDG 28	X		X
	Building 30 Chemical Warehouse			
126	HEATING & VENTILATING SYSTEM BLDG 30	X		X
152	STORAGE WAREHOUSE UPGRADE BUILDING 30		X	

Table A.6 (continued)

Project Number	Project Name	Affected Resource: Air	Water	Worker Health
	Building 31 Engine House-Garage			
105	HEATING & VENTILATING SYSTEM BLDG 31	X		X
	Plant 39 Incinerator Plant			
109	HEATING & VENTILATING SYSTEM BLDG 39	X		X
	Building 46 Heavy Equipment Garage			
111	HEATING & VENTILATING SYSTEM BLDG 46	X		X
	Building 56 CP Storage Warehouse			
114	HEATING & VENTILATING SYSTEM BLDG 56	X		X
	Building 64 Plant 9 Warehouse			
154	STORAGE WAREHOUSE UPGRADE BLDG 64 & 65		X	
	Building 65 Plant 4 Warehouse			
154	STORAGE WAREHOUSE UPGRADE BLDG 64 & 65		X	
172	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 65			X
	Building 71 General In-Process Warehouse			
4	TRUCK DOCK SHELTER			

Table A.7. FMPC renovation projects descriptions

Project Number	Project Description
2	INSPECTION AND PACKING LINE: Addition of material handling equipment for inspection and packaging of 2" flat billets.
3	ENCLOSE SAWS AND LATHES: Construct enclosures to capture fumes from cutting operations.
4	TRUCK DOCK SHELTER: Install a Truck Dock Shelter.
5	POWER FEEDER REPLACEMENT: Replace approximately 96,000 linear feet of high voltage (13.2 KV) primary power feeder cables.
6	ULTRAVIOLET SYSTEM UPGRADE: System shall be fed from the existing power panel which feeds the existing system.
7	CONTROLLING SURFACE WATER ON STORAGE PAD: Divert water to Stormwater Retention Basin.
8	SHREDDER/COMPACTOR FACILITY CONSTRUCTION: Waste volume reduction.
9	AIR MONITORING STATIONS: Install perimeter air monitoring stations to assess the amount of radionuclides emitted.
10	WASTE CONTAINERS:
11	WASTE REPACKAGING SYSTEM:
14	WATER POLLUTION CONTROL PHASE II - BIODENTRIFICATION FACILITY UPGRADE: Improve waste handling and operate all four bio-reactor towers and install BDN effluent treatment plant.
15	NORTH ACCESS ROAD UPGRADE CONSTRUCTION:
19	SURGE LAGOON PIPING REPLACEMENT: Replace surge lagoon piping which has deteriorated.
27	SITE UTILITIES UPGRADE: The replacement or restoration of site utilities, (e.g. compressed air, steam and condensate nitrogen and water lines).
28	REPLACEMENT OF CONDENSATE RETURN: This project will be replacing piping which contains uranium particulates and organics.
29	REPLACE PLANT SCALES (1985): Involves the replacement of the FMPC plant scales.
32	METAL DISSOLVER: Replace the metal dissolver and include a material handling system for direct charging of metal from 30 gallon drums and improved ventilation system.
33	UO_3 GULPING: Involves replacement of size reduction and packaging equipment and improvements in sampling, material classification and dust control.
34	PLANT 6 SUMP: The restoration is to provide automatically controlled parallel sump systems for depleted and enriched liquors and new traced/insulated lines from Plant 5 to Plant 6.
35	F MACHINE WEST: Replace to existing "F" Machines.

Table A.7 (continued)

Project Number	Project Description
36	REPLACE ROTARY KILN: The new rotary kiln must be capable of drying, roasting, or oxidizing up to 1,000 lb/hour of various process residues. Also included in this subproject are new feeders, packaging stations, dust collectors, filters, and scrubbers.
37	DRUM RECONDITIONING: The new Drum Reconditioning Facility will be capable of washing drums (plus lid and lock ring). The drum straightener and painting system will be capable of processing or handling 35 drums per hour. Each system will be capable of handling 55 gallon, 30 gallon, or 10 gallon drums with minimal manual rearrangement/adjustment of equipment.
38	TANK FARM: The renovated Tank Farm will be capable of receiving , storing, and distributing various flammable, toxic, and corrosive chemicals in a safe and efficient manner. All Tank Farm operations will be controllable from a remote control center.
39	FILTRATION SYSTEM DC: Replace Dust Collector G5-250 and G5-251, east remelt separation. Involves the installation of a cartridge type filtration with HEPA secondary filter to reduce uranium emissions to the atmosphere.
40	SCRAP PICKLING & HANDLING FACILITY: The upgrade of an existing process for pickling and handling scrap uranium metal Nitric acid fumes from the tank will be sent to the new NO_x destructor for Plant 6. The air emissions from the process will also pass through a dust collector for collection of dust particles.
41	ELECTRICAL SUBSTATION: Provide an addition to Plant 5 for a new electrical substation. The activity consists of construction of a new metal building.
42	MODIFICATION OF FURNACES 1-4: Modification of existing furnaces for mod and crucible handling. The modifications are needed to allow the equipment to handle different shaped billets.
43	MOLD HANDLING FACILITY INCLUDING INGOT COOLING, INGOT SEPARATION, MOLD CLEANING, AND MOLD COATING: Automation of the existing mold handling process. The new process will consist of a conveyor, with an enclosed run for cooling, and associated equipment for removing the ingot and cleaning and coating the mold. The new equipment will be vented to a new dust collector.
44	ULTRASONIC TESTING FACILITY: New equipment for the ultrasonic testing of ingots before they are shipped from the FMPC.
45	MOLD DRYING OVENS: Install new ovens to dry mold casting on molds for 2" ingots.

Table A.7 (continued)

Project Number	Project Description
46	INGOT SEPARATION AND MOLD COATING: Interim facility for separating ingots from mold and coating of molds for 2" ingots processing.
47	FINISHED PRODUCT WAREHOUSE: A new storage facility constructed east of Plant 6. It will be used for short-and long-term storage of uranium products for staging into the Plant 6 inspection area or for offsite shipment.
48	LAB/OFFICE MODIFICATION: Modification of Lab rooms into offices.
49	ROOF REPAIR BLDGS 2,3 & 53: Install multi-ply roof on Buildings 2 and 3, single ply roof on Building #53.
50	GUARD RAIL: Installation of a guard rail for the nitrogen storage area.
51	WEST SLAG MILLING: Provide a dedicated facility for processing slag which will eliminate the need to convert the existing facility in Plant 55 from enriched to depleted milling, and also provide the flexibility of simultaneous processing of both enriched and depleted slag.
52	GENERAL SUMP: Upgrade/replace worn components as necessary and install new equipment to meet projected NPDES requirements.
53	REFINERY SUMP: Automate operations to minimize labor and supervision, and to meet projected NPDES requirements. A new closed heating system will replace the existing receiver steam sparge preventing the dilution of the waste stream with condensate. Pumps and piping will be replaced as needed to improve maintainability.
54	NITROGEN SYSTEM: Produce high purity nitrogen at a reduced cost and a higher level of reliability and availability.
55	ELEVATORS, PLANT 8: Install service elevator to support product and Plant 8 needs.
57	WEST DERBY BREAKOUT: Replace present system of breaking slag with a custom-built Derby slag separator.
58	MATERIAL HANDLING: Reduce human exposure to uranium compounds in Plant 5 by replacing Dust Collectors G5-249 and G5-250 for the west side F-Machines with a new cartridge dust collector module and HEPA filters.
59	NO_x SCRUBBER: Remove the nitric oxides from the exhaust air streams in the present scrap and chip pickling processes. A scrubber system will reduce NO_x emissions to below regulatory standards.
61	PLANT 8 SUMP: Improve wastewater treatment processes thereby facilitating compliance with environmental regulations. Increased capacity, improved process control and reduced operator exposure will result from this project.
62	MISCELLANEOUS OFFICE: Portable Offices Plant 6, 12A and Plant 4 Maintenance.

Table A.7 (continued)

Project Number	Project Description
63	ENVIRONMENTAL EFFLUENT MEASUREMENT SAMPLING UPGRADE: The FMPC Environmental Effluent Flow Measurement and Sampling Upgrade will provide accurate total flow maesurement.
64	TRAILER MODIFICATION & LAB: Repaired trailer and converted Lab rooms into office space.
65	IDENTIFICATION OF PIPING: All piping will be identified to reflect contents.
66	OFFSITE AIR MONITORS: Install off-site air monitor to assess the amount of radionuclides present in the respective areas.
67	CRUSHER SYSTEM - PLANT 8: This project will provide the means of crushing various types of scrap material from different areas of the facility. The new equipment will reduce personnel exposure to radioactive and toxic material and produce consistently sized feed for the Plant 8 furnaces or other processes.
70	NuSAL FURNACE: Replace and relocate NuSal Salt Furnace work station to reduce material handling. Adding material handling devices will increase throughput and productivity.
71	WATER TREATMENT PLANT: Provide equipment and materials to upgrade the Water Treatment Plant. This is necessary because of system deterioration, possible personnel exposure to toxic dust, and lack of working space in the Water Treatment Lab.
72	NITRIC ACID RECOVERY: Improve Nitric Acid Recovery and reduce NO_x emissions per OEPA regulations. The system will be a modification of the existing process and will be automated to reduce operator interaction and workload.
75	RAILWAY/CRANE: Renovate the existing sections of the railroad system.
77	F MACHINE PARTICULATE CONTAINMENT SYSTEM:
78	ROTARY FURNACE: Install a new Rotary Furnace to replace existing oxidation and box furnaces.
80	REPLACE DUST COLLECTOR: Dust Collector G2-6042 A & B in Plant 1 and their associated equipment will be replaced by a new system.
81	DUST COLLECTOR G2-104: Dust Collector G2-104 and its associated equipment will be replaced by a new system.
82	DUST COLLECTOR G1-856: Dust Collector G1-856 and its associated equipment shall be replaced by a new system.
87	DUST COLLECTOR G5-A-100: Replace existing dust collector and its associated hoods and ducting for three ingot saws, a mold reconditioning station and a separation booth, and replace the vacuum system.
88	DUST COLLECTOR G5-247 AND G5-248: Dust Collector G5-247 and G5-248 will be demolished and replaced with a new collection system.

Table A.7 (continued)

Project Number	Project Description
89	DUST COLLECTOR G43-27 AND G43-29: Dust Collector G43-27 (Primary Calciner) and Dust Collector G43-29 (Rotex Screening) shall be demolished and replaced with a new collection system.
90	DUST COLLECTOR G42-615, DERBY SALT CLEANING: Demolish existing dust collector and replace with a new collection system.
91	DUST COLLECTORS G1 AND G2: The dust collectors and associated ductwork shall be demolished and replaced with new ductwork and vacuum system piping, tied in with the house system, and routed to a new filter system.
92	HEATING & VENTILATION SYSTEM: Nine new H&V units shall replace old units and two new ventilation fans shall be installed.
93	PLANT 5 HEATING AND VENTILATING SYSTEM: The existing system will be demolished and removed, and replaced with a new system.
94	PLANT 6 HEATING AND VENTILATING SYSTEM: The existing system will be demolished and removed, and replaced with a new system.
96	CAFETERIA HEATING, VENTILATING, AND AIR CONDITIONING: Replace existing HVAC system.
97	BUILDING 12 HEATING AND VENTILATING SYSTEM: Existing H&V units will be demolished and removed, and replaced by a new H&V system consisting of an outside H&V unit, ductwork and several unit heaters.
99	BUILDING 20 HEATING, VENTILATING, AND AIR CONDITIONING SYSTEMS: Existing 2nd floor H&V system will be removed and replaced with draw-through H&V units with recirculation capability and including louvers, ductwork and controls. The floor will get a new rooftop HVAC unit.
100	BUILDING 24 HEATING SYSTEM: Existing steam space heaters will be removed and replaced by two new units.
101	BUILDING 25A VENTILATING SYSTEM: Remove and replace a first floor air handling unit coil and install filters.
102	BUILDING 25C HEATING AND VENTILATING SYSTEM: Replace existing outside air inlets and filters with a new outside air louver and filter bank. Remove and replace the lower level unit heater, exhaust fan and stack with upgraded units.
103	BUILDING 28 AIR CONDITIONING SYSTEM: All 3 existing AC units will be demolished and removed, leaving the ductwork intact. New AC units will be provided to replace the old ones.

Table A.7 (continued)

Project Number	Project Description
105	Building 31 Heating and Ventilating System: The eight existing unit heaters are deteriorated and will be replaced with new unit heaters and accessories. Thermostatic controls will regulate comfort levels. A motorized wall louver damper will be installed for make-up air.
109	BUILDING 39 HEATING AND VENTILATING SYSTEM: Provide a new H&V unit to complement the existing units.
111	BUILDING 46 HEATING AND VENTILATING SYSTEM: Existing heaters are in a deteriorated condition and inoperative. Building ventilation system does not exist except for windows. Remove old equipment and install new H&V system.
112	BUILDING 54 HEATING AND VENTILATING SYSTEM: Existing unit heaters and pipe back to the mains will be demolished. A new once-through air heating and ventilating unit with controls will be provided.
113	BUILDING 55 HEATING AND VENTILATING SYSTEMS: Remove and replace the existing unit heaters, roof ventilators and the office H&V unit.
114	BUILDING 56 HEATING AND VENTILATING SYSTEM: Existing louvers will be replaced by two new units with matching motorized dampers. New powered roof ventilators will replace the existing roof vents. Four unit heaters will be added to the building.
118	WET PROCESS EXHAUST MODIFICATION: Wet process exhaust modificatin of existing scrubbing system (nitric acid recovery tower) and addition of new equipment and modifications of existing ductwork.
120	MAINTENANCE, SAW SHARPENING, AND FURNACE REPAIR SHOPS EXHAUST: The existing exhaust system will be demolished and replaced by H&V system that will filter and heat the air prior to release to the atmosphere.
121	FLAT MACHINING AREA EXHAUST SYSTEMS: Replaced and routed through new demisters to Filter Building 6-C-89.
126	BUILDING 30 HEATING AND VENTILATING SYSTEM: Existing roof ventilators are nonoperational. Each fan will be replaced with a similar propeller style of nominal size, and thermostatically controlled. New heaters will be installed to replace existing ones in the restroom and sprinkler room.
129	CROSS TRANSFERMATIC VENTILATION UPGRADE PLANT 6: Replaced and routed through a demister to a new filter system.
132	CHIP BRIQUETTING PRESS AND CONVEYOR EXHAUST SYSTEM: These will be replaced with a new system and routed to Filter Building 6-C-89.
133	SALT OIL TREATMENT ROOM VENTILATION UPGRADE PLANT 6: The Salt Oil Treatment Room exhaust system shall be replaced with a new system and routed to Filter Building 6-C-89.

Table A.7 (continued)

Project Number	Project Description
134	UF_6 TO UF_4 FIRE RETARDANT EXHAUST SYSTEM: The system and associated ductwork shall be integrated with the Pilot Plant HF scrubber and tied in with a new filter system.
135	PLANT 1 COVERED CONTROLLED STORAGE PAD: To provide confinement and collection of spills and washwater from escaping untreated in to the storm sewer system. The canopy over the pad will reduce the amount of contaminated water run-off from the stored drums of radioactive material awaiting further processing.
136	PLANT 5 COVERED CONTROLLED STORAGE PAD: To provide confinement and collection of contaminated water from escaping untreated into the storm sewer system. A canopy is required to minimize contaminated rainwater and the overdilution of the contaminant.
137	PLANT 8 STORAGE PAD WEST: Install concrete foundations and storage pad, approximately 6,000 sf.
138	PLANTWIDE CONTROLLED STORAGE PADS: Repair or replace deteriorated storage pads and provide containment systems that will retain potentially untreated contaminated spills and runoff from escaping into the storm sewer system.
139	PLANT 8 STORAGE PAD COVER: Install a new metal canopy, approximately 26,000 sf with concrete foundations over the existing east storage pad.
142	PLANTWIDE LEAKPROOF DIKES: Upgrade existing diked areas that surround chemical and fuel tanks.
143	WASTEWATER TREATMENT IMPROVEMENTS - PLANTWIDE: This project is made up of four sub-projects: Advanced Wastewater Treatment (AWWT) Facility, Water Recycle and Reuse, Process and Storm Water Runoff Control, and Waste Pit Area Stormwater Runoff Control. An Advanced Wastewater Treatment Facility will be installed at MH. 175 to remove radionuclides and hexavalent chrome from FMPC wastewater. A water recycle system will be installed for use as process water. The waste pit area stormwater runoff control project is a CERCLA removal action and will be covered under separate RI/FS and NEPA documentation. Although it is an element of project 143, it is not part of the proposed action for this EIS.
144	STORM SEWER IMPROVEMENTS: This project involves replacing all crushed storm sewer pipe and repairing all cracked manholes. The area collected by the storm sewer system will be increased by adding more piping, berms, and ditches.
146	THORIUM HANDLING: Removal of thorium oxide from a silo and two bins. The thorium shall be packaged for long-term storage.
147	DECONTAMINATION AND DECOMMISSIONING (D&D) FACILITY: This includes state-of-the-art decontamination equipment to decontaminate and/or decommission equipment and buildings.

Table A.7 (continued)

Project Number	Project Description
148	WASTE HANDLING FACILITY: A facility to provide nondestructive assay of the contents of waste packages and provide for the treatment and/or storage of the salt sludge wastes. Passivation or treatment of the salt-sludge, to remove or stabilize the hazardous component, will render the waste suitable for management as a low-level radioactive waste.
149	WAREHOUSE - RCRA WASTES: Construct a new, pre-engineered metal building of approximately 17,000 sf. to store RCRA wastes.
150	PLANT 8 WAREHOUSE: Construct a new, pre-engineered metal building, approximately 12,000 sf. for RCRA storage.
151	PLANT 9 WAREHOUSE: Construct a new, pre-engineered metal building of approximately 8,000 sf. to store uranium ingots and derbies.
152	BUILDING 30 STORAGE WAREHOUSE UPGRADE: Repairing/removing/replacing the concrete floor slab/dock, roof panels, pedestrian door, doors, and lighting.
153	PILOT PLANT STORAGE: Existing greensalt storage shed to be enclosed by adding three side panels and an overhang.
154	BUILDING 64 & 65 STORAGE WAREHOUSE UPGRADE: Repairing/removing/replacing the concrete floor areas, roof and wall panels, and all other deteriorated structural components.
155	PLANT 1 MATERIAL HANDLING SYSTEM: The material handling for the Large Drum Sampling System, Pin Cutting System, Enriched Lab Process, Safe Geometry System, Small Sampling System, and Repackaging System shall be upgraded.
157	PLANT 5 JOLTER & ROCKWELL HOIST, & ETC: The Material Handling System for the Jolter Area Bridge Cranes, Rockwell Furnace Area Monorail Hoists, and ingot saws shall be upgraded.
158	PLANT 6 MATERIAL HANDLING: Material handling, physical and radiological safety improvements shall be made in the following areas: Core Element Processing, Chip Briquetting, Derby Processing, and Ingot Processing.
159	BUILDING 10 JIB & HOIST: Install a new jib and hoist to raise and lower equipment and components in and out of the basement of Building 10.
160	LAUNDRY HANDLING: Improve method of handling dirty laundry within Bldg. 11 and transportation from Bldgs. 15 and 53.
161	REPLACING CHAIN TO HOIST: Replace existing 1/2 ton chain hoist with a new 1-1/2 ton chain hoist.
162	INTERPLANT MOVEMENT OF MATERIAL: Replace plant material handling equipment.
163	BOILER PLANT STORAGE, MAINTENANCE, & OFFICE FACILITIES: New building to store chemicals, lubricants, and equipment. Also, to provide maintenance and office facilities.

Table A.7 (continued)

Project Number	Project Description
164	LOCKER ROOM UPGRADE/LAUNDRY UPGRADE (LU/LU), PHASE II: Expansion and refurbishing of the men's locker rooms and replacements of outdated equipment.
165	EXPANSION OF ANALYTICAL FACILITY, BUILDING 15: Build a 71,000 sq. ft. expansion for additional laboratory space.
166	ES&H BUILDING EXPANSION AND UPGRADE: Existing building expansion and renovation.
167	RECEIVING AND INCOMING MATERIALS INSPECTION AREA (RIMIA): Construct a new, pre-engineered building of approximately 12,000 sf. for receiving and inspection. Relocate 20 office trailers to north of site, upgrade west road access, construct truck trailer staging pad. Expand parking lot to recover lost spaces.
168	FIRE PROTECTION IMPROVEMENTS: Upgrade pilot plant's fire protection by installing a Halon Dry Chemical System in the DC room, under the raised metal floor.
169	SMOKE DETECTION SYSTEMS UPGRADE: Install new smoke detection system in the Magnesium Storage Warehouse, Plant 5 Motor Generator Room, Magnesium Storage Area, and Building 71, to meet NFPA code requirements.
170	FIRE PROTECTION IMPROVEMENTS: Sprinkler system upgrade to meet current requirements.
171	FIRE PROTECTION IMPROVEMENTS: A new complete, dry sprinkler system will be installed to allow for storage of combustible items.
172	FIRE PROTECTION IMPROVEMENTS - SYSTEM OVERHAUL: Replacing/installing new piping, valves and sprinklers.
173	FIRE PROTECTION IMPROVEMENTS: A new fire tanker truck to replace the existing 30 year-old, deteriorated tanker. This tanker will be used to supply water to fight grass fires around the site's perimeter and community.
174	FIRE ALARM SYSTEM: Upgrade present fire alarm system to provide more information and improve system reliability.
175	PLANTWIDE LIGHTING UPGRADE: Improve lighting by replacing old, incandescent fixtures.
176	RADIATION PROTECTION ALARM UPGRADE: Upgrade detection radiation alarm systems.
177	THORIUM OVERPACKING AND ONSITE INTERIM STORAGE: Thorium overpacking and onsite interim storage.
179	TITAN MILL CYCLONE & DUCTWORK: Replace Titan Mill Cyclone and ductwork.
180	PORTABLE OFFICES: Involves portable offices at Plants 4 and 6, and the Pilot Plant.
181	MAINTENANCE SHOP THAW TUNNEL: Involves the contruction of a maintenance shop within Plant 1 to allow maintenance to be performed in the building.
182	NAR PAD TOWER CONCRETE: Repair concrete containment slab and equipment foundations in NAR.

Table A.7 (continued)

Project Number	Project Description
186	PLANTWIDE PIPING REPLACEMENT AHF: This project will replace all pipes containing uranium, asbestos, and other contaminated organics.
188	REPLACE DUST COLLECTOR G4-14 #1 PACKING STATION: Involves the removal of existing air filtration equipment and the installation of a HEPA filter at Plant 4 to reduce uranium emissions to the atmosphere.
190	INGOT CLEAN ACID PICKLING: Automated process for dipping ingots in nitric acid to remove uranium residues.
191	COLD SAW: This project will be removing the old equipment, scrap, securing electrical lines, and installing a new saw.
192	SPECIAL MATERIAL PROCESSES (West Remelt Furnaces and Conveyor Systems): Involves the upgrade of 14 product furnaces and all associated equipment. It involves the renovation of existing equipment. The renovation will include a new conveyor that will be isolated and automated, thereby resulting in reduced worker exposure.
193	SPECIAL MATERIAL PROCESSES REPLACE G5-258, 259 DUST COLLECTORS: Consists of a new air filtration system for the new furnaces and associated equipment that are described above. The existing air filtration system will be removed, and a new one will be installed.
194	INGOT COOLING BOOTH: Fabricate and install a replacement cooling booth for freshly cast ingots.
195	REPLACE DUST COLLECTOR G5-251: Involves replacing existing dust collector on the east side of Plant 5 near the F machines to reduce uranium emissions to the atmosphere.
196	REPLACE DUST COLLECTOR G5-253: Involves replacing existing dust collector on the east side of Plant 5 near the F machines to reduce uranium emissions to the atmosphere.
198	UPGRADE ROCKWELL FURNACE MONORAIL: Involves a combined maintenance and upgrade activity in removing a one-ton hoist and replacing it with a two-ton hoist in Plant 5.
199	MODIFICATION OF 5-8 REMELT FURNACES: Modify existing furnaces for mold and crucible handling. The modifications will allow the equipment to handle different-shaped billets.
200	CRUCIBLE ENLARGEMENT: Upgrade of existing remelt furnaces to permit processing of scrap material into 2" flat ingots.
203	DEEP HOLE DRILLING: Involves the replacement of a machine in Plant 9 for drilling holes in FMPC products.
204	INGOT O.D. LATHE: Involves the replacement of two lathes with one new lathe.
205	REPLACE AIR FILTRATION SYSTEM: This project involves the replacement of the air filtration system in Plant 9 to reduce uranium emissions into the atmosphere.

Table A.7 (continued)

Project Number	Project Description
206	INGOT CRANE: This project will replace the forklift with a new crane to reduce worker exposure and improve worker safety.
207	PLANT 9 INGOT COLD SAW: Install replacement ingot cutting saw.
215	STORAGE RACKS-ENRICHED NUCLEAR MATERIALS: Installation of storage racks for enriched materials which assure proper spacing for nuclear safety requirements.
216	REPLACEMENT INSTRUMENTATION FOR BOILERS 1 & 3: Will replace the existing instruments with a microprocessor-based digital distributed control system, an automatic combustion control system with more consistent repeatability and improved response, variable BTU contents of fuels, rapid fault indication followed by a fast, simple change of failed printed circuit board will restore the system without loss of control (manual backup will be provided for each control loop), and operators will be capable of understanding and operating the advanced system without extensive retraining.
217	GAS FIRED BOILER: Provide added assurance that boiler stack emissions can be held within the established regulations.
218	REPAIR OBSOLETE BOILER CONTROL: Instrumentation for boiler was upgraded to latest state-of-the-art.
219	REPLACE ASH CONVEYOR - BOILER PLANT: Involves the replacement of the ash conveyor for Boilers 1 and 3 at the FMPC Steam Plant.
220	VACUUM SYSTEM BOILER PLANT: Install house vacuum system for boiler plant.
221	LAUNDRY MACHINES & DISHWASHER REPLACEMENT: Replace washing equipment - Service Building.
222	LOCKER ROOM UPGRADE (PHASE I): Modify the room's geometry and layout to reduce worker exposure in the women's locker room.
223	CAFETERIA CEILING: Install a new drop ceiling and lights over cafeteria food lines.
224	RESPIRATOR WASHING SYSTEM: Install a respirator refurbishment facility.
225	RADIO REPAIR SHOP RELOCATION: Constructed new radio repair shop and office in Building 12.
226	SCRAP METAL MANAGEMENT: Segregation of metals as initiated in the Metals Segregation Program. Metal will be used to support the DOE Metals Reclamation Program.
227	REPLACE HVAC UNITS - NE WING ADMINISTRATION BUILDING: Installation of a forced air system, heating ventilation and air conditioning system at the southeast corner of the Administration Building.

Table A.7 (continued)

Project Number	Project Description
228	REPLACE HVAC UNITS - SOUTHEAST WING ADMIN. BLDG.: Installation of a forced-air system, heating ventilation and air conditioning system at the southeast corner of the Administration Building.
229	OFFICE RENOVATION: Renovated offices in Administration Building for President's offices and conference room.
231	ADMIN BLDG 2ND FLOOR EAST-DOE OFFICE: Renovated offices in the Administration Building for DOE personnel.
232	OFFICE RENOVATIONS TO ADMIN BLDG: Renovated office space into two new offices.
233	COMPUTER AIDED DESIGN SUPPORT SYSTEM: Involves the modification of the heating and ventilating equipment in a room in the Administration Building for a computer-aided design system.
234	OFFICE RENOVATION: Renovated office space in Administration Building.
236	ADMIN BLDG OFFICE RENOVATIONS: Renovated office space in Administration Building.
237	SINGLE PLY ROOF ADMIN: Removed and replaced existing east wing roof of Administration Building with single-ply.
238	EMERGENCY OPERATIONS CENTER: Convert an existing room in the Administration Building into an emergency operations center.
239	EVACUATION ALARM - LAB BUILDING: Evacuation alarm in the Lab Building was upgraded to provide an audible and reliable system.
240	UPGRADE HIGH VACUUM SYSTEM: Replacement of existing lab vacuum system with a state-of-the-art vacuum system to minimize worker exposure and reduce air emissions.
241	COAL STORAGE FACILITY ENVIRONMENTAL UPGRADE: Upgrade the current FMPC coal storage facility to prevent acidic stormwater run-off or groundwater contamination. Install clay liner beneath coal storage area, run-off collection, and neutralization basin, if needed.
242	STORM WATER COLLECTION BASIN: A 6.5 million gallon stormwater retention basin was constructed to collect and settle stormwater run-off from the process area.
243	WPC PHASE I BIOREACTORS: Installation of four bio-reactor towers, Biodenitrification Surge Lagoon (BSL), and demonstration test utilizing two of bio-reactor towers.
245	FENCING RETENTION BASIN: The stormwater retention basin perimeter area was fenced to discourage entry to intruders.
247	STORMWATER RETENTION BASIN EXPANSION: The stormwater retention basin will be enlarged to hold a ten year, twenty-four hour storm event (4.3 million gallons).

Table A.7 (continued)

Project Number	Project Description
248	MONITORING WELLS IMPROVEMENTS: Modification and installation of new equipment to improve quality of FMPC groundwater monitoring network.
249	BIO SURGE LAGOON LINER REPLACEMENT: An additional liner with a separate underdrain system is to be installed over the existing liner. The inlet and outlet of the BSL will each be modified. A separate sump will be installed to collect the new underdrain system. Assoicated with this project is the installation of temporary tanks.
250	REPLAC[c] SEALWATER HEADER: This project involves the replacement of a sealwater header.
251	COOLING TOWER RENOVATIONS: Replaced sections of the cooling water towers.
252	UTILITY MODIFICATIONS SE TRAILERS: Provide utilities to the SE trailers (mainly electric).
253	EMERGENCY WARNING SYSTEM: Additional vicinity warning sirens to provide a safety system to alert onsite personnel and the public within a two-mile radius of any dangerous or environmentally hazardous situations occurring at the FMPC.
254	ADDITIONAL TELEPHONE ES&H BLDG: Site communication distribution system upgrade will provide new fiber optic cables to expand the distribution system between facilities, additional premise wire within facilities and multi-plexes in several facilities to expand the capacity of existing wire pairs.
255	UPGRADE SECURITY (PHASE II): The security upgrade will improve the existing outdoor firing range, to provide personnel safety with adequate firing facilities, and support structures.
256	RAILROAD REPAIR: Consists of miscellaneous maintenance repairs to the FMPC railroad tracks.
257	HUMAN RESOURCES BUILDING EXPANSION: Involves expanding the existing Human Resources Building about 36 ft.
258	UPGRADE SECURITY PERIMETER FENCE: Twenty-six acres of land were cleared for the installation of 9,000 ft of new fence to create an isolation zone.
259	MAIN GATE VEHICLE TRAP: Two barriers will be constructed 75 feet south of main gate to define the drive lanes and control the size of vehicles to enter the plant. One hydraulic barrier will be installed in each drive lane to control vehicles prior to approaching the main gate. Automated rolling gates and new fence fabric will replace existing gates.
261	UPGRADE GARAGE FACILITIES: Provide 20′ x 40′ mezzanine in the southeast corner to provide for parts storage; new ventilation system.

Table A.7 (continued)

Project Number	Project Description
262	K-65 SILOS CC TV MONITORING SYSTEM: Purchase and installation of a surveillance system for security purposes in the waste pit area consisting of television cameras and associated support equipment to monitor the K-65 silos.
263	K-65 SILOS INTERIM STABILZATION: Involves stabilization of silo structures and installation of a radon containment system that is used during maintenance activities only.
264	PROPANE SHUTOFF VALVES: This project involves the installation of shut-off valves in existing propane fed lines.
265	ASBESTOS REMOVAL: Replacement of insulation containing asbestos in various locations.
266	CHEMICAL WAREHOUSE MODIFICATIONS: Install two walls in NE corner of Bldg 30 to provide a work/storage area for waste operations.
269	WASTE SEGREGATION PROGRAM: Determination and initiation of a cost efficient method to control and segregate noncontaminated trash in the process and nonprocess area.
270	DRUMMED/METALLIC THORIUM REPACKAGING: Repackaging of thorium metal in proper containers for storage onsite.
271	INTERIM CLOSURE FOR PIT #4: Construct interim cover for pit #4.
272	IN-VIVO MONITORING FACILITY: Establish an in-vivo monitoring facility for measuring uranium lung burdens of employees. The facility will be housed in a new building and will consist of a shielded counting chamber, gamma radiation detectors, associated electronics and a computer for control and data analysis.
273	PILOT PLANT: Line Item to renovate the 6-4 building for autoclaves and reaction vessels.
274	REPLACE G55-E-100 DUST COLLECTOR: Involves the replacement of G55-E-100 dust collector in Plant 55 to reduce uranium emissions to the atmosphere.
275	REPLACE SLAG CONVEYORS: Involves a replacement of a slag conveyor in Plant 5.
276	NEW SLAB: Add a concrete slab to Quonset #1 to provide a place to locate the trash compactor.
277	CENTRIFUGES: Replacing of centrifuges in Plant 6.
278	EXT. CONCRETE PAD AND FENCE: Concrete pad was extended and fence was installed near the decontamination pad to provide segregation while the scrap metal pile was separated.
279	PARKING LOT IMPROVEMENTS: Improved lighting and resurfacing.
280	CONCRETE REPAIRS PLANTWIDE: Involves miscellaneous concrete repairs at the FMPC .
281	REPAIR ASPHALT PAVED AREAS: Resurface existing parking lots (north, south, and east lots).

Table A.7 (continued)

Project Number	Project Description
282	REDUCTION FURNACES VENTILATION: Install a new ventilation system for exhausting the hot air from the reduction furnaces to outside.
283	T-HOPPER TURNER FACILITY: Construct a T-Hopper Turner Facility east of Plant 4 to receive, unload contents, and clean incoming T-Hoppers.
284	FURNACE POT COOLER: All eastside and westside exhaust systems will be replaced by new ductwork, high temperature filter system, volume controls, and a heat recovery system.
285	STORAGE BUILDING - SOUTH PLANT 2: Build a 40 ft x 40 ft pre-engineered structure to protect equipment and materials from hazardous chemicals and theft.
286	MAINTENANCE WAREHOUSE: Construct a 6,000 sq. ft. pre-engineered building north of Bldg. 12.
287	NEW FILTER SYSTEM: North, middle, and south Electrostatic Precipitators shall be removed and its previous suppliers exhausted to a new filter system.
288	FUME HOOD REPLACEMENT: Replace deteriorated lab fume hoods.
292	INGOT LATHE-CROP, END FACE (#2): Install ingot lathe for cropping and end facing.
293	INGOT LATHE-REWORK CENTER: Install ingot rework lathe for machining repairs.
294	PLANT 5 INGOT SAW (#2): Install replacement ingot cutting saw.
295	RAFFINATE EVAPORATOR: Replace existing raffinate evaporator.
296	PLANT 5 DRUM STATION FOR BURN-OUT: Upgrade burn-out drumming station.
300	INGOT/CORE MARKING SYSTEM: This project will minimize worker exposure and improve productivity.
301	INGOT CUTTING EQUIPMENT : Replace ingot cutting equipment.
302	FUME HOODS: Replace deteriorated lab fume hoods.
304	PLANT 6 CORE PICKLING SYSTEM: Upgrade core pickling operation.
305	PLANT 6 TOOL MILLING MACHINE: Replace tool milling machine.
306	PLANT 8 ROTEX SCREEN: Replace Rotex screen.
307	CUT-OFF SAW: Install replacement ingot cutting saw.
308	FUME HOOD REPLACEMENT: Replace deteriorated lab fume hoods.
309	HILCO UNIT UPGRADE: Upgrade Machining Coolant Facility.
310	PLANT 1 DUST COLLECTOR: Replace Dust Collector G2-172, sampling area. Removal of existing filtration system in Plant 1 and installation of a cartridge filter system with HEPA secondary filters to reduce uranium emissions to the atmosphere.
311	EVAPORATOR FLASH CHAMBER: Replace evaporator flash chamber.
312	UNIVERSAL MACHINING CENTER: Install a state-of-the-art machining center for core making.

Table A.7 (continued)

Project Number	Project Description
313	PLANT 4 EAST BRIDGE CRANE: Replace existing worn bridge cranes used for T-hoppers.
314	DC - E.S. COOL BOOTH/FURN REP (PLANT 5): Replace Dust Collector for the ingot cooling booth, Plant 5. Removal of an existing filtration system and installation of a cartridge filter system with HEPA secondary filter to reduce uranium emissions to the atmosphere.
315	BULK ARGON FACILITY: This project will supply argon to each point of use in the laboratory.
316	FUME HOOD REPL-E47 N19: Replace deteriorated lab fume hoods.
317	FUME HOOD REPL-N5: Replace deteriorated lab fume hoods.
318	METAL SEGREGATION PROGRAM: Segregated 5,000 tons of contaminated scrap metal according to metal type and level of contamination. Metals suspected to be covered with or containing asbestos will be containerized to eliminate releases to the environment.
319	NW ELECTRIC SUBSTATION: Substation and all distribution equipment shall be housed in a new prefabricated environmentally-controlled building.
321	LLW TRUCK DOCK UPGRADE: Upgrade LLW truck dock.
324	WATER POLLUTION CONTROL - COAL PILE RUN-OFF: Collection and subsequent treatment of run-off water from the coal pile. Includes construction of a run-off catch basin to be used for settling and treatment of the run-off water.
325	STRUCTURAL IMPROVEMENT OF THE THORIUM SILO
326	BARIUM CHLORIDE TREATMENT FACILITY CLOSURE

Table A.8. Renovation project numbers and names, construction dates, facility numbers, and NEPA document numbers

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
2	INSPECTION AND PACKAGING STATION	03/86	07/86	PS	5	RMU/RO 090
3	ENCLOSE SAWS AND LATHES	08/88	05/90	PS	5/9	NF 059
4	TRUCK DOCK SHELTER	12/91		PA	71	
5	POWER FEEDER REPLACEMENT	04/90	07/91	PA,CA	PW	
6	ULTRAVIOLET SYSTEM	09/89	03/90	PS	25	
7	CONTROLLING SURFACE WATER ON PLANT 1 STORAGE PAD	08/88	12/88	PS	1	NC 122
8	SHREDDER/COMPACTOR FACILITY CONSTRUCTION	12/91		PA,CA		
9	AIR MONITORING STATION	10/88	05/89	PS	PW	NF 044
10	WASTE CONTAINERS	12/91		PA,CA		
11	WASTE REPACKAGING SYSTEM	12/91		PA,CA		
14	WATER POLLUTION CONTR PHASEII-BIODENITRIFICATION FAC UPGRADE	06/89	11/90	PS	18	NC 119
15	NORTH ACCESS ROAD UPGRADE CONSTRUCTION	08/90	12/91	PA,CA		
19	SURGE LAGOON PIPING REPLACEMENT	04/90	08/90	PA,CA	18D	
27	SITE UTILITIES UPGRADE	07/91	09/92	PA,CA	PW	
28	REPLACEMENT OF CONDENSATE RETURN	08/85	02/87	PS	PW	CAT EX 169
29	REPLACE PLANT SCALES (1985)	02/87	09/87	PS	PW	CAT EX 167
32	METAL DISSOLVER	01/88	08/88	PS	2/3	NC 082
33	UO_3 GULPING	07/87		PS	3	NC 073
34	PLANT 6 SUMP	09/87	03/89	PS	6	NC 080
35	F MACHINES WEST	10/88	08/89	PS	5	NC 074
36	REPLACE ROTARY KILN	02/88	08/89	PS	8	NC 081
37	DRUM RECONDITIONING	02/88	05/89	PS	8	NC 053
38	TANK FARM PROJECT	09/86	09/89	PS	4	ADM 054
39	FILTRATION SYSTEM DC	12/91		PA	5	NC 094
40	SCRAP PICKLING & HANDLING FACILITY	04/88	03/89	PS	6	NC 125
41	ELECTRICAL SUBSTATION	12/86	10/87	PS	5	NC 108
42	MODIFICATIONS OF REMELT FURNACES (1-4)	07/86	04/87	PS	5	RMU/RO 092
43	MOLD HAND FAC INC:INGOT COOL MOLD CLEAN	05/90	09/90	PA	5	NC 214
44	ULTRASONIC TESTING FACILITY	02/87	12/88	PS	6	RMU/RO 088
45	MOLD DRYING OVENS	11/86	04/87	PS	6	RMU/RO 195
46	INGOT SEPARATION BOOTH AND MOLD COATING	05/85	11/85	PS	5	NC 125
47	FINISHED PRODUCT WAREHOUSE (4A)	03/87	10/87	PS	77	NC 098
48	LAB/OFFICE MODIFICATIONS	06/86	05/87	PS	15	CAT EX 171
49	ROOF REPAIR BLDG 2,3 & 53	09/86	11/86	PS	PW	CAT EX 177

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
50	GUARD RAIL	09/86	11/86	PS	PW	
51	WEST SLAG MILLING	08/88	05/90	PS	5	NC 075
52	GENERAL SUMP	12/88	07/90	PS	18	NC 084
53	REFINERY SUMP	04/89	02/90	PS	18	NC 085
54	NITROGEN SYSTEM	12/87	03/89	PS	4	NC 077
55	PLANT 8 ELEVATOR	03/88	11/88	PS	8	NC 050
57	WEST DERBY BREAKOUT	01/89	03/91	PS	5	NC 087
58	MATERIAL HANDLING INC: REPLACE DUST COLL 249 & 250	02/89	12/90	PS	5	
59	PLANT 6 NO_x SCRUBBER (DESTRUCTORS)	03/88	03/89	PS	6	NC 078
61	PLANT 8 SUMP	12/88	04/90	PS	8	NC 083
62	MISCELLANEOUS OFFICES	07/87	11/87	PS	PW	
63	ENVIRONMENTAL EFFLUENT MEASURMENT SAMPLING UPGRADE	11/88	06/89	PS	PW	NC 017
64	TRAILER MODIF & LAB	11/86	06/87	PS	PW	CAT EX 181
65	IDENTIFICATION OF PIPING	12/88		PS	PW	
66	OFFSITE AIR MONITORS	12/87		PS	OS	NC 207
67	CRUSHER SYSTEM	06/89	07/90	PS	8	
70	MODERNIZATION OF NuSAL HEAT TREATMENT FURNACE	03/89	09/90	PS	9	
71	WATER TREATMENT PLANT	11/88	03/90	PS	20	NC 111
72	IMPROVE NITRIC ACID RECOVERY	10/89	09/90	PA,CA	3	NC 110
75	CRANE/RAILWAY MODERNIZATION	03/88	12/88	PS	PW	NC 099
77	"F" MACHINE PARTICULATE CONTAINMENT SYSTEM	09/88		PS	5	NC 016
78	ROTARY FURNACE	05/89	11/90	PS	8	
80	REPLACE DUST COLLECTOR G2-6042 A&B PLT 1	05/89	09/89	PS	1	NF 135
81	DUST COLLECTOR G2-104	12/95		PA,CA	2/3	
82	DUST COLLECTOR G1-856	05/89	09/89	PS	2/3	NF 136
87	DUST COLLECTOR G5A-100 VENTILATION UPGRADE	05/88	12/88	PS	5	NF 023
88	DUST COLLECTOR G5-247 AND G5-248	02/89	03/90	PS	5	NF 056
89	DUST COLLECTOR G43-27 AND G43-29	01/89	10/89	PS	8	NF 057
90	VENTILATION UPGRADE DUST COLLECTOR G42-615	02/91		PA	9	NF 058
91	UPGRADE DUST COLL G1 & G2 BUILDING 54	10/92	01/93	PA	54	
92	BUILDING HEATING & VENTILATION SYSTEM	12/95		PA,CA	2/3	
93	HEATING & VENTILATING SYSTEM PLANT 5	05/92	12/92	PA,CA	5	
94	HEATING & VENTILATING SYSTEM UPGRADE PLANT 6	11/92	05/94	PA	6	
96	CAFETERIA HVAC BLDG 11	10/87	08/88	PS	11	NF 021
97	HEATING & VENTILATING BLDG 12	05/92	01/93	CA	12	

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
99	HVAC SYSTEM BLDG 20	04/92	08/92	PA,CA	20	
100	HEATING BLDG 24	04/92	06/92	PA,CA	24	
101	HEATING & VENTILATING SYSTEM BLDG 25A	05/92	06/92	PA,CA	25	
102	HEATING & VENTILATING SYSTEM BLDG 25C	05/92	07/92	PA,CA	25	
103	AIR CONDITIONING SYSTEM BLDG 28	04/92	08/92	PA,CA	28	
105	HEATING & VENTILATING SYSTEM BLDG 31	05/92	08/92	PA,CA	31	
109	HEATING & VENTILATING SYSTEM BLDG 39	06/92	09/92	PA	39	
111	HEATING & VENTILATING SYSTEM BLDG 46	04/92	07/92	PA,CA	46	
112	UPGRADE HEATING & VENTILATION BLDG 54	05/92	07/92	PA	54	
113	HEATING & VENTILATING UPGRADE BLDG 55	03/92	06/92	PA	55	
114	HEATING & VENTILATING SYSTEM BLDG 56	06/92	08/92	PA,CA	56	
118	WET PROCESS EXHAUST-SCRUBBING SYSTEM EXHAUST MOD.	05/89	09/89	PS	2/3	NF 148
120	PLT 5 SAW SHARPENING & MAINT SHOP VENTILATION UPGRADE	05/89	09/89	PS	5	NF 161
121	FLAT MACHINING AREA VENTILATION UPGRADE	04/90	08/90	PA	6	NF 152
126	HEATING & VENTILATING SYSTEM BLDG 30	04/92	06/92	PA,CA	30	
132	CHIP BRIQUETTING PRESS & CONVEYOR VENTILATION UPGRADE	03/90	05/90	PA	6	NF 153
133	SALT OIL TREATMENT ROOM VENTILATION UPGRADE PLANT 6	04/90	08/90	PA	6	NF 154
134	UF_6-UF_4 FIRE RETARD. EXH. SYS. (TO BE COORD WITH UF6)	04/92	08/92	PA	54	
135	COVERED CONTROL STORAGE PAD PLANT 1	10/90	02/92	PA,CA	1	NF 151
136	CONTROLLED COVERED STORAGE PAD PLANT 5	09/90	04/91	PA,CA	5	NF 138
137	CONTROLLED STORAGE PAD WEST OF PLANT 8	08/88	12/89	PS	8	NF 045
138	CONTROLLED STORAGE PADS PLANTWIDE	08/91	11/92	PA,CA	PW	
139	COVERED STORAGE PAD EAST OF PLANT 8	08/88	11/89	PS	8	NF 046
142	LEAKPROOF DIKES: PLANTWIDE	09/88	09/89	PS	PW	NF 061
143	WASTE WATER TREATMENT IMPROVEMENTS	10/91	11/92	PA,CA	PW	
144	STORM SEWER IMPROVEMENTS	10/92	11/93	PA,CA	PW	

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
146	THORIUM REMOVAL/HANDLING SYSTEM	08/88	05/89	PS	8	EA 338
147	DECONTAMINATION & DECOMMISSIONING FACILITY	01/89	03/91	PS	69	EA 055
148	WASTE HANDLING FACILITY	01/93	08/94	PA,CA		
149	STORAGE BUILDING, RCRA WASTES	08/88	10/89	PS	6	NF 040
150	RCRA WASTES WAREHOUSE (PLANT 8 WAREHOUSE)		05/88	10/88	PS	8NF 039
151	PLANT 9 WAREHOUSE - NORTH	07/88	11/88	PS	9	NF 041
152	STORAGE WAREHOUSE UPGRADE BUILDING 30	09/90	03/91	PA,CA	30	
153	GREENSALT PILOT PLANT	05/88	06/89	PS	13	NF 042
154	STORAGE WAREHOUSE UPGRADE BLDG 64 & 65	10/90	02/91	PA,CA	64/65	
155	PLANT 1 MATERIAL HANDLING SYSTEM	02/89	09/89	PS	1	NF 065
157	JOLTER & ROCKWELL HOIST, & ETC. (PLANT 5)	03/89		PS	5	NF 066
158	MATERIAL HANDLING PLANT 6	06/92		PA	6	NF 067
159	JIB & HOIST BUILDING 10	03/92	08/92	PA,CA	10	
160	LAUNDRY HANDLING BUILDING 11, 15, 53	10/88	11/89	PS	PW	NF 064
161	REPLACE EXISTING 1/2 TON CHAIN W/ 1.5 TON HOIST	03/89	04/89	PS	12	NF 063
162	INTERPLANT MOVEMENT OF MATERIAL	10/88	12/89	PS	PW	NF 069
163	MAINTENANCE AREA BOILER PLANT	11/87	05/88	PS	10	NF 025
164	LOCKER ROOM UPGRADE/LAUNDRY UPGRADE PHASE II	05/88	09/89	PS	11	NF 028
165	EXPAN OF ANALY FACILITY	08/90	08/91	PA,CA	15	NF 142
166	EXPAND ES&H BLDG	06/88	12/89	PS	53	NF 027
167	RECEIVING INCOMING MATERIAL INSPECTION AREA (RIMIA)	06/88	03/90	PS	RO128/NF43	
168	FIRE PROTECTION IMPROVEMENT: PILOT PLANT	09/90	12/90	PA	13	
169	SMOKE DETECTION SYSTEM UPGRADE PLANT 5 & BLDG 71	10/88	02/89	PS	5/71	NF 060
170	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 14	08/90	01/91	PA,CA	14	
171	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 64	10/88	03/89	PS	64	NF 144
172	FIRE PROTECTION IMPROVEMENT SPRINKLER SYSTEM BLDG 65	09/90	03/91	PA,CA	65	
173	FIRE TRUCK PLANTWIDE	09/88	01/89	PS	PW	NF 163
174	FIRE ALARM SYSTEM	02/88	09/88	PS	PW	NF 026
175	PLANTWIDE LIGHTING UPGRADE	09/88	03/90	PS	PW	NF 062

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
176	RADIATION DETECTION ALARM UPGRADE	09/88	01/89	PS	PW	NF 139
177	THORIUM OVERPACKING AND ONSITE INTERIM STORAGE (212)	07/88		PS	64	NC 106
179	TITAN MILL CYCLONE & DUCT WORK	10/86	01/87	PS	1	NC 097
180	PORTABLE OFFICES	10/86	02/87	PS	PW	NC 001
181	MAINTENANCE SHOP THAW TUNNEL	08/87	12/87	PS	1	NC 200
182	NAR PAD TOWER CONCRETE	09/86	12/86	PS	3	NC 199
186	PLANTWIDE PIPING REPLACEMENT #AHF	04/85	12/85	PS	PW	NF 202
188	DUST COLLECTOR REPLACEMENT #1 PACKAGING STATION	03/90	02/91	PA	4	
190	INGOT CLEAN ACID PICKLING	10/86		PS	5	
191	COLD SAW	03/86	04/87	PS		
194	INGOT COOLING BOOTH	12/91		PA	5	
195	REPLACE DUST COLLECTOR G5-251	12/87	01/89	PS	5	NC 035
196	REPLACE DUST COLLECTOR G5-253	12/87	01/89	PS	5	NC 035
198	UPGRADE ROCKWELL FURNACE MONORAIL PLANT 5	09/86	08/87	PS	5	
199	MODIFICATIONS OF REMELT FURNACES (5-8)	11/86	08/87	PS	5	RMU/RO 091
200	CRUCIBLE ENLARGEMENT	01/90		PA	5	RMU/RO 089
203	DEEP HOLE DRILLING	09/88	02/89	PS	9	NC 076
204	INGOT OD LATHE	09/88	02/89	PS	9	NC 076
205	REPLACE AIR FILTRATION SYSTEM	08/85	06/87	PS	9	NC 210
206	INGOT CRANE	09/88		PS	9	NC 076
207	INGOT COLD SAW PLANT 9	12/89		PA	9	
215	STORAGE RACKS - ENRICHED NUCLEAR MATERIALS	12/87	07/88	PS	1	
216	REPLACE INSTRUMENT BOILERS 1 & 3	07/85		PS	10	CAT EX 170
217	GAS FIRED BOILER #2	12/90		PA	10	NC 093
218	REPAIR OBSOLETE BOILER CONTROL	12/87		PS	10	
219	REPLACE ASH CONVEYOR - BOILER PLANT	04/8	07/87	PS	10	NC 105
220	VACUUM SYSTEM BOILER PLT	10/88	04/89	PS	10	
221	LAUNDRY MACHINES & DISHWASHER REPLACEMENT	07/85	06/86	PS	11	NC 103
222	LOCKER ROOM UPGRADE (PHASE 1)	05/88	12/88	PS	11	NC 020
223	CAFETERIA CEILING	06/86	08/86	PS	11	CAT EX 172
224	RESPIRATOR WASHING SYSTEM	06/88		PS	11	NC 129
225	RADIO REPAIR SHOP RELOCATION	11/86	02/87	PS	12	CAT EX 182
226	SCRAP METAL MANAGEMENT	12/92	12/96	PA,CA	PW	
227	REPLACE HVAC UNITS - S.E. WING ADMIN. BLDG	12/86	09/87	PS	14	CAT EX 184
228	REPLACE HVAC UNITS - N.E. WING ADMIN. BLDG	12/86	09/87	PS	14	CAT EX 185

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
229	PRESIDENT'S OFFICE COMPLEX ADM BLDG	11/87	04/88	PS	14	CAT EX 192
231	ADMIN BLDG 2ND FLOOR EAST - DOE OFFICE	11/86	02/87	PS	14	CAT EX 183
232	OFFICE RENOVATIONS TO ADMIN BLDG	09/86	02/87	PS	14	CAT EX 178
233	COMPUTER AIDED DESIGN SUPPORT SYSTEM	08/87	12/87	PS	14	
234	OFFICE RENOVATIONS	10/86	05/87	PS	14	CAT EX 180
236	ADMIN BLDG OFFICE RENOVATIONS	12/86	05/87	PS	14	CAT EX 187
237	SINGLE PLY ROOF ADMIN	12/86	01/87	PS	14	CAT EX 188
238	EMERGENCY OPERATING CENTER	02/87	04/87	PS	14	CAT EX 189
239	EVACUATION ALARM - LAB BUILDING	08/86	10/86	PS	15	
240	UPGRADE HIGH VACUUM SYSTEM-LAB	10/89	01/90	PA	15	
241	COAL STORAGE FACILITY ENVIRONMENTAL UPGRADE	01/91	02/92	PA,CA	18	
242	STORM WATER COLLECTION BASIN	12/87		PS	18	
243	WPC PHASE I BIOREACTORS	12/87		PS	18	
245	FENCING RETENTION BASIN	08/86	09/86	PS	18	NC 198
247	STORMWATER RETENTION BASIN EXPANSION	04/88	12/88	PS	18	NC 015
248	MONITORING WELL IMPROVEMENTS	02/88	05/88	PS	PW	
249	SURGE LAGOON LINER REPLACEMENT	05/87	12/88	PS	18	NC 029
250	REPLACE SEALWATER HEADER	08/85	06/87	PS	20	CAT EX 164
251	COOLING TOWER RENOVATIONS	06/88	10/88	PS	20	NC 116
252	UTILITY MODIFICATIONS SE TRAILERS	11/88	07/89	PS	22	NC 048
253	EMERGENCY WARNING SYSTEM	12/86	10/87	PS	PW	RMU/RO 194
254	COMMUNICATIONS SYSTEMS UPGRADE	03/87		PS	PW	RMU/RO 132
255	UPGRADE SECURITY PHASE 2	03/89		PS	PW	NC 115
256	RAILROAD REPAIR 1987	06/87	09/87	PS	24	CAT EX 166
257	HUMAN RESOURCES BUILDING EXPANSION	06/88	01/89	PS	28	NC 010
258	UPGRADE SECURITY PERIMETER FENCE	06/89	09/89	PS	PW	ADM 030
259	MAINGATE VEHICLE TRAP	04/89	10/89	PS	28	
261	UPGRADE GARAGE FACILITY	06/89	12/89	PS	31	
262	K-65 SILOS CC TV MONITORING SYSTEM	02/87	07/87	PS	34	NC 019
263	K-65 SILO INTERIM STABILIZATION	09/87	12/88	PS	34	ADM 038
264	PROPANE SHUTOFF VALVES	09/85	06/87	PS	38	CAT EX 165
265	ASBESTOS REMOVAL	12/87		PS	40	RMU/RO 201
266	CHEMICAL WAREHOUSE - REFURBISH BLDG 30	12/86	07/87	PS	30	NC 013
269	WASTE SEGREGATION PROGRAM	12/85		PS	PW	

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
270	DRUMMED/METALLIC THORIUM REPACKAGING	12/88		PS	PW	
271	INTERIM CLOSURE FOR PIT 4	09/88	07/89	PS	P	NC 012
272	IN-VIVO MONITORING FACILITY	10/87	09/88	PS	53	NC 036
273	PILOT PLANT	05/82	12/87	PS	54	RMU/RO 127
274	PLANT 55 DC G55-E-100	03/88	03/89	PS	55	NC 034
275	REPLACE SLAG CONVEYOR	03/87	08/87	PS	55	NC 049
276	NEW SLAB	05/86		PS	60	NC 211
277	CENTRIFUGES	05/86	08/86	PS	6	CAT EX 203
278	EXT. CONCRETE PAD AND FENCE	09/86		PS	69	CAT EX 204
279	PARKING LOT IMPROVEMENTS	08/86	03/87	PS	PW	CAT EX 176
280	PLANTWIDE CONCRETE REPAIR	06/86	10/86	PS	PW	
281	REPAIR ASPHALT PAVED AREAS	06/86	09/86	PS	PW	CAT EX 174
282	REDUCTION FURNACES VENT - PLANT 5	11/89		PA	5	NF 141
283	T-HOPPER TURNER MAINTENANCE FACILITY	04/89	10/89	PS	4	NF 143
284	FURNACE POT COOLERS	11/89		PA	5	NF 160
285	STORAGE BUILDING - SOUTH PLANT 2	06/90	10/90	PA,CA	2	
286	MAINTENANCE WAREHOUSE	07/90	02/91	PA,CA	12	
287	NEW FILTER SYSTEM	02/90	11/90	PA	6	NF 157
288	FUME HOOD REPLACMENT	12/89		PA,CA	15	
292	INGOT LATHE-CROP, END FACE (#2)	12/89		PA	9	
293	INGOT LATHE-REWORK CENTER	12/89		PA	6	
294	INGOT SAW - PLANT 5 - (#2)	12/90		PA,CA	5	
295	RAFFINATE EVAPORATOR	12/90		PA,CA	3	
296	DRUM STATION FOR BURN-OUT - PLANT 5	12/90		PA	5	
300	INGOT/CORE MARKING SYS	12/90		PA	5	
301	INGOT CUTTING EQUIP (4)	12/91		PA	9	
302	FUME HOODS	12/91		PA,CA	15	
304	CORE PICKLING SYS - PLANT 6	12/92		PA	6	
305	MILLING MACH - PLANT 6 TOOL	12/91		PA	6	
306	ROTEX SCREEN - PLANT 8	12/91		PA,CA	8	
307	CUT-OFF SAW	12/95		PA	9	
308	FUME HOOD REPLACEMENT	12/91		PA,CA	15	
309	HILCO UNIT UPGRADE	12/91		PA	5	
310	DUST COLLECTOR - PLANT 1	12/91		PA,CA	1	
311	EVAPORATOR FLASH CHAMBER	12/91		PA,CA	3	
312	UNIVERSAL MACHINING CENTER	12/92		PA	6	
313	EAST BRIDGE CRANE - PLANT 4	11/89		PA	4	
314	DC - E.S. COOL BTH/FURN REP - PLANT 5	12/89		PA	5	
315	BULK ARGON FACILITY	05/89	08/89	PS	15	
316	FUME HOOD REPL - E47 & N19	08/89	12/89	PS	15	
317	FUME HOOD REPL - N5	08/89	12/89	PS	15	

Table A.8 (continued)

Project Number	Project Name	Construction Dates Start	Construction Dates Complete	Alternative	Facility No.[a]	Environmental Documentation No.[b]
318	METALS SEGREGATION PROGRAM	04/86	06/87	PS		
319	NW ELECTRICAL SUBSTATION	03/89		PS	P	
321	LLW TRUCK DOCK UPGRADE	12/91		PA,CA	1	
324	WATER POLLUTION CONTROL - COAL PILE RUN-OFF	05/84	10/85	PS	18	
325	STRUCTURAL IMPROVEMENT TO THORIUM SILO	06/86	09/86	PS	8	
326	BARIUM CHLORIDE TREATMENT FACILITY CLOSURE	03/89	09/89	PS	PW	

[a]P = Waste Pit area
PW = Plantwide
See Fig. A-1 for definitions of other facilities.
A blank means the facility does not currently have a number.

[b]ADM = Action description memorandum
EA = Environmental Assessment
CAT EX = Categorical exclusion
NC = NEPA checklist
NF = NEPA factsheet

APPENDIX B

AN OVERVIEW OF THE FEED MATERIALS PRODUCTION CENTER

APPENDIX B. AN OVERVIEW OF THE FEED MATERIALS PRODUCTION CENTER*

The Feed Materials Production Center (FMPC) produces uranium metal products used as feed materials in U.S. Department of Energy (DOE) defense programs. This appendix provides a technical overview of FMPC's specialized processes.

B.1 PRINCIPAL PRODUCTS

FMPC's principal products are variously sized, highly purified uranium metal forms of assorted standard isotopic assay. Producing uranium metal requires a series of chemical and metallurgical conversions that occur in eight specialized on-site plants. The finished metal products are then shipped to Rocky Flats, Colorado; Savannah River, South Carolina; Oak Ridge, Tennessee; and Hanford, Washington, for DOE's national defense programs use. Figure B.1 shows the role of FMPC in these programs.

B.2 THE PRODUCTION PROCESS

At FMPC, uranium metal derbies can be produced only from processes using UF_4 (called "green salt"), which is obtained from any one of three sources: shipment to FMPC from other facilities, production on-site by reducing UF_6, or recycling uranium-bearing scrap metal (Fig. B.2). In this last method, the scrap metals are dissolved in nitric acid to produce a crude uranyl nitrate (UNH) solution for solvent extraction purification. Purified UNH is concentrated by evaporation thermally denitrated to uranium trioxide (UO_3), or orange oxide, and then converted to UF_4.

To begin uranium metal production, UF_4 is blended with magnesium granules and placed in a closed reduction pot lined with MgF_2. The reduction pot is heated until the contents react to produce uranium metal shaped in forms called derbies, weighing 136 to 168 kg. Some derbies are sent directly to other DOE sites; however, most are cast into ingots at FMPC.

Ingots are formed by melting derbies, along with metallic scrap and briquettes recycled from earlier production and fabrications, in a graphite crucible in a vacuum induction furnace. When the molten metal reaches the proper temperature, it is bottom poured into a graphite mold to form ingots.

Ingots vary in weight, size, and shape according to how they will be used. Since the late 1960s, all cylindrical ingots have been center drilled at FMPC and sent off-site for fabrication into tubing by extrusion (the process of forming metal into tubes). Most of the extruded tubes are returned to FMPC for heat treatment and final machining before shipment.

---

*Excerpted from *A Closer Look at Uranium Metal Production, A Technical Overview*, Feed Materials Production Center, Fernald, Ohio.

000380

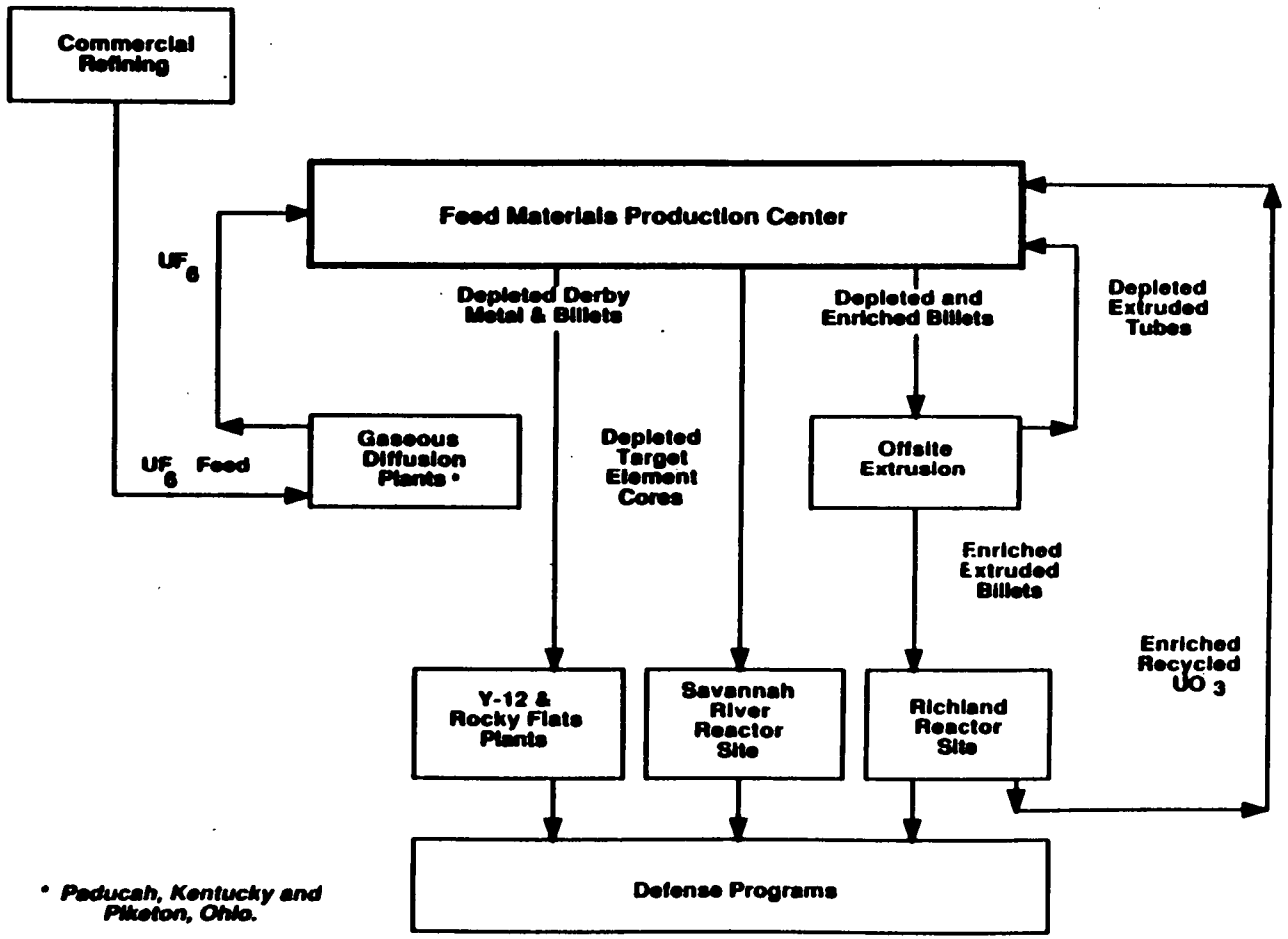


Fig. B.1. Role of the Feed Materials Production Center in U.S. Department of Energy programs.

F-0441

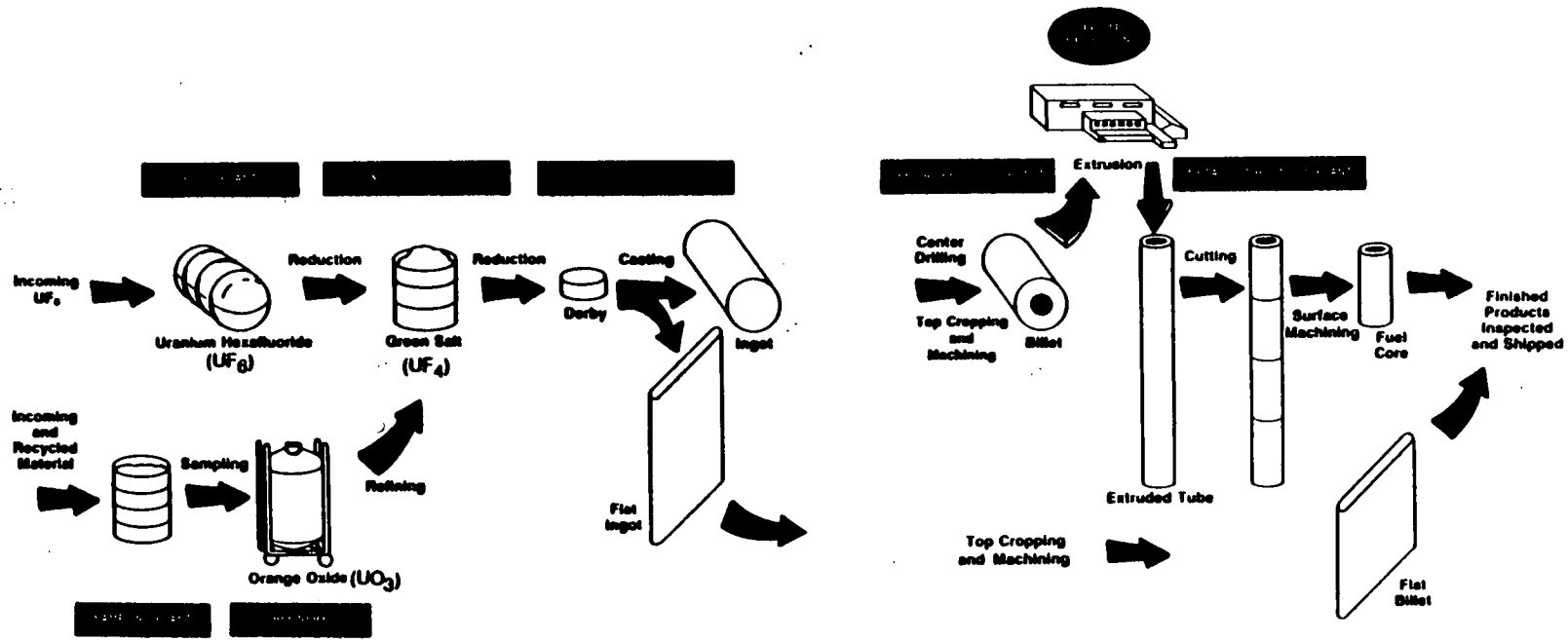


Fig. B.2. The production process at the Feed Materials Production Center.

E- 0441

000381

B.3 PLANT-BY-PLANT PROCESS FLOW

The plant-by-plant process flow is shown in Fig. B.3.

B.3.1 Plant 1: The Sampling Plant

Personnel in the Sampling Plant weigh and sample recycled material to establish nuclear materials control data for accountability and control of fissionable materials processed at FMPC. The Sampling Plant also houses nondestructive isotopic-verification equipment that determines the assay of materials for long-term storage and eventual processing and verifies the nuclear materials control data.

Sampling Plant functions include

- shipping, receiving, sampling, and storing large amounts of depleted, normal, and enriched uranium materials in open and covered storage areas;
- crushing, milling, grinding, and classifying feed materials for FMPC processing;
- reconditioning usable steel drums for reuse and baling deteriorated drums; and
- digesting enriched feed materials assaying up to 5% U-235 in geometrically safe equipment.

At one time, the principal function of the Sampling Plant was to obtain representative samples of the large quantities of incoming ore concentrates. Recently, however, the primary function of the Sampling Plant has been to store recycled materials until they are needed by the production plants. In addition, the Sampling Plant grinds enriched-uranium-contaminated slag and selected recycled materials in a ring-roller mill for chemical processing to UO_3 in the Refinery (Plant 2/3).

The Sampling Plant has over 19,045 m^2 of storage space, of which 3,879 m^2 is under roof. The remaining storage area is fenced in open pad. Several large-scale systems, still present in the Sampling Plant from its early days of operation, have a combined capacity for crushing, grinding, and blending of more than 9.1 metric tons/h of solid material.

In 1970, FMPC installed a safe-geometry digestion system to process enriched uranium materials assaying up to 5% U-235. The system, employing the safe-diameter concept for all process vessels, has operated intermittently during the past several years.

The Sampling Plant also reconditions 30- and 55-gal drums used for on-site transport and storage of process materials. Only new drums are used to ship waste off-site. First, dents are removed; and the chimes, the ring-like protrusions around the barrels, are regrooved. Drums are then sent to the shot blaster, where they are bombarded with small pieces of steel shot to remove rust, paint, and other materials down to the bare metal. Afterward,

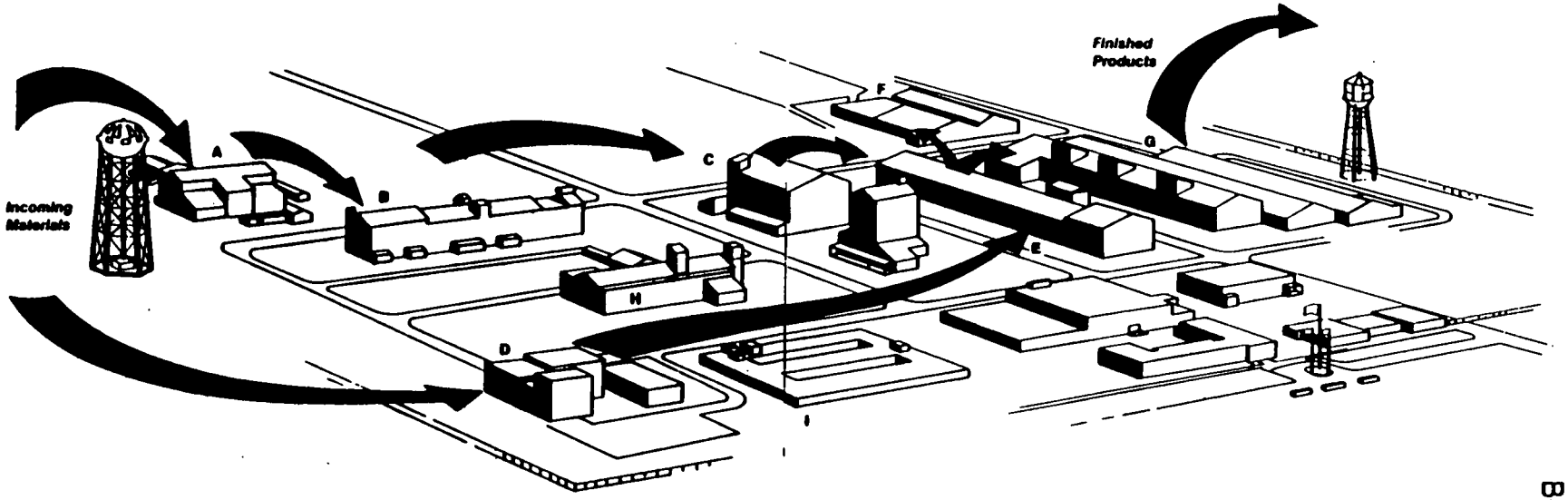


Fig. B.3. The plant-by-plant process flow.

A. Plant 1–The Sampling Plant: Incoming materials are sampled and analyzed for uranium content.
B. Plant 2/3–The Refinery: Uranium is recovered from recycled materials and converted to high-purity UO_3.
C. Plant 4–The Green Salt Plant: The UO_3 is treated to form uranium dioxide (UO_2), or brown oxide. The UO_2 is converted to UF_4.
D. Pilot Plant–The UF_6 to UF_4 Reduction Plant: As an alternative method of producing UF_4, incoming UF_6 from other DOE facilities is reduced to UF_4.
E. Plant 5–The Metals Production Plant: The UF_4 is converted to uranium metal derbies. Some derbies are melted to form ingots.
F. Plant 9–The Special Products Plant: Special oversized ingots are cast from derbies and recycled metal. Ingots are machined into billets.
G. Plant 6–The Metals Fabrication Plant: Billets are heat treated for off-site extrusion. Final machining, inspection, and shipping of finished products are carried out.
H. Plant 8–The Scrap Recovery Plant: Metal scraps remaining from production are recycled by roasting and filtering.
I. Analytical Laboratory: Samples of materials are tested and analyzed throughout the production process to ensure that final products are of the highest quality.

F-0441

000383

drums are visually inspected for holes, out-of-round rims, or dents that couldcause later structural failure. Drums that fail this inspection are scrapped. If a drum can be reconditioned, its exterior is painted with a water-based paint and its interior with a clear, water-based lacquer.

B.3.2 Plant 2/3: The Refinery

At one time, the Refinery converted the government stockpile of natural uranium ore concentrates to UO_3. Today, the Refinery operates intermittently to convert recycled uranium-bearing materials to oxide (Fig. B.4). The primary functions of the Refinery include

- o digesting recycled materials in nitric acid, using large stainless steel tanks and conveying equipment;
- o recovering uranium from internal process wastes, including uranium-contaminated slag;
- o performing liquid-liquid countercurrent solvent extraction in stainless steel, perforated-plate columns for purification;
- o recovering nitric acid from nitrogen oxide (NO_x) discharges from the digestion and denitration operations; and
- o calcining the concentrated uranium liquor to UO_3 in denitration pots.

The three steps in the process of converting recycled materials to UO_3 are digestion, extraction, and denitration. In the digestion step, the recycled materials are conveyed into agitating tanks for digestion in nitric acid. The resulting slurry consists of acid insolubles and a digest liquor of impure UNH and excess nitric acid. Following a check for proper concentration of the solution, the slurry is analyzed and pumped to the extraction system. Low-grade uranium slurries must be filtered and evaporated before they are transferred into pulsed, perforated-plate extraction columns.

In the primary extraction step, the aqueous feed slurry and an organic solvent—a mixture of tributyl phosphate and kerosene—enter the first column from opposite ends. They are pumped countercurrent to one another in a pulsating manner through a large number of perforated plates. This plate arrangement increases the turbulence within the column, forcing the two liquids to mix thoroughly. In the presence of nitric acid, the UNH in the feed slurry is preferentially attracted to the organic solvent. Most of the nitric acid and impurities are left behind in what is called the aqueous raffinate. A raffinate mixer-settler is used in series with the primary extraction columns to further reduce the uranium content of the aqueous waste stream leaving these columns.

The purified UNH is recovered from the organic solvent stream by re-extraction with deionized water in parallel columns (56- and 66-cm inner diameter). Inside the columns are perforated plates with 0.32-cm-diam holes. In the absence of nitric acid, the UNH contained in the solvent is preferentially attracted to the water phase. After the solution is treated

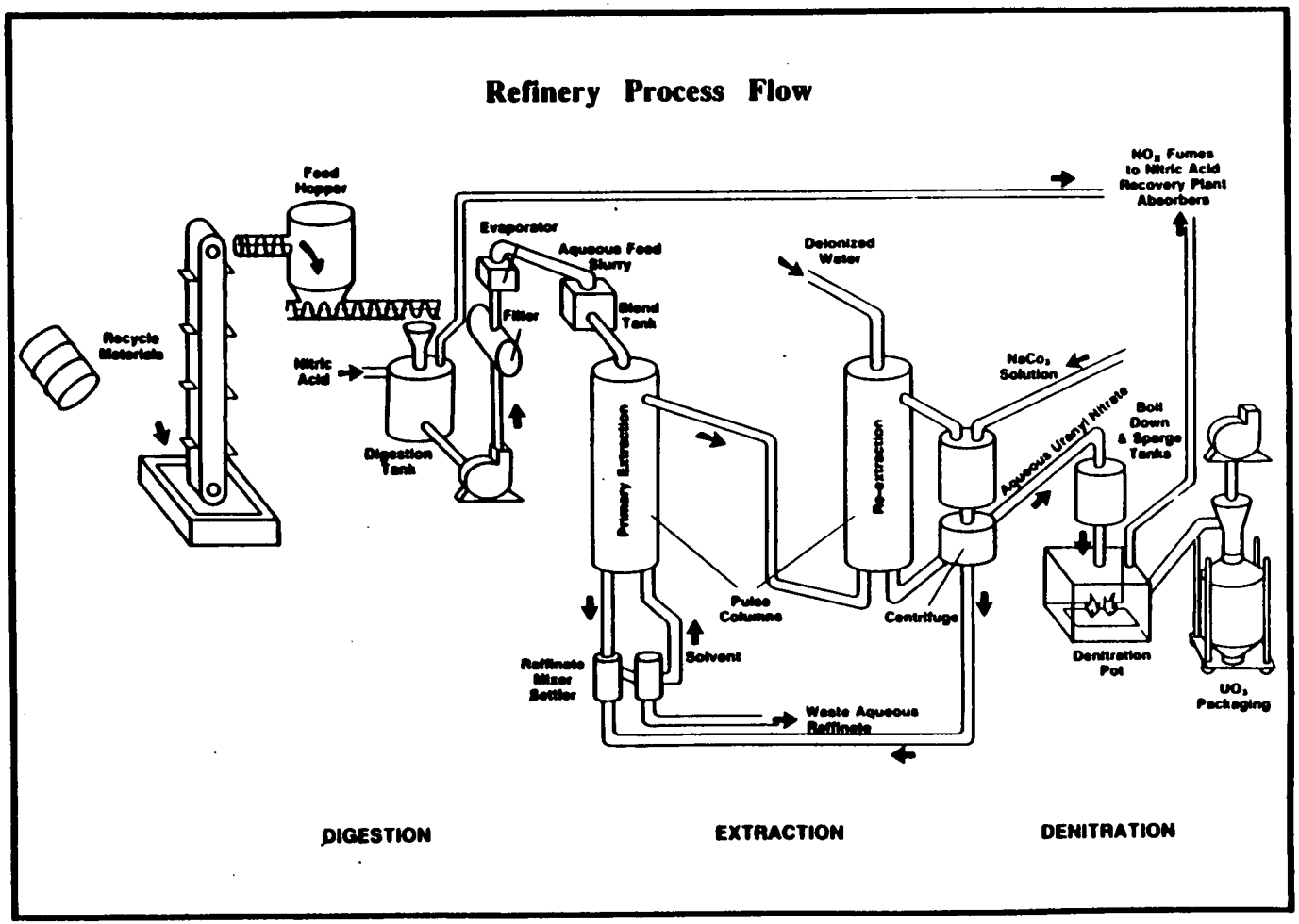


Fig. B.4. Digestion, extraction, and denitration of uranium to produce orange oxide (UO_3).

F-0441

000385

with a sodium carbonate ($NaCO_3$) solution to remove degradation products, the stripped solvent stream is reacidified and recycled to the primary extraction columns. The aqueous UNH product is sampled and analyzed to ensure that it conforms to specifications.

This aqueous UNH product begins the denitration step at a concentration of about 100 g/L uranium. The aqueous product is then concentrated to about 1350 g/L uranium by boiling and evaporation. The product is calcined in batches in nominal 1900-L denitration pots to yield UO_3. The UO_3 is milled and packaged into hoppers with a capacity of 3.6 metric tons each or into 55-gal drums.

The Nitric Acid Recovery Plant operates in conjunction with the Refinery to recover nitric acid from the NO_x fumes generated in Refinery processes. The acid is returned to the digestion area for reuse.

Uranium in the aqueous waste streams from the solvent treatment and cleanout operations is precipitated with magnesia and reclaimed. Extraction raffinate and other low-level uranium wastes are neutralized with lime before they are processed for disposal.

B.3.3 Plant 4: The Green Salt Plant

The Green Salt Plant produces UF_4 from UO_3, which is (Fig. B.5) either produced in the Refinery or recycled from other DOE sites. The primary functions of the Green Salt Plant include

- converting UO_3 to UF_4 in continuous-flow reactor banks designed and staged for gas-solids reactions and
- blending and packaging depleted green salt for the Metals Production Plant (Plant 5).

The UO_3 is first converted to UO_2, or brown oxide, by reducing it with hydrogen. The UO_2 is then reacted with anhydrous hydrogen fluoride (AHF) to produce UF_4. The UO_3 recycled from the reactor sites undergoes double-pass reduction-oxidation-reduction processing to yield high-purity UF_4.

At the beginning of the process, UO_3 is delivered in mobile hoppers to stainless steel fluid-bed reactors. These reactors are heated in the range of 529 to 593°C. Dissociated ammonia (H_2 and N_2) enters the bottom of the reactor through a gas diffuser.

The dissociated ammonia holds the UO_3 powder in suspension so that it behaves much like a liquid (hence the name "fluid bed"). Partially converted UO_3 overflows from the first fluid-bed reactor into the second, where the reaction with the hydrogen is completed. A computer monitors and controls, within specified limits, the feed rate (by weight) of UO_3 fed to each reactor bank.

Hydrofluorination occurs in a group of three heated, horizontal ribbon-screw reactors arranged in vertical stacks. Each reactor tube is 40.6 cm in

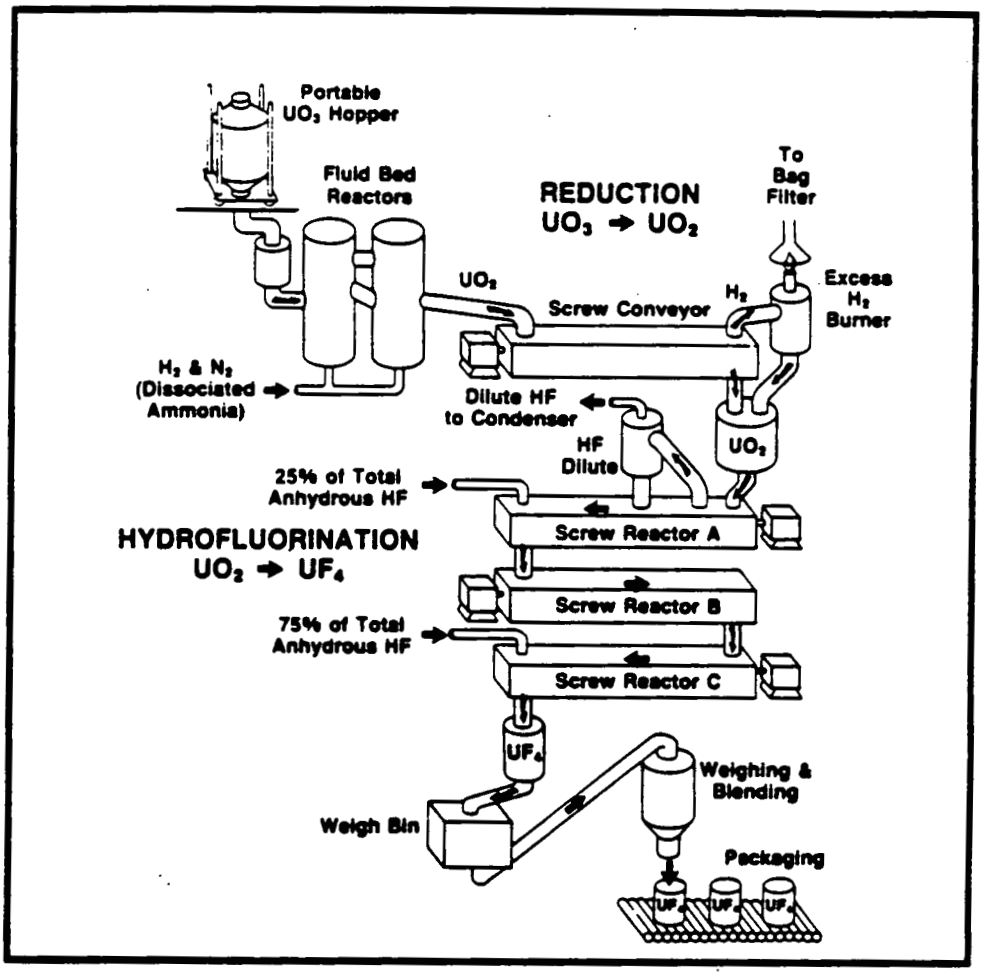


Fig. B.5. Converting UO_3 to UF_4.

diameter, 5.9 m long, and is constructed of Inconel. The operating temperature of each reactor is progressively higher—starting at about 149°C for the first reactor and ranging to 649°C for the third. The UO_2 enters at one end of the top reactor and is conveyed slowly to the other end as it is stirred by a power-driven ribbon screw constructed of Hastelloy. Of the total AHF, 75% enters at the discharge end of the bottom reactor and flows countercurrent to the UO_2 up through all three reactors. The remaining 25% of the total AHF enters the top reactor and mixes with the UO_2. The resulting product, UF_4, is weighed, blended, sampled for chemical analysis, and packaged in 38-L cans for transportation to Plant 5, the Metals Production Plant.

Excess HF is vented from the top reactor and is condensed to form a dilute HF solution (ranging from 20 to 35%).

B.3.4 Pilot Plant: The UF_6 To UF_4 Reduction Plant

The primary functions of the Pilot Plant (Fig. B.6) are to convert UF_6 to UF_4 for use in the metal production process and to coat crucibles by plasma spray used for casting uranium metal.

A considerable part of the metal produced at FMPC is depleted uranium. The principal source for depleted uranium is the UF_6 tails, the by-product from uranium enrichment at the DOE-owned gaseous diffusion plants.

Uranium hexafluoride arrives in solid form in large cylinders at the Pilot Plant. To produce UF_4, the UF_6 is first heated to gaseous state and then reduced to UF_4. The reduction occurs in a reaction with hydrogen from dissociated ammonia at approximately 538°C.

In 1984, FMPC installed new equipment at the Pilot Plant to convert UF_6 to UF_4. The equipment includes three autoclaves for heating solid UF_6 to a gaseous form. Twin reduction reaction vessels with a computerized distributive control system reduce the gaseous UF_6 to solid UF_4. The UF_6 flow rate from an autoclave to the reduction system is approximately 1000 kg/h at 50 psig and 110°C. Both reduction reactors are constructed of Monel and are about 5.9 m long. They operate at a range of 480 to 650°C. The facility is designed to produce solid UF_4 equivalent to [illegible] metric tons of uranium per day. The equipment is geometrically safe for low-enriched materials and can process UF_6 assaying as much as 2.5% U-235.

The Pilot Plant also has equipment to coat metal-casting crucibles by plasma spray to minimize carbon pickup in uranium metal products.

B.3.5 Plant 5: The Metals Production Plant

At the Metals Production Plant, UF_4 undergoes a thermite-type reaction with magnesium to produce uranium metal (Fig. B.7). The primary functions of Plant 5 include

- reducing UF_4 to high-purity depleted, normal, and enriched uranium derby metal;

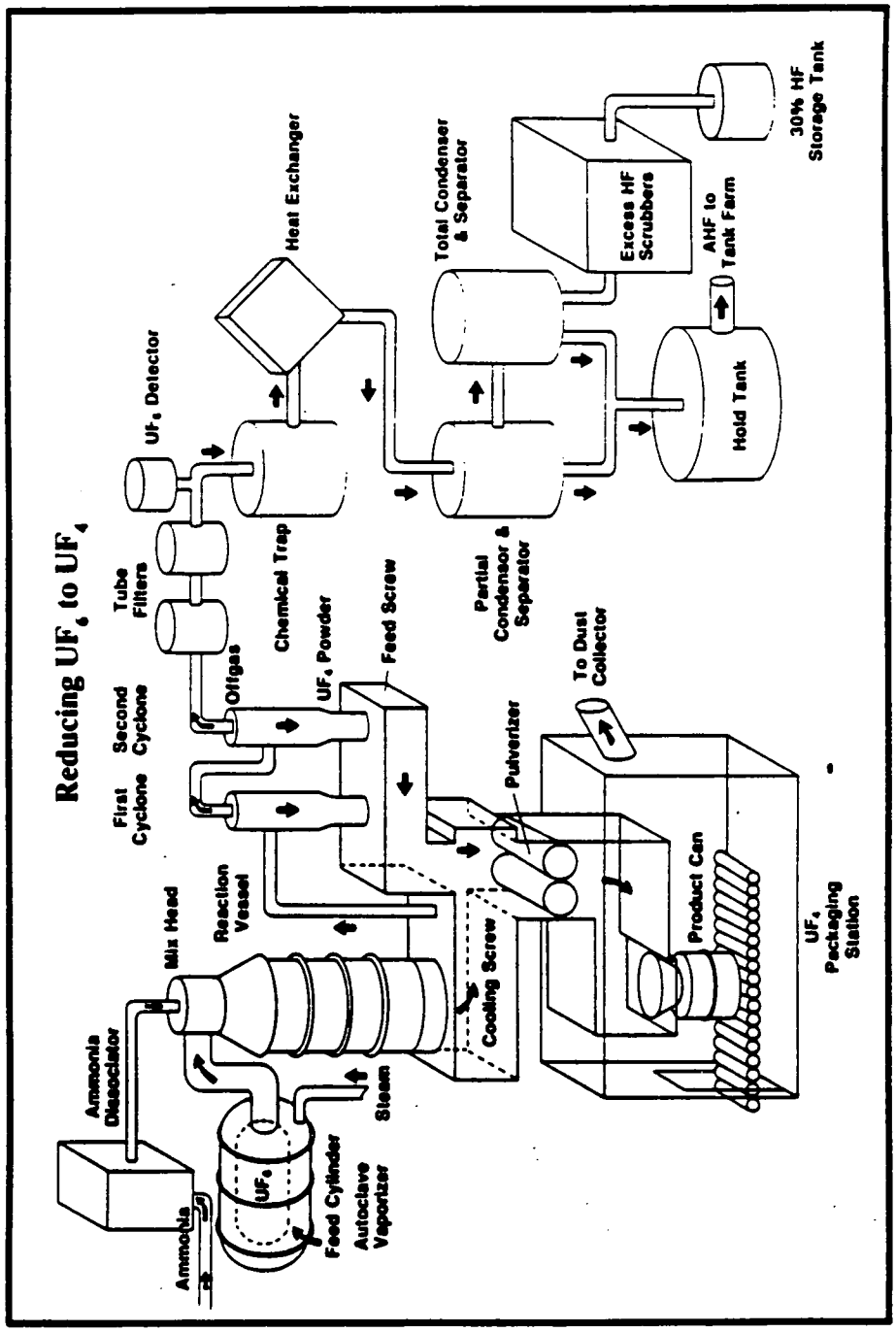


Fig. B.6. Reducing UF_6 to UF_4.

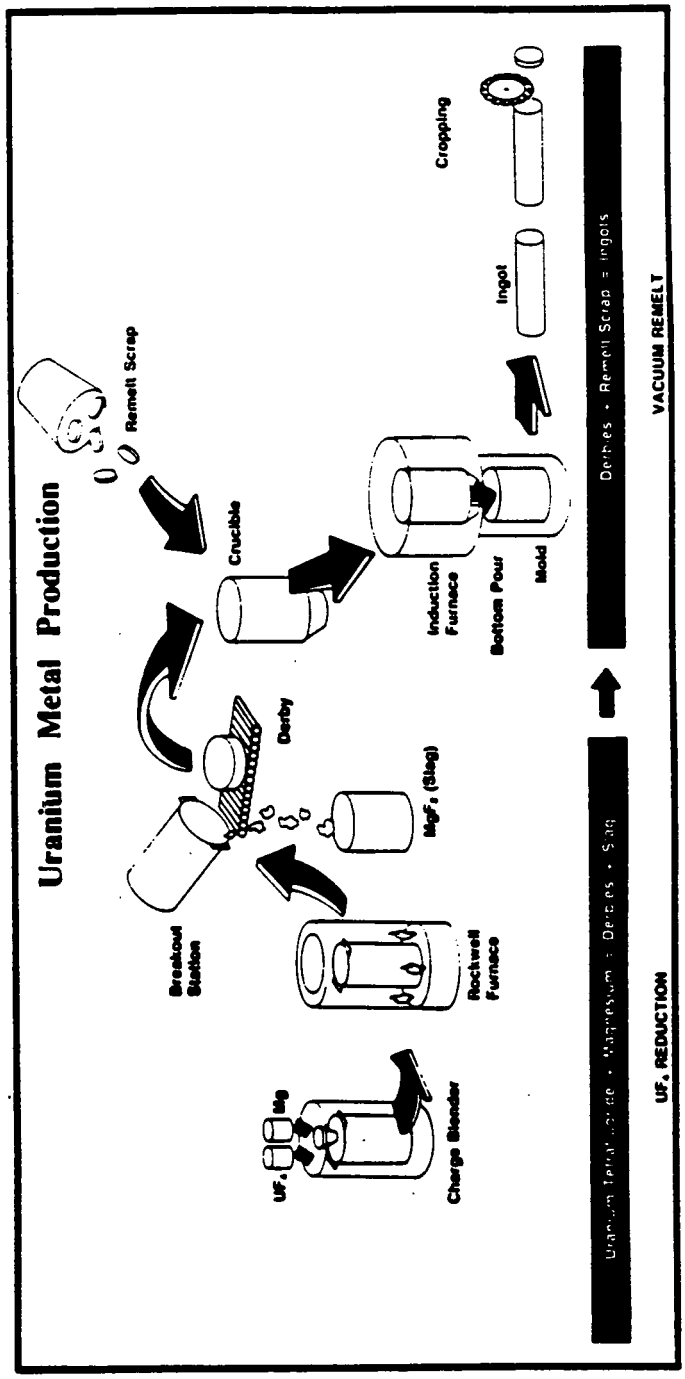


Fig. B.7. Uranium metal production.

- remelting derby and recycled metals in vacuum induction furnaces for casting into ingots;
- sawing ingots to size;
- sampling metal products for quality;
- machining graphite into various shapes using lathes, saws, milling machines, routers, and grinders; and
- milling MgF_2 slag by-product for reuse in lining reduction pots.

To begin the reduction process that produces uranium metal, UF_4 and magnesium granules, totalling about 263 kg, are blended and charged into a steel pot lined with MgF_2 slag. The pot is capped with slag to protect it from the intense heat of the reaction, fitted with a steel cover, and heated in a Rockwell resistance furnace at 649 to 816°C for 3-4 h until the contents react. At this point, the internal temperature of the pot may reach 1649°C. A minimum of 20 min after the contents react, the pot is removed from the furnace and stored in an air-cooling tank for at least 1 h. The pot is then removed to a water-cooling tank for several hours. After the pot cools, the resulting uranium mass, called a derby, is cleaned and separated from the slag.

Standard depleted and normal production derbies weigh about 168 kg; enriched derbies weigh about 136 kg. Some derbies are transferred to the casting area in Plant 5 or to the Special Products Plant (Plant 9) for cleaning; before being shipped to various DOE sites for use in related research and development programs.

In the process of casting ingots, cleaned derbies are charged along with uranium recycled metals into a graphite crucible. The loaded crucible is placed in a vacuum induction furnace and heated for about 95 minutes at 130-kW input. When the contents of the crucible reach 1482°C, a shear plug in the bottom of the crucible is broken, allowing the molten metal to flow into a heated graphite mold directly under the crucible. After cooling, the newly formed ingot is removed from the mold. The mold is cleaned and prepared for reuse, and the crucibles are flame treated to oxidize any residual uranium.

Ingots range from 58.4 to 101.6 cm long. As-cast ingots weigh up to 653 kg. Sawing about 5 cm from the top section of each ingot removes shrinkage cavities and impurities that rise to the top of the melt during solidification. The longer ingots are sawed in half, producing two billets for extrusion. The cropped billets are sampled and transferred to the Special Products Plant for center drilling and surface machining. Machined billets weigh as much as 520 kg and are heat treated in Plant 6, the Metals Fabrication Plant, before they are moved to another site.

B.3.6 Plant 9: The Special Products Plant

In the Special Products Plant, ingots larger than those produced in Plant 5 are cast, and uranium metal pieces are machined for extrusion. The primary functions of Plant 9 include

- machining ingots for extrusion,
- casting derbies and high-grade recycled metals into large-diameter ingots, and
- chemically decladding unirradiated fuel elements.

Ingots cast in Plant 9 are up to 33 cm in diameter and 63.5 cm long and weigh up to 900 kg. The top section of each ingot is cropped to remove shrinkage cavities and impurities (as in Plant 5). Cropped billets from both plants are center drilled on a rapid-boring machine and are surface machined on standard lathes. Machined billets are heat treated in the Metals Fabrication Plant (Plant 6) before they are inspected and shipped off-site for extrusion and additional processing.

A chemical decladding process called Zirnlo is also performed in Plant 9. In this process, rejected coextrusion sections from the cladding operation at the Hanford reactor site are immersed in dilute nitric acid to remove the outer copper layer that serves as a lubricant during coextrusion of Zircaloy-2 and uranium. The decoppered coextrusion sections are then treated with dilute HF to remove the Zircaloy-2 cladding that encases the uranium metal fuel core. FMPC recycles these uranium metal cores to the casting operation for remelting to ingot form.

B.3.7 Plant 6: The Metals Fabrication Plant

At the Metals Fabrication Plant, uranium metal products are heat treated to improve their strength and grain structure. Some of these products are shipped off-site for extrusion. The extruded tubes are returned to the Metals Fabrication Plant to be machined into final products. After inspecting the products, FMPC ships them to other DOE sites. The process is shown in Fig. B.8. The specific functions of Plant 6 include

- heat treating products in neutral salt (NuSal) and salt-oil baths;
- performing final machining of target element cores;
- cropping, surface milling, and inspecting products for shipment;
- performing metal pickling and chip briquetting operations; and
- inspecting finished target element cores and final products before shipment.

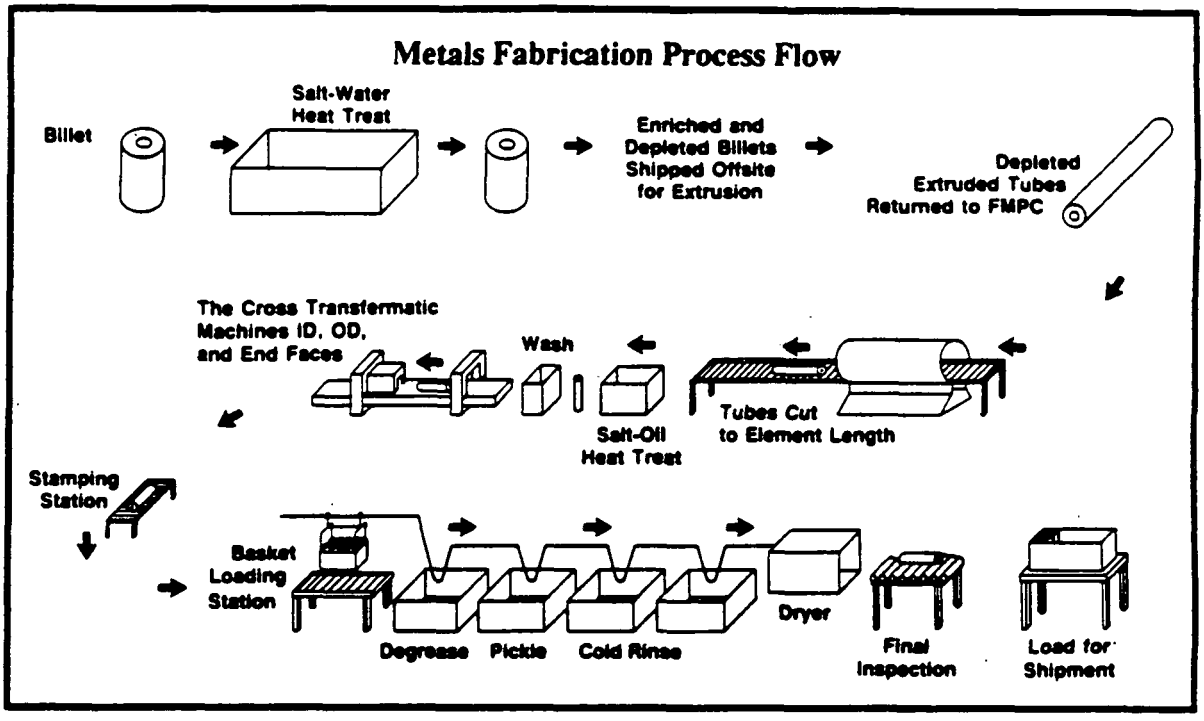


Fig. B.8. Metals fabrication process flow.

After heat treating is completed, FMPC ships the billets off-site for extrusion into tubes of various inner- and outer-diameter dimensions. Some of these tubes are returned to FMPC for further fabrication.

A cut-off lathe is used to cut the extruded tubes into blanks of appropriate length. After the blanks are treated in a hot salt bath and quenched in oil, the Cross Transfermatic machine automatically machines them to specific tolerances. The machined elements are then individually stamped for identification and degreased. Chips and lathe turnings from machining are crushed, pickled, rinsed, dried, briquetted, and recycled to the casting operations. Cleaned, finished elements are then conveyed to the final inspection area, where they are carefully checked for quality and are packaged and shipped to other DOE production sites. Salvageable fuel cores are returned for processing, and all rejects are recycled through the Metals Production Plant.

B.3.8 Plant 8: The Scrap Recovery Plant

In the Scrap Recovery Plant, recycled residues and scrap from uranium processing are upgraded before they are sent to the Refinery for uranium extraction. Besides its recycle functions, the plant helps achieve waste management objectives. The primary operations in the Scrap Recovery Plant include

- screening recycled materials;
- heating uranium-containing residues in a furnace to dry them and oxidize impurities;
- drying and heating waste materials (including contaminated filter cakes from neutralized process waste streams and Refinery slag leach operations) for off-site disposal,
- drum washing; and
- filtering contaminated water for recovery and waste operation.

At Plant 8, scrap materials prepared for the Refinery digestion cycle include uranium metals, black oxide, furnace salts, dust collector materials, and floor sweepings. Recycled or scrap materials containing metallic impurities, oil, graphite, or other contaminants are roasted to oxidize the impurities.

Oversized pieces of scrap are screened, and wet materials are dried in either a rotary kiln or three multiple-hearth vertical furnaces.

Recycled materials of significantly different isotopic assays must be segregated throughout processing and storage. The dimensions of the production equipment limit processing enriched materials to a maximum of 1.25% U-235.

APPENDIX C

DESCRIPTIONS OF REMEDIAL ACTION SITES

APPENDIX C. DESCRIPTIONS OF REMEDIAL ACTION SITES

This appendix provides additional detail on the remedial action sites listed in Sect. 2.3.3. Except where noted, the source of this information is the Task 1 Report of the Remedial Investigation/Feasibility Study (RI/FS) of Feed Materials Production Center (FMPC). Additional information on the remedial action sites is being developed as part of the RI/FS process.

C.1 DEACTIVATED PROCESS AND TREATMENT FACILITIES

Four facilities--the Hexafluoride Reduction Plant (Plant 7), the solid waste incinerator at the east site boundary, the graphite burner, and the oil burner have been completely deactivated. Plant 7, however, is still used for storage purposes.

C.1.1 Hexafluoride Reduction Plant (Plant 7)

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

- mixing UF_6 gas with hydrogen gas produced by ammonia dissociation,
- blending and packaging UF_4, and
- condensing anhydrous liquid HF for storage in the Tank Farm.

Plant 7 was shut down in May 1956, and most equipment inside the building was sold. Currently, Plant 7 is used as a general storage facility for empty cans and 10-gallon cans of UF_4.

C.1.2 Solid Waste Incinerator

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

C.1.3 Graphite Burner

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

C.1.4 Oil Burner

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

Another oil burner, located in Building 39, was used to burn the same types of liquid organics as the oil burner in the vicinity of the coal pile. The Building 39 burner ceased operation in May 1986.

C.1.5 Barium Chloride Waste Salt Treatment Facility

The Barium Chloride Waste Salt Treatment Facility was used as a development facility to investigate the processing of barium chloride ($BaCl_2$) waste (WMCO 1987). During the facility's three months of operation (December 12, 1985 through March 10, 1986), the treatment facility was used to treat approximately 8400 Kg (18,500 lb) of a eutectic salt mixture composed of 45% $BaCl_2$, 32.5% potassium chloride, and 22.5% sodium chloride. The $BaCl_2$ component, a hazardous toxic waste as defined by the Resource Conservation and Recovery Act (RCRA) Extraction Procedure (EP) Toxicity Test, was converted to barium sulfate, a nonhazardous material. Operation at this test facility was discontinued when corrosion problems developed in the process piping and tanks. Construction of a new Barium Chloride Waste Salt Treatment Facility is planned and is included in the project listing (Appendix A).

Closure of the Barium Chloride Waste Salt Treatment Facility will be completed in accordance with the RCRA performance standards (WMCO 1987). Hazardous waste construction residues will be stored in approved FMPC RCRA storage. Any residues that prove to be non-hazardous will be drummed and transported to the FMPC Plant 1 Pad for storage. The non-hazardous residues and/or free liquid will be disposed of according to the existing solid waste management program or National Pollutant Discharge Elimination System (NPDES) permits. In addition, all wastewater used as a cleaning agent that proves hazardous by method of EP Toxicity will be handled as a hazardous waste and stored appropriately until treatment in the proposed Barium Chloride Waste Salt Treatment Facility can be accomplished.

C.1.6 Trane Liquid Hazardous Waste Incinerator Unit

FMPC maintains a nonoperating hazardous waste treatment unit previously used for the incineration of liquid waste (DOE 1988a). This unit was operated at FMPC until May 7, 1986. Original design of this unit called for the incineration of liquid wastes contaminated with radionuclides. Operations were suspended after it became apparent, during early 1986, that hazardous wastes were being combined with the liquid wastes incinerated in this unit.

Closure of the Trane Thermal Liquid Waste Incinerator and storage pad will be completed in accordance with RCRA closure requirements after U.S. EPA and Ohio EPA approval of the closure plan (DOE 1988a). Hazardous waste construction rubble, equipment and residues will be placed in an appropriate container and put in FMPC RCRA storage until disposal or further treatment can be completed. If the analysis demonstrates that the wastewater is nonhazardous, the waste will be disposed of in the FMPC wastewater treatment system. If the analysis demonstrates that the wastewater is hazardous, it will remain in storage until the appropriate disposal method can be identified.

A possibility for soil contamination exists in the area surrounding the incinerator building and beneath the incinerator and drum storage pad. The investigation of soil at FMPC is being performed by the FMPC RI/FS Program. However, sampling of exposed soil within the immediate area outside of the incinerator building and oil storage pad will be performed under the closure plan to determine if hazardous constituents are present in the soils (DOE 1988a). Once the source is identified, decontamination efforts or excavation will be performed and the soils will be handled as solid waste.

C.1.7 Underground Storage Tanks

Sixteen fuel and hazardous substance underground storage tanks are located at the FMPC (Boswell 1988). Two fiberglass tanks with a total capacity of 3000 gal were installed in 1980 and remain in use for the storage of gasoline. The remaining 14 tanks are steel and were installed during plant construction. Three of these steel tanks remain in use. Locations, inventories, and the current status of these tanks are presented in Table C.1. (One kerosene tank, not on the list, was removed from service and excavated in April 1988.) A management plan for these underground storage tanks has been developed (Boswell 1988).

C.2 WASTE MANAGEMENT AREAS AND STORAGE UNITS

C.2.1 Ferrous Metal Scrap Pile

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

C.2.2 Copper Scrap Pile

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

C.2.3 Waste Pits

The waste pits consist of Waste Pits 1 through 6, the burn pit, and the clear well. The waste pits are numbered chronologically in their order of construction. Although the pits no longer receive waste materials, they are referred to as "wet" (3 and 5) or "dry" (1, 2, 4, and 6), depending upon the physical state of the materials which were disposed in the pits. Tables C.2 and C.3 describe the characteristics of the Waste Storage Area, and an

Table C.1. Characteristics and locations of underground storage tanks

No.	Size (gal)	Product	Material	Age (years)	Location	Status
1	1,500	Gasoline	Fiberglass	8	Garage	In use
2	1,500	Gasoline	Fiberglass	8	Garage	In use
3	12,250	Diesel fuel	Steel	36	Engine house	In use
4	3,000	Kerosene	Steel	36	Plant 1 truck dock	Not in active use (contains 700 gallons)
5	200	Waste oil	Steel	36	Garage	Abandoned
6	1,000	Gasoline	Steel	36	Maintenance shops	In use
7	5,000	Soluble oil	Steel	36	Plant 9 (north side inside)	Stand by
8	1,000	Gasoline	Steel	36	Garage	Abandoned
9	1,000	Gasoline	Steel	36	Garage	Abandoned
10	3,000	Gasoline	Steel	36	Garage	Abandoned
11	3,000	Gasoline	Steel	36	Plant 1 truck dock	Abandoned
12	3,000	Gasoline	Steel	36	Plant 1 truck dock	Abandoned
13	3,000	Gasoline	Steel	36	Plant 1 truck dock	Abandoned
14	10,000	Soluble or cutting oil	Steel	26	Plant 6	Abandoned
15	10,000	Soluble oils	Steel	26	Plant 6	In use
16	20,000	Nitric acid and water	Steel	36	Plant 9 SE corner	In use

Source: Boswell (1988).

Table C.2. Waste storage area characteristics

Facility	Estimated bottom elevation (feet above sea level)	Lining/Walls	Period of Use
Pit 1	560	1.5- to 2.0-ft compacted clay or 4-ft clay[a]	1952-1959
Pit 2	570	1.5- to 2.0-ft compacted clay or unknown[a]	1957-1964
Pit 3	548	1.0-ft compacted clay	1959-1977 1975-1977
Pit 4	560	1.0-ft compacted clay	1960-1986
Pit 5	558	1/16-in. rubberized elastomeric membrane	1968-1987
Pit 6	560	Elastomeric membrane	1979-1986
Burn pit	Unknown	None	1957-1986
Clear well	Unknown	Clay	1959-present
K-65 silos (1,2)		8-in. concrete, post-stressed with steel wire, earthen embankment	1952-1959
Metal oxide Tank (3)		8-in. concrete, post-stressed with steel wire	1952-1959
Metal oxide Tank (4)		8-in. concrete, post-stressed with steel wire	Never used
Fly ash area 1		None	Unknown

Source: DOE (1987).

[a]Sources used by DOE (1987) do not agree.

000401

Table C.3 Approximate waste storage inventory

Facility	Contents	Estimated volume (yd^3)	Uranium (kg)	Uranium-235 (kg)	Thorium (kg)	Total curies (Ci)
Pit 1	Neutralized waste filter cakes, graphite brick scrap, sump liquor & cakes, depleted slag	40,000	52,000	370	a	108
Pit 2	Neutralized waste filter cakes, graphite, brick scrap, sump liquor & cakes, depleted slag	13,000	1,206,000	2,550	400	35
Pit 3	Lime neutralized raffinate concentrate, slag leach residues, filter cakes, fly ash, lime sludge	227,000	129,000	1,771 1,010[b]	400	553
Pit 4	Process residues, trailer cakes, slurries, raffinates, depleted graphite, non-burnable trash, asbestos, barium chloride salt	500,000	3,000,371 3,048,087[b]	5,400 5,529[b]	61,700 61,800[b]	233
Pit 5	Solids from neutralized raffinate, slag leach slurry, sump slurry, lime sludge	102,500	50,261 50,309[b]	420	17,000	327
Pit 6	Depleted slag, scrap green salt, process residues, filter cake	9,000	427,857 843,142[b]	813 1,740[b]	a	178

F-0441

Table C.3. (continued)

Facility	Contents	Estimated volume (yd^3)	Uranium (kg)	Uranium-235 (kg)	Thorium (kg)	Total curies (Ci)
K-65 Silos (1,2)	Radium cake, and pitchblend processing residues	7,200	11,200	80	a	17,600
Metal oxide tanks (3)	Metallic oxides	5,100	18,000	130	a	23
Burn Pit	Pyrophoric and reactive chemicals, oils, combustible wastes	a	a	a	a	a
Clear Well	Clear process effluents, surface runoff	a	a	a	a	a
Fly Ash Area 1	Fly ash, oils	50,000	1,000	a	a	a
Southfield Area	Construction rubble	a	a	a	a	a

[a]Unknown, currently being determined under the RI/FS.

[b]Double entries are the result of disagreeing sources used by DOE (1987).

Source: DOE (1987).

0441

000402

approximate inventory of stored wastes respectively. A study to characterize the wastes in the pits has been completed (Weston 1987a).

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

Liquid wastes were transported from the General Sump to the Pits and from the Clear Well to MH-175 via two six-inch diameter pipes. Since February 1987, liquid wastes have been routed through the Biodenitrification Surge Lagoon before discharge to MH-175. These pipes leave the Production Area on the west side, enclosed in a concrete trench covered with slabs of concrete. The trench extends from the Production Area to the fence of the K-65 silos at which point the pipes turn north and are buried underground. One pipe goes between Pits 2, 3, and 4 to Pit 5, while the other pipe originates at the Clear Well.

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

An additional pipe originated in the tower at the west end of Pit 5 and extended, buried in the dike of Pit 3, to the Clear Well. This pipe transported Pit 5 supernatant to the Clear Well. Another six-inch pipe, which connected the Clear Well and the General Sump, was used to transport Clear Well effluent back to the General Sump for the few times when Clear Well effluent did not meet NPDES discharge limits.

C.2.3.1 Waste Pit 1

Waste Pit 1, constructed in 1952, was excavated into an existing clay lens and was lined with clay excavated from the burn pit. The capacity of the waste pit was expanded by the addition of a berm on the west end in 1957 to provide a total capacity of 40,000 yd^3 (Table C.3). The waste material placed in the waste pit consisted primarily of neutralized waste filter cakes, production plant sump cakes, depleted slag, scrap graphite, contaminated brick, and sump liquor. Although the majority of the wastes were dry solids, decant pipes were constructed through the west berm. The 52,000 kg (114,400 lb) of uranium are estimated to have been put in the pit. Waste Pit 1 was closed in 1959, backfilled, and covered with clean fill dirt. Surface water runoff flows to the Clear Well prior to its discharge to the Great Miami River.

C.2.3.2 Waste Pit 2

Waste Pit 2 was constructed in 1957 and was used from 1957 to 1964. This pit was constructed in a small pond east of Waste Pit 1 and was lined with a compacted clay layer (Table C.2). Waste Pit 2 received primarily dry,

low-level radioactive wastes consisting of neutralized waste filter cakes, sump cakes from production plants, depleted slag, scrap graphite, contaminated brick, sump liquor and concentrated raffinate residues (Table C.2). Similar to Pit 1, decant pipes were located through the west berm. The pit holds approximately 13,000 yd^3 of wastes that contain about 1,206,000 kg (2,653,200 lb) of uranium and approximately 400 kg (880 lb) of thorium. The waste pit has been covered with clean fill and graded to direct surface water runoff to the Clear Well for subsequent discharge to the Great Miami River.

C.2.3.3 Waste Pit 3

Waste Pit 3 was constructed in 1959 by excavating into the underlying clay lens and placing a layer of 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 waste solution from the FMPC Production Plants (Table C.2). From 1975 to 1977, the waste pit was used to dispose slag leach residue, filter cakes, fly ash, and lime sludges. The pit contains an estimated 227,000 yd^3 of wastes including 129,000 kg (285,600 lb) of uranium, and 400 kg (880 lb) of thorium (Table C.3). Other constituents of Waste Pit 3 wastes are shown in Table C.4. The pit was retired in 1977 and clean fill was placed over the area. Surface water runoff flows to the Clear Well prior to discharge to the Great Miami River.

C.2.3.4 Waste Pit 4

Waste Pit 4 was constructed in 1960 and was used until May 1986 (Table C.2). This pit was constructed similar to Pit 3. Waste Pit 4 received process residues, filter cakes, slurries, raffinates, graphite, barium chloride waste sludges (received from Reactive Metals, Inc. (RMI) from 1981-1983), noncombustible trash, and asbestos. The pit contains an estimated 500,000 yd^3, including more than 3 million kg (6.6 million lb) of uranium and 61,800 kg (135,960 lb) of thorium (Table C.3). Pit 4 also contains barium chloride which makes it subject to the Resource Conservation and Recovery Act. Pit 4 has had an interim cover placed over it as of November 1988.

C.2.3.5 Waste Pit 5

Waste Pit 5 was constructed in 1968 and was operated from 1968 to 1987 (Table C.2). The pit is lined with a 60-mil thick Royal-Seal EPDM Elastomeric Membrane. This liner has had occasional joint failures and tears that have been repaired. Like Wet Pit 3, this waste pit received liquid waste slurries from the Refinery and the Recovery Plant, including neutralized raffinate settled solids, slag leach slurry, sump slurries, and lime sludge (Table C.3). The waste volume consists of approximately 102,500 yd^3, containing 50,309 kg (110,680 lb) of uranium and 17,000 kg (37,400 lb) of thorium. Other constituents are shown in Table C.4. From 1983 to February 1987 when it was taken out of service, Pit 5 received only clear decant from the General Sump, filtrate from the Recovery Plant, or nonradioactive slurries, such as blowdown from the Boiler Plant and Water Treatment Plant.

Table C.4. Nonradioactive, inorganic constituents of Waste Pits 3 and 5

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

Table C.4. (continued)

Constituent	Pit 3 (metric tons)[a]	Pit 5 (metric tons)
Rare Earths:		
Dy	<15.3	<5.29
Er	<0.09	<0.05
Eu	<5.1	<1.76
Gd	<7.65	<2.65
Ho	<0.06	<0.02
Lu	<0.02	<0.008
Sm	<15.3	<5.29
Tb	<0.06	<0.02
Tm	<0.03	<0.01
Y	7.65	2.65
Yb	<0.60	<0.20

[a]Percent on dried solids basis of samples from Pit 3.

Source: DOE 1987.

C.2.3.6 Waste Pit 6

Waste Pit 6 was constructed in 1979 and operated until 1985 (Table C.2). It was constructed in the same manner as Waste Pit 5 and lined with a similar synthetic liner. Joint failures or tears have been observed and repaired. Noncoarse, nonpyrophoric solid wastes, including green salt, filter cakes, and process residues, containing elevated levels of uranium have been disposed in this pit. Rainfall that is collected in the pit was pumped to Waste Pit 5 for settling and discharge via the Clear Well until February 1987. Since February 1987, collected rainfall has been pumped to the Biodenitrification Surge Lagoon. The current waste volume is approximately 9000 yd^3, which consists of 843,142 kg (1,854,972 lb) uranium (Table C.2).

C.2.3.7 Burn Pit

The burn pit was first used in 1953 as a site to excavate clay to line Waste Pits 1 and 2 (Table C.2). Beginning in 1957, the resulting excavation was used to dispose laboratory chemicals and to burn combustible materials, including pyrophoric and reactive chemicals, oils and other low-level mixed combustible materials. The quantities of materials or chemicals that were placed in the burn pit is unknown.

C.2.3.8 Clear Well

The Clear Well receives surface runoff from the waste pits. Historically, the Clear Well received flow-through process wastewater. It has been used as a final settling basin prior to discharge to the Great Miami River via Manhole 175. It is anticipated that a significant amount of uranium-bearing solids have settled in the Clear Well (DOE 1988c).

C.2.4 Waste Storage Silos

The waste storage silos, which include the K-65 Silos, the Metal Oxide Silo and Silo No. 4 (empty), are located south of the waste pit area. The four 80-ft-diameter silos were constructed with floors of 4-in. concrete over an 8-in. layer of gravel. The silos contain an underdrain system of a 2-in. slotted pipe draining to a collection tank located in the gravel. Below the gravel is a two-in. layer of asphaltic concrete underlain by 18 in. of compacted clay. The walls are 8 in. thick pre-and post-stressed concrete with a 0.75-in. Gunite coating on the exterior. The dome roofs are made of reinforced concrete 4-in.-thick in the middle to 8 in. thick at the dome edges.

C.2.4.1 K-65 Silos

Waste raffinate slurries from the processing of pitchblende ore were pumped into the K-65 Silos (Silos 1 and 2), allowing the solids to settle. The clarified liquid was then decanted to a treatment facility through valves placed along the 26-ft height of the silo wall. As the depth of solids reached the level of a valve, it was sealed and the next higher valve was used to decant liquids. Settling and decanting were continued in this way until

the silos were filled to approximately 4 ft below the top of the vertical wall. Additions to the silos ended in 1962.

The K-65 silos contain approximately 7,200 yd^3 of waste raffinate slurries. More than 11,200 kg (24,640 lb) of uranium and 1600 curies of radium are known to be present in the waste materials. Quantities of other metals are also known to be present in the silos (Table C.5).

In 1964, an earthen embankment was placed around Silos 1 and 2 to provide protection and support to the silos and to minimize gamma emissions. The earthen embankment was further enlarged in 1983 to alleviate observed soil erosion on the slopes. Following identification of cracks in the center portion of the domes of the silos, protective covers consisting of prefabricated wood and metal structures were placed over the domes of Silos 1 and 2.

C.2.4.2 Metal Oxide Silo No. 3

Approximately 5100 yd^3 of calcined residues are stored in Silo 3 awaiting final disposal. Waste raffinate slurries from refinery operations were dewatered in an evaporator and spray calcined to produce a dry, powder-like waste form. This waste was pneumatically conveyed to the silo. Approximately 18,000 kg (39,600 lb) of uranium and 23 curies of radium are estimated to be present in the contents of Silo 3. Other metals are known to be present in the stored materials as listed in Table C.5. Metal Oxide Tank 4 remains empty.

C.2.5 Retired Fly Ash Pile 1

The two fly ash disposal areas are located southwest of the Production Area. Fly ash resulting from operating the coal-fired boiler plant is loaded into dump trucks and transported to the disposal area. One of the fly ash piles is retired and contains approximately 50,000 yd^3 of fly ash and is sparsely covered with soil and vegetation. About 1000 kg (2200 lb) of uranium are present from the spreading of oils containing uranium over the fly ash to control dust.

C.2.6 Southfield Area

Below-ground disposal of construction rubble, containing low levels of radioactivity, occurred in the vicinity of the fly ash disposal area. This repository, known as the Southfield area, is assumed to be encompassed by the area north of and including the retired fly ash pile. Radiological surveys indicate that the soil in this area contains elevated levels of radionuclides.

C.2.7 Lime Sludge Ponds

Spent lime from FMPC Water Treatment Plant operations (lime-alum sludges and boiler plant blowdown fly ash) are conveyed to two unlined ponds for storage. Each pond is approximately 100 ft by 200 ft by 6-8 ft deep with a total volume of 5000 yd^3 per pond. One pond is completely filled and retired. The other is approximately one-half full. No hazardous materials are recorded

Table C.5. Nonradioactive, inorganic constituents of FMPC silos

Constituent	Silos 1 & 2 (metric tons)	Silo 3 (metric tons)
Ag	0.176	<0.07
Al	77.	98.67
As	<2.64	
Au	0.44	<0.14
B	1.32	0.70
Ba	6.16	0.70
Be		No data
Bi		No data
Ca	342.	144.48
Cd	<0.008	
Cl	0.19	
Co	15.4	8.81
Cr	1.06	1.76
Cu	4.4	8.81
F	0.33	
Fe	105.6	225.52
Hg		
La	7.83	No data
Mg	110.	229.52
Mn	1.76	17.27
Mo	1.76	2.11
Na	61.6	133.90
Ni	19.8	22.90
Pb	448.8	8.81
PO_4		683.62
Sb		<0.53
Se		No data
SiO_2	3,587.	461.62
Sn	0.7	1.41
SO_4	No data	692.08
Ti	6.16	2.11
V	1.85	3.52
Zn	<0.060	
Zr	1.76	
Rare Earths:		
Dy	0.26	<0.11
Er	<0.006	
Eu	<0.001	
Gd	0.35	<0.21
Ho	0.13	<0.11
Lu	<0.002	
Sm	0.42	<0.21
Tb		No data
Tm	0.07	<0.07
Y	0.35	0.28
Yb	0.05	0.14

Source: DOE (1987).

as being received at the lime sludge ponds. Sampling data suggest possible contamination of the northern lime sludge pond. This pond is being evaluated under the RI/FS. The southern pond is believed to be uncontaminated.

C.2.8 Paddy's Run On-Site

Natural drainage from large portions of the FMPC is to Paddy's Run. Surface contaminants enter Paddy's Run via surface water drainageways, and contaminated groundwater discharges to Paddy's Run. The Great Miami River is the most obvious receptor of contaminants in Paddy's Run, but not far south of the silos, Paddy's Run creekbed has eroded through the glacial till into the glacial outwash that hosts the Great Miami Aquifer. Gravel mining in Paddy's Run Creek upstream of the silos may also have penetrated the glacial till. Contaminants carried by Paddy's Run may end up in the Great Miami Aquifer.

On-site portions of Paddy's Run may be a remedial action site if the banks or bed of the stream have been contaminated by past activities.

C.2.9 Perched Groundwater On-Site

Most of the land surrounding the FMPC is underlain by the Great Miami Aquifer but above the Great Miami Aquifer, groundwater is borne in the more weathered parts of the till and lacustrine sediments on which the FMPC is built. The perched groundwater in these sediments may have been contaminated by previous FMPC activities.

C.2.10 Contaminated Surface Soils—On-Site

On-site surface soils may have been contaminated by deposition of airborne emissions from the production area or by other activities at FMPC. Water soluble contaminants most likely will have been leached into the soil. These soluble contaminants may be present in perched groundwaters or may have found their way to the Great Miami Aquifer or Great Miami River. Insoluble contaminants may be present in the top few inches of the surface soils.

C.2.11 Stormwater Drainage Ditch

During periods of heavy rain, excess storm/sewer water was discharged into the stormwater drainage ditch (sometimes called the storm sewer outfall ditch) which discharges into Paddy's Run. The new stormwater retention basin is designed to reduce the frequency with which storm water is released into the stormwater drainage ditch. Contaminated stormwater may have contaminated the bed and banks of the stormwater drainage ditch.

C.2.12 Surface Drainageways

Several drainageways exist within and adjacent to the waste pit area, and drain parts of the production area. Contaminated runoff that passes through these drainageways may have contaminated the drainageways.

C.3 OFF-SITE REMEDIAL ACTION SITES

Five off-site areas may have been contaminated by past FMPC operations: Paddy's Run outside the FMPC property, the Great Miami River, the Great Miami Aquifer, contaminated surface soils outside the FMPC property, and groundwater in perched aquifers. A survey of on-site soils contamination has been completed (Weston 1987b). These possible remedial action sites are described below.

C.3.1 Great Miami River

The Great Miami River is about 1 1/2 miles from the FMPC along Paddy's Run. Paddy's Run may have carried waterborne pollutants from FMPC to the Great Miami River. Water soluble pollutants may have washed down the Great Miami River. Insoluble contaminants washed out of Paddy's Run may be present in sediments of the Great Miami downstream of the confluence. In addition, FMPC effluents to the Great Miami River (via Manhole-175) may have contaminated sediments upstream of Paddy's Run.

C.3.2 Great Miami Aquifer

The Great Miami Aquifer underlies nearly all of FMPC and much of the surrounding area. Liquid wastes that leak through the till and lacustrine sediments on which FMPC is built will leach into the Great Miami Aquifer. The lower reaches of Paddy's Run on FMPC penetrate into the Great Miami Aquifer, thus contaminated water in Paddy's Run Creek may leak into the Great Miami Aquifer.

Monitoring well data on FMPC suggests that there may be a plume of contaminants moving east under the plant. This plume is believed to have originated at Pit 3. Data from RI/FS monitoring wells will help to determine the extent of the plume.

Off-site water wells south of the FMPC suggest that there is another plume moving south from the plant. This plume is believed to have originated at the storm water sewer outfall ditch.

C.3.3 Paddy's Run Off-Site

Natural drainage from large portions of the FMPC is to Paddy's Run. Contaminants can enter Paddy's Run via surface water drainageways and groundwater discharge. The Great Miami River is the most obvious receptor of contaminants in Paddy's Run, but not far south of the silos, Paddy's Run creekbed penetrates the glacial till into the glacial outwash which hosts the Great Miami Aquifer. Contaminants carried by Paddy's Run creek may end up in the Great Miami Aquifer.

Off-site portions of Paddy's Run may be a remedial action site if the banks or bed of the stream have been contaminated by past activities.

C.3.4 Perched Groundwater Off-Site

Most of the land surrounding the FMPC is underlain by the Great Miami Aquifer, but above the Great Miami Aquifer are groundwater bearing formations or soils. The perched groundwater in these soils or formations may have been contaminated by atmospheric emissions from the FMPC.

C.3.5 Contaminated Surface Soils-Off-Site

Off-site surface soils may have been contaminated by deposition of airborne emissions from the FMPC. Water soluble contaminants most likely will have been leached into the soil. These soluble contaminants may be present in perched groundwaters or may have migrated into the Great Miami Aquifer or Great Miami River. Insoluble contaminants may be present in the top few inches of the surface soils.

C.4 REFERENCES

Boswell, M. B. 1988. Westinghouse Materials Company of Ohio, letter and attached report to J. A. Reafsnyder, U. S. Department of Energy, Nov. 16.

DOE (U.S. Department of Energy) 1987. Remedial Investigations and Feasibility Study, Feed Materials Production Center, Fernald, Ohio, Task 1 Report: Description of Current Situation.

DOE (U.S. Department of Energy) 1988a. Closure Plan for the Trane Thermal Liquid Waste Incinerator, August.

DOE (U.S. Department of Energy) 1988b. Thorium Handling Environmental Assessment, Feed Materials Production Center, Fernald, Ohio, DOE/EA-0338, January.

DOE (U.S. Department of Energy) 1988c. "Work Plan for Conducting the Sitewide Remedial Investigation and Feasibility Study of the Feed Materials Production Center, Fernald, Ohio," March.

Heisler, S. W., Jr. 1988. "FMPC NEPA Documentation 35-GE (CE) Thorium Metal Overpacking and On-Site Interim Storage (212 Drums)" NEPA Document Number 106, Revision 2, May 30.

Weston (Roy F. Weston, Inc.) 1987a. Characterization Investigation Study, Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits, FMPC/SUB 008, Vol. 2, UC-70, prepared by A. J. Solow and D. R. Phoenix, November.

Weston (Roy F. Weston, Inc.) 1987b. Characterization Investigation Study, Volume 3: Radiological Survey of Surface Soils. FMPC/SUB 008, Vol. 3, VC-70, December, prepared by A. J. Solow and D. R. Phoenix, December.

WMCO (Westinghouse Materials Company of Ohio) 1987. Closure Plan for the Barium Chloride Waste Salt Treatment Facility, August.

APPENDIX D

SOCIOECONOMIC DATA AND METHODS

APPENDIX D. SOCIOECONOMIC DATA AND METHODS

D.1 DESCRIPTION OF KEY ECONOMIC DATA

The crucial data for developing the alternative scenarios are taken from projected expenditures data from the Feed Materials Production Center (FMPC) Controller's Office. The actual expenditures for FY 1985 were subtracted from actual (FY 1986 and FY 1987) and projected expenditures for FY 1987-FY 1995. This calculation provides the incremental level of expenditures used in the analysis.

The basic data for the projected expenditures for the Maximum Level of Production were as follows: FY 1985-87 are actual costs, and FY 1988-95 figures were provided by Westinghouse Materials Company of Ohio (WMCO) Scheduling Department based on estimates of expenditures required to produce tonnages. Estimated costs for renovation projects were based on actual costs for years available and estimates contained in Schedule 1-B-7 for Line Item projects for future years (Brettschneider, D. J. October 14, 1988).

The WMCO Controller's Office provided estimated breakdowns of projected expenditures into labor and non-labor. These were further separated into estimates of local and non-local expenditures, with local defined as the Cincinnati-Hamilton metropolitan area. The breakdown of expenditures into the various categories of labor, non-labor, local, and non-local were estimated from various sources at WMCO. These sources included but were not limited to various directives, subcontract files, and information provided by the WMCO Procurement Section and project managers.

The information provided by the WMCO Controller's Office was used to make estimates of changes in direct and regional expenditures, employment, and income. The estimates of local labor expenditures were divided by the typical rates of compensation for construction-related employment and FMPC employment to estimate the increase in direct employment for project- and operation-related expenditures respectively.

D.2 METHOD FOR ESTIMATING REGIONAL ECONOMIC AND EMPLOYMENT IMPACTS

The direct expenditures for labor and materials in the Cincinnati area would result in indirect expenditures that would help increase income and employment in the region. The Economic Impact Forecast System (EIFS) was used to estimate the multiplier effect on expenditures (Construction Engineering 1987). This is an economic base model that estimates regional income and employment effects at the county level or for a combination of counties. The model was applied for a regional economic area that includes the combined Ohio counties of Butler, Hamilton, and the Indiana county of Dearborn. The most recent data calculate multipliers for 1982. The combined area had a 1980 population of 1,166,302 in 1,189 mile^2, or 981 persons/mile^2. The Income Multiplier for this area was 3.5. This means that for every $1 from outside the region that is spent within the region, approximately $2.50 more is generated through respending within the region.

The secondary employment impacts were estimated by applying average rates of retail and wholesale trade per employee to the appropriate estimate of regional expenditures. The average amount of retail expenditures per retail trade employee ($79,170) was divided into the estimate of secondary expenditures impact resulting from increased FMPC payments for regional labor. The average amount of wholesale expenditures per wholesale trade employee ($297,984) was divided into the total primary and secondary expenditures attributed to non-labor purchases in the Cincinnati-Hamilton region. The sum of these two calculations gives the estimate of secondary labor impacts within the region.

The secondary income impacts were estimated by applying a retail and wholesale income factor (0.7835 and 0.6802 respectively) to the estimates of consumption expenditures resulting from increased FMPC payments for regional labor and total expenditures for non-labor purchases in the region. The income factors used in this calculation are from the BEA RIMs model for the state of Ohio (USDC 1986).

D.3 DESCRIPTION OF EMPLOYMENT DISPERSION ANALYSIS

Residential zip codes of FMPC employees for 1986 were used to assess potential concentrations in specific communities near the plant site (FMPC 1986). Employees lived in 135 postal zip code area with an average of approximately 11 employees per zip code. The Ohio cities of Hamilton and Cincinnati had multiple zip codes. In contrast, in several areas, more than one town as well as rural areas were included within one zip code area. Because zip codes were not uniquely matched with towns and cities, it was not practical to determine precisely how many FMPC employees were represented in small communities near the site such as Fernald and Harrison. For instance, there were 100 employees in the Harrison, Ohio, postal zip code that included the communities of Fernald (population 30), New Haven (population 200), New Baltimore (population 200), and Harrison (population 5855), as well as significant populations in the associated rural areas. However, it is probable that no significant concentration of employees occurs in any of the smaller communities near the FMPC plant. This conclusion is supported by the general dispersion of FMPC employment across 135 postal zip codes, as noted previously, as well as the wide availability of housing and transportation in the region.

D.4 DESCRIPTION OF TRAFFIC ASSESSMENT

The assessment of traffic impacts focused on the four-way signalized intersection of State Roads 126 and 128 in the town of Ross. The potential traffic in 1991 was assessed to determine how various levels of increased employment during the period of renovation might impact this intersection. Several scenarios were developed to reflect uncertainty in the projected increase in employment at FMPC over the period of renovation projects. These scenarios were designed to reflect both increases in construction employment and operations employment. For the worst-case scenario (Traffic Scenario I) it was assumed that construction employment and operating employment each

scenario (Traffic Scenario I) it was assumed that construction employment and operating employment each increased by 1000, resulting in an increase in the intersection's peak hour traffic by about 930. For traffic Scenario II, it was assumed that construction employment and operating employment each increased by 600, increasing peak hour traffic by about 560. For traffic Scenario III, it was assumed that construction employment increased by 600 and operating employment increased by 200, thus increasing peak hour traffic by about 280. For traffic Scenario IV, it was assumed that construction employment increased by 600 and operating employment did not change, thus increasing peak hour traffic by about 140.

Given the assumptions about increased employment at FMPC, several factors were considered in developing estimates of the percentage of cars associated with increased employment that would be using the intersection during peak traffic hours. The most important factors taken into consideration in making these estimates were (1) the access that this intersection provided to residential areas where existing employees at FMPC reside and (2) the time of employees' arrival and departure. In general, under existing conditions, the increase in construction employment would tend to have a smaller impact than a similar increase in operations employment because the existing peak traffic at the intersection is from 4 to 5 p.m., when most regular employees at FMPC depart. However, most of the construction crafts employees at FMPC sites work 10-hour shifts in 4-day weeks. These craft workers depart FMPC between 5 and 6 p.m., one hour after the 4-5 p.m. peak.

The four traffic scenarios associated with increased employment were assessed by the Ohio-Kentucky-Indiana Regional Council of Governments (OKI). The assessment indicated that in 1991 with normal growth (without changes at FMPC) both the morning and afternoon peak hours would be less than 75% of critical capacity. This assessment indicated that increased traffic generated under Traffic Scenario I would result in extending the demand for the intersection to more than its physical capacity and cause excessive delays during both the 7-8 a.m. and the 4-5 p.m. critical periods. Traffic Scenario II would also result in "over capacity" demand during the 4-5 p.m. critical period and "near capacity" during the 7-8 a.m. critical period. "Near capacity" demand is characterized by unstable traffic flow with the possibility of wide variations in vehicular delay, while "over capacity" is characterized by excessive delays.

Traffic Scenarios III and IV both resulted in below-capacity operation at the intersection and thus would not have significant negative impacts on the traffic. Both of these scenarios involved 600 construction workers. Traffic Scenario III included increased operating employment of 200 people, and Traffic Scenario IV assumed no increase in operating personnel. The key problem with the intersection is assumed to be associated with increases in operating employment and differences in scheduled arrival and departure times. Construction workers in crafts use the intersection before 7 a.m. and after 5 p.m. and therefore avoid contributing to the critical hour traffic. However, operating personnel were assumed to use the intersection at the 7-8 a.m. and 4-5 p.m. rush hours and thus would contribute to traffic at the critical hours.

The OKI assessment indicates that one possible alternative to alleviate potential problems encountered under Traffic Scenarios I and II is an extra lane for both northbound and southbound approaches. Evaluating the feasibility of this solution would require more detailed traffic studies including detailed traffic projections, a more precise evaluation of the intersection including the capabilities of traffic signal equipment, and the availability of right-of-way required for the additional traffic lanes.

Another alternative to alleviate any potential problem with "near capacity" and "over capacity" demand for the intersection would be to adjust arrival and departure times for employees to avoid contributing to additional traffic during the 7-8 a.m. and 4-5 p.m. critical periods. This alternative might be especially attractive if the peak employment period were for only a relatively short period. Any such adjustment would have to be carefully considered to avoid instituting a new critical period with similar problems of "near capacity" and "over capacity" demand.

D.5 REFERENCES

Brettschneider, D. J. October 14, 1988. Westinghouse Materials Company of Ohio [WMCO:SR(WR):88-422(EISTF-43)], letter to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Construction Engineering 1987. Economic Impact Forecast System (EIFS) Version 3.0, for the Combined Counties of Dearborn, Indiana; Butler, Ohio; and Hamilton, Ohio [computer program run], Construction Engineering Research Laboratory, April 2, 1987.

FMPC 1986. "Disaster Plan List for Ohio" [Computer printout of FMPC wage and salary employees by zip code and address], Feed Materials Production Center, July 7 and 14, 1986.

USDC 1986. Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II), U.S. Department of Commerce, Bureau of Economic Analysis, May 1986.

APPENDIX E

HAZARD EVALUATION OF WASTE PITS

APPENDIX E

HAZARD EVALUATION OF WASTE PITS

Samples from the waste pits underwent extensive chemical analyses [as discussed in the Characterization Investigation Study (CIS) for the Feed Materials Production Center (FMPC) (Solow and Phoenix 1987)], which includes Resource Conservation and Recovery Act characteristics, U.S. Environmental Protection Agency (EPA) Hazardous Substance List (HSL) inorganics, and HSL organics with a library search for non-HSL constituents, indicators and ions, for a total of approximately 165 chemical compounds or characteristics per sample. In addition, radiochemical analyses were performed to characterize radionuclides in the waste pits. Thus, component characterization of the waste pits is relatively complete. A more difficult task conceptually is the characterization of the hazard presented by the toxic components in the pits and the determination of the hazard posed by an underground effluent plume originating at the pits.

Estimates of potential insult to humans must be preceded by an exposure assessment, (i.e., an evaluation of how much of a toxic material or materials a person could be exposed to). For the case of the waste pits the route of exposure is the drinking water. This, in turn, requires modeling an underground plume from the pits through the groundwater to sources of human intake--usually wells. Pollutant materials dissolved in or carried with the groundwater move at rates that depend on the physical and chemical characteristics of the pollutant and of the soil. Thus it is important to identify the most hazardous and the most mobile pollutants since these two properties are not necessarily concurrent in any given pollutant.

Of the pollutants identified in the CIS, the radioactive isotopes are among the better studied (in terms of groundwater movement). Among the radioisotopes identified, ^{238}U and ^{230}Th are the most abundant. The dominant radiological hazards, as characterized by the product of abundance and radiotoxicity, are presented by ^{238}U and ^{230}Th, which alternate in abundance from one pit to another. These two radionuclides are about equally radiotoxic on a curie (Ci) activity basis (Sullivan et al. 1981). Thus, the plume has been modeled as described in the main body of the EIS using ^{238}U as the reference material.

Recent advances in evaluation of toxicological data have allowed for potency ranking of chemicals (Jones et al. 1988; Glass et al. 1988). In this relative potency framework, toxicological data for a given material is compared with data for the same type of experiment with a well-studied reference compound. In this application, the reference compound is benzo(a)pyrene [B(a)P]. A wide variety of experimental settings are examined in an attempt to determine a typical response of an organism to the toxicant rather than an atypical one. The determination of a range of responses is important since the modern bioassays are designed to be highly sensitive to certain types of chemicals and are often atypical of human responses. Thus, as a result of the inclusion of a large amount of toxicological data, the central biological tendency (median) becomes stable and is thus used for the

basis for relative potency rankings. Using relative potency concepts, materials in the pits (Table E.1) were evaluated. The inorganic chemicals are seen to present greater hazards than the organic chemicals (Table E.2). This difference is due to the greater abundance of inorganics rather than inherent toxicity. Within the inorganics, the metal magnesium stands out as the greater hazard (product of concentration and relative potency) as seen in Table E.3. Thus monitoring for magnesium in addition to ^{238}U would cover most of the potential hazards for leakage from the waste pit area. The much lower concentration of organics overall suggests that their hazard in a plume would be well below that for magnesium.

Because potential ingestion exposures to ^{238}U will be to low concentrations, a comparison of uranium and magnesium chemical toxicities is more appropriate than a comparison of radiotoxicities. Chemical toxicity can be put into relative perspective by the method cited in Jones et al. (1988) and Glass et al. (1988). Assuming a nitrate form of uranium, the chemical toxicity is put on the same scale as the inorganic materials. The potency of uranyl nitrate is the same as that of the standard, B(a)P (i.e., 1). Thus, the product of potency and average concentration of ^{238}U across the pits is, for all practical purposes, the same as the chemical hazard estimated for magnesium. However, magnesium, an essential trace element, is nontoxic at very low concentrations, while uranium is nonessential and contributes no benefit at any concentration.

Long-term possibilities include reversion of FMPC to private use. This possibility might permit human exposure to the contents of the waste pits by means of ingestion of vegetables grown in the soil or water from wells close to the pits and from inhalation of suspended materials. An assumed 1 g of material per day is taken as the upper limit credible intake from these combined sources (Sedman 1989). Samples from the waste pits were analyzed as inorganic, organic,and radiochemicals (Solow and Phoenix 1987). The inorganic and organic fractions have been analyzed for composite relative toxicity using B(a)P as the reference (Jones et al. 1988; Glass et al. 1988). The radionuclides were analyzed for composite relative radiotoxicity using a reference of 1 mrem/year exposure to low linear energy transfer radiation (Sullivan et al. 1981).

Result

Combining the organic and inorganic hazards results in a cumulative hazard equivalent to 10 g of (B[a]P)/kg total material in the waste pits. One g of soil ingested per day is the equivalent of a dose of about 0.01 g B(a)P. This level would exceed, by a total of 10,000, the EPA's recommended daily limit of 0.06 μg as inferred from the acceptable drinking water daily intake level of 0.03 μg/L.

Similarly, examination of the radionuclide content has shown that ^{238}U and ^{230}Th are the dominant components. Typically, a pit has a combined ^{238}U and ^{230}Th burden of about 6000 pCi/g. Ingestion of 1 g of this material per day (365 g/year) results in a radiological dose of approximately 20 rem/year

Table E.1. Materials detected in FMPC waste pits and incorporated in hazard analysis

Class of material	Used in analysis	Relative hazard comparison[a,b]
Inorganic		
Aluminum	Yes	0.020
Antimony	Yes	0.024
Arsenic	Yes	0.16
Barium	Yes	0.051
Beryllium	Yes	2.9
Cadmium	Yes	0.079
Calcium	No	d
Chromium (assumed to be Cr^{6+})	Yes	44
Cobalt	No	d
Copper	No	d
Cyanide	No	d
Fluoride	No	d
Iron	Yes	0.00016
Lead	Yes	0.092
Magnesium	Yes	0.3
Manganese	Yes	0.75
Mercury	Yes	0.40
Nickel	Yes	0.13
Potassium	No	d
Selenium	No	d
Silver	Yes	0.00021
Sodium	No	d
Sulfide	No	d
Thallium	No	d
Vanadium	Yes	0.85
Zinc	No	d
Organic		
Acenaphthene	No	d
Anthracene	No	d
Archlor-1016	Yes	0.0033
-1242	Yes	0.0033
-1248	Yes	0.0033
-1254	Yes	0.0033
-1260	Yes	0.0033
Benzo(a)anthracene	Yes	1.0
Benzo(a)pyrene	Yes	1.0
Benzo(b)fluoranthene	No	d
Benzo(k)fluoranthene	No	d
Benzo(g,h,i)perylene	No	d
Butyl benzyl Phthalate	No	d
Chlordane	Yes	0.13
Chloroform	No	d
4-Chlorophenyl-phenylether	No	d
Chrysene	Yes	0.22

Table E.1. (continued)

Class of material	Used in analysis	Relative hazard comparison[a]
Organic (continued)		
DDT	Yes	0.031
Dibenzo(a,h)anthracene	No	d
Dibenzofuran	No	d
Ethylbenzene	No	d
Ethyl parathion	No	d
Fluoranthene	Yes	0.061
Fluorene	Yes	0.0041
Indeno(1,2,3-cd)pyrene	No	d
Malathion	No	d
2-Methylnaphthalene	No	d
Methyl parathion	Yes	0.58
Naphthalene	Yes	0.0048
Pentachlorophenol-2	No	d
Phenanthrene	Yes	0.55
Phenol	No	d
Pyrene	Yes	0.010
1,1,2,2-Tetrachloroethane	No	d
Tetrachloroethene	No	d
Trichloroethene	No	d
Vinyl chloride	Yes	0.00031
Radiochemicals		
^{137}Cs	Yes	9.1×10^{-5}[c]
^{237}Np	Yes	2.8×10^{-3}
^{210}Pb	Yes	3.4×10^{-4}
^{238}Pu	Yes	2.5×10^{-3}
$^{239/240}Pu$	Yes	2.8×10^{-3}
^{226}Ra	Yes	9.6×10^{-4}
^{228}Ra	Yes	4.5×10^{-4}
^{106}Ru	Yes	3.3×10^{-5}
^{90}Sr	Yes	1.5×10^{-5}
^{99}Tc	Yes	1.9×10^{-6}
^{228}Th	Yes	1.4×10^{-4}
^{230}Th	Yes	4.2×10^{-4}
^{232}Th	Yes	4.0×10^{-4}
^{234}U	Yes	5.1×10^{-4}
^{235}U	Yes	4.2×10^{-4}
^{238}U	Yes	4.3×10^{-4}

[a]When chemical form is unspecified the more toxic form is assumed.

[b]Potency relative to benzo(a)pyrene (1.0).

[c]Relative risk per pCi/year intake compared with a constant exposure of 1 mrem/year of low-linear energy transfer (LET) radiation.

[d]Analysis not performed.

Table E.2. Cumulative hazard level in waste pits at the FMPC, Fernald, Ohio[a] (μg B(a)P/kg soil)

Location	Inorganic chemicals		Organic chemicals	
	Minimum[b] hazard	Maximum[c] hazard	Minimum hazard	Maximum hazard
Pit 1	2.53×10^6	1.36×10^7	d	d
Pit 2	4.02×10^6	8.89×10^6	2.28×10^3	4.33×10^5
Pit 3	3.31×10^5	5.72×10^6	d	d
Pit 4	4.93×10^6	1.11×10^7	2.31×10^3	3.98×10^3
Pit 5	8.88×10^6	2.28×10^7	2.45	2.45
Pit 6	9.70×10^6	9.80×10^6	d	d
Burn pit	1.57×10^6	1.92×10^7	1.49×10^2	2.12×10^2
Clear Well	5.84×10^6	1.53×10^7	3.45	3.45
Upper fly ash	1.07×10^6	1.01×10^7	9.68×10^{-1}	4.27
Lower fly ash	9.82×10^6	1.25×10^7	d	d
North lime sludge pond	6.19×10^6	6.94×10^6	1.76×10^2	1.76×10^2
South lime sludge pond	5.09×10^6	5.96×10^6	d	d
Sanitary landfill	2.44×10^6	9.69×10^6	5.38×10^3	1.44×10^4

[a]Hazard is expressed in equivalent units (mg or μg) of benzo(a)pyrene [B(a)P] per kg soil by adding equivalent B(a)P units for each identified waste constituent.

[b]Based on minimum measured concentrations (Solow and Phoenix 1987).

[c]Based on maximum measured concentrations (Solow and Phoenix 1987).

[d]Organics not present in detectable quantities.

Table E.3. Relative hazard of inorganic materials (Product of concentration x relative potency)

Material	Relative hazard
Magnesium	1
Manganese	0.1
Barium	0.04
Chromium	0.02
Vanadium	0.01
Arsenic	0.008
Beryllium	0.007
Cadmium	0.001

(NCRP 1984). This level is significantly above the allowable public or occupational dose and two orders of magnitude above the natural background.

The analysis of combined hazards of the waste pits indicates that the public needs to be protected from exposure to the contents of these pits. If action is taken to remove the contents of these pits, suitable protection will be necessary for the workers.

REFERENCES

Eckerman, K. F., and R. W. Leggett 1989. Oak Ridge National Laboratory, Oak Ridge, Tenn., letter to C. E. Easterly, Oak Ridge National Laboratory, Oak Ridge, Tenn., April 7, 1989, Limits for Occupational Exposures to U: A Comparison of Chemical and Radiological Toxicities.

Glass, L. R., T. D. Jones, C. E. Easterly, and P. J. Walsh 1988. "Ranking of Carcinogenic Potency using a Relative Potency Approach," to be published in Environmental Health Perspectives.

Jones, T. D., P. J. Walsh, A. P. Watson, B. A. Owen, L. W. Barnthouse, and D. A. Sanders 1988. "Chemical Scoring by a Rapid Screening of Hazard (RASH) Method," Risk Analysis 8(1), 99-118.

NCRP (National Council on Radiation Protection and Measurements) 1984. Earthquakes from the Uranium Series with Emphasis on Radon and Its Daughters, NCRP Report No. 77, Bethesda, Md.

Sedman, R. M. 1989. "The Development of Applied Action Levels for Soil Contact: A Scenario for the Exposure of Humans to Soil in a Residential Setting," Environ. Health Perspect. 79: 291-313.

Solow, A. J., and D. R. Phoenix 1987. Characterization Investigation Study, Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits, FMPC/Sub 008, prepared by Roy F. Weston, Inc., for the Feed Materials Production Center, Fernald, Ohio.

Sullivan, R. E., N. S. Nelson, W. H. Ellett, D. E. Dunning, Jr., R. W. Leggett, M. G. Yalcintas, and K. F. Eckerman 1981. Estimates of Health Risk from Exposure to Radioactive Pollutants, ORNL/TM-7745, Oak Ridge National Laboratory, Oak Ridge, Tenn.

APPENDIX F

GEOHYDROLOGY

APPENDIX F. GEOHYDROLOGY

F.1 SUMMARY

This appendix is divided into four major sections. This first section summarizes the salient features of the solute transport model developed to evaluate the environmental impacts of the Feed Materials Production Center (FMPC) on the Great Miami Aquifer (GMA). The second section elaborates on seven basic concepts from groundwater hydrology and how each of them relates to an interpretation of contaminant migration pathways in the GMA beneath the FMPC. The primary emphasis in the third section is development of the mathematical analysis of the contaminant plume from the Storm Sewer Outfall Ditch (SSOD). This solute transport model also can be applied directly to the plume migrating toward the eastern FMPC reservation boundary from the waste pit. Unknown dispersivities and the distribution coefficient have been computed as explained in the fourth section. These unknown parameters are fundamental to a solute transport analysis of contaminant migration in the GMA. Without them, no meaningful quantitaive results can be obtained from which FMPC environmental impacts can be evaluated.

The mathematical analysis performed in this study couples a steady, one-dimensional groundwater flow field with a time-dependent, three-dimensional solute transport model. A time-dependent boundary condition (written as a series of pulses using the unit step function) is utilized to represent the behavior of the contaminant source. Adsorption of uranium in the aquifer is accounted for by assuming that uranium adsorption is linearly proportional to its concentration in the groundwater (linear isotherm). The mathematical solution obtained from this solute transport model can be calculated using standard numerical techniques on a digital computer.

Solution of the contaminant transport equation requires specification of the distribution coefficient as well as the longitudinal, transverse, and vertical dispersivity components. These parameters have been inferred from data collected near the plant site. Three wells located various distances south of the site and screened at different depths in the GMA have exhibited elevated concentrations of dissolved uranium. This groundwater plume resulted from contaminated water that entered the GMA at the SSOD near the southern FMPC boundary. The history of these discharges has been recorded over much of the operating history of the plant, and concentrations of dissolved uranium at the three off-site wells have been measured since 1981. These data, the solute transport model, and a trial-and-error optimization procedure were used to calculate the unknown distribution coefficient and dispersivity components. These parameters then were used for analysis of future plume movements in the GMA south of the SSOD and east of the waste pit area.

F.2 CONCEPTS FROM GROUNDWATER HYDROLOGY RELATED TO AN ENVIRONMENTAL IMPACT EVALUATION OF THE FMPC

F.2.1 Darcy's Law

Darcy's law states that the velocity of groundwater flow, specific discharge, or Darcian velocity is directly proportional to the difference in

total head (taken to be the sum of the pressure and elevation heads) between two points and inversely proportional to the distance between them (Freeze and Cherry 1979). The quotient of the head difference and distance is known as the hydraulic gradient. The constant of proportionality is defined as the hydraulic conductivity, while the groundwater flows from the higher total head location to the lower one, a minus sign usually appended to the hydraulic gradient to account for this. Although the specific discharge has the same dimensions as velocity, it is actually the volumetric flux of groundwater divided by the full cross-sectional area of the solids and voids comprising the porous medium. The average linear velocity of groundwater in the pores is obtained by dividing the specific discharge by the effective porosity for flow. Darcy's law is used to obtain estimates of the average linear velocity of groundwater in the GMA.

F.2.2 Hydraulic Conductivity

The hydraulic conductivity is a measure of the ease with which groundwater will flow through a porous hydrogeologic formation. Estimates of hydraulic conductivity are required in order to obtain contaminant transport velocities in the GMA.

Hydraulic conductivity is usually anisotropic, varying with direction at a specified location in a geological formation. This occurs in alluvial deposits because of the highly stratified bedding character of the gravels, sands, silts, and clays comprising them. Anisotropy ratios, defined as the quotient of the horizontal to the vertical hydraulic conductivities, range from 2 to 200 in alluvial deposits of the type found in the GMA (Davis 1969; GeoTrans 1985). Anisotropy ratio increases with the fraction of clay present in a stratigraphic unit because the smaller clay particles restrict vertical groundwater movement. Higher anisotropy ratios are expected in the glacial till and lacustrine deposits as well as the alluvium directly beneath them (and the FMPC) which have somewhat higher fractions of clay, than to the south and east of the FMPC reservation where alluvium is exposed along the Great Miami River floodplain and clay content is at a relative minimum.

Directly beneath the FMPC, where the composite saturated thickness of the upper and lower portions of the GMA is approximately 45.7 m (150 ft), the hydraulic conductivity varies between 76.2 and 81.7 m/d (250 and 268 ft/d) (Spieker and Norris 1962, Spieker 1968), while in the 3 to 6 m (10 to 20 ft) thick blue clay layer separating the upper and lower portions of the GMA, the hydraulic conductivity ranges from 0.10 to 0.13 m/d (0.33 to 0.43 ft/d) (Spieker and Norris 1962).

Directly east of the terrace remnant on which the FMPC is situated and northeast of and including the Southwestern Ohio Water Company (SOWC) well fields, the saturated alluvial thickness varies from 45.7 to 61 m (150 to 200 ft), while hydraulic conductivities have been quoted between 95 and 236 m/d (312 and 774 ft/d), with an average value of 119.8 m/d (393 ft/d) (GeoTrans 1985). South of the SOWC well fields proceeding around the bedrock island from New Baltimore to Cleves, where the saturated alluvial thickness is <45.7 m (150 ft), the transmissivity (defined as the product of the hydraulic

conductivity and the saturated alluvial thickness) ranges from 1200 to 4000 m^2/d (100,000 to 300,000 gal/d per ft) (Spieker 1968).

Measurements of hydraulic conductivity reported for the 6 to 15.2 m (20 to 50 ft) thick topmost stratum, described as glacial till, vary from 0.06 to 0.76 m/d (0.2 to 2 ft/d) (Dames & Moore 1985); but it is not known whether these hydraulic conductivities measured in the topmost stratum are representative of glacial till, lacustrine sediments, or sand and gravel lenses. These hydraulic conductivities are several orders of magnitude larger than those for conductivities deep clay beds (Bouwer 1978), which are beneath overburden and not interlaced with sand and gravel lenses.

F.2.3 Porosity

The effective porosity for flow, which is the quotient of the interconnected void volume and the total volume of a porous media, ranges from 0.25 to 0.50 in unconsolidated sand and gravel deposits (Freeze and Cherry 1979). A value of 0.25 is representative of the GMA along the floodplain, while a slight reduction to 0.2 seems appropriate in both alluvial strata (the upper and lower portions of the GMA) beneath the FMPC, where clay content is somewhat increased. Dames & Moore (1985) use an empirical relationship between porosity and hydraulic conductivity in their model simulations of the GMA. A hydraulic conductivity decrease in alluvial strata implies a corresponding increase in clay content and a decrease in porosity. The glacial till and lacustrine deposits on the FMPC site have unconnected pore spaces that substantially reduce the effective porosity for flow. Values as low as 0.05 are not uncommon (Cleary et al. 1987). Because the hydraulic conductivity in the till and lacustrine deposits also is decreased, this reduction in effective porosity does not necessarily imply a substantial increase in pore velocity.

Estimates of porosity are required in order to obtain contaminant transport velocities in the GMA. A porosity of 0.25 is used throughout this study as a preliminary estimate. Porosity changes attributable to clay content are neglected and assumed to be a second-order effect.

F.2.4 Presence of Unsaturated Zones

The layer of glacial till and lacustrine deposits on which the FMPC is situated affects the hydrology of the GMA located beneath it. These surficial strata contain perched groundwater that is released continually in seeps that discharge into Paddy's Run and the SSOD. Pockets of perched groundwater may be trapped in lacustrine deposits at boundaries with glacial till, while unmapped sand and gravel lenses may provide buried channels through which groundwater can flow. The decreased permeability of the glacial till and lacustrine deposits reduces the recharge in the form of incident precipitation entering the subterranean environment and cause a corresponding increase in runoff to Paddy's Run and the SSOD.

The interrelationship between the unconfined GMA beneath FMPC and the perched groundwater residing in the till and lacustrine deposits is complex. An unsaturated zone, in which the pores are partially filled with groundwater

and the fluid pressures are less than atmospheric, exists above the GMA water table, the surface on which the fluid pressure is exactly atmospheric. If no differences in water level elevations were observed between wells screened in undisturbed till or lacustrine deposits and those in the GMA, this unsaturated zone, commonly known as a capillary fringe, would not be present. Under these conditions the perched groundwater and GMA would be hydraulically connected and behave as a single water-bearing formation. However, significant water level elevation differences have been measured in these wells, thus confirming the presence of the unsaturated zone (Sedam 1984; WMCO 1987).

When the fluid pressure in the pores becomes sufficiently lower than atmospheric, a large decrease in hydraulic conductivity occurs (which can be many orders of magnitude) (Bouwer 1964). This situation minimizes vertical groundwater transport and provides for hydraulic isolation between the two formations. The particle sizes in the till and lacustrine deposits are much smaller than in the alluvium. Higher suction pressures, or fluid pressures much lower than atmospheric, can be realized to a greater degree in these deposits than in the alluvium. Suction of groundwater, similar to the action of a wick, by the till and lacustrine deposits takes place from this unsaturated zone, which could enhance the effect of the hydraulic barrier.

Unsaturated zones just below the land surface also exist above the perched groundwater and the GMA east and south of FMPC as defined by the Great Miami River floodplain. Near-surface weathering and desiccation-induced fracturing in the surface soil (A horizon) may promote infiltration of precipitation that is then trapped by the adjacent, less permeable underlying soil (B horizon).

This model does not account for the presence of these unsaturated zones in the evaluation of environmental impacts of the FMPC on groundwater. Inclusion of these effects would require unsaturated hydraulic properties that have not been measured. For instance, hydraulic conductivity is a function of both moisture content and pressure in an unsaturated zone. Additionally, an evaluation of possible isolating properties of the capillary fringe above the GMA water table would require a precise mapping of the base of the till and lacustrine deposits that is not available.

F.2.5 Location of Groundwater Divides

A groundwater divide is an imaginary vertical boundary across which no flow occurs (Freeze and Cherry 1979). When geologic strata are homogeneous and isotropic, the location of groundwater divides coincides exactly with surface-water divides; their orientation is then precisely vertical.

A groundwater divide has been postulated to exist between the SOWC and the eastern FMPC site reservation boundary, which essentially parallels the north-to-south topographic high along the eastern edge of the terrace remnant (Dove and Norris 1951; Spieker 1968; Sedam 1984). Subsequent studies (Dames & Moore 1985; GeoTrans 1985; ITC 1986), which are based on the water table map measured by Sedam (1984) in August 1982, have inferred the presence of this same groundwater divide. This postulated location does not account for either the anisotropic properties of the alluvium in the GMA or the presence of the

glacial till and lacustrine stratum on which the FMPC is situated. The probable location of the groundwater divide is parallel to the course of Paddy's Run and coincident with the streambed recharge area where a groundwater mound, or high, occurs in the GMA. The postulated groundwater divide does not exist because low-permeability glacial till and lacustrine deposits restrict water, as recharge, from entering the GMA. There is no eastern groundwater divide that prevents groundwater flow in the GMA beneath FMPC from reaching the SOWC collectors.

F.2.6 Geochemical Considerations

Retardation refers to the chemical partitioning of solutes dissolved in groundwater by adsorption onto the soil matrix (Freeze and Cherry 1979). Because solutes are actually being removed from the liquid phase, downgradient plume concentrations are reduced, and the movement of the contaminant front is slowed. Results of adsorption experiments which quantify this liquid- to solid-phase partitioning are expressed in terms of a distribution coefficient.

The distribution coefficient for dissolved uranium has not been measured in the till and lacustrine deposits or the alluvium in the vicinity of FMPC. As a general rule, the effects of retardation become more pronounced as the fraction of clay and silt increases in the soil. Table F.1 contains measured values of the uranium distribution coefficient for a silty soil known as the Minford silts (Stout and Schaaf 1931) of southern Ohio. The distribution coefficient is increased at lower groundwater concentrations because less uranium is available for adsorption by the soil. A larger volume of dilute leachate is required to saturate the soil matrix with uranium because a smaller mass of adsorbate is available on a per unit volume basis. These values can be used to estimate the effects of retardation in the till and lacustrine deposits at FMPC because they have approximately the same total fraction of clay and silt as the Minford silts. Values for alluvium are expected to be at least one order of magnitude lower since smaller fractions of silt and clay are contained in it. Because the effects of adsorption are more pronounced in the glacial till and lacustrine deposits, the change in distribution coefficient with concentration of dissolved uranium is an important consideration that should be accounted for in an analysis of solute transport. In the alluvium, however, where the effects of adsorption are expected to be smaller, the distribution coefficient can be treated as a constant.

Retardation of uranium is affected by the geochemical state of the groundwater. Equilibrium, or stable domains of ions or minerals, presented as diagrams relative to redox potential, or Eh (volts), and pH are used to express the dependency of occurrence of dissolved species on the geochemical state. The redox potential, Eh, is the energy gained in the transfer of one mole of electrons e^- from an oxidant to diatomic hydrogen (H_2) (Freeze and Cherry 1979), whereas the pH is the negative of the common logarithm of the number of moles of protons in solution. Dissolved gases, particularly diatomic oxygen (O_2) and carbon dioxide (CO_2), also influence the geochemical state. These dissolved gases are present in groundwater as a result of exposure of precipitation to the earth's atmosphere prior to infiltration, contact with soil gases during percolation through the unsaturated zone, and

Table F.1. Distribution coefficient for uranium leachate measured for groundwater transport through the Minford silts of southern Ohio

Maximum concentration of uranium in groundwater (mg/L)	Distribution coefficient (mL/g)
10	10
7	15
5	20
3	30
2	35
1	40
0.5	50

Source: R. Blumberg et al. 1983.

chemical reactions that occur between groundwater, minerals, organics, andbacteria in the saturated zone. Evidence that these two dissolved gases are being replenished by recharge entering the GMA is provided by the significant concentrations of calcium and magnesium that have been measured in the groundwater. The dissolved CO_2 in the infiltrating precipitation reacts with the groundwater to form aqueous carbonic acid (H_2CO_3). The carbonic acid then dissolves the minerals calcite ($CaCO_3$) and dolomite [$CaMg(CO_3)_2$] in the till, lacustrine, and alluvial deposits. Significant fractions of these two minerals exist in the shale and limestone bedrock in the Fernald area which were transported into the New Haven Trough during glacial advances. Significant replenishment of gaseous CO_2 then implies that similar recharge processes are occurring that make available O_2.

An Eh-pH diagram for the U-O_2-H_2O-CO_2 system typical of natural waters is presented in Fig. F.1 (Jennings and Leventhal 1978). Solid phases, which may precipitate out or remain suspended, include the minerals uraninite (UO_2), schoepite [$UO_2(OH)_2H_2O$] (not shown), and rutherfordine (UO_2CO_3) (shown underlined). Soluble species include the cations U^{+4}, UOH^{+3}, the uranyl ions UO_2^{++} and UO_2OH^+, as well as the anion complexes $UO_2(CO_3)_2 2H_2O^{-2}$ and $UO_2(CO_3)_3^{-4}$, known as uranyl dicarbonate (dicarbonatouranylate) and uranyl tricarbonate (tricarbonatouranylate) respectively. Uranium occurs in the tetravalent state in uraninite UO_2, U^{+4}, and UOH^{+3}, while being hexavalent in the remaining minerals and ions. The trivalent and pentavalent oxidation states of uranium do not exist appreciably in natural waters; the U^{+3} cation, when present in solution, is easily oxidized to U^{+4} even in the absence of oxygen, while solutions containing pentavalent uranium, either as U^{+5} or UO_2^+, have been obtained under laboratory conditions (Udal'tstova 1970) and have not been identified in nature.

It is clear from Fig. F.1 that tetravalent uranium is essentially insoluble in reducing groundwaters in the pH range from 3 to 7, whereas in oxidizing groundwaters, hexavalent uranium is stable as either a cation, anion, or ion complex whose precise chemical composition depends strongly on the redox potential. In distinctly alkaline groundwater, the uranyl cation can form additional, more complicated anion complexes with fluoride, phosphate, carbonate, and hydroxide anions, which are unretarded (Langmuir 1978, GeoTrans 1985), whereas under slightly acidic conditions the uranyl cation, or its cation complexes, are adsorbed by negatively charged colloidal minerals (the clay and silt particles). The pH and redox potential of the groundwater, as well as the amount and type of dissolved gases determine which uranyl ion will be present. Measurements of pH in groundwater at FMPC range from 6.58 to 7.87 (WMCO 1987), indicating slightly alkaline conditions, whereas redox potential and the quantity of dissolved CO_2 and O_2 have not been recorded. Measurements in the easterly plume emanating from the waste pit area show elevated chloride and sulfate levels, while corresponding uranium and nitrate values are lower, by a factor of from 2 to 4, than would be expected under unretarded conditions. The uranyl cation or a uranyl cation complex is present and being adsorbed by colloidal minerals. Otherwise, higher concentrations of dissolved uranium and a larger areal extent of plume migration would have been observed downgradient from the waste pits. Biodenitrification by bacteria in the soil may be responsible for the reduced nitrate values occurring in this same area.

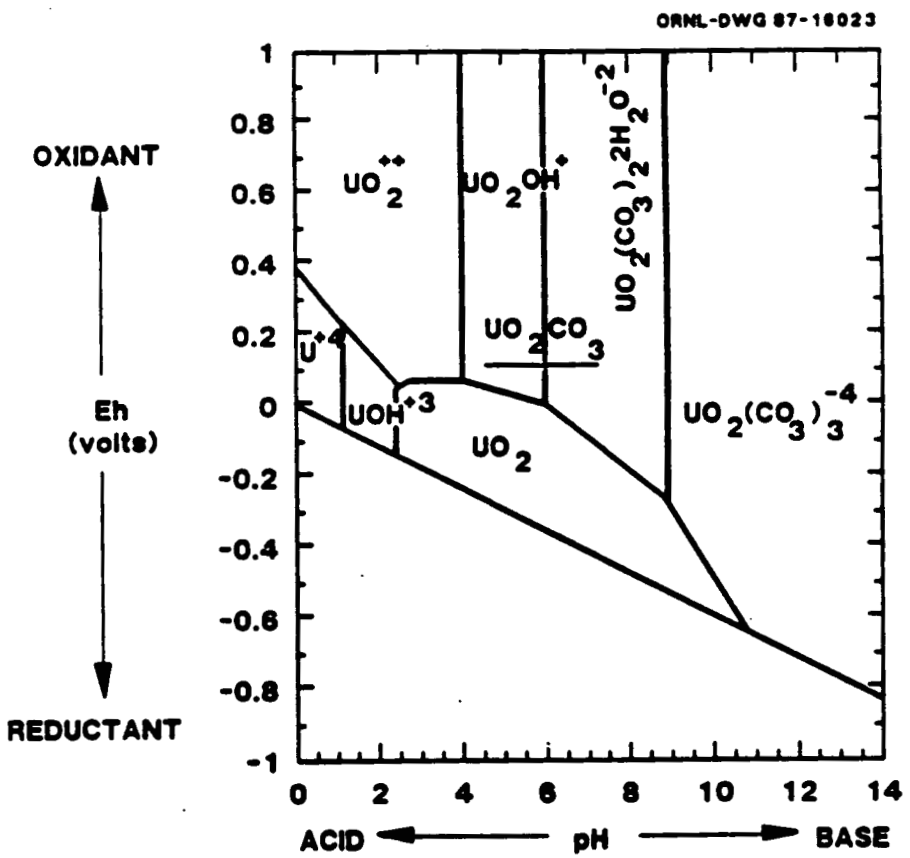


Fig. F.1. Eh-pH equilibrium diagram for the $U\text{-}O_2\text{-}H_2O\text{-}CO_2$ system at 25° C, 1 atm, and a partial pressure of CO_2 at $10^{-3.4}$ atm. (Jennings and Leventhal 1978).

F.2.7 Hydrodynamic Dispersion

To carry out a solute transport analysis of the FMPC waste facilities, coefficients must be specified which quantify the effects of hydrodynamic dispersion in the GMA. The coefficient of hydrodynamic dispersion is expressed as the sum of two components. The first of these components accounts for the effects of molecular diffusion created by the random motion and resultant collisions between solute and solvent molecules which impart a net transport of solute from regions of higher concentration to lower ones (Welty et al. 1969). The second component accounts for dispersion or mixing caused entirely by motion of the fluid which results in dilution of the solute. Mechanical, or hydraulic, dispersion is attributed to three factors: (1) the viscous drag exerted by pore surfaces on the flowing fluid; (2) the variation in the size of the pores resulting in distinct maximum velocities in each pore channel; and (3) the branching, or interfingering, of pore channels that define the actual flow path followed by individual fluid elements (Fried and Combarnous 1971, Freeze and Cherry 1979). Molecular diffusion is important only at very low or stagnant groundwater flow velocities and can be neglected in an analysis of the GMA. The effects of dispersion are usually anisotropic, being predominant in the principal direction of flow rather than in directions normal to the flow.

The information needed to characterize dispersion in groundwater aquifers such as the GMA is elusive. Dispersivity tests performed in the laboratory on borehole samples seldom yield data representative of the physical processes actually occurring in the field. Dispersivity values obtained in the laboratory do not account for heterogeneities in geological materials, such as the presence of a sand lenses or a fault, for example, which usually occur on a much larger scale in the field. Parameters describing the effects of dispersion require field measurements using tracer tests. Such tests have not been performed in the groundwater environment underlying the FMPC. Results from such experiments are then used in conjunction with analytical or numerical models to calculate the unknown parameters (Fried 1976; Bureau of Mines 1986).

Published values of dispersivity can be used as initial estimates to calibrate the solute transport model utilized in this environmental impact statement to evaluate the effects of FMPC waste facilities on the GMA. Dispersivity values determined for a glacial outwash aquifer in Long Island, New York, are 21.3 m (69.9 ft) longitudinally and 4.7 m (14.0 ft) transversely (Pinder 1973).

F.3 MATHEMATICAL ANALYSIS OF THE CONTAMINANT–DISPERSION PROCESS DOWNGRADIENT OF THE STORM SEWER OUTFALL DITCH (SSOD)

The equation describing the transport of a dissolved solute in an adsorbing, saturated, porous media is (Ogata 1970)

$$\frac{\partial C}{\partial t} + \frac{\rho_{bulk}}{n} \cdot \frac{\partial S}{\partial t} + \frac{u}{n} \cdot \frac{\partial C}{\partial x} = D_x \frac{\partial^2 C}{\partial x^2} + D_y \frac{\partial^2 C}{\partial y^2} + D_z \frac{\partial^2 C}{\partial z^2}, \qquad (1)$$

where

C = concentration of dissolved solute,

D_x = longitudinal dispersivity,

D_y = transverse dispersivity,

D_z = vertical dispersivity,

n = effective porosity for flow,

S = concentration of the dissolved solute adsorbed by the soil matrix,

t = time coordinate,

u = specific discharge in the longitudinal direction,

x = longitudinal coordinate,

y = transverse coordinate,

z = vertical coordinate, and

ρ_{bulk} = bulk density of the soil matrix.

Equation (1) is based on the assumption that the uniform, steady flow of groundwater is parallel to the x direction and that Darcy's Law is applicable. The specific discharge u can then be determined from

$$u = -K_x \cdot \frac{dh}{dx}, \qquad (2)$$

where

h = total head at a specified point which is the sum of the elevation and pressure heads,

K_x = longitudinal hydraulic conductivity of the soil matrix, and

$\frac{dh}{dx}$ = hydraulic gradient of the groundwater flow in the longitudinal direction.

The appearance of the negative sign in Eq. (2) accounts for the fact that groundwater flows from regions of higher hydraulic potential, or head, to lower ones. The hydraulic gradient has been written as a total rather than a partial derivative, because the flow of groundwater is assumed to be one–dimensional.

All quantities located to the left of, and which are multiples of the partial derivatives in Eq. (1), are constants in both time and space. The porous medium comprising the aquifer is assumed to be homogeneous and isotropic. Molecular diffusion is assumed to be negligible with respect to hydrodynamic dispersion. The hydrodynamic dispersion coefficients do not vary with time or space in a homogeneous medium in which the flow of groundwater is steady and uniform. The principal directions of anisotropy belonging to the second–rank, symmetric, dispersivity coefficient tensor are assumed to coincide with the x, y, and z coordinate axes.

The amount of dissolved solute adsorbed by the soil matrix must be related to the solute concentration. Mathematical expressions that relate S to C are known as isotherms. The simplest isotherm expressing the relation between the partitioning of the contaminant from the liquid to the solid phase is a linear one,

$$S = K_d C , \tag{3}$$

where K_d is known as the distribution coefficient of the dissolved solute in the porous media.

Introduction of Eq. (3) into Eq. (1) yields the equation,

$$R_d \frac{\partial C}{\partial t} + \frac{u}{n} \cdot \frac{\partial C}{\partial x} = D_x \frac{\partial^2 C}{\partial x^2} + D_y \frac{\partial^2 C}{\partial y^2} + D_z \frac{\partial^2 C}{\partial z^2} , \tag{4}$$

where

$$R_d \equiv 1 + \frac{\rho_{bulk}}{n} \cdot K_d . \tag{5}$$

The quantity R_d is defined as the retardation factor. Equation (4) is the form of the advection–dispersion equation that is to be applied to the contamination problem south of the FMPC SSOD.

Equation (4) is a transient, three–dimensional, linear, partial differential equation of second order. An initial condition and suitable boundary conditions must be specified before a solution to it can be developed. It is known that the boundary condition imposed by the SSOD is strongly time dependent. Moreover, the flow in the SSOD has not been measured and at best is ephemeral. Discharges into the SSOD from the Storm Sewer System are impulsive, depending on available retention capacity. Leakage rates through the floor of the SSOD are unknown and cannot be predicted without a knowledge of its flow rates and water levels. The streambed itself is extremely diverse, having been cut through a layer of glacial till and lacustrine deposits whose base elevation is not precisely mapped. Locations where significant leakage events into the underlying GMA have occurred are unknown. It is therefore postulated that the contamination emanating from the SSOD can be analyzed by developing an equivalent point–source model. This assumption may seem to be overly conservative because the SSOD is, in reality, a finite–length line source. Available measurements that have been reported between the Storm Water Retention Basin, SSOD, and the contaminated off–site wells south of the

FMPC reservation indicate that the plume has a long, narrow cigar shape; furthermore, the contaminant has not migrated into the deeper portions of the GMA.

The physical situation is depicted in Fig. F.2. A quantity of contaminant having mass Q is released instantaneously at time $t = 0$ and allowed to advect and disperse from the top of the GMA at the coordinates $x = x_0$, $y = y_0$, and $z = 0$. The xy plane at $z = 0$ is the water table surface. Mass can cross this surface only at the release point. The aquifer is assumed to be uncontaminated initially, at time $t = 0$. The aquifer is infinite in extent in the x and y directions, while being semi–infinite in the positive z direction which points downward from the water table surface into the GMA.

Conservation of mass requires that the total mass contained within the semi–infinite volume for all time be equal to Q. This condition may be written as

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{\infty}\left[\int_{0}^{\infty} C(x,y,z,t)\,dz\right] dx\,dy\,dt = Q\,. \tag{6}$$

The xy plane is a plane of symmetry. Equation (6) then becomes

$$\int_{-\infty}^{+\infty}\int_{-\infty}^{\infty}\int\int C(x,y,z,t)\,dx\,dy\,dz\,dt = 2Q\,. \tag{7}$$

The Dirac delta function (Arfken 1979) can be used to express Eq. (7) in an alternative form. This function has the following mathematical properties:

$$\delta(x-x^*) = 0 \text{ for } x \neq x^*\,, \tag{8}$$

$$\int_{-\infty}^{+\infty} \delta(x-x^*)\,dx = 1\,, \tag{9}$$

and

$$\int_{-\infty}^{+\infty} f(x)\,\delta(x-x^*)\,dx = f(x^*)\,. \tag{10}$$

The equivalent form of Eq. (7), which is the appropriate form of the instantaneous point–source boundary condition, is

$$C(x=x_0,y=y_0,z=0,t=0) = 2Q\,\delta(x-x_0)\,\delta(y-y_0)\,\delta(z)\,\delta(t)\,. \tag{11}$$

Since no mass is injected into the semi–infinite volume at infinity, the second boundary condition is

$$\lim_{x,y,z,t\to\infty} C(x,y,z,t) = 0\,. \tag{12}$$

The aquifer is assumed to be uncontaminated initially. The appropriate initial condition is

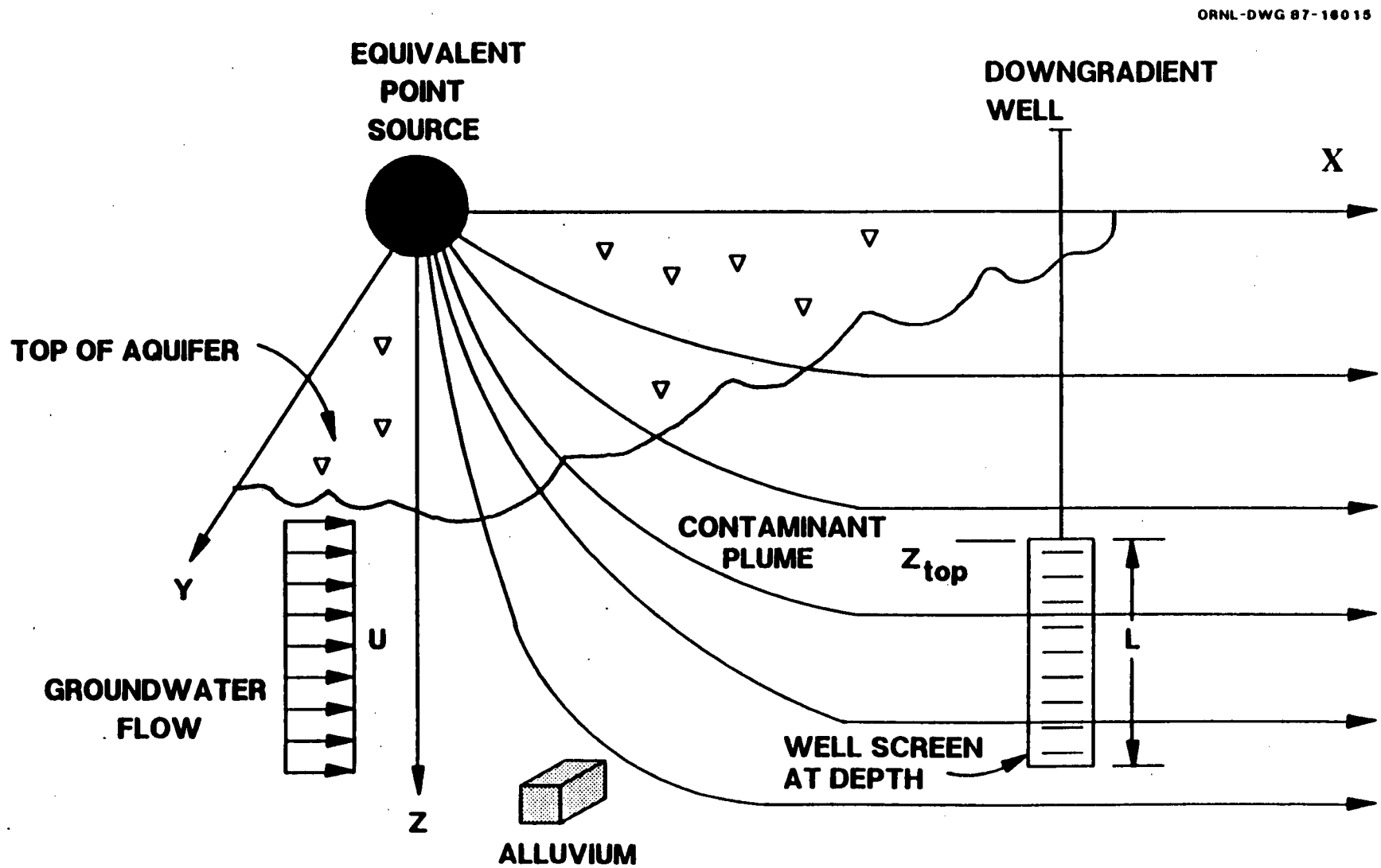


Fig. F.2. Contaminant transport from a point source into a one-dimensional, plane parallel alluvial aquifer.

$$\lim_{t \to 0} C(x,y,z,t) = 0 \text{ for } \sqrt{(x-x_o)^2 + (y-y_o)^2 + z^2} > 0 . \tag{13}$$

The solution to Eq. (4), subject to boundary condition Eqs. (11) and (12) as well as the initial condition stated in Eq. (13), is (Sutton 1953)

$$C(x,y,z,t) = \frac{Q}{4} \cdot \left[\frac{R_d}{\pi t}\right]^{3/2} \cdot \frac{1}{\sqrt{D_x D_y D_z}} \cdot$$

$$\exp\left\{-\frac{R_d\left[(x-x_o) - \frac{ut}{n \cdot R_d}\right]^2}{4 D_x t} - \frac{R_d (y-y_o)^2}{4 D_y t} - \frac{R_d z^2}{4 D_z t}\right\} . \tag{14}$$

To obtain the solution for Eq. (4) for the time–varying, continuously discharging point source, a variant of Duhamel's principle (Farlow 1982) can be used. The desired solution is determined by performing the integration,

$$C(x,y,z,t) = \frac{1}{4} \cdot \left[\frac{R_d}{\pi}\right]^{3/2} \cdot \frac{1}{\sqrt{D_x D_y D_z}} \cdot \int_o^t \frac{Q(\tau)\, H(\tau-t_o)}{(t-\tau)^{3/2}} \cdot$$

$$\exp\left\{-\frac{R_d\left[(x-x_o) - \frac{u(t-\tau)}{n \cdot R_d}\right]^2}{4 D_x (t-\tau)} - \frac{R_d (y-y_o)^2}{4 D_y (t-\tau)} - \frac{R_d z^2}{4 D_z (t-\tau)}\right\} \cdot d\tau , \tag{15}$$

where $Q(\tau)$ is now an arbitrary function defining the mass of contaminant discharged into the SSOD per unit time over the interval from t_o to t. The function $Q(\tau)$ has been multiplied by the Heaviside or unit step function $H(\tau-t_o)$ (Lighthill 1962; Kreyszig 1968), which is equal to zero when $\tau < t_o$ or equal to one when $\tau > t_o$. It formally restricts the time domain for $Q(\tau)$ to the interval between t_o and t as shown in Fig. F.3, and allows Eq. (15) to be rewritten as

$$C(x,y,z,t) = \frac{1}{4} \cdot \left[\frac{R_d}{\pi}\right]^{3/2} \cdot \frac{1}{\sqrt{D_x D_y D_z}} \cdot \int_{t_o}^t \frac{Q(\tau)}{(t-\tau)^{3/2}} \cdot$$

$$\exp\left\{-\frac{R_d\left[(x-x_o) - \frac{u(t-\tau)}{n \cdot R_d}\right]^2}{4 D_x (t-\tau)} - \frac{R_d (y-y_o)^2}{4 D_y (t-\tau)} - \frac{R_d z^2}{4 D_z (t-\tau)}\right\} \cdot d\tau , \tag{16}$$

in which the integration interval is now between t_o and t. It is emphasized that Eq. (14) is the solution for an instantaneous point source, while Eq. (16) is the solution for a source that continuously discharges contaminant at a specified rate as an arbitrary function of time over the interval from t_o to t.

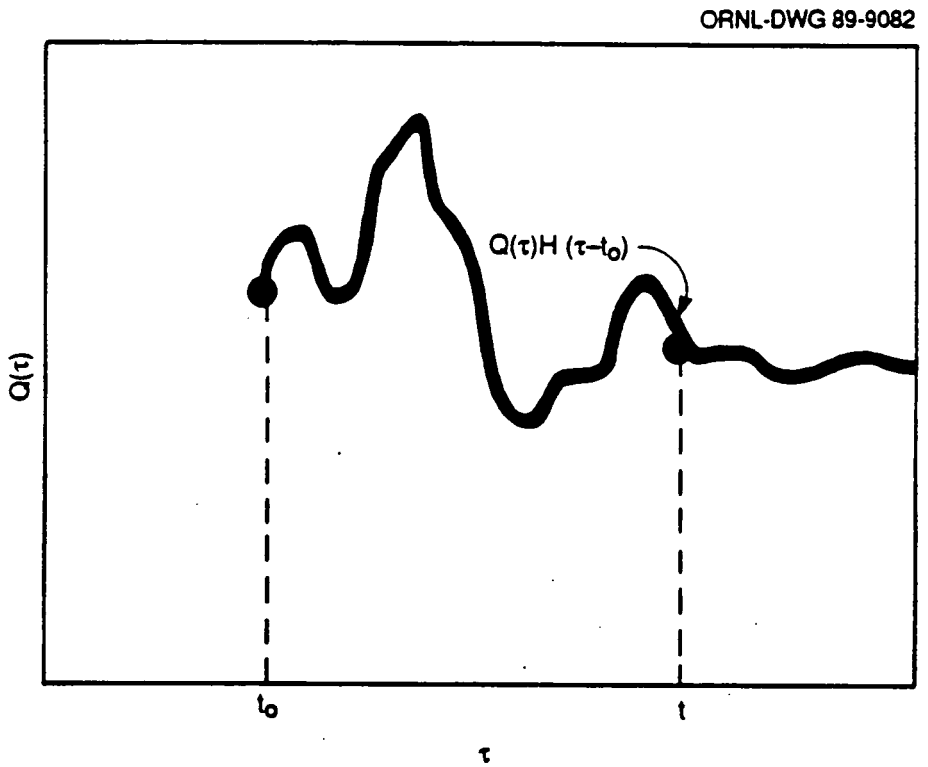


Fig. F.3. Mathematical representation of the discharge per unit time of contaminant into the Storm Sewer Outfall Ditch.

At some downgradient well location that intercepts the contaminant plume over a specified screened interval as shown in Fig. F.2, the solute concentration will vary with depth, in accordance with Eq. (16). It is therefore appropriate to calculate an average concentration $\overline{C}(x,y,t)$ over the screened interval when comparing results predicted by this theoretical analysis with experimental measurements reported for the well. Such data are usually collected on either a quarterly or annual basis. Moreover, the precise elevation of the sampling tube in the well, which directs groundwater to the sampling pump, is not moved up and down such that a constant elevation with respect to seasonal or annual fluctuations of the water table is maintained. If z_{top} is the elevation of the top of the well screen and L is its length, the expression for $\overline{C}(x,y,t)$ is

$$\overline{C}(x,y,t) = \frac{1}{4L} \cdot \left[\frac{R_d}{\pi}\right]^{3/2} \cdot \frac{1}{\sqrt{D_x\ D_y\ D_z}} \cdot \int_{z_{top}}^{z_{top}+L} \int_{t_o}^{t} \frac{Q(\tau)}{(t-\tau)^{3/2}} \cdot$$

$$\exp\left\{ -\frac{R_d\left[(x-x_o) - \frac{u(t-\tau)}{n \cdot R_d}\right]^2}{4\ D_x\ (t-\tau)} - \frac{R_d\ (y-y_o)^2}{4\ D_y\ (t-\tau)} - \frac{R_d\ z^2}{4\ D_z\ (t-\tau)} \right\} \cdot d\tau\, dz\,. \qquad (17)$$

Before evaluation of the integrals in Eqs. (16) and Eq. (17) can proceed, the function $Q(\tau)$ must be prescribed. Data are available that define the mass of uranium discharged into the SSOD in any given year between 1956 and 1984 (Starkey et al. 1962; ACCR 1965–85; Dames & Moore 1985). Details that describe how each discharge event occurred (impulsively, over a few days, continuously, etc.) are not available. Hence, the most appropriate mathematical representation is simply a series of steps written in terms of the Heaviside function, as shown in Fig. F.4. Using the notation in Fig. F.4, the equation for $Q(\tau)$ is

$$Q(\tau) = \sum_{i=0}^{N-1} a_i \left[H(\tau-t_i) - H(\tau-t_{i+1})\right] = \begin{cases} 0 \text{ for } \tau < t_i \\ a_i \text{ for } t_i < \tau < t_{i+1} \\ 0 \text{ for } \tau > t_{i+1} \end{cases}. \qquad (18)$$

Time t_o is understood to be the year 1956, while a unit increment in i corresponds to a one–year interval increase. Data beyond 1984 are dependent on the alternatives to be evaluated and must be specified on a case–by–case basis. In this study, both $Q(\tau)$ and the a_i in Eq. (18) are specified in kilograms per year. The Heaviside functions are dimensionless, being numerically equal to either zero or one.

The total mass M discharged into the SSOD is the integral of $Q(\tau)$ with respect to τ over the time interval of interest. For example, consider the interval between t_o and t^* where $t_{N-3} < t^* < t_{N-2}$. Then,

$$M = \int_{t_o}^{t^*} Q(\tau) \cdot d\tau\,,$$

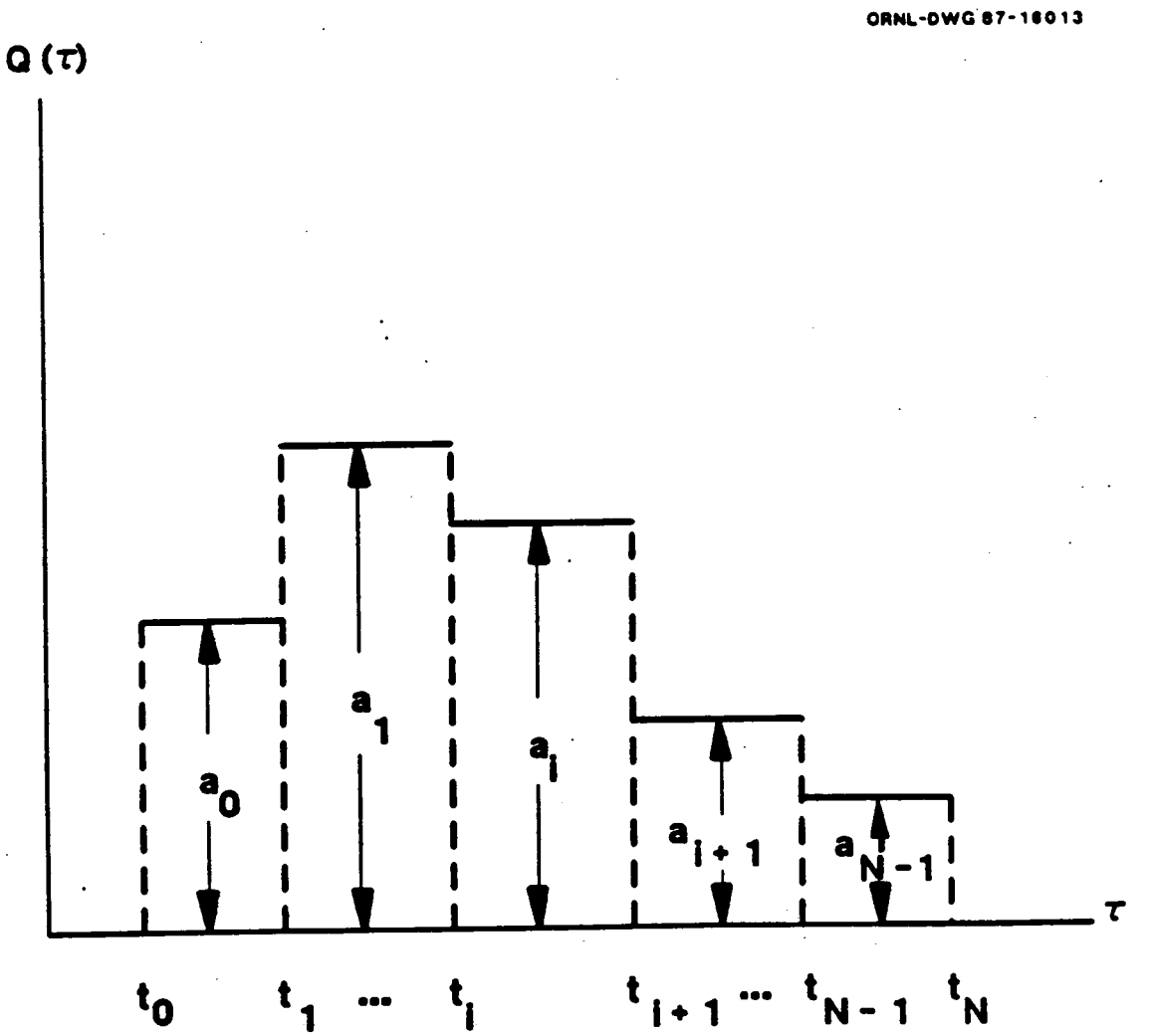


Fig. F.4. Step function representation of the time history of discharge rate into the Storm Sewer Outfall Ditch.

$$= \int_{t_0}^{t^*} \sum_{i=0}^{N-1} a_i \left[H(\tau - t_i) - H(\tau - t_{i+1}) \right] d\tau ,$$

$$= a_{N-3} \left[t^* - t_{N-3} \right] + \sum_{i=0}^{N-4} a_i \left[t_i - t_{i+1} \right] . \tag{19}$$

Under the summation sign, each of the temporal differences $t_i - t_{i+1}$ is equal to one year, while in the first term of the third line $t^* - t_{N-3}$ is the applicable fraction of a year between t_{N-2} and t_{N-3}. It is clear that the total mass discharged into the SSOD between t_0 and t^* is numerically equal to the sum of the first N–4 of the a_i plus a_{N-3} multiplied times that remaining fractional portion of a year. While this result may seem trite, it serves as a check on the logic and dimensional analysis necessary to specify $Q(\tau)$. This must be carried out correctly before an attempt is made to evaluate the integrals in Eqs. (16) and (17).

The integrals in Eqs. (16) and (17) with respect to τ are variants of the exponential integral, while the integrals in Eq. (17) with respect to z can be expressed as error functions. Neither the exponential integral nor the error function can be represented in terms of finitely many elementary functions. Recourse to numerical techniques is necessary to perform these integrations.

Selection of a suitable numerical integration technique requires consideration of the finite number of discontinuities appearing in the expression for $Q(\tau)$. An open interval integration method, which does not require information about the integrand at the limits of integration, should be used to approximate numerically the integrations with respect to τ. By subdividing the interval of integration and then applying the quadrature formula separately on each subinterval, the integration can be performed such that no information about the integrand is required at the discontinuities along $Q(\tau)$, or the endpoint as τ approaches t which could cause computational problems since the denominator would go to zero. Numerical quadrature involving interval subdivision and repeated application of the same integration formula is known as composite integration.

Numerical evaluation of the integrals with respect to τ defined in Eqs. (16) and (17) was accomplished by using a four–point, Gauss–Legendre quadrature formula (Carnahan, Luther, and Wilkes 1969). This quadrature formula can be written as

$$\int_{-1}^{+1} f(\tau)\, d\tau \approx \sum_{i=0}^{3} w_i\, f(\tau_i) , \tag{20}$$

in which the τ_i are the roots of the fourth–degree Legendre polynomial $P_4(\tau)$ where,

$$P_4(\tau) = (35\tau^4 - 30\tau^2 + 3) / 8 . \tag{21}$$

The weight factor w_i is determined from the integral product relation,

$$w_i = \int_{-1}^{+1} \prod_{\substack{j=0 \\ j \neq i}}^{3} \left[\frac{\tau - \tau_j}{\tau_i - \tau_j} \right] d\tau . \tag{22}$$

Table F.2 contains the roots and weight factors for four–point, Gauss–Legendre quadrature. The integration of $f(\tau)$ is exact for any polynomial of degree ≤ 7 if the roots and weight factors in Table F.2 are used in accordance with Eq. (20). The methodology outlined here is quite superior to other techniques based on either the trapezoidal rule or Simpson's rule for the evaluation of exponential integrals [Conte and de Boor 1972 (See Example 5.5 on p. 304.)].

If the integrals with respect to τ are written with arbitrary limits of integration from t_o to t and represented as

$$\int_{t_o}^{t} f(\tau)\, d\tau , \tag{23}$$

the linear transformation $2\tau = (t-t_o)\,\xi + (t+t_o)$, where $2\, d\tau = (t-t_o)\, d\xi$, allows an equivalent form of Eq. (20) to be written as

$$\int_{t_o}^{t} f(\tau)\, d\tau = \frac{(t-t_o)}{2} \int_{-1}^{+1} f\left[\frac{(t-t_o)\ \xi + (t+t_o)}{2}\right] d\xi ,$$

$$\approx \frac{(t-t_o)}{2} \sum_{i=o}^{3} w_i\, f\left[\frac{(t-t_o)\ \xi_i + (t+t_o)}{2}\right] . \tag{24}$$

Values of ξ_i are given in the first column of Table F.2 while the w_i are contained in the second one.

Each yearly interval was subdivided into six equal parts, to which the quadrature formula expressed in Eq. (24) could be applied separately in a composite manner. The differential increment in τ is 1/6 year. If t is the year in which the solution is desired, and t_o is the beginning of the first year for which data is available for $Q(\tau)$, the composite Gauss–Legendre integration formula can be written as

$$\int_{t_o}^{t} f(\tau)\, d\tau \approx \frac{1}{12} \sum_{j=1}^{6(t-t_o)} \sum_{i=0}^{3} w_i\, f\left[\frac{\xi_i}{12} + t_o + \frac{(2j-1)}{12}\right] . \tag{25}$$

This equation was used to numerically evaluate the integrals with respect to τ displayed in Eqs. (16) and (17). By solving the problem with the format illustrated here, no functional evaluations are required at any of the finite number of discontinuities that are present over the domain of definition of the integrand. This methodology also can be applied to the case where t is not an integer number of years by simply subtracting off the fractional portion of a year, applying Eq. (25) over the remaining interval, and then using the same Gauss–Legendre quadrature methodology over the fractional interval.

Table F.2. Roots of the Legendre Polynomial $P_4(\tau$ or $\xi)$ and the weight factors for four–point, Gauss–Legendre quadruature.

Root (τ_i or ξ_i)	Weight factor (w_i)
$\pm$ 0.339981043584856	0.652145154862546
$\pm$ 0.861136311594053	0.347854845137454

Source: B. Carnahan, H. A. Luther, and J. O. Wilkes. 1969. Applied Numerical Methods. Wiley, New York, table 2.2, p. 103.

Improved accuracy will be obtained over the last fractional interval because subdivision into six equal parts would still be employed, making $d\tau$ proportional to the interval size. The endpoint as τ approaches t will still be avoided in the calculation.

The second integration with respect to z required in Eq. (17) to obtain $\overline{C}(x,y,t)$ is not as difficult to perform. Once the integrations with respect to τ have been carried out, a numerically continuous, pointwise distribution of $C(x,y,z,t)$ is available as defined in Eq. (16). Hence, a much simpler integration formula, such as the trapezoidal rule or Simpson's rule, can be used. The trapezoidal rule was selected to calculate $\overline{C}(x,y,t)$.

Let the results of the integration with respect to τ be denoted by $C(x,y,z_j,t)$, where $j = 1,2,\ldots, M$, and $z_j = \Delta z \cdot (j-1)$ is an assumed, equally spaced discretization of the independent variable. The value of z_j is zero at the top of the aquifer (j=1), while it is equal to the depth of the aquifer when $j = M$. The two-point form of a straight line (Fuller 1962) can be used to linearly interpolate the required values of $C(x,y,z,t)$ at z_{top} and $z_{top} + L$. The resultant piecewise continuous function is

$$C(x,y,z,t) \approx C(x,y,z_j,t) + \left[\frac{C(x,y,z_{j+1},t) - C(z,y,z_j,t)}{z_{j+1} - z_j}\right](z-z_j)$$

$$\text{for } j = 1,2,\ldots, M-1 . \tag{26}$$

Once the correct intervals for z_{top} and $z_{top} + L$ have been identified, Eq. (26) allows computation of the corresponding values of $C(x,y,z,t)$ at these two points.

If $z_{j,top}$ refers to the first node point to the right of z_{top}, and $z_{j,top+L}$ is the first point to the left of $z_{top} + L$, the trapezoidal integration can be written as

$$\overline{C}(x,y,t) = \frac{1}{L}\int_{z_{top}}^{z_{top}+L} C(x,y,z,t)\, dz ;$$

$$\approx \frac{1}{L}\left\{\frac{(z_{j,top} - z_{top})}{2}\left[C(x,y,z_{top},t) + C(x,y,z_{j,top},t)\right]\right.$$

$$+ \frac{\Delta z}{2}\left[C(x,y,z_{j,top},t) + C(x,y,z_{j+1,top})\right]$$

$$+ \cdots + \frac{\Delta z}{2}\left[C(x,y,z_{j-1,top+L},t) + C(x,y,z_{j,top+L},t)\right]$$

$$\left. + \frac{[z_{top} + L - z_{j,top+L}]}{2}\left[C(x,y,z_{j,top+L},t) + C(x,y,z_{top} + L,t)\right]\right\} . \tag{27}$$

This is nothing more than an application of the composite trapezoidal rule (Carnahan, Luther, and Wilkes 1969) at the interior node points or z_j with corrections on the ends to account for any nonuniform distribution of z_{top} and $z_{top} + L$. Obviously, no corrections would occur if z_{top} and $z_{top} + L$ coincide exactly with any of the z_j.

A computer program using the Fortran 77 language (Meissner and Organick 1982) was written to perform the calculations required by the above analysis. A flow chart of

the procedure is shown in Fig. F.5. The subroutine Gauss published by Carnahan, Luther, and Wilkes (1969) was used with minor modification to carry out the Gauss–Legendre quadrature. A separate trapezoidal routine was written that employed a binary search (Forsythe et al. 1977) for locating the proper interval within the z_j where z_{top} and z_{top}+ L reside. Because it was known ahead of time that many of the input parameters were not available, particularly D_x, D_y, D_z, and K_d, the program was set up so that it could be deployed in an iterative manner. The decision tree on the right–hand side of the flow chart in Fig. F.5 details the logic for this methodology. By continually rerunning the code for different values of the independent parameters, a "best fit" to measured data could be obtained by using a trial–and–error optimization process. The bulk density of soil was obtained as a function of porosity from the data reported by Freeze and Cherry (1979) for unconsolidated deposits. The values are listed in Table F.3. Simple linear interpolation was used to calculate intermediate values based on the porosity.

The computer program that has been described was used to model the contaminant migration occurring in the GMA south of the FMPC SSOD. The model was able to successfully match all available measured data. The results and conclusions from these calculations are discussed in the first volume of this Environmental Impact Statement. All results were calculated on the Cray X–MP/1 computer located at the Oak Ridge Gaseous Diffusion Plant. While the code can be executed on a personal computer, the computing capacity or speed of such a machine quickly becomes exhausted when calculating an entire time history of contaminant migration, which must be done to fit the model to measured data. The results quoted in this study used an aquifer depth of 150 ft (45.7 m) with a vertical discretization Δz of 15 ft (4.57 m).

ORNL-DWG 87-16017

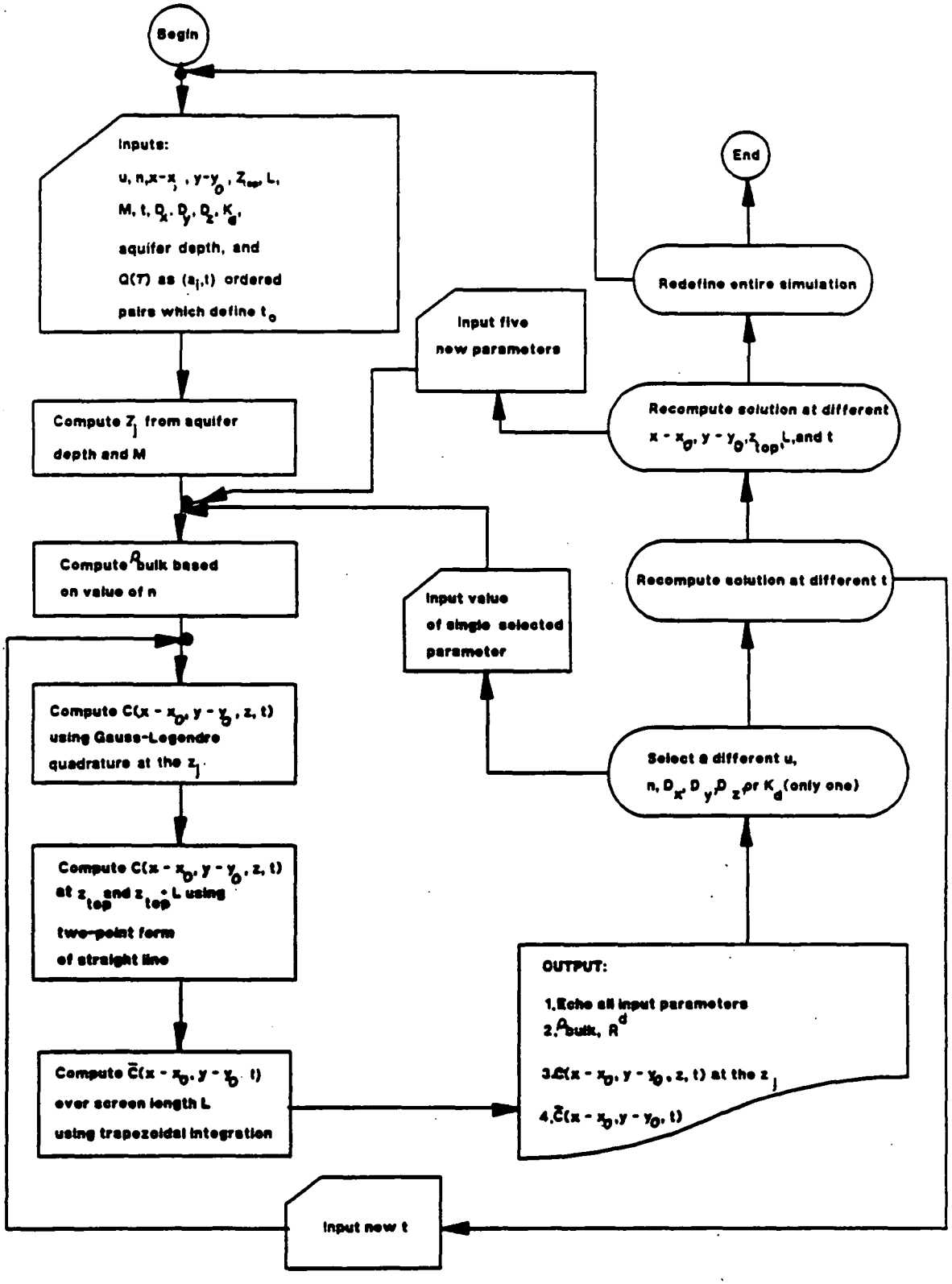


Fig. F.5. Flow chart of computational procedure.

Table F.3. Bulk density of unconsolidated soil deposits as a function of porosity.

Bulk density (g/cm^3)	Porosity
1.6	0.2
2.1	0.4

Source: R. A. Freeze and J. A. Cherry. 1979. Groundwater. Prentice–Hall, Englewood Cliffs, New Jersey, pp. 404–405.

F.4 DETERMINATION OF THE INDEPENDENT PARAMETERS REQUIRED BY THE SOLUTE TRANSPORT MODEL

Field measurements have not been made at the FMPC from which the three dispersivity components and the distribution coefficient can be determined. However, sufficient information is available which describes the plume migrating southward from the SSOD to permit an inverse calculation to be performed similar to that carried out in a formal tracer test. The mass of uranium discharged into the SSOD from the Storm Sewer System has been recorded since 1956 (Starkey et al. 1962, ACCR 1965-1985, Dames and Moore 1985), while elevated concentrations of dissolved uranium have been measured since 1981 at three off-site well locations downgradient from the SSOD (Sedam 1984; Dames and Moore 1985; Aas et al. 1986; Clement 1987; WMCO 1987). The principal groundwater flow direction in the vicinity of the SSOD is south, nearly one-dimensional, and essentially time-independent, whereas the contaminant migration transport mechanisms are transient and three-dimensional. The resultant partial differential equation governing these processes subject to the boundary condition imposed by the discharges of uranium into the SSOD as shown in Sect. F.3 can be solved analytically in terms of the unknown dispersivities and distribution coefficient. These unknown parameters then can be determined using the measured concentrations at the downgradient wells as a basis. Resolution of this inverse problem at the SSOD is of paramount importance to this study since no reliable analysis of contaminant migration from the waste pit area can be performed without believable estimates of the dispersivities and distribution coefficient based on an analysis of in situ field measurements. Once these unknown parameters are available, an analysis of the waste pit area can be carried out in a relatively straightforward manner.

The formal process of determining the unknown dispersivities and distribution coefficient from the known discharges into the SSOD and the contaminant concentrations measured at the downgradient wells in conjunction with the solute transport model belongs to a class of problems known as parameter optimization. For instance, in a least-squares analysis of this problem, the unknown parameters would be determined by minimizing a residual error function defined as the sum of the squares of the difference between the computed and measured contaminant concentrations at the wells. Various mathematical methods can be used to calculate the unknown parameters. Optimization procedures have been used to solve analogous problems in related areas such as streamflow simulation (Linsley et al. 1975), stormwater modeling (Overton and Meadows 1976), and the determination of the transmissivity and storativity of aquifers from pump test data (Kashyap et al. 1988). This study uses a simple trial-and-error optimization technique to obtain estimates of the dispersivities and distribution coefficient.

Figures F.6 and F.7 contain a plan view and cross section through the GMA downgradient from the SSOD. Unknown quantities that must evolve naturally from the trial-and-error optimization procedure include the location of the equivalent point source, the three spatial components of dispersivity, the distribution coefficient, and the unknown screen length of off-site well OS-2. The equivalent point source is located at the top of the GMA water table;

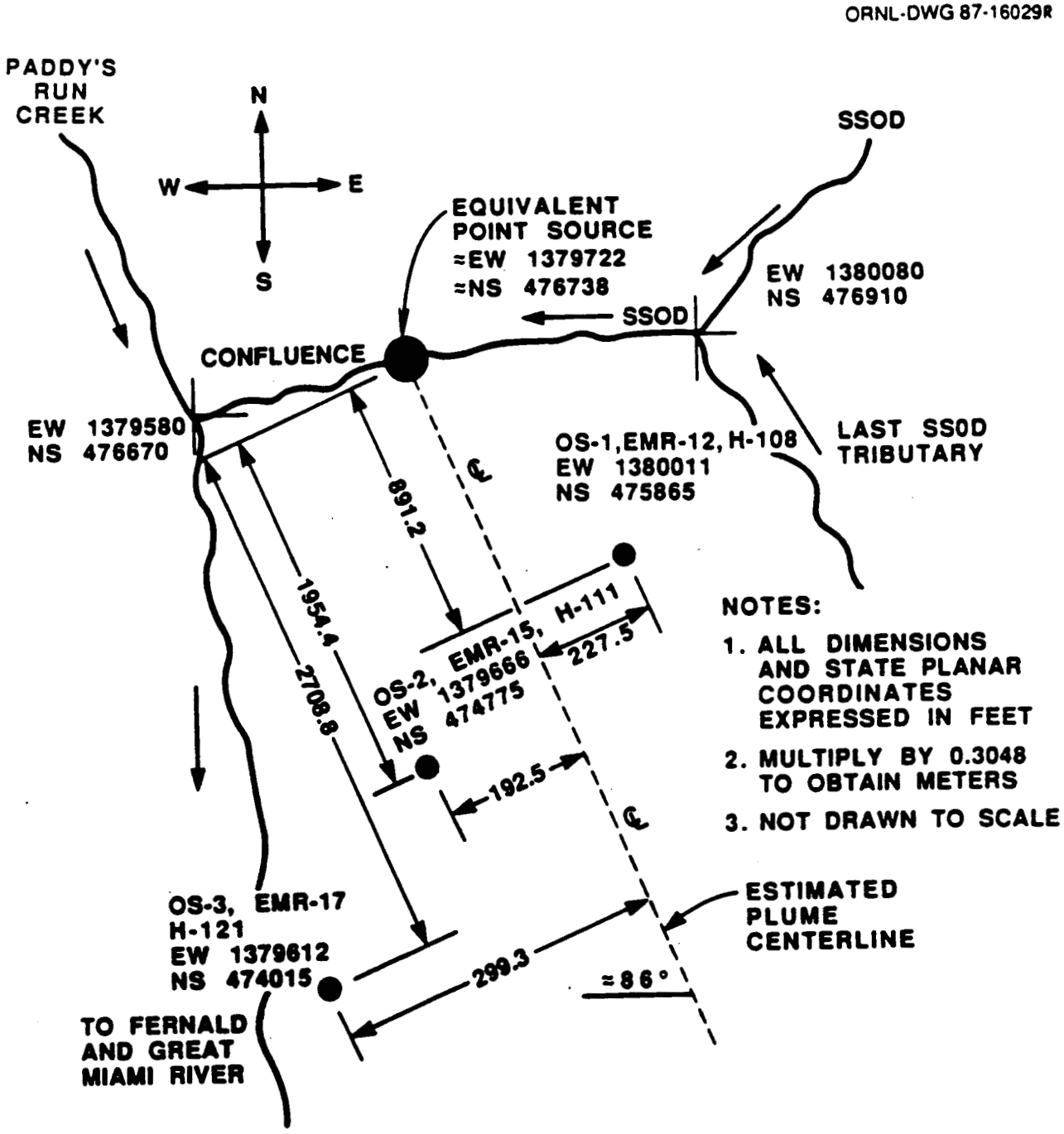
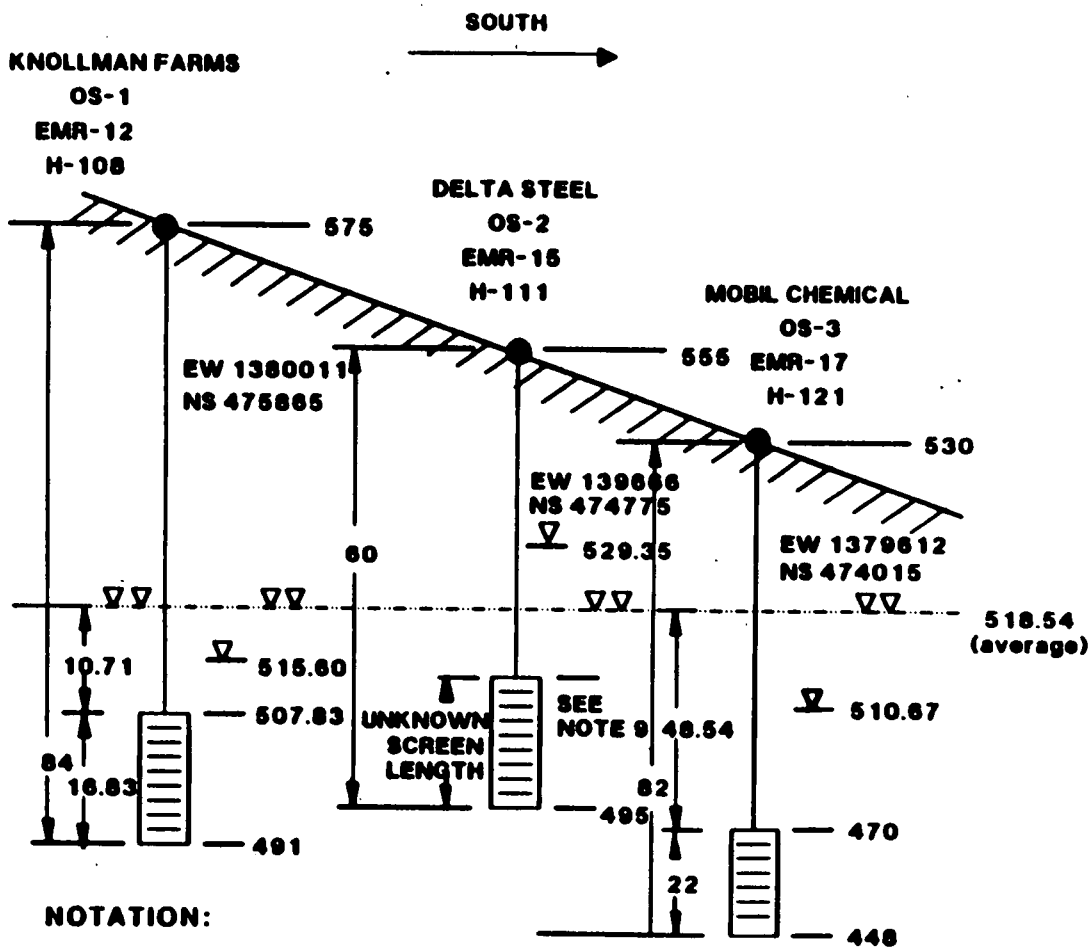


Fig. F.6. Plan view south of the Feed Materials Production Center showing equivalent point source location along Storm Sewer Outfall Ditch, plume centerline, and contaminated off-site wells.

ORNL-DWG 87-16030R



NOTES:

1 ALL ELEVATIONS IN FEET ABOVE MEAN SEA LEVEL

2 ALL DISTANCES EXPRESSED IN FEET

3 MULTIPLY FEET BY 0.3048 TO OBTAIN METERS

4 STATE PLANAR COORDINATES MEASURED IN FEET

5 WELL ENUMERATION INCLUDES THAT USED BY DAMES & MOORE (1985) AND THAT FROM THE 1986 ENRIRONMENTAL MONITORING REPORT (WMCO, 1987a). COUNTY WELL NUMBERS WERE TAKEN FROM SEDAM (1984)

6 ELEVATION FOR TOP OF SCREENS TAKEN FROM DAMES & MOORE (1986)

7 COMPLETED WELL DEPTHS TAKEN FROM SEDAM (1984)

8 REMAINING DATA TAKEN FROM GEOTRANS (1985)

9 TOP OF SCREEN ELEVATION REPORTED BY DAMES & MOORE (1985) FOR DELTA STEEL WELL IS IN ERROR SINCE IT IS BELOW ELEVATION OF TOTAL COMPLETED DEPTH

NOTATION:

▽ WATER TABLE ELEVATIONS REPORTED BY GEOTRANS (1985) THAT WERE MEASURED AUGUST 2 AND 3, 1982

▽▽ MEAN WATER TABLE ELEVATION

Fig. F.7. Cross section through Great Miami Aquifer south of the Feed Materials Production Center showing installation details of contaminated off-site wells.

0441

000453

hence, only the two coordinates of its location near the land surface are unknown. The specific discharge, effective porosity, and soil bulk density can be estimated from published information already discussed in this appendix. Initial estimates of the longitudinal and transverse dispersivities are provided by the measurements reported by Pinder (1973). The vertical dispersivity is expected to be less than either the longitudinal or transverse dispersivity. The distribution coefficient should be at least one order of magnitude lower than the values listed in Table F.1.

The first step in arriving at an optimal solution is the determination of the location of the equivalent point source. Initial attempts to find a solution placed this source at the confluence of the SSOD with Paddy's Run and at the confluence of the last SSOD tributary with the SSOD. Neither of these locations is plausible because the three off-site wells are too far from the plume centerline. Resultant contaminant concentrations that were predicted using these two source locations were orders of magnitude below measured values.

The next logical position for placement of the equivalent point source is either between wells OS-1 and OS-2, or wells OS-2 and OS-3. The concentrations at well OS-1 are significantly larger than those measured at wells OS-2 and OS-3. Hence, the source must be located somewhere between wells OS-1 and OS-2. Additional trial simulations with well OS-2 positioned on the centerline of the plume did not yield concentrations that agreed with the measurements. The final source location shown in Fig. F.6 is the only one that resulted in believable concentrations at the off-site wells. Of course, the choice of the unknown screen length at well OS-2 affects the optimization procedure and concomitant results. An optimized screen length of 1.5 m (5 ft) was found to be appropriate. The close proximity of the screen on well OS-2 to the top of the water table of the GMA causes predicted concentrations to be quite sensitive to the location of the equivalent point source.

The final step in the optimization process begins at wells OS-1 and OS-3 by selecting a set of dispersivities and a distribution coefficient that best reproduces the observed concentration values. The measured results at well OS-2 are then refined by adjusting the unknown screen length to a more appropriate value. At this point, a distribution coefficient estimate is introduced by requiring that the time at which the peaks occur in the analysis and measurements be the same. Initial attempts to match the measured data using the longitudinal and transverse dispersivities quoted by Pinder (1973) predicted a concentration chronology having a single, rapidly rising peak, corresponding to the highest FMPC production period in the early 1960s, which then decayed exponentially. Introduction of a suitable distribution coefficient that caused this peak to coincide with the measurements produced a relatively flat time history that did not resemble the spiked behavior exhibited by the data. Moreover, the overall concentration levels could be made to agree with the measurements only by substantially increasing the vertical dispersivity that allowed the contaminant to disperse into the deeper portions of the GMA. Elevated uranium concentration levels have not been observed near the bottom of the GMA south of the FMPC.

In order to obtain corresponding peaks in the chronology of the contaminant history that correlated with each of the spikes exhibited by the SSOD source, the dispersivity estimates had to be reduced. When this was done, the vertical dispersivity had to be increased so that predicted concentration levels near the top of the GMA did not exceed the saturation limit, which is physically impossible. Table F.4 contains the values of the unknown independent parameters obtained from the trial-and-error optimization procedure. The longitudinal and transverse dispersivities in Table F.4, are one-fourth of those quoted by Pinder (1973) in a glacial outwash aquifer; his longitudinal-to-transverse anisotropy ratio of 5 has been maintained. The optimized longitudinal-to-vertical anisotropy ratio of 50 is well within the range observed for hydraulic conductivity in alluvial aquifers similar to the GMA (GeoTrans 1985). Anisotropy ratios for hydraulic conductivity and dispersivity are expected to be similar. This value of vertical dispersivity does not allow excessive contaminant to penetrate into the deeper portions of the aquifer which would invalidate the analysis. The optimized distribution coefficient is significantly lower than the values measured in the Minford silts contained in Table F.1 which is an expected result.

The mathematical analysis of the dispersion process occurring in the GMA does not account for the change in distribution coefficient with concentration. The governing solute transport equation has been linearized by assuming that the distribution coefficient is a constant. By forcing the temporal relationship of the analysis to agree with the measurements at well OS-2, the results predicted at well OS-1 will slightly lag the observed data, while leading them by a small amount at well OS-3. This phenomenon is a logical result of treating the distribution coefficient as a constant. When the independent parameters listed in Table F.4 are utilized in the equivalent point source model of the SSOD, an excellent match is obtained between measured and predicted contaminant concentrations at off-site wells OS-1, OS-2, and OS-3.

Field measurements in 1987 at off-site wells OS-1, OS-2, and OS-3 have exhibited a rise in the concentration levels of dissolved uranium (WMCO 1988). These increases have been caused by spillway overflows from the first SWRB into the SSOD during large precipitation events. When these overflows are accounted for in the formulation of the equivalent point source located in the streambed of the SSOD, good agreement is obtained between observed and predicted concentrations of dissolved uranium. These overflows will, for all practical purposes, cease when the second SWRB is placed into service, and future downgradient concentrations will then decrease.

The independent parameters, quoted in Table F.4, obtained by using the trial-and-error optimization procedure, form the basis for the environmental impact evaluations carried out in this study. By altering the equivalent point source to account for future releases into the SSOD, future impacts to groundwater south of the FMPC reservation can be predicted. The model also can be used to evaluate future impacts of the waste pit area. The eastward-specific discharge is one-third of the value given in Table F.4. This results in a lowering of the dispersion coefficients in Eq. (4) because these coefficients are computed as the product of the dispersivity and the average linear velocity of groundwater.

Table F.4. Values of independent parameters used to predict the plume downgradient of the Storm Sewer Outfall Ditch.

Quantity	Value	Source
Specific discharge	0.6 ft/d (0.18 m/d)	Measurements
Effective porosity	0.25	Estimated
Longitudinal dispersivity	17.5 ft (5.33 m)	Optimized
Transverse dispersivity[a]	3.5 ft (1.07 m)	Optimized
Vertical dispersivity[b]	0.35 ft (0.107 m)	Optimized
Screen length of well OS–2	5 ft (1.5 m)	Optimized
Distribution coefficient (for U)	8.3 $in.^3$/lb (0.3 mL/g)	Optimized
Soil bulk density[c]	106 lb/ft^3 (1.7 g/cm^3)	Table F.3

[a]Ratio of longitudinal–to–transverse dispersivity = 5

[b]Ratio of longitudinal–to–vertical dispersivity = 50

[c]Defined as the oven–dried soil mass divided by its field volume

F.5 REFERENCES

Aas, C. A., D. L. Jones, and R. W. Keys 1986. *Feed Materials Production Center Environmental Monitoring Annual Report for 1985*, FMPC–2047, Special, UC–41, Westinghouse Materials Company of Ohio, Cincinnati.

Arfken, G. 1979. *Mathematical Methods for Physicists*, 2d ed. Academic Press, New York.

ACCR (Aquifer Contamination Control Reports) 1965–85. Prepared by R. H. Starkey, 1965–69; M. W. Boback, 1970–81; R. B. Weidner, 1982–84; and C. F. Facemire, 1985, Feed Materials Production Center, Fernald, Ohio.

Blumberg, R., et al. January 1983. *GCEP Waste Pathways Analysis Study*, K/D–5375, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Bouwer, H. September 1964. "Unsaturated Flow in Ground–Water Hydraulics," *Journal of the Hydraulics Division, Proceedings of the American Society of Civil Engineers* 90(HY5), 121–144.

Bouwer, H. 1978. *Groundwater Hydrology.* McGraw–Hill, New York.

Bureau of Mines December 1986. "Field Test for Measuring Cation Exchange Parameters," *Bureau of Mines, U.S. Department of the Interior Technology News*, 267, Technology Transfer Group, Bureau of Mines, Washington, D.C.

Carnahan, B., Luther, H. A., and Wilkes, J. O. 1969. *Applied Numerical Methods*; Wiley, New York.

Cleary, R. W., Miller, D. W., and Pinder G. F.; Jan. 26–30, 1987. *Groundwater Pollution and Hydrology*, course offered in Miami, Florida, by Princeton Associates, Princeton, N.J.

Clement, S. 1987. Westinghouse Materials Company of Ohio, Cincinnati, unpublished open file data, personal communication.

Conte, S. D., and de Boor, C. 1972. *Elementary Numerical Analysis: An Algorithmic Approach*, 2d ed. McGraw–Hill, New York.

Dames & Moore July 1985. *Department of Energy Feed Materials Production Center Groundwater Study Task C Report.* White Plains, New York.

Davis, S. N. 1969. "Porosity and Permeability of Natural Materials," pp. 53–89 in *Flow Through Porous Media*, ed. R. J. M. De Wiest, Academic Press, New York.

Dove, G. D., and Norris, S. E., September 1951. *Conditions Governing the Occurrence of Ground Water in the Fernald Area, Ohio, with Reference to the Possibilities of Contamination by Disposal of Chemical Wastes,* U. S. Geological Survey, Ground Water Branch, Columbus, Ohio.

Farlow, S. J. 1982. *Partial Differential Equations for Scientists and Engineers*, Wiley, New York.

Forsythe, G. E., Malcolm, M. A., and Moler, C. B. 1977. *Computer Methods for Mathematical Computations*, Prentice–Hall, Englewood Cliffs, N. J.

Freeze, R. A., and Cherry, J. A. 1979. *Groundwater*. Prentice–Hall, Englewood Cliffs, N. J.

Fried, J. J. 1976. "Groundwater Pollution," *Developments in Water Science*, Vol. 4, Elsevier Science Publishing Company, Inc., New York.

Fried, J. J., and Combarnous, M. A. 1971. "Dispersion in Porous Media," pp. 169–282 in *Advances in Hydroscience*, ed. V. T. Chow, Vol. 7, Academic Press, New York.

Fuller, G. 1962. *Analytic Geometry*, 2d ed. Addison–Wesley, Reading, Mass.

GeoTrans, Inc. Sept. 30, 1985. *Preliminary Characterization of the Groundwater Flow System Near the Feed Materials Production Center, Great Miami River Valley–Fill Aquifer Fernald, Ohio*, Columbus, Ohio.

International Technology Corp. 1986. *Final Interim Report Air, Soil, Water, and Health Risk Assessment in the Vicinity of the FMPC Fernald, Ohio.*

Jennings, J. K., and Leventhal, J. S. 1978. *A Literature Review of Interaction of Oxidized Uranium Species and Uranium Complexes with Soluble Organic Matter* United States Department of the Interior Geological Survey Open–File Report 78–179.

Kashyap, D., Dachadesh, P., and Sinha, L.S.J. 1988. "An Optimization Model for Analysis of Test Pumping Data," *Ground Water* 26 (3), 289–97.

Kreyszig, E. June 1968. *Advanced Engineering Mathematics*, 2d corrected printing, Wiley, New York.

Langmuir, D. 1978. "Uranium Solution–Mineral Equilibria at Low Temperatures with Applications to Sedimentary Ore Deposits," *Geochim. Cosmochim. Acta* 42, 547–69.

Lighthill, M. J. 1962. *Introduction to Fourier Analysis and Generalized Functions*, Cambridge University Press, London.

Linsley, R. K., Jr., Kohler, M. A., and Paulhus, J.L.H. 1975. *Hydrology for Engineers*, 2d ed. McGraw–Hill, New York.

Meissner, L. P., and Organick, E. I. April 1982. *Fortran 77 Featuring Structural Programming*, corrected reprint, Addison–Wesley, Reading, Mass.

Ogata, A. 1970. *Theory of Dispersion in a Granular Medium*, U.S. Geological Survey Professional Paper 411–I.

Overton, D. E., and Meadows, M. E. 1976. *Stormwater Modeling*. Academic Press, Inc., New York.

Pin, F. G., et al. October 1984. *Radionuclide Migration Pathways Analysis for the Oak Ridge Central Waste Disposal Facility on the West Chestnut Ridge Site*, ORNL/TM–9231, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Pinder, G. F. 1973. "A Galerkin Finite–Element Simulation of Groundwater Contamination on Long Island, New York," *Water Resour. Res.* 9, 1657–99.

Sedam, A. C. 1984. *Occurrence of Uranium in Ground Water in the Vicinity of the U. S. Department of Energy Feed Materials Production Center, Fernald, Ohio*, U. S. Geological Survey Administrative Report DOE/OR/20998–T1, Columbus, Ohio.

Spieker, A. M. 1968. *Ground–Water Hydrology and Geology of the Lower Great Miami River Valley Ohio.* U. S. Geological Survey Professional Paper 605–A.

Spieker, A. M., and S. E. Norris. September 1962. *Groundwater Movement and Contamination at the AEC Feed Materials Production Center Located Near Fernald, Ohio*, prepared by the U. S. Geological Survey for the U. S. Atomic Energy Commission, Columbus, Ohio.

Starkey, R. H. Sept. 30, 1962. *Report of FMPC Ground Contamination Study Committee*, FMPC–110, Cincinnati, Ohio.

Stout, W., and Schaaf, D., Sept. 30, 1931. "Minford Silts of Southern Ohio," *Bulletin of the Geological Society of America* **42**, 663–72.

Sutton, O. G. 1953. *Micrometeorology: A Study of Physical Processes in the Lowest Layers of the Earth's Atmosphere*, McGraw–Hill, New York.

Udal'stova, N. I. 1970. "General Information on Uranium," pp. 1–27, in *Analytical Chemistry of Uranium*, comp. P. N. Palei, Ann Arbor–Humphrey Science Publishers, Inc., Ann Arbor, Mich.

Welty, J. R., Wick, C. E., and Wilson, R. E. 1969. *Fundamentals of Momentum, Heat, and Mass Transfer*, Wiley, New York.

WMCO (Westinghouse Materials Company of Ohio), April 30, 1987. *Feed Materials Production Center Environmental Monitoring Annual Report for 1986*, FMPC–2076, Special, UC–41.

APPENDIX G

AIR QUALITY/METEOROLOGY

APPENDIX G. AIR QUALITY/METEOROLOGY

The purpose of this appendix is to give more detailed information on modeling procedures and input data used to predict the air quality impacts of FMPC emissions. The air quality modeling analysis of non-radiological emissions is described in Sect. G.1. The choices of meteorological input data for the non-radiological and radiological modeling analyses are explained in Sect. G.2. Section G.3 presents a summary of climatic data for the Greater Cincinnati Airport. Finally, a modeling analysis of hypothetical accidental releases of anhydrous ammonia and anhydrous hydrogen fluoride is described in Sect. G.4.

G.1 DISPERSION MODELING METHODOLOGY AND MODEL INPUT DATA FOR NON-RADIOLOGICAL EMISSIONS

The Industrial Source Complex Short-Term (ISCST) Dispersion Model, (EPA 1987; EPA 1988) was selected as the best available tool for simulating dispersion of non-radiological air emissions from the FMPC. The ISCST model is approved by the U.S. Environmental Protection Agency for regulatory application (EPA 1986). It is based on a straight-line Gaussian plume formulation using the Pasquill-Gifford curves (Turner 1970) for growth of the plume height and width with travel distance. The model, like all straight-line Gaussian models, works best when applied to elevated sources in flat terrain under moderate to strong winds over distances of 10 km (6 miles) or less.

Appended to the basic Gaussian core of the ISCST model are a number of features designed to account for emissions in certain types of complex situations. Those of interest to the current study include:

1. Multiple-source capability, with each source having its own emission characteristics;

2. An account for plume rise due to buoyancy and momentum (Briggs 1975);

3. An account of stack-tip downwash and building-wake effects on the plume rise and initial plume dispersion (Huber and Snyder 1976; Huber 1977; Scire and Shulman 1980); and

4. Use of a power-law profile to relate wind speed at anemometer height to wind speed at plume height.

Additionally, the ISCST model contains certain features that accommodate its application in a regulatory framework and which were of use for this study. These include the following:

1. Model-defined receptor grids of either polar-coordinate or rectangular-coordinate form.

2. The ability to treat sources in groups, allowing simultaneous computation for several source scenarios.

3. Tables indicating the highest and second highest concentrations for each receptor.

4. Tables of the 50 highest average concentrations over the year for averaging times of 1 h, 3 h, 8 h, 24 h, and other time periods of regulatory interest. The highest concentrations, along with their ranks, locations, and times, are printed in these tables.

A number of features of the ISCST model were not used for various reasons. Those requiring some explanation include the following:

1. Deposition and plume depletion. The ISCST model is capable of calculating the amount of dry deposition of particulate matter due to the processes of gravitational settling and particle impaction. It can also account for the depletion of plume particulate matter concentrations due to the effects of dry deposition. Neglecting to use this feature will result in a more conservative (high) estimate of particulate matter concentrations.

2. Chemical decay of pollutant species during dispersion. Significant depletion of the concentration of most of the pollutants due to chemical reactions is unlikely for the relatively short transport distances and times considered in this study. The most likely exception to this is hydrogen fluoride (HF), which, because of its highly reactive nature, may be significantly depleted by the time it leaves the plant site.

3. Site-specific potential temperature gradients. Cincinnati data do not provide such information.

4. Site-specific wind profile exponents. Cincinnati data do not include this information.

5. Terrain effects. A crude adjustment for terrain is possible by specifying receptor elevations at heights different from the source ground-level elevation. However, most of the elevated terrain is beyond the range of the nearest residents to FMPC. The overall maximum concentrations occur very near the facility. Concentrations decrease rapidly with distance, making it unlikely that there is significant plume impact on rising terrain.

Table G.1 summarizes the input data used for a typical ISCST model run (in this case, for the HF emissions scenarios). Table G.2 lists the ISCST source input data (except for emission rates, which varied by scenario as shown in Table 4.13) used to model the non-radiological emission sources at the FMPC.

Table G.1. Typical U.S. EPA Industrial Source Complex Short-Term (ISCST) model input data for Feed Materials Production Center (FMPC) air quality analysis

CALCULATE (CONCENTRATION=1,DEPOSITION=2)	ISW(1) = 1
RECEPTOR GRID SYSTEM (RECTANGULAR=1 OR 3, POLAR=2 OR 4)	ISW(2) = 4
DISCRETE RECEPTOR SYSTEM (RECTANGULAR=1,POLAR=2)	ISW(3) = 1
TERRAIN ELEVATIONS ARE READ (YES=1,NO=0)	ISW(4) = 0
CALCULATIONS ARE WRITTEN TO TAPE (YES=1,NO=0)	ISW(5) = 0
LIST ALL INPUT DATA (NO=0,YES=1,MET DATA ALSO=2)	ISW(6) = 1
COMPUTE AVERAGE CONCENTRATION (OR TOTAL DEPOSITION) WITH THE FOLLOWING TIME PERIODS:	
HOURLY (YES=1,NO=0)	ISW(7) = 0
2-HOUR (YES=1,NO=0)	ISW(8) = 0
3-HOUR (YES=1,NO=0)	ISW(9) = 0
4-HOUR (YES=1,NO=0)	ISW(10) = 0
6-HOUR (YES=1,NO=0)	ISW(11) = 0
8-HOUR (YES=1,NO=0)	ISW(12) = 0
12-HOUR (YES=1,NO=0)	ISW(13) = 0
24-HOUR (YES=1,NO=0)	ISW(14) = 1
PRINT 'N'-DAY TABLE(S) (YES=1,NO=0)	ISW(15) = 1
PRINT THE FOLLOWING TYPES OF TABLES WHOSE TIME PERIODS ARE SPECIFIED BY ISW(7) THROUGH ISW(14):	
DAILY TABLES (YES=1,NO=0)	ISW(16) = 0
HIGHEST & SECOND HIGHEST TABLES (YES=1,NO=0)	ISW(17) = 1
MAXIMUM 50 TABLES (YES=1,NO=0)	ISW(18) = 1
METEOROLOGICAL DATA INPUT METHOD (PRE-PROCESSED=1,CARD=2)	ISW(19) = 2
RURAL-URBAN OPTION (RU.=0,UR. MODE 1=1,UR. MODE 2=2,UR. MODE 3=3)	ISW(20) = 0
WIND PROFILE EXPONENT VALUES (DEFAULTS=1,USER ENTERS=2,3)	ISW(21) = 1
VERTICAL POT. TEMP. GRADIENT VALUES (DEFAULTS=1,USER ENTERS=2,3)	ISW(22) = 1
SCALE EMISSION RATES FOR ALL SOURCES (NO=0,YES>0)	ISW(23) = 0
PROGRAM CALCULATES FINAL PLUME RISE ONLY (YES=1,NO=2)	ISW(24) = 1
PROGRAM ADJUSTS ALL STACK HEIGHTS FOR DOWNWASH (YES=2,NO=1)	ISW(25) = 2
PROGRAM USES BUOYANCY INDUCED DISPERSION (YES=1,NO=2)	ISW(26) = 2
CONCENTRATIONS DURING CALM PERIODS SET = 0 (YES=1,NO=2)	ISW(27) = 2
REG. DEFAULT OPTION CHOSEN (YES=1,NO=2)	ISW(28) = 2
TYPE OF POLLUTANT TO BE MODELLED (1=SO2,2=OTHER)	ISW(29) = 2
DEBUG OPTION CHOSEN (YES=1,NO=2)	ISW(30) = 2
ABOVE GROUND (FLAGPOLE) RECEPTORS USED (YES=1,NO=0)	ISW(31) = 0
NUMBER OF INPUT SOURCES	NSOURC = 6
NUMBER OF SOURCE GROUPS (=0,ALL SOURCES)	NGROUP = 4
TIME PERIOD INTERVAL TO BE PRINTED (=0,ALL INTERVALS)	IPERD = 0
NUMBER OF X (RANGE) GRID VALUES	NXPNTS = 5
NUMBER OF Y (THETA) GRID VALUES	NYPNTS = 36
NUMBER OF DISCRETE RECEPTORS	NXWYPT = 0
NUMBER OF HOURS PER DAY IN METEOROLOGICAL DATA	NHOURS = 24
NUMBER OF DAYS OF METEOROLOGICAL DATA	NDAYS = 365
SOURCE EMISSION RATE UNITS CONVERSION FACTOR	TK =.10000E+07
HEIGHT ABOVE GROUND AT WHICH WIND SPEED WAS MEASURED	ZR = 6.10 METERS
LOGICAL UNIT NUMBER OF METEOROLOGICAL DATA	IMET = 5
ALLOCATED DATA STORAGE	LIMIT = 43500 WORDS
REQUIRED DATA STORAGE FOR THIS PROBLEM RUN	MIMIT = 7247 WORDS

Table G.1 (continued)

NUMBER OF SOURCE NUMBERS REQUIRED TO DEFINE SOURCE GROUPS ***
(NSOGRP)

2, 2, 3, 3,

*** SOURCE NUMBERS DEFINING SOURCE GROUPS ***
(IDSOR)

1, -3, 2, -4, 1, 3, 5, 3, 5, 6,

*** UPPER BOUND OF FIRST THROUGH FIFTH WIND SPEED CATEGORIES ***
(METERS/SEC)

1.54, 3.09, 5.14, 8.23, 10.80,

*** WIND PROFILE EXPONENTS ***

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
B	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01	.70000E-01
C	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00	.10000E+00
D	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00	.15000E+00
E	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00	.35000E+00
F	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00	.55000E+00

*** VERTICAL POTENTIAL TEMPERATURE GRADIENTS ***
(DEGREES KELVIN PER METER)

STABILITY CATEGORY	WIND SPEED CATEGORY 1	2	3	4	5	6
A	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
B	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
C	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
D	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00	.00000E+00
E	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01	.20000E-01
F	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01	.35000E-01

*** RANGES OF POLAR GRID SYSTEM ***
(METERS)

750.0, 1000.0, 1250.0, 1500.0, 2000.0,

*** RADIAL ANGLES OF POLAR GRID SYSTEM ***
(DEGREES)

10.0,	20.0,	30.0,	40.0,	50.0,	60.0,	70.0,	80.0,	90.0,	100.0,
110.0,	120.0,	130.0,	140.0,	150.0,	160.0,	170.0,	180.0,	190.0,	200.0,
210.0,	220.0,	230.0,	240.0,	250.0,	260.0,	270.0,	280.0,	290.0,	300.0,
310.0,	320.0,	330.0,	340.0,	350.0,	360.0,				

Table G.1 (Continued)

*** Source Data ***

Source number	TYPE	WAKE	Number part. cats.	Emission rate type=0,1 (grams/sec) type=2 (grams/sec) *Per meter**2	X (meters)	Y (meters)	Base elev. (meters)	Height (meters)	Temp. type=0 (deg.K); vert.dim type=1 (meters)	Exit vel. type=0 (m/sec); horz.dim type=1,2 (meters)	Diameter type=0 (meters)	Bldg. height type=0 (meters)	Bldg. length type=0 (meters)	Bldg. width type=0 (meters)
1	0	0	0	.72000E-02	-175.1	-55.7	.0	15.40	1.00	14.67	.37	14.60	18.30	79.20
2	0	0	0	.17300E-01	-256.7	-163.2	.0	15.70	1.00	12.97	.52	16.50	64.00	71.60
3	0	0	0	.31600E-01	-32.6	175.0	.0	.10	1.00	.00	.00	5.00	10.00	10.00
4	0	0	0	.72000E-03	-175.1	-55.7	.0	15.40	1.00	14.67	.37	14.60	18.30	79.20
5	0	0	0	.19000E-01	-256.7	-163.2	.0	15.70	1.00	12.97	.52	16.50	64.00	71.60
6	0	0	0	.14400E-02	-175.1	-55.7	.0	15.40	1.00	14.67	.37	14.60	18.30	79.20

— 0441

000465

Table G.2. U.S. EPA Industrial Source Complex Short-Term (ISCST) source input data (except emission rates) used to model Feed Materials Production Center (FMPC) air pollutant emission sources

*** Source Data ***

Emission point	X (meters)	Y (meters)	Base elev. (meters)	Height (meters)	Temp. type=0 (deg.k); vert.dim type=1 (meters)	Exit vel. type=0 (m/sec); horz.dim type=1,2 (meters)	Diameter type=0 (meters)	Bldg. height type=0 (meters)	Bldg. length type=0 (meters)	Bldg. width type=0 (meters)
PLANTS 2 & 3	-179.1	44.8	.0	21.90	1.00	13.76	.48	20.40	115.80	18.30
PLANT 6	218.9	-9.9	.0	11.90	1.00	17.46	.88	11.90	152.40	61.00
PLANT 8	-175.1	-55.7	.0	15.40	1.00	14.67	.37	14.60	18.30	79.20
PLANT 9	189.1	183.1	.0	13.40	1.00	16.04	.88	12.20	91.40	68.60
PILOT PLANT	-256.7	-163.2	.0	15.70	1.00	12.97	.52	16.50	64.00	71.60
BOILER PLANT	-15.9	334.2	.0	33.20	483.00	11.13	1.63	25.90	51.70	19.90
TANK FARM	-32.6	175.0	.0	.10	1.00	.00	.00	.00	.00	.00

E-0441

000459

G.2 METEOROLOGICAL INPUT DATA FOR RADIOLOGICAL AND NON-RADIOLOGICAL DISPERSION MODELING

G.2.1 Selection of Meteorological Input Data

For both the radiological and non-radiological air pollutants, atmospheric dispersion models were integral to the process of predicting the impacts of the alternatives considered in the Environmental Impact Statement (EIS). However, the type of meteorological input data required for the non-radiological assessment differed from that required for the radiological assessment. The model used for non-radiological emissions (ISCST) uses hourly, sequential meteorological data, in this case, for a whole year (8760 h). The model used for radiological emissions (AIRDOS-EPA) uses an annual frequency distribution of wind speed, wind direction, and atmospheric stability. Because of these differing requirements, the choices of the appropriate meteorological input data for the radiological and non-radiological assessments were made independently of one another.

For the radiological assessment, on-site data from the FMPC, which were about 86% complete for a one-year period, were considered most appropriate. It was felt that the annual frequency distribution of the meteorological parameters would not change significantly when using 86% of the data as compared to a 100% complete data set.

The ISCST model, used for the non-radiological air quality assessment, requires that there be no gaps in the hourly data. Because of the amount of missing meteorological data (14%) at the FMPC site, it was determined that the use of interpolation or some other method to fill in the missing data was not appropriate. Therefore, a full year of meteorological data from the Greater Cincinnati Airport, the nearest National Weather Service reporting station, was used for the non-radiological air quality impact assessment.

G.2.2 Comparison of FMPC and Greater Cincinnati Airport Wind Data

Because terrain around the Greater Cincinnati Airport is different from that around the FMPC site, there is a possibility of somewhat different air quality modeling results when using Greater Cincinnati Airport winds instead of on-site winds. The primary difference between the distribution of winds measured at the Greater Cincinnati Airport and the distribution of winds measured at FMPC is in the wind directions. This is demonstrated by the wind roses for the Greater Cincinnati Airport and FMPC, which are shown in Figs. G.1 and G.2, respectively. Wind speeds are comparable for the two data sets, which were measured at nearly the same height above ground-level (10 m at FMPC and 6.1 m at the Greater Cincinnati Airport).

The use of off-site meteorological data with a wind direction distribution different from that observed at FMPC was compensated for in the dispersion modeling analysis of non-radiological emissions. The polar receptor grid shown in Fig. G.3 was used for the concentration calculations. Many of the receptors on the inner rings fell within the plant property. However, the maximum predicted concentration at any receptor was listed in the summary of maximum predicted concentrations in Chapt. 4, regardless of whether

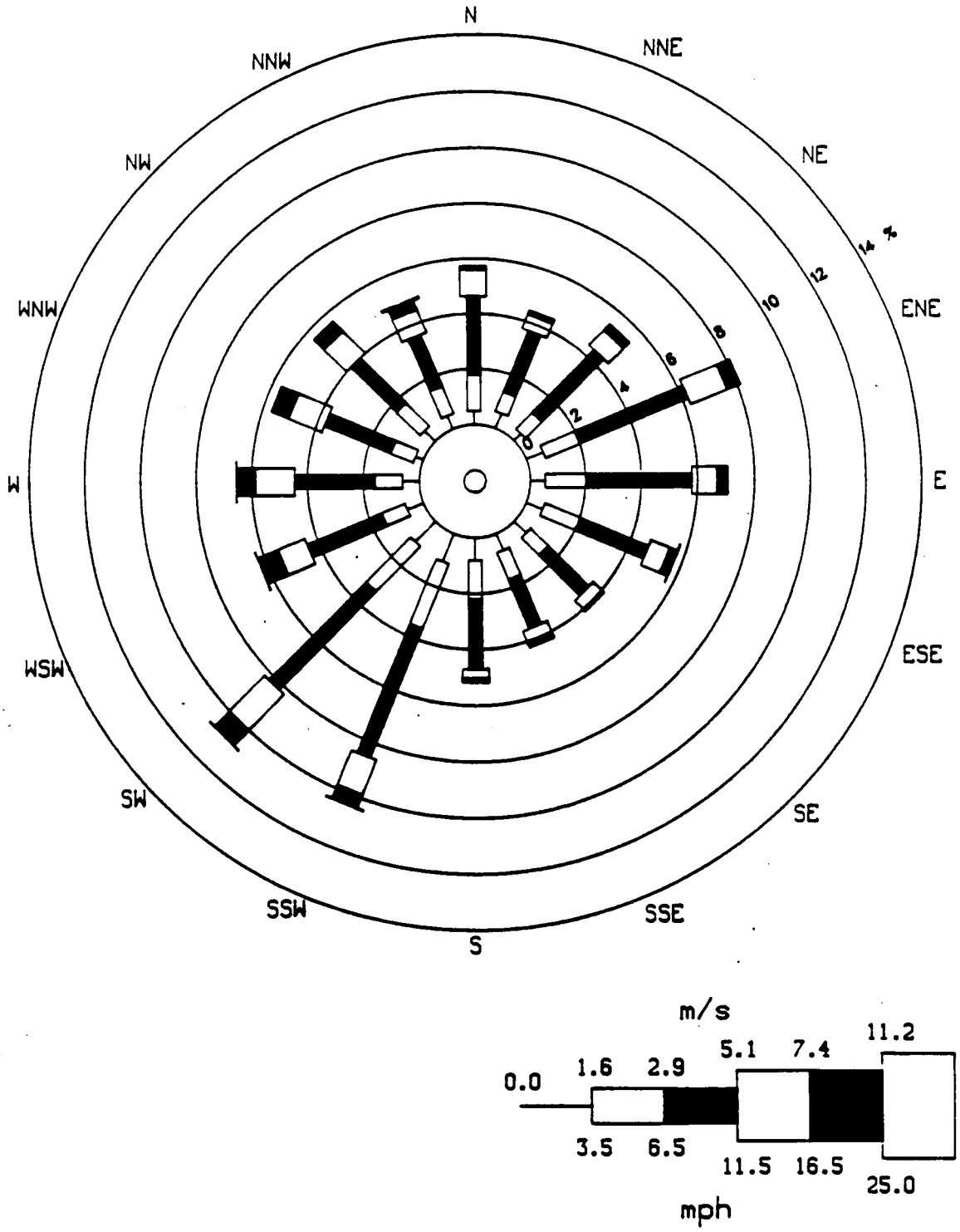


Fig. G.1. Greater Cincinnati Airport wind rose for 6.1-m (20-ft) level, August 5, 1986–April 22, 1987.

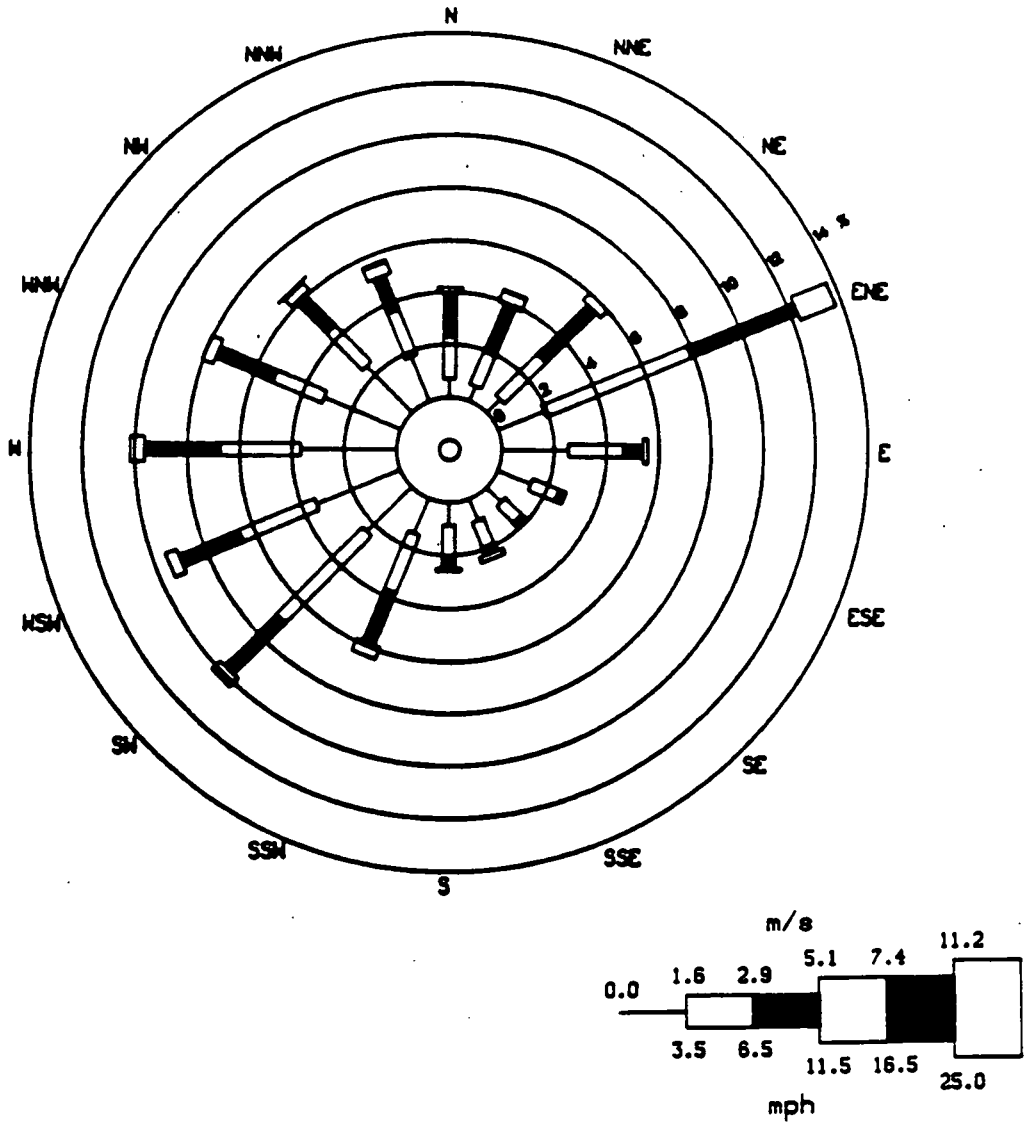


Fig. G.2. Fernald Feed Materials Production Center wind rose for 10-m level, August 5, 1986–April 22, 1987.

ORNL-DWG 88-12519

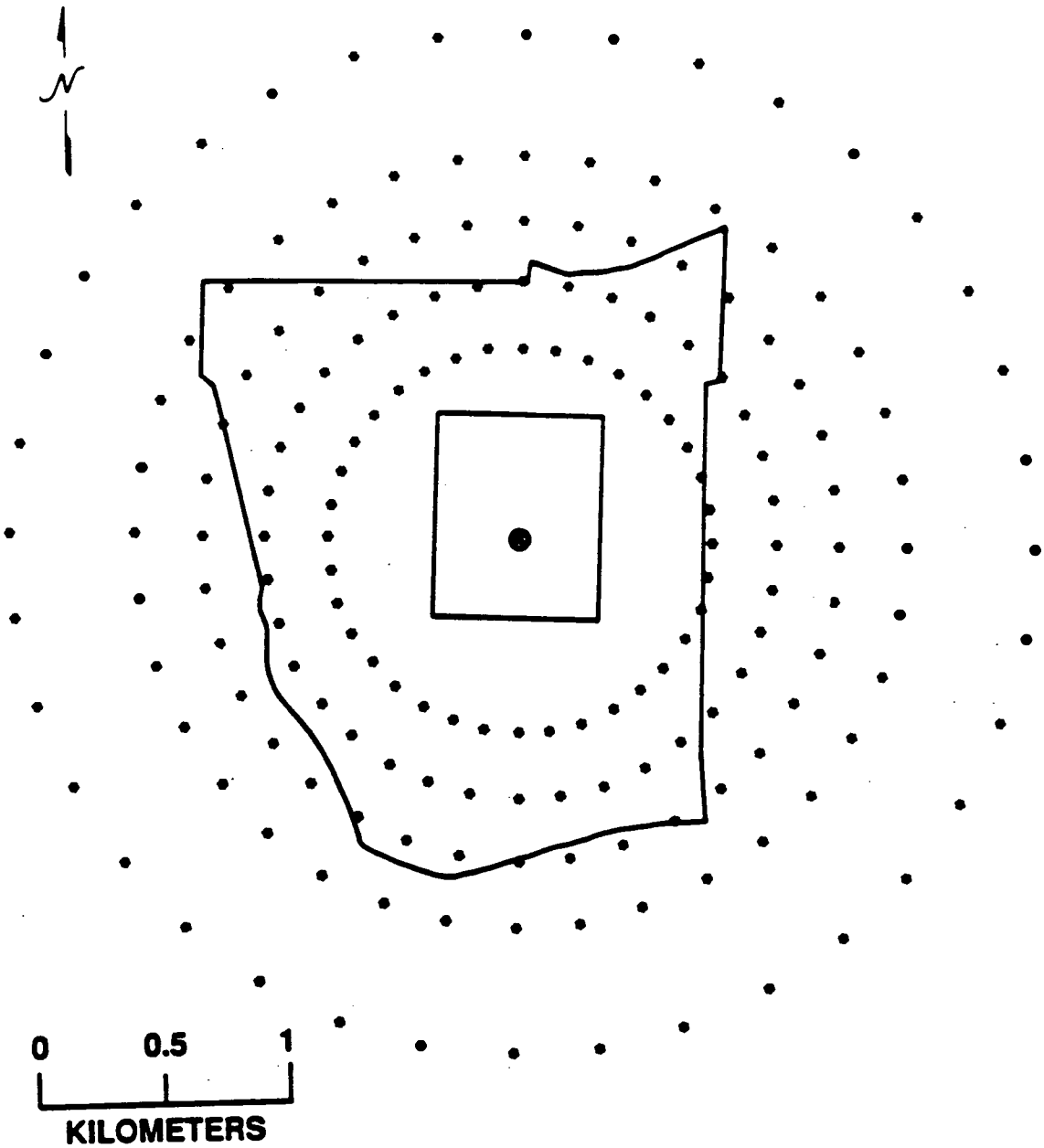


Fig. G.3. Polar receptor grid for atmospheric dispersion calculations. The outer boundary is the Feed Materials Production Center plant property boundary. The inner boundary contains the production area. The circled "X" indicates the centroid of the polar receptor grid, which was centered on the Plant 4 process building.

the receptor was on or off the FMPC property. This was done in order to compensate for using off-site winds. For example, with the use of on-site winds, one might predict the maximum concentration at a point on the inner receptor ring, due east of the plant complex (see Fig. G.3). This would be just off the plant property and would constitute an impact on ambient air quality. On the other hand, the use of off-site (Greater Cincinnati Airport) winds might predict the maximum concentration at a point on the inner receptor ring which is inside the FMPC property boundary. Normally, such a prediction would be discounted, since air over the plant property is not considered "ambient" air. However, for the analysis of non-radiological air quality impacts, such predictions were not discounted, in order to compensate for the use of off-site wind data for model input.

G.3 DETAILED CLIMATIC DATA SUMMARY

Table G.3 summarizes historical climatological data collected at the Greater Cincinnati Airport, Boone County, Kentucky.

G.4 AIR QUALITY IMPACTS OF MAJOR CHEMICAL SPILLS

G.4.1 Selection of Scenarios and Dispersion Model

Given the amounts and relative toxicity of various chemicals used at FMPC, anhydrous hydrogen fluoride (AHF) and anhydrous ammonia (NH_3) are considered to have the greatest potential for off-site health impacts in the case of an accidental spill. A safety analysis report for the FMPC tank farm (Davis et al. 1983) examined possible release scenarios and risks for AHF, NH_3, and other chemicals stored at the tank farm. Based on that analysis, it was postulated that the maximum potential spill amounts and rates would be 95,000 lbs of HF over 17 min and 45,000 lb of NH_3 over less than a minute.

The Air Force Toxic Chemical Dispersion Model (AFTOX) was chosen to assess maximum potential downwind concentrations of HF and NH_3 for the major spills postulated by Davis et al. (1983). AFTOX is a simple Gaussian puff model that was modified by the Air Force Geophysics Laboratory (Kunkel 1987) from a model called SPILLS (Fleischer 1980). AFTOX does not account for spatially or temporally varying winds, chemical reactions within the plume, or deposition effects. The AFTOX model is capable of simulating continuous or instantaneous releases of liquid or gas. For a release of finite duration, AFTOX simulates a plume segment with a series of overlapping puffs.

Rather than directly using the six discrete Pasquill stability categories (A-F) that are traditionally a part of atmospheric dispersion models, AFTOX calculates a continuous stability parameter ranging from 0.5 to 6. This parameter is then used to interpolate between the discrete Pasquill-Gifford dispersion curves in order to calculate the distribution of materials within each puff. This alleviates the often sharp changes in predicted concentration when moving from one Pasquill stability category to the next. AFTOX computes the stability parameter based either on wind speed and solar insolation or on the standard deviation of horizontal wind direction. For the simulation of HF and NH_3 dispersion, the former option was used.

Month	Temperatures °F: Normal: Daily maximum	Daily minimum	Monthly	Extremes: Record highest	Year	Record lowest	Year	Normal degree days base 65 °F: Heating	Cooling	Precipitation in inches: Water equivalent: Normal	Maximum monthly	Year	Minimum monthly	Year	Maximum in 24 hrs.	Year	Snow, ice pellets: Maximum monthly	Year	Maximum in 24 hrs.	Year
Jan				16		10					20		30		30		30		30	
Feb	39.7	22.4	31.1	69	1967	-23	1977	1081	0	3.24	9.45	1950	0.75	1967	4.33	1950	30.3	1977	8.0	1977
Mar	43.7	25.0	33.3	73	1972	-10	1965	888	0	3.04	6.72	1955	0.61	1950	2.81	1950	13.3	1971	9.3	1966
Apr	51.0	31.0	41.7	82	1977	7	1977	722	0	4.09	12.16	1964	1.14	1960	3.21	1964	13.0	1966	9.0	1966
May	65.0	42.7	53.9	89	1976	17	1964	241	0	3.04	7.19	1970	1.04	1971	2.72	1950	9.7	1977	3.6	1977
Jun	74.4	51.9	63.2	93	1967	27	1965	108	82	3.76	9.40	1968	1.13	1964	3.71	1964	7	1964	7	1964
Jul	85.2	61.0	73.1	97	1971	39	1972	9	223	3.01	7.86	1977	0.95	1965	3.40	1974	0.0		0.0	
Aug	80.8	60.0	70.4	100	1970	47	1965	0	229	3.12	8.36	1972	1.10	1971	3.47	1953	0.0		0.0	
Sep	73.8	53.0	63.4	102	1962	43	1965	0	204	2.62	6.10	1954	0.01	1955	3.12	1957	0.0		0.0	
Oct	70.7	39.9	57.0	98	1964	25	1965	44	120	2.53	6.23	1950	0.10	1963	3.30	1950	0.0		0.0	
Nov	60.3	43.0	50.0	88	1965	16	1962	271	17	3.15	4.39	1973	0.39	1963	2.47	1973	1.7	1962	1.7	1962
Dec	53.2	34.3	43.8	80	1972	1	1976	656	0	3.00	6.26	1972	0.49	1949	3.36	1948	12.1	1960	9.0	1960
Ann	62.0	39.3	53.7	78	1930	-11	1963	970	0	3.04	6.17	1951	0.01	1930	2.06	1948	12.9	1960	6.0	1974
Yr	64.4	43.5	54.0	102	AUG 1962	-29	JAN 1977	4070	1080	39.04	12.16	MAR 1964	0.10	SEP 1963	3.21	MAR 1964	30.3	JAN 1977	9.0	MAR 1960

Month	Relative humidity pct. (Local time): Hour 01	Hour 07	Hour 13	Hour 19	Wind: Mean speed m.p.h.	Prevailing direction	Fastest mile: Speed m.p.h.	Direction	Year	Pct. of possible sunshine	Mean sky cover, tenths, sunrise to sunset	Mean number of days: Sunrise to sunset: Clear	Partly cloudy	Cloudy	Precipitation .01 inch or more	Snow, ice pellets 1.0 inch or more	Thunderstorms	Heavy fog, visibility ¼ mile or less	Temperatures °F: Max. 90° and above	32° and below	Min. 32° and below	0° and below	Average station pressure mb. Elev. 877 ft. m.s.l.
Jan	15	15	15	15	30	16	14	14			24	24	24	24	30	30	30	14	15	15	15	15	*
Feb	73	70	67	69	10.7	SSW	46	20	1976		7.3	5	6	20	12	2	1	3	0	12	24	3	987.0
Mar	73	74	62	64	10.7	SSW	40	29	1967		7.5	5	6	17	11	2	2	2	0	7	23	2	983.2
Apr	73	77	60	61	11.2	SSW	44	23	1977		7.4	5	7	19	13	1	3	2	0	1	14	0	983.4
May	70	74	53	55	10.0	SSW	40	23	1970		7.0	5	8	17	12	0	4	1	0	0	5	0	983.1
Jun	76	79	53	56	8.8	SSW	35	31	1972		6.7	6	10	15	12	0	6	1	1	0	4	0	983.1
Jul	80	82	55	59	7.9	SSW	40	24	1971		6.2	7	10	13	11	0	7	1	3	0	0	0	984.0
Aug	85	85	57	61	7.1	SSW	35	32	1966		6.0	7	12	12	10	0	5	2	3	0	0	0	985.0
Sep	83	80	57	63	6.7	SSW	32	07	1972		5.7	8	13	10	9	0	3	3	3	0	0	0	987.1
Oct	83	80	59	60	7.4	SSW	32	24	1972		5.7	9	9	12	8	0	4	4	2	0	0	0	986.6
Nov	77	83	55	64	8.0	SSW	35	27	1967		5.5	11	8	11	9	0	3	3	0	0	3	0	980.8
Dec	76	79	63	60	9.6	SSW	35	20	1966		7.3	6	6	19	11	1	1	2	0	1	14	0	986.7
Ann	77	79	59	72	10.2	SSW	40	21	1972		7.0	5	6	20	12	1	4	3	0	4	22	1	983.6
Yr	77	81	59	63	9.1	SSW	40	20	JAN 1976		6.4	79	100	186	129	7	44	26	21	27	107	6	983.6

(a) Length of record (years).
* Less than one half.
T Trace.
DATE OF AN EXTREME - The most recent in cases of multiple occurrence.
WIND DIRECTION - Numerals indicate tens of degrees clockwise from true north. 00 indicates calm.

Table G.3. Summary of climatological data recorded at the Cincinnati Airport, Boone County, Kentucky (1947-1977).

000472

E-0441

G.4.2 HF Analysis

AHF, which has a boiling point of 67°F, is stored as a liquid at the FMPC tank farm. In the event of a spill, most of the HF would be emitted as a liquid. Depending on the temperature of the liquid as it is spilled and on ground and air temperatures, a portion of the HF could vaporize almost immediately upon spilling. If ambient ground and air temperatures are substantially above 67°F, the liquid portion of HF would tend to boil away rapidly. If the temperatures of air and ground were below 67°F, the HF would vaporize much more slowly. These unknowns and other aspects unique to the particular accident make the characteristics (emission rate and time of release) of an HF spill difficult to predict.

In order to obtain worst-case estimates of ambient air concentrations of HF, the maximum spill postulated by Davis et al. (1983) was assumed to evaporate as quickly as it spilled (95,000 lb in 17 min). Table G.4 presents the AFTOX model results for two sets of meteorological conditions for this accident scenario. The light wind case corresponds to Pasquill stability category "F," while the moderate wind case corresponds approximately to Pasquill stability category "D."

According to data summarized by Davis et al. (1983), exposure to an HF concentration over 700 mg/m^3 for a period of 2-10 min would be lethal. AFTOX indicated that this exposure would be exceeded up to roughly 1 km downwind (slightly beyond the nearest plant boundary) under the neutral stability, moderate windspeed condition. Under the very stable, light wind condition, this level of exposure could be exceeded several kilometers downwind, possibly endangering nearby communities, depending on the wind direction.

G.4.3 NH_3 Analysis

Anhydrous ammonia boils at -28°F. Even a relatively large spill would tend to vaporize very quickly. Much of the heat of vaporization would be obtained from the ambient air as it comes in contact with the liquid. Thus, an NH_3 spill would produce a cold-cloud mixture of ambient air and NH_3 vapor. The cold cloud would behave as a heavy gas, tending to remain near the ground and dispersing rather slowly until the cloud was diluted and its temperature approached the ambient temperature.

The AFTOX model does not account for heavy gas dispersion effects. Thus, it will likely overpredict the rate of dispersion and underpredict near-field concentrations from a cold-cloud situation. However, the assumptions of instantaneous release and evaporation provide some compensation for this underprediction. Also, the AFTOX model does not account for deposition or chemical conversion, which would reduce plume concentrations, particularly at greater distances downwind.

The AFTOX model NH_3 predictions for a rapid release of 45,000 lbs of NH_3 are shown in Table G.5 for two sets of meteorological conditions. The National Institute of Occupational Safety and Health (NIOSH 1985) considers 500 ppm (approximately 386 mg/m^3) "immediately dangerous to life and health," which is defined as the maximum level from which one could escape within

Table G.4. Maximum 10-min HF concentrations (mg/m^3) predicted by Air Force Toxic Chemical Dispersion Model (AFTOX)

Distance (km)	Meteorological conditions: Neutral stability and 5 m/s windspeed	Meteorological conditions: Very stable and 1 m/s windspeed
1.0	699	9546
2.0	266	3035
3.0	150	1886
4.0	112	1197
5.0	90	831
7.0	64	460
10.0	47	233
15.0	33	106
20.0	25	62

Table G.5. Maximum 1-min NH_3 concentrations (mg/m^3) predicted by Air Force Toxic Chemical Dispersion Model (AFTOX)

	Meteorological conditions	
Distance (km)	Neutral stability and 5 m/s windspeed	Very stable and 1 m/s windspeed
1.0	15,000	148,000
2.0	3,280	35,700
3.0	1,475	16,850
4.0	843	10,130
5.0	548	5,990
7.0	306	3,290
10.0	158	1,660
15.0	80	676
20.0	46	440

30 min without any escape-imparing symptoms or any irreversible health effects. AFTOX indicated that this level could be exceeded briefly (~1 min) at distances up to approximately 22 km downwind under the very stable, light wind condition and up to approximately 6 km downwind under the neutral, moderate windspeed condition. However, a 30-min average concentration above 500 ppm would be exceeded at distances up to approximately 12 km under the stable, light wind condition. Davis et al. (1983) summarize health effects data for NH_3; the data indicate that concentrations above 3500 mg/m^3 are fatal within minutes. The AFTOX model predicted that this concentration could be exceeded up to approximately 7 km downwind under the stable, light wind condition and up to approximately 2 km for the neutral stability, moderate windspeed condition.

G.5 REFERENCES

Briggs, G. A. 1975. "Plume Rise Predictions," in Lectures on Air Pollution and Environmental Impact Analysis, American Meteorological Society, Boston, Mass.

Davis, T. C., et al. 1983. Final Safety Analysis Report for the FMPC Tank Farm (NLCO-1191 Special), Westinghouse Materials Company of Ohio, Feed Materials Production Center, Fernald, Ohio.

EPA (U.S. Environmental Protection Agency) 1986. Guideline on Air Quality Models (revised EPA publication No. EPA-450/2-78-027R), U.S. Environmental Protection Agency, Research Triangle Park, N.C.

EPA (U.S. Environmental Protection Agency) 1987. Industrial Source Complex (ISC) Dispersion Model User's Guide, 2d ed. (revised), Vols. 1 and 2, EPA Publication No. EPA-450/4-88-002a and 002b, U.S. Environmental Protection Agency, Research Triangle Park, N.C.

EPA (U.S. Environmental Protection Agency) 1988. User's Network for Applied Modeling of Air Pollution (UNAMAP), version 6 (revised 1/88), [computer programs on tape], National Technical Information Service, Springfield, Va.

Fleischer, M. T. 1980. SPILLS--An Evaporation/Air Dispersion Model for Chemical Spills on Land, Shell Development Company, PB 83109470.

Huber, A. H., and W. H. Snyder 1976. "Building Wake Effects on Short Stack Effluents", Preprint Volume for the Third Symposium on Atmospheric Diffusion and Air Quality, American Meteorological Society, Boston, Mass.

Huber, A. H. 1977. "Incorporating Building/Terrain Wake Effects on Stack Effluents," Preprint Volume for the Joint Conference on Applications of Air Pollution Meteorology, American Meteorological Society, Boston, Mass.

Kunkel, B. A. 1987. "User's Guide for the Air Force Toxic Chemical Dispersion Model (AFTOX)," AFGL-TR-88-0009, Environmental Research Papers, No. 992, Air Force Geophysics Laboratory, Atmospheric Structure Branch, Hanscom AFB, Mass.

National Institute of Occupational Safety and Health (NIOSH) 1985. Pocket Guide to Chemical Hazards, DHEW (NIOSH) Publication No. 78-210, U.S. Department of Health and Human Services.

Scire, J. S., and L. L. Schulman 1980. "Modeling Plume Rise from Low-Level Buoyant Line and Point Sources," pp. 133-39 in Proceedings Second Joint Conference on Applications of Air Pollution Meteorology, New Orleans, March 24-28, 1980.

Turner, D. B. 1970. Workbook of Atmospheric Dispersion Estimates, Publications No. AP-26 (revised), Office of Air Programs, Environmental Protection Agency.

APPENDIX H

MAJOR RENOVATION PROJECTS AFFECTING THE ENVIRONMENT

APPENDIX H. MAJOR RENOVATION PROJECTS AFFECTING THE ENVIRONMENT*

H.1 AIR EMISSION CONTROL PROJECTS

H.1.1 Introduction

To reduce airborne emissions and occupational-related exposure to as low as reasonably achievable levels, several distinct facility improvements and changes in plant ventilation operations are required at the Feed Materials Production Center (FMPC). To achieve these exposure levels, new process ventilation equipment will be installed in virtually every section of the plant. The new equipment will be state-of-the-art design and sized to maintain satisfactory cleanliness of the process and work area.

In most cases, the ventilation system capacity will be increased to serve equipment in a satisfactory manner. New ductwork, dust collectors, high-efficiency particulate air filters and fans will be provided to extend the life of the ventilation system approximately 30 years. If space is not available in the existing buildings, new filter buildings located next to the process buildings will house the new equipment.

Instrumentation will be installed to monitor stack emissions downstream from of containment points and in areas where operators are potentially subject to exposure.

A safe working environment for in-plant workers will be maintained and will include comfortable temperatures and atmospheric cleanliness in the work zones. Dust collectors and filter housings employing the bag-in/bag-out method of maintenance will be used to separate the worker from direct contact with contaminated materials to lessen worker exposure to radiation and minimize spillage of contaminated dust. Also, whenever possible and practical, the dust collector, filter housing, etc., will be located in a segregated building area or, if necessary, in a separate building to provide additional control of the contaminated material.

Atmospheric cleanliness, as provided by workstation enclosures and supporting equipment, will provide more efficient containment of airborne contamination. Routine cleaning of surfaces (floors, walls, equipment, etc.) will also reduce the amount of loose airborne contaminant particles. In addition to reducing worker exposure, this cleaning will also minimize releases to the environment through roof exhausts, open doors, exfiltration, and traffic-tracking.

---

*Compiled from Brettschneider, D. J., January 18, 1989. Westinghouse Materials Company of Ohio, Cincinnati, letter [WMCO:SR(WR):89-032(EISTF-75)] to R. E. Saylor, Oak Ridge National Laboratory, Oak Ridge, Tenn.

Several projects have been scheduled to reduce exposure to FMPC employees and the public and releases to the environment. These projects include the following:

- Plant 8 Scrubbers
- NO_x Destructors
- Derby Breakout
- Titan Milling System
- Nitric Acid Recovery
- Packaging System Stations
- Tank Farm.

H.1.2 Plant 8 Scrubbers

There are several operating furnaces in Plant 8 whose off-gases are handled by unmonitored wet scrubber systems. These furnaces include the Rotary Kiln (the Primary Calciner), Oxidation Furnaces 1 and 2, and the Box Furnace. These systems currently use process water as the scrubbing liquid. Previously, the systems used a solution of sodium hydroxide (NaOH) as the scrubbing fluid; this is no longer done because it interfered with the settling of suspended solids in the hot well.

Installation of process instrumentation on the Plant 8 wet scrubbers has been scheduled. Because these instruments will enable the process parameters of the scrubbers to be monitored, it will be possible to ensure that the process conditions match those for which the system was designed. Currently, the instrumentation is in place on the Rotary Kiln scrubber. Installation of instruments on other Plant 8 scrubbers is scheduled for 1989.

Two projects in progress will completely replace three of the four functioning Plant 8 furnaces as well as Oxidation Furnace 2. Only the Primary Calciner will remain unmodified.

A new Rotary Kiln is being built in Plant 8 to replace the existing kiln. Also, a new rotary furnace is being built to replace Oxidation Furnaces 1 and 2 and the Box Furnace. The new furnaces will each employ a three-stage off-gas treatment system. Two ejector-venturi scrubbers, similar in design and operation to the existing scrubber system, will operate in series. These scrubbers will be followed by a packed tower scrubber. A permanently mounted isokinetic stack monitor will be installed to monitor stack discharges.

H.1.3 NO_x Destructors

Plant 6 NO_x Destructor

The release of NO_x gases currently exceeds allowable limits. The water scrubber on the chip pickling process is ineffective in removing the NO_x gases from the exhaust gas stream, and the scrap currently has no scrubbing system on its exhaust air stream. The processes exhaust visible gas streams to the atmosphere. This subproject will remove the NO_x gases from both exhaust air streams to below the concentration level at which the NO_x is invisible and

considered a safe level for release to the atmosphere. This scrubbing system shall meet current Ohio Environmental Protection Agency (OEPA) standards.

The NO_x destructors subproject will provide for the installation of NO_x scrubbing systems on the scrap remelt and chip pickling processes to reduce NO_x fumes to an acceptable level. Each process will be equipped with a NO_x system which consists of two polypropylene-packed towers made up of three stages, three recirculation tanks which recirculate a countercurrent stream of chemicals through the towers, a caustic storage tank used to adjust the pH in the recirculation tanks, and one proprietary chemical storage tank that automatically feeds the recirculation tanks. The NO_x scrubbing systems will remove the 10,000-ppm NO_x gases from the exhaust air streams to a level below 100 ppm. The process is based on a reduction reaction that reduces the NO_x gases to nitrogen (N_2). The invisible level for NO_x release is required to meet Ohio EPA standards.

Plant 9 NO_x Destructor

The Scrap Processing Facilities in Plant 9 include nitric acid and water rinse tanks which exhaust nitrous oxide fumes from the work area, often creating a visible plume. The noxious, corrosive fumes exceed EPA guidelines. A NO_x destructor system will be provided to capture and convert NO_x from two existing pickling processes. At times, these gases contain high concentrations of NO_x that are currently being vented directly to the atmosphere.

Installation of the NO_x destructor will include new push-pull hoods and ductwork to minimize exposure to operating personnel. Fumes in the workplace as well as releases to the environment will be reduced to a minimum. An induced draft fan, provided with the NO_x system, will draw NO_x-laden air from a push-pull vent hood at the acid and rinse tanks. After the vent air has passed through the NO_x destructor towers, the air can be discharged to the atmosphere.

H.1.4 Derby Breakout

The existing derby breakouts are original pieces of equipment that have been subjected to 30 years of intense use. The jaw crushers which were originally specified for the breakouts are undersized for current requirements. Thus, a sledge hammer must be used to break the slag into acceptable sizes to pass through the small jaw-crusher opening. This hammering is done manually, which exposes the operator to a health hazard and reduces throughput of each breakout.

The Derby Breakout Project will provide for the acquisition of new pot-handling and derby-handling equipment as well as the renovation of existing machinery. The proposed material-handling equipment is state of the art and uses robotics and process controllers to increase productivity and decrease labor.

The east breakout contains a grizzly conveyor which empties into a scalping grate. At the west breakout, the pot contents are jolted directly

into the scalping grate. The manipulation and cleaning of the derby in the scalping grate is hazardous. Approximately 40% of the accidents which occur in Plant 5 occur at the derby breakout. These accidents are primarily pinched and broken fingers and hands caused by the manual handling of derbies and slag. The new derby-slag separator will reduce these accidents by separating the derby from the slag before delivering it to the operator.

H.1.5 Titan Milling System

The existing Titan Milling System is located in Plant 1 and is used to process magnesium fluoride slag into liner material to be used in the uranium reduction process. The Titan Mill was installed in the plant as original equipment and has been subjected to over 30 years of heavy use. The primary purpose of this project is to replace the Titan Mill and all ancillary equipment. This replacement will allow continued reuse of the magnesium fluoride slag in the reduction operations. This material is a cornerstone of the reduction process.

Work on this project consists of the replacement of the Titan Mill and its hoppers, dust collection systems, explosion suppression systems, drumming station equipment, associated bucket conveyors, screw conveyors, and ancillary ductwork. The feed system consists of screw conveyors and bucket elevators which are high maintenance items because of the abrasive nature of the material. The replacement material-handling system will reduce the maintenance required to operate this system.

H.1.6 Nitric Acid Recovery

The existing Nitric Acid Recovery (NAR) facility receives the nitric acid fumes from the digestion operation in Plant 2 and the denitration operation in Plant 3. This facility uses a series of bubble cap columns and other equipment to recover the nitric acid fumes as dilute aqueous nitric acid by absorption into water. The acid recovery operation also reduces NO_x emissions. The existing facility does not adequately remove the nitric acid fumes from the off-gases of Plants 2 and 3, as required by current OEPA regulations.

The tail gases from the existing NAR system occasionally contain a substantial concentration of NO_x gas, causing visible plumes to leave the stack. The addition of the new tail-gas scrubber will ensure that only clean air is introduced to the environment. The proposed modification of the scrubbing system of the gulping and denitration areas will ensure efficient recovery of the nitric acid fumes from the vent gases.

H.1.7 Packaging System Stations

Green salt packaging stations are an integral part of operations in Plant 4. Processing material through these packaging stations assists in maintaining final green salt product specifications and in accounting of material. Existing equipment is obsolete, inflexible, and labor intensive. It needs upgrading to lower dust emissions and to improve safety and environmental quality.

This project will replace the existing obsolete packaging stations. The replacement will alleviate the following problems:

- Excessive dust emissions
- Excessive labor requirements
- Lack of material screening on Packaging Stations 2 and 3
- Lack of flexibility to process filled hoppers on Packaging Stations 2 and 3
- Inability to discharge UF_4 reactors by conveyor to Packaging Station 3.

H.1.8 Tank Farm

The existing tank farm facilities are 35 years old and are at or near the end of their useful lives. The Tank Farm is being upgraded to meet current industrial safety standards and to ensure the capability to safely supply chemicals essential to production needs.

The entire Tank Farm will be demolished and new facilities will be constructed. A phased-construction effort will allow demolition and construction to proceed without interrupting the Tank Farm's ability to receive, store and distribute chemicals required by FMPC processes. Instead of a one-unit storage facility, the new storage facility will be situated at three separate on-site locations.

H.2 ADVANCED WASTEWATER TREATMENT FACILITY

A large number of wastewater treatment improvements have been made at the FMPC. These improvements have brought wastewater into compliance with all regulatory requirements except for those for chromium and radionuclides. The Advanced Wastewater Treatment (AWWT) Facility is intended to correct these deficiencies. The U.S. Department of Energy (DOE) has committed to the construction of the AWWT Facility, but its design is in the preliminary stages.

Current wastewater discharges violate the National Pollution Discharge Elimination System (NPDES) limit for chromium, the DOE Derived Concentration Guides, and the proposed DOE Order 5400.3 sum-of-ratios limit for radionuclides. The AWWT Facility is intended to put wastewater discharges into compliance during full FMPC operations. Current wastewater treatment includes both primary and secondary treatment. The AWWT Facility is expected to use a combination of filtration, carbon adsorption, ion exchange, and reverse osmosis (Fig. H.1). The AWWT Facility will use best available technology economically achievable to treat all wastewater streams for chromium and radionuclides.

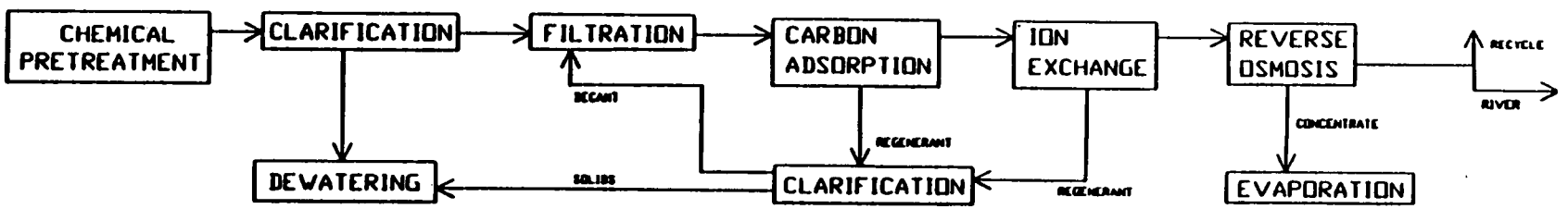


Fig. H.1. Advanced Wastewater Treatment Facility projected process flow treatment scheme.

000484

T-0441

H.2.1 Pretreatment

Proper pretreatment of the wastewater is essential for the protection of the downstream ion exchange or reverse osmosis system. Constituents that may interfere with the downstream processes will be targeted for removal. Pretreatment of the wastewaters will also provide for the partial removal of dissolved solids. Initial estimates of targeted components are carbonates, magnesium, and sulfates. Chemicals may be added to produce and coagulate precipitates of the targeted components.

The wastewaters will be filtered to remove any suspended solids that were originally contained in the wastewater or that were produced in the chemical pretreatment step. Suspended solids will tend to plug the downstream equipment. Although the purpose of filtration is to remove particulates, it can also remove a significant fraction of organics present in the suspended form.

H.2.2 Carbon Adsorption

Carbon adsorption will be used to remove residual organics (total coliforms and biochemical oxygen demand), and it will also remove other contaminants coordinated with organic complexes.

H.2.3 Ion Exchange

According to an FMPC stream analysis for radionuclides, uranium daughter and technetium appear to be the greatest sources of beta radiation, whereas uranium daughters are the major source of alpha, with radium being a minor source of alpha. Because of the complex nature of the wastewater being treated, a two-step ion exchange process involving softening and alkalization may be needed.

H.2.4 Reverse Osmosis

Reverse osmosis (RO) may also serve as the process to remove radionuclides or to provide a further reduction in total dissolved solids. Reverse osmosis uses a semipermeable membrane that is selective in that certain components of a solution can pass through it while others cannot. The direction of flow is determined by its chemical potential, which is a function of pressure, temperature and the concentration of dissolved solids. The use of RO will be dictated by process economics and reject-water handling requirements.

H.2.5 Technological Alternatives

Uranium can occur in both surface water runoff (stormwater), process wastewater, and groundwater; thus, the same treatment technologies have been evaluated to handle these types of waters. Although laboratory and pilot plant studies have been conducted to evaluate a variety of treatment methods, few full-scale systems have been built to remove uranium.

Most of the technological alternatives described below are in the experimental stage of development for removing radionuclides or occur in combination with other processes.

Evaporation (Multieffect)

Wastewater discharges to Manhole 175 could be evaporated to remove any trace radionuclides and pollutants. When the wastewater is evaporated, all water and any components that are more volatile than water would be converted into the vapor phase. All less volatile components would remain behind and be treated by conventional means to remove dissolved solids. Once- through evaporation would be very expensive to operate. To reduce the cost, multieffect evaporation could be used. Multieffect evaporation recovers the heat of vaporization and uses it to preheat the water. The evaporated water is condensed and the heat of vaporization is recovered. The uncertainties of this process are the quantity and types of volatile pollutants and the percent separation water and the nonvolatile components.

Conventional Coagulation-Lime Softening

For wastewaters laden with suspended solids, laboratory and pilot plant studies have shown that both conventional coagulation and lime softening can achieve removal of uranium. However, uranium removal by coagulation treatment is pH dependent with best removals occurring at pH 6 and pH 10. Also, lime softening is most effective when a magnesium hydroxide precipitate is formed either from the natural magnesium in the water or from the addition of magnesium ($MgCO_3$). Coagulation-lime softening is used functionally to remove water hardness coupled with suspended solids, but its prime function is not radionuclide removal. The use of this technology would produce large volumes of solid waste. Control of this system would be very difficult with large flows and major changes in flow rate.

Activated Alumina Treatment

Based on groundwater treatment technology, the U.S. Environmental Protection Agency (EPA) Drinking Water Research Division conducted a bench-scale column test with activated alumnia for uranium removal. Six cycles were run with a column containing 129 mL of activated alumina using test water containing uranium ranging from 273 to 432 μg/L. The test data showed that although the alumina was able to remove the uranium with virgin alumina (pH 7.2 to 8.2), initial breakthrough of alumina was near 1600 bed volumes (BV). Later cycles were able to achieve around 2,000 BV, but none approached the capacity of the anion resins (with 8,000 to > 50,000 BV).

Granular Activated Carbon Treatment

Research conducted by the University of Maine and University of New Hampshire, under the sponsorship of EPA, has shown that uranium is removed by granular activated carbon (GAC). Two small, full-scale GAC systems had removed uranium (26 to 101 μg/L) from the water supplies down to about 1 μg/L for over three months before the uranium broke through the carbon. After breakthrough, the uranium continued to increase in the effluent until the

concentration was higher than the influent level. This information suggests that carbon has a limited capacity and therefore limited application.

H.3 DENITRIFICATION OF FMPC WASTEWATER

At FMPC, uranium production may begin with recycled uranium from reprocessing spent reactor fuel at Richland, Washington, or with various uranium compounds and metal forms. Impure starting material is dissolved in nitric acid, and the soluble uranium is extracted into an immisible organic liquid. It is then re-extracted into high-purity water to yield a solution of uranyl nitrate. The raffinate wastewaters generated from the extraction operation contain high concentrations of free nitrate ions. In June 1975, EPA identified the need for nitrate control when they issued an NPDES permit to discharge for the FMPC.

In November 1978, Oak Ridge National Laboratory (ORNL) published the results of a study prepared for DOE entitled *Operation of a Fluidized Bed Denitrification Bioreactor*. The results of the ORNL study served as the basis for the design of a Biodenitrification Facility (BDN) for removal of nitrates at the FMPC. A Conceptual Design Report (CDR) was prepared based upon the study. A CDR is the primary support document for a line item project funding request through the budgetary cycle.

H.3.1 Description of the FMPC Denitrification Facility

Nitrate-bearing process wastewaters previously pumped to Pit 5 are now pumped to the new 8.6-million gallon Bio-Surge Lagoon (BSL). The BSL serves to equalize the nitrate concentrations and flows from various FMPC processing plants. The wastewater from the BSL is pumped to a neutralization tank for pH adjustment, discharged to a feed tank, and then treated in the BDN.

BDN uses four bioreactors operating in series. Each of the bioreactors is 1.3 m (4 ft) in diameter and has an active bed height of 12 m (38 ft). A minimum flow of 568 L/min (150 gal/min) is required to fluidize the reactors. Recycle capablity is provided from the column effluent back to the initial feed tank or to the BSL.

In each bioreactor, bacteria are utilized to remove the nitrate from the wastewaters by converting the nitrate to gaseous nitrogen. This is accomplished under anoxic (oxygen deficient) conditions.

Methanol, the carbon source for the microorganisms is fed into the line from the BSL to the BDN. The microbes are mesophylic, requiring temperatures from 25 to 40°C (77 to 104°F) for optimum performance. Steam is injected for raising the temperature of the incoming wastewater as needed. To maintain temperatures required for the reaction in the winter months, all reactors are insulated. Control of the pH between each reactor is required, because during the conversion of nitrates to nitrogen, the pH is raised.

The facility is designed to be capable of producing an effluent containing less than 100 mg/L of nitrate at flow rates ranging from 600 to 800 L/min (150 to 200 gal/min) with inlet nitrate concentrations up to 10,000 mg/L.

Construction of BDN began in May 1984 and will be completed by October 1989. A number of modifications have been required during development because this facility is the first of its kind. Before construction of the FMPC BDN, this technology had never been used on an industrial scale. The design was based on the laboratory-scale bioreactor columns used in the original ORNL study.

As knowledge of the engineering requirements of the BDN have increased, additional features have been added. The major new features include the following:

- A pre-engineered steel frame building will enclose the existing BDN tower and equipment to control climate. Fire, evacuation, and public address systems will be installed in the new building to interface with the FMPC-site data gathering panels.

- A temporary power distribution installation used to expedite the demonstration testing will be replaced with a permanent installation.

- A control panel, laboratory, and equipment room will be added in a control building adjacent to the BDN process enclosure building.

- A new independent BDN Effluent Treatment Facility will be added. A building will be constructed to house the primary control panel for the effluent treatment system and the disinfection and dewatering units required. The new treatment facility will discharge its effluents directly to Manhole 175, thus reducing the loading on the existing Sewage Treatment Plant.

- A 500,000-gal open-top steel tank will be provided to receive high-nitrate process wastewater flows from the General Sump. This will allow the sporadic batch discharges from the refinery operation to be stored and discharged over a longer time to level the feeding of nitrates to the BDN. An aboveground reinforced concrete containment structure will encompass the steel holding tank to provide environmental protection in case of tank failure. A level transmitter with high- and low-level alarm will be provided.

- A continuously recirculating Acid Injection System containing more acid injection points than the existing system will be installed for more precise acid injection control.

- A new 1500-gal stainless steel phosphoric acid storage tank will be installed.

- Methanol system flow controls will be relocated from the Waste Storage Area to the BDN.

- Bioreactor towers will be modified to improve fluidized bed performance and reduce foaming. Feed manifolds and nozzles located in the bottom of the towers will be upgraded to prevent clogging by coal particles. Towers 3 and 4 will be brought into full production status by installing and connecting piping and auxiliary systems as required. Additional vent piping with demisters will be installed to vent inert gases from the reactors to a header for dispersion outside the building enclosure. Main feed piping will be redesigned to provide the capability of operating Towers 3 and 4 in parallel or in series with Towers 1 and 2. Modifications to Towers 3 and 4 will be completed before they are tied into Towers 1 and 2 so that two reactors can remain in service at all times during construction.

H.3.2. Technological Alternatives

High-strength industrial nitrate bioreactor technology was not available commercially at the time of the BDN project implementation in 1984, nor was it documented in standard literature. This manual presents theoretical and process design criteria for the implementation of nitrogen control technology in municipal wastewater treatment facilities. The standard manual also presents descriptions of various processes employed in wastewater treatment facilities which, to varying degrees, remove (nitrate) nitrogen from waste streams. Some of these processes are presented in Sects. H.3.2.1 through H.3.2.6.

In addition, a comprehensive survey of best available technology (BAT) and alternatives in support of NPDES permit being given to FMPC was conducted by Dorr-Oliver, Inc., for Martin Marietta Energy Systems, Inc. Their reports indicated that an official BAT had not been established for nitrate removal in the Inorganic Chemicals Category (40 CFR Pt.415) and that biological denitrification appeared to be an environmentally acceptable and economically sound process, and, often, the only available technology for the treatment of high-strength nitrate wastewaters.

Other technological alternatives for denitrification include the following:

- Ion Exchange
- Reverse Osmosis
- Electrodialysis
- Bipolar Electroreduction
- Drying and Calcination
- Conversion to liquid or solid fertilizer.

Although most of these are in the experimental stage of development or occur in combination with other processes, each is discussed briefly below.

H.3.2.1 Ion Exchange

The primary technological alternative to BDN is the use of selective ion exchange for nitrate removal. Ion exchange, like BDN, was developed specifically for nitrate removal. The first extensive study was undertaken in 1969 by Battelle Northwest in a federally sponsored demonstration project. Selective ion exchange for removal of nitrates from wastewater can be accomplished by passing the wastewater through a column of clinoptilolite, a naturally occurring zeolite which has a high selectivity for nitrate ions. Regeneration of the clinoptilolite is undertaken when the exchange sites are used and breakthrough occurs.

Use of anionic exchange resins (such as clinoptilolite) for removal of nitrate was developed principally for treatment of irrigation return waters. Two major unsolved problems are the lack of resins that have a high selectivity for nitrate over chloride and the disposal of nitrogen-laden regenerants.

H.3.2.2 Reverse Osmosis

In the reverse osmosis process, water flows selectively out of a concentrated salt solution, diffusing through a polymeric membrane, and flows into a solution of low salt concentration. The natural process of osmosis causes the water to flow in the opposite direction until a pressure imbalance equal to the differential osmotic pressure build up. (The osmotic pressure is proportional to solute activity and, hence, is approximately proportional to the salt concentration.) At this point, this system would be at equilibrium. If the pressure difference across the membrane becomes less than the osmotic pressure, water enters the concentrated salt solution by osmosis, but when the pressure difference across the membrane is greater than the osmotic pressure, water flows from the concentrated salt solution into the dilute solution by reverse osmosis. For the water passing through the membrane to be essentially salt free in a reverse osmosis process, it is necessary that the membrane be permeable to water but relatively impermeable to salts.

The salts build up a concentration gradient near the membrane surface. The increase in salt concentration at the membrane surface is known as concentration polarization. Concentration polarization is the principal difficulty with reverse osmosis. Besides concentration polarization, other constraints such as pretreatment protocol requirements have inhibited the universal application of reverse osmosis for reducing total dissolved solids [TDS (including high-strength nitrate solution)].

H.3.2.3 Electrodialysis

The principal use for electrodialysis outside a laboratory was for brackish water desalination. The first attempt at commercializing electrodialysis was made in the 1920s. This venture was unsuccessful, in part, because of the low level of technological development. Electrodialysis became a practical commercial process after the development of the synthetic ion-exchange membrane in 1948.

In industrial applications, the water is usually desalinated to between 100 and 200-ppm TDS. When purer water is required, electrodialysis is followed by ion exchange. This water can be used in petroleum refining, petrochemical production, and mining as well as boiler feedwater, cooling water, and for other process purposes.

Approximately 40% nitrate removal can be expected for electrodialysis. This process is normally expensive and energy intensive and is unlikely to be used if nitrate removal alone is required.

H.3.2.4 Bipolar Electroreduction

Bipolar electroreduction (BPER) is the controlled electrolysis of a sodium nitrate solution. For most of the testing done in 1987, the electrodes used were made of nickel sheeting. During electrolysis, ammonia and nitrogen gases developed at the cathode, and oxygen was evolved at the anode. In a typical 30- to 40-h run, nitrate-nitrogen was reduced from a starting concentration of 15,000 ppm in 23 L to a final concentration of 600 ppm in 17 L. Cell off-gas treatment indicated that about 30% of the nitrate-nitrogen was being converted to ammonia. Electrical power required at the cell was 50 kWh/kg nitrate-nitrogen.

While the technology works, BPER requires that extensive pretreatment be done to a nitrate stream to remove all multivalent metal ions. This pretreatment produces significant quantities of low-level waste which, along with the electrical cost, makes for a high-cost method of nitrate treatment.

H.3.2.5 Drying and Calcination (Including Plasma)

Drying and denitration of mixed nitrate solutions via common drying equipment such as spray dryers, drum dryers, and rotary kilns was tried at the FMPC in the late 1950s. From the beginning, severe corrosion and plugging problems plagued the system. Throughput and on-stream time were unacceptably low, and the system was abandoned.

The final drying system tried at the FMPC consisted of two drum dryers followed by denitration in two rotary kilns. The drum dryers consisted of rotating cast iron drums that were heated internally with steam. As the drums rotated, concentrated nitrate solution was spattered on the outside hot surface and, when dry, scraped off with a blade. The dried nitrates from the drum dryers were then fed to metal-tube externally gas-fired rotary kilns for final denitration to metal oxides and NO_x gas.

Review of the operating experience of this drying and calcination system revealed that, although it could be made to work, extensive modification and development would have to be done to produce a viable operation.

Another calcination process investigated was plasma denitration. This technique involves spraying a concentrated nitrate stream into an air stream superheated by a plasma torch. The nitrates are flash-dried and denitrated to metal oxides and off-gases. A pilot-scale demonstration test was performed in

October 1987 which showed that nitrates could be destroyed in this manner. The build-up of a significant amount of fused oxide solids on the inside of the reactor wall was a serious operational problem.

Plasma denitration testing is costly. It would take at least several years to develop the process to the point that a plant trial could be considered.

H.3.2.6 Conversion to Fertilizer

Land application of nitrate wastes was studied at ORNL and FMPC in the early 1970s. While land application of nitrate wastes apparently is feasible, in recent years it has not been seriously considered as an option at FMPC because of the potential for environmental insult.

H.3.2.7 Summary

The BDN demonstration system at FMPC is being used as a routine production operation. None of the alternatives discussed above is known to be successfully operating on an industrial scale. Although certain combinations of these technologies could probably operate successfully, significant time and money would have to be spent to develop them to compare with the efficiency of the operation of the BDN system.

APPENDIX I

FEED MATERIALS PRODUCTION CENTER NEPA AND ENVIRONMENTAL DOCUMENTS

APPENDIX I. FMPC'S NEPA AND ENVIRONMENTAL DOCUMENTS

As a U.S. Department of Energy (DOE) facility, the Feed Materials Production Center (FMPC) must consider the environmental effects of its actions as required by the National Environmental Policy Act of 1969 (NEPA). In response to this obligation, FMPC uses five levels of environmental documents. This environmental impact statement (EIS) is an example of the highest-level NEPA document. Besides this EIS on renovation of the FMPC production facilities, several environmental documents are anticipated for remedial action projects which come out of the Remedial Action/Feasibility Study. An environmental assessment (EA), the next lower-level NEPA document, is prepared for a project for which there is some doubt whether an EIS is needed. EAs concerning the handling of thorium (DOE 1988a) and construction and operation of a decontamination and decommissioning facility (DOE 1988b) have recently been made public.

The three lower-level environmental documents are Action Description Memorandums (ADMs), NEPA Fact Sheets (NFs) and NEPA Check Lists (NCs). These documents are not usually made public. (Some projects that clearly have no effect on the environment are categorically excluded from the need for NEPA consideration by DOE and Council on Environmental Quality regulations.) Exhibit I-1 is an example of an approved ADM. Exhibit I-2 is an example of an NF. Exhibit I-3 is an example of an NC, the lowest level of environmental documentation.

Table A-6 of Appendix A lists the NEPA document numbers of the projects that have been completed between 1985 and the present. Further information on any of these completed projects can be obtained from these environmental documents.

Exhibit I.1. Feed Materials Production Center, National Environmental Policy Act (1969) Documentation, Upgrade Security Perimeter Fence.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER L. A. GRIFFIN
		PROJECT LOCATION WEST OF K-65/Pit Area
PROJECT/PROGRAM TITLE GPP-GE (FA-166) UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	CONSTRUCTION START DATE SEPTEMBER, 1987
		NEPA SUBMITTAL DATE September 4, 1987

The above NEPA document has been

_X_ Approved by DOE on 4-18-88. A copy of the signed coversheet is enclosed for your files.

____ Returned by DOE on _____, pending receipt of additional information. DOE comments are shown on the attached document, please designate the changes you have made. Your attention to this within the week is imperative.

____ Disapproved by DOE on _____. DOE requests the following additional documentation.

_____.

If you have any questions regarding this action, please contact me (6854).

Jeff Gaufon for
J. A. Van Ooteghem

Date

0441

I-4

United States Government

Department of Energy

Oak Ridge Operations

memorandum

DATE: October 26, 1987

REPLY TO ATTN OF: SE-31:Alexander

SUBJECT: NATIONAL ENVIRONMENTAL POLICY ACT (NEPA) DETERMINATION - UPGRADE SECURITY PERIMETER FENCE AND K-65 SILO RADON MITIGATION AND DOME REINFORCEMENT

TO: Joe La Grone, Manager

In accordance with the delegation of authority relative to NEPA granted you by the Assistant Secretary for Defense Programs on August 25, 1981, the attached Action Description Memoranda are submitted for your review and decision.

1. Upgrade - Security Perimeter Fence

2. K-65 Silo Radon Mitigation and Dome Reinforcement

It is our recommendation that you exercise the delegated authority to determine that these projects clearly will not have significant environmental effects; and, therefore, do not warrant the preparation of environmental assessments or environmental impact statements.

If you have any questions or require additional information, please contact either of us at 6-0891 or 6-0742, respectively.

Richard L. Egli
Assistant Manager for
Safety and Environment

William R. Bibb
Deputy Assistant Manager
for Fernald

CONCUR: R.T. Marquess, Acting
Joe La Grone, Manager

DATE: Oct. 26, 1987

Attachments:
As stated

cc w/attachment:
C. M. Borgstrom, EH-23, FORSTL
T. E. Wade, DP-1, FORSTL
J. A. Reafsnyder, DP-84

000497

FMPC

NEPA DOCUMENTATION

COGNIZANT PROJECT ENGINEER	L. A. Griffin
PROJECT LOCATION	West of K-65/Pit Area
PROJECT/PROGRAM TITLE	GPP-GE (FA-166) UPGRADE - SECURITY PERIMETER FENCE
PROJECT COST	$465,000
CONSTRUCTION START DATE	September, 1987
PROJECT/PROGRAM NUMBER	28-87102
NEPA DOCUMENT NUMBER	000030
NEPA SUBMITTAL DATE	SEP 04 1987

PROJECT EXECUTIVE SUMMARY

The project will consist of installing approximately 9,000 linear feet of fencing and the clearing of 26 acres of trees and shrubbery around the K-65 and Waste Pit area.

There is a need to establish controls to prevent unauthorized access to the plant by way of the K-65/Pit area. Providing a security zone will allow control measures to be established.

PROJECT JUSTIFICATION

The project will not encounter, handle or dispose of hazardous or toxic material. However, the possibility of handling radioactive material exists with the soil to be removed during the installation of fence posts, the trees to be removed north of the K-65/Pit area, and the fence to be removed. The soil, trees, and fence will be sampled and tested for contamination by ES&H. These items will be handled as directed by WMCO Environmental Compliance.

The operation of the project will not result in any discharge or emission to the environment and/or plant systems. Cumulative impacts of this project have been assessed to be neutral overall. Other options have not been precluded by this action.

EXISTING NEPA DOCUMENTATION/DATE SUBMITTED

NONE	N.C. AUG 31 1987	ADM.	E.A.

THIS NEPA DOCUMENT

N.C.	ADM. SEP 04 1987	E.A.	E.I.S.

DOE APPROVAL REQUESTED		
	COGNIZANT PROJECT ENGINEER/DATE	Leslie A. Griffin / 9-3-87
	SITE NEPA COORDINATOR/DATE	[illegible] 9-4-87
DOE/FMPC XX	SITE NEPA MANAGER/DATE	[illegible] 9/4/87
DOE/ORO XX	SITE DOE OFFICER/DATE	James A. Rechnyder 10/17/87
DOE/HQ ____	ADDITIONAL DOE APPROVALS NEEDED/DATE	Carol Borgstrom 4/18/88

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
		CONSTRUCTION START DATE September, 1987
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	NEPA SUBMITTAL DATE SEP 04 1987

1.0 PURPOSE AND NEED

Westinghouse Materials Company of Ohio (WMCO) is the prime contractor at the United States Department of Energy (DOE) Feed Materials Production Center (FMPC). The FMPC is located in Hamilton County near Fernald, Ohio, approximately 20 miles northwest of Cincinnati (see Figure 1). The facility was constructed in the early 1950's and produces uranium metal forms used in the fabrication of fuel and target elements for the DOE defense program.

The K-65/Pit Area has been reclassified as a "protected area". The definition of a protected area is "an area enclosed by a physical barrier within the perimeter of the isolation zone" (See References). The K-65/Pit Area lacks the proper isolation zone required to adequately assure protection from intrusion by unauthorized individuals. Therefore, this area is vulnerable to potential damage and/or destruction arising from deliberate acts of arson, civil disorder, sabotage, terrorism or vandalism.

2.0 PROPOSED ACTION

Establish a boundary and construct an isolation zone around the west side periphery of the FMPC.

The establishment of an isolation zone will require the installation of an additional plant perimeter security fence around the west side of the FMPC. (See attached Drawing No. 28X-5500-G-00212).

Installation of the new perimeter fence will establish an isolation zone (the area between the two fences). This isolation zone will be cleared of all trees and shrubbery which could conceal individuals and obstruct observation of entry into the area.

The construction duration will be approximately six weeks for the site clearing and fence installation. Work crews on site could range between 2 to 12 workers at a time.

This project will be conducted in conformance with DOE, OSHA, and FMPC regulations governing Health and Safety (See References). Required permits will be obtained.

FMPC NEPA DOCUMENTATION		COOPERANT PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
		CONSTRUCTION START DATE September, 1987
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	NEPA SUBMITTAL DATE SEP 04 1987

3.0 ALTERNATIVES

3.1 No Action

If it were determined that no action is to be taken, security could not adequately assure protection from intrusion into the K-65/Pit area by unauthorized individuals.

The geographical condition of the surrounding terrain is so densely populated with trees that the establishment of an isolation zone is not feasible without site changes.

3.2 Erect Guard Towers

An alternative could be to erect guard towers around the west side of the FMPC. These towers would be occupied by guards to provide twenty-four hours a day observation of the area. The clearing of trees still would be required to allow for unobstructed observation.

This alternative would require more security personnel, and be less effective than the proposed action.

3.3 Proposed Action

Providing a fenced isolation zone will allow other security measures to be added in the future and provide a physical barrier preventing unauthorized entrance into the area. The installation of a plantwide closed circuit monitoring system is one of these measures to be considered. Likewise, the installation of a micro-wave sensing device is being considered.

This action is preferred because a fenced isolation zone is the first phase of an overall security upgrade at the FMPC site.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS

Negligible impacts will occur to the existing environment, construction workers and FMPC employees.

There will not be any emissions resulting from the operation of the project. Potential emissions will be considered more fully below. Construction vehicles and transport vehicles will be used during construction.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
		CONSTRUCTION START DATE September, 1987
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	NEPA SUBMITTAL DATE SEP 04 1987

The activities listed below will be performed during construction. Included in these activities are the measures that will be taken to stabilize the area.

Nearly twenty-six acres will be cleared of trees and shrubbery. Of this 26 acres, about 17 acres are comprised of trees (pine, walnut, and others) and 9 acres contain shrubbery, brush, and grass. The trees to the west of the K-65/Pit area have been surveyed for contamination and the test report shows they are not contaminated (See References). The trees to the north of the K-65/Pit area will be surveyed for contamination. These trees are expected to be clean based on the results from the trees surveyed to the west of the K-65/Pit area. Approximately 4,948 ft^3 of trees will be cut to about 1-2 inches above ground using a power saw. The root systems of these trees removed will remain undisturbed so as not to contribute to erosion in this area.

The exact disposition of the trees has not been determined. The following options are being considered:

OPTION 1 - Subcontractor to cut and pile up trees and limbs in the general area using 2 front end loaders, 1 bulldozer, and 1 backhoe. Leaving trees in this area permanently is unacceptable because it would be unsightly to local residents. These trees would have to be disposed of by WMCO at a later date.

OPTION 2 - Subcontractor to chip anything up to 4" in diameter and leave in place as mulch. This could be done as another means of preventing erosion. Anything salvageable would be hauled off site by the subcontractor. For this option, 1 small chipper, 2 skitters, 1 bulldozer, and 1 front end loader or backhoe, and various trucks would be used.

OPTION 3 - Subcontractor to chip anything up to 4" in diameter and leave in place as mulch. This could be done as another means of preventing erosion. Logs over 4" in diameter would be hauled to a laydown area close to the security shooting range for storage. A log truck, 1 chipper, 2 skitters, 1 bulldozer, 1 front end loader or backhoe would be required for this option.

FMPC NEPA DOCUMENTATION		CONTRACT PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
		CONSTRUCTION START DATE September, 1987
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	NEPA SUBMITTAL DATE SEP 04 1987

OPTION 4 - Chip anything up to 20" in diameter and leave in place as mulch. This could be done as another means of preventing erosion. Logs over 20" in diameter would be left in a designated area outside of the exterior fence. For this option 1 giant chipper, 2 skitters, 1 dozer, and 1 front end loader or backhoe would be required.

The following activities will be performed regardless of tree disposition:

The entire area will be mowed to approximately 1-2" aboveground by a "bush hog".

Culverts will be located throughout the construction site at points where the fence must be placed across gulleys and ditches. These culverts will be covered with soil using a backhoe. The soil will be seeded to prevent long term erosion. For the short term, straw will be used to prevent erosion.

It may be necessary to place the fence over swales. Prior to fence installation these swales will be covered with uncontaminated soil using a backhoe, then seeded to prevent long term erosion. For the short term, straw will be used to prevent erosion.

Approximately 9200 ft^3 of soil will be removed during installation of the fence posts. This soil will be sampled and tested for contamination by WMCO ES&H. All soil will be handled as directed by WMCO Environmental Compliance.

Approximately 1000 linear feet of fence will be removed during construction. This fence will be surveyed for contamination by WMCO ES&H. The fence will be handled as directed by WMCO Environmental Compliance.

In the original design, the fence was placed closer to Paddy's Run Creek than in the current design. Concerns about erosion and the possible impact on Paddy's Run Creek lead to the change in design. The change reduced the number of trees to be removed and relocated the fence further away from the creek for less potential impact. The installation of the fence will be in close proximity to Paddy's Run Creek but the creek will not be disturbed as a result of this installation.

FMPC NEPA DOCUMENTATION		COORDINATE PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
		CONSTRUCTION START DATE September, 1987
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	NEPA SUBMITTAL DATE SEP 04 1987

During the six week construction period, workers should encounter normal construction hazards.

The construction/operation of the of the proposed project will not encounter any material that is identified on the attached NEPA Checklist other than those previously mentioned.

The construction/operation of the proposed project will not involve discharges to any of the systems identified on the NEPA Checklist. Storage will not be required during construction/operation of this project.

5.0 CONCLUSION

Based on the information provided in the preceding paragraphs and the attached NEPA Checklist, it is concluded that the project has negligible environmental impacts.

Upgrade of the Security Perimeter Fence represents an action which may be taken during the course of an ongoing EIS, as defined by the Council on Environmental Quality (40 CFR 1506.1). As such:

1. This action has no net adverse environmental impact. Upgrade of the Security Perimeter Fence help establish the controls necessary to prevent unauthorized access to the plant by way of the K-65/Waste Pit area. Although the fence is near Paddy's Run Creek, impacts to the creek directly or by way of increased erosion are not expected.

2. This action does not preclude the choice of reasonable alternatives to the action being undertaken. Should future findings be made which suggest that the Security Perimeter Fence is not needed, decontamination and decommissioning or relocation of the can be readily undertaken.

6.0 CUMULATIVE IMPACTS

No net negative environmental impacts have been assessed to result from this project, and other reasonable alternatives are not precluded by this action.

000503

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
PROJECT/PROGRAM NUMBER 28-87102	NEPA DOCUMENT NUMBER 000030	CONSTRUCTION START DATE September, 1987
		NEPA SUBMITTAL DATE SEP 04 1987

REFERENCES

Code of Federal Regulations, Title 29, Chapter XVII, Part 1910, Occupational Safety and Health Administration.

Department of Energy Order 5480.1A, 1981, Environmental Protection Program for DOE Operations, U. S. Department of Energy.

Department of Energy Order 6430.1, 1983, General Design Criteria Manual, U. S. Department of Energy.

Department of Energy Order 5632.4, 1985, Physical Protection of Security Interests, U. S. Department of Energy.

Feed Materials Production Center FMPC-2069, 1987, General Design Criteria Manual, Feed Materials Production Center/Westinghouse Materials Company of Ohio.

Feed Materials Production Center Radiological Survey Report, August 3, 1987, Results from Radiological Survey on Trees, No Letter or Document Number.

Feed Materials Production Center FMPC-2063, latest revision, Project Management Procedures for the Technical Department

FMPC NEPA DOCUMENTATION ATTACHMENT		CONTRACT PROJECT ENGINEER L. A. Griffin
		PROJECT LOCATION West of K-65/Pit Area
PROJECT/PROGRAM TITLE UPGRADE - SECURITY PERIMETER FENCE		PROJECT COST $465,000
PROJECT/PROGRAM NUMBER 28-87102	THIS NEPA DOCUMENT 000030	CONSTRUCTION START DATE September, 1987
		NEPA SUBMITTAL DATE SEP 04 1987

1.0 Will any of the following be encountered, handled, stored, used, or disposed of during the construction of the proposed program or project?

	Y	N	U
Radioactive materials (identify)			X
Hazardous materials (identify)		X	
Toxic materials (identify)		X	
Mixed hazardous and radioactive materials (identify)		X	
PCB's (identify source)		X	
Asbestos (identify source)		X	
Organic chemicals (identify)		X	
Heavy metals (identify)		X	

2.0 Will program activities involve discharges to any one of the following systems during the construction of the proposed project?

	Y	N	U
Low level waste disposal (describe)		X	
Process waste stream		X	
Sanitary waste stream		X	
Storm sewer		X	

3.0 Will any of the following be encountered, handled, stored, used, or disposed of during operation of, or following the proposed program changes?

	Y	N	U
Radioactive materials (identify)		X	
Hazardous materials (identify)		X	
Toxic materials (identify)		X	
Mixed hazardous and radioactive materials (ident.fy)		X	
PCB's (identify source)		X	

Asbestos (identify source)	Y	N X	U
Organic chemicals (identify)	Y	N X	U
Heavy metals (identify)	Y	N X	U

4.0 Will program activities involve discharges to any one of the following systems during operation of, or following the proposed program changes?

Low level waste disposal (describe)	Y	N X	U
Process waste stream	Y	N X	U
Sanitary waste stream	Y	N X	U
Storm sewer	Y	N X	U

5.0 Are uncontrolled emissions, discharges, or spills possible during:

The construction phase of this project?	Y	N X	U
The operational phase, upon completion of the project?	Y	N X	U

6.0 Will the project involve any of the following:

	Y	N	U
Need for aboveground storage during construction?		X	
Need for underground storage during construction?		X	
Need for aboveground storage during operations?		X	
Need for underground storage during operations?		X	

	Y	N	U
7.0 Is the project located in close proximity to a natural stream or within the floodplain of a natural stream?	X		

8.0 Are controlled emissions or discharges planned during:

	Y	N	U
The construction phase of this project?		X	
The operational phase, upon completion of this project?		X	

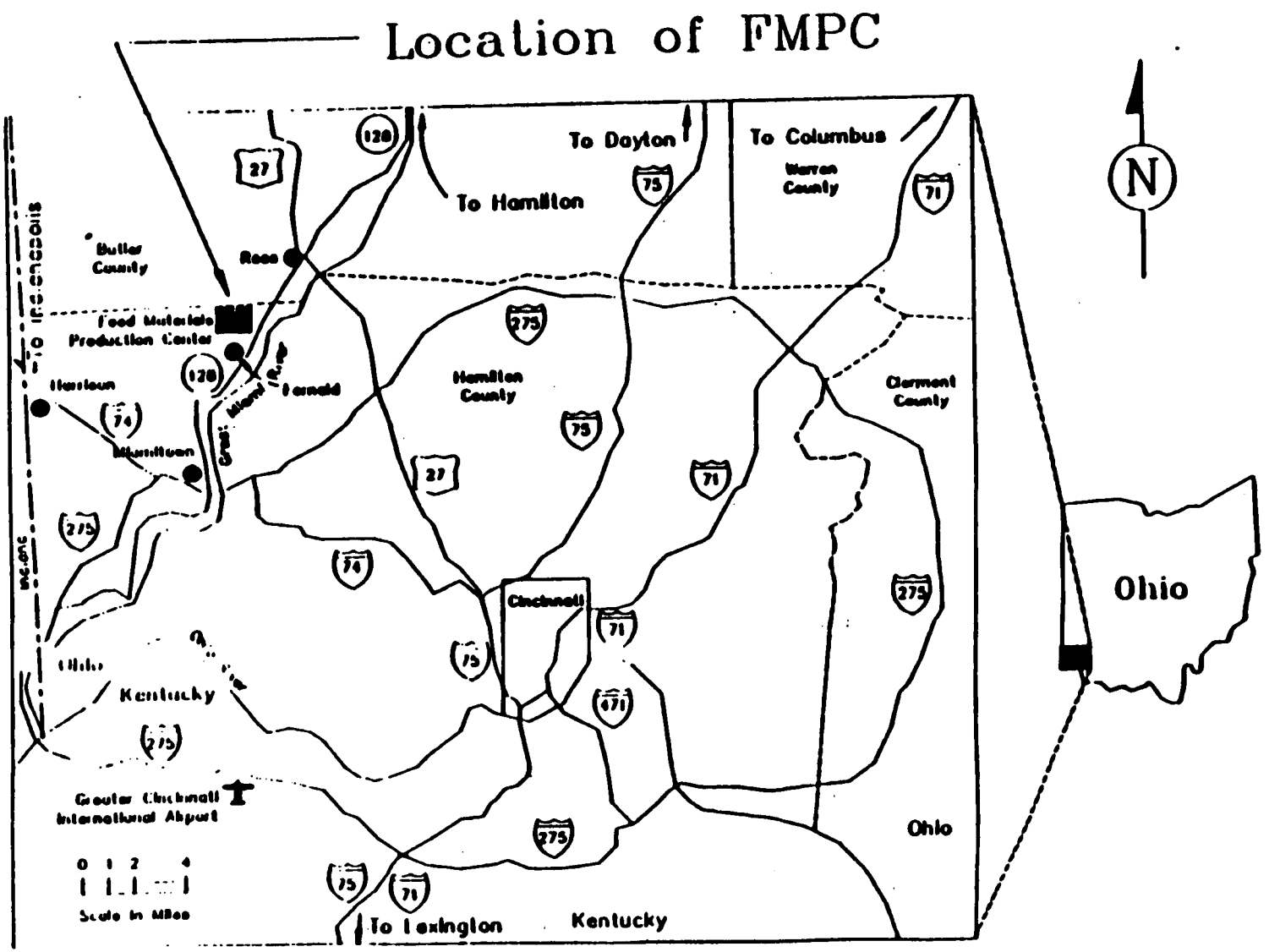


FIGURE 1. FMPC Location Map

Exhibit I.2. Feed Materials Production Center, National Environmental Policy Act (1969) Documentation, ES&H Building Expansion and Upgrade.

FMPC

NEPA DOCUMENTATION

COGNIZANT PROJECT ENGINEER	M. R. Spencer
PROJECT LOCATION	ES&H Building
PROJECT/PROGRAM TITLE	EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION & UPGRADE
PROJECT COST	$13,251,000
CONSTRUCTION START DATE	October, 1988
PROJECT/PROGRAM NUMBER	0087502 - 1.1.4.1.04
NEPA DOCUMENT NUMBER	000027
NEPA SUBMITTAL DATE	SEP 03 1987

PROJECT EXECUTIVE SUMMARY

Upgrading and expansion of the Health and Safety Building, will provide larger and more modern medical facilities as well as increased office space for additional medical, environmental, health , and safety personnel.

The FMPC Security Communications Center will be relocated to the basement of this expansion. Minimal environmental impacts are anticipated from performance of this project.

PROJECT JUSTIFICATION

The Health and Safety Building has insufficient space to accommodate the necessary Medical, Environmental, Health, and Safety personnel required to handle the current and projected employee population.

The cumulative impacts of this project have been assessed, and it has been determined that the action does not result in net adverse impacts to the environment. Other options have not been precluded by this action.

EXISTING NEPA DOCUMENTATION/DATE SUBMITTED

NONE	N.C.	ADM.	E.A.
	AUG 06 1987		

THIS NEPA DOCUMENT

N.P.	ADM.	E.A.	E.I.S.
SEP 03 1987			

DOE APPROVAL REQUESTED		
	COGNIZANT PROJECT ENGINEER/DATE	M.R. Spencer 9/3/87
	SITE NEPA COORDINATOR/DATE	[illegible] 9-3-87
DOE/FMPC XX	SITE NEPA MANAGER/DATE	[illegible] for C.R. Connor 9-3-87
DOE/ORO XX	SITE DOE OFFICER/DATE	James A. Rodgers 9/15/87
DOE/HQ XX	ADDITIONAL DOE APPROVALS NEEDED) DATE	

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION AND UPGRADE		PROJECT COST $13,251,000
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	NEPA DOCUMENT NUMBER 000027	CONSTRUCTION START DATE OCTOBER, 1988
		NEPA SUBMITTAL DATE SEP 03 1987

1.0 PURPOSE AND NEED FOR ACTION

The expansion and renovation of the Health and Safety Building will provide a more efficient and modern medical facility and create more available space to house offices and laboratories for health and safety operations. This will eliminate the present deficiencies in these services by upgrading the facility to a level consistent with the needs of the current and projected plant population. By renovating and expanding the present building, space will be available to house the following departments: Medical Services, Environmental and Radiological Safety, Regulatory Compliance, Material Control and Accountability, Industrial Hygiene and Safety, and Impact Assessment.

Installation of the Security Communications Center in the basement of the Health and Safety Building expansion will provide adequate space to accommodate day-to-day surveillance of plant communications, a center for monitoring of alarm systems and testing, a communications center from which command post exercises can be conducted, a meteorological, atmospheric and data monitoring center, and a new center for fax and telecommunications equipment.

2.0 DESCRIPTION OF PROPOSED ACTION

The addition to the existing Health and Safety Building will consist of three floors of block and concrete construction containing approximately 18,000 square feet. Interior non load bearing masonry walls and existing doors and frames will be demolished and removed for construction of office space and labs. Uninsulated exterior doors and single pane windows will be demolished and removed. Provisions will be made to properly remove, store, decontaminate and reuse, or dispose of materials that require decontamination. The renovated Health and Safety Building will provide office space for medical/health, safety, environmental, and emergency functions at FMPC. A new addition will house the Security Communications Center, additional offices and a laboratory for environmental and industrial hygiene operations.

The new Security Communication Center will be relocated from the Security Building (Building 28) to the basement of the Health and Safety Building addition. The Security Communications Center will consist of approximately 6,000 square feet of access controlled space and will include support facilities necessary to create a self-contained environment with air, water, food, power, and communications.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION AND UPGRADE		PROJECT COST $13,251,000
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	NEPA DOCUMENT NUMBER 000027	CONSTRUCTION START DATE OCTOBER, 1988 NEPA SUBMITTAL DATE SEP 03 1987

The complete heating, ventilating, and air conditioning (HVAC) system for the existing Health and Safety Building will be demolished and removed. A new roof-mounted HVAC system will be installed to meet the requirements of both the renovated space and the expansion.

Emergency power generation will be provided by a 150 kva diesel powered electric generator. Fuel for the generator will be stored onsite in a tank with sufficient capacity to support two weeks of continuous operation. The generator will be provided with a weatherproof housing and a suitable controller to provide high priority emergency electric power.

This project will be conducted in conformance with DOE, OSHA, and FMPC regulations governing Health and Safety. Required permits will be obtained.

3.0 ALTERNATIVES CONSIDERED

3.1 NO ACTION

Inaction on expansion and upgrading of the Health and Safety Building constitutes tacit acceptance of the current condition. Medical, Health and Safety, and Emergency response functions would continue to be performed under current constraints of insufficient space, staff limitation, dated medical and communications equipment, and lack of sophisticated emergency response systems.

Without upgrading and expanding the Health and Safety Building, the current deficiencies in medical services and health and safety services can be expected to continue. Projected expansion of the employee population would place further limitations on the quality and performance of these services.

Continued operation of the Security Communications Center in the Security Building would delay introduction of improved response capabilities in the event of an emergency situation.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION AND UPGRADE		PROJECT COST $13,251,000
		CONSTRUCTION START DATE OCTOBER, 1988
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	NEPA DOCUMENT NUMBER 000027	NEPA SUBMITTAL DATE SEP 03 1987

3.2 ALTERNATIVE TO THE PROPOSED ACTION

The present space problems of the ES&H building can resolved by adding more temporary buildings in the area. The present functions being performed could expand and occupy these temporary facilities and continue to function at some level above their present point.

These temporary buildings would not solve the more critical requirements of controlled access and extra quality space needed for the Security communications Center, upgrading of the heating, ventilating, and air conditioning (HVAC) system for the existing Health and Safety Building, and providing proper lab space needed for the Environmental Safety and Health functions at the FMPC.

3.3 PROPOSED ACTION

The proposed action, expansion and upgrading of the Health and Safety Building, meets all of the necessary performance, space, as well as safety and security considerations. This alternative provides an opportunity to expand critical services with minimal disruption to ongoing operations.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS OF PROPOSED ACTIONS

Minimal adverse environmental impacts are anticipated during project construction. Primary environmental concerns focus on demolition and construction activities. Following project completion, service departments occupying the building may be involved in the routine collection, analysis, and management of both nuclear and non-nuclear contaminated materials. Department operations will be in compliance with all appropriate FMPC requirements.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION AND UPGRADE		PROJECT COST $13,251,000
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	NEPA DOCUMENT NUMBER 000027	CONSTRUCTION START DATE OCTOBER, 1988
		NEPA SUBMITTAL DATE SEP 09 1987

Construction of the Health and Safety Building expansion will require excavation and grading of the site. Erosion control measures using silt barriers and dikes will be instituted during excavation and construction. The operation side of the addition will be paved and the clean side of the facility will be graded, seeded and landscaped to control erosion after the construction is completed. An area sufficient for the construction of the foundation and basement will be excavated and approximately 2,700 cubic yards of dirt will have to be removed. Construction rubble made up of concrete block, door and window frames, scrap pipe, electrical conduit and wire, wood framing, asbestos insulation, HVAC duct and miscellaneous building materials will be encountered. Approximately 500 linear feet of asbestos pipe insulation will have to be demolished and removed. Removal and demolition of this material will be handled according to appropriate FMPC disposal requirements. It is estimated that the construction level of effort required will be approximately sixty three man years over the eighteen month duration of the project. Upon completion of this expansion approximately 350 persons per day will use the facility.

The activities proposed for the expansion are an extension of the existing activities being conducted in the facility at this time. The addition of the Security Communication Center is not expected to produce adverse environmental impacts at the FMPC. Most of the activities assigned to this Center represent data collection and monitoring functions and will not result in controlled or uncontrolled discharges, spills, or releases of any undesirable materials. The Center will be connected to the sanitary waste system for the safe disposal of human waste.

The emergency diesel powered electric generator will release exhaust emissions during performance testing and operation. These emissions are expected to be within atmospheric emission compliance requirements appropriate for this type of equipment. The generator exhaust fumes will be monitored and kept at concentrations in conformance with OSHA regulations. The area around the diesel generator will be posted properly for health and safety concerns. Personnel working within the area of the generator, where noise levels exceed 85 decibels, will be required to wear protective equipment. Fuel for the emergency diesel generator will be stored in an above ground tank in the same protective structure as the generator, and in accordance with OSHA regulations. Those regulations specifically involved include, storage containers, relief valves, dikes and re-filling procedures. Potential spills of diesel fuel may occur during fuel loading of the storage tank but the quantity of lost fuel should be easily and appropriately managed by maintenance staff without extraordinary requirements.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION AND UPGRADE		PROJECT COST $13,251,000
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	NEPA DOCUMENT NUMBER 000027	CONSTRUCTION START DATE OCTOBER, 1988
		NEPA SUBMITTAL DATE SEP 03 1987

5.0 CONCLUSION

Expansion and upgrading of the Health and Safety Building, Building 53, will result in a more efficient and modern medical facility and create more available space to house offices and laboratories. Renovation of the building will permit consolidation of many related activities in the same facility. It is proposed that Medical Services, Environmental and Radiological Safety, Regulatory Compliance, Materials Control and Accountability, Industrial Hygiene and Safety, and Impact Assessment will occupy the new and renovated space.

Installation of the Security Communications Center in the access controlled basement of the Health and Safety Building expansion will provide adequate facilities to accommodate day-to-day surveillance of plant communications, monitoring and testing of alarm systems, monitoring of command post exercises, meteorological data monitoring, and a new center for fax and telecommunication equipment.

Minimal environmental impacts are anticipated as a result of construction and operation of this project. Scrap materials generated as a result of renovating Building 53 and construction of the expansion will be handled by approved FMPC disposal practices. Materials such as asbestos steam pipe wrap, encountered during demolition will be dealt with by qualified personnel in accordance with appropriate FMPC practices and procedures. Soil from site excavation will be disposed of in accordance with the appropriate FMPC procedure.

The diesel powered electric generator will release exhaust emissions during performance testing and operation, but these emissions are expected to be within atmospheric emissions compliance requirements appropriate for this type of equipment. Fuel for the generator will be stored in an above ground tank in the same protective structure as the generator. These tanks and structures will be constructed and remain in conformance with OSHA regulations. Potential spills may occur during fuel loading of the storage tank but the quantity of lost fuel should be easily and appropriately managed by the maintenance staff without needing extraordinary requirements.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION AND UPGRADE		PROJECT COST $13,251,000
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	NEPA DOCUMENT NUMBER 000027	CONSTRUCTION START DATE OCTOBER, 1988
		NEPA SUBMITTAL DATE SEP 03 1987

The ES&H upgrade and expansion is an action which may be taken during the course of an ongoing EIS, as defined by the Council on Environmental Quality (40 CFR 1506.1). As such:

1. This action has no net adverse environmental impact. The ES&H upgrade and expansion will provide needed medical, technical, and worker health assessment facilities. Some construction rubble will be generated and is expected to be clean, however it will be handled according to the proper FMPC procedures. The dirt excavated from the foundation site will be used as fill where required onsite. The action does not impact an environmentally sensitive area.

2. This action does not preclude the choice of reasonable alternatives to the action being undertaken. Upgrade and expansion of the ES&H building represents only an alteration and improvement of an existing structure. This building could be used for other purposes or demolished if necessary.

6.0 CUMULATIVE IMPACTS

The cumulative impacts of expansion and upgrade of the ES&H building have been assessed, and it has been determined that the action does not result in net adverse impacts to the environment.

FMPC NEPA DOCUMENTATION ATTACHMENT		COGNIZANT PROJECT ENGINEER M. R. Spencer
		PROJECT LOCATION ES&H Building
PROJECT/PROGRAM TITLE EHSI LINE ITEM (87-D-159) ES&H BUILDING, EXPANSION & UPGRADE		PROJECT COST $13,251,000
PROJECT/PROGRAM NUMBER 0087502 - 1.1.4.1.04	THIS NEPA DOCUMENT 000027	CONSTRUCTION START DATE October, 1988
		NEPA SUBMITTAL DATE SEP 03 1987

1.0 Will any of the following be encountered, handled, stored, used, or disposed of during the construction of the proposed program or project?

	Y	N	U
Radioactive materials (identify) Potential building contamination with unknown radionuclides	x		
Hazardous materials (identify)		x	
Toxic materials (identify)		x	
Mixed hazardous and radioactive materials (identify)		x	
PCB's (identify source)		x	
Asbestos (identify source) pipe wrapped with asbestos insulation	x		
Organic chemicals (identify)		x	
Heavy metals (identify)		x	

2.0 Will program activities involve discharges to any one of the following systems during the construction of the proposed project?

	Y	N	U
Low level waste disposal (describe)		x	
Process waste stream		x	
Sanitary waste stream Human waste	x		
Storm sewer		x	

3.0 Will any of the following be encountered, handled, stored, used, or disposed of during operation of, or following the proposed program changes?

	Y	N	U
Radioactive materials (identify)		x	
Hazardous materials (identify)		x	
Toxic materials (identify)		x	
Mixed hazardous and radioactive materials (identify)		x	
PCB's (identify source)		x	

	Y	N	U
Asbestos (identify source)		x	
Organic chemicals (identify)		x	
Heavy metals (identify)		x	

4.0 Will program activities involve discharges to any one of the following systems during operation of, or following the proposed program changes?

	Y	N	U
Low level waste disposal (describe)		x	
Process waste stream		x	
Sanitary waste stream Human Waste	x		
Storm sewer expansion will drain to storm sewer	x		

5.0 Are uncontrolled emissions, discharges, or spills possible during:

	Y	N	U
The construction phase of this project?	x		
The operational phase, upon completion of the project? Filling the diesel storage tank	x		

6.0 Will the project involve any of the following:

	Y	N	U
Need for aboveground storage during construction? construction laydown and staging area	x		
Need for underground storage during construction?		x	
Need for aboveground storage during operations? Diesel fuel for emergency generator	x		
Need for underground storage during operations?		x	

7.0 Is the project located in close proximity to a natural stream or within the floodplain of a natural stream?

	Y	N	U
		x	

8.0 Are controlled emissions or discharges planned during:

	Y	N	U
The construction phase of this project?		x	
The operational phase, upon completion of this project?		x	

Exhibit I.3. Feed Materials Production Center, National Environmental Policy Act (1969) Documentation, Productivity & Rad. Improvements South Ammonia Storage Facility.

FMPC

NEPA DOCUMENTATION

COORDINANT PROJECT ENGINEER	R. W. Helmes
PROJECT LOCATION	PLANT 19X
PROJECT/PROGRAM TITLE	PRI (85-D-140) PRODUCTIVITY & RAD. IMPROVEMENTS SOUTH AMMONIA STORAGE FACILITY
PROJECT COST	$1,100,000
CONSTRUCTION START DATE	9/86
PROJECT/PROGRAM NUMBER	00-85501-1100
NEPA DOCUMENT NUMBER	000031
NEPA SUBMITTAL DATE	9/4/87

PROJECT EXECUTIVE SUMMARY

This project involves the installation of a facility to be used for the bulk storage of anhydrous ammonia. The facility was constructed on a previously unused plot of land within the production area at the FMPC. The South Ammonia Storage Facility (SASF) is located on the Southwest side of the FMPC plant site. The facility consists of two 20,000 gallon storage vessels, two ammonia transfer pumps, a compressor, and a concrete containment structure designed to contain any liquid spills. The containment structure also includes a sump pump and all piping, instrumentation and safety features necessary for operation.

PROJECT JUSTIFICATION

The project is required to insure the continued safe storage and delivery of ammonia to production facilities at the FMPC. Existing facilities for the bulk storage of ammonia at the FMPC are over 30 years old and have a limited useful life remaining. New facilities are required to assure an uninterrupted supply of ammonia to site production operations.

The cumulative impacts of this project have been assessed, and it has been determined that this action does not have net adverse environmental impacts. Other options have not been precluded by this action.

EXISTING NEPA DOCUMENTATION/DATE SUBMITTED

NONE	R.C.	ADM.	R.A.
	AUG 0 7 1987		

THIS NEPA DOCUMENT

R.C.	ADM.	R.A.	R.I.S.
SEP 0 4 1987			

DOE APPROVAL REQUESTED	COORDINANT PROJECT ENGINEER/DATE R.W. Helmes by C.O. Foster 9/4/87
	SITE NEPA COORDINATOR/DATE [illegible] 9-4-87
DOE/FMPC XX	SITE NEPA MANAGER/DATE [illegible] 9/4/87
DOE/ORO ____	SITE DOE OFFICER/DATE James A. Rafferty 9/8/87
DOE/HQ ____	ADDITIONAL DOE APPROVALS REQUIRED DATE Carol Borgstrom 11/9/87

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER R. W. Helmes
		PROJECT LOCATION PLANT 19X
PROJECT/PROGRAM TITLE PRI (85-D-140) PRODUCTIVITY & RAD. IMPROVEMENTS SOUTH AMMONIA STORAGE FACILITY		PROJECT COST $1,100,000
		CONSTRUCTION START DATE 9/86
PROJECT/PROGRAM NUMBER 00-85501-1100	NEPA DOCUMENT NUMBER 000031	NEPA SUBMITTAL DATE 9/4/87

1.0 PURPOSE AND NEED FOR ACTION:

The FMPC was constructed in the early 1950's and has been operating continuously since that time. The original ammonia storage tanks were constructed at that time. Therefore, existing ammonia storage facilities are at or near the end of their useful life. New storage facilities are required to assure the safe storeage and supply of anhydrous ammonia to onsite users. An available ammonia supply is essential for maintaining production at the FMPC. Ammonia is a key reagent in both the production of Uranium Tetrafluoride (UF_4) from Uranium Trioxide (UO_3) and for the conversion of Uranium Hexafluoride (UF_6) to Uranium Tetrafluoride.

This project was designed and constructed and will be operated in conformance with DOE, OSHA and FMPC regulations governing health and safety, i.e. - DOE 6430.1 "General Design Criteria", DOE 5480.1B "Environmental Protection Program for DOE Operations" and Code of Federal Regulations, Title 29, Chapter 1910, Occupational Safety and Health Administration.

2.0 DESCRIPTION OF PROPOSED ACTION:

A completely new anhydrous ammonia storage facility was constructed on a previously unused plot of land within the plant production area (Figure 1). Once this facility is operational, storage of ammonia will be discontinued in the existing ammonia storage tanks. The existing tank farm will be replaced with new facilities including two additional ammonia storage tanks. During construction of the ammonia storage tanks for the main tank farm, ammonia from the South Ammonia Storage Facility will supply the entire FMPC site. Once both ammonia storage sites are operational, the long ammonia transfer pipeline currently needed will no longer be required. Each facility will then supply only its local production users.

FMPC NEPA DOCUMENTATION		COGNIZANT PROJECT ENGINEER R. W. Helmes
		PROJECT LOCATION PLANT 19X
PROJECT/PROGRAM TITLE PRI (85-D-140) PRODUCTIVITY & RAD. IMPROVEMENTS SOUTH AMMONIA STORAGE FACILITY		PROJECT COST $1,100,000
		CONSTRUCTION START DATE 9/86
PROJECT/PROGRAM NUMBER 00-85501-1100	NEPA DOCUMENT NUMBER 000031	NEPA SUBMITTAL DATE 9/4/87

No environmental permits associated with this facility were required, however, a Notice of Intent, summarizing the processing steps for any collected waste water at this facility will be issued to the EPA.

3.0 ALTERNATIVES CONSIDERED:

3.1 No Action

No new storage facilities for anhydrous ammonia. This would necessitate continued utilization of existing storage vessels and piping. Since the existing facilities are near the end of their useful life, this could increase the probability of an ammonia release.

3.2 Alternate Action

New storage vessels located on the same site as current facilities. This alternative would retain the long ammonia transfer piping required to supply ammonia from the main tank farm to the two facilities on the West side of the FMPC site. The risks associated with possible leaks from this pipeline would persist.

3.3 Proposed Action

New storage facility located near the UF_6 - UF_4 conversion plants - this alternative combines the advantages of a new storage facility designed to modern standards with minimal transfer piping.

4.0 POTENTIAL ENVIRONMENTAL IMPACTS OF PROPOSED ACTION:

The Attached NEPA checklist summarizes the elements involved with the construction and operation of the South Ammonia Storage Facility.

Construction of this facility was on a previously unused plot of land within the plant production area (Figure 1). The only radioactive material associated with this project was low levels of Uranium found in the soil (less than 200 ppm). Approximately 400 cubic yards of soil was handled in

FMPC NEPA DOCUMENTATION PRI (85-D-140)		COGNIZANT PROJECT ENGINEER R. W. Helmes
		PROJECT LOCATION PLANT 19X
PROJECT TITLE PRODUCTIVITY & RAD. IMPROVEMENTS SOUTH AMMONIA STORAGE FACILITY		PROJECT COST $1,100,000
		CONSTRUCTION START DATE 9/86
PROJECT/PROGRAM NUMBER 00-85501-1100	NEPA DOCUMENT NUMBER 000031	NEPA SUBMITTAL DATE 9/4/87

accordance with site procedures in effect at the time of excavation. Disposal of construction debris was in accordance with applicable site procedures.

It is estimated, for about 1000 hours diesel powered equipment was operated during construction of this project. The workforce added to the site was approximately 4 men on a 4 day work week schedule over a 12 month construction period.

Wastewater collected at the South Ammonia Storage Facility will drain to a collection sump where it will be analyzed to determine it's required discharge. Water will be discharged to either the stormsewer system by gravity drain, or it will be pumped to wastewater holding tanks at the Pilot Plant. At the Pilot Plant, South Ammonia Storage Facility wastewater will be mixed with additional wastewaters before being transferred to existing onsite treatment facilities.

Controlled emission of ammonia is anticipated during startup and commissioning of the facility. The tanks will be pressurized with ammonia and vented at a controlled rate through water to absorb the bulk of the ammonia. The aqueous ammonia solution will be disposed of according to existing approved procedures.

FMPC NEPA DOCUMENTATION PRI (85-B-140)		COGNIZANT PROJECT ENGINEER R. W. Helmes
		PROJECT LOCATION PLANT 19X
PROJECT TITLE PRODUCTIVITY & RAD. IMPROVEMENTS SOUTH AMMONIA STORAGE FACILITY		PROJECT COST $1,100,000
		CONSTRUCTION START DATE 9/86
PROJECT/PROGRAM NUMBER 00-85501-1100	NEPA DOCUMENT NUMBER 000031	NEPA SUBMITTAL DATE 9/4/87

Construction of the South Ammonia Storage Facility represents an action which may be taken during the course of an ongoing EIS, as defined by the Council on Environmental Quality (40 CFR 1506.1). As such:

1. This action has no net adverse environmental impact. The South Ammonia Storage Facility is located within the previously developed production area and is not in close proximity to waterways. This facility is necessary to continued safe production operations at the FMPC.

2. This action does not preclude the choice of reasonable alternatives to the action being undertaken. Should future findings be made which suggest that the South Ammonia Storage Facility is not needed, decontamination and decommissioning or relocation of the facility be undertaken.

6.0 CUMULATIVE IMPACTS

No net negative environmental impacts have been assessed to result from this project, and other reasonable alternatives are not precluded by this action.

FMPC NEPA CHECKLIST ATTACHMENT		COGNIZANT PROJECT ENGINEER R. W. Helmes
		PROJECT LOCATION PLANT 19X
PROJECT/PROGRAM TITLE PRI (85-D-140) PRODUCTIVITY & RAD. IMPROVEMENTS SOUTH AMMONIA STORAGE FACILITY		PROJECT COST $1,100,000
PROJECT/PROGRAM NUMBER 00-85501-1100	THIS NEPA DOCUMENT 000031	CONSTRUCTION START DATE 9/86
		NEPA SUBMITTAL DATE SEP 04 1987

1.0 Will any of the following be encountered, handled, stored, used, or disposed of during the construction of the proposed program or project?

Radioactive materials (identify) Contaminated soil - less than 200 ppm	(Y)	N	U
Hazardous materials (identify)	Y	(N)	U
Toxic materials (identify)	Y	(N)	U
Mixed hazardous and radioactive materials (identify)	Y	(N)	U
PCB's (identify source)	Y	(N)	U
Asbestos (identify source)	Y	(N)	U
Organic chemicals (identify)	Y	(N)	U
Heavy metals (identify)	Y	(N)	U

2.0 Will program activities involve discharges to any one of the following systems during the construction of the proposed project?

Low level waste disposal (describe) Contaminated soil - less than 200 ppm	(Y)	N	U
Process waste stream	Y	(N)	U
Sanitary waste stream	Y	(N)	U
Storm sewer Stormwater drainage to stormsewer	(Y)	N	U

3.0 Will any of the following be encountered, handled, stored, used, or disposed of during operation of, or following the proposed program changes?

Radioactive materials (identify)	Y	(N)	U
Hazardous materials (identify) Anhydrous Ammonia	(Y)	N	U
Toxic materials (identify) Anhydrous Ammonia	(Y)	N	U
Mixed hazardous and radioactive materials (identify)	Y	(N)	U
PCB's (identify source)	Y	(N)	U

Asbestos (identify source) Y (N) U

Organic chemicals (identify) Y (N) U

Heavy metals (identify) Y (N) U

4.0 Will program activities involve discharges to any one of the following systems during operation of, or following the proposed program changes?

Low level waste disposal (describe) Y (N) U

Process waste stream (Y) N U

See 4th paragraph of Section 4.0

Sanitary waste stream Y (N) U

Storm sewer (Y) N U

See 4th paragraph of Section 4.0

5.0 Are uncontrolled emissions, discharges, or spills possible during:

The construction phase of this project? Y (N) U

The operational phase, upon completion of the project? (Y) N U

Possible leak of ammonia to atmosphere or contaminated water to stormsewer.

6.0 Will the project involve any of the following:

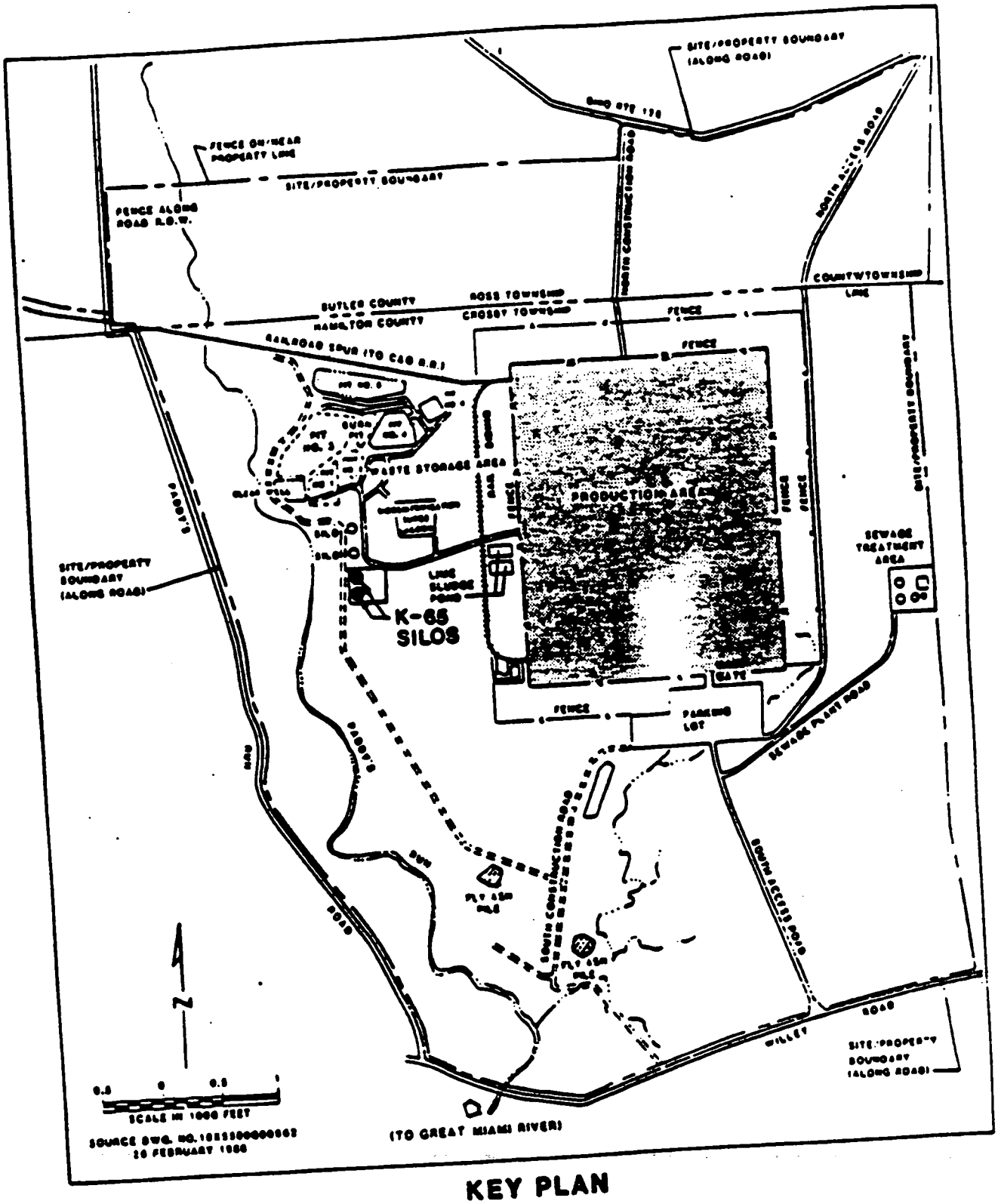
Need for aboveground storage during construction?	Y	(N)	U
Need for underground storage during construction?	Y	(N)	U
Need for aboveground storage during operations?	(Y)	N	U
2 Anhydrous Ammonia Tanks			
Need for underground storage during operations?	Y	(N)	U

7.0 Is the project located in close proximity to a natural stream or within the floodplain of a natural stream? Y (N) U

8.0 Are controlled emissions or discharges planned during:

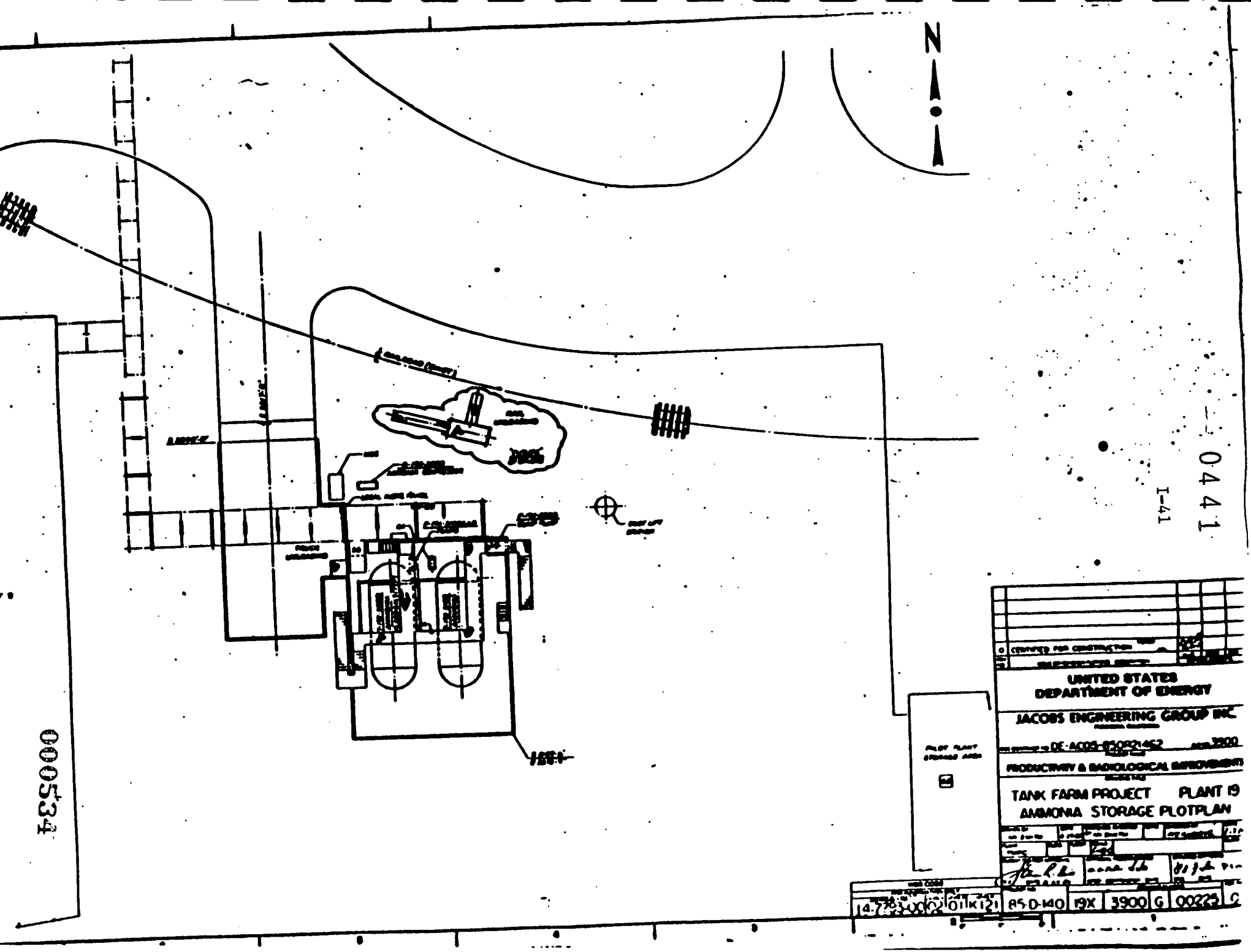
The construction phase of this project?	Y	(N)	U
The operational phase, upon completion of this project?	(Y)	N	U

See last paragraph in Section 4.0



KEY PLAN

FIGURE 1


N
UNITED STATES
DEPARTMENT OF ENERGY
JACOBS ENGINEERING GROUP INC.
PRODUCTIVITY & RADIOLOGICAL IMPROVEMENTS
TANK FARM PROJECT
PLANT 19
AMMONIA STORAGE PLOTPLAN
14-7733-XXX2
011K121
R5D-140
19X
3900
G
00223
0441
I-41
000534

E-0441

REFERENCE

DOE (U.S. Department of Energy) 1988a. Thorium Handling Environmental Assessment, Feed Materials Production Center, Fernald, Ohio, DOE/EA-0338, January 1988.

DOE (U.S. Department of Energy) 1988b. Decontamination and Decommissioning Facility Environmental Assessment, DOE/EA-0333, August 19, 1988.

000535

APPENDIX J

CONSULTATION WITH AGENCIES

APPENDIX J

CONSULTATION WITH AGENCIES

In accordance with the Council on Environmental Quality (CEQ) regulations (40 CFR Pt. 1502.25), the U.S. Department of Energy (DOE) has consulted with a number of federal and state agencies during the preparation of the Draft Environmental Impact Statement (EIS), including the following:

- U.S. Fish and Wildlife Service (in accordance with the Fish and Wildlife Coordination Act and the Endangered Species Act),
- Ohio State Historic Preservation Officer (in accordance with the National Historic Preservation Act), and
- Ohio Department of Natural Resources.

This appendix is a compilation of the correspondence between DOE and these federal and state environmental agencies.

0441

OhioEPA

State Of Ohio Environmental Protection Agency

P.O. Box 1049 361 East Broad St. Columbus, Ohio 43216-1049
(614) 466-8565

J-2

Richard F Celeste Governo

November 4, 1986

James A. Reafsnyder
Department of Energy
Oak Ridge Operations
P.O. Box E
Oak Ridge, Tennessee 37831

Mr. Reafsnyder:

This letter is in response to your September 25, 1986 request for the Ohio Environmental Protection Agency to participate as a cooperating agency in the preparation of the draft Environmental Impact Statement (DEIS) for the proposed renovation and remedial action activities at the Feed Materials Production Center (FMPC) located near Fernald, Ohio.

The Ohio Environmental Protection Agency is interested in participating in the development of the draft EIS for the proposed renovation and remedial action activities at the FMPC. Thank you for the opportunity to comment in this process.

Warren W. Tyler

RSM
12020.0

cc: Jack Van Kley, Attorney General
Graham Mitchell, Ohio EPA, SEDO
Virginia Aveni, Ohio EPA, Director's Office
Chuck Taylor, Ohio EPA, DSIWM
Andy Turner, Ohio EPA, DWPC
Tom Winston, Ohio EPA, SWDO
Don Marshall, Ohio EPA, SEDO
Jenny Tiell, Ohio EPA, LA

Doc. #1113P

000533

J-3

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 5
230 SOUTH DEARBORN ST.
CHICAGO, ILLINOIS 60604

REPLY TO THE ATTENTION OF

25 NOV 1986

5RA-14

Mr. James A. Reafsnyder
Site Manager
U.S. Department of Energy
Feed Materials Production Center
P.O. Box E
Oak Ridge, Tennessee 37831

Dear Mr. Reafsnyder:

We are writing in response to your letter of September 25, 1986, requesting our Agency to be a cooperating agency in the preparation of the draft Environmental Impact Statement (EIS) for the proposed renovation and remedial action activities at the Feed Materials Production Center near Fernald, Ohio.

In order for us to decide whether or not it would be appropriate to be a cooperating agency, our role and responsibilities must be clearly defined. There is the potential for this Agency to be seen as compromising its oversight responsibilities by becoming a cooperating agency. Our role as a party to the Federal Facility Compliance Agreement, and our review responsibilities under Section 309 of the Clean Air Act, must remain independent of any cooperating agency role.

Before we agree to become a cooperating agency, the following items must be addressed:

1. What EPA is to provide?

2. How EPA will review its portion of the EIS for concurrence, prior to publishing the document?

3. How EPA will review the rest of the document (that portion for which it does not take responsibility), via the 309 process?

4. How EPA will deal with the public comments on its portion of the document?

5. How EPA's cooperating agency status will be acknowledged in the document (defining its area and degree of responsibility)?

6. How differences will be resolved; or, if they cannot be resolved, what process will be used to dissolve the relationship?

7. EPA should be promptly informed of all schedule changes that would affect its ability to provide timely input to the document.

DEC 02 1986

It should be understood that the clarification of our role, by addressing the seven items above, does not necessarily guarantee that we will be a cooperating agency, as defined by the Council on Environmental Quality's regulations. Because of our role and responsibility under the Federal Facility Compliance Agreement, we are reluctant to become a cooperating agency. The public perception of our agency as having oversight responsibilities could be compromised if we took an active role in the environmental impact statement process. However, we are willing to discuss what you view as our role in the preparation of the environmental impact statement.

In order for our two agencies to decide on the roles and responsibilities, we recommend that we meet to discuss the issues. It may be helpful if a draft Memorandum of Understanding is prepared, as suggested in your letter, to focus the discussion.

If you have any questions regarding our response, please feel free to contact Mr. William D. Franz, Chief, Environmental Review Branch, at 312/886-7500.

Sincerely yours,

Robert Springer for

Valdas V. Adamkus
Regional Administrator

Department of Energy
Oak Ridge Operations
P. O. Box E
Oak Ridge, Tennessee 37831

April 9, 1987

Ecological Services Field Office
U. S. Fish and Wildlife Service
6950-H Americana Parkway
Reynoldsburg, Ohio 43068

Dear Sir/Madam:

The Department of Energy (DOE) is preparing an Environmental Impact Statement (EIS) addressing renovation and remedial action activities at the Feed Materials Production Center (FMPC), which is a DOE-owned manufacturing facility for the production of uranium metal used in the United States defense programs (51 FR 29583). The FMPC is located near Fernald, Ohio.

A map showing the site is enclosed. Proposed alternative actions include continued operation, renovation of existing facilities, and cleanup of wastes disposed from previous operations. No new facilities are planned to be constructed outside the fence shown on the map. No modification of natural waterways is planned. Treated effluents are presently discharged, under the terms of a NPDES permit, to the Great Miami River.

We request from you a list of threatened and endangered species that should be addressed in the EIS. Any other information that you may wish to provide on the presence of other important species and habitats on or near the site would also be useful.

We also request a determination of whether further consultation will be necessary to comply with the Fish and Wildlife Coordination Act. We can send you more information if necessary for this determination.

Any information you provide will be incorporated into the environmental impact analyses in the EIS, and any letter you send in response to this request will be reproduced in an appendix to the EIS.

Sincerely,

Ray Hansen

for James A. Reafsnyder
Site Manager

Enclosure:
As stated above

bcc: Margaret Wilson, ORO, SE-31
Bob Connor, WMCO
Don Hunsaker, ORNL

J-7

Department of Energy
Oak Ridge Operations
P. O. Box E
Oak Ridge, Tennessee 37831

April 13, 1987

Max E. Duckworth, Chief
Division of Wildlife
Ohio Department of National Resources
Fountain Square
Columbus, Ohio 43224

Dear Mr. Duckworth:

The Department of Energy (DOE) is preparing an Environmental Impact Statement (EIS) addressing renovation and remedial action activities at the Feed Materials Production Center, which is a DOE-owned manufacturing facility for the production of uranium metal used in the United States defense programs (51 FR 29583). The FMPC is located near Fernald, Ohio.

A map showing the site is enclosed. Proposed alternative actions include continued operation, renovation of existing facilities, and clean-up of wastes disposed from previous operations. No new facilities are planned to be constructed outside the fence shown on the map. No modification of natural waterways is planned. Treated effluents are presently discharged, under the terms of an NPDES permit, to the Great Miami River.

We request from you an indication of which threatened and endangered fish and wildlife species should be considered in the EIS. We would also welcome any information you might wish to provide on the presence of other important species and habitats on or near the site. The information would be incorporated into the environmental impact analyses in the EIS, and any letter you send in response to this request would be reproduced in an appendix to the EIS.

Sincerely,

James A. Reafsnyder
Site Manager

Enclosure:

bcc: Margaret Wilson, ORO, SE-31
Bob Conner, WMCO
Don Hunsaker, ORNL

E-0441

J-8

Department of Energy
Oak Ridge Operations
P. O. Box E
Oak Ridge, Tennessee 37831

April 13, 1987

Mr. W. Ray Luce, State Historic
Preservation Officer
Ohio Historic Preservation Office
1985 Velma Avenue
Columbus, Ohio 43211

Dear Mr. Luce:

The Department of Energy (DOE) is preparing an Environmental Impact Statement (EIS) addressing renovation and remedial action activities at the Feed Materials Production Center, which is a DOE-owned manufacturing facility for the production of uranium metal used in the United States defense programs (51 FR 29583). The FMPC is located near Fernald, Ohio.

A map showing the site is enclosed. Proposed alternative actions include continued operation, renovation of existing facilities, and clean-up of wastes disposed from previous operations. No new facilities are planned to be constructed outside the fence shown on the map.

As part of DOE's consultation responsibilities during the EIS process (40 CFR 1502.25), and in compliance with requirements of the National Historic Preservation Act, we are requesting the following information:

1. the existence of known historic resources in the project area;

2. any previous surveys performed with an evaluation of their quality; and

3. the need for further survey work including recommendations on the type of methods which should be applied and the boundaries of the survey area.

Mr. W. Ray Luce - 2 - April 13, 1987

This information would be incorporated into the analyses in the EIS, and any letter you send in response to this request would be reproduced in an appendix to the EIS.

Sincerely,

Original Signed by
J. A. Reafsnyder

James A. Reafsnyder
Site Manager

Enclosure:
As stated above

bcc: Margaret Wilson, SE-31, ORO
Bob Conner, WMCO
Don Hunsaker, ORNL

0441

J-10

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Columbus Field Office
6950-H Americana Parkway
Reynoldsburg, Ohio 43068

IN REPLY REFER TO:

April 23, 1987

Mr. James A. Reafsnyder
Department of Energy
Oak Ridge Opertions
P. O. Box E
Oak Ridge, Tennessee 37831

Dear Mr. Reafsnyder:

This responds to your April 9, 1987 letter requesting a list of threatened and endangered species which may be impacted by renovation and remedial action activities at the Feed Materials Production Center at Fernald, Hamilton County, Ohio.

This technical assistance letter is submitted in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.), the Endangered Species Act, of 1973, as amended, and is consistent with the intent of the National Environmental Policy Act of 1969 and the U. S. Fish and Wildlife Service's Mitigation Policy. It does not, however, constitute the report of the Secretary of the Interior under Section 2(b) of the Act, nor does it represent the review comments of the Department of the Interior on any forthcoming environmental document.

The proposed project lies within the range of the Indiana bat, a Federally listed endangered species. Due to the location (within existing facility), the projects, as proposed, will have no effect on this species. This precludes the need for further action on these projects as required by the 1973 Endangered Species Act, as amended. Should the projects be modified or new information become available that indicates listed or proposed species may be affected, consultation should be initiated.

At this time, it appears that further coordination under the Fish and Wildlife Coordination Act (FWCA) will be necessary. Depending on information provided in the environmental impact statement, we may have additional comments as to offsite impacts on fish and wildlife resources which may result from activities within the facility. Our FWCA comments would be contained in our letter of comment on the environmental impact statement and a separate FWCA report would not be necessary.

Date Rec'd APR 28 1987
Log 2201
File 5440

000546

We appreciate this opportunity to comment on your proposed projects. If you have any questions, please call Ken Multerer at 641/469-6923.

Sincerely yours,

Kent E. Kroonemeyer

Kent E. Kroonemeyer
Supervisor

cc: Chief, Ohio Division of Wildlife, Columbus, OH
Ohio DNR, Outdoor Recreation Serv, M. Colvin, Columbus, OH

0441

Ohio Historic Preservation Office

1985 Velma Avenue
Columbus, Ohio 43211
614/297-2470

J-12

OHIO HISTORICAL SOCIETY
SINCE 1885

May 5, 1987

James A. Reafsnyder
Site Manager
Department of Energy
Oak Ridge Operations
P.O. Box E
Oak Ridge, Tennessee 37831

Dear Mr. Reafsnyder:

Re: Feed Materials Production Center, near Fernald, Ohio

This letter is in response to your correspondence dated April 13, 1987 concerning the project noted above. My staff has reviewed the information provided. Based on their recommendation, it is my opinion that the proposed undertaking will have no effect on any properties that are either listed in or eligible for the National Register of Historic Places. Therefore, no further coordination with our office will be necessary unless the scope of the undertaking changes.

If you have any questions about this matter, please contact Richard Boisvert or Catherine Stroup at (614) 297-2470 . Thank you for your cooperation.

Sincerely,

W. Ray Luce

W. Ray Luce
State Historic Preservation Officer

WRL/CAS:cs

Date Rec'd MAY 12 1987
Log A-196
File
Library

000548

J-13

Ohio EPA
State of Ohio Environmental Protection Agency
P.O. Box 1049, 1800 WaterMark Dr.
Columbus, Ohio 43266-0149

Toward A Cleaner Environment

Richard F. Celeste
Governor

September 15, 1987

Mr. James A. Reafsnyder
FMPC DOE Site Manager
U.S. Department of Energy
Oak Ridge Operations
P.O. Box E
Oak Ridge, TN 37831

Dear Mr. Reafsnyder:

The Ohio Environmental Protection Agency currently is reviewing the DRAFT MEMORANDUM OF UNDERSTANDING (MOU) - ENVIRONMENTAL IMPACT STATEMENT (EIS) FOR THE FEED MATERIALS PRODUCTION CENTER. Ohio EPA comments will be transmitted to you when they are finalized.

Please continue to use Tom Winston, Chief, Southwest District Office, as Ohio EPA's point of contact.

Regards,

Edward Armstrong for

Carl A. Wilhelm
Chief, Planning

CAW, RBM:mp
#1113P,p26

cc: Alan Lapp, Acting Legal Advisor, Ohio EPA
Chuck Taylor, Chief, DSHWM, Ohio EPA
Matt Tin, Chief, DWPC, Ohio EPA
Pat Walling, Chief, DAPC, Ohio EPA
Tom Winston, Chief, SWDO, Ohio EPA
Graham Mitchell, Fernald Site Coordinator, SWDO, Ohio EPA
Reading/File
EIS File

APPENDIX K

SUMMARY AND ANALYSIS OF PUBLIC SCOPING COMMENTS

APPENDIX K

SUMMARY AND ANALYSIS OF PUBLIC SCOPING COMMENTS

K.1 SCOPING PROCESS

The U.S. Department of Energy (DOE) began the scoping process for the Environmental Impact Statement (EIS) addressing renovation and waste clean-up at FMPC with the publication of a Notice of Intent (NOI) to Prepare an Environmental Impact Statement and to Conduct a Public Scoping Meeting. This notice was published in the Federal Register on Tuesday, August 19, 1986, on pp. 29583-87. On Friday, August 22, 1986, DOE issued a press release to the media in the Cincinnati area announcing the EIS preparation and the meeting scheduled for Wednesday, September 3, 1986, at the Crosby Township School located near the Feed Materials Production Center (FMPC) site.

On September 8, 1986, DOE published in the Federal Register an amendment to the Notice of Intent that announced the holding of a second scoping meting at the same location on Monday, September 22, 1986 (Federal Register, Vol. 51, pp. 31963-64). The second meeting was scheduled because after the NOI was published, DOE received a number of requests for additional time to prepare comments. DOE issued a press release with this same announcement on Friday, August 29, 1986.

Public scoping meetings for the FMPC EIS were held at Crosby Township School at 7:30 p.m. on September 3, 1986, and on September 22, 1986. Approximately 100 people attended the first meeting, and five people presented comments. At the second meeting, more than 186 people attended, and about 35 speakers presented comments. Transcripts of both meetings are available in locations given in the NOI, as are of written comments submitted for the record of both meetings.

K.2 DISCUSSION OF PUBLIC SCOPING COMMENTS

Tables K.1, K.2, and K.3 summarize and evaluate written and verbal comments from the September 1986 public scoping meeting. Major issues raised were (1) radiation doses to the general public and workers; (2) chemical exposure effects to the general public, workers, and ecological resources; (3) exposure pathways, including surface water, groundwater, air, and direct radiation; (4) socioeconomic impacts associated with traffic, expenditures, and cultural resources; (5) monitoring and mitigation; and (6) cumulative impacts.

Each of these summary tables contains five columns that present the following information: (1) a summary comment number, (2) the name of the person who presented a verbal or written comment, (3) the page number in the official meeting transcript or document from which a comment was derived, (4) an assessment of the scoping meeting comment, and (5) a summary of the comment made from the meeting transcript.

Issues raised during the EIS were reviewed to see if they fell into one of the following categories:

- o EIS--comment to be addressed in the EIS,
- o NRR--no response required in the EIS,
- o BSD--comments beyond the scope of the EIS, or
- o RI/FS--comment to be addressed in future FMPC Remedial Investigation/Feasibility Study (RI/FS) and FMPC National Environmental Policy Act (NEPA) documentation.

Issues beyond the scope of the document (BSD) and comments that required no response (NRR) in the EIS are not addressed in the EIS. Examples of comments judged BSD include protection for "whistleblowers," compensation, "peace and serenity," testing of houses for contamination, renaming FMPC, need for nuclear weapons, closing of FMPC immediately, split samples, property values, and acceleration of the NEPA process. An example of a comment judged NRR is that the Sierra Club supports EIS preparation.

Remedial Investigation/Feasibility Study issues deal with topics that will be addressed in future FMPC RI/FS-EIS documentation. These include such issues as the final disposal of the K-65 silo waste and specific methods of site remedial action.

Table K.1. Analysis of verbal comments made at the September 3, 1986, scoping meeting

	NAME	PAGE	RESPONSE*	COMMENT
1	Leist, Virginia N.	9	BSD	Worker health compensation
2	Davidson, Gerry	11	BSD	FMPC accountability to residents
3	Davidson, Gerry	11	EIS	FMPC relocation
4	Davidson, Gerry	11	BSD	Scrutiny of local universities
5	Davidson, Gerry	11	BSD	Outside monitoring of FMPC radionuclide discharges
6	Dastillung, Vicki	14	EIS	Explanation of "defined hazardous material."
7	Dastillung, Vicki	14	EIS	Radiation standards and guidelines
8	Dastillung, Vicki	14	EIS	Description of remedial action and renovation projects
9	Dastillung, Vicki	14	EIS	Increased probabilities for accidents and impacts
10	Dastillung, Vicki	14	EIS	Baseline monitoring
11	Dastillung, Vicki	14	EIS	Increased monitoring during renovation and remedial action
12	Dastillung, Vicki	14	EIS	Use of earlier studies in EIS
13	Dastillung, Vicki	14	BSD	Split sampling used for FMPC monitoring
14	Dastillung, Vicki	14	EIS	Off-site and on-site well testing
15	Dastillung, Vicki	14	EIS	Test wells for EPA priority pollutants and radionuclides
16	Dastillung, Vicki	14	EIS	Public wells in the FMPC vicinity should be tested
17	Dastillung, Vicki	14	EIS	Ambient air monitoring should be increased
18	Dastillung, Vicki	14	EIS	Offsite soil testing for radionuclides
19	Dastillung, Vicki	14	EIS	Testing of food sources for uranium and other chemicals
20	Dastillung, Vicki	14	BSD	High radon levels in homes in the Ross area
21	Dastillung, Vicki	14	EIS	Temporary and permanent disposal of chemical and radioactive wastes generated during new construction
22	Dastillung, Vicki	14	EIS	Offsite radioactive contamination and noise levels from new construction
23	Dastillung, Vicki	14	RI/FS	Impacts from collapse of the K-65 silos and on the final disposition of the waste in the silos
24	Dastillung, Vicki	14	EIS	Thorium onsite management
25	Dastillung, Vicki	14	EIS	Air quality impacts from operating the FMPC incinerator
26	Dastillung, Vicki	14	EIS	Contents of the waste pits
27	Dastillung, Vicki	14	RI/FS	Temporary and permanent disposition of this waste

000553

—0441

000541

Table K.1 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
28	Dastillung, Vicki	14	EIS	Radionuclide and/or chemical leaks from pits into the aquifer
29	Dastillung, Vicki	14	EIS	Waste shipment from FMPC
30	Dastillung, Vicki	14	EIS	Generation and storage of new waste types not now present
31	Dastillung, Vicki	14	EIS	Effects on flora and fauna of the area
32	Dastillung, Vicki	14	EIS	Impacts from tank farm accidents
33	Dastillung, Vicki	14	EIS	Worker health studies
34	Dastillung, Vicki	14	EIS	Evacuation alarm system
36	Dastillung, Vicki	14	EIS	Health and quality of life of future generations
37	Weitz, Conrad	21	BSD	Reasons for terminating DOE/NLO contract should be given
38	Weitz, Conrad	21	BSD	DOE oversight of defense plants
39	Morr, Fred E.	23	BSD	Acceleration of EIS
40	Morr, Fred E.	23	EIS	Monitoring data included in EIS

*EIS--Comment will be addressed in the EIS.
NRR--No response required.
BSD--Comment is beyond the scope of the EIS.
RI/FS--Comment will be addressed in the FMPC Remedial Investigation/Feasibility Study Documentation

E-0441

Table K.2. Analysis of verbal comments made at the September 22, 1986, scoping meeting

	NAME	PAGE	RESPONSE*	COMMENT
41	Weiss, Leonard	12	BSD	Summary of Senator Glenn's activities
42	Von Kley, Jack	16	EIS	Don't limit alternatives
43	Von Kley, Jack	16	EIS	Cumulative impacts need evaluation
44	Von Kley, Jack	16	EIS	Waste pits - impacts
45	Von Kley, Jack	16	EIS	Increased emissions
46	Von Kley, Jack	16	EIS	Water pollution
47	Von Kley, Jack	16	BSD	Home values
48	Von Kley, Jack	16	EIS	Truck traffic
49	Aveni, Virginia	21	BSD	Effects of present practices need to be controlled before renovation
50	Murdock,Norm	24	BSD	Involve community in EIS process
51	Murdock,Norm	24	BSD	Move quicker than 2 years
52	Murdock,Norm	24	EIS	Deal with waste pits, silos, aquifer
53	Crawford, Lisa	30	EIS	Monitoring quality of food, water, air, and soil in the community
54	Crawford, Lisa	30	BSD	Control rate of waste production
55	Crawford, Lisa	30	RI/FS	Relocate wastes
56	Crawford, Lisa	30	BSD	Determine source of elevated radon level in some homes
57	Crawford, Lisa	30	EIS	No increase in noise, decrease in air quality, or new waste generated
58	Crawford, Lisa	30	EIS	Increase monitoring
59	Crawford, Lisa	30	BSD	Construction worker training with regard to hazards
60	Crawford, Lisa	30	EIS	Remove renovation wastes
61	Crawford, Lisa	30	EIS	Define allowable exposure
62	Crawford, Lisa	30	EIS	Emergency plan
63	Crawford, Lisa	30	EIS	Health and safety of residents during construction and remedial action
64	Crawford, Lisa	30	BSD	Property values
65	Crawford, Lisa	30	BSD	Peace and serenity
66	Crawford, Ken	34	EIS	Off-site wells monitored
67	Crawford, Ken	34	NRR	Names and addresses of DOE officials
68	Crawford, Ken	34	EIS	Operate FMPC safely
69	Crawford, Ken	34	BSD	Don't increase production until impacts are known
70	Crawford, Ken	34	BSD	Provide test results to affected residents

000555

-0441

000556

Table K.2 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
71	Meyer, Kathy	35	EIS	Study should include air, water, soil K-65 silos and new processes--what are health effects
73	McFarland, Gerda	37	EIS	Future health effects
74	McFarland, Gerda	37	EIS	Noise levels--abatement
75	McFarland, Gerda	37	BSD	Television interference
76	Folker, Tim	39	EIS	Characterize contaminants from reprocessing
77	Folker, Tim	39	BSD	Examine methods to protect the worker
78	Folker, Tim	39	EIS	Examine flow of contaminants during processing operations
79	Folker, Tim	39	EIS	Characterize ultimate fate of contaminants
80	Folker, Tim	39	BSD	Accuracy of monitoring data
81	Folker, Tim	39	BSD	Have EIS done by an independent agency
82	Shearer, Velma	43	BSD	Assume responsible community concern
83	Shearer, Velma	43	BSD	Westinghouse conflict of interest
84	Shearer, Velma	43	BSD	Safety of operation
85	Shearer, Velma	43	EIS	Aquifer protection
86	Shearer, Velma	43	BSD	Air quality data suspect
87	Shearer, Velma	43	EIS	Does expansion equal increased release of radiation in the air
88	Brandel, Fred C.	46	NRR	First 9 years of Fernald were clean
89	Feibelman, Allen	54	EIS	Need HEPA filters
90	Feibelman, Allen	54	EIS	Renovate ventilation system
91	Feibelman, Allen	54	EIS	Steam catch basin needed
92	Feibelman, Allen	54	EIS	Construction waste needs to be removed
93	Feibelman, Allen	54	EIS	Waste pits and silos prevented from leaching into aquifer
94	Feibelman, Allen	54	EIS	Waste might be stored above ground
95	Feibelman, Allen	54	EIS	Waste volume reduction
96	Schumacher, Steve	59	EIS	Scope must go back 36 years and include impacts of past, present, future
97	Schumacher, Steve	59	EIS	Chemical spills and contamination from tank farm
98	Schumacher, Steve	59	EIS	Impacts of construction and renovation
99	Schumacher, Steve	59	EIS	Disposal of low-level wastes
100	Schumacher, Steve	59	EIS	Impacts of radon gas from K-65 wastes

F-0441

Table K.2 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
101	Schumacher, Steve	59	EIS	Plans for replacing K-65 silos
102	Schumacher, Steve	59	BSD	Impacts of previous airborne releases of radioactive material
103	Schumacher, Steve	59	BSD	Verifiability and reliability of air quality data
104	Schumacher, Steve	59	EIS	Impacts of past, present and future releases on farm products, vegetation, and farmland within a 10-mile radius
105	Schumacher, Steve	59	EIS	Transportation equipment and practices
106	Schumacher, Steve	59	EIS	Examination of wells, creeks, surface runoff, Great Miami River, and all aquifers for contamination
107	Schumacher, Steve	59	BSD	Check water-treatment systems (Bolton Intake Station), for contamination
108	Schumacher, Steve	59	BSD	Health study of workers by independent agency
109	Schumacher, Steve	59	BSD	Health study of residents in 10-mile radius
110	Reicher, Dan	63	BSD	EIS needed much earlier
111	Reicher, Dan	63	BSD	No expansion or renovation work until EIS is prepared
112	Reicher, Dan	63	EIS	Consider all reasonable alternatives
113	Reicher, Dan	63	EIS	Abandon FMPC and build new facility in Cincinnati area
114	Reicher, Dan	63	EIS	Turn FMPC over to private sector
115	Reicher, Dan	63	BSD	Enemy or terrorist attack
116	Reicher, Dan	63	BSD	Cooperating federal agencies
117	Reicher, Dan	63	BSD	Use of EIS in decision-making process
118	Mersfelder, Sylvia	61	EIS	Adequacy of air monitoring stations
119	Mersfelder, Sylvia	61	BSD	Sampling by independent agency
120	Mersfelder, Sylvia	61	BSD	Use and storage of hazardous substances
121	Mersfelder, Sylvia	61	EIS	Standards for uranium emission
122	Mersfelder, Sylvia	61	BSD	Best available technology for filtering uranium dust
123	Mersfelder, Sylvia	61	EIS	Schedule for waste pit characterization
124	Mersfelder, Sylvia	61	EIS	Location of monitoring wells
125	Mersfelder, Sylvia	61	EIS	Remedial actions for waste pits
126	Mersfelder, Sylvia	61	BSD	Training of operators
127	Mersfelder, Sylvia	61	BSD	QA program for FMPC
128	Carpenter, Tom	85	EIS	Focus on waste pits, silos, and warehouses

0441

000557

000558

Table K.2 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
129	Carpenter, Tom	85	EIS	Removal of residue from greenhouse
130	Carpenter, Tom	85	EIS	Effect of plutonium and enriched uranium in pits on remedial action
131	Carpenter, Tom	85	EIS	Worker health and safety
132	Coyle, Dana	89	NRR	Sierra Club supports EIS preparation
133	Coyle, Dana	89	EIS	FMPC groundwater contamination
134	Coyle, Dana	89	EIS	Cones of influence of FMPC wells
135	Coyle, Dana	89	EIS	Modeling groundwater behavior
136	Coyle, Dana	89	EIS	Increased uranium in offsite wells
137	Coyle, Dana	89	EIS	Groundwater divide
138	Coyle, Dana	89	EIS	Bathtub effect
139	Coyle, Dana	89	EIS	Waste pit exhumation
140	Coyle, Dana	89	EIS	Waste pit characterization
141	Coyle, Dana	89	RI/FS	Methods for pit exhumation
142	Coyle, Dana	89	EIS	Options for disposal of radioactive/hazardous waste
143	Coyle, Dana	89	EIS	Waste transportation
144	Coyle, Dana	89	BSD	Offsite waste disposal impacts
145	Coyle, Dana	89	EIS	Deep aquifer/shallow aquifer interaction
146	Coyle, Dana	89	EIS	Groundwater recharge from Paddy's Run
147	Coyle, Dana	89	EIS	Surface water runoff
148	Coyle, Dana	89	EIS	FMPC site geology/glacial till
149	Coyle, Dana	89	EIS	Groundwater movement through the till
150	Coyle, Dana	89	EIS	Contamination in Paddy's Run sediments
151	Coyle, Dana	89	EIS	Excavation/removal of contaminated sediments in Paddy's Run
152	Coyle, Dana	89	EIS	Mechanism of uranium appearing in wells
153	Coyle, Dana	89	EIS	Offsite impacts from increased production
154	Coyle, Dana	89	EIS	Increased pumping affects aquifer
155	Coyle, Dana	89	EIS	Chemical toxicity of uranium
156	Coyle, Dana	89	EIS	Accidental release of uranium
157	Coyle, Dana	89	EIS	Evacuation plans
158	Coyle, Dana	89	BSD	Necessity for increasing warhead inventory
159	Fein, Diane	95	BSD	Identification of plant

F-0441

Table K.2 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
160	Fein, Diane	95	EIS	Health of residents near FMPC
161	Fein, Diane	95	BSD	Conduct survey of present resident health
162	Fein, Diane	95	NRR	Thanks to Sen. Glenn for bringing out need for health survey
163	Meyer, Don	99	BSD	20% of FMPC budget is for environmental concerns
164	Meyer, Don	99	NRR	Encouraged over EPA/DOE compliance agreement
165	Meyer, Don	99	BSD	Compliance agreement should be made federal law
166	Meyer, Don	99	EIS	EIS addresses only short term problems
167	Meyer, Don	99	BSD	Funds should be available to fix long-term problems
168	Meyer, Don	99	BSD	Immediate action needed to correct FMPC problems
169	Meyer, Don	99	EIS	Plant-wide HEPA filters needed
170	Meyer, Don	99	EIS	Thorium storage tanks should be stabilized
171	Meyer, Don	99	BSD	Identify onsite use for thorium or store at approved site
172	Meyer, Don	99	EIS	Stabilize K-65 silos immediately
173	Meyer, Don	99	EIS	Remove K-65 radium wastes--top priority
174	Meyer, Don	99	EIS	Diversion of stormwater runoff needed
175	Meyer, Don	99	EIS	Immediate corrective action needed at waste pits
176	Meyer, Don	99	BSD	DOE--lack of openness
177	Meyer, Don	99	BSD	Budget obscures ES&H improvements
178	McGee, Kevin	104	NRR	Citizen follow up to comments is important
179	McGee, Kevin	104	BSD	Need for weapons
180	Davidson, Jerry	105	BSD	Fernald will become a "no-man's land"
181	Davidson, Jerry	105	BSD	Residents will begin to leave area
182	Davidson, Jerry	105	BSD	Sale of real estate difficult
183	Davidson, Jerry	105	BSD	River should be cleaned up to raise fish
184	Davidson, Jerry	105	EIS	FMPC should be moved from area
185	Davidson, Jerry	105	NRR	Previous comments have been good
186	Estes, Ray	108	EIS	Close FMPC and transfer waste to unpopulated area
187	Estes, Ray	108	BSD	Convert FMPC to a research facility
188	Estes, Ray	108	BSD	DOE research on psychological effects on weapons material processing
189	Estes, Ray	108	BSD	Now is time for U.S. Academy of Peace to be formed
190	Qualls, Roxanne	109	BSD	DOE/NLO engaged in deception and coverup

F-0441

000559

000560

Table K.2 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
191	Qualls, Roxanne	109	NRR	Hearing is overdue
192	Qualls, Roxanne	109	EIS	Pits and silos should be addressed
193	Qualls, Roxanne	109	EIS	Pits should be characterized
194	Qualls, Roxanne	109	RI/FS	Core sampling should be done to determine creek contamination
195	Qualls, Roxanne	109	EIS	Study groundwater and surface water
196	Qualls, Roxanne	109	BSD	DOE standards should be more stringent
197	Qualls, Roxanne	109	EIS	Silo contents should be characterized
198	Qualls, Roxanne	109	BSD	Wells of all residents should be tested
199	Qualls, Roxanne	109	BSD	Health study should be done on residents exposed to contaminated water
200	Qualls, Roxanne	109	BSD	Resident's houses should be tested for contamination
201	Qualls, Roxanne	109	BSD	Current and previous workers should be tested for contamination
202	Qualls, Roxanne	109	BSD	EIS should fully uncover all FMPC problems
203	Qualls, Roxanne	109	BSD	DOE should apply most stringent environmental standards to FMPC
204	Dierig, Vicki	113	BSD	FMPC should not be expanded because of existing problems
205	Dierig, Vicki	113	NRR	All nuclear facilities pollute the environment
206	Dierig, Vicki	113	EIS	Perform risk assessment on community
207	Dierig, Vicki	113	BSD	Compensate community for health hazard
208	Dierig, Vicki	113	BSD	Environmental clean-up should start immediately
209	Dierig, Vicki	113	BSD	FMPC should be closed tomorrow
210	Dierig, Vicki	113	BSD	Nuclear weapons aren't needed
211	Shirley, Jack	115	EIS	Move FMPC to Piketon, Ohio
212	Jordan, Deborah	116	EIS	Long-range health effects of FMPC
213	Jordan, Deborah	116	BSD	Psychological effect of FMPC
214	Jordan, Deborah	116	BSD	More weapons not needed
215	Jordan, Deborah	116	BSD	FMPC should be closed, cleaned and converted to a research facility
216	Anderson, Rick	117	BSD	FMPC has been surrounded by secrecy
217	Anderson, Rick	117	BSD	DOE should guarantee immunity for whistleblowers
218	Anderson, Rick	117	BSD	Telephone hotline should be established for FMPC whistleblowers
219	Anderson, Rick	117	BSD	DOE should use 3rd party intervention in whistleblowing disclosure
220	Anderson, Rick	117	BSD	Worker security should be contractually guaranteed

F-0441

Table K.2 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
221	Pitzer, Joseph	120	EIS	Clean up the mess
222	Arthur, Daniel	121	BSD	Sampling of No. 1 test well, shallow & possible contamination of FMPC's drinking water
223	Arthur, Daniel	121	BSD	Provision of information to public
224	Morr, Fred	124	BSD	Cleanup while EIS is being developed
225	Enders, Gene	127	EIS	Spatial extent of EIS coverage

*EIS--Comment will be addressed in the draft EIS.
NRR--No response required.
BSD--Comment is beyond the scope of the draft EIS.
RI/FS--Comment will be addressed in the FMPC Remedial Investigation Feasiblity Study Documentation.

0441

000561

000564

Table K.3. Analysis of written comments submitted for the records of the scoping meetings

	NAME	PAGE	RESPONSE*	COMMENT
226	Branham, Gene	3	EIS	Define allowable exposure levels (rad and chem)
227	Branham, Gene	3	EIS	Identify areas of elevated risk at FMPC
228	Branham, Gene	3	BSD	EIS should comply w/ Cincinnatti Right to Know ordinance
229	Branham, Gene	3	BSD	Notices of risk posted in workplaces
230	Branham, Gene	3	EIS	Provide complete waste inventory
231	Branham, Gene	3	EIS	Characterize all pits completely, including releases
232	Branham, Gene	3	EIS	Describe handling procedures for all wastes on site
233	Branham, Gene	3	EIS	Increase monitoring during remedial actions
234	Branham, Gene	3	EIS	Don't compromise health and safety of workers and residents
235	Branham, Gene	3	BSD	Give priority to safety-related job/work orders
237	Branham, Gene	3	BSD	All improvements to FMPC should be state-of-the-art
238	Branham, Gene	3	EIS	Consider alternatives, identify most feasible plan
239	Branham, Gene	3	EIS	Consider all types of hazards
240	Branham, Gene	3	EIS	Improved dust collection and monitoring are needed
241	Branham, Gene	3	EIS	Describe procedures for unknown, unidentifiable wastes
242	Branham, Gene	3	BSD	Provide training for construction workers
243	Branham, Gene	3	BSD	Remedial actions may cause layoffs of FMPC workers
244	Branham, Gene	3	EIS	Consider modification, enclosure of equipment
245	Caldwell, Larry	10	EIS	Don't consider Hanford reservation for offsite disposal
246	Miller, R.	11	EIS	Recommends above-ground storage of uranium, wastes
247	Miller, R.	11	EIS	Need leakage detection systems
248	Miller, R.	11	EIS	Consider long-term expanded use of aquifer, in all directions
249	Reicher, Dan	12	BSD	Proposed action already underway
250	Reicher, Dan	12	BSD	Notice of Scoping too vague
251	Reicher, Dan	12	BSD	Preparers of EIS must disclose interests
252	Reicher, Dan	12	BSD	DOE must be willing to alter plans based on EIS results
253	Reicher, Dan	12	EIS	A "Suggested Scope of the EIS" is presented in outline form. [DOE Response: All topics suggested will be addressed in the EIS, except for those noted below.]
254	Reicher, Dan	12	BSD	Consider reducing DOD's need for nuclear weapons
255	Reicher, Dan	12	BSD	Consider supplying less FMPC material to foreign gov'ts

F-0441

Table K.3 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
256	Handke, Jan	33	EIS	Groundwater contamination
257	Fein, Diane	34	BSD	FMPC's name is deceptive
258	Fein, Diane	34	BSD	Call FMPC a "uranium refinery"
259	Fein, Diane	34	EIS	Health and safety of residents
260	Fein, Diane	34	BSD	Implement intensive health study of households
261	Haring, Marilyn	36	BSD	Impacts of FMPC on property values
262	Haring, Marilyn	36	EIS	Potential for major accidents
263	Haring, Marilyn	36	EIS	Emergency planning for evacuation
264	Shirley, Jack	38	EIS	Consider transfer of FMPC function to Piketon, Ohio
265	Feibelman, Allen	40	EIS	Consider installing HEPA filters on all buildings
266	Feibelman, Allen	40	EIS	Consider renovating ventilation systems
267	Feibelman, Allen	40	EIS	Consider bringing stormwater basin on line
268	Feibelman, Allen	40	EIS	Consider removing/recycling all rubble, scrap
269	Feibelman, Allen	40	EIS	Upgrade storage for low-level and mixed radwaste
270	Feibelman, Allen	40	EIS	Consider above-ground storage and volume reduction
271	Feibelman, Allen	40	EIS	Consider env., health, safety upgrades before expansion
272	Feibelman, Allen	40	BSD	Allocate weapons expenditures to clean-up instead
273	Morr, Fred E.	44	NRR	Castigate, penalize public officials responsible for FMPC
274	Morr, Fred E.	44	BSD	Consider emergency waiver of NEPA to accelerate clean-up
275	Badinghous, Robert	45	EIS	Noise disturbance - trucks, target practice. Monitoring and mit., noise study
276	Dastillung, Vicky	46	EIS	Need detailed list of proposed renovations, remedial actions
277	Dastillung, Vicky	46	EIS	Define "defined hazardous materials"
278	Dastillung, Vicky	46	EIS	Establish standards, guidelines for exposure (rad & chem)
279	Dastillung, Vicky	46	EIS	Write EIS in layman's terms
280	Dastillung, Vicky	46	EIS	Consider clean-up, but increase production at another site
281	Dastillung, Vicky	46	EIS	Perform intensive monitoring to establish baseline
282	Dastillung, Vicky	46	BSD	Have split samples analyzed by independent labs
283	Dastillung, Vicky	46	EIS	Reanalyse past reports
284	Dastillung, Vicky	46	EIS	More intensive groundwater sampling
285	Dastillung, Vicky	46	EIS	More air monitors, better placement
286	Dastillung, Vicky	46	EIS	Expand testing of soils, crops, milk

0044 1

000563

000564

Table K.3 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
287	Dastillung, Vicky	46	BSD	Radon gas in homes
288	Dastillung, Vicky	46	EIS	Define new types of waste to be generated
289	Dastillung, Vicky	46	EIS	Asbestos waste
290	Dastillung, Vicky	46	EIS	Disposal sites for rubble, contaminated equipment
291	Dastillung, Vicky	46	EIS	Offsite contaminant levels
292	Dastillung, Vicky	46	EIS	Radioactive or chemical contamination of construction dust
293	Dastillung, Vicky	46	EIS	Noise impacts
294	Dastillung, Vicky	46	EIS	Continuous monitoring, frequent reporting during const.
295	Dastillung, Vicky	46	BSD	Training of construction workers
296	Dastillung, Vicky	46	EIS	Will scrap pile get larger?
297	Dastillung, Vicky	46	EIS	Silos: escaping gas, possible collapse
298	Dastillung, Vicky	46	BSD	Stabilization or offsite disposal of thorium
299	Dastillung, Vicky	46	EIS	Incinerator emissions
300	Dastillung, Vicky	46	EIS	Waste pits: contents, disposal plans, releases to groundwater
301	Dastillung, Vicky	46	EIS	Rates and impacts of wastes from increased production
302	Dastillung, Vicky	46	EIS	Safety, impacts of waste transport offsite
303	Dastillung, Vicky	46	EIS	New types of waste from increased production
304	Dastillung, Vicky	46	EIS	Ecological impacts of increased production
305	Dastillung, Vicky	46	EIS	Accidental releases, emergency preparedness
306	Abbott, Nancy	54	EIS	What is coming from FMPC
307	Abbott, Nancy	54	BSD	Plant's effect on nearby cancer deaths
308	Abbott, Nancy	54	BSD	Workman's compensation
309	Resnikoff, Marvin	59	NRR	Background paper cited by letter from Dana Coyle--comparison of FMPC environmental releases from 1984 and 1985
310	Coyle, Dana	68	EIS	FMPC leakage into groundwater
311	Coyle, Dana	68	EIS	Evidence of increased levels of contamination over time at the South West Ohio Water Company. Data does now show this
312	Coyle, Dana	68	EIS	Cones of influence, FMPC production wells
313	Coyle, Dana	68	EIS	Increased levels of uranium in wells south and east of the plant--groundwater divide
314	Coyle, Dana	68	EIS	Address the spread of contamination by the bathtub effect

F-0441

Table K.3 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
315	Coyle, Dana	68	EIS	Exhumation of the waste pits
316	Coyle, Dana	68	EIS	Characterization study of waste pits
317	Coyle, Dana	68	RI/FS	Methods for exhuming the pits
318	Coyle, Dana	68	RI/FS	Methods for disposing of the waste
319	Coyle, Dana	68	RI/FS	Disposal options for hazardous and radioactive waste from pits and silos--short-term and long-term
320	Coyle, Dana	68	EIS	Assess transportation hazards
321	Coyle, Dana	68	EIS	Detailed investigations into hydrology, geology and geochemistry of site
322	Coyle, Dana	68	EIS	Investigation of interaction between deep aquifer and shallow aquifer
323	Coyle, Dana	68	RI/FS	Discharge measurements of Paddy's Run to determine water lost to ground
324	Coyle, Dana	68	EIS	Measurements to determine contamination pathways in Paddy's Run
325	Coyle, Dana	68	EIS	EIS should address contamination washed off production and waste pits to Paddy's Run during heavy and normal runoff periods
326	Coyle, Dana	68	EIS	Permanent monitoring program to measure contamination during flood stage
327	Coyle, Dana	68	EIS	Site geology should include glacial till and potential to spread contamination
328	Coyle, Dana	68	EIS	Movement of water and contamination thru till
329	Coyle, Dana	68	EIS	Contamination in sediment samples along Paddy's Run and the Storm Sewer Drainage Ditch
330	Coyle, Dana	68	RI/FS	Excavation and removal of contaminated sediment along Paddy's Run and Storm Sewer Drainage Ditch
331	Coyle, Dana	68	RI/FS	Geochemical analysis of soil and sediment to determine ion exchange between soil and radionuclides
332	Coyle, Dana	68	EIS	Existing contamination and potential for future contamination
333	Coyle, Dana	68	EIS	Mechanism for offsite contamination of private wells
334	Coyle, Dana	68	EIS	Estimate of how much contamination will get offsite
335	Coyle, Dana	68	EIS	Offsite contamination of areas around Fernald that al ready have above background

000595

—0441

000566

F-0441

Table K.3 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
336	Coyle, Dana	68	EIS	Effects of increased pumping on Great Miami aquifer
337	Coyle, Dana	68	EIS	Uranium's chemical toxicity to humans
338	Coyle, Dana	68	EIS	Should review all health standards including EPA draft exposure limits
339	Coyle, Dana	68	BSD	Health effects that have resulted from FMPC
340	Coyle, Dana	68	EIS	Potential effects of an accidental release of hazardous chemicals or nuclear material
341	Coyle, Dana	68	EIS	Evacuation plans for the plant, surrounding residences, businesses, and schools in the area
342	Coyle, Dana	68	BSD	Necessity of increasing the number of nuclear warheads
343	Coyle, Dana	68	EIS	Offsite well contamination
344	Coyle, Dana	68	EIS	Increasing levels of uranium in Southwest Ohio wells
345	Coyle, Dana	68	EIS	Contamination of soil
346	Coyle, Dana	68	EIS	Contamination of surface waterways
347	Coyle, Dana	68	EIS	Contamination of stream sediment
348	Coyle, Dana	68	EIS	Contamination of aquatic life and animals that feed there
349	Coyle, Dana	68	EIS	The amount of chemical, nuclear, and mixed waste present in the waste pits
350	Coyle, Dana	68	EIS	The physical form of wastes in the waste pits
351	Coyle, Dana	68	EIS	Identification/characterization of the chemical, nuclear, and mixed waste present in Silos
352	Coyle, Dana	68	EIS	The effects of past waste management and disposal activities
353	Coyle, Dana	68	BSD	Dates and effects of releases on environment
354	Coyle, Dana	68	EIS	FMPC compliance with all federal regulations
355	Coyle, Dana	68	EIS	Long-term waste disposal options for all waste from the pits, silos, and waste generated at the plant
356	Coyle, Dana	68	EIS	Waste transportation hazard
357	Coyle, Dana	68	BSD	FMPC programs to reduce the possibilities of abnormal operations or accidents at waste management and disposal facilities
358	Coyle, Dana	68	EIS	The extent of contamination of Paddy's Run water and sediment
359	Coyle, Dana	68	EIS	Existing health hazards

Table K.3 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
360	Coyle, Dana	68	EIS	Potential effects of FMPC on other industries locating to the Miami River Basin
361	Coyle, Dana	68	EIS	The effect increased FMPC production will have on the Great Miami Aquifer
362	Sierra Club RWC	80	NRR	Background paper cited by letter from Dana Coyle--uranium in private wells near FMPC
363	Crawford, Ken	103	NRR	Identify DOE officials who awarded N.L.O. bonuses while FMPC polluted the environment
364	Crawford, Ken	103	BSD	Show initiative to operate the FMPC safely without public pressure
365	Crawford, Ken	103	BSD	Don't increase production until after the impact on the environment is ascertained
366	Crawford, Ken	103	BSD	End public relations charade
367	Crawford, Ken	103	BSD	Give test results to affected and concerned residents
368	Crawford, Ken	103	NRR	Try to use common sense
369	Crawford, Lisa	104	EIS	Address the air, water, soil, welfare, safety, future generations, and quality of life
370	Crawford, Lisa	104	BSD	Extensive monitoring of food, water, air, and soil in the community with printed monthly reports to interested parties
371	Crawford, Lisa	104	BSD	Split sampling with independent laboratories
372	Crawford, Lisa	104	EIS	Monitoring should be increased both in quality and quantity
373	Crawford, Lisa	104	EIS	Monitors should be properly positioned for all substances and/or contaminants
374	Crawford, Lisa	104	BSD	More frequent and timely testing of ingested farm products
375	Crawford, Lisa	104	EIS	Expansion of well testing program both on and off-site
376	Crawford, Lisa	104	BSD	FMPC must not produce more waste per week than it can safely dispose of off-site per week
377	Crawford, Lisa	104	EIS	Relocate off-site the waste currently stored on-site
378	Crawford, Lisa	104	EIS	Source of the elevated radon found in some area homes
379	Crawford, Lisa	104	EIS	No increase in noise levels
380	Crawford, Lisa	104	EIS	No decrease in air quality
381	Crawford, Lisa	104	BSD	No new types of waste generated

0005667

F-0441

000563

F-0441

Table K.3 (continued)

	NAME	PAGE	RESPONSE*	COMMENT
382	Crawford, Lisa	104	EIS	Increased monitoring during construction
383	Crawford, Lisa	104	BSD	Construction worker training, with regard to all hazards on-site
384	Crawford, Lisa	104	BSD	Removal off-site of contaminated machinery
385	Crawford, Lisa	104	EIS	Definition of allowable exposure levels to radioactive and chemical substances
386	Crawford, Lisa	104	BSD	Stop construction and production if exposure levels exceed allowable EPA standards
387	Crawford, Lisa	104	BSD	An adequate emergency plan must be implemented
388	Crawford, Lisa	104	EIS	Health and safety of the residents must not be compromised during the proposed construction and remedial actions
389	Crawford, Lisa	104	BSD	EIS should re-establish our faith and confidence in our government's ability to protect FMPC neighbors
390	Crawford, Lisa	104	BSD	Property values should return to at least pre-December, 1984 values
391	Crawford, Lisa	104	BSD	Peace and serenity of rural life has been replaced with stress, fear, and mental anguish due to DOE's and FMPC's history of neglect
392	Crawford, Lisa	104	BSD	Would like to go back to living a normal and healthy life
393	Anderson, Rick	107	BSD	Procedures to facilitate FMPC whistleblowers
394	Anderson, Rick	107	BSD	Telephone hotline should be established for FMPC whistleblowers
395	Anderson, Rick	107	BSD	DOE should use 3rd party intervention in whistleblowing disclosure
396	Anderson, Rick	107	BSD	Worker security should be contractually guaranteed
397	Jordan, Deborah	108	EIS	Long range health effects of FMPC operations
398	Jordan, Deborah	108	BSD	Psychological effect of FMPC on young people
399	Jordan, Deborah	108	BSD	Relationship between weapons production and feeling of security
400	Jordan, Deborah	108	BSD	FMPC should be closed, cleaned and converted into a research facility to determine what to do with radioactive waste already present
401	Pitzer, Joseph M.	109	BSD	More weapons aren't needed
402	Pitzer, Joseph M.	109	BSD	Clean up FMPC before expanding
403	Silberstein, Edward	110	BSD	Chromosome studies on long-term FMPC workers should be performed

*EIS--Comment will be addressed in the draft EIS.
NRR--No response required.
BSD--Comment is beyond the scope of the draft EIS.
RI/FS--Comment will be addressed in the FMPC Remedial Investigation/Feasibility Study Documentation.

0441

000569

APPENDIX L

FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

APPENDIX L

FEDERAL AND STATE ENVIRONMENTAL REQUIREMENTS

This appendix summarizes the federal and state of Ohio agreements and requirements intended to protect human health and the environment that apply to activities at the Feed Material Production Center (FMPC).

L.1 INTERAGENCY AGREEMENTS

L.1.1 Memorandum of Understanding Among DOE, U.S. EPA, and OEPA for Preparation of the FMPC Renovation and Remedial Action EIS

A Memorandum of Understanding (MOU) exists among the U.S. Department of Energy (DOE), the U.S. Environmental Protection Agency Region V (EPA-V) and the State of Ohio Environmental Protection Agency (OEPA) (MOU 1987) regarding the conditions and procedures to be followed in the preparation of the FMPC renovation and remedial actions Environmental Impact Statement (EIS). The MOU sets forth the basic principles and guidelines under which the parties intend to cooperate in exchanging ideas, information, and data in the development of the FMPC EIS. Under the terms of the MOU, DOE is identified as the lead agency for preparation of the EIS, and EPA-V and OEPA are identified as cooperating agencies.

L.1.2 Federal Facility Compliance Agreement

EPA and DOE have entered into a Federal Facility Compliance Agreement (FFCA) (EPA-V 1986) which is intended to ensure that FMPC complies with existing environmental statues and implementing regulations, including the Clean Air Act of 1970 (CAA), the Resource Conservation and Recovery Act of 1976 (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA). The Agreement is also intended to ensure that the known environmental impacts associated with past and current activities at FMPC are thoroughly investigated and that appropriate remedial actions are taken. The Agreement does not address compliance with the Clean Water Act of 1977 (CWA).

DOE and EPA agreed that DOE shall conduct a Remedial Investigation/ Feasibility Study (RI/FS) to determine the nature and extent of contamination both on and off the FMPC site and shall implement initial remedial measures, in accordance with CERCLA guidelines. The Agreement also describes activities to be undertaken that would enable FMPC to comply with the CAA and RCRA and maintain compliance.

L.1.3 OEPA Director's Findings and Orders

Pursuant to Ohio Revised Code Section 6111.03(H), the Director of OEPA issued the Director's Findings and Orders in June 1987 for FMPC (OEPA 1987). This document details OEPA's findings on how past and current FMPC operations have affected and could affect "waters of the state," as defined by Ohio Revised Code Section 6111.01(H). The orders in this plan specify several near-term and long-term actions to protect the waters of

the state. Examples of short-term activities that have been implemented at FMPC include (1) cessation of waste discharges to Waste Pit 5 and (2) the repair of the Biodenitrification Surge Lagoon Liner to prevent possible leakage. An example of an order directed at long-term FMPC operations is the completion of a draft contingency plan (September 30, 1987) that describes actions to be taken to minimize impacts to Paddy's Run and the environment because of overflow surface water leakage, and overflow or bypass from the Stormwater Retention Basin. The order also specifies that a Best Management Practices (BMP) plan for the control of industrial wastes and other wastes be completed. The BMP plan was completed March 1, 1988.

L.1.4 Consent Decree Between State of Ohio and DOE

On March 11, 1986, the State of Ohio filed a complaint against DOE, alleging that DOE, in its operation of FMPC, violated various provisions of federal and Ohio environmental law and regulations. DOE denied any violation of and all liability under any federal or state statute, regulation, or common law. To avoid expensive and protracted litigation, the parties negotiated a Consent Decree (Consent Decree 1988).

The Consent Decree is a settlement for approximately 23 actions listed in the litigation. In general terms, the decree deals with requirements for the treatment, storage, and disposal of all hazardous and mixed waste at the FMPC and control of wastewater and runoff. The execution of the Consent Decree is not an admission of liability on any issue dealt with in the Consent Decree and thus is not admissible in any judicial or administrative proceeding. The Consent Decree was signed in December 1988. As a result of the signing of the Consent Decree, the Director's Finding and Orders became a part of the Consent Decree.

L.2 SUMMARY OF ENVIRONMENTAL REVIEW REQUIREMENTS

L.2.1 National Environmental Policy Act of 1969

The National Environmental Policy Act of 1969 (NEPA; Pub. L. 91-190) is the basic national charter for the protection of the environment. It establishes environmental policy, sets goals, and provides means for carrying out a policy. The NEPA environmental review process is intended to help public officials make thoughtful decisions that are based in part on a clear understanding of the environmental consequences of a federal action.

All federal agencies are subject to the mandate of NEPA, and all must abide by the President's Council on Environmental Quality (CEQ) regulations, which provide the direction for incorporating environmental review in the planning and execution of federal actions and set forth procedures for establishing legal documentation of such review (40 CFR Pts. 1500-08). In addition, all organizational units of DOE except the Federal Energy Regulatory Commission must follow the DOE NEPA Guidelines [Fed. Regist. 45(62):20694 (1980)] for implementing the CEQ regulations.

L.2.2 Executive Order 12088: Federal Compliance with Pollution Control Standards

In addition to the authority of Congress and federal and state administrative agencies to establish and enforce environmental standards, the President of the United States has the authority to issue Executive Orders (EOs) to clarify environmental policies. EO 12088, of October 13, 1978, Federal Compliance with Pollution Control Standards, states that the head of an executive agency is responsible for ensuring that the agency takes all actions necessary for the prevention, control, and abatement of environmental pollution with respect to federal facilities and activities under its control. The agency head is also responsible for compliance with applicable pollution control standards, such as those defined under CWA and CAA.

L.2.3 DOE Orders for Environmental, Safety, and Health Protection

DOE has developed a uniform system of communicating policy and procedures to its employees through DOE Orders (administrative orders), which contain information on procedures, responsibilities, and authorities for performing DOE's various functions.

In general, DOE Orders establish policy guidance and assign responsibility for implementation. At FMPC, DOE Orders are implemented through DOE Oak Ridge Operations Office Orders, which specify procedures and responsibilities for implementation. The numbering system for the Orders parallels that of the corresponding DOE Orders.

L.2.4 Atomic Energy Act of 1954

Congress passed the Atomic Energy Act of 1954 (AEA) (42 USC 2018) to ensure that research and development of atomic energy for both peaceful and military purposes would be coordinated and timely and that the processing of source, by-product, and special nuclear materials would be managed in the national interest. The Act established the Atomic Energy Commission (AEC) to administer its provisions.

In 1974, the Energy Reorganization Act (Pub. L. 93-437) divided the responsibilities of AEC between the Energy Research and Development Administration and the U.S. Nuclear Regulatory Commission. In 1977, the DOE Organization Act (Pub. L. 95-91) further centralized the administration of national programs related to energy policy formulation, research and development activities, and demonstration project development.

The act confers full jurisdiction to DOE for waste management activities at FMPC involving source, special nuclear, and by-product materials. In addition, Sect. 84 of the Act requires that management of by-product materials be performed in conformance with EPA general standards that are applicable to similar hazardous material.

L.2.5 Hazardous Waste Regulations

L.2.5.1 Comprehensive Environmental Response, Compensation, and Liability Act

The CERCLA (Pub. L. 96-510), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA), provides liability, compensation, cleanup, and emergency response by the federal government for hazardous substances released into the environment and for the cleanup of inactive hazardous waste disposal sites.

Three types of government cleanup and response actions include: (1) immediate removal, where emergency action is required (e.g., to avert fire or explosion or to prevent the contamination of a drinking-water supply); (2) planned removal, where a short-term response is required to minimize danger to the public or the environment; and (3) remedial actions taken at sites identified on the National Priorities List. Section 107(g) of CERCLA, which specifies the liability of DOE, states that departments of the federal government are both "procedurally and substantively" subject to compliance with CERCLA. In other words, "remedial actions" for the equivalent of CERCLA sites are to be undertaken at all federal facilities.

The National Contingency Plan (40 CFR Pt. 300), which was established under Section 105 of CERCLA, defines responses to actual or threatened releases of oil or hazardous substances to the environment. It calls for RI/FSs for all remedial actions. These studies determine the nature and extent of the threat presented by the release of hazardous substances, and they provide an evaluation of the proposed remedies. RI/FSs involve sampling, monitoring, assessing exposure, and gathering sufficient information to determine the necessity for and extent of the proposed remedial actions. As mentioned in Sect. L.1.2, DOE and EPA have agreed that DOE shall conduct an RI/FS, in accordance with the guidelines under CERCLA, to determine the nature and extent of contamination both on and off the FMPC site.

Section 120 of SARA provides for federal agency procedural and substantive compliance with the Act and includes liability provisions. Section 121 addresses cleanup standards, including a degree of cleanup of hazardous substances that ensures protection of human health and the environment.

L.2.5.2 Resource Conservation and Recovery Act and Hazardous and Solid Waste Amendments

In 1976, Congress passed RCRA (Pub. L. 94-580, 42 ISC 6901 et seq.) to provide a national program for the management, transportation, treatment, and disposal of hazardous waste. In addition to RCRA, Congress later passed the Hazardous and Solid Waste Amendments (HSWA) of 1984. The amendments instituted an accelerated schedule for permit application submittals, prohibited future land-based disposal of hazardous wastes, specified an annual inspection program for federal facilities, required an

inventory of federal hazardous-waste facilities, set up a permitting program for underground storage tanks, established a waste-minimization program, and set a closure schedule for the use of existing surface impoundments.

RCRA provides a detailed "cradle-to-grave" manifest tracking system for all wastes that EPA has designated as hazardous. Wastes are hazardous (1) if they exhibit the characteristics of ignitability, corrosivity, reactivity, or toxicity using a specified extraction procedure, and/or (2) if they are listed in Subpart D of 40 CFR Pt. 261, which provides industry and EPA waste numbers, descriptions, and a hazard code and identifies the waste source as either specific or nonspecific. Other wastes are hazardous if they are discarded commercial chemical products, off-specification species, containers, and spill residues thereof, as defined in 40 CFR Pt. 261.

Under RCRA, the permitting of treatment, storage, or disposal facilities is a two-part process. First, a Part A application is submitted to provide basic information about the facility. Second, a Part B application is submitted, containing substantially more detailed information about individual interim-status waste management units.

EPA regulations for implementing RCRA are codified in 40 CFR Pts. 260-65. These regulations provide a system of standards for owners and operators of hazardous-waste storage, treatment, and disposal facilities; specific procedures for the manifest-tracking system; identification and classification of hazardous waste; listing and delisting requirements; requirements for transporters of hazardous waste; interim-status standards; closure and postclosure requirements; standards for landfills, incinerators, and surface impoundments; and permitting requirements. Also stipulated are financial responsibility, insurance, personnel training, and liability requirements.

The HSWA prohibits land disposal of hazardous wastes unless EPA has determined that it is not required. The amendments also require EPA to promulgate regulations specifying levels or methods of waste treatment that would substantially diminish the toxicity or reduce the migration of hazardous constituents of the waste. After pretreatment, the waste may be disposed of in specified types of land-disposal facilities that meet minimum technological requirements.

In addition to these requirements, the HSWA imposed minimum technological requirements on new landfills or surface impoundments. Permits for these units require the installation of two or more liners, a leachate-collection system, and groundwater monitoring. New units, replacements, and lateral expansions of existing landfills, surface impoundments, and waste piles under interim status must conform to these minimum technological requirements with respect to wastes received beginning May 8, 1985.

L.2.5.3 State of Ohio Hazardous Waste Rules

The Ohio hazardous waste program regulations ("Hazardous Waste Rules," Chaps. 3754-50 through 3745-69, OAC) are essentially the same as RCRA. In practice, application for the RCRA Part B permit must be made to the federal EPA, and a BMP must be submitted to EPA to address implementation of the hazardous waste management program described in the Part B permit. However, the Ohio State Implementation Plan (SIP) for primacy in administration of RCRA has recently been disapproved. Until the state receives approval of a new SIP, the federal EPA will administer all RCRA programs in Ohio.

L.2.6 Water Quality Regulations

L.2.6.1 Federal Safe Drinking Water Act and Amendments

The Safe Drinking Water Act Amendments (SDWAA) of 1986, Pub. L. 99-339, were enacted in June 1986. The amendments are designed to protect the quality of public water supplies and all sources of drinking water. The law substantially broadens the federal government's role in protecting groundwater against contamination. EPA may give grants to states to protect public drinking water supplies at the well head. States must develop protection plans that meet minimum criteria to qualify for federal grants. Regulation of groundwater remains in the domain of the states.

The "wellhead protection area" is defined as the surface and subsurface area surrounding a well or wells supplying a public water system through which contaminants are reasonably likely to move to reach the well or wells. Another provision of SDWAA, the Underground Injection Control Program, is designed to protect groundwater quality. (Injection wells are not now and have not in the past been used for the disposal of wastewater at FMPC.)

L.2.6.2 State of Ohio Water Quality Regulations

The EPA has authorized Ohio to protect the quality of public water supplies and all sources of drinking water; the state has adopted primary drinking-water regulations. Administration and enforcement of the SDWAA by the Ohio EPA consist of construction permits, preliminary site inspections, final construction inspections, monthly sampling collections, and regular operations and maintenance inspections.

Water quality standards that apply to all surface waters in the state except for Lake Erie and the Ohio River are presented in "Water Quality Standards," Chap. 3745-1, OAC. The specific criteria were determined by the use designations assigned to the water. Existing in-stream water is to be maintained and protected. No waste quality degradation of designated uses is allowable. The Great Miami River Basin standards are specifically addressed in Chap. 3745-1-18. Regulated parameters are suspended solids;

floating debris, oil, and scum; nuisance conditions; toxic substances; and nutrients that create nuisance growths of aquatic weeds and algae.

The Ohio EPA has also assumed primacy ("Ohio NPDES Permits," Chap. 3745-33, OAC) for National Pollutant Discharge Elimination System (NPDES) permit management. Holders of valid federal NPDES permits are not required to reapply to the Ohio EPA unless their discharge has changed substantially in nature, volume, or frequency. Point source discharges are allowed under an Ohio NPDES permit that specifies the concentration or total quantities of pollutants discharged.

Pollutants addressed include the following: dredged spoil, solid waste, incinerator residue, filter backwash, sewage, garbage, sewage sludge, chemical wastes, biological materials, radioactive materials except those regulated by the Nuclear Regulatory Commission, heat, discarded equipment, and industrial waste discharged into water.

L.2.7 Air Quality Regulations

L.2.7.1 Clean Air Act (CAA) and Amendments

The CAA, Pub. L. 88-206 as amended, is the basic federal enabling legislation that governs air pollution. The implementing EPA regulations are contained in 40 CFR Pts. 50-87.

Federal regulations provide a framework within which each state designs specific regulatory strategies to deal with air pollution problems within state boundaries. Much of what EPA defines as reasonably available control technology (RACT) may be found in state programs, but the requirement of a specific RACT will depend on the existence of an air pollutant problem in the state. In addition, RACT often includes two or more levels of control, depending on the seriousness of the nonattainment.

EPA has established primary and secondary ambient air standards. Primary standards are intended to protect the health of the population, whereas secondary standards are meant to protect the public welfare. Standards have been established for seven pollutants: sulfur dioxide (SO_2), particulates (PM-10), carbon monoxide (CO), ozone (O_3), hydrocarbons (HC), nitrogen oxides (NO_x), and lead (Pb).

L.2.7.2 State of Ohio Air Quality Regulations

"General Provisions on Air Pollution Control.," Chaps. 3745-15 through 3745-23, OAC) provides air pollution regulations covering emissions of particulate matter (Chap. 3745-17); sulfur dioxide (Chap. 3745-18); open burning (Chap. 3745-19); carbon monoxide, photochemically reactive materials, hydrocarbons, and related materials (Chap. 3745-21); and nitrogen oxides (Chap. 3745-23). Emission limits are set for specific counties as well as for the state as a whole. Concentration limits at the site boundary are specified for carbon monoxide, sulfur dioxide, and particulate matter. Emission limits are specified for nitrogen oxides and volatile organics.

A permit to operate must be obtained from the Ohio EPA for each stationary source of air contamination ("Air Permits to Operate and Variances," Chap. 3745-35, OAC). The permit application must show source and quantity of both controlled and uncontrolled emissions, provide information on emission control facilities, and indicate the impact of emissions on the existing air quality. The source must be in compliance with the applicable air pollution control laws. Permits are effective for 1 to 3 years and may be suspended, revoked, or modified by Ohio EPA in response to changes in the applicable laws or other factors.

L.3 FMPC ENVIRONMENTAL COMPLIANCE PLAN

The standards, regulations, and guidelines of federal and state agencies have been reviewed by WMCO (ECQAP 1987) to determine which are applicable to FMPC. The FMPC Environmental Compliance and Quality Assurance Plan briefly summarizes each regulation and details the responsible Westinghouse Materials Company of Ohio (WMCO) organizations, the cognizant regulatory agencies, and points of contact for each subject area. For each regulation, the requirements for action by WMCO personnel are summarized, the frequencies of action are noted, and the information required is specified.

L.4 REFERENCES

Consent Decree December 1988. State of Ohio v. U.S. Department of Energy. Proposed Consent and Decree Between the Plaintiff State of Ohio and Defendant Department of Energy, Civil Action No. C-1-86-0217, U.S. District Court Southern District of Ohio, Western Division.

ECQAP (Environmental Compliance and Quality Assurance Plan for Feed Materials Production Center, Fernald, Ohio) April 1987. Prepared by Los Alamos Technical Associates, Inc., for Feed Materials Production Center, Fernald, Ohio

EPA-V (U.S. Environmental Protection Agency, Region V) July 1986. Federal Facility Compliance Agreement (for DOE's Feed Materials Production Center, Fernald, Ohio).

MOU (Memorandum of Understanding) June 12, 1987. U.S. Department of Energy Draft Memorandum of Understanding among the U.S. Department of Energy, the U.S. Environmental Protection Agency (Region V), and the Ohio Environmental Protection Agency for Preparation of the FMPC Renovation and Remedial Action EIS.

OEPA (Ohio Environmental Protection Agency) March 9, 1987. "Director's Findings and Orders," *Director's Journal*.