U-004-402.8

1165

INITIAL SCREENING OF ALTERNATIVES FOR OPERABLE UNIT 2 TASK 12 REPORT APRIL 1991

04-01-91

FMPC-0212-6
DOE-ORO
250
REPORT

[redacted]

1165

INITIAL SCREENING OF ALTERNATIVES FOR OPERABLE UNIT 2

TASK 12 REPORT

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

REMEDIAL INVESTIGATION and FEASIBILITY STUDY

April 1991

U. S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE

FINAL

1

1165

INITIAL SCREENING OF ALTERNATIVES FOR OPERABLE UNIT 2

TASK 12 REPORT

FEED MATERIALS PRODUCTION CENTER
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

April 1991

U.S. DEPARTMENT OF ENERGY
OAK RIDGE OPERATIONS OFFICE

FMPC-0212-6 FINAL

2

TABLE OF CONTENTS

1165

	Page
List of Tables	viii
List of Figures	ix
List of Acronyms	x
Distribution List	xii
Executive Summary	ES-1
1.0 Introduction	1-1
1.1 Background	1-1
1.2 Site History	1-1
1.3 Purpose of RI/FS	1-3
1.4 Report Organization	1-5
1.5 Operable Unit 2 Background	1-6
1.5.1 General Site Description	1-6
1.5.2 Operable Unit 2 - Site Descriptions and Histories	1-8
1.5.2.1 Sanitary Landfill	1-8
1.5.2.2 South Lime Sludge Pond	1-10
1.5.2.3 North Lime Sludge Pond	1-10
1.5.2.4 Inactive Fly Ash Disposal Area	1-10
1.5.2.5 Active Fly Ash Pile	1-13
1.5.2.6 Southfield	1-15
1.5.3 Nature and Extent of Contamination	1-15
1.5.3.1 Sanitary Landfill	1-17
1.5.3.2 Lime Sludge Ponds	1-18
1.5.3.3 Active Fly Ash Pile	1-19
1.5.3.4 Inactive Fly Ash Disposal Area	1-20
1.5.3.5 Southfield	1-21
2.0 Identification and Screening of Technologies and Process Options	2-1
2.1 Introduction	2-1
2.2 Remedial Action Objectives	2-1
2.2.1 Point of Compliance	2-2
2.2.2 Chemicals of Potential Concern	2-3
2.2.3 RAOs Based on ARARs	2-3
2.2.4 RAOs Based on Risk Criteria	2-3
2.2.5 Summary of Operable Unit 2 RAOs	2-9
2.2.5.1 Direct Radiation	2-10
2.2.5.2 Air (Fugitive Dust)	2-10
2.2.5.3 Soils	2-10
2.2.5.4 Sediments and Surface Water	2-10
2.2.5.5 Groundwater	2-10
2.3 General Response Actions	2-10
2.3.1 No Action	2-18
2.3.2 Institutional Actions	2-18
2.3.3 Containment	2-18
2.3.4 Containment With Treatment	2-18
2.3.5 Removal, Treatment, and Disposal	2-18

TABLE OF CONTENTS (continued)

	Page
2.4 Identification and Screening of Technologies and Process Options	2-18
2.4.1 Sanitary Landfill	2-19
2.4.1.1 Groundwater/Surface Water Media	2-19
2.4.1.2 Soils/Sediments/Wastes Media	2-35
2.4.1.3 Direct Radiation/Air (Fugitive Dust) Media	2-41
2.4.2 Lime Sludge Ponds	2-42
2.4.2.1 Groundwater	2-42
2.4.2.2 Soils/Sediments/Wastes Media	2-42
2.4.2.3 Direct Radiation/Air (Fugitive Dust) Media	2-56
2.4.3 Fly Ash/Southfield Areas	2-56
2.4.3.1 Groundwater/Surface Water Media	2-56
2.4.3.2 Soils/Sediments/Wastes Media	2-56
2.4.3.3 Direct Radiation/Air (Fugitive Dust) Media	2-69
2.5 Evaluation of Screened Technologies and Process Options	2-70
2.5.1 Screening Criteria	2-70
2.5.1.1 Effectiveness	2-70
2.5.1.2 Implementability	2-70
2.5.1.3 Cost	2-70
2.6 Process Option Evaluation for Sanitary Landfill	2-71
2.6.1 Groundwater/Surface Water Media	2-71
2.6.1.1 No Action	2-71
2.6.1.2 Institutional Actions	2-82
2.6.1.3 Control/Containment Actions	2-82
2.6.1.4 Removal Actions	2-82
2.6.1.5 Treatment Actions	2-84
2.6.2 Soils, Sediments, and Solid Wastes Media	2-86
2.6.2.1 No Action	2-86
2.6.2.2 Institutional Actions	2-86
2.6.2.3 Control/Containment Actions	2-87
2.6.2.4 Removal Actions	2-87
2.6.2.5 Treatment Actions	2-87
2.6.2.6 Disposal Actions	2-90
2.6.3 Radiation/Air (Fugitive Dust) Media	2-92
2.7 Process Option Evaluation for Lime Sludge Ponds	2-92
2.7.1 Groundwater/Surface Water Media	2-92
2.7.2 Soils/Sediments/Wastes Media	2-92
2.7.2.1 Removal Actions	2-92
2.7.2.2 Containment/Treatment Action	2-102
2.7.3 Evaluation of Process Options for Direct Radiation/Air (Fugitive Dust) Media	2-103

4

TABLE OF CONTENTS (continued)

	Page
2.8 Fly Ash/Southfield Areas	2-104
2.8.1 Groundwater/Surface Water Media	2-104
2.8.2 Soils/Sediments/Wastes Media	2-104
2.8.3 Direct Radiation/Air (Fugitive Dust) Media	2-112
3.0 Development and Descriptions of Alternatives	3-1
3.1 Development of Alternatives	3-1
3.2 Description of Alternatives	3-39
3.2.1 Sanitary Landfill	3-39
3.2.1.1 Alternative 1: Containment	3-39
3.2.1.2 Alternative 2: Containment With Perched Groundwater Treatment	3-42
3.2.1.3 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal	3-45
3.2.1.4 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal	3-49
3.2.1.5 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	3-54
3.2.1.5 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal	3-57
3.2.2 Lime Sludge Ponds	3-61
3.2.2.1 Alternative 1: Containment With In Situ Stabilization	3-61
3.2.2.2 Alternative 2: Containment With In Situ Stabilization and Perched Groundwater Treatment	3-64
3.2.2.3 Alternative 3: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	3-66
3.2.2.4 Alternative 4: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal	3-70
3.2.3 Fly Ash/Southfield	3-72
3.2.3.1 Alternative 1: Nonremoval/Cap	3-73
3.2.3.2 Alternative 2: Containment With Perched Groundwater Treatment	3-75
3.2.3.3 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal	3-79
3.2.3.4 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal	3-82
3.2.3.5 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	3-82
3.2.3.6 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal	3-86
4.0 Alternative Screening Methodology	4-1

5

TABLE OF CONTENTS (continued)

	Page
4.1 Introduction	4-1
4.2 Alternative Evaluation Process	4-1
4.2.1 Effectiveness Evaluation	4-1
4.2.2 Implementability Evaluation	4-1
4.2.3 Cost Evaluation	4-3
4.2.4 Innovative Technologies	4-3
4.3 Compliance With ARARs	4-3
4.4 Land Disposal Restrictions	4-4
5.0 Screening of Alternatives	5-1
5.1 Sanitary Landfill	5-1
5.1.1 Alternative 0: No Action	5-1
5.1.1.1 Effectiveness	5-1
5.1.1.2 Implementability	5-2
5.1.1.3 Cost	5-2
5.1.2 Alternative 1: Nonremoval - Containment	5-2
5.1.2.1 Effectiveness	5-2
5.1.2.2 Implementability	5-2
5.1.2.3 Cost	5-3
5.1.3 Alternative 2: Nonremoval - Containment With Perched Groundwater Treatment	5-3
5.1.3.1 Effectiveness	5-3
5.1.3.2 Implementability	5-3
5.1.3.3 Cost	5-4
5.1.4 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal	5-4
5.1.4.1 Effectiveness	5-4
5.1.4.2 Implementability	5-4
5.1.4.3 Cost	5-4
5.1.5 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal	5-5
5.1.5.1 Effectiveness	5-5
5.1.5.2 Implementability	5-5
5.1.5.3 Cost	5-5
5.1.6 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	5-5
5.1.6.1 Effectiveness	5-5
5.1.6.2 Implementability	5-6
5.1.6.3 Cost	5-6
5.1.7 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal	5-6
5.1.7.1 Effectiveness	5-6
5.1.7.2 Implementability	5-7
5.1.7.3 Cost	5-7

6

TABLE OF CONTENTS (continued)

	Page
5.2 Lime Sludge Ponds	5-7
5.2.1 Alternative 0: No Action	5-7
5.2.1.1 Effectiveness	5-7
5.2.1.2 Implementability	5-8
5.2.1.3 Cost	5-8
5.2.2 Alternative 1: Nonremoval-Containment With In Situ Stabilization	5-8
5.2.2.1 Effectiveness	5-8
5.2.2.2 Implementability	5-8
5.2.2.3 Cost	5-9
5.2.3 Alternative 2: Nonremoval-Containment With In Situ Stabilization and Perched Groundwater Treatment	5-9
5.2.3.1 Effectiveness	5-9
5.2.3.2 Implementability	5-9
5.2.3.3 Cost	5-9
5.2.4 Alternative 3: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	5-10
5.2.4.1 Effectiveness	5-10
5.2.4.2 Implementability	5-10
5.2.4.3 Cost	5-10
5.2.5 Alternative 4: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal	5-10
5.2.5.1 Effectiveness	5-10
5.2.5.2 Implementability	5-11
5.2.5.3 Cost	5-11
5.3 Fly Ash/Southfield Areas	5-11
5.3.1 Alternative 0: No Action	5-11
5.3.1.1 Effectiveness	5-11
5.3.1.2 Implementability	5-12
5.3.1.3 Cost	5-12
5.3.2 Alternative 1: Nonremoval - Containment	5-12
5.3.2.1 Effectiveness	5-12
5.3.2.2 Implementability	5-13
5.3.2.3 Cost	5-13
5.3.3 Alternative 2: Nonremoval - Containment With Perched Groundwater Treatment	5-13
5.3.3.1 Effectiveness	5-13
5.3.3.2 Implementability	5-13
5.3.3.3 Cost	5-14
5.3.4 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal	5-14
5.3.4.1 Effectiveness	5-14
5.3.4.2 Implementability	5-14
5.3.4.3 Cost	5-14

TABLE OF CONTENTS (continued)

1165

	Page
5.3.5 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal	5-14
5.3.5.1 Effectiveness	5-14
5.3.5.2 Implementability	5-15
5.3.5.3 Cost	5-15
5.3.6 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	5-15
5.3.6.1 Effectiveness	5-15
5.3.6.2 Implementability	5-15
5.3.6.3 Cost	5-16
5.3.7. Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal	5-16
5.3.7.1 Effectiveness	5-16
5.3.7.2 Implementability	5-16
5.3.7.3 Cost	5-16
5.4 Additional Costs	5-17
5.5 Screening Summary	5-17
6.0 General Summary	6-1
6.1 Sanitary Landfill	6-1
6.2 Lime Sludge Ponds	6-1
6.3 Fly Ash/Southfield Areas	6-1
6.4 Presentation of Alternatives Recommended for Detailed Analysis	6-2
6.5 Detailed Analysis Preview	6-2
References	R-1
Appendix A - Description of Technologies and Process Options	A-1
Appendix B - Applicable or Relevant and Appropriate Requirements	B-1
Appendix C - Solid Waste Unit Characteristics	C-1

8

LIST OF TABLES

1165

Tables		Page
ES-1	Development of Alternatives, Sanitary Landfill	ES-3
ES-2	Development of Alternatives, Lime Sludge Ponds	ES-4
ES-3	Development of Alternatives, Fly Ash/Southfield Areas	ES-5
ES-4	Alternatives Recommended for Detailed Analysis - Sanitary Landfill and Fly Ash/Southfield Areas	ES-6
ES-5	Alternatives Recommended for Detailed Analysis - Lime Sludge Ponds	ES-7
2-1	Chemicals and Radionuclides of Potential Concern in Operable Unit 2	2-4
2-2	Operable Unit 2 ARARs	2-5
2-3	Preliminary Remediation Goals for Nonradioactive Chemicals in Soils, Operable Unit 2	2-11
2-4	Freshwater Chronic Water Criteria	2-13
2-5	Preliminary Remediation Goals for Organic Chemicals in Groundwater, Operable Unit 2	2-14
2-6	Groundwater Remedial Action Objectives for Inorganic Chemicals, Operable Unit 2	2-16
2-7	Groundwater Remedial Action Objectives for Radionuclides, Operable Unit 2	2-17
3-1	Development of Alternatives, Sanitary Landfill	3-2
3-2	Development of Alternatives, Lime Sludge Ponds	3-3
3-3	Development of Alternatives, Fly Ash/Southfield Areas	3-4
5-1	Screening Summary for the Alternatives for Operable Unit 2, Sanitary Landfill	5-18
5-2	Screening Summary for the Alternatives for Operable Unit 2, Lime Sludge Ponds	5-19
5-3	Screening Summary for the Alternatives for Operable Unit 2, Fly Ash/Southfield Areas	5-20
6-1	Alternatives Recommended for Detailed Analysis - Sanitary Landfill and Fly Ash/Southfield Areas	6-2
6-2	Alternatives Recommended for Detailed Analysis - Lime Sludge Ponds	6-2

9

LIST OF FIGURES

Figures		Page
1-1	Five-Mile Radius Map, Feed Materials Production Center	1-2
1-2	Operable Unit 2 Site Plan	1-4
1-3	Sanitary Landfill	1-9
1-4	North and South Lime Sludge Ponds	1-11
1-5	Inactive Fly Ash Disposal Area	1-12
1-6	Active Fly Ash Pile	1-14
1-7	Southfield	1-16
2-1	Remedial Action Objectives and Associated General Response Actions	2-8
2-2	Initial Screening of Technologies and Process Options - Sanitary Landfill	2-20
2-3	Initial Screening of Technologies and Process Options - Lime Sludge Ponds	2-43
2-4	Initial Screening of Technologies and Process Options - Fly Ash/Southfield Areas	2-57
2-5	Evaluation of Process Options - Sanitary Landfill	2-72
2-6	Evaluation of Process Options - Lime Sludge Ponds	2-93
2-7	Evaluation of Process Options - Fly Ash/Southfield Areas	2-104
3-1	General Alternative Development Process - Sanitary Landfill	3-5
3-2	General Alternative Development Process - Lime Sludge Ponds	3-17
3-3	General Alternative Development Process - Fly Ash/Southfield Areas	3-28
3-4	Sanitary Landfill with Cap - Alternative 1	3-41
3-5	Sanitary Landfill - Alternative 2	3-42
3-6	Remedial Action Alternative 3 - Sanitary Landfill	3-45
3-7	Engineered Disposal Facility	3-46
3-8	Sanitary Landfill - Alternative 4	3-49
3-9	Sanitary Landfill - Alternative 5	3-53
3-10	Sanitary Landfill - Alternative 6	3-56
3-11	Lime Sludge Ponds - Alternative 1	3-60
3-12	Lime Sludge Ponds - Alternative 2	3-61
3-13	Lime Sludge Ponds - Alternative 3	3-63
3-14	Lime Sludge Stabilization System	3-65
3-15	Lime Sludge Ponds - Alternative 4	3-67
3-16	Fly Ash Areas and Southfield - Alternative 1	3-69
3-17	Fly Ash Areas and Southfield - Alternative 2	3-72
3-18	Geological Cross Section of Fly Ash Areas and Southfield	3-73
3-19	Fly Ash Areas and Southfield - Alternative 3	3-76
3-20	Fly Ash Areas and Southfield - Alternative 4	3-78

LIST OF FIGURES

1165

Figures		Page
3-21	Fly Ash Areas and Southfield - Alternative 5	3-80
3-22	Fly Ash Areas and Southfield - Alternative 6	3-82
4-1	Relationship of Screening Criteria to the Nine Evaluation Criteria	4-2

11

LIST OF ACRONYMS

AEC	U.S. Atomic Energy Commission
ARAR	applicable or relevant and appropriate requirement
AWQC	Ambient Water Quality Criteria
AWWT	advanced wastewater treatment
CAA	Clean Air Act
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CIS	Characterization Investigation Study
CSF	cancer slope factor
CWA	Clean Water Act
dcf	dose conversion factor
DOE	U.S Department of Energy
DOT	U.S. Department of Transportation
EDF	engineered disposal facility
EPA	U.S. Environmental Protection Agency
FFCA	Federal Facility Compliance Agreement
FMPC	Feed Materials Production Center
FS	feasibility study
HDPE	high density polyethylene (liner)
HI	hazard index
ICC	Interstate Commerce Commission
ISA	Initial Screening of Alternatives
LC/DS	leachate collection/detection system
LLRW	low level radioactive waste
LSA	low specific activity
MCL	maximum contaminant level
MCLG	maximum contaminant level goal
MPRSA	Marine Protection Research and Sanctuaries Act
NCP	National Oil and Hazardous Substance Pollution Contingency Plan
NLO	National Lead of Ohio
NPDES	National Pollutant Discharge Elimination System
NRC	Nuclear Regulatory Commission
NTS	Nevada Test Site
ODH	Ohio Department of Health

LIST OF ACRONYMS
Continued

ODNR	Ohio Department of Natural Resources
OEPA	Ohio Environmental Protection Agency
O&M	operations and maintenance
PAH	polyaromatic hydrocarbon
PCB	polychlorinated biphenyl
PMCL	proposed maximum contaminant level
RAO	remedial action objective
RCRA	Resource Conservation and Recovery Act
RfD	reference dose
RI	remedial investigation
RI/FS	Remedial Investigation/Feasibility Study
RO	reverse osmosis
SARA	Superfund Amendments and Reauthorization Act
SDWA	Safe Drinking Water Act
SSM	shallow soil mixing
SSOD	storm sewer outfall ditch
TBC	to be considered
TCL	Target Compound List
TCLP	toxicity characteristics leachate procedure
TDS	total disolved solids
TSCA	Toxic Substances Control Act
TSD	treatment, storage, and disposal
UMTRA	Uranium Mill Tailings Radiation Control Act
WMCO	Westinghouse Materials Company of Ohio

DISTRIBUTION LIST

Project Direct - John Wood, Fernald

Deputy Director/Technical - John Razor, Fernald

Technical Manager - Bob Galbraith, Fernald

Operable Unit/Task Managers - Mike Higgins, Knoxville
Dan Smith, Oak Ridge
Sam Wolinsky, Fernald
Linda Dolan, Knoxville
Robin Smith, Pittsburgh
John Frazier, Knoxville
Suzanne Gray, Fernald
Sue Wolinsky, Fernald

Project QA Officer - Larry Sexton, Fernald

Technical QA Officer - Don Mack, Knoxville

Site Project Files - Fernald

IT-Monroeville Project Central Files

IT-Knoxville Project Central Files

ASI-Oak Ridge Project Files

DOE COR - Bobby Davis, Fernald

WMCO - Dennis Carr, Fernald

Lee Wan & Associates - M. Neal, Fernald

Parsons - Fernald

DOE-HQ - Kim Hayes, Washington, DC
Oak Ridge Office

EPA, Region 5 - Catherine McCord, Chicago

OEPA - Graham Mitchell, Dayton

EXECUTIVE SUMMARY

On July 18, 1986, a Federal Facility Compliance Agreement (FFCA) was jointly signed by the U.S. Department of Energy (DOE) and U.S. Environmental Protection Agency (EPA) pertaining to environmental impacts associated with the Feed Material Production Center (FMPC) near Fernald, Ohio. The FFCA was entered into pursuant to Executive Order 12088 (43FR47707) to ensure compliance with existing environmental statutes and implementing such regulations as the Clean Air Act (CAA); the Resource Conservation and Recovery (RCRA); and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In particular, the FFCA was intended to ensure that environmental impacts associated with past and present activities at the FMPC are thoroughly and adequately investigated so that remedial response actions can be formulated, assessed, and implemented. The 1986 FFCA was amended by a Consent Agreement under Section 120 and 106(a) of CERCLA (Consent Agreement) in order to achieve consistency with the operable unit concept and the current commitments of the Remedial Investigation/Feasibility Study (RI/FS) program without modifying the underlying objectives. The Consent Agreement was signed on April 9, 1990 and became effective on June 29, 1990.

In response to the FFCA and consistent with the modifications agreed to in April 1990, DOE is conducting an RI/FS pursuant to CERCLA, as amended by the Superfund Amendments and Reauthorization Act (SARA). The technical strategy adopted for the RI/FS is to issue distinct RI/FS reports for each of five identified operable units at the FMPC.

This report presents the initial screening of alternatives for Operable Unit 2. This operable unit is composed of other non-process wastes generated at the FMPC, and contains the following waste areas:

- Sanitary Landfill
- Lime Sludge Ponds
- Southfield
- Inactive Fly Ash Disposal Area
- Active Fly Ash Pile

The Fly Ash/Southfield areas have been grouped together because they exhibit similar physical characteristics, contaminant characterization, and are located adjacent to each other.

This report is divided into Sections 1.0 through 6.0 and appendices. Section 1.0 presents the Operable Unit 2 background, and a summary of the extent of contamination. Section 2.0 provides a discussion of the preliminary remedial action objectives (RAOs) and development and screening of technologies and process options used to assemble the RAOs for Operable Unit 2. Section 3.0 provides a summary of the development of alternatives from the general response actions. Section 4.0 discusses the methodology used to screen the alternatives. Section 5.0 presents and summarizes the screening of

alternatives. Section 6.0 discusses the alternatives selected for detailed analysis. Appendix A contains descriptions of technologies and process options, Appendix B contains potential applicable or relevant and appropriate requirements (ARARs), and Appendix C contains waste characteristics.

Remedial action objectives and general response actions are presented and discussed in Section 2.0 for contaminants of concern within Operable Unit 2. It should be noted that RAOs presented within this document are those which are currently proposed by DOE and are preliminary. The RAOs contained herein are under review by DOE and EPA and will be established prior to continuation of the Feasibility Study. Technologies and process options are then identified and screened with respect to technical implementability. Surviving technologies and process options are evaluated for effectiveness, implementability, and cost. This evaluation focuses on the process options themselves and is distinguished from alternative screening, which occurs after alternative development. Alternatives are then assembled by combining general response actions and process options chosen to represent the various technology types; this process is depicted on Tables ES-1 through ES-3 for the Sanitary Landfill, Lime Sludge Ponds, and Fly Ash/Southfield areas, respectively. Section 3.0 discusses the alternatives in greater detail. Section 4.0 discusses the methodology used to screen alternatives. Section 5.0 screens the alternatives against the short- and long-term aspects of three broad criteria: effectiveness, implementability, and cost. However, because the intent of this evaluation is to reduce the number of alternatives that will undergo a more thorough and extensive analysis, alternatives are evaluated more generally in this phase than during the subsequent detailed analysis task. Therefore, in an effort to gain a sense of direction as to the decision requirements of the detailed analysis phase, five primary balancing factors have been established for preliminary consideration:

- Long-term effectiveness and permanence
- Reductions in toxicity, mobility, and volume through treatment
- Short-term effectiveness
- Implementability
- Cost

These factors have been considered with caution since they are dependent upon treatability studies that have not been completed. However, the primary balancing factors will become more prominent in the decision processes, which will evolve in the detailed analysis.

The results of the screening performed in Section 5.0 are presented in Section 6.0 and are summarized for each waste unit group. A discussion of the No-Action Alternative (Alternative 0) is not presented; however, it will be carried forward into detailed analysis as a baseline for comparison.

1165

TABLE ES-1

DEVELOPMENT OF ALTERNATIVES
SANITARY LANDFILL

TECHNOLOGY TYPE	GENERAL RESPONSE ACTIONS						
	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
	No-Action	Containment	Containment With Perched Groundwater Treatment (Wellpoint Extraction)	Removal Of Waste/Perched Groundwater Treatment and On-Property Disposal	Removal Of Waste/Perched Groundwater Treatment and Off-Site Disposal	Removal and Treatment of Waste/Perched Groundwater Treatment and On-Property Disposal	Removal and Treatment of Waste/Perched Groundwater Treatment and Off-Site Disposal
Access Restrictions		●	●	●		●	
Monitoring	●	●	●	●	●	●	●
Run-on/Runoff Control		●	●	●	●	●	●
Capping		●	●				
Insitu Waste Stabilization							
Subsurface Flow Control			●	●	●	●	●
Perched Groundwater/ Wastewater Treatment			●	●	●	●	●
Physical Waste Treatment							
Thermal Waste Treatment						●	●
Mechanical Removal				●	●	●	●
Hydraulic Removal							
Waste Stabilization						●	●
Segregation				●	●	●	●
On Property Disposal				●		●	
Off Site Disposal					●		●

17

1165

TABLE ES-2

DEVELOPMENT OF ALTERNATIVES
LIME SLUDGE PONDS

TECHNOLOGY TYPE	GENERAL RESPONSE ACTIONS				
	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	No-Action	Containment With In Situ Stabilization	Containment with In Situ Stabilization and Perched Groundwater Treatment (Wellpoint Extraction)	Removal and Treatment of Waste/Perched Groundwater Treatment and On-Property Disposal	Removal and Treatment of Waste/ Perched Groundwater Treatment and Off-Site Disposal
Access Restrictions		●	●	●	
Monitoring	●	●	●	●	●
Run-on/Runoff Control		●	●	●	●
Capping		●	●		
In situ Stabilization		●	●		
Subsurface Flow Control			●	●	●
Perched Groundwater Wastewater Treatment			●	●	●
Physical Waste Treatment					
Thermal Waste Treatment					
Mechanical Removal				●	●
Hydraulic Removal				●	●
Waste Stabilization				●	●
Segregation					
On-Property Disposal				●	
Off-Site Disposal					●

18

1165

TABLE ES-3

DEVELOPMENT OF ALTERNATIVES
FLY ASH/SOUTHFIELD AREAS

	GENERAL RESPONSE ACTIONS						
TECHNOLOGY TYPE	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
	No-Action	Containment	Containment With Perched Groundwater Treatment (Wellpoint Extraction)	Removal Of Waste/Perched Groundwater Treatment and On-Property Disposal	Removal Of Waste/Perched Groundwater Treatment and Off-Site Disposal	Removal and Treatment of Waste/Perched Groundwater Treatment and On-Property Disposal	Removal and Treatment of Waste/ Perched Groundwater Treatment and Off-Site Disposal
Access Restrictions		●	●	●		●	
Monitoring	●	●	●	●	●	●	●
Run-on/Runoff Control		●	●	●	●	●	●
Capping		●	●				
In situ Waste Stabilization							
Subsurface Flow Control			●	●	●	●	●
Perched Groundwater Wastewater Treatment			●	●	●	●	●
Physical Waste Treatment							
Thermal Waste Treatment							
Mechanical Removal				●	●	●	●
Hydraulic Removal							
Waste Stabilization						●	●
Segregation				●	●	●	●
On-Property Disposal				●		●	
Off-Site Disposal					●		●

19

SANITARY LANDFILL

Of the removal alternatives ranked for comparison, Alternatives 5 and 6 received the highest ranking and will be carried forward into detailed analysis. Alternatives 1 and 2 received a lower ranking than Alternatives 5 and 6, but will be carried forward into detailed analysis to maintain the range of alternatives retained for further evaluation. Alternatives 3 and 4 received the lowest rankings of the alternatives evaluated and, therefore, have been eliminated from further consideration. This is consistent with provisions outlined in CERCLA Section 121, which do not favor removal and redisposal of wastes without treatment.

LIME SLUDGE PONDS

The results of the screening exercise indicate no significant advantage for any of the action alternatives. Therefore all of the alternatives will be carried forward into detailed analysis.

FLY ASH/SOUTHFIELD AREAS

Of the removal alternatives ranked for comparison, Alternatives 5 and 6 received the highest ranking and will be carried forward into detailed analysis. Although Alternatives 1 and 2 received a lower ranking than Alternatives 5 and 6, they will be carried forward into detailed analysis to maintain the range of alternatives retained for further evaluation. Alternatives 3 and 4 received the lowest rankings of the alternatives evaluated and, therefore, have been eliminated from further consideration. This is consistent with provisions outlined in CERCLA Section 121, which do not favor removal and redisposal of wastes without treatment.

PRESENTATION OF ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS

Tables ES-4 and ES-5 show the alternatives that are recommended for detailed analyses as a result of initial screening.

TABLE ES-4

ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS - SANITARY LANDFILL AND FLY ASH/SOUTHFIELD AREAS

Waste Unit	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
Sanitary Landfill	X	X	X			X	X
Fly Ash/Southfield Areas	X	X	X			X	X

1165

TABLE ES-5

ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS - LIME SLUDGE PONDS

Waste Unit	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Lime Sludge Ponds	X	X	X	X	X

21

1.0

1.0 INTRODUCTION

1.1 BACKGROUND

The Feed Materials Production Center (FMPC) is a contractor-operated federal facility where pure uranium metals were produced for the U.S. Department of Energy (DOE) between 1951 and 1989. The FMPC site is located on 1050 acres in a rural area of Hamilton and Butler counties approximately 18 miles northwest of Cincinnati, Ohio. The production area is limited to an approximate 136-acre tract near the center of the FMPC site. The villages of Fernald, New Baltimore, Ross, New Haven, and Shandon are all located within a few miles of the plant (Figure 1-1).

On March 9, 1985, the U.S. Environmental Protection Agency (EPA) issued a Notice of Noncompliance to DOE identifying EPA's major concerns over potential environmental impacts associated with the FMPC's past and present operations. Between April 1985 and July 1986, conferences were held between DOE and EPA representatives to discuss the issues and to identify the steps DOE proposed to take towards achieving and maintaining environmental compliance.

On July 18, 1986, a Federal Facility Compliance Agreement (FFCA) pertaining to environmental impacts associated with the FMPC was signed by DOE and EPA. The FFCA was entered into pursuant to Executive Order 12088 (43FR47707) to ensure compliance with existing environmental statutes and implementing regulations such as the Clean Air Act (CAA), the Resource Conservation and Recovery Act (RCRA), and the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). In particular, the FFCA was intended to ensure that environmental impacts associated with past and present activities at the FMPC are thoroughly and adequately investigated so that appropriate remedial response actions can be formulated, assessed, and implemented. In response to the FFCA, a Remedial Investigation/Feasibility Study (RI/FS) was initiated pursuant to CERCLA, as amended by the Superfund Amendment and Reauthorization Act (SARA). All RI/FS activities are being conducted in conformance with EPA's "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" (EPA 1988b).

The 1986 FFCA was amended by a Consent Agreement under Section 120 and 106(a) of CERCLA (Consent Agreement) in order to achieve consistency with the operable unit concept and the current commitments of the RI/FS program without modifying the underlying objectives. The Consent Agreement was signed on April 9, 1990 and became effective on June 29, 1990.

1.2 SITE HISTORY

The FMPC was constructed in 1951 to produce high-purity uranium metals (for use at other DOE facilities) in several physical forms, using various chemical and metallurgical processes. A small amount of thorium processing also was performed from 1954 to 1975 in the metals fabrication plant,

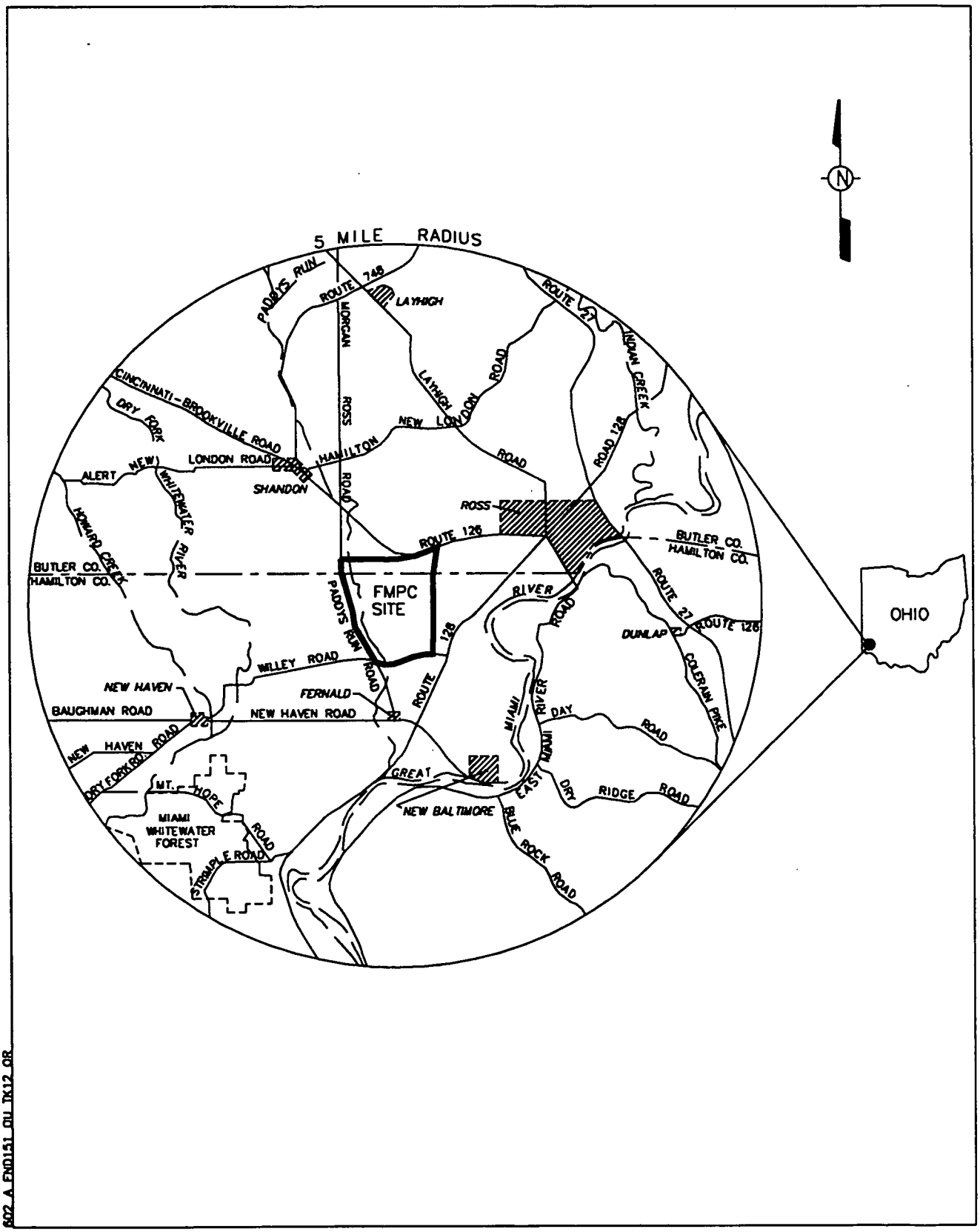


FIGURE 1-1. FIVE-MILE RADIUS MAP, FEED MATERIALS PRODUCTION CENTER

the recovery plant, the special projects plant, and the pilot plant. Small quantities of fission products (e.g., strontium-90 [Sr-90], cesium-137 [Cs-137], and technetium-99 [Tc-99]) and transuranics may be present in some plant effluents and wastes as a consequence of the processing of recycled fuel materials. Past activities have also produced a variety of wastes including general scrap and refuse, sanitary waste, contaminated and noncontaminated metal scrap, waste oils, asbestos, and fly ash. The wastes are currently stored at the FMPC. The FMPC also serves as the thorium repository for DOE.

The Sanitary Landfill, North and South Lime Sludge Ponds, Active Fly Ash Pile, Inactive Fly Ash Disposal Area, and the Southfield are the waste disposal areas that comprise Operable Unit 2. They are differentiated from other areas and grouped into one operable unit because each area represents a large-volume waste unit into which small volumes of radiological or chemical wastes may have been codisposed. Figure 1-2 presents the general locations of these units within the FMPC.

1.3 PURPOSE OF RI/FS

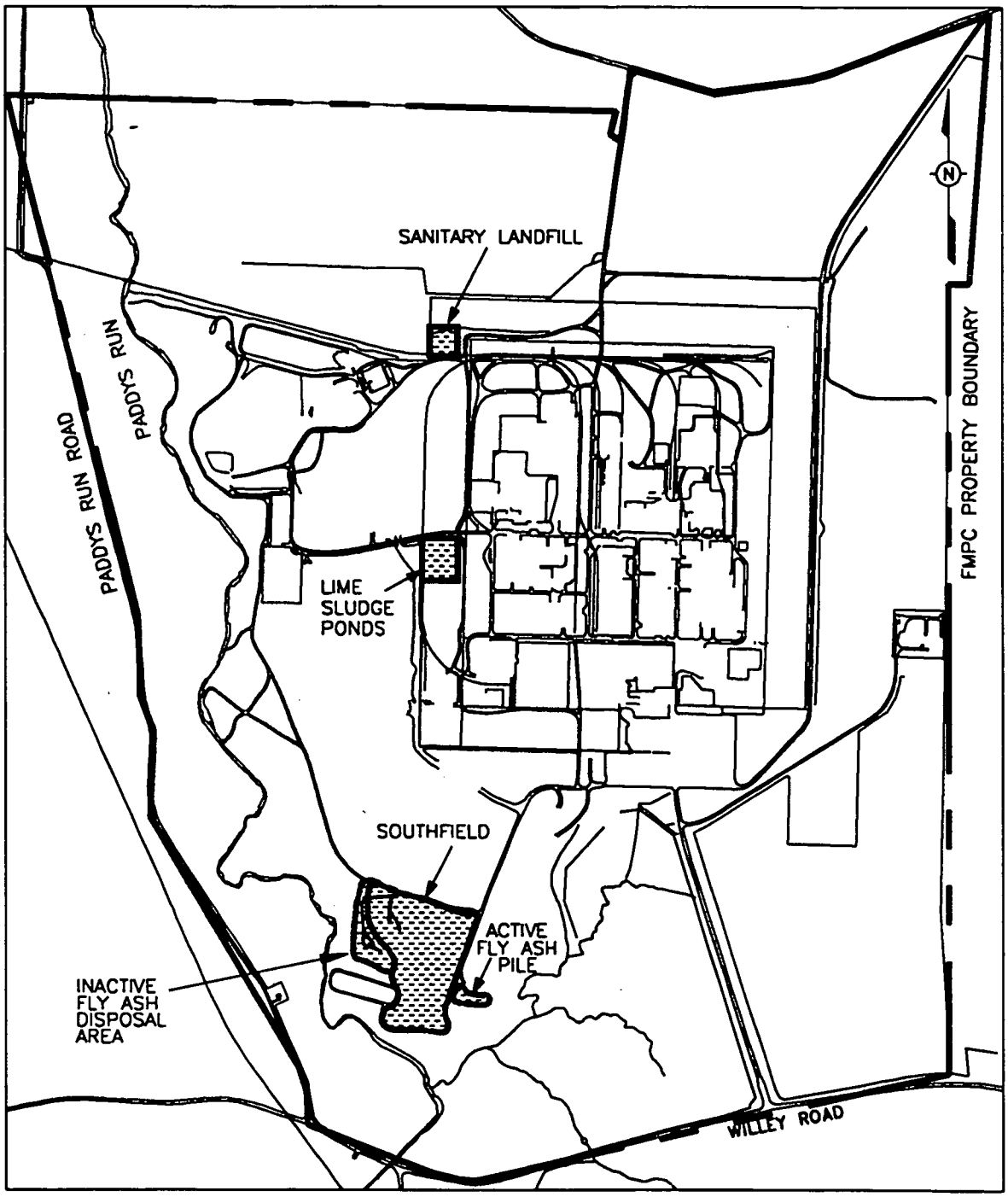
The RI/FS for the FMPC was initially designed to address the entire site and to focus on various environmental media that could be affected by past and present operations at the FMPC.

The work plan prepared for the site-wide RI/FS provided the overall technical approach, identified a number of investigative areas, developed objectives for each of the specified investigations, and established overall objectives for the evaluation of the data that were collected during RI activities. The work plan included the following detailed plans to establish specific procedures to be followed for the completion of the RI/FS for the FMPC:

- Sampling Plan
- Health and Safety Plan
- Community Relations Plan
- Data Management Plan
- Quality Assurance Project Plan

The Sampling Plan contained objectives, sampling locations, and sampling procedures for specific RI/FS activities including the following:

- Radiation measurement
- Surface soils
- Groundwater
- Subsurface soils
- Surface water and sediment
- Biological resources



602_A_FN0182_OU2_TK12_OR

FIGURE 1–2. OPERABLE UNIT 2 SITE PLAN

The work plan identified 27 units of the FMPC to be investigated in the RI/FS; several modifications to the list eventually increased this total to 39 units. In the course of the investigation it became apparent that, for technical and program management purposes, these 39 units needed to be categorized and grouped together.

The concept of operable units was introduced into the program to allow the remedial action process to proceed to completion for the most well-defined or problematic units, while data collection and analysis continued for other operable units.

There are five operable units:

- Operable Unit 1 - Waste Pits 1 through 6, Clearwell, and Burn Pit
- Operable Unit 2 - Other Waste Units
- Operable Unit 3 - Production Area and Suspect Areas
- Operable Unit 4 - Silos 1, 2, 3, and 4
- Operable Unit 5 - All Environmental Media

This report presents the results of the FS screening process, the Initial Screening of Alternatives (ISA), for Operable Unit 2. As part of the screening process (explained more fully in Section 4.0), the estimate of volume (or amount) of waste material has been refined using information gathered during the field investigation. This information was also used to further refine the alternatives to distinguish between the long- and short-term effects of three broad criteria: effectiveness, implementability, and cost. Only similar alternatives were compared in the ISA process, thereby preserving the no-action to more-action range of alternatives. Alternatives judged most promising will be carried into Task 13, the Detailed Analysis of Alternatives, which will compare the entire range of alternatives for the purpose of selecting a single preferred alternative.

1.4 REPORT ORGANIZATION

The remainder of this report is divided into Sections 2.0 through 6.0 and appendices. Section 2.0 provides a discussion of the preliminary remedial action objectives (RAOs) and development and screening of technologies and process options used to assemble the alternatives for Operable Unit 2. Section 3.0 provides a summary of the development of alternatives from the general response actions. Section 4.0 discusses the methodology used to screen the alternatives. Section 5.0 presents and summarizes the screening of alternatives. Section 6.0 discusses the alternatives selected for detailed analysis. Appendix A contains descriptions of technologies and process options, Appendix B contains potential applicable or relevant and appropriate requirements (ARARs), and Appendix C contains waste unit characteristics.

For alternative development, the Operable Unit 2 waste units are grouped as follows: the Sanitary Landfill, the Lime Sludge Ponds, and the Fly Ash/Southfield areas. The Sanitary Landfill and Lime Sludge Ponds which are dissimilar in their physical characteristics, are located in geographically distinct areas within the FMPC and will be considered as separate units. The Fly Ash and Southfield

areas are grouped together because they are located adjacent to one another on the property, and their wastes exhibit similar characteristics. The Southfield consists primarily of soil; fly ash is similar to soil in that it can be used as fill material and has similar handling characteristics.

1.5 OPERABLE UNIT 2 BACKGROUND

The following subsections present Operable Unit 2 site descriptions and histories along with information from previous Operable Unit 2 investigations. The FS assumes that all waste disposal within any Operable Unit 2 waste disposal site will cease prior to the onset of any remediation activity.

1.5.1 General Site Description

The U.S. Atomic Energy Commission (AEC), predecessor to DOE, established the FMPC for processing uranium and its compounds from natural uranium ore concentrates and recycled recoverable residues for government needs. This integrated production complex began operations in conformance with AEC Orders in the early 1950's. In 1951, National Lead Company of Ohio (now NLO Inc.) entered into contract with the AEC as Operations and Maintenance (O&M) Contractor. This contractual relationship with AEC, and eventually DOE, lasted until January 1, 1986. Westinghouse Materials Company of Ohio (WMCO), a wholly owned subsidiary of Westinghouse Electric Corporation, then assumed management responsibilities of the site operations and facilities for a minimum of five years.

A variety of chemical and metallurgical processes were utilized at the FMPC for the manufacture of uranium products. During the manufacturing process, high quality uranium compounds were introduced into the FMPC processes at several points. Impure starting materials were dissolved in nitric acid and the uranium was purified through solvent extraction to yield a solution of uranyl nitrate. Evaporation and heating converted the nitrate solution to uranium trioxide (UO_3) powder. This compound was reduced with hydrogen to uranium dioxide (UO_2) and then converted to uranium tetrafluoride (UF_4) by reaction with anhydrous hydrogen fluoride. Uranium metal was produced by reacting UF_4 and magnesium metal in a refractory-lined vessel. This primary uranium metal was then remelted with scrap uranium metal to yield a purified uranium ingot. Various uranium metalworking processes were also housed on the FMPC.

From 1953 through 1955, the FMPC Refinery processed pitchblende ore from the Belgian Congo. Pitchblende ore contains all daughter products of the uranium decay chains and is particularly high in radium content. No chemical separation or purification was performed on the ore prior to arrival at the FMPC. Beginning in 1956, the refinery feedstock consisted of uranium concentrates (yellowcake)

from Canada and the United States. Canadian concentrates were not processed after 1960. In the production of these concentrates, most of the uranium daughters had been removed. However, radium-226 (Ra-226) remained in the yellowcake in amounts that varied with the process.

Large quantities of liquid and wastes were generated by the various operations at the FMPC. Before 1984, solid and slurried wastes from FMPC processes were disposed of in the on-property waste storage area. This area, which is located west of the production facilities includes six low-level radioactive waste storage pits; two earthen-bermed concrete silos containing K-65 residues which are high-specific activity, radium-bearing residues resulting from the pitchblende refining process; one concrete silo containing metal oxides and one unused concrete silo; two lime sludge ponds; and a sanitary landfill. The waste storage area is addressed under Operable Units 1 and 4.

An Inactive Fly Ash Disposal Area and an Active Fly Ash Pile, addressed under Operable Unit 2, are located approximately 3000 feet south-southeast of the waste storage area. One pile remains active for the disposal of fly ash from the FMPC coal-fired boiler plant. An area between and adjacent to the fly ash areas, known as the Southfield, is believed to be the disposal site for construction debris and possibly other types of solid wastes from FMPC operations. The Southfield is also being addressed under Operable Unit 2.

Surface water runoff from the waste storage area, fly ash piles, and other affected areas within the western portion of the FMPC enters Paddys Run, a tributary of the Great Miami River. Paddys Run is an intermittent stream that originates just north of the FMPC and flows south-southeast along the western edge of the site.

There is potential for leachate from these same areas to migrate vertically through a till layer of varying thickness to the regionally important Great Miami Aquifer which underlies the site. This aquifer serves as a principal source of domestic, municipal, and industrial water throughout the region. A portion of the flow in Paddys Run is also known to enter this aquifer as a result of leakage through the stream bottom. Leakage occurs over the length of Paddys Run, beginning at a point west of the waste storage area and extending to the Great Miami River.

Liquid waste effluent generated from FMPC process operations is sent to a general plant sump for treatment and analysis prior to release to the Great Miami River through the main effluent line. The main effluent line to the Great Miami River is the permitted discharge point for wastewater from the FMPC. The discharge is regulated by a National Pollutant Discharge Elimination System (NPDES) permit and DOE Orders. Compliance monitoring is performed at Manhole 175 before the effluent leaves the FMPC boundary.

Storm water runoff from the production area is collected in storm water retention basins, located on the south side of the production area, allowing solids to settle out before the water is analyzed and released to the Great Miami River through the same effluent line. If, during extreme storm events, the storm water retention basins overflow, storm water is discharged through the Storm Sewer Outfall Ditch (SSOD) to Paddys Run.

1.5.2 Operable Unit 2 - Site Descriptions and Histories

1.5.2.1 Sanitary Landfill

The FMPC Sanitary Landfill is located in the northeast corner of what is termed the waste storage area. The facility is organized into five individual cells, all of which are filled to capacity and no longer in service.

Previous estimates (Weston 1988) of actual waste volume indicated that the landfill contained approximately 10,000 cubic yards of waste. A review of historical site photos (EPA 1988b) indicates that activity at the Sanitary Landfill occurred as early as 1954; borehole logs (Weston 1988) indicate that waste material also was deposited in an area adjacent to the five landfill cells. The actual waste volume is now believed to be approximately 16,000 to 18,000 cubic yards. The ISA will focus on the five cells that have been filled with waste as well as the area adjacent to the five cells. Together they comprise approximately one acre of the landfill (Figure 1-3).

A soil cover has been placed over the five cells and the adjacent disposal area, forming the topographic setting shown in Figure 1-3. Currently, sanitary wastes and general refuse are being collected for shipment and disposal at approved off-site locations.

The Sanitary Landfill was used for the disposal of cafeteria waste, rubbish, and other types of wastes from nonproduction areas. Materials reported to have been accepted in the past include nonburnable and nonradioactive sanitary wastes generated on property, nonradioactive construction-related rubble, and double-bagged and bulk quantities of nonradioactive asbestos. Construction rubble placed in the landfill and the soil used to cover exposed wastes may have been contaminated with radionuclides. The five existing cells, when filled to capacity, were covered with soil. Use of the landfill was halted in early 1986.

As part of the on-going Remedial Investigation at the FMPC, additional samples of the Sanitary Landfill will be taken and analyzed to determine whether the wastes exhibit toxicity characteristics as defined in 40CFR261. Samples will be analyzed by the Toxicity Characteristic Leachate Procedure (TCLP) in accordance with the regulation.

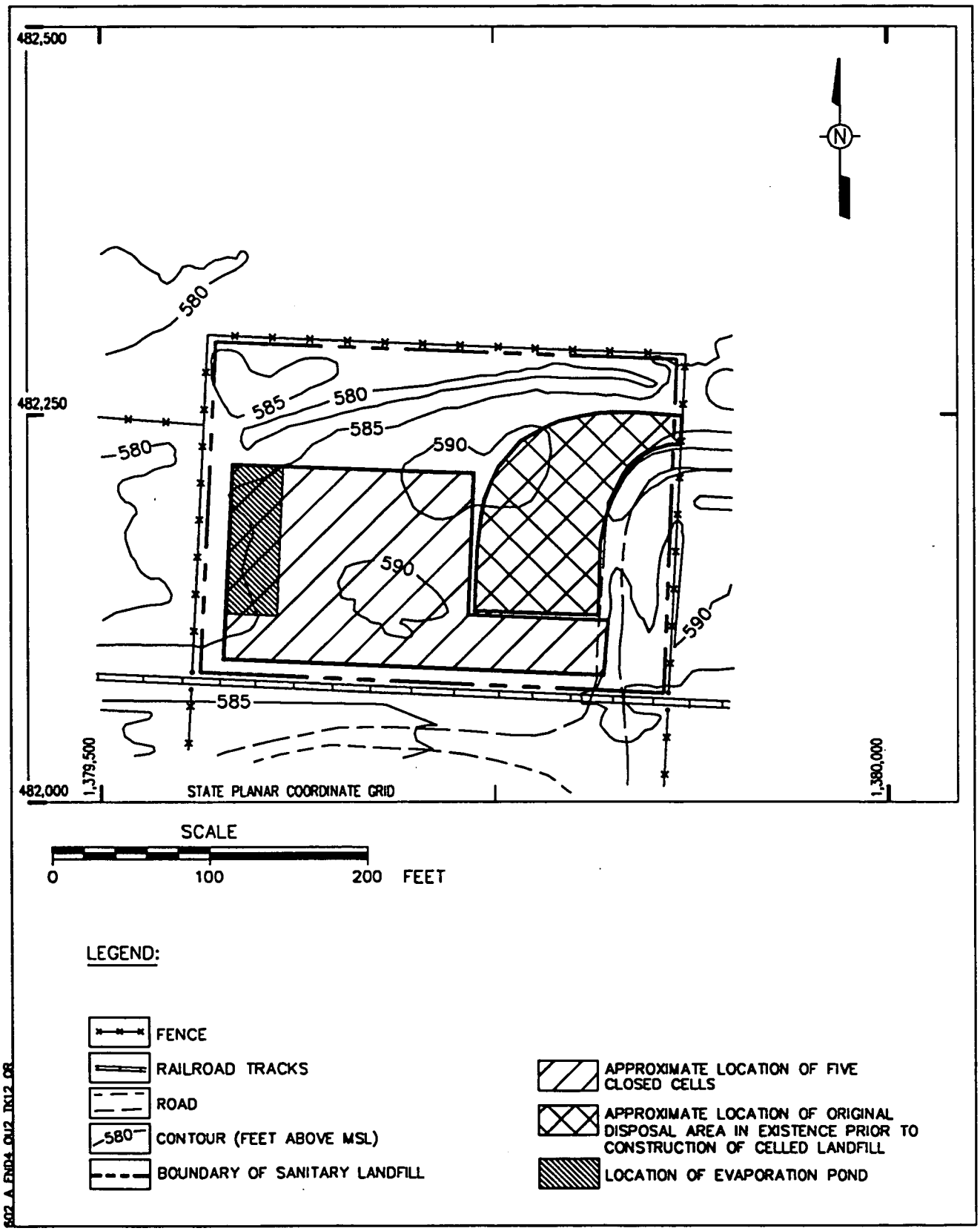


FIGURE 1-3. SANITARY LANDFILL

30

1165

1.5.2.2 South Lime Sludge Pond

The South Lime Sludge Pond is an unlined pond in the southeast corner of the waste storage area, as depicted in Figure 1-4; its approximate surface dimensions are 150 by 250 feet, and it is now overgrown with grass and shrubs. The depth had been previously reported as 6 to 8 feet, and the volume had been estimated at 5000 cubic yards (DOE 1988a). Borehole log information (Weston 1988), however, indicates the depth of the South Pond to be approximately 11.5 feet. Using this information, the sludge volume has been revised to be approximately 11,500 cubic yards (ASI 1990b). The volume of the berm material is estimated to be 2800 cubic yards (DOE 1990).

Spent lime sludges from FMPC water treatment plant operations (lime-alum sludges and boiler plant blowdown) were pumped to this pond and allowed to settle. This pond was inactive for a number of years, but was reactivated recently by WMCO and currently receives spent lime sludge.

1.5.2.3 North Lime Sludge Pond

The North Lime Sludge Pond is an unlined pond that has received spent lime sludge until recently (Figure 1-4). It is approximately 150 by 250 feet in size, approximately 90 percent full, and has a previously reported lime-sludge depth of 6 to 8 feet (DOE 1988a). This pond is partially covered with water (estimated to be a maximum of 150,000 gallons) that ranges from 1 to 7 feet in depth. The actual volume of water can vary, depending on plant operations and precipitation.

The height of the berm surrounding the North Pond is lower than the height of the South Pond, and the depth of lime sludge in the North Pond ranges from five to seven feet (Weston 1988). Therefore, the volume of lime sludge contained in the North Pond is estimated to be 5000 cubic yards (DOE 1990). The volume of the berm material is estimated to be 1100 cubic yards (DOE 1990).

As with the South Pond, spent lime sludges from the FMPC water treatment plant operations (lime-alum sludges and boiler plant blowdown) are pumped to this pond and allowed to settle. The total volume of lime sludge in both ponds is estimated at 16,500 cubic yards.

1.5.2.4. Inactive Fly Ash Disposal Area

This waste unit is located approximately 2000 feet southwest of the production area and is depicted in Figure 1-5. Based on a review of historical photos (EPA 1988c) and borehole logs (Weston 1988), the following observations were made:

- The northern portion of the Inactive Fly Ash Disposal Area is on top of an old drainage leading to Paddys Run. Borehole 10 is located in the upper portion of this area and was bored to a depth of approximately 26 feet before reaching undisturbed soil. Approximately one foot of clay was found in this undisturbed interval, with sand located under the clay.

31

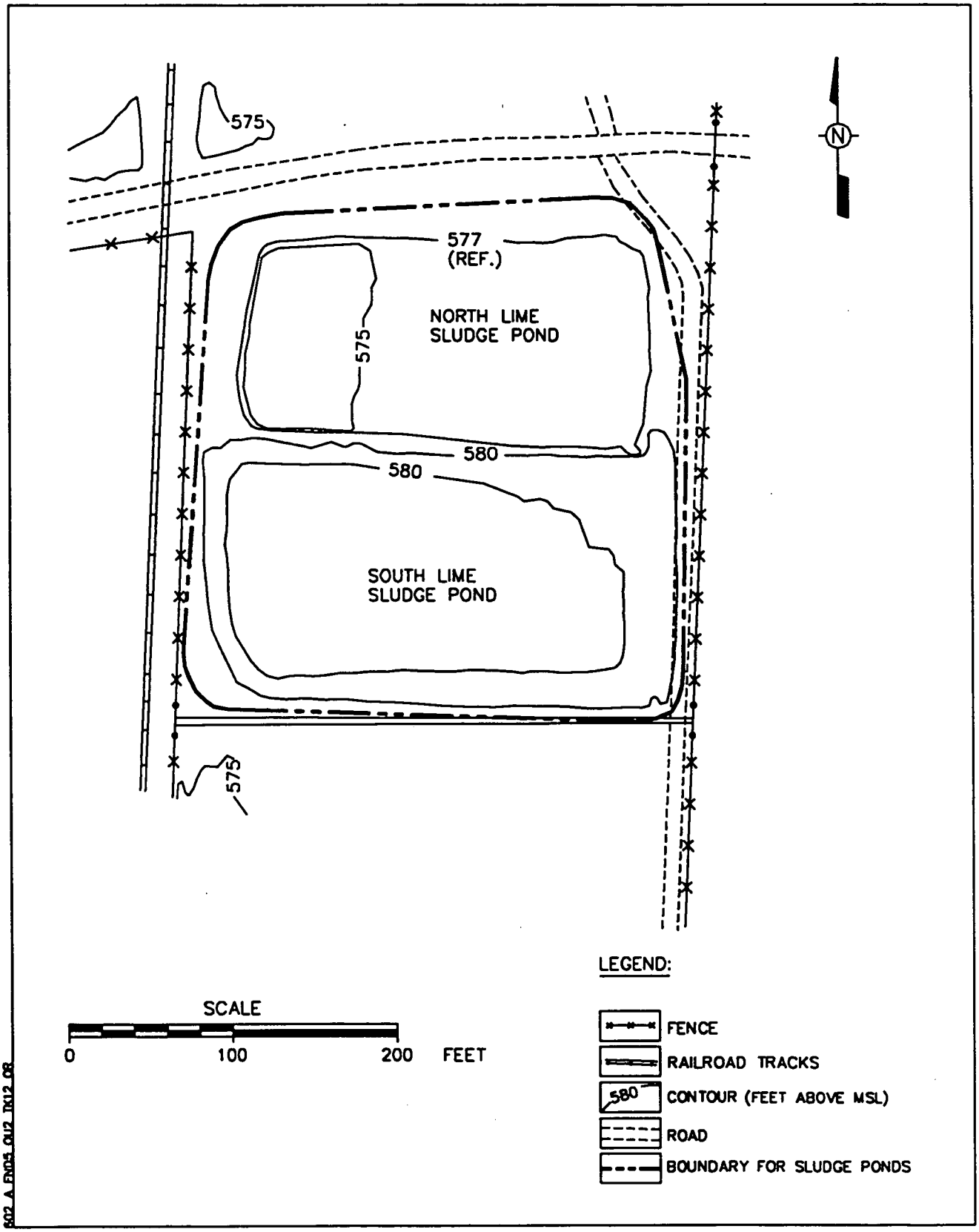


FIGURE 1-4. NORTH AND SOUTH LIME SLUDGE PONDS

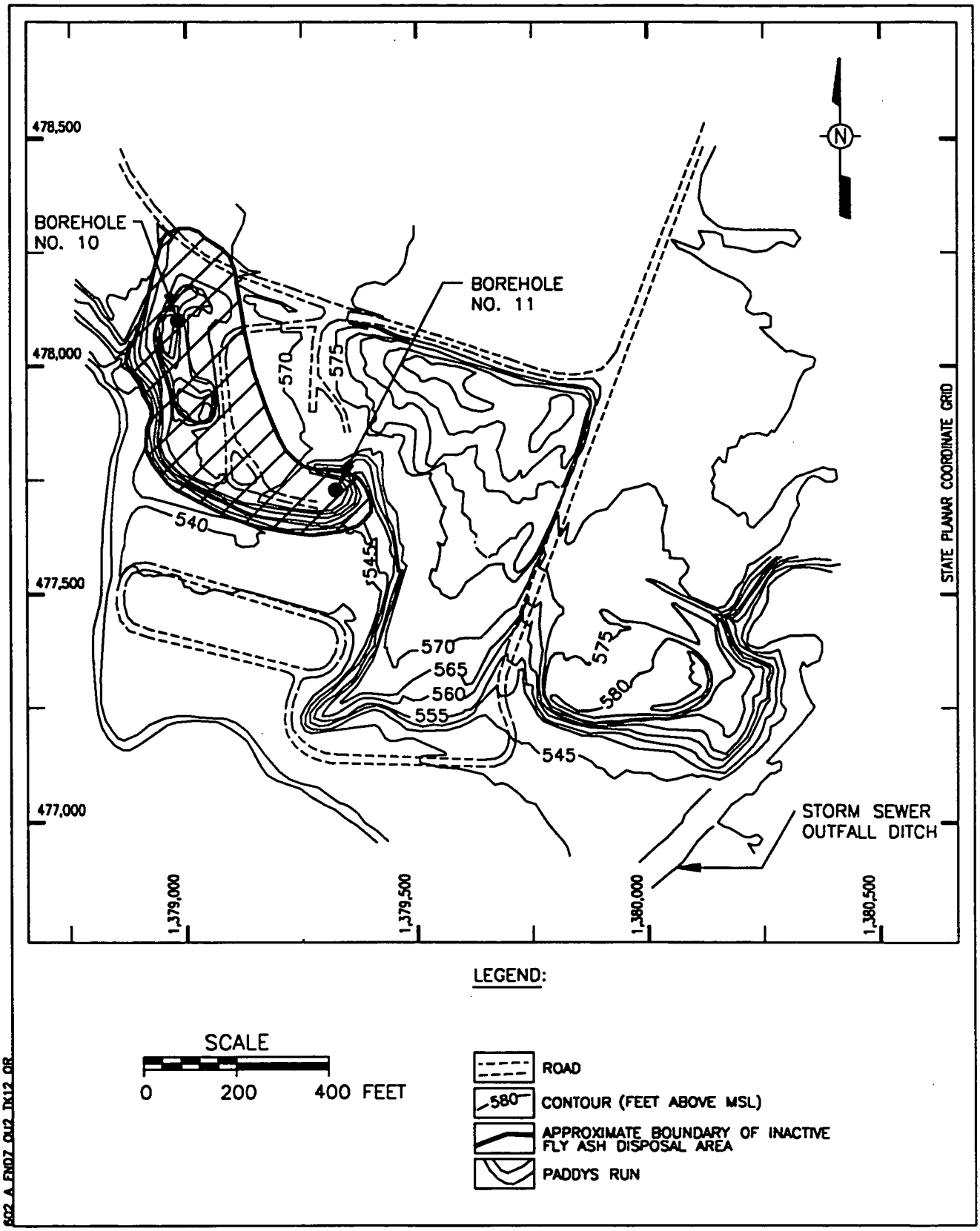


FIGURE 1-5. INACTIVE FLY ASH DISPOSAL AREA

- The west-southwest portion of the Inactive Fly Ash Disposal Area is on a slope just north of the running track/firing range. Borehole 11 is located in the southeast portion of the Inactive Fly Ash Disposal Area and was bored to a depth of 34 feet before reaching undisturbed soil. The borehole description and historical photos seem to indicate that layers of soil and fly ash were deposited in this area.

- Based on information provided by WMCO, 2500 to 3500 tons per year of fly ash were generated. Assuming a 38-year operating period and a density of 80 pounds per cubic feet (2160 pounds per cubic yards), a total of 88,000 cubic yards of fly ash is estimated to be present in the Active Fly Ash Pile and Inactive Fly Ash Disposal Area. This is the quantity assumed to exist for Operable Unit 2; however, it is an overestimation of the actual volume because some fly ash was disposed of in the Burn Pit and Pit 3, parts of Operable Unit 1 (Weston 1988). This information is the most reliable and current estimate of the total volume of fly ash under the stated assumptions.

- Previous reports (DOE 1988a) have estimated the volume of fly ash in the Inactive Fly Ash Disposal Area to be approximately 50,000 cubic yards. Historical photographs indicate that disposal activity ceased here between 1964 and 1968. The 1988 estimate of 50,000 cubic yards for the Inactive Fly Ash Disposal Area is reasonable.

- Elevated levels of uranium were found during sampling activity performed in the Characterization Investigation Study (CIS) (Weston 1987a), so it is suspected that waste oils containing uranium were sprayed on the pile as a dust suppressant. Approximately 1000 kg of uranium is estimated to have been present in the oils used as a dust suppressant (DOE 1988b; Weston 1987a).

- Building rubble such as concrete, gravel, asphalt, masonry, and steel rebar also reportedly was discarded at this site.

1.5.2.5 Active Fly Ash Pile

This waste unit is easily distinguishable; it is uncovered and located just east of the running track/Southfield, on the opposite side of the south construction road (Figure 1-6). The SSOD is located to the east of the Active Fly Ash Pile. A previous estimate of the volume of the fly ash deposited in the active fly ash pile is 33,000 cubic yards (DOE 1988a); however, the previously cited estimate of total fly ash produced at the FMPC has caused the estimated volume in this unit to be raised to 38,000 cubic yards.

In current operations, as in the past, fly ash from the coal-fired boiler plant is loaded into dump trucks and transported to the fly ash disposal site. In the past, contaminated waste oils were sprayed onto the fly ash pile on a periodic basis as a means of dust control (DOE 1988b; Weston 1987a), and elevated levels of radiological contaminants have been found in surface samples.

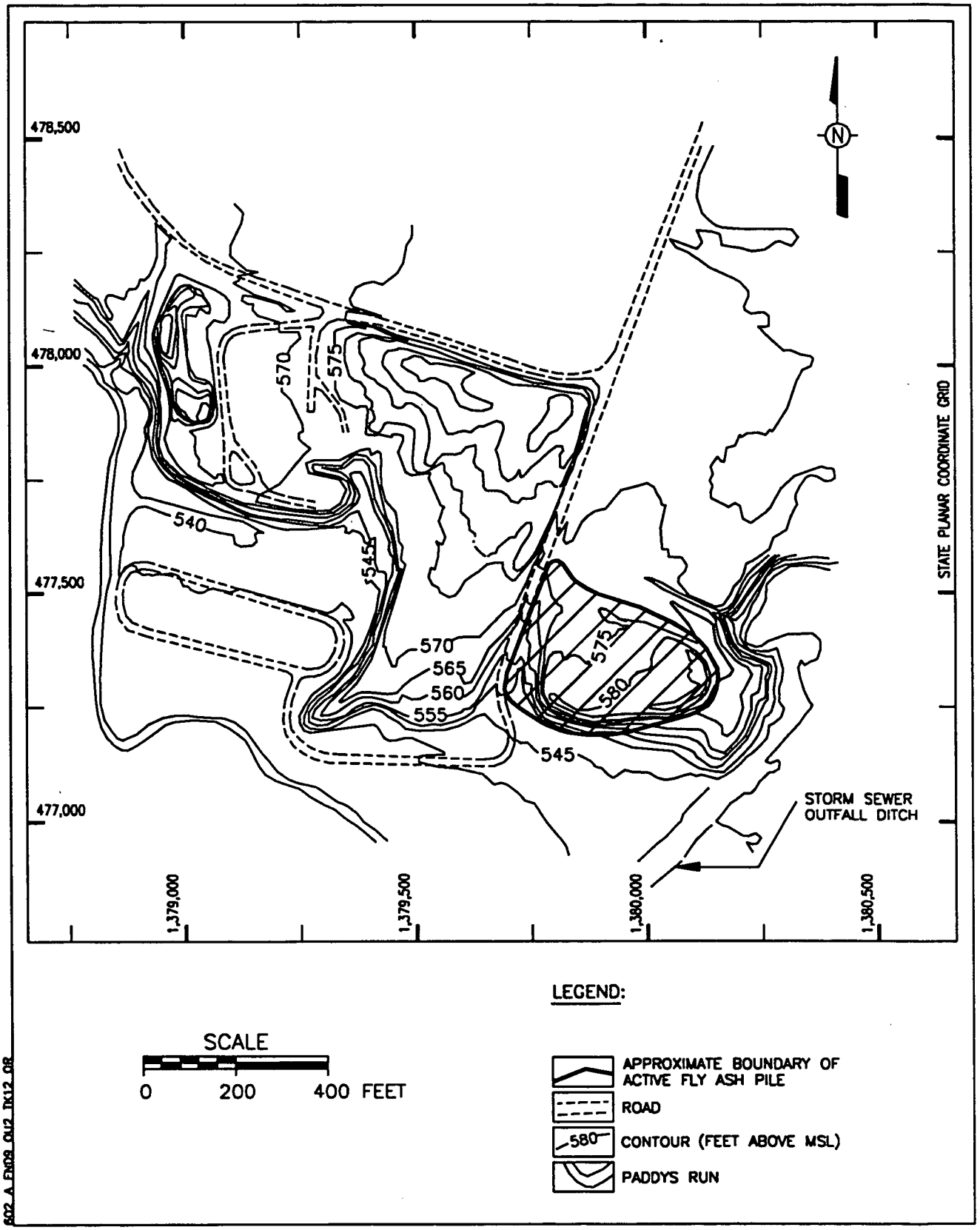


FIGURE 1-6. ACTIVE FLY ASH PILE

1.5.2.6 Southfield

Previous reports (DOE 1988a; DOE 1989; Weston 1987b) have not defined the volume or boundaries of the Southfield. Reviews of the previously mentioned historical photos and borehole logs were used to estimate the boundaries that were then used to estimate the volume and area. For example, aerial photographs from 1954 and 1957 indicate where fill activity occurred. The boundary of the Southfield assumed for the ISA and FS, representing a surface area of approximately 11 acres with a volume of 125,000 cubic yards (DOE 1990), is shown in Figure 1-7. This quantity estimate is supported by information obtained from borehole logs (Weston 1988) and trenches excavated during the RI/FS sampling effort (DOE 1989).

The Southfield was reportedly used as a burial site for construction rubble that may have contained low levels of radioactivity; this includes debris from the razing of the old administration building.

1.5.3 Nature and Extent of Contamination

The objective of the field investigation is to characterize the nature and extent of contamination so that informed decisions can be made as to the level of risk presented by the site and the appropriate type(s) of remedial response. This process involves using information on source location and physical site data (e.g., groundwater flow directions, overland flow patterns) to give a preliminary estimate of the locations of contaminants that may have migrated.

At waste sites, the nature and extent of contamination may be of concern in five media: groundwater, soil, surface water, sediments, and air (fugitive dust). The following text explains contaminant transport mechanisms in each of the five media listed above.

Rainfall at a waste site is transported in one of the following ways:

- Precipitation percolates through the waste and forms leachate, which migrates through the underlying substrata and eventually into an aquifer containing a source of groundwater. Some contaminants may not reach the groundwater and could remain in the soil.

- Rainfall remains on the surface (commonly known as runoff), travels via a surfacial route, and enters surface streams or rivers. Surface contamination can spread to sediments on the ground surface or in stream and river beds.

- Precipitation evaporates from the surface, or becomes available for uptake in vegetation. This is known as evapotranspiration.

Wind is also a transport mechanism. Uncovered waste can be transported via wind deposition, with the waste remaining in the ground surface.

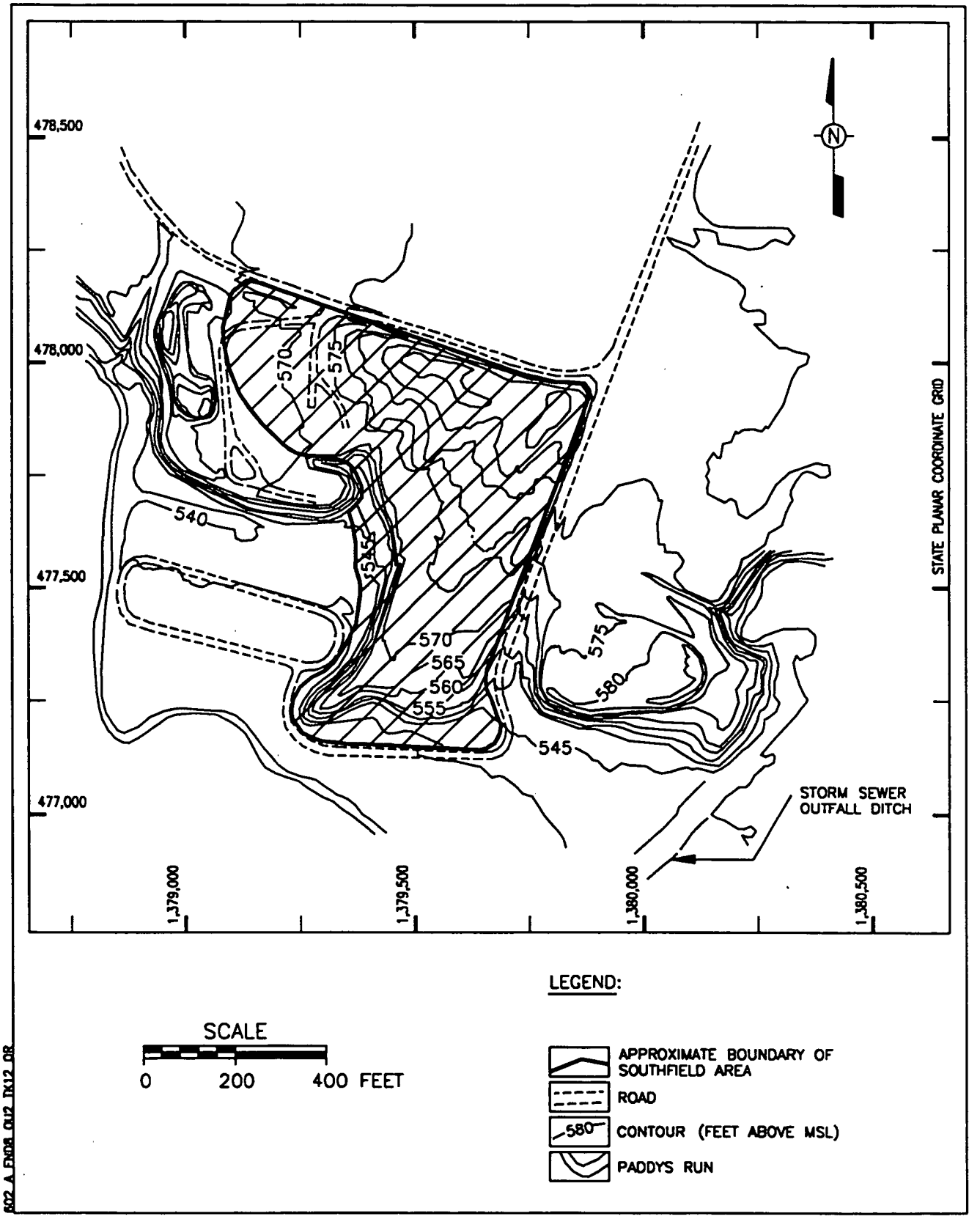


FIGURE 1-7. SOUTHFIELD

The following sections discuss the current results of the field characterization program conducted as part of the remedial investigation. The various media discussed earlier were sampled to determine the nature and extent of contamination. Sampling of air was not conducted specifically for Operable Unit 2; however, the FMPC conducts an ongoing monitoring program for air.

1.5.3.1 Sanitary Landfill

The Sanitary Landfill contains the highest diversity of organic and inorganic chemicals among the Operable Unit 2 sites. A large variety of organic compounds, including polychlorinated biphenyls (PCBs) (e.g., Aroclors 1242, 1248, and 1254), polynuclear aromatic hydrocarbons (e.g., benzo[a]pyrene and benzo[b]fluoranthene), other volatile organics (e.g., 1,1,1-trichloroethane and benzene), semivolatile organics (e.g., naphthalene and phenol), and common laboratory contaminants (e.g., acetone, methylene chloride, and di-n-butyl phthalate) were all detected in samples of waste from the landfill. In addition to the organic compounds, cadmium, zinc, U-234, U-235, and U-238 were detected in the source at concentrations above available background levels. Ranges of detected values of contaminants in the Sanitary Landfill waste are presented in Table C-1 of Appendix C.

Chemicals detected above blank and background concentrations in both the source and perched groundwater were cadmium, U-234, and U-238. Wells 1035 and 1038 are screened in the perched groundwater beneath the Sanitary Landfill. Well 1035 is located north of the drainage channel that forms the northern boundary of the landfill. Well 1038 is located just south of the east-to-west-oriented rail spur that serves as the southern limit of the landfill. The concentrations of cadmium detected ranged from 0.007 to 0.0128 ppm. The highest concentration of cadmium was detected in Well 1038. U-234 and U-238 detected in the perched groundwater beneath the Sanitary Landfill ranged from 1.2 ± 0.4 picocuries per liter (pCi/ℓ) to 4.6 ± 0.7 pCi/ℓ and from 1.0 ± 0.3 pCi/ℓ to 3.9 ± 0.6 pCi/ℓ, respectively. [Section 3.4.2.1 indicates an apparent southerly to southeasterly perched groundwater gradient beneath the Sanitary Landfill. Section 3.4.2.1 also suggests that the potentiometric surface of the perched groundwater intersects the base of the landfill, indicating that the landfill is a possible source of contamination for the perched groundwater.]

Surface water and sediment samples were taken in the drainage channel north of the Sanitary Landfill. Surface water sampling location ASIT-021 is located at the bottom of the drainage channel directly north of the landfill. The concentrations of U-234 and U-238 detected at ASIT-021 were 6.1 ± 0.9 pCi/ℓ and 9.7 ± 1.4 pCi/ℓ, respectively. Bis(2-ethylhexyl)phthalate and 2-propanone were detected in the associated blank and in the surface water sample, indicating that the contaminants were probably introduced during laboratory analysis.

As part of the Weston CIS, sediment samples were taken in the portion of the drainage channel north of the Sanitary Landfill. U-238 concentrations ranged from 2.90 ± 1.80 pCi/g to 6.80 ± 1.30 pCi/g.

Based on the U-234 and U-238 concentrations detected in surface water and sediment samples taken from the drainage channel, the landfill may be a minor source of surface water and sediment contamination through its surface water runoff from and/or seepage through the southern bank of the drainage channel.

Organics detected in the Sanitary Landfill were not detected in surface water, sediment, and perched groundwater adjacent to and below the landfill. This suggests that these organics have been contained within the landfill, or bound in the surrounding glacial overburden.

1.5.3.2 Lime Sludge Ponds

The North and South Lime Sludge Ponds contain a similar variety of chemicals. Organic compounds detected in both of the sludge ponds include: phenol, acetone, bis(2-ethylhexyl)phthalate, di-n-butyl phthalate, and methylene chloride. Radionuclides detected at concentrations greater than background levels in the lime sludge were thorium-230 (Th-230), U-234, U-235, and U-238. Ranges of detected values of contaminants in the Lime Sludge Ponds are presented in Table C-2 of Appendix C.

Chemicals detected at concentrations above background levels in both the Lime Sludge Ponds and perched groundwater were Th-230, U-234, and U-238. U-234 and U-238 detected in the perched groundwater beneath the Lime Sludge Ponds ranged from 1.4 ± 0.4 pCi/ℓ to 9.5 ± 1.5 pCi/ℓ and from 1.7 ± 0.5 pCi/ℓ to 9.7 ± 1.5 pCi/ℓ, respectively. The highest concentrations of U-234 and U-238 were measured in Well 1042, located southwest of the Lime Sludge Ponds. The highest concentration of Th-230, 1.6 ± 0.6 pCi/ℓ, was measured in Well 1041 in the east berm of the South Pond.

Section 3.4.2.2 indicates an apparent southwesterly perched groundwater gradient beneath the Lime Sludge Ponds. Section 3.4.2.2 also suggests that the potentiometric surface of the perched groundwater intersects the base of the Lime Sludge Ponds. The perched groundwater zone beneath the Lime Sludge Ponds appears to extend continuously beneath the production area. The potentiometric surface of the perched water table appears to reside within the Lime Sludge Ponds, suggesting the presence of a groundwater mound. The near background levels of uranium in the sludges from neutralization of coal pile storm water runoff may be a source of this uranium.

Organics detected in the Lime Sludge Ponds were not detected in perched groundwater beneath the ponds. This suggests that these organics have been contained within the Lime Sludge Ponds or bound in the surrounding glacial overburden.

Calcium and magnesium are primary components of lime sludge. Increased levels of calcium and magnesium in the perched groundwater in the vicinity of the Lime Sludge Ponds indicate release of these constituents from the Lime Sludge Ponds into the environment.

1.5.3.3 Active Fly Ash Pile

Chemical analyses of constituents in the Active Fly Ash Pile were performed for RCRA metals (barium and chromium), volatile organics, and radionuclides in composited and surface soil samples. Analyses for inorganic and PCB constituents will be performed on additional samples collected. Organics detected in the Active Fly Ash Pile were acetone, 2-butanone, chloroform, methylene chloride, and 1,1,1-trichloroethane. In addition to these constituents, Pb-210, Ra-226, Th-230, U-234, U-235, and U-238 were detected at above background levels in the Active Fly Ash Pile. Ranges of detected values of contaminants in the Active Fly Ash Pile are presented in Table C-3 of Appendix C. Neither inorganic nor PCB analyses were performed on samples taken in the Active Fly Ash Pile. The concentrations of these constituents were assumed to be similar to those in the Inactive Fly Ash Disposal Area. The only inorganic chemicals detected at above background concentrations in the Inactive Fly Ash Disposal Area were cadmium and lead. Inorganic and PCB analyses will be performed on additional samples taken from the Active Fly Ash Pile.

Chemicals detected at concentrations above background levels in both the Active Fly Ash Pile and perched groundwater were U-234, U-238, and cadmium. U-234 and U-238 detected in the perched groundwater beneath the Active Fly Ash Pile ranged from 4.5 ± 1.0 pCi/ℓ to 6.6 ± 1.2 pCi/ℓ and from 4.0 ± 1.0 pCi/ℓ to 6.9 ± 1.1 pCi/ℓ, respectively. U-234 and U-238 were detected in Well 1048, located north of the Active Fly Ash Pile. Cadmium was detected at a concentration of 0.003 to 0.0069 ppm in Well 1048. Elevated levels of uranium detected in the Active Fly Ash Pile indicate possible migration of the source contamination to the underlying perched groundwater. Possible transport mechanisms include surface water runoff and/or seepage through the northern slope of the Active Fly Ash Pile, vertically migrating through the weathered glacial overburden into the perched groundwater.

Chemicals detected at concentrations above background levels in both the Active Fly Ash Pile and adjacent surface waters were Ra-226, total uranium, and lead. Concentrations of total uranium measured at sampling locations ASIT-006 and ASIT-007 were 14.0 ± 2.0 µg/ℓ and 24.0 ± 4.0 µg/ℓ, respectively. ASIT-006 and ASIT-007 are located in a drainage channel north of the Active Fly Ash Pile. The drainage channel empties into the SSOD. Ra-226 was detected at a concentration of 1.5 ± 0.3 pCi/ℓ at sampling location ASIT-005, in a drainage channel immediately west of the Active Fly Ash Pile. Lead was detected at a concentration of 0.036 ppm at ASIT-005. Detection of total uranium, Ra-226, and lead at surface water sampling locations adjacent to the Active Fly Ash Pile indicates probable migration of contamination from the Active Fly Ash Pile via the surface water media.

Chemicals detected at concentrations above background levels in both the Active Fly Ash Pile and adjacent sediments were Ra-226 and total uranium. Ra-226 was detected at concentrations between

0.6 ± 0.1 pCi/g and 2.9 ± 0.3 pCi/g. The highest concentration of Ra-226 was detected at sampling location ASIT-005. Total uranium was detected at concentrations between 4.5 ± 1.2 µg/g and 51.8 ± 8.3 µg/g. The highest concentration of total uranium was detected at sampling location ASIT-005. Detection of Ra-226 and total uranium at sediment sampling locations adjacent to the Active Fly Ash Pile indicates that the Active Fly Ash Pile is a probable source of contamination to adjacent sediments.

1.5.3.4 Inactive Fly Ash Disposal Area

Comparison of both chemicals and radionuclides in the Inactive Fly Ash Disposal Area to concentrations detected in blanks and background samples reveals PCBs (aroclors-1242, 1254, and 1260), cadmium, lead, Pb-210, Ra-226, Ra-228, Th-230, U-234, U-235, and U-238 as chemicals of potential concern at the source. Ranges of detected values of contaminants in the Inactive Fly Ash Disposal Area are presented in Table C-4 of Appendix C.

Chemicals detected at concentrations above background levels in both the Inactive Fly Ash Disposal Area and perched groundwater were cadmium, U-234, and U-238. U-234 and U-238 detected in the perched groundwater beneath the Inactive Fly Ash Disposal Area ranged from 3.7± 0.6 pCi/ℓ, to 7.4 pCi/ℓ and from 2.1± to 0.4 pCi/ℓ to 3.6± 0.7 pCi/ℓ, respectively. U-234 and U-238 were detected in Well 1047, north of the Inactive Fly Ash Disposal Area. Cadmium was detected at a concentration of 0.009 ppm in Well 1047.

Total uranium was at a concentration of 40.0 ± 6.0 µg/ℓ at surface water-sampling location ASIT-009, in a drainage channel west of the northwest section of the Inactive Fly Ash Disposal Area. The drainage channel empties into Paddys Run. Detection of total uranium at sampling location ASIT-009 indicates probable migration of contamination from the Inactive Fly Ash Disposal Area via the surface water media.

Chemicals detected at concentrations above background levels in both the Inactive Fly Ash Disposal Area and adjacent sediments were Ra-226, Ra-228, and U-238. The maximum, measured concentrations of both Ra-226 and Ra-228 were 0.9 ± 0.1 pCi/g at sampling location ASIT-008, southwest of the Inactive Fly Ash Disposal Area in an east-west oriented drainage channel that empties into Paddys Run. Two sediment samples taken in the drainage channel west of the Inactive Fly Ash Disposal Area during the Weston CIS had U-238 concentrations ranging from 4 pCi/g to 9 pCi/g. Total uranium concentrations measured at sampling locations ASIT-008 and ASIT-009 were 13.9 ± 1.8 µg/g and 5.4 ± 1.1 µg/g, respectively. Detection of uranium at sediment sampling locations adjacent to the Inactive Fly Ash Disposal Area indicates the Inactive Fly Ash Disposal Area is a probable source of contamination to adjacent sediments.

PCBs (Aroclors 1242, 1254, and 1260) were detected in the source at concentrations ranging from 5.70 parts per billion(ppb) to 290.0 ppb. PCBs were not detected in perched groundwater, surface water, or sediments beneath and adjacent to the Inactive Fly Ash Disposal Area, indicating that the PCBs have been contained within the source or bound in the surrounding glacial overburden.

1.5.3.5 Southfield

The Southfield is a large, heterogeneous site that overlaps the Inactive Fly Ash Disposal Area. Chemicals and radionuclides that were detected in the Southfield at concentrations exceeding available background levels were PCBs (Aroclors 1242, 1254, and 1260), methylene chloride, cadmium, mercury, Sr-90, Pb-210, Ra-226, Ra-228, Th-228, Th-230, Th-232, U-234, U-235, and U-238. Ranges of detected values of contaminants in the Southfield waste are presented in Table C-5 of Appendix C.

Chemicals detected at concentrations above background levels in both the Southfield and perched groundwater were cadmium, Th-228, Th-230, U-234, and U-238. Th-228 and Th-230 were detected in Well 1046 at concentrations of 1.1 ± 0.5 pCi/ℓ and 1.0 ± 0.5 pCi/ℓ, respectively. Well 1046 is located at the northern boundary of the Southfield. U-234 and U-238 detected in the perched groundwater beneath the Southfield ranged from 2.0 ± 0.5 pCi/ℓ to 2.8 ± 0.5 pCi/ℓ and from 1.9 ± 0.4 pCi/ℓ to 2.3 ± 0.5 pCi/ℓ, respectively. Cadmium was detected at a concentration of 0.008 ppm in Well 1046. Elevated levels of uranium and cadmium detected in the Southfield indicate possible migration of source contamination to the underlying perched groundwater via vertical transport through the weathered glacial overburden.

Organics (methylene chloride and Aroclors 1242, 1254, and 1260) detected in the Southfield were not detected in the perched groundwater beneath the Southfield. This suggests that these organics have been contained within the Southfield, or bound in the surrounding glacial overburden.

2.0

1165

2.0 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

2.1 INTRODUCTION

This section discusses the development and screening of the technologies and process options used to assemble the remedial action alternatives for Operable Unit 2. The steps involved in this screening include:

- Development of media-specific RAOs
- Development of media-specific general response actions
- Identification and screening of remedial technologies within each general response action
- Identification and screening of process options within each technology

2.2 REMEDIAL ACTION OBJECTIVES

RAOs are contaminant-specific, medium-specific goals for protecting human health and the environment and are, therefore, an integral part of evaluating the ability of a remedial alternative to achieve an acceptable risk level. The "Guidance for Conducting Remedial Investigations and Feasibility Studies Under CERCLA" states, "objectives should be as specific as possible but not so specific that the range of alternatives that can be developed is unduly limited."

RAOs are normally determined on the basis of the results of a baseline risk assessment. The objectives must address the contaminants of concern and the exposure routes and receptors identified. However, in a situation where a site is divided into operable units, the operable unit-specific RAOs must also be based on knowledge of the site-
wide risks. It should be noted that RAOs presented within this document are those which are currently proposed by DOE and are preliminary. The RAO's contained herein are under review by DOE and EPA and will be established prior to the continuation of the Feasibility Study.

It is the goal of the FMPC RI/FS to manage risk from a site-wide perspective. Since many preliminary remediation goals are being developed before completion of site characterization and a site-wide assessment, it is difficult to quantify how an individual operable unit may contribute to total site risk. For example, it is not known how many operable units contribute chemical "x" via exposure pathway "y" to receptor "z", making it difficult to apportion risk levels among operable units when developing RAOs.

The interim policy for developing preliminary remediation goals is to make use of " . . . readily available ARARs . . . and other criteria, advisories or guidance," as specified in the preamble to 40CFR300 (EPA 1990a). Where ARARs or to be considereds (TBCs) are not available, preliminary remediation goals will be developed based on a 1 x 10^{-6} risk level. Effort is underway to develop final

43

remediation goals based on the results of a site-wide baseline risk assessment. This will ensure that final remediation goals account for such concerns as multiple contaminants, multiple exposure pathways, and multiple sources.

When characterization of individual operable units and the site-wide risk assessment are complete, the risk distribution will be reevaluated, and appropriate adjustments will be made in the operable unit-specific remediation goals.

2.2.1 Point of Compliance

For each operable unit at the FMPC, the point of compliance must be identified. The point of compliance is the geographical location at which the RAO must be achieved. At most hazardous waste sites, the point of compliance is the nearest identified receptor location for each exposure pathway. The final determination of the point of compliance for remedial goals will be made during remedy selection.

There are two major human-exposure categories identified for Operable Unit 2: current land-use exposures and future potential land-use exposures. The current exposure setting at the FMPC is based on the assumption of the presence of active security control measures (e.g., fencing, restricted access, security measures, etc.). It is assumed that these controls will remain in place for up to 100 years. It is also assumed that no active security controls can be relied on for protection of human health after 100 years. The point of compliance, under current exposure conditions, would be the FMPC property boundary. To be health protective in developing RAOs, the point of compliance for each medium will be identified. Proposed points of compliance are listed below:

- Groundwater — The point is in the aquifer immediately below the waste units.
- Soil — The point is that at which direct contact with the wastes may occur after 100 years. Assuming that passive control measures are implemented for the site (as part of each remedial alternative), this point is conservatively set at the boundary of the waste unit.
- Surface water — The point is Paddys Run where runoff from the waste units may enter the creek.
- Air — The point of maximum exposure is at the boundary of the waste unit.

These points of compliance were developed in accordance to proposed regulations under 40CFR264, 265, 270, and 271. No passive controls are assumed for the No-Action Alternative. However, each remedial alternative may include passive control measures.

Establishing a point of complaince for perched groundwater is dependent on the type of use that is likely for the groundwater. Certain perched groundwater zones may or may not be considered sources of drinking water depending on the quality of the water, the depth of the zone, and the ability of the

zone to produce a sustained yield in relation to water supply demand. The preamble to the NCP (55FR8717, EPA 1990) accounts for these considerations as stated below:

- "Groundwater that is not an actual or potential source of drinking water may not require remediation to a 1 x 10 E-4 to 1 x 10 E-6 [risk] level."
- "The likelihood of exposure actually occurring should be considered when deciding the appropriate level of remediation."

At the FMPC, perched water zones are being located and defined with respect to depth and potential yield as the remedial investigation proceeds. As the FS proceeds to completion, determinations as to the potential use of perched groundwater will have to be made in consultation with state and federal environmental protection agencies. For those zones which are designated as sources of potable water, the point of compliance would be at and beyond the edge of the waste management area when the waste is left in place.

2.2.2 Chemicals of Potential Concern

Those chemicals of potential concern for Operable Unit 2 which are associated with significant pathways to potential human receptors (i.e., those chemicals of potential concern quantitatively evaluated) are identified in Table 2-1.

2.2.3 RAOs Based on ARARs

The development of RAOs is concurrent with the identification of ARARs. In the case of the FMPC, ARARs may need to be interpreted in relation to site-specific conditions to ensure sufficient health protection based on multiple sources and pathways.

Chemical-specific ARARs have been identified for the control of radionuclide concentrations in air and groundwater and for chemical concentrations in drinking water. These chemical-specific ARARs are listed in Table 2-2. In the case where both a maximum contaminant level (MCL) and a proposed MCL (PMCL) exist for a constituent, the PMCL is used to develop the RAO. Promulgation of these MCLs is expected to occur in the near future.

2.2.4 RAOs Based on Risk Criteria

For several constituents in Operable Unit 2, no MCLs or PMCLs exist. In these cases, the RAOs are based on available toxicity information. EPA provides guidance on using toxicity-based reference doses (RfDs) and cancer slope factors (CSFs) to determine acceptable intake levels of water in a manner similar to the method used to develop MCLs. Briefly, RAOs are estimated using the following steps:

TABLE 2-1

CHEMICALS AND RADIONUCLIDES OF POTENTIAL CONCERN IN OPERABLE UNIT 2

Organic Compounds	Inorganic Analytes
Acenapthene	Aluminum
Acetone	Arsenic
Anthracene	Barium
Aroclor-1242	Beryllium
Aroclor-1248	Cadmium
Aroclor-1254	Cobalt
Aroclor-1260	Lead
Benzene	Manganese
Benzo(a)anthracene	Mercury
Benzo(a)pyrene	Nickel
Benzo(b)fluoranthene	Selenium
Benzo(ghi)perylene	Uranium
Benzo(k)fluoranthene	Vanadium
Bis(2-ethylhexyl)phthalate	Zinc
2-butanone	
Butyl benzyl phthalate	
Carbon disulfide	**Radionuclides**
Chlordane	Radium-226
Chloroform	Radium-228
Chrysene	Thorium-228
Dibenzo(a,h)anthracene	Thorium-230
Dibenzofuran	Thorium-232
1,1 - dichloroethane	Uranium-234
2,4 - dimethylphenol	Uranium-235
di-n-butylphthalate	Uranium-238
di-n-octylphthalate	
Ethylbenzene	
Fluoranthene	
Fluorene	
Indeno(1,2,3-cd)pyrene	
Methylene chloride	
2 - Methylnaphthalene	
2 - methylphenol	
4 - methylphenol	
Naphthalene	
N - nitrosodiphenylamine	
Phenanthrene	
Phenol	
Pyrene	
Tetrachloroethene	
Toluene	
1,1,1 - trichloroethane	
1,1,2 - trichloro - 1,2,2 - trifluoroethane	
Xylenes (Total)	

TABLE 2-2

OPERABLE UNIT 2 ARARs

Chemical-Specific	Standard	ARAR/TBC	Regulation
Airborne Radionuclide Emission (Except Airborne Rn-222)	Public Dose < 10 mrem/yr	Applicable	40CFR61, Subpart H
Radiation Dose Limits (All Pathways)	100 mrem/year	To Be Considered	DOE Order 5400.5
Chemicals or Radionuclides in Drinking Water	Arsenic 0.05 mg/ℓ Barium 1.0 mg/ℓ Cadmium 0.005 mg/ℓ Lead 0.05 mg/ℓ Mercury 0.002 mg/ℓ Selenium 0.05 mg/ℓ 1,1,1-Trichloroethane 0.2 mg/ℓ PCBs (total) 0.0005 mg/ℓ Benzene 0.005 mg/ℓ Chlordane 0.002 mg/ℓ Ethylbenzene 0.7 mg/ℓ Tetrachloroethane 0.005 mg/ℓ Toluene 1.0 mg/ℓ Xylenes (total) 10 mg/ℓ Radium 5 pCi/ℓ Beta Emissions 4mrem/yr	Applicable	40CFR141.11[a] OAC3645-81-11
Chemicals in Drinking Water	Barium 2.0 mg/ℓ Beryllium 0.001 mg/ℓ Nickel 0.1 mg/ℓ Benzo(a)anthracene 0.0001 mg/ℓ Benzo(a)pyrene 0.0002 mg/ℓ Benzo(b)fluoranthene 0.0002 mg/ℓ Benzo(k)fluoranthene 0.0002 mg/ℓ Bis(2-ethylhexyl)phthahte 0.004 mg/ℓ Chrysene 0.0002 mg/ℓ Dibenzo (a,h,)anthrancene 0.0003 mg/ℓ Indeno(1,2,3-cd)pyrene 0.0004 mg/ℓ Methylene chloride 0.005 mg/ℓ	To Be Considered Proposed Rule	40CFR Parts[b] 141,142, 143

TABLE 2-2
(Continued)

Chemical-Specific	Standard	ARAR/TBC	Regulation
Chemicals in Drinking Water	Cadmium 0.005 mg/ℓ Mercury 0.002 mg/ℓ Selenium 0.05 mg/ℓ Ethylbenzene 0.7 mg/ℓ Toluene 1.0 mg/ℓ Xylenes (total) 10 mg/ℓ	To Be Considered	40CFR141, 142 and 143[c]
Chemicals in Surface Water	Chemical-Specific (See Table 2-4)	To Be Considered	40CFR131.21 Quality Criteria for Water State of Ohio Administrative Code, Chapter 3745-1

[a]Maximum Contaminant Levels

[b]Proposed Maximum Contaminant Levels

[c]Maximum Contaminant Level Goals

- Determination of the acceptable daily intake, or RfD, for noncarcinogens based on dose response data and appropriate safety factors.

- Determination of the acceptable risk level for carcinogens.

- Determination of the acceptable water concentration (c) based on the assumption that a 70-kg adult drinks two liters of water per day, such that:

  [(c mg/ℓ)(2ℓ/d)]/70 kg = RfD (mg/kg/d), for noncarcinogens or
  [(c mg/ℓ)(2 ℓ/d)]/70 kg = (acceptable risk level/CSF mg/kg/d), for carcinogens.

- Application of any site-specific or operable unit-specific relative source contribution factors. The acceptable risk level for carcinogens as specified by the National Oil and Hazardous Substances Pollution Contingency Plan (NCP) is 10^{-4} to 10^{-6}.

2.2.5 Summary of Operable Unit 2 RAOs

RAOs for all relevant media associated with Operable Unit 2 are summarized in Figure 2-1. As shown, many of the RAOs for Operable Unit 2 are based on ARARs and TBCs. Risk-based RAOs had to be developed for one inorganic metal and for several organic compounds for the groundwater pathway. RAOs for each medium are briefly summarized in Sections 2.2.5.1 through 2.2.5.5.

An RAO that must be applied across all media is that total cancer risk from carcinogens must fall within the 10^{-4} to 10^{-6} goal set forth in the NCP. This is being addressed by setting risk levels for individual carcinogens at the 10^{-6} "point-of-departure" risk level. The resulting cumulative risk of all carcinogens will fall below 10^{-4}, as suggested by the NCP. The goal for noncancer hazards is the allowable Hazard Index (HI) of 1.0. The HI is the ratio of the estimated intake of a noncarcinogen to the allowable intake or RfD. An HI greater than one indicates that an exposure may be unacceptable.

2.2.5.1 Direct Radiation

A goal for remediation of Operable Unit 2 is to prevent penetrating radiation doses from all pathways to the public from exceeding the 100-mrem annual dose limit, as specified in DOE Order 5400.5. This order has been identified as a TBC for Operable Unit 2.

2.2.5.2 Air (Fugitive Dust)

One ARAR was identified as applicable to Operable Unit 2: 40CFR61, subpart H, Part 102 allows for a 10 mrem/yr limit to the public for all airborne radionuclides except Rn-222. It should be noted that air does not contribute measurably to dose.

2.2.5.3 Soils

Remedial actions related to soils surrounding Operable Unit 2 must meet the following objective: they must prevent direct contact with and inhalation of soils and fugitive dusts that contain chemicals and

MEDIUM		REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION
1. ALL PATHWAYS	1-1	***For Human Health:*** Prevent current and future radiation doses from exceeding 100 mrem/year.	No Action Institutional Actions Containment Collection/Treatment Removal/Treatment/Disposal
	1-2	***For Environmental Protection:*** Prevent current and future radiation emissions from causing detectable chronic effects.	
2. AIR	2-1	***For Human Health:*** Prevent current and future above-background airborne radiation doses from exceeding 10 mrem/yr.	No Action Institutional Actions Containment Containment/Treatment Removal/Treatment/Disposal
	2-2	Prevent current and future airborne chemical concentrations from exceeding risk levels of 10^{-4} to 10^{-6} cancer risk and/or a hazard index of 1.0.	
	2-3	***For Environmental Protection:*** Prevent current and future radiation emissions from causing detectable chronic effects.	
3. SOILS	3-1	***For Human Health:*** Prevent radionuclide doses in excess of 100 mrem/yr from all radionuclides and pathways.	No Action Institutional Actions Containment Containment/Treatment Removal/Treatment/Disposal
	3-2	Prevent erosion of soil to surface waterways that would result in cancer risks of 10^{-4} to 10^{-6}, or non-cancer hazards resulting in a hazard index of 1.0 (Table 2-3).	
	3-3	Prevent contact with Radium and Thorium to 5 pCi/g in the first 15cm of soil, and 15 pCi/g below. Prevent contact with other nuclides to concentrations resulting in doses greater than 100 mrem/yr.	
	3-4	***For Environmental Protection:*** Prevent erosion of soil that would contribute to surface water concentrations of chemicals in Operable Unit 2 from reaching concentrations in excess of levels reported in Table 2-4.	

FIGURE 2-1. REMEDIAL ACTION OBJECTIVES AND ASSOCIATED GENERAL RESPONSE ACTIONS

602 A FND181 OU2 TK12 OR

MEDIUM		REMEDIAL ACTION OBJECTIVE	GENERAL RESPONSE ACTION
4. SEDIMENTS AND SURFACE WATER	4-1	***For Human Health:*** Prevent releases of Operable Unit 2 constituents into creek sediments that would result in persons having direct contact with radioactive and nonradioactive constituents in excess of 10^{-4} to 10^{-6} cancer risk, and noncarcinogenic constituents resulting in hazard indices greater than 1.0.	No Action Institutional Actions Containment Containment/Treatment Removal/Treatment/Disposal
	4-2	***For Environmental Protection:*** Prevent releases of chemicals and radionuclides from Operable Unit 2 from reaching surface water at concentrations in excess of levels reported in Table 2-4.	
5. GROUNDWATER	5-1	***For Human Health:*** Prevent releases of radionuclides to the groundwater in excess of levels shown on Table 2-7. Prevent release of inorganic and organic chemicals to the groundwater in excess of levels shown in Tables 2-5 and 2-6.	No Action Institutional Actions Containment Containment/Treatment Removal/Treatment/Disposal
	5-2	***For Environmental Protection:*** None. Biota are not exposed to chemical and radionuclide concentrations in groundwater.	
6. SOLID WASTES	6-1	***For Human Health:*** Prevent direct contact with waste.	No Action Institutional Actions Containment Containment/Treatment Removal/Treatment/Disposal
	6-2	Prevent circumstances that may provoke leaching of wastes to groundwater.	
	6-3	Prevent current and future radiation doses migrating from wastes from exceeding 100 mrem/yr.	
	6-4	***For Environmental Protection:*** Prevent direct contact with waste.	

FIGURE 2-1. REMEDIAL ACTION OBJECTIVES AND ASSOCIATED GENERAL RESPONSE ACTIONS (Continued)

002 A FND182 OU2 TK12 OR

51

1165

radionuclides at concentrations greater than RAOs for protection of human health or the environment. The goals are to prevent contact with chemicals in these soils that would result in cancer risks of 10^{-4} to 10^{-6} and to prevent noncancer hazards that would be above a HI of 1.0 (Table 2-3). These preliminary remediation goals are based on an exposure scenario of a 16-kg child ingesting 200 mg of soil per day for noncarcinogens, and a 70-kg person ingesting 100 mg of soil per day for carcinogens. This exposure scenario is suggested by proposed 40CFR264, 265, 270, and 271. Radionuclide concentrations must satisfy DOE Order 5400.5, which limits the radiation dose from all pathways for all radionuclides to 100 mrem/yr.

The environmental objectives of preventing contact with the soils are similar except that quantitative goals are based on potential contributions to a receiving water body in excess of the federal or state surface water quality criteria as listed in Table 2-4.

2.2.5.4 Sediments and Surface Water

Preliminary RAOs for surface water are presented in Table 2-4.

2.2.5.5 Groundwater

Of great concern is the potential for the constituents of Operable Unit 2 to leach to the underlying Great Miami Aquifer in the future. RAOs developed for groundwater specify that future releases should not exceed MCLs specified in 40CFR141 MCLs. For chemicals without MCLs, future releases should not exceed risk-based cleanup levels. Specific groundwater RAOs for Operable Unit 2 are listed in Tables 2-5 and 2-6.

Except for radium, which has a promulgated MCL, radionuclide RAOs were derived by dividing the allowable drinking water radiation dose of 4 mrem/yr (DOE Order 5400.5) by an annual drinking water intake (730 ℓ) and the radiation dose conversion factor (DCF). Thus for uranium, with a dcf of 2.69×10^{-4} mrem/pCi, the resultant acceptable drinking water concentration is 20 pCi/ℓ. Table 2-7 lists the resulting concentrations for all radionuclides associated with Operable Unit 2. These limits do not reflect the "sum" rule, which requires that the sum of the radiation dose from all radionuclides (excluding Ra-226, Ra-228, and radon) must not exceed 4 mrem/yr.

2.3 GENERAL RESPONSE ACTIONS

General response actions are broad categories of media-specific remediation actions that will satisfy one or more of the RAOs. In the case of Operable Unit 2, these general response actions include no action, institutional action, containment with and without treatment, and removal with treatment and disposal. Figure 2-1 shows the relationship between the RAOs and these general response actions.

TABLE 2-3

PRELIMINARY REMEDIATION GOALS FOR NONRADIOACTIVE CHEMICALS IN SOILS
OPERABLE UNIT 2

Chemical	Basis for Remedial Objective[a]	Acceptable Soil Concentration (mg/kg)[b]
Organics		
Acenapthene	0.06 mg/kg/d RfD[c]	4800
Acetone	0.1 mg/kg/d RfD	8000
Anthracene	0.3 mg/kg/d RfD	24,000
Benzo(a)anthracene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Benzo(a)pyrene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Benzo(b)fluoranthene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Benzo(ghi)perylene	-	-
Benzo(k)fluoranthene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Bis(2-ethylhexyl) phthalate	0.014 mg/kg/d^{-1} CSF	50
2-Butanone	0.05 mg/kg/d RfD	4000
Butyl benzylphthalate	0.2 mg/kg/d RfD	16,000
Carbon disulfide	0.1 mg/kg/d RfD	8000
Chlordane	1.3 mg/kg/d^{-1} CSF	0.54
Chloroform	0.0061 mg/kg/d^{-1} CSF	115
Chrysene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Dibenzo(a,h)anthracene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Dibenzofuran	–	–
1,1-Dichloroethane	0.1 mg/kg/d RfD	8000
2,4-Dimethylphenol	0.02 mg/kg/d RfD	1600
Di-n-butylphthalate	0.1 mg/kg/d RfD	8000
Di-n-octylphthalate	0.02 mg/kg/d RfD	1600
Ethylbenzene	0.1 mg/kg/d RfD	8000
Fluoranthene	0.04 mg/kg/d RfD	3200
Fluorene	0.04 mg/kg/d RfD	3200
Indeno(1,2,3-cd)pyrene[e]	11.5 mg/kg/d^{-1} CSF	0.061
Methylene chloride	0.0075 mg/kg/d^{-1} CSF	93
2-Methylnaphthalene	–	–
2-Methylphenol	–	–
4-methylphenol	–	–
Naphthalene	0.004 mg/kg/d RfD	320
N-nitrosodiphenylamine	0.0049 mg/kg/d^{-1} CSF	143
PCBs (total)[f]	7.7 mg/kg/d^{-1} CSF[d]	0.091
Phenanthrene	–	–
Phenol	0.6 mg/kg/d RfD	48,000
Pyrene	0.03 mg/kg/d RfD	2400
Tetrachoroethene	0.051 mg/kg/d^{-1} CSF	13.7
Toluene	0.2 mg/kg/d RfD	16,000
1,1,1-Trichloroethane	0.09 mg/kg/d RfD	7200

TABLE 2-3
(continued)

Chemical	Basis for Remedial Objective[a]	Acceptable Soil Concentration (mg/kg)[b]
Organics (continued)		
1,1,2-trichloro-1,2,2-trifluoroethane	3 mg/kg/d RfD	240,000
Xylenes (Total)	2 mg/kg/d RfD	160,000
Inorganics		
Aluminum	–	–
Arsenic	1.75 mg/kg/d^{-1} CSF	0.4
Beryllium	4.3 mg/kg/d^{-1} CSF	0.16
Barium	0.05 mg/kg/d RfD	4000
Cadmium	0.001 mg/kg/d RfD	80
Cobalt	–	–
Lead	0.0007 mg/kg/d[g] RfD	56
Manganese	0.1 mg/kg/d RfD	8000
Mercury	0.0003 mg/kg/d RfD	24
Nickel	0.02 mg/kg/d RfD	1600
Selenium	–	–
Uranium	0.003 mg/kg/d RfD	240
Vanadium	0.007 mg/kg/d RfD	560
Zinc	0.2 mg/kg/d RfD	16,000

[a] When both RfD and CSF values are available for a chemical, the lowest resulting concentration is presented here.

[b] Assumes for noncarcinogens that a 16-kg child ingests 200 mg/d soil; and for carcinogens, a 70-kg person ingests 100 mg/d.

[c] Reference dose (RfD) is the estimate of a daily exposure level that is likely to be without appreciable risk. The chronic RfD was used (applies for time periods of seven years or longer). RfDs are from the U.S. Environmental Protection Agency's "Health Effects Summary Tables," Fourth Quarter, FY 1990, OE RR 9200 6-303 (90-4).

[d] Cancer slope factor (CSF) is an estimate of probability of carcinogenicity per unit intake of a chemical over a lifetime. CSFs are from the U.S. Environmental Protection Agency's "Health Effects Assessment Summary Tables," Fourth Quarter, FY 1990, OE RR 9200 6-303(90-4).

[e] The cancer slope factor for benzo(a)pyrene is used for all PAHs classified as "B2"carcinogens.

[f] Total PCBs is the sum of Aroclors 1242, 1248, 1254, and 1260.

[g] Marcus, W.L., 1986, "Lead health effects in drinking water," Toxicology and Industrial Health, 2(4): 363-407.

TABLE 2-4

SURFACE WATER QUALITY CRITERIA

Protection of Aquatic Life Chemical	Protection of Aquatic Life Federal Water Quality Criteria[a] (µg/ℓ)	Ohio Water Quality Criteria[b] (µg/ℓ)	Protection of Human Health Federal Water Quality Criteria (µg/ℓ)[c]
Organics			
Acenaphthene	520	67	-
Acetone	-	78,000	-
Benzene	-	560	40
Bis(2-ethylhexylphthalate)	-	8.4	50,000
2-Butanone	-	7100	-
Butylbenzylphthalate	-	49	-
Chlordane	0.0043	0.01	0.46
Chloroform	1240	79	15.7
Di-n-butylphthalate	-	190	154,000
Ethylbenzene	-	62	3,280
Fluoranthene	-	8.9	54
Methylene Chloride	-	430	-
2-Methylphenol	-	22	-
4-Methylphenol	-	6.2	-
Naphthalene	620	44	-
N-nitrosodiphenylamine	-	13	16.1
PAHs[d]	-	0.31	0.0311
PCBs (all Aroclors)	0.014	0.001	0.000079
Phenol	2580	370	-
Tetrachloroethene	940	73	8.85
Toluene	-	1700	424,000
1,1,1-Trichloroethane	-	88	1,030,000
Inorganics			
Arsenic	48[f]	190	0.0175
Beryllium	53	23[e]	0.117
Cadmium	1.1[e]	1.4[e]	-
Lead	3.2[e]	6.9[e]	-
Mercury	0.012	0.2	0.146
Nickel	160[e]	170[e]	100
Selenium	36	5.0	-
Zinc	110[e]	110[e]	-

[a] Freshwater chronic criteria for aquatic life protection. Ref: U.S. EPA 1986, Quality Criteria for Water Office of Water Regulation and Standards, Washington D.C. EPA 44015-86-001 (40CFR131.21) and 51FR43665.

[b] For Aquatic Life Protection, 30-day average concentrations ref: Chapter 3745-1, Ohio Administrative Code; most recent revision, 3/21/90.

[c] Water Quality Criteria for Protection of Human Health fish consumption only. (same ref as [a]).

[d] Sum of anthracene, benzo(a)anthracene, benzo(k)fluoranthene, benzo(b)fluoranthene, benzo(ghi)perylene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluorene, indeno(1,2,3-cd)pyrene, naphthalene, phenanthrene and pyrene.

[e] Assuming a water hardness of 100 mg/ℓ as $CaCO_3$

[f] Value is for arsenic (pent)

55

1165

TABLE 2-5

PRELIMINARY REMEDIATION GOALS FOR ORGANIC CHEMICALS IN GROUNDWATER
OPERABLE UNIT 2

Chemical	Basis for Remedial Objective[a]	Acceptable Water Concentration (mg/ℓ)[b]
Acenapthene	0.06 mg/kg/d RfD[c]	2.1
Acetone	0.1 mg/kg/d RfD	3.5
Anthracene	0.3 mg/kg/d RfD	10.5
Benzene	0.005 mg/ℓ MCL	0.005
Benzo(a)anthracene	0.0001 mg/ℓ PMCL	0.0001
Benzo(a)pyrene	0.0002 mg/ℓ PMCL	0.0002
Benzo(b)fluoranthene	0.0002 mg/ℓ PMCL	0.0002
Benzo(ghi)perylene	-	-
Benzo(k)fluoranthene	0.0002 mg/ℓ PMCL	0.0002
Bis(2-ethylhexyl) phthalate	0.004 mg/ℓ PMCL	0.004
2-Butanone	0.05 mg/kg/d RfD	1.75
Butyl benzylphthalate	0.2 mg/kg/d RfD	7.0
Carbon disulfide	0.1 mg/kg/d RfD	3.5
Chlordane	0.002 mg/ℓ MCL	0.002
Chloroform	0.0061 mg/kg/d^{-1} CSF[d]	0.006
Chrysene	0.0002 mg/ℓ PMCL	0.0002
Dibenzo(a,h)anthracene	0.0003 mg/ℓ PMCL	0.0003
Dibenzofuran	–	–
1,1-Dichloroethane	0.1 mg/kg/d RfD	3.5
2,4-Dimethylphenol	0.02 mg/kg/d RfD	0.7
Di-n-butylphthalate	0.1 mg/kg/d RfD	3.5
Di-n-octylphthalate	0.02 mg/kg/d RfD	0.7
Ethylbenzene	0.7 (mg/ℓ) MCL	0.7

TABLE 2-5
(continued)

Chemical	Basis for Remedial Objective[a]	Acceptable Water Concentration (mg/ℓ)[b]
Fluoranthene	0.04 mg/kg/d RfD	1.4
Fluorene	0.04 mg/kg/d RfD	1.4
Indeno(1,2,3-cd)pyrene	0.0004 mg/ℓ PMCL	0.0004
Methylene chloride	0.005 mg/ℓ PMCL	0.005
2-Methylnaphthalene	-	-
2-Methylphenol	-	-
4-methylphenol	-	-
Naphthalene	0.004 mg/kg/d RfD	0.14
N-nitrosodiphenylamine	0.0049 mg/kg/d^{-1} CSF	0.0071
PCBs (total)[e]	0.0005 mg/ℓ MCL	0.0005
Phenanthrene	-	-
Phenol	0.6 mg/kg/d RfD	21.0
Pyrene	0.03 mg/kg/d RfD	1.0
Tetrachoroethene	0.005 mg/ℓ MCL	0.005
Toluene	1.0 mg/ℓ MCL	1.0
1,1,1-Trichloroethane	0.2 mg/ℓ MCL	0.2
1,1,2-trichloro-1,2,2-trifluoroethane	3.0 mg/kg/d RfD	105
Xylenes (Total)	10.0 mg/ℓ MCL	10.0

[a] When both RfD and CSF values are available for a chemical, the lowest resulting concentration is presented here.

[b] When an MCL or PMCL is not available, risk-based concentration is based on the assumption that a 70-kg adult consumes 2-ℓ of water per day.

[c] Reference dose (RfD) is the estimate of a daily exposure level that is likely to be without appreciable risk. The chronic RfD was used (applies for time periods of seven years or longer). RfDs are from the U.S. Environmental Protection Agency's"Health Effects Summary Tables," Fourth Quarter, FY 1990, OE RR 9200 6-303(90-4).

[d] Cancer slope factor (CSF) is an estimate of probability of carcinogenicity per unit intake of a chemical over a lifetime. CSFs are from the U.S. Environmental Protection Agency's "Health Effects Summary Tables," Fourth Quarter, FY 1990, OE RR 9200 6-303(90-4).

[e] Total PCBs is the sum of Aroclors 1242, 1248, 1254 and 1260.

1165

TABLE 2-6

GROUNDWATER REMEDIAL ACTION OBJECTIVES FOR INORGANIC CHEMICALS OPERABLE UNIT 2

Chemical	Basis for Remedial Objective	Acceptable Water Concentration[a] (mg/ℓ)
Aluminum	-	-
Arsenic	0.05 mg/ℓ MCL	0.05
Beryllium	0.001 mg/ℓ PMCL	0.001
Barium	2.0 mg/ℓ PMCL	2.0
Cadmium	0.005 mg/ℓ MCL	0.005
Cobalt	-	-
Lead	0.05 mg/ℓ MCL	0.05
Manganese	0.1 mg/kg/d RfD[b]	3.5
Mercury	0.002 mg/ℓ MCL	0.002
Nickel	0.1 mg/ℓ PMCL	0.1
Selenium	0.05 mg/ℓ MCL	0.05
Uranium	0.003 mg/kg/d RfD	0.1
Vanadium	0.007 mg/kg/d RfD	0.24
Zinc	0.2 mg/kg/d RfD	7.0

[a] When an MCL or PMCL is not available, risk-based concentration is based on the assumption that a 70-kg adult consumes 2ℓ of water per day.

[b] Reference dose (RfD) is the estimate of a daily exposure level that is likely to be without appreciable risk. The chronic RfD was used (applies for time periods of seven years or longer). RfDs are from the U.S. Environmental Protection Agency's"Health Effects Summary Tables," Fourth Quarter, FY 1990, OE RR 9200 6-303(90-4).

58

1165

TABLE 2-7

GROUNDWATER REMEDIAL ACTION OBJECTIVES FOR RADIONUCLIDES OPERABLE UNIT 2

Constituents	Drinking Water Concentration Corresponding to 4 mrem/yr (pCi/ℓ)
Uranium-234	19
Uranium-235	21
Uranium-238	21
Thorium-228	14
Thorium-230	10
Thorium-232	2
Radium-226 and Radium-228	5[a]
Strontium-90	38.6

[a] Values listed are the Maximum Contaminant Levels (MCLs) for Radium-226 plus Radium-228 combined as defined in 40CFR141.

59

2.3.1 No Action

The no-action general response action is required for consideration by the NCP and will be carried through as an alternative. The No-Action Alternative would provide no remediation and would simply leave the Operable Unit 2 wastes in their present state. It would include the installation of long-term monitoring equipment. The No-Action Alternative provides a baseline against which the other alternatives can be compared.

2.3.2 Institutional Actions

Institutional actions refer to actions taken by the responsible authorities to minimize the potential for dangers to human health and the environment as a result of any ongoing activities. Examples of institutional actions would include monitoring and access control.

2.3.3 Containment

Containment refers to the prevention of any uncontrolled leakage of waste materials and/or gases by proper in situ isolation of the waste. Isolation techniques in this category include run-on/runoff control, and capping. Waste stabilization technologies are included when applicable to a particular waste. Several waste stabilization technologies are available for this purpose.

2.3.4 Containment With Treatment

Containment with treatment is similar to the containment general response action as mentioned above, with the exception that an in situ treatment technology has been added. The objective of the in situ treatment technologies would be to reduce the toxicity, mobility, or volume of waste present in and around the waste units of Operable Unit 2. In situ treatment technologies (chemical and/or physical) have been included for the Lime Sludge Ponds and perched groundwater. A treatment action combined with containment would further reduce the potential for a release from the facility.

2.3.5 Removal, Treatment, and Disposal

This general response action considers treatment of the waste after removal from its present location. Treatment technologies and process options have been included for the Sanitary Landfill, the Lime Sludge Ponds, Fly Ash/Southfield areas, and for contaminated perched groundwater. After the treatment process, the waste would be disposed of in either on-property or off-site disposal facilities.

2.4 IDENTIFICATION AND SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS

The following section contains a summary of remedial technologies and process options identified and screened for Operable Unit 2. Before the identification and screening of technologies and process options can be accomplished, it is necessary to identify the volumes or areas of media to which

response actions might be applied. The characteristics, volumes, and areas of the waste units in Operable Unit 2 are included in Appendix C.

For each media (i.e., direct radiation, air [fugitive dust], soils, sediments and surface water, groundwater, and wastes), potentially feasible remedial technologies and process options have been identified for each of the relevant response actions. Media have been grouped together as follows: direct radiation/air (fugitive dust); soils/sediments/wastes; and surface water/groundwater. Technologies applicable for removal of organic compounds in the Sanitary Landfill, for instance, are applicable also for removal of organic compounds in soils. Technologies applicable for removal of uranium in surface water are applicable also for groundwater. These technologies were compiled by utilizing technologies described in various EPA documents as well as other applicable references. Each of these technologies and process options underwent an initial screening for technical feasibility. The goal of the screening process is to reduce the original number of possible technologies to a smaller and more workable number of individual technologies that are considered applicable or appropriate for the various media. In this step, both process options and entire technology types could be eliminated based on technical implementability. Information regarding site characterization, contaminant types, and contaminant concentrations can be used to eliminate technologies and process options that are either not applicable or cannot be implemented effectively at the site. Figures in this section document the results of the technology screening process for Operable Unit 2. Following is a list of technologies applicable to Operable Unit 2.

Monitoring
Access Control
Run-on/Runoff Control
Capping
In situ Stabilization
Perched Groundwater Removal
Subsurface Containment
Perched Groundwater/Wastewater Treatment
Mechanical Removal
Hydraulic Removal
Waste Stabilization
On-Property Disposal
Off-Site Disposal
Physical Treatment
Thermal Treatment
Biological Treatment
Volume Reduction
Segregation

Rationale for the elimination of certain technology types for Operable Unit 2 wastes are presented in the following sections.

2.4.1 Sanitary Landfill

2.4.1.1 Groundwater/ Surface Water Media

The general response actions that are applicable for perched groundwater/surface water include no action, institutional actions, control/containment, removal, treatment, and discharge. A summary of the screening process for the groundwater medium is presented in Figure 2-2. The following sections

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
NO ACTION	NONE	NOT APPLICABLE	REQUIRED FOR CONSIDERATION BY NCP	REQUIRED FOR CONSIDERATION BY NCP
INSTITUTIONAL ACTIONS	MONITORING	WELLPOINT MONITORING	INSTALLATION OF WELLS FOR MONITORING GROUNDWATER	POTENTIALLY APPLICABLE
		LEACHATE MONITORING	INSTALLATION OF LEACHATE COLLECTION/DETECTION SYSTEM	POTENTIALLY APPLICABLE
	ACCESS CONTROL	PHYSICAL BARRIERS	FENCING, SECURITY, LIMITED ROAD ACCESS, ETC.	POTENTIALLY APPLICABLE
		ADMINISTRATIVE CONTROLS	RESTRICTED ACCESS ONLY, POSTED SIGNS, ETC.	POTENTIALLY APPLICABLE
		DEED RESTRICTIONS	DEEDS FOR PROPERTY WITHIN POTENTIALLY CONTAMINATED AREAS INCLUDE RESTRICTIONS ON USE OF PROPERTY AND/OR GROUND-WATER USE	POTENTIALLY APPLICABLE

FND178

FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL

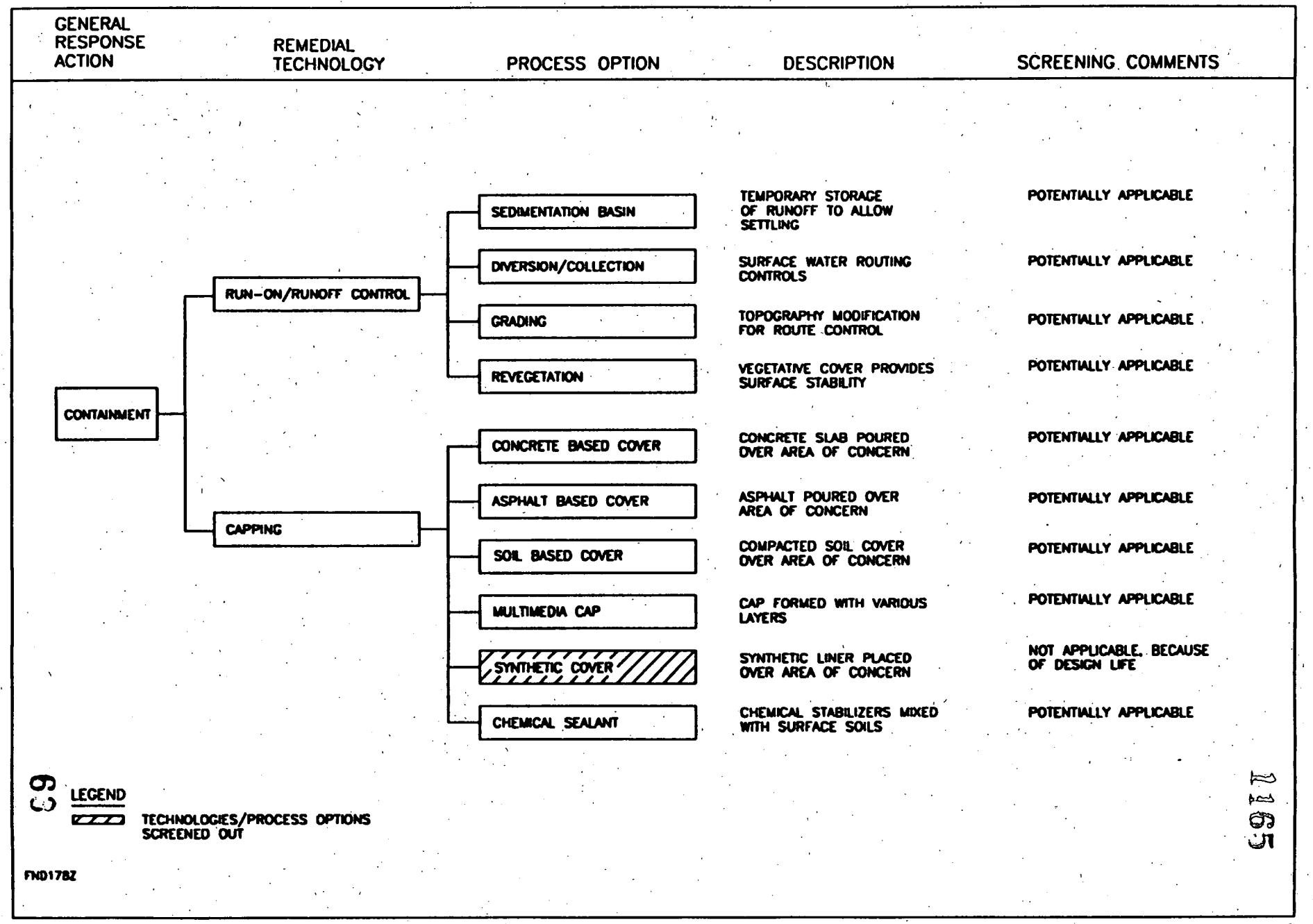


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL, (Continued)

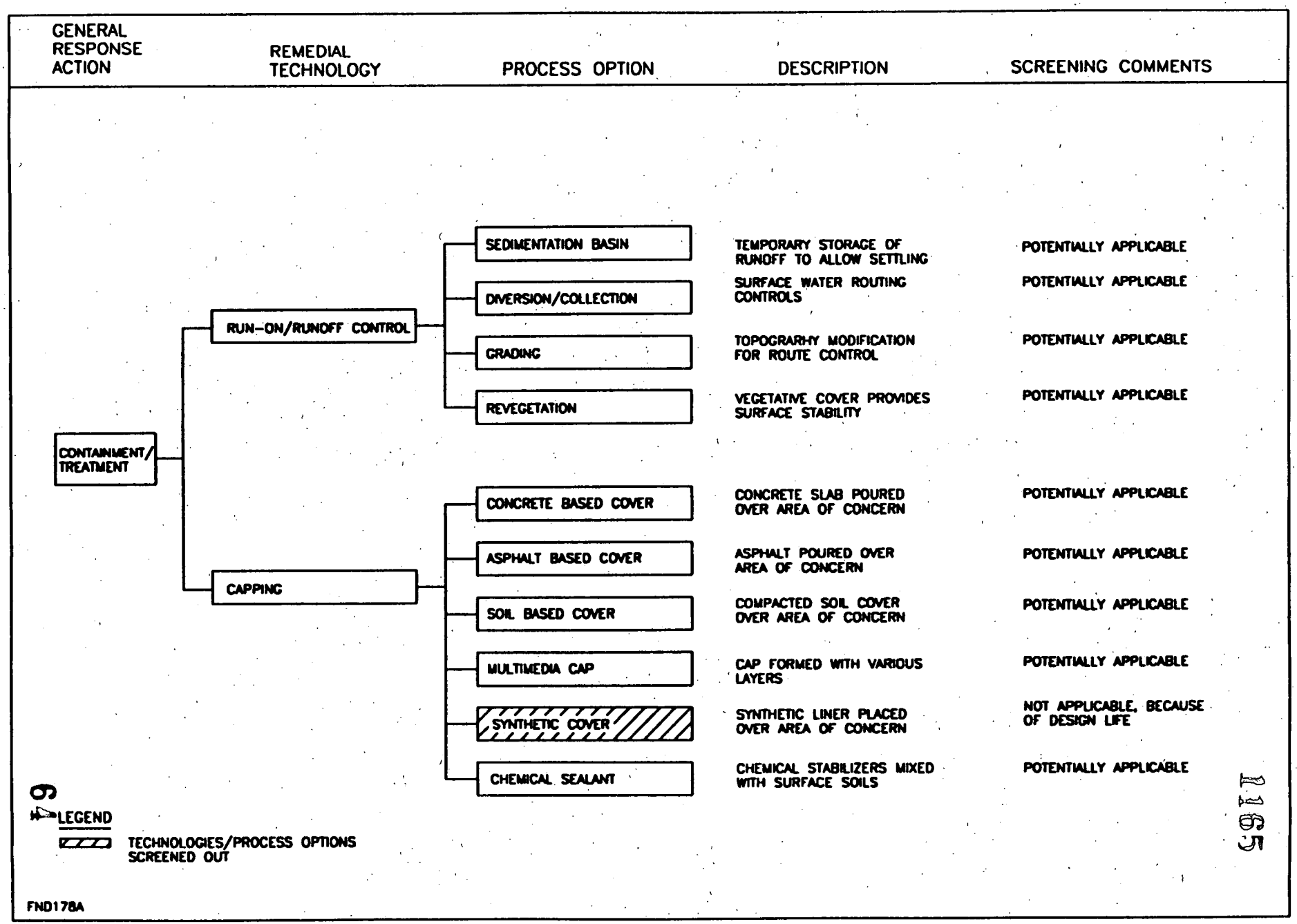


FIGURE 2-2 INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL, (Continued)

1165

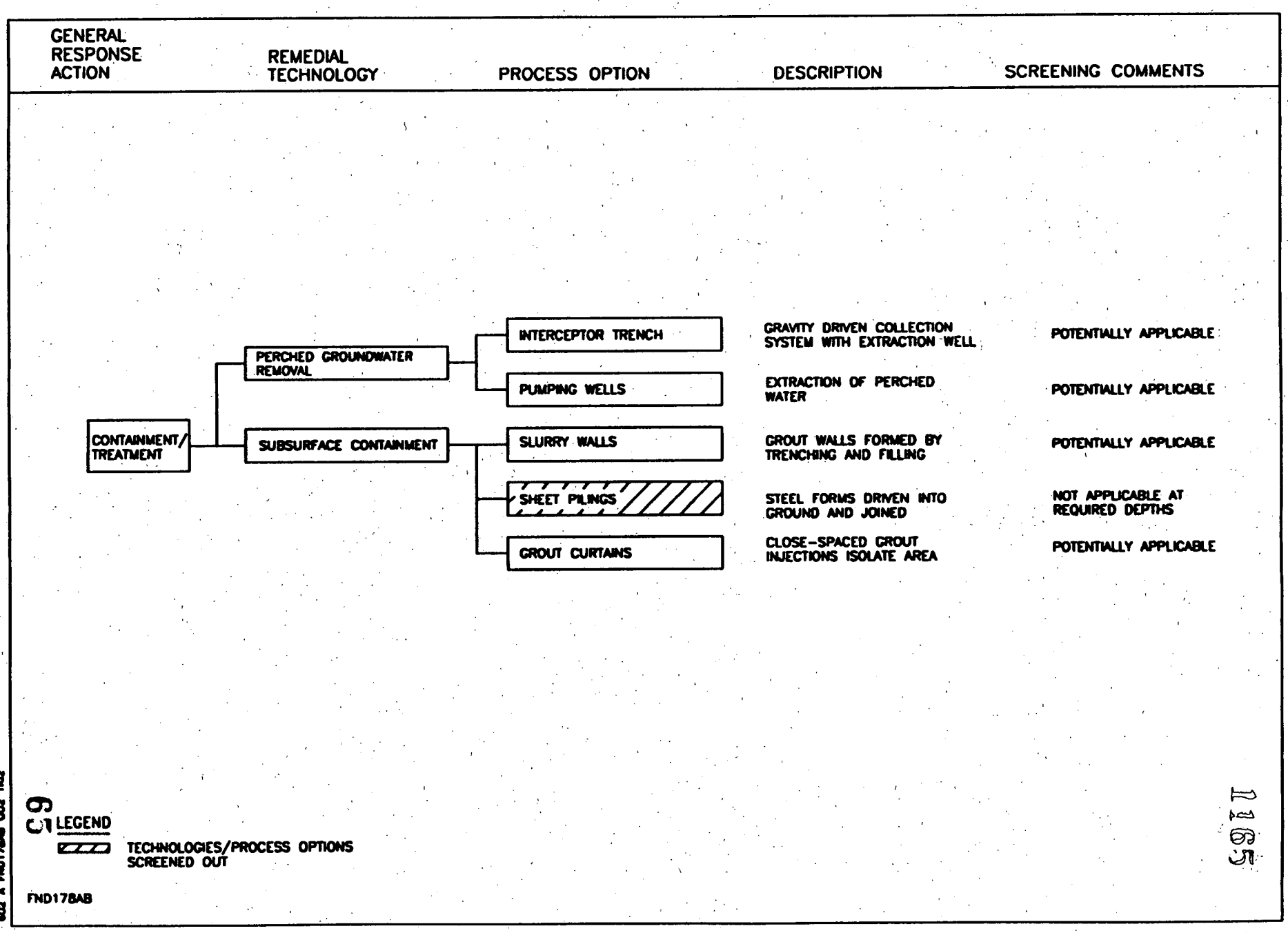


FIGURE 2-2 INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL. (Continued)

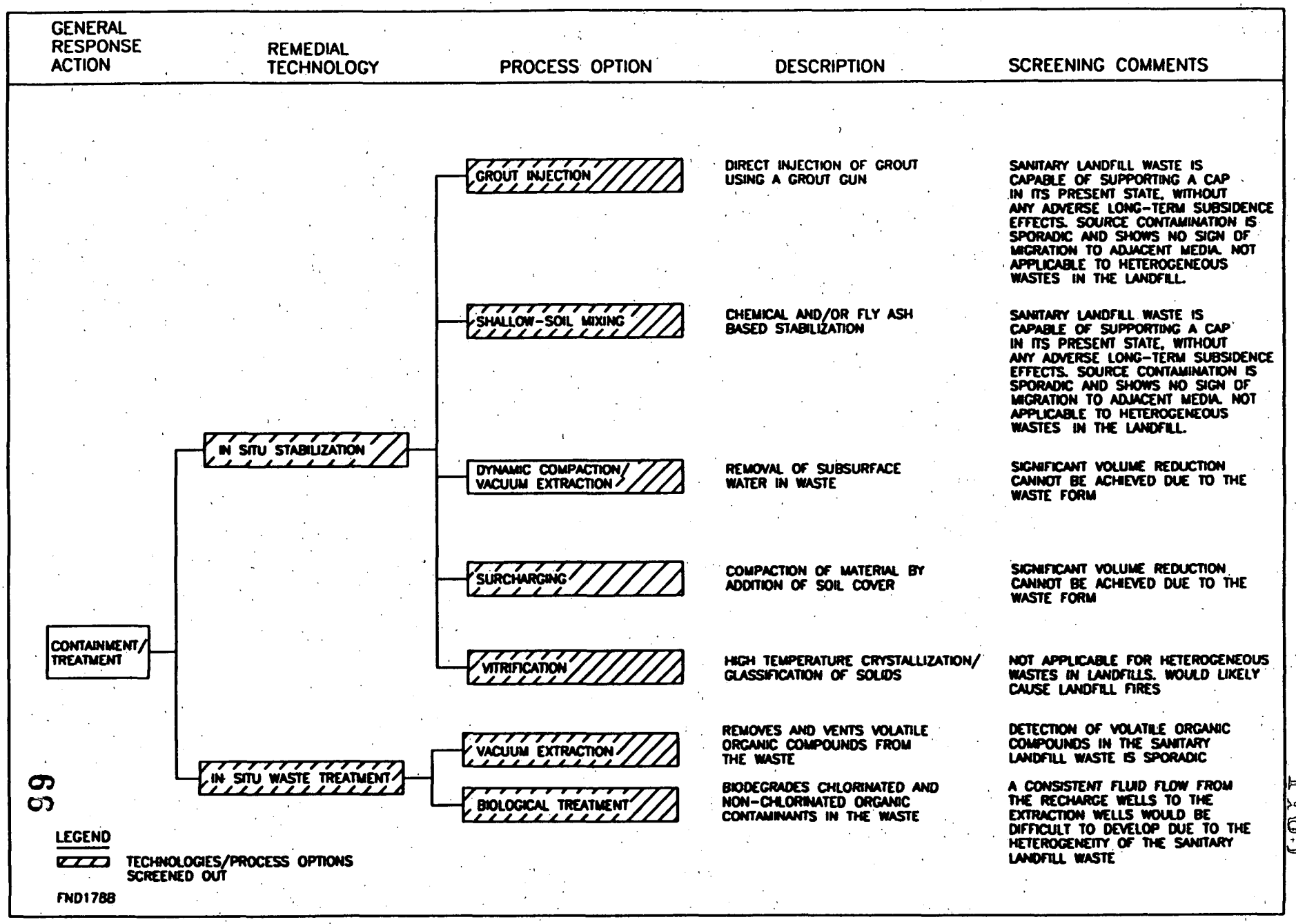


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL. (Continued)

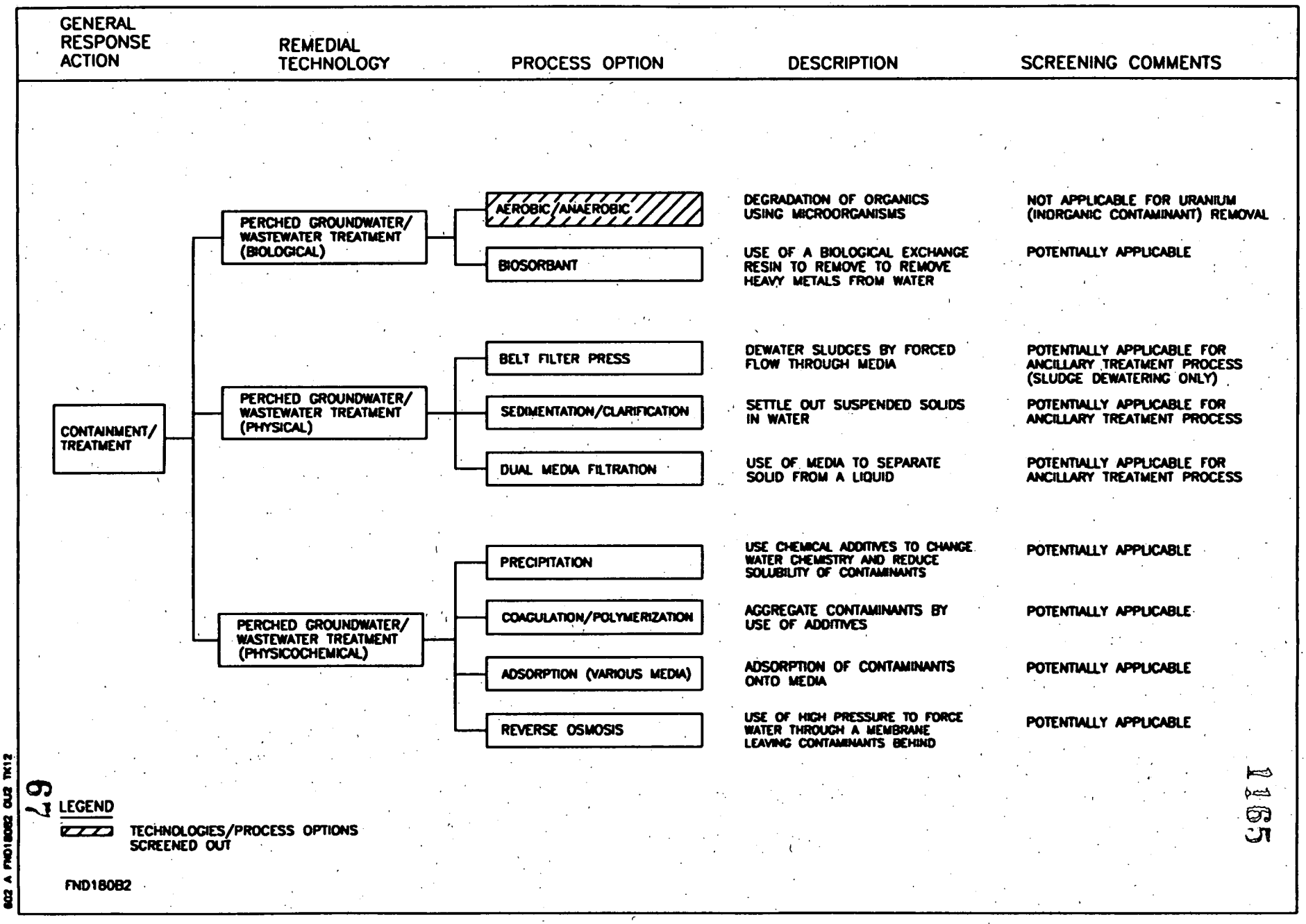


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL. (Continued)

602 A FND180B2 OU2 TK12

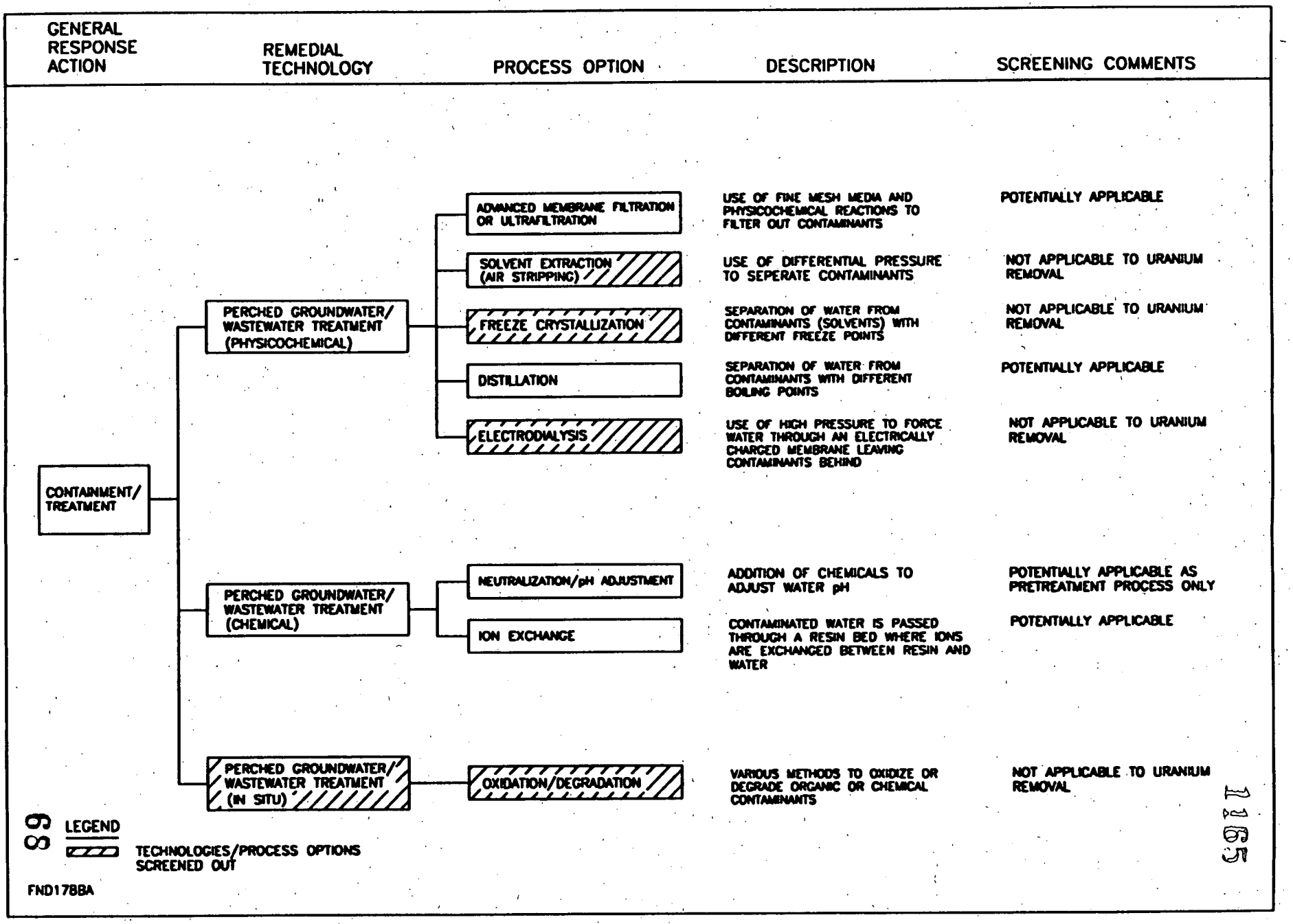


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS–SANITARY LANDFILL, (Continued)

FINAL CTO V0810/DRAFT V 2.0

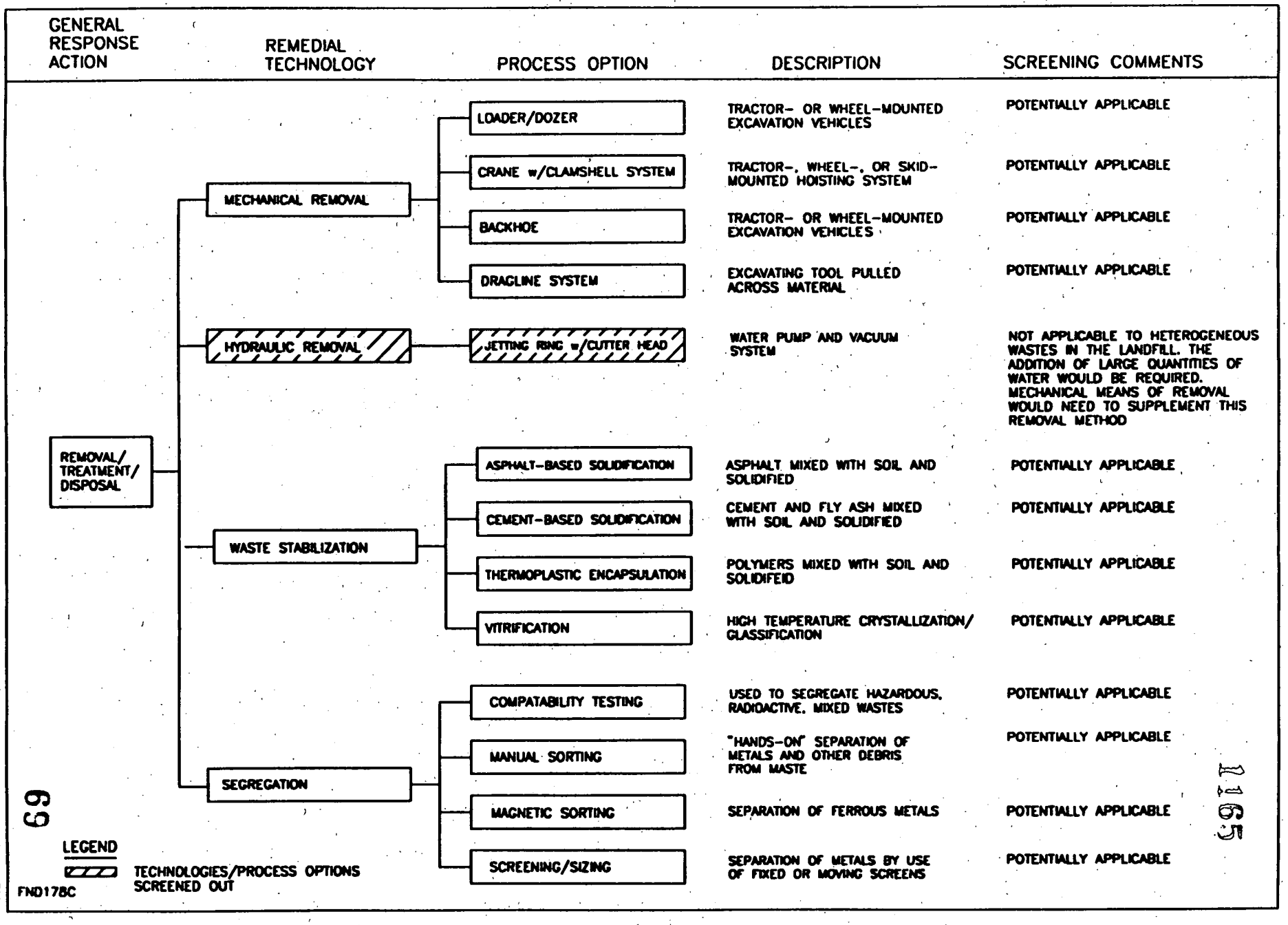


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL. (Continued)

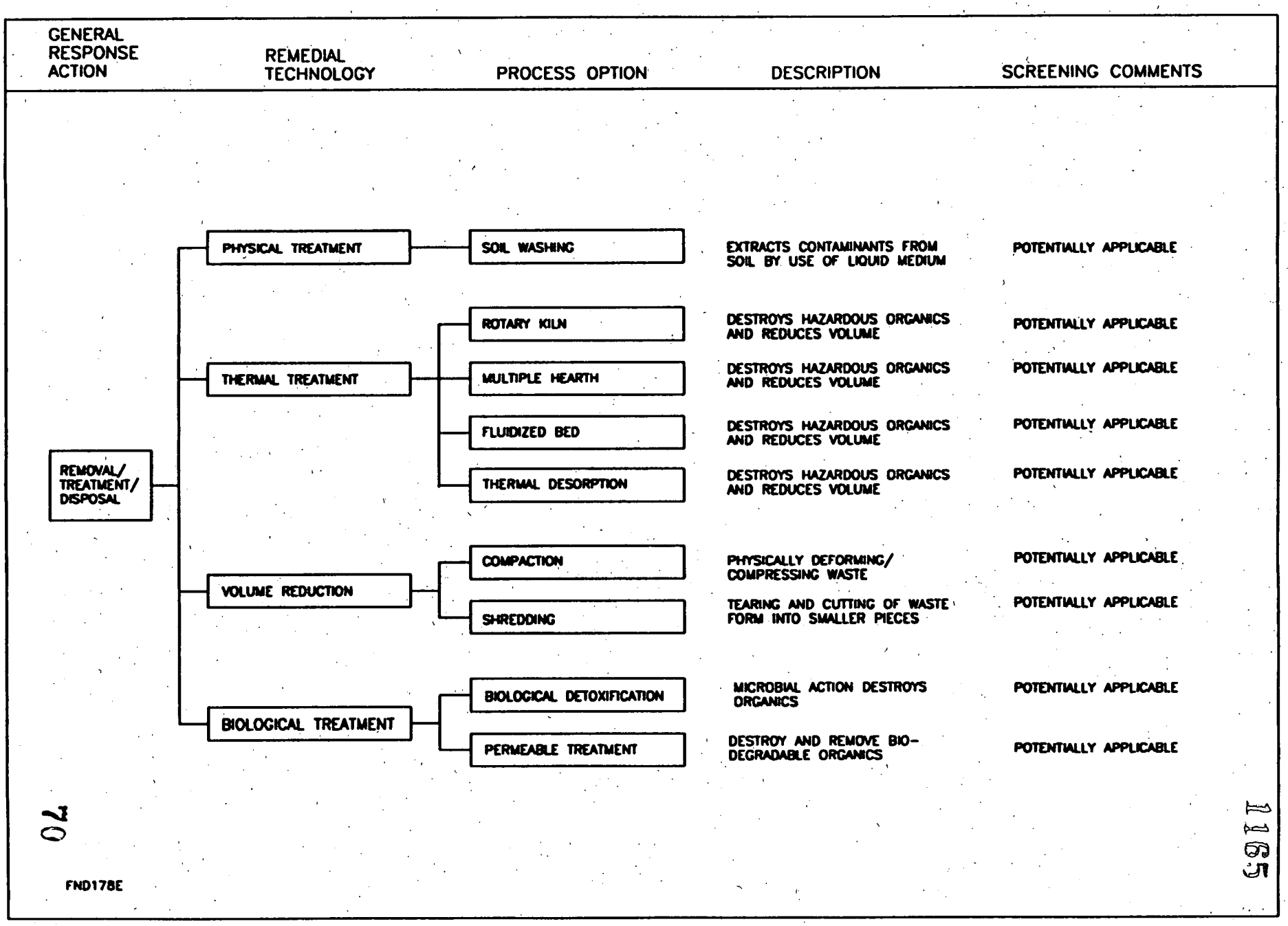


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL, (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
REMOVAL/ TREATMENT/ DISPOSAL	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (BIOLOGICAL)	AEROBIC/ANAEROBIC	DEGRADATION OF ORGANICS USING MICROORGANISMS	NOT APPLICABLE FOR URANIUM (INORGANIC CONTAMINANT) REMOVAL
		BIOSORBANT	USE OF A BIOLOGICAL EXCHANGE RESIN TO REMOVE TO REMOVE HEAVY METALS FROM WATER	POTENTIALLY APPLICABLE
	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	DEWATER SLUDGES BY FORCED FLOW THROUGH MEDIA	POTENTIALLY APPLICABLE FOR ANCILLARY TREATMENT PROCESS (SLUDGE DEWATERING ONLY)
		SEDIMENTATION/CLARIFICATION	SETTLE OUT SUSPENDED SOLIDS IN WATER	POTENTIALLY APPLICABLE FOR ANCILLARY TREATMENT PROCESS
		DUAL MEDIA FILTRATION	USE OF MEDIA TO SEPARATE SOLID FROM A LIQUID	POTENTIALLY APPLICABLE FOR ANCILLARY TREATMENT PROCESS
	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (PHYSICOCHEMICAL)	PRECIPITATION	USE CHEMICAL ADDITIVES TO CHANGE WATER CHEMISTRY AND REDUCE SOLUBILITY OF CONTAMINANTS	POTENTIALLY APPLICABLE
		COAGULATION/POLYMERIZATION	AGGREGATE CONTAMINANTS BY USE OF ADDITIVES	POTENTIALLY APPLICABLE
		ADSORPTION (VARIOUS MEDIA)	ADSORPTION OF CONTAMINANTS ONTO MEDIA	POTENTIALLY APPLICABLE
		REVERSE OSMOSIS	USE OF HIGH PRESSURE TO FORCE WATER THROUGH A MEMBRANE LEAVING CONTAMINANTS BEHIND	POTENTIALLY APPLICABLE

FND178DE

FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL, (Continued)

71

1195

FND178DE 02 TK12

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
REMOVAL/ TREATMENT/ DISPOSAL	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (PHYSICOCHEMICAL)	ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	USE OF FINE MESH MEDIA AND PHYSICOCHEMICAL REACTIONS TO FILTER OUT CONTAMINANTS	POTENTIALLY APPLICABLE
		SOLVENT EXTRACTION (AIR STRIPPING)	USE OF DIFFERENTIAL PRESSURE TO SEPERATE CONTAMINANTS	NOT APPLICABLE TO URANIUM REMOVAL
		FREEZE CRYSTALLIZATION	SEPARATION OF WATER FROM CONTAMINANTS (SOLVENTS) WITH DIFFERENT FREEZE POINTS	NOT APPLICABLE TO URANIUM REMOVAL
		DISTILLATION	SEPARATION OF WATER FROM CONTAMINANTS WITH DIFFERENT BOILING POINTS	NOT APPLICABLE DUE TO VOLUME AND COST
		ELECTRODIALYSIS	USE OF HIGH PRESSURE TO FORCE WATER THROUGH AN ELECTRICALLY CHARGED MEMBRANE LEAVING CONTAMINANTS BEHIND	NOT APPLICABLE TO URANIUM REMOVAL
	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (CHEMICAL)	NEUTRALIZATION/pH ADJUSTMENT	ADDITION OF CHEMICALS TO ADJUST WATER pH	POTENTIALLY APPLICABLE AS PRETREATMENT PROCESS ONLY
		ION EXCHANGE	CONTAMINATED WATER IS PASSED THROUGH A RESIN BED WHERE IONS ARE EXCHANGED BETWEEN RESIN AND WATER	POTENTIALLY APPLICABLE
	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (IN SITU)	OXIDATION/DEGRADATION	VARIOUS METHODS TO OXIDIZE OR DEGRADE ORGANIC OR CHEMICAL CONTAMINANTS	NOT APPLICABLE TO URANIUM REMOVAL

FND178DF

FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS—SANITARY LANDFILL, (Continued)

602 A FND178DF OLD TK12

72

1185

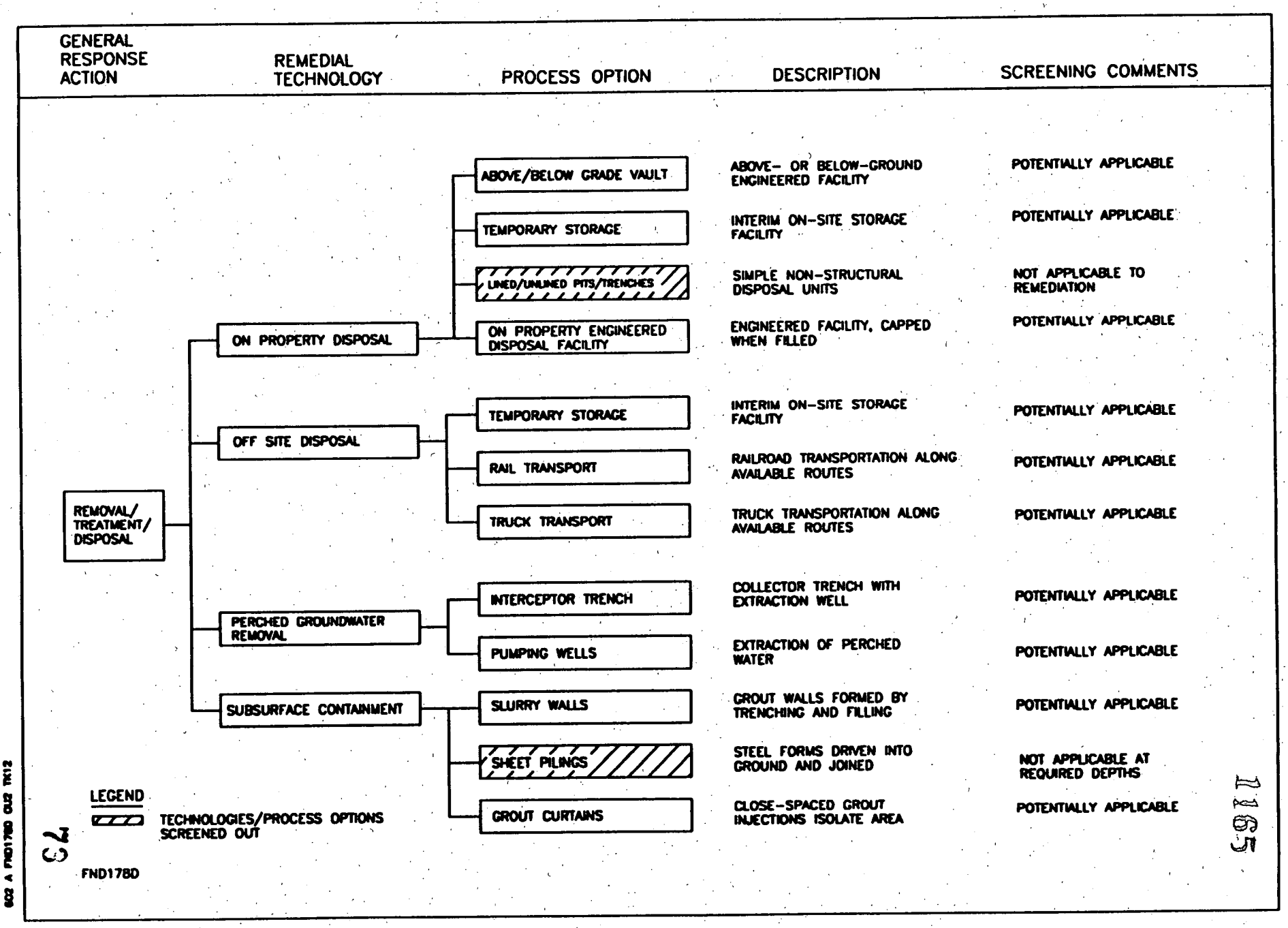


FIGURE 2-2. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-SANITARY LANDFILL, (Continued)

provide a discussion of this screening process. Process options that are considered to be implementable at the site are further evaluated in Section 2.5.

No Action

The no-action response was retained for consideration during the development and analysis of alternatives as required by the NCP. The no-action response does not provide additional remediation or security activities at the site to further minimize risk to public health or the environment, but could include environmental monitoring. This no-action response will be further evaluated as a baseline for comparison with other remedial alternatives developed for this operable unit.

Institutional Actions

The institutional actions screened for the groundwater medium include monitoring and use of access control. Both of these actions are applicable for perched groundwater and both are retained for further evaluation.

The access control technology includes the following process options:

- Physical barriers such as fencing, security, limited road access
- Administrative controls such as restricted access and posted signs

Process options for monitoring technology include:

- Wellpoint monitoring, which involves the installation of wells for monitoring groundwater
- Leachate monitoring, which involves the installation of leachate collection and detection systems

Wellpoint monitoring is applicable to both containment technologies such as capping and removal/disposal technologies; leachate monitoring is applicable only to removal and disposal technologies, because leachate collection/detection systems are included in on- or off-site disposal facilities. A leachate collection system cannot be retrofitted to existing disposal sites in Operable Unit 2.

Containment

The waste containment measures screened for the groundwater medium include, primarily, physical measures that restrict contaminant migration and minimize potential impacts on receptors. The control and contaminant technologies evaluated include run-on/runoff control and capping and both are retained for further consideration. These ancillary process options are not carried through the evaluation of process options and the assembly of alternatives, but may be included during the detailed analysis of alternatives as necessary for the complete conceptualization, costing, and evaluation of a groundwater treatment system. Surface water control can be used to direct the flow of surface waters, and it reduces or eliminates the erosion and off-property transport of soils that have been contaminated. This technology includes the use of sedimentation basins, diversion and collection

systems, grading, and site revegetation. Sedimentation basins allow for temporary storage of runoff to allow for settling. The diversion/collection systems are surface-water-routing controls—grading modifies the topography for routing control, and revegetation provides surface stability. These process options are applicable to Operable Unit 2 because they are effective both in controlling surface water contact with wastes and in reducing water infiltration through waste, via a surface pathway.

Run-on/runoff control process options include:

- Sedimentation basin for the temporary storage of runoff to allow settling
- Surface-water-routing controls for diversion and/or collection
- Grading the topography for route control
- Vegetative cover to provide surface stability

Capping process options include:

- Multimedia cap that combines materials to form various layers
- Single layer caps that add concrete, asphalt, soil, or chemical sealants to soil

Removal

The process options screened for groundwater removal are wellpoint systems or interceptor trenches. The interceptor trenches would require a pumping well to extract collected water from a sump. Slurry walls or grout curtains can be used in combination with extraction wells to better control groundwater flow. Groundwater extraction process options include:

- Slurry walls
- Interceptor trenches
- Wellpoint systems
- Grout curtains
- Sheet piles

Sheet piles are more difficult to implement than the slurry wall. Sheet piling is subject to leakage between joints and is, therefore, eliminated from further consideration.

Collected surface water can be removed from sedimentation basins by pumping it to a treatment facility.

The removal technologies described above are combined with the treatment technologies described below and the containment technologies in Figure 2-2 to form a containment/treatment response action.

Treatment

The treatment response action includes the technologies of biological, physical, physicochemical, chemical, and in situ processes that reduce the volume, toxicity, or mobility of a contaminant by

altering its physical or chemical properties. Concentrations of uranium in the perched groundwater zone underlying the Sanitary Landfill were discussed in Section 1.5.3.1 and are below the proposed concentration value of 20 pCi/ℓ, which has been approved by EPA only for removal actions at the FMPC.

The highest concentration of U-234 is 4.6 ± 0.7 pCi/ℓ (Well 1035), which is below the drinking water concentration corresponding to 4 mrem/yr (19 pCi/ℓ). The highest concentration of U-238 is 3.9 ± 0.6 pCi/ℓ, which is below the proposed drinking water concentration standard (21 pCi/ℓ for U-238).

It would seem then, that uranium removal would not be required for perched groundwater underneath the Sanitary Landfill; however, since the action levels are only proposed action levels at this time, the possibility does exist that final action levels could be lower. Consequently, this technology is retained for further consideration.

A majority of the technologies and process options considered in the initial screening, while they may be effective for treatment of organics, are ineffective for removing uranium from the groundwater. Since uranium is the most prevalent contaminant in the perched groundwater, only technologies applicable for uranium removal will be used in the initial development and screening of alternatives. Aerobic and anaerobic biological treatment processes, solvent extraction, and electrodialysis are ineffective for removing inorganic compounds, particularly chemical elements such as uranium. The processes of chemical oxidation and reduction are also ineffective for treating uranium. Other treatment processes that are ineffective for the removal of uranium contamination include solvent extraction, freeze crystallization, and electrodialysis. All of these technologies and process options have been eliminated at this phase of the study. The process of distillation, however, is potentially applicable and is, therefore, retained for further consideration.

The potentially applicable process options retained for uranium removal include biosorbant, adsorption, precipitation, coagulation/polymerization, reverse osmosis, advanced membrane filtration, and ion exchange. Additionally, several treatment processes were found to be potentially applicable as ancillary pre- or post-treatment processes. These include dual media filtration, belt filter press, drum filter, sedimentation, biodenitrification, and neutralization. It should be noted that reverse osmosis and polymerization are recognized as innovative technologies.

Discharge

Discharge refers to the release of treated or untreated groundwater/surface water to either a surface water body via a permitted outfall or to the subsurface environment via deep-well injection. The options of discharge to the Great Miami River via an existing or new pipeline have been retained for consideration, as well as the use of pumping wells for reinjection of treated water back into the

aquifer. Each is considered potentially applicable for groundwater discharge. These ancillary process options are not carried through the evaluation of process options and the assembly of alternatives; but they may be included during the detailed analysis of alternatives as necessary for the complete conceptualization, costing, and evaluation of a groundwater treatment system. The discharge of treated groundwater to Paddys Run represents a variation of discharge technology and will not be independently evaluated.

Summary of Technology Screening For Groundwater/ Surface Water

The previous sections provided a discussion of the rationale for elimination of numerous technologies and process options inapplicable for remediation of Operable Unit 2 perched groundwater and surface water. The technologies and related process options that have been retained for further evaluation and subsequent development of remedial action alternatives are presented in Figure 2-2. The general technologies retained for groundwater/surface water media include monitoring, use/access controls, capping, run-on/runoff control, groundwater extraction, physicochemical and chemical treatment processes. The no-action response has also been retained and will be considered as a baseline throughout the FS process.

2.4.1.2 Soils/Sediments/and Wastes Media

This section includes a discussion of the initial screening of technologies and process options considered potentially applicable for remediation of site soils, sediments, and wastes in the Sanitary Landfill. This remediation includes the solids as well as contaminated soil that may be under the Sanitary Landfill. Summaries of each process for both soils, sediments and wastes are presented in Figure 2-2 and are jointly discussed in the following sections.

No Action

The no-action response is applicable to soils, sediments, and wastes media as required by the NCP. The no-action response does not provide additional remediation, monitoring, or security activities at the site to further minimize risk to public health or the environment. The NCP requires that the no-action response be carried through the detailed analysis of alternatives, so it will not be eliminated at this stage. The no-action response will be further evaluated as a baseline for comparison with other remedial action alternatives developed for the soils, sediments and surface water, and wastes.

Institutional Actions

The institutional actions discussed in Section 2.4.1.1 are applicable also to this media, and are retained for further consideration.

Containment

The containment response is applicable for soils, sediments, and wastes. Major control and containment remedial technologies evaluated for these media include capping and surface water run-on/runoff control systems. These technologies are described in Section 2.4.1.1. Capping and run-on/runoff control technologies are retained for further consideration.

Removal

Removal of contaminated material would prevent migration of contaminants toward potential receptors. This could be accomplished using mechanical excavation equipment, due to the consistency of the waste in the Sanitary Landfill.

Mechanical excavation involves the use of common construction equipment, such as backhoe or bulldozer, to remove the soil or sediments. These methods are viable for soils, wastes, and sediments not in contact with surface waters, and are retained for further consideration. The mechanical removal technology involves the following process options:

- Loader/dozer, which includes wheel- or tractor-mounted excavation vehicles
- Crane with clamshell system, which uses tractor-, wheel-, or skid-mounted hoisting system
- Backhoe, tractor- or wheel-mounted
- Dragline system excavating bucket pulled across the waste

Hydraulic removal is not retained as a viable means of removing Sanitary Landfill wastes, since these wastes have a low percentage of liquids.

Segregation

This technology is applicable to soils, sediments, and wastes. Segregation technology provides the following four means of segregating the wastes upon removal:

- Compatibility testing determines the hazardous and radioactive characteristics of the wastes
- Manual sorting separates nonferrous materials from the wastes
- Magnetic sorting removes ferrous materials
- Screening/sizing screens debris and large particles from the wastes

This technology is viable for the Sanitary Landfill and is retained for further consideration.

In Situ Treatment

In situ treatment technologies for soil, sediment, and wastes include waste treatment and stabilization. The process options for in situ waste treatment include in situ vacuum extraction, and in situ biological treatment. In situ vacuum extraction is suitable for the remediation of organics, but the detection of organics in the Sanitary Landfill is sporadic. Therefore, this treatment method is being deleted from further consideration. The in situ biological treatment biodegrades chlorinated and nonchlorinated

77

organic contaminants, but a consistent fluid flow from the recharge wells to the extraction wells would be difficult to develop due to the heterogeneity of Sanitary Landfill wastes. Therefore, biological treatment is being deleted from further consideration and in situ waste treatment for the Sanitary Landfill is not being considered.

Process options for in situ stabilization include in situ vitrification, shallow soil mixing (SSM), grout injection, surcharging, and dynamic compaction. In situ vitrification involves passing a high current of electricity through the contaminated media. The generated heat drives off volatile organic compounds and solidifies the soil into a glassy, solid matrix that is then resistant to deterioration from weathering or leaching. Although this technology removes organics, it is not applicable for the Sanitary Landfill, which contains heterogeneous wastes consisting of rubbish, cafeteria waste placed in plastic bags, ordinary sanitary waste, and other wastes—all of which would make this technology difficult to properly implement. An additional drawback is that in situ vitrification has the potential to create fires, due to the extreme heat generated.

Grout injection and SSM are similar process options that can solidify sludges, soils, and wastes that are physically homogeneous. Since the Sanitary Landfill is heterogeneous, these process options are not applicable, either.

Surcharging and dynamic compaction are also similar process options. The Weston Geotechnical Report (Weston 1988) indicated that settlement from a cap placed on the landfill would be minimal and would not affect the integrity of a cap. These process options are not effective, in that significant volume reduction cannot be achieved due to the waste form.

Ex situ Treatment

The treatment technologies for soils, sediment, and wastes include ex situ physical, thermal, and biological treatment and stabilization.

The ex situ physical treatment process of soil washing was evaluated. Soil washing involves the extraction of organic and inorganic compounds from excavated soils or sediments by leaching. Soil washing may be viable for the removal of soluble uranium compounds and is retained for further evaluation.

Thermal treatment is a process in which molecular bonding of organic or inorganic compounds is altered through thermal decomposition and oxidation. The end products of this process typically include carbon dioxide, elemental carbon, ionized halogen, phosphorous, sulfur, and other inorganics—depending on the original composition of the waste materials. The following process options were evaluated for on-site thermal treatment:

78

- Incineration (rotary kiln, multiple hearth, fluidized bed)
- Thermal Desorption

The Sanitary Landfill does not contain high concentrations of uranium throughout the waste, but does contain a high diversity of organic contaminants. Both of the thermal treatment process options remove organic contaminants; therefore, both are retained for further consideration. It should be noted that thermal desorption is recognized as an innovative technology.

Volume reduction is a process in which the removed waste (construction debris, wallboard, etc.) is physically deformed by tearing or compacting it for handling purposes. The process options considered for volume reduction were:

- Compacting
- Shredding

Volume reduction is considered to be an ancillary technology and the associated process options were not carried through the evaluation of process options and assembly of alternatives, but will be included in the detailed analysis of alternatives for the complete conceptual, costing, and evaluation of the alternatives.

Biological treatment is a process which uses microbes to remove and degrade organic matter from the wastes. The following process options were evaluated for biological treatment:

- Biological detoxification
- Permeable treatment

Both process options destroy organic contaminants, and both will be retained for further consideration.

Residuals left over from thermal treatment would contain radionuclides. Therefore, the ex situ waste stabilization technology is applicable to treat these residuals. Ex situ waste stabilization could consist of blending a fly ash and portland cement mixture (cement-based solidification) with the residuals from thermal treatment to form a solidified product. This process option is retained for further consideration, and is depicted on Figure 2-2 (removal/treatment/disposal General Response Action).

Other process options evaluated for consideration include thermoplastic encapsulation, vitrification, and asphalt solidification. Thermoplastic encapsulation involves mixing the waste with polymers to form a rigid solid. Vitrification is a process which involves mixing the waste with molten glass at a high temperature; the mixture is then cooled to form a solid matrix. Asphalt solidification involves mixing the waste with asphalt and then cooling the mixture to form a solidified product. These process options are viable for the Sanitary Landfill and retained for further consideration.

On-Property Disposal

Disposal technologies include physical measures (other than in situ) that will provide a permanent pre-engineered environment to restrict movement or migration and thus minimize potential impacts on a receptor. For this screening process, an on-property landfill engineered disposal facility (EDF) is being designed to meet established federal and state regulations. On-property disposal of contaminated soils and sediments is considered applicable and has been retained for further consideration.

The on-property disposal technology includes the following process options:

- EDF, which consists of mounding over waste that has been placed over a stable structural pad (the EDF will have a multilayer-type closure cap with leachate collection/detection systems placed beneath the waste)
- Abovegrade vault, which is a reinforced vault-like concrete structure built above ground level
- Belowgrade vault, which is a reinforced concrete, engineered facility built below ground level
- Temporary on-property storage, which is necessary to provide a buffer for delivery to on- or off-property disposal sites
- Lined/unlined pits or trenches, which are simple, nonstructural disposal units

See Appendix A for more details concerning the on-property disposal process options.

Lined/unlined pits or trenching will not be considered further. Because of their potential to allow contaminant migration, they are unsuitable for permanent remediation.

In accordance with current EPA guidance, ARARs are to be progressively developed and applied on a site-specific basis as the RI/FS proceeds. Potential ARARs for the EDF fall within the following EPA recommended classifications:

ARARs

- Safe Drinking Water Act - 40CFR141-149
- Resource Conservation Recovery Act - 40CFR260-279
- Federal Water Pollution Control Act - 40CFR104-140
- Fish and Wildlife Coordination Act - 40CFR6.302
- Clean Air Act - 40CFR61, Subparts H and Q
- EPA Regulations for Health and Environmental Protection Standard for Uranium and Thorium Mill Tailings - 40CFR192
- NRC Regulations for Standards for Protection against Radiation - 10CFR20
- Licensing Requirements for Land Disposal of Radioactive Waste - 10CFR61
- Floodplain/Wetlands Environmental Review Requirements - 10CFR1022

Ohio ARARs

- Water Quality Standards - OAC3745-1
- Water Well Installation - OAC3745-9
- Air Pollution Control - OAC3745-15, OAC3745-17
- Solid and Hazardous Waste Disposal Law - OAC 3745-27 through 70

- Drinking Water Rules - OAC3745-81-01 through 55
- Ohio Water Pollution Control Law - ORC 6111

Because ARARs may not exist or be sufficient to protect human health and the environment at a CERCLA site, it is necessary to evaluate nonlegally binding or promulgated criteria, advisories, guidance, or policies for protective cleanup levels when determining the remedy design. The following are Federal and DOE orders to be considered in the design of the EDF:

TBCs

- DOE Order for Radiation Protection of the public and the Environment - 5400.5
- DOE Order for Radioactive Waste Management - 5400.2A
- DOE Plan for Implementing EPA Standards for UMTRA Sites - UMTRA-DOE/AL-163
- DOE Technical Approach Document Revision II - UMTRA-DOE/AL-050425.0002
- DOE Remedial Action Planning and Disposal Cell Design - UMTRA-DOE/AL-4000503
- DOE Project Surveillance and Maintenance Plan - UMTRA-DOE/AL-350124
- EPA Health Effect Assessment Guidance - "Health Effects Assessment Summary Tables (HEAST)" and/or "Integrated Risk Information System"
- National Primary Drinking Water Standards - 40CFR141.50 through 141.51
- Floodplain Management - Executive Order 11988
- Protection of Wetlands - Executive Order 11990

A brief discussion of each of the ARARs and TBCs is included in Appendix B.

Off-Site Disposal

Off-site disposal technologies are considered to be practiced at existing facilities that are approved by the appropriate federal and state regulatory agencies such as EPA. For this screening process, an off-site landfill has been defined as a pre-engineered disposal area that meets the applicable regulations. Off-site disposal of contaminated soils and sediments will be retained for further consideration. Off-site disposal will involve transportation of the waste by truck or rail. Both transportation options are retained for further consideration.

Summary of Technology Screening for Soils, Sediments, and Wastes

Based on the rationale presented in the previous sections, numerous technologies and process options were judged not to be applicable to uranium or other site-specific conditions, so they have been deleted from further consideration. Figure 2-2 presents the technologies and related process options that have been retained for further evaluation and for subsequent development of remedial action alternatives for soils, sediments, and wastes. The retained technologies for soils, sediments, and wastes include access/use restrictions, capping, removal, treatment, and landfilling. The no-action response has also been retained for each media and will be considered as a remedial action alternative in the next phase of the FS.

2.4.1.3 Direct Radiation/Air (Fugitive Dust) Media

This section includes a discussion of the initial screening of technologies and process options considered potentially applicable for direct radiation/air (fugitive dust) emissions. Summaries of technologies and process options are presented in Figure 2-2 and are jointly discussed in the following sections.

No Action

The no-action response is applicable to direct radiation/air (fugitive dust) as required by the NCP. The no-action response for direct radiation/air is the same as for the other media discussed.

Institutional Actions

The general response action includes access/use restrictions for direct radiation/air (fugitive dust). The access/use restriction response includes physical barriers and administrative controls for minimizing access to and use of the areas of concern.

Containment

The containment response is applicable for air (fugitive dust). Major control and containment remedial technologies evaluated for this media include capping and containment structures. Capping involves the installation of a barrier over the surface of the contaminated area. Capping is designed to alleviate or eliminate possible direct and indirect exposures to the contaminants via inhalation, ingestion, or dermal contact. Capping is also effective in reducing exposure to direct radiation. Capping techniques considered for evaluation include single-layer and multilayer caps.

Removal

Since removal technology would provide for dust control measures, the technologies required for removal of the waste would apply to direct radiation/air (fugitive dust). These technologies are identical to those for soils/sediments/wastes media, and are discussed in Section 2.4.1.2.

Treatment

The treatment technologies applicable for air (fugitive dust) include those required for the treatment of soils, sediments, and wastes. These treatment technologies would prevent airborne concentrations of chemicals or radiation doses from exceeding the acceptable risk levels. The treatment technologies include ex situ physical, thermal, and biological treatment.

On-Property Disposal

On-property disposal technologies and process options are the same as those for soil media.

Off-Site Disposal

Off-site disposal technologies and process options for air (fugitive dust) are the same as those presented for soil media.

Summary of Technology Screening for Air (Fugitive Dust)

The Sanitary Landfill, based on the waste characterization, contains a high diversity of organic contaminants throughout its wastes. Therefore, those technologies and process options applicable to destruction or removal of organics have been retained for further consideration. Figure 2-2 presents the technologies and related process options that were screened and retained for subsequent development of remedial action alternatives. The retained technologies include access/use controls, capping, waste removal methods, physical treatment, thermal treatment, biological treatment, on-property disposal, off-property disposal, and segregation. The no-action response has also been retained and will be evaluated, for baseline purposes, as a remedial action alternative throughout the FS.

2.4.2 Lime Sludge Ponds

2.4.2.1 Groundwater/Surface Water Media

General response actions and technology and process options applicable (for this media) for the Sanitary Landfill are also applicable for the Lime Sludge Ponds. It should be noted that concentrations of uranium in perched groundwater near the Lime Sludge Ponds (presented in Section 1.5.3.2) are similar to those given for the Sanitary Landfill. The screening performed in Section 2.4.1.1 is applicable also to the Lime Sludge Ponds and will not be repeated here. Figure 2-3 presents the screening results for the Lime Sludge Ponds.

2.4.2.2 Soils/Sediments/Wastes Media

General response actions and technologies are identical to those for the Sanitary Landfill except for the following:

- In situ waste treatment
- In situ waste stabilization
- Hydraulic waste removal
- Ex situ waste stabilization
- Waste segregation
- Physical waste treatment
- Thermal waste treatment

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
NO ACTION	NONE	NOT APPLICABLE	REQUIRED FOR CONSIDERATION BY NCP	REQUIRED FOR CONSIDERATION BY NCP
INSTITUTIONAL ACTIONS	MONITORING	WELLPOINT MONITORING	INSTALLATION OF WELLS FOR MONITORING GROUNDWATER	POTENTIALLY APPLICABLE
		LEACHATE MONITORING	INSTALLATION OF LEACHATE COLLECTION/DETECTION SYSTEM	POTENTIALLY APPLICABLE
	ACCESS CONTROL	PHYSICAL BARRIERS	FENCING, SECURITY, LIMITED ROAD ACCESS, ETC.	POTENTIALLY APPLICABLE
		ADMINISTRATIVE CONTROLS	RESTRICTED ACCESS ONLY, POSTED SIGNS, ETC.	POTENTIALLY APPLICABLE
		DEED RESTRICTIONS	DEEDS FOR PROPERTY WITHIN POTENTIALLY CONTAMINATED AREAS INCLUDE RESTRICTIONS ON USE OF PROPERTY AND/OR GROUND-WATER USE	POTENTIALLY APPLICABLE

84

FND180

1165

FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS

212 200 0180 FND V 209

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
CONTAINMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	TEMPORARY STORAGE OF RUNOFF TO ALLOW SETTLING	POTENTIALLY APPLICABLE
		DIVERSION/COLLECTION	SURFACE WATER ROUTING CONTROLS	POTENTIALLY APPLICABLE
		GRADING	TOPOGRAPHY MODIFICATION FOR ROUTE CONTROL	POTENTIALLY APPLICABLE
		REVEGETATION	VEGETATIVE COVER PROVIDES SURFACE STABILITY	POTENTIALLY APPLICABLE
	CAPPING	CONCRETE BASED COVER	CONCRETE SLAB POURED OVER AREA OF CONCERN	POTENTIALLY APPLICABLE
		ASPHALT BASED COVER	ASPHALT POURED OVER AREA OF CONCERN	POTENTIALLY APPLICABLE
		SOIL BASED COVER	COMPACTED SOIL COVER OVER AREA OF CONCERN	POTENTIALLY APPLICABLE
		MULTIMEDIA CAP	CAP FORMED WITH VARIOUS LAYERS	POTENTIALLY APPLICABLE
		SYNTHETIC COVER	SYNTHETIC LINER PLACED OVER AREA OF CONCERN	NOT APPLICABLE, BECAUSE OF DESIGN LIFE
		CHEMICAL SEALANT	CHEMICAL STABILIZERS MIXED WITH SURFACE SOILS	POTENTIALLY APPLICABLE

LEGEND

TECHNOLOGIES/PROCESS OPTIONS SCREENED OUT

FND180Z

FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

8 3

1165

602 A FND180Z OU2 TK12

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
CONTAINMENT/ TREATMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	TEMPORARY STORAGE OF RUNOFF TO ALLOW SETTLING	POTENTIALLY APPLICABLE
		DIVERSION/COLLECTION	SURFACE WATER ROUTING CONTROLS	POTENTIALLY APPLICABLE
		GRADING	TOPOGRARHY MODIFICATION FOR ROUTE CONTROL	POTENTIALLY APPLICABLE
		REVEGETATION	VEGETATIVE COVER PROVIDES SURFACE STABILITY	POTENTIALLY APPLICABLE
	CAPPING	CONCRETE BASED COVER	CONCRETE SLAB POURED OVER AREA OF CONCERN	POTENTIALLY APPLICABLE
		ASPHALT BASED COVER	ASPHALT POURED OVER AREA OF CONCERN	POTENTIALLY APPLICABLE
		SOIL BASED COVER	COMPACTED SOIL COVER OVER AREA OF CONCERN	POTENTIALLY APPLICABLE
		MULTIMEDIA CAP	CAP FORMED WITH VARIOUS LAYERS	POTENTIALLY APPLICABLE
		SYNTHETIC COVER	SYNTHETIC LINER PLACED OVER AREA OF CONCERN	NOT APPLICABLE, BECAUSE OF DESIGN LIFE
		CHEMICAL SEALANT	CHEMICAL STABILIZERS MIXED WITH SURFACE SOILS	POTENTIALLY APPLICABLE

FND180A

FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

86

1165

FND180A 022 TK12

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
CONTAINMENT/ TREATMENT	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCH	GRAVITY DRIVEN COLLECTION SYSTEM EXTRACTION WELL	POTENTIALLY APPLICABLE
		PUMPING WELLS	EXTRACTION OF PERCHED WATER	POTENTIALLY APPLICABLE
	SUBSURFACE CONTAINMENT	SLURRY WALLS	GROUT WALLS FORMED BY TRENCHING AND FILLING	POTENTIALLY APPLICABLE
		SHEET PILINGS	STEEL FORMS DRIVEN INTO GROUND AND JOINED	NOT APPLICABLE AT REQUIRED DEPTHS
		GROUT CURTAINS	CLOSE-SPACED GROUT INJECTIONS ISOLATE AREA	POTENTIALLY APPLICABLE
	IN SITU STABILIZATION	GROUT INJECTION	DIRECT INJECTION OF GROUT USING A GROUT GUN	POTENTIALLY APPLICABLE
		SHALLOW-SOIL MIXING	CHEMICAL AND/OR FLY ASH BASED STABILIZATION	POTENTIALLY APPLICABLE
		DYNAMIC COMPACTION/ VACUUM EXTRACTION	REMOVAL OF SUBSURFACE WATER IN WASTE	POTENTIALLY APPLICABLE
		SURCHARGING	COMPACTION OF MATERIAL BY ADDITION OF SOIL COVER	POTENTIALLY APPLICABLE
		VITRIFICATION	HIGH TEMPERATURE CRYSTALLIZATION/ GLASSIFICATION OF SOLIDS	SINCE THE LIME SLUDGE HAS HIGH MOISTURE CONTENT, IN SITU VITRIFICATION IS NON-EFFECTIVE
	IN SITU WASTE TREATMENT	VACUUM EXTRACTION	REMOVES AND VENTS VOLATILE ORGANIC COMPOUNDS FROM THE WASTE	PROCESS OPTION IS NOT PROVEN FOR HIGH MOISTURE CONTENT MATERIAL SUCH AS LIME SLUDGE
		BIOLOGICAL TREATMENT	BIODEGRADES CHLORINATED AND NON-CHLORINATED ORGANIC CONTAMINANTS IN THE WASTE	DIFFICULT TO IMPLEMENT DUE TO LOW PERMEABILITY OF LIME SLUDGE

LEGEND

TECHNOLOGIES/PROCESS OPTIONS SCREENED OUT

FND180B

FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

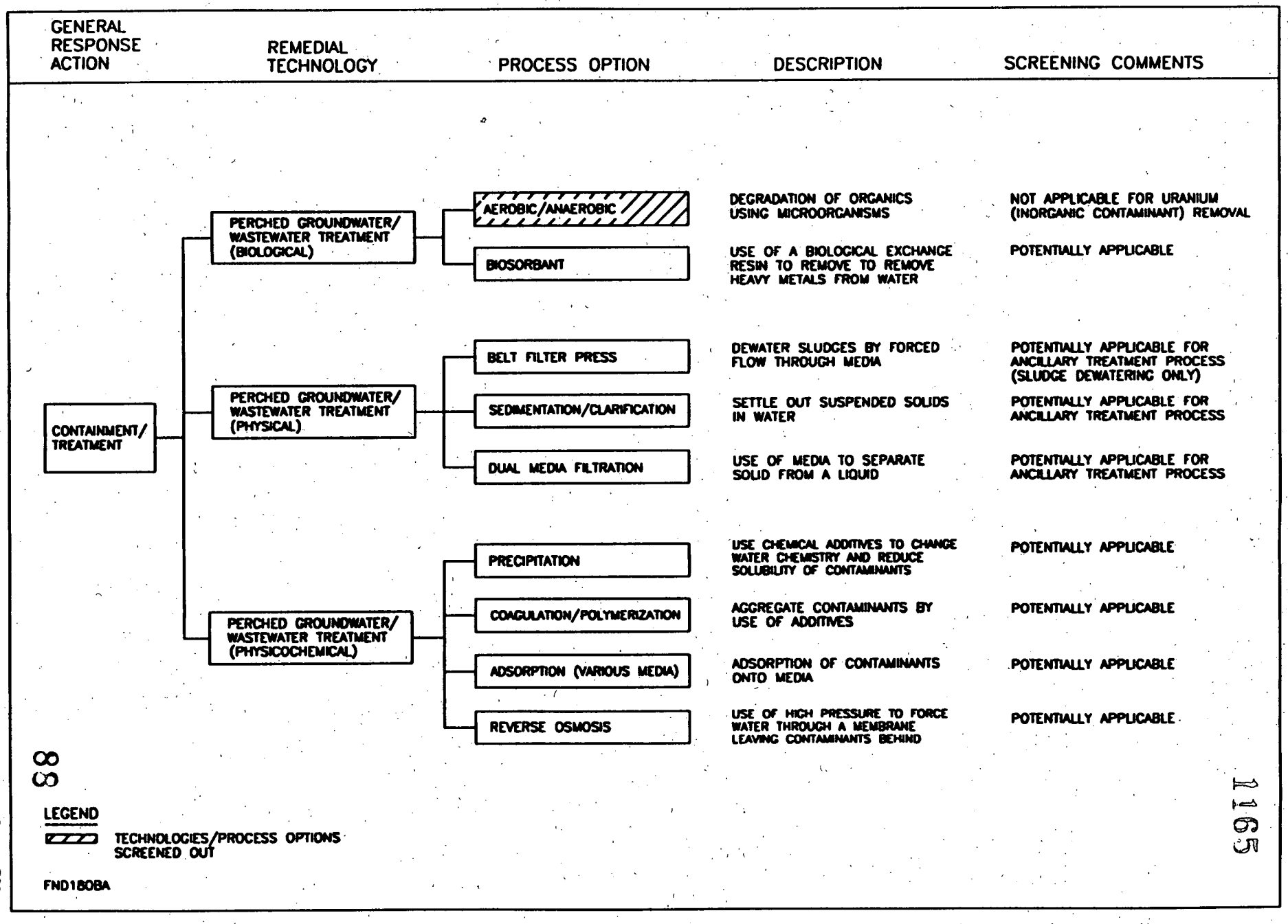


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

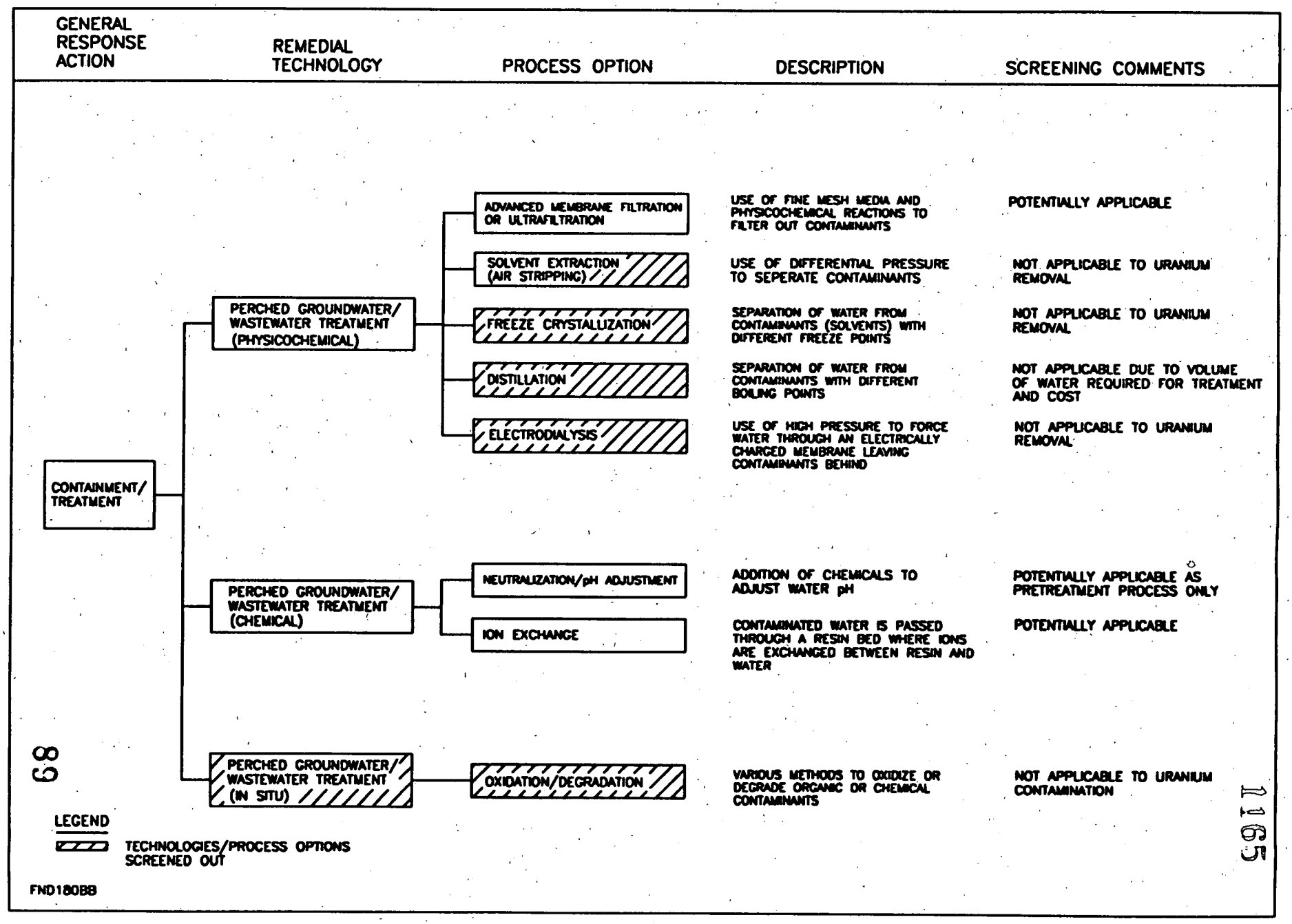


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

212 TNI 200 BBOB10NJ V 209

89

1165

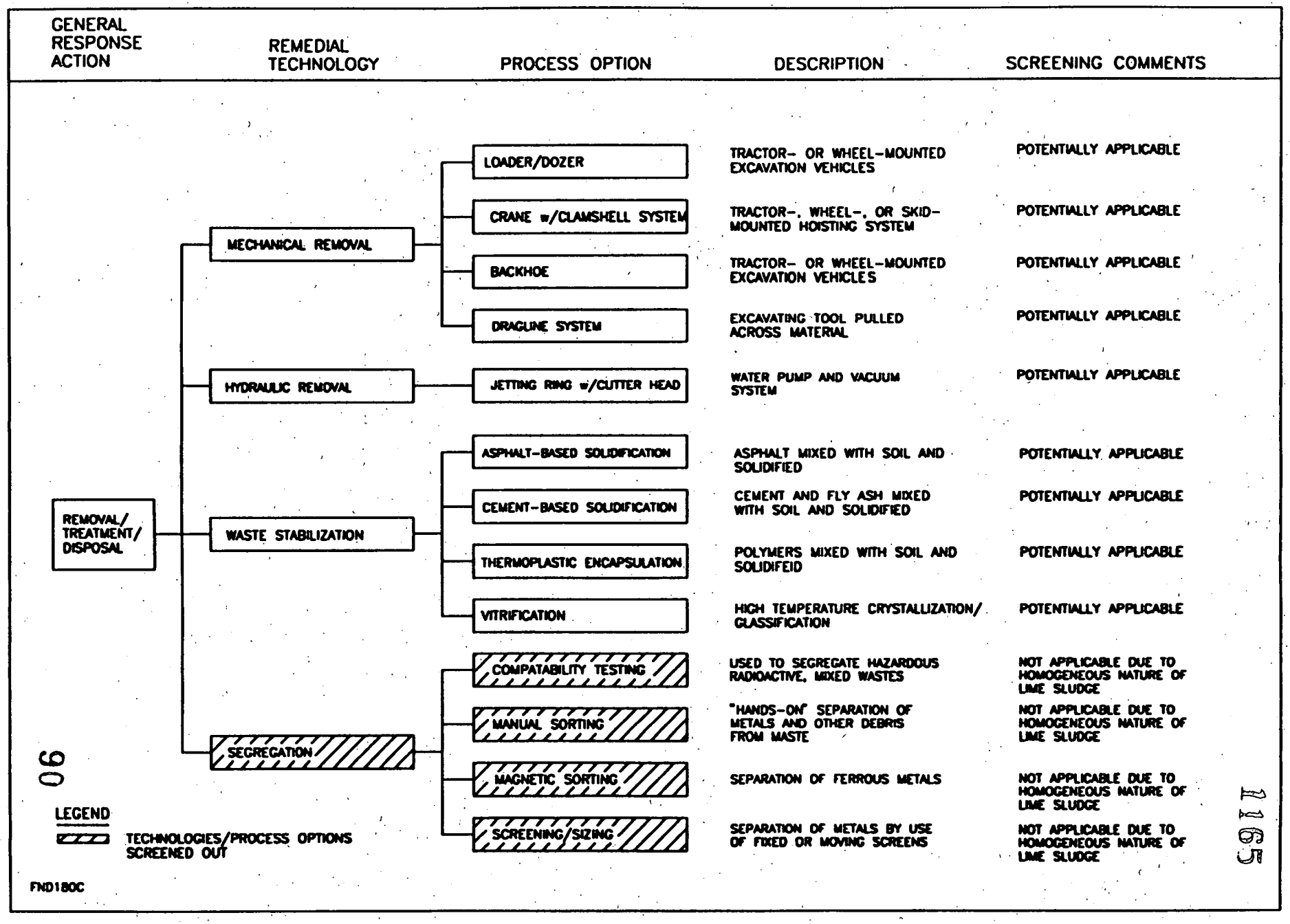


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

802 A FND180C OU2 TK12

90

1195

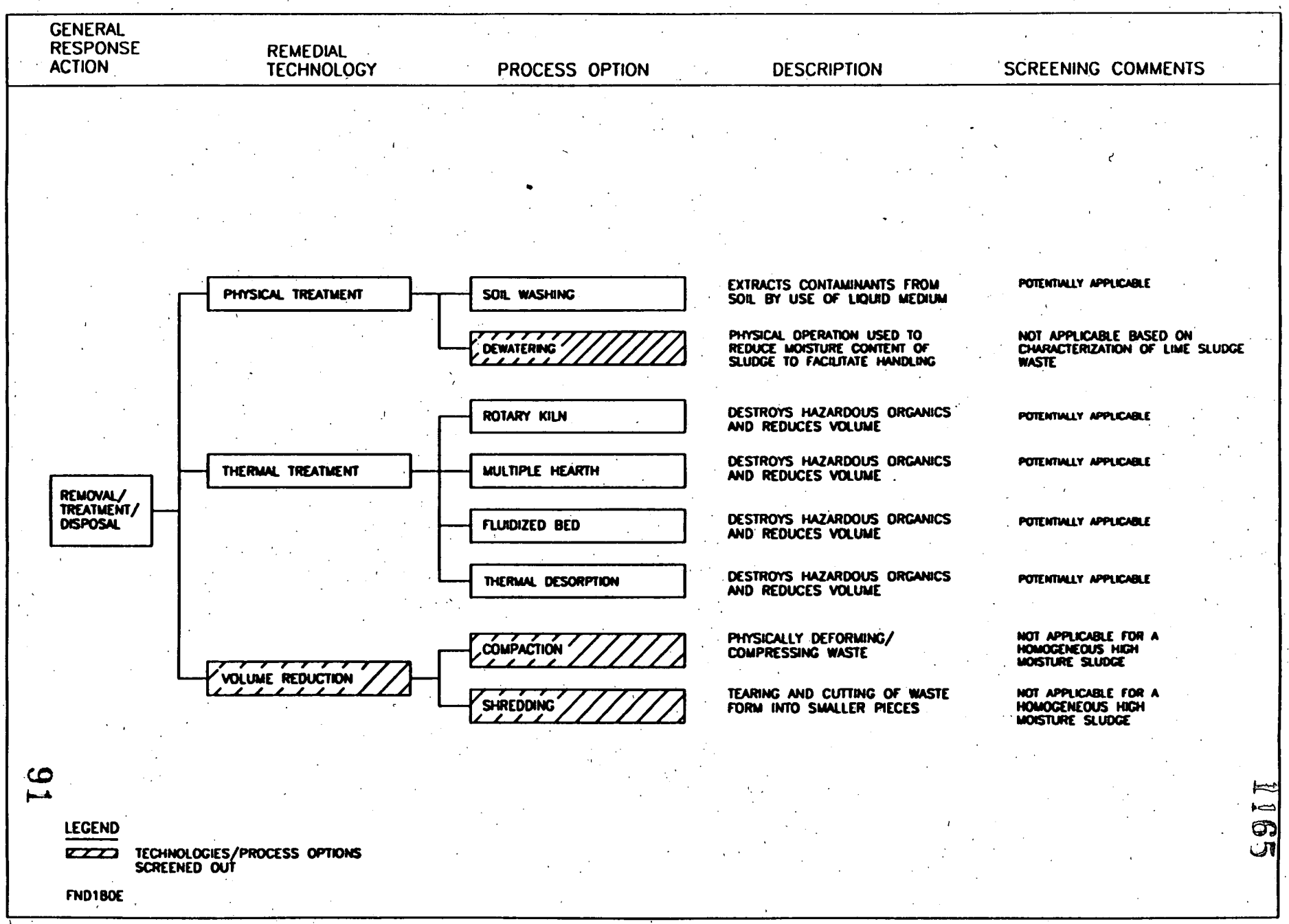


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

91
1165
000 A FND180E 022 TK12

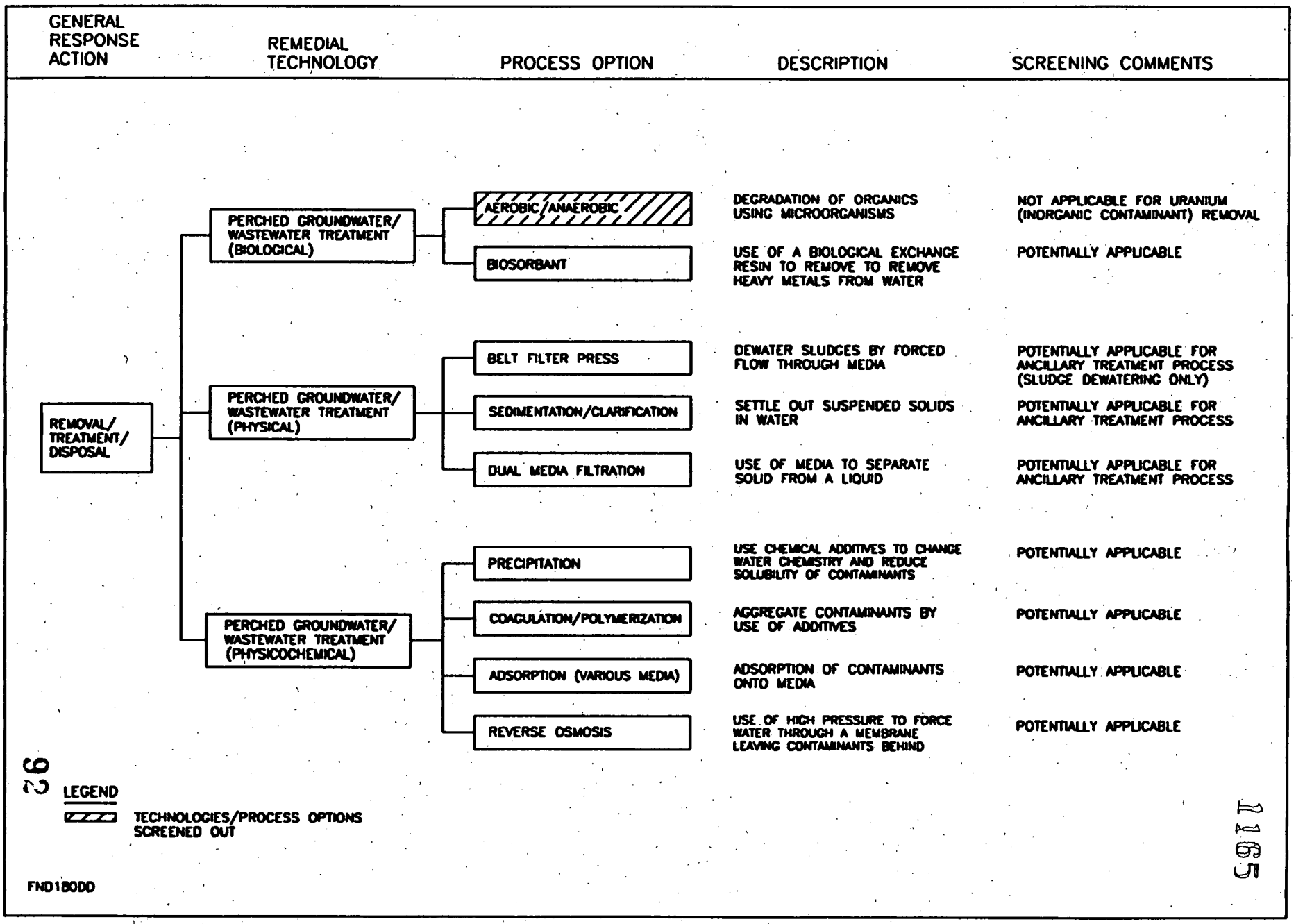


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

602 A FND18DDD OLE TK12

92

1165

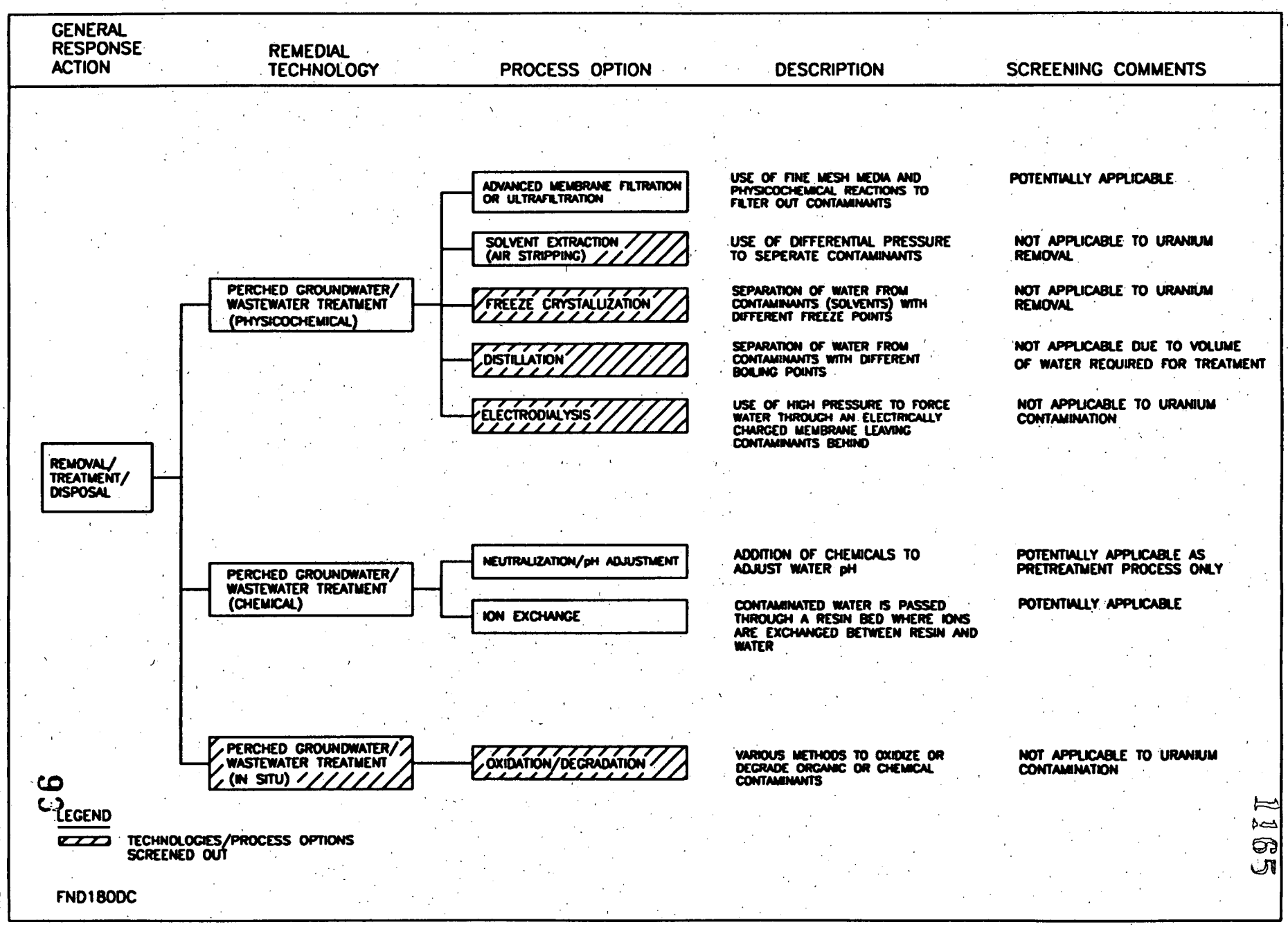


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

002 A FND180DC OU2 TK12

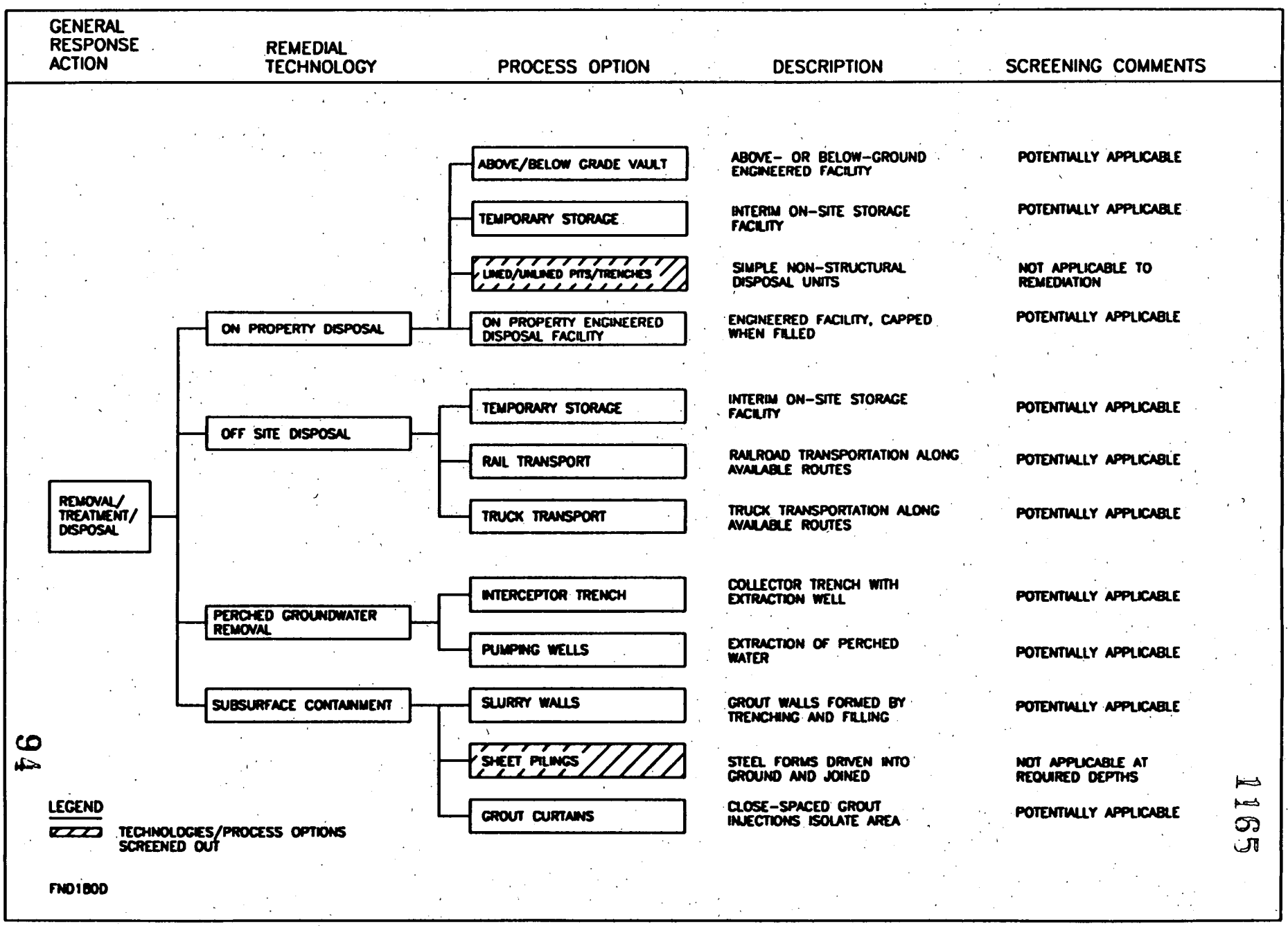


FIGURE 2-3. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-LIME SLUDGE PONDS (Continued)

2121 ZTO 00180NU A 208

Removal

Removal of contaminated material would prevent migration of contaminants toward potential receptors. This could be accomplished by mechanical or hydraulic excavation equipment, due to the consistency of the waste in the Lime Sludge Ponds.

Mechanical excavation, described earlier in Section 2.4.1.2, involves the use of common construction equipment such as back hoe or bulldozer to remove the soil or sediments. These methods are viable for soils, wastes, and sediments that are not in contact with surface waters and are retained for further consideration.

Since the waste in the Lime Sludge Ponds is homogeneous in its nature, and because this waste was slurried into its present location, hydraulic removal is a viable process option for the Lime Sludge Ponds.

Segregation

Segregation is not applicable to the Lime Sludge Ponds due to the homogeneous nature of this waste. Therefore, segregation is not retained as a viable technology for the Lime Sludge Ponds. Compatibility testing (for hazardous waste characteristics) was performed under the Weston CIS, but did not include a TCLP test. This test is included as part of the additional sampling under the Work Plan Addendum for Operable Unit 2.

Volume Reduction

The process options listed under volume reduction include compaction and shredding. These process options are not effective for lime sludges due to the homogeneous nature of these wastes. It should be noted, however, that the technology of physical wastewater treatment (discussed previously for groundwater/surface water media) could be utilized to remove moisture from the lime sludges, effecting volume reduction.

In Situ Treatment/Stabilization

The treatment technologies for soils, sediments, and wastes include in situ waste treatment and in situ stabilization.

The process options for in situ waste treatment include in situ vacuum extraction and in situ biological treatment. In situ vacuum extraction is suitable for remediation of organics; however, it would be of limited effectiveness in the Lime Sludge Ponds due to the high moisture content present in this waste unit. In situ biological treatment biodegrades chlorinated and nonchlorinated organic contaminants. Extraction and recharge wells would be utilized in implementation of this technology. Due to the

relatively low permeability exhibited by the lime sludge, this technology would be difficult to implement for this waste unit. Therefore, these process options are not viable for the Lime Sludge Ponds.

Process options for in situ stabilization include in situ vitrification, surcharging, dynamic compaction, SSM, and grout injection. It should be noted that vitrification is recognized as an innovative technology. In situ vitrification involves passing a high current of electricity through the contaminated media. The generated heat drives off volatile organic compounds and solidifies the soil into a glassy, solid matrix, resistant to deterioration from weathering or leaching. Although this technology removes organics, it is not applicable for the Lime Sludge Ponds since the high moisture content of this waste would make this technology difficult to properly implement.

Grout injection and SSM are similar process options which can solidify sludges, soils, and physically homogeneous wastes. Since the Lime Sludge is homogeneous and since these technologies have historically been applied to lime sludges, these process options are applicable and are retained for consideration.

Surcharging and dynamic compaction are also similar process options. Standard penetration tests performed as part of waste sampling are documented in the Weston Geotechnical Report (Weston 1988). Results of these tests indicated that this material is very soft and unlikely to support the additional weight of a cap. Therefore, these process options (which would allow cap support) are retained for further consideration.

Ex Situ Treatment/Stabilization

The treatment technologies for soils, sediment, and wastes include ex situ physical and thermal treatment.

The ex situ physical treatment process of soil washing was evaluated. Soil washing involves the extraction of organic and inorganic compounds from excavated soils or sediments by leaching. Soil washing may be viable for the removal of soluble uranium compounds and is retained for further evaluation.

Thermal treatment is a process in which molecular bonding of organic or inorganic compounds is altered through thermal decomposition and oxidation. The end products of this process typically include carbon dioxide, elemental carbon, ionized halogen, phosphorous, sulfur, and other inorganics depending on the original composition of the waste material. The following process options were evaluated for on-site thermal treatment:

- Rotary kiln incineration

- Multiple hearth incineration
- Fluidized bed incineration
- Thermal desorption

These technologies are effective in removing organics from waste and are retained for future consideration.

Ex situ waste stabilization is a process used after waste removal and could consist of blending a fly ash and portland cement mixture with the lime sludge (concrete-based solidification) to create a solidified product. Due to the homogeneous nature of the lime sludge and to the fact that this technology has historically been used to solidify lime sludge, this process option is retained for further consideration. Other ex situ waste stabilization process options evaluated for consideration include thermoplastic encapsulation, vitrification, and asphalt solidification. Thermoplastic encapsulation involves mixing the waste with polymers to form a rigid, solid material. Vitrification is a process that involves mixing the waste with molten glass at a high temperature; the mixture is then cooled to form a solid matrix. To implement ex situ vitrification, the waste would have to be dried; additives may also be required. Asphalt solidification involves mixing the waste with asphalt and then cooling the mixture to form a solidified product. These process options are viable and are retained for further consideration.

2.4.2.3 Direct Radiation/Air (Fugitive Dust) Media

Response actions and technologies utilized for the soils/sediments/wastes media are applicable for the direct radiation/ air (fugitive dust) media.

2.4.3 Fly Ash/Southfield Areas: Initial Screening

2.4.3.1 Groundwater/Surface Water Media

General response actions, technologies, and process options applicable to this media for the Sanitary Landfill are also applicable for the Fly Ash/Southfield areas. It should be noted that concentrations of uranium in perched groundwater near the Fly Ash/Southfield areas (presented in Sections 1.5.3.3, 1.5.3.4, and 1.5.3.5) are similar to those presented for the Sanitary Landfill and Lime Sludge Ponds. The screening described in Section 2.4.1.1 is applicable also to the Fly Ash/Southfield areas, and is not repeated here. Figure 2-4 presents the screening summary for the Fly Ash/Southfield areas.

2.4.3.2 Soils/Sediments/Wastes Media

General response actions and technologies are identical to those for the Sanitary Landfill except for the following:

97

- In situ waste treatment
- In situ waste stabilization

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
NO ACTION	NONE	NOT APPLICABLE	REQUIRED FOR CONSIDERATION BY NCP	REQUIRED FOR CONSIDERATION BY NCP
INSTITUTIONAL ACTIONS	MONITORING	WELLPOINT MONITORING	INSTALLATION OF WELLS FOR MONITORING GROUNDWATER	POTENTIALLY APPLICABLE
		LEACHATE MONITORING	INSTALLATION OF LEACHATE COLLECTION/DETECTION SYSTEM	POTENTIALLY APPLICABLE
	ACCESS CONTROL	PHYSICAL BARRIERS	FENCING, SECURITY, LIMITED ROAD ACCESS, ETC.	POTENTIALLY APPLICABLE
		ADMINISTRATIVE CONTROLS	RESTRICTED ACCESS ONLY, POSTED SIGNS, ETC.	POTENTIALLY APPLICABLE
		DEED RESTRICTIONS	DEEDS FOR PROPERTY WITHIN POTENTIALLY CONTAMINATED AREAS INCLUDE RESTRICTIONS ON USE OF PROPERTY AND/OR GROUND-WATER USE	POTENTIALLY APPLICABLE

FND179

FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS

602 # FND179 OU2 TK12

98

1165

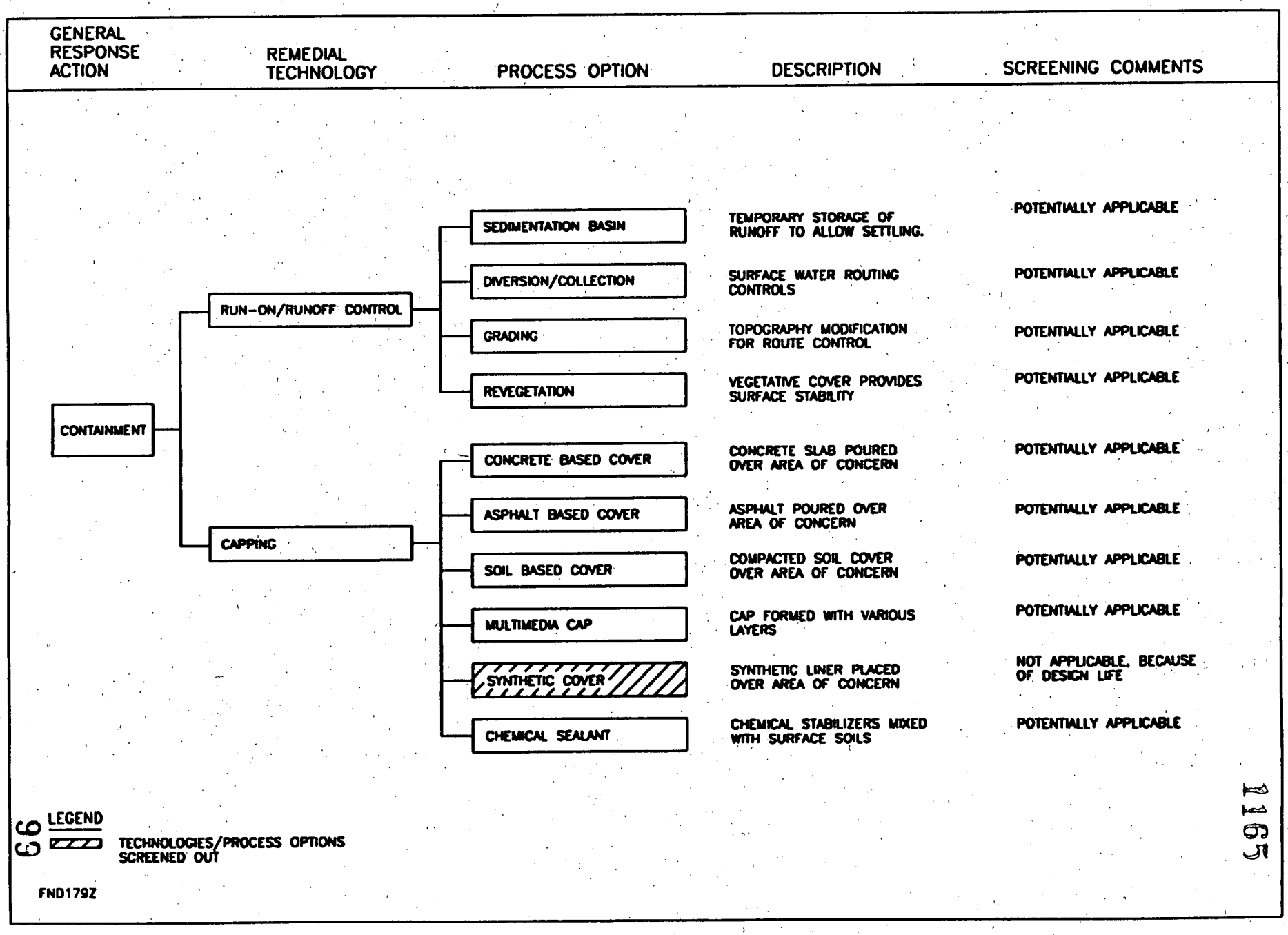


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

1165
99
002 A FND179Z OU2 TK12

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
CONTAINMENT/ TREATMENT	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCH	GRAVITY DRIVEN COLLECTION SYSTEM EXTRACTION WELL	POTENTIALLY APPLICABLE
		PUMPING WELLS	EXTRACTION OF PERCHED WATER	POTENTIALLY APPLICABLE
	SUBSURFACE CONTAINMENT	SLURRY WALLS	GROUT WALLS FORMED BY TRENCHING AND FILLING	POTENTIALLY APPLICABLE
		SHEET PILINGS	STEEL FORMS DRIVEN INTO GROUND AND JOINED	NOT APPLICABLE AT REQUIRED DEPTHS
		GROUT CURTAINS	CLOSE-SPACED GROUT INJECTIONS ISOLATE AREA	POTENTIALLY APPLICABLE
	IN SITU STABILIZATION	GROUT INJECTION	DIRECT INJECTION OF GROUT USING A GROUT GUN	THE FLY ASH/SOUTHFIELD AREAS ARE CAPABLE OF SUPPORTING A CAP IN THEIR PRESENT STATE, WITHOUT ANY ADVERSE LONG-TERM SUBSIDENCE EFFECTS. SOURCE CONTAMINATION IS SPORADIC AND SHOWS NO SIGN OF MIGRATION TO ADJACENT MEDIA. NOT APPLICABLE TO HETEROGENEOUS WASTES IN THE SOUTHFIELD.
		SHALLOW-SOIL MIXING	CHEMICAL AND/OR FLY ASH BASED STABILIZATION	THE FLY ASH/SOUTHFIELD AREAS ARE CAPABLE OF SUPPORTING A CAP IN THEIR PRESENT STATE, WITHOUT ANY ADVERSE LONG-TERM SUBSIDENCE EFFECTS. SOURCE CONTAMINATION IS SPORADIC AND SHOWS NO SIGN OF MIGRATION TO ADJACENT MEDIA. NOT APPLICABLE TO HETEROGENEOUS WASTES IN THE SOUTHFIELD.
		DYNAMIC COMPACTION/ VACUUM EXTRACTION	REMOVAL OF SUBSURFACE WATER IN WASTE	THE FLY ASH/SOUTHFIELD AREAS ARE CAPABLE OF SUPPORTING A CAP IN THEIR PRESENT STATE, WITHOUT ANY LONG-TERM SUBSIDENCE EFFECTS
		SURCHARGING	COMPACTION OF MATERIAL BY ADDITION OF SOIL COVER	THE FLY ASH/SOUTHFIELD AREAS ARE CAPABLE OF SUPPORTING A CAP IN THEIR PRESENT STATE, WITHOUT ANY LONG-TERM SUBSIDENCE EFFECTS
		VITRIFICATION	HIGH TEMPERATURE CRYSTALLIZATION/ GLASSIFICATION OF SOLIDS	CONTAMINATION WITHIN THE FLY ASH PILES IS SPORADIC AND SHOWS NO SIGN OF MIGRATION TO ADJACENT MEDIA. TECHNOLOGY IS DIFFICULT TO IMPLEMENT FOR THE FLYASH WASTES SINCE DEPTHS OF THIS WASTE EXCEED 20 FEET IN SOME PLACES

LEGEND

TECHNOLOGIES/PROCESS OPTIONS SCREENED OUT

FND179B

FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

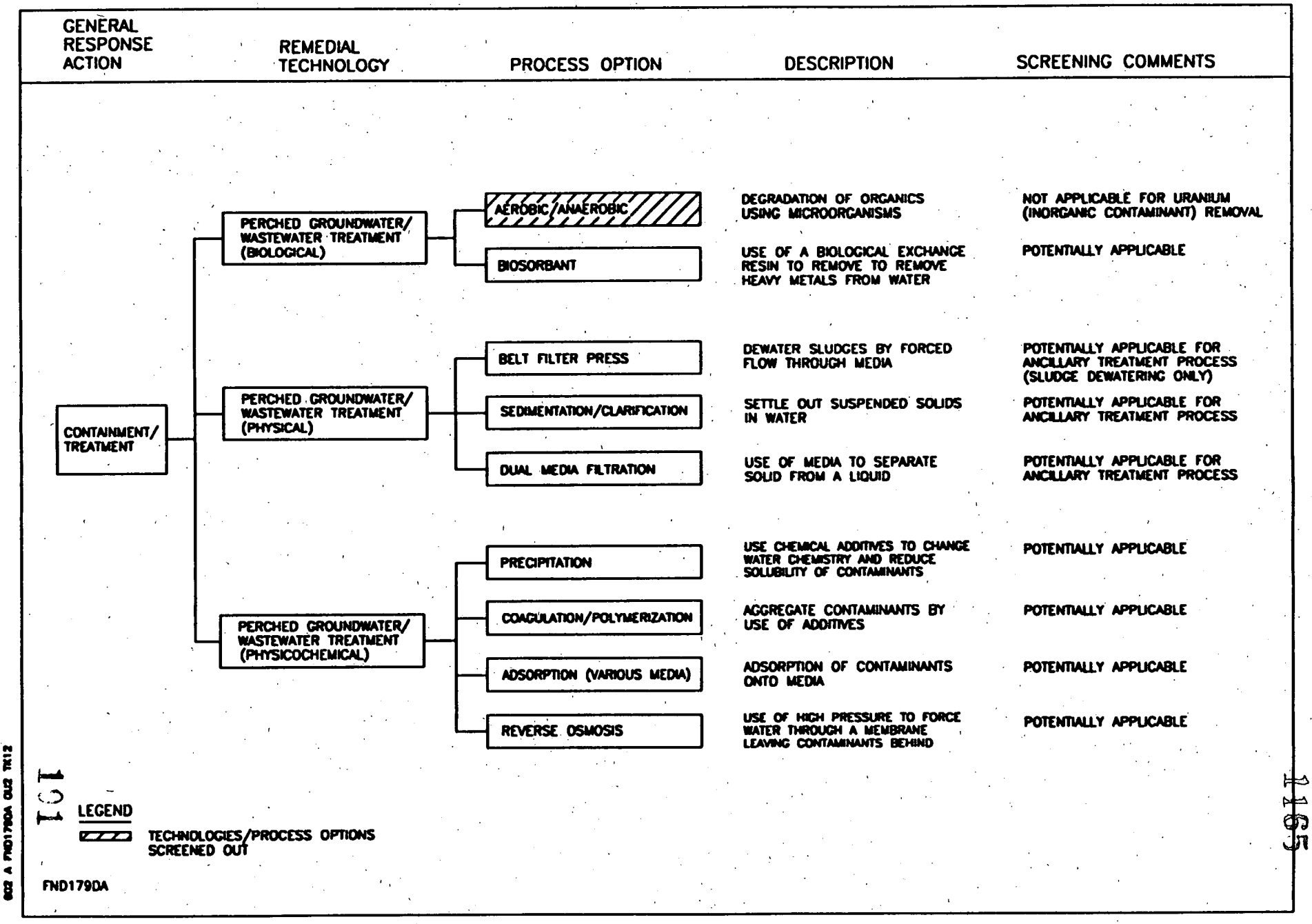


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

602 A FND179DA OU2 TK12

1101

1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
CONTAINMENT/ TREATMENT	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (PHYSICOCHEMICAL)	ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	USE OF FINE MESH MEDIA AND PHYSICOCHEMICAL REACTIONS TO FILTER OUT CONTAMINANTS	POTENTIALLY APPLICABLE
		SOLVENT EXTRACTION (AIR STRIPPING)	USE OF DIFFERENTIAL PRESSURE TO SEPERATE CONTAMINANTS	NOT APPLICABLE TO URANIUM REMOVAL
		FREEZE CRYSTALLIZATION	SEPARATION OF WATER FROM CONTAMINANTS (SOLVENTS) WITH DIFFERENT FREEZE POINTS	NOT APPLICABLE TO URANIUM REMOVAL
		DISTILLATION	SEPARATION OF WATER FROM CONTAMINANTS WITH DIFFERENT BOILING POINTS	NOT APPLICABLE DUE TO VOLUME OF WATER REQUIRED FOR TREATMENT AND COST
		ELECTRODIALYSIS	USE OF HIGH PRESSURE TO FORCE WATER THROUGH AN ELECTRICALLY CHARGED MEMBRANE LEAVING CONTAMINANTS BEHIND	NOT APPLICABLE TO URANIUM REMOVAL
	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (CHEMICAL)	NEUTRALIZATION/pH ADJUSTMENT	ADDITION OF CHEMICALS TO ADJUST WATER pH	POTENTIALLY APPLICABLE AS PRETREATMENT PROCESS ONLY
		ION EXCHANGE	CONTAMINATED WATER IS PASSED THROUGH A RESIN BED WHERE IONS ARE EXCHANGED BETWEEN RESIN AND WATER	POTENTIALLY APPLICABLE
	PERCHED GROUNDWATER/ WASTEWATER TREATMENT (IN SITU)	OXIDATION/DEGRADATION	VARIOUS METHODS TO OXIDIZE OR DEGRADE ORGANIC OR CHEMICAL CONTAMINANTS	NOT APPLICABLE TO URANIUM REMOVAL

LEGEND

TECHNOLOGIES/PROCESS OPTIONS SCREENED OUT

FND179DB

FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

1165

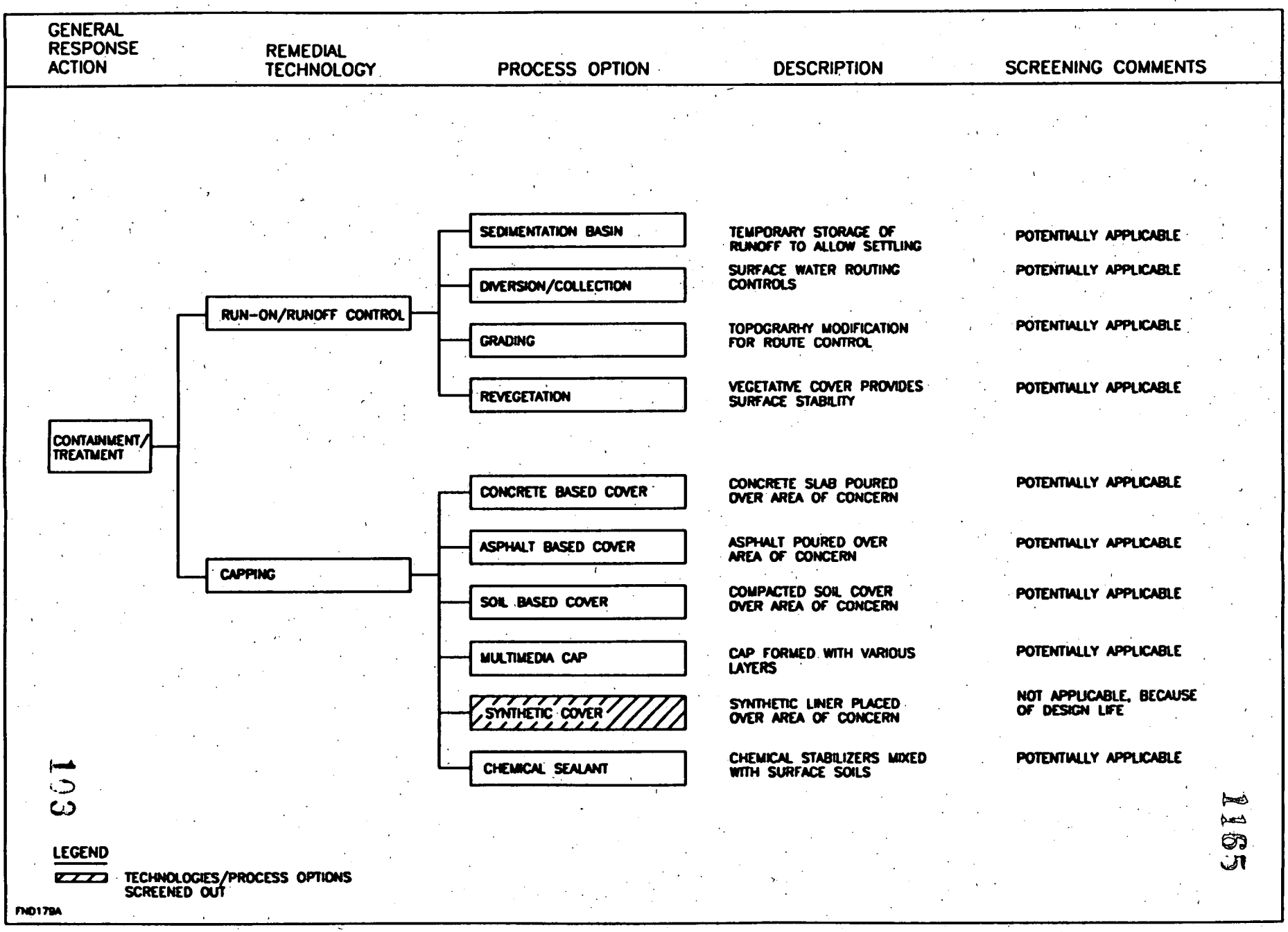


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

822 A FND179A OU2 TK12

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	DESCRIPTION	SCREENING COMMENTS
REMOVAL/ TREATMENT/ DISPOSAL	MECHANICAL REMOVAL	LOADER/DOZER	TRACTOR- OR WHEEL-MOUNTED EXCAVATION VEHICLES	POTENTIALLY APPLICABLE
		CRANE w/CLAMSHELL SYSTEM	TRACTOR-, WHEEL-, OR SKID-MOUNTED HOISTING SYSTEM	POTENTIALLY APPLICABLE
		BACKHOE	TRACTOR- OR WHEEL-MOUNTED EXCAVATION VEHICLES	POTENTIALLY APPLICABLE
		DRAGLINE SYSTEM	EXCAVATING TOOL PULLED ACROSS MATERIAL	POTENTIALLY APPLICABLE
	HYDRAULIC REMOVAL	JETTING RING w/CUTTER HEAD	WATER PUMP AND VACUUM SYSTEM	NOT APPLICABLE TO HETERO-GENEOUS WASTES IN THE SOUTHFIELD. THE ADDITION OF LARGE QUANTITIES OF WATER WOULD BE REQUIRED. MECHANICAL MEANS OF REMOVAL WOULD NEED TO SUPPLEMENT THIS REMOVAL METHOD
	SEGREGATION	COMPATABILITY TESTING	USED TO SEGREGATE HAZARDOUS, RADIOACTIVE, MIXED WASTES	POTENTIALLY APPLICABLE
		MANUAL SORTING	"HANDS-ON" SEPARATION OF METALS AND OTHER DEBRIS FROM WASTE	POTENTIALLY APPLICABLE
		MAGNETIC SORTING	SEPARATION OF FERROUS METALS	POTENTIALLY APPLICABLE
		SCREENING/SIZING	SEPARATION OF METALS BY USE OF FIXED OR MOVING SCREENS	POTENTIALLY APPLICABLE

LEGEND

TECHNOLOGIES/PROCESS OPTIONS SCREENED OUT

FND179C

FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

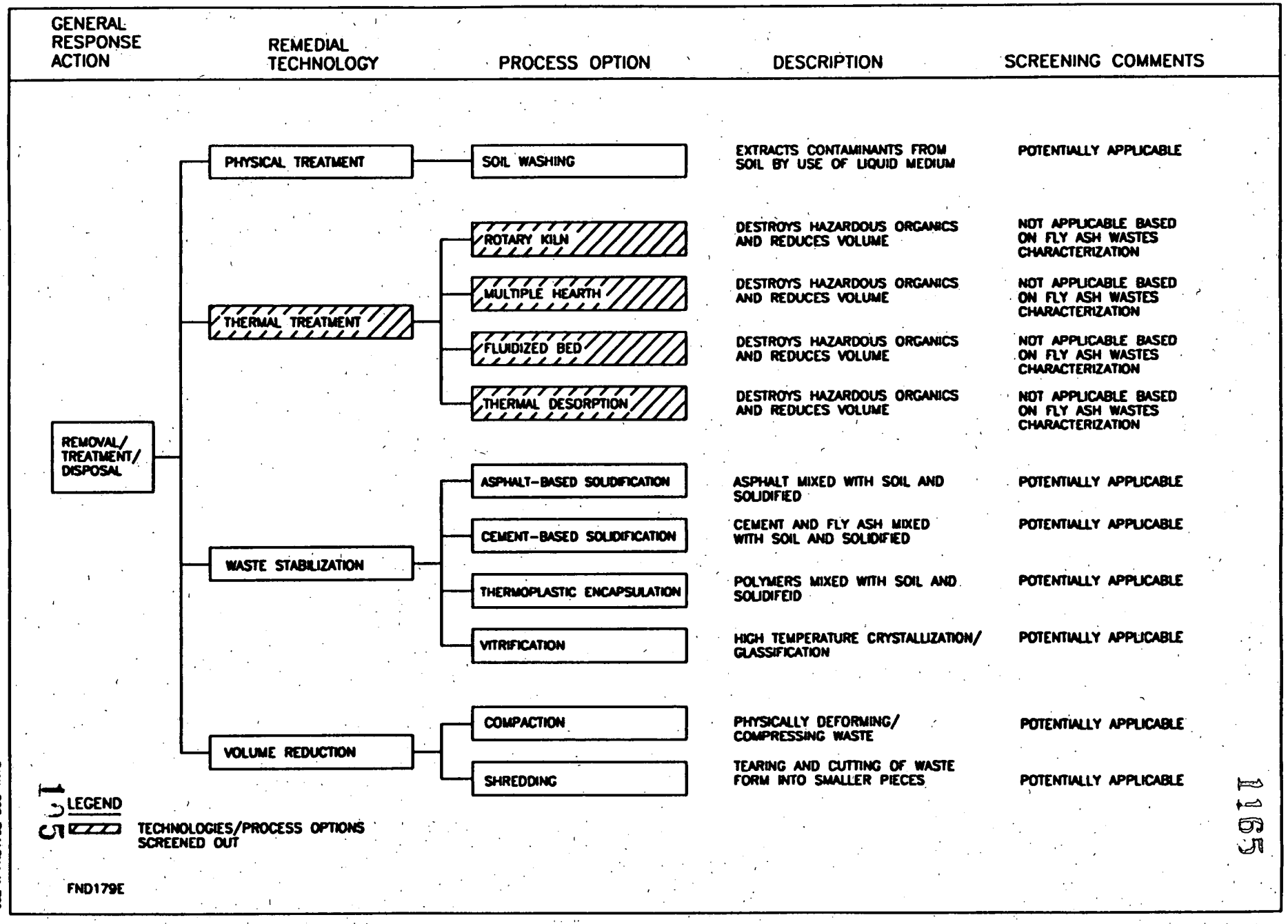


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

602 A FND179E OU2 TK12

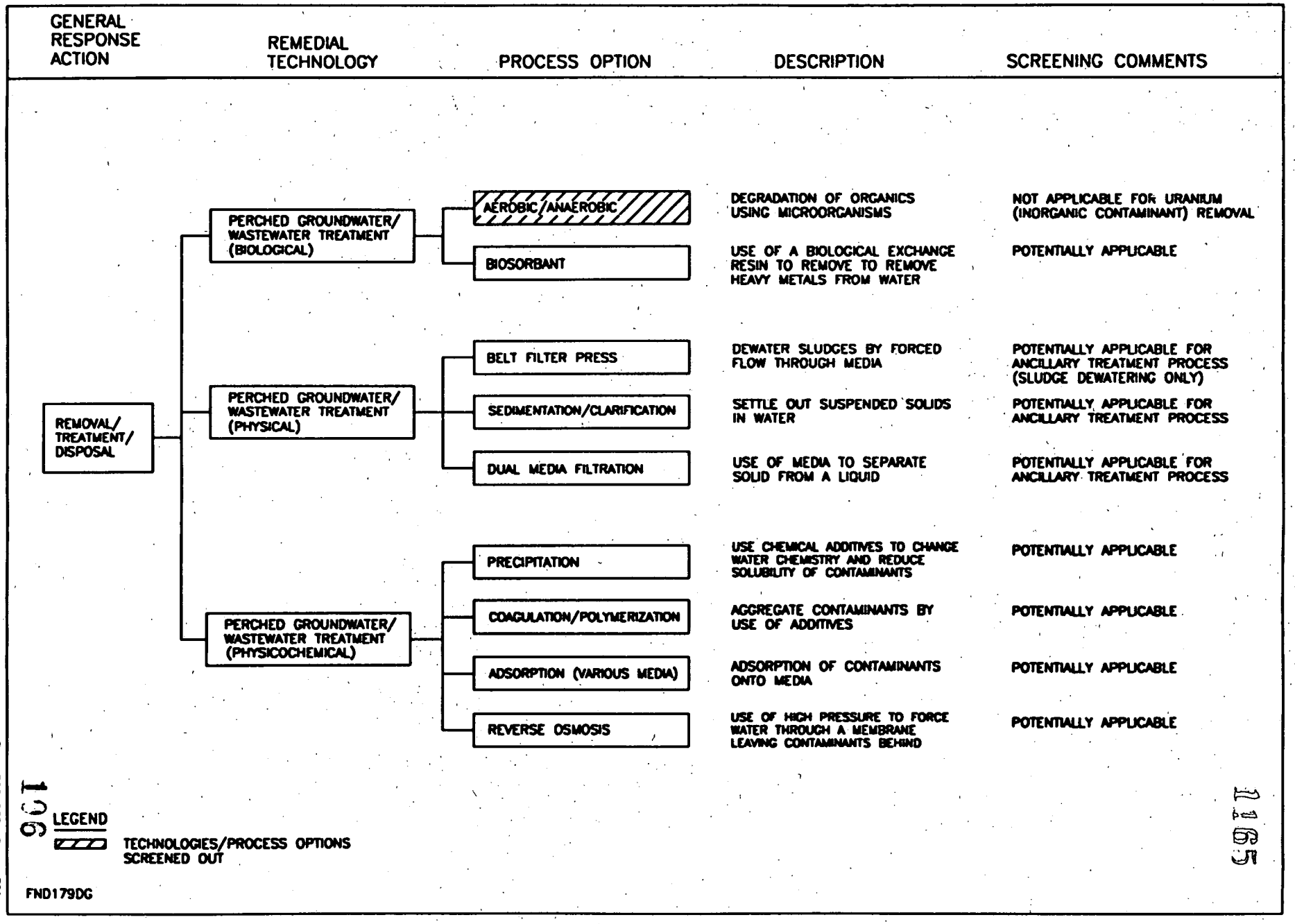


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

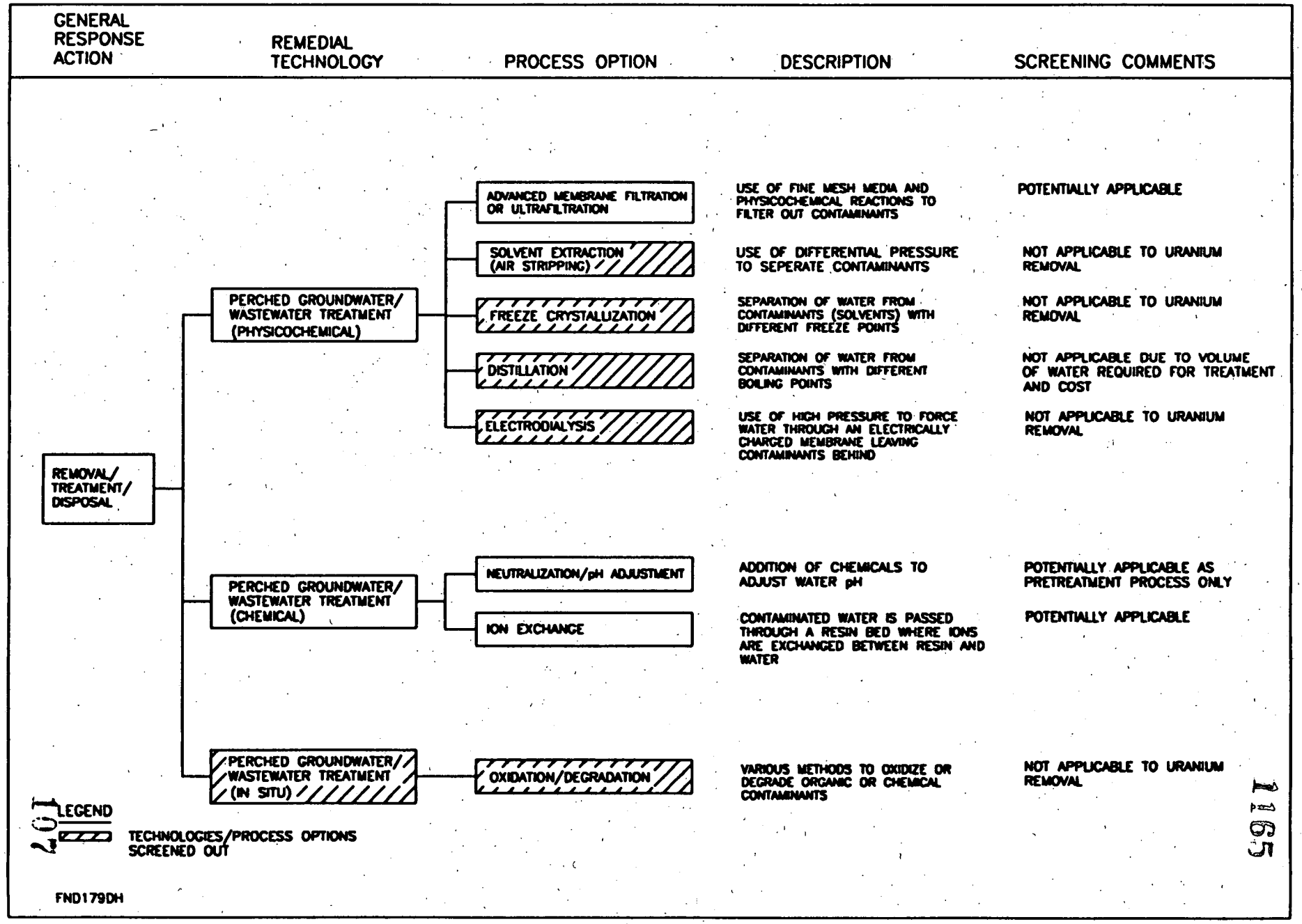


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

602 A FND179DH 0102 TK12

1195

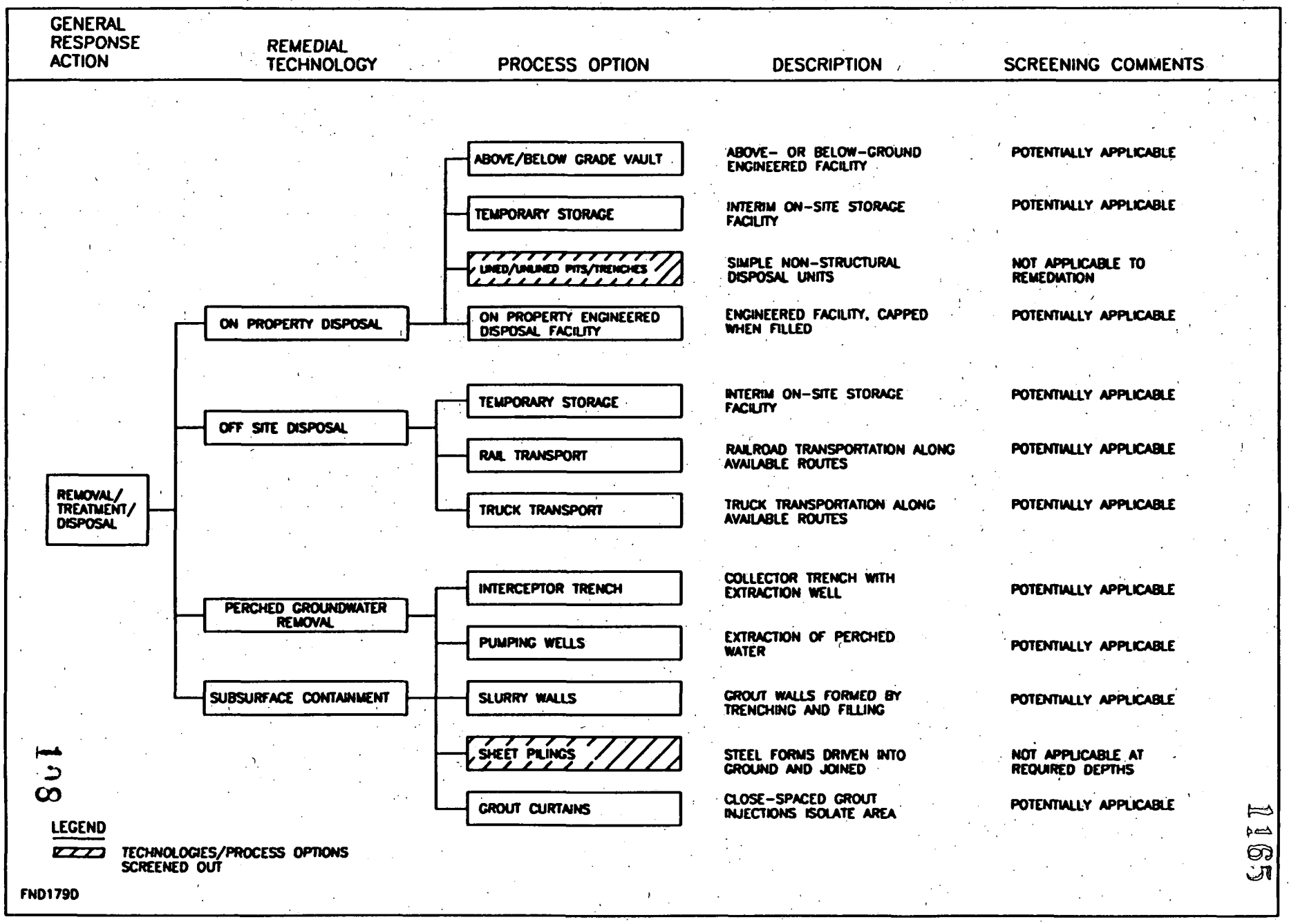


FIGURE 2-4. INITIAL SCREENING OF TECHNOLOGIES AND PROCESS OPTIONS-FLY ASH/SOUTHFIELD AREAS (Continued)

- Ex situ waste stabilization
- Physical waste treatment
- Thermal waste treatment

In Situ Treatment/Stabilization

The treatment technologies for soil, sediment, and wastes include in situ stabilization. Process options for in situ stabilization include in situ vitrification, surcharging, dynamic compaction, SSM, and grout injection.

In situ vitrification involves passing a high current of electricity through the contaminated media in situ. The generated heat drives off volatile organic compounds and solidifies the soil into a glassy, solid matrix, resistant to deterioration from weathering or leaching. Although this technology removes organics, it is not applicable for the fly ash areas since the depths of these wastes exceed 20 feet in some areas and would make this technology difficult to properly implement.

Grout injection and SSM are similar process options which can solidify sludges, soils, and physically homogeneous wastes. Since there is construction rubble present in the Southfield and Inactive Fly Ash Disposal areas, implementation of these process options is difficult and is not retained for consideration. Owing to the impracticality of stabilizing such a large volume in place, these processes are eliminated from further consideration.

Surcharging and dynamic compaction are also similar process options. Standard penetration tests performed as part of waste sampling are documented in the Weston Geotechnical Report (Weston 1988). Results of these tests indicated that this material is firm and compacted and that the Fly Ash/Southfield Areas would be able to support the additional weight of a cap. Therefore, these process options are unnecessary and are not retained for further consideration.

Ex situ Treatment

The treatment technologies for soils, sediments, and wastes include ex situ physical and thermal treatment and waste stabilization.

The ex situ physical treatment process of soil washing was evaluated. Soil washing involves the extraction of organic and inorganic compounds from excavated soils or sediments by leaching. Soil washing may be viable for the removal of soluble uranium compounds and is retained for further evaluation.

Thermal treatment is a process in which molecular bonding of organic or inorganic compounds is altered through thermal decomposition and oxidation. The end products of this process typically

include carbon dioxide, elemental carbon, ionized halogen, phosphorous, sulfur, and other inorganics depending on the original composition of the waste. The following process options were evaluated for on-site thermal treatment:

- Incineration (rotary kiln, multiple hearth, fluidized bed)
- Thermal desorption

The Fly Ash/Southfield areas do not contain high concentrations of organic chemicals throughout the waste, but there are elevated levels of radionuclides. Although both of the thermal treatment process options would remove organic contaminants, they would not remove or destroy the radionuclides contained in the Fly Ash/Southfield areas. In addition, application of this technology is impractical for the high volume of Fly Ash/Southfield wastes. Therefore, these technologies are eliminated from further consideration.

Volume reduction is a process in which the removed waste (construction debris, wallboard, etc.,) is physically deformed by tearing or compacting it for handling purposes. The process options considered for volume reduction were:

- Compaction
- Shredding

Volume reduction is considered to be an ancillary technology and the associated process options were not carried through the evaluation of process options and assembly of alternatives, but they will be included in the detailed analysis of alternatives for the complete conceptual, costing, and evaluation of the alternatives.

Ex situ waste stabilization is a process used after waste removal and could consist of blending a fly ash and portland cement mixture (cement-based solidification) to create a solidified product. Due to the homogeneous nature of the Fly Ash/Southfield areas (except for the construction rubble), and the fact that this technology has application for use to solidify these wastes, this process option is retained for further consideration. Other process options evaluated for consideration include thermoplastic encapsulation, vitrification, and asphalt solidification. Thermoplastic encapsulation involves mixing the waste with polymers to form a rigid, solid material. Vitrification is a process which involves mixing the waste with molten glass at a high temperature; the mixture is then cooled to form a solid matrix. Asphalt solidification involves mixing the waste with asphalt and then cooling the mixture to form a solidified product. These process options are viable and are retained for further consideration.

2.4.3.3 Direct Radiation/Air (Fugitive Dust) Media

Response actions and technologies utilized for the soils/sediments/wastes media are applicable for the direct radiation/air (fugitive dust) media.

110

2.5 EVALUATION OF SCREENED TECHNOLOGIES AND PROCESS OPTIONS

1165

The next step in alternative development and screening involves a detailed evaluation of the technologies and process options remaining from the initial technology screening. In particular, the initial list of screened technologies and process options is further evaluated against three criteria: effectiveness, implementability, and cost. The technology process options that have been identified are evaluated based on these criteria relative to other processes within the same technology types. The major focus of this evaluation is the effectiveness of each option, with less emphasis on implementability and cost. These three criteria and the results of the evaluation process for the groundwater, soils, and sediments media are described in the remainder of the section.

2.5.1 Screening Criteria

2.5.1.1 Effectiveness

The effectiveness evaluation focuses on the following elements:

- The potential effectiveness of process options in handling the estimated areas or volumes of media and in meeting the remediation goals identified in the RAOs
- The potential impacts of process options upon human health and the environment during the construction and implementation phase
- The reliability and proven effectiveness of process options with respect to the contaminants and conditions at the site

2.5.1.2 Implementability

The implementability evaluation includes both the technical and institutional feasibility of implementing each process at the FMPC. The initial technology screening eliminated technology types or process options that were clearly ineffective or unworkable at the site; therefore, this subsequent, more detailed evaluation places greater emphasis on the institutional aspects of implementability. These institutional aspects include:

- The potential for obtaining necessary permits and rights-of-way for off-site actions
- The availability of necessary equipment and skilled workers to implement the technology
- The availability of treatment, storage, and disposal services

2.5.1.3 Cost

Cost plays a limited role in the screening of process options. Relative capital and operating costs are considered rather than detailed estimates. The cost analysis for this evaluation, is made on the basis of engineering judgment; and each process option is evaluated as to whether costs are low, moderate, or

111

high, relative to other process options in the same technology type. A technology process option can be eliminated on the basis of cost only if other process options within the same technology type are comparably effective and implementable but have a much lower cost. Costs that document the process option evaluation are shown in the following figures and will not be elaborated upon in the following text.

2.6 PROCESS OPTION EVALUATION FOR SANITARY LANDFILL

2.6.1 Groundwater/Surface Water Media

The technologies and process options remaining after the initial screening were evaluated based on effectiveness, implementability, and cost. The preferred or representative process option for each technology type was retained for incorporation into the remedial action alternatives. The results of this evaluation are discussed below, and are depicted on Figure 2-5.

2.6.1.1 No Action

The no-action response does not provide additional remediation, monitoring, or security activities at the site to further minimize risk to the environment or public health, and will not achieve the remedial action objectives. The NCP, however, requires the no-action response to be carried through the detailed analysis of alternatives; therefore, it will not be eliminated at this stage. The no-action response will be further evaluated as a baseline for comparison with other remedial action alternatives developed for the groundwater medium.

2.6.1.2 Institutional Actions

The remedial technologies retained for this response action include monitoring and access control. The process options pertaining to these technology groups are wellpoint monitoring, leachate monitoring, physical barriers, administrative controls, and deed restrictions.

Groundwater/Leachate

Groundwater and leachate monitoring, sampling, and analysis is used to assess the concentration levels and movement of the contaminants of concern. The evaluation of groundwater and leachate monitoring is summarized below:

- Effectiveness: The monitoring of groundwater and leachate, by itself, would not meet any of the preliminary RAOs. The potential impacts on human health and the environment during the construction and implementation phase of this option are negligible. The only additional exposure to the contaminated groundwater and leachate would be to the personnel performing the sampling and analysis.

- Implementability: A large number of monitoring wells currently exist at the FMPC site. Additional wells could be installed quickly, and equipment and services are readily available.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NOT APPLICABLE	MAY NOT MEET RAO's.	MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
INSTITUTIONAL ACTIONS	MONITORING	WELLPOINT MONITORING LEACHATE MONITORING	USEFUL IN DOCUMENTING CONDITIONS. DOES NOT REDUCE RISK.	ALONE, MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
	ACCESS CONTROL	PHYSICAL BARRIERS ADMINISTRATIVE CONTROLS DEED RESTRICTIONS	EFFECTIVENESS DEPENDS ON CONTINUED FUTURE IMPLEMENTATION. DOES NOT REDUCE CONTAMINATION.	ALONE, MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	EFFECTIVE WHEN COMBINED WITH CAPPING. ALONE, NOT AS EFFECTIVE.	EASILY IMPLEMENTED.	H CAP L OM
		DIVERSION/COLLECTION		EASILY IMPLEMENTED.	M CAP L OM
		GRADING		EASILY IMPLEMENTED.	L CAP L OM
		REVEGETATION		EASILY IMPLEMENTED.	L CAP L OM
	CAPPING	CONCRETE-BASED COVER	EFFECTIVE, BUT SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		ASPHALT-BASED COVER			
		SOIL-BASED COVER	EFFECTIVE, LESS SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		MULTIMEDIA CAP	EFFECTIVE. LEAST SUSCEPTIBLE TO CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	H CAP H OM
		CHEMICAL SEALANT	MODERATELY EFFECTIVE IF MAINTAINED.	MODERATELY DIFFICULT TO IMPLEMENT.	M CAP M OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

114

1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	EFFECTIVE WHEN COMBINED WITH CAPPING. ALONE, NOT AS EFFECTIVE.	EASILY IMPLEMENTED.	H CAP L OM
		DIVERSION/COLLECTION		EASILY IMPLEMENTED.	M CAP L OM
		GRADING		EASILY IMPLEMENTED.	L CAP L OM
		REVEGETATION		EASILY IMPLEMENTED.	L CAP L OM
	CAPPING	CONCRETE-BASED COVER	EFFECTIVE, BUT SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		ASPHALT-BASED COVER			
		SOIL-BASED COVER	EFFECTIVE, LESS SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		MULTIMEDIA CAP	EFFECTIVE. LEAST SUSCEPTIBLE TO CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	H CAP H OM
		CHEMICAL SEALANT	MODERATELY EFFECTIVE IF MAINTAINED.	MODERATELY DIFFICULT TO IMPLEMENT.	M CAP M OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT CONTINUED	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCHES	PERMEABILITIES OF UNDERLYING SAND LENSES CREATE SLOW RECOVERY OF CONTAMINATED PERCHED GROUNDWATER VIA THIS GRAVITY DRIVEN COLLECTION SYSTEM.	DEPTH OF PERCHED WATER ZONES CAUSES VERTICAL AND AERIAL EXTENT OF EXCAVATION TO BE EXTREMELY LARGE.	H CAP L OM
		PUMPING WELLS	EFFECTIVE	EASILY IMPLEMENTED.	M CAP M OM
	SUBSURFACE CONTAINMENT	SLURRY WALLS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	EASILY IMPLEMENTED.	L CAP L OM
		GROUT CURTAINS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	MORE DIFFICULT TO IMPLEMENT THAN SLURRY WALL.	H CAP L OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (BIOLOGICAL)	BIOSORBANT	HAS ACHIEVED SOME DEGREE OF SEPERATION OF HEAVY METALS IN PILOT-PLANT TESTING, NEW TECHNOLOGY.	EMERGING TECHNOLOGY; TREATABILITY STUDIES REQUIRED.	M CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSIOCHEMICAL)	PRECIPITATION	EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	L CAP L OM
		COAGULATION/POLYMERIZATION	MAY BE EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES; REQUIRES FURTHER STUDY.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
		ADSORPTION	LIMITED EFFECTIVENESS IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; GENERATION OF RESIDUALS.	H CAP H OM
		REVERSE OSMOSIS	FOUND TO BE EFFECTIVE IN EXPERIMENTAL APPLICATIONS; FURTHER STUDY REQUIRED.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS AND HIGH CONCENTRATION WASTE STREAM.	M CAP M OM
		ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	NOT EFFECTIVE FOR DISSOLVED URANIUM REMOVAL.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT CONTINUED	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (CHEMICAL)	ION EXCHANGE	EFFECTIVE IN REDUCTION OF URANIUM IN AQUEOUS WASTE STREAMS.	COMMONLY UTILIZED TECHNOLOGY FOR URANIUM REMOVAL; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	EFFECTIVE IN DEWATERING SLUDGES AND SLURRIES. WILL NOT REDUCE HAZARD ASSOCIATED WITH INSOLUABLE WASTEWATER CONSTITUENTS.	COMMON, PROVEN EQUIPMENT AND EASILY IMPLEMENTED.	M CAP L OM
		SEDIMENTATION/CLARIFICATION	EFFECTIVE IN REMOVING SUSPENDED SOLIDS PRIOR TO PROCESSING.	EQUIPMENT IS READILY AVAILABLE AND EASILY IMPLEMENTED.	H CAP H OM
		DUAL MEDIA FILTRATION	RELIABLE AND EFFECTIVE IN REMOVING LOW LEVELS OF SOLIDS FROM WASTEWATER.	READILY AVAILABLE AND EASY TO OPERATE AND CONTROL. EASILY INTEGRATED WITH OTHER TREATMENT STEPS.	L CAP L OM

LEGEND:

L – LOW COST
M – MODERATE COST
H – HIGH COST
CAP – CAPITAL
OM – OPERATION AND MAINTENANCE

FIGURE 2–5. EVALUATION OF PROCESS OPTIONS – SANITARY LANDFILL (Continued)

117
1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL	MECHANICAL REMOVAL	LOADER/DOZER	EFFECTIVE FOR REMOVAL OF WASTE WITH LOW MOISTURE CONTENT.	EASILY IMPLEMENTED.	M CAP L OM
		BACKHOE	EFFECTIVE FOR REMOVAL OF WASTE WITH LOW MOISTURE CONTENT.	EASILY IMPLEMENTED.	M CAP L OM
		CRANE W/CLAMSHELL SYSTEM	EFFECTIVE FOR REMOVAL OF WASTE WITH VARYING MOISTURE CONTENTS.	EASILY IMPLEMENTED.	M CAP M OM
		DRAGLINE	EFFECTIVE FOR REMOVAL OF WASTE WITH VARYING MOISTURE CONTENTS.	EASILY IMPLEMENTED.	H CAP M OM
	SEGREGATION	COMPATIBILITY TESTING	EFFECTIVE FOR AN AREA WHICH CONTAINS HAZARDOUS AND RADIOACTIVE WASTE.	EASILY IMPLEMENTED.	H CAP L OM
		MANUAL SORTING	EFFECTIVE FOR WASTE WHICH CONTAINS NONFERROUS MATERIALS.	EASILY IMPLEMENTED.	L CAP L OM
		MAGNETIC SORTING	EFFECTIVE FOR WASTE WHICH CONTAINS FERROUS MATERIALS.	EASILY IMPLEMENTED.	M CAP M OM
		SCREENING/SIZING	EFFECTIVE. SCREENS OUT DEBRIS AND LARGE PARTICLES WHICH REQUIRE CRUSHING BEFORE DISPOSAL.	EASILY IMPLEMENTED.	M CAP M OM

118

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

1165

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL	ON PROPERTY DISPOSAL	ABOVE/BELOW GRADE VAULT	VERY EFFECTIVE.	CAN BE CONSTRUCTED. THE TECHNOLOGY IS AVAILABLE. REQUIRES LARGE AMOUNT OF SPACE.	H CAP L OM
		ON PROPERTY ENGINEERED DISPOSAL FACILITY	VERY EFFECTIVE.	CAN BE CONSTRUCTED. THE TECHNOLOGY IS AVAILABLE. REQUIRES LARGE AMOUNT OF SPACE.	H CAP M OM
		TEMPORARY STORAGE	EFFECTIVE, BUT TEMPORARY STORAGE DOES NOT MEET RAO REQUIREMENTS.	REQUIRES LARGE AMOUNT OF SPACE AND FUTURE PLAN FOR STORAGE.	L CAP H OM
	OFF SITE DISPOSAL	TEMPORARY STORAGE	EFFECTIVE, BUT TEMPORARY STORAGE DOES NOT MEET RAO REQUIREMENTS.	REQUIRES LARGE AMOUNT OF SPACE AND FUTURE PLAN FOR STORAGE.	L CAP H OM
		RAIL TRANSPORT	EFFECTIVE	READILY IMPLEMENTED.	M CAP L OM
		TRUCK TRANSPORT	EFFECTIVE. HIGHER HAZARD POTENTIAL.	READILY IMPLEMENTED.	H CAP L OM

LEGEND:

L – LOW COST
M – MODERATE COST
H – HIGH COST
CAP – CAPITAL
OM – OPERATION AND MAINTENANCE

FIGURE 2–5. EVALUATION OF PROCESS OPTIONS – SANITARY LANDFILL (Continued)

119

1165

602_A_PN0165A_0I2_TX12_0R

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCHES	PERMEABILITIES OF UNDERLYING SAND LENSES CREATE SLOW RECOVERY OF CONTAMINATED PERCHED GROUNDWATER VIA THIS GRAVITY DRIVEN COLLECTION SYSTEM.	DEPTH OF PERCHED WATER ZONES CAUSES VERTICAL AND AERIAL EXTENT OF EXCAVATION TO BE EXTREMELY LARGE.	H CAP L OM
		PUMPING WELLS	EFFECTIVE	EASIER TO IMPLEMENT WHEN COUPLED WITH WASTE REMOVAL.	M CAP M OM
	SUBSURFACE CONTAINMENT	SLURRY WALLS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	EASILY IMPLEMENTED.	L CAP L OM
		GROUT CURTAINS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	MORE DIFFICULT TO IMPLEMENT THAN SLURRY WALL.	H CAP L OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (BIOLOGICAL)	BIOSORBANT	HAS ACHIEVED SOME DEGREE OF SEPERATION OF HEAVY METALS IN PILOT-PLANT TESTING, NEW TECHNOLOGY.	EMERGING TECHNOLOGY; TREATABILITY STUDIES REQUIRED.	M CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSIOCHEMICAL)	PRECIPITATION	EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	L CAP L OM
		COAGULATION/POLYMERIZATION	MAY BE EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES; REQUIRES FURTHER STUDY.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
		ADSORPTION	LIMITED EFFECTIVENESS IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; GENERATION OF RESIDUALS.	H CAP H OM
		REVERSE OSMOSIS	FOUND TO BE EFFECTIVE IN EXPERIMENTAL APPLICATIONS; FURTHER STUDY REQUIRED.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS AND HIGH CONCENTRATION WASTE STREAM.	M CAP M OM
		ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	NOT EFFECTIVE FOR DISSOLVED URANIUM REMOVAL.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (CHEMICAL)	ION EXCHANGE	EFFECTIVE IN REDUCTION OF URANIUM IN AQUEOUS WASTE STREAMS.	COMMONLY UTILIZED TECHNOLOGY FOR URANIUM REMOVAL; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	EFFECTIVE IN DEWATERING SLUDGES AND SLURRIES. WILL NOT REDUCE HAZARD ASSOCIATED WITH INSOLUABLE WASTEWATER CONSTITUENTS.	COMMON, PROVEN EQUIPMENT AND EASILY IMPLEMENTED.	M CAP L OM
		SEDIMENTATION/CLARIFICATION	EFFECTIVE IN REMOVING SUSPENDED SOLIDS PRIOR TO PROCESSING.	EQUIPMENT IS READILY AVAILABLE AND EASILY IMPLEMENTED.	H CAP H OM
		DUAL MEDIA FILTRATION	RELIABLE AND EFFECTIVE IN REMOVING LOW LEVELS OF SOLIDS FROM WASTEWATER.	READILY AVAILABLE AND EASY TO OPERATE AND CONTROL. EASILY INTEGRATED WITH OTHER TREATMENT STEPS.	L CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

121

1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PHYSICAL TREATMENT	SOIL WASHING	EFFECTIVE. EXTRACTS ORGANIC CONTAMINANTS FROM SOIL. POTENTIALLY EFFECTIVE FOR REMOVAL OF SOLUBLE URANIUM COMPOUNDS.	READILY IMPLEMENTED.	H CAP M OM
	THERMAL TREATMENT	ROTARY KILN	EFFECTIVE IN REMOVING CONTAMINANTS FROM SOIL.	READILY IMPLEMENTED.	H CAP H OM
		MULTIPLE-HEARTH	EFFECTIVE IN REMOVING ORGANICS FROM SOIL.	READILY IMPLEMENTED.	M CAP H OM
		FLUIDIZED-BED	EFFECTIVE IN REMOVING ORGANICS FROM SOIL.	READILY IMPLEMENTED.	L CAP M OM
		THERMAL DESORPTION	EFFECTIVE IN REMOVING ORGANICS FROM SOIL.	READILY IMPLEMENTED.	M CAP M OM
	WASTE STABILIZATION	ASPHALT-BASED SOLIDIFICATION	EFFECTIVE AT IMMOBILIZING RADIOACTIVE WASTES, THUS ELIMINATING EXPOSURE PATHWAYS; SUBJECT TO LEACHING.	USES COMMON AVAILABLE TECHNOLOGY; NO PERMITS REQUIRED.	M CAP M OM
		CEMENT-BASED SOLIDIFICATION	SAME AS ABOVE.	SAME AS ABOVE.	M CAP M OM
		THERMOPLASTIC ENCAPSULATION	LIMITED APPLICABILITY FOR RADIOACTIVE WASTES; LESS POTENTIAL FOR LEACHING.	REQUIRES SPECIAL EQUIPMENT AND OPERATORS. NO PERMITS REQUIRED.	H CAP M OM
		VITRIFICATION	HAS BEEN USED TO SOLIDIFY LOW-LEVEL RADIOACTIVE WASTES; STILL EXPERIMENTAL.	REQUIRES SPECIAL EQUIPMENT AND OPERATORS. AIR PERMIT REQUIRED FOR OFF-GASES.	H CAP H OM
	BIOLOGICAL TREATMENT	BIOLOGICAL DETOXIFICATION	EFFECTIVE IN REMOVING ORGANICS FROM SOILS.	READILY IMPLEMENTED.	M CAP M OM
		PERMEABLE TREATMENT	EFFECTIVE IN REMOVING ORGANICS FROM SOILS.	READILY IMPLEMENTED.	M CAP M OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-5. EVALUATION OF PROCESS OPTIONS - SANITARY LANDFILL (Continued)

122

165

Approved sampling and analysis protocols are available. This process option may not, however, be acceptable to the agencies without additional remedial response.

These process options are viable and are retained for alternative development in combination with other technologies and process options.

2.6.1.3 Control/Containment Actions

The technologies retained from the initial screening for this response action include capping and run-on/runoff control. The specific process options retained for the capping technology include concrete-based cover, asphalt-based cover, soil-based cover, multimedia cap, and chemical sealants. The process options retained for the run-on/runoff control technology include sedimentation basin, diversion/collection, grading, and revegetation. Run-on/runoff technologies are effective when combined with capping and other technologies, but they are of limited effectiveness when they are used by themselves. These process options are not evaluated separately, but they will be retained as ancillary process options for combination into alternatives.

Concrete-Based Cover/Asphalt-Based Cover

- Effectiveness: The concrete-based cover and asphalt-based cover are both susceptible to weathering and cracking. The use of either cover would require maintenance into the future. The use of either cover could achieve human health and environmental objectives by isolating potential receptors from contaminated surface water and by reducing the mobility of the contaminants.

- Implementability: The concrete-based cover and asphalt-based cover are both readily available technical solutions; however, the use of either cover would create restrictions on future land use.

Soil-Based Cover

- Effectiveness: The soil-based cover is more effective than the concrete-based or asphalt-based covers, since it is less susceptible to weathering and cracking. A properly constructed and maintained soil-based cover provides a longer service life than a concrete- or an asphalt-based covers. Human health and environmental aspects are similar to those discussed for concrete-asphalt-based covers.

- Implementability: Implementability of this process option is similar to that for the concrete- and asphalt-based covers.

Multimedia Cap

- Effectiveness: The multimedia cap is least susceptible to cracking compared with the concrete-based, asphalt-based, and soil-based covers. Human health and environmental aspects are similar to those discussed for each of the previously described covers.

- Implementability: Implementability of this process option is similar to that discussed for the previous covers.

Chemical Sealants

- Effectiveness: Chemical sealants can enhance the effectiveness of a soil-only cap; however a single layer cap is less effective than a multimedia cap.

- Implementability: This process option can be readily implemented.

A multimedia cap was chosen as the representative process option because it offers the best performance and most versatility of the options evaluated. It allows incorporation of an intrusion barrier comparable to a concrete cap, provides the permeability of natural soil-based covers, and has greater durability than chemical sealants or asphalt-based covers.

2.6.1.4 Removal Actions

The technologies retained from the initial screening are subsurface containment and perched groundwater removal. The specific process options retained for the technology groups include interceptor trenches, pumping wells, slurry walls, and grout curtains.

Interceptor Trenches

- Effectiveness: Use of this process option could achieve human health objectives by isolating potential receptors from contaminated perched groundwater. This process option requires the use of a pumping well placed in a sump. The permeability of the underlying sand lense creates slow recovery of contaminated perched groundwater via this gravity driven collection system.

- Implementability: This process option is a readily available technical solution; however, the depth of the perched water zone will cause the vertical and aerial extent of the excavation to be extremely large.

Slurry Walls/Grout Curtains

- Effectiveness: These process options could isolate contaminated perched groundwater from horizontal movement so that it would remain underneath the waste unit, provided the wall surrounded the waste unit. These process options are most effective when they are used in conjunction with pumping wells. The slurry wall or grout injection cannot reduce or eliminate the downward migration of contaminants into the underlying Great Miami Aquifer and is therefore of limited effectiveness.

- Implementability: These process options are readily available, but implementation of the grout curtain option is more difficult than that of the slurry walls because it is more difficult to verify the installation of grout curtains.

Pumping Wells

- Effectiveness: Implementation of this process option could achieve human health and environmental objectives by removing contaminated perched groundwater. A well point system would remove groundwater at faster rates than interceptor trenches.

- Implementability: This process option is a readily available technical solution.

Pumping wells are chosen as the representative process option. Slurry walls and grout curtains are of limited effectiveness in preventing the downward migration of contaminants from perched groundwater at the FMPC. Pumping wells are easier to implement and would achieve effectiveness at a faster rate than interceptor trenches.

2.6.1.5 Treatment Actions

The treatment technologies retained from the initial screening for this response action include biological, physicochemical, and physical treatments. Specific process options retained from these technology groups include biosorbant, precipitation, coagulation/polymerization, adsorption, reverse osmosis, advanced membrane filtration, ion exchange, neutralization, belt filter press, sedimentation/clarification, and dual media filtration. Each of these options is evaluated in the following sections.

Biological/Biosorbant

- Effectiveness: The biological exchange resin has achieved some degree of separation of heavy metals in pilot plant testing; it is a relatively new commercial process. Feasibility assessments would be required. This process would be effective in meeting long-term public health and environmental objectives.

- Implementability: This process uses a proprietary sorption technique and is being newly marketed; therefore, the availability of equipment or workers may be limited.

Physicochemical/Precipitation

- Effectiveness: Precipitation is a proven technology for removal of metals, including uranium, from wastewater. This process option also is effective in meeting long-term public health and environmental objectives. However, there is potential for workers to be exposed to concentrated uranium in the precipitate from the process.

- Implementability: The chemicals and equipment required to implement this technology are readily available. The precipitation operation is difficult to operate, so it requires close manual control. All precipitation processes generate a solid sludge, which would require subsequent disposal as a hazardous/radiological waste. Adherence to substantive requirements for NPDES permits for discharge of treated water and for sludge treatment and disposal would be required.

Physicochemical/Coagulation/Polymerization

- Effectiveness: Coagulation is an efficient way of removing submicron particles, reducing their toxicity and volume ratio in water. Residual and contaminated water handling would result in potential increased risk of exposure to employees, the public, and the environment. This technology has not been widely used for uranium removal.

- Implementability: This technology requires ancillary treatment processes such as precipitation and pH adjustment. Technical literature indicates optimum uranium removal occurs at either acidic or basic pH, depending upon the coagulant used. Use of high or low pH raises the possibility of generating mixed waste sludge which would create disposal problems.

Physicochemical/Adsorption

- Effectiveness: The use of adsorption has been shown to be effective in removal of uranium from water but not as efficient as other treatment processes. This technology has been most commonly used for the removal of organics.

- Implementability: The phenomenon of adsorption is extremely complex and not mathematically predictable. Pilot studies would be necessary to predict performance, longevity, and operating economics.

Physicochemical/Reverse Osmosis (RO)

- Effectiveness: Further studies will be required to confirm the effectiveness of this technology for uranium removal. There is an increased potential exposure risk to plant employees, the environment, and the public from handling the contaminated groundwater and from disposal of residuals.

- Implementability: RO is a commercial process that can be reliably implemented. Pretreatment may be required to use RO. Also, a sizeable concentrated waste stream would need to be addressed for treatment and disposal. Multiple permits would be required for operation, as well as for residual and effluent disposal.

Physicochemical/Advanced Membrane Filtration

- Effectiveness: To use advanced membrane filtration for uranium removal from the groundwater, suitable pretreatment would be required. The use of this technology is not applicable to the removal of dissolved species. Since uranium present in the groundwater is assumed to be primarily in the dissolved form, advanced membrane filtration would not be effective.

- Implementability: This technology is undergoing rapid improvement and adaption to numerous industrial wastewater problems but has not yet been accepted as a uranium removal process. Residual production and disposal presents additional technical difficulties. Multiple permits for operation, as well as for residual and effluent disposal, would be required.

Chemical/Ion Exchange

- Effectiveness: Ion exchange is a suitable process option for removing uranium from groundwater based upon information available on the effectiveness and reliability of this technology for dissolved uranium removal. Use of this technology would assist in meeting the remedial action objectives by reducing the uranium concentration in the treated water to acceptable levels. There would be potential for exposure to humans and the environment during the implementation of this process.

- Implementability: Ion exchange is an easily implemented, reliable, commercial technology. The resins may be used once and disposed of, or they may be regenerated. This would produce a concentrated waste stream for treatment and disposal; the concentrated regenerate can be treated with the sludge. Pretreatment and sludge disposal would be required. Adherence to substantive permit requirements would be required for the treatment facilities and for disposal of residuals and treated water. The ion exchange process is a proven technology for which several equipment suppliers are available, but it could require a specific design for this application.

Process Option Summary

RO and ion exchange were chosen as the representative process options for water treatment, because they are both are effective in removal of uranium and are implementable. Sedimentation/clarification was chosen for pretreatment because of its proven effectiveness for initial removal of organic and inorganic contaminants and because it is easily implementable.

2.6.2 Soils/Sediments/Wastes Media

The technologies and process options remaining after the initial screening were evaluated based on effectiveness, implementability, and cost. The preferred or representative process option for each technology type was retained for incorporation into the remedial action alternatives. A discussion of the results of this evaluation follows.

2.6.2.1 No-Action

The no-action response is applicable to the soils, sediments, and wastes as required by the NCP. The no-action response will be further evaluated as a baseline for comparison with other remedial action alternatives developed for these media.

2.6.2.2 Institutional Actions

The remedial technology retained under this response action is access control. The process options associated with access control are discussed in Section 2.6.1.2 and are applicable to soils, sediments, and wastes.

2.6.2.3 Control/Containment Actions

The remedial technology retained under this general response action is capping. The various process options discussed in section 2.6.1.3 and also are applicable to soils, sediments, and wastes.

2.6.2.4 Removal Actions

The remedial technology retained under this general response action is mechanical removal. The process options retained from the initial screening include the loader/dozer, backhoe, crane with clamshell system, and dragline.

Removal by excavation can be accomplished with conventional heavy construction equipment and is applicable to almost all site conditions. The physical characteristics of the waste and the estimated volume indicate that the backhoe is the option most appropriate for the removal of these wastes and adjacent contaminated soils and sediments. Use of a backhoe in certain situations, however, may require that some or all of the process options listed in the previous paragraph be utilized as well. An evaluation of this process option is presented below:

- Effectiveness: Mechanical excavation is effective for removal of contaminated soils, sediments, and wastes and in achieving the objectives for protection of public health and the environment. However, there is a potential for increased exposure to workers during the removal process. Depending on what materials may be encountered during excavation of the wastes, ancillary process options could include manual sorting, magnetic sorting, and/or screening/sizing of the waste.

- Implementability: The equipment necessary for the removal of soils, sediments, and wastes is conventional and readily available. The site conditions are also conducive to easy implementation. This action would require treatment and/or disposal after removal.

2.6.2.5 Treatment Actions

The technologies remaining from the initial screening for the treatment response action include physical treatment, thermal treatment, biological treatment, and waste stabilization. The associated process options include soil washing; rotary kiln, multiple-hearth, and fluidized-bed incineration; thermal desorption; asphalt-based solidification; cement-based solidification; thermoplastic encapsulation; vitrification; biological detoxification; and permeable treatment beds.

Soil Washing

- Effectiveness: Soil washing is a simple operation and should require no major process development. This technology has achieved some degree of separation with clay soils in pilot-plant testing. The process is based on commonly available mineral treatment processes and has been proven effective during batch treatability testing. In this process, waste is minimized and both environmental and health objectives can be met.

- Implementability: Only a few mobile units necessary for this process are commercially available.

Soil washing is a viable option and is retained for incorporation into remedial action alternatives.

Rotary Kiln

- Effectiveness: Rotary kiln incineration with a secondary combustion system is very effective for the destruction of organic contaminants in waste. Rotary kilns are capable of burning waste in any physical form and have a high destruction/removal efficiency. Environmental and human health objectives can be achieved by incineration, and air pollution control equipment can be installed for particulate and gas treatment.

- Implementability: Rotary kiln incinerators (fixed and mobile) are widely commercially available and are in use for most hazardous waste applications, including RCRA and CERCLA wastes. Substantive requirements of on-site permits for incineration would have to be met.

Multiple Hearth

- Effectiveness: Multiple hearth incineration is most effective (best suited) for destruction of hazardous contaminants in sludges. Wastes can be treated also, provided that pretreatment (shredding and sorting) is performed. Environmental and health objectives can be achieved by this high-temperature, high-residence-time (of waste) process option.

- Implementability: Multiple hearth incineration is commercially available and implementable.

Fluidized Bed Incineration

- Effectiveness: Fluidized bed incineration thermally decontaminates or destroys harmful organic contaminants in soils, sludges, or wastes. This process option is well suited for high-moisture wastes. With proper retention time of the waste and the ability of the bed to trap particulates and gases generated as a result of incinerating the waste, environmental and health objectives can be achieved.

- Implementability: Fluidized bed incineration is a relatively new design. A full-scale fluidized bed system has successfully completed its Part B permit trial burn on RCRA wastes. Only a few commercial mobile units are presently available, and others are planned.

Thermal Desorption

- Effectiveness: Thermal desorption is a process which uses low-temperature (500° to 800°F) to remove volatile organic compounds from soils and solids. The solids containing organic contaminants are heated in the desorption unit, driving off any moisture and organic contaminants and producing a dry solid containing trace amounts of organics. Gases generated as a result of the process (including the volatilized organics) are tested in the off-gas treatment system; i.e., organics are condensed out of the off-gases and collected or thermally destroyed in an afterburner or secondary combustion system.

- Implementability: A pilot-scale system (constructed of off-the-shelf components) has been tested on soils at one CERCLA site, at least. Plans to conduct other tests on mixed hazardous and radioactive wastes are being formed.

Asphalt-Based Solidification

- Effectiveness: This process is most applicable or suitable to wastes containing heavy metals. In relation to cement-based stabilization, the volume and the rate of leaching are less. Its long-term application to radioactive waste is limited, since radiation may cause degradation of the asphalt.

- Implementability: Specialty equipment and highly trained operators are required for this process.

Cement-Based Solidification

- Effectiveness: On a commercial basis, pozzolanic-based methods, either lime or cement-based, have been effective in immobilizing radioactive wastes. This solidification process would be effective in eliminating direct exposures to receptors and also in eliminating soils and sediments as a pathway to other environmental media.

- Implementability: The equipment necessary for this process is similar to that used for cement mixing and handling. It includes a feed system, mixing vessels, and a curing area. There is an abundance of fly ash at the FMPC, which makes this process option particularly attractive since fly ash could be used in the cement-based solidification process. Bench-scale treatability testing may be necessary to determine the selection of proper additives and proportions for mixing.

Thermoplastic Solidification

- Effectiveness: This method is most applicable and effective for heavy metals. Using this method, relative to cement solidification, the increase in volume and rate of leaching is significantly less. However, this technique has not been applied to radioactive materials.

- Implementability: Specialized equipment and operators are required for this process.

Based on the overall evaluation, this option is not retained for incorporation into the remedial alternatives.

Vitrification

- Effectiveness: This process is largely in the experimental stage in this country. It has, however, been shown to be generally applicable to radiologically contaminated soils and has been used for the solidification of low-level radioactive wastes in Great Britain. The volume of soil is usually reduced after vitrification treatment. The collection and treatment of off-gases is an important technical consideration. In the event of system failure, the superheated gases would be released to the environment.

- Implementability: Most techniques for this process are not commercially available but can be made available for DOE sites, since much of the research and development were conducted in support of DOE programs.

This process is potentially viable for treatment of soils, sediments, and wastes.

Biological Detoxification/Permeable Treatment Beds

- Effectiveness: The biological detoxification process treats soils in an abovegrade system using soil management practices to enhance the microbial degradation of contaminants. The system is designed for proper drainage of contaminated water as it leaches from contaminated soils placed on the treatment bed. The contaminated water that drains from the soil is transported by drain pipes and collected in a lined-gravity-flow sump and then pumped to a bio-reactor for treatment. This process can effectively treat soil contaminated with mineral oil products and light aromatic compounds.

- Implementability: This process is in full scale operation at one site and is at the pilot scale at another site. The technology and services are available.

Summary of Treatment/Stabilization

Rotary kiln incineration is chosen as the representative process because of its high effectiveness and implementability. This process option is effective in destroying hazardous organics and is readily available. It does not, however, destroy or immobilize radiological constituents, which will remain in treatment residuals. Therefore, cement-based stabilization is chosen as the representative process option for stabilizing the residuals left from incineration because of its effectiveness in immobilizing radiological constituents.

2.6.2.6 Disposal Actions

The general technologies retained for this response action are on-property disposal and off-site disposal. On-property disposal is accomplished by transporting excavated soils, sediments, and wastes to an on-property EDF, above/belowgrade vaults, and temporary storage. Off-site disposal includes temporary storage followed by rail or truck transport of the excavated soils, sediments, and wastes to an approved off-site disposal facility.

On-Property Disposal Process Options

The three process options being considered within the on-property disposal technology are above/belowgrade vault, EDF, and temporary storage.

Above/belowgrade vault

- Effectiveness: Abovegrade vaults constructed of concrete are quite effective in isolating waste from the environment. Construction of a RCRA type cap can enhance long-term effectiveness.

Belowgrade vaults are not desirable at the FMPC due to limited glacial overburden thickness and proximity to the underlying Great Miami Aquifer.

- Implementability: Materials equipment and skilled labor are readily available to construct the facility. The facility can be constructed to withstand natural phenomenon such as earthquakes and tornados.

EDF

- Effectiveness: A properly designed EDF will dispose of the waste as effectively as a RCRA-design landfill while providing superior isolation qualities from the groundwater regime and isolation of the waste from the surface environment and human contact.

- Implementability: The EDF process option basically consists of mounding over waste that has been placed on a stable structural pad. Once designed, the construction and implementation of the EDF should occur without delay.

Temporary Storage:

- Effectiveness: Temporary storage is not effective as a long-term solution to waste management, but it is effective when utilized during remediation.

- Implementability: Facilities can be readily constructed to store waste and prevent environmental degradation and migration.

The EDF was selected as a representative process option because it is more cost effective for the relatively low concentration low level radioactive wastes (LLRWs) contained in Operable Unit 2. Aboveground vaults will likely result in higher costs, but with limited additional effectiveness. Because the remedial action is to be permanent, the temporary storage facility was not chosen as the representative process option. The EDF will be carried through as the representative process option because, with proper design, it can meet the long-term storage requirements of 10CFR61.

Off-site Disposal Process Options

The three process options being considered within the off-site disposal technology are rail transport, truck transport, and temporary storage.

Rail Transport

- Effectiveness: The rail transport process option is an effective option for off-site transportation because of the reduced risk to human life. By transporting waste by rail, public exposure is drastically limited as compared to other transportation methods. In addition, rail transport provides the ability to haul large tonnages of waste at one time, reducing the probability of an accident per ton of waste transported.

- Implementability: The rail transport process option will be easily implemented from the standpoint that the FMPC can readily accommodate rail transport by use of an existing on-site

rail spur. However, the rail transport process option requires a dedicated railway line and is susceptible to route availability.

Rail transport is chosen as the representative process option because it poses less transportation risk and is less costly than truck transport. Temporary storage (previously discussed) is needed as support of off-site disposal and also is considered a representative process option.

2.6.3 Direct Radiation/Air (Fugitive Dust) Media

Technologies and process options that were discussed in Section 2.5.3 for soils, sediments, and wastes also are applicable for direct radiation and air (fugitive dust). Further discussion will not be pursued for the direct radiation/air (fugitive dust) media.

2.7 PROCESS OPTION EVALUATION FOR LIME SLUDGE PONDS

2.7.1 Groundwater/Surface Water Media

Technologies and process options that were discussed in Section 2.6.1 for groundwater and surface water also are applicable for the Lime Sludge Ponds. Further discussion will not be pursued for the groundwater and surface water media associated with the Lime Sludge Ponds. Figure 2-6 documents the evaluation of process options for the Lime Sludge Ponds.

2.7.2 Soils/Sediments/Wastes Media

Technologies and process options discussed in Section 2.6.2 for soils, sediments, and wastes are applicable also for the Lime Sludge Ponds except for those discussed in the following subsections.

2.7.2.1 Removal Actions

Removal technologies and associated process options discussed in Section 2.6.2.4 are applicable for soils and sediments adjacent to the Lime Sludge Ponds. Due to the physical characteristics (high moisture content) of the lime sludge, hydraulic removal will be retained as a technology for the solid waste. The process option retained from the initial screening includes the jetting ring with cutter head.

Jetting Ring with Cutter Head

- Effectiveness: The jetting ring with cutter head is very effective for removal of sludge with a high moisture content (10 to 20 percent solids content). Hydraulic excavation is effective in achieving the objectives for protection of public health and the environment. However, there is a potential for increased exposure to workers during the removal process.

- Implementability: The equipment necessary for the removal of the wastes is conventional and readily available.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NOT APPLICABLE	MAY NOT MEET RAO's.	MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
INSTITUTIONAL ACTIONS	MONITORING	WELLPOINT MONITORING	USEFUL IN DOCUMENTING CONDITIONS. DOES NOT REDUCE RISK.	ALONE, MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
		LEACHATE MONITORING			
	ACCESS CONTROL	PHYSICAL BARRIERS	EFFECTIVENESS DEPENDS ON CONTINUED FUTURE IMPLEMENTATION. DOES NOT REDUCE CONTAMINATION.	ALONE, MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
		ADMINISTRATIVE CONTROLS			
		DEED RESTRICTIONS			

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS

134

1195

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	EFFECTIVE WHEN COMBINED WITH CAPPING. ALONE, NOT AS EFFECTIVE.	EASILY IMPLEMENTED.	H CAP L OM
		DIVERSION/COLLECTION		EASILY IMPLEMENTED.	M CAP L OM
		GRADING		EASILY IMPLEMENTED.	L CAP L OM
		REVEGETATION		EASILY IMPLEMENTED.	L CAP L OM
	CAPPING	CONCRETE-BASED COVER	EFFECTIVE, BUT SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		ASPHALT-BASED COVER			
		SOIL-BASED COVER	EFFECTIVE, LESS SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		MULTIMEDIA CAP	EFFECTIVE. LEAST SUSCEPTIBLE TO CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	H CAP H OM
		CHEMICAL SEALANT	MODERATELY EFFECTIVE IF MAINTAINED.	MODERATELY DIFFICULT TO IMPLEMENT.	M CAP M OM
	IN SITU STABILIZATION	GROUT INJECTION	EFFECTIVE	DUSTING HAZARD.	L CAP L OM
		SHALLOW-SOIL MIXING	EFFECTIVE	EASILY IMPLEMENTED.	M CAP L OM
		DYNAMIC COMPACTION/ VACUUM EXTRACTION	LESS EFFECTIVE THAN ADDITION OF STABILIZING AGENTS; SAND LENSE MAY INTERSECT LIME SLUDGE PONDS RESULTING IN RECHARGE OF LIQUID IN WASTE UNIT.	EASILY IMPLEMENTED.	M CAP L OM
		SURCHARGING		EASILY IMPLEMENTED.	M CAP L OM

LEGEND:

L – LOW COST
M – MODERATE COST
H – HIGH COST
CAP – CAPITAL
OM – OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS – LIME SLUDGE PONDS (Continued)

135

1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	EFFECTIVE WHEN COMBINED WITH CAPPING. ALONE, NOT AS EFFECTIVE.	EASILY IMPLEMENTED.	H CAP L OM
		DIVERSION/COLLECTION		EASILY IMPLEMENTED.	M CAP L OM
		GRADING		EASILY IMPLEMENTED.	L CAP L OM
		REVEGETATION		EASILY IMPLEMENTED.	L CAP L OM
	CAPPING	CONCRETE-BASED COVER	EFFECTIVE, BUT SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		ASPHALT-BASED COVER			
		SOIL-BASED COVER	EFFECTIVE, LESS SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		MULTIMEDIA CAP	EFFECTIVE. LEAST SUSCEPTIBLE TO CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	H CAP H OM
		CHEMICAL SEALANT	MODERATELY EFFECTIVE IF MAINTAINED.	MODERATELY DIFFICULT TO IMPLEMENT.	M CAP M OM
	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCHES	PERMEABILITIES OF UNDERLYING SAND LENSES CREATE SLOW RECOVERY OF CONTAMINATED PERCHED GROUNDWATER VIA THIS GRAVITY DRIVEN COLLECTION SYSTEM.	DEPTH OF PERCHED WATER ZONES CAUSES VERTICAL AND AERIAL EXTENT OF EXCAVATION TO BE EXTREMELY LARGE.	H CAP L OM
		PUMPING WELLS	EFFECTIVE	EASILY IMPLEMENTED.	M CAP M OM
	SUBSURFACE CONTAINMENT	SLURRY WALLS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	EASILY IMPLEMENTED.	L CAP L OM
		GROUT CURTAINS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	MORE DIFFICULT TO IMPLEMENT THAN SLURRY WALL.	H CAP L OM

LEGEND:

L – LOW COST
M – MODERATE COST
H – HIGH COST
CAP – CAPITAL
OM – OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS – LIME SLUDGE PONDS (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT CONTINUED	IN SITU STABILIZATION	GROUT INJECTION	EFFECTIVE	DUSTING HAZARD.	L CAP L OM
		SHALLOW-SOIL MIXING	EFFECTIVE	EASILY IMPLEMENTED.	M CAP L OM
		DYNAMIC COMPACTION/ VACUUM EXTRACTION	LESS EFFECTIVE THAN ADDITION OF STABILIZING AGENTS; SAND LENSE MAY INTERSECT LIME SLUDGE PONDS RESULTING IN RECHARGE OF LIQUID IN WASTE UNIT.	EASILY IMPLEMENTED.	M CAP L OM
		SURCHARGING		EASILY IMPLEMENTED.	M CAP L OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (BIOLOGICAL)	BIOSORBANT	HAS ACHIEVED SOME DEGREE OF SEPERATION OF HEAVY METALS IN PILOT-PLANT TESTING, NEW TECHNOLOGY.	EMERGING TECHNOLOGY; TREATABILITY STUDIES REQUIRED.	M CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSIOCHEMICAL)	PRECIPITATION	EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	L CAP L OM
		COAGULATION/POLYMERIZATION	MAY BE EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES; REQUIRES FURTHER STUDY.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
		ADSORPTION	LIMITED EFFECTIVENESS IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; GENERATION OF RESIDUALS.	H CAP H OM
		REVERSE OSMOSIS	FOUND TO BE EFFECTIVE IN EXPERIMENTAL APPLICATIONS; FURTHER STUDY REQUIRED.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS AND HIGH CONCENTRATION WASTE STREAM.	M CAP M OM
		ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	NOT EFFECTIVE FOR DISSOLVED URANIUM REMOVAL.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS (Continued)

137

1195

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT CONTINUED	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (CHEMICAL)	ION EXCHANGE	EFFECTIVE IN REDUCTION OF URANIUM IN AQUEOUS WASTE STREAMS.	COMMONLY UTILIZED TECHNOLOGY FOR URANIUM REMOVAL; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	EFFECTIVE IN DEWATERING SLUDGES AND SLURRIES. WILL NOT REDUCE HAZARD ASSOCIATED WITH INSOLUABLE WASTEWATER CONSTITUENTS.	COMMON, PROVEN EQUIPMENT AND EASILY IMPLEMENTED.	M CAP L OM
		SEDIMENTATION/CLARIFICATION	EFFECTIVE IN REMOVING SUSPENDED SOLIDS PRIOR TO PROCESSING.	EQUIPMENT IS READILY AVAILABLE AND EASILY IMPLEMENTED.	H CAP H OM
		DUAL MEDIA FILTRATION	RELIABLE AND EFFECTIVE IN REMOVING LOW LEVELS OF SOLIDS FROM WASTEWATER.	READILY AVAILABLE AND EASY TO OPERATE AND CONTROL. EASILY INTEGRATED WITH OTHER TREATMENT STEPS.	L CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL	MECHANICAL REMOVAL	LOADER/DOZER	EFFECTIVE FOR REMOVAL OF WASTE WITH LOW MOISTURE CONTENT.	EASILY IMPLEMENTED.	M CAP L OM
		BACKHOE	EFFECTIVE FOR REMOVAL OF WASTE WITH LOW MOISTURE CONTENT.	EASILY IMPLEMENTED.	M CAP L OM
		CRANE W/CLAMSHELL SYSTEM	EFFECTIVE FOR REMOVAL OF WASTE WITH VARYING MOISTURE CONTENTS.	EASILY IMPLEMENTED.	M CAP M OM
		DRAGLINE	EFFECTIVE FOR REMOVAL OF WASTE WITH VARYING MOISTURE CONTENTS.	EASILY IMPLEMENTED.	H CAP M OM
	HYDRAULIC REMOVAL	JETTING RING W/CUTTERHEAD	EFFECTIVE FOR REMOVAL OF LOW-SOLID SLUDGE.	EASILY IMPLEMENTED.	M CAP M OM
	WASTE STABILIZATION	ASPHALT-BASED SOLIDIFICATION	EFFECTIVE AT IMMOBILIZING RADIOACTIVE WASTES, THUS ELIMINATING EXPOSURE PATHWAYS; SUBJECT TO LEARNING.	USES COMMON AVAILABLE TECHNOLOGY; NO PERMITS REQUIRED.	M CAP M OM
		CEMENT-BASED SOLIDIFICATION	SAME AS ABOVE.	SAME AS ABOVE.	M CAP M OM
		THERMOPLASTIC ENCAPSULATION	LIMITED APPLICABILITY FOR RADIOACTIVE WASTES; LESS POTENTIAL FOR LEARNING.	REQUIRES SPECIAL EQUIPMENT AND OPERATORS. NO PERMITS REQUIRED.	H CAP M OM
		VITRIFICATION	HAS BEEN USED TO SOLIDIFY LOW-LEVEL RADIOACTIVE WASTES; STILL EXPERIMENTAL.	REQUIRES SPECIAL EQUIPMENT AND OPERATORS. AIR PERMIT REQUIRED FOR OFF-GASES.	H CAP H OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS (Continued)

139

1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL	ON PROPERTY DISPOSAL	ABOVE/BELOW GRADE VAULT	VERY EFFECTIVE.	CAN BE CONSTRUCTED. THE TECHNOLOGY IS AVAILABLE. REQUIRES LARGE AMOUNT OF SPACE.	H CAP L OM
		ON PROPERTY ENGINEERED DISPOSAL FACILITY	VERY EFFECTIVE.	CAN BE CONSTRUCTED. THE TECHNOLOGY IS AVAILABLE. REQUIRES LARGE AMOUNT OF SPACE.	H CAP M OM
		TEMPORARY STORAGE	EFFECTIVE, BUT TEMPORARY STORAGE DOES NOT MEET RAO REQUIREMENTS.	REQUIRES LARGE AMOUNT OF SPACE AND FUTURE PLAN FOR STORAGE.	L CAP H OM
	OFF SITE DISPOSAL	TEMPORARY STORAGE	EFFECTIVE, BUT TEMPORARY STORAGE DOES NOT MEET RAO REQUIREMENTS.	REQUIRES LARGE AMOUNT OF SPACE AND FUTURE PLAN FOR STORAGE.	L CAP H OM
		RAIL TRANSPORT	EFFECTIVE	READILY IMPLEMENTED.	M CAP L OM
		TRUCK TRANSPORT	EFFECTIVE. HIGHER HAZARD POTENTIAL.	READILY IMPLEMENTED.	H CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS (Continued)

140
1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCHES	PERMEABILITIES OF UNDERLYING SAND LENSES CREATE SLOW RECOVERY OF CONTAMINATED PERCHED GROUNDWATER VIA THIS GRAVITY DRIVEN COLLECTION SYSTEM.	DEPTH OF PERCHED WATER ZONES CAUSES VERTICAL AND AERIAL EXTENT OF EXCAVATION TO BE EXTREMELY LARGE.	H CAP L OM
		PUMPING WELLS	EFFECTIVE	EASIER TO IMPLEMENT WHEN COUPLED WITH WASTE REMOVAL.	M CAP M OM
	SUBSURFACE CONTAINMENT	SLURRY WALLS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	EASILY IMPLEMENTED.	L CAP L OM
		GROUT CURTAINS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	MORE DIFFICULT TO IMPLEMENT THAN SLURRY WALL.	H CAP L OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (BIOLOGICAL)	BIOSORBANT	HAS ACHIEVED SOME DEGREE OF SEPERATION OF HEAVY METALS IN PILOT-PLANT TESTING, NEW TECHNOLOGY.	EMERGING TECHNOLOGY; TREATABILITY STUDIES REQUIRED.	M CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSIOCHEMICAL)	PRECIPITATION	EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	L CAP L OM
		COAGULATION/POLYMERIZATION	MAY BE EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES; REQUIRES FURTHER STUDY.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
		ADSORPTION	LIMITED EFFECTIVENESS IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; GENERATION OF RESIDUALS.	H CAP H OM
		REVERSE OSMOSIS	FOUND TO BE EFFECTIVE IN EXPERIMENTAL APPLICATIONS; FURTHER STUDY REQUIRED.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS AND HIGH CONCENTRATION WASTE STREAM.	M CAP M OM
		ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	NOT EFFECTIVE FOR DISSOLVED URANIUM REMOVAL.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (CHEMICAL)	ION EXCHANGE	EFFECTIVE IN REDUCTION OF URANIUM IN AQUEOUS WASTE STREAMS.	COMMONLY UTILIZED TECHNOLOGY FOR URANIUM REMOVAL; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP M OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	EFFECTIVE IN DEWATERING SLUDGES AND SLURRIES. WILL NOT REDUCE HAZARD ASSOCIATED WITH INSOLUABLE WASTEWATER CONSTITUENTS.	COMMON, PROVEN EQUIPMENT AND EASILY IMPLEMENTED.	M CAP L OM
		SEDIMENTATION/CLARIFICATION	EFFECTIVE IN REMOVING SUSPENDED SOLIDS PRIOR TO PROCESSING.	EQUIPMENT IS READILY AVAILABLE AND EASILY IMPLEMENTED.	H CAP H OM
		DUAL MEDIA FILTRATION	RELIABLE AND EFFECTIVE IN REMOVING LOW LEVELS OF SOLIDS FROM WASTEWATER.	READILY AVAILABLE AND EASY TO OPERATE AND CONTROL. EASILY INTEGRATED WITH OTHER TREATMENT STEPS.	L CAP L OM
	PHYSICAL TREATMENT	SOIL WASHING	EFFECTIVE IN EXTRACTING ORGANIC CONTAMINANTS FROM SOIL. POTENTIALLY EFFECTIVE FOR REMOVAL OF SOLUBLE URANIUM COMPOUNDS.	READILY IMPLEMENTED.	H CAP M OM
	THERMAL TREATMENT	ROTARY KILN	EFFECTIVE IN REMOVING ORGANICS.	READILY IMPLEMENTED.	H CAP H OM
		MULTIPLE HEARTH	EFFECTIVE IN REMOVING ORGANICS.	READILY IMPLEMENTED.	M CAP H OM
		FLUIDIZED BED	EFFECTIVE IN REMOVING ORGANICS.	READILY IMPLEMENTED.	L CAP M OM
		THERMAL DESORPTION	EFFECTIVE IN REMOVING ORGANICS.	READILY IMPLEMENTED.	M CAP M OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-6. EVALUATION OF PROCESS OPTIONS - LIME SLUDGE PONDS (Continued)

142

1165

Both mechanical and hydraulic removal technologies are utilized as representative technologies for Lime Sludge Pond remediation because the ponds have sludges of varying moisture content. Some of the sludge at the surface tends to be much drier than that which is underneath the surface. Representative process technologies are jetting ring and mechanical removal with a backhoe.

2.7.2.2 Containment/Treatment Actions

Due to the physical characteristics of the lime sludge, in situ stabilization of the material would be required prior to capping to eliminate adverse long-term subsidence effects. Process options associated with the in situ stabilization technology include grout injection, SSM, dynamic compaction/vacuum extraction, and surcharging.

Dynamic Compaction, Vacuum Extraction, and Surcharging

- Effectiveness: These process options induce consolidation of the lime sludge material by promoting drainage of pore water. Alone they do not meet human health and environmental objectives. Dynamic compaction and surcharging could cause release of contaminated pore liquid into the underlying sand lense.

- Implementability: These process options are readily available technical solutions.

Grout Injection and SSM

- Effectiveness: Although grout injection and SSM are stabilization process options, they would reduce the toxicity and mobility of the contamination in the Lime Sludge Ponds. These process options alone would probably meet human health and environmental objectives.

- Implementability: Both process options are readily available technical solutions; however, grout injection can create a potential dusting hazard.

SSM was chosen as the representative process option because it can reduce the toxicity and mobility of contaminants in the lime sludge, and the solidified product is structurally stable. In addition, it can support the weight of a cap.

2.7.3 Direct Radiation/Air (Fugitive Dust) Media

Technologies and process options discussed in Section 2.7.2 for soils, sediments, and wastes are also applicable for direct radiation and air (fugitive dust). Further discussion will not be pursued for these media.

2.8 PROCESS OPTION EVALUATION FOR FLY ASH/SOUTHFIELD AREAS

2.8.1 Groundwater/Surface Water Media

Technologies and process options discussed in Section 2.6.1 for groundwater and surface water also are applicable for the Fly Ash/Southfield areas. Further discussion will not be pursued for the groundwater/surface water media associated with the Fly Ash/Southfield areas. Figure 2-7 documents the evaluation options for the Fly Ash/Southfield areas.

2.8.2 Soils/Sediments/Wastes Media

Technologies and process options discussed in Section 2.6.2 for soils, sediments, and wastes are applicable for the Fly Ash/Southfield areas. Cement-based stabilization is chosen as the representative process option for these units because fly ash lends itself to this process because of the pozzolonic properties possessed by this material. It can be utilized (along with portland cement) to solidify the soils in the Southfield, immobilizing radiological constituents.

2.8.3 Evaluation of Process Options for Direct Radiation and Air (Fugitive Dust)

Technologies and process options discussed in Section 2.8.2 for direct radiation and air (fugitive dust) are also applicable for the Fly Ash/Southfield areas. Further discussion will not be pursued for the direct radiation/air (fugitive dust) media associated with the Fly Ash/Southfield areas.

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
NO ACTION	NONE	NOT APPLICABLE	MAY NOT MEET RAO's.	MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
INSTITUTIONAL ACTIONS	MONITORING	WELLPOINT MONITORING	USEFUL IN DOCUMENTING CONDITIONS. DOES NOT REDUCE RISK.	ALONE, MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
		LEACHATE MONITORING			
	ACCESS CONTROL	PHYSICAL BARRIERS	EFFECTIVENESS DEPENDS ON CONTINUED FUTURE IMPLEMENTATION. DOES NOT REDUCE CONTAMINATION.	ALONE, MAY NOT BE ACCEPTABLE TO PUBLIC.	L CAP L OM
		ADMINISTRATIVE CONTROLS			
		DEED RESTRICTIONS			

145

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

1165

FIGURE 2-7. EVALUATION OF PROCESS OPTIONS - FLY ASH/SOUTHFIELD AREAS

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	EFFECTIVE WHEN COMBINED WITH CAPPING. ALONE, NOT AS EFFECTIVE.	EASILY IMPLEMENTED.	H CAP L OM
		DIVERSION/COLLECTION		EASILY IMPLEMENTED.	M CAP L OM
		GRADING		EASILY IMPLEMENTED.	L CAP L OM
		REVEGETATION		EASILY IMPLEMENTED.	L CAP L OM
	CAPPING	CONCRETE-BASED COVER	EFFECTIVE, BUT SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		ASPHALT-BASED COVER			
		SOIL-BASED COVER	EFFECTIVE, LESS SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		MULTIMEDIA CAP	EFFECTIVE. LEAST SUSCEPTIBLE TO CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	H CAP H OM
		CHEMICAL SEALANT	MODERATELY EFFECTIVE IF MAINTAINED.	MODERATELY DIFFICULT TO IMPLEMENT.	M CAP M OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-7. EVALUATION OF PROCESS OPTIONS - FLY ASH/SOUTHFIELD AREAS (Continued)

146
1165

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT	RUN-ON/RUNOFF CONTROL	SEDIMENTATION BASIN	EFFECTIVE WHEN COMBINED WITH CAPPING. ALONE, NOT AS EFFECTIVE.	EASILY IMPLEMENTED.	H CAP L OM
		DIVERSION/COLLECTION		EASILY IMPLEMENTED.	M CAP L OM
		GRADING		EASILY IMPLEMENTED.	L CAP L OM
		REVEGETATION		EASILY IMPLEMENTED.	L CAP L OM
	CAPPING	CONCRETE-BASED COVER	EFFECTIVE, BUT SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		ASPHALT-BASED COVER			
		SOIL-BASED COVER	EFFECTIVE, LESS SUSCEPTIBLE TO WEATHERING AND CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	L CAP L OM
		MULTIMEDIA CAP	EFFECTIVE. LEAST SUSCEPTIBLE TO CRACKING.	EASILY IMPLEMENTED. RESTRICTIONS ON FUTURE LAND USE.	H CAP H OM
		CHEMICAL SEALANT	MODERATELY EFFECTIVE IF MAINTAINED.	MODERATELY DIFFICULT TO IMPLEMENT.	M CAP M OM
	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCHES	PERMEABILITIES OF UNDERLYING SAND LENSES CREATE SLOW RECOVERY OF CONTAMINATED PERCHED GROUNDWATER VIA THIS GRAVITY DRIVEN COLLECTION SYSTEM.	DEPTH OF PERCHED WATER ZONES CAUSES VERTICAL AND AERIAL EXTENT OF EXCAVATION TO BE EXTREMELY LARGE.	H CAP L OM
		PUMPING WELLS	EFFECTIVE	EASILY IMPLEMENTED.	M CAP M OM
	SUBSURFACE CONTAINMENT	SLURRY WALLS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	EASILY IMPLEMENTED.	L CAP L OM
		GROUT CURTAINS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	MORE DIFFICULT TO IMPLEMENT THAN SLURRY WALL.	H CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-7. EVALUATION OF PROCESS OPTIONS - FLY ASH/SOUTHFIELD AREAS (Continued)

147
1165
022 A FIGURE 2-7 (Cont) 08

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
CONTAINMENT/ TREATMENT CONTINUED	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (BIOLOGICAL)	BIOSORBANT	HAS ACHIEVED SOME DEGREE OF SEPERATION OF HEAVY METALS IN PILOT-PLANT TESTING, NEW TECHNOLOGY.	EMERGING TECHNOLOGY; TREATABILITY STUDIES REQUIRED.	M CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSIOCHEMICAL)	PRECIPITATION	EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	L CAP L OM
		COAGULATION/POLYMERIZATION	MAY BE EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES; REQUIRES FURTHER STUDY.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
		ADSORPTION	LIMITED EFFECTIVENESS IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; GENERATION OF RESIDUALS.	H CAP H OM
		REVERSE OSMOSIS	FOUND TO BE EFFECTIVE IN EXPERIMENTAL APPLICATIONS; FURTHER STUDY REQUIRED.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS AND HIGH CONCENTRATION WASTE STREAM.	M CAP M OM
		ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	NOT EFFECTIVE FOR DISSOLVED URANIUM REMOVAL.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (CHEMICAL)	ION EXCHANGE	EFFECTIVE IN REDUCTION OF URANIUM IN AQUEOUS WASTE STREAMS.	COMMONLY UTILIZED TECHNOLOGY FOR URANIUM REMOVAL; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	EFFECTIVE IN DEWATERING SLUDGES AND SLURRIES. WILL NOT REDUCE HAZARD ASSOCIATED WITH INSOLUABLE WASTEWATER CONSTITUENTS.	COMMON, PROVEN EQUIPMENT AND EASILY IMPLEMENTED.	M CAP L OM
		SEDIMENTATION/CLARIFICATION	EFFECTIVE IN REMOVING SUSPENDED SOLIDS PRIOR TO PROCESSING.	EQUIPMENT IS READILY AVAILABLE AND EASILY IMPLEMENTED.	H CAP H OM
		DUAL MEDIA FILTRATION	RELIABLE AND EFFECTIVE IN REMOVING LOW LEVELS OF SOLIDS FROM WASTEWATER.	READILY AVAILABLE AND EASY TO OPERATE AND CONTROL. EASILY INTEGRATED WITH OTHER TREATMENT STEPS.	L CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-7. EVALUATION OF PROCESS OPTIONS - FLY ASH/SOUTHFIELD AREAS (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL	MECHANICAL REMOVAL	LOADER/DOZER	EFFECTIVE FOR REMOVAL OF WASTE WITH LOW MOISTURE CONTENT.	EASILY IMPLEMENTED.	M CAP L OM
		BACKHOE	EFFECTIVE FOR REMOVAL OF WASTE WITH LOW MOISTURE CONTENT.	EASILY IMPLEMENTED.	M CAP L OM
		CRANE W/CLAMSHELL SYSTEM	EFFECTIVE FOR REMOVAL OF WASTE WITH VARYING MOISTURE CONTENTS.	EASILY IMPLEMENTED.	M CAP M OM
		DRAGLINE	EFFECTIVE FOR REMOVAL OF WASTE WITH VARYING MOISTURE CONTENTS.	EASILY IMPLEMENTED.	H CAP M OM
	WASTE STABILIZATION	ASPHALT-BASED SOLIDIFICATION	EFFECTIVE AT IMMOBILIZING RADIOACTIVE WASTES, THUS ELIMINATING EXPOSURE PATHWAYS; SUBJECT TO LEARNING.	USES COMMON AVAILABLE TECHNOLOGY; NO PERMITS REQUIRED.	M CAP M OM
		CEMENT-BASED SOLIDIFICATION	SAME AS ABOVE.	SAME AS ABOVE.	M CAP M OM
		THERMOPLASTIC ENCAPSULATION	LIMITED APPLICABILITY FOR RADIOACTIVE WASTES; LESS POTENTIAL FOR LEARNING.	REQUIRES SPECIAL EQUIPMENT AND OPERATORS. NO PERMITS REQUIRED.	H CAP M OM
		VITRIFICATION	HAS BEEN USED TO SOLIDIFY LOW-LEVEL RADIOACTIVE WASTES; STILL EXPERIMENTAL.	REQUIRES SPECIAL EQUIPMENT AND OPERATORS. AIR PERMIT REQUIRED FOR OFF-GASES.	H CAP H OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-7. EVALUATION OF PROCESS OPTIONS - FLY ASH/SOUTHFIELD AREAS (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL	SEGREGATION	COMPATIBILITY TESTING	EFFECTIVE FOR AN AREA WHICH CONTAINS HAZARDOUS AND RADIOACTIVE WASTE.	EASILY IMPLEMENTED.	H CAP L OM
		MANUAL SORTING	EFFECTIVE FOR WASTE WHICH CONTAINS NONFERROUS MATERIALS.	EASILY IMPLEMENTED.	L CAP L OM
		MAGNETIC SORTING	EFFECTIVE FOR WASTE WHICH CONTAINS FERROUS MATERIALS.	EASILY IMPLEMENTED.	M CAP M OM
		SCREENING/SIZING	EFFECTIVE. SCREENS OUT DEBRIS AND LARGE PARTICLES WHICH REQUIRE CRUSHING BEFORE DISPOSAL.	EASILY IMPLEMENTED.	M CAP M OM
	ON PROPERTY DISPOSAL	ABOVE/BELOW GRADE VAULT	VERY EFFECTIVE.	CAN BE CONSTRUCTED. THE TECHNOLOGY IS AVAILABLE. REQUIRES LARGE AMOUNT OF SPACE.	H CAP L OM
		ON PROPERTY ENGINEERED DISPOSAL FACILITY	VERY EFFECTIVE.	CAN BE CONSTRUCTED. THE TECHNOLOGY IS AVAILABLE. REQUIRES LARGE AMOUNT OF SPACE.	H CAP M OM
		TEMPORARY STORAGE	EFFECTIVE, BUT TEMPORARY STORAGE DOES NOT MEET RAO REQUIREMENTS.	REQUIRES LARGE AMOUNT OF SPACE AND FUTURE PLAN FOR STORAGE.	L CAP H OM
	OFF SITE DISPOSAL	TEMPORARY STORAGE	EFFECTIVE, BUT TEMPORARY STORAGE DOES NOT MEET RAO REQUIREMENTS.	REQUIRES LARGE AMOUNT OF SPACE AND FUTURE PLAN FOR STORAGE.	L CAP H OM
		RAIL TRANSPORT	EFFECTIVE	READILY IMPLEMENTED.	M CAP L OM
		TRUCK TRANSPORT	EFFECTIVE. HIGHER HAZARD POTENTIAL.	READILY IMPLEMENTED.	H CAP L OM
	PHYSICAL TREATMENT	SOIL WASHING	EFFECTIVE IN EXTRACTING ORGANIC CONTAMINANTS. POTENTIAL EFFECTIVENESS FOR REMOVAL OF SOLUBLE URANIUM COMPOUNDS.	IMPLEMENTABLE, BUT TREATMENT RESIDUALS REMAIN.	H CAP M OM

LEGEND:

L – LOW COST
M – MODERATE COST
H – HIGH COST
CAP – CAPITAL
OM – OPERATION AND MAINTENANCE

FIGURE 2–7. EVALUATION OF PROCESS OPTIONS – FLY ASH/SOUTHFIELD AREAS (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PERCHED GROUNDWATER REMOVAL	INTERCEPTOR TRENCHES	PERMEABILITIES OF UNDERLYING SAND LENSES CREATE SLOW RECOVERY OF CONTAMINATED PERCHED GROUNDWATER VIA THIS GRAVITY DRIVEN COLLECTION SYSTEM.	DEPTH OF PERCHED WATER ZONES CAUSES VERTICAL AND AERIAL EXTENT OF EXCAVATION TO BE EXTREMELY LARGE.	H CAP L OM
		PUMPING WELLS	EFFECTIVE	EASIER TO IMPLEMENT WHEN COUPLED WITH WASTE REMOVAL.	M CAP M OM
	SUBSURFACE CONTAINMENT	SLURRY WALLS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	EASILY IMPLEMENTED.	L CAP L OM
		GROUT CURTAINS	PREVENTS DILUTION OF CONTAMINATION IN PERCHED GROUNDWATER BY DIVERTING UNCONTAMINATED RECHARGE.	MORE DIFFICULT TO IMPLEMENT THAN SLURRY WALL.	H CAP L OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (BIOLOGICAL)	BIOSORBANT	HAS ACHIEVED SOME DEGREE OF SEPERATION OF HEAVY METALS IN PILOT-PLANT TESTING, NEW TECHNOLOGY.	EMERGING TECHNOLOGY; TREATABILITY STUDIES REQUIRED.	M CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSIOCHEMICAL)	PRECIPITATION	EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	L CAP L OM
		COAGULATION/POLYMERIZATION	MAY BE EFFECTIVE IN TREATMENT OF URANIUM COMPLEXES; REQUIRES FURTHER STUDY.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM
		ADSORPTION	LIMITED EFFECTIVENESS IN TREATMENT OF URANIUM COMPLEXES.	COMMONLY UTILIZED TECHNOLOGY; GENERATION OF RESIDUALS.	H CAP H OM
		REVERSE OSMOSIS	FOUND TO BE EFFECTIVE IN EXPERIMENTAL APPLICATIONS; FURTHER STUDY REQUIRED.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS AND HIGH CONCENTRATION WASTE STREAM.	M CAP M OM
		ADVANCED MEMBRANE FILTRATION OR ULTRAFILTRATION	NOT EFFECTIVE FOR DISSOLVED URANIUM REMOVAL.	COMMONLY UTILIZED TECHNOLOGY; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP H OM

LEGEND:

L – LOW COST
M – MODERATE COST
H – HIGH COST
CAP – CAPITAL
OM – OPERATION AND MAINTENANCE

FIGURE 2–7. EVALUATION OF PROCESS OPTIONS – FLY ASH/SOUTHFIELD AREAS (Continued)

GENERAL RESPONSE ACTION	REMEDIAL TECHNOLOGY	PROCESS OPTION	EFFECTIVENESS	IMPLEMENTABILITY	COST
REMOVAL/ TREATMENT/ DISPOSAL CONTINUED	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (CHEMICAL)	ION EXCHANGE	EFFECTIVE IN REDUCTION OF URANIUM IN AQUEOUS WASTE STREAMS.	COMMONLY UTILIZED TECHNOLOGY FOR URANIUM REMOVAL; IMPLEMENTABILITY CONCERNS REGARDING RESIDUALS GENERATED NEED TO BE ADDRESSED.	H CAP M OM
	PERCHED GROUNDWATER/ WASTE WATER TREATMENT (PHYSICAL)	BELT FILTER PRESS	EFFECTIVE IN DEWATERING SLUDGES AND SLURRIES. WILL NOT REDUCE HAZARD ASSOCIATED WITH INSOLUABLE WASTEWATER CONSTITUENTS.	COMMON, PROVEN EQUIPMENT AND EASILY IMPLEMENTED.	M CAP L OM
		SEDIMENTATION/CLARIFICATION	EFFECTIVE IN REMOVING SUSPENDED SOLIDS PRIOR TO PROCESSING.	EQUIPMENT IS READILY AVAILABLE AND EASILY IMPLEMENTED.	H CAP H OM
		DUAL MEDIA FILTRATION	RELIABLE AND EFFECTIVE IN REMOVING LOW LEVELS OF SOLIDS FROM WASTEWATER.	READILY AVAILABLE AND EASY TO OPERATE AND CONTROL. EASILY INTEGRATED WITH OTHER TREATMENT STEPS.	L CAP L OM

LEGEND:

L - LOW COST
M - MODERATE COST
H - HIGH COST
CAP - CAPITAL
OM - OPERATION AND MAINTENANCE

FIGURE 2-7. EVALUATION OF PROCESS OPTIONS - FLY ASH/SOUTHFIELD AREAS (Continued)

3.0

3.0 DEVELOPMENT AND DESCRIPTIONS OF ALTERNATIVES

3.1 DEVELOPMENT OF ALTERNATIVES

Tables 3-1 through 3-3 show the combining of general response actions into alternatives for the Sanitary Landfill, Lime Sludge Ponds, and Fly Ash/Southfield areas.

Seven potential remedial action alternatives have been developed for both the Sanitary Landfill and Fly Ash/Southfield waste disposal units. Five remedial action alternatives have been developed for the Lime Sludge Ponds. The following sections discuss in greater detail the alternatives developed for each Operable Unit 2 waste area. The requirements and refinement of technology necessary for screening are also further analyzed. Waste volumes and areas are refined to detail sufficient for screening.

The selected process options discussed in Section 2.0 have been assembled into remedial action alternatives for each of the waste units for initial screening, as shown in Figures 3-1 through 3-3. In some cases, more than one process option was selected to represent a technology type if there were sufficient differences in performance to indicate that one would not adequately represent the other (e.g., stabilization versus vitrification). This method provides flexibility for any necessary additions or refinements to these alternatives. It is noteworthy that run-on/runoff control is common to Alternatives 1 through 6; as such, it is considered an ancillary action and (although not highlighted in Figures 3-1 through 3-3) an integral part of these alternatives. It should also be noted that capping is included as an integral part of the technology of on-property disposal. Since capping is discussed extensively for Alternative 1, that discussion is not repeated for Alternatives 3 and 5.

Alternative 0 (the No-Action Alternative) involves no implementation of corrective action for the waste units; however, ongoing water quality monitoring would continue. This alternative is retained throughout the FS as a No-Action Alternative and for baseline comparison with other alternatives. Because Alternative 0 is repeated for each of the Operable Unit 2 waste units, the information is provided in this section rather than repeated throughout.

Alternative 0 would not change the present site characteristics. No additional space would be needed because the space required by monitoring equipment would be insignificant. Permits would not be required for Alternative 0, and no new waste would be generated. The protection of public health would be poor because of inadequate prevention of contaminated source migration from the waste unit. For the same reasons, short- and long-term protection of the environment also would be poor.

TABLE 3-1

DEVELOPMENT OF ALTERNATIVES
SANITARY LANDFILL

TECHNOLOGY TYPE	GENERAL RESPONSE ACTIONS						
	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
	No-Action	Containment	Containment With Perched Groundwater Treatment (Wellpoint Extraction)	Removal Of Waste, Perched Groundwater Treatment, and On-Property Disposal	Removal Of Waste, Perched Groundwater Treatment, and Off-Site Disposal	Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal
Access Restrictions		●	●	●		●	
Monitoring	●	●	●	●	●	●	●
Run-on/runoff Control		●	●	●	●	●	●
Capping		●	●				
In Situ Waste Stabilization							
Subsurface Flow Control			●	●	●	●	●
Perched Groundwater/ Wastewater Treatment			●	●	●	●	●
Physical Waste Treatment							
Thermal Waste Treatment						●	●
Mechanical Removal				●	●	●	●
Hydraulic Removal							
Waste Stabilization						●	●
Segregation				●	●	●	●
On-Property Disposal				●		●	
Off-Site Disposal					●		●

154

TABLE 3-2

DEVELOPMENT OF ALTERNATIVES
LIME SLUDGE PONDS

TECHNOLOGY TYPE	GENERAL RESPONSE ACTIONS				
	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4
	No-Action	Containment With In Situ Stabilization	Containment with In Situ Stabilization and Perched Groundwater Treatment (Wellpoint Extraction)	Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	Removal and Treat-ment of Waste, Perched Ground-water Treatment, and Off-Site Disposal
Access Restrictions		●	●	●	
Monitoring	●	●	●	●	●
Run-on/runoff Control		●	●	●	●
Capping		●	●		
In Situ Stabilization		●	●		
Subsurface Flow Control			●	●	●
Perched Groundwater/ Wastewater Treatment			●	●	●
Physical Waste Treatment					
Thermal Waste Treatment					
Mechanical Removal				●	●
Hydraulic Removal				●	●
Waste Stabilization				●	●
Segregation					
On-Property Disposal				●	
Off-Site Disposal					●

TABLE 3-3

DEVELOPMENT OF ALTERNATIVES
FLY ASH/SOUTHFIELD AREAS

	GENERAL RESPONSE ACTIONS						
TECHNOLOGY TYPE	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
	No-Action	Containment	Containment With Perched Groundwater Treatment (Wellpoint Extraction)	Removal Of Waste, Perched Groundwater Treatment, and On-Property Disposal	Removal Of Waste, Perched Groundwater Treatment, and Off-Site Disposal	Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal	Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal
Access Restrictions		●	●	●		●	
Monitoring	●	●	●	●	●	●	●
Run-on/runoff Control		●	●	●	●	●	●
Capping		●	●				
In Situ Waste Stabilization							
Subsurface Flow Control			●	●	●	●	●
Perched Groundwater/ Wastewater Treatment			●	●	●	●	●
Physical Waste Treatment							
Thermal Waste Treatment							
Mechanical Removal				●	●	●	●
Hydraulic Removal							
Waste Stabilization						●	●
Segregation				●	●	●	●
On-Property Disposal				●		●	
Off-Site Disposal					●		●

156

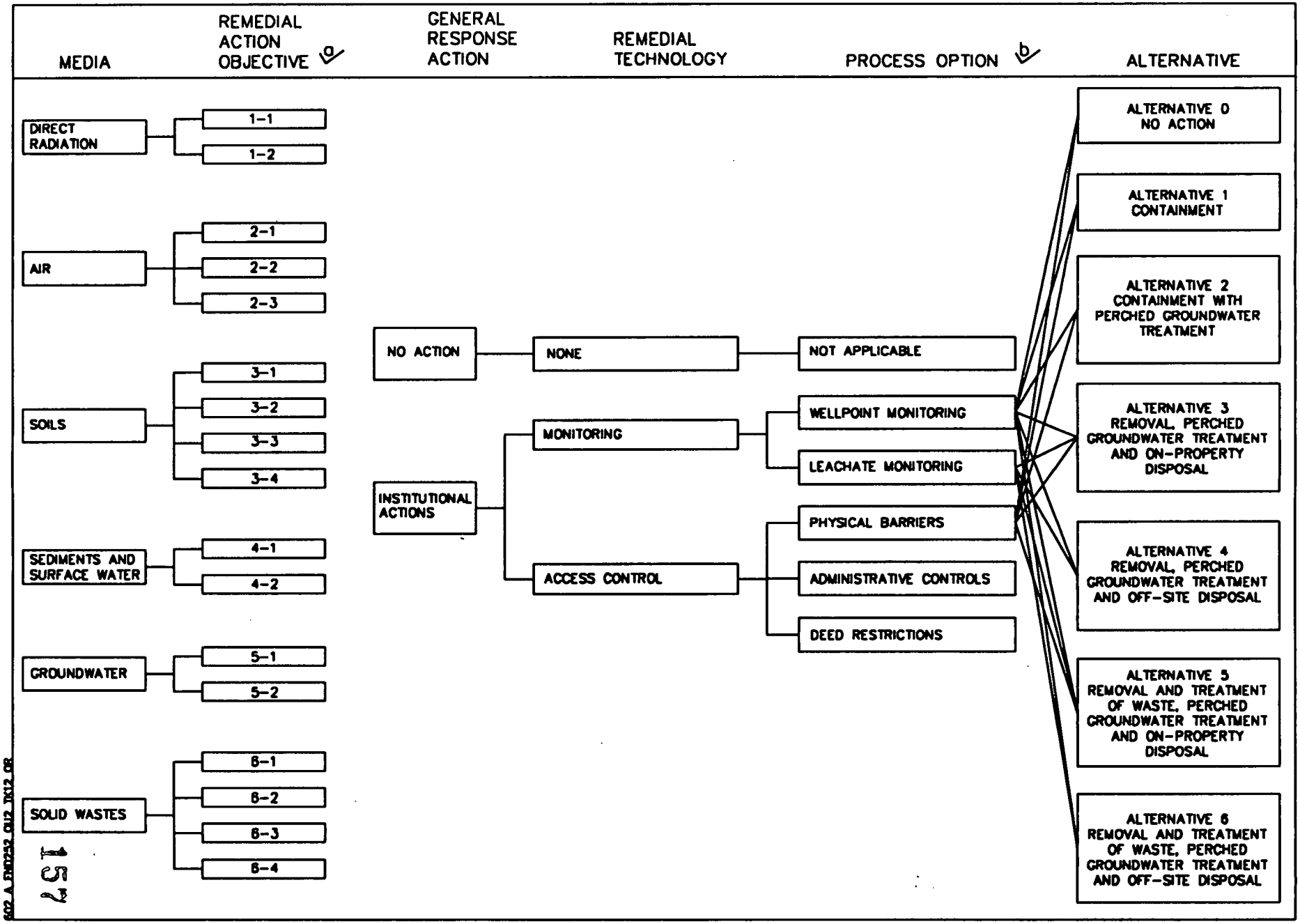


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL

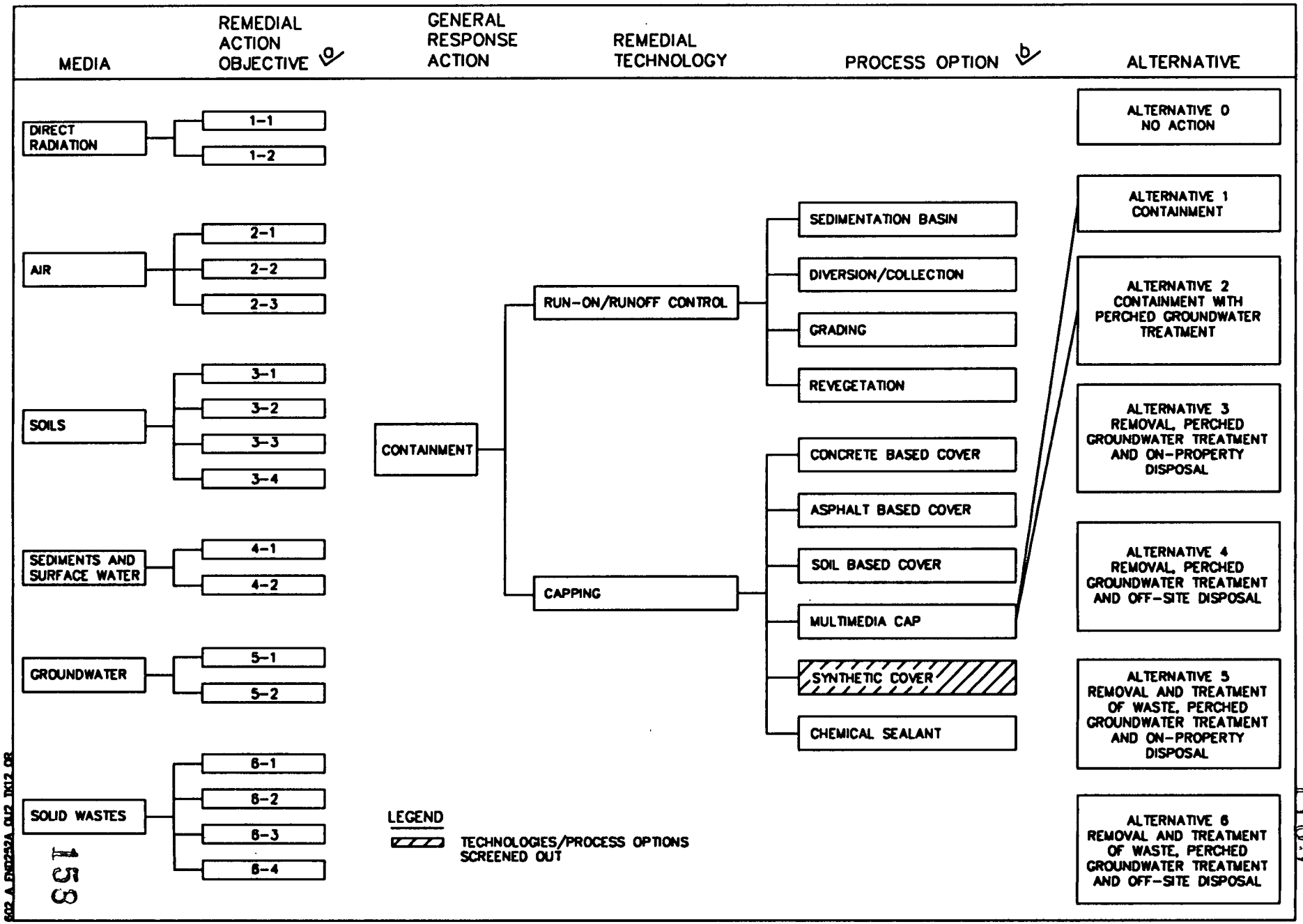


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

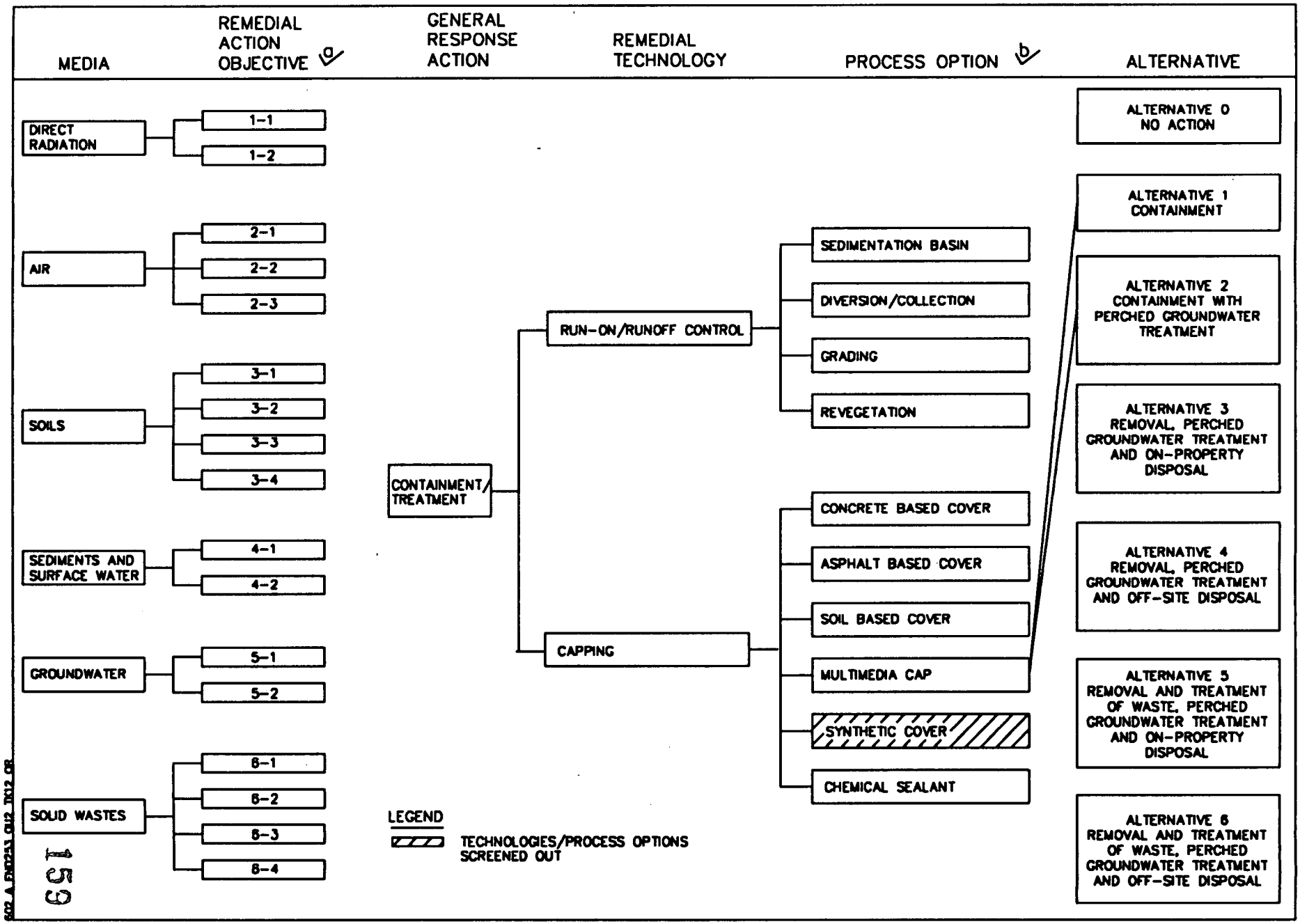


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

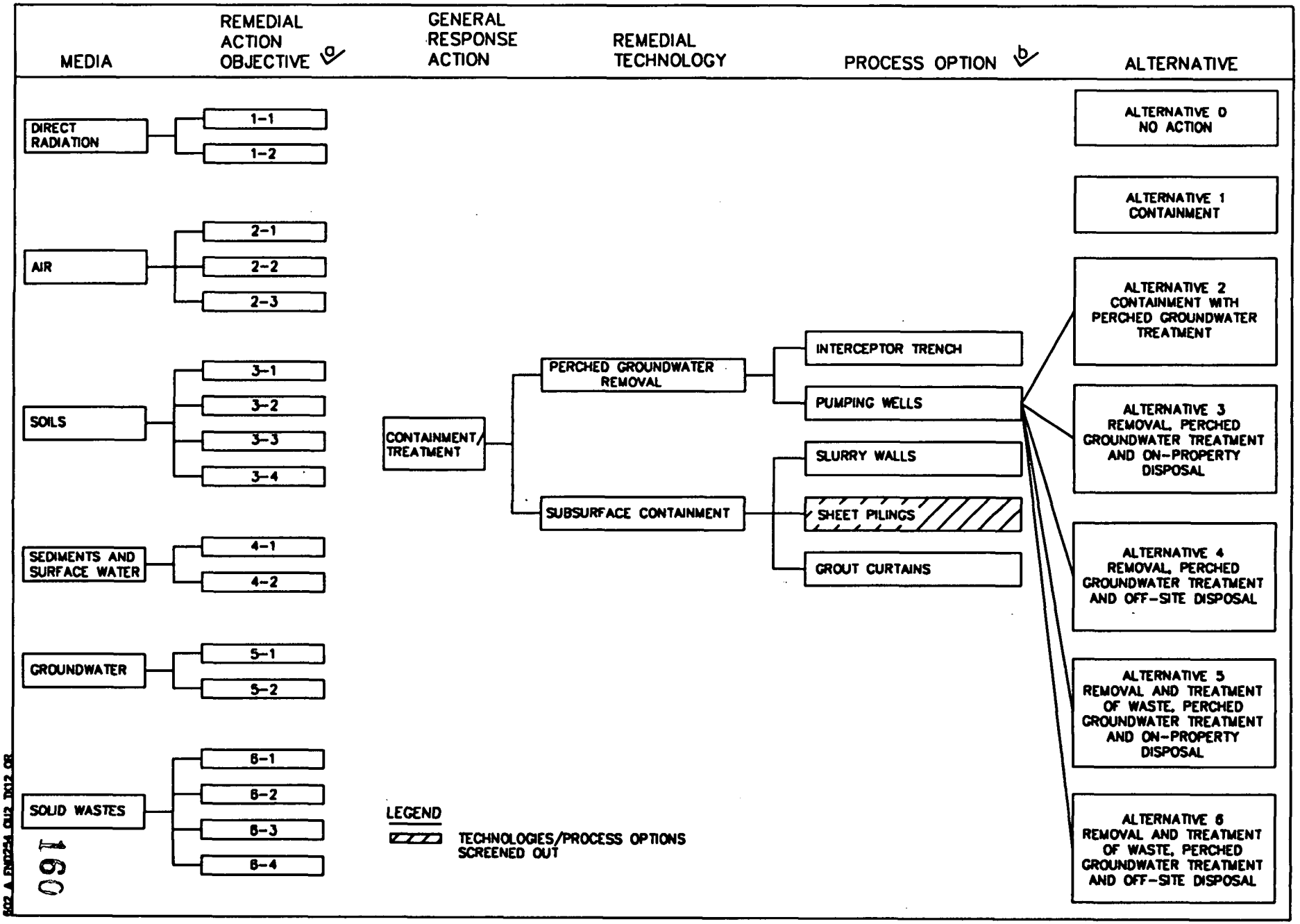


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

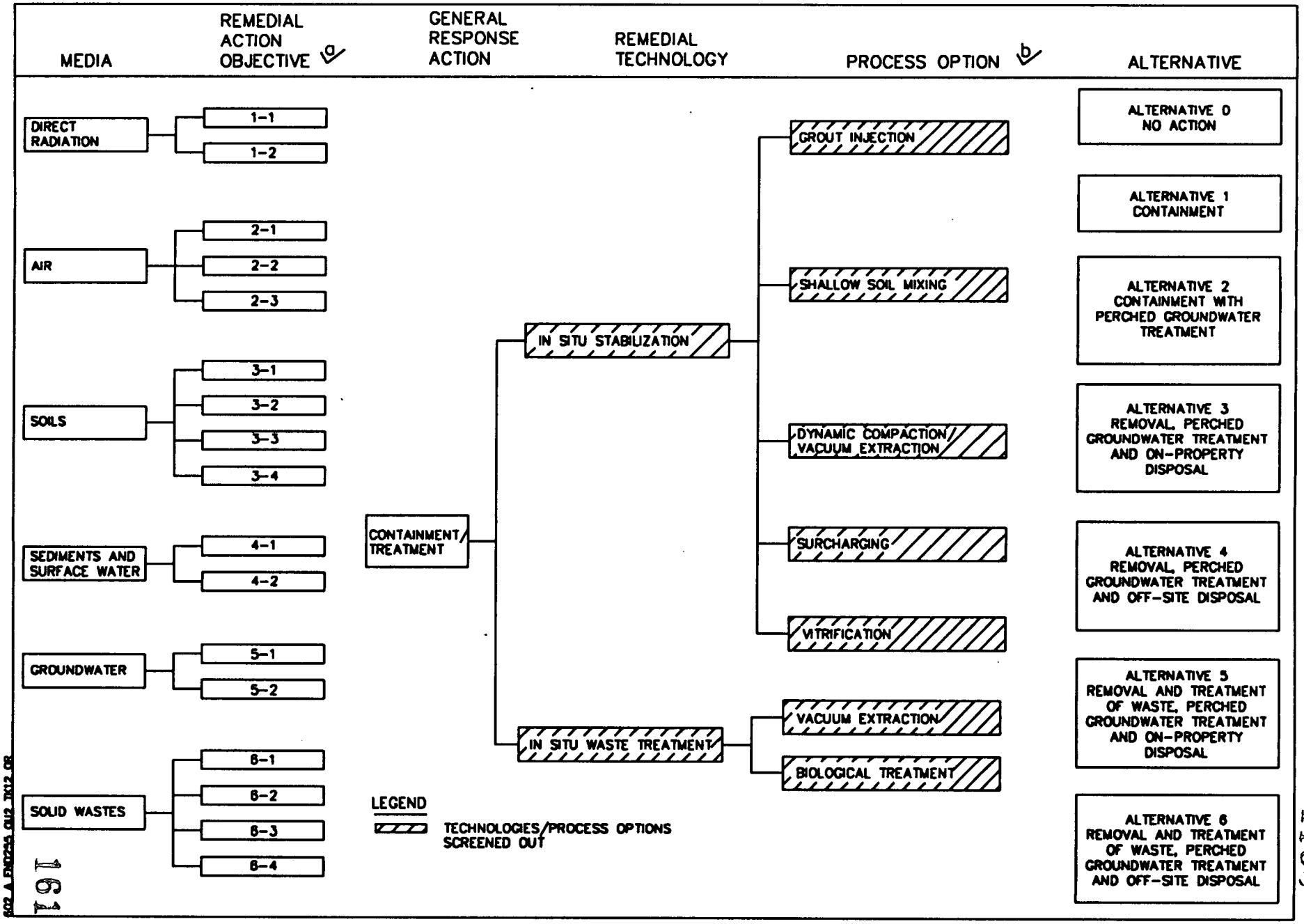


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

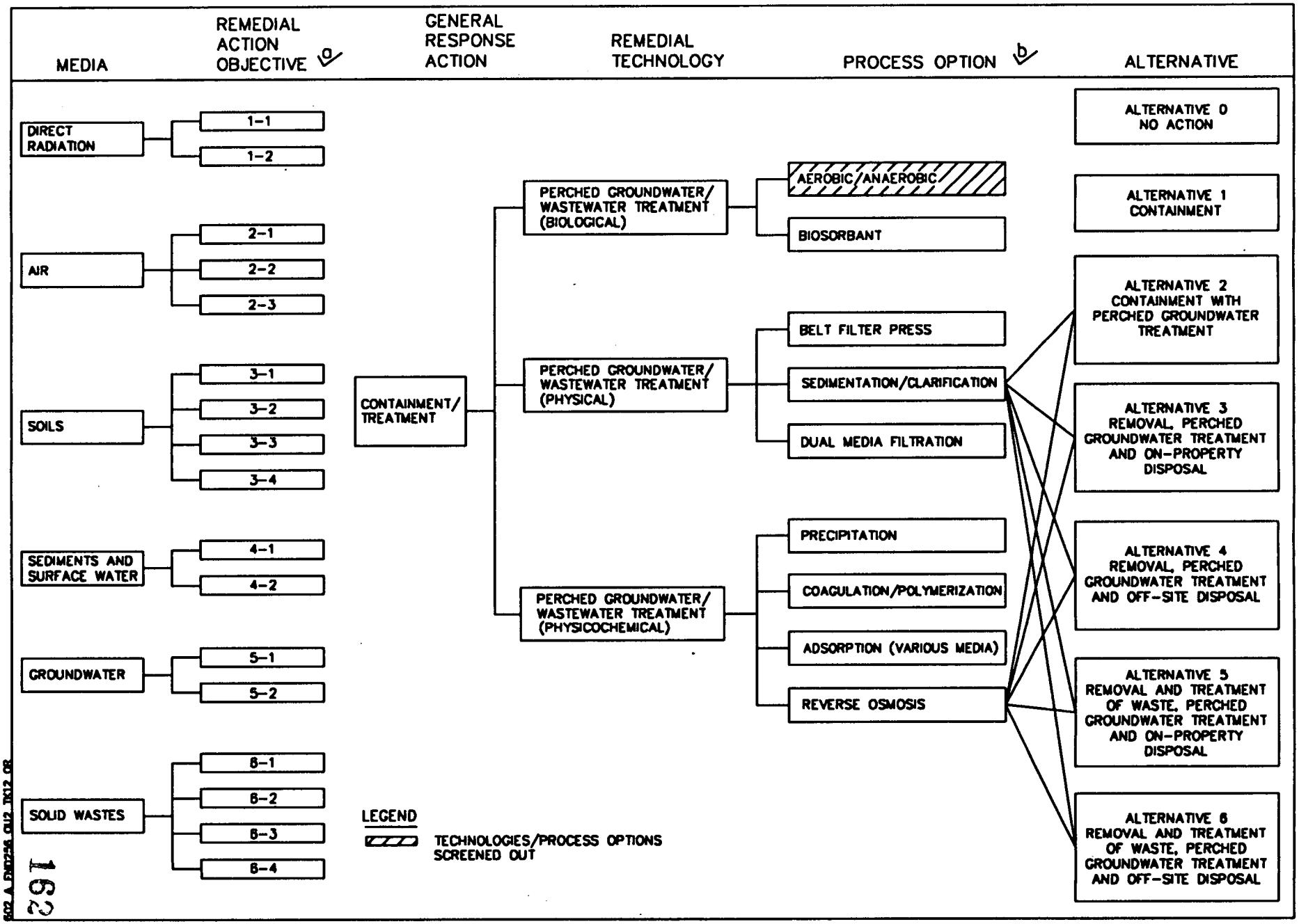


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

1165

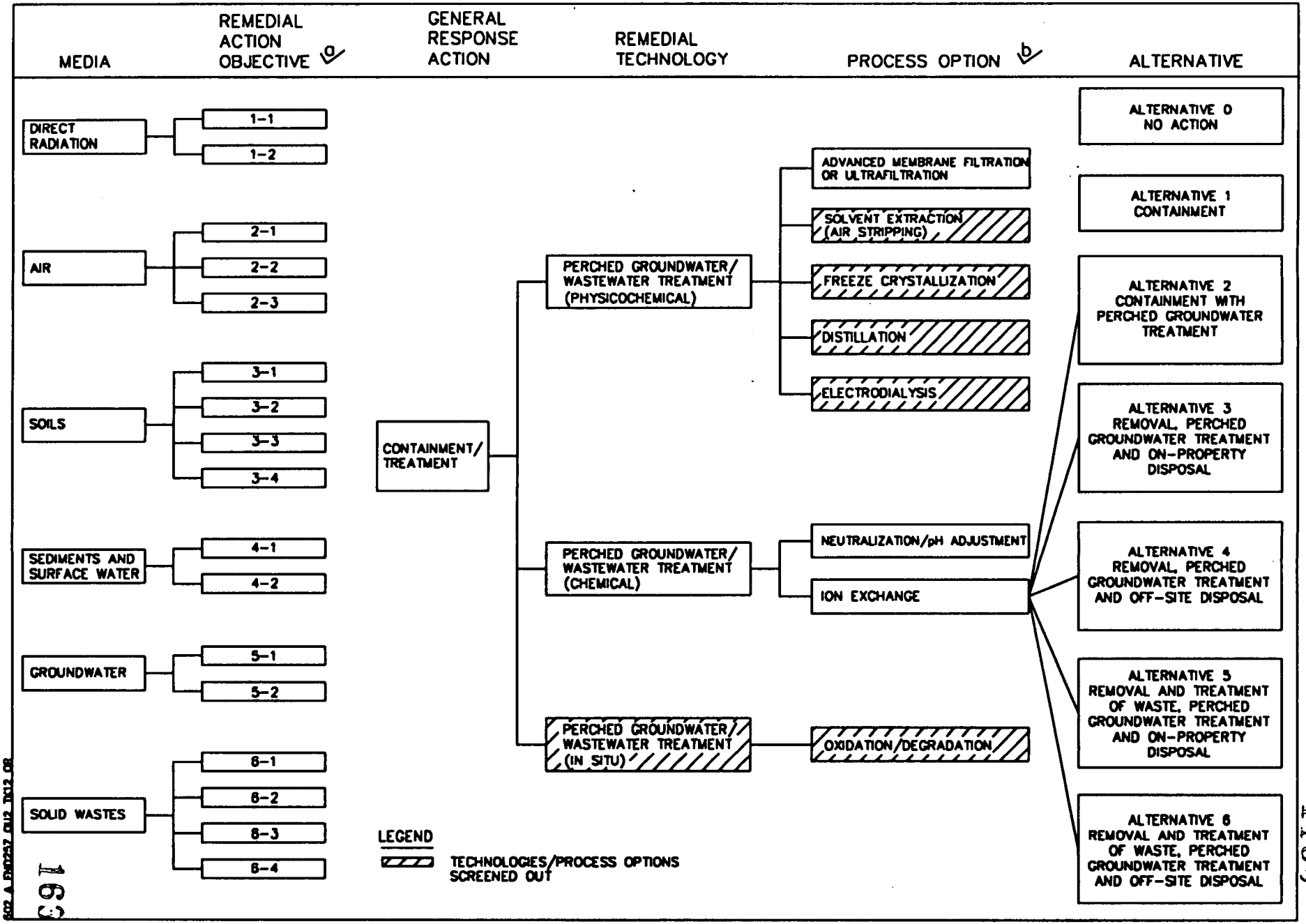


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

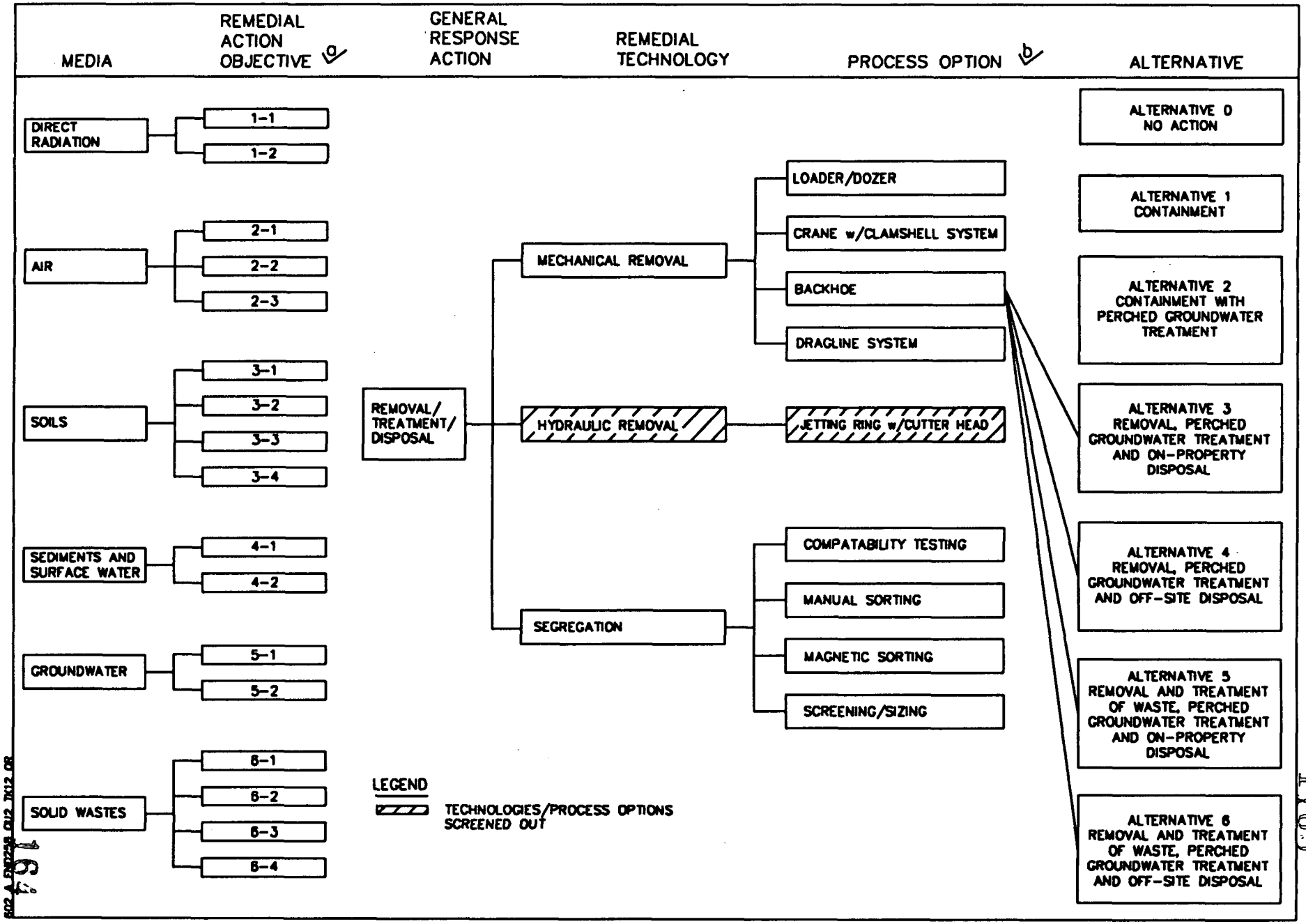


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

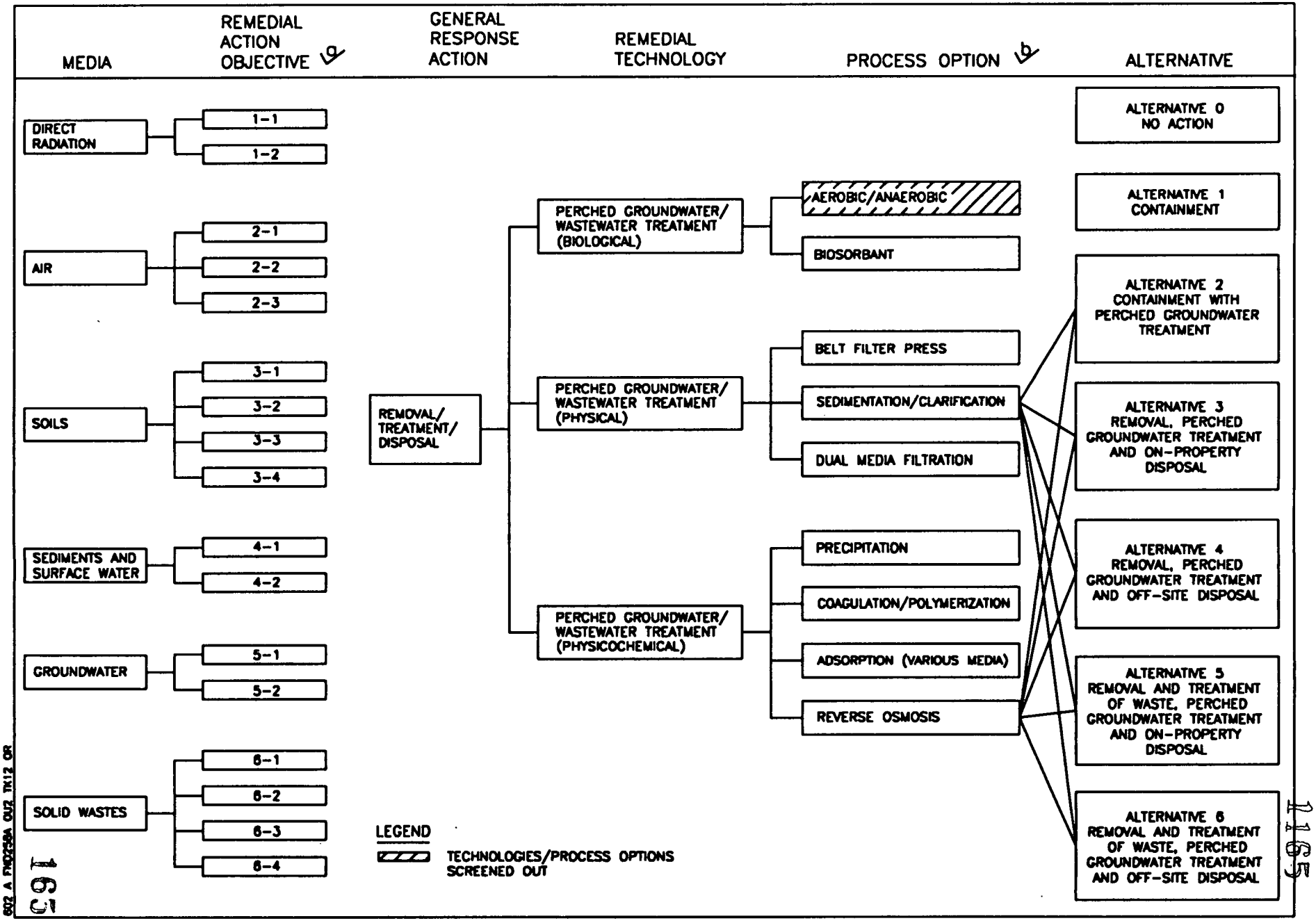


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

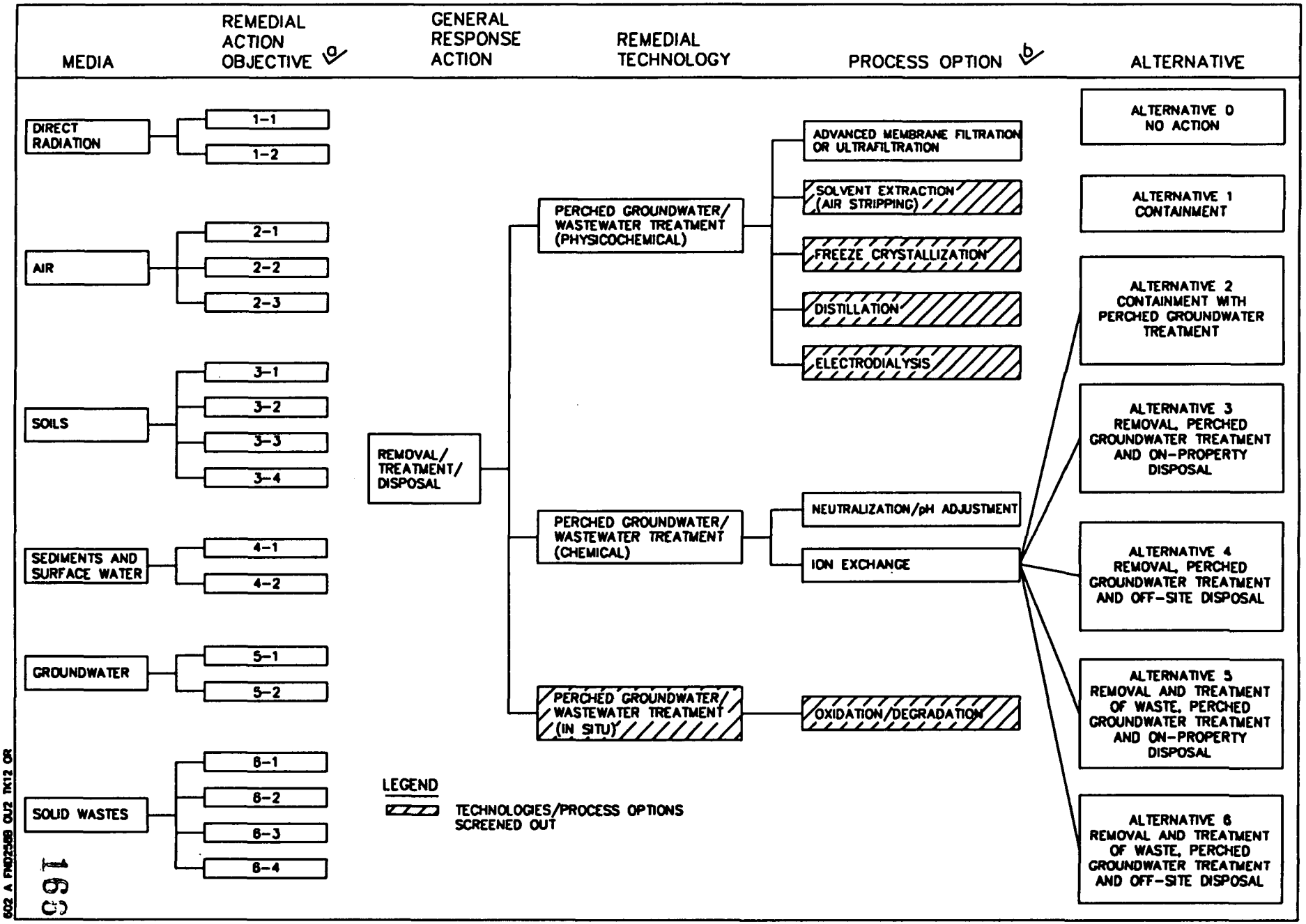


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

6402 A FN02588 OU2 TK12 GR

1165

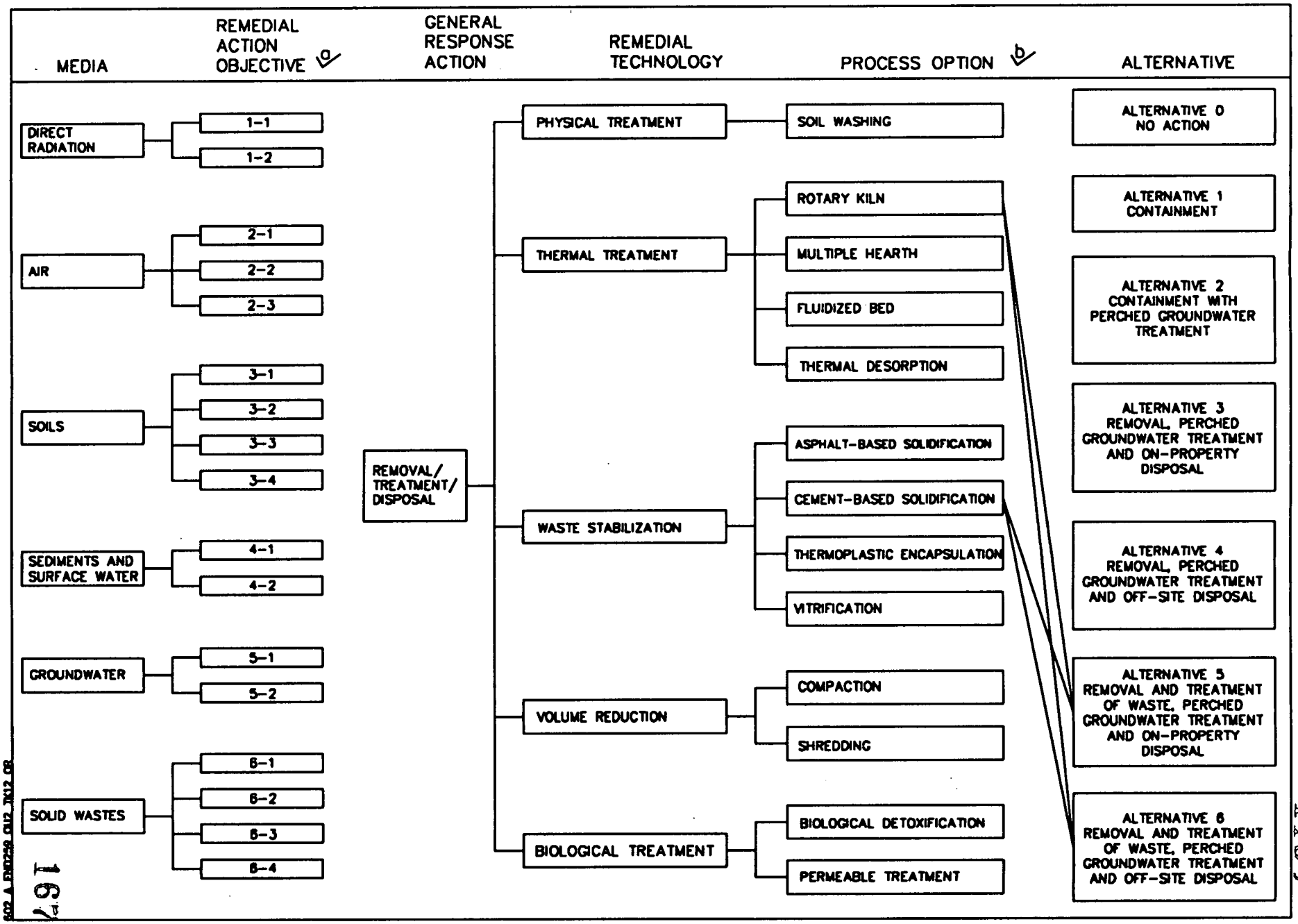


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

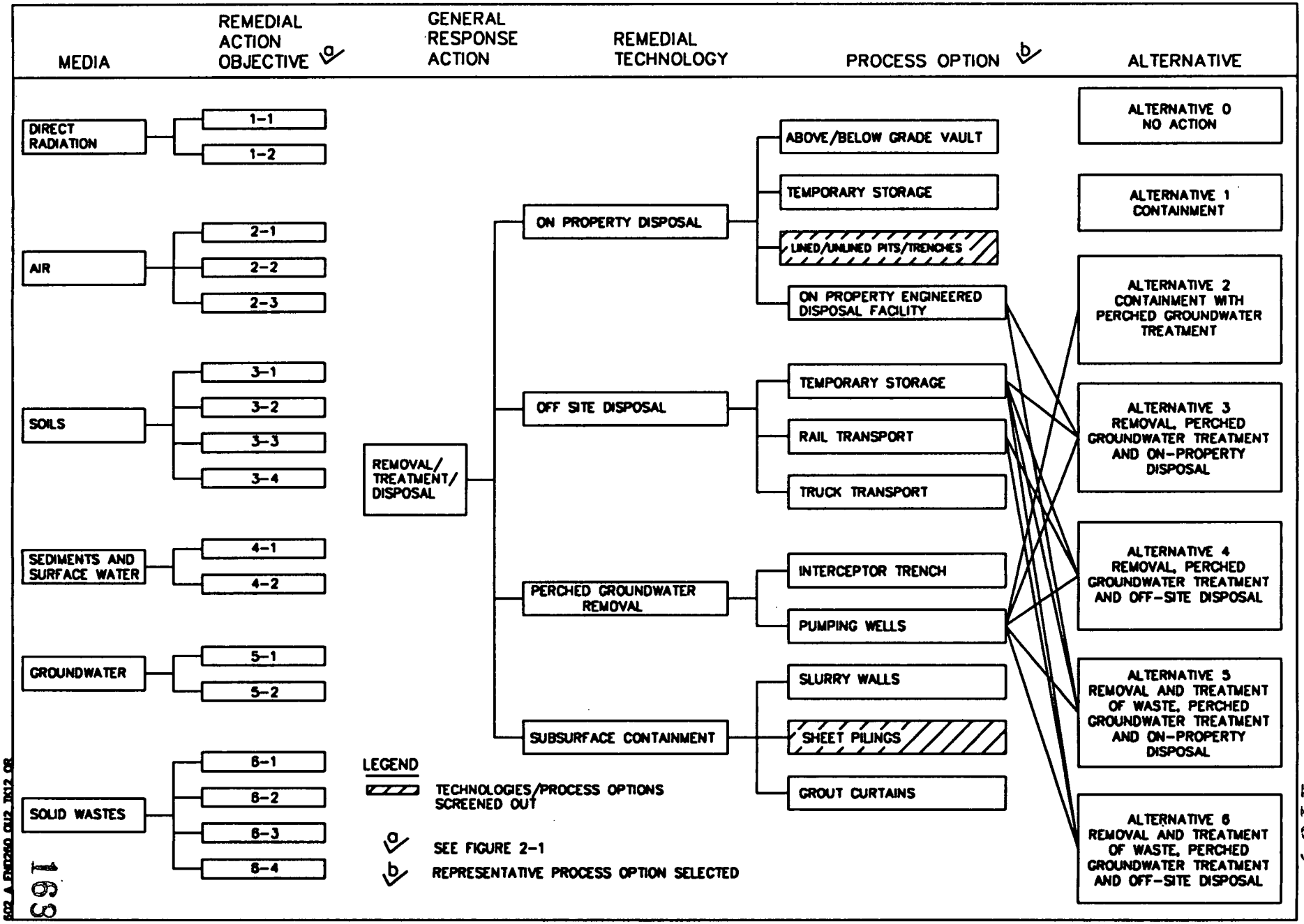


FIGURE 3-1. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – SANITARY LANDFILL (Continued)

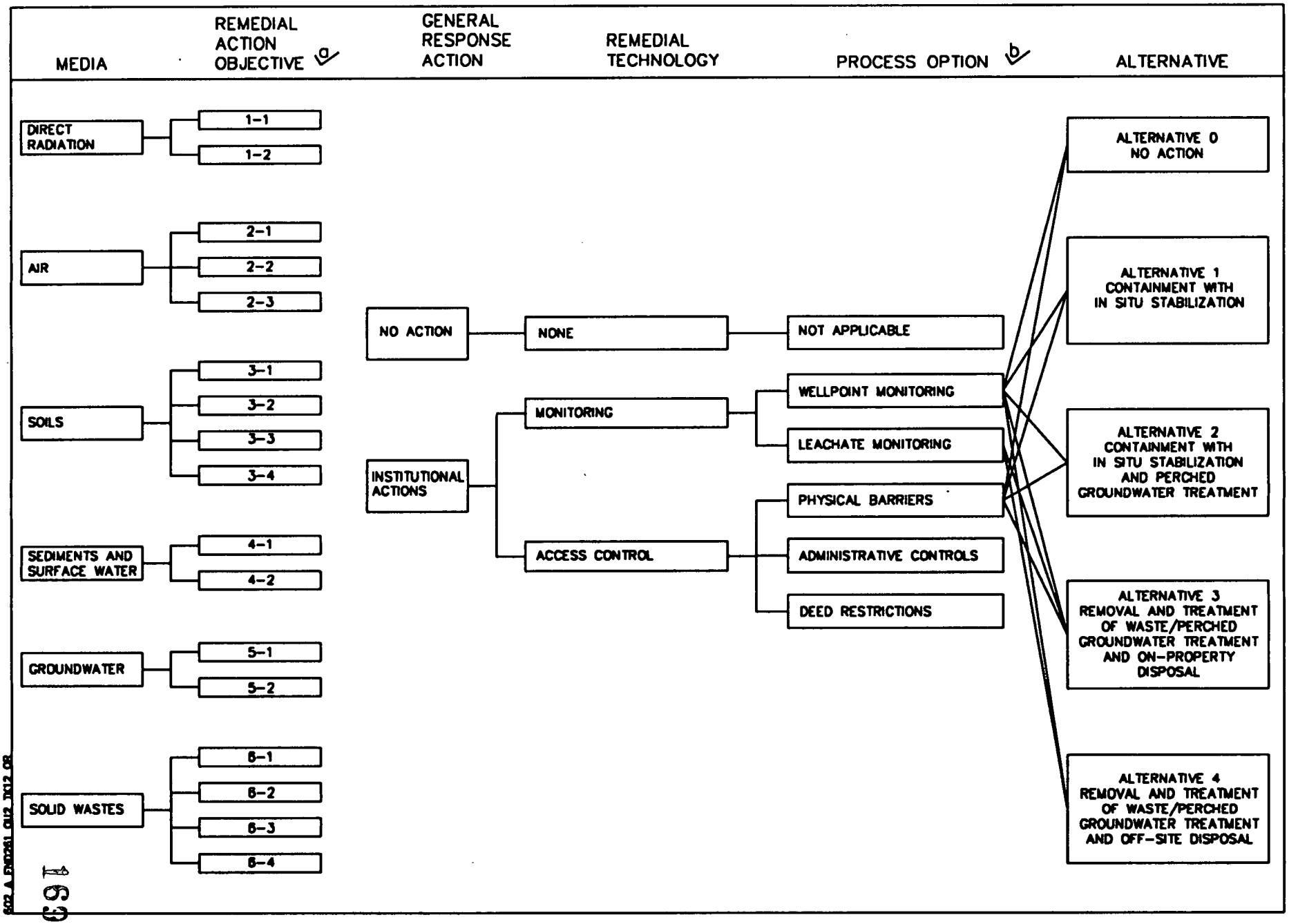


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS

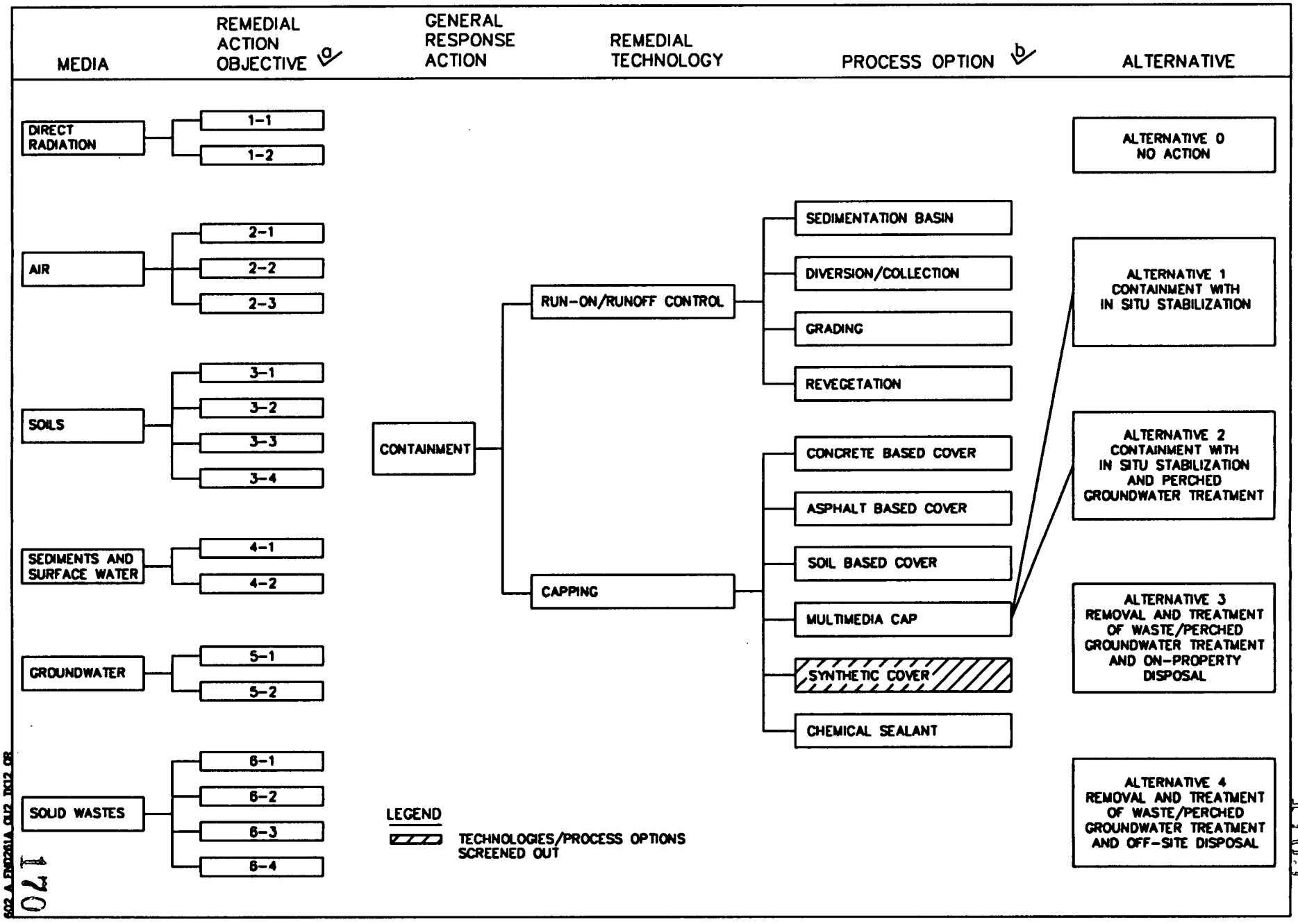


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

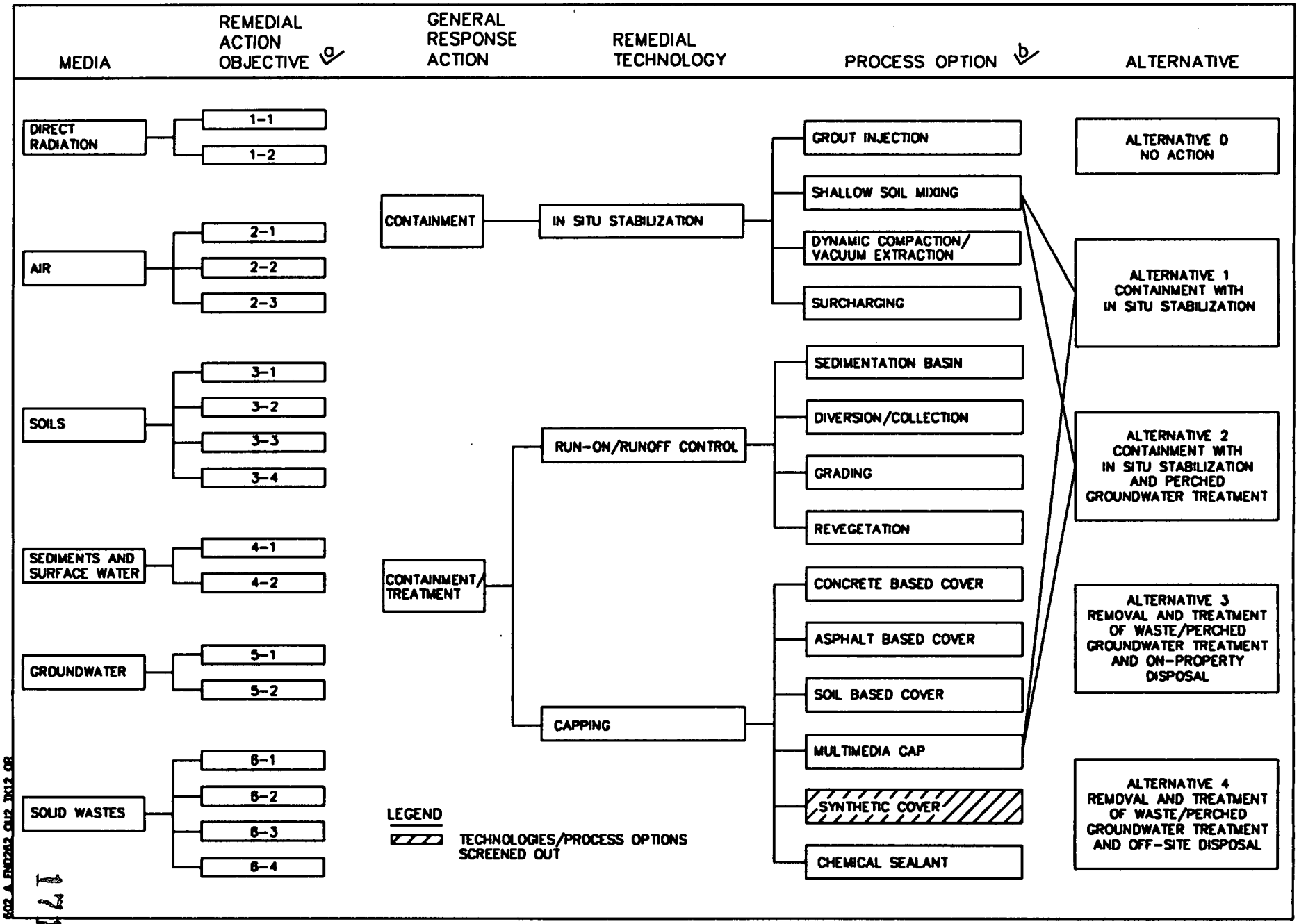


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

602_A_FN02262_OU2_TK12_OR

1195

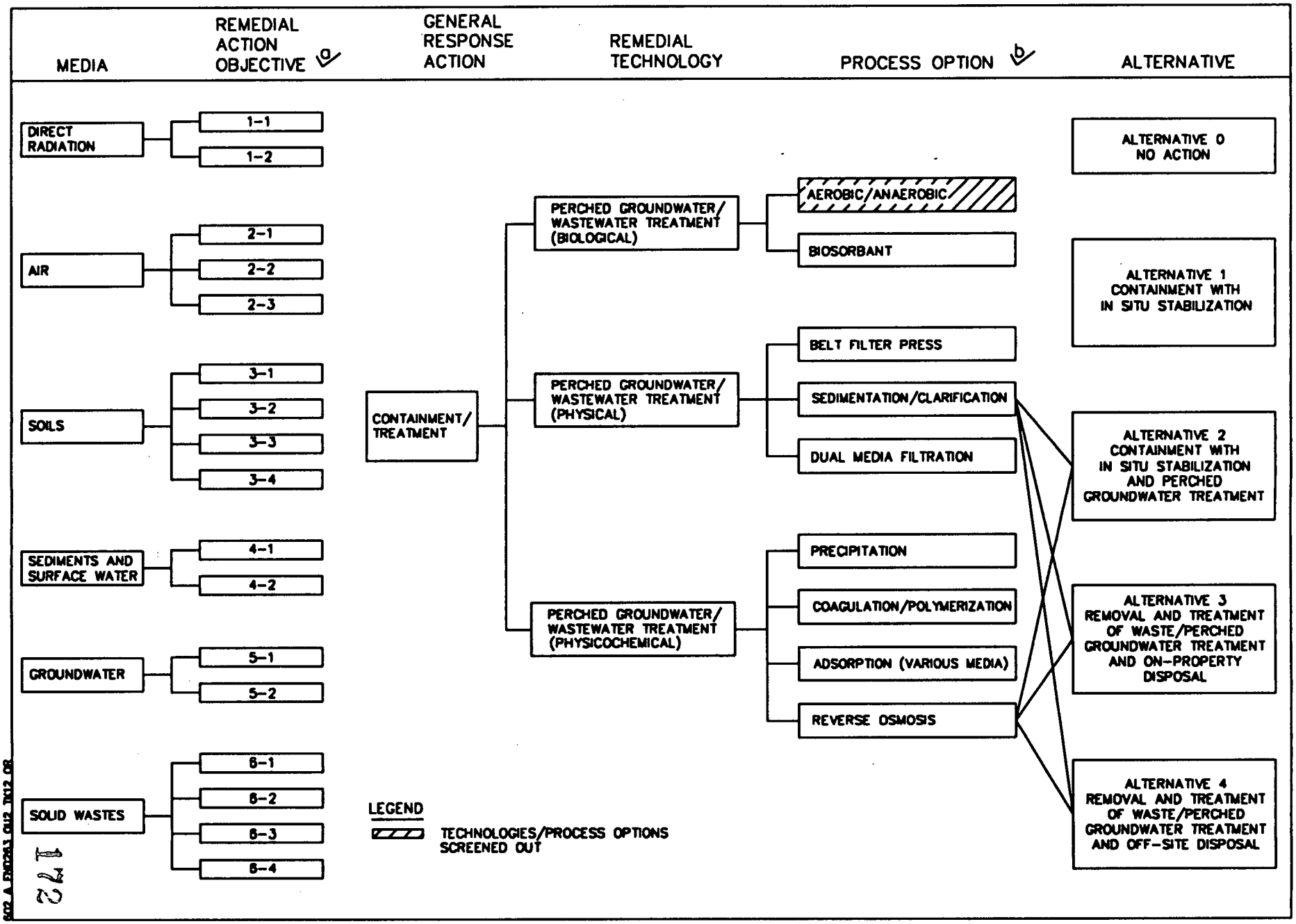


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

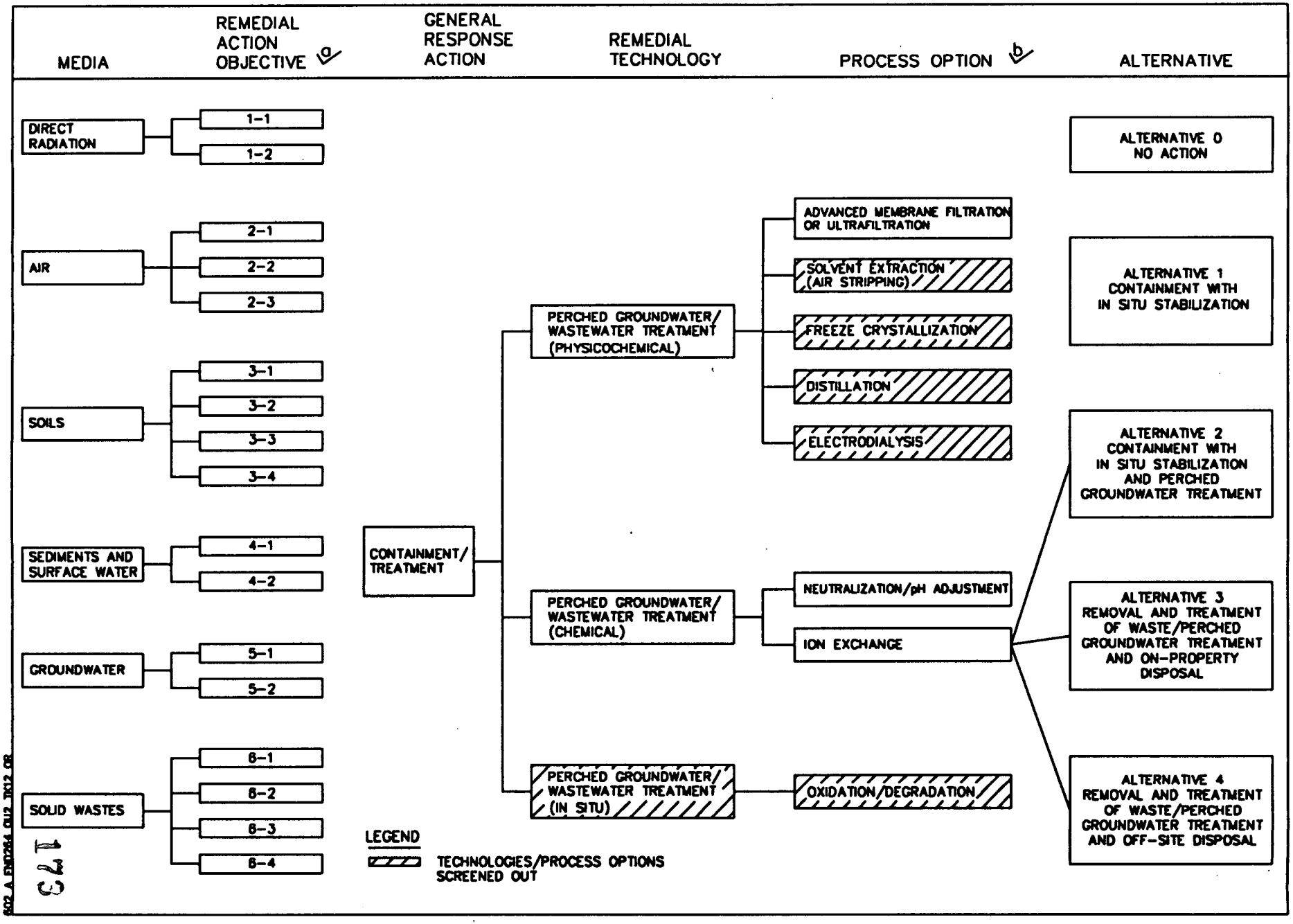


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

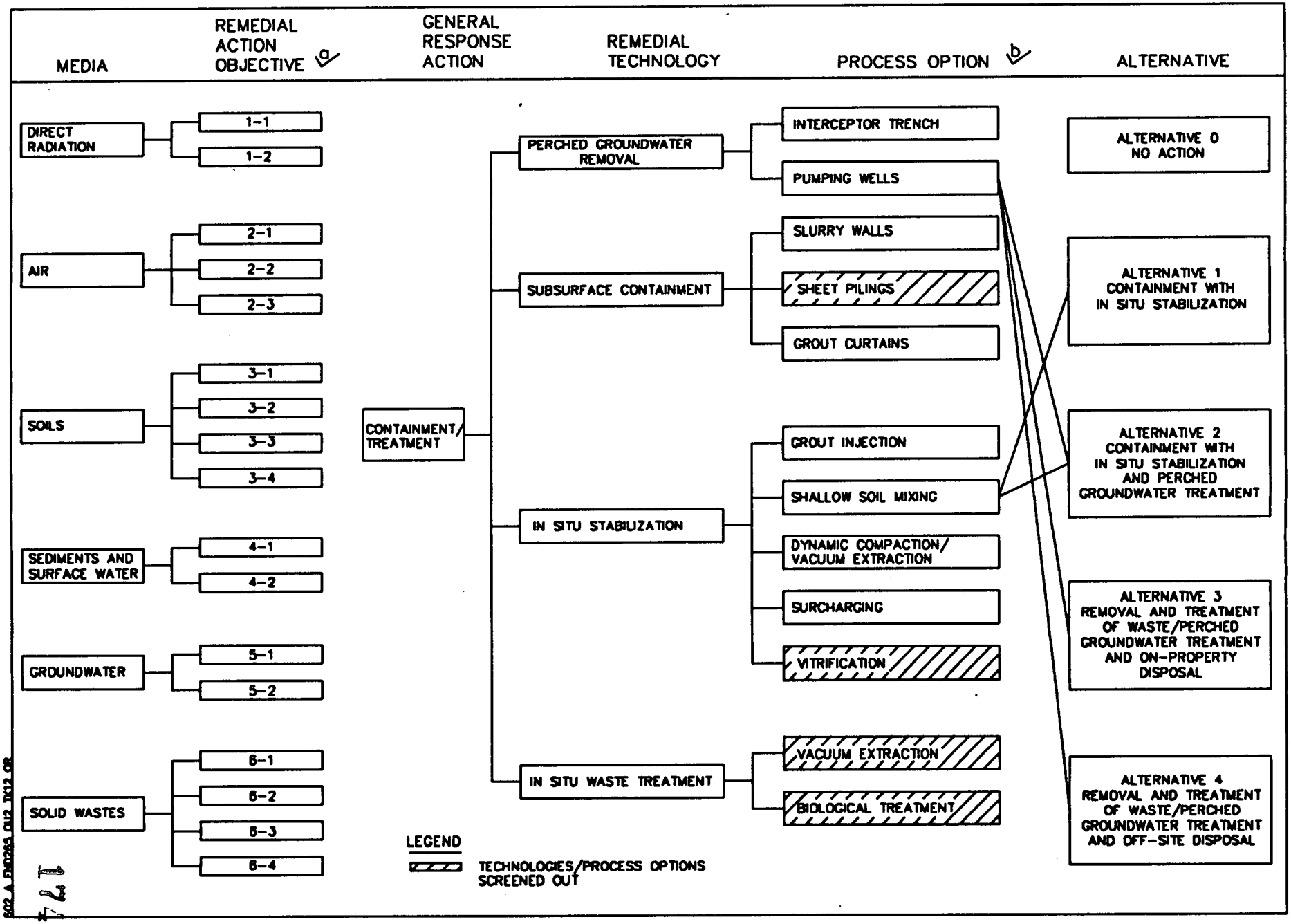


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

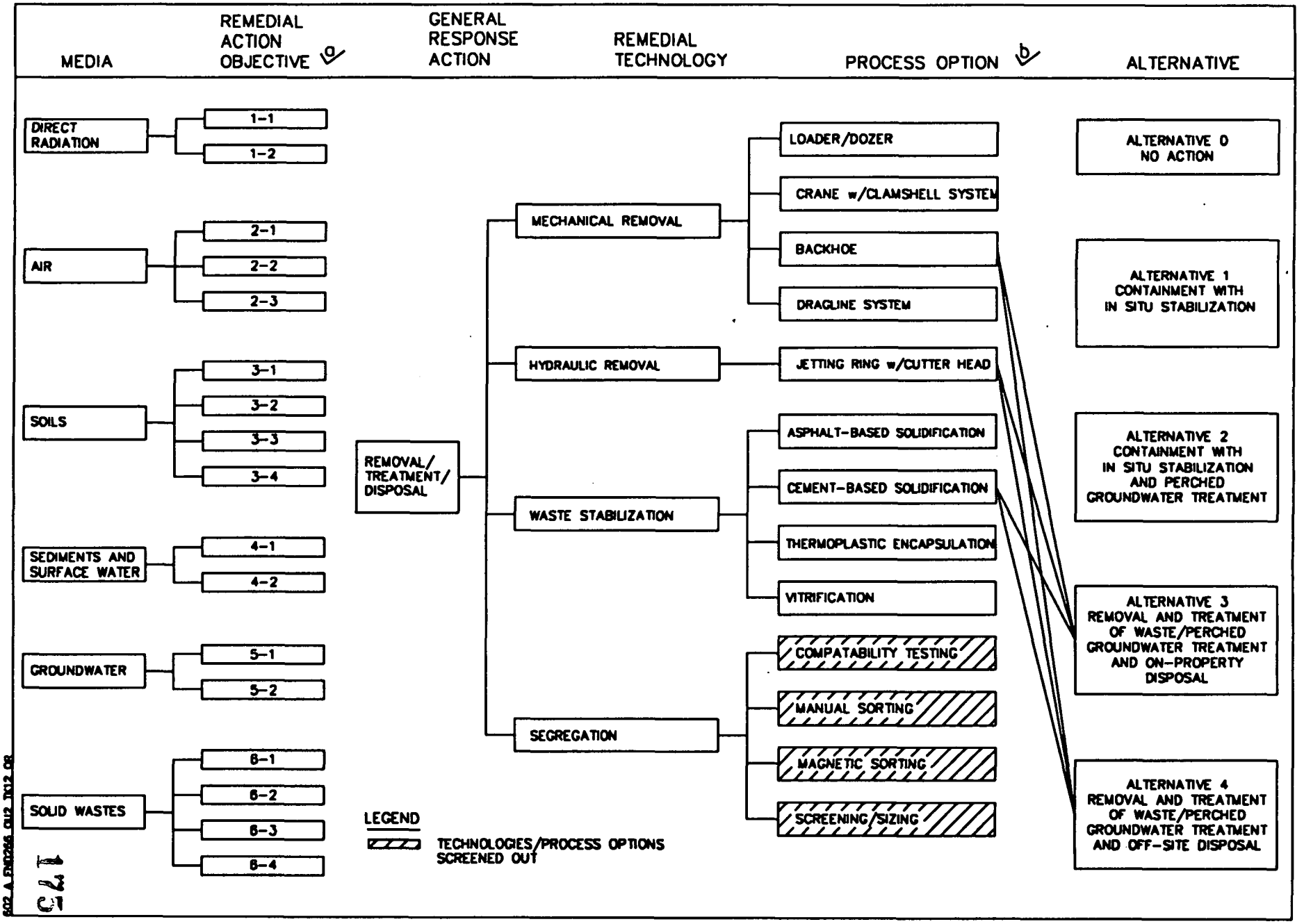


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

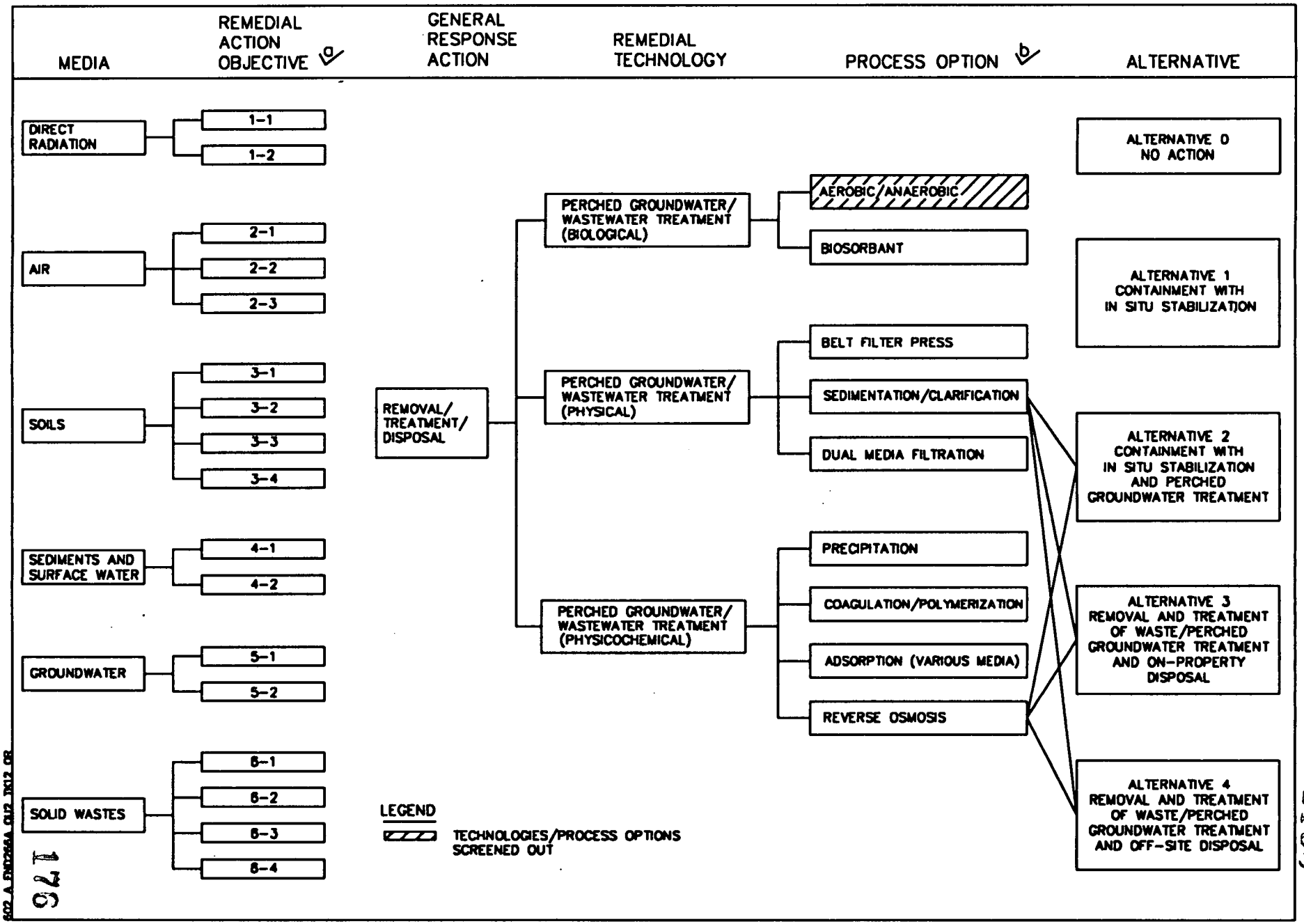


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS — LIME SLUDGE PONDS (Continued)

1185
176
SEE A FOLDING TO FOLLOW

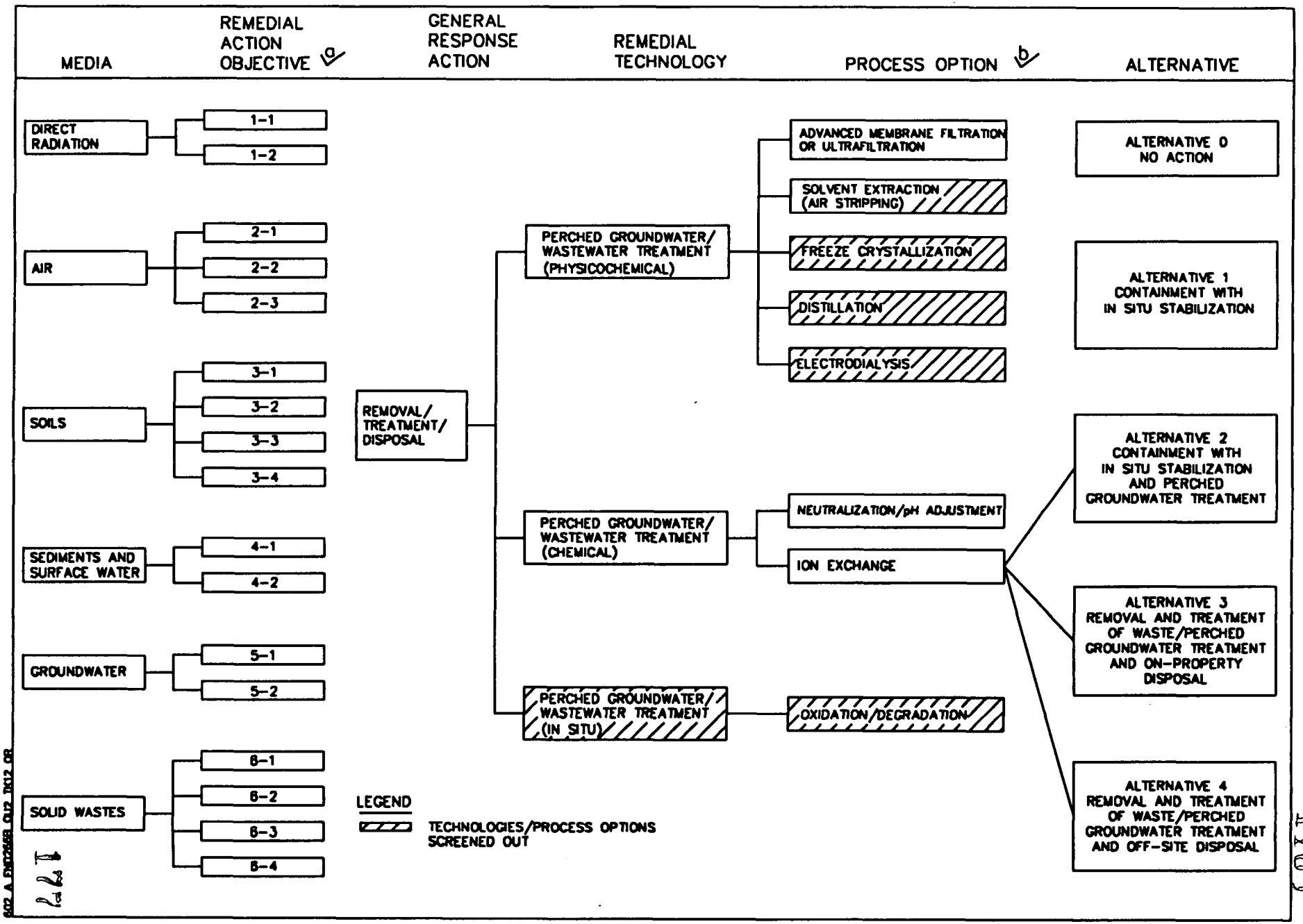


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

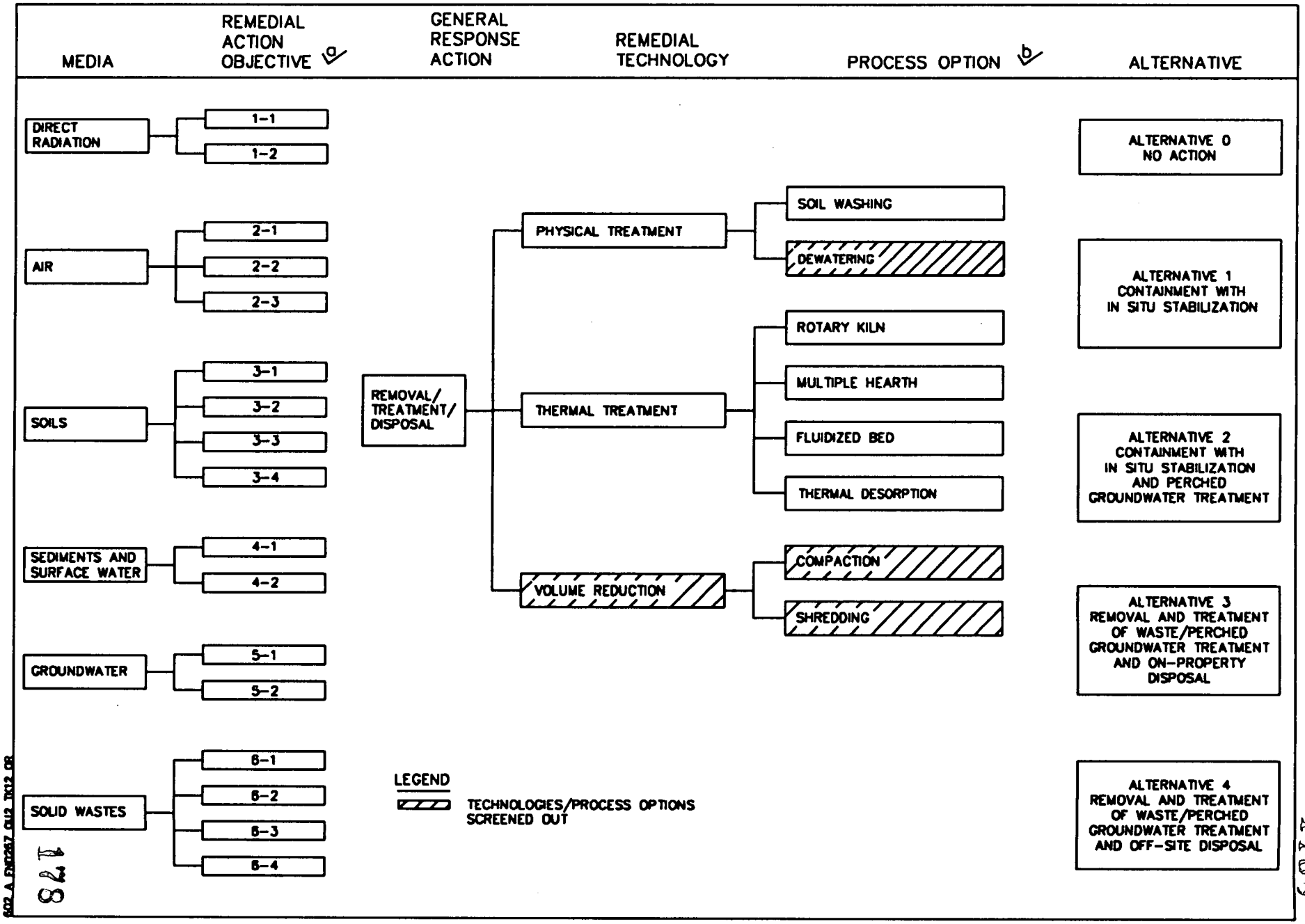


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

1195
178

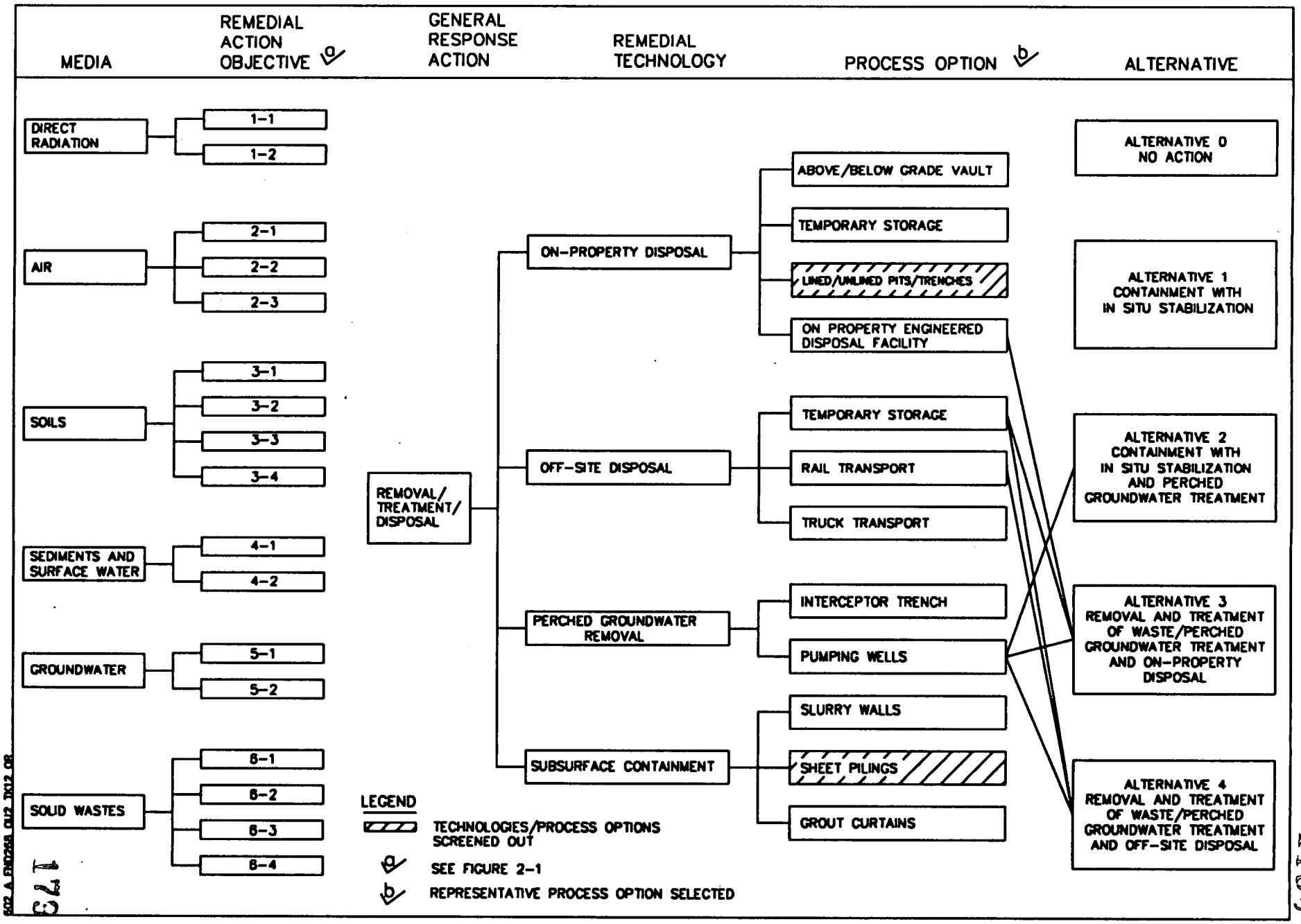


FIGURE 3-2. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – LIME SLUDGE PONDS (Continued)

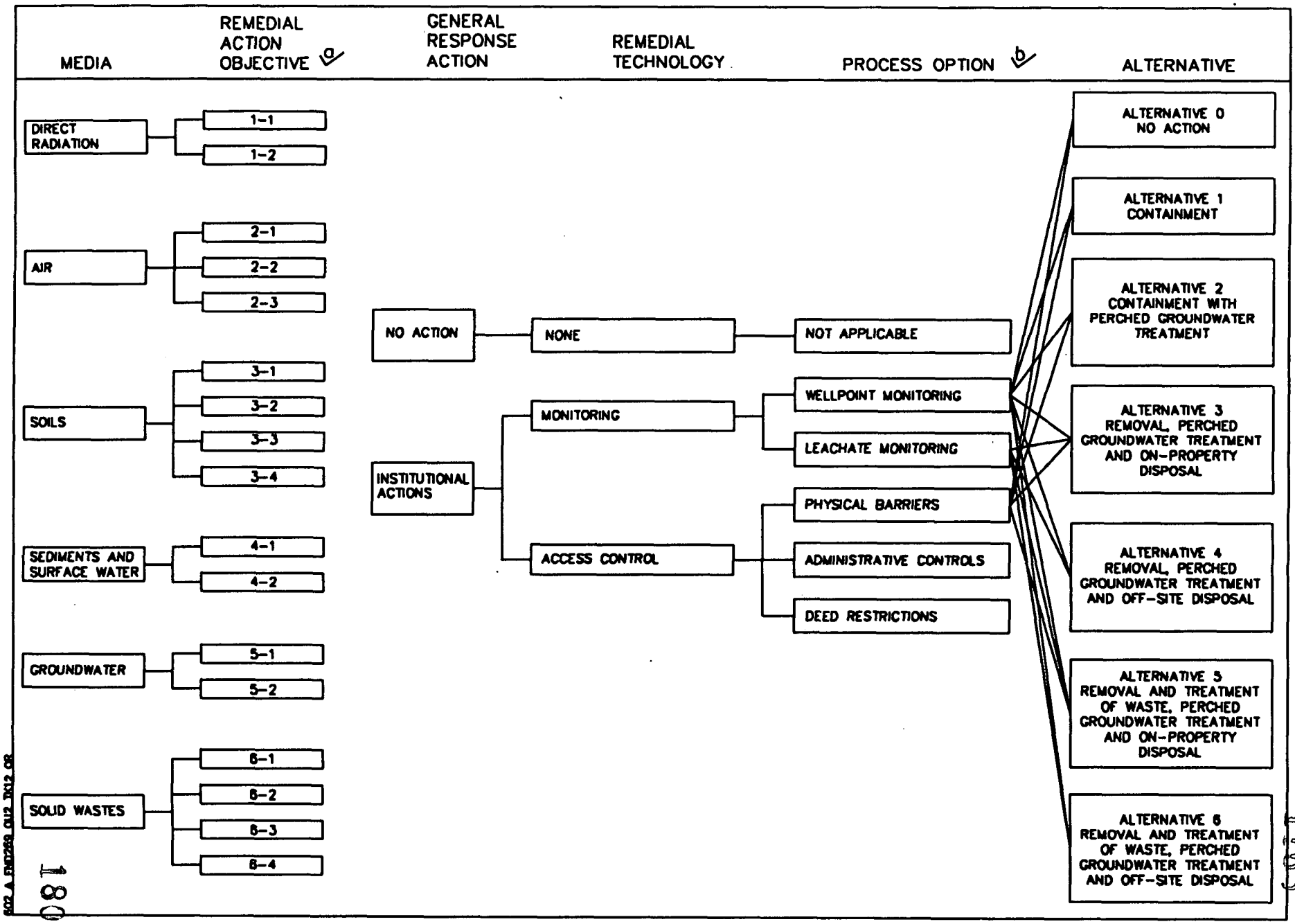


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS

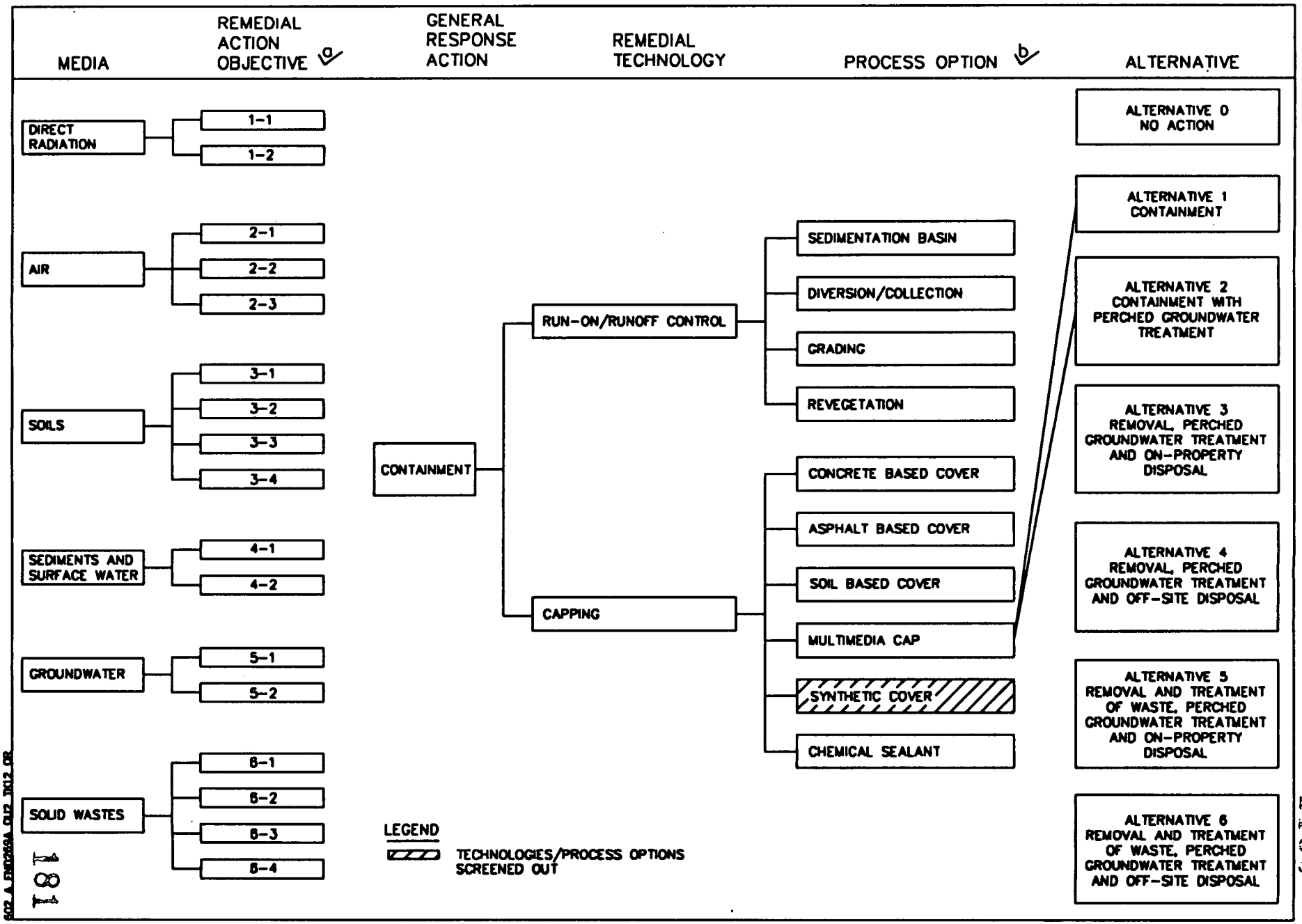


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

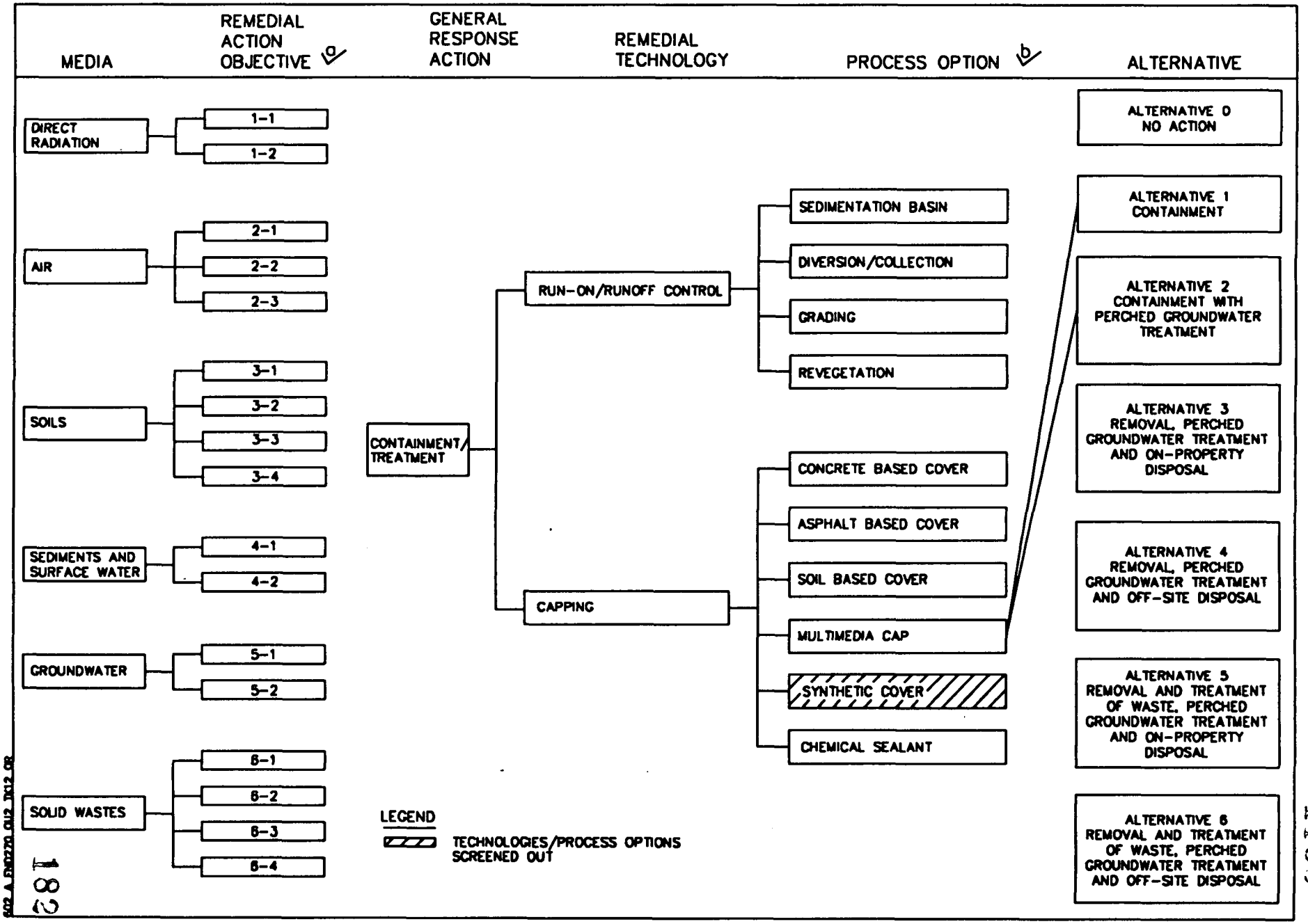


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

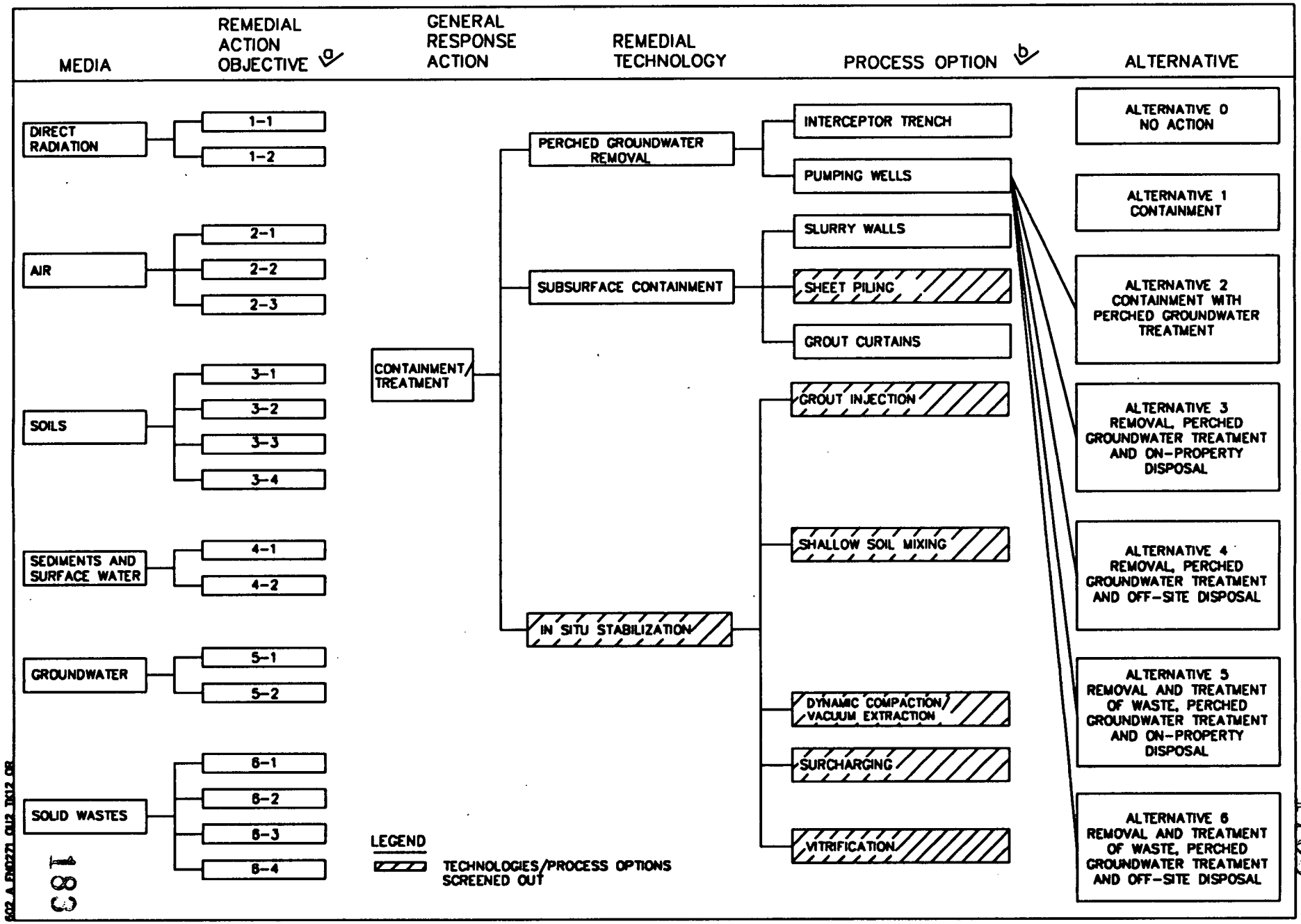


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

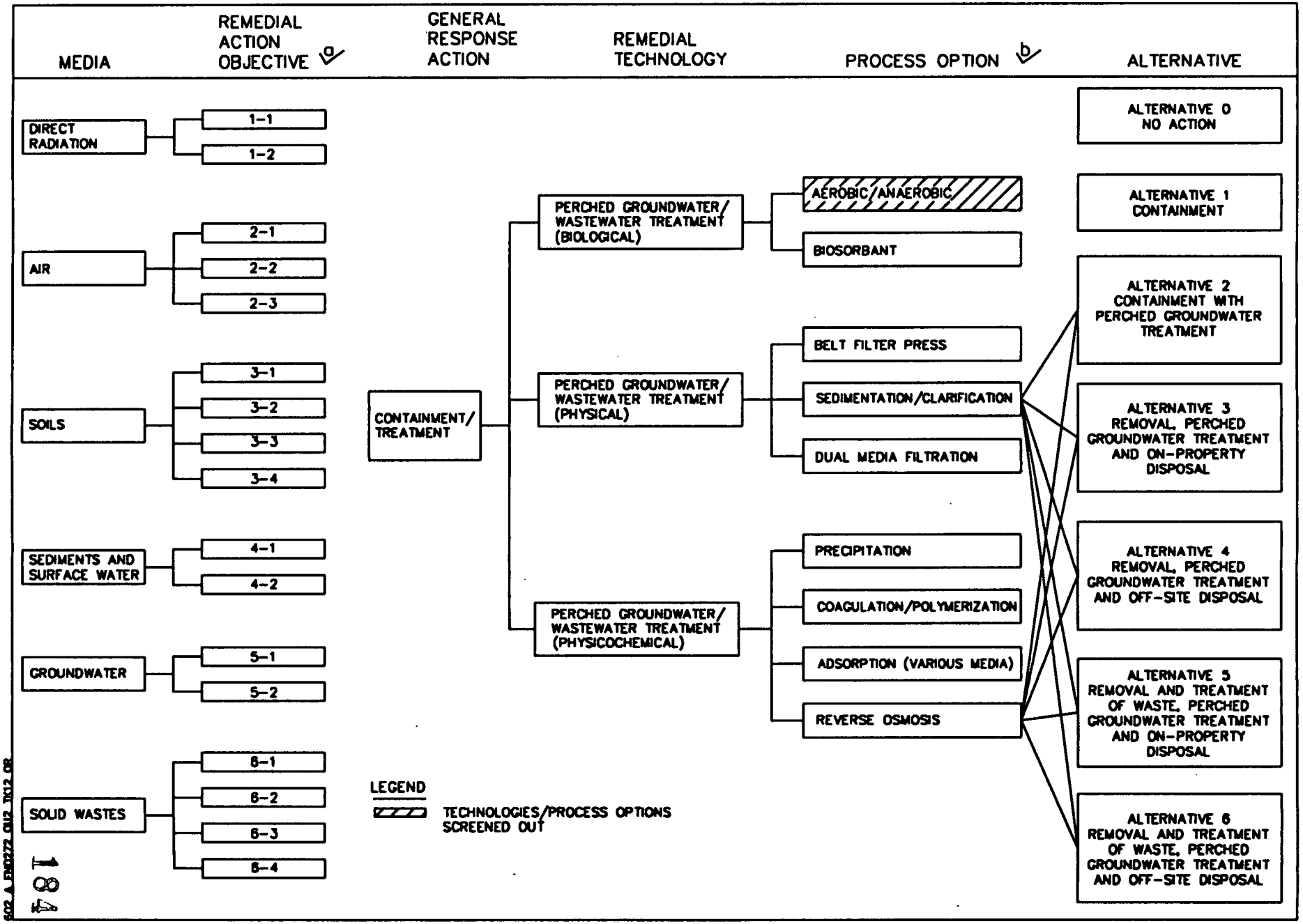


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

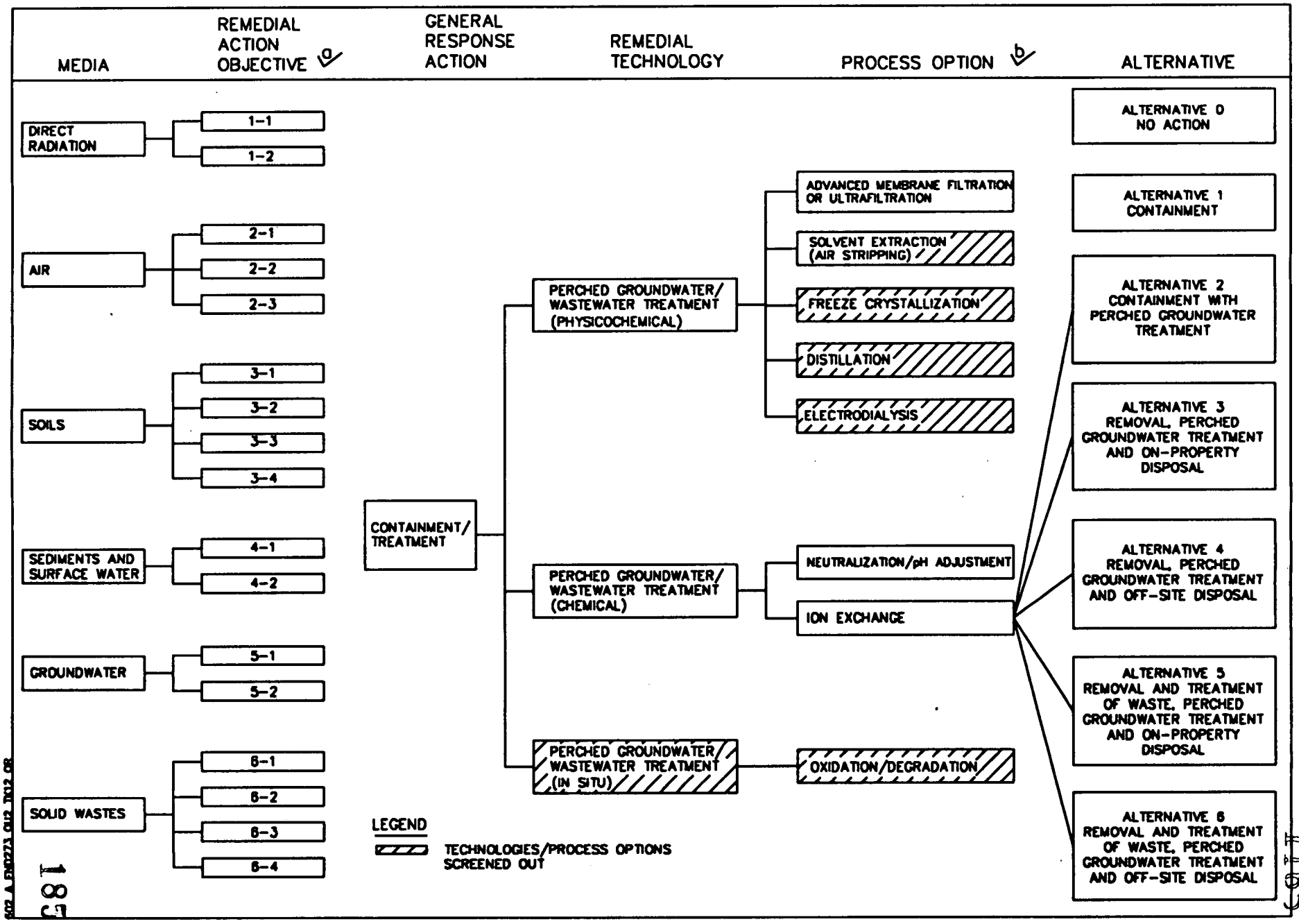


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

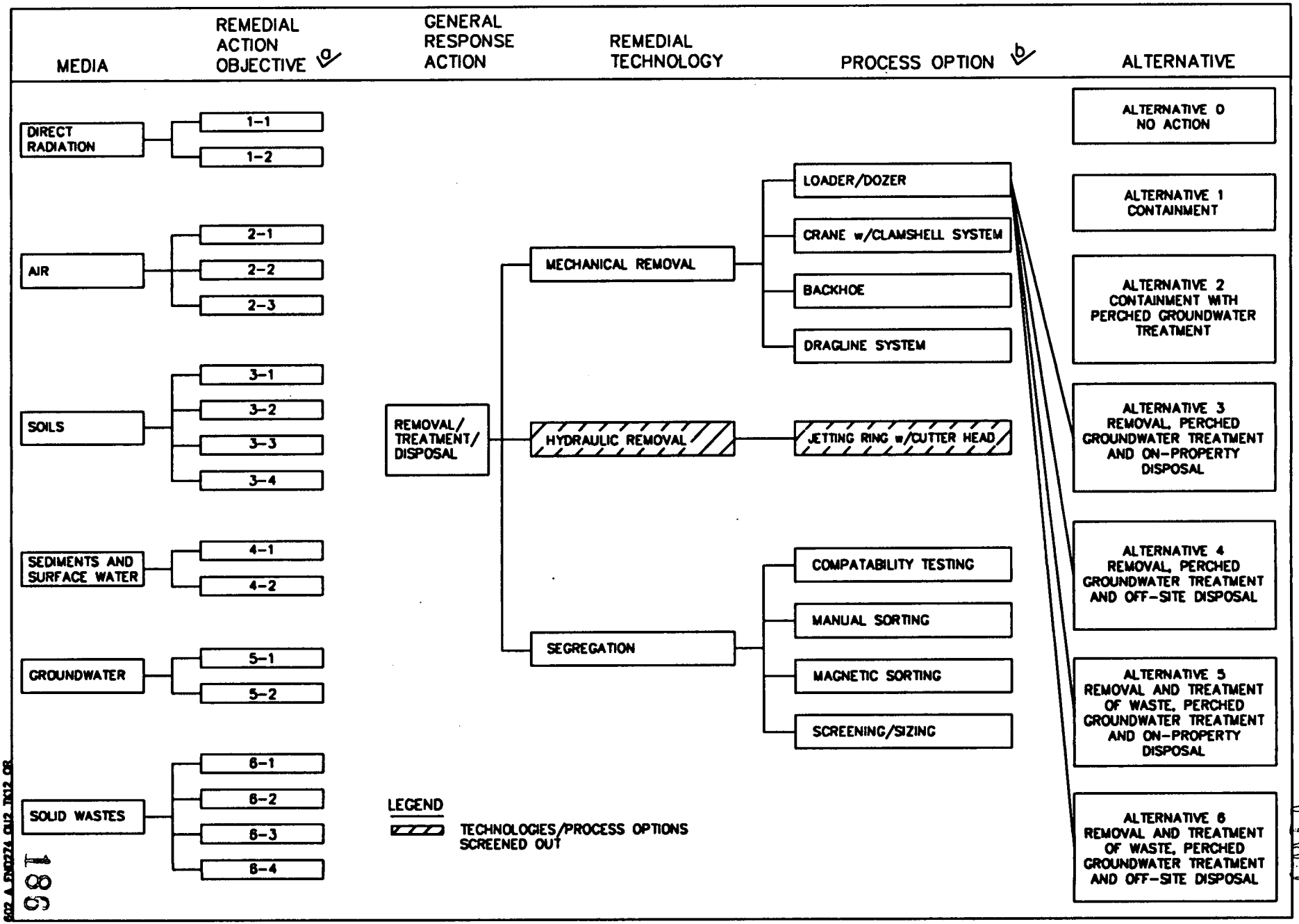


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

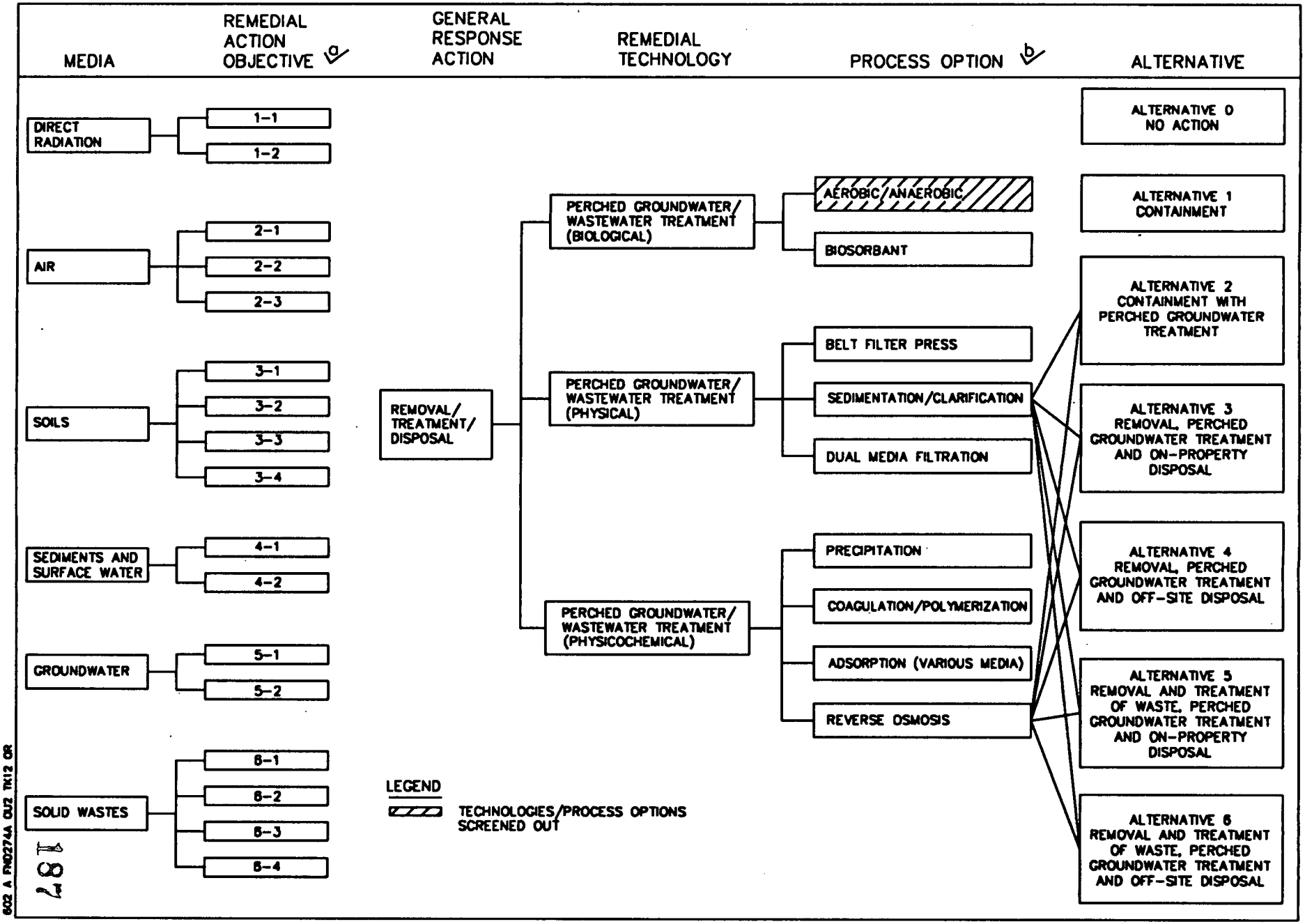


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

602 A FN0274A OUZ TK12 OR

187

1195

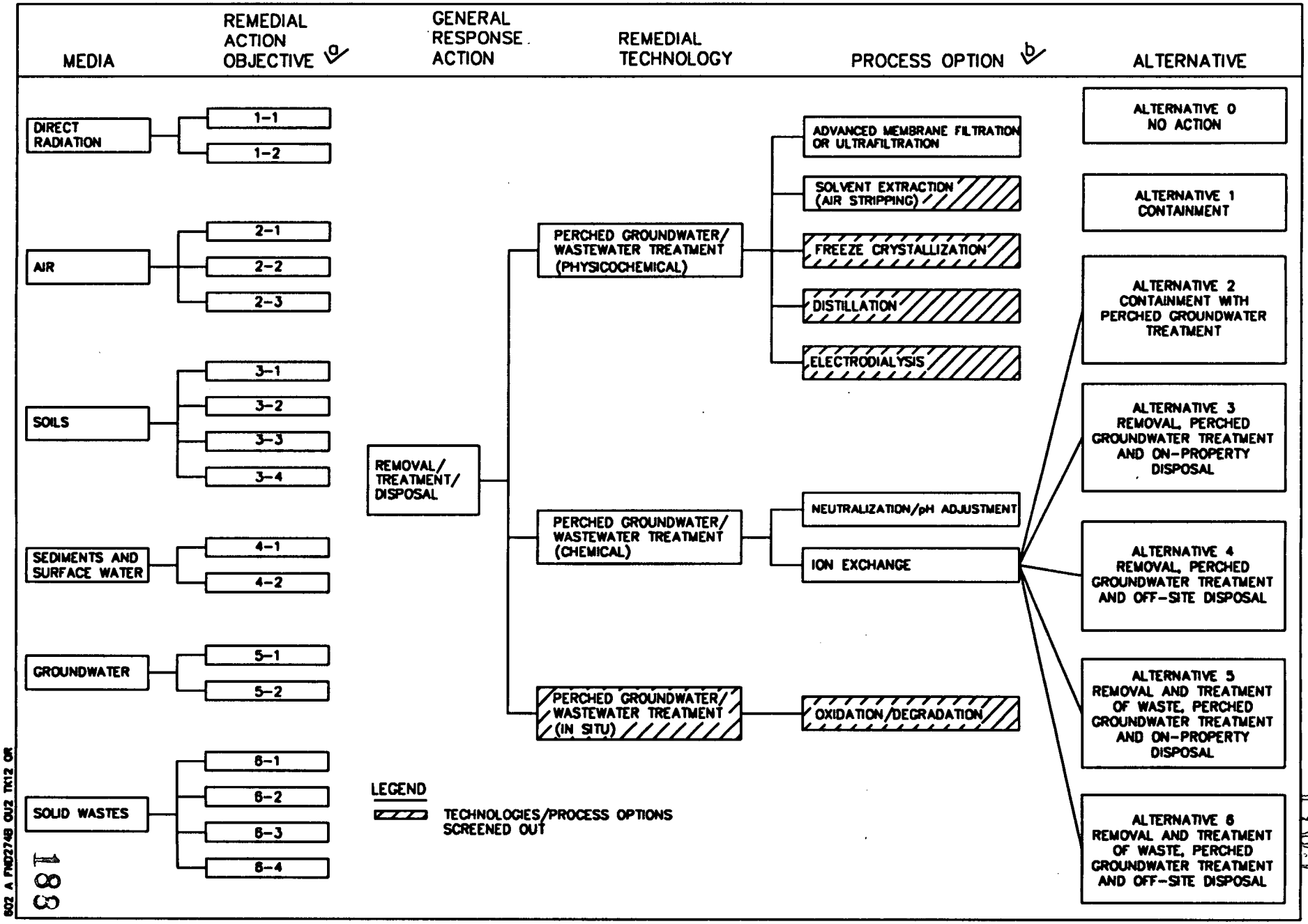


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

602 A FND2749 OU2 TK12 OR
183
115

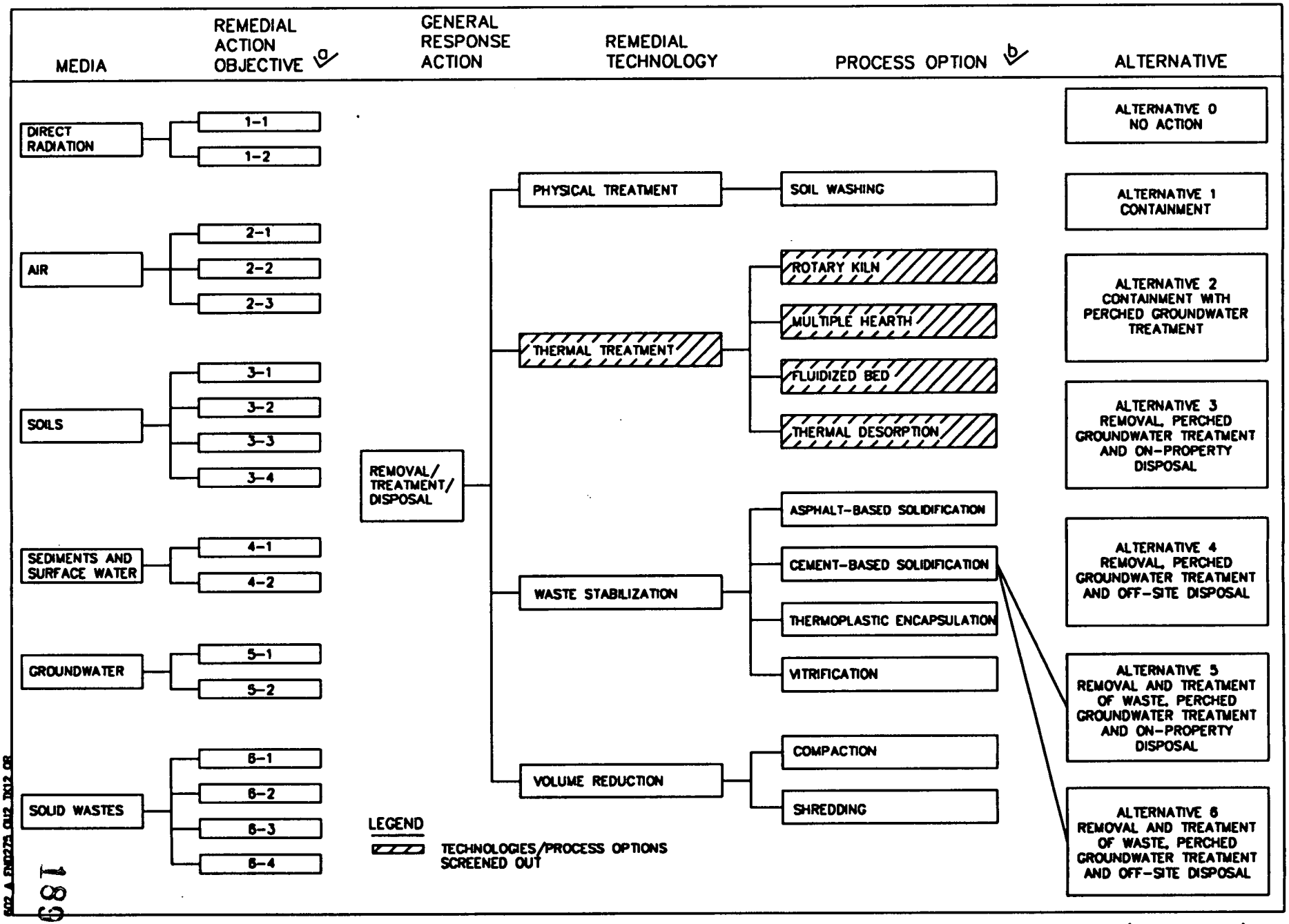


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

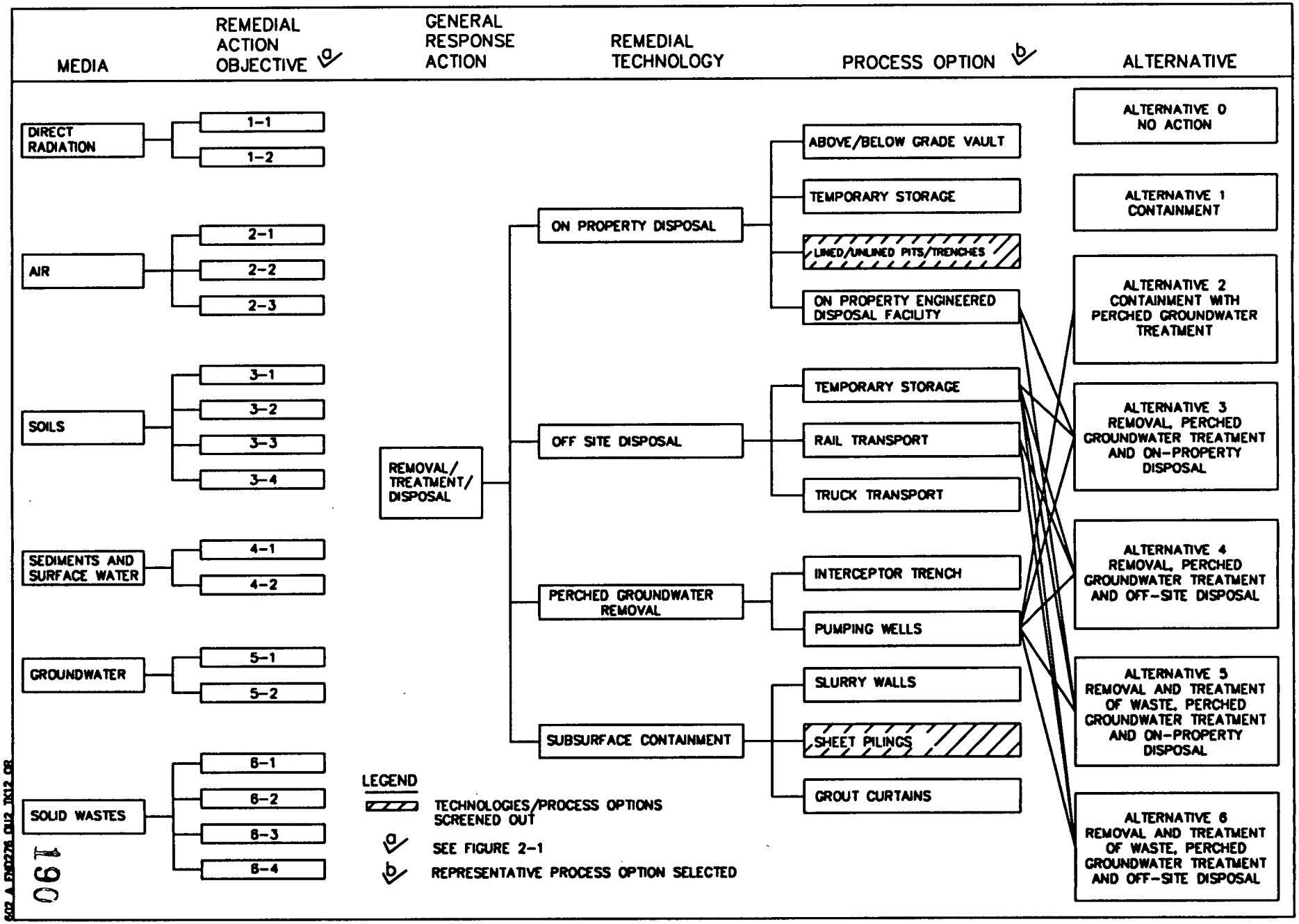


FIGURE 3-3. GENERAL ALTERNATIVE DEVELOPMENT PROCESS – FLY ASH/SOUTHFIELD AREAS (Continued)

3.2 DESCRIPTIONS OF ALTERNATIVES

3.2.1 Sanitary Landfill

The Sanitary Landfill is composed of approximately one acre and is located just outside the northwest corner of the production facility in the northern portion of the FMPC property. A fence bounds three sides of the area, and a railroad track bounds the fourth side. Additional information pertaining to the Sanitary Landfill is described in Sections 1.5.2.1 and 1.5.3.1.

3.2.1.1 Alternative 1: Containment

The first nonremoval alternative represents a minimum-action scenario that is intended to isolate the wastes and to minimize the vertical infiltration of rainfall/runoff into and through the Sanitary Landfill wastes. This alternative includes access restrictions, monitoring activities, capping, and run-on/runoff control. Before to cap construction, the waste areas would be contour graded with clean and compacted fill to provide proper drainage. The cap would consist of a vegetation cover, a natural drainage layer, a flexible membrane liner, and a low-permeability clay liner; and it is expected to cover approximately one acre. All cap elements and layers would be contoured to grades that promote drainage while minimizing the effects of waste subsidence and storm-water erosion. Properly constructed run-on/runoff control features would safely remove precipitation water from the closed area. Run-on/runoff control would be accomplished using one or more of the following: site contour grading; vegetation; diversion; collection; scales; ditches; and various physical devices including weirs, baffles, and lined sedimentation basins. Details of system requirements and spatial requirements for this alternative follow.

System requirements for this alternative are:

- Earth-moving, excavation, and compaction equipment
- Clay capable of achieving 10^{-7} cm/s vertical permeability
- Long-term maintenance and environmental monitoring program
- Partial relocation of the drainage located north of the landfill
- Water treatment facility and water supply
- Decontamination facilities
- Short- and long-term run-on/runoff control

The spatial requirements are:

- Staging area for construction material and equipment - 0.5 acre
- Office and field laboratories - 0.5 acre
- Decontamination facilities - 0.5 acre
- Wastewater treatment system - 0.5 acre

An alternative to the capping sequence described previously would be the inclusion of a biointrusion barrier between the vegetation cover and drainage layer. This barrier could consist of a two-foot-thick layer of cobbles and would be designed to preclude deep-rooting plants and burrowing animals from damaging the flexible membrane liner and low-permeability clay liner. A filter layer would be placed on top of the biointrusion barrier to limit soil migration into this layer, thereby reducing performance.

All waste units would require runoff and sediment control prior to cap construction to prevent transport of waste unit material. The Sanitary Landfill is relatively flat, so only minor grading would be required. The existing drainage north of the Sanitary Landfill would require realignment; a temporary sedimentation pond could be constructed as shown in Figure 3-4.

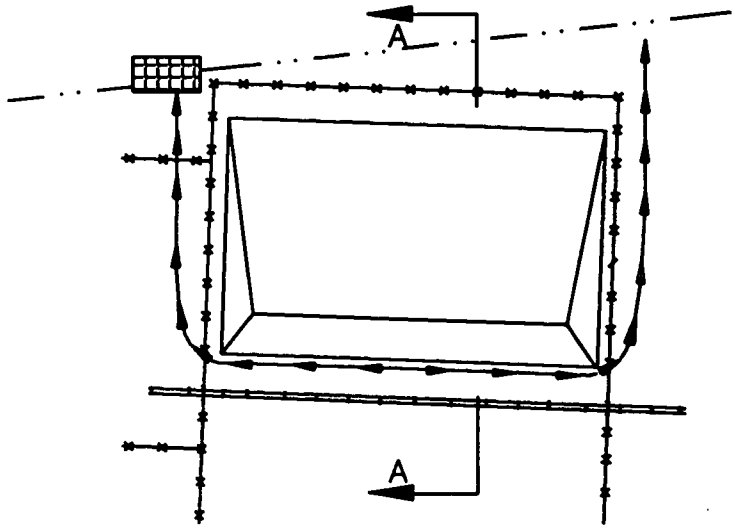
The remediation time frame for the implementation of Alternative 1 at the Sanitary Landfill is expected to be approximately two years, anticipating time lost due to bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways.

There are no transportation requirements for the waste itself since all waste would remain in place on the FMPC property. LLRWs generated as a result of construction activities would be considered low specific activity (LSA) material and, if shipped off site, would be packaged in accordance with applicable portions of 49CFR173. The packaging used for transport and disposal of LLRW should be watertight, certified for the transport of LSA material (i.e., it should meet U.S. Department of Transportation [DOT] packaging requirements), and of suitable size. Any LLRW generated as a result of construction activities could be disposed of on property. Any on-property transportation of construction-generated wastes would be in accordance with the requirements set forth in DOE Order 5480.3a (Draft). CERCLA exempts on-site activities from permits but requires compliance with substantive requirements of ARARs.

3.2.1.2 Alternative 2: Containment with Perched Groundwater Treatment

The second nonremoval alternative is an extension of Alternative 1 but provides for a more proactive approach to leachate control. In addition to the response actions identified for Alternative 1, Alternative 2 consists of wellpoint extraction and treatment of perched groundwater. Figure 3-5 shows a wellpoint system that would surround the Sanitary Landfill. Wells would be placed in the glacial overburden to extract perched water that may be contained in sand lenses that underlie the Sanitary Landfill. The remaining steps that comprise this alternative are identical to Alternative 1.

Sand lenses in the glacial overburden can yield up to 50 gallons per minute (gpm) (DOE 1988c). However, yields of that flow rate are not likely in the vicinity of the FMPC. The presence of sand lenses is confirmed by results of the field investigation. It appears that a two-foot-thick sand



PLAN

SCALE

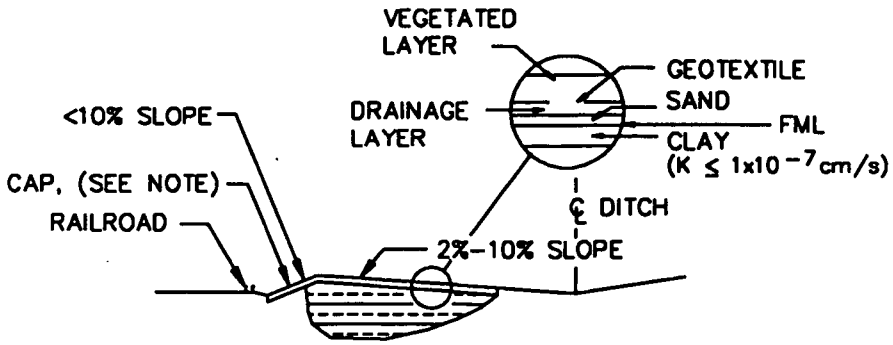
0 100 200 FEET

LEGEND:

- FENCE
- RAILROAD TRACKS
- DRAINAGE
- RELOCATED DITCH
- TEMPORARY SEDIMENTATION POND

NOTES:

1. CONTOURS AND EXISTING FEATURES ARE TO SCALE
2. CONCEPTUAL FEATURES ARE FOR ILLUSTRATIVE PURPOSES ONLY AND NOT TO SCALE



SECTION A–A

NTS

FIGURE 3–4. SANITARY LANDFILL WITH CAP – ALTERNATIVE 1

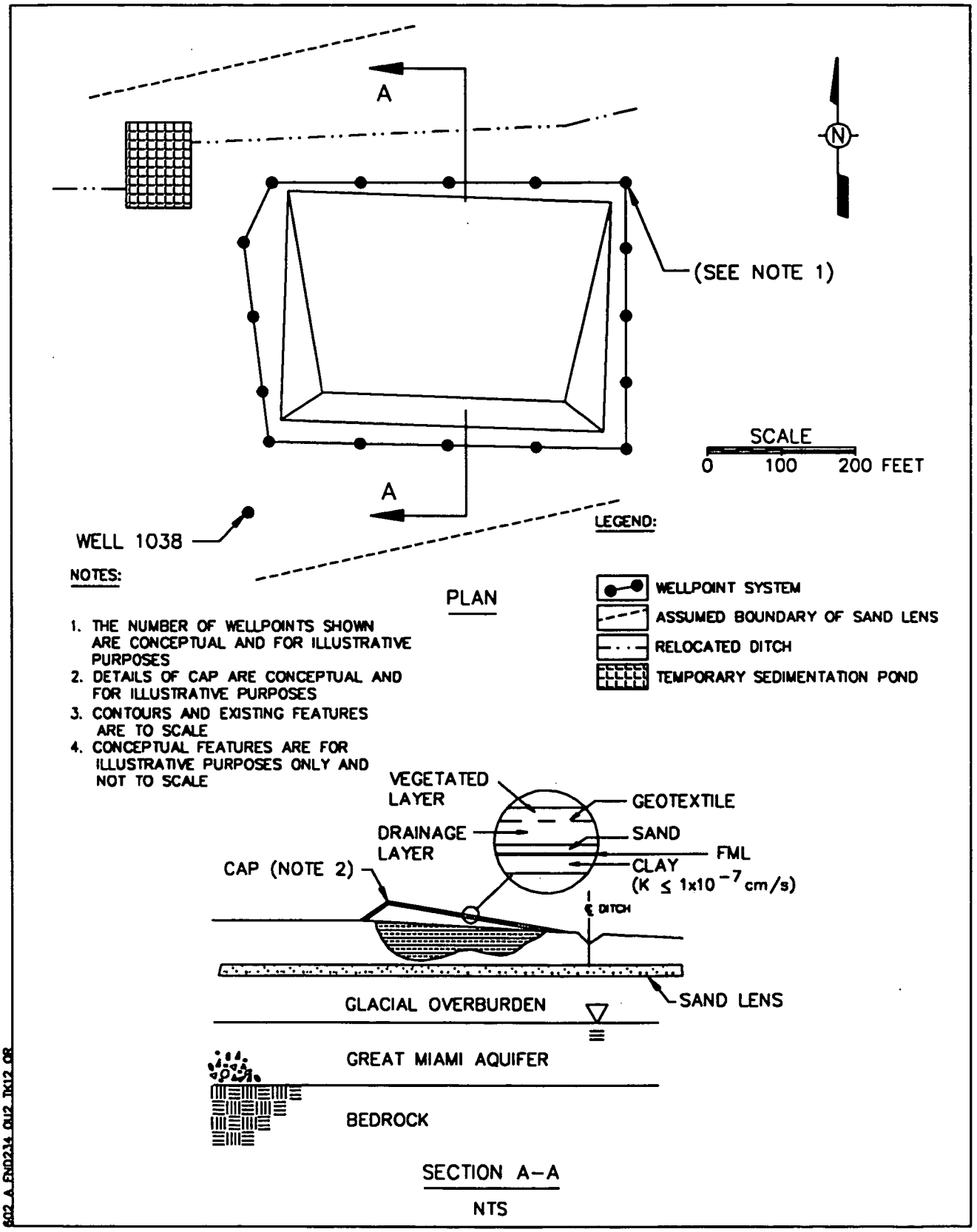


FIGURE 3-5. SANITARY LANDFILL - ALTERNATIVE 2

lens is continuous below the bottom of the Sanitary Landfill. It is assumed that implementation of this alternative would require the placement of an extraction wellpoint system sized for no more than 10 gpm flow rate. The water collected would be treated in the advanced wastewater treatment (AWWT) system prior to its release to the Great Miami River. This would reduce concentration levels of radiological or hazardous chemical constituents. The water treatment system may include presedimentation and a sedimentation/filtration process which includes flocculation (by chemical addition) and filtration (using pressure filtration to force fluid through a porous media).

The process (after the sedimentation/filtration) consists of ion exchange to remove metallic ions and reverse osmosis to remove total dissolved solids (TDS), so that the toxicity and mobility of contaminants and the concentration of contaminants in the water would be reduced before it is discharged.

The wellpoint system locations are approximate; exact placement would depend on a detailed analysis of data. Each system should be designed to pump no more than 10 gpm; this flow rate is conservative and is the maximum flow rate anticipated for perched water removal in Operable Unit 2. The wellpoint system would be operated until contaminant concentrations are below levels of concern (as established by ARARs) or the quantity of collected water becomes negligible. The time frame for pumping is not presently known; however, for purposes of volume and cost estimation, one year is assumed. Should this alternative be selected for detailed analysis, modeling studies could determine a realistic time frame. Based on the above estimates, and assuming a sand lens area roughly equivalent to the area of each waste unit, approximately 436,000 gallons would be extracted from perched water zones underlying the Sanitary Landfill. This volume estimate assumes a sand lens that is continuous under the unit and a time frame of one year for pumping the local groundwater.

Extraction of perched water, plugging the extraction wells, and capping would also take an estimated two years to complete. Open space that surrounds the Sanitary Landfill would allow for construction activities, but they should be coordinated with the remediation of other operable units.

There are no transportation requirements for the waste since all waste would remain in place and on property. LLRW generated as a result of construction activities would be considered LSA material and, if shipped off site, would be packaged in accordance with applicable portions of 49CFR173. Packaging used for the transport and disposal of the low-level radioactive material should be watertight, certified for the transport of LSA material (i.e., meet DOT packaging requirements), and of suitable size. LLRW generated as a result of construction activities could be disposed of on property. Any on-site transportation of construction-generated wastes would be in accordance with the requirements set forth in DOE Order 5480.4a (Draft).

Construction activities would generate ordinary sanitary (solid) waste and LLRW in the form of contaminated clothing, tools, and equipment. Treatment of groundwater would generate additional chemically and radiologically contaminated wastes. CERCLA exempts on-site activities from permit requirements. However, CERCLA necessitates compliance with substantive requirements of ARARs, so ARARs should be included in decision documentation used for site remediation. The discharge of treated water off site would be in compliance with the in-place NPDES permit.

3.2.1.3 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal

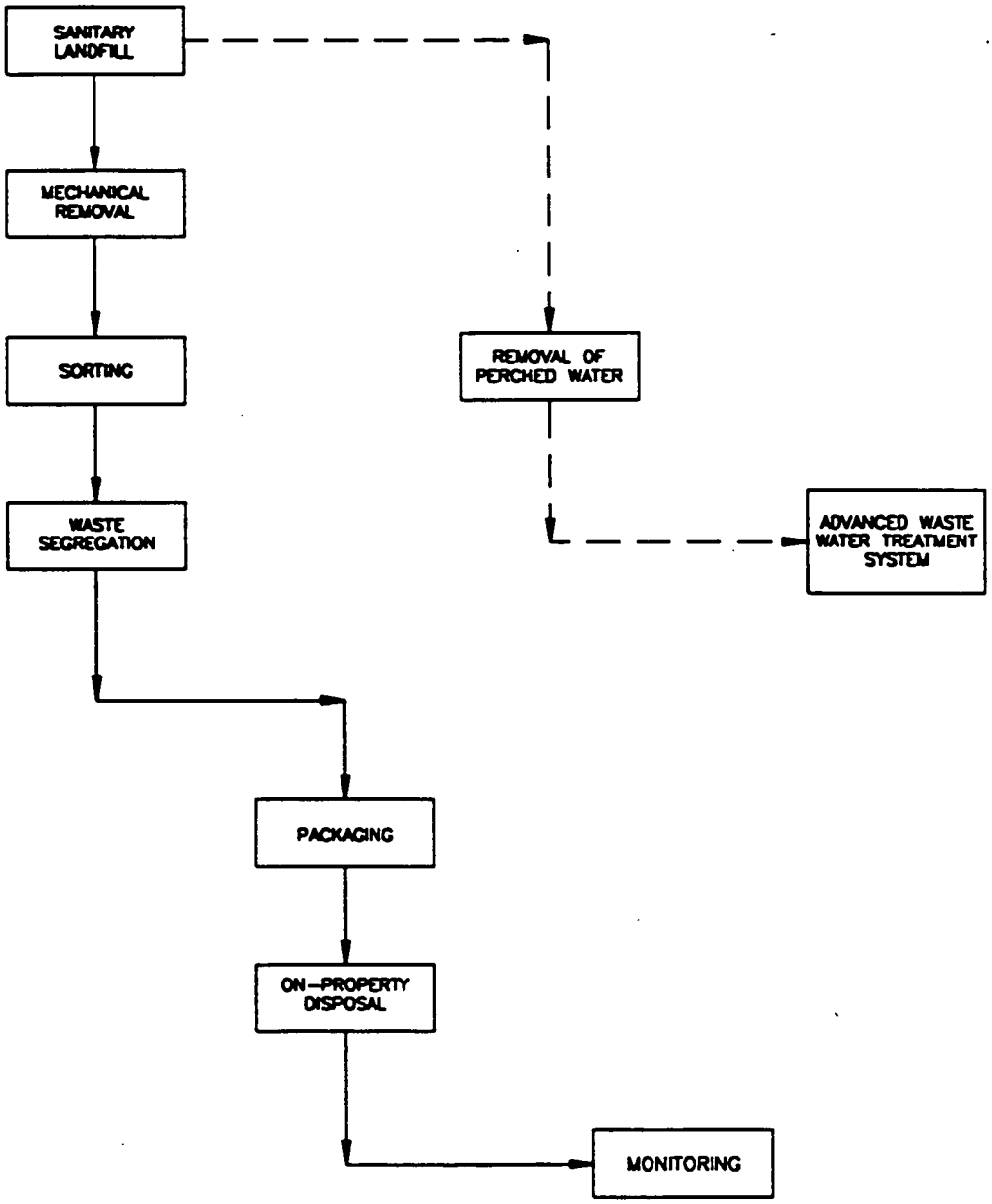
In addition to access restrictions, groundwater monitoring, and runoff control, this alternative incorporates mechanical removal and on-property disposal of waste materials and treatment of perched groundwater removed from the sand lenses that underlie the Sanitary Landfill. The process sequences associated with this alternative are depicted in Figure 3-6.

The system requirements for Alternative 3 include an aboveground on-property EDF (Figure 3-7) and an AWWT facility capable of treating any wastewater (to decrease its radiological and hazardous effects) generated as a result of the removal of perched groundwater which underlies the waste units. A removal system that utilizes mechanical equipment would be required to remove and transport wastes from the Sanitary Landfill to the EDF. Where applicable, a sorting method would be used to segregate the waste, followed by volume reduction. The system requirements are described more fully in the following sections.

Mechanical removal methods would be employed for the removal of wastes from the Sanitary Landfill. Excavation equipment (such as backhoes) would be used for waste removal. A truck or conveyor system would then move the excavated waste to an interim area where there would be equipment for segregation, volume reduction, and compaction/shredding. The waste would then be packaged and transported to the aboveground, on-property EDF.

To achieve the overall goal of protecting human health and the environment, this alternative would provide for the removal and treatment of any perched groundwater contained in the sand lenses that underlie the Sanitary Landfill. A wellpoint system that surrounds the Sanitary Landfill, described in Section 3.2.1.2, would be installed in the glacial overburden layer to extract the perched groundwater. The time required to complete efforts as described in this alternative is estimated to be four years and anticipates bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. This time frame begins with site mobilization and continues through decontamination, disassembly, construction of an EDF, and finally to removal of any process equipment.

OPERABLE UNIT 2
REMOVAL OF WASTE, PERCHED GROUNDWATER TREATMENT
AND ON-PROPERTY DISPOSAL



802 A FND245 OU2 TK12 OR

FIGURE 3-6. REMEDIAL ACTION ALTERNATIVE 3-SANITARY LANDFILL

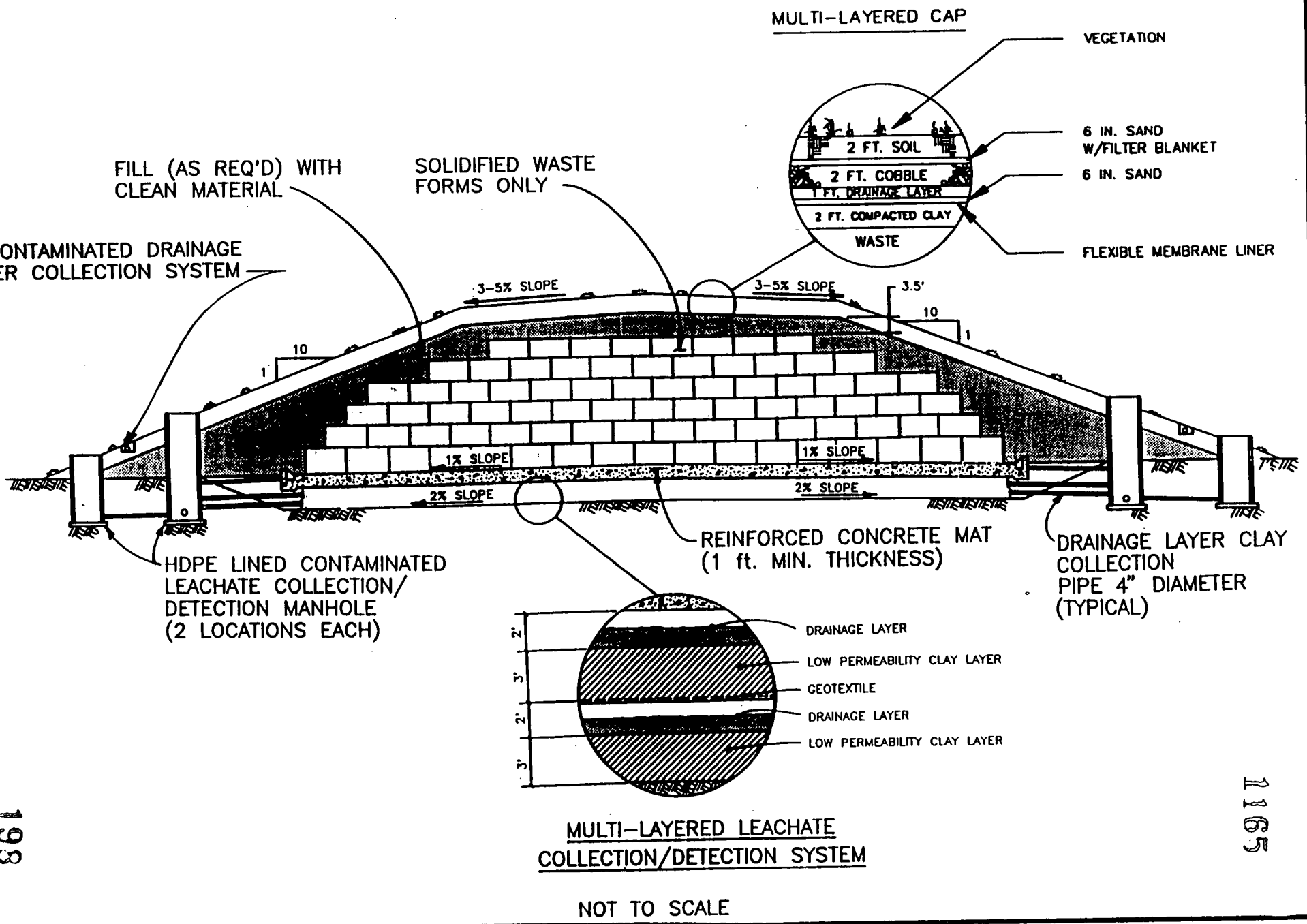


FIGURE 3-7. ENGINEERED DISPOSAL FACILITY

602 A FND251 OU2 TK12 CR

198

1165

Before packaging and transport, the waste from the Sanitary Landfill may be segregated so that material requiring volume reduction could be screened. Cover would be removed and visual inspection would be made to determine the types of materials (construction rubble, concrete, drums, etc.) present and the best method for handling and sorting them. Care would be taken during removal of materials to avoid puncturing drums or other containers, if they were encountered. The following segregation process options have been selected for further consideration:

- Magnetic sorting - This method would identify areas of ferrous materials within the Sanitary Landfill. Recovered drums or containers would be isolated.

- Manual sorting - This method involves the "hands-on" separation of the different physical types of waste materials. The safest method would be used to evaluate and remove metals or other types of debris that are different from the majority waste forms. Special cleaning and decontamination procedures may be necessary for large objects before disposal.

- Screening/sizing - Physical separation of materials may be required. To do this, a series of fixed or moving screens, sized to retain particles of a desired size range while allowing smaller particles and liquids to pass through the screen surface, would be used.

After segregation, and depending on the waste composition, the wastes may be subjected to volume reduction before transport to the aboveground EDF. The following process options are selected for further consideration:

- Compaction - Physically deforming or compressing the waste into a more dense configuration

- Shredding - Tearing or cutting the waste form into smaller pieces to facilitate handling and disposal

In addition to some manual sorting of materials, the need for a combination screening/ shredding/ crushing system with a capacity of 10 to 20 tons per hour is anticipated.

An EDF was considered for the on-property disposal of the waste material. A basic disposal concept would consist of mounding over containerized waste that has been placed on a stable structural pad. For maintenance of structural integrity (cap subsidence) and control of water infiltration (leaching), the EDF should accept only containerized or highly stabilized waste forms. An EDF consists of an on-grade, reinforced, concrete structural pad incorporating (1) a RCRA-type closure cap that includes a biointrusion barrier, described for Alternative 1, and (2) a RCRA-type impermeable liner and underlayment with a leachate collection and detection system. A combined EDF for all operable units at the FMPC could be useful if it were available at the time of Operable Unit 2 remedial actions. A concept of an EDF is depicted in Figure 3-7.

The spatial requirements for implementing this alternative are as follows:

- Offices and field laboratory - 0.5 acre
- Decontamination facilities - 0.5 acre
- On-property packaging facility - 0.5 acre
- Staging area for supplies and earth-moving equipment - 0.5 acre
- EDF or equivalent - 1.5 acres
- Wastewater treatment plant - 0.5 acre

3.2.1.4 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal

This second removal alternative is similar to Alternative 3, except that the removed waste materials would be transported and disposed of at an approved off-site location (Figure 3-8). A temporary storage structure would be required at the FMPC to support the off-site transportation effort. The transport process options selected for further consideration include transport by rail. Any waste acceptance criteria the disposal facility imposes (e.g., no free liquids, no respirable particulate fines) would be satisfied prior to shipping.

The system requirements for off-site disposal include an AWWT facility that would be capable of treating: (1) any wastewater generated as a result of the removal action and (2) perched groundwater removed from under the waste units, in order to decrease radiological and hazardous effects.

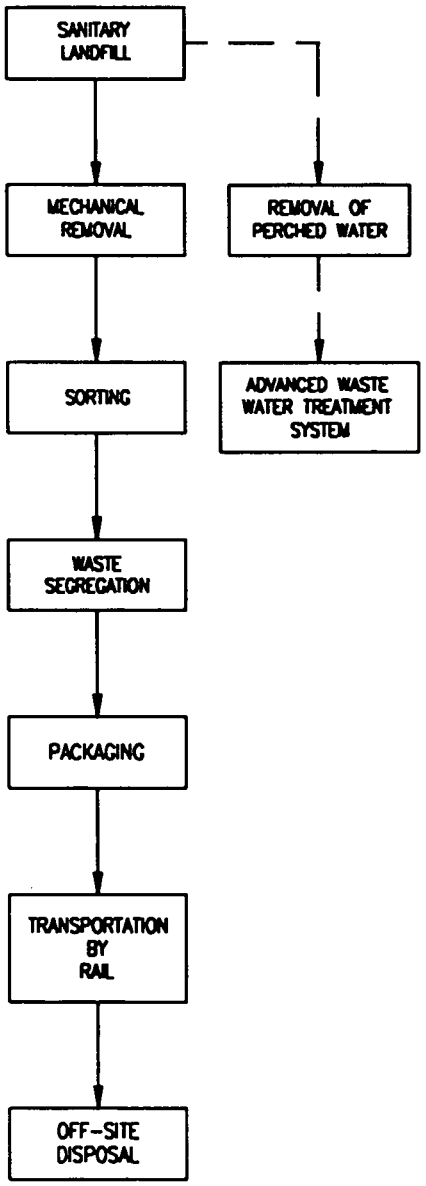
Mechanical removal methods would be employed to remove waste from the Sanitary Landfill. This technology uses excavation equipment such as backhoes. A truck or conveyor system would move the excavated waste to the interim storage area where there would be equipment for segregating/sorting the waste and for compaction/shredding. Since most of the waste is in a consolidated state, no significant volume reduction can be expected. Miscellaneous rubble and wastes such as drums, crates, etc., can be reduced in volume by either shredding or compaction; but this quantity of material is not considered significant compared to overall volumes involved.

To achieve the overall goal of protecting human health and the environment, this alternative provides for the removal and treatment of any perched groundwater contained in the sand lenses that underlie the Operable Unit 2 waste units. A well and wellpoint system that would surround the Sanitary Landfill would be installed. As discussed previously in Section 3.2.1.2, wells would be placed in the glacial overburden to extract the perched groundwater.

The time required to complete efforts described in this alternative is estimated at four years and anticipates bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. This time frame begins with site mobilization and continues through decontamination, disassembly, construction of on-property facilities, and finally to removal of any process equipment.

OPERABLE UNIT 2

REMOVAL OF WASTE, PERCHED GROUNDWATER TREATMENT AND OFF-SITE DISPOSAL



602 A FND249A OU2 TK15 OR

FIGURE 3-8. SANITARY LANDFILL - ALTERNATIVE 4

Before waste treatment and/or volume reduction, the waste from the Sanitary Landfill may be segregated into separate, various components (concrete, asphalt, construction rubble, etc.). Waste removal would be accomplished as discussed previously for Alternative 3.

A temporary storage/load-out facility would be necessary for waste storage. Under Alternative 4, the wastes from the Sanitary Landfill would be removed and packaged for off-site disposal. Rail transport offers several advantages over trucking, especially in the area of safety concerns. The packaging used for the transport and disposal of the LLRW should be water tight, certified for the transport of LSA material (i.e., meet DOT packaging requirements) and of suitable size. For rail shipment, it is also assumed that materials would be shipped off site as LSA. The solid waste would be placed in containers and loaded onto railcars.

The Nevada Test Site (NTS) is an approved DOE facility (although not permitted by EPA) and could serve as an off-site disposal facility for Operable Unit 2 wastes. The possibility of using other disposal facilities (or proposed regional compact sites) located around the country was investigated also.

Several regional compacts have been formed in accordance with the Low-Level Radioactive Waste (LLRW) Policy Amendments Act of 1985, which provides improved procedures for the establishment and operation of regional disposal facilities for these wastes. As stated in Section 3(a)(1) of this act, each state is responsible for providing, either by itself or in cooperation with other states (regional compact), for the disposal of:

1. LLRW generated within the state (other than by the federal government) that consists of or contains Class A, B, or C radioactive waste as defined by section 61.55 of title 10, Code of Federal Regulations (10CFR61) as in effect on January 26, 1983;

2. That same LLRW (as described in 1) that is generated by the federal government, with exceptions (see next paragraph); and

3. Wastes (described in 1 and 2) that are generated outside the state and accepted for disposal in accordance with Sections 5 or 6 of the LLRW Policy Amendments Act.

As stated in Section 3(a) (1) (B), the regional compacts are not responsible (by law) for providing for the disposal of the following LLRW that is:

1. Generated or owned by DOE;

2. Owned or generated by the U.S. Navy as a result of decommissioning of vessels of the U.S. Navy;

3. Owned or generated as a result of any research, development, testing, or production of any atomic weapon. The federal government is responsible for the disposal of these wastes (Section [b] [1] of the LLRW Act).

The basic policy of the individual regional compacts concerning the acceptance of DOE-generated wastes is stated in Table 3, page 48, of the CRC Handbook of Management of Radiation Protection Programs (Miller and Weidner 1986).

The Barnwell, South Carolina disposal facility and the Beatty, Nevada regional disposal facility are due to close at the end of 1992. The Hanford, Washington site will remain open. The commercial low-level waste burial site at Hanford does not accept DOE-generated waste. The Hanford commercial burial site lies between two DOE radioactive waste burial sites that have been in use since 1944 and are still active today (Godbee et al. 1986).

Based on the above information, the only possible sites to be considered for the disposal of Operable Unit 2 wastes are (1) NTS; (2) the DOE waste burial sites at Hanford; (3) Envirocare in Clive, Utah; and (4) any other major DOE facility that provides for the disposal of LLRW. All other (regional compact) sites should be eliminated from further consideration for Alternative 4.

LLRWs in the form of contaminated clothing, tools, and equipment that may be generated during the construction, excavation, treatment, and storage phases of the Sanitary Landfill wastes would be disposed of with the waste from the Sanitary Landfill. The wastewater would be treated in the AWWT system.

Appropriate DOT, state, and local permits would be required for off-site transportation.

The transportation of radioactive materials is subject to the regulations and jurisdiction of many federal, state, and local authorities. Three federal agencies have jurisdiction over shipments of radioactive materials:

- DOT has primary responsibility for issuing regulations for the safe transportation of all hazardous materials, including radioactive materials. DOT regulations apply to all shippers and carriers of radioactive materials except for shipments made on federal government vehicles.

- The Interstate Commerce Commission (ICC) regulates rates, charges, and conditions of truck and rail services operating in interstate commerce. The role of the ICC in interstate commerce is diminishing as a result of gradual deregulation of the transportation industry.

- DOE exerts operational control of the shipment activities of its "government-owned" contractors. Except for shipments made on government-owned vehicles, all DOE shipments are subject to DOT regulations. By DOE's own internal directives, the additional safety standards

imposed by Nuclear Regulatory Commission (NRC) also apply to DOE shipments, although the administrative requirements of NRC do not apply.

3.2.1.5 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal

In addition to access restrictions, monitoring, and run-on/runoff control, this alternative incorporates mechanical removal, treatment and on-property disposal of waste materials, and the removal and treatment of perched groundwater contained in the sand lenses that underlie the Sanitary Landfill.

The system requirements for Alternative 5 include an aboveground, on-property EDF (Figure 3-7) and an AWWT facility capable of treating any wastewater generated as a result of the removal of perched groundwater (to decrease its radiological and hazardous effects) that underlies the waste units as described in Section 3.2.1.2 for Alternative 2. A removal system, composed of mechanical equipment, would be required to remove and transport wastes from the Sanitary Landfill to a waste processing and treatment facility. A sorting method would be used to segregate the waste, where applicable, followed by volume reduction. The process sequence associated with this alternative is depicted in Figure 3-9. The system requirements are described more fully in the following sections.

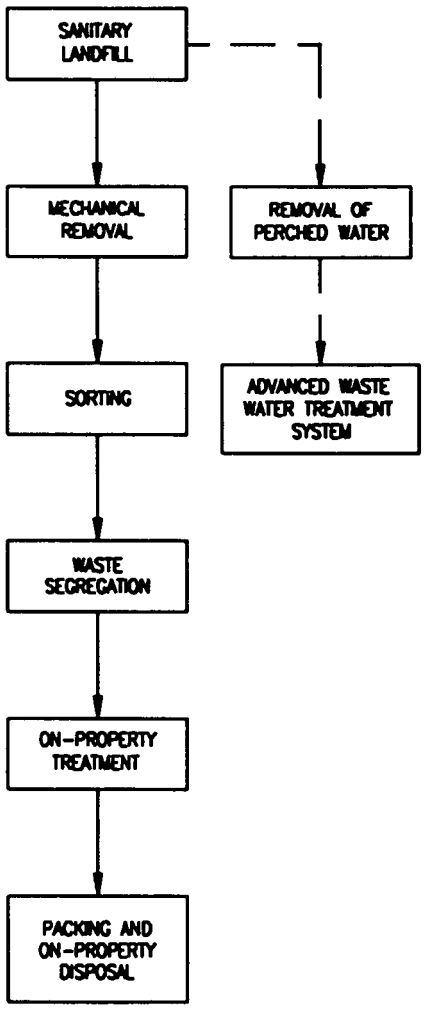
Mechanical removal methods would be employed for the removal of wastes from the Sanitary Landfill. Excavation equipment (such as backhoes) would be used for waste removal. A truck or conveyor system would then move the excavated waste to the treatment area where there would be equipment for segregation, volume reduction, and compaction/shredding.

To achieve the overall goal of protecting human health and the environment, this alternative provides for the removal and treatment of any perched groundwater contained in the sand lenses that underlie the Sanitary Landfill. A wellpoint system surrounding the Sanitary Landfill would be installed in the glacial overburden for extraction of perched groundwater.

The time required to complete efforts as described in this alternative is estimated to be six years and anticipates bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. This time frame begins with site mobilization and continues through decontamination and disassembly, construction of an on-property EDF, and finally to process equipment removal.

Before waste treatment and/or volume reduction, the waste from the Sanitary Landfill would be segregated into, various types of wastes. Cover would be removed and visual inspection would be made to determine the types of materials present (construction rubble, concrete, drums, etc.), and the best method for handling and sorting them. Since the proposed ARARs for Operable Unit 2 consider

OPERABLE UNIT 2
REMOVAL AND TREATMENT OF WASTE, PERCHED GROUNDWATER TREATMENT
AND ON-PROPERTY DISPOSAL



602 ● FM0249 OU2 TK15 OR

FIGURE 3-9. SANITARY LANDFILL - ALTERNATIVE 5

RCRA Subtitle C for the Sanitary Landfill, compatibility testing would be performed, before bulking wastes for disposal transport, to ensure that consolidation would not result in incompatible waste reactions or large volumes of wastes that would be unacceptable for disposal. Compatibility testing refers to simple, rapid, and cost-effective testing procedures that are used to segregate wastes into broad categories. If drums are encountered during excavation, the contents would be tested and determined to be either mixed, hazardous, LLRW, or solid wastes.

As the wastes in the Sanitary Landfill are excavated, they would be segregated by sampling. If they are determined to be mixed or hazardous wastes, they would be treated prior to on-property disposal. Various process options and combinations of options (rotary kiln incinerator and cement solidification) are available to treat these wastes for disposal.

Rotary kiln incineration, because of its ability to handle wastes in any physical form and its high thermal destruction efficiency, is a preferred method for treating mixed or hazardous waste residues. The rotary kiln is a cylindrical, refractory-lined shell and is fueled by either natural gas, oil, or pulverized coal. The waste is heated primarily by radiant and conductive heat transfer from the flame combustion of product gases and from the walls of the kiln. The rotary-kiln incinerator consists of the kiln and an afterburner (secondary combustion chamber) to ensure complete combustion of the hazardous constituents. The waste is fed into the kiln and passes through the combustion zone. The incinerator also would be equipped with a gas scrubber air pollution control system for emission controls.

Cement-based solidification represents a process option that is suitable for fixation of either inorganic wastes or radioactive materials and also can be used to solidify residuals left after incineration. Cement-based solidification uses cement and admixtures (e.g., fly ash) to immobilize contaminants. Its waste form contains no free liquids and causes no dusting or air contamination.

An EDF would be considered for the on-property disposal of the waste material as described in Section 3.2.1.3. A combined EDF for all operable units at the FMPC could be useful if it were available at the time of Operable Unit 2 remedial actions.

The spatial requirements for implementing this alternative are as follows:

- Offices and field laboratory - 0.5 acre
- Decontamination facilities - 0.5 acre
- On-property treatment and packaging and process facility - 1.0 acre
- Staging area for supplies and earth-moving equipment - 0.5 acre
- EDF or equivalent - 1.5 acre
- Treated waste transfer station - 2.0 acres
- Wastewater treatment plant - 0.5 acre

3.2.1.6 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal

This removal alternative is similar to Alternative 5, except that the removed waste materials would be transported and disposed of at an approved off-site location (Figure 3-10). If the Sanitary Landfill were found to contain hazardous wastes, they would be treated and packaged before their shipment to a permitted off-site disposal facility. A temporary storage structure would be required at the FMPC to support the off-site transportation effort. Transport process options selected for further consideration include transport by rail. Any waste acceptance criteria the disposal facility imposes (e.g., no free liquids, no respirable particulate fines) would be satisfied before shipment.

The system requirements for off-site disposal include an AWWT facility that would be capable of treating any wastewater generated as a result of removal of the perched groundwater that underlies the waste units, to decrease its radiological and hazardous effects.

Mechanical removal methods would be employed to remove wastes from the Sanitary Landfill. This technology uses excavation equipment such as backhoes, draglines, and clamshells for waste removal. A truck or conveyor system then moves the excavated wastes to the interim storage area, where there would be equipment for segregating/sorting and compaction/shredding.

To achieve the overall goal of protecting human health and the environment, this alternative would provide for the removal and treatment of any perched groundwater contained in the sand lenses which are present in the vicinity of Operable Unit 2 waste sites. A wellpoint system that surrounds the Sanitary Landfill would be installed. Wells would be placed in the glacial overburden to extract the perched groundwater.

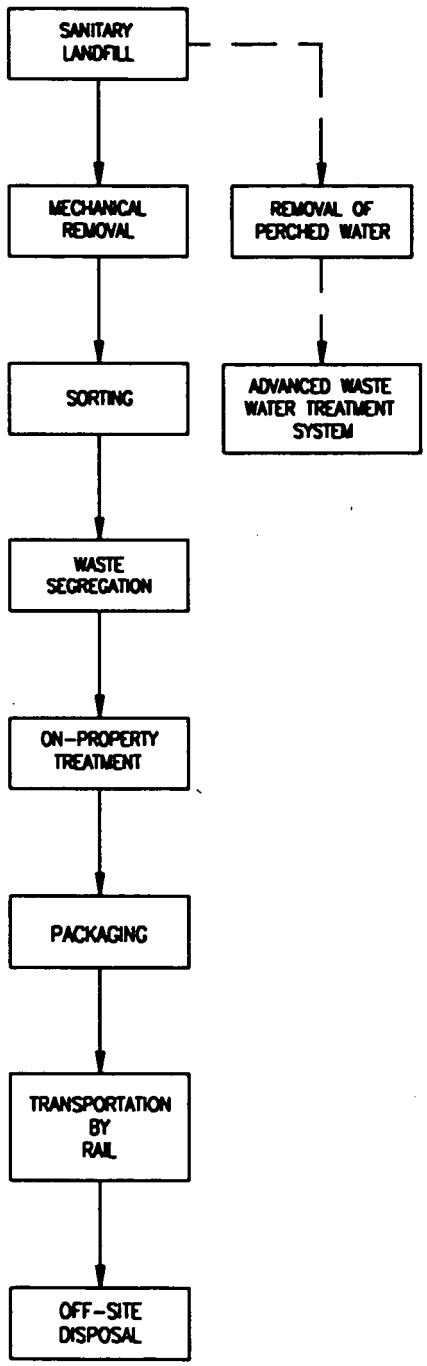
The time required to implement this alternative is estimated to be six years and anticipates time lost from bad weather, and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. This time frame begins with site mobilization and continues to decontamination, disassembly, construction of on-property handling and treatment facilities, and finally to process equipment removal.

The mixed and hazardous wastes would require treatment before off-site disposal. Various process options exist (rotary kiln incinerator and cement solidification) which are available to treat these wastes for disposal. These treatment options were described in detail for Alternative 5.

Cover would be removed and visual inspection would be made to determine the types of material present and the best method for handling and sorting them. Care would be taken during removal of materials to avoid puncturing drums or other containers, if they were encountered. The following segregation technologies have been selected for further consideration and have been previously

OPERABLE UNIT 2

REMOVAL AND TREATMENT OF WASTE, PERCHED GROUNDWATER TREATMENT AND OFF-SITE DISPOSAL



602 A FND2498-OU2 TK15 OR

FIGURE 3-10. SANITARY LANDFILL - ALTERNATIVE 6

described for Alternative 4: magnetic sorting, manual sorting, and screening/sizing. After segregation, and depending on the waste composition, the waste may be subjected to volume reduction before disposal. Compaction and/or shredding process options are selected for further consideration and are described earlier for Alternative 3. In addition to some manual sorting of materials, the need for a combination screening/shredding/crushing system with a capacity of 10 to 20 tons/hour is anticipated. As excavation progresses, the waste material from the Sanitary Landfill would be moved to interim storage on the FMPC property.

A temporary storage/load-out facility would be necessary for waste storage. Under Alternative 6, the mixed and hazardous wastes from the Sanitary Landfill would be treated on-site and packaged for off-site disposal.

The actual packaging used for the transport and disposal of the LLRW should be water tight, certified for the transport of LSA material (i.e., meet DOT packaging requirements), and be of suitable size. For rail shipment, it is also assumed that materials would be shipped off site as LSA. The wastes would be placed in containers and loaded on railcars.

The mixed and hazardous wastes from the Sanitary Landfill would be packaged and maintained with the applicable portions of 40CFR260, 40CFR262, and 40CFR264. The LSA wastes would be packaged in accordance with 40CFR173, 49CFR178, 49CFR179, and 49CFR172.
NTS is an approved DOE facility (although not permitted by EPA) and could serve as an off-site disposal facility for Operable Unit 2 wastes. The possibility of disposal at other facilities (or proposed regional compact sites) located around the country also were investigated, and are discussed in Section 3.2.1.4.

There are no facilities, at this time, that handle (process) mixed waste. Consequently, if any mixed waste were found in the Sanitary Landfill, it would be treated to meet land disposal restrictions before shipment to an off-site disposal facility. CERCLA exempts on-site activities from permit requirements; however, compliance with substantive requirements of ARARs is necessary.

LLRW in the form of contaminated clothing, tools, and equipment which are generated during the construction, excavation, treatment, and storage phases of this alternative would be disposed of with the waste from the Sanitary Landfill. The wastewater would be treated in the AWWT facility.

Appropriate DOT, state, and local permits would be required along the off-site transport route.

The transportation of radioactive materials is subject to the regulations and jurisdiction of many federal, state, and local authorities, as discussed in Section 3.2.1.4. Several state and local

governments have issued regulations and passed statutes that impose restrictions on shipments of radioactive materials. The U.S. Congress has, by statute, given DOT preemptive regulatory authority over state and local jurisdictions in the matter of transportation of radioactive materials. In 1984, the U.S. Supreme Court upheld this preemptive authority in a case where the City of New York filed suit against DOT, challenging DOT's regulatory authority.

Although state or local regulations regarding the transport of radioactive materials are preempted by federal law (Federal Materials Transportation Act, Section 12, Title I, of Public Law 93-633), a state or local municipality has the option of filing with DOT for a nonpreemption determination (i.e., a waiver of preemption). A state or local requirement influencing the transport of radioactive materials will cease to be preempted by federal law if, upon application for the nonpreemption determination, the secretary of DOT finds that the state or local ruling:

- Provides an equal or greater level of public safety than the Hazardous Material Transportation Act or regulations issued thereunder
- Does not burden commerce

Preemption determination, therefore, does offer the state or local area recourse in the case of disputes over federal preemption.

3.2.2 Lime Sludge Ponds

The Lime Sludge Ponds are unlined storage units that encompass a combined area of approximately two acres and are located just to the west of the Production Area (Figure 3-10). Spent lime sludges from FMPC water treatment plant operations (lime-alum sludges and boiler plant blowdown) are pumped to this pond and allowed to settle. A berm surrounds and divides both the North and the South Lime Sludge Ponds. Additional information applicable to the Lime Sludge Ponds is described in Sections 1.5.2.2, 1.5.2.3 and 1.5.3.2.

3.2.2.1 Alternative 1: Containment with In Situ Stabilization

Alternative 1 represents a minimum-action scenario that is intended to isolate the waste and to minimize the vertical infiltration of rainfall/runoff into and through the Lime Sludge Ponds. Access restrictions, monitoring, runoff control, capping, and in situ stabilization technologies are combined for this alternative. Prior to capping, in situ stabilization can be accomplished using SSM with a mixture of soils or sludges with dry or fluid treatment chemicals to produce a solidified or stabilized end product. SSM is designed to provide in-place mixing at depths up to 30 feet using a crane-mounted mixing system that includes a mixing head enclosed in an open-bottomed cylinder, which allows a closed system for the mixing of waste and additives. As the mixing head blades pass in an up-and-down motion through the waste, a negative pressure is maintained on the cylinder headspace to pull any vapors or dust to an air treatment system.

The Lime Sludge Ponds would be stabilized in such a manner that the surface would provide drainage following stabilization. As described in Section 3.2.1.1, the cap would consist of a vegetation cover, a drainage layer, membrane liner, and clay liner, and would be expected to cover approximately 2.5 acres. All cap elements and layers would be contour graded and runoff control features would be constructed to safely direct precipitation away from the closed area. A temporary sedimentation pond and a drainage channel would be constructed surrounding the Lime Sludge Ponds to direct surface water runoff into a sedimentation basin before stabilization (Figure 3-11). Details of system requirements for this alternative and spatial requirements follow:

- Earth-moving, excavation, and compaction equipment
- Temporary groundwater extraction system
- Clay capable of achieving 10^{-7} centimeters per second vertical permeability
- Long-term maintenance and environmental monitoring program
- AWWT facility and water supply
- Decontamination facilities
- Short- and long-term run-on/runoff control
- SSM equipment and labor

The time frame for implementation of this alternative is estimated to be two years, anticipating delays due to bad weather. Currently, open space surrounds the Lime Sludge Ponds; however, additional on-site environmental restoration programs could require space coordination with Operable Unit 2 remediation. Mobilization of equipment should pose no problems.

There are no transportation requirements for the waste, since it would remain in place and on property.

CERCLA exempts on-site activities from permit requirements. LLRW generated as a result of construction activities in the form of contaminated clothing, tools, and equipment — and requirements for packaging and shipment — would be similar to those presented in 3.2.1.1.

3.2.2.2 Alternative 2: Containment with In Situ Stabilization and Perched Groundwater Treatment

Alternative 2 is similar to Alternative 1 with the addition of perched groundwater extraction pumping and treatment. Wells would be placed in the glacial overburden to extract perched water from sand lenses. The remaining steps that comprise this alternative are identical to Alternative 1 and are shown in Figure 3-12.

Sand lenses in the glacial overburden can yield up to 50 gpm (DOE 1988c). The presence of sand lenses is confirmed by results of the field investigation. An interpretation of the lateral extent of the sand lenses indicates that they are continuous below the bottom of the Lime Sludge Ponds. It is assumed that implementation of this alternative would require the placement of an extraction wellpoint system sized for no more than 10 gpm flow rate.

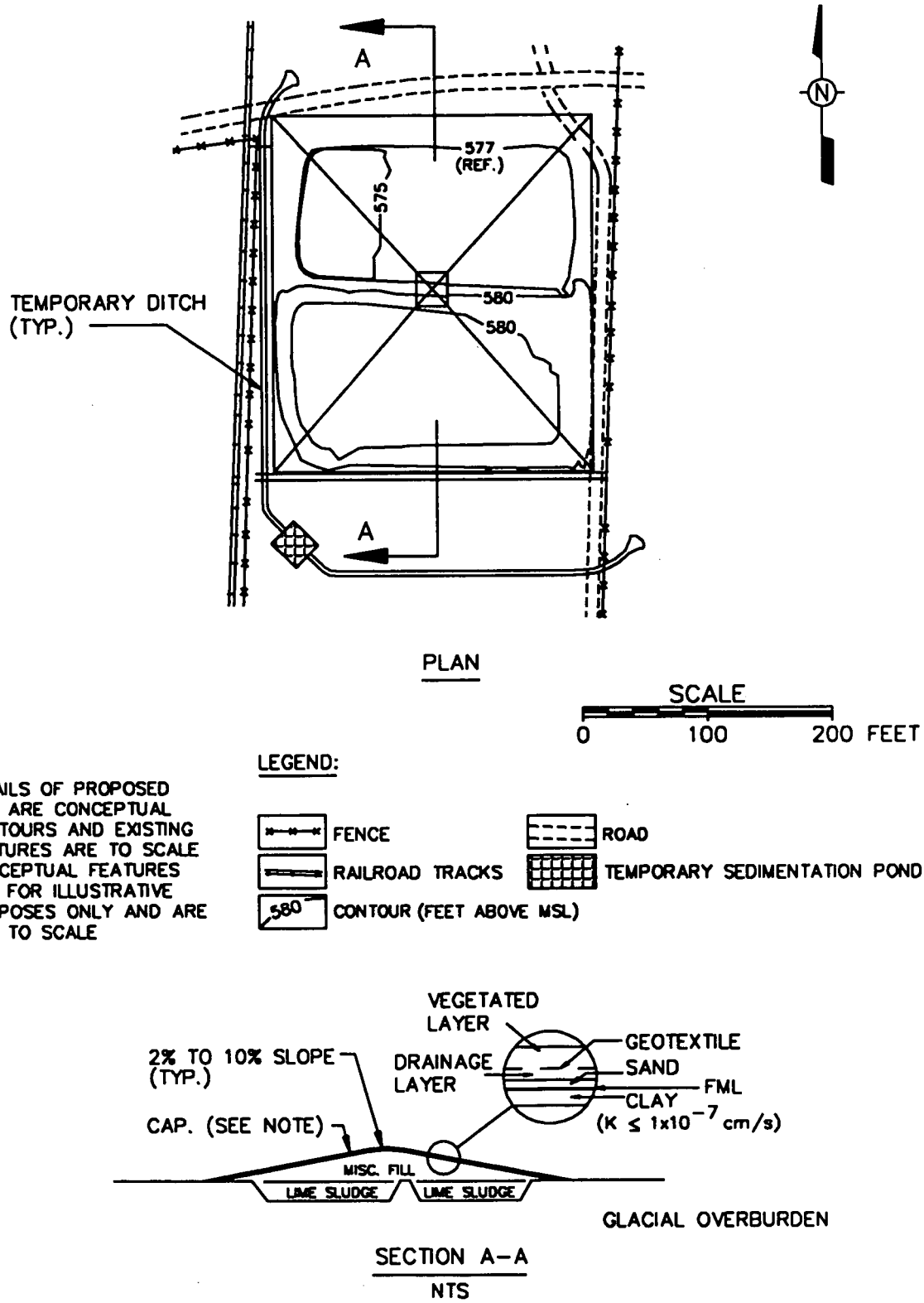


FIGURE 3-11. LIME SLUDGE PONDS - ALTERNATIVE 1

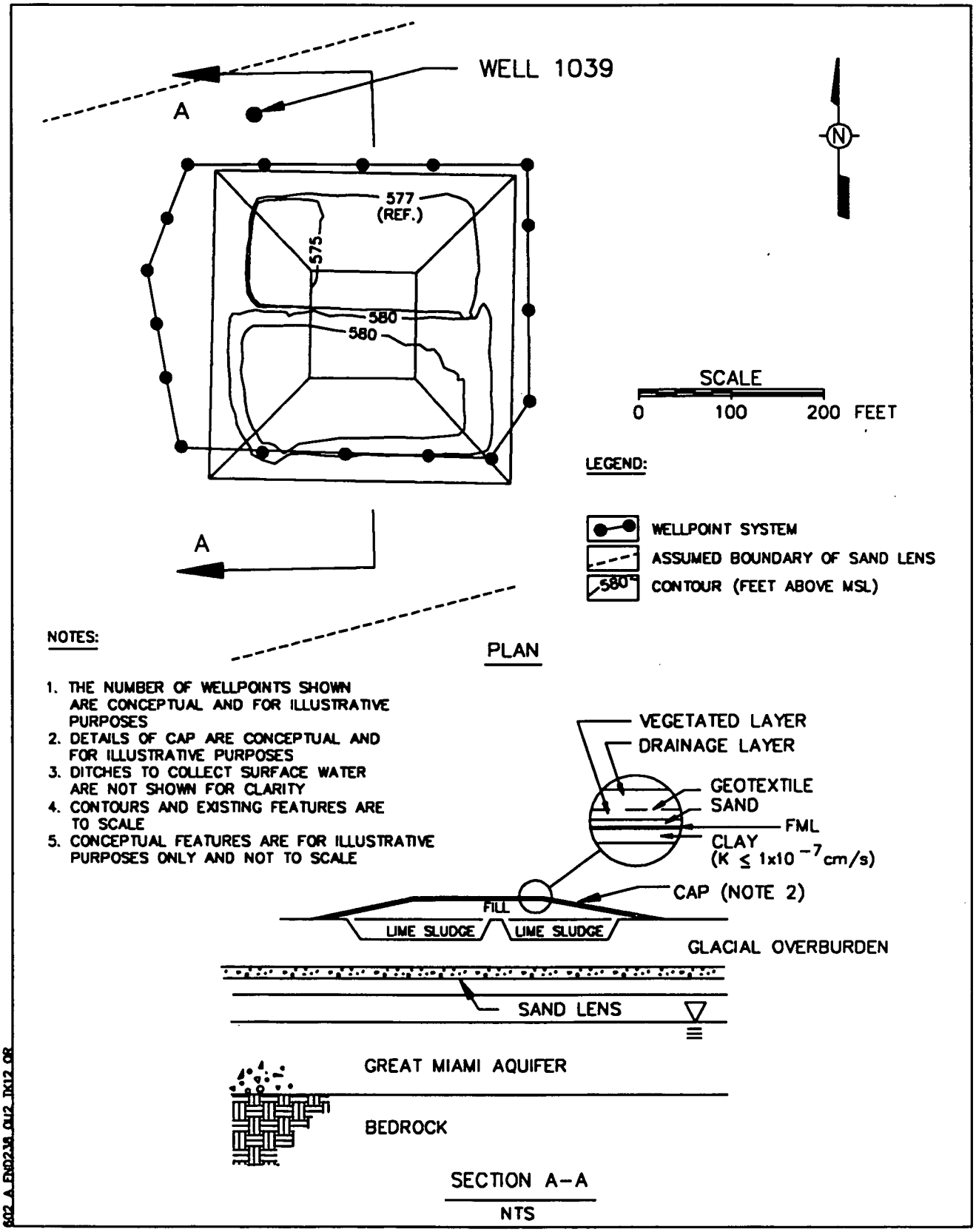


FIGURE 3-12. LIME SLUDGE PONDS – ALTERNATIVE 2

The water collected would be treated in the AWWT facility before its release to the Great Miami River. The concentration levels of radiological or hazardous constituents would be reduced by the wastewater treatment system described in Section 3.2.1.2.

A configuration of a wellpoint system for the Lime Sludge Ponds is shown in Figure 3-12. The wellpoint locations are approximate; exact placement would depend on a detailed analysis of the data. The wellpoint system would be operated until contaminant concentrations were below levels of concern (as established by ARARs) or the quantity of collected water became negligible. The time frame for pumping is not presently known; however, for the purposes of volume and cost estimation, one year is assumed. The volume estimates of water assume a continuous sand lens under the waste unit. It is estimated that approximately 616,000 gallons would be extracted from the perched water zones underlying the Lime Sludge Ponds.

It is estimated that extraction of perched water, plugging the extraction wells, and stabilization/capping would take four years to complete. Open space that surrounds the Lime Sludge Ponds allows for construction activities, but they should be coordinated with the remediation of other operable units and other site activities as stated earlier.

There are no transportation requirements for the waste itself since all waste would remain in place and on property. Wastes generated as a result of construction activities would be in the form of contaminated clothing, tools, and equipment. CERCLA exempts on-site activities from permit requirements; however, compliance with substantive requirements of ARARs is necessary.

3.2.2.3 Alternative 3: Removal and Treatment of Waste/Perched Groundwater Treatment, and On-Property Disposal

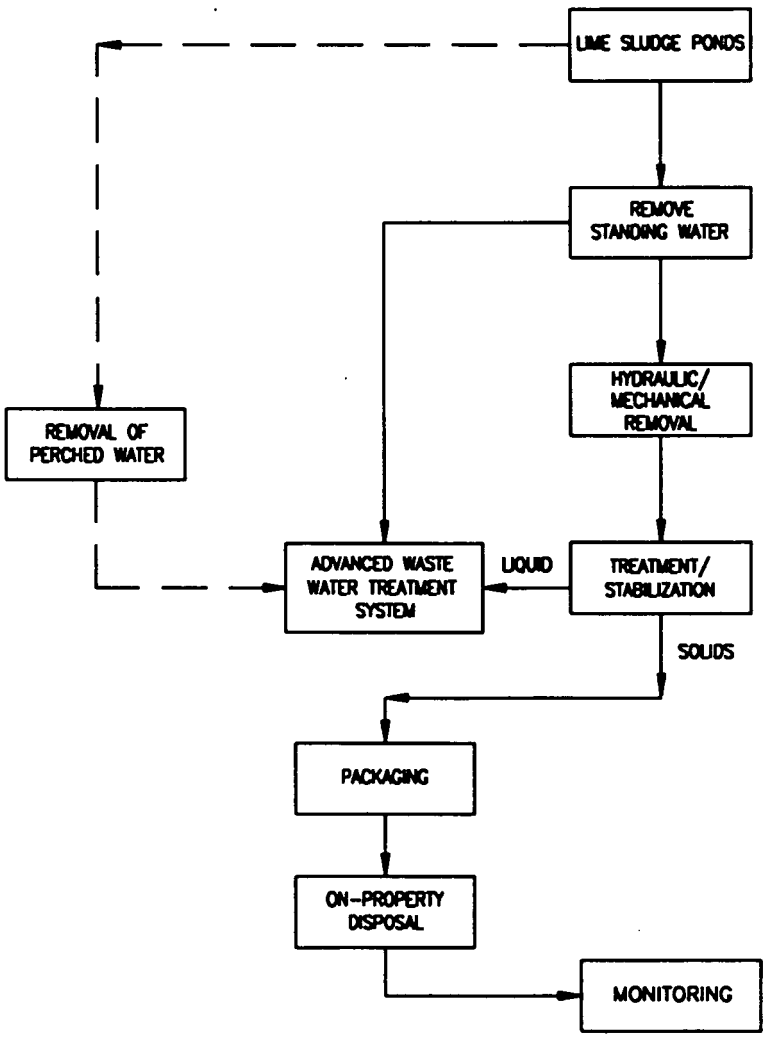
This alternative incorporates hydraulic and mechanical removal, treatment, and on-property disposal of waste materials and the removal and treatment of perched groundwater contained in the sand lenses of the Lime Sludge Ponds, in addition to the placement of access restrictions, groundwater monitoring, and runoff control. The response actions are depicted in Figure 3-13.

The system requirements for on-property disposal include an AWWT facility capable of treating any wastewater (to decrease its radiological and hazardous effects) generated as a result of the removal of perched groundwater that underlies the waste units. A removal system, composed of mechanical and hydraulic equipment, would be required to remove and transport lime sludge to a waste processing facility.

The standing water and saturated condition of the sludge would require special removal, dewatering, and treatment considerations. Depending on the physical nature of the waste (such as the amount of water content and the presence of standing surface water), hydraulic dredging may be employed. This

OPERABLE UNIT 2

REMOVAL AND TREATMENT OF WASTE, PERCHED GROUNDWATER TREATMENT AND ON-PROPERTY DISPOSAL



602 A FND246 OU2 TK15 OR

FIGURE 3-13. LIME SLUDGE PONDS - ALTERNATIVE 3

technology uses vacuuming and pumping to dislodge, capture, and transport sludges to a central collection/processing point. This dredging method cannot be used for the removal of nonsludge wastes, so it is applicable only to the Lime Sludge Ponds. A mechanical removal system would be used to remove the lime sludge if the solids content should increase to a level that warrants it. The high-solids sludge would be removed by backhoe or other excavating equipment and transported to the collection/processing point.

After removal, the sludge material from the Lime Sludge Ponds may be treated before disposal. The process options selected for further consideration include stabilization and solidification. Any water removed from the pond or sludge would be treated at the AWWT facility.

To achieve the overall goal of protecting human health and the environment, this alternative would provide for the removal and treatment of any perched groundwater contained in the sand lenses that underlie the Lime Sludge Ponds. A wellpoint system that surrounds the Lime Sludge Ponds would be installed in the glacial overburden to extract the perched groundwater. Any perched groundwater collected will be treated at the AWWT facility as described for Alternative 2.

The standing water on the Lime Sludge Ponds could be either slurried with the lime sludge or removed prior to removing the lime sludge. The need for treating the water could be avoided by slurrying the standing water with the lime sludge. Any contaminants in the water and the sludge would be bound in a solid matrix of a hardened product that is produced through mixing appropriate amounts of fly ash and cement into the sludge. To obtain an optimal slurry moisture content, low-solids sludge (8-15 percent solids) and high-solids sludge would be blended together. When these solids are blended together to obtain an optimal slurry-moisture content, dewatering methods are not required.

The stabilization treatment that uses cement and fly ash offers the potential to immobilize contaminants. The cement-based stabilization process is a well-recognized and proven process. Its waste form contains no free liquid and causes no dusting or air contamination. Treatability testing would be required to determine the optimal slurry-moisture content and the appropriate amounts of fly ash and cement required to produce a solidified waste.

After stabilization, the waste would be discharged to unit packages/containers and transported to an on-property EDF. Volume increase in the sludge could range up to 50 percent, but a reduction in net volume of FMPC fly ash to be disposed of on property would offset this to some degree. The design production rate for a sludge treatment/stabilization facility would be 10 to 15 tons (approximately 8 to 13 cubic yards) of sludge per hour. A schematic diagram of a sludge treatment stabilization facility is shown in Figure 3-14.

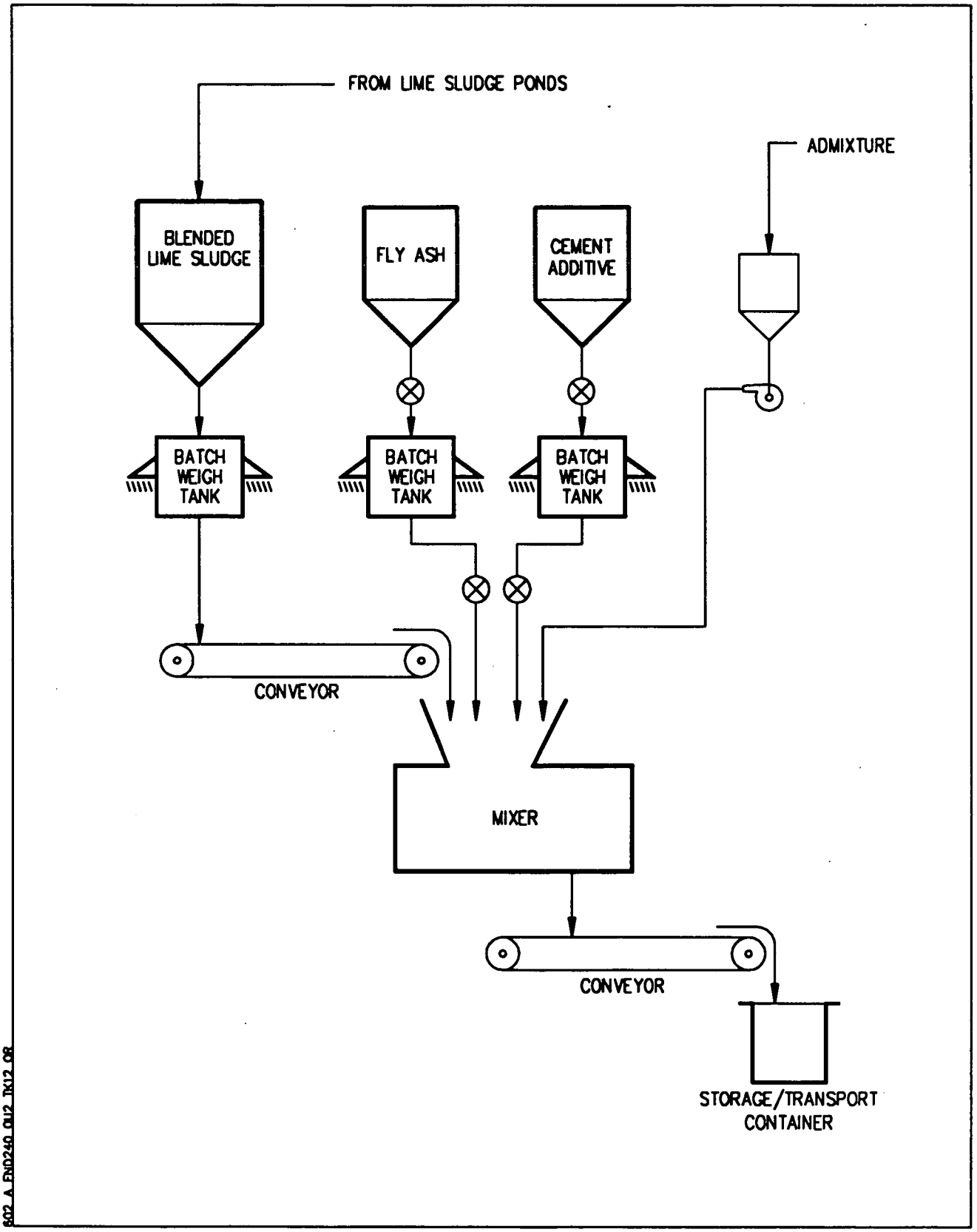


FIGURE 3–14. LIME SLUDGE STABILIZATION SYSTEM

The time required to complete remediation efforts described in this alternative is estimated to be six years from site mobilization to decontamination, disassembly, construction of disposal facility, and finally to process equipment removal. The waste material would be transported and deposited at the site. Disposal of waste could occur in an on-property EDF constructed for all FMPC wastes. The lime sludge stabilization plant would require approximately one acre for processing and storage.

The cement/fly ash stabilization method would require packaging to facilitate handling and to control external exposure levels. Haul trucks would transport all waste materials from the treatment or excavation area to the on-property EDF. The haul trucks should be plastic lined and have canvas covers to minimize potential loss of contaminated soils during transport from the excavation area.

CERCLA exempts on-site activities from permit requirements. There are no off-site activities associated with Alternative 3; however, CERCLA guidelines necessitate compliance with substantive ARAR requirements.

The spatial requirements for implementing this alternative are as follows:

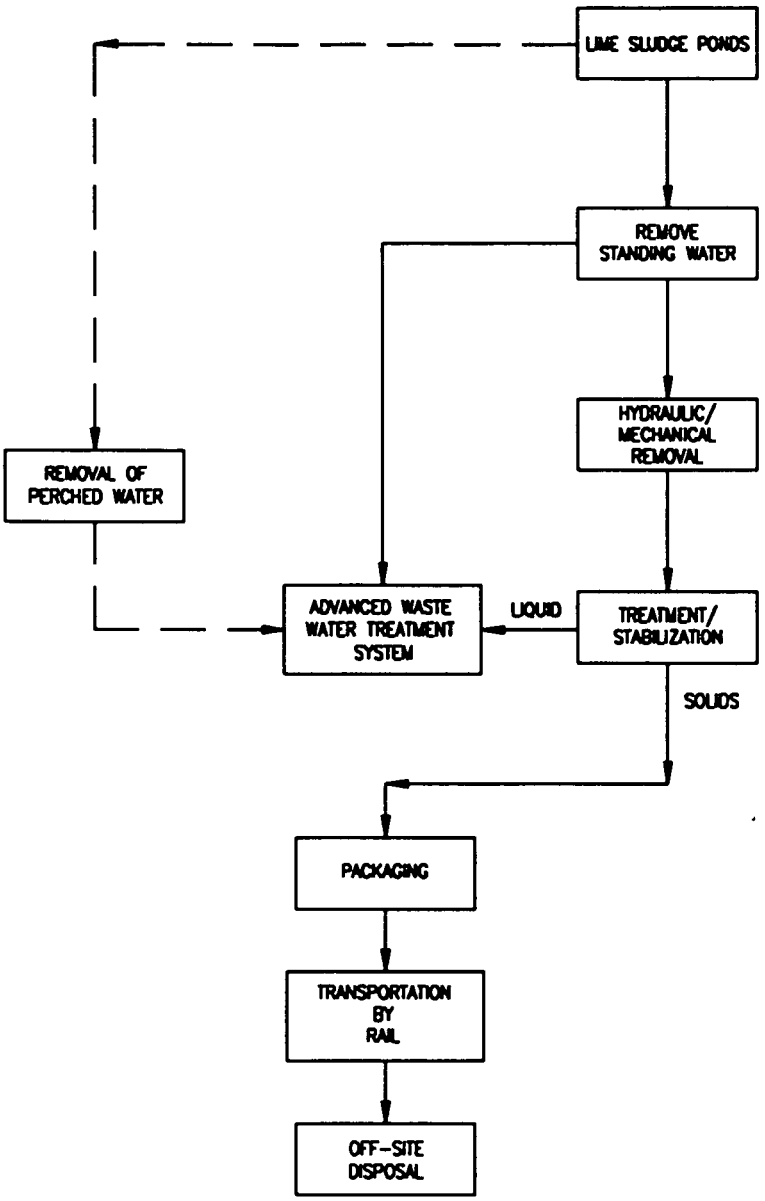
- Offices and field laboratory - 0.5 acre
- Decontamination facilities - 0.5 acre
- On-property treatment and packaging and process facility - 1.0 acre
- Staging area for supplies and earth-moving equipment - 5.0 acres
- EDF or equivalent - 4.0 acres
- Treated waste transfer station - 2.0 acres
- Wastewater treatment plant - 0.5 acre

3.2.2.4 Alternative 4: Removal and Treatment of Waste/Perched Groundwater Treatment, and Off-Site Disposal

This second removal alternative is similar to Alternative 3, except that the removed waste materials would be transported and disposed of at an approved off-site location. Figure 3-15 depicts the various remedial response actions comprising this alternative. The lime sludge would be treated on property, packaged and shipped to an off-site disposal facility. A temporary storage structure would be required at the FMPC to support the off-site transportation effort. Rail transportation has been selected as part of this alternative. Any waste acceptance criteria the disposal facility imposes (e.g., no free liquids, no respirable particulate fines) would be satisfied before shipping. For further detail and description of the transportation and disposal requirements for this alternative, see Section 3.2.1.6.

The time required to complete the remediation efforts as described in this alternative is estimated to be six years, from site mobilization through decontamination, disassembly, construction of on-property facilities, and finally to process equipment removal.

OPERABLE UNIT 2
REMOVAL AND TREATMENT OF WASTE, PERCHED GROUNDWATER TREATMENT AND OFF-SITE DISPOSAL



602 A FN0250 OU2 TK12 OR

FIGURE 3-15. LIME SLUDGE PONDS - ALTERNATIVE 4

3.2.3 Fly Ash/Southfield Areas

The alternatives for the Inactive Fly Ash Disposal Area, Active Fly Ash Pile, and Southfield will be discussed together because of these areas' proximity (Figure 1-7) and the similarity in physical properties exhibited by their wastes. A short description of each area is followed by the development of their alternatives, treating the three areas as one.

Inactive Fly Ash Disposal Area

This waste unit (with little soil, vegetation or soil cover) is located approximately 2000 feet southwest of the Production Area. The Inactive Fly Ash Disposal Area covers approximately three acres and contains approximately 50,000 cubic yards of fly ash and small amounts of building rubble such as concrete, gravel, asphalt, masonry, and steel rebar. Additional information describing the Inactive Fly Ash Disposal Area is contained in Section 1.3.1.4.

Active Fly Ash Pile

The Active Fly Ash Pile is easily distinguishable because it is presently uncovered and located just east of the running track/Southfield, on the opposite side of the south construction road. The SSOD is located to the east of the Active Fly Ash Pile. The Active Fly Ash Pile covers an area of approximately two acres and contains approximately 38,000 cubic yards of material.

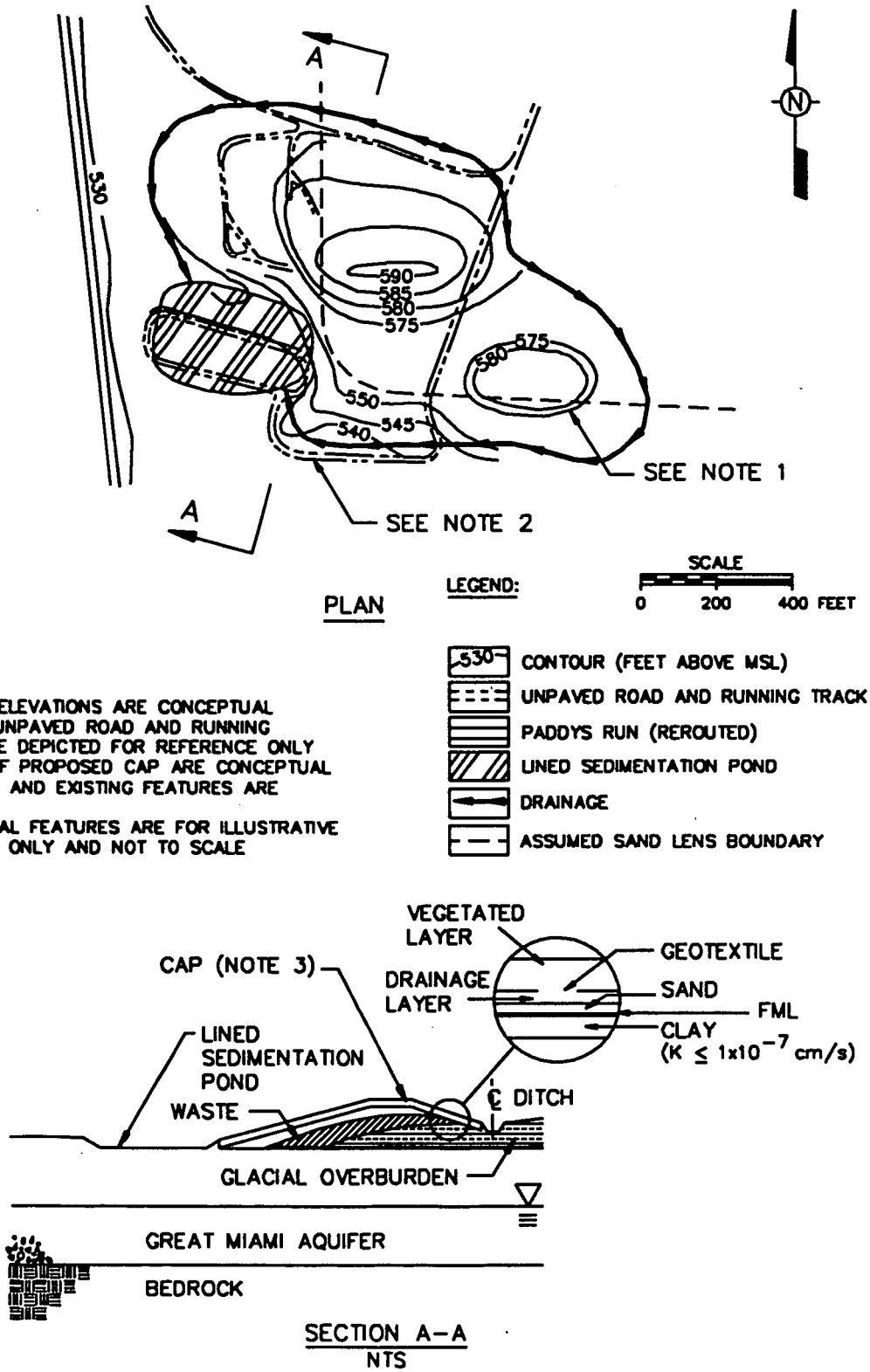
In current operations, as in the past, fly ash from the coal-fired boiler plant is loaded into dump trucks and transported to the fly ash site. It has been reported that, in the past, contaminated waste oils were periodically sprayed onto the fly ash pile as a means of dust control (DOE 1988b). The elevated levels of radiological contaminants found in surface samples provide evidence of these dust control activities.

Southfield

The Southfield was reportedly used as a burial site for construction rubble that may have contained low levels of radioactivity; this includes debris from the razing of the administration building. The area of the Southfield is assumed to be approximately 11 acres and to have a volume of 125,000 cubic yards of material. These estimates were made using historical photos and borehole logs. The Southfield was used from 1954 to 1957.

3.2.3.1 Alternative 1: Nonremoval/Cap

Alternative 1 represents a minimum action scenario that is intended to isolate the wastes and to minimize the vertical infiltration of rainfall/runoff into and through the Fly Ash/Southfield areas. Remedial response actions included in this alternative are access restrictions, monitoring, runoff control, and capping. Figure 3-16 depicts the implementation of this alternative. The cap would consist of a vegetation layer, a drainage layer, a membrane liner, and a clay liner. The cap



NOTES:

1. CONTOUR ELEVATIONS ARE CONCEPTUAL
2. EXISTING UNPAVED ROAD AND RUNNING TRACK ARE DEPICTED FOR REFERENCE ONLY
3. DETAILS OF PROPOSED CAP ARE CONCEPTUAL
4. CONTOURS AND EXISTING FEATURES ARE TO SCALE
5. CONCEPTUAL FEATURES ARE FOR ILLUSTRATIVE PURPOSES ONLY AND NOT TO SCALE

802_A_FN0241_OU2_TK12_OR

FIGURE 3-16. FLY ASH AREAS AND SOUTHFIELD - ALTERNATIVE 1

requirements are described in detail in Section 3.2.1.1. To minimize future erosion, the Fly Ash/Southfield areas would require new slopes not to exceed 20 percent (a ratio of 5 horizontal: 1 vertical). Some slopes in this area currently exceed 20 percent.

The Fly Ash/Southfield areas would require control of runoff and sediment during cap construction. This area would also require construction of ditches and lined sedimentation basins to capture runoff and sediment migration. A single cap for the Inactive Fly Ash Disposal and Southfield areas, as well as a cap for the Active Fly Ash Pile (coupled with a common run-off system) could be constructed as depicted in Figure 3-16. Combining these areas under two caps provides an area in which the material could be regraded so that a maximum slope of 20 percent could be achieved, which would reduce cap erosion. An additional consideration for the Fly Ash/Southfield areas is their location between Paddys Run and the SSOD. Construction of a cap would require realigning both of these drainageways to prevent future erosion into the cap. It is noteworthy that Paddys Run and the SSOD are being considered for remediation as part of Operable Unit 5. Paddys Run has historically received surface water runoff from the waste storage area at the FMPC, and remedial action alternatives have been developed for soil and groundwater media comprising Operable Unit 5. Any channel realignment conducted as part of Operable Unit 2 would require coordination with proposed remedial action alternatives for Operable Unit 5.

There are no transportation requirements for the wastes themselves, because all wastes would remain in place and on property. Construction activities would generate ordinary sanitary (solid) wastes and LLRW in the form of contaminated clothing, tools, and equipment. The LLRW generated as a result of construction activities would be considered LSA material and, if shipped off site, would be packaged in accordance with applicable portions of 49CFR173. The actual packaging used for transport and disposal of the LLRW should be watertight, certified for the transport of LSA material (i.e., it should meet DOT packaging requirements), and of suitable size. LLRW generated as a result of construction activities could be disposed of on property. Any on-site transportation of construction-generated wastes would be in accordance with the requirements set forth in DOE Order 5480.3a (Draft).

The time frame for implementation of this alternative for the Fly Ash/Southfield areas is expected to be up to two years and anticipates delays due to bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. The open space that surrounds the Fly Ash/Southfield areas should allow for the mobilization of equipment.

CERCLA exempts on-site activities from permit requirements. However, CERCLA necessitates compliance with substantive requirements of ARARs, so ARARs should be included in decision documentation used for site remediation.

3.2.3.2 Alternative 2: Containment with Perched Groundwater Treatment

The second nonremoval alternative is similar to Alternative 1 and consists of perched groundwater extraction and treatment in addition to those response actions included in Alternative 1. Figure 3-17 shows a wellpoint system that extends partially around the Fly Ash/Southfield areas. Wells would be placed in the glacial overburden to extract perched water contained in underlying sand lenses in the vicinity of Operable Unit 2 waste sites.

This alternative includes groundwater pumping and treatment of contaminated perched groundwater under the Fly Ash/Southfield areas. Sand lenses in the glacial overburden can yield up to 50 gpm (DOE 1988c); however, yields of this magnitude are not expected at the FMPC. The presence of sand lenses is confirmed by results of the field investigation. An interpretation of the lateral extent of the sand lenses indicates a 2-foot-thick sand lens approximately 10 feet below grade within the boundaries of the Fly Ash/Southfield areas; however, the sand lens pinches out in the west and south. Therefore, a wellpoint system could be placed around the northeast perimeter of the Fly Ash/Southfield areas to extract perched groundwater.

The area depicted in Figure 3-18 is characterized by a layer of surficial silt and sand, underlain by a layer of silty clay approximately five feet thick. Underneath the silty clay is a layer of silty sand. This sand layer is directly above the sand and gravel medium that characterizes the Great Miami Aquifer, but is above the water table.

Water treatment would be required as part of this alternative. The water collected would be treated by an AWWT facility before its release into the Great Miami River. This would reduce concentration levels of radiological or hazardous chemical constituents. The AWWT system should include presedimentation, and a sedimentation/filtration process which includes flocculation (by chemical addition) and filtration (using pressure filtration to force fluid through a porous media). The process (after sedimentation/filtration) uses ion exchange to remove metallic ions and reverse osmosis to remove the TDS. Therefore, before discharge, the toxicity and mobility of contaminants and the volume of contaminants in the water are reduced.

Included in the capping alternatives are provisions for extracting and treating perched groundwater from below these waste units.

The configuration of the wellpoint system for the Fly Ash/Southfield areas is illustrated in Figure 3-17. The wellpoint locations are approximate; exact placement would depend on a detailed analysis of data. The system should be conservatively designed to pump a maximum of 10 gpm. The wellpoint system would be operated until contaminant concentrations were below levels of concern (as established by

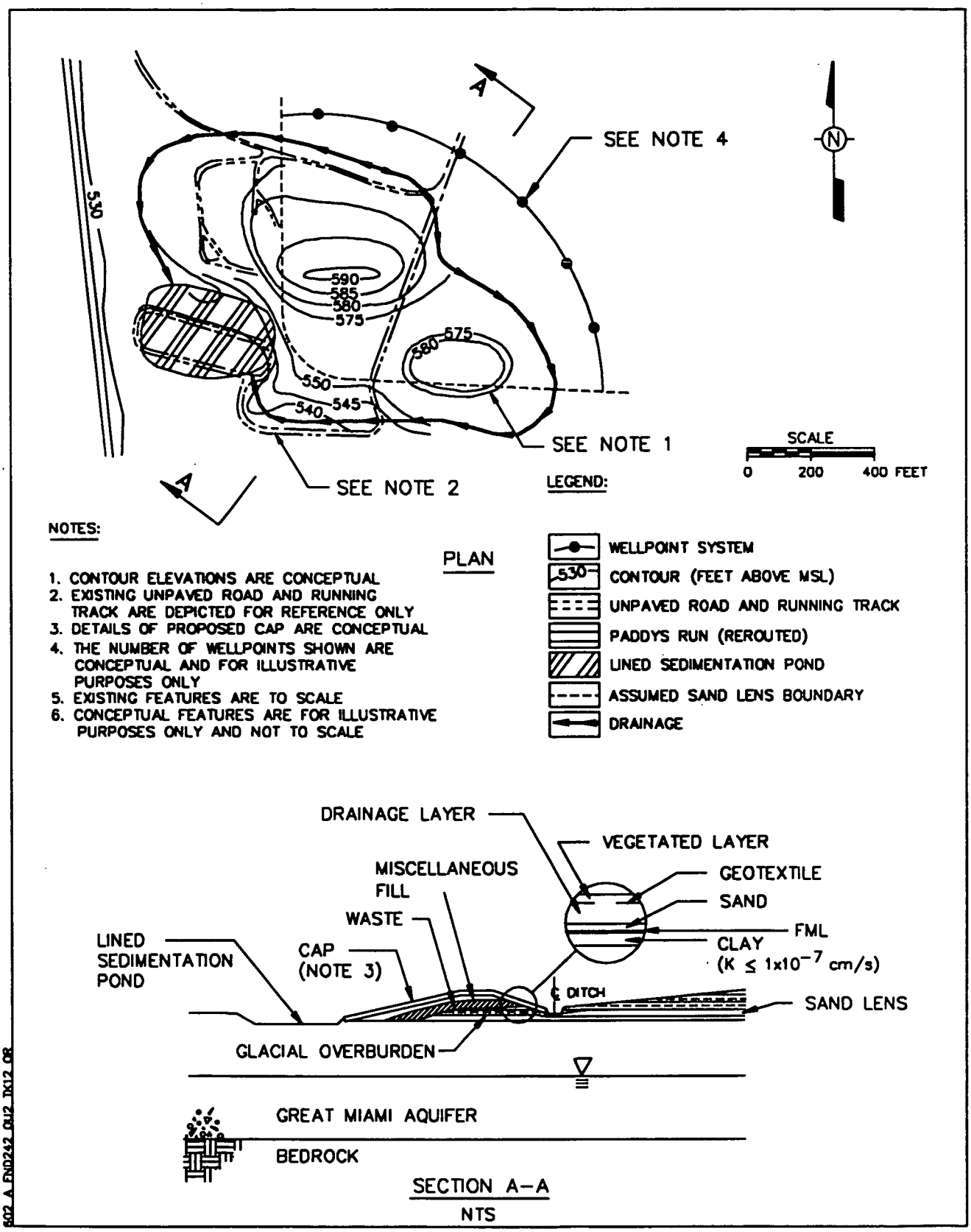


FIGURE 3–17. FLY ASH AREAS AND SOUTHFIELD – ALTERNATIVE 2

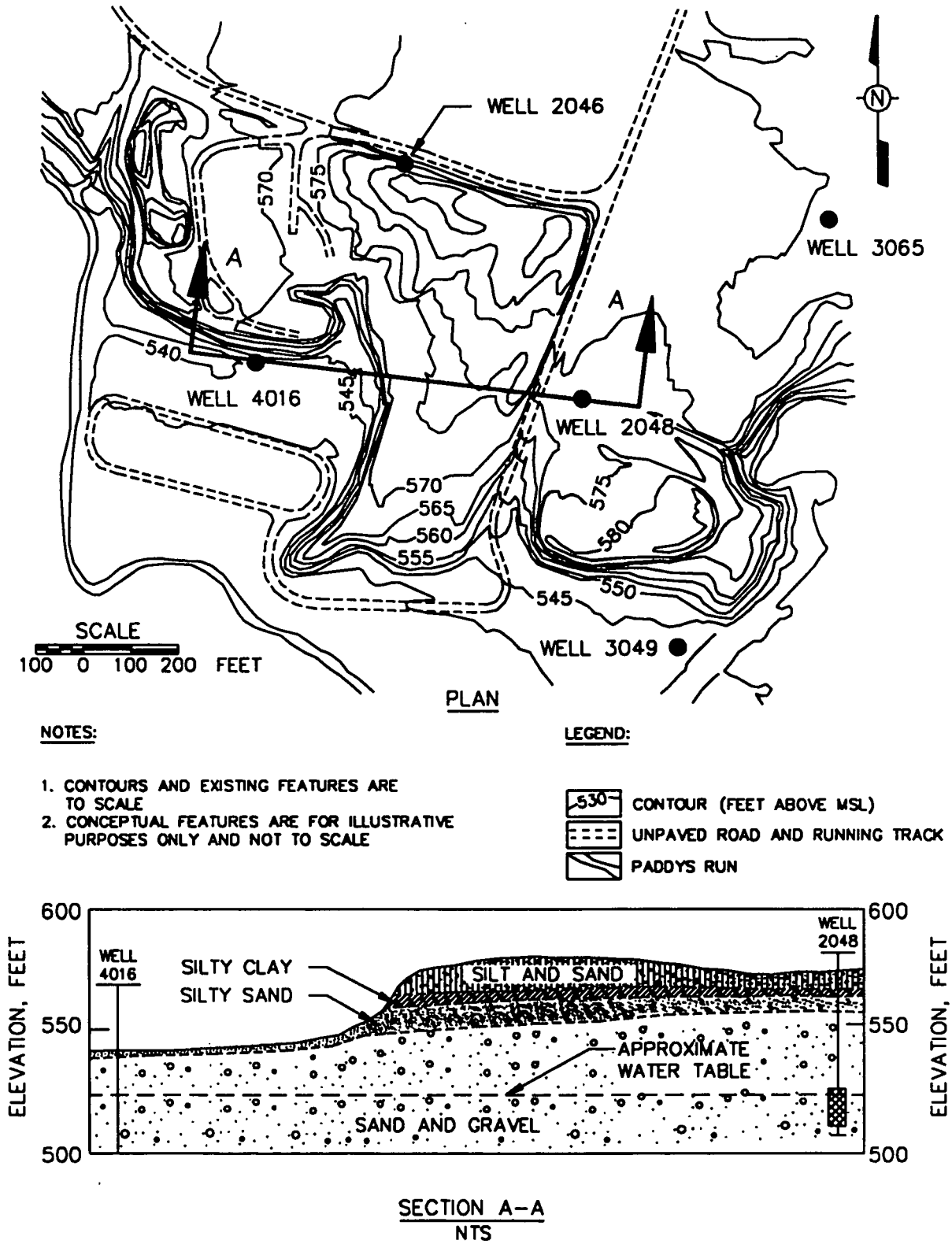


FIGURE 3–18. GEOLOGICAL CROSS SECTION OF FLY ASH AREAS AND SOUTHFIELD

ARARs) or until the quantity of collected water became negligible. The time frame for pumping is not presently known; however, for purposes of volume and cost estimation, one year is assumed. Should this alternative be selected for detailed analysis, modeling studies could determine a realistic time frame. Based on the above estimates, and assuming a sand lens area roughly equivalent to that of the Fly Ash/Southfield, the pumped volume would be approximately 4,900,000 gallons (DOE 1990b). This estimate of water volume assumes a sand lens that is continuous under each area. For the Fly Ash/Southfield areas this is a conservative assumption. Again, a one-year time frame was used to generate an estimate of these volumes.

Extraction of perched water, plugging the extraction wells, and stabilization/capping would take an estimated two years to complete. This estimate anticipates time lost to bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. Open space that surrounds the Fly Ash/Southfield areas will allow for construction activities, but they should be coordinated with the remediation of other operable units.

There are no transportation requirements for the wastes themselves, because all wastes would remain in place and on-property. LLRW generated as a result of construction activities would be considered as LSA material and, if shipped off-site, would be packaged in accordance with applicable portions of 40CFR173. The actual packaging used for transport and disposal of the LLRW would be watertight, certified for the transport of LSA material (i.e., meet DOT packaging requirements), and of suitable size. LLRW generated as a result of construction activities could be disposed of on property. Any on-site transportation of construction-generated wastes would be in accordance with the requirements set forth in DOE Order 5480.4a (Draft).

Construction activities would generate ordinary sanitary (solid) waste and LLRW in the form of contaminated clothing, tools, and equipment. Treatment of groundwater would generate additional chemically and radiologically contaminated wastes.

CERCLA exempts on-site activities from permit requirements. However, CERCLA necessitates compliance with substantive requirements of ARARs, so ARARs should be included in decision documentation used for site remediation.

This alternative will require:

- Earth-moving, excavation, and compaction equipment
- Clay capable of achieving 10^{-7} centimeters per second vertical permeability
- Long-term maintenance and environmental monitoring program
- Partial relocation of Paddys Run and the SSOD

- Water treatment facility and water supply
- Decontamination facilities
- Short- and long-term run-on/runoff control

The spatial requirements are as follows:

- Staging area for construction material and equipment - 1.0 acre
- Office and field laboratories - 0.5 acre
- Decontamination facilities - 0.5 acre
- Wastewater treatment system - 0.5 acre

3.2.3.3 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal

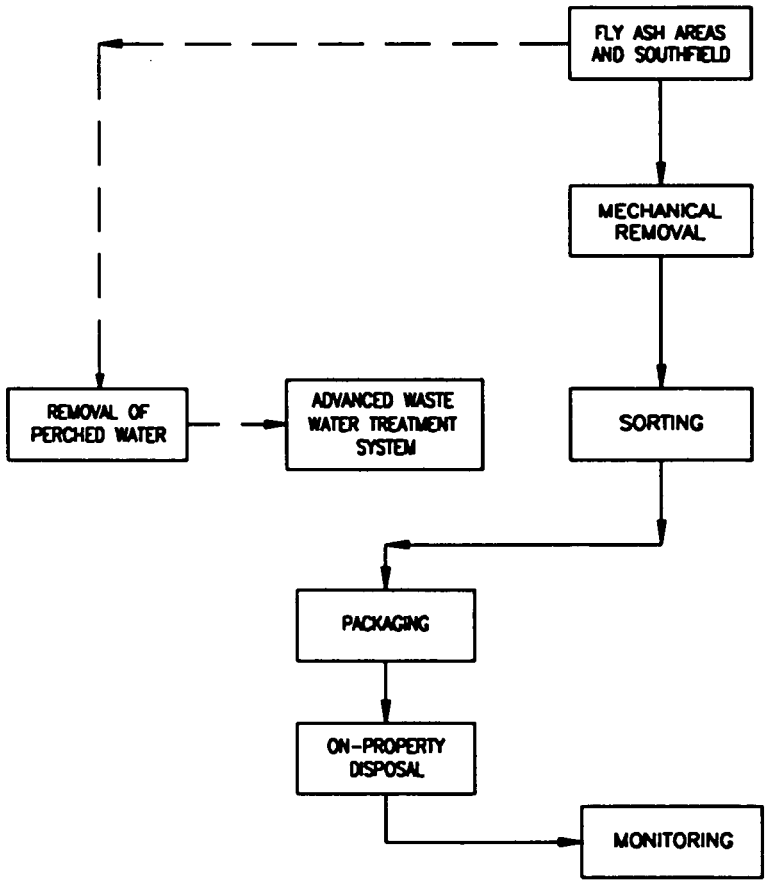
This alternative incorporates removal and on-property disposal of the waste materials and the removal and treatment of perched groundwater contained in the sand lenses. It also involves the mechanical removal and on-property disposal of the wastes from the Fly Ash/Southfield areas in an EDF (Figure 3-6). The flow diagram associated with this alternative is depicted in Figure 3-19.

Mechanical removal methods would be employed to remove the wastes in the Fly Ash/Southfield areas. The wastes in these areas have a fairly firm, compacted, and unsaturated consistency. This technology uses excavation equipment such as backhoes, draglines, and clamshells for waste removal. The wastes would then be packaged and moved to the EDF for final disposal. This alternative does not include any form of treatment for the wastes from the Fly Ash/Southfield areas.

To achieve the overall goal of protecting human health and the environment, this alternative would provide for the removal and treatment of any perched groundwater contained in the sand lenses that underlie the Fly Ash/Southfield areas. A wellpoint system that extends partially around the Fly Ash/Southfield areas would be installed. Wells would be placed in the glacial overburden to extract the perched groundwater. Any perched groundwater collected would be treated in the AWWT facility as described in Alternative 2.

The time required to complete the remediation efforts as described in this alternative is estimated at approximately four years and anticipates time lost to bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. This time frame begins with site mobilization and continues to decontamination, disassembly, construction of an on-property disposal facility, and finally to process equipment removal.

OPERABLE UNIT 2
REMOVAL OF WASTE, PERCHED GROUNDWATER TREATMENT
AND ON-PROPERTY DISPOSAL



602 A FN0247A OU2 TK12 GR

FIGURE 3-19. FLY ASH AREAS AND SOUTHFIELD - ALTERNATIVE 3

As excavation progresses, the waste would be packaged, transported, and deposited at the site. Disposal of solid waste could occur in an on-property EDF constructed for all FMPC wastes. On-property transportation of all Operable Unit 2 wastes would be in accordance with requirements set forth in DOE Order 5480.3a (draft).

The wastes that would be generated during the execution of construction, excavation, and storage phases of this alternative are:

- LLRW in the forms of contaminated clothing, tools, and equipment that are generated during the construction and treatment phases
- Sanitary wastes

Disposal of the sanitary (solid) waste material generated during the remedial action could occur in a facility designed only for solid waste. The wastewater generated as a result of excavation (cleaning of equipment, etc.) would be treated in the AWWT facility.

CERCLA exempts on-site activities from permit requirements. There are no off-site activities associated with Alternative 4; however, CERCLA guidelines necessitate compliance with substantive ARAR requirements. These requirements will be included in decision documentation used for site remediation.

The spatial requirements for implementing this alternative are as follows:

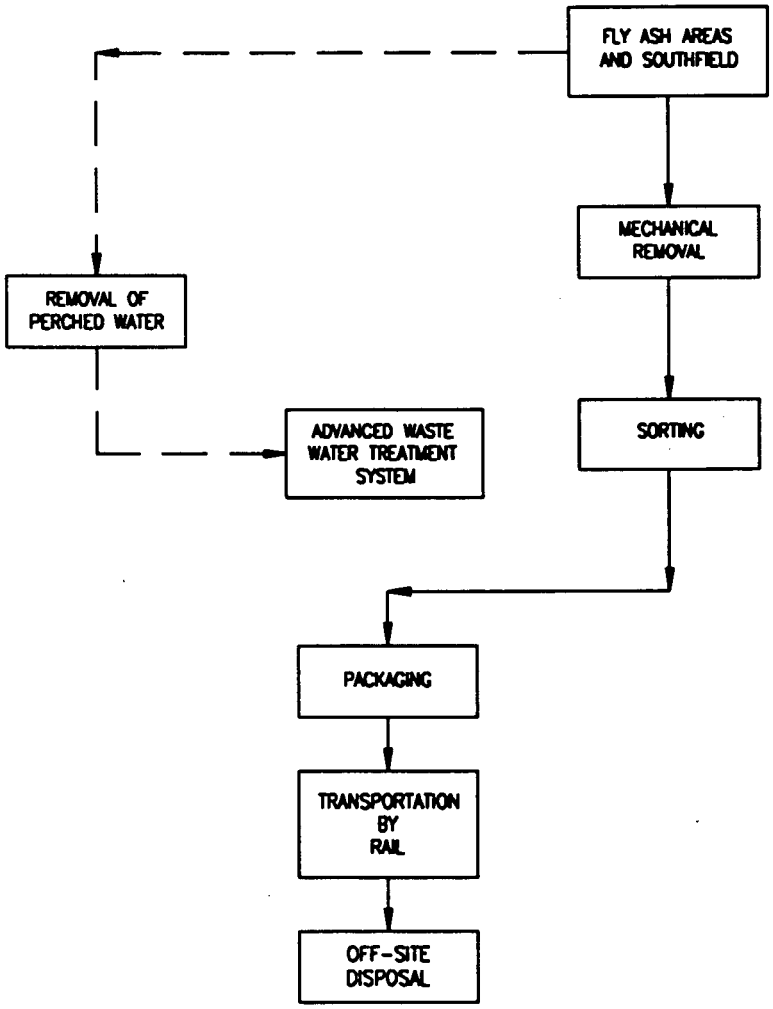
- Offices and field laboratory - 0.5 acre
- Decontamination facilities - 0.5 acre
- On-property packaging and facility - 0.5 acre
- Staging area for supplies and earth-moving equipment - 1.5 acres
- EDF or equivalent - 20 acres
- Transfer station - 2.0 acres
- Wastewater treatment plant - 0.5 acre

3.2.3.4 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal

This second removal alternative for the Fly Ash/Southfield areas is similar to Alternative 3, except that the removed waste materials would be transported and disposed of at an approved or licensed off-site location (Figure 3-20). The LLRW would not require treatment prior to shipping. A temporary on-property storage structure would be required to support the off-site transportation effort. The transport process option selected for further consideration is transport by rail. Any waste acceptance criteria the

OPERABLE UNIT 2

REMOVAL OF WASTE, PERCHED GROUNDWATER TREATMENT AND OFF-SITE DISPOSAL



602 A FND248A OU2 TK12 OR

FIGURE 3-20. FLY ASH AREAS AND SOUTHFIELD - ALTERNATIVE 4

disposal facility imposes (e.g., no free liquids, no respirable particulate fines) would be satisfied prior to shipping. For further details and a description of the transportation and disposal requirements for this alternative see Section 3.2.1.4.

3.2.3.5 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal

Alternative 5 is similar to Alternative 3 except that the removed waste materials are treated before being packaged and transported to the on-property EDF. The process-sequence associated with this alternative is depicted in Figure 3-21.

After the wastes are removed and segregated they will be treated as described in Section 3.2.1.5.

As excavation progresses, the waste material would be treated, packaged, and transported to an EDF constructed for all FMPC wastes. The on-property EDF, intended for containment of LLRW, would be capable of storing RCRA hazardous or mixed wastes under CERCLA. On-property transportation of all Operable Unit 2 wastes would be in accordance with requirements set forth in DOE Order 5480.3a (draft).

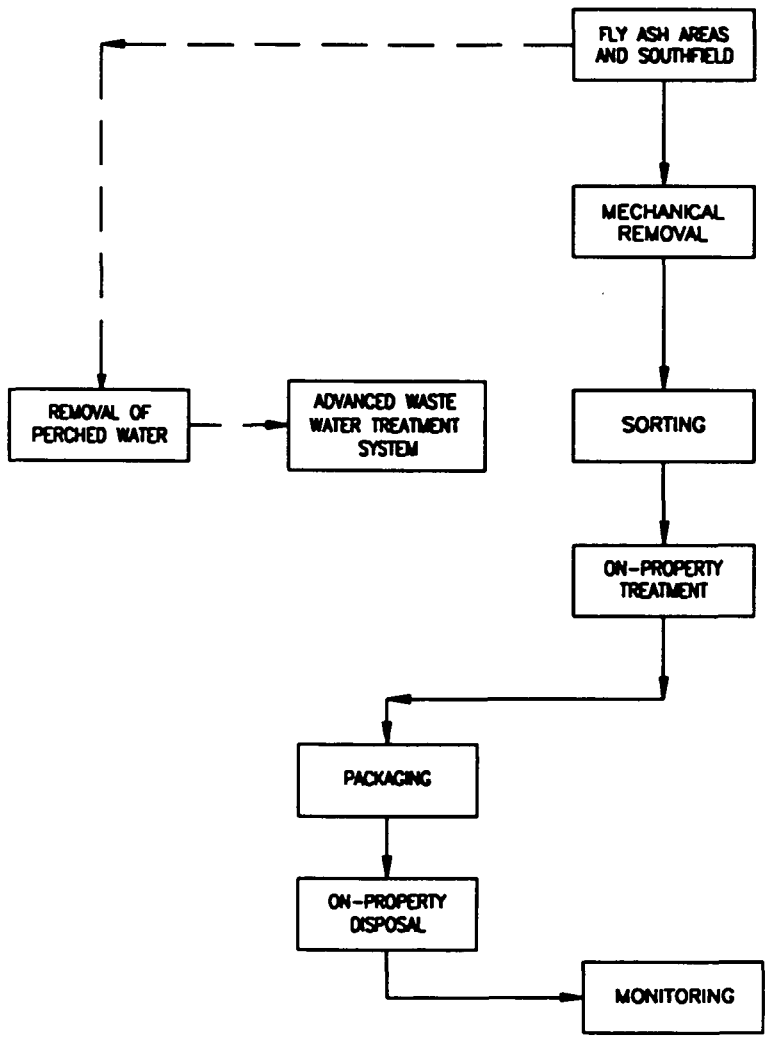
Wastes that would be generated during the execution of construction, excavation, treatment and storage phases of this alternative are:

- Low-level radioactive wastes in the forms of contaminated clothing, tools, and equipment that are generated during the construction and treatment phases, and
- Sanitary wastes.

Disposal of the sanitary (solid) waste material generated during the remedial action could occur in a facility designed only for sanitary (solid) waste. The wastewater generated as a result of excavation (cleaning of equipment, etc.) would be treated in the AWWT facility.

CERCLA exempts on-site activities from permit requirements. There are no off-site activities associated with Alternative 5; however, CERCLA guidelines necessitate compliance with substantive ARAR requirements. These requirements will be included in decision documentation used for site remediation. The time estimate for completion of the remediation efforts described in this alternative is six years; it anticipates time lost to bad weather and possible delays caused by addressing the environmental impacts associated with rerouting on-site drainage pathways. This time frame begins with site mobilization and continues through decontamination, disassembly, construction of an EDF, and finally to removal of process equipment.

OPERABLE UNIT 2
REMOVAL AND TREATMENT OF WASTE, PERCHED GROUNDWATER TREATMENT AND ON-PROPERTY DISPOSAL



602 A FND247 OU2 TK15 OR

FIGURE 3-21. FLY ASH AREAS AND SOUTHFIELD - ALTERNATIVE 5

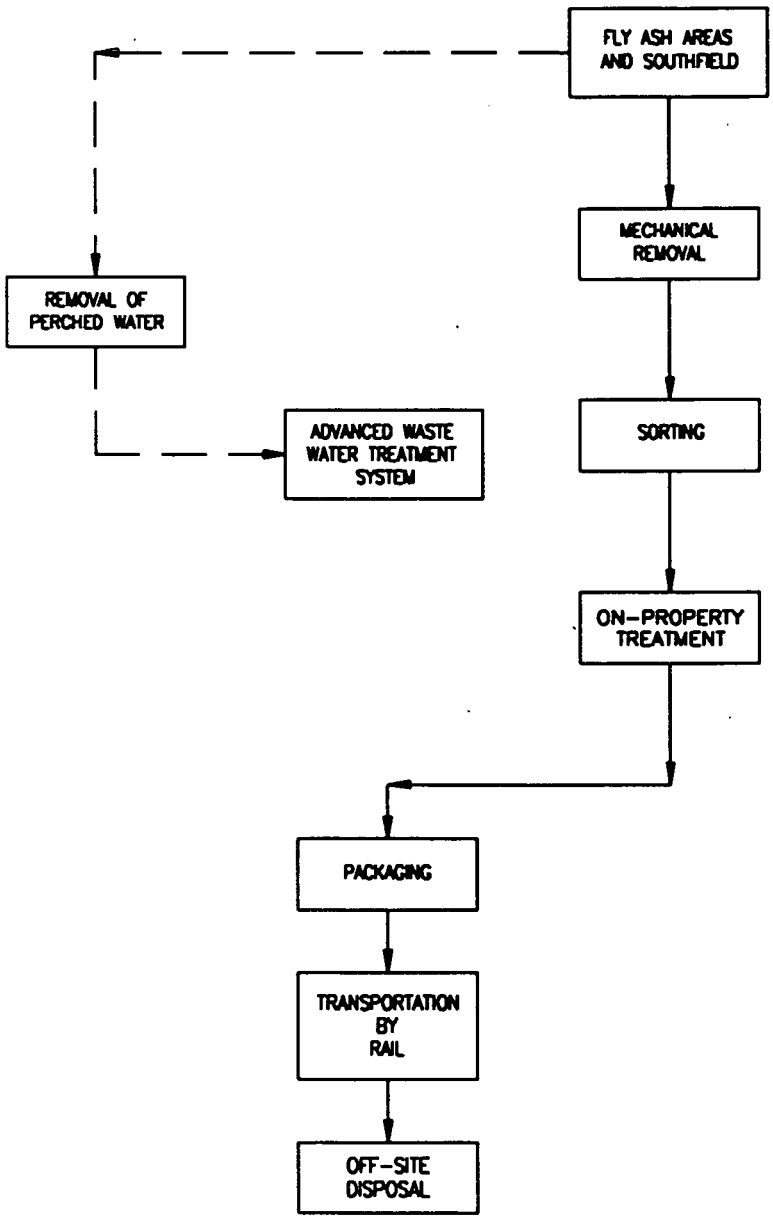
The spatial requirements for implementing this alternative are as follows:

- Offices and field laboratory - 0.5 acre
- Decontamination facilities - 0.5 acre
- On-property treatment and packaging and process facility - 1.0 acre
- Staging area for supplies and earth-moving equipment - 1.5 acres
- EDF or equivalent - 20 acres
- Treated waste transfer station - 2.0 acres
- Wastewater treatment plant - 0.5 acre

3.2.3.6 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal

Alternative 6 is similar to Alternative 5, except that the removed and treated waste materials would be transported and disposed of at an approved off-site location (Fig 3-22). The Fly Ash/Southfield wastes would be treated on property, packaged, and shipped offsite to a permitted disposal facility. A temporary on-property storage structure would be required to support the off-site transportation effort. The transport process option selected for further consideration is transport by rail. Any waste acceptance criteria the disposal facility imposes (e.g., no free liquids, no respirable particulate fines) would be satisfied before shipping. For further details and a description of the transportation and disposal requirements for this alternative, see Section 3.2.1.6.

OPERABLE UNIT 2
REMOVAL AND TREATMENT OF WASTE, PERCHED GROUNDWATER TREATMENT AND OFF-SITE DISPOSAL



602 A FND248 OU2 TK12 OR

FIGURE 3-22. FLY ASH AREAS AND SOUTHFIELD - ALTERNATIVE 6

4.0

4.0 ALTERNATIVE SCREENING METHODOLOGY

4.1 INTRODUCTION

This section discusses the methodology used to screen alternatives. In Section 3, alternatives were assembled based on the evaluations of technologies and process options performed in Section 2. In Section 5, alternatives are screened using three broad criteria: effectiveness (short and long term), implementability, and cost. It is important to note that comparisons during screening are usually made between similar alternatives, whereas comparisons during the detailed analysis differentiate among the entire range of alternatives. Figure 4-1 shows a comparison of the general screening criteria used in the Initial Screening of Alternatives to the nine evaluation criteria used in the detailed analysis. The three broad criteria are discussed in Sections 4.2.1, 4.2.2, and 4.2.3.

4.2 ALTERNATIVE EVALUATION PROCESS

4.2.1 Effectiveness Evaluation

Each alternative is evaluated for effectiveness in protecting human health and the environment. Protection of human health for on-site activities involves site workers and nearby residents in the short term, and nearby residents in the long term. Off-site activities will affect residents along the shipment routes in the short term. Additionally, alternatives are evaluated for effectiveness in reducing toxicity, mobility, and volume in both short-term and long-term time frames. Short term refers to the construction and implementation period, while long term refers to the period after the remedial action is complete.

4.2.2 Implementability Evaluation

Implementability refers to the technical and the administrative feasibility of constructing, operating, and maintaining a remedial action alternative. Technical feasibility is defined as the ability to construct, reliably operate, and meet technology-specific regulations for process options until a remedial action is complete. It also includes operation, maintenance, replacement, and monitoring of technical components of an alternative, if required, into the future (after the remedial action is complete). Administrative feasibility refers to the ability to obtain approvals from other offices and agencies; the availability of treatment, storage, and disposal services and capacity; and the requirements for, and availability of, special equipment and technical specialists.

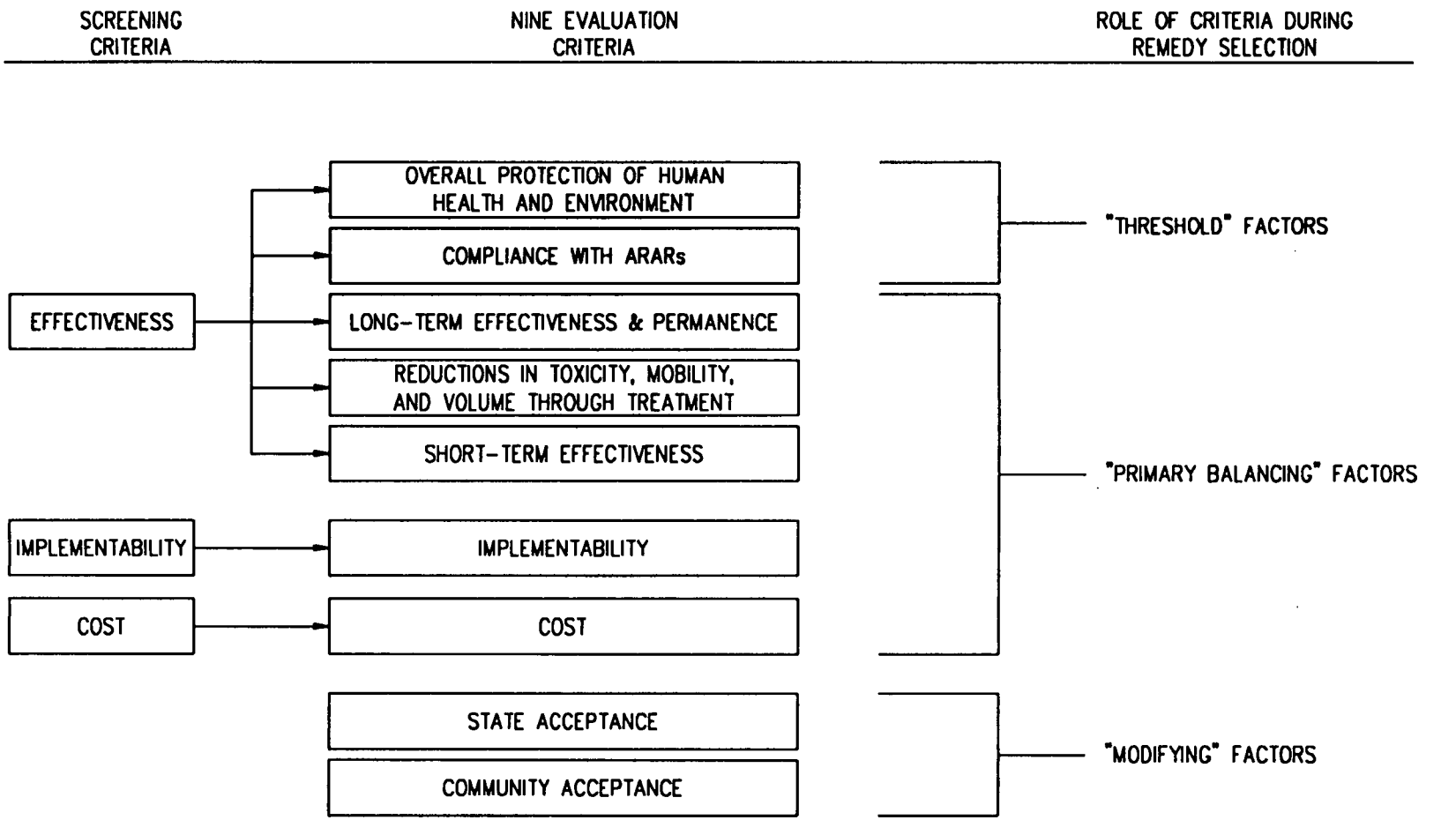


FIGURE 4-1. RELATIONSHIP OF SCREENING CRITERIA TO THE NINE EVALUATION CRITERIA

4.2.3 Cost Evaluation

Cost estimates for screening alternatives typically will be based on a variety of cost-estimating data. Cost estimates may include cost curves, generic unit costs, vendor information, conventional cost-estimating guides, and prior similar estimates as modified by site-specific information. Prior estimates, site-cost experience, and good engineering judgments are needed to identify those items in each alternative that will control these comparative estimates. Cost estimates for items common to all alternatives or indirect costs (engineering, financial, supervision, outside contractor support, contingencies) do not normally warrant substantial effort during the alternative screening phase. Both capital and operation and maintenance (O & M) costs are considered, where appropriate, during the screening of alternatives. The evaluation also includes those O & M costs that may continue beyond the completion of initial remedial action. In addition, potential future remedial action costs are considered during alternative screening to the extent that they can be defined. Present-worth analyses are used during alternative screening to evaluate expenditures that occur over different time periods. Discounting all costs to a common base year allows the costs for different remedial action alternatives to be compared on the basis of a single figure for each alternative. The present worth and capital cost for each alternative are given in Section 5.0. The present worth is based on a discount rate of 5 percent and a 30-year period of performance.

4.2.4 Innovative Technologies

Technologies are classified as innovative if they are fully developed but lack sufficient cost or performance data for routine use at cleanup sites. In the case of Operable Unit 2, reverse osmosis, polymerization, and vitrification technologies are considered innovative.

4.3 COMPLIANCE WITH ARARs

CERCLA requires that remedial actions achieve a level of cleanup or standard of control of hazardous substances, pollutants, or contaminants that, as a minimum, assures the protection of human health and the environment with respect to those hazardous substances, pollutants, and contaminants that will remain on site. CERCLA further specifies that remedial actions meet any federal standards, requirements, criteria, or limitations that are determined to be legal ARARs.

ARARs are classified as chemical specific, location specific, or action specific. Chemical-specific ARARs address the acceptable amount or concentration of a specific pollutant that may be found in or discharged to soil, water, and air. Location-specific ARARs are based on the specific setting and nature of the site; action-specific ARARs relate to technology or activity-based requirements or limitations on the specific response actions taken with respect to the type of wastes. Thus, a determination of the potential ARARs for proposed actions at a site is based on factors specific to that site and to a specific proposed action.

Appendix B contains a general list of potential ARARs and TBCs. The potential ARARs are based on the nature of the contamination, the location of the site, and the general scope of the identified remedial action alternatives.

4.4 LAND DISPOSAL RESTRICTIONS

Since the proposed ARARs for Operable Unit 2 consider Subtitle C of RCRA, regulations for land disposal restrictions will be complied with regarding on-site or off-site disposal for those Sanitary Landfill wastes classified as RCRA hazardous.

5.0

5.0 SCREENING OF ALTERNATIVES

In this section, alternatives are screened against three general criteria: effectiveness, implementability, and cost. Each alternative is examined for each of the waste unit groups; the Sanitary Landfill, the Lime Sludge Ponds, and the Active/Inactive Fly Ash and Southfield areas. There are two reasons for grouping the Fly Ash/Southfield areas together: (1) they are located adjacent to one another on the site, and (2) the wastes exhibit similar physical characteristics. The Southfield consists primarily of soil; fly ash is similar to soil in that it can be used as fill material and has similar handling characteristics. Both areas exhibit above-background levels of radionuclides, and the alternatives scored identically in the screening.

Each alternative was assigned a numerical value of 1 through 5 for each criterion, depending on how well it fulfills the criterion. A ranking of 1 indicates that the alternative is least favorable for a particular criterion, while 5 indicates that the alternative is most favorable for that criterion relative to other alternatives. As stated earlier in Section 4.1, alternatives are screened against the general categories of effectiveness, implementability, and cost. Weighting factors are not used for the initial screening of alternatives, but will be used as the alternative selection process progresses. Section 5.5 consists of summary tables that reflect the relative ranking of the alternatives.

The costs for each alternative were estimated in accordance with the cost evaluation of Section 4.2.3.

5.1 SANITARY LANDFILL

5.1.1 Alternative 0: No Action

5.1.1.1 Effectiveness

In the short term, the implementation of this alternative would pose little risk to workers or the public living immediately off property since all material would remain in place and would not be disturbed. It is assumed that property access restrictions would be in place during the remedial action, and overall risks related to this alternative are considered to be low. The baseline risk assessment indicates that the potential for groundwater contamination would be low and that continuing the existing access restrictions would prevent direct contact with the waste; therefore, this alternative is rated 4 with respect to short-term effectiveness in protection of human health. However, because present environmental impacts would continue, this alternative rated 2 in terms of its effectiveness in protecting the environment.

Alternative 0 is given a lower ranking for long-term effectiveness in public health and environmental protection because it does not mitigate the spread of contamination. The baseline risk assessment

assumes that access restrictions would be removed in the future and that the receptor of contamination could be on site, so the risk to the potential receptor is much higher over the long term than it is for the short term. Also, this alternative provides no reduction of toxicity, mobility or volume. Due to this combination of factors, its rating for long-term effectiveness is only 1.

5.1.1.2 Implementability

This alternative is rated 5 in all categories for implementability. The current situation at the site illustrates the implementability of Alternative 0. There would be no construction, and no technologies other than groundwater monitoring would be utilized. The likelihood of schedule delays during the implementation of this alternative is remote. Agency approvals would not be needed since no action would be taken, and no special engineering would be needed.

5.1.1.3 Cost

The present worth of this alternative for this waste area is $ 384,000. There are no capital costs associated with the implementation of this alternative.

5.1.2 Alternative 1: Nonremoval - Containment

5.1.2.1 Effectiveness

Alternative 1 rated 4 in short-term effectiveness, because the benefits of its implementation would begin immediately and it would be relatively effective in protecting both public health and the environment. A reduction of infiltration of precipitation would begin with the onset of cap construction and would increase as cap construction progressed. Since the wastes would not be removed, the risk to workers would be minimal. Consequently, a rating of 4 was assigned to this alternative's potential for short-term effectiveness.

The long-term effectiveness of this alternative is less favorable. The cap would require periodic maintenance, and no liners would be placed underneath the waste to inhibit migration of the contamination. Therefore this alternative was rated 2 for this category. Although the mobility of contaminants would be reduced by the cap, there would be no reduction of toxicity or volume as a result of implementing Alternative 1. Consequently, this alternative received a rating of 2 in each of these categories.

5.1.2.2 Implementability

Alternative 1 has received a rating of 4 in each of the implementability categories of constructability, reliability, maintainability, and requirement of agency approvals. Capping is a proven technology and can be implemented for Operable Unit 2 waste units. Reliability focuses on the probability of schedule delays; since implementation of this alternative would involve no removal action, it is not as

likely as a removal alternative to involve such delays. Some maintenance would be required for the cap, and some agency approvals would be required (to discharge treated water collected from surface runoff). The implementation of Alternative 1 would require no special engineering at all, so it was rated 5 in that category.

5.1.2.3 Cost

The present worth of this alternative for this waste area is $ 1,800,000. Capital costs associated with the implementation of this alternative are $ 1,206,000.

5.1.3 Alternative 2: Nonremoval - Containment with Perched Groundwater Treatment

5.1.3.1 Effectiveness

Alternative 2 is rated 4 in the categories of short-term protection of public health and the environment. The benefits would be attained rapidly since the wastes would not be removed, and capping would reduce infiltration of precipitation as cap construction progressed. There is some potential for worker exposure to contaminated perched groundwater, but the increased risk due to this (when compared to Alternative 1) is not sufficient to warrant a reduced numerical ranking. Both Alternatives 1 and 2 provide for treatment of contaminated water collected from surface runoff.

The long-term effectiveness of this alternative rated a 3 for protection of public health and long-term environmental protection, since the removal and treatment of contaminated perched groundwater offers enhanced protection over that provided by Alternative 1. As would be the case for Alternative 1, the wastes would receive no treatment under this alternative, so there would be no reduction in toxicity or volume; however, the cap would reduce the mobility of contaminants to the groundwater, so this alternative was rated 2 in this category.

5.1.3.2 Implementability

Constructability, reliability, maintainability, and agency approvals have all been assigned ratings of 4 under Alternative 2. The favorable ratings are primarily due to the fact that the wastes would not be removed from the property. The technologies of capping the landfill wastes and of removing the perched water from the ground and treating it are proven and implementable. Skilled labor and the materials needed to implement this alternative are available. The probability of schedule delays, the extent of maintenance, and the need for obtaining agency approvals are all comparable to those described for the implementation of Alternative 1. Alternative 2 was rated 5 in the category of special engineering, because the technologies involved in its implementation are all proven.

5.1.3.3 Cost

The present worth of this alternative for this waste area is $ 1,870,000. Capital costs associated with the implementation of this alternative are $ 1,250,000.

5.1.4 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal

5.1.4.1 Effectiveness

Alternative 3 received a rating of 3 in the category of short-term protection of public health and the environment. Because the implementation of this alternative would involve the removal of landfill wastes from their current location and its disposal in an EDF that would be constructed on property, the risks to workers would be higher than those incurred for nonremoval alternatives. There also would be short-term environmental impacts such as dust, noise, and construction traffic associated with building the EDF, so that Alternative 3 was rated 2 in that category.

This alternative is rated 3 in the category of long-term effectiveness in protecting public health and the environment, because the on-property EDF would include liners underneath the stored wastes from the landfill, thereby inhibiting the leaching of contamination and providing enhanced environmental protection over that offered by alternative 1. Alternative 3, which would require on-site disposal, is rated lower than Alternative 4 because the area surrounding the FMPC is more densely populated than areas around off-site disposal locations. This alternative rated 2 in the category of reduction in toxicity, mobility or volume, because its implementation would have essentially the same results as those described for Alternatives 1 and 2.

5.1.4.2 Implementability

This alternative rated a 4 for constructability. An EDF would have to be built on property, but the technologies involved in construction of this type do not differ significantly from those used in cap construction. In the reliability category, this alternative rated 3 because of increased potential for schedule delays associated with excavation of the waste and construction of the EDF. Since maintenance of the EDF would consist primarily of maintaining the multilayer cap, a rating of 4 was assigned to this alternative in this category. As with Alternative 2, agency approvals would be required for discharging the treated groundwater off property, but other remedial activities are confined to the property and would require no permits. This alternative was rated 4 in the agency approval category. Technologies utilized in the implementation of this alternative are proven, so Alternative 3 was rated 5 in the special engineering category.

5.1.4.3 Cost

The present worth of this alternative for this waste area is $ 23,260,000. Capital costs associated with the implementation of this alternative are $ 14,610,000.

5.1.5 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal

5.1.5.1 Effectiveness

This alternative was rated 3 in the category of short-term protection of public health, because of the increased risk (over the previously discussed alternatives) to workers involved in both the removal and off-site shipment of the landfill wastes. The short-term environmental impacts of the removal, packaging, and transportation of the wastes earned a rating of 2 for this alternative in the category of short-term protection of the environment, because removal actions coupled with off-site transportation are more disruptive to the environment.

Because an off-site facility provides enhanced protection (disposal must meet applicable regulations) and because human population in the vicinity of candidate off-site disposal facilities is less than that surrounding the FMPC, Alternative 4 has been rated 4 for long-term effectiveness in protecting human health and the environment. As with Alternatives 1 and 2, the implementation of Alternative 4 would provide no reduction in the volume or toxicity of the landfill wastes, but there would be a reduction in mobility since the wastes would be removed from the site; so, this alternative is rated 2 in that category.

5.1.5.2 Implementability

The ratings for this alternative are identical to those assigned to Alternative 3, with the exception of agency approvals. Permits for off-site transportation and disposal would be required.

Since (under Alternative 4 implementation) the wastes may have to be shipped across several states to reach the off-site disposal facility, the required agency approvals may be considerably more difficult to obtain, so a rating of 3 was given in that category. Proven technologies would be used in the implementation of this alternative, so it was rated 5 in the special engineering category.

5.1.5.3 Cost

Using rail transportation, the present worth of this alternative for this waste area is $ 66,600,000. Capital costs associated with the implementation of this alternative are $ 42,000,000.

5.1.6 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal

5.1.6.1 Effectiveness

Alternative 5 received a rating of 3 in the category of short-term protection of public health, because it calls for removal of wastes from the landfill. Risks of exposure to workers would be higher under this alternative than for nonremoval actions. The implementation of this alternative also would result in

short-term environmental impacts associated with the construction of an on-property EDF, so it received a rating of only 2 for short-term protection of the environment.

In the categories under long-term effectiveness, this alternative has been assigned a rating of 4 for protection of human health and the environment due to the treatment of the waste coupled with the protective features offered by the EDF. Also, under the implementation of this alternative, thermal treatment of the landfill wastes would be employed and would result in reduction of toxicity, mobility, and volume. In this category, this alternative received a rating of 5.

5.1.6.2 Implementability

Alternative 5 would involve the construction of an on-property EDF, but the technologies used would not differ significantly from cap construction; so this alternative has been rated 4 for constructability. For reliability this alternative has been rated 3, due primarily to the increased potential for schedule delays associated with excavation of the landfill wastes and construction of the EDF. Under this alternative, maintenance would consist primarily of the EDF's multilayer cap and has been given a rating of 4. Most activities associated with this alternative would be conducted on-property. Agency approvals would be required only for the off-property discharge of treated, perched groundwater; so a rating of 4 was assigned to this alternative in that category. Proven technologies would be used to implement this alternative, with the exception of waste incineration. Incineration in itself is a proven technology, but it is more complex than the other technologies utilized for Operable Unit 2, so it was given a 4 for special engineering.

5.1.6.3 Cost

The present worth of this alternative for this waste area is $ 31,800,000; capital costs associated with the implementation of this alternative are $ 20,150,000.

5.1.7 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal

5.1.7.1 Effectiveness

For short-term protection of public health, this alternative has been rated 3. The landfill wastes are removed and disposed of off-site, so worker exposure risks are higher than for nonremoval alternatives. Short-term environmental impacts would result from the excavation, packaging, and transportation (to the off-site facility) of the wastes. Consequently, Alternative 6 received a rating of 2 in this category.

This alternative was rated 5 in the category of long-term effectiveness, because an off-site facility provides enhanced protection (disposal must meet applicable regulations) and because human

population in the vicinity of candidate off-site disposal facilities is less than that surrounding the FMPC property. Toxicity, mobility, and volume would be reduced by thermal treatment of the wastes, so this alternative was rated 5 for this criteria as well.

5.1.7.2 Implementability

Under this alternative, it is likely that an existing off-site disposal facility would have to be enlarged to accept the landfill wastes, but construction of that type does not differ significantly from cap construction, so Alternative 6 was assigned a rating of 4 in the constructability category. Primarily because of the increased potential for schedule delays associated with excavation of the landfill waste, this alternative has been rated 3 for reliability. This alternative would not require any perpetual maintenance because the waste would not be stored on property, so this alternative also has been rated 5 in maintainability.

Since the wastes may have to be shipped across several states to reach the off-site disposal facility, the required agency approvals may be considerably more difficult to obtain, so a rating of 3 is given in that category. Proven technologies (except for incineration) would be used in the implementation of this alternative. Incineration is a proven technology but is more complex, so it was rated 4 in the special engineering category.

5.1.7.3 Cost

Using rail transportation, the present worth of this alternative for this waste area is $ 90,350,000. Capital costs associated with the implementation of this alternative are $ 56,940,000.

5.2 LIME SLUDGE PONDS

5.2.1 Alternative 0: No Action

5.2.1.1 Effectiveness

The No-Action Alternative for the Lime Sludge Ponds is similar to that of the Sanitary Landfill. For short-term effectiveness in protecting public health, Alternative 0 rated a 4. However, because present environmental impacts would continue, this alternative has been rated 2 for its effectiveness in protecting the environment. Implementation of this alternative would not mitigate the spread of contamination. The baseline risk assessment assumes that access restrictions will be removed in the future and that the receptors of contamination will be located adjacent to this waste unit. The resulting risk to these receptors, under implementation of Alternative 0, would be higher for the long term (than for the short term); therefore, this alternative was rated only 1 for long-term effectiveness. Implementation of this alternative would not reduce toxicity, mobility, or volume, so has been assigned a rating of 1 in that category.

5.2.1.2 Implementability

The current situation at the site illustrates the implementability of this alternative. There would be neither construction nor use of technologies (other than groundwater monitoring); the likelihood of schedule delays would be remote. Agency approvals would not be needed, because no action would be taken and no special engineering would be needed. Alternative 0 rated 5 in all these categories.

5.2.1.3 Cost

The present worth of this alternative for this waste unit is $ 384,000. There are no capital costs associated with the implementation of this alternative.

5.2.2 Alternative 1: Nonremoval - Containment With In Situ Stabilization

5.2.2.1 Effectiveness

This alternative has been rated 4 for short-term effectiveness, because the benefits of its implementation would begin immediately and because it would be relatively effective in protecting both public health and the environment. Reduction of the infiltration of precipitation would begin with the onset of cap construction and would increase as construction progressed. Since the waste would not be removed from the lime sludge ponds, the risks of exposure to workers would be minimal.

This alternative was rated 3 in the category of long-term effectiveness, because the mobility of contamination is reduced by stabilization of the waste. Protection of public health and the environment is greater than for the No-Action Alternative. There would be a reduction in toxicity and mobility for this alternative, but verification of stabilization of lime sludge in situ would be more difficult than it would be under a removal alternative; therefore, a lower ranking was assigned for this category when compared to a removal alternative. The volume of the lime sludge would increase by the volume of additives used to stabilize it, but the total waste volume of Operable Unit 2 would not increase substantially if ash from the FMPC fly ash piles were used to stabilize the lime sludge. Alternative 1 has been rated 3 in the category of reduction of mobility, toxicity, or volume.

5.2.2.2 Implementability

Alternative 1 has received a rating of 4 in the implementability categories of constructability, reliability, maintainability, and requirement of agency approvals. Capping is a proven technology and can be implemented for Operable Unit 2. Reliability focuses on the probability of schedule delays, and since implementation of this alternative would involve no removal action, it would not be as likely to involve such delays as would a removal alternative. Some maintenance would be required for the

cap, and some agency approvals would be required (to discharge treated water collected form surface runoff). The implementation of Alternative 1 would require no special engineering, so it has been rated 5 in that category.

5.2.2.3 Cost

The present worth of this alternative for this waste area is $ 11,000,000. Capital costs associated with the implementation of this alternative are $ 7,100,000.

5.2.3 Alternative 2: Nonremoval - Containment with In Situ Stabilization and Perched Groundwater Treatment

5.2.3.1 Effectiveness

Alternative 2 is rated 4 in the categories of short-term protection of public health and the environment. The benefits would be attained rapidly since the waste would not be removed from its present location, and the reduction in infiltration of precipitation would begin with cap construction and increase as construction progressed. There would be some potential for worker exposure to contaminated perched groundwater, but the increased risk due to this (when compared to Alternative 1) is not sufficient to warrant a reduced numerical ranking. Both Alternatives 1 and 2 provide for the treatment of collected surface water runoff.

This alternative has been rated 3 for long-term protection of public health and long-term environmental effectiveness, because including removal and treatment of perched groundwater offers enhanced protection over that provided by Alternative 1. In the category of reduction of toxicity, mobility, and volume this alternative was assigned a favorable rating of 4, because the lime sludge would receive on-property treatment.

5.2.3.2 Implementability

Alternative 2 has received ratings of 4 under the criteria of constructability, reliability, maintainability, and agency approvals. The favorable ratings are primarily due to the fact that the lime sludge waste would not be removed from the property. The technologies of capping the stabilized lime sludge and of removing the perched water from the ground and treating it are proven and implementable. Skilled labor and the materials needed to implement this alternative are available. The probability of schedule delays, the extent of maintenance, and the need for obtaining agency approvals are all comparable to those described for the implementation of Alternative 1. Alternative 2 was rated 5 in the category of special engineering, because proven technologies would be used in its implementation.

5.2.3.3 Cost

The present worth of this alternative for this waste area is $ 11,110,000. Capital costs associated with the implementation of this alternative are $ 7,144,000.

5.2.4 Alternative 3: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal

5.2.4.1 Effectiveness

This alternative was rated 3 in the category of short-term protection of public health, because of the increased risk (over the previously discussed alternatives) to workers involved in the removal, stabilizing, and packaging of the lime sludge. The short-term environmental impacts of the removal and packaging of the wastes earned a rating of 2 for this alternative in the category of short-term protection of the environment.

Alternative 3 was rated 4 in the category of long-term effectiveness in protection of public health and the environment. The treatment and on-property disposal of the lime sludge offers enhanced human health and environmental protection, since disposal must meet applicable regulations. There would be an increase in the volume of the lime sludge waste under the implementation of this alternative, but the total waste volume of Operable Unit 2 would not increase substantially if ash from the FMPC fly ash piles were used to stabilize the lime sludge. Due to the high reduction of toxicity and mobility under this alternative, it was rated 5 in this category.

5.2.4.2 Implementability

Alternative 3 would involve the construction of an on-property EDF, but the technologies used would not differ significantly from cap construction; so this alternative has been rated 4 for constructability. For reliability this alternative was rated 3, due primarily to the increased potential for schedule delays associated with excavation of the landfill waste and construction of the EDF. Under this alternative, maintenance would consist primarily of the disposal facility's multilayer cap and has been given a rating of 4. Most activities associated with this alternative would be conducted on-property. Agency approvals would be required only for the off-property discharge of treated, perched groundwater, so a rating of 4 was assigned to this alternative in that category. Proven technologies would be used to implement this alternative, so it was given a 5 for special engineering.

5.2.4.3 Cost

The present worth of this alternative for this waste unit is $ 28,950,000; capital costs associated with the implementation of this alternative are $ 18,020,000.

5.2.5 Alternative 4: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal

5.2.5.1 Effectiveness

For short-term protection of public health, this alternative has been rated 3 because the landfill waste would be removed and disposed of off site, and worker exposure risks are higher for removal than for

nonremoval alternatives. Short-term environmental impacts would result from the excavation, packaging, and transportation of the wastes. Consequently, this alternative received a rating of 2 in this category.

This alternative rated 5 for protection of public health and the environment because waste treatment and off-site disposal provide enhanced protection, since disposal must meet applicable regulations. Also, human population in the vicinity of candidate off-site disposal facilities is less than that surrounding the present location. In addition, stabilization of waste achieves a reduction in toxicity and mobility due to the treatment employed. Stabilizing the lime sludge would result in a net increase in volume for Operable Unit 2 overall, but this increase is minimized by using FMPC fly ash as a stabilizing agent. Therefore this alternative rates 5 for this criteria, as well.

5.2.5.2 Implementability

Under this alternative, it is likely that an existing off-site disposal facility would have to be enlarged to accept the landfill waste, but construction of that type does not differ significantly from cap construction, so Alternative 4 has been assigned a rating of 4 in the constructability category. Primarily because of the increased potential for schedule delays associated with excavation of the waste, this alternative has been rated 3 for reliability. This alternative would not require any perpetual maintenance because the waste would not be stored on-property, so this alternative has been rated 5 for maintainability. Since (under Alternative 4 implementation) the waste may have to be shipped across several states to reach the off-site disposal facility, the required agency approvals may be considerably more difficult to obtain, so a rating of 3 was given in that category. Proven technologies would be used in the implementation of this alternative, so it has been rated 5 in the special engineering category.

5.2.5.3 Cost

Using rail transportation, the present worth of this alternative for this waste area is $ 77,000,000. Capital costs associated with the implementation of this alternative are $ 46,500,000.

5.3 FLY ASH/SOUTHFIELD AREAS

5.3.1 Alternative 0: No Action

5.3.1.1 Effectiveness

In the short term, this alternative poses little risk to public health or the environment, since all material would remain in place and would not be disturbed. It is assumed that property access restrictions would exist in the short term, and overall risks are considered low. The baseline risk assessment indicates that the potential for groundwater contamination under this alternative would be low, and

access restrictions would prevent receptors from coming into direct contact with the wastes. In the category of short-term protection of public health, this alternative was rated 4. However, present environmental impacts would continue under this alternative, so the No-Action Alternative was rated 2 for short-term effectiveness in protecting the environment.

Alternative 0 was rated an unfavorable 1 for long-term protection of public health and the environment, because it does not mitigate the spread of contamination. The baseline risk assessment assumes that access restrictions will be removed in the future and that the receptor would be located on site. The resulting risk to these receptors is much higher for the long term. A rating of 1 also was given in the category of reduction of toxicity, mobility, or volume, because there would be no such reduction under the implementation of this alternative.

5.3.1.2 Implementability

The current situation at the site illustrates the implementability of this alternative. There would be neither construction nor use of technologies (other than groundwater monitoring); the likelihood of schedule delays would be remote. Agency approvals would not be needed, because no action would be taken; and no special engineering would be needed. Alternative 0 received a rating of 5 in all these categories.

5.3.1.3 Cost

The present worth of this alternative for this waste area is $ 1,152,000. There are no capital costs associated with the implementation of this alternative.

5.3.2 Alternative 1: Nonremoval - Containment

5.3.2.1 Effectiveness

This alternative rates 4 for short-term protection of public health and the environment, because the reduction in infiltration of precipitation would begin with the onset of cap construction and increase as construction progresses. The potential for exposure to workers is less for this nonremoval alternative than it would be for a removal alternative.

In the long term, the effectiveness of this alternative is less favorable than for the short term. The cap would require periodic maintenance, and no liners would be placed under the waste. Therefore, this alternative has been rated a 2 in this category. There would be no reduction in toxicity or volume under the implementation of this alternative, but the cap would reduce the mobility of the contaminants. In the category of reduction in toxicity, mobility, or volume, Alternative 1 was rated 2.

5.3.2.2 Implementability

Alternative 1 received a rating of 4 in the implementability categories of constructability, reliability, maintainability, and requirement of agency approvals. Capping is a proven technology and can be implemented for Operable Unit 2. Reliability focuses on the probability of schedule delays; and since this is a nonremoval alternative, it is not as likely as a removal alternative to involve such delays. Some maintenance would be required for the cap, and some agency approvals would be required to discharge treated water collected form surface runoff. Like the other waste units discussed, the implementation of Alternative 1 for the Fly Ash/Southfield areas would require no special engineering. It has been rated 5 in that category.

5.3.2.3 Cost

The present worth of this alternative for this waste area is $ 70,870,000. Capital costs associated with the implementation of this alternative are $ 46,850,000.

5.3.3 Alternative 2: Nonremoval - Containment with Perched Groundwater Treatment

5.3.3.1 Effectiveness

For the short term, this alternative rates 4 because the benefits of implementing it would be attained rapidly, since the wastes is not removed and capping would reduce infiltration of precipitation as cap construction progresses. There is the potential for worker exposure to contaminated perched groundwater; however, when compared to Alternative 1, this increased risk is not sufficiently high to warrant a reduced numerical ranking. Both Alternatives 1 and 2 provide for treatment of contaminated water collected from surface runoff.

The long-term effectiveness of this alternative rates a 3 for public health and environmental protection, since the removal and treatment of contaminated perched groundwater would offer enhanced protectiveness over that provided by Alternative 1. As was the case for Alternative 1, the wastes would receive no treatment; however, the cap would reduce the mobility of contaminants to the groundwater. Therefore this alternative rates a 2 for this category.

5.3.3.2 Implementability

This alternative rates a 4 for constructability, reliability, maintainability, and agency approval. Since the wastes would not be removed but would remain on-property, these four criteria received overall favorable ratings. Capping is a proven technology; skilled labor and materials exist to implement this alternative. The technologies for removing and treating perched groundwater are proven and implementable. Schedule delays are not likely with this alternative, so reliability is ranked favorably. Maintenance and agency approval is comparable to that expected for Alternative 1. Special engineering is rated as 5 since proven technologies would be utilized for this alternative.

5.3.3.3 Cost

The present worth of this alternative for this waste area is $ 70,940,000. Capital costs associated with the implementation of this alternative are $ 46,900,000.

5.3.4 Alternative 3: Removal of Waste, Perched Groundwater Treatment, and On-Property Disposal

5.3.4.1 Effectiveness

This alternative was rated 3 in short-term protection of public health because the wastes would be removed and placed in an EDF to be constructed on-property; potential for worker exposure is less, however, for nonremoval than for removal alternatives. For environmental protection, there would be short- term impacts due to construction of the EDF, so this alternative rates a 2.

Long-term effectiveness rates a 3 because the on-property EDF would provide enhanced protection due to the liners being placed beneath the wastes. Reduction in toxicity, mobility, or volume is essentially unchanged from that of Alternatives 1 and 2; therefore this alternative was rated a 2 in that category.

5.3.4.2 Implementability

This alternative rates a 4 for constructability, because an EDF would have to be built on-property. The technologies used in this type of construction do not differ significantly from those used in cap construction. For reliability this alternative rated a 3, due primarily to the increased likelihood of schedule impacts from construction of the on-property EDF and the excavation of wastes. Maintainability was rated 4 because maintenance of the EDF would consist primarily of maintenance of the multilayer cap. Since most activities would be conducted on-property, the agency approvals category was rated 4; however, treated water would require off-property discharge. Technologies utilized for this alternative are proven; therefore special engineering has been rated 5.

5.3.4.3 Cost

The present worth of this alternative for this waste area is $ 291,000,000. Capital costs associated with the implementation of this alternative are $ 180,010,000.

5.3.5 Alternative 4: Removal of Waste, Perched Groundwater Treatment, and Off-Site Disposal

5.3.5.1 Effectiveness

For short-term public health protection, this alternative has received a rating of 3 because the wastes are removed and disposed of off-site; worker exposures are higher for removal than for nonremoval alternatives. For environmental protection, there would be short-term impacts due to transportation of the wastes to an off-site disposal facility, so this alternative was rated 2.

Alternative 4 was rated 4 in long-term protection of public health because an off-site facility would provide enhanced protection (disposal must meet applicable regulations). Also, human population in the vicinity of candidate off-site disposal facilities is less than that surrounding the present location. Reduction in toxicity, mobility, or volume would be similar to that of Alternatives 1 and 2; therefore this alternative rates a 2.

5.3.5.2 Implementability

This alternative has been rated a 4 for constructability since the only construction would be enlargement of an existing facility. The technologies used in this type of construction do not differ significantly from those used in cap construction. For reliability this alternative was rated a 3, due primarily to the increased likelihood of schedule impacts incurred from the excavation of wastes. Maintainability is rated 5 because maintenance would not be required for this alternative since the waste would not be stored on-property. Since the waste would be disposed of off-site, agency approvals may be more difficult to obtain, so this category was rated 4. Technologies utilized for this alternative are proven; therefore special engineering was rated 5.

5.3.5.3 Cost

Using rail transportation, the present worth of this alternative for this waste area is $ 825,170,000. Capital costs associated with the implementation of this alternative are $ 517,200,000.

5.3.6 Alternative 5: Removal and Treatment of Waste, Perched Groundwater Treatment, and On-Property Disposal

5.3.6.1 Effectiveness

For short-term public health protection, this alternative has been rated 3 because the wastes are removed and disposed of on-property; again, worker exposures are higher for removal alternatives. For environmental protection, there will be short-term impacts due to construction of an on-property EDF, so this alternative rates 2.

This alternative was rated 4 for long-term effectiveness, because an on-property EDF provides enhanced protection (disposal must meet applicable regulations). Also, waste treatment is employed and results in a reduction of toxicity and mobility. The volume would increase in about the same amount as the additives involved in the treatment process, but the total waste volume of Operable Unit 2 would not increase substantially if FMPC fly ash were used as a stabilizer.

5.3.6.2 Implementability

This alternative rated 4 for constructability since an EDF would have to be built on-property. The technologies used in this type of construction do not differ significantly from those used in cap construction. For reliability this alternative was rated 3, primarily due to the increased likelihood of

schedule impacts from construction of an on-property EDF and the excavation of wastes. Maintainability was rated 4 because maintenance of the EDF would consist primarily of maintenance of the multilayer cap. This alternative was rated 4 for agency approvals because most activities would be conducted on-property. However, treated water would require off-property discharge. Technologies utilized for this alternative are proven, so a rating of 5 was assigned for special engineering.

5.3.6.3 Cost

The present worth of this alternative for this waste area is $ 293,810,000; capital costs associated with the implementation of this alternative are $ 182,070,000.

5.3.7 Alternative 6: Removal and Treatment of Waste, Perched Groundwater Treatment, and Off-Site Disposal

5.3.7.1 Effectiveness

For the short-term protection of public health, this alternative rates 3, because the wastes would be removed and disposed of off-site; potential for worker exposure is higher for removal than for nonremoval alternatives. For environmental protection, there would be short-term impacts due to transportation of waste to an off-site disposal facility, so this alternative rates a 2.

This alternative was rated 5 in long-term effectiveness, because an off-site facility would provide enhanced protection (disposal must meet applicable regulations). Also, human population in the vicinity of candidate off-site disposal facilities is less than that surrounding the present location. Thermal treatment of waste would achieve a reduction in toxicity and mobility, so this alternative rates 5 for this criteria, also.

5.3.7.2 Implementability

This alternative rates a 4 for constructability since, although an existing facility would have to be enlarged, technologies used in this type of construction do not differ significantly from those used in cap construction. For reliability this alternative rates a 3, due primarily to the increased likelihood of schedule delays associated with the excavation of wastes. Maintainability was rated 5, because no perpetual maintenance would be required since the waste would be stored off-site. Since off-site disposal could involve transporting the waste across several states, agency approvals might be considerably more difficult to obtain, so this alternative was rated 3 in this category. Proven technologies would be utilized for this alternative; therefore special engineering was rated 5.

5.3.7.3 Cost

Using rail transportation, the present worth of this alternative for this waste area is $ 818,300,000. Capital costs associated with the implementation of this alternative are $ 511,000,000.

5.4 ADDITIONAL COSTS

The costs listed in Sections 5.1 through 5.3 do not include all costs for all alternatives; e.g., the cost of the on-site EDF that is a part of the remediation for several alternatives. The present worth and capital costs of such facilities are listed below.

The present worth of the on-site EDF is $ 359,500,000; the capital costs are $ 249,600,000.

The present worth of the shredder/compactor is $ 4,650,000; the capital costs are $ 2,850,000.

The present worth of the temporary holding facility is $ 15,500,000; the capital costs are $ 10,200,000.

The present worth of the railroad spur is $ 12,800,000; the capital costs are $ 8,560,000.

The present worth of the load-out facility is $ 5,370,000; the capital costs are $ 3,730,000.

The present worth of the AWWT facility is $ 1,440,000; the capital costs are $ 350,000.

Total rail transportation costs would include costs for the shredder/compactor, railroad spur, and the loadout facility.

5.5 SCREENING SUMMARY

Tables 5-1 through 5-3 summarize a composite ranking for alternatives considered for each waste unit within Operable Unit 2. Results of the screening summary relative to alternative retention are discussed in Section 6.0.

TABLE 5-1

SCREENING SUMMARY FOR THE ALTERNATIVES FOR OPERABLE UNIT 2

SANITARY LANDFILL

Criteria	ALT 0	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
EFFECTIVENESS							
Short-term Public Health	4	4	4	3	3	3	3
Short-term Environmental	2	4	4	2	2	2	2
Long-term Public Health	1	2	3	3	4	4	5
Long-term Environmental	1	2	3	3	4	4	5
Reduction in Toxicity, Mobility and Volume	1	2	2	2	2	5	5
IMPLEMENTABILITY							
Constructibility	5	4	4	4	4	4	4
Reliability	5	4	4	3	3	3	3
Maintainability	5	4	4	4	5	4	5
Agency Approvals	5	4	4	4	3	4	3
Special Engineering	5	5	5	5	5	4	4
TOTAL	**34**	**35**	**37**	**33**	**35**	**37**	**39**

TABLE 5-2

SCREENING SUMMARY FOR THE ALTERNATIVES FOR OPERABLE UNIT 2

LIME SLUDGE PONDS					
Criteria	ALT 0	ALT 1	ALT 2	ALT 3	ALT 4
EFFECTIVENESS					
Short-term Public Health	4	4	4	3	3
Short-term Environmental	2	4	4	2	2
Long-term Public Health	1	3	3	4	5
Long-term Environmental	1	2	3	4	5
Reduction in Toxicity, Mobility and Volume	1	3	4	5	5
IMPLEMENTABILITY					
Constructibility	5	4	4	4	4
Reliability	5	4	4	3	3
Maintainability	5	4	4	4	5
Agency Approvals	5	4	4	4	3
Special Engineering	5	5	5	5	5
TOTAL	**34**	**37**	**39**	**38**	**40**

TABLE 5-3

SCREENING SUMMARY FOR THE ALTERNATIVES FOR OPERABLE UNIT 2

FLY ASH/SOUTHFIELD AREAS

Criteria	ALT 0	ALT 1	ALT 2	ALT 3	ALT 4	ALT 5	ALT 6
EFFECTIVENESS							
Short-term Public Health	4	4	4	3	3	3	3
Short-term Environmental	2	4	4	2	2	2	2
Long-term Public Health	1	2	3	3	4	4	5
Long-term Environmental	1	2	3	3	4	4	5
Reduction in Toxicity, Mobility and Volume	1	2	2	2	2	5	5
IMPLEMENTABILITY							
Constructibility	5	4	4	4	4	4	4
Reliability	5	4	4	3	3	3	3
Maintainability	5	4	4	4	5	4	5
Agency Approvals	5	4	4	4	3	4	3
Special Engineering	5	5	5	5	5	5	5
TOTAL	**34**	**35**	**37**	**33**	**35**	**38**	**40**

6.0

6.0 GENERAL SUMMARY

In Section 5.0 the alternatives were formally ranked according to their ability to meet the general screening criteria. The results of that ranking indicate a narrow range of scores. This narrow range can be attributed to the fact that all of these alternatives can be implemented, and short-term effectiveness favors nonremoval alternatives while long-term effectiveness favors removal and treatment alternatives. The results of the screening are presented for each waste unit group. A discussion of the No-Action Alternative (Alternative 0) is not presented; however, it will be carried forward into detailed analysis as a baseline for comparison. It also should be emphasized that although a separate alternative was not developed for reutilization of the fly ash or lime sludges to stabilize other FMPC wastes, this option is available and can be incorporated into any of the alternatives developed. CERCLA Section 121 outlines certain considerations for remedy selection (discussed in EPA RI/FS Guidance Section 1.3.1), including resource recovery technologies. For example, the fly ash could be used as a stabilizing agent for the Southfield wastes under Alternatives 5 or 6.

6.1 SANITARY LANDFILL

Of the removal alternatives ranked for comparison, Alternatives 5 and 6 received the highest ranking and will be carried forward into detailed analysis. Alternatives 1 and 2 received a lower ranking than Alternatives 5 and 6, but will be carried forward into detailed analysis to maintain the range of alternatives retained for further evaluation. Alternatives 3 and 4 received the lowest rankings of the alternatives evaluated and, therefore, have been eliminated from further consideration. This is consistent with provisions outlined in CERCLA Section 121, which do not favor removal and redisposal of wastes without treatment.

6.2 LIME SLUDGE PONDS

The results of the screening exercise indicate no significant advantage for any of the action alternatives. Therefore all of the alternatives will be carried forward into detailed analysis.

6.3 FLY ASH/SOUTHFIELD AREAS

Of the removal alternatives ranked for comparison, Alternatives 5 and 6 received the highest ranking and will be carried forward into detailed analysis. Although Alternatives 1 and 2 received a lower ranking than Alternatives 5 and 6, they will be carried forward into detailed analysis to maintain the range of alternatives retained for further evaluation. Alternatives 3 and 4 received the lowest rankings of the alternatives evaluated and, therefore, have been eliminated from further consideration. This is consistent with provisions outlined in CERCLA Section 121, which do not favor removal and redisposal of wastes without treatment.

6.4 PRESENTATION OF ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS

Tables 6-1 and 6-2 show the alternatives that are recommended for detailed analysis as a result of initial screening.

TABLE 6-1

ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS - SANITARY LANDFILL AND FLY ASH/SOUTHFIELD AREAS

Waste Unit	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4	Alt. 5	Alt. 6
Sanitary Landfill	X	X	X			X	X
Fly Ash/Southfield Areas	X	X	X			X	X

TABLE 6-2

ALTERNATIVES RECOMMENDED FOR DETAILED ANALYSIS - LIME SLUDGE PONDS

Waste Unit	Alt. 0	Alt. 1	Alt. 2	Alt. 3	Alt. 4
Lime Sludge Ponds	X	X	X	X	X

6.5 DETAILED ANALYSIS PREVIEW

The detailed analysis of alternatives will follow the development and screening of alternatives and precedes the selection of a preferred remedial action. The screened alternatives will be refined to provide greater detail and accuracy based on the results of additional analysis. During the detailed analysis, each alternative will be assessed against the criteria below:

- Overall protection of human health and environment
- Compliance with ARARs
- Long-term effectiveness and permanence
- Reduction of toxicity, mobility, and volume
- Short-term effectiveness
- Implementability
- Cost

1165

This approach to analyzing alternatives is designed to provide decision makers with sufficient information to adequately compare the alternatives, select an operable unit remedy, and demonstrate satisfaction of the CERCLA remedy selection requirements in the Record of Decision.

261

REFERENCES

LIST OF REFERENCES

Advanced Sciences, Inc., 1990, "Supporting Calculations for Initial Screening of Alternatives for Operable Unit 2," Rev.0, 6021202.0, Oak Ridge, TN.

Advanced Sciences, Inc., 1990, "Biological Sampling, Analysis, and Resources Report," TM-01, prepared for the U.S. Department of Energy Feed Materials Production Center, Fernald, OH.

Canter, L.W. and R.C. Knox, 1985, Groundwater Pollution Control, Lewis Publishers, Inc., Chelsea, MI.

Godbee, H.W., S.A. Hobert, and A.A. Moghissi, eds., 1986, Radioactive Waste Technology, American Society of Mechanical Engineers, New York, NY.

Hakonson, T.E., J.W. Nyhan and E.A. Lopez, 1986, "Corrective Measures Technology for Shallow Land Burial at Arid Sites: Field Studies of Biointrusion Barriers and Erosion Control," LA-10573-MS, UC-7B, Los Alamos National Laboratory, Los Alamos, NM.

Marcus, W.L., 1986, "Lead Health Effects in Drinking Water," Toxicology and Industrial Health, Vol. 2, No. 4, pp 363-407.

Mc Daniel, E.W., T.M. Gilliam, L.R. Dole, and G.A. West, 1987, "Weldon Spring, Missouri, Raffinate Pits 1, 2, 3, and 4: Preliminary Grout Development Screening Studies for In-Situ Waste Immobilization," ORNL/TM-9264, prepared by Martin Marietta Energy Systems at Oak Ridge National Laboratory for the U.S. Department of Energy, Oak Ridge, TN.

Miller, K.L. and W.A. Weidner, eds., 1986, CRC Handbook of Management of Radiation Protection Programs, CRC Press, Boca Raton, FL.

U.S. Dept. of Energy, 1988a, "Development of Alternatives (Task 12) for the Feasibility Study," Rev. 1, Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1988b, "FMPC Sampling and Analysis Report," Draft, Oak Ridge Operations Office, Oak Ridge, TN, Vols. 1 and 2.

U.S. Dept. of Energy, 1988c, "Hydrogeologic Study of the FMPC Discharge to the Great Miami River (Zone of Influence Report)," Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Dept. of Energy, 1989, "Remedial Investigation Work Plan Addendum, Production and Additional Suspect Areas Work Plan," Oak Ridge Operations Office, Oak Ridge, TN.

U.S. Environmental Protection Agency, 1988a, "Drinking Water Criteria Document for Inorganic Mercury," Office of Drinking Water, Washington, DC.

U.S. Environmental Protection Agency, 1988b, "Guidance for Conducting Remedial Investigations and Feasibility Studies under CERCLA," EPA/540/G-89/004, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency, 1988c, "Site Analysis, Feed Materials Production Center, Fernald, Ohio; Interim Report," prepared by Mary D. Sitton of Bionetics Corp., for the Environmental Photographic Interpretation Center, Warrenton, VA.

REFERENCES
(continued)

U.S. Environmental Protection Agency, 1988d, "Technology Screening Guide for Treatment of CERCLA Soils and Sludges," EPA/540/2-88/04, September, Washington, DC.

U.S. Environmental Protection Agency, 1989, "Risk Assessment Guidance for Superfund: Human Health Evaluation Manual, Part A, Interim Final," EPA/540/1-89/002, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency, 1990, "Health Effects Assessment Summary Tables," Fourth Quarter, Washington, DC.

Weston, Inc., Roy F., 1987a, "Characterization Investigation Study: Geophysical Survey," Vol.1, Weston, Inc., West Chester, PA, prepared for Westinghouse Materials Company of Ohio, Cincinnati, OH.

Weston, Inc., Roy F., 1987b, "Characterization Investigation Study, Volume 2: Chemical and Radiological Analysis of the Waste Pits," Weston, Inc., West Chester, PA, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

Weston, Inc., Roy F., 1988, "Geotechnical Evaluation of Material Properties of Waste Pit Materials at the Feed Materials Production Center Fernald, Ohio," Weston, Inc., West Chester, PA, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

Westinghouse Materials Company of Ohio, 1989, "Feed Materials Production Center Environmental Monitoring Annual Report for 1988," FMPC-2173, WMCO, Cincinnati, OH, prepared for U.S. Dept. of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

APPENDIX
A

APPENDIX A

DESCRIPTION OF TECHNOLOGIES AND PROCESS OPTIONS

A.0 DESCRIPTION OF TECHNOLOGIES AND PROCESS OPTIONS

A.1 INTRODUCTION

The following description of potentially applicable technologies and process options is presented in alphabetical order.

A.1.1 Biological/Biosorbant

This sorption process for removing toxic metal ions from water is based upon the natural strong affinity of biological materials, such as the cell walls of plants and microorganisms, for heavy metal ions. Biological materials, primarily algae, are immobilized in a polymer to produce a "biological" ion exchange resin. The material has a remarkable affinity for heavy metal ions. The bound metals can be stripped and recovered from the algal material in a manner similar to conventional resins.

A.1.2 Capping (Infiltration Capping)

The capping specified is a multiple-layer design that minimizes the vertical infiltration of storm water through the covered area. Before cap construction, clean fill soils would be placed and contoured to provide long-term cap support and to minimize any potential future settlement problems. The multiple-layer cap design would consist of the following elements:

- Clay layer — A two-foot minimum thickness, compacted clay layer with a verified 1×10^{-7} centimeters per second (cm/s) permeability would be placed over the fill soils. Caps must minimally comply with requirements set forth in OAC 3745-27-08 and 3745-27-11. Caps must also meet the requirements set forth in 40CFR61 Subpart Q and 40CFR192. The cap must be constructed with enough erosion resistance to provide reasonable assurance of containment of radioactive waste.

- Drainage layer — A drainage layer with a 1×10^{-3} cm/s minimum permeability would be placed over the clay and consist of a 1-ft-thick layer. The upper portion would be a graded natural aggregate filter protecting the lower drainage layer from clogging. Although more costly to procure and install than the typical Resource Conservation and Recovery Act (RCRA) geotextile filter fabric, the all-natural drainage layer would alleviate concerns over long-term material durability, as well as improving the overall drainage layer performance including:

  - Reducing the hydraulic driving forces acting on the clay layer by more timely removal of water percolating through the vegetative cover

  - Balancing the moisture content of vegetative and clay layers against seasonal extremes, including drought

- Biointrusion Barrier — A biointrusion barrier would be placed between the vegetative and drainage layers of the cap. This barrier would consist of a two-foot thick layer of cobbles, and would be designed to preclude deep rooting plants and burrowing animals from damaging the clay liner lying below the drainage layer. The biointrusion barrier would be designed to progressively grade to aggregate of size suitable for use in the drainage layer. This type of

barrier was considered for low-level radioactive disposal trench rehabilitation at the Maxey Flats site located in Kentucky, as well as the Niagara Falls storage site in New York. Research has been conducted to determine the effectiveness of these barriers (Hakonson et al. 1986). The research was conducted at Los Alamos National Laboratory in New Mexico. Soil erosion and infiltration of water into simulated trench caps with various surface treatments were measured for arid sites. A control plot, which consists of crushed tuff covered by a soil layer, was established on the top of existing trench caps. The improved plot consisted of a cobble layer covered by gravel and soil.

Cesium chloride was used as a tracer and was applied to the existing trench caps prior to construction of the test plots. After three growing seasons, 16 percent of the samples collected over the control plot contained elevated levels of cesium, whereas all of the samples from the intrusion barrier plot contained background concentrations of cesium. Therefore the biointrusion barrier was effective in prevention of plant roots from penetrating the trench cap.

- Vegetative layer — The two-foot-thick vegetative layer placed over the drainage layer would be composed of common clean soils with the upper three-inch thickness capable of supporting a hardy, persistent growth, shallow-rooted (zero root density at 12 inches deep) grass crop.

  The vegetative layer protects the clay layer against environmental abrasion including desiccation, freeze/thaw damage, erosion, and hydraulic-induced stresses caused by standing or ponding water.

All cap layers would be contoured to grades that promote drainage while minimizing the effects of waste subsidence and storm water erosion.

A.1.3 Clarification

Clarification is also known as sedimentation and involves the separation of suspended solids from a liquid by gravity. It has no effect on the dissolved solids.

Clarification can either be used as a pretreatment technique to remove suspended organic or inorganic contaminants before downstream processing or as a final polishing step to produce a high quality effluent suitable for direct discharge. Solids separation is usually enhanced by flocculation. Clarification can be performed in large tanks or pits (preferably with a sloped bottom) or in package equipment supplied by vendors.

Clarification would not reduce the hazards associated with the solids, but it would reduce their volume. The sludge and wastewater produced by clarification would probably have to be treated further. No adverse environmental effects would be expected from this process. Clarification is a common process that can be included in the advanced wastewater treatment facility.

A.1.4 Dynamic Compaction

Dynamic compaction involves dropping 5- to 40-ton weights from heights of 20 to 100 feet, resulting in compaction of surface and subsurface soils. A large-capacity crane repeatedly lifts and releases the weight at one location before moving on to the next location.

This technology has been proven very effective in treating all types of soils, and has been shown to be extremely cost-effective. The technique would generate craters of various depths depending on the subsurface conditions. To minimize the potential of contaminate release into the surface environment, a thick soil blanket (approximately four or five feet) would be placed over the treatment area. The following support activities would be required before the start of any compaction effort:

- Carry out studies to confirm the technology's abilities
- Remove and treat free-standing water
- Evaluate and implement groundwater control measures

After treatment, the soil blanket would be contoured and a RCRA-type cap constructed. Groundwater control measures would be installed to make each dynamically compacted area an environmentally secure and permanent waste disposal unit.

A.1.5 Flocculation

Flocculation is the coagulation of small, colloidal, suspended solids into larger particles to allow relatively easier separation from the wastewater.

Flocculation is primarily a physical process that would help remove only the suspended solids but would not affect the dissolved solids. Typically, chemicals such as alum, ferric chloride, and high molecular weight polymeric compounds are added to help agglomerate the particles. More than one flocculent is normally used for removing inorganics in conjunction with neutralization/precipitation and clarification/filtration. Typically, laboratory-scale bench settling tests are required to select type and dosage of flocculent.

Flocculation could be a part of a system to remove the suspended solids from wastewater. Flocculation would not reduce the hazard associated with the solids, but it would facilitate their subsequent treatment and disposal. The wastewater may have to be treated further before discharge. The sludge could be processed with the other sludges for disposal. Significant adverse environmental impacts should not result from this process if the flocculent is properly handled and stored. Flocculation costs are usually relatively low. However, depending on the type and/or dosage of flocculent used, the costs can be high.

A.1.6 Hydraulic Removal/Dredging

Hydraulic removal/dredging uses properly selected and designed pumps, with material-dislodging mechanisms, drivers, suction and discharge line—all included in a site-specific, self-contained package.

Hydraulic removal/dredging is generally limited to excavating slurries containing 10 to 20 percent solids by weight. It offers flexibility in pumping the slurry/sediment a considerable distance (several thousand feet) to a designated treatment/storage area.

By combining the capabilities of plain suction, cutterhead, and portable dredges, a site-specific pretested hybrid unit can be ordered to pump a slurry with a larger percentage of solids. Similar units have been built in the past and have a dredging depth capacity of 10 to 50 feet.

This dredging method cannot be used for the removal of nonsludge wastes. Therefore, mechanical removal methods would be employed to complete waste removal by excavation.

A.1.7 Interceptor Trench

An interceptor trench installed around the perimeter of a waste area, or at a minimum along the downgradient side, will lower the water table in the vicinity of the waste and will capture leachate before it escapes into the sand and gravel aquifer. Wells installed into the lowest point in the trench would be used to pump the collected water to the surface for treatment prior to disposal. This method of groundwater collection and control is applicable to Operable Unit 2 since these waste units either lie totally above the natural till material or intersect the till to only shallow depths; in either case, the waste units lie above the groundwater table. Although the trench system could be maintained on a permanent basis, it is anticipated that reduction in infiltration achieved by the cap and runoff control measures would allow the eventual abandonment of the trench.

A.1.8 Ion Exchange

Ion exchange is a process in which certain dissolved ions are removed from water by exchanging them with other (counter) ions held by an insoluble solid (resin). Ion exchange resins are typically polymer beads that have been modified by the addition of chemical groups which attract various ionic species. The resins can be regenerated for reuse with a strong solution of the exchangeable counter ion. Resin types range from general purpose demineralization resins (which remove nearly all salts) to selective chelating resins (which have high affinities for specific ions).

Ion exchange is used extensively for water and wastewater treatment. It is used also for treatment of a variety of industrial wastes to allow for the recovery of materials or by-products. Additionally, ion exchange has been used in waste treatment for removal and recovery of radioactive materials from

contaminated streams. It is usually used to remove low levels of ionic species (generally between 100 and 500 parts per million [ppm]) and is not cost-effective at higher concentrations. Treatment of water with ion exchange can achieve very low effluent concentrations of contaminants.

Ion exchange may be used as a final treatment to remove trace metals and radionuclides from dilute wastewater. The resins may be used once and disposed of or they may be regenerated, which would produce a concentrated waste stream for treatment and disposal; the concentrated regenerate may be treated with the sludge. Ion exchange is an easily implemented, reliable, commercial technology. Treatment cost is moderately expensive and depends on the type of resin employed and the quantity of the various ionic species removed from the wastewater.

A.1.9 Mechanical Removal

- Backhoe — A backhoe is normally used for trenching and for other subsurface excavation where the excavator remains near the original working level. Backhoes are mechanically or hydraulically operated in a drag and hoist maneuver and are usually crawler-mounted. The lateral and vertical reach of a backhoe is limited by the length of the boom. Conventional backhoes are capable of digging to a depth of approximately 40 feet. Deeper digging depths (up to 80 feet) are achieved by using modified backhoes with extended booms, modified engines, and counterweights.

  Backhoes have limited lateral and vertical reaches that can be improved upon by using an extended reach and depth machine. They are capable of excavating almost any type of material.

  Material transport and support equipment are required for a successful operation.

- Clamshell — A clamshell (or grab bucket) is a crane-operated mechanical removal device that could be crawler-mounted for this application. A clamshell is normally used for a reach/depth of up to 100 feet. Production rates for clamshells are relatively low (typically in the range of 20 to 30 cycles per hour), and vary with depth, working media, and swing angle. Clamshell buckets range in capacity from 1 to 12 cubic yards. A large-capacity, specially designed bucket could be used for this application. The bucket could be designed so that the probability of losing material during hoisting would be reduced to a minimum.

  Clamshell dredging can excavate any type of material except highly consolidated sediments and solid rock. The excavation is done at nearly in situ densities. Clamshell dredges can be operated in confined areas; and by using a long boom, operator exposure can be minimized. Major problems are low production, potential of losing material during hoisting operation, and high energy/operational costs. Material transport and support equipment are required for a successful operation.

- Front-End Loader — A front-end loader is a tractor with a bucket for digging, lifting, hauling, and dumping materials. Front-end loaders are generally equipped with a hydraulically controlled bucket lift and can be either crawler- or rubber-tire-mounted. Their buckets vary in capacity and design.

Crawler-mounted loaders can be good excavators and can carry material as far as 300 feet. Medium-sized crawler-loaders typically have maximum bucket capacities of 5 to 6 cubic yards. Rubber-tire-mounted loaders for high production operations on stable surfaces have bucket capacities up to 20 cubic yards. Usually front-end loaders are used in combination with excavation equipment such as backhoes.

- Dragline — A dragline is similar to a clamshell and is also a crane-operated device that would be crawler-mounted for this application. The primary difference is that a dragline bucket is loaded by being pulled across the material, whereas the clamshell is dropped into the material and hoisted vertically. A dragline can be used to excavate many types of materials.

  The dragline has a longer reach and better horizontal control than a clamshell. It also has a greater potential of hoisting material and may require a specially designed bucket.

A.1.10 On-Property Disposal Facility

An on-site engineered disposal facility (EDF) or an aboveground waste disposal facility could be constructed for the disposal of the waste material. The proposed EDF disposal concept basically consists of mounding over waste that has been placed on a stable structural pad. The aboveground structure is a reinforced vault-like concrete structure designed for permanent waste disposal. Both the EDF and the aboveground structure would accept only dry waste placed in noncorrosive containers and/or highly stabilized/solidified waste forms. The following design(s) are being considered:

- EDF
  - RCRA-type closure cap with leachate collection/detection system (LC/DS)
  - Low permeability (1×10^{-7} cm/s, maximum) multiple clay liner underlayment with LC/DS
- Aboveground Structure
  - Designs 1A and 1B - The vault is constructed directly on grade
    - (a) Design 1A with a liner system including LC/DS
    - (b) Design 1B is without the secondary leachate collection system or the high density polyethylene (HDPE) liner (only a primary leachate collection system).
    - (c) A RCRA-type cap can be placed over the closed structure
  - Designs 2A and 2B - The vault is constructed with the structural support slab placed six feet over grade using an extended height reinforced concrete foundation.
    - (a) Design 2A with a liner system including LC/DS
    - (b) Design 2B is without the secondary leachate collection system or the HDPE liner (only a primary leachate collection system)
    - (c) A RCRA-type cap can be placed over the closed structure

As a condition of placement, no untreated (wet, raw) waste or free liquids will be accepted for disposal in any on-property disposal facility. After treatment the resulting waste form may be placed in bulk and/or containerized as follows:

- Dry (having a moisture content less than 15 percent by dry weight basis) placed in a noncorrosive, structurally adequate container
- Pumpable, self-leveling, setable grout/waste mix

As with all on-property disposal technologies, a properly designed site along with regularly scheduled monitoring and facility maintenance programs will be required.

A.1.11 Packaging/Transportation

Shipment of wastes off site must meet the U.S. Department of Transportation's (DOT) stringent packaging requirements for radioactive materials. DOT in 49CFR provides a number of general categories under which radioactive material may be shipped. Within the possible shipping designations allowed in the DOT regulations, low specific activity (LSA) applies to Operable Unit 2 (with certain restrictions).

Under this category, the Operable Unit 2 wastes will be specified as "normal form" because they have not been tested to meet the requirements of 49CFR173.469.

A.1.11.1 Low Specific Activity

The advantage of shipping radioactive material as LSA is the gaining of exemptions by using specification packaging (i.e., Type A, Type B, etc.). Whereas the other packaging and shipping classifications place a limit on the curie content of a package, the LSA classification places a limit on the specific activity of the contents of each package.

Operable Unit 2 wastes will have to meet the restrictions of 49CFR173.403(n)(4) which states,

> Material in which the radioactivity is essentially uniformly distributed and in which the average concentration of the contents do not exceed:
>
> (i) 0.0001 millicurie per gram of radionuclides for which the A_2 quantity is not more than 0.05 curie
>
> (ii) 0.005 millicurie per gram of radionuclides for which the A_2 quantity is more than 0.05 curie, but not more than 1 curie
>
> (iii) 0.3 millicurie per gram of radionuclides for which the A_2 quantity is more than 1 curie."

Note: "A_2" is the maximum activity of radioactive material, other than special form or low specific activity radioactive material, permitted in a Type A package.

In order to apply this definition, it must be noted that 49CFR173.433(b)(3) states,

In the case of a mixture of different radionuclides, where the identity and activity of each radionuclide is known, the permissible activity of each radionuclide R_1, R_2, ...R_n must be such that $F_1 + F_2 + ... + F_n$ is not greater than unity, when:

$$F_1 = \frac{\text{Total activity of } R_1}{A_1(R_1)}$$

$$F_2 = \frac{\text{Total activity of } R_2}{A_1(R_2)}$$

$$F_n = \frac{\text{Total activity of } R_n}{A_1(R_n)}$$

where $A_1(R_1, R_2,...R_n)$ is the value of A_1 or A_2 as appropriate for nuclide R_1, R_2,...R_n."

Note: "A_1" is the maximum activity of special form radioactive material permitted in a Type A package.

What all of the foregoing means for Operable Unit 2 is that the radionuclides in the decay chain present will have to be divided into three categories: those with an A_2 value equal to or less than 0.05 curies, those with an A_2 value greater than 0.05 but not more than 1 curie, and those with an A_2 value greater than 1 curie. Then, using the above formula, the maximum activity concentrations may be calculated to determine packaging requirements.

A.1.12 Physicochemical Adsorption

Adsorption is a physicochemical process that involves the removal of dissolved solids from liquid waste by adsorption onto a treatment medium (e.g., activated carbon or activated alumina).

A.1.13 Physicochemical/Advanced Membrane Filtration/Ultrafiltration

Advanced membrane filtration uses a specific pore-sized membrane usually in a special configuration to perform filtration. Ultrafiltration is the use of micro-pore membranes, which may be enhanced

chemically or structurally to attract particles to the surface of the media for more effective filtering. Advanced membrane filtration has been used in the treatment of plating wastewater, printed circuit board wastewater, laundry recycling, and contaminated groundwater. Advanced membrane filtration consists of the following three essential elements:

- Pretreatment
- Membrane design
- System cleaning

A.1.14 Physicochemical/Coagulation/Polymerization

Coagulation is the process by which fine particulate material is removed from water by the addition of inorganic chemicals called coagulants, which accelerate the aggregation of particles into larger aggregates. Polymerization is a type of coagulation that uses organic polymers as the coagulant.

Coagulation is one of the most frequently used process options for water treatment. The process involves reducing the repelling charges between colloidal particles in order to destabilize the particulates and assist in their aggregation. To improve the performance of a coagulant, it is necessary to include a slow mixing step. Various chemicals have been used as coagulants, including polyelectrolytes and polymers. Coagulants can be cationic, anionic, or nonionic.

A.1.15 Precipitation

Precipitation is the removal of metals and other components from wastewater by chemical addition and adjustment of pH to a point where the various species exhibit minimum solubilities.

The most commonly used precipitation technique is pH adjustment with alkaline materials (e.g., caustic soda, soda ash, and lime) or sulfides. The insoluble compounds that precipitate can be removed from the wastewater by flocculation, clarification, and filtration. Coagulants such as alum, ferrous sulfate, or ferric chloride are also used to facilitate metals removal. Precipitation typically produces an effluent with 0.1 to 1.0 ppm metals, and the wastewater may require additional treatment to meet discharge criteria. Problems are encountered when ammonia levels are high or chelating and when complexing agents are present in the wastewater.

Most of the metals are concentrated in the sludge, and the wastewater is relatively low in heavy metals such as zinc, uranium, and thorium. Additional lime or caustic soda treatment is unlikely to be effective. Sulfide precipitation may be more effective but still not adequate to meet stringent discharge requirements. Sulfide precipitation can have some potential environmental problems. A sulfide reagent coming into contact with an acidic waste stream can result in the evolution of toxic hydrogen sulfide fumes. Another potential problem for processes discharging to enclosed sewers is the danger associated with residual levels of sulfide in the wastewater. In addition, all precipitation

processes generate a solid sludge, which may be hazardous and must be disposed of properly. Precipitation is a proven commercial technology, and the costs for this technique are low.

A.1.16 Reverse Osmosis

Reverse osmosis (RO) involves diffusion of water through a semipermeable membrane with applied pressure. It is a separation process that can retain particles (including dissolved species) as small as 1 to 10 Angstroms.

Historically, RO has been associated with removal of salts and inorganic compounds from brackish water. Unlike water, salts and other contaminants cannot pass through the semipermeable membrane and are concentrated. The degree of concentration depends on the pressures on the membrane. Membranes can foul, reducing treatment rate. This situation occurs if the solubility limit of any of the salt species in wastewater is exceeded: chemical reagents known as sequestrants can be added to reduce this effect.

RO might be used to concentrate the salts in the wastewater. Calcium sulfate fouling can be a problem in treating most of the Feed Materials Production Center (FMPC) wastewaters. RO will not reduce the hazards associated with the salts but will facilitate their subsequent treatment and disposal. Adverse environmental effects should not result from this process. RO can be implemented with commercially available process equipment; costs are moderate compared to other wastewater treatment processes.

A.1.17 Shallow Soil Mixing

Shallow soil mixing (SSM) is a method of mixing soils or sludges with dry or fluid treatment chemicals to produce a solidified or stabilized end product. SSM is designed to provide in situ mixing of ponds, pits, and lagoons to a depth of 30 feet or more using a crane-mounted mixing system. The mixing head is enclosed in a bottom-opened cylinder that allows a closed system for the mixing of waste and treatment chemicals. As the mixing head blades pass in an up-and-down motion through the waste, a negative pressure is maintained on the cylinder headspace to pull any vapors or dust to an air treatment system.

The SSM system has the advantages of a negative head pressure, treatment of any off-gases and/or dust, waste treatment by stabilization chemicals that can be correctly proportioned during mixing operations, and operable to mixing depths of 30 feet or more. Therefore, SSM will be retained as a viable technology.

A.1.18 Soil-Bentonite Slurry Walls (Containment Barrier)

Slurry walls are the most commonly used subsurface barriers. Slurry walls are constructed in a vertical trench that is excavated under a slurry. The slurry (which is usually a mixture of bentonite and water) assists in shoring the trench to prevent collapse and forms a filter cake on the trench walls that prevents fluid loss to surrounding ground.

Backfilling, performed with soil materials mixed with a bentonite and water slurry, results in this type of slurry wall. For on-site slurry preparation to be effective, the work area should be located adjacent to the slurry-wall installation site.

For slurry walls to be effective it is necessary to use them in conjunction with a suitable cap. The slurry wall should extend to the least permeable underlying layer and go to a predetermined design depth below the bottom of the waste. A detailed predesign investigation characterizing the subsurface conditions and materials is required. Permeabilities of the subsurface layer (to which the slurry wall extends) and the soil-bentonite wall are critical elements in the design. The issue of waste/wall compatibility should be addressed early in the design by permeability testing of the proposed backfill mixture with actual site leachate or groundwater. Based on the investigation results, suitable design and support activities can be recommended.

Slurry walls can also be placed upgradient from the waste and can divert groundwater away from waste, minimizing leachate production.

A.1.19 Solidification and Stabilization of Radioactive Materials

Radioactive waste forms are defined as Class A, Class B, and Class C by 10CFR61.55. The solidification process applies to Class A. The stabilization process is applicable to Class A, B, and C. Solidified Class A waste products are free-standing monoliths and have no more than 0.50 percent of the waste volume as free liquids. Stabilized Class B and C wastes must meet American Society for Testing and Materials standards for compressive strength, exposure to radiation fields, biodegradation, and leaching, as stated in the U.S. Nuclear Regulatory Commission Technical Position on Waste Form.

Although there is a difference between solidification and stabilization, this discussion will treat them the same. Solidification may be necessary for preparation for disposal to reduce liquid volumes to acceptable levels and to provide structural integrity to prevent slumping, subsidence, and collapse or other failure when disposed. A number of different solidification agents are available including portland cement, limestone, fly ash, gypsum, absorbents, resins, and polymers. Laboratory testing will be required to determine the proper solidification formula.

A.1.20 Surcharging (Overburdening)

This technology typically induces densification and subsidence in incompetent soils by mounding or overburdening the area of treatment with large fill soil quantities for a long period of time. After the compaction goal is achieved, the soil overburden may be removed and discarded or used for surcharging another area (termed "rotating surcharge technique").

This technology is one of the simplest and least expensive methods for large area treatment. This method can be used most effectively in free-draining soils and also can be readily applied to fine-grained and cohesive soils by installation of sand drains, collection trenches and sumps, or wick drains to decrease the waste consolidation time.

If drains were installed, they would provide a pathway for contaminated pore water to the fill surface. Pore water would then be collected and treated, which could create the potential for worker exposure to contamination.

If the drains were not used, the surcharge would force the contaminated pore water into the surrounding soil and confining basin subsoils, leading to a possible, slight rise in monitored contaminants for a short period of time. In either case, the surcharge would produce an adequately compacted waste/soil matrix for closure-cap-bearing purposes.

After treatment, the surcharge would be removed to design-specified elevations, and a RCRA-type cap constructed in conjunction with required groundwater control measures to provide an environmentally secure permanent waste disposal unit.

A.1.21 Vitrification

Vitrification converts contaminated solids into a glass (amorphous) and crystalline mineral matrix that has mechanical and chemical durability properties similar to granite. Vitrification, at melting temperatures between 1100° and 1600°C, will destroy organics and fix metals into the nonleachable solidified melt. In vitrification the waste mixture must have sufficient mineral content to form the glassy/crystalline matrix. If the waste is low in silica or alumina compounds, they may be added in the form of sand or soil.

Glass melting equipment (both continuous and batch) and in situ techniques can be used to vitrify wastes. Conventional equipment, including "cold cap" and "drop tube electro" melters, have been studied for vitrifying radioactive waste. Batch (in can) melting of radioactive waste has been studied. A stirred tank melter has also been proposed but not extensively studied. Gas-fired melters are not appropriate because of air pollutant emission control requirements.

The cold cap, drop tube, and stirred-tank melters would be fed a mix of waste, sand, and fluxing agents and would produce a glass melt to be "pulled" off. This melt could be cast as blocks or frit and would resemble bottle glass. This product could be entombed or buried as required for final disposal.

For in situ vitrification, the contaminated waste is not excavated but is vitrified in place. The energy required to heat and melt the waste is supplied by applying electric current to electrodes buried in the waste. Because the molten waste is conductive, it is heated by its own resistance (joule heating). For this process to be cost-effective, the depth of contamination must be at least six feet. Large sites can be treated by successive vitrification of adjacent blocks or zones. Another modified in situ approach that may have a wider application is placing the contaminated waste from a site in a pit or an aboveground mound and then vitrifying it. This allows mixing with other wastes and addition of sand or soil to improve the melting characteristics.

Any vitrification process would produce off-gas containing steam, products from combustion of any organics, and some particulates. Some metals may be volatilized, but these emissions should be lower than with other thermal techniques. This off-gas from any vitrification process must be collected and treated.

A.1.22 Waste Segregation

Waste segregation is a process that separates and isolates the different components making up a waste stream. Waste segregation as applied at FMPC will be accomplished by using the differences in physical characteristics within the waste streams.

Waste segregation would be used on Operable Unit 2 to separate the metallic material, wood, and other debris from the other wastes contained in Operable Unit 2 waste units. Magnetic surveys were taken to identify metallic objects within the Operable Unit 2 waste units. This step was taken so that test borings could take place without disturbing the metals. Wood fragments were encountered in some of the test borings, indicating that wood materials had been buried. Technologies for waste segregation include magnetic sorting, manual sorting, and screening/sizing:

- Magnetic sorting — This method would further identify areas of ferrous materials within the pits. As cover material is removed, visual inspection could be made to determine the type of material present and the best method for handling and sorting. As cover materials were removed, care would be taken to avoid puncturing drums or other containers. Recovered drums or containers would be isolated and sampled to determine RCRA constituents and radioactivity.

- Manual sorting — This method involves the "hands-on" separation of the different physical types of waste material. As metals or other types of debris that are different from the majority waste

forms are encountered, they would be evaluated and removed by the safest method. Special cleaning and decontamination procedures would be necessary for large debris before its disposal.

- Screening/Sizing — This method involves the physical separation of materials by a series of screens sized to retain particles of a desired size range while allowing smaller particles and liquid to pass through the screen surface. This method would separate materials by size only. The screen can either be moving or fixed. The more widely used moving screens can be vibrating, revolving, or gyrating, with vibrating being the most common and most efficient. Fixed screens are usually inclined and used for separating larger materials.

A.1.23 Waste Disposal Off Site

After treatment, the FMPC waste can be transported to an approved waste disposal facility for permanent disposal. As a condition of disposal, no untreated wet, raw waste, or free liquids will be accepted for transport. Bulk and/or containerized wastes may be transported as follows:

- Dry (having a moisture content less than 15 percent by dry waste weight)
- Pumpable, self-leveling, setable grout/waste mix

The FMPC can readily accommodate rail transport by use of existing on-property track spurs. Rail transport offers many advantages over trucking, including:

- Low cost per waste ton/mile transported
- Transport safety
- Ability to haul large tonnages at one time, which could lessen the potential public exposure

A possibility exists that the approved waste site may not have an available rail spur. However, a spur could be built. Rail transport with the existing system could provide an estimated shipment rate of 90 tons of waste per car with 90 cars per train.

Truck transport can provide portal-to-portal service with the road system available between FMPC and the approved waste site. The main disadvantage of truck transport is the near-FMPC public roadways. These two-lane rural roads are heavily traveled with considerable uncontrolled cross traffic and regional access/egress commuter traffic.

A major consideration for any off-site disposal technology may be resistance from local groups. While considerable local opposition should be expected, the mass transportation required to implement off-site disposal could be challenged in numerous local political jurisdictions along the transport route, creating unacceptable site cleanup delays.

APPENDIX B

APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS

B.0 APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS (ARARs)

The development of applicable or relevant and appropriate requirements (ARARs) is in a transitional phase and this appendix represents an early stage of that development. This appendix is intended to provide a global overview of these requirements, which have been submitted to the U.S. Environmental Protection Agency (EPA) in greater detail in a separate transmittal.

In keeping with the requirements of the Section 120 Consent Agreement, this document has been prepared in such a manner as to avoid making ARAR determinations.

B.1 INTRODUCTION

The U.S. Department of Energy (DOE) must generally comply with all provisions of federal environmental statutes and regulations, as well as all applicable state and local requirements. In performing the Remedial Investigation/Feasibility Study (RI/FS) and subsequent remedial actions for Operable Unit 2 within the Comprehensive Environmental Response, Compensation, and Liability Act/Superfund Amendments and Reauthorization Act of 1986/National Contingency Plan (CERCLA/SARA/NCP) framework, the Feed Materials Production Center (FMPC) is required to comply with all applicable or relevant and appropriate requirements. The purpose of this appendix is to list potential ARARs and/or their sources.

Applicable requirements are those federal and state regulatory requirements that directly and fully address or regulate the hazardous substance, pollutant, contaminant, action being taken, or other circumstance at a CERCLA site. Examples of federal statutes specifically cited in CERCLA from which requirements may apply include the Resource Conservation and Recovery Act (RCRA), the Toxic Substances Control Act (TSCA), the Safe Drinking Water Act (SDWA), the Clean Air Act (CAA), the Clean Water Act (CWA), and the Marine Protection Research and Sanctuaries Act (MPRSA). Relevant and appropriate requirements are those federal and state human health and environmental regulatory requirements that address problems or situations sufficiently similar to those encountered at CERCLA sites and are appropriate to the circumstances of release or threatened release, so that their uses are well-suited to the particular site. In such cases, application of these requirements would be relevant and appropriate although not mandated by law. Relevant and appropriate requirements are intended to carry the same weight as applicable requirements.

B.2 POTENTIAL ARARs FOR OPERABLE UNIT 2

In accordance with current EPA guidance, ARARs are to be progressively developed and applied on a site-specific basis as the RI/FS proceeds. The initial step in the process entails the listing of all potential ARARs for the remedial action process at the subject site. A comprehensive listing of

potential ARARs for all of the operable units for the FMPC was completed as part of the Feasibility Study Work Plan. The potential ARARs for the FMPC were categorized into the following EPA-recommended classifications:

- Chemical-Specific ARARs - Usually health- or risk-based numerical values or methodologies that, when applied to site-specific conditions, result in the establishment of numerical values for each chemical of concern. These values establish the acceptable amount or concentration of a chemical that may be found in or discharged to the environment.

- Location-Specific ARARs - Restrictions placed on the concentration of a chemical or the conduct of activities solely because they occur in special locations.

- Action-Specific ARARs - Usually technology- or activity-based requirements or limitations on actions taken with respect to waste management and site cleanup.

A brief discussion of each of the primary federal and state of Ohio ARARs, along with pertinent agency-issued criteria, advisories, and guidance is given below. A summary listing of potential ARARs is found at the end of this appendix in Table B-1.

Federal ARARs

Federal ARARs and other criteria, advisories, or guidelines from specific laws include the following:

- Safe Drinking Water Act (42USC300f, et seq. and 40CFR141 to 149) - Establishes maximum contaminant levels (MCLs) that are enforceable standards for chemicals in public drinking water supplies. They not only consider health factors but also the economic and technical feasibility of removing a contaminant from a water supply system. EPA has recently proposed MCL goals (MCLGs) for several organic and inorganic compounds in drinking water. MCLGs are nonenforceable guidelines that do not consider the technical feasibility of contaminant removal. The SDWA also authorizes the following programs:

  - The Underground Injection Control Program
  - The Sole-Source Aquifer Program
  - The Wellhead Protection Program

- Toxic Substances Control Act (15USC2601, et seq. and 40CFR702 to 799) - Regulates the use and disposal of polychlorinated biphenyls (PCBs) and asbestos.

- Resource Conservation and Recovery Act/Solid Waste (40CFR240-257) - Establishes the criteria and standards for identification, management, and disposal of solid waste.

- Resource Conservation and Recovery Act (42USC6901, et seq. as amended and 40CFR260 to 279) - Establishes the criteria and standards for identification, management, and disposal of hazardous waste.

- Federal Water Pollution Control Act, as amended by the Clean Water Act (33USC1251, et seq. and 40CFR104 to 140) - Governs point-source discharges through the National Pollutant Discharge Elimination System (NPDES), dredge and fill activities which may degrade or disturb wetlands or other aquatic habitats, and oil or hazardous substance spills to waters of the United States.

- Ambient Water Quality Criteria (AWQC) - Criteria for 64 chemicals were established in 1980, pursuant to Section 304(a)(1) of the CWA. AWQC are available for the protection of human health from exposure to chemicals in drinking water and ingestion of aquatic biota, and for the protection of fresh-water and salt-water aquatic life.

- Regulation of Activities Affecting Waters of the U.S. (33CFR320 to 329) - U.S. Army Corps of Engineers regulations that are applicable to wetlands and navigable waters.

- Endangered Species Act of 1978 (16USC1531, et seq.) - Provides for consideration of the impacts of remedial actions on endangered and threatened species.

- Fish and Wildlife Coordination Act (16USC661, et seq. and 40CFR6.302) - Provides for consideration of the impacts on wetlands and protected habitats.

- Fish and Wildlife Improvement Act of 1978 (16USC742a) - Provides for consideration of the impacts on wetlands and protected habitats.

- Clean Air Act (42USC4701, et seq. and 40CFR61, Subparts H and Q)) - Through the National Ambient Air Quality Standards it identifies primary and secondary standards for six "criteria" pollutants, and through the National Emission Standards for Radionuclides Emissions from DOE facilities, it provides annual exposure limits from air emissions from DOE facilities.

- EPA Regulations for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40CFR192) - Applies to the control of residual radioactive material at designated processing or repository sites under Section 108 of the Uranium Mill Tailings Radiation Control Act (UMTRA) of 1978 and to restoration of such sites following any use of subsurface minerals under Section 104(h) of the above-referenced act.

- NRC Regulations for Standards for Protection against Radiation (10CFR20) - Establishes standards for protection against radiation hazards arising out of activities under licenses issued by the U.S. Nuclear Regulatory Commission (NRC) and issued pursuant to the Atomic Energy Act of 1954, as amended, and the Energy Reorganization Act of 1974.

- NRC Criteria Relating to the Operation of Uranium Mills and the Disposition of Tailings or Wastes Produced by the Extraction or Concentration of Source Material From Ores Processed Primarily for Their Source Material Content (10CFR40, Appendix A) - Establishes technical and long-term site surveillance criteria relating to siting, operation, decontamination, decommissioning, and reclamation of mills and tailings or waste systems and sites at which such mills and systems are located.

- The Atomic Energy Act of 1954 (42USC2011, as amended) - Authorizes the conduct of atomic energy activities.

- Licensing Requirements for Land Disposal of Radioactive Waste (10CFR61) - Establishes procedures and criteria for the land disposal of radioactive wastes.

State of Ohio ARARs

State of Ohio ARARs and other criteria, advisories, or guidance include the authority of the Ohio Environmental Protection Agency (OEPA) to manage federal environmental programs. OEPA shares several responsibilities with other Ohio agencies including the Ohio Department of Health (ODH), the Ohio Department of Natural Resources (ODNR), and the Ohio Public Utilities Commission:

- Ohio Water Pollution Control Act (ORC Chapter 6111) -OEPA has the authority to administer all of the federally mandated water discharge programs, including the NPDES programs for all source categories (OAC3745-33-01 through 3745-33-05), and an effective pretreatment program (OAC3745-3). ORC 6111 also prohibits pollution of waters of the state.

- Solid and Hazardous Waste Disposal Law (OAC Chapter 3734) - OEPA has developed extensive solid and hazardous waste regulations (OAC3745 Chapters 27-70). These programs are administered by the Solid and Hazardous Waste Division of OEPA.

- Water Quality Standards (OAC3745-1) - Ohio has developed water quality standards applicable to state surface water (OAC3745-1-04), an antidegradation policy (OAC3745-1-05) and has surface water quality criteria for both acute and chronic effects on aquatic organisms as part of OAC3745-1-07 in addition to water use criteria for all major surface water bodies.

- Drinking Water Rules - The rules for public drinking water are set forth by OAC3745-81-01 to 55, and includes MCLs. OAC3745-82 sets secondary contaminant standards.

- Water Well Installation - Installation and abandonment of new wells and borings, including those intended for human consumption, are regulated under OAC3745-9 by OEPA and ODNR.

- The Underground Injection Well Control Program - Approvals for injection wells are required from the ODNR and OEPA. The requirements for permits to inject fluids via wells are set forth in OAC3745-34.

- Water System - Authority to establish and enforce rules regarding private water systems is granted to the ODH under OAC3701. ODH governs plan approvals, procedures, construction, and abandonment for private water systems (OAC3701-38). Community and public water supply systems are governed and approved by the OEPA under OAC3745-83 to 95.

- Radiation Standards - Standards for protection and handling of equipment and materials associated with ionizing radiation are governed by rules set by ODH under OAC3701-38.

- Air Pollution Control (ORC3704, OAC3745-15, OAC3745-17) - Establishes the authority of OEPA to regulate and control air pollution within the state under ORC 3704.03. Requires person responsible for any air contaminant source to install, employ, maintain, and operate such emissions, ambient air quality, meteorological, or other monitoring devices or methods as director prescribes. Requires the sampling of emissions at such locations, intervals and in a

manner which the director prescribes. Requires the maintenance of records and filing of periodic reports with the director on the location, size, and height of emissions outlets, as well as the rate, duration, and composition of emissions.

- Control of Asbestos Emissions (OAC3745-20-05) - Specifies the standards which must be met regarding the handling and disposal of asbestos.

B.3 GUIDANCE TO BE CONSIDERED (TBC)

Because ARARs may not exist or may not be sufficient to protect human health and the environment at a CERCLA site, it is necessary to evaluate nonlegally binding or promulgated criteria, advisories, guidance, or policies for protective cleanup levels when determining cleanup requirements or designing a remedy. EPA and support agencies may, as appropriate, identify other advisories, criteria, or guidance to be considered (TBC) for a particular remediation activity. This TBC category consists of advisories, criteria, or guidance that were developed by EPA, other federal agencies, or states that are not ARARs.

The application of the ARARs to Operable Unit 2 at the FMPC is complicated by the fact that the DOE and radionuclides (particularly uranium) have been exempted from some environmental regulations. From a radiological standpoint, DOE has been primarily self-regulating for environmental activities and has established its own policies for environmental monitoring, waste disposal, and limits of exposure to employees and the public. EPA regulations regarding the handling and disposal of wastes containing radionuclides are under programs set up by the Uranium Mill Tailings Act and the NRC. It should also be noted that DOE orders are not promulgated requirements, but fall into the category of TBCs.

A brief discussion of each of the primary federal TBCs presently being considered is given below.

FEDERAL TBCs

- Health Effects Assessments - Presents toxicity data for specific chemicals for use in public health assessments. Also considered applicable are cancer slope factors and referenced doses provided in the Human Health Evaluation Manual (EPA 1989).

- Groundwater Protection Strategy - Documents EPA policy to protect groundwater for its highest present or potential beneficial use. The strategy designates three categories of groundwater:

  - Class 1 - Special Groundwaters: Waters that are highly vulnerable to contamination and are either irreplaceable or ecologically vital sources of drinking water.

  - Class 2 - Current and Potential Sources of Drinking Water and Waters Having other Beneficial Uses: Waters that are currently used or that are potentially available for use.

1165

- Class 3 - Groundwater not a Potential Source of Drinking Water and of Limited Beneficial Use: Class 3 groundwater units are further subdivided into the following two subclasses:

  a. Subclass 3A includes groundwater units that are highly to intermediately interconnected to adjacent groundwater units of a higher class and/or surface waters. They may, as a result, be contributing to the degradation of the adjacent waters. They may be managed at a similar level as Class 2 groundwaters, depending upon the potential for producing adverse effects on the quality of adjacent waters.

  b. Subclass 3B is restricted to groundwater units characterized by a low degree of interconnection to adjacent surface waters or other groundwater units of a higher class within the Classification Review Area. These groundwaters are naturally isolated from sources of drinking water in such a way that there is little potential for producing adverse effects on quality. They have low resource value outside of mining or waste disposal.

- DOE Order for CERCLA Program (5400.4) (Draft) - Provides direction for DOE to implement a CERCLA program.

- DOE Order for Radiation Protection of the Public and the Environment (5400.5) (February 8, 1990) - Establishes standards and requirements with respect to protection of the public and the environment against radiation.

- DOE Order for Hazardous and Radioactive Mixed Waste Management (5480.2) (December 13, 1982) - Establishes hazardous waste management procedures for facilities operated under authority of the Atomic Energy Act of 1954, as amended.

- DOE Order for Environmental Protection, Safety, and Health Protection Information Reporting Requirements (5484.1) (February 24, 1981) - Establishes the requirements and procedures for reporting and investigating matters of environmental protection, safety, and health protection significant to DOE operations.

- DOE Order for Quality Assurance (5700.6B) (September 23, 1986) - Establishes DOE's quality assurance program.

- DOE Order for Radioactive Waste Management (5820.2A) (September 26, 1988) - Establishes policies and guidelines for the management of radioactive waste and contaminated facilities.

- DOE Plan for Implementing EPA Standards for UMTRA Sites (UMTRA-DOE/AL-163) (January 1984) - Presents guidance for implementing EPA standards on uranium mill tailing remedial action sites.

- DOE Technical Approach Document - Revision II (UMTRA-DOE/AL-050425.0002) (December 1989) - Presents the technical approach for remediation of uranium mill tailings remedial action sites.

- DOE Remedial Action Planning and Disposal Cell Design (UMTRA-DOE/AL-400503) (January 1989) - Presents guidance for complying with the proposed 40CFR192 for planning and disposal cell design for uranium mill tailings remedial action sites.

285

- DOE Project Surveillance and Maintenance Plan (UMTRA-DOE/AL-350124) - Presents guidance for surveillance and maintenance of uranium mill tailings remedial action sites.
- Executive Order 11988 - Presents requirements for federal agencies to protect floodplains.
- Executive Order 11990 - Presents requirements for federal agencies to protect wetlands.
- National Primary Drinking Water Standards (40CFR141.50 and 141.51) - Provides proposed MCLs and MCLGs which may provide guidance for cleanup remedial actions.
- NRC Regulatory Guide for Termination of Operating Licenses for Nuclear Reactors (NRC Regulatory Guide 1.86) (June 1974) - Establishes acceptable surface radioactivity contamination levels for releases of equipment and facilities for unrestricted use.

A summary listing of TBCs is found in Table B-1.

B.4 SUMMARY

The establishment of final federal and state ARARs and TBCs for uranium and other constituents found in the operable unit for the evaluation of remedial action alternatives for Operable Unit 2 at the FMPC will be a progressive, multi-step process involving interactive discussions among DOE, EPA, and OEPA. The critical application of the final ARARs will be performed during the detailed analysis of alternatives. The ARARs, in conjunction with the baseline risk assessment, will assist in the determination of the cleanup levels required to adequately protect public health and the environment at the FMPC.

TABLE B-1.
SUMMARY LIST OF POTENTIAL APPLICABLE OR RELEVANT AND APPROPRIATE REQUIREMENTS AND GUIDANCE TO BE CONSIDERED

Chemical-Specific ARARs

Requirement	Description
Resource Conservation and Recovery Act (40CFR260-272)	Sets standards applicable to hazardous waste treatment, storage, and disposal
RCRA/Solid Waste (40CFR240-257)	Sets standards applicable to solid waste treatment, storage, and disposal
Safe Drinking Water Act (40CFR141-149) Maximum contaminant levels (MCLs)	Remedial actions may provide cleanup to the MCLs considered, pursuant to SARA Section 121(d)(2)(A)(ii)
NRC Regulations for Standards for Protection Against Radiation (10CFR20)	Establishes doses, levels, and concentrations for restricted and unrestricted areas (10CFR20.101-105)
EPA Regulations for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40CFR192)	Establishes cleanup limits for uranium and thorium mill tailings in soil and groundwater
Clean Air Act (42USC7401, et seq.)	Identifies primary and secondary standards for six "criteria pollutants" (i.e., lead, particulates)
a. National Ambient Air Quality Standards for six criteria pollutants (40CFR50)	
b. National Emission Standards for Radionuclides Emissions from DOE Facilities (40CFR61 Subpart H)	Provides annual limits of 10 mrem/yr (whole body) for air emissions (except radon) from DOE facilities
NRC Licensing Requirements for Land Disposal of radioactive Waste (10CFR61)	Provides for protection of the general population from releases of radioactivity (<25 mrem/yr)
Ohio Regulations	Escape, releases, emissions to open air
a. Air Pollution	
OAC3745-17	Air quality
OAC3745-20-05	Asbestos emissions

TABLE B-1.
(Continued)

Chemical-Specific ARARs	
Requirement	Description
b. Water Pollution OAC3745-81	Drinking water rules, sets MCLs for chemical and gross alpha, beta and radium-226 and radium-228
OAC3745-31	Set requirements for wastewater treatment facilities
OAC3745-1	Water Quality standards, 3745-1-04 sets those criteria that are applicable to all waters, 3745-01-05 sets forth the antidegradation policy for state waters, 3745-01-07 presents specific surface water quality criteria for both acute and chronic effects on aquatic organisms, 3745-01-21 describes use designations for the Great Miami River, 3745-1-32(c)(9) sets standards for radioactive materials in receiving waters of the Ohio River
c. Radiation Protection OAC3701-38	Ohio Radiation Protection Standards provide concentration limits for discharge of radioactive materials into air or water in unrestricted areas

TABLE B-1.
(Continued)

Location-Specific ARARs	
Requirement	Description
Rivers and Harbors Act of 1899 (33CFR320 to 327)	Remedial alternatives may effect the Great Miami River
Ohio Location Standards (OAC3745-27-07)	Governs the location of solid waste disposal facilities with respect to floodplains
Ohio Location Standards (OAC3745-54-18)	Governs the location of hazardous waste treatment, storage, or disposal with respect to floodplains
Regulations of activities affecting waters of the U.S. (33CFR320 to 329)	Corps of Engineers (U.S. Army) regulations apply to both wetlands and navigable waters (33CFR320-329), and for Ohio (OAC3745-32) waters
Fish and Wildlife Coordination Act (40CFR6.302)	Provides for coordination of the impacts on wetlands and protected habitats

TABLE B-1.
(Continued)

Action-Specific ARARs	
Requirements	**Description**
Resource Conservation and Recovery Act (40CFR260-272)	Sets standards applicable to hazardous waste treatment, storage, and disposal
RCRA/Solid Waste (40CFR240-257)	Sets standards applicable to solid waste treatment, storage, and disposal
Clean Water Act Ambient Water Quality Criteria (40CFR104-140)	Alternatives include discharge to surface waters
NRC Licensing Requirements for Land Disposal of Radioactive Waste (10CFR61)	Provides criteria for siting, decontamination, decommissioning, and disposition of uranium tailings and wastes (Appendix A)
NRC Regulations for Licensing of Source Material (10CFR40)	Provides requirements for siting, design, operation, closure, and control after closure for radioactive waste disposal facilities
EPA Regulations for Health and Environmental Protection Standards for Uranium and Thorium Mill Tailings (40CFR192)	Provides standards for control of residual radioactive materials from inactive uranium processing sites
Ohio General Radiation Protection Standards (OAC3701 to 70)	Applies to all facilities that receive, possess, use, store, transfer, etc., any source of radiation
Ohio Radiation Protection Standards (OAC3701-38)	Applies to all facilities that receive, possess, use, store, transfer, etc., any source of radiation
Air Pollution Nuisances Prohibited (OAC3745-15-07) (OAC3704.03(E))	Prohibits air emissions that could be constituted as a public nuisance
Ohio Air Pollution Rules	
(3745-21-05)	Nondegradation policy
(3745-21-07)	Control of emissions of organic materials from stationary sources
Abandonment of Test Holes and Wells (OAC3745-9-10)	Regulates installation and abandonment of borings and wells
Solid Waste Disposal Facility Requirements (OAC3745-27)	Sets requirements for solid non-hazardous waste treatment and disposal facility design

290

TABLE B-1.
(Continued)

TBCs	
Requirements	Description
Executive Order 11988, Floodplain Management	Provides considerations for protection of wetlands
Executive Order 11990, Protection of Wetlands	Sets requirements for management of radioactive wastes at DOE facilities
Radioactive Waste Management (DOE Order 5820.2A)	Sets requirements for protection of the public and the environment from radioactive materials at DOE facilities
Radiation Protection of the Public and the Environment (DOE Order 5400.5)	Provides direction for DOE to implement a CERCLA program
CERCLA Program (DOE Order 5400.4) (Draft)	Establishes hazardous waste management procedures for facilities operated under authority of the Atomic Energy Act of 1954, as amended
Hazardous and Radioactive Mixed Waste Management (DOE Order 5480.2) (December 13, 1982)	Presents guidance for implementing EPA standards on uranium mill tailings remedial action sites
Plan for Implementing EPA Standards for UMTRA Sites (UMTRA-DOE/AL-163)	Presents the technical approach used by DOE for remediation of uranium mill tailings remedial action sites
Technical Approach Document (UMTRA-DOE/AL 050425)	Presents guidance for complying with 40CFR192 for planning and disposal cell design for uranium mill tailings remedial action sites
Remedial Action Planning and Disposal Cell Design (UMTRA-DOE/AL 400503)	Presents guidance for surveillance and maintenance of uranium mill tailings remedial action sites
Project Surveillance and Maintenance Plan (UMTRA-DOE/AL 35012)	Provides considerations for management of floodplain areas

TABLE B-1.
(Continued)

TBCs	
Requirements	**Description**
Minimum Technology Guidance for Final Covers on Hazardous Waste Landfills and Surface Impoundments (EPA)	Presents guidance for covers of hazardous waste landfills and surface impoundments
Safe Drinking Water Act (40CFR141-149; Section 1412(b))	Presents guidance for groundwater cleanup
a. Proposed maximum contaminant levels b. MCLGs	
Residual Radioactive Material as Surface Contamination (USNRC Regulatory Guide 1.86)	Provides surface contamination guidelines for release of equipment and building components for unrestricted use
Chemical Reference Dose Guidance (USEPA Health Effects Assessment Summary Tables)	Provides chemical dose guidance intended to be protective of human health
Chemicals in Drinking Water (40CFR141.50-141.57) (OAC3745-81-11)	Sets MCLGs for potential chemicals of concern in community water systems

APPENDIX
C

APPENDIX C
SOLID WASTE UNIT CHARACTERISTICS

TABLE C-1

OPERABLE UNIT 2 - SANITARY LANDFILL CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
1.	Area	42,300 ft^2 (1 acre)	A soil cover exists over the area.
2.	Contents: Nonburnable, nonradioactive sanitary wastes generated on property (20 yd^3/wk), double-bagged and bulk quantities of nonradioactive asbestos, radioactive contaminated construction rubble and soils.	Volume of waste 16,000 to 18,000 yd^3	References 1 and 2 5 full cells and an area adjacent to the cells used to dispose of waste.
3.	Surface Water	None	
4.	Data from geotechnical evaluation		Reference 3
	(a) Specific gravity	2.57 to 2.58	
	(b) Moisture content[b]	17.8%	
	(c) Maximum dry density	100.2 to 114 ft^3	
5.	Material consistency	52 to 60% of particles smaller than 74 µm	Reference 2 Per ASTMD[c]422, silt-sized particles are defined in 5 to 74 µm range
6.	Radioactive materials		
	Uranium-238	12 to 35 pCi/g	All other radionuclide concentrations were below background levels. (References 1 and 2)
	Uranium-235	0.4 to 1.4 pCi/g	
	Uranium-234	4.9 to 28.0 pCi/g	
	Plutonium-238	0.1 pCi/g	
7.	Volatile Inorganics		Detected quantities of arsenic and mercury are below available background levels. (References 1 and 2)
	Arsenic (As)	3.28 to 6.69 mg/kg	
	Mercury (Hg)	0.14 to 0.20 mg/kg	

TABLE C-1 (Continued)

OPERABLE UNIT 2 - SANITARY LANDFILL CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
8.	Organics		References 1 and 2
	PCBs (Aroclors 1242, 1248, and 1254)	78 to 1600 µg/kg	
	2-Methylnaphthalene	66 to 11,000 µg/kg	
	Xylenes (volatile)	320 µg/kg	
9.	HSL Volatiles		
	Acetone	12 to 25 µg/kg	
	2-Butanone	120 µg/kg	
	Ethyl Benzene	91 µg/kg	
	Methylene Chloride	8 to 160 µg/kg	
	Tetrachloroethene	97 µg/kg	
	Toluene	180 µg/kg	
	Chloroform	9 to 13 µg/kg	
	1,1,1 Trichloroethane	5 to 6 µg/kg	
10.	HSL Semivolatiles		References 1 and 2
	Chrysene	170 to 4,600 µg/kg	
	Acenaphthene	1,300 to 28,000 µg/kg	
	Anthracene	85 to 2,800 µg/kg	
	Benzo(a)anthracene	130 to 5,100 µg/kg	
	Benzo(a)pyrene	100 to 7,000 µg/kg	
	Benzo(b)fluoranthene	98 to 6,700 µg/kg	
	Benzo(g,h,i)perylene	110 to 6,000 µg/kg	
	Benzo(k)fluoranthene	84 to 4,900 µg/kg	
	Dibenzo(a,h)anthracene	560 to 2,100 µg/kg	
	Fluoranthene	330 to 450 µg/kg	
	Fluorene	1,400 to 2,500 µg/kg	
	Indeno(1,2,3-cd)pyrene	81 to 5,700 µg/kg	
	Naphthalene	2,700 to 19,000 µg/kg	
	Phenanthrene	320 to 330 µg/kg	
	Pyrene	240 to 6,300 µg/kg	
	bis(2-ethylhexyl)phthalate	49 to 150 µg/kg	
	Butyl benzylphthalate	320 µg/kg	

TABLE C-1 (Continued)

OPERABLE UNIT 2 - SANITARY LANDFILL CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
10.	HSL Semivolatiles (continued)		
	Dibenzofuran	620 to 1,900 µg/kg	
	2,4-Dimethylphenol	240 µg/kg	
	Di-n-butyl phthalate	55 to 330 µg/kg	
	Di-n-octyl phthalate	300 to 350 µg/kg	
	2-Methylphenol	96 µg/kg	
	4-Methylphenol	360 µg/kg	
	N-nitrosodiphenylamine	67 µg/kg	
	Phenol	310 µg/kg	
11.	HSL Inorganics		All other inorganic concencrations were below background levels. (References 1 and 2)
	Cadmium	1.92 to 5.33 mg/kg	
	Nickel	12.73 to 42.35 mg/kg	
	Zinc	39.61 to 166.7 mg/kg	

[a] References:

1. Weston, Roy F., November 1987b, "Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits," U.S. Dept of Energy Feed Materials Production Center, Fernald, OH, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

2. U.S. Dept of Energy, 1988b, "FMPC Sampling and Analysis Report," 2 Vols., Draft, DOE, Oak Ridge Operations Office, Oak Ridge, TN.

3. Weston, Roy F., March 1988, "Geotechnical Evaluation of Material Properties of Waste Pit Materials at the Feed Materials Production Center, Fernald, Ohio," prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

[b] By percent of total dry weight

[c] American Society for Testing Materials

TABLE C-2

OPERABLE UNIT 2 - NORTH AND SOUTH LIME SLUDGE POND CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
1.	Area: Approximate dimensions in ft 150 x 250 x 11.5 deep (South Pond) 150 x 250 x 5 to 7 deep (North Pond)	 29,600 ft^2 (South Pond) 28,000 ft^2 (North Pond)	
2.	Contents: Spent lime, lime-alum sludge and boiler plant blowdown	5,000 yd^3 (North Pond) 11,500 yd^3 (South Pond)	References 1 and 2 North Pond is approximately 90% full. The South Pond was reactivated recently and currently receives spent lime sludge.
3.	Surface water		
	North Pond: Water depth ranging from 1 to 7 ft	150,000 gal. (maximum)	
	South Pond	None	
4.	Data from geotechnical evaluation		Reference 3
	Specific gravity Moisture content[b] Maximum dry density	2.33 to 2.49 38.8 to 134% 72.8 lbs/ft^3	
5.	Material consistency: Nonplastic silty-clayey type material	94 to 99% of particles smaller than 74 µm	Per ASTM[c]422, silt-sized particles are defined in the 5 - 74 µm range.
		10.5 to 16.7% of particles smaller than 5 µm	Per ASTMD422, this size designation defines the beginning of clay and colloid particle range.

TABLE C-2 (Continued)

OPERABLE UNIT 2 - NORTH AND SOUTH LIME SLUDGE POND CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
6.	Radioactive materials		All other radionuclide concentrations were below background levels. (References 1 and 2)
	North Pond		
	Strontium-90	2.20 pCi/g	
	Thorium-230	0.5 to 20.0 pCi/g	
	Uranium-234	2.1 to 2.5 pCi/g	
	Uranium-235	0.1 to 0.2 pCi/g	
	Uranium-238	2.4 to 7.6 pCi/g	
	South Pond		
	Thorium-230	0.9 to 7.0 pCi/g	
	Uranium-234	1.8 to 3.1 pCi/g	
	Uranium-235	0.1 to 0.3 pCi/g	
	Uranium-238	2.2 to 2.8 pCi/g	
7.	Volatile Inorganics		References 1 and 2
	Arsenic (As)	6.3 to 16.0 mg/kg	North Pond Only. South Pond data indicates no As and Hg present.
	Mercury (Hg)	0.30 mg/kg	
8.	Organics		References 1 and 2
	North Pond		
	Chlordane	1,200 µg/kg	
	PCBs (Aroclor 1248)	1,200 µg/kg	
9.	HSL Volatiles		References 1 and 2
	North Pond		
	Acetone	20 to 150 µg/kg	
	Carbon disulfide	7 to 9 µg/kg	
	1,1-dichloroethane	30 µg/kg	
	Methylene Chloride	21 to 26 µg/kg	
	1,1,2-Trichloro-1,2,2-Trifluoroethane	50 to 81 µg/kg	
	Toluene	20 µg/kg	

TABLE C-2 (Continued)

OPERABLE UNIT 2 - NORTH AND SOUTH LIME SLUDGE POND CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
9.	HSL Volatiles (continued)		
	South Pond		
	Acetone	18 to 140 µg/kg	
	2-Butanone	1800 µg/kg	
	Methylene Chloride	110 to 240 µg/kg	
	Chloroform	7 to 11 µg/kg	
	1,1,1-Trichloroethane	9 to 14 µg/kg	
10.	HSL Semivolatiles		References 1 and 2
	North Pond		
	bis(2-ethylhexyl)phthalate	100 to 310 µg/kg	
	Butyl Benzyl Phthalate	370 to 2,800 µg/kg	
	Di-n-butyl Phthalate	89 to 330 µg/kg	
	Phenol	61 µg/kg	
	South Pond		
	Benzoic Acid	160 µg/kg	
	bis(2-ethylhexyl)phthalate	230 to 310 µg/kg	
	Di-n-butyl Phthalate	47 to 73 µg/kg	
	Phenol	89 µg/kg	
11.	HSL inorganic		North Pond Only. All other inorganic concentrations were below background levels. (References 1 and 2)
	Zinc	38 to 75 mg/kg	

[a] References:

1. Weston, Roy F., November 1987b, "Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits," U.S. Dept of Energy Feed Materials Production Center, Fernald, OH, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.
2. U.S. Dept of Energy, 1988b, "FMPC Sampling and Analysis Report," 2 Vols., Draft, DOE Oak Ridge Operations Office, Oak Ridge, TN.
3. Weston, Roy F., March 1988, "Geotechnical Evaluation of Material Properties of Waste Pit Materials at the Feed Materials Production Center, Fernald, Ohio," prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

[b] By percent of total dry weight

[c] American Society for Testing Materials

TABLE C-3

OPERABLE UNIT 2 - ACTIVE FLY ASH PILE CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
1.	Area	93,800 ft^2 (2.2 acres)	
2.	Contents: Fly Ash	38,000 yd^3	
3.	Surface water	None	
4.	Data from geotechnical evaluation	None	Reference 3
5.	Material consistency		No geotechnical information or visual classification available.
6.	Radioactive materials		All other radionuclide concentrations were below background levels. (References 1 and 2) Elevated levels of uranium from waste oil sprayed for dust control.
	Lead-210	4.0 pCi/g	
	Radium-226	0.4 to 2.4 pCi/g	
	Thorium-228	0.1 to 2.2 pCi/g	
	Thorium-230	0.7 to 52.0 pCi/g	
	Uranium-234	4.5 to 41.0 pCi/g	
	Uranium-235	0.1 to 4.9 pCi/g	
	Uranium-238	2.2 to 253.0 pCi/g	
7.	Volatile Inorganics	Analysis not performed	References 1 and 2
8.	Organics	Analysis not performed	References 1 and 2
9.	HSL Volatiles		References 1 and 2
	Acetone	37 to 940 µg/kg	
	2-Butanone	29 to 67 µg/kg	
	Chloroform	6 to 11 µg/kg	
	Methylene Chloride	160 to 1,100 µg/kg	
	1,1,1-Trichloroethane	19 to 420 µg/kg	
	Toluene	19 to 89 µg/kg	

TABLE C-3 (Continued)

OPERABLE UNIT 2 - ACTIVE FLY ASH PILE CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
10.	HSL Semivolatiles	Analysis not performed	References 1 and 2
11.	HSL Inorganics	Analysis not performed	References 1 and 2

[a] References:

1. Weston, Roy F., November 1987b, "Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits," U.S. Dept of Energy Feed Materials Production Center, Fernald, OH, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

2. U.S. Dept of Energy, 1988b, "FMPC Sampling and Analysis Report," 2 Vols., Draft, DOE Oak Ridge Operations Office, Oak Ridge, TN.

3. Weston, Roy F., March 1988, "Geotechnical Evaluation of Material Properties of Waste Pit Materials at the Feed Materials Production Center, Fernald, Ohio," prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

TABLE C-4

OPERABLE UNIT 2 - INACTIVE FLY ASH DISPOSAL AREA

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
1.	Area	131,000 ft^2 (3 acres)	
2.	Contents: fly ash and building rubble	50,000 yd^3	
3.	Surface water	None	
4.	Data from geotechnical evaluation	None	Reference 3
5.	Material consistency: High to low plasticity clays intermixed with sand-sized particles and fly ash.		Reference 3 Visual Classification
6.	Radioactive materials		References 1 and 2 Elevated levels of uranium from waste oil sprayed for dust control.
	Lead-210	2.0 to 5.0 pCi/g	
	Radium-226	0.6 to 4.1 pCi/g	
	Radium-228	1.7 to 2.0 pCi/g	
	Thorium-228	0.2 to 2.3 pCi/g	
	Thorium-230	0.2 to 11.0 pCi/g	
	Thorium-232	0.1 to 2.6 pCi/g	
	Uranium-234	3.7 to 48.0 pCi/g	
	Uranium-235	0.2 to 2.2 pCi/g	
	Uranium-238	6.6 to 50.0 pCi/g	
7.	Volatile Organics		References 1 and 2 Detected quantities of arsenic are below available background levels.
	Arsenic (As)	5.91 to 10.76 mg/kg	
	Mercury (Hg)	0.139 to 0.26 mg/kg	

TABLE C-[illegible] (Continued)

OPERABLE UNIT 2 - INACTIVE FLY ASH DISPOSAL AREA

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
8.	Organics PCBs (Aroclors 1242, 1254, and 1260)	5.70 µg/kg to 290.0 µg/kg	References 1 and 2
9.	HSL Volatiles	Analyzed for, but not detected	References 1 and 2
10.	HSL Semivolatiles	Analyzed for, but not detected	References 1 and 2
11.	HSL Inorganics Cadmium Lead	 2.43 to 3.82 mg/kg 13.8 to 56.0 mg/kg	All other inorganic concentrations were below background concentrations. (References 1 and 2)

[a] References:

1. Weston, Roy F., November 1987b, "Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits," U.S. Dept of Energy Feed Materials Production Center, Fernald, OH, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

2. U.S. Dept of Energy, 1988b, "FMPC Sampling and Analysis Report," 2 Vols., Draft, DOE Oak Ridge Operations Office, Oak Ridge, TN.

3. Weston, Roy F., March 1988, "Geotechnical Evaluation of Material Properties of Waste Pit Materials at the Feed Materials Production Center, Fernald, Ohio," prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

TABLE C-5

OPERABLE UNIT 2 - SOUTHFIELD CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
1.	Area	455,000 ft^2 (10.4 acres)	
2.	Contents: Construction rubble containing low levels of radioactivity.	125,000 yd^3	
3.	Surface Water	None	
4.	Data from geotechnical evaluation	None	Reference 3
5.	Material Consistency: Construction rubble intermixed with native clay fill		Reference 3 Visual Classification
6.	Radioactive Materials		All other radionuclide concentrations were below background levels. (References 1 and 2)
	Lead-210	2.0 to 28 pCi/g	
	Cesium-137	0.3 pCi/g	
	Radium-226	0.4 to 266.0 pCi/g	
	Radium-228	0.6 to 10 pCi/g	
	Thorium-228	0.1 to 129 pCi/g	
	Thorium-230	0.1 to 1,070 pCi/g	
	Thorium-232	0.1 to 130 pCi/g	
	Uranium-234	2.0 to 11,400 pCi/g	
	Uranium-235	0.09 to 5.8 pCi/g	
	Uranium-238	2.0 to 8,600 pCi/g	
7.	Volatile Inorganics		Detected quantities of Arsenic are below available background levels. (References 1, 2, and 4)
	Arsenic (As)	3.7 to 8.1 mg/kg	
	Mercury (Hg)	0.121 to 1.22 mg/kg	

TABLE C (Continued)

OPERABLE UNIT 2 - SOUTHFIELD CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
8.	Organics		References 1, 2, and 4
	PCBs (Aroclors 1242, 1254, and 1260)	1.9 to 1100 µg/kg	
9.	HSL Volatiles		References 1, 2, and 4
	Acetone	3 to 180 µg/kg	
	2-Butanone	4 to 42 µg/kg	
	Chloroform	2 to 10 µg/kg	
	Methylene chloride	2 to 280 µg/kg	
	Toluene	1 to 26 µg/kg	
10.	HSL Semivolatiles		Reference 4
	Fluoranthene	39 to 300 µg/kg	
	Pyrene	43 to 270 µg/kg	
	Phenanthrene	110 µg/kg	
	Benzo(a)anthracene	170 µg/kg	
	Chrysene	170 µg/kg	
	Benzo(b)fluoranthene	290 µg/kg	
	Benzo(a)pyrene	230 µg/kg	
	Bis(2-Ethylhexyl)phthalate	40 µg/kg	
11.	HSL Inorganics		References 1, 2, and 4
	Cadmium	2.12 to 5.15 mg/kg	All other inorganic concentrations were below background concentrations (References 1 and 2.)
	Cobalt	9.76 to 27.7 mg/kg	
	Lead	10.4 to 34 mg/kg	
	Nickel	10.2 to 48.3 mg/kg	
	Beryllium	1.2 to 1.5 mg/kg	Reference 4 (These inorganic concentrations were above background concentrations listed in Reference 5)
	Calcium	12,100 to 126,000 mg/kg	
	Copper	9.7 to 24.3 mg/kg	
	Iron	15,900 to 25,900 mg/kg	

TABLE C-5 (Continued)

OPERABLE UNIT 2 - SOUTHFIELD CHARACTERISTICS

Item No.	Description	Quantities (Approximate) and Units	References[a] and/or Comments
11.	HSL Inorganics		Reference 4
	Magnesium	6,000 to 24,800 mg/kg	(These inorganic concentrations
	Manganese	323 to 823 mg/kg	were above background
	Zinc	41 to 66.3 mg/kg	concentrations listed in
	Potassium	548 to 866 mg/kg	Reference 5)

[a] References:

1. Weston, Roy F., November 1987b, "Characterization Investigation Study Volume 2: Chemical and Radiological Analyses of the Waste Storage Pits," U.S. Dept of Energy Feed Materials Production Center, Fernald, OH, prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

2. U.S. Dept of Energy, 1988b, "FMPC Sampling and Analysis Report," 2 Vols., Draft, DOE Oak Ridge Operations Office, Oak Ridge, TN.

3. Weston, Roy F., March 1988, "Geotechnical Evaluation of Material Properties of Waste Pit Materials at the Feed Materials Production Center, Fernald, Ohio," prepared for Westinghouse Materials Co. of Ohio, Cincinnati, OH.

4. IT, 1990. Certificate of Analysis, January 9 through 15, Sampling Locations 55906, 55919, 55945, 55959, and 55972, International Technology Corporation, Analytical Services, Knoxville, TN.

5. U.S. Geological Survey Data for the Eastern United States (Shacklette and Boerngen 1984).