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FEASIBILITY STUDY REPORT/ENVIRONMENTAL ASSESSMENT FOR OPERABLE UNIT 2 ****FINAL**** MARCH 1995 - VOL 4 OF 6 - APPENDICES D & E

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REPORT

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT

FEASIBILITY STUDY REPORT OPERABLE UNIT 2

Volume 4 of 6
Appendices D and E

March 1995

FINAL

. DEPARTMENT OF ENERGY
FERNALD FIELD OFFICE

6647

FEASIBILITY STUDY REPORT FOR OPERABLE UNIT 2

FERNALD ENVIRONMENTAL MANAGEMENT PROJECT
FERNALD, OHIO

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

VOLUME 4 OF 6
APPENDICES D AND E

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U.S. DEPARTMENT OF ENERGY
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FINAL

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TABLE OF CONTENTS
APPENDIX D

List of Figures . . . . . D-v
List of Tables . . . . . D-vii
List of Acronyms . . . . . D-ix
D.1.0 Groundwater Fate and Transport for Contaminants of Concern D-1-1
D.1.1 Soil Erosion Potential D-1-3
D.1.2 Conceptual Groundwater Flow Model D-1-3
D.1.3 Technical Approach D-1-11
D.1.3.1 Source Term Development D-1-12
D.1.3.2 Methods of Estimating Leachate Concentrations D-1-14
D.1.3.3 Parameters D-1-14
D.1.3.4 Vadose Zone Modeling D-1-18
D.1.3.5 Great Miami Aquifer Modeling D-1-18
D.1.4 Model Descriptions D-1-18
D.1.4.1 HELP Model D-1-18
D.1.4.2 ODAST/SWIFTLOAD Model D-1-19
D.1.4.3 SWIFT Model D-1-22
D.1.5 Cross-Media PRG Development to be Protective of the Great Miami Aquifer D-1-25
D.1.5.1 Solid Waste Landfill D-1-25
D.1.5.2 Lime Sludge Ponds D-1-30
D.1.5.3 Inactive Flyash Pile/South Field D-1-36
D.1.5.3.1 Impact of the Perched Water Subsurface Seep Pathway D-1-36
D.1.5.3.2 Remediated Perched Water and No Source Controls D-1-43
D.1.5.3.3 Source Controls for Lateral Migration of Perched Water . . . D-1-54
D.1.5.3.4 Consolidation and Capping with Source Controls for Lateral Migration of Perched Water D-1-71
D.1.5.4 Active Flyash Pile D-1-76
D.1.6 Preliminary Waste Acceptance Criteria for On-Site Disposal of Operable Unit 2 Materials D-1-76
D.1.7 Sensitivity to the Distribution Coefficient D-1-83
D.2.0 Air Transport Modeling for Long-Term Residual Risk D-2-1
D.2.1 Introduction D-2-1

TABLE OF CONTENTS

(Continued)

D.2.2 Source Term Assumptions for Air Transport Analysis D-2-2
D.2.2.1 Alternative 2: Consolidation and Capping D-2-4
D.2.2.2 Alternative 3: Off-Site Disposal D-2-5
D.2.2.3 Alternative 4: Excavation and On-Site Disposal with Off-Site Disposal of Fraction Exceeding the WAC D-2-6
D.2.3 Air Transport Models D-2-7
D.2.4 Particulate Contaminant Emission Rates D-2-7
D.2.4.1 Contaminated Soil Concentrations D-2-9
D.2.4.2 Suspended Particulate Emission Estimate D-2-9
D.2.4.2.1 Emission Rates with Private Ownership D-2-10
D.2.4.2.2 Emission Rates with Administrative Controls D-2-12
D.2.5 Gaseous Contaminant Emission Rates D-2-14
D.2.6 Meteorological Data D-2-14
D.2.7 Receptor Locations D-2-15
D.2.8 Dispersion Coefficients D-2-15
D.2.9 Model Output Processing D-2-17
D.2.10 Results of Air Dispersion Modeling D-2-18
D.2.10.1 Alternative 2 - Consolidation and Capping D-2-18
D.2.10.2 Alternative 3 - Excavation and Off-Site Disposal D-2-20
D.2.10.2.1 Future Land Use With Federal Ownership D-2-20
D.2.10.2.2 Future Land Use With Private Ownership D-2-23
D.2.10.3 Alternative 6 - Excavation and On-Site Disposal with Off-Site Disposal of Fraction Exceeding Waste Acceptance Criteria D-2-23
D.2.10.3.1 Future Land Use with Federal Ownership D-2-23
D.2.10.3.2 Future Land Use with Private Ownership D-2-26
D.2.11 References D-2-26
D.3.0 Uranium Partition Coefficient Evaluation Study D-3-1
D.3.1 Soil Sample Selection D-3-1
D.3.1.1 Waste Samples D-3-3
D.3.1.2 Glacial Overburden Layer D-3-4
D.3.1.3 Sand and Gravel Layer D-3-4

TABLE OF CONTENTS

(Continued)

D.3.2 Laboratory Procedures D-3-4
D.3.2.1 Desorption Test D-3-5
D.3.2.2 Adsorption Test D-3-6
D.3.2.3 Analytical Methods/Procedures D-3-7
D.3.3 Partition Coefficient Calculations D-3-8
D.3.4 Summary and Conclusions D-3-15
D.3.4.1 Desorption Versus Adsorption D-3-15
D.3.4.2 Operable Unit 2 K_d Values Versus Literature Values D-3-17
D.3.4.3 Operable Unit 2 K_d Values Versus In Situ Values D-3-17
D.4.0 Operable Unit 5 Geochemical Study D-4-1
D.5.0 Development of Modified Soil PRGs Protective of Sediments and Surface Water D-5-1
D.5.1 Risk-Based Soil PRG Development D-5-1
D.5.2 Land-Use Modified Soil Development D-5-2
D.5.3 Cross-Media Modified PRG Development D-5-2
D.5.3.1 Cross-Media Impact on Groundwater D-5-7
D.5.3.2 Cross-Media Impact on Surface Water
D.5.3.2.1 Great Miami River D-5-7
D.5.3.2.2 Paddys Run D-5-7
D.5.3.3 Cross-Media Impact on Sediments D-5-9
D.5.3.4 Radon PRG Development D-5-12
D.5.4 Source Control Modified Soil PRG Development D-5-14
References D-R-1
Attachment D.1-I Infiltration Calculations for ODAST/SWIFT Modeling D-1-I-1
Attachment D.1-II Soil Erosion Calculations D-1-II-1
Attachment D.1-III Calibration of Fate and Transport Model Against Lysimeter Data . . . D-1-III-1
Attachment D.1-IV Alternate Modeling Approach for Preliminary Waste Acceptance Criteria D-1-IV-1
Attachment D.2-I Contaminant Concentrations in Exposed Soil D-2-I-1
Attachment D.2-II Contaminant Air Emission Rates D-2-II-1
Attachment D.2-III RAECOM Model Output Files D-2-III-1
Attachment D.2-IV Five-Year Composite Joint Frequency Distribution for the FEMP . . . D-2-IV-1
Attachment D.2-V Contaminant Concentrations in Air D-2-V-1

TABLE OF CONTENTS

(Continued)

Attachment D.3-I Laboratory Procedures D-3-I-1

Attachment D.3-II Laboratory Results for Desorption Tests D-3-II-1

Attachment D.3-III Laboratory Results for Adsorption Tests D-3-III-1

Attachment D.3-IV K_d Calculations for Desorption Tests D-3-IV-1

Attachment D.3-V K_d Calculations for Adsorption Tests D-3-V-1

Attachment D.4-I Historical Airborne Release of Uranium and Geochemical Concepts of the Subsurface Uranium Distribution at the Fernald Site D-4-I-1

LIST OF FIGURES

D.1-1 South Field Locations and Slopes for Soil Erosion Calculations D-1-4

D.1-2 Conceptual Model of Loading to the Great Miami Aquifer and Contaminant Transport By Groundwater D-1-5

D.1-3 Conceptual Vadose Zone Model D-1-6

D.1-4 Conceptual Model for Lateral Drainage Infiltrating to the Unsaturated Great Miami Aquifer D-1-9

D.1-5 Conceptual Model for Perched Water Subsurface Seeps D-1-10

D.1-6 Extent of Waste an Modeled SWIFT Grid Cells, Solid Waste Landfill D-1-26

D.1-7 Uranium-238 Loading Curve for Source Materials at 60 pCi/g Solid Waste Landfill Without Source Controls D-1-27

D.1-8 Extent of Waste and Modeled SWIFT Grid Cells, Lime Sludge Ponds D-1-31

D.1-9 Uranium-238 Loading Curve for the Lime Sludge Ponds Without Source Controls . . D-1-32

D.1-10 SWIFT Model Grid at Inactive Flyash Pile and South Field D-1-37

D.1-11 Uranium-238 Loading to the Great Miami Aquifer from the South Field/Inactive Flyash Pile for Perched Water Subsurface Seep Pathway D-1-40

D.1-12 Projected Increase in Uranium-238 Concentrations in the Great Miami Aquifer at 80 Years Due to Loading from the Inactive Flyash Pile/South Field Via Subsurface Pathway D-1-41

D.1-13 Uranium-238 Loading Curve for Source Materials at 2.5 pCi/g and Clean Perched Water, Inactive Flyash Pile and South Field D-1-44

D.1-14 Pre-Construction Glacial Till Terrace Slope at Inactive Flyash Pile, South Field and Active Flyash Pile Area D-1-55

D.1-15 Uranium-238 Loading Curve for Source Materials at 5 pCi/g on the Terrace Face and on the Great Miami Aquifer, Inactive Flyash Pile and South Field D-1-56

D.1-16 Uranium-238 Loading Curve for Source Materials at 60 pCi/g on the Terrace Face and on the Great Miami Aquifer, Inactive Flyash Pile and South Field D-1-59

D.1-17 Uranium-238 Loading Curve for Source Materials up to 819 pCi/g on the Terrace Face and on the Great Miami Aquifer, Inactive Flyash Pile and South Field D-1-60

D.1-18 Uranium-238 Loading Curve for Source Materials up to 70 pCi/g on the Terrace Face, Inactive Flyash Pile and South Field D-1-72

D.1-19 Site Restoration - Consolidation/Containment SWIFT Model Grid for Inactive Flyash Pile, South Field, and Active Flyash Pile D-1-73

D.1-20 Potentially Acceptable Locations for Sitewide On-Site Disposal and Modeled Area for WAC Development D-1-77

LIST OF FIGURES

(Continued)

D.1-21 Gray Till Thickness in Feet for Disposal Cell Area D-1-78

D.1-22 Unsaturated Great Miami Aquifer Thickness in Feet for Disposal Cell Area D-1-79

D.2-1 Sequential Block Diagram of Air Transport Analysis D-2-3

D.2-2 Operable Unit 2 Source Groups for Residual Air Modeling D-2-8

D.2-3 Receptor Grids for Air Dispersion Modeling D-2-16

D.2-4 Rn-222 Concentration in Air for Consolidation and Capping Alternative Expanded Trespasser (Impacts Above Background) D-2-19

D.2-5 U-238 Concentration in Air for Consolidation and Capping Alternative Expanded Trespasser (Impacts Above Background) D-2-21

D.2-6 Rn-222 Concentration in Air for Off-Site and On-Site Disposal Alternatives - Expanded Trespasser (Impacts Above Background) D-2-22

D.2-7 U-238 Concentration in Air for Off-Site and On-Site Disposal Alternatives - Expanded Trespasser (Impacts Above Background) D-2-24

D.2-8 U-238 Concentration in Air for Off-Site and On-Site Disposal Alternatives On-Property Resident Farmer (Impacts Above Background) D-2-25

D.2-9 Rn-222 Concentration in Air for Off-Site and On-Site Disposal Alternatives - On-Property Resident Farmer (Impacts Above Background) D-2-27

LIST OF TABLES

D.1-1 Summary of Soil Erosion Calculations D-1-2

D.1-2 Media Parameters D-1-15

D.1-3 Parameters for the SWIFT Cells Solid Waste Landfill Without a Cap D-1-28

D.1-4 Solid Waste Landfill - Cross-Media Modified Soil PRGs Protective of the Great Miami Aquifer Without Source Controls D-1-29

D.1-5 Parameters for the SWIFT Cells - Solid Waste Landfill with a Cap D-1-33

D.1-6 Solid Waste Landfill - Modified Soil PRGs Protective of the Great Miami Aquifer Using a Cap D-1-34

D.1-7 Parameters for the SWIFT Cells Lime Sludge Ponds Without a Cap D-1-35

D.1-8 Lime Sludge Ponds - Cross-Media Modified Soil PRGs Protective of the Great Miami Aquifer Without Source Controls D-1-38

D.1-9 Parameters for the SWIFT Cells Impacted by the Perched Water Subsurface Seep Pathway, South Field and Inactive Flyash Pile D-1-42

D.1-10 Parameters for the SWIFT Cells After Removal of Waste to 2.5 pCi/g South Field and Inactive Flyash Pile D-1-45

D.1-11 HELP Model Results for the SWIFT Cells After Removal of Waste to 2.5 pCi/g and No Source Controls, South Field and Inactive Flyash Pile D-1-47

D.1-12 Inactive Flyash Pile/South Field - Cross-Media Modified Soil PRGs Protective of the Great Miami Aquifer Without Source Controls D-1-49

D.1-13 Parameters for the SWIFT Cells After Removal of Waste to 5 pCi/g on the Great Miami Aquifer and on the Terrace Face, South Field and Inactive Flyash Pile D-1-50

D.1-14 HELP Model Results for the SWIFT Cells After Removal of Waste to 5 pCi/g on the Great Miami Aquifer and on the Terrace Face, South Field and Inactive Flyash Pile D-1-52

D.1-15 Inactive Flyash Pile/South Field - Cross-Media Modified Soil PRGs Protective of the Great Miami Aquifer Using Lateral Migration Source Controls D-1-57

D.1-16 Parameters for the SWIFT Cells After Removal of Waste to 60 pCi/g on the Great Miami Aquifer and on the Terrace Face, South Field and Inactive Flyash Pile D-1-61

D.1-17 HELP Model Results for the SWIFT Cells after Removal of Waste to 60 pCi/g on the Great Miami Aquifer and on the Terrace Face, South Field and Inactive Flyash Pile D-1-63

D.1-18 Parameters for the SWIFT Cells With No Removal of Waste on the Great Miami Aquifer and on the Terrace Face, South Field, and Inactive Flyash Pile D-1-65

LIST OF TABLES

(Continued)

D.1-19 HELP Model Results for the SWIFT Cells With No Removal of Waste on the Great Miami Aquifer and on the Terrace Face, South Field and Inactive Flyash Pile D-1-67

D.1-20 Parameters for the SWIFT Cells for PRG Development for the Waste on the Top of the Terrace, South Field and Inactive Flyash Pile D-1-69

D.1-21 HELP Model Results for the SWIFT Cells for PRG Development for the Top of Terrace - South Field and Inactive Flyash Pile D-1-70

D.1-22 Parameters for the SWIFT Cells After Consolidation and Capping - South Field, Inactive Flyash Pile, and Active Flyash Pile D-1-74

D.1-23 Inactive Flyash Pile/South Field/Active Flyash Pile - Cross-Media Modified Soil PRGs Protective of the Great Miami Aquifer Using a Cap and Source Controls for Perched Water D-1-80

D.1-24 Active Flyash Pile - Cross-Media Modified Soil PRGs Protective of the Great Miami Aquifer Without Source Controls D-1-81

D.1-25 Preliminary Waste Acceptance Criteria Protective of the Great Miami Aquifer for On-Site Disposal of Operable Unit 2 Materials D-1-84

D.1-26 Sensitivity of PRGs to the Glacial till Distribution Coefficient - Operable Unit 2 . . . D-1-85

D.3-1 Summary of K_d Study Samples for Operable Unit 2 . . . . . D-3-2

D.3-2 Operable Unit 2 K_d Values for Desorption Test D-3-11

D.3-3 Operable Unit 2 K_d Values for Adsorption Test D-3-14

D.3-4 Summary of K_d Values for Operable Unit 2 . . . . . D-3-16

D.5-1 On-Property Resident Farmer South Field Pathway Risks (ILCR or HI) and Risk-Based PRGs D-5-3

D.5-2 Expanded Trespasser Federal Ownership Modified Soil PRGs - South Field Concentrations and Risks D-5-5

D.5-3 Off-Property Farmer Federal Ownership Modified Soil PRGs - South Field Concentrations and Risks D-5-6

D.5-4 South Field Cross-Media Modified PRGs Protective of the Great Miami River Surface Water Without Source Controls D-5-8

D.5-5 South Field Cross-Media Modified Soil PRGs and PRLs Meets ARARs in the Paddys Run Without Source Control D-5-10

D.5-6 Cross-Media Modified Soil PRGs and PRLs Protective of Sediments Without Source Controls D-5-11

D.5-7 Radon PRG Calculations D-5-13

LIST OF ACRONYMS

ASL	analytical support level
ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act of 1980
CLP	Contract Laboratory Program
cm	centimeter
cm/sec	centimeters per second
cm^2/sec	square centimeters per second
COC	contaminant of concern
CPC	constituent of potential concern
DI	deionized water
DOE	U.S. Department of Energy
EPA	U.S. Environmental Protection Agency
E_h	oxidation/reduction potential
FEMP	Fernald Environmental Management Project
ft	foot
FS	feasibility study
GMA	Great Miami Aquifer
ILCR	incremental lifetime cancer risk
in.	inch
IT	International Technology Corporation
ITAS	International Technology Corporation Analytical Services
K_d	partition coefficients
Kg	kilogram
L	liter
m	meter
m^2	square meter
MCL	maximum contaminant level
mg	milligram
mL	milliliter
NWS	National Weather Service
ODAST	One-Dimensional Analytical Solute Transport

LIST OF ACRONYMS
(Continued)

PE	precipitation index
PRG	preliminary remediation goal
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
SCS	Soil Conservation Service
SWIFTLOAD	Sandia Waste Isolation Fate and Transport Loading
TCLP	toxicity characteristic leaching procedure
TFV	threshold friction velocity
TSP	total suspended particulate
μg/g	micrograms per gram
UCL	upper confidence level
USGS	U.S. Geological Survey
USLE	Universal Soil Loss Equation
WAC	waste acceptance criteria

APPENDIX D.1

GROUNDWATER FATE AND TRANSPORT FOR CONTAMINANTS OF CONCERN

D.1.0 GROUNDWATER FATE AND TRANSPORT FOR CONTAMINANTS OF CONCERN

This section summarizes the results of fate and transport modeling that was used to simulate constituent movement from the Operable Unit 2 subunits to potential human receptors from residual soils, in situ containment of waste with cap, and waste deposited in an engineered disposal cell. The fate and transport models provide the only means of predicting potential groundwater concentrations at receptor locations in the future under assumed conditions. Results of the fate and transport modeling are needed to evaluate various alternatives and are used in the risk assessment to evaluate residual risk from Operable Unit 2 waste. Conservative assumptions were used to simulate "worst-case" contaminant migration scenarios. Impacts of deposition of airborne contaminated dust and leaching of sediments were not considered here. Impacts of those mechanisms will be considered under Operable Unit 5 modeling efforts. The models used were as follows:

- The Universal Soil Loss Equation (USLE) model was used to estimate erosion potential in 1,000 years.
- The Hydrological Evaluation of Landfill Performance (HELP) model was used to estimate exfiltration and infiltration rates.
- The One-Dimensional Analytical Solute Transport/Sandia Waste Isolation Fate and Transport Loading (ODAST/SWIFTLOAD) model was used to predict contaminant movement through the vadose zone and prepare input files for the SWIFT III model.
- The SWIFT III model was used to predict contaminant movement through the Great Miami Aquifer

Only a brief description of the methodology used to quantitatively predict concentrations of contaminants is presented here. For a more complete description of the methods and parameters used for the Operable Unit 2 modeling, refer to Appendix A of the Remedial Investigation (RI) Report for Operable Unit 2 (DOE 1994).

D.1.1 SOIL EROSION POTENTIAL

Depths of erosion were calculated to determine the minimum topsoil and vegetative support zone thickness. The USLE model was used to estimate the yearly amount of sediments released from the South Field and Inactive Flyash Pile area annually. Depth of soil erosion was then calculated by dividing the sediment loss by area and the bulk density. Details of the calculations are included in Attachment D.1-II. Table D.1-1 presents the summary of soil erosion depths in 1,000 years for a

TABLE D.1-1

SUMMARY OF SOIL EROSION CALCULATIONS[a]

Area	R (100m-tonne-cm/ Ha-hr)	K (tonnes/Ha/R)	LS	C	P	ρ (gm/cm^3)	Erosion Depth (cm/yr)	Erosion Depth (cm/1,000 yr)	Erosion Depth (in/1,000 yr)
A	303.6	0.55	2.2	0.003	1	1.3	8.48E-03	8.48	3.34
B	303.6	0.55	6	0.003	1	1.3	2.31E-02	23.12	9.10
C	303.6	0.55	3	0.003	1	1.3	1.16E-02	11.56	4.55

[a]See Attachment D.1.II for definitions of parameters.

number of cross-sections shown in Figure D.1-1. For the future slope scenario, soil erosion depths range from 8.4 to 23.1 centimeters (cm) [3.3 to 9.1 inches (in.)] in 1,000 years. Therefore, less than 30.5 cm (12 in.) of topsoil/vegetative cover will erode in 1,000 years, and surface runoff will not carry contaminants.

D.1.2 CONCEPTUAL GROUNDWATER FLOW MODEL

The geology of the FEMP site is dominated by glacial sediments. Well-sorted sand and gravel glacial outwash forms the regional Great Miami Aquifer. Beneath the site, this aquifer is divided by a 0.3 to 6.6 meter (m) [1 to 20 foot (ft)] thick clay interbed at an approximate depth of 37 m (120 ft) (Figure D.1-2). The receptor pathway considered for this modeling is the upper part of the Great Miami Aquifer above the clay interbed. The term glacial overburden has been selected to describe the deposits located stratigraphically above the glaciofluvial material of the Great Miami Aquifer. A sequence of fine-grained till deposits interbedded with sand and gravel glaciofluvial stringers forms the glacial overburden at the site.

The migration of contaminants from sources to the groundwater begins with the infiltration of rainwater (Figure D.1-3). As the water percolates through the waste, contaminants in the waste are dissolved into the water to form a leachate. Fluid and/or leachate entering from the waste areas migrates first through the glacial overburden (if present), then through the unsaturated outwash deposits, and finally into the Great Miami Aquifer. Downward movement of water, driven by the forces resulting from gravitational potential, capillary pressure, and other components of total fluid potential, mobilize the constituents and carry them through the vadose zone.

Based on characteristics of the geology underlying the Operable Unit 2 subunits and the on-site disposal cell, a conceptual model was developed for the pathways between the subunits and potential receptor locations. Five pathways for contaminant migration from the Operable Unit 2 subunits to the Great Miami Aquifer were identified in the RI Report:

- Vadose Zone Pathway: Migration of constituents of potential concern (CPCs) from the waste unit laterally and vertically through the vadose zone to the aquifer was designated as the vadose zone pathway.
- Perched Water Infiltration Pathway: Vertical migration of perched water through the glacial till to the Great Miami Aquifer was designated as the perched water infiltration pathway.

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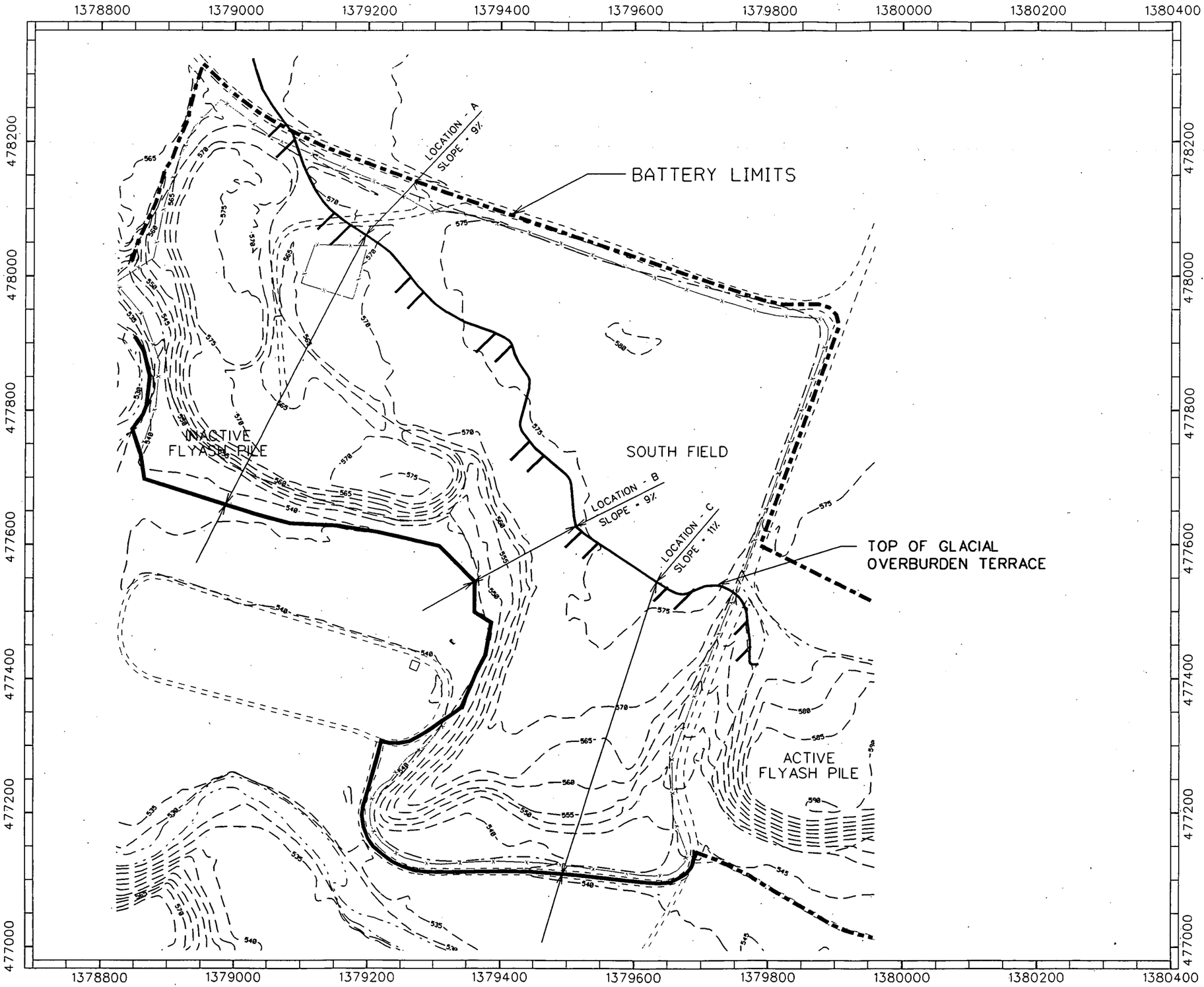

LEGEND

- 575 — ELEVATION CONTOURS
- ROADS
- STREAM
- FENCE
- TOP OF GLACIAL OVERBURDEN TERRACE

NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.

N

SCALE (FT)
0 150 300

SCALE (METER)
0 36 72

FIGURE D.1-1
SOUTH FIELD LOCATIONS AND SLOPES FOR SOIL EROSION CALCULATIONS

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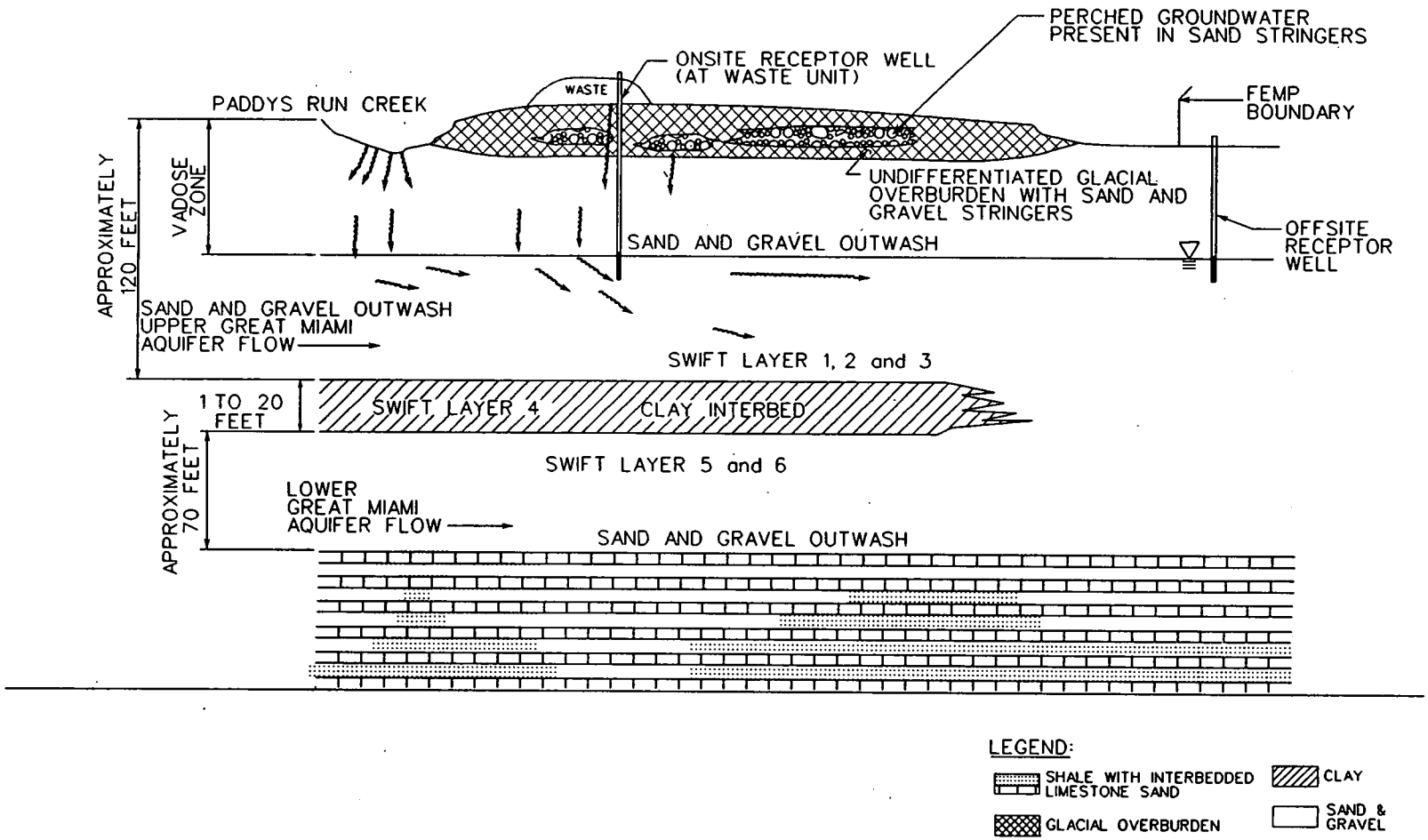

FIGURE D.1-2
CONCEPTUAL MODEL OF LOADING TO THE GREAT MIAMI AQUIFER AND CONTAMINANT TRANSPORT BY GROUNDWATER

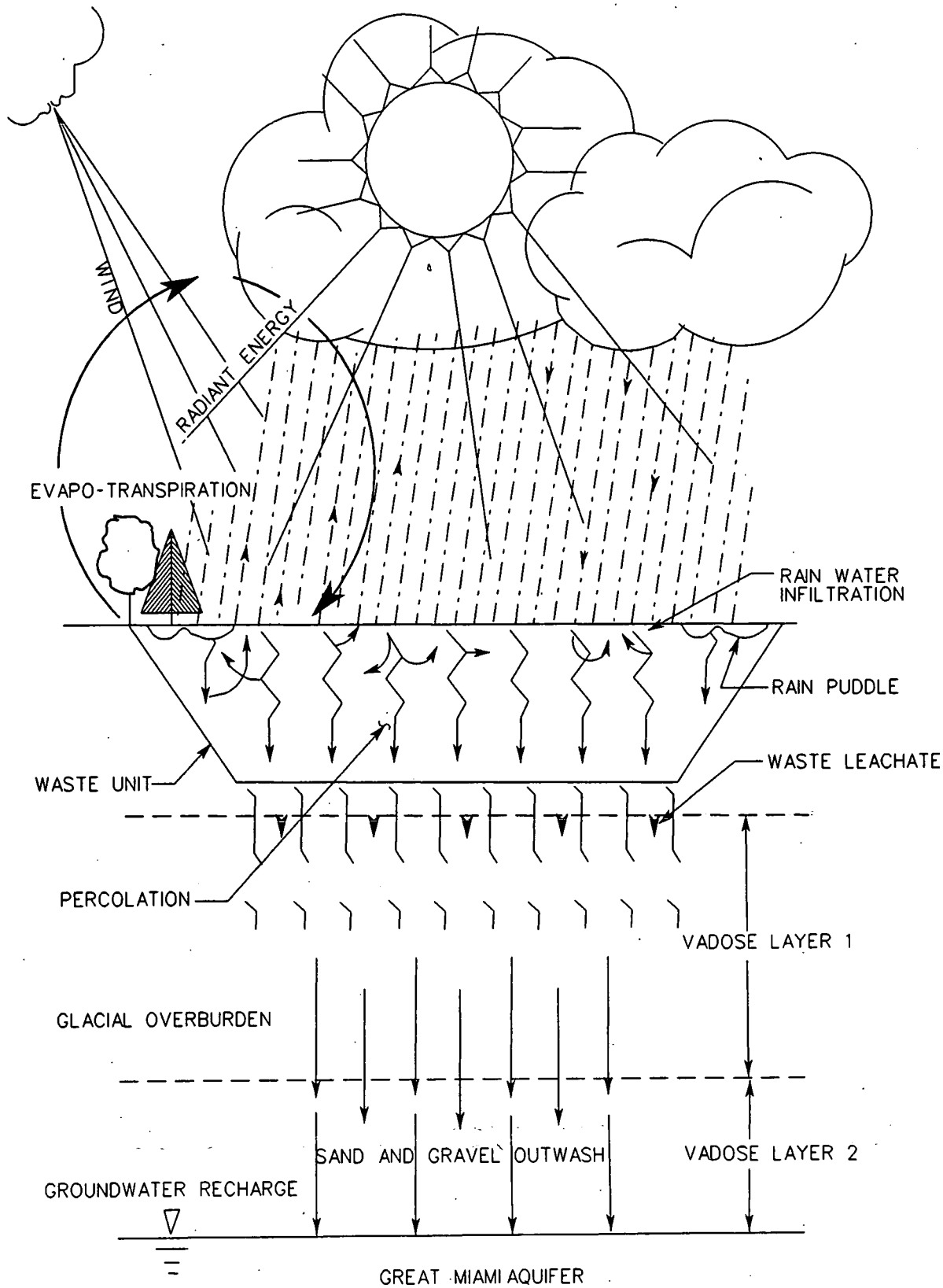

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FIGURE D.1-3
CONCEPTUAL VADOSE ZONE MODEL

- Perched Water Subsurface Seep Pathway: Lateral migration of CPCs occurs when perched water in sand and gravel layers within the glacial overburden comes in contact with waste material. Perched water moves laterally in the sand layer until it is intercepted at the sand/gravel and waste interface. At that point, perched water moves along the slope of the waste and till interface until it comes in contact with the unsaturated Great Miami Aquifer. This water containing CPCs then infiltrates vertically to the aquifer.

- Seep Pathway: Migration of CPCs from seeps to an area where glacial overburden is not present, and then through the unsaturated portion of the Great Miami Aquifer to the groundwater was designated as the seep pathway.

- Surface Water Pathway: Migration of CPCs from the surface soils due to storm-event runoff to Paddys Run or the Storm Sewer Outfall Ditch, and then vertically to the aquifer as the surface water pathway.

This appendix considers all of the steps of the vadose zone, perched water infiltration pathways, and perched water subsurface seep. The seep pathway was not included because seeps are present at only two limited sites, and under every scenario these seeps would be excavated. The RI modeling indicated that the impact of the surface water (runoff) pathway on the Great Miami Aquifer is very small for contaminants of concern (COCs). Furthermore, all remediation areas would be covered with backfill and vegetated to eliminate surface water pathways to the Great Miami Aquifer. Therefore, the surface water pathway was not included in the fate and transport modeling for groundwater.

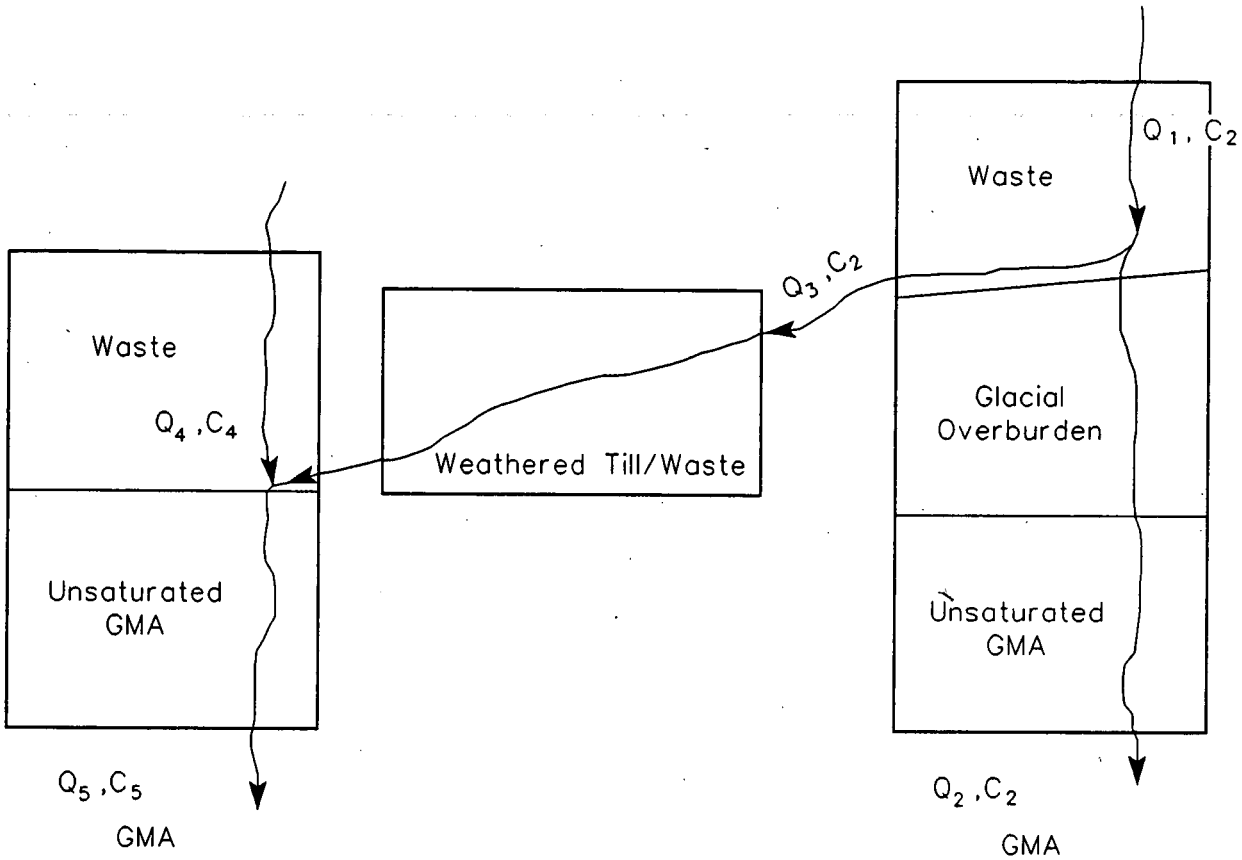
Vadose Zone Pathway: The vadose zone, applicable to all subunits and modeled disposal areas, was modeled as two layers (Figure D.1-3), the glacial overburden underlying the subunits (Layer 1) and the unsaturated portion of the underlying Great Miami Aquifer (Layer 2). Layer 1 soils consist of tills in the glacial overburden. The travel time through the sand and gravel unit within the glacial overburden was not included in the vadose zone modeling, because this layer has much higher permeability and less adsorption potential than the clays and silts in the glacial overburden. Similarly, weathered till was not included in the vadose zone modeling since vertical permeability of this zone can be significantly higher than the unweathered till. The thickness of till (till below the perched water) for the vadose zone model ranges between 0 and 6.7 m (0 and 22 ft) for Operable Unit 2 subunits. Beneath the till is the unsaturated sand and gravel outwash layer (Layer 2), which is present beneath all the subunits. The thickness of Layer 2 ranges from 4.8 to 10.1 m (16 to 33 ft).

The lithology under the Inactive Flyash Pile and South Field is variable. The southwestern portion contains virtually no tills, while the till thickness increases to 6.7 m (22 ft) toward the northeastern portion of the South Field. When leachate from waste arrives at the interface of waste and till, a portion of the leachate infiltrates through the glacial overburden (till and sand/gravel stringers) and the remainder drains laterally to areas where till does not exist. Figure D.1-4 shows the conceptual model for lateral drainage. The area receiving lateral drainage, has increased flow. One vadose zone modeling run was used to simulate vertical infiltration. A separate vadose zone modeling run was used to simulate contaminant contribution from lateral drainage, and contaminant mass loading was added to the Great Miami Aquifer. Lateral drainage and infiltration through waste were summed to calculate total vertical percolation rate and interstitial fluid velocity for the areas receiving lateral drainage from upgradient waste areas.

Perched Water Infiltration Pathway: Another pathway that would apply after remediation is the perched water infiltration pathway. The conceptual model for the perched water infiltration pathway is similar to that of the vadose zone pathway. This pathway was modeled with two layers. Layer 1 soils consist of tills below the perched water zone, and Layer 2 soils consist of the unsaturated portion of the Great Miami Aquifer. Contaminant mass in the perched water and adsorbed to the sand layer, were considered in the source term for the perched water infiltration. The perched water was simulated as an additional source of contaminant loading based on the contaminant concentrations detected in the 1,000-series wells located within the Operable Unit 2 subunits.

Perched Water Subsurface Seep Pathway: Perched water not only represents a source for vertical infiltration, but it also serves as a source for perched water subsurface seeps. Figure D.1-5 shows the conceptual model for the perched water subsurface seeps. Sand and gravel within the glacial overburden (containing perched water) comes in contact with the waste in sections of the Inactive Flyash Pile and South Field. Perched water moves laterally in the sand and gravel layer until it is intercepted at the sand/gravel and waste interface. At that point, perched water moves along the slope of waste and till interface until it comes in contact with the unsaturated Great Miami Aquifer. The subsurface seep water then infiltrates vertically to the aquifer.

Based on characteristics of the material underlying each Operable Unit 2 subunit and the disposal cell, a detailed conceptual model was developed for the pathways between each subunit and the receptor locations. These more detailed models were developed to account for the variable stratigraphies of



$$Q_1 = Q_2 + Q_3$$

$$Q_5 = Q_3 + Q_4$$

$$C_5 = \frac{Q_3 C_2 + Q_4 C_4}{Q_3 + Q_4}$$

NOTE:
C_i - CONSTITUENT CONCENTRATION
Q_i - FLOW RATE

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FIGURE D.1-4
CONCEPTUAL MODEL FOR LATERAL DRAINAGE INFILTRATING TO THE UNSATURATED GREAT MIAMI AQUIFER

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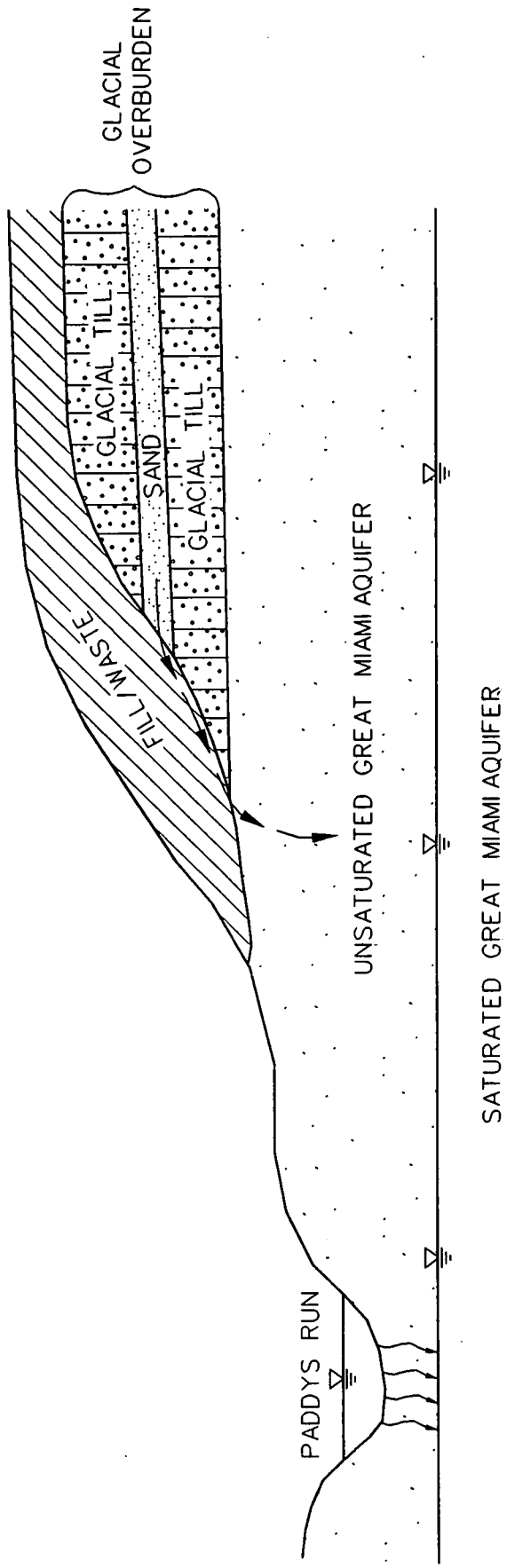

FIGURE D.1-5
CONCEPTUAL MODEL FOR PERCHED WATER SUBSURFACE SEEPS

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the soils of the subunits of Operable Unit 2. Areas overlying each SWIFT III grid block in all subunits were modeled separately with individual stratigraphy, contaminant concentration, and infiltration rate parameters, and each COC was simulated using retardation and decay factors taken from literature studies or site-specific data.

Contributions to COC concentrations from other FEMP sources and from soils at background concentrations were not included in the modeling and results presented in this appendix. The results presented here represent the incremental change in COC concentrations in the Great Miami Aquifer due to loading from Operable Unit 2 areas only.

D.1.3 TECHNICAL APPROACH

This section describes the technical approach used for defining parameters required for groundwater modeling. Section D.1.4 provides a brief description of the models used in groundwater fate and transport modeling. Table 2-1 in Section 2 provides the list of COCs identified in the Final RI report for Operable Unit 2. Table 2-1 lists that only uranium isotopes were identified as COCs for the groundwater pathway. Of these isotopes, only uranium-238 was modeled in order to more efficiently utilize computation time. Uranium-238 was selected for modeling because more samples were analyzed for uranium-238 than any other uranium isotope, and uranium-238 constitutes more than 99 percent of total uranium mass. All uranium isotopes are assumed to have the same flow and transport properties (for example, adsorption) as uranium-238. Furthermore, the radioactive half-lives of uranium-234, uranium-235, uranium-236, and uranium-238 exceed 200,000 years. Therefore, modeling results for uranium-238 can be used to predict concentrations of uranium-234, uranium-235/236, and total uranium. Preliminary remediation goals (PRGs) for other uranium isotopes were estimated by applying scaling factors proportional to their groundwater incremental lifetime cancer risk (ILCR) concentration. For example, 10^{-6} ILCR groundwater concentrations for uranium-238 and uranium-234 are 0.72 pCi/L and 1.10 pCi/L, respectively. Therefore, if the modified soil PRG for uranium-238 was 5 pCi/g, then the modified soil PRG for uranium-234 was 7.64 [=(5)(1.1)/(.72)] pCi/g.

The modified soil PRGs were first estimated using the ECTran model. Results of the ECTran modeling were used as the initial estimates of the modified soil PRGs to be used in the ODAST/SWIFT models. These concentrations were adjusted so that groundwater concentrations at the receptor points do not exceed risk-based concentrations. If the predicted groundwater

concentration at the receptor point was close to the desired concentration level, the modified soil PRGs were calculated by applying a scaling factor to the maximum soil concentration used in the model. The scaling factor was calculated as a ratio of risk-based groundwater concentration to the model-predicted groundwater concentration.

For long-term risk estimation, concentrations of uranium-234 and uranium-235/236 were estimated by using site-specific activity ratios for uranium. The following relationships were derived between various uranium forms in the Final RI Report for Operable Unit 2:

Uranium-234 = 0.91 (Uranium-238)	activity ratio
Uranium-235/236 = 0.048 (Uranium-238)	activity ratio
Uranium-238 = 0.9925 (Uranium-total)	mass ratio

Note that these ratios are very close to the uranium isotope ratios for naturally occurring uranium. Although these relationships were developed from soil samples, the relationships should apply to uranium concentrations in the groundwater, because all uranium isotopes have very long half-lives (greater than 10,000 years). The simulation time period of 1,000 years was selected based on the Risk Assessment Work Plan Addendum (DOE 1992).

D.1.3.1 Source Term Development

The source included waste as well as the impacted till. The impacted till was defined as the till immediately below the fill and waste to a depth of 0.8 m (2.5 ft) for the Solid Waste Landfill, 1.2 m (4 ft) for the South Field, 0.6 m (2 ft) for the Inactive Flyash Pile, and 0.8 m (2.5 ft) for the Active Flyash Pile. Depths of impacted till were selected from the analytical results for uranium for the soil samples. See Section 1.7.1 of the FS for more detail on defining impacted till thickness.

The uranium-238 concentration in each block was estimated using kriging, as described in Appendix A.2 of the Operable Unit 2 RI Report. This approach was selected for uranium, because uranium controls the risk from groundwater pathways and to simulate known hot spots identified during field investigations. All validated uranium-238 results from Remedial Investigation/Feasibility Study (RI/FS) Phase I and Phase II field investigations for each subunit were segregated by waste/fill, impacted till, remaining glacial overburden, and the unsaturated Great Miami Aquifer soils.

Uranium-238 concentrations in each 7.6 x 7.6 x 0.76 m (25 x 25 x 2.5 ft) block were estimated using three-dimensional kriging for each media type. Average waste concentrations in each 38 x 38 m (125 x 125 ft) SWIFT III grid cell were then calculated from all 7.6 x 7.6 x 0.76 m (25 x 25 x 2.5 ft) thick blocks within each SWIFT III grid cell.

Source terms for residual soils were determined by evaluating the kriged uranium-238 concentration on a block-by-block basis against the remediation criteria selected for the alternative. All blocks above a block containing a uranium-238 concentration exceeding the remediation level were removed from the source term. Within a grid cell, when uranium-238 concentration in any block exceeded the remediation level, then all remaining blocks in that grid cell were conservatively assigned a uranium-238 concentration equal to the remediation level. However, if all the blocks in a grid cell were below the remediation level, the kriged average concentration in that grid cell was used as the source term for modeling purposes.

Because excavated soils can be placed anywhere under the cap, the source term for fate and transport modeling for consolidation and placement under a cap was based on maximum detected uranium-238 concentration in each media type. If existing soils in a grid cell contained uranium-238 (at the South Field, for example), the uranium-238 mass from existing soils was added to the total mass for that grid cell. However, leachate concentrations were estimated from the layer containing the highest level of uranium-238. This approach was selected to simulate a "worst-case" scenario, since the sequence of contaminated soil removal and placement was not determined in detail during this Feasibility Study.

The source terms for perched water infiltration pathways were estimated using the following equation:

$$\text{Mass} = (\phi\, C_w + \rho_b K_d C_w)\, Ab \qquad \text{(D.1-1)}$$

where

- A = area of cell [1,452 square meters (m^2) (125 ft x 125 ft)]
- b = average perched water zone thickness
- C_w = upper 95 percent confidence level on the mean (UCL) of the perched water concentration
- K_d = distribution coefficient
- ϕ = porosity
- ρ_b = bulk (dry) density

D.1.3.2 Methods of Estimating Leachate Concentrations

An exponentially declining source leachate concentration term was used:

$$C = C_o \, Exp(-\alpha t) \tag{D.1- 2}$$

where

$$\alpha = \frac{qAC_o}{M} \tag{D.1-3}$$

A = area of the grid cell [1,452 m^2 (125 ft x 125 ft)]
C_o = initial leachate concentration
M = mass of contaminant in the grid cell
q = infiltration rate

The depletion factor (α) is inversely proportional to the depletion half life. The preferred data for estimating initial contaminant concentrations (C_o) in leachate was analyses of in situ leachate or toxicity characteristic leaching procedure (TCLP) analysis. However, in-situ leachate or TCLP analyses were not available for uranium-238 at all soil concentration levels needed for PRG development. Therefore, initial leachate concentration (C_o) for uranium-238 was estimated from the ratio between waste concentration and distribution coefficient for the waste. Distribution coefficients (K_d) for the uranium-238 were 75 mL/g for the Solid Waste Landfill, 200 mL/g for the Lime Sludge Ponds and berm material, 177 mL/g for the South Field waste, and 37.5 mL/g for flyash. These values represent the lowest desorption K_d's measured on waste/fill samples collected at the Operable Unit 2 subunits (see Appendix D.3).

D.1.3.3 Parameters

Most of the input parameters were taken directly from the Operable Unit 2 RI fate and transport modeling sections. Physical parameters of the media for the Operable Unit 2 subunits are presented in Table D.1-2. These parameters values were taken from the Final RI report for Operable Unit 2.

The vertical hydraulic conductivity values for Layer 1 were obtained from the geometric average horizontal hydraulic conductivities of 1000-series wells completed in dark gray clay or clayey silt or from the maximum permeability measurements conducted on core samples. The vertical hydraulic conductivity for Layer 2 was obtained by dividing the horizontal hydraulic conductivity of the Great Miami Aquifer by 10. The factor of 10 (or a ratio of 0.1) represents a typical horizontal to vertical

TABLE D.1-2
MEDIA PARAMETERS

Parameter	Unit	Solid Waste Landfill	Lime Sludge Pond	Active Flyash Pile/ Inactive Flyash Pile	South Field	Disposal Cell
Bulk Density	gm/cm^3					
Waste/Fill		1.83	0.76	0.86	1.70	-[a]
Glacial Till		1.85	1.85	1.85	1.85	1.85
Unsaturated GMA[b]		1.60	1.60	1.60	1.60	1.60
Hydraulic Conductivity	cm/sec					
Waste/Fill		1.10×10^{-4}	1.00×10^{-3}	1.80×10^{-4}	2.00×10^{-4}	1.80×10^{-4}
Glacial Till		1.90×10^{-6}	1.90×10^{-6}	1.40×10^{-7}	1.40×10^{-7}	1.9×10^{-6}
Unsaturated GMA		1.59×10^{-2}	1.59×10^{-2}	1.59×10^{-2}	1.59×10^{-2}	1.59×10^{-2}
Porosity	%					
Waste/Fill		52	55	44	52	52
Glacial Till		41	41	41	41	41
Unsaturated GMA		39	39	39	39	39
Field Capacity	%					
Waste/Fill		29.4	37.8	28.4	29.4	29.4
Glacial Till		37.1	37.1	37.1	37.1	37.1
Unsaturated GMA		4.5	4.5	4.5	4.5	4.5
Wilting Point	%					
Waste/Fill		14.0	26.5	13.5	14.0	14
Glacial Till		25.1	25.1	25.1	25.1	25.1
Unsaturated GMA		2.0	2.0	2.0	2.0	2.0
Vegetative Cover		fair grass	fair grass	fair grass	fair grass	fair grass
Evaporation Zone Depth	in.	12	12	12	12	12

[a]- = not used
[b]GMA = Great Miami Aquifer

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hydraulic conductivity ratio. Results of the recent South Plume pump test calculated aquifer values for vertical to horizontal hydraulic conductivity ratios from 0.07 to 0.17 (i.e., over a range which includes this value) (Parsons 1993). The vertical hydraulic conductivity was estimated to be 2.4 x 10^{-6} to 1.4 x 10^{-7} centimeter per second (cm/sec) for Layer 1. The vertical hydraulic conductivity of Layer 2 was estimated to be 1.6 x 10^{-2} cm/sec for all Operable Unit 2 subunits and the disposal cell area.

The vertical seepage velocities (v) used in the vadose zone transport model were calculated from the infiltration rates and equations presented in the EPA's Superfund Exposure Assessment Manual (EPA 1988). For the saturated glacial till, seepage velocities were calculated from:

$$v = \frac{q}{P_e} = \frac{q}{\theta_s - \theta_w} \qquad \text{(D.1-4)}$$

where

q = infiltration rate (length/time)
P_e = effective porosity (volume fraction)
Θ_s = saturated moisture content (volume fraction)
Θ_w = wilting point moisture content (volume fraction)

The seepage velocity in the unsaturated Great Miami Aquifer was calculated from:

$$v = \frac{q}{\theta} \qquad \text{(D.1-5)}$$

where

q = infiltration rate (length/time)
Θ = moisture content (volume fraction)

The longitudinal dispersion coefficients (D_x), a function of dispersivity, interstitial seepage, velocity, and molecular diffusion coefficient were estimated by the methods presented by Biggar and Nielsen (1976), and Mills et al. (1982).

$$D = 0.6 + 2.93\, v^{1.11} \qquad \text{(D.1-6)}$$

where

D = dispersion coefficient in square centimeters per second (cm^2/sec)
v = seepage velocity in cm/sec

Flow and solute transport through the porous media are not only determined by the parameters considered in the conceptual model description above, but they are also affected by decay rates and retardation factors (R). The radioactive half life for uranium-234 is 2.45 x 10^5 years, for uranium-235, 7.04 x 10^8 years, and for uranium-238, 4.47 x 10^9 years. The retardation factor was used to account for those reversible reactions that slow the arrival of a contaminant front, but do not act as a sink. The retardation factor can be expressed as the ratio between the rate of groundwater movement and the rate of contaminant movement. These parameters are both chemical- and media-specific. The retardation factors were calculated from Walton (1984) and Mills et al. (1982):

$$R = 1 + \frac{\rho_b K_d}{\theta} \qquad \text{(D.1-7)}$$

where

K_d = distribution coefficient
R = retardation factor
ρ_b = bulk dry density
Θ = soil moisture content

During the improvement of the SWIFT-based Great Miami Aquifer model and subsequent calibration, the distribution coefficient for uranium-238 in the Great Miami Aquifer was determined to be 1.78 mL/g. The uranium-238 distribution coefficient for glacial overburden used in the RI modeling was 200 mL/g. The Operable Unit 5 Geochemical Study presented in Appendix D.4 recommends that 24 mL/g be used as the K_d for uranium-238 in glacial overburden. This value is considered to be applicable at the Operable Unit 2 subunits. Attachment D.1-III describes how lysimeter data from Operable Unit 5 were matched with the ODAST model using a K_d value of 3.1 mL/g for glacial till. Since a disposal cell could receive waste from sources outside Operable Unit 2, it seems possible that the geochemical circumstances that resulted in the lysimeter data could present themselves again. Therefore, preliminary waste acceptance criteria (WAC) for the on-site disposal of Operable Unit 2 material were developed using the conservative assumption that 3.1 mL/g is the glacial till K_d.

Till (Layer 1) thickness at the South Field for the ODAST/SWIFTLOAD model was modified from the RI values to delete impacted till that is now included in the source term. Furthermore, only the thickness of the gray till below the perched water was used as Layer 1 thickness. Thus, it is assumed that travel time to the perched water is negligible due to increased hydraulic conductivity or potential for fractures in the brown till layer above the perched water.

D.1.3.4 Vadose Zone Modeling

Vadose zone modeling was performed by using the leachate concentrations as input to a one-dimensional unsaturated flow model to simulate transport through the vadose zone to the Great Miami Aquifer. The ODAST model was used to simulate dispersion, retardation, and decay through unsaturated materials. The HELP model was used to estimate infiltration rates. For estimating infiltration rates, it was assumed that the geomembrane water barrier will deteriorate and that the leachate collection system in the liner will be ineffective. Waste above each SWIFT III grid cell was modeled separately with individual stratigraphy, contaminant type and concentration, and infiltration rate parameters.

D.1.3.5 Great Miami Aquifer Modeling

The improved and calibrated SWIFT-based groundwater flow model for the FEMP site was used to simulate the solute transport of COCs in the Great Miami Aquifer. The Operable Unit 2 fate and transport modeling involved incorporating the vadose zone modeling results (for the vadose zone and perched water infiltration pathways) to determine loading rates to the Great Miami Aquifer from the subunits or disposal areas. The model then simulated the transport of constituents away from these source areas. Dispersion, retardation, and decay were factored into the contaminant transport process. SWIFT III simulations of COC transport in the Great Miami Aquifer were run for up to 1,000 years.

The loading from each grid cell impacted by the subunit was entered into the SWIFT III model as a discrete source, making multiple sources for each constituent. Due to the proximity of the Inactive Flyash Pile to the South Field, sources from the Inactive Flyash Pile and South Field were combined into one SWIFT III run. The modeling runs produced simulations of the aggregate effects of loading from these two subunits for the COCs.

D.1.4 MODEL DESCRIPTIONS

A description of each of the models used in the groundwater fate and transport modeling is contained in the following sections.

D.1.4.1 HELP Model

Infiltration (seepage) rates through the waste to the Great Miami Aquifer for various conceptual models were calculated using the HELP model. The HELP model is a quasi-two-dimensional

hydrologic model of water movement across, into, through, and out of a waste unit. The model accepts climatologic, soil, and design data and simulates a number of hydraulic processes, including surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. The systems that can be simulated by the HELP model include various combinations of vegetation, cover soils, waste cells, drainage layers, and relatively impermeable barrier soils.

The HELP model is designed to perform water budget calculations for a system having as many as 12 layers. Each layer must be identified as either a vertical percolation, lateral drainage, barrier soil layer, or barrier soil layer with a geomembrane. Two barrier layers, other than geomembrane over the soil barrier layer, next to each other cannot be simulated in the HELP model. The identification of each layer used in the model is critical because the program models water flow through various types of layers in different ways. Runoff is calculated using the Soil Conservation Service (SCS) runoff curve number method by considering daily precipitation. Percolation and vertical water routing are modeled using Darcy's Law for saturated flow, with modifications for unsaturated conditions. Evapotranspiration is estimated by a modified Penman method adjusted for limiting soil moisture conditions.

The HELP model output consists of input data echo, optional simulation details, and a summary of results. The input data echo includes all the information used for input, including the values chosen from the model's built-in data base and manually input data. Following the input data echo, the program produces a table of daily results, monthly totals, and annual totals for each year if the option for detailed output was used. The summary includes average monthly totals, average annual totals, peak daily values on any day during the simulation period, and final moisture contents in all layers modeled. The average totals include precipitation, runoff, evapotranspiration, percolation, and lateral drainage for appropriate layers.

D.1.4.2 <u>ODAST/SWIFTLOAD Model</u>

The ODAST/SWIFTLOAD model was used in the Operable Unit 2 analysis to define vertical contaminant transport from contaminated soil or perched water to the Great Miami Aquifer. ODAST, which is a subroutine of SWIFTLOAD, evaluates the basic one-dimensional analytical solute transport equation as a function of seepage velocity, dispersion coefficient, source decay, retardation factor, depletion time, and source rate. SWIFTLOAD has been developed as a data processing program to create an appropriate input file for the SWIFT model. It runs ODAST as a subroutine on a cell-by-

cell basis using the same 120-by-112 grid as the SWIFT Great Miami Aquifer model. SWIFTLOAD reads an external file defining the layer thickness for each model cell and hydraulic and transport properties for each block.

The ODAST computer code is based on the solution originally developed by Ogata and Banks (1961) and calculates the normalized concentrations of a given constituent in a uniform flow field from a source having a constant or varying concentration in the initial layer (Javendel et al. 1984). ODAST has been extensively verified against STRIP1B (Batu 1989).

The ODAST model implements an analytical solution to the partial differential equation

$$D\frac{\partial^2 C}{\partial x^2} - V\frac{\partial C}{\partial x} - \lambda RC = R\frac{\partial C}{\partial t} \qquad \text{(D.1-8)}$$

where

C	=	solute concentration (mass/volume)
		and with the constant coefficients
D	=	dispersion coefficient (length^2/time)
V	=	seepage velocity (length/time)
R	=	retardation factor (dimensionless)
x	=	vertical distance (length)
t	=	time (time)
λ	=	solute decay factor (time^{-1})

The solution must satisfy the initial and boundary conditions

$$C(x,0) = 0 \qquad \text{(D.1-9)}$$

$$-D\frac{\partial C}{\partial x} + VC\,|_{x=0} = \begin{cases} VC_0\, e^{-\alpha t}, & 0 \le t \le \tau_0 \\ 0, & t > \tau_0 \end{cases} \qquad \text{(D.1-10)}$$

$$\frac{\partial C}{\partial x}\Big|_{x\to\infty} = 0 \qquad \text{(D.1-11)}$$

where the constants

C_o	=	initial source concentration (mass/vol)
α	=	source depletion factor (time^{-1})
τ_o	=	source depletion time (time)

The solution is obtained using a Laplace transform technique and involves products of exponential and complementary error functions (Javandel et al. 1984). The solution for C is divided by C_0 to yield normalized concentrations.

Because the coefficients in the governing equation are constant, and the solution must satisfy a zero concentration gradient condition as x approaches infinity, ODAST is only strictly applicable to one-dimensional transport in homogeneous, semi-infinite media. However, the present application of ODAST is intended only to provide conservative estimates of aquifer mass loading.

ODAST model runs can be executed for only one constituent at a time, and the solution may be applied over any arbitrary segment of a waste area that is judged to contain a subsurface which does not change over time. A superposition technique is used to combine calculations for the two homogeneous layers comprising the vadose zone conceptual model. The ODAST solution at the bottom of Layer 1 is divided into 1,000 small time steps and a Layer 2 run is performed for each of these steps. Each of these Layer 2 runs assumes no source decay, a recharge period 1/1,000 of the total modeling time, and a source concentration equal to the averaged Layer 1 solution for that time period. The solution at the bottom of Layer 2 is obtained by summing the results of the 1,000 Layer 2 runs at specified time steps. For RI/FS modeling, concentrations are calculated for up to 1,000 years, typically in steps of 20 years. Constituents that migrate quickly, such as technetium-99, require smaller time steps for accurate representation of loading curves.

Input parameters for ODAST are the dispersion coefficient, seepage velocity, retardation factor, source depletion time, solute decay factor, and source depletion factor. These are discussed below.

- Seepage velocity and the dispersion coefficient depend on the characteristics of the waste area and the vadose zone medium. Seepage velocity is calculated as an empirical function of the percolation rate obtained from the HELP model, saturated hydraulic conductivity, and effective porosity (EPA 1988). The dispersion coefficient is obtained as an empirical function of seepage velocity (Biggar and Nielsen 1976).

- The retardation factor accounts for transport delays due to reversible reactions between the chemical constituent and the vadose zone solid matrix. It is thus dependent on both solute and medium characteristics, and is calculated as a function of the constituent's partitioning coefficient and the vadose zone bulk density and moisture content (Walton 1984; Mills et al. 1985).

- The solute decay factor is constituent dependent. This parameter accounts for biodegradation in organics and radioactive decay in radionuclides, and is zero for stable inorganics.

- Source depletion time and factor control the mass flux history of the constituent at the top of the modeled layer. Based on the upstream boundary condition, source mass flux decays exponentially. To calculate depletion time and factor for the waste at the top of Layer 1, the time-dependent expression for mass flow from the source is integrated from zero to the source depletion time. This integral is equated to the depleted mass of the constituent to provide a single equation in two unknowns. A second equation is obtained by arbitrarily specifying a mass depletion fraction. This is the level (very close to, but less than one) at which the source is declared depleted; technically, the source is depleted only as time approaches infinity. As stated previously, depletion factor is zero and depletion time is 1/1000 of the total modeling time for the Layer 2 runs.

D.1.4.3 SWIFT Model

The SWIFT model is used for simulating three dimensional contaminant transport in the Great Miami Aquifer. The SWIFT code is a fully coupled, transient, three-dimensional finite-difference model for groundwater flow and transport through both porous and fractured media. The mass transport equations solved include terms for convection, dispersion, retardation by sorption, and decay or degradation of the contaminant. The SWIFT code, originally developed by Sandia National Laboratory in the late 1970s for the High Level Waste Program (GeoTrans 1987), has been revised several times to increase its capability and to change computer platforms. These revisions include the addition of fractured media, a free water surface, extended boundary conditions, conversion to Fortran 77, and extended options for matrix solutions and post processing. GeoTrans has converted SWIFT for use on 386 and 486 personal computers and made additional changes to improve user friendliness and input and output control, the most recent version being SWIFT 2.52 (GeoTrans 1992).

SWIFT was selected from among several codes for use in developing a flow and transport model of the Great Miami Aquifer in the vicinity of the FEMP. Subsequent to selection of the code, the SWIFT code was specifically verified for use at the FEMP (IT 1990). A model of the Great Miami Aquifer (using SWIFT) was originally developed and calibrated from 1988 through 1990 (DOE 1993a). This model-building effort consisted of

- Developing and calibrating two- and three-dimensional regional flow models

- Developing and calibrating a telescoped and more refined grid of a three-dimensional flow model of the FEMP and its adjacent areas

- Developing and calibrating two- and three-dimensional solute transport models on the more refined grid.

The original model consisted of five layers. The two uppermost layers represented the upper and lower parts of the upper Great Miami Aquifer, the middle layer included a clay interbed that is present beneath the FEMP site and the lower two layers represented the lower Great Miami Aquifer. The layers extended laterally into bedrock at the edges of the buried valley that contains the aquifer. This original FEMP steady-state flow model was calibrated to 1986 water elevation data.

Since that time, additional data have been collected, new wells have been installed, and a large-scale pumping test (South Plume Pumping Test) has been conducted. Based on these factors and agency comments, a model improvement program was initiated (DOE 1993b). The essential elements of this model improvement program were completed in March 1994 (DOE 1994c). The Operable Unit 2 Feasibility Study modeling makes use of this "improved" model. Model improvements consisted of the following:

- The model grid for steady-state flow and solute transport was expanded. The previous solute transport grid of 78 cells by 102 cells was enlarged by adding a band approximately 5,250 feet wide along the eastern side and a band approximately 1,250 feet wide along the northern side. The new grid contains 120 cells by 112 cells, each 125 feet square. The layering of the model also has been refined. The five layers of the original model have been replaced with six layers to better match existing well screen elevations. This allowed field data to be more accurately depicted and provided better vertical control over contaminant dispersion.

- Geostatistical analysis has been conducted to understand and correlate the spatial distribution of key data sets. These data sets include the water elevation data and the uranium analytical data from the 2000-, 3000- and 4000-series monitoring wells. Calculations included the sample semivariogram, and kriging and cokriging estimators, along with their estimation variance. This analysis was used to help determine calibration criteria and to identify areas of the site where there is lower confidence in the analyzed data sets.

- A transient flow calibration was performed using the South Plume Pumping Test results. Parameter values for porosity and rock compressibility were developed from this calibration. Because of the scale and orientation of the pumping test wells, a telescoped grid (25 foot cell size) was created in the south plume area to effectively simulate the results of the pumping test.

- A steady-state flow calibration was conducted using the expanded and reconstructed steady-state grid. Steady-state heads were matched to the established calibration criteria. This recalibrated steady-state model is the primary model used for flow and solute transport simulations.

- The solute transport model was recalibrated to determine reasonable values of K_d (for uranium) and dispersivity for a representative source loading. The range of acceptable uranium K_d values has been established by reviewing site data related to K_d and by reviewing sensitivity runs of previously utilized K_d values corresponding to retardation factors of 9 and 12.

- The historical source loading terms were decoupled from the model and monitoring data were used to define initial conditions of uranium concentrations. Results from the glacial overburden and Paddys Run models were used to define future loading terms.

- Sensitivity analysis was performed on horizontal hydraulic conductivity (K_h), ratio between horizontal hydraulic conductivity and vertical hydraulic conductivity (K_h/K_v), porosity, uranium distribution coefficient, and dispersivity (α) in order to understand the effect of variation of these parameters on the maximum concentration and transport of a normalized plume.

- Quality assurance/quality control procedures for modeling were defined to control and confirm the quality of the modeling effort.

New data sets have been used in the construction and calibration of the model. In summary, new data sets include:

- Monitoring data from the 1990 to 1993 time period
- Monitoring data from new wells installed since the original calibration
- Results of additional aquifer analysis to define K_d
- Geostatistical analysis of data sets
- Results from the South Plume Pumping Test
- Results from construction and operation of the South Plume Recovery Well System
- Output from additional models (glacial overburden, surface water) to define hydraulic and solute loading terms

Model simulations of the improved site SWIFT model were performed using a Silicon Graphics Computer (Unix based). Simulation execution times for 1,000-year solute transport runs varied between 30 and 40 hours. These 1,000-year simulations generate extremely large output files and require peripheral hardware. Output was written to files from which relevant data was extracted using data manipulation programs written for that purpose. Contour plots were made using SURFER for selected constituents at different simulation times. Report graphics were imported into Intergraph workstations for preparation of final graphics.

D.1.5 Cross-Media PRG Development to be Protective of the Great Miami Aquifer

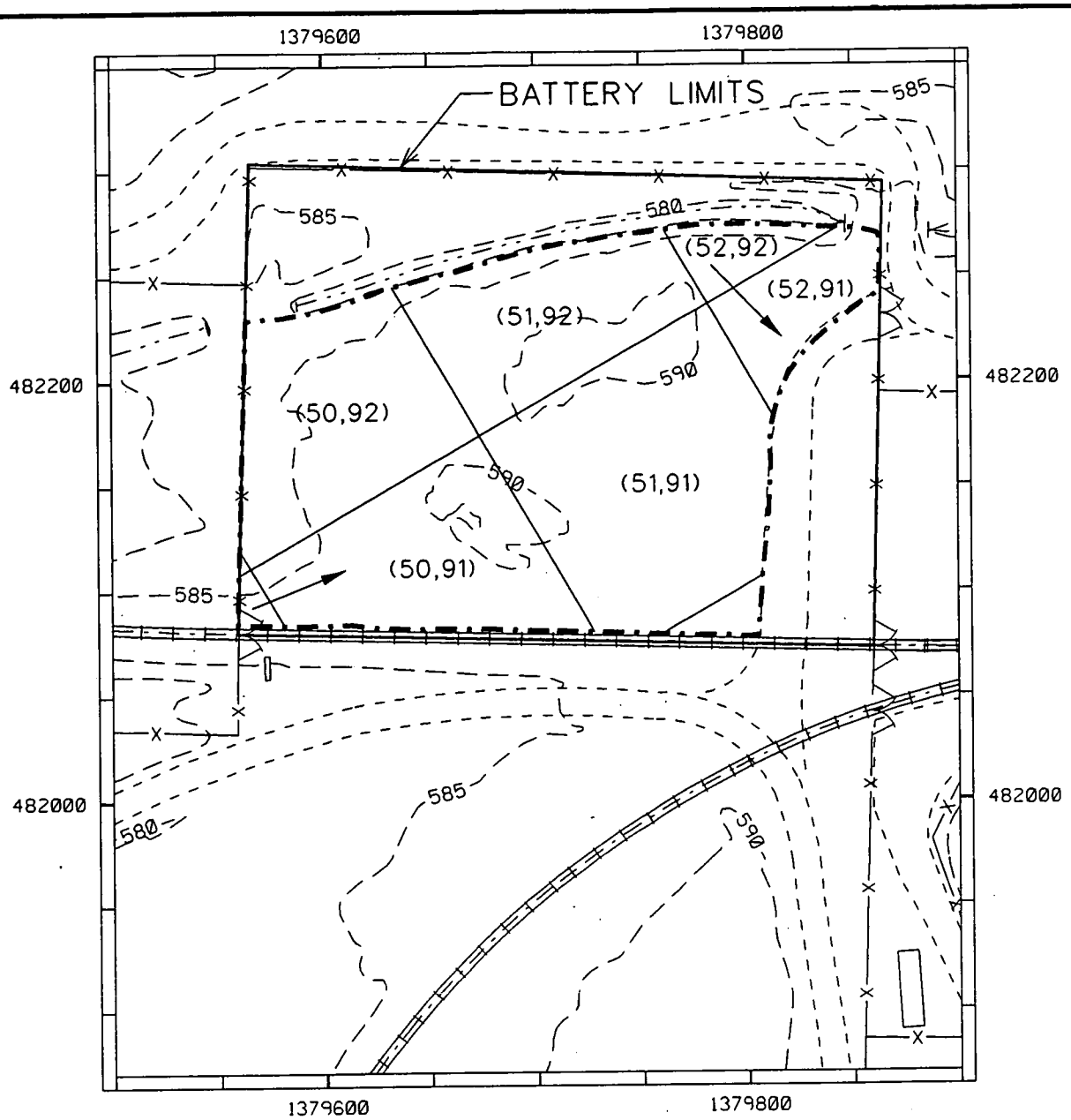
D.1.5.1 Solid Waste Landfill

Without Source Controls

Figure D.1-6 shows the SWIFT III grid blocks directly beneath the waste at the Solid Waste Landfill. Table D.1-3 presents the physical parameters for the SWIFT grid cells impacted by the Solid Waste Landfill. The HELP model was used to estimate the infiltration rate (see Attachment D.1-I) as 24 centimeters per year (cm/yr) [9.61 inches per year (in./yr)]. Calculated seepage rates were 153 and 320 cm/yr (60.4 and 126 in./yr) in the glacial till and unsaturated Great Miami Aquifer, respectively. The vadose zone and the perched water infiltration pathways were applicable for this alternative. Based on the Operable Unit 2 RI data, initial perched water concentration was set to 15.2 pCi/L.

Figure D.1-7 shows the loading curve for the Solid Waste Landfill without source controls. Based on the parameters shown in Table D.1-3, the fenceline maximum uranium-238 concentration predicted by the SWIFT model was 0.80 pCi/L. This run assumed that maximum uranium-238 concentration in the source will be 45 pCi/g. Therefore, for uranium-238 concentrations at the FEMP fenceline not to exceed 0.72 pCi/L (10^{-6} ILCR level), the source concentration should not exceed 40.5 pCi/g. In other words, the modified soil PRG for the off-property resident farmer is 40.5 pCi/g. Modified soil PRGs for other risk levels were similarly calculated. Table D.1-4 provides a summary of modified soil PRGs for the off-property resident farmer without source controls. The 10^{-6} ILCR groundwater concentration for uranium-234 and uranium-235/236 is 1.1 pCi/L. Modified soil PRGs for uranium-234 and uranium-235/236 are greater than uranium-238. Modified soil PRGs for uranium-234, uranium-235/236, and total uranium are also shown in Table D.1-4.

The maximum on-subunit concentration predicted by the SWIFT model was 23.3 pCi/L for the parameters shown in Table D.1-3. Therefore, for uranium-238 concentrations at the subunit not to exceed 0.72 pCi/L (10^{-6} ILCR level), the source concentration should not exceed 1.39 pCi/g (45*0.72/23.3). In other words, the modified soil PRG for the on-property resident farmer is 1.39 pCi/g. Modified soil PRGs for other risk levels were similarly calculated. Table D.1-4 also provides a summary of modified soil PRGs for the on-property resident farmer without source controls.



LEGEND

- 575 ELEVATION CONTOURS
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- EXTENT OF WASTE
- WASTE FROM CELL IS INCLUDED IN OTHER CELL
- (51,91) SWIFT MODEL CELL (COLUMN, ROW)

NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.

N

SCALE (FT)
0 40 80 160

FIGURE D.1-6
EXTENT OF WASTE AND MODELED SWIFT GRID CELLS, SOLID WASTE LANDFILL

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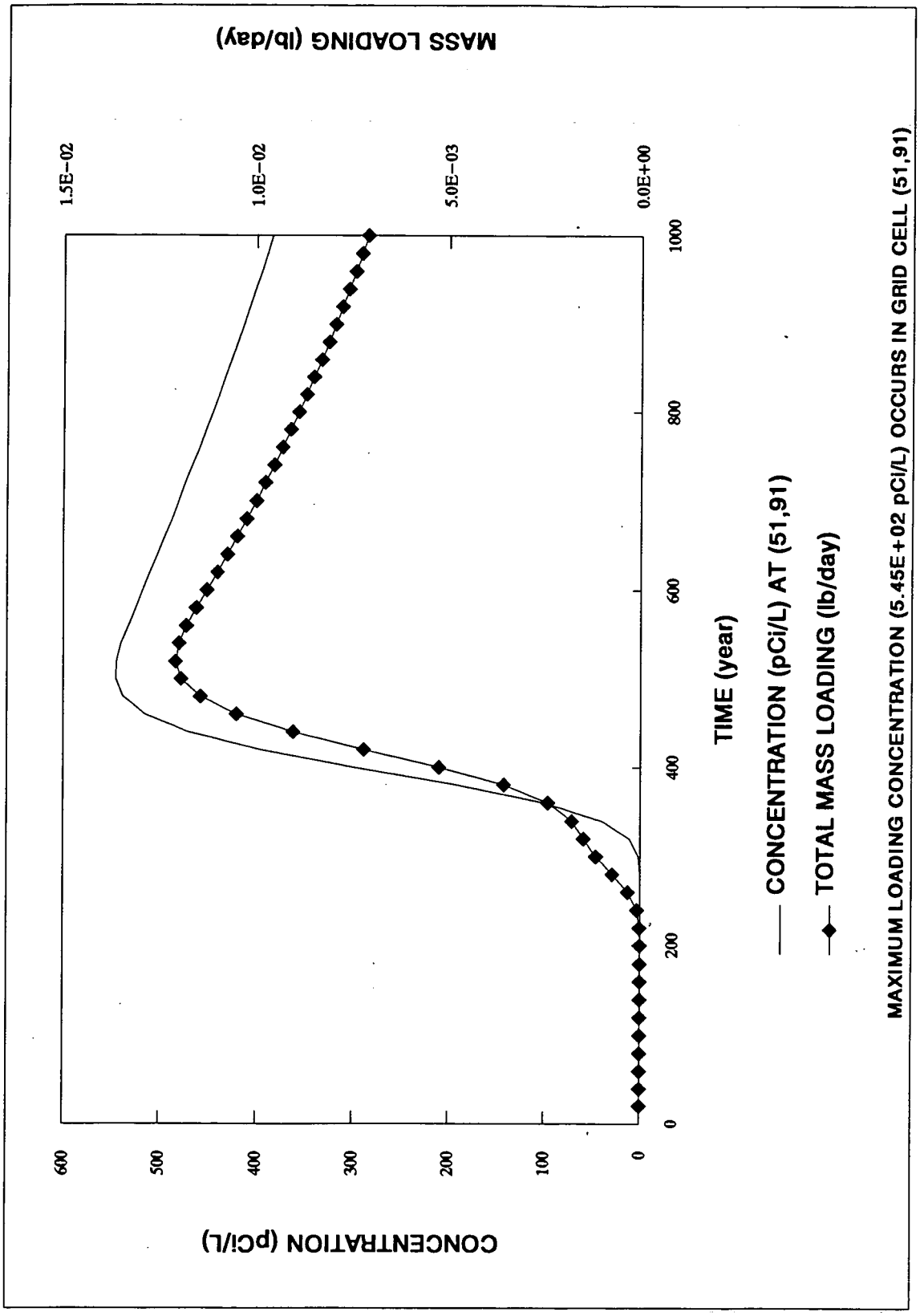

Figure D.1–7 Uranium–238 Loading Curve for Source Materials at 60 pCi/g
Solid Waste Landfill Without Source Controls

TABLE D.1-3

PARAMETERS FOR THE SWIFT CELLS
SOLID WASTE LANDFILL WITHOUT A CAP

Row	Column	Source Volume (ft^3)	U-238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Gray Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
50	91	85160	45.00	591.48	600.00	9.7	16.3	21.7
50	92	73090	34.27	386.60	456.93	7.8	16.6	19.4
51	90	4375	40.66	27.46	542.13	7.0	9.4	25.7
51	91	121906	45.00	846.70	600.00	8.5	14.4	23.5
51	92	66213	18.01	184.05	240.13	8.2	17.3	20.6
52	91	38990	20.19	121.50	269.20	8.8	14.1	23.3
52	92	11388	1.81	3.18	24.15	9.1	15.4	22.2

[a]GMA = Great Miami Aquifer.

TABLE D.1-4

SOLID WASTE LANDFILL
CROSS-MEDIA MODIFIED SOIL PRGs
PROTECTIVE OF THE GREAT MIAMI AQUIFER
WITHOUT SOURCE CONTROLS

COCs Impacting Groundwater	Units	Private Ownership On-Property Resident Farmer PRGs					Federal Ownership Off-Property Resident Farmer PRGs					Background Concentration
		10^{-4} ILCR[a]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[b]	ARAR	10^{-4} ILCR	10^{-5} ILCR	10^{-6} ILCR	0.2 HI	ARAR	
Uranium-234	pCi/g	212	21.2	2.12	NA[c]	NA	6190	619	61.9	NA	NA	1.04
Uranium-235/236	pCi/g	212	21.2	2.12	NA	NA	6190	619	61.9	NA	NA	0.15
Uranium-238	pCi/g	139	13.9	1.39	NA	NA	4050	405	40.5	NA	NA	1.12
Uranium-Total	mg/kg	NA	NA	NA	32.8	38.6	NA	NA	NA	956	38.6	3.4

[a]ILCR = incremental lifetime cancer risk.

[b]HI = hazard index.

[c]NA = not applicable.

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With Source Controls

Consolidation and capping was another alternative for which PRGs were developed. Table D.1-5 provides the physical parameters of various layers for each of the blocks modeled. The HELP model was used to estimate infiltration as 2.9 cm/yr (1.14 in./yr). Infiltration is controlled by the cap, and glacial overburden properties have negligible influence on the infiltration rate.

Based on the parameters shown in Table D.1-5, the predicted maximum uranium-238 concentration was 4.3 x 10^{-7} pCi/L. This run assumed that none of the waste was removed. In other words, current uranium-238 concentration under a cap at the Solid Waste Landfill will not cause the Great Miami Aquifer concentrations to exceed the 10^{-6} ILCR level. Predicted maximum fenceline concentration is below 10^{-6} ILCR because of low infiltration rate, low maximum uranium concentration (below WAC developed in Section D.1.6), and relatively large distance between the Solid Waste Landfill and the downgradient receptor at the fenceline. Table D.1-6 provides a summary of modified soil PRGs with source controls for the off-property resident farmer.

D.1.5.2 Lime Sludge Ponds

Without Source Controls

Figure D.1-8 shows the SWIFT III grid blocks directly beneath the waste at the Lime Sludge Ponds. Table D.1-7 presents the physical parameters for the SWIFT grid cells impacted by the Lime Sludge Ponds. The HELP model was used to estimate the infiltration rate (see Attachment D.1-I as 24 cm/yr (9.61 in./yr). Calculated seepage rates were 153 and 320 cm/yr (60.4 and 124 in./yr) in the glacial till and unsaturated Great Miami Aquifer, respectively. The vadose zone and the perched water infiltration pathways were applicable for this alternative. Based on the Operable Unit 2 RI data, initial perched water concentration was set to 2.72 pCi/L.

Figure D.1-9 shows the loading curve for the Lime Sludge Ponds without source controls. Based on the parameters shown in Table D.1-7, the FEMP fenceline maximum uranium-238 concentration predicted by the SWIFT model was 0.041 pCi/L. This run used current source uranium-238 concentration. Predicted maximum fenceline concentration is below 10^{-6} ILCR because of low maximum uranium concentration (below WAC developed in Section D.1.6) and relatively large distance between the Lime Sludge Ponds and the downgradient receptor at the fenceline. Because maximum FEMP fenceline uranium-238 concentrations does not exceed 0.72 pCi/L (10^{-6} ILCR level), the modified soil PRG for the off-property resident farmer is greater than current source

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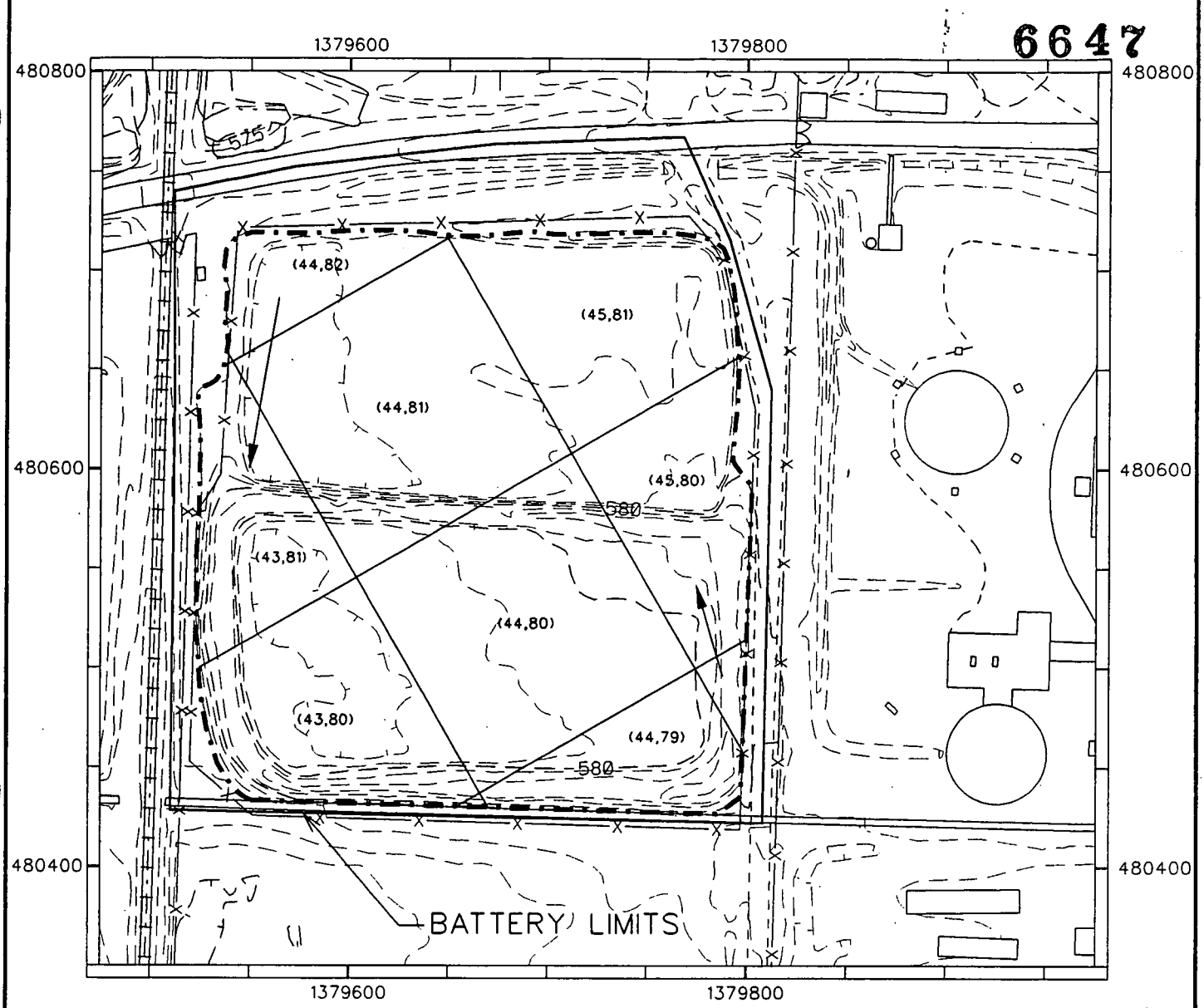

LEGEND

- ELEVATION CONTOURS (575)
- ROADS
- DRAINAGE
- FENCE
- RAILROAD
- WASTE FROM CELL IS INCLUDED IN OTHER CELL
- EXTENT OF WASTE
- SWIFT MODEL CELL (COLUMN, ROW) (44,80)

NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.

SCALE (FT)
0 50 100

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FIGURE D.1-8
EXTENT OF WASTE AND MODELED SWIFT GRID CELLS, LIME SLUDGE PONDS

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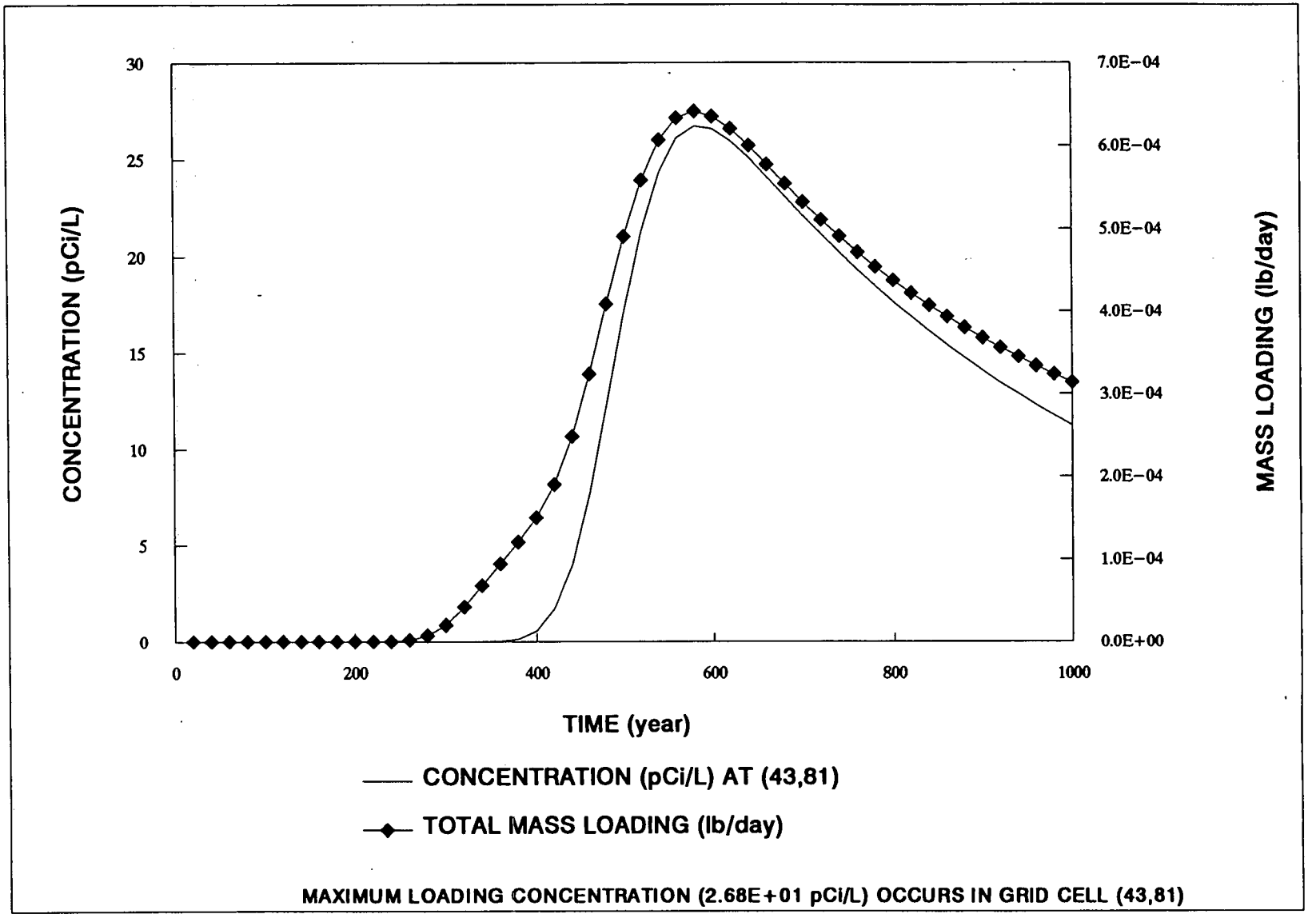

Figure D.1–9 Uranium–238 Loading Curve for The Lime Sludge Ponds Without Source Controls

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TABLE D.1-5

PARAMETERS FOR THE SWIFT CELLS
SOLID WASTE LANDFILL WITH A CAP

Row	Column	Source Volume (ft^3)	U-238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Gray Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
50	91	85160	107.18	1408.77	1429.07	9.7	16.3	21.7
50	92	73090	34.27	386.62	456.96	7.8	16.6	19.4
51	90	4375	40.66	27.45	542.08	7.0	9.4	25.7
51	91	121906	67.20	1264.40	896.00	8.5	14.4	23.5
51	92	66213	18.01	184.05	240.13	8.2	17.3	20.6
52	91	38990	20.19	121.52	269.25	8.8	14.1	23.3
52	92	11388	1.81	3.18	24.15	9.1	15.4	22.2

[a]GMA = Great Miami Aquifer.

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TABLE D.1-6

SOLID WASTE LANDFILL
MODIFIED SOIL PRGs
PROTECTIVE OF THE GREAT MIAMI AQUIFER USING A CAP

COCs Impacting Groundwater	Units	Modified Soil PRGs[a] (Off-Property Farmer)			Background Concentration
		10^{-6} ILCR[b]	0.2 HI[c]	ARAR	
Uranium-234	pCi/g	>100,000	NA[d]	NA	1.04
Uranium-235/236	pCi/g	>100,000	NA	NA	0.15
Uranium-238	pCi/g	>100,000	NA	NA	1.12
Uranium-Total	mg/kg	NA	>100,000	>100,000	3.4

[a]Modified soil PRGs are based on ODAST/SWIFT modeling and assume an infiltration rate of 1.14 in./yr through the cap and soils (HELP model results). Glacil till K_d and Great Miami Aquifer K_d were assumed to be .24 mL/g and 1.78 mL/g, respectively.

[b]ILCR = incremental lifetime cancer risk.

[c]HI = hazard index.

[d]NA = not applicable.

TABLE D.1–7

PARAMETERS FOR THE SWIFT CELLS
LIME SLUDGE PONDS WITHOUT A CAP

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Gray Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
43	80	69238	5.33	23.64	26.63	6.9	22	16.7
43	81	36381	6.94	16.18	34.69	3.9	19.7	18.3
44	79	15019	7.25	6.98	36.24	2.7	18.9	17.7
44	80	146931	2.84	26.74	14.20	9.4	18.6	18.2
44	81	100156	0.78	5.03	3.91	6.4	16.6	19.7
45	80	31863	2.56	5.24	12.82	3.6	13.5	19.0
45	81	89781	1.81	10.42	9.06	8.5	11.6	20.5

[a]GMA = Great Miami Aquifer.

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concentrations. Table D.1-8 provides a summary of modified soil PRGs for the off-property resident farmer without source controls.

The maximum on-subunit concentration predicted by the SWIFT model was 1.07 pCi/L for the parameters shown in Table D.1-7. Therefore, for uranium-238 concentrations at the subunit not to exceed 0.72 pCi/L (10^{-6} ILCR level), the source concentration should not exceed 4.66 pCi/g (= 6.94*0.72/1.07). In other words, the modified soil PRG for the on-property resident farmer is 4.66 pCi/g. Modified soil PRGs for other risk levels were similarly calculated. Table D.1-8 also provides a summary of modified soil PRGs for the on-property resident farmer without source controls.

With Source Controls

On-property resident farmer PRGs are not applicable for the consolidation and capping alternative. Furthermore, predicted uranium-238 concentrations without source controls are less than the 10^{-6} ILCR level for the off-property resident farmer. Therefore, modified soil PRGs for source control alternatives were not developed for the Lime Sludge Ponds.

D.1.5.3 Inactive Flyash Pile/South Field

Figure D.1-10 shows the areal extent of the waste in the South Field/Inactive Flyash Pile and the SWIFT III grid cells impacted by direct loading from these subunits. The vadose zone pathway, the perched water infiltration pathway, and the perched water subsurface seep pathway were applicable for FS modeling for the South Field/Inactive Flyash Pile. The lithology of the South Field/Inactive Flyash Pile area is variable. The southwestern portion contains virtually no glacial overburden, while the glacial overburden thicknesses increase to 6.7 m (22 ft) toward the northeastern side. The thickness of the unsaturated zone in the Great Miami Aquifer (Layer 2) ranges from 4.9 to 10.1 m (16 to 33 ft). Therefore, the vadose zone model depicting flow in the subsurface soils at the South Field/Inactive Flyash Pile used two layers in the area where till is present and used one layer (unsaturated Great Miami Aquifer) where till is not present. The HELP model was used to estimate infiltration through the residual soils and the composite cap. Results from the HELP run are presented in Attachment D.1-I.

D.1.5.3.1 Impact of the Perched Water Subsurface Seep Pathway

Fate and transport modeling for the Operable Unit 2 RI indicated that the perched water subsurface seep pathway has a major impact on the Great Miami Aquifer. This modeling scenario quantifies the

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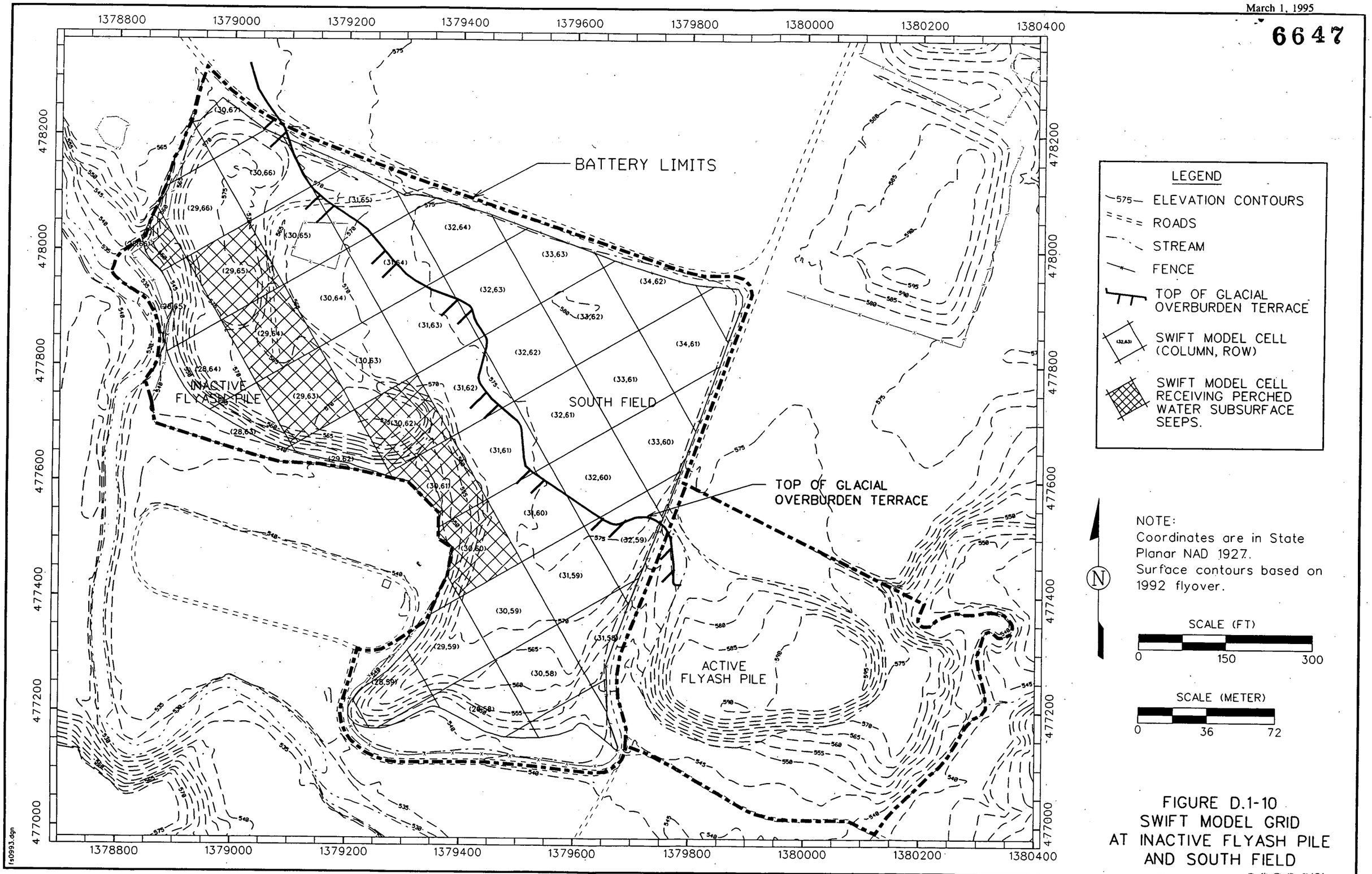

FIGURE D.1-10
SWIFT MODEL GRID
AT INACTIVE FLYASH PILE
AND SOUTH FIELD

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TABLE D.1-8

LIME SLUDGE PONDS
CROSS-MEDIA MODIFIED SOIL PRGs
PROTECTIVE OF THE GREAT MIAMI AQUIFER
WITHOUT SOURCE CONTROLS

COCs Impacting Groundwater	Units	Private Ownership On-Property Resident Farmer PRGs					Federal Ownership Off-Property Resident Farmer PRGs					Background Concentration
		10^{-4} ILCR[a]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[b]	ARAR	10^{-4} ILCR	10^{-5} ILCR	10^{-6} ILCR	0.2 HI	ARAR	
Uranium-234	pCi/g	712	71.2	7.12	NA[c]	NA	19500	1950	195	NA	NA	1.04
Uranium-235/236	pCi/g	712	71.2	7.12	NA	NA	19500	1950	195	NA	NA	0.15
Uranium-238	pCi/g	466	46.6	4.66	NA	NA	12700	1270	127	NA	NA	1.12
Uranium-Total	mg/kg	NA	NA	NA	115	136	NA	NA	NA	3000	136	3.4

[a]ILCR = incremental lifetime cancer risk.

[b]HI = hazard index.

[c]NA = not applicable.

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impact of the perched water subsurface seep pathway on the Great Miami Aquifer. Figure D.1-10 identifies grid cells that may receive perched water from the subsurface seep pathways. Figure D.1-5 shows the conceptual model for perched water subsurface seeps. Perched water has been observed in 0 to 1 m (0 to 3 ft) thick sand and gravel layers in the glacial overburden. Perched water not only represents a source for vertical infiltration, it also serves as a source for the current surface seeps and subsurface seeps. As shown in Figure D.1-5, perched water moves laterally in the sand/gravel layer until it is intercepted at the sand/gravel and waste interface. At that point, perched water moves along the slope of waste and till interface until it comes in contact with the unsaturated Great Miami Aquifer. The subsurface seep water then infiltrates vertically to the aquifer. The travel time for lateral movement of the perched water was assumed to be short compared to the travel time for the vertical movement of the perched water.

The source term for the perched water subsurface seep pathways included uranium-238 in perched water, as well as uranium-238 adsorbed in the sand and gravel in the glacial overburden underneath the Inactive Flyash Pile and South Field. Table D.1-9 shows the physical parameters for this simulation. Figure D.1-11 shows the loading curve for uranium-238 to the Great Miami Aquifer due to the perched water subsurface seep pathway. The predicted maximum uranium-238 loading concentration for the Great Miami Aquifer was 1,670 pCi/L. This loading curve was used as input to the SWIFT model to calculate impact of the perched water subsurface seep pathway on the Great Miami Aquifer. The maximum predicted uranium-238 concentration in the Great Miami Aquifer was 303 pCi/L, and maximum concentration at the FEMP fenceline was 15.6 pCi/L. The maximum uranium-238 concentrations on site and at the FEMP fenceline were predicted to occur at 80 and 160 years, respectively. Figure D.1-12 shows the projected increase in uranium-238 concentrations due the perched water subsurface seep pathways at 80 years. Figure D.1-12 indicates that uranium-238 concentrations due to perched water subsurface seeps alone may exceed the 10^{-4} ILCR level and total uranium concentration may exceed maximum contaminant level (MCL) (20 μg/l). Therefore, perched water lateral migration should be controlled. Furthermore, if perched water is not remediated, modified soil PRGs at the Inactive Flyash Pile/South Field are zero.

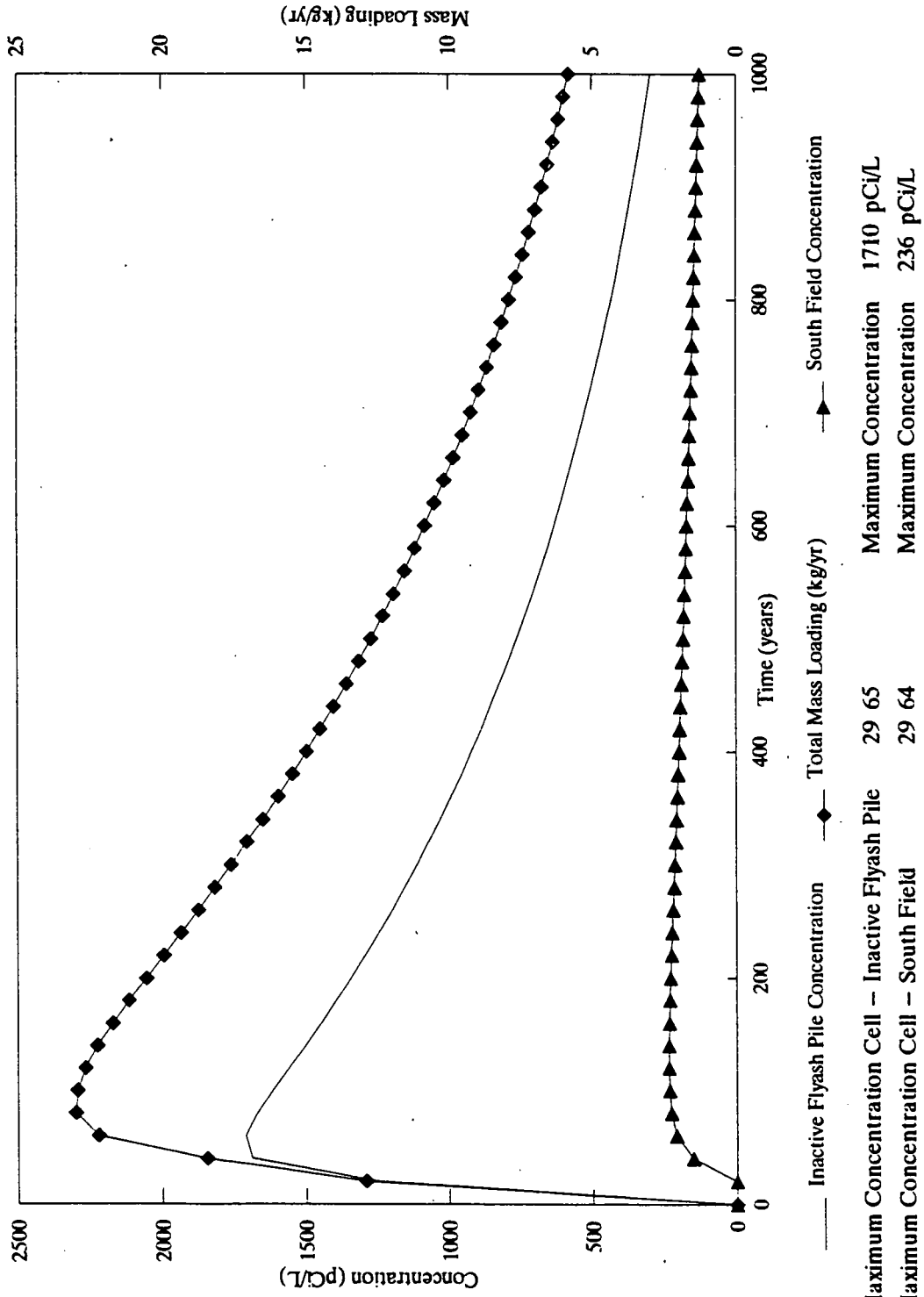
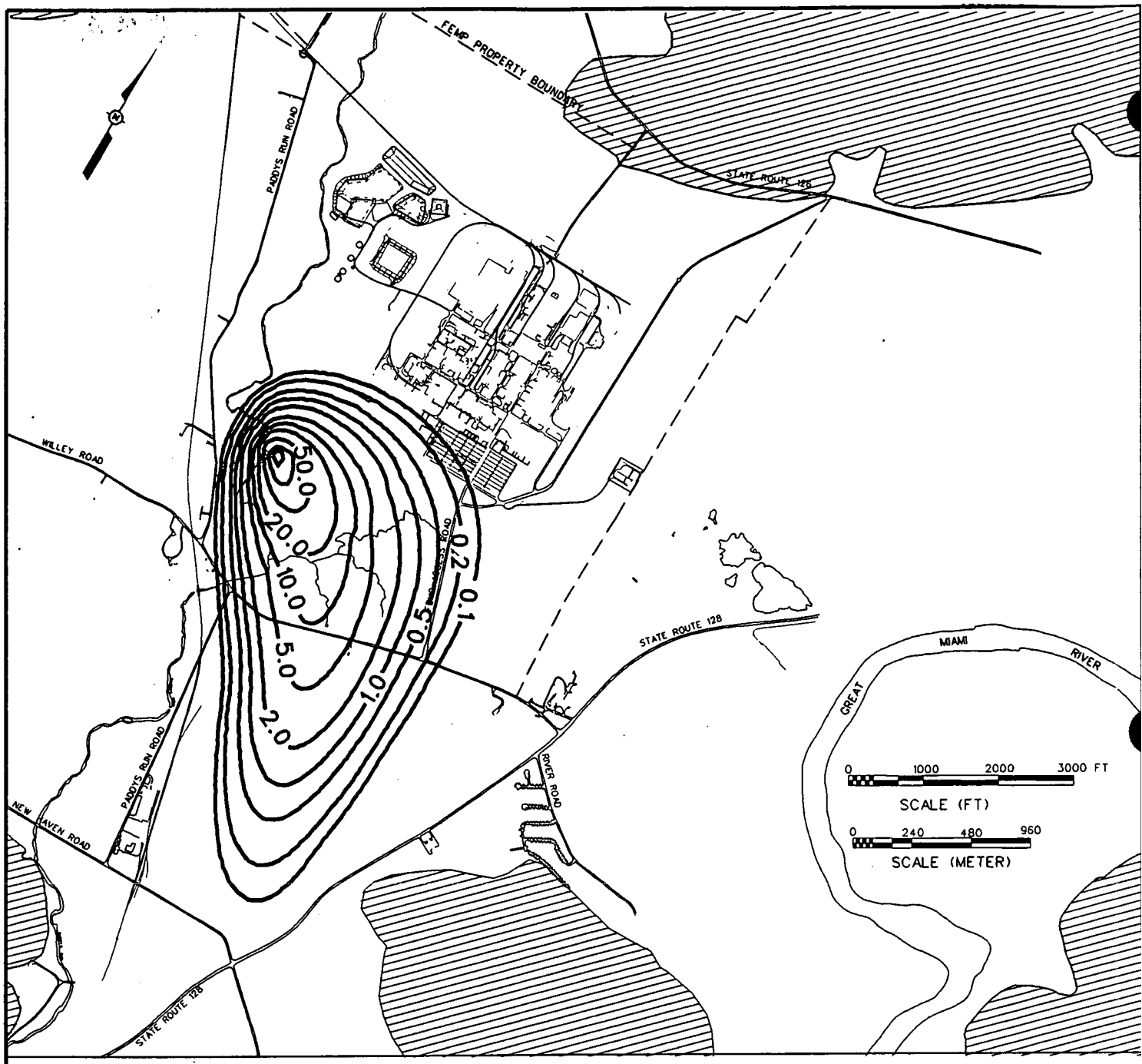


Figure D.1-11 Uranium–238 Loading to the Great Miami Aquifer from the South Field / Inactive Flyash Pile for Perched Water Subsurface Seep Pathway



LEGEND:

0.1 CONCENTRATION CONTOUR (pCi/L)

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FIGURE D.1-12
PROJECTED INCREASE IN URANIUM-238 CONCENTRATIONS IN THE GREAT MIAMI AQUIFER AT 80 YEARS DUE TO LOADING FROM THE INACTIVE FLYASH PILE/SOUTH FIELD VIA SUBSURFACE PATHWAY

TABLE D.1-9

PARAMETERS FOR THE SWIFT CELLS IMPACTED BY THE PERCHED WATER SUBSURFACE SEEP PATHWAY, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Perched Water Concentration (pCi/L)	Flow Rate		Unsaturated GMA[a] Thickness
			Gallons/Minute	Inches/Year	
28	66	1880	0.44	23.6	21.3
29	62	257	0.15	8.1	18.5
29	63	257	0.45	24.4	20.8
29	64	257	0.77	41.8	25.5
29	65	1880	1.73	93.6	24.8
30	60	257	0.20	10.9	29.0
30	61	257	0.40	21.7	24.8
30	62	257	0.40	21.7	24.1

[a]GMA = Great Miami Aquifer.

D.1.5.3.2 Remediated Perched Water and No Source Controls

This alternative assumes that the perched water is remediated and no source controls are applied. In other words, perched water is clean for the purposes of this modeling scenario. Figure D.1-10 shows the areal extent of the waste in the South Field/Inactive Flyash Pile and the SWIFT III grid cells impacted by direct loading from these subunits. Tables D.1-10 and D.1-11 presents the physical parameters and infiltration rates for the SWIFT grid cells impacted by the Inactive Flyash Pile/South Field. The HELP model was used to estimate infiltration rates (see Attachment D.1-I). The vadose zone pathway was the only applicable pathway for this alternative. Note that the vadose zone pathway includes lateral migration of infiltrated leachate at the top of the gray till (see Figure D.1-4). For this modeling scenario, the maximum source uranium-238 concentration was 2.5 pCi/g. It was assumed that source material above this concentration has been excavated.

Figure D.1-13 shows the loading curve. The maximum on-subunit concentration predicted by the SWIFT model was 2.02 pCi/L for the parameters shown in Tables D.1-10 and D.1-11. Therefore, for uranium-238 concentrations at the subunit not to exceed 0.72 pCi/L (10^{-6} ILCR level), the source concentration should not exceed 0.89 pCi/g (= 6.94*0.72/2.02). In other words, the modified soil PRG for on-property resident farmer is 0.89 pCi/g. Modified soil PRGs for other risk levels were similarly calculated. Table D.1-12 also provides a summary of modified soil PRGs for the on-property resident farmer without any source controls and remediated perched water.

Based on the parameters shown in Tables D.1-10 and D.1-11, the FEMP fenceline maximum uranium-238 concentration predicted by SWIFT model was 0.34 pCi/L. This run limited source uranium-238 concentrations to 2.5 pCi/g. Therefore, for uranium-238, concentrations at the FEMP fenceline did not exceed 0.72 pCi/L (10^{-6} ILCR level). Tables D.1-13 and D.1-14 present parameter and infiltration rates for SWIFT cells impacted by source material at 5 pCi/g on the Great Miami Aquifer and on the terrace face. For this case, the maximum predicted fenceline concentration was 0.49 pCi/L. Table D.1-12 provides a summary of modified soil PRGs for the off-property resident farmer if source material on the Great Miami Aquifer is left at 5 pCi/g uranium-238. In this case, source material above 2.1 pCi/g on top of the terrace may result in uranium-238 concentrations at the FEMP fenceline that exceed 10^{-6} ILCR levels. Table D.1-12 provides a summary of modified soil PRGs for the off-property resident farmer without any source controls and remediated perched water.

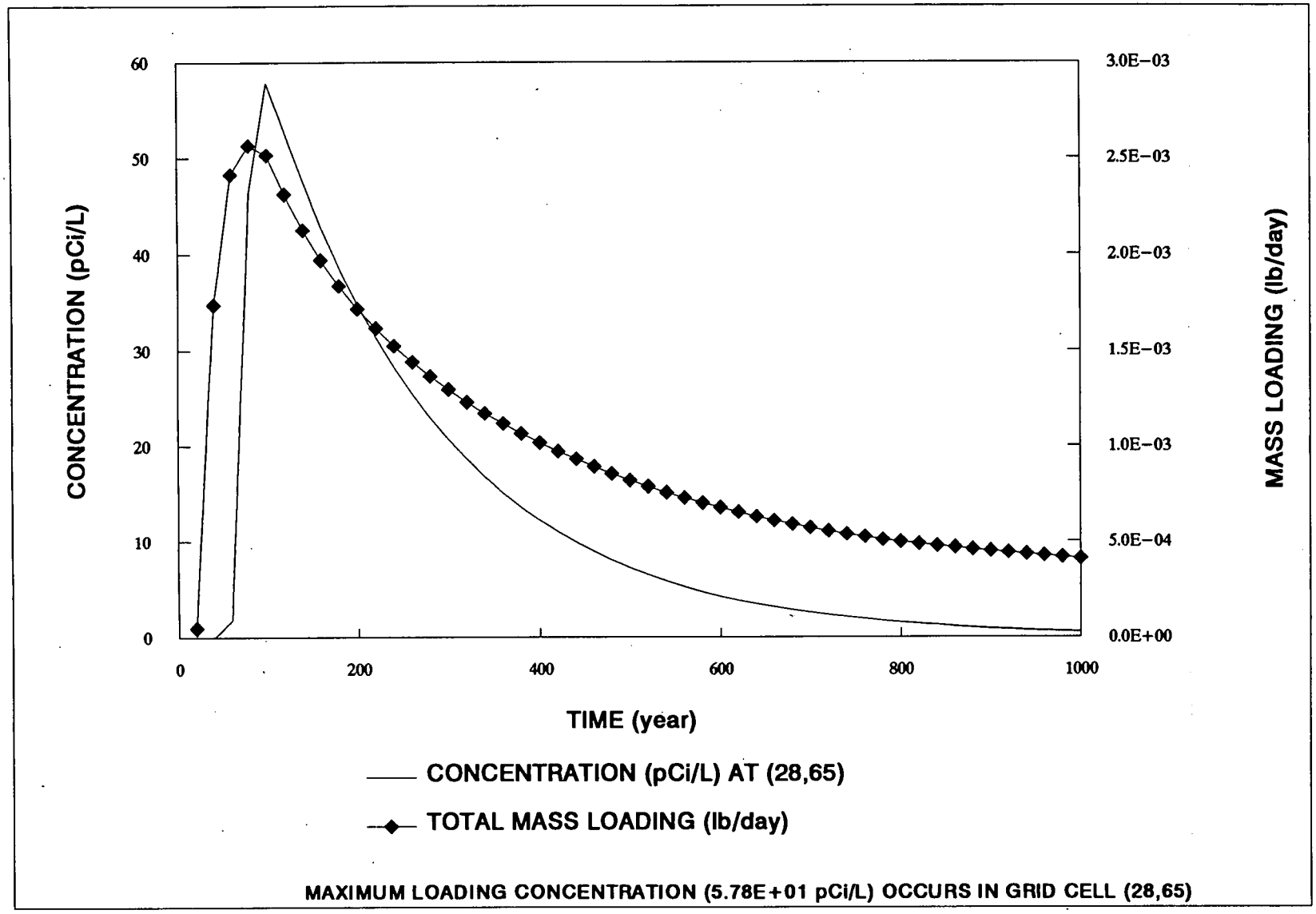

Figure D.1–13 Uranium–238 Loading Curve for Source Materials at 2.5 pCi/g and Clean Perched Water, Inactive Flyash Pile and South Field

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TABLE D.1–10

PARAMETERS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 2.5 pCi/g
SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration[a] (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[b] Thickness (ft)
ZONE 1 – SOURCE DIRECTLY UNDERLAIN BY THE GREAT MIAMI AQUIFER								
28	59	54675	2.50	19.59	14.12	5.5	0.0	16.7
28	65	37500	2.50	13.44	66.67	4.4	0.0	19.6
28	66	10940	2.50	3.92	66.67	2.5	0.0	19.3
29	59	23430	2.50	8.40	14.12	1.6	0.0	20.2
29	60	4690	2.22	1.49	12.54	4.3	0.0	21.4
29	63	51550	2.50	18.47	66.67	3.3	0.0	20.8
30	58	1560	2.50	0.56	14.12	0.1	0.0	21.7
30	62	3135	2.50	1.12	14.12	0.6	0.0	24.1
30	63	25000	2.50	8.96	14.12	1.9	0.0	22.8
Zone Average		23609	2.47	8.44	31.46	2.7	0.0	20.7
ZONE 2 – ZERO FILL, IMPACTED TILL AS SOURCE ON THE TERRACE FACE								
29	67	10950	2.50	4.09	66.67	2.9	2.2	32.5
30	59	7800	2.50	4.75	14.12	0.5	2.5	28.2
31	58	18750	2.50	8.00	14.12	1.8	1.9	29.6
31	59	14060	2.50	7.00	14.12	0.9	7.8	31.4
31	61	3120	2.50	3.08	14.12	0.2	6.8	30.8
31	62	20300	2.50	9.24	14.12	1.3	7.5	30.1
31	63	17170	2.50	8.10	14.12	1.1	8.2	29.5
32	59	48430	2.50	18.93	14.12	3.9	10.1	32.5
Zone Average		17573	2.50	7.90	20.69	1.6	5.9	30.6

See footnotes at end of table.

000055

TABLE D.1–10

PARAMETERS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 2.5 pCi/g
SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration[a] (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[b] Thickness (ft)
ZONE 3 – AREAS WITH TILL AND NO LATERAL DRAINAGE								
29	66	3120	2.50	1.22	66.67	0.2	2.6	32.0
30	60	9370	2.50	5.04	14.12	0.7	3.0	29.0
30	64	17190	2.50	6.70	14.12	1.1	0.4	26.4
30	67	9370	2.50	3.75	66.67	1.5	3.9	29.7
Zone Average		9763	2.50	4.18	40.40	0.9	2.5	29.3
ZONE 4 – SOURCE ON THE TOP OF TERRACE								
31	64	15620	2.50	7.51	14.12	1.0	0.5	25.5
31	65	6240	2.50	4.02	14.12	0.4	1.8	22.8
32	60	26560	2.50	11.33	14.12	1.9	3.6	20.2
32	61	25000	2.50	10.89	14.12	1.6	3.7	20.8
32	62	7800	2.50	4.76	14.12	0.5	3.3	24.1
32	63	6240	2.50	4.15	14.12	0.4	4.4	22.8
32	64	21900	2.50	9.59	14.12	1.6	6.6	20.8
33	59	6250	2.50	2.44	14.12	4.0	5.8	21.3
33	60	28130	2.50	12.00	14.12	1.9	6.7	21.7
33	61	34375	2.50	14.17	14.12	2.4	6.7	29.0
34	60	3140	2.50	1.22	14.12	0.8	8.8	21.3
34	61	17175	2.50	8.14	14.12	1.1	7.0	21.7
Zone Average		16535.8	2.50	7.52	14.12	1.5	4.9	22.7

[a]Initial leachate concentration was calculated using a desorption K_d of 177 mL/g for the South Field and 37.5 mL/g for the Inactive Flyash Pile.
[b]GMA = Great Miami Aquifer.

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TABLE D.1 –11

HELP MODEL RESULTS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 2.5 pCi/g AND NO SOURCE CONTROLS, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 1 – ZERO TILL, LESS THAN 7 FEET OF SOURCE									
28	59	9.61	NA[a]	9.61	NA	9.61	7.33	NA	131.1
28	65	9.61	NA	9.61	NA	9.61	7.95	NA	120.9
28	66	9.61	NA	9.61	(29,67)	17.70	7.95	NA	222.6
29	59	9.61	NA	9.61	(32,60)	17.70	7.33	NA	241.5
29	60	9.61	NA	9.61	NA	9.61	7.95	NA	120.9
29	63	9.61	NA	9.61	(32,64)	17.70	7.33	NA	241.5
30	58	9.61	NA	9.61	(31,59) & (33,60) & (34,61)	33.88	7.95	NA	426.2
30	62	9.61	NA	9.61	(31,62) & (32,62)	25.79	7.95	NA	324.4
30	63	9.61	NA	9.61	(31,63) & (32,63)	25.79	7.95	NA	324.4
ZONE 2 – ZERO FILL, IMPACTED TILL AS SOURCE ON THE TERRACE FACE									
29	67	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
30	59	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
31	58	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
31	59	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
31	61	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
31	62	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
31	63	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
32	59	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9

See footnote at end of table.

TABLE D.1 – 11

HELP MODEL RESULTS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 2.5 pCi/g AND NO SOURCE CONTROLS, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 3 – AREAS WITH TILL AND NO LATERAL DRAINAGE									
29	66	1.73	NA	1.73	NA	1.73	5.95	4.22	29.1
30	60	3.99	NA	3.99	(31,60) & (33,61)	12.08	5.88	29.46	205.4
30	64	1.73	NA	1.73	NA	1.73	5.95	4.22	29.1
30	67	1.73	NA	1.73	NA	1.73	5.95	4.22	29.1
ZONE 4 – SOURCE ON THE TOP OF TERRACE									
31	64	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
31	65	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
32	60	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
32	61	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
32	62	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
32	63	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
32	64	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
33	59	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
33	60	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
33	61	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
34	60	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
34	61	1.52	8.09	9.61	NA	1.52	5.88	3.71	25.9
ZONE 5 – AREAS WITH NO SOURCE BUT RECEIVING LATERAL DRAINAGE									
29	58	NA	NA	NA	(30,59)	8.09	7.95	NA	101.8
29	64	NA	NA	NA	(31,64)	8.09	7.95	NA	101.8
29	65	NA	NA	NA	(31,65)	8.09	7.95	NA	101.8
30	57	NA	NA	NA	(31,58) & (33,59) & (32,59) & (34,60)	32.36	7.95	NA	407.0
30	61	NA	NA	NA	(31,61) & (32,61)	16.18	7.95	NA	203.5

[a]NA = Not applicable.

TABLE D.1-12

INACTIVE FLYASH PILE/SOUTH FIELD CROSS-MEDIA MODIFIED SOIL PRGs[a] PROTECTIVE OF THE GREAT MIAMI AQUIFER WITHOUT SOURCE CONTROLS

COCs Impacting Groundwater	Units	Private Ownership On-Property Resident Farmer PRG-Carcinogenic Risk Based					Federal Ownership Off-Property Resident Farmer PRGs					Background Concentration
		10^{-4} ILCR[b]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[c]	ARAR	10^{-4} ILCR	10^{-5} ILCR	10^{-6} ILCR	0.2 HI	ARAR	
SOURCE MATERIAL OVER THE GREAT MIAMI AQUIFER												
Uranium-234	pCi/g	136	13.6	1.36	NA[d]	NA	1250	91	7.64	NA	NA	1.04
Uranium-235/236	pCi/g	136	13.6	1.36	NA	NA	1250	91	7.64	NA	NA	0.15
Uranium-238	pCi/g	89	8.9	0.89	NA	NA	819	60	5	NA	NA	1.12
Uranium-Total	mg/kg	NA	NA	NA	21	24.8	NA	NA	NA	17	20	3.4
SOURCE MATERIAL ON THE TOP OF THE TERRACE (GLACIAL TILL)												
Uranium-234	pCi/g	136	13.6	1.36	NA	NA	320	32	3.2	NA	NA	1.04
Uranium-235/236	pCi/g	136	13.6	1.36	NA	NA	320	32	3.2	NA	NA	0.15
Uranium-238	pCi/g	89	8.9	0.89	NA	NA	210	21	2.1	NA	NA	1.12
Uranium-Total	mg/kg	NA	NA	NA	21	24.8	NA	NA	NA	8.5	10	3.4

[a]Those data were developed by considering future impacts on perched groundwater and do not include current perched groundwater contamination.

[b]ILCR = incremental lifetime cancer risk.

[c]HI = hazard index.

[d]NA = not applicable.

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TABLE D.1–13

PARAMETERS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 5 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 1 – ZERO TILL, LESS THAN 8 FEET OF SOURCE								
28	65	68770	5.00	49.29	133.33	8.0	0.0	19.6
28	66	12530	5.00	8.98	133.33	2.9	0.0	19.3
29	58	15620	5.00	11.20	28.25	1.3	0.0	18.2
29	60	4690	1.90	1.28	10.72	4.3	0.0	21.4
29	62	57830	5.00	41.45	133.33	6.3	0.0	18.5
30	58	42190	5.00	30.24	28.25	2.8	0.0	21.7
30	61	10930	5.00	7.83	28.25	0.9	0.0	20.8
30	62	6240	5.00	4.47	28.25	1.1	0.0	24.1
30	63	31260	5.00	22.41	28.25	2.4	0.0	22.8
Zone Average		27784	4.66	19.68	61.33	3.3	0.0	20.7
ZONE 2 – ZERO TILL, MORE THAN 15 FEET OF SOURCE								
28	59	157810	2.62	59.27	14.80	15.7	0.0	16.7
29	59	298440	5.00	213.91	28.25	21.0	0.0	20.2
29	63	278150	5.00	199.37	133.33	17.9	0.0	20.8
Zone Average		244800	4.21	157.52	58.79	18.2	0.0	19.2
ZONE 3 – ZERO FILL, IMPACTED TILL AS SOURCE								
29	66	4670	5.00	3.64	133.33	0.3	2.6	32.0
30	64	18750	5.00	14.62	28.25	1.2	0.4	26.4
30	67	9370	5.00	7.50	133.33	1.5	3.9	29.7
31	61	56250	5.00	44.32	28.25	3.5	6.8	30.8
31	62	60930	5.00	47.60	28.25	3.9	7.5	30.1
31	63	54680	5.00	43.12	28.25	3.5	8.2	29.5
Zone Average		34108	5.00	26.80	63.28	2.3	4.9	29.8

See footnote at end of table.

TABLE D.1–13

PARAMETERS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 5 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 4 – LESS THAN 3 FEET OF TILL BELOW SOURCE								
29	67	10950	5.00	8.18	133.33	2.9	2.2	32.5
30	59	135940	5.00	101.36	28.25	8.7	2.5	28.2
30	60	134370	3.63	72.36	20.51	10.1	3.0	29.0
31	58	76560	5.00	57.45	28.25	7.5	1.9	29.6
Zone Average		89455	4.66	59.84	52.58	7.3	2.4	29.8
ZONE 5 – 7 to 10 FEET OF NOT IMPACTED TILL, 9 to 12 FEET OF SOURCE								
31	59	154680	5.00	114.79	28.25	9.9	7.8	31.4
31	60	176560	5.00	130.31	28.25	11.8	8.6	31.6
32	59	110940	2.45	40.50	13.84	8.9	10.1	32.5
Zone Average		147393	4.15	95.20	23.45	10.2	8.8	31.8

[a]GMA = Great Miami Aquifer.

TABLE D.1 – 14

HELP MODEL RESULTS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 5 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 1 – ZERO TILL, LESS THAN 8 FEET OF SOURCE									
28	65	9.61	NA[a]	9.61	NA	9.61	7.95	NA	120.9
28	66	9.61	NA	9.61	(29,67)	15.56	7.95	NA	195.7
29	58	9.61	NA	9.61	(30,59)	15.56	7.95	NA	195.7
29	60	9.61	NA	9.61		9.61	7.95	NA	120.9
29	62	9.61	NA	9.61		9.61	7.95	NA	120.9
30	58	9.61	NA	9.61	(31,59)	17.02	7.95	NA	214.1
30	61	9.61	NA	9.61	(31,61)	17.70	7.95	NA	222.6
30	62	9.61	NA	9.61	(31,62)	17.70	7.95	NA	222.6
30	63	9.61	NA	9.61	(31,63)	17.70	7.95	NA	222.6
ZONE 2 – ZERO TILL, MORE THAN 15 FEET OF SOURCE									
28	59	9.61	NA	9.61		9.61	7.33	NA	131.1
29	59	9.61	NA	9.61		9.61	7.33	NA	131.1
29	63	9.61	NA	9.61		9.61	7.33	NA	131.1
ZONE 3 – ZERO FILL, IMPACTED TILL AS SOURCE									
29	66	1.73	NA	1.73		1.73	5.95	4.22	29.1
30	64	1.73	NA	1.73		1.73	5.95	4.22	29.1
30	67	1.73	NA	1.73		1.73	5.95	4.22	29.1
31	61	1.52	8.09	9.61		1.52	5.88	3.71	25.9
31	62	1.52	8.09	9.61		1.52	5.88	3.71	25.9
31	63	1.52	8.09	9.61		1.52	5.88	3.71	25.9

See footnote at end of table.

TABLE D.1–14

HELP MODEL RESULTS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 5 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 4 – LESS THAN 3 FEET OF TILL BELOW SOURCE									
29	67	2.59	5.95	8.54		2.59	6.28	6.32	41.2
30	59	2.59	5.95	8.54		2.59	6.28	6.32	41.2
30	60	3.99	NA	3.99	(31,60)	11.40	6.28	27.80	181.5
31	58	2.59	5.95	8.54		2.59	6.28	6.32	41.2
ZONE 5 – 7 to 10 FEET OF NOT IMPACTED TILL, 9 to 15 FEET OF SOURCE									
31	59	2.21	7.41	9.62		2.21	6.16	5.39	35.9
31	60	2.21	7.41	9.62		2.21	6.16	5.39	35.9
32	59	2.21	7.41	9.62		2.21	6.16	5.39	35.9
ZONE 6 – ALL SOURCE MATERIAL REMOVED									
30	57	NA	NA	NA	(31,58)	5.95	7.95	NA	74.8

[a]NA = not applicable.

000063

D.1.5.3.3 Source Controls for Lateral Migration of Perched Water

This alternative assumes that lateral migration of perched water is controlled. However, perched water is assumed to provide a source to the Great Miami Aquifer via vertical infiltration. For this alternative, two sets of PRGs were developed. The first set of PRGs were applicable for source material directly underlain by the Great Miami Aquifer or source material on the terrace face. Figure D.1-14 identifies the location of terrace face at the Inactive Flyash Pile and South Field. It is defined as the area where glacial overburden thickness is less than 5.5 m (18 ft). The second set of PRGs was developed for the source material underlain by at least 5.5 m (18 ft) of glacial overburden. This area is also referred to as "top of terrace."

Source Directly Underlain by The Great Miami Aquifer and on Terrace Face

This alternative assumes that the only source material impacting the Great Miami Aquifer is directly underlain by the Great Miami Aquifer, or the source material is on the terrace face. The source material directly underlain by the Great Miami Aquifer provides only a source for vertical infiltration. However, the leachate from the source material on the terrace face can infiltrate vertically through the gray till or can migrate laterally before vertically infiltrating through the unsaturated sands and gravels of the Great Miami Aquifer. Tables D.1-13 and D.1-14 present the physical parameters and infiltration rates for the SWIFT grid cells impacted for this scenario. The HELP model was used to estimate infiltration rates (see Attachment D.1-I). The vadose zone pathway was the only applicable pathway for this alternative. Note that the vadose zone pathway includes lateral migration of infiltrated leachate at the top of the gray till (see Figure D.1-4). For this modeling scenario, maximum source uranium-238 concentration was 5 pCi/g. It was assumed that source material above this concentration has been excavated.

Figure D.1-15 shows the loading curve. The maximum on-subunit concentration predicted by the SWIFT model was 3.55 pCi/L for the parameters shown in Tables D.1-13 and D.1-14. For the same parameters, the FEMP fenceline maximum uranium-238 concentration predicted by the SWIFT model was 0.49 pCi/L, less than 0.72 pCi/L (10^{-6} ILCR level). To be conservative, the source concentration of 5 pCi/g used for this modeling scenario was also taken as the modified soil PRG for the off-property resident farmer. Table D.1-15 provides a summary of modified soil PRGs for the off-property resident farmer with source controls for lateral migration of perched water.

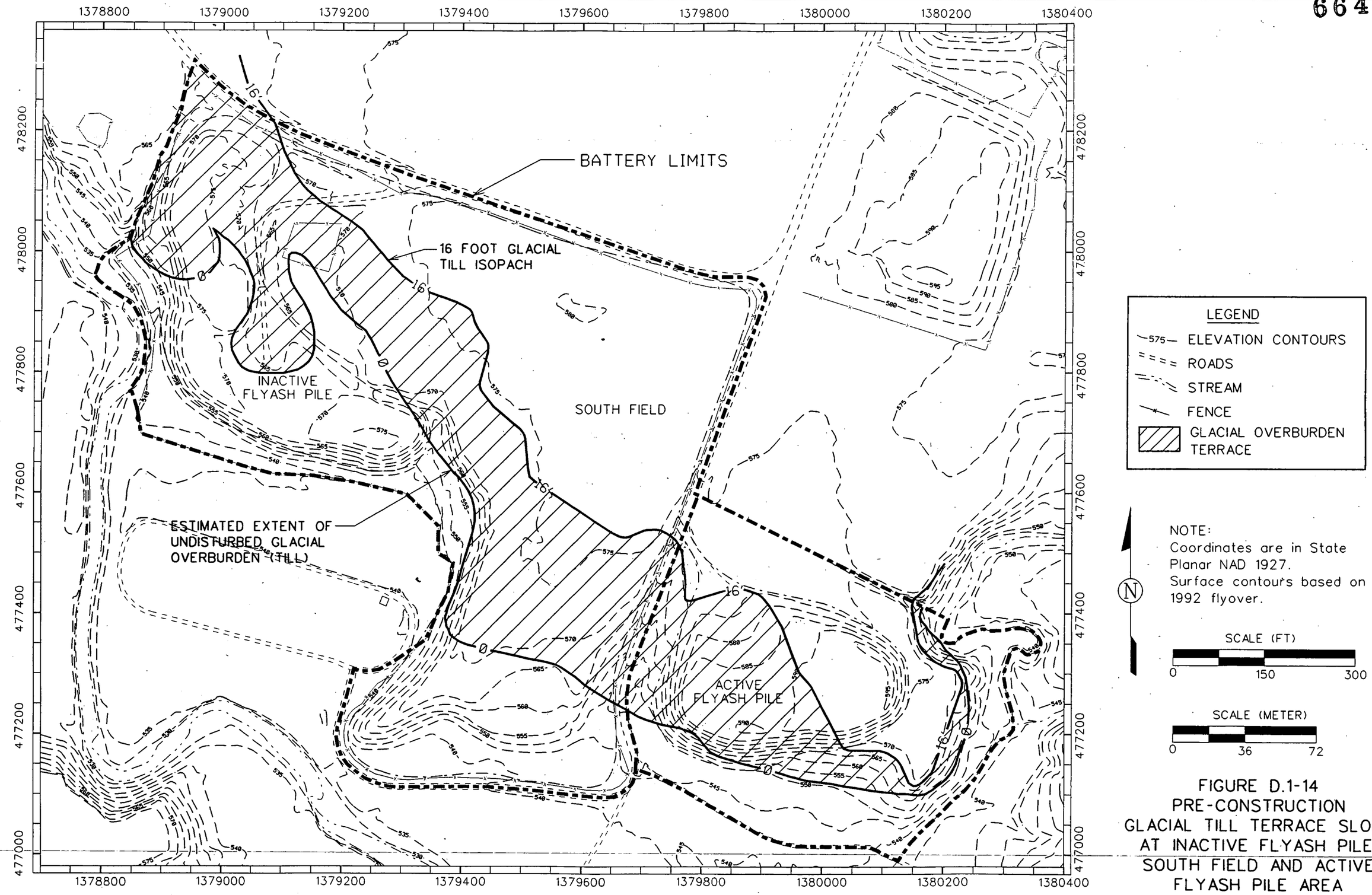

FIGURE D.1-14
PRE-CONSTRUCTION
GLACIAL TILL TERRACE SLOPE
AT INACTIVE FLYASH PILE,
SOUTH FIELD AND ACTIVE
FLYASH PILE AREA

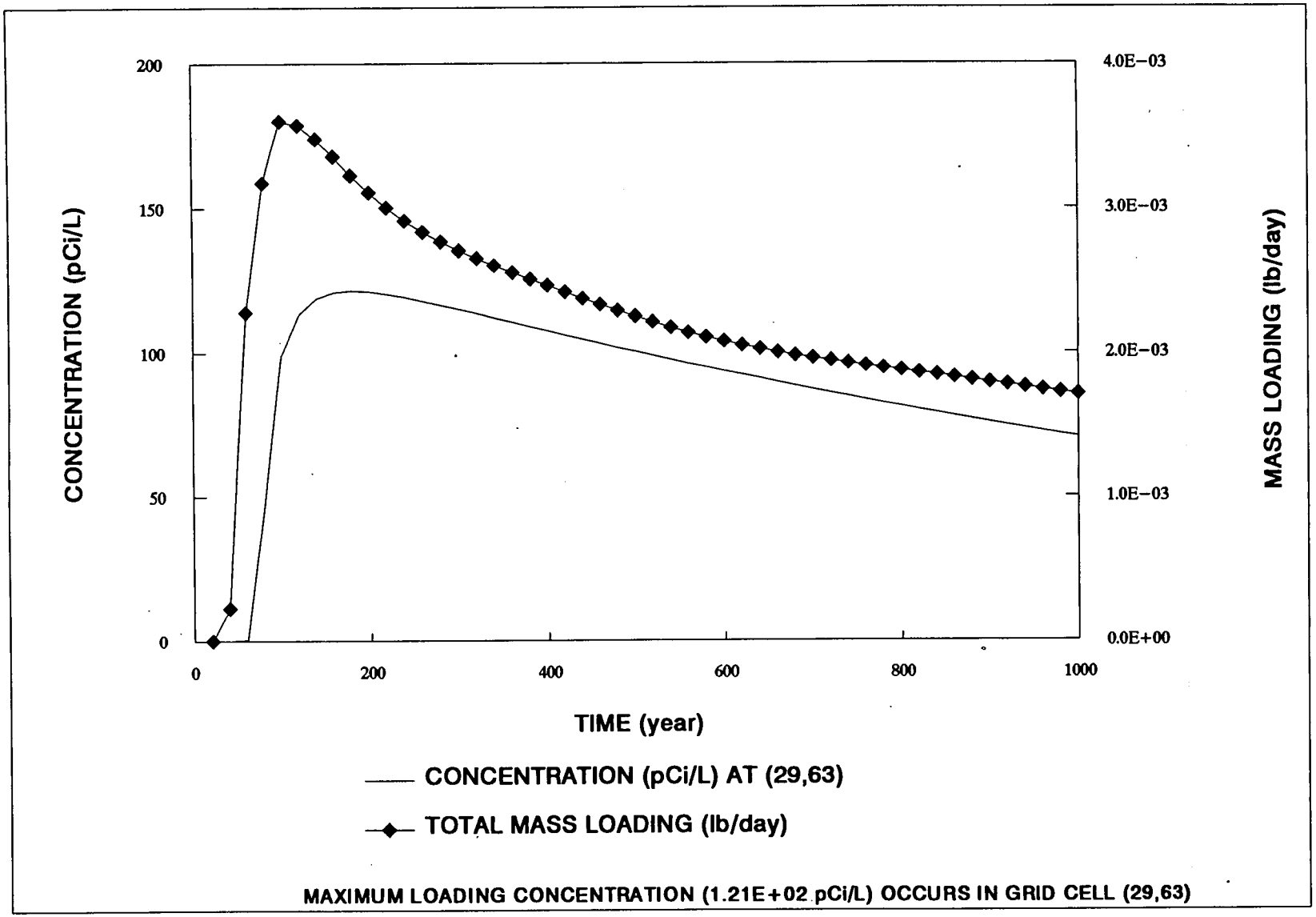

Figure D.1−15 Uranium−238 Loading Curve for Source Materials at 5 pCi/g on the Terrace Face and on the Great Miami Aquifer, Inactive Flyash Pile and South Field

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TABLE D.1-15

INACTIVE FLYASH PILE/SOUTH FIELD
CROSS-MEDIA MODIFIED SOIL PRGs
PROTECTIVE OF THE GREAT MIAMI AQUIFER
USING LATERAL MIGRATION SOURCE CONTROLS

COCs Impacting Groundwater	Units	Federal Ownership Off-Property Resident Farmer PRGs					Background Concentration
		10^{-4} ILCR[a]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[b]	ARAR	
Source Material Over The Great Miami Aquifer							
Uranium-234	pCi/g	1250	91	7.64	NA[c]	NA	1.04
Uranium-235/236	pCi/g	1250	91	7.64	NA	NA	0.15
Uranium-238	pCi/g	819	60	5	NA	NA	1.12
Uranium-Total[d]	mg/kg	NA	NA	NA	172	28	3.4
Source Material On The Top Of The Terrace (Glacial Till)							
Uranium-234	pCi/g	10700	1070	107	NA	NA	1.04
Uranium-235/236	pCi/g	10700	1070	107	NA	NA	0.15
Uranium-238	pCi/g	7000	700	70	NA	NA	1.12
Uranium-Total	mg/kg	NA	NA	NA	2975	450	3.4

[a]ILCR = incremental lifetime cancer risk.
[b]HI = hazard index.
[c]NA = not applicable
[d]Total uranium PRGs and PRLs were developed for a HI of 0.2.

Tables D.1-16 and D.1-17 present the physical parameters and infiltration rates for the modeling run to estimate PRGs for 10^{-5} ILCR. The HELP model was used to estimate infiltration rates (see Attachment D.1-I). For this modeling scenario, the maximum source uranium-238 concentration was 60 pCi/g. It was assumed that source material above this concentration has been excavated.

Figure D.1-16 shows the loading curve. The maximum on-subunit concentration predicted by the SWIFT model was 50.5 pCi/L for the parameters shown in Tables D.1-16 and D.1-17. For the same parameters, the FEMP fenceline maximum uranium-238 concentration predicted by the SWIFT model was 4.29 pCi/L, less than 7.2 pCi/L (10^{-5} ILCR level). To be conservative, the source concentration of 60 pCi/g used for this modeling scenario was also taken as the modified soil PRG for the off-property resident farmer. Table D.1-15 provides a summary of modified soil PRGs for the off-property resident farmer with source controls for lateral migration of perched water.

Tables D.1-18 and D.1-19 presents the physical parameters and infiltration rates for the modeling run to estimate PRGs for 10^{-4} ILCR. The HELP model was used to estimate infiltration rates (see Attachment D.1-I). For this modeling scenario, maximum source uranium-238 concentration in each grid cell was used. It was assumed that no source material is removed.

Figure D.1-17 shows the loading curve. The maximum on-subunit concentration predicted by the SWIFT model was 498 pCi/L for the parameters shown in Tables D.1-16 and D.1-17. For the same parameters, the FEMP fenceline maximum uranium-238 concentration predicted by the SWIFT model was 36.2 pCi/L, less than the 72 pCi/L (10^{-4} ILCR level). Therefore, the modified soil PRG for off-property resident farmer exceeds the maximum uranium-238 concentration (819 pCi/g) by about a factor of 2. Table D.1-15 provides a summary of modified soil PRGs for the off-property resident farmer with source controls for lateral migration of perched water.

Source on the Top of Terrace

This alternative assumes that the only source material impacting the Great Miami Aquifer is on the top of terrace [i.e., underlain by at least 5.5 m (18 ft) of glacial overburden]. For modeling purposes, only gray till in the glacial overburden is assumed to provide any barrier. The leachate from the source material and perched water infiltrate vertically through the gray till and the unsaturated sands and gravels of the Great Miami Aquifer. Tables D.1-20 and D.1-21 present the physical parameters and infiltration rates for the SWIFT grid cells impacted for this scenario. The

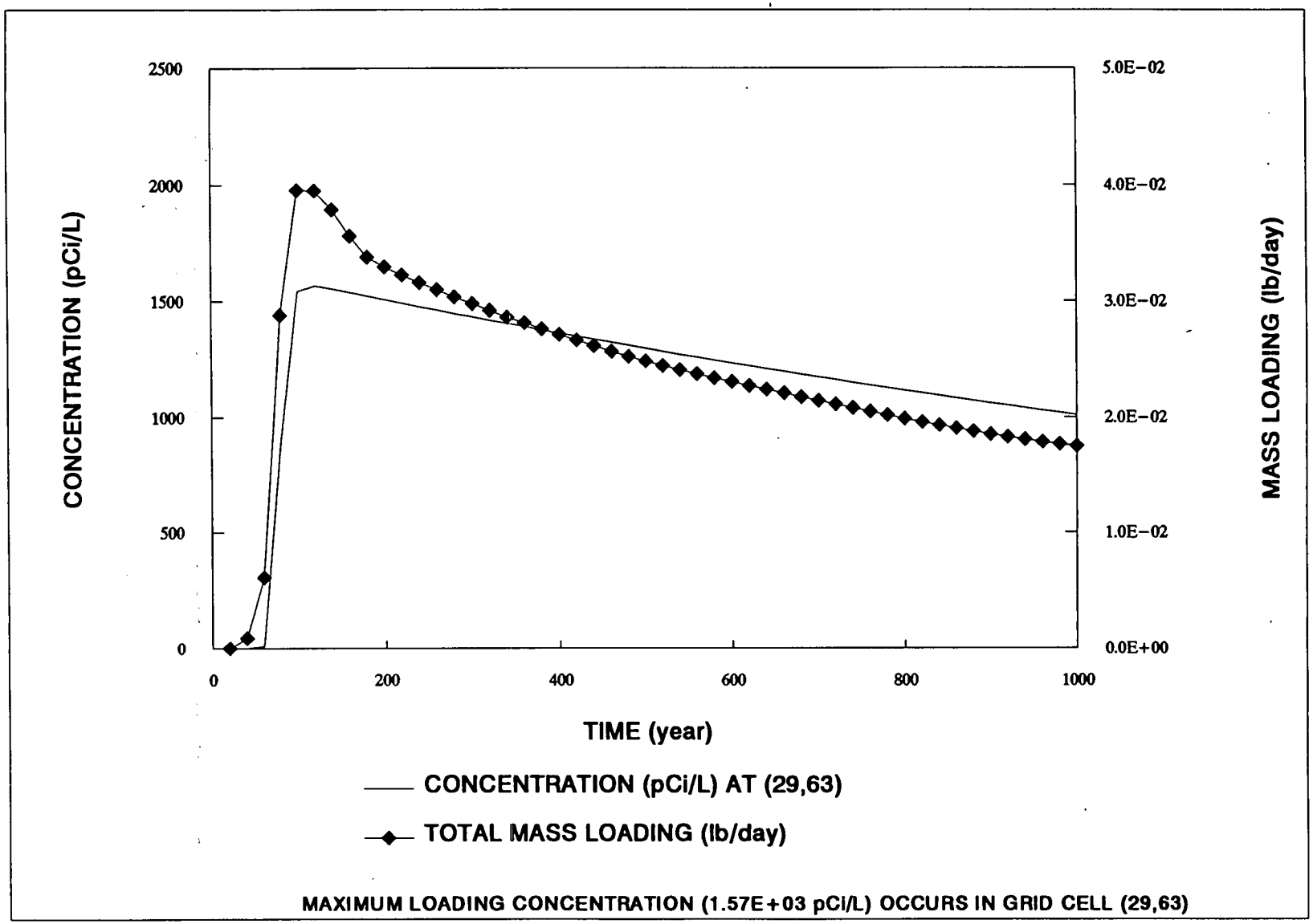

Figure D.1−16 Uranium−238 Loading Curve for Source Materials at 60 pCi/g on the Terrace Face and on the Great Miami Aquifer, Inactive Flyash Pile and South Field

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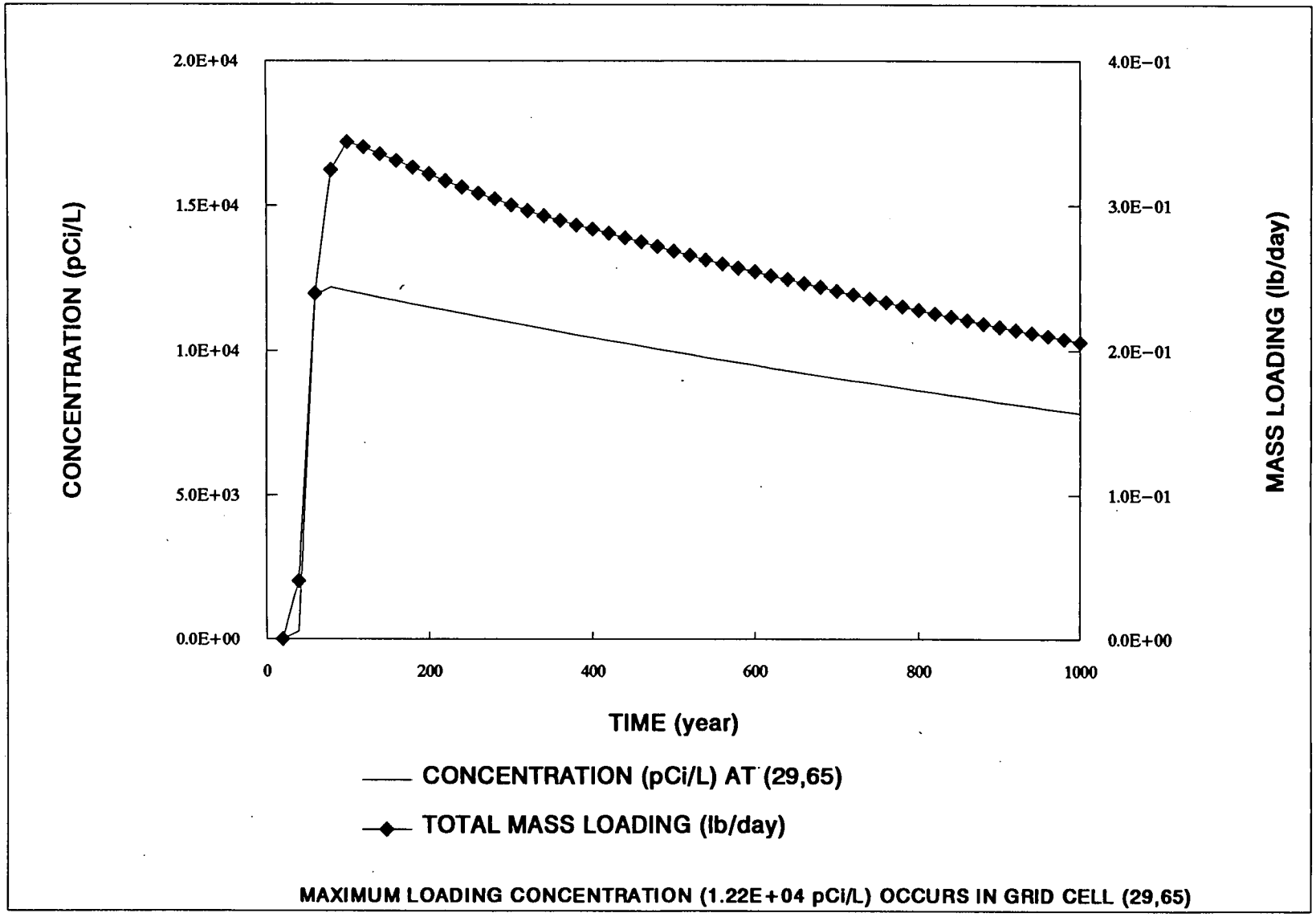

Figure D.1−17 Uranium−238 Loading Curve for Source Materials up to 819 pCi/g on the Terrace Face and on the Great Miami Aquifer, Inactive Flyash Pile and South Field

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TABLE D.1 – 16

PARAMETERS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 60 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Perched Water Source?	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 1 – ZERO TILL, LESS THAN 5 FEET OF SOURCE									
28	63	No	1570	60.00	13.50	1600.00	0.1	0.0	16.9
28	66	No	15630	5.80	13.00	154.67	4.6	0.0	19.3
29	60	No	4690	1.90	1.28	10.72	4.3	0.0	21.4
29	64	No	1570	60.00	14.69	1600.00	0.1	0.0	24.8
29	65	No	1570	60.00	13.50	1600.00	0.1	0.0	22.8
30	57	No	15630	5.18	11.61	29.27	0.1	0.0	21.3
30	61	No	34370	3.83	18.87	21.64	2.8	0.0	20.8
Zone Average			10719	28.10	12.35	716.61	1.7	0.0	21.0
ZONE 2 – ZERO TILL, MORE THAN 8 FEET OF SOURCE									
28	59	No	157810	2.62	59.27	14.80	15.7	0.0	16.7
28	64	No	215600	60.00	1854.43	1600.00	13.8	0.0	19.7
28	65	No	129700	60.00	1115.58	1600.00	8.3	0.0	19.6
29	58	No	154690	4.43	98.24	25.03	12.5	0.0	18.2
29	59	No	318750	2.95	134.80	16.67	22.4	0.0	20.2
29	62	No	150000	15.65	336.52	417.33	16.2	0.0	18.5
29	63	No	390600	60.00	3359.65	1600.00	25.0	0.0	20.8
30	58	No	215600	5.94	183.59	33.56	14.1	0.0	21.7
30	62	No	310900	7.94	353.88	211.73	19.2	0.0	24.1
30	63	No	332800	8.22	392.16	46.44	21.3	0.0	22.8
Zone Average			237645	22.78	788.81	556.56	16.8	0.0	20.2

See footnote at end of table.

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TABLE D.1–16

PARAMETERS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 60 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Perched Water Source?	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 3 – ZERO FILL, IMPACTED TILL AS SOURCE									
29	66	No	29700	60.00	277.83	1600.00	1.9	2.6	32.0
30	64	No	35950	60.00	336.30	338.98	2.3	0.4	26.4
30	65	No	17180	60.00	160.71	338.98	1.1	6.1	27.3
30	66	No	14070	60.00	131.62	1600.00	0.9	7.1	28.6
Zone Average			24225	60.00	226.62	969.49	1.5	4.1	28.6
ZONE 4 – LESS THAN 4 FEET OF TILL BELOW SOURCE									
29	67	No	18750	13.40	36.91	357.33	5.0	2.2	32.5
30	59	No	293750	5.60	240.21	31.64	18.8	2.5	28.2
30	60	No	134374	3.63	72.36	20.51	10.1	3.0	29.0
30	67	No	68750	6.30	63.10	168.00	10.8	3.9	29.7
31	58	No	89060	4.01	53.26	22.66	8.7	1.9	29.6
Zone Average			120937	6.59	93.17	120.03	10.7	2.7	29.8
ZONE 5 – 7 to 10 FEET OF NOT IMPACTED TILL, 9 to 15 FEET OF SOURCE									
31	59	No	193750	4.44	126.80	25.08	12.4	7.8	31.4
31	60	Yes	178120	4.47	117.58	25.27	11.8	8.6	31.6
31	61	Yes	214050	4.47	140.74	25.25	13.4	6.8	30.8
31	62	Yes	196875	2.96	85.86	16.72	12.6	7.5	30.1
31	63	Yes	221875	3.14	102.31	17.74	14.4	8.2	29.5
32	59	Yes	110940	2.45	40.50	13.84	8.9	10.1	32.5
Zone Average			185935	3.66	102.30	20.65	12.2	8.2	31.0

[a]GMA = Great Miami Aquifer.

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TABLE D.1 – 17

HELP MODEL RESULTS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 60 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 1 – ZERO TILL, LESS THAN 5 FEET OF SOURCE									
28	63	9.61	NA[a]	9.61	NA	9.61	7.95	NA	120.9
28	66	9.61	NA	9.61	(29,67)	16.54	7.95	NA	208.1
29	60	9.61	NA	9.61	NA	9.61	7.95	NA	120.9
29	64	9.61	NA	9.61	NA	9.61	7.95	NA	120.9
29	65	9.61	NA	9.61	NA	9.61	7.95	NA	120.9
30	57	9.61	NA	9.61	(31,58)	16.54	7.95	NA	208.1
30	61	9.61	NA	9.61	(31,61)	16.60	7.95	NA	208.8
ZONE 2 – ZERO TILL, MORE THAN 8 FEET OF SOURCE									
28	59	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
28	64	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
28	65	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	58	9.61	NA	9.61	(30,59)	16.54	7.33	NA	225.6
29	59	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	62	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	63	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
30	58	9.61	NA	9.61	(31,59)	16.60	7.33	NA	226.5
30	62	9.61	NA	9.61	(31,62)	16.60	7.33	NA	226.5
30	63	9.61	NA	9.61	(31,63)	ERR	7.33	NA	ERR
ZONE 3 – ZERO FILL, IMPACTED TILL AS SOURCE									
29	66	1.48	NA	1.48	NA	1.48	5.83	9.31	25.4
30	64	1.48	NA	1.48	NA	1.48	5.83	9.31	25.4
30	65	1.48	NA	1.48	NA	1.48	5.83	9.31	25.4
30	66	1.48	NA	1.48	NA	1.48	5.83	9.31	25.4

TABLE D.1-17

HELP MODEL RESULTS FOR THE SWIFT CELLS AFTER REMOVAL OF WASTE TO 60 pCi/g ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 4 – LESS THAN 4 FEET OF TILL BELOW SOURCE									
29	67	2.68	6.93	9.61	NA	2.68	6.70	16.86	40.0
30	59	2.68	6.93	9.61	NA	2.68	6.70	16.86	40.0
30	60	3.99	NA	3.99	(31,60)	10.98	6.70	69.06	163.9
30	67	2.68	6.93	9.61	NA	2.68	6.70	16.86	40.0
31	58	2.68	6.93	9.61	NA	2.68	6.70	16.86	40.0
ZONE 5 – 7 to 10 FEET OF NOT IMPACTED TILL, 9 to 15 FEET OF SOURCE									
31	59	2.23	6.99	9.22	NA	2.23	6.30	14.03	35.4
31	60	2.23	6.99	9.22	NA	2.23	6.30	14.03	35.4
31	61	2.23	6.99	9.22	NA	2.23	6.30	14.03	35.4
31	62	2.23	6.99	9.22	NA	2.23	6.30	14.03	35.4
31	63	2.23	6.99	9.22	NA	2.23	6.30	14.03	35.4
32	59	2.23	6.99	9.22	NA	2.23	6.30	14.03	35.4

[a]NA = not applicable

TABLE D.1 – 18

PARAMETERS FOR THE SWIFT CELLS WITH NO REMOVAL OF WASTE ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Perched Water Source?	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 1 – ZERO TILL									
28	59	No	157810	3.80	85.97	21.47	15.7	0.0	16.7
28	63	No	109375	135.08	2117.97	3602.13	16.0	0.0	16.9
28	64	No	293750	282.23	11884.78	7526.13	21.4	0.0	19.7
28	65	No	135950	98.12	1912.26	2616.53	15.9	0.0	19.6
28	66	No	20300	13.03	37.92	347.47	4.6	0.0	19.3
29	58	No	154690	6.72	149.02	37.97	12.5	0.0	18.2
29	59	No	318750	6.69	305.69	37.80	22.4	0.0	20.2
29	60	No	4690	2.22	1.49	12.54	4.3	0.0	21.4
29	62	No	150000	55.28	1188.69	1474.13	16.2	0.0	18.5
29	63	No	393750	64.58	3645.26	1722.13	25.3	0.0	20.8
29	64	No	289060	223.76	10084.35	5966.93	18.5	0.0	24.8
29	65	No	407800	818.99	47877.97	21839.73	26.6	0.0	22.8
30	57	No	15630	5.18	11.61	29.27	0.1	0.0	21.3
30	58	No	215600	9.48	293.00	53.56	14.1	0.0	21.7
30	61	No	34370	7.32	36.07	41.36	2.8	0.0	20.8
30	62	No	310900	58.46	2605.49	1558.93	19.9	0.0	24.1
30	63	No	332800	33.54	1600.13	189.49	21.3	0.0	22.8
Zone Average			215460	127.88	6734.41	3288.81	14.9	0.0	21.9

See footnote at end of table.

TABLE D.1–18

PARAMETERS FOR THE SWIFT CELLS WITH NO REMOVAL OF WASTE ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Perched Water Source?	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 2 – LESS THAN 4 FEET OF TILL BELOW SOURCE									
29	66	No	259375	130.01	4933.72	3466.93	17.0	2.6	32.0
29	67	No	18750	23.27	66.97	620.53	5.0	2.2	32.5
30	59	No	293750	8.76	375.76	49.49	18.8	2.5	28.2
30	60	No	134374	4.90	97.67	27.68	10.1	3.0	29.0
30	64	No	285950	216.85	9057.49	1225.14	18.5	0.4	26.4
30	67	No	68750	39.83	404.98	1062.13	11.1	3.9	29.7
31	58	No	89060	7.00	92.97	39.55	8.7	1.9	29.6
Zone Average			164287	61.52	2147.08	927.35	12.7	2.4	29.6
ZONE 3 – 6 to 10 FEET OF NOT IMPACTED TILL, 9 to 15 FEET OF SOURCE									
30	65	No	162500	547.30	13178.90	3092.09	10.4	6.1	27.3
30	66	No	181250	147.97	3960.82	3945.87	11.6	7.1	28.6
31	59	No	193750	7.12	203.34	40.23	12.4	7.8	31.4
31	60	Yes	178120	5.08	133.57	28.70	11.8	8.6	31.6
31	61	Yes	214050	7.24	227.96	40.90	13.4	6.8	30.8
31	62	Yes	196875	5.86	169.99	33.11	12.6	7.5	30.1
31	63	Yes	221875	6.65	216.67	37.57	14.4	8.2	29.5
32	59	Yes	110940	3.06	50.59	17.29	8.9	10.1	32.5
Zone Average			182420	91.29	2267.73	904.47	11.9	7.8	30.2

[a]GMA – Great Miami Aquifer

TABLE D.1 – 19

HELP MODEL RESULTS FOR THE SWIFT CELLS WITH NO REMOVAL OF WASTE ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 1 – ZERO TILL									
28	59	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
28	63	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
28	64	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
28	65	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
28	66	9.61	NA	9.61	(29,66) & (30,66)	23.94	7.33	NA	326.6
29	58	9.61	NA	9.61	(30,59)	16.58	7.33	NA	226.2
29	59	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	60	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	62	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	63	9.61	NA	9.61	NA	9.61	7.33	NA	131.1
29	64	9.61	NA	9.61	(30,64)	16.58	7.33	NA	226.2
29	65	9.61	NA	9.61	(30,65)	16.97	7.33	NA	231.5
30	57	9.61	NA	9.61	(31,58)	16.58	7.33	NA	226.2
30	58	9.61	NA	9.61	(31,59)	16.97	7.33	NA	231.5
30	61	9.61	NA	9.61	(31,61)	16.97	7.33	NA	231.5
30	62	9.61	NA	9.61	(31,62)	16.97	7.33	NA	231.5
30	63	9.61	NA	9.61	(31,63)	16.97	7.33	NA	231.5

See footnote at end of table.

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TABLE D.1-19

HELP MODEL RESULTS FOR THE SWIFT CELLS WITH NO REMOVAL OF WASTE ON THE GREAT MIAMI AQUIFER AND ON THE TERRACE FACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Lateral Drainage Rate (in./yr)	Waste Infiltration Rate (in./yr)	Receives Lateral Drainage From	Vadose Layer 1 & 2 Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 2 – LESS THAN 4 FEET OF TILL BELOW SOURCE									
29	66	2.64	6.97	9.61	NA	9.61	6.74	60.44	142.6
29	67	4.17	NA	4.17	NA	2.68	6.28	16.86	42.7
30	59	2.64	6.97	9.61	NA	2.68	6.28	16.86	42.7
30	60	4.17	NA	4.17	(31,60)	11.53	6.74	72.52	171.1
30	64	2.64	6.97	9.61	NA	9.61	6.74	60.44	142.6
30	67	4.17	NA	4.17	NA	2.68	6.28	16.86	42.7
31	58	2.64	6.97	9.61	NA	2.68	6.28	16.86	42.7
ZONE 3 – 6 to 10 FEET OF NOT IMPACTED TILL, 9 to 15 FEET OF SOURCE									
30	65	2.25	7.36	9.61	NA	9.61	6.43	60.44	149.5
30	66	2.25	7.36	9.61	NA	9.61	6.43	60.44	149.5
31	59	2.25	7.36	9.61	NA	2.23	6.17	14.03	36.1
31	60	2.25	7.36	9.61	NA	2.23	6.17	14.03	36.1
31	61	2.25	7.36	9.61	NA	2.23	6.17	14.03	36.1
31	62	2.25	7.36	9.61	NA	2.23	6.17	14.03	36.1
31	63	2.25	7.36	9.61	NA	2.23	6.17	14.03	36.1
32	59	2.25	7.36	9.61	NA	2.23	6.17	14.03	36.1

[a]NA = not applicable

TABLE D.1–20

PARAMETERS FOR THE SWIFT CELLS FOR PRG DEVELOPMENT FOR THE WASTE ON THE TOP OF THE TERRACE, SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	Initial Leachate Concentration (pCi/L)	Source Thickness (ft)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 1 – About 4.25 Feet of Source Material								
34	60	9374	5.48	34	31	4.3	7.8	32.7
35	61	4687	25.95	79	147	4.2	9.1	32.2
Zone Average		7031	15.72	57	89	4.3	8.5	32.5
ZONE 2 – About 6 Feet of Source Material								
31	65	98125	35.63	3336	201	6.3	10.7	28.6
31	66	93749	24.37	2081	138	6.0	9.4	28.7
32	64	96876	6.26	641	35	7.0	9.6	29.6
33	59	93125	2.55	215	14	6.0	7.2	33.0
33	60	90625	5.93	474	34	5.8	7.7	32.7
33	61	101875	12.00	1205	68	6.5	9.2	31.8
33	62	51560	70.00	1869	395	3.3	9.8	31.1
33	63	78125	63.54	4836	359	6.4	9.6	30.6
34	61	104690	42.48	4447	240	6.6	9.1	32.1
34	62	64060	62.50	4107	353	6.8	9.7	31.5
Zone Average		87281	32.53	2321	184	6.1	9.2	31.0
ZONE 3 – 8 to 11 Feet of Source Material								
31	64	167188	17.56	4654	99	10.7	10.6	29.1
32	59	110938	3.06	449	17	8.9	7.9	32.5
32	60	121875	5.66	877	32	8.5	7.5	32.3
32	61	126563	7.09	1110	40	8.3	8.6	31.4
32	62	157812	25.22	6024	142	10.2	9.0	30.7
32	63	154688	21.95	5139	124	10.2	9.3	30.1
Zone Average		139844	13.42	3042	76	9.5	8.8	31.0

[a]GMA = Great Miami Aquifer.

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TABLE D.1–21

HELP MODEL RESULTS FOR THE SWIFT CELLS FOR PRG DEVELOPMENT FOR THE TOP OF TERRACE SOUTH FIELD AND INACTIVE FLYASH PILE

Row	Column	Vertical Infiltration Rate (in./yr)	Layer 2 Moisture Content (Vol %)	Layer 1 Seepage Rate (in./yr)	Layer 2 Seepage Rate (in./yr)
ZONE 1 – ABOUT 4.25 FEET OF SOURCE					
34	60	2.55	6.31	16.04	40.4
35	61	2.55	6.31	16.04	40.4
ZONE 2 – ABOUT 6 FEET OF SOURCE					
31	65	3.05	6.46	19.18	47.2
31	66	3.05	6.46	19.18	47.2
32	64	3.05	6.46	19.18	47.2
33	59	3.05	6.46	19.18	47.2
33	60	3.05	6.46	19.18	47.2
33	61	3.05	6.46	19.18	47.2
33	62	3.05	6.46	19.18	47.2
33	63	3.05	6.46	19.18	47.2
34	61	3.05	6.46	19.18	47.2
34	62	3.05	6.46	19.18	47.2
ZONE 3 – 8 TO 11 FEET OF SOURCE					
31	64	3.68	6.63	23.14	55.5
32	59	3.68	6.63	23.14	55.5
32	60	3.68	6.63	23.14	55.5
32	61	3.68	6.63	23.14	55.5
32	62	3.68	6.63	23.14	55.5
32	63	3.68	6.63	23.14	55.5

HELP model was used to estimate infiltration rates (see Attachment D.1-I). For this modeling scenario, the maximum source uranium-238 concentration was 70 pCi/g. It was assumed that source material above this concentration has been excavated.

Figure D.1-18 shows the loading curve. The maximum on-subunit concentration predicted by the SWIFT model was 3.11 pCi/L for the parameters shown in Table D.1-20. For the same parameters, the FEMP fenceline maximum uranium-238 concentration predicted by the SWIFT model was 0.40 pCi/L, less than 0.72 pCi/L (10^{-6} ILCR level). To be conservative, the source concentration of 70 pCi/g used for this modeling scenario was also taken as the modified soil PRG for the off-property resident farmer. Table D.1-15 provides a summary of modified soil PRGs for the off-property resident farmer with source controls for lateral migration of perched water.

D.1.5.3.4 Consolidation and Capping with Source Controls for Lateral Migration of Perched Water

Figure D.1-19 shows the areal extent of the South Field, Inactive Flyash Pile, and Active Flyash Pile waste consolidation area and the SWIFT III grid cells impacted by direct loading from this area. For this alternative, waste containing uranium-238 at concentrations greater than 5 pCi/g was consolidated and capped as shown in Figure D.1-19. This modeling scenario evaluates the impact of the consolidation area on the Great Miami Aquifer from the South Field, Inactive Flyash Pile, and Active Flyash Pile. These three units are evaluated together, because wastes from these areas will be placed under one capped consolidation area. The fate and transport modeling assumed that the lateral migration of the perched water will be controlled and, therefore, will not require seepage modeling. However, the perched water still represents a source for vertical infiltration, and was modeled.

Table D.1-22 shows the physical parameters for this alternative. To be conservative, all source material form a subunit was assumed to be at its maximum concentration. In other words, all source from the Inactive Flyash Pile was assumed to be at 1,570 pCi/g, while all source material from the South Field was assumed to be at 397 pCi/g, and all source material from the Active Flyash Pile was assumed to be at 12.6 pCi/g. These assumptions were made because exact placement of the waste is not known and to calculate worst-case modified soil PRGs. The maximum predicted loading concentration and maximum on-subunit Great Miami Aquifer concentrations were 2.17×10^{-4} pCi/L and 1.46×10^{-6} pCi/L, respectively. These concentrations are well below 0.72 pCi/L (10^{-6} ILCR level) due to low infiltration rate. Therefore, consolidation and capping should be protective of the

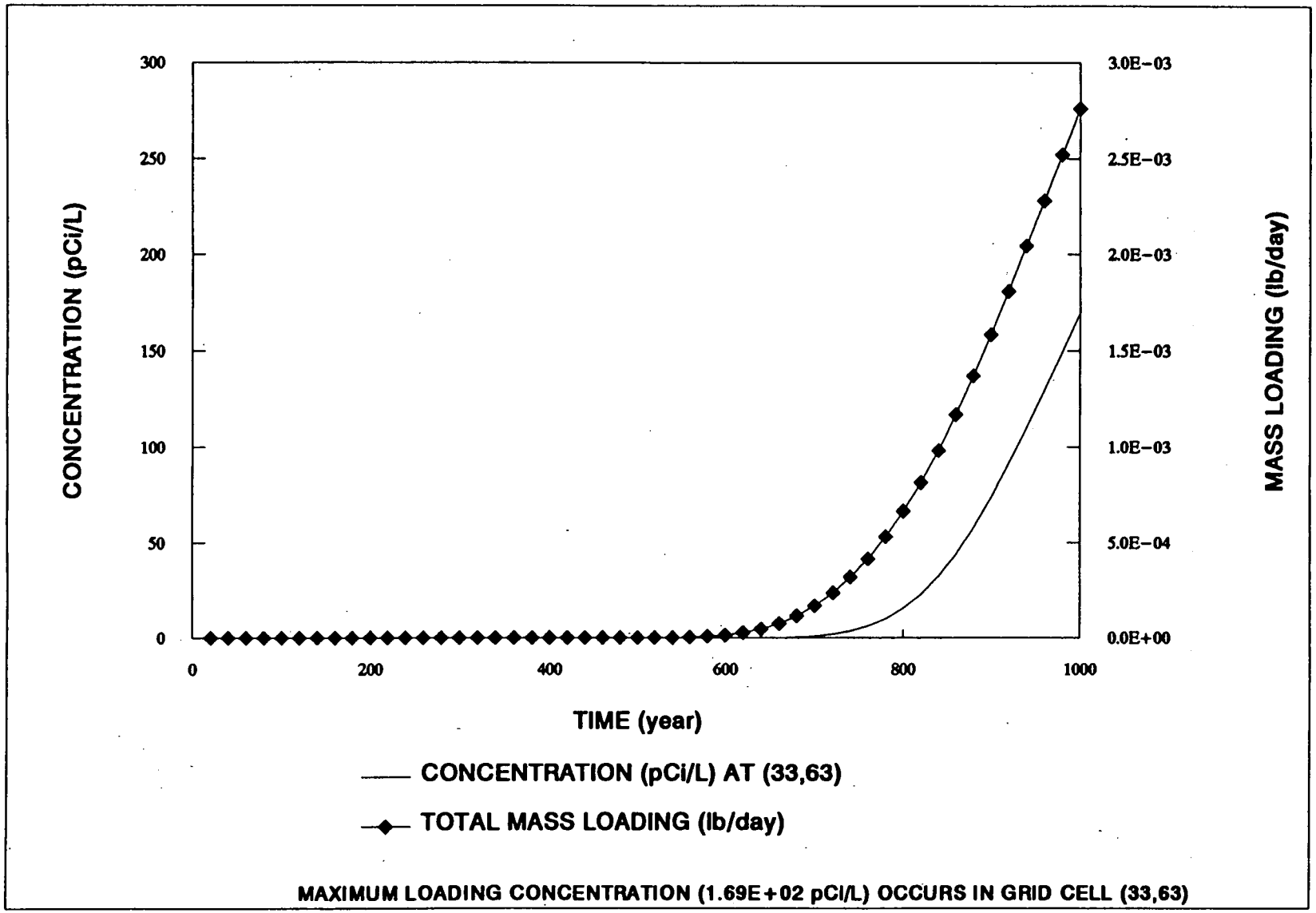

Figure D.1–18 Uranium–238 Loading Curve for Source Materials up to 70 pCi/g on the Terrace Face, Inactive Flyash Pile and South Field

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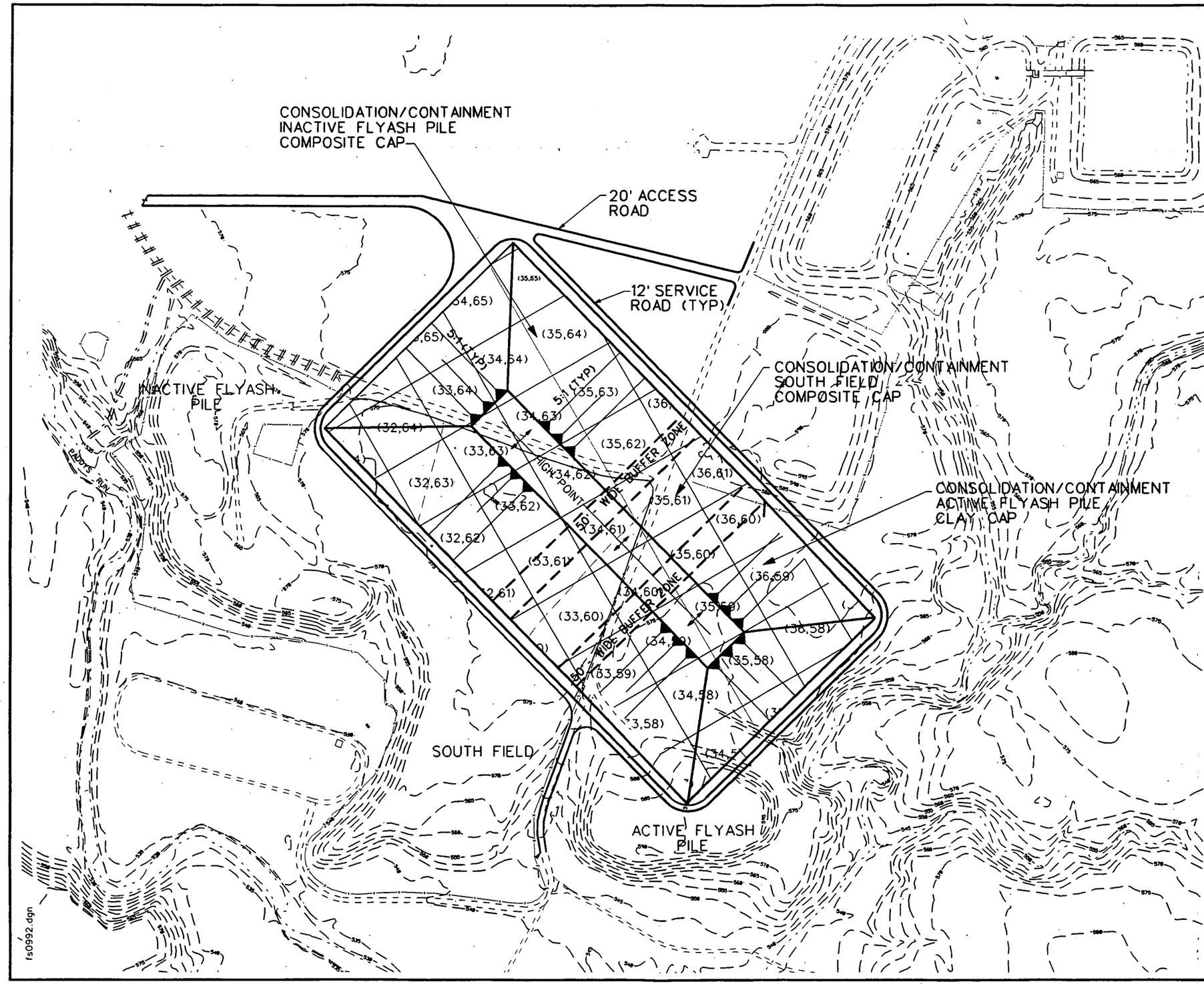

LEGEND

- 575 — ELEVATION CONTOURS
- 575 — PROPOSED CONTOURS
- ROADS
- PROPOSED ROADS
- STREAM
- FENCE
- RAILROAD
- (35,64) SWIFT GRID (COLUMN,ROW)

NOTE:
Surface contours based on 1992 flyover.

N

SCALE (FT)
0 100 200 400

SCALE (METER)
0 24 48 96

FIGURE D.1-19
SITE RESTORATION
CONSOLIDATION/CONTAINMENT
SWIFT MODEL GRID
FOR INACTIVE
FLYASH PILE, SOUTH FIELD,
AND ACTIVE FLYASH PILE

TABLE D.1–22

PARAMETERS FOR THE SWIFT CELLS AFTER CONSOLIDATION AND CAPPING
SOUTH FIELD, INACTIVE FLYASH PILE, AND ACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	U–238 Leachate Concentration (pCi/L)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 1 – CAPPED WASTE FROM INACTIVE FLYASH PILE							
32	61	208550	1570.00	23749.1	41866.7	8.6	31.4
32	62	208550	1570.00	23749.1	41866.7	9.0	30.7
32	63	208550	1570.00	23749.1	41866.7	9.3	30.1
33	61	208550	1570.00	23749.1	41866.7	9.2	31.8
33	62	208550	1570.00	23749.1	41866.7	9.8	31.1
33	63	208550	1570.00	23749.1	41866.7	9.6	30.6
34	61	208550	1570.00	23749.1	41866.7	9.1	32.1
34	62	208550	1570.00	23749.1	41866.7	9.7	31.5
34	63	208550	1570.00	23749.1	41866.7	9.0	31.1
34	64	208550	1570.00	23749.1	41866.7	9.0	31.0
35	61	208550	1570.00	23749.1	41866.7	9.1	32.2
35	62	208550	1570.00	23749.1	41866.7	9.0	32.0
35	63	208550	1570.00	23749.1	41866.7	9.0	31.9
ZONE 2 – CAPPED WASTE FROM SOUTH FIELD							
33	59	203750	397.00	5867.1	2243	7.2	33.0
33	60	203750	397.00	5867.1	2243	7.7	32.7
34	60	203750	397.00	5867.1	2243	7.8	32.7
35	60	203750	397.00	5867.1	2243	7.5	32.7
36	60	203750	397.00	5867.1	2243	7.5	33.4

See footnote at end of table.

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TABLE D.1–22

PARAMETERS FOR THE SWIFT CELLS AFTER CONSOLIDATION AND CAPPING
SOUTH FIELD, INACTIVE FLYASH PILE, AND ACTIVE FLYASH PILE

Row	Column	Source Volume (ft^3)	U–238 Concentration (pCi/g)	Source Inventory (Kg)	U–238 Leachate Concentration (pCi/L)	Till Thickness (ft)	Unsaturated GMA[a] Thickness (ft)
ZONE 3 – CAPPED WASTE FROM THE ACTIVE FLYASH PILE							
33	58	219650	12.60	200.7	336.0	7.5	32.6
34	57	219650	12.60	200.7	336.0	7.5	32.1
34	58	219650	12.60	200.7	336.0	7.5	32.6
34	59	219650	12.60	200.7	336.0	7.5	32.3
35	57	219650	12.60	200.7	336.0	7.5	33.2
35	58	219650	12.60	200.7	336.0	7.5	33.3
35	59	219650	12.60	200.7	336.0	7.5	33.0
36	58	219650	12.60	200.7	336.0	7.5	33.9
36	59	219650	12.60	200.7	336.0	7.5	33.7

[a]GMA = Great Miami Aquifer.

Great Miami Aquifer. Table D.1-23 provides a summary of modified soil PRGs for the off-property resident farmer for consolidation and capping with source controls for lateral migration of perched water.

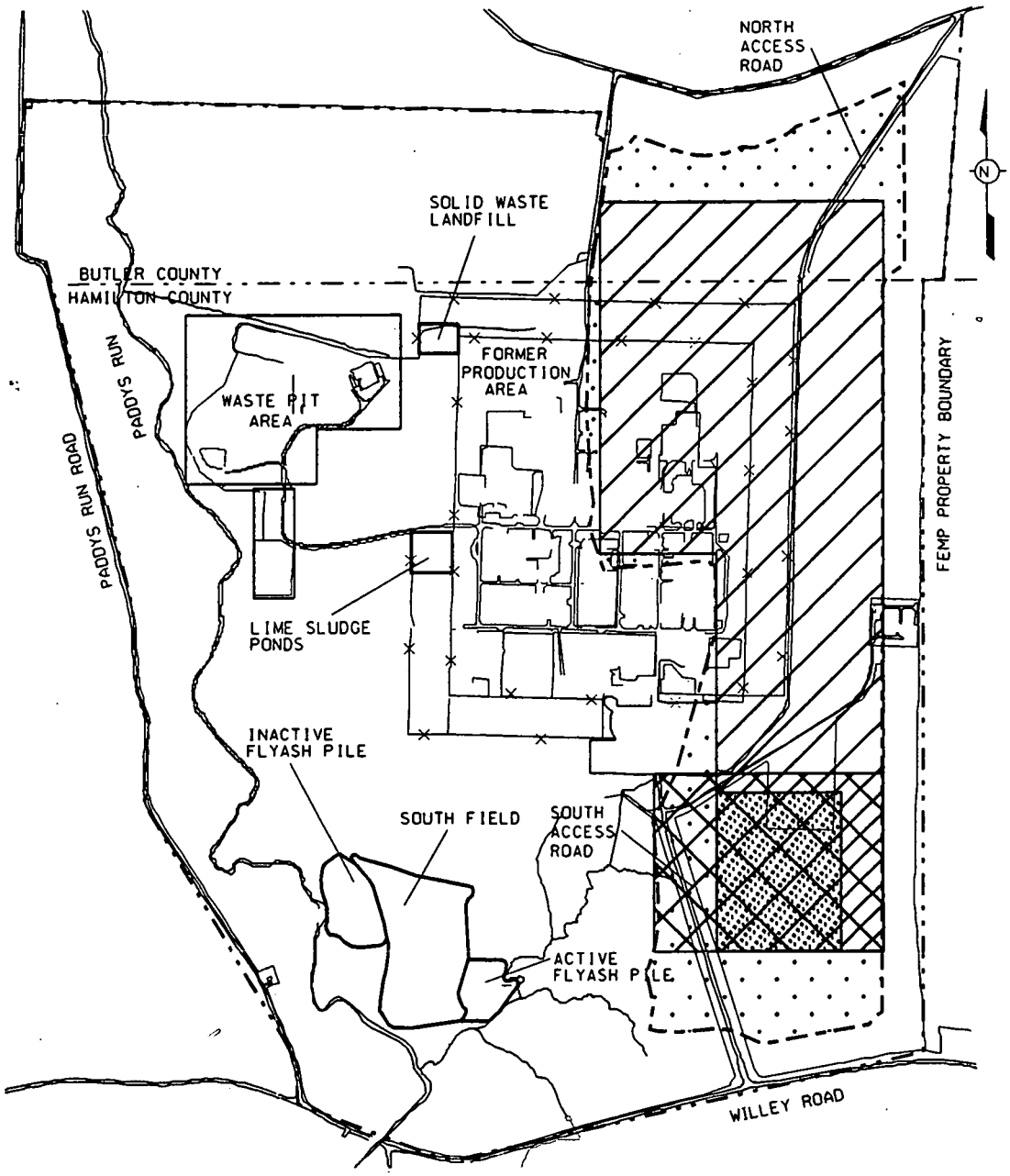
D.1.5.4 Active Flyash Pile

Two alternatives were considered for the Active Flyash Pile. The first alternative (Alternative 3) deals with excavation and disposal away from the subunit. The Operable Unit 2 RI modeling indicated that the Active Flyash Pile is nearly homogenous with respect to the uranium-238 concentrations. Furthermore, the Active Flyash Pile is either underlain by the Great Miami Aquifer, or it is on the terrace face. Therefore, PRGs developed for the similar scenario for the South Field/Inactive Flyash Pile are applicable to the Active Flyash Pile. Table D.1-24 provides a summary of modified soil PRGs for the Active Flyash Pile for excavation.

The second alternative (Alternative 2) considered was consolidation and capping. Figure D.1-19 shows the SWIFT III grid blocks directly beneath the flyash from the Active Flyash Pile after consolidation. As shown in Section D.1.5.3.4, impact of the Active Flyash Pile source was included in the modeling for the Inactive Flyash Pile and South Field. Modeling indicated that modified soil PRGs are much higher than the maximum soil concentrations detected in the Active Flyash Pile.

D.1.6 PRELIMINARY WASTE ACCEPTANCE CRITERIA FOR ON-SITE DISPOSAL OF OPERABLE UNIT 2 MATERIALS

Figure D.1-20 shows the proposed Operable Unit 2 disposal cell in relation to the area available for an overall disposal facility for the FEMP. The proposed Operable Unit 2 disposal cell is relatively small compared to this area. Figures D.1-21 and D.1-22 show the gray till and unsaturated Great Miami Aquifer thicknesses. The minimum gray till thickness in the proposed disposal cell area is 3.7 m (12 ft). Furthermore, groundwater flow is from the west toward the east-southeast under the disposal cell. To consider cumulative impacts on the groundwater, preliminary WAC were developed from modeling an area which included the proposed Operable Unit 2 disposal cell and areas to the east and west of the proposed cell (see Figure D.1-20).



LEGEND

- ADDITIONAL AREA FOR 8,500,000 CU. YD. FEMP CELL
- PROPOSED OU2 DISPOSAL CELL LOCATION
- POTENTIALY ACCEPTABLE GEOLOGY
- AREA MODELED FOR WAC DEVELOPMENT
- FEMP BOUNDARY

SCALE

0 1200 2400 FEET

0 288 576 METER

FIGURE D.1-20
POTENTIALLY ACCEPTABLE LOCATIONS FOR SITEWIDE ON-SITE DISPOSAL AND MODELED AREA FOR WAC DEVELOPMENT

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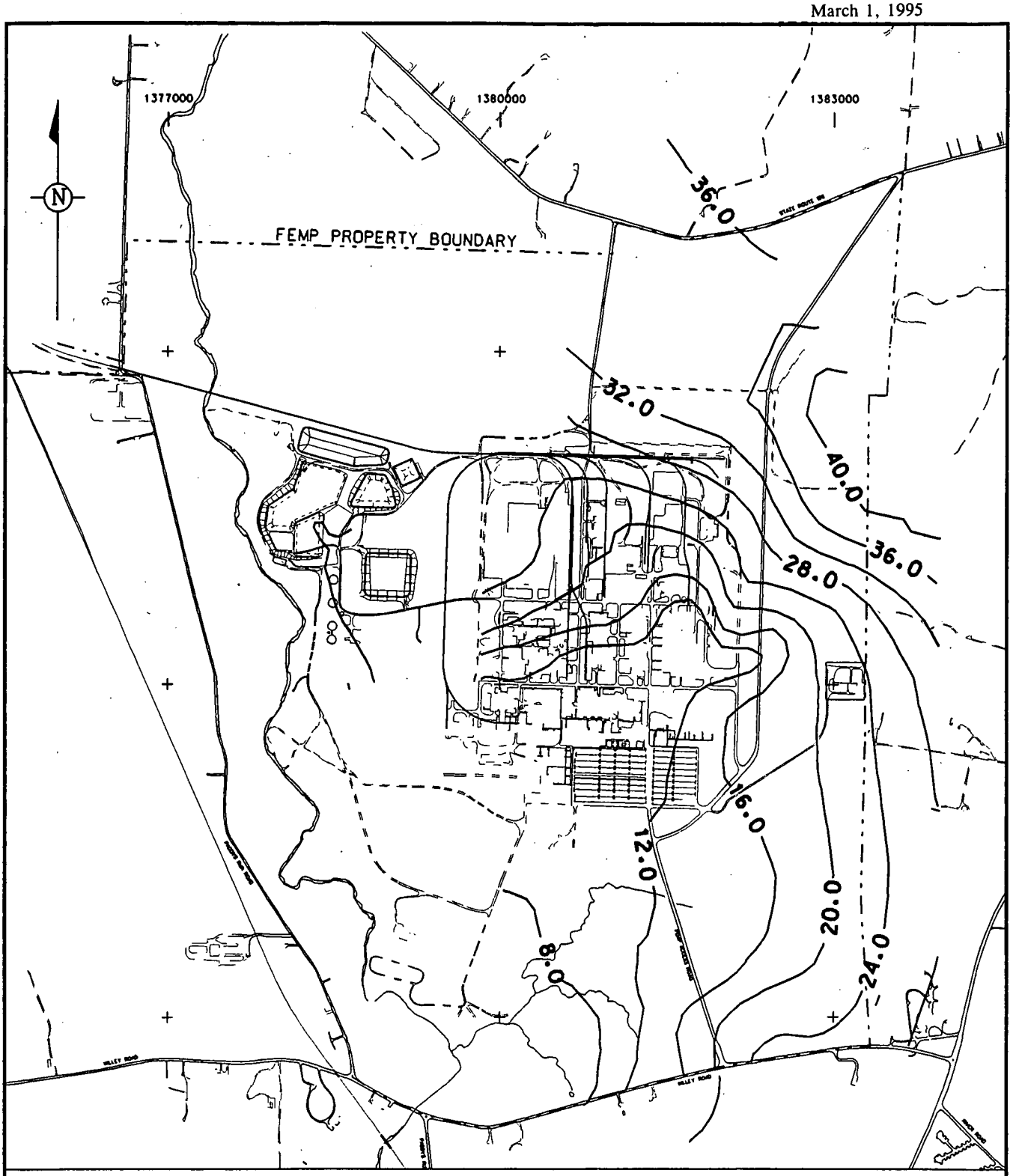

NOTE:

MAXIMUM THICKNESS
= 40.0 FT

LEGEND: 10.0 THICKNESS CONTOUR (FT.)

SCALE
0 325 650 1300 FEET

0 78 156 312 METER

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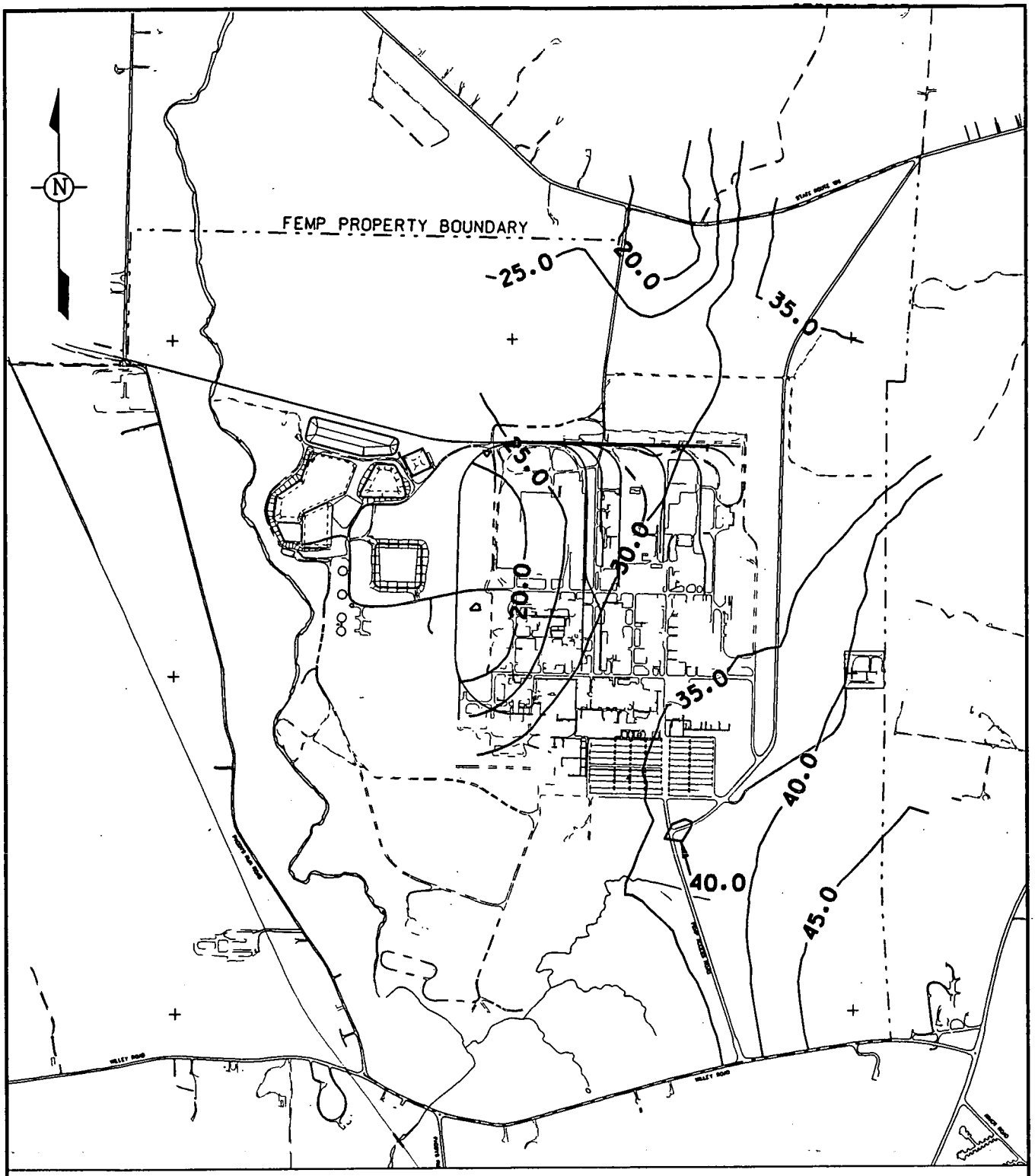
FIGURE D.1-21
GRAY TILL THICKNESS IN FEET FOR
DISPOSAL CELL AREA



NOTE:

MAXIMUM THICKNESS
= 47.85 FT

LEGEND: 20.0 THICKNESS CONTOUR (FT)

SCALE
0 325 650 1300 FEET
0 78 156 312 METER

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FIGURE D.1-22
UNSATURATED GREAT MIAMI AQUIFER THICKNESS
INFEET FOR DISPOSAL CELL AREA

TABLE D.1-23

INACTIVE FLYASH PILE/SOUTH FIELD/ACTIVE FLYASH PILE CROSS-MEDIA MODIFIED SOIL PRGs PROTECTIVE OF THE GREAT MIAMI AQUIFER USING A CAP AND SOURCE CONTROLS FOR PERCHED WATER

COCs Impacting Groundwater	Units	Federal Ownership Off-Property Resident Farmer PRGs[a]					Background
		10^{-4} ILCR[b]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[c]	ARAR	
SOURCE MATERIAL ON THE TOP OF THE TERRACE (GLACIAL TILL)							
Uranium-234	pCi/g	> 100,000	> 100,000	> 10,000	NA	NA	1.04
Uranium-235/236	pCi/g	> 100,000	> 100,000	> 10,000	NA	NA	0.15
Uranium-238	pCi/g	> 100,000	> 100,000	> 10,000	NA	NA	1.12
Uranium-Total[d]	mg/kg	NA	NA	NA	> 10,000	> 10,000	3.4

[a]Cap is not considered in an area where source material is directly underlain by the Great Miami Aquifer; therefore, no PRGs were developed for this case.

[b]ILCR - incremental lifetime cancer risk.

[c]HI - hazard index.

[d]Total uranium PRGs and PRLs were developed only for a HI of 0.2.

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TABLE D.1-24

ACTIVE FLYASH PILE
CROSS-MEDIA MODIFIED SOIL PRGs
PROTECTIVE OF THE GREAT MIAMI AQUIFER
WITHOUT SOURCE CONTROLS

COCs Impacting Groundwater	Units	Private Ownership On-Property Resident Farmer PRG-Carcinogenic Risk Based					Federal Ownership Off-Property Resident Farmer PRGs					Background Concentration
		10^{-4} ILCR[a]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[b]	ARAR	10^{-4} ILCR	10^{-5} ILCR	10^{-6} ILCR	0.2 HI	ARAR	
Uranium-234	pCi/g	155	15.5	1.55	NA[c]	NA	760	76	7.6	NA	NA	1.04
Uranium-235/236	pCi/g	155	15.5	1.55	NA	NA	760	76	7.6	NA	NA	0.15
Uranium-238	pCi/g	101	10.1	1.01	NA	NA	500	50	5.0	NA	NA	1.12
Uranium-Total	mg/kg	NA	NA	NA	24	28	NA	NA	NA	172	28	3.4

[a]ILCR = incremental lifetime cancer risk.

[b]HI = hazard index.

[c]NA = not applicable.

The following conservative assumptions were made to provide a margin of safety in the WAC development:

- Evaluating the MCL criterion anywhere under the facility rather than at the edge of the facility where additional dilution, adsorption, and dispersion in the aquifer would have occurred,
- Ignoring the geomembrane in the capping system and liner system,
- Ignoring the contributions of the liner, leachate collection, and leak detection systems,
- Ignoring adsorption and transport time through the brown till, and
- Utilizing assumptions for moisture content and infiltration that result in conservative values of contaminant travel time.

Wastes from the Lime Sludge Ponds, South Field, Inactive Flyash Pile, Active Flyash Pile, and Solid Waste Landfill were considered for containment at the disposal cell. If a contaminant was not a groundwater COC for subunits based on the Baseline Risk Assessment, it did not become a groundwater COC at the disposal cell because the infiltration rate is much less at the disposal cell than at the unremediated subunits. Because uranium isotopes were the only groundwater COCs at the Operable Unit 2 subunits, the only COCs for groundwater at the proposed disposal cell were uranium isotopes. It was assumed that waste will not be treated before disposal; this represents the worst-case scenario. Furthermore, wastes from other operable units might be placed in a site-wide disposal facility. Due to the unknown nature of the geochemistry of wastes from other sources, 3.1 mL/g was used as the K_d of the gray till. Only the vadose zone pathway was applicable for the disposal cell. The vadose zone model depicting flow in the subsurface soils at the disposal cell considers two layers. Layer 1 soils consist of gray tills with thickness ranging from 3.6 to 6.1 m (11.9 to 20 ft). Brown till and interbedded sand and gravel stringers within the glacial overburden were not considered as a barrier layer in the vadose zone pathway. Beneath the till layer is more than 10.7 m (35 ft) of unsaturated sand and gravel as Layer 2. Figures D.1-21 and D.1-22 show the thicknesses of the two layers used in the modeling. The HELP model was used to estimate infiltration through the composite cap. Outputs of the HELP model are included in Attachment D.1-I. Infiltration through the cap was estimated to be 3.1 cm/yr (1.2 in./yr). The seepage velocity in the gray till was 19.6 cm/yr (7.7 in./yr) and in the unsaturated Great Miami Aquifer was 77.5 cm/yr (30.5 in./yr).

Using a constant leachate concentration of 10 mg/L (3,360 pCi/L), the maximum concentration in the Great Miami Aquifer was predicted to be 0.93 pCi/L (2.78 μg/L). The maximum predicted fenceline concentration was 0.032 pCi/L. If uranium-238 leachate concentration is 71.38 mg/L (23,980 pCi/L), the maximum on-site concentration in the Great Miami Aquifer will be 20 μg/L of total uranium (19.85 μg/L uranium-238 or 6.67 pCi/L uranium-238) and the maximum FEMP fenceline concentration will be 0.23 pCi/L uranium-238. Note that 0.23 pCi/L is below the 10^{-6} ILCR value of 0.72 pCi/L. However, 20 μg/L is the MCL for total uranium. Thus, to be acceptable for on-site disposal, waste should not result in uranium-238 leachate concentrations exceeding 71.38 mg/L. The waste concentrations are a function of waste leachability, which can be quantified with use of the distribution coefficient for leaching or desorption (K_L). Table D.1-25 presents WAC as a function of K_L. The Operable Unit 2 waste with the lowest K_L is flyash (see Appendix D.3). For flyash, K_L is 37.5 mL/g; this results in a preliminary WAC of 2,677 mg/Kg uranium-238 or 900 pCi/g uranium-238. If K_L was 15 mL/g, the WAC would be 1,070 mg/Kg or 360 pCi/g uranium-238.

To confirm the protectiveness of the preliminary WAC, an alternate modeling approach was utilized. That modeling is presented in Attachment D.5-IV. That alternate approach ignores any contribution of the unsaturated Great Miami Aquifer to the retardation of uranium. However, it does include the contribution of a clay liner having a K_d of 24 mL/g. Also, the alternate approach uses a recalculated infiltration rate that accounts for all layers in the disposal cell cross-section except for geomembranes. This alternate approach results in an even lower loading to the Great Miami Aquifer than the original modeling simulates.

D.1.7 SENSITIVITY TO THE DISTRIBUTION COEFFICIENT

Distribution coefficient (K_d) of soils under the waste is the most important parameter in PRG and preliminary WAC development. Distribution coefficients developed from different tests/studies for the glacial overburden indicate that the K_d for this layer may vary from about 3.1 mL/g to more than 200 mL/g. All of the PRGs developed in this appendix are based on a K_d of 24 mL/g for the glacial till. If the K_d for the glacial till is set at 200 mL/g while holding all other parameters (including K_L) constant, the PRGs for all areas with more than 2.1 m (7 ft) of gray till would be more than the maximum source concentrations in the Operable Unit 2 subunits. On the other hand, if a K_d of 3.1 mL/g is selected, the PRGs would decrease significantly. Table D.1-26 shows the sensitivity of the PRGs (at 10^{-6} ILCR) to the glacial till K_d values.

TABLE D.1-25

PRELIMINARY WASTE ACCEPTANCE CRITERIA PROTECTIVE OF THE GREAT MIAMI AQUIFER FOR ON-SITE DISPOSAL OF OPERABLE UNIT 2 MATERIALS

Desorption Distribution Coefficient (mL/g)	Preliminary WAC Concentration[a]	
	Uranium-238 (pCi/g)	Total Uranium (ppm)
15	360	1070
37.5[b]	900	2680
75[c]	1800	5360
177[d]	4250	12600
200[e]	4800	14300

[a]Preliminary WACs are based on leachate concentration of 71.38 mg/L uranium-238, which results in a GMA concentration of 20 μg/L under the disposal cell and is below 10^{-6} ILCR levels at the fenceline.

[b]Desorption distribution coefficient for Inactive Flyash and Active Flyash waste.

[c]Desorption distribution coefficient for the Solid Waste Landfill waste.

[d]Desorption distribution coefficient for the South Field waste.

[e]Desorption distribution coefficient for the Lime Sludge Ponds and berms material.

TABLE D.1-26

SENSITIVITY OF PRGs TO THE GLACIAL TILL DISTRIBUTION COEFFICIENT OPERABLE UNIT 2

Subunit/Source Area	Receptor	Modified Soil PRGs for Uranium-238 at 10^{-6} ILCR in pCi/g		
		K_d = 3.1 mL/g	K_d = 24 mL/g	K_d = 200 mL/g
Solid Waste Landfill without a cap	Off-property resident farmer	40.5	40.5	> 100,000
	On-property resident farmer	1.25	1.25	> 100,000
Solid Waste Landfill with a cap	Off-property resident farmer	2,430	> 100,000	> 100,000
Lime Sludge Ponds without a cap	Off-property resident farmer	106	127	> 100,000
	On-property resident farmer	4.06	4.66	> 100,000
Inactive Flyash Pile/South Field - Clean perched water without any controls (Most of flow is directly through the unsaturated Great Miami Aquifer.)	Off-property resident farmer	2.5	2.5	2.5
	On-property resident farmer	0.89	0.89	0.89
Inactive Flyash Pile/South Field - Source control for lateral migration of perched water, source on the top of the terrace	Off-property resident farmer	60	70	> 100,000
Inactive Flyash Pile/South Field/Active Flyash Pile - Consolidation and capping, and controls for lateral migration of perched water	Off-property resident farmer	171	> 10,000	> 100,000

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Sensitivity of preliminary WAC to the K_d of glacial till was also investigated. Due to a low infiltration rate at the engineered disposal cell, WAC are more sensitive to the value of K_d for the glacial till. At the disposal cell the preliminary WAC would increase to a large number for a glacial till K_d of 24 mL/g and higher. This would be due to no breakthrough of the uranium-238 from the soil layers beneath the disposal cell.

APPENDIX D.1

ATTACHMENT D.1-I

INFILTRATION CALCULATIONS FOR ODAST/SWIFT MODELING

D.1.I INFILTRATION CALCULATIONS FOR ODAST/SWIFT MODELING

MODELING APPROACH

Infiltration rates (seepage rates) through the waste to the Great Miami Aquifer for various conceptual models were calculated using the Hydraulic Evaluation of Landfill Performance (HELP) model. The HELP model is a quasi-two-dimensional hydrologic model of water movement across, into, through, and out of a waste unit. The model accepts climatologic, soil, and design data and simulates a number of hydraulic processes, including surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage. The systems that can be modeled by the HELP model include various combinations of vegetation, cover soils, waste cells, drainage layers, and relatively impermeable barrier soils.

The HELP model was run in 5-year steps using the climatologic data (precipitation and mean monthly temperatures) from 1974 to 1978 for Cincinnati, Ohio. These data were obtained from the HELP model database. The HELP model was run to "steady state," that is, until successive simulations showed less than 0.005 change between initial- and final-year soil moisture content in any of the layers. A successive substitution procedure was used to reach steady-state conditions.

Physical properties of waste, glacial till, and the Great Miami Aquifer soils were the same as properties used in the Operable Unit 2 RI fate and transport modeling (Appendix A.2 of the RI Report). These values were defined based upon RI sampling activities, or literature values for similar soil types.

Figure D.1-I-1 shows a typical section for the composite cap and liner. Design data for conceptual models available up to July 12, 1994, were used for infiltration calculations. Topsoil, vegetative soil support, sand filter, cobbles, pea gravel, bentonite geocomposite, clay liner with bentonite, and compacted structural fill were simulated as HELP soil texture number 6, 5, 2, 1, 1, 18, 18, and 17, respectively. HELP default hydraulic conductivities were modified to match the design. Hydraulic conductivities for these layers were 1×10^{-3}, 5×10^{-4}, 1×10^{-3}, 10.0, 1×10^{-2}, 1×10^{-8}, 1×10^{-7}, and 2.6×10^{-5} cm/sec, respectively. Grass cover was assumed to be fair, and the evaporative zone depth was conservatively estimated to be 18 inches.

The bentonite geocomposite was assumed to be 0.6 cm (0.25 in.) thick, with properties of recompacted clay. The high density polyethylene (HDPE) geomembrane was assumed to have deteriorated, and the drainage layer in the liner was assumed to be ineffective. The bentonite geocomposite (a barrier layer) is on top of clay soil liner with a bentonite layer (another barrier layer). However, the HELP model cannot simulate two barrier layers next to each other. Therefore, a vertical percolation (sand) layer with hydraulic conductivity of 10.0 cm/sec was inserted between the two barrier layers.

For conceptual models with a cap, the HELP model simulation showed that the infiltration rate is not sensitive to the thicknesses of waste, glacial overburden, or the unsaturated Great Miami Aquifer. This may be because infiltration through these caps is very small and is within the transmissive capability of the glacial overburden under gravity drainage.

The remaining conceptual models were simulated with typical thicknesses of waste, glacial till, and unsaturated Great Miami Aquifer obtained during field activities for the RI and were modified to account for any source removal considered. It was assumed that 30.5 cm (12 in.) of soil fill material will be added on top of all areas from which wastes are removed. Sand/gravel layers within the Glacial Overburden and weathered till were ignored while calculating glacial till thickness. An attempt was made to estimate worst-case infiltration rates.

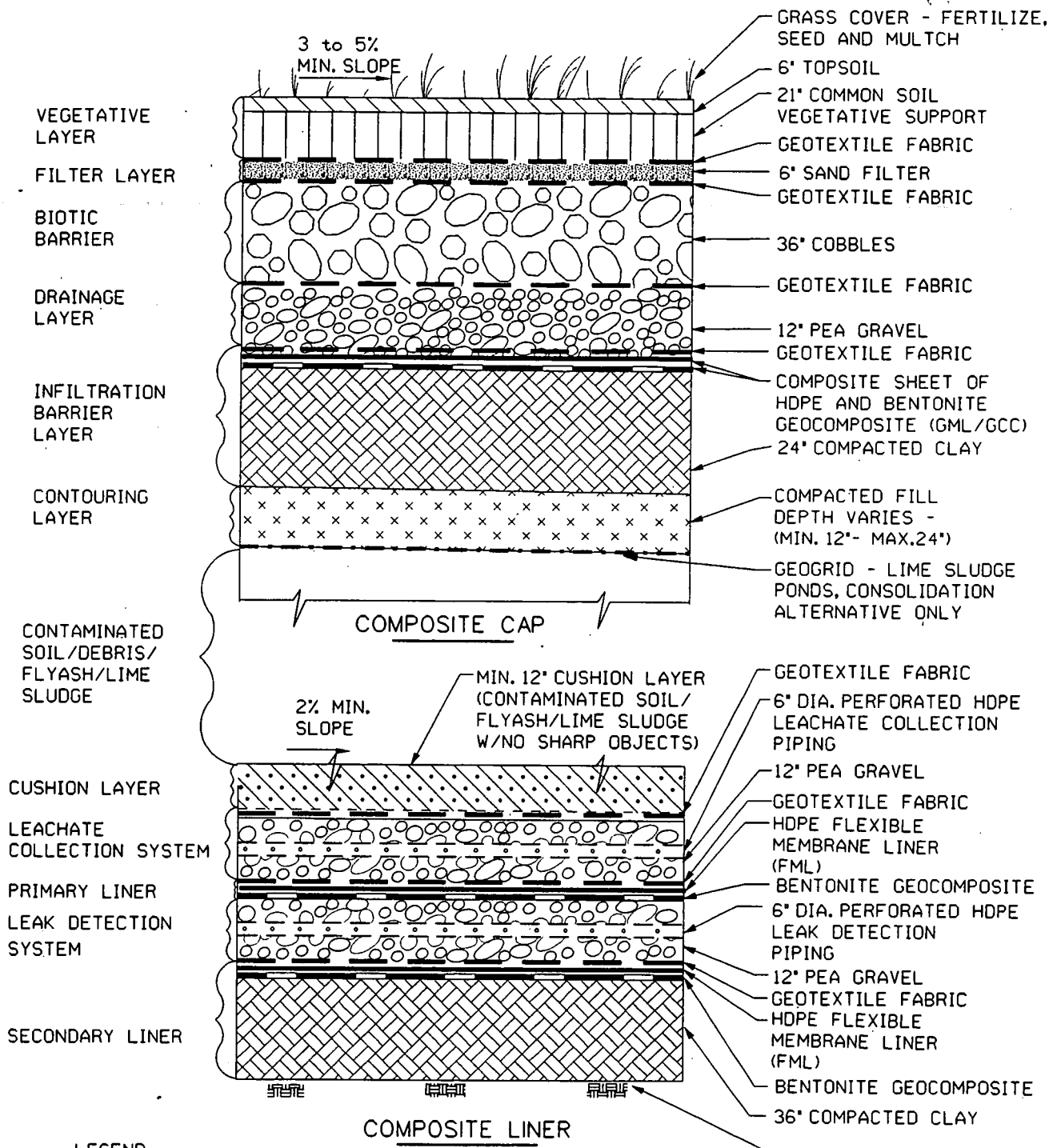

FIGURE D.1.I-1
TYPICAL DETAIL
COMPOSITE CAP AND LINER
(NOT TO SCALE)

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LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY FOR OPERABLE UNIT 2
GEOCOMPOSITE CAP AND LINER - NO HDPE LINER AND FAILED LEACHATE COLLECTION SY
MINIMUM WASTE THICKNESS                                February 28, 1994

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                              FAIR GRASS

                              LAYER  1
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                     VERTICAL PERCOLATION LAYER
THICKNESS                              =      6.00 INCHES
POROSITY                               =      0.4530 VOL/VOL
FIELD CAPACITY                         =      0.1901 VOL/VOL
WILTING POINT                          =      0.0848 VOL/VOL
INITIAL SOIL WATER CONTENT             =      0.3243 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =      0.001000000047 CM/SEC


                              LAYER  2
                              --------

                     VERTICAL PERCOLATION LAYER
THICKNESS                              =     21.00 INCHES
POROSITY                               =      0.4570 VOL/VOL
FIELD CAPACITY                         =      0.1309 VOL/VOL
WILTING POINT                          =      0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT             =      0.2440 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =      0.000500000024 CM/SEC


                              LAYER  3
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                     VERTICAL PERCOLATION LAYER
THICKNESS                              =      6.00 INCHES
POROSITY                               =      0.4370 VOL/VOL
FIELD CAPACITY                         =      0.0624 VOL/VOL
WILTING POINT                          =      0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT             =      0.1581 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY       =      0.001000000047 CM/SEC
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LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0454 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 5

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4170 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.009999999776 CM/SEC
SLOPE	=	4.00 PERCENT
DRAINAGE LENGTH	=	800.0 FEET

LAYER 6

BARRIER SOIL LINER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000010000 CM/SEC

LAYER 7

VERTICAL PERCOLATION LAYER

THICKNESS	=	2.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0564 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 8

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LAYER 9

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3808 VOL/VOL
FIELD CAPACITY	=	0.1924 VOL/VOL
WILTING POINT	=	0.1043 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2523 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000026000000 CM/SEC

LAYER 10

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2794 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 11

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0454 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.009999999776 CM/SEC

LAYER 12

BARRIER SOIL LINER

THICKNESS	=	60.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	1102500. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	5.4600 INCHES
INITIAL VEG. STORAGE	=	3.4098 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	58.2148 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.004	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.001	0.000	0.005
STD. DEVIATIONS	0.000	0.009	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.002	0.000	0.011
EVAPOTRANSPIRATION						
TOTALS	0.853	1.535	2.424	2.871	2.814	4.791
	3.826	4.116	2.198	1.959	1.683	0.905
STD. DEVIATIONS	0.188	0.312	0.120	0.265	1.712	1.202
	1.451	0.997	1.704	0.567	0.120	0.179
LATERAL DRAINAGE FROM LAYER 5						
TOTALS	1.3155	1.4678	1.1784	0.9902	0.6175	0.5255
	0.5178	0.4965	0.6843	0.4741	0.4245	0.7490
STD. DEVIATIONS	0.6603	1.2556	1.1494	0.6790	0.1245	0.0628
	0.0694	0.0626	0.4737	0.1049	0.1121	0.7123
PERCOLATION FROM LAYER 6						
TOTALS	0.1141	0.1071	0.1175	0.1157	0.1173	0.1063
	0.1024	0.0937	0.0851	0.0842	0.0811	0.0921
STD. DEVIATIONS	0.0405	0.0405	0.0441	0.0333	0.0261	0.0272
	0.0269	0.0232	0.0273	0.0336	0.0341	0.0355

PERCOLATION FROM LAYER 8

TOTALS	0.1077	0.0983	0.1082	0.1048	0.1084	0.0978
	0.1012	0.1018	0.0970	0.0983	0.0918	0.1010
STD. DEVIATIONS	0.0025	0.0034	0.0023	0.0024	0.0026	0.0179
	0.0184	0.0169	0.0194	0.0236	0.0257	0.0161

PERCOLATION FROM LAYER 12

TOTALS	0.1050	0.0919	0.0998	0.0975	0.1018	0.0994
	0.1035	0.1042	0.1013	0.1050	0.1017	0.1051
STD. DEVIATIONS	0.0016	0.0088	0.0120	0.0100	0.0084	0.0064
	0.0050	0.0036	0.0024	0.0017	0.0013	0.0014

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	3733984.	100.00
RUNOFF	0.010	(0.014)	920.	0.02
EVAPOTRANSPIRATION	29.974	(2.728)	2753890.	73.75
LATERAL DRAINAGE FROM LAYER 5	9.4411	(3.7889)	867399.	23.23
PERCOLATION FROM LAYER 6	1.2163	(0.3337)	111743.	2.99
PERCOLATION FROM LAYER 8	1.2162	(0.1433)	111743.	2.99
PERCOLATION FROM LAYER 12	1.2162	(0.0607)	111741.	2.99
CHANGE IN WATER STORAGE	0.000	(3.907)	34.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	220500.0
RUNOFF	0.025	2269.9
LATERAL DRAINAGE FROM LAYER 5	0.5774	53045.4
PERCOLATION FROM LAYER 6	0.0045	415.1
HEAD ON LAYER 6	12.2	
PERCOLATION FROM LAYER 8	0.0036	331.4
HEAD ON LAYER 8	1.4	
PERCOLATION FROM LAYER 12	0.0034	314.4
HEAD ON LAYER 12	0.4	
SNOW WATER	1.18	108843.8

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3497

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0711

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	1.95	0.3243
2	5.12	0.2440
3	0.95	0.1581
4	1.64	0.0454
5	5.00	0.4170
6	0.40	0.4000
7	0.11	0.0564
8	10.32	0.4300
9	3.03	0.2523
10	3.35	0.2794
11	0.55	0.0454
12	25.80	0.4300
SNOW WATER	0.00	

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GRAY TILL ONLY
SOLID WASTE LANDFILL

July 12, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	99.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3140 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	155.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000001900000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	384.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0762 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	128.6608 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
PERCOLATION FROM LAYER 3						
TOTALS	1.6208	1.6289	1.5251	1.1168	0.5161	0.2535
	0.1939	0.0844	0.3983	0.5914	0.3213	1.3635
STD. DEVIATIONS	0.8551	0.6425	0.5794	1.0308	0.9119	0.4921
	0.4335	0.1746	0.8906	0.6639	0.4839	0.8907
PERCOLATION FROM LAYER 4						
TOTALS	0.7604	0.8614	1.1076	1.1059	1.0855	0.9203
	0.7868	0.6540	0.5747	0.5912	0.5591	0.6059
STD. DEVIATIONS	0.3140	0.3531	0.4679	0.4935	0.5676	0.5443
	0.3844	0.2586	0.2095	0.2819	0.2379	0.2442

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
PERCOLATION FROM LAYER 3	9.6141	(3.8484)	36854.	23.66
PERCOLATION FROM LAYER 4	9.6128	(3.9916)	36849.	23.65
CHANGE IN WATER STORAGE	0.001	(4.532)	5.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
PERCOLATION FROM LAYER 3	0.0719	275.7
HEAD ON LAYER 3	17.5	
PERCOLATION FROM LAYER 4	0.0613	234.8
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	31.09	0.3140
3	63.55	0.4100
4	29.27	0.0762
SNOW WATER	0.00	

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GRAY TILL ONLY
LIME SLUDGE PONDS

July 12, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	102.00 INCHES
POROSITY	=	0.5500 VOL/VOL
FIELD CAPACITY	=	0.3782 VOL/VOL
WILTING POINT	=	0.2650 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3969 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	139.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000001900000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	283.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0775 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	124.1703 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00

START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
PERCOLATION FROM LAYER 3						
TOTALS	1.6514	1.6575	1.4936	1.1343	0.4894	0.2146
	0.1939	0.0844	0.4052	0.5871	0.3187	1.3832
STD. DEVIATIONS	0.8784	0.6590	0.6206	1.0523	0.9363	0.4053
	0.4334	0.1746	0.9060	0.6559	0.4785	0.9085

PERCOLATION FROM LAYER 4

TOTALS	0.7951	0.9575	1.2453	1.1995	1.1204	0.8924
	0.7153	0.5712	0.5005	0.5331	0.5077	0.5752
STD. DEVIATIONS	0.3698	0.4286	0.5697	0.5952	0.6519	0.5845
	0.3538	0.2145	0.1782	0.2985	0.2409	0.2645

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
PERCOLATION FROM LAYER 3	9.6133	(3.8256)	36851.	23.65
PERCOLATION FROM LAYER 4	9.6132	(4.2193)	36851.	23.65
CHANGE IN WATER STORAGE	0.001	(4.424)	3.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
PERCOLATION FROM LAYER 3	0.0751	287.9
HEAD ON LAYER 3	22.5	
PERCOLATION FROM LAYER 4	0.0659	252.4
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	40.49	0.3969
3	56.99	0.4100
4	21.93	0.0775
SNOW WATER	0.00	

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REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 1 June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	32.40 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3472 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	249.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0795 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	35.8088 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.893
STD. DEVIATIONS	0.189	0.311	0.129	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
PERCOLATION FROM LAYER 3						
TOTALS	0.8069	1.0173	1.2504	1.2871	1.0878	0.8236
	0.6931	0.5819	0.5128	0.5267	0.4737	0.5507
STD. DEVIATIONS	0.3686	0.4689	0.6940	0.9485	0.6910	0.4383
	0.3016	0.2016	0.1713	0.2508	0.2071	0.2316

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.970)	118246.	75.90
PERCOLATION FROM LAYER 3	9.6120	(4.3781)	36846.	23.65
CHANGE IN WATER STORAGE	0.002	(4.529)	9.	0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
PERCOLATION FROM LAYER 3	0.1002	384.0
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4810

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	11.25	0.3472
3	19.81	0.0795
SNOW WATER	0.00	

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 REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
 SOUTH FIELD AND INACTIVE FLYASH PILE
 ZONE 2                                        June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	202.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3348 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	228.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0733 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	89.1060 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.984	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.332	1.635	1.381
	1.402	1.207	1.767	0.527	0.138	0.170
PERCOLATION FROM LAYER 3						
TOTALS	0.6935	0.7015	0.8605	0.9339	1.0061	0.9334
	0.8931	0.8170	0.7321	0.7192	0.6619	0.6623
STD. DEVIATIONS	0.2001	0.2161	0.3007	0.4161	0.4980	0.4525
	0.4011	0.3302	0.2673	0.2518	0.2221	0.2052

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118248.	75.90
PERCOLATION FROM LAYER 3	9.6146	(3.6066)	36856.	23.66
CHANGE IN WATER STORAGE	-0.001	(4.935)	-3.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
PERCOLATION FROM LAYER 3	0.0570	218.4
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	67.64	0.3348
3	16.70	0.0733
SNOW WATER	0.00	

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REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 3 June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

BARRIER SOIL LINER

THICKNESS	=	19.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	317.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0595 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	32.8915 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.804	0.747	1.072	0.427	0.000	0.201
	0.020	0.043	0.239	0.026	0.000	1.651
STD. DEVIATIONS	1.121	1.656	1.655	0.513	0.000	0.421
	0.045	0.097	0.517	0.046	0.000	1.630
EVAPOTRANSPIRATION						
TOTALS	0.848	1.533	2.471	2.865	3.121	5.061
	5.631	4.307	2.301	1.986	1.659	0.901
STD. DEVIATIONS	0.186	0.308	0.124	0.279	1.675	1.216
	1.340	1.247	1.772	0.496	0.157	0.169
PERCOLATION FROM LAYER 2						
TOTALS	0.1990	0.1969	0.2109	0.1995	0.1966	0.1843
	0.1071	0.0186	0.0402	0.0716	0.1238	0.1786
STD. DEVIATIONS	0.0879	0.0274	0.0242	0.0098	0.0076	0.0148
	0.0297	0.0324	0.0898	0.0785	0.0898	0.1004
PERCOLATION FROM LAYER 3						
TOTALS	0.1407	0.1316	0.1483	0.1470	0.1547	0.1518
	0.1574	0.1502	0.1389	0.1383	0.1322	0.1377
STD. DEVIATIONS	0.0198	0.0200	0.0213	0.0203	0.0203	0.0189
	0.0183	0.0163	0.0143	0.0154	0.0164	0.0183

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	6.231	(3.526)	23887.	15.33
EVAPOTRANSPIRATION	32.684	(3.084)	125288.	80.42
PERCOLATION FROM LAYER 2	1.7270	(0.3920)	6620.	4.25
PERCOLATION FROM LAYER 3	1.7288	(0.2070)	6627.	4.25
CHANGE IN WATER STORAGE	-0.002	(2.820)	-7.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.237	8575.0
PERCOLATION FROM LAYER 2	0.0078	30.0
HEAD ON LAYER 2	12.5	
PERCOLATION FROM LAYER 3	0.0058	22.4
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	7.79	0.4100
3	18.85	0.0595
SNOW WATER	0.00	

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REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 3 - Lateral Drainage June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3463 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000036000001 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	11.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2535 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.004000000190 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	102.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	361.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0588 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	78.9105 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99

RUNOFF

TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036

EVAPOTRANSPIRATION

TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.893
STD. DEVIATIONS	0.189	0.311	0.129	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170

LATERAL DRAINAGE FROM LAYER 3

TOTALS	1.5655	1.4884	1.1401	1.1149	0.7642	0.2630
	0.1454	0.0605	0.2601	0.2950	0.2205	0.7765
STD. DEVIATIONS	1.0236	0.8340	0.8940	1.0176	0.8788	0.3571
	0.1792	0.1084	0.5448	0.5054	0.3177	0.7719

PERCOLATION FROM LAYER 4

TOTALS	0.1311	0.1359	0.1517	0.1472	0.1497	0.1245
	0.1183	0.1113	0.1104	0.1030	0.1089	0.1284
STD. DEVIATIONS	0.0499	0.0101	0.0044	0.0057	0.0036	0.0271
	0.0411	0.0362	0.0399	0.0398	0.0491	0.0477

PERCOLATION FROM LAYER 5

TOTALS	0.1272	0.1163	0.1288	0.1256	0.1308	0.1270
	0.1308	0.1300	0.1251	0.1282	0.1232	0.1270
STD. DEVIATIONS	0.0087	0.0098	0.0092	0.0087	0.0087	0.0081
	0.0079	0.0077	0.0065	0.0060	0.0064	0.0077

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.970)	118245.	75.90
LATERAL DRAINAGE FROM LAYER 3	8.0941	(3.5454)	31027.	19.92
PERCOLATION FROM LAYER 4	1.5204	(0.2203)	5828.	3.74
PERCOLATION FROM LAYER 5	1.5200	(0.0848)	5827.	3.74
CHANGE IN WATER STORAGE	0.000	(3.739)	1.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
LATERAL DRAINAGE FROM LAYER 3	0.1007	386.0
PERCOLATION FROM LAYER 4	0.0054	20.7
HEAD ON LAYER 4	14.3	
PERCOLATION FROM LAYER 5	0.0045	17.3
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4810

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	8.31	0.3463
3	2.79	0.2535
4	41.82	0.4100
5	21.23	0.0588
SNOW WATER	0.00	

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REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 4 June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	92.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	73.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	358.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0670 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	107.9960 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.664	0.724	1.008	0.339	0.000	0.027
	0.021	0.043	0.136	0.027	0.000	0.810
STD. DEVIATIONS	1.042	1.620	1.588	0.487	0.000	0.061
	0.047	0.097	0.286	0.046	0.000	1.453
EVAPOTRANSPIRATION						
TOTALS	0.849	1.535	2.473	2.866	3.169	5.001
	4.867	4.268	2.252	2.000	1.671	0.901
STD. DEVIATIONS	0.186	0.307	0.123	0.279	1.636	1.320
	1.184	1.201	1.766	0.497	0.153	0.173
PERCOLATION FROM LAYER 3						
TOTALS	0.3483	0.3159	0.3449	0.3330	0.3418	0.3283
	0.3342	0.3307	0.3213	0.3305	0.3207	0.3414
STD. DEVIATIONS	0.0178	0.0171	0.0155	0.0083	0.0067	0.0078
	0.0020	0.0007	0.0082	0.0081	0.0107	0.0161
PERCOLATION FROM LAYER 4						
TOTALS	0.3376	0.3081	0.3394	0.3289	0.3402	0.3292
	0.3399	0.3391	0.3274	0.3376	0.3261	0.3369
STD. DEVIATIONS	0.0051	0.0081	0.0064	0.0066	0.0068	0.0066
	0.0066	0.0060	0.0054	0.0053	0.0050	0.0051

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	4.800	(3.566)	18398.	11.81
EVAPOTRANSPIRATION	31.851	(3.432)	122097.	78.37
PERCOLATION FROM LAYER 3	3.9910	(0.0871)	15299.	9.82
PERCOLATION FROM LAYER 4	3.9904	(0.0687)	15297.	9.82
CHANGE IN WATER STORAGE	0.001	(3.872)	2.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.194	8411.9
PERCOLATION FROM LAYER 3	0.0116	44.3
HEAD ON LAYER 3	104.6	
PERCOLATION FROM LAYER 4	0.0112	43.0
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	47.84	0.5200
3	29.93	0.4100
4	23.99	0.0670
SNOW WATER	0.00	

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 REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
 SOUTH FIELD AND INACTIVE FLYASH PILE
 ZONE 4 - Lateral Drainage                    June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	33.60 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4969 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	73.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	358.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0628 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	80.1122 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.361	0.567	0.074	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.808	1.268	0.119	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.850	1.538	2.477	2.855	3.167	4.813
	4.138	4.272	2.250	2.018	1.687	0.901
STD. DEVIATIONS	0.187	0.307	0.121	0.281	1.634	1.383
	1.353	1.207	1.767	0.510	0.160	0.180
LATERAL DRAINAGE FROM LAYER 3						
TOTALS	0.5551	0.5675	0.6161	0.5775	0.5557	0.5014
	0.4824	0.4356	0.4147	0.4097	0.3785	0.4533
STD. DEVIATIONS	0.1867	0.2036	0.2313	0.1856	0.1797	0.1767
	0.1518	0.1312	0.1613	0.1669	0.1434	0.1471
PERCOLATION FROM LAYER 4						
TOTALS	0.2249	0.2138	0.2332	0.2241	0.2265	0.2140
	0.2164	0.2108	0.2031	0.2071	0.1982	0.2127
STD. DEVIATIONS	0.0235	0.0275	0.0298	0.0240	0.0232	0.0221
	0.0184	0.0165	0.0207	0.0210	0.0187	0.0184

PERCOLATION FROM LAYER 5

TOTALS	0.2178	0.1990	0.2197	0.2135	0.2212	0.2143
	0.2212	0.2207	0.2128	0.2191	0.2112	0.2175
STD. DEVIATIONS	0.0114	0.0125	0.0113	0.0112	0.0118	0.0117
	0.0123	0.0124	0.0120	0.0125	0.0121	0.0122

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	1.144	(2.032)	4387.	2.82
EVAPOTRANSPIRATION	30.965	(3.096)	118700.	76.19
LATERAL DRAINAGE FROM LAYER 3	5.9475	(1.8922)	22799.	14.63
PERCOLATION FROM LAYER 4	2.5848	(0.2420)	9908.	6.36
PERCOLATION FROM LAYER 5	2.5881	(0.1346)	9921.	6.37
CHANGE IN WATER STORAGE	-0.003	(4.369)	-11.	-0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	1.806	6923.3
LATERAL DRAINAGE FROM LAYER 3	0.0279	107.1
PERCOLATION FROM LAYER 4	0.0085	32.7
HEAD ON LAYER 4	58.0	
PERCOLATION FROM LAYER 5	0.0076	29.1
SNOW WATER	1.18	4541.3
MAXIMUM VEG. SOIL WATER (VOL/VOL)	0.5200	
MINIMUM VEG. SOIL WATER (VOL/VOL)	0.1391	

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	16.70	0.4969
3	6.24	0.5200
4	29.93	0.4100
5	22.47	0.0628
SNOW WATER	0.00	

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REMOVE FILL TO 5 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 5 - Lateral Drainage June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	62.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4129 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	153.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	381.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0616 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	122.8034 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
LATERAL DRAINAGE FROM LAYER 3						
TOTALS	0.6474	0.6642	0.7522	0.7653	0.7356	0.6404
	0.6080	0.5484	0.5174	0.5112	0.4693	0.5420
STD. DEVIATIONS	0.2162	0.2375	0.3092	0.3478	0.3369	0.2899
	0.2508	0.2169	0.2122	0.2103	0.1820	0.1574
PERCOLATION FROM LAYER 4						
TOTALS	0.1888	0.1757	0.1939	0.1894	0.1930	0.1833
	0.1869	0.1839	0.1771	0.1817	0.1745	0.1837
STD. DEVIATIONS	0.0115	0.0138	0.0157	0.0165	0.0161	0.0145
	0.0128	0.0116	0.0117	0.0118	0.0106	0.0089

PERCOLATION FROM LAYER 5

TOTALS	0.1866	0.1700	0.1872	0.1816	0.1881	0.1822
	0.1883	0.1881	0.1817	0.1875	0.1811	0.1868
STD. DEVIATIONS	0.0062	0.0078	0.0058	0.0056	0.0058	0.0058
	0.0061	0.0063	0.0062	0.0064	0.0062	0.0062

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
LATERAL DRAINAGE FROM LAYER 3	7.4015	(2.7185)	28372.	18.21
PERCOLATION FROM LAYER 4	2.2120	(0.1419)	8479.	5.44
PERCOLATION FROM LAYER 5	2.2092	(0.0686)	8469.	5.44
CHANGE IN WATER STORAGE	0.003	(4.792)	13.	0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
LATERAL DRAINAGE FROM LAYER 3	0.0441	169.0
PERCOLATION FROM LAYER 4	0.0072	27.5
HEAD ON LAYER 4	77.4	
PERCOLATION FROM LAYER 5	0.0063	24.2
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	25.60	0.4129
3	6.24	0.5200
4	62.73	0.4100
5	23.48	0.0616
SNOW WATER	0.00	

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REMOVE FILL TO 60 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 3                                          June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

BARRIER SOIL LINER

THICKNESS	=	40.80 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	317.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0583 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	41.4491 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.835	0.761	1.096	0.451	0.000	0.218
	0.020	0.043	0.241	0.026	0.007	1.704
STD. DEVIATIONS	1.133	1.669	1.681	0.523	0.000	0.438
	0.045	0.097	0.523	0.046	0.016	1.647
EVAPOTRANSPIRATION						
TOTALS	0.848	1.533	2.471	2.865	3.121	5.021
	5.749	4.307	2.302	1.985	1.658	0.900
STD. DEVIATIONS	0.186	0.308	0.124	0.279	1.675	1.245
	1.414	1.246	1.771	0.496	0.157	0.169
PERCOLATION FROM LAYER 2						
TOTALS	0.1602	0.1637	0.1776	0.1696	0.1711	0.1630
	0.1017	0.0177	0.0340	0.0639	0.1103	0.1462
STD. DEVIATIONS	0.0662	0.0133	0.0112	0.0043	0.0034	0.0065
	0.0252	0.0312	0.0759	0.0698	0.0764	0.0812
PERCOLATION FROM LAYER 3						
TOTALS	0.1206	0.1121	0.1258	0.1242	0.1306	0.1283
	0.1336	0.1285	0.1195	0.1195	0.1145	0.1191
STD. DEVIATIONS	0.0143	0.0143	0.0147	0.0139	0.0139	0.0130
	0.0126	0.0112	0.0097	0.0106	0.0117	0.0133

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	6.403	(3.594)	24545.	15.75
EVAPOTRANSPIRATION	32.760	(3.107)	125580.	80.61
PERCOLATION FROM LAYER 2	1.4789	(0.3159)	5669.	3.64
PERCOLATION FROM LAYER 3	1.4762	(0.1435)	5659.	3.63
CHANGE IN WATER STORAGE	0.003	(2.779)	10.	0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.252	8631.3
PERCOLATION FROM LAYER 2	0.0062	23.7
HEAD ON LAYER 2	12.4	
PERCOLATION FROM LAYER 3	0.0048	18.5
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	16.73	0.4100
3	18.49	0.0583
SNOW WATER	0.00	

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REMOVE FILL TO 60 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 4 - Lateral Drainage June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	80.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3810 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	73.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	358.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0629 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	93.9322 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
LATERAL DRAINAGE FROM LAYER 3						
TOTALS	0.6089	0.6270	0.7105	0.7246	0.6933	0.6011
	0.5686	0.5107	0.4816	0.4751	0.4288	0.5054
STD. DEVIATIONS	0.2086	0.2293	0.2991	0.3389	0.3255	0.2792
	0.2405	0.2072	0.2033	0.2016	0.1842	0.1521
PERCOLATION FROM LAYER 4						
TOTALS	0.2300	0.2171	0.2403	0.2360	0.2383	0.2234
	0.2256	0.2192	0.2104	0.2148	0.2040	0.2190
STD. DEVIATIONS	0.0242	0.0273	0.0326	0.0340	0.0335	0.0300
	0.0265	0.0238	0.0242	0.0244	0.0235	0.0186

PERCOLATION FROM LAYER 5

TOTALS	0.2251	0.2055	0.2267	0.2205	0.2288	0.2218
	0.2292	0.2287	0.2206	0.2271	0.2188	0.2252
STD. DEVIATIONS	0.0145	0.0157	0.0139	0.0135	0.0143	0.0143
	0.0152	0.0155	0.0151	0.0157	0.0151	0.0152

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
LATERAL DRAINAGE FROM LAYER 3	6.9354	(2.6264)	26586.	17.06
PERCOLATION FROM LAYER 4	2.6783	(0.2955)	10267.	6.59
PERCOLATION FROM LAYER 5	2.6778	(0.1651)	10265.	6.59
CHANGE IN WATER STORAGE	0.001	(4.812)	3.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
LATERAL DRAINAGE FROM LAYER 3	0.0422	161.7
PERCOLATION FROM LAYER 4	0.0096	36.6
HEAD ON LAYER 4	73.5	
PERCOLATION FROM LAYER 5	0.0080	30.6
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	30.48	0.3810
3	6.24	0.5200
4	29.93	0.4100
5	22.52	0.0629
SNOW WATER	0.00	

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 REMOVE FILL TO 60 PCI/G ON TERRACE SLOPE
 SOUTH FIELD AND INACTIVE FLYASH PILE
 ZONE 5 - Lateral Drainage                    June 8, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	47.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4491 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	141.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	372.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0617 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	112.8741 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.395	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.884	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.074	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.400	1.207	1.767	0.526	0.138	0.170
LATERAL DRAINAGE FROM LAYER 3						
TOTALS	0.6245	0.6447	0.7270	0.6962	0.6725	0.5962
	0.5702	0.5152	0.4890	0.4849	0.4461	0.5196
STD. DEVIATIONS	0.2054	0.2303	0.3006	0.2631	0.2592	0.2401
	0.2096	0.1816	0.1930	0.1978	0.1701	0.1539
PERCOLATION FROM LAYER 4						
TOTALS	0.1911	0.1782	0.1971	0.1905	0.1942	0.1846
	0.1883	0.1851	0.1784	0.1831	0.1758	0.1855
STD. DEVIATIONS	0.0122	0.0146	0.0177	0.0151	0.0149	0.0137
	0.0121	0.0109	0.0118	0.0122	0.0109	0.0096
PERCOLATION FROM LAYER 5						
TOTALS	0.1885	0.1718	0.1892	0.1836	0.1901	0.1841
	0.1902	0.1900	0.1835	0.1893	0.1828	0.1885
STD. DEVIATIONS	0.0062	0.0078	0.0059	0.0058	0.0061	0.0060
	0.0064	0.0065	0.0064	0.0066	0.0064	0.0065

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.576	(0.919)	2209.	1.42
EVAPOTRANSPIRATION	30.848	(2.971)	118251.	75.90
LATERAL DRAINAGE FROM LAYER 3	6.9860	(2.3927)	26780.	17.19
PERCOLATION FROM LAYER 4	2.2319	(0.1426)	8556.	5.49
PERCOLATION FROM LAYER 5	2.2314	(0.0710)	8554.	5.49
CHANGE IN WATER STORAGE	0.000	(4.600)	1.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.601	2303.7
LATERAL DRAINAGE FROM LAYER 3	0.0378	145.0
PERCOLATION FROM LAYER 4	0.0072	27.4
HEAD ON LAYER 4	71.0	
PERCOLATION FROM LAYER 5	0.0064	24.4
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	21.11	0.4491
3	6.24	0.5200
4	57.81	0.4100
5	22.96	0.0617
SNOW WATER	0.00	

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REMOVE FILL TO 900 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 1 July 7, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	166.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3374 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	262.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0733 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	79.9770 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.984	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.332	1.635	1.381
	1.402	1.207	1.767	0.527	0.138	0.170
PERCOLATION FROM LAYER 3						
TOTALS	0.6834	0.6988	0.8672	0.9518	1.0246	0.9432
	0.8952	0.8131	0.7246	0.7095	0.6508	0.6504
STD. DEVIATIONS	0.2029	0.2207	0.3159	0.4493	0.5347	0.4778
	0.4174	0.3395	0.2724	0.2563	0.2253	0.2075

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118247.	75.90
PERCOLATION FROM LAYER 3	9.6125	(3.7688)	36848.	23.65
CHANGE IN WATER STORAGE	0.001	(4.903)	5.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
PERCOLATION FROM LAYER 3	0.0593	227.5
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	56.01	0.3374
3	19.21	0.0733
SNOW WATER	0.00	

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REMOVE FILL TO 900 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 2 July 7, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	104.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	76.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	355.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0674 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	115.4070 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.610	0.722	1.001	0.333	0.000	0.027
	0.021	0.043	0.123	0.027	0.000	0.774
STD. DEVIATIONS	0.995	1.615	1.580	0.481	0.000	0.061
	0.047	0.097	0.259	0.046	0.000	1.397
EVAPOTRANSPIRATION						
TOTALS	0.849	1.535	2.474	2.866	3.169	5.001
	4.801	4.269	2.252	2.001	1.672	0.901
STD. DEVIATIONS	0.186	0.307	0.123	0.279	1.637	1.320
	1.183	1.201	1.766	0.498	0.152	0.173
PERCOLATION FROM LAYER 3						
TOTALS	0.3633	0.3296	0.3601	0.3476	0.3569	0.3430
	0.3497	0.3464	0.3363	0.3461	0.3356	0.3564
STD. DEVIATIONS	0.0175	0.0171	0.0154	0.0085	0.0071	0.0080
	0.0021	0.0007	0.0080	0.0079	0.0103	0.0158
PERCOLATION FROM LAYER 4						
TOTALS	0.3529	0.3220	0.3546	0.3437	0.3555	0.3440
	0.3551	0.3544	0.3422	0.3529	0.3409	0.3521
STD. DEVIATIONS	0.0052	0.0084	0.0065	0.0068	0.0070	0.0068
	0.0068	0.0061	0.0055	0.0054	0.0051	0.0052

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	4.682	(3.527)	17947.	11.52
EVAPOTRANSPIRATION	31.789	(3.486)	121859.	78.22
PERCOLATION FROM LAYER 3	4.1710	(0.0879)	15989.	10.26
PERCOLATION FROM LAYER 4	4.1702	(0.0701)	15986.	10.26
CHANGE IN WATER STORAGE	0.001	(3.890)	3.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.189	8391.5
PERCOLATION FROM LAYER 3	0.0121	46.2
HEAD ON LAYER 3	116.6	
PERCOLATION FROM LAYER 4	0.0117	44.9
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	54.08	0.5200
3	31.16	0.4100
4	23.93	0.0674
SNOW WATER	0.00	

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REMOVE FILL TO 900 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 2 - Lateral Drainage July 7, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	92.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3702 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	76.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	355.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0628 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	98.5164 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
LATERAL DRAINAGE FROM LAYER 3						
TOTALS	0.6127	0.6307	0.7144	0.7285	0.6971	0.6045
	0.5720	0.5139	0.4846	0.4737	0.4287	0.5083
STD. DEVIATIONS	0.2090	0.2298	0.2997	0.3395	0.3261	0.2798
	0.2410	0.2077	0.2039	0.2083	0.1897	0.1530
PERCOLATION FROM LAYER 4						
TOTALS	0.2272	0.2142	0.2370	0.2327	0.2351	0.2206
	0.2229	0.2167	0.2081	0.2118	0.2015	0.2165
STD. DEVIATIONS	0.0232	0.0263	0.0314	0.0327	0.0321	0.0288
	0.0254	0.0229	0.0232	0.0245	0.0234	0.0179

PERCOLATION FROM LAYER 5

TOTALS	0.2222	0.2028	0.2237	0.2176	0.2258	0.2189
	0.2262	0.2257	0.2177	0.2242	0.2160	0.2223
STD. DEVIATIONS	0.0141	0.0152	0.0134	0.0131	0.0138	0.0138
	0.0146	0.0149	0.0146	0.0151	0.0145	0.0147

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
LATERAL DRAINAGE FROM LAYER 3	6.9692	(2.6448)	26715.	17.15
PERCOLATION FROM LAYER 4	2.6445	(0.2858)	10137.	6.51
PERCOLATION FROM LAYER 5	2.6432	(0.1592)	10132.	6.50
CHANGE IN WATER STORAGE	0.002	(4.813)	6.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
LATERAL DRAINAGE FROM LAYER 3	0.0423	162.3
PERCOLATION FROM LAYER 4	0.0094	36.0
HEAD ON LAYER 4	73.7	
PERCOLATION FROM LAYER 5	0.0079	30.1
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	34.06	0.3702
3	6.24	0.5200
4	31.16	0.4100
5	22.30	0.0628
SNOW WATER	0.00	

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REMOVE FILL TO 900 PCI/G ON TERRACE SLOPE
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 3 - Lateral Drainage                    July 7, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	82.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3836 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC
SLOPE	=	10.00 PERCENT
DRAINAGE LENGTH	=	125.0 FEET

LAYER 4

BARRIER SOIL LINER

THICKNESS	=	141.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 5

VERTICAL PERCOLATION LAYER

THICKNESS	=	362.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0617 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	122.6046 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	122.6046 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
LATERAL DRAINAGE FROM LAYER 3						
TOTALS	0.6443	0.6612	0.7488	0.7630	0.7321	0.6372
	0.6047	0.5452	0.5145	0.5082	0.4665	0.5390
STD. DEVIATIONS	0.2156	0.2368	0.3084	0.3490	0.3359	0.2890
	0.2499	0.2160	0.2115	0.2097	0.1814	0.1569
PERCOLATION FROM LAYER 4						
TOTALS	0.1921	0.1790	0.1976	0.1931	0.1967	0.1866
	0.1901	0.1868	0.1799	0.1845	0.1771	0.1866
STD. DEVIATIONS	0.0125	0.0149	0.0170	0.0177	0.0175	0.0157
	0.0139	0.0125	0.0127	0.0128	0.0115	0.0096
PERCOLATION FROM LAYER 5						
TOTALS	0.1897	0.1729	0.1904	0.1848	0.1914	0.1854
	0.1916	0.1914	0.1849	0.1907	0.1841	0.1899
STD. DEVIATIONS	0.0070	0.0086	0.0066	0.0064	0.0067	0.0066
	0.0070	0.0072	0.0070	0.0073	0.0070	0.0071

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
LATERAL DRAINAGE FROM LAYER 3	7.3647	(2.7123)	28231.	18.12
PERCOLATION FROM LAYER 4	2.2500	(0.1538)	8625.	5.54
PERCOLATION FROM LAYER 5	2.2471	(0.0778)	8614.	5.53
CHANGE IN WATER STORAGE	0.002	(4.794)	9.	0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
LATERAL DRAINAGE FROM LAYER 3	0.0440	168.5
PERCOLATION FROM LAYER 4	0.0073	28.0
HEAD ON LAYER 4	75.6	
PERCOLATION FROM LAYER 5	0.0065	24.8
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	31.45	0.3836
3	6.24	0.5200
4	57.81	0.4100
5	22.35	0.0617
SNOW WATER	0.00	

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TOP OF THE TERRACE - TILL PRG DEVELOPMENT - 70 pCi/g
SOUTH FIELD
ZONE 1 July 12, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	47.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	110.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	374.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0631 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	99.3794 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.814	0.750	1.075	0.381	0.000	0.034
	0.020	0.043	0.186	0.027	0.000	1.292
STD. DEVIATIONS	1.125	1.660	1.659	0.535	0.000	0.061
	0.045	0.097	0.399	0.046	0.000	1.597
EVAPOTRANSPIRATION						
TOTALS	0.848	1.533	2.472	2.865	3.167	5.021
	5.485	4.291	2.263	1.965	1.662	0.901
STD. DEVIATIONS	0.186	0.308	0.123	0.279	1.634	1.285
	1.280	1.228	1.781	0.509	0.155	0.169

PERCOLATION FROM LAYER 3

TOTALS	0.2215	0.2010	0.2198	0.2126	0.2182	0.2098
	0.2129	0.2098	0.2043	0.2108	0.2054	0.2185
STD. DEVIATIONS	0.0098	0.0093	0.0079	0.0029	0.0026	0.0036
	0.0013	0.0004	0.0051	0.0049	0.0069	0.0091

PERCOLATION FROM LAYER 4

TOTALS	0.2157	0.1966	0.2164	0.2096	0.2167	0.2098
	0.2167	0.2163	0.2089	0.2156	0.2084	0.2153
STD. DEVIATIONS	0.0022	0.0044	0.0027	0.0027	0.0028	0.0027
	0.0026	0.0025	0.0023	0.0023	0.0021	0.0022

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	5.623	(3.794)	21557.	13.84
EVAPOTRANSPIRATION	32.474	(3.083)	124483.	79.90
PERCOLATION FROM LAYER 3	2.5447	(0.0433)	9755.	6.26
PERCOLATION FROM LAYER 4	2.5460	(0.0292)	9759.	6.26
CHANGE IN WATER STORAGE	-0.001	(3.438)	-5.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.241	8590.7
PERCOLATION FROM LAYER 3	0.0073	28.1
HEAD ON LAYER 3	59.4	
PERCOLATION FROM LAYER 4	0.0071	27.2
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	24.44	0.5200
3	45.10	0.4100
4	23.59	0.0631
SNOW WATER	0.00	

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TOP OF THE TERRACE - TILL PRG DEVELOPMENT - 70 pCi/g
SOUTH FIELD
ZONE 2 July 12, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	75.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	104.00	INCHES
POROSITY	=	0.4100	VOL/VOL
FIELD CAPACITY	=	0.3710	VOL/VOL
WILTING POINT	=	0.2510	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100	VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000	CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	375.00	INCHES
POROSITY	=	0.3900	VOL/VOL
FIELD CAPACITY	=	0.0454	VOL/VOL
WILTING POINT	=	0.0200	VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0646	VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930	CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00	
TOTAL AREA OF COVER	=	46000.	SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00	INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400	INCHES
INITIAL VEG. STORAGE	=	6.2400	INCHES
INITIAL SNOW WATER CONTENT	=	0.0000	INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	112.1050	INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.779	0.737	1.052	0.367	0.000	0.028
	0.021	0.043	0.170	0.027	0.000	1.127
STD. DEVIATIONS	1.107	1.649	1.634	0.519	0.000	0.062
	0.046	0.097	0.364	0.046	0.000	1.573
EVAPOTRANSPIRATION						
TOTALS	0.849	1.534	2.473	2.865	3.168	5.021
	5.252	4.280	2.263	1.967	1.666	0.902
STD. DEVIATIONS	0.186	0.307	0.123	0.279	1.636	1.285
	1.202	1.215	1.781	0.510	0.154	0.169
PERCOLATION FROM LAYER 3						
TOTALS	0.2650	0.2406	0.2631	0.2543	0.2613	0.2513
	0.2558	0.2528	0.2458	0.2535	0.2465	0.2614
STD. DEVIATIONS	0.0111	0.0109	0.0093	0.0041	0.0035	0.0045
	0.0012	0.0005	0.0055	0.0054	0.0075	0.0103
PERCOLATION FROM LAYER 4						
TOTALS	0.2582	0.2354	0.2591	0.2510	0.2596	0.2513
	0.2595	0.2591	0.2503	0.2583	0.2496	0.2579
STD. DEVIATIONS	0.0026	0.0054	0.0032	0.0033	0.0034	0.0033
	0.0033	0.0030	0.0027	0.0027	0.0026	0.0026

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	5.351	(3.694)	20513.	13.17
EVAPOTRANSPIRATION	32.239	(3.193)	123584.	79.33
PERCOLATION FROM LAYER 3	3.0514	(0.0513)	11697.	7.51
PERCOLATION FROM LAYER 4	3.0493	(0.0351)	11689.	7.50
CHANGE IN WATER STORAGE	0.002	(3.625)	8.	0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.225	8530.3
PERCOLATION FROM LAYER 3	0.0088	33.6
HEAD ON LAYER 3	87.5	
PERCOLATION FROM LAYER 4	0.0085	32.6
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	39.00	0.5200
3	42.64	0.4100
4	24.24	0.0646
SNOW WATER	0.00	

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TOP OF THE TERRACE - TILL PRG DEVELOPMENT - 70 pCi/g
SOUTH FIELD
ZONE 3 July 12, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	114.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	105.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	372.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0663 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	133.2336 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.728	0.729	1.025	0.349	0.000	0.028
	0.021	0.043	0.150	0.027	0.000	0.913
STD. DEVIATIONS	1.081	1.631	1.605	0.499	0.000	0.062
	0.047	0.097	0.320	0.046	0.000	1.534
EVAPOTRANSPIRATION						
TOTALS	0.849	1.534	2.473	2.866	3.169	5.006
	4.984	4.268	2.262	1.971	1.670	0.903
STD. DEVIATIONS	0.186	0.307	0.123	0.279	1.636	1.311
	1.170	1.201	1.782	0.512	0.153	0.170

PERCOLATION FROM LAYER 3

TOTALS	0.3181	0.2889	0.3161	0.3055	0.3141	0.3023
	0.3087	0.3061	0.2972	0.3063	0.2973	0.3139
STD. DEVIATIONS	0.0119	0.0121	0.0103	0.0052	0.0043	0.0051
	0.0013	0.0006	0.0056	0.0057	0.0077	0.0109

PERCOLATION FROM LAYER 4

TOTALS	0.3116	0.2840	0.3126	0.3028	0.3131	0.3030
	0.3129	0.3123	0.3018	0.3114	0.3009	0.3109
STD. DEVIATIONS	0.0035	0.0064	0.0042	0.0044	0.0045	0.0043
	0.0043	0.0040	0.0036	0.0036	0.0034	0.0035

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	5.013	(3.604)	19216.	12.33
EVAPOTRANSPIRATION	31.955	(3.330)	122492.	78.62
PERCOLATION FROM LAYER 3	3.6746	(0.0578)	14086.	9.04
PERCOLATION FROM LAYER 4	3.6771	(0.0461)	14096.	9.05
CHANGE IN WATER STORAGE	-0.003	(3.842)	-10.	-0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.206	8456.9
PERCOLATION FROM LAYER 3	0.0105	40.2
HEAD ON LAYER 3	126.5	
PERCOLATION FROM LAYER 4	0.0103	39.3
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	59.28	0.5200
3	43.05	0.4100
4	24.65	0.0663
SNOW WATER	0.00	

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REMOVE FILL TO 90 PCI/G ON TOP OF TERRACE - CLEAN PERCHED WATER
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 1 June 13, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	80.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	54.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	384.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0678 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	96.0152 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.519	0.718	0.988	0.325	0.000	0.027
	0.021	0.043	0.109	0.027	0.000	0.729
STD. DEVIATIONS	0.910	1.606	1.566	0.472	0.000	0.061
	0.047	0.097	0.228	0.046	0.000	1.331
EVAPOTRANSPIRATION						
TOTALS	0.849	1.535	2.474	2.866	3.169	5.001
	4.768	4.269	2.252	2.001	1.673	0.901
STD. DEVIATIONS	0.186	0.307	0.123	0.279	1.637	1.320
	1.179	1.202	1.766	0.498	0.152	0.173

PERCOLATION FROM LAYER 3

TOTALS	0.3854	0.3491	0.3804	0.3668	0.3757	0.3600
	0.3655	0.3606	0.3505	0.3600	0.3491	0.3745
STD. DEVIATIONS	0.0255	0.0237	0.0225	0.0128	0.0108	0.0120
	0.0035	0.0018	0.0118	0.0118	0.0149	0.0227

PERCOLATION FROM LAYER 4

TOTALS	0.3696	0.3377	0.3722	0.3609	0.3734	0.3614
	0.3730	0.3719	0.3589	0.3699	0.3571	0.3687
STD. DEVIATIONS	0.0076	0.0107	0.0092	0.0096	0.0099	0.0096
	0.0097	0.0089	0.0080	0.0080	0.0075	0.0077

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	4.507	(3.460)	17276.	11.09
EVAPOTRANSPIRATION	31.757	(3.473)	121737.	78.14
PERCOLATION FROM LAYER 3	4.3777	(0.1342)	16781.	10.77
PERCOLATION FROM LAYER 4	4.3746	(0.1004)	16769.	10.76
CHANGE IN WATER STORAGE	0.003	(3.881)	12.	0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.180	8356.3
PERCOLATION FROM LAYER 3	0.0129	49.5
HEAD ON LAYER 3	92.7	
PERCOLATION FROM LAYER 4	0.0124	47.5
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	41.60	0.5200
3	22.14	0.4100
4	26.05	0.0678
SNOW WATER	0.00	

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REMOVE FILL TO 90 PCI/G ON TOP OF TERRACE - CLEAN PERCHED WATER
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 2 June 13, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	26.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	112.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	271.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0619 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	82.4549 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.832	0.759	1.091	0.390	0.000	0.041
	0.020	0.043	0.196	0.026	0.000	1.402
STD. DEVIATIONS	1.131	1.668	1.676	0.545	0.000	0.062
	0.045	0.097	0.421	0.046	0.000	1.618
EVAPOTRANSPIRATION						
TOTALS	0.848	1.533	2.471	2.865	3.167	4.981
	5.682	4.299	2.263	1.963	1.659	0.900
STD. DEVIATIONS	0.186	0.308	0.124	0.279	1.634	1.311
	1.407	1.237	1.781	0.509	0.157	0.169

PERCOLATION FROM LAYER 3

TOTALS	0.1928	0.1749	0.1912	0.1849	0.1897	0.1824
	0.1846	0.1812	0.1767	0.1824	0.1781	0.1901
STD. DEVIATIONS	0.0092	0.0085	0.0072	0.0024	0.0023	0.0031
	0.0015	0.0004	0.0049	0.0046	0.0067	0.0086

PERCOLATION FROM LAYER 4

TOTALS	0.1868	0.1704	0.1876	0.1819	0.1881	0.1821
	0.1881	0.1876	0.1811	0.1868	0.1805	0.1865
STD. DEVIATIONS	0.0022	0.0041	0.0028	0.0028	0.0028	0.0027
	0.0026	0.0024	0.0021	0.0022	0.0021	0.0022

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	5.802	(3.865)	22239.	14.27
EVAPOTRANSPIRATION	32.632	(3.013)	125087.	80.29
PERCOLATION FROM LAYER 3	2.2090	(0.0396)	8468.	5.44
PERCOLATION FROM LAYER 4	2.2075	(0.0286)	8462.	5.43
CHANGE IN WATER STORAGE	0.001	(3.326)	6.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.251	8630.5
PERCOLATION FROM LAYER 3	0.0064	24.5
HEAD ON LAYER 3	38.4	
PERCOLATION FROM LAYER 4	0.0062	23.7
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	13.52	0.5200
3	45.92	0.4100
4	16.78	0.0619
SNOW WATER	0.00	

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REMOVE FILL TO 90 PCI/G ON TOP OF TERRACE - CLEAN PERCHED WATER
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 3 June 13, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	53.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	96.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	260.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0638 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	89.7480 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX = 2.00
START OF GROWING SEASON (JULIAN DATE) = 133
END OF GROWING SEASON (JULIAN DATE) = 300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.798	0.744	1.064	0.375	0.000	0.029
	0.021	0.043	0.179	0.027	0.000	1.221
STD. DEVIATIONS	1.117	1.655	1.647	0.529	0.000	0.062
	0.046	0.097	0.384	0.046	0.000	1.584
EVAPOTRANSPIRATION						
TOTALS	0.849	1.533	2.472	2.865	3.168	5.021
	5.385	4.287	2.263	1.966	1.664	0.902
STD. DEVIATIONS	0.186	0.307	0.123	0.279	1.635	1.285
	1.245	1.222	1.781	0.509	0.155	0.169

PERCOLATION FROM LAYER 3

TOTALS	0.2413	0.2189	0.2393	0.2314	0.2374	0.2281
	0.2313	0.2280	0.2220	0.2289	0.2230	0.2376
STD. DEVIATIONS	0.0116	0.0109	0.0094	0.0037	0.0033	0.0043
	0.0015	0.0005	0.0059	0.0057	0.0080	0.0107

PERCOLATION FROM LAYER 4

TOTALS	0.2341	0.2136	0.2353	0.2281	0.2360	0.2284
	0.2358	0.2351	0.2269	0.2339	0.2260	0.2335
STD. DEVIATIONS	0.0034	0.0055	0.0043	0.0043	0.0043	0.0041
	0.0040	0.0036	0.0032	0.0032	0.0031	0.0033

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	5.501	(3.744)	21087.	13.54
EVAPOTRANSPIRATION	32.374	(3.128)	124099.	79.66
PERCOLATION FROM LAYER 3	2.7674	(0.0519)	10608.	6.81
PERCOLATION FROM LAYER 4	2.7669	(0.0430)	10606.	6.81
CHANGE IN WATER STORAGE	0.000	(3.518)	2.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.234	8562.5
PERCOLATION FROM LAYER 3	0.0080	30.7
HEAD ON LAYER 3	65.5	
PERCOLATION FROM LAYER 4	0.0078	29.8
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	27.56	0.5200
3	39.36	0.4100
4	16.59	0.0638
SNOW WATER	0.00	

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REMOVE FILL TO 90 PCI/G ON TOP OF TERRACE - CLEAN PERCHED WATER
SOUTH FIELD AND INACTIVE FLYASH PILE
ZONE 4 June 13, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.5200 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

BARRIER SOIL LINER

THICKNESS	=	133.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000140000 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	265.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0576 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	6.2400 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	76.0340 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	1.859	0.769	1.111	0.462	0.000	0.231
	0.020	0.043	0.243	0.026	0.013	1.732
STD. DEVIATIONS	1.145	1.677	1.697	0.530	0.000	0.456
	0.045	0.097	0.526	0.046	0.030	1.654
EVAPOTRANSPIRATION						
TOTALS	0.848	1.533	2.471	2.864	3.121	5.021
	5.797	4.307	2.302	1.985	1.657	0.900
STD. DEVIATIONS	0.186	0.308	0.124	0.279	1.675	1.245
	1.419	1.246	1.771	0.496	0.156	0.169
PERCOLATION FROM LAYER 2						
TOTALS	0.1366	0.1434	0.1569	0.1512	0.1550	0.1492
	0.0973	0.0174	0.0302	0.0591	0.1019	0.1264
STD. DEVIATIONS	0.0530	0.0050	0.0034	0.0013	0.0010	0.0019
	0.0226	0.0304	0.0675	0.0645	0.0685	0.0698
PERCOLATION FROM LAYER 3						
TOTALS	0.1083	0.1005	0.1129	0.1115	0.1175	0.1157
	0.1208	0.1159	0.1074	0.1071	0.1027	0.1069
STD. DEVIATIONS	0.0135	0.0132	0.0133	0.0124	0.0123	0.0115
	0.0111	0.0098	0.0084	0.0095	0.0109	0.0126

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	6.511	(3.632)	24959.	16.02
EVAPOTRANSPIRATION	32.806	(3.122)	125758.	80.72
PERCOLATION FROM LAYER 2	1.3245	(0.2675)	5077.	3.26
PERCOLATION FROM LAYER 3	1.3271	(0.1290)	5087.	3.27
CHANGE IN WATER STORAGE	-0.003	(2.768)	-10.	-0.01

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	2.253	8635.1
PERCOLATION FROM LAYER 2	0.0052	20.0
HEAD ON LAYER 2	12.4	
PERCOLATION FROM LAYER 3	0.0043	16.7
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.5200

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	6.24	0.5200
2	54.53	0.4100
3	15.25	0.0576
SNOW WATER	0.00	

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APPENDIX D.1

ATTACHMENT D.1-II

SOIL EROSION CALCULATIONS

D.1-II - SOIL EROSION CALCULATIONS

PURPOSE

To calculate the depth of erosion on the South Field for Operable Unit 2 for the proposed conditions.

PROCEDURE

Use the universal soil loss equation (D.1-II-1) to estimate the yearly amount of sediment released from the South Field. The amount will then be converted to a depth using the area and the soil bulk density. The 1,000-year depth will be calculated by multiplying the annual depth of soil lost by 1,000.

To account for distinct changes in slope, the amount of soil loss for each segment will be calculated using the average slope for that segment. Then the erosion depth will be developed. The maximum erosion amount for all the segments will be taken as the erosion amount for the South Field.

CALCULATION

The universal soil loss equation takes the following form (EPA 1985; EPA 1988; Maidment 1993):

$$M = R \times K \times LS \times C \times P \times A$$

where

M	=	annual soil loss (metric tons/year)
R	=	rainfall erosivity factor (100 m-tonne-cm/ha-hr)
K	=	soil erodability factor (metric tons/ha/R)
LS	=	slope length steepness factor (dimensionless)
C	=	cover factor (dimensionless)
P	=	erosion control practice factor (dimensionless)
A	=	subbasin area (Ha)

The depth of soil lost per year is given by

$$Depth = \frac{M}{100\ \rho A}$$

where

M	=	annual soil loss (metric tons/year)
Depth	=	the depth of soil lost per year (cm)
ρ	=	soil bulk density (g/cm^3)

therefore

$$\text{Depth} = \frac{R \times K \times LS \times C \times P}{\rho \times 100} \qquad \text{(D.1-II-3)}$$

The values of the parameters are

R = 303.6

From Figure III-10 of EPA (1985). Value of 175 converted to metric units with

$$1.735 \frac{(100 \text{ m-tonne-cm/ha-hr})}{(10 \text{ ft-ton-}\in\text{/ac-hr})}$$

K = 0.55 tonne/ha/R

Assume that cover soil is similar to natural soils around FEMP. Use Ho A (Henshaw) from USDA (1982) converted to metric with factor 1.29 (EPA 1988):

0.43 x 1.292 = 0.55 tonnes/ha/R

C = 0.003

From Table 2-4 of EPA (1988), 95 percent ground cover, no appreciable canopy, surface covered with grass.

P = 1.0

Assume no special erosion control practices. Use 1.0 for uncontrolled hazardous waste sites (EPA 1988, p. 22).

LS

Use following table based on Figure 2-6 of EPA (1988). Use steep slope. Do not average slope, since steep slope controls erosion.

Location*	Steep Slope Portion		LS
	Slope	Length (ft)	
A	9%	425	2.2
B	22%	125	6.0
C	11%	400	3.0

*See Figure D.1-II-1 for locations.

ρ = 1.30 g/cm^3

See explanation for K factor.

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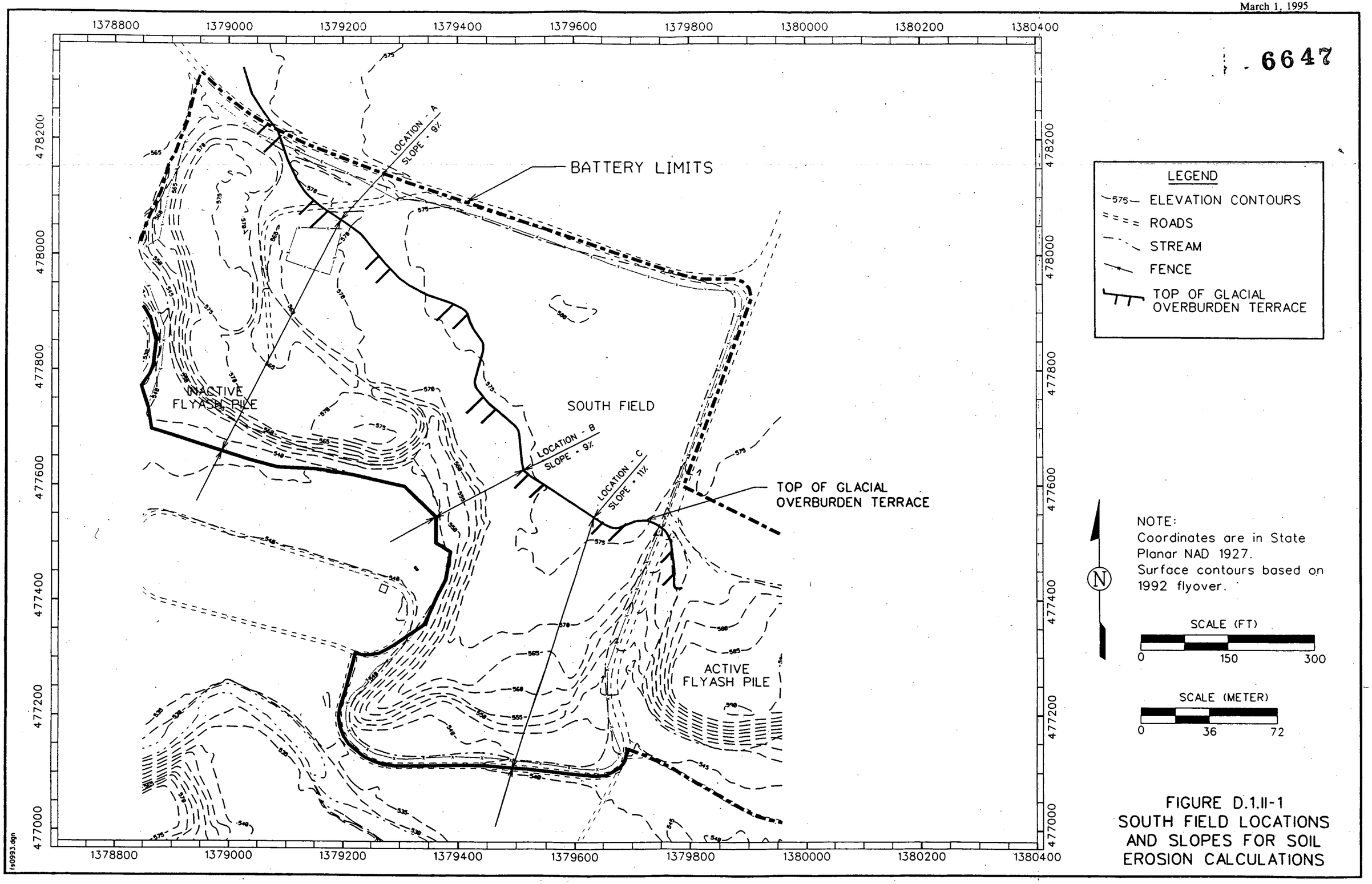

FIGURE D.1.II-1
SOUTH FIELD LOCATIONS AND SLOPES FOR SOIL EROSION CALCULATIONS

RESULTS

Results of soil erosion calculations are summarized in the following table.

SUMMARY OF SOIL EROSION CALCULATIONS

Area	R (100 m-tonne-cm/ ha-hr)	K (tonnes/ha/R)	LS	C	P	ρ (gm/cm^3)	Erosion Depth (cm/yr)	Erosion Depth (cm/1,000 yr)	Erosion Depth (in/1,000 yr)
A	303.6	0.55	2.2	0.003	1	1.3	8.48E-03	8.48	3.34
B	303.6	0.55	6	0.003	1	1.3	2.31E-02	23.12	9.10
C	303.6	0.55	3	0.003	1	1.3	1.16E-02	11.56	4.55

APPENDIX D.1

ATTACHMENT D.1-III

CALIBRATION OF FATE AND TRANSPORT MODEL AGAINST LYSIMETER DATA

D.1-III - CALIBRATION OF FATE AND TRANSPORT MODEL AGAINST LYSIMETER DATA

Three pairs of lysimeters were installed at the FEMP site by Operable Unit 5. At each location, one lysimeter was installed in the gray till and another in the unsaturated Great Miami Aquifer. Details of lysimeter installation and data collected from these lysimeters are reported in the Operable Unit 5 RI Report. Typically, lysimeters were installed 0.9 m (3 ft) above and 0.9 m (3 ft) below the contact between the gray till and the Great Miami Aquifer. Lysimeter pair 11130/11131 is in the area of the proposed disposal cell for Operable Unit 2. Lysimeter pair 11129/11234 is close to the South Field, and lysimeter pair 11132/11133 is located in the northeast part of the FEMP. Table D.1-III-1 shows the uranium concentrations measured in the water samples collected from the lysimeters. With one exception, this data show that the uranium concentration is higher in the lysimeter in the unsaturated Great Miami Aquifer than in the one in the gray till. Average uranium concentrations in the water samples collected from the unsaturated Great Miami Aquifer are approximately 4.8 times higher than water samples collected from the gray till. Typical barrier layer (i.e., gray clay) thickness is about 3 m (10 ft).

The ODAST model was used to simulate the fate and transport of uranium in the glacial overburden and unsaturated Great Miami Aquifer. To match uranium concentrations detected in lysimeter samples, the infiltration rate was estimated to be 8.4 inch/year at the lysimeters (Operable Unit 5 RI Report). Soil properties shown in Table D.1-2 of Appendix D.1 were used. Seepage velocities, dispersion coefficients, and retardation factors were calculated as described in Section D.1.3.3. For example, the seepage velocity in the glacial till was calculated to be 52.8 in/yr.

Large quantities of the soluble forms of uranium were dispersed and deposited over the site during the first 5 years of operations at the FEMP (see Appendix D.4). This was simulated by using a source term with constant loading for the initial 5 year period of the model. The model was then run, and current measured concentrations were compared to the model predictions at 40 years. This is the approximate time period that has elapsed since the operations began at the FEMP and initial uranium release occurred.

The model was first set up to simulate average hydrogeologic conditions for all three of the lysimeter sites. Typical barrier layer (i.e., grey clay) thickness is about 3 m (10 ft). Table D.1-III-2 shows

model predictions based on the assumption that the distribution coefficient (K_d) is 3.1 mL/g for the gray till and 1.78 mL/g for the unsaturated Great Miami Aquifer. The ODAST model predicted that the ratio of uranium concentration between the unsaturated Great Miami Aquifer lysimeter and gray till lysimeter is 5 at 40 years. This is considered a good agreement between model predictions (concentration ratio of 5) and field measured data (concentration ratio of 4.8). Observed average concentration data were matched by assuming the leachate concentration at the source to be constant at 175 μg/L.

The model was also calibrated against data from a specific lysimeter pair instead of average data. Lysimeter pair 11129/11234 was selected for calibration because of good soil sample recovery during installation of lysimeters and clear indications of breaks in lithology. At this location, soil boring data indicate that gray till thickness is approximately 2.4 m (8 ft). Lysimeter 11234 was installed approximately 1.4 m (4.5 ft) into gray clay [approximately 1.1 m (3.5 ft) above the unsaturated Great Miami Aquifer and gray till interface]. Lysimeter 11129 was installed in the unsaturated Great Miami Aquifer approximately 0.96 m (3 ft) below gray till. Average uranium concentrations in the unsaturated Great Miami Aquifer were about 4.9 times that in the gray till at these lysimeters (Table D.1-III-1). Table D.1-III-3 shows model predictions based on the assumption that the distribution coefficient (K_d) is 4.3 mL/g for the gray till and 1.78 mL/g for the unsaturated Great Miami Aquifer. The ODAST model predicted that the ratio of uranium concentration between the unsaturated Great Maim Aquifer lysimeter and gray till lysimeter is 4.7 at 40 years. This is considered a good agreement between model predictions and field-measured data. Observed concentration data were matched by using 375 μg/L as the leachate concentration.

Model calculations indicate that lysimeter data can be explained by glacial till K_d values in the range of 3.1 to 4.3 mL/g and leachate concentrations in the range of 175 to 375 μg/L for first the 5 years of operations at the FEMP.

TABLE D.1-III-1

URANIUM CONCENTRATIONS MEASURED IN THE WATER SAMPLES COLLECTED FROM THE LYSIMETERS

Date	Southwest Lysimeters			Southeast Lysimeters			Northeast Lysimeters		
	Unsaturated GMA[a] Lysimeter 11129 (μg/L)	Gray Till Lysimeter 11234 (μg/L)	Ratio of Unsaturated GMA to Gray Till Concentration	Unsaturated GMA Lysimeter 11131 (μg/L)	Gray Till Lysimeter 11130 (μg/L)	Ratio of Unsaturated GMA to Gray Till Concentration	Unsaturated GMA Lysimeter 11133 (μg/L)	Gray Till Lysimeter 11132 (μg/L)	Ratio of Unsaturated GMA to Gray Till Concentration
9/93	15.0	ND[b]	NA[c]	11.0	7.9	1.4	52.0	ND	NA
3/21/94	16.0	4.1	3.9	3.4	13.0	0.3	47.0	4.6	10.2
3/22/94	29.0	3.9	7.4	12.0	2.9	4.1	16.0	2.5	6.4
3/23/94	28.0	4.6 (4.2)	6.1	12.0 (12.0)	2.8	4.3	17.0 (14.0)	2.3	7.4
3/24/94	ND	4.9	NA	ND	2.8	NA	16.0	3.5	4.6
5/06/94	28.0	5.6	5.0	10.0	2.4	4.2	12.0	2.9	4.1
5/13/94	27.0	5.2	5.2	9.1	2.5	3.6	12.0	2.8	4.3
5/20/94	26.0	5.4	4.8	8.9	3.0	3.0	13.0	2.8	4.6
5/27/94	ND	5.1	NA	ND	2.4	NA	ND	2.6	NA
6/03/94	24.0	5.2	4.6	8.1	2.4	3.4	12.0	2.6	4.6
6/10/94	ND	5.4	NA	ND	2.4	NA	ND	2.6	NA
6/17/94	23.0	5.3	4.3	8.3	2.6	3.2	12.0	2.4	5.0
Average	24.0	4.9	4.9	9.5	3.9	2.4	20.3	2.9	7.1

Overall average unsaturated GMA concentration = 17.9 μg/L.
Overall average gray till concentration = 3.9 μg/L.
Overall average ratio = 4.8.

[a]GMA = Great Miami Aquifer
[b]ND = No data available
[c]NA = Not applicable

000253

6647

TABLE D.1-III-2

PREDICTED URANIUM CONCENTRATIONS FOR TYPICAL LYSIMETER INSTALLATION

Time (Years)	Predicted Uranium Concentrations		
	Unsaturated GMA[a] Lysimeter (μg/L)	Gray Till Lysimeter (μg/L)	Ratio of Unsaturated GMA to Gray Till Concentration
5	0.0	0.0	0.0
10	0.0	0.0	0.0
15	0.0	1.6	0.0
20	0.0	31.0	0.0
25	0.0	71.3	0.0
30	0.1	49.6	0.0
35	3.1	17.0	0.2
40	18.9	3.8	5.0
45	50.3	0.1	584.8

[a]GMA = Great Miami Aquifer

TABLE D.1-III-3

PREDICTED URANIUM CONCENTRATIONS FOR SOUTHWEST LYSIMETER PAIR 11129/11234

Time (Years)	Predicted Uranium Concentrations		
	Unsaturated GMA[a] Lysimeter 11129 (μg/L)	Gray Till Lysimeter 11234 (μg/L)	Ratio of Unsaturated GMA to Gray Till Concentration
5	0.0	0.0	0.0
10	0.0	0.4	0.0
15	0.0	32.6	0.0
20	0.0	128.3	0.0
25	0.0	126.9	0.0
30	0.2	60.9	0.0
35	3.6	19.6	0.2
40	23.3	5.0	4.7
45	63.8	1.1	59.4

[a]GMA = Great Miami Aquifer

ATTACHMENT D.1-IV

ALTERNATE MODELING APPROACH FOR PRELIMINARY WASTE ACCEPTANCE CRITERIA

ATTACHMENT D.1-IV

ALTERNATE MODELING APPROACH FOR PRELIMINARY WASTE ACCEPTANCE CRITERIA

In order to evaluate the protectiveness of the proposed waste acceptance criteria (WAC), additional modeling was performed using a conceptual model for the vadose zone that differed from the model used throughout the remainder of the groundwater modeling. The differences were as follows:

- The infiltration was recalculated using less conservative assumptions than those used in the original HELP modeling.
- The 3 feet thick disposal cell liner, which was not used in the original modeling, was included in the ODAST simulation.
- The unsaturated sand and gravel layer in the Great Miami Aquifer, which was used in the original modeling, was not included in the ODAST simulation.

Infiltration was calculated by the HELP model using the entire disposal cell cross section. The HELP model output indicates that the infiltration rate would be 0.89 in./yr which is lower than the original value of 1.22 in./yr. A summary of the HELP model input and output is presented in Table D.5-IV-1. In contrast to the original infiltration calculation, the current calculation includes the overburden waste material layer and the underlying natural material beneath the disposal cell. Also, while the original calculation included only a 1-foot lateral drainage layer with a hydraulic conductivity of 1 x 10^{-2} cm/s, which does not provide much lateral drainage, the updated HELP model simulation includes a 4.5-foot combined lateral drainage layer consisting of the sand filter (0.5 feet of sand), biotic barrier (3 feet of cobbles), and the drainage layer (1 foot of sand) functioning together as a unit. Together these layers are capable of sufficiently draining water above the infiltration barrier, thus preventing the buildup of excessive hydraulic head above the infiltration barrier. The hydraulic conductivity in this combined lateral drainage layer is estimated to be 1 x 10^{-1} cm/s. All of the layers utilized in the updated HELP run are present in the disposal cell cap cross section and can be accounted for in the simulation. However, conservatism is still maintained by omission of the geomembranes in the system. The clay liner was set at 3 feet thick and assumed to consist of clay with a K_d value of 24 L/Kg. This K_d value, which is higher than that of the gray glacial till, was based on the assumption that the quality of clay from a borrow source would be controlled to ensure the higher value. The clay liner was the first of two layers in the ODAST model.

The second layer in the ODAST model consisted of gray till (clay). Properties of the gray till are shown in Table D.1-IV-1. The moisture content of the gray till from the HELP modeling was 19 percent. Therefore, the retardation factor in the gray till was recalculated using the simulated moisture content of 19 percent . Because of the updated infiltration rate and moisture content, the retardation factor is 31.2, higher than the original value of 14.99, which was based on the original, higher infiltration rate and moisture content.

The thickness of the unsaturated sand and gravel layer in the Great Miami Aquifer was assumed to be zero (compared to approximately 35 feet in the original modeling). Thus, any retardation in the sand and gravel is eliminated.

Using the updated layers, infiltration rate, and retardation factor, an ODAST/SWIFT modeling run was completed. The source leachate concentration was assumed to be 24,000 pCi/L. The simulated maximum uranium concentration in the Great Miami Aquifer in 1,000 years was about 1.4 ug/L, well below the target MCL value of 20 ug/L. The uranium plume at the end of the simulation is shown in the Figure D.5-IV-1. This result serves to support the current preliminary WAC proposed in this FS. Confirmation of the preliminary WAC by a different modeling approach also serves to demonstrate that the proposed criteria are robust.

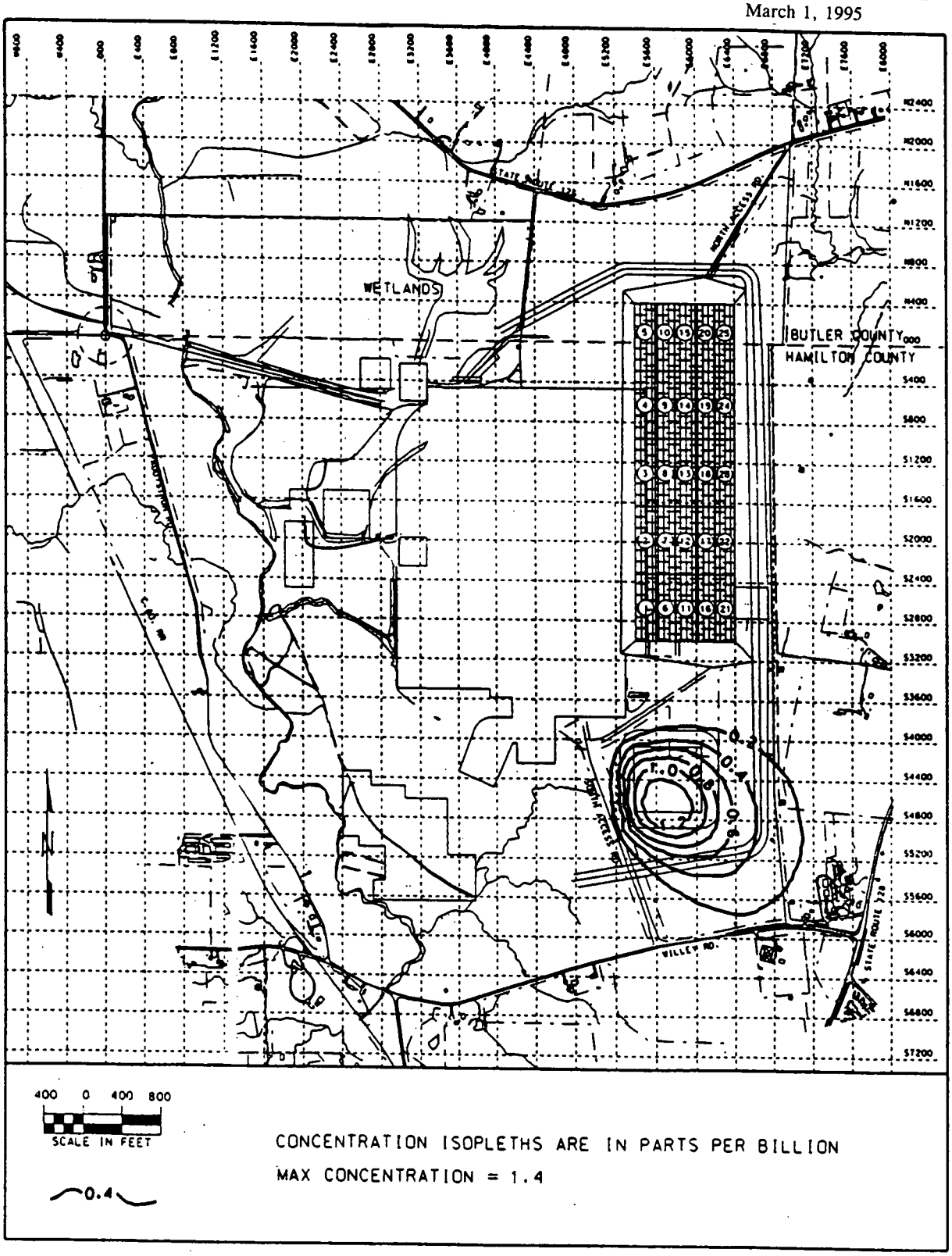

FIGURE D.1-IV-1
ALTERNATE MODELING APPROACH
PROJECTED INCREASE IN TOTAL URANIUM CONCENTRATIONS

APPENDIX D.2

AIR TRANSPORT MODELING FOR LONG-TERM RESIDUAL RISK

D.2.0 AIR TRANSPORT MODELING FOR LONG-TERM RESIDUAL RISK

D.2.1 INTRODUCTION

This section presents the approach, methodology, and results of the long-term air transport analysis of the Operable Unit 2 remedial alternatives. The objective of this analysis was to determine the maximum on-property and off-property annual average air contaminant concentrations and deposition rates from the remediated Operable Unit 2 subunits. These concentrations were used for the residual risk assessment described in this FS. The discussion and results of the site-wide air transport analysis for all operable units is presented in the Operable Units 1 and 2 CRARE submitted with this FS.

The analysis was conducted in accordance with EPA guidance (EPA 1989a). Two emission models and an air dispersion model were used to estimate air emissions from each source and to calculate annual average concentrations and deposition rates at various receptor locations. One emission model predicted the quantity of exposed soil that would be resuspended by the wind, and the other emission model estimated the flux of radon-222 gas from soil containing radium-226. Particulate-phase contaminants examined include radionuclides and inorganic compounds, as well as semivolatile and nonvolatile organic compounds. The only gas-phase contaminant evaluated in this analysis was radon-222. VOCs were not analyzed, as they would be lost to the atmosphere prior to the start of the postremediation periods analyzed in the FS. The air dispersion model accounted for dispersion and dilution of the contaminants under defined meteorological conditions, such as wind speed and direction, atmospheric stability, and mixing height. The meteorological parameters used were collected from an on-property meteorological station, as well as from the National Weather Service (NWS) in Dayton, Ohio.

Five major steps were required to achieve the objective of this analysis:

1. Scenarios for the air transport analysis were defined.
2. Sources of air emissions and contaminants released were identified based on site-specific information.
3. The appropriate EPA regulatory air dispersion model was selected which best represented the site characteristics and the objective of the analysis.
4. Particulate or gaseous air emissions were estimated from site-specific soil contaminant concentrations, and additional inputs to the model, such as meteorological data and receptor locations, were determined.

5. Results of the air dispersion model were processed to determine the maximum on- and off-property annual average concentrations and deposition rates for residual risk calculations.

Figure D.2-1 presents the sequential block diagram of these steps and indicates the sections below that describe them.

Throughout the analysis, site-specific data were used where available. When such data were not available, conservative assumptions were made. Regulatory default options and values were used where applicable in the air emission and dispersion models. The intent of the assumptions was to make the results relevant to the site so that the risk associated with the air exposure pathway was realistic.

D.2.2 SOURCE TERM ASSUMPTIONS FOR AIR TRANSPORT ANALYSIS

The residual risks from remediated Operable Unit 2 subunits were evaluated for a number of exposure scenarios under two land-use assumptions: future with federal ownership and future with private ownership. The impact that the RME receptor was assumed to have on the generation of air emissions from the FEMP was different between these two scenarios. With federal ownership, the expanded trespasser was assumed to have little impact on the generation of fugitive particulate matter emissions. With private ownership, the on-property resident farmer was assumed to significantly contribute to the generation of fugitive particulate matter emissions, primarily from agricultural tilling. Therefore, separate sets of air emissions and concentration estimates were developed for each of the future land-use scenarios.

A detailed analysis of four remedial alternatives is presented in Section 5.0 of this FS. These alternatives include no action (Alternative 1), consolidation and capping (Alternative 2), excavation and off-site disposal (Alternative 3), and excavation and on-site disposal with off-site disposal of fraction exceeding the waste acceptance criteria (Alternative 6). Therefore, exposure point concentrations were required for Alternatives 2, 3, and 6 to complete the risk assessments for these alternatives. Exposure point concentrations were determined for Alternative 1 in the Operable Unit 2 RI Report Baseline Risk Assessment (DOE 1994). The assumptions regarding the air pathway impacts associated with the other three remedial alternatives are discussed in the following paragraphs.

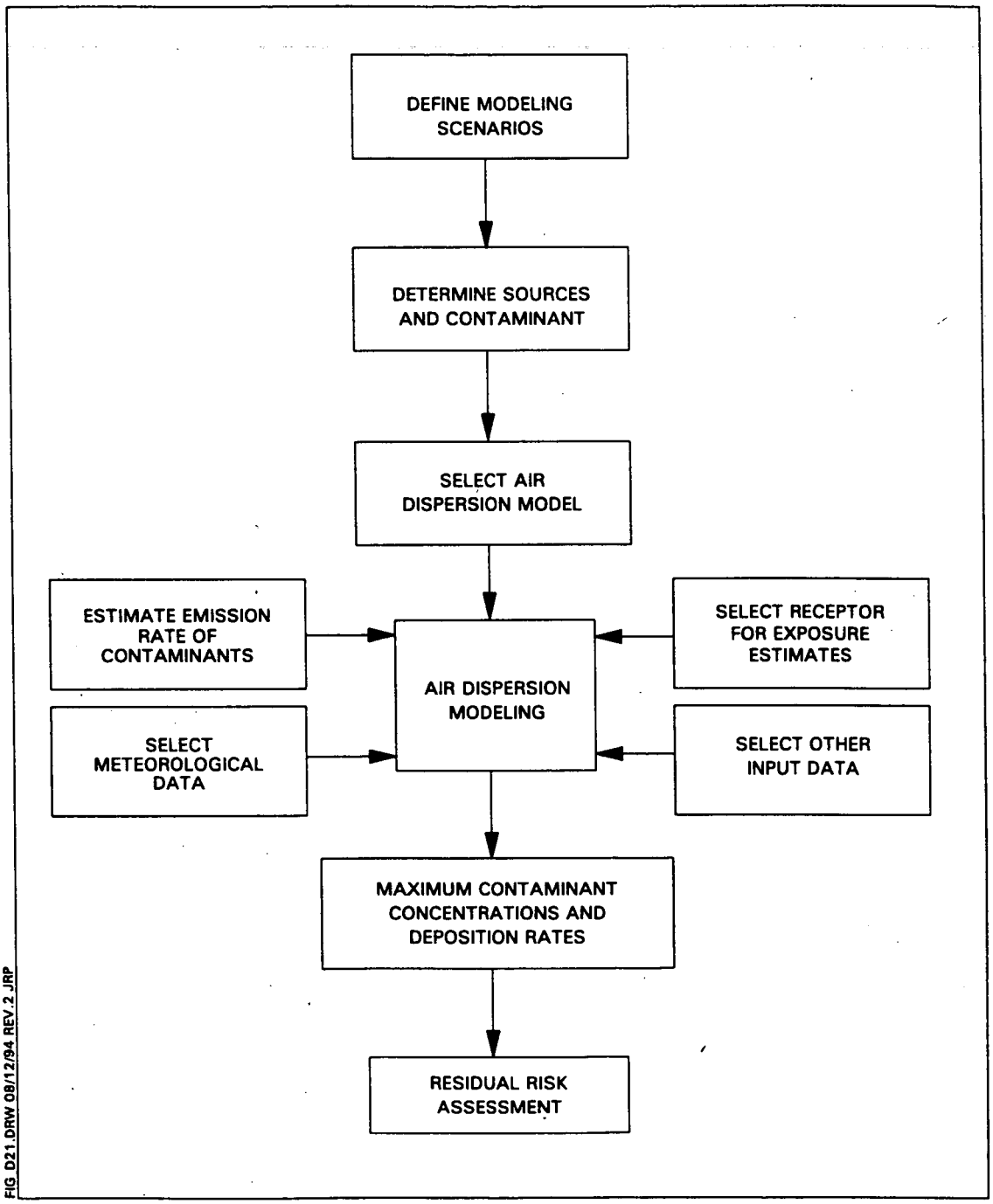

FIGURE D.2-1. SEQUENTIAL BLOCK DIAGRAM OF AIR TRANSPORT ANALYSIS

D.2.2.1 Alternative 2: Consolidation and Capping

This alternative involves excavation, consolidation, and capping within each Operable Unit 2 subunit. Air fate and transport analysis for this alternative was conducted only for the future land use with federal ownership. Therefore, the expanded trespasser and/or off-property resident farmer PRLs were assumed to set the upper limit on residual surface soil contamination levels.

The consolidation area for the South Field area (South Field, Active Flyash Pile, and Inactive Flyash Pile) will be located on the deep till in the northeast portion of the South Field and Active Flyash Pile. The contaminated material directly overlying the Great Miami Aquifer (GMA) and/or down surface from the old terrace face in the South Field area will be excavated and placed in the consolidation area. A multi-layer capping system, as shown in Appendix E, will be constructed over the consolidation area. The excavated areas may be backfilled or covered with clean material.

Several layers of South Field area soil containing residual contamination were assumed to be exposed to the atmosphere after completion of remedial activities for this analysis. The contaminant concentrations in the GMA soil (from Appendix A) were assumed for the areas excavated down to the GMA. The contaminant concentrations in the old terrace face (listed as "Other Till" in Appendix A) were assumed for the Inactive Flyash Pile area that was excavated to the old terrace. The contaminant concentrations in the impacted till below portions of the South Field and Active Flyash Pile were used for those areas where excavation was completed just below the fill or source material. Radon emissions were estimated from residual radium concentrations in the exposed soil. The multi-layer cap over the consolidation area will be constructed to last 1,000 years without exposure of contained material. Therefore, the consolidation area was not assumed to contribute particulate matter emissions. However, gaseous radon emissions through the cap were quantified and included in radon dispersion modeling.

Contaminated material in the Solid Waste Landfill with concentrations exceeding the expanded trespasser and off-property resident farmer PRLs will be consolidated within the landfill and a composite cap constructed over the material. The excavated areas will be backfilled with clean soil. The capped area was assumed to cover most of the surface area of the Solid Waste Landfill.

Therefore, no significant contribution to particulate matter emissions was assumed for this subunit. Gaseous radon emissions through the cap were quantified and included in radon dispersion modeling.

The Lime Sludge Ponds will be capped in place with a multi-layered cap. No significant contribution to particulate matter emissions was assumed for this subunit. However, gaseous radon emissions through the cap were quantified and included in radon dispersion modeling.

D.2.2.2 Alternative 3: Offsite Disposal

This alternative involves excavation of all contaminated material, segregation, staging, size reduction, drying, packaging, and off-site disposal. Air fate and transport analysis for this alternative was conducted for both future land-use scenarios. With federal ownership, the expanded trespasser and/or off-property resident farmer PRLs were assumed to set the upper limit on residual surface soil contamination levels. With private ownership, the on-property resident farmer PRLs were assumed to set the upper limit on residual surface soil contamination levels.

As in Alternative 2, the contaminated material directly overlying the GMA and/or down surface from the old terrace face in the South Field area will be excavated. The contaminant concentrations in the GMA soil (from Appendix A) were assumed for the areas excavated down to the GMA. The contaminant concentrations in the old terrace face (listed as "Other Till" in Appendix A) were assumed for the areas that were excavated to the old terrace. The contaminant concentrations in the impacted till were used for those areas where excavation was completed just below the fill or source material. The contaminant concentrations in the surface soil in the northeast corner of the South Field and Active Flyash Pile were assumed to be at or below the appropriate PRL values for each land-use scenario. Radon emissions were estimated from residual radium concentrations in the exposed soil.

The material in the Solid Waste Landfill with contaminant concentrations which exceed the appropriate PRL values will be excavated. The excavated areas will be backfilled with clean soil. The residual soil concentrations were assumed to be at or below the PRL values. Radon emissions were estimated from residual radium concentrations in the surface soil.

The material in the Lime Sludge Ponds with contaminant concentrations which exceed the appropriate PRL values will be excavated. The excavated areas will be backfilled with clean soil. The residual

soil concentrations were assumed to be at or below the PRL values. Radon emissions were estimated from residual radium concentrations in the surface soil.

D.2.2.3 Alternative 6: Excavation and On-Site Disposal with Offsite Disposal of Fraction Exceeding the WAC

This alternative involves excavation of contaminated material and transportation to an on-site disposal cell. Material with contamination exceeding the on-site disposal cell waste acceptance criteria (WAC) will be disposed off site at a permitted commercial facility. Air fate and transport analysis for this alternative was conducted for both future land-use scenarios. With federal ownership, the expanded trespasser and/or off-property resident farmer PRLs were assumed to set the upper limit on residual surface soil contamination levels. With private ownership, the on-property resident farmer PRLs were assumed to set the upper limit on residual surface soil contamination levels.

As in Alternatives 2 and 3, the contaminated material directly overlying the GMA and/or down surface from the old terrace face in the South Field Area will be excavated. The contaminant concentrations in the GMA soil (from Appendix A) were assumed for the areas excavated down to the GMA. The contaminant concentrations in the old terrace face (listed as "Other Till" in Appendix A) were assumed for the areas that were excavated to the old terrace. The contaminant concentrations in the impacted till were used for those areas where excavation was completed just below the fill or source material. The contaminant concentrations in the surface soil in the northeast corner of the South Field and Active Flyash Pile were assumed to be at or below the appropriate PRL values for each land use scenario. Radon emissions were estimated from residual radium concentrations in the exposed soil.

The material in the Solid Waste Landfill with contaminant concentrations which exceed the appropriate PRL values will be excavated. The excavated areas will be backfilled with clean soil. The residual soil concentrations were assumed to be at or below the PRL values. Radon emissions were estimated from residual radium concentrations in the surface soil.

The material in the Lime Sludge Ponds with contaminant concentrations which exceed the appropriate PRL values will be excavated. The excavated areas will be backfilled with clean soil. The residual soil concentrations were assumed to be at or below the PRL values. Radon emissions were estimated from residual radium concentrations in the surface soil.

The excavated material which meets the disposal cell WAC will be placed in the on-site disposal cell. This cell will be covered with a multi-layered cap designed to last 1,000 years. Therefore, the disposal cell was not assumed to contribute particulate matter emissions. However, gaseous radon emissions through the cap were quantified and included in radon dispersion modeling.

To analyze the Operable Unit 2 subunits, a total of 373 area sources were used. These sources were combined into 13 source groups; each source group contained sources with identical emission rates. The eight major source groups in the South Field Area are presented on Figure D.2-2. The remaining five source groups included the Solid Waste Landfill, Lime Sludge Ponds, On-Site Disposal Cell, and the Consolidation Area (north end and south end).

D.2.3 AIR TRANSPORT MODELS

The annual average contaminant concentrations and deposition rates were determined using the ISCLT2 model (EPA 1992a). This model is recommended by EPA for air pathway analysis of Superfund sites (EPA 1989a). The annual average deposition rates were calculated by multiplying the contaminant concentrations in air by the particulate deposition velocity of 0.0018 m/s (DOE 1992).

The ISCLT2 model was designed by the EPA to assess the impact on air quality of emissions from a wide variety of sources. It incorporates a steady-state gaussian plume equation that is applicable in flat or gently rolling terrain, for multiple point, area, and volume sources. The ISCLT2 model calculates the annual average concentration due to airborne emissions at user-selected receptors, based on sector-averaged statistical wind summaries. Data required for input to the model include source emission rates, the locations and configurations of sources, statistical summaries of wind speed, wind direction, and atmospheric stability, and the locations of the selected receptors.

D.2.4 PARTICULATE CONTAMINANT EMISSION RATES

Radionuclide, inorganic, semivolatile organic, and nonvolatile organic contaminants were assumed to be present in the suspended particulate matter emitted from the site. The emission rate for each contaminant in this particulate matter was calculated from the concentration of the contaminant in the exposed soil and from the estimated average particulate matter emission rates from Operable Unit 2. For concentration calculations, the emission rate of particulate matter less than 10 micrometers in diameter (PM_{10}) was used. For deposition rate calculations, the emission rate of total suspended

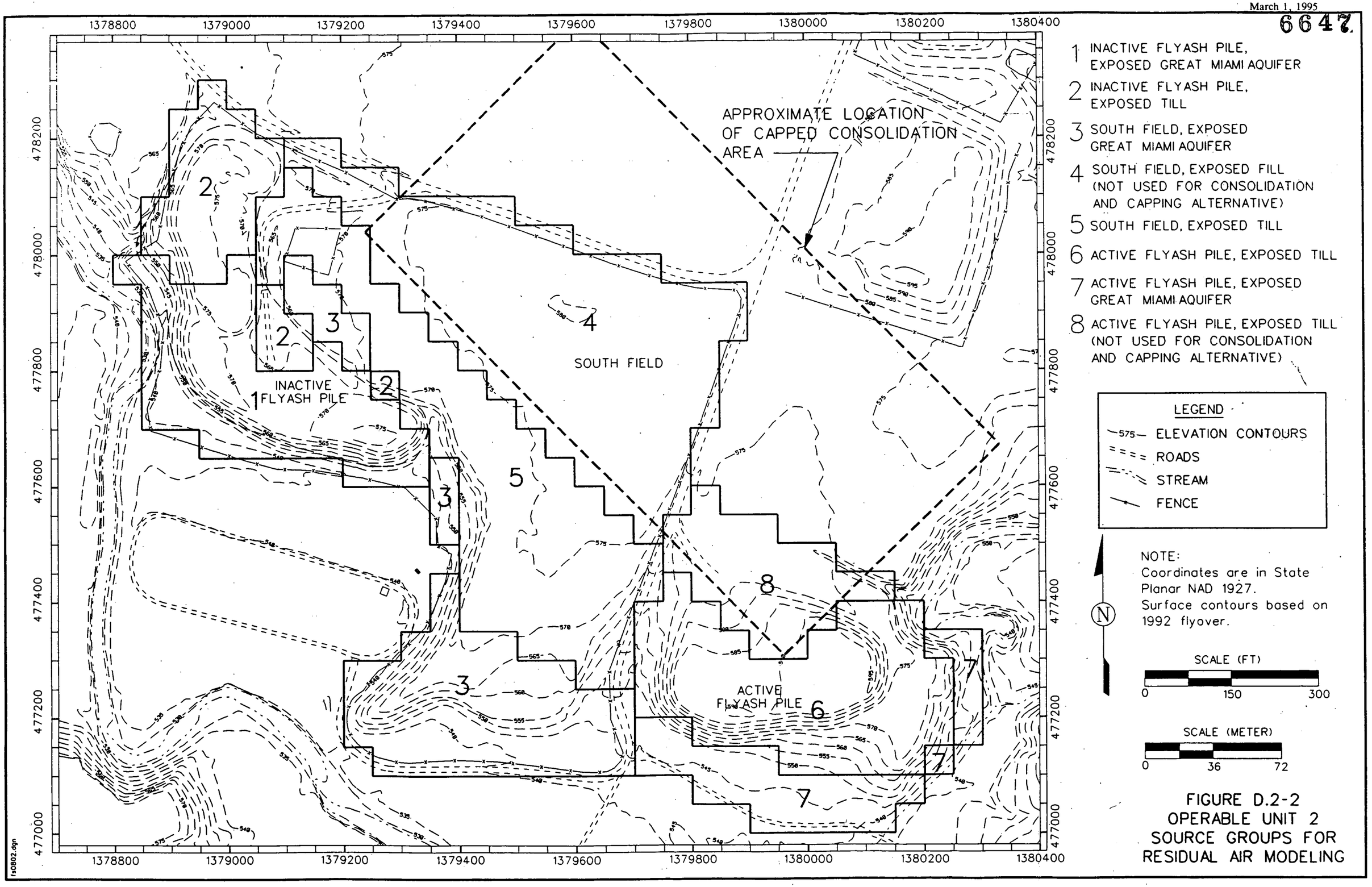

FIGURE D.2-2
OPERABLE UNIT 2
SOURCE GROUPS FOR
RESIDUAL AIR MODELING

particulates (TSP) was used. The TSP emission rate was determined by assuming that PM_{10} represented 50 percent of the TSP value (EPA 1993).

D.2.4.1 Contaminated Soil Concentrations

The contaminant concentrations in soil used to develop of emission source terms are presented in Attachment D.2-I. The initial contaminant soil concentrations were selected from data in Appendix A of this FS.

Because this analysis assumed that the site has been remediated, any soil concentrations exceeding the expanded trespasser or on-property resident farmer PRLs identified in this FS were reset to the appropriate PRL value. For COCs which did not exceed the PRL value, the exposed soil concentration terms were used. These layers included the upper GMA and till in the Flyash Piles and South Field (all alternatives) as well as the fill in the South Field (Alternatives 3 and 6). This approach assumed that the residual contamination after remediation will not be worse than currently measured levels.

D.2.4.2 Suspended Particulate Emission Estimate

The method used to estimate PM_{10} emission rates for the FEMP is based on EPA guidance for estimating wind erosion rates from flat soil surfaces at hazardous waste sites (EPA 1985a). The EPA methodology assumes that a minimum wind speed is required for the suspension of respirable dust, and the emission rate is a nonlinear function of the "Threshold Friction Velocity" (TFV) and the erosion potential of the site, which depends on the particle size distribution of the soil. Very fine soils (those with small modal diameters) have low TFVs and high potential for erosion by wind.

In addition to modal diameter, other factors such as the amount of nonerodible elements [gravel and pebbles with diameters greater than approximately 1 cm (0.4 in.)], crustiness of the surface soil, and the amount of vegetative cover effect the quantity of soil that can be resuspended by the wind.

The on-property resident farmer receptor would be continuously breaking up the soil crust in the farmed area. Therefore, crustiness was not applied as a factor in determining the particulate emissions for this receptor. To conservatively estimate the emissions from an on-property farm, only the modal diameter was used to calculate the flux of particulate matter for determining risk under this

scenario. For all other receptors/scenarios, the ability of the soil to form a crust, as well as moisture content and presence of nonerodible elements, was taken into account.

D.2.4.2.1 Emission Rates with Private Ownership

The modal diameter of Operable Unit 2 exposed soil was estimated from particle size distributions presented in the Operable Unit 2 RI Report (DOE 1994). From the data in that report, the modal diameter occurs in the silt fraction, which is between 0.002 and 0.075 mm (0.000001 and 0.00003 in.). The modal diameter selected was approximately 0.021 mm (0.00001 in.), which is in agreement with the typical 50 percent particle size diameter for the FEMP (Mulder 1993).

Using an exposed soil modal diameter of 0.021 mm, the TFV can be determined from the EPA guidance document (EPA 1985a, Figure 3-4). The relationship between the modal diameter and the TFV can be represented by the equation:

$$\log (TFV) = 1.812 + 0.4161 \log (d_p) \qquad \text{(D.2-1)}$$

where

TFV = threshold friction velocity (cm/s) near the soil surface, and
d_p = modal diameter of soil sample (mm).

The calculated TFV is approximately 13.0 cm/s (5 in./s) based on a modal diameter of 0.021 mm (0.00001 in.). The calculated TFV should be corrected based on the surface roughness, crustiness, and quantity of nonerodible elements. The ratio of the corrected TFV to the uncorrected TFV is a nonlinear function of the ratio of the silhouette area of the roughness elements to the total area of bare loose soil (EPA 1985a). For this FS, no correction was applied to the calculated TFV based on the assumption that the exposed surface would behave like dry, loose silt. This assumption is obviously conservative, since the site has enough clay in the soil to form a nonerodible crust, the surface contains nonerodible elements, and the vegetation present will significantly increase the TFV necessary to resuspend surface soil.

The calculated TFV is less than the 75 cm/s (30 in./s); therefore, the FEMP surface soil was

considered to have an "unlimited" erosion potential (EPA 1985a). The equation for respirable particulate emissions of soils with unlimited erosion potential takes the following form:

$$E_{10} = 0.036 \times (1-V) \times [(u/u_t)^3] \times F(y) \qquad \text{(D.2-2)}$$

where

E_{10} = annual average PM_{10} emission rate per unit area of contaminated surface ($g/hr/m^2$),

PM_{10} = particulate matter with a diameter $\leq$ 10 meters,

V = fraction of soil covered by vegetation,

u = mean annual wind speed (m/s),

u_t = TFV at the height of "u" (m/s),

y = $0.886 \times u_t / u$,

$F(y)$ = 1.91 for $y < 0.5$,

$F(y)$ = $0.18 \times (y^3 + 12y) \times EXP(-y^2)$ for $y > 2$, and

$F(y)$ = See Figure 4-3, EPA 1985a, for $0.5 < y < 2$.

For the on-property resident farmer exposure scenarios, the farmed land will be periodically plowed and planted, harvested, plowed, and left fallow. Under these scenarios, the topsoil is assumed to be covered with vegetation for only 50 percent of the year.

The TFV must be corrected to the anemometer height [10 m (30 ft)] used to collect site wind speed data. The corrected TFV is calculated from the following equation (EPA 1985a):

$$U_t/TFV = (1/0.4) \ln (Z/Z_o) \qquad \text{(D.2-3)}$$

where

Z = anemometer height (m), and

Z_o = surface roughness height (m).

The surface at the FEMP will be covered with grass and other vegetation after completion of remedial actions. Using an approximated value of 0.03 m (0.1 ft) for grassland (EPA 1985a) as Z_o, the value of U_t was calculated to be 1.89 m/s (6 ft/s).

The methodology used to calculate the emissions for soil with unlimited erosion potential is based on multiplying the emission rate for a single mean annual wind speed value by an estimated annual wind speed probability distribution. This method allows for rapid calculation of annual PM_{10} emissions knowing only the mean annual wind speed. The highest annual average wind speed from the on-site meteorological data set was 2.28 m/s (DOE 1993c). Using this wind speed value in Equation D.2-2 provides an estimated PM_{10} emission flux of 1.59×10^{-5} g/sec/m^2.

The annual average contaminant emission rates from each subunit under each alternative is presented in Attachment D.2-II. Only those emission rates associated with soil concentrations which exceed background are included in the attachment.

D.2.4.2.2 Emission Rates with Administrative Controls

Observations of the surface soil at the FEMP indicate that the surface may have a limited erosion potential, based on comparison of the FEMP surface to photographs of limited erosion potential surfaces presented in the reference document (EPA 1985a). Therefore, the limited erosion potential equation, presented below, is used to estimate particulate emissions for the expanded trespasser/off-property farmer exposure scenarios:

$$E_{10} = 0.83 \times f \times P(u^+) \times (1 - V) / (PE/50)^2 \qquad \text{(D.2-4)}$$

where

E_{10} = annual average PM_{10} emission rate per unit area of contaminated surface (g/hr/m^2),

f = frequency of disturbance per month,

$P(u^+)$ = erosion potential, the quantity of erodible particles present on the surface prior to the onset of wind erosion (g/m^2),

u^+ = observed (or probable) fastest mile, of wind for the period between disturbances (m/s),

V = fraction of soil covered by vegetation, and

PE = Thornthwaite's Precipitation Index (a measure of average soil moisture content).

The erosion potential in Equation D.2-4 depends on the fastest mile as follows (EPA 1985a):

$$P(u^+) = 6.7 \times (u^+ - u_t), \text{ for } u^+ \geq u_t, \qquad \text{(D.2-5)}$$
$$= 0, \text{ for } u^+ < u_t.$$

A typical fastest mile for the region is 24 m/s (EPA 1985a) at 7 m above the ground. Correcting the threshold friction velocity previously determined for the unlimited erosion potential to 7 m above the ground (using Equation D.2-3) results in a value of 1.77 m/s for u_t. The calculated value for $P(u^+)$ is 148.93 g/m^2.

Since the remediated site under scenarios other than the on-property resident farmer will be infrequently disturbed, the value of **f** was assumed to be 1. Thornthwaite's Precipitation Index (PE) for the southwest corner of Ohio is 103 (EPA 1985a).

Currently, the FEMP is 80 to 85 percent covered with vegetation. After remediation, each subunit will be planted with appropriate vegetation for erosion control and aesthetics. The region easily supports plant life, and a 100 percent vegetative cover is expected over the postremediated site, with or without continued maintenance. For this air transport analysis, the site was conservatively assumed to be 85 percent covered with vegetation. The 85 percent value is in line with EPA estimates of control efficiencies for vegetative covers (EPA 1987).

The limited erosion potential of PM_{10} for the FEMP is then calculated to be 1.21×10^{-6} $g/s/m^2$.

Note that the ISCLT2 model calculates dispersion for six wind speed categories (EPA 1992a). The use of a single emission rate for dispersion under all six wind speed categories will overestimate the concentrations for low wind speeds and underestimate concentrations for high wind speeds. The frequency of wind speeds in the lower wind speed categories is much greater than the frequency of wind speeds in the upper wind speed categories. Therefore, using a single emission rate for all wind speed categories in ISCLT2 will tend to overestimate the ground level PM_{10} concentrations. Evidence indicates (EPA 1985b) that no substantial fugitive particulate emissions occur for wind speeds less than 5 m/s (16.4 ft/s or 12 mph). These wind speeds include the lower three wind speed categories analyzed by ISCLT2.

The annual average contaminant emission rates from each subunit under each alternative is presented in Attachment D.2-II. Only those emission rates associated with soil concentrations which exceed background are included in the attachment.

D.2.5 GASEOUS CONTAMINANT EMISSION RATES

Emissions of radon-222 were estimated for exposed soil as well as from capped or covered areas. No other gaseous emissions were estimated. Volatile organics were assumed to have decayed to negligible levels prior to the time period studied by this analysis. Radionuclides, semivolatile and nonvolatile organics, and inorganics were assumed to be transported with the particulates emitted from the site.

Radon-222 emissions were determined from the radium-226 concentrations in the contaminated soil using the RAECOM model algorithms developed for the NRC (NRC 1984). The model accounts for the half-lives of radon and radium, as well as the density, porosity, moisture content, and depth of contaminated layers and cover layers in estimating radon-222 emission rates. The model converts radium-226 soil concentrations (in pCi/g) to radon-222 fluxes (in pCi/s/m^2). The basic equations are presented in the Risk Assessment Work Plan Addendum (DOE 1992). The RAECOM model input parameters and output are presented in Attachment D.2-III.

D.2.6 METEOROLOGICAL DATA

Meteorological data characterizing the transport and dispersion conditions of an area are needed as input to the ISCLT2 model. These data include wind speed, wind direction, atmospheric stability, ambient air temperature, and mixing height. Measurements for all of these meteorological parameters, except mixing height, have been recorded at the FEMP site as part of a comprehensive environmental monitoring program since August 1986.

Direct measurements of wind speed, wind direction, and ambient air temperature were taken at a height of 10 m (30 ft) above the ground. Atmospheric stability was derived from direct measurements of the standard deviation of the horizontal wind direction (σ_θ) during the day and the low-level temperature difference (ΔT) at night. Measurements of σ_θ were taken at a height of 60 m (180 ft) above the ground. The temperature difference was calculated from air temperature measurements taken at 60 and 10 m (180 and 30 ft) above the ground. Site-specific hourly measurements were obtained for 1987 through 1992, excluding 1990 due to poor data recovery. A 5-year composite joint frequency distribution of wind speed, wind direction, and atmospheric stability is presented in Attachment D.2-IV. The composite distribution was used in the ISCLT2 dispersion model.

Mixing heights were determined from twice-daily atmospheric soundings made by the NWS. The nearest NWS station is in Dayton, Ohio.

D.2.7 RECEPTOR LOCATIONS

As previously stated, the objective of the air transport analysis was to determine the maximum on- and off-property contaminant concentrations for risk assessment calculations. Two rectangular receptor grid systems were used to determine the maximum on-property concentrations and approximate locations. The first grid consisted of 676 receptor points in a 121.9 x 121.9 m (400 x 400 ft) pattern which extended over the entire FEMP property. The 1927 State Planar coordinate system was used for origin and location. The second grid consisted of 360 receptor points, also in a 121.9 x 121.9 m (400 x 400 ft) pattern, located over the center of the FEMP. The second grid was offset 200 ft north and 200 ft east of the first grid, resulting in an effective 86.2 x 86.2 m (283 x 283 ft) pattern over the center of the FEMP.

Thirty-six fenceline receptor points located around the FEMP were included in the air transport analysis to identify the maximum off-property receptor. These fenceline receptor locations were determined from the intersection of the FEMP fenceline and imaginary lines extending in 36 directions at 10-degree intervals from a point located at 1,381,000 ft East and 480,000 ft North (1927 State Planar coordinates). The analysis results for the fenceline receptor with the highest air quality impacts are reported as the maximum off-property concentrations in Section D.2.10.

Figure D.2-3 shows the layout of the receptor grid considered in the air dispersion modeling. Because the concentrations were used primarily to estimate inhalation pathway risk for outdoor activities, the receptors were assumed to be 1.5 m (5 ft) above the ground to simulate a typical person's breathing height for outdoor activities (EPA 1989b). The variation of ground level concentration within 0 to 1.5 m (0 to 5 ft) is negligible.

D.2.8 DISPERSION COEFFICIENTS

The selection of rural or urban dispersion coefficients for use in the ISCLT2 model was based on a land-use typing procedure to determine whether the characteristics of the area around the FEMP are primarily rural or urban. The procedure involved classifying the land use within an area circumscribed by a 3 km (1.9 mi) radius about the site. Urban dispersion coefficients were

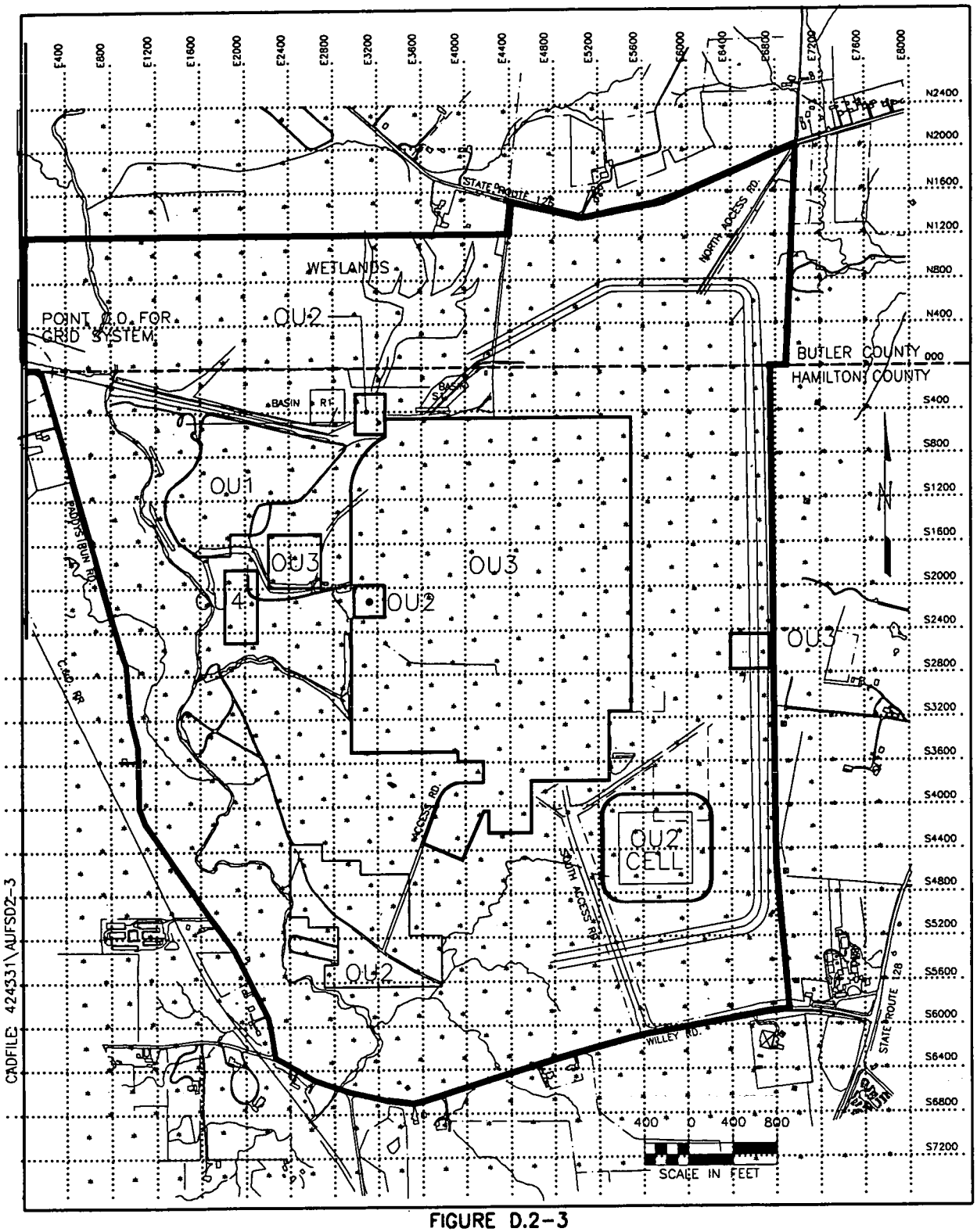

FIGURE D.2-3

RECEPTOR GRIDS FOR AIR DISPERSION MODELING

recommended for use if land-use types of heavy industrial, light-to-moderate industrial, commercial, single-compact residential, and multi-compact residential account for 50 percent or more of the area. Otherwise, rural dispersion coefficients were recommended.

A review of U.S. Geological Survey (USGS) maps and a site survey of the area indicated that industrial, commercial, and compact residential land use comprise no more than 10 percent of the area within a 3 km (1.9 mi) radius of the site. Therefore, the area was classified as rural for the purpose of air dispersion modeling, indicating the use of rural dispersion coefficients would be appropriate.

D.2.9 MODEL OUTPUT PROCESSING

The air dispersion modeling analysis was simplified by running the ISCLT2 model with an assumed emission rate of 1.0 g/s/m^2 or 1.0 pCi/s/m^2 for each area source. The source group and plot file options of the ISCLT2 program were used to group sources and write the grouped results to a plot file. The ISCLT2 source group results were multiplied by the contaminant emission rates listed in Attachments D.2-II and D.2-III to determine the contaminant-specific annual concentrations presented in Section D.2.10. Spreadsheets were used to calculate the contaminant-specific concentrations from the ISCLT2 model output and emissions data in Attachments D.2-I and D.2-II. The 373 area sources were combined into 13 source groups:

1. Active Flyash Pile - exposed GMA (26 sources)
2. Active Flyash Pile - exposed till, consolidation/capping alternatives (36 sources)
3. Active Flyash Pile - exposed till, additional sources for on-site disposal cell and off-site disposal alternatives (21 sources)
4. Inactive Flyash Pile - exposed GMA (32 sources)
5. Inactive Flyash Pile - exposed till (22 sources)
6. South Field - exposed GMA (40 sources)
7. South Field - exposed till (43 sources)
8. South Field - exposed fill, on-site disposal cell and off-site disposal alternatives (58 sources)

9. Consolidation Area - Inactive Flyash Pile and South Field end (49 sources for radon-222 emissions only)

10. Consolidation Area - Active Flyash Pile end (22 sources for radon-222 emissions only)

11. Solid Waste Landfill (4 sources)

12. Lime Sludge Ponds (4 sources)

13. On-site disposal cell (16 sources for radon-222 emissions only)

D.2.10 RESULTS OF AIR DISPERSION MODELING

This section discusses the modeled air concentrations for each alternative. Values are presented for the maximum on-property and maximum off-property (fenceline) concentration or deposition rate for each contaminant in Attachment D.2-V.

D.2.10.1 Alternative 2 - Consolidation and Capping

The modeled maximum annual average contaminant concentrations (above background) under the consolidation and capping alternative are presented in Tables D.2-V-1 and D.2-V-9.

Gaseous radon-222 emissions resulted in the highest activity concentrations of any radionuclide analyzed by at least four orders of magnitude. The maximum on- and off-property (fenceline) concentrations of radon-222 were modeled at 1.55 and 0.080 pCi/m^3, respectively, from the South Field area. The exposed till in the South Field and Active Flyash Pile were the major contributors to the radon-222 impacts under this alternative. Radon-222 emissions from the capped areas are approximately five orders of magnitude below the emissions from exposed soil. Therefore, assuming that capped areas provide insignificant contribution to gas and particulate air emissions should be reasonable. The operable unit-wide radon-222 air concentrations are presented on Figure D.2-4.

The maximum radon-222 value is over three orders of magnitude below the EPA action level of 4,000 pCi/m^3 (4 pCi/l) for indoor radon concentrations. The maximum value is approximately three orders of magnitude below the annual average U.S. residential radon concentration of 1,250 pCi/m^3 (Marcinowski and Napolitano 1993).

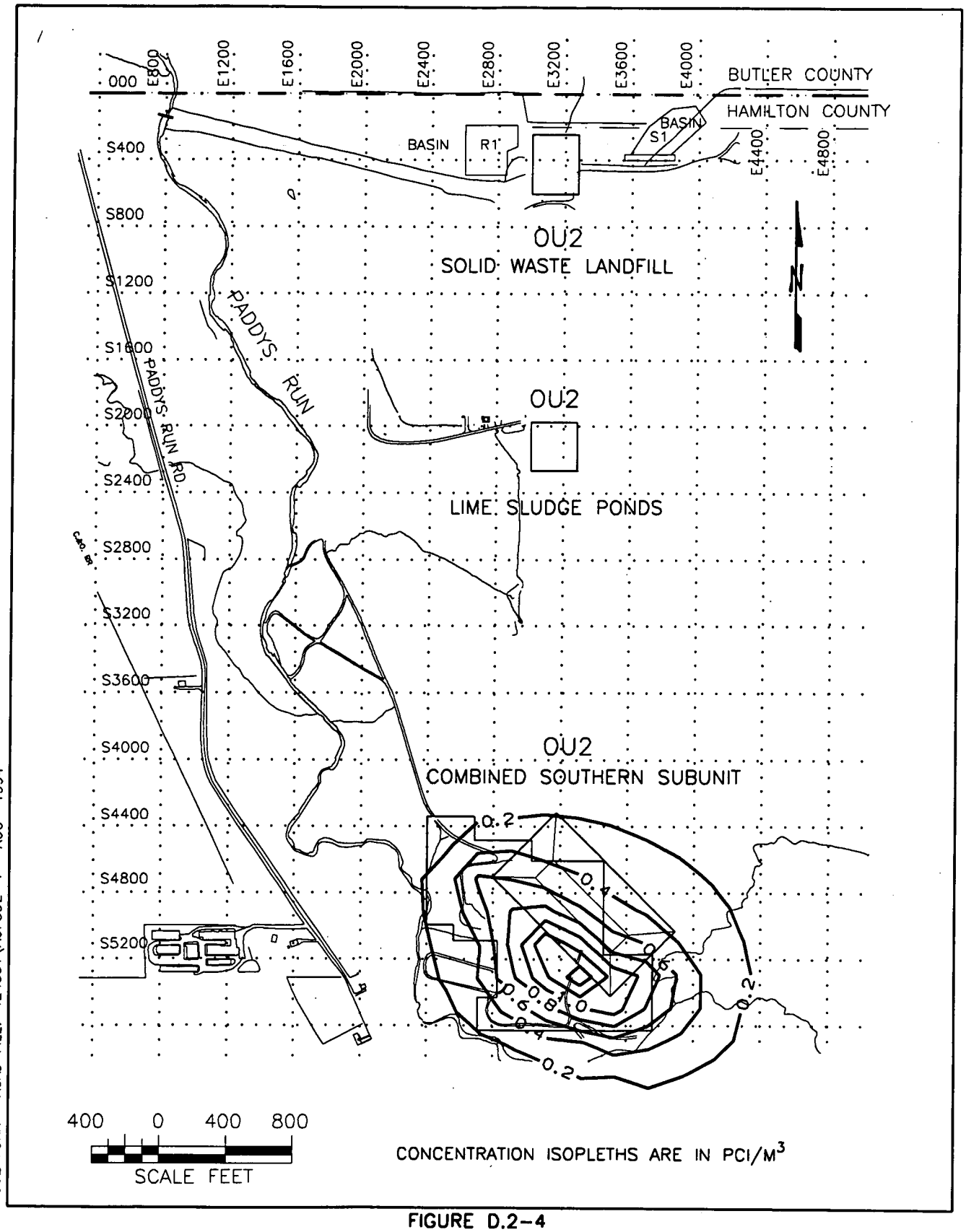

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FIGURE D.2-4

Rn-222 CONCENTRATION IN AIR FOR CONSOLIDATION AND CAPPING ALTERNATIVE
EXPANDED TRESPASSER (IMPACTS ABOVE BACKGROUND)

Modeled concentrations of uranium-238 typically represented one of the more prevalent radionuclides in the particulate phase. The maximum on- and off-property concentrations of uranium-238 in PM_{10} were modeled at 9.47 x 10^{-5} and 4.55 x 10^{-6} pCi/m^3, respectively, for the South Field area. The maximum on- and off-property deposition rates of uranium-238 were modeled at 3.40 x 10^{-7} and 1.64 x 10^{-8} pCi/m^2/s, respectively, for the South Field area. The exposed till in the South Field was the major contributor to the uranium-238 impacts under this alternative. The operable unit-wide uranium-238 air concentrations are presented on Figure D.2-5.

D.2.10.2 Alternative 3 - Excavation and Off-site Disposal

The modeled maximum annual average contaminant concentrations under the off-site disposal alternative with federal ownership are presented in Tables D.2-V-2, D.2-V-3, D.2-V-4, and D.2-V-8. The modeled maximum annual average contaminant concentrations under the off-site disposal alternative with private ownership are presented in Tables D.2-V-5, D.2-V-6, D.2-V-7, and D.2-V-8.

D.2.10.2.1 Future Land Use with Federal Ownership

Gaseous radon-222 emissions resulted in the highest activity concentrations of any radionuclide analyzed by at approximately four orders of magnitude under this alternative and land use. The maximum on- and off-property concentrations of radon-222 were modeled at 1.68 and 0.087 pCi/m^3, respectively, for the South Field area. The exposed till and fill in the South Field were the major contributors to the radon-222 impacts. The operable unit-wide radon-222 air concentrations are presented on Figure D.2-6 for Alternative 3 with federal ownership.

Again, the maximum radon-222 value is over three orders of magnitude below the EPA action level of 4,000 pCi/m^3 (4 pCi/l) for indoor radon concentrations. The maximum value is approximately three orders of magnitude below the annual average U.S. residential radon concentration of 1,250 pCi/m^3 (Marcinowski and Napolitano 1993). The difference between Alternatives 2 and 3 is insignificant with regard to radon-222 air concentrations..

The maximum on- and off-property concentrations of uranium-238 were modeled at 1.97 x 10^{-5} and 1.08 x 10^{-6} pCi/m^3, respectively, from the South Field area. The maximum on- and off-property concentrations of uranium-238 were modeled at 5.57 x 10^{-6} and 1.52 x 10^{-7} pCi/m^3, respectively, from the Solid Waste Landfill. The exposed till and fill in the South Field and were the major

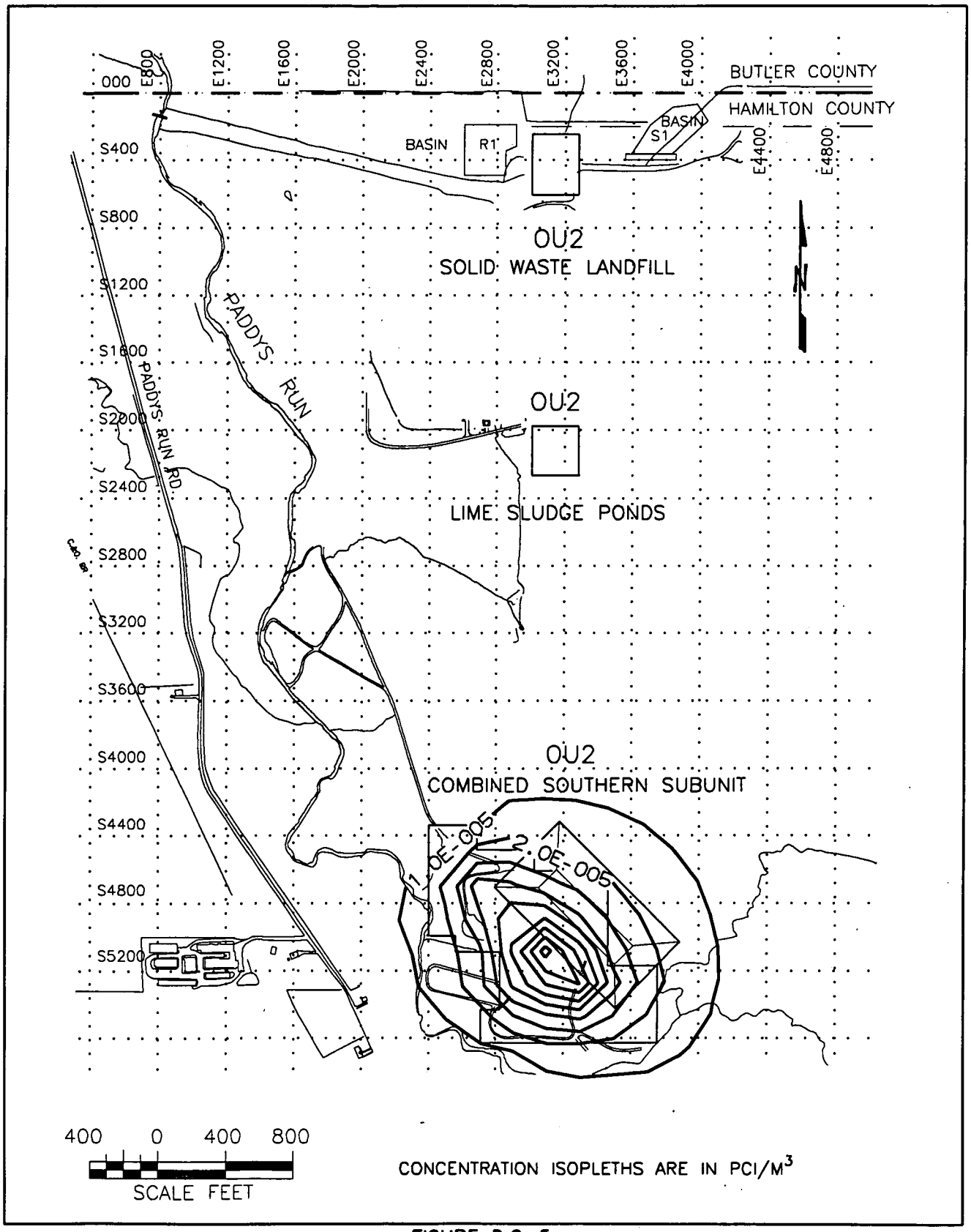

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FIGURE D.2-5

U-238 CONCENTRATION IN AIR FOR CONSOLIDATION AND CAPPING ALTERNATIVE
EXPANDED TRESPASSER (IMPACTS ABOVE BACKGROUND)

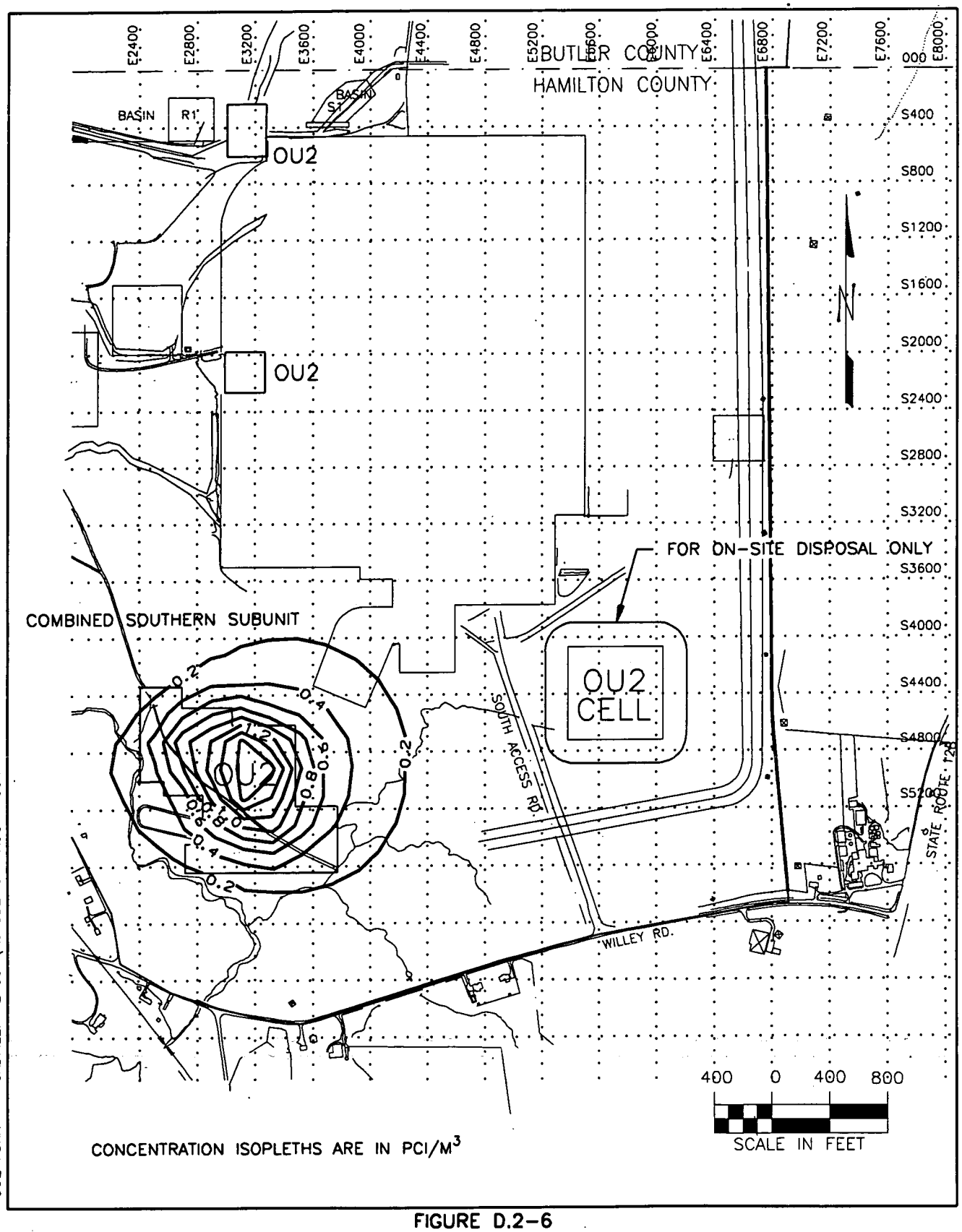

FIGURE D.2-6

Rn-222 CONCENTRATION IN AIR FOR OFF-SITE AND ON-SITE DISPOSAL ALTERNATIVES
EXPANDED TRESPASSER (IMPACTS ABOVE BACGROUND)

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contributors to the uranium-238 impacts. The operable unit-wide uranium-238 air concentrations are presented on Figure D.2-7 for Alternative 3 with federal ownership.

D.2.10.2.2 Future Land Use with Private Ownership

Residual radium-226 concentrations in exposed soil were estimated to be at or below background concentrations for all subunits under Alternative 3 with private ownership. Therefore, no emissions of radon-222 above background were assumed and no radon-222 concentrations were estimated.

The maximum on- and off-property concentrations of uranium-238 were modeled at 1.14×10^{-5} and 8.83×10^{-7} pCi/m^3, respectively, from the South Field area. The exposed GMA in the Inactive Flyash Pile was the major contributor to the uranium-238 impacts. The operable unit-wide uranium-238 air concentrations are presented on Figure D.2-8 for Alternative 3 with private ownership.

D.2.10.3 Alternative 6 - Excavation on On-Site Disposal with Off-site Disposal of Fraction Exceeding Waste Acceptance Criteria

The modeled maximum annual average contaminant concentrations under the on-site disposal alternative with federal ownership are also presented in Tables D.2-V-2, D.2-V-3, D.2-V-4, and D.2-V-8. The modeled maximum annual average contaminant concentrations under the on-site disposal alternative with private ownership are presented in Tables D.2-V-5, D.2-V-6, D.2-V-7, and D.2-V-8.

D.2.10.3.1 Future Land Use with Federal Ownerships

Gaseous radon-222 emissions for Alternative 6 with federal ownership are essentially identical to emissions for Alternative 3 with the same land use. The only difference is the additional radon-222 emissions from the disposal cell. The disposal cell emissions were approximately five orders of magnitude below the exposed soil emissions from the South Field area. Therefore, the air impacts from the disposal cell are insignificant compared to impacts from the South Field area. The operable unit-wide radon-222 air concentrations are also presented on Figure D.2-6 for Alternative 6 with federal ownership.

Estimated uranium-238 emissions for Alternative 6 with federal ownership are identical to emissions for Alternative 3 with the same land use. Therefore, the operable unit-wide uranium-238 air concentrations are also presented on Figure D.2-7 for Alternative 6 with federal ownership.

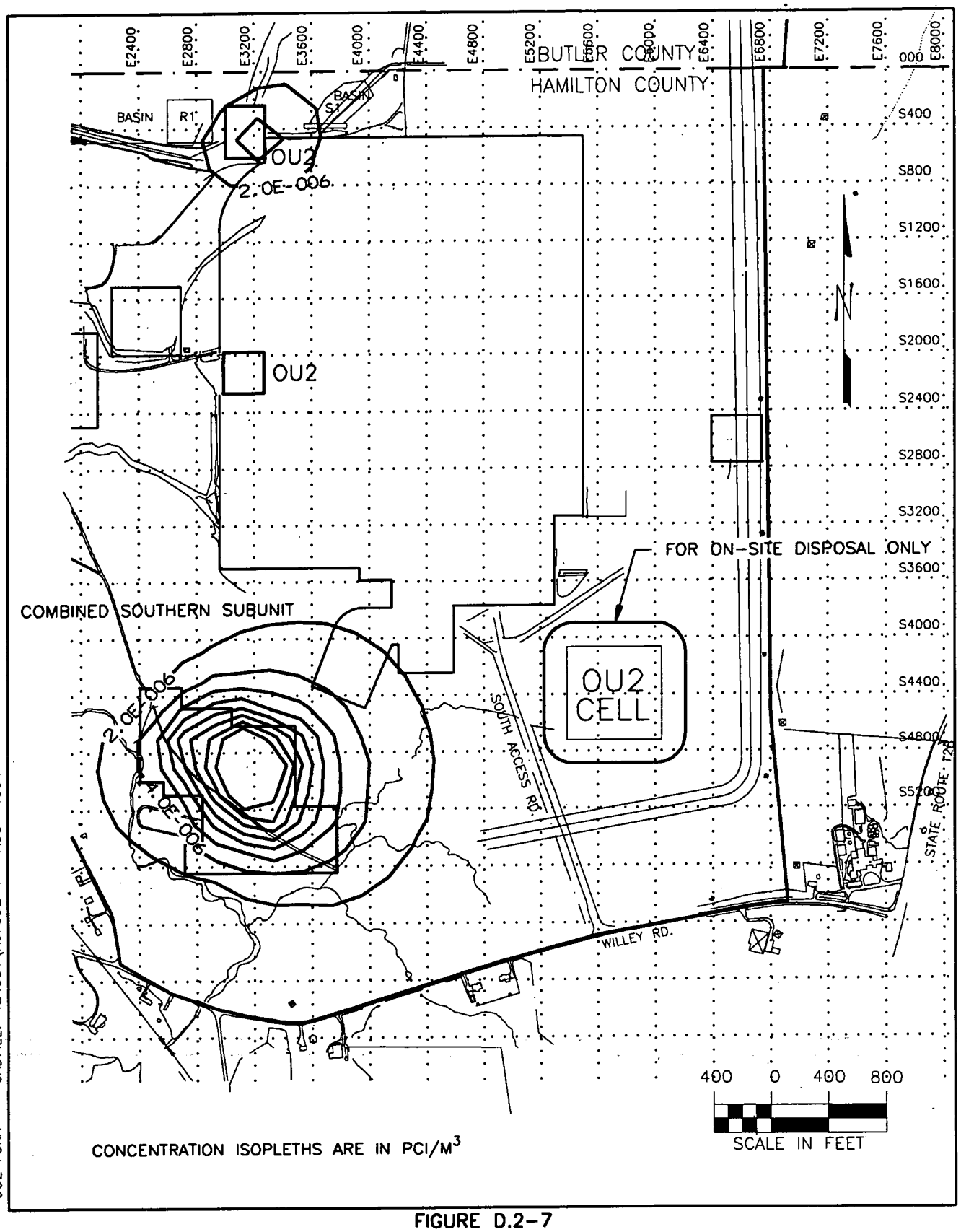

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FIGURE D.2-7

U-238 CONCENTRATION IN AIR FOR OFF-SITE AND ON-SITE DISPOSAL ALTERNATIVES
EXPANDED TRESPASSER (IMPACTS ABOVE BACKGROUND)

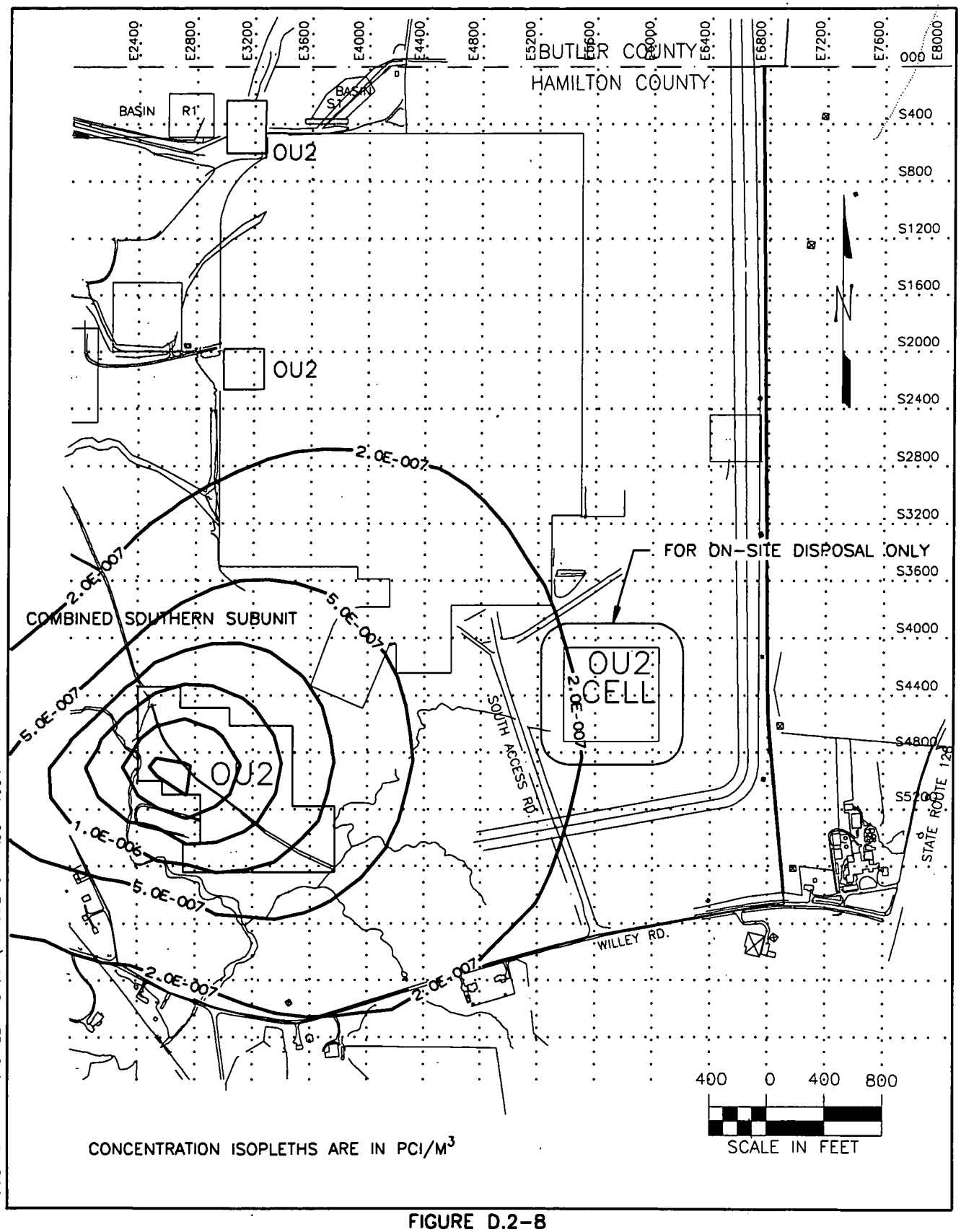

FIGURE D.2-8

U-238 CONCENTRATION IN AIR FOR OFF-SITE AND ON-SITE DISPOSAL ALTERNATIVES
ON-PROPERTY RESIDENT FARMER (IMPACTS ABOVE BACKGROUND)

D.2.10.3.2 Future Land Use with Private Ownership

Residual radium-226 concentrations in exposed soil were estimated to be at or below background concentrations for all subunits under Alternative 6 with private ownership. The only source of radon-222 emissions above background was the disposal cell. The maximum on- and off-property concentrations of radon-222 were modeled at 2.90 x 10^{-6} and 1.05 x 10^{-6} pCi/m^3, respectively, from the disposal cell. The operable unit-wide radon-222 air concentrations are presented on Figure D.2-9 for Alternative 6 with private ownership.

Estimated uranium-238 emissions for Alternative 6 with private ownership are identical to emissions for Alternative 3 with the same land use. Therefore, the operable unit-wide uranium-238 air concentrations are also presented on Figure D.2-8 for Alternative 6 with private ownership.

D.2.11 REFERENCES

Marcinowski, F. and S. Napolitano, 1993, "Reducing Risks from Radon," J. Air and Waste Management Association, Vol. 43, pp. 955-962.

Mulder, T., International Technology Corp., August 2, 1993, [Memorandum to S. Wolinski, FERMCO CRU4, Subject: Grain Size of Soil at the FEMP.]

U.S. Department of Energy (DOE), 1992, "Risk Assessment Work Plan Addendum, Fernald Environmental Management Project, Remedial Investigation/Feasibility Study, (Final)" U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1993c, "Remedial Investigation Report for Operable Unit 4 (Final)," U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1994, "Remedial Investigation Report for Operable Unit 2 (Draft)," U.S. DOE, Fernald Field Office, Fernald, OH.

U.S. Environmental Protection Agency (EPA), 1985a, "Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites," EPA/600/8-85/002, Office of Health and Environmental Assessment, U.S. EPA, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1985b, "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," including Supplement E, October 1992, AP-42 Volume I, Office of Air and Radiation and Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1987, "A Method for Estimating Fugitive Particulate Emissions from Hazardous Waste Sites," EPA/600/2-87/066, Office of Research and Development, U.S. EPA, Cincinnati, OH.

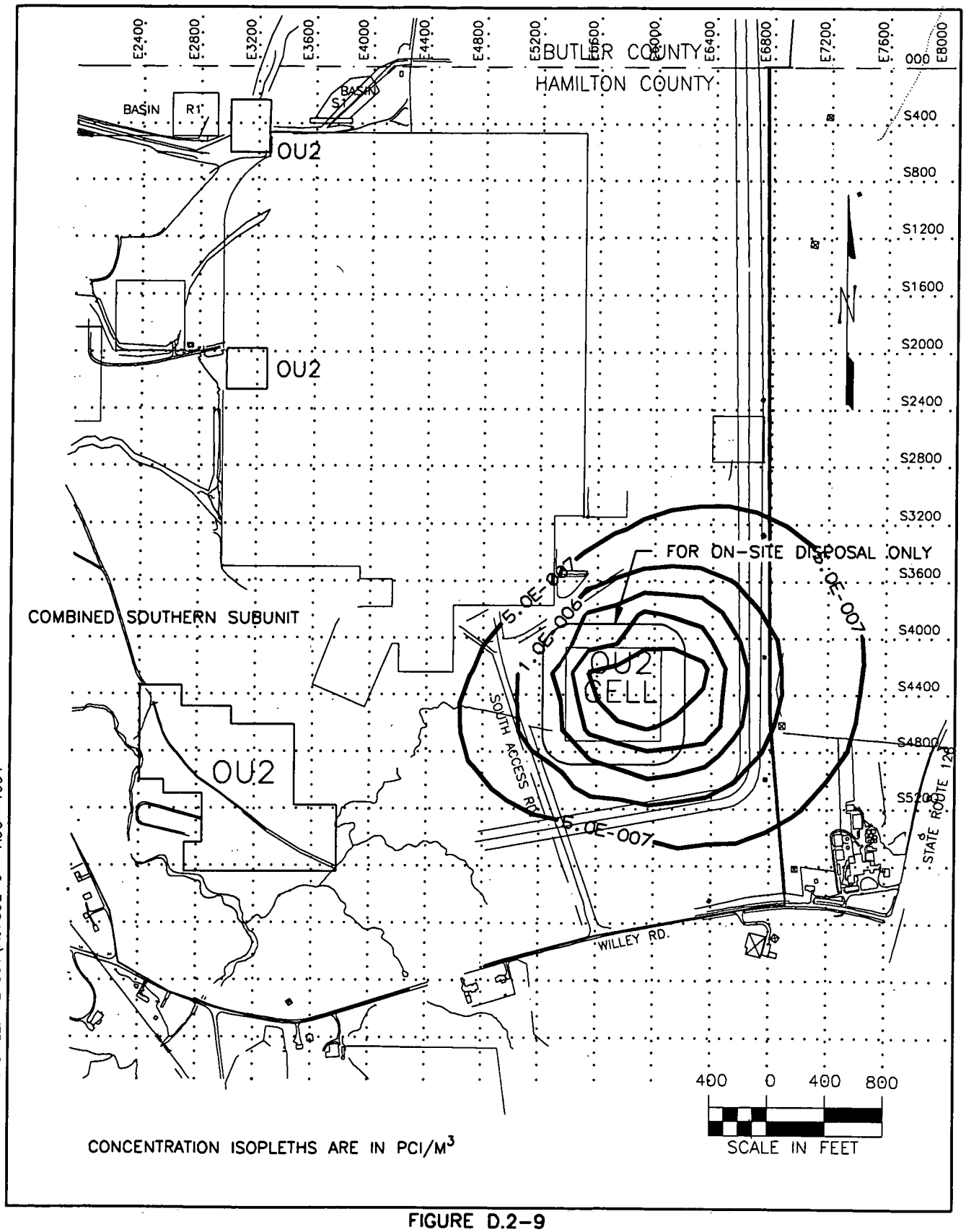

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FIGURE D.2-9

RN-222 CONCENTRATION IN AIR FOR OFF-SITE AND ON-SITE DISPOSAL ALTERNATIVES
ON-PROPERTY RESIDENT FARMER (IMPACTS ABOVE BACKGROUND)

U.S. Environmental Protection Agency (EPA), 1989a, "Air/Superfund National Technical Guidance Study Series, Volume IV - Procedures for Dispersion Modeling and Air Monitoring for Superfund Air Pathway Analysis," EPA/450/1-89/004, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park.

U.S. Environmental Protection Agency (EPA), 1989b, "Risk Assessment Guidance for Superfund, Human Health Evaluation Manual," Part A, Interim Final, EPA/540/1-89/002, U.S. EPA, Office of Emergency and Remedial Response, Washington, D.C.

U.S. Environmental Protection Agency (EPA), 1992a, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Model, Volumes I,II and III," including Addendum A, September 1992, EPA-540/4-92-008a,b,c, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1993, "Air/Superfund National Technical Guidance Study Series - Estimation of Air Impacts from Area Sources of Particulate Matter Emissions at Superfund Sites," EPA-451/R-93-004, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Nuclear Regulatory Commission (NRC), 1984, "Radon Attenuation Handbook for Uranium Mill Tailing Cover Design," NUREG/CR-3533, Office of Nuclear Regulatory Research, U.S. NRC, Washington, D.C.

ATTACHMENT D.2-I

CONTAMINANT CONCENTRATIONS IN EXPOSED SOIL

LIST OF TABLES

ATTACHMENT D.2-I

CONTAMINANT CONCENTRATIONS IN EXPOSED SOIL

Table		Page
D.2-I-1	Contaminant Concentrations in Exposed Soil - South Field - Exposed GMA - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-site Disposal Cell	D.2-I-1
D.2-I-2	Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed GMA - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-2
D.2-I-3	Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-3
D.2-I-4	Contaminant Concentrations in Exposed Soil - Inactive Flyash Pile - Exposed GMA - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-4
D.2-I-5	Contaminant Concentrations in Exposed Soil - Inactive Flyash Pile - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-5
D.2-I-6	Contaminant Concentrations in Exposed Soil - Solid Waste Landfill - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-6
D.2-I-7	Contaminant Concentrations in Exposed Soil - Lime Sludge Ponds - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-7
D.2-I-8	Contaminant Concentrations in Exposed Soil - South Field - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-8
D.2-I-9	Contaminant Concentrations in Exposed Soil - South Field - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-9
D.2-I-10	Contaminant Concentrations in Exposed Soil - South Field - Exposed Fill - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-10
D.2-I-11	Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-11
D.2-I-12	Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-I-12

D.2-I-13 Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-I-13

D.2-I-14 Contaminant Concentrations in Exposed Soil - Inactive Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-I-14

D.2-I-15 Contaminant Concentrations in Exposed Soil - Solid Waste Landfill - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-I-15

D.2-I-16 Contaminant Concentrations in Exposed Soil - Lime Sludge Ponds - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-I-16

D.2-I-17 Contaminant Concentrations in Exposed Soil - South Field - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping D.2-I-17

D.2-I-18 Contaminant Concentrations in Exposed Soil - South Field - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping D.2-I-18

D.2-I-19 Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping D.2-I-19

D.2-I-20 Contaminant Concentrations in Exposed Soil - Active Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping D.2-I-20

D.2-I-21 Contaminant Concentrations in Exposed Soil - Inactive Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping D.2-I-21

D.2-I-22 Contaminant Concentrations in Exposed Soil - Inactive Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping D.2-I-22

Table D.2–I–1
Contaminant Concentrations in Exposed Soil
South Field – Exposed GMA – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	South Field GMA Inside Conc. Term[a]	OU2 Soil PRL (SF Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	7.20E–01	0.000	0.71	0.000
Neptunium–237	0.000	4.30E–02	0.000	0	0.000
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	0.676	1.43E+00	0.676	1.42	0.000
Radium–228	0.461	1.26E+00	0.461	1.25	0.000
Strontium–90	0.700	1.60E–02	0.016	0	0.016
Technetium–99	0.000	2.10E–02	0.000	0	0.000
Thorium–228	0.330	1.43E+00	0.330	1.43	0.000
Thorium–230	1.370	2.74E+00	1.370	1.97	0.000
Thorium–232	0.330	1.36E+00	0.330	1.36	0.000
Uranium–234	0.585	2.00E+00	0.585	1.04	0.000
Uranium–235/236	0.020	2.40E–01	0.020	0.15	0.000
Uranium–238	0.660	1.47E+00	0.660	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	0.000	1.50E–03	0.000	0	0.000
Aroclor 1260	0.000	2.30E–04	0.000	0	0.000
Arsenic	6.200	8.20E+00	6.200	8.2	0.000
Benzo(a)anthracene	0.000	2.30E–02	0.000	0	0.000
Benzo(a)pyrene	0.000	1.50E–03	0.000	0	0.000
Benzo(b)fluoranthene	0.000	1.40E–02	0.000	0	0.000
Benzo(k)fluoranthene	0.000	4.70E–02	0.000	0	0.000
Beryllium	0.000	6.00E–01	0.000	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	4.60E–04	0.000	0	0.000
Dieldrin	0.000	4.00E–05	0.000	0	0.000
Indeno(1,2,3–cd)pyrene	0.000	7.30E–03	0.000	0	0.000
Uranium (total)	10.300	3.40E+00	3.400	3.4	0.000

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-2
Contaminant Concentrations in Exposed Soil
Active Flyash Pile - Exposed GMA - On Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Active Flyash GMA Inside Conc. Term[a]	OU2 Soil PRL (AFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	0.000	7.20E-01	0.000	0.71	0.000
Neptunium-237	0.000	4.30E-02	0.000	0	0.000
Plutonium-238	0	NA	NC	0	0.000
Radium-226	0.594	1.43E+00	0.594	1.42	0.000
Radium-228	0.537	1.26E+00	0.537	1.25	0.000
Strontium-90	0.500	1.60E-02	0.016	0	0.016
Technetium-99	0.000	2.10E-02	0.000	0	0.000
Thorium-228	1.190	1.43E+00	1.190	1.43	0.000
Thorium-230	1.420	2.74E+00	1.420	1.97	0.000
Thorium-232	0.965	1.36E+00	0.965	1.36	0.000
Uranium-234	0.921	2.00E+00	0.921	1.04	0.000
Uranium-235/236	0.000	2.40E-01	0.000	0.15	0.000
Uranium-238	0.754	1.47E+00	0.754	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	1.50E-03	NC	0	0.000
Aroclor 1260	NC	2.30E-04	NC	0	0.000
Arsenic	NC	8.20E+00	8.200	8.2	0.000
Benzo(a)anthracene	NC	2.30E-02	NC	0	0.000
Benzo(a)pyrene	NC	1.50E-03	NC	0	0.000
Benzo(b)fluoranthene	NC	1.40E-02	NC	0	0.000
Benzo(k)fluoranthene	NC	4.70E-02	NC	0	0.000
Beryllium	NC	6.00E-01	0.600	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	4.60E-04	NC	0	0.000
Dieldrin	NC	4.00E-05	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	7.30E-03	NC	0	0.000
Uranium (total)	8.416	2.40E+01	8.416	3.4	5.016

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–3
Contaminant Concentrations in Exposed Soil
Active Flyash Pile – Exposed Till – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Active Flyash Till Other Conc. Term[a]	OU2 Soil PRL (AFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	7.20E–01	0.000	0.71	0.000
Neptunium–237	0.190	4.30E–02	0.043	0	0.043
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.140	1.43E+00	1.140	1.42	0.000
Radium–228	0.900	1.26E+00	0.900	1.25	0.000
Strontium–90	1.200	1.60E–02	0.016	0	0.016
Technetium–99	0.000	2.10E–02	0.000	0	0.000
Thorium–228	1.760	1.43E+00	1.430	1.43	0.000
Thorium–230	2.670	2.74E+00	2.670	1.97	0.700
Thorium–232	1.200	1.36E+00	1.200	1.36	0.000
Uranium–234	1.000	2.00E+00	1.000	1.04	0.000
Uranium–235/236	0.034	2.40E–01	0.034	0.15	0.000
Uranium–238	1.050	1.47E+00	1.050	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	1.50E–03	NC	0	0.000
Aroclor 1260	NC	2.30E–04	NC	0	0.000
Arsenic	14.000	8.20E+00	8.200	8.2	0.000
Benzo(a)anthracene	NC	2.30E–02	NC	0	0.000
Benzo(a)pyrene	NC	1.50E–03	NC	0	0.000
Benzo(b)fluoranthene	NC	1.40E–02	NC	0	0.000
Benzo(k)fluoranthene	NC	4.70E–02	NC	0	0.000
Beryllium	1.100	6.00E–01	0.600	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	4.60E–04	NC	0	0.000
Dieldrin	NC	4.00E–05	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	7.30E–03	NC	0	0.000
Uranium (total)	4.270	2.40E+01	4.270	3.4	0.870

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-4
Contaminant Concentrations in Exposed Soil
Inactive Flyash Pile - Exposed GMA - On Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Inactive Flyash GMA Inside Conc. Term[a]	OU2 Soil PRL (IFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	NC	7.20E-01	NC	0.71	0.000
Neptunium-237	0.180	4.30E-02	0.043	0	0.043
Plutonium-238	0	NA	NC	0	0.000
Radium-226	0.870	1.43E+00	0.870	1.42	0.000
Radium-228	0.530	1.26E+00	0.530	1.25	0.000
Strontium-90	NC	1.60E-02	NC	0	0.000
Technetium-99	0.000	2.10E-02	0.000	0	0.000
Thorium-228	0.410	1.43E+00	0.410	1.43	0.000
Thorium-230	2.030	2.74E+00	2.030	1.97	0.060
Thorium-232	0.360	1.36E+00	0.360	1.36	0.000
Uranium-234	1.290	2.00E+00	1.290	1.04	0.250
Uranium-235/236	0.080	2.40E-01	0.080	0.15	0.000
Uranium-238	1.440	1.47E+00	1.440	1.22	0.220
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	1.50E-03	NC	0	0.000
Aroclor 1260	NC	2.30E-04	NC	0	0.000
Arsenic	5.100	8.20E+00	5.100	8.2	0.000
Benzo(a)anthracene	NC	2.30E-02	NC	0	0.000
Benzo(a)pyrene	NC	1.50E-03	NC	0	0.000
Benzo(b)fluoranthene	NC	1.40E-02	NC	0	0.000
Benzo(k)fluoranthene	NC	4.70E-02	NC	0	0.000
Beryllium	NC	6.00E-01	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	4.60E-04	0.000	0	0.000
Dieldrin	NC	4.00E-05	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	7.30E-03	NC	0	0.000
Uranium (total)	5.860	2.10E+01	5.860	3.4	2.460

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-5
Contaminant Concentrations in Exposed Soil
Inactive Flyash Pile - Exposed Till - On Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Inactive Flyash Till Other Conc. Term[a]	OU2 Soil PRL (IFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	NC	7.20E-01	NC	0.71	0.000
Neptunium-237	0.160	4.30E-02	0.043	0	0.043
Plutonium-238	NC	NA	NC	0	0.000
Radium-226	1.010	1.43E+00	1.010	1.42	0.000
Radium-228	0.730	1.26E+00	0.730	1.25	0.000
Strontium-90	NC	1.60E-02	NC	0	0.000
Technetium-99	NC	2.10E-02	NC	0	0.000
Thorium-228	0.833	1.43E+00	0.833	1.43	0.000
Thorium-230	1.620	2.74E+00	1.620	1.97	0.000
Thorium-232	0.732	1.36E+00	0.732	1.36	0.000
Uranium-234	0.770	2.00E+00	0.770	1.04	0.000
Uranium-235/236	0.052	2.40E-01	0.052	0.15	0.000
Uranium-238	0.850	1.47E+00	0.850	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	1.50E-03	NC	0	0.000
Aroclor 1260	NC	2.30E-04	NC	0	0.000
Arsenic	6.900	8.20E+00	6.900	8.2	0.000
Benzo(a)anthracene	NC	2.30E-02	NC	0	0.000
Benzo(a)pyrene	NC	1.50E-03	NC	0	0.000
Benzo(b)fluoranthene	NC	1.40E-02	NC	0	0.000
Benzo(k)fluoranthene	NC	4.70E-02	NC	0	0.000
Beryllium	NC	6.00E-01	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	4.60E-04	0.000	0	0.000
Dieldrin	NC	4.00E-05	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	7.30E-03	NC	0	0.000
Uranium (total)	4.390	2.10E+01	4.390	3.4	0.990

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-6
Contaminant Concentrations in Exposed Soil
Solid Waste Landfill - Exposed Till - On Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Solid Waste Till Other Conc. Term[a]	OU2 Soil PRL (SWL Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	NC	NA	NC	0.71	0.000
Neptunium-237	0.400	4.30E-02	0.043	0	0.043
Plutonium-238	0	4.00E-01	0.200	0	0.200
Radium-226	1.000	1.43E+00	1.000	1.42	0.000
Radium-228	0.900	1.26E+00	0.900	1.25	0.000
Strontium-90	0.730	1.60E-02	0.016	0	0.016
Technetium-99	0.000	1.89E-03	0.000	0	0.000
Thorium-228	1.100	1.43E+00	1.100	1.43	0.000
Thorium-230	3.100	2.74E+00	2.740	1.97	0.770
Thorium-232	0.900	1.36E+00	0.900	1.36	0.000
Uranium-234	1.300	1.12E+00	1.120	1.04	0.080
Uranium-235/236	0.100	2.30E-01	0.100	0.15	0.000
Uranium-238	3.600	1.17E+00	1.170	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	23	1.33E+00	1.330	0	1.330
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	7.700	8.20E+00	7.700	8.2	0.000
Benzo(a)anthracene	0.290	2.30E-02	0.023	0	0.023
Benzo(a)pyrene	0.290	1.50E-03	0.002	0	0.002
Benzo(b)fluoranthene	0.260	1.40E-02	0.014	0	0.014
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	1.000	6.00E-01	0.600	0.6	0.000
Carbazole	0.210	6.43E-03	0.006	0.00E+00	0.006
Dibenzo(a,h)anthracene	0.110	4.60E-04	0.000	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3-cd)pyrene	0.210	7.30E-03	0.007	0	0.007
Uranium (total)	7.700	3.40E+00	3.400	3.4	0.000

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–7
Contaminant Concentrations in Exposed Soil
Lime Sludge Ponds – Exposed Till – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Lime Sludge Till Other Conc. Term[a]	OU2 Soil PRL (LSP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	7.20E–01	0.000	0.71	0.000
Neptunium–237	0.130	5.10E–03	0.005	0	0.005
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.190	1.43E+00	1.190	1.42	0.000
Radium–228	1.110	1.26E+00	1.110	1.25	0.000
Strontium–90	0.540	5.60E–03	0.006	0	0.006
Technetium–99	0.000	1.89E–03	0.000	0	0.000
Thorium–228	0.970	1.43E+00	0.970	1.43	0.000
Thorium–230	2.490	2.74E+00	2.490	1.97	0.520
Thorium–232	1.050	1.36E+00	1.050	1.36	0.000
Uranium–234	NC	1.26E+00	1.260	1.04	0.000
Uranium–235/236	NC	2.40E–01	0.240	0.15	0.000
Uranium–238	1.140	1.26E+00	1.140	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	14.890	NA	14.890	8.2	6.690
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	NA	NC	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	14.300	3.40E+00	3.400	3.4	0.000

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-8
Contaminant Concentrations in Exposed Soil
South Field - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	South Field GMA Inside Conc. Term[a]	OU2 Soil PRL (SF GMA)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	0.000	NA	NC	0.71	0.000
Neptunium-237	0.000	NA	NC	0	0.000
Plutonium-238	0	NA	NC	0	0.000
Radium-226	0.676	1.80E+00	0.676	1.42	0.000
Radium-228	0.461	2.00E+00	0.461	1.25	0.000
Strontium-90	0.700	NA	0.700	0	0.700
Technetium-99	0.000	7.10E+01	0.000	0	0.000
Thorium-228	0.330	1.80E+00	0.330	1.43	0.000
Thorium-230	1.370	4.02E+02	1.370	1.97	0.000
Thorium-232	0.330	1.50E+00	0.330	1.36	0.000
Uranium-234	0.585	8.68E+00	0.585	1.04	0.000
Uranium-235/236	0.020	7.79E+00	0.020	0.15	0.000
Uranium-238	0.660	6.12E+00	0.660	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	0.000	NA	0.000	0	0.000
Aroclor 1260	0.000	2.50E+01	0.000	0	0.000
Arsenic	6.200	NA	6.200	8.2	0.000
Benzo(a)anthracene	0.000	NA	0.000	0	0.000
Benzo(a)pyrene	0.000	2.86E+00	0.000	0	0.000
Benzo(b)fluoranthene	0.000	NA	0.000	0	0.000
Benzo(k)fluoranthene	0.000	NA	0.000	0	0.000
Beryllium	0.000	NA	0.000	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	2.00E+00	0.000	0	0.000
Dieldrin	0.000	NA	0.000	0	0.000
Indeno(1,2,3-cd)pyrene	0.000	1.20E+04	0.000	0	0.000
Uranium (total)	10.300	1.90E+01	10.300	3.4	6.900

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–9
Contaminant Concentrations in Exposed Soil
South Field – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	South Field Till Impacted Conc. Term[a]	OU2 Soil PRL (SF Till)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	NA	0.000	0.71	0.000
Neptunium–237	0.291	NA	0.291	0	0.291
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.990	1.80E+00	1.800	1.42	0.380
Radium–228	1.444	2.00E+00	1.444	1.25	0.194
Strontium–90	1.100	NA	1.100	0	1.100
Technetium–99	0.900	7.10E+01	0.900	0	0.900
Thorium–228	1.426	1.80E+00	1.426	1.43	0.000
Thorium–230	4.410	4.02E+02	4.410	1.97	2.440
Thorium–232	1.332	1.50E+00	1.332	1.36	0.000
Uranium–234	17.205	4.24E+00	4.240	1.04	3.200
Uranium–235/236	2.730	3.35E+00	2.730	0.15	2.580
Uranium–238	17.888	3.22E+00	3.220	1.22	2.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	0.041	NA	0.041	0	0.041
Aroclor 1260	0.000	2.50E+01	0.000	0	0.000
Arsenic	11.900	NA	11.900	8.2	3.700
Benzo(a)anthracene	0.000	NA	0.000	0	0.000
Benzo(a)pyrene	0.000	2.86E+00	0.000	0	0.000
Benzo(b)fluoranthene	0.000	NA	0.000	0	0.000
Benzo(k)fluoranthene	0.000	NA	0.000	0	0.000
Beryllium	0.850	NA	0.850	0.6	0.250
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	2.00E+00	0.000	0	0.000
Dieldrin	0.000	NA	0.000	0	0.000
Indeno(1,2,3–cd)pyrene	0.000	1.20E+04	0.000	0	0.000
Uranium (total)	189.000	8.00E+00	8.000	3.4	4.600

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–10
Contaminant Concentrations in Exposed Soil
South Field – Exposed Fill – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	South Field Fill Conc. Term[a]	OU2 Soil PRL (SF Till)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.692	NA	0.692	0.71	0.000
Neptunium–237	0.369	NA	0.369	0	0.369
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	9.210	1.80E+00	1.800	1.42	0.380
Radium–228	3.740	2.00E+00	2.000	1.25	0.750
Strontium–90	1.360	NA	1.360	0	1.360
Technetium–99	0.900	7.10E+01	0.900	0	0.900
Thorium–228	13.400	1.80E+00	1.800	1.43	0.370
Thorium–230	13.800	4.02E+02	13.800	1.97	11.830
Thorium–232	12.900	1.50E+00	1.500	1.36	0.140
Uranium–234	78.300	4.24E+00	4.240	1.04	3.200
Uranium–235/236	4.050	3.35E+00	3.350	0.15	3.200
Uranium–238	82.700	3.22E+00	3.220	1.22	2.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	0.430	NA	0.430	0	0.430
Aroclor 1260	0.038	2.50E+01	0.038	0	0.038
Arsenic	6.975	NA	6.975	8.2	0.000
Benzo(a)anthracene	1.100	NA	1.100	0	1.100
Benzo(a)pyrene	1.800	2.86E+00	1.800	0	1.800
Benzo(b)fluoranthene	1.600	NA	1.600	0	1.600
Benzo(k)fluoranthene	1.600	NA	1.600	0	1.600
Beryllium	0.880	NA	0.880	0.6	0.280
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.440	2.00E+00	0.440	0	0.440
Dieldrin	0.010	NA	0.010	0	0.010
Indeno(1,2,3–cd)pyrene	0.620	1.20E+04	0.620	0	0.620
Uranium (total)	297.000	8.00E+00	8.000	3.4	4.600

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-11
Contaminant Concentrations in Exposed Soil
Active Flyash Pile – Exposed GMA – Expanded Trespasser/Off-Property Farmer – 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Active Flyash GMA Inside Conc. Term[a]	OU2 Soil PRL (AFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	0.000	NA	0.000	0.71	0.000
Neptunium-237	0.000	4.99E+00	0.000	0	0.000
Plutonium-238	0	NA	NC	0	0.000
Radium-226	0.594	1.80E+00	0.594	1.42	0.000
Radium-228	0.537	2.00E+00	0.537	1.25	0.000
Strontium-90	0.500	NA	0.500	0	0.500
Technetium-99	0.000	NA	0.000	0	0.000
Thorium-228	1.190	1.80E+00	1.190	1.43	0.000
Thorium-230	1.420	NA	1.420	1.97	0.000
Thorium-232	0.965	1.50E+00	0.965	1.36	0.000
Uranium-234	0.921	8.64E+00	0.921	1.04	0.000
Uranium-235/236	0.000	7.75E+00	0.000	0.15	0.000
Uranium-238	0.754	6.12E+00	0.754	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	NC	1.69E+01	16.900	8.2	8.700
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	NA	NC	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	8.416	2.80E+01	8.416	3.4	5.016

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–12
Contaminant Concentrations in Exposed Soil
Active Flyash Pile – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Active Flyash Till Impacted Conc. Term[a]	OU2 Soil PRL (AFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	7.20E–01	0.000	0.71	0.000
Neptunium–237	0.400	4.30E–02	0.043	0	0.043
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.730	1.43E+00	1.430	1.42	0.010
Radium–228	1.330	1.26E+00	1.260	1.25	0.010
Strontium–90	3.610	NA	3.610	0	3.610
Technetium–99	0.000	NA	0.000	0	0.000
Thorium–228	1.400	1.43E+00	1.400	1.43	0.000
Thorium–230	3.600	NA	3.600	1.97	1.630
Thorium–232	1.350	1.36E+00	1.350	1.36	0.000
Uranium–234	1.270	2.00E+00	1.270	1.24	0.030
Uranium–235/236	0.069	2.40E–01	0.069	0.15	0.000
Uranium–238	2.600	1.47E+00	1.470	1.22	0.250
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	18.700	1.69E+01	16.900	8.2	8.700
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	1.400	NA	1.400	0.6	0.800
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	NA	NC	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	7.170	2.80E+01	7.170	3.4	3.770

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–13
Contaminant Concentrations in Exposed Soil
Inactive Flyash Pile – Exposed GMA – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Inactive Flyash GMA Inside Conc. Term[a]	OU2 Soil PRL (IFP GMA)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	NC	NA	NC	0.71	0.000
Neptunium–237	0.180	NA	0.180	0	0.180
Plutonium–238	0	NA	NC	0	0.000
Radium–226	0.870	1.80E+00	0.870	1.42	0.000
Radium–228	0.530	2.00E+00	0.530	1.25	0.000
Strontium–90	NC	NA	NC	0	0.000
Technetium–99	0.000	NA	0.000	0	0.000
Thorium–228	0.410	1.80E+00	0.410	1.43	0.000
Thorium–230	2.030	NA	2.030	1.97	0.060
Thorium–232	0.360	1.50E+00	0.360	1.36	0.000
Uranium–234	1.290	8.68E+00	1.290	1.04	0.250
Uranium–235/236	0.080	7.79E+00	0.080	0.15	0.000
Uranium–238	1.440	6.12E+00	1.440	1.22	0.220
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	5.100	1.69E+01	5.100	8.2	0.000
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	NA	0.000	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	5.860	1.90E+01	5.860	3.4	2.460

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–II–13
Contaminant Emission Rates
Inactive Flyash Pile – Exposed GMA – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	2.18E–07	4.36E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	0.00E+00	0.00E+00
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	7.26E–08	1.45E–07
Thorium–232	0.00E+00	0.00E+00
Uranium–234	3.03E–07	6.05E–07
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	2.66E–07	5.32E–07
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	2.98E–06	5.95E–06

Table D.2–I–14
Contaminant Concentrations in Exposed Soil
Inactive Flyash Pile – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Inactive Flyash Till Other Conc. Term[a]	OU2 Soil PRL (IFP Till)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	NC	NA	NC	0.71	0.000
Neptunium–237	0.160	NA	0.160	0	0.160
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.010	1.80E+00	1.010	1.42	0.000
Radium–228	0.730	2.00E+00	0.730	1.25	0.000
Strontium–90	NC	NA	NC	0	0.000
Technetium–99	NC	NA	NC	0	0.000
Thorium–228	0.833	1.80E+00	0.833	1.43	0.000
Thorium–230	1.620	NA	1.620	1.97	0.000
Thorium–232	0.732	1.50E+00	0.732	1.36	0.000
Uranium–234	0.770	4.24E+00	0.770	1.04	0.000
Uranium–235/236	0.052	3.35E+00	0.052	0.15	0.000
Uranium–238	0.850	3.22E+00	0.850	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	6.900	1.69E+01	6.900	8.2	0.000
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	NA	0.000	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	4.390	8.00E+00	4.390	3.4	0.990

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-15
Contaminant Concentrations in Exposed Soil
Solid Waste Landfill - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Solid Waste Till Other Conc. Term[a]	OU2 Soil PRL (SWL Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	NC	NA	NC	0.71	0.000
Neptunium-237	0.400	NA	0.400	0	0.400
Plutonium-238	0	NA	0.200	0	0.200
Radium-226	1.000	1.80E+00	1.000	1.42	0.000
Radium-228	0.900	2.00E+00	0.900	1.25	0.000
Strontium-90	0.730	NA	0.730	0	0.730
Technetium-99	0.000	NA	0.000	0	0.000
Thorium-228	1.100	1.80E+00	1.100	1.43	0.000
Thorium-230	3.100	NA	3.100	1.97	1.130
Thorium-232	0.900	1.50E+00	0.900	1.36	0.000
Uranium-234	1.300	6.29E+01	1.300	1.04	0.260
Uranium-235/236	0.100	6.31E+01	0.100	0.15	0.000
Uranium-238	3.600	5.48E+01	3.600	1.22	2.380
Inorganics and Organics (mg/kg):					
Antimony	23	NA	22.600	0	22.600
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	7.700	NA	7.700	8.2	0.000
Benzo(a)anthracene	0.290	NA	0.290	0	0.290
Benzo(a)pyrene	0.290	NA	0.290	0	0.290
Benzo(b)fluoranthene	0.260	NA	0.260	0	0.260
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	1.000	NA	1.000	0.6	0.400
Carbazole	0.210	NA	0.210	0.00E+00	0.210
Dibenzo(a,h)anthracene	0.110	NA	0.110	0	0.110
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3-cd)pyrene	0.210	NA	0.210	0	0.210
Uranium (total)	7.700	9.56E+02	7.700	3.4	4.300

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–16
Contaminant Concentrations in Exposed Soil
Lime Sludge Ponds – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Lime Sludge Till Other Conc. Term[a]	OU2 Soil PRL (LSP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	NA	0.000	0.71	0.000
Neptunium–237	0.130	NA	0.130	0	0.130
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.190	1.80E+00	1.190	1.42	0.000
Radium–228	1.110	2.00E+00	1.110	1.25	0.000
Strontium–90	0.540	NA	0.540	0	0.540
Technetium–99	0.000	NA	0.000	0	0.000
Thorium–228	0.970	1.80E+00	0.970	1.43	0.000
Thorium–230	2.490	NA	2.490	1.97	0.520
Thorium–232	1.050	1.50E+00	1.050	1.36	0.000
Uranium–234	NC	1.96E+02	196.000	1.04	0.000
Uranium–235/236	NC	1.95E+02	195.000	0.15	0.000
Uranium–238	1.140	5.48E+01	1.140	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	14.890	NA	14.890	8.2	6.690
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	NA	NC	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	14.300	1.36E+02	14.300	3.4	10.900

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–17
Contaminant Concentrations in Exposed Soil
South Field – Exposed GMA – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	South Field GMA Inside Conc. Term[a]	OU2 Soil PRL (SF GMA)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	0.000	NA	NC	0.71	0.000
Neptunium–237	0.000	NA	NC	0	0.000
Plutonium–238	0	NA	NC	0	0.000
Radium–226	0.676	NA	0.676	1.42	0.000
Radium–228	0.461	NA	0.461	1.25	0.000
Strontium–90	0.700	NA	0.700	0	0.700
Technetium–99	0.000	NA	0.000	0	0.000
Thorium–228	0.330	NA	0.330	1.43	0.000
Thorium–230	1.370	NA	1.370	1.97	0.000
Thorium–232	0.330	NA	0.330	1.36	0.000
Uranium–234	0.585	1.00E+04	0.585	1.04	0.000
Uranium–235/236	0.020	1.00E+04	0.020	0.15	0.000
Uranium–238	0.660	1.00E+04	0.660	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	0.000	NA	0.000	0	0.000
Aroclor 1260	0.000	NA	0.000	0	0.000
Arsenic	6.200	NA	6.200	8.2	0.000
Benzo(a)anthracene	0.000	NA	0.000	0	0.000
Benzo(a)pyrene	0.000	NA	0.000	0	0.000
Benzo(b)fluoranthene	0.000	NA	0.000	0	0.000
Benzo(k)fluoranthene	0.000	NA	0.000	0	0.000
Beryllium	0.000	NA	0.000	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	NA	0.000	0	0.000
Dieldrin	0.000	NA	0.000	0	0.000
Indeno(1,2,3–cd)pyrene	0.000	NA	0.000	0	0.000
Uranium (total)	10.300	1.00E+04	10.300	3.4	6.900

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-18
Contaminant Concentrations in Exposed Soil
South Field - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	South Field Till Impacted Conc. Term[a]	OU2 Soil PRL (SF Till)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	0.000	NA	0.000	0.71	0.000
Neptunium-237	0.291	NA	0.291	0	0.291
Plutonium-238	NC	NA	NC	0	0.000
Radium-226	1.990	NA	1.990	1.42	0.570
Radium-228	1.444	NA	1.444	1.25	0.194
Strontium-90	1.100	NA	1.100	0	1.100
Technetium-99	0.900	NA	0.900	0	0.900
Thorium-228	1.426	NA	1.426	1.43	0.000
Thorium-230	4.410	NA	4.410	1.97	2.440
Thorium-232	1.332	NA	1.332	1.36	0.000
Uranium-234	17.205	1.00E+04	17.205	1.04	16.165
Uranium-235/236	2.730	1.00E+04	2.730	0.15	2.580
Uranium-238	17.888	1.00E+04	17.888	1.22	16.668
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	0.041	NA	0.041	0	0.041
Aroclor 1260	0.000	NA	0.000	0	0.000
Arsenic	11.900	NA	11.900	8.2	3.700
Benzo(a)anthracene	0.000	NA	0.000	0	0.000
Benzo(a)pyrene	0.000	NA	0.000	0	0.000
Benzo(b)fluoranthene	0.000	NA	0.000	0	0.000
Benzo(k)fluoranthene	0.000	NA	0.000	0	0.000
Beryllium	0.850	NA	0.850	0.6	0.250
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	NA	0.000	0	0.000
Dieldrin	0.000	NA	0.000	0	0.000
Indeno(1,2,3-cd)pyrene	0.000	NA	0.000	0	0.000
Uranium (total)	189.000	1.00E+04	189.000	3.4	185.600

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-19
Contaminant Concentrations in Exposed Soil
Active Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	Active Flyash GMA Inside Conc. Term[a]	OU2 Soil PRL (AFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	0.000	NA	0.000	0.71	0.000
Neptunium-237	0.000	NA	0.000	0	0.000
Plutonium-238	0	NA	NC	0	0.000
Radium-226	0.594	NA	0.594	1.42	0.000
Radium-228	0.537	NA	0.537	1.25	0.000
Strontium-90	0.500	NA	0.500	0	0.500
Technetium-99	0.000	NA	0.000	0	0.000
Thorium-228	1.190	NA	1.190	1.43	0.000
Thorium-230	1.420	NA	1.420	1.97	0.000
Thorium-232	0.965	NA	0.965	1.36	0.000
Uranium-234	0.921	1.00E+04	0.921	1.04	0.000
Uranium-235/236	0.000	1.00E+04	0.000	0.15	0.000
Uranium-238	0.754	1.00E+04	0.754	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	NC	NA	NC	8.2	0.000
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	NA	NC	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	8.416	1.00E+04	8.416	3.4	5.016

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-20
Contaminant Concentrations in Exposed Soil
Active Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	Active Flyash Till Impacted Conc. Term[a]	OU2 Soil PRL (AFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	0.000	NA	0.000	0.71	0.000
Neptunium-237	0.400	NA	0.400	0	0.400
Plutonium-238	NC	NA	NC	0	0.000
Radium-226	1.730	NA	1.730	1.42	0.310
Radium-228	1.330	NA	1.330	1.25	0.080
Strontium-90	3.610	NA	3.610	0	3.610
Technetium-99	0.000	NA	0.000	0	0.000
Thorium-228	1.400	NA	1.400	1.43	0.000
Thorium-230	3.600	NA	3.600	1.97	1.630
Thorium-232	1.350	NA	1.350	1.36	0.000
Uranium-234	1.270	1.00E+04	1.270	1.24	0.030
Uranium-235/236	0.069	1.00E+04	0.069	0.15	0.000
Uranium-238	2.600	1.00E+04	2.600	1.22	1.380
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	18.700	NA	18.700	8.2	10.500
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	1.400	NA	1.400	0.6	0.800
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	NC	NA	NC	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	7.170	1.00E+04	7.170	3.4	3.770

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2-I-21
Contaminant Concentrations in Exposed Soil
Inactive Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	Inactive Flyash GMA Inside Conc. Term[a]	OU2 Soil PRL (IFP GMA)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post-Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium-137	NC	NA	NC	0.71	0.000
Neptunium-237	0.180	NA	0.180	0	0.180
Plutonium-238	0	NA	NC	0	0.000
Radium-226	0.870	NA	0.870	1.42	0.000
Radium-228	0.530	NA	0.530	1.25	0.000
Strontium-90	NC	NA	NC	0	0.000
Technetium-99	0.000	NA	0.000	0	0.000
Thorium-228	0.410	NA	0.410	1.43	0.000
Thorium-230	2.030	NA	2.030	1.97	0.060
Thorium-232	0.360	NA	0.360	1.36	0.000
Uranium-234	1.290	1.00E+04	1.290	1.04	0.250
Uranium-235/236	0.080	1.00E+04	0.080	0.15	0.000
Uranium-238	1.440	1.00E+04	1.440	1.22	0.220
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	5.100	NA	5.100	8.2	0.000
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	NA	0.000	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3-cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	5.860	1.00E+04	5.860	3.4	2.460

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

Table D.2–I–22
Contaminant Concentrations in Exposed Soil
Inactive Flyash Pile – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	Inactive Flyash Till Other Conc. Term[a]	OU2 Soil PRL (IFP Soil)[b]	Minimum of PRL or Conc. Term	Background[b]	OU2 Post–Remedial Incr. Conc.[c]
Radionuclides (pCi/g):					
Cesium–137	NC	NA	NC	0.71	0.000
Neptunium–237	0.160	NA	0.160	0	0.160
Plutonium–238	NC	NA	NC	0	0.000
Radium–226	1.010	NA	1.010	1.42	0.000
Radium–228	0.730	NA	0.730	1.25	0.000
Strontium–90	NC	NA	NC	0	0.000
Technetium–99	NC	NA	NC	0	0.000
Thorium–228	0.833	NA	0.833	1.43	0.000
Thorium–230	1.620	NA	1.620	1.97	0.000
Thorium–232	0.732	NA	0.732	1.36	0.000
Uranium–234	0.770	1.00E+04	0.770	1.04	0.000
Uranium–235/236	0.052	1.00E+04	0.052	0.15	0.000
Uranium–238	0.850	1.00E+04	0.850	1.22	0.000
Inorganics and Organics (mg/kg):					
Antimony	NC	NA	NC	0	0.000
Aroclor 1254	NC	NA	NC	0	0.000
Aroclor 1260	NC	NA	NC	0	0.000
Arsenic	6.900	NA	6.900	8.2	0.000
Benzo(a)anthracene	NC	NA	NC	0	0.000
Benzo(a)pyrene	NC	NA	NC	0	0.000
Benzo(b)fluoranthene	NC	NA	NC	0	0.000
Benzo(k)fluoranthene	NC	NA	NC	0	0.000
Beryllium	NC	NA	NC	0.6	0.000
Carbazole	NC	NA	NC	NA	0.000
Dibenzo(a,h)anthracene	0.000	NA	0.000	0	0.000
Dieldrin	NC	NA	NC	0	0.000
Indeno(1,2,3–cd)pyrene	NC	NA	NC	0	0.000
Uranium (total)	4.390	1.00E+04	4.390	3.4	0.990

NA = Not applicable.
NC = Not characterized.
[a]Concentrations from Appendix A.
[b]PRLs and Background Concentrations from Section 2.
[c]A zero value indicates that the residual concentration is at or below background. This subunit/layer does not contribute to risks above background.

ATTACHMENT D.2-II

CONTAMINANT AIR EMISSION RATES

LIST OF TABLES

ATTACHMENT D.2-II

CONTAMINANT AIR EMISSION RATES

Table | Page

D.2-II-1 Contaminant Emission Rates - South Field - Exposed GMA - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-1

D.2-II-2 Contaminant Emission Rates - Active Flyash Pile - Exposed GMA - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-2

D.2-II-3 Contaminant Emission Rates - Active Flyash Pile - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-3

D.2-II-4 Contaminant Emission Rates - Inactive Flyash Pile - Exposed GMA - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-4

D.2-II-5 Contaminant Emission Rates - Inactive Flyash Pile - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-5

D.2-II-6 Contaminant Emission Rates - Solid Waste Landfill - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-6

D.2-II-7 Contaminant Emission Rates - Lime Sludge Ponds - Exposed Till - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal Cell . . D.2-II-7

D.2-II-8 Contaminant Emission Rates - South Field - Exposed GMA - Expanded Trespasser/ Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-8

D.2-II-9 Contaminant Emission Rates - South Field - Exposed Till - Expanded Trespasser/ Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-9

D.2-II-10 Contaminant Emission Rates - South Field - Exposed Till - Expanded Trespasser/ Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-10

D.2-II-11 Contaminant Emission Rates - Active Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-11

D.2-II-12 Contaminant Emission Rates - Active Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-12

D.2-II-13 Contaminant Emission Rates - Inactive Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-13

D.2-II-14 Contaminant Emission Rates - Inactive Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-14

D.2-II-15 Contaminant Emission Rates - Solid Waste Landfill - Exposed Till - Expanded

Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-15

D.2-II-16 Contaminant Emission Rates - Lime Sludge Ponds - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-16

D.2-II-17 Contaminant Emission Rates - South Field - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal D.2-II-17

D.2-II-18 Contaminant Emission Rates - South Field - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping . . . D.2-II-18

D.2-II-19 Contaminant Emission Rates - Active Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping . . . D.2-II-19

D.2-II-20 Contaminant Emission Rates - Active Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping . . . D.2-II-20

D.2-II-21 Contaminant Emission Rates - Inactive Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping . . . D.2-II-21

D.2-II-22 Contaminant Emission Rates - Inactive Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping . . . D.2-II-22

Table D.2-II-1
Contaminant Emission Rates
South Field - Exposed GMA - On Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium-137	0.00E+00	0.00E+00
Neptunium-237	0.00E+00	0.00E+00
Plutonium-238	0.00E+00	0.00E+00
Radium-226	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00
Strontium-90	2.54E-07	5.09E-07
Technetium-99	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00
Thorium-230	0.00E+00	0.00E+00
Thorium-232	0.00E+00	0.00E+00
Uranium-234	0.00E+00	0.00E+00
Uranium-235/236	0.00E+00	0.00E+00
Uranium-238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	0.00E+00	0.00E+00

Table D.2-II-2
Contaminant Emission Rates
Active Flyash Pile - Exposed GMA - On Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium-137	0.00E+00	0.00E+00
Neptunium-237	0.00E+00	0.00E+00
Plutonium-238	0.00E+00	0.00E+00
Radium-226	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00
Strontium-90	2.54E-07	5.09E-07
Technetium-99	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00
Thorium-230	0.00E+00	0.00E+00
Thorium-232	0.00E+00	0.00E+00
Uranium-234	0.00E+00	0.00E+00
Uranium-235/236	0.00E+00	0.00E+00
Uranium-238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	7.98E-05	1.60E-04

000318

Table D.2–II–3
Contaminant Emission Rates
Active Flyash Pile – Exposed Till – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	6.84E–07	1.37E–06
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	2.54E–07	5.09E–07
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	1.11E–05	2.23E–05
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	1.38E–05	2.77E–05

Table D.2–II–4
Contaminant Emission Rates
Inactive Flyash Pile – Exposed GMA – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	6.84E–07	1.37E–06
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	0.00E+00	0.00E+00
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	9.54E–07	1.91E–06
Thorium–232	0.00E+00	0.00E+00
Uranium–234	3.98E–06	7.95E–06
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	3.50E–06	7.00E–06
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	3.91E–05	7.82E–05

000320

Table D.2–II–5
Contaminant Emission Rates
Inactive Flyash Pile – Exposed Till – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	6.84E–07	1.37E–06
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	0.00E+00	0.00E+00
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	0.00E+00	0.00E+00
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	1.57E–05	3.15E–05

Table D.2–II–6
Contaminant Emission Rates
Solid Waste Landfill – Exposed Till – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	6.84E–07	1.37E–06
Plutonium–238	3.18E–06	6.36E–06
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	2.54E–07	5.09E–07
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	1.22E–05	2.45E–05
Thorium–232	0.00E+00	0.00E+00
Uranium–234	1.27E–06	2.54E–06
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	2.11E–05	4.23E–05
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	3.66E–07	7.31E–07
Benzo(a)pyrene	2.39E–08	4.77E–08
Benzo(b)fluoranthene	2.23E–07	4.45E–07
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	1.02E–07	2.04E–07
Dibenzo(a,h)anthracene	7.31E–09	1.46E–08
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	1.16E–07	2.32E–07
Uranium (total)	0.00E+00	0.00E+00

Table D.2–II–7
Contaminant Emission Rates
Lime Sludge Ponds – Exposed Till – On Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	8.11E–08	1.62E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	8.90E–08	1.78E–07
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	8.27E–06	1.65E–05
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	1.06E–04	2.13E–04
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	0.00E+00	0.00E+00

Table D.2–II–8
Contaminant Emission Rates
South Field – Exposed GMA – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	0.00E+00	0.00E+00
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	8.47E–07	1.69E–06
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	0.00E+00	0.00E+00
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	8.35E–06	1.67E–05

Table D.2–II–9
Contaminant Emission Rates
South Field – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	3.52E–07	7.04E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	4.60E–07	9.20E–07
Radium–228	2.35E–07	4.69E–07
Strontium–90	1.33E–06	2.66E–06
Technetium–99	1.09E–06	2.18E–06
Thorium–228	0.00E+00	0.00E+00
Thorium–230	2.95E–06	5.90E–06
Thorium–232	0.00E+00	0.00E+00
Uranium–234	3.87E–06	7.74E–06
Uranium–235/236	3.12E–06	6.24E–06
Uranium–238	2.42E–06	4.84E–06
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	4.96E–08	9.92E–08
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	4.48E–06	8.95E–06
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	3.03E–07	6.05E–07
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	5.57E–06	1.11E–05

Table D.2–II–10
Contaminant Emission Rates
South Field – Exposed Fill – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	4.46E–07	8.93E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	4.60E–07	9.20E–07
Radium–228	9.08E–07	1.82E–06
Strontium–90	1.65E–06	3.29E–06
Technetium–99	1.09E–06	2.18E–06
Thorium–228	4.48E–07	8.95E–07
Thorium–230	1.43E–05	2.86E–05
Thorium–232	1.69E–07	3.39E–07
Uranium–234	3.87E–06	7.74E–06
Uranium–235/236	3.87E–06	7.74E–06
Uranium–238	2.42E–06	4.84E–06
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	5.20E–07	1.04E–06
Aroclor 1260	4.60E–08	9.20E–08
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	1.33E–06	2.66E–06
Benzo(a)pyrene	2.18E–06	4.36E–06
Benzo(b)fluoranthene	1.94E–06	3.87E–06
Benzo(k)fluoranthene	1.94E–06	3.87E–06
Beryllium	3.39E–07	6.78E–07
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	5.32E–07	1.06E–06
Dieldrin	1.17E–08	2.35E–08
Indeno(1,2,3–cd)pyrene	7.50E–07	1.50E–06
Uranium (total)	5.57E–06	1.11E–05

000326

Table D.2–II–11
Contaminant Emission Rates
Active Flyash Pile – Exposed GMA – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	0.00E+00	0.00E+00
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	6.05E–07	1.21E–06
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	0.00E+00	0.00E+00
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	1.05E–05	2.11E–05
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	6.07E–06	1.21E–05

Table D.2–II–12
Contaminant Emission Rates
Active Flyash Pile – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	5.20E–08	1.04E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	1.21E–08	2.42E–08
Radium–228	1.21E–08	2.42E–08
Strontium–90	4.37E–06	8.74E–06
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	1.97E–06	3.94E–06
Thorium–232	0.00E+00	0.00E+00
Uranium–234	3.63E–08	7.26E–08
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	3.03E–07	6.05E–07
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	1.05E–05	2.11E–05
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	9.68E–07	1.94E–06
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	4.56E–06	9.12E–06

Table D.2–II–14
Contaminant Emission Rates
Inactive Flyash Pile – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	1.94E–07	3.87E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	0.00E+00	0.00E+00
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	0.00E+00	0.00E+00
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	1.20E–06	2.40E–06

Table D.2-II-15
Contaminant Emission Rates
Solid Waste Landfill - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium-137	0.00E+00	0.00E+00
Neptunium-237	4.84E-07	9.68E-07
Plutonium-238	2.42E-07	4.84E-07
Radium-226	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00
Strontium-90	8.83E-07	1.77E-06
Technetium-99	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00
Thorium-230	1.37E-06	2.73E-06
Thorium-232	0.00E+00	0.00E+00
Uranium-234	3.15E-07	6.29E-07
Uranium-235/236	0.00E+00	0.00E+00
Uranium-238	2.88E-06	5.76E-06
Inorganics and Organics (g/s/m^2):		
Antimony	2.73E-05	5.47E-05
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	3.51E-07	7.02E-07
Benzo(a)pyrene	3.51E-07	7.02E-07
Benzo(b)fluoranthene	3.15E-07	6.29E-07
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	4.84E-07	9.68E-07
Carbazole	2.54E-07	5.08E-07
Dibenzo(a,h)anthracene	1.33E-07	2.66E-07
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	2.54E-07	5.08E-07
Uranium (total)	5.20E-06	1.04E-05

Table D.2–II–16
Contaminant Emission Rates
Lime Sludge Ponds – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	1.57E–07	3.15E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	6.53E–07	1.31E–06
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	6.29E–07	1.26E–06
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	8.09E–06	1.62E–05
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	1.32E–05	2.64E–05

Table D.2–II–17
Contaminant Emission Rates
South Field – Exposed GMA – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	0.00E+00	0.00E+00
Plutonium–238	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00
Strontium–90	8.47E–07	1.69E–06
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	0.00E+00	0.00E+00
Thorium–232	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	8.35E–06	1.67E–05

000332

Table D.2–II–18
Contaminant Emission Rates
South Field – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	3.52E–07	7.04E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	6.90E–07	1.38E–06
Radium–228	2.35E–07	4.69E–07
Strontium–90	1.33E–06	2.66E–06
Technetium–99	1.09E–06	2.18E–06
Thorium–228	0.00E+00	0.00E+00
Thorium–230	2.95E–06	5.90E–06
Thorium–232	0.00E+00	0.00E+00
Uranium–234	1.96E–05	3.91E–05
Uranium–235/236	3.12E–06	6.24E–06
Uranium–238	2.02E–05	4.03E–05
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	4.96E–08	9.92E–08
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	4.48E–06	8.95E–06
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	3.03E–07	6.05E–07
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	2.25E–04	4.49E–04

Table D.2-II-19
Contaminant Emission Rates
Active Flyash Pile – Exposed GMA – Expanded Trespasser/Off-Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium-137	0.00E+00	0.00E+00
Neptunium-237	0.00E+00	0.00E+00
Plutonium-238	0.00E+00	0.00E+00
Radium-226	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00
Strontium-90	6.05E-07	1.21E-06
Technetium-99	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00
Thorium-230	0.00E+00	0.00E+00
Thorium-232	0.00E+00	0.00E+00
Uranium-234	0.00E+00	0.00E+00
Uranium-235/236	0.00E+00	0.00E+00
Uranium-238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	6.07E-06	1.21E-05

Table D.2–II–20
Contaminant Emission Rates
Active Flyash Pile – Exposed Till – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium–137	0.00E+00	0.00E+00
Neptunium–237	4.84E–07	9.68E–07
Plutonium–238	0.00E+00	0.00E+00
Radium–226	3.75E–07	7.50E–07
Radium–228	9.68E–08	1.94E–07
Strontium–90	4.37E–06	8.74E–06
Technetium–99	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00
Thorium–230	1.97E–06	3.94E–06
Thorium–232	0.00E+00	0.00E+00
Uranium–234	3.63E–08	7.26E–08
Uranium–235/236	0.00E+00	0.00E+00
Uranium–238	1.67E–06	3.34E–06
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	1.27E–05	2.54E–05
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	9.68E–07	1.94E–06
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	4.56E–06	9.12E–06

Table D.2-II-21
Contaminant Emission Rates
Inactive Flyash Pile - Exposed GMA - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: Consolidation/Capping

	Emission Rates Above Background	
Contaminant	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2):		
Cesium-137	0.00E+00	0.00E+00
Neptunium-237	2.18E-07	4.36E-07
Plutonium-238	0.00E+00	0.00E+00
Radium-226	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00
Strontium-90	0.00E+00	0.00E+00
Technetium-99	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00
Thorium-230	7.26E-08	1.45E-07
Thorium-232	0.00E+00	0.00E+00
Uranium-234	3.03E-07	6.05E-07
Uranium-235/236	0.00E+00	0.00E+00
Uranium-238	2.66E-07	5.32E-07
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	2.98E-06	5.95E-06

Table D.2-II-22
Contaminant Emission Rates
Inactive Flyash Pile - Exposed Till - Expanded Trespasser/Off-Property Farmer - 10^{-6}
Alternatives: Consolidation/Capping

Contaminant	Emission Rates Above Background	
	Inhalable Particulates (PM10)	Total Particulates (TSP)
Radionuclides (pCi/s/m^2)		
Cesium-137	0.00E+00	0.00E+00
Neptunium-237	1.94E-07	3.87E-07
Plutonium-238	0.00E+00	0.00E+00
Radium-226	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00
Strontium-90	0.00E+00	0.00E+00
Technetium-99	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00
Thorium-230	0.00E+00	0.00E+00
Thorium-232	0.00E+00	0.00E+00
Uranium-234	0.00E+00	0.00E+00
Uranium-235/236	0.00E+00	0.00E+00
Uranium-238	0.00E+00	0.00E+00
Inorganics and Organics (g/s/m^2):		
Antimony	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	0.00E+00	0.00E+00
Uranium (total)	1.20E-06	2.40E-06

ATTACHMENT D.2-III.1

RAECOM MODEL INPUT PARAMETERS

Table D.2-III-1

RAECOM Input Parameters and Results
Private Ownership - On-Property Resident Farmer - 10^{-6}
Alternative: On-Site Disposal Cell

Layer	Ra-226 Conc. Above Bckgrd (pCi/g)	Soil Bulk Density (g/cm^3)	Rn-222 Emanation Coefficient	Rn-222 Decay Constant (1/s)	Layer Thickness (cm)	Soil Porosity	Soil Moisture Content (dry Wt%)	Rn-222 Water/ Air Partition Coefficient	Rn-222 Emission Rate ($pCi/s/m^2$)
Disposal Cell:									
Waste Material	4.559	1.44	0.22	2.1E-06	900.	0.457	16.9	0.26	---
Contouring Fill	0	1.44	NA	NA	30.	0.457	16.9	0.26	---
Clay Barrier	0	1.44	NA	NA	60.	0.430	28.5	0.26	---
Gravel	0	1.44	NA	NA	30.	0.417	2.95	0.26	---
Sand Filter	0	1.44	NA	NA	60.	0.417	2.95	0.26	---
Vegetative Soil	0	1.44	NA	NA	50.	0.457	16.9	0.26	---
Cover (Top) Soil	0	1.44	NA	NA	15.	0.457	16.9	0.26	3.64E-07

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Table D.2-III-2

RAECOM Input Parameters and Results
Administrative Controls - Expanded Trespasser/Off-Property Resident Farmer - 10^{-6}
Alternative: On-Site Disposal Cell or Offsite Disposal

Layer	Ra-226 Conc. Above Bckgrd (pCi/g)	Soil Bulk Density (g/cm^3)	Rn-222 Emanation Coefficient	Rn-222 Decay Constant (1/s)	Layer Thickness (cm)	Soil Porosity	Soil Moisture Content (dry Wt%)	Rn-222 Water/ Air Partition Coefficient	Rn-222 Emission Rate ($pCi/s/m^2$)
Residual Soil:									
AFP Till	0.01	1.44	0.22	2.1E-06	300.	0.457	16.9	0.26	4.70E-03
SF Till	0.38	1.44	0.22	2.1E-06	300.	0.457	16.9	0.26	1.93E-01
SF Fill	0.38	1.44	0.22	2.1E-06	300.	0.457	16.9	0.26	1.93E-01
Disposal Cell:									
Waste Material	8.81	1.44	0.22	2.1E-06	900.	0.457	16.9	0.26	---
Contouring Fill	0	1.44	NA	NA	30.	0.457	16.9	0.26	---
Clay Barrier	0	1.44	NA	NA	60.	0.430	28.5	0.26	---
Gravel	0	1.44	NA	NA	30.	0.417	2.95	0.26	---
Sand Filter	0	1.44	NA	NA	60.	0.417	2.95	0.26	---
Vegetative Soil	0	1.44	NA	NA	50.	0.457	16.9	0.26	---
Cover (Top) Soil	0	1.44	NA	NA	15.	0.457	16.9	0.26	7.06E-07

000340

Table D.2-III-3

RAECOM Input Parameters and Results
Federal Ownership - Expanded Trespasser/Off-Property Resident Farmer - 10^{-6}
Alternative: Consolidation and Capping

Layer	Ra-226 Conc. Above Bckgrd (pCi/g)	Soil Bulk Density (g/cm^3)	Rn-222 Emanation Coefficient	Rn-222 Decay Constant (1/s)	Layer Thickness (cm)	Soil Porosity	Soil Moisture Content (dry Wt%)	Rn-222 Water/ Air Partition Coefficient	Rn-222 Emission Rate ($pCi/s/m^2$)
Residual Soil:									
AFP Till	0.31	1.44	0.22	2.1E-06	300.	0.457	16.9	0.26	1.61E-01
SF Till	0.57	1.44	0.22	2.1E-06	300.	0.457	16.9	0.26	2.58E-01
Consolidation Area (SF):									
Waste Material	11.62	1.44	0.22	2.1E-06	900.	0.457	16.9	0.26	---
Contouring Fill	0	1.44	NA	NA	30.	0.457	16.9	0.26	---
Clay Barrier	0	1.44	NA	NA	60.	0.430	28.5	0.26	---
Gravel	0	1.44	NA	NA	30.	0.417	2.95	0.26	---
Vegetative Soil	0	1.44	NA	NA	45.	0.457	16.9	0.26	---
Cover (Top) Soil	0	1.44	NA	NA	15.	0.457	16.9	0.26	1.74E-06

000341

Table D.2-III-3 (Continued)

Layer	Ra-226 Conc. Above Bckgrd (pCi/g)	Soil Bulk Density (g/cm^3)	Rn-222 Emanation Coefficient	Rn-222 Decay Constant (1/s)	Layer Thickness (cm)	Soil Porosity	Soil Moisture Content (dry Wt%)	Rn-222 Water/ Air Partition Coefficient	Rn-222 Emission Rate (pCi/s/m^2)
SWL Cap:									
Waste Material	0.88	1.44	0.22	2.1E-06	300.	0.457	16.9	0.26	---
Contouring Fill	0	1.44	0.22	2.1E-06	30.	0.457	16.9	0.26	---
Clay Barrier	0	1.44	0.22	2.1E-06	60.	0.430	28.5	0.26	---
Gravel	0	1.44	0.22	2.1E-06	30.	0.417	2.95	0.26	---
Vegetative Soil	0	1.44	0.22	2.1E-06	45.	0.457	16.9	0.26	---
Cover (Top) Soil	0	1.44	0.22	2.1E-06	15.	0.457	16.9	0.26	1.94E-07
LSP Cap:									
Waste Material	0.63	1.44	0.22	2.1E-06	15.	0.457	16.9	0.26	---
Contouring Fill	0	1.44	NA	NA	30.	0.457	16.9	0.26	---
Clay Barrier	0	1.44	NA	NA	60.	0.430	28.5	0.26	---
Vegetative Soil	0	1.44	NA	NA	15.	0.457	16.9	0.26	---
Cover (Top) Soil	0	1.44	NA	NA	15.	0.457	16.9	0.26	7.95E-08

000342

ATTACHMENT D.2-III.2

RAECOM MODEL OUTPUT FILES

OU2 DISPOSAL CELL: PRIVATE OWNERSHIP (ON-SITE FARMER)

********** INPUT PARAMETERS **********

NUMBER OF LAYERS: 7
RADON FLUX INTO LAYER 1: .000 pCi/m2/sec
SURFACE RADON CONCENTRATION: .000 pCi/LITER

LAYER 3 EXCEEDS SATURATION. MOISTURE CHANGED FROM .285 TO .277

BARE SOURCE FLUX (Jo) FROM LAYER 1: 2.126 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	900.	.1044E-01	.4570	.6600E-05	16.90
2	30.	.1044E-01	.4570	.0000E+00	16.90
3	60.	.6184E-04	.4300	.0000E+00	27.66
4	30.	.4845E-01	.4170	.0000E+00	2.95
5	60.	.4845E-01	.4170	.0000E+00	2.95
6	50.	.1044E-01	.4570	.0000E+00	16.90
7	15.	.1044E-01	.4570	.0000E+00	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	900.	.6377E+00	.2200E+05	.5988
2	30.	.4353E-01	.1989E+05	.5988
3	60.	.1355E-05	.3733E-02	.2674
4	30.	.1043E-05	.1104E-01	.9176
5	60.	.5302E-06	.8729E-02	.9176
6	50.	.3724E-06	.1154E-02	.5988
7	15.	.3642E-06	.0000E+00	.5988

OU2 DISPOSAL CELL: ADMIN. CONTROLS (EXPANDED TRESPASSER)

********** INPUT PARAMETERS **********

NUMBER OF LAYERS: 7
RADON FLUX INTO LAYER 1: .000 pCi/m2/sec
SURFACE RADON CONCENTRATION: .000 pCi/LITER

LAYER 3 EXCEEDS SATURATION. MOISTURE CHANGED FROM .285 TO .277

BARE SOURCE FLUX (Jo) FROM LAYER 1: 4.124 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	900.	.1044E-01	.4570	.1280E-04	16.90
2	30.	.1044E-01	.4570	.0000E+00	16.90
3	60.	.6184E-04	.4300	.0000E+00	27.66
4	30.	.4845E-01	.4170	.0000E+00	2.95
5	60.	.4845E-01	.4170	.0000E+00	2.95
6	50.	.1044E-01	.4570	.0000E+00	16.90
7	15.	.1044E-01	.4570	.0000E+00	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	900.	.1237E+01	.4267E+05	.5988
2	30.	.8441E-01	.3858E+05	.5988
3	60.	.2628E-05	.7240E-02	.2674
4	30.	.2022E-05	.2140E-01	.9176
5	60.	.1028E-05	.1693E-01	.9176
6	50.	.7223E-06	.2238E-02	.5988
7	15.	.7063E-06	.0000E+00	.5988

OU2 AFP EXPOSED TILL: ON/OFF-SITE DISPOSAL, EXP. TRESPASSER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS:	1	
RADON FLUX INTO LAYER 1:	.000	pCi/m2/sec
SURFACE RADON CONCENTRATION:	.000	pCi/LITER
BARE SOURCE FLUX (Jo) FROM LAYER 1:	0.005	pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	300.	.1044E-01	.4570	.1460E-07	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	300.	.4702E-02	.0000E+00	.5988

OU2 SF EXPOSED TILL OR FILL: ON/OFF-SITE DISPOSAL, EXP. TRESPASSER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS:	1	
RADON FLUX INTO LAYER 1:	.000	pCi/m2/sec
SURFACE RADON CONCENTRATION:	.000	pCi/LITER
BARE SOURCE FLUX (Jo) FROM LAYER 1:	.1932	pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	300.	.1044E-01	.4570	.6000E-06	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	300.	.1932E+00	.0000E+00	.5988

OU2 SF CONSOLIDATION AREA: CONSOLIDATION/CAPPING (EXPANDED TRESPASSER)

********** INPUT PARAMETERS **********

NUMBER OF LAYERS: 6
RADON FLUX INTO LAYER 1: .000 pCi/m2/sec
SURFACE RADON CONCENTRATION: .000 pCi/LITER

LAYER 3 EXCEEDS SATURATION. MOISTURE CHANGED FROM .285 TO .277

BARE SOURCE FLUX (Jo) FROM LAYER 1: 5.445 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	900.	.1044E-01	.4570	.1690E-04	16.90
2	30.	.1044E-01	.4570	.0000E+00	16.90
3	60.	.6184E-04	.4300	.0000E+00	27.66
4	30.	.4845E-01	.4170	.0000E+00	2.95
5	45.	.1044E-01	.4570	.0000E+00	16.90
6	15.	.1044E-01	.4570	.0000E+00	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	900.	.1633E+01	.5634E+05	.5988
2	30.	.1115E+00	.5093E+05	.5988
3	60.	.3456E-05	.1227E-01	.2674
4	30.	.2411E-05	.3776E-01	.9176
5	45.	.1781E-05	.5517E-02	.5988
6	15.	.1741E-05	.0000E+00	.5988

OU2 AFP EXPOSED TILL: CONSOLIDATION/CAPPING, EXP. TRESPASSER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS:	1	
RADON FLUX INTO LAYER 1:	.000	pCi/m2/sec
SURFACE RADON CONCENTRATION:	.000	pCi/LITER
BARE SOURCE FLUX (Jo) FROM LAYER 1:	.1610	pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	300.	.1044E-01	.4570	.5000E-06	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	300.	.1610E+00	.0000E+00	.5988

OU2 SF EXPOSED TILL: CONSOLIDATION/CAPPING, EXP. TRESPASSER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS:	1	
RADON FLUX INTO LAYER 1:	.000	pCi/m2/sec
SURFACE RADON CONCENTRATION:	.000	pCi/LITER
BARE SOURCE FLUX (Jo) FROM LAYER 1:	.2576	pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	300.	.1044E-01	.4570	.8000E-06	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	300.	.2576E+00	.0000E+00	.5988

OU2 SWL CAP: CONSOLIDATION/CAPPING, EXP. TRESPASSER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS: 6
RADON FLUX INTO LAYER 1: .000 pCi/m2/sec
SURFACE RADON CONCENTRATION: .000 pCi/LITER

LAYER 3 EXCEEDS SATURATION. MOISTURE CHANGED FROM .285 TO .277

BARE SOURCE FLUX (Jo) FROM LAYER 1: .4187 pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	300.	.1044E-01	.4570	.1300E-05	16.90
2	30.	.1044E-01	.4570	.0000E+00	16.90
3	60.	.6184E-04	.4300	.0000E+00	27.66
4	30.	.4845E-01	.4170	.0000E+00	2.95
5	15.	.1044E-01	.4570	.0000E+00	16.90
6	15.	.1044E-01	.4570	.0000E+00	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	300.	.1256E+00	.4333E+04	.5988
2	30.	.8573E-02	.3918E+04	.5988
3	60.	.2672E-06	.6655E-03	.2674
4	30.	.2121E-06	.1929E-02	.9176
5	15.	.1986E-06	.6154E-03	.5988
6	15.	.1942E-06	.0000E+00	.5988

OU2 LSP CAP: CONSOLIDATION/CAPPING, EXP. TRESPASSER

********** INPUT PARAMETERS **********

NUMBER OF LAYERS: 5
RADON FLUX INTO LAYER 1: .000 pCi/m2/sec
SURFACE RADON CONCENTRATION: .000 pCi/LITER

LAYER 3 EXCEEDS SATURATION. MOISTURE CHANGED FROM .285 TO .277

BARE SOURCE FLUX (Jo) FROM LAYER 1: .6078E-01pCi/m2/sec

LAYER	THICKNESS (cm)	DIFF COEFF (cm2/SEC)	POROSITY	SOURCE (pCi/cm3/sec)	MOISTURE (dry wt. %)
1	15.	.1044E-01	.4570	.9000E-06	16.90
2	30.	.1044E-01	.4570	.0000E+00	16.90
3	60.	.6184E-04	.4300	.0000E+00	27.66
4	15.	.1044E-01	.4570	.0000E+00	16.90
5	15.	.1044E-01	.4570	.0000E+00	16.90

***** RESULTS OF RADON DIFFUSION CALCULATION*****

LAYER	THICKNESS (cm)	EXIT FLUX (pCi/m2/sec)	EXIT CONC. (pCi/liter)	MIC
1	15.	.4081E-01	.1408E+04	.5988
2	30.	.2786E-02	.1273E+04	.5988
3	60.	.8677E-07	.2300E-03	.2674
4	15.	.8127E-07	.2518E-03	.5988
5	15.	.7946E-07	.0000E+00	.5988

ATTACHMENT D.2-IV

FIVE-YEAR COMPOSITE JOINT FREQUENCY DISTRIBUTION FOR THE FEMP

Table D.2-IV-1
FEMP Standard Joint Frequency Distribution (8/30/93)

Stability Class	Wind Direction	Wind Speed (kts) ≤3	≤6	≤10	≤16	≤21	≥21
A	N	0.000263	0.000904	0.000904	0.000058	0.000000	0.000000
	NNE	0.000292	0.001546	0.000671	0.000000	0.000000	0.000000
	NE	0.000817	0.002888	0.001196	0.000029	0.000000	0.000000
	ENE	0.001430	0.004434	0.002042	0.000117	0.000000	0.000000
	E	0.001050	0.002013	0.000204	0.000146	0.000000	0.000000
	ESE	0.000700	0.000817	0.000058	0.000000	0.000000	0.000000
	SE	0.000467	0.000438	0.000000	0.000000	0.000000	0.000000
	SSE	0.000583	0.000554	0.000000	0.000000	0.000000	0.000000
	S	0.000700	0.001575	0.001196	0.000000	0.000000	0.000000
	SSW	0.001021	0.004347	0.003793	0.000146	0.000000	0.000000
	SW	0.001284	0.005076	0.004755	0.000554	0.000000	0.000000
	WSW	0.001750	0.004755	0.003647	0.000204	0.000000	0.000000
	W	0.000992	0.003880	0.003267	0.000467	0.000000	0.000000
	WNW	0.000613	0.001809	0.002626	0.000525	0.000000	0.000000
	NW	0.000583	0.001575	0.001400	0.000117	0.000000	0.000000
	NNW	0.000350	0.001313	0.001284	0.000058	0.000000	0.000000
B	N	0.000029	0.000817	0.000700	0.000117	0.000000	0.000000
	NNE	0.000117	0.000525	0.000496	0.000058	0.000000	0.000000
	NE	0.000350	0.000963	0.000613	0.000058	0.000000	0.000000
	ENE	0.000321	0.001459	0.000554	0.000146	0.000000	0.000000
	E	0.000467	0.000671	0.000175	0.000029	0.000000	0.000000
	ESE	0.000263	0.000263	0.000029	0.000000	0.000000	0.000000
	SE	0.000233	0.000204	0.000029	0.000000	0.000000	0.000000
	SSE	0.000263	0.000467	0.000088	0.000029	0.000000	0.000000
	S	0.000408	0.001138	0.000321	0.000000	0.000000	0.000000
	SSW	0.000525	0.001546	0.001313	0.000175	0.000000	0.000000
	SW	0.000613	0.002042	0.002071	0.000233	0.000000	0.000000
	WSW	0.000613	0.001692	0.001284	0.000175	0.000000	0.000000
	W	0.000671	0.001167	0.001225	0.000146	0.000000	0.000000
	WNW	0.000233	0.000788	0.000875	0.000204	0.000000	0.000000
	NW	0.000263	0.000671	0.001021	0.000204	0.000000	0.000000
	NNW	0.000146	0.000642	0.000904	0.000088	0.000000	0.000000

Table D.2-IV-1
FEMP Standard Joint Frequency Distribution (8/30/93)

Stability Class	Wind Direction	Wind Speed (kts) ≤3	≤6	≤10	≤16	≤21	≥21
C	N	0.000204	0.000846	0.001079	0.000233	0.000000	0.000000
	NNE	0.000175	0.001313	0.000729	0.000058	0.000000	0.000000
	NE	0.000408	0.001488	0.001021	0.000088	0.000000	0.000000
	ENE	0.000700	0.001721	0.000438	0.000263	0.000000	0.000000
	E	0.001050	0.000875	0.000204	0.000058	0.000000	0.000000
	ESE	0.000671	0.000583	0.000058	0.000000	0.000000	0.000000
	SE	0.000321	0.000467	0.000088	0.000000	0.000000	0.000000
	SSE	0.000146	0.000467	0.000058	0.000058	0.000000	0.000000
	S	0.000321	0.001167	0.000554	0.000058	0.000000	0.000000
	SSW	0.000554	0.001750	0.001575	0.000058	0.000029	0.000000
	SW	0.000904	0.002742	0.001750	0.000175	0.000000	0.000000
	WSW	0.000759	0.002421	0.001254	0.000204	0.000000	0.000000
	W	0.000788	0.001284	0.001138	0.000321	0.000000	0.000000
	WNW	0.000321	0.001342	0.001254	0.000204	0.000000	0.000000
	NW	0.000233	0.001342	0.001138	0.000117	0.000029	0.000000
	NNW	0.000233	0.001079	0.000963	0.000029	0.000000	0.000000
D	N	0.002101	0.008723	0.009219	0.001079	0.000000	0.000000
	NNE	0.002830	0.010532	0.008256	0.001138	0.000000	0.000000
	NE	0.004464	0.013420	0.007498	0.000496	0.000000	0.000000
	ENE	0.006331	0.017825	0.009161	0.002042	0.000000	0.000000
	E	0.004493	0.006127	0.001079	0.000088	0.000000	0.000000
	ESE	0.003238	0.002976	0.000117	0.000000	0.000000	0.000000
	SE	0.002626	0.002626	0.000350	0.000000	0.000000	0.000000
	SSE	0.002801	0.003618	0.001109	0.000204	0.000000	0.000000
	S	0.003063	0.006593	0.002888	0.000321	0.000000	0.000000
	SSW	0.005806	0.014091	0.007439	0.001809	0.000000	0.000000
	SW	0.007848	0.014470	0.008023	0.001050	0.000058	0.000000
	WSW	0.008373	0.011203	0.006272	0.001167	0.000000	0.000000
	W	0.007060	0.011553	0.009482	0.001430	0.000000	0.000000
	WNW	0.004785	0.010415	0.010619	0.001546	0.000000	0.000000
	NW	0.003734	0.009044	0.007264	0.000963	0.000088	0.000000
	NNW	0.002976	0.008840	0.005631	0.001050	0.000058	0.000000

Table D.2-IV-1 (Continued)

Stability Class	Wind Direction	Wind Speed (kts) ≤3	≤6	≤10	≤16	≤21	≥21
E	N	0.003618	0.003880	0.000759	0.000029	0.000000	0.000000
	NNE	0.002596	0.003092	0.000788	0.000175	0.000000	0.000000
	NE	0.002976	0.003472	0.000438	0.000000	0.000000	0.000000
	ENE	0.008694	0.009219	0.001809	0.000000	0.000000	0.000000
	E	0.008198	0.002742	0.000233	0.000000	0.000000	0.000000
	ESE	0.004785	0.001254	0.000146	0.000000	0.000000	0.000000
	SE	0.004843	0.001721	0.000292	0.000000	0.000000	0.000000
	SSE	0.005572	0.003413	0.001284	0.000204	0.000000	0.000000
	S	0.006973	0.007673	0.003355	0.000642	0.000000	0.000000
	SSW	0.011582	0.014033	0.006798	0.001692	0.000000	0.000000
	SW	0.018496	0.018263	0.007410	0.000671	0.000000	0.000000
	WSW	0.017796	0.010328	0.003297	0.000642	0.000000	0.000000
	W	0.012486	0.010007	0.004143	0.000146	0.000000	0.000000
	WNW	0.009482	0.007614	0.003297	0.000583	0.000000	0.000000
	NW	0.008344	0.004668	0.001109	0.000175	0.000000	0.000000
	NNW	0.006214	0.003822	0.001079	0.000263	0.000000	0.000000
F	N	0.004988	0.000117	0.000000	0.000000	0.000000	0.000000
	NNE	0.005251	0.000088	0.000029	0.000000	0.000000	0.000000
	NE	0.005076	0.000117	0.000000	0.000000	0.000000	0.000000
	ENE	0.009102	0.001605	0.000117	0.000000	0.000000	0.000000
	E	0.013361	0.000904	0.000000	0.000000	0.000000	0.000000
	ESE	0.008927	0.000058	0.000000	0.000000	0.000000	0.000000
	SE	0.005922	0.000321	0.000000	0.000000	0.000000	0.000000
	SSE	0.005456	0.000175	0.000000	0.000000	0.000000	0.000000
	S	0.007002	0.000467	0.000000	0.000000	0.000000	0.000000
	SSW	0.011815	0.001196	0.000263	0.000000	0.000000	0.000000
	SW	0.019576	0.002101	0.000029	0.000000	0.000000	0.000000
	WSW	0.026811	0.001867	0.000058	0.000000	0.000000	0.000000
	W	0.029757	0.000671	0.000029	0.000000	0.000000	0.000000
	WNW	0.029319	0.000233	0.000029	0.000000	0.000000	0.000000
	NW	0.022785	0.000758	0.000058	0.000000	0.000000	0.000000
	NNW	0.011523	0.000876	0.000058	0.000000	0.000000	0.000000

ATTACHMENT D.2-V

CONTAMINANT CONCENTRATIONS IN AIR

LIST OF TABLES

ATTACHMENT D.2-V

CONTAMINANT CONCENTRATIONS IN AIR

Table		Page
D.2-V-1	Particulate-Phase Contaminant Concentrations in Air (Above Background) - South Field Area (SF/AFP/IFP) - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: Consolidation/Capping	D-2-V-1
D.2-V-2	Particulate-Phase Contaminant Concentrations in Air (Above Background) - South Field Area (SF/AFP/IFP) - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D-2-V-2
D.2-V-3	Particulate-Phase Contaminant Concentrations in Air (Above Background) - Solid Waste Landfill - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D-2-V-3
D.2-V-4	Particulate-Phase Contaminant Concentrations in Air (Above Background) - Lime Sludge Ponds - Expanded Trespasser/Off-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D-2-V-4
D.2-V-5	Particulate-Phase Contaminant Concentrations in Air (Above Background) - South Field Area (SF/AFP/IFP) - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D-2-V-5
D.2-V-6	Particulate-Phase Contaminant Concentrations in Air (Above Background) - Solid Waste Landfill - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D-2-V-6
D.2-V-7	Particulate-Phase Contaminant Concentrations in Air (Above Background) - Lime Sludge Ponds - On-Property Farmer - 10^{-6} Alternatives: On-Property Disposal Cell; Off-Site Disposal	D-2-IV-7
D.2-V-8	Radon-222 Concentration in Air - Alternatives: On-Property Disposal Cell; Off-Site Disposal	D.2-V-8
D.2-V-9	Radon-222 Concentration in Air - Alternatives: Consolidation and Capping	D.2-V-8

Table D.2–V–1
Particulate–Phase Contaminant Concentrations in Air (Above Background)
South Field Area (SF/AFP/IFP) – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: Consolidation/Capping

	Maximum On–Property		Maximum Off–Property	
Contaminant	Concentration	Deposition Rate	Concentration	Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium–137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium–237	2.84E–06	1.02E–08	1.75E–07	6.29E–10
Plutonium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–226	3.65E–06	1.32E–08	1.90E–07	6.84E–10
Radium–228	1.16E–06	4.16E–09	6.12E–08	2.20E–10
Strontium–90	2.29E–05	8.24E–08	1.12E–06	4.02E–09
Technetium–99	5.06E–06	1.82E–08	2.34E–07	8.41E–10
Thorium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–230	1.67E–05	6.02E–08	8.64E–07	3.11E–09
Thorium–232	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–234	9.12E–05	3.28E–07	4.24E–06	1.53E–08
Uranium–235/236	1.45E–05	5.22E–08	6.69E–07	2.41E–09
Uranium–238	9.47E–05	3.41E–07	4.55E–06	1.64E–08
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254	2.31E–07	8.30E–10	1.06E–08	3.83E–11
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	6.09E–05	2.19E–07	2.84E–06	1.02E–08
Benzo(a)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	4.59E–06	1.65E–08	2.12E–07	7.62E–10
Carbazole	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium (total)	1.06E–03	3.83E–06	5.15E–05	1.85E–07

Table D.2–V–2
Particulate–Phase Contaminant Concentrations in Air (Above Background)
South Field Area (SF/AFP/IFP) – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Maximum On–Property Concentration	Maximum On–Property Deposition Rate	Maximum Off–Property Concentration	Maximum Off–Property Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium–137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium–237	3.62E–06	1.30E–08	2.50E–07	9.01E–10
Plutonium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–226	3.67E–06	1.32E–08	1.89E–07	6.79E–10
Radium–228	5.93E–06	2.13E–08	2.44E–07	8.80E–10
Strontium–90	2.99E–05	1.08E–07	1.62E–06	5.85E–09
Technetium–99	8.67E–06	3.12E–08	4.44E–07	1.60E–09
Thorium–228	2.73E–06	9.84E–09	9.82E–08	3.54E–10
Thorium–230	9.28E–05	3.34E–07	3.89E–06	1.40E–08
Thorium–232	1.03E–06	3.72E–09	3.72E–08	1.34E–10
Uranium–234	3.10E–05	1.12E–07	1.66E–06	5.97E–09
Uranium–235/236	2.93E–05	1.06E–07	1.44E–06	5.18E–09
Uranium–238	1.97E–05	7.08E–08	1.08E–06	3.89E–09
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254	3.26E–06	1.17E–08	1.23E–07	4.45E–10
Aroclor 1260	2.81E–07	1.01E–09	1.01E–08	3.63E–11
Arsenic	8.22E–05	2.96E–07	4.26E–06	1.53E–08
Benzo(a)anthracene	8.13E–06	2.93E–08	2.92E–07	1.05E–09
Benzo(a)pyrene	1.33E–05	4.79E–08	4.78E–07	1.72E–09
Benzo(b)fluoranthene	1.18E–05	4.26E–08	4.25E–07	1.53E–09
Benzo(k)fluoranthene	1.18E–05	4.26E–08	4.25E–07	1.53E–09
Beryllium	6.31E–06	2.27E–08	3.21E–07	1.15E–09
Carbazole	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	3.25E–06	1.17E–08	1.17E–07	4.20E–10
Dieldrin	7.17E–08	2.58E–10	2.57E–09	9.27E–12
Indeno(1,2,3–cd)pyrene	4.58E–06	1.65E–08	1.65E–07	5.92E–10
Uranium (total)	7.00E–05	2.52E–07	5.73E–06	2.06E–08

Table D.2–V–3
Particulate–Phase Contaminant Concentrations in Air (Above Background)
Solid Waste Landfill – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Maximum On–Property Concentration	Maximum On–Property Deposition Rate	Maximum Off–Property Concentration	Maximum Off–Property Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium–137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium–237	9.36E–07	3.37E–09	2.55E–08	9.19E–11
Plutonium–238	4.68E–07	1.68E–09	1.28E–08	4.59E–11
Radium–226	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium–90	1.71E–06	6.15E–09	4.66E–08	1.68E–10
Technetium–99	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–230	2.64E–06	9.52E–09	7.21E–08	2.59E–10
Thorium–232	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–234	6.08E–07	2.19E–09	1.66E–08	5.97E–11
Uranium–235/236	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–238	5.57E–06	2.00E–08	1.52E–07	5.47E–10
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	5.29E–05	1.90E–07	1.44E–06	5.19E–09
Aroclor 1254	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	6.78E–07	2.44E–09	1.85E–08	6.66E–11
Benzo(a)pyrene	6.78E–07	2.44E–09	1.85E–08	6.66E–11
Benzo(b)fluoranthene	6.08E–07	2.19E–09	1.66E–08	5.97E–11
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	9.36E–07	3.37E–09	2.55E–08	9.19E–11
Carbazole	4.91E–07	1.77E–09	1.34E–08	4.82E–11
Dibenzo(a,h)anthracene	2.57E–07	9.26E–10	7.02E–09	2.53E–11
Dieldrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	4.91E–07	1.77E–09	1.34E–08	4.82E–11
Uranium (total)	1.01E–05	3.62E–08	2.74E–07	9.87E–10

Table D.2–V–4
Particulate–Phase Contaminant Concentrations in Air (Above Background)
Lime Sludge Ponds – Expanded Trespasser/Off–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Maximum On–Property Concentration	Maximum On–Property Deposition Rate	Maximum Off–Property Concentration	Maximum Off–Property Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium–137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium–237	4.33E–07	1.56E–09	6.19E–09	2.23E–11
Plutonium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium–90	1.80E–06	6.48E–09	2.57E–08	9.26E–11
Technetium–99	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–230	1.73E–06	6.24E–09	2.48E–08	8.91E–11
Thorium–232	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	2.23E–05	8.02E–08	3.19E–07	1.15E–09
Benzo(a)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium (total)	3.63E–05	1.31E–07	5.19E–07	1.87E–09

Table D.2-V-5
Particulate-Phase Contaminant Concentrations in Air (Above Background)
South Field Area (SF/AFP/IFP) - On-Property Farmer - 10^{-6}
Alternatives: On-Property Disposal Cell; Off-site Disposal

Contaminant	Maximum On-Property Concentration	Maximum On-Property Deposition Rate	Maximum Off-Property Concentration	Maximum Off-Property Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium-137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium-237	4.28E-06	1.54E-08	3.26E-07	1.17E-09
Plutonium-238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium-226	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium-90	3.10E-06	1.12E-08	2.17E-07	7.81E-10
Technetium-99	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium-230	6.59E-05	2.37E-07	2.76E-06	9.92E-09
Thorium-232	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-234	1.30E-05	4.67E-08	1.00E-06	3.61E-09
Uranium-235/236	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium-238	1.14E-05	4.11E-08	8.83E-07	3.18E-09
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3-cd)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium (total)	2.48E-04	8.94E-07	1.52E-05	5.48E-08

Table D.2–V–6
Particulate–Phase Contaminant Concentrations in Air (Above Background)
Solid Waste Landfill – On–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

Contaminant	Maximum On–Property Concentration	Maximum On–Property Deposition Rate	Maximum Off–Property Concentration	Maximum Off–Property Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium–137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium–237	1.32E–06	4.76E–09	3.60E–08	1.30E–10
Plutonium–238	6.15E–06	2.21E–08	1.68E–07	6.03E–10
Radium–226	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium–90	4.92E–07	1.77E–09	1.34E–08	4.83E–11
Technetium–99	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–230	2.37E–05	8.52E–08	6.45E–07	2.32E–09
Thorium–232	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–234	2.46E–06	8.85E–09	6.71E–08	2.41E–10
Uranium–235/236	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	4.09E–05	1.47E–07	1.11E–06	4.00E–09
Aroclor 1254	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)anthracene	7.07E–07	2.55E–09	1.93E–08	6.94E–11
Benzo(a)pyrene	4.61E–08	1.66E–10	1.26E–09	4.53E–12
Benzo(b)fluoranthene	4.30E–07	1.55E–09	1.17E–08	4.22E–11
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbazole	1.98E–07	7.12E–10	5.39E–09	1.94E–11
Dibenzo(a,h)anthracene	1.41E–08	5.09E–11	3.86E–10	1.39E–12
Dieldrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	2.24E–07	8.08E–10	6.12E–09	2.20E–11
Uranium (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D.2–V–7
Particulate–Phase Contaminant Concentrations in Air (Above Background)
Lime Sludge Ponds – On–Property Farmer – 10^{-6}
Alternatives: On–Property Disposal Cell; Off–site Disposal

	Maximum On–Property		Maximum Off–Property	
Contaminant	Concentration	Deposition Rate	Concentration	Deposition Rate
Radionuclides (pCi/m^3 or pCi/m^2/s):				
Cesium–137	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Neptunium–237	2.23E–07	8.04E–10	3.19E–09	1.15E–11
Plutonium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–226	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Radium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Strontium–90	2.45E–07	8.83E–10	3.50E–09	1.26E–11
Technetium–99	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–228	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Thorium–230	2.28E–05	8.20E–08	3.25E–07	1.17E–09
Thorium–232	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–234	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–235/236	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium–238	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Inorganics and Organics (ug/m^3 or ug/m^2/s):				
Antimony	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1254	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Aroclor 1260	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Arsenic	2.93E–04	1.05E–06	4.19E–06	1.51E–08
Benzo(a)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(a)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(b)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Benzo(k)fluoranthene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Beryllium	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Carbazole	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dibenzo(a,h)anthracene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Dieldrin	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Indeno(1,2,3–cd)pyrene	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Uranium (total)	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Table D.2–V–8
Radon–222 Concentration in Air
Alternatives: On–Property Disposal Cell; Off–site Disposal

Subunit or Source	Maximum On–Property Concentration (pCi/m3)	Maximum Off–Property Concentration (pCi/m3)
Private Ownership, On–Property Farmer:		
Disposal Cell (On–Property Disposal Alternative only)	2.90E–06	1.05E–06
Administrative Controls, Expanded Trespasser:		
Disposal Cell (On–Property Disposal Alternative only)	5.62E–06	2.03E–06
South Field Area (SF/AFP/IFP)	1.68E+00	8.70E–02

Table D.2–V–9
Radon–222 Concentration in Air
Alternatives: Consolidation and Capping

Subunit or Source	Maximum On–Property Concentration (pCi/m3)	Maximum Off–Property Concentration (pCi/m3)
Administrative Controls, Expanded Trespasser:		
South Field Area (SF/AFP/IFP Consolidaiton Area)	1.55E+00	8.00E–02
Solid Waste Landfill	4.07E–07	1.12E–08
Lime Sludge Ponds	2.37E–07	3.42E–09

APPENDIX D.3

URANIUM PARTITION COEFFICIENT EVALUATION STUDY

D.3.0 URANIUM PARTITION COEFFICIENT EVALUATION STUDY

This appendix documents the results of the Uranium Partition Coefficient Evaluation Study carried out in support of the Remedial Investigation/Feasibility Study (RI/FS) for Operable Unit 2 - Other Waste Units at the U.S. Department of Energy (DOE), Fernald Environmental Management Project (FEMP) at Fernald, Ohio. The study consisted of laboratory analyses conducted to determine the partition coefficients (K_d) for waste, soils, and geologic formations in Operable Unit 2 as an input in fate and transport modeling. This appendix will focus on the K_d for total uranium, which is prevalent throughout the Operable Unit 2 waste units. The K_d results are based on both adsorption and desorption tests conducted at the FEMP laboratory.

To identify Operable Unit 2-specific K_d values, a laboratory study was conducted on Operable Unit 2 waste and soil. Waste and soil samples were collected from the waste units and associated geological layers for each of the subunits. These waste or soil samples underwent laboratory tests in which they were mixed with a leachate solution in a batch-type reactor. Two separate tests were conducted: one test evaluated the amount of uranium that was leached from the waste and soil, and the other test evaluated the amount of uranium that was adsorbed by the waste or soil. The first test was conducted on samples (collected in the subunits where the media was contaminated) that were considered to be contaminated. The second test was conducted on samples which analysis showed had little or no contamination.

D.3.1 Soil Sample Selection

Table D.3-1 is a summary of the samples which were used to develop K_d values and the location where they were sampled. The samples were collected from the ongoing field sampling activities or retrieved from the FEMP sample archives. The contaminated samples were identified by the beta-gamma field readings conducted during the field sampling program. Samples with beta-gamma field readings above background were considered contaminated. Once the appropriate sample(s) were located, sample numbers were identified for retrieval from FEMP archives. Since the RI field sampling program was in progress at the time, some soil samples were collected directly from the field.

TABLE D.3-1

SUMMARY OF K_d STUDY SAMPLES FOR OPERABLE UNIT 2

Waste Subunits	Waste Material Samples	Glacial Overburden Samples	Sand and Gravel Samples	Great Miami Aquifer Samples
Solid Waste Landfill	Boring 1985 (depth 0-3 ft.) Boring 1986 (depth 5-7.5 ft.)	Boring 1986 (depth 12.5-15 ft.) Boring 11037 (depth 20-22.5 ft.)	Boring 2953 (depth 46 ft.)	Boring 2953 (depth 70 ft.)
Lime Sludge Ponds	LSP-SS-03 (depth 0-12 in.) LSP-SS-05 (depth 0-6 in.) LSP-SS-06 (depth 0-6 in.)	N/S[a]	N/S	N/S
Inactive Flyash Pile	Boring 11001 (depth 0.5-2.5 ft.) Boring 11003 (depth 3.5-5.5 ft.)	N/S	N/S	N/S
Active Flyash Pile	Boring 1980 (depth 4-5.5 ft.)	N/S	N/S	N/S
South Field	Trench No. 1 (depth 2 ft.)	Boring 11187 (depth 6.5-7 ft.) Trench No. 4 (depth 7 ft.)	Boring 2944 (depth 25-51 ft.)	Boring 2944 (depth 50-65 ft.)

[a]N/S = no sample collected.

The main purpose for collecting samples directly from the field was to ensure that samples with significant levels of contamination were used. The field samples included both Trench Nos. 1 and 4 samples in the South Field; Boring No. 1985 in the Solid Waste Landfill; and the sand and gravel samples from Boring No. 2944 in the South Field and Boring No. 2953 in the Solid Waste Landfill. The samples with the highest contamination based on hand-held beta-gamma measurements were found in the South Field trench locations and at Boring No. 1985 in the Solid Waste Landfill. The sand and gravel samples from Boring Nos. 2944 and 2953 were collected because the samples were the last two borings to be drilled in the RI sampling program, and all the previous borings contained low concentrations in the sand and gravel zones. After collection, however, these samples also showed no or little contamination.

The sample volume required for the test was approximately two liters; however, the archive samples were usually in 500 milliliter (mL) jars. Therefore, three to four archive samples were required at slightly different depths to make one K_d sample. However, all of the samples were from the same split spoon interval, with the exception of samples from Boring No. 2944. Samples from Boring No. 2944 in the South Field were collected over a 7.9 m (26 ft) interval and a 4.6 m (15 ft) interval for the unsaturated and saturated sand and gravel, respectively. These samples were composited in the field, whereas the archive samples were combined and homogenized in the FEMP laboratory.

D.3.1.1 Waste Samples

A waste material sample was collected from each subunit. All were identified as containing elevated levels of uranium, except the Active Flyash Pile sample. The waste material was considered the flyash for the Active Flyash Pile and the Inactive Flyash Pile. One sample from each pile was collected. A second sample at the Inactive Flyash Pile was collected for the earthen cover material overlying the flyash. The waste material at the Lime Sludge Pond was the lime sludge. Two samples were taken at the north Lime Sludge Pond and composited into one. Another sample of the earthen berm material was also collected.

Two waste samples were collected for the Solid Waste Landfill. Both were in the boundaries of the waste cells and were taken at different depths. Two waste material samples were collected for the South Field. The samples were collected during the RI trenching at the South Field; visual inspection identified the samples as fill material. Sample No. 113721 was taken at a depth of approximately 1.8 m (6 ft) in Trench No. 4 where the fill appeared to transition to natural till.

D.3.1.2 Glacial Overburden Layer

The glacial overburden was characterized using soil samples collected from two separate areas composed of Operable Unit 2 subunits. The areas were the Solid Waste Landfill/Lime Sludge Ponds and the Active Flyash Pile/Inactive Flyash Pile/South Field. This approach was based on similarities in lithologic descriptions taken from boring logs from each collection area. Additionally, the South Field and the Solid Waste Landfill were considered to have the greatest potential for future impact to the Great Miami Aquifer. All of the glacial overburden samples collected for the study were contaminated.

Two samples were collected from Solid Waste Landfill: one in a blue clay just below the bottom of the Solid Waste Landfill at a depth of 3.8 to 4.6 m (12.5 to 15.0 ft) and the other in an olive clay area below the blue clay at a depth of 6.1 to 6.9 m (20 to 22.5 ft). One sample was collected from the South Field at Boring No. 1974 in a light olive brown silty clay at a depth of 21 m (7 ft).

D.3.1.3 Sand and Gravel Layer

The sand and gravel samples were considered to be similar at all the subunits. This approach was based on the Great Miami Aquifer being continuous over the site. All the sand and gravel samples collected for the K_d study were relatively free of contamination. The samples were collected at two locations. One set of samples (saturated and unsaturated) was collected at the Solid Waste Landfill/Lime Sludge Ponds in an area between the two units. The other set of samples was collected in the South Field.

D.3.2 Laboratory Procedures

Two types of batch tests were used to perform the laboratory K_d studies. One was a desorption test used on the contaminated samples and was based on determining the amount of total uranium that leached into solution. The other was an adsorption test used on the samples which contained low concentrations of total uranium and was based on determining the total uranium adsorbed by the soil/waste from a uranium spiked water solution. The desorption and adsorption tests meet the same objectives but operate in reverse of one another. Both tests will determine the equilibrium uranium concentrations of the soil and liquid solution. The selection of the appropriate K_d test was based on the soil sample's initial total uranium concentration. A total of 19 tests were performed on the soil samples, which consisted of 11 desorption tests and 8 adsorption tests.

The desorption test was performed for all of the samples that had a total uranium concentration above background. The adsorption test was performed on the remaining soil samples. For some samples, both the adsorption and desorption tests were performed for comparison purposes. A total uranium analysis on the initial waste/soil samples was performed by both the FEMP and International Technology Corporation Analytical Services (ITAS), which participates in the U.S. Environmental Protection Agency's (EPA) Contract Laboratory Program (CLP).

The American Society for Testing and Materials (ASTM) D 4319-83 Standard Test Method for Distribution Ratios by the Short-Term Batch Method was evaluated and used as guidance in the preparation of the procedure used in the K_d evaluation. Where appropriate, specific preparatory procedures of the ASTM were used. The K_d evaluation procedure is provided in Attachment D.3-I.

D.3.2.1 Desorption Test

In general, the desorption test consisted of placing a 400-gram portion of the sample into a 1-gallon Nalgene plastic jar/reactor with 3,500 mL of a water solution. This equated to a liquid-to-soil ratio of 8.75. The soil and liquid mixture was tumbled continuously at approximately 29 revolutions per minute until the total uranium concentration in the water solution reached equilibrium.

Soil preparation started with compositing several archive samples for the same boring and depth (due to the small volumes archived) into a 600-gram sample. The 600-gram sample was then filtered to remove any free liquids. No drying was performed. The only samples requiring filtering were the saturated sand and gravel samples. After filtering, a 400-gram sample was weighed and placed in a reactor with the water.

The remaining portion of the waste/soil sample that was not placed in the jar was prepared for laboratory analysis on total uranium and moisture content. A 200-gram sample was oven dried at 103°C for 24 hours. The moisture content was calculated by using the weight of the sample before oven drying and the weight of the sample after oven drying. A 10-gram portion of the oven dried sample was used for the FEMP total uranium analysis and a 135-gram portion was used for the off-site laboratory analysis.

In the desorption tests, three different water solutions were used with the soils to determine the K_d and were based on the location/type of the soil sample. For the waste material samples, a

distilled-water solution adjusted to 5.6 pH with a 60/40 mixture of sulfuric acid to nitric acid solution was used. This water solution was used to represent the rainwater percolating through the waste material. The glacial overburden soil samples used a distilled-water solution with no pH adjustment. The unsaturated and saturated sand and gravel samples were mixed with FEMP groundwater from a 3000- series background well. The groundwater was considered to have a uranium concentration that was representative of the background level at the site.

The time period for the desorption test samples to reach equilibrium was approximately 2 weeks. During each test, a sample of the water solution was periodically analyzed for total uranium to verify when the sample reached equilibrium. This was performed by drawing off 20 mL of leachate and filtering the sample through a 0.45 micron size membrane filter to remove any solids. The sampling frequency for some of the water samples was adjusted on occasion because of holidays or weekends. All of the intermediate water samples were analyzed for total uranium at the FEMP laboratory to allow quick turnaround times which were required during the test. The final samples from each test were split between the ITAS and FEMP laboratory.

Other parameters such as pH, oxidation/reduction potential (E_h), and specific conductivity can effect the "sorption" process and K_d value (ASTM D-4319). Therefore, during each adsorption/desorption test, periodic measurements were made for temperature, pH, E_h, and specific conductivity. The measurements were made at the same time that samples of the water solutions were collected for total uranium analysis during the test.

All of the subunits' waste samples and glacial overburden samples underwent the desorption test, except for the Active Flyash Pile flyash. The Active Flyash Pile flyash was not contaminated above background concentrations. Also, the Inactive Flyash Pile flyash sample did not leach uranium at concentrations which were detectable, and, therefore, was discontinued after ten days. Attachment D.3.II provides the laboratory desorption test results.

D.3.2.2 Adsorption Test

In the adsorption test, the same type of water solutions were prepared as in the desorption tests, depending on the location of the sample. The exception in the preparation activities between the two tests was that the water solutions were spiked with uranium for the adsorption test. The spiked solution was a 1.0 mg/mL concentration of uranium nitrate in 2 percent nitric acid. The water was

spiked with 7 mL of the uranium nitrate solution. The addition of the uranium nitrate solution resulted in a uranium concentration of 2 mg/L for the initial water solution in all of the adsorption tests.

The testing period on the adsorption of non-contaminated samples focused more on the first 72 hours of the test. During this period, a sample was collected each day. Literature review indicates most adsorption tests reach equilibrium within that time period (ASTM D-4319). If equilibrium was not reached, periodic sampling would continue after the 72-hour period until equilibrium was reached. Equilibrium was determined by evaluating results from two consecutive samples. If the samples were within 5 percent (+ or -) or less, the sample was considered at equilibrium, and the test was stopped.

All of the sand and gravel samples underwent the adsorption test, since they were not contaminated. The soil samples from the glacial overburden at Boring No. 1986 in the Solid Waste Landfill, flyash at both the Active Flyash Pile and Inactive Flyash Pile, and Trench No. 4 in the South Field were also tested. These soil samples, except for the Active Flyash Pile flyash, had total uranium concentrations which were considered too low to leach into solution under the desorption test. The desorption test was performed on these three samples, with the adsorption test performed for comparison purposes. The flyash sample from the Inactive Flyash Pile (Sample No. 114068) did not leach any measurable quantity of uranium during the desorption test. The other two glacial overburden samples (Sample Nos. 111457 and 113721) had detectable uranium concentrations in the leachate. Attachment D.3.III provides the laboratory adsorption test results.

D.3.2.3 Analytical Methods/Procedures

The total uranium analysis was performed by both the FEMP laboratory and the ITAS. The FEMP analysis was at an analytical support level B and the ITAS analysis was at an analytical support level C. The FEMP laboratory used calorimetric analysis for the soil analysis and laser phosphorimetry for the water analysis. The volume requirements were 5 grams for the soils and 10 mL for the water. The FEMP Analytical Laboratory Services methods used were 3002 and 3062 for soils and water, respectively, which is consistent with the FEMP Site-Wide Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) Quality Assurance Project Plan requirements.

The ITAS used gamma spectrometry for the soil analysis and pulsed laser phosphorimetry for the water analysis. The volume requirements were 135 grams for the soils and 210 mL for the water. The standard operating procedures used were OR7003 and OR7127 for soils and water, respectively, and was consistent with the EPA-approved CLP operating procedures.

The pH, E_h, conductivity, and temperature were measured by placing the instrument probe directly into the jar/reactor. The instrument was calibrated each day for E_h, conductivity, and pH. The E_h and conductivity calibration was performed by zeroing the meter. The pH was calibrated by using a 4.0 and 7.0 pH buffer. Also, when using the probe, the jars were organized to be sampled in increasing aqueous uranium concentrations; the probe was also raised with deionized water between samples to avoid cross-contamination of the samples.

D.3.3 Partition Coefficient Calculations

The K_d values for both the adsorption and desorption tests were calculated by dividing the concentration of uranium in the test media or soil (at equilibrium) by the concentration of uranium in the test liquid or groundwater (at equilibrium), as follows:

$$K_d = \frac{C_s'}{C_l} \qquad \text{(D.3-1)}$$

where

C_s' = concentration of uranium in soil or test media (minus background)

C_l = concentration of uranium in liquid (at equilibrium)

The concentration of uranium in the liquid (at equilibrium) was obtained directly from laboratory analytical results; however, the concentration of uranium in the soil was calculated.

Desorption Calculations:

In order to calculate the concentration of uranium in the soil (at equilibrium), the mass of uranium in the water (at equilibrium) must first be determined. The mass of uranium was calculated by multiplying the concentration of uranium in the liquid (at equilibrium) by the total volume of the test liquid used during the desorption test, as follows:

$$m_l = C_l \times V \qquad \text{(D.3-2)}$$

where

m_l = mass of uranium in liquid (at equilibrium)

V = volume of liquid used during desorption testing

The initial mass of uranium in the soil was calculated by multiplying the initial concentration of uranium in the soil by the mass of the soil, as follows:

$$m_s = C_o \times M \qquad \text{(D.3-3)}$$

where

m_s = initial mass of uranium in soil or test media

C_o = initial concentration of uranium in soil or test media

M = mass of soil or test media

Once these two values were determined, the concentration of uranium in the soil (at equilibrium) was calculated by subtracting the mass of uranium in the liquid (at equilibrium) from the initial mass of uranium in the soil and dividing the difference by the mass of the soil, as follows:

$$C_s = \frac{m_s - m_l}{M} \qquad \text{(D.3-4)}$$

where

C_s = concentration of uranium in soil or test media (at equilibrium)

In calculating the K_d values, the liquid source has an impact on determining the total uranium concentration in the soil. The background uranium concentration in soil was assumed to be in equilibrium with groundwater. In tests where groundwater was used as the desorption test liquid, the background uranium concentration was not subtracted from the concentration of uranium in the soil (at equilibrium); therefore, C_s' equals C_s. However, in tests where groundwater was not used as the adsorption test liquid, the background uranium concentration was subtracted from the concentration of uranium in the soil (at equilibrium), as follows:

$$C_s' = C_s - C_b \qquad \text{(D.3-5)}$$

where

C_b = background concentration of uranium

The background total uranium concentration in soil was calculated to be 3.7 micrograms per gram (μg/g) by using the FEMP background activity for uranium isotopes. The equation used for the calculation is found in Data Validation Program, Rev. 0, DOE Oak Ridge Operations Office, 1991, pages D-3 through D-5.

The K_d calculations for the desorption tests were based on the analytical results for the ITAS laboratory and can be found in Attachment D.3-IV. A summary of the off-site analytical results and the K_d values for the desorption tests are provided in Table D.3-2.

Desorption Test Calculation Example:

The following is an example of desorption testing calculations for Sample No. 111457 to determine the K_d value.

C_o = 18.3 μg/g
C_l = 10.6 μg/L
M = 400 g
V = 3.5 L
C_b = 3.7 μg/g
m_l = C_l x V = 10.6 μg/L x 3.5 l = 37.1 μg
m_s = C_o x M = 18.3 μg/g x 400 g = 7,320 μg

$$C_s = \frac{m_s - m_l}{M} = \frac{7{,}320\ \mu g - 37.1\ \mu g}{400\ g} = \frac{7282.9\ \mu g}{400\ g} = 18.2\ \mu g/g$$

$$C_s' = C_s - C_b = 18.2\ \mu g/g - 3.7\ \mu g/g = 14.5\ \mu g/g$$

$$K_d = \frac{C_s'}{C_l} = \frac{14.5\ \mu g/g}{10.6\ \mu g/L} = 1.37\ L/g = 1370\ L/kg$$

$$K_d = 1370\ L/kg$$

TABLE D.3-2
OPERABLE UNIT 2 K_d VALUES FOR DESORPTION TEST

Sample No.	Location[a]	Total Uranium			K_d Values (L/kg)
		Initial Soil Concentration (μg/g)	Equilibrium Soil Concentration (μg/g)	Equilibrium Water Concentration (μg/L)	
111455	Solid Waste Landfill/1986 - Waste Material	146.0	127.4	1700.0	75
111440	Solid Waste Landfill/1985 - Waste Material	74.0	63.9	726.0	88
111457	Solid Waste Landfill/1986 - Glacial Overburden	18.3	14.5	10.6	1370
115370	Solid Waste Landfill/11037 - Glacial Overburden	9.0/2.65[b]	2.0	10.0	200
114472	Lime Sludge Pond/SS03 - Waste/Berm Material	18.9	14.8	41.6	360
114494	Lime Sludge Pond/SS05&06 - Lime Sludge	14.3	10.6	4.0	2650
114067	Inactive Flyash Pile/11001 - Cover Material	147.0	127.5	1810.0	70
114068	Inactive Flyash Pile/11003 - Flyash	16.9	---[c]	---	---
114070	South Field/11187 - Glacial Overburden	308.0	304	32.5	9350
113717	South Field/Trench No. 1 - Waste Material	278.0	261.4	1480.0	180
113721	South Field/Trench No. 4 - Waste Material	4.34	0.6	2.16	280

[a]Identifies subunit and boring number

[b]Used average of FEMP and IT soil concentration

[c]Concentration below detection limit

Adsorption Calculations:

In order to calculate the concentration of uranium in the soil (at equilibrium), the amount of uranium adsorbed to the soil must first be calculated. The mass of uranium adsorbed was calculated by multiplying the initial concentration of uranium spiked in the liquid by the volume of the liquid used during adsorption testing, as follows:

$$m_i = S \times V \qquad \text{(D.3-6)}$$

where

m_i = initial mass of uranium spiked in liquid

S = initial concentration of uranium spiked in liquid

V = volume of liquid used during adsorption testing

Then, the mass of uranium in the solution (at equilibrium) was calculated by multiplying the concentration of uranium in the liquid (at equilibrium) by the volume of the liquid used during adsorption testing, as follows:

$$m_f = C_l \times V \qquad \text{(D.3-7)}$$

where

m_f = mass of uranium in liquid (at equilibrium)

C_l = concentration of uranium in liquid (at equilibrium)

The concentration of uranium adsorbed in the soil was calculated by subtracting the mass of uranium in the liquid (at equilibrium) from the initial mass of uranium spiked in the liquid and dividing the difference by the total soil mass, as follows:

$$C_a = \frac{m_i - m_f}{M} \qquad \text{(D.3-8)}$$

where

C_a = concentration of uranium adsorbed in soil or test media

M = mass of soil or test media

The final concentration of uranium in the soil (at equilibrium) was calculated by adding the concentration of uranium adsorbed in the soil to the initial concentration of uranium in the soil, as follows:

$$C_s = C_a + C_o \qquad \text{(D.3-9)}$$

where

C_s = concentration of uranium in soil or test media (at equilibrium)
C_o = initial concentration of uranium in soil or test media

The background uranium concentration in the soil was assumed to be in equilibrium with the groundwater concentrations; therefore, in tests where groundwater was used as the adsorption test liquid, the background uranium concentration was not subtracted from the concentration of uranium in the soil (at equilibrium); therefore, Cs' equals Cs. In tests where groundwater was not used as the adsorption test liquid, the background uranium concentration was subtracted from the concentration of uranium in the soil (at equilibrium), as follows:

$$C_s' = C_s - C_b \qquad \text{(D.3-10)}$$

where

C_b = background concentration of uranium

The K_d calculations for the adsorption tests were based on the analytical results for the ITAS laboratory and can be found in Attachment D.3-V. A summary of the off-site analytical results and the K_d values for the adsorption test are provided in Table D.3-3.

Adsorption Test Calculation Example:

The following is an example of adsorption testing calculations for Sample No. 11457 to determine the K_d values.

Given:

C_o = 18.3 μg/g V = 3.5 L
C_l = 357 μg/L S = 2000 μg/L
M = 400 g

Calculations:

m_i = S x V = 2000 μg/L x 3.5 L = 7000 μg
m_f = C_l x V = 357 μg/L x 3.5 L = 1249.5 μg

$$C_a = \frac{m_i - m_f}{M} = \frac{7000\ \mu g - 1249.5\ \mu g}{400\ g} = \frac{5750.5\ \mu g}{400\ g} = 14.4\ \mu g/g$$

TABLE D.3-3
OPERABLE UNIT 2 K_d VALUES FOR ADSORPTION TEST

Sample No.	Location[a]	Total Uranium			K_d Values (L/kg)
		Initial Soil Concentration (μg/g)	Equilibrium Soil Concentration (μg/g)	Equilibrium Water Concentration (μg/L)	
115445	Solid Waste Landfill/2953 - Unsaturated Sand and Gravel	1.63	11.1	918.0	12.0
115454	Solid Waste Landfill/2953 - Saturated Sand and Gravel	1.17	10.1	982.0	10.0
111457	Solid Waste Landfill/1986 - Glacial Overburden	18.3	29.0	357.0	81
114068	Inactive Flyash Pile/11003 - Flyash	16.9	30.7	3.0[b]	10,230
114069	Active Flyash Pile/1980 - Flyash	12.2	21.1	564.0	37.0
113721	South Field/Trench No. 4 - Waste Material	4.34	10.4	876.0	12.0
113755	South Field/2944 - Unsaturated Sand and Gravel	1.43	11.7	826.0	14.0
113770	South Field/2944 - Saturated Sand and Gravel	2.86	9.9	1190.0	8.0

[a]Identifies subunit and boring number

[b]Used FEMP average water analysis result

$$C_s = C_a + C_o = 14.4\ \mu g/g + 18.3\ \mu g/g = 32.7\ \mu g/g$$

$$C_{s'} = C_s - C_b = 32.7\ \mu g/g - 3.7\ \mu g/g = 29.0\ \mu g/g$$

$$K_d = \frac{C_{s'}}{C_l} = \frac{29.0\ \mu g/g}{357\ \mu g/L} = 0.081\ L/g = 81.0\ L/kg$$

$$K_d = 81.0\ L/kg$$

The off-site results were used, because they were performed by a laboratory using EPA CLP procedures.

D.3.4 Summary and Conclusions

This section presents the K_d values that were calculated for all tests, and discusses the significance of these test results.

D.3.4.1 Desorption Versus Adsorption

A summary of K_d values for desorption and adsorption tests is provided in Table D.3-4. Two values were provided wherever there were two samples from the same area, and for the sand and gravel samples since they were similar. The K_d values, based on desorption values, were significantly higher then the adsorption test based K_d values. Results for Solid Waste Landfill Sample No. 111457 and South Field Sample No. 113721 provide a direct comparison between the two tests. Measurement of the Solid Waste Landfill sample yielded a K_d of 1,370.0 L/kg from the desorption test and a K_d of 81.0 L/kg from the adsorption test. On the South Field sample, the desorption test showed a K_d value of 280.0 L/kg and the adsorption test showed a K_d value of 12.0 L/kg.

The results between the adsorption and desorption tests were different and can be attributed to the difference in the tests. One difference was the generation or presence of uranium in the leachate. In the adsorption test, uranium was added to the leachate at the beginning of the test. In the desorption test, the uranium was leached, during the test, from the soil sample in the leachate.

The uranium in the leachate was also different between the tests. In the adsorption test, the uranium was in the form of uranium nitrate. In the desorption test, the uranium varied chemically depending on the source and/or chemical changes that may have occurred during its presence in the soil. In addition, the desorption test was different than the adsorption test by the process. The desorption test

TABLE D.3-4

SUMMARY OF K_d VALUES FOR OPERABLE UNIT 2

Sample Location	Desorption Test K_d (L/Kg)	Adsorption Test K_d (L/Kg)
Solid Waste Landfill - Waste Material	75.0/88.0	
Solid Waste Landfill - Glacial Overburden	200.0/1370.0	81.0
Inactive Flyash Pile - Cover Material	70.0	
Inactive Flyash Pile/Active Flyash Pile - Flyash		37.0/10,230.0
Lime Sludge Pond - Berm Material	360.0	
Lime Sludge Pond - Lime Sludge	2650.0	
South Field - Waste Material	180.0/280	12.0
South Field - Glacial Overburden	9350.0	
South Field/Solid Waste Landfill - Unsaturated Sand and Gravel		12.0/14.0
South Field/Solid Waste Landfill - Saturated Sand and Gravel		8.0/10.0

worked on the process of removing absorbed uranium from the soil. The adsorption test used the process of soil particles absorbing uranium from solution.

The desorption test is considered more representative for the fill and till layers of the subunits, because it depicts the behavior of the uranium migration in the contaminated soil layers upon contact with infiltration and perched groundwater. Whereas the adsorption test better depicts the sand and gravel layers since, in these layers, the media is free of uranium contamination and would act in an adsorption fashion on contaminated groundwater moving through the media. The adsorption values were mainly used in the unsaturated and saturated sand and gravel zones where the desorption test was not practical, because the soils were not contaminated or not contaminated to a level that would leach at detectable concentrations.

D.3.4.2 Operable Unit 2 K_d Values Versus Literature Values

Several literature reviews were performed to evaluate the range of K_d values for uranium. One reference (Thibault et al. 1990) provided a range of K_d values from 46 to 395,100 L/kg for clay-rich soils and 0.03 to 2,200 L/kg for sandy soils. For agriculture soils or the soil layer where plants and roots uptake nutrients, the K_d value for uranium ranged from 10.5 to 4,400 L/kg (Baes et al. 1984).

Both the waste layer and glacial overburden layer soils at the Solid Waste Landfill and South Field were clay-rich soil with K_d values from 12 to 180 L/Kg for the waste layer and 9,350 L/kg for the glacial overburden layer. In comparison with the literature values, the Operable Unit 2 K_d values were on the low end of the range. Likewise, for the sand and gravel at the Solid Waste Landfill and South Field, the K_d values ranged from 8.0 to 14.0 L/kg, which was on the low end of the literature values for sandy soils. No literature values were obtained for the flyash and lime sludge.

D.3.4.3 Operable Unit 2 K_d Values Versus In Situ Values

A final assessment of the Operable Unit 2 K_d values was made by comparison with in situ samples. The in situ K_d determination was conducted by Operable Unit 5 and was determined by analyzing a soil and water sample at the same location in 1000-series wells. Because the perched water flow velocities are low in the glacial overburden, it was assumed the measured soil and liquid phase concentrations were in equilibrium.

Before the in situ K_ds were calculated, the soil concentration was corrected for the uranium contained in the soil moisture. Approximately 25 percent of the soil uranium concentration was subtracted to adjust for the soil moisture. The Operable Unit 5 in situ K_d values ranged from 16 to 235 L/kg, which were similar to the range of Operable Unit 2 K_d values for the Solid Waste Landfill and South Field in the glacial overburden (12 to 280 L/kg) when the high K_d values are deleted from the Solid Waste Landfill (1,370 L/kg) and South Field (9,350 L/kg).

The Operable Unit 2 RI sampling program collected a soil (silty sand) and water sample from Inactive Flyash Pile Boring No. 11003 at 7.9 m (26 ft), which produced an in situ K_d value of 525 L/kg. Also, a K_d value was calculated for the South Field saturated sand and gravel layer by removing the free liquid from the sample and analyzing the free liquid and sand and gravel material. The sand and gravel were considered to be in equilibrium with the groundwater. A K_d value of 64 L/kg resulted. These two Operable Unit 2 in situ K_d values were much higher then the Operable Unit 2 laboratory K_d values for the sand and gravel layer. The in situ K_d at Boring No. 11003 was believed to be high due to the uranium contamination not being soluble and was probably specific to that area of contamination.

APPENDIX D.3

ATTACHMENT D.3-I

LABORATORY PROCEDURES

ATTACHMENT D.3-1
LABORATORY PROCEDURES

D.3-I.1 Procedure A (Contaminated Samples for Uranium K_d Determination)

D.3-I.1.1 Sample Homogenization

The sample will be thoroughly homogenized using a stainless steel mixing spoon in a stainless steel mixing bowl.

D.3-I.1.2 Sample Filtration

If the sample has any free liquid, it should be vacuum filtered through a .45 micron filter paper. (Note that it may be necessary to use several filtration steps.) Any filtrate should be collected and analyzed for total uranium.

D.3-I.1.3 Initial Characterization of Soil Sample

Samples for the total uranium soil analysis should be split between the FEMP laboratory and the off-site laboratory if adequate sample is available. If there is inadequate sample for the off-site analysis, then samples should only be analyzed at the FEMP laboratory. Sample volumes should be collected for total uranium and placed in the containers as shown in Table D.3-I-1. Additionally, a 10-gram sample should be analyzed for moisture content at the FEMP laboratory.

D.3-I.1.4 Sample Preparation

Place 400 grams (dry weight) of soil sample in the 4.0 liter reactor and add 3,500 ml of the appropriate leachate solution to the reactor. For soil samples collected in the subunits, the leachate solution will be 3,500 ml of deionized (DI) water adjusted to a pH of 5.6 using a mixture of sulfuric acid and nitric acid at a 60/40 ratio. For soil samples collected from the glacial overburden below the subunits, use DI water with no pH adjustment. For soil samples from the sand and gravel zone (unsaturated or saturated) below the subunits, the leachate solution will be clean groundwater from a background well. A sample of the background groundwater must be submitted for total uranium analysis to the off-site laboratory and the FEMP laboratory according to the volumes and container requirements shown in Table D.3-I-1. This analysis will serve as a background concentration for the groundwater used for the testing. (Note: Background groundwater only requires one analysis to establish a baseline concentration.)

D.3-I.1.5 Sample Mixing

The samples should be placed in the rotating tumbler and mixed continuously until completion of the testing. The extractor must be operated at 29 +/- 2 rpm.

D.3-I.1.6 Sample Collection

Samples of the leachate should be collected by stopping the tumbler for a sufficient time period (minimum of 10 minutes) to allow the solids to settle. An appropriate volume of the leachate (see Table D.3-I-1 for sample volumes required for analysis) should then be decanted from the reactor and filtered through a .45 micron filter paper or separated with a constant temperature centrifuge capable of separating greater than 0.1 micron particles. Any solids from the separation step should be returned to the reactor.

Intermediate samples should be collected at 72, 144, 168, 240, 288, 360, and 384 hours and analyzed at the FEMP laboratory for total uranium. The study may be stopped earlier if the data indicates that uranium is in equilibrium with the soil and liquid. Equilibrium will be determined by plotting each concentration (Y-axis) versus time (X-axis) to determine when the curve begins to flatten, which indicates that an equilibrium concentration is achieved. Prior to stopping the test earlier or collecting intermediate samples for one of the radionuclides, confirm with the Operable Unit 2 representative that the contaminant is in equilibrium.

The final sample will be collected after the results indicate that uranium is in equilibrium and will be split between the FEMP laboratory and the off-site laboratory. The final sample will be collected and analyzed for total uranium. If a sample does not reach equilibrium after 384 hours, then the Operable Unit 2 representative (Bert Crapse at extension 6974) should be notified to determine the appropriate action to be taken. (Note: The final water samples should only be split with the FEMP and off-site laboratories if the soil samples were initially split between the two laboratories.)

At the completion of the study, the soil will be stored for possible future leaching tests to determine the extractable concentrations of the radionuclides. Prior to storing the sample, the sample will be vacuum filtered through a .45 micron filter paper to remove all free liquid. The Operable Unit 2 representative will identify which samples will be used to determine the extractable portion.

D.3-I.2 Procedure A1 (Non-Contaminated Samples for Uranium K_d Determination)

D.3-I.2.1 Sample Homogenization

The sample will be thoroughly homogenized using a stainless steel mixing spoon in a stainless steel mixing bowl.

D.3-I.2.2 Sample Filtration

If the sample has any free liquid, it should be vacuum filtered through a .45 micron filter paper. (Note that it may be necessary to use several filtration steps.)

D.3-I.2.3 Initial Characterization of Soil Sample

Samples for the total uranium soil analysis should be split between the FEMP laboratory and the off-site laboratory if an adequate sample is available. If there is inadequate sample for the off-site analysis, then samples should only be analyzed at the FEMP laboratory. Sample volumes should be collected for total uranium and placed in the containers as shown in Table D.3-I-1. Additionally, a 10-gram sample should be analyzed for moisture content at the FEMP laboratory.

D.3-I.2.4 Sample Preparation

Place 400 grams (dry weight) of soil sample in the 4.0 liter reactor and add 3,500 ml of the appropriate leachate solution to the reactor. For soil samples collected in the subunits, the leachate solution will be 3,500 ml of DI water adjusted to a pH of 5.6 using a mixture of sulfuric acid and nitric acid at a 60/40 ratio. For soil samples from the sand and gravel zone (unsaturated or saturated) below the subunits, the leachate solution will be clean groundwater from a background well. If baseline concentration is not established for groundwater, then a sample must be submitted for total uranium analysis to the off-site laboratory and the FEMP laboratory according to the volumes and container requirements shown in Table D.3-I-1.

Once the proper leaching solution has been prepared, the proper mass of radionuclides must be added to obtain a liquid concentration of approximately 100 times the MCL concentration. The following is the MCL (proposed) for uranium:

Radionuclide	MCL	Mass of Radionuclide to be Spiked
Uranium	20 μg/L	7.0 mg Uranium 238

Place 400 grams (dry weight) of soil/waste in the 4.0 liter reactor, and add 3,500 ml of the appropriate leachate solution to the reactor.

D.3-I.2.5 Sample Mixing

The samples should be placed in the rotating tumbler and mixed continuously until completion of the testing. The extractor must be operated at 29 +/- 2 rpm.

D.3-I.2.6 Sample Collection

Samples of the leachate should be collected by stopping the tumbler for a sufficient time period (minimum of 10 minutes) to allow the solids to settle. An appropriate volume of the leachate (see Table D.3-I-1 for sample volumes required for analysis) should then be decanted from the reactor and filtered through a .45 micron filter paper or separated with a constant temperature centrifuge capable of separating greater than 0.1 micron particles. Any solids from the separation step should be returned to the reactor.

Intermediate samples should be collected at 4, 24, 48, and 72 hours. After the 72 hour data point is obtained, verify that the uranium is at an equilibrium concentration between the soil and the leachate solution. Equilibrium will be determined by plotting each concentration (Y-axis) versus time (X-axis) to determine when the curve begins to flatten, which indicates that an equilibrium concentration is achieved. If a sample does not reach equilibrium after 72 hours, then the Operable Unit 2 representative contact person (Bert Crapse at extension 6974) should be notified to determine the appropriate action to be taken.

All of the intermediate samples will be analyzed for total uranium at the FEMP laboratory. The final sample will be collected after the results indicate that uranium is in equilibrium. The final sample will be split between the FEMP laboratory and the off-site laboratory and analyzed for total uranium. (Note: The final water samples should only be split with the FEMP and off-site laboratories if the soil samples were split.)

Table D.3-I-1

SAMPLE VOLUMES/DETECTION LIMIT

Chemical	Media	Method	Volume	Sample Container	Instrument	Detection Limit
Off-Site Laboratory						
Total - Uranium	Water Soil	OR 7127 OR 7003	210 ml 135 g (dry)	250 ml glass 250 ml glass	Laser Phosphorimetry Gamma Spectrometry	1 μg/l 1 ppm
FEMP laboratory						
Total - Uranium	Water Soil	3062 3002	10 ml 5 g	-[a]	Laser Phosphorimetry Color Metric	1 μg/l 0.1 ppm

[a]To be determined by laboratory personnel.

Note: Water samples to be preserved with HNO_3.

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APPENDIX D.3

ATTACHMENT D.3-II

LABORATORY RESULTS FOR DESORPTION TESTS

DESORPTION TEST FOR
SOLID WASTE LANDFILL BORING 1986
WASTE MATERIAL
SAMPLE #111455

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 6/18/93	3	6	7	10	12	14	18	20	28 Final[1]
Total-U Conc. (μg/l)	N/A	1300	1685	1667	1762	1626	1619	1300	1500	1768/ 1700
Percent Concentration Change	-	-	+29.6	-1.1	+5.7	-7.7	-0.4	-19.7	+15.4	+17.9
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	-
pH	5.60	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Specific Conductivity (μMHOS)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Temp. (°C)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Initial Soil Uranium Concentration = 146 ppm (IT) & 94 ppm (FEMP)
Soil Sample Wt. = 400 g
Initial Liquid to Soil Ratio = 8.75
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not Analyzed

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DESORPTION TEST FOR
SOLID WASTE LANDFILL BORING 1985
WASTE MATERIAL
SAMPLE #111440

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 7/19/93	1	3	4	7	10	11	15	17	18 Final[1]
Total-U Conc. (μg/l)	N/A	360	579	465	476	489	507	555	549	551/52.5
Percent Concentration Change	-	-	+61	-19.7	+2.4	+2.7	+3.7	+9.5	-1.1	0.4
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	-
pH	5.60	8.54	8.42	8.42	8.32	8.04	7.98	7.89	7.85	N/A
Specific Conductivity (μMHOS)	N/A	185	220	234	275	300	310	325	322	N/A
Temp. (°C)	N/A	30.1	31.2	32.0	33.0	32.1	32.0	30.5	28.8	N/A

Initial Soil Uranium Concentration = 74 ppm (IT) & 64 ppm (FEMP)
Moisture Content = 86.5% solid
Soil Wt. = 400g
Initial Liquid to Soil Ratio = 8.75
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

DESORPTION TEST FOR
SOLID WASTE LANDFILL BORING 1986
GLACIAL OVERBURDEN LAYER
SAMPLE #111457

	SAMPLING PERIOD (DAYS)								
LEACHATE ANALYTICAL PARAMETERS	Start 7/27/93	1	3	6	8	10	13	15	16 Final[1]
Total-U Conc. (μg/l)	N/A	6.6	12.1	9.9	9.9	14.0	10.1	14.5	11.6/10.6
Percent Concentration Change	-	-	+83.3	-18.2	0.0	+41.4	-27.9	43.6	-20
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	-
pH	5.60	7.32	7.36	7.23	7.31	7.34	7.26	7.32	7.31
Specific Conductivity (μMHOS)	N/A	170	205	230	248	249	260	265	265
Temp. (°C)	N/A	32.4	30.8	29.6	31.1	28.4	29.4	29.0	28.7

Initial Soil Uranium Concentration = 18.3 ppm (IT) & 6 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 74.9% solid
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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DESORPTION TEST FOR
SOLID WASTE LANDFILL BORING 11037
GLACIAL OVERBURDEN LAYER
SAMPLE #115370

	SAMPLING PERIOD (DAYS)								
LEACHATE ANALYTICAL PARAMETERS	Start 7/27/93	1	3	6	8	10	13	15	16 Final[1]
Total-U Conc. (μg/l)	N/A	5.4	10.0	8.6	13.6	7.5	10.8	11.5	10.1/10.0
Percent Concentration Change	-	-	+85.2	-14.0	+58.1	-44.8	+44.0	+6.5	-12.2
Ratio Change of Liquid									
pH	5.60	7.94	7.82	7.80	7.72	7.80	7.76	7.69	7.75
Specific Conductivity (μMHOS)	N/A	300	380	420	430	440	455	467	470
Temp. (°C)	N/A	32.9	31.9	31.3	30.9	28.2	29.0	29.3	28.6

Initial Soil Uranium Concentration = 2.65 ppm (IT) & 9 ppm (FEMP)
Soil sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 80.9% solid
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A = Not Analyzed

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DESORPTION TEST FOR
LIME SLUDGE PONDS SURFACE SOIL #03
LIME SLUDGE
SAMPLE #114472

	SAMPLING PERIOD (DAYS)								
Analytical Parameters	Start	1	3	6	8	10	13	15	16 Final[1]
Total-U Conc. (μg/l)	0	18.1	34.0	24.9	30.0	31.1	36.1	37.9	40.0/41.6
Percent Concentration Change	-	-	87.8	-26.8	20.5	3.7	16.1	5.0	5.5
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	-
pH	5.60	7.60	7.47	7.28	7.17	7.16	7.08	7.00	7.05
Specific Conductivity (μMHOS)	0	191	257	320	357	380	420	449	455
Temp. (°C)	N/A	33.0	31.7	30.4	31.0	28.6	29.1	29.1	28.8

Initial Soil Uranium Concentration = 18.9 ppm (IT) & 17 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 80.6% solid
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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DESORPTION TEST FOR
INACTIVE FLYASH PILE BORING 11001
COVER MATERIAL LAYER (FLYASH)
SAMPLE #114067

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 7/19/93	1	3	4	7	10	11	15	17	18 Final [1]
Total-U Conc. (μg/l)	N/A	1557	2240	2111	1634	1505	1506	1472	1470	1696/ 1810
Percent Concentration Change	-	-	+43.9	-5.8	-22.6	-7.9	+0.1	-2.3	+0.1	+15.4
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	-
pH	5.60	8.50	8.47	8.52	8.44	8.27	8.15	8.18	8.20	N/A
Specific Conductivity (μMHOS)	N/A	175	200	213	239	249	264	255	252	N/A
Temp. (°C)	N/A	30.1	31.2	32.2	33.6	31.9	32.2	30.9	28.8	N/A

Initial Soil Uranium Concentration = 147 ppm (IT) & 150 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 97.9% solid (air-dried)
[1] - Final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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DESORPTION TEST FOR
INACTIVE FLYASH PILE BORING 11003
WASTE MATERIAL (FLYASH)
SAMPLE #114068

	SAMPLING PERIOD (DAYS)					
LEACHATE ANALYTICAL PARAMETERS	Start 7/29/93	1	3	6	8	10 Final[1]
Total-U Conc. (μg/l)	N/A	<0.2	0.7	<0.2	<0.2	0.5
Percent Concentration Change	-	-	-	-	-	-
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50
pH	5.60	5.95	6.02	5.96	5.95	6.00
Specific Conductivity (μMHOS)	N/A	123	160	178	184	190
Temp. (°C)	N/A	32.5	32.1	29.9	30.9	28.7

Initial Soil Uranium Concentration = 16.9 ppm (IT) & 6 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 98.8% (air-dried)
N/A - Not Analyzed
Note: Test was stopped due to leachate being below detection limit

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DESORPTION TEST FOR SOUTH FIELD BORING 1974 GLACIAL OVERBURDEN SAMPLE # 114070

LEACHATE ANALYTICAL PARAMETERS	SAMPLING PERIOD (DAYS)								
	Start 7/27/93	1	3	6	8	10	13	15	16 Final[1]
Total-U Conc. (μg/l)	N/A	15.3	13.6	15.5	32.0	14.7	13.3	18.3	28.0/32.5
Percent Concentration Change	-	-	-11.1	+14.0	+106.5	-54.1	-9.5	+37.6	+53.0
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	-
pH	5.60	7.11	7.28	7.26	7.31	7.29	7.30	7.30	7.41
Specific Conductivity (μMHOS)	N/A	53	60	60	60	60	60	60	65
Temp. (°C)	N/A	33.2	31.1	30.7	30.6	28.7	29.1	28.7	28.8

Initial Soil Uranium Concentration = 308 ppm (IT) & 140 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 83.3%
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

DESORPTION TEST FOR
SOUTH FIELD TRENCH #1
WASTE MATERIAL
SAMPLE # 113717

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 7/19/93	1	3	4	7	10	11	15	17	18 Final[1]
Total-U Conc. (μg/l)	N/A	1621	1831	1314	946	865	1168	1221	1253	1526/ 1480
Percent Concentration Change	-	-	+13.0	-28.2	28.0	-8.6	+35.0	+4.5	+2.6	+21.8
Ratio Change in Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	-
pH	5.60	8.85	8.86	8.90	8.90	8.67	8.60	8.47	8.45	N/A
Specific Conductivity (μMHOS)	N/A	170	185	183	211	239	245	260	260	N/A
Temp. (°C)	N/A	30.3	31.3	31.7	33.6	32.2	32.6	31.1	28.9	N/A

Initial Soil Uranium Concentration = 278 ppm (IT) & 96 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 88.7%
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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DESORPTION TEST FOR
SOUTH FIELD TRENCH #4
GLACIAL OVERBURDEN LAYER
SAMPLE #113721

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 7/19/93	1	3	4	7	10	11	15	17	18 Final[1]
Total-U Conc. (μg/l)	N/A	30.1	7.3	2.6	8.0	14.0	10.6	12.1	5.6	2.4/2.16
Percent Concentration Change	-	-	-75.7	-64.4	+207.7	+75.0	-24.3	14.2	-53.7	-57.1
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	-
pH	5.60	8.44	8.42	8.63	8.60	8.29	8.15	8.10	8.09	N/A
Specific Conductivity (μMHOS)	N/A	103	120	130	143	157	159	165	163	N/A
Temp. (°C)	N/A	30.4	31.4	31.7	33.0	32.3	32.1	30.5	29.0	N/A

Initial Soil Uranium Concentration = 4.34 ppm (IT) & 15 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 79.7%
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

DESORPTION TEST FOR
LIME SLUDGE POND SURFACE SOIL #05/06
LIME SLUDGE
SAMPLE #114494

	SAMPLING PERIOD (DAYS)										
LEACHATE ANALYTICAL PARAMETERS	Start 8/19/93	1	4	6	8	11	12	13	14	15	19 Final[1]
Total-U Conc. (μg/l)	N/A	8.2	5.4	5.7	276[A]	3934[A]	39	48	1.8	3.8	6.4
Percent Concentration Change	-	-	-34.1	+3.7	>1000	>1000	-99	+23.0	-96.3	+111	+40.6
Ratio Change of Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	8.30	-
pH	8.90	8.81	8.77	8.84	8.86	8.81	8.85	8.74	8.75	8.74	8.70
Specific Conductivity (μMHOS)	152	202	216	218	232	239	240	238	236	247	270
Temp. (°C)	23.8	25.3	24.9	23.7	25.8	25.1	25.4	24	22.6	25.1	24.6

Initial Soil Uranium Concentration = ? ppm (IT) & 15 ppm (FEMP)
Moisture Content = 56.66% solid
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
[A] - samples were contaminated
N/A - Not Analyzed

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APPENDIX D.3

ATTACHMENT D.3-III

LABORATORY RESULTS FOR ADSORPTION TESTS

ADSORPTION TEST FOR
SOLID WASTE LANDFILL BORING 2953
UNSATURATED SAND AND GRAVEL LAYER
SAMPLE # 115445

	SAMPLING PERIOD (DAYS)											
LEACHATE ANALYTICAL PARAMETERS	Start 7/20/93	1/6 (4 hr)	1	2	3	6	8	9	13	15	16	17 Final[1]
Total-U Conc. (μg/l)	2000	1697	1354	1262	1492	1361	897	948	839	736	888	793/918
Percent Concentration Change	-	+15.2	+20.2	+6.8	-18.2	+8.8	+34.1	-5.7	+11.5	+12.3	-20.7	+10.7
Ratio Change of Liquid	8.75	8.7	8.65	8.6	8.55	8.50	8.45	8.40	8.35	8.30	8.25	-
pH	6.70	6.95	6.82	6.86	7.00	7.03	7.07	7.20	7.27	7.29	7.35	N/A
Specific Conductivity (μMHOS)	700	1480	1470	1470	1470	1500	1440	1420	1400	1380	1340	N/A
Temp. (°C)	N/A	28.8	30.2	30.0	31.2	33.1	31.0	32.3	30.6	30.5	28.2	N/A

Initial Soil Uranium Concentration = 1.63 ppm (IT) & 4 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 96.8% solids
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

ADSORPTION TEST FOR
SOLID WASTE LANDFILL BORING 2953
SATURATED SAND AND GRAVEL LAYER
SAMPLE # 115454

	SAMPLING PERIOD (DAYS)											
LEACHATE ANALYTICAL PARAMETERS	Start 7/20/93	1/6 (4 hr.)	1	2	3	6	8	9	13	15	16	17 Final[1]
Total-U Conc. (μg/l)	2000	1258	1282	1247	1240	1172	969	1035	873	851	900	752/982
Percent Concentration Change	-	+37.1	-1.9	+2.7	+0.6	+5.5	+17.3	-6.8	+15.6	+2.5	-5.8	+16.4
Ratio Change in Liquid	8.75	8.70	8.65	8.60	8.55	8.50	8.45	8.40	8.35	8.30	8.25	
pH	6.70	7.12	7.09	7.11	7.30	7.25	7.20	7.40	7.45	7.45	7.52	N/A
Specific Conductivity (μMHOS)	700	900	900	900	920	980	920	900	920	900	880	N/A
Temp. (°C)	N/A	28.6	30.2	30.3	31.5	33.1	31.1	31.1	30.6	30.5	28.1	N/A

Initial Soil Uranium Concentration = 1.17 ppm (IT) & 4 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 86.3% solid
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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ADSORPTION TEST FOR
SOLID WASTE LANDFILL BORING 1986
GLACIAL OVERBURDEN LAYER
SAMPLE # 111457

	SAMPLING PERIOD (DAYS)								
LEACHATE ANALYTICAL PARAMETERS	Start 7/27/93	1/6 (4 hr)	1	2	3	7	8	10	10 Final[1]
Total-U Conc. (μg/l)	2000	506	334	367	343	295	283	288	318/357
Percent Concentration Change	-	+74.7	+34.0	-9.9	+6.5	+14.0	+4.1	-1.8	-10.4
Ratio Change in Liquid	8.75	8.70	8.65	8.6	8.55	8.5	8.45	8.4	-
pH	6.70	7.49	6.84	6.92	6.99	6.95	6.96	7.13	N/A
Specific Conductivity (μMHOS)	700	830	810	810	800	790	780	750	N/A
Temp. (°C)	N/A	32.1	32.7	31.8	32.0	30.1	30.8	28.3	N/A

Initial Soil Uranium Concentration = 18.3 ppm (IT) & 6 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 74.9% solid
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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ADSORPTION TEST FOR
ACTIVE FLYASH PILE BORING 1980
WASTE MATERIAL (FLYASH)
SAMPLE # 114069

LEACHATE ANALYTICAL PARAMETERS	SAMPLING PERIOD (DAYS)									
	Start 7/20/93	1/6 (4 hr.)	1	2	3	6	8	9	10	10 Final[1]
Total-U Conc. (μg/l)	2000	668	612	564	556	450	431	507	449	493/564
Percent Concentration Change	-	+66.6	+8.4	+7.8	+1.4	+19.1	+4.2	-17.6	+11.4	-9.8
Ratio Change in Liquid	8.75	8.7	8.65	8.6	8.55	8.50	8.45	8.4	8.35	-
pH	6.70	6.81	6.85	6.86	6.95	6.90	6.80	6.96	7.00	N/A
Specific Conductivity (μMHOS)	700	1380	1400	1400	1400	1450	1400	1400	1280	N/A
Temp. (°C)	N/A	28.4	28.9	30.3	30.9	32.5	31.4	30.6	27.9	N/A

Initial Soil Uranium Concentration = 12.2 ppm(IT) & 6 ppm (FEMP)
Moisture Content = 99.3% solid (air-dried)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

ADSORPTION TEST FOR
SOUTH FIELD TRENCH #4
GLACIAL OVERBURDEN LAYER
SAMPLE #113721

	SAMPLING PERIOD (DAYS)											
LEACHATE ANALYTICAL PARAMETERS	Start 7/20/93	1/6 (4 hrs.)	1	2	3	6	8	9	13	15	16	17 Final[1]
Total-U Conc. (μg/l)	2000	1072	1282	1122	1015	878	748	854	718	714	785	724/876
Percent Concentration Change	-	+46.4	-19.6	+12.5	+9.5	+13.5	+14.8	-14.2	+15.9	+0.6	-9.9	+7.7
Ratio Change in Liquid	8.75	8.7	8.65	8.6	8.55	8.5	8.45	8.4	8.35	8.3	8.25	-
pH	6.70	7.10	7.14	7.20	7.30	7.21	7.00	7.25	7.26	7.22	7.34	N/A
Specific Conductivity (μMHOS)	700	810	810	820	830	800	780	790	800	780	720	N/A
Temp. (°C)	N/A	28.7	29.1	30.3	31.0	32.4	31.6	30.6	30.4	30.7	27.8	N/A

Initial Soil Uranium Concentration = 1.63 ppm (IT) & 15 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 79.7%
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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ADSORPTION TEST FOR
SOUTH FIELD BORING 2944
UNSATURATED SAND AND GRAVEL LAYER
SAMPLE #113755

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 7/20/93	1/6 (4 hrs.)	1	2	3	6	8	9	10	10 Final[1]
Total-U Conc. (μg/l)	2000	1564	1080	1285	1209	898	791	777	609	651/826
Percent Concentration Change	-	+21.8	+30.9	-19.0	+5.9	+25.7	+11.9	+17.7	+21.6	-6.9
Ratio Change in Liquid	8.75	8.7	8.65	8.6	8.55	8.5	8.45	8.4	8.35	-
pH	6.70	7.03	7.14	7.20	7.35	7.37	7.22	7.46	7.50	N/A
Specific Conductivity (μMHOS)	700	850	880	880	890	900	880	850	800	N/A
Temp. (°C)	N/A	28.6	29.7	30.0	31.0	33.0	31.0	32.0	29.8	N/A

Initial Soil Uranium Concentration = 1.43 ppm (IT) & 2 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 93.1% solid
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

ADSORPTION TEST #1 FOR SOUTH FIELD BORING 2944 SATURATED SAND AND GRAVEL SAMPLE #113770

	SAMPLING PERIOD (DAYS)									
LEACHATE ANALYTICAL PARAMETERS	Start 7/20/93	1/6 (4 hours)	1	2	3	6	8	9	10	10 Final[1]
Total-U Conc. (μg/l)	2000	1593	1598	1423	1417	1310	1290	1326	1219	958/1190
Percent Concentration Change	-	+20.4	-0.3	+11.0	+0.4	+7.6	+1.5	-2.8	+8.1	+21.4
Ratio Change in Liquid	8.75	8.7	8.65	8.6	8.55	8.5	8.45	8.4	8.35	-
pH	6.70	7.09	7.21	7.26	7.40	7.36	7.17	7.49	7.50	N/A
Specific Conductivity (uMHOS)	700	850	900	900	900	900	890	840	800	N/A
Temp. (°C)	N/A	28.6	30.0	30.4	30.8	32.5	31.4	31.1	28.4	N/A

Initial Soil Uranium Concentration = 2.86 ppm (IT) & 6 ppm (FEMP)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
Moisture Content = 98.8% solid (air-dried)
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

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ADSORPTION TEST FOR
INACTIVE FLYASH PILE BORING 11003
WASTE MATERIAL (FLYASH)
SAMPLE #114068

	SAMPLING PERIOD (DAYS)						
LEACHATE ANALYTICAL PARAMETERS	Start 8/11/93	1/6 (4 hours)	1	2	5	6	7 Final[1]
Total-U Conc. (μg/l)	2000	3.2	4.0	1.2	4.0	2.6	3.1/ <1.0
Percent Concentration Change	-	+99.8	-25.0	+70.0	-233.3	+35.0	-19.2
Ratio Change to LIquid	8.75	8.70	8.65	8.60	8.55	8.50	-
pH	N/A	5.71	5.76	5.79	5.81	5.83	5.79
Specific Conductivity (μMHOS)	N/A	287	286	255	260	268	269
Temp. (°C)	N/A	29.9	29.5	23.3	24.3	25.0	25.1

Initial Soil Uranium Concentration = 16.9 ppm (IT) & 6 ppm (FEMP)
Moisture Content = 98.8% solid (air-dried)
Soil Sample Wt. = 400g
Liquid to Soil Ratio = 8.75
[1] - final sample split and analyzed for total-U by FEMP/IT Oak Ridge
N/A - Not analyzed

APPENDIX D.3

ATTACHMENT D.3-IV

K_d CALCULATIONS FOR DESORPTION TESTS

Symbols and Units

$$K_d = \frac{C_s'}{C_L}$$

V = volume of liquid used during equilibrium tests always ~~[illegible]~~ ≈ 3.5 liters

M = mass of soil or test media; ~~[illegible]~~ ≈ 400 grams

C_o = initial concentration of uranium in soil or test media (μg/g)

C_s = concentration of uranium in soil or test media at equilibrium (μg/g)

C_b = background concentration of uranium in soil ~~[illegible]~~; calculated ≈ 3.7 μg/g

C_L = concentration of uranium in liquid at equilibrium (μg/ℓ)

C_s' = final concentration of uranium in soil or test media above background (μg/g)

m_L = mass of uranium leached from soil (μg)

m_s = mass of uranium in soil at equilibrium (μg)

---

① Sample # 111457 (Glacial Overburden)

C_o = 18.3 μg/g

C_L = 10.6 μg/ℓ

uranium mass leached from soil

$$m_\ell = C_L V = (10.6\ \mu g/\ell)(3.5\ \ell) = 37.1\ \mu g$$

uranium mass remaining in soil

$$m_s = C_o M - 37.1\ \mu g = (18.3\ \mu g/g)(400\ g) - 37.1\ \mu g$$

$$= 7282.9\ \mu g$$

$$C_s = \frac{m_s}{M} = \frac{7282.9\ \mu g}{400\ g} = 18.2\ \mu g$$

10/15/93

subtract background concentration from sample

$$C_s' = C_s - C_b = 18.2\ \mu g/g - 3.7\ \mu g/g$$

$$= 14.5\ \mu g/g$$

so, $$K_d = \frac{C_s'}{C_L} = \frac{14.5\ \mu g/g}{10.6\ \mu g/\ell} = 1.37\ \ell/g = 1370\ \ell/kg$$

---

(2) Sample # 111440 (Waste Material)

$C_o = 74.0\ \mu g/g$

$C_L = 726.0\ \mu g/\ell$

uranium mass leached from soil

$$m_\ell = C_L V = (726.0\ \mu g/\ell)(3.5\ \ell)$$

$$= 2541.0\ \mu g$$

uranium mass remaining in soil

$$m_s = C_o M - 2541.0\ \mu g = (74.0\ \mu g/g)(400\ g) - 2541.0\ \mu g$$

$$= 27{,}059\ \mu g$$

$$C_s = \frac{m_s}{M} = \frac{27{,}059\ \mu g}{400\ g} = 67.6\ \mu g/g$$

subtract background concentration from sample

$$C_s' = C_s - C_b = 67.6\ \mu g/g - 3.7\ \mu g/g$$

$$= 63.9\ \mu g/g$$

so, $$K_d = \frac{C_s'}{C_L} = \frac{63.9\ \mu g/g}{726.0\ \mu g/\ell} = 0.088\ \ell/g = 88\ \ell/kg$$

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Checked by: AC

③ Sample # 111455 (waste material)

$C_o = 146.0\ \mu g/g$

$C_L = 1700\ \mu g/\ell$

$$C_s = \frac{(C_o \times M) - (C_L \times V)}{M} = \frac{[(146.0\ \mu g/g)(400\ g) - (1700\ \mu g/\ell)(3.5$$

$$= 131.1\ \mu g/g$$

$$C_s' = 131.1\ \mu g/g - 3.7\ \mu g/g = 127.4\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{127.4\ \mu g/g}{1700} = 0.075\ \ell/g = 75\ \ell/kg$$

---

④ Sample # 115370 (Glacial Overburden)

$$C_o = \frac{9.0\ \mu g/g + 2.65\ \mu g/g}{2} = 5.83\ \mu g/g$$ {average of both IT + FEMP analysis}

$C_L = 10.0\ \mu g/\ell$

$$C_s = \frac{(C_o \times M) - (C_L \times V)}{M} = \frac{[(5.83\ \mu g/g)(400\ g) - (10.0\ \mu g/\ell)(3.5\ \ell)]}{400\ g}$$

$$= 5.7\ \mu g/g$$

$$C_s' = C_s - C_b = 5.7\ \mu g/g - 3.7\ \mu g/g = 2.0\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{2.0\ \mu g/g}{10.0\ \mu g/\ell} = 0.2\ \ell/g = 200\ \ell/kg$$

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(5) Sample # 114472 (Waste Material)

$C_o = 18.9\ mg/g$
$C_L = 41.6\ mg/l$

$$C_s = \frac{(C_o \times M) - (C_L \times V)}{M} = \frac{[(18.9\ mg/g)(400g) - (41.6\ mg/l)(3.5l)]}{400g}$$

$$= 18.5\ mg/g$$

$$C_s' = 18.5\ mg/g - 3.7\ mg/g = 14.8\ mg/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{14.8\ mg/g}{41.6\ mg/l} = 0.36\ l/g = 360\ l/kg$$

---

(6) Sample # 114067 (Cover Material)

$C_o = 147.0\ mg/g$
$C_L = 1810.0\ mg/l$

$$C_s = \frac{(147.0\ mg/g)(400g) - (1810.0\ mg/l)(3.5l)}{400g} = 131.2\ mg/g$$

$$C_s' = 131.2\ mg/g - 3.7\ mg/g = 127.5\ mg/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{127.5\ mg/g}{1810\ mg/l} = 0.07\ l/g = 70\ l/kg$$

Checked by: ACS 10/15/93

Desorption Test | Calculations | pg. 5 of 6 | 6647

10/15/93

(7) Sample # 114070 (Glacial overburden) B. Crapse

$C_o = 308\ \mu g/g$

$C_L = 32.5\ \mu g/l$

$$C_s = \frac{(308.0\ \mu g/g)(400\ g) - (32.5\ \mu g/l)(7.5\ l)}{400\ g} = 307.7\ \mu g/g$$

$$C_s' = C_s - C_b = 307.7\ \mu g/g - 3.7\ \mu g/g$$

$$= 304\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{304\ \mu g/g}{32.5\ \mu g/l} = 9.35\ l/g = 9350\ l/kg$$

(8) Sample # 113717 (Waste Material)

$C_o = 278.0\ \mu g/g$

$C_L = 1480.0\ \mu g/l$

$$C_s = \frac{(278.0\ \mu g/g)(400\ g) - (1480\ \mu g/l)(3.5\ l)}{400\ g} = 265.1\ \mu g/g$$

$$C_s' = 265.1\ \mu g/g - 3.7\ \mu g/g = 261.4\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{261.4\ \mu g/g}{1480\ \mu g/l} = .18\ l/g = 180\ l/kg$$

000418

10/15/93

checked by: AC

Desorption Test | Calculations | pg. 6 of 6

10-15-93
B. Crapse

(9) Sample # 113721 (Glacial overburden)

$C_o = 4.34\ \mu g/g$

$C_L = 2.16\ \mu g/l$

$$C_s = \frac{(4.34\ \mu g/g)(400g) - (2.16\ \mu g/l)(3.5l)}{400g} = 4.3\ \mu g/g$$

$$C_s' = 4.3\ \mu g/g - 3.7\ \mu g/g = 0.6\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{0.6\ \mu g/g}{2.16\ \mu g/l} = .28\ l/g = 280\ l/kg$$

---

(10) Sample # 114494 (Lime sludge)

$C_o = 14.3\ \mu g/g$

$C_L = 4.0\ \mu g/l$

$$C_s = \frac{(14.3\ \mu g/g)(400g) - (4.0\ \mu g/l)(3.5l)}{400\ g} = 14.3\ \mu g/g$$

$$C_s' = 14.3\ \mu g/g - 3.7\ \mu g/g = 10.6\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{10.6\ \mu g/g}{4.0\ \mu g/l} = 2.65\ l/g$$

$$= 2650\ l/kg$$

10/15/93
Checked by: ACS

APPENDIX D.3

ATTACHMENT D.3-V

K_d CALCULATIONS FOR ADSORPTION TESTS

10-15-93
B. Crapse

6647

Symbols and units:

V = volume of liquid used during equilibrium testing always ≈ 3.5 liters

M = mass of soil or test media; approximately 400 grams

S = initial concentration of uranium in spiked solution ≈ 2000 μg/ℓ

C_o = initial concentration of uranium in soil or test media (μg/g)

C_s = concentration of uranium in soil or test media at equilibrium (μg/g)

C_b = background concentration of uranium in soil; calculated ≈ 3.7 μg/g

C_L = concentration of uranium in liquid at equilibrium (μg/ℓ)

C_s' = final concentration of uranium in soil or test media above background μg/g

C_a = concentration of uranium adsorbed in soil or test media above background (μg/g)

m_a = mass of uranium adsorbed in soil or test media (μg)

$$K_d = \text{adsorption coefficient} \left(\frac{\ell}{kg}\right) = \frac{C_s'}{C_L}$$

Assumption: The mass of soil prior to the leachate testing is approximately equal to the mass of soil after the leachate testing.

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Checked by: AC

FEMP-OU02-6 FIN
March 1, 1995

① Sample # 115445 (Unsaturated sand + gravel)

$C_o = 1.63\ \mu g/g$

$C_L = 918.0\ \mu g/l$

mass of uranium adsorbed

$$m_a = SV - C_L V = (2000\ \mu g/l)(3.5\ l) - (918.0\ \mu g/l)(3.5\ l)$$

$$= 3787.0\ \mu g$$

Concentration of uranium adsorbed

$$C_a = \frac{m_a}{M} = \frac{3787.0\ \mu g}{400\ g} = 9.5\ \mu g/g$$

Concentration of uranium in soil at equilibrium

$$C_s = C_o + C_a = 1.63\ \mu g/g + 9.5\ \mu g/g = 11.1\ \mu g/g$$

$$C_s' = C_s$$ [background concentration not subtracted]

Note: The background concentration was not subtracted because site groundwater was used for the water solutions. When groundwater is used, the background concentration in the soil is assumed to be in equilibrium with groundwater background concentration.

$$K_d = \frac{C_s'}{C_L} = \frac{11.1\ \mu g/g}{918.0\ \mu g/l} = 0.012\ l/g$$

$$= 12.0\ l/kg$$

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10-15-93
B. Crapse | 6647

(2) Sample # 115454 (saturated sand + gravel)

$C_o = 1.17\ \mu g/g$

$C_L = 982.0\ \mu g/\ell$

mass of uranium adsorbed

$$m_a = SV - C_L V = (2000\ \mu g/\ell)(3.5\ \ell) - (982.0\ \mu g/\ell)(3.5\ \ell)$$

$$= 3563.0\ \mu g$$

concentration of uranium adsorbed

$$C_a = \frac{m_a}{M} = \frac{3563.0\ \mu g}{400\ g} = 8.9\ \mu g/g$$

Concentration of uranium in soil at equilibrium

$$C_s = C_o + C_a = 1.17\ \mu g/g + 8.9\ \mu g/g = 10.1\ \mu g/g$$

$$C_s' = C_s$$

$$K_d = \frac{C_s'}{C_L} = \frac{10.1\ \mu g/g}{982\ \mu g/\ell} = 0.010\ \ell/g$$

$$= 10\ \ell/kg$$

---

(3) Sample # 111457 (Glacial Overburden)

$C_o = 18.3\ \mu g/g$

$C_L = 357.0\ \mu g/\ell$

amount of uranium adsorbed

$$m_a = SV - C_L V = (2000\ \mu g/\ell)(3.5\ \ell) - (357.0\ \mu g/\ell)(3.5\ \ell)$$

$$= 5750.5\ \mu g$$

Concentration adsorbed

$$C_a = \frac{m_a}{M} = \frac{5750.5\ \mu g}{400\ g} = 14.4\ \mu g/g$$

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10-15-93
B. Capse

concentration in soil at equilibrium

$C_s = 14.4\ \mu g/g + 18.3\ \mu g/g$

$C_s = 32.7\ \mu g/g$

subtract background concentration for soil

$C_s' = C_s - C_b = 32.7\ \mu g/g - 3.7\ \mu g/g$

$= 29.0\ \mu g/g$

$$K_d = \frac{C_s'}{C_L} = \frac{29.0\ \mu g/g}{357.0\ \mu g/l} = 0.081\ l/g$$

$K_d = 81\ l/kg$

(+) Sample # 113721 (Glacial Overburden)

$C_o = 4.34\ \mu g/g$

$C_L = 876.0\ \mu g/l$

Concentration adsorbed

$$C_a = \frac{(2000\ \mu g/l)(3.5\ l) - (876.0\ \mu g/l)(3.5\ l)}{400\ g}$$

$= 9.84\ \mu g/g$

concentration at equilibrium

$C_s = 9.84\ \mu g/g + 4.34\ \mu g/g = 14.2\ \mu g/g$

$C_s' = 14.2\ \mu g/g - 3.7\ \mu g/g = 10.4\ \mu g/g$

$$K_d = \frac{10.4\ \mu g/g}{876.0\ \mu g/l} = 0.012\ l/g = 12\ l/kg$$

checked by: 10/18

10-5-93 B. Cooper

(5) Sample # 113755 (Unsaturated sand and gravel)

$C_o = 1.43\ \mu g/g$

$C_L = 826\ \mu g/l$

concentration adsorbed

$$C_a = \frac{(2000\ \mu g/l)(3.5\ l) - (826\ \mu g/l)(3.5\ l)}{400\ g}$$

$$= 10.3\ \mu g/g$$

Concentration at equilibrium

$$C_s = 10.3\ \mu g/g + 1.43\ \mu g/g = 11.7\ \mu g/g$$

$$C_s' = C_s$$

$$K_d = \frac{C_s'}{C_L} = \frac{11.7\ \mu g/g}{826.0\ \mu g/l} = 0.014\ l/g$$

$$= 14\ l/kg$$

---

(6) Sample # 113770 (Saturated sand + gravel)

$C_o = 2.86\ \mu g/g$

$C_L = 1190\ \mu g/l$

$$C_a = \frac{(2000\ \mu g/l)(3.5\ l) - (1190\ \mu g/l)(3.5\ l)}{400\ g} = 7.088\ \mu g/g$$

$$C_s = 7.09\ \mu g/g + 2.86\ \mu g/g = 9.95\ \mu g/g$$

$$C_s' = C_s$$

$$K_d = \frac{9.95\ \mu g/g}{1190\ \mu g/l} = 0.0084\ l/g$$

$$k_d = \text{[redacted]} = 8.4\ l/kg$$

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checked by: [illegible]

10-15-93
B. Caplan

(7) Sample # 114068 (Flyash)

$C_o = 16.9\ \mu g/g$

$C_L = 3.0\ \mu g/l$

$$C_a = \frac{(2000\ \mu g/l)(3.5\ l) - (3.0\ \mu g/l)(3.5\ l)}{400\ g} = 17.5\ \mu g/g$$

$$C_s = 17.5\ \mu g/g + 16.9\ \mu g/g = 34.4\ \mu g/g$$

$$C_s' = 34.7\ \mu g/g - 3.7\ \mu g/g = 30.7\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{30.7\ \mu g/g}{3.0\ \mu g/l} = 10.23\ l/g$$

$$K_d = 10{,}230\ l/kg$$

---

(8) Sample # 114069 (Flyash Material)

$C_o = 12.2\ \mu g/g$

$C_L = 564.0\ \mu g/l$

$$C_a = \frac{(2000\ \mu g/l)(3.5\ l) - (564.0\ \mu g/l)(3.5\ l)}{400\ g} = 12.6$$

$$C_s = 12.6\ \mu g/g + 12.2\ \mu g/g = 24.8\ \mu g/g$$

$$C_s' = 24.8\ \mu g/g - 3.7\ \mu g/g = 21.1\ \mu g/g$$

$$K_d = \frac{C_s'}{C_L} = \frac{21.1\ \mu g/g}{564.0\ \mu g/l} = 0.037\ l/g$$

$$= 37\ l/kg$$

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APPENDIX D.4

OPERABLE UNIT 5 GEOCHEMICAL STUDY

D.4.0 OPERABLE UNIT 5 GEOCHEMICAL STUDY

The attached study was originally published as part of Appendix F.3 in the Operable Unit 5 Remedial Investigation (RI) Report. It is included here without any changes from the original. Cross-references in the study refer to sections of the Operable Unit 5 RI, rather than to this Feasibility Study.

APPENDIX F.3

ATTACHMENT I

HISTORICAL AIRBORNE RELEASE OF URANIUM AND GEOCHEMICAL CONCEPTS OF THE SUBSURFACE URANIUM DISTRIBUTION AT THE FERNALD SITE

F.3.I.1.0 INTRODUCTION

Remediation of uranium-contaminated soil is considered a high priority at the Fernald Environmental Management Project (FEMP). The concepts of leaching and subsequent transport of uranium must be understood for predicting the environmental impact this soil could potentially have on the underlying groundwater quality in the Great Miami Aquifer. This report was prepared to summarize historical airborne uranium releases, type of deposition, form of uranium, and the geochemical conditions which have and will affect uranium migration through the soil column. Finally, this report relates these concepts to the leaching and distribution coefficients (K_l and K_d) used in the uranium fate and transport model for the Operable Unit 5 Remedial Investigation (RI) Report.

Historical releases of uranium are covered in Section F.3.I.2.0 to introduce the forms of uranium present in the existing source areas. In general, uranium releases from the process plants at the site have occurred in the past either as repetitive emissions or as singular, and in some instances, episodic, well-documented events. An example of a singular airborne release is the 1966 UF_6 tank leak at the pilot plant. Episodic UF_6 releases occurred at Plant 7 in the mid-1950s and repetitive airborne releases of various forms of uranium oxide have been emitted from Plants 2/3, 4, and 5. Examples of former repetitive point source releases to the soil are acid bath spills at Plants 2/3, 6, and 8.

In Section F.3.I.3.0, the mobilization of the various uranium forms in the source will be examined from a geochemical perspective. Rainwater will leach the various uranium forms and both dissolved and particulate forms will migrate downward through the soil column with infiltrating rainwater. In general, the soil column is dominated by carbonate minerals in the glacial overburden which is predominantly highly fractured and weathered (brown) glacial overburden in the upper 8 to 15 feet of the column underlain by dense gray glacial overburden to a depth of 20 to 50 feet across most of the site. Fractured glacial overburden has a brown appearance due to the oxidation of iron, as this sediment and groundwater are in contact with oxygen in the atmosphere. The gray glacial overburden has not been oxidized because the absence of fractures eliminates the principal atmospheric pathway for oxygen exchange. Dissolution reactions between rainwater and carbonate minerals are the primary control on the porewater and groundwater compositions, resulting in carbonate-rich waters that is effective at complexing and transporting uranium. Adsorption of uranium by the weathered and unweathered glacial overburden is not significantly different, as the aqueous form of uranium is

homogenous throughout the glacial overburden. The surface of the water table in the glacial overburden is about 3 to 5 feet below land surface.

Below the glacial overburden is the highly permeable sand and gravel that contain the Great Miami Aquifer. Due to the high hydraulic conductivity contrast between the glacial overburden and the upper portion of the sand and gravel is unsaturated and the Great Miami Aquifer exists as a second unconfined water table as much as 45 feet below the bottom of the glacial overburden. The composition of groundwater in the Great Miami Aquifer is very similar to groundwater in the glacial overburden. Therefore, the nature and mobility of uranium species in these groundwaters is similar.

Airborne releases of uranium particles have been deposited site wide on the surface of the soil as both highly soluble uranium fluorides and less soluble uranium oxides. Over the 1951 to 1989 period of operation, the uranium fluoride forms in this air-deposited source have been leached and transported into the soil column by infiltrating rainfall. Additionally, uranium oxide particles may have been suspended and carried into the subsurface by infiltrating rainwater. The aqueous uranium derived primarily from dissolution of the uranium fluoride forms migrated into the soil first and the less soluble uranium oxide particles remained at or near the surface. As time progresses, the uranium fluoride forms are depleted from the source and uranium concentrations in the infiltrating rainfall begin to decrease, as the less soluble uranium oxide particles become the primary source for leaching. The nature and extent of these migrating fronts with respect to past, present, and future distribution of uranium is evaluated in Section F.3.I.4.0.

Section F.3.I.5.0 of this report will relate the historical releases and geochemical concepts to the leaching and distribution coefficients (K_l and K_d) used in the uranium fate and transport model for the Operable Unit 5 RI Report. Leaching coefficients are used to determine the input uranium loading as a function of time, and the large range in observed and calculated values (about 1 to 3500 L/kg) reflects the heterogeneity of uranium forms in the source. In contrast, the large range in distribution coefficients (about 1 to 2400 L/kg) reflects the kinetics of adsorption versus desorption, rather than a variety of uranium forms. Adsorption distribution coefficients are well constrained to the range of 11 to 40 L/kg, while desorption coefficients vary from 75 to 2433 L/kg. The lower adsorption values are used to model uranium migration when the source is present, and desorption coefficients are applicable once the source has been removed.

F.3.I.2.0 AIRBORNE RELEASE HISTORY

Uranium releases at the FEMP (known until 1991 as the Feed Materials Production Center [FMPC]) are addressed in this section through discussions of the release mechanism, routine discharges from production operations, significant episodal releases from plant operations, and nonproduction source releases of primary contamination.

F.3.I.2.1 AIRBORNE RELEASE MECHANISMS

The major features of the FEMP are illustrated in Figure F.3.I.2-1. Plant process operations were limited to a fenced, 136-acre tract known as the production area. Liquid and solid wastes that were generated by the various chemical and metallurgical processes were stored or disposed of in the waste storage area located west of the production area. The cessation of production operations in 1989 essentially eliminated further primary releases to environmental media; secondary release mechanisms and resultant contaminant migration are continuing.

Several mechanisms of airborne release exist for the transport of radiological contaminants to environmental media primarily from process operations and waste management practices. Secondary releases, such as air resuspension of contaminated soil, contributed to further migration and likely transport to other media as outlined in Table F.3.I.2-1.

F.3.I.2.1.1 Primary Discharges From Production Operations

Uranium processing operations within the FEMP production cycle resulted in both routine and episodal primary releases of airborne radiological contaminants to environmental media. Airborne particles and gases were generated during most production, storage and handling operations over some 38 years of processing uranium materials. The principal sources of routine airborne emissions from process operations were dust collector discharges, wet scrubber discharges, and acid-pickling fume stacks. Episodal releases resulted from unplanned incidents arising from either human error, equipment malfunctions, procedures, or situational conditions.

F.3.I.2.1.2 Secondary Releases From Nonproduction Sources

Emissions of uranium from nonproduction sources included those from waste management storage practices, incinerator operations and building exhausts. Fugitive dust generated from the waste storage pits can be attributed to load-in/load-out operations, wind erosion of stored materials, and

vehicle movement in the storage area. Five nonproduction solid/liquid waste incinerators supported the general site operations. Exhausts from buildings located within the production area and the laboratory contributed uranium releases.

F.3.I.2.2 ROUTINE DISCHARGES FROM PRODUCTION OPERATIONS

Routine operations at the FEMP resulted in occasional discharges from the process stacks and by-products, which were handled in a variety of ways. Figure F.3.I.2-2 is a schematic flow diagram of the FEMP process and identifies the major products by each plant. Contamination of environmental media resulted from releases during process operations and from handling and disposition of the by-products that were treated as waste streams. Descriptions of process operations and waste management practices are presented from a broad perspective of how these activities contaminated the environmental media.

The total airborne emissions since operations began in 1951 amount to 179,058 kilograms of uranium (kg U), and are compiled in Table F.3.I.2-2. The total releases are determined by summing the estimated and measured uranium emissions from a number of process stacks, and vents. For the purpose of analysis, releases through 1984 were considered inasmuch as airborne emissions beyond that time were relatively insignificant. Uranium discharges from monitored stacks were the only measured emissions. Table F.3.I.2-2 summarizes the annual airborne emissions from all sources at the FEMP since operations were started in the 1950s.

F.3.I.2.2.1 Description of Plant-by-Plant Operations and History

The FEMP began operations in 1951 upon completion of the pilot plant, the site's first operational facility. This plant served as the prototype for the entire FEMP process during the design and construction of the other plants. Plant 6 began operations in 1952, followed by Plants 1, 2/3, 4, 5 and 8 in 1953. Plants 7 and 9 became operational in 1954. Production peaked in 1960 at approximately 12,000,000 kg U. A product decline began in 1964 and reached a low of 1,230,000 kg U in 1975.

The following paragraphs provide a highlight overview of the chemical and metallurgical processes used at the FEMP for the manufacture of uranium metal products (Figure F.3.I.2-3). In general, these processes occurred in seven of the FEMP's more than 50 production, storage and support

buildings. Emphasis is placed on the process chemistry, equipment and uranium species discharged as primary airborne releases during different periods of operation.

F.3.I.2.2.1.1 Plant 1 (Sampling Plant)

Operations began in 1951 for the sampling of impure uranium feed materials. The plant received large quantities of natural, enriched and depleted uranium materials which were sampled and analyzed for uranium assay and isotopic enrichment. Drummed K-65 materials were temporarily stored on the Plant 1 pad in the early 1950s. The plant had 15 dust collectors; dust particles were generally 8 to 24 microns in size and in the form of uranium ores concentrates, and oxides.

F.3.I.2.2.1.2 Plant 2/3 (Refinery)

Operations began in 1953 for the conversion of impure feed materials (received from Plant 1) to pure uranium trioxide (UO_3). This was accomplished by dissolving the feeds in nitric acid; purification by solvent extraction; and thermal decomposition of the purified uranyl nitrate (UNH) solution to produce UO_3, commonly called orange oxide.

Plant 2/3 processed three classes of materials: pitchblende ores as they were mined and shipped to the FEMP; domestic uranium concentrates that had undergone a preliminary refining process at the mill sites; and residues recovered at various stages of FEMP operations. Pitchblende ores contained elevated levels of radium and were processed from 1953 to 1955.

Beginning in 1962, Plant 2/3 was used for processing quantities of residues that were generated by the FEMP processing plants along with those received from several DOE facilities. Residing within the residues received from off site were trace quantities of fission products and transuranics. These feed streams generally contained less than 3 parts per billion (ppb) of transuranics such as plutonium (Pu)-239 and less than 10 parts per million (ppm) of fission products such as technetium (Tc)-99. Plant 2/3 contained four dust collectors and two scrubbers. Releases included small UO_3 particles which penetrated the scrubbers, uranyl nitrate hexahydrate, and radium (Ra)-226.

F.3.I.2.2.1.3 Plant 4 (Green Salt Plant)

Operations began in 1953 for the conversion of pure UO_3 (received from Plant 2/3) to pure uranium tetrafluoride (UF_4), commonly called green salt. This was accomplished by a two-step process that reduced UO_3 with hydrogen to form uranium dioxide (UO_2), which was then converted to UF_4 by

reaction with anhydrous hydrogen fluoride. Plant 4 contained 12 dust collectors. Dust particles were 2 to 22 microns in size and ranged from 50 to 81 percent uranium (UO_2, UO_3, U_3O_8, and UF_4). Discharges of UF_4 are estimated to contain 2 percent UO_2F_2, a uranium species side product from the Plant 4 process.

F.3.I.2.2.1.4 Plant 5 (Metals Production Plant)

Operations began in 1953 for the conversion of pure UF_4 (received from Plant 4) to uranium metal derbies by high-temperature reduction using magnesium metals granules. After heating for 3 to 4 hours at approximately 1200°F, the UF_4 and the magnesium would initiate an exothermic reaction. The resulting product was a 300- to 375-pound piece of pure uranium metal and a by-product, magnesium fluoride slag. The resultant piece of uranium metal had the shape of a gentleman's hat, or derby; therefore, these pieces were called derbies. Most of the derbies were recast to form ingots for further processing at the FEMP, but some were shipped directly or cast into flat billets. Graphite crucibles were machined and the magnesium fluoride slag milled for reuse in reduction pots. Plant 5 contained 17 dust collectors. Dusts in the reduction area were mostly UF_4 and U_3O_8 in magnesium fluoride slag. Remelt area dusts were mostly U_3O_8. Dust particles were 0.5 to >44 microns in size.

F.3.I.2.2.1.5 Plant 6 (Metals Fabrication Plant)

Operations began in 1952 for the fabrication of finished cores from normal uranium cylindrical ingots received from Plant 5 via rolling mill, heat treat and machining operations. Later, enriched and depleted uranium ingots were machined in Plant 9 and heat treated in Plant 6 for shipment to Reactive Metals, Inc. (RMI) Company located in Ashtabula, Ohio. At RMI, uranium ingots were extruded into tubes for return to Plant 6 at the FEMP where they were cut into sections, heat treated, machined to final dimensions, and inspected for final product quality. The completed target element cores were shipped to the Savannah River Plant. Ingots consisting of slightly enriched uranium were upset forged, machined, and shipped from RMI to the Hanford site. Scrap metal that was generated during the various metal production and fabrication steps was pickled in nitric acid to remove oxide contamination and progeny products before recycling via remelt casting operations. Chips and lathe turnings were crushed, pickled, rinsed, dried, briquetted, and recycled to remelt casting operations. Plant 6 contained three dust collectors and three electrostatic precipitators. The principal airborne emission path from Plant 6 was the acid-vapor exhaust from the stack that ventilated the pickling tank, two wash tanks, and the exhaust from the briquetting operations.

F.3.I.2.2.1.6 Plant 7 (Hex Reduction Plant)

Operations began in 1954 for the conversion of UF_6 received from the gaseous diffusion plants to produce high purity UF_4 as a supplement to the Plant 4 production. Actual production ran from 1954 to 1956; the plant contained four dust collectors.

F.3.I.2.2.1.7 Plant 8 (Scrap Recovery Plant)

Operations began in 1953. Plant 8 processed impure metals and residues including off-specification UO_3 and UF_4, magnesium fluoride slag, crucible burnout, ingot top crops, sump cakes, chips, and sawdust received from nearly all the production plants. High-grade scrap, such as machining chips and turnings, were oxidized to U_3O_8 in an oxidation furnace or burned in a box furnace. Fine material (<8 mesh) was sent to Plant 2/3; coarse material (>8 mesh) was further oxidized in a muffle furnace. The furnaces were vented to wet scrubbers before gases were discharged to the atmosphere.

F.3.I.2.2.1.8 Plant 9 (Special Products Plant)

Uranium operations began in 1957. Plant 9 originally conducted casting and cropping of ingots from Plant 5. Cropped billets from Plant 5 were drilled and machined for further processing in Plant 6. Beginning in 1961, the Zirnlo process was used to recover rejected coextrusion sections from the fuel fabrication operation at Hanford. The process used dilute hydrofluoric acid to remove zirconium followed by nitric acid for copper removal from uranium cores. The decladded cores were then recycled through Plant 5 remelt casting operations. The acid tanks had an exhaust stack with a blower. Core pickling was used from 1961 to 1963; briquetting of uranium and thorium was performed from 1953 to 1963.

F.3.I.2.2.1.9 Pilot Plant

Operations began in 1951. During the early years, the pilot plant produced limited quantities of enriched uranium metal. Box furnaces were used to process U_3O_8, enriched uranium turnings and "sawdust" generated in the production of enriched uranium cores. Crucibles were plasma coated in the pilot plant. Material up to 3.85 percent enrichment was processed to metal via the UF_6 reduction process. Most uranium operations were suspended during the thorium production that occurred between 1967 and 1975.

Conversion of UF_6 to uranium tetrafluoride (UF_4) began by heating the UF_6 in an autoclave to transform the solid into a gas. The gaseous UF_6 was then reduced with hydrogen to form UF_4. The UF_4 was feed material for Plants 5 and 9. The offgas from the production of UF_4 consisted of hydrogen, nitrogen, hydrogen fluoride, uranium tetrafluoride, a carbon trap to remove unreacted uranium hexafluoride, a two-stage refrigerated condenser system to remove anhydrous hydrogen fluoride, and a water scrubber to remove trace aqueous hydrofluoric acid before being vented to the atmosphere. Equipment in the pilot plant was used for a variety of special production operations. The dust from the collectors in the pilot plant was 9 to 44 microns in size and assayed approximately 80 percent uranium in the form of UO_3, U_3O_8, and UF_4.

F.3.I.2.2.2 Time/Form Characterization of Plant Discharges

The principal sources of airborne emissions from FEMP processing operations were:

- Dust collector stack discharges
- Wet scrubber discharges
- Acid-pickling fume stacks

Airborne releases from these sources totaled 169,147 kg U through 1984, and are characterized in the following subsections.

When combined with the release of 8891 kg U from nonproduction sources (Sections F.3.I.2.3 and F.3.I.2.4), the FEMP total comes to 178,038 kg U through 1984 (see Table F.3.I.2-2).

F.3.I.2.2.2.1 Dust Collector Stack Discharges

Dust collector stack discharges were the principal sources of airborne emissions during the span of FEMP operations from 1951 to 1984. Airborne releases of uranium from plant stacks totaled 94,590 kg U (Table F.3.I.2-2) and are characterized, as follows:

Plant	Stacks (kg U)	Percent	Principal U Species
1	985	1	U Ores, U_3O_8
2/3	3219*	3	U Ores, U_3O_8, UO_3
4	33,217	35	UO_3, U_3O_8,
5	26,189	28	U_3O_8, UF_4/UO_2F_2

Plant	Stacks (kg U)	Percent	Principal U Species
6	1204	1	U_3O_8
7	13,272	14	UF_4
8	10,773	12	U_3O_8, UAP, UCl_4
9	2599	3	U_3O_8, UF_4/UO_2F_2
Pilot	3132	3	U_3O_8, UF_4
Total	94,590	100	

*Estimated releases due to gulping operations (38179.3 kg U) have been subtracted from the Table F.3.I.2-2 total for Plant 2/3 and will be covered in Section F.3.I.2.2.2.2.

The Plant 8 scrubbers discharged another 36,378 kg U, primarily in the form of uranyl ammonium phosphate (UAP) and uranous tetrachloride from the dissolution of U-metal in hydrochloric acid. Each plant discharged dust as uranium residues from processing operations. Plants 4, 5, and 9 discharged UO_2F_2 as a companion side-product contained in UF_4. Estimates of dust collector discharges from all FEMP processing plants categorized by U species follow:

Uranium Species	kg U	Percent of Total
Ores	3590	4
U_3O_8, UO_2	66,649	70
UO_3	149	<1
UF_4	23,387	25
UO_2F_2	194	<1
UCl_4	28	<1
UAP*, ADU**	593	<1
Total	94,590	

*Uranyl ammonium phosphate
**Diammonium diuranate

Ninety-five percent of the discharges were oxides and green salt. Stack discharges from Plants 4 and 5 comprised 63 percent of the total discharged from the FEMP processing plants. It should be noted that dust collector discharges from Plants 2/3 and 8, when combined with emissions from gulping operations and the wet scrubber discharges, together accounted for 52 percent,

(88,549 kg U), as discussed in Section F.3.I.2.2.2.2. Also, Plant 7 discharged 14 percent of the FEMP total in just three years of its operation between 1954-56. Most of the FEMP releases occurred during the first 20 years of plant operations (Section F.3.I.2.2.2.3). A breakdown of uranium stack discharges by plant, species and time is summarized in Table F.3.I.2-3.

F.3.I.2.2.2.2 Wet Scrubber and Acid-Pickling Discharges

Wet scrubber discharges over the four decades of FEMP operations resulted from Plant 2/3 gulping operations and wet scrubbers in Plant 8. Acid-pickling operations in Plants 6 and 9 further contributed to these uranium emissions. Releases of 38,179 kg U as uranyl nitrate are estimated from the Plant 2/3 gulping operations (Table F.3.I.2-4) and 36,378 kg U from the Plant 8 wet scrubbers (Table F.3.I.2-2). Emissions from the Plant 6 and 9 acid-pickling sources are judged to be relatively insignificant. The impact of these emissions to the environmental media is in the discharge of acidic vapors that are conducive to promoting solubilization of particulate uranium species released from other sources.

F.3.I.2.2.2.3 Historical Discharges of FEMP Dust Collector and Wet Scrubbers

Historical discharges of FEMP dust collector and wet scrubbers are listed below:

	Discharges (kg U)				
Plant	1950s	1960s	1970s	1980s	Total
1	642	252	57	34	985
2/3	14,556	13,249	12,804	789	41,398
4	27,861	4350	336	670	33,217
5	22,978	2407	332	472	26,189
6	449	751	2	2	1204
7	13,272	0	0	0	13,272
8	12,251	21,675	1952	273	47,151
9	1096	1159	168	176	2599
Pilot	1934	1179	13	6	3132
Total	95,039	56,022	15,664	2422	169,147
Percent	37	33	9	1	100

The significance of the time characterization is that the substantial quantities of uranium discharged during the initial years of operation have had ample opportunity to come into solubility equilibrium

with environmental media, undergo slow hydrolysis to other uranium species, or have migrated by transport to other media.

F.3.I.2.2.3 Dose Reconstruction Project Release Estimates

In November 1993 a draft report entitled "The Fernald Dosimetry Reconstruction Project – Radionuclide Source Terms and Uncertainties" was issued for review by the Radiological Assessments Corporation (RAC) under contract to the Centers for Disease Control (CDC). The report was prepared to support an initiative being undertaken by the CDC to reconstruct the potential radiological doses received by members of the public residing around the FEMP as a result of environmental discharges during the facility's 38-year operational history.

Within the draft CDC report, RAC evaluated the projected quantities and characteristics of radiological contaminants released to the environment from facility operations. Existing FEMP historical release estimates, as presented in the U.S. Department of Energy's (DOE's) remedial investigation/feasibility study (RI/FS) documents, were based upon an evaluation of historical stack monitoring data and production records by FEMP scientific staff members. The RAC estimates employed a probabilistic approach to projecting these same historical release levels.

The probabilistic-based estimates completed by RAC included use of Monte Carlo methods to evaluate the propagation of uncertainty in the estimating process. These Monte Carlo simulations were completed for total site dust collector emissions, Plant 8 scrubber emissions, Plant 2/3 scrubber discharges, and radon released from the site. In general, the best estimate of the mass of releases from these sources, as projected by RAC, were, on average, approximately 250 percent higher than similar estimates completed by the FEMP. The primary differences reside in the estimation of releases from the Plant 8 scrubbers (385 percent higher release estimates) and the site-wide dust collection systems (265 percent higher emission estimates).

No attempt has been made to reconcile the differences between the two estimates of total mass of historical site emissions. For the purposes of this report, it is the types of uranium chemical forms (species) that are of significance to the report's findings, not the total mass of contaminants released. The differences in projected total quantities of emissions is not considered significant to the identification of geochemical parameters for fate and transport modeling, which is dependent on the species of uranium forms historically released.

F.3.I.2.3 SIGNIFICANT EPISODAL RELEASES FROM PLANT OPERATIONS

F.3.I.2.3.1 Plant 7 Releases of UF_6 in 1954-55

Eyewitness accounts have stated frequent releases of UF_6 during the start-up and early operation of Plant 7 in the 1954 period. During these incidents, building windows were closed and laboratory ventilation hoods were shutdown until the visible white plume of UF_6 dissipated from cylinders placed on-line for operations. Quantities released as UF_6 have been estimated to be 252 kg U during the operation of Plant 7.

F.3.I.2.3.2 Pilot Plant Releases of UF_6 in 1966

On February 14, 1966, an unmonitored release of 1195 kg U as UF_6 occurred during a one-hour period, beginning at 8:40 a.m. At that time winds were from the north/northwest at 5 mph. The release point was about six feet above the ground and resulted from a valve being inadvertently removed. Releases of another 264 kg U have been estimated for other intermittent periods of operation.

F.3.I.2.3.3 Plant 2/3 Releases of UNH/Nitric Acid Vapor

Quantities of uranium were emitted from the Plant 2/3 gulping system as a vapor mist of UNH solution in nitric acid. These emissions occur when UO_3 was removed by vacuum gulping from denitration pots. Estimates of 38,179 kg U discharged were based on uranium production records; measurements of U content in acid mists; and collection efficiency expected from the entire particulate control system. Releases totaling 272 kg U have been estimated based on two specifically documented incidents.

F.3.I.2.3.4 Other Nonroutine Production Discharges

Emissions of uranium from metal fires and solid spills occurring outdoors have been estimated to be 907 kg U and 1059 kg U, respectively, over the period of FEMP operations through 1984. Uranium metal fires generally occurred on the east storage pads of Plants 6 and 8, where drums of machining chips and turnings were stored for the pickling and briquetting operations. Outdoor spills amounting to 37 kg U occurred during the interplant shipment of uranium compounds, usually from a drum falling from a transport trailer.

F.3.I.2.4 NONPRODUCTION SOURCE RELEASES OF PRIMARY CONTAMINATION

F.3.I.2.4.1 Incineration

Five non-production incinerators supported the general site operations. Discharges (Table F.3.I.2-2) from these incinerators were as follows;

- Old solid waste incinerator at the sewage treatment plant (2480 kg U)
- Oil burner (463 kg U)
- Graphite burner (125 kg U)
- New solid waste incinerator (12 kg U)
- Liquid organic waste incinerator (17 kg U)

Uranium releases from these sources are estimated to be 3087 kg U for the FEMP's operational period. The likely form of release is U_3O_8.

F.3.I.2.4.2 Storage

Up to 1984, on-property disposal of solid and slurried wastes at the FEMP occurred in pits and silos. Transport of solid wastes to the pits was dependent on the type of wastes generated and the type of storage containers. In general, drummed wastes were transported on flat-bed trailers; metal dumpsters were carried by dumpster vehicles; bulk wastes were transported by dump trucks and trailers; and drummed pyrophoric metal was conveyed on four-wheeled flat-bed trailers pulled by two tractors. At the waste storage area, dump trucks, dump trailers, dumpster units, and drummed wastes were emptied directly onto the pits' edges. The material was then pushed into the pits by either a bulldozer or a dragline scraper. Loose contamination was washed from bulldozers, the dragline scraper, vehicles, dumpsters, and fork trucks with water at the pits. Fugitive airborne uranium emissions at the waste pits have been estimated to be 1371 kg U for the FEMP operational period through 1984 (Table F.3.I.2-4).

F.3.I.2.4.3 Other Emissions

Estimates of uranium releases from building exhausts and laboratory emissions have been estimated to be 379 kg U and 68 kg U, respectively, for the FEMP operational period through 1984 (columns numbered 4 and 5, Table F.3.I.2-4). The likely form of release is U_3O_8 or intermediate uranium compounds specific to each processing plant.

SUMMARY OF SITE CONTAMINATION

Potential Source	Release Mechanisms	Affected Media/Pathways
Process Operations (OU3) Dust collectors Scrubbers Fugitive emissions Wastewater discharges Storm water discharges Process material handling Underground storage tanks Process piping Sewage treatment plant	Air emissions Process emissions Building exhausts Fugitive emissions Wastewater/storm water discharges	Air Suspended particulates Radon gas | → Direct radiation | → Air resuspension Soil | | → Groundwater via leaching | → Storm water runoff ↓ Surface water/sediment ↓ Groundwater recharge
Waste Management OU1 OU2 OU4 Regulated units Soil/debris piles Scrap metal piles	Land disposal/storage practices Spills/Leaks Process materials Wastewater	Surface water/sediment ↓ Groundwater recharge Direct radiation

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TABLE F.3.I.2-2

URANIUM EMISSIONS FROM FEMP AIRBORNE RELEASES*
Uranium Discharges (kg)

Calendar Year	Dust Collectors													
	Plant 1	Plant 2/3[a]	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9	Pilot Plant	Plant 8 Wet Scrubbers[b]	Non-Production Sources[c]	Other Sources[d]	Total Emissions	Percent of Total 1951-1984
1951	--	--	--	--	--	--	--	--	123	--	--	2	125	0.1
1952	--	--	--	--	6	--	--	--	493	--	--	44	543	0.3
1953	3.8	6	1,473	90	12	--	--	--	493	--	--	105	2,182.8	1.2
1954	46.2	281	5,890	4,119	28	4,261	201	0	271	217	15	157	15,486.2	8.7
1955	46.2	1,113	12,450	10,410	53	7,268	877	0	443	948	118	167	33,893.2	19.0
1956	43.4	1,978	5,145	3,501	27	1,743	1,316	0	32	1,442	118	174	15,519.4	8.7
1957	49.4	3,730	814	3,664.4	35	--	791	0.4	18	1,575	118	230	11,025.2	6.2
1958	407.4	3,520	661	715	161	--	875	679	27	1,650	118	242	9,055.4	5.1
1959	46	3,929	1,428	478.4	127	--	260	417	34	2,100	118	240	9,177.4	5.2
1960	20	4,233	212	202.8	268	--	298	219	718	2,604	118	260	9,152.8	5.1
1961	52.8	3,707	262	76.2	119	--	209	67.4	174	2,271	118	271	7,427.4	4.2
1962	14	2,137	703	356	59	--	618	135	174	2,304	138	304	6,942	3.9
1963	82.6	0	1,469	783	181	--	994	159	51.8	2,171	145	339	6,375.4	3.6
1964	18	0	545	330.4	34	--	1,051	252	13	2,865	145	330	5,583.4	3.1
1965	4.1	192.7	334.7	226.5	42.6	--	390	68	10	5,810	146.2	269	7,493.8	4.2
1966	12.2	514	227.7	76.7	11.3	--	327	48.5	18.1+1,195[e]	926	152	222	3,730.5	2.1
1967	20.4	646.8	279.9	147.9	2.7	--	417	76.2	11.8	1,790	152	181	3,725.7	2.1
1968	0.5	1,119.5	267.2	88	30.4	--	901	121.0	3.6	3,082	152	120	5,885.2	3.3
1969	27.2	698.2	49.4	119.3	2.7	--	424	12.7	3.6	3,123	128	120	4,708.1	2.6
1970	4.5	356.7	29.9	53.1	0	--	569	13.6	0	666	105	185	1,982.8	1.1
1971	9	306	0	0	0	--	91	0	0	541	105	40	1,092	0.6
1972	28.4	1,360	9	33	0	--	5	24	0	--	105	37	1,601.4	0.9
1973	1	1,396	57	79	0	--	14	15	0	39	105	33	1,739	1.0
1974	1.4	2,445	24.4	40	0	--	11	38	0	--	105	32	2,696.8	1.5
1975	5.6	2,844.7	119.8	19	0	--	3.5	0	0.4	--	105	40	3,138	1.8
1976	2.7	3,339.2	26.1	13.7	2.4	--	7.2	2.8	0	--	105	40	3,539.1	2.0
1977	0.6	756.2	11.8	53.3	0	--	4.6	0	10.4	--	105	36	977.9	0.5
1978	1.8	0	11.9	29.1	0	--	0	72	2.2	--	105	39	261.0	0.1
1979	0.8	0	46.3	12.3	0	--	0	2.3	0	--	93	45	199.7	0.1

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TABLE F.3.I.2-2 (Continued)

Calendar Year	Dust Collectors										Non-Production Sources[c]	Other Sources[d]	Total Emissions	Percent of Total 1951-1984
	Plant 1	Plant 2/3[a]	Plant 4	Plant 5	Plant 6	Plant 7	Plant 8	Plant 9	Pilot Plant	Plant 8 Wet Scrubbers[b]				
1980	13.4	2.7	133.8	89.5	0	--	5.1	0	3.3	11	7.7	50	316.5	0.2
1981	1.3	30	432.1	135.6	0	--	0	0	0	10	8.2	60	677.2	0.4
1982	2.1	52.3	21	121.8	0.5	--	81.2	5.1	0	37	8.8	65	394.8	0.2
1983	6.4	130	42.9	41.4	0	--	24.7	0	0	58	7.8	65	376.2	0.2
1984	12.1	574.3	39.6	83.9	1.0	--	8.1	170.9	2,8	38	16.8	66	1,013.5	0.6
Total 1951-1984	985.3	41,398.3	33,216.5	26,189.3	1,203.6	13,272	10,773.4	2,598.9	4,326.0	36,378	3,086.5	4,610	178,037.8	100.0
% of Total	0.6	23.3	18.7	14.7	0.7	7.5	6.1	1.5	2.4	20.4	17.4	2.6	100	
1985												64	315.3	
1986												68	130.2	
1987												60	302.3	
Total 1951-1987												5,074[f]	179,057.6	

aIncludes gulping emissions.

[b]Data are on a fiscal year basis:

- 1952-1976, July 1 - June 30
- 1976 transition
- 1977 and after, October 1 - September 30

[c]Consists of:

Old solid waste incinerator (1954 - 1979)	2474.7 kg
Old burner (1962-1979)	462.9 kg
Graphite burner (1965-1984)	124.6 kg
New solid waste incinerator (1980-1984)	<20 kg
Liquid organic waste incinerator (1983-1984)	<20 kg
	3086.5 kg

[d]Includes other process emissions, buildings exhausts, laboratory emissions, fugitive emissions from waste pits, and nonroutine events.

[e]Unmonitored UF_6 release on February 14, 1966.

[f]Includes an additional 272 kg from nonroutine events (concentrated liquid uvanyl nitrate hexahydrate releases).

*Boback, et al., 1987, "History of FMPC Radiological Discharges," FMPC-2082, prepared for DOE, Oak Ridge Operations Office, Oak Ridge, TN.

Clark, et al., 1989, "History of FMPC Radionuclide Discharges - Revised Estimates of uranium and Thorium Air Emissions from 1951-1987," Addendum to FMPC-2082, prepared for DOE, Oak Ridge Operations Office, Oak Ridge, TN.

TABLE F.3.I.2-3

ESTIMATE OF TIME/FORM URANIUM STACK DISCHARGES

Plant	Species	Uranium Discharged (kg) 1950s	1960s	1970s	1980s	Species Total	Plant Total
1	ORES	642	149	0	0	791	
	U_3O_8	0	103	57	34	194	985
2/3	ORES	1,788	414	597	0	2,799	
	U_3O_8	199	45	105	6	355	
	UO_8	0	0	62	3	65	3,219
4	UO_3	0	75	0	8	83	
	U_3O_8	21,349	3,468	29	18	24,864	
	UF_4	6,382	791	301	631	8,105	
	UO_2F_2	130	16	6	13	165	33,217
5	U_3O_8	22,185	2,230	322	436	25,173	
	UF_4	777	176	10	36	999	
	UO_2F_2	16	0	0	0	16	26,188
6	U_3O_8	449	751	2	2	1,204	1,204
7	UF_4	13,272	0	0	0	13,272	13,272
8	U_3O_8	4,089	5,239	706	119	10,153	
	UAP	222	371	0	0	593	
	UCl_4	9	19	0	0	28	10,774
9	U_3O_8	672	696	168	176	1,712	
	UF_4	416	371	0	0	874	
	UO_2F_2	8	5	0	0	13	2,599
Pilot	U_3O_8	1,912	1,064	13	5	2,994	
	UF_4	22	115	0	1	138	3,132
Total		74,537	16,187	2,378	1,488	94,590	

TABLE F.3.I.2-4

FMPC AIRBORNE EMISSIONS SUMMARY IN KILOGRAMS

Year	1 Uranium FMPC-2082 Totals	2 Uranium Gulping Emissions	3 Other Uranium Process Emissions	4 Uranium Emissions Building Exhausts	5 Uranium Estimated Laboratory Emissions	6 Uranium Fugitive Emissions Waste Pits	7 Uranium Emissions Non-Routine Events	8 Total Uranium Emissions*
1951	123.0	0	0	0	2	0	0	125
1952	499.0	0	0	0	2	0	42	543
1953	2,077.8	0	3	1	2	0	99	2,183
1954	15,119.2	210	8	5	2	0	142	15,486
1955	32,976.2	750	11	11	2	1	142	33,893
1956	13,595.4	1,750	12	16	2	2	142	15,519
1957	8,045.2	2,750	12	26	2	48	142	11,025
1958	5,513.4	3,300	14	31	2	95	100	9,055
1959	5,127.4	3,810	15	28	2	95	100	9,177
1960	4,872.8	4,020	17	33	2	108	100	9,153
1961	3,516.4	3,640	18	30	2	121	100	7,427
1962	4,568.0	2,070	19	26	2	125	132	6,952
1963	6,036.4	0	19	25	2	125	168	6,375
1964	5,253.4	0	22	20	2	129	157	5,583
1965	7,044.8	180	22	19	2	71	155	7,494
1966	3,048.5	460	12	16	2	49	143	3,731
1967	2,924.7	620	11	16	2	11	141	3,726
1968	4,655.2	1,110	7	14	2	12	85	5,885
1969	3,898.1	690	7	8	2	15	88	4,708

TABLE F.3.I.2-4 (Continued)

Year	1 Uranium FMPC-2082 Totals	2 Uranium Gulping Emissions	3 Other Uranium Process Emissions	4 Uranium Emissions Building Exhausts	5 Uranium Estimated Laboratory Emissions	6 Uranium Fugitive Emissions Waste Pits	7 Uranium Emissions Non-Routine Events	8 Total Uranium Emissions*
1970	1,487.8	310	6	6	2	16	155	1,983
1971	772.0	280	5	2	2	16	15	1,092
1972	614.4	950	4	3	2	15	13	1,601
1973	496.0	1,210	5	3	2	15	8	1,739
1974	234.8	2,430	4	6	2	14	6	2,697
1975	318.0	2,780	4	7	2	18	9	3,138
1976	169.1	3,330	5	7	2	20	6	3,539
1977	191.9	750	5	2	2	20	7	978
1978	222.0	0	4	2	2	22	9	261
1979	154.7	0	4	1	2	31	7	200
1980	266.5	0	4	2	2	34	8	317
1981	587.2	30	5	2	2	42	9	677
1982	279.8	50	6	2	2	41	14	395
1983	181.2	130	6	4	2	40	13	376
1984	377.5	570	6	5	2	40	13	1,014
Total	135,473.6	38,179	319	379	68	1,371	2,780**	
					Total Uranium			179,058 kg

NOTE: Numbers may not add due to round-off.
*The 1985, 1986 and 1987 emissions as reported in the Environmental Monitoring Annual Reports have been added into the column total.
**Includes 272 kg U from estimated emissions not distributed over production years.

F.3.I.3.0 GEOCHEMICAL PROCESSES INFLUENCING THE URANIUM DISTRIBUTION

F.3.I.3.1 RAINWATER/SOIL CHEMISTRY

Rainwater falling on soil media will react with minerals/solids and organic material to form porewater. The geochemistry of porewater is controlled by the pH of the rainwater, activity of carbon dioxide (CO_2) in the water/soil system, and the solubility of various minerals or leaching of solids in the soil. A mineralogical summary of FEMP soils is provided in Table F.3.I.3-1. At the FEMP site, the moderately low pH of the rainwater (about 5) is raised by dissolution reactions with carbonate mineral fragments (dolomite and calcite) present in the soil. Rainwater dissolution reactions are most likely to occur in the upper few feet of the glacial overburden, and these reactions affect the leaching of uranium from near-surface sources. The pH of the water/soil system will be buffered in the range of 7 to 8 by carbonate mineral (e.g., $CaCO_3$) dissolution, CO_2 dissolution, and carbonic acid (H_2CO_3) dissociation. Important reactions in this system are:

(1) $CaCO_3 + H_2O <-> Ca^{+2} + HCO_3^- + OH^-$

(2) $CO_2 + H_2O <-> H_2CO_3$

(3) $H_2CO_3 <-> H^+ + HCO_3^-$

The dissolution of $CaCO_3$ in water (Reaction 1) contacting air containing about 0.03 percent CO_2 results in an equilibrium pH of about 8. Lower pH values are generally observed in FEMP soil because the activity of CO_2 (i.e., partial pressure of CO_2) in the soil is greater than in the air, due to decomposition of organic debris and respiration of microorganisms. The higher CO_2 activity in soil drives Reaction 2 to the right to produce more H_2CO_3, which dissociates immediately (Reaction 3) to release H^+ and lower the pH. The large reservoir of carbonate minerals (30 to 50 percent of the soil) and biogenic sources of CO_2 allow the water/soil system to be buffered between 7 and 8 by the interplay of the above three reactions.

Silicate minerals present in the soil (e.g., quartz, feldspar, and clay minerals) have less influence on the chemistry of the porewater due to their low solubilities (relative to carbonate minerals) at near neutral pH values. These minerals provide silica, potassium, sodium, aluminum, and various trace metals to the porewater via dissolution and ion-exchange reactions. The weathered surface area of these minerals plays an important part in the adsorption of ions from the porewater.

F.3.I.3.2 LEACHING OF URANIUM SOLIDS

Uranium solids present in near-surface sources will be leached by rainwater to form a portion of the dissolved constituents (i.e., solute) delivered to the porewater. Leaching refers to removing constituents from the solid by desorption, ion exchange, and dissolution reactions. In this sense, dissolution of a solid is a subset process of leaching. The degree to which individual uranium solids will dissolve is a function of bond type (e.g., ionic, covalent, etc.) in the mineral structure, which is reflected by the composition of the solid. The extent of dissolution is expressed mathematically by the solubility product. For example, consider the solubility of UO_2 and UF_4 in distilled water of pH 7 at 25°C with an oxygen partial pressure of 1 x 10^{-39} atmospheres (corresponding to an Eh of 0.24 volts at pH 7). The reactions are:

(4) $UO_2 + \frac{1}{2}O_2 + 2H^+ <-> UO_2^{+2} + H_2O$

(5) $UF_4 + \frac{1}{2}O_2 + H_2O <-> UO_2^{+2} + 2H^+ + 4F^-$

Using the equilibrium constants reported in the EQ3/6 thermodynamic data base (Version 7.2; Wolery 1992; Wolery and Daveler 1992) for the above reactions, UO_2 will dissolve to yield 0.3 milligrams of uranium per kilogram of water (mg U/kg water) and dissolution of UF_4 yields 28,000 mg U/kg water. Therefore, the solubility of UF_4 under these conditions (i.e., pH = 7, Eh = 0.24 volts, and UO_2^{+2} is the only uranium species formed) is almost 6 orders of magnitude greater than UO_2. It is important to highlight that the calculation above assumes UO_2^{+2} is the only uranium species formed. In natural groundwater systems, a variety of common ions (e.g., CO_3^{-2}) are available to complex UO_2^{+2}, resulting in increased dissolution of uranium solids. Most of these complexing ions are provided by dissolution reactions between rainwater and soil minerals. This important point is discussed in more detail below.

The example above illustrates that UO_2 will remain in the environment much longer than UF_4 if the particle size and emitted quantities (i.e., moles) are similar for each uranium form. As the dissolution rate of a solid is a function of the particle surface area, leaching of very fine UO_2 particles can yield uranium concentrations that are similar to those derived from leaching of coarser UF_4 particles – if the leaching time period is less than that required to establish solubility equilibrium. From the example above, note that if the water is allowed to equilibrate with the solids the uranium yield would be 6 orders of magnitude greater for the UF_4 relative to UO_2, regardless of particle size.

Another point to emphasize from the preceding discussion is that release of uranium to the glacial overburden is tied to the solubility of the uranium solid in the source. Particles of UF_4 will release more dissolved uranium to the glacial overburden than UO_2 particles during any given storm event, given that the quantity (i.e., moles) and particle size of each form are similar. Additionally, UF_4 is not expected to persist in the environment for long periods of time due to its high solubility. This implies that little, if any, of the UF_4 released from operations/accidents remains in the FEMP soil today.

The use of solubility calculations can be extended to all uranium forms believed to have been released from FEMP sources (Section F.3.I.2.0) to develop a leaching hierarchy for uranium minerals. A relative ranking of mineral solubility in rainwater was obtained by computing the saturation indices for most FEMP uranium minerals of interest. The saturation index (SI) is equal to the log of the ion activity product (iap) minus the log of the solubility product (sp), or SI = log(iap/sp). An SI value of zero (iap = sp) indicates the mineral is saturated in the solution (i.e., the mineral is at its solubility limit). When SI values are compared among the uranium minerals, minerals with the lowest SI values are most soluble and those with the highest values are least soluble. SI calculations were carried out with the EQ3/6 geochemical computer code (Version 7.2; Wolery 1992; Wolery and Daveler 1992) and results are summarized in Table F.3.I.3-2; results are listed in qualitative categories of most leachable (i.e., most soluble), moderately leachable, and least leachable.

TABLE F.3.I.3-2

LEACHABILITY OF URANIUM SOLIDS IN RAINWATER AT 25°C

Most Leachable (SI[a])	Moderately Leachable (SI)	Least Leachable (SI)
$UO_2(NO_3)_2 \cdot 6H_2O$ (−95.6))	UF_4 (−33.2)	U_3O_8 (−8.88)
UF_6 (−89.9)	$Na_2U_2O_7$ (−20.1)	UO_2 (−8.42)
$(NH_4)_2U_2O_7$[b]		UO_3 (−7.10)
$NH_4UO_2PO_4$[b]		

[a] Saturation Index (SI) calculated with the EQ3/6 geochemical code using pH = 5, Eh = 0.4 Volts, and U = 0.001 mg/L. Lowest SI values correspond to most soluble, or leachable, uranium forms.

[b] Mineral is not in EQ3/6 thermodynamic database; therefore, SI is unavailable. Ammonium salts are generally very soluble, and this assumption is used to support the placement of these minerals in the most leachable category.

Important dissolution reactions for uranium minerals in past and present near-surface sources (Table F.3.I.3-2) are given below:

(6) $UO_2(NO_3)_2 \cdot 6H_2O + H_2O <-> UO_2^{+2} + 2NO_3^- + 7H_2O$

(7) $UF_6 + 2H_2O <-> UO_2^{+2} + 4H^+ + 6F^-$

(8) $(NH_4)_2U_2O_7 + 3H_2O <-> 2NH_4^+ + 2UO_2^{+2} + 6OH^-$

(9) $NH_4UO_2PO_4 + 3H_2O <-> NH_4^+ + UO_2^{+2} + PO_4^{-3}$

(10) $UF_4 + ½O_2 + H_2O <-> UO_2^{+2} + 2H^+ + 4F^-$

(11) $Na_2U_2O_7 + 3H_2O <-> 2Na^+ + 2UO_2^{+2} + 6OH^-$

(12) $U_3O_8 + ½O_2 + 6H^+ <-> 3UO_2^{+2} + 3H_2O$

(13) $UO_2 + ½O_2 + 2H^+ <-> UO_2^{+2} + H_2O$

(14) $UO_3 + 2H^+ <-> UO_2^{+2} + H_2O$

As Reactions 6 through 11 involve uranium salts of moderate to high solubility (Table F.3.I.3-2), rainwater contacting these solids would result in rapid dissolution and subsequent mobilization of uranium. Because of their soluble nature, the uranium salts in Reactions 6 through 11 are not expected to be present in near-surface sources today due to the high annual rainfall (greater than 40 inches) and the cessation of production activities at the FEMP in 1989.

Under the wet and oxidizing surface soil conditions present at the FEMP, uranium will be leached from near-surface sources and released initially as the uranyl ion (UO_2^{+2}). UO_2^{+2} readily forms aqueous complexes with carbonate (CO_3^{-2}), phosphate (PO_4^{-3}), and hydroxide (OH^-) ions present in porewater and groundwater. The rainwater/soil reactions discussed above produce porewater and groundwater compositions that reflect equilibrium with carbonate minerals, resulting in waters composed primarily of the ions Ca^{+2}, HCO_3^-, Mg^{+2}, and CO_3^{-2}. The CO_3^{-2} ion has a strong affinity for UO_2^{+2} and readily forms aqueous uranium complexes as follows:

(15) $UO_2^{+2} + 2CO_3^- <-> UO_2(CO_3)_2^{-2}$

(16) $UO_2^{+2} + 3CO_3^- <-> UO_2(CO_3)_3^{-4}$

Other uranium species that are predicted (based on EQ3/6 geochemical modeling) to exist in FEMP perched groundwater at much lower concentrations are indicated below:

(17) $2UO_2^{+2} + CO_3^{-2} + 3OH^- <-> (UO_2)CO_3(OH)_3^-$

(18) $UO_2^{+2} + 2OH^- <-> UO_2(OH)_2^o$

(19) $UO_2^{+2} + PO_4^{-3} <-> UO_2PO_4^-$

(20) $UO_2^{+2} + CO_3^{-2} <-> UO_2CO_3^o$

The formation of uranium complexes in FEMP porewater and perched groundwater enhances the dissolution of uranium minerals by decreasing the activity (i.e., concentration) of UO_2^{+2} in the water. As the UO_2^{+2} activity is lowered in Reactions 15 through 20 by the formation of the indicated complexes, the affinity to drive Reactions 6 through 14 to the right is increased, resulting in dissolution of additional uranium solids. The principle illustrated here is that formation of aqueous uranium complexes increases the uranium concentration in solution.

Another important observation is that the predicted uranium speciation in perched groundwater (Reactions 15 through 20) is dominated by negatively charged complexes, which have greater mobility in most water/soil systems. Most water/soil systems are dominated by particles that have a net negative charge on their surface, creating favorable conditions for the adsorption of positively charged ions (e.g., Cd^{+2}, Ra^{+2}, etc.). The adsorption of negatively charged species is controlled largely by the presence of iron, manganese, and aluminum oxyhydroxide coatings on weathered mineral grains.

F.3.I.3.3 ADSORPTION AND ION-EXCHANGE REACTIONS

As the speciation of uranium into carbonate complexes enhances the solubility of uranium solids, it is unlikely that precipitation of uranium solids from perched groundwater (HCO_3^- = 470 mg/L) will occur at observed uranium concentrations below about 100 mg/L (discussed below). Therefore, the most important processes affecting the migration of uranium in glacial overburden media are adsorption and ion-exchange reactions with the surfaces of soil particles. Examples of these reactions for $UO_2(CO_3)_2^{-2}$ are given below:

(21) $site^{+2} + UO_2(CO_3)_2^{-2} <-> site\text{-}UO_2(CO_3)_2$

(22) $site\text{-}CO_3 + UO_2(CO_3)_2^{-2} <-> site\text{-}UO_2(CO_3)_2 + CO_3^{-2}$

Adsorption (Reaction 21) refers to two distinct processes: physical adsorption and chemisorption (Lasaga 1981). Physical adsorption results from the intermolecular or van der Waal's forces acting between the particle surface and ion. This is the initial step in removing the ion from solution.

Chemisorption involves the formation of chemical or ionic bonds between the surface atoms and the adsorbed species. Although physical adsorption occurs rapidly, chemisorption is slow and requires that the physically adsorbed specie "age" on the site to allow time for the bonding reaction to take place. Once chemisorption has occurred, it is very difficult to desorb the specie from the solid. Therefore, adsorption/desorption reactions become irreversible with time (i.e., only a fraction of what is initially adsorbed to the solid can be removed or extracted by desorption), which is in contrast to the fully reversible assumption invoked in fate and transport models by the use of the solid/liquid partition coefficient (i.e., K_d). The use of adsorption and desorption values in fate and transport modeling, via the K_d approach, is discussed in Section F.3.I.5.0.

Ion exchange (Reaction 22) is physical adsorption that is accompanied by desorption of a different specie. The exchangeability of an adsorbed ion depends on how it is attached to the soil particle; i.e., physical adsorption versus chemisorption. Species physically adsorbed to the soil particle surface are readily exchanged, while chemisorbed particles are more commonly exchanged only when they are on the corners or edges of particle fragments. In this paper, the term adsorption is used in a generic sense to include all processes in the continuum of physical adsorption, chemisorption, and ion exchange.

Adsorption of negatively charged uranyl carbonate species can take place on mineral surfaces that have a pH zero point of charge (pH_{zpc}) above the water/soil system pH. The pH_{zpc} is the pH at which the net charge on a mineral's surface is zero. When the pH of the water/soil system is below the mineral's pH_{zpc}, there is a net positive charge on its surface and the mineral has an affinity for negatively charged species. At the FEMP, the pH of perched groundwaters is generally near 7.5. Therefore, minerals with a pH_{zpc} above 7.5 will contain potential adsorption sites for negatively charged uranyl carbonate species. Minerals present in the glacial overburden that fit this description are summarized in Table F.3.I.3-3, along with the pH_{zpc} reported by Stumm and Morgan (1981) for oxide and hydroxide minerals and values calculated by the EQ3/6 geochemical code for calcite and dolomite.

TABLE F.3.I.3-3

GLACIAL OVERBURDEN MINERALS WITH pH_{zpc} GREATER THAN 7.5[a]

Mineral	pH_{zpc}
Calcide $CaCO_3$	8.4[b] (7.6[c])
Dolomite $MgCa(CO3)_2$	8.3[b] (7.5[c])
Aluminum oxide $\alpha-Al_2O_3$	9.1
Aluminum oxyhydroxide $\gamma-AlOOH$	8.2
Iron oxyhydroxide $\alpha-FeOOH$	7.8
Amorphous iron hydroxide $Fe(OH)_3$	8.5

[a]Oxide and hydroxide minerals compiled from Stumm and Morgan (1981).
[b]pH_{zpc} calculated with EQ3/6 geochemical code for $P_{CO2} = 10^{-3.5}$.
[c]pH_{zpc} calculated with EQ3/6 geochemical code for $P_{CO2} = 10^{-2.5}$.

The most important oxide and hydroxide surfaces are found on minerals containing aluminum and iron (Table F.3.I.3-3). Weathering of feldspar and amphibole minerals (Table F.3.I.3-1) to clay minerals can produce the oxide and hydroxide phases noted in Table F.3.I.3-3. Additionally, clay minerals (illite, corrensite, chlorite, and iron oxyhdroxide minerals in Table F.3.I.3-1) can provide the aluminum and iron oxyhydroxide surfaces to catalyze the adsorption reactions.

For the carbonate minerals present in the glacial overburden (Table F.3.I.3-1), the pH_{zpc} is dependent on the partial pressure of CO_2 (Table F.3.I.3-3). Rainwater equilibrated with air ($P_{CO2} = 10^{-3.5}$) has a lower CO_2 partial pressure than soil containing organic material and microorganisms. Measurements of the composition of gas samples from soil generally show CO_2 partial pressures from 10^{-3} to 10^{-1} (Freeze and Cherry 1979). The higher CO_2 partial pressure in soil atmosphere drives Reaction 2 to the right to produce more H_2CO_3. Dissociation of the additional H_2CO_3 leads to higher concentrations of HCO_3^- and H^+, which lowers a carbonate minerals pH_{zpc} (Stumm and Morgan 1981). In Table F.3.I.3-3, the pH_{zpc} for calcite drops from 8.4 to 7.6 as P_{CO2} is raised from $10^{-3.5}$ to $10^{-2.5}$. This implies that carbonate minerals in the fractured, weathered glacial overburden should be more efficient at adsorption of uranyl carbonate species because P_{CO2} will be kept near $10^{-3.5}$ by communication with the air reservoir. Specific adsorption values used to model uranium migration in the glacial overburden are discussed in Section F.3.I.5.0.

F.3.I.3.4 URANIUM MINERAL SOLUBILITY IN PERCHED GROUNDWATER

The concentration of uranium in perched groundwater will be controlled by the dissolution rates of uranium solids in the soil, the adsorption of uranium onto glacial overburden solids, and/or the solubility of uranium minerals in perched groundwater. Observed uranium concentrations in perched groundwater at the FEMP range from 0.0001 to 136 mg/L (based on the statistical reduction of preliminary data). Using the average groundwater constituent concentrations and a uranium concentration of 136 mg/L, mineral SIs were calculated to evaluate the saturation state of uranium phases in perched groundwater (Table F.3.I.3-4).

Five uranium phases are predicted to be saturated (Table F.3.I.3-4) in perched groundwater when pH = 7.4, UO_2^{+2} = 154 mg/L (i.e., U = 136 mg/L), SiO_2° = 4.5 mg/L, and Eh = 200 mV. The most saturated (i.e., least soluble or leachable) phases are the uranyl silicate phases soddyite and haweeite. However, the kinetics of nucleation and precipitation of silicate minerals is considered to be on the order of 10^{+5} to 10^{+6} years at ambient temperatures (Lasaga 1981). Therefore, it is doubtful that uranyl silicate phases have precipitated from groundwater in the 43-year history of the FEMP. Table F.3.I.3-4 suggests that triuranyl diphosphate, saleeite, and calcium uranate are the phases controlling uranium concentrations in perched groundwater. Given the uncertainty in the SI calculations (about ± 0.4 SI units), schoepite is close to saturation and may also play a role in controlling uranium concentrations. As the SIs in Table F.3.I.3-4 are dependent on solution pH, Eh, and composition, large deviations from the average groundwater composition can change the order and magnitude of the listed SIs.

It is important to emphasize that mineral solubility is only one of several geochemical processes that may control uranium concentrations in perched groundwater. Table F.3.I.3-4 indicates that uranium concentrations in groundwater have to be on the order of 100 mg/L (at pH = 7.4, Eh = 0.2 V, Ca^{+2} = 304 mg/L, and PO_4^{-3} = 4.4 mg/L) before $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $Mg(UO_2)_2(PO_4)_2$, or $CaUO_4$ will precipitate. Therefore, if the soluble uranium phases in the source have been removed by leaching, future uranium concentrations in groundwater may never reach saturation with respect to $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ or other uranium solids. Under this future scenario, the uranium concentration in perched groundwater will be controlled by dissolution rates in the source and adsorption reactions in the soil. This scenario is hypothesized to be the most probable case for present sources of uranium oxide particles derived from air emissions, while mineral solubility may control some uranium

concentrations observed in present groundwater contaminated by past spills of uranyl nitrate and other uranium solutions.

F.3.I.3.5 SUMMARY

Uranium will be mobilized in source areas by rainwater leaching and aqueous complexation of the uranyl ion with carbonate ion. Leaching in the source takes place by dissolution of uranium solids and desorption of uranium from soil particles. As the mobilized uranium migrates away from the source, the plume encounters lower portions of the glacial overburden where adsorption of uranium and/or precipitation of uranium may occur. Precipitation of uranium will be controlled primarily by the concentration of carbonate ion, with waters having higher aqueous carbonate concentrations suppressing uranium precipitation by formation of uranyl carbonate complexes.

Finally, it is important to highlight the contrast between the heterogeneous uranium forms in the source area and the homogeneous uranium forms in the water/glacial overburden system. The heterogeneity of uranium forms in the different source areas results in a wide range of release concentrations to porewater and groundwater (Table F.3.I.3-2 and Reactions 6 through 14). However, once the uranium has been released to the porewater and groundwater, the uranium is homogenized throughout the FEMP area as uranyl carbonate species (Reactions 15 and 16). This conceptual picture is important to recall throughout the discussion presented in Sections F.3.I.4.0 and F.3.I.5.0.

TABLE F.3.I.3-1

MINERALOGICAL SUMMARY OF FEMP GLACIAL OVERBURDEN SOIL

Phase/Ideal Formula	Modal Percent[a]
Calcite $CaCO_3$	25.75 ± 11.62
Dolomite $MgCa(CO_3)_2$	20.77 ±10.53
Quartz SiO_2	18.03 ± 8.58
Feldspar $KAlSiO_3$	14.76 ± 6.49
Illite $KAl_5Si_7O_{20}(OH)_4$	9.15 ± 17.37
Corrensite $NaCaMg_8Fe_5Al_5Si_{14}O_{40}(OH)_{20}$	4.27 ± 8.30
Organic debris (humus)	3.49 ± 3.68
Chlorite $Mg_7Fe_4Al_2Si_7O_{20}(OH)_{16}$	1.13 ± 1.50
Amphibole $KCa_2Mg_2Fe_2Al_2Si_6O_{20}(OH)_4$	0.95 ± 0.72
Iron oxyhydroxide minerals	0.83 ± 0.72
$Fe(OH)_3$, $FeOOH$, Fe_2O_3	

[a]Average and standard deviation of 20 soil samples analyzed by McCrone Associates, Inc. (1992). Modal percent is based on the mineral area exposed on a thin section prepared for microscopic examination.

TABLE F.3.I.3-4

SATURATION INDICES FOR URANIUM MINERALS IN PERCHED GROUNDWATER[a]

Mineral Formula (name)	SI[b]
Saturated Phases	
$(UO_2)_2SiO_4 \cdot 2H_2O$ (soddyite)	4.569
$Ca(UO_2)_2(Si_2O_5)_3 \cdot 5H_2O$ (haweeite)	3.634
$(UO_2)_3(PO_4)_2 \cdot 4H_2O$	0.642
$Mg(UO_2)_2(PO_4)_2$ (saleeite)	0.165
$CaUO_4$	0.035
Undersaturated Phases	
$UO_3 \cdot 2H_2O$ (schoepite)	-0.601
β-$UO_2(OH)_2$	-0.751
α-$UO_3 \cdot 0.9H_2O$	-0.820
$Mg(H_3O)_2(UO_2)_2(SiO_4) \cdot 4H_2O$ (sklodowskite)	-0.926
UO_2CO_3 (rutherfordine)	-1.133
U_3O_8	-1.357
U_4O_9	-1.559
$UO_2HPO_4 \cdot 4H_2O$	-2.217
β-U_3O_7	-2.612
UO_2HPO_4	-2.653
UO_2 (uraninite)	-3.059
γ-UO_3	-3.659

TABLE F.3.I.3-4 (Continued)

Mineral Formula (name)	SI[b]
$USiO_4$ (coffinite)	-3.774
$Ca(UO_2)_2(SiO_3)_2(OH)$ (uranophane)	-4.209
$UO_2FOH \cdot 2H_2O$	-4.243
β-UO_3	-4.283
α-UO_3	-4.630
$UO_2FOH \cdot H_2O$	-4.675
UPO_5	-4.965
UO_2FOH	-5.176
$CaU(PO_4)_2 \cdot 2H_2O$ (ningyoite)	-5.343
$H_2(UO_2)_2(PO_4)_2$ (H-autunite)	-5.502
$Na_2U_2O_7$	-5.786
UO_2 (amorphous)	-7.527

[a]Using preliminary average groundwater concentrations from working drafts, except SiO_2^o = 4.55 mg/L. The slight differences in constituent concentrations derived from the most recent statistical reduction of data (contained in this report) will slightly change the SI numbers in this table, but the ranking of the minerals will be unchanged.
[b]Saturation Index (SI) calculated with EQ3/6 geochemical code (Version 7.2) for pH = 7.4, Eh = 0.2 volts, and UO_2^{+2} = 154 mg/L.

F.3.I.4.0 DISTRIBUTION OF URANIUM IN THE GLACIAL OVERBURDEN

F.3.I.4.1 INTRODUCTION

Past releases of uranium from the FEMP occurred in two ways: spills from the handling of uranium solutions in Plants 2/3, 6, and 8 (estimated to be 1,300 kg of uranium; RAC 1994); and air emissions from the pilot plant and Plants 1, 2/3, 4, 5, and 8 (estimated to be 179,000 kg of uranium; Table F.3.I.2-2). Accidental spills resulted in concentrated, mobile point sources in the form of uranyl nitrate, ammonium uranyl, and other uranium solutions, while air emissions led to site-wide deposition of uranium fluoride and oxide solids. The leachability, and hence mobility, of uranium solids processed at the FEMP is summarized and discussed in Table F.3.I.3-2 and Section F.3.I.3.0.

Discussed in this section is the past, present, and future uranium distribution in the glacial overburden based on the uranium solids given in Table F.3.I.3-2 and the aqueous uranium forms discussed in Section F.3.I.2.0. The temporal distribution will be discussed with respect to releases in the production area (i.e., aqueous spills and air emissions) and those areas outside of the production area, Operable Units 1, 2, and 4 (i.e., air emissions only).

F.3.I.4.2 INITIAL URANIUM DISTRIBUTION AT TIME OF RELEASE

Figure F.3.I.4-1a is a schematic cross-section of FEMP glacial overburden showing a conceptual view of the initial uranium distribution in the production area. Although the release events occurred over a 30-year period (1955 to 1985), the conceptual view in Figure F.3.I.4-1a depicts all releases as occurring simultaneously at some time in the past. In the illustrated scenario on Figure F.3.I.4-1a, aqueous acid spills released mobile forms of uranium that immediately began to percolate into and react with the glacial overburden. If uranium concentrations in the aqueous spills exceeded mineral solubilities after reactions with glacial overburden, precipitation of $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $CaUO_4$, $Mg(UO_2)_2(PO_4)_2$, $UO_3 \cdot 2H_2O$, and/or other uranium solids may have occurred (see Table F.3.I.3-4 in Section F.3.I.3.0). The initial distribution of solids released by air emissions is restricted to the top 18 inches of the soil.

Figure F.3.I.4-2a illustrates the initial conditions for uranium release in areas outside of the production area. In these areas, aqueous forms of uranium are absent during the initial deposition, as uranium is deposited as particles derived from air emissions. The more soluble form of these uranium particles (e.g., UF_6) is rapidly dissolved upon the first storm event.

F.3.I.4.3 URANIUM DISTRIBUTION AT THE PRESENT TIME

The present-day scenario under the production area is conceptualized in Figure F.3.I.4-1b, which shows uranium distributed throughout most of the glacial overburden. Soluble uranium forms have been removed by leaching, leaving the less soluble U_3O_8, UO_2, and UO_3. The primary uranium phases may be mixed with alteration products like $UO_3 \cdot 2H_2O$ and precipitates of $CaUO_4$ and $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ throughout the upper portion of the brown glacial overburden. The uranium plume generated from the dissolution of soluble $UO_2(NO_3)_2 \cdot 6H_2O$, UF_6, UF_4, and $Na_2U_2O_7$ particles commingles with the plume derived from spills of aqueous uranium solutions. Principal aqueous species in the migrating plumes are predicted to be $UO_2(CO_3)_2^{-2}$ and $UO_2(CO_3)_3^{-4}$, with minor formation of $(UO_2)_2CO_3(OH)_3^-$, $UO_2(OH)_2^o$, and $UO_2PO_4^-$. Adsorption of uranium on soil particles may be accompanied by precipitation of $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $CaUO_4$, $Mg(UO_2)_2(PO_4)_2$, and/or $UO_3 \cdot 2H_2O$. Site-specific data supporting this conceptual scenario are presented after discussing the uranium distribution in areas outside of the production area.

Figure F.3.I.4-2b summarizes the present conceptual model for uranium distribution in areas impacted solely by uranium particles derived from past atmospheric releases. The uranium plume generated from the dissolution of soluble UF_6, UF_4, and $Na_2U_2O_7$ particles has reached the lower section of the glacial overburden in some areas. Principal aqueous species in the migrating plume are predicted to be $UO_2(CO_3)_2^{-2}$ and $UO_2(CO_3)_3^{-4}$, with minor formation of $(UO_2)_2CO_3(OH)_3^-$, $UO_2(OH)_2^o$, and $UO_2PO_4^-$. Adsorption of uranium on soil particles may be accompanied by precipitation of $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $CaUO_4$, $Mg(UO_2)_2(PO_4)_2$, and/or $UO_3 \cdot 2H_2O$, if a large mass of soluble uranium particles was present initially. Site-specific data supporting this conceptual scenario are presented below.

Across most of the FEMP site, the released uranium is concentrated in the upper 1.5 feet of the glacial overburden and may reach uranium concentrations of greater than 1000 mg/kg of soil (Plates D-10 through D-19; see Plates in DOE, 1994). The uranium forms in the upper 15 feet of weathered and fractured soil are expected to be dominated by the less soluble oxides U_3O_8, UO_2, and UO_3, possibly mixed with precipitates of $CaUO_4$ and $(UO_2)_3(PO_4)_2 \cdot 4H_2O$. $CaUO_4$ and $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ are predicted to be present based on EQ3/6 modeling results using solution analyses obtained from a 70-day leach of surface soil contaminated with uranium oxide particles (Lee et al. 1993). Much of the uranium in the upper 15 feet of the glacial overburden may have been distributed by mechanical processes after deposition. For example, air emission particles that have

been reworked into the upper portion of the glacial overburden by construction activities are transported into fractures by percolating rainwater. However, neutralization of acidic uranyl nitrate spills by carbonate minerals may have produced local areas of intense uranium precipitation in the upper few feet of soil. The persistence of these areas through time is dependent on the solubility of the precipitated solid and the volume of percolating water that contacts the precipitate.

Analytical data collected on subsurface soil samples indicate that uranium is distributed throughout the glacial overburden to a depth of 20 feet in the general area surrounding the pilot plant, Plant 2/3, and Plants 6 and 9 (Plates D-10 through D-19). Uranium concentrations in the 15- to 20-foot interval of unfractured gray glacial till reach values greater than 100 mg/kg. The presence of uranium in this interval implies geochemical, rather than mechanical processes are responsible for the distribution. Aqueous spills, rainwater dissolution of $UO_2(NO_3)_2 \cdot 6H_2O$, UF_6, UF_4, and $Na_2U_2O_7$ particles, and reactions with carbonate minerals in the glacial overburden mobilize the uranium primarily as the aqueous species $UO_2(CO_3)_2^{-2}$, $UO_2(CO_3)_3^{-4}$, and to a lesser extent as $(UO_2)_2CO_3(OH)_3^-$, $UO_2(OH)_2^o$, and $UO_2PO_4^-$. Percolating rainwater transports the species into the subsurface were adsorption and possibly precipitation occur to redistribute the uranium in the subsurface soil. Solids predicted to precipitate in the subsurface include $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $CaUO_4$, $Mg(UO_2)_2(PO_4)_2$, and/or $UO_3 \cdot 2H_2O$.

As noted in Section F.3.I.3.0, uranium concentrations range from 0.0001 to 136 mg/L in groundwater perched within the glacial overburden. Groundwater or porewater containing high uranium concentrations will partition some of the uranium into and onto the soils by precipitation and adsorption processes. A uranium concentration of 136 mg/L is in close agreement with the predicted solubility limits for $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $Mg(UO_2)_2(PO_4)_2$, and $CaUO_4$ in perched groundwater having high bicarbonate activity (Table F.3.I.3-4), implying $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $Mg(UO_2)_2(PO_4)_2$, and/or $CaUO_4$ have precipitated in some of the perched water zones. Scanning electron microscope work conducted on FEMP soil by Oak Ridge National Laboratory (ORNL) noted the association of calcium and phosphate with uranium particles (Lee and Marsh 1992), supporting the presence of $CaUO_4$, $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ or other calcium/phosphate uranium phases in the soil.

Lysimeters placed near the base of the unweathered glacial overburden recovered fluid samples with uranium concentrations that varied from 0.002 to 0.052 mg/L. This information indicates uranium mobilized on the surface of the glacial overburden is capable of infiltrating to the base of the glacial

overburden in less than 40 years. Major ions in the porewater have concentrations similar to perched groundwater, but pH, silica, and phosphate measurements are unavailable. Using major ion analyses of the porewater from Boring 11133, a uranium concentration of 0.052 mg/L, and silica and phosphate analyses from perched groundwater, mineral saturation in the pore fluid was evaluated at a pH of 7.2 (based on the pH for calcite saturation in the porewater). Results of the EQ3/6 run indicate all uranium minerals are undersaturated in the porewater. This implies that the uranium distribution in soil at the base of the unweathered glacial (i.e., in excess of background) is controlled by adsorption.

F.3.I.4.4 URANIUM DISTRIBUTION AT SOME FUTURE TIME

Most of the present source of U_3O_8, UO_2, and $UO_3 \cdot 2H_2O$, and possibly $CaUO_4$ and $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, in the upper 1.5 feet of glacial overburden will be remediated through soil washing and/or removed for solidification. Therefore, the future distribution of uranium in the glacial overburden will be controlled by desorption of physically adsorbed uranium and dissolution of $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $Mg(UO_2)_2(PO_4)_2$, $CaUO_4$, $UO_3 \cdot 2H_2O$, and/or other uranium particles in the subsurface. This scenario is depicted in Figures F.3.I.4-1c and F.3.I.4-2c. Semiquantification of this future uranium distribution is addressed in the remaining discussion of this section.

Based on a hypothetical Operable Unit 5 FS clean-up level of 150 mg U/kg soil, future uranium concentrations in subsurface soil will be less than or equal to 150 mg/kg. If the uranium is assumed to be physically adsorbed, then bounds can be placed on the future concentration of uranium in glacial overburden porewater and groundwater by using the calculated adsorption/desorption values for the 15- to 20-foot depth of glacial overburden (Wells 1348, 1354, 1360, 1266, 1317, 1341, 1225, 1230, and 1250 in Table F.3.II.3-3 of Attachment F.3.II). The lowest and highest adsorption/desorption values for the indicated well locations are 12 and 2433 L/kg, yielding respective uranium concentrations of 12.5 and 0.064 mg/L in groundwater equilibrated with a soil containing 150 mg U/kg soil (i.e., 150 mg/kg ÷ 12 L/kg and 150 mg/kg ÷ 2344 L/kg).

As noted in Section F.3.I.3.0, desorption of adsorbed uranium will depend on the extent of chemisorption, with the expectation that with time desorption values will be higher than adsorption values as uranium is retained or incorporated into the solid by chemisorption (which is evident in the 75 to 2433 L/kg range of values reported in Table F.3.II.3-3. Therefore, a uranium concentration of

12.5 mg/L can be considered the maximum future groundwater concentration (i.e., a conservative estimate) derived from a kilogram of soil containing 150 mg of adsorbed uranium.

For particulate uranium that remains in FEMP soil after remediation efforts are completed, useful information can be extracted from the ORNL leaching study (Lee et al. 1993) to estimate the fraction of uranium leached and released during a three day storm event. A conclusion from the leaching of A-14 and B-16 soil is that 0.1 to 4.5 percent, respectively, of the available uranium may be leached from this soil in three days of leaching (i.e., a large storm event). If FEMP soil of density 1.8 kg/L contains 150 mg of particulate uranium per kg of soil (Operable Unit 5 hypothetical clean-up level) and the porosity is 30 percent, 1 liter of water will contact 3.3 liters of soil – or 891 mg of uranium (i.e., 1.8 kg/L * 3.3 L * 150 mg U/kg). Using the 0.1 and 4.5 percent extractable uranium values from the ORNL study, the calculated uranium solution concentration after three days of leaching is 0.89 and 40 mg/L, respectively. Assuming the uranium forms are similar to the particles present in the ORNL study, these calculated solution concentrations indicate that uranium pore water concentrations derived from the leaching of uranium particulates (as indicated by lysimeter data) can exceed the solubility limit of $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, $Mg(UO_2)_2(PO_4)_2$, and/or $CaUO_4$ if bicarbonate concentrations in the porewater remain below 300 mg/L. The effect of bicarbonate concentrations on uranium solubility is addressed in the summary presented below.

F.3.I.4.5 SUMMARY OF URANIUM DISTRIBUTION

Dissolution of uranium particles (derived from past releases) and precipitates (derived from leaching of uranium source materials) will occur as undersaturated water percolates through the glacial overburden. The rate of dissolution will be highly variable and depend on the surface area and composition of the solid, the pH and composition of the water, and the resident time of the water (i.e., the infiltration rate). As water percolates from the surface to greater depths, total dissolved solids increase and the concentration of individual ions can have a significant effect on uranium concentrations (e.g., HCO_3^-). For example, distilled water contacted with FEMP soil in the ORNL study simulate the conditions in the surface and near surface soil, perched groundwater analyses represent complete equilibration of the water/soil system, and lysimeter data have solute concentrations between these two end members that serve as an analog of percolating porewater. A significant factor influencing the uranium concentration in the water/soil system is the increase in HCO_3^- concentration as water moves from the near surface (121 mg/L, ORNL study), to subsurface (310 mg/L, lysimeter data), to the perched groundwater (470 mg/L). The geochemical conditions in

each of these three zones is discussed with respect to the future distribution of uranium in the glacial overburden.

The ORNL study provides analytical data that can be used to estimate the uranium concentrations that may be attainable if rainwater interacts with surface and near-surface soil containing $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ or $CaUO_4$. Based on the ORNL analytical results after 70 days of leaching, EQ3/6 solubility calculations indicate both solutions are supersaturated with the uranium silicate phases haweeite and soddyite and saturated with quartz, while one solution is saturated with calcite, dolomite, and $CaUO_4$ (pH = 7.7, Ca^{+2} = 40.7 mg/L, UO_2^{+2} = 9.5 mg/L, HCO_3^- = 121 mg/L, PO_4^{-2} = 0.12 mg/L) and the other solution is saturated with $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ (pH = 7.1, Ca^{+2} = 31.8 mg/L, UO_2^{+2} = 0.84 mg/L, HCO_3^- = 90 mg/L, PO_4^{-3} = 4.2 mg/L). The predicted supersaturated state for haweeite and soddyite is in agreement with current understanding on the long time periods required to nucleate and precipitate silicate minerals, as discussed in Section F.3.I.3.0. Saturation of $CaUO_4$ in the B-16 solution indicates that uranium concentrations may reach about 9 mg/L when $CaUO_4$ is present in the glacial overburden and the PO_4^{-3} concentration is kept below 1 mg/L. In contrast, $(UO_2)_3(PO_4)_2 \cdot 4H_2O$ will be stabilized if the PO_4^{-3} concentration increases to about 4 mg/L, resulting in a lower uranium concentration of about 1 mg/L. Therefore, the presence of PO_4^{-3} in moderate concentration will stabilize the more insoluble phase and prolong the time needed to flush uranium from the soil.

As water percolates into the subsurface, HCO_3^- concentrations increase as the CO_2 partial pressure in the soil atmosphere rises (Reactions 2 and 3). As the HCO_3^- concentration increases, the CO_3^{-2} concentration also increases and additional uranium can be complexed by Reactions 15 and 16. Therefore, the solubility of uranium solids is enhanced by the formation of uranyl carbonate species and waters containing higher HCO_3^- concentrations that have the ability to dissolve and flush more uranium out of the soil. Solubility calculations performed with the lysimeter data indicate that uranium concentrations in the water/soil system rise to 42, 17, and 12 mg/L when the lysimeter porewater is saturated with $CaUO_4$, $Mg(UO_2)_2(PO_4)_2$, and $(UO_2)_3(PO_4)_2 \cdot 4H_2O$, respectively. A possible drawback of porewater being saturated with one of the indicated uranium phases is that higher uranium concentrations in the water may result in less desorption of uranium. Therefore, if uranium precipitates persist in the subsurface soil, their dissolution will increase the time needed to desorb uranium from underlying soil.

Groundwater present in perched bodies within the glacial overburden has the highest observed concentrations of HCO_3^- in the water/glacial overburden system, and therefore the highest observed uranium concentrations. As noted in previous discussions, the uranium concentration in perched groundwater will be close to 100 mg/L when the water is near saturation with $CaUO_4$, $Mg(UO_2)_2(PO_4)_2$, or $(UO_2)_3(PO_4)_2 \cdot 4H_2O$. In line with the same arguments presented for the lysimeter data, the increased HCO_3^- concentrations allow a greater portion of the precipitated uranium to be solubilized and carried out of the system. However, the presence of these precipitates in the perched groundwater system will result in less desorption of uranium along the flow path, with the possibility of additional uranium being partitioned onto the soil.

In summary, the future distribution of uranium forms will be similar to the present day distribution with the exception of the removed uranium oxide particles from the surface source. Remediation activities will result in uranium concentrations in the glacial that are less than or equal to 150 mg/kg. Uranium concentrations in groundwater will be lowered as a result of soil remediation and source removal, and will continually decrease with time as fresh water percolates through the soil and removes uranium by dissolution and desorption. Dissolution of uranium solids will be enhanced as the fresh water increases its HCO_3^- concentration, but the extent of desorption will be suppressed if the dissolution of uranium solids takes place in advance of encountered adsorbed uranium.

F.3.I.5.0 GEOCHEMICAL PARAMETERS FOR FATE AND TRANSPORT MODELING

F.3.I.5.1 DEFINITION OF GEOCHEMICAL PARAMETERS

Available site-specific data on uranium concentrations in soil and aqueous media are used to define the following geochemical parameters used in the Operable Unit 5 fate and transport model.

- K_l – FEMP term defined as the leaching coefficient in units of L/kg. This coefficient is determined using a batch test that contacts waste or contaminated soil with a distilled water solution adjusted to a pH of 5.6 with sulfuric acid. The batch test is run for 15 to 20 days by tumbling the solid and solution in a reaction vessel, and the final solution is analyzed for uranium. A leaching coefficient is calculated by dividing the uranium concentration on the solid (only uranium in excess of background) by the uranium concentration in solution (i.e., mg/kg ÷ mg/L = L/kg).

- K_l^{calc} – FEMP term defined as the calculated leaching coefficient in units of L/kg. This coefficient represents the in situ leaching coefficient as determined by dividing the uranium concentration for the contaminated soil (only uranium in excess of background) by the uranium concentration in perched groundwater contacting the soil (i.e., mg/kg ÷ mg/L = L/kg). The calculated leaching coefficient applies to soils in the upper 15 feet of glacial overburden, where weathering and fractures allow particulate uranium to be transported to depth.

- K_d – the adsorption/desorption value or partition coefficient in units of L/kg. The partition coefficient is determined by batch tests that contact soil with spiked uranium solutions (adsorption) and distilled water (desorption). A partition coefficient is calculated by dividing the uranium concentration on the solid (only uranium in excess of background) by the uranium concentration in solution (i.e., mg/kg ÷ mg/L = L/kg). In general, only an adsorption or desorption value is determined from the batch test and the assumption is made that the reaction is reversible (i.e., adsorption = desorption = K_d). These tests are conducted with uncontaminated soil (adsorption) or contaminated soil that are known to contain only adsorbed uranium (desorption).

- K_d^{calc} – the calculated adsorption/desorption value or calculated partition coefficient in units of L/kg. The calculated partition coefficient represents the in situ partition coefficient as determined by dividing the adsorbed uranium concentration for the contaminated soil (only uranium in excess of background) by the uranium concentration in perched groundwater contacting the soil (i.e., mg/kg ÷ mg/L = L/kg). The calculated partition coefficient applies to soil in unweathered gray till at depths of 15 to 20 feet below the surface, where weathering and fractures are absent and uranium is transported only as a dissolved specie.

- K_e – the extractable uranium present in contaminated soil in units of percent total uranium. This parameter represents the extractable portion of uranium that can be removed from contaminated soil by washing techniques proposed for the Operable Unit 5 FS. Preliminary batch tests indicate 30 to 90 percent of the total uranium present can be extracted using soil washing reagents.

The distinction between the parameters K_l and K_d is based on the type of uranium solid that is present in the soil. For K_l, uranium may be present as particulate and adsorbed uranium, and the leaching coefficient measures uranium mobilization due to dissolution and desorption. The K_d is a measurement of adsorption/desorption equilibrium between soil and water, and solid uranium in excess of background is present only as adsorbed uranium.

In the Operable Unit 5 fate and transport model describing uranium migration in the glacial overburden, K_l or K_l^{calc} is used to define the initial aqueous loading of uranium based on the extractable portion of uranium (i.e., K_e) in the soil. For example, a kilogram of soil contains 150 mg of uranium of which 50 percent can be extracted by soil washing techniques, and K_l is determined to be 20 L/kg. Using these values, the first pore volume of rain water to move through this soil is estimated to have a uranium concentration of 3.75 mg/L (i.e., (150 mg/kg * 0.5) ÷ 20 L/kg). Each successive pore volume of water will have a lower uranium concentration as the extractable percent of uranium becomes depleted. A calculated depletion curve is used to determine the uranium loading as a function of time. Once uranium is loaded into the aqueous medium and transport begins through the glacial overburden, K_d or K_d^{calc} is used to calculate the uranium retardation factor for the glacial overburden. Further details on the use of these parameters are developed below.

F.3.I.5.2 SITE-SPECIFIC GEOCHEMICAL PARAMETERS

Available information that can be used to assign geochemical parameters for fate and transport modeling include site-specific batch tests with waste materials and contaminated and uncontaminated soil, existing uranium analytical data on glacial overburden and perched groundwater, and pertinent literature studies conducted with similar soil. The current range of site-specific geochemical parameters is given in Table F.3.I.5-1.

For contaminated soil defined as waste materials (Table F.3.I.5-1), the K_l values range from 12 to 1708 L/kg and K_l^{calc} from 0.6 to 3558 L/kg. This wide range in leaching coefficients reflects both the variation in solubility of the uranium solids present in the soil (see Table F.3.I.3-2) and the amount of time adsorbed uranium has been present on the soil particles. Soil (containing soluble uranium forms (e.g., UF_6) and physically adsorbed uranium (as opposed to chemisorbed uranium) readily release the uranium to solution, resulting in low leaching coefficients. Conversely, less soluble uranium particles (e.g., UO_2) and chemisorbed uranium are slowly released to solution, resulting in high leaching coefficients.

For the Operable Unit 5 fate and transport model, the leaching coefficients that reflect the present release of uranium from contaminated soil range from 12 to 311 L/kg (Table F.3.I.5-1). This range is in good agreement with the mean values reported for K_l^{calc} in the production area, with 14 L/kg representing the soluble uranium forms and 301 L/kg the less soluble uranium solids. Therefore, uranium loadings in the fate and transport model will be derived using leaching coefficients near 12 L/kg when aqueous spills and/or soluble uranium forms are known or suspected to be present (i.e., in the Plant 2/3, Plant 6, and Plant 9 areas) and by using values near 311 L/kg when less soluble forms of uranium are present. This latter condition presently holds for most of the site soil where residual uranium oxide particles are the dominant source of uranium.

After uranium is leached from the source it is free to migrate through the glacial overburden; the fate and transport model uses K_d or K_d^{calc} to describe the retardation of uranium by the glacial overburden. Glacial overburden K_d values derived from adsorption batch tests range from 11 to 40 L/kg, with a combined mean of 25 L/kg for the four reported values (Table F.3.I.5-1). The K_d^{calc} values are grossly different for production area soil associated with aqueous spills (12 to 32 L/kg) as compared to the soil known to be contaminated solely by release of uranium from surface particles (75 to 2433 L/kg). Discreet ranges of K_d^{calc} for these two areas are interpreted to reflect the difference in surface reaction kinetics associated with adsorption and desorption, as discussed in Section F.3.I.3.0 and conceptualized below.

Leaching of uranium results in a migrating plume away from the source. The front of this plume reaches an underlying soil horizon and the uranium concentration in the plume continues to increase at this horizon as the plume passes through. As long as the surface source is present, the uranium concentration in the plume will increase toward its maximum concentration and adsorption of uranium will be the dominant process at this soil horizon if the maximum concentration (i.e., the peak) of uranium remains below the solubility limit of uranium solids. To illustrate, assume partition-coefficient equilibrium (a tenet of the fate and transport model) between the aqueous and solid phases is given by:

$$\text{adsorbed uranium (mg/kg)} \div \text{aqueous uranium (mg/L)} = 24 \text{ L/kg}$$

where 24 L/kg is the average K_d value for the Operable Unit 2 and Brookhaven National Laboratory (BNL) adsorption studies (Table F.3.I.5-1). As the aqueous uranium concentration increases,

uranium must be adsorbed onto the solid to satisfy the partition-coefficient equilibrium. Therefore, desorption is not favored as long as the aqueous uranium concentration is increasing toward the peak concentration.

Removal of the uranium source will result in dilution of the uranium plume by fresh infiltrating rainwater, which will lower aqueous uranium concentrations and initiate desorption to satisfy the partition-coefficient equilibrium. However, as noted in Section F.3.I.3.0, desorption values are greater than adsorption values when enough time is available (i.e., months to years) for chemisorption to occur because chemisorption imparts a hysteresis to the adsorption/desorption process that prevents desorption of the entire mass of adsorbed uranium. Using the partition-coefficient expression above and the principle of chemisorption, adsorbed uranium will not completely desorb in response to a decreasing aqueous uranium concentration and the partition coefficient must increase to account for the hysteresis phenomenon. Therefore, if the migrating plume takes years to pass a given horizon of the soil (a common observation), ample time has passed for chemisorption to occur and calculated desorption values will exceed adsorption values.

These adsorption and desorption concepts can be applied to glacial overburden in the production area. Glacial overburden soil contaminated by aqueous spills is experiencing active adsorption (12 to 32 L/kg, Table F.3.I.5-1), due to the presence of a soluble uranium source that is leaching to produce increasing uranium concentrations in the plume. Soil contaminated by the release of uranium from air emissions are experiencing desorption (75 to 2,433 L/kg, Table F.3.I.5-1), because past releases of soluble particles (e.g., UF_6) have been dissolved by rainwater and the peak concentration from the dissolution of these particles has passed through the overburden. The less soluble uranium oxides remaining on the surface do not leach as readily as uranium fluoride particles, resulting in a decrease in the aqueous uranium concentration in the plume and initiation of the desorption process.

Historical information on uranium releases (Section F.3.I.2.0) supports the conceptual model of adsorption in areas of aqueous spills/leaks versus desorption in areas that received only uranium particles from air emissions. Aqueous spills and leaks occurred on a continuous basis from production activities associated with Plants 2/3, 6, and 9, and these activities have placed a large source of soluble uranium in local areas of the glacial overburden. Air emissions of uranium fluoride and oxide particles cover the entire production area, with uranium oxides comprising about 75 percent of the released mass (Section F.3.I.2.0). As rainwater rapidly dissolved the soluble uranium fluoride

particles, the resulting plume reached its maximum uranium concentration quickly and this peak has passed through the glacial overburden in most areas (i.e., desorption is now occurring in these areas). Around Plants 2/3, 6, and 9, the large source of soluble uranium has not been depleted, and the uranium concentration in the migrating plume continues to increase (i.e., adsorption is occurring in these areas). Therefore, adsorption values best describe uranium retardation in areas having soluble uranium sources.

Independent evidence for active adsorption in the Plant 2/3, Plant 6, and Plant 9 areas can be found in the adsorption values obtained from the Operable Unit 2 and BNL studies (Table F.3.I.5-1). The average K_d value derived from these adsorption studies is identical to the K_d^{calc} average reported for production area soil contaminated by aqueous spills (i.e., 24 L/kg). Given the Operable Unit 2 and BNL batch-test results and in situ measurements from the production area, a K_d value of 24 L/kg is recommended for the fate and transport model to describe the adsorption of uranium onto glacial overburden, if the migrating plume hasn't reached its peak concentration. When soluble forms of uranium have been depleted from the source and the plume peak has passed through the glacial overburden, larger K_d values are warranted to describe the desorption. The best estimate of K_d for the fate and transport model when desorption is occurring is the K_d^{calc} geometric mean of 270 L/kg (Table F.3.I.5-1). A sensitivity analysis conducted with the fate and transport model has bounded the uranium migration using values of 15 and 222 L/kg. The slight difference in these and the recommended values will produce no significant change in the existing sensitivity analysis.

Numerous uranium adsorption values have been reported in the literature, and a summary by Sheppard et al. (1984) lists several studies conducted under a variety of conditions that cover a range of uranium adsorption values from 0.13 to 790,000 L/kg. The studies summarized in Sheppard et al. (1984) that are most pertinent to the FEMP glacial overburden and Great Miami Aquifer are those of Rancon (1973) and Yamamoto et al. (1973).

Rancon (1973) studied the adsorption of uranium on carbonate soil and reported uranium adsorption values of 16 and 33 L/kg, respectively. These values are in good agreement with the Operable Unit 2 and BNL adsorption studies (Table F.3.I.5-1), and indicate that the adsorption behavior of uranium in carbonate soils is remarkably consistent.

Yamamoto et al. (1973) investigated uranium adsorption onto sandy soil from carbonate solutions and reported uranium adsorption values of 0.13 to 0.25 L/kg. These low values reflect the coarse particle size (i.e., reduced surface area) and composition (i.e., lack of carbonate minerals, aluminum and iron oxyhydroxide surfaces, and clay minerals) of the sandy soil and the complexation of uranium by carbonate ion (Reactions 15 and 16 in Section F.3.I.3.0). Results from this study are close to the lowest value reported for the saturated sand and gravel aquifer in the south plume area (Table F.3.I.5-1), and may be appropriate for examining adsorption in the Great Miami Aquifer.

F.3.I.5.3 SUMMARY

Experimental data derived from batch tests, site-specific uranium concentrations in soil and groundwater, and literature studies are used to define and justify the assignment of geochemical parameters to the ODAST fate and transport model of the glacial overburden. Leaching of uranium from near-surface Operable Unit 5 soil sources has been investigated with batch tests and analytical measurements on site-specific soil and groundwater samples to define the 12 to 311 L/kg range for K_l and K_l^{calc} values. The K_l and K_l^{calc} values are used to develop uranium loading curves as a function of time, and these curves are used as input data to the fate and transport model. The large range in K_l and K_l^{calc} values reflects the heterogeneity of uranium forms in the contaminated soil.

Adsorption batch tests, uranium analyses of site-specific soil and groundwater samples, and literature studies indicate that the adsorption of uranium onto glacial overburden soil is best defined using a K_d value of 24 L/kg. The uniform range of adsorption values for several independent studies reflects the homogeneous distribution of uranyl carbonate species in the groundwater/glacial overburden environment. Desorption of uranium will occur when the plume peak has passed through the overburden or when the uranium source is removed from the glacial overburden, and a K_d value as high as 270 L/kg may be used to model the desorption of uranium. A large range in the observed desorption values (75 to 2433 L/kg) reflects chemisorption of uranium by the soil particle surface; with chemisorption favored by increasing residence time. Modeling a desorption scenario will apply to source areas depleted of their soluble uranium or areas where the source is excavated and removed.

TABLE F.3.I.5-1

RANGE OF SITE-SPECIFIC GEOCHEMICAL PARAMETERS

Media	Parameter (L/kg)	Range
Waste Materials		
Plant 2/3, Plant 6, and Plant 9 contaminated soil	K_l^{calc}	0.6 - 8.35[a] (14[b])
Remaining production area contaminated soil	K_l^{calc}	75 - 3,558[a] (301[b])
OU2 waste	K_l	37 - 177[c]
OU2 contaminated soil	K_l	200 - 280[c]
OU4 contaminated soil	K_l	12 - 15[c]
OU5 contaminated soil	K_l	12 - 311[d]
Contaminated soil studied by Oak Ridge National Laboratory	K_l	64 - 1708[e]
Glacial Overburden		
OU2 soil	Adsorption K_d	11 - 40[c]
BNL study	Adsorption K_d	23 - 25[f]
Production area subsurface soil contaminated by aqueous spills	Adsorption K_d^{calc}	12 - 32[g] (24[h])
Production area subsurface soil contaminated by air emissions	Desorption K_d^{calc}	75 - 2,433[g] (270[b])
Unsaturated Sand and Gravel		
OU2 South Field	K_d	10 - 12[c]
Saturated Sand and Gravel		
OU1 waste pit area	K_d^{calc}	2 - 68[i] (14[b])
OU2 South Field	K_d	6 - 9[c]
South Plume area	K_d^{calc}	0.8 - 4.4[i] (2.7[h])
Calibration of SWIFT model	K_d^{calc}	1.8

[a]Production area soil contaminated by uranium releases, as indicated in Table F.3.II.3-3.
[b]Geometric mean for indicated range.
[c]DOE (1993c). K_l determined from 17-day batch test with deionized water at initial pH of 5.6. Adsorption K_d determined from 17-day batch test with spiked solution.
[d]Unpublished preliminary results from OU5 soil washing studies. K_l determined from 17-day batch test with deionized water at initial pH of 5.6.
[e]Lee et al. (1993). K_l determined from 21-day batch test with deionized water.
[f]IT (1993). K_d determined from 60-day batch test with spiked perched groundwater.
[g]Production area subsurface soil between 15 and 20 feet below the surface contaminated by uranium releases, as indicated by Wells 1348, 1354, 1360, 1266, 1317, 1341, 1225, 1230, and 1250 in Table F.3.II.
[h]Arithmetic mean for indicated range.
[i]DOE (1993d). Appendix A, Issue 3 and 5 Report.

REFERENCES

Faure, G., 1977, Principles of Isotope Geology, John Wiley and Sons, New York.

Freeze, R. A. and J. A. Cherry, 1979, Groundwater, Prentice-Hall, Inc., Englewood Cliffs, NJ.

IT Corp., 1993, "Adsorption of Select Metals and Radionuclides on Glacial Overburden Present at the Fernald Environmental Management Project Site," Draft, Fernald Environmental Management Program, Cincinnati, OH.

Lasaga, A. C., 1981, Rate Laws of Chemical Reactions," in Reviews in Mineralogy, Volume 8, Kinetics of Geochemical Processes, A.C. Lasaga and R.J. Kirkpatrick, eds., Mineralogical Soc. of America, Washington, DC.

Lee, S. Y. and J. D. Marsh, 1992, "Characterization of Uranium Contaminated Soils from DOE Fernald Environmental Management Project Site: Results of Phase I Characterization," Oak Ridge National Laboratory, ORNL/TM-11980, Oak Ridge, TN.

Lee, S. Y., M. Elless, and F. Hoffman, 1993, "Solubility Measurement of Uranium in Uranium Contaminated Soils," Oak Ridge National Laboratory, ORNL/TM-12401, Oak Ridge, TN.

McCrone Associates, Inc., 1992, "Mineralogy of Soil Core Samples," Fernald Environmental Management Project, Cincinnati, OH.

Radiological Assessments Corporation (RAC), 1993, "The Fernald Dosimetry Reconstruction Project, Tasks 2 and 3, Radionuclide Source Terms and Uncertainties," RAC Report CDC-5, RAC, Neeses, SC.

Rancon, D., 1973, "The Behavior in Underground Environments of Uranium and Thorium Discharged by the Nuclear Industry," in: Environmental Behavior of Radionuclides Released in the Nuclear Industry, International Atomic Energy Agency Report, IAEA-SM-172/55.

Sheppard, M. I., D. I. Beals, D. H. Thibault, and P. O'Connor, 1984, "Soil Nuclide Distribution Coefficients and Their Statistical Distributions," Atomic Energy of Canada Limited, AECL-8364, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba.

Stumm W. and J. J. Morgan, 1981, Aquatic Geochemistry, John Wiley and Sons, New York, NY.

U.S. Dept. of Energy, 1993a, "Groundwater Modeling Report – Summary of Model Development," Fernald Environmental Management Program, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1993b, "Groundwater Model Evaluation Report and Improvement Plan," Fernald Environmental Management Project, DOE, Fernald Field Office, Cincinnati, OH.

U.S. Dept. of Energy, 1993c, "Uranium Partition Coefficient Evaluation Study for Operable Unit 2," Fernald Environmental Management Program, DOE, Fernald Field Office, Cincinnati, OH.

Wolery, T. J., 1992, EQ3NR, "A Computer Program for Geochemical Aqueous Speciation-Solubility Calculations: Theoretical Manual, User's Guide, and Related Documentation (Version 7.0)," Lawrence Livermore National Laboratory, UCRL-MA-110662 PT III, Berkeley, CA.

Wolery, T. J. and S. A. Daveler, 1992, EQ6, "A Computer Program for Reaction Path Modeling of Geochemical Systems: Theoretical Manual, User's Guide, and Related Documentation (Version 7.0)," Lawrence Livermore National Laboratory, UCRL-MA-110662 PT IV, Berkeley, CA.

Yamamoto, T., E. Yunoki, M. Yamakawa, and M. Shimizu, 1973, "Studies on Environmental Contamination by Uranium. 3: The Effects of Carbonate Ion on Uranium Adsorption to and Desorption from Soils," Journal of Radiation Research, V. 14, p. 219.

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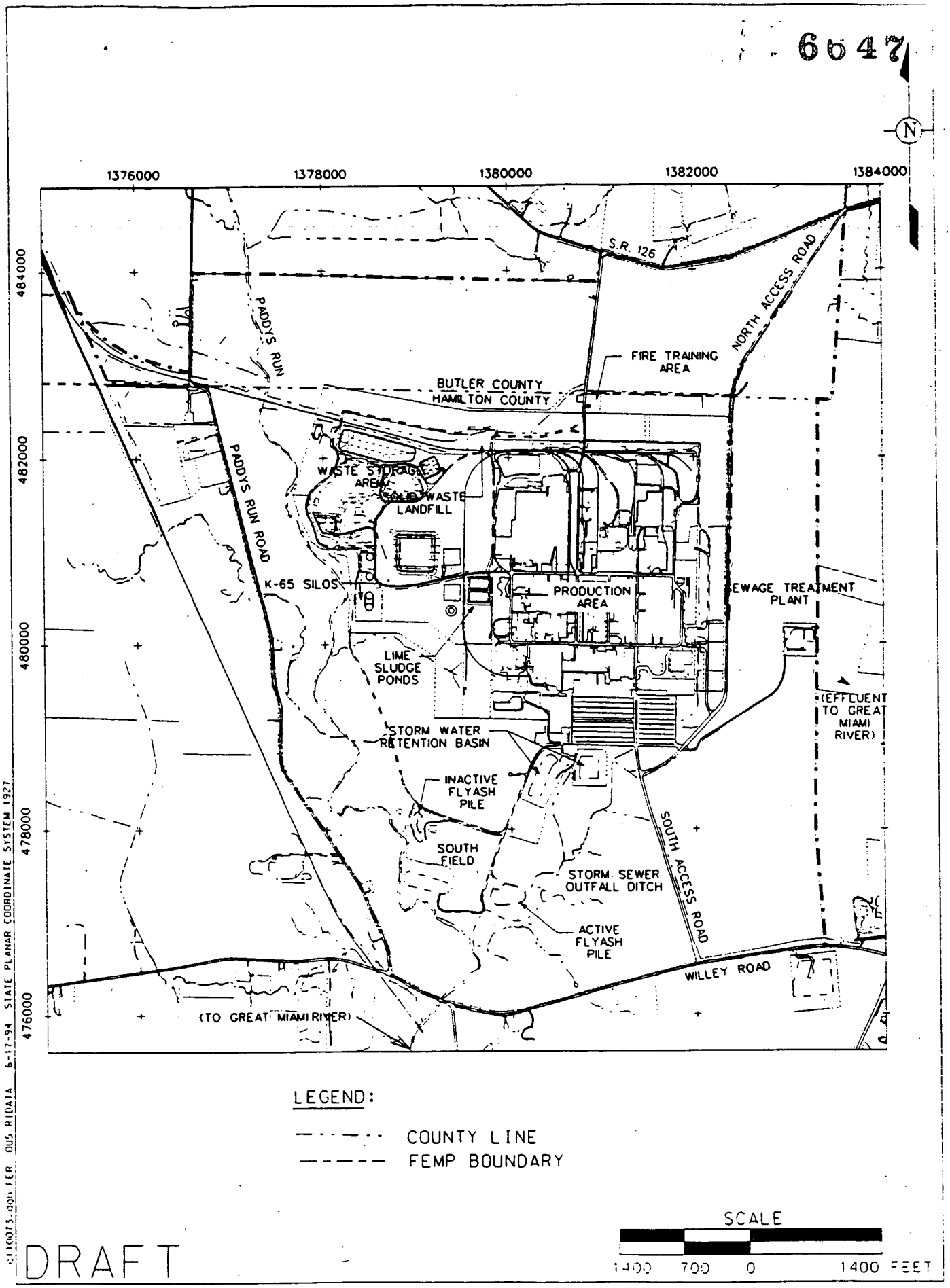

FIGURE F.3.I.2-1. MAJOR FEATURES OF THE FEMP

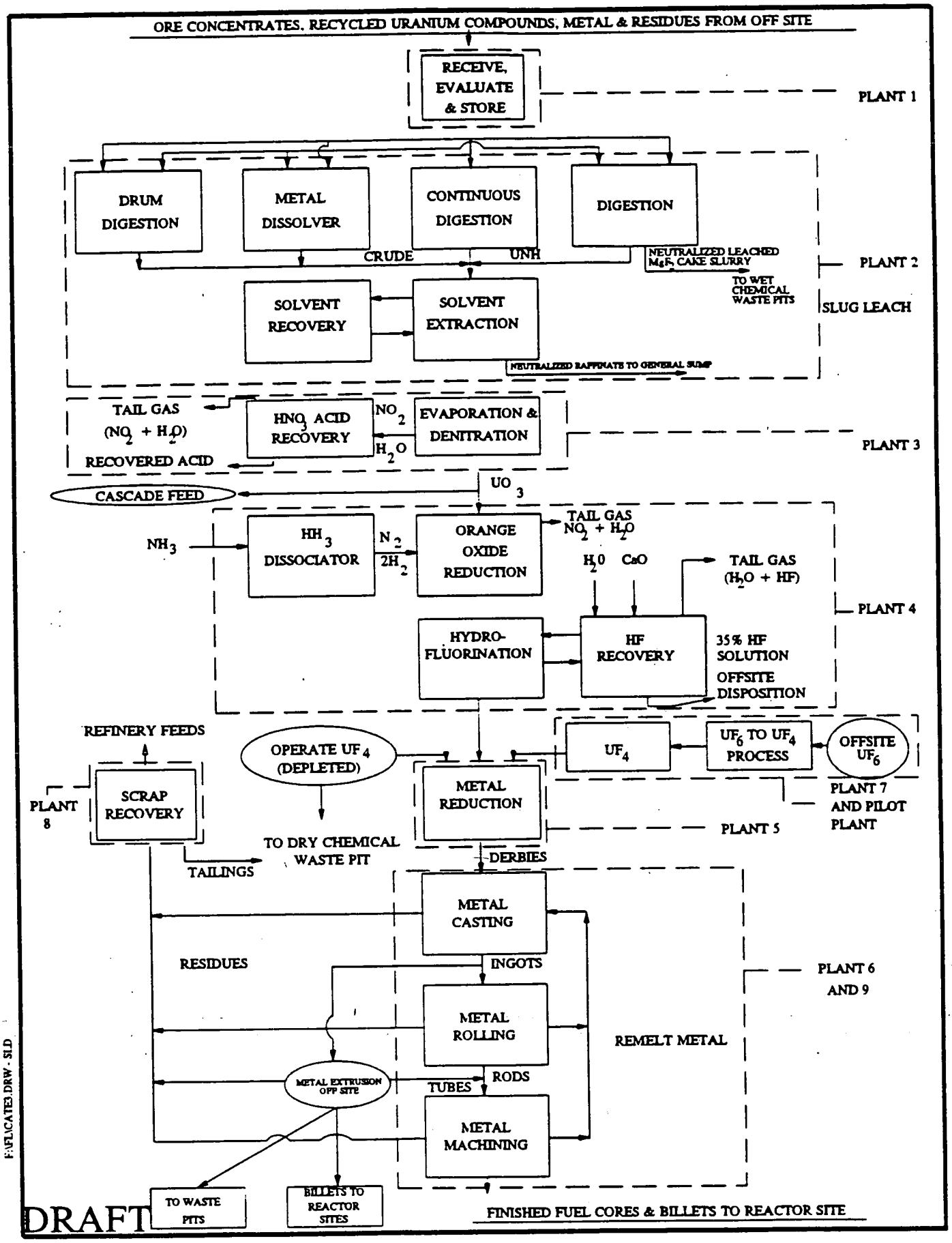

FIGURE F.3.1.2-2. SCHEMATIC DIAGRAM OF THE FEMP PROCESS

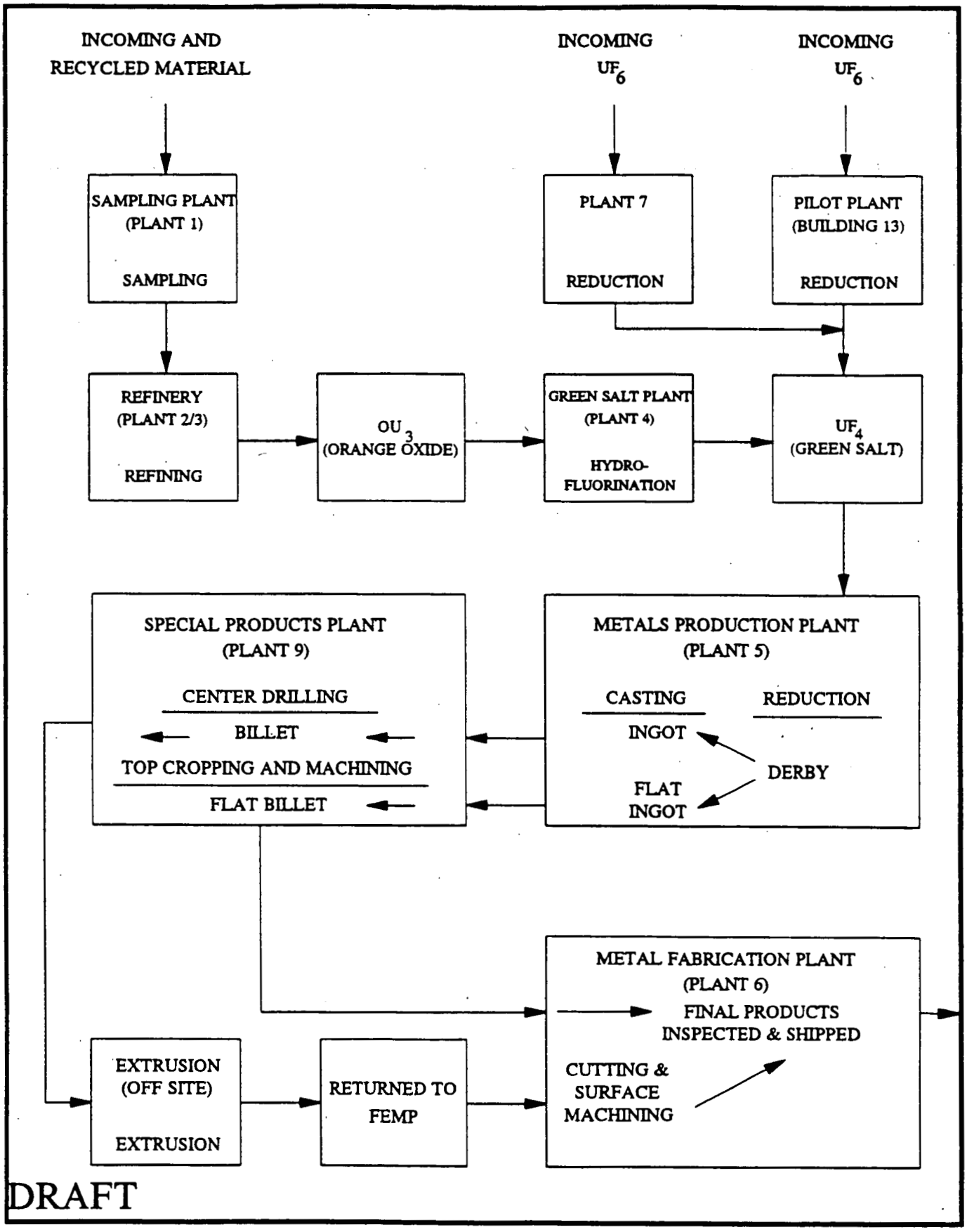

FIGURE F.3.I.2-3. URANIUM METAL PROCESS DIAGRAM

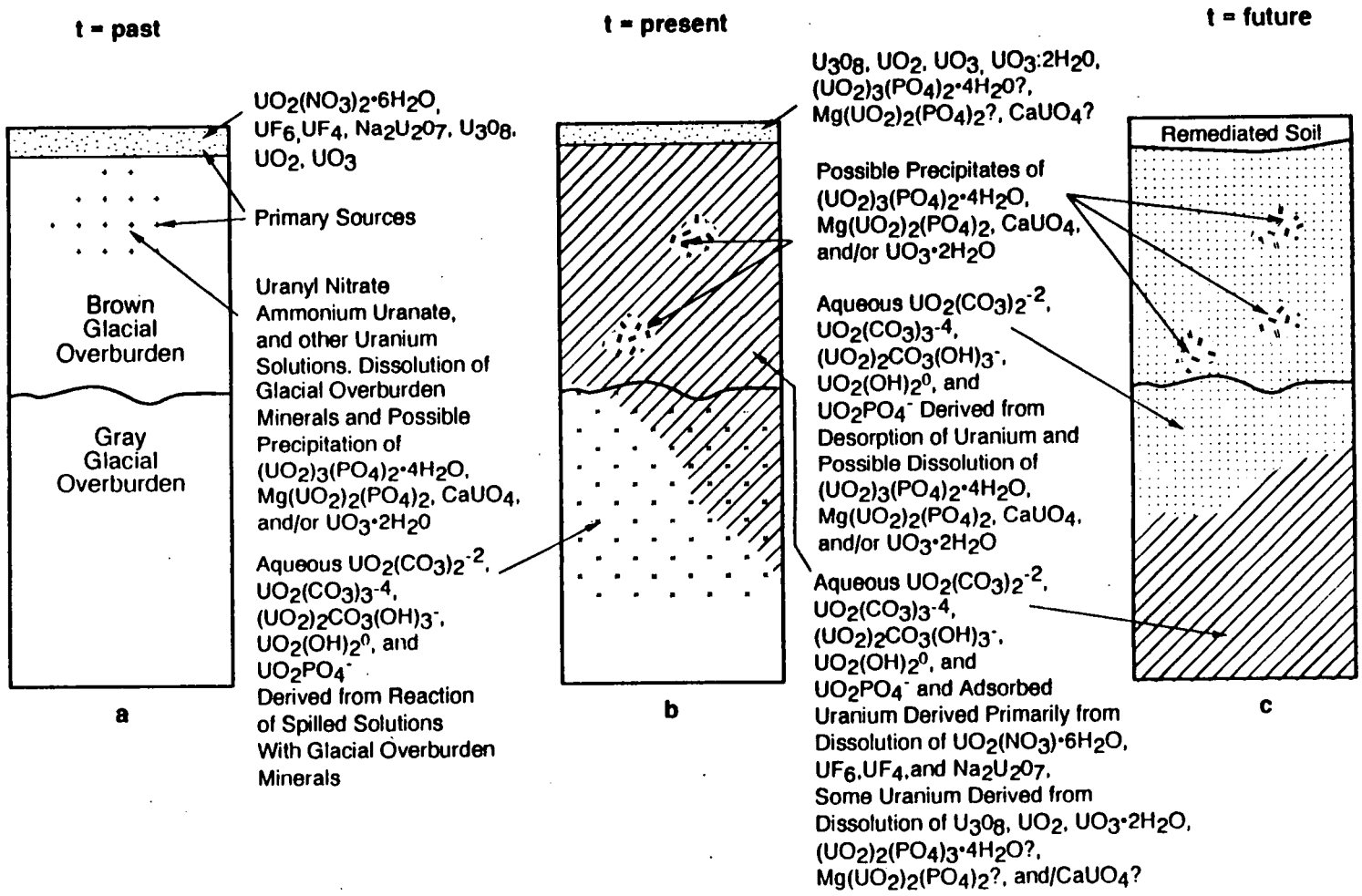

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FIGURE F.3.1.4-1. URANIUM DISTRIBUTION RESULTING FROM AQUEOUS AND PARTICULATE SOURCES

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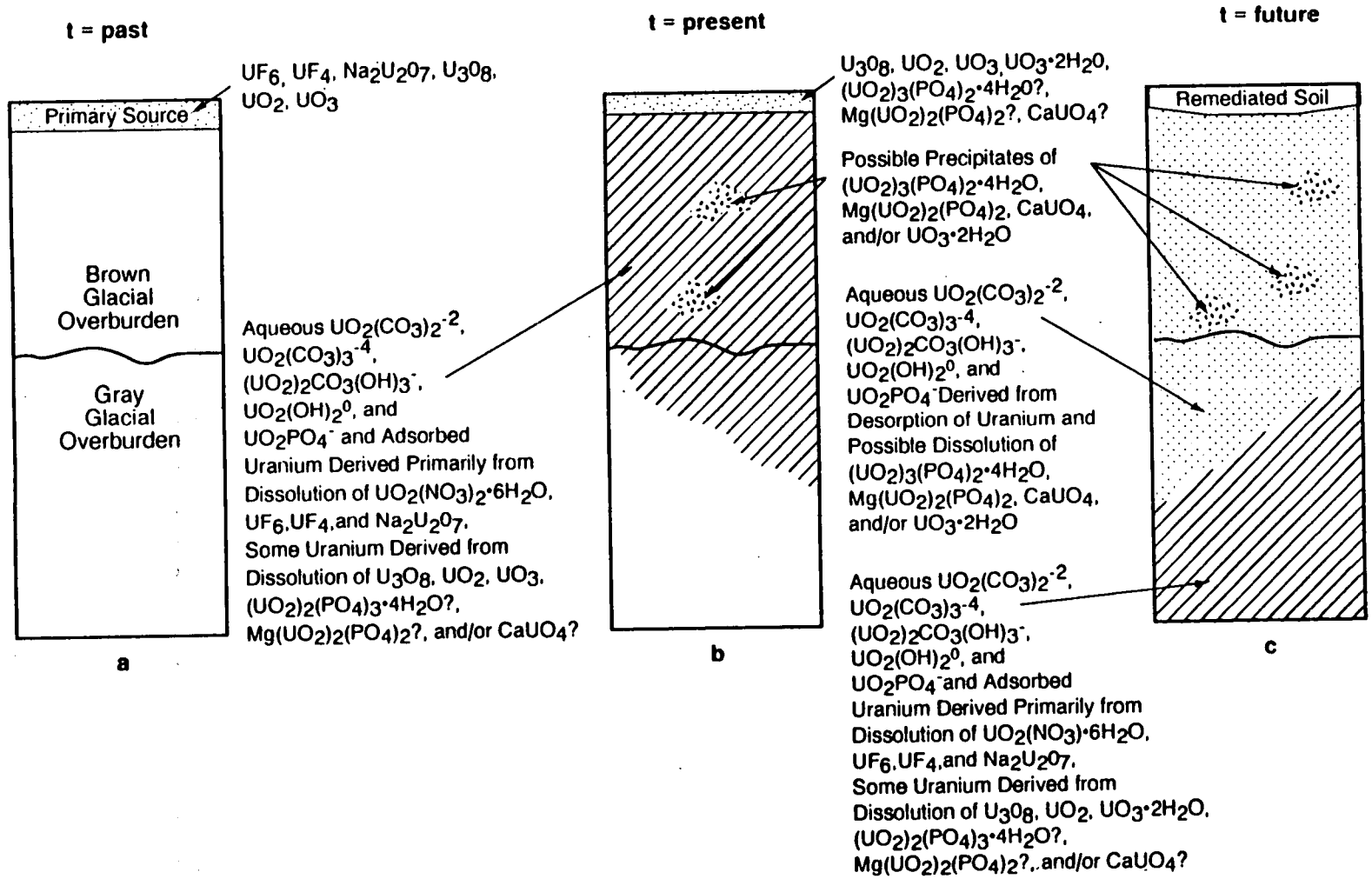

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FIGURE 5.7.1.4-2 URANIUM DISTRIBUTION RESULTING FROM PARTICULATE SOURCES

APPENDIX D.5

DEVELOPMENT OF MODIFIED SOIL PRGS PROTECTIVE OF SEDIMENTS AND SURFACE WATER

D.5.0 DEVELOPMENT OF MODIFIED SOIL PRGS PROTECTIVE OF SEDIMENTS AND SURFACE WATER

The following section summarizes the calculation of PRGs for use in the FS. PRGs and PRLs are presented in Section 2.0, utilized in Section 3.0 to calculate volumes, and utilized in Section 5.0 to define long-term residual risks. PRGs were calculated for COCs that were defined in the Baseline Risk Assessment. These COCs are listed in Table 2-1. PRGs are separated into four categories: risk based, land-use modified, cross-media modified, and source control modified.

D.5.1 Risked Based Soil PRG Development

Risked based soil PRGs were calculated in the Baseline Risk Assessment for the on-property resident farmer, the expanded trespasser, and the off-property resident farmer. The risk based soil PRGs were calculated by proportioning the risk due to a COC from all pertinent pathways to the COC's soil concentration and equating that value to the ratio of an acceptable ILCR (1×10^{-6}) to the PRG.

$$PRG_i = \frac{(ILCR)(C_{si})}{\Sigma risk_i} \qquad (D.5\text{-}1)$$

where:

PRG_i = Preliminary remediation goal for constituent "i" in surface soils

ILCR = Target risk level 10^{-4} to 10^{-6} for carcinogens

Σ $risk_i$ = Sum of risk from all direct and indirect exposure pathways from Great Miami River water

C_{si} = Concentration of COC "i" in surface soils

The soil PRG for a COC is calculated for those subunits where the COC applies by using the risk and soil concentrations from the Baseline Risk Assessment. Since the relationship between risk and exposure point concentration is linear, the resulting PRG will remain the same when concentrations and risks vary for the individual Operable Unit 2 subunits. Only a small variation occurs in the PRGs between the Operable Unit 2 subunits due to rounding and changes in the exposure pathways.

Because the PRGs are similar, the South Field PRGs were chosen to represent the Operable Unit 2 risk based PRGs. The South Field was chosen because it had the most COCs, and it's PRGs were conservative when compared to other subunits (i.e. South Field PRGs were lower than other

subunits). For those COCs that were not in the South Field (e.g. carbazole in the Solid Waste Landfill) the most conservative PRG from the other subunits was used. Table D.5-1 contains the risk values and soil concentrations used to develop the risk based soil PRGs for Operable Unit 2 COCs.

An example calculation for the risk based soil PRG is provided below:

$$PRG = \frac{9.31\ pCi/g}{3.8E-5\ ILCR} \times 10^{-6}\ ILCR$$

$$PRG = 2.5E-1\ pCi/g$$

The values shown in the above equation are for the South Field (see Table D.5-1). The soil concentration is the concentration term for uranium-238 in surface soils in the South Field, and the risk is the ILCR for uranium-238 exposure to the on-property resident farmer. The resulting PRG is the risk based soil PRG for uranium-238 in the South Field.

D.5.2 Land-use Modified Soil PRG Development

Land-use modified soil PRGs are calculated using equation D.5-1, the same as risk based PRGs; however, the ILCR is for the expanded trespasser or off-property resident farmer, rather than the on-property resident farmer. Table D.5-2 contains the data from the RI Report that was used to calculate expanded trespasser PRGs. The risk to soil is due to ingestion, inhalation, dermal contact, and external radiation. Table D.5-3 contains the data from the RI Report that was used to calculate off-property resident farmer PRGs for federal ownership.

D.5.3 Cross Media Modified PRG Development

This section provides the details of development of the modified soil PRGs protective of sediments, surface water, and air (radon). Modified soil PRGs were based on the following:

- For chemical toxicants, a HI $\geq$ 0.2
- For chemical and radiation carcinogens, an ILCR $\geq$ 1.0×10^{-6}
- Dose limits, ARARs, and TBC requirements

TABLE D.5-1

ON-PROPERTY RESIDENT FARMER SOUTH FIELD PATHWAY RISKS (ILCR or HI) AND RISK BASED PRGs

COCs	Soil Concentration (mg/kg or pCi/g)	Risk Due to Ingestion, Inhalation, Dermal Contact, and Direct Radiation from Soil	Risk Due to Ingestion From Vegetables and Fruits	Risk Due to Ingestion From Milk and Beef	Total Risk	PRG 1×10^{-6} ILCR or 0.2 HI
Cesium - 137	0.509	4.2E-5	5.4E-7	5.5E-6	4.8E-5	1.1E-2
Neptunium - 237	0.21	4.3E-6	6.1E-7	3.6E-8	4.95E-6	4.3E-2
Plutonium - 238	0.12	3.0E-7	1.6E-9	2.2E-11	3.02E-7	4.0E-1
Radium - 226	30.80	7.8E-3	4.7E-5	1.1E-4	7.96E-3	3.9E-3
Radium - 228	3.88	4.7E-4	7.5E-7	1.8E-6	4.73E-4	8.2E-3
Thorium - 228	4.41	1.0E-3	2.7E-8	6.2E-9	1E-3	4.3E-3
Thorium - 230	13.80	1.8E-5	2.1E-8	4.7E-9	1.8E-5	7.7E-1
Thorium - 232	3.99	1.4E-3	7.8E-8	1.8E-8	1.4E-3	2.8E-3
Uranium - 234	8.66	9.9E-6	7.2E-7	6.1E-7	1.1E-5	7.7E-1
Uranium - 235/236	0.89	9.8E-6	7.3E-8	6.3E-8	9.9E-6	9.0E-2
Uranium - 238	9.31	3.5E-5	1.3E-6	1.2E-6	3.8E-5	2.5E-1
Arsenic	7.27	3.5E-5	5.5E-5	7.3E-5	1.6E-4	4.5E-2
Beryllium	0.94	2.0E-5	4.4E-6	4.2E-6	2.9E-5	3.3E-2
Benzo(a)anthracene	5.5	2.0E-5	6.0E-5	1.6E-4	2.4E-4	2.3E-2
Benzo(a)pyrene	9.4	3.4E-4	5.7E-4	5.4E-3	6.3E-3	1.5E-3
Benzo(b)fluoranthene	6.2	2.2E-5	3.7E-5	3.7E-4	4.3E-4	1.4E-2
Benzo(k)fluoranthene	7.3	2.6E-6	1.7E-6	1.5E-4	1.5E-4	4.7E-2
Dibenzo(a,h)anthracene	1.9	6.9E-5	4.3E-5	4.0E-3	4.1E-3	4.6E-4
Indeno(1,2,3-cd)pyrene	6	2.2E-5	1.9E-5	7.8E-4	8.2E-4	7.3E-3
Aroclor - 1254	0.09	6.0E-6	6.3E-6	4.9E-5	6.1E-5	1.5E-3
Aroclor - 1260	0.05	3.5E-6	8.3E-7	2.1E-4	2.1E-4	2.3E-4
Dieldrin	0.01	1.2E-6	2.5E-4	1.5E-7	2.5E-4	4E-5
Uranium Total[a]	214.32	------	9.3E-4	1.7E-4	1.1E-3	37000
Strontium - 90	1.6	2.6E-7	1.9E-5	8.3E-5	1.02E-4	1.6E-2

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TABLE D.5-1
(continued)

COCs	Soil Concentration (mg/kg or pCi/g)	Risk Due to Ingestion, Inhalation, Dermal Contact, and Direct Radiation from Soil	Risk Due to Ingestion From Vegetables and Fruits	Risk Due to Ingestion From Milk and Beef	Total Risk	PRG 1 x 10^{-6} ILCR or 0.2 HI
Technetium 99	142.00	8.7E-7	3.6E-4	7.8E-3	8.16E-3	1.74E-2
Antimony*	22.6	4.4E-1	2.8	1.7E-1	3.4	1.33
Arsenic*	7.27	6.2E-2	1.0E-1	1.9E-4	1.6E-1	8.97

*These PRGs are HI based.
[a]The data for this PRG is from the Lime Sludge Ponds.

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TABLE D.5-2

EXPANDED TRESPASSER FEDERAL OWNERSHIP MODIFIED SOIL PRGs SOUTH FIELD CONCENTRATIONS AND RISKS

COC	Soil Concentration (mg/kg or pCi/g)	Risk Due to Ingestion, Dermal Contact, and Direct Radiation From Soil	PRG 1×10^{-6} ILCR 0.2 HI
Neptunium - 237	0.21	4.2E-8	4.99
Radium - 226	30.8	8.3E-5	3.69E-1
Radium - 228	3.88	5.0E-5	7.7E-1
Thorium - 228	4.41	1.1E-5	3.99E-1
Thorium - 232	3.99	1.5E-5	2.63E-1
Uranium - 238	9.31	1.7E-7	53.6E+1
Arsenic	7.27	4.3E-7	1.69E+1
Benzo(a)pyrene	9.4	3.3E-6	2.86
Arsenic*	7.27	1.3E-3	1E+3
Uranium Total[a]	214.32	2.1E-1	2E+2

*These PRGs are HI based.
[a]This data is from the Lime Sludge Ponds.

TABLE D.5-3

OFF-PROPERTY FARMER FEDERAL OWNERSHIP MODIFIED SOIL PRGs SOUTH FIELD CONCENTRATIONS AND RISKS

COC	Soil Concentration (mg/kg or pCi/g)	Risk Due to Inhalation of Suspended Particles	Risk Due to Ingestion of Home Produce	Risk Due to Ingestion of Beef/Milk	Total Risk or HI	PRG 1×10^{-6} ILCR 0.2 HI
Thorium - 228	4.41	2.9E-8	2.6E-10	2.6E-13	2.9E-8	1.5E+2
Thorium - 230	13.8	3.4E-8	2.0E-10	1.1E-12	3.4E-8	4.0E+2
Thorium - 232	3.99	3.7-E8	7.4E-10	4.2E-12	3.8E-8	1.1E+2
Uranium - 238	9.31	4.1E-8	2.8E-10	2.9E-11	4.1E-8	2.2E+2
Benzo(a)pyrene	9.4	2.7E-9	4.3E-8	1.3E-7	1.8E-7	5.1E+1
Dibenzo(a,h)anthrance	1.9	5.5E-10	8.5E-9	1.4E-7	1.5E-7	1.3E+1
Indeno(1,2,3-cd)pyrene	6	1.7E-10	2.7E-9	2.4E-8	3.03E-8	2E+2
Aroclor - 1260	0.05	-	3.7E-10	4.4E-8	4.4E-8	1.1

*These PRGs are HI based.
[a]This data is from the Lime Sludge Pond.

D.5.3.1 Cross-Media Impact on Groundwater

Cross Media impacts to groundwater occur when soil concentrations leach into a drinking water supply. Cross media impacts to groundwater are calculated by defining the highest acceptable groundwater concentration at the receptor and reverse model to determine the soil concentration that would produce the desired groundwater concentration. Appendix D.1 discusses the process of calculating cross-media impacts to groundwater.

D.5.3.2 Cross-Media Impact on Surface Water

D.5.3.2.1 Great Miami River

Modified soil PRGs were developed to be protective of the Great Miami River surface water for the South Field. Other Operable Unit 2 subunits had no COCs that impacted the Great Miami River surface water. Modified soil PRGs were calculated from the results of the RI modeling and the Baseline Risk Assessment. The relationships between surface soil concentrations, the Great Miami River concentrations, and risk are linear. Therefore, the modified PRGs can be calculated using equation D.5-1. Table D.5-4 presents modified soil PRGs protective of the Great Miami River surface water from the South Field surface soils. These modified soil PRGs were developed assuming no source controls and apply for continued administrative controls as well as private ownership of the FEMP.

D.5.3.2.2 Paddys Run

Surface water concentrations on the subunits determined in the Baseline Risk Assessment (no action alternative) were compared to water quality standards for Paddys Run (see Appendix B). Only the South Field surface water concentrations were high enough to cause the surface water concentrations in Paddys Run to exceed water quality standards for Dieldrin and polynuclear aromatic hydrocarbons (PAHs). Therefore, modified soil PRGs were developed for the South Field so that concentrations in Paddys Run surface water will not exceed ARARs. Other Operable Unit 2 subunits had no COCs with concentrations exceeding ARARs in Paddys Run.

TABLE D.5-4

SOUTH FIELD
CROSS-MEDIA MODIFIED PRGs
PROTECTIVE OF THE GREAT MIAMI RIVER SURFACE WATER
WITHOUT SOURCE CONTROLS

COCs Impacting Great Miami River	Units	Surface Soil Concentration	Baseline Risk	Modified Soil PRGs[a]			Background
				10^{-4} ILCR[b]	10^{-5} ILCR	10^{-6} ILCR	
Radium-226	pCi/g	30.8	1.3E-6	2,400	240	24	1.42
Technetium-99	pCi/g	142	2.0E-6	7,100	710	71	0

[a]Modified soil PRGs were calculated using Equation D.5-1.

[b]ILCR = incremental lifetime cancer risk.

The ARARs are concentration-based requirements; therefore the PRGs are calculated by the following equation:

$$\frac{\text{ARAR Concentration}}{\text{PRG (Soil)}} = \frac{\text{Paddys Run Concentration}}{\text{Surface Soil Concentration}}$$

$$\text{PRG (Soil)} = \frac{\text{ARAR} * \text{Surface Soil Concentration}}{\text{Paddys Run Concentration}}$$

This equation is possible because the relationship between surface soil concentrations and Paddys Run concentrations is linear. For total PAHs, the ratio of the concentration of one PAH to the total PAH concentration is assumed to be the same for the PRG (e.g., benzo(a)pyrene contributes 10 percent of the total PAH concentration in Paddys Run; therefore, it contributes 10 percent of the PRG concentration). Table D.5-5 presents modified soil PRGs for the South Field contaminated material/soil that would not exceed ARAR water quality standards in Paddys Run. These modified soil PRGs were developed assuming no source control and apply for continued federal ownership as well as private ownership of the FEMP.

D.5.3.3 Cross-Media Impact on Sediments

Modified soil PRGs were developed to be protective of sediments. Modified PRGs were required for the Solid Waste Landfill, South Field, and Active Flyash Pile. The Lime Sludge Ponds and Inactive Flyash Pile had no COCs that impacted sediments; therefore, no modified soil PRGs were necessary for these two subunits.

Modified soil PRGs were calculated from the results of the RI modeling and the Baseline Risk Assessment. The relationship between surface soil concentrations and sediment concentration is linear. The relationship between sediment concentration and the risk is also linear. Therefore, the modified PRGs can be calculated from equation D.5-1.

Table D.5-6 presents the modified soil PRGs that were calculated to be protective of sediments. These modified soil PRGs were developed assuming no source controls and apply to continued administrative controls (i.e., expanded trespasser).

TABLE D.5-5

SOUTH FIELD
CROSS-MEDIA MODIFIED SOIL PRGs AND PRLs
MEETS ARARs IN THE PADDYS RUN WITHOUT SOURCE CONTROL

COCs Impacting Paddys Run	Surface Soil Concentration (mg/kg)	Paddys Run Concentration (mg/L)	Modified Soil PRGs and PRLs (mg/kg)
Dieldrin[a]	9.7E-3	7.73E-4	9.57×10^{-3}
Benzo(a)anthracene[b]	5.5E-3	3.52E-3	4.55×10^{-1}
Benzo(a)pyrene[b]	9.4E-3	2.52E-3	7.77×10^{-1}
Benzo(b)fluoranthene[b]	6.2E-3	4.26E-4	5.13×10^{-1}
Benzo(k)fluoranthene[b]	7.3E-3	2.70E-4	6.03×10^{-1}
Dibenzo(a,h)anthracene[b]	1.9E-3	5.20E-4	1.57×10^{-1}
Indeno(1,2,3-cd)pyrene[b]	6.0E-3	3.37E-5	4.96×10^{-1}
Phenanthrene[b]	2.3E-3	3.75E0	1.90×10^{-1}

[a]ARAR for dieldrin was 7.6E-4 μg/L.
[b]ARAR for total PAHs was 0.31 μg/L.

TABLE D.5-6

CROSS-MEDIA MODIFIED SOIL PRGs AND PRLs PROTECTIVE OF SEDIMENTS WITHOUT SOURCE CONTROLS

COCs Impacting Sediments	Units	Surface Soil Concentration	Baseline Risk	Hazard Index	FEDERAL OWNERSHIP Expanded Trespasser Modified PRGs[a]				Background
					10^{-4} ILCR[b]	10^{-5} ILCR	10^{-6} ILCR	0.2 HI[c]	
Solid Waste Landfill									
Uranium-Total	mg/kg	225	NA[e]	0.26	-[d]	-	-	180	3.7
South Field									
Radium-226	pCi/g	30.8	1.3E-5	NA	240	24	2.4	NA	1.42
Active Flyash Pile									
Radium-226	pCi/g	4.6	2.2E-6	NA	230	23	2.3	NA	1.42
Arsenic	mg/kg	90	1.0E-6	NA	8,600	860	86	NA	8.2

[a]Modified PRGs were developed using Equation D.5-1.

[b]ILCR = incremental lifetime cancer risk.

[c]HI = hazard index.

[d]For total uranium, PRGs/PRLs were developed for a non-carcinogenic HI of 0.2.

[e]NA = not applicable.

D.5.3.4 Radon PRG Development

Radon-222 is a COC for four of the five Operable Unit 2 subunits (Solid Waste Landfill, Active Flyash Pile, Inactive Flyash Pile, and South Field). Radon concentrations in air result from radium-226 concentrations in the soil. Radon concentrations were estimated using the REACOM model algorithms developed for the NRC (NRC 1984) which converts radium-226 concentrations (pCi/g) to radon-222 fluxes (pCi/s-m^2).

Radon-222 is a cross-media impact from radium-226 in soils, therefore the PRG developed to be protective of human health due to exposure to radon is a cross media modified soil PRG for radium-226. The PRG is calculated by proportioning the risk due to radon-222 to the radium-226 soil concentration and equating that value to the ratio of an acceptable ILCR (1 x 10^{-6}) to the PRG.

$$\text{PRG} = \frac{\text{Radium-226 soil concentration(pCi/g)}}{\sum \text{risk, inhalation of radon-222}} \times 1\text{x}10^{-6}\ \text{ILCR}$$

The cross media modified soil PRG for radium-226 is calculated for those subunits where radon-222 is a COC by using the risk and soil concentrations from the Baseline Risk Assessment. Table D.5-7 contains the risk values and soil concentrations used to develop the cross media modified soil PRGs for radium-226.

An example calculation for the cross media modified soil PRG is provided below:

$$\text{PRG} = \frac{31\ \text{pCi/g}}{6.0\text{E-5 ILCR}} \times 10^{-6}\ \text{ILCR}$$

$$\text{PRG} = 5.1\text{E-1 pCi/g}$$

The values shown in the above equation are for the South Field (see Table D.5-7). The soil concentration is the concentration term for surface soils in the South Field, and the risk is the ILCR for the on-property resident farmer. The resulting PRG is the private ownership cross media modified soil PRG for radium-226 in the South Field.

TABLE D.5-7

RADON PRG CALCULATIONS

Subunit	Soil Concentration	Risk Expanded Trespasser	PRG	Off-Property Farmer		On-Property Farmer	
				Risk	PRG	Risk	PRG
Active Flyash Pile	4.6E+00	NA[a]	NA	NA	NA	1.5E-06	3.1E+00
South Field	3.1E+01	1.9E-06	1.6E+01	4.4E-06	7.0E+00	6.0E-05	5.1E-01
Inactive Flyash Pile	2.0E+00	NA	NA	NA	NA	4.2E-06	4.7E-01
Solid Waste Landfill	1.4E+00	NA	NA	NA	NA	1.4E-06	1.0E+00
Lime Sludge Pond	NA	NA	NA	NA	NA	NA	NA

[a]NA means not applicable to that receptor or subunit.

D.5.4 Source Control Modified Soil PRG Development

Source control modified PRGs are generated by controlling exposure pathways or contaminant migration through engineering source controls. Source controls in this FS are capping and lateral migration. Capping source controls prevent direct-contact exposure pathways and limit source migration to groundwater. Lateral migration source controls limit the source migration laterally, thereby reducing overall source migration. The calculation of source control modified soil PRGs is covered in detail in Appendix D.1.

References

REFERENCES

ASTM D-4319, January 1984, Standard Test Method for Distribution Ratios by the Short-Term Batch Method

Baes, C. F., III, R. D. Sharp, A. L. Sjoreen, and R. W. Shor, September 1984, A Review and Analysis of Parameters for Assessing Transport of Environmentally Released Radionuclides through Agriculture, Oak Ridge National Laboratory, Health and Safety Research Division, Oak Ridge, TN, ORNL-5786.

Batu, V., 1989, "A Generalized Two-Dimensional Analytical Solution for Hydrodynamic Dispersion in Bounded Media with the First-Type Boundary Condition at the Source," Water Resources Research, Vol. 25, No. 6, pp. 1125-1132.

Biggar, J. W. and D. R. Nielsen, 1976, "Spatial Variability of the Leaching Characteristics of a Field Soil," Water Resources Research, Vol. 12, No. 1.

GeoTrans, Inc., 1987, "The Sandia Waste-Isolation Flow and Transport Model for Fractured Media, SWIFT III, Release 2.32," Herndon, VA.

GeoTrans, Inc., 1991, "The Sandia Waste-Isolation Flow and Transport Model for Fractured Media, SWIFT III, Release 2.5," GeoTrans, Herndon, VA.

GeoTrans, Inc., 1992, "The Sandia Waste-Isolation Flow and Transport Model for Fractured Media, SWIFT III, Release 2.52," GeoTrans, Herndon, VA.

IT Corporation, 1990b, "Flow and Solute Transport Computer Code Verification," prepared for U.S. Department of Energy, Oak Ridge Operations Office, Oak Ridge, TN.

Javandel, I., C. Doughty and C. F. Tsang, 1984, "Groundwater Transport: Handbook of Mathematical Models," American Geophysical Union Water Resources Monograph Series 10, Washington DC.

Maidment, D. R., 1993, Handbook of Hydrology, McGraw Hill.

Marcinowski, F. and S. Napolitano, 1993, "Reducing Risks from Radon," J. Air and Waste Management Association, Vol. 43, pp. 955-962.

Mills, W. B., J. D. Dean and D. B. Porcella, 1982, "Water Quality Assessment: A Screening Procedure for Toxic and Conventional Pollutants: Parts 1, 2, and 3," EPA/600/6-82/004, U.S. Environmental Protection Agency Office of Research and Development, Environmental Research Laboratory, Athens, GA.

Mulder, T., International Technology Corp., August 2, 1993, Memorandum to S. Wolinski, FERMCO CRU4, Subject: Grain Size of Soil at the FEMP.

Ogata, A. and R. B. Banks, 1961, "A Solution of the Differential Equation of Longitudinal Dispersion in Porous Media," U.S. Geological Survey, Professional Paper 411-A, Reston, VA.

REFERENCES
(Continued)

Parsons, April 1993, "Groundwater Modeling Evaluation Report and Improvement Plan," U.S. Department of Energy, Fernald, OH.

Thibault, D. H., M. I. Sheppard and P. A. Smith, March 1990, A Critical Compilation and Review of Default Soil Solid/Liquid Partition Coefficients, K_d, for Use in Environmental Assessments, Atomic Energy of Canada Limited, Whiteshell Nuclear Research Establishment, Pinawa, Manitoba, Canada, AECL-10125.

U.S. Department of Agriculture (USDA), 1992, Soil Survey of Hamilton County, Ohio.

U.S. Department of Energy (DOE), 1991, Data Validation Program, Revision O, Oak Ridge Operations Office.

U.S. Department of Energy (DOE), 1992, "Risk Assessment Work Plan Addendum, Fernald Environmental Management Project, Remedial Investigation/Feasibility Study," Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1993a, "Feasibility Study Report for Operable Unit 4 (Final Draft)," Volume 4, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1993b, "Site-Wide Characterization Report, FEMP, Fernald, Ohio, Remedial Investigation and Feasibility Study," Fernald Office, Fernald, OH.

U.S. Department of Energy (DOE), 1993c, "Remedial Investigation Report for Operable Unit 4 (Final)," Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), June 1994, "Operable Unit 2 Remedial Investigation Report, Draft," Table A.1-1, Fernald Field Office, Fernald, OH.

U.S. Department of Energy (DOE), 1994, "Remedial Investigation Report for Operable Unit 2 (Draft)," Fernald Field Office, Fernald, OH.

U.S. Environmental Protection Agency (EPA), 1985, Water Quality Assessment, a Screening Procedure for Toxic and Conventional Pollutants in Surface and Groundwater-Part I, EPA/600/6-85/002a.

U.S. Environmental Protection Agency (EPA), 1985a, "Rapid Assessment of Exposure to Particulate Emissions from Surface Contamination Sites," EPA/600/8-85/002, Office of Health and Environmental Assessment, U.S. EPA, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1985b, "Compilation of Air Pollutant Emission Factors, Volume I: Stationary Point and Area Sources," including Supplement E, October 1992, AP-42 Volume I, Office of Air and Radiation and Office of Air Quality Planning and Standards, Research Triangle Park, NC.

REFERENCES
(Continued)

U.S. Environmental Protection Agency (EPA), 1987, "A Method for Estimating Fugitive Particulate Emissions from Hazardous Waste Sites," EPA/600/2-87/066, Office of Research and Development, U.S. EPA, Cincinnati, OH.

U.S. Environmental Protection Agency (EPA), April, 1988, Superfund Exposure Assessment Manual, EPA/540/1-88/001.

U.S. Environmental Protection Agency (EPA), 1989a, "Air/Superfund National Technical Guidance Study Series, Volume IV - Procedures for Dispersion Modeling and Air Monitoring for Superfund Air Pathway Analysis," EPA/450/1-89/004, Office of Air Quality Planning and Standards, U.S. EPA, Research Triangle Park.

U.S. Environmental Protection Agency (EPA), 1989b, "Risk Assessment Guidance for Superfund, Human Health Evaluation Manual," Part A, Interim Final, EPA/540/1-89/002, U.S. EPA, Office of Emergency and Remedial Response, Washington, DC.

U.S. Environmental Protection Agency (EPA), 1992, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Model, Volume II - Description of Model Algorithms," including Addendum A, September 1992, EPA-540/4-92-008b, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S Environmental Protection Agency (EPA), 1992a, "User's Guide for the Industrial Source Complex (ISC2) Dispersion Model, Volume I - User Instructions, "including Addendum A, September 1992, EPA-540/4-92-008b, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Environmental Protection Agency (EPA), 1993, "Air/Superfund National Technical Guidance Study Series - Estimation of Air Impacts from Area Sources of Particulate Matter Emissions at Superfund Sites," EPA-451/R-93-004, Office of Air Quality Planning and Standards, Research Triangle Park, NC.

U.S. Nuclear Regulatory Commission (NRC), 1984, "Radon Attenuation Handbook for Uranium Mill Tailing Cover Design," NUREG/CR-3533, Office of Nuclear Regulatory Research, U.S. NRC, Washington, DC.

Walton, W. C., 1988, Practical Aspects of Groundwater Modeling - 3rd Edition, National Water Well Assoc., Worthington, OH.

APPENDIX E

ENGINEERING CALCULATIONS AND TYPICAL SECTIONS

APPENDIX E

ENGINEERING CALCULATIONS AND TYPICAL SECTIONS

TABLE OF CONTENTS

Section	Title	Page
E.1	Remediation Volumes	E-1-1
E.1.1	Remediation Volume Summary	E-1-1-1
E.1.2	Remediation Volume Calculations—General Criteria and Methodology	E-1-2-1
E.1.2.1	Introduction	E-1-2-1
E.1.2.2	General Criteria	E-1-2-1
E.1.2.3	Order of Calculation	E-1-2-2
E.1.2.4	Block Model Analysis	E-1-2-2
E.1.2.5	Screening for Other COCs	E-1-2-2
E.1.2.6	Total Uranium	E-1-2-3
E.1.2.7	Base Volume Calculations	E-1-2-4
E.1.2.8	Specific Volume Calculations for Remedial Alternatives	E-1-2-4
E.1.2.9	Total Excavation Volume	E-1-2-5
E.1.2.10	Uranium-238 Volume Tables	E-1-2-5
E.1.2.11	Firing Range Calculations	E-1-2-6
E.1.3	Remediation Volume Calculations—Solid Waste Landfill	E-1-3-1
E.1.3.1	Federal Ownership (Expanded Trespasser, 10^{-6} ILCR)	E-1-3-1
E.1.3.2	Federal Ownership (Expanded Trespasser, 10^{-5} ILCR)	E-1-3-4
E.1.3.3	Private Ownership (Resident Farmer, 10^{-6} ILCR)	E-1-3-7
E.1.3.4	Private Ownership (Resident Farmer, 10^{-5} ILCR)	E-1-3-11
E.1.4	Remediation Volume Calculations—Lime Sludge Ponds	E-1-4-1
E.1.4.1	Federal Ownership (Expanded Trespasser, 10^{-6} ILCR)	E-1-4-1
E.1.4.2	Federal Ownership (Expanded Trespasser, 10^{-5} ILCR)	E-1-4-4
E.1.4.3	Private Ownership (Resident Farmer, 10^{-6} ILCR)	E-1-4-7
E.1.4.4	Private Ownership (Resident Farmer, 10^{-5} ILCR)	E-1-4-10
E.1.5	Remediation Volume Calculations—Inactive Flyash Pile	E-1-5-1
E.1.5.1	Federal Ownership (Expanded Trespasser, 10^{-6} ILCR)	E-1-5-1
E.1.5.2	Federal Ownership (Expanded Trespasser, 10^{-5} ILCR)	E-1-5-4
E.1.5.3	Private Ownership (Resident Farmer, 10^{-6} ILCR)	E-1-5-7

E.1.5.4 Private Ownership (Resident Farmer, 10^{-5} ILCR) E-1-5-10
E.1.6 Remediation Volume Calculations—South Field E-1-6-1
E.1.6.1 Federal Ownership (Expanded Trespasser, 10^{-6} ILCR) E-1-6-1
E.1.6.2 Federal Ownership (Expanded Trespasser, 10^{-5} ILCR) E-1-6-5
E.1.6.3 Private Ownership (Resident Farmer, 10^{-6} ILCR) E-1-6-8
E.1.6.4 Private Ownership (Resident Farmer, 10^{-5} ILCR) E-1-6-12
E.1.7 Remediation Volume Calculations—Active Flyash Pile E-1-7-1
E.1.7.1 Federal Ownership (Expanded Trespasser, 10^{-6} ILCR) E-1-7-1
E.1.7.2 Federal Ownership (Expanded Trespasser, 10^{-5} ILCR) E-1-7-4
E.1.7.3 Private Ownership (Resident Farmer, 10^{-6} ILCR) E-1-7-7
E.1.7.4 Private Ownership (Resident Farmer, 10^{-5} ILCR) E-1-7-10
E.1.8 Block Model Volume Summary for Uranium-238 . . . . . E-1-8-1
E.1.9 Supporting Volume Calculations for Uranium-238 . . . . . E-1-9-1
E.1.9.1 On-Site Disposal Cell Waste Acceptance Criteria Volumes E-1-9-1
E.1.9.2 PPE Remediation Volumes E-1-9-2
E.1.9.3 Remediation Berm Volumes Disposal Cell Berm E-1-9-3
E.1.10 Remediation Volume Calculations—Firing Range Lead E-1-10-1
E.2 Waste Acceptance Criteria
E.2.1 Waste Acceptance Criteria for Off-Site Disposal E-2-1-1
E.2.2 Preliminary Waste Acceptance Criteria for On-Site Disposal E-2-2-1
E.3 Operable Unit 2 On-Site Disposal Cell E-3-1
E.3.1 On-Site Disposal Cell E-3-1-1
E.3.1.1 Siting Criteria E-3-1-1
E.3.1.1.1 General E-3-1-1
E.3.1.1.2 Siting of Operable Unit 2 Disposal Cell E-3-1-3
E.3.1.1.3 Ongoing Studies E-3-1-3
E.3.1.2 Disposal Cell Design E-3-1-5
E.3.1.2.1 General Design Considerations E-3-1-5
E.3.1.2.2 Cell Cap E-3-1-5
E.3.1.2.3 Cell Liner E-3-1-6
E.3.1.2.4 Waste Placement E-3-1-11
E.3.2 On-Site Disposal Geology E-3-2-1
E.3.3 Geotechnical Data Report and Additional Boring Logs E-3-3-1

E.3.4 Disposal Cell Volume Calculations E-3-4-1

E.4 Perched Groundwater Collection and Control E-4-1

E.4.1 Passive Perched Water Collection at South Field Area E-4-1

E.4.2 Excavation-Period Groundwater Control E-4-3

E.4.2.1 Solid Waste Landfill E-4-3

E.4.2.2 Lime Sludge Ponds E-4-4

E.4.2.3 Inactive Flyash Pile E-4-4

E.4.2.4 South Field E-4-4

E.4.2.5 Active Flyash Pile E-4-5

E.4.3 Calculations E-4-5

E.5 Infiltration Calculations E-5-1

E.6 Typical Sections and Details E-6-1

E.7 On-Site Borrow Source E-7-1

LIST OF TABLES

Table	Title	Page
E.1-1	Alternative 2—Consolidation and Capping, Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level), Consolidation and Off-Site Disposal Volumes	E-1-1-1
E.1-2	Alternative 3—Excavation and Off-Site Disposal (Envirocare), Federal Ownership, (Expanded Trespasser, 10^{-6} Level), Remediation and Off-Site Disposal Volumes	E-1-1-2
E.1-3	Alternative 6—Excavation and On-Site Disposal with Off-Site Disposal of Fraction Above Waste Acceptance Criteria, Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level) Remediation and Disposal Volume	E-1-1-3
E.1-4	Alternative 3—Excavation and Off-Site Disposal (Envirocare), Private Ownership (Resident Farmer, 10^{-6} Risk Level) Remediation and Off-Site Disposal Volumes	E-1-1-4
E.1-5	Alternative 6—Excavation and On-Site Disposal with Off-Site Disposal of Fraction Above Waste Acceptance Criteria, Private Ownership (Resident Farmer, 10^{-6} Risk Level), Remediation and Disposal Volume	E-1-1-5
E.1-6	Alternative 2—Consolidation and Capping, Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level), Consolidation and Off-Site Disposal Volume	E-1-1-6
E.1-7	Alternative 3—Excavation and Off-Site Disposal (Envirocare), Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level), Remediation and Off-Site Disposal Volumes	E-1-1-7
E.1-8	Alternative 6—Excavation and On-Site Disposal With Off-Site Disposal of Fraction Above Waste Acceptance Criteria, Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level), Remediation and Disposal Volumes	E-1-1-8
E.1-9	Alternative 3—Excavation and Off-Site Disposal (Envirocare), Private Ownership (Resident Farmer, 10^{-5} Risk Level), Remediation and Off-Site Disposal Volumes	E-1-1-9
E.1-10	Alternative 6—Excavation and On-Site Disposal With Off-Site Disposal of Fraction Above Waste Acceptance Criteria, Private Ownership (Resident Farmer, 10^{-5} Risk Level), Remediation and Disposal Volumes	E-1-1-10
E.1-11	Solid Waste Landfill—Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level)	E-1-3-3
E.1-12	Solid Waste Landfill—Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level)	E-1-3-6
E.1-13	Solid Waste Landfill—Private Ownership (Resident Farmer, 10^{-6} Risk Level)	E-1-3-9
E.1-14	Solid Waste Landfill—Private Ownership (Resident Farmer, 10^{-5} Risk Level)	E-1-3-13
E.1-15	Lime Sludge Ponds—Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level)	E-1-4-3
E.1-16	Lime Sludge Ponds—Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level)	E-1-4-6

000504

LIST OF TABLES
(Continued)

Table	Title	Page
E.1-17	Lime Sludge Ponds—Private Ownership (On-Property Resident Farmer, 10^{-6} Risk Level)	E-1-4-9
E.1-18	Lime Sludge Ponds—Private Ownership (On-Property Resident Farmer, 10^{-5} Risk Level)	E-1-4-12
E.1-19	Inactive Flyash Pile—Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level)	E-1-5-3
E.1-20	Inactive Flyash Pile—Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level)	E-1-5-6
E.1-21	Inactive Flyash Pile—Private Ownership (On-Property Resident Farmer, 10^{-6} Risk Level)	E-1-5-9
E.1-22	Inactive Flyash Pile—Private Ownership (On-Property Resident Farmer, 10^{-5} Risk Level)	E-1-5-12
E.1-23	South Field—Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level)	E-1-6-3
E.1-24	South Field—Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level)	E-1-6-7
E.1-25	South Field—Private Ownership (On-Property Resident Farmer, 10^{-6} Risk Level)	E-1-6-10
E.1-26	South Field—Private Ownership (On-Property Resident Farmer, 10^{-5} Risk Level)	E-1-6-14
E.1-27	Active Flyash Pile—Federal Ownership (Expanded Trespasser, 10^{-6} Risk Level)	E-1-7-3
E.1-28	Active Flyash Pile—Federal Ownership (Expanded Trespasser, 10^{-5} Risk Level)	E-1-7-6
E.1-29	Active Flyash Pile—Private Ownership (On-Property Resident Farmer, 10^{-6} Risk Level)	E-1-7-9
E.1-30	Active Flyash Pile—Private Ownership (On-Property Resident Farmer, 10^{-5} Risk Level)	E-1-7-12
E.1-31	Total Volume—Solid Waste Landfill	E-1-8-2
E.1-32	Total Volume—Lime Sludge Ponds	E-1-8-4
E.1-33	Total Volume—Inactive Flyash Pile	E-1-8-6
E.1-34	Total Volume—South Field	E-1-8-9
E.1-35	Total Volume—Active Flyash Pile	E-1-8-11
E.1-36	Till-Based Volume (More Than 18 Feet of Till)	E-1-8-13
E.1-37	Till-Based Volume (Less Than 18 Feet of Till)	E-1-8-17
E.1-38	Summary of Volume Exceeding On-Site WAC	E-1-9-1
E.1-39	Summary of Volume Exceeding 125pCi/g	E-1-9-2
E.1-40	Volume Exceeding Uranium-238 Surface Soil Exposure Pathway PRL (55 pCi/g)	E-1-9-3

LIST OF TABLES

(Continued)

Table	Title	Page
E.1-41	Summary of Volume Available for Berm Construction for Alternative 6 with an ILCR of 10^{-6}	E-1-9-5
E.2.1-1	Regulatory Level Compared to Maximum Concentrations Detected	E-2-1-2
E.2.1-2	Envirocare Acceptance Criteria Compared to Maximum Activities Detected	E-2-1-4
E.2.1-3	Incoming - Shipment Parameters for Off-Site Disposal Facilities	E-2-1-5
E.2.2-1	Preliminary Waste Acceptance Criteria for On-Site Disposal Compared to Maximum Detected Value	E-2-2-7

000506

LIST OF FIGURES

Figure	Title	Page
E.1.8-1	Solid Waste Landfill - Uranium-238 Contaminated Volumes	E-1-8-3
E.1.8-2	Lime Sludge Ponds - Uranium-238 Contaminated Volumes	E-1-8-5
E.1.8-3	Inactive Flyash Pile - Uranium-238 Contaminated Volumes	E-1-8-8
E.1.8-4	South Field - Uranium-238 Contaminated Volumes	E-1-8-10
E.1.8-5	Active Flyash Pile - Uranium-238 Contaminated Volumes	E-1-8-12
E.3.1-1	Site Plan - Potentially Acceptable Region for Sitewide On-Site Disposal Cell	E-3-1-2
E.3.1-2	Site Plan - Feasible Locations for Operable Unit 2 On-Site Disposal	E-3-1-4
E.3.1-3	Proposed Location - On-Site Disposal Cell	E-3-1-7
E.3.1-4	Typical Sections - Operable Unit 2 On-Site Disposal Cell	E-3-1-8
E.3.1-5	Typical Details - Composite Caps and Liners	E-3-1-9
E.3.1-6	Typical Details - Composite Cap and Liner	E-3-1-10
E.3.2-1	Geologic Cross-Sections On-Site Disposal Cell, Sheet 1 of 3	E-3-2-3
E.3.2-2	Geologic Cross-Sections On-Site Disposal Cell, Sheet 2 of 3	E-3-2-4
E.3.2-3	Geologic Cross-Sections On-Site Disposal Cell, Sheet 3 of 3	E-3-2-5
E.4-1	Typical Section - Subsurface Drain	E-4-2
E.6-1	Typical Section - Access Road	E-6-1
E.6-2	Typical Section - Surfacing at Equipment Storage Area	E-6-2
E.6-3	Typical Section - Staging Area	E-6-3
E.6-4	Typical Detail - Personnel Decontamination Facility	E-6-4
E.6-5	Typical Detail - Equipment Decontamination Facility	E-6-5
E.6-6	Typical Detail - Composite Cap and Liner	E-6-6
E.6-7	Typical Section - Subsurface Drain	E-6-7
E.6-8	Typical Section - Interceptor Trench	E-6-8
E.7-1	Location of Prospective On-Site Borrow Area	E-7-2
E.7-2	Geologic Cross Sections of the Waste Storage Area	E-7-3

APPENDIX E

LIST OF ACRONYMS AND ABBREVIATIONS

ARAR	applicable and relevant or appropriate requirement
COC	contaminant of concern
DOT	U.S. Department of Transportation
GMA	Great Miami Aquifer
HELP	Hydraulic Evaluation of Landfill Performance
HOC	halogenated organic compound
HDPE	high density polyethylene
ILCR	incremental lifetime cancer risk
LARM	low activity radioactive material
LDR	land disposal restriction
LLW	low-level waste
LRA	leading remedial alternative
MW	mixed waste
NORM	normally occurring radioactive material
NTS	Nevada Test Site
PCB	polychlorinated biphenyl
PPE	personal protective equipment
PRL	preliminary remediation level
RCRA	Resource Conservation and Recovery Act
TCLP	toxicity characteristic leaching procedure
TRU	transuranic waste
TRUMW	transuranic mixed waste
WAC	waste acceptance criteria

APPENDIX E.1
REMEDIATION VOLUMES

APPENDIX E.1.1

REMEDIATION VOLUME SUMMARY

TABLE E.1-1

ALTERNATIVE 2 - CONSOLIDATION AND CAPPING
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-6} RISK LEVEL)
CONSOLIDATION AND OFF-SITE DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Off-Site Disposal Volume (yd^3)	Consolidation Volume (yd^3)			Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavcation		Excavation Volume to On-Site Disposal	Generated Waste Volume	Total Consolidation Volume		
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total								
Solid Waste Landfill	10,400	1,700	12,100	1,200	13,300	0	13,300	3,000	16,300	5,300	0
Lime Sludge Ponds	1,600	0	1,600	200	1,800	0	1,800	3,000	4,800	100	0
Inactive Flyash Piles	84,800	9,200	94,000	9,400	103,400	0	103,400	3,000	106,400	4,000	0
South Field	41,600	500	42,100	4,200	46,300	300	46,000	3,000	49,000	6,500	0
Active Flyash Pile	65,100	0	65,100	6,500	71,600	0	71,600	3,000	74,600	0	0
Total	203,500	11,400	214,900	21,500	236,400	300	236,100	15,000	251,100	15,900	0

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

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TABLE E.1-2

ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL (ENVIROCARE) FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-6} RISK LEVEL) REMEDIATION AND OFF-SITE DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Generated Waste Volume (yd^3)	Total Off-Site Disposal Volume (yd^3)	Debris Volume (yd^3)	Drying Volume yd^3
	Remediation Volume			Additional Excavation	Total Excavcation				
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total						
Solid Waste Landfill	19,500	1,700	21,200	2,100	23,300	3,000	26,300	5,300	7,000
Lime Sludge Ponds	16,800	0	16,800	1,700	18,500	3,000	21,500	0	7,100
Inactive Flyash Piles	84,800	9,200	94,000	9,400	103,400	3,000	106,400	4,000	6,900
South Field	771,00	500	77,600	7,800	85,400	3,000	88,400	6,500	11,000
Active Flyash Pile	651,00	0	65,100	6,500	71,600	3,000	74,600	0	700
Total	263,300	11,400	274,700	27,500	302,200	15,000	317,200	15,800	32,700

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

TABLE E.1-3

ALTERNATIVE 6 - EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION ABOVE WASTE ACCEPTANCE CRITERIA EXPANDED TRESPASSER AND 10^{-6} RISK LEVEL REMEDIATION AND DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Off-Site Disposal Volume (yd^3)	On-site Disposal Volume (yd^3)			Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation		Excavation Volume to On-Site Disposal	Generated Waste Volume	Total On-Site Disposal Volume		
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total								
Solid Waste Landfill	19,500	1,700	21,200	3,000	24,200	0	24,200	3,000	27,200	5,300	0
Lime Sludge Ponds	16,800	0	16,800	1,700	18,500	0	18,500	3,000	21,500	0	0
Inactive Flyash Piles	84,800	9,200	94,000	9,400	103,400	3,100	100,300	3,000	103,300	4,000	0
South Field	77,100	500	77,600	7,800	85,400	300	85,100	3,000	88,100	6,500	0
Active Flyash Pile	65,100	0	65,100	6,500	71,600	0	71,600	3,000	74,600	0	0
Total	263,300	11,400	274,700	28,400	303,100	3,400	299,700	15,000	314,700	15,800	0

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

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TABLE E.1-4

ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL (ENVIROCARE) PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, 10^{-6} RISK LEVEL) REMEDIATION AND OFF-SITE DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Generated Waste Volume (yd^3)	Total Off-Site Disposal Volume (yd^3)	Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation				
	PPE Level - D (< 125 pCi/g)	PPE Level C (> 125 pCi/g)	Total						
Solid Waste Landfill	96,700	1,700	98,400	13,800	112,200	3,000	115,200	5,300	7,000
Lime Sludge Ponds	81,600	0	81,600	8,200	89,800	3,000	92,800	0	7,100
Inactive Flyash Piles	91,700	9,200	100,900	10,100	111,000	3,000	114,000	4,000	6,900
South Field	338,900	500	339,400	34,000	373,400	3,000	376,400	6,500	11,000
Active Flyash Pile	74,900	0	74,900	7,500	82,400	3,000	85,400	0	700
Total	683,800	11,400	695,200	73,600	768,800	15,000	783,800	15,800	32,500

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

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TABLE E.1-5

ALTERNATIVE 6 - EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION ABOVE WASTE ACCEPTANCE CRITERIA PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, 10^{-6} RISK LEVEL) REMEDIATION AND DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Off-Site Disposal Volume (yd^3)	On-Site Disposal Volume (yd^3)			Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation		Excavation Volume to On-Site Disposal	Generated Waste Volume	Total On-Site Disposal Volume		
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total								
Solid Waste Landfill	96,700	1,700	98,400	13,800	112,200	0	112,200	3,000	115,200	5,300	0
Lime Sludge Ponds	81,600	0	81,600	8,200	89,800	0	89,800	3,000	92,800	0	0
Inactive Flyash Piles	91,700	9,200	100,900	10,100	111,000	3,100	107,900	3,000	110,900	4,000	0
South Field	338,900	500	339,400	34,000	376,400	300	373,100	3,000	373,100	6,500	0
Active Flyash Pile	74,900	0	74,900	7,500	85,400	0	82,400	3,000	82,400	0	0
Total	683,800	11,400	695,200	73,600	780,400	3,400	765,400	15,000	765,400	15,800	0

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

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TABLE E.1-6

ALTERNATIVE 2 - CONSOLIDATION AND CAPPING
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-5} RISK LEVEL)
CONSOLIDATION AND OFF-SITE DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Off-Site Disposal Volume (yd^3)	Consolidation Volume (yd^3)			Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation (yd^3)	Total Excavation (yd^3)		Excavation Volume to On-Site Disposal	Generated Waste Volume	Total Consolidation Volume		
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total								
Solid Waste Landfill	10,400	1,700	12,100	1,200	13,300	0	13,300	3,000	16,300	5300	0
Lime Sludge Ponds	1,600	0	1,600	200	1,800	0	1,800	3,000	4,800	100	0
Inactive Flyash Piles	76,600	9,200	85,800	8,600	94,400	0	94,400	3,000	97,400	4000	0
South Field	18,000	500	18,500	1,900	20,400	300	20,100	3,000	23,100	6500	0
Active Flyash Pile	65,000	0	65,000	6,500	71,500	0	71,500	3,000	74,500	0	0
Total	171,600	11,400	183,000	18,400	201,400	300	201,200	15,000	216,000	15900	0

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

TABLE E.1-7

ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL (ENVIROCARE) FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-5} RISK LEVEL) REMEDIATION AND OFF-SITE DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Generated Waste Volume (yd^3)	Total Off-Site Disposal Volume (yd^3)	Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation				
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total						
Solid Waste Landfill	19,500	1,700	21,200	2,100	23,300	3,000	26,300	5,300	7,000
Lime Sludge Ponds	16,800	0	16,800	1,700	18,500	3,000	21,500	0	7,100
Inactive Flyash Piles	76,700	9,200	85,900	8,600	94,500	3,000	97,500	4,000	6,900
South Field	35,900	500	36,400	3,600	40,000	3,000	43,000	6,500	11,000
Active Flyash Pile	65,000	0	65,000	6,500	71,500	3,000	74,500	0	700
Total	213,900	11,400	225,300	22,500	247,800	15,000	262,800	15,800	32,700

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

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TABLE E.1-8

ALTERNATIVE 6 - EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION ABOVE WASTE ACCEPTANCE CRITERIA FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-5} RISK LEVEL)

Subunit	Excavation Volumes (yd^3)					Off-Site Disposal Volume (yd^3)	On-Site Disposal Volume (yd^3)			Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation		Excavation Volume to On-Site Disposal	Generated Waste Volume	Total On-Site Disposal Volume		
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total								
Solid Waste Landfill	19,500	1,700	21,200	3,000	24,200	0	24,200	3,000	27,200	5,300	0
Lime Sludge Ponds	16,800	0	16,800	1,700	18,500	0	18,500	3,000	21,500	0	0
Inactive Flyash Piles	76,700	9,200	85,900	8,600	94,500	3,100	91,400	3,000	94,400	4,000	0
South Field	35,900	500	36,400	3,600	40,000	,300	39,700	3,000	42,700	6,500	0
Active Flyash Pile	65,000	0	65,000	6,500	71,500	0	71,500	3,000	74,500	0	0
Total	213,900	11,400	225,300	23,400	248,700	3,400	245,300	15,000	260,300	15,800	0

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

TABLE E.1-9

ALTERNATIVE 3 - EXCAVATION AND OFF-SITE DISPOSAL (ENVIROCARE) PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, 10^{-5} RISK LEVEL) REMEDIATION AND OFF-SITE DISPOSAL VOLUMES

Subunit	Excavation Volumes (yd^3)					Generated Waste Volume (yd^3)	Total Off-Site Disposal Volume (yd^3)	Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation				
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total						
Solid Waste Landfill	78,800	1,700	80,500	8,000	88,500	3,000	91,500	5,300	7,000
Lime Sludge Ponds	36,300	0	36,300	3,600	39,900	3,000	42,900	0	7,100
Inactive Flyash Piles	91,200	9,200	100,400	10,000	110,400	3,000	113,400	4,000	6,900
South Field	186,400	500	186,900	19,000	205,900	3,000	208,900	6,500	11,000
Active Flyash Pile	74,900	0	74,900	7,500	82,400	3,000	85,400	0	500
Total	468,900	11,400	479,000	48,100	527,100	15,000	543,600	15,800	32,700

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

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TABLE E.1-10

ALTERNATIVE 6 - EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION ABOVE WASTE ACCEPTANCE CRITERIA PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, 10^{-5} RISK LEVEL)

Subunit	Excavation Volumes (yd^3)					Off-Site Disposal Volume (yd^3)	On-Site Disposal Volume (yd^3)			Debris Volume (yd^3)	Drying Volume (yd^3)
	Remediation Volume			Additional Excavation	Total Excavation		Excavation Volume to On-Site Disposal	Generated Waste Volume	Total On-Site Disposal Volume		
	PPE Level - D (<125 pCi/g)	PPE Level - C (>125 pCi/g)	Total								
Solid Waste Landfill	78,800	1,700	80,500	8,000	88,500	0	88,500	3,000	91,500	5,300	0
Lime Sludge Ponds	36,300	0	36,300	3,600	39,900	0	39,900	3,000	42,900	0	0
Inactive Flyash Piles	91,200	9,200	100,400	10,000	110,400	3,100	107,300	3,000	110,300	4,000	0
South Field	186,400	500	186,900	19,000	205,900	300	205,600	3,000	208,600	6,500	0
Active Flyash Pile	74,900	0	74,900	7,500	82,400	0	82,400	3,000	85,400	0	0
Total	468,900	11,400	479,000	48,100	527,100	3,400	523,700	15,000	538,700	15,800	0

Note: For excavation volume criteria and methodology, refer to Appendix E.1.2

APPENDIX E.1.2
REMEDIATION VOLUME CALCULATIONS—
GENERAL CRITERIA AND METHODOLOGY

E.1.2 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS GENERAL CRITERIA AND METHODOLOGY

E.1.2.1 INTRODUCTION

This section defines the general criteria and provides an overview of the methodology used to produce the remediation and excavation volumes that are summarized in section E.1.1 and calculated in sections E.1.3 through E.1.10. The remediation volumes have been produced primarily by block model analysis with screening for the COCs that were not included in the model.

The critical receptors which drive the remediation volumes under Federal ownership and private ownership scenarios are the expanded trespasser and on-site resident farmer, respectively. Because of that, the receptor names are frequently used synonymously with the scenario names. Throughout Appendix E, the reader should simply equate the receptor and ownership scenario as follows:

- Expanded Trespasser = Federal Ownership
- On-Site Resident Farmer = Private Ownership

E.1.2.2 GENERAL CRITERIA

The following items represent general criteria used in evaluation of the COCs and calculation of remediation volumes:

- Primary risk receptors are the on-property resident farmer and expanded trespasser.
- Incremental lifetime cancer risk (ILCR) criteria are 10^{-5} and 10^{-6}.
- Modeling parameters are radium-228, thorium-228, and uranium-238.
- PRLs used for modeling and screening are those developed in Section 2.0 of the Feasibility Study.
- All flyash and lime sludge present within the subunits are considered solid waste; thus, the entire volume of those materials will be remediated.
- Material exceeding the on-site waste acceptance criteria (see Section E.2) will not be placed in the on-site disposal cell.
- Material to be disposed off site must not exceed the off-site waste acceptance criteria set forth in Section E.2.
- DOE 5400.5 was included as a screening parameter for applicable radium and thorium isotopic COCs.

E.1.2.3 ORDER OF CALCULATION

In determining remediation volumes, a specific order was used to provide consistency to the calculations and to assist in the development of Section 3. The order used to calculate remediation volumes is as follows:

- Volume based on block modeling
- Volume based on other COCs (not addressed directly in the block model)
- Any remaining flyash and lime sludge

In addition, volumes of material required to facilitate cap construction and to support the removal of contaminated material were calculated.

E.1.2.4 BLOCK MODEL ANALYSIS

A block model was used to determine a remediation volume for each subunit/alternative. The block model was based on the three radiological COCs most representative of contamination in the Operable Unit 2 subunits. These radiological COCs were radium-228, thorium-228, and uranium-238. Data based on sampling results from the Operable Unit 2 Remedial Investigation and corresponding to the three radiological COCs are contained in a three-dimensional array within the block model. The model was used to determine the volumes of material exceeding various radiological contaminant levels for each of the three modeled COCs. These radiological contaminant levels correspond to the governing PRLs applicable to each subunit/alternative.

E.1.2.5 SCREENING FOR OTHER COCs

In addition to the modeled COCs, other COCs may require additional remediation. Tables E.1-11 through E.1-30 (in Sections E.1.3 through E.1.7) were developed so that the concentration term for each COC (in various layers) could be compared with the corresponding PRL. Wherever a concentration term for other COCs exceeded its corresponding PRL, the concentration term was highlighted (bold with a shaded background on the corresponding table) to signify that further analysis was necessary. Other concentration terms (not highlighted) were eliminated from further consideration. The concentration terms for the modeled COCs were not highlighted when they were found to exceed PRLs, since these COCs were accounted for in the block model.

Many of the highlighted concentration terms were immediately screened out because entire subunit layers were included in the modeled volume. For the remaining COCs corresponding to the

highlighted concentration terms, further screening was performed to determine if individual sample points (where the COCs exceeded the concentration terms) were included within the modeled volume.

For each sample location with a COC level above an established PRL, the modeled COC levels at that location were assessed. Whenever a sample location was determined to have a contaminant level above one of the modeled COC's PRL (signifying that sample location was already included within the modeled volume), all other COCs at that location were eliminated from further consideration. To be concise, these comparisons are not included in sections E.1.3 through E.1.7, however, information necessary to make these comparisons is available in Appendix A.

For sample locations where other COCs were not screened out by the methods listed above, each sample point's coordinates were compared to the block model volume. COC locations corresponding with the modeled volume were excluded. The remaining COC locations were assessed in Sections E.1.3 through E.1.7 and additional volumes added to the modeled excavation.

E.1.2.6 TOTAL URANIUM

Total uranium was not screened in the same manner as the other COCs. Based on the results of the Remedial Investigation, it was assumed that uranium contamination in the Operable Unit 2 subunits had an isotopic arrangement similar to that of natural (non-enriched/non-depleted) uranium (99.27 percent uranium-238, 0.72 percent uranium-235, and 0.0055 percent uranium-234). Therefore, a correlation could be used between total uranium concentrations and uranium-238 radiological contaminant levels. Based on this assumption, an equation (balanced for the natural uranium isotopic relationship) was used to convert total uranium concentrations in milligrams per kilogram (mg/kg) to equivalent uranium-238 radiological contaminant levels in pico curies per gram (pCi/g). Uranium-238 radiological contamination levels converted from total uranium could then be used directly in the block model.

Based on data obtained from the Remedial Investigation, the highest uranium-238 radiological contamination level for each sample location from either uranium-238 converted from total-uranium or uranium-238 derived directly from analysis was used to develop the block model.

Also, PRLs based on total-uranium (identified in Section 2) were converted to equivalent uranium-238 radiological contamination levels for use in the remedial volume calculations. These total-uranium PRLs include:

- surface soil PRLs based on groundwater 20 percent of the Hazard Index (0.2 HI)
- surface soil PRLs based on groundwater ARAR
- surface soil PRLs based on perched groundwater 20 percent of the Hazard Index (0.2 HI)
- surface soil PRLs based on perched groundwater ARAR.

E.1.2.7 BASE VOLUME CALCULATIONS

A separate calculation subsection is provided for each subunit, receptor, and incremental lifetime cancer risk (ILCR) criteria. Under each subsection, the modeling parameters are summarized and the modeled volumes totaled. Justification is then made for additional remediation as a result of other COCs. Any additional remediation volumes are combined with the modeled value and totaled. The total represents a base remediation volume.

E.1.2.8 SPECIFIC VOLUME CALCULATIONS FOR EACH REMEDIAL ALTERNATIVE

Following the base calculation, the remedial alternatives are summarized, and any adjustments to the general case that apply to a particular alternative are made. The feasibility study considered the following eight remediation alternatives:

- Alternative 1—No action
- Alternative 2—Consolidation and capping
- Alternative 3—Excavation and off-site disposal
- Alternative 4—Excavation and off-site disposal with treatment of fraction exceeding waste acceptance criteria
- Alternative 5—Excavation and on-site disposal
- Alternative 6—Excavation and on-site disposal with off-site disposal of fraction exceeding waste acceptance criteria
- Alternative 7—Excavation and on-site disposal with treatment of fraction exceeding waste acceptance criteria
- Alternative 8—Excavation and treatment with on-site disposal

Of these alternatives, Alternative 1 required no calculations to be performed. For the expanded trespasser and ILCR level of 10^{-6}, remediation volumes were calculated for Alternatives 2 through 8. For the expanded trespasser and ILCR level of 10^{-5}, remediation volumes were calculated for Alternatives 2, 3, and 6. For the resident farmer and both ILCR levels of 10^{-6} and 10^{-5}, remediation volumes were calculated for Alternatives 3 and 6.

E.1.2.9 TOTAL EXCAVATION VOLUME

The remediation volumes summarized in Tables E.1-1 through E.1-10 were adjusted to account for construction considerations such as safe side slopes, which require that additional materials be excavated within the five Operable Unit 2 subunits. The total excavation includes remediation volume plus the excavation of the additional materials.

Estimates of additional excavation required to enable removal of the remediation volume at each subunit is based on preliminary excavation limits. The following percentages of the remediation volume were developed to estimate additional excavation:

- Solid Waste Landfill—14 percent
- Lime Sludge Ponds—10 percent
- Inactive Flyash Pile—10 percent
- South Field—10 percent
- Active Flyash Pile—10 percent

Additionally, a waste volume is included for contaminated materials generated during remedial action. This material includes generated waste at the decontamination facilities; sediments deposited in the sedimentation tanks from contaminated construction runoff and construction water; and contamination removed during site restoration activities at the decontamination facilities, staging and storage areas, and waste haul roads. Estimated generated waste volume varies between 4,800 yd^3 and 26,800 yd^3. For cost estimating purposes, total volume of generated waste is assumed to be 15,000 yd^3 (3000 yd^3 per subunit).

E.1.2.10 URANIUM-238 VOLUME TABLES

The tables included in Section E.1.8 indicate the volume of material above various uranium-238 concentrations. The values shown in these tables were determined through the use of the block model based only on uranium-238. Since these tables were not based on the three modeling isotopes (uranium-238, radium-228, and thorium-228), they have not been used to determine remediation

volumes; however, these tables can be used to approximate specific volumes based only on the uranium-238 isotope, namely:

- On-site disposal cell waste acceptance criteria volumes
- Remediation volumes requiring different levels of personal protective equipment
- Volumes available for construction of the on-site disposal cell berm

Appendix E.1.9 summarizes these volumes for each Operable Unit 2 subunit.

E.1.2.11 FIRING RANGE CALCULATIONS

Appendix E.1.10 provides the calculations for determining the quantity of lead in the South Field and the volume of material considered to be contaminated with lead at concentrations above hazardous waste requirements.

APPENDIX E.1.3
REMEDIATION VOLUME CALCULATIONS—
SOLID WASTE LANDFILL

E.1.3.1 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOLID WASTE LANDFILL, FEDERAL OWNERSHIP (EXPANDED TRESPASSER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 12.9 pCi/g (soil PRL based on perched groundwater ARAR)

For material within and above source/impacted till

Radium-228 ..... 2.0 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.8 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Solid Waste Landfill:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
15,046 yd^3	4,282 yd^3	1,736 yd^3	0 yd^3	21,064 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the fill. Since total fill volume is 15,220 yd^3 and modeled volume is 15,046 yd^3, only 174 yd^3 of fill is not modeled. Including this 174 yd^3 will ensure all COCs present above established PRLs in the fill are removed.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
21,064 yd^3	174 yd^3	21,238 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVE 2

For Alternative 2, a separate analysis was performed modeling only materials outside the area to be capped. The same PRLs as listed above were used. The results are as follows:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
1,389 yd^3	579 yd^3	0 yd^3	0 yd^3	1,968 yd^3

There are no other COCs present at levels above their respective PRLs at locations beyond the cap limit; therefore, no additional volume results from other COCs. However, to facilitate construction of the cap, a trench will have to be excavated between the Solid Waste Landfill and the adjacent railroad track. A total of 10,100 yd^3 of trench material will have to be excavated and placed under the cap. Thus, the total volume for Alternative 2 will be 1,968 yd^3 + 10,100 yd^3 = 12,100 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 3, 4, 5, 6, 7, and 8

No volume adjustments need to be made for Alternatives 3, 4, 5, 6, 7, and 8. Thus, the remedial volume for these alternatives is 21,200 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-11 SOLID WASTE LANDFILL
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL
Radium-226	pCi/g	2.0E+03	1.8	2.3	1.6	1.0	--
Radium-228[c]	pCi/g	1.8E+03	2.0	3.2	1.5	0.9	--
Thorium-228[c]	pCi/g	--[d]	1.8	2.0	2.0	1.1	0.7
Thorium-232	pCi/g	6.8E+02	1.5	1.7	1.2	0.9	--
Uranium-234	pCi/g	3.7E+04	62.9	54.2	30.6	1.3	--
Uranium-235/236	pCi/g	7.7E+02[e]	63.1	3.8	2.5	0.1	--
Uranium-238[c]	pCi/g	2.8E+04[f]	12.9	98.4	47.7	3.6	--
Total Uranium[c]	mg/kg	--[g]	38.6	272.3	146.0	7.7	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

[a]Criteria for off-site disposal at Envirocare
[b]Represents governing PRL for each constituent (refer to Section 2)
[c]Modeled constituent (except total uranium which, correlates directly with modeling of uranium-238)
[d]Thorium-228 is a daughter of thorium 232 (assume at same concentration in equilibrium).
[e]Off-site waste acceptance criteria for uranium-235. Uranium-236 acceptance criteria is 3.6E+04 pCi/g.
[f]For on-site disposal, activity for uranium-238 is limited to 300 pCi/g.
[g]Acceptance criteria for uranium-natural is 1.8E+4 pCi/g and for uranium-depleted is 1.1E+05 pCi/g.

000531

6647

E.1.3.2 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOLID WASTE LANDFILL, EXPANDED TRESPASSER (10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 12.9 pCi/g (soil PRL based on groundwater ARAR)

For material within and above source/impacted till

Radium-228 ..... 8.9 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 5.4 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Solid Waste Landfill:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
15,046 yd^3	4,282 yd^3	1,736 yd^3	0 yd^3	21,064 yd^3

VOLUME FROM OTHER COCs

Other COCs have not been detected above their respective PRLs in any layer of the solid waste landfill; however, since only 174 yd^3 of material from the fill layer is excluded from the model, this volume will be added to the modeled volume.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
21,064 yd^3	174 yd^3	21,238 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVE 2

For Alternative 2, a separate analysis was performed modeling only materials outside the area to be capped. The same PRLs as listed above were used. The results are as follows:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
1,389 yd^3	579 yd^3	0 yd^3	0 yd^3	1,968 yd^3

There are no other COCs present at levels above their respective PRLs at locations beyond the cap limit; therefore, no additional volume results from other COCs. However, to facilitate construction of the cap, a trench will have to be excavated between the Solid Waste Landfill and the adjacent railroad track. A total of 10,100 yd^3 of material will have to be excavated and placed under the cap. Thus, the total volume for Alternative 2 will be 1,968 yd^3 + 10,100 yd^3 = 12,100 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 3 and 6

There is no variance between these alternatives. Thus, the remedial volume for these alternatives is 21,200 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 4, 5, 7, and 8

These alternatives do not apply to the expanded trespasser risk base 10^{-5}.

TABLE E.1-12 SOLID WASTE LANDFILL
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL
Radium-226	pCi/g	2.0E+03	5.1	2.3	1.6	1.0	--
Radium-228[c]	pCi/g	1.8E+03	8.9	3.2	1.5	0.9	--
Thorium-228[c]	pCi/g	--[d]	5.4	2.0	2.0	1.1	0.7
Thorium-232	pCi/g	6.8E+02	3.9	1.7	1.2	0.9	--
Uranium-234	pCi/g	3.7E+04	620	54.2	30.6	1.3	--
Uranium-235/236	pCi/g	7.7E+02[e]	619	3.8	2.5	0.1	--
Uranium-238[c]	pCi/g	2.8E+04[f]	12.9	98.4	47.7	3.6	--
Total Uranium[c]	mg/kg	--[g]	38.6	272.3	146.0	7.7	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000534

E.1.3.3 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOLID WASTE LANDFILL, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers within and above the perched groundwater

Uranium-238 ..... 1.12 pCi/g (soil PRL based on perched groundwater ARAR/0.2 HI)

For all layers below the perched groundwater

Uranium-238 ..... 1.47 pCi/g (surface soil exposure pathways PRL)

For all layers

Radium-228 ..... 1.26 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.43 pCi/g (surface soil exposure pathways PRL)

the following remedial volumes were modeled for the Solid Waste Landfill:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
15,220 yd^3	4,282 yd^3	58,160 yd^3	0 yd^3	77,662 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the fill, impacted till, and other till; however, the entire fill and impacted till layers are included in the modeled volume. Thus, the only layer that may require further remediation is the other till. Of the COCs present above established PRLs, only neptunium-237 and beryllium were identified in material outside the modeled excavation. As a result of widespread contamination from neptunium-237 and beryllium, all material within/above the sand and gravel will be removed. From the block model it was determined that there is 54,456 yd^3 of material above/within the sand and gravel in the till layer, and that 33,681 yd^3 of that material was included in the modeled volume. Thus, an additional excavation of 54,456 yd^3 - 33,681 yd^3 = 20,775 yd^3 will be required from the till layer.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
77,662 yd^3	20,775 yd^3	98,437 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVE 3 and 6

No material was detected that exceeds on-site or off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for alternatives 3 and 6 is 98,400 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-13 SOLID WASTE LANDFILL
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL
Neptunium-237	pCi/g	2.0E+03	0.043	1.7	--	0.4	--
Plutonium-238	pCi/g	1.0E+04	0.40	0.4	--	0.2	--
Radium-226	pCi/g	2.0E+03	1.43	2.3	1.6	1.0	--
Radium-228 [c]	pCi/g	1.8E+03	1.26	3.2	1.5	0.9	--
Strontium-90	pCi/g	2.0E+04	0.016	1.99	1.42	0.73	--
Technetium-99	pCi/g	1.0E+05	0.00189	0.8	--	--	--
Thorium-228 [c]	pCi/g	-- [d]	1.43	2.0	2.0	1.1	0.7
Thorium-230	pCi/g	1.5E+04	2.74	15.4	3.8	3.1	0.7
Thorium-232	pCi/g	6.8E+02	1.36	1.7	1.2	0.9	--
Uranium-234	pCi/g	3.7E+04	1.12	54.2	30.6	1.3	--
Uranium-235/236	pCi/g	7.7E+02 [e]	0.23	3.8	2.5	0.1	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.12	98.4	47.7	3.6	--
Uranium-238 [c] (below perched groundwater)	pCi/g	2.8E+04 [f]	1.47	98.4	47.7	3.6	--
Total Uranium [c]	mg/kg	-- [g]	3.4	272.3	146	7.7	--

000537

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TABLE E.1-13 SOLID WASTE LANDFILL
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL
Antimony	mg/kg	--	1.33	16.4	11.9	22.6	--
Arsenic	mg/kg	1.0E+02	8.2	7.1	15.4	7.7	--
Beryllium	mg/kg	--	0.6	1.1	1.0	1.0	--
Benzo(a)anthracene	mg/kg	--	0.023	18	--	0.29	--
Benzo(a)pyrene	mg/kg	--	0.0015	13	--	0.29	--
Benzo(b)fluoranthene	mg/kg	--	0.014	15	--	0.26	--
Carbazole	mg/kg	--	0.00643	4.2	--	0.21	--
Dibenzo(a,h)anthracene	mg/kg	--	0.00046	3	--	0.11	--
Indeno(1,2,3-cd)pyrene	mg/kg	--	0.0073	6.5	--	0.21	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000538

E.1.3.4 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOLID WASTE LANDFILL, FEDERAL OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria:

For all layers within and above the perched groundwater

Uranium-238 ..... 1.12 pCi/g (soil PRL based on perched groundwater ARAR/02 HI)

For all layers below the perched groundwater

Uranium-238 ..... 3.72 pCi/g (surface soil exposure pathways PRL)

For all layers

Radium-228 ..... 1.33 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.44 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Solid Waste Landfill:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
15,220 yd^3	4,282 yd^3	51,042 yd^3	0 yd^3	70,544 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the fill, impacted till, and other till; however, the entire fill and impacted till layers are included in the modeled volume. Thus, the only layer that may require further remediation is the other till. Of the COCs detected in the other till, only strontium-90 and beryllium do not correlate with the modeled excavation. It is assumed that an additional excavation of 10,000 yd^3 will be sufficient to remove these COCs located outside the modeled volume.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
70,544 yd^3	10,000 yd^3	80,544 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVES 3 and 6

No material was detected that exceeds on-site or off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for alternatives 3 and 6 is 80,500 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-14 SOLID WASTE LANDFILL
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL
Neptunium-237	pCi/g	2.0E+03	0.43	1.7	--	0.4	--
Plutonium-238	pCi/g	1.0E+04	4.0	0.4	--	0.2	--
Radium-226	pCi/g	2.0E+03	1.46	2.3	1.6	1.0	--
Radium-228 [c]	pCi/g	1.8E+03	1.33	3.2	1.5	0.9	--
Strontium-90	pCi/g	2.0E+04	0.16	1.99	1.42	0.73	--
Technetium-99	pCi/g	1.0E+05	0.0189	0.8	--	--	--
Thorium-228 [c]	pCi/g	-- [d]	1.44	2.0	2.0	1.1	0.7
Thorium-230	pCi/g	1.5E+04	6.97	15.4	3.8	3.1	0.7
Thorium-232	pCi/g	6.8E+02	1.39	1.7	1.2	0.9	--
Uranium-234	pCi/g	3.7E+04	1.86	54.2	30.6	1.3	--
Uranium-235/236	pCi/g	7.7E+02 [e]	0.97	3.8	2.5	0.1	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.12	98.4	47.7	3.6	--
Uranium-238 [c] (below perched groundwater)	pCi/g	2.8E+04 [f]	3.72	98.4	47.7	3.6	--
Total Uranium [c]	mg/kg	-- [g]	3.4	272.3	146	7.7	--
Antimony	mg/kg	--	1.33	16.4	11.9	22.6	--
Arsenic	mg/kg	1.0E+02	8.2	7.1	15.4	7.7	--

TABLE E.1-14 SOLID WASTE LANDFILL
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL
Beryllium	mg/kg	--	0.6	1.1	1.0	1.0	--
Benzo(a)anthracene	mg/kg	--	0.23	18	--	0.29	--
Benzo(a)pyrene	mg/kg	--	0.015	13	--	0.29	--
Benzo(b)fluoranthene	mg/kg	--	0.14	15	--	0.26	--
Carbazole	mg/kg	--	0.0643	4.2	--	0.21	--
Dibenzo(a,h)anthracene	mg/kg	--	0.0046	3	--	0.11	--
Indeno(1,2,3-cd)pyrene	mg/kg	--	0.073	6.5	--	0.21	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000542

APPENDIX E.1.4
REMEDIATION VOLUME CALCULATIONS—
LIME SLUDGE PONDS

E.1.4.1 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS LIME SLUDGE PONDS, FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 38.3 pCi/g (soil PRL based on groundwater 0.2 HI)

For material above till

Radium-228 ..... 2.0 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.8 pCi/g (surface soil exposure pathways PRL)

the volume modeled for the Lime Sludge Ponds is 0 yd^3.

VOLUME FROM OTHER COCs

One sample within the berm and two surface sample locations on the road adjacent to the Lime Sludge Ponds have radium-226 concentrations above the PRL for that constituent. To remove material contaminated with radium-226 will require excavation of 300 yd^3.

LIME SLUDGE VOLUME

All lime sludge will be removed. Total lime sludge volume is 16,493 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	LIME SLUDGE	TOTAL
0 yd^3	300 yd^3	16,493 yd^3	16,793 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVE 2

An area of 13,500 sq ft (the area outside the capped area but inside the battery limits) that includes berm material and material along the road will be leveled and moved to the center of the Lime Sludge Ponds to facilitate construction of the cap. An average depth of 3 ft will be removed. The volume to be excavated will be 13,500 sq ft x 3 ft x 1 $yd^3/27\ ft^3$ = 1,500 yd^3.

Additionally, the K-65 trench will be excavated and the material placed under the cap. It is estimated that 100 yd^3 of material from the K-65 trench will require removal.

Thus, the total volume to be excavated for Alternative 2 is 1,500 yd^3 + 100 yd^3 = 1,600 yd^3.

ALTERNATIVES 3, 4, 5, 6, 7, and 8

No volume adjustments need to be made for Alternatives 3, 4, 5, 6, 7 and 8. Thus, the remedial volume for these alternatives is 16,800 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-15 LIME SLUDGE PONDS
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS		
				BERM	TILL	GMA SOIL
Radium-226	pCi/g	2.0E+03	1.8	3.15	1.19	0.40
Radium-228 [c]	pCi/g	1.8E+03	2.0	1.38	1.11	--
Thorium-228 [c]	pCi/g	-- [d]	1.8	1.17	0.97	1.30
Thorium-232	pCi/g	6.8E+02	1.5	1.06	1.05	--
Uranium-234	pCi/g	3.7E+04	196	13.40	1.10	--
Uranium-235/236	pCi/g	7.7E+02 [e]	195	0.77	0.15	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	45.3	8.45	1.14	--
Total Uranium [c]	mg/kg	-- [g]	136	29.36	14.30	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

E.1.4.2 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS LIME SLUDGE PONDS, FEDERAL OWNERSHIP (EXPANDED TRESPASSER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria:

For all layers

Uranium-238 ..... 38.3 pCi/g (soil PRL based on groundwater 0.2 HI)

For material above till:

Radium-228 ..... 8.9 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 5.4 pCi/g (surface soil exposure pathways PRL)

the volume modeled for the Lime Sludge Ponds is 0 yd^3.

VOLUME FROM OTHER CONTAMINANTS

Two surface sample locations on the road adjacent to the Lime Sludge Ponds have radium-226 concentrations above the PRL for that constituent. To remove material contaminated with radium-226 will require an excavation of 300 yd^3.

LIME SLUDGE VOLUME

All lime sludge will be removed. Total sludge volume is 16,493 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	LIME SLUDGE	TOTAL
0 yd^3	300 yd^3	16,493 yd^3	16,793 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVE 2

An area of 13,500 sq ft (the area outside the capped area but inside the battery limit) that includes berm material and material along the road will be leveled and moved to the center of the Lime Sludge Ponds to facilitate construction of the cap. An average depth of 3 ft will be removed. The volume to be excavated will be 13,500 sq ft x 3 ft x 1 $yd^3/27\ ft^3$ = 1,500 yd^3.

Additionally, the K-65 trench will be excavated and the material placed under the cap. It is estimated that 100 yd^3 of material from the K-65 trench will require removal.

Thus, the total volume to be excavated for Alternative 2 is 1,500 yd^3 + 100 yd^3 = 1,600 yd^3.

ALTERNATIVES 3, and 6

There is no variance between these alternatives. Thus, the remedial volume for these alternatives is 16,800 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 4, 5, 7, and 8

These alternatives do not apply to the expanded trespasser risk base 10^{-5}.

TABLE E.1-16 LIME SLUDGE PONDS
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS		
				BERM	TILL	GMA SOIL
Radium-226	pCi/g	2.0E+03	5.1	3.15	1.19	0.40
Radium-228 [c]	pCi/g	1.8E+03	8.9	1.38	1.11	--
Thorium-228 [c]	pCi/g	-- [d]	5.4	1.17	0.97	1.30
Thorium-232	pCi/g	6.8E+02	3.9	1.06	1.05	--
Uranium-234	pCi/g	3.7E+04	1951	13.40	1.10	--
Uranium-235/236	pCi/g	7.7E+02 [e]	1950	0.77	0.15	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	45.3	8.45	1.14	--
Total Uranium [c]	mg/kg	-- [g]	136	29.36	14.30	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000549

E.1.4.3 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS LIME SLUDGE PONDS, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers within and above the perched groundwater

Uranium-238 ..... 1.12 pCi/g (soil PRL based on perched groundwater 0.2 HI)

For all layers below the perched groundwater

Uranium-238 ..... 1.47 pCi/g (surface soil exposure pathways PRL)

For all layers

Radium-228 ..... 1.26 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.43 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Lime Sludge Ponds:

SLUDGE	BERM	TILL	GMA SOIL	SEDIMENT	TOTAL
15,451 yd^3	5,556 yd^3	15,056 yd^3	0 yd^3	0 yd^3	36,053 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the berm and till; however, the entire berm is included in the modeled volume. Thus, the till is the only layer that may require further remediation. Neptunium-237, strontium-90, and technetium-99 were present above established PRLs in various samples within the till layer above/within the sand and gravel. To ensure removal of all COCs, all material above/within the sand and gravel will be excavated. From the block model it was determined that there is 59,548 yd^3 of material above/within the sand and gravel in the till layer. Thus, an additional excavation of 59,548 yd^3 - 15,046 yd^3 = 44,502 yd^3 will be required from the till layer.

OTHER LIME SLUDGE VOLUME

All lime sludge will be removed. Volume not modeled is 16,493 yd^3 - 15,451 yd^3 = 1,042 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	OTHER LIME SLUDGE	TOTAL
36,053 yd^3	44,502 yd^3	1,042 yd^3	81,597 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer option.

ALTERNATIVES 3 and 6

No material was detected that exceeds on-site disposal or off-site acceptance criteria; therefore, no volume adjustments are required. Thus, remedial volume for Alternatives 3 and 6 is 81,600 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-17 LIME SLUDGE PONDS
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS		
				BERM	TILL	GMA SOIL
Cesium-137	pCi/g	5.6E+02	0.72	0.18	--	--
Neptunium-237	pCi/g	2.0E+03	0.0051	0.31	0.13	--
Radium-226	pCi/g	2.0E+03	1.43	3.15	1.19	0.40
Radium-228 [c]	pCi/g	1.8E+02	1.26	1.38	1.11	--
Strontium-90	pCi/g	2.0E+04	0.0056	0.96	0.54	--
Technetium-99	pCi/g	1.0E+05	0.00189	1.05	0.45	--
Thorium-228 [c]	pCi/g	-- [d]	1.43	1.17	0.97	1.30
Thorium-230	pCi/g	1.5E+04	2.74	12.25	2.49	--
Thorium-232	pCi/g	6.8E+02	1.36	1.06	1.05	--
Uranium-234	pCi/g	3.7E+04	1.26	13.40	1.10	--
Uranium-235/236	pCi/g	7.7E+02 [e]	0.24	0.77	0.15	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.12	8.45	1.14	--
Uranium-238 [c] (below perched groundwater)	pCi/g	2.8E+04 [f]	1.47	8.45	1.14	--
Total Uranium [c]	mg/kg	-- [g]	3.4	29.36	14.30	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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E.1.4.4 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS LIME SLUDGE PONDS, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER (10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria:

For all layers within and above the perched groundwater

Uranium-238 ..... 1.12 pCi/g (soil PRL based on perched groundwater ARAR)

For all layers below the perched groundwater

Uranium-238 ..... 3.72 pCi/g (surface soil exposure pathways PRL)

For all layers

Radium-228 ..... 1.33 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.44 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Lime Sludge Ponds:

SLUDGE	BERM	TILL	GMA SOIL	SEDIMENT	TOTAL
15,451 yd^3	5,556 yd^3	13,484 yd^3	0 yd^3	0 yd^3	34,491 yd^3

VOLUME FROM OTHER COCs

Other COCs were detected in the berm and till at levels above their respective PRLs; however, the entire berm is included in the modeled volume. Thus, the till is the only layer that may require further remediation. Of the COCs detected in the till, only one sample location for neptunium-237 did not correlate with the modeled excavation. This sample location is 17.5 ft below the surface with no material above it removed. Assume 800 yd^3 will be required to remediate neptunium-237 contamination.

LIME SLUDGE VOLUME

All lime sludge will be removed. Lime sludge not modeled is 16,493 yd^3 - 15,451 yd^3 = 1,042 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	LIME SLUDGE	TOTAL
34,491 yd^3	800 yd^3	1,042 yd^3	36,333 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVES 3 and 6

No material was detected that exceeds on-site or off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternatives 3 and 6 is 36,300 yd^3.

TABLE E.1-18 LIME SLUDGE PONDS
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS		
				BERM	TILL	GMA SOIL
Cesium-137	pCi/g	5.6E+02	0.89	0.18	--	--
Neptunium-237	pCi/g	2.0E+03	0.051	0.31	0.13	--
Radium-226	pCi/g	2.0E+03	1.46	3.15	1.19	0.40
Radium-228 [c]	pCi/g	1.8E+02	1.33	1.38	1.11	--
Strontium-90	pCi/g	2.0E+04	0.056	0.96	0.54	--
Technetium-99	pCi/g	1.0E+05	0.0189	1.05	0.45	--
Thorium-228 [c]	pCi/g	-- [d]	1.44	1.17	0.97	1.30
Thorium-230	pCi/g	1.5E+04	6.97	12.25	2.49	--
Thorium-232	pCi/g	6.8E+02	1.39	1.06	1.05	--
Uranium-234	pCi/g	3.7E+04	3.24	13.40	1.10	--
Uranium-235/236	pCi/g	7.7E+02 [e]	1.05	0.77	0.15	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.12	8.45	1.14	--
Uranium-238 [c] (below perched groundwater)	pCi/g	2.8E+04 [f]	3.72	8.45	1.14	--
Total Uranium [c]	mg/kg	-- [g]	3.4	29.36	14.30	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

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APPENDIX E.1.5
REMEDIATION VOLUME CALCULATIONS—
INACTIVE FLYASH PILE

E.1.5.1 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS INACTIVE FLYASH PILE, FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

Over the till (greater than 18 ft of till)

For material within and above the interbedded sand layer

Uranium-238 ..... 3.2 pCi/g (cross media modified groundwater PRL)

For material below the interbedded sand layer

Uranium-238 ..... 71 pCi/g (cross media modified groundwater PRL)

Over the GMA (less than 18 ft of till)

Uranium-238 ..... 6.12 pCi/g (cross media modified groundwater PRL)

For all material (over entire subunit) within and above the fill/impacted till

Radium-228 ..... 2.0 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.8 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Inactive Flyash Pile:

COVER	FLYASH	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
1,042 yd^3	43,229 yd^3	45,891 yd^3	3,472 yd^3	0 yd^3	0 yd^3	93,634 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the fill/debris and other till. All locations where these COCs were detected correspond to areas modeled for removal; therefore, no additional excavation is necessary.

OTHER FLYASH

All flyash will be removed. Volume of flyash not modeled is 43,634 yd^3 - 43,229 yd^3 = 405 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	OTHER FLYASH	TOTAL
93,634 yd^3	0 yd^3	405 yd^3	94,039 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVE 2

For Alternative 2, a separate model analysis was performed for material outside the area to be capped. The same PRLs as listed above were used. Modeling results were no different from previous results. Thus, total volume for Alternative 2 is 94,000 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 3, 4, 5, and 8

No volume adjustments need to be made for Alternatives 3, 4, 5, and 8. Thus, the remedial volume for these alternatives is 94,000 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 6

For Alternative 6 material with uranium-238 activity above 300 pCi/g will be disposed off site. Based on model analysis, 3,100 yd^3 of material must be disposed off-site. Thus, 94,039 yd^3 - 3,100 yd^3 = 90,900 yd^3 (rounded to nearest 100 yd^3) will be disposed on site.

ALTERNATIVE 7

For Alternative 7, material with uranium-238 activity above 300 pCi/g will be treated prior to on-site disposal. Based on block model analysis, 3,100 yd^3 of material must be treated. Bulking due to treatment is assumed to increase volume by 20 percent. Thus, on-site disposal volume will be 93,981 yd^3 + 3,100 yd^3 x 0.20 = 94,600 yd^3 (rounded to nearest 100 yd^3). Excavation volume remains 94,000 yd^3.

TABLE E.1-19 INACTIVE FLYASH PILE
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS					
				COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Radium-226	pCi/g	2.0E+03	1.8	1.22	37.8	36.0	1.01	0.87	--
Radium-228 [c]	pCi/g	1.8E+03	2.0	1.20	2.048	3.12	0.730	0.53	--
Thorium-228 [c]	pCi/g	-- [d]	1.8	--	2.279	3.03	0.833	0.41	--
Thorium-232	pCi/g	6.8E+02	1.5	--	2.118	3.28	0.732	0.36	--
Uranium-234	pCi/g	3.7E+04	4.24	6.18	771	187	0.77	1.29	--
Uranium-234 (less than 18 ft of till)	pCi/g	3.7E+04	8.68	6.18	771	187	0.77	1.29	--
Uranium-235/236	pCi/g	7.7E+02 [e]	3.35	0.276	49.1	18.5	0.052	0.08	--
Uranium-235/236 (less than 18 ft of till)	pCi/g	7.7E+02 [e]	7.79	0.276	49.1	18.5	0.052	0.08	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	3.22	6.12	1570	191	0.850	1.44	--
Uranium-238 [c] (less than 18 ft of till)	pCi/g	2.8E+04 [f]	6.12	6.12	1570	191	0.850	1.44	--
Uranium-238 [c] (below sand layer)	pCi/g	2.8E+04 [f]	71	6.12	1570	191	0.850	1.44	--
Total Uranium [c]	mg/kg	-- [g]	24.8	19.7	2280	873	4.39	5.86	--
Arsenic	mg/kg	1.0E+02	16.9	5.1	49.7	5.0	6.9	5.1	6.3

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

E.1.5.2 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS INACTIVE FLYASH PILE, FEDERAL OWNERSHIP (EXPANDED TRESPASSER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

Over the till (greater than 18 ft of till)

For material within and above the interbedded sand layer

Uranium-238 ..... 8.3 pCi/g (soil PRL based on groundwater ARAR)

For material below the interbedded sand layer

Uranium-238 ..... 150 pCi/g (soil PRL based on groundwater ARAR)

Over the GMA (less than 18 ft of till)

Uranium-238 ..... 8.3 pCi/g (soil PRL based on groundwater ARAR)

For all material (over entire subunit) within and above the fill/impacted till

Radium-228 ..... 8.9 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 5.4 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Inactive Flyash Pile:

FLYASH	COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
15,336 yd^3	984 yd^3	38,368 yd^3	2,720 yd^3	0 yd^3	0 yd^3	0 yd^3	57,408 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected above their respective PRLs in the fill/debris and other till layers. All locations where these COCs were detected correspond to areas modeled for removal. For the cover, only 173 yd^3 of material within that layer is excluded from the modeled volume. Because it would be difficult to segregate this volume, it will be added to the total excavation volume.

FLYASH VOLUME

All flyash will be removed. Volume of flyash not modeled is 43,634 yd^3 - 15,336 yd^3 = 28,298 yd^3.

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TOTAL VOLUME

MODELED	OTHER COCs	OTHER FLYASH	TOTAL
57,408 yd^3	173 yd^3	28,298 yd^3	85,879 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVE 2

For Alternative 2, a separate analysis was performed modeling only material outside the area to be capped. The same PRLs as listed above were used. Based on that criterion, only 58 yd^3 of material previously modeled in the impacted till is now excluded from excavation. Thus, the remediation volume for Alternative 2 is 85,879 yd^3 - 58 yd^3 = 85,800 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 3

No material was detected that exceeds off-site disposal facilty waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternative 3 is 85,900 yd^3 (rounded to the nearest 100 yd^3).

ALTERNATIVES 4, 5, 7, and 8

Alternatives 4, 5, 7, and 8 do not apply to expanded trespasser risk base 10^{-5}.

ALTERNATIVE 6

For Alternative 6, material with uranium-238 activity above 300 pCi/g will be disposed off site. Based on model analysis, 3,100 yd^3 of material must be disposed off site. Thus 85,879 yd^3 - 3,100 yd^3 = 82,800 yd^3 (rounded to nearest 100 yd^3) will be disposed on site.

TABLE E.1-20 INACTIVE FLYASH PILE
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS					
				COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Radium-226	pCi/g	2.0E+03	5.1	1.22	37.8	36.0	1.01	0.87	--
Radium-228 [c]	pCi/g	1.8E+03	8.9	1.20	2.048	3.12	0.730	0.53	--
Thorium-228 [c]	pCi/g	-- [d]	5.4	--	2.279	3.03	0.833	0.41	--
Thorium-232	pCi/g	6.8E+02	3.9	--	2.118	3.28	0.732	0.36	--
Uranium-234	pCi/g	3.7E+04	33	6.18	771	187	0.77	1.29	--
Uranium-234 (less than 18 ft of till)	pCi/g	3.7E+04	92	6.18	771	187	0.77	1.29	--
Uranium-235/236	pCi/g	7.7E+02 [e]	32	0.276	49.1	18.5	0.052	0.08	--
Uranium-235/236 (less than 18 ft of till)	pCi/g	7.7E+02 [e]	91	0.276	49.1	18.5	0.052	0.08	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	8.3	6.12	1570	191	0.850	1.44	--
Uranium-238 [c] (below sand layer)	pCi/g	2.8E+04 [f]	150	6.12	1570	191	0.850	1.44	--
Total Uranium [c]	mg/kg	-- [g]	24.8	19.7	2280	873	4.39	5.86	--
Arsenic	mg/kg	1.0E+02	169	5.1	49.7	5.0	6.9	5.1	6.3

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000562

E.1.5.3 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS INACTIVE FLYASH PILE, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 1.47 pCi/g (surface soil exposure pathways PRL)

Radium-228 ..... 1.26 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.43 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Inactive Flyash Pile

FLYASH	COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
43,634 yd^3	1,157 yd^3	50,752 yd^3	4,514 yd^3	0 yd^3	463 yd^3	100,520 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the cover, fill/debris, and impacted till; however, the entire cover and impacted till layers are included in the modeled volume. Thus, the only layer that may require further remediation is the fill/debris. Since the total volume of the fill/debris layer is 51,100 yd^3, and the volume modeled for removal is 50,752 yd^3, only 342 yd^3 of material in the fill/debris layer is not included in the modeled volume. Including this 348 yd^3 volume will ensure that all COCs present above established PRLs in the fill/debris layer are removed.

OTHER FLYASH VOLUME

The total flyash volume has been modeled; therefore, no additional volume needs to be added.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
100,520 yd^3	348 yd^3	100,868 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVE 3

No material was detected that exceeds off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternative 3 is 100,900 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 6

For Alternative 6, material with uranium-238 activity above 300 pCi/g will be disposed off site. Based on model analysis, 3,100 yd^3 of material must be disposed off site. Thus 100,900 yd^3 - 3,100 yd^3 = 97,800 yd^3 of material will be disposed on site.

TABLE E.1-21 INACTIVE FLYASH PILE
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS					
				COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Radium-226	pCi/g	2.0E+03	1.43	1.22	37.8	36.0	1.01	0.87	--
Radium-228 [c]	pCi/g	1.8E+03	1.26	1.20	2.048	3.12	0.730	0.53	--
Thorium-228 [c]	pCi/g	-- [d]	1.43	--	2.279	3.03	0.833	0.41	--
Thorium-232	pCi/g	6.8E+02	1.36	--	2.118	3.28	0.732	0.36	--
Uranium-234	pCi/g	3.7E+04	2.0	6.18	771	187	0.77	1.29	--
Uranium-235/236	pCi/g	7.7E+02 [e]	0.24	0.276	49.1	18.5	0.052	0.08	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.47	6.12	1570	191	0.850	1.44	--
Total Uranium [c]	mg/kg	-- [g]	21	19.7	2280	873	4.39	5.86	--
Arsenic	mg/kg	1.0E+02	8.2	5.1	49.7	5.0	6.9	5.1	6.3
Dibenzo(a,h)anthracene	mg/kg	--	4.6E-04	--	2.2	--	--	--	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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E.1.5.4 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS INACTIVE FLYASH PILE, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers at all depths

Uranium-238 ..... 3.72 pCi/g (surface soil exposure pathways PRL)

Radium-228 ..... 1.33 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.44 pCi/g (surface soil exposure pathways PRL)

the following volume were modeled for the Inactive Flyash Pile:

FLYASH	COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	SEDIMENT	TOTAL
43,576 yd^3	1,157 yd^3	50,463 yd^3	4,514 yd^3	0 yd^3	0 yd^3	99,710 yd^3

VOLUME FROM OTHER CONTAMINANTS

Other COCs were detected at levels above their respective PRLs in the fill/debris and impacted till; however, the entire impacted till layer is included in the modeled volume. Thus, the only layer that may require further remediation is the fill/debris. To ensure that all COCs present above established PRLs are removed, the entire fill/debris layer will be removed. The additional excavation required to remove this entire layer is 51,100 yd^3 - 50,463 yd^3 = 637 yd^3.

OTHER FLYASH VOLUME

All flyash will be removed. Flyash not modeled equals 43,634 yd^3 - 43,576 yd^3 = 58 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	OTHER FLYASH	TOTAL
99,710 yd^3	637 yd^3	58 yd^3	100,405 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVE 3

No material was detected that exceeds off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternative 3 is 100,400 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 6

For Alternative 6, material with uranium-238 activity above 300 pCi/g will be disposed off site. Based on model analysis, 3,100 yd^3 of material must be disposed off site. Thus, 100,405 yd^3 - 3,100 yd^3 = 97,300 yd^3 (rounded to nearest 100 yd^3) can be disposed on site.

TABLE E.1-22 INACTIVE FLYASH PILE
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONSTITUENT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS					
				COVER	FILL/DEBRIS	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Radium-226	pCi/g	2.0E+03	1.46	1.22	37.8	36.0	1.01	0.87	--
Radium-228 [c]	pCi/g	1.8E+03	1.33	1.20	2.048	3.12	0.730	0.53	--
Thorium-228 [c]	pCi/g	-- [d]	1.44	--	2.279	3.03	0.833	0.41	--
Thorium-232	pCi/g	6.8E+02	1.39	--	2.118	3.28	0.732	0.36	--
Uranium-234	pCi/g	3.7E+04	8.9	6.18	771	187	0.77	1.29	--
Uranium-235/236	pCi/g	7.7E+02 [e]	1.05	0.276	49.1	18.5	0.052	0.08	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	3.72	6.12	1570	191	0.850	1.44	--
Total Uranium [c]	mg/kg	-- [g]	21	19.7	2280	873	4.39	5.86	--
Arsenic	mg/kg	1.0E+02	8.2	5.1	49.7	5.0	6.9	5.1	6.3
Dibenzo(a,h)anthracene	mg/kg	--	0.0046	--	2.2	--	--	--	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000568

APPENDIX E.1.6
REMEDIATION VOLUME CALCULATIONS—
SOUTH FIELD

E.1.6.1 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOUTH FIELD, FEDERAL OWNERSHIP (EXPANDED TRESPASSER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

Over the till (greater than 18 ft of till)

For material within and above the interbedded sand layer

Uranium-238 ..... 3.22 pCi/g (cross media modified groundwater PRL)

For material below the interbedded sand layer

Uranium-238 ..... 71 pCi/g (cross media modified groundwater PRL)

Over the GMA (less than 18 ft of till)

Uranium-238 ..... 6.12 pCi/g (cross media modified groundwater PRL)

For all material (over entire subunit) within and above the fill/impacted till

Radium-228 ..... 2.0 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.8 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the South Field:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
48,553 yd^3	24,363 yd^3	4,340 yd^3	0 yd^3	77,256 yd^3

VOLUME FROM OTHER COCs

Material contaminated with lead at concentrations above RCRA land disposal levels has been detected at the Firing Range in the South Field. Lead-contaminated material is estimated to be 300 yd^3 (see section E.1.10). For all alternatives this material will be treated and disposed off site.

Other COCs have been detected at levels above their respective PRLs in the fill and impacted fill. All locations where these COCs were detected correspond to areas modeled for removal. Thus, no additional volume will be excavated for these COCs.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
77,256 yd^3	300 yd^3	77,556 yd^3

ALTERNATIVE 1

Under this alternative, no material will be excavated.

ALTERNATIVE 2

Under this alternative contaminated material in areas where less than 18 feet of till overlie the GMA will be excavated and consolidated. In order to calculate this volume a separate model analysis was performed. The results of the analysis are as follows:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	TOTAL
33,333 yd^3	8,449 yd^3	0 yd^3	0 yd^3	41,782 yd^3

All COCs present at levels above their respective PRLs at locations beyond the cap limit are included in the modeled volume. Thus, the total volume for Alternative 2 will be 41,800 yd^3 (rounded to nearest 100 yd^3).

Additionally, 300 yd^3 of waste from the Firing Range will be treated and disposed off site.

ALTERNATIVES 3 and 4

No volume adjustment need to be made for Alternatives 3 and 4. Thus, the remedial volume for these alternatives is 77,600 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 5, 6, and 7

Under these alternatives, 300 yd^3 of material will be treated and disposed off site. Thus, the on-site disposal volume will be 77,556 yd^3 - 300 yd^3 = 77,300 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 8

Under this alternative, 300 yd^3 of material will be treated and disposed off site. The remaining material will be treated before being placed in the disposal cell. The excavated volume for treatment and on-site disposal will be 77,300 yd^3.

TABLE E.1-23 SOUTH FIELD
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Radium-226	pCi/g	2.0E+03	1.8	**9.21**	**1.99**	1.057	0.676	--
Radium-228 [c]	pCi/g	1.8E+03	2.0	3.74	1.444	1.022	0.461	--
Technetium-99	pCi/g	1.0E+05	71	0.90	0.90	--	--	--
Thorium-228 [c]	pCi/g	-- [d]	1.8	13.40	1.426	0.875	0.33	--
Thorium-230	pCi/g	1.5E+04	6.97	**13.80**	4.41	1.094	1.37	--
Thorium-232	pCi/g	6.8E+02	1.5	**12.90**	1.332	0.792	0.33	--
Uranium-234	pCi/g	3.7E+04	4.24	**78.3**	**17.20**	3.51	0.585	--
Uranium-234 (less than 18 ft of till)	pCi/g	3.7E+04	8.68	**78.3**	**17.20**	3.51	0.585	--
Uranium-235/236	pCi/g	7.7E+02 [e]	3.37	**4.05**	2.73	0.219	0.02	--
Uranium-235/236 (less than 18 ft of till)	pCi/g	7.7E+02 [e]	7.79	4.05	2.73	0.219	0.02	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	3.22	82.7	17.888	4.55	0.66	--
Uranium-238 [c] (less than 18 ft of till)	pCi/g	2.8E+04 [f]	6.12	82.7	17.888	4.55	0.66	--
Uranium-238 [c] (below sand layer)	pCi/g	2.8E+04 [f]	71	82.7	17.888	4.55	0.66	--
Total Uranium [c]	mg/kg	-- [g]	24.8	297	189	16.8	10.30	--

000572

TABLE E.1-23 SOUTH FIELD
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Benzo(a)pyrene	mg/kg	--	2.86	1.8	--	--	--	0.11
Dibenzo(a,h)anthracene	mg/kg	--	13	0.44	--	--	--	--
Indeno(1,2,3-cd)pyrene	mg/kg	--	200	0.62	--	--	--	0.099
Aroclor-1260	mg/kg	--	25	0.038	--	--	--	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

000573

E.1.6.2 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOUTH FIELD, FEDERAL OWNERSHIP (EXPANDED TRESPASSER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

Over the till (greater than 18 ft of till)

For material within and above the interbedded sand layer

Uranium-238 ..... 8.3 pCi/g (soil PRL based on groundwater ARAR)

For material below the interbedded sand layer

Uranium-238 ..... 150 pCi/g (soil PRL based on groundwater ARAR)

Over the GMA (less than 18 ft of till)

Uranium-238 ..... 8.3 pCi/g (soil PRL based on groundwater ARAR)

For all material (over entire subunit) within and above the fill/impacted till

Radium-228 ..... 8.9 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 5.4 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the South Field:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
22,512 yd^3	13,542 yd^3	0 yd^3	0 yd^3	0 yd^3	36,054 yd^3

VOLUME FROM OTHER COCs

Material contaminated with lead at concentrations above RCRA land disposal levels has been detected at the Firing Range in the South Field. Lead contaminated material is estimated to be 300 yd^3 (see section E.1.10). For all alternatives this material will be treated and disposed off site.

Other COCs have been detected at levels above their respective PRLs in the fill. All locations where these COCs were detected correspond to areas modeled for removal. Thus, no additional volume will be excavated for these COCs.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
36,054 yd^3	300 yd^3	36,354 yd^3

ALTERNATIVE 1

Under this alternative, no material will be excavated.

ALTERNATIVE 2

Under this alternative, contaminated material in areas where less than 18 feet of till overlie the GMA will be excavated and consolidated. In order to calculate this volume, a separate model analysis was performed. The results of the analysis are as follows:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
13,947 yd^3	4,225 yd^3	0 yd^3	0 yd^3	0 yd^3	18,172 yd^3

All COCs present at levels above their respective PRLs at locations beyond the cap limit are included in the modeled volume. Thus, the total volume for Alternative 2 will be 18,200 yd^3 (rounded to nearest 100 yd^3).

Additionally, 300 yd^3 of waste from the Firing Range will be treated and disposed off site.

ALTERNATIVE 3

No materials were detected that exceed off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for this alternative is 36,400 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVES 4, 5, 7, and 8

These alternatives do not apply to expanded trespasser risk base 10^{-5}.

ALTERNATIVE 6

Under this alternative, 300 yd^3 of material will be treated and disposed off site. Thus, the on-site disposal volume will be 36,354 yd^3 - 300 yd^3 = 36,100 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-24 SOUTH FIELD
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Radium-226	pCi/g	2.0E+03	5.1	9.21	1.99	1.057	0.676	--
Radium-228 [c]	pCi/g	1.8E+03	8.9	3.74	1.444	1.022	0.461	--
Technetium-99	pCi/g	1.0E+05	710	0.90	0.90	--	--	--
Thorium-228 [c]	pCi/g	-- [d]	5.4	13.40	1.426	0.875	0.33	--
Thorium-230	pCi/g	1.5E+04	6.97	13.80	4.41	1.094	1.37	--
Thorium-232	pCi/g	6.8E+02	3.9	12.90	1.332	0.792	0.33	--
Uranium-234	pCi/g	3.7E+04	33	78.3	17.20	3.51	0.585	--
Uranium-234 (less than 18 ft of till)	pCi/g	3.7E+04	92	78.3	17.20	3.51	0.585	--
Uranium-235/236	pCi/g	7.7E+02 [e]	32	4.05	2.73	0.219	0.02	--
Uranium-235/236 (less than 18 ft of till)	pCi/g	7.7E+02 [e]	91	4.05	2.73	0.219	0.02	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	8.3	82.7	17.888	4.55	0.66	--
Uranium-238 [c] (below sand layer)	pCi/g	2.8E+04 [f]	150	82.7	17.888	4.55	0.66	--
Total Uranium [c]	mg/kg	-- [g]	24.8	297	189	16.8	10.30	--
Benzo(a)pyrene	mg/kg	--	28.6	1.8	--	--	--	0.11
Dibenzo(a,h)anthracene	mg/kg	--	130	0.44	--	--	--	--
Indeno(1,2,3-cd)pyrene	mg/kg	--	0.496	0.62	--	--	--	0.099
Aroclor-1260	mg/kg	--	250	0.038	--	--	--	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

6647

E.1.6.3 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOUTH FIELD, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers at all depths

Uranium-238 ..... 1.47 pCi/g (surface soil exposure pathways PRL)

Radium-228 ..... 1.26 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.43 pCi/g (surface soil exposure pathways PRL)

the following volumes modeled for the South Field:

FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
115,047 yd^3	51,331 yd^3	47,570 yd^3	0 yd^3	0 yd^3	213,948 yd^3

VOLUME FROM OTHER COCs

Other COCs were detected at levels above their respective PRLs in the fill, impacted till, other till, GMA soil, and sediment. Because of the number of samples containing COCs above established PRLs (primarily neptunium-237 and beryllium), all material in the fill, impacted till, other till, and sediment will be excavated. Additional volumes to be excavated for these layers will be:

Fill = 120,081 yd^3 - 115,047 yd^3 = 5,034 yd^3

Impacted Till = 55,903 yd^3 - 51,331 yd^3 = 4,570 yd^3

Other Till = 162,789 yd^3 - 47,570 yd^3 = 115,219 yd^3

Sediment = 23 yd^3

In addition, one sample location within the GMA soil contained strontium-90 at a level above its PRL. While a precise areal extent of contamination cannot be ascertained based on one sample location, a remediation volume of 637 yd^3 was assumed to account for removal of strontium-90 based on contamination at this location.

The total volume as a result of other COCs is thus:

5,034 yd^3 + 4,570 yd^3 + 115,219 yd^3 + 23 yd^3 + 637 yd^3 = 125,483 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
213,948 yd^3	125,483 yd^3	339,431 yd^3

Since all the material located above the GMA will be removed, the estimated 300 yd^3 of lead-contaminated material from the Firing Range will be included in this total volume.

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVE 3

No material was detected that exceeds off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternative 3 is 339,400 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 6

The 300 yd^3 of lead-contaminated materials at the Firing Range that exceeds RCRA disposal criteria cannot be disposed on site. Thus, this additional 300 yd^3 volume must be disposed off site separately from other materials. Thus, 339,100 yd^3 (rounded to nearest 100 yd^3) will be disposed on site with an additional 300 yd^3 disposed off site.

TABLE E.1-25 SOUTH FIELD
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Cesium-137	pCi/g	5.6E+02	0.72	0.692	--	--	--	--
Neptunium-237	pCi/g	2.0E+03	0.043	0.369	0.291	5.696	--	--
Radium-226	pCi/g	2.0E+03	1.43	9.21	1.99	1.057	0.676	--
Radium-228 [c]	pCi/g	1.8E+03	1.26	3.74	1.444	1.022	0.461	--
Strontium-90	pCi/g	2.0E+04	0.016	1.36	1.1	0.95	0.7	1.01
Technetium-99	pCi/g	1.0E+05	0.017	0.90	0.90	--	--	--
Thorium-228 [c]	pCi/g	-- [d]	1.43	13.40	1.426	0.875	0.33	--
Thorium-230	pCi/g	1.5E+04	2.74	13.80	4.41	1.094	1.37	--
Thorium-232	pCi/g	6.8E+02	1.36	12.90	1.332	0.792	0.33	--
Uranium-234	pCi/g	3.7E+04	2.0	78.3	17.20	3.51	0.585	--
Uranium-235/236	pCi/g	7.7E+02 [e]	0.24	4.05	2.73	0.219	0.02	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.47	82.7	17.888	4.55	0.66	--
Total Uranium [c]	mg/kg	-- [g]	21	297	189	16.8	10.30	--
Arsenic	mg/kg	1.0E+02	8.2	6.975	11.9	7.64	6.20	75.6
Beryllium	mg/kg	--	0.6	0.88	0.85	0.779	--	4.6

000579

TABLE E.1-25 SOUTH FIELD
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Benzo(a)anthracene	mg/kg	--	0.023	1.1	--	--	--	0.066
Benzo(a)pyrene	mg/kg	--	0.0015	1.8	--	--	--	0.11
Benzo(b)fluoranthene	mg/kg	--	0.014	1.6	--	--	--	--
Benzo(k)fluoranthene	mg/kg	--	0.047	1.6	--	--	--	0.12
Dibenzo(a,h)anthracene	mg/kg	--	0.00046	0.44	--	--	--	--
Indeno(1,2,3-cd)pyrene	mg/kg	--	0.0073	0.62	--	--	--	0.099
Aroclor-1254	mg/kg	--	0.0015	0.43	0.041	--	--	0.096
Aroclor-1260	mg/kg	--	0.00023	0.038	--	--	--	--
Dieldrin	mg/kg	0.13	0.00004	0.0097	--	--	--	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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000580

E.1.6.4 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS SOUTH FIELD, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria:

For all layers

Uranium-238 ..... 3.72 pCi/g (surface soil exposrue pathways PRL)

Radium-228 ..... 1.33 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.44 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the south field:

FILL	IMPACT. TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
82,234 yd^3	33,275 yd^3	3,415 yd^3	0 yd^3	0 yd^3	118,924 yd^3

VOLUME FROM OTHER CONTAMINANTS

Other COCs were detected at levels above their respective PRLs in the fill, impacted till, other till, GMA soil, and sediment. Because contamination within the fill, impacted till, and sediment is widespread, each of these layers shall be entirely removed. Additional volumes to be excavated for these layers will be:

Fill = 120,081 yd^3 - 82,234 yd^3 = 37,847 yd^3

Impacted Till = 55,903 yd^3 - 33,275 yd^3 = 22,628 yd^3

Sediment = 23 yd^3

For the other till, six sample locations have levels of strontium-90 or beryllium above the respective PRLs for those COCs. A volume of 6,500 yd^3 is estimated to remove contamination resulting from these constituents.

In the GMA soil, one sample location was detected that contains strontium-90 at a level above its PRL. While a precise areal extent of contamination cannot be assertained based on one sample location, a remedial volume of 637 yd^3 was assumed to account for removal of contamination resulting from strontium-90 at this location.

Material contaminated with lead at concentrations above RCRA land disposal levels has been detected at the Firing Range in the South Field. Lead-contaminated material is estimated to be 300 yd^3 (see section E.1.10). For all alternatives this material will be treated and disposed off site.

Total volume from other COCs is:

37,847 yd^3 + 22,628 yd^3 + 23 yd^3 + 6,500 yd^3 + 637 yd^3 + 300 yd^3 = 67,935 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
118,924 yd^3	67,935 yd^3	186,859 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVE 3

No volume adjustments need to be made for Alternative 3. Thus, the remedial volume for this alternative is 186,900 yd^3 (rounded to nearest 100 yd^3).

ALTERNATIVE 6

Under this alternative, 300 yd^3 of material will be treated and disposed off site. Thus, the on-site disposal volume will be 186,859 yd^3 - 300 yd^3 = 186,600 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-26 SOUTH FIELD
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Cesium-137	pCi/g	5.6E+02	0.89	0.692	--	--	--	--
Neptunium-237	pCi/g	2.0E+03	0.43	0.369	0.291	5.696	--	--
Radium-226	pCi/g	2.0E+03	1.46	9.21	1.99	1.057	0.676	--
Radium-228 [c]	pCi/g	1.8E+03	1.33	3.74	1.444	1.022	0.461	--
Strontium-90	pCi/g	2.0E+04	0.16	1.36	1.1	0.95	0.7	1.01
Technetium-99	pCi/g	1.0E+05	0.17	0.90	0.90	--	--	--
Thorium-228 [c]	pCi/g	-- [d]	1.44	13.40	1.426	0.875	0.33	--
Thorium-230	pCi/g	1.5E+04	6.97	13.80	4.41	1.094	1.37	--
Thorium-232	pCi/g	6.8E+02	1.39	12.90	1.332	0.792	0.33	--
Uranium-234	pCi/g	3.7E+04	8.9	78.3	17.20	3.51	0.585	--
Uranium-235/236	pCi/g	7.7E+02 [e]	1.05	4.05	2.73	0.219	0.02	--
Uranium-238 [c]	pCi/g	2.8E+04 [f]	3.72	82.7	17.888	4.55	0.66	--
Total Uranium [c]	mg/kg	-- [g]	21	297	189	16.8	10.30	--
Arsenic	mg/kg	1.0E+02	8.2	6.975	11.9	7.64	6.20	75.6
Beryllium	mg/kg	--	0.6	0.88	0.85	0.779	--	4.6
Benzo(a)anthracene	mg/kg	--	0.23	1.1	--	--	--	0.066

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TABLE E.1-26 SOUTH FIELD
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS				
				FILL	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Benzo(a)pyrene	mg/kg	--	0.015	1.8	--	--	--	0.11
Benzo(b)fluoranthene	mg/kg	--	0.14	1.6	--	--	--	0.11
Benzo(k)fluoranthene	mg/kg	--	0.47	1.6	--	--	--	0.12
Dibenzo(a,h)anthracene	mg/kg	--	0.0046	0.44	--	--	--	--
Indeno(1,2,3-cd)pyrene	mg/kg	--	0.073	0.62	--	--	--	0.099
Aroclor-1254	mg/kg	--	0.015	0.43	0.041	--	--	0.096
Aroclor-1260	mg/kg	--	0.0023	0.038	--	--	--	--
Dieldrin	mg/kg	0.13	0.0004	0.0097	--	--	--	--

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

APPENDIX E.1.7
REMEDIATION VOLUME CALCULATIONS—
ACTIVE FLYASH PILE

E.1.7.1 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS ACTIVE FLYASH PILE, FEDERAL OWNERSHIP (EXPANDED TRESPASSER, 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 6.12 pCi/g (cross media modified groundwater PRL)

For material within and above flyash/impacted till

Radium-228 ..... 2.0 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.8 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Active Flyash Pile:

FLYASH	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
63,137 yd^3	0 yd^3	0 yd^3	0 yd^3	0 yd^3	63,137 yd^3

VOLUME FROM OTHER COCs

One sample within the impacted till has an arsenic concentration above the PRL for that COC. Assume an excavation of 50 yd^3 removes this contaminated material.

OTHER FLYASH VOLUME

All flyash will be removed. Volume of flyash not modeled is 65,046 yd^3 - 63,137 yd^3 = 1,909 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	OTHER FLYASH	TOTAL
63,137 yd^3	50 yd^3	1,909 yd^3	65,096 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 3, 4, 5, 6, 7, and 8

There is no variance between these alternatives. Excavated volume will be 65,100 yd^3 (rounded to nearest 100 yd^3). For Alternative 2, it is assumed that all excavated material will be consolidation under the cap.

TABLE E.1-27 ACTIVE FLYASH PILE
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Neptunium-237	pCi/g	2.0E+03	4.99	0.40	0.19	--	0.038
Radium-226	pCi/g	2.0E+03	1.8	1.73	1.14	0.594	1.32
Radium-228 [c]	pCi/g	1.8E+03	2.0	1.33	0.90	0.537	1.08
Thorium-228 [c]	pCi/g	-- [d]	1.8	1.40	1.76	1.19	0.824
Thorium-232	pCi/g	6.8E+02	1.5	1.35	1.20	0.965	0.883
Uranium-234	pCi/g	3.7E+04	8.64	1.27	1.00	0.921	2.77
Uranium-235/236	pCi/g	7.7E+02 [e]	7.75	0.069	0.034	--	0.163
Uranium-238 [c]	pCi/g	2.8E+04 [f]	6.12	2.60	1.05	0.754	2.9
Total Uranium [c]	mg/kg	-- [g]	28	7.17	4.27	8.416	51.8
Arsenic	mg/kg	1.0E+02	16.9	18.70	14.00	--	10.9

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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E.1.7.2 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS ACTIVE FLYASH PILE, FEDERAL OWNERSHIP (EXPANDED TRESPASSER 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 9.3 pCi/g (soil PRL based on groundwater ARAR)

For all material above the remaining till

Radium-228 ..... 8.9 pCi/g (surface soil exposure pathway PRL)

Thorium-228 ..... 5.4 pCi/g (surface soil exposure pathway PRL)

the following volumes were modeled for the Active Flyash Pile:

FLYASH	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
174 yd^3	0 yd^3	0 yd^3	0 yd^3	0 yd^3	174 yd^3

VOLUME FROM OTHER COCs

There were no other COCs that exceeded their respective PRLs for the Active Flyash Pile.

OTHER FLYASH VOLUME

All flyash will be removed. Volume of flyash not modeled is 65,046 yd^3 - 174 yd^3 = 64,872 yd^3.

TOTAL VOLUME

MODELED	OTHER COCs	OTHER FLYASH	TOTAL
174 yd^3	0 yd^3	64,872 yd^3	65,046 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 3, and 6

There is no variance between these alternatives. Excavated volume will be 65,000 yd^3 (rounded to nearest 100 yd^3). For Alternative 2, it is assumed that all excavated material will be consolidated under the cap.

ALTERNATIVES 4, 5, 7, and 8

These alternatives do not apply to expanded trespasser risk base 10^{-5}.

TABLE E.1-28 ACTIVE FLYASH PILE
FEDERAL OWNERSHIP (EXPANDED TRESPASSER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Neptunium-237	pCi/g	2.0E+03	49.9	0.40	0.19	--	0.038
Radium-226	pCi/g	2.0E+03	5.1	1.73	1.14	0.594	1.32
Radium-228 [c]	pCi/g	1.8E+03	8.9	1.33	0.90	0.537	1.08
Thorium-228 [c]	pCi/g	-- [d]	5.4	1.40	1.76	1.19	0.824
Thorium-232	pCi/g	6.8E+02	3.9	1.35	1.20	0.965	0.883
Uranium-234	pCi/g	3.7E+04	77.0	1.27	1.00	0.921	2.77
Uranium-235/236	pCi/g	7.7E+02 [e]	76.2	0.069	0.034	--	0.163
Uranium-238 [c]	pCi/g	2.8E+04 [f]	9.3	2.60	1.05	0.754	2.9
Total Uranium [c]	mg/kg	-- [g]	28	7.17	4.27	8.416	51.8
Arsenic	mg/kg	1.0E+02	169	18.70	14.00	--	10.9

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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E.1.7.3 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS ACTIVE FLYASH PILE, PRIVATE OWNERSHIP (RESIDENT FARMER 10^{-6} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

For all layers

Uranium-238 ..... 1.47 pCi/g (surface soil exposure pathways PRL)

Radium-228 ..... 1.26 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.43 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Active Flyash Pile:

FLYASH	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
65,046 yd^3	1,968 yd^3	1,679 yd^3	0 yd^3	0 yd^3	68,693 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the impacted till, other till, and sediment. Contamination from other COCs within the impacted till is widespread; therefore, the entire layer will be removed. Excavation of an additional 8,160 yd^3 - 1,968 yd^3 = 6,192 yd^3 will be required to remove all impacted till. For the other till layer, only one location where COCs were detected corresponds to an area not included in the modeled volume. That location contains levels for neptunium-237 and beryllium that are above the respective PRLs for those COCs. To remove that material an additional excavation of 30 yd^3 will be required. Because of the topographic layout of the active flyash pile, sediment was included within the impacted till for modeling purposes. Thus, the COCs detected in the sediment will be removed, since the entire impacted till layer will be removed. Total volume from other COCs therefore equals 6,192 yd^3 + 30 yd^3 = 6,222 yd^3.

FLYASH VOLUME

All flyash was modeled. Thus, no additional material requires removal.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
68,693 yd^3	6,222 yd^3	74,915 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVES 3 and 6

No material was detected that exceeds on-site or off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternatives 3 and 6 is 74,900 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-29 ACTIVE FLYASH PILE
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER (RISK BASE = 10^{-6} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Cesium-137	pCi/g	5.6E+02	0.72	--	--	--	0.086
Neptunium-237	pCi/g	2.0E+03	0.043	0.40	0.19	--	0.038
Radium-226	pCi/g	2.0E+03	1.43	1.73	1.14	0.594	1.32
Radium-228 [c]	pCi/g	1.8E+03	1.26	1.33	0.90	0.537	1.08
Thorium-228 [c]	pCi/g	-- [d]	1.43	1.40	1.76	1.19	0.824
Thorium-232	pCi/g	6.8E+02	1.36	1.35	1.20	0.965	0.883
Uranium-234	pCi/g	3.7E+04	2.0	1.27	1.00	0.921	2.77
Uranium-235/236	pCi/g	7.7E+02 [e]	0.24	0.069	0.034	--	0.163
Uranium-238 [c]	pCi/g	2.8E+04 [f]	1.47	2.60	1.05	0.754	2.9
Total Uranium [c]	mg/kg	-- [g]	24	7.17	4.27	8.416	51.8
Arsenic	mg/kg	1.0E+02	8.2	18.70	14.00	--	10.9
Beryllium	mg/kg	--	0.6	1.40	1.10	--	1.4

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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E.1.7.4 OPERABLE UNIT 2 REMEDIATION VOLUME CALCULATIONS ACTIVE FLYASH PILE, PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, 10^{-5} ILCR)

MODELED VOLUME: RADIUM-228, THORIUM-228, URANIUM-238

Based on the following criteria

for all layers

Uranium-238 ..... 3.72 pCi/g (surface soil exposure pathways PRL)

Radium-228 ..... 1.33 pCi/g (surface soil exposure pathways PRL)

Thorium-228 ..... 1.44 pCi/g (surface soil exposure pathways PRL)

the following volumes were modeled for the Active Flyash Pile:

FLYASH	IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT	TOTAL
65,046 yd^3	0 yd^3	1,679 yd^3	0 yd^3	0 yd^3	66,725 yd^3

VOLUME FROM OTHER COCs

Other COCs have been detected at levels above their respective PRLs in the impacted till, other till, and sediment. Contamination from other COCs within the impacted till is widespread; therefore, the entire layer will be removed. The total volume of impacted till is 8,160 yd^3. For the other till layer, only one location where COCs were detected corresponds to an area not included in the modeled volume. That location contains levels for neptunium-237 and beryllium that are above the respective PRLs for those COCs. To remove that material, an additional excavation of 30 yd^3 will be required. Because of the topographical layout of the Active Flyash Pile, sediment was included within the impacted till for modeling purposes. Thus, the COCs detected in the sediment will be removed, since the entire impacted till layer will be removed. Total volume from other COCs, therefore, equals 8,160 yd^3 + 30 yd^3 = 8,190 yd^3.

OTHER FLYASH VOLUME

All flyash was modeled. Thus, no additional material requires removal.

TOTAL VOLUME

MODELED	OTHER COCs	TOTAL
66,725 yd^3	8,190 yd^3	74,915 yd^3

ALTERNATIVE 1

Under this alternative, no material will be removed.

ALTERNATIVES 2, 4, 5, 7, and 8

Alternatives 2, 4, 5, 7, and 8 do not apply to the on-property resident farmer scenario.

ALTERNATIVES 3 and 6

No material was detected that exceeds on-site or off-site disposal facility waste acceptance criteria; therefore, no volume adjustments are required. Thus, the remedial volume for Alternatives 3 and 6 is 74,900 yd^3 (rounded to nearest 100 yd^3).

TABLE E.1-30 ACTIVE FLYASH PILE
PRIVATE OWNERSHIP (ON-PROPERTY RESIDENT FARMER, RISK BASE = 10^{-5} ILCR)

CONTAMINANT OF CONCERN	UNIT	OFF-SITE DISPOSAL CRITERIA [a]	PRELIM. REMED. LEVEL [b]	CONCENTRATION TERMS			
				IMPACTED TILL	OTHER TILL	GMA SOIL	SEDIMENT
Cesium-137	pCi/g	5.6E+02	0.89	--	--	--	0.086
Neptunium-237	pCi/g	2.0E+03	0.43	0.40	0.19	--	0.038
Radium-226	pCi/g	2.0E+03	1.46	1.73	1.14	0.594	1.32
Radium-228 [c]	pCi/g	1.8E+03	1.33	1.33	0.90	0.537	1.08
Thorium-228 [c]	pCi/g	-- [d]	1.44	1.40	1.76	1.19	0.824
Thorium-232	pCi/g	6.8E+02	1.39	1.35	1.20	0.965	0.883
Uranium-234	pCi/g	3.7E+04	8.9	1.27	1.00	0.921	2.77
Uranium-235/236	pCi/g	7.7E+02 [e]	1.05	0.069	0.034	--	0.163
Uranium-238 [c]	pCi/g	2.8E+04 [f]	3.72	2.60	1.05	0.754	2.9
Total Uranium [c]	mg/kg	-- [g]	24	7.17	4.27	8.416	51.8
Arsenic	mg/kg	1.0E+02	8.2	18.70	14.00	--	10.9
Beryllium	mg/kg	--	0.6	1.40	1.10	--	1.4

Concentration terms exceeding PRLs (Concentration terms for modeled COCs exceeding PRLs are not shaded.)

For notes refer to Table E.1-11.

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APPENDIX E.1.8

BLOCK MODEL VOLUME SUMMARY FOR URANIUM-238

E.1.8 BLOCK MODEL VOLUME SUMMARY FOR URANIUM-238

The tables included in this section indicate the volume of material above various uranium-238 concentrations. The values shown in these tables have been determined through the use of the block model based on uranium-238. These tables are not based on the three modeling isotopes (uranium-238, radium-228, and thorium-228); therefore, these tables have not been used to determine remediation volumes. However, these tables have been used to determine certain support volumes which are based only on the uranium-238 isotope, namely:

- On-site disposal cell waste acceptance criteria volumes
- PPE remediation volumes
- Volumes not available for construction of the on-site disposal cell berm

TABLE E.1-31
TOTAL VOLUME
SOLID WASTE LANDFILL

		Volumes in Cubic Yards; U-238 in pCi/g								
		Fill		Impacted Till		Remaining Till		GMA Soil		TOTAL
U-238 Concentration		Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume
Above	0 pCi/g:	15220	52.0	4282	49.5	92187	2.8	---	---	---
Above	1.12 pCi/g:	15220	52.0	4282	49.5	59780	3.9	0	0	79282
Above	2.5 pCi/g:	15220	52.0	4282	49.5	27315	6.7	0	0	46817
Above	5 pCi/g:	15220	52.0	4282	49.5	15973	8.9	0	0	35475
Above	7.5 pCi/g:	15220	52.0	4282	49.5	10243	10.6	0	0	29745
Above	15 pCi/g:	14873	52.9	4167	50.5	347	15.8	0	0	19387
Above	30 pCi/g:	8738	73.9	2373	70.6	0	0	0	0	11111
Above	40 pCi/g:	6134	91.0	1505	91.3	0	0	0	0	7639
Above	50 pCi/g:	5093	100.1	1215	102.0	0	0	0	0	6308
Above	60 pCi/g:	4282	108.3	926	117.4	0	0	0	0	5208
Above	90 pCi/g:	2662	129.0	637	137.2	0	0	0	0	3299
Above	125 pCi/g:	1273	159.9	405	159.3	0	0	0	0	1678
Above	250 pCi/g:	0	0	0	0	0	0	0	0	0
Above	500 pCi/g:	0	0	0	0	0	0	0	0	0
Above	1000 pCi/g:	0	0	0	0	0	0	0	0	0

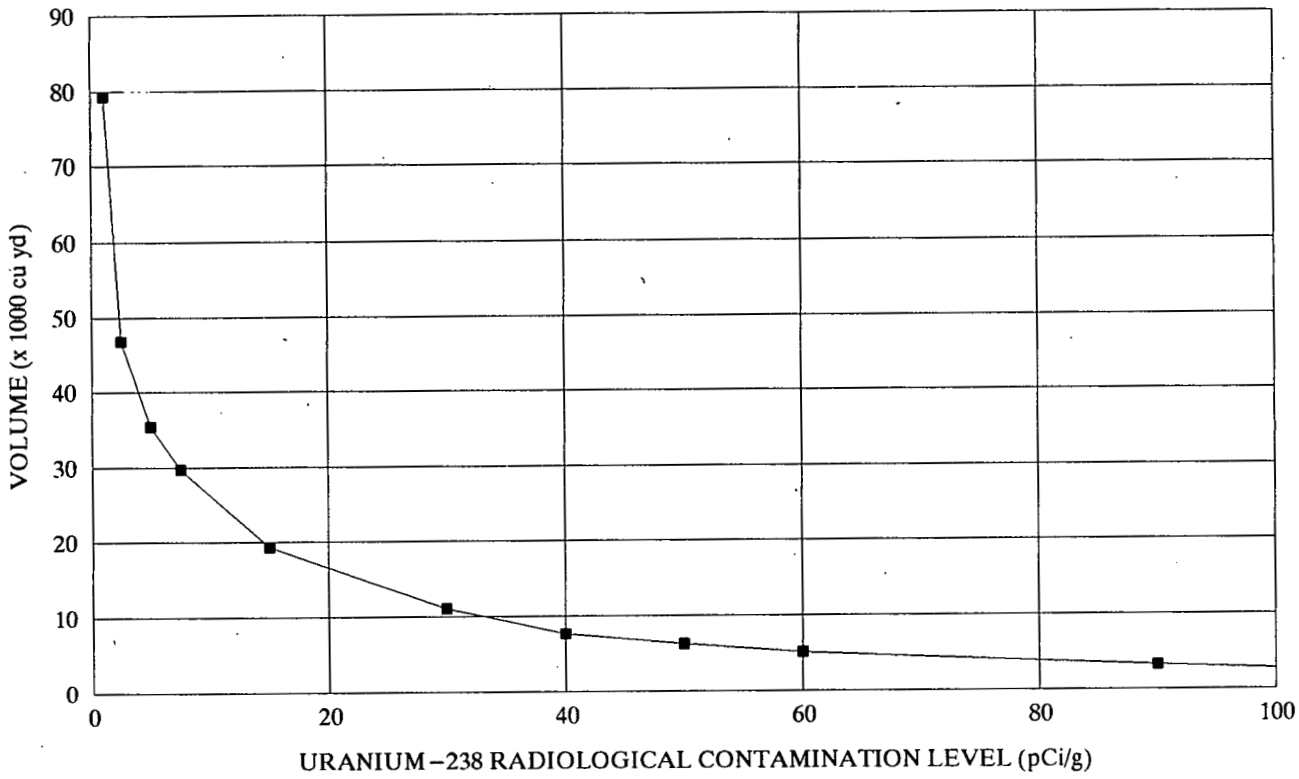

FIGURE E.1.8-1
SOLID WASTE LANDFILL
URANIUM-238 CONTAMINATED VOLUMES

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TABLE E.1-32
TOTAL VOLUME
LIME SLUDGE PONDS

		Volumes in Cubic Yards; U-238 in pCi/g								
		Berm		Sludge		Till		GMA Soil		Total
U-238	Concentration	Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume
Above	0 pCi/g :	5556	6.1	16493	2.2	119560	0.8	- - -	- - -	- - -
Above	1.12 pCi/g :	5556	6.1	15451	2.3	13425	1.2	0	0	34432
Above	2.5 pCi/g :	5556	6.1	4456	3.5	0	0	0	0	10012
Above	5 pCi/g :	3762	6.9	231	5.8	0	0	0	0	3993
Above	7.5 pCi/g :	1042	9.5	0	0	0	0	0	0	1042
Above	15 pCi/g :	0	0	0	0	0	0	0	0	0
Above	30 pCi/g :	0	0	0	0	0	0	0	0	0
Above	40 pCi/g :	0	0	0	0	0	0	0	0	0
Above	50 pCi/g :	0	0	0	0	0	0	0	0	0
Above	60 pCi/g :	0	0	0	0	0	0	0	0	0
Above	90 pCi/g :	0	0	0	0	0	0	0	0	0
Above	125 pCi/g :	0	0	0	0	0	0	0	0	0
Above	250 pCi/g :	0	0	0	0	0	0	0	0	0
Above	500 pCi/g :	0	0	0	0	0	0	0	0	0
Above	1000 pCi/g :	0	0	0	0	0	0	0	0	0

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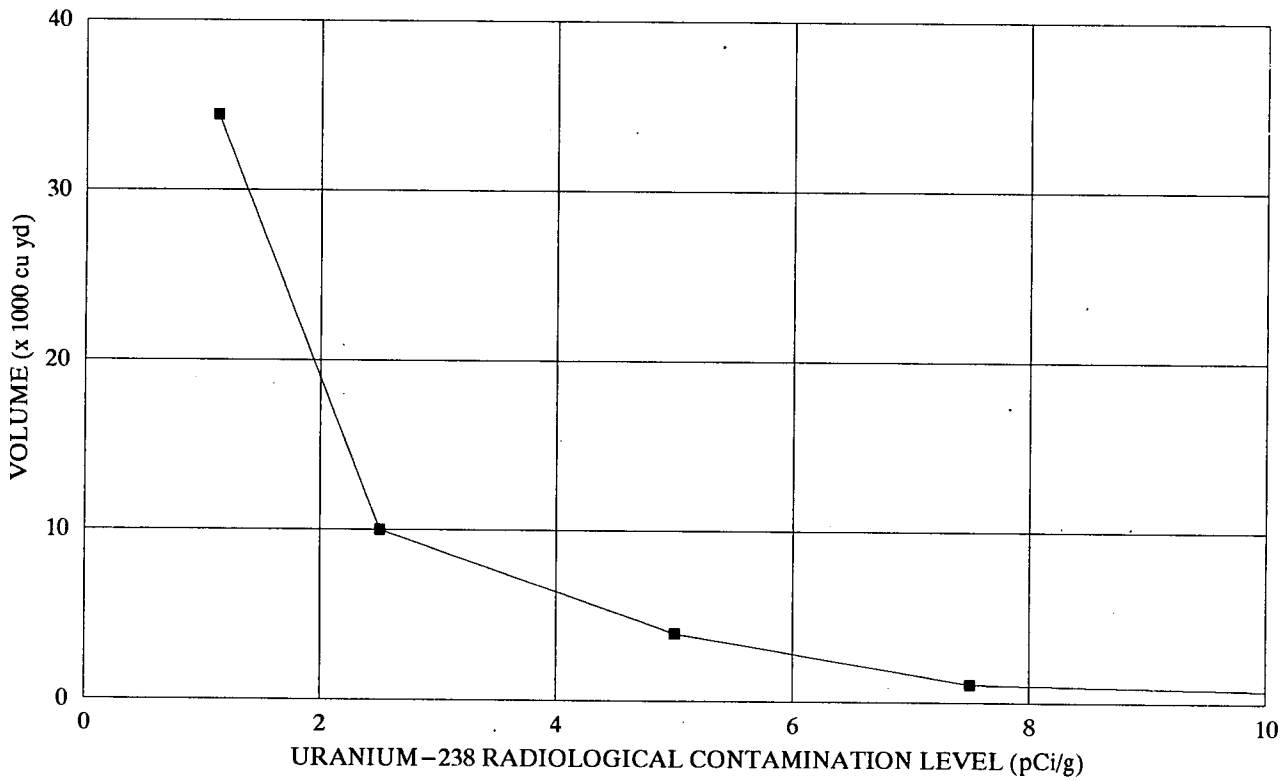

FIGURE E.1.8-2
LIME SLUDGE PONDS
URANIUM-238 CONTAMINATED VOLUMES

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TABLE E.1–33
TOTAL VOLUME
INACTIVE FLYASH PILE

		Inactive Flyash Pile (Volumes in Cubic Yards, U–238 in pCi/g)							
		Cover Material		Flyash		Fill/Debris		Impacted Till	
U–238 Concentration		Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above	0 pCi/g:	1157	19.3	43634	7.2	51100	67.4	4514	93.0
Above	1.12 pCi/g:	1042	21.5	43634	7.2	46412	74.2	3299	127.2
Above	2.5 pCi/g:	1042	21.5	42593	7.3	45486	75.7	3241	129.4
Above	5 pCi/g:	1042	21.5	21528	10.9	41898	81.8	3183	131.7
Above	7.5 pCi/g:	984	22.4	16435	12.4	38947	87.5	2836	147.0
Above	15 pCi/g:	637	28.6	3299	19.1	30729	108.0	2431	169.7
Above	30 pCi/g:	289	37.9	0	0	21644	144.4	1505	261.3
Above	40 pCi/g:	58	48.3	0	0	18229	164.9	1331	290.9
Above	50 pCi/g:	0	0	0	0	15856	182.9	1215	314.0
Above	60 pCi/g:	0	0	0	0	13947	200.5	1215	314.0
Above	90 pCi/g:	0	0	0	0	10590	240.4	1042	352.7
Above	125 pCi/g:	0	0	0	0	8275	277.6	926	383.6
Above	250 pCi/g:	0	0	0	0	3530	426.9	637	476.6
Above	500 pCi/g:	0	0	0	0	926	683.7	231	676.7
Above	1000 pCi/g:	0	0	0	0	0	0	0	0

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TABLE E.1-33, Continued
TOTAL VOLUME
INACTIVE FLYASH PILE

		Inactive Flyash Pile (Continued)				
		Remaining Till		GMA		TOTAL
U-238 Concentration		Volume	Avg.U-238	Volume	Avg.U-238	Volume
Above	0 pCi/g:	12268	0.6	---	---	---
Above	1.122 pCi/g:	0	0	984	1.4	95371
Above	2.5 pCi/g:	0	0	0	0	92362
Above	5 pCi/g:	0	0	0	0	67651
Above	7.5 pCi/g:	0	0	0	0	59202
Above	15 pCi/g:	0	0	0	0	37096
Above	30 pCi/g:	0	0	0	0	23438
Above	40 pCi/g:	0	0	0	0	19618
Above	50 pCi/g:	0	0	0	0	17071
Above	60 pCi/g:	0	0	0	0	15162
Above	90 pCi/g:	0	0	0	0	11632
Above	125 pCi/g:	0	0	0	0	9201
Above	250 pCi/g:	0	0	0	0	4167
Above	500 pCi/g:	0	0	0	0	1157
Above	1000 pCi/g:	0	0	0	0	0

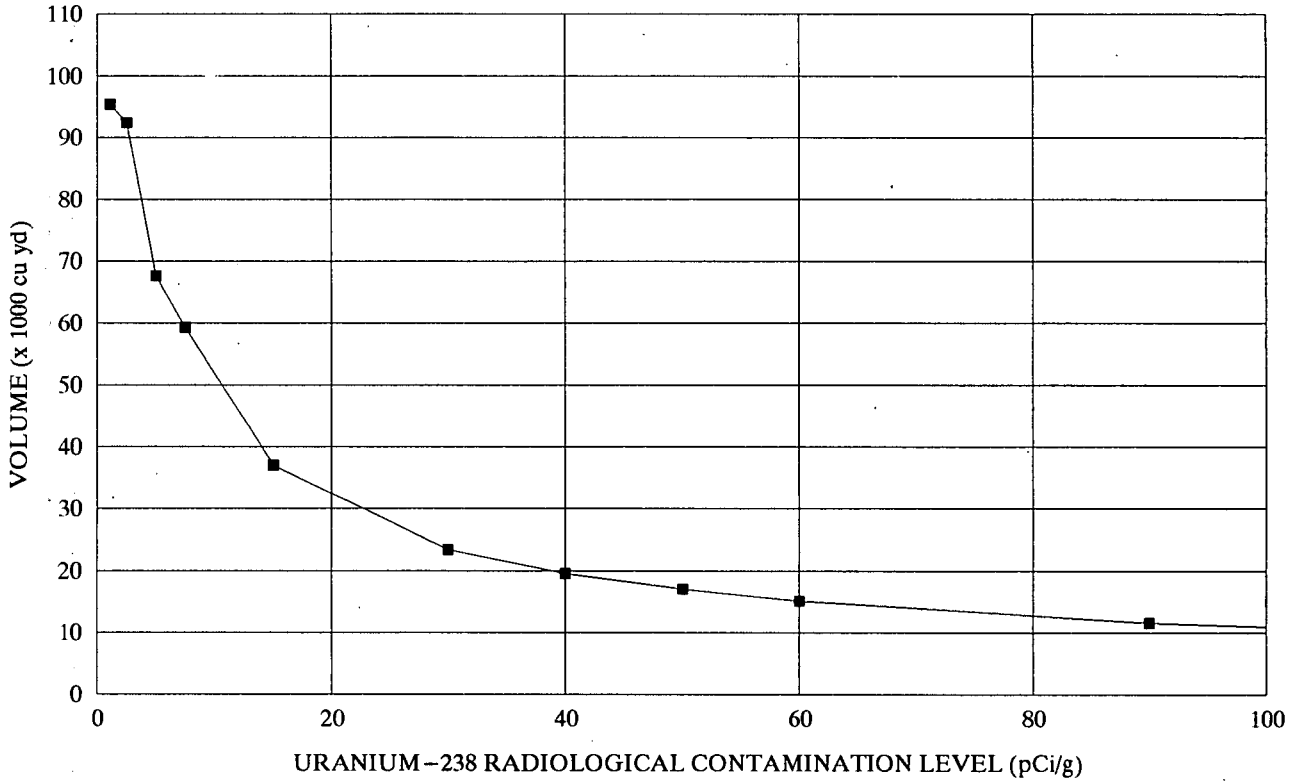

FIGURE E.1.8-3
INACTIVE FLYASH PILE
URANIUM-238 CONTAMINATED VOLUMES

000005

TABLE E.1-34
TOTAL VOLUME
SOUTH FIELD

		South Field (Volumes in Cubic Yards, U-238 in pCi/g)								
		Fill/Debris		Impacted Till		Remaining Till		GMA Soil		Total
U-238 Concentration		Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume
Above	0 pCi/g:	120081	8.5	55903	10.0	162789	1.2	---	---	---
Above	1.12 pCi/g:	109896	9.2	49421	11.3	56771	2.3	637	1.2	216609
Above	2.5 pCi/g:	95660	10.3	40509	13.3	21181	3.2	0	0	157234
Above	5 pCi/g:	44618	17.9	18576	24.8	0	0	0	0	63136
Above	7.5 pCi/g:	22049	30.0	14063	30.9	0	0	0	0	36112
Above	15 pCi/g:	13252	43.2	9144	41.9	0	0	0	0	22396
Above	30 pCi/g:	8275	56.2	5266	57.5	0	0	0	0	13541
Above	40 pCi/g:	5324	67.8	3299	71.1	0	0	0	0	8623
Above	50 pCi/g:	3762	77.4	2488	79.9	0	0	0	0	6250
Above	60 pCi/g:	2720	85.9	1447	97.9	0	0	0	0	4167
Above	90 pCi/g:	868	111.6	579	134.4	0	0	0	0	1447
Above	125 pCi/g:	174	140.1	347	154.9	0	0	0	0	521
Above	250 pCi/g:	0	0	0	0	0	0	0	0	0
Above	500 pCi/g:	0	0	0	0	0	0	0	0	0
Above	1000 pCi/g:	0	0	0	0	0	0	0	0	0

000607

6647

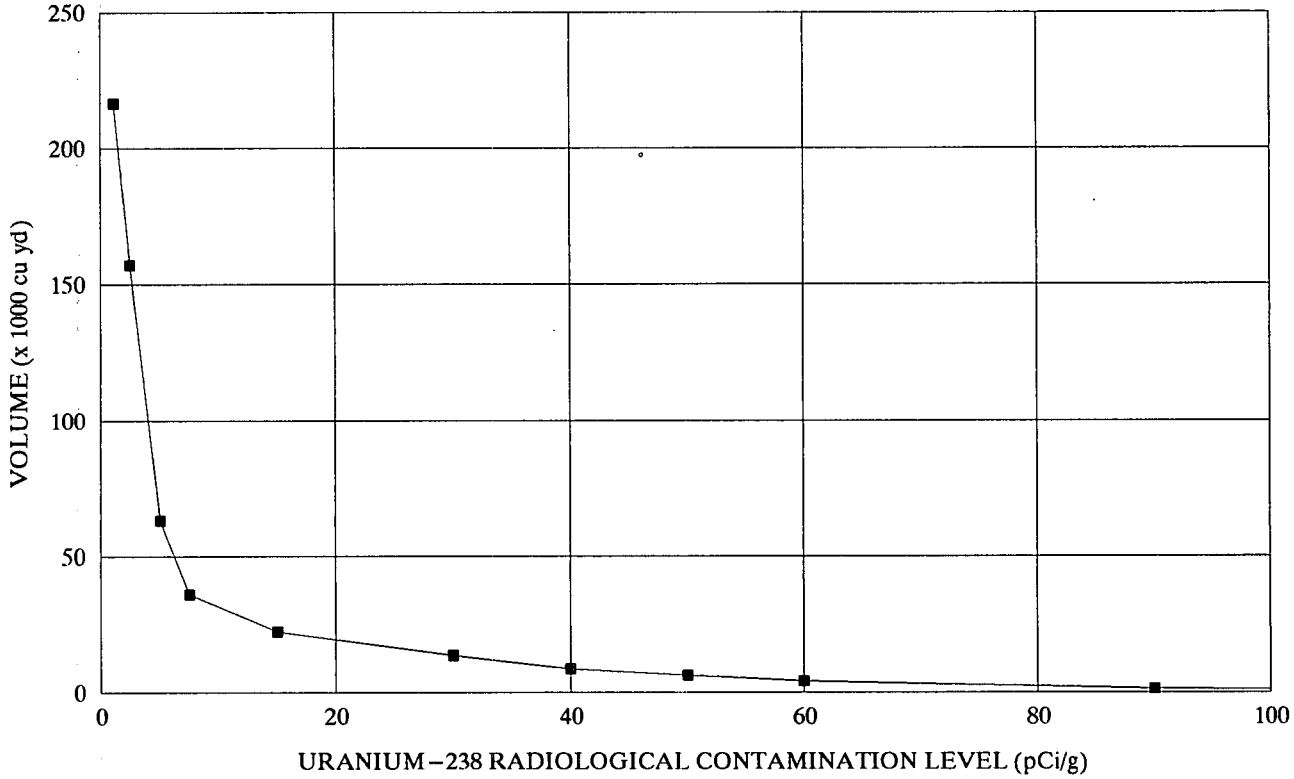

FIGURE E.1.8-4
SOUTH FIELD
URANIUM-238 CONTAMINATED VOLUMES

000603

TABLE E.1-35
TOTAL VOLUME
ACTIVE FLYASH PILE

	Active Flyash Pile (Volumes in Cubic Yards, U-238 in pCi/g)								
	Flyash		Impacted Till		Remaining Till		GMA		TOTAL
U-238 Concentration	Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume	Avg.U-238	Volume
Above 0 pCi/g:	65046	4.4	8160	1.3	39873	0.8	---	---	---
Above 1.12 pCi/g:	65046	4.4	6424	1.4	0	0	0	0	71470
Above 2.5 pCi/g:	65046	4.4	58	2.7	0	0	0	0	65104
Above 5 pCi/g:	14120	5.7	0	0	0	0	0	0	14120
Above 7.5 pCi/g:	289	10.1	0	0	0	0	0	0	289
Above 15 pCi/g:	0	0	0	0	0	0	0	0	0
Above 30 pCi/g:	0	0	0	0	0	0	0	0	0
Above 40 pCi/g:	0	0	0	0	0	0	0	0	0
Above 50 pCi/g:	0	0	0	0	0	0	0	0	0
Above 60 pCi/g:	0	0	0	0	0	0	0	0	0
Above 90 pCi/g:	0	0	0	0	0	0	0	0	0
Above 125 pCi/g:	0	0	0	0	0	0	0	0	0
Above 250 pCi/g:	0	0	0	0	0	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0

000509

6647

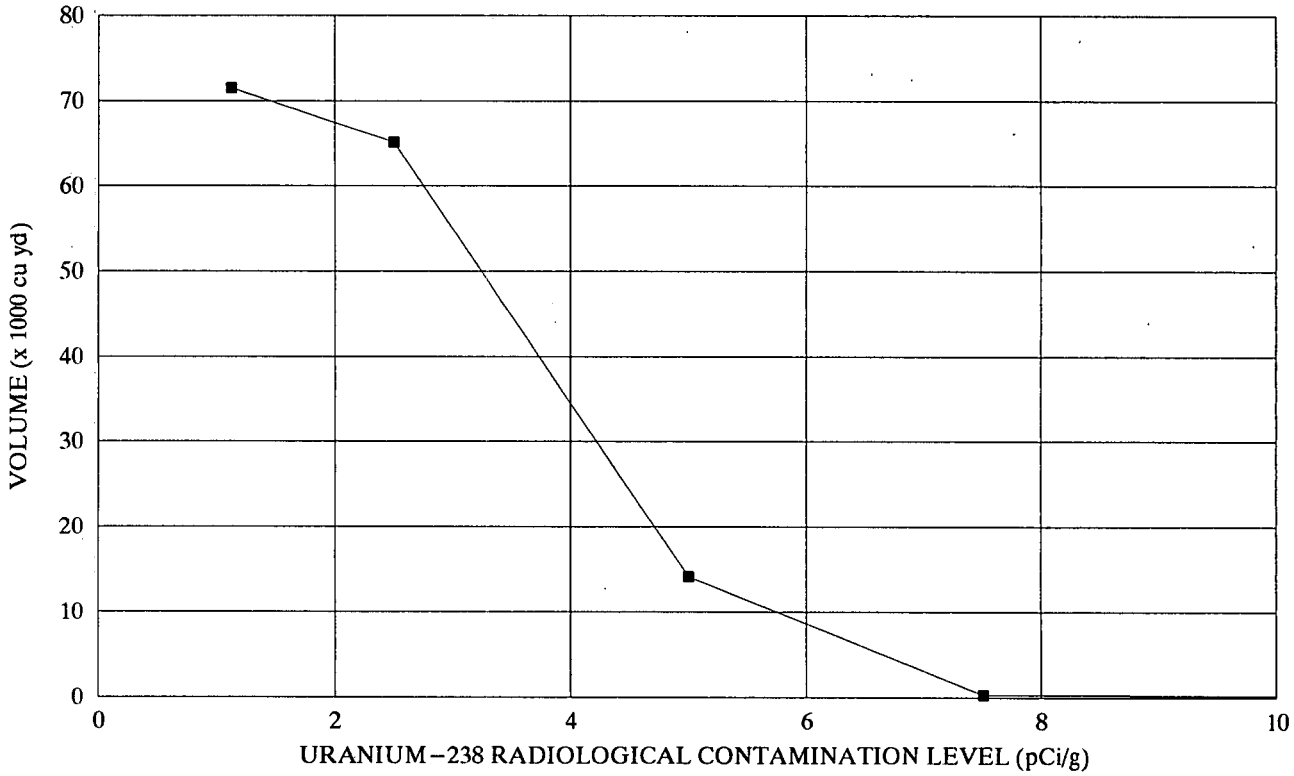

FIGURE E.1.8-5
ACTIVE FLYASH PILE
URANIUM-238 CONTAMINATED VOLUMES

000610

TABLE E.1–36
Till–Based Volume
(More Than 18 Feet of Till)

	Cover Material		Volumes in Cubic Yards; U–238 in pCi/g				Other Fill & Debris		Volumes in Cubic Yards; U–238 in pCi/g			
	Inactive Flyash Pile		South Field		Active Flyash Pile		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above 0 pCi/g:	0	0	0	0	0	0	0	0	19908	14.3	0	0
Above 1.12 pCi/g:	0	0	0	0	0	0	0	0	17882	15.9	0	0
Above 2.5 pCi/g:	0	0	0	0	0	0	0	0	16667	16.9	0	0
Above 5 pCi/g:	0	0	0	0	0	0	0	0	12442	21.4	0	0
Above 7.5 pCi/g:	0	0	0	0	0	0	0	0	9433	26.2	0	0
Above 15 pCi/g:	0	0	0	0	0	0	0	0	5671	36.8	0	0
Above 30 pCi/g:	0	0	0	0	0	0	0	0	3183	48.8	0	0
Above 40 pCi/g:	0	0	0	0	0	0	0	0	1736	60.1	0	0
Above 50 pCi/g:	0	0	0	0	0	0	0	0	1100	69.4	0	0
Above 60 pCi/g:	0	0	0	0	0	0	0	0	694	77.3	0	0
Above 90 pCi/g:	0	0	0	0	0	0	0	0	116	90.6	0	0
Above 125 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 250 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0

000611

TABLE E.1–36, Continued
Till–Based Volume
(More Than 18 Feet of Till)

	Flyash		Volumes in Cubic Yards; U–238 in pCi/g				Impacted Till		Volumes in Cubic Yards; U–238 in pCi/g			
	Inactive Flyash Pile		South Field		Active Flyash Pile		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above 0 pCi/g:	0	0	0	0	10706	3.9	58	32.6	23090	12.8	1968	1.3
Above 1.12 pCi/g:	0	0	0	0	10706	3.9	58	32.6	19734	14.9	1852	1.3
Above 2.5 pCi/g:	0	0	0	0	10706	3.9	58	32.6	17535	16.5	0	0
Above 5 pCi/g:	0	0	0	0	1331	6	58	32.6	13021	20.9	0	0
Above 7.5 pCi/g:	0	0	0	0	58	7.5	58	32.6	10069	25.3	0	0
Above 15 pCi/g:	0	0	0	0	0	0	58	32.6	6019	35.4	0	0
Above 30 pCi/g:	0	0	0	0	0	0	58	32.6	3183	48.7	0	0
Above 40 pCi/g:	0	0	0	0	0	0	0	0	1852	58.4	0	0
Above 50 pCi/g:	0	0	0	0	0	0	0	0	1331	64.3	0	0
Above 60 pCi/g:	0	0	0	0	0	0	0	0	637	74.6	0	0
Above 90 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 125 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 250 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0

000612

TABLE E.1–36, Continued
Till–Based Volume
(More Than 18 Feet of Till)

	Other Till		Volumes in Cubic Yards; U–238 in pCi/g				Sand & Gravel		Volumes in Cubic Yards; U–238 in pCi/g			
	Inactive Flyash Pile		South Field		Active Flyash Pile		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above 0 pCi/g:	405	0.8	90856	1.5	15220	0.8	0	0	13715	1.6	0	0
Above 1.12 pCi/g:	0	0	46586	2.3	0	0	0	0	7639	2.2	0	0
Above 2.5 pCi/g:	0	0	17998	3.2	0	0	0	0	2662	3.2	0	0
Above 5 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 7.5 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 15 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 30 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 40 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 50 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 60 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 90 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 125 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 250 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E.1–36, Continued
Till–Based Volume
(More Than 18 Feet of Till)

		GMA Sand & Gravel Volumes in Cubic Yards; U–238 in pCi/g					
		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration		Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above	0 pCi/g:	637	0.3	184954	0	24769	0
Above	1.12 pCi/g:	0	0	0	0	0	0
Above	2.5 pCi/g:	0	0	0	0	0	0
Above	5 pCi/g:	0	0	0	0	0	0
Above	7.5 pCi/g:	0	0	0	0	0	0
Above	15 pCi/g:	0	0	0	0	0	0
Above	30 pCi/g:	0	0	0	0	0	0
Above	40 pCi/g:	0	0	0	0	0	0
Above	50 pCi/g:	0	0	0	0	0	0
Above	60 pCi/g:	0	0	0	0	0	0
Above	90 pCi/g:	0	0	0	0	0	0
Above	125 pCi/g:	0	0	0	0	0	0
Above	250 pCi/g:	0	0	0	0	0	0
Above	500 pCi/g:	0	0	0	0	0	0
Above	1000 pCi/g:	0	0	0	0	0	0

000614

TABLE E.1–37
Till–Based Volume
(Less Than 18 Feet of Till)

	Cover Material		Volumes in Cubic Yards; U–238 in pCi/g				Other Fill & Debris		Volumes in Cubic Yards; U–238 in pCi/g			
	Inactive Flyash Pile		South Field		Active Flyash Pile		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above 0 pCi/g:	1157	19.3	0	0	0	0	51100	67.4	100174	7.3	0	0
Above 0.844 pCi/g:	1042	21.5	0	0	0	0	46528	74	92419	7.9	0	0
Above 1.122 pCi/g:	1042	21.5	0	0	0	0	46412	74.2	92014	7.9	0	0
Above 2.5 pCi/g:	1042	21.5	0	0	0	0	45486	75.7	78993	8.9	0	0
Above 5 pCi/g:	1042	21.5	0	0	0	0	41898	81.8	32176	16.5	0	0
Above 7.5 pCi/g:	984	22.4	0	0	0	0	38947	87.5	12616	32.8	0	0
Above 15 pCi/g:	637	28.6	0	0	0	0	30729	108	7581	48	0	0
Above 30 pCi/g:	289	37.9	0	0	0	0	21644	144.4	5093	60.8	0	0
Above 40 pCi/g:	58	48.3	0	0	0	0	18229	164.9	3588	71.6	0	0
Above 50 pCi/g:	0	0	0	0	0	0	15856	182.9	2662	80.7	0	0
Above 60 pCi/g:	0	0	0	0	0	0	13947	200.5	2025	88.9	0	0
Above 90 pCi/g:	0	0	0	0	0	0	10590	240.4	752	114.8	0	0
Above 125 pCi/g:	0	0	0	0	0	0	8275	277.6	174	140.1	0	0
Above 250 pCi/g:	0	0	0	0	0	0	3530	426.9	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	926	683.7	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E.1–37, Continued
Till–Based Volume
(Less Than 18 Feet of Till)

	Flyash		Volumes in Cubic Yards; U–238 in pCi/g				Impacted Till		Volumes in Cubic Yards; U–238 in pCi/g			
	Inactive Flyash Pile		South Field		Active Flyash Pile		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above 0 pCi/g:	43634	7.2	0	0	54340	4.6	4456	93.8	32813	8.1	6192	1.4
Above 0.844 pCi/g:	43634	7.2	0	0	54340	4.6	3241	128.9	29977	8.8	6192	1.4
Above 1.122 pCi/g:	43634	7.2	0	0	54340	4.6	3241	128.9	29688	8.9	4572	1.5
Above 2.5 pCi/g:	42593	7.3	0	0	54340	4.6	3183	131.2	22975	10.9	58	2.7
Above 5 pCi/g:	21528	10.9	0	0	12789	5.6	3125	133.5	5556	33.9	0	0
Above 7.5 pCi/g:	16435	12.4	0	0	231	10.7	2778	149.4	3993	44.9	0	0
Above 15 pCi/g:	3299	19.1	0	0	0	0	2373	173.1	3125	54.6	0	0
Above 30 pCi/g:	0	0	0	0	0	0	1447	270.4	2083	71.1	0	0
Above 40 pCi/g:	0	0	0	0	0	0	1331	290.9	1447	87.3	0	0
Above 50 pCi/g:	0	0	0	0	0	0	1215	314	1157	97.9	0	0
Above 60 pCi/g:	0	0	0	0	0	0	1215	314	810	116.2	0	0
Above 90 pCi/g:	0	0	0	0	0	0	1042	352.7	579	134.4	0	0
Above 125 pCi/g:	0	0	0	0	0	0	926	383.6	347	154.9	0	0
Above 250 pCi/g:	0	0	0	0	0	0	637	476.6	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	231	676.7	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E.1–37, Continued
Till–Based Volume
(Less Than 18 Feet of Till)

	Other Till		Volumes in Cubic Yards; U–238 in pCi/g				Sand & Gravel		Volumes in Cubic Yards; U–238 in pCi/g			
	Inactive Flyash Pile		South Field		Active Flyash Pile		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentration	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above 0 pCi/g:	10127	0.6	54572	0.6	24653	0.8	1736	0.7	3646	0.8	0	0
Above 0.844 pCi/g:	0	0	14641	1.2	14931	0.9	0	0	2257	0.9	0	0
Above 1.122 pCi/g:	0	0	2546	2.2	0	0	0	0	0	0	0	0
Above 2.5 pCi/g:	0	0	521	2.8	0	0	0	0	0	0	0	0
Above 5 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 7.5 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 15 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 30 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 40 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 50 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 60 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 90 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 125 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 250 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 500 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0
Above 1000 pCi/g:	0	0	0	0	0	0	0	0	0	0	0	0

TABLE E.1–37, Continued
Till–Based Volume
(Less Than 18 Feet of Till)

		GMA Sand & Gravel Volumes in Cubic Yards; U–238 in pCi/g					
		Inactive Flyash Pile		South Field		Active Flyash Pile	
U–238 Concentratior		Volume	Avg.U–238	Volume	Avg.U–238	Volume	Avg.U–238
Above	0 pCi/g:	131887	0.1	284954	0	87095	0
Above	0.844 pCi/g:	3877	1.1	637	1.2	0	0
Above	1.122 pCi/g:	984	1.4	637	1.2	0	0
Above	2.5 pCi/g:	0	0	0	2.7	0	0
Above	5 pCi/g:	0	0	0	0	0	0
Above	7.5 pCi/g:	0	0	0	0	0	0
Above	15 pCi/g:	0	0	0	0	0	0
Above	30 pCi/g:	0	0	0	0	0	0
Above	40 pCi/g:	0	0	0	0	0	0
Above	50 pCi/g:	0	0	0	0	0	0
Above	60 pCi/g:	0	0	0	0	0	0
Above	90 pCi/g:	0	0	0	0	0	0
Above	125 pCi/g:	0	0	0	0	0	0
Above	250 pCi/g:	0	0	0	0	0	0
Above	500 pCi/g:	0	0	0	0	0	0
Above	1000 pCi/g:	0	0	0	0	0	0

APPENDIX E.1.9

SUPPORTING VOLUME CALCULATIONS FOR URANIUM-238

E.1.9.1 ON-SITE DISPOSAL CELL WASTE ACCEPTANCE CRITERIA VOLUMES

In accordance with the preliminary waste acceptance criteria (WAC) for on-site disposal listed in Appendix E.2, material remediated from the Operable Unit 2 subunits containing uranium-238 at concentrations exceeding 360 pCi/g will not be placed in the on-site disposal cell. Block modeling results were used to estimate the volume exceeding WAC. However, block modeling smooths high and low sample results in its interpolation process. In order to ensure conservative quantities for cost estimating purposes, 300 pCi/g was used as the cutoff for calculating volume. For each subunit, Table E.1-38 identifies the volume, obtained from block model analysis, that exceeds the 300 pCi/g criterion.

TABLE E.1-38
SUMMARY OF VOLUME EXCEEDING ON-SITE WAC

SUBUNIT	VOLUME EXCEEDING ON-SITE WAC
Solid Waste Landfill	0 yd^3
Lime Sludge Ponds	0 yd^3
Inactive Flyash Pile	3,100 yd^3
South Field	0 yd^3
Active Flyash Pile	0 yd^3
TOTAL	3,100 yd^3

E.1.9.2 PPE REMEDIATION VOLUME

In support of the cost estimates, it will be assumed that material excavated from the Operable Unit 2 subunits containing uranium-238 at concentrations exceeding 125 pCi/g will require level C personnel protective equipment (PPE). For each subunit, Table E.1-39 indentifies the volume, obtained from block model analysis, that will require level C PPE during excavation and handling.

TABLE E.1-39
SUMMARY OF VOLUME EXCEEDING LEVEL C PPE

SUBUNIT	VOLUME EXCEEDING 125 pCi/g
Solid Waste Landfill	1,678 yd^3
Lime Sludge Ponds	0 yd^3
Inactive Flyash Pile	9,201 yd^3
South Field	521 yd^3
Active Flyash Pile	0 yd^3
TOTAL	11,400 yd^3

E.1.9.3 REMEDIATION BERM VOLUMES

For Alternative 6 (Excavation and On-Site Disposal with Off-Site Disposal of Fraction Exceeding WAC), the on-site disposal cell's exterior berm will be constructed from structurally sound clays and soils excavated from the subunits. Material used to construct the berm must not include any of the following:

- Material with uranium-238 concentration above surface soil exposure pathways PRL (55 pCi/g)
- Material contaminated with other COCs above established surface soil exposure pathways PRL
- Flyash
- Lime sludge
- Cover material
- Debris
- Sand or gravel
- Hazardous waste

The following volumes having a uranium-238 concentration above the surface soil exposure pathways PRL (55 pCi/g) have been interpolated from the tables in Section E.1.8.

TABLE E.1-40
VOLUME EXCEEDING URANIUM-238 SURFACE SOIL
EXPOSURE PATHWAYS PRL (55 pCi/g)

SUBUNIT	VOLUME EXCEEDING 55 pCi/g
Solid Waste Landfill	5,800 yd^3
Lime Sludge Ponds	0 yd^3
Inactive Flyash Pile	16,100 yd^3
South Field	5,200 yd^3
Active Flyash Pile	0 yd^3
TOTAL	27,100 yd^3

Based on the aforementioned criteria, the following volumes have been calculated for each subunit.

Solid Waste Landfill:

Remediation Volume		21,200 yd^3
Exceeding 55 pCi/g	-	5,800 yd^3
Debris	-	5,300 yd^3
Total		10,100 yd^3

Lime Sludge Ponds:

Remediation Volume		16,800 yd^3
Exceeding 55 pCi/g	-	0 yd^3
Lime Sludge	-	16,500 yd^3
Other COCs	-	300 yd^3
Total		0 yd^3

Inactive Flyash Pile:

Remediation Volume		94,000 yd^3
Exceeding 55 pCi/g	-	16,100 yd^3
Debris	-	4,000 yd^3
Flyash	-	43,600 yd^3
Cover Material	-	1,000 yd^3
Total		29,300 yd^3

South Field:

Remediation Volume		77,600 yd^3
Exceeding 55 pCi/g	-	5,200 yd^3
Debris	-	6,500 yd^3
Sand and Gravel	-	1,200 yd^3
Hazardous Waste	-	300 yd^3
Total		64,400 yd^3

Active Flyash Pile:

Remediation Volume		65,100 yd^3
Exceeding 55 pCi/g	-	0 yd^3
Flyash	-	65,000 yd^3
Other COCs	-	100 yd^3
Total		0 yd^3

Table E.1-41 presents a summary of the remediation berm volumes.

TABLE E.1-41
SUMMARY OF VOLUME AVAILABLE FOR BERM CONSTRUCTION
FOR ALTERNATIVE 6 WITH AN ILCR OF 10^{-6}

SUBUNIT	VOLUME EXCEEDING 55 pCi/g
Solid Waste Landfill	10,100 yd^3
Lime Sludge Ponds	0 yd^3
Inactive Flyash Pile	29,300 yd^3
South Field	64,400 yd^3
Active Flyash Pile	0 yd^3
TOTAL	103,800 yd^3

APPENDIX E.1.10
REMEDIATION VOLUME CALCULATIONS—
FIRING RANGE LEAD

E.1.10 REMEDIATION VOLUME CALCULATIONS FIRING RANGE LEAD

Surface area of firing range is divided into three sectional grids (left, center, right) each 33.33 ft x 25 ft

Two borings taken in each grid in upper and lower center of grid (6 borings total).

boring dia. =	3 1/4 inch (or 0.058 ft^2)
boring depth =	5 ft
boring volume =	0.058 ft^2 x 5 ft = 0.29 ft^3

The two borings in the right grid produced no lead. The two borings in the left grid had lead in the first foot of the depth. The two borings in the center grid had lead at depths throughout the 5-foot boring.

	LEFT	CENTER	RIGHT
Boring No.	Sp-I, Sp-4	Sp-2, Sp-5	Sp-3, Sp-6
Depth of Lead	1 ft, 1 ft	5 ft, 5 ft	-0-, -0-

Average depth of lead

1 + 1 + 5 + 5 + 0 + 0 = 12/6 = 2 ft.

Volume of Lead Contaminated Soil

3 sections x section area x avg. depth of lead =
3 x (33.33 ft x 25 ft) x 2 ft = 5000 ft^3 OR 185 yd^3

Center Section had lead to 5 ft. So, additional volume of soil:

33.33 ft x 25 ft x (5-2)ft = 2500 ft^3 or 93 yd^3

Total volume of soil:

185 cyd + 93 cyd = 278 cyd

say 300 cyd

Quantity of Lead

Sample	SP-1	SP-2	SP-3SP-4SP-5SP-6
	367g	941g	-0-10g509g-0-

Lead in borings: SP-1 & SP-4 are in left grid and contain lead to a 1-foot depth.

SP-2 & SP-5 are in middle grid and contain lead to a 5-foot depth.

SP-3 & SP-6 do not contain lead.

Quantity of lead in left grid:

Avg. lead per boring: (367g + 10g)/2 = 189g = .42 lb

borehole vol: $\frac{\pi\ (.27)^2}{4}$ x 1 ft = .06 cf

density of lead per boring = .42 lb/.06 cf = 7 lb/cf

Qty lead = 7 lb/cf x (33.33' x 25' x 1') = 5833 lb

say ⇒ 5850 lb

Quantity of lead in middle grid:

Avg. lead per boring = (941g + 509g)/2 = 725g = 1.6 lb

Borehole Vol: = $\frac{\pi\ (.27)^2}{4}$ x 5 ft = .29 cf

density of lead per boring = 1.6 lb/.29 cf = 5.5 lb/cf

Qty lead = 5.5 lb/cf x (33.33' x 25' x 5') = 22914 lb

say ⇒ 22950 lb

Qty lead in right grid:

0 lb

Total lead: 5850 lb + 22950 lb = 28800 lb

Quantity of Lead

Sample	Sp-1	Sp-2	Sp-3	Sp-4	Sp-5	Sp-6
Lead Qt.	367 g	941 g	-0-	10 g	509 g	-0-

Avg. lead per boring $= \frac{1827}{6} = 304.5g$

apparent density per borehole:

$$\frac{0.67 \text{ lb}}{0.29 \text{ ft}^3} = 2.31 \text{ lb/ft}^3$$

Use 2.31 lb/ft^3 density of lead

Amount of soil is 300 cyd or 8100 ft^3

Quantity of lead = 8100 ft^3 x 2.31 lb/ft^3

= 18,711 lbs.

say 19,000 lbs.

APPENDIX E.2
WASTE ACCEPTANCE CRITERIA

APPENDIX E.2.1

WASTE ACCEPTANCE CRITERIA FOR OFF-SITE DISPOSAL

APPENDIX E.2.1
WASTE ACCEPTANCE CRITERIA FOR OFF-SITE DISPOSAL

Envirocare, Inc. of Clive, Utah (Envirocare) and the Nevada Test Site (NTS) have been identified as potential off-site disposal facilities for contaminated material from Operable Unit 2. For contaminated material from Operable Unit 2 to be accepted at either disposal site, samples from each shipment must be provided to the disposal site. Samples must pass the toxicity characteristic leaching procedure (TCLP) for eight metals and 32 organics as defined in 40 CFR 261.24. Furthermore, materials that have free-standing moisture in excess of 0.5 percent by volume of the container cannot be accepted at either disposal facility. Free moisture, however, does not include in-situ moisture. Free moisture can be measured by the paint filter liquid test or may be assessed by visual inspection at the discretion of the disposal site. For transport, contaminated materials must meet Department of Transportation (DOT) requirements (49 CFR 173.431).

Mixed waste from Operable Unit 2 can be accepted at either of the proposed off-site facilities provided the material meets certain disposal criteria. Table E.2.1-1 presents the metals, semivolatile organic compounds, and pesticides listed as contaminants of concern (COCs) for Operable Unit 2. Where applicable, the regulatory level associated with each compound is also presented. This regulatory level is one of two values:

- Twenty times the toxicity characteristic concentration (40 CFR 261.24). If the concentration in a sample exceeds this value, a TCLP test must be conducted.
- Maximum allowable concentrations in wastes for land disposal (40 CFR 268.43).

The following sections discuss the two proposed off-site disposal facilities and the acceptance criteria particular to each facility.

Envirocare of Utah

Envirocare can dispose of mixed waste (MW), normally occurring radioactive material (NORM), and low activity radioactive material (LARM). Envirocare can handle bulk materials or materials packaged in bags, drums, boxes, or roll-off containers. Transportation to the site can be via truck or rail.

REGULATORY LEVEL COMPARED TO MAXIMUM CONCENTRATIONS DETECTED

Contaminant of Concern	Regulatory Level (mg/kg)	Maximum Detected Concentration (mg/kg) by Operable Unit 2 Subunit[a,b]				
		Solid Waste Landfill	Lime Sludge Pond	Inactive Flyash Pile	South Field	Active Flyash Pile
METALS						
Antimony	NA	2.73E+01	2.92E+01	1.63E+01	2.97E+01	3.11E+01
Arsenic	1.00E+02[c]	1.54E+01	1.46E+01	8.18E+01[f]	7.56E+01[f]	1.45E+02[f]
Beryllium	NA	1.80E+00	2.10E+00	8.70E+00	4.60E+00	6.40E+00
SEMIVOLATILE ORGANICS						
Benzo(a)anthracene	NA	3.10E+02	9.10E-01	1.30E-01	5.50E+00	1.10E-01
Benzo(a)pyrene	NA	2.60E+02	1.10E+00	1.30E-01	9.40E+00	1.20E-01
Benzo(b)fluoranthene	NA	2.20E+02	1.00E+00	3.60E-01	6.20E+00	1.80E-01
Benzo(k)fluoranthene	NA	1.40E+02	8.00E-01	2.60E-01	7.30E+00	7.30E-02
Dibenzo(a,h)anthracene	NA	7.9E+01	3.20E-01	2.00E-03	1.90E+00	ND
Indeno(1,2,3-cd)pyrene	NA	1.50E+02	7.20E-01	6.30E-02	6.00E+00	7.40E-02
PESTICIDES[d]						
Aroclor-1254	NA	1.50E-01	5.90E-01	5.70E-01	1.10E+00	ND
Aroclor-1260	NA	6.10E-01	ND	3.90E-01	8.90E-02	ND
Dieldrin	1.3E-01[e]	1.30E-02	ND	ND	1.60E-02	ND

Contaminant of Concern ND -- Non-Detect NA -- Not Applicable

[a]Concentrations represent maximum detected value for surface soil, subsoil, or sediment for each subunit.
[b]Some samples from the Firing Range in the South Field failed TCLP analysis for lead. Maximum detected lead concentration was 2.82E+03 mg/kg. Regulatory limit for lead is 1.00E+02 mg/kg (see Note c). However, lead is not a contaminant of concern for Operable Unit 2.
[c]This is total concentration based on 20 times toxicity characteristic concentration (40 CFR 261.24) to account for dilution during TCLP test.
[d]Maximum allowable concentration of total halogenated organic compounds (HOCs) is 1000 mg/kg (40 CFR 268.32)
[e]Maximum allowable concentration in waste for land disposal (40 CFR 268.43)
[f]Although the maximum detected concentration was near or above the regulatory level, all samples were below TCLP limits for classification as a hazardous waste.

TABLE E.2.1-1

As indicated on Table E.2.1-1, at least one sample from the Active Flyash Pile exceeded the waste acceptance criteria (WAC) for arsenic and samples from the Inactive Flyash Pile and South Field approach it. However, all samples were below the TCLP limit for arsenic for classification as a hazardous waste. Therefore, none of this material is expected to exceed these criteria, although testing would have to be conducted to confirm this. Samples from the Firing Range exceeded the TCLP limit for lead. Therefore, it is estimated that approximately 300 cubic yards of this material will require treatment prior to disposal.

Low level radioactive waste must also meet acceptance criteria for each radionuclide present. Table E.2.1-2 lists acceptance criteria for Envirocare and maximum activity levels detected in each Operable Unit 2 subunit for the complete list of radioactive COCs (across all five subunits).

As indicated on Table E.2.1-2, maximum activity levels of radionuclides detected within the five subunits are generally 1 to 3 orders of magnitude lower than the acceptance criteria for Envirocare. The only exceptions are that activity levels for radium-228, thorium-232, and thorium-228 in the South Field have been detected in isolated samples on the same order of magnitude as the acceptance criteria. However, none of the contaminants have been shown to exceed the acceptance criteria for Envirocare. Also, contaminant levels may be averaged over a shipment to Envirocare, thus providing flexibility should activity levels for individual samples be detected above the acceptance limits. Therefore, it is assumed that all material from the Operable Unit 2 subunits will meet the average radiological waste acceptance criteria for a shipment.

Samples are to be provided in advance of shipment and will be analyzed by Envirocare for the incoming-shipment parameters listed in Table E.2.1-3. Shipments failing any of the listed parameters will not be accepted for disposal.

Nevada Test Site

NTS will accept low-level waste (LLW) and MW for disposal. Transuranic waste (TRU) and transuranic mixed waste (TRUMW) will only be accepted for storage. NTS cannot accept bulk shipments of MW, so such material from Operable Unit 2 will have to be containerized. LLW is defined as radioactive waste not classified as high-level waste, spent nuclear fuel, TRU, uranium mill tailings, MW, or 11e(2) by-product material as defined in DOE Order 5820.2a. LLW must have a transuranic nuclide activity level less than 100 nCi/g.

000634

ENVIROCARE ACCEPTANCE CRITERIA COMPARED TO MAXIMUM ACTIVITIES DETECTED

Contaminant of Concern	Acceptance Criteria for Envirocare[b] (pCi/g)	Maximum Detected Activity (pCi/g) by Operable Unit 2 Subunit[a]				
		Solid Waste Landfill	Lime Sludge Pond	Inactive Flyash Pile	South Field	Active Flyash Pile
Cesium-137	< 5.6E+02	5.22E-01	8.90E-01	6.41E-01	8.36E-01	9.19E-01
Neptunium-237	< 2.0E+03	3.11E+00	7.20E-01	3.73E+01	6.53E+00	4.50E-01
Plutonium-238	< 1.0E+04	9.02E-01	6.62E-01	1.85E+00	7.35E-01	1.29E+00
Radium-226	< 2.0E+03	1.13E+02	5.93E+00	4.23E+01	3.12E+01	6.22E+00
Radium-228	< 1.8E+03	6.65E+00	2.92E+00	3.13E+00	6.75E+02	5.32E+00
Thorium-228	--[c]	9.36E+00	2.91E+00	4.10E+00	5.95E+02	5.79E+00
Thorium-230	< 1.5E+04	7.20E+02	4.48E+01	1.21E+02	5.73E+01	6.74E+00
Thorium-232	< 6.8E+02	8.22E+00	2.75E+00	4.00E+00	6.00E+02	5.08E+00
Uranium-234	< 3.7E+04	5.53E+02	2.65E+01	1.38E+03	3.78E+02	1.73E+01
Uranium-235/236	< 7.7E+02[d]	2.89E+01	1.83E+00	6.88E+01	2.06E+01	4.12E+00
Uranium-238	< 2.8E+04	5.77E+02	8.40E+01	1.57E+03	3.97E+02	1.26E+01
Uranium-Total (mg/kg)	--[e]	1.77E+03	2.44E+02	3.58E+03	1.17E+03	5.18E+01

Contaminant of Concern

[a] Activity levels represent maximum detected value for surface soil, subsoil, or sediment for each subunit.
[b] Acceptance criteria for Envirocare is the maximum average value permitted for a shipment of waste.
[c] Thorium 228 is a daughter of Thorium 232 (assumed at same concentration in equilibrium).
[d] Acceptance criteria provided is for uranium-235. Uranium-236 acceptance criteria is 3.6E+04 pCi/g.
[e] Acceptance criteria for uranium-natural is 1.8E+04 pCi/g and for uranium-depleted is 1.1E+05 pCi/g.

TABLE E.2.1-2

INCOMING-SHIPMENT PARAMETERS FOR OFF-SITE DISPOSAL FACILITIES

ENVIROCARE		NEVADA TEST SITE	
Parameter	Test Method [a]	Parameter	Test Method
Paint Filter Liquid Test	EC-0725	Free Liquid (Paint Filter Test)	EPA Method 9095
Cyanide Test	EC-0775	Cyanides	EPA Method 9010 or 9012
Sulfide Test	EC-0775	Sulfides	EPA Method 9030
Pyrophoricity	EC-1350	Reactivity	As Described in 40 CFR 261.23
Air Reactivity	EC-1400		
Water Reactivity	EC-1425		
Solid/Soil pH	EC-0700		
Oxydizer/Reducer Test	EC-0750		
Photoionizer "sniffer" Test	EC-0800		
Shock Sensitivity	EC-1375		
		Ignitability	EPA Method 1010 or 1020
		Corrosivity	EPA Method 9040
		Toxicity Characteristic	EPA Method 1311
		Land Disposal Restriction--Solvents	TCLP (F001-F005)
		Land Disposal Restriction--Halogenated Organic Compounds	EPA Method 9020
		PCBs	EPA Method 8080

[a] Tests must be performed to specific criteria provided by Envirocare.

TABLE E.2.1-3

MW is defined as waste containing both radioactive and hazardous components, as defined by the Atomic Energy Act and the Resource Conservation and Recovery Act, respectively. MW must meet land disposal restrictions (LDRs) (40 CFR 268).

NTS has not provided a breakdown based on the particular radioactive contaminants of concern present in Operable Unit 2, as was provided by Envirocare. However, the external radiation level for packages must not exceed 200 millirem per hour on contact during handling, shipment, and disposal.

Samples are to be provided in advance of shipment and will be analyzed by NTS for the incoming-shipment parameters listed in Table E.2.1-3. Shipments failing any of the listed parameters will not be accepted for disposal.

APPENDIX E.2.2

PRELIMINARY WASTE ACCEPTANCE CRITERIA FOR ON-SITE DISPOSAL

APPENDIX E.2.2

PRELIMINARY WASTE ACCEPTANCE CRITERIA FOR ON-SITE DISPOSAL

An on-site engineered disposal facility is an option for disposal of contaminated material from Operable Unit 2. To be protective of groundwater in the Great Miami Aquifer over the 1,000 year modeling timeframe, the contaminated material must meet certain acceptance criteria. Preliminary WAC were developed for uranium. As discussed in Appendix D, the only COCs for groundwater at the disposal cell were uranium isotopes. This is because uranium isotopes were the only groundwater COCs identified at the individual subunits and the infiltration rate is much lower at the disposal cell then at the unremediated subunits.

The preliminary WAC were developed based on a conservative groundwater modeling approach that is presented in Appendix D.1.6. The final WAC will be determined during design of the disposal facility. During design, additional information that will allow finalization of the WAC will be available from the following studies:

- The predesign investigation that has begun in the area where a site-wide disposal facility could potentially be located,
- Infiltration studies during final cap design,
- The RI/FS reports from other operable units (which will identify additional COCs).

Table E.2.2-1 presents the preliminary WAC for the on-site disposal facility and compares it with maximum levels of the respective contaminants detected in the Operable Unit 2 subunits. As indicated in the table, only material from the Solid Waste Landfill, Inactive Flyash Pile, and South Field is expected to exceed the criteria. It is estimated that a maximum of 3100 cubic yards of material will require off-site disposal or treatment prior to disposal in the on-site cell (see Appendix E.1).

The preliminary WAC presented here are based on a desorption distribution coefficient of 15 mL/g, which is lower than any actually measured in the Operable Unit 2 materials. Therefore, the assumed leachability is considerably higher than the measured leachability and results in a lower WAC for uranium concentration in soil. Hence, the assumption of the lower desorption distribution coefficient

serves to cause a conservative WAC and minimize concerns about the relationship between leachability and uranium concentration for Operable Unit 2 wastes during remediation.

TABLE E.2.2-1

PRELIMINARY WASTE ACCEPTANCE CRITERIA FOR ON-SITE DISPOSAL COMPARED TO MAXIMUM DETECTED VALUE

Contaminant of Concern	Units	Preliminary Waste Acceptance Criteria for On-Site Disposal	Maximum Detected Value by Operable Unit 2 Subunit [a]				
			Solid Waste Landfill	Lime Sludge Pond	Inactive Flyash Pile	South Field	Active Flyash Pile
Uranium-238	pCi/g	< 3.6E+02	5.77E+02	8.40E+01	1.57E+03	3.97E+02	1.26E+01
Total Uranium	ppm	< 1.1E+03	1.77E+03	2.44E+02	3.58E+03	1.17E+03	3.13E+01

Contaminant of Concern

[a] Activity levels represent maximum detected value for surface soil, subsoil, or sediment for each subunit.
[b] Acceptance criteria for on-site disposal is the maximum value permitted (see Appendix D.1 for development).

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as polyethylene. The cap would slope at 4 percent from the crown out to the perimeter berms. The cap system includes the following design components:

- A 6-inch thick topsoil layer planted with grass to reduce the potential for erosion.
- A 21-inch thick soil cover layer to accommodate moisture retention in order to maintain the vegetative cover.
- A 6-inch thick gravel filter layer between top and bottom layers of geotextile separator to protect the underlying biotic barrier from infiltration of fine-grained soil particles.
- A 3-foot thick biotic barrier consisting of cobbles to prevent animal and plant intrusion.
- A 12-inch thick sand drainage layer between top and bottom layers of geotextile separator to intercept infiltrating water. (This layer could be replaced with a geosynthetic drainage layer such as a geonet.)
- A layer of HDPE and a bentonite geocomposite to impede infiltration.
- A 24-inch thick compacted clay soil layer, with a maximum hydraulic conductivity of 1×10^{-7} cm/sec, to impede infiltration.
- A 12-inch thick (typical) layer of compacted contouring fill immediately above the contaminated materials to support the installation of cover materials.

E.3.1.2.3 Cell Liner

The details of the disposal cell liner configuration are depicted in Figure E.3.1-6. The composite liner consists of the following components:

- A 12-inch-thick protective layer consisting of a material such as soil or flyash to protect the liner when waste containing debris is placed.
- An 12-inch-thick leachate collection system of gravel with 6-inch diameter perforated pipe to collect leachate and direct it to a collection point. A geonet is considered an alternative to the gravel and pipe system. Collected leachate would go to the AWWT facility for treatment.
- A primary geomembrane liner consisting of HDPE above and a composite bentonite liner below.
- An 12-inch-thick leachate detection system of gravel and 6-inch diameter perforated pipe to collect leachate and direct it to a monitoring and collection point. A geonet is considered an alternative to this gravel system.
- A secondary liner consisting of HDPE, composite bentonite, and 24-inches of compacted native clay soil with a maximum permeability of 1×10^{-7} cm/sec.

E.3.1.2 DISPOSAL CELL DESIGN

E.3.1.2.1 General Design Considerations

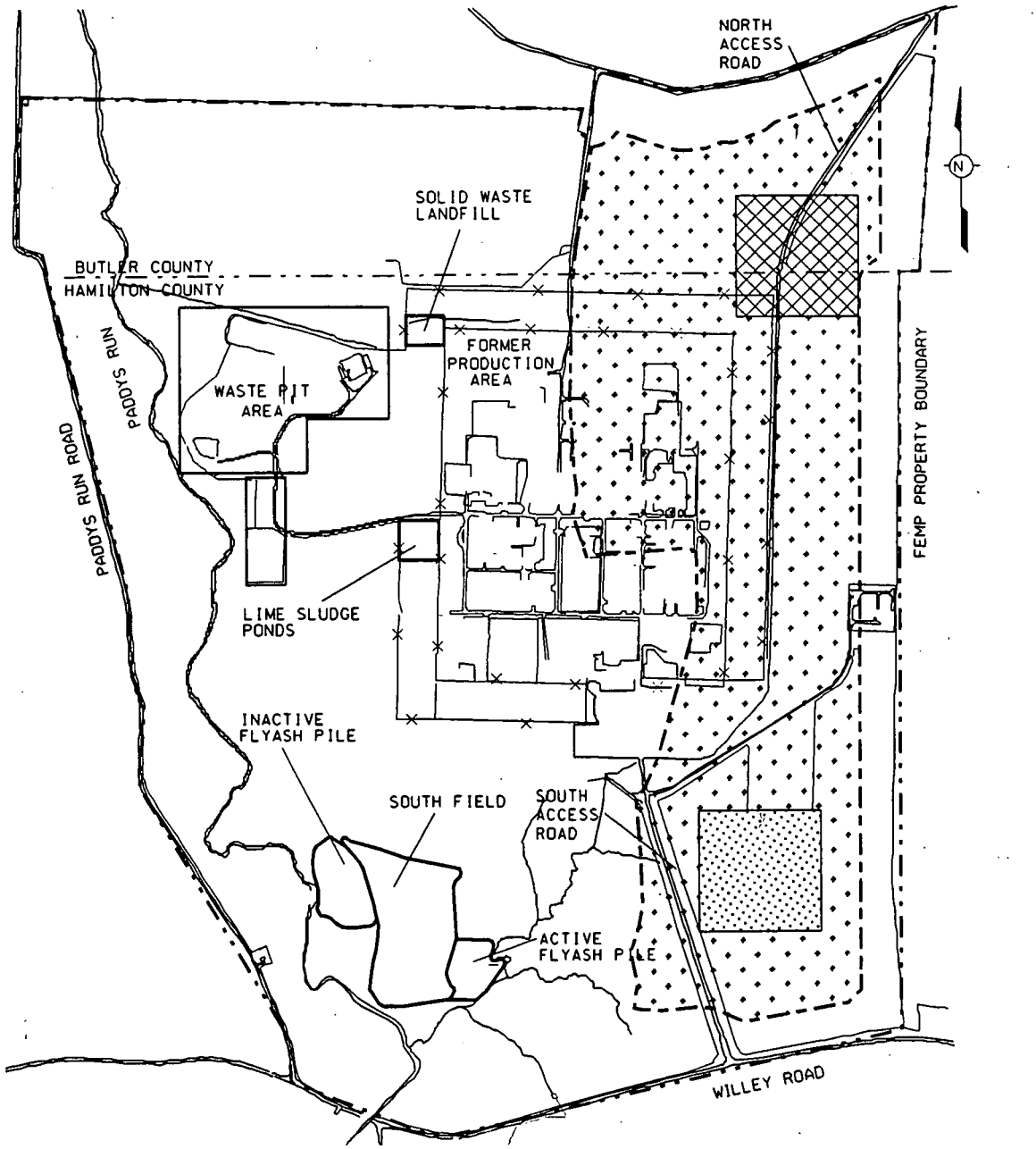
The disposal cell configuration is depicted in plan and cross section in Figures E.3.1-3 and E.3.1-4, respectively. The cell configuration will be finalized during remedial design. The disposal cell conceptual design includes the following considerations:

- Attainment of regulatory design criteria.
- Effectiveness for up to 1,000 years, to the extent practical and reasonably achievable, and in any case, for at least 200 years (40 CFR 192.02).
- Protection against animal and plant intrusion, and minimization of the potential for human intrusion though the use of stone barriers.
- Reduction of potential for settlement through compaction of the contaminated soil placed in the cell.

The primary components of the disposal cell are the cap and liner. In general, material disposed of by Operable Unit 2 can be classified as low-level radioactive solid waste. In developing the conceptual cap and liner, design components of typical solid waste and RCRA caps and liners were incorporated with the above criteria. A comparison of the Operable Unit 2 conceptual cap and liner with typical solid waste and Resource Conseration and Revovery Act (RCRA) caps and liners is presented on Figure E.3.1-5. The Operable Unit 2 cap and liner provide additional safeguards against infiltration and leakage, respectively, than the typical solid waste and RCRA caps and liners. In the cap, the biotic layer provides a barrier to burrowing animals and a basically water-free zone that will discourage root growth. The liner provides an added bentonite geocomposite in the primary liner. Although the compacted clay thickness of the secondary liner is less than in a typical soil waste liner, the addition of an high density polyethlene (HDPE) geomembrane and bentonite geocomposite result in a composite secondary liner that is less permeable. The individual components of the conceptual cap and liner are discussed in the following sections.

E.3.1.2.2 Cell Cap

The details of the cap configuration are depicted in Figure E.3.1-6. The cap is based on a composite design employing both natural materials, such as sand, gravel and clay, and synthetic materials, such



LEGEND

- PROPOSED OU2 ON-SITE DISPOSAL CELL LOCATION
- ALTERNATE OU2 DISPOSAL CELL LOCATION, AS PART OF SITE-WIDE FACILITY
- POTENTIALY ACCEPTABLE REGION
- FEMP BOUNDARY

FIGURE E.3.1-2
SITE PLAN
FEASIBLE LOCATIONS
FOR OPERABLE UNIT 2 ON-SITE DISPOSAL

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E.3.1.1.2 Siting of Operable Unit 2 Disposal Cell

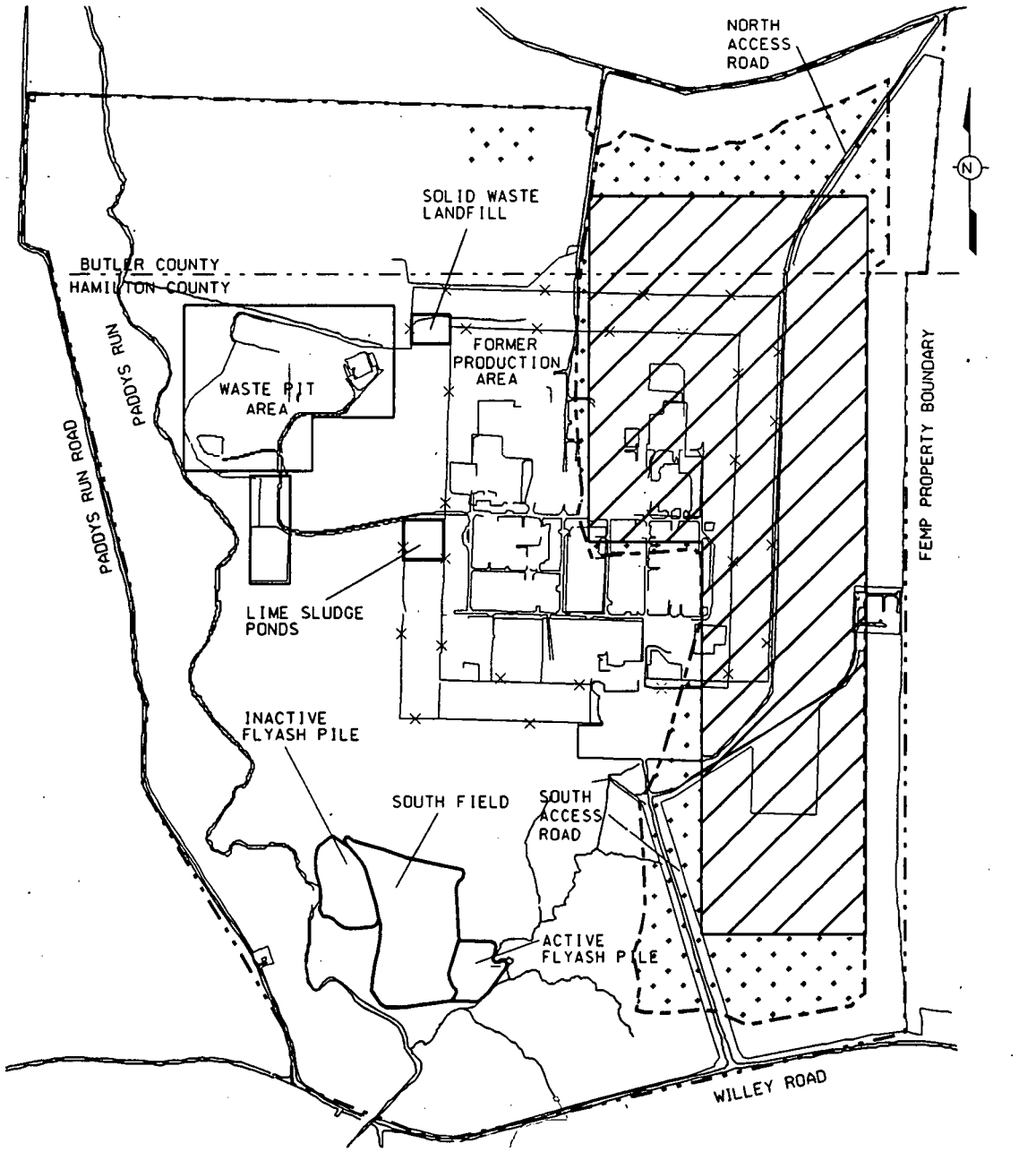
Figure E.3.1-2 presents a feasible proposed location for an Operable Unit 2 disposal cell and a possible alternate location. The proposed location was chosen based on the following:

- The site selection was coordinated with the leading remedial alternatives (LRA) of other Operable Units in order to minimize potential conflicts over on-site disposal needs.
- The area is located outside the process area, thus allowing Operable Unit 2 to maintain an acceptable remedial action schedule.
- The location of this specific area would minimize waste transport time/distance due to its proximity to the larger Operable Unit 2 subunits (the South Field and the flyash piles).
- Operable Unit 2 has performed additional field exploration and geotechnical testing in this area to further confirm its feasibility (see E.3.2 and E.3.3).

If the Operable Unit 2 cell is constructed as part of a larger site-wide facility or if the Operable Unit 3 LRA does not include on-site disposal along the east side of the FEMP, the Operable Unit 2 disposal cell would likely be placed elsewhere. The Operable Unit 2 schedule would make Operable Unit 2 materials the first to enter a site-wide facility, and, hence, the Operable Unit 2 cell would go in the initial cell to be constructed as part of such a facility. As part of a larger facility, it would likely be located in the northeast corner (the area identified as a possible alternate location in Figure E.3-2) in order to allow construction of the site-wide facility to progress from north to south. Surface drainage on the eastern portion of the FEMP property runs approximately from the north toward the south. Therefore, drainage control features would best be started on the north and expanded southward. Starting in the northeast outside the process area also provides the additional advantage of minimizing the double handling of materials from the process area by other operable units.

E.3.1.1.3 Ongoing Studies

Three ongoing efforts at the FEMP will serve to clarify the disposal cell location. Two of these efforts are the feasibility study reports for Operable Units 3 and 5. Those reports will give refinements to the volume of material suitable for on-site disposal and determine engineering requirements (protectiveness and ARARs) for on-site disposal. The third effort is the On-site Disposal Facility Predesign Investigation, which is an activity of the Operable Unit 2 remedial design process. This effort will gather additional information for the design of the on-site disposal facility.



LEGEND

AREA FOR 8,500,000 CU. YD. SITE-WIDE FACILITY

POTENTIALY ACCEPTABLE REGION

FEMP BOUNDARY

FIGURE E.3.1-1
SITE PLAN
POTENTIALLY ACCEPTABLE REGION
FOR SITEWIDE ON-SITE DISPOSAL

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E.3.1 ON-SITE DISPOSAL CELL

E.3.1.1 SITING CRITERIA

E.3.1.1.1 General

Siting of an on-site disposal facility is limited by certain physical and administrative constraints. Figure E.3.1-1 presents the area that is potentially acceptable for siting a disposal facility. This area was determined based on the following physical constraints:

- Underlying gray till in excess of 10 feet.
- Boundaries of the waste at least 1,000 feet from residences or residential wells [OAC 3745-27-07(B)11) and (B)(13)].
- Boundaries of the waste offset at least 300 feet from the site property lines [OAC 3745-27-07(B)(12)].

In addition to these considerations, siting of a disposal facility avoids the western portion of the property for four general reasons:

- The presence of a stream (Paddys Run) and its associated floodplain [OAC 3745-27-07 (A)(3) & (B)(10)].
- The presence of wetlands at various locations [OAC 3745-27-07 (B)(14)].
- A geologic basin feature (as described in Section 3.5 of the Operable Unit 5 RI) dominates the southwestern portion of the property.
- Sands interbedded in the glacial till are more frequently encountered in the western portion of the property (these sands are also described in the Operable Unit 5 RI).

Figure E.3.1-1 also shows an area sufficient to site a FEMP-wide disposal facility that would accept the maximum anticipated volume of material generated from Operable Units 2, 3, and 5. This conceptual cell would have side slopes of 5:1, 40 feet high at the top of the side slopes, and a maximum central height of about 70 feet. This represents an extreme case, and any actual facility is likely to be much smaller than this footprint. This footprint is presented to show that the maximum anticipated waste volume can conceptually be fit into the area that is potentially acceptable for locating an on-site facility. Suitable hydrogeology in this area would be verified during design of the on-site disposal facility.

APPENDIX E.3.1
ON-SITE DISPOSAL CELL

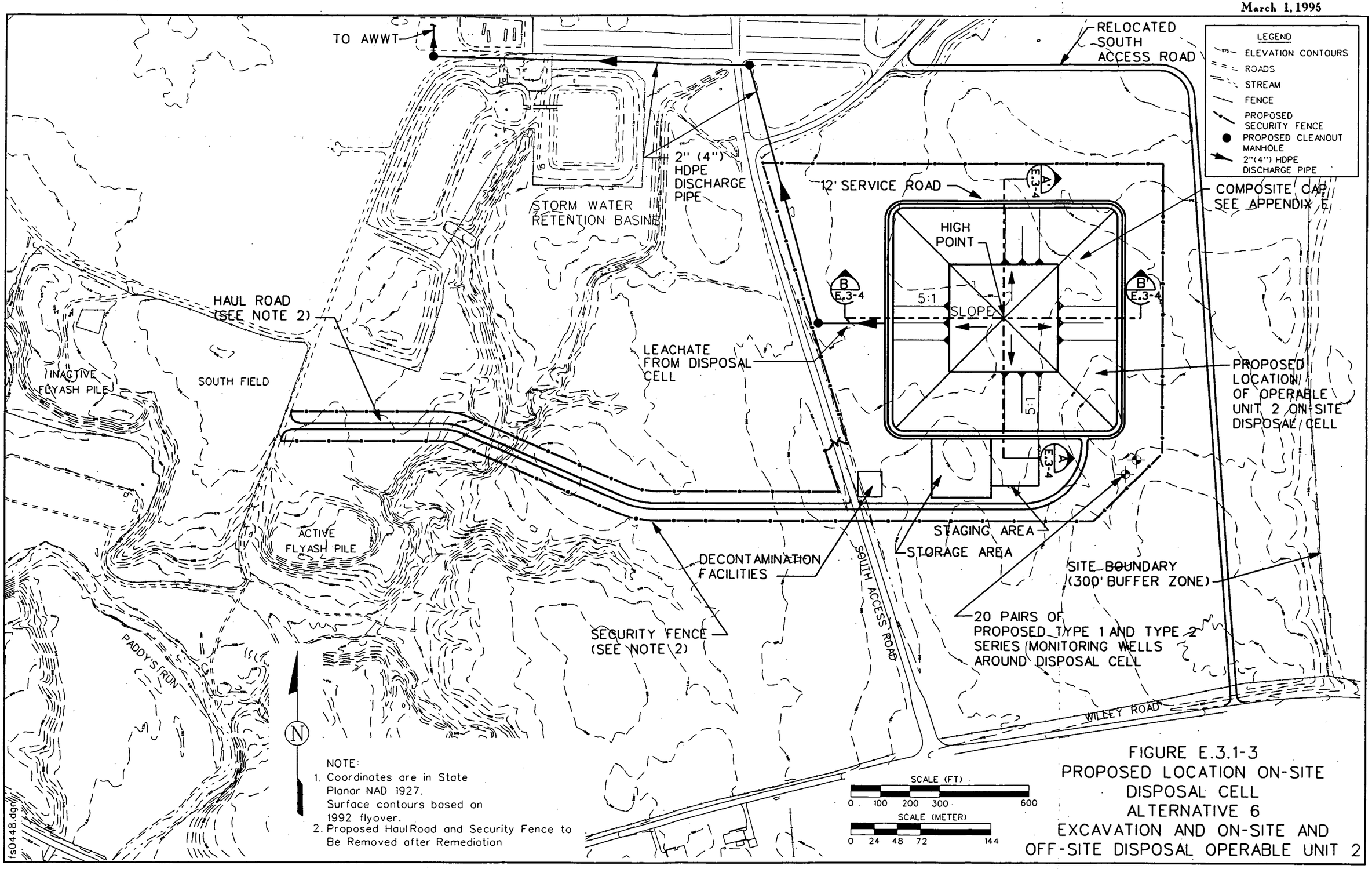
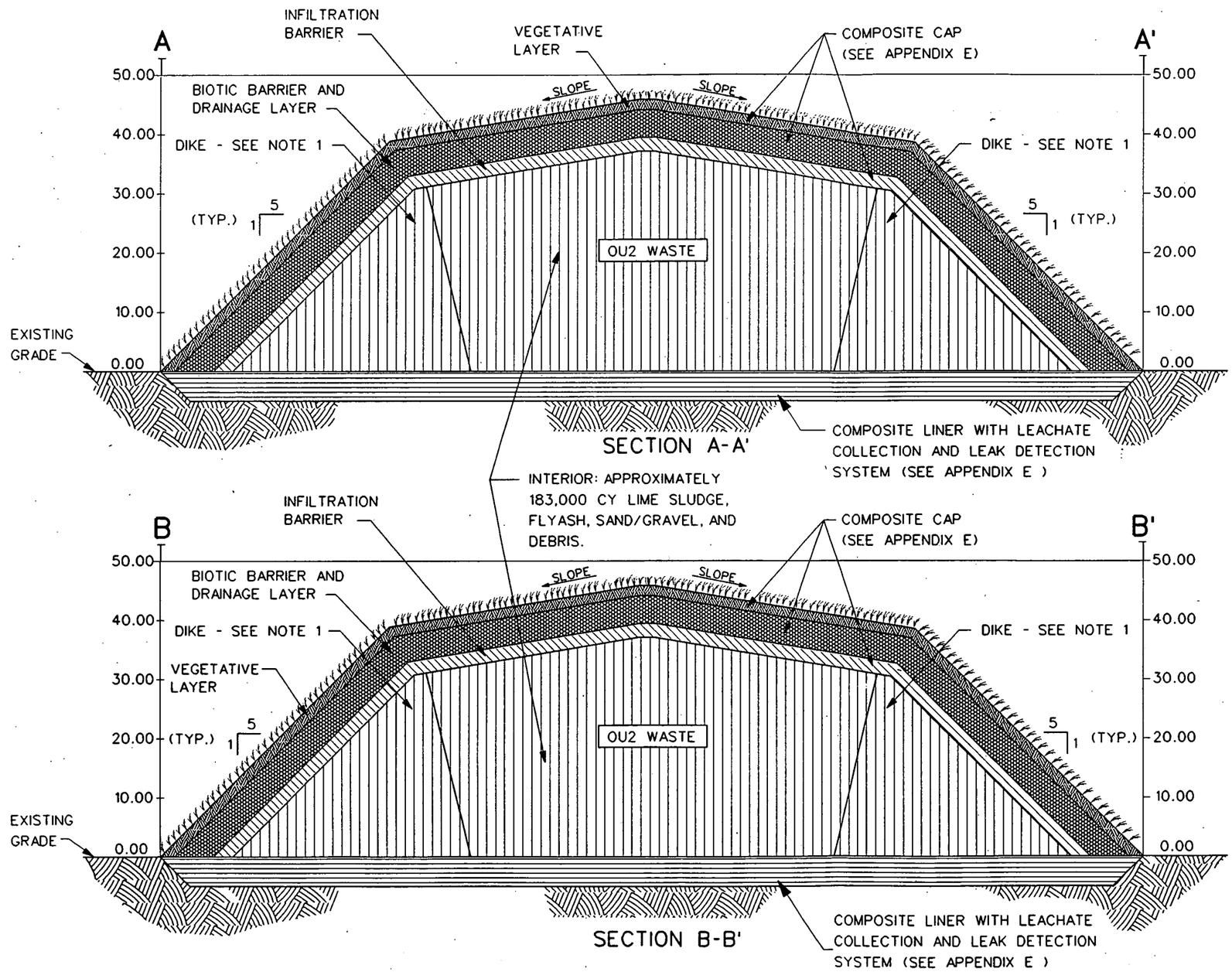
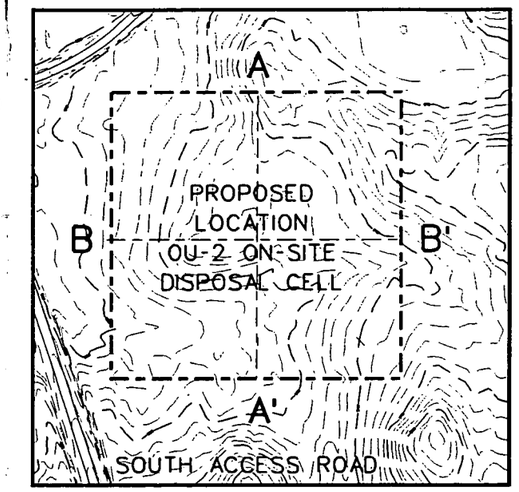


FIGURE E.3.1-3
PROPOSED LOCATION ON-SITE DISPOSAL CELL
ALTERNATIVE 6
EXCAVATION AND ON-SITE AND OFF-SITE DISPOSAL OPERABLE UNIT 2

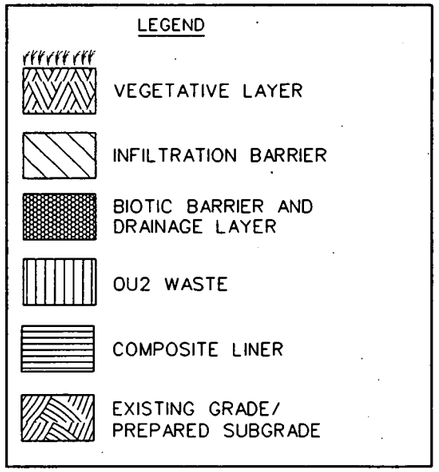




LOCATION KEY (1" = 400')

NOTE:

1. Dike shall be constructed of suitable fill and till material excavated from the waste units.
2. Surface contours based on 1992 flyover.

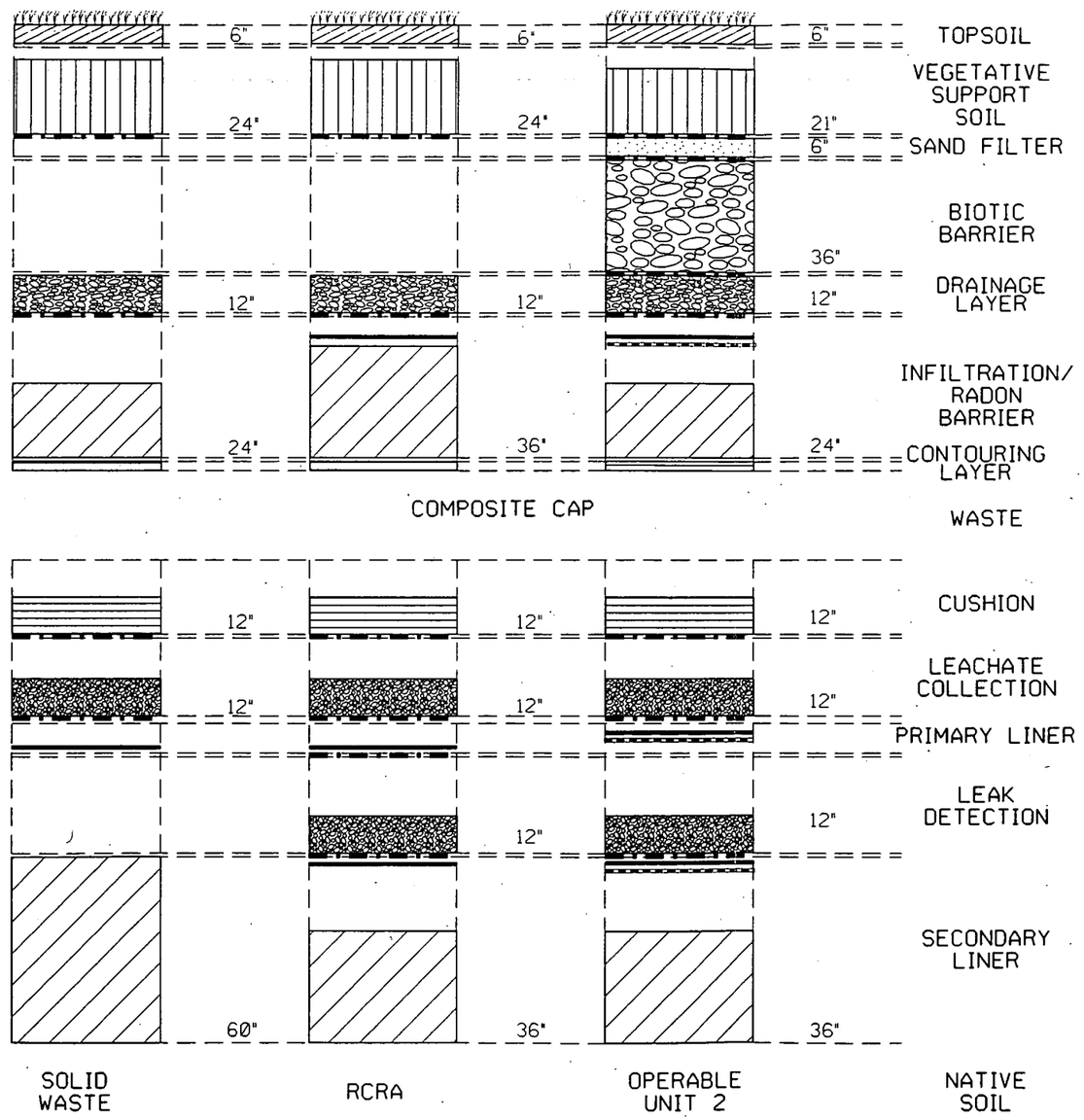


HORIZONTAL SCALE: 0 50' 100' 200'
VERTICAL 0 10' 20' 40'

HORIZONTAL SCALE: 0 12 m 24 m 48 m
VERTICAL 0 2.4 m 4.8 m 9.6 m

FIGURE E.3.1-4
TYPICAL SECTIONS
OPERABLE UNIT 2
ON-SITE DISPOSAL CELL

fs0437.dgn



LEGEND

- TOPSOIL
- VEGETATIVE SUPPORT
- SAND
- COBBLES
- PEA GRAVEL
- COMPACTED CLAY
- CONTOURING LAYER
- GEOTEXTILE FABRIC
- BENTONITE GEOCOMPOSITE
- HDPE FLEXIBLE MEMBRANCE LINER

FIGURE E.3.1-5
TYPICAL DETAILS
COMPOSITE CAPS AND LINERS

000650

fs0441.dgn

6647

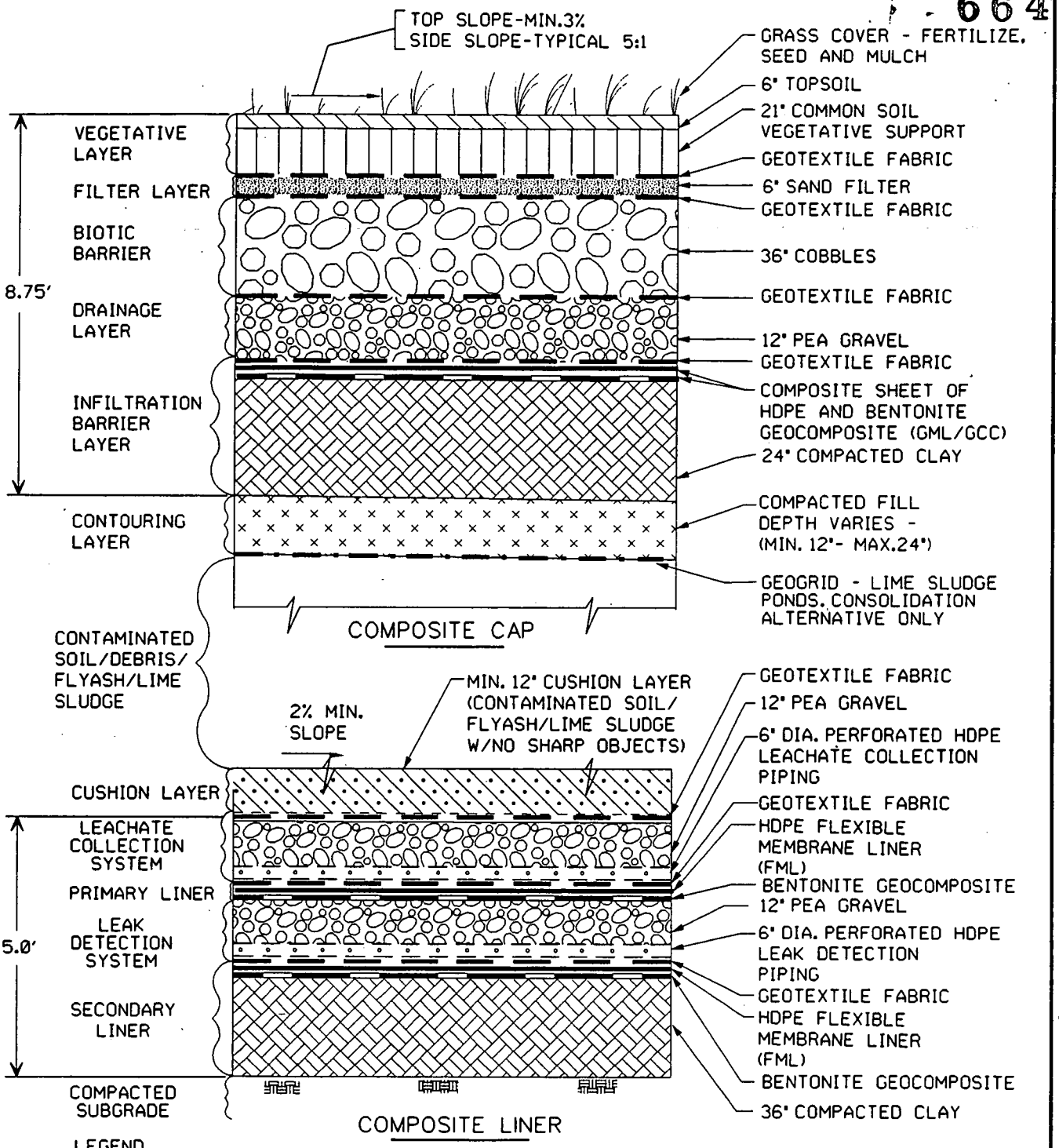


FIGURE E.3.1-6
TYPICAL DETAIL
COMPOSITE CAP AND LINER
(NOT TO SCALE)

000651

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E.3.1.2.4 Waste Placement

The waste material placed in the disposal cell would consist of contaminated soil, flyash, dewatered lime sludge, and debris. The contaminated soil, flyash, lime sludge, and debris would be loaded at the excavation site and delivered to the cell construction site. A staging facility would be constructed for the receipt of contaminated soils. After unloading at the staging facility, the trucks would pass through a radiological screening and washing station to reduce the spread of contaminants to clean areas of the FEMP site. After screening/washing, the truck would return to the soil excavation site.

The contaminated soil would be transported from the staging facility to the disposal cell by standard earth-moving equipment. The soil would be placed in 8- to 10-inch loose lifts and compacted to achieve the desired 95 percent Standard Proctor density. The working face and lift area would be limited to minimize the area exposed to the environment. Appropriate control measures would be employed to mitigate dust releases during soil placement. Periodic monitoring, including sampling and analysis of airborne particulates, would be conducted to ensure the effectiveness of dust control measures.

Scheduling of material removal from the Operable Unit 2 subunits would be done so that flyash and lime sludge would be delivered to the cell at the same time. This allows for mixing during placement, resulting in a stabilized composite material due to the natural cementing of these materials.

Crushed debris would be mixed with soil or flyash at the cell to form a more homogeneous fill. The overall dimensions of larger debris would be limited in length to accommodate the spreading and compaction equipment and to a height less than the compactual lift thickness. Debris would not be placed in the initial fill lifts.

APPENDIX E.3.2

ON-SITE DISPOSAL CELL GEOLOGY

E.3.2 ON-SITE DISPOSAL CELL GEOLOGY

The geology underlying the proposed on-site disposal cell was derived from a review of boring logs and geotechnical data from 22 soil borings installed at the vicinity of cell site. These boring logs and geotechnical data are presented in Section E.3.3 of this appendix. The geology consists of a layer of glacial overburden overlying glacial outwash deposits, as shown in the sections in Figures E.3.2-1, E.3.2-2, and E.3.2-3. The glacial overburden encountered ranges in thickness from approximately 24 to 35 feet. The overburden is a glacial till, consisting primarily of a dense silty clay with some admixed sand and gravel. The surficial clay is dark yellowish brown that lightens in color with depth and grades to an olive and gray color.

Scattered sand and gravel lenses were encountered in some of the borings located in the northern and eastern portions of the site. Sand lenses encountered in the glacial water-bearing overburden are localized and discontinuous across the site. Sand lens thicknesses range from a few inches to 6 feet. Three apparent sand lenses were observed in the proposed disposal cell location and adjacent areas and are described below.

- Soil Boring G2-206, located near the southeast corner of the proposed on-site disposal cell, contains a 6.5-foot thick, dark gray silty sand (SM) lens from 16 to 22 feet below grade. This sand unit is believed to be correlative with a water-bearing 4.5-foot thick, dark gray silty sand lens observed at a depth of 16 to 20.5 feet below grade in Soil Boring G2-204 (located east of the proposed on-site disposal cell), based on similarity of depth, lithology, moisture content, and color. These sands may also be correlative with a 0.5-foot thick sand lens reported in Lysimeter 11130 (also located east of the proposed on-site disposal cell) at a depth of 15 to 15.5 feet below grade. This apparently correlative sand unit, termed the "A" Sand, was not observed in Lysimeter 11131 and Soil Borings G2-209, 1749, G2-208, 1747, G2-207, G2-205, G2-203, and 1750, which surround the area of Soil Borings G2-206 and G2-204 and Lysimeter 11130. The "A" Sand unit appears to have a lobate form, elongated in a north-northeast to south-southwest direction. The southwestern extent of the "A" Sand lens (i.e., in the direction of Boring G2-205) is not well documented due to sparsity of data in this area.

- A moist 2-foot thick olive gray unit consisting of sand with admixed silt and gravel (GW-GM) was observed at a depth of 20 to 22 feet below grade in Soil Boring G2-202, which is located near the northern perimeter of the proposed on-site disposal cell. This sand unit is believed to be correlative with a 1.5-foot thick sand lens observed at a depth of 24 to 25.5 feet below grade in Soil Boring 3431 (located northeast of the proposed on-site disposal cell), based on similarity of depth. This apparently correlative sand unit, termed the "B" Sand, was not observed in Lysimeter 11130 and Soil Borings 1745, G2-203, and 1750, which are located to the south of the area of Soil Borings G2-202 and 3431.

The "B" Sand unit appears to have a lobate form, elongated in an east-northeast to west-southwest direction. The southern extent of the "B" Sand lens (i.e., in the direction of Soil Boring G2-203) is not well documented due to sparsity of data in this area.

- A 2.5-foot thick sand lens was observed at a depth of 7 to 9.5 feet below grade in Soil Boring 1746. No sands were observed at corresponding depths in surrounding Soil Borings G2-206, G2-208, 1747, G2-205, and G2-203, indicating that this sand, termed the "C" Sand, is of limited areal extent.

The glacial outwash deposits of the Great Miami Aquifer underlie the glacial overburden. The Great Miami Aquifer consists of yellowish to brown fine to medium sand with gravel. The top of the Great Miami Aquifer is encountered approximately 22 to 31 feet below grade at an elevation of approximately 555 feet. The upper portion of the Great Miami Aquifer is unsaturated. Groundwater is encountered 61 to 74 feet below grade at an approximate elevation of 516 feet. Soil Boring 2400, the deepest boring at the site, was terminated 57 feet into the Great Miami Aquifer.

SCALE:

HORIZONTAL 1" = 100'
VERTICAL 1" = 40'

SCALE:

HORIZONTAL 1 cm = 12 m
VERTICAL 1 cm = 4.8 m

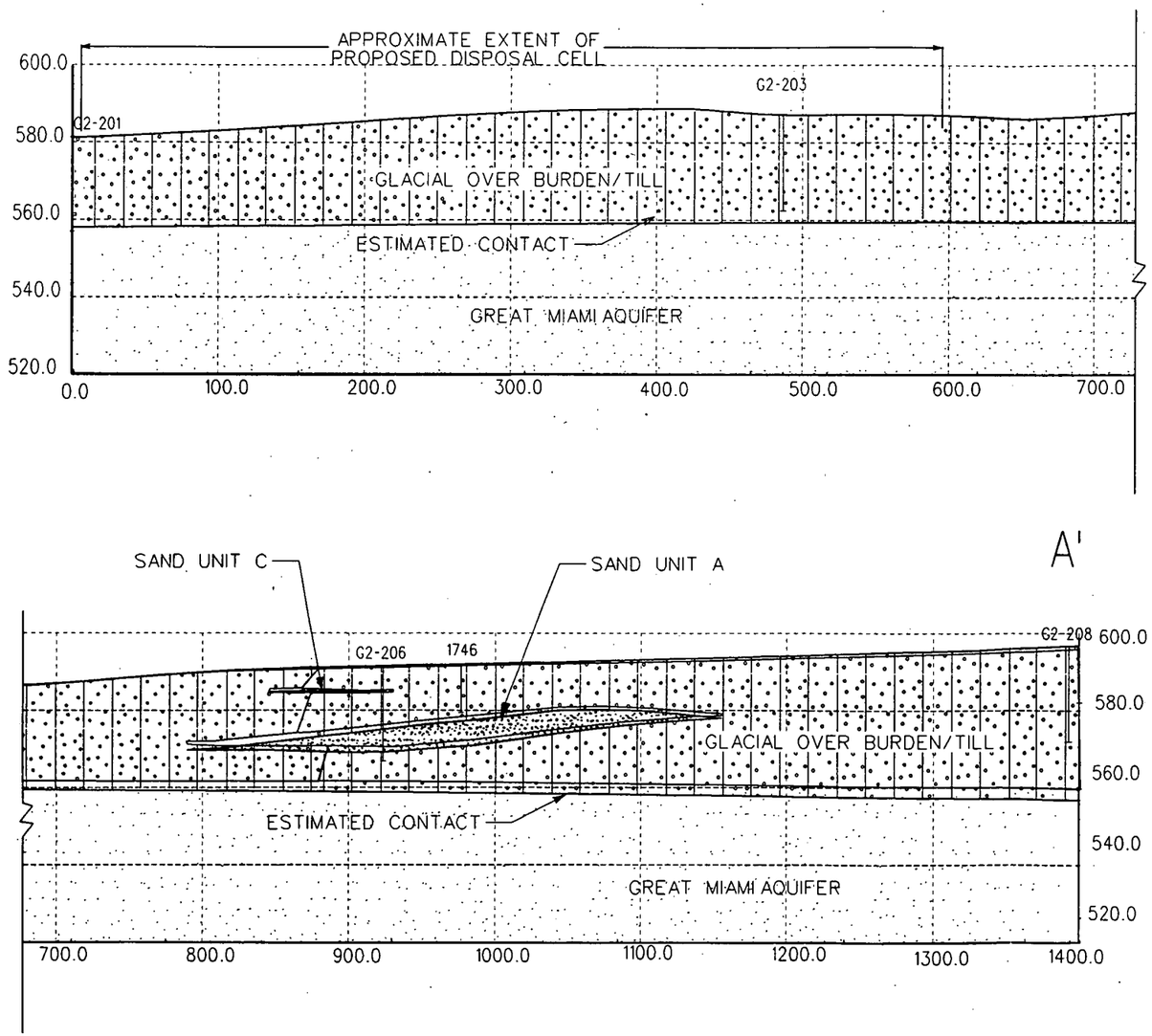
SCALE:

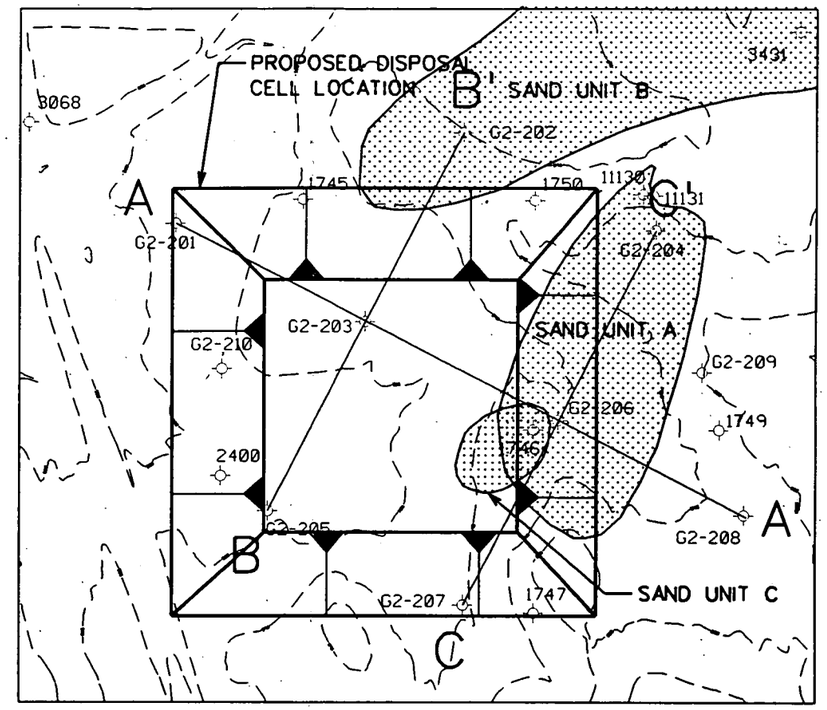
0 50 100 200

SCALE:

0 12 24 48

NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.





LEGEND
- ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
- FENCE
- RAILROAD
- SOIL BORING
- SAND/GRAVEL
- GLACIAL OVERBURDEN/TILL
- GREAT MIAMI AQUIFER

FIGURE E.3.2-1
GEOLOGIC CROSS SECTIONS
ON-SITE DISPOSAL CELL
SHEET 1 OF 3

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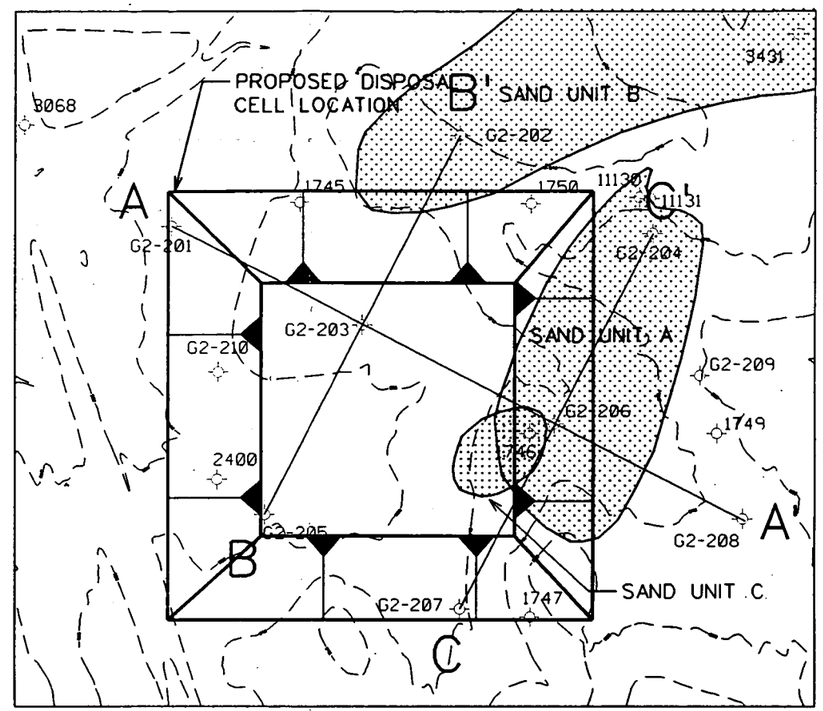
NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.

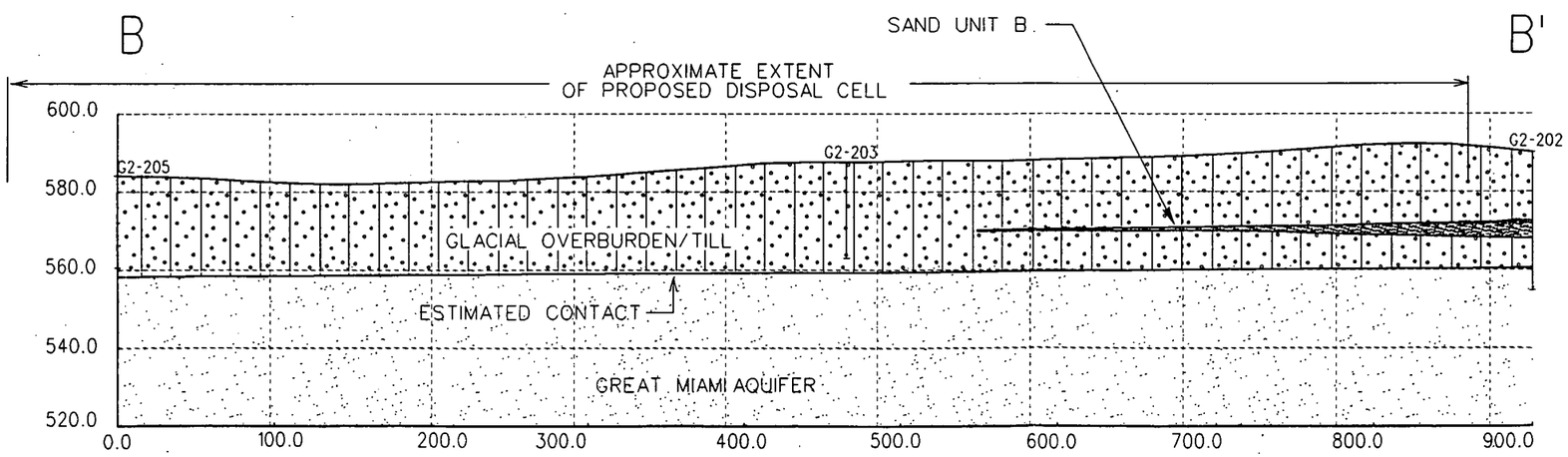
SCALE:
HORIZONTAL 1" = 100'
VERTICAL 1" = 40'

SCALE:
HORIZONTAL 1 cm = 12 m
VERTICAL 1 cm = 4.8 m

SCALE:
0 50 100 200

SCALE:
0 12 24 48





LEGEND
- ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
- FENCE
- RAILROAD
- SOIL BORING
- SAND/GRAVEL
- GLACIAL OVERBURDEN/TILL
- GREAT MIAMI AQUIFER

FIGURE E.3.2-2
GEOLOGIC CROSS SECTIONS
ON-SITE DISPOSAL CELL
SHEET 2 OF 3

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SCALE:

HORIZONTAL 1" = 100'
VERTICAL 1" = 40'

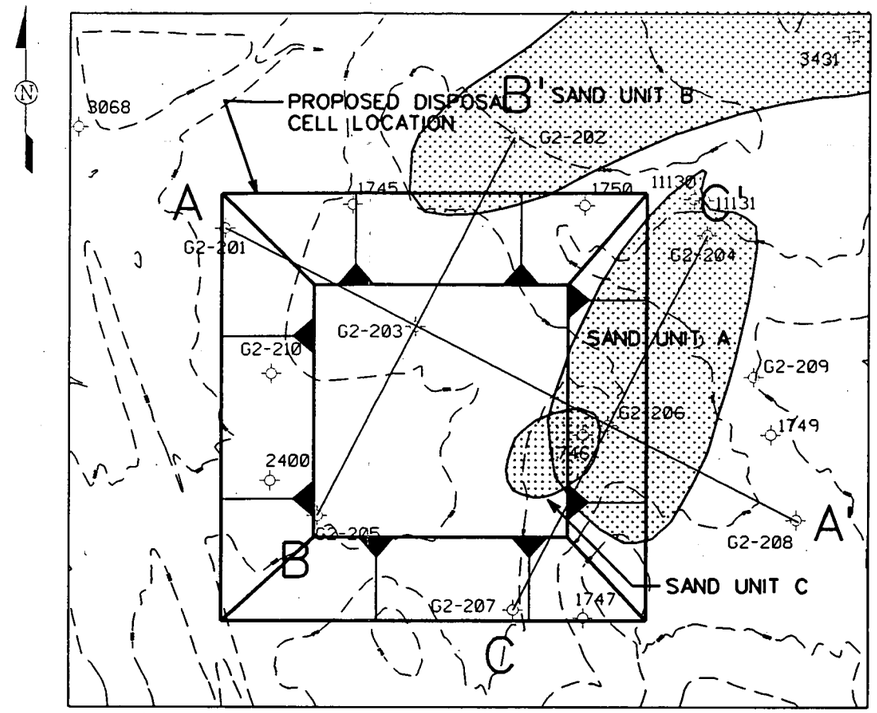
SCALE:
0 50 100 200

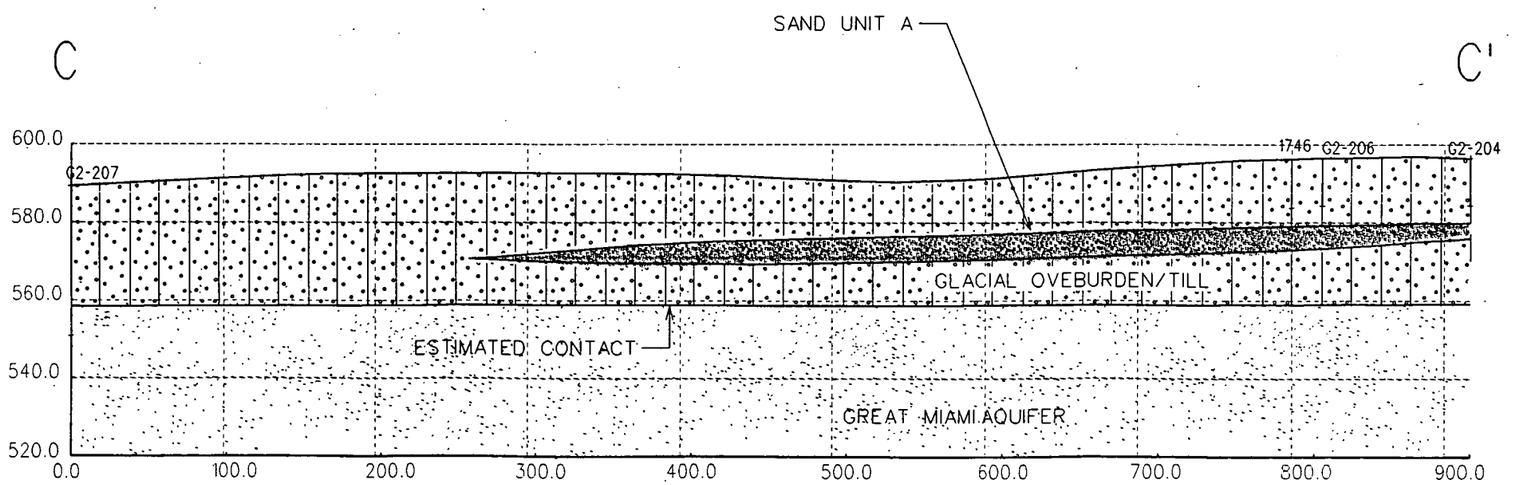
SCALE:

HORIZONTAL 1 cm = 12 m
VERTICAL 1 cm = 4.8 m

SCALE:
0 12 24 48

NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.





LEGEND
- ELEVATION CONTOURS
- ROADS
- STREAM
- BATTERY LIMITS
- FENCE
- RAILROAD
- SOIL BORING
- SAND/GRAVEL
- GLACIAL OVERBURDEN/TILL
- GREAT MIAMI AQUIFER

FIGURE E.3.2-3.
GEOLOGIC CROSS SECTIONS
ON SITE DISPOSAL CELL
SHEET 3 OF 3

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APPENDIX E.3.3

GEOTECHNICAL DATA REPORT AND ADDITIONAL BORING LOGS

On-Site Disposal Cell
Pre-Design Activities Engineering Report

Operable Unit 2
Project Order 101
April 1994
Revision 0

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FERMCO Subcontract No. 2-21487

PARSONS

Fairfield Executive Center
6120 South Gilmore Road
Fairfield, Ohio 45014

APPENDIX E.6.3

ON-SITE DISPOSAL CELL
PRE-DESIGN ACTIVITIES ENGINEERING REPORT

Section	Title	Page
1.0	Introduction	E-6-3-6
2.0	Background	E-6-3-7
3.0	Field Program	E-6-3-9
3.1	Soil Test Borings	E-6-3-9
3.2	Environmental Soil Sampling	E-6-3-12
4.0	Geotechnical Laboratory Testing Program	E-6-3-13
4.1	Laboratory Methods and Procedures	E-6-3-13
4.2	Laboratory Test Results	E-6-3-16
5.0	Environmental Laboratory Testing	E-6-3-35
6.0	Recommendations and Additional Testing	E-6-3-36
6.1	Generalized Site Conditions	E-6-3-36
6.2	Bearing Capacity	E-6-3-36
6.3	Additional Testing	E-6-3-38
7.0	References	E-6-3-39

The entire On-Site Disposal Cell Pre-Design Activities Engineering Report by Parsons has been incorporated into this Appendix (Section E.6.3). The page numbers of the report have been revised accordingly.

CONTENTS (Continued)

APPENDICES

A Boring Logs

B Grain-Size Distribution Curves

C Moisture-Density Relationships

D Mohr Strength Envelopes

E Consolidation Test Results

F Environmental Laboratory Test Results

LIST OF ILLUSTRATIONS

FIGURES

2-1 Site Plan

3-1 Soil Boring Plan

4-1 Plasticity Chart
4-2 Grain-Size Distribution, Fine-Grained Brown Glacial Till CL Samples
4-3 Grain-Size Distribution, Fine-Grained Gray Glacial Till CL Samples
4-4 Remolded Sample Hydraulic Conductivity Results vs. Standard Proctor Compaction Curve
4-5 Behavior of Compacted Cohesive Soils

TABLES

3-1 Field Test Program Soil Borings Depth and Location
3-2 Existing Soil Borings - Depth and Location

4-1 Summary of Geotechnical Laboratory Program
4-2 Summary of Index Properties
4-3 Summary of Unit Weight
4-4 Summary of Standard Proctor Tests
4-5 Summary of Consolidated-Undrained Triaxial Compression Tests
4-6 Summary of Mohr Circle Construction Results
4-7 Summary of Laboratory Permeability Tests
4-8 Summary of Consolidation Tests

6-1 Design Parameters

LIST OF ACRONYMS AND ABBREVIATIONS

ASTM	American Society for Testing and Materials
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
FEMP	Fernald Environmental Management Project
FERMCO	Fernald Environmental Restoration Management Corporation
LL	Liquid Limit
OCR	Overconsolidation Ratio
ODC	On-Site Disposal Cell
OU	Operable Unit
pcf	pounds per cubic foot
PI	Plasticity Index
PL	Plastic Limit
psf	pounds per square foot
SWL	Solid Waste Landfill

SECTION 1

INTRODUCTION

This report presents the results of the subsurface exploration performed to evaluate the subsurface soil conditions at the proposed location for the Operable Unit 2 (OU-2) On-Site Disposal Cell (ODC). The objectives of the subsurface exploration were to (1) characterize the subsurface materials, (2) determine physical and engineering properties of the subsurface soils, and (3) provide geotechnical parameters for subsequent design of the ODC. Limited environmental sampling and testing activities were also performed in conjunction with the geotechnical activities.

The generalized scope of work was as follows:

1) Drill, sample, and test soil at locations around the perimeter of the proposed ODC.

2) Prepare boring logs indicating the subsurface strata and other applicable features.

3) Perform geotechnical laboratory analyses to aid in the classification and determination of engineering properties, including shear strength and consolidation properties, of the subsurface soils.

4) Perform geotechnical evaluations and recommendations to be used for assessment of the slope stability and settlement of the ODC.

5) Prepare a summary of findings, including geotechnical engineering considerations.

The following sections discuss in more detail the scope and methods used for drilling, laboratory analyses, characterization of the subsurface materials, and geotechnical evaluations and recommendations for the design of the ODC.

SECTION 2

BACKGROUND

The alternative remedial concepts being considered by the Fernald Environmental Restoration Management Corporation (FERMCO) include an on-site disposal cell designed for receipt of contaminated materials from the OU-2 subunits (i.e., OU-2 ODC). The proposed disposal cell would be an essentially aboveground, encapsulated containment structure with a soil/geosynthetics composite liner, bio-intrusion barrier with a sacrificial soil erosional layer, and cap.

The proposed site for the OU-2 Disposal Cell is situated at the southeast corner of the Fernald Environmental Management Project (FEMP) as shown in Figure 2-1. The area currently is a gently rolling, grassed field that has no buildings and was not involved in any production activities. The site is bounded by the South Access Road to the west, the North Access Road, and the East Property Line. The parking lot and former production facilities are located north of this area. Drainage from the area is towards the east and progresses to the outfall ditch, which discharges into Paddy's Run. The proposed disposal cell footprint (interior bottom) is approximately 400 feet square. The disposal cell, with its proposed 5 Horizontal to 1 Vertical (5H:1V) outer slopes, occupies approximately 13 acres of land. The perimeter drainage channels could occupy as much as an additional 25 acres around the disposal cell.

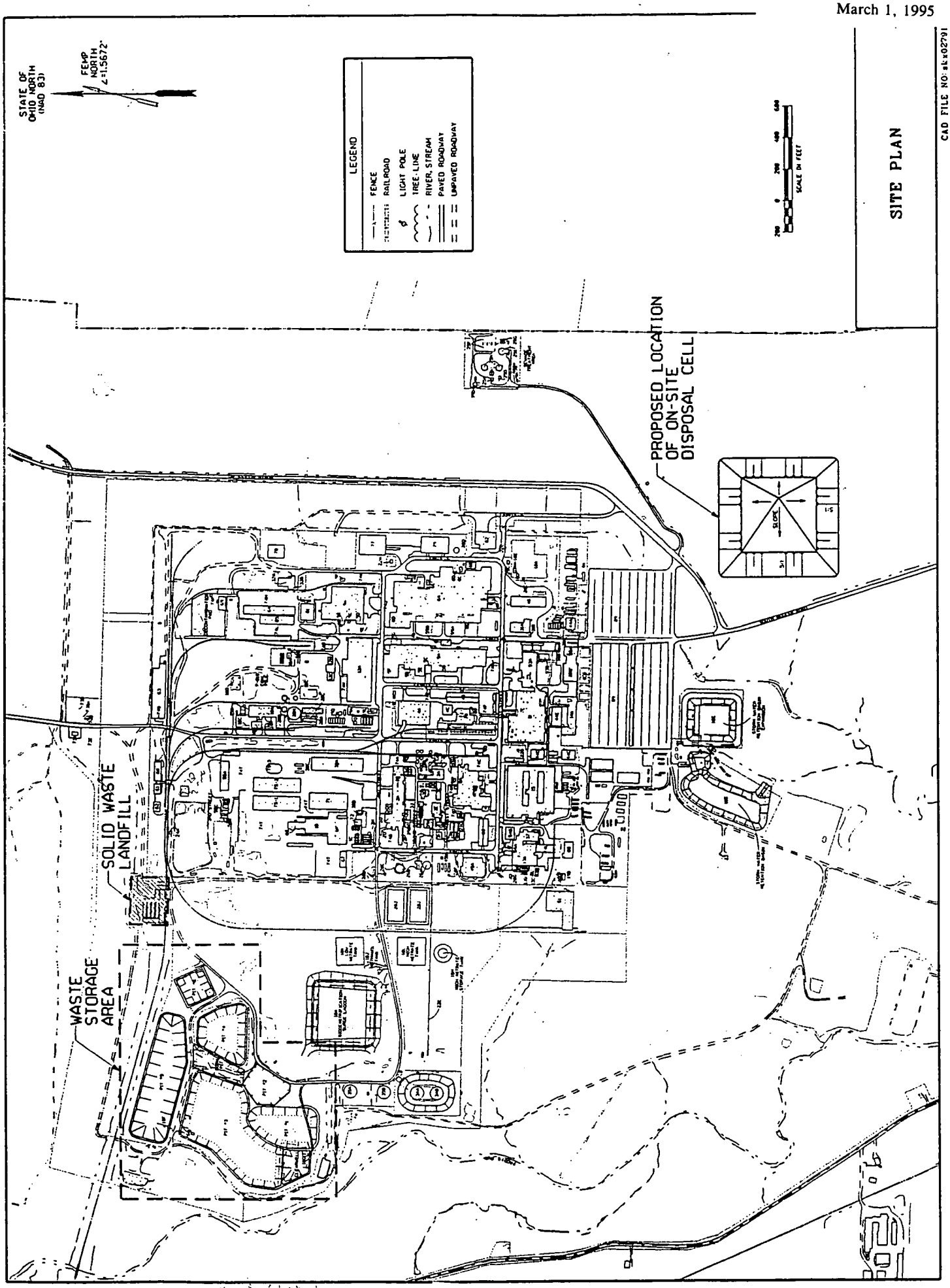


Figure 2-1 - Site Plan

SECTION 3

FIELD PROGRAM

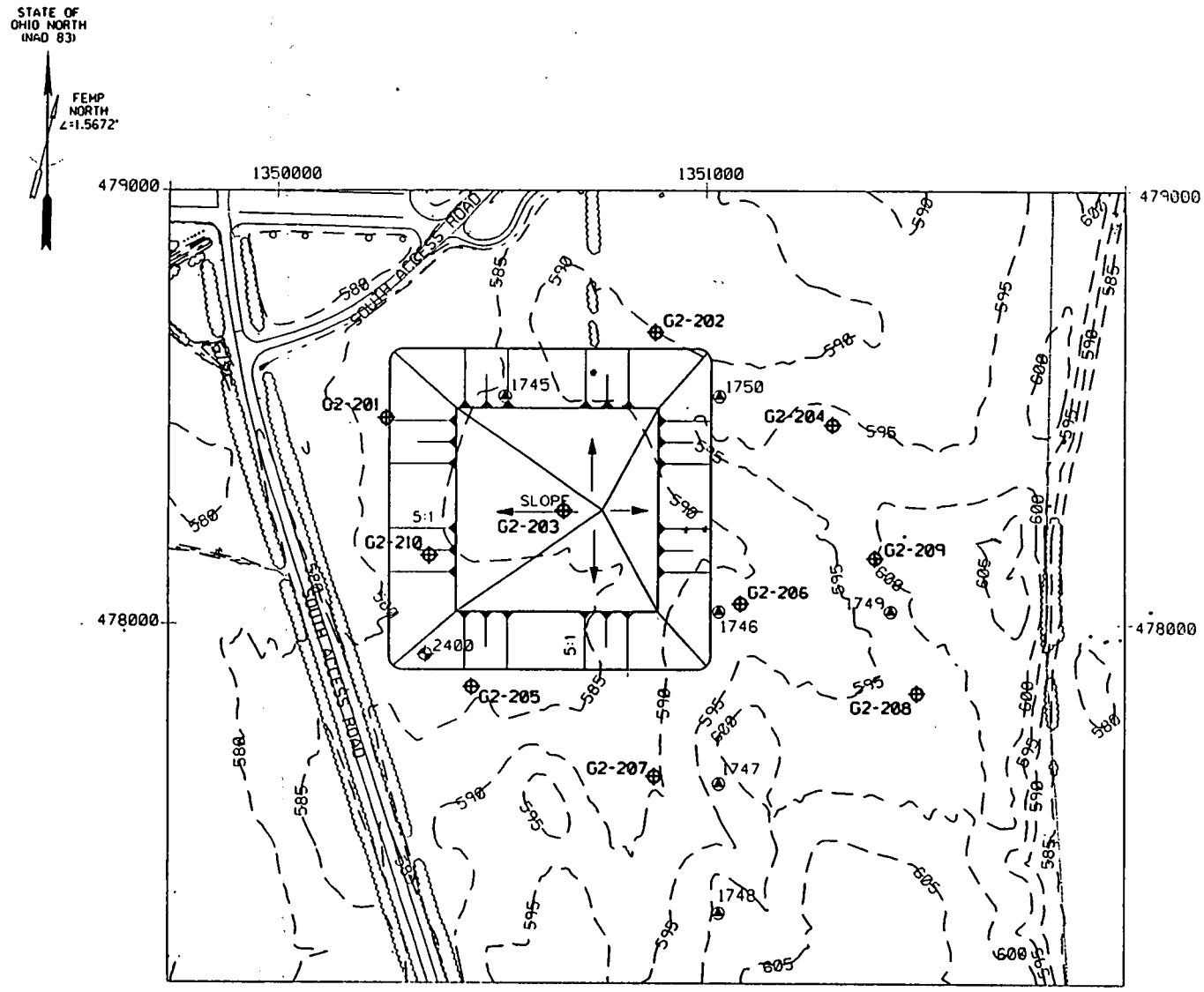
This section describes the geotechnical field test program implemented per the *Solid Waste Landfill and On-Site Waste Disposal Cell Geotechnical Sampling and Testing Plan* (PARSONS 1993) at the proposed ODC site during November and December 1993. In conjunction with the geotechnical field investigation, FERMCO site media sampling technicians collected surface soil samples for environmental analysis.

3.1 Soil Test Borings

Ten soil test borings were advanced at the locations shown on Figure 3-1. The boring locations for Borings G2-201 through G2-208 were established in the field by the survey crew. Locations of Borings G2-209 and G2-210 were established in the field by using the surveyed borehole locations as references. Upon completion of the soil borings, the location and elevation of each were surveyed. All surveying was performed by Woolpert Consultants.

The borings were advanced with 3-1/4-inch inside-diameter, hollow-stem augers to depths of approximately 24.5 feet with the exception of borings G2-202 and G2-207, which were advanced with 4-1/4-inch inside-diameter, hollow-stem augers to depths of approximately 75 feet.

Soil samples were recovered in the undisturbed material below the bottom of the augers using the Standard Method for Penetration Resistance and Split-barrel Sampling (American Society for Testing and Materials [ASTM] D 1586). In lieu of the standard 18-inch interval, the split-barrel sampler was driven 24 inches into the undisturbed material below the augers. Therefore, the standard penetration resistance value (N) is taken as the number of blows required to drive the sampler the middle 12 inches. The split-barrel samples were collected at 2.5-foot intervals to approximate depths of either 20 feet or 24.5 feet. Borings G2-202 and G2-207 were sampled at 5-foot intervals below a depth of 20 feet. Boring G2-209 and G2-210 were augured without sampling. Additional sampling included obtaining relatively undisturbed 3-inch-diameter, thin-walled Shelby tube samples (ASTM D 1587) and bulk samples of the drill cuttings. A summary of the boring depths, sample intervals, elevations, and Ohio State Plane Coordinates for test borings completed during the geotechnical field test program are presented in Table 3-1. Table 3-2 summarizes the coordinates and boring depths of existing borings in the vicinity of the proposed site.



LEGEND	
2400	EXISTING MONITORING WELL
1748	EXISTING SOIL BORING
G2-209	GEOTECHNICAL BORING
600	SURFACE CONTOUR (FT ABOVE MEAN SEA LEVEL)

BORINGS COMPLETED DURING ODC FIELD TEST PROGRAM (P0101)

BORING NO	NORTH	EAST	ELEVATION
G2-201	478479.253	1350255.013	580.567
G2-202	478676.083	1350881.046	590.103
G2-203	478264.290	1350667.588	587.597
G2-204	478463.156	1351295.595	596.152
G2-205	477852.362	1350454.876	583.491
G2-206	478048.670	1351081.497	591.426
G2-207	477646.512	1350879.507	588.990
G2-208	477838.168	1351493.018	596.274
G2-209	478155.044	1351394.371	598.783
G2-210	478161.692	1350355.363	583.181

EXISTING BORINGS

BORING NO	NORTH	EAST	ELEVATION
1745	478529.38	1350531.00	586.00
1746	478029.38	1351031.01	591.80
1747	477629.38	1351031.01	597.40
1748	477329.38	1351031.01	601.00
1749	478029.37	1351431.00	597.50
1750	478529.39	1351031.00	593.00
2400	477928.86	1350346.82	580.70

NOTE: COORDINATES ARE NAD 1983

SCALE IN FEET

ON-SITE DISPOSAL CELL SOIL BORING PLAN

CAD FILE NO: ak02792

Figure 3-1 - Soil Boring Plan

ERAFS1\VOL1:RSAPPS\RSDATA\

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Table 3-1 - Field Test Program Soil Borings Depth and Location

Boring No.	Coordinates (NAD[1] 1983)		Coordinates (NAD 1927)		Ground Surface Elevation (feet)	Depth of Boring (feet)	Split-Spoon Samples	Shelby Tubes
	Northing	Easting	Northing	Easting				
G2-201	478479.25	1350255.01	478449.83	1381723.93	580.57	24.5	5	5
G2-202	478676.08	1350881.05	478646.65	1382349.97	590.10	75.0	15	5
G2-203	478264.29	1350667.59	478234.86	1382136.51	587.60	24.5	5	5
G2-204	478463.15	1351295.60	478433.71	1382764.52	596.15	24.2	5	5
G2-205	477852.36	1350454.88	477822.93	1381923.79	583.49	23.7	5	5
G2-206	478048.67	1351081.50	478019.24	1382550.42	591.43	24.5	5	5
G2-207	477646.51	1350879.51	477617.08	1382348.42	589.00	77.0	16	5
G2-208	477838.17	1351493.02	477808.73	1382961.93	596.27	24.2	5	5
G2-209	478155.04	1351394.37	478125.60	1382863.29	598.78	25	0	0
G2-210	478161.69	1350355.36	478132.27	1381824.28	583.18	25	0	0

(1) NAD: North American Datum

Table 3-2 - Existing[2] Soil Borings - Depth and Location

Boring No.	Coordinates (NAD[1] 1983)		Coordinates (NAD 1927)		Ground Surface Elevation (feet)	Depth of Boring (feet)
	Northing	Easting	Northing	Easting		
1745	478529.38	1350531.00	478500.00	1382000.00	586.00	27.0
1746	478029.38	1351031.01	478000.00	1382500.00	591.80	12.5
1747	477629.38	1351031.01	477600.00	1382500.00	597.40	21.5
1748	477329.38	1351031.01	477300.00	1382500.00	601.00	32.0
1749	478029.37	1351431.00	478000.00	1382900.00	597.50	30.0
1750	478529.39	1351031.00	478500.00	1382500.00	593.00	30.0
2400	477928.86	1350346.82	477899.48	1381815.81	580.70	81.5

(1) NAD: North American Datum
(2) Soil borings completed prior to November 1993 in conjunction with FEMP Remedial Investigation and Feasibility Study

During drilling a geologist was on site to visually classify the soil samples, log the borings, and record water levels if groundwater was encountered. During sampling activities, FERMCO Environmental Monitoring Technicians screened the soil samples and drill cuttings for volatile organics and radiation with hand-held instruments. Screening readings for organics and beta/gamma radiation were at or below background levels.

Boring logs are presented in Appendix A. Underlying materials investigated and sampled broadly consist of varying mixtures of fine-grained and coarse-grained soils typical of glacial till deposits. Fine-grained soils are predominantly clay, whereas coarse-grained soils are predominantly silty and clayey sand. Directly below the till are sands and gravels of the Great Miami Aquifer. Borings G2-202 and G2-207 encountered the sands and gravels of the Great Miami Aquifer at depths of approximately 29.5 and 30.5 feet, respectively. For purposes of description in this report, the glacial till at the proposed site is discussed in two broad categories: (1) brown glacial till and (2) gray glacial till. As shown in the boring logs, the brown till overlays the gray till. Additionally, following the method of ASTM D 2487, the glacial till samples collected and tested are classified as fine-grained soil if 50 percent or more of the material passed the No. 200 sieve (.075 mm), or coarse-grained soil if more than 50 percent is retained on the No. 200 sieve.

Steam cleaning of drilling equipment and tools associated with drilling operations was performed prior to arrival at the site to avoid contamination of soils and/or groundwater from off-site sources. Within the same boring, the sampling devices were rinsed between samples by FERMCO site media sampling technicians.

Upon completion of each boring, the soil test borings were backfilled throughout the entire length of the boring with cement-bentonite grout. Borings G2-202 and G2-207 which extended into the Great Miami Aquifer were grouted with an expansive grout using C150 Type K Portland Cement (ASTM D 5299).

3.2 Environmental Soil Sampling

The environmental field work consisted of collecting surface soil samples in the immediate vicinity of each of the soil test borings. A total of eight surface soil samples were collected to be analyzed for herbicide and pesticide contamination. The surface soils were collected by FERMCO Environmental Sampling Technicians, using FERMCO sampling procedures per the *Sitewide CERCLA Quality Assurance Project Plan* (DOE 1993).

SECTION 4

GEOTECHNICAL LABORATORY TESTING PROGRAM

This section summarizes the results of geotechnical laboratory tests performed on subsurface soil samples collected during the ODC field program. Geotechnical laboratory testing was performed by Advanced Terra Testing, Inc., in Lakewood, Colorado, from December 1993 through March 1994. The laboratory data sheets from this testing are compiled in a two-volume reported entitled *On-Site Waste Disposal Cell Soil Investigation Data Report* (SAIC 1994).

4.1 Laboratory Methods and Procedures

The laboratory testing program was directed toward the classification of the in situ soils and determining their engineering properties. A variety of index tests were performed on selected samples to aid in soil classification and to extend the utility of the more sophisticated strength and permeability tests. Table 4-1 presents a list of the number of tests performed and the laboratory test methods. The laboratory testing was performed on split-spoon samples (disturbed sample), bulk samples (collected from auger cuttings), and Shelby tube samples (relatively undisturbed samples) obtained during the field exploration program. A PARSONS geotechnical engineer assigned laboratory tasks after reviewing the field boring logs and sample recovery. Prior to sample shipment to the geotechnical laboratory, alpha/beta screenings with laboratory counting equipment were performed at the FERMCO Sample Processing Lab on portions of the samples collected by the Site Media Sampling technicians. Upon completion of the alpha/beta screenings, the samples were packaged and shipped to Advanced Terra Testing, Inc., in Lakewood, Colorado, for geotechnical laboratory testing.

4.1.1 Water Content (ASTM D 2216)

The natural water (moisture) content of a soil is calculated by determining the mass of water removed by drying the moist material test specimen to a constant mass in a drying oven controlled at 110 ± 5 degrees C. The water content is then given as the mass of water in the test specimen divided by the mass of the solids remaining.

4.1.2 Liquid Limit, Plastic Limit, and Plasticity Index (ASTM D 4318)

The liquid and plastic limits are used for identification and classification. These tests are performed on material that passes through a No. 40 sieve (0.425 mm). The liquid limit (LL) is calculated by determining the water content at which a standard 1/2-inch wide groove cut in a pat of soil placed in a standard cup will flow together at 25 blows of the cup being dropped 1 centimeter. Similarly, the plastic limit (PL) is the water content at which a soil can no longer be deformed by rolling into 1/8-inch

diameter threads without crumbling. The Plasticity Index (PI) is calculated as the difference between the liquid limit and the plastic limit (PI = LL - PL).

Table 4-1 - Summary of Geotechnical Laboratory Program

Test Method	Title	Number Performed
ASTM D 2216	Method for Laboratory Determination of Water content of Soil, Rock, and Soil-Aggregate	30(2)
ASTM D 4318	Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils	35
ASTM D 422	Method for Particle-Size Analysis of Soils	37
ASTM D 854	Test Method for Specific Gravity of Soils	37(1)
ASTM D 698	Test Method for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures Using 5.5-lb Hammer and 12-in. Drop	4
ASTM D 5084	Standard Test Method for Measurement of Hydraulic Conductivity of Saturated Porous Materials Using a Flexible Wall Permeameter	6
ASTM D 4767	Test Method for Consolidated Undrained Triaxial Compressive Strength Test on Cohesive Soils	10
ASTM D 2435	Test Method for One-Dimensional Consolidation Properties of Soil	3

(1) Specific gravity tests were performed in conjunction with hydrometer (i.e., grain-size analyses) and consolidation tests.

(2) Additional moisture contents were determined in conjunction with permeability, consolidation, and triaxial compression tests.

4.1.3 Particle-Size Analysis (ASTM D 422)

A quantitative determination of the distribution of the particle sizes in soils is obtained by this test. the distribution of the particle sizes larger than the No. 200 sieve (0.075 mm) is determined by passing the material through a stack of progressively smaller-sized sieves. The distribution of particle sizes smaller than the No. 200 sieve is determined by a sedimentation process, using a hydrometer.

4.1.4 Specific Gravity of Soils (ASTM D 854)

The specific gravity of soils finer than the No. 4 sieve (4.75 mm) is determined using a pycnometer. Specific gravity is calculated as the ratio of the mass of a unit volume of a material at a stated temperature to the mass in air of the same volume of gas-free distilled water at a stated temperature.

4.1.5 Moisture -Density Relationships (ASTM D 698)

Standard Proctor compaction tests are used to determine the relationship between the moisture content and density of soils. The soil is compacted in a mold having a capacity of 1/30 cubic foot. The results of these tests are generally used to determine the extent to which the material should be compacted and the degree of drying/wetting required during earthwork operations.

For a Standard Proctor test, the soil is mixed with varying amounts of water and then compacted in three equal layers by a hammer that weighs 5.5 pounds. The hammer is used to deliver 25 blows to each layer with a drop of 12 inches.

4.1.6 Permeability Tests (ASTM D 5084)

The permeability of fine-grained soils (fine sands to fat clays) is determined by the falling-head type test where the head of the inflow water is allowed to fall during the test. The specimen can be enclosed in a thin flexible rubber membrane under a constant confining pressure or in a metal or polyvinyl chloride fixed wall mold. The sample is completely saturated prior to permeation. The test is terminated when the sample has reached equilibrium (i.e., the measured coefficient of permeability is approximately constant for a period of at least 48 hours).

4.1.7 Consolidated-Undrained Triaxial Compression Test (ASTM D 4767)

This test method covers the determination of strength and stress-strain relationships for a soil specimen either in undisturbed or remolded state. The soil specimen is enclosed in a thin rubber membrane and is then saturated under back pressure. The sample is then allowed to drain under a constant confining pressure usually equal to the effective overburden pressure. At the end of the consolidation phase, the specimen is axially loaded to failure at a nearly constant rate of strain with pore-pressure measurements. No drainage is permitted during axial loading. The axial load is applied to the specimen using a rate of strain that will produce approximate equalization of pore pressures throughout the specimen at failure.

The tests are typically performed on three specimens under different confining pressures to develop Mohr strength envelopes. The shear strength parameters, cohesion, and internal friction angle are then estimated from the Mohr strength envelopes.

4.1.8 Incremental Consolidation Test (ASTM D 2435)

The rate and magnitude of the consolidation of the soils is determined by the incremental consolidation test. The data from the consolidation test can be used to develop an estimate of both differential and total settlement of a structure or landfill. In this test, a specimen of undisturbed cohesive soil is trimmed to fit inside a rigid ring with a height of 0.75 inches and 2.5-inch diameter. Porous discs are placed on the exposed ends of the specimen and the entire assembly is immersed in water. Increments of vertical loads are then applied to the specimen through a loading head on the top porous disc.

The change in thickness of the specimen is observed and recorded at selected time intervals. The sample is permitted to consolidate completely under each load increment before application of the next load. After consolidation due to final loading has occurred, loads are removed incrementally and the change in sample height due to rebound is measured and recorded. The results of the tests are presented as curves of percent vertical strain versus applied vertical effective pressure. This test method also provides data to determine the preconsolidation pressure (the maximum pressure to which the soil was ever subjected in the past) and the rate at which compression can occur.

4.2 Laboratory Test Results

Specific laboratory testing was conducted to determine the physical properties and engineering characteristics of the subsurface soils. Index properties are used to classify soils, to group soils in major strata, to obtain estimates of physical properties, and to correlate the results of physical property tests in one portion of a stratum with other portions of the same stratum or other similar soils where only index test data are available. Physical properties such as undrained shear strength and consolidation characteristics provide data for use in bearing capacity, stability, and settlement calculations.

4.2.1 Index/Classification Tests

The natural moisture content was determined as routine parts of test procedures for strength, consolidation, and permeability. Additional moisture tests were performed on selected samples to complete soil moisture profiles of the borings. Table 4-2 presents a summary of the natural moisture content test results along with the LL, PL, PI, grain-size, and specific gravity of the soil. For the samples tested, the moisture content of the soil samples of brown glacial till ranged from 8 percent to 26 percent with an average value of about 16 percent. The moisture content of the gray glacial till samples tested ranged from 9 percent to 14 percent with an average value of 13 percent. The average natural moisture content for both the brown and gray glacial till are higher than the optimum moisture content of 12.3 percent determined from Standard Proctor Compaction tests (see Subsection 4.2.2.).

Table 4-2 - Summary of Index Properties

Boring No.	Sample No.	Depth (feet)	Description[6]	USCS Symbol[6]	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Grain Size				Specific Gravity
									% Gravel	% Sand	% Silt	% Clay[7]	
G2-201	2	2.5-4.5	Yellowish Brown Lean Clay	CL	19[2]	49	18	31	0	3	49	48	2.70
G2-201	4	7.5-9.5	Yellowish Brown Lean Clay	CL	16	30	17	13	2	10	46	42	2.73
G2-201	7	15-17	Gray Sandy Lean Clay[1]	CL[1]	13	NA	NA	NA	NA	NA	NA	NA	NA
G2-201	9	20-22	Gray Sandy Lean Clay[1]	CL[1]	14	NA	NA	NA	NA	NA	NA	NA	NA
G2-201	10	22.5-24.5	Gray Sandy Lean Clay	CL	13[2]	24	14	10	8	29	39	24	2.75
G2-202	1	0-2	Brown Sandy Lean Clay[1]	CL[1]	25	NA	NA	NA	NA	NA	NA	NA	NA
G2-202	3	5-7	Yellowish Brown Sandy Silty Clay	CL-ML	13	20	14	6	10	29	43	18	2.85
G2-202	4	7.5-9.5	Yellowish Brown Sandy Lean Clay	CL	14[2]	27	15	12	10	25	38	27	2.81
G2-202	5	10-12	Yellowish Brown Sandy Lean Clay	CL	12	25	14	11	7	24	42	27	2.84
G2-202	7	15-17	Gray Sandy Lean Clay	CL	14	25	14	11	10	25	39	26	2.81
G2-202	9	20-22	Gray Silty Gravel with Sand	GM[1]	NA	NA	NA	NA	40	38	17	5	2.80
G2-203	5	10-12	Yellowish Brown Clayey Sand with Gravel	SC	8	21	13	8	18	41	26	15	2.74
G2-203	7	15-17	Yellowish Brown Sandy Lean Clay	CL	17	28	16	12	7	27	39	27	2.76
G2-203	8	17.5-19.5	Yellowish Brown Sandy Lean Clay	CL	17[3]	27	16	11	7	31	32	30	2.74
G2-203	9	20-22	Gray Sandy Lean Clay	CL	12	21	13	8	5	35	39	21	2.77
G2-203	10	22.5-24.5	Gray Sandy Lean Clay	CL	14[4]	23	14	9	7	28	40	25	2.79
G2-204	1	0-2	Brown Sandy Lean Clay[1]	CL[1]	19	NA	NA	NA	NA	NA	NA	NA	NA
G2-204	4	7.5-9.5	Yellowish Brown Sandy Lean Clay	CL	14[4]	27	15	12	6	26	39	29	2.74
G2-204	6	12.5-14.5	Gray Lean Clay with Sand	CL	13[2]	24	14	10	4	25	44	27	2.76
G2-204	7	15-17	Gray Sandy Lean Clay	CL	10	25	14	11	4	26	45	25	2.74
G2-204	8	17.5-19.5	Gray Silty Sand	SM	9	13	12	1	8	51	32	9	2.78

Table 4-2 - Summary of Index Properties (Continued)

Boring No.	Sample No.	Depth (feet)	Description[6]	USCS Symbol[6]	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Grain Size				Specific Gravity
									% Gravel	% Sand	% Silt	% Clay[7]	
G2-204	9	20-22	Gray Sandy Lean Clay[1]	CL[1]	12	NA	NA	NA	NA	NA	NA	NA	NA
G2-204	10	22.5-24.5	Gray Sandy Lean Clay	CL	12[3]	24	14	10	7	29	38	26	2.78
G2-205	2	2.5-4.5	Yellowish Brown Lean Clay	CL	11[3]	41	23	18	1	12	51	36	2.68
G2-205	3	5-7	Yellowish Brown Lean Clay[1]	CL[1]	12	NA	NA	NA	NA	NA	NA	NA	NA
G2-205	5	10-12	Yellowish Brown Sandy Lean Clay	CL	14	28	16	12	10	25	38	27	2.79
G2-205	8	17.5-19.5	Gray Sandy Lean Clay	CL	13[2]	23	14	9	16	27	37	20	2.77
G2-206	1	0-2	Grayish Brown Lean Clay with Sand[1]	CL[1]	20	NA	NA	NA	NA	NA	NA	NA	NA
G2-206	2	2.5-4.5	Yellowish Brown Lean Clay with Sand	CL	11[4]	35	17	18	5	19	41	35	2.76
G2-206	3	5-7	Yellowish Brown Lean Clay with Sand[1]	CL[1]	13	NA	NA	NA	10	18	35	37	2.76
G2-206	4	7.5-9.5	Yellowish Brown Sandy Lean Clay	CL	14[3]	28	15	13	9	23	38	30	2.75
G2-206	5	10-12	Yellowish Brown Sandy Lean Clay	CL	14	26	15	11	8	28	38	26	2.76
G2-206	6	12.5-14.5	Yellowish Brown Lean Clay With Sand[1]	CL[1]	12	NA	NA	NA	NA	NA	NA	NA	NA
G2-206	7	15-17	Gray Sandy Lean Clay	CL	12	22	13	9	6	33	39	22	2.73
G2-206	8	17.5-19.5	Gray Silty Sand [1]	SM[1]	13	NA	NA	NA	NA	NA	NA	NA	NA
G2-206	10	22.5-24.5	Gray Sandy Lean Clay	CL	13[2]	25	15	10	7	28	41	24	2.73
G2-207	1	0-2	Brown Sandy Lean Clay[1]	CL[1]	25	NA	NA	NA	NA	NA	NA	NA	NA
G2-207	5	10-12	Yellowish Brown Sandy Lean Clay	CL	13	26	16	10	6	27	40	27	2.83
G2-207	11	25-27	Gray Sandy Silty Clay	CL-ML	14	19	13	6	16	32	38	14	2.81
G2-208	2	2.5-4.5	Yellowish Brown Lean Clay	CL	23[2]	44	20	24	0	2	63	35	2.76
G2-208	3	5-7	Yellowish Brown Sandy Lean Clay	CL	26	40	17	23	1	29	39	31	2.74
G2-208	4	7.5-9.5	Yellowish Brown Sandy Lean Clay	CL	17[2]	31	15	16	1	30	42	27	2.76

Table 4-2 - Summary of Index Properties (Continued)

Boring No.	Sample No.	Depth (feet)	Description[6]	USCS Symbol[6]	Moisture Content (%)	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI)	Grain Size				Specific Gravity
									% Gravel	% Sand	% Silt	% Clay[7]	
G2-208	5	10-12	Gray Sandy Lean Clay[1]	CL[1]	13	NA	NA	NA	NA	NA	NA	NA	NA
G2-208	9	20-22	Gray Sandy Lean Clay	CL	13	24	14	10	6	33	39	22	2.80
G2-209	BULK	0-25	Brown and Gray Sandy Lean Clay	CL	6[5]	28	13	15	3	27	40	30	2.80
G2-210	BULK	0-25	Brown and Gray Lean Clay with Sand	CL	7 [5]	28	14	14	3	22	44	31	2.76
G2-201 G2-202 G2-203 G2-204	BULK	0-24.5	Brown and Gray Lean Clay with Sand	CL	N/A	27	15	12	3	25	44	28	2.79
G2-205 G2-206 G2-207 G2-208	BULK	0-24.5	Brown and Gray Sandy Lean Clay	CL	NA	27	14	13	3	27	42	28	2.81

NA Not Analyzed
(1) Visual Classification
(2) Average moisture content from CU triaxial test specimens
(3) Moisture content from permeability test specimen
(4) Moisture content from consolidation test specimen
(5) Moisture content of auger cuttings; not representative of natural moisture content
(6) Description (excluding color) and USCS symbol assigned per ASTM D 2487 based on laboratory grain-size analyses (ASTM D 422) and plasticity tests (ASTM D 4318) except as noted (see Note 1).
(7) Clay size particles defined as those smaller than 0.005 mm (reference ASTM D 422)

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Plastic and liquid limits, collectively termed Atterberg Limits, were determined for 35 samples to provide classification information. Table 4-2 summarizes the Atterberg Limit results. Figure 4-1 presents a Plasticity Chart with LL and PI results for the fine-grained (50 percent or more passing the No. 200 sieve) glacial till samples.

The plasticity chart indicates that the fine-grained samples of both the brown and gray glacial till predominantly classify as CL in accordance with ASTM D 2487 (Unified Soil Classification System). The liquid limit for fine-grained samples of brown glacial till ranged from 20 to 49, with an average of 31; and that of the fine-grained gray glacial till ranged from 13 to 25, with an average of 23. Similarly, the plasticity indices of the fine-grained brown glacial till samples ranged from 6 to 31, with an average of 15; and that of the fine-grained gray glacial till samples ranged from 9 to 11, with an average of 9.

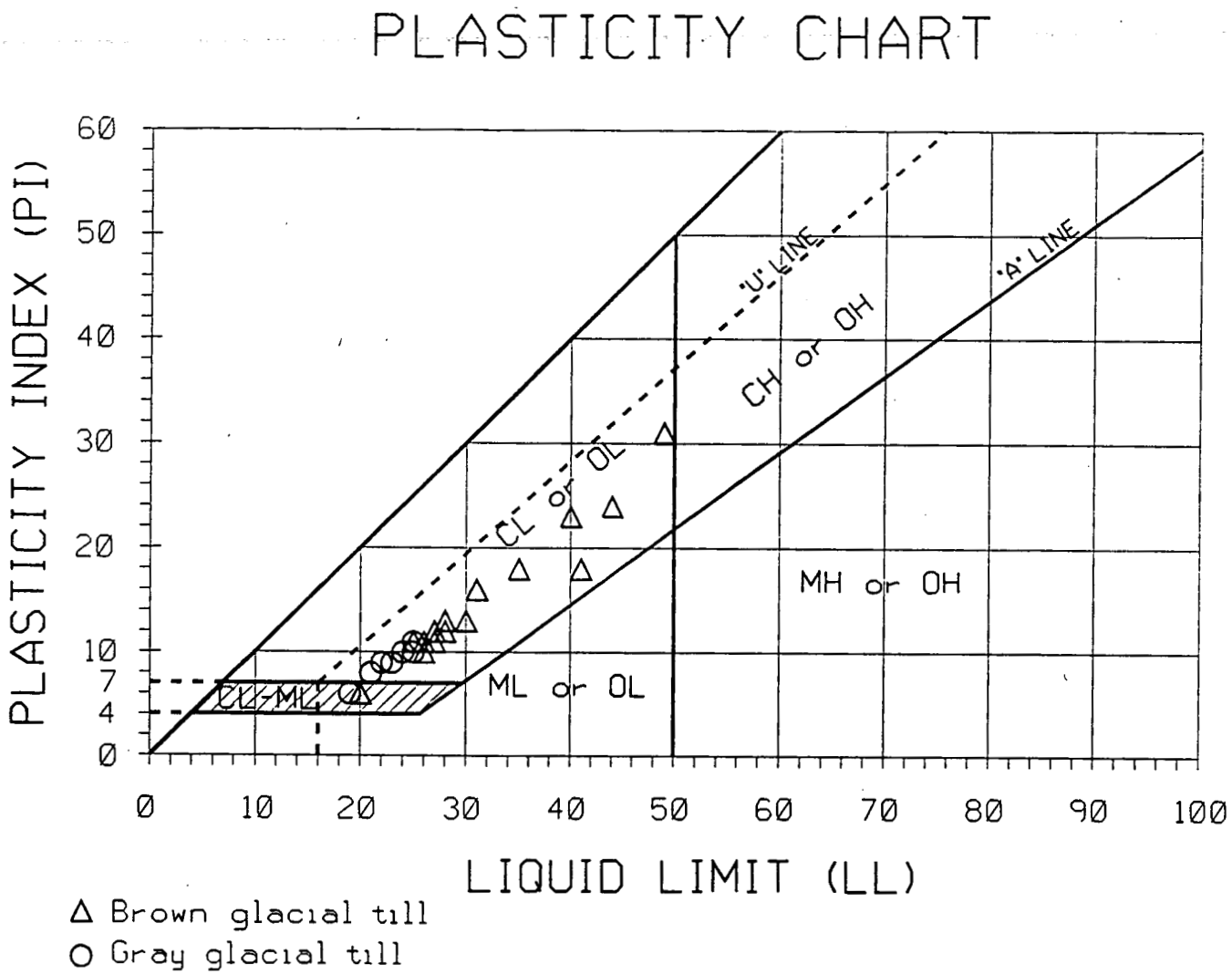
Figure 4-2 presents a generalized summary of the grain-size distribution of the fine-grained CL soil samples from the brown glacial till. The grain-size distribution tests indicate that the fine-grained CL brown glacial till samples consist predominantly of silt-size particles. The grain-size distribution analyses show that about 62 percent to 98 percent by weight of the brown glacial till classifying as CL passes the No. 200 sieve, with the majority of the particles falling within the silt-size range (0.005 to 0.074 mm). Figure 4-3 presents a generalized summary of the grain-size distribution of the fine-grained CL gray glacial till soil samples. The grain-size analyses for these soil samples classifying as CL show that about 57 percent to 71 percent of this material by weight passed the No. 200 sieve. About 37 percent to 45 percent of the material fell within the silt size range for the gray glacial till samples.

Two fine-grained samples were classified as CL-ML. A fine-grained brown glacial till sample from Boring G2-202 (5-7 feet) were classified as CL-ML as was a fine-grained gray glacial till sample from Boring G2-207 (25-27 feet).

Four samples were classified as coarse-grained (more than 50 percent retained in the No. 200 sieve). Samples from Boring G2-204 (17.5-19.5 feet) and Boring G2-206 (17.5-19.5 feet) were classified as silty sand (SM). A sample from G2-202 (20-22 feet) was classified as a silty gravel with sand (GM). These three samples were within the gray glacial till. A sample from within the brown glacial till, G2-203 (5-7 feet), was classified as a clayey sand with gravel (SC).

Appendix B presents individual grain-size distribution curves.

Specific gravity tests were performed on samples of both the brown and gray glacial tills. The average specific gravity of the brown till was 2.76 and the average specific gravity of the gray till was 2.77. Table 4-2 presents the results of specific gravity tests.



Source of Chart: ASTM D 2487

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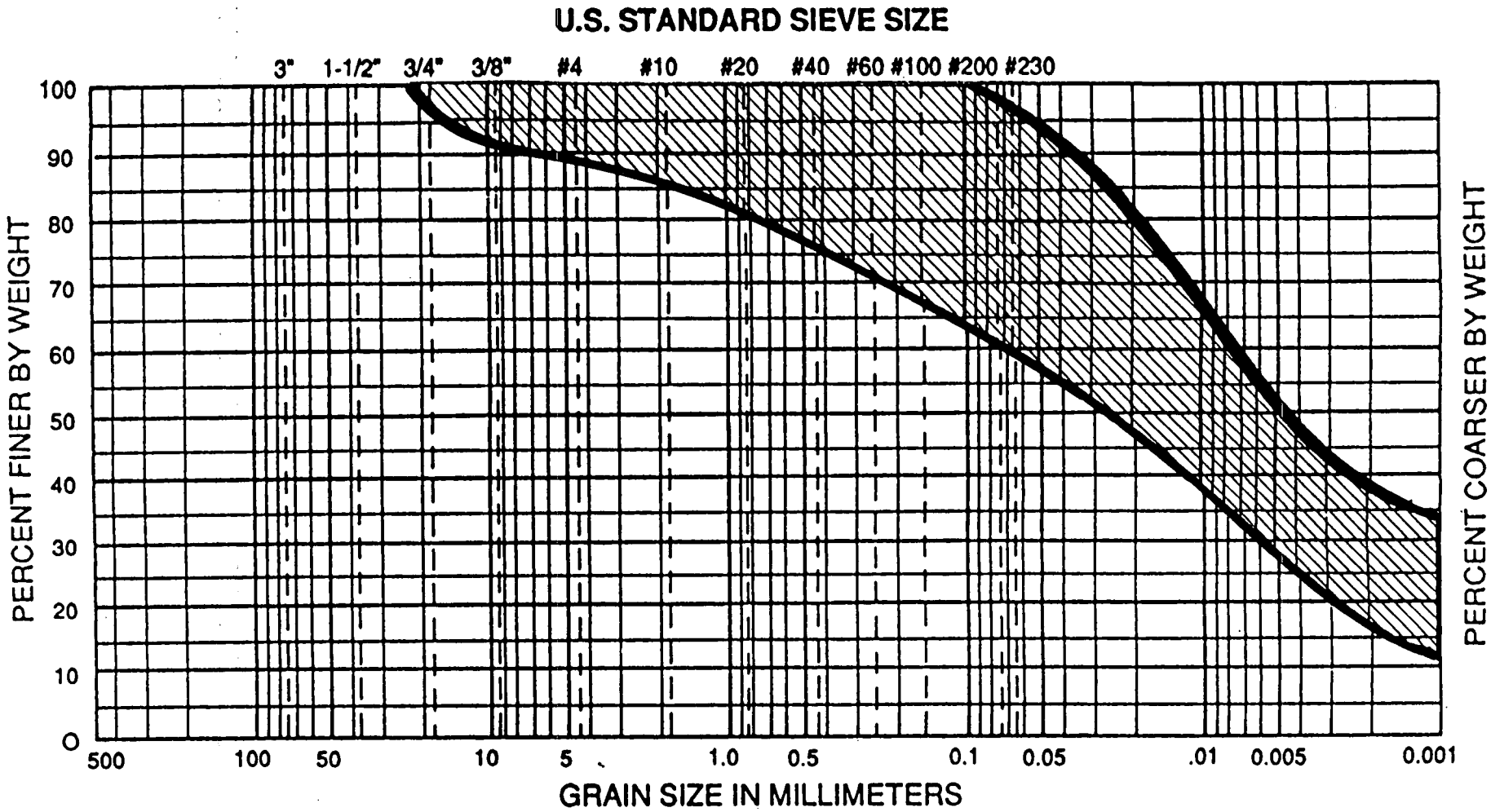
Figure 4-1 - Plasticity Chart

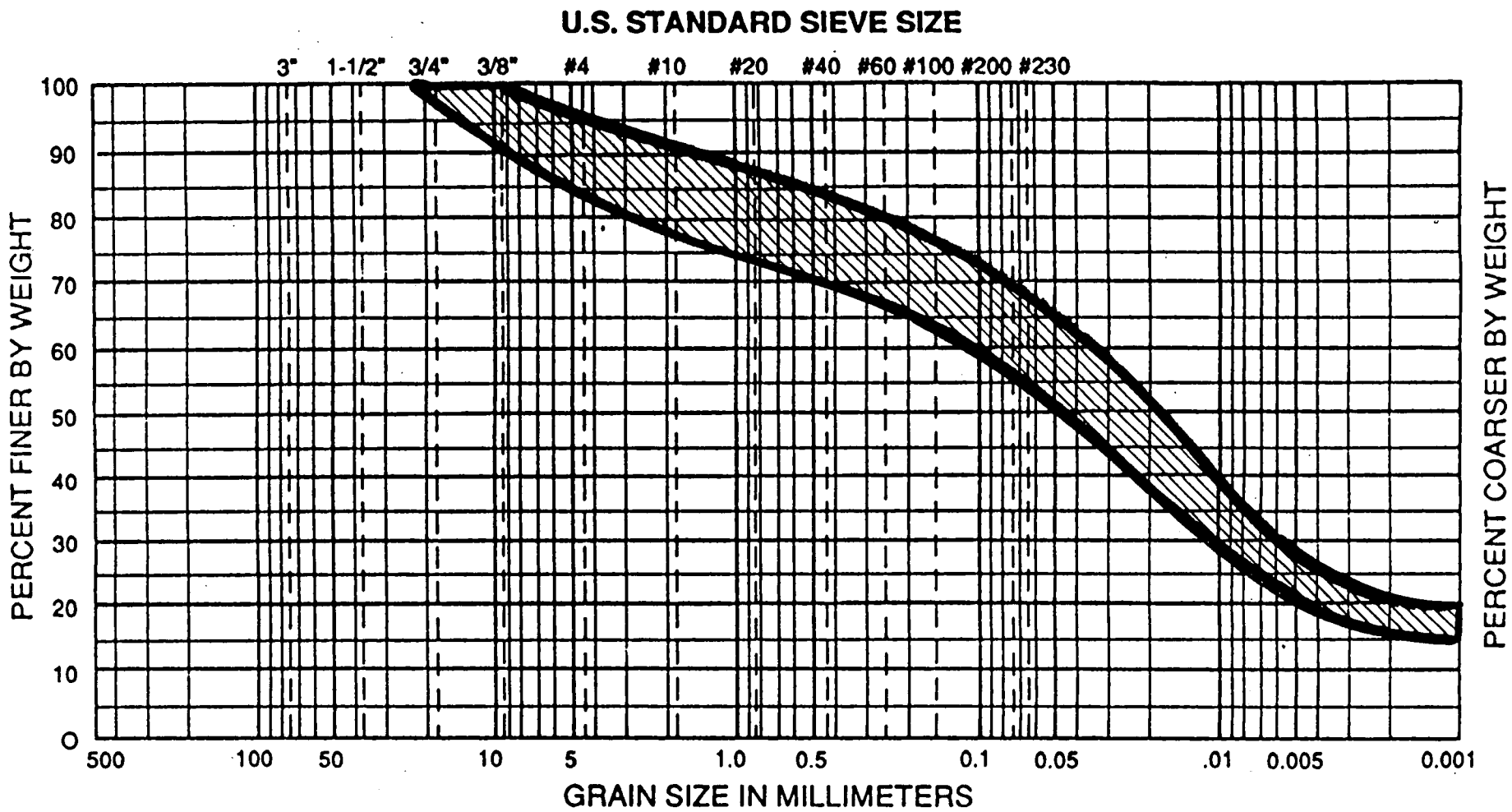


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

PROJECT NO.: PO-101

Figure 4-2 - Grain-Size Distribution, Fine-Grained Brown Glacial Till CL Samples



ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

PROJECT NO.: PO-101

Figure 4-3 - Grain-Size Distribution, Fine-Grained Gray Glacial Till CL Samples

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March 1, 1995
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The total and dry unit weight of the soils were determined in conjunction with other laboratory tests (i.e., consolidation, permeability, and triaxial shear tests) and are presented in Table 4-3. The dry unit weight of the brown glacial till ranged between 99 pounds per cubic foot (pcf) and 131 pcf, with an average value of 117 pcf. For the gray glacial till, the dry unit weight ranged between 122 pcf and 129 pcf, with an average value of 127 pcf.

4.2.2 Moisture-Density Relationships

Standard Proctor compaction tests were performed on bulk samples collected from auger cuttings to determine the maximum dry density and the optimum moisture content of the proposed site's soils. The amount of compaction and degree of wetting/drying operations required during earthwork operations can be estimated from the compaction test results. The average maximum dry density of the bulk samples is 123 pcf and the average optimum moisture content is 12.3 percent. Table 4-4 summarizes the results of the Standard Proctor tests. Appendix C presents the moisture-density relationships of the samples tested.

4.2.3 Consolidated-Undrained Triaxial Compression Tests

Consolidated-undrained compressive strength tests were performed on relatively undisturbed Shelby tube samples and remolded soil samples compacted to 95 percent of the Standard Proctor maximum dry density. For each soil sample, two to three specimens were tested under varying confining pressures to determine the shear strength parameters. Table 4-5 provides a summary of the triaxial test results used to construct Mohr failure circles. Table 4-6 summarizes the cohesion and friction angles from Mohr circle constructions. Appendix D contains the Mohr strength envelopes. Some of these envelopes show bi-linearity. The break points in these curves correspond to the transition from overconsolidated conditions (low confining pressures) to normally consolidated conditions (high confining pressures).

4.2.4 Permeability Tests

Laboratory permeability tests were performed on six Shelby tube samples and two remolded samples using flexible wall equipment and the falling head method. Results of the permeability tests performed on Shelby tube samples of brown glacial till ranged from 7.8×10^{-8} cm/sec to 9.4×10^{-9} cm/sec. The Shelby tube sample of gray glacial till had a permeability of 6.3×10^{-9} cm/sec. Two permeability tests were performed on remolded samples compacted to 95 percent of the Standard Proctor maximum dry density. The average permeability for the remolded samples was about 1.8×10^{-6} cm/sec. Table 4-7 summarizes the results of the permeability tests.

Table 4-3 - Summary of Unit Weight

Boring No.	Depth (feet)	Soil Description	Moisture Content (%)	Total Unit Weight (pcf)	Dry Unit Weight (pcf)
G2-201	2.5-4.5	Yellowish Brown Lean Clay	19(1)	124(1)	104(1)
GS-201	7.5-9.5	Yellowish Brown Lean Clay	16	137	118
G2-201	22.5-24.5	Gray Sandy Lean Clay	13(1)	143(1)	127(1)
G2-202	7.5-9.5	Yellowish Brown Sandy Lean Clay	14(1)	141(1)	124(1)
G2-203	17.5-19.5	Yellowish Brown Sandy Lean Clay	17(3)	139(3)	119(3)
G2-203	22.5-24.5	Gray Sandy Lean Clay	14(2)	139(2)	122(2)
G2-204	7.5-9.5	Yellowish Brown Sandy Lean Clay	14(2)	139(2)	122(2)
G2-204	12.5-14.5	Gray Lean Clay with Sand	13(1)	144(1)	128(1)
G2-204	22.5-24.5	Gray Sandy Lean Clay	12(3)	144(3)	129(3)
G2-205	2.5-4.5	Yellowish Brown Lean Clay	11(3)	138(3)	124(3)
G2-205	17.5-19.5	Gray Sandy Lean Clay	13(1)	144(1)	128(1)
G2-206	2.5-4.5	Yellowish Brown Lean Clay With Sand	11(2)	123(2)	110(2)
G2-206	7.5-9.5	Yellowish Brown Sandy Lean Clay	14(3)	139(3)	122(3)
G2-206	12.5-14.5	Yellowish Brown Lean Clay with Sand	12	146	131(1)
G2-206	22.5-24.5	Gray Sandy Lean Clay	23(1)	122(1)	131(1)
G2-208	2.5-4.5	Yellowish Brown Lean Clay	23(1)	122(1)	99(1)
G2-208	7.5-9.5	Yellowish Brown Sandy Lean Clay	17(1)	137(1)	117(1)

(1) Average values from two or three point triaxial tests.
(2) Values obtained from consolidation test results.
(3) Values from Permeability test results.

Table 4-4 - Summary of Standard Proctor Tests

Boring No.	Depth (feet)	Soil Description and Classification	Maximum Dry Density (pcf)	Optimum Moisture Content (%)
G2-209	0-25	Brown and Gray Sandy Lean Clay (CL)	122	12.3
G2-210	0-25	Brown and Gray Lean Clay with Sand (CL)	122	12.4
G2-201 G2-202 G2-203 G2-204	0-24.5	Brown and Gray Lean Clay with Sand (CL)	123	12.0
G2-205 G2-206 G2-207 G2-208	0-24.5	Brown and Gray Sandy Lean Clay (CL)	123	12.3

Table 4-5 - Summary of Consolidated-Undrained Triaxial Compression Tests

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-201	2.5-4.5	1	18.2	27.5	119.4	101.1	0.33	1953	259	29	1982	68.82
		2	17.7	25.7	120.9	102.8	1.37	2472	504	648	3120	4.82
		3	20.4	24.7	130.2	108.2	3.33	3711	605	1555	5266	3.39
G2-201	22.5-24.5	1	12.6	12.2	143.7	127.6	6.17	3595	835	1325	4919	3.71
		2	13.0	12.1	143.4	126.9	5.14	4566	994	1886	6453	3.42
		3	13.8	12.5	142.4	125.2	6.06	5938	2218	2102	8041	3.82
G2-202	7.5-9.5	1	14.2	14.4	139.6	122.3	3.60	2673	835	1325	3997	3.02
		2	14.1	14.7	142.4	124.8	0.96	2001	245	907	2908	3.21
G2-204	12.5-14.5	1	12.5	13.2	142.9	127.0	6.18	2838	-518	1238	4076	3.29
		2	12.9	12.8	144.0	127.6	3.56	3888	806	1354	5242	3.87
		3	12.7	12.1	145.9	129.5	4.43	5366	1397	2203	7569	3.44
G2-205	17.5-19.5	1	12.2	12.6	143.3	127.7	2.68	1797	202	518	2316	4.47
		2	13.0	12.5	143.1	126.6	6.75	4344	619	1541	5885	3.82
		3	12.6	12.6	144.4	128.2	5.97	5395	1498	2102	7498	3.57

Table 4-5 - Summary of Consolidated-Undrained Triaxial Compression Tests (Continued)

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-206	22.5-24.5	1	12.8	13.0	143.5	127.2	2.51	1932	115	605	2537	4.20
		2	12.7	12.4	144.2	128.0	5.87	4072	634	1526	5598	3.67
		3	12.7	12.1	144.4	128.1	6.92	5638	1613	1987	7625	3.84
G2-208	2.5-4.5	1	22.9	27.3	122.6	99.7	0.70	1103	216	72	1175	16.31
		2	21.8	28.8	120.7	99.1	2.01	2317	634	518	2835	5.47
		3	25.4	27.2	123.0	98.1	5.09	3182	1008	1152	4334	3.76
G2-208	7.5-9.5	1	13.5	14.5	140.0	123.4	1.00	1024	29	259	1283	4.95
		2	14.3	13.7	143.4	125.4	2.55	2700	389	763	3463	4.54
		3	23.4	23.0	126.6	102.6	5.10	2444	1238	922	3365	3.65
G2-209[1]	0-25	1	12.0	17.6	131.4	117.3	3.36	770	461	259	1030	3.97
		2	12.1	16.0	131.6	117.4	9.33	1827	1195	965	2791	2.89
		3	12.1	15.2	130.6	116.5	10.12	2665	2002	1598	4263	2.67
G2-210[1]	0-25	1	12.0	18.1	131.4	117.3	1.67	1102	432	288	1390	4.83
		2	12.0	16.1	133.1	118.9	10.28	1986	1051	1109	3095	2.79
		3	11.9	14.8	133.2	119.1	6.86	2861	1958	1642	4503	2.74

[1] Tests performed on remolded samples compacted to 95% Standard Proctor maximum dry density.

Table 4-6 - Summary of Mohr Circle Construction Results

Boring No.	Depth (ft)	Soil Description	Normally Consolidated			
			Effective		Total	
			Cohesion (psf)	Angle of Internal Friction (degrees)	Cohesion (psf)	Angle of Internal Friction (degrees)
G2-201 (1)	2.5-4.5	Yellowish Brown Lean Clay (CL)	500	24	300	22
G2-202	7.5-9.5	Yellowish Brown Sandy Lean Clay (CL)	200	26	450	15
G2-208	2.5-4.5	Yellowish Brown Lean Clay (CL)	300	30	250	22
G2-208	7.5-9.5	Yellowish Brown Sandy Lean Clay (CL)	150	31	300	16
G2-201	22.5-24.5	Gray Sandy Lean Clay (CL)	400	28	250	24
G2-204(1)	12.5-14.5	Gray Sandy Lean Clay (CL)	450	270	600	20
G2-205	17.5-19.5	Gray Sandy Lean Clay (CL)	200	32	300	23
G2-206	22.5-24.5	Gray Sandy Lean Clay (CL)	250	31	200	26
G2-209	0-25	Brown and Gray Sandy Lean Clay (CL)	150	25	100	15
G2-210	0-25	Brown and Gray Lean Clay with Sand (CL)	300	21	250	13
		Estimated Preconsolidation Pressure (psf)	Over Consolidated			
G2-201(1)	2.5-4.5	1075	800	12	700	12
G2-204(1)	12.5-14.5	1500	450	27	850	16

(1) Mohr circle constructions for these samples show soil to be over-consolidated

Table 4-7 - Summary of Laboratory Permeability Tests

Boring No.	Sample No.	Sample Depth (feet)	Soil Description and Classification	Initial Water Content (%)	Final Water Content	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Sample Preparation	Permeability (cm/sec)
203	8	17.5-19.5	Yellowish Brown Sandy Lean Clay (CL)	16.7	15.4	138.6	118.8	in situ	1.6×10^{-8}
204	10	22.5-24.5	Gray Sandy Lean Clay (CL)	12.1	11.8	144.3	128.7	in situ	6.3×10^{-9}
205	2	2.5-4.5	Yellowish Brown Lean Clay (CL)	11.3	16.9	138.3	124.2	in situ	7.8×10^{-8}
206	4	7.5-9.5	Yellowish Brown Sandy Lean Clay (CL)	13.7	14.7	138.5	121.8	in situ	9.4×10^{-9}
209	bulk	0-25	Brown and Gray Sandy Lean Clay (CL)	11.7	16.7	130.0	116.3	remold[1]	1.4×10^{-6}
210	bulk	0-25	Brown and Gray Lean Clay with Sand (CL)	11.8	17.0	130.2	116.5	remold[1]	2.1×10^{-6}

[1]Remolded samples compacted to 95% Standard Proctor maximum dry density.

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Figure 4-4 shows the dry density, molding water content, and corresponding hydraulic conductivity for the remolded samples plotted in relation to a Standard Proctor compaction curve (Bulk Sample G2-210) for the glacial till at the proposed site. As described above, the laboratory permeability tests were performed on samples recompacted to 95 percent of Standard Proctor maximum dry density. The molding water contents for the two samples were near or at the optimum moisture content.

Figure 4-5 illustrates the behavior of compacted, cohesive soils with respect to molding water content, dry density, compactive effort and hydraulic conductivity. In general, if the compactive effort is increased, the hydraulic conductivity decreases because the void ratio decreases (increasing dry density). Hydraulic conductivity at constant compactive effort decreases with increasing water content and reaches a minimum at about the optimum. However, clay particle arrangement can also have a significant effect on hydraulic conductivity. Often the dispersed clay structure achieved by compacting cohesive soils wet of optimum conditions additionally lowers the vertical hydraulic conductivity in compacted clay liners. This behavior suggests that the hydraulic conductivity of the recompacted glacial tills could be decreased by compacting the soil wet of optimum and/or by using a greater compactive effort (increasing the dry density).

4.2.5 Incremental Consolidation Tests

Three consolidation tests were performed on Shelby tube samples. The preconsolidation pressure for the samples varied from approximately 1,500 pounds per square foot (psf) to 4,900 psf. The overconsolidation ratio (OCR) for the samples of brown till was 4. The sample of gray glacial till is normally consolidated, hence it has an OCR of approximately 1. The change from overconsolidation in the shallow portion (0-10 feet depth) of the till to normal consolidation in the deeper portion of the till (greater than 20 feet) is not readily explainable, but may be due to many different factors (e.g., mode of deposition, sample disturbance, etc.). Table 4-8 presents a summary of the consolidation test results. Consolidation test curves may be found in Appendix E.

COMPACTION TEST DATA

Sample No. G2-210 Depth 0 - 25 Elevation _____

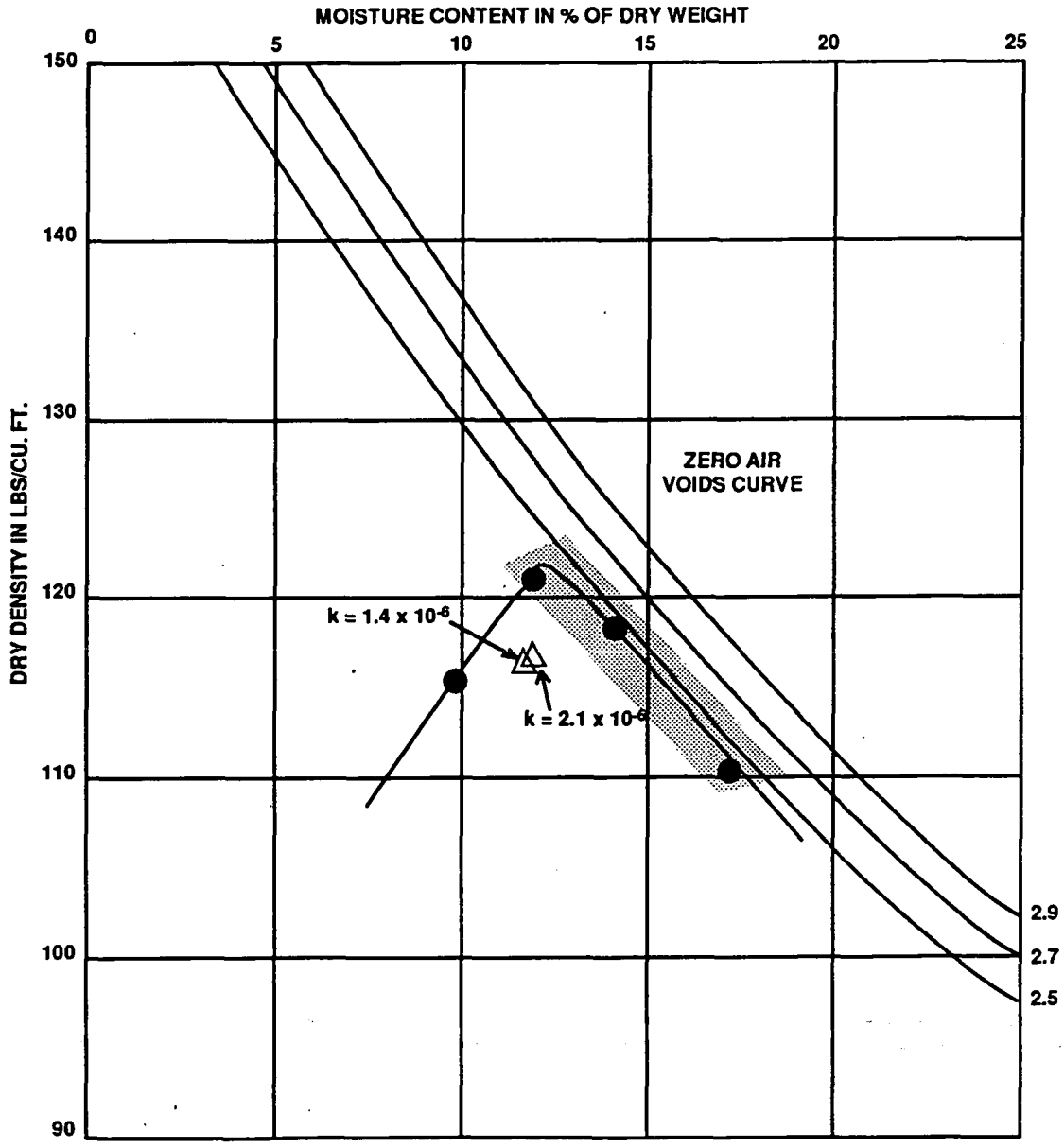
Soil Brown and Gray Lean Clay with Sand (CL)

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.4%

Maximum Dry Density 122.3 pcf

Method of Compaction ASTM D 698, Method A



△ REMOLDED SAMPLE

EXPECTED MOISTURE-DENSITY ZONE FOR PERMEABILITIES IN THE ORDER OF 10^{-7} cm/sec

k = MEASURED LABORATORY PERMEABILITY (cm/sec)

*ILLUS\OU-2\PO-10\COMPACT TEST.EPS

Figure 4-4 - Remolded Sample Hydraulic Conductivity Results vs. Standard Proctor Compaction Curve

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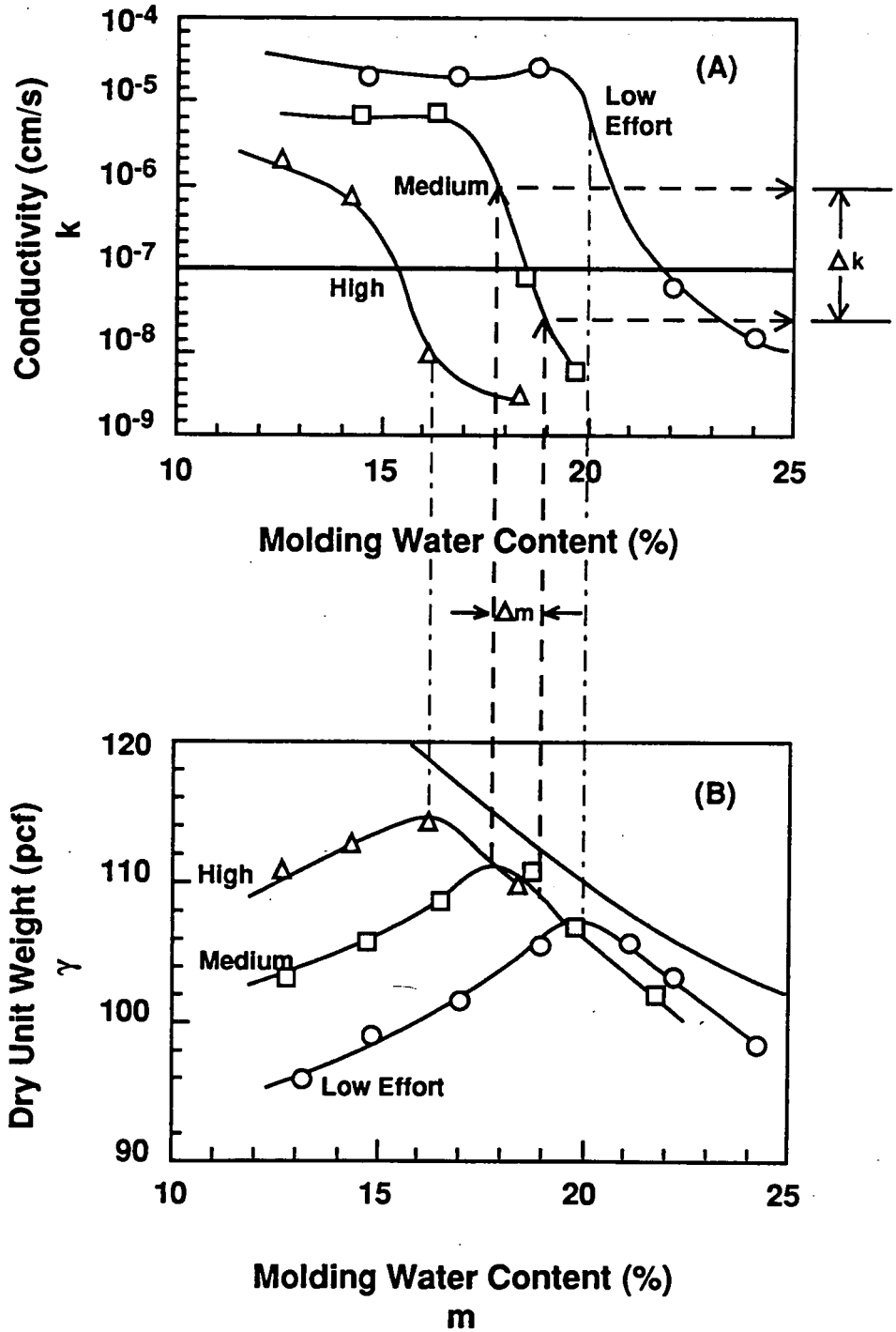


\\ILLUS\OU-2\PO-101\MOLDING WATER CONT.EPS

Figure 4-5 - Behavior of Compacted Cohesive Soils

Table 4-8 - Summary of Consolidation Tests

Boring No.	Sample Depth (feet)	Soil Type	Initial Moisture Content (%)	Dry Unit Weight (pcf)	Initial Void Ratio	Overburden Pressure (psf)	Maximum Past Pressure (psf)	Average Coefficient of Consolidation Cv (sq. in/min)	Compression Index Cc	Recompression Index Cr	Over-Consolidation Ratio (OCR)
203	22.5-24.5	Gray Sandy Lean Clay	14.0	122.4	0.4234	3279	2398	0.1426	0.100	0.028	1
204	7.5-9.5	Yellowish Brown Sandy Lean Clay	14.2	122.0	0.4023	1184	4898	0.1651	0.084	0.023	4
206	2.5-4.5	Yellowish Brown Lean Clay with Sand	11.4	110.2	0.5631	429	1514	0.2086	0.141	0.038	4

SECTION 5

ENVIRONMENTAL LABORATORY TESTING

Surface soil samples collected at ODC borehole locations by FERMCO Site Media Sampling Technicians were packaged and shipped to a FERMCO contract analytical laboratory for testing. The samples were analyzed for herbicide and pesticide contamination. Results of the analyses are contained in Appendix F.

SECTION 6

RECOMMENDATIONS AND ADDITIONAL TESTING

This section presents geotechnical engineering recommendations to support preliminary design and analysis of the cell. The preliminary geotechnical engineering analyses conducted for the proposed ODC included (1) evaluation of the generalized site conditions, (2) an estimate of the bearing capacity of the soils underlying the on-site cell, and (3) recommendations for additional testing. Data presented in Subsection 4.2 provide the basis for additional geotechnical engineering design considerations and analyses as design of the ODC progresses.

6.1 Generalized Site Conditions

The soil boring locations are shown on Figure 3-1. Appendix A contains the soil boring logs which include Standard Penetration Test data. Generalized soil parameters to be used for the geotechnical engineering evaluation of the site were interpreted from these data and the laboratory test results. For evaluation purposes, the subsurface soils were placed in two broad classifications: (a) brown glacial till and (b) gray glacial till. Design parameters were established for in situ and remolded states for the two soil classifications and also for remolded composite samples of brown and gray till. The design parameters are presented in Table 6-1. These design parameters represent a conservative estimate based on our interpretation of the index/classification tests, strength tests, and consolidation tests performed on the site soils. These design parameters may be used as the basis for slope stability calculations. Actual parameters selected for stability analyses will be based on the individual slope section to be analyzed. The consolidation parameters presented in Table 4-8 can be used for estimating settlements of the ODC. Once again, the actual parameters selected for settlement calculations will be dependent on each individual loading condition analyzed. A summary of the laboratory testing program and the discussion of the results are available in Section 4.

6.2 Bearing Capacity

Methods developed by Meyerhof (Bowles 1988) were used to evaluate bearing capacity for soils in the area of the proposed cell. The soils in the vicinity of the ODC were estimated to have a net allowable bearing pressure of 5,000 psf based on a Safety Factor of 3. This estimate is preliminary. Data contained in Subsection 4.2 provide the basis for further bearing capacity evaluation once the specific details of ODC geometry, foundation, and loading are finalized. It should be noted that bearing capacity really only has relevance when used in relation to a specific set of foundation dimensions. In the present context, the concept of bearing capacity is not readily applicable.

Table 6-1 - Design Parameters

Soil Description	Moisture Content (%)	Dry Unit Weight (pcf)	Effective Strength Parameters		Total Strength Parameters	
			Cohesion	Friction Angle (degrees)	Cohesion	Friction Angle (degrees)
Brown Till	16	117	200	28	300	20
Gray Till	13	127	200	29	250	24
Soil Recompacted to 95% Standard Proctor	12[1]	123[2]	225	23	175	14

(1) Optimum Moisture Content

(2) Maximum Dry Density

6.3 Additional Testing

Permeability test results for the remolded glacial till samples suggest that lower permeabilities could be achieved by compacting the soil wet of optimum and/or by increasing the dry density (see Subsection 4.2.4). A series of additional permeability tests performed to evaluate the moisture-density-permeability relationship for recompacted glacial till has been planned to provide additional hydraulic conductivity data for design. Additionally, any further subsurface exploration at the proposed site should include particle-size analysis, plastic limit, and plasticity index tests to allow for identification and classification of the soils.

SECTION 7

REFERENCES

(ASTM 1991) American Society for Testing and Materials, 1991. Annual Book of ASTM Standards, *Volume 4.08, Soil and Rock, Building Stones, and Geotextiles, 1991 Edition*. Philadelphia, Pennsylvania: ASTM.

(Bowles 1988) Bowles, Joseph E., 1988. *Foundation Analysis and Design*, 4th Edition. New York: McGraw-Hill Publishing Company.

(DOE 1993) United States Department of Energy, April 1993. *Sitewide CERCLA Quality Assurance Project Plan*, Revision 0.1. Fernald, Ohio: DOE.

(PARSONS 1993) PARSONS ERA Project, October 1993. *Solid Waste Landfill and On-Site Disposal Cell Geotechnical Sampling and Testing Plan*, Revision 0. Fairfield, Ohio: PARSONS.

(SAIC 1994) Science Applications International Corporation, March 3, 1994. *On-Site Waste Disposal Cell Soil Investigation Data Report*. Volumes 1 and 2. Golden, Colorado: SAIC.

APPENDIX A

BORING LOGS

ct No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
oring No. G2-201	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-02-93
oordinates: N478479.25 E1350255.01	Geologist: J. Haney	Date Completed: 11-02-93
round Surface Elevation: 580.57	GWL/DATE: NA	Page 1 of 1

otes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard enetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil lassification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
S = Split-spoon Sample ST = Shelby Tube Sample

epth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Light to dark yellowish brown lean clay [CL], moist - stiff to very stiff (brown glacial till).	1	0.0-2.0	SS	6-7-8-6	12	beta/gamma = 0 cpm PID = 0.0 ppm
		2	2.5-4.5	ST		24	beta/gamma = 0 cpm PID = 0.3 ppm
		3	5.0-7.0	SS	5-7-9-12	6	beta/gamma = 0 cpm PID = 0.4 ppm
		4	7.5-9.5	ST		8	beta/gamma = 0 cpm PID = 0.4 ppm
		5	10.0-12.0	SS	7-10-7-10	6	beta/gamma = 0 cpm PID = 0.1 ppm
		6	12.5-14.5	ST		2	beta/gamma = 0 cpm PID = NA
15.0	Dark gray sandy lean clay [CL], moist - stiff (gray glacial till).	7	15.0-17.0	SS	14-6-8-15	12	beta/gamma = 0 cpm PID = 0.4 ppm
		8	17.5-19.5	ST		6	No sample
		9	20.0-22.0	SS	3-4-5-7	15	beta/gamma = 0 cpm PID = 0.3 ppm
		10	22.5-24.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
24.5	Boring terminated at 24.5 feet.						

Project No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-202	Drilling Method: 4-1/4" Inside-diameter Hollow Stem Augers	Date Started: 12-13-93
Coordinates: N478676.08 E1350881.05	Geologist: J. Haney	Date Completed: 12-13-93
Ground Surface Elevation: 590.10	GWL/DATE: 72.0 ft / 12-13-93	Page 1 of 2

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Yellowish brown to brown sandy silty clay [CL-ML], moist - stiff to very stiff (brown glacial till). Clayey sand encountered at 3.0 to 3.5 feet. Sand increases with depth.	1	0.0-2.0	SS	3-5-8-7	11	beta/gamma = 0 cpm PID = 2.5 ppm
		2	2.5-4.5	ST		20	beta/gamma = 0 cpm PID = 7.0 ppm
		3	5.0-7.0	SS	6-7-10-12	24	beta/gamma = 0 cpm PID = 6.5 ppm
7.0	Yellowish brown sandy lean clay [CL], moist - very stiff (brown glacial till)	4	7.5-9.5	ST		18	beta/gamma = 0 cpm PID = 5.4 ppm
		5	10.0-12.0	SS	9-15-18-19	12	beta/gamma = 0 cpm PID = 6.3 ppm
10.5	Olive gray to dark gray sandy lean clay [CL], moist - very stiff (gray glacial till).	6	12.5-14.5	ST		2	beta/gamma = 0 cpm PID = 1.3 ppm
		7	15.0-17.0	SS	6-7-9-13	14	beta/gamma = 0 cpm PID = 0.8 ppm
		8	17.5-19.5	ST		2	
20.0	Olive gray poorly graded gravel with silt and sand [GM], moist - medium dense	9	20.0-22.0	SS	15-15-8-11	16	beta/gamma = 0 cpm PID = 0.9 ppm
22.5	Olive gray to dark gray sandy lean clay, moist - hard (gray glacial till).	10	22.5-24.5	ST		3	beta/gamma = 0 cpm PID = 2.1 ppm
		11	28.0-30.0	SS	7-10-20-18	24	beta/gamma = 0 cpm PID = 0.0 ppm
29.5	Dark gray to brownish gray poorly graded to well graded sand, moist to wet - dense to very dense (GMA)	12	33.0-35.0	SS	34-31-29-30	13	beta/gamma = 0 cpm PID = 0.0 ppm
		13	38.0-40.0	SS	17-21-21-24	19	beta/gamma = 0 cpm PID = 0.0 ppm
		14	43.0-45.0	SS	37-50/4	10	beta/gamma = 0 cpm PID = 0.0 ppm
		15	48.0-50.0	SS	14-17-18-17	16	beta/gamma = 0 cpm PID = 0.0 ppm
		16	53.0-55.0	SS	10-30-50/3	12	beta/gamma = 0 cpm PID = 0.0 ppm

ect No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
oring No. G2-202	Drilling Method: 4-1/4" Inside-diameter Hollow Stem Augers	Date Started: 12-13-93
oordinates: N478676.08 E1350881.05	Geologist: J. Haney	Date Completed: 12-13-93
round Surface Elevation: 590.10	GWL/DATE: 72.0 ft / 12-13-93	Page 2 of 2

otes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard enetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil assification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
S = Split-spoon Sample ST = Shelby Tube Sample

		17	58.0-60.0	SS	17-34-42-50/4	14	beta/gamma = 0 cpm PID = 0.0 ppm
		18	63.0-65.0	SS	37-50/5	10	beta/gamma = 0 cpm PID = 0.0 to 0.5 ppm
		19	68.0-70.0	SS	27-43-50/3	11	beta/gamma = 0 cpm PID = 0.0 to 4.5 ppm
		20	73.0-75.0	SS	12-18-29-28	21	beta/gamma = 0 cpm PID = 0.0 ppm
5.0	Boring terminated at 75.0 feet.						

Project No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-203	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-03-93
Coordinates: N478264.29 E1350667.59	Geologist: J. Haney	Date Completed: 11-03-93
Ground Surface Elevation: 587.60	GWL/DATE: NA	Page 1 of 1

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Yellowish brown sandy lean clay, moist - stiff to very hard (brown glacial till). ¼ to ½ inch wet clayey sand lense encountered at 18 feet.	1	0.0-2.0	SS	5-7-9-11	16	beta/gamma = 0 cpm PID = 0.0 ppm
		2	2.5-4.5	ST		2	beta/gamma = 0 cpm PID = 0.0 ppm
		3	5.0-7.0	SS	10-10-10-13	2	beta/gamma = 0 cpm PID = 0.0 ppm
		4	7.5-9.5	ST		5	beta/gamma = 0 cpm PID = 0.0 ppm
10.0	Yellowish brown clayey sand with gravel [SC], moist - very dense	5	10.0-12.0	SS	5-20-50/3	12	beta/gamma = 0 cpm PID = 0.1 ppm
12.5	Yellowish brown sandy lean clay [CL], moist - stiff (brown glacial till)	6	12.5-14.5	ST		2	beta/gamma = 0 cpm PID = 0.0 ppm
		7	15.0-17.0	SS	3-4-5-6	14	beta/gamma = 0 cpm PID = 0.0 ppm
		8	17.5-19.5	ST		18	beta/gamma = 0 cpm PID = 0.0 ppm
18.5	Dark gray sandy lean clay [CL], moist - stiff (gray glacial till).	9	20.0-22.0	SS	4-4-5-8	14	beta/gamma = 0 cpm PID = 0.2 ppm
	¼ to ¾ inch wet sand seam encountered at 20.5 feet.	10	22.5-24.5	ST		24	beta/gamma = 0 cpm PID = 0.3 ppm
24.5	Boring terminated at 24.5 feet.						

ect No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
ring No. G2-204	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-05-93
ordinates: N478463.16 E1351295.60	Geologist: J. Haney	Date Completed: 11-05-93
ound Surface Elevation: 596.15	GWL/DATE: NA	Page 1 of 1

tes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard netration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil assification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
= Split-spoon Sample ST = Shelby Tube Sample

pth ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
.0	Yellowish brown to brown sandy lean clay [CL], moist - stiff to very stiff (brown glacial till).	1	0.0-2.0	SS	3-6-8-11	15	beta/gamma = 0 cpm PID = 0.2 ppm
		2	2.5-4.5	ST		3	beta/gamma = 0 cpm PID = 0.1 ppm
		3	5.0-7.0	SS	10-11-10-12	3	beta/gamma = 0 cpm PID = 0.3 ppm
		4	7.5-9.5	ST		15	beta/gamma = 0 cpm PID = 0.2 ppm
		5	10.0-12.0	SS	6-9-12-13	20	beta/gamma = 0 cpm PID = 0.0 ppm
.5	Dark gray lean clay with sand to sandy lean clay [CL], moist - very stiff (gray glacial till). sand increases with depth	6	12.5-14.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
		7	15.0-17.0	SS	4-9-11-22	14	beta/gamma = 0 cpm PID = 0.0 ppm
.0	Dark gray silty sand [SM], wet - medium dense.	8	17.5-19.5	ST		4	beta/gamma = 0 cpm PID = 0.0 ppm
.5	Dark gray sandy lean clay [CL], moist - very stiff (gray glacial till).	9	20.0-22.0	SS	5-8-10-12	17	beta/gamma = 0 cpm PID = 0.0 ppm
		10	22.5-24.5	ST		18	beta/gamma = 0 cpm PID = 0.2 ppm
.2	Boring terminated at 24.2 feet.						

Project No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-205	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-03-93
Coordinates: N477852.36 E1350454.88	Geologist: J. Haney	Date Completed: 11-03-93
Ground Surface Elevation: 583.49	GWL/DATE: NA	Page 1 of 1

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Light to dark yellowish brown lean clay [CL], moist - stiff to very stiff (brown glacial till).	1	0.0-2.0	SS	4-7-8-10	12	beta/gamma = 0 cpm PID = 0.0 ppm
		2	2.5-4.5	ST		12	beta/gamma = 0 cpm PID = 0.0 ppm
		3	5.0-7.0	SS	7-8-11-12	16	beta/gamma = 0 cpm PID = 0.0 ppm
6.0	Dark yellowish brown clayey sand, wet - medium dense.						
7.0	Yellowish brown sandy lean clay [CL], moist - very stiff (brown glacial till).	4	7.5-9.5	ST		6	beta/gamma = 0 cpm PID = 0.0 ppm
		5	10.0-12.0	SS	16-16-9-13	8	beta/gamma = 0 cpm PID = 0.0 ppm
		6	12.5-14.5	ST		0	No recovery
15.5	Dark gray sandy lean clay [CL], moist - very stiff (gray glacial till). 1 inch wet clayey sand lense encountered at 20.5 feet.	7	15.0-17.0	SS	6-8-11-15	12	beta/gamma = 0 cpm PID = 0.0 ppm
		8	17.5-19.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
		9	20.0-22.0	SS	6-9-18-15	10	beta/gamma = 0 cpm PID = 0.0 ppm
		10	22.5-24.5	ST		14	beta/gamma = 0 cpm PID = 0.0 ppm
23.7	Boring terminated at 23.7 feet.						

ect No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-206	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-05-93
Coordinates: N478048.67 E1351081.50	Geologist: J. Haney	Date Completed: 11-05-93
Ground Surface Elevation: 591.43	GWL/DATE: NA	Page 1 of 1

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Grayish brown to yellowish brown lean clay with sand to sandy lean clay [CL], moist - stiff to very stiff (brown glacial till). Sand increases with depth	1	0.0-2.0	SS	4-6-6-8	12	beta/gamma = 0 cpm PID = 0.0 ppm
		2	2.5-4.5	ST		12	beta/gamma = 0 cpm PID = 0.0 ppm
		3	5.0-7.0	SS	15-15-13-14	10	beta/gamma = 0 cpm PID = 0.0 ppm
		4	7.5-9.5	ST		18	beta/gamma = 0 cpm PID = 0.0 ppm
		5	10.0-12.0	SS	16-12-10-17	18	beta/gamma = 0 cpm PID = 0.0 ppm
		6	12.5-14.5	ST		18	beta/gamma = 0 cpm PID = 0.0 ppm
13.5	Dark gray lean clay, moist - stiff (gray glacial till).	7	15.0-17.0	SS	3-4-8-42	17	beta/gamma = 0 cpm PID = 0.0 ppm
16.0	Dark gray silty sand, wet - medium dense.	8	17.5-19.5	ST		6	beta/gamma = 0 cpm PID = 0.0 ppm
		9	20.0-22.0	SS	5-7-10-11	2	beta/gamma = 0 cpm PID = 0.0 ppm
22.5	Dark gray sandy lean clay [CL], moist - very stiff (gray glacial till).	10	22.5-24.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
24.5	Boring terminated at 24.5 feet.						

Project No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-207	Drilling Method: 4-1/4" Inside-diameter Hollow Stem Augers	Date Started: 12-09-93
Coordinates: N477646.51 E1350879.51	Geologist: J. Haney	Date Completed: 12-09-93
Ground Surface Elevation: 588.99	GWL/DATE: 74 ft. / 12-09-93	Page 1 of 2

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Yellowish brown to brown sandy lean clay [CL], moist - medium stiff to very stiff (brown glacial till).	1	0.0-2.0	SS	3-3-5-8	14	beta/gamma = 0 cpm PID = 1.2 ppm
		2	2.5-4.5	ST		17	beta/gamma = 0 cpm PID = 0.8 ppm
		3	5.0-7.0	SS	15-16-11-10	3	beta/gamma = 0 cpm PID = 2.1 ppm
		4	7.5-9.5	ST		15	beta/gamma = 0 cpm PID = 0.0 ppm
		5	10.0-12.0	SS	9-10-17-19	19	beta/gamma = 0 cpm PID = 0.0 ppm
13.0	Dark gray sandy silty clay [CL-ML], moist - medium stiff to very stiff (brown glacial till). 1 inch sand lense encountered at 26.5 feet.	6	12.5-14.5	ST		3	beta/gamma = 0 cpm PID = 0.0 ppm
		7	15.0-17.0	SS	10-8-11-15	1	
		8	17.5-19.5	ST		16	beta/gamma = 0 cpm PID = 0.0 ppm
		9	20.0-22.0	SS	7-9-12-11	5	beta/gamma = 0 cpm PID = 0.0 ppm
		10	22.5-24.5	ST		19	beta/gamma = 0 cpm PID = 0.0 ppm
		11	25.0-27.0	SS	6-7-17-16	24	beta/gamma = 0 cpm PID = 0.0 ppm
30.5	Yellowish brown to dark yellowish brown silty sand with gravel, moist - medium dense to very dense. Sand wet at 75.0 feet.	12	30.0-32.0	SS	5-6-10-13	22	beta/gamma = 0 cpm PID = 0.0 ppm
		13	35.0-37.0	SS	6-26-50/4	16	beta/gamma = 0 cpm PID = 0.2 ppm
		14	40.0-42.0	SS	21-35-29-39	19	beta/gamma = 0 cpm PID = 0.0 ppm
		15	45.0-47.0	SS	19-24-30-39	24	beta/gamma = 0 cpm PID = 0.0 ppm
		16	50.0-52.0	SS	11-12-14-19	24	beta/gamma = 0 cpm PID = 0.0 ppm

ct No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
oring No. G2-207	Drilling Method: 4-1/4" Inside-diameter Hollow Stem Augers	Date Started: 12-09-93
oordinates: N477646.51 E1350879.51	Geologist: J. Haney	Date Completed: 12-09-93
round Surface Elevation: 588.99	GWL/DATE: 74 ft. / 12-09-93	Page 2 of 2

otes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard netration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil assification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
S = Split-spoon Sample ST = Shelby Tube Sample

		17	55.0-57.0	SS	6-20-44-50/4	16	beta/gamma = 0 cpm PID = 0.0 ppm
		18	60.0-62.0	SS	15-15-14-19	19	beta/gamma = 0 cpm PID = 0.0 ppm
		19	65.0-67.0	SS	20-50/4	10	beta/gamma = 0 cpm PID = 0.0 ppm
		20	70.0-72.0	SS	14-25-35-50/5	15	beta/gamma = 0 cpm PID = 0.0 ppm
		21	75.0-77.0	SS	19-24-27-30	17	beta/gamma = 0 cpm PID = 0.0 ppm
7.0	Boring terminated at 77.0 feet.						

Project No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-208	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-04-93
Coordinates: N477838.17 E1351493.02	Geologist: J. Haney	Date Completed: 11-04-93
Ground Surface Elevation: 596.27	GWL/DATE: NA	Page 1 of 1

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Field Screening
0.0	Yellowish brown to dark brown lean clayto sandy lean clay [CL], moist - medium stiff to stiff (brown glacial till). Clayey sand lense encountered at 6.0 feet. Sand increases with depth.	1	0.0-2.0	SS	4-6-8-10	8	beta/gamma = 0 cpm PID = 0.0 ppm
		2	2.5-4.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
		3	5.0-7.0	SS	4-3-3-3	20	beta/gamma = 0 cpm PID = 0.0 ppm
		4	7.5-9.5	ST		21	beta/gamma = 0 cpm PID = 0.0 ppm
10.5	Dark gray sandy lean clay [CL], moist - stiff to very stiff (gray glacial till). Clayey sand encountered at 21.0 to 21.5 feet.	5	10.0-12.0	SS	8-10-12-13	15	beta/gamma = 0 cpm PID = 0.0 ppm
		6	12.5-14.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
		7	15.0-17.0	SS	6-8-11-14	20	beta/gamma = 0 cpm PID = 0.0 ppm
		8	17.5-19.5	ST		24	beta/gamma = 0 cpm PID = 0.0 ppm
		9	20.0-22.0	SS	4-5-6-6	20	beta/gamma = 0 cpm PID = 0.0 ppm
		10	22.5-24.5	ST		20	beta/gamma = 0 cpm PID = 0.0 ppm
24.2	Boring terminated at 24.2 feet.						

ect No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
oring No. G2-209	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-09-93
oordinates: N478155.04 E1351394.37	Geologist: J. Haney	Date Completed: 11-09-93
ound Surface Elevation: 598.78	GWL/DATE: NA	Page 1 of 1

otes: Samples collected per ASTM D 1586 and ASTM D 1587. Colors identified using Munsell Color Chart. Consistency based on Standard netration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil assification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
S = Split-spoon Sample ST = Shelby Tube Sample

epth ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Comments/ Field Screening
							Augured 0 to 25 ft. Bulk sample collected.
.0	Dark yellowish brown sandy lean clay [CL], moist (brown glacial till).		2.0-2.5				beta/gamma = 0 cpm PID = 4.4 ppm
			4.5-5.0				beta/gamma = 0 cpm PID = 3.3 ppm
			7.0-7.5				beta/gamma = 0 cpm PID = 5.3 ppm
			9.5-10.0				beta/gamma = 0 cpm PID = 5.1 ppm
.0	Olive gray to dark gray sandy lean clay [CL], moist (gray glacial till).		12.0-12.5				beta/gamma = 0 cpm PID = 4.9 ppm
			14.5-15.0				beta/gamma = 0 cpm PID = 8.7 ppm
			17.0-17.5				beta/gamma = 0 cpm PID = 1.8 ppm
			19.5-20.0				beta/gamma = 0 cpm PID = 0.7 ppm
			22.0-22.5				beta/gamma = 0 cpm PID = 0.0 ppm
			24.5-25.0				beta/gamma = 0 cpm PID = 2.7 ppm
.0	Boring terminated at 25.0 feet.						

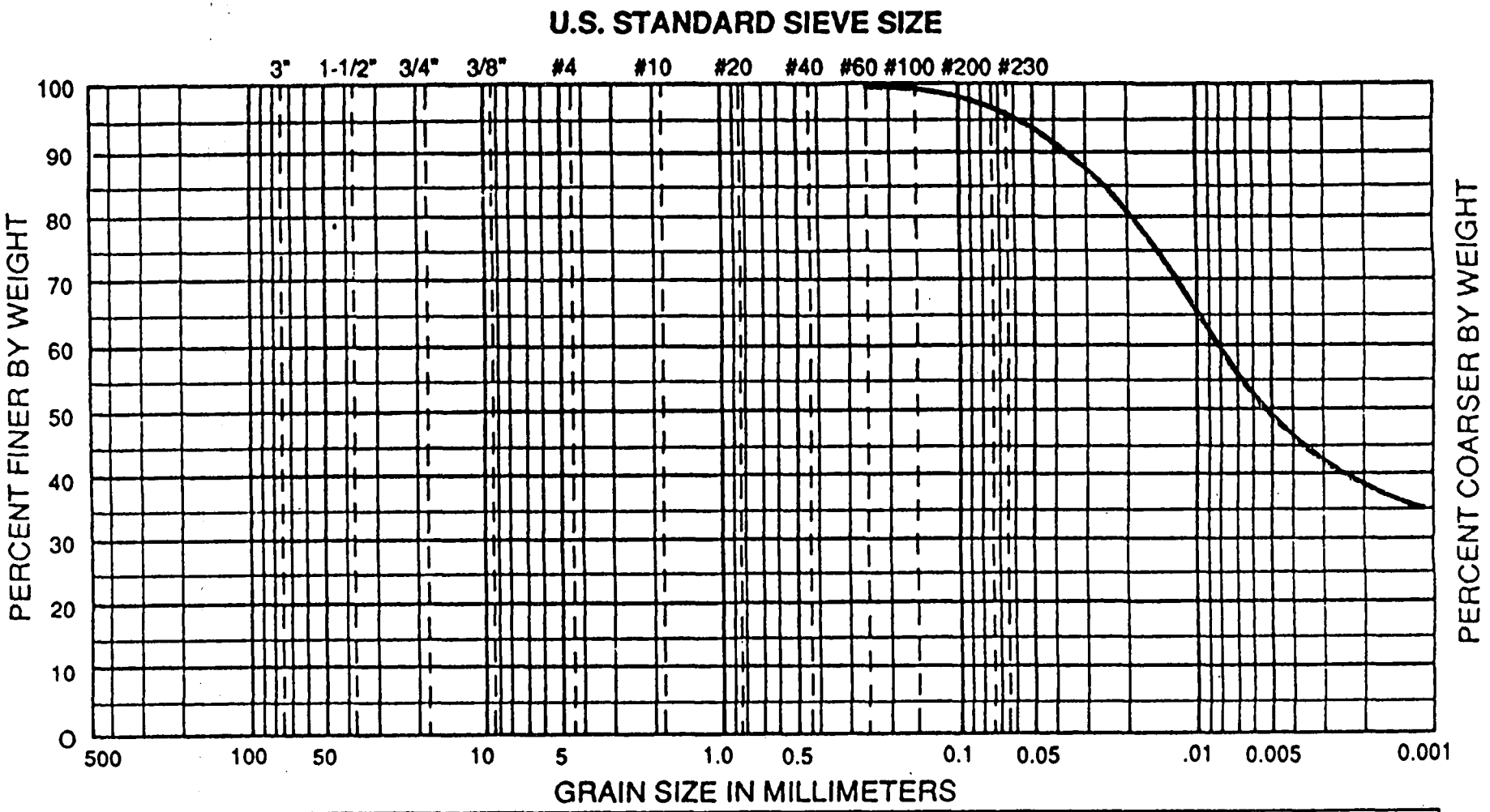
Project No: PO-101	Project Title: On-Site Waste Disposal Cell Predesign Field Investigation - Geotechnical Sampling and Tesing Exploration	
Boring No. G2-210	Drilling Method: 3-1/4" Inside-diameter Hollow Stem Augers	Date Started: 11-08-93
Coordinates: N478161.69 E1350355.36	Geologist: J. Haney	Date Completed: 11-08-93
Ground Surface Elevation: 583.18	GWL/DATE: NA	Page 1 of 1

Notes: Samples collected per ASTM D 1586 and ASTM D 1587. *Colors identified using Munsell Color Chart.* Consistency based on Standard Penetration Resistance Value. Screening readings are in units above background levels. Soils visual description per ASTM D 2488 and soil classification per ASTM D 2487. Soil descriptions interpreted from field logs and laboratory results.
SS = Split-spoon Sample ST = Shelby Tube Sample

Depth (ft)	Description [ASTM Symbol]	Sample No.	Sample Depth (ft)	Sample Type	Blows per 6"	Recovery (in)	Comments/ Field Screening
							Augured 0 to 25 ft. Bulk sample collected.
0.0	Dark yellowish brown sandy lean clay [CL], *moist (brown glacial till).*		2.0-2.5				beta/gamma = 0 cpm PID = 33.0 ppm
			4.5-5.0				beta/gamma = 0 cpm PID = 24.0 ppm
			7.0-7.5				beta/gamma = 0 cpm PID = 7.0 ppm
			9.5-10.0				beta/gamma = 0 cpm PID = 12.5 ppm
14.5	Olive gray to dark sandy lean clay [CL], moist (gray glacial till).		12.0-12.5				beta/gamma = 0 cpm PID = 30.0 ppm
			14.5-15.0				beta/gamma = 0 cpm PID = 16.0 ppm
			17.0-17.5				beta/gamma = 0 cpm PID = 26.5 ppm
			19.5-20.0				beta/gamma = 0 cpm PID = 20.0 ppm
			22.0-22.5				beta/gamma = 0 cpm PID = 25.1 ppm
			24.5-25.0				beta/gamma = 0 cpm PID = 26.5 ppm
25.0	Boring terminated at 25.0 feet.						

APPENDIX B

GRAIN SIZE DISTRIBUTION CURVES

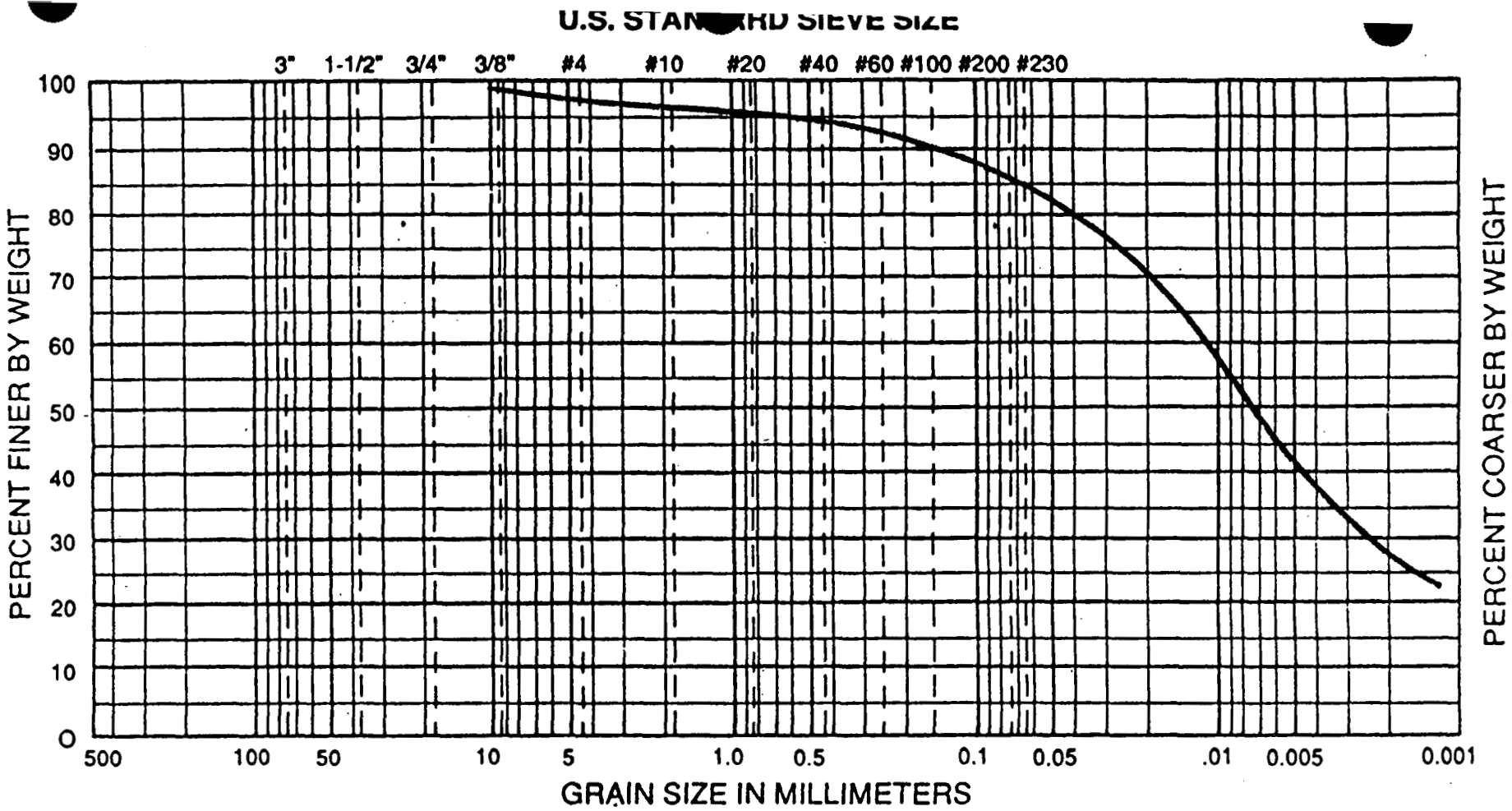


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-201 SAMPLE NO.: 2 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	2.5 - 4.5 ft	Yellowish Brown Lean Clay (CL)



ADVANCED TERRA TESTING

E-3-3-55

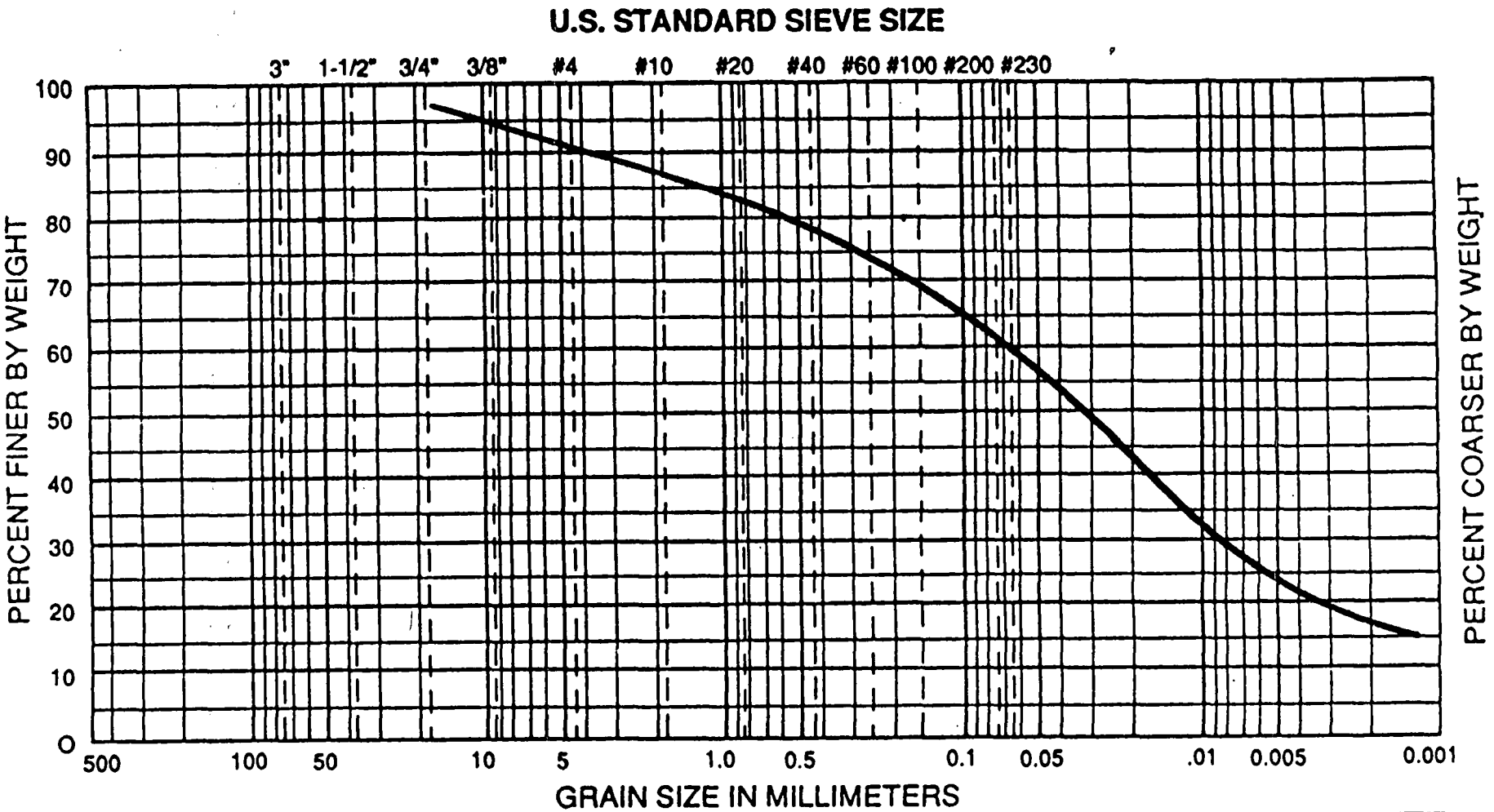
ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-201 SAMPLE NO.: 4 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	7.5 - 9.5 ft	Yellowish Brown Lean Clay (CL)

000274

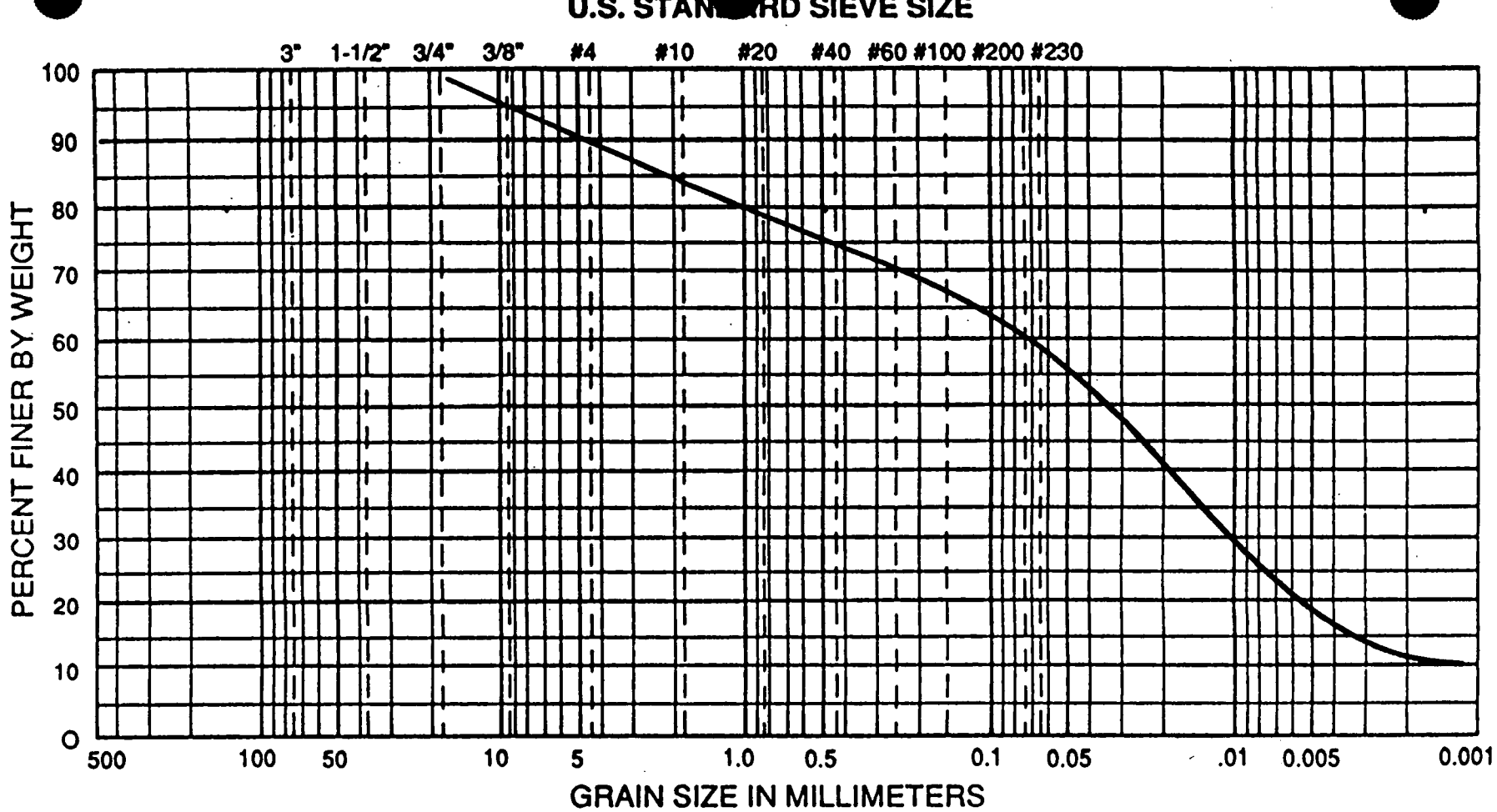


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-201 SAMPLE NO.: 10 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	22.5 - 24.5 ft	Gray Sandy Lean Clay (CL)



ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-202 SAMPLE NO.: 3 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	5 - 7 ft	Yellowish Brown Sandy Silty Clay (CL)

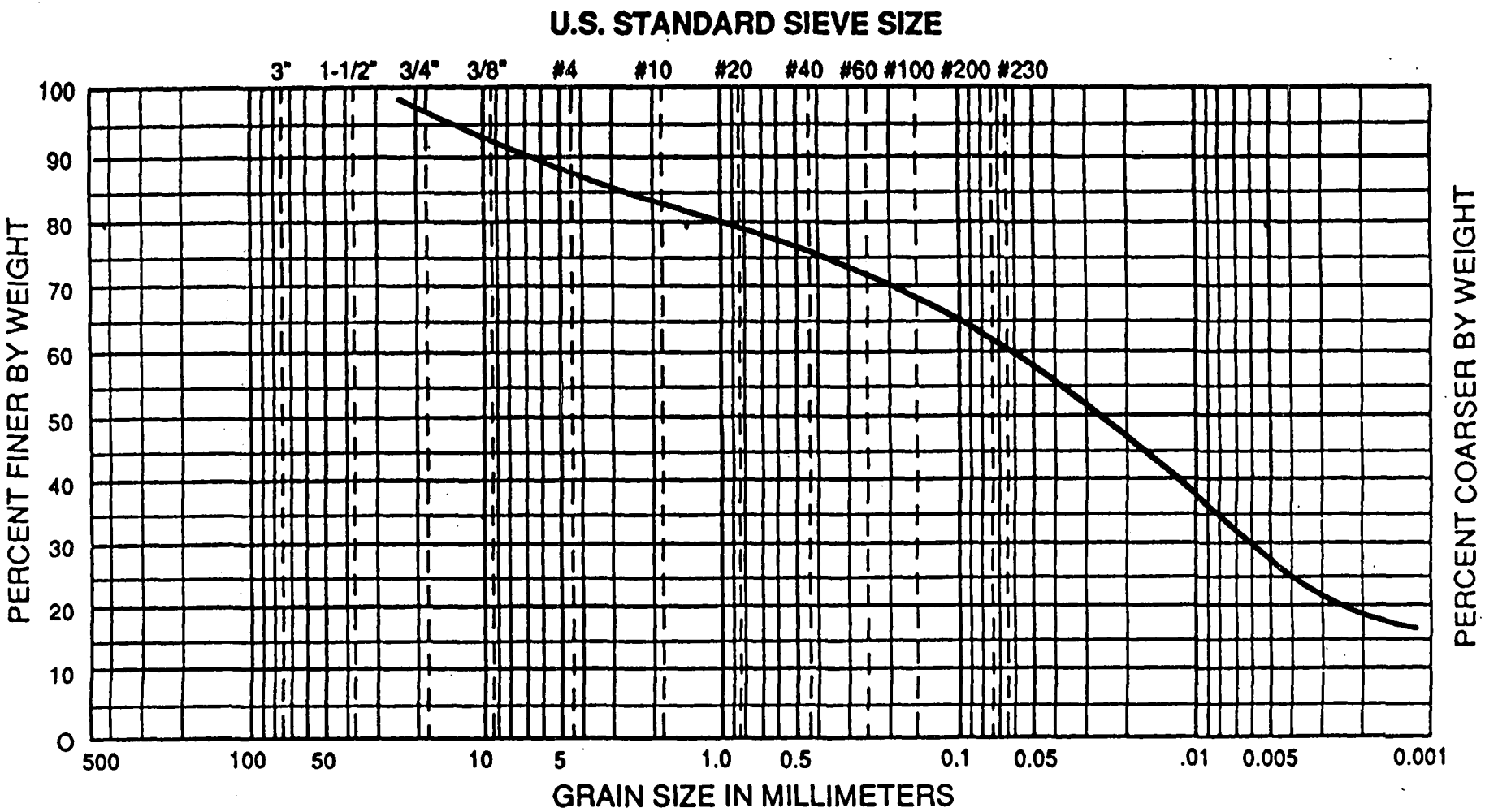
ADVANCED TERRA TESTING

E-3-3-57

00076

66 47

FEMP-OU02-6 FINAL
March 1, 1995

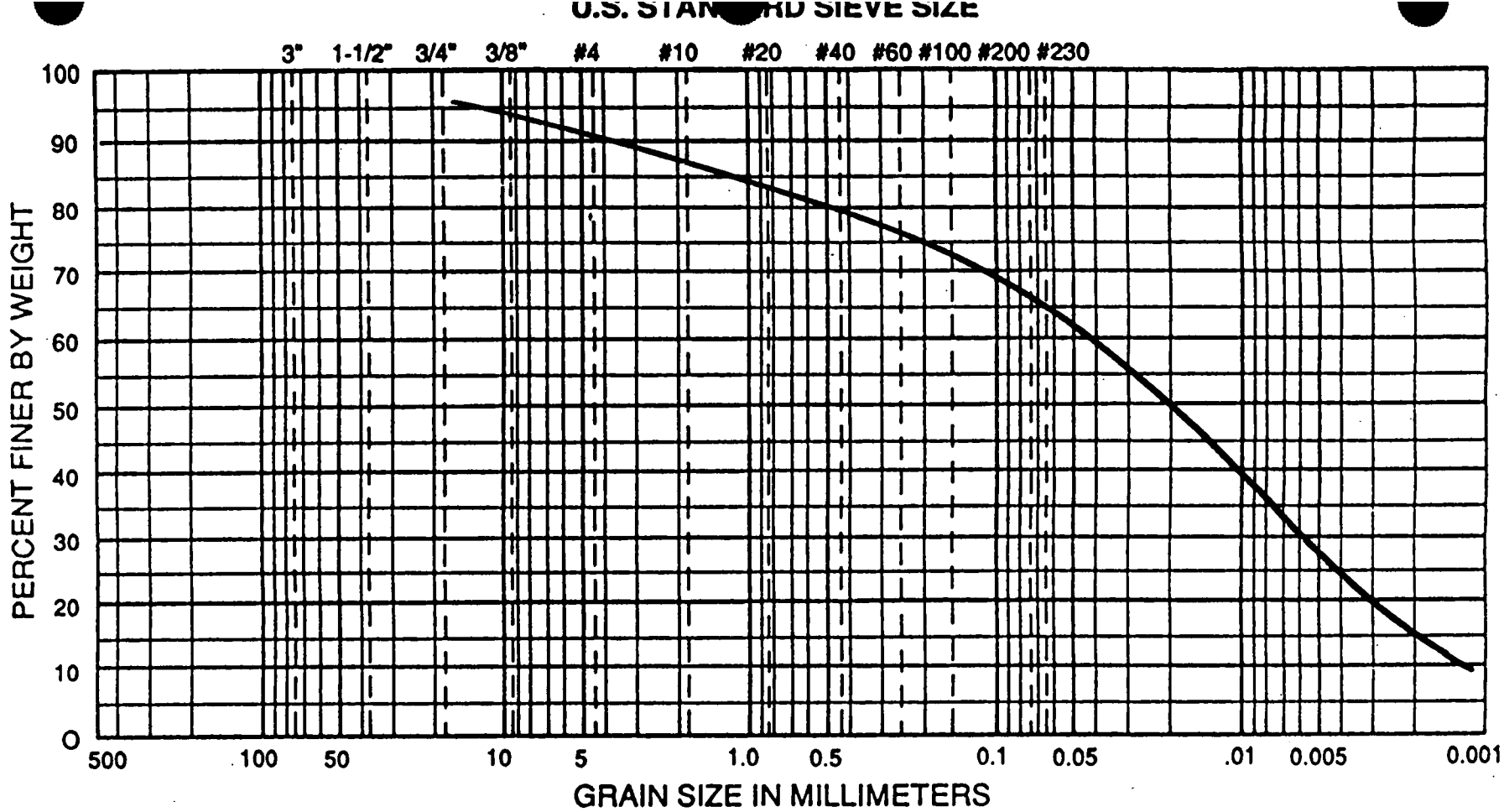


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-202 SAMPLE NO.: 4 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	7.5 - 9.5 ft	Yellowish Brown Sandy Lean Clay (CL)



ADVANCED TERRA TESTING

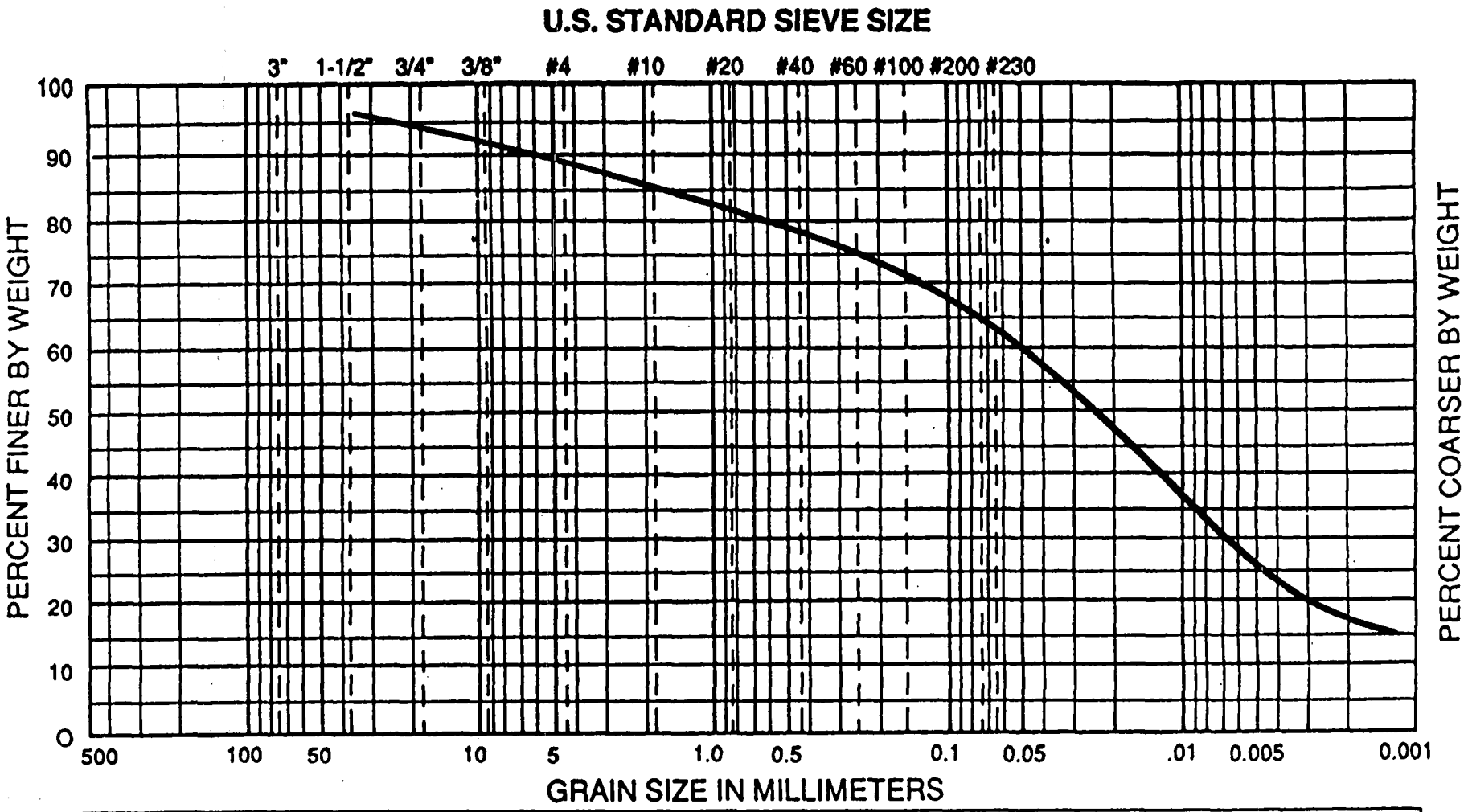
E-3-3-59

ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-202 SAMPLE NO.: 5 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	10 - 12 ft	Yellowish Brown Sandy Lean Clay (CL)



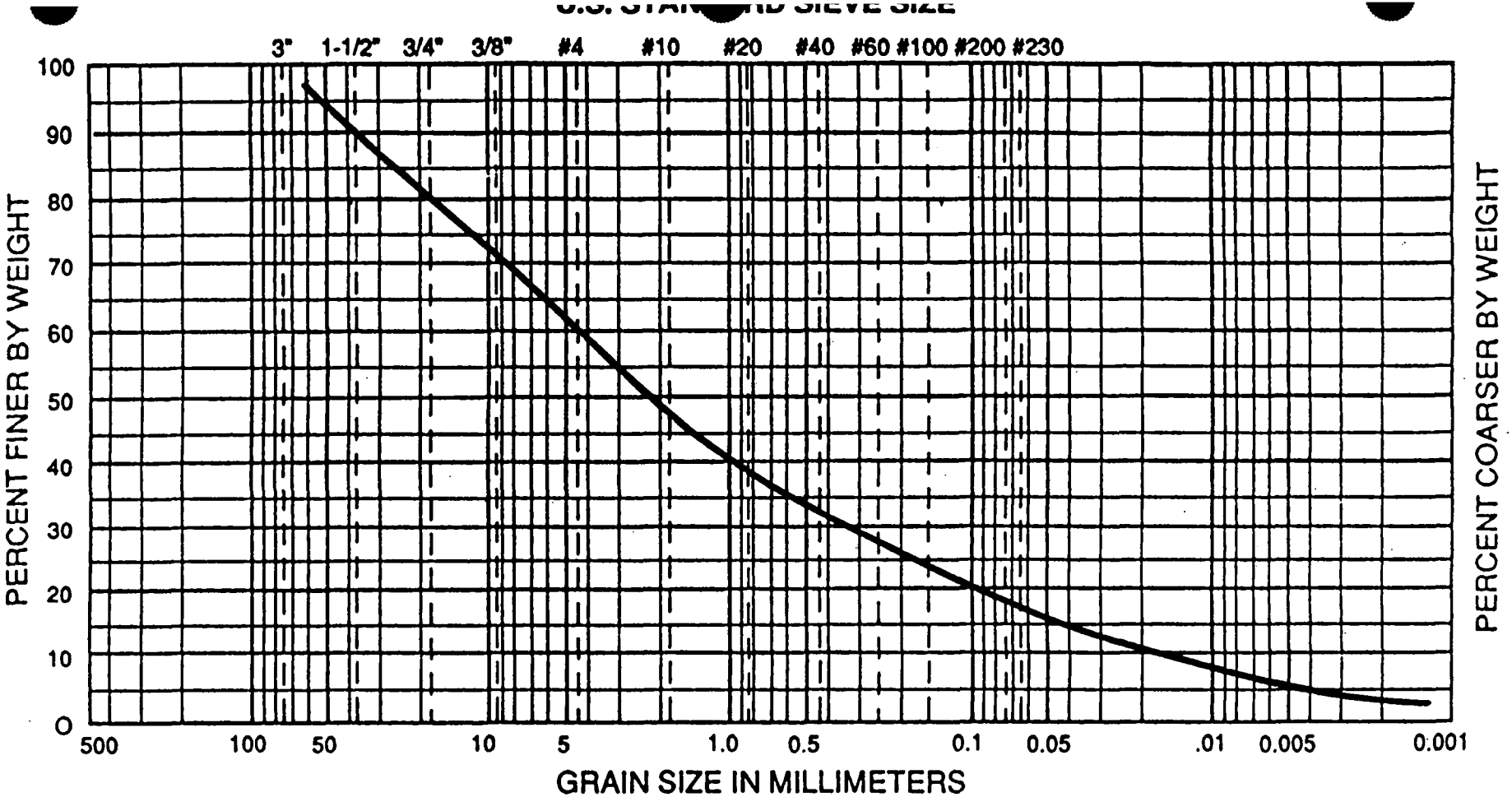
ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-202 SAMPLE NO.: 7 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	15 - 17 ft	Gray Sandy Lean Clay (CL)

ADVANCED TERRACO TESTING
000013

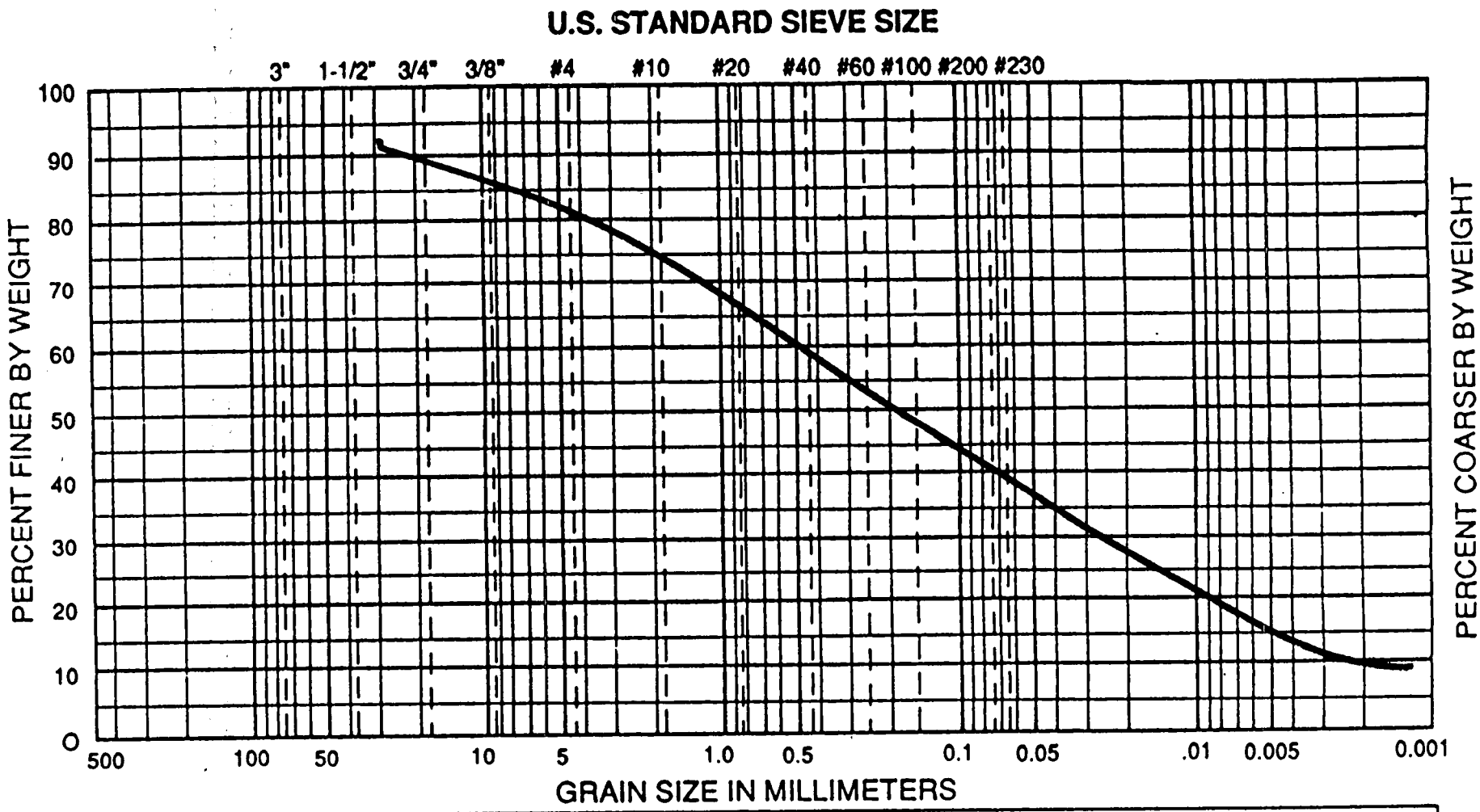


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-202 SAMPLE NO.: 9 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	20 - 22 ft	Gray Poorly-Graded Gravel with Silt and Sand (GW-GM)

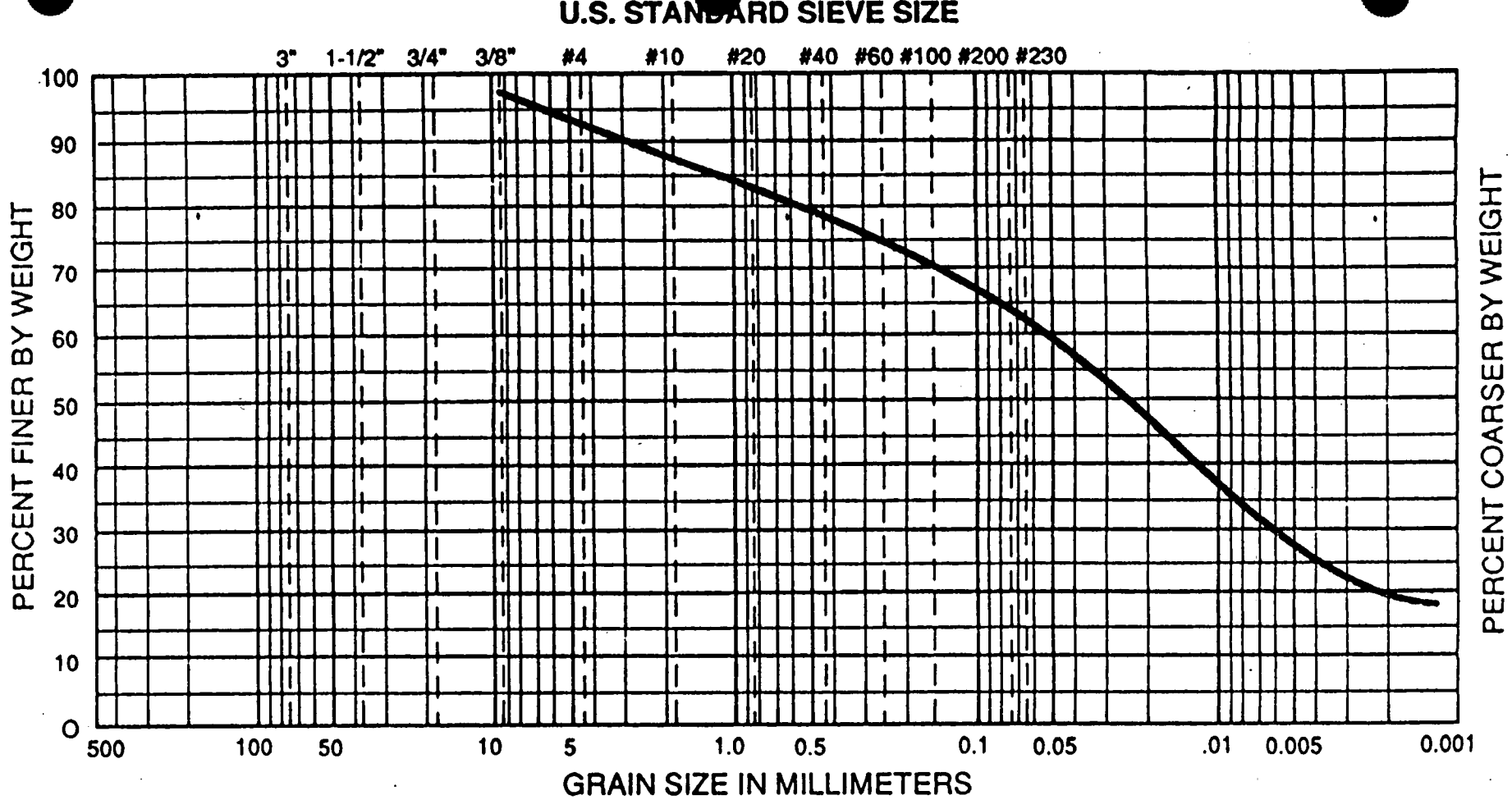


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-203 SAMPLE NO.: 5 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	10 - 12 ft	Yellowish Brown Clayey Sand with Gravel (SC)



ADVANCED TERRA TESTING

E-3-3-63

ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

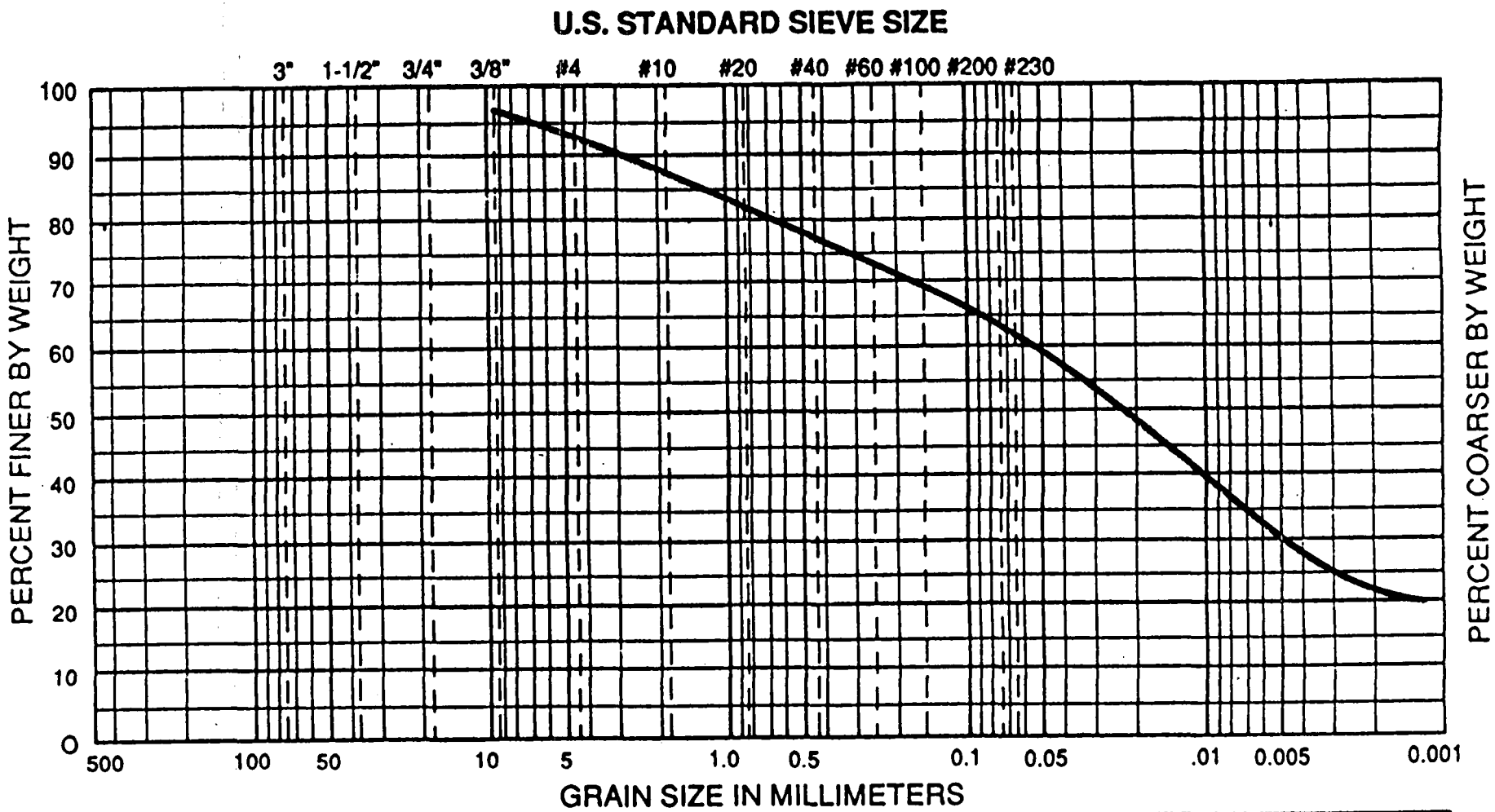
WELLNAME: G2-203 SAMPLE NO.: 7 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	15 - 17 ft	Yellowish Brown Sandy Lean Clay (CL)

6647

FEMP-OU02-6 FINAL
March 1, 1995

000722



ASTM D 2487 (USCS)

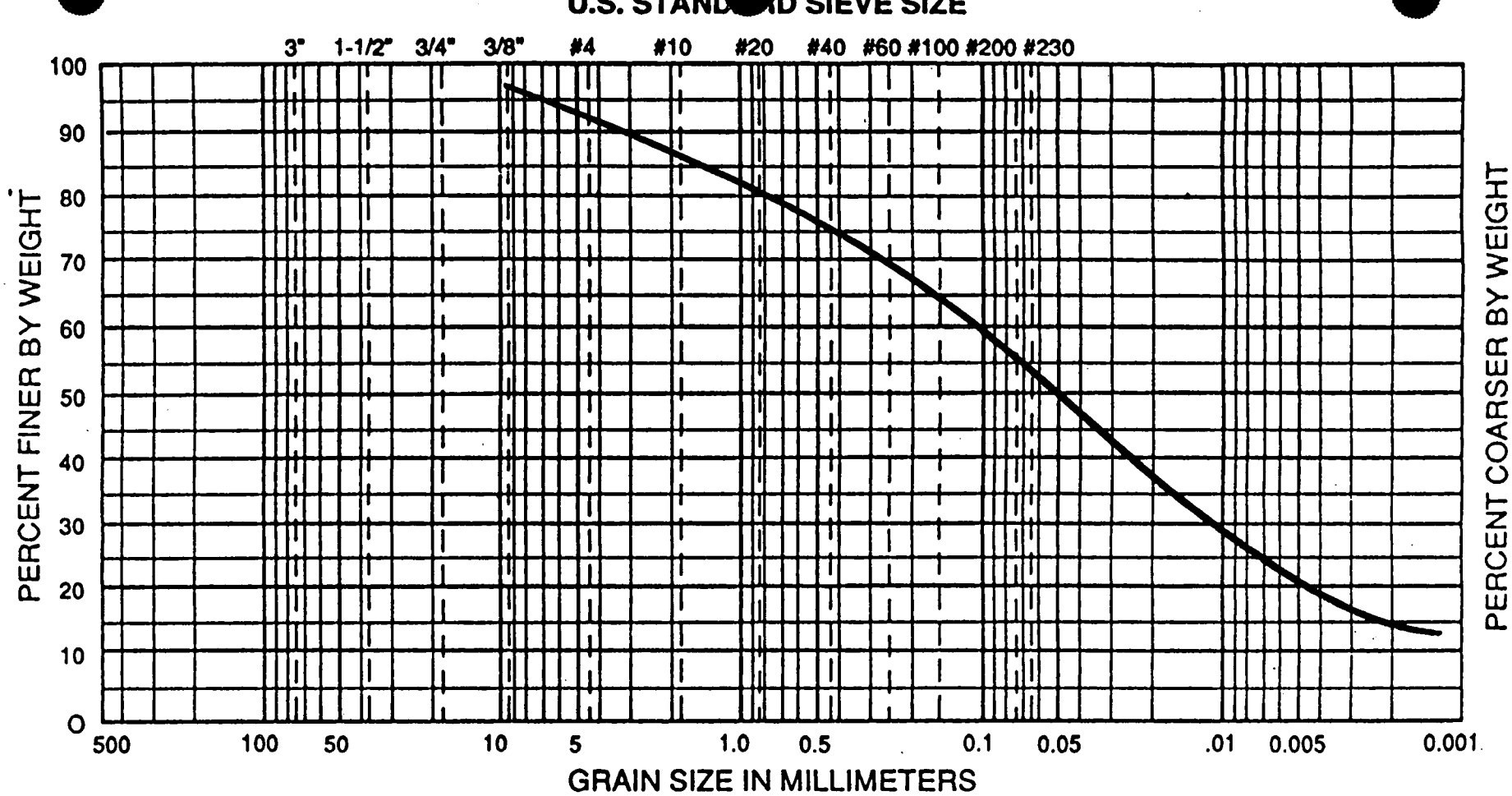
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-203 SAMPLE NO.: 8 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	17.5 - 19.5 ft	Yellowish Brown Sandy Lean Clay (CL)

ADVANCED TERRA TESTING
000723



ADVANCED TERRA TESTING

E-3-3-65

ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

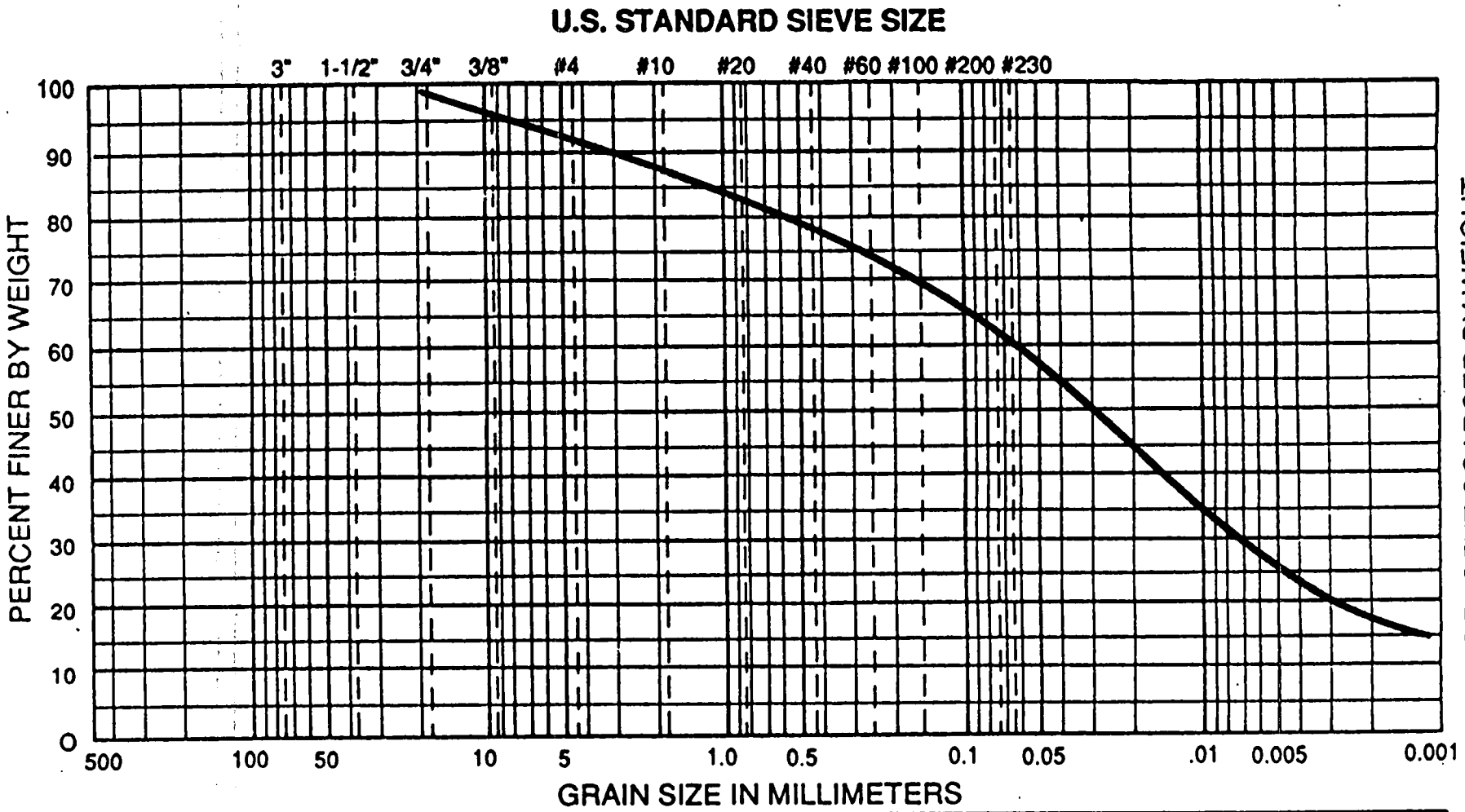
WELL NAME: G2-203 SAMPLE NO.: 9 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	20 - 22 ft	Gray Sandy Lean Clay (CL)

6647

FEMP-OU02-6 FINAL
March 1, 1995

000224



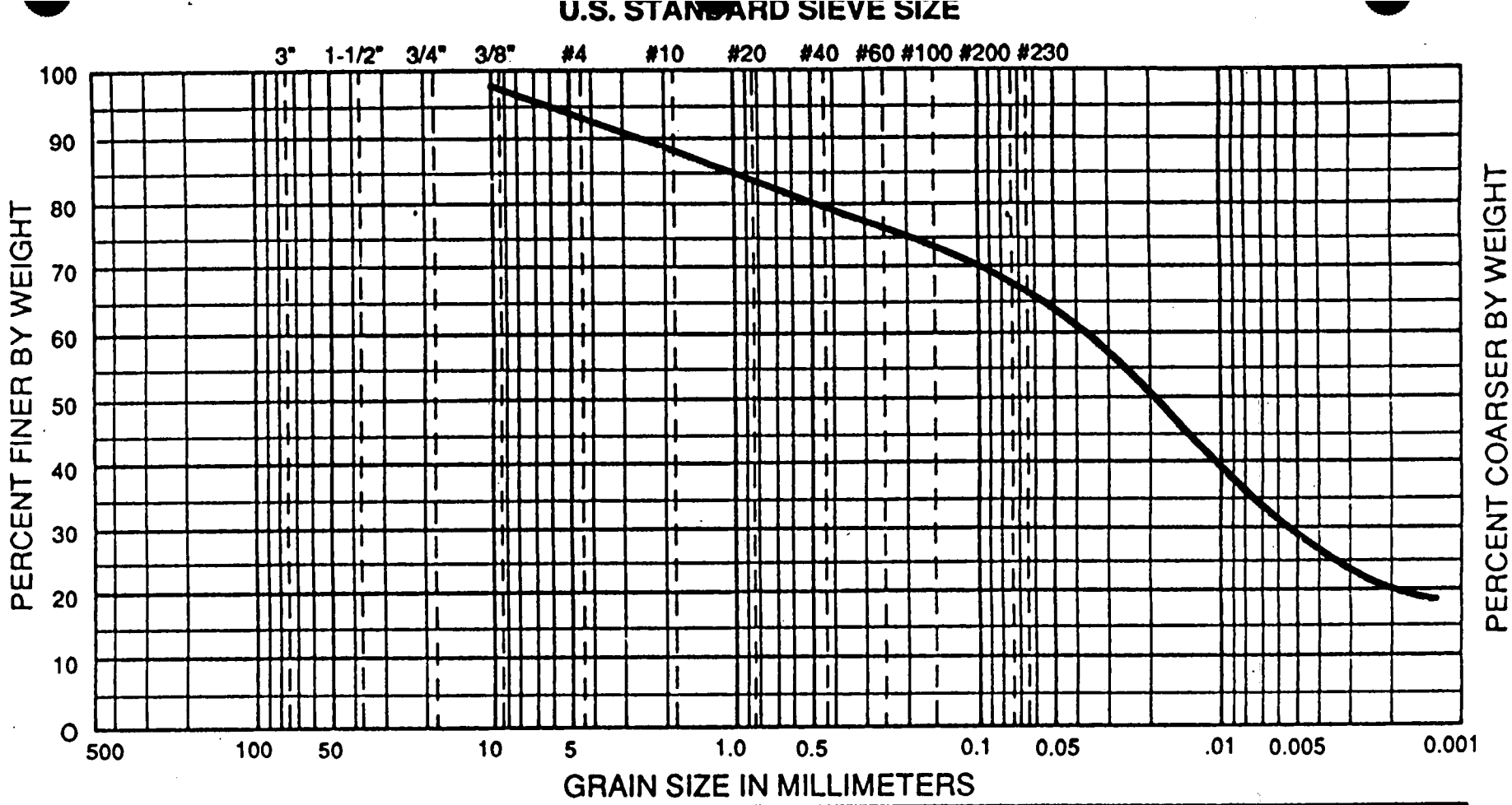
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-203 SAMPLE NO.: 10 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	22.5 - 24.5 ft	Gray Sandy Lean Clay (CL)



ADVANCED TERRA TESTING

E-3-3-67

ASTM D 2487 (USCS)

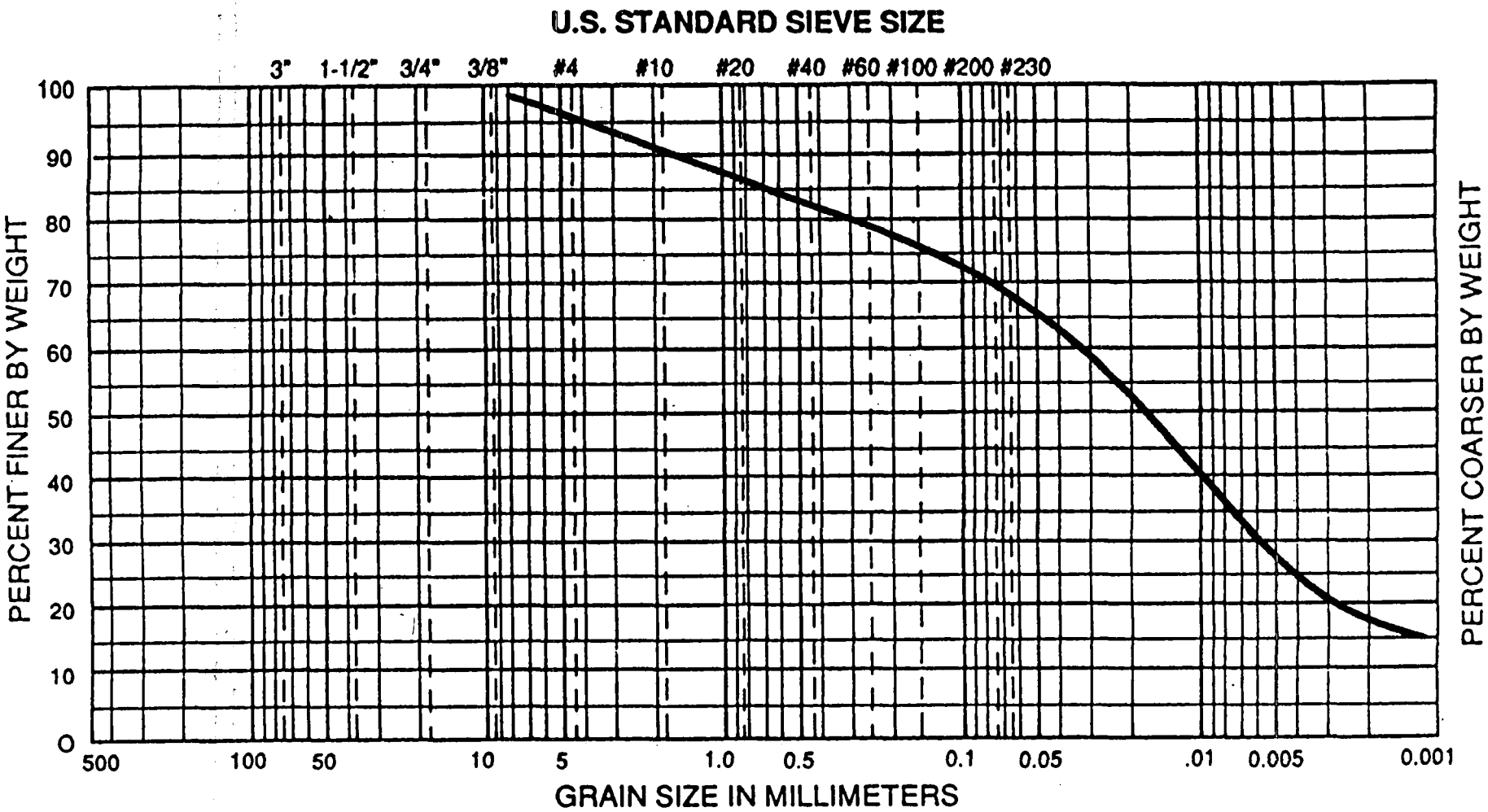
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-204 SAMPLE NO.: 4 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	7.5 - 9.5 ft	Yellowish Brown Sandy Lean Clay (CL)

000728

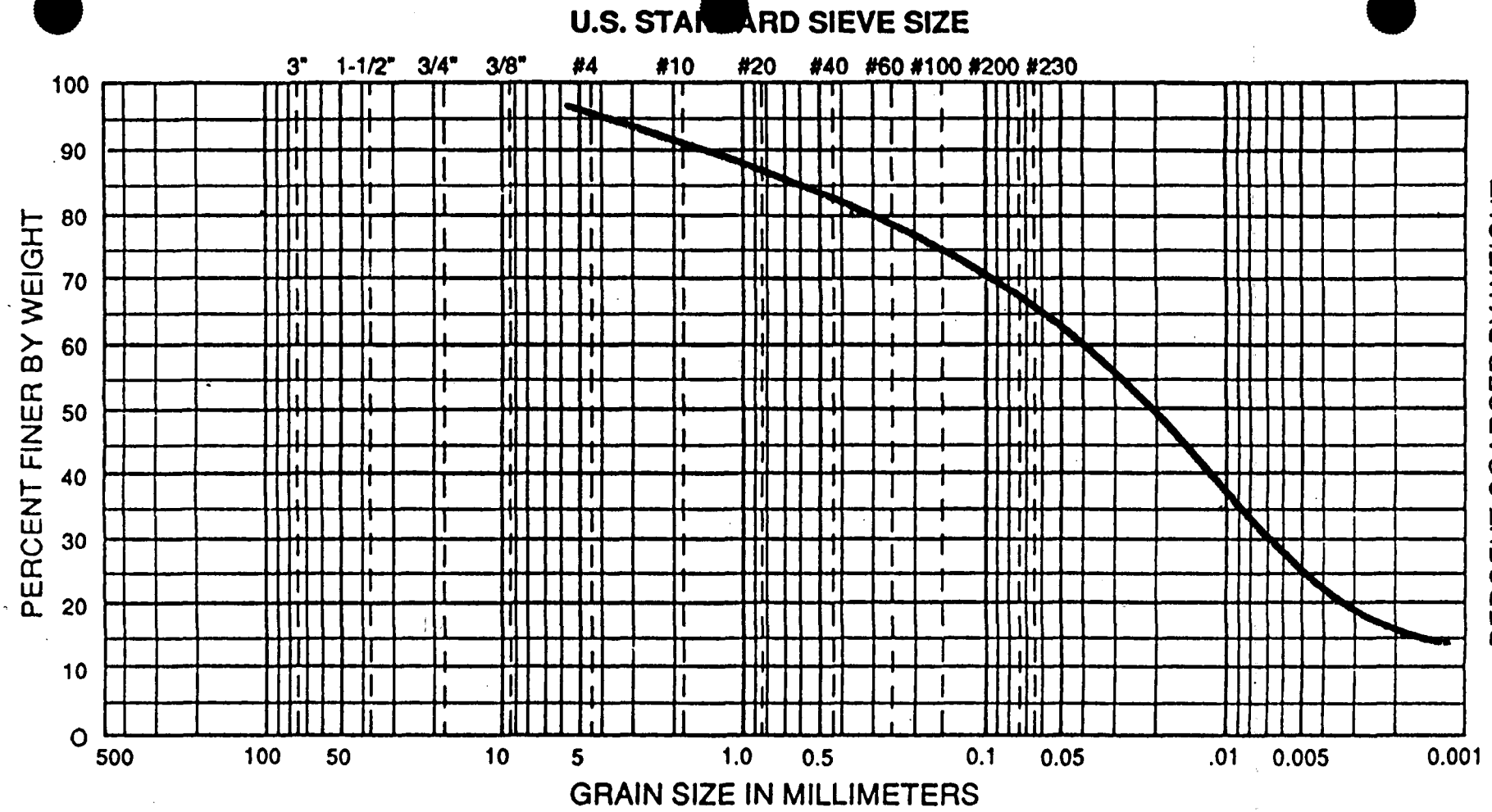


ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-204 SAMPLE NO.: 6 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	12.5 - 14.5 ft	Gray Lean Clay with Sand (CL)



ADVANCED TERRA TESTING

E-3-3-69

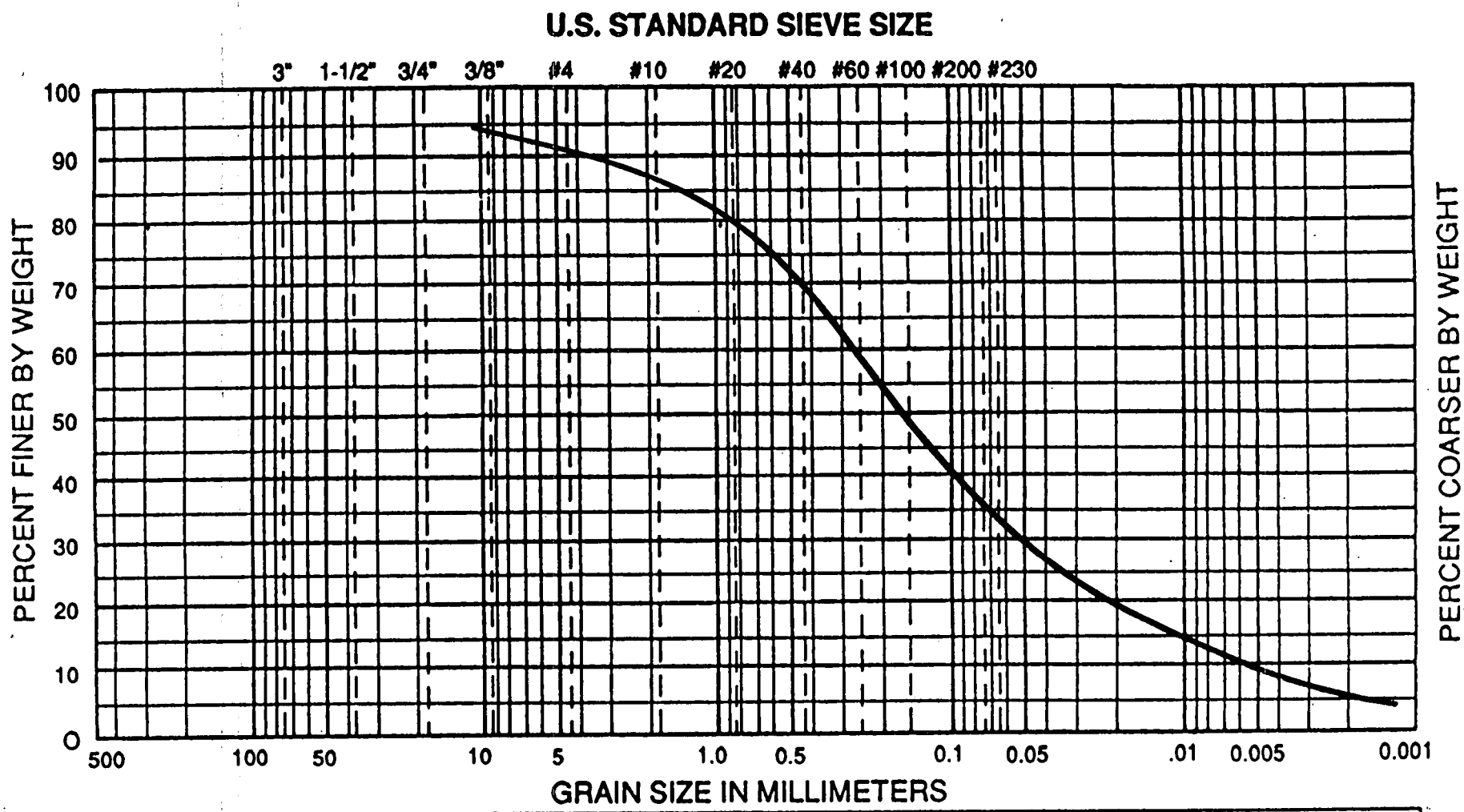
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-204 SAMPLE NO.: 7 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	15 - 17 ft	Gray Sandy Lean Clay (CL)



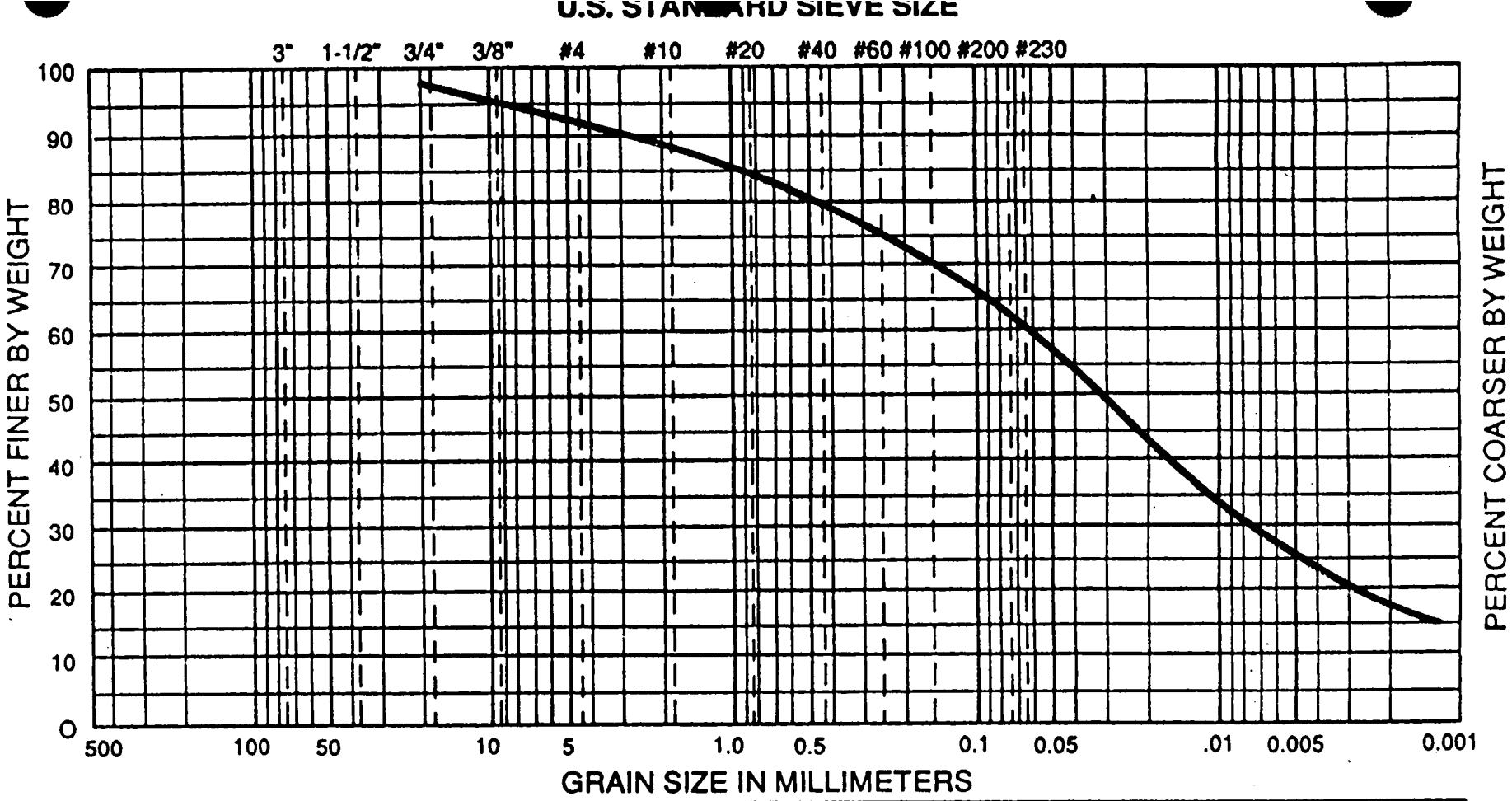
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-204 SAMPLE NO.: 8 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	17.5 - 19.5 ft	Gray Silty Sand (SM)



ADVANCED TERRA TESTING

E-3-3-71

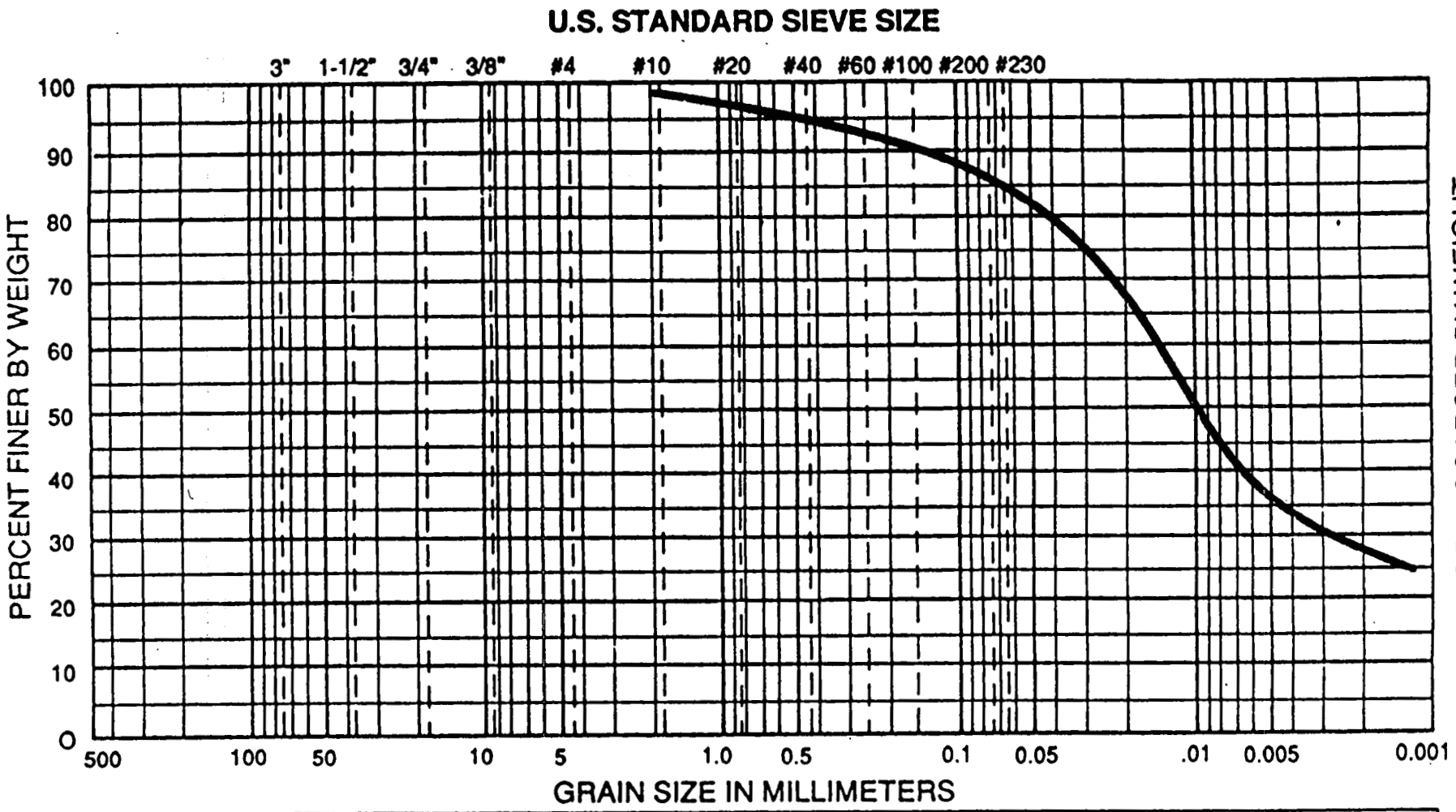
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELL NAME: G2-204 SAMPLE NO.: 10 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	22.5 - 24.5 ft	Gray Sandy Lean Clay (CL)



ASTM D 2487 (USCS)

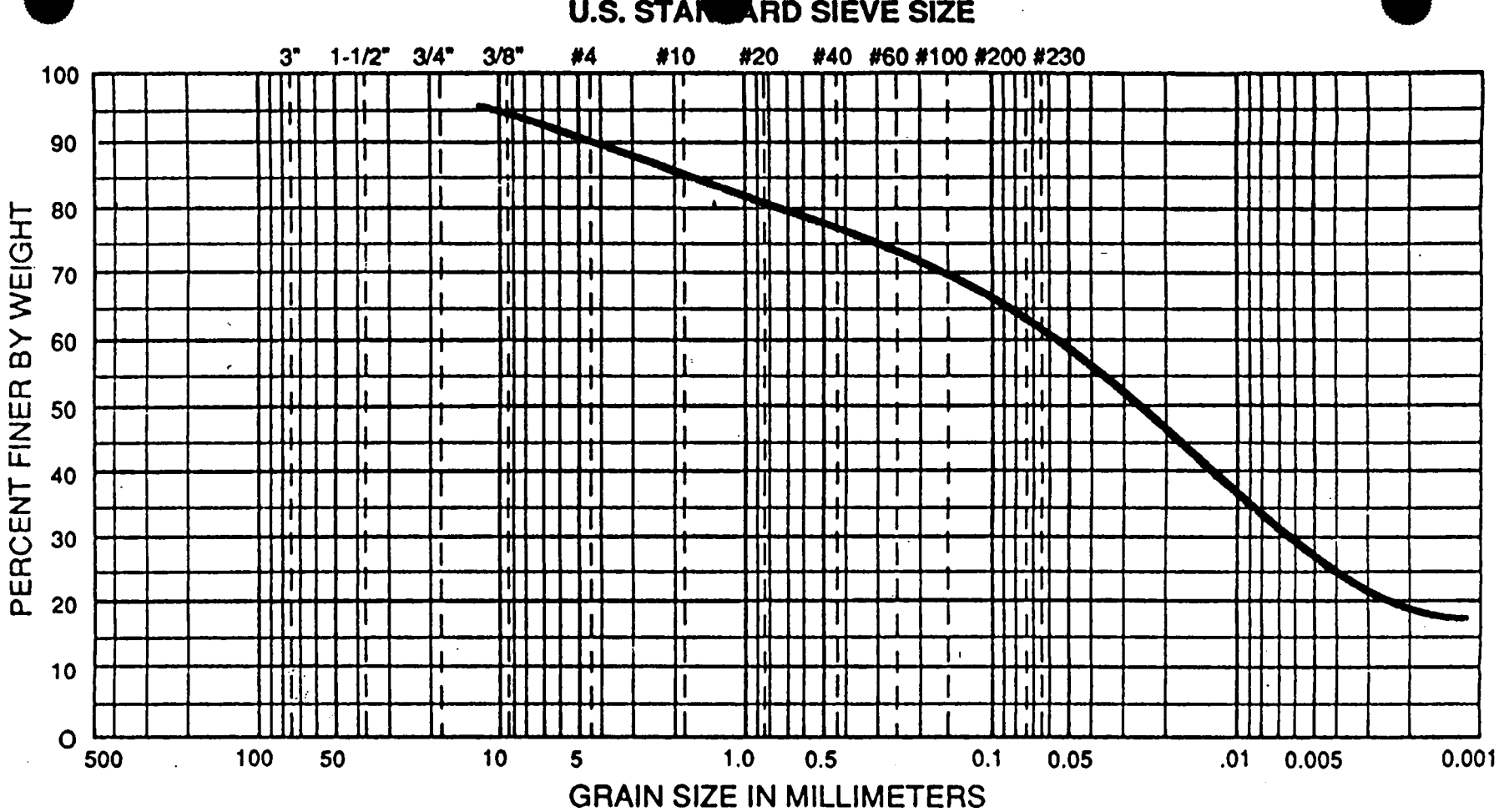
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-205 SAMPLE NO.: 2 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	2.5 - 4.5 ft	Yellowish Brown Lean Clay (CL)

ADVANCED TERRA TESTING
000731



ADVANCED TERRA TESTING

E-3-3-73

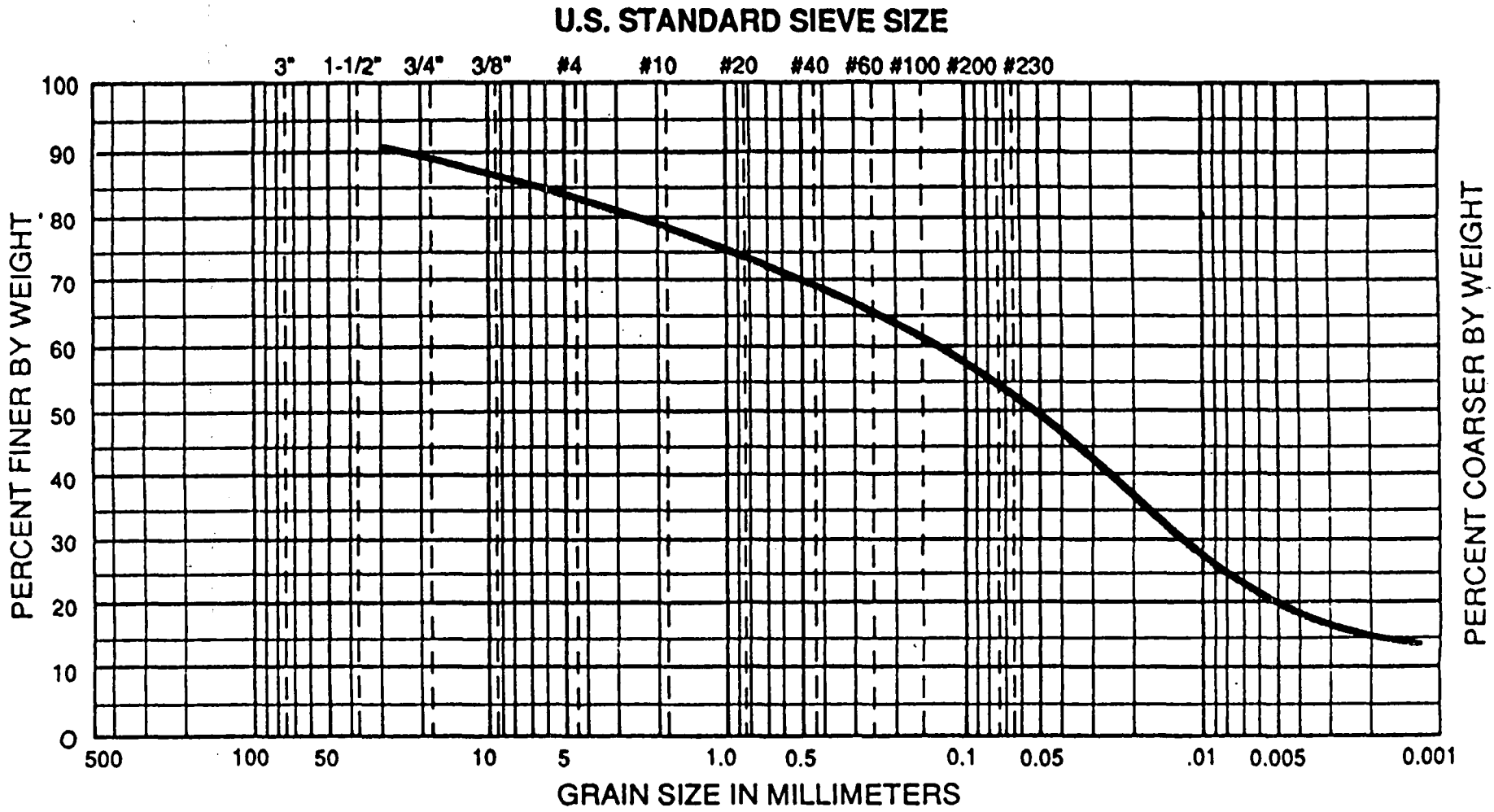
ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-205 SAMPLE NO.: 5 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	10 - 12 ft	Yellowish Brown Sandy Lean Clay (CL)

ADVANCED TERRA TESTING
000733



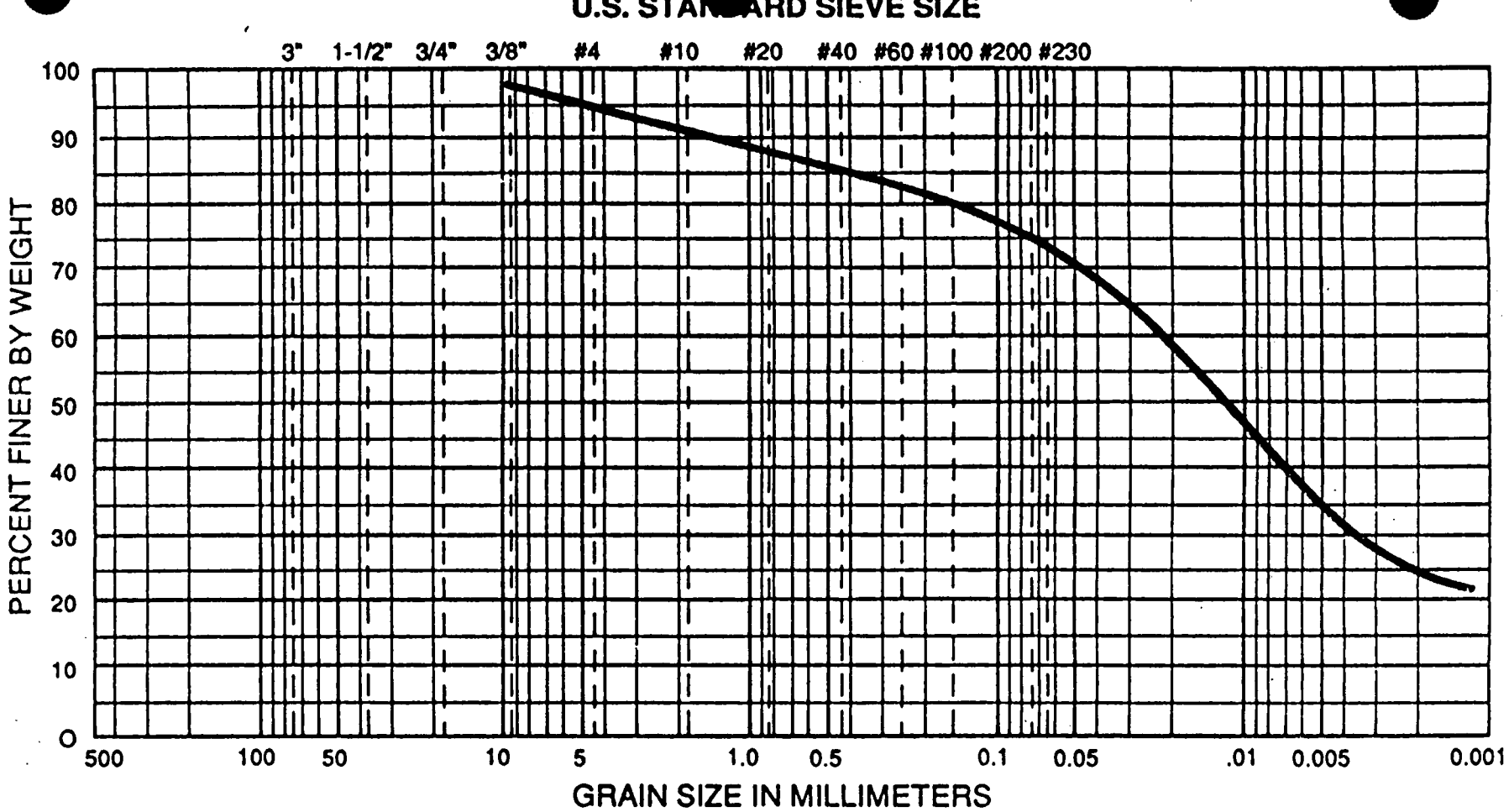
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-205 SAMPLE NO.: 8 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	17.5 - 19.5 ft	Gray Sandy Lean Clay (CL)



ADVANCED TERRA TESTING

E-3-3-75

ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-206 SAMPLE NO.: 2 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	2.5 - 4.5 ft	Yellowish Brown Lean Clay with Sand (CL)

6647

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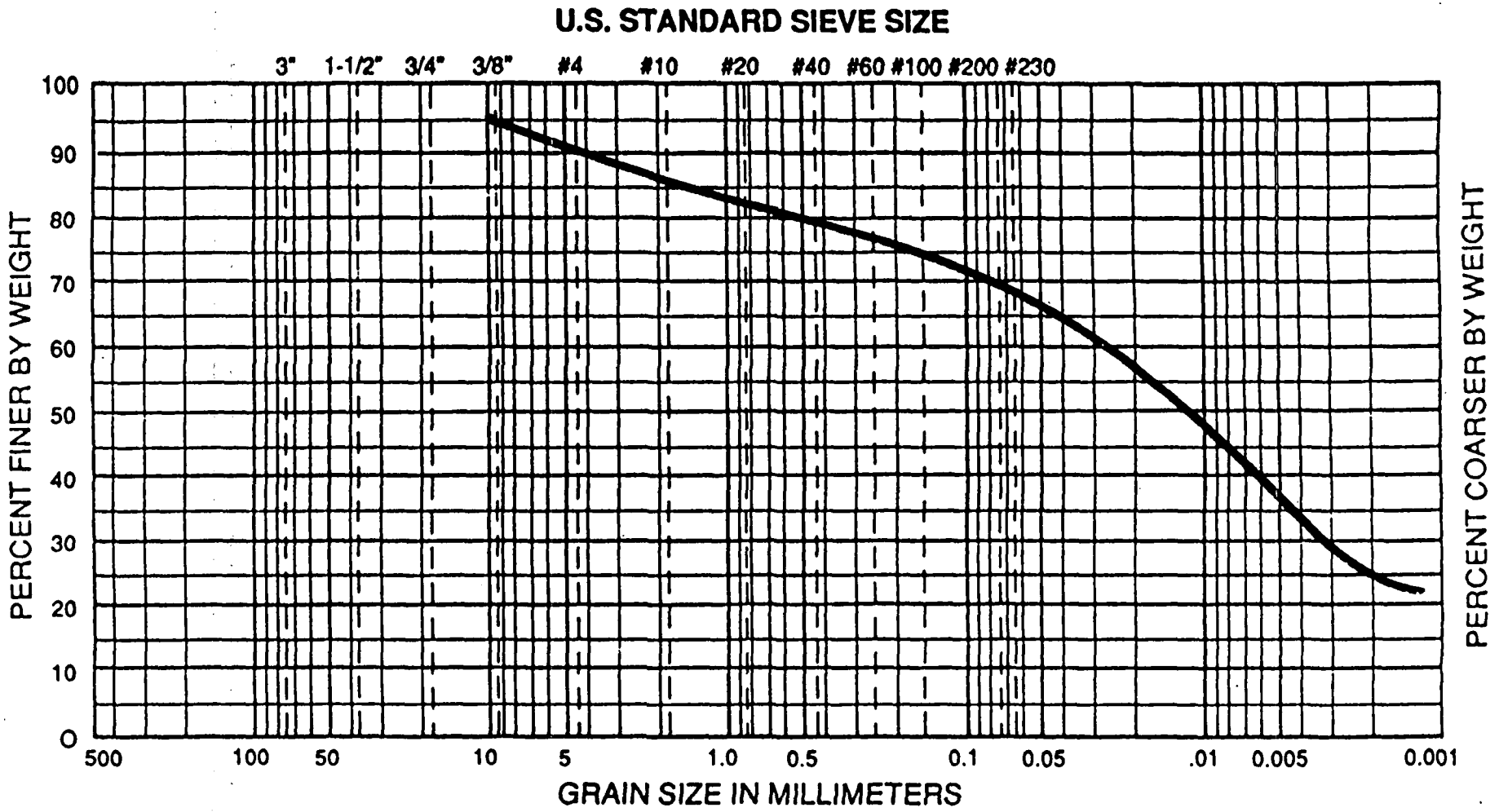
March 1, 1995



ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

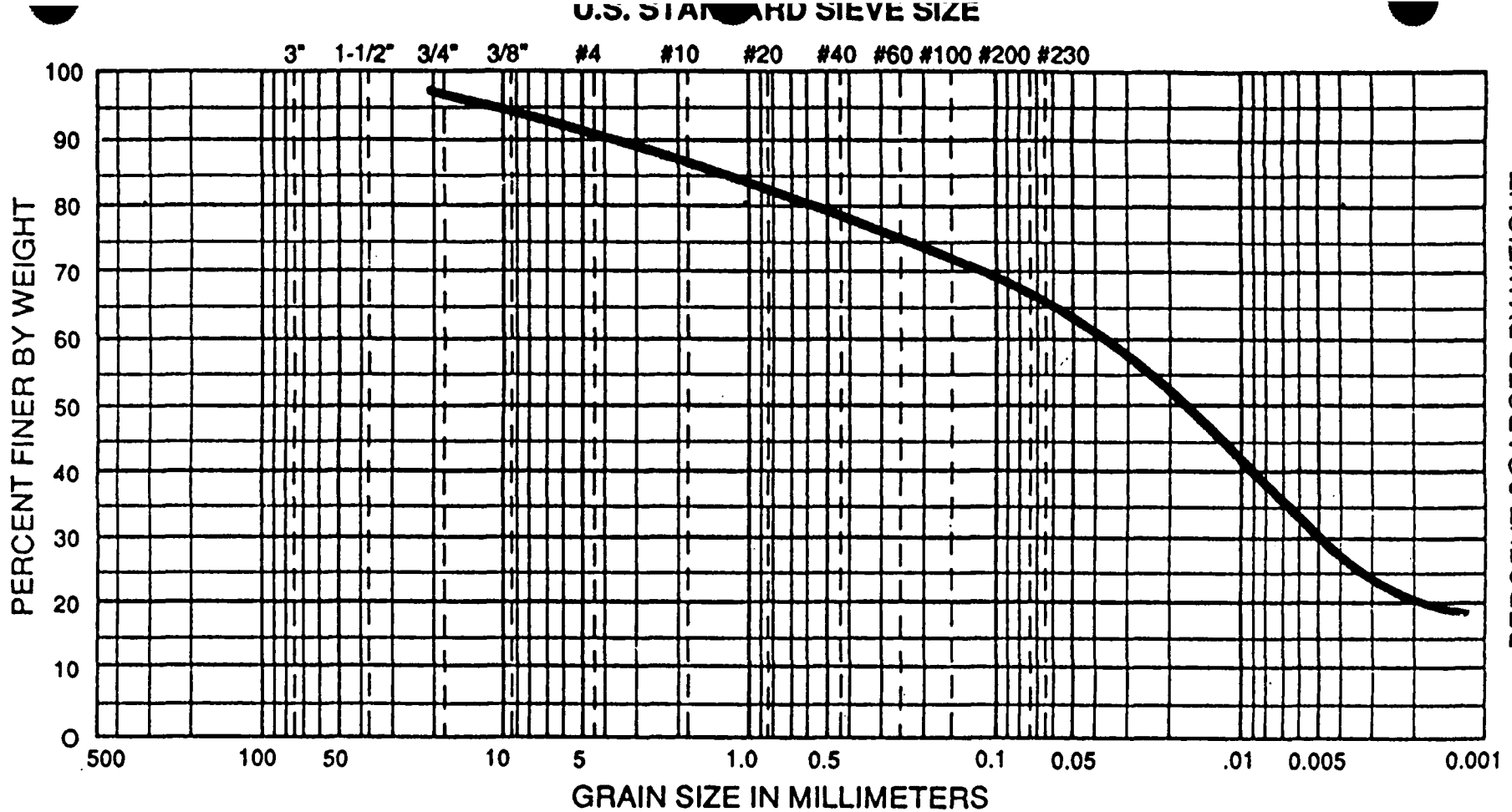
Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-206 SAMPLE NO.: 3 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	5 - 7 ft	Yellowish Brown Lean Clay with Sand (CL)

ADVANCED TERRA TESTING
000735

E-3-3-76



ADVANCED TERRA TESTING

E-3-3-77

ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

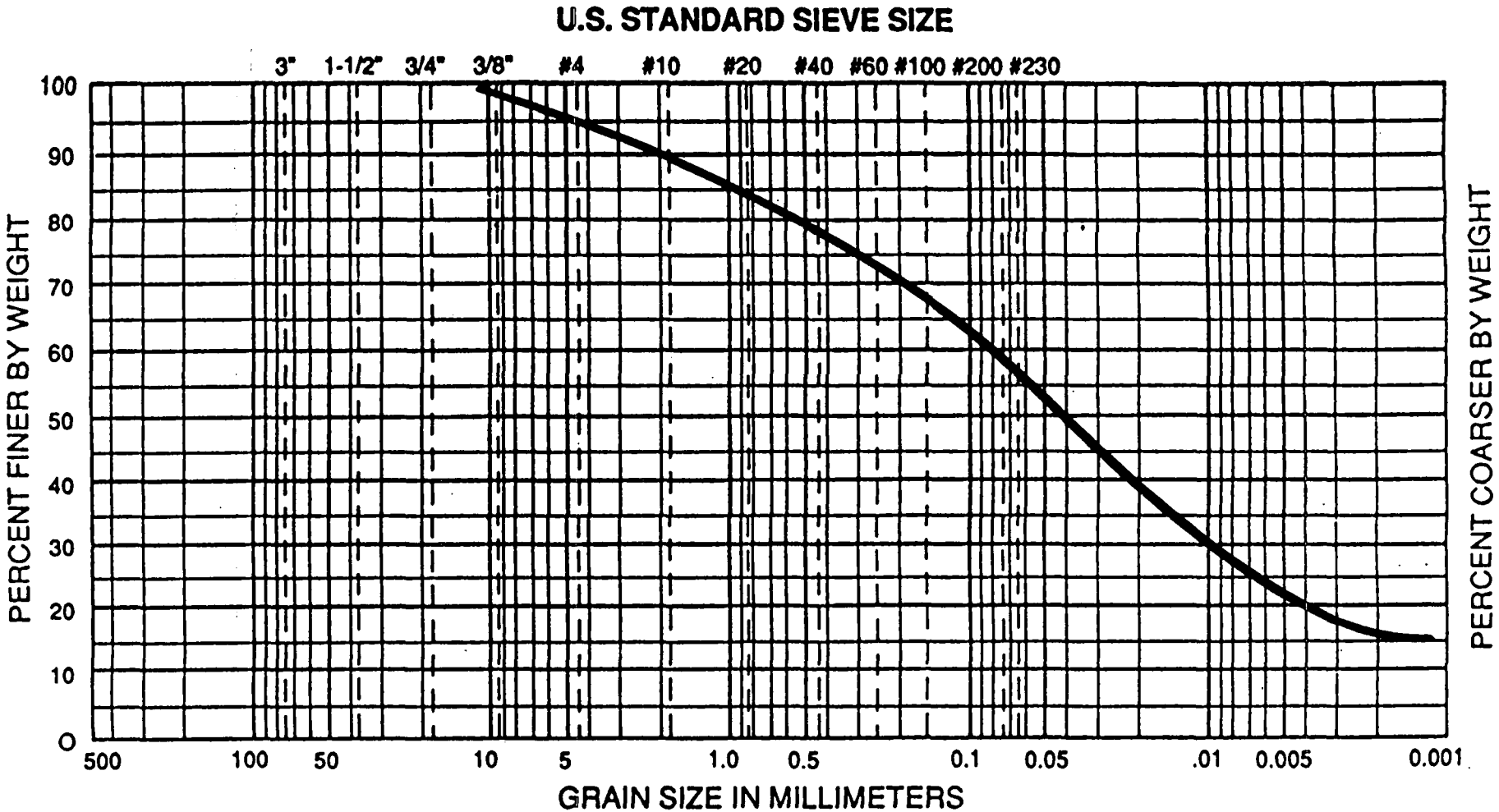
WELLNAME: G2-206 SAMPLE NO.: 4 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	7.5 - 9.5 ft	Yellowish Brown Sandy Lean Clay (CL)

00736

6647

FEMP-OU02-6 FINAL
March 1, 1995



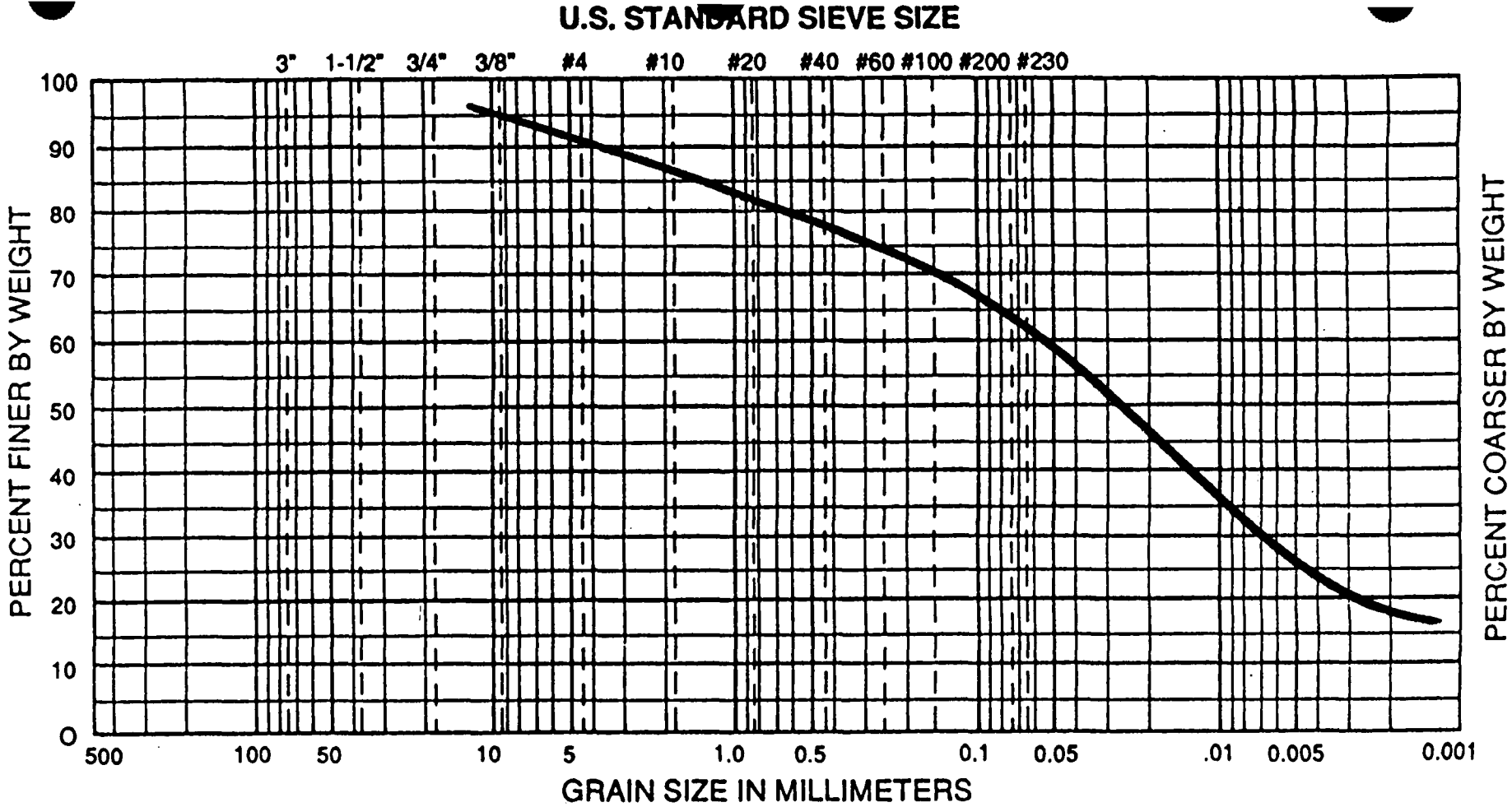
ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-206 SAMPLE NO.: 7 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	15 - 17 ft	Gray Lean Clay (CL)

ADVANCED TERRA. TESTING 000737



ADVANCED TERRA TESTING

E-3-3-79

ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-206 SAMPLE NO.: 5 DATE: 1-17-94 PROJECT NO.: PO-101

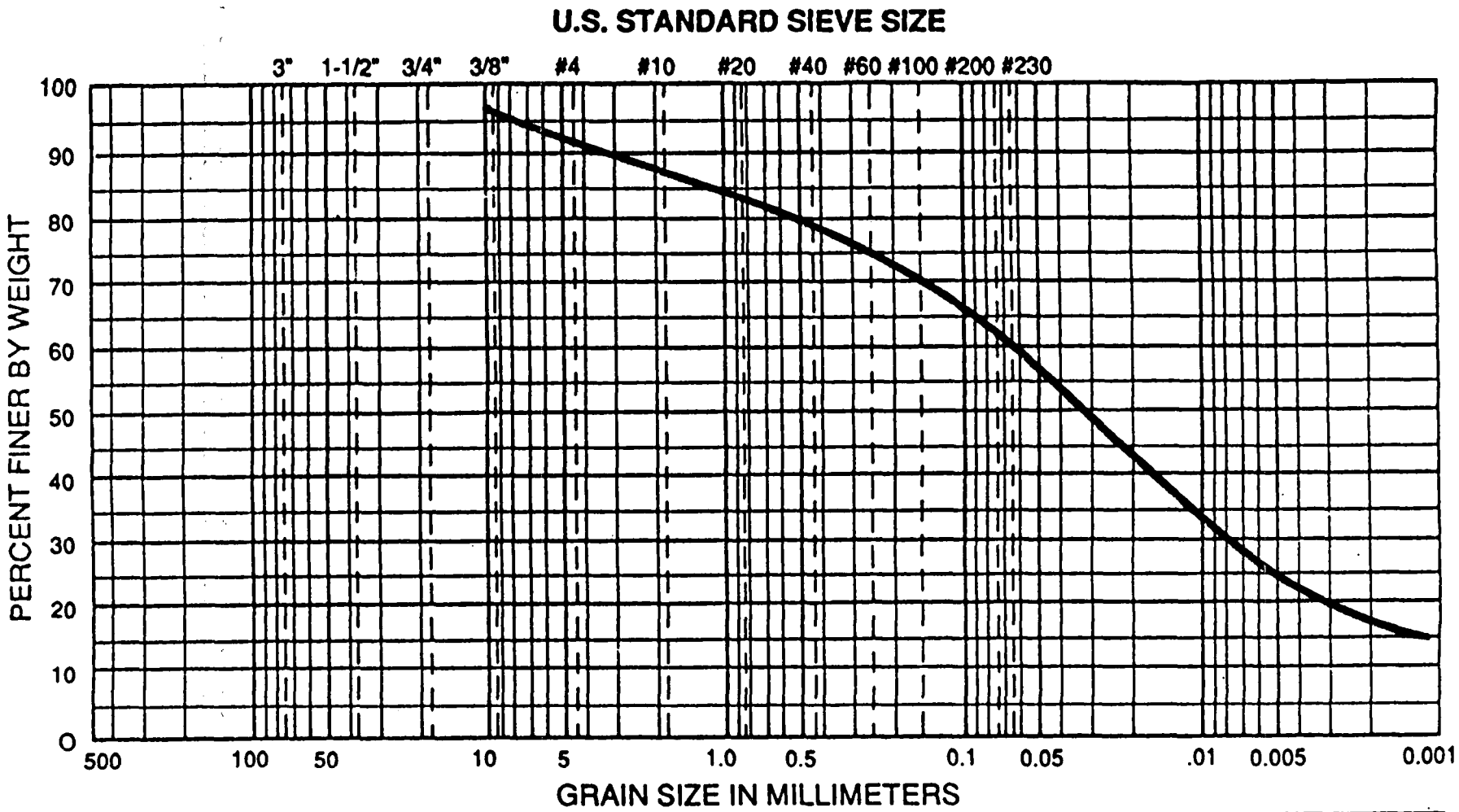
AREA	DEPTH	CLASSIFICATION
On-Site Cell	10 - 12 ft	Yellowish Brown Sandy Lean Clay (CL)

6647

FEMP-OU02-6 FINAL
March 1, 1995

000238

ADVANCED TERRA TESTING
000239



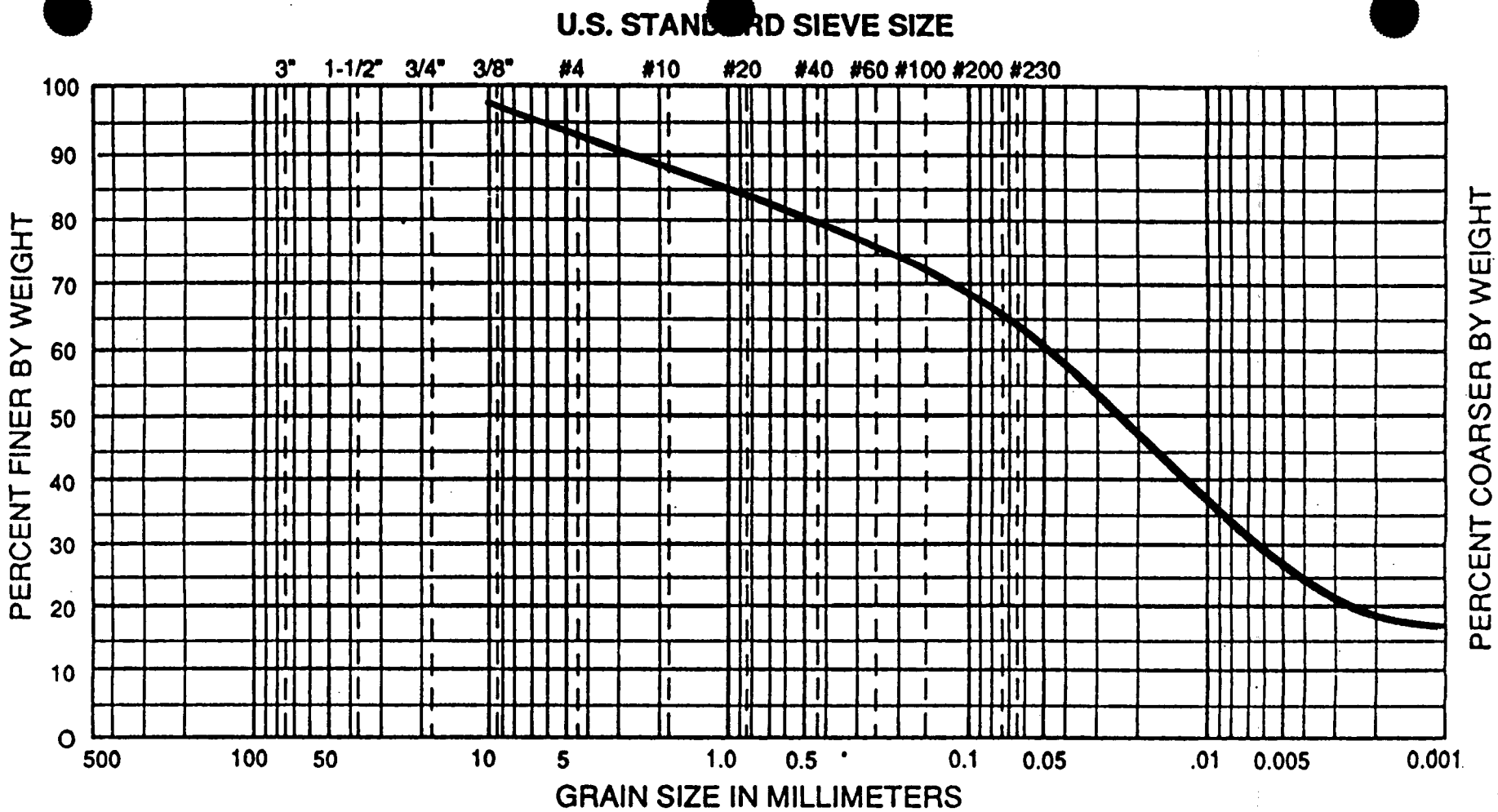
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-206 SAMPLE NO.: 10 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	22.5 - 24.5 ft	Gray Sandy Lean Clay (CL)



ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

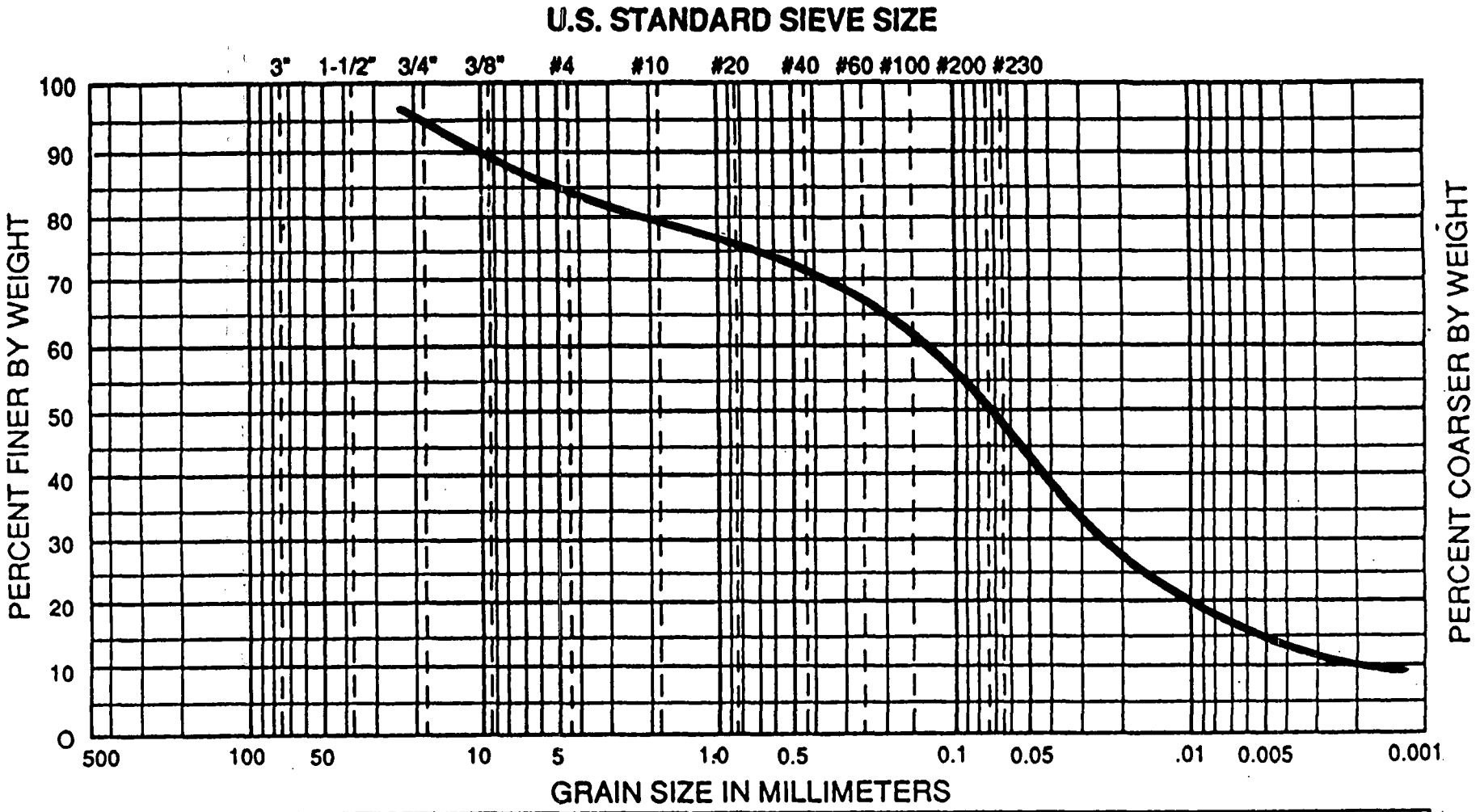
Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-207 SAMPLE NO.: 5 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	10 - 12 ft	Yellowish Brown Sandy Lean Clay (CL)

E-3-3-81

000740



ASTM D 2487 (USCS)

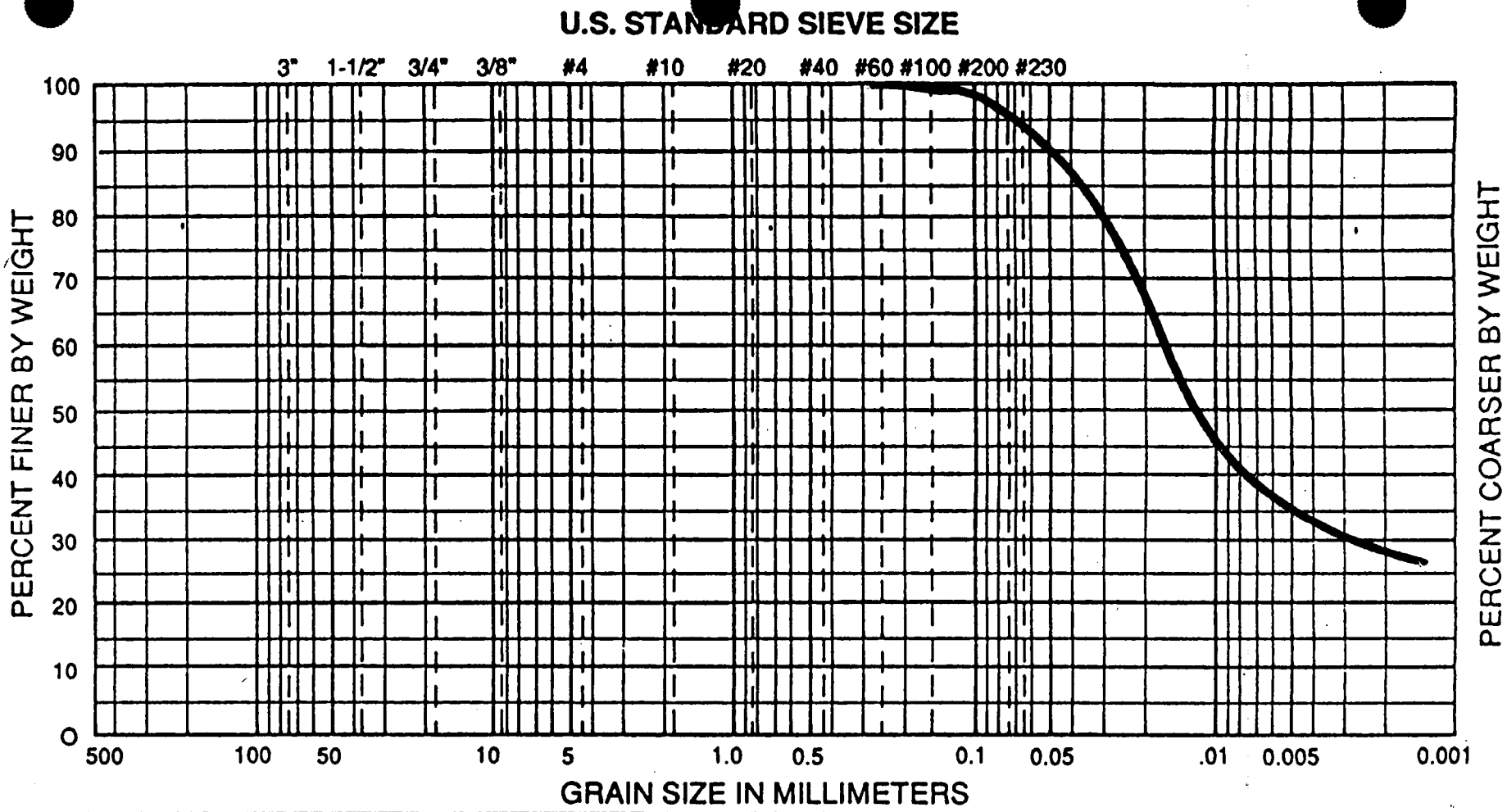
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-207 SAMPLE NO.: 11 DATE: 2-10-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	25 - 27 ft	Gray Sandy Silty Clay (CL-ML)

ADVANCED TERRA TESTING 000741



ADVANCED TERRA TESTING

E-3-3-83

ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

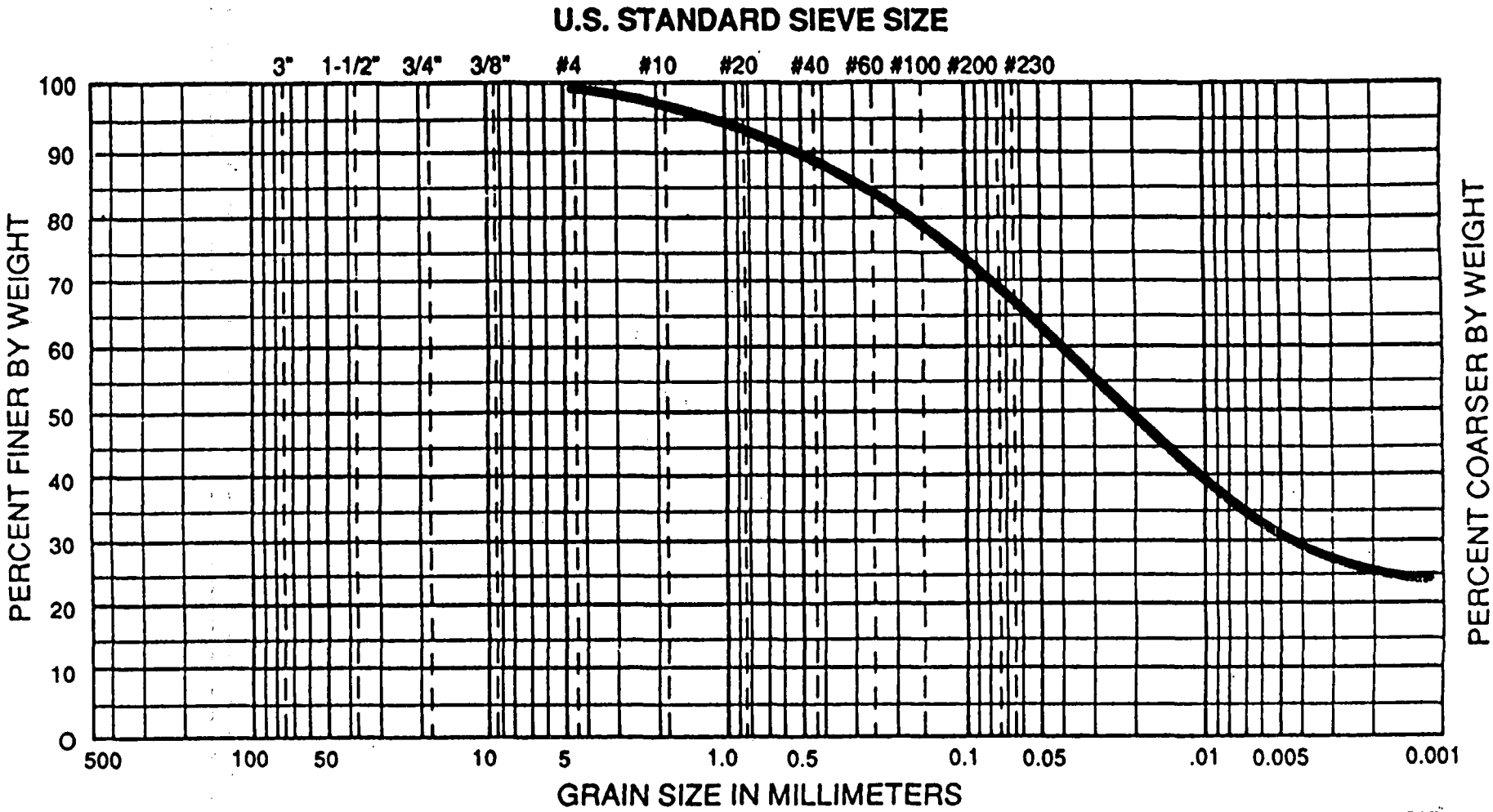
WELLNAME: G2-208 SAMPLE NO.: 2 DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	2.5 - 4.5 ft	Yellowish Brown Lean Clay (CL)

6642

FEMP-OU02-6 FINAL
March 1, 1995

000242



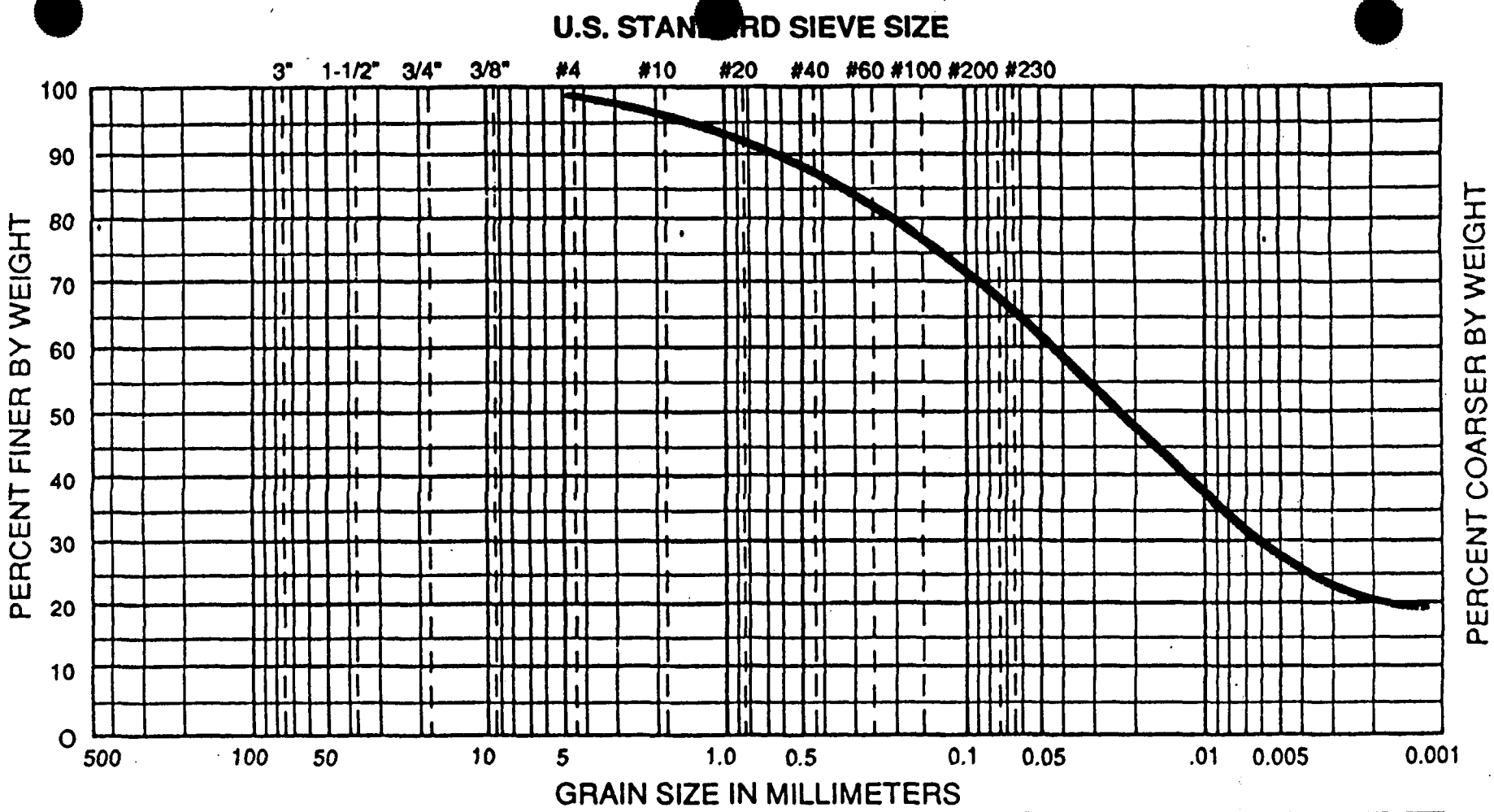
ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-208 SAMPLE NO.: 3 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	5 - 7 ft	Yellowish Brown Sandy Lean Clay (CL)

ADVANCED TERRA TESTING
000743



ADVANCED TERRA TESTING

E-3-3-85

ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-208 SAMPLE NO.: 4 DATE: 1-3-94 PROJECT NO.: PO-101

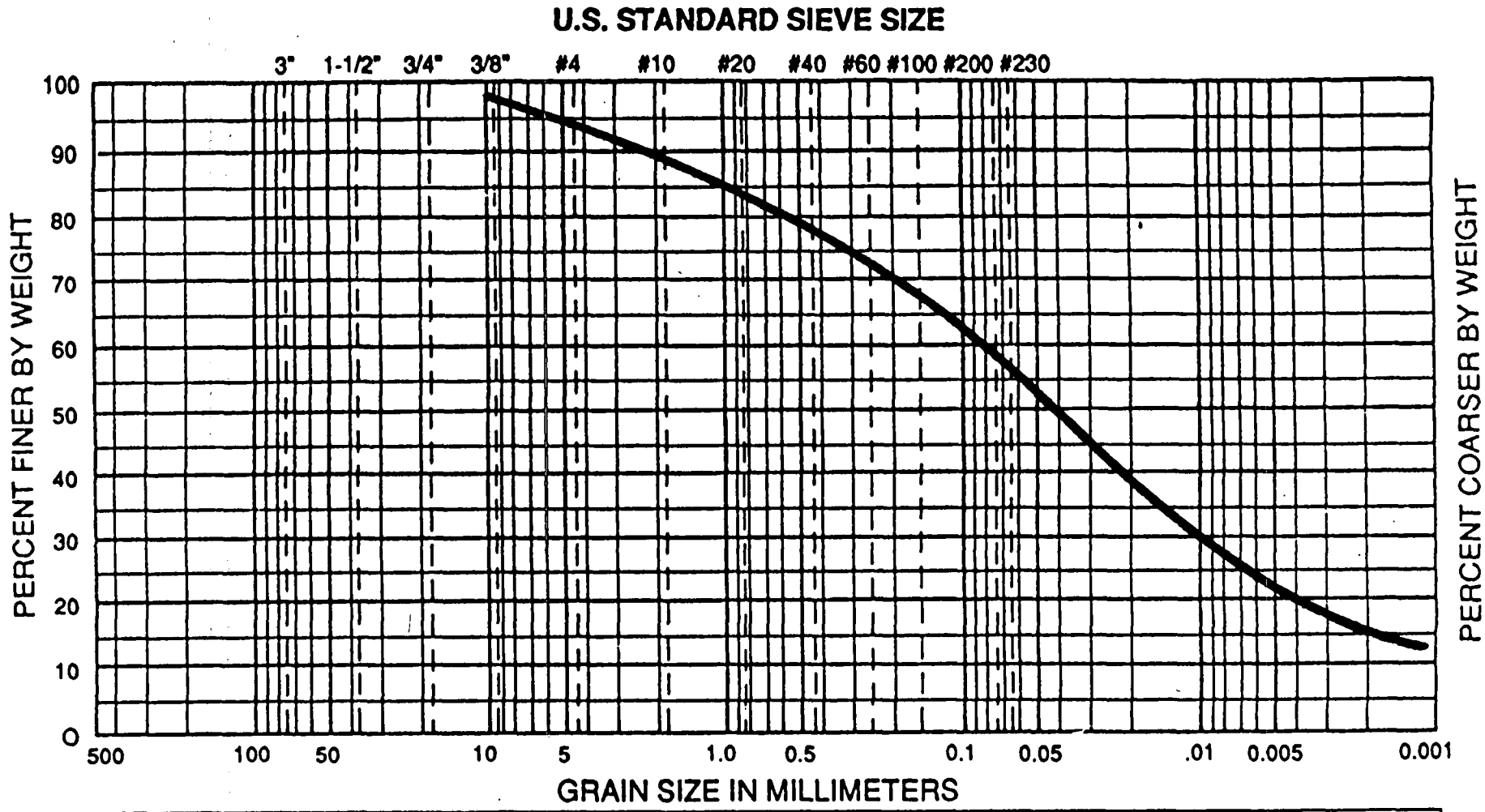
AREA	DEPTH	CLASSIFICATION
On-Site Cell	7.5 - 9.5 ft	Yellowish Brown Sandy Lean Clay (CL)

000744

- 6647

FEMP-OU02-6 FINAL
March 1, 1995

ADVANCED TERRA TESTING
000245



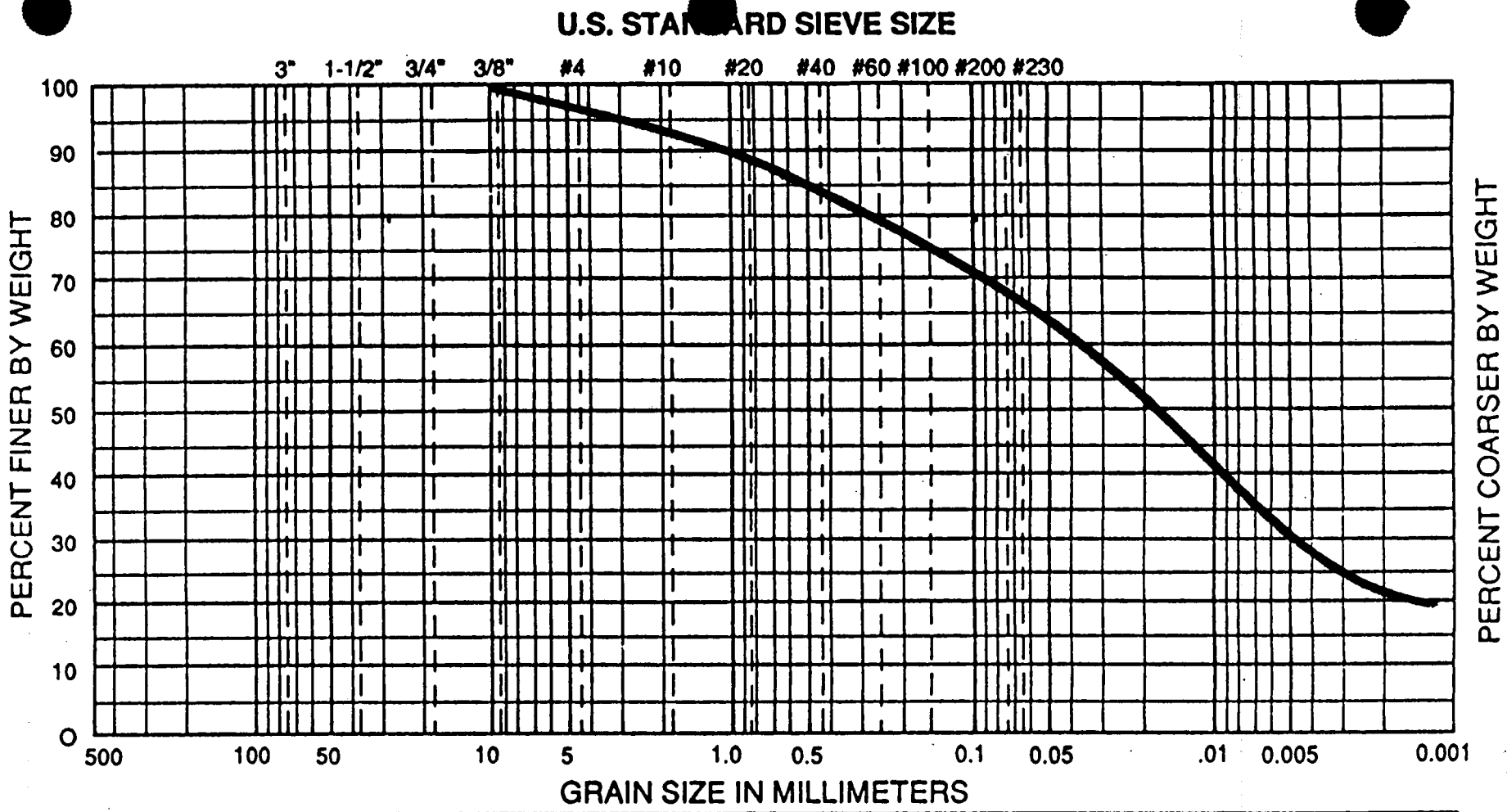
E-3-3-86

ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-208 SAMPLE NO.: 9 DATE: 1-17-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	20 - 22 ft	Gray Sandy Lean Clay (CL)



ADVANCED TERRA TESTING

E-3-3-87

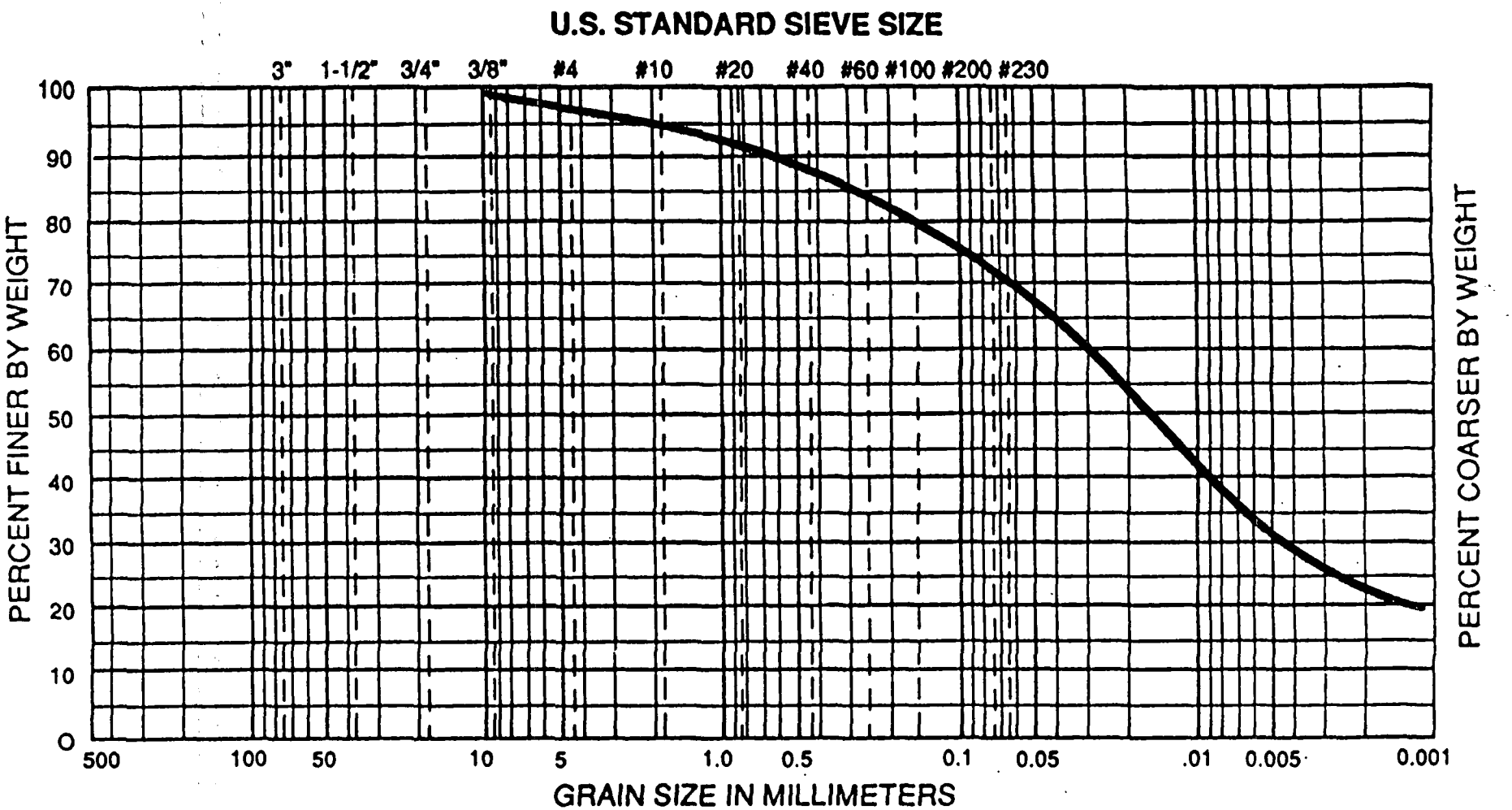
ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-209 SAMPLE NO.: BULK DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	0 - 25 ft	Brown and Gray Sandy Lean Clay (CL)



ASTM D 2487 (USCS)

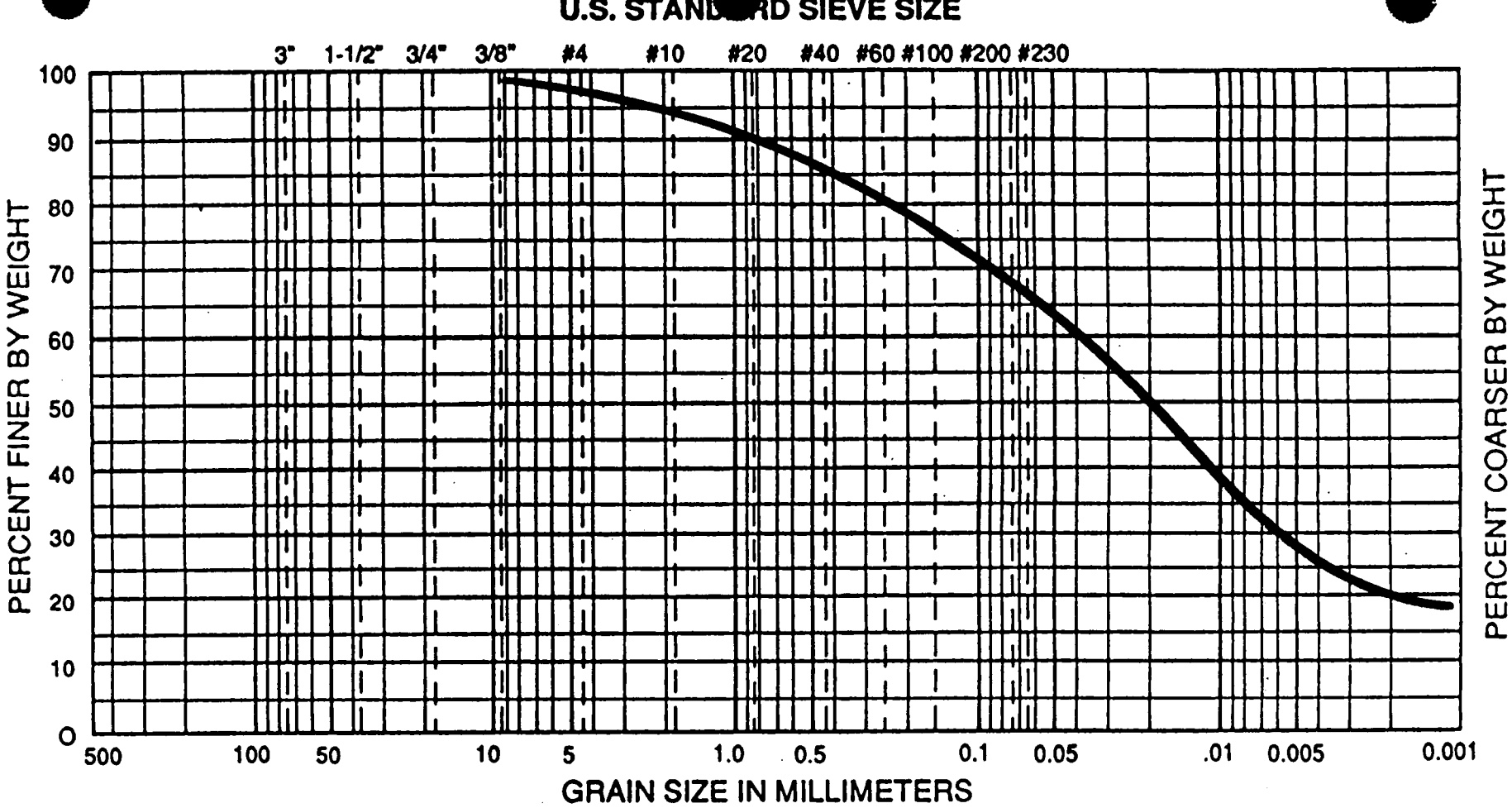
COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as *those smaller than 0.005 mm* (Ref: ASTM D 422)

WELLNAME: G2-210 SAMPLE NO.: BULK DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	0 - 25 ft	Brown and Gray Lean Clay with Sand (CL)

ADVANCED TERRA TESTING
000247



ADVANCED TERRA TESTING

E-3-3-89

ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

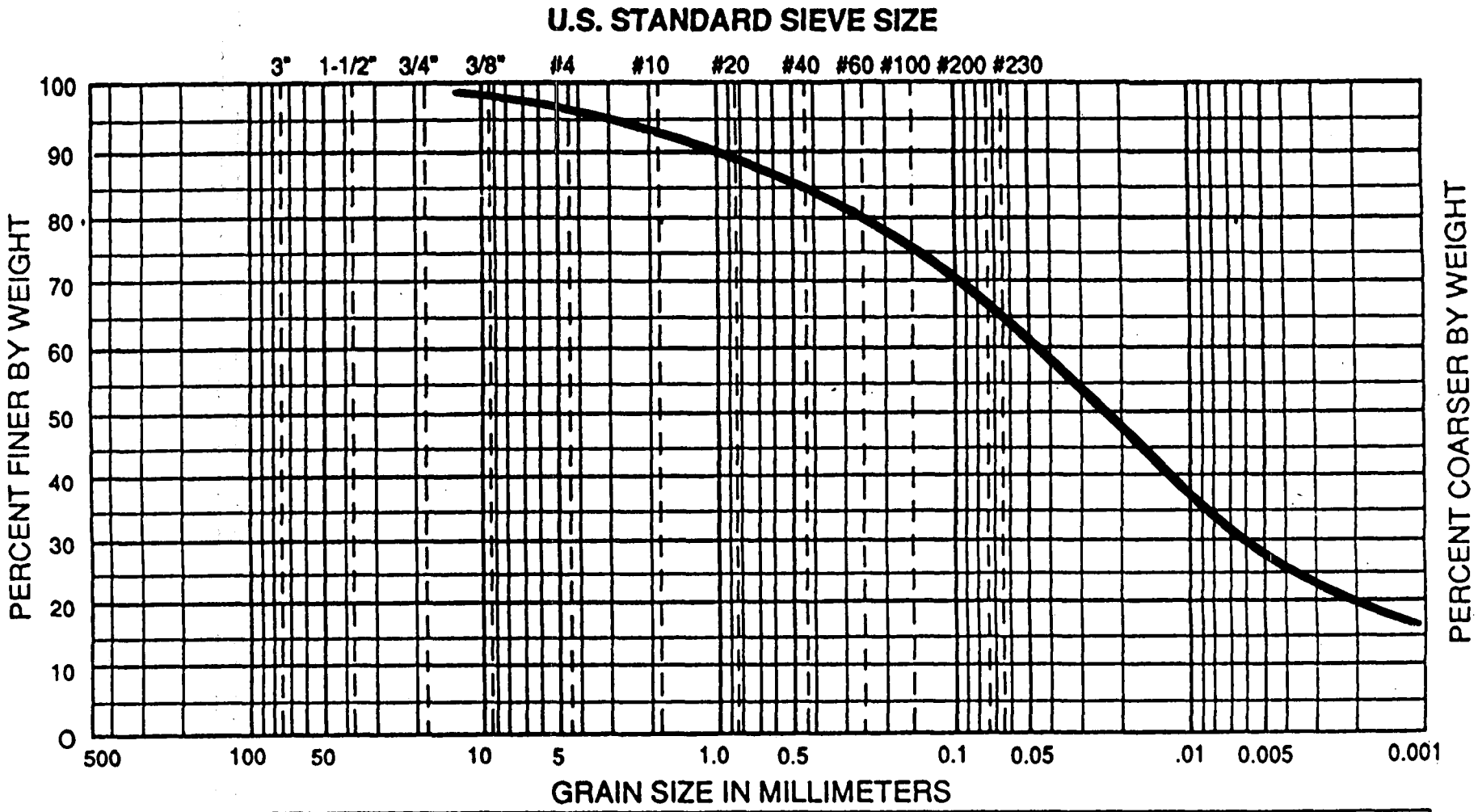
Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-201-204 SAMPLE NO.: BULK DATE: 2-9-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	0 - 24.5 ft	Brown and Gray Lean Clay with Sand (CL)

000748

6647



ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-205-208 SAMPLE NO.: BULK DATE: 2-9-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	0 - 24.5 ft	Brown and Gray Sandy Lean Clay (CL)

APPENDIX C

MOISTURE DENSITY RELATIONSHIPS

Sample No. G2-205-208 Depth 0 - 24.5 Elevation _____

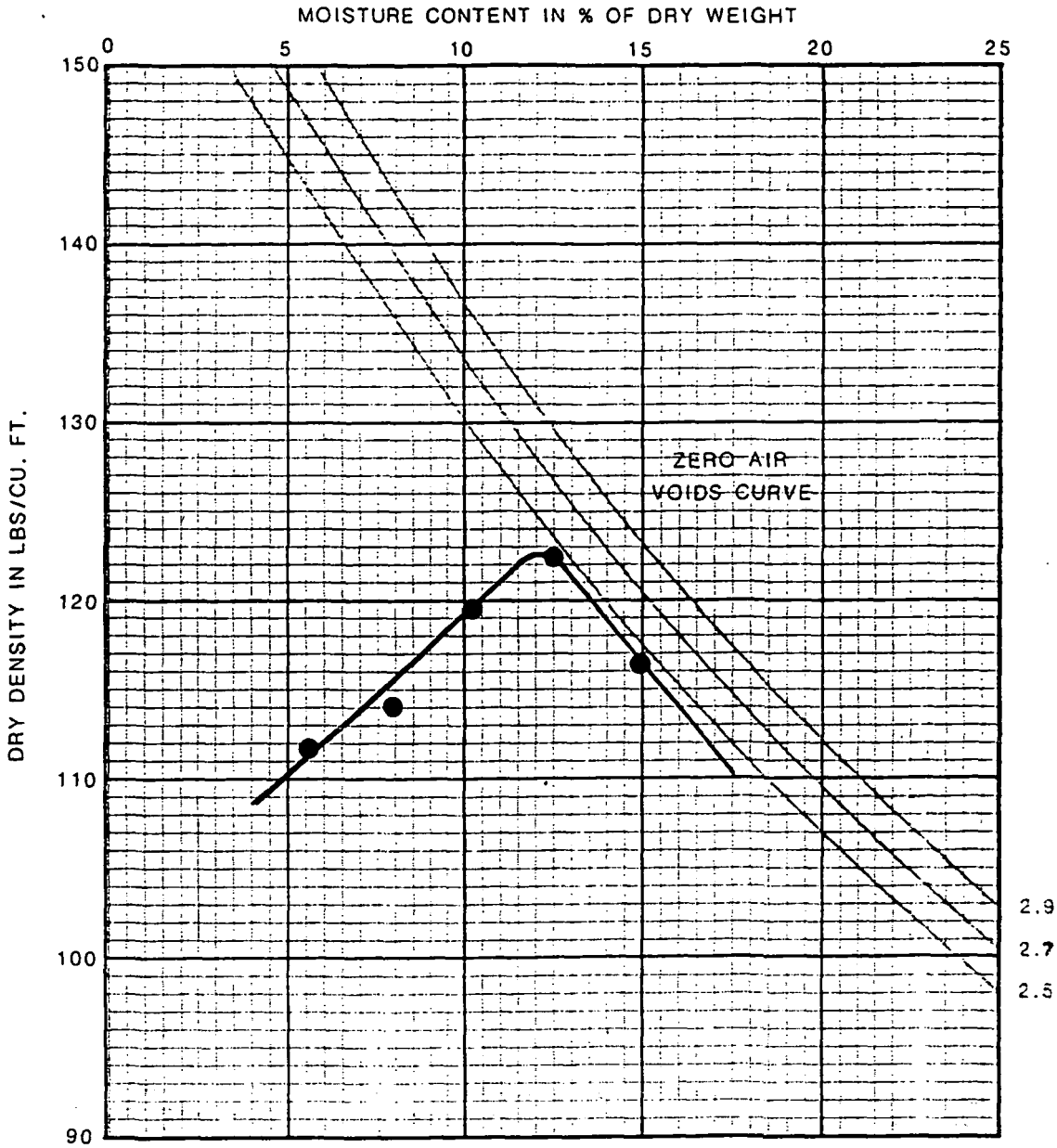
Soil Composite 205, 206, 207, 208

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.3%

Maximum Dry Density 122.5 pcf

Method of Compaction ASTM D 698, Method A



File _____

COMPACTION TEST DATA

ADVANCED TERRA TESTING

Sample No. G2-201-204 Depth 0 - 24.5 Elevation _____

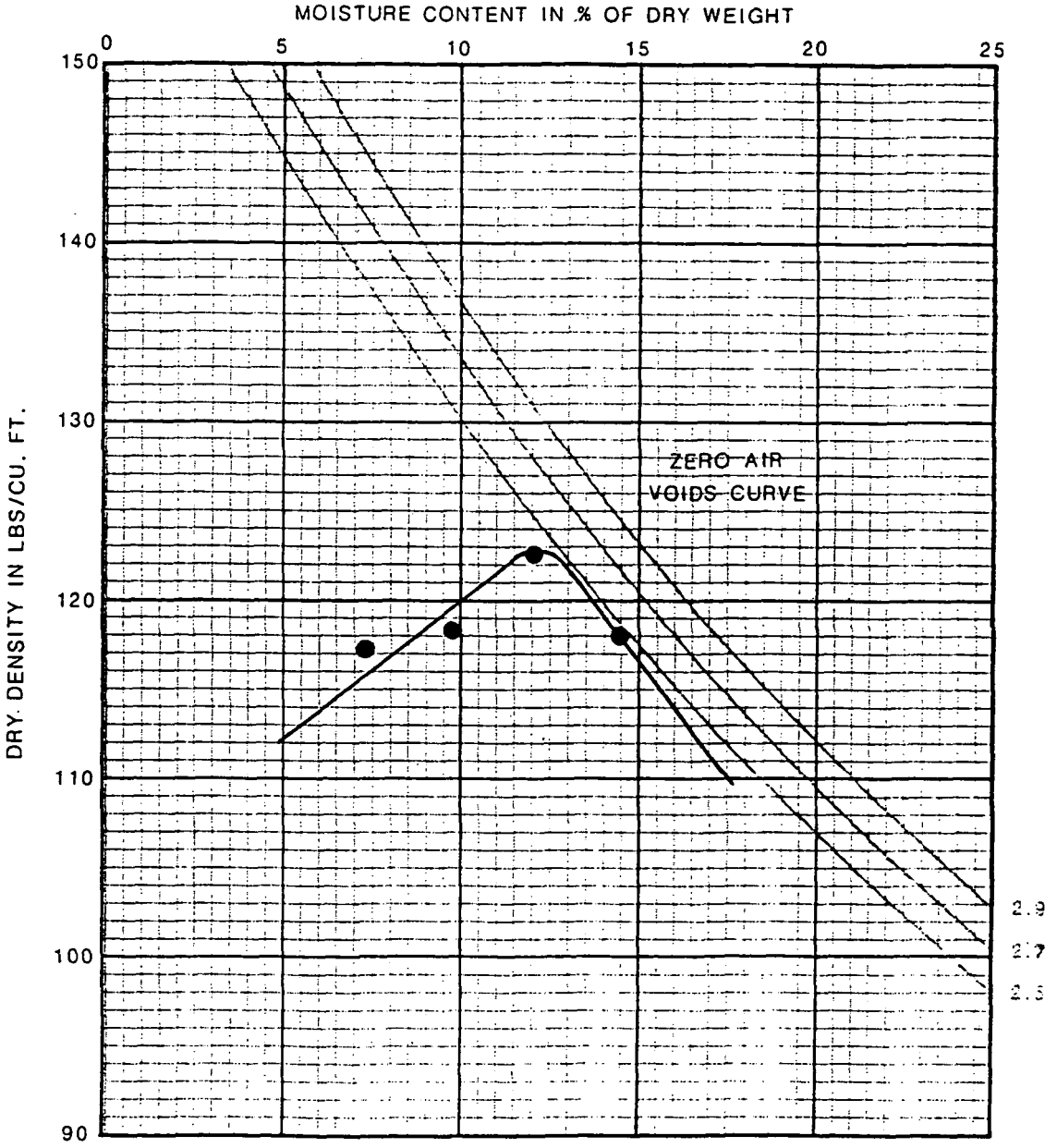
Soil Composite 201, 202, 203, 204

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.0%

Maximum Dry Density 122.7 pcf

Method of Compaction ASTM D 698, Method A



COMPACTION TEST DATA

ADVANCED TERRA TESTING

File

000252

Sample No. G2-210 Depth 0 - 25 Elevation _____

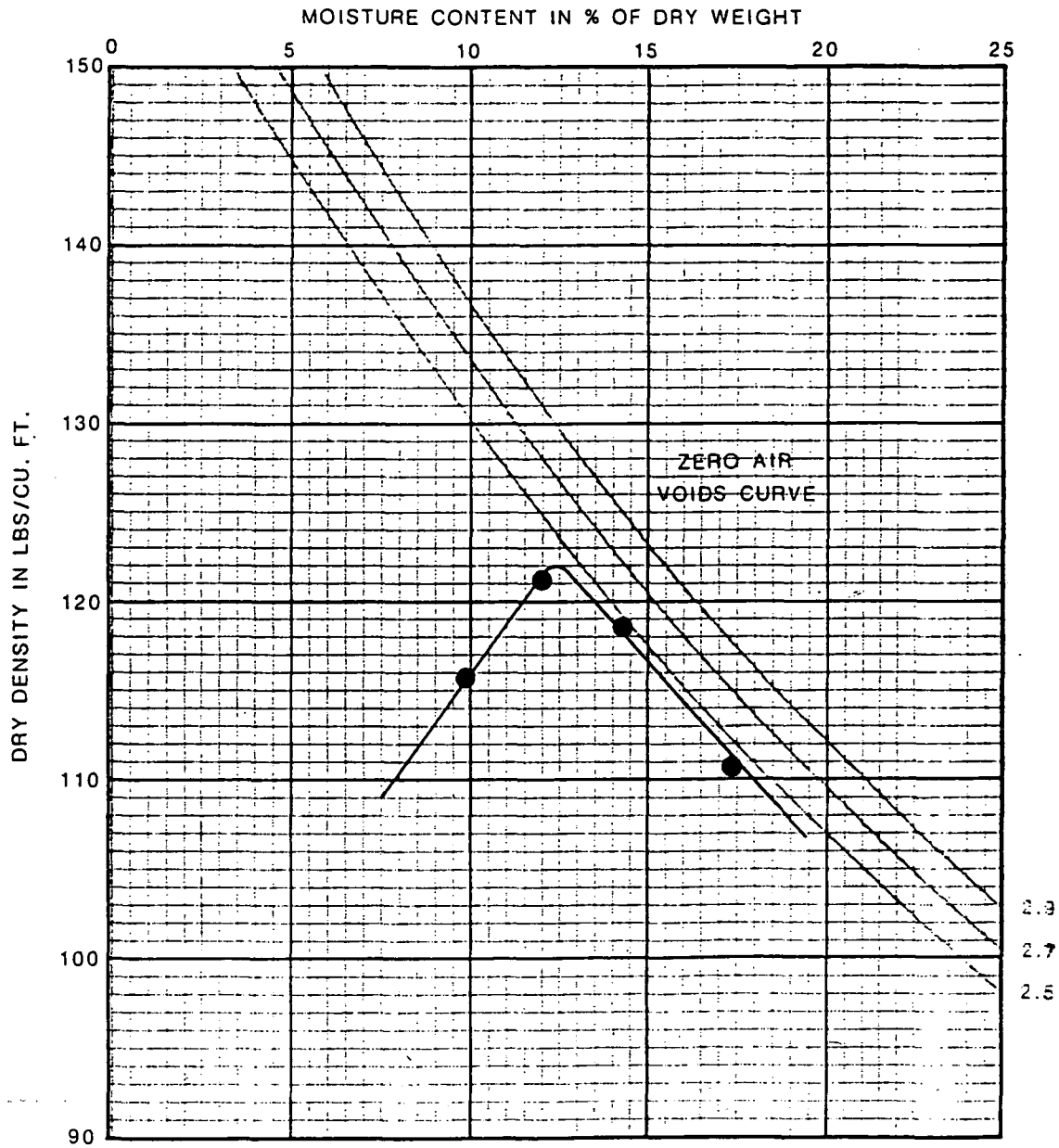
Soil Brown and Gray Lean Clay with Sand (CL)

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.4%

Maximum Dry Density 122.3 pcf

Method of Compaction ASTM D 698, Method A



File _____

COMPACTION TEST DATA

ADVANCED TERRA TESTING

Sample No. G2-209 Depth 0 - 25 Elevation _____

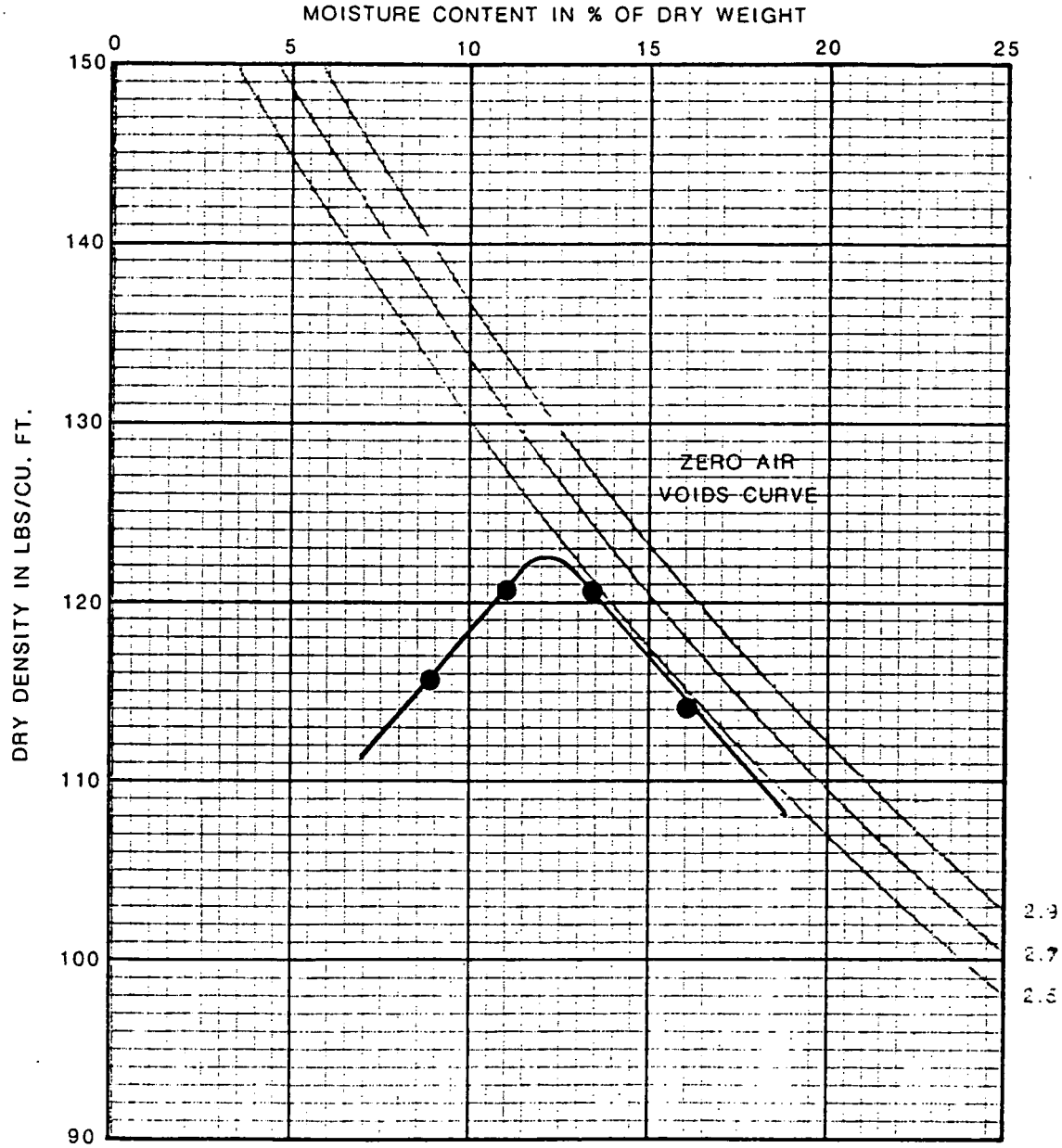
Soil Brown and Gray Sandy Lean Clay (CL)

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.3%

Maximum Dry Density 122.3 pcf

Method of Compaction ASTM D 698, Method A



COMPACTION TEST DATA

ADVANCED TERRA TESTING

000254

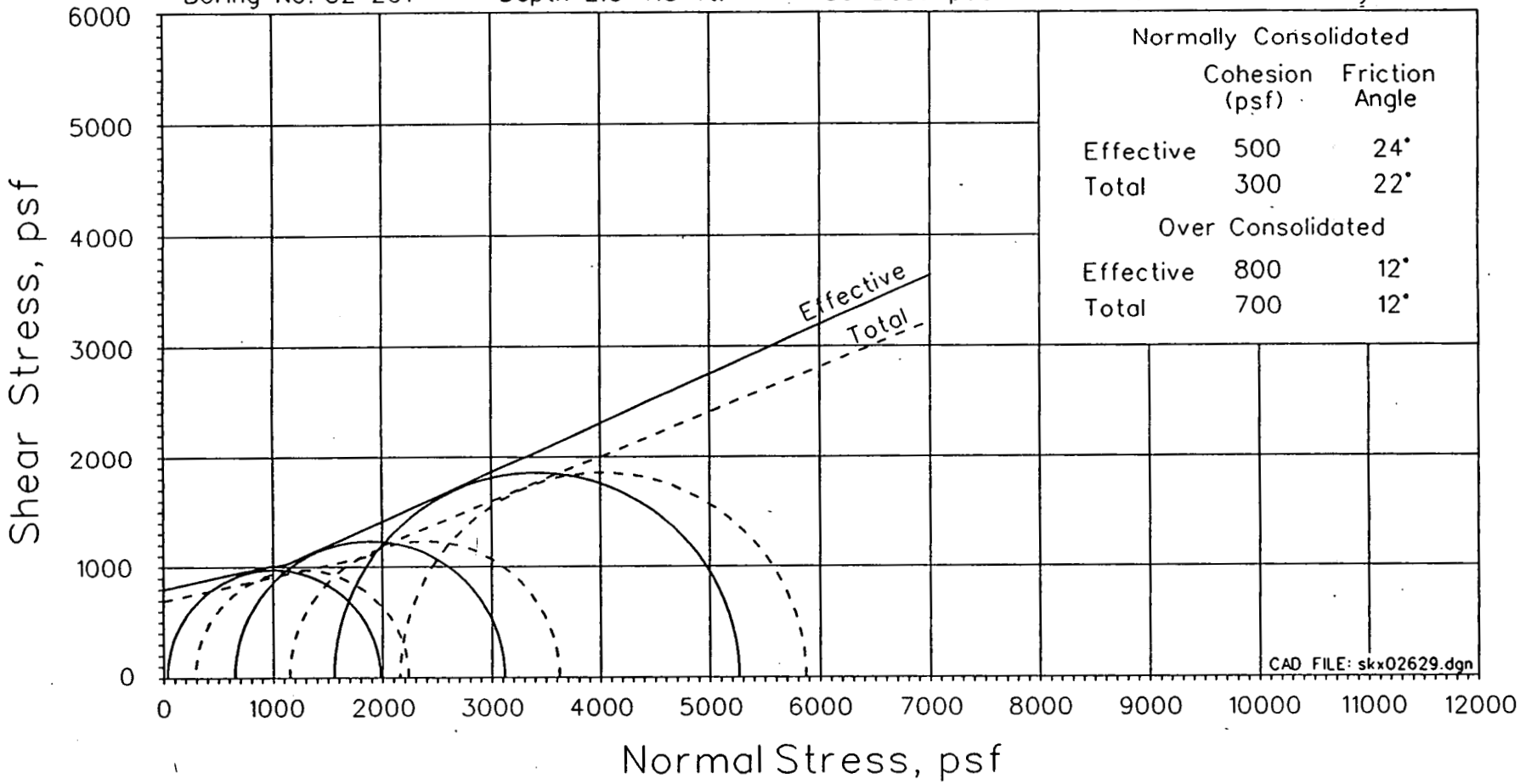
File

APPENDIX D

MOHR STRENGTH ENVELOPES

Triaxial Compression Test Report

Boring No. G2-201 Depth 2.5-4.5 ft. Soil Description - Yellowish brown lean clay [CL]



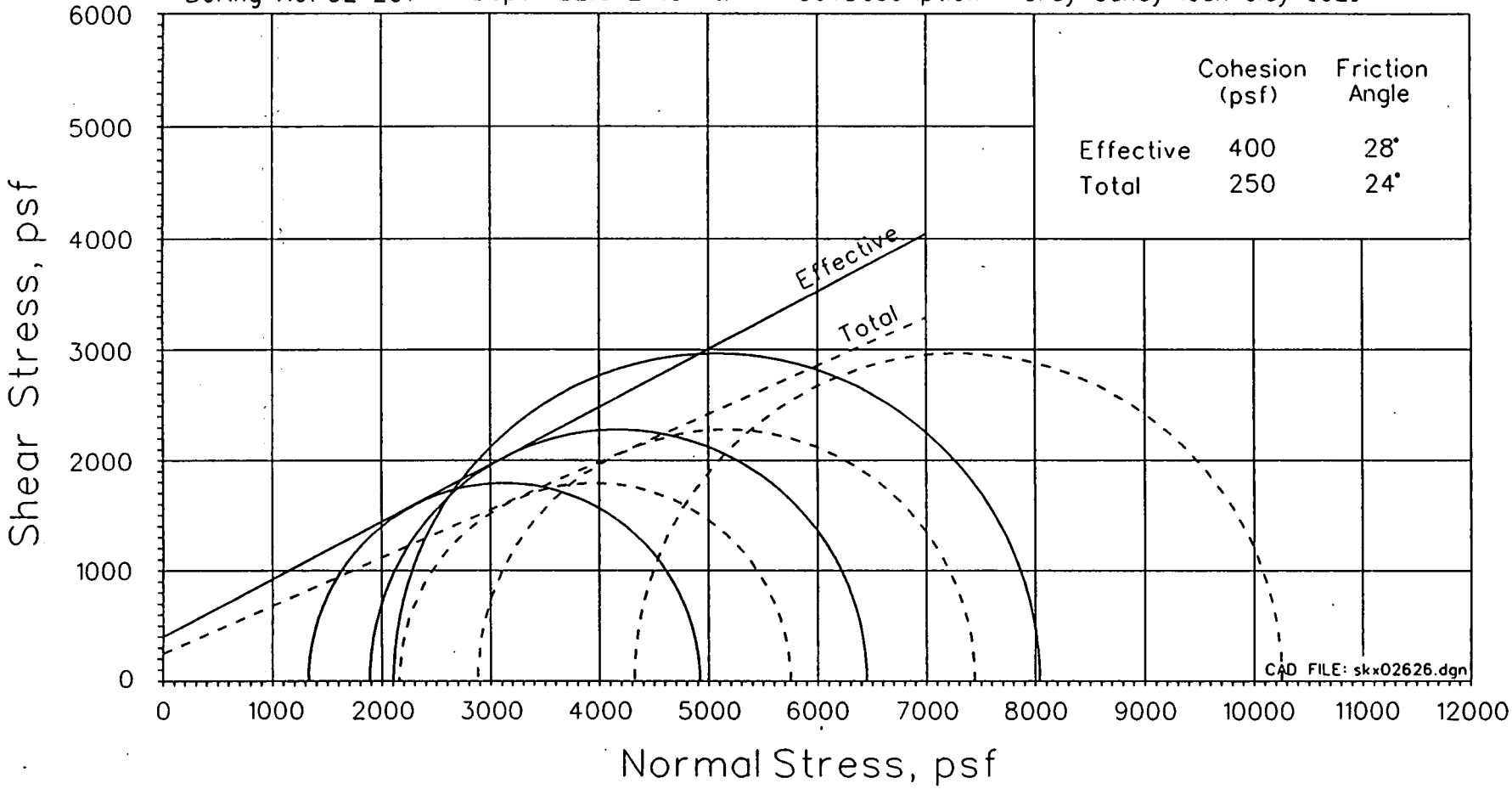
Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-201	2.5-4.5	1	18.2	27.5	119.4	101.1	0.33	1953	259	29	1982	68.82
		2	17.7	25.7	120.9	102.8	1.37	2472	504	648	3120	4.82
		3	20.4	24.7	130.2	108.2	3.33	3711	605	1555	5266	3.39

6647
000756

Triaxial Compression Test Report

Boring No. G2-201 Depth 22.5-24.5 ft. Soil Description - Gray sandy lean clay [CL]

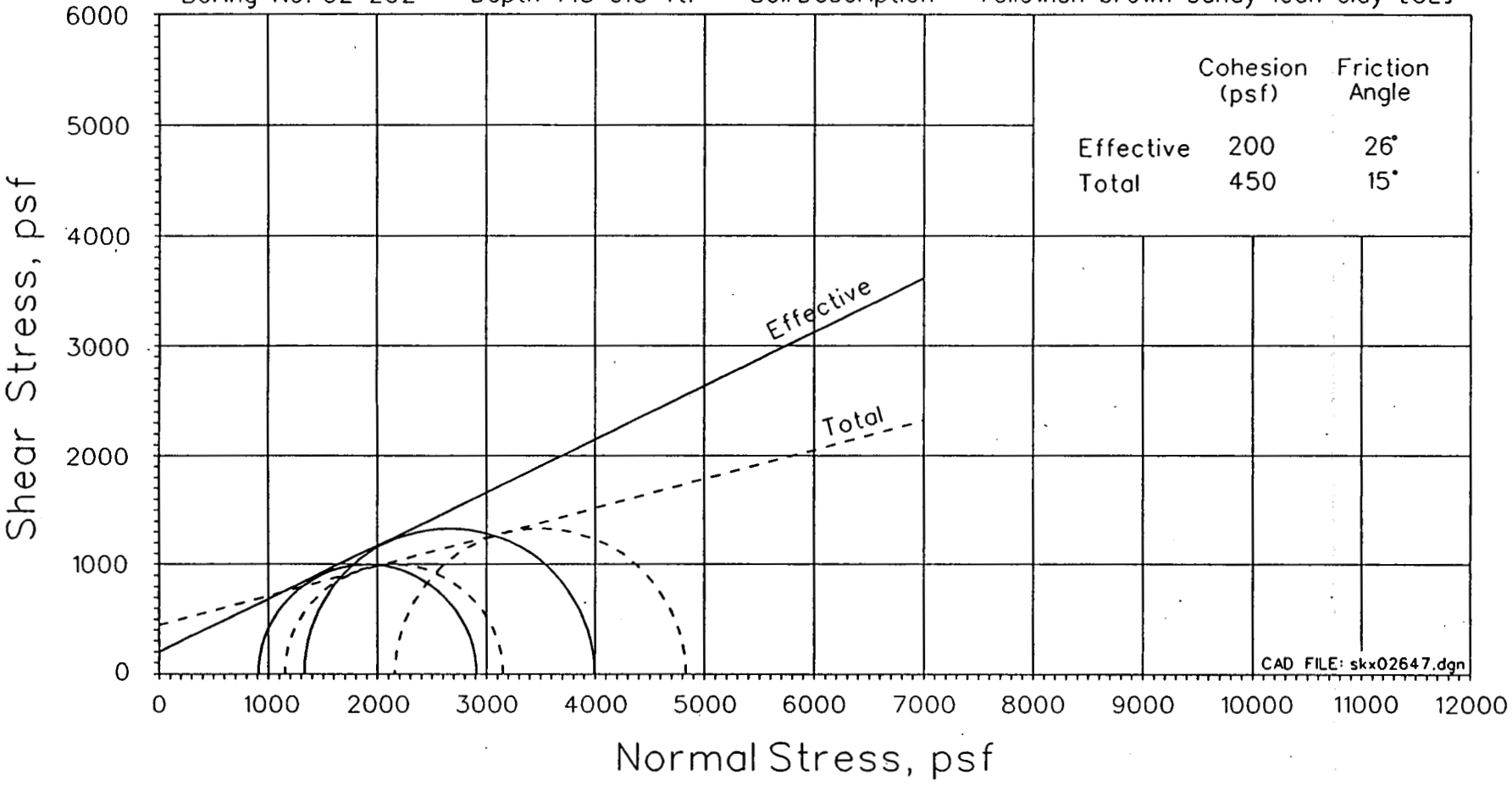


Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-201	22.5-24.5	1	12.6	12.2	143.7	127.6	6.17	3595	835	1325	4919	3.71
		2	13.0	12.1	143.4	126.9	5.14	4566	994	1886	6453	3.42
		3	13.8	12.5	142.4	125.2	6.06	5938	2218	2102	8041	3.82

Triaxial Compression Test Report

Boring No. G2-202 Depth 7.5-9.5 ft. Soil Description - Yellowish brown sandy lean clay [CL]

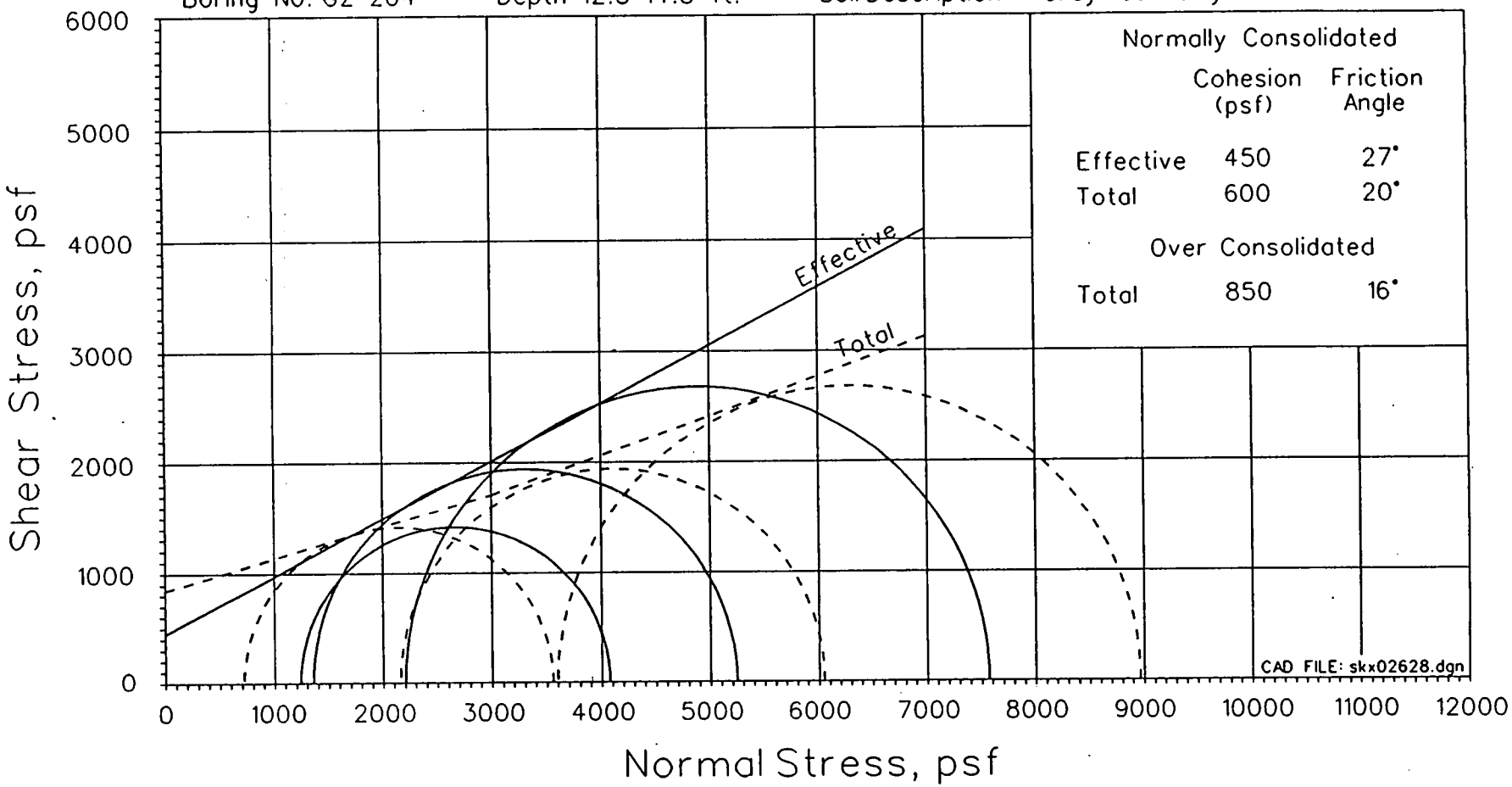


Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-202	7.5-9.5	1	14.2	14.4	139.6	122.3	3.60	2673	835	1325	3997	3.02
		2	14.1	14.7	142.4	124.8	0.96	2001	245	907	2908	3.21

Triaxial Compression Test Report

Boring No. G2-204 Depth 12.5-14.5 ft. Soil Description - Gray lean clay with sand [CL]

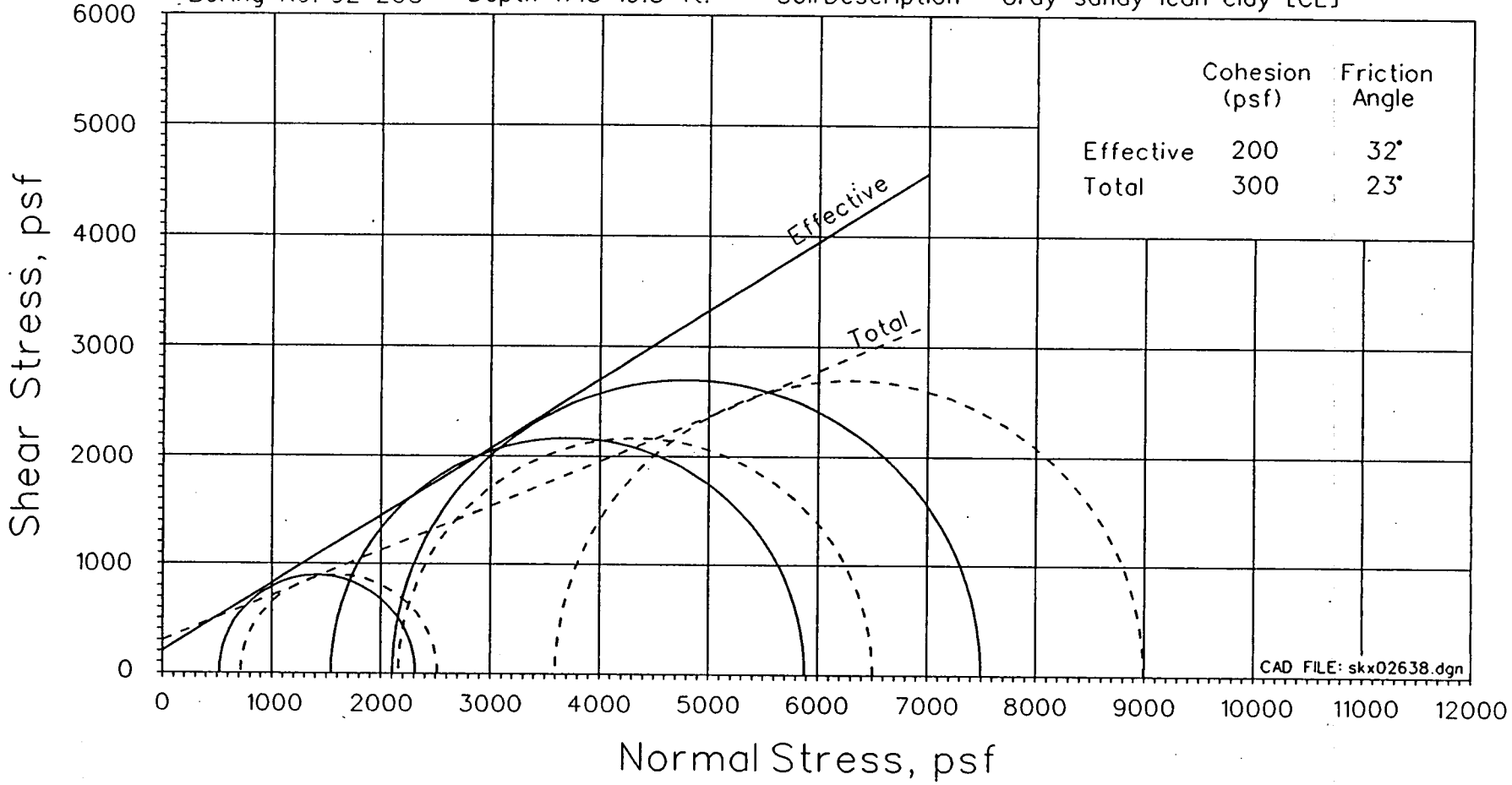


Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-204	12.5-14.5	1	12.5	13.2	142.9	127.0	6.18	2838	-518	1238	4076	3.29
		2	12.9	12.8	144.0	127.6	3.56	3888	806	1354	5242	3.87
		3	12.7	12.1	145.9	129.5	4.43	5366	1397	2203	7569	3.44

Triaxial Compression Test Report

Boring No. G2-205 Depth 17.5-19.5 ft. Soil Description - Gray sandy lean clay [CL]



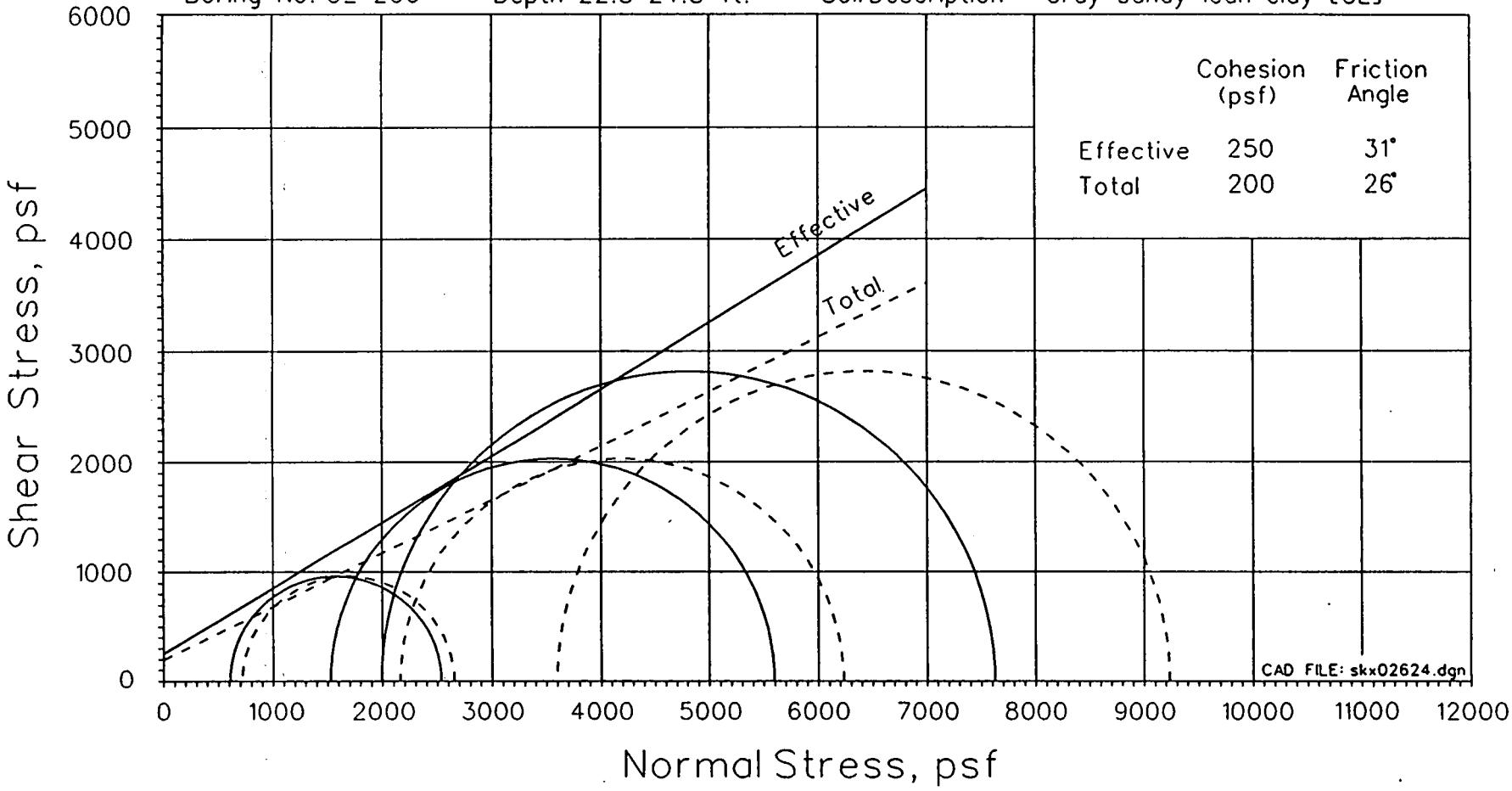
Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-205	17.5-19.5	1	12.2	12.6	143.3	127.7	2.68	1797	202	518	2316	4.47
		2	13.0	12.5	143.1	126.6	6.75	4344	619	1541	5885	3.82
		3	12.6	12.6	144.4	128.2	5.97	5395	1498	2102	7498	3.57

000760

Triaxial Compression Test Report

Boring No. G2-206 Depth 22.5-24.5 ft. Soil Description - Gray sandy lean clay [CL]

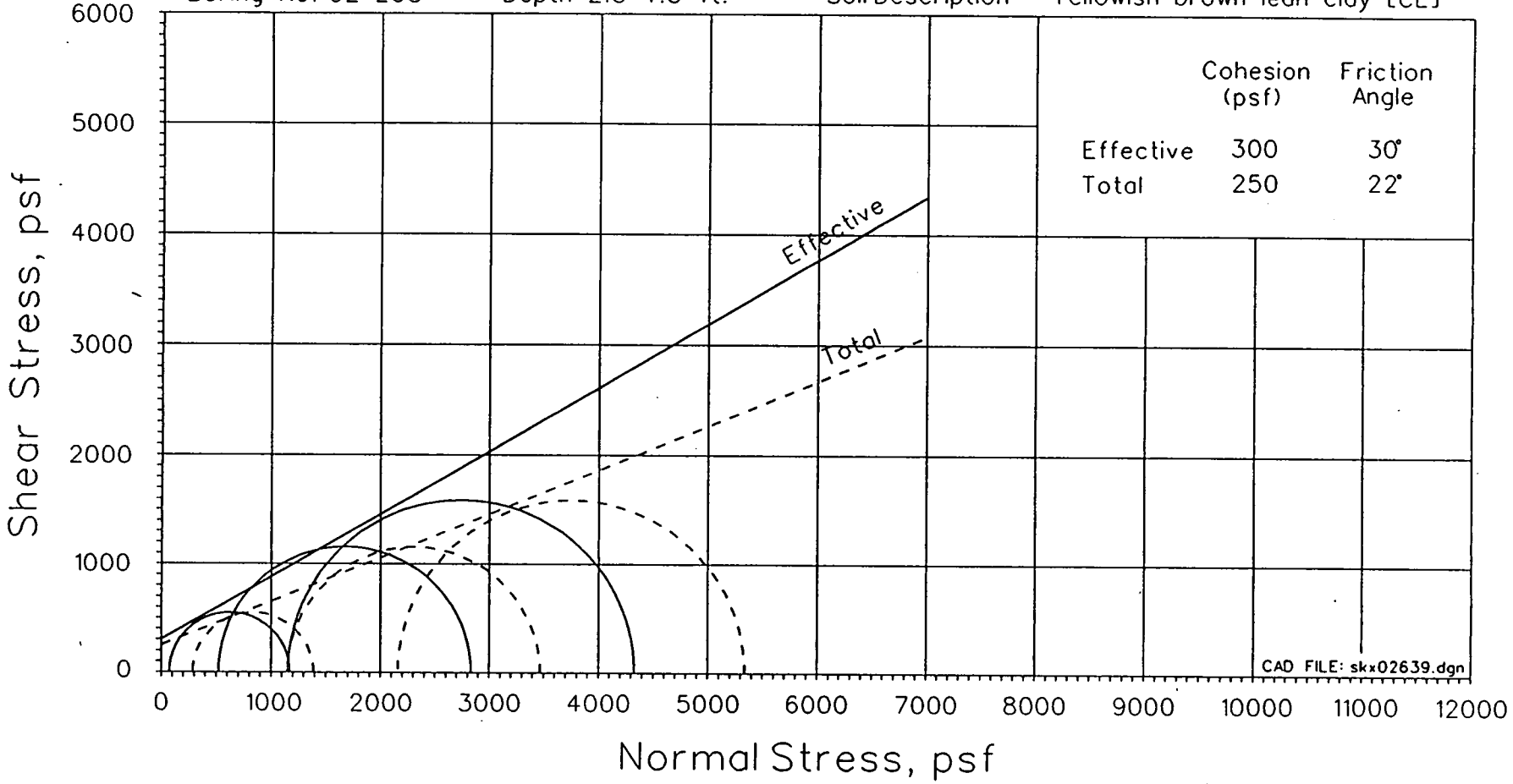


Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%) Initial	Moisture Content (%) Final	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
G2-206	22.5-24.5	1	12.8	13.0	143.5	127.2	2.51	1932	115	605	2537	4.20
		2	12.7	12.4	144.2	128.0	5.87	4072	634	1526	5598	3.67
		3	12.7	12.1	144.4	128.1	6.92	5638	1613	1987	7625	3.84

Triaxial Compression Test Report

Boring No. G2-208 Depth 2.5-4.5 ft. Soil Description - Yellowish brown lean clay [CL]



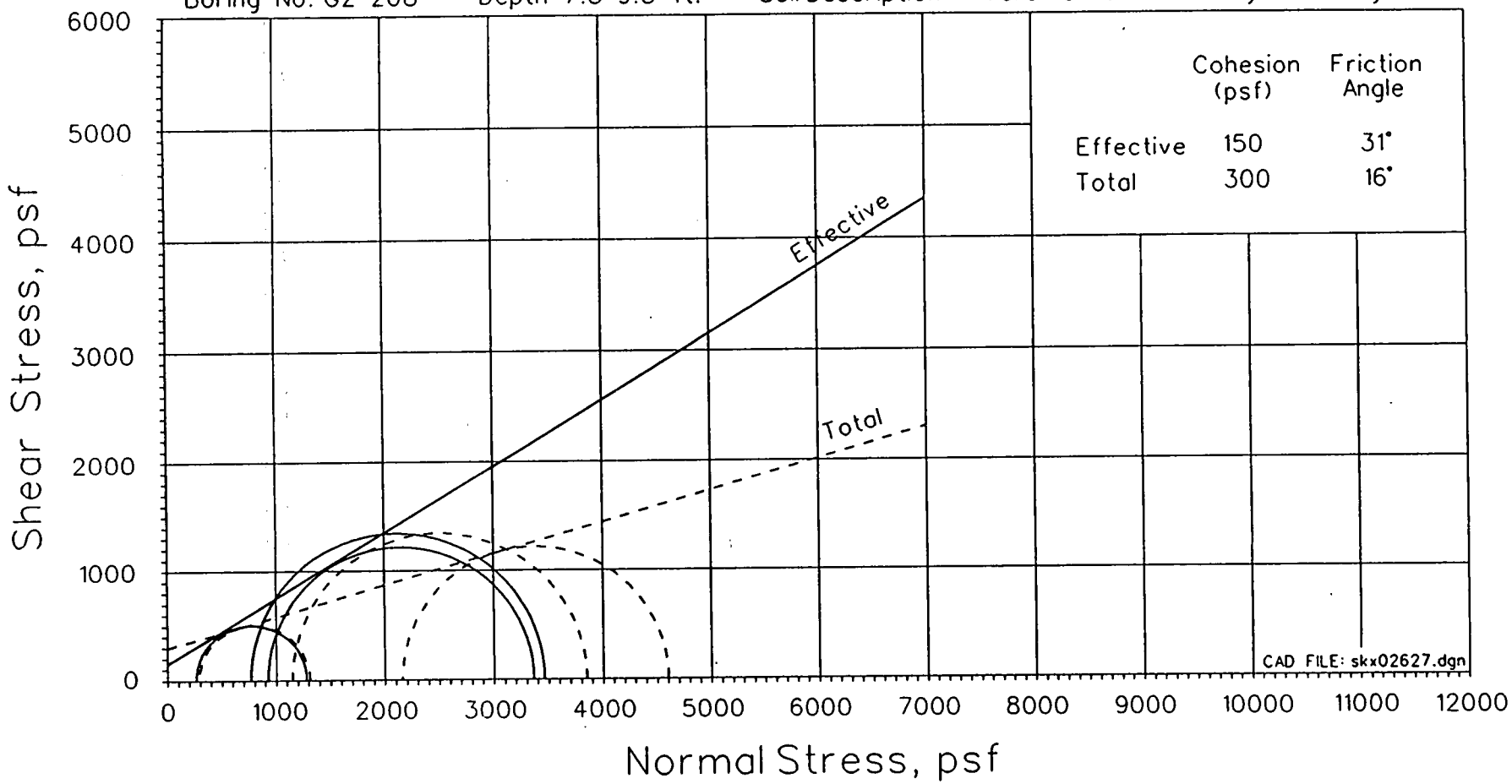
Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-208	2.5-4.5	1	22.9	27.3	122.6	99.7	0.70	1103	216	72	1175	16.31
		2	21.8	28.8	120.7	99.1	2.01	2317	634	518	2835	5.47
		3	25.4	27.2	123.0	98.1	5.09	3182	1008	1152	4334	3.76

000762

Triaxial Compression Test Report

Boring No. G2-208 Depth 7.5-9.5 ft. Soil Description - Yellowish brown sandy lean clay [CL]

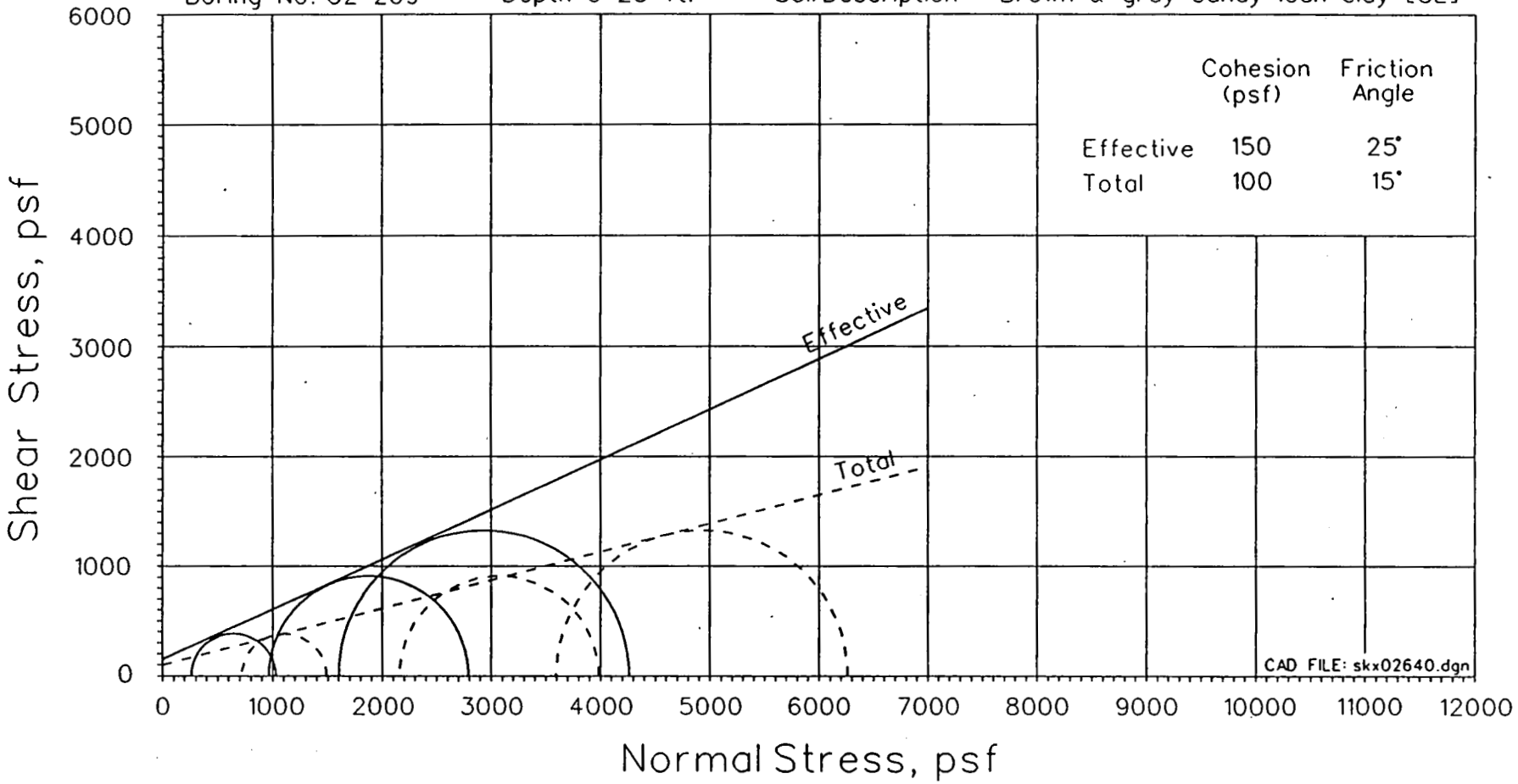


Type of Test: CU w/pp Sample Type: Insitu

Boring No.	Depth (feet)	Stage	Moisture Content (%)		Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
			Initial	Final								
G2-208	7.5-9.5	1	13.5	14.5	140.0	123.4	1.00	1024	29	259	1283	4.95
		2	14.3	13.7	143.4	125.4	2.55	2700	389	763	3463	4.54
		3	23.4	23.0	126.6	102.6	5.10	2444	1238	922	3365	3.65

Triaxial Compression Test Report

Boring No. G2-209 Depth 0-25 ft. Soil Description - Brown & gray sandy lean clay [CL]



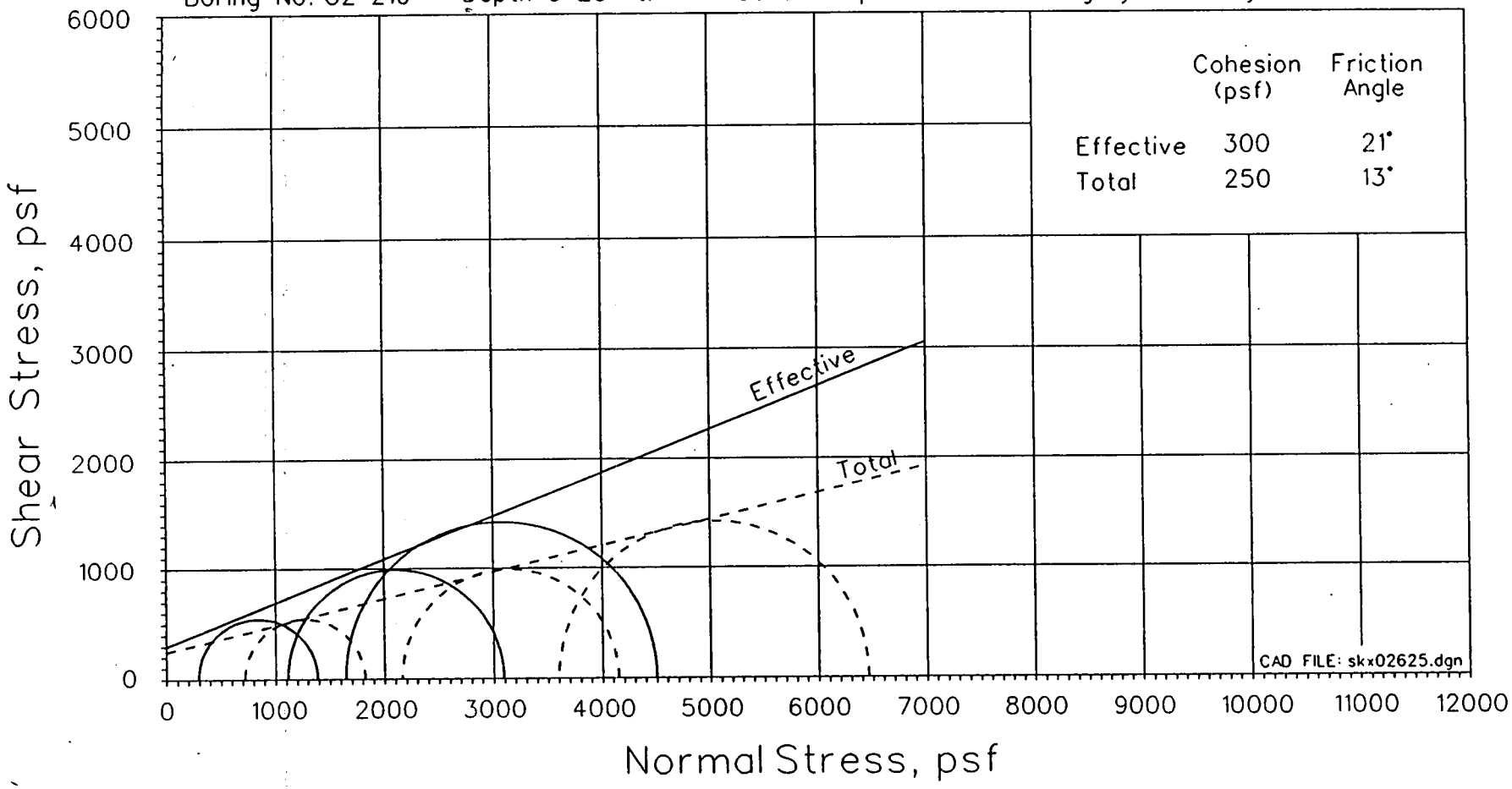
Type of Test: CU w/pp Sample Type: Remold

Boring No.	Depth (feet)	Stage	Moisture Content (%) Initial	Moisture Content (%) Final	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
G2-209	0-25	1	12.0	17.6	131.4	117.3	3.36	770	461	259	1030	3.97
		2	12.1	16.0	131.6	129.4	9.33	1827	1195	965	2791	2.89
		3	12.1	15.2	130.6	116.5	10.12	2665	2002	1598	4263	2.67

000764

Triaxial Compression Test Report

Boring No. G2-210 Depth 0-25 ft. Soil Description - Brown & gray lean clay with sand [CL]



Type of Test: CU w/pp Sample Type: Remold

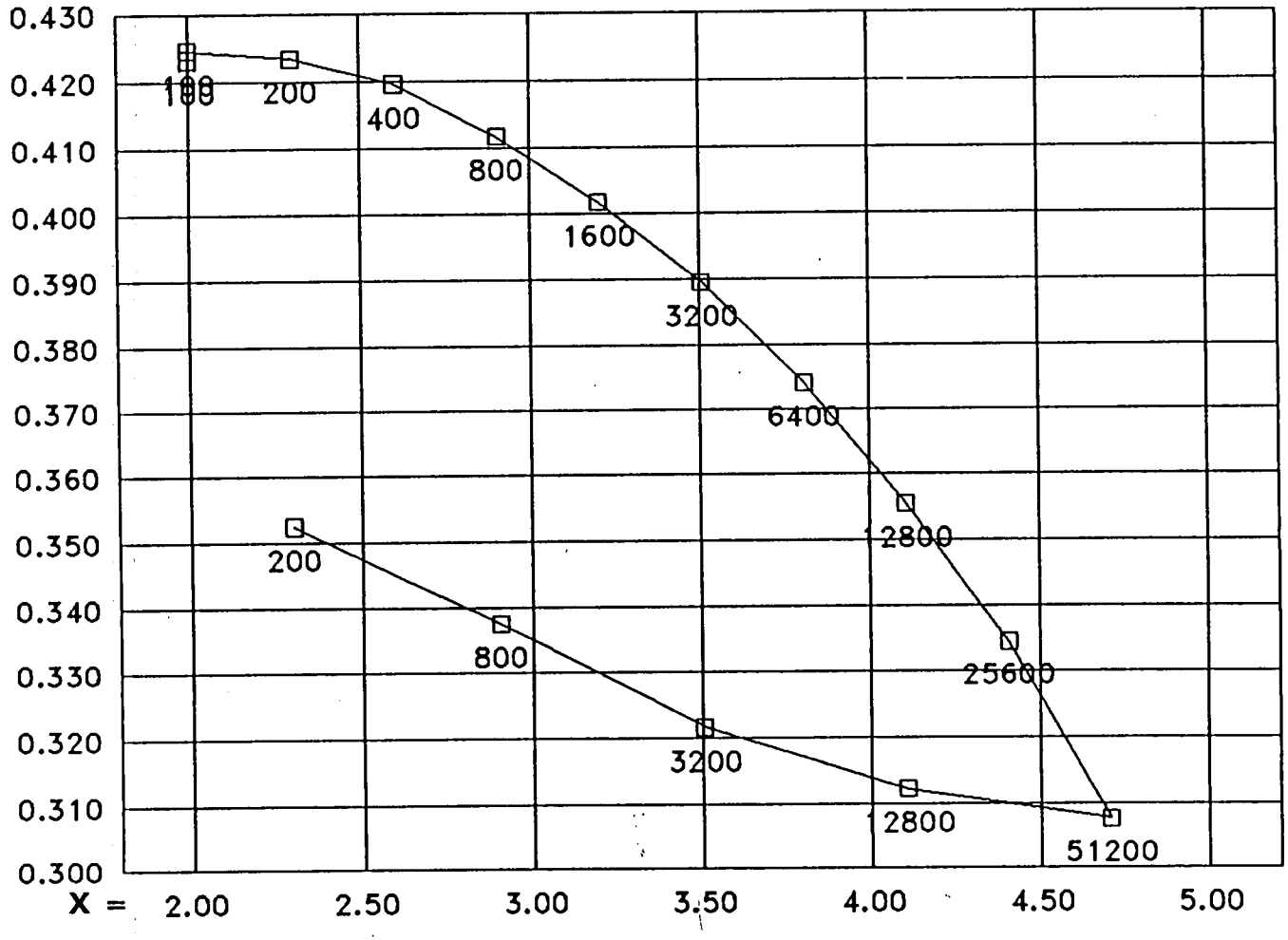
Boring No.	Depth (feet)	Stage	Moisture Content (%) Initial	Moisture Content (%) Final	Total Unit Weight (pcf)	Dry Unit Weight (pcf)	Axial Strain (%)	Deviator Stress (psf)	Pore Pressure (psf)	Effective Confining Pressure ($sigma_3$) (psf)	Major Principal Stress ($sigma_1$) (psf)	Principal Stress Ratio
G2-210	0-25	1	12.0	18.1	131.4	117.3	1.67	1102	432	288	1390	4.83
		2	12.0	16.1	133.1	118.9	10.28	1986	1051	1109	3095	2.79
		3	11.9	14.8	133.2	119.1	6.86	2861	1958	1642	4503	2.74

APPENDIX E

CONSOLIDATION TEST RESULTS

CONSOLIDATION TEST DATA

G2-203 931110-139 10A @22.5-24.5'

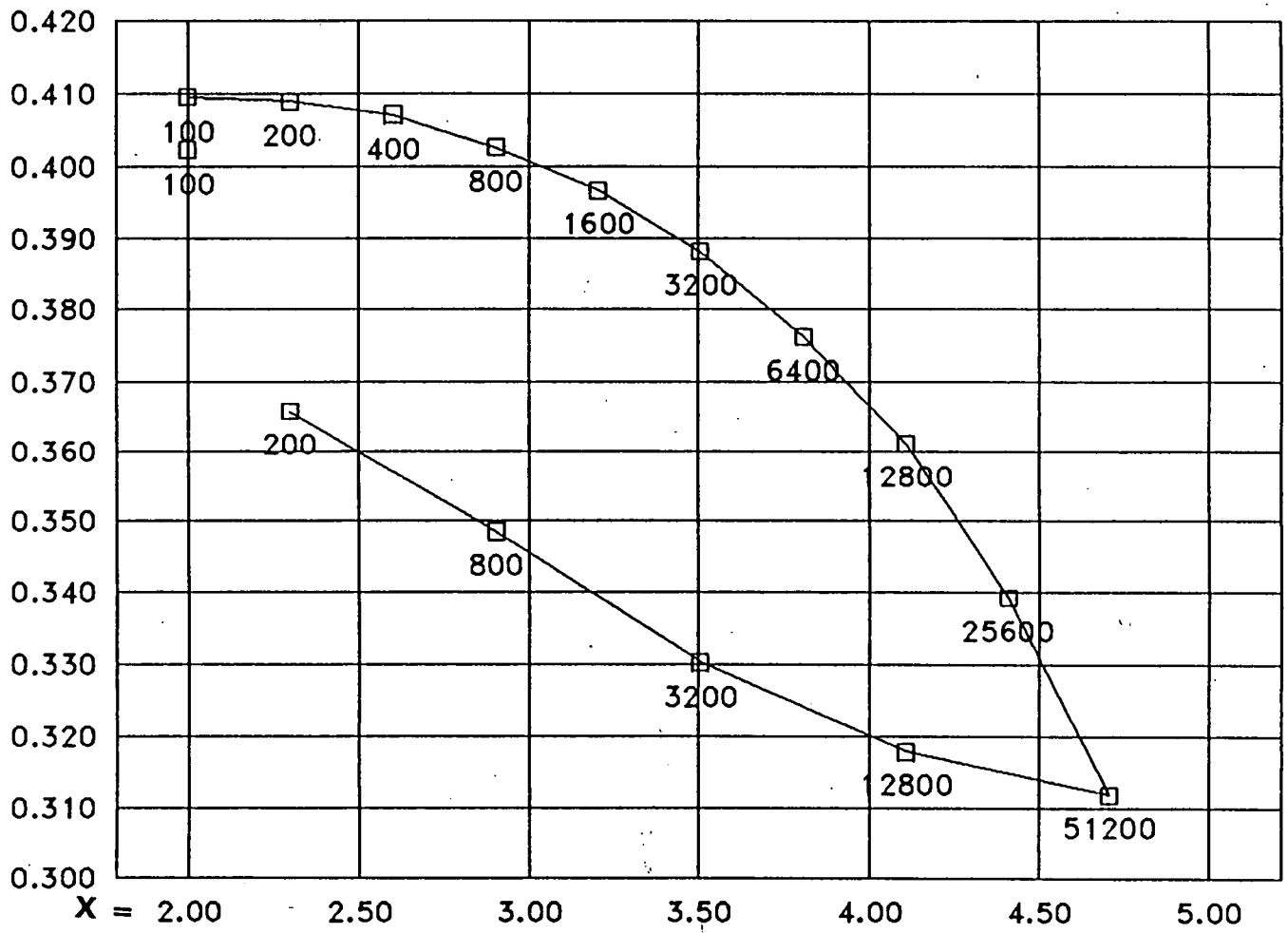


LOG P = X

P = Pressure (psf)

CONSOLIDATION TEST DATA

G2-204 931110-123 4A @7.5-9.5'



LOG P = X

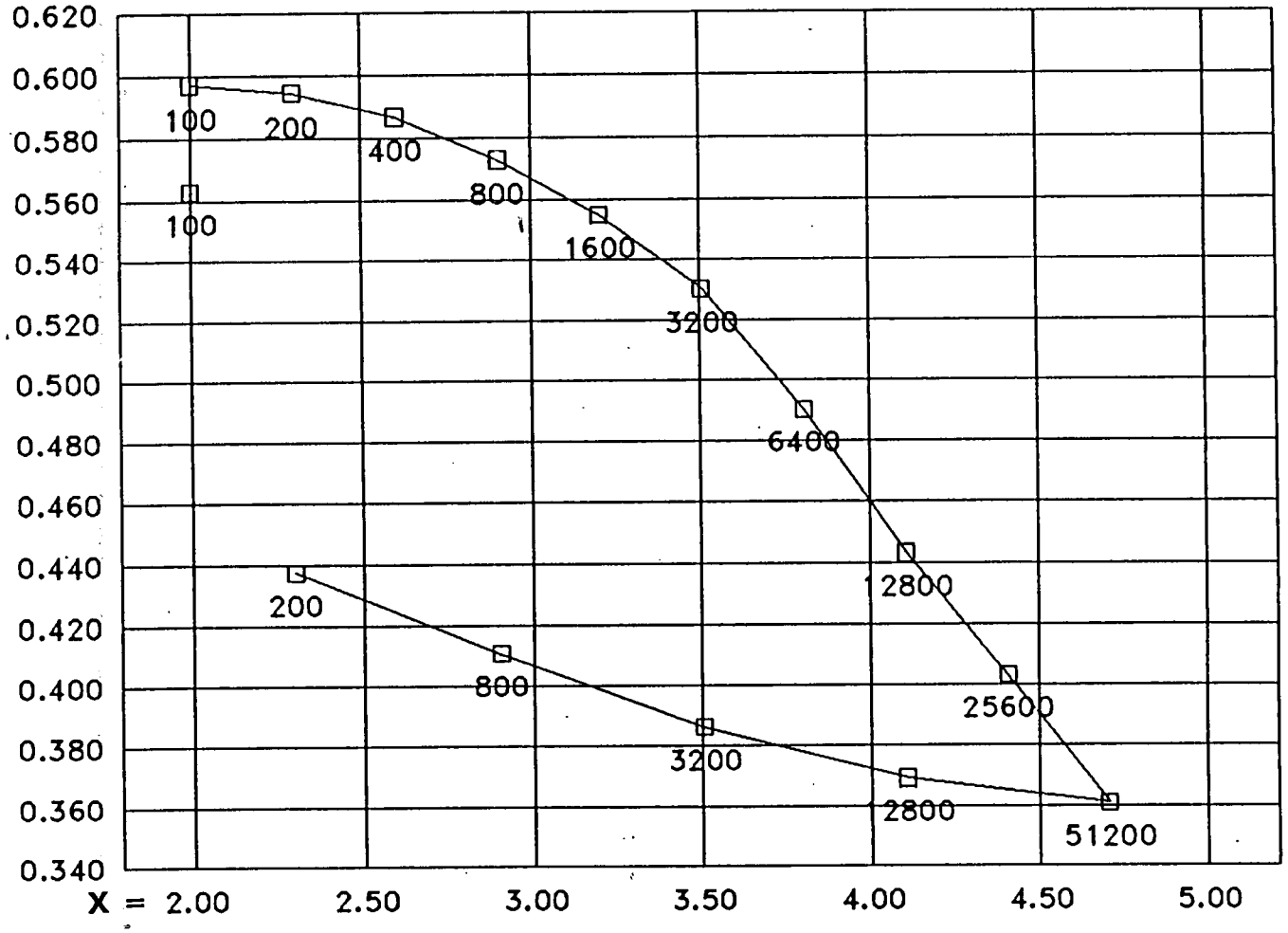
P = Pressure (psf)

6647

000758

CONSOLIDATION TEST DATA

G2-206 931110-111 2A @2.5-4.5'



LOG P = X

P = Pressure (psf)

000269

6647

APPENDIX F

ENVIRONMENTAL LABORATORY TEST RESULTS

6647

APPENDIX F

PESTICIDE/HERBICIDE RESULTS FROM SURFACE SOIL SAMPLES

This Appendix presents the results of sampling for pesticides and herbicides in surface soil samples from the vicinity of the proposed OU2 disposal cell. These data were provided by FERMCO. Following the sampling results tables are two tables from the draft OU2 Remedial Investigation report which explain the validation qualifiers and validation levels on the sampling results.

The pesticides and herbicides analyzed for were below detectable limits in all samples except as follows: 4,4'-DDT was detected in three samples in concentrations ranging from 0.7 to 1 ug/kg; Endosulfan Sulfate was detected in four samples in concentrations ranging from 1.1 to 1.6 ug/kg; and Endrin was detected in two samples in concentrations ranging from 0.8 to 1.5 ug/kg.

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026066	2,4,5-TP (Silvex)	12/01/93	G2-202	NORMAL	9.4	ug/kg	U	B
200026065	2,4,5-TP (Silvex)	12/01/93	G2-204	NORMAL	9.4	ug/kg	U	B
200026070	2,4,5-TP (Silvex)	12/01/93	G2-209	NORMAL	9.4	ug/kg	UJ	B
200026063	2,4,5-TP (Silvex)	12/01/93	G2-201	NORMAL	9.4	ug/kg	U	B
200026068	2,4,5-TP (Silvex)	12/01/93	G2-206	NORMAL	9.4	ug/kg	U	B
200026069	2,4,5-TP (Silvex)	12/01/93	G2-207	NORMAL	9.4	ug/kg	UJ	B
200026067	2,4,5-TP (Silvex)	12/01/93	G2-208	NORMAL	9.4	ug/kg	U	B
200026060	2,4,5-TP (Silvex)	12/01/93	G2-205	NORMAL	9.4	ug/kg	U	B
200026064	2,4,5-TP (Silvex)	12/01/93	G2-203	NORMAL	9.4	ug/kg	U	B
200026064	2,4-D	12/01/93	G2-203	NORMAL	43.6	ug/kg	U	B
200026069	2,4-D	12/01/93	G2-207	NORMAL	43.6	ug/kg	UJ	B
200026065	2,4-D	12/01/93	G2-204	NORMAL	43.6	ug/kg	U	B
200026066	2,4-D	12/01/93	G2-202	NORMAL	43.6	ug/kg	U	B
200026068	2,4-D	12/01/93	G2-206	NORMAL	43.6	ug/kg	U	B
200026070	2,4-D	12/01/93	G2-209	NORMAL	43.6	ug/kg	UJ	B
200026067	2,4-D	12/01/93	G2-208	NORMAL	43.6	ug/kg	U	B
200026060	2,4-D	12/01/93	G2-205	NORMAL	43.6	ug/kg	U	B
200026063	2,4-D	12/01/93	G2-201	NORMAL	43.6	ug/kg	U	B
200026079	4,4'-DDD	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026074	4,4'-DDD	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026073	4,4'-DDD	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C
200026061	4,4'-DDD	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026075	4,4'-DDD	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026078	4,4'-DDD	12/01/93	G2-207	NORMAL	4.7	ug/kg	U	C
200026077	4,4'-DDD	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026072	4,4'-DDD	12/01/93	G2-201	NORMAL	5	ug/kg	U	C
200026076	4,4'-DDD	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026079	4,4'-DDE	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026074	4,4'-DDE	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026073	4,4'-DDE	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026061	4,4'-DDE	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026078	4,4'-DDE	12/01/93	G2-207	NORMAL	4.7	ug/kg	U	C
200026077	4,4'-DDE	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026075	4,4'-DDE	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026072	4,4'-DDE	12/01/93	G2-201	NORMAL	5	ug/kg	U	C
200026076	4,4'-DDE	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026075	4,4'-DDT	12/01/93	G2-202	NORMAL	0.7	ug/kg	J	C
200026074	4,4'-DDT	12/01/93	G2-204	NORMAL	0.82	ug/kg	J	C
200026073	4,4'-DDT	12/01/93	G2-203	NORMAL	0.88	ug/kg	J	C
200026078	4,4'-DDT	12/01/93	G2-207	NORMAL	1	ug/kg	J	C
200026079	4,4'-DDT	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026061	4,4'-DDT	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026077	4,4'-DDT	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026076	4,4'-DDT	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026072	4,4'-DDT	12/01/93	G2-201	NORMAL	5	ug/kg	U	C
200026079	Aldrin	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026074	Aldrin	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026073	Aldrin	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026077	Aldrin	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026078	Aldrin	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026075	Aldrin	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026061	Aldrin	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026076	Aldrin	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026072	Aldrin	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026079	alpha-BHC	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	alpha-BHC	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	alpha-BHC	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026078	alpha-BHC	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026061	alpha-BHC	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026077	alpha-BHC	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026075	alpha-BHC	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026076	alpha-BHC	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026072	alpha-BHC	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026079	alpha-Chlordane	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026074	alpha-Chlordane	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026073	alpha-Chlordane	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026061	alpha-Chlordane	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026078	alpha-Chlordane	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026075	alpha-Chlordane	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026077	alpha-Chlordane	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026072	alpha-Chlordane	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026076	alpha-Chlordane	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026079	Aroclor-1016	12/01/93	G2-209	NORMAL	43	ug/kg	U	C
200026073	Aroclor-1016	12/01/93	G2-203	NORMAL	45	ug/kg	U	C
200026074	Aroclor-1016	12/01/93	G2-204	NORMAL	45	ug/kg	U	C
200026061	Aroclor-1016	12/01/93	G2-205	NORMAL	46	ug/kg	U	C
200026077	Aroclor-1016	12/01/93	G2-206	NORMAL	47	ug/kg	U	C
200026078	Aroclor-1016	12/01/93	G2-207	NORMAL	47	ug/kg	U	C
200026075	Aroclor-1016	12/01/93	G2-202	NORMAL	47	ug/kg	U	C
200026076	Aroclor-1016	12/01/93	G2-208	NORMAL	50	ug/kg	U	C
200026072	Aroclor-1016	12/01/93	G2-201	NORMAL	50	ug/kg	U	C
200026079	Aroclor-1221	12/01/93	G2-209	NORMAL	88	ug/kg	U	C
200026073	Aroclor-1221	12/01/93	G2-203	NORMAL	91	ug/kg	U	C
200026074	Aroclor-1221	12/01/93	G2-204	NORMAL	91	ug/kg	U	C
200026061	Aroclor-1221	12/01/93	G2-205	NORMAL	94	ug/kg	U	C
200026077	Aroclor-1221	12/01/93	G2-206	NORMAL	96	ug/kg	U	C
200026078	Aroclor-1221	12/01/93	G2-207	NORMAL	96	ug/kg	U	C
200026075	Aroclor-1221	12/01/93	G2-202	NORMAL	96	ug/kg	U	C
200026076	Aroclor-1221	12/01/93	G2-208	NORMAL	100	ug/kg	U	C
200026072	Aroclor-1221	12/01/93	G2-201	NORMAL	100	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026079	Aroclor-1232	12/01/93	G2-209	NORMAL	43	ug/kg	U	C
200026073	Aroclor-1232	12/01/93	G2-203	NORMAL	45	ug/kg	U	C
200026074	Aroclor-1232	12/01/93	G2-204	NORMAL	45	ug/kg	U	C
200026061	Aroclor-1232	12/01/93	G2-205	NORMAL	46	ug/kg	U	C
200026077	Aroclor-1232	12/01/93	G2-206	NORMAL	47	ug/kg	U	C
200026075	Aroclor-1232	12/01/93	G2-202	NORMAL	47	ug/kg	U	C
200026078	Aroclor-1232	12/01/93	G2-207	NORMAL	47	ug/kg	U	C
200026076	Aroclor-1232	12/01/93	G2-208	NORMAL	50	ug/kg	U	C
200026072	Aroclor-1232	12/01/93	G2-201	NORMAL	50	ug/kg	U	C
200026079	Aroclor-1242	12/01/93	G2-209	NORMAL	43	ug/kg	U	C
200026074	Aroclor-1242	12/01/93	G2-204	NORMAL	45	ug/kg	U	C
200026073	Aroclor-1242	12/01/93	G2-203	NORMAL	45	ug/kg	U	C
200026061	Aroclor-1242	12/01/93	G2-205	NORMAL	46	ug/kg	U	C
200026078	Aroclor-1242	12/01/93	G2-207	NORMAL	47	ug/kg	U	C
200026077	Aroclor-1242	12/01/93	G2-206	NORMAL	47	ug/kg	U	C
200026075	Aroclor-1242	12/01/93	G2-202	NORMAL	47	ug/kg	U	C
200026072	Aroclor-1242	12/01/93	G2-201	NORMAL	50	ug/kg	U	C
200026076	Aroclor-1242	12/01/93	G2-208	NORMAL	50	ug/kg	U	C
200026079	Aroclor-1248	12/01/93	G2-209	NORMAL	43	ug/kg	U	C
200026074	Aroclor-1248	12/01/93	G2-204	NORMAL	45	ug/kg	U	C
200026073	Aroclor-1248	12/01/93	G2-203	NORMAL	45	ug/kg	U	C
200026061	Aroclor-1248	12/01/93	G2-205	NORMAL	46	ug/kg	U	C
200026075	Aroclor-1248	12/01/93	G2-202	NORMAL	47	ug/kg	U	C
200026078	Aroclor-1248	12/01/93	G2-207	NORMAL	47	ug/kg	U	C
200026077	Aroclor-1248	12/01/93	G2-206	NORMAL	47	ug/kg	U	C
200026076	Aroclor-1248	12/01/93	G2-208	NORMAL	50	ug/kg	U	C
200026072	Aroclor-1248	12/01/93	G2-201	NORMAL	50	ug/kg	U	C
200026079	Aroclor-1254	12/01/93	G2-209	NORMAL	43	ug/kg	U	C
200026074	Aroclor-1254	12/01/93	G2-204	NORMAL	45	ug/kg	U	C
200026073	Aroclor-1254	12/01/93	G2-203	NORMAL	45	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026061	Aroclor-1254	12/01/93	G2-205	NORMAL	46	ug/kg	U	C
200026078	Aroclor-1254	12/01/93	G2-207	NORMAL	47	ug/kg	U	C
200026075	Aroclor-1254	12/01/93	G2-202	NORMAL	47	ug/kg	U	C
200026077	Aroclor-1254	12/01/93	G2-206	NORMAL	47	ug/kg	U	C
200026072	Aroclor-1254	12/01/93	G2-201	NORMAL	50	ug/kg	U	C
200026076	Aroclor-1254	12/01/93	G2-208	NORMAL	50	ug/kg	U	C
200026079	Aroclor-1260	12/01/93	G2-209	NORMAL	43	ug/kg	U	C
200026073	Aroclor-1260	12/01/93	G2-203	NORMAL	45	ug/kg	U	C
200026074	Aroclor-1260	12/01/93	G2-204	NORMAL	45	ug/kg	U	C
200026061	Aroclor-1260	12/01/93	G2-205	NORMAL	46	ug/kg	U	C
200026077	Aroclor-1260	12/01/93	G2-206	NORMAL	47	ug/kg	U	C
200026078	Aroclor-1260	12/01/93	G2-207	NORMAL	47	ug/kg	U	C
200026075	Aroclor-1260	12/01/93	G2-202	NORMAL	47	ug/kg	U	C
200026072	Aroclor-1260	12/01/93	G2-201	NORMAL	50	ug/kg	U	C
200026076	Aroclor-1260	12/01/93	G2-208	NORMAL	50	ug/kg	U	C
200026079	beta-BHC	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026074	beta-BHC	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026073	beta-BHC	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026078	beta-BHC	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026077	beta-BHC	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026061	beta-BHC	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026075	beta-BHC	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026072	beta-BHC	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026076	beta-BHC	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026079	delta-BHC	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	delta-BHC	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	delta-BHC	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026077	delta-BHC	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026075	delta-BHC	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026078	delta-BHC	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026061	delta-BHC	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026072	delta-BHC	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026076	delta-BHC	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026079	Dieldrin	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026073	Dieldrin	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C
200026074	Dieldrin	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026061	Dieldrin	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026077	Dieldrin	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026078	Dieldrin	12/01/93	G2-207	NORMAL	4.7	ug/kg	U	C
200026075	Dieldrin	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026072	Dieldrin	12/01/93	G2-201	NORMAL	5	ug/kg	U	C
200026076	Dieldrin	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026088	Disulfoton	12/01/93	G2-209	NORMAL	0.28	ug/kg	UJ	B
200026084	Disulfoton	12/01/93	G2-202	NORMAL	0.28	ug/kg	U	B
200026082	Disulfoton	12/01/93	G2-203	NORMAL	0.28	ug/kg	U	B
200026081	Disulfoton	12/01/93	G2-201	NORMAL	0.28	ug/kg	U	B
200026083	Disulfoton	12/01/93	G2-204	NORMAL	0.28	ug/kg	UJ	B
200026086	Disulfoton	12/01/93	G2-206	NORMAL	0.28	ug/kg	U	B
200026085	Disulfoton	12/01/93	G2-208	NORMAL	0.28	ug/kg	U	B
200026062	Disulfoton	12/01/93	G2-205	NORMAL	0.28	ug/kg	U	B
200026087	Disulfoton	12/01/93	G2-207	NORMAL	0.28	ug/kg	U	B
200026079	Endosulfan II	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026073	Endosulfan II	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C
200026074	Endosulfan II	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026061	Endosulfan II	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026077	Endosulfan II	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026075	Endosulfan II	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026078	Endosulfan II	12/01/93	G2-207	NORMAL	4.7	ug/kg	U	C
200026076	Endosulfan II	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026072	Endosulfan II	12/01/93	G2-201	NORMAL	5	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026073	Endosulfan sulfate	12/01/93	G2-203	NORMAL	1.1	ug/kg	J	C
200026079	Endosulfan sulfate	12/01/93	G2-209	NORMAL	1.1	ug/kg	J	C
200026072	Endosulfan sulfate	12/01/93	G2-201	NORMAL	1.6	ug/kg	J	C
200026078	Endosulfan sulfate	12/01/93	G2-207	NORMAL	1.6	ug/kg	J	C
200026074	Endosulfan sulfate	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026061	Endosulfan sulfate	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026077	Endosulfan sulfate	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026075	Endosulfan sulfate	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026076	Endosulfan sulfate	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026079	Endosulfan-I	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	Endosulfan-I	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	Endosulfan-I	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026077	Endosulfan-I	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026078	Endosulfan-I	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026075	Endosulfan-I	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026061	Endosulfan-I	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026076	Endosulfan-I	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026072	Endosulfan-I	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026072	Endrin	12/01/93	G2-201	NORMAL	0.8	ug/kg	J	C
200026078	Endrin	12/01/93	G2-207	NORMAL	1.5	ug/kg	J	C
200026079	Endrin	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026074	Endrin	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026073	Endrin	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C
200026061	Endrin	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026077	Endrin	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026075	Endrin	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026076	Endrin	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026079	Endrin aldehyde	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026074	Endrin aldehyde	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026073	Endrin aldehyde	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026061	Endrin aldehyde	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026077	Endrin aldehyde	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026075	Endrin aldehyde	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026078	Endrin aldehyde	12/01/93	G2-207	NORMAL	4.7	ug/kg	U	C
200026076	Endrin aldehyde	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026072	Endrin aldehyde	12/01/93	G2-201	NORMAL	5	ug/kg	U	C
200026079	Endrin ketone	12/01/93	G2-209	NORMAL	4.3	ug/kg	U	C
200026073	Endrin ketone	12/01/93	G2-203	NORMAL	4.5	ug/kg	U	C
200026074	Endrin ketone	12/01/93	G2-204	NORMAL	4.5	ug/kg	U	C
200026061	Endrin ketone	12/01/93	G2-205	NORMAL	4.6	ug/kg	U	C
200026075	Endrin ketone	12/01/93	G2-202	NORMAL	4.7	ug/kg	U	C
200026078	Endrin ketone	12/01/93	G2-207	NORMAL	4.7	ug/kg	U	C
200026077	Endrin ketone	12/01/93	G2-206	NORMAL	4.7	ug/kg	U	C
200026072	Endrin ketone	12/01/93	G2-201	NORMAL	5	ug/kg	U	C
200026076	Endrin ketone	12/01/93	G2-208	NORMAL	5	ug/kg	U	C
200026083	Famphur	12/01/93	G2-204	NORMAL	23	ug/kg	UJ	B
200026082	Famphur	12/01/93	G2-203	NORMAL	23	ug/kg	U	B
200026088	Famphur	12/01/93	G2-209	NORMAL	23	ug/kg	UJ	B
200026084	Famphur	12/01/93	G2-202	NORMAL	24	ug/kg	U	B
200026062	Famphur	12/01/93	G2-205	NORMAL	24	ug/kg	U	B
200026087	Famphur	12/01/93	G2-207	NORMAL	24	ug/kg	U	B
200026081	Famphur	12/01/93	G2-201	NORMAL	25	ug/kg	U	B
200026086	Famphur	12/01/93	G2-206	NORMAL	25	ug/kg	U	B
200026085	Famphur	12/01/93	G2-208	NORMAL	26	ug/kg	U	B
200026079	gamma-BHC (Lindane)	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	gamma-BHC (Lindane)	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	gamma-BHC (Lindane)	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026078	gamma-BHC (Lindane)	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026061	gamma-BHC (Lindane)	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026077	gamma-BHC (Lindane)	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026075	gamma-BHC (Lindane)	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026072	gamma-BHC (Lindane)	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026076	gamma-BHC (Lindane)	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026079	gamma-Chlordane	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	gamma-Chlordane	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	gamma-Chlordane	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026075	gamma-Chlordane	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026077	gamma-Chlordane	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026078	gamma-Chlordane	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026061	gamma-Chlordane	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026072	gamma-Chlordane	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026076	gamma-Chlordane	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026079	Heptachlor	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	Heptachlor	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	Heptachlor	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026075	Heptachlor	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026078	Heptachlor	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026077	Heptachlor	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026061	Heptachlor	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026072	Heptachlor	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C
200026076	Heptachlor	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026079	Heptachlor epoxide	12/01/93	G2-209	NORMAL	2.2	ug/kg	U	C
200026073	Heptachlor epoxide	12/01/93	G2-203	NORMAL	2.3	ug/kg	U	C
200026074	Heptachlor epoxide	12/01/93	G2-204	NORMAL	2.3	ug/kg	U	C
200026061	Heptachlor epoxide	12/01/93	G2-205	NORMAL	2.4	ug/kg	U	C
200026078	Heptachlor epoxide	12/01/93	G2-207	NORMAL	2.4	ug/kg	U	C
200026077	Heptachlor epoxide	12/01/93	G2-206	NORMAL	2.4	ug/kg	U	C
200026075	Heptachlor epoxide	12/01/93	G2-202	NORMAL	2.4	ug/kg	U	C
200026076	Heptachlor epoxide	12/01/93	G2-208	NORMAL	2.6	ug/kg	U	C
200026072	Heptachlor epoxide	12/01/93	G2-201	NORMAL	2.6	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026079	Methoxychlor	12/01/93	G2-209	NORMAL	22	ug/kg	U	C
200026073	Methoxychlor	12/01/93	G2-203	NORMAL	23	ug/kg	U	C
200026074	Methoxychlor	12/01/93	G2-204	NORMAL	23	ug/kg	U	C
200026077	Methoxychlor	12/01/93	G2-206	NORMAL	24	ug/kg	U	C
200026061	Methoxychlor	12/01/93	G2-205	NORMAL	24	ug/kg	U	C
200026075	Methoxychlor	12/01/93	G2-202	NORMAL	24	ug/kg	U	C
200026078	Methoxychlor	12/01/93	G2-207	NORMAL	24	ug/kg	U	C
200026072	Methoxychlor	12/01/93	G2-201	NORMAL	26	ug/kg	U	C
200026076	Methoxychlor	12/01/93	G2-208	NORMAL	26	ug/kg	U	C
200026088	Methyl parathion	12/01/93	G2-209	NORMAL	23	ug/kg	UJ	B
200026083	Methyl parathion	12/01/93	G2-204	NORMAL	23	ug/kg	UJ	B
200026082	Methyl parathion	12/01/93	G2-203	NORMAL	23	ug/kg	U	B
200026062	Methyl parathion	12/01/93	G2-205	NORMAL	24	ug/kg	U	B
200026084	Methyl parathion	12/01/93	G2-202	NORMAL	24	ug/kg	U	B
200026087	Methyl parathion	12/01/93	G2-207	NORMAL	24	ug/kg	U	B
200026086	Methyl parathion	12/01/93	G2-206	NORMAL	25	ug/kg	U	B
200026081	Methyl parathion	12/01/93	G2-201	NORMAL	25	ug/kg	U	B
200026085	Methyl parathion	12/01/93	G2-208	NORMAL	26	ug/kg	U	B
200026062	Phorate	12/01/93	G2-205	NORMAL	0.23	ug/kg	U	B
200026081	Phorate	12/01/93	G2-201	NORMAL	0.23	ug/kg	U	B
200026084	Phorate	12/01/93	G2-202	NORMAL	0.23	ug/kg	U	B
200026087	Phorate	12/01/93	G2-207	NORMAL	0.23	ug/kg	U	B
200026082	Phorate	12/01/93	G2-203	NORMAL	0.23	ug/kg	U	B
200026085	Phorate	12/01/93	G2-208	NORMAL	0.23	ug/kg	U	B
200026086	Phorate	12/01/93	G2-206	NORMAL	0.23	ug/kg	U	B
200026083	Phorate	12/01/93	G2-204	NORMAL	0.23	ug/kg	UJ	B
200026079	Toxaphene	12/01/93	G2-209	NORMAL	220	ug/kg	U	C
200026073	Toxaphene	12/01/93	G2-203	NORMAL	230	ug/kg	U	C
200026074	Toxaphene	12/01/93	G2-204	NORMAL	230	ug/kg	U	C
200026061	Toxaphene	12/01/93	G2-205	NORMAL	240	ug/kg	U	C

Pesticide/Herbicide Results
Surface Soil Samples
Proposed OU2 Disposal Cell Vicinity

Sample	Parameter	Sample Date	Boring	QA Type	Result	Units	Validation Qualifier	Validation Level
200026078	Toxaphene	12/01/93	G2-207	NORMAL	240	ug/kg	U	C
200026075	Toxaphene	12/01/93	G2-202	NORMAL	240	ug/kg	U	C
200026077	Toxaphene	12/01/93	G2-206	NORMAL	240	ug/kg	U	C
200026076	Toxaphene	12/01/93	G2-208	NORMAL	260	ug/kg	U	C
200026072	Toxaphene	12/01/93	G2-201	NORMAL	260	ug/kg	U	C

TABLE 2-16

Data Qualifiers and Definitions

DATA QUALIFIERS AND DEFINITIONS	
J	Analyte was analyzed for and positively identified, but the associated numerical value may not be consistent with the amount present in the environmental sample. Data should be seriously considered for making decisions and are usable for many purposes.
N	Analysis indicates that an analyte is present and there are strong indications that the identity is correct.
R	Data are unusable for any purpose. Analyte was analyzed for, but the presence or absence of the analyte was not verified. Resampling and reanalysis are necessary to confirm or deny presence of the analyte.
U	Analyte was analyzed for and was not present above the level of the associated value. Associated numerical value indicates the approximate concentration necessary to detect the analyte in the sample.
UJ	This is a combination of the "U" and "J" qualifiers. Analyte was analyzed for and was not present above the level of the associated value. The associated value may not accurately or precisely represent the concentration necessary to detect the analyte in the sample. If a decision requires quantitation of the analyte close to the associated numerical level, reanalysis or alternative analytical methods should be considered.

(Notation from QAPP March 1992)

TABLE 2-17

ANALYTICAL SUPPORT LEVELS

Support Level	Description	Typical Data Uses
A	*Qualitative Field Analysis* - This level is characterized by the use of portable instruments that can provide real-time data to assist in the optimization of sampling point locations and in providing health and safety support. Data can be generated regarding the presence or absence of contaminants (e.g., radionuclides, volatiles) at sampling locations. Analogous to EPA analytical level 1.	• Site characterization • Monitoring during implementation • Establishing worker protective equipment
B	*Qualitative, Semi-Quantitative, and Quantitative Analyses* - This level may include the use of more sophisticated screening techniques, such as portable analytical instruments that can be used on site (close-support laboratories). Depending upon the types of contaminants, sample matrix, and QC checks applied, qualitative and quantitative data can be obtained. Analogous to EPA analytical level 2.	• Site characterization • Evaluation of alternatives • Engineering design • Monitoring during implementation
C	*Quantitative with fully defined QA/QC* - Laboratory analyses generated with full QA/QC checks of types and frequencies specified for ASL D according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The analytical methods are identical to ASL D for QA/QC sample analysis and method performance criteria. However, the data package does not typically contain raw instrument output but does include summaries of QA/QC sample results. ASL C may be used when analyses require a rigid, well-defined protocol, but where other information is available, so that a complete raw data package validation effort is not required. Laboratories are required to retain raw instrument data to upgrade ASL C reports to ASL D in the project file. Analogous to EPA analytical level 3.	• Risk assessment • Site characterization • Evaluation of alternatives • Engineering design • Monitoring during implementation
D	*Confirmational with complete QA/QC and reporting* - Provides data generated with a full complement of QA/QC checks of specified types and frequencies according to FEMP-specified analytical protocols for radiological and nonradiological parameters. The data package includes raw instrument output for validation. These data may be used to confirm data gathered at ASLs B and C, and when full validation of raw data is required. Analogous to EPA analytical level 4.	• Risk assessment • Evaluation of alternatives • Engineering design
E	*Nonstandard* - Analyses by nonstandard protocols that often require method development or validation (e.g., when extracting detection limits or analysis of an unusual chemical compound is required). New methods may be developed for ASL E data to allow for parameters or matrices that cannot be analyzed by existing standard methods. Analogous to EPA analytical level 5.	• Risk assessment

ADDITIONAL BORING LOGS

1745
1746
1747
1748
1749
1750
2399
2400
3068
3431
11130
11131

PAGE 1 OF 1

PROJECT NO: 313327
DATE BEGAN: 12-16-91
DRILLER: E GARDNER, D. JAMESON
GROUND SURFACE ELEV.: 586.00'
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1745
DATE FINISHED: 12-17-91
N: 478500.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: D. O'BRIEN
E: 1392000.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILL 80
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	(DIRECT READING)	REMARKS
	0.00	S 1253	5	0.5		Firm, (10YR 5/4), yellowish-brown, silty CLAY, low plasticity, moist 1.0'	CL	1.0	HNU - 0 ppm βγ - 0 cpm
			5	0.42				1.0	
585.0			7	0		No recovery 2.0'	NA	NA	
			8	0				NA	
			5	0.5		Very firm, (10YR 5/4), yellowish-brown, silty CLAY, low plasticity, moist 3.0'	CL	2.75	HNU - 0 ppm βγ - 0 cpm
			11	0.5				2.75	
			14	0.08		Hard, (10YR 5/4), yellowish-brown, silty CLAY, low plasticity, moist 3.5'		4.5	
			17	0		No recovery 4.5'	NA	NA	
			8	0				NA	HNU - 0 ppm βγ - 0 cpm
		S 1254	16	0.33		Firm, (10YR 5/4), yellowish-brown, silty CLAY with sand and gravel, low plasticity, moist 5.0'	CL	2.0	
	-5.00	S 1255	18	0.5		Hard, (10YR 5/4), yellowish-brown, silty CLAY with sand and gravel, moist 6.0'		>4.5	
		S 1256	20	0.5				4.5	
580.0		S 1260	SHELBY TUBE	2.5		Firm, (10YR 5/4), yellowish-brown, silty CLAY with some sand, low plasticity, moist 10.5'	CL	1.75	HNU - 0 ppm βγ - 0 cpm
		S 1263	11	0.5				1.75	HNU - 0 ppm βγ - 0 cpm
			47	0.5				1.5	
	-10.00		9	0.5				2.75	
			14	0		No recovery 11.0'	NA	NA	
575.0			15	0.5		Firm, (10YR 5/4), yellowish-brown, silty CLAY with some sand, low plasticity, moist 11.5'	CL	1.5	HNU - 0 ppm βγ - 0 cpm
			21	0.5		Very Firm, (10YR 5/4), yellowish-brown, silty CLAY with some sand, low plasticity, moist 12.0'		3.0	
		S 1265	20	0.42		Firm, (5Y 5/3), olive, silty CLAY with some sand, low plasticity, moist 12.5'		1.75	HNU - 0 ppm βγ - 0 cpm
			13	0		No recovery 14.0'	NA		
		S 1269	3	0					
			7	0					
			9	0.5		Very Firm, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist 15.0'	CL	2.5	HNU - 0 ppm βγ - 0 cpm
			17	0.08				2.75	
	-15.00		5	0		No recovery 16.0'	NA		HNU - 0 ppm βγ - 0 cpm
			11	0					
570.0		S 1268	14	0.5		Very Firm, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist 16.5'		2.75	
		S 1268	17	0.5		Hard, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist 17.0'		4.25	

PROJECT NO: 313327
DATE BEGAN: 12-16-91
DRILLER: E. GARDNER, D. JAMESON
GROUND SURFACE ELEV.: 586.00'
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1745
DATE FINISHED: 12-17-91
N: 478500.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: D. O'BRIEN
E: 1382000.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILL 80
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	OVA (PPM)	REMARKS
		S 1270	SHELBY TUBE	2.33		Very firm, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist 20.0'	CL	2.5	HNU - 0 ppm βγ - 0 cpm
	-20.00		6	0		No recovery			
			14	0					
565.0			14	0					
			19	0					
			9	0					
			18	0			NA	NA	
			21	0					
			24	0					
			9	0					
			14	0		25.0'			
	-25.00	S 1273	9	0.5		Very firm, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist 25.5'	CL	2.0	HNU - 0 ppm βγ - 0 cpm
560.0		S 1275	18	0.5		Hard, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist 26.0'		4.5	
		S 1277	21	0.5		Very firm, (5Y 5/3), olive, silty CLAY with sand and gravel, low plasticity, moist		2.5	
		S 1279	24	0.5				3.0	
	-30.00					BOTTOM OF BORING AT 27.0'			
556.0									

NOTE:
ALL SAMPLE NUMBERS AR
INCREMENTED BY 100, OC
ie. 1253 IS 101253

000737

PAGE 1 OF 1

PROJECT NO:	313327	BORING NO:	1746	PROJECT NAME:	FERNALD
DATE BEGAN:	12-16-91	DATE FINISHED:	12-16-91	FIELD ENGINEER:	G. MARSHALL
DRILLER:	B. YOST, K. MYERS	N:	478000.00'	E:	1382500.00'
GROUND SURFACE ELEV.:	EST 593.0'	GWL DATE/TIME:	NA	GWL DEPTH:	NA
DRILLING METHOD:	HOLLOW STEM AUGER			EQUIPMENT:	MOBILE DRILL 80
CONTRACTOR:	PENN DRILLING			CHECKED BY:	D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	BPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	OVA (PPM)	REMARKS
	0.00	S 0687	5	0.5		Firm, (10YR 3/6), yellowish-brown, silty CLAY with rootlets, no plasticity, dry 0.5'	cl	1.5	HNU - 0 ppm βγ - 0 cpm
			7	0		No recovery	NA	NA	
			7	0		1.5'		NA	
		S 0689	13	0.5		Hard, (10YR 4/6), dark yellowish-brown, silty CLAY, trace of gravel, no plasticity, dry 2.0'	cl	>4.5	HNU - 0 ppm βγ - 0 cpm
			12	0		No recovery	NA	NA	
			16	0		3.0'		NA	
590.0		S 0689	16	0.5		Hard, (10YR 6/4), light yellowish-brown, silty CLAY with gravel, no plasticity, dry	cl	>4.5	HNU - 0 ppm βγ - 0 cpm
			28	0.5		4.15'		>4.5	
			27	0.25		Hard, (10YR 4/4), dark yellowish-brown, silty CLAY with some gravel, no plasticity, dry		>4.5	
		S 0690	12	0.5				>4.5	HNU - 0 ppm βγ - 0 cpm
	-5.00	S 0691	13	0.5				>4.5	
		S 0692	14	0.42		6.0'		>4.5	
			13	0		No recovery 6.5'	NA	NA	
		S 0696	18	0.5		Hard, (10YR 5/6), yellowish-brown, gravelly CLAY, no plasticity, dry 7.0'	cl	>4.5	HNU - 0 ppm βγ - 0 cpm
		S 0697	19	0.5		Medium firm, (10YR 5/4), yellowish-brown, very fine, clayey SAND, no plasticity, moist 8.0'	sc	1.0	
585.0		S 0697	16	0.33				1.0	HNU - 0 ppm βγ - 0 cpm
		S 0697	20	0.5		Very soft, (10YR 5/4), yellowish-brown mottled with (10YR 5/1), gray, very fine, clayey SAND, no plasticity, wet 8.5'		0.25	HIT PERCHED WATER AT 8
			22	0.33		Very soft, (10YR 5/4), yellowish-brown, very fine, clayey SAND, no plasticity, moist 9.0'		0.25	
		S 0698	17	0		No recovery 9.5'	NA	NA	
	-10.00	S 0699	SHELBY TUBE	1.58		Very firm, (2.5Y 4/3), olive brown, gravelly CLAY, low plasticity, wet 9.75'	cl	2.75	HNU - 0 ppm βγ - 0 cpm
						Very soft, (2.5Y 4/3), olive brown, clayey GRAVEL, no plasticity, wet 10.5'	gc	0.25	
						Very firm, (2.5Y 4/3), olive brown, gravelly CLAY, low plasticity, moist 10.75'	cl	2.25	
						No recovery	NA		
580.0						BOTTOM OF BORING AT 12.5'			
	-15.00								

NOTE: ALL SAMPLE NUMBERS ARE INCREMENTED BY 100.00 i.e. 687 IS 100687

PAGE 1 OF 2

PROJECT NO: 313327
DATE BEGAN: 12-10-91
DRILLER: E. GARDNER, D. JAMISON
GROUND SURFACE ELEV.: NA
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1747
DATE FINISHED: 12-11-91
N: 477600.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: P. CASSIDAY
E: 1382500.00'
GWL DEPTH: NA
EQUIPMENT: NA
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	DRILLING RATE	DESCRIPTION	USCS	OVA (BZ/BH) (PPM)	REMARKS
0.0	0.00	S 1226	2	0.5		Med Firm, (10YR 4/6), dark yellowish-brown, silty CLAY, abundant roots and organic material, slightly moist 0.5'		0.5	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			3	0.5		Very Firm, (10YR 4/6), dark yellowish-brown, silty CLAY, less organic material, low plasticity, slightly moist 1.0'	cl	3.5	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			5	0.25				>4.0	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
		S 1225	12	0		Hard, (10YR 4/6), dark yellowish brown, silty CLAY, less organic material, low plasticity, slightly moist 1.5'	NA	NA	
		S 1227	15	0.5		No recovery 2.0'		NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			21	0.5		Dense, (2.5Y 6/6), olive yellow, clayey SILT with minor sand, low plasticity, trace gravel, dry 3.0'		NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			28	0.5		Dense, (2.5Y 6/6), olive yellow, clayey SILT with minor sand and some gravel, dry		NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			20	0			ml	NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			20	0.17				NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			20	0.5				NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
-5.0	-5.00		20	0.5		5.5'		NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
		S 1228	24	0.17		Firm, (10YR 5/4), yellowish brown, silty CLAY with trace of sand, plastic, moist 6.0'		1.5	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			22	0.5		Medium Firm, (10YR 5/4), yellowish brown, silty CLAY trace sand, some intermittent gravel, slightly plastic, moist		0.75	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			22	0.5				0.75	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			26	0.5		7.5'	cl	0.75	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			14	0.5		Medium Firm, (10YR 5/4), yellowish brown, silty CLAY, trace sand, some intermittent gravel, slightly plastic, some larger chunks of gravel, moist		0.75	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			16	0		8.5'		1.5	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			21	0.5		Very Firm, (10YR 5/4), yellowish brown, silty CLAY, trace sand, some Intermittent gravel, slightly plastic, some larger chunks of gravel, moist 9.0'		3.5	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
		S 1229	NA	1.0		Medium Firm, (10YR 4/4), dark yellowish brown, clayey SILT, some small gravel, slightly moist		NA	
-10.0	-10.00		NA	1.0		11.0'	ml	NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
			NA	0.33		Firm, (10YR 5/6), yellowish brown, silty CLAY with some gravel, and plastic, moist 12.0'		1.25	
		S 1230	SHELBY TUBE	2.5		Medium Firm, (10YR 5/6), yellowish brown, silty CLAY with some gravel, plastic, moist	cl	1.0	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
						Firm, (5Y 5/1), gray CLAY with some large gravel, plastic, moist 14.5'		1.5	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
		S 1248	15	0		No recovery 15.0'	NA	NA	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
-15.0	-15.00	S 1233	6	0.5		Firm, (5Y 5/1), gray CLAY with minor silt and some gravel, plastic, moist 15.5'	cl	1.75	HNU - 0 ppm βγ - 20 cpm α - 0 cpm
		S 1247	0	0		No recovery	NA	NA	

000789

PROJECT NO: 313327
DATE BEGAN: 12-10-91
DRILLER: E. GARDNER, D. JAMISON
GROUND SURFACE ELEV.: NA
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1747
DATE FINISHED: 12-11-91
N: 477600.00'
GWL DATE/TIME: NA

PAGE 2 OF 2
PROJECT NAME: FERNALD
FIELD ENGINEER: P. CASSIDAY
E: 1382500.00'
GWL DEPTH: NA
EQUIPMENT: NA
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	BPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	OVA (DIRECT READING)	REMARKS
			11	0			NA	NA	
			21	0				NA	
		S 1234	34	0.5		Very firm, (5Y 5/1), gray CLAY, some silt and gravel, plastic, moist		2.5	HNU - 0 ppm, βγ - 20 cpm, α - 0 cpm
		S 1238	30	0.5		17.0'		3.0	HNU - 0 ppm, βγ - 20 cpm, α - 0 cpm
		S 1238	27	0.5		Very firm, (5Y 5/1), gray CLAY, grading into a clayey silt with gravel, moist	cl	3.0	HNU - 0 ppm, βγ - 20 cpm, α - 0 cpm
		S 1240	21	0.5		Very firm, (5Y 5/1), gray CLAY, grading into a clayey silt with gravel, moist		3.0	HNU - 0 ppm, βγ - 20 cpm, α - 0 cpm
		S	SHELBY TUBE			18.0'			HNU - 0 ppm, βγ - 20 cpm, α - 0 cpm
20.0	-20.00	1242		2.5		Very firm, (5Y 5/1), gray, sandy SILT, some gravel, very wet	ml	3.0	
						19.0'			
25.0	-25.00					BOTTOM OF BORING AT 21.5'			
30.0	-30.00								

NOTE:
ALL SAMPLE NUMBERS ARE INCREMENTED BY 100,000
ie. 1226 IS 101226

PAGE 1 OF 2

PROJECT NO: 313327
DATE BEGAN: 12-9-91
DRILLER: B. YOST, K. MEYERS
GROUND SURFACE ELEV.: NA
DRILLING METHOD: AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1748
DATE FINISHED: 12-12-91
N: 477300.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: B. MARSHALL
E: 1292500.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILLING R
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	(OZHNU/BZ/BG) 1ST	REMARKS
0.0	0.00	S 0651	3	0.5		Firm, (10YR 3/6), dark yellowish-brown, silty CLAY, silt, rootlets, no plasticity, dry 0.5'	cl	1.5	TRIP/FIELD BLANK NO. 10052
			5	0.5		Medium firm, (10YR 3/6), dark yellowish-brown, silty CLAY, no plasticity, dry		1.0	HNU - 0 ppm
								1.75	βY - 0 cpm ABOVE BACKGROUND
			3	0			NA	NA	
		S 0653	6	0.5		Firm, (10YR 5/8), yellowish-brown silty CLAY, no plasticity, dry 1.0'	cl	>4	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
			12	0		No recovery 1.5'	NA	NA	
			15	0		Hard, (10YR 5/8), yellowish-brown, silty CLAY, no plasticity, dry 2.0' No recovery 3.0'			
		S 0654	12	0.5		Hard, (10YR 5/8), yellowish-brown, silty CLAY, no plasticity, dry 4.0'	cl	>4	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
		S 0655	22	0.5					
			21	0.8		Hard, (10YR 5/6), yellowish-brown, silty CLAY with traces of gravel, no plasticity, dry 5.0'			HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
		S 0656	21	0.5					
-5.0	-5.00		18	0		No recovery 6.0'	NA	NA	
			12	0					
		S 0654	11	0.5		Very firm, (10YR 5/3), brown, CLAY with sand and gravel, high plasticity, moist	cl	3.5	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
		S 0654	15	0.5		Firm, (10YR 5/3), brown, CLAY with sand and gravel, high plasticity, moist		1.75	
			11	0.5		Very firm, (10YR 5/3), brown, CLAY with sand and gravel, high plasticity, moist		2.75	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
		S 0654	11	0.5				1.0	
			13	0.5		Firm, (10YR 5/3), brown, CLAY with sand and gravel, high plasticity, moist		2.0	
			11	0.5		Very firm, (10YR 5/3), brown, CLAY with sand and gravel, high plasticity, moist		4.0	
		S 0655	SHELBY TUBE	4.5		Hard, (10YR 5/3), brown, CLAY with sand and gravel, high plasticity, moist		1.5	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
-10.0	-10.00					Firm, (10YR 5/1), gray CLAY with sand and gravel, no plasticity, dry 12.0'		>4.0	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
		S 0658	9	0.5		Hard, (5YR 5/8), yellowish-red, silty CLAY with some sand and gravel, low plasticity, moist		3.0	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
			10	0.5		13.0'		2.5	
			16	0.5		Very hard, (10YR 5/1), gray mottled with (5YR 5/8), yellowish-red CLAY with sand and gravel, low plasticity, moist 13.5'		>4.5	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
			20	0		No recovery 14.0'	NA	NA	
		S 0664	4	0.5		Firm, (5YR 4/4), reddish-brown, silty CLAY with sand and gravel, low plasticity, moist 15.0'	cl	1.25	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
			9	0.5			cl	2.5	
-15.0	-15.00		13	0		No recovery 15.5'	NA	NA	
		S 0665	9	0.5		Firm, (10YR 5/1), gray, gravelly CLAY with sand, low plasticity, moist	cl	1.5	HNU - 0 ppm βY - 0 cpm ABOVE BACKGROUND
			12	0.5		Very firm, (10YR 5/1), gray, gravelly CLAY with sand, low plasticity, moist	cl	2.75	
			16	0.17		17.0'	cl	2.75	

PROJECT NO: 213387
DATE BEGAN: 12-9-91
DRILLER: B. YOST, K. MEYERS
GROUND SURFACE ELEV.: NA
DRILLING METHOD: AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1749
DATE FINISHED: 12-12-91
N: 477300.00'
GWL DATE/TIME: NA

PAGE 2 OF 2
PROJECT NAME: FERNALD
FIELD ENGINEER: G. MARSHALL
E: 1392500.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILLING RIG 60
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	OVA (BZ&1000ZOO 1B4)	REMARKS
		S 0683	11	0.5		Very firm, (5Y 5/1), gray, gravelly CLAY with sand, low plasticity, moist		2.75	HNU - 0 ppm
			20	0.5				2.50	γ - 0 cpm ABOVE BACKGROUND
			23	0.5		18.5'		2.50	SAMPLE INTERVAL USED FOR DISTURBED GEOTECH
		S 0665	SHELBY TUBE	1.83		Very firm, (5Y 5/1), gray, gravelly CLAY with sand, low plasticity, moist		3.0	HNU - 0 ppm γ - 0 cpm ABOVE BACKGROUND
-20.0	-20.00	S	TUBE	1.33			cl	2.5	HNU - 0 ppm γ - 0 cpm ABOVE BACKGROUND
						21.5'			
						No recovery 22.0'	NA	NA	DRILLED AN EXTRA 6" TO TRY TO GET PAST COBBLE
		S 0665	SHELBY TUBE	2.0		Very firm, (5Y 5/1), gray, gravelly CLAY with sand, low plasticity, moist 25.0'	cl	3.0	HNU - 0 ppm γ - 0 cpm ABOVE BACKGROUND TUBE CRUSHED. LOW RECOVERY. ARCHIVE SAMPLE
-25.0	-25.00	S 0686	7	0.5		Firm, (5Y 5/1), gray, gravelly CLAY with sand, low plasticity, moist			
		S 0687	11	0.5			cl	>4.5	
		S 0688	14	0.5		26.5'			
			18			No recovery 27.0'	NA	NA	
		S 0672	SHELBY TUBE	1.33		Firm, (5Y 5/2), olive gray, gravelly CLAY with sand (fine), low plasticity, moist 30.0'	cl	>4.5	
-30.0	-30.00	S 0676	5	0.5		Very firm, (5Y 5/1), gray, gravelly CLAY, with medium sand, low plasticity, moist		3.0	HNU - 0 ppm γ - 0 cpm ABOVE BACKGROUND
		S 0676	17	0.5				2.5	
		S 0677	22	0.5				2.75	
		S 0678	27	0.5				2.75	
						BOTTOM OF BORING AT 32.0'			
	-35.00								

000792

PAGE 1 OF 2

PROJECT NO: 313327
DATE BEGAN: 2-10-92
DRILLER: J BARILE, C COULTER
GROUND SURFACE ELEV.: NA
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1749
DATE FINISHED: 2-11-92
N: 479000.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: D. O'BRIEN
E: 1392900.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILL 80
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC. (FT)	METHOD	DESCRIPTION	USCS	OVA (ppm)	REMARKS
0.0	0.00	S 1501	2	0.5		Firm, (10YR 5/4), yellowish-brown, silty CLAY, no plasticity, slightly moist		1.0	HNU - 0 ppm, βγ - 50 cpm
			3	0.5		1.0'	cl	1.25	HNU - 0 ppm, βγ - 60 cpm
			4	0.25		Very firm, (10YR 5/4), yellowish-brown, silty CLAY, no plasticity, slightly moist 1.5'		2.5	HNU - 0 ppm, βγ - 60 cpm
			6	0		No recovery 2.0'	NA	NA	
		S 1502	5	0.5		Firm, (10YR 5/4), yellowish-brown silty CLAY, no plasticity, slightly moist		2.0	HNU - 0 ppm, βγ - 40 cpm
		S 1504	7	0.5		3.0'	cl	2.0	HNU - 0 ppm, βγ - 40 cpm
		S 1508	9	0.5		Very firm, (10YR 5/4), yellowish-brown, silty CLAY, no plasticity, slightly moist 3.5'		3.0	HNU - 0 ppm, βγ - 60 cpm
			11	0		No recovery 4.0'	NA	NA	
		S 1508	6	0.5		Very firm, (2.5Y 6/3), light yellowish-brown, silty CLAY with gravel, no plasticity, dry		2.0	HNU - 0 ppm, βγ - 50 cpm
			9	0.5			cl	2.25	HNU - 0 ppm, βγ - 50 cpm
-5.0	-5.00		13	0.5		5.5'		2.25	HNU - 0 ppm, βγ - 40 cpm
			17	0.5		Hard, (2.5Y 6/3), light yellowish-brown, silty CLAY with gravel, no plasticity, dry		4.0	HNU - 0 ppm, βγ - 40 cpm
		S 1508	6	0.5		6.5'		4.0	HNU - 0 ppm, βγ - 40 cpm
			11	0		No recovery		NA	
			14	0			NA	NA	
			18	0		8.0'		NA	
		S 1509	SHELBY TUBE	1.5		Very firm, (2.5Y 6/3), light yellowish-brown, silty CLAY with gravel, low plasticity, slightly moist 11.0'		3.5	HNU - 0 ppm, βγ - 60 cpm
-10.0	-10.00	S 1510	14	0.5		Very firm, (5Y 5/1), gray CLAY with gravel, low plasticity, dry	cl	2.0	HNU - 0 ppm, βγ - 60 cpm
			18	0.5		12.0'		3.25	HNU - 0 ppm, βγ - 40 cpm
			27	0.5		Hard, (5Y 5/1), gray CLAY with gravel, no plasticity, dry 12.5'		>4.0	HNU - 0 ppm, βγ - 40 cpm
			36	0.5		Very firm, (5Y 5/1), gray CLAY with gravel, no plasticity, dry 13.0'		2.75	HNU - 0 ppm, βγ - 40 cpm
		S 1511	6	0.5		Firm, (5Y 5/1), gray CLAY with gravel, no plasticity, dry 13.5'		2.0	HNU - 0 ppm, βγ - 60 cpm
		S 1514	7	0.5		Very firm, (5Y 5/1), gray CLAY with gravel, no plasticity, dry		2.25	HNU - 0 ppm, βγ - 60 cpm
		S 1514	14	0.25		14.5'		2.25	HNU - 0 ppm, βγ - 60 cpm
			22	0		No recovery 15.0'	NA	NA	
-15.0	-15.00	S 1517	4	0.5		Very firm, (5Y 5/1), gray CLAY with pockets of poorly graded, coarse sand, low plasticity, wet	cl	2.0	HNU - 0 ppm, βγ - 60 cpm
			9	0.25		16.0'		2.0	HNU - 0 ppm, βγ - 50 cpm
			11	0		No recovery	NA	NA	
			20	0		17.0'		NA	

000793

PROJECT NO: 313327 | BORING NO: 1749 | PAGE 2 OF 2
DATE BEGAN: 3-10-92 | DATE FINISHED: 3-11-92 | PROJECT NAME: FERNALD
DRILLER: J. BARILE, C. COULTER | N: 478000.00' | FIELD ENGINEER: D. O'BRIEN
GROUND SURFACE ELEV.: NA | GWL DATE/TIME: NA | E: 1382900.00'
DRILLING METHOD: HOLLOW STEM AUGER | GWL DEPTH: NA
CONTRACTOR: PENN DRILLING | EQUIPMENT: MOBILE DRILL 80
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	OVA (0.2-10 PPM)	REMARKS
		S 1518	7	0.5		Very firm, (5Y 5/1), gray CLAY, some gravel, low plasticity, wet		2.0	HNU - 0 ppm, βγ - 50 cpm
			14	0.5				2.0	HNU - 0 ppm, βγ - 50 cpm
			15	0.5		18.5'		2.0	HNU - 0 ppm, βγ - 60 cpm
			18	0.5		Medium firm, (5Y 5/1), gray CLAY, some gravel, low plasticity, wet 19.0'		0.75	HNU - 0 ppm, βγ - 60 cpm
-20.0	-20.00	6 1521	SHELBY TUBE	2.58		Firm, (5Y 5/1), gray CLAY, some gravel, low plasticity, wet 22.0'	CI	1.75	HNU - 0 ppm, βγ - 60 cpm
		S 1524	8	0.5		Medium firm, (5Y 5/1), gray CLAY, low plasticity, slightly moist 22.5'		0.5	HNU - 0 ppm, βγ - 40 cpm
			12	0.17		Firm, (5Y 5/1), gray CLAY, low plasticity, slightly moist 23.0'		1.0	HNU - 0 ppm, βγ - 40 cpm
			13	0		No recovery	NA	NA	
			15	0		24.0'		NA	
		S 1529	6	0.5		Firm, (5Y 5/1), gray CLAY, some gravel, high plasticity, slightly moist		1.25	HNU - 0 ppm, βγ - 40 cpm
			8	0.5		25.0'		1.0	HNU - 0 ppm, βγ - 40 cpm
-25.0	-25.00		11	0.5		Medium firm, (5Y 5/1), gray CLAY, some gravel, high plasticity, slightly moist		0.5	HNU - 0 ppm, βγ - 40 cpm
			14	0.5			CI	0.5	HNU - 0 ppm, βγ - 40 cpm
		S 1529	4	0.5				0.75	HNU - 0 ppm, βγ - 40 cpm
			5	0.5		27.0'		0.75	HNU - 0 ppm, βγ - 40 cpm
			7	0.33		Soft, (5Y 5/1), gray CLAY, high plasticity, moist 27.5'		<0.5	HNU - 0 ppm, βγ - 50 cpm
			9	0		No recovery 28.0'	NA	NA	
		S 1528	11	0.5		Soft, (5Y 5/1), gray CLAY, medium plasticity, moist 28.5'		<0.5	HNU - 0 ppm, βγ - 40 cpm
		S 1528	14	0.5		Medium firm, (5Y 5/1), gray CLAY, medium plasticity, moist	CI	.75	HNU - 0 ppm, βγ - 40 cpm
		S 1530	27	0.5		29.5'		0.75	HNU - 0 ppm, βγ - 40 cpm
			31	0		No recovery	NA	NA	
-30.0	-30.00					BOTTOM OF BORING AT 30.0'			

NOTE:
ALL SAMPLE NUMBERS ARE INCREMENTED BY 100,000 i.e. 1501 IS 101501

PAGE 1 OF 2

PROJECT NO: 213727
DATE BEGAN: 3-18-98
DRILLER: J. BARILE C. COULTER
GROUND SURFACE ELEV.: NA
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1750
DATE FINISHED: 3-13-98
N: 478500.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: D. O'BRIEN
E: 1382500.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILL 80
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	(OZ/10 MIN/200 SQ. IN.)	REMARKS
0.0	0.00	S 1534	2	0.5		Medium firm, (10YR 5/4), yellowish-brown, silty CLAY, low plasticity, slightly moist 0.5'		0.75	HNU - 0 ppm, pY - 40 cpm
			4	0.5		Firm, (10YR 5/4), yellowish-brown, silty CLAY, low plasticity, slightly moist	CI	1.0	HNU - 0 ppm, pY - 40 cpm
			6	0.33		1.5'		1.75	HNU - 0 ppm, pY - 40 cpm
			8	0		No recovery 2.0'	NA	NA	HNU - NA ppm, pY - NA cpm
		S 1535	3	0.25		Medium firm, (10YR 5/10), yellowish-brown, silty CLAY, low plasticity, slightly moist		0.5	HNU - 0 ppm, pY - 50 cpm
		S 1537	7	0.5			CI	0.5	HNU - 0 ppm, pY - 50 cpm
		S 1539	9	0.5		3.5'		0.5	HNU - 0 ppm, pY - 50 cpm
			12	0		No recovery 4.0'	NA	NA	HNU - NA ppm, pY - NA cpm
		S 1541	8	0.5		Soft, (2.5Y 5/4), light olive-brown, silty CLAY, some gravel, medium plasticity, moist 4.5'		<.5	HNU - 0 ppm, pY - 40 cpm
			12	0.5		Very firm, (2.5Y 5/4), light olive-brown, silty CLAY, some gravel, medium plasticity, moist		2.25	HNU - 0 ppm, pY - 40 cpm
-5.0	-5.00		15	0.5				3.0	HNU - 0 ppm, pY - 40 cpm
			18	0.5				3.0	HNU - 0 ppm, pY - 40 cpm
		S 1544	3	0.5				2.0	HNU - 0 ppm, pY - 50 cpm
			6	0.5				2.0	HNU - 0 ppm, pY - 50 cpm
			10	0.5			CI	2.5	HNU - 0 ppm, pY - 50 cpm
			10	0.17				2.5	HNU - 0 ppm, pY - 50 cpm
		S 1543	SHELBY TUBE	2.08		11.0'		3.5	HNU - 0 ppm, pY - 50 cpm
-10.0	-10.00								HNU - NA ppm, pY - NA cpm; HNU - NA ppm, pY - NA cpm; HNU - NA ppm, pY - NA cpm
			8	0		No recovery		NA	HNU - 0 ppm, pY - 0 cpm
			11	0			NA	NA	HNU - NA ppm, pY - NA cpm
			15	0				NA	HNU - NA ppm, pY - NA cpm
			19	0		13.0'		NA	HNU - NA ppm, pY - NA cpm
		S 1546	6	0.5		Medium firm, (2.5Y 5/4), light olive-brown, silty CLAY with gravel, medium plasticity, moist 13.5'		0.75	HNU - 0 ppm, pY - 50 cpm
			6	0.5		Very firm, (2.5Y 5/4), light olive-brown, silty CLAY with gravel, medium plasticity, moist 14.0'		2.25	HNU - 0 ppm, pY - 50 cpm
		S 1547	11	0.5		Firm, (5Y 5/1), gray CLAY with gravel, low plasticity, slightly moist 14.5'	CI	1.5	HNU - 0 ppm, pY - 50 cpm
			20	0.33		Medium firm, (5Y 5/1), gray CLAY with gravel, low plasticity, slightly moist 15.0'		0.75	HNU - 0 ppm, pY - 50 cpm
-15.0	-15.00	S 1548	6	0.5		Very firm, (2.5Y 5/4), light olive-brown, silty CLAY, low plasticity, moist 15.5'		2.25	HNU - 0 ppm, pY - 60 cpm
		S 1549	7	0.5		Very firm, (5Y 5/1), gray CLAY with gravel, low plasticity, moist 16.0'		2.5	HNU - 0 ppm, pY - 60 cpm
			9	0		No recovery	NA	NA	HNU - NA ppm, pY - NA cpm
			14	0		17.0'		NA	HNU - NA ppm, pY - NA cpm

PROJECT NO: 313327
DATE BEGAN: 3-12-92
DRILLER: J. BARILE C. COULTER
GROUND SURFACE ELEV.: NA
DRILLING METHOD: HOLLOW STEM AUGER
CONTRACTOR: PENN DRILLING

BORING NO: 1750
DATE FINISHED: 3-13-92
N: 478500.00'
GWL DATE/TIME: NA

PROJECT NAME: FERNALD
FIELD ENGINEER: D. O'BRIEN
E: 1382500.00'
GWL DEPTH: NA
EQUIPMENT: MOBILE DRILL 80
CHECKED BY: D. AMBROSE

ELEV (FT)	DEPTH (FT)	SAMPLE TYPE AND NO.	SPT BLOWS PER (0.5')	REC (FT)	PROFILE	DESCRIPTION	USCS	(OZ/10/88/20) TBV	REMARKS
		S 1550	6	0.5		Very firm, (5Y 5/1), gray CLAY with gravel, low plasticity, wet	cl	2.5	HNU - 0 ppm, βγ - 50 cpm
			10	0.25		18.0'		2.5	HNU - 0 ppm, βγ - 50 cpm
			13	0		No recovery	NA	NA	HNU - NA ppm, βγ - NA cpm
			15	0		19.0'		NA	HNU - NA ppm, βγ - NA cpm
-20.0	-20.00	S 1551	SHELBY TUBE	1.42		Hard, (5Y 5/1), gray CLAY with gravel, low plasticity, moist	cl	>4.0	HNU - 0 ppm, βγ - 50 cpm; HNU - 0 ppm, βγ - 50 cpm; HNU - 0 ppm, βγ - 50 cpm; HNU - NA ppm, βγ - NA cpm; HNU - NA ppm, βγ - NA cpm; HNU - NA ppm, βγ - NA cpm
		S 1552	10	0.5		Hard, (5Y 5/1), gray, gravelly CLAY, no plasticity, moist		>4.0	HNU - 0 ppm, βγ - 60 cpm
		S 1554	12	0.5		23.0'		>4.0	HNU - 0 ppm, βγ - 60 cpm
		S 1556	14	0.5		Very firm, (5Y 5/1), gray, gravelly CLAY, no plasticity, moist 23.5'		3.5	HNU - 0 ppm, βγ - 60 cpm
		S 1558	18	0.5		Hard, (5Y 5/1), gray, gravelly CLAY, no plasticity, moist 24.0'		>4.0	HNU - 0 ppm, βγ - 60 cpm
		S 1560	10	0.5		Firm, (5Y 5/1) gray, gravelly CLAY, no plasticity		1.75	HNU - 0 ppm, βγ - 40 cpm
			11	0.33		25.0'		1.5	HNU - 0 ppm, βγ - 40 cpm
-25.0	-25.00		14	0		No recovery	NA	NA	HNU - NA ppm, βγ - NA cpm
			13	0		26.0'		NA	HNU - NA ppm, βγ - NA cpm
		S 1560	4	0.5		Firm, (5Y 5/1), gray, gravelly CLAY, low plasticity, wet	cl	1.25	HNU - 0 ppm, βγ - 40 cpm
			4	0.5		27.0'		1.25	HNU - 0 ppm, βγ - 40 cpm
			6	0		No recovery	NA	NA	HNU - NA ppm, βγ - NA cpm
			7	0		28.0'		NA	HNU - NA ppm, βγ - NA cpm
		S 1562	6	0.5		Very firm, (5Y 5/1), gray, gravelly CLAY, low plasticity, wet	cl	2.0	HNU - 0 ppm, βγ - 60 cpm
		S 1564	8	0.5				2.0	HNU - 0 ppm, βγ - 60 cpm
		S 1566	9	0.5				2.0	HNU - 0 ppm, βγ - 60 cpm
		S 1568	11	0.5				2.5	HNU - 0 ppm, βγ - 60 cpm
-30.0	-30.00					BOTTOM OF BORING AT 30.0'			

NOTE:
ALL SAMPLE NUMBERS ARE INCREMENTED BY 100,000
ie. 1534 IS 101534

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 2399	COORDINATES:	DATE 11-19-91
ELEVATION:	GWL: Depth 64.04 Date/Time 11-22-91	DATE STARTED: 11-19-91
ENGINEER/GEOLOGIST: J. Lear	Depth 63.12 Date/Time 12-9-91	DATE COMPLETED: 12-10-91
DRILLING METHODS: Cable Tool		PAGE 1 OF 8

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	33581 0950 11-19-91	4 7 9	8	Med dense, Pale brown (10yr, 6/3) Silt, Some organics, dry	ML	NA	Hno - 0 ppm BD - 40 cpm α - 0 cpm
2 3	33582 0955 11-19-91	6 9 12	2	Hard, yellowish brown (10yr. 5/8) silty clay, Low plasticity, Sl. moist.	CL	>4.0	Hno - 0 ppm BD - 40 cpm α - 0 cpm
4	33583 1000 11-19-91	7 13 16	10	Hard, yellowish brown, (10yr, 5/4) silty clay, Some gravel, Low plasticity, Sl. moist.	CL	>4.0	Hno - 0 ppm BD - 40 cpm α - 0 cpm
5 6	33584 1005 11-19-91	25 28 30	13	S.A.A. add 10yr, 5/8	CL	>4.0	Hno - 0 ppm BD - 40 cpm α - 0 ppm
7	33585 1010 11-19-91	4 11 36	12	Hard, Pale Brown to yellowish brown (10yr, 6/3) silty clay, trace gravel, laminar sand, (10yr, 5/4) dry to sl. moist.	CL	>4.0	Hno - 0 ppm BD - 40 cpm α - 0 cpm
8 9	33586 1015 11-19-91	50/4	4	Hard, Pale brown to brown, (10yr, 6/3 to 10yr 5/3) silty clay, trace gravel, low plast. dry to sl. moist.	CL	>4.0	Hno - 0 ppm BD - 40 cpm α - 0 cpm
10	33587 1025 11-19-91	11 11 26	6	V. stiff, yellowish brown, (10yr, 5/4) silty clay. Trace gravel, Low to mod plasticity, moist.	CL	2.5	Hno - 0 ppm BD - 40 cpm α - 0 cpm
11 12	33588 1040 11-19-91	9 14 18	9	Hard, gray to yellowish brown, (10yr. 5/1 to 10yr 5/4) silty clay, Trace sand, Trace gravel, ~~Med~~ Low plasticity, sl moist.	CL	>4.0	Hno - 0 ppm BD - 40 cpm α - 0 cpm
13	33589 1335 11-19-91	10 30 29	10	V. stiff, gray (10yr. 5/1) silty clay, some gravel, trace sand, Low plasticity, Sl. moist	CL	3.5	Hno - 0 ppm BD - 40 cpm α - 0 cpm
14	33590 1340 11-19-91	10 10 26	12	J.L 11-19-91 Hard, S.A.A 14.0 ft	CL	3.5	Hno - 0 ppm BD - 50 cpm α - 0 cpm
15				Hard, yellowish brown, (10yr. 5/4) silty clay, Some sand, laminar gravel, moist. Low plast.	CL	4.5	

NOTES

Drilling Contractor - Penn Drilling
Drilling Equipment - Cyclone 45
Driller - Craig Coulter
Asst - Gary Dye

S.A.A. Same as Above
N.R. No Recovery
Sl. - slightly

Background
Hno - 0 ppm
BD - 40 cpm
α - 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 2399	COORDINATES:	DATE 11-19-91
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-19-91
ENGINEER/GEOLOGIST: J. Lear	Depth Date/Time	DATE COMPLETED: 12-10-91
DRILLING METHODS: Cable Tool		PAGE 2 OF 8

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 6in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	33592 1346 11-19-91	14 16 20	7	V. stiff, gray (10yr, 5/1) silty clay, trace gravel, low plasticity, sl. moist.	CL	3.25	Hnu - 0 ppm Bq - 40 cpm α - 0 cpm
17 18	33593 1400 11-19-91	3 6 13	10	V stiff, gray, (10yr, 5/1) silty clay, some gravel, Laminar sand, low plast. sl. moist.	CL	3.5	Hnu - 0 ppm Bq - 40 cpm α - 0 cpm
19	33594 1415 11-19-91	10 16 25	6	S.A.A. no sand.	CL	3.5	Hnu - 0 ppm Bq - 40 cpm α - 0 cpm
20 21	33594 1420 11-19-91	4 6 9	11	Stiff, gray, (10yr, 5/1) silty clay, trace gravel med. plasticity, moist.	CL	1.75	Hnu - 0 ppm Bq - 40 cpm α - 0 cpm
22	33595 1425 11-19-91	6 9 13	15	S.A.A. -21.75 FT med. dense, gray (10yr, 6/1) clayey silt, trace sand, moist.	CL ML	1.75 NA	Hnu - 0 ppm Bq - 40 cpm α - 0 ppm
23 24	33596 1435 11-19-91	7 8 15	0	N.R	NA	NA	NA
25	33598 0920 11-21-91	9 15 22	8	very stiff, gray, (10yr, 5/1) silty clay, trace gravel, med Plasticity, moist.	CL	5.75	Hnu - 0 ppm Bq - 50 cpm α - 0 cpm
26 27	33598 0930 11-21-91	4 6 9	8 12	med dense, gray, (10yr 5/1) silt, very moist -26.0' very stiff, gray (10yr, 5/1) silt clay, trace gravel, low to med plasticity, moist.	ML CL	NA 2.75	Hnu - 0 ppm Bq - 50 cpm α - 0 cpm
28	~~33600~~ 33599 0940 11-21-91	50/4	4	V. dense, yellowish brown, (10yr, 5/6) well sorted med sand, trace gravel, moist.	SP	NA	Hnu - 0 ppm Bq - 50 cpm α - 0 cpm
29 30				Sand and gravel Aquifer met at 27.0 ft. Samples will be taken at 5.0 ft intervals starting at 30.0 ft			

NOTES see pg 1

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 2399	COORDINATES:		DATE 11-21-91
ELEVATION:	GWL: ~~Depth~~	Date/Time	DATE STARTED: 11-19-91
ENGINEER/GEOLOGIST: J. Lear	Depth	Date/Time	DATE COMPLETED: 12-10-91
DRILLING METHODS: cable tool			PAGE 3 OF 8

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30							
31	33600 0955 11-21-91	21 35 31	15	V. dense, gray (10yr, 6/1) gravel clay sand mixture, V. moist. -30.7 ft V. dense, yellowish brown (10yr, 5/6) wellsorted med sand some gravel, moist.	GC SP	NA NA	H_{NU} - 0 ppm $\beta\gamma$ - 50 cpm α - 0 cpm
32							
33							
34							
35	J.L. 11-21-91						
36	33602 1600 11-21-91	50/5	3	S.A.A	SP	NA	H_{NU} - 0 ppm $\beta\gamma$ - 50 cpm α - 0 cpm
37							
38							
39							
40	J.L. 11-21-91						
41	33602 1630 11-21-91	50/5	5	S.A.A.	SP	NA	H_{NU} - 0 ppm $\beta\gamma$ - 50 cpm α - 0 cpm
42							
43							
45							
46							

NOTES: see page 1

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.5.23	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 2399	COORDINATES:		DATE 11-21-91
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 11-19-91
ENGINEER/GEOLOGIST: J. Lear	Depth	Date/Time	DATE COMPLETED: 12-10-91
DRILLING METHODS: Cable Tool			PAGE 4 OF 8

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45	J.L. 11-21-91						
46	33603 1715 11-21-91	11 50/4	8	v. dense, yellowish brown (10yr. 5/4) well sorted, fine sand, trace gravel, moist	SP	NA	Hnu - 0 ppm βδ - 50 cpm α - 0 cpm
47							
48							
49							
50	J.L. 11-21-91						
51	33604 1730 11-21-91	13 50/5	10	S.A.A	SP	NA	Hnu - 0 ppm βδ - 50 cpm α - 0 cpm
52							
53							
54							
55	J.L. 11/22/91						
56	33605 0855 11-22-91	25 50/3	4	S.A.A	SP	NA	Hnu - 0 ppm βδ - 50 cpm α - 0 cpm
57							
58							
59							
60							

NOTES: see pg 1

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 2399	COORDINATES:		DATE 11-22-91
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 11-19-91
ENGINEER/GEOLOGIST: J. Lear	Depth	Date/Time	DATE COMPLETED: 12-10-91
DRILLING METHODS:			PAGE 5 OF 8

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60							
61	33608 0925 11-22-91	20 50/5	7	V. dense, dark yellowish brown (10yr 4/4) well sorted sand, some gravel, some silt, moist.	SP	NA	Hnu - 0 ppm; BB - 50 cpm; α - 0 cpm
62							
63							
64							
65	11-22-91						
water table	33608 1005 11-22-91	22 31 37	6	V. dense, grayish brown, (10yr. 5/2) poorly sorted gravelly sand, trace silt, wet.	SW	NA	Hnu - 0 ppm; BB - 50 cpm; α - 0 cpm
66							
67							
68							
69							
70	33608 1045 11-22-91	28 50/5	7	S.A.A	SW	NA	Hnu - 0 ppm; BB - 50 cpm; α - 0 cpm
71							
72							
73							
74							
75							

NOTES: See page 1

VISUAL CLASSIFICATION OF SOILS

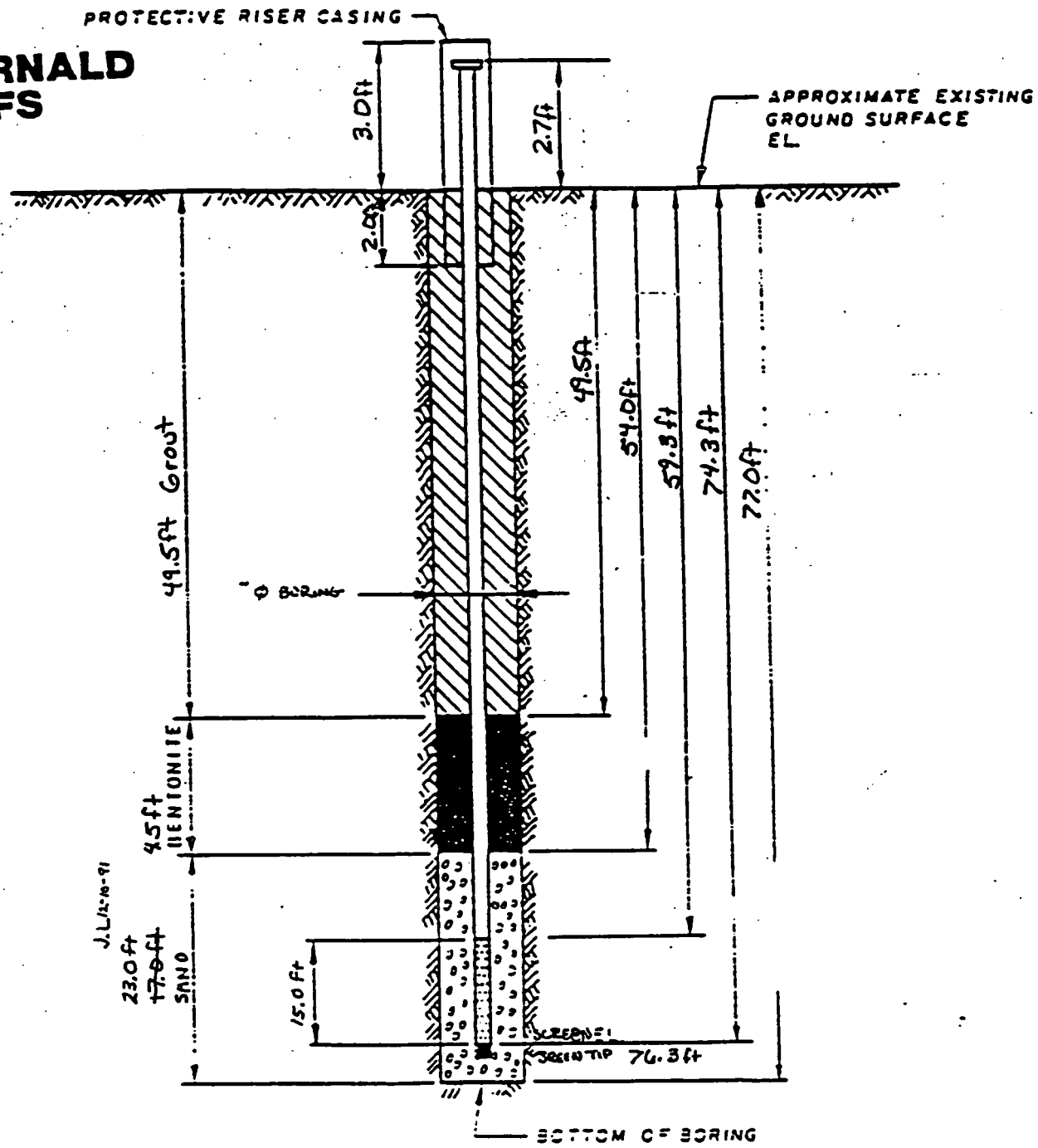
PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 2399	COORDINATES:	DATE 11-22-91
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 11-19-91
ENGINEER/GEOLOGIST: J. Lesr	Depth Date/Time	DATE COMPLETED: 12-10-91
DRILLING METHODS: cable tool		PAGE 6 OF 8

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75							
76	33609 1120 11-22-91	6 10 10	13	med dense, dark grayish brown, (10yr. 4/2) sandy gravel, trace silt, wet.	GW	NA	Hnu - 0 ppm BS - 50 cpm α - 0 cpm
77				Drilling ends at 77.0 ft J.L 11-22-91 Sampling ends at 76.5 ft			

NOTES: See page 1

/8

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY / APPROVED BY

J. Lear 12-10-91

DRAWN BY

J.L. 12-10-91

NOTES:

1. RISER PIPE IS 4.0 IN I.D SCHEDULE 40 PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4.0 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL 63.12 Ft.
5. WATER LEVEL READING ON 12-9-91

500 gals H_2O used
11 80 lb bags of 10x20 sand used
17 bags (50 lb) volclay grout used
4 5 gal buckets of bentonite used

INSTALLATION DETAILS
MONITORING WELL
2399
PREPARED FOR
Fernald RI/FS

FERNALD
RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FEMP RI/FS
PROJECT NO. 1602.3.23
BORING NO. 2399
PIEZOMETER NO. 2399
FIELD ENG./GEO. J. Lear
CHECKED BY
DATE 12-10-91
DATE
DATE OF INSTALLATION 12-9-91 - 12-10-91

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID H_2O FROM 0 ft TO 77 ft
FLUID NA FROM NA TO NA

TYPE OF BIT Cable Tool
CASING SIZE (S) USED:
SIZE 8 in FROM 0 ft TO 80 ft
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE 4 in Schedule 40 stainless
DIAMETER OF PERFORATED SECTION 4.0 in
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ Slotted SCREEN ☑
AVERAGE SIZE OF PERFORATIONS .010 in
TOTAL PERFORATED AREA 15 ft

RISER PIPE MATERIAL Schedule 40 Stainless
RISER PIPE DIAMETERS:
O.D. 4.35 I.D. 4.0
LENGTH OF PIPE SECTIONS 10 ft, 5 ft, 2 ft
JOINING METHOD Threaded flush Jointed

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 ft
PROTECTIVE PIPE O.D. 10.75

OTHER PROTECTION Hinged Cap, Locked. Well cap, vented

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft)		ELEVATION ( )	
TOP OF RISER PIPE	2.7			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.0			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.5	BOTTOM 49.0	TOP	BOTTOM
BENTONITE	TOP J.L. 12-10-91 49.5	BOTTOM 54.0	TOP	BOTTOM
SAND J.L. 12-10-91 ~~GRAVEL~~	TOP 54.0	BOTTOM 77.0	TOP	BOTTOM
	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 59.3	BOTTOM 74.3	TOP	BOTTOM
PIEZOMETER TIP	76.3			
BOTTOM OF BOREHOLE	77.0			
GWL AFTER INSTALLATION	63.12			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

REMARKS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 2400	COORDINATES:	DATE 12-12-91	
ELEVATION:	GWL: Depth 63.4 Date/Time 12-21-91/1230	DATE STARTED: 12-12-91	
ENGINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91	
DRILLING METHODS: Cable Tool 10" drill bit		PAGE 1 OF 8/10	

K.M. 1-16-92

DEPTH (ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0 – .9	12-12-91 1410 53625	3 5 5	11	Stiff yellowish brown (10 YR, 5/4) CLAYEY SILT with organic matter, moist	ML	1.5	Hnu = .2 ppm Bγ = 60 cpm α = 0 cpm
1.5 – 2.3	12-12-91 1415 53626	5 13 15	10	Hard yellowish brown (10YR, 5/4) SILTY CLAY with sand and some black weathering, a little organic matter, damp, non plastic	CL	>4.5	Hnu = .2 ppm Bγ = 60 cpm α = 0 cpm
3.0 – 3.5	12-12-91 1420 53627	15 16 20	6	Hard light yellowish brown (2.5Y, 6/4) SILTY CLAY with sand and a little fine gravel, dry, non plastic	CL	>4.5	Hnu = .2 ppm Bγ = 60 cpm α = 0 cpm
4.5 – 5.3	12-12-91 1430 53628	18 18 18	10	Hard light yellowish brown (2.5Y, 6/4) SILTY CLAY with sand and trace fine gravel, damp, non plastic	CL	4.5	Hnu = .2 ppm Bγ = 60 cpm α = 0 cpm
6.0 – 6.8	12-12-91 1435 53629	17 17 16	10	Hard light yellowish brown (2.5Y, 6/4) SILTY CLAY with sand and a little gravel, damp, non plastic	CL	4.5	Hnu = .2 ppm Bγ = 60 cpm α = 0 cpm
7.5							

NOTES:
Drilling Company: Pennsylvania Drilling
Driller: Dave Newman
Assistant Driller: Bob Johnson

Samples Collected per ASTM Standard Penetration Test
Colors Identified using Munsell Color Chart

Hnu = A01343	.2 ppm	Background Levels
Bγ S/N: 73937	60 cpm	
α S/N: 73908	0 cpm	

-02-11-66

000805

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 2400	COORDINATES:	DATE: 12-12-91	
ELEVATION:	GWL: Depth 63.4 Date/Time 12-21-91/1230	DATE STARTED: 12-12-91	
ENGINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91	
DRILLING METHODS: CABLE Tool 10" drill bit		PAGE 2 OF 8/10	

K.M. 1-16-92

DEPTH (ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
7.5	12-12-91 1440 53630	13 12 21	0	No Recovery	N/A	N/A	Hnu= Br= α= N/A
9.0 9.5	12-12-91 1450 53631	13 21 30	6	Stiff light yellowish brown (2.5Y, 6/4) CLAY with some sand and fine gravel, moist, medium plasticity	CL	1.5	Hnu= .2 ppm Br= 60 cpm α= 0 cpm
10.5 11	12-16-91 1314 53632	8 12 18	6	Stiff light yellowish brown (2.5Y, 6/4) SANDY CLAY with gravel, moist medium plasticity	CL	1.5	Hnu= .2 ppm Br= 40 cpm α= 0 cpm
12	12-16-91 1325 53633	12 28 31	18	Very stiff gray (2.5Y, 5/0) SANDY CLAY with gravel, damp, low plasticity	CL	3.0	Hnu= .2 ppm Br= 40 cpm α= 0 cpm
13.5 13.75	12-16-91 1345 53634	7 9 12	3	Same as above	CL	3.0	Hnu= .2 ppm Br= 40 cpm α= 0 cpm
15							

NOTES:

on 12-16-91 Gary Dye was the Assistant Driller

12-16-91

Hnu S/N: A01343	.2 ppm	Background Levels
Br S/N: 73937	40 cpm	
α S/N: 73908	0 cpm	

-02-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 2400	COORDINATES:	DATE 12-16-91
ELEVATION:	GWL: Depth 63.4 Date/Time 12-21-91/1230	DATE STARTED: 12-12-91
ENGINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91
DRILLING METHODS: CABLE Tool 10" Drill Bit		PAGE 3 OF 8/10

K.M. 1-16-92

DEPTH (ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6" (in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15	12-16-91 1400 53635	3 5 8	12	Very stiff gray (5Y, 5/1) SANDY CLAY with gravel, damp, low plasticity	CL	3.0	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
16.5	12-16-91 1410 53636	3 4 8	6	Same as above	CL	3.0	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
18	12-16-91 1430 53637	3 8 10	12	Very stiff gray (5Y, 5/1) SANDY CLAY with gravel, damp, medium plasticity	CL	2.0	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
19.5	12-16-91 1540 53638	3 6 9	0	No Recovery	N/A	N/A	N/A
21	12-16-91 1645 53639	5 9 9	12	Very stiff gray (5Y, 5/1) SANDY CLAY with gravel, damp, medium plasticity	CL	2.5	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
22.5							

NOTES

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	K.M. 12-16-91
BORING NUMBER: 2400	COORDINATES:	DATE 12-16-91
ELEVATION:	GWL: Depth 63.4 Date/Time 12-21-91 1230	DATE STARTED: 12-12-91
ENGINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91
DRILLING METHODS: Cable Tool 10" drill bit		PAGE 4 OF 8/10

K.M. 1-6-92

DEPTH (ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
22.5	12-16-91 1655 53640	2 4 5	14	Loose olive brown (2.5Y, 4/3) medium SAND with trace gravel, dry	SP	N/A	Hnu = .2 ppm BγT = 40 cpm α = 0 cpm
23.7							
24	12-18-91 0900 53641	4 6 12	12	Medium dense grayish brown (2.5Y, 5/2) medium SAND with trace gravel, dry	SP	N/A	Hnu = .2 ppm BγT = 40 cpm α = 0 cpm
25							
				Samples will be taken at 5 ft. intervals			
29							

NOTES

12-17-91

Hnu S/N: 711111	.2 ppm	Background Levels
BγT S/N: 73937	40 cpm	
α S/N: 73908	0 cpm	

402-11-66

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 2400	COORDINATES:	DATE 12-17-91
ELEVATION:	GWL: Depth 63.4 Date/Time 12-21-91/1230	DATE STARTED: 12-12-91
ENGINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91
DRILLING METHODS: Cable Tool 10" drill bit		PAGE 5 OF 8/10

K.M. 1-16-92

DEPTH (ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30	12-17-91 0945 53642	39 45 49	14	Very dense light yellowish brown (2.5Y, 6/3) gravelly SAND, dry	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
31.5							
35	12-17-91 1015 53643	19 18 23	18	Same as above but dense	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
36.5							
40	12-17-91 1120 53644	10 17 20	15	Same as above	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
41.5							
45							

NOTES:

402-11-66

VISUAL CLASSIFICATION OF SOILS

CT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
RING NUMBER: 2400	COORDINATES:	DATE 12-17-91
EVATION:	GWL: Depth 63.4 Date/Time 12-21-91/1230	DATE STARTED: 12-12-91
GINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91
ILLING METHODS: Cable Tool 10" drill bit		PAGE 6 OF 8/10

K.M. 1-6-92

ft.	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5	12-17-91 1430 53645	17 49 50	18	Same as above but very dense	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
5							
0	12-17-91 1520 53646	6 15 27	14	Same as above but dense	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
5	12-17-91 1600 53647	39 50	12	Very dense light yellowish brown (2.5Y, 6/3) Sandy Gravel dry	GW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
6.5							

OTES:

000810

402-11-88

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3-23	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 2400	COORDINATES:	DATE 12-18-91
ELEVATION:	GWL: Depth 63.4 Date/Time 12-21-91/1230	DATE STARTED: 12-12-91
ENGINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91
DRILLING METHODS: Cable Tool 10" drill bit		PAGE 7 OF 8/10

K.M. 1-16-92

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60							
60.8 / 61.5	12-18-91 0915 53648	3 6 9	10	Medium dense grayish brown (2.5Y, 5/2) medium sand with fine gravel, damp	SP	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
63.4				Water Level ▽			The water level = 63.4 ft below the ground surface on 12-21-91 at 1230
65	12-18-91 1030 53649	5 6 13	10	Medium dense grayish brown (2.5Y, 5/2) fine gravel with sand, wet	GW ~~SW~~ KM 12-18-91	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
66							
70	12-18-91 1417 53650	2 3 5	18	Loose ~~medium dense~~ KM 12-18-91 grayish brown (2.5Y, 5/2) SAND with ~~fine~~ KM 12-18-91 a little gravel, wet	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
71.5							
75							

NOTES:

12-18-91

Hnu S/N: 711111	.2 ppm	Background Levels
Bγ S/N: 73937	40 cpm	
α S/N: 73808	0 cpm	

402-11-86

VISUAL CLASSIFICATION OF SOILS

ECT NUMBER: 602.3.23	PROJECT NAME: FEMP RI/FS	
ORING NUMBER: 2400	COORDINATES:	DATE 12-18-91.
EVATION:	GWL: Depth 63.4 Date/Time 12-21-91 1230	DATE STARTED: 12-12-91
GINEER/GEOLOGIST: Ken Marion	Depth Date/Time	DATE COMPLETED: 12-20-91
RILLING METHODS: Cable Tool 10" drill bit		PAGE 8 OF 8 10

K.M. 1-16-92

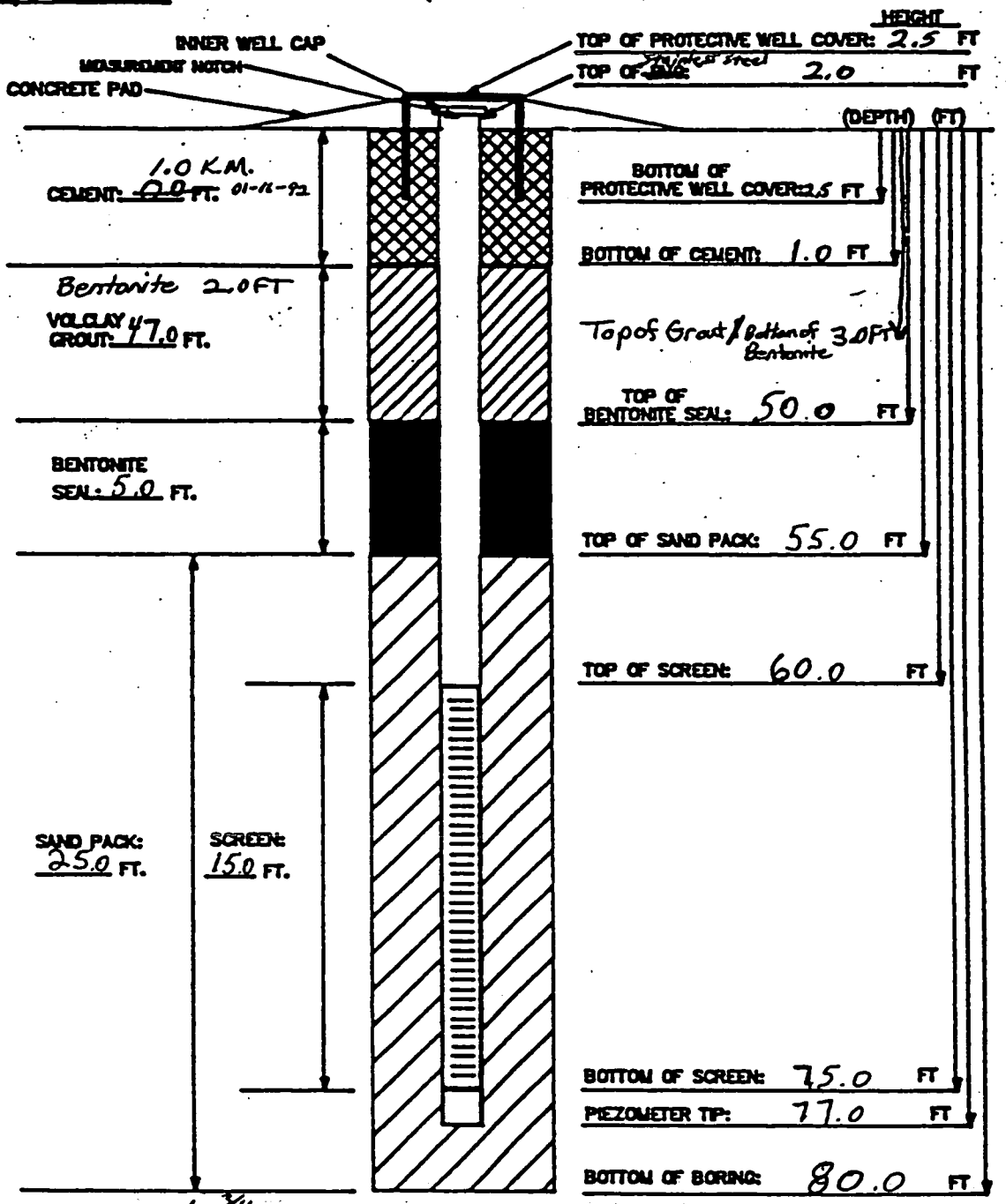
ft.	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75	12-18-91 1500 53651	3 6 9	14	Medium dense grayish brown (2.5Y, 5/2) SAND with fine gravel, wet	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
65							
80	12-18-91 1549 53652	5 7 6	5	Same as above	SW	N/A	Hnu = .2 ppm Bγ = 40 cpm α = 0 cpm
				Bottom of Bore Hole Drilled to 80 ft. Depth of sampling - 81.5 ft.			

NOTES:

FERNALD RI/FS

INSTALLATION DIAGRAM
MONITORING WELL NO. 2400

INSTALLATION DATE: 12-20-91



BOREHOLE DIAMETER: 10 3/4 INCHES

MATERIALS USED:

SAND TYPE AND QUANTITY: 430 Sand, 14 bags
BENTONITE PELLETS (5-GALLON BUCKETS): 11
BAGS OF VOLCLAY GROUT: 9
AMOUNT OF CEMENT: 1/2 bag
AMOUNT OF WATER USED: 800 gallons
OTHER:

NOTES:

1) RISER PIPE IS 2-INCH SCHEDULE 40 PVC PIPE; FLUSH-THREADED JOINTS.
2) SCREEN IS 2-INCH I.D. SCHEDULE 40 PVC PIPE WITH 0.020-INCH SLOTS.
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP.
4) WATER DEPTH/DATE: 63.4 ft. / 12-21-91
5) TOP OF PVC IS SECURED WITH EXPANDABLE RUBBER PLUG AND PADLOCK.
6) PARENTHESES INDICATE DEPTH BELOW GROUND LEVEL.

TASK: 602.3.23 GEOLOGIST/ENGINEER: Ken Marion

PIEZOMETER INSTALLATION SHEET

JECT NAME FEMP RI/FS
CJECT NO. 6023-23
RING NO. 2400
EZOMETER NO. ~~2400~~ ~~N/A~~ 2400 K.M. 12-22-91

FIELD ENG./GEO. Ken Marion DATE 12-22-91
CHECKED BY C Gula DATE 01/16/92
DATE OF INSTALLATION 12-20-91

REHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0.0 TO 80.0
FLUID _____ FROM _____ TO _____

TYPE OF BIT 10" churn bit
CASING SIZE (S) USED:
SIZE 10 3/4 in FROM 0.0 TO 80.0
SIZE _____ FROM _____ TO _____

EZOMETER DESCRIPTION

TYPE Cable Tool
DIAMETER OF PERFORATED SECTION 40 in. I.D.
PERFORATION TYPE:
SLOTS ☑ HOLES ☐ SCREEN ☐
AVERAGE SIZE OF PERFORATIONS .010
TOTAL PERFORATED AREA 15 ft.

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 40
LENGTH OF PIPE SECTIONS 60 (6 - 10 ft. Section, 1 - 2 ft. Section)
JOINING METHOD flush - Joint Threaded

TECTION SYSTEM

ISER PROTECTIVE PIPE LENGTH 5 ft.
PROTECTIVE PIPE O.D. 10 3/4 in.

OTHER PROTECTION Steel Well Cover with lock

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft.)		ELEVATION (ft.)	
OP OF RISER PIPE	2.0			
ROUND SURFACE	0.0			
OTTOM OF PROTECTIVE PIPE	2.5			
OREHOLE FILL MATERIALS:	Top 0.0	Bottom 1.0		
CEMENT GROUT/SLURRY	TOP 3.0	BOTTOM 50.0	TOP	BOTTOM
BENTONITE	TOP 1.8 30.0	BOTTOM 3.0 55.0	TOP	BOTTOM
SAND	TOP 55.0	BOTTOM 80.0	TOP	BOTTOM
GRAVEL	TOP N/A	BOTTOM N/A	TOP N/A	BOTTOM N/A
ERFORATED SECTION	TOP 60.0	BOTTOM 75.0	TOP	BOTTOM
EZOMETER TIP	77.0			
OTTOM OF BOREHOLE	80.0			
WL AFTER INSTALLATION	63.4 ft. on 12-21-91			

THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
ENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑
RKS The temporary casing was removed during the installation of the well

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B368	COORDINATES:	DATE: Jan 20, 1988
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: Lowell/Wilke	Depth Date/Time	DATE COMPLETED: Jan. 28, 1988
DRILLING METHODS: Cable Tool		PAGE 1 OF 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 ft.)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	07764 945	1 6 6	11	soft black 7½YR 3/0 silty clay some sand-moist	ol	2.5	HNU=0ppm γβ=80cpm α=0cpm
2 3	07765 950	4 5 5	9	stiff yellowish brown 10YR 5/6 clay some silt, trace sand-moist; stiff brownish yellow 10YR 6/6 silty clay trace sand, caliche lens at 3.0 ft-moist		2.0 2.0	HNU=0ppm γβ=60cpm α=0cpm
4	07766 955	3 3 4	11	stiff brownish yellow 10YR 6/6 clay trace sand and silt-moist		<1	HNU=0ppm γβ=80cpm α=0cpm
5 6	07767 1000	6 6 8	12	Stiff brownish yellow 10YR 6/6 silty clay trace sand-moist		1.5	HNU=0ppm γβ=60cpm α=0cpm
7	07768 1005	10 11 13	14	very stiff brownish yellow 10YR 6/6 silty clay, trace sand-moist	cl	2.5	HNU=0ppm γβ=60cpm α=0cpm
8 9	07769 1125	7 10 25	15	very stiff brownish yellow 10YR 6/6 clay with trace silt and sand-moist 9.0		3.5	HNU=0ppm γβ=60cpm α=0ppm
10	07980 1145	6 12 12	11	very stiff gray 7½YR 5/0 clay trace sand and gravel-moist		3.5	HNU=0ppm γβ=60cpm α=0cpm
11	NO SAMPLE						Tried Shelby tube-No Return
12	07981 1430	4 7 5	6	Stiff gray 7½YR 5/0 silty clay ~~with~~ some gravel and sand-moist	cl	1.25	HNU=0ppm γβ=40cpm α=0cpm
13	NO SAMPLE						Tried Shelby Tube No Return
14	07982 1515	8 9 15	9	very stiff gray 7½YR 5/0 clay some gravel and sand, trace pebbles-moist		3.5	HNU=0ppm γβ=60cpm α=0cpm

NOTES:
Pennsylvania Drilling Co.
Driller Dow Newman
Helper Bob Johson

Background
HNU=0ppm
γβ=80cpm
α=2cpm

Blows on sampler follow ASTM for Standard penetration test for 2in diameter by 2 ft length standard split spoon
Soil color description follow Munsell color chart

water added to boring (5 gallon buckets) ~~IIII~~ ~~IIII~~ ~~III~~ ~~III~~ ~~III~~ ~~III~~ ~~III~~ ~~III~~ ~~IIII~~ ~~IIII~~ ~~III~~

000015

6647

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B368	COORDINATES:	DATE: Jan 20, 1988
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L. Wille/J. O'Connor	Depth Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable Tool		PAGE 2 OF ~~10~~ 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	7983 1530	5 11 16	14	~~gray~~ very stiff gray 7½YR 6/0 clay, some silt, gravel, trace sand - moist		4.5	HNU = 0ppm βB = 100cpm α = 2 cpm
17 18	7984 1550	5 11 18	18	very stiff gray 7½YR 5/0 clay ~~trace~~ some gravel, trace silt and sand - moist	cl	4.0	HNU = 0ppm βB = 100cpm α = 2cpm
19	7985 1610	12 21 20	18	very stiff dark gray 7½YR 4/0 silty clay some sand and gravel - moist		3.0	HNU = 0ppm βB = 60cpm α = 0cpm
20 21	7986 820	5 6 10	11	stiff dark gray 7½YR 4/0 silty clay with some sand and gravel - moist	cl	1.5	HNU = 0ppm βB = 40 cpm α = 0 cpm
22	7987 845	3 16 40	15	very stiff gray 7½YR 5/0 silty clay some sand and trace gravel - moist 21½		2.0	HNU = 0ppm βB = 60 cpm α = 2 cpm
23 24	7988 930	34 37 32	12	loose gray 2½Y 5/0 silty sand trace gravel - dry	SM	NA	HNU = 0ppm βB 40 α = 0 cpm
25	7989 945	16 23 33	12	dense gray 5Y 5/1 sand some gravel and silt, trace pebbles - moist	SW	NA	HNU = 0ppm βB = 60 cpm α = 4 cpm
26							
27							
28							
29							

NOTES:

000816

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B368	COORDINATES:	DATE: Jan 21, 1988
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L Wittek / T O'Connor	Depth Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable Tool		PAGE 3 OF ~~10~~ 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 ft)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	7990 1405	8 16 16	9	dense gray 5Y 6/1 sand, some gravel trace silt and pebbles-dry	SP	NA	HNU=0ppm γβ=60cpm α=20cpm
32							
33							
34							wood encountered while drilling 30-35 ft
35	7991 1550	8 45 50r	17	very dense gray 5Y 6/1 sand some gravel ~~trace~~ silt-dry	SP	NA	HNU=0ppm γβ=80cpm α=0cpm
36							
37							
38							
39							
40	7992 1600	12 24 22	17	medium dense gray 5YR 6/1 medium to coarse sand, some coarse sand silt and clay - dry	~~SP~~ SW	NA	HNU=0ppm γβ=60cpm α=0cpm
41							
42							
43							
44							

NOTES:

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B368	COORDINATES:	DATE: Jan 21, 1988
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L. Wills/T O'Connor	Depth Date/Time	DATE COMPLETED: Jan. 28, 1988
DRILLING METHODS: Cable tool		PAGE 4 OF 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (½ FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	7993 1645	27 25 35	14	very dense gray 5YR6/1 gravelly sand some pebbles, trace silt-dry	SM	NA	HNU=0ppm ββ: 60cpm α = 0cpm
47							
48							
49							
50							
51	7994 950	30 28 23	14	very dense gray 7½YR 6/0 sand and gravel, some silt and clay dry	SM	NA	HNU=0ppm ββ=60cpm α=0cpm
52							
53							
54							
55							
56	7995 1155	9 24 50+	18	very dense gray 7½YR 6/0 sand and gravel, some silt and clay-dry	SM	NA	HNU=0ppm ββ=60cpm α=0cpm
57							
58							
59							

NOTES:

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602 3 2	PROJECT NAME: Fernald RI/FS		
BORING NUMBER: 13368	COORDINATES:		DATE: Jan 27, 1988
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L. Wilcoxson	Depth	Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable tool			PAGE 5 OF 12

DEPTH (ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 ft)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	7996 1400	12 15 11	11	medium dense gray 10YR 5/1 gravelly coarse sand some pebbles, silt and fine to medium sand - wet	gm	NA	HNU = 0 ppm γβ = 70 cpm α = 0 cpm
62							
63							
64							
65							
66	7997 1540	25 40 40	18	very dense gray 5Y 5/1 sandy gravel some pebbles and silt wet	gm	NA	HNU = 0 ppm γβ = 80 cpm α = 0 cpm
67							
68							
69							
70							
71	7998 1630	7 10 10	10	dense gray 5YR 5/1 sand and gravel some silt, clay and pebbles - wet	gm	NA	HNU = 0 ppm γβ = 60 cpm α = 0 cpm
72							
73							
74							

NOTES:

000819

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 60232	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B358	COORDINATES:	DATE: Jan 23, 1988
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L.Willo/J.O'Connor	Depth Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable Tool		PAGE 6 OF ~~17~~ 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1½ ft)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	7999 930	6 15 23	14	dense olive gray 5Y 5/2 sandy gravel some pebbles, trace silt and clay - wet	gm	NA	HNU = 0 ppm; β = 80 cpm; α = 0 cpm
77							
78							
79							
80	8000 1015	6 5 8	14	medium dense gray 7½YR 5/0 sandy gravel some silt, clay and pebbles - wet	gm	NA	HNU = 0 ppm; β = 20 cpm; α = 0 cpm
81							
82							
83							
84							
85	8001 1335	17 36 32	12	very dense gray 7½YR 5/0 gravelly sand some pebbles, trace silt and clay - wet	gm	NA	HNU = 0 ppm; β = 40 cpm; α = 0 cpm
86							
87							
88							
89							

NOTES:

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B368	COORDINATES:	DATE: Jan 23 1988
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L. Wille/J. O'Connor	Depth Date/Time	DATE COMPLETED: Jan 28 1988
DRILLING METHODS: Cable ~~Jet~~ Tool		PAGE 7 OF ~~10~~ 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	1500 8002	9 19 21	18	dense gray 10YR 5/1 sandy gravel with some pebbles, trace silt-wet			HNU=0ppm γβ=40cpm α=0cpm
92							
93							
94							
95	910 9003	29 72	12	very dense gray 7½YR 5/1 coarse sand with some silt and trace clay-wet			HNU=0ppm γβ=40cpm α=0cpm
96							
97							
98							
99							
100	945 8004	4 6 11	18	medium dense gray 5YR 5/1 gravelly sand, some silt, trace clay and pebbles-wet			HNU=0cpm γβ=80cpm α=0cpm
101							
102							
103							
104							

NOTES:

000821

402-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS		
BORING NUMBER: B368	COORDINATES:		DATE: Jan 24, 1988
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: Jan 20, 1988
ENGINEER/GEOLOGIST: L. Willey / J. O'Connor	Depth	Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable Tool			PAGE 8 OF 12

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 FT)	RECOVERY (FT)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106	8005 1100	6 32 54/4	15	very dense gray 10YR 6/0 sand, some gravel, silt and clay, trace pebbles - wet	SM	NA	HNU = 0 ppm; β = 60 cpm; α = 2 cpm
107							
108							
109							
110							
111	8006 1145	5 7 7	13	medium dense gray 7½YR 6/1 sand and gravel, some silt and clay, trace pebbles - wet	SM	NA	HNU = 0 ppm; β = 4 cpm; α = 2 cpm
112							
113							
114							
115	8007 1445	12 32 54	18	very dense 7½YR 6/0 sand some gravel, silt and clay - wet	SM	NA	HNU = 0 ppm; β = 60 cpm; α = 1 cpm
116							
117							
118							
119							

NOTES:

000822

402-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: B368	COORDINATES:	DATE: Jan 25, 1988
ELEVATION:	GWL: Depth 60.3 Date/Time 1/25/88 2200	DATE STARTED: Jan 20 1988
ENGINEER/GEOLOGIST: T. Sullivan	Depth Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable Tool		PAGE 9 OF 10

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 ft.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
121	1/25/88 0345 08002	7 6 7	8	med. dense, gray 10YR 4/1 sand with some gravel, trace pebbles, trace silt and clay wet.	SM	NA	HNU = 0ppm HB = 60ppm α = 2cpm
122							
123							
124							
125	1/25/88 10:35 08007	13 17 8	11	med. dense, gray 10YR 4/1 gravelly sand, some pebbles, trace silt and clay, wet.	SM	NA	HNU = 0ppm HB = 30cpm α = 2cpm
126							
127							
128							
129							
130	1/25/88 1345 08010	10 17 12	12	med. dense, gray 10YR 4/1, gravelly sand, some pebbles, some silt, wet.	SM	NA	HNU = 0ppm HB = 60cpm α = Unknown, not functioning
131							
132							
133							
134							

NOTES:

000823

402-1

FERNALD RI/FS

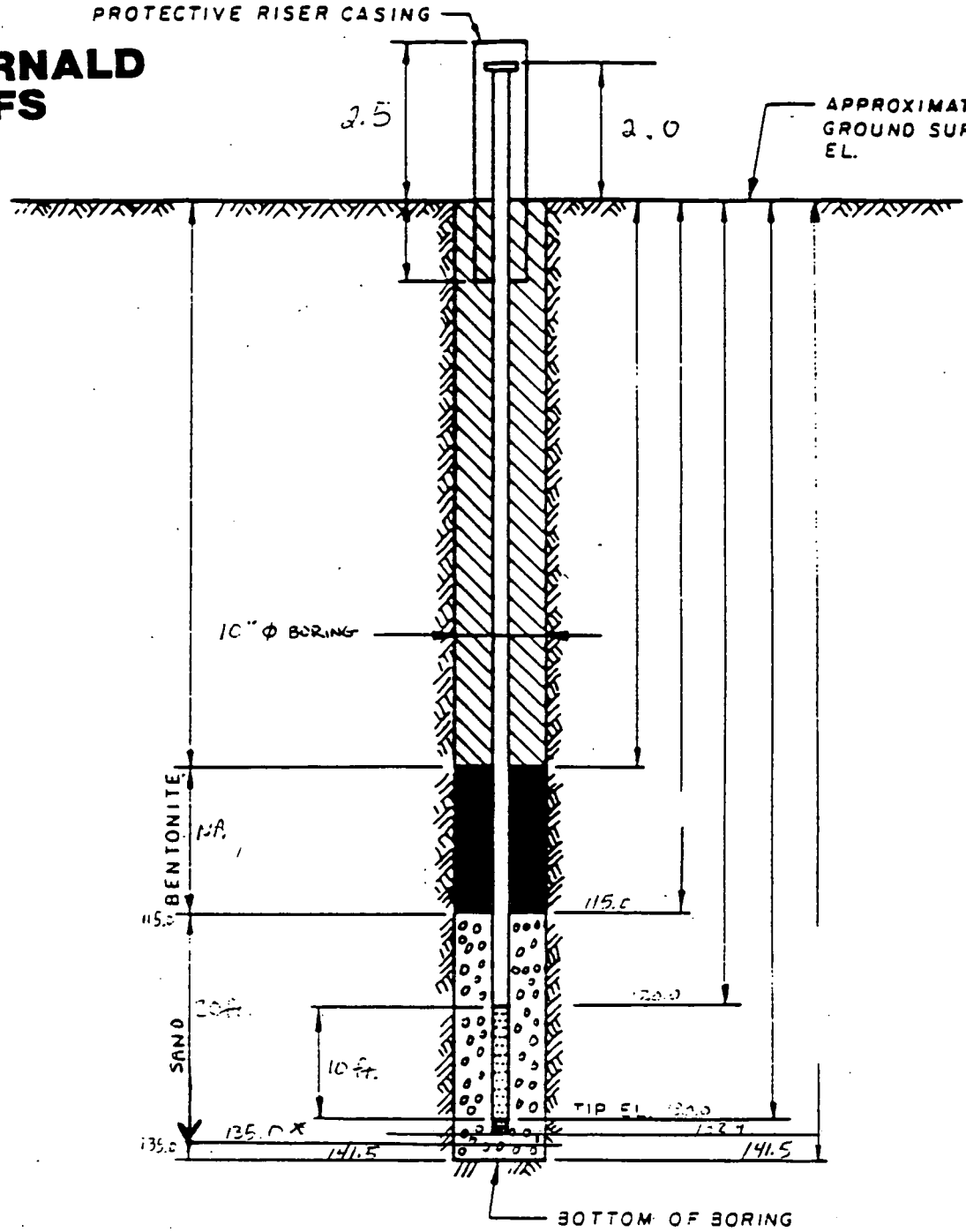
VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 606.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: 3363	COORDINATES:	DATE: Jan. 25, 1988
ELEVATION:	GWL: Depth 60.45 Date/Time 1/26/88 0715	DATE STARTED: Jan. 20, 1988
ENGINEER/GEOLOGIST: T. Sullivan	Depth Date/Time	DATE COMPLETED: Jan 28, 1988
DRILLING METHODS: Cable Tool		PAGE 10 OF 12

DEPTH (ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (1/2 ft.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
135	1/25/88 1505 08011	6 6 12	3	med. dense, gray 10YR4/1, sand, trace gravel and silt, wet.	SM	NA	HNU = 0ppm HB = 60cpm α = 2cpm
136							
137							
138							
139							
140	1/25/88 1630 08012	42 44 45	16	very dense, gray 10YR4/1 sand, some silt, trace gravel, wet. 140.5	SM	NA	HNU = 0ppm HB = 100cpm α = 2cpm
141				very dense, gray 10YR4/1 sandy gravel, some pebbles, some silt, wet	SP		
142				Bottom of Boring 141½ ft			
				E.O.B. 141.5			

NOTES:

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY

APPROVED BY

DRAWN BY

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. S.S. PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL 61.65 ft.
5. WATER LEVEL READING ON 2/3/82, 16:30

INSTALLATION DETAILS
MONITORING WELL B368

PREPARED FOR

* Bottom 5 ft. of boring caved in with natural formation sand and gravel, sand pack placed above cave in.

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS FIELD ENG./GEO. T. Sullivan DATE 2/3/88
PROJECT NO. 602.3.8 CHECKED BY _____ DATE _____
BORING NO. B368
PIEZOMETER NO. 368 DATE OF INSTALLATION 1/26/88 – 2/3/88

BOREHOLE DRILLING

DRILLING METHOD Cable Tool	TYPE OF BIT Drive Shoe
DRILLING FLUID (S) USED: NA	CASING SIZE (S) USED: NA
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____
FLUID _____ FROM _____ TO _____	SIZE _____ FROM _____ TO _____

PIEZOMETER DESCRIPTION

TYPE Monitoring Well	RISER PIPE MATERIAL Stainless steel
DIAMETER OF PERFORATED SECTION 4in.	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 in. I.D. 4 in.
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 ft./2 ft.
AVERAGE SIZE OF PERFORATIONS 0.010 in.	JOINING METHOD Screw joints.
TOTAL PERFORATED AREA 3 in²/ft.	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 ft.	OTHER PROTECTION Padlock on cap
PROTECTIVE PIPE O.D. 10 3/4 in.	of protective pipe.

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft.)		ELEVATION ( )	
TOP OF RISER PIPE	2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 115.0	TOP	BOTTOM
BENTONITE	TOP NA	BOTTOM NA	TOP	BOTTOM
SAND	TOP 115.0	BOTTOM 135.0	TOP	BOTTOM
GRAVEL	TOP NA	BOTTOM NA	TOP	BOTTOM
PERFORATED SECTION	TOP 120.0	BOTTOM 130.0	TOP	BOTTOM
PIEZOMETER TIP	132.4			
BOTTOM OF BOREHOLE	141.5			
GWL AFTER INSTALLATION	61.65			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS _____

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.04.27	PROJECT NAME. RCRA Phase I		
BORING NUMBER: 3431	COORDINATES:	DATE 11-4-92	
ELEVATION: 591.6	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92	
ENGINEER/GEOLOGIST. Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92	
DRILLING METHODS. Cable Tool		PAGE 1 OF ~~13~~ 16	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	0920 103215 11-4-92	3 4 7	15	Medium stiff (10YR, 4/4) dark yellowish brown silty clay, trace organics, moist, medium plasticity	Cl	1.0	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
2 3	0925 103216 11-4-92	5 14 14	10	~~SAA~~ Mod stiff (10YR, 5/6) yellowish brown silty clay, medium plasticity, moist	Cl	1.0	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
4	0930 103217 11-4-92	14 26 50/.4	8	Stiff (10YR, 5/6) yellowish brown clay, trace gray mottling, low plasticity, trace limestone gravel, slightly moist	Cl	2.0	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
5 6	0935 MS 103 11-4-92 11-4-92	50/0	0.	NO RECOVERY	N/A	N/A	OVM = N/A ppm Bγ = N/A cpm α = N/A cpm
7	1300 103218 11-4-92	12 28 36	5	Stiff (10YR, 5/6) yellowish brown silty clay, trace gravel, low plasticity, slightly moist	Cl	2.0	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
8 9	1305 103219 11-4-92	50/.3	6	Very stiff, SAA	Cl	2.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
10	1330 103220 11-4-92	10 17 25	14	SAA, gray mottling	Cl	3.0	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
11 12	1340 103221 11-4-92	16 26 40	16	Very stiff (10YR, 5/1) gray clay trace gravel, low plasticity, slightly moist	Cl	3.0	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
13	1400 103222 11-4-92	16 21 26	18	~~SAA~~ Very stiff (10YR, 4/1) dark gray clay, trace gravel, low plasticity, slightly moist	Cl	3.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
14 15	1410 103223 11-4-92	40 50 36	18	~~SAA~~ Very stiff (10YR 4/1) dark gray silty clay, trace gravel, low plasticity, slightly moist	Cl	3.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speedstar

Driller: Joe Barile
Rick Pierce

* Samples collected per ASTM Standard Penetration Test
* All colors identified by Munsell Color Chart

SAA - SAME AS ABOVE
NA - NOT APPLICABLE

Background { OVM = 0 ppm, Bγ = 20 cpm, α = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.04.27	PROJECT NAME: RCRA Phase I		
BORING NUMBER: 3431	COORDINATES:	DATE 11-4-92	
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92	
ENGINEER/GEOLOGIST: Michael Worley	Depth: Date/Time	DATE COMPLETED: 11-24-92	
DRILLING METHODS: Cable Tool		PAGE 2 OF ~~13~~ 16	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	1420 103224 11-4-92	13 26 21	12	Very stiff (10YR, 5/1) gray Clay, trace sand and gravel, low plasticity, slightly moist	Cl	2.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
17 18	1505 103225 11-4-92	7 12 21	12	Very stiff (10YR 5/1) ~~SAA~~ gray Silty clay, trace gravel, ~~SAA~~ low plasticity, slightly moist CB 2-22-93 CB 2/22/93	Cl	2.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
19	1515 103226 11-4-92	18 28 18	12	Very stiff (10YR, 5/1) gray clay trace silt, trace gravel, low plasticity, slightly moist	Cl	2.75	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
20 21	1640 103227 11-4-92	45 10 10	3	Stiff (10YR, 5/1) gray gravely Clay, trace sand, medium plasticity, moist	Cl	1.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
22	1650 N/A 11-4-92	2 5 7	0	NO RECOVERY	N/A	N/A	N/A
23 24	1700 103228 11-4-92	2 5 11	4	medium stiff (10YR, 5/1) gray gravely clay, medium plasticity, moist	Cl	1.0	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
25	1720 103229 11-4-92	6 7 9	3	medium dense (10YR, 5/1) gray Clayey gravel, no plasticity, wet	GC	N/A	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
26 27	1400 N/A 11-5-92	3 5 6	0	NO RECOVERY	N/A	N/A	N/A
28	1410 103230 11-5-92	4 7 11	3	Soft (10YR, 5/1) gray gravely clay, medium plasticity, moist.	Cl	0.5	OVM = 0 ppm Bγ = 20 cpm α = 0 cpm
29 30	1600 N/A 11-5-92	5 5 9	0	NO RECOVERY	N/A	N/A	OVM = N/A ppm Bγ = N/A cpm α = N/A cpm

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speedstar

Driller: Joe Barile
Rick Pierce

SAA - SAME AS ABOVE
NA - NOT APPLICABLE

Background { OVM = 0 ppm, Bγ = 30 cpm, α = 0 cpm

* Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6002.04.27	PROJECT NAME: RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE: 11-5-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST: Michael Worley	Depth: Date/Time:	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 3 OF ~~13~~ 16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31	1605 103231 11-5-92	14 12 12	12	Stiff (10YR, 5/1) gray clay, trace sand, trace gravel, medium plasticity, moist	CI	1.0	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm
32 33	1620 103232 11-5-92	31 50/.4	8	Very dense (2.5Y, 5/6) light olive brown well graded sand, trace gravel, dry	SW	N/A	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm Base of fill
34 35				* Next sample at 35.0 feet. Samples will be collected at 5.0 feet intervals from 35.0 feet.			
36	1645 103233 11-5-92	50/.5	3	Very dense (2.5Y, 5/6) light olive brown well graded sand, trace gravel, dry	SW	N/A	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm
37 38 39 40							
41	0950 103234 11-6-92	5 50/.4	5	Very dense (2.5Y, 5/6) light olive brown well graded coarse sand, trace gravel, dry	SW	N/A	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm
42 43 44 45							

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speed star

Driller: Joe Barile
Rick Pierce

* Samples collected per ASTM Standard Penetration Test
* All colors identified by the Munsell Color Chart

SAA - SAME AS ABOVE
NA - NOT Applicable

Background { ovm = 0 ppm, Bγ = 30 cpm, α = 0 cpm

000029

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.04.27	PROJECT NAME. RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE 11-6-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST. Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 4 OF 13 16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
46	1320 103235 11-6-92	13 50/.4	6	Very dense (2.5Y, 5/6) light olive brown well graded gravelly sand, slightly moist	SW	N/A	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm
47							
48							
49							
50							
51	1355 103236 11-6-92	18 45 40	18	SAA	SW	N/A	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm
52							
53							
54							
55							
56	1500 103237 11-6-92	7 50/.4	6	Very dense (2.5Y, 5/4) light olive brown well graded sand, trace gravel, slightly moist	SW	N/A	ovm = 0 ppm Bγ = 30 cpm α = 0 cpm
57							
58							
59							
60							

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speedstar

Driller: Joe Barile
Rick Pierce

SAA - SAME AS ABOVE
NA - NOT Applicable

Background { ovm = 0 ppm, Bα = 30 cpm, α = 0 cpm

* Samples collected per ASTM Standard Penetration Test
* Colors identified by the Munsell Color Chart

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.04.27	PROJECT NAME. RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE 11-6-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST. Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 5 OF ~~13~~ 16

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECIVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61	1530 103238 11-6-92	14 40 40	15	Very dense (2.5Y, 5/3) light olive brown well graded sand, trace gravel, slightly moist	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
62							
63							
64							
65	1630 103239 11-6-92	7 40 50/.0	12	Very Dense (2.5Y 5/3) light olive brown, SAA, well graded gravelly sand, slightly moist.	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
66							
67							
68							
69							
70	1720 103240 11-6-92	10 50/.4	10	SAA, moist	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
71							
72							
73							
74							
75				* water table at 75.0 FT			

NOTES:

Drilling Contractor Pennsylvania Drilling

Drilling Equipment 72 Speedstar

Driller: Joe Barile
Rick Pierce

SAA - SAME AS ABOVE
NA - NOT Applicable

Background { OVM = 0 ppm, Bα = 30 cpm, α = 0 cpm

* Samples collected per ASTM Standard Penetration Test
* Colors identified by the Munsell Color Chart

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.04.27	PROJECT NAME. RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE 11-18-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST. Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 6 OF ~~15~~ 16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
76	1425 105201 11-10-92	21 50/.4	8	Very dense (2.5Y, 5/3) light olive brown well graded gravel, trace sand, wet	GW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
77							
78							
79							
80							
81	1615 105202 11-10-92	40 21 20	10	SAA	GW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
82							
83							
84							
85							
86	0950 105203 11-11-92	50/.3	2	Very dense (2.5Y, 5/3) light olive brown clayey gravel, wet.	GC	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
87							
88							
89							
90							

NOTES:

Drilling Contractor Pennsylvania Drilling

Drilling Equipment 72 Speedstar

Driller: Joe Barile
Rick Pierce

SAA - SAME AS ABOVE
NA - NOT APPLICABLE

Background { OVM = 0 ppm, Bα = 30 cpm, α = 0 cpm

- Samples collected per ASTM Standard Penetration Test
* Colors identified by the Munsell Color Chart

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.04.27	PROJECT NAME: RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE 11-11-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST: Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 7 OF ~~13~~ 16

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
91	1020 105204 11-11-92	26 31 27	13	Very dense (2.5Y, 5/3) light olive brown, well graded sand, trace gravel, wet	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
92							
93							
94							
95							
96	1320 105205 11-11-92	50/.3	4	SAA	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
97							
98							
99							
100							
101	1345 105206 11-11-92	5 17 21	8	Dense (2.5Y, 5/3) light olive brown well graded gravel, trace coarse sand, wet	GW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
102							
103							
104							
105							

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speedstar

Driller: Joe Barile
Rick Pierce

*Samples collected per ASTM Standard Penetration Test

*Colors identified by the Munsell Color Chart

SAA - SAME AS ABOVE
NA - NOT APPLICABLE

Background { OVM = 0 ppm, Bα = 30 cpm, α = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.04.27	PROJECT NAME: RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE 11-11-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST: Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 8 OF 15

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
106	1510 105207 11-11-92	50/.3	4	Very dense (2.5Y, 5/3) light olive brown poorly graded coarse sand, trace gravel, wet	SP	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
107							
108							
109							
110							
111	1550 105208 11-11-92	25 25 25	7	Dense (2.5Y, 5/3) light olive brown gravely sand, well graded, wet MW 11-13-92	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
112							
113							
114							
115							
116	0900 105211 11-13-92	10 29 36	14	Very dense (2.5Y, 5/3) light olive brown well graded sand, trace gravel, wet	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
117							
118							
119							
120							

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speedstar

Driller: Joe Barile
Rick Pierce

SAA - SAME AS ABOVE
NA - NOT Applicable

Background { OVM = 0 ppm, Bα = 30 cpm, α = 0 cpm

* Samples collected per ASTM standard Penetration Test
* Colors identified by the Munsell Color Chart

VISUAL CLASSIFICATION OF SOILS

NUMBER: 602.24.20	PROJECT: RCRA Phase I		DATE: 11-13-92
NUMBER: 3431	COUNTY:		DATE STARTED: 11-4-92
ON:	GWL:	Date/Time 11-24-92/1430	DATE COMPLETED: 11-24-92
GEOLOGIST: Michael Worley	CHECK:	Date/Time	PAGE 9 OF ~~15~~ 16
METHODS: Cable Tool			

	SAMPLE NO.	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
7/10 9/12 9/14	3 7 9	6	Medium dense (2.5Y, 5/4) light olive brown well graded sand, trace gravel. Moist	SW	N/A	OVM = 0 ppm $\beta\gamma$ = 30 cpm α = 0 cpm
9/15 9/15 9/17	3 6 11	8	SAA	SW	N/A	OVM = 0 ppm $\beta\gamma$ = 30 cpm α = 0 cpm
		12	Very dense, SAA	SW	N/A	OVM = 0 ppm $\beta\gamma$ = 30 cpm α = 0 cpm

Pennsylvania Drilling
Barile
Rebold
collected per ASTM Standard Penetration Test
identified by the Munsell Color Chart

SAA - SAME AS ABOVE
NA - NOT Applicable

Background { OVM = 0 ppm, $\beta\alpha$ = 30 cpm, α = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.04.27	PROJECT NAME. RCRA Phase I		
BORING NUMBER: 3431	COORDINATES:	DATE 11-16-92	
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92	
ENGINEER/GEOLOGIST. Michael Worley	Depth Date/Time	DATE COMPLETED: 11-24-92	
DRILLING METHODS: Cable Tool		PAGE 10 OF ~~15~~ 16	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
136	1025 105216 11-16-92	12 15 42	18	Very dense (2.5Y, 5/3) light olive brown well graded sand, trace gravel, wet	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
137 138	N/A	N/A	N/A	Continuous sampling will resume at 138.0 - 148.0 FT for screend interval of this well.	N/A	N/A	OVM Bγ α N/A
139	1100 105217 11-16-92	21 35 42	18	Very dense (2.5Y, 5/3) light olive brown poorly graded sand, wet	SP	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
140 141	1525 105218 11-16-92	25 50/.2	9.	SAA, trace gravel	SP	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
142	1615 105219 11-16-92	50/.4	5	SAA	SP	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
143 144	1630 105220 11-16-92	50/.5 50/0	6	SAA	SP	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
145	1645 105221 11-16-92	50/.5 50/.2	9	Very dense (2.5Y, 5/4) light olive brown well graded sand, trace gravel, wet	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
146 147	1715 105222 11-16-92	25 32 45	15	SAA	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
148	1725 105223 11-16-92	50/.4	7	Very dense (2.5Y, 5/4) light olive brown poorly graded sand, trace gravel, wet	SP	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
~~149~~ ~~148~~ 11-16-92 150	N/A	N/A	N/A	NO SAMPLE TAKEN. NEXT SAMPLE AT 150.0 - 151.5 FT	N/A	N/A	N/A

NOTES:

Drilling Contractor Pennsylvania Drilling

Drilling Equipment 72 Speedstar

Driller: Joe Barile
Rick Pierce

SAA - SAME AS ABOVE
NA - NOT Applicable

Background { HNU = 0 ppm, Bγ = 30 cpm, α = 0 cpm

L Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.04.27	PROJECT NAME: RCRA Phase I	
BORING NUMBER: 3431	COORDINATES:	DATE 11-17-92
ELEVATION:	GWL: Depth 73.3 FT Date/Time 11-24-92/1430	DATE STARTED: 11-4-92
ENGINEER/GEOLOGIST: Michael Worley	Depth: Date/Time	DATE COMPLETED: 11-24-92
DRILLING METHODS: Cable Tool		PAGE 11 OF 11

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
151	1500 105225 11-17-92	39 40 31	18	Very dense (2.5Y, 5/3) light olive brown well graded sand, trace gravel, wet	SW	N/A	OVM = 0 ppm Bγ = 30 cpm α = 0 cpm
152				Bottom of sampling at 151.5 FT			
153							
154							
155				Bottom of boring at 155.0 FT			

NOTES:

Drilling Contractor: Pennsylvania Drilling

Drilling Equipment: 72 Speedstar

Driller: Joe Barile

Rick Pierce

* Samples collected per ASTM Standard Penetration Test

* Colors identified by the Munsell Color Chart

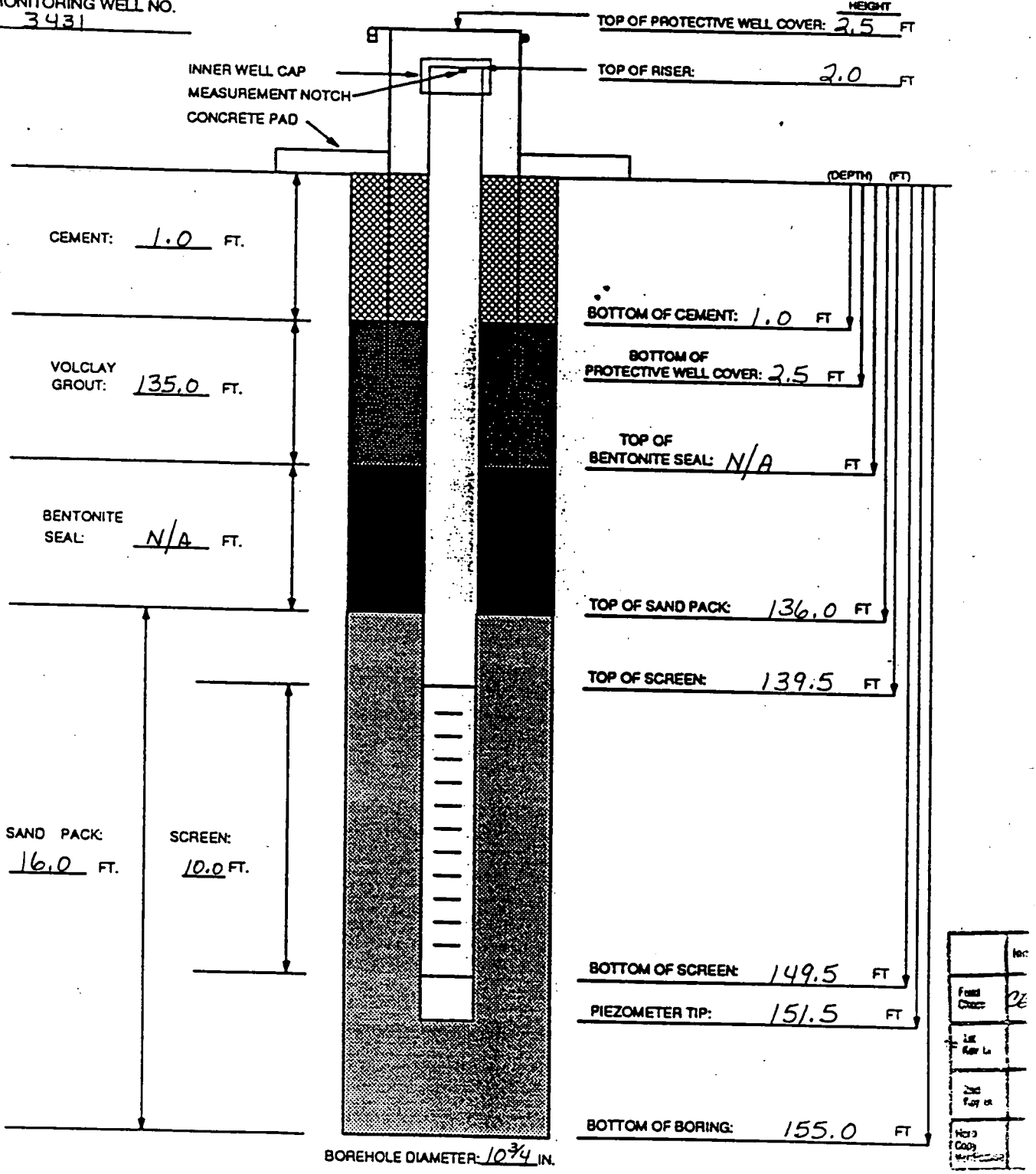
SAA - SAME AS ABOVE

NA - NOT Applicable

Background { OVM = 0 ppm, Bγ = 30 cpm, α = 0 cpm

FERNALD RI/FS
INSTALLATION DIAGRAM
MONITORING WELL NO. 3431

INSTALLATION DATE: 11-24-92



MATERIALS USED

SAND TYPE AND QUANTITY: 10/20, 10 bags
BENTONITE PELLETS (5-GALLON BUCKETS): NONE USED
BAGS OF VOLCLAY GROUT: 30 - 50 lb.
AMOUNT OF CEMENT: 80 lbs.
AMOUNT OF WATER USED: 1,800 gallons
OTHER: 1 water drum, 26 soil drums
TASK: RCRA Phase I

NOTES:

1) RISER PIPE IS 4.0 IN. ID. 316 STAINLESS STEEL PIPE, FLUSH-THREADED JOINTS.
2) SCREEN IS 4.0 IN. ID. 316 STAINLESS STEEL PIPE WITH 0.010 IN. SLOTS.
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP.
4) WATER DEPTH AND DATE 73.3 FT/ 11-24-
5) TOP OF CASING IS SECURED WITH A STAINLESS STEEL CAP.
6) PARENTHESIS INDICATE DEPTH BELOW GROUND LEVEL.
7) WELL CASING HAS A PROTECTIVE COVER WITH PADLOCK.

GEOLOGIST/ENGINEER: Michael Worley

SI FORM 0157 REV. (0)

PIEZOMETER INSTALLATION SHEET

PROJECT NAME RCRA Phase I
PROJECT NO. 602.04.27
BORING NO. 3431
PIEZOMETER NO. 3431

FIELD ENG./GEO. Michael Worley DATE 11-
CHECKED BY C. Brier DATE 12-
DATE OF INSTALLATION 11-24-92

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID WATER FROM 0.0 FT TO 150.0 FT.
FLUID N/A FROM N/A TO N/A

TYPE OF BIT Hammer Percussion Bit
CASING SIZE (S) USED:
SIZE 10.0 in I.D. FROM 0.0 FT TO 155.
SIZE N/A FROM N/A TO N/

PIEZOMETER DESCRIPTION

TYPE Monitoring Well
DIAMETER OF PERFORATED SECTION 4.0 in. I.D.
PERFORATION TYPE:
SLOTS ☒ HOLES ☐ SCREEN ☐
AVERAGE SIZE OF PERFORATIONS 0.010 in.
TOTAL PERFORATED AREA 10.0 FT

RISER PIPE MATERIAL 316 Stainless S
RISER PIPE DIAMETERS:
O.D. 4 3/8 in I.D. 4.0 in
LENGTH OF PIPE SECTIONS 1-1.5 FT, 1-2 FT,
JOINING METHOD Screw type - flush joint threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 FT
PROTECTIVE PIPE O.D. 10 3/4 in.

OTHER PROTECTION Hinged locking cover with padlock

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION ( )	
TOP OF RISER PIPE	CB 2-22-93 ~~2.5~~ 2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS: VOLCLAY GROUT / ~~SLURRY~~ CEMENT M.W. 11-24-92	TOP 0.0 FT TOP 1.0 FT	BOTTOM 1.0 FT BOTTOM 136.0 FT	TOP	BOTTOM
BENTONITE NONE USED	TOP N/A	BOTTOM N/A	TOP	BOTTOM
SAND 10/20	TOP 136.0 FT	BOTTOM 152.0 FT	TOP	BOTTOM
GRAVEL NONE USED	TOP N/A	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 139.5 FT	BOTTOM 149.5 FT	TOP	BOTTOM
PIEZOMETER TIP	151.5 FT			
BOTTOM OF BOREHOLE	155.0 FT			
GWL AFTER INSTALLATION	73.3 FT			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS Cement placed 0.0 to 1.0 FT to hold protective cover in place.

6647
14/16

Boring - #3431
Screen Sieve Analysis

11-18-92

1. 90% = .006
   50% = .018
   40% = .022

2. $\frac{.022}{.006} = 3.7$, 3.7 > 3 so use a factor of 4.

3. 4 x .018 = .072

4. .072 most closely fits the curve for ~~fine~~ medium sand pack with a .010 slotted well screen
CB 8/20/93

Field Check
1st Rev to
2nd Rev to
Hard Copy Verification

000840

NOV-18-92 WED 10:11 WMCO ANALYTICAL FAX NO. 5137386667 P.01

MW-3431

Customer Number 10512

MATERIAL: _____ SAMPLE NUMBER: 921117-137

DETERMINATION: Particle Size METHOD: Sieve Analysis

Sample weight: 233.5

Sieve Number	Weight Retained, g	% Retained	Cumulative % Retained	Grain Size, 1/1000 inch
10	11.35	4.9	4.9	78.7
20	18.66	8.0	12.9	33.5
40	84.74	36.3	49.2	16.7
60	73.15	31.3	80.5	9.8
100	22.12	9.5	90.0	5.9
200	12.55	5.4	95.4	3.0
Pan	9.91	4.2	99.6	

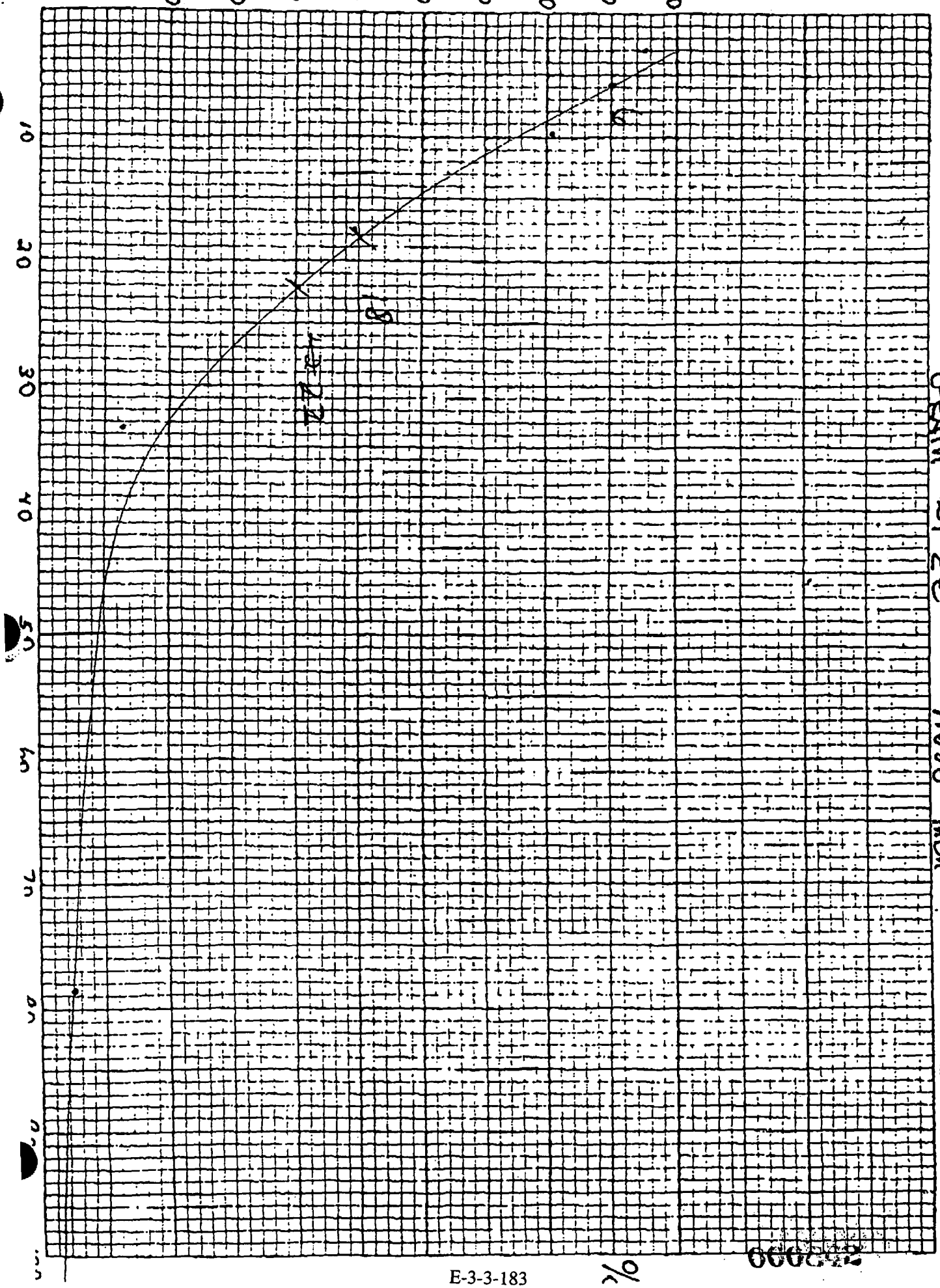
$$\frac{W_2 \times 100\%}{W_1} = R \qquad \left|\frac{\text{Original} - \text{Duplicate}}{\text{Average}}\right| \times 100\% = RPD$$

Analyzed by: John Roberts | Checked by: [signature] OK. | Date analyzed: 11-17-92

GRAIN SIZE 40% RETAINED 22 .001 in

50% 18

90% 6


10
20
30
40
50
60
70
80
90
100
GRAIN SIZE
1/1000 inch
MW 3431
%

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 50.03.24	PROJECT NAME Glacial Till/Yazoo Zone Investigation	
BORING NUMBER 11130 (BL1)	COORDINATES	DATE 09-22-93/09-23-93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED 09-22-93
ENGINEER/GEOLOGIST P. McCarren/Riley	Depth Date/Time	DATE COMPLETED 09-25-93
DRILLING METHODS Cable Tool (16" casing)		PAGE 1 OF 4

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6")	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0.0				PRELIMINARY			SEE BORING LOG FOR 11131 FOR FULL LITHOLOGIC DESCRIPTION 0.0'-13.0'
2.5							
5.0							
7.5							
10.0							
12.5							
13.0	NA	40 48 50 50/3	18"	HARD (2.5Y 5/1-4/1) GREY TO DARK GREY FINELY INTERBEDDED CLAY, SILT & FINE SAND TRACE WELL ROUNDED SMALL PEBBLES, MEDIUM TO NO PLASTICITY, MOIST	CL ML SP	4.5	DROVE ~~[illegible]~~ SPLIT SPOON 13.0'-15.0'
15.0							

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment: Cable Tool
Driller: Dave Newman
Helper: Mike Leon

SAA - Same as above
N/A - Not applicable

* Samples collected per ASTM Standard Penetration Test
* All colors identified by a Munsell Color Chart

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 50.08.24	PROJECT NAME: CRU 5 VADOSE ZONE		
BORING NUMBER: 11130	COORDINATES:		DATE: 9-25-93
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 9-23-93
ENGINEER/GEOLOGIST: PATRICK RILEY	Depth	Date/Time	DATE COMPLETED: 9-25-93
DRILLING METHODS: HOLLOWSTEM AUGER			PAGE 2 OF 4

DEPTH (FEET)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 INCH)	RECOVERY (INCH)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15.5							MICROTIP = ppm BG = cpm
16.0							
	309256A11130-01 1105 9-25-93	10	6	VERY STIFF, GRAY (2.5Y 5/1) SILTY CLAY WITH SOME MED SAND AND MEDIUM ANGULAR GRAVEL, MEDIUM PLASTIC, MOIST	CL	3.0	
16.5	309256A11130-02 1105 9-25-93	12	6	SAA	CL	3.25	MICROTIP = 0.0 ppm BG = 40 cpm
17.0	309256A11130-03 1105 9-25-93	13	6	SAA	CL	3.5	
17.5	309256A11130-04 1105 9-25-93	12	4	SAA	CL	4.0	
18.0							MICROTIP = ppm BG = cpm
				LYSIMETER TIP SET AT 22.5 FT			
23.0				TOTAL DEPTH 23.0 FT (NO SAMPLES RECOVERED (18.0-23.0))			
							MICROTIP = ppm BG = cpm

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment : MOBILE B-80
Driller : JIM GACCINI
Helper : DOUG NELSON

SAA = Same As Above
N/A = Not Applicable

Background =
MT = 0.0 ppm
BG = 30 cpm

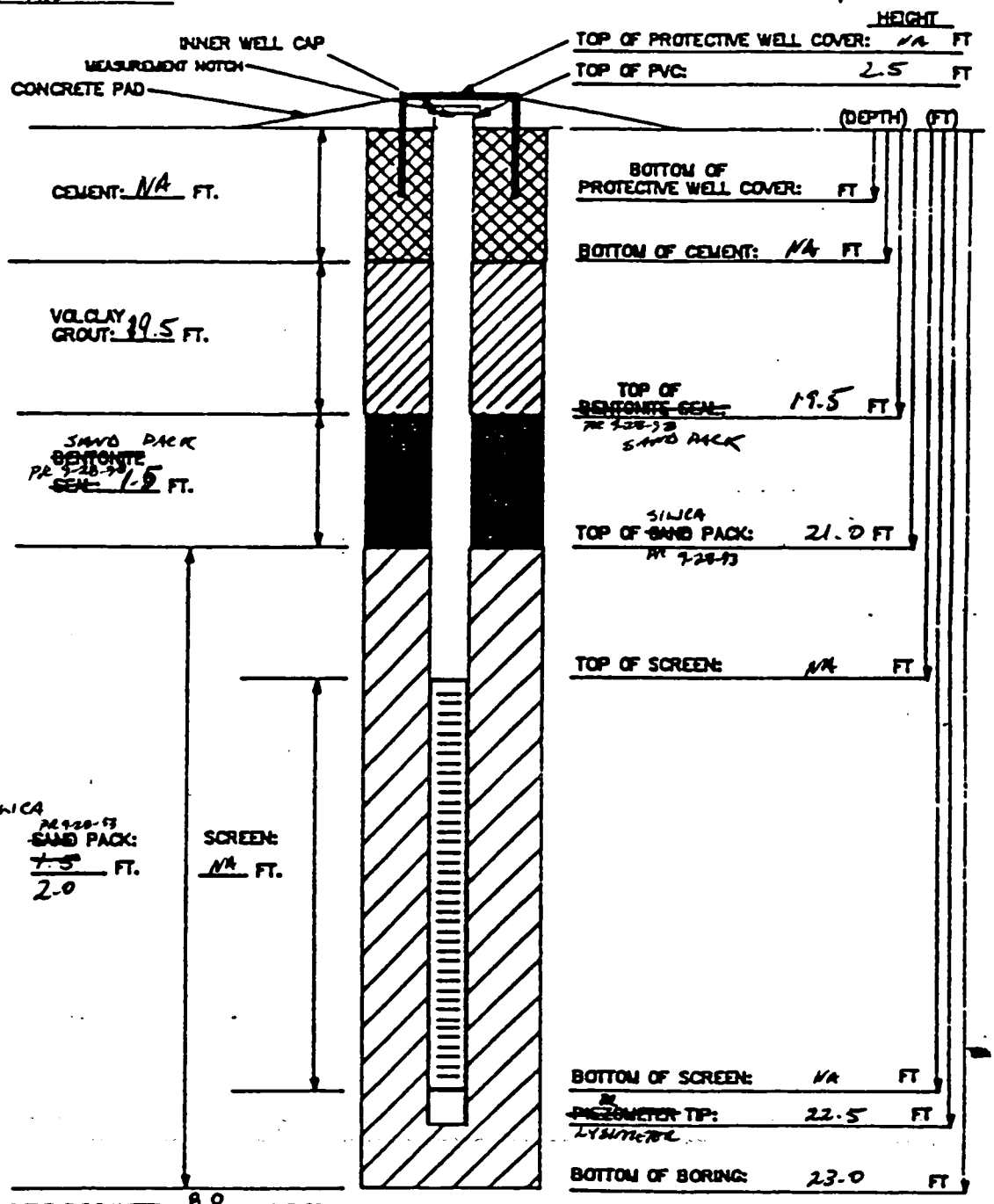
• Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

FERNALD RI/FS

INSTALLATION DATE: 9-25-93

INSTALLATION DIAGRAM

PZ ~~MONITORING~~ LYSIMETER WELL NO. 1130



BOREHOLE DIAMETER: 8.0 INCHES

MATERIALS USED:

SAND TYPE AND QUANTITY: 1 BAG
BENTONITE PELLETS (5-GALLON BUCKETS): NA
BAGS OF VOLCLAY GROUT: 8 BAGS
AMOUNT OF CEMENT: NA
AMOUNT OF WATER USED: 100 GALLONS
OTHER:

NOTES:

1) RISER PIPE IS 2-INCH SCHEDULE 40 PVC PIPE, FLUSH-THREADED JOINTS.
2) SCREEN IS 2-INCH I.D. SCHEDULE 40 PVC PIPE WITH 0.020-INCH SLOTS.
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP.
4) WATER DEPTH/DATE:
5) TOP OF PVC IS SECURED WITH NA EXPANDABLE RUBBER PLUG AND PADLOCK.
6) PARENTHESIS INDICATE DEPTH BELOW GROUND LEVEL.

TASK: 50.03.24 GEOLOGIST/ENGINEER:

PIEZOMETER INSTALLATION SHEET

PROJECT NAME CRU 5 VADOSE ZONE FIELD ENG./GEO. PATRICK RILEY DATE 9-25-93
PROJECT NO. 50-03.24 CHECKED BY _____ DATE _____
BORING NO. 11130
PR 5-23-93 ~~PIEZOMETER~~ LYSIMETER NO. 11130 DATE OF INSTALLATION 9-25-93

BOREHOLE DRILLING

DRILLING METHOD AUGER	TYPE OF BIT AUGER
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE _____	RISER PIPE MATERIAL PVC
DIAMETER OF PERFORATED SECTION _____	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 1 3/8 IN I.D. 1 5/8 IN
SLOTS ☐ HOLES ☐ SCREEN ☐	LENGTH OF PIPE SECTIONS 5 FEET
AVERAGE SIZE OF PERFORATIONS _____	JOINING METHOD SCREW TYPE - FLUSH
TOTAL PERFORATED AREA _____	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH NA	OTHER PROTECTION NA
PROTECTIVE PIPE O.D. NA	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION ( )	
TOP OF RISER PIPE	2.5			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	NA			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0	BOTTOM 19.5	TOP	BOTTOM
BENTONITE	TOP NA	BOTTOM NA	TOP	BOTTOM
SAND	TOP 19.5 ~~NA~~	BOTTOM 21.0	TOP	BOTTOM
~~GRAVEL~~ PR 9-28-93 SILICA PACK	TOP 21.0	BOTTOM 23.0	TOP	BOTTOM
PERFORATED SECTION	TOP NA	BOTTOM NA	TOP	BOTTOM
~~PIEZOMETER~~ LYSIMETER TIP PR 9-28-93	22.5			
BOTTOM OF BOREHOLE	23.0			
GWL AFTER INSTALLATION	NA			

WAS THE ~~PIEZOMETER~~ LYSIMETER FLUSHED AFTER INSTALLATION? PR 9-28-93 YES ☒ NO ☐ ~~☒~~ PR 5-20-93
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS NA

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 50.03 24	PROJECT NAME: Glacial till / vadose zone hydrogeologic investigation		
BORING NUMBER: 1113 (GLZ)	COORDINATES:	DATE: 09-15-93	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 09-15-93	
ENGINEER/GEOLOGIST: P. McLaren	Depth Date/Time	DATE COMPLETED: 9-22-93	
DRILLING METHODS: Cable tool (10" casing) continuous sampling		PAGE 1 OF 10	

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6"	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0 .5	Soil 09/15/93 0930	11	6"	HARD (2.5Y 6/3) Light Yellowish Brown silt, some sand, trace small pebbles damp.	ML	4.5	MICROTIP = .2 ppm BG = 40-60 cpm
1.0		29	ϕ	NO RECOVERY			
1.5		30	ϕ	NO RECOVERY 1.5			Sample No. 30915 - 1131-01
2.0	Soil 09/15/93 0940	23	6"	HARD (2.5Y 6/3) Light Yellowish Brown silt, trace small angular gravels damp	ML	4.5	MICROTIP = .2 ppm BG = 40-60 cpm
2.5		24	ϕ	NO RECOVERY			
3.0		31	ϕ	NO RECOVERY 3.0			Sample No 30915 - 1131-02
3.5	Soil 09/15/93 0945	45	6"	HARD (2.5Y 5/4) Light olive Brown silt, trace small angular gravels damp	ML	4.5	MICROTIP = .2 ppm BG = 40-60 cpm
4.0		50	3"	SAA - Fe staining	ML	4.5	
4.5		51	ϕ	NO RECOVERY 4.5			Sample No. 30915 - 1131-03 30915A 1131-04
5.0	Soil 09/15/93 0950	46	6"	HARD (2.5Y 4/4) Olive Brown silt with clay and trace small to medium angular gravels. damp. low plasticity	ML	4.5	MICROTIP = .2 ppm BG = 40-60 cpm

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment :
Driller : Dave Newman
Helper : Mike Leon

SAA = Same As Above
N/A = Not Applicable

Background =
MICROTIP = 0-0.2 ppm
BG = 40-60 cpm

* Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 50.03.24	PROJECT NAME: GLACIAL till / VADOSE ZONE Hydraulic Investigation	
BORING NUMBER: 11131 (BL2)	COORDINATES:	DATE: 09-15-93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 09-15-93
ENGINEER/GEOLOGIST: D. McCARREN	Depth Date/Time	DATE COMPLETED: 9-22-93
DRILLING METHODS: CABLE TOOL (16") CONTINUOUS SAMPLING		PAGE 2 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6")	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5.0							
5.5		47	4"	SAA	ML	4.5	SEE PREVIOUS PAGE
6.0		50	Ø	NO RECOVERY 6.0			SAMPLE NO. 30915A 11131-05 30915A 11131-06
6.5	SOIL 09/15/93 0955	39	6"	VERY STIFF (2.5Y 4/4) OLIVE BROWN CLAYEY SILT, TRACE SMALL GRAVELS MOIST, SLIGHT PLASTICITY	ML	3.5	MICROTIP = .2 BY = 40-60 PPM CPM
7.0		40	6"	SAA	ML	3.5	
7.5		41	1"	SAA 7.5	ML	3.5	SAMPLE NO. 30915 - 11131-07 30915A 11131-08 30915A 11131-09
8.0	SOIL 09/15/93 1005	25	6"	VERY STIFF (2.5Y 4/3) OLIVE BROWN CLAYEY SILT TRACE FINE SAND AND SMALL ANGULAR GRAVELS, MEDIUM PLASTICITY, MOIST	ML	3.0	MICROTIP = .2 BY = 40-60 PPM CPM
8.5		27	6"	SAA	ML	3.0	SAMPLE NO 30915 - 11131-10 30915A 11131-11 30915A 11131-12
9.0		20	6"	SAA 9.0	ML	3.0	
9.5	SOIL 09/15/93 1015	20	6"	SAA	ML	3.0	MICROTIP = .2 BY = 40-60 PPM CPM
10.0		25	6"	SAA	ML	3.0	SAMPLE NO 30915A 11131-13 30915A 11131-14

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment :
Driller : DAVE NEWMAN
Helper : MIKE LEW

SAA = Same As Above
N/A = Not Applicable
Background =

* Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 50.03.29	PROJECT NAME: Glacial till / Jacobs Zone Hydraulic Investigation	
BORING NUMBER: 11131 (BL2)	COORDINATES:	DATE: 09/15-16/93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 09-15-93
ENGINEER/GEOLOGIST: P. McCarren	Depth Date/Time	DATE COMPLETED: 9-22-93
DRILLING METHODS: Cable tool (16" casing) continuous sampling		PAGE 3 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6"	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
10.0				SAA			SEE PREVIOUS PAGE
10.5		26	4"	LAST 1 1/2" OF SPOON 2.5 5/2 GRAYISH BROWN SILTY CLAY LOW PLASTICITY MOIST 10.5	ML	3.0	SAMPLE NO. 30915 A 11131-15
11.0	SOIL cylinders 1010	9	6"	VERY STIFF (2.5Y 5/2) GRAYISH BROWN SILTY CLAY MEDIUM PLASTICITY MOIST	CL	3.5	MICROTIP = .2 PPM BG = 40-60 CPM
11.5		18	3"	HARD (2.5Y 4/1) DARK GRAY CLAY, TRACE SILT, TRACE SMALL ANGULAR GRAVELS MEDIUM PLASTICITY MOIST	CL	4.5	BROWN SILT/CLAY 10.5-13.0 30916-11131-13 A/B SCREEN = 30916-11131-14
12.0		28	Ø	NO RECOVERY			SAMPLE NO. 30916 - 11131-01 30916 - 11131-02
12.5	SOIL cylinders 1520	6	6"	HARD (2.5Y 5/1) GRAY CLAY, TRACE FINE SAND AND SILT, TRACE SMALL WELL ROUNDED PEBBLES, MEDIUM PLASTICITY MOIST	CL	3.75	MICROTIP = .2 PPM BG = 40-60 CPM
13.0		13	6"	SAA	CL	3.75	
13.5		26	2"	SAA 13.5	CL	3.75	SAMPLE NO. 30916 - 11131-03 30916A 11131-04 30916A 11131-05
14.0	SOIL cylinders 1535	48	6"	HARD (2.5Y 5/1-4/1) GRAY TO MOTTLED FINELY INTERBEDDED CLAY SILT (FINE SAND TRACE WELL ROUNDED SMALL PEBBLES MEDIUM TO NO PLASTICITY MOIST		4.5	MICROTIP = .2 PPM BG = 40-60 CPM
14.5		50	4" ~~Ø~~	SAA ~~NO RECOVERY~~		4.5	SAMPLE NO 30916 - 11131-06 30916A 11131-07
15.0		60/3"	Ø	NO RECOVERY			

PRELIMINARY

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment :
Driller : Paul Newman
Helper : Mike Ilen

SAA = Same As Above
N/A = Not Applicable
Background =

* Samples collected per ASTM Standard Penetration Test.
• All colors identified by the Munsell Color Chart.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 50.03.24	PROJECT NAME: GLACIAL TILL/VADOSE ZONE HYDRAULIC INVESTIGATION	
BORING NUMBER: 11131 (BL2)	COORDINATES:	DATE: 09/16-17/93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 09-15-93
ENGINEER/GEOLOGIST: A. McCARREN	Depth Date/Time	DATE COMPLETED: 9-22-93
DRILLING METHODS: CABLE TOOL (16" CASING) CONTINUOUS SAMPLING		PAGE 4 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6"	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	* REMARKS
15.0	SOIL 09/16/93 1550	36	6"	DENSE, (2.5Y 4/1) DARK GREY, POORLY GRADED FINE & MEDIUM SAND	SP	NA	MICROTIP = 0 PPM; BZ = 40-60 CPM
15.5		47	Ø	NO RECOVERY	/	/	SAMPLE NO. 30916-11131-08
16.0		51	Ø	NO RECOVERY 16.5	/	/	
16.5	SOIL 09/16/93 1810	7	6"	VERY STIFF (2.5Y 5/1) GREY CLAY SOME ROCK FRAGS & WELL ROUNDED SMALL PEBBLES TRACE FINE SAND AND SILT MEDIUM PLASTICITY MOIST	CL	3.0	MICROTIP = 0 PPM; BZ = 40-60 CPM
17.0		11	6"	SAA (LAST 11" (2.5Y 4/1) DARK GREY POORLY GRADED FINE & MEDIUM SAND	CL	3.0	SAMPLE NO 30916-11131-09; 30916A 11131-10
17.5		22	Ø	NO RECOVERY 18.0	/	/	
18.0	SOIL 09/16/93 1825	5	6"	VERY STIFF (2.5Y 5/1) GREY SILTY CLAY SOME ROCK FRAGS & SMALL WELL ROUNDED PEBBLES, HIGH PLASTICITY MOIST	CL	2.75	MICROTIP = 0 PPM; BZ = 40-60 CPM
18.5		9	6"	SAA	CL	2.75	SAMPLE NO 30916-11131-11; 30916A 11131-12
19.0		14	Ø	NO RECOVERY 19.5	/	/	
19.5	SOIL 09/17/93 1325	6	6"	SAA	CL	3.25	MICROTIP = 0 PPM; BZ = 40-60 CPM
20.0							

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment :
Driller : CARL NEUMAN
Helper : MIKE FLYNN

SAA = Same As Above
N/A = Not Applicable
Background =

* Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 50.03.24	PROJECT NAME: Glacial till / Vadose Zone Hydraulic Investigation	
BORING NUMBER: 11131 (BL2)	COORDINATES:	DATE: 9-17-93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 09-15-93
ENGINEER/GEOLOGIST: P. McCarren	Depth Date/Time	DATE COMPLETED: 9-22-93
DRILLING METHODS: Cable tool (10" casing) continuous sample / Auger		PAGE 5 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6")	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	*REMARKS
20.0 – 20.5		9	ϕ	NO RECOVERY	/	/	See previous page
20.5 – 21.0		17	ϕ	NO RECOVERY 21.0	/	/	Sample No. 30917 A 11131-01
21.0 – 21.5	D.L. 09/17/93 1335	12	6"	SAA	CL	3.0	MICROTIP = 0. PAM BY = 40-60 CPM
21.5 – 22.0		24	ϕ	NO RECOVERY	/	/	
22.0 – 22.5		27	ϕ	NO RECOVERY 22.5	/	/	Sample No. 30917 A 11131-02
22.5 – 23.0	1530 9-20-93	6	0	No Recovery 23.0	NA	NA	~~MICROTIP = PAM~~ ~~BY = CPM~~ Above Shelby tubes 18.0 - 20.5 30917 - 11131 - 03 A/B 30917 - 11131 - 04
23.0 – 23.5	1530 9-20-93	8	0	No Recovery	NA	NA	20.5 - 23.0 30917 - 11131 - 05 A/B 30917 - 11131 - 06
23.5 – 24.0	1530 9-20-93	10	0	No Recovery	NA	NA	
24.0 – 24.5	30920-11131-01 1535 9-20-93	5	6	Medium Dense (5Y, 5/1) Gray, Clayey Silt with trace sand and gravel, low plasticity, moist	ML	NA	MICROTIP = 0.0 PAM BY = 70 CPM
24.5 – 25.0	30920A 11131-02 1535 9-20-93	6	6	SAA	ML	NA	

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment :
Driller : Dave Neuman / Joe Rank
Helper : Mike Leon / James Anderson

SAA = Same As Above
N/A = Not Applicable

Background = M-tip = 0.0 ppm
BY = 50 cpm

* Samples collected per ASTM Standard Penetration Test.
* All colors identified by the Munsell Color Chart.

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

JECT NUMBER 50.03.24	PROJECT NAME GT/V2 Hydraulic Investigation	
ING NUMBER 11131	COORDINATES:	DATE 9-20-93
LEVATION:	GWL. Depth Date/Time	DATE STARTED 9-15-93
NGINEER/GEOLOGIST K. Payne	Depth Date/Time	DATE COMPLETED 9-22-93
RILLING METHODS Hollow Stem Auger		PAGE 6 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
5.5	3C926A 11131-03 1535 9-20-93	9	1	SAA	ML	NA	
6.0	3C926A 11131-04 1540 9-20-93	4	5	SAA	ML	NA	m-t.p = 0.0 ppm BY = 60 cpm
6.5	1540 9-20-93	5	0	No Recovery	NA	NA	
	1540 9-20-93	7	0	No Recovery	NA	NA	
7.5	3C926 - 11131-05 1610 9-20-93	4	6	Loose (5Y, 5/1) Gray, clayey Silt with trace sand, medium plasticity, moist	ML	NA	m-t.p = 0.0 ppm BY = 60 cpm
8.0	1610 9-20-93	4	0	No Recovery	NA	NA	
8.5	1610 9-20-93	5	0	No Recovery	NA	NA	
9.0	1615 9-20-93	4	0	No Recovery	NA	NA	m-t.p = NA ppm BY = NA cpm
9.5	1615 9-20-93	8	0	No Recovery	NA	NA	
	1615 9-20-93	10	0	No Recovery	NA	NA	

NOTES:

Drilling Contractor Pennsylvania Drilling
Drilling Equipment Acker
Driller Joe Rauh
James Anderson

SAA - Same as above
NA - Not Applicable

Samples collected per ASTM standard penetration test
Colors identified using Munsell Color Chart

Background Readings 9-20-93 { BY - 50 cpm, m-t.p 0.0 ppm

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

IECT NUMBER 50.03.24	PROJECT NAME GT/V2 Hydraulic Investigation	
.ING NUMBER 11131	COORDINATES:	DATE 9-20-93
ELEVATION:	GWL. Depth Date/Time	DATE STARTED 9-15-93
ENGINEER/GEOLOGIST K. Payne	Depth Date/Time	DATE COMPLETED 9-22-93
DRILLING METHODS Hollow Stem Auger		PAGE 7 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30.5	1620 9-20-93	15	0	No Recovery	NA	NA	m.t.p = NA ppm BZ = NA cpm
31.0	1620 9-20-93	16	0	No Recovery	NA	NA	
31.5	1620 9-20-93	14	0	No Recovery	NA	NA	
	30920 11131-06 1630 9-20-93	38	6	Very Dense (5Y, 5/1) Gray Clayey Silt with trace sand, slight plasticity, moist	ML	NA	m.t.p - [illegible] ppm BZ - [illegible] cpm
32.5	30920A 11131-07 1630 9-20-93	42	6	SAA	ML	NA	
33.0	30920 11131-08 1630 9-20-93	53	5	Very Dense (10YR 6/6) Brownish yellow clayey silt with trace sand, slight plasticity, moist KP 9-20-93	ML	NA	
33.5	30921 11131-01 0900 9-21-93	9	6	Very Soft (5Y, 6/1) light gray silty clay, medium plasticity, moist Dense (2.5Y, 5/4) light olive brown, medium sand, slightly moist 2 IN	CL SP	.25 NA	m.t.p = [illegible] ppm BZ - [illegible] cpm
34.0	30921A 11131-02 0900 9-21-93	19	6	Dense (2.5Y, 5/6) light olive brown, medium sand, slightly moist	SP	NA	
34.5	30921A 11131-03 0900 9-21-93	22	2	SAA	SP	NA	
35.0	30921A 11131-04 0900 9-21-93	22	6	Dense (2.5Y, 6/6) olive yellow well Graded Sand, moist	SW	NA	m.t.p 0.[illegible] ppm BZ [illegible]

NOTES

Drilling Contractor Pennsylvania Drilling
Drilling Equipment Acker
Driller Joe Kerb
Jamie Anderson

SAA - Same as above
NA - Not Applicable

Samples collected per ASTM standard penetration test
Colors identified using Munsell Color Chart

Background Readings (a) [illegible] ppm (b) [illegible]

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

JECT NUMBER 50.03.24	PROJECT NAME GT/V2 Hydraulic Investigation	
RING NUMBER 11131	COORDINATES:	DATE 9-21-93
EVATION:	GWL. Depth Date/Time	DATE STARTED 9-15-95
GINEER/GEOLOGIST K. Payne	Depth Date/Time	DATE COMPLETED 9-22-93
ILLING METHODS Hollow Stem Auger		PAGE 8 OF 10

(FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	30921A 11131-05 0920 9-21-93	34	6	SAA	SW	NA	
5.5	30921A 11131-06 0920 9-21-93	56	6	Very Dense (2.5Y, 6/6) Olive Yellow, Well Graded Sand with trace angular gravel, moist	SW	NA	
6.0	30921 - 11131-07 0930 9-21-93	62	6	SAA	SW	NA	m.t.p 0.0 ppm BG 70 cpm
6.5	30921A 11131-08 0930 9-21-93	73	6	SAA	SW	NA	
7.0	30921A 11131-09 0930 9-21-93	40	6	SAA	SW	NA	
7.5	30921A 11131-10 1005 9-21-93	16	6	SAA	SW	NA	m.t.p = 0.0 ppm BG = 50 cpm
8.0	30921A 11131-11 1005 9-21-93	32	6	SAA	SW	NA	
8.5	30921A 11131-12 1005 9-21-93	20	3	SAA	SW	NA	
9.0				Bottom of Boring 39.0 FT			

NOTES

Drilling Contractor Pennsylvania Drilling

Drilling Equipment Baker

Driller Joe Rook

Jason Hoover

SAA - Same as above
NA - Not Applicable

Samples collected per ASTM standard penetration test

Colors identified using Munsell Color Chart

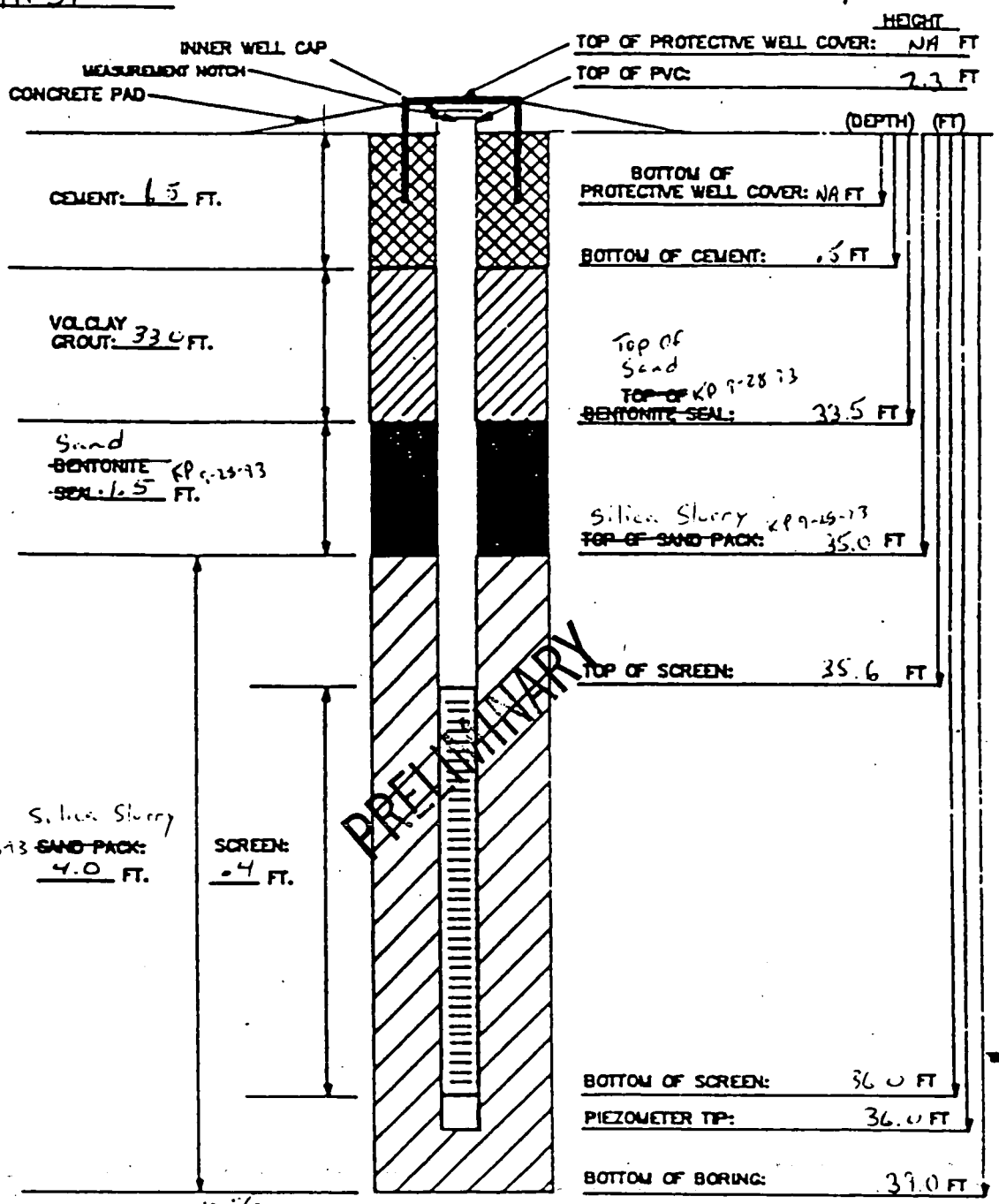
Background = 12 cpm
m.t.p = 0.0 ppm

PRELIMINARY

FERNALD RI/FS

INSTALLATION DIAGRAM
MONITORING WELL NO. 11131

INSTALLATION DATE: 9-22-93



BOREHOLE DIAMETER: 10 3/4 INCHES

MATERIALS USED:
SAND TYPE AND QUANTITY: 35 lbs of #7
BENTONITE PELLETS (5-GALLON BUCKETS): NA
BAGS OF VOLCLAY GROUT: [illegible]
AMOUNT OF CEMENT: 270 lbs KP 9-28-93
AMOUNT OF WATER USED: 70 [illegible]
OTHER: 60 lbs of silica flour

NOTES:
1) RISER PIPE IS 2-INCH SCHEDULE 40 PVC PIPE, FLUSH-THREADED KP 9-28-93
2) SCREEN IS 2-INCH I.D. SCHEDULE 40 PVC PIPE WITH 0.020-INCH SLOTS KP 9-28-93
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP KP 9-28-93
4) WATER DEPTH/DATE:
5) TOP OF PVC IS SECURED WITH EXPANDABLE RUBBER PLUG AND PADLOCK KP 9-28-93
6) PARENTHESES INDICATE DEPTH BELOW GROUND LEVEL

TASK: 50.03.24 GEOLOGIST/ENGINEER: Keith Payne

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PIEZOMETER INSTALLATION SHEET

PROJECT NAME GT/V2 Hydraulic Investigation FIELD ENG./GEO. Keith Payne DATE 9-28-93
PROJECT NO. 50.03.24 CHECKED BY _____ DATE _____
BORING NO. 11131
~~PIEZOMETER~~ Lysimeter NO. 11131 DATE OF INSTALLATION 9-22-93

BOREHOLE DRILLING

DRILLING METHOD Cable Tool/Hollow Stem Auger	TYPE OF BIT Hammer Percussion/Hollow Stem Auger
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID Water FROM 0.0 FT TO 22.5 FT	SIZE 16.0 IN FROM 0.0 FT TO 20.4 FT
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Lysimeter	RISER PIPE MATERIAL PVC
DIAMETER OF PERFORATED SECTION NA	RISER PIPE DIAMETERS:
PERFORATION TYPE: NA	O.D. 1 7/8 IN I.D. 1 5/8 IN
SLOTS ☐ HOLES ☐ SCREEN ☐	LENGTH OF PIPE SECTIONS 7-5FT, 1-1.2 FT
AVERAGE SIZE OF PERFORATIONS NA	JOINING METHOD Screw type - flush joint threaded
TOTAL PERFORATED AREA NA	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH NA	OTHER PROTECTION None
PROTECTIVE PIPE O.D. NA	

PRELIMINARY

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE ( )		ELEVATION ( )	
TOP OF RISER PIPE	2.3 FT			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	NA			
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP .5 FT	BOTTOM 33.5 FT	TOP	BOTTOM
~~BENTONITE~~ cement 9-28-93	TOP 1.0 FT	BOTTOM .5 FT	TOP	BOTTOM
SAND	TOP 33.5 FT	BOTTOM 35.0 FT	TOP	BOTTOM
~~GRAVEL~~ Silica Flour KP 9-28-93	TOP 35.0 FT	BOTTOM 39.0 FT	TOP	BOTTOM
PERFORATED SECTION	TOP 35.6	BOTTOM 36.0	TOP	BOTTOM
PIEZOMETER TIP	36.0			
BOTTOM OF BOREHOLE	39.0			
GWL AFTER INSTALLATION	NA			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS None

FEMP-OU02-6 FINAL
March 1, 1995

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On-Site Disposal Cell Pre-Design Activities Engineering Supplemental Report

Operable Unit 2
Project Order 101

July 1994
Revision 0

Environmental Remedial Action Project
Fernald Environmental Management Project
Fernald, Ohio
FERMCO Subcontract No. 2-21487

PARSONS

Fairfield Executive Center
6120 South Gilmore Road
Fairfield, Ohio 45014

E-3-3-198

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On-Site Disposal Cell Pre-Design Activities Engineering Supplemental Report

CONTENTS

1.0 Introduction 1-1

2.0 Background 2-1

3.0 Supplemental Geotechnical Laboratory Testing 3-1
- 3.1 Geotechnical Properties of Permeability Test Soil Samples 3-1
- 3.2 Laboratory Plan for Supplemental Geotechnical Testing 3-4
- 3.3 Results of Supplemental Geotechnical Laboratory Testing 3-4

4.0 Conclusions 4-1

5.0 References 5-1

Appendices

A Geotechnical Data for Samples G2-209 and G2-210 from Previous (December 1993 through March 1994) Geotechnical Testing

B Limits of Acceptable Dry Densities for Permeability Testing for Samples G2-209 (Modified Proctor) and G2-210 (Standard Proctor)

C Test Plan for Supplemental Geotechnical Laboratory Testing

D Supplemental Laboratory Testing Data Sheets

000858

6647

LIST OF ILLUSTRATIONS

Figures

2-1 Proposed On-Site Disposal Cell Site and Soil Boring Plan

Tables

3-1 Summary of Index Properties of Bulk Samples from Borings G2-209 and G2-210
3-2 Summary of Standard Proctor Compaction Test Results
3-3 Summary of Atterberg Limit Test Results for Bulk Samples G2-209 and G2-210 Conducted During Supplemental Geotechnical Testing
3-4 Summary of Modified Proctor Compaction Test Results
3-5 Summary of Laboratory Permeability Results for Test Specimens Compacted Using Standard Proctor Compactive Effort
3-6 Summary of Laboratory Permeability Results for Test Specimens Compacted Using Modified Proctor Compactive Effort

000059

LIST OF ACRONYMS AND ABBREVIATIONS

cm	Centimeters
ODC	On-Site Disposal Cell
ODC PAER	On-Site Disposal Cell Pre-Design Activities Engineering Report
OU	Operable Unit
pcf	Pounds per cubic foot
sec	Second

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SECTION 1

INTRODUCTION

This report presents the results of supplemental geotechnical laboratory permeability testing performed on compacted specimens of soil from the proposed location of the Operable Unit 2 (OU-2) On-Site Disposal Cell (ODC). The purpose of the testing is to provide pre-design geotechnical data regarding the permeability of soil samples compacted wet of optimum moisture content and compacted with Standard and Modified Proctor compactive efforts. This report supplements geotechnical data for the proposed ODC site contained in *On-Site Disposal Cell Pre-Design Activities Engineering Report*, Revision 0, April 1994 (PARSONS 1994).

SECTION 2

BACKGROUND

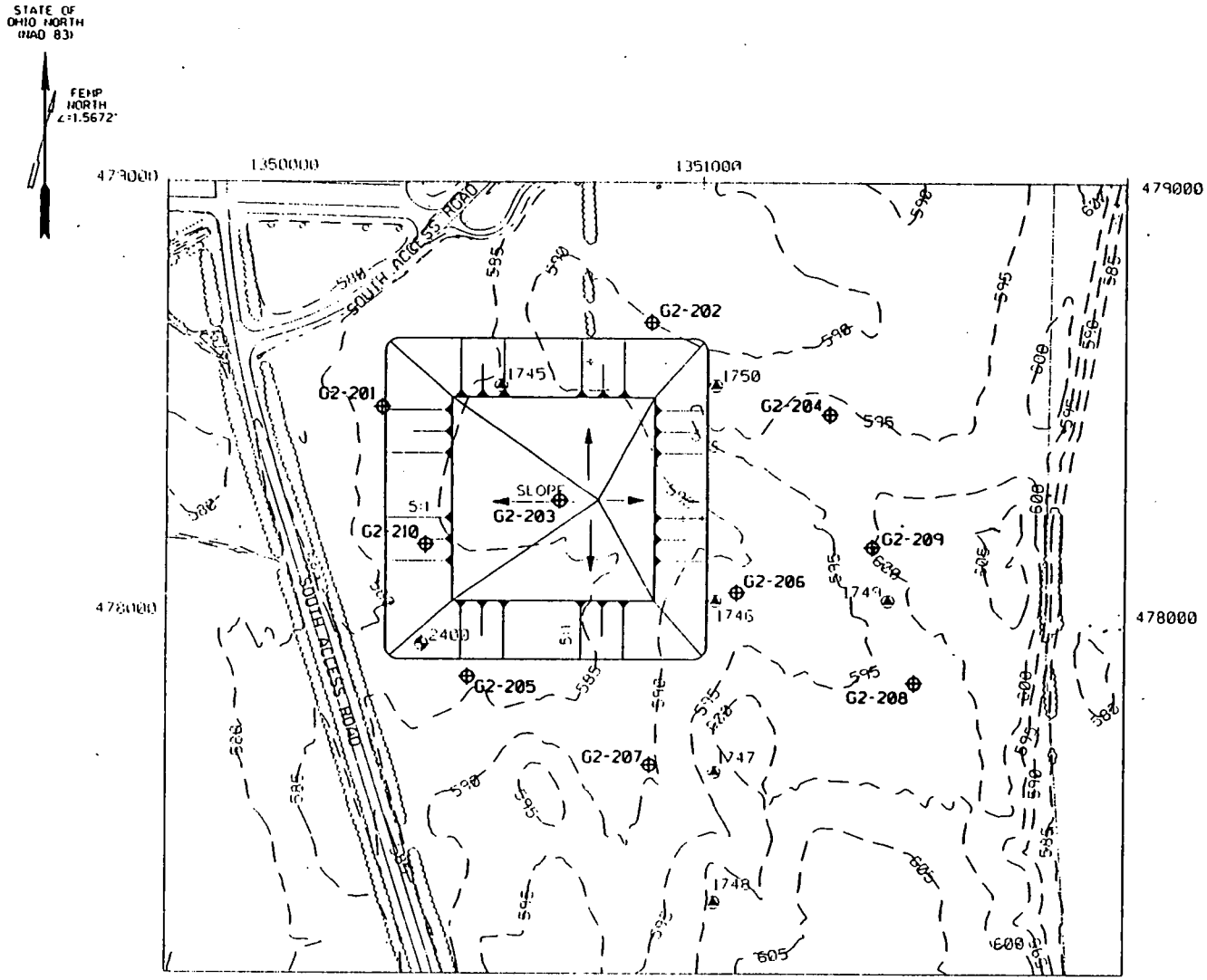
The alternative remedial concepts being considered by the Fernald Environmental Restoration Management Corporation include an on-site disposal cell designed for receipt of contaminated materials from the OU-2 subunits (i.e., OU-2 ODC). The proposed cell would essentially be an aboveground, encapsulated containment structure with a soil/geosynthetics composite liner, bio-intrusion barrier with a sacrificial soil erosional layer and cap.

A proposed site for the OU-2 Disposal Cell is situated at the southeast corner of the Fernald Environmental Management Project site (Figure 2-1). The area is currently a gently rolling, grassed field that has no buildings and was not involved in any production activities.

A geotechnical field test program was implemented per the *Solid Waste Landfill and On-Site Waste Disposal Cell Geotechnical Sampling and Testing Plan* (PARSONS 1993) at the proposed ODC site during November and December 1993. Subsurface soil samples were collected at the G2-series boring locations shown on Figure 2-1. Samples collected during the field program were packaged and shipped to Advanced Terra Testing, Inc., in Lakewood, Colorado for geotechnical laboratory testing. The laboratory testing program was directed toward the classification of the soils and determining their engineering properties. The laboratory data sheets from this testing are compiled in a two-volume report entitled *On-Site Waste Disposal Cell Soil Investigation Data Report, Volume 1 and 2* (SAIC 1994a). The results of the geotechnical field and laboratory programs are summarized in the *On-Site Disposal Cell Pre-Design Activities Engineering Report* (ODC PAER), Revision 0, April 1994 (PARSONS 1994).

Permeability test results from the ODC PAER for remolded glacial till samples suggested that lower permeabilities could be achieved by compacting the soil wet of optimum moisture content and/or by increasing the dry density.

This document reports the results of a series of additional laboratory permeability tests performed to evaluate the moisture-density-permeability relationship of compacted glacial till samples collected at the proposed ODC site.



LEGEND	
2400	EXISTING MONITORING WELL
1748	EXISTING SOIL BORING
G2-209	GEOTECHNICAL BORING
600	SURFACE CONTOUR (FT ABOVE MEAN SEA LEVEL)

BORINGS COMPLETED DURING ODC FIELD TEST PROGRAM (P0101)

BORING NO	NORTH	EAST	ELEVATION
G2-201	478479.253	1350255.013	580.567
G2-202	478676.083	1350881.046	590.103
G2-203	478264.290	1350667.588	587.597
G2-204	478463.156	1351295.595	596.152
G2-205	477852.362	1350454.876	583.491
G2-206	478048.670	1351081.497	591.426
G2-207	477646.512	1350879.507	588.990
G2-208	477838.168	1351493.018	596.274
G2-209	478155.044	1351394.371	598.783
G2-210	478161.692	1350355.363	583.181

EXISTING BORINGS

BORING NO	NORTH	EAST	ELEVATION
1745	478529.38	1350531.00	586.00
1746	478029.38	1351031.01	591.80
1747	477629.38	1351031.01	597.40
1748	477329.38	1351031.01	601.00
1749	478029.37	1351431.00	597.50
1750	478529.39	1351031.00	593.00
2400	477928.86	1350346.82	580.70

NOTE: COORDINATES ARE NAD 1983

SCALE IN FEET

ON-SITE DISPOSAL CELL SOIL BORING PLAN

CAD FILE NO sk02792

Figure 2-1 - Proposed On-Site Disposal Cell Site and Soil Boring Plan

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SECTION 3

SUPPLEMENTAL GEOTECHNICAL LABORATORY TESTING

This section summarizes the results of geotechnical laboratory permeability testing performed on specimens of recompacted glacial till from subsurface soil samples G2-209 and G2-210 which were collected during the ODC field program. Geotechnical laboratory testing was performed by Advanced Terra Testing, Inc., in Lakewood, Colorado from April through June 1994. The laboratory data sheets for this supplemental testing are compiled in a report entitled *On-Site Waste Disposal Cell Soil Investigation Data Report, Volume 3*, June 30, 1994 (SAIC 1994b).

3.1 Geotechnical Properties of Permeability Test Soil Samples

Bulk samples of auger cuttings were collected from a depth interval of 0 to 25 feet at borings G2-209 and G2-210 during the ODC field program (see Figure 2-1). The cuttings were placed in 5-gallon drums and shipped to the geotechnical laboratory. Index properties for these sample materials were determined during the December 1993 through March 1994 geotechnical testing period. Sample G2-209 is classified as a sandy lean clay (CL). Sample G2-210 is classified as a lean clay with sand (CL). Table 3-1 summarizes the results of the index properties tests.

Also during the December 1993 through March 1994 testing period, Standard Proctor compaction tests (ASTM D 698), and laboratory permeability tests (ASTM D 5084) were performed on the sample material. Table 3-2 summarizes the results of the Standard Proctor compaction tests. The results of the permeability tests are included in Subsection 3.3. Appendix A contains the grain-size curves, compaction curves, and laboratory data sheets for Samples G2-209 and G2-210 from the ODC PAER and *On-Site Waste Disposal Cell Soil Investigation Data Report, Volumes 1 and 2* (SAIC 1994).

As part of the supplemental geotechnical laboratory testing conducted during April through June 1994, Atterberg limits tests (ASTM D 4318) were performed on the soil materials from bulk samples G2-209 and G2-210 prior to performing compaction and permeability tests in order to verify chain of custody and expected material properties. Table 3-3 summarizes the results of these tests.

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Table 3-1 - Summary of Index Properties of Bulk Samples from Borings G2-209 and G2-210[1]

Boring No.	G2-209	G2-210
Depth (feet)	0-25	0-25
Sample Type	Auger Cuttings	Auger Cuttings
Description[2]	Brown and Gray Sandy Lean Clay	Brown and Gray Lean Clay with Sand
USCS Group Symbol[2]	CL	CL
Moisture Content[3]	6	7
Liquid Limit	28	28
Plastic Limit	13	14
Plasticity Index	15	14
Percent Gravel	3	3
Percent Sand	27	22
Percent Silt	40	44
Percent Clay[4]	30	31
Specific Gravity	2.80	2.76

Notes:

(1) Data Source: *On-Site Disposal Cell Pre-Design Activities Engineering Report*, April 1994 (PARSONS 1994)

(2) Description (excluding color) and USCS Group Symbol assigned per ASTM D 2487 based on grain size analyses and plasticity tests.

(3) Moisture content of auger cuttings; not representative of natural moisture content.

(4) Clay size particles defined as those smaller than 0.005 mm (reference ASTM D 422)

Table 3-2 - Summary of Standard Proctor Compaction Test Results[1]

Boring No.	G2-209	G2-210
Depth (feet)	0-25	0-25
Sample Type	Auger Cuttings	Auger Cuttings
Description and Classification	Brown and Gray Sandy Lean Clay (CL)	Brown and Gray Lean Clay with Sand (CL)
Maximum Dry Density (pcf)	122.3	122.3
Optimum Moisture Content (% dry weight)	12.3	12.4

Note:

(1) Data Source: *On-Site Disposal Cell Pre-Design Activities Engineering Report*, April 1994 (PARSONS 1994) moisture content. The test plan for performing the supplemental compaction-permeability testing is contained in Appendix C.

Table 3-3 - Summary of Atterberg Limit Test Results for Bulk Samples G2-209 and G2-210 Conducted During Supplemental Geotechnical Testing[1]

Boring No.	G2-209	G2-210
Depth (feet)	0-25	0-25
Sample Type	Auger Cuttings	Auger Cuttings
Liquid Limit	28	28
Plastic Limit	17	15
Plasticity Index	11	13
USCS Symbol	CL	CL

Note:

(1) Data Source: *On-site Waste Disposal Cell Soil Investigation Data Report, Volume 3*, June 30, 1994 (SAIC 1994b)

3.2 Laboratory Plan for Supplemental Geotechnical Testing

The supplemental geotechnical laboratory testing was conducted in two phases. The objective of the first phase was to provide permeability data for the proposed ODC site soil recompacted using Standard Proctor compactive effort at moisture contents ranging from optimum to wet of optimum moisture content. The objective of the second phase was to provide permeability data for proposed ODC site soil recompacted using the Modified Proctor compactive effort at moisture contents ranging from optimum to wet of optimum.

3.2.1 Phase 1 Testing

In the first phase (Phase 1), Atterberg limits tests were performed on the soil materials from bulk sample G2-209 and G2-210 to verify expected material index properties. Three laboratory permeability tests (ASTM D 5084) were then performed on test specimens of bulk sample G2-210 soil that was prepared at moisture contents ranging from optimum moisture content to 5 percent wet of optimum and compacted using the Standard Proctor compaction method (ASTM D 698). The "target" moisture contents for permeability testing were at or near optimum, 2 percent wet of optimum, and 5 percent wet of optimum moisture content. Prior to permeability testing, the dry density of the G2-210 soil sample was checked by the laboratory to fall within the limits of acceptable dry densities shown in Appendix B, Figure B-1.

3.2.2 Phase 2 Testing

For the second phase (Phase 2), a Modified Proctor compaction test was performed on the G2-209 sample soil to establish the Modified Proctor Compaction Curve for the material. Three laboratory permeability tests (ASTM D 5084) were then performed on test specimens of bulk sample G2-209 soil that was prepared at moisture contents ranging from optimum moisture content to 5 percent wet of optimum and compacted using the Modified Proctor compaction method (ASTM D 1557). The "target" moisture contents for permeability testing were at or near optimum, 2 percent wet of optimum, and 5 percent wet of optimum moisture content. Prior to permeability testing, the dry density of the G2-209 soil sample was checked by the laboratory to fall within the limits of acceptable dry densities shown in Appendix B, Figure B-2.

3.3 Results of Supplemental Geotechnical Laboratory Testing

This subsection summarizes the results of the Atterberg limits tests, compaction tests and permeability tests conducted during April through June 1994. The associated laboratory data sheets are contained in Appendix D.

3.3.1 Atterberg Limits Tests

Table 3-3 summarizes the results of the Atterberg limits tests performed of Samples G2-209 and G2-210. As expected, the materials tested (fines) classified as CL. In general, the plastic and liquid limits of the samples were consistent with those of the December 1993 through March 1994 testing period considering the nature of the index test performed on a portion of a bulk soil sample.

3.3.2 Standard Proctor Compaction Test

Standard Proctor compaction curves for samples G2-209 and G2-210 were obtained previously and were presented in the *On-Site Disposal Cell Pre-Design Activities Engineering Report* (ODC PAER), Revision 0, April 1994 (PARSONS 1994). Table 3-2 summarizes the results. The compaction curves are contained in Appendix A. For practical purposes, maximum dry density was 122.3 pounds per cubic foot (pcf) and optimum moisture content was 12.4 percent.

3.3.3 Modified Proctor Compaction Test

Table 3-4 summarizes the results of the Modified Proctor compaction test performed on Sample G2-209. The maximum dry density was 133.6 pcf and the optimum moisture content was 10.3 percent. The compaction curve is contained in Appendix D.

Table 3-4 - Summary of Modified Proctor Compaction Test Results

Boring No.	**G2-209**
Depth (feet)	0-25
Sample Type	Auger Cuttings
Description and Classification(1)	Brown and Gray Sandy Lean Clay (CL)
Maximum Dry Density (pcf)(2)	133.6
Optimum Moisture Content (% dry weight)(2)	10.3

Notes:

(1) Data Source: *On-Site Disposal Cell Pre-Design Activities Engineering Report*, April 1994 (PARSONS 1994)

(2) Data Source: *On-site Waste Disposal Cell Soil Investigation Data Report, Volume 3*, June 30, 1994 (SAIC 1994b)

3.3.4 Permeability Tests (Phase 1: Standard Proctor)

Table 3-5 summarizes the results of permeability tests of Sample G2-210 test specimens compacted using Standard Proctor compactive effort. The results of the permeability tests for Samples G2-209 and G2-210 conducted during the December 1993 through March 1994 testing period are also shown on Table 3-5.

The specimen (120 pcf @ 12.4 percent) compacted at or near the optimum moisture content had a coefficient of permeability (k) of 2.4×10^{-6} cm/sec. For practical purposes, this is the same as the results of the Samples G2-209 (1.4×10^{-6} cm/sec) and G2-210 (2.1×10^{-6} cm/sec) compacted to 95 percent Standard Proctor at or near optimum during the December through March geotechnical testing. The specimen (118 pcf @ 14.4 percent) compacted approximately 2 percent wet of optimum had a k of 7.7×10^{-6}, which is slightly more permeable than the specimens compacted at or near optimum. This increase in conductivity was not expected and may be an erratic result since the usual trend displays decreasing permeability as moisture content increases wet of the optimum moisture content. The specimen (112 pcf @ 17.4 percent) compacted at 5 percent wet of optimum moisture content had a k of 3.7×10^{-8} cm/sec.

Table 3-5 - Summary of Laboratory Permeability Results for Test Specimens Compacted Using Standard Proctor Compactive Effort

Boring No.	Depth (feet)	Specimen	Soil Description and Classification[1]	Specimen Preparation(6)	Initial Moisture Content (%)	Final Moisture Content (%)	Dry Density (pcf)	Wet Density (pcf)	Coefficient of Permeability (cm/sec)
209	0-25	bulk[2]	Brown and Gray Sandy Lean Clay (CL)	Compacted to 95% Standard Proctor max. dry density[6]	11.7	16.7	116.3	130.0	1.4×10^{-6}
210	0-25	bulk[2]	Brown and Gray Lean Clay with Sand (CL)	Compacted to 95% Standard Proctor max. dry density[6]	11.8	17.0	116.5	130.2	2.1×10^{-6}
210	0-25	120 pcf @ 12.4%[3]	Brown and Gray Lean Clay with Sand (CL)	Compacted at or near optimum moisture content[4] and dry density within limits of Figure B-1	12.0	16.6	120.0	134.4	2.4×10^{-6}
210	0-25	118 pcf @ 14.4%[3]	Brown and Gray Lean Clay with Sand (CL)	Compacted 2% wet of optimum moisture content[5] and dry density within limits of Figure B-1	13.8	16.6	118.0	134.3	7.7×10^{-6}
210	0-25	112 pcf @ 17.4%[3]	Brown and Gray Lean Clay with Sand (CL)	Compacted 5% wet of optimum moisture content[5] and dry density within limits of Figure B-1	16.9	17.7	113.5	132.6	3.7×10^{-8}

Notes:

(1) Soil description and classification from *On-Site Disposal Cell Pre-Design Activities Engineering Report*, April 1994 (PARSONS 1994)

(2) Data source for test specimen: *On-Site Disposal Cell Pre-Design Activities Engineering Report*, April 1994 (PARSONS 1994)

(3) Data source for test specimen: *On-Site Waste Disposal Cell Soil Investigation Data Report, Volume 3*, June 30, 1994 (SAIC 1994b)

(4) Tolerance for moisture content: -0.5%, +1.5%

(5) Tolerance for moisture content: ±1.0%

(6) Standard Proctor compaction data: Sample G2-209: maximum dry density = 122.3 pcf, optimum moisture content.= 12.3%; Sample G2-210: maximum dry density = 122.3 pcf, optimum moisture content = 12.4%

3.3.5 Permeability Tests (Phase 2: Modified Proctor)

Table 3-6 summarizes the results of permeability tests of Sample G2-209 test specimens compacted using Modified Proctor compactive effort. The test specimen (#3 at OMC) compacted at or near optimum moisture content had a k of 2.5 x 10^{-8} cm/sec. The specimen (#4 +2 OMC) compacted at 2 percent wet of optimum was the least permeable of the six specimens tested during the supplemental testing program with a k of 9.5 x 10^{-9} cm/sec. The test specimen (#5 @ 5 percent OMC) compacted at 5 percent wet of optimum had a k of 2.1 x 10^{-8} cm/sec.

Table 3-6 - Summary of Laboratory Permeability Results for Test Specimens Compacted Using Modified Proctor Compactive Effort

Boring No.	Depth (feet)	Specimen No.	Soil Description and Classification[1]	Specimen Preparation(5)	Initial Moisture Content (%)	Final Moisture Content (%)	Dry Density (pcf)	Wet Density (pcf)	Coefficient of Permeability (cm/sec)
G2-209	0-25	3 at OMC[2]	Brown and Gray Sandy Lean Clay (CL)	Compacted at or near optimum moisture content[3] and dry density within limits of Figure B-2	10.0	13.3	131.8	145.0	2.5×10^{8}
G2-209	0-25	4 +2% OMC[2]	Brown and Gray Sandy Lean Clay (CL)	Compacted 2% wet of optimum moisture content[4] and dry density within limits of Figure B-2	12.1	13.3	128.4	144.0	9.5×10^{9}
G2-209	0-25	5 @ +5% OMC[2]	Brown and Gray Sandy Lean Clay (CL)	Compacted 5% wet of optimum moisture content[4] and dry density within limits of Figure B-2	14.9	15.6	120.9	138.9	2.1×10^{8}

Notes:

(1) Soil description and classification from *On-Site Disposal Cell Pre-Design Activities Engineering Report*, April 1994 (PARSONS 1994)

(2) Data source for test specimen: *On-Site Waste Disposal Cell Soil Investigation Data Report, Volume 3*, June 30, 1994 (SAIC 1994b)

(3) Tolerance for moisture content: -0.5%, +1.5%

(4) Tolerance for moisture content: $\pm$1.0%

(5) Modified Proctor compaction data: Sample G2-209: maximum dry density = 133.6 pcf, optimum moisture content = 10.3%

SECTION 4

CONCLUSIONS

Based on the laboratory permeability test results of five test specimens compacted using Standard Proctor compactive effort:

1) The laboratory k ranges from approximately 10^{-6} to 10^{-5} cm/sec in test specimens with molding water contents that range from at or near optimum to approximately 2 percent wet of optimum.

2) The test data, though not conclusive, indicate that the laboratory k decreases from the 10^{-6} to 10^{-5} cm/sec range at approximately 2 percent wet of optimum to an approximate 10^{-8} to 10^{-7} range at 5 percent wet of optimum.

Based on the laboratory permeability test results of three test specimens compacted using Modified Proctor compactive effort:

1) The laboratory k of three specimens tested within a range of molding water contents of at or near optimum to 5 percent wet of optimum fall within an approximate range of 1×10^{-8} to 5×10^{-8} cm/sec.

2) The least permeable specimen ($k = 9.5 \times 10^{-9}$ cm/sec) was the test specimen compacted at 2 percent wet of optimum moisture content.

SECTION 5

REFERENCES

(ASTM 1991) American Society for Testing and Materials, 1991. Annual Book of ASTM Standards, *Volume 4.08, Soil and Rock, Building Stones and Geotextiles, 1991 Edition*. Philadelphia, Pennsylvania: ASTM.

(PARSONS 1993) PARSONS ERA Project, October 1993. *Solid Waste Landfill and On-Site Waste Disposal Cell Geotechnical Sampling and Testing Plan*, Revision 0. Fairfield: PARSONS.

(PARSONS 1994) PARSONS ERA Project, April 1994. *On-Site Disposal Cell Pre-Design Activities Engineering Report*, Revision 0. Fairfield: PARSONS.

(SAIC 1994a) Science Applications International Corporation, March 3, 1994. *On-Site Waste Disposal Cell Soil Investigation Data Report, Volume 1 and 2*. Golden, Colorado: SAIC.

(SAIC 1994b) Science Applications International Corporation, June 30, 1994. *On-Site Waste Disposal Cell Soil Investigation Data Report, Volume 3*. Golden, Colorado: SAIC.

APPENDIX A

GEOTECHNICAL DATA FOR SAMPLES G2-209 AND G2-210 FROM PREVIOUS (DECEMBER 1993 THROUGH MARCH 1994) GEOTECHNICAL TESTING

APPENDIX A

Contents

Item **Page**

Soil Boring Logs
Boring No. G2-209 . . . . . A-3
Boring No. G2-210 . . . . . A-7

Specific Gravity
Boring No. G2-209 . . . . . A-12
Boring No. G2-210 . . . . . A-12

Moisture Content
Boring No. G2-209 . . . . . A-14
Boring No. G2-210 . . . . . A-14

Grain Size Analysis
Boring No. G2-209 . . . . . A-16
Boring No. G2-210 . . . . . A-20

Atterberg Limits
Boring No. G2-209 . . . . . A-25
Boring No. G2-210 . . . . . A-26

Proctor Compaction - Standard
Boring No. G2-209 . . . . . A-28
Boring No. G2-210 . . . . . A-30

Triaxial, Back-Pressure Permeability(Tx/Pbp)
Boring No. G2-209 . . . . . A-33
Boring No. G2-210 . . . . . A-37

000876

6647

SOIL BORING LOGS

000877

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101 (PARSONS)	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 209		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478155.04 EAST 1351394.37	DATE STARTED: 09NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 598.78 FT	DATE COMPLETED: 09NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 1 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
0.0 to 0.5							AUGERED 0 TO 25 FT BULK SAMPLE COLLECTED
0.5 to 1.0							
1.0 to 1.5							
1.5 to 2.0							
2.0 to 2.5	0900 hrs			SILTY CLAY - FIRM, LOW TO MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/4), TRACE SAND - FINE TO COARSE GRAINED, TRACE GRAVEL - 1/4 TO 1/2", DRY.	CL		BETA / GAMMA - 0 CPM PID - 4.4 PPM
2.5 to 3.0							
3.0 to 3.5							
3.5 to 4.0							
4.0 to 4.5							
4.5 to 5.0	0905 hrs			SILTY CLAY - FIRM, LOW TO MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/4), TRACE SAND - FINE TO COARSE GRAINED, TRACE GRAVEL - 1/4 TO 1/2", DRY.	CL		BETA / GAMMA - 0 CPM PID - 3.3 PPM
5.0 to 5.5							
5.5 to 6.0							
6.0 to 6.5							
6.5 to 7.0							
7.0 to 7.5	0910 hrs			SILTY CLAY - FIRM, MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10 YR 4/4), TRACE SAND - FINE TO MEDIUM GRAINED, SLIGHTLY MOIST.	CL		BETA / GAMMA - 0 CPM PID - 5.3 PPM

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROND LEVELS. SOIL DESCRIPTION AND CLASSIFICATION PER ASTM D-2488.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 209		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478155.04 EAST 1351394.37	DATE STARTED: 09NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 598.78	DATE COMPLETED: 09NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 2 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
7.5 to 8.0							
8.0 to 8.5							
8.5 to 9.0							
9.0 to 9.5							
9.5 to 10.0	0915 hrs			SILTY CLAY - FIRM, MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/4), TRACE SAND - FINE TO COARSE GRAINED, TRACE GRAVEL - 1/4 TO 1", MOIST.	CL		BETA / GAMMA - 0 CPM PID - 5.1 PPM
10.0 to 10.5							
10.5 to 11.0							
11.0 to 11.5							
11.5 to 12.0							
12.0 to 12.5	0920 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM PLASTICITY, OLIVE GRAY (5Y 4/2), TRACE SAND - FINE TO COARSE GRAINED, TRACE GRAVEL 1/4 TO 1/2", MOIST.	CL		BETA / GAMMA - 0 CPM PID - 4.9 PPM
12.5 to 13.0							APPROXIMATE TOP OF GRAY CLAY
13.0 to 13.5							
13.5 to 14.0							
14.0 to 14.5							
14.5 to 15.0	0925 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SAND - FINE TO MEDIUM GRAINED, MOIST.	CL		BETA / GAMMA - 0 CPM PID - 8.7 PPM

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROUND LEVELS.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 209		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478155.04 EAST 1351394.37	DATE STARTED: 09NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 598.78 FT	DATE COMPLETED: 09NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 3 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
15.0 to 15.5							
15.5 to 16.0							
16.0 to 16.5							
16.5 to 17.0							
17.0 to 17.5	0928 hrs			SILTY CLAY - SOFT, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SAND - FINE TO MEDIUM GRAINED, TRACE GRAVEL 1/4 TO 1/2", MOIST.	CL		BETA / GAMMA - 0 CPM PID - 1.8 PPM
17.5 to 18.0							
18.0 to 18.5							
18.5 to 19.0							
19.0 to 19.5							
19.5 to 20.0	0932 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SNAD - FINE TO COARSE GRAINED, TRACE GRAVEL - 1/4 TO 1/2", MOIST.	CL		BETA / GAMMA - 0 CPM PID - 0.7 PPM
20.0 to 20.5							
20.5 to 21.0							
21.0 to 21.5							
21.5 to 22.0							
22.0 to 22.5	0935 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SAND - FINE TO MEDIUM GRAINED, TRACE GRAVEL - 1/4 TO 1", MOIST.	CL		BETA / GAMMA - 0 CPM PID - 0.0 PPM

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROND LEVELS.

6647

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 209		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478155.04 EAST 1351394.37	DATE STARTED: 09NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 598.78 FT	DATE COMPLETED: 09NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 4 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
22.5 to 23.0							
23.0 to 23.5							
23.5 to 24.0							
24.0 to 24.5							
24.5 to 25.0	0940 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SAND - FINE TO COARSE GRAINED, TRACE GRAVEL - 1/4 TO 1", MOIST	CL		BETA / GAMMA - 0 CPM PID - 2.7 PPM
25.0 to 25.5				TOTAL DEPTH - 25.0 FT			
25.5 to 26.0							
26.0 to 26.5							
26.5 to 27.0							
27.0 to 27.5							
27.5 to 28.0							
28.0 to 28.5							
28.5 to 29.0							
29.0 to 29.5							
29.5 to 30.0							

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROUND LEVELS.

000681

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101 (PARSONS)	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 210		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478161.69 EAST 1350355.36	DATE STARTED: 08NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 583.18 FT	DATE COMPLETED: 08NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 1 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
0.0 to 0.5							AUGERED 0 TO 25' BULK SAMPLE COLLECTED
0.5 to 1.0							
1.0 to 1.5							
1.5 to 2.0							
2.0 to 2.5	1532 hrs			SILTY CLAY - FIRM, LOW TO MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/6), DRY.	CL		BETA / GAMMA - 0 CPM PID - 33.0 PPM
2.5 to 3.0							
3.0 to 3.5							
3.5 to 4.0							
4.0 to 4.5							
4.5 to 5.0	1537 hrs			SANDY SILTY CLAY - SOFT TO FIRM, MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/6), SAND - FINE TO MEDIUM GRAINED, DRY.	CL		BETA / GAMMA - 0 CPM PID - 24.0 PPM
5.0 to 5.5							
5.5 to 6.0							
6.0 to 6.5							
6.5 to 7.0							
7.0 to 7.5	1625 hrs			SANDY SILTY CLAY - SOFT TO FIRM, MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/6), SAND - FINE TO MEDIUM GRAINED, SLIGHTLY MOIST.	CL		BETA / GAMMA - 0 CPM PID - 7.0 PPM

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROUND LEVELS. SOIL DESCRIPTION AND CLASSIFICATION PER ASTM D-2488.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 210		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478161.69 EAST 1350355.36	DATE STARTED: 08NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 583.19 FT	DATE COMPLETED: 08NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 2 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
7.5 to 8.0							
8.0 to 8.5							
8.5 to 9.0							
9.0 to 9.5							
9.5 to 10.0	1633 hrs			SILTY CLAY - SOFT, MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/6), TRACE SAND - FINE TO MEDIUM GRAINED, MOIST.	CL		BETA / GAMMA - 0 CPM PID - 12.5 PPM
10.0 to 10.5							
10.5 to 11.0							
11.0 to 11.5							
11.5 to 12.0							
12.0 to 12.5	1639 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM PLASTICITY, DARK YELLOWISH BROWN (10YR 4/6), TRACE SAND - FINE TO MEDIUM GRAINED, TRACE GRAVEL - 1/4 TO 1/2", MOIST.	CL		BETA / GAMMA - 0 CPM PID - 30.0 PPM
12.5 to 13.0							
13.0 to 13.5							
13.5 to 14.0							
14.0 to 14.5							
14.5 to 15.0	1642 hrs			GRAVELLY SILTY CLAY - SOFT, MEDIUM PLASTICITY, OLIVE GRAY (5Y 4/2), GRAVEL - 1/4 TO 1 1/2", TRACE SAND - FINE TO COARSE, MOIST.	CL		BETA / GAMMA - 0 CPM PID - 16.0 PPM

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROUND LEVELS.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 210		
GEOLOGIST: J. HANEY	COORDINATES: NORTH 478161.69 EAST 1350355.36	DATE STARTED: 08NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 583.18 FT	DATE COMPLETED: 08NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 3 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSF	REMARKS
15.0 to 15.5							APPROXIMATE TOP OF GRAY CLAY
15.5 to 16.0							
16.0 to 16.5							
16.5 to 17.0							
17.0 to 17.5	1647 hrs			GRAVELLY SILTY CLAY - SOFT TO FIRM, MEDIUM PLASTICITY, DARK GRAY (5Y 4/1), GRAVEL - 1/4 TO 1", TRACE SAND - FINE TO MEDIUM GRAINED, MOIST.	CL		BETA / GAMMA - 0 CPM PID - 26.5 PPM
17.5 to 18.0							
18.0 to 18.5							
18.5 to 19.0							
19.0 to 19.5							
19.5 to 20.0	1652 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM PLASTICITY, DARK GRAY (5Y 4/1), TRACE GRAVEL - 1/4 TO 1/2", TRACE SAND - FINE TO MEDIUM GRAINED, MOIST.	CL		BETA / GAMMA - 0 CPM PID - 20.0 PPM
20.0 to 20.5							
20.5 to 21.0							
21.0 to 21.5							
21.5 to 22.0							
22.0 to 22.5	1657 hrs			SILTY CLAY - SOFT, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SAND - FINE TO MEDIUM GRAINED, MOIST.	CL		BETA / GAMMA - 0 CPM PID - 25.1 PPM

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROUND LEVELS.

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: P.O. 101	PROJECT NAME: SOLID WASTE LANDFILL AND ON-SITE WASTE DISPOSAL CELL PREDESIGN FIELD INVESTIGATIONS - GEOTECHNICAL SAMPLING AND TESTING SUBSURFACE EXPLORATION	
BORING NUMBER: G2 - 210		
GEOLOGIST: J. BANEY	COORDINATES: NORTH 478161.69 EAST 1350355.36	DATE STARTED: 08NOV93
DRILLING METHOD: AUGER (HOLLOW STEM)	GROUND ELEVATION: 583.18 FT	DATE COMPLETED: 08NOV93
REPORT DATE: 10JAN94	GWL / DATE: NA	PAGE NUMBER: 4 of 4

DEPTH (ft)	SAMPLE # TIME			DESCRIPTION OF SOIL	USCS SYM	TSP	REMARKS
22.5 to 23.0							
23.0 to 23.5							
23.5 to 24.0							
24.0 to 24.5							
24.5 to 25.0	1700 hrs			SILTY CLAY - SOFT TO FIRM, MEDIUM TO HIGH PLASTICITY, DARK GRAY (5Y 4/1), TRACE SAND - FINE TO MEDIUM GRAINED, MOIST.	CL		BETA - GAMMA - 0 CPM PID - 26.5 PPM
25.0 to 25.5				TOTAL DEPTH 25.0 FT			
25.5 to 26.0							
26.0 to 26.5							
26.5 to 27.0							
27.0 to 27.5							
27.5 to 28.0							
28.0 to 28.5							
28.5 to 29.0							
29.0 to 29.5							
29.5 to 30.0							

NOTES: COLORS IDENTIFIED USING MUNSELL COLOR CHART. ALL FERMCO READINGS FOR ORGANIC VOLATILES AND BETA/GAMMA GIVEN IN UNITS ABOVE BACKGROUND LEVELS.

SPECIFIC GRAVITY
ASTM D 854

000886

ADVANCED TERRA TESTING INC

Specific Gravity Tests

Job No. 24-39-08

Location Paducah

Page ___ of ___

Boring No.	G2-209	G2-210				
Depth ~~Sample No.~~	0-24.5	0-24.5				
Sampled	11-9-93	11-5-93				
By:	JPH	JPH				
Tested	12-14-93	→				
By:	SR	→				
Checked	2-14-94	→				
By:	MW					
Specific Gravity Flask #	1	2				
Weight of flask (g)	62.227	62.4465				
Weight of oven dry soil (g) (Wo)	25.769	25.431				
Weight of flask, soil and water (g) (Wb)	178.321	178.552				
Temperature (deg. C) (Tx)	24.5	24.6				
Weight of water & flask at Tx (from cal. curve) (Wa)	161.740	162.030				
Specific Gravity *	2.80 MW ~~2.68~~	2.76				
Pan No.	7C13	13C				

* Specific Gravity = Wo/[Wo+(Wa−Wb)]

6647

FEMP-OU02-6 FINAL
March 1, 1995

E-3-3-228

000027

MOISTURE CONTENT
ASTM D 2216

E-3-3-229

000888

MOISTURE AND DENSITY DETERMINATIONS

6642

FEMP-OU02-6 FINAL
March 1, 1995

ADVANCED TERRA TESTING

CLIENT Parsons PO1601

JOB NO. 2057-02

LOCATION Proposed Fire Station Diesel Cell

PAGE 1 OF 1

SAMPLE & SOIL TYPE	BORING	G2-209	G2-210						
	SAMPLE NO.								
	SAMPLE DEPTH	0-24.5'	0-24.5						
	DATE SAMPLED BY								
	DATE TESTED BY	12-20-93	12-20-93						
	SOIL TYPE								
	LABORATORY IDENTIFICATION								
DENSITY	NO. OF RINGS								
	WT. OF WET SOIL & RINGS								
	WT. OF RINGS								
	WT. OF WET SOIL								
	WET DENSITY (LBS./CU.FT.)								
	DRY DENSITY (LBS./CU.FT.)								
MOISTURE CONTENT	DISH NO.	12A	6A						
	WT. OF WET SOIL & DISH	131.75	115.34						
	WT. OF DRY SOIL & DISH	124.44	108.46						
	NET LOSS OF MOISTURE	7.31	7.38						
	WT. OF DISH	8.20	8.17						
	WT. OF DRY SOIL	116.24	100.29						
	MOISTURE CONTENT (% DRY WT.)	6.3	7.4						

11-91

E-3-3-230

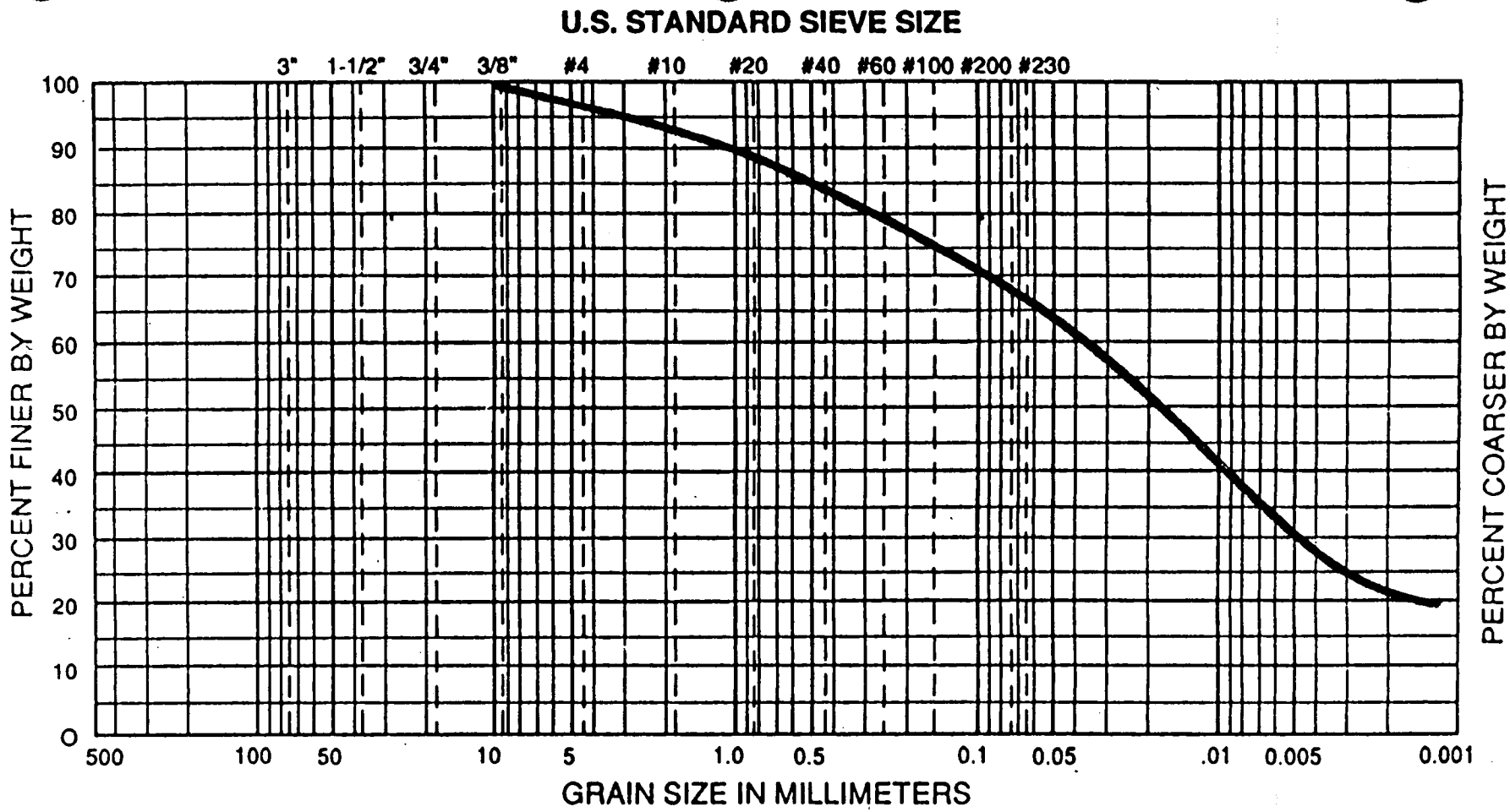
12-20-93

GRAIN SIZE ANALYSIS WITH HYDROMETER
ASTM D 422

E-3-3-231

000890

F - 6647



ADVANCED TERRA TESTING

E-3-3-232

ASTM D 2487 (USCS)

COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-209 SAMPLE NO.: BULK DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	0 - 25 ft	Brown and Gray Sandy Lean Clay (CL)

000091

MECHANICAL ANALYSIS - SIEVE TEST DATA

CLIENT Parsons

JOB NO. 2059-08

BORING NO.	G2-209	SAMPLED	
DEPTH	0 - 24.5'	DATE TESTED	12/20/93 TNU
SAMPLE NO.	931110-133	WASH SIEVE	Yes
SOIL DESCR.	PO 101	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC Yes

NATURAL No

Wt. Wet Soil & Pan	(g)	64.25
Wt. Dry Soil & Pan	(g)	60.66
Wt. Lost Moisture	(g)	3.59
Wt. of Pan Only	(g)	3.65
Wt. of Dry Soil	(g)	57.01
Moisture Content	%	6.3
Wt. Hydrom. Sample Wet	(g)	55.24
Wt. Hydrom. Sample Dry	(g)	51.96

WASH SIEVE ANALYSIS

Wt. Total Sample	Wet (g)	1188.00
Weight of + #10 Before Washing	(g)	111.10
Weight of + #10 After Washing	(g)	81.97
Weight of - #10	Wet (g)	1076.90
Weight of - #10	Dry (g)	1040.51
Wt. Total Sample	Dry (g)	1122.48
Calc. Wt. "W"	(g)	56.06
Calc. Mass + #10		4.09

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	13.66	13.66	13.66	1.2	98.8
#4	0.00	21.87	21.87	35.53	3.2	96.8
#10	0.00	46.44	46.44	81.97	7.3	92.7
#20	1.56	4.04	2.48	2.48	11.7	88.3
#40	1.58	3.78	2.20	4.68	15.7	84.3
#60	1.57	3.64	2.07	6.75	19.3	80.7
#100	1.58	4.16	2.58	9.33	23.9	76.1
#200	1.56	5.03	3.47	12.80	30.1	69.9

ADVANCED TERRA TESTING, INC.

HYDROMETER ANALYSIS - SEDIMENTATION DATA

CLIENT	Parsons	JOB NO.	2059-08
BORING NO.	G2-209	SAMPLED	
DEPTH	0 - 24.5'	DATE TESTED	12/20/93 TNU
SAMPLE NO.	931110-133	WASH SIEVE	Yes
SOIL DESCR.	PO 101	DRY SIEVE	No

Hydrometer #	ASTM 152 H	Temp., Deg. C	23.0
Sp. Gr. of Soil	2.80	Temp. Coef. K	0.01261
Value of "a"	0.97	Wt. Dry Sample "W"	56.057
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	-1.0		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	44.00	38.00	65.8	65.8	9.07	0.0537
1.0	41.00	35.00	60.6	60.6	9.57	0.0390
2.0	38.50	32.50	56.2	56.2	9.98	0.0282
5.0	36.00	30.00	51.9	51.9	10.39	0.0182
15.0	30.50	24.50	42.4	42.4	11.29	0.0109
30.0	28.00	22.00	38.1	38.1	11.70	0.0079
60.0	25.00	19.00	32.9	32.9	12.19	0.0057
120.0	23.00	17.00	29.4	29.4	12.52	0.0041
250.0	20.75	14.75	25.5	25.5	12.89	0.0029
1440.0	18.00	12.00	20.8	20.8	13.34	0.0012

Grain Diameter = K*(SQRT(L/T))

ADVANCED TERRA TESTING, INC.

PAH4 022C9

ADVANCED TERRA TESTING

COMBINED MECHANICAL ANALYSIS

Page ____ of ____

CLIENT Parsons PO 101
JOB NO. 12034-081 BORING NO. G2-209 SAMPLE NO. _____ DEPTH 0-24.5'
DATE SAMPLED 11-9-93 BY JPM DATE TESTED _____ BY _____ COMPUTER _____
SOIL TYPE (Field Classification) _____

MOISTURE DETERMINATION (Dish No. 5/C.)

Wt. of wet soil & dish	64.25g
Wt. of dry soil & dish	60.66g
Wt. of water	
Wt. of dish	3.65
Wt. of dry soil	
Moisture Content, %	

TEST CONTENTS

Hydrometer No.	ASTM 152H
Spec. Grav. of Soil	~~2.68~~ 2.80
Value of "a"	~~.979~~ .970
Deflocculant	~~125~~ cc. of $(NaPO_3)_6$
Defloc. Correction	5.0
Meniscus Corr'n	-1.0

Temperature, °C	23.0		
Temperature Corr'n	~~.0305~~ .01261		

SIEVE ANALYSIS (Dish No. ____)

Wt. of total sample (wet)	1188.0
Wt. of total sample (dry)	
Wt. of + #10 (wet) 4A	111.10g (+)
Wt. of + #10 (dry)	81.97
Wt. of - #10 (wet) 013	1076.9g (+)
Wt. of - #10 (dry)	

Tyler Sieve Size	Ind. Wt. Dry Soil Retained g(+)	Cum. Wt. Dry Soil Retained	% Finer Than	% Total Sample
3/8	13.66			
4	21.87			
10	46.44			

AFTER HYDROMETER ANALYSIS (Dish No. ____)
Wt. of dry sample "W" _____
% of total sample _____

Tyler Sieve Size	Pan # A37	Pan wt.	Dry Soil & Pan	Cum. Wt. Dry Soil Retained	% Finer Than	% Total Sample
20	82P	1.56	4.04			
40	18P	1.58	3.78			
60	78	1.57	3.68			
100	36	1.58	4.16			
200	78	1.56	5.03			

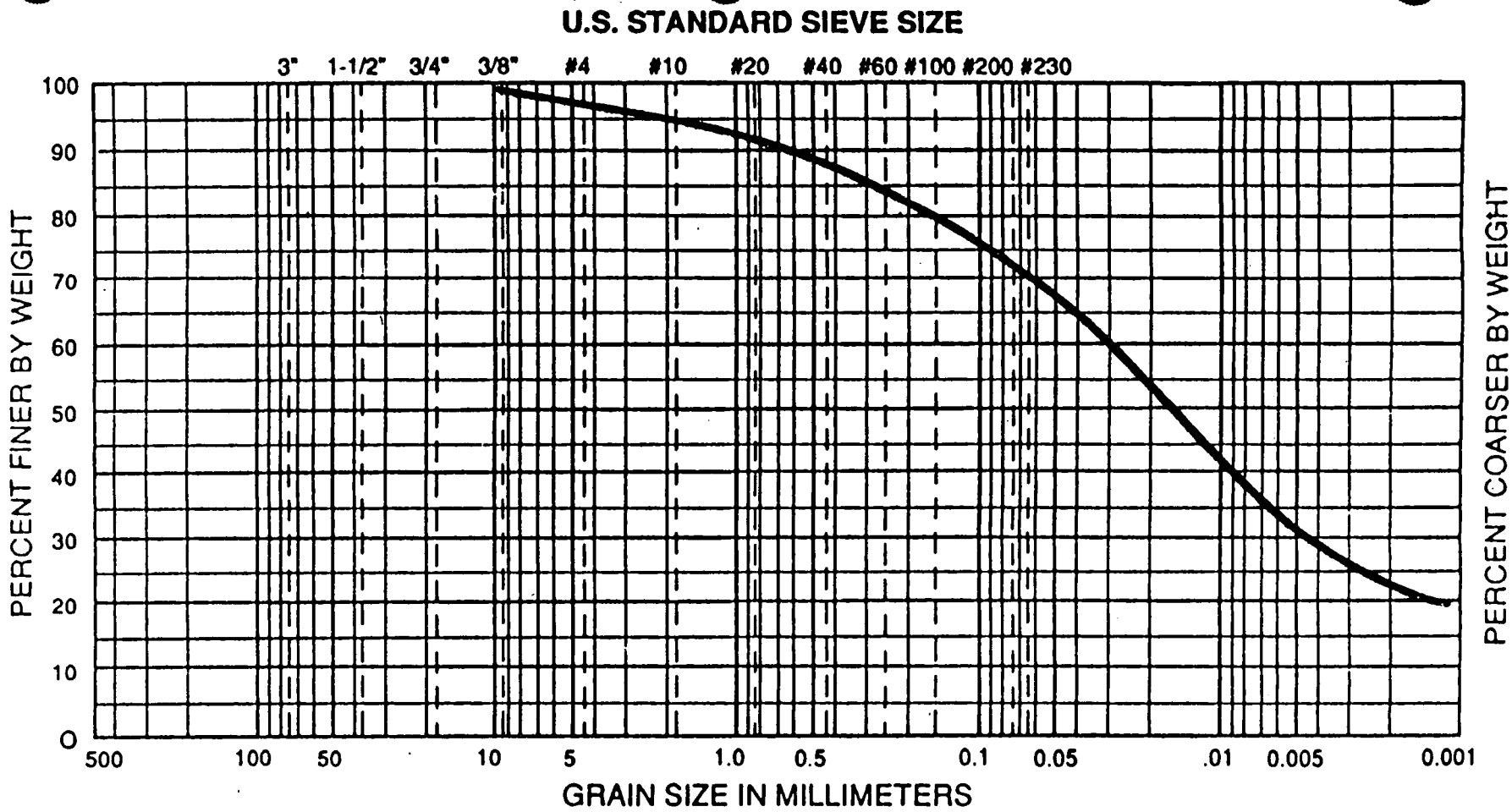
HYDROMETER ANALYSIS (Cylinder No. ____)

Wt. of wet sample (Passing # sieve) 55.33g(+) SL 2-16-94
Wt. of dry sample (Passing # sieve) _____ "W" _____ % of total sample _____

Observed Time	Elapsed Time (min)	Temp. (°C)	Hyd. Reading Original	Hyd. Reading Corrected "R"	100Ra W	% Total Sample	Grain Diam. (mm.)	Corr'n Coef L	Corr'n Coef k	Corr'n Coef	Corrected Diameter (mm.)
1236	0	22.3	....	....	....	....	.....	...	...	...	.....
	½		44.0								
1237	1		41.0								
1238	2		38.5								
1241	5		36.0								
1251	15		30.5								
1306	30		28.0								
1336	60		25.0								
1436	120		23.0								
1646	250	23.3	20.75								
1836	1440	22.8	18.0								

On reverse side-Notes ☐ Calculation ☐

000834



ASTM D 2487 (USCS)	COBBLES	GRAVEL		SAND			SILT OR CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE	

Note: Clay size particles defined as those smaller than 0.005 mm (Ref: ASTM D 422)

WELLNAME: G2-210 SAMPLE NO.: BULK DATE: 1-3-94 PROJECT NO.: PO-101

AREA	DEPTH	CLASSIFICATION
On-Site Cell	0 - 25 ft	Brown and Gray Lean Clay with Sand (CL)

ADVANCED TERRA TESTING

E-3-3-236

000295

- 6647

MECHANICAL ANALYSIS - SIEVE TEST DATA

CLIENT	Parsons	JOB NO.	2059-08
BORING NO.	G2-210	SAMPLED	11/08/93 JPH
DEPTH	0 - 24.5'	DATE TESTED	12/20/93 TNU
SAMPLE NO.	931110-132	WASH SIEVE	Yes
SOIL DESCR.	PO 101	DRY SIEVE	No

MOISTURE DATA

HYGROSCOPIC	Yes	
NATURAL	No	
Wt. Wet Soil & Pan	(g)	56.80
Wt. Dry Soil & Pan	(g)	53.26
Wt. Lost Moisture	(g)	3.54
Wt. of Pan Only	(g)	3.60
Wt. of Dry Soil	(g)	49.66
Moisture Content	%	7.1
Wt. Hydrom. Sample Wet	(g)	55.31
Wt. Hydrom. Sample Dry	(g)	51.63

WASH SIEVE ANALYSIS

Wt. Total Sample Wet (g)	1111.46
Weight of + #10 Before Washing (g)	98.06
Weight of + #10 After Washing (g)	62.58
Weight of - #10 Wet (g)	1013.40
Weight of - #10 Dry (g)	979.09
Wt. Total Sample Dry (g)	1041.67
Calc. Wt. "W" (g)	54.93
Calc. Mass + #10	3.30

Sieve Number (Size)	Pan Weight (g)	Indiv. Wt. + Pan (g)	Indiv. Wt. Retain.	Cum. Wt. Retain.	Cum. % Retain.	% Finer By Wt.
1 1/2"	0.00	0.00	0.00	0.00	0.0	100.0
3/4"	0.00	0.00	0.00	0.00	0.0	100.0
3/8"	0.00	9.76	9.76	9.76	0.9	99.1
#4	0.00	20.30	20.30	30.06	2.9	97.1
#10	0.00	32.52	32.52	62.58	6.0	94.0
#20	1.56	3.29	1.73	1.73	9.2	90.8
#40	1.56	3.37	1.81	3.54	12.5	87.5
#60	1.57	3.32	1.75	5.29	15.6	84.4
#100	1.57	3.67	2.10	7.39	19.5	80.5
#200	1.56	4.47	2.91	10.30	24.8	75.2

ADVANCED TERRA TESTING, INC.

HYDROMETER ANALYSIS - SEDIMENTATION DATA

CLIENT Parsons

JOB NO. 2059-08

BORING NO.	G2-210	SAMPLED	11/08/93 JPH
DEPTH	0 - 24.5'	DATE TESTED	12/20/93 TNU
SAMPLE NO.	931110-132	WASH SIEVE	Yes
SOIL DESCR.	PO 101	DRY SIEVE	No

Hydrometer #	ASTM 152 H	Temp., Deg. C	23.0
Sp. Gr. of Soil	2.76	Temp. Coef. K	0.01275
Value of "a"	0.98	Wt. Dry Sample "W"	54.930
Deflocculant	Sodium Hexametaphosphate	% of Total Sample	100.0
Defloc. Corr'n	5.0		
Meniscus Corr'n	-1.0		

T Elapsed Time (min)	Hydrometer Reading Original	Corrected "R"	100Ra/W	% Total Sample	Effective Depth L	Grain Diameter (mm)
0.0	--	--	--	--	--	--
0.5	44.50	38.50	68.5	68.5	8.99	0.0541
1.0	42.00	36.00	64.1	64.1	9.40	0.0391
2.0	39.50	33.50	59.6	59.6	9.81	0.0282
5.0	36.00	30.00	53.4	53.4	10.39	0.0184
15.0	30.00	24.00	42.7	42.7	11.37	0.0111
30.0	28.00	22.00	39.2	39.2	11.70	0.0080
60.0	25.50	19.50	34.7	34.7	12.11	0.0057
120.0	23.00	17.00	30.3	30.3	12.52	0.0041
250.0	21.00	15.00	26.7	26.7	12.85	0.0029
1440.0	17.50	11.50	20.5	20.5	13.42	0.0012

Grain Diameter = K*(SQRT(L/T))

ADVANCED TERRA TESTING, INC.

ADVANCED TERRA TESTING

COMBINED MECHANICAL ANALYSIS

Page ____ of ____

CLIENT Parsons PO101
JOB NO. 1305-05 BORING NO. 62-210 SAMPLE NO. _____ DEPTH 0-24.5'
DATE SAMPLED 11-8-93 BY JPH DATE TESTED _____ BY _____ COMPUTER _____
SOIL TYPE (Field Classification) 951110-132

MOISTURE DETERMINATION (Dish No. 72)

Wt. of wet soil & dish	56.80 g
Wt. of dry soil & dish	53.26 g
Wt. of water	
Wt. of dish	3.60 g
Wt. of dry soil	
Moisture Content, %	

TEST CONTENTS

Hydrometer No.	ASTM 152 H
Spec. Grav. of Soil	2.76
Value of "a"	.978
Deflocculant	125 cc. of $(NaPO_3)_6$
Defloc. Correction	5.0
Meniscus Corr'n	-1.0

Temperature, °C	23°		
Temperature Corr'n	.01075		

SIEVE ANALYSIS (Dish No. _____)

Wt. of total sample (wet)	1111.46
Wt. of total sample (dry)	
Wt. of + #10 (wet) 53	98.06 g (T)
Wt. of + #10 (dry)	62.58
Wt. of - #10 (wet) 015	1013.4 g (T)
Wt. of - #10 (dry)	

Tyler Sieve Size	Ind. Wt. Dry Soil Retained g (t)	Cum. Wt. Dry Soil Retained	% Finer Than	% Total Sample
3/8	9.76			
4	20.30			
10	32.52			

AFTER HYDROMETER ANALYSIS (Dish No. ____)

Wt. of dry sample "W" _____
% of total sample _____

Tyler Sieve Size	Pan # 202	Pan wt.	Dry Soil & Pan	Cum. Wt. Dry Soil Retained	% Finer Than	% Total Sample
20	808	1.56	3.29			
40	46	1.56	3.37			
60	07	1.57	3.32			
100	118	1.57	3.67			
200	X1	1.50	4.47			

Test by _____ Date _____
Checked by [illegible] Date 2-16-94

HYDROMETER ANALYSIS (Cylinder No. ____)

Wt. of wet sample (Passing # sieve) 55.310 g (t)
Wt. of dry sample (Passing # sieve) _____ "W" _____ % of total sample _____

Observed Time	Elapsed Time (min)	Temp. (°C)	Hyd. Reading Original	Hyd. Reading Corrected "R"	100Ra W	% Total Sample	Grain Diam. (mm.)	Corr'n Coef L	Corr'n Coef k	Corr'n Coef	Corrected Diameter (mm.)
1154	0	22.1	....	....	....	....	.....	...	...	...	.....
	½		44.5								
1155	1		42.0								
1156	2		39.5								
1159	5		36.0								
1209	15		30.0								
1224	30	22.2	28.0								
1254	60	22.4	25.5								
1354	120		23.0								
1604	250	23.2	21.0								
1154	1440	22.8	17.5								

On reverse side-Notes ☐ Calculation ☐

ATTERBERG LIMITS
ASTM D 4318

ATTERBERG LIMITS TEST DATA

JOB NO. 2059-08
CLIENT/OWNER Parsons PO 101
LOCATION
BORING 62-209 SAMPLE ____ DEPTH 0-24.5'

FIELD CLASSIFICATION
LABORATORY CLASSIFICATION

FIELD DENSITY BY ___/___/___

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL g		
WT OF RINGS g	—	—
WT OF WET SOIL g		
FIELD DENSITY PCF		
DRY DENSITY PCF		

THIS IS AN 1/8-INCH THREAD

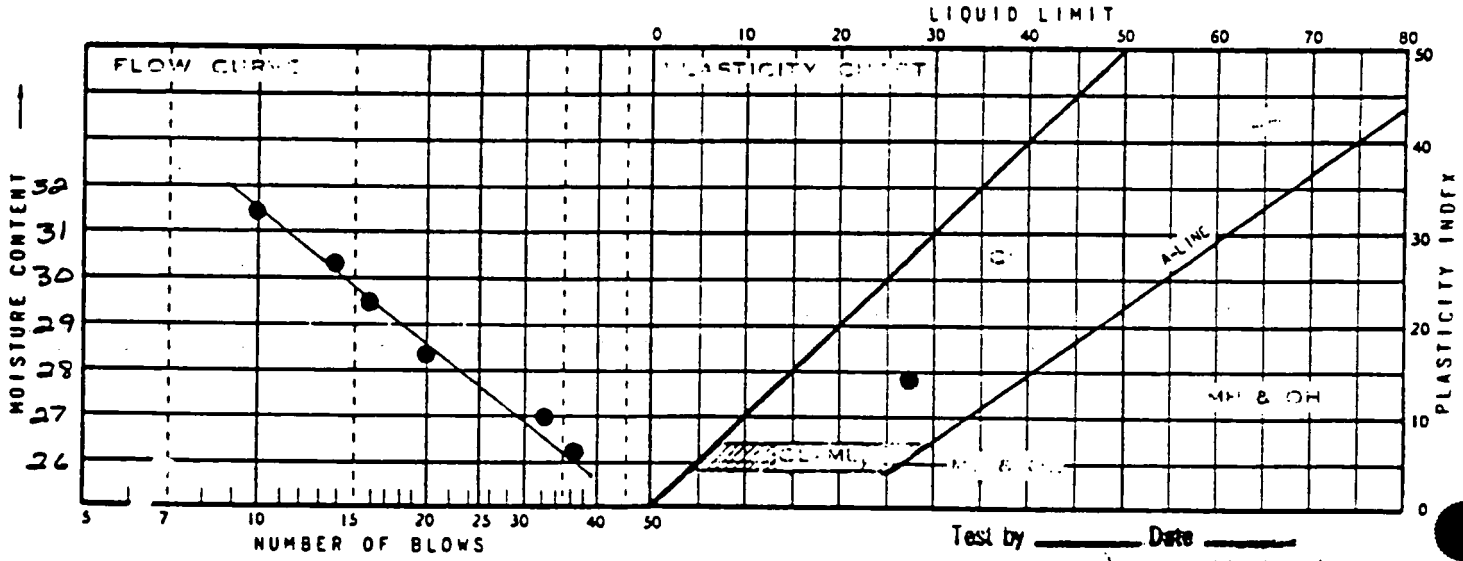
DETERMINATION	1	2
DISH #		
WT OF DISH + WET SOIL g		
WT OF DISH + DRY SOIL g	—	—
WT OF MOISTURE g		
WT OF DISH g	—	—
WT OF DRY SOIL g		
FIELD MOISTURE CONTENT %		

PLASTIC LIMIT BY SRL 12/15/93

DETERMINATION	1	2	3	4	5	6
DISH	200 8	43 C	7 C			
WT OF DISH + WET SOIL g	3.19	3.72	3.47			
WT OF DISH + DRY SOIL g	2.95	3.40	3.19	—	—	—
WT OF MOISTURE g	.24	.32	.28			
WT OF DISH g	1.07	1.06	1.07	—	—	—
WT OF DRY SOIL g	1.88	2.34	2.12			
MOISTURE CONTENT %	12.8	13.7	13.2			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	2023	B44	B43	2061	B13	29C
NUMBER OF BLOWS	37	33	20	16	14	10
WT OF DISH + WET SOIL g	12.11	12.39	11.40	13.08	10.75	13.14
WT OF DISH + DRY SOIL g	9.82	9.98	9.11	10.34	8.50	10.25
WT OF MOISTURE g	2.29	2.41	2.29	2.74	22.50	2.89
WT OF DISH g	1.08	1.07	1.06	1.04	1.09	1.07
WT OF DRY SOIL g	8.74	8.91	8.05	9.30	7.41	9.18
MOISTURE CONTENT %	26.2	27.0	28.4	29.5	30.4	31.5



Test by ____ Date ____
Checked by [illegible] Date 12-16-93

SUMMARY

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		27.7	13.2	14.5	CL	

ADVANCED TERRA TESTING INC

ATTERBERG LIMITS TEST DATA

FIELD CLASSIFICATION _____

LABORATORY CLASSIFICATION _____

JOB NO. 3CE9.08
CLIENT/OWNER Parsons
LOCATION PO 101
BORING GA-21D SAMPLE 931110-132 DEPTH 6'-24.5'

6647

FIELD DENSITY BY ___/___/___

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL g		
WT OF RINGS g	—	—
WT OF WET SOIL g		
FIELD DENSITY PCF		
DRY DENSITY PCF		

THIS IS AN 1/8-INCH THREAD

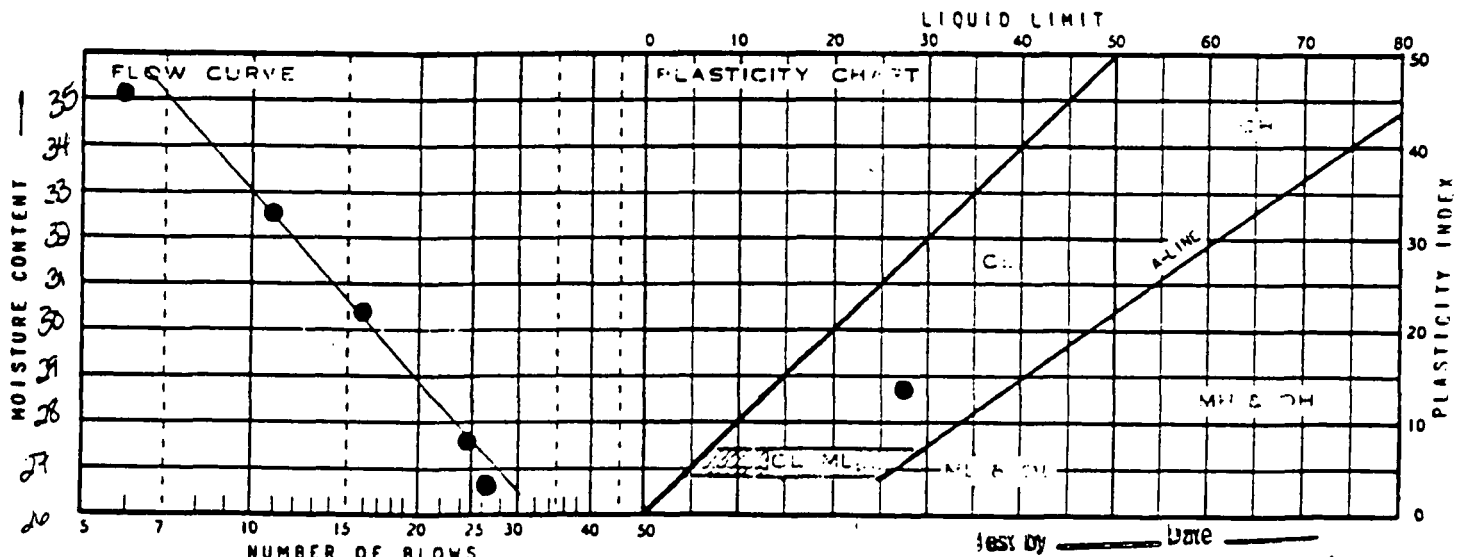
DETERMINATION	1	2
DISH#		
WT OF DISH + WET SOIL g		
WT OF DISH + DRY SOIL g	—	—
WT OF MOISTURE g		
WT OF DISH g	—	—
WT OF DRY SOIL g		
FIELD MOISTURE CONTENT %		

PLASTIC LIMIT BY DMW 1/24/94

DETERMINATION	1	2	3	4	5	6
DISH	B5	4	2017			
WT OF DISH + WET SOIL g	4.27	5.38	4.72			
WT OF DISH + DRY SOIL g	3.88	4.85	4.26	—	—	—
WT OF MOISTURE g	.39	.53	.46			
WT OF DISH g	1.06	1.07	1.07	—	—	—
WT OF DRY SOIL g	2.82	3.78	3.19			
MOISTURE CONTENT %	13.8	14.0	14.4			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	15C	2051	B17	2007	2024	
NUMBER OF BLOWS	27	25	16	11	6	
WT OF DISH + WET SOIL g	10.68	12.52	14.54	15.29	12.60	
WT OF DISH + DRY SOIL g	8.66	10.04	11.41	11.80	9.61	—
WT OF MOISTURE g	2.02	2.48	3.13	3.49	2.99	
WT OF DISH g	1.08	1.06	1.08	1.09	1.08	—
WT OF DRY SOIL g	7.58	8.98	10.33	10.71	8.53	
MOISTURE CONTENT %	26.6	27.6	30.3	32.6	35.1	



Test by _____ Date _____
Checked by SC Date 1-25-94

SUMMARY

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		27.6	14.1	13.5	CL	

000301

ADVANCED TERRA TESTING INC

PROCTOR COMPACTION - STANDARD
ASTM D 698

000202

Sample No. G2-209 Depth 0 - 25 Elevation _____

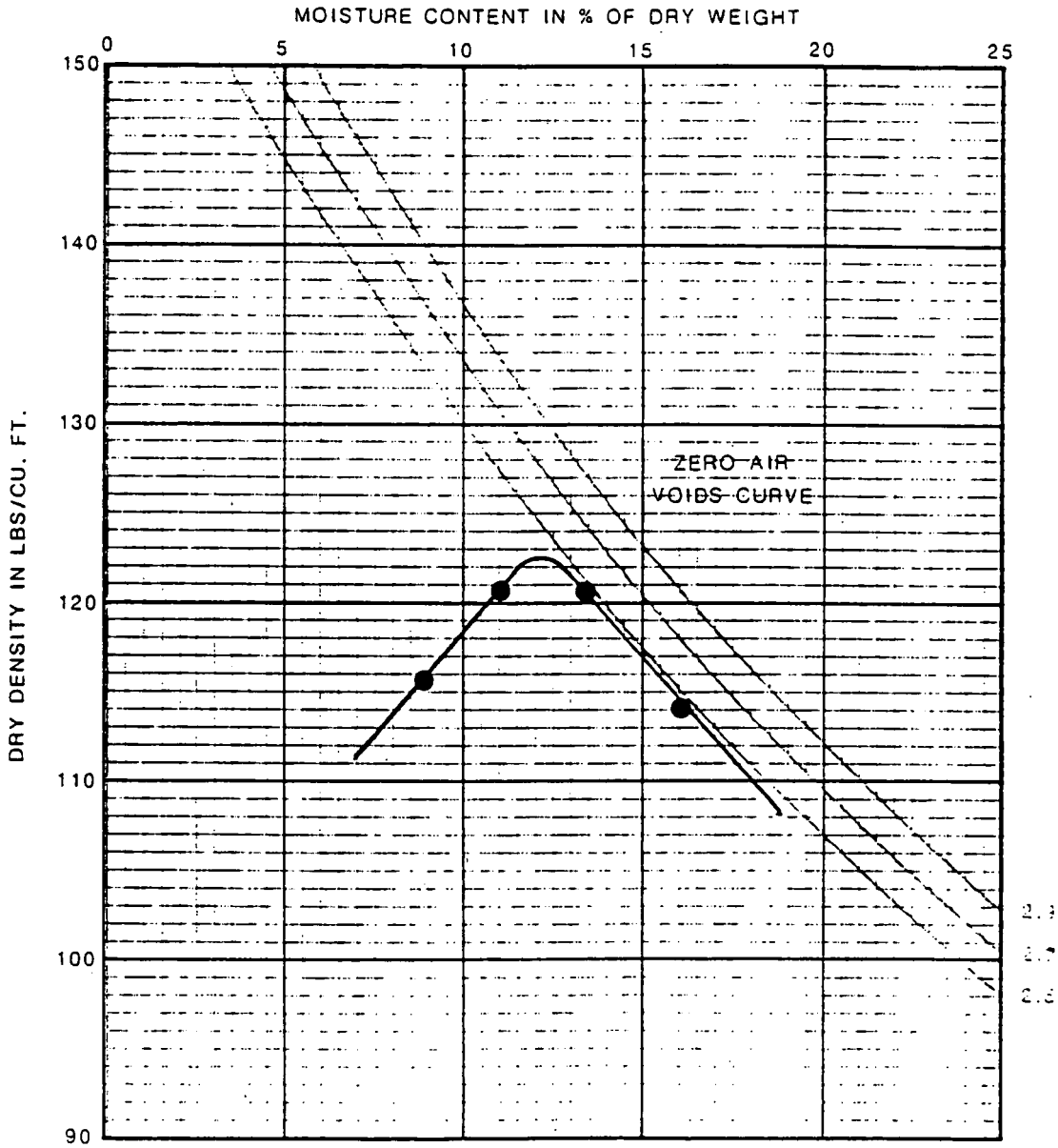
Soil Brown and Gray Sandy Lean Clay (CL)

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.3%

Maximum Dry Density 122.3 pcf

Method of Compaction ASTM D 698, Method A



COMPACTION TEST DATA

ADVANCED TERRA TESTING

File

COMPACTION TEST DATA

PAGE NO.____ OF____

ADVANCED TERRA TESTING, INC.

Job No. 2059-08 Client Parsons - P0101 Location Proposed On-Site Disposal

Sampled 11/9/93 By JPH Tested 12-11-93 By DLL Checked 12-13-93 By SR

SAMPLE DESCRIPTION	Soil ____ Sample No. G2-209					
	Specific Gravity ____ Depth or Elevation 0-24.5'					
	% Passing 3/4" ____ % Passing ~~1/4"~~ #4 ~95%					
TEST SPECIFICATIONS ASTM D 698 METHOD A	Compaction method (F, G)	☐ Proctor	☒ Standard AASHO	☐ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	50	100	150	200	
MOISTURE DETERMINATION	Dish number	26A	Z3	4E	29A	7E
	Wt. of soil & dish g	269.99	410.83	237.41	155.96	
	Dry wt. soil & dish g	243.95	370.77	210.09	163.78	
	Net loss of moisture (B) g	20.98	40.06	27.32	25.18	
	Wt. of dish only g	7.20	8.41	8.04	7.32	8.13
	Net wt. of dry soil (A) g	236.75	362.36	202.05	156.5	
	Moisture, % of dry wt. (C)	8.9	11.1	13.5	16.1	
DENSITY DETERMINATION	Wt. of soil & mold #	14.57	14.83	14.93	14.78	
	Wt. of mold only #	10.37	10.37	10.37	10.37	10.37
	Net wt. of wet soil (D) #	4.20	4.46	4.56	4.41	
	Net wt. of dry soil (E) #	3.86	4.02	4.02	3.80	
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	115.7	120.5	120.5	114.0	
PENETROMETER	Needle Size					
	Resistance Reading					
	Resistance, lbs/sq in					

Then add piston and ...

Sample No. G2-210 Depth 0 - 25 Elevation _____

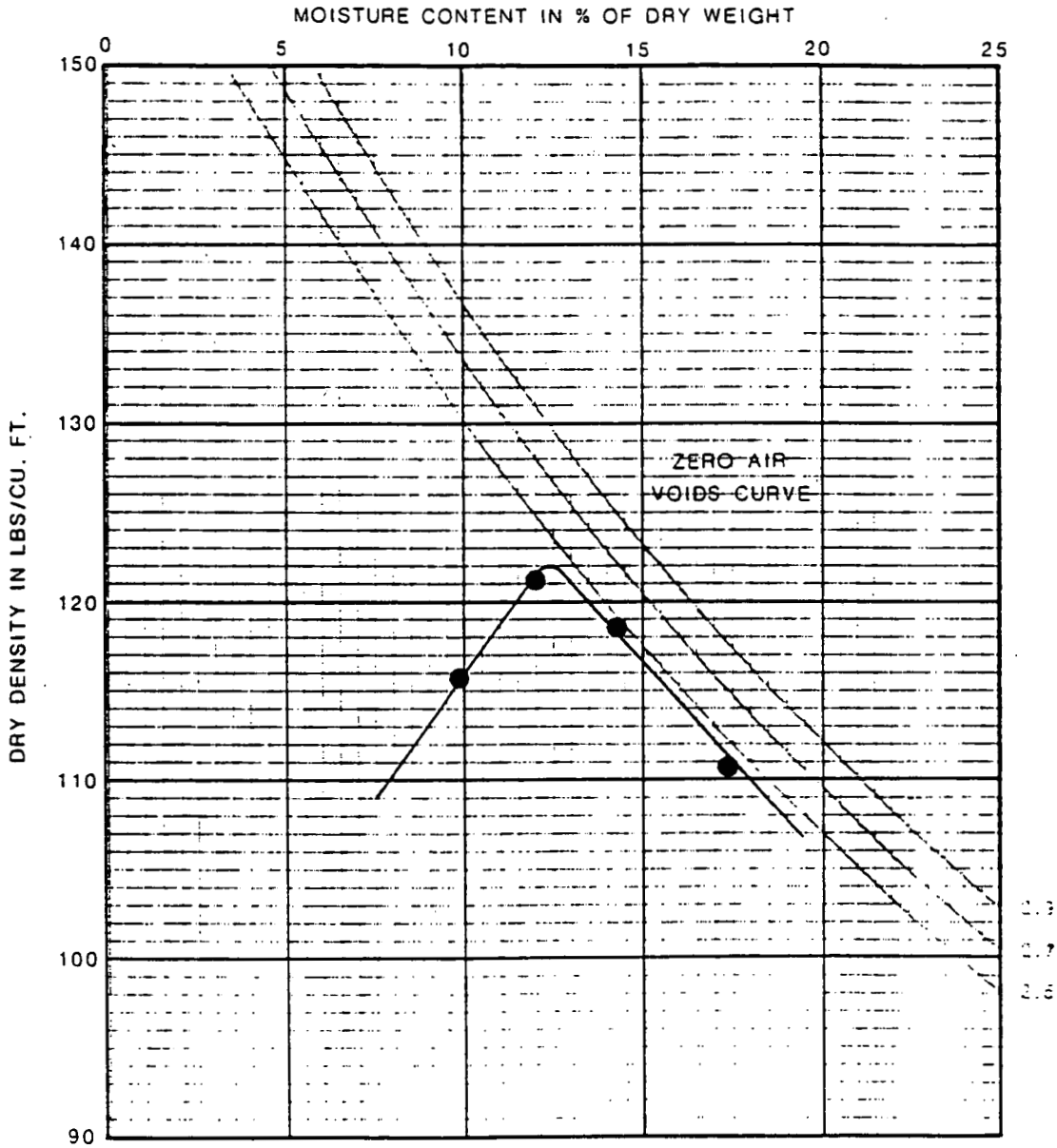
Soil Brown and Gray Lean Clay with Sand (CL)

Location Proposed On-Site Disposal Cell (PO-101)

Optimum Moisture Content 12.4%

Maximum Dry Density 122.3 pcf

Method of Compaction ASTM D 698, Method A



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COMPACTION TEST DATA

ADVANCED TERRA TESTING

COMPACTION . TEST DATA

PAGE NO.____ OF____

ADVANCED TERRA TESTING

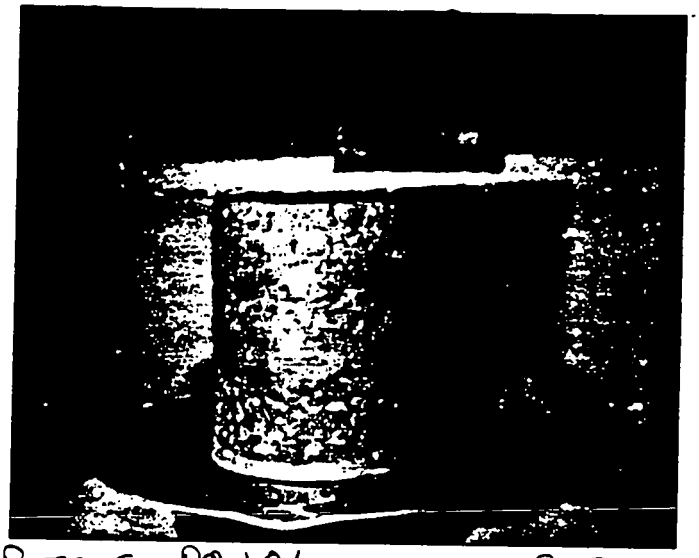
Job No. 2059-03 Client Parsons PO101 Location Proposed On-Site Disposal C

Sampled 11/5/93 By TPH Tested 10-11-93 By [illegible] Checked 10-13-93 By JE

SAMPLE DESCRIPTION	Soil ____ Sample No. 62-210					
	Specific Gravity ____ Depth or Elevation 0-24.5'					
	% Passing 3/4" ____ % Passing ~~1/4~~ #4" ~92.0%					
TEST SPECIFICATIONS ASTM D 698 METHOD A	Compaction method (F, G)	☐ Proctor	☒ Standard AASHO	☐ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	50	100	150	200	
MOISTURE DETERMINATION	Dish number	12A	6A	7A	018	
	Wt. of soil & dish g	374.11	356.26	315.90	227.46	
	Dry wt. soil & dish g	341.31	319.00	277.31	195.35	
	Net loss of moisture (B) g	32.80	37.26	38.59	32.11	
	Wt. of dish only g	8.22	5.17	8.20	9.65	
	Net wt. of dry soil (A) g	333.09	310.83	269.11	185.70	
	Moisture, % of dry wt. (C)	9.8	12.0	14.3	17.3	
DENSITY DETERMINATION	Wt. of soil & mold #	14.61	14.89	14.89	14.69	
	Wt. of mold only #	10.37	10.37	10.37	10.37	
	Net wt. of wet soil (D) #	4.24	4.52	4.52	4.32	
	Net wt. of dry soil (E) #	3.86	4.04	3.95	3.68	
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	115.8	121.1	115.6	110.5	
PENETROMETER	Needle Size					
	Resistance Reading					
	Resistance, lbs/sq in					

000906

TRIAXIAL, BACK-PRESSURE PERMEABILITY, TX/Pbp
ASTM D 5084



Parsons PO 101 2059-08
G2-209 @ 0-24'
TX/PDP $\bar{\sigma}_3$ = 1440 PSI

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons	JOB NO.	2059-08
BORING NO.	G2-209	SAMPLED	11/09/93
DEPTH	0-24'	TEST STARTED	12/18/93 DCW
SAMPLE NO.	931110-133	TEST FINISHED	12/31/93
SOIL DESCR.	PO 101	SETUP NO.	7S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	1440	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	467.8	488.8
Wt. Wet Soil & Pan	(g)	475.9	496.9
Wt. Dry Soil & Pan	(g)	426.8	426.8
Wt. Lost Moisture	(g)	49.1	70.1
Wt. of Pan Only	(g)	8.1	8.1
Wt. of Dry Soil	(g)	418.7	418.7
Moisture Content %		11.7	16.7
Wet Density PCF		130.0	144.0
Dry Density PCF		116.3	123.4

Init. Diameter	(in)	2.399	(cm)	6.093
Init. Area	(sq in)	4.520	(sq cm)	29.164
Init. Height	(in)	3.033	(cm)	7.704
Vol. Bef. Consol.	(cu ft)	0.00793		
Vol. After Consol.	(cu ft)	0.00748		
Porosity %		33.09		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
756.0	45360	50.0	11.1	36.1	2.2E-06
694.0	41640	49.5	12.3	35.6	2.3E-06
519.0	31140	49.9	19.7	31.4	2.4E-06
847.0	50820	49.7	9.5	37.0	2.1E-06
493.0	29580	49.8	22.6	29.9	2.3E-06
934.0	56040	49.9	5.9	38.9	2.1E-06
592.0	35520	50.0	19.4	31.6	2.1E-06
885.0	53100	49.9	10.2	36.6	2.0E-06
530.0	31800	49.9	27.3	27.4	1.7E-06
824.0	49440	50.0	20.6	30.9	1.5E-06
670.0	40200	49.9	25.2	28.5	1.5E-06
847.0	50820	49.5	21.1	30.9	1.4E-06
1348.0	80880	49.9	7.7	37.9	1.4E-06

ADVANCED TERRA TESTING, INC.

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons	JOB NO.	2059-08
BORING NO.	G2-209	SAMPLED	11/09/93
DEPTH	0-24'	TEST STARTED	12/18/93 DCW
SAMPLE NO.	931110-133	TEST FINISHED	12/31/93
SOIL DESCR.	PO 101	SETUP NO.	7S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	1440	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	2.0	12.2				
50.0	48.0	12.7	13.7	38.9	47.5	8.6	0.86
60.0	58.0	14.0	14.9	49.1	57.9	8.8	0.88
70.0	68.0	14.9	15.7	58.5	67.7	9.2	0.92
80.0		16.1	16.3	68.8	78.3	9.5	0.95

CONSOLIDATION DATA

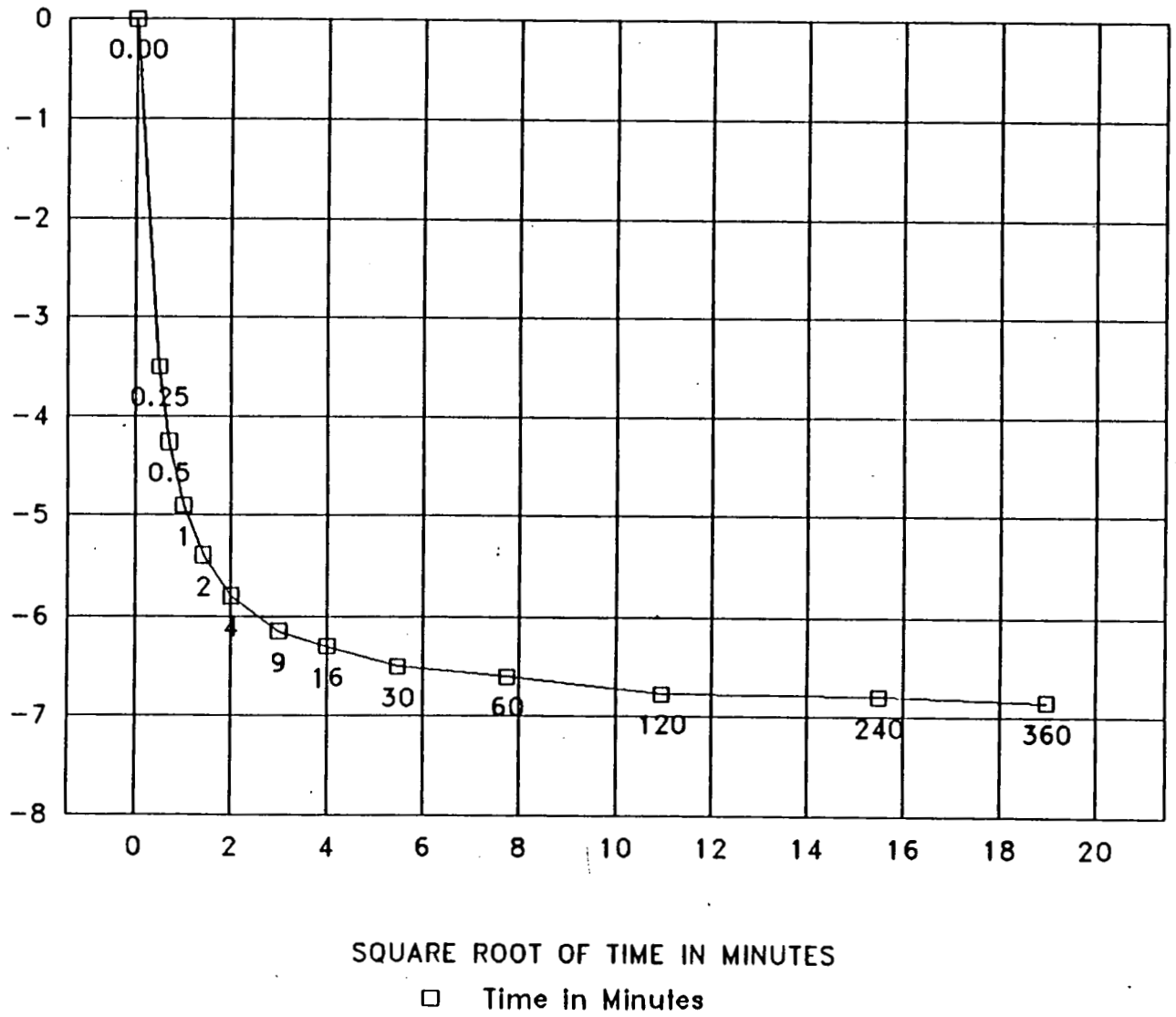
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	0.00	0.00
0.25	0.50	3.50	-3.50
0.5	0.71	4.25	-4.25
1	1.00	4.90	-4.90
2	1.41	5.40	-5.40
4	2.00	5.80	-5.80
9	3.00	6.15	-6.15
16	4.00	6.30	-6.30
30	5.48	6.50	-6.50
60	7.75	6.60	-6.60
120	10.95	6.78	-6.78
240	15.49	6.80	-6.80
360	18.97	6.85	-6.85

Initial Height	(in)	3.033	Init. Vol.	(CC)	224.70
Height Change	(in)	0.042	Vol. Change	(CC)	22.10
Ht. After Cons.	(in)	2.991	Cell Exp.	(CC)	9.30
Initial Area	(sq in)	4.520	Net Change	(CC)	12.80
Area After Cons.	(sq in)	4.322	Cons. Vol.	(CC)	211.90

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

G2-209 @ 0 - 24' 1440 psf Conf.



Parsons PO 101 2059-08
G2-210 @ 0-24.5'
TX/Pbp $\bar{\sigma}_3$ = 1440 PSF

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons	JOB NO.	2059-08
BORING NO.	G2-210	SAMPLED	
DEPTH	0 - 24.5'	TEST STARTED	12/19/93 DCW
SAMPLE NO.	931110-132	TEST FINISHED	12/30/93
SOIL DESCR.	PO 101	SETUP NO.	13S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	1440	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	468.4	490.4
Wt. Wet Soil & Pan	(g)	476.6	498.6
Wt. Dry Soil & Pan	(g)	427.2	427.2
Wt. Lost Moisture	(g)	49.4	71.4
Wt. of Pan Only	(g)	8.1	8.1
Wt. of Dry Soil	(g)	419.1	419.1
Moisture Content %		11.8	17.0
Wet Density PCF		130.2	138.5
Dry Density PCF		116.5	118.3

Init. Diameter	(in)	2.399	(cm)	6.093
Init. Area	(sq in)	4.520	(sq cm)	29.164
Init. Height	(in)	3.031	(cm)	7.699
Vol. Bef. Consol.	(cu ft)	0.00793		
Vol. After Consol.	(cu ft)	0.00781		
Porosity %		32.28		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
395.0	23700	49.9	28.5	26.7	2.1E-06
880.0	52800	49.9	5.7	39.0	2.2E-06
542.0	32520	49.9	18.6	32.0	2.3E-06
814.0	48840	49.9	8.3	37.6	2.2E-06
680.0	40800	49.9	15.1	33.9	2.1E-06
840.0	50400	49.7	8.7	37.5	2.1E-06

ADVANCED TERRA TESTING, INC.

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons	JOB NO.	2059-08
BORING NO.	G2-210	SAMPLED	
DEPTH	0 - 24.5'	TEST STARTED	12/19/93 DCW
SAMPLE NO.	931110-132	TEST FINISHED	12/30/93
SOIL DESCR.	PO 101	SETUP NO.	13S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	1440	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	0.9	6.1				
50.0	48.0	6.1	6.9	39.2	47.3	8.1	0.81
60.0	58.0	6.8	7.3	49.3	57.9	8.6	0.86
70.0	68.0	7.5	8.1	59.6	68.5	8.9	0.89
80.0	78.0	8.1	8.7	70.4	79.5	9.1	0.91
90.0		8.9	8.9	80.2	89.8	9.6	0.96

CONSOLIDATION DATA

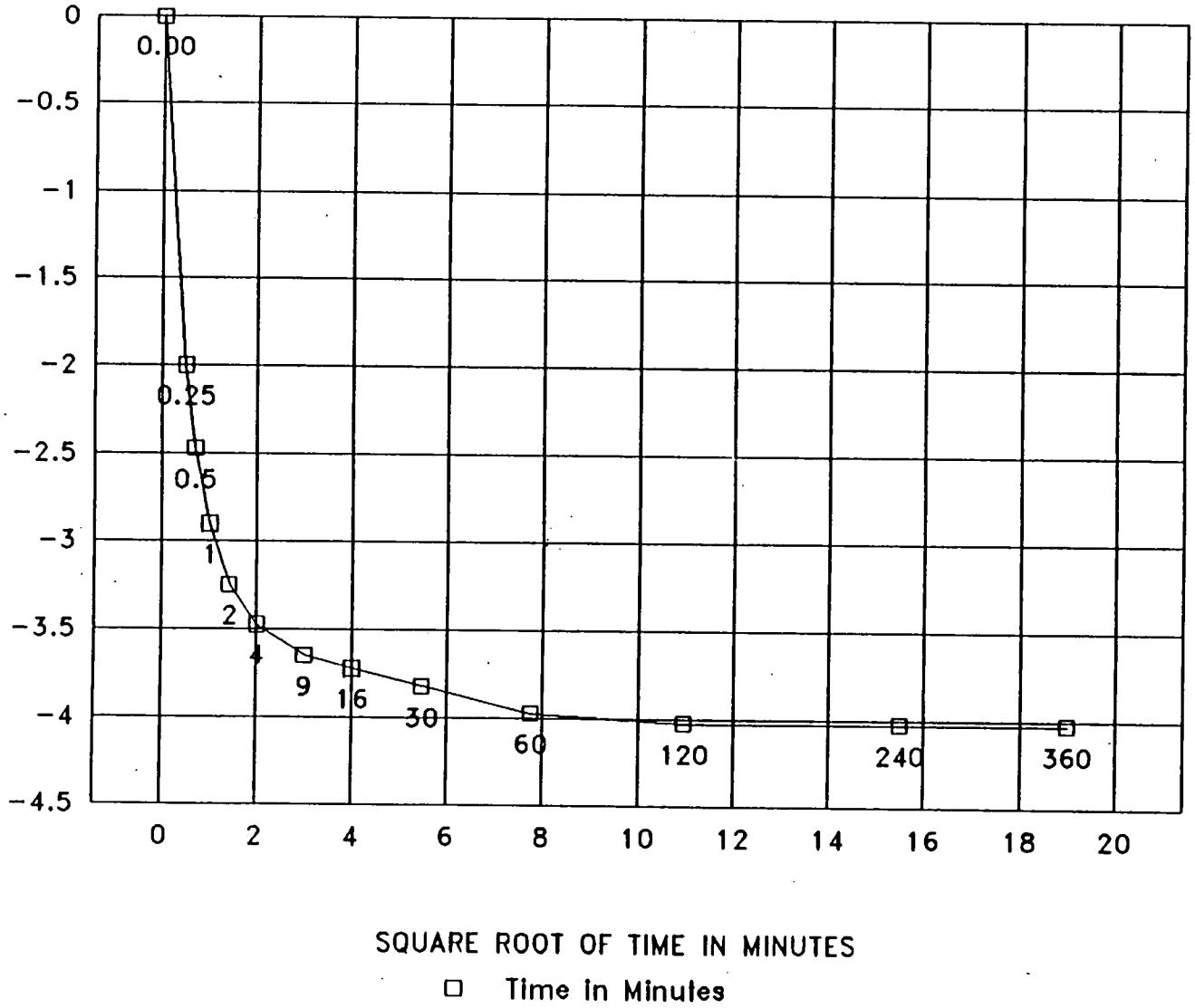
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	10.30	0.00
0.25	0.50	12.30	-2.00
0.5	0.71	12.78	-2.47
1	1.00	13.20	-2.90
2	1.41	13.55	-3.25
4	2.00	13.78	-3.47
9	3.00	13.95	-3.65
16	4.00	14.03	-3.72
30	5.48	14.13	-3.82
60	7.75	14.28	-3.97
120	10.95	14.33	-4.02
240	15.49	14.33	-4.02
360	18.97	14.33	-4.02

Initial Height	(in)	3.031	Init. Vol.	(CC)	224.55
Height Change	(in)	0.021	Vol. Change	(CC)	12.95
Ht. After Cons.	(in)	3.010	Cell Exp.	(CC)	9.50
Initial Area	(sq in)	4.520	Net Change	(CC)	3.45
Area After Cons.	(sq in)	4.482	Cons. Vol.	(CC)	221.10

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

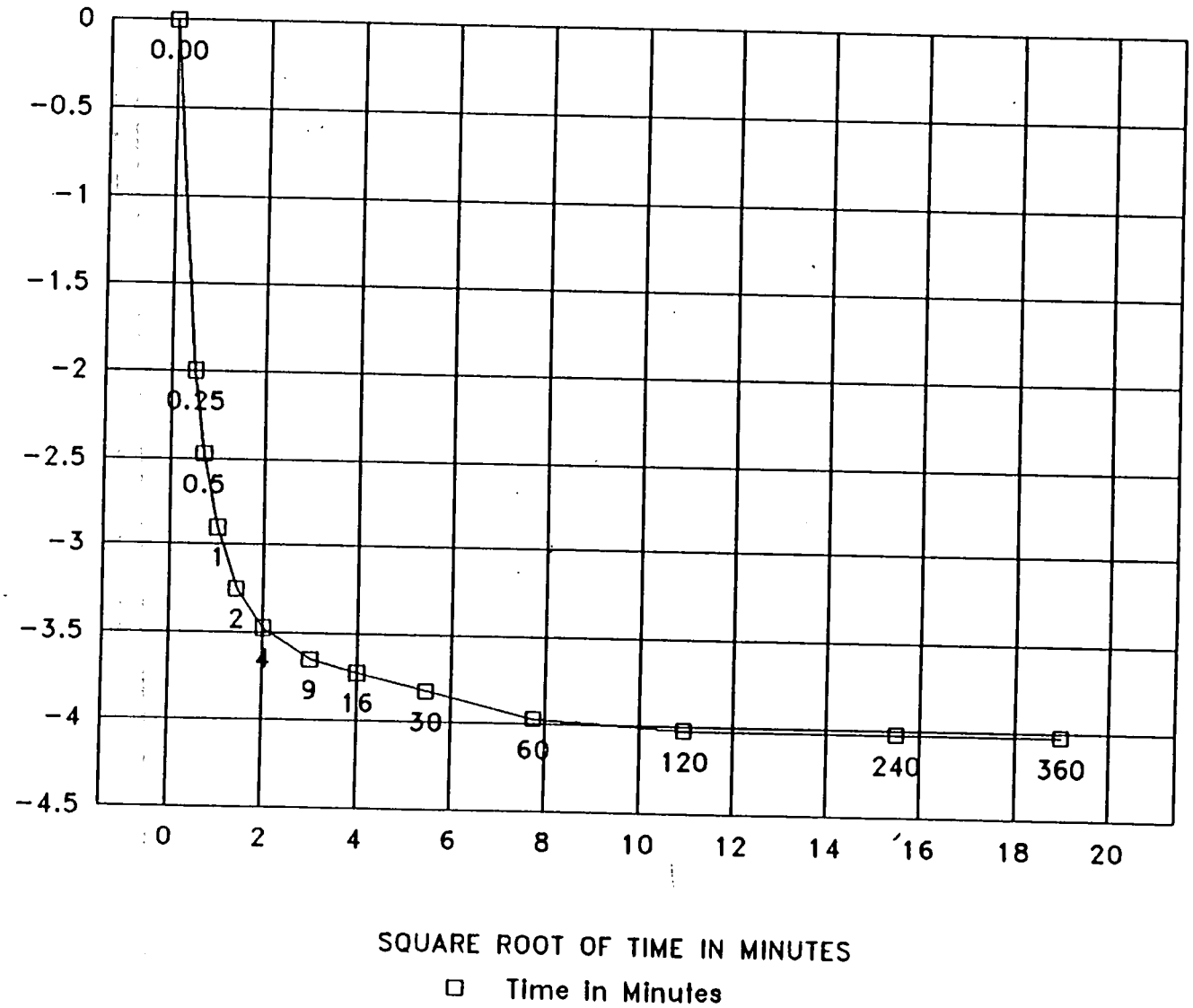
G2-210 @ 0-24.5' 1440 psf Conf.



E-3-3-256

CONSOLIDATION DATA

G2-210 @ 0-24.5' 1440 psf Conf.



APPENDIX B

LIMITS OF ACCEPTABLE DRY DENSITIES FOR PERMEABILITY TESTING FOR SAMPLES G2-209 (MODIFIED PROCTOR) AND G2-210 (STANDARD PROCTOR)

Sample No. G--210 Depth 0 - 25 Elevation _____

Soil Brown and Gray Lean Clay with Sand (CL)

Location Proposed On-Site Disposal Cell

Optimum Moisture Content 12.4%

Maximum Dry Density 122.3 PCF

Method of Compaction ASTM D698, Method A

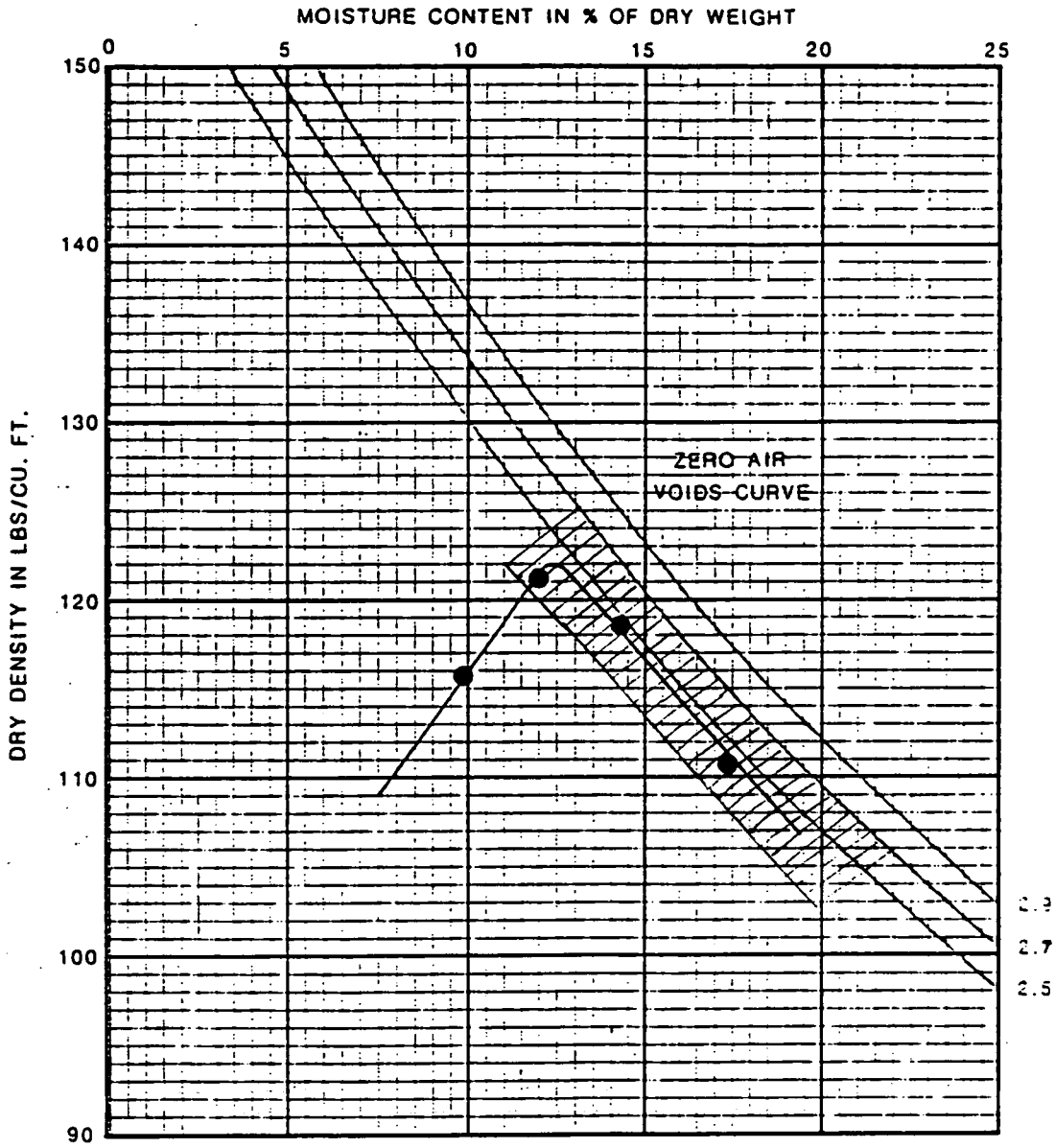


Figure B-1: G2-210 Dry Density Band

COMPACTION TEST DATA

= ZONE OF ACCEPTABLE SPECIMEN DRY DENSITY FOR PERMEABILITY TESTING

ADVANCED TERRA TESTING

File _____

K. Ernst 3/29/94

Sample No. G2-209 Depth 0-24.5' Elevation _____

Soil Bulk

Location Onsite Waste Disposal Cell

Optimum Moisture Content ~ 10.3 %

Maximum Dry Density ~ 133.8 pcf

Method of Compaction ASTM D 1557 A

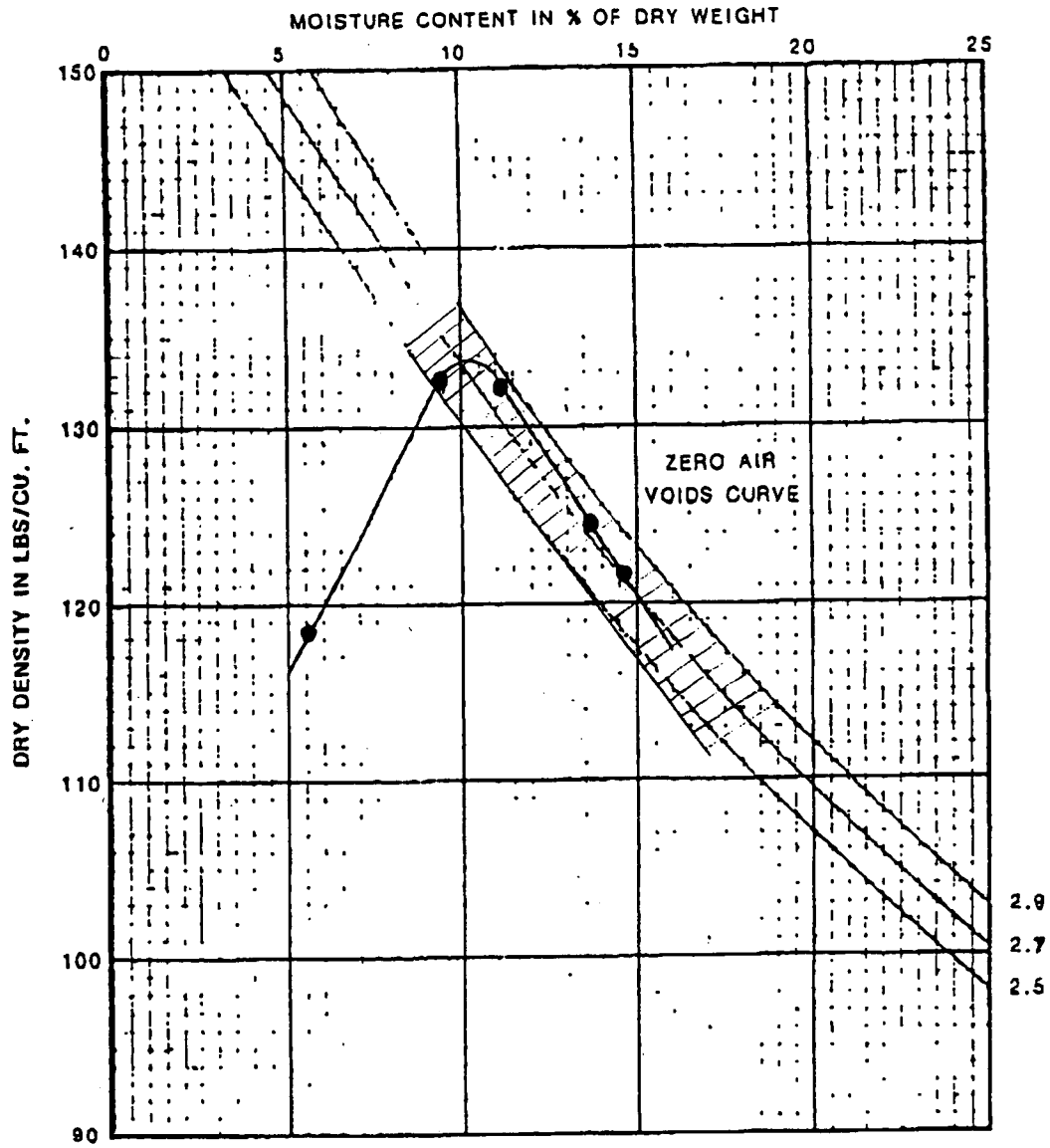


Figure B-2: G2-209 Modified Proctor Dry Density Band

COMPACTION TEST DATA

= ZONE OF ACCEPTABLE SPECIMEN DRY DENSITY FOR PERMEABILITY TESTING

ADVANCED TERRA TESTING

File PARSONS PO 101 2059-10

Ernst 5-11-94

APPENDIX C

TEST PLAN FOR SUPPLEMENTAL GEOTECHNICAL LABORATORY TESTING

PO 101 On-Site Disposal Cell
Supplemental Geotechnical Laboratory Testing Program
Revision 0
3/29/94

Prepared by PARSONS ERA Project

The supplemental geotechnical laboratory testing described herein consists of laboratory permeability testing on recompacted samples prepared from soil samples (auger cuttings) collected at Borings G2-209 and G2-210 in November 1993 during implementation of the *Solid Waste Landfill and On-site Waste Disposal Cell Geotechnical Sampling and Testing Plan* (PARSONS 1993). The samples are currently in storage at Advanced Terra Testing, Inc., Lakewood, Colorado. The purpose of the additional testing is to provide pre-design data regarding the permeability of recompacted samples, compacted wet of optimum moisture content (Phase 1); and, compacted with higher compactive energies (Phase 2).

1. Testing Plan for Sample G2-210 (PHASE 1 testing)

Attachment A, from *On-site Waste Disposal Cell Soil Investigation Data Report* (SAIC 1994) contains compaction test data for a standard proctor test (ASTM D 698) performed on Sample G2-210 (0-25 feet). Optimum moisture content was 12.4% ; maximum dry density was 122.3 pcf.

Test G2-210-#1:

1) Perform Atterberg limits test (ASTM D 4318) on representative soil material from Sample G2-210. Compare results with those of previous results for Sample G2-210 in SAIC 1994.

2) Compact soil from Sample G2-210 using standard proctor method at a moisture content of 12.4% (-0.5, +1.5%).

3) Verify that dry density falls within the band shown on Figure 1 prior to testing.

4) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen per ASTM D 5084.

Test G2-210-#2:

1) Compact soil from Sample G2-210 using standard proctor method at a moisture content of 14.4% ($\pm$1.0%).

2) Verify that dry density falls within the band shown on Figure 1 prior to testing.

3) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen per ASTM D 5084.

Test G2-210-#3:

1) Compact soil from Sample G2-210 using standard proctor method at a moisture content of 17.4% (±1.0%).

2) Verify that dry density falls within the band shown on Figure 1 prior to testing.

3) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen per ASTM D 5084.

4) Transmit test results for Tests #1, 2 and #3 above to PARSONS for review. Do not proceed with testing plan for Sample G2-209 without PARSONS authorization.

000922

2. Testing Plan for Sample G2-209 (PHASE 2 testing)

Attachment B, from *On-site Waste Disposal Cell Soil Investigation Data Report* (SAIC 1994) contains compaction test data for a standard proctor test (ASTM D 698) performed on sample G2-209 (0-25 feet). Optimum moisture content was 12.3% ; maximum dry density was 122.3 pcf. Based on the results of Sample G2-210 testing of PHASE 1, either an additional permeability test (G2-209-#1) for confirmation will be conducted, or a modified proctor (G2-209-#2) and a series of permeability tests (G2-209-#3 through #5) will be performed.

Test G2-209-#1:

1) Perform Atterberg limits test (ASTM D 4318) on representative soil material from Sample G2-209. Compare results with those of previous results for Sample G2-209 in SAIC 1994.

2) Compact soil from Sample G2-209 using standard proctor method at a moisture content to be provided by PARSONS.

3) Verify that dry density falls within the band shown on Figure 2.

4) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen per ASTM D 5084.

Test G2-209-#2:

1) Perform Atterberg limits test (ASTM D 4318) on representative soil material from Sample G2-209. Compare results with those of previous results for Sample G2-209 in SAIC 1994.

2) Perform a modified proctor test (ASTM D 1557) on soil from Sample G2-209.

3) Transmit moisture-density data from the modified proctor test to PARSONS for review. Do not proceed with tests #3, #4 and #5 listed below without PARSONS authorization.

Test G2-209-#3:

1) Compact soil from Sample G2-209 using modified proctor method at optimum moisture content (-0.5, +1.5%).

2) Verify that dry density falls within the band shown on Figure to be provided by PARSONS prior to testing.

3) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen

per ASTM D 5084.

Test G2-209-#4:

1) Compact soil from Sample G2-209 using modified proctor method at a moisture content 2%(±1.0%) wet of optimum.

2) Verify that dry density falls within the band shown on Figure to be provided by PARSONS prior to testing.

3) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen per ASTM D 5084.

Test G2-209-#5:

1) Compact soil from Sample G2-209 using modified proctor method at a moisture content 5%(±1.0%) wet of optimum.

2) Verify that dry density falls within the band shown on Figure to be provided by PARSONS prior to testing.

3) Perform a Triaxial, Back-Pressure Permeability Test on a compacted soil test specimen per ASTM D 5084.

000924

3. References:

Annual Book of ASTM Standards, *Vol. 4.08 Soil and Rock, Building Stones, Geotextiles, 1993 Edition.* American Society for Testing and Materials: Philadelphia, Pennsylvania.

(PARSONS 1993) PARSONS ERA Project, October 1993. *Solid Waste Landfill and On-Site Disposal Cell Geotechnical Sampling and Testing Plan*, Revision 0. Fairfield, Ohio: PARSONS.

(SAIC 1994) Science Applications International Corporation, March 3, 1994. *On-Site Disposal Cell Soil Investigation Data Report.* Volumes 1 and 2. Golden, Colorado: SAIC.

Sample No. G2-209 Depth 0 - 25 Elevation _____

Soil Brown and Gray Sandy Lean Clay (CL)

Location On-Site Disposal Cell

Optimum Moisture Content 12.3%

Maximum Dry Density 122.3 PCF

Method of Compaction ASTM D698, Method A

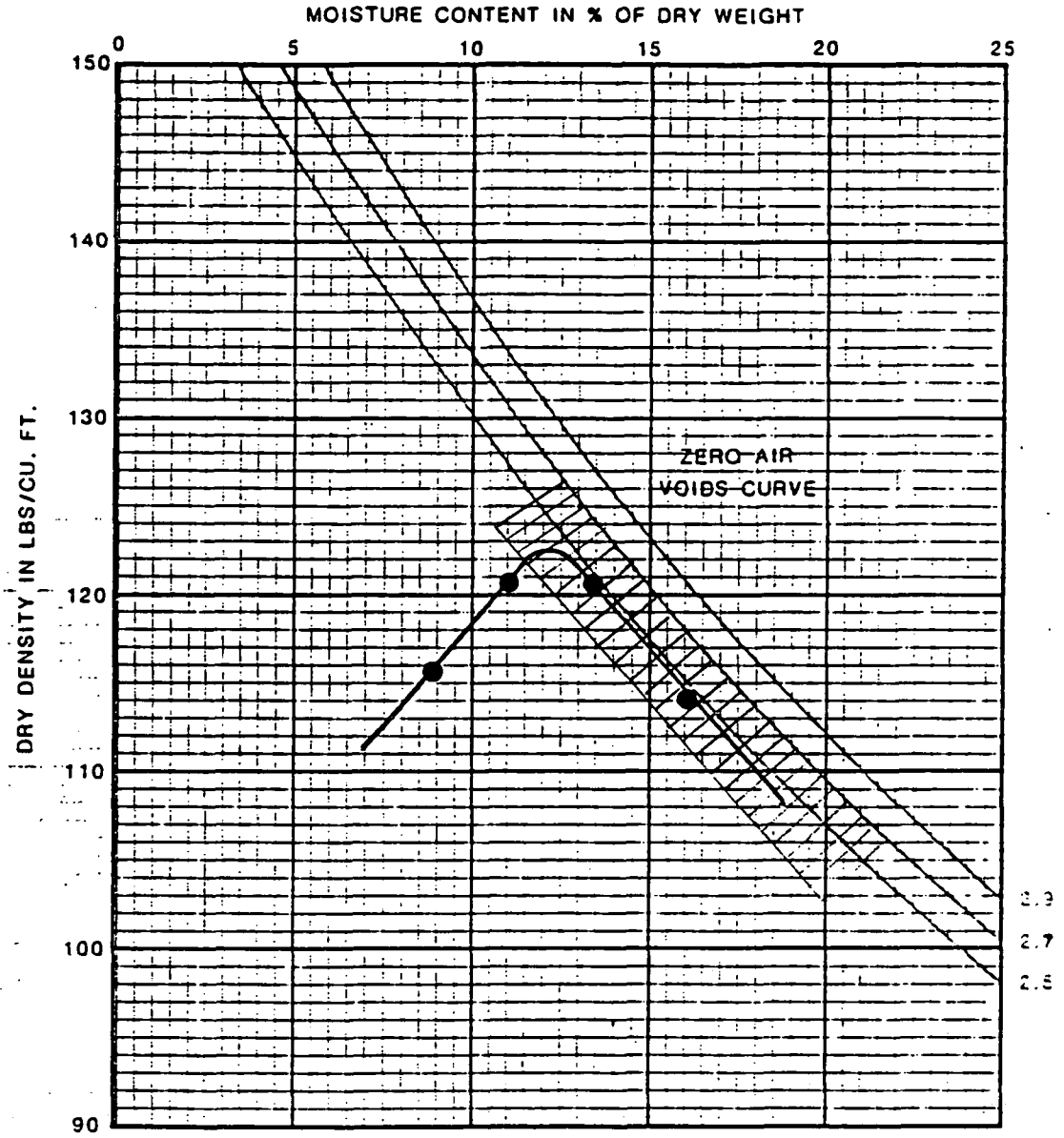


Figure 2: G2-209 Dry Density Band

File _____

COMPACTION TEST DATA

= ZONE OF ACCEPTABLE SPECIMEN DRY DENSITY FOR PERMEABILITY TESTING

ADVANCED TERRA TESTING

Sample No. G2-210 Depth 0 - 25 Elevation _____

Soil Brown and Gray Lean Clay with Sand (CL)

Location Proposed On-Site Disposal Cell

Optimum Moisture Content 12.4%

Maximum Dry Density 122.3 PCF

Method of Compaction ASTM D698, Method A

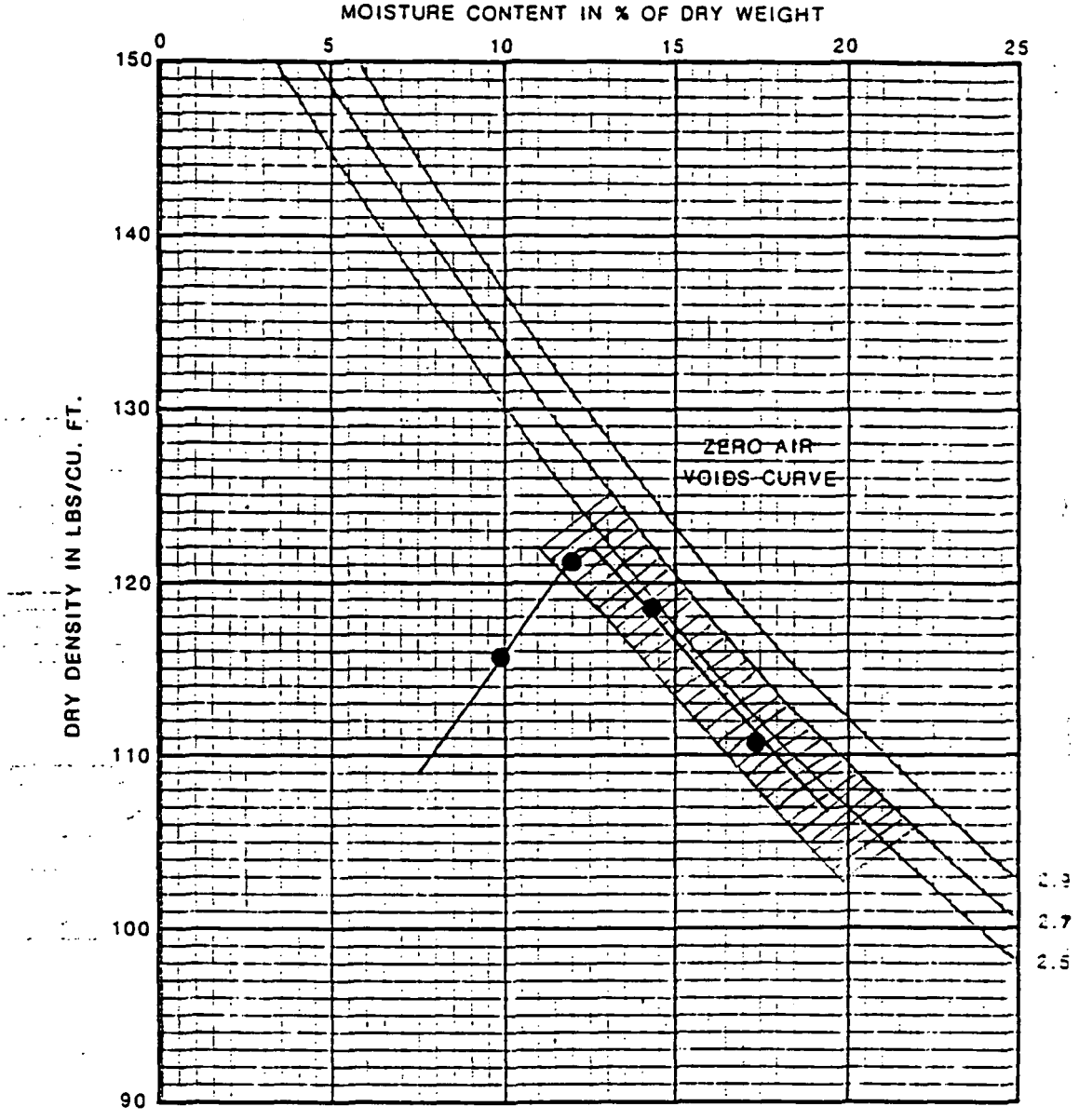


Figure 1: G2-210 Dry Density Band

COMPACTION TEST DATA

= ZONE OF ACCEPTABLE SPECIMEN DRY DENSITY FOR PERMEABILITY TESTING

ADVANCED TERRA TESTING

K. Einst 3/29/94

File

COMPACTION TEST DATA

PAGE NO.____ OF____

ADVANCED TERRA TESTING

Job No. 2059-08 Client Parsons PO101 Location Proposed On-Site Disposal

Sampled 11/8/93 By JPH Tested 12-11-93 By Dw Checked 12-13-93 By JE

SAMPLE DESCRIPTION	Soil ____ Sample No. 62-210					
	Specific Gravity ____ Depth or Elevation 0-24.5'					
	% Passing 3/4" ____ % Passing ~~1/4~~ #4" ~92.0%					
TEST SPECIFICATIONS ASTM D 698 METHOD A	Compaction method (F, G)	☐ Proctor	☒ Standard AASHO	☐ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	50	100	150	200	
MOISTURE DETERMINATION	Dish number	12A	6A	7A	018	
	Wt. of soil & dish g	374.11	356.26	315.90	227.46	
	Dry wt. soil & dish g	341.31	319.00	277.31	195.35	
	Net loss of moisture (B) g	32.80	37.26	38.59	32.11	
	Wt. of dish only g	8.22	5.17	8.20	9.65	
	Net wt. of dry soil (A) g	333.09	310.83	269.11	185.70	
	Moisture, % of dry wt. (C)	9.8	12.0	14.3	17.3	
DENSITY DETERMINATION	Wt. of soil & mold #	14.61	14.89	14.89	14.69	
	Wt. of mold only #	10.37	10.37	10.37	10.37	
	Net wt. of wet soil (D) #	4.24	4.52	4.52	4.32	
	Net wt. of dry soil (E) #	3.86	4.04	3.95	3.68	
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	115.8	121.1	115.6	110.5	
PENETROMETER	Needle Size					
	Resistance Reading					
	Resistance, lbs/sq in					

000328

Sample No. 32-210 Depth 0-24.5' Elevation _____

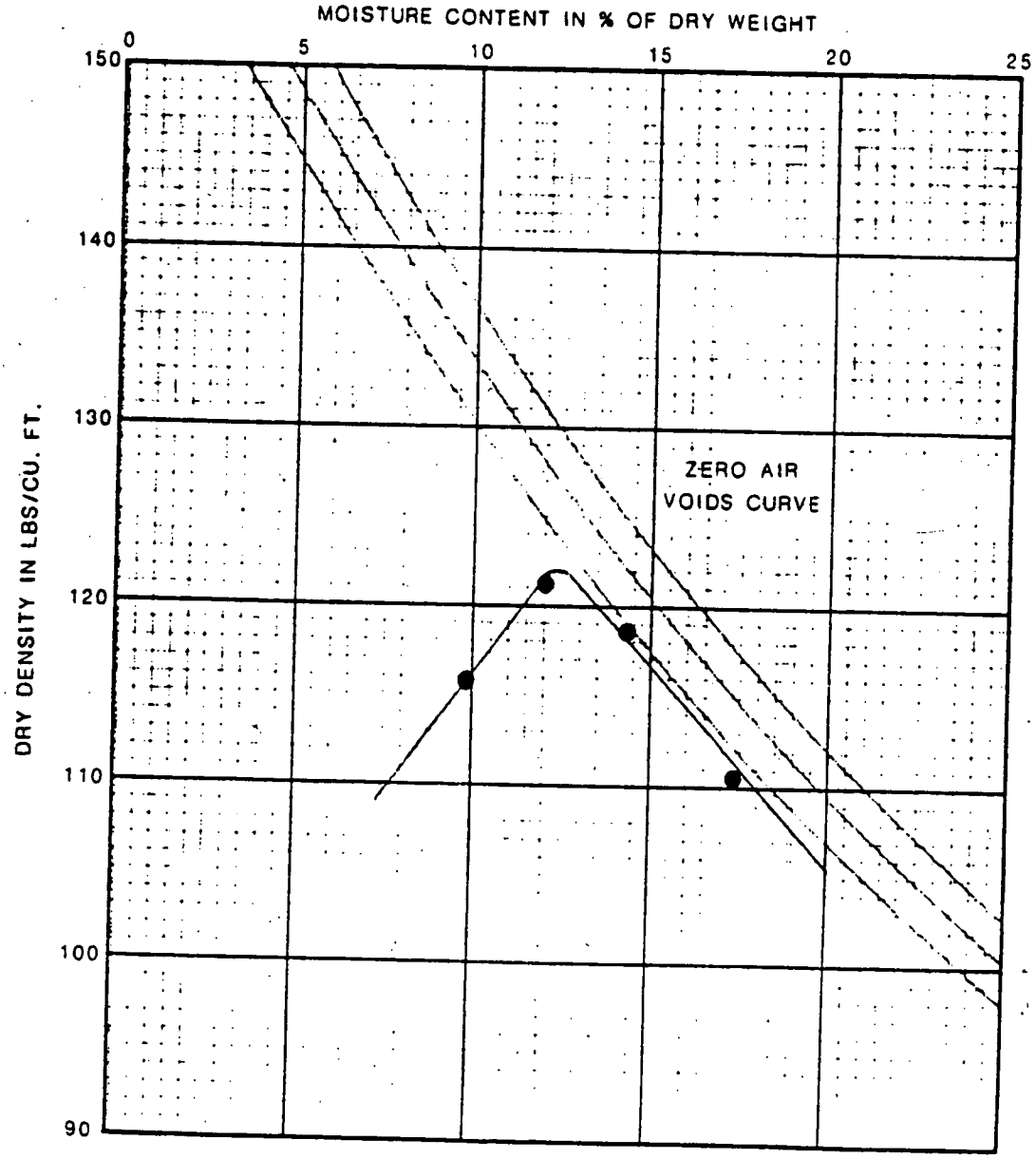
Soil _____

Location Proposed On-Site Disposal Cell

Optimum Moisture Content 12.4 %

Maximum Dry Density 122.3 PCF

Method of Compaction ASTM D698 Method A



COMPACTION TEST DATA

ADVANCED TERRA TESTING

File Parsons Pt 101 2059-03

COMPACTION TEST DATA

PAGE NO.____ OF____

ADVANCED TERRA TESTING INC

Job No. 2059-08 Client Parsons - PO101 Location Proposed On-Site Disposal

Sampled 11/9/93 By JPH Tested 12-11-93 By DW Checked 12-13-93 By SR

SAMPLE DESCRIPTION	Soil _____ Sample No. G2-209					
	Specific Gravity _____ Depth or Elevation 0-24.5					
	% Passing 3/4" _____ % Passing ~~#4~~ #4" ~95%					
TEST SPECIFICATIONS ASTM D 698 METHOD A	Compaction method (F, G)	☐ Proctor	☒ Standard AASHO	☐ Modified AASHO	☐ Cali	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variabl	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	50	100	150	200	
MOISTURE DETERMINATION	Dish number	26A	Z3	4E	29A	7A
	Wt. of soil & dish g	264.99	410.83	237.41	188.96	
	Dry wt. soil & dish g	243.95	370.77	210.09	163.78	
	Net loss of moisture (B) g	20.98	40.06	27.32	25.18	
	Wt. of dish only g	7.20	8.41	8.04	7.32	8.13
	Net wt. of dry soil (A) g	236.75	362.36	202.05	156.5	
	Moisture, % of dry wt. (C)	8.9	11.1	13.5	16.1	
DENSITY DETERMINATION	Wt. of soil & mold #	14.57	14.83	14.93	14.78	
	Wt. of mold only #	10.37	10.37	10.37	10.37	10.37
	Net wt. of wet soil (D) #	4.20	4.46	4.56	4.41	
	Net wt. of dry soil (E) #	3.86	4.02	4.02	3.80	
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	115.7	120.5	120.5	114.0	
PENETROMETER	Needle Size					
	Resistance Reading					
	Resistance, lbs/sq in					

Then add piston and ...

Sample No. G2-209 Depth 0-24.5' Elevation _____

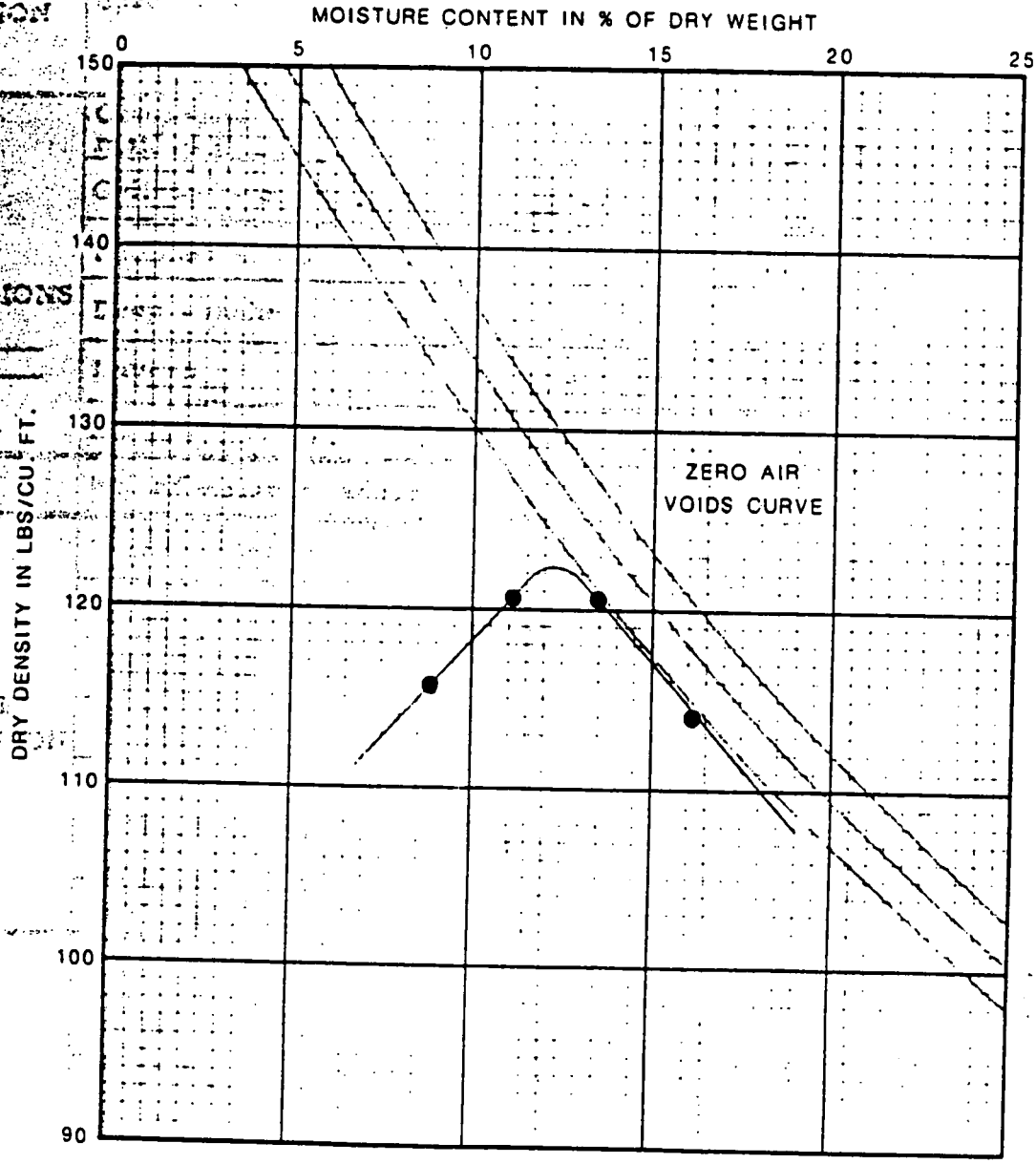
Soil _____

Location Proposed On-Site Disposal Cell

Optimum Moisture Content 12.3%

Maximum Dry Density 122.3 PCF

Method of Compaction ASTM D 698 Method A



COMPACTION TEST DATA

ADVANCED TERRA TESTING

File Parsons P0101 2051-03

TECHNICAL DIRECTION MEMORANDUM

PROJECT: P.O. 101 Supplemental Laboratory Testing

DATE: 5/11/94

FROM: Kevin Ernst, PARSONS ERA Project, Fairfield, OH KE

TO: Dermot Ross-Brown, SAIC, Golden, CO

REFERENCE:

1. *P.O. 101 On-Site Disposal Cell Supplemental Geotechnical Laboratory Testing Program*, Revision 0, 3/29/94. PARSONS ERA Project.

2. SAIC FAX Memorandum: May 9-94 1739 SAIC ENV 3032788624, Subj; Preliminary Data for Phase 1 Testing. Science Applications International, Inc., Golden, CO.

MESSAGE:

Dermot,

Please proceed with Phase 2 of the P.O. 101 On-site Disposal Cell supplemental geotechnical laboratory testing of Reference 1. The following direction is provided:

1. Perform Tests G2-209-#3, -#4, and -#5 (Modified Proctor - permeability tests) as described in the Reference 1. From review of the information copy of the Modified Proctor curve for Sample G2-209 in your fax (Reference 2) the optimum moisture content appears to be 10.3%. Please use your reviewed (QA) compaction data to select the optimum moisture content. The hydraulic conductivity tests should then be performed as described in Reference 1 (i.e., at optimum moisture content, 2% wet of optimum, and 5% wet of optimum) Use Figure 3 (attached) to verify that the dry density of the specimen falls within the acceptable band prior to the hydraulic conductivity testing.

2. Do not perform Test G2-209-#1 at this time. Instead, this confirmatory hydraulic conductivity test will be performed on a specimen from either G2-209 (Modified Proctor compactive effort) or G2-210 (Standard Proctor Compactive effort) at a moisture content specified by PARSONS upon review of data from the Modified Proctor-permeability data.

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000832

13 of 17

Sample No. G2-209 Depth 0-24.5' Elevation _____

Soil Bulk

Location Onsite Waste Disposal Cell

Optimum Moisture Content ~ 10.3 %

Maximum Dry Density ~ 133.8 pcf

Method of Compaction ASTM D 1557 A

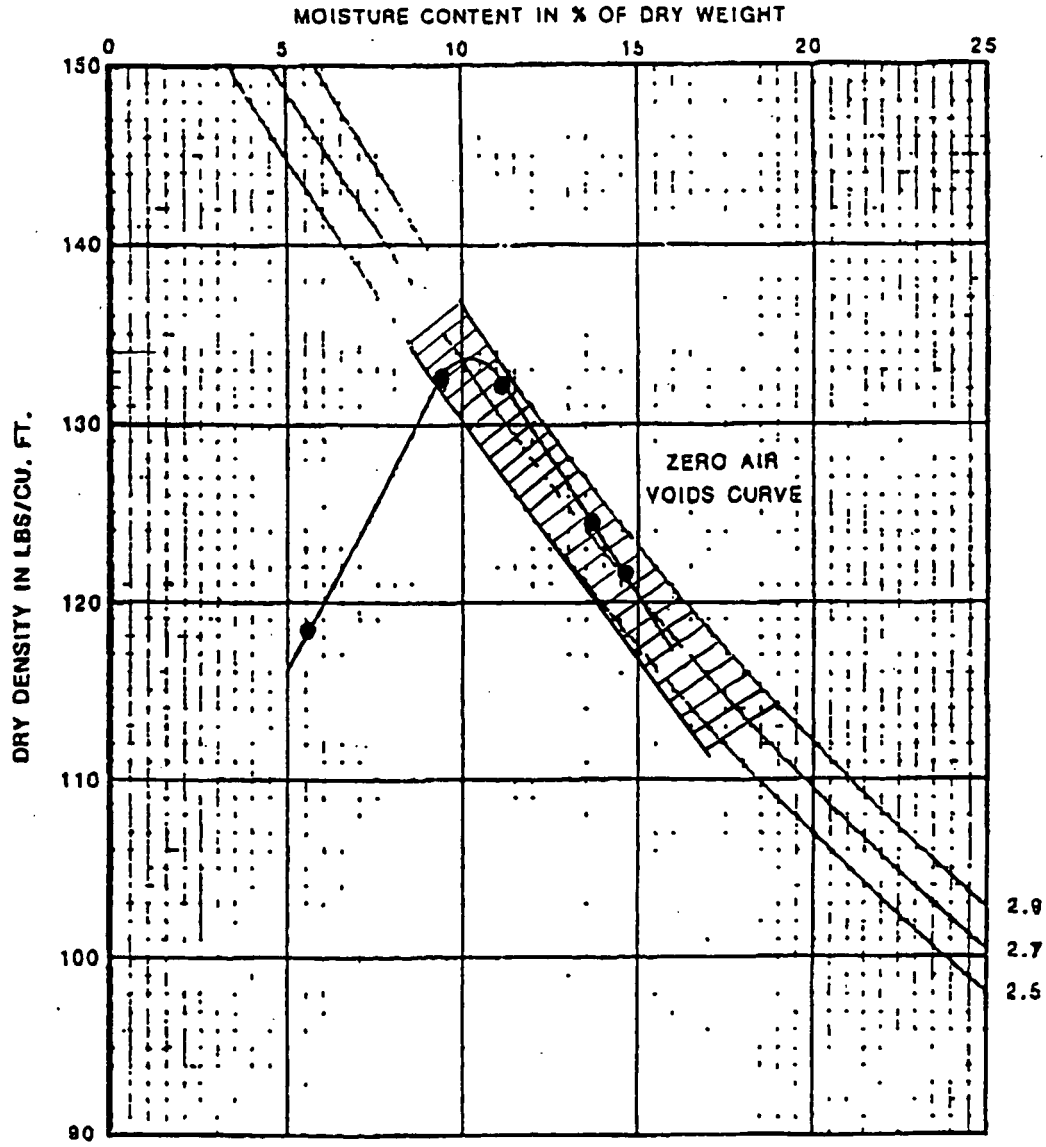


Figure 3: G2-209 Modified Proctor
Dry Density Band

COMPACTION TEST DATA

= ZONE OF ACCEPTABLE SPECIMEN DRY DENSITY FOR PERMEABILITY TESTING

ADVANCED TERRA TESTING

File Parsons PO 101
2059-10

K. Ernst 5-11-94

APPENDIX D

SUPPLEMENTAL LABORATORY TESTING DATA SHEETS

Index of Tests **Page**

PHASE 1
Atterberg Limits
Boring No. G2-209 . . . . . D-4
Boring No. G2-210 . . . . . D-5

Triaxial, Back-Pressure Permeability (Tx/Pbp)
Boring No. G2-210 (112pcf @ 17.4%) D-7
Boring No. G2-210 (118pcf @ 14.4%) D-11
Boring No. G2-210 (120pcf @ 12.4%) D-15

PHASE 2
Proctor Compaction - Modified
Boring No. G2-209 . . . . . D-20

Triaxial, Back-Pressure Permeability (Tx/Pbp)
Boring No. 209 (@ OMC) D-23
Boring No. 209 (@ OMC + 2%) D-27
Boring No. 209 (@ OMC + 5%) D-31

List of Tests Conducted

Test	Boring No.	Depth (ft)	Sample No.
PHASE 1			
Atterberg Limits	G2-209 G2-210	0-24.5 "	Composite "
Triaxial, Back-Pressure Permeability (TX/Pbp)	G2-210 G2-210 G2-210	" " "	112pcf @ 17.4% 118pcf @ 14.4% 120pcf @ 12.4%
PHASE 2			
Proctor Compaction - Modified	G2-209	"	Composite
Triaxial, Back-Pressure Permeability (TX/Pbp)	G2-209 G2-209 G2-209	" " "	3 (@ OMC) 4 (@ OMC + 2%) 5 (@ OMC + 5%)

000936

ATTERBERG LIMITS
ASTM D 4318

ATTERBERG LIMITS TEST DATA

JOB NO. 2059-1C
CLIENT/OWNER PARSONS PO 101
LOCATION
BORING ____ SAMPLE G2-2C9 DEPTH 0-24

FIELD CLASSIFICATION
LABORATORY CLASSIFICATION

FIELD DENSITY BY ___/__/__

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL g		
WT OF RINGS g	—	—
WT OF WET SOIL g		
FIELD DENSITY PCF		
DRY DENSITY PCF		

THIS IS AN 1/8-INCH THREAD

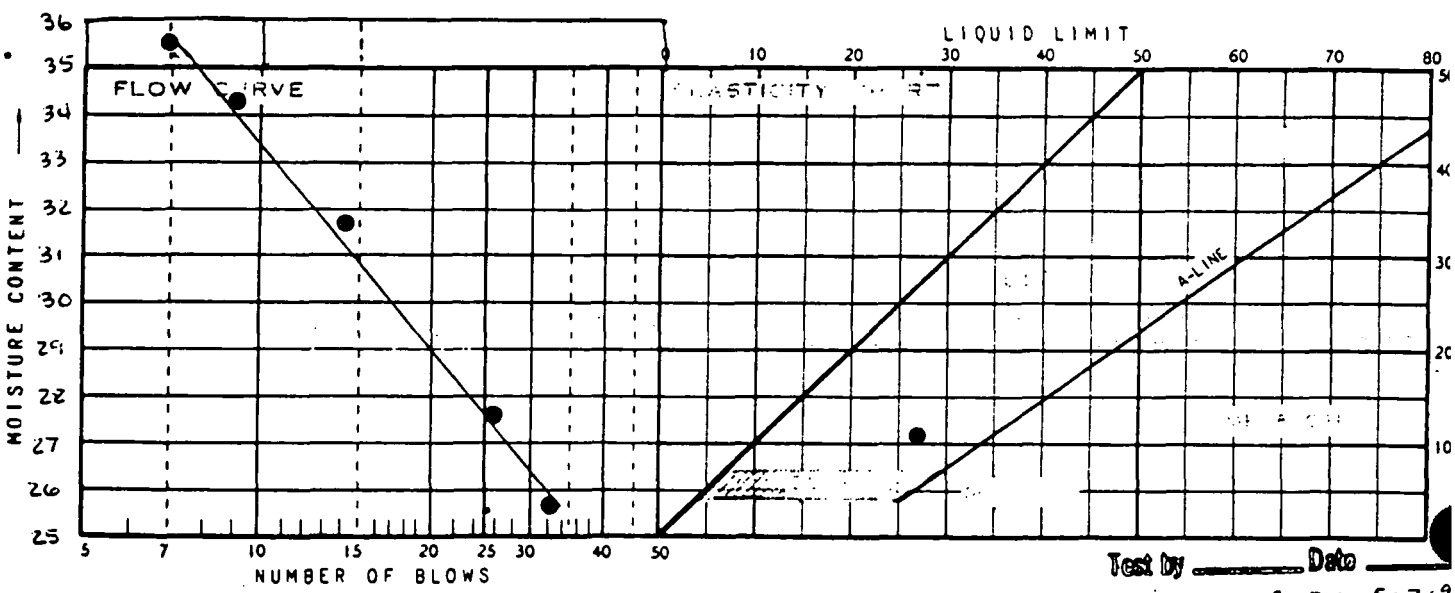
DETERMINATION	1	2
DISH#		
WT OF DISH + WET SOIL g		
WT OF DISH + DRY SOIL g	—	—
WT OF MOISTURE g		
WT OF DISH g	—	—
WT OF DRY SOIL g		
FIELD MOISTURE CONTENT %		

PLASTIC LIMIT BY RB 4/25/94

DETERMINATION	1	2	3	4	5	6
DISH	54C	B57	2035			
WT OF DISH + WET SOIL g	4.40	5.39	4.78			
WT OF DISH + DRY SOIL g	3.94	4.77	4.25	—	—	—
WT OF MOISTURE g	.46	.62	.53			
WT OF DISH g	1.09	1.09	1.08	—	—	—
WT OF DRY SOIL g	2.25	3.68	3.17			
MOISTURE CONTENT %	16.14	16.85	16.72			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	2012	2059	B8	2011	1356	
NUMBER OF BLOWS	32	27	14	9	7	
WT OF DISH + WET SOIL g	9.29	10.34	11.73	13.01	13.01	
WT OF DISH + DRY SOIL g	7.61	8.34	9.20	9.97	9.87	—
WT OF MOISTURE g	1.68	2.00	2.53	3.04	3.14	
WT OF DISH g	1.07	1.07	1.06	1.07	1.07	—
WT OF DRY SOIL g	6.54	7.27	8.14	8.90	8.20	
MOISTURE CONTENT %	25.69	27.51	31.08	34.16	35.68	



Test by ____ Date ____
Checked by ____ Date 5-2-9

SUMMARY

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		27.5	16.57	10.93	CL	

ATTERBERG LIMITS TEST DATA

FIELD CLASSIFICATION _____

LABORATORY CLASSIFICATION _____

JOB NO. 2054-10

CLIENT/OWNER PARSONS POICI

LOCATION

BORING ____ SAMPLE G2-2@10 DEPTH 0-24.5

FIELD DENSITY BY ___/__/__

DETERMINATION	1	2
NUMBER OF RINGS		
WT OF RINGS + WET SOIL g		
WT OF RINGS g	—	—
WT OF WET SOIL g		
FIELD DENSITY PCF		
DRY DENSITY PCF		

THIS IS AN 1/8-INCH THREAD

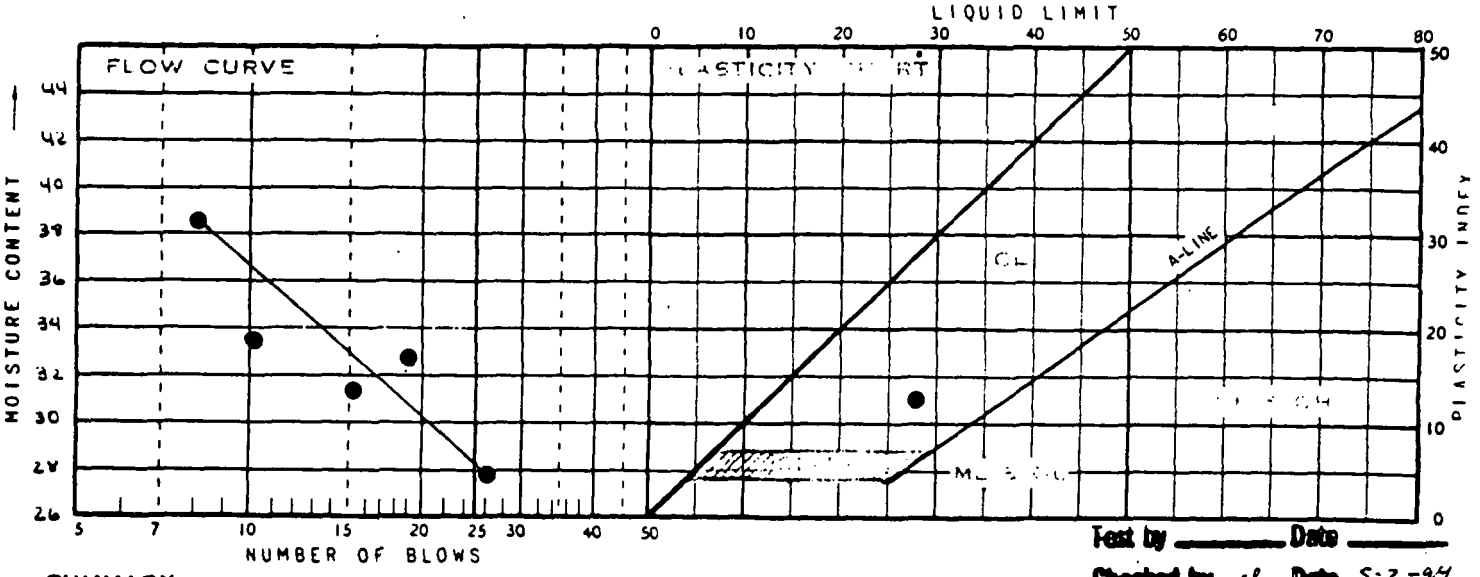
DETERMINATION	1	2
DISH #		
WT OF DISH + WET SOIL g		
WT OF DISH + DRY SOIL g	—	—
WT OF MOISTURE g		
WT OF DISH g	—	—
WT OF DRY SOIL g		
FIELD MOISTURE CONTENT %		

PLASTIC LIMIT BY WB 4/25/94

DETERMINATION	1	2	3	4	5	6
DISH	17C	1C	13C			
WT OF DISH + WET SOIL g	4.93	5.52	4.87			
WT OF DISH + DRY SOIL g	4.42	4.93	4.37	—	—	—
WT OF MOISTURE g	.51	.59	.50			
WT OF DISH g	1.07	1.07	1.06	—	—	—
WT OF DRY SOIL g	3.35	3.86	3.31			
MOISTURE CONTENT %	15.22	15.29	15.11			

LIQUID LIMIT

DETERMINATION	1	2	3	4	5	6
DISH	362	B72	B12	B61	B17	
NUMBER OF BLOWS	26	19	15	10	8	
WT OF DISH + WET SOIL g	10.41	11.93	10.99	11.85	12.21	
WT OF DISH + DRY SOIL g	8.38	9.29	8.62	9.16	9.14	—
WT OF MOISTURE g	2.03	2.64	2.37	2.69	3.07	
WT OF DISH g	1.08	1.06	1.08	1.08	1.12	—
WT OF DRY SOIL g	7.30	8.23	7.54	8.08	8.02	
MOISTURE CONTENT %	27.81	32.08	31.43	33.29	38.28	



Test by _____ Date _____

Checked by _____ Date 5-2-94

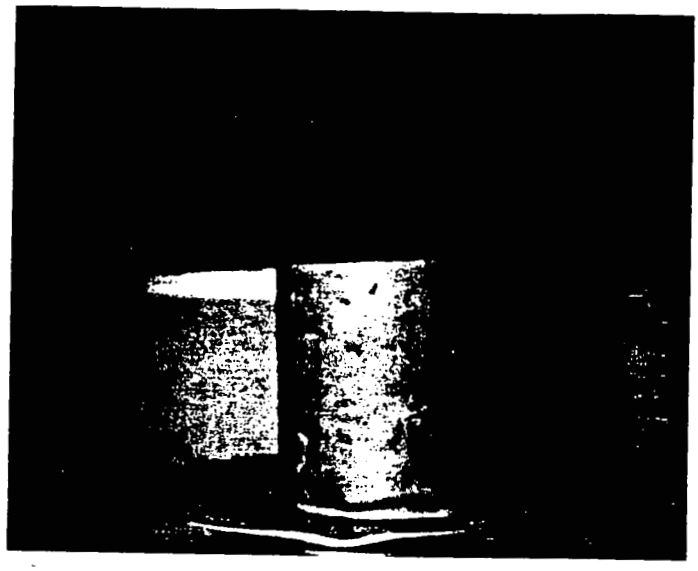
SUMMARY

DRY DENSITY	MOISTURE CONTENT	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX	IDENTIFICATION	
		28.4	15.21	13.19	CL	000039

ADVANCED TERRA TESTING inc

TRIAXIAL, BACK-PRESSURE PERMEABILITY, TX/Pbp
ASTM D 5084

000840



Parsons PO'01

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons	JOB NO.	2059-10
BORING NO.	G2-210	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	04-23-94 DCW
SAMPLE NO.	112 pcf @ 17.4%	TEST FINISHED	05-6-94
SOIL DESCR.	PO 101	SETUP NO.	5P
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	469.5	472.7
Wt. Wet Soil & Pan	(g)	477.8	480.9
Wt. Dry Soil & Pan	(g)	410.0	410.0
Wt. Lost Moisture	(g)	67.8	70.9
Wt. of Pan Only	(g)	8.2	8.2
Wt. of Dry Soil	(g)	401.7	401.7
Moisture Content %		16.9	17.7
Wet Density PCF		132.6	140.1
Dry Density PCF		113.5	119.1

Init. Diameter	(in)	2.415	(cm)	6.134
Init. Area	(sq in)	4.581	(sq cm)	29.554
Init. Height	(in)	2.945	(cm)	7.480
Vol. Bef. Consol.	(cu ft)	0.00781		
Vol. After Consol.	(cu ft)	0.00744		
Porosity %		33.68		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
1363.0	81780	49.1	47.5	16.9	4.2E-08
1440.0	86400	47.5	46.1	18.5	3.5E-08
1440.0	86400	46.1	44.6	20.1	3.8E-08
1474.0	88440	44.6	43.2	21.6	3.5E-08
1400.0	84000	43.2	41.9	23.1	3.5E-08
1400.0	84000	41.9	40.6	24.5	3.5E-08

ADVANCED TERRA TESTING, INC.

6647

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons	JOB NO.	2059-10
BORING NO.	G2-210	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	04-23-94 DCW
SAMPLE NO.	112 pcf @ 17.4%	TEST FINISHED	05-6-94
SOIL DESCR.	PO 101	SETUP NO.	5P
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	2.0	14.2				
50.0	48.0	15.1	16.8	39.2	48.3	9.1	0.91
60.0	58.0	16.9	17.9	49.3	58.7	9.4	0.94
70.0		18.0	18.2	59.2	68.8	9.6	0.96

CONSOLIDATION DATA

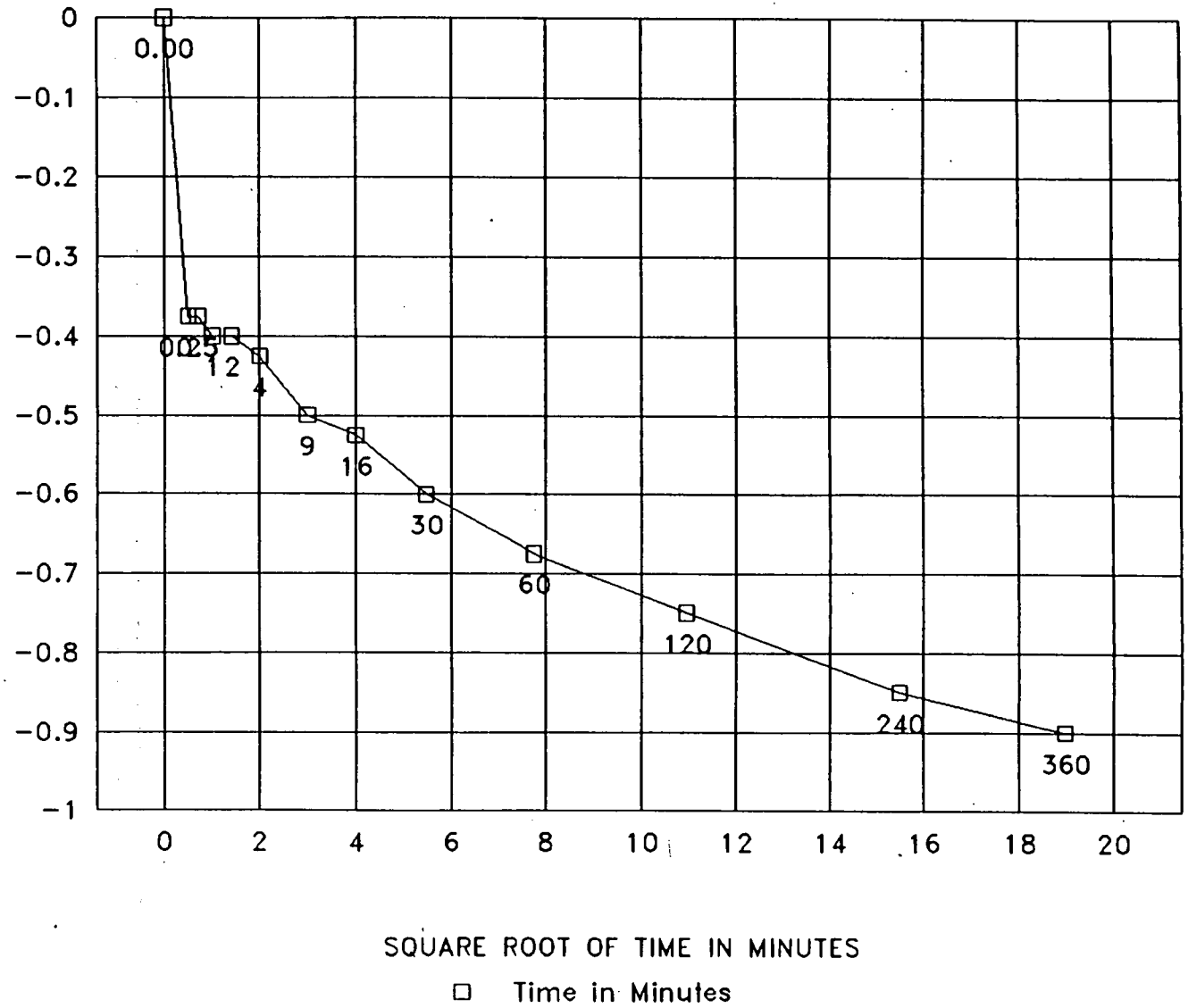
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	18.20	0.00
0.25	0.50	18.58	-0.38
0.5	0.71	18.58	-0.38
1	1.00	18.60	-0.40
2	1.41	18.60	-0.40
4	2.00	18.63	-0.43
9	3.00	18.70	-0.50
16	4.00	18.73	-0.53
30	5.48	18.80	-0.60
60	7.75	18.88	-0.68
120	10.95	18.95	-0.75
240	15.49	19.05	-0.85
360	18.97	19.10	-0.90

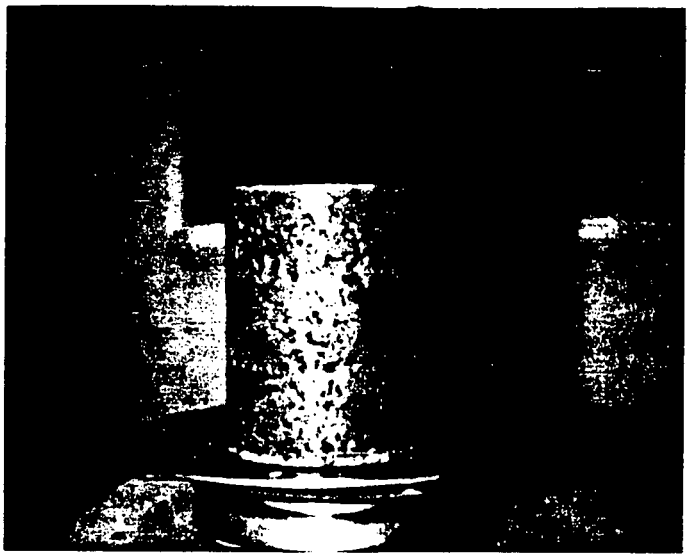
Initial Height	(in)	2.945	Init. Vol.	(CC)	221.10
Height Change	(in)	0.013	Vol. Change	(CC)	18.30
Ht. After Cons.	(in)	2.932	Cell Exp.	(CC)	7.80
Initial Area	(sq in)	4.581	Net Change	(CC)	10.50
Area After Cons.	(sq in)	4.382	Cons. Vol.	(CC)	210.60

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

G2-210 112PCF @ 17.4%, 0-24.5'





PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons	JOB NO.	2059-10
BORING NO.	G2-210	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	04-24-94 DCW
SAMPLE NO.	118 pcf @ 14.4%	TEST FINISHED	05-06-94 DCW
SOIL DESCR.	PO 101	SETUP NO.	6P
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	484.5	496.5
Wt. Wet Soil & Pan	(g)	492.0	503.9
Wt. Dry Soil & Pan	(g)	433.3	433.3
Wt. Lost Moisture	(g)	58.7	70.6
Wt. of Pan Only	(g)	7.5	7.5
Wt. of Dry Soil	(g)	425.8	425.8
Moisture Content %		13.8	16.6
Wet Density PCF		134.3	139.3
Dry Density PCF		118.0	119.5

Init. Diameter	(in)	2.401	(cm)	6.099
Init. Area	(sq in)	4.528	(sq cm)	29.212
Init. Height	(in)	3.036	(cm)	7.711
Vol. Bef. Consol.	(cu ft)	0.00795		
Vol. After Consol.	(cu ft)	0.00786		
Porosity %		31.75		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
116.0	6960	49.1	11.5	36.3	1.4E-05
188.0	11280	49.3	0.0	42.4	1.2E-05
190.0	11400	50.0	6.7	38.4	9.9E-06
194.0	11640	49.5	12.6	35.5	8.0E-06
309.0	18540	49.9	0.7	41.7	7.1E-06
240.0	14400	50.0	12.6	35.2	6.5E-06
303.0	18180	49.9	5.3	39.2	6.4E-06
240.0	14400	49.9	11.4	35.9	6.8E-06
346.0	20760	49.9	-0.4	42.3	6.5E-06
241.0	14460	49.9	12.5	35.3	6.5E-06
240.0	14400	50.2	10.5	36.2	7.0E-06
260.0	15600	50.0	6.6	38.4	7.2E-06
240.0	14400	49.9	5.7	39.0	8.0E-06
240.0	14400	48.7	9.0	37.9	7.1E-06
240.0	14400	49.9	9.9	36.7	7.1E-06
240.0	14400	50.0	12.5	35.3	6.6E-06
326.0	19560	50.0	3.7	40.0	6.2E-06
240.0	14400	49.7	14.4	34.4	6.1E-06

ADVANCED TERRA TESTING, INC.

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons	JOB NO.	2059-10
BORING NO.	G2-210	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	04-24-94 DCW
SAMPLE NO.	118 pcf @ 14.4%	TEST FINISHED	05-06-94 DCW
SOIL DESCR.	PO 101	SETUP NO.	6P
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	1.1	7.7				
50.0	48.0	7.6	8.5	39.3	48.3	9.0	0.90
60.0		8.6	8.6	49.3	58.8	9.5	0.95

CONSOLIDATION DATA

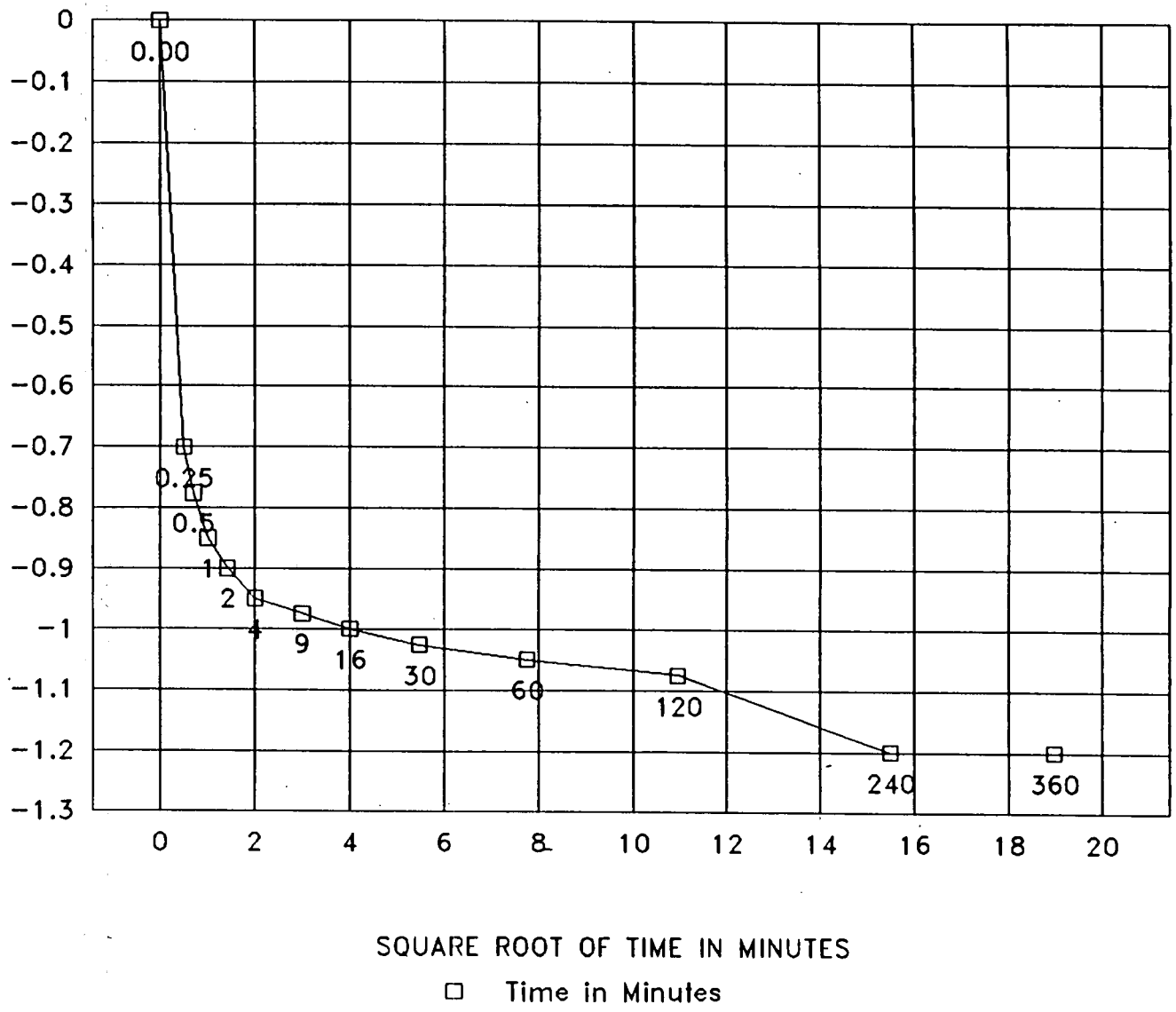
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	8.60	0.00
0.25	0.50	9.30	-0.70
0.5	0.71	9.38	-0.78
1	1.00	9.45	-0.85
2	1.41	9.50	-0.90
4	2.00	9.55	-0.95
9	3.00	9.58	-0.97
16	4.00	9.60	-1.00
30	5.48	9.63	-1.03
60	7.75	9.65	-1.05
120	10.95	9.68	-1.08
240	15.49	9.80	-1.20
360	18.97	9.80	-1.20

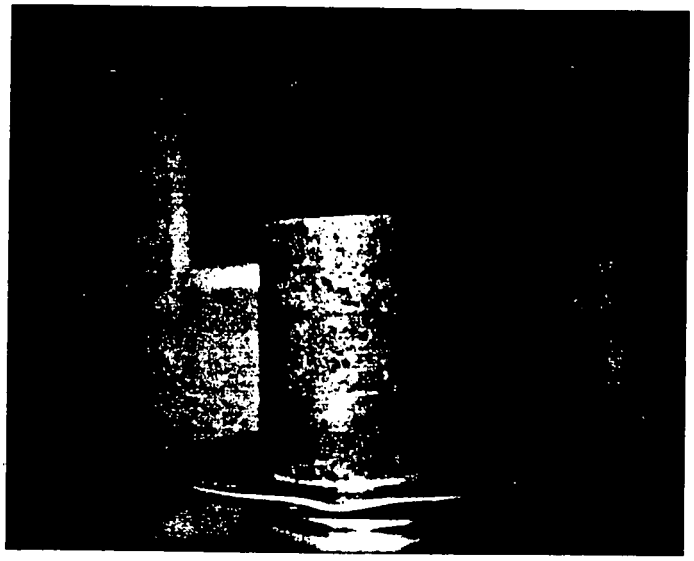
Initial Height	(in)	3.036	Init. Vol.	(CC)	225.30
Height Change	(in)	0.009	Vol. Change	(CC)	10.40
Ht. After Cons.	(in)	3.027	Cell Exp.	(CC)	7.60
Initial Area	(sq in)	4.528	Net Change	(CC)	2.80
Area After Cons.	(sq in)	4.485	Cons. Vol.	(CC)	222.50

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

G2-210 118 PCF @ 18%, 720 psf Conf.





Parsons PO101
2059-10

GZ-21020-24.5'
TX/PbP
120 PCF @ 12.4%

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons	JOB NO.	2059-10
BORING NO.	G2-210	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	04-24-94 DCW
SAMPLE NO.	120 pcf @ 12.4%	TEST FINISHED	05-06-94
SOIL DESCR.	PO 101	SETUP NO.	4P
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	484.3	504.0
Wt. Wet Soil & Pan	(g)	492.7	512.5
Wt. Dry Soil & Pan	(g)	440.9	440.9
Wt. Lost Moisture	(g)	51.8	71.6
Wt. of Pan Only	(g)	8.4	8.4
Wt. of Dry Soil	(g)	432.4	432.4
Moisture Content %		12.0	16.6
Wet Density PCF		134.4	141.1
Dry Density PCF		120.0	121.0

Init. Diameter	(in)	2.401	(cm)	6.099
Init. Area	(sq in)	4.528	(sq cm)	29.212
Init. Height	(in)	3.032	(cm)	7.701
Vol. Bef. Consol.	(cu ft)	0.00794		
Vol. After Consol.	(cu ft)	0.00788		
Porosity %		32.09		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
240.0	14400	49.7	25.7	28.3	3.9E-06
296.0	17760	49.4	22.7	30.1	3.6E-06
240.0	14400	49.6	34.0	23.9	2.5E-06
540.0	32400	49.5	17.9	32.6	2.4E-06
685.0	41100	49.6	14.3	34.5	2.1E-06
614.0	36840	49.4	18.9	32.1	2.0E-06
763.0	45780	49.7	15.6	33.8	1.8E-06
540.0	32400	49.6	23.9	29.3	1.9E-06
860.0	51600	49.8	12.6	35.3	1.8E-06
360.0	21600	49.8	31.6	25.1	1.9E-06

ADVANCED TERRA TESTING, INC.

000950

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons	JOB NO.	2059-10
BORING NO.	G2-210	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	04-24-94 DCW
SAMPLE NO.	120 pcf @ 12.4%	TEST FINISHED	05-06-94
SOIL DESCR.	PO 101	SETUP NO.	4P
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	1.0	7.0				
50.0	48.0	5.6	6.4	39.2	47.2	8.0	0.80
60.0	58.0	6.6	7.2	49.2	57.8	8.6	0.86
70.0	68.0	7.6	8.4	59.1	68.2	9.1	0.91
80.0	78.0	9.0	9.9	69.1	78.4	9.3	0.93
90.0		10.0	10.1	79.0	88.5	9.5	0.95

CONSOLIDATION DATA

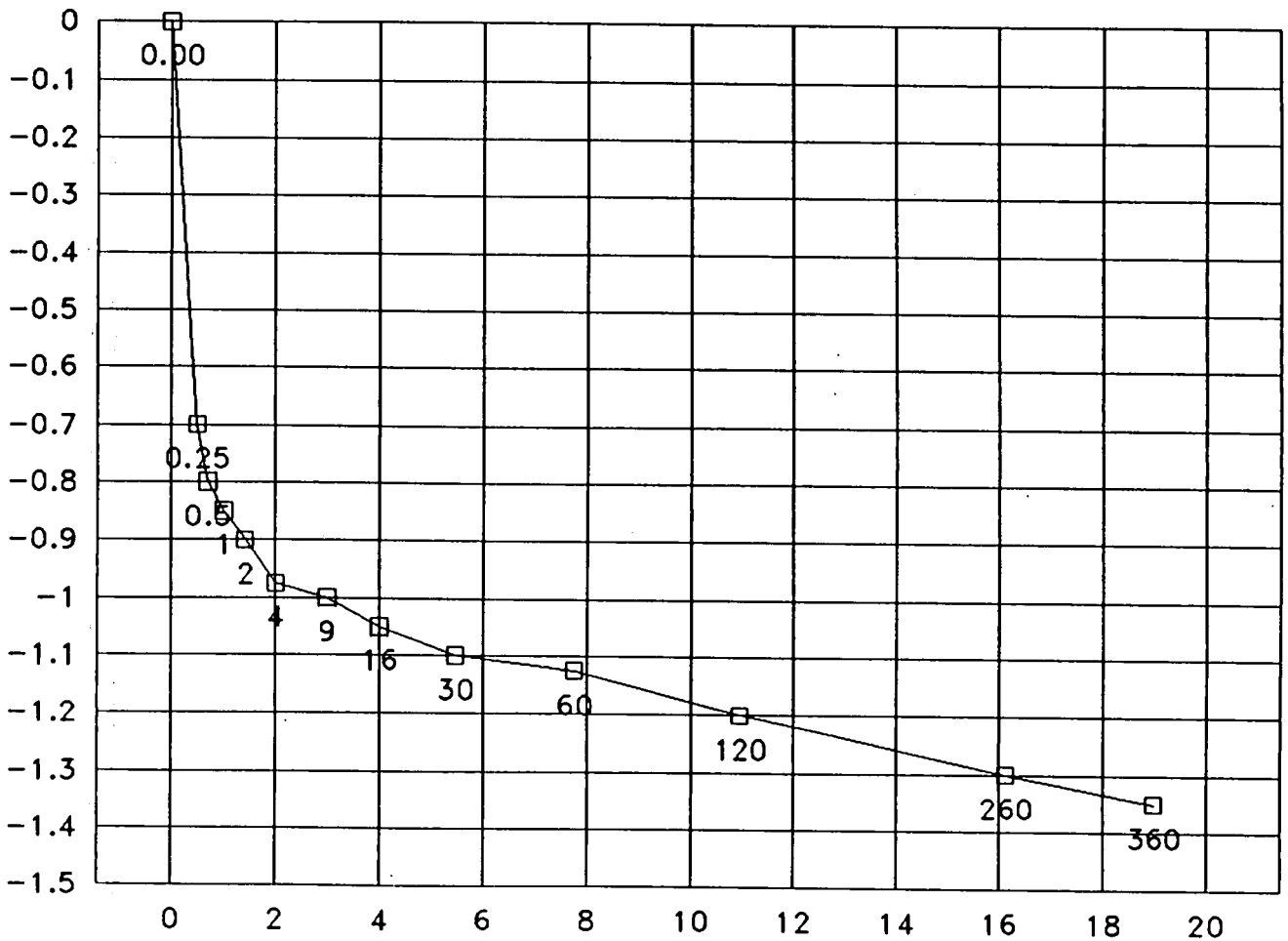
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	10.10	0.00
0.25	0.50	10.80	-0.70
0.5	0.71	10.90	-0.80
1	1.00	10.95	-0.85
2	1.41	11.00	-0.90
4	2.00	11.08	-0.97
9	3.00	11.10	-1.00
16	4.00	11.15	-1.05
30	5.48	11.20	-1.10
60	7.75	11.23	-1.13
120	10.95	11.30	-1.20
260	16.12	11.40	-1.30
360	18.97	11.45	-1.35

Initial Height	(in)	3.032	Init. Vol.	(CC)	225.00
Height Change	(in)	0.008	Vol. Change	(CC)	11.70
Ht. After Cons.	(in)	3.024	Cell Exp.	(CC)	9.80
Initial Area	(sq in)	4.528	Net Change	(CC)	1.90
Area After Cons.	(sq in)	4.501	Cons. Vol.	(CC)	223.10

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

G2-210 120 PCF @ 12.4%, 0-24.5'



VOLUME DEFLECTION - cc

SQUARE ROOT OF TIME IN MINUTES

□ Time in Minutes

PROCTOR COMPACTION - MODIFIED
ASTM D 1557

COMPACTION TEST DATA

ADVANCED TERRA TESTING INC

Job No. 2059.10 Client Parsons PO 101 Location ONSITE WASTE Disp

Sampled 11/9/93 By JPH Tested 4-15-94 By MV Checked 4/19/94 By MV

SAMPLE DESCRIPTION	Soil			Sample No. G2-209		
	Specific Gravity			Depth or Elevation 0-24.5'		
	% Passing 3/4"			% Passing ~~1/4"~~ #4 ~95%		
TEST SPECIFICATIONS ASTM D 1557 METHOD A	Compaction method (F, G)	☐ Proctor	☐ Standard AASHO	☒ Modified AASHO	☐ Calif.	
	Cylinder - cu. ft.	1/20	1/30	1/30	Variable	
	Rammer - lbs.	5 1/2	5 1/2	10	10	
	Drop - inches	18	12	18	18	
	Layers	3	3	5	5	
	Blows per layer	25	25	25	20 *	
	Wt. of moisture added ml	ϕ	100	150	200	225
MOISTURE DETERMINATION	Dish number	11 B	4B	2B	0 11	7B
	Wt. of soil & dish g	429.05	461.60	674.66	555.22	522.35
	Dry wt. soil & dish g	407.55	423.41	609.00	490.45	457.89
	Net loss of moisture (B) g	21.50	38.19	65.66	64.77	64.46
	Wt. of dish only g	15.84	15.88	15.94	15.61	15.89
	Net wt. of dry soil (A) g	391.71	407.53	593.06	474.84	442.00
	Moisture, % of dry wt. (C)	5.5	9.4	11.1	13.6	14.6
DENSITY DETERMINATION	Wt. of soil & mold #	10.53	15.21	15.26	15.09	15.02
	Wt. of mold only #	10.37	10.37	10.37	10.37	10.37
	Net wt. of wet soil (D) #	4.16	4.84	4.89	4.72	4.65
	Net wt. of dry soil (E) #	3.94	4.43	4.40	4.15	4.06
	Ht. of sample - Calif. (G)					
	Dry Density, lbs/cu ft (H)	118.3	132.8	132.1	124.6	121.7
PENETROMETER	Needle Size					
	Resistance Reading					
	Resistance, lbs/sq in					

* Then add piston and seat with 5 blows

Sample No. G2-209 Depth 0-24.5' Elevation _____

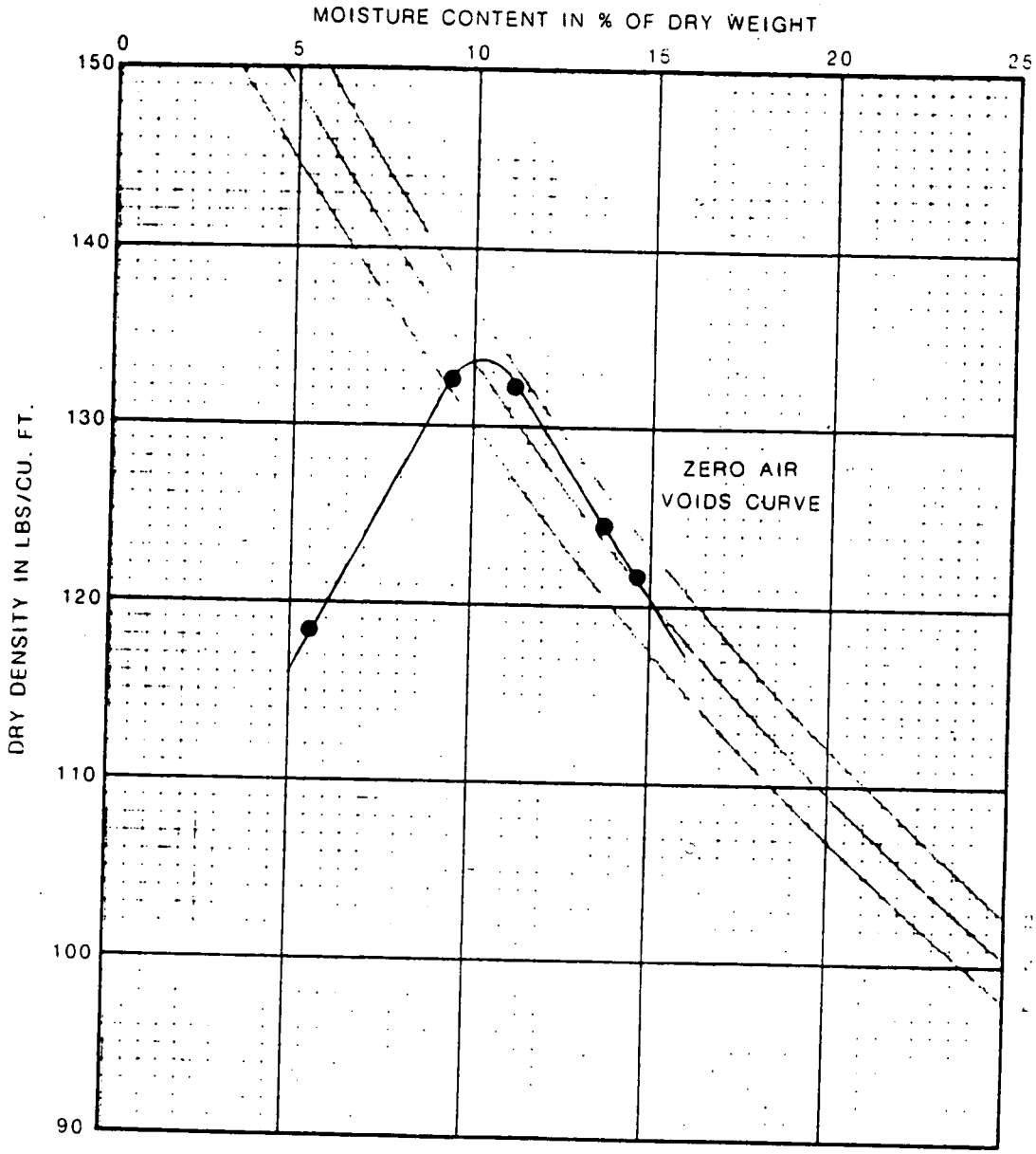
Soil Bulk

Location Onsite Waste Disposal Cell

Optimum Moisture Content 10.3 %

Maximum Dry Density 133.6 pcf

Method of Compaction ASTM D 1557 A



COMPACTION TEST DATA

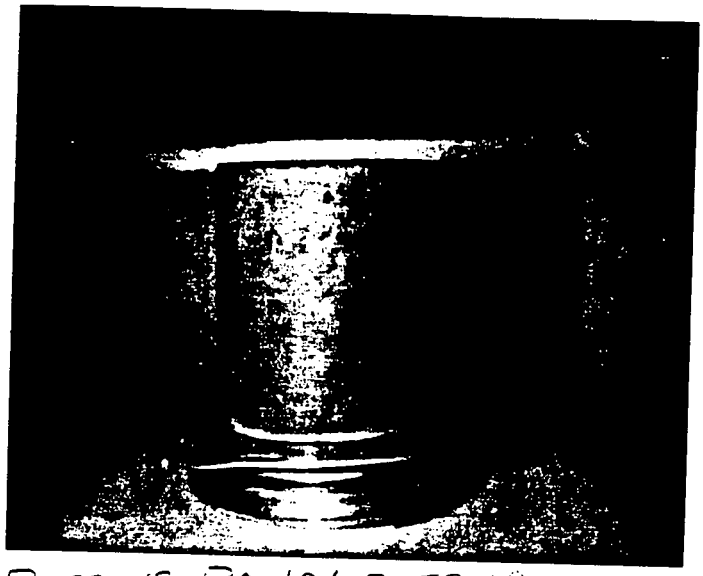
ADVANCED TERRA TESTING

File Parsons PO 101
2059-10

000955

TRIAXIAL, BACK-PRESSURE PERMEABILITY, TX/Pbp
ASTM D 5084

6647



PARSONS PO 101 2059-10
GZ-209
0-24.5'
3 @ 1MC

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons PO 101	JOB NO.	2059-10
BORING NO.	G2-209	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	5-26-94 CAL
SAMPLE NO.	3 at OMC	TEST FINISHED	6-7-94
SOIL DESCR.	On Site Disposal Cell	SETUP NO.	20S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	522.3	538.0
Wt. Wet Soil & Pan	(g)	530.7	546.4
Wt. Dry Soil & Pan	(g)	483.2	483.2
Wt. Lost Moisture	(g)	47.5	63.2
Wt. of Pan Only	(g)	8.4	8.4
Wt. of Dry Soil	(g)	474.8	474.8
Moisture Content %		10.0	13.3
Wet Density PCF		145.0	145.9
Dry Density PCF		131.8	128.8

Init. Diameter	(in)	2.399	(cm)	6.093
Init. Area	(sq in)	4.520	(sq cm)	29.164
Init. Height	(in)	3.036	(cm)	7.711
Vol. Bef. Consol.	(cu ft)	0.00794		
Vol. After Consol.	(cu ft)	0.00813		
Porosity %		27.45		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
1514.0	90840	49.9	48.7	15.8	2.7E-08
1445.0	86700	48.7	47.6	17.1	2.6E-08
1440.0	86400	47.6	46.6	18.2	2.4E-08
1431.0	85860	46.6	45.6	19.3	2.5E-08
1447.0	86820	45.6	44.6	20.4	2.5E-08

ADVANCED TERRA TESTING, INC.

000858

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons PO 101	JOB NO.	2059-10
BORING NO.	G2-209	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	5-26-94 CAL
SAMPLE NO.	3 at OMC	TEST FINISHED	6-7-94
SOIL DESCR.	On Site Disposal Cell	SETUP NO.	20S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	0.3	8.1				
50.0	48.0	1.2	2.1	39.4	47.2	7.8	0.78
60.0	58.0	1.7	2.4	49.2	57.7	8.5	0.85
70.0	68.0	2.6	3.3	59.2	68.1	8.9	0.89
80.0	78.0	3.3	4.0	69.1	78.3	9.2	0.92
90.0	88.0	4.1	4.8	79.1	88.4	9.3	0.93
100.0		5.0	5.1	89.2	98.7	9.5	0.95

CONSOLIDATION DATA

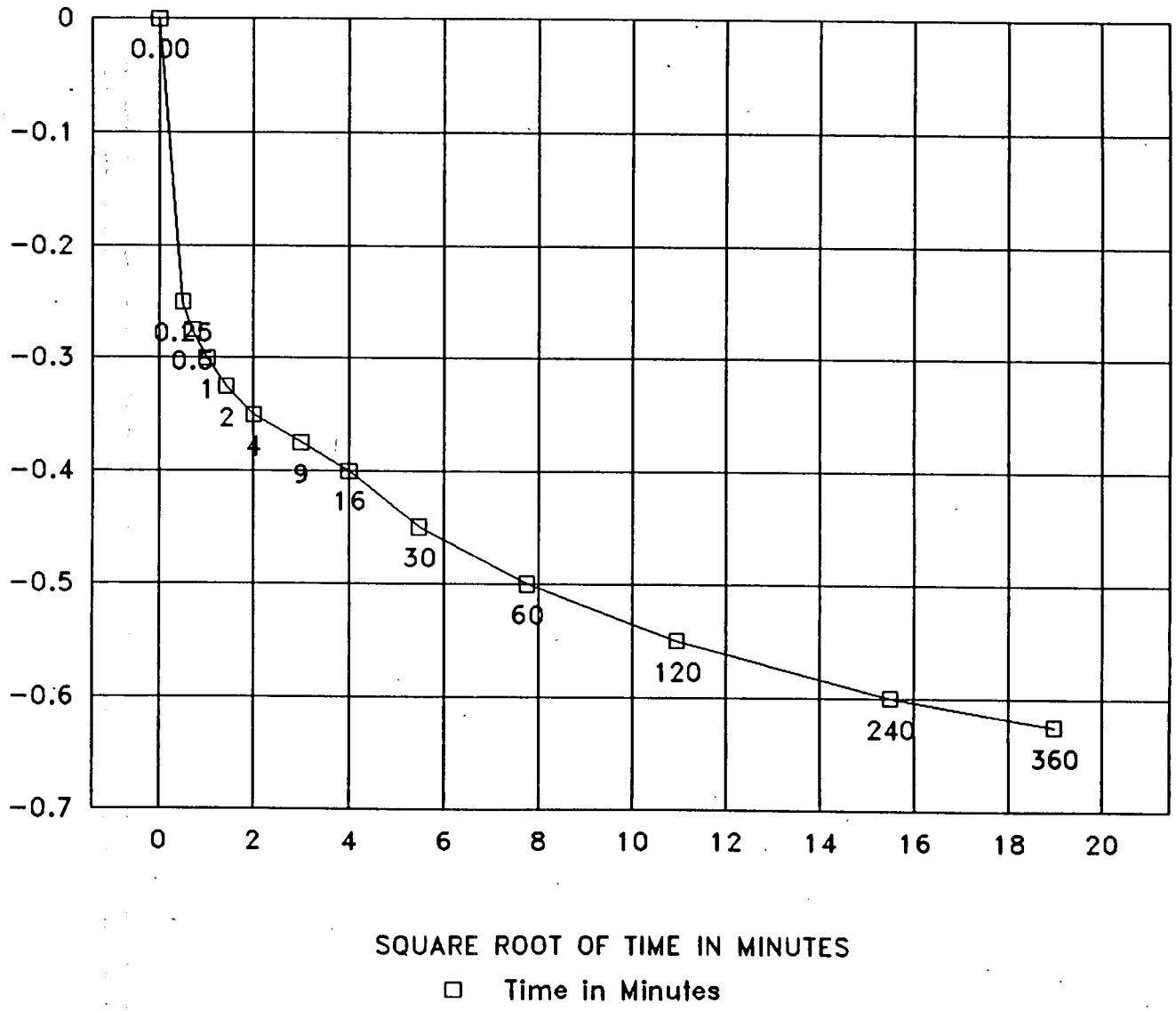
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	5.10	0.00
0.25	0.50	5.35	-0.25
0.5	0.71	5.38	-0.28
1	1.00	5.40	-0.30
2	1.41	5.43	-0.33
4	2.00	5.45	-0.35
9	3.00	5.48	-0.38
16	4.00	5.50	-0.40
30	5.48	5.55	-0.45
60	7.75	5.60	-0.50
120	10.95	5.65	-0.55
240	15.49	5.70	-0.60
360	18.97	5.73	-0.63

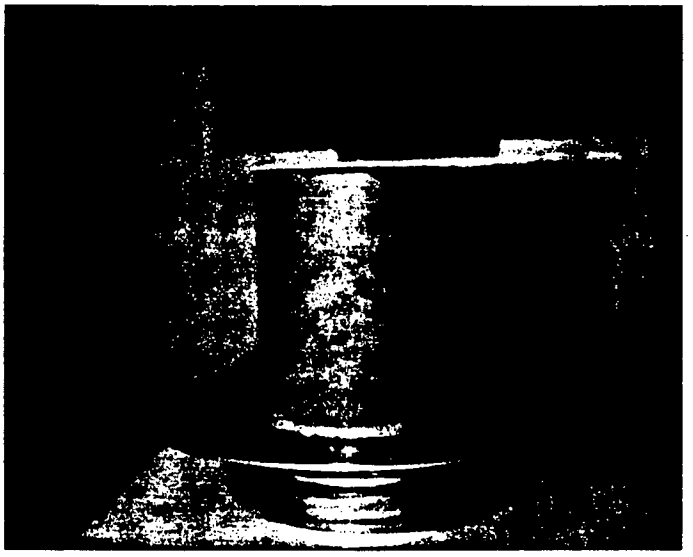
Initial Height	(in)	3.036	Init. Vol.	(CC)	224.92
Height Change	(in)	0.009	Vol. Change	(CC)	5.90
Ht. After Cons.	(in)	3.027	Cell Exp.	(CC)	11.20
Initial Area	(sq in)	4.520	Net Change	(CC)	-5.30
Area After Cons.	(sq in)	4.640	Cons. Vol.	(CC)	230.22

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

G2-209 @0-24.5' #3 720 psf Conf.





Farsons P.O.101
2059-10
TX/Pbp σ_3 720psf

62-209
=4 (+2/0 ome)
0-24.5'

000961

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons PO 101	JOB NO.	2059-01
BORING NO.	G2-209	SAMPLED	
DEPTH	0-24.0'	TEST STARTED	5-26-94 DCW
SAMPLE NO.	4 +2% OMC	TEST FINISHED	05-25-91
SOIL DESCR.	On Site Disposal Cell	SETUP NO.	9S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	519.3	524.8
Wt. Wet Soil & Pan	(g)	527.9	533.5
Wt. Dry Soil & Pan	(g)	471.9	471.9
Wt. Lost Moisture	(g)	56.0	61.6
Wt. of Pan Only	(g)	8.6	8.6
Wt. of Dry Soil	(g)	463.2	463.2
Moisture Content %		12.1	13.3
Wet Density PCF		144.0	144.6
Dry Density PCF		128.4	127.6

Init. Diameter	(in)	2.400	(cm)	6.10
Init. Area	(sq in)	4.524	(sq cm)	29.19
Init. Height	(in)	3.037	(cm)	7.71
Vol. Bef. Consol.	(cu ft)	0.00795		
Vol. After Consol.	(cu ft)	0.00800		
Porosity %		27.17		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
1291.0	77460	49.8	49.3	15.6	1.3E-08
1426.0	85560	49.3	48.9	16.0	9.7E-09
2870.0	172200	48.9	48.1	16.7	9.7E-09
1476.0	88560	48.1	47.6	17.4	1.2E-08
1437.0	86220	47.6	47.3	17.8	7.4E-09
1440.0	86400	47.3	47.0	18.2	8.6E-09
1440.0	86400	47.0	46.7	18.5	7.4E-09
1455.0	87300	46.7	46.3	18.9	8.6E-09
1442.0	86520	46.3	46.0	19.3	8.7E-09

ADVANCED TERRA TESTING, INC.

TRIAXAL COMPRESSION TEST DATA

CLIENT	Parsons PO 101	JOB NO.	2059-01
BORING NO.	G2-209	SAMPLED	
DEPTH	0-24.0'	TEST STARTED	5-26-94 DCW
SAMPLE NO.	4 +2% OMC	TEST FINISHED	05-25-91
SOIL DESCR.	On Site Disposal Cell	SETUP NO.	9S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	1.1	8.3				
50.0	48.0	6.1	7.0	39.5	48.5	9.0	0.90
60.0	58.0	6.5	7.3	49.4	58.5	9.1	0.91
70.0	68.0	7.5	8.2	59.1	68.5	9.4	0.94
80.0	78.0	8.1	8.8	69.2	78.5	9.3	0.93
90.0	88.0	8.9	9.6	79.1	88.5	9.4	0.94
100.0		9.8	9.8	89.1	98.6	9.5	0.95

CONSOLIDATION DATA

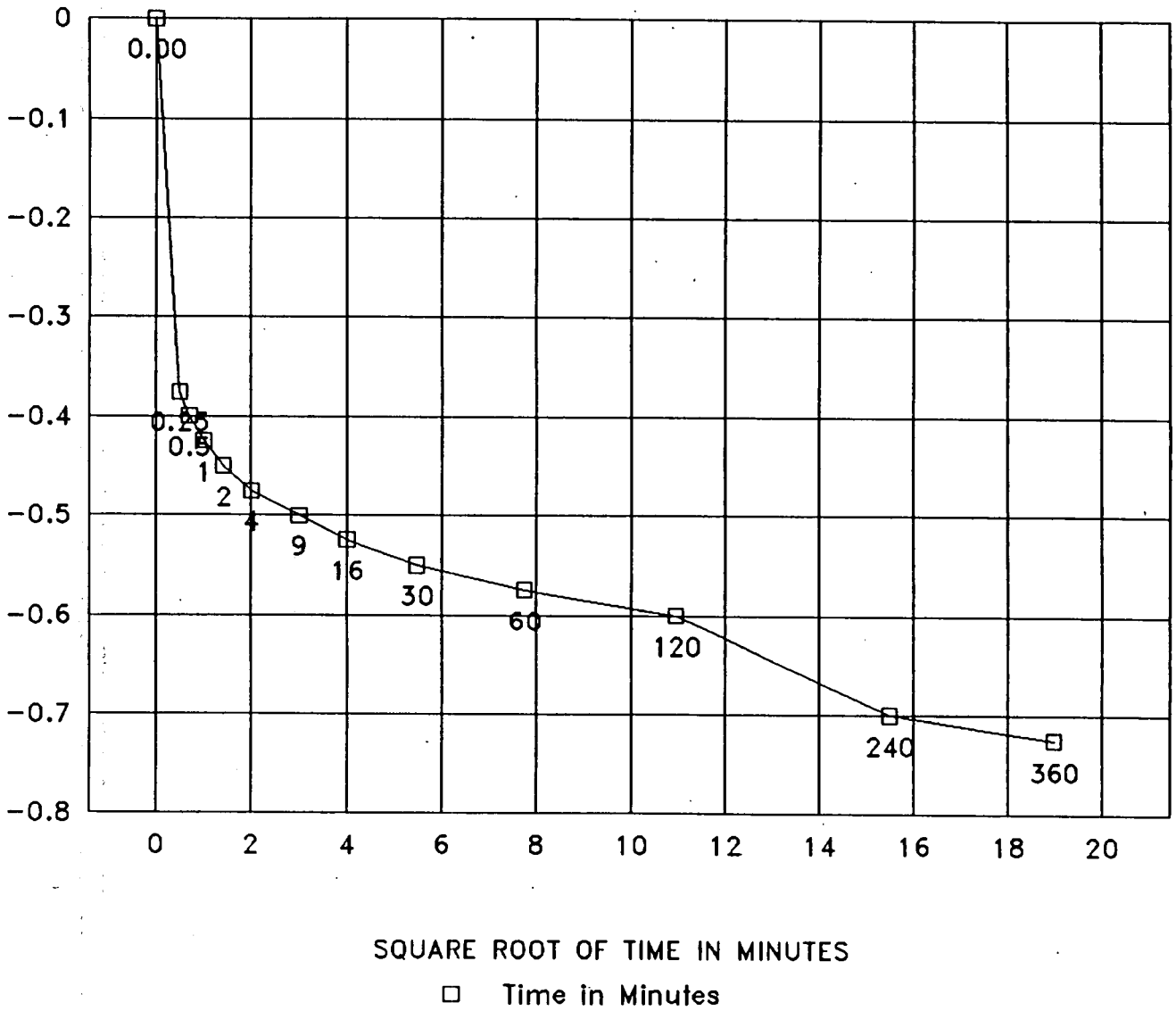
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	9.80	0.00
0.25	0.50	10.18	-0.38
0.5	0.71	10.20	-0.40
1	1.00	10.23	-0.42
2	1.41	10.25	-0.45
4	2.00	10.28	-0.47
9	3.00	10.30	-0.50
16	4.00	10.33	-0.52
30	5.48	10.35	-0.55
60	7.75	10.38	-0.57
120	10.95	10.40	-0.60
240	15.49	10.50	-0.70
360	18.97	10.53	-0.72

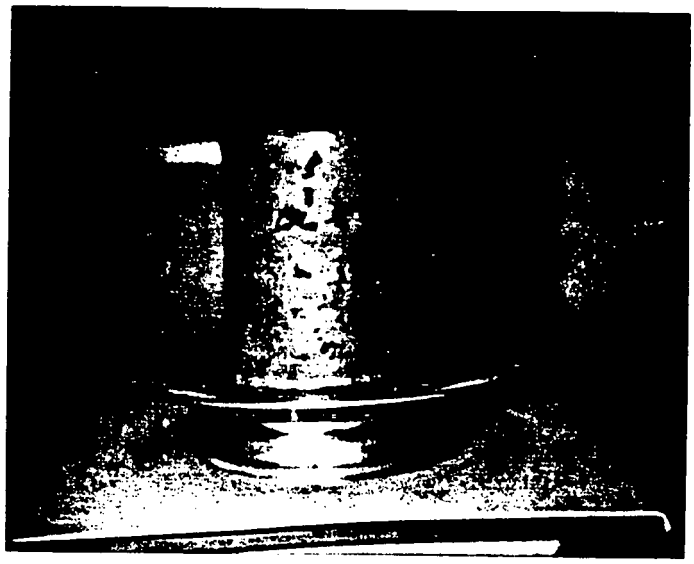
Initial Height	(in)	3.04	Init. Vol.	(CC)	225.18
Height Change	(in)	0.02	Vol. Change	(CC)	10.80
Ht. After Cons.	(in)	3.02	Cell Exp.	(CC)	12.30
Initial Area	(sq in)	4.52	Net Change	(CC)	-1.50
Area After Cons.	(sq in)	4.58	Cons. Vol.	(CC)	226.68

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

G2-209 #4 (+2% OMC) 720 psf





Parsons P.O.
3057-10

PERMEABILITY TEST - BACK PRESSURE CONSTANT HEAD

CLIENT	Parsons PO 101	JOB NO.	2059-01
BORING NO.	G2-209	SAMPLED	
DEPTH	0-24.5'	TEST STARTED	5-26-94 DCW
SAMPLE NO.	5 @5% OMC	TEST FINISHED	6-10-94
SOIL DESCR.	On Site Disposal Cell	SETUP NO.	19S
TEST TYPE	TX/Pbp	SATURATED TEST	Yes
CONF. PRES. PSF	720	AT FIELD MOIST.	No

MOISTURE/DENSITY DATA		BEFORE TEST	AFTER TEST
Wt. Soil + Moisture	(g)	490.3	493.4
Wt. Wet Soil & Pan	(g)	498.8	501.8
Wt. Dry Soil & Pan	(g)	435.3	435.3
Wt. Lost Moisture	(g)	63.5	66.6
Wt. of Pan Only	(g)	8.4	8.4
Wt. of Dry Soil	(g)	426.8	426.8
Moisture Content %		14.9	15.6
Wet Density PCF		138.9	144.7
Dry Density PCF		120.9	125.2

Init. Diameter	(in)	2.382	(cm)	6.050
Init. Area	(sq in)	4.456	(sq cm)	28.752
Init. Height	(in)	3.017	(cm)	7.663
Vol. Bef. Consol.	(cu ft)	0.00778		
Vol. After Consol.	(cu ft)	0.00752		
Porosity %		31.27		
Constant Head	(PSI)	2.00	(cm)	140.79

Time Min	Time Sec	Init. Burette CC	Final Burette CC	Head Corr. CC	Permeability k cm/sec
1443.0	86580	49.8	48.8	15.8	2.5E-08
1413.0	84780	48.8	48.0	16.8	2.1E-08
1443.0	86580	48.0	47.2	17.7	2.0E-08
1465.0	87900	47.2	46.3	18.6	2.3E-08
1455.0	87300	46.3	45.4	19.5	2.3E-08
1439.0	86340	45.4	44.2	20.7	3.1E-08
1441.0	86460	44.2	43.9	21.5	7.8E-09
1430.0	85800	43.9	43.2	22.1	2.0E-08
1448.0	86880	43.2	42.4	22.9	2.0E-08
1459.0	87540	42.4	41.7	23.6	1.8E-08
1440.0	86400	41.7	41.0	24.4	1.9E-08

ADVANCED TERRA TESTING, INC.

TRIAXAL COMPRESSION TEST DATA

CLIENT Parsons PO 101

JOB NO. 2059-01

BORING NO.	G2-209
DEPTH	0-24.5'
SAMPLE NO.	5 @5% OMC
SOIL DESCR.	On Site Disposal Cell
TEST TYPE	TX/Pbp
CONF. PRES. PSF	720

SAMPLED	
TEST STARTED	5-26-94 DCW
TEST FINISHED	6-10-94
SETUP NO.	19S
SATURATED TEST	Yes
AT FIELD MOIST.	No

SATURATION DATA

Cell Pres. (PSI)	Back Pres. (PSI)	Burette Reading (CC)		Pore Pressure (PSI)		Change	B
		Close	Open	Close	Open		
40.0	38.0	1.1	11.4				
50.0	48.0	10.7	11.6	39.7	49.0	9.3	0.93
60.0		11.7	11.7	49.5	59.1	9.6	0.96

CONSOLIDATION DATA

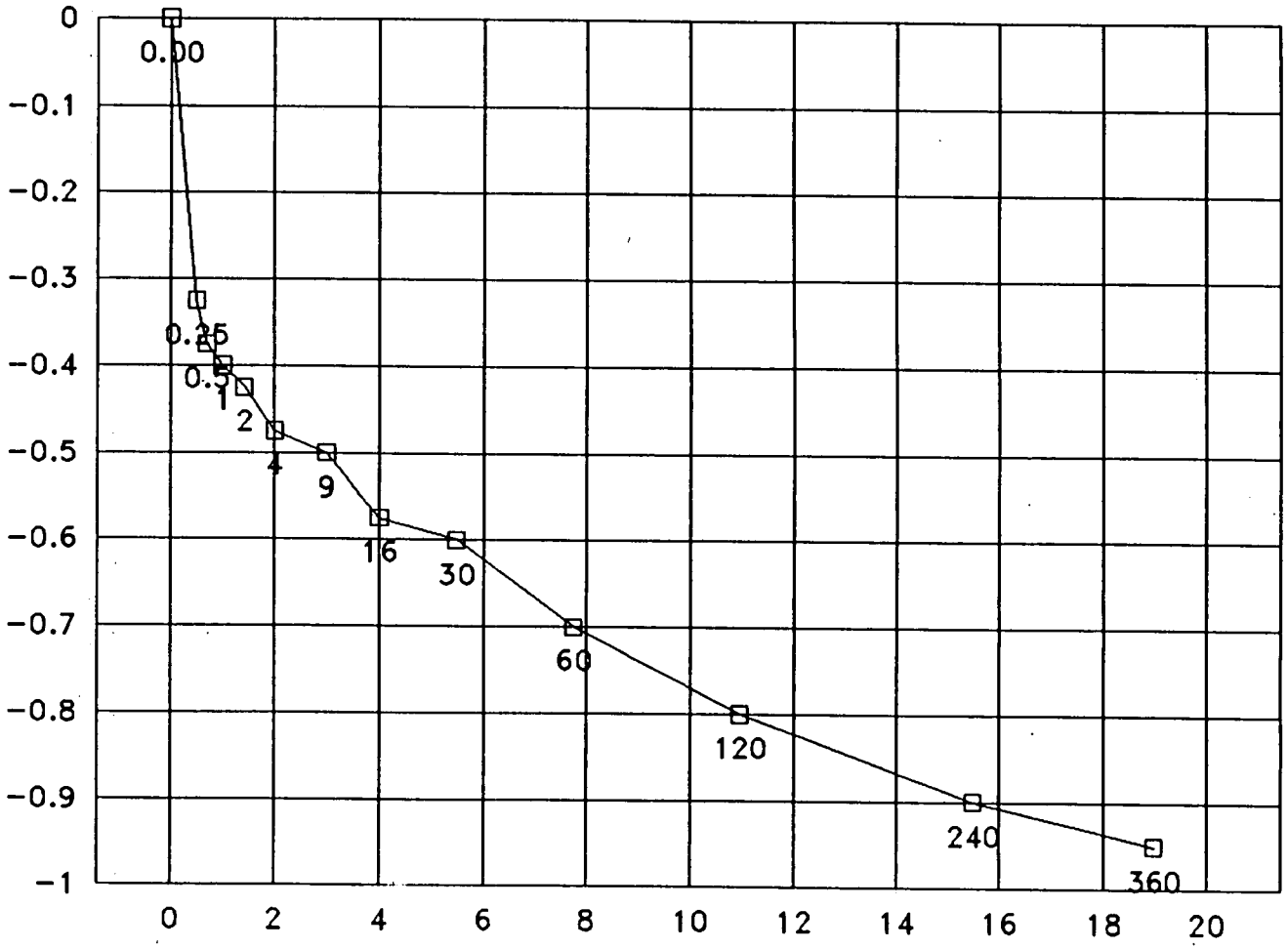
Elapsed Time (Min)	SQRT Time (Min)	Burette Reading (CC)	Volume Defl. (cc)
0.00	0.00	11.80	0.00
0.25	0.50	12.13	-0.32
0.5	0.71	12.18	-0.38
1	1.00	12.20	-0.40
2	1.41	12.23	-0.42
4	2.00	12.28	-0.47
9	3.00	12.30	-0.50
16	4.00	12.38	-0.57
30	5.48	12.40	-0.60
60	7.75	12.50	-0.70
120	10.95	12.60	-0.80
240	15.49	12.70	-0.90
360	18.97	12.75	-0.95

Initial Height	(in)	3.017	Init. Vol.	(CC)	220.36
Height Change	(in)	0.035	Vol. Change	(CC)	13.90
Ht. After Cons.	(in)	2.982	Cell Exp.	(CC)	6.40
Initial Area	(sq in)	4.456	Net Change	(CC)	7.50
Area After Cons.	(sq in)	4.355	Cons. Vol.	(CC)	212.86

ADVANCED TERRA TESTING, INC.

CONSOLIDATION DATA

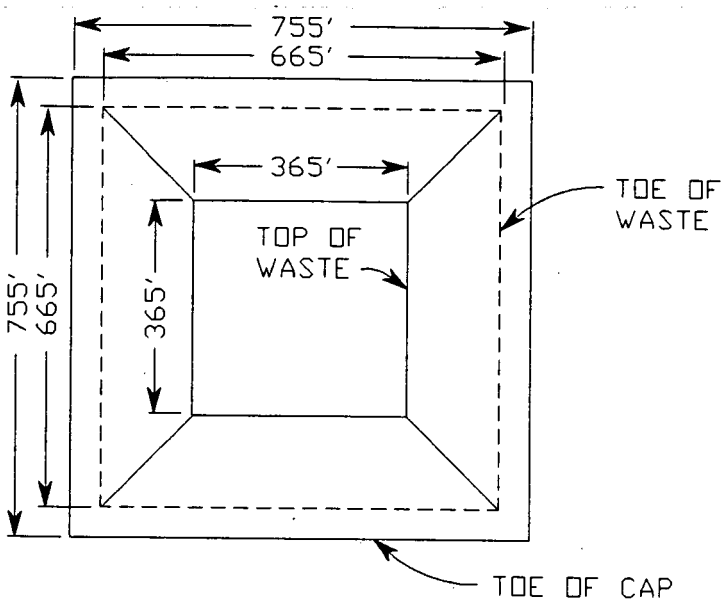
G2-209 @0-24.5' #5 720 psf Conf.



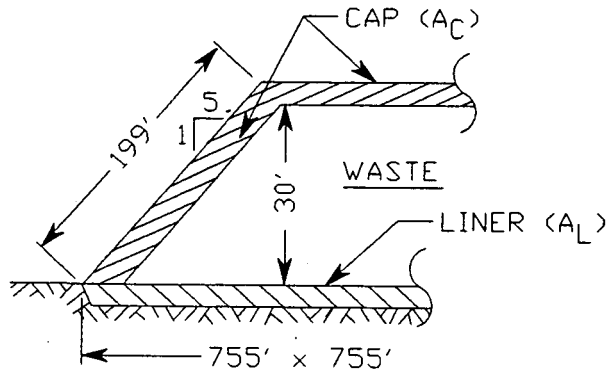
APPENDIX E.3.4

DISPOSAL CELL VOLUME CALCULATIONS

ALT. 6A -- EXCAVATION AND ON-SITE DISPOSAL (EXPANDED TRESPASSER)



OU2 DISPOSAL CELL



1. Volume of Disposal Cell

$$V = \frac{(665' \times 665') + (365' \times 365')}{2} \times 30' \times \frac{CY}{27'} = 319{,}700\ CY$$

Since the cell capacity for this design (319,700 CY) is greater than the estimated volume of waste (314,200 CY) to be disposed, the capacity of this cell is sufficient.

2. Liner Area

$$A_L = (755' \times 755') \times \frac{SY}{9'} = 63{,}336\ SY$$

3. Cap Area

$$A_C = (365' \times 365' + (4 \times 199' \times \frac{365' + 755'}{2})) \times \frac{SY}{9'} = 64{,}331\ SY$$

ALTERNATIVE 6: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: EXPANDED TRESPASSER

CLEAR & GRUB AREA = 23 AC
STAGING AREA = 670 CY
TOTAL # OF WELLS = 20
TOTAL LINER AREA = 63,336 SY
TOTAL CAP AREA = 64,331 SY

			CELL LINER			CELL CAP								
SUBUNIT	WASTE* VOLUME TO CELL (CY)	PERCENT OF TOTAL WASTE VOLUME	LINER AREA (SY)	(3 FEET) CLAY QUANTITY (CY)	(12 IN.) PEA GRAVEL (CY)	CAP AREA (SY)	(18 IN.) CONTOURING LAYER (CY)	(2 FEET) CLAY CAP (CY)	(1.75') COMMON SOIL (CY)	(6 IN.) TOP SOIL (CY)	(12 IN.) PEA GRAVEL (CY)	(3 FEET) COBBLES (CY)	(6 IN) SAND LAYER (CY)	NUMBER OF MONITORING WELLS
SWL	27,100	8	5,067	5,067	1,689	5,146	2,573	3,431	3,002	858	1,715	5,146	858	2
LSP	21,200	7	4,434	4,434	1,478	4,503	2,252	3,002	2,627	751	1,501	4,503	751	1
IFP	103,300	33	20,901	20,901	6,966	21,229	10,615	14,154	12,383	3,539	7,076	21,229	3,539	7
SF	88,000	28	17,734	17,734	5,911	18,013	9,006	12,009	10,507	3,003	6,004	18,013	3,003	6
AFP	74,600	24	15,201	15,201	5,066	15,439	7,720	10,293	9,006	2,574	5,146	15,439	2,574	5
TOTAL	314,200	100	63,336	63,336	21,110	64,331	32,166	42,889	37,524	10,724	21,442	30,879	5,148	20

* WASTE VOLUME = REMEDIATION VOLUME + ADDITIONAL EXCAVATION REQUIRED TO REMOVE REMEDIATION VOLUME**
+ 3,000 CY OF GENERATED WASTE (15,000 CY/5 = 3,000 CY)

** 14% FOR SWL AND 10% FOR LSP, IFP, SF, AND AFP

ALTERNATIVE 6A: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: EXPANDED TRESPASSER

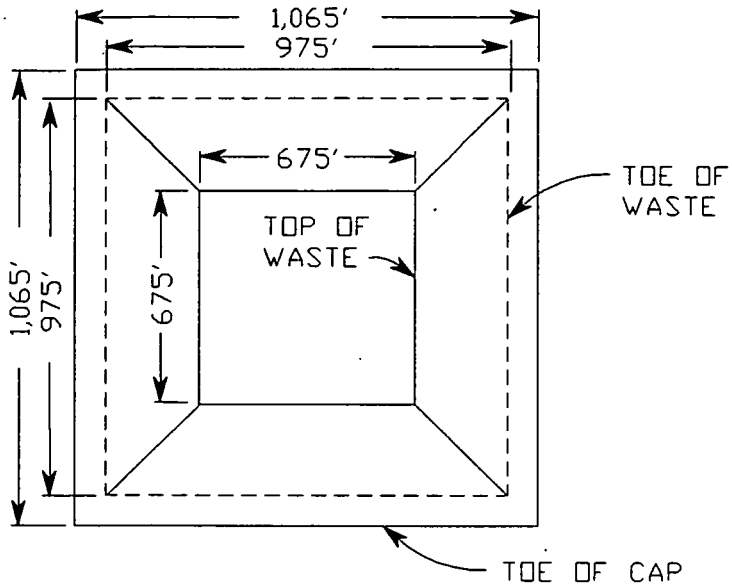
FENCE	=	4,000 LF	BORROW FOR DIKE	=	0 CY
6" PERFORATED PIPE	=	4,000 LF	GEOTEXTILE	=	0 SY
6/10 HDPE PIPE TO AWWT	=	3,500 LF	COBBLES	=	0 CY
HDPE MANHOLES	=	10	DRAINAGE PIPE	=	0 LF

SUBUNIT	PERCENT OF TOTAL WASTE VOLUME	LEACHATE COLLECTION SYSTEM				SIDE SLOPE DIKE			
		6" PIPE PERFORATED (LF)	10/6-HDPE PIPE TO AWWT (CY)	MANHOLES (EA)	FENCE (LF)	BORROW FOR DIKE (CY)	GEOTEXTILE (SY)	COBBLES (CY)	DRAINAGE PIPE (LF)
SWL	8	320	280	1	320	0	0	0	0
LSP	7	280	245	1	280	0	0	0	0
IFP	33	1,320	1,155	2	1320	0	0	0	0
SF	28	1,120	980	4	1120	0	0	0	0
AFP	24	960	840	2	960	0	0	0	0
TOTAL	100	4,000	3,500	10	4,000	0	0	0	0

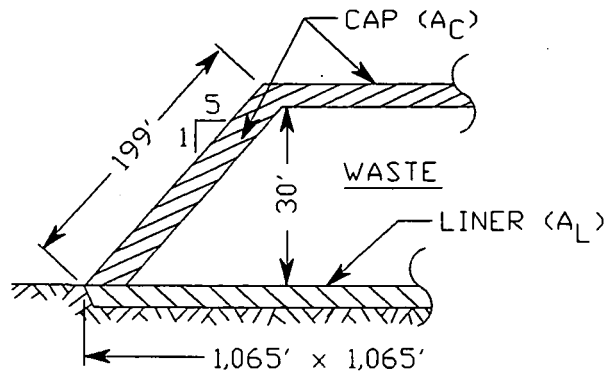
000022

6647 FEMP-OU02-6 FINAL
March 1, 1995

ALT. 6B -- EXCAVATION AND ON-SITE DISPOSAL (RESIDENT FARMER)



OU2 DISPOSAL CELL



1. Volume of Disposal Cell

$$V = \frac{(975' \times 975') + (675' \times 675')}{2} \times 30' \times \frac{CY}{27'} = 781{,}250 \text{ CY}$$

Since the cell capacity for this design (781,250 CY) is greater than the estimated volume of waste (780,700 CY) to be disposed, the capacity of this cell is sufficient.

2. Liner Area

$$A_L = (1{,}065' \times 1{,}065') \times \frac{SY}{9'} = 126{,}025 \text{ SY}$$

3. Cap Area

$$A_C = (675' \times 675' + (4 \times 199' \times \frac{675' + 1{,}065'}{2})) \times \frac{SY}{9'} = 127{,}571 \text{ SY}$$

000973

ON-SITE DISPOSAL CELL FOR ALTERNATIVE 6B (RESIDENT FARMER) 10/19/94

ALTERNATIVE 6B: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: RESIDENT FARMER

CLEAR & GRUB AREA = 37 AC
STAGING AREA = 670 CY
TOTAL # OF WELLS = 28
TOTAL LINER AREA = 126,025 SY
TOTAL CAP AREA = 127,571 SY

			CELL LINER			CELL CAP								
SUBUNIT	WASTE* VOLUME TO CELL (CY)	PERCENT OF TOTAL WASTE VOLUME	LINER AREA (SY)	(3 FEET) CLAY QUANTITY (CY)	(12 IN.) PEA GRAVEL (CY)	CAP AREA (SY)	(18 IN.) CONTOURING LAYER (CY)	(2 FEET) CLAY CAP (CY)	(1.75') COMMON SOIL (CY)	(6 IN.) TOP SOIL (CY)	(12 IN.) PEA GRAVEL (CY)	(3 FEET) COBBLES (CY)	(6 IN) SAND LAYER (CY)	NUMBER OF MONITORING WELLS
SWL	115,200	15	18,904	18,904	6,301	19,136	9,568	12,758	11,162	3,190	6,378	19,136	3,190	4
LSP	92,800	12	15,123	15,123	5,041	15,309	7,654	10,206	8,929	2,552	5,102	15,309	2,552	3
IFP	110,900	14	17,644	17,644	5,881	17,860	8,930	11,907	10,418	2,977	5,953	17,860	2,977	4
SF	376,400	48	60,492	60,492	20,164	61,234	30,617	40,825	35,718	10,208	20,409	61,234	10,208	13
AFP	85,400	11	13,863	13,863	4,621	14,033	7,016	9,356	8,185	2,339	4,677	14,033	2,339	3
TOTAL	780,700	100	126,025	126,025	42,008	127,571	63,786	85,052	74,412	21,266	42,519	52,304	8,719	28

* WASTE VOLUME = REMEDIATION VOLUME + ADDITIONAL EXCAVATION REQUIRED TO REMOVE REMEDIATION VOLUME**
+ 3,000 CY OF GENERATED WASTE (15,000 CY/5 = 3,000 CY)

** 14% FOR SWL AND 10% FOR LSP, IFP, SF, AND AFP

ALTERNATIVE 6B: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: RESIDENT FARMER

FENCE	=	5,500 LF	BORROW FOR DIKE	=	0 CY
6" PERFORATED PIPE	=	7,000 LF	GEOTEXTILE	=	0 SY
6/10 HDPE PIPE TO AWWT	=	3,500 LF	COBBLES	=	0 CY
HDPE MANHOLES	=	10	DRAINAGE PIPE	=	0 LF

SUBUNIT	PERCENT OF TOTAL WASTE VOLUME	LEACHATE COLLECTION SYSTEM: 6" PIPE PERFORATED (LF)	LEACHATE COLLECTION SYSTEM: 10/6-HDPE PIPE TO AWWT (CY)	LEACHATE COLLECTION SYSTEM: MANHOLES (EA)	FENCE (LF)	SIDE SLOPE DIKE: BORROW FOR DIKE (CY)	SIDE SLOPE DIKE: GEOTEXTILE (SY)	SIDE SLOPE DIKE: COBBLES (CY)	SIDE SLOPE DIKE: DRAINAGE PIPE (LF)
SWL	15	1,050	525	1	825	0	0	0	0
LSP	12	840	420	1	660	0	0	0	0
IFP	14	980	490	2	770	0	0	0	0
SF	48	3,360	1,680	4	2640	0	0	0	0
AFP	11	770	385	2	605	0	0	0	0
TOTAL	100	7,000	3,500	10	5,500	0	0	0	0

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-5})
BERM VOLUME OF ON-SITE DISPOSAL CELL

CRU2 FS
8/10/94

S1 =	3	3:1 interior side slope
S2 =	5	5:1 exterior side slope
HB1 =	31	ft, height of interior berm (Waste Ht. + 1' Contour Layer)
WB =		width of berm
WB1 =	93	ft, S1*(HB1) see sketch
WB2 =	10	ft, S2*2', see sketch
WB3 =	155	ft, S2*(HB1), see sketch
WB12 =	103	ft, WB1 + WB2

VB1 = 4*(L)*(1/2*WB1*HB1)+1/3*(2*WB1)*HB1
VB2 = ((2*(L+(2*WB1)+(2*WB2))*HB1*WB1)+(2*(W+(2*WB1))*WB1*WB2))/27
VB3 = (((2*0.5*(L+(2*WB12))*WB3*HB1)+(2*0.5*(W+(2*WB12))*WB3*HB1)))+
+((1/3)*((2*WB3) ^ 2)*(HB1)))/27

W	L	H1	WB	H4	VB1	VB2	VB3	TOTAL (cy)
272	272	31	155	25	71,328	21,493	206,912	299,732
273	273	31	155	25	71,541	21,539	207,268	300,348
274	274	31	155	25	71,755	21,585	207,623	300,963
275	275	31	155	25	71,968	21,631	207,979	301,579
276	276	31	155	25	72,182	21,677	208,335	302,194
277	277	31	155	25	72,395	21,723	208,691	302,810
278	278	31	155	25	72,609	21,769	209,047	303,425
279	279	31	155	25	72,822	21,815	209,403	304,040
280	280	31	155	25	73,036	21,861	209,759	304,656
281	281	31	155	25	73,250	21,907	210,115	305,271
282	282	31	155	25	73,463	21,953	210,471	305,887
283	283	31	155	25	73,677	21,999	210,827	306,502
284	284	31	155	25	73,890	22,044	211,183	307,117
285	285	31	155	25	74,104	22,090	211,539	307,733
286	286	31	155	25	74,317	22,136	211,895	308,348
287	287	31	155	25	74,531	22,182	212,250	308,964
288	288	31	155	25	74,744	22,228	212,606	309,579
289	289	31	155	25	74,958	22,274	212,962	310,194
290	290	31	155	25	75,172	22,320	213,318	310,810
291	291	31	155	25	75,385	22,366	213,674	311,425
292	292	31	155	25	75,599	22,412	214,030	312,041
293	293	31	155	25	75,812	22,458	214,386	312,656
294	294	31	155	25	76,026	22,504	214,742	313,271
295	295	31	155	25	76,239	22,550	215,098	313,887
296	296	31	155	25	76,453	22,596	215,454	314,502
297	297	31	155	25	76,666	22,641	215,810	315,118

NOTE: The formulas assume some simplification of the geometry of the cell. See sketches.
The cap is assumed to be a pyramid.

ONSDCET.WK3 E:

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-6})

BERM VOLUME OF ON-SITE DISPOSAL CELL

CRU2 FS
8/9/94

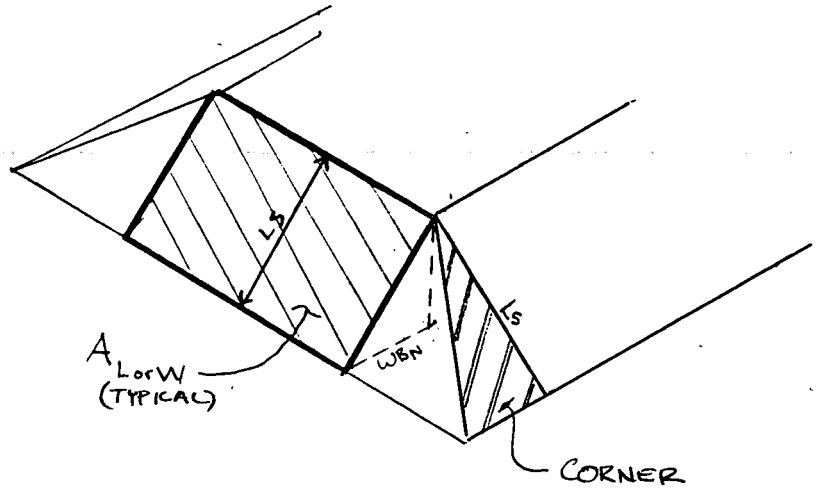
S1 =	3	3:1 interior side slope
S2 =	5	5:1 exterior side slope
HB1 =	31	ft, height of interior berm (Waste Ht. + 1' Contour Layer)
WB =		width of berm
WB1 =	93	ft, S1*(HB1) see sketch
WB2 =	10	ft, S2*2', see sketch
WB3 =	155	ft, S2*(HB1), see sketch
WB12 =	103	ft, WB1 + WB2

VB1 = 4*(L)*(1/2*WB1*HB1)+1/3*(2*WB1)*HB1
VB2 = ((2*(L+(2*WB1)+(2*WB2))*HB1*WB1)+(2*(W+(2*WB1))*WB1*WB2))/27
VB3 = (((2*0.5*(L+(2*WB12))*WB3*HB1)+(2*0.5*(W+(2*WB12))*WB3*HB1)))+
+((1/3)*((2*WB3) ^ 2)*(HB1)))/27

W	L	H1	WB	H4	VB1	VB2	VB3	TOTAL (cy)
272	272	31	155	25	71,328	21,493	206,912	299,732
273	273	31	155	25	71,541	21,539	207,268	300,348
274	274	31	155	25	71,755	21,585	207,623	300,963
275	275	31	155	25	71,968	21,631	207,979	301,579
276	276	31	155	25	72,182	21,677	208,335	302,194
277	277	31	155	25	72,395	21,723	208,691	302,810
278	278	31	155	25	72,609	21,769	209,047	303,425
279	279	31	155	25	72,822	21,815	209,403	304,040
280	280	31	155	25	73,036	21,861	209,759	304,656
281	281	31	155	25	73,250	21,907	210,115	305,271
282	282	31	155	25	73,463	21,953	210,471	305,887
283	283	31	155	25	73,677	21,999	210,827	306,502
284	284	31	155	25	73,890	22,044	211,183	307,117
285	285	31	155	25	74,104	22,090	211,539	307,733
286	286	31	155	25	74,317	22,136	211,895	308,348
287	287	31	155	25	74,531	22,182	212,250	308,964
288	288	31	155	25	74,744	22,228	212,606	309,579
289	289	31	155	25	74,958	22,274	212,962	310,194
290	290	31	155	25	75,172	22,320	213,318	310,810
291	291	31	155	25	75,385	22,366	213,674	311,425
292	292	31	155	25	75,599	22,412	214,030	312,041
293	293	31	155	25	75,812	22,458	214,386	312,656
294	294	31	155	25	76,026	22,504	214,742	313,271
295	295	31	155	25	76,239	22,550	215,098	313,887
296	296	31	155	25	76,453	22,596	215,454	314,502
297	297	31	155	25	76,666	22,641	215,810	315,118

NOTE: The formulas assume some simplification of the geometry of the cell. See sketches. The cap is assumed to be a pyramid.

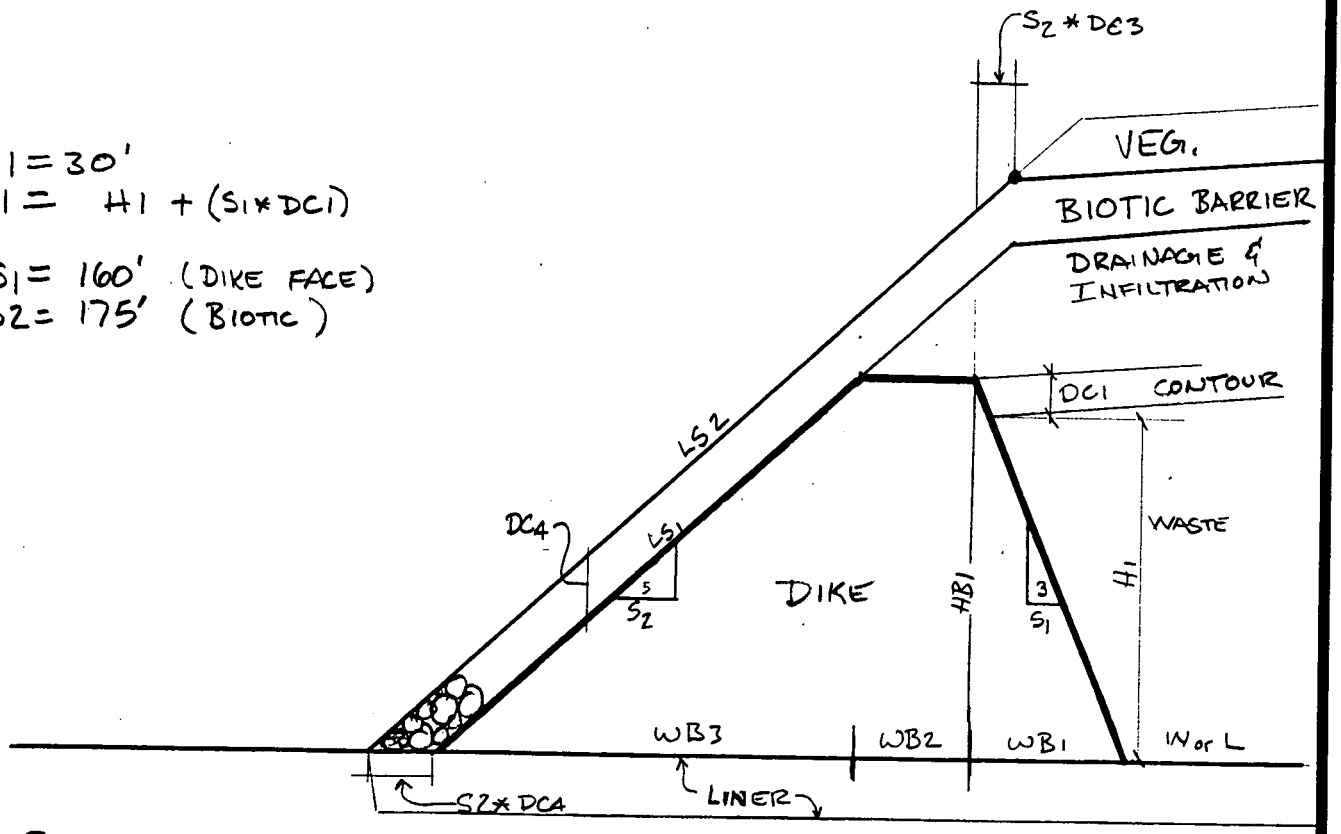
SLOPE QUANTITIES



ISOMETRIC
W/O TOP
nts

H1 = 30'
HB1 = H1 + (S1 * DC1)

LS1 = 160' (DIKE FACE)
LS2 = 175' (BIOTIC)



DIKE SECTION
nts

ASSUME THIS COVER/DIKE GEOMETRY TO SIMPLIFY QUANTITY CALCULATIONS

CLIENT		DEPARTMENT CRUZ	
PROJECT		ORIGINATED BY KG	DATE 8-9-94
ENG. COMM. NO.	PROJECT NO.	CHECKED BY 000978	DATE
AREA		REVISION NUMBER	DATE
SUBJECT ON-SITE DISPOSAL CELL ~ EXPANDED TRESPASSER		REVISED BY	

Form E53-2 (2-90)

CRU2 FS

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-5})
SLOPE, COVER, AND LINER QUANTITIES

Given:

W =	284	ft	From Waste Geometry Calculations
L =	284	ft	From Waste Geometry Calculations
H1 =	30	ft	Waste Height
HB1 =	31	ft	top height of dike
HTotal =	40.5	ft	height at hinge point (+/-)
LS1 =	160	ft	(slope length rounded up for dike)
LS2 =	175	ft	(slope length rounded up for biotic barrier)
S1 =	3 : 1		
S2 =	5 : 1		
WB1 =	93	ft	S1*HB1
WB2 =	10	ft	(width at top of berm see sketch)
WB3 =	155	ft	= S2*HB1 see sketch
WL =	170	ft	(S2*DC3)+WB2+WB3 (see sketch)
DC1 =	1	ft	Contour fill +/-
DC2 =	2	ft	Infiltration Varrier
DC3 =	1	ft	Drainage Layer
DC4 =	3	ft	Biotic Barrier

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-5})
SLOPE, COVER, AND LINER QUANTITIES - Con't

CRU2 FS

BIOTIC BARRIER

AREA AL = LS2*(L+2(WB1-(S2*DC3)))
AREA AL = 80,500 sf 2*AL = 161,000 sf

AREA AW =LS2*(W+2(WB1-(S2*DC3)))
AREA AW = 80,500 sf 2*AW = 161,000 sf

AREA C = "Corner Area" = 1/2*LS*WL
AREA C = 14,875 sf 8*AREA C = 119,000 sf
Subtotal = 441,000 sf

BIOTIC BARRIER VOL. = AREA * DC4 1,323,000 cf 49,000 cy

Cap area, assume pyramid, and L = W

Base = L+2(WB1-(S2*DC3))
Base = 460 ft
altitude = slope length = (((base/2)*4%) ^2+(base/2) ^2) ^0.5
Alt = 230.2 ft
Cap Area = 1/2*(base)*(altitude)*4 sides/(9sf/sy)
Cap Area = 23,530 sy

Liner area, assume L = W

AreaL = ((L+2(WB1+WB2+WB3+(S2*DC4))) ^2)/(9sf/sy)
AreaL = 76,544 sy

Toe to Toe Width, assume level ground & L=W.

Width = L + 2(WB1+WB2+WB3+(S2*DC4))
Width = 830 ft

CRU2 FS

ON-SITE DISPOSAL – EXPANDED TRESPASSER (10^{-5})
SLOPE, COVER, AND LINER QUANTITIES – Con't

1. 261,000 cy = Design Capacity (waste including dike)

2. 52,000 cy = Volume of soil (Fill & Till) w/ ave. U238 approx. 15 pCi/g (56 pCi/g max) available from excav.
   26,000 cy = additional excavation volume
   78,000 cy = Total available soil for dike

3. 183,000 cy = Interior cell volume required (Item 1 – Item 2)
   284 ft From above calculations, bottom L & W will yield approx 183,000 cy

4. 76,544 sy = Liner Area (bottom + dike bottom width) ^ 2 / 9

5. 23,530 sy = Cap Area (top slope only)

6. 307,117 cy = Total Dike (Berm) Volume (see Berm Vol Calc)

7. 229,117 cy = Borrow Required for Dike (Total Berm Vol – Item 2)

11. 830 ft = Toe to Toe Width

NOTE: The following quantites for cap and liner areas and borrow for dike are shown on the figures and included in the cost estimates. They are based on conservative cap/dike interface.

4. 77,562 sy Liner area

5. 26,482 sy Cap Area

6. 333,720 cy Total Dike Volume

7. 201,720 cy Borrow required for dike

8. 893 ft Toe to Toe

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-6}) CRU2 FS
SLOPE, COVER, AND LINER QUANTITIES

Given:

W =	284	ft	From Waste Geometry Calculations
L =	284	ft	From Waste Geometry Calculations
H1 =	30	ft	Waste Height
HB1 =	31	ft	top height of dike
HTotal =	40.5	ft	height at hinge point (+/-)
LS1 =	160	ft	(slope length rounded up for dike)
LS2 =	175	ft	(slope length rounded up for biotic barrier)
S1 =	3 : 1		
S2 =	5 : 1		
WB1 =	93	ft	S1*HB1
WB2 =	10	ft	(width at top of berm see sketch)
WB3 =	155	ft	= S2*HB1 see sketch
WL =	170	ft	(S2*DC3)+WB2+WB3 (see sketch)
DC1 =	1	ft	Contour fill +/-
DC2 =	2	ft	Infiltration Varrier
DC3 =	1	ft	Drainage Layer
DC4 =	3	ft	Biotic Barrier

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-6}) CRU2 FS
SLOPE, COVER, AND LINER QUANTITIES - Con't

BIOTIC BARRIER

AREA AL = LS2*(L+2(WB1-(S2*DC3)))
AREA AL = 80,500 sf 2*AL = 161,000 sf

AREA AW =LS2*(W+2(WB1-(S2*DC3)))
AREA AW = 80,500 sf 2*AW = 161,000 sf

AREA C = "Corner Area" = 1/2*LS*WL
AREA C = 14,875 sf 8*AREA C = 119,000 sf
Subtotal = 441,000 sf

BIOTIC BARRIER VOL. = AREA * DC4 = 1,323,000 cf 49,000 cy

Cap area, assume pyramid, and L = W

Base = L+2(WB1-(S2*DC3))
Base = 460 ft
altitude = slope length = (((base/2)*4%) ^ 2+(base/2) ^ 2) ^ 0.5
Alt = 230.2 ft
Cap Area = 1/2*(base)*(altitude)*4 sides/(9sf/sy)
Cap Area = 23,530 sy

Liner area, assume L = W

AreaL = ((L+2(WB1+WB2+WB3+(S2*DC4))) ^ 2)/(9sf/sy)
AreaL = 76,544 sy

Toe to Toe Width, assume level ground & L=W.

Width = L + 2(WB1+WB2+WB3+(S2*DC4))
Width = 830 ft

ON-SITE DISPOSAL - EXPANDED TRESPASSER (10^{-6}) CRU2 FS
SLOPE, COVER, AND LINER QUANTITIES - Con't

1. 261,000 cy = Design Capacity (waste including dike)

2. 104,000 cy = Volume of soil (Fill & Till) w/ ave. U238 approx. 15 pCi/g (56 pCi/g max) available from excav.
   28,000 cy = additional excavation volume
   132,000 cy = Total available soil for dike

3. 129,000 cy = Interior cell volume required (Item 1 - Item 2)
   284 ft From above calculations, bottom L & W will yield approx 183,000 cy

4. 76,544 sy = Liner Area (bottom + dike bottom width) ^ 2 / 9

5. 23,530 sy = Cap Area (top slope only)

6. 307,117 cy = Total Dike (Berm) Volume (see Berm Vol Calc)

7. 175,117 cy = Borrow Required for Dike (Total Berm Vol - Item 2)

11. 830 ft = Toe to Toe Width

NOTE: The following quantites for cap and liner areas and borrow for dike are shown on the figures and included in the cost estimates. They are based on conservative cap/dike interface.

4. 77,562 sy Liner area

5. 26,482 sy Cap Area

6. 333,720 cy Total Dike Volume

7. 201,720 cy Borrow required for dike

8. 893 ft Toe to Toe

ONSDCET.WK3 C: 8/10/94

ON-SITE DIS[illegible] CELL FOR ALTERNATIVE 6 (EXPANDED TRESPASSER) [redacted] 08/08/94 pm

ALTERNATIVE 6: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: EXPANDED TRESPASSER

CLEAR & GRUB AREA = 35 AC
STAGING AREA = 670 CY
TOTAL # OF WELLS = 24
TOTAL LINER AREA = 77,562 SY
TOTAL CAP AREA = 26,482 SY

SUBUNIT	WASTE* VOLUME TO CELL (CY)	PERCENT OF TOTAL WASTE VOLUME	CELL LINER: LINER AREA (SY)	CELL LINER: CLAY QUANTITY (CY)	CELL LINER: PEA GRAVEL (CY)	CELL CAP: CAP AREA (SY)	CELL CAP: CONTOURING LAYER (CY)	CELL CAP: CLAY CAP (CY)	CELL CAP: COMMON SOIL (CY)	CELL CAP: TOP SOIL (CY)	CELL CAP: PEA GRAVEL (CY)	CELL CAP: COBBLES (CY)	CELL CAP: SAND LAYER (CY)	NUMBER OF MONITORING WELLS
SWL	27,100	8	6,205	6,205	2,048	2,119	1,059	1,419	1,229	360	699	2,119	360	2
LSP	21,200	7	5,429	5,429	1,792	1,854	927	1,242	1,075	315	612	1,854	315	2
IFP	103,300	33	25,595	25,595	8,447	8,739	4,370	5,855	5,069	1,486	2,884	8,739	1,486	8
SF	88,000	28	21,717	21,717	7,167	7,415	3,707	4,968	4,301	1,261	2,447	7,415	1,261	7
AFP	74,600	24	18,615	18,615	6,143	6,356	3,178	4,258	3,686	1,080	2,097	6,356	1,080	6
TOTAL	314,200	100	77,562	77,562	25,595	26,482	13,241	17,743	15,360	4,502	8,739	12,711	2,161	24

* WASTE VOLUME = REMEDIATION VOLUME + ADDITIONAL EXCAVATION REQUIRED TO REMOVE REMEDIATION VOLUME**
+ 3,000 CY OF GENERATED WASTE (15,000 CY/5 = 3,000 CY)

** 14% FOR SWL AND 10% FOR LSP, IFP, SF, AND AFP

16

ALTERNATIVE 6: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC

RECEPTOR: EXPANDED TRESPASSER

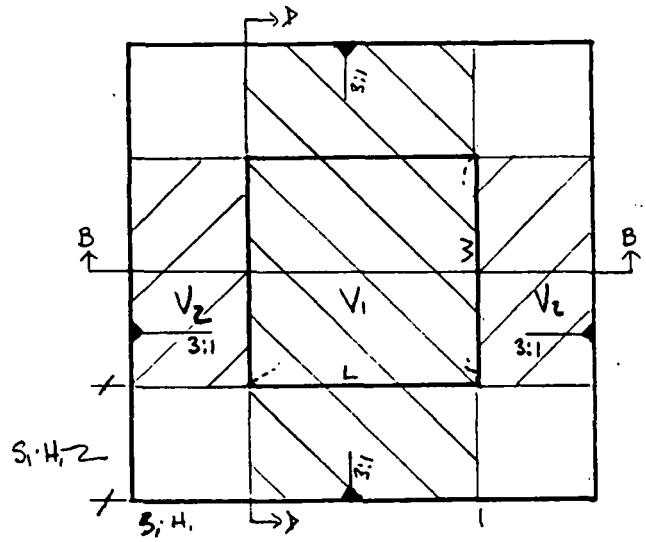
			BORROW FOR DIKE	=	201,720 CY	GEOTEXTILE	= 58,868 SY
FENCE	=	5,000 LF	DIKE COVER	=	~~18,978 CY~~	COBBLES	= 58,868 CY
6" PERFORATED PIPE	=	4,500 LF	VEGETATIVE ZONE	=	~~36,669 CY~~	SAND	= ~~9,811 CY~~
6/10 HDPE PIPE TO AWWT	=	3,500 LF	TOP SOIL	=	~~10,485 CY~~	DRAINAGE PIPE	= 4,000 LF
HDPE MANHOLES	=	10					

	PERCENT OF TOTAL WASTE VOLUME	LEACHATE COLLECTION SYSTEM				SIDE SLOPE DIKE							
SUBUNIT		6" PIPE PERFORATED (LF)	10/6-HDPE PIPE TO AWWT (CY)	MANHOLES (EA)	FENCE (LF)	BORROW FOR DIKE (CY)	DIKE COVER (CY)	VEGETATIVE ZONE (CY)	TOP SOIL (CY)	GEOTEXTILE (SY)	COBBLES (CY)	SAND LAYER (CY)	DRAINAGE PIPE (LF)
SWL	8	360	280	1	400	16,138	1,518	2,934	839	4,709	4,709	785	320
LSP	7	315	245	1	350	14,120	1,328	2,567	734	4,121	4,121	687	280
IFP	33	1,485	1,155	2	1650	66,568	6,263	12,101	3,460	19,426	19,426	3,238	1,320
SF	28	1,260	980	4	1400	56,482	5,314	10,267	2,936	16,483	16,483	2,747	1,120
AFP	24	1,080	840	2	1200	48,413	4,555	8,801	2,516	14,128	14,128	2,355	960
TOTAL	100	4,500	3,500	10	5,000	201,720	18,978	36,669	10,485	58,868	58,868	9,811	4,000

000586
17
6647

ON-SITE DISPOSAL CELL GEOMETRY

ALT 6 ~ EXCAVATION & ON-SITE DISPOSAL
OFF-SITE DISPOSAL > WAC (RESIDENT FARMER)



PLAN VIEW w/o TOP COVER

ASSUME A SQUARE SHAPE. *

ASSUME VOLUME OF TOP & CORNERS ARE APPROXIMATELY EQUAL TO A PYRAMID.

ASSUME V_2 APPROXIMATELY EQUAL TO A TRIANGLE X LENGTH.

$$V_{TOTAL} = V_1 + \Sigma V_2 + V_{CORNE} + V_{TOP}$$

$$V_{PYRAMID} = 1/3 \cdot (\text{area base}) \cdot (\text{altitude})$$

SEE X-SECTIONS NEXT SHEET

$$V_1 = L \times \left(\frac{W + (W + 2(S_1 \cdot H_1))}{2} \right) \times H_1$$

(By average end area. using Top & Bottom)

$$\Sigma V_2 = 2 \times \left(1/2 \times (S_1 \cdot H_1)(H_1) \right) \times W$$

$$V_{CORNER} = 1/3 \times (2(S_1 \cdot H_1))^2 \cdot (H_1)$$

(NOTE EACH CORNER WHEN COMBINED WILL MAKE A PYRAMID).

$$V_{TOP} = 1/3 \times (L + 2(S_1 \cdot H_1))^2 \left(\frac{(L + 2(S_1 \cdot H_1))}{2} \times 0.04 \right)$$

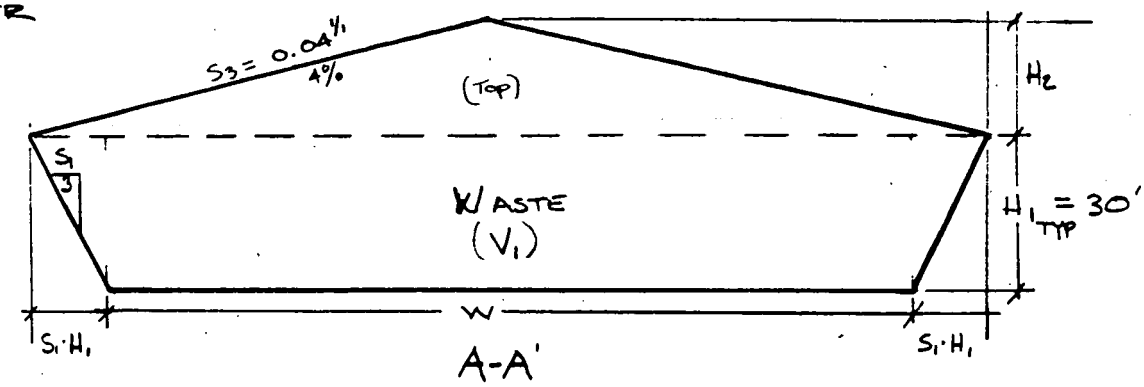
(FOR THIS CALCULATION, ASSUME ALTITUDE HT = 4% of ½ WIDTH AND L = W.)

* NOTE THAT SIMPLIFING GEOMETRY ASSUMPTIONS ARE MADE TO OBTAIN APPROXIMATE QUANTITIES.

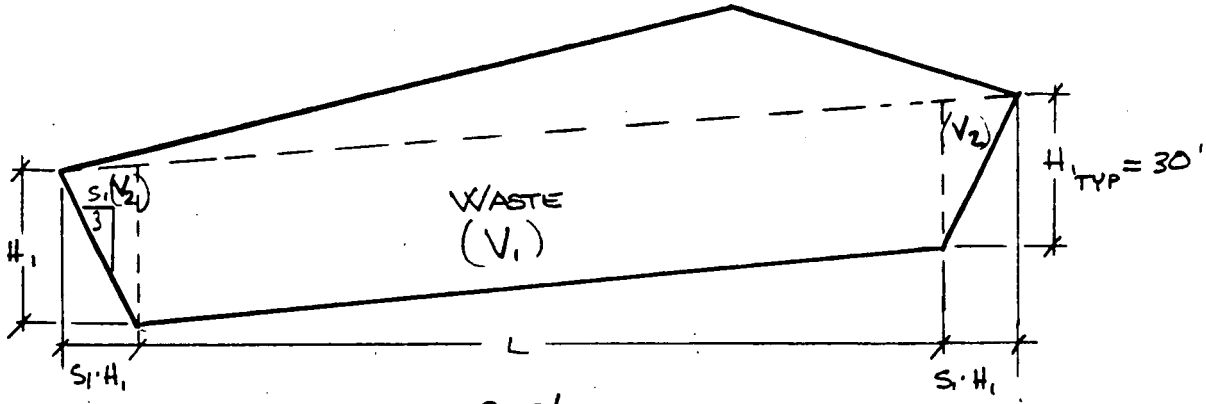
CLIENT		DEPARTMENT CRU2	
PROJECT		ORIGINATED BY KG	DATE 7-27-94
ENG. COMM. NO. 000827	PROJECT NO.	CHECKED BY	DATE
AREA		REVISION NUMBER	DATE
SUBJECT ON-SITE DISPOSAL CELL ~ RESIDENT FARMER			

ALT 6 (RESIDENT FARMER)

X-SECTIONS
w/o COVER



A-A'



B-B'

CALCULATIONS

The following calculations (LOTUS 1·2·3 File ONSDC6RF.WK3 A:) will generate a waste volume given W, L, H_1. This volume is to be compared to a given volume to see which W & L yields the closest value. (adjust the 1ST ROW values of W & L to make changes throughout this worksheet)

CLIENT		DEPARTMENT CRU-2	
PROJECT		ORIGINATED BY K.G.	DATE 7-27-94
ENG. COMM. NO.	PROJECT NO.	CHECKED BY	DATE
AREA		REVISION NUMBER 000888	DATE
SUBJECT ON-SITE DISPOSAL CELL		REVISED BY	

Form ES1-2 2-90

ALTERNATIVE 6 **Excavation and On–Site Disposal w/ Off–Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-5})**

Interior Waste Geometry (Based on Volume)

W = width of base
L = length of base
H = height of 3:1 interior slope
H2 = height of top = (0.5)*(W+(2*W2)*S1
S1 = top slope = 0.04 ft/ft
W2 = side slope top width
W2 = 90 ft

Divide all volumes by 27 cf/cy
(ave end area w/ top & bottom areas)

Volume 1 = L*((W+(W+(3*H)*2))/2)*H
Volume 2 = 2700*W
Volume 3 = 1/3*(S1*H*2)^2*H
Volume 4 = 1/3*(W+180)^2*(0.02*W+3.60) (assumes H2 = 4% of 1/2 W & W=L)

W	L	H	H2	V1	V2	V3	V4	Interior TOTAL (cy)	Dike (cy)	Interior + Dike (cy)
283	283	30	9.26	117,288	28,300	12,000	24,507	182,095	336,779	518,874
284	284	30	9.28	118,018	28,400	12,000	24,666	183,084	337,438	520,522
285	285	30	9.3	118,750	28,500	12,000	24,826	184,076	338,097	522,173
286	286	30	9.32	119,484	28,600	12,000	24,986	185,071	338,756	523,827
287	287	30	9.34	120,221	28,700	12,000	25,148	186,069	339,415	525,483
288	288	30	9.36	120,960	28,800	12,000	25,309	187,069	340,074	527,143
289	289	30	9.38	121,701	28,900	12,000	25,472	188,073	340,733	528,806
290	290	30	9.4	122,444	29,000	12,000	25,635	189,080	341,391	530,471
291	291	30	9.42	123,190	29,100	12,000	25,799	190,089	342,050	532,140
292	292	30	9.44	123,938	29,200	12,000	25,964	191,102	342,709	533,811
293	293	30	9.46	124,688	29,300	12,000	26,129	192,117	343,368	535,485
294	294	30	9.48	125,440	29,400	12,000	26,295	193,135	344,027	537,162
295	295	30	9.5	126,194	29,500	12,000	26,462	194,157	344,686	538,842
296	**296**	30	9.52	126,951	29,600	12,000	26,630	**195,181**	345,345	**540,526**
297	297	30	9.54	127,710	29,700	12,000	26,798	196,208	346,004	542,211
298	298	30	9.56	128,471	29,800	12,000	26,967	197,238	346,663	543,900
299	299	30	9.58	129,234	29,900	12,000	27,136	198,271	347,321	545,592
300	300	30	9.6	130,000	30,000	12,000	27,307	199,307	347,980	547,287
301	301	30	9.62	130,768	30,100	12,000	27,478	200,345	348,639	548,985
302	302	30	9.64	131,538	30,200	12,000	27,649	201,387	349,298	550,685
303	303	30	9.66	132,310	30,300	12,000	27,822	202,432	349,957	552,389
304	304	30	9.68	133,084	30,400	12,000	27,995	203,479	350,616	554,095
305	305	30	9.7	133,861	30,500	12,000	28,169	204,530	351,275	555,805
306	306	30	9.72	134,640	30,600	12,000	28,344	205,584	351,934	557,517
307	307	30	9.74	135,421	30,700	12,000	28,519	206,640	352,593	559,232
308	308	30	9.76	136,204	30,800	12,000	28,695	207,699	353,251	560,951

Note: See next Sheet for Dike Volume Calculations.

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-6})**

Interior Waste Geometry (Based on Volume)

W = width of base
L = length of base
H = height of 3:1 interior slope
H2 = height of top = (0.5)*(W+(2*W2)*S1
S1 = top slope = 0.04 ft/ft
W2 = side slope top width
W2 = 90 ft

Divide all volumes by 27 cf/cy
(ave end area w/ top & bottom areas)

Volume 1 = L*((W+(W+(3*H)*2))/2)*H
Volume 2 = 2700*W
Volume 3 = 1/3*(S1*H*2) ^ 2*H
Volume 4 = 1/3*(W+180) ^ 2*(0.02*W+3.60) (assumes H2 = 4% of 1/2 W & W=L)

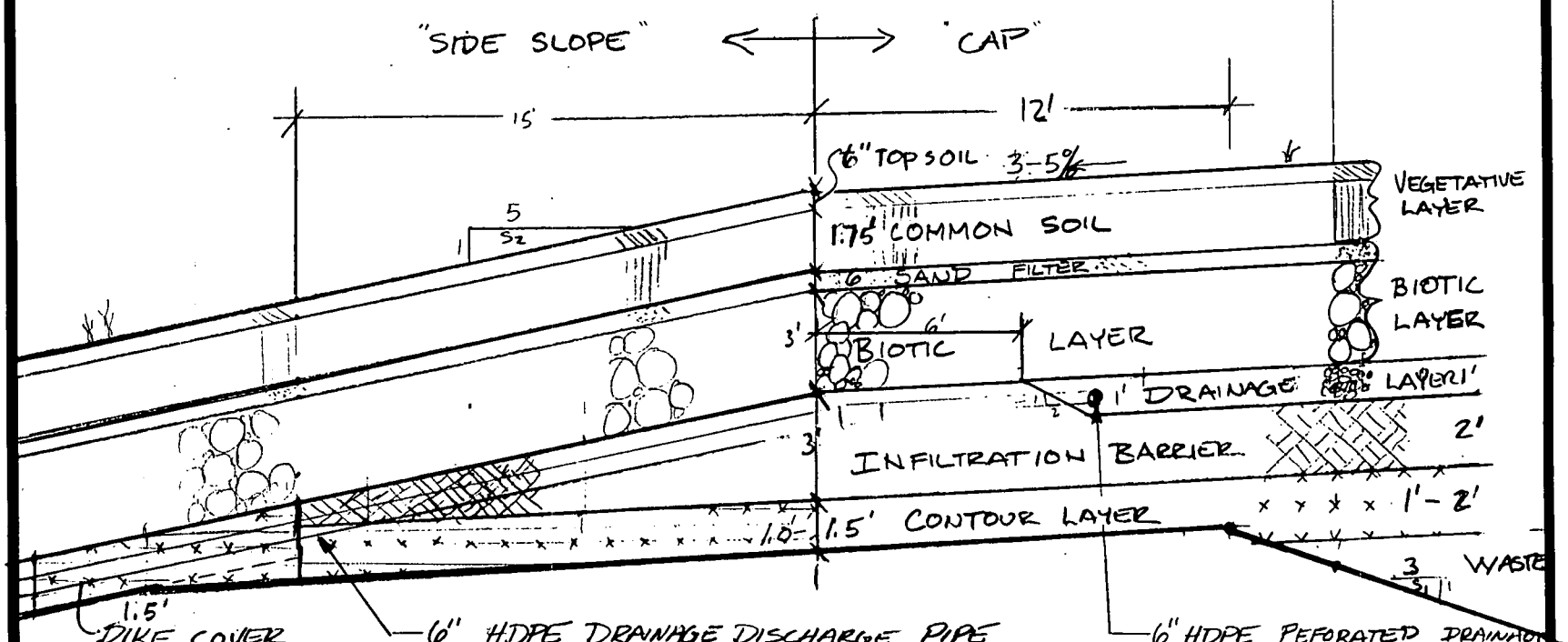
W	L	H	H2	V1	V2	V3	V4	Interior TOTAL (cy)	Dike (cy)	Interior + Dike (cy)
411	411	30	11.82	228,790	41,100	12,000	50,969	332,859	421,117	753,976
412	412	30	11.84	229,804	41,200	12,000	51,228	334,233	421,776	756,009
413	413	30	11.86	230,821	41,300	12,000	51,488	335,609	422,435	758,044
414	414	30	11.88	231,840	41,400	12,000	51,749	336,989	423,094	760,083
415	415	30	11.9	232,861	41,500	12,000	52,011	338,372	423,753	762,125
416	416	30	11.92	233,884	41,600	12,000	52,274	339,758	424,411	764,170
417	417	30	11.94	234,910	41,700	12,000	52,537	341,147	425,070	766,218
418	418	30	11.96	235,938	41,800	12,000	52,802	342,540	425,729	768,269
419	419	30	11.98	236,968	41,900	12,000	53,067	343,935	426,388	770,323
420	420	30	12	238,000	42,000	12,000	53,333	345,333	427,047	772,380
421	421	30	12.02	239,034	42,100	12,000	53,600	346,735	427,706	774,441
422	422	30	12.04	240,071	42,200	12,000	53,868	348,140	428,365	776,504
423	423	30	12.06	241,110	42,300	12,000	54,137	349,547	429,024	778,571
424	**424**	30	12.08	242,151	42,400	12,000	54,407	**350,958**	**429,683**	**780,641**
425	425	30	12.1	243,194	42,500	12,000	54,678	352,372	430,341	782,714
426	426	30	12.12	244,240	42,600	12,000	54,949	353,789	431,000	784,790
427	427	30	12.14	245,288	42,700	12,000	55,222	355,210	431,659	786,869
428	428	30	12.16	246,338	42,800	12,000	55,495	356,633	432,318	788,951
429	429	30	12.18	247,390	42,900	12,000	55,770	358,060	432,977	791,036
430	430	30	12.2	248,444	43,000	12,000	56,045	359,489	433,636	793,125
431	431	30	12.22	249,501	43,100	12,000	56,321	360,922	434,295	795,217
432	432	30	12.24	250,560	43,200	12,000	56,598	362,358	434,954	797,311
433	433	30	12.26	251,621	43,300	12,000	56,876	363,797	435,613	799,409
434	434	30	12.28	252,684	43,400	12,000	57,154	365,239	436,271	801,510
435	435	30	12.3	253,750	43,500	12,000	57,434	366,684	436,930	803,614
436	436	30	12.32	254,818	43,600	12,000	57,715	368,133	437,589	805,722

Note: See next Sheet for Dike Volume Calculations.

(GEOSYNTHETICS NOT SHOWN)

CAP / SIDE SLOPE DETAIL

n.t.s.



DIKE / BERM

(ASSUMES AVE. 15 pCi/g w/ < 56 pCi/g max.)

USED TO ILLUSTRATE DIMENSIONS FOR APPROXIMATE QUANTITIES.

ASSUMES SIMPLIFIED GEOMETRY TO OBTAIN APPROXIMATE QUANTITIES.

CLIENT
PROJECT ON-SITE DISPOSAL CELL
ENG: COMM. NO. PROJECT NO.
AREA
SUBJECT RESIDENT FARMER
DEPARTMENT CRU2
ORIGINATED BY K.G. DATE
CHECKED BY DATE
REVISION NUMBER DATE
REVISED BY

Form ES9-2 (1/89) 00031

E-3-4-22

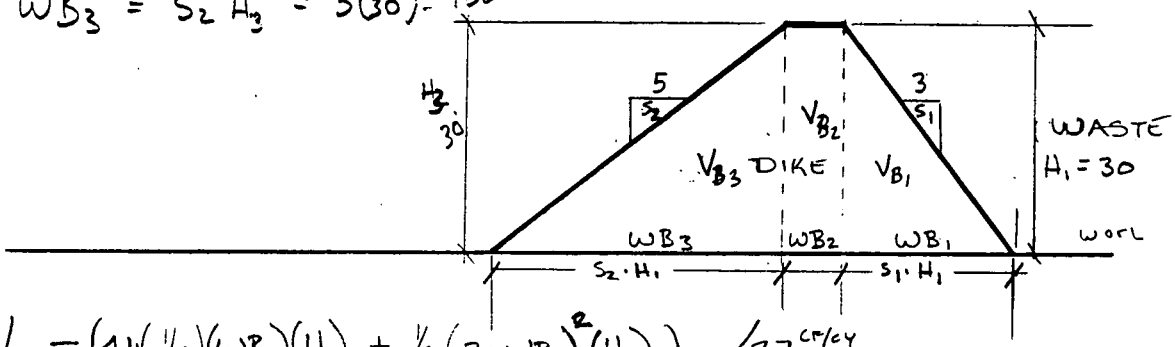
SHEET 5 OF

DIKE / BERM VOLUME

$WB_1 = S_1 \cdot H_1 = 3 \cdot 30' = 90'$

$WB_2 = 27'$ (see CAP/SIDE SLOPE DETAIL)

$WB_3 = S_2 H_3 = 5(30') = 150'$

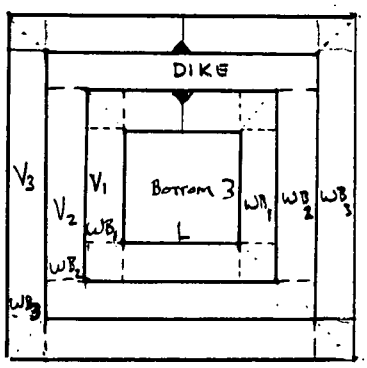


(COVER NOT SHOWN)

$V_{B1} = \left(4 \cdot L\left(\tfrac{1}{2}\right)(WB_1)(H_1) + \tfrac{1}{3}\left(2 \cdot WB_1\right)^2 (H_1)\right) / 27^{cf/cy}$

$(L = W)$ $\quad$ (Σ Corners = pyramid w/ base $= (2 \cdot WB)^2$)

$V_{B2} = \left(2 \cdot (\overset{L}{L + 2(WB_1) + 2(WB_2)}) \times \overset{W}{WB_2} \times \overset{H}{H_1} + 2(W + 2(WB_1)) \times WB_2 \times H_1\right) / 27$



$V_{B3} = \left(2 \cdot (L + 2(WB_1 + WB_2) \cdot \tfrac{1}{2}(WB_3)(H_1) + 2 \cdot (W + 2(WB_1 + WB_2)) \cdot \tfrac{1}{2}(WB_3)(H_1) + \tfrac{1}{3}(2 \cdot WB_3)^2 (H_3)\right) / 27$

CLIENT		DEPARTMENT CRU2	
PROJECT		ORIGINATED BY KG	DATE
ENG. COMM. NO.	PROJECT NO.	CHECKED BY	DATE
AREA		REVISION NUMBER	DATE
SUBJECT ON-SITE DISPOSAL CELL ~		REVISED BY 000002	

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-5})**

BERM VOLUME OF ON-SITE DISPOSAL CELL

S1 =	3	3:1 interior side slope
S2 =	5	5:1 exterior side slope
H1 =	30	ft, height of interior berm
WB =		width of berm
WB1 =	90	ft, (S1*H1)
WB2 =	28.25	ft, assumed width, see sketch
WB3 =	150	ft, (S2*H1)
WB12 =	118.25	ft, WB1 + WB2

VB1 = 4*(L)*(1/2*WB1*H1)+1/3*(2*WB1)*H1
VB2 = ((2*(L+(2*WB1)+(2*WB2))*H1*WB1)+(2*(W+(2*WB1))*WB1*WB2))/27
VB3 = (((2*0.5*(L+(2*WB12))*WB3*H1)+(2*0.5*(W+(2*WB12))*WB3*H1)))+
+((1/3)*((2*WB3)^2)*(H1)))/27

W	L	H1	WB	H4	VB1	VB2	VB3	TOTAL (cy)
283	283	30	150	24	68,600	61,679	206,500	336,779
284	284	30	150	24	68,800	61,805	206,833	337,438
285	285	30	150	24	69,000	61,930	207,167	338,097
286	286	30	150	24	69,200	62,056	207,500	338,756
287	287	30	150	24	69,400	62,181	207,833	339,415
288	288	30	150	24	69,600	62,307	208,167	340,074
289	289	30	150	24	69,800	62,433	208,500	340,733
290	290	30	150	24	70,000	62,558	208,833	341,391
291	291	30	150	24	70,200	62,684	209,167	342,050
292	292	30	150	24	70,400	62,809	209,500	342,709
293	293	30	150	24	70,600	62,935	209,833	343,368
294	294	30	150	24	70,800	63,060	210,167	344,027
295	295	30	150	24	71,000	63,186	210,500	344,686
296	296	30	150	24	71,200	63,311	210,833	345,345
297	297	30	150	24	71,400	63,437	211,167	346,004
298	298	30	150	24	71,600	63,563	211,500	346,663
299	299	30	150	24	71,800	63,688	211,833	347,321
300	300	30	150	24	72,000	63,814	212,167	347,980
301	301	30	150	24	72,200	63,939	212,500	348,639
302	302	30	150	24	72,400	64,065	212,833	349,298
303	303	30	150	24	72,600	64,190	213,167	349,957
304	304	30	150	24	72,800	64,316	213,500	350,616
305	305	30	150	24	73,000	64,441	213,833	351,275
306	306	30	150	24	73,200	64,567	214,167	351,934
307	307	30	150	24	73,400	64,693	214,500	352,593
308	308	30	150	24	73,600	64,818	214,833	353,251

NOTE: The formulas assume some simplification of the geometry of the cell. See sketches.
The cap is assumed to be a pyramid.

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-6})**

BERM VOLUME OF ON-SITE DISPOSAL CELL

S1 =	3	3:1 interior side slope
S2 =	5	5:1 exterior side slope
H1 =	30	ft, height of interior berm
WB =		width of berm
WB1 =	90	ft, (S1*H1)
WB2 =	28.25	ft, assumed width, see sketch
WB3 =	150	ft, (S2*H1)
WB12 =	118.25	ft, WB1 + WB2

VB1 = 4*(L)*(1/2*WB1*H1)+1/3*(2*WB1)*H1

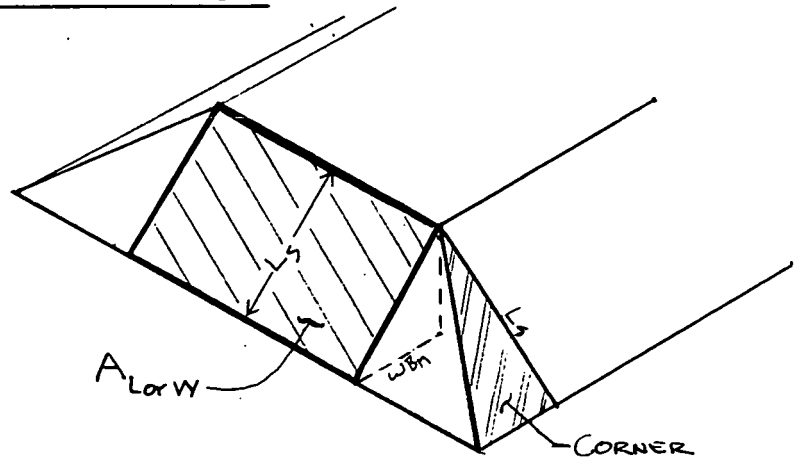
VB2 = ((2*(L+(2*WB1)+(2*WB2))*H1*WB1)+(2*(W+(2*WB1))*WB1*WB2))/27

VB3 = (((2*0.5*(L+(2*WB12))*WB3*H1)+(2*0.5*(W+(2*WB12))*WB3*H1)))+
+((1/3)*((2*WB3)^2)*(H1)))/27

W	L	H1	WB	H4	VB1	VB2	VB3	TOTAL (cy)
411	411	30	150	24	94,200	77,750	249,167	421,117
412	412	30	150	24	94,400	77,876	249,500	421,776
413	413	30	150	24	94,600	78,001	249,833	422,435
414	414	30	150	24	94,800	78,127	250,167	423,094
415	415	30	150	24	95,000	78,253	250,500	423,753
416	416	30	150	24	95,200	78,378	250,833	424,411
417	417	30	150	24	95,400	78,504	251,167	425,070
418	418	30	150	24	95,600	78,629	251,500	425,729
419	419	30	150	24	95,800	78,755	251,833	426,388
420	420	30	150	24	96,000	78,880	252,167	427,047
421	421	30	150	24	96,200	79,006	252,500	427,706
422	422	30	150	24	96,400	79,131	252,833	428,365
423	423	30	150	24	96,600	79,257	253,167	429,024
424	**424**	**30**	**150**	**24**	**96,800**	**79,383**	**253,500**	**429,683**
425	425	30	150	24	97,000	79,508	253,833	430,341
426	426	30	150	24	97,200	79,634	254,167	431,000
427	427	30	150	24	97,400	79,759	254,500	431,659
428	428	30	150	24	97,600	79,885	254,833	432,318
429	429	30	150	24	97,800	80,010	255,167	432,977
430	430	30	150	24	98,000	80,136	255,500	433,636
431	431	30	150	24	98,200	80,261	255,833	434,295
432	432	30	150	24	98,400	80,387	256,167	434,954
433	433	30	150	24	98,600	80,513	256,500	435,613
434	434	30	150	24	98,800	80,638	256,833	436,271
435	435	30	150	24	99,000	80,764	257,167	436,930
436	436	30	150	24	99,200	80,889	257,500	437,589

NOTE: The formulas assume some simplification of the geometry of the cell. See sketches. The cap is assumed to be a pyramid.

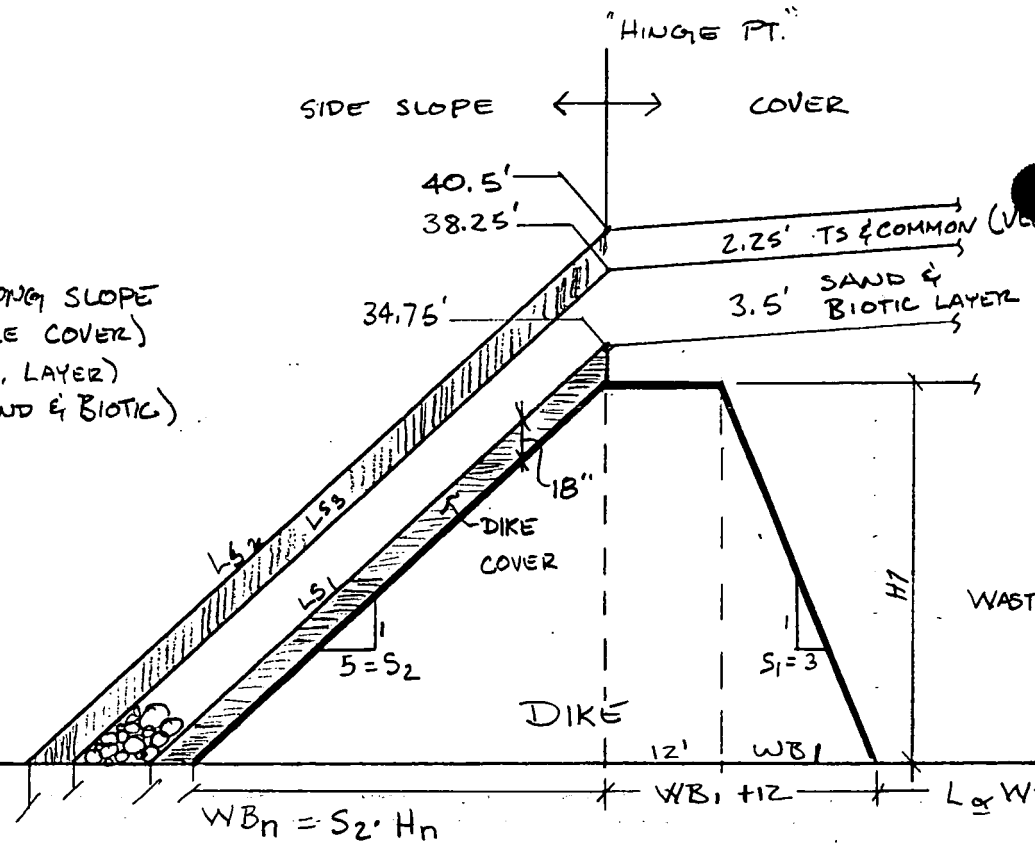
SLOPE QUANTITIES



ISOMETRIC w/o TOP n.t.s.

$H_1 = 30'$
$H_{TOTAL} = 40.5'$

LS = LENGTH ALONG SLOPE
$LS_1 \approx 175'$ (DIKE COVER)
$LS_2 \approx 205'$ (VEG. LAYER)
$LS_3 \approx 195'$ (SAND & BIOTIC)



SECTION n.t.s.

ASSUME THIS COVER GEOMETRY TO SIMPLIFY QUANTITY CALCULATIONS

CLIENT		DEPARTMENT CRU 2	
PROJECT		ORIGINATED BY KG	DATE 8-5-94
ENG. COMM. NO. 000995	PROJECT NO.	CHECKED BY	DATE
AREA		REVISION NUMBER	DATE
SUBJECT ON-SITE DISPOSAL CELL		REVISED BY	

Form E53-2 (2-90)

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-5})**

SLOPE, COVER, AND LINER QUANTITIES

Given:

W =	296	ft	From Waste Geometry Calculations
L =	296	ft	From Waste Geometry Calculations
H1 =	30	ft	Waste/Dike Ht.
Hb =	38.25	ft	height of sand/biotic layer HTotal-Veg
HTotal =	40.5	ft	height at hinge point (+/-)
LS1 =	175	ft	(slope length rounded up for dike cover)
LS2 =	205	ft	(slope length rounded up for vegetative layers)
LS3 =	195	ft	(slope length rounded up for sand & biotic)
S1 =	3 : 1		
S2 =	5 : 1		
WB1 =	90	ft	S1*H1
WB2 =	28.25	ft	(width at top of berm see sketch)
WB1+12 =	102	ft	= S1*H1 + 12' see sketch
WB2-12 =	16.25	ft	(see sketch)
DC1 =	1.5	ft	Dike Cover
DC2 =	1.75	ft	Common Soil
DC3 =	0.5	ft	Top Soil and Sand Filter
DC4 =	3	ft	Biotic Layer

DIKE COVER

AREA AL = LS1*(L+2(WB1+12))
AREA AL = 87,500 sf 2*AL = 175,000 sf

AREA AW =LS1*(W+2(WB1+12))
AREA AW = 87,500 sf 2*AW = 175,000 sf

AREA C = "Corner Area" = 1/2*LS*LH
AREA C = 2,250 sf 8*AREA C = 18,000 sf
Subtotal = 350,000 sf **38,889 sy**

DIKE COVER VOLUME = AREA * DC1 = 525,000 cf **19,444 cy**

COMMON SOIL & TOP SOIL

AREA AL = LS2*(L+2(WB1+12))
AREA AL = 102,500 sf 2*AL = 205,000 sf

AREA AW =LS2*(W+2(WB1+12))
AREA AW = 102,500 sf 2*AW = 205,000 sf

AREA C = "Corner Area" = 1/2*LS*LH
AREA C = 20,756 sf 8*AREA C = 166,050 sf
Subtotal = 576,050 sf

COMMON SOIL VOLUME = AREA * DC2 = 1,008,088 cf **37,337 cy**

TOP SOIL VOLUME = AREA * DC3 = 288,025 cf **10,668 cy**

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-5})**

SLOPE, COVER, AND LINER QUANTITIES – Con't

SAND & BIOTIC LAYERS

AREA AL = LS3*(L+2(WB1+12))
AREA AL = 97,500 sf 2*AL = 195,000 sf

AREA AW =LS3*(W+2(WB1+12))
AREA AW = 97,500 sf 2*AW = 195,000 sf

AREA C = "Corner Area" = 1/2*LS*LH
AREA C = 18,647 sf 8*AREA C = 149,175 sf
Subtotal = 539,175 sf

BIOTIC LAYER VOLUME = AREA * DC4 = 1,617,525 cf 59,908 cy

SAND LAYER VOLUME = AREA * DC3 = 269,588 cf 9,985 cy

Cap area, assume pyramid, and L = W

Base = L+2(WB1+12)
Base = 500 ft
altitude = slope length = (((base/2)*4%) ^ 2+(base/2) ^ 2) ^ 0.5
Alt = 250.2 ft
Cap Area = 1/2*(base)*(altitude)*4 sides/(9sf/sy)
Cap Area = 27,800 sy

Liner area, assume L = W

AreaL = ((L+2(WB1+12+(Hb-(DC3+DC4))*S2)) ^ 2)/(9sf/sy)
AreaL = 79,806 sy

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-5})**

SLOPE, COVER, AND LINER QUANTITIES - Con't

1. 540,000 cy = Design Capacity (waste including dike)

2. 353,100 cy = Volume of soil (Fill & Till) w/ ave. U238 approx. 15 pCi/g (56 pCi/g max) available from excav.
   54,000 cy = additional excavation volume
   407,100 cy = Total available soil for dike

3.a. 132,900 cy = Minimum Interior cell volume required (Item 1 - Item 2)
   424 ft From above calculations, bottom L & W will yield the following:

b. 540,526 cy Total Volume (Interior + Dike)
c. 195,181 cy Total Interior Volume Available (>132,900 cy therefore OK)
d. 345,345 cy Total Berm Volume
e. 62,281 cy Interior Volume available for Excess soil (3c-3a)

4. 79,806 sy = Liner Area (bottom + dike bottom width) ^ 2 / 9

5. 27,800 sy = Cap Area (top slope only)

6. 19,444 cy = Dike Cover (Clean Borrow) see above sheet

7. 37,337 cy = Vegetative Cover (Common Soil, 18" thick) on 5:1 slope

8. 10,668 cy = Top Soil (6" thick) on 5:1 slope

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-6})**

SLOPE, COVER, AND LINER QUANTITIES

Given:

W =	424	ft	From Waste Geometry Calculations
L =	424	ft	From Waste Geometry Calculations
H1 =	30	ft	Waste/Dike Ht.
Hb =	38.25	ft	height of sand/biotic layer HTotal-Veg
HTotal =	40.5	ft	height at hinge point (+/-)
LS1 =	175	ft	(slope length rounded up for dike cover)
LS2 =	205	ft	(slope length rounded up for vegetative layers)
LS3 =	195	ft	(slope length rounded up for sand & biotic)
S1 =	3 : 1		
S2 =	5 : 1		
WB1 =	90	ft	S1*H1
WB2 =	28.25	ft	(width at top of berm see sketch)
WB1+12 =	102	ft	= S1*H1 + 12' see sketch
WB2-12 =	16.25	ft	(see sketch)
DC1 =	1.5	ft	Dike Cover
DC2 =	1.75	ft	Common Soil
DC3 =	0.5	ft	Top Soil and Sand Filter
DC4 =	3	ft	Biotic Layer

DIKE COVER

AREA AL = LS1*(L+2(WB1+12))
AREA AL = 109,900 sf 2*AL = 219,800 sf

AREA AW =LS1*(W+2(WB1+12))
AREA AW = 109,900 sf 2*AW = 219,800 sf

AREA C = "Corner Area" = 1/2*LS*LH
AREA C = 2,250 sf 8*AREA C = 18,000 sf
Subtotal = 439,600 sf 48,844 sy

DIKE COVER VOLUME = AREA * DC1 = 659,400 cf 24,422 cy

COMMON SOIL & TOP SOIL

AREA AL = LS2*(L+2(WB1+12))
AREA AL = 128,740 sf 2*AL = 257,480 sf

AREA AW =LS2*(W+2(WB1+12))
AREA AW = 128,740 sf 2*AW = 257,480 sf

AREA C = "Corner Area" = 1/2*LS*LH
AREA C = 20,756 sf 8*AREA C = 166,050 sf
Subtotal = 681,010 sf

COMMON SOIL VOLUME = AREA * DC2 = 1,191,768 cf 44,140 cy

TOP SOIL VOLUME = AREA * DC3 = 340,505 cf 12,611 cy

ONSDC6RF.WK3 C: 8/5/94

13

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-6})**

SLOPE, COVER, AND LINER QUANTITIES - Con't

SAND & BIOTIC LAYERS

AREA AL = LS3*(L+2(WB1+12))
AREA AL = 122,460 sf 2*AL = 244,920 sf

AREA AW =LS3*(W+2(WB1+12))
AREA AW = 122,460 sf 2*AW = 244,920 sf

AREA C = "Corner Area" = 1/2*LS*LH
AREA C = 18,647 sf 8*AREA C = 149,175 sf
Subtotal = 639,015 sf

BIOTIC LAYER VOLUME = AREA * DC4 = 1,917,045 cf 71,002 cy

SAND LAYER VOLUME = AREA * DC3 = 319,508 cf 11,834 cy

Cap area, assume pyramid, and L = W

Base = L+2(WB1+12)
Base = 628 ft
altitude = slope length = (((base/2)*4%) ^ 2+(base/2) ^ 2) ^ 0.5
Alt = 314.3 ft
Cap Area = 1/2*(base)*(altitude)*4 sides/(9sf/sy)
Cap Area = 43,855 sy

Liner area, assume L = W

AreaL = ((L+2(WB1+12+(Hb-(DC3+DC4))*S2)) ^ 2)/(9sf/sy)
AreaL = 105,733 sy

ALTERNATIVE 6 **Excavation and On-Site Disposal w/ Off-Site Disposal of Fraction Exceeding WAC (Resident Farmer) (10^{-6})**

SLOPE, COVER, AND LINER QUANTITIES - Con't

1. 780,000 cy = Design Capacity (waste including dike)

2. 519,500 cy = Volume of soil (Fill & Till) w/ ave. U238 approx. 15 pCi/g (56 pCi/g max) available from excav.
   73,600 cy = additional excavation volume
   593,100 cy = Total available soil for dike

3.a. 186,900 cy = Minimum Interior cell volume (Item 1 - Item 2)
   424 ft From above calculations, bottom L & W will yield the following:

b. 780,641 cy Total Volume (Interior + Dike)
c. 350,958 cy Total Interior Volume Available (>186,900 cy therefore OK)
d. 429,683 cy Total Berm Volume
e. 164,058 cy Interior Volume available for Excess soil (3c-3a)

4. 105,733 sy = Liner Area
   (bottom + dike bottom width) ^ 2 / 9

5. 43,855 sy = Cap Area (top slope only)

6. 24,422 cy = Dike Cover (Clean Borrow) see above sheet

7. 44,140 cy = Vegetative Cover (Common Soil, 18" thick) on 5:1 slope

8. 12,611 cy = Top Soil (6" thick) on 5:1 slope

ON-SITE DISPOSAL CELL FOR ALTERNATIVE 5 (RESIDENT FARMER) 08/08/94 am

ALTERNATIVE 6: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: RESIDENT FARMER

CLEAR & GRUB AREA = 60 AC
STAGING AREA = 670 CY
TOTAL # OF WELLS = 32
TOTAL LINER AREA = 105,733 SY
TOTAL CAP AREA = 43,855 SY

SUBUNIT	WASTE* VOLUME TO CELL (CY)	PERCENT OF TOTAL WASTE VOLUME	CELL LINER			CELL CAP								NUMBER OF MONITORING WELLS
			LINER AREA (SY)	CLAY QUANTITY (CY)	PEA GRAVEL (CY)	CAP AREA (SY)	CONTOURING LAYER (CY)	CLAY CAP (CY)	COMMON SOIL (CY)	TOP SOIL (CY)	PEA GRAVEL (CY)	COBBLES (CY)	SAND LAYER (CY)	
SWL	115,200	15	15,860	15,860	5,234	6,578	3,289	4,407	3,815	1,118	2,171	6,578	1,118	5
LSP	92,800	12	12,688	12,688	4,187	5,263	2,631	3,526	3,052	895	1,737	5,263	895	4
IFP	110,900	14	14,803	14,803	4,885	6,140	3,070	4,114	3,561	1,044	2,026	6,140	1,044	4
SF	376,400	48	50,752	50,752	16,748	21,050	10,525	14,104	12,209	3,579	6,947	21,050	3,579	15
AFP	85,400	11	11,631	11,631	3,838	4,824	2,412	3,232	2,798	820	1,592	4,824	820	4
TOTAL	780,700	100	105,733	105,733	34,892	43,855	21,928	29,383	25,436	7,455	14,472	17,981	3,057	32

* WASTE VOLUME = REMEDIATION VOLUME + ADDITIONAL EXCAVATION REQUIRED TO REMOVE REMEDIATION VOLUME**
+ 3,000 CY OF GENERATED WASTE (15,000 CY/5 = 3,000 CY)

** 14% FOR SWL AND 10% FOR LSP, IFP, SF, AND AFP

001603

ALTERNATIVE 6: EXCAVATION AND ON-SITE DISPOSAL WITH OFF-SITE DISPOSAL OF FRACTION EXCEEDING WAC
RECEPTOR: RESIDENT FARMER

FENCE	=	7,000 LF	BORROW FOR DIKE	=	0 CY	GEOTEXTILE	=	71,002 SY
6" PERFORATED PIPE	=	8,000 LF	DIKE COVER	=	24,422 CY	COBBLES	=	71,002 CY
6/10 HDPE PIPE TO AWWT	=	3,500 LF	VEGETATIVE ZONE	=	0 CY	SAND	=	0 CY
HDPE MANHOLES	=	10	TOP SOIL	=	0 CY	DRAINAGE PIPE	=	9,000 LF

	PERCENT OF TOTAL WASTE	LEACHATE COLLECTION SYSTEM				SIDE SLOPE DIKE							
SUBUNIT	VOLUME	6" PIPE PERFORATED (LF)	10/6-HDPE PIPE TO AWWT (CY)	MANHOLES (EA)	FENCE (LF)	BORROW FOR DIKE (CY)	DIKE COVER (CY)	VEGETATIVE ZONE (CY)	TOP SOIL (CY)	GEOTEXTILE (SY)	COBBLES (CY)	SAND LAYER (CY)	DRAINAGE PIPE (LF)
SWL	15	1,200	525	1	1050	0	3,663	0	0	10,650	10,650	0	1,350
LSP	12	960	420	1	840	0	2,931	0	0	8,520	8,520	0	1,080
IFP	14	1,120	490	2	980	0	3,419	0	0	9,940	9,940	0	1,260
SF	48	3,840	1,680	4	3360	0	11,723	0	0	34,081	34,081	0	4,320
AFP	11	880	385	2	770	0	2,686	0	0	7,810	7,810	0	990
TOTAL	100	8,000	3,500	10	7,000	0	24,422	0	0	71,002	71,002	0	9,000

E.4

APPENDIX E.4

PERCHED GROUNDWATER COLLECTION AND CONTROL

APPENDIX E.4

PERCHED GROUNDWATER COLLECTION AND CONTROL

Alternatives involving consolidation and capping at the South Field include provisions for passive perched water collection and treatment at the AWWT facility. Perched groundwater at all the subunits will require control during the construction period. The following sections describe groundwater collection and control measures applicable for these requirements.

E.4.1 PASSIVE PERCHED WATER COLLECTION AT SOUTH FIELD AREA

Long-term perched groundwater collection will be provided by a downgradient subsurface drain consisting of a trench backfilled with granular material located along the southeast and southwest facing sides of the facility. The 1,800 foot total length of trench will be divided into three segments with centrally located sumps. The trench will be 3 feet wide and vary in depth. Bottom of trench elevation will range from El 560 to El 557 to provide gravity drainage to the sumps. A typical section of the trench is shown in the attached calculation package.

The trench bottom elevations were established so that the trench would extend a minimum of 1 foot below the base of the natural sand layer encountered throughout the area between El 564 and El 561. (See Figures 3-6 through 3-10 for cross sections of the sand layer). A 6-inch diameter perforated pipe wrapped with a nonwoven geotextile will be placed in the trench prior to backfilling to increase the flow capacity of the trench. Provisions will be made for intermediate risers along the length of the trench to allow for cleanout and flushing of the system. Ten feet of fine concrete aggregate (ASTM C-33) will be placed in the bottom of the trench to form the primary interception zone. Select sand backfill will be placed above the primary interception zone to within 3 feet of the ground surface. Clay will be placed in the top 3 feet of the trench to prevent the infiltration of surface water.

Flow rates along the trench will be several orders of magnitude greater than through native soil on the downgradient side of the trench. However, to provide a higher degree of cutoff, a downgradient liner consisting of 40 mil HDPE is included. Figure E.4-1 details the typical trench section.

Sumps will consist of a 12-inch diameter riser slotted and wrapped with a nonwoven geotextile over the bottom 10 feet with a submersible pump. Each sump will drain approximately 600 linear feet of trench. A typical section at the sump location is shown in the attached calculation package. Initial

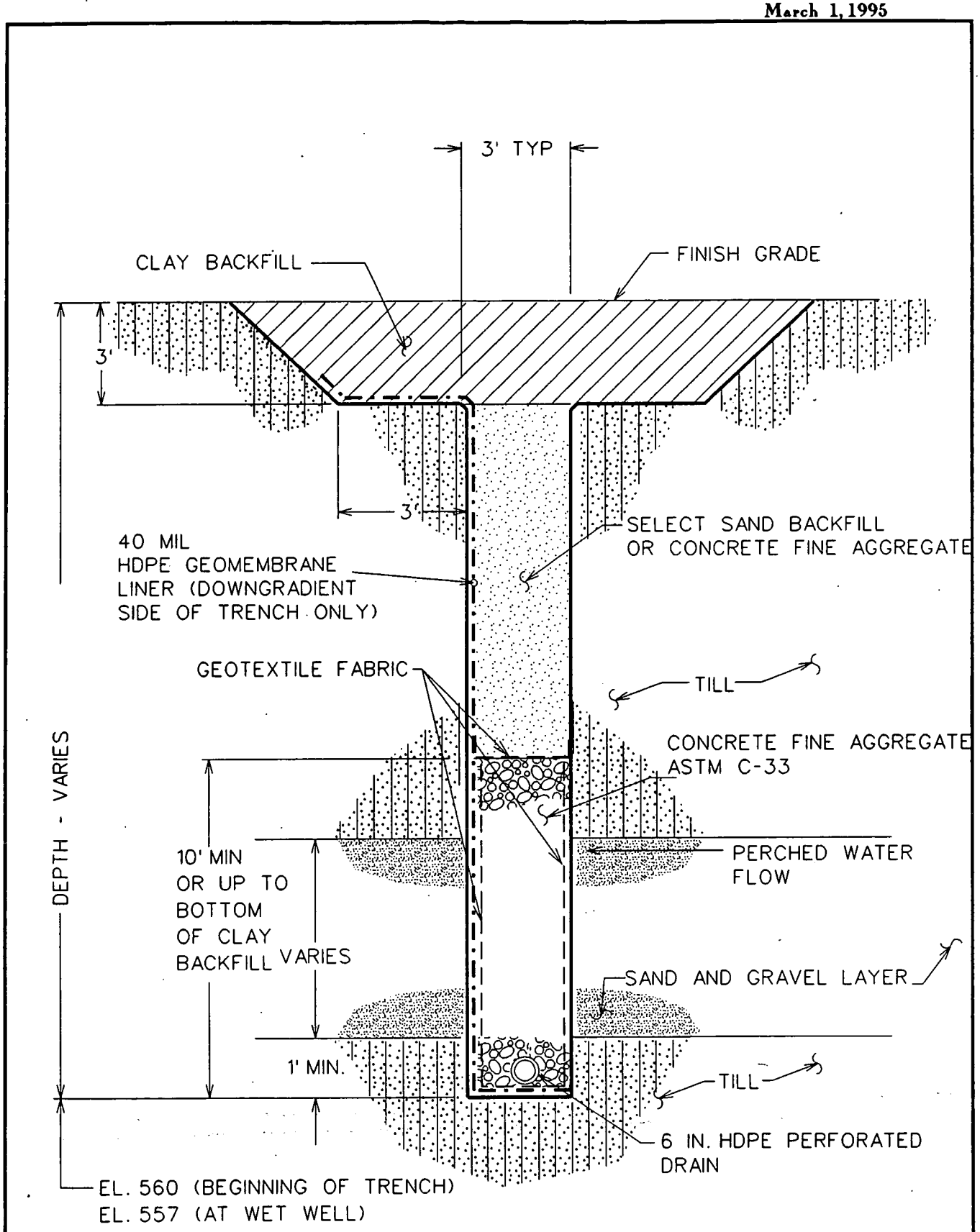


FIGURE E.4-1
TYPICAL SECTION - SUBSURFACE DRAIN

computed flow rate from each 600-foot trench segment is on the order of 5 to 7 gpm. Steady-state flow rate will be about 2 to 3 gpm. Following periods of heavy rain, flow rate will increase to 3 to 4 gpm. Water from the sumps will be pumped to a sedimentation/holding tank before being sent to the AWWT facility.

The sedimentation/holding tank will be partitioned into three sections with a capacity of 10,000 gallons each. This capacity will provide a 24 hour hold time for sedimentation during steady-state flow from all three trench segments. Section 1 will receive water from the trenches during periods of steady-state flow. A weir will decant water into Section 2 where it will be continuously pumped to the AWWT facility. During peak flows, such as startup, the discharge from the trenches may have to be piped to both Sections 1 and 3 if the water cannot be pumped from the sedimentation tank to the AWWT facility. Section 3 will be used in place of Section 1 when sediment is being removed from Section 1. The sediment will be screened prior to removal and disposed of appropriately. Additionally, Section 3 can be used as a secondary sedimentation tank for surface runoff while material is being placed in the consolidation/capping area. A schematic of the tank setup is shown in the attached calculation package. Flow into the tank at startup of the interceptor trench and after extended periods of rain will be about 12 to 18 gpm. Steady-state flow should average about 8 gpm. All piping will be 2-inch PVC.

E.4.2 EXCAVATION-PERIOD GROUNDWATER CONTROL

E.4.2.1 Solid Waste Landfill

The highest recorded perched water levels in the Solid Waste Landfill range from El 580 (east) to El 575 (west) across the site. Excavation levels over all but a limited area near the south and southwest portion of the site will be above these elevations. Therefore, excavation "in the dry" can be expected. The bottom of the excavation should be sloped to a sump to collect rainwater.

In the south and southeast portion of the site, excavation below the perched water level can proceed with the bottom of the excavation sloped to a sump to collect any water seeping through the side walls or from the bottom. The sump can also be used to collect rainwater falling into the excavation. Due to the low hydraulic conductivity of the soils in this area, seepage volumes are expected to be small. The excavation can continue to El 568 without the risk of "blow out" of the bottom due to the proximity of the intermediate sand layer (at El 562) in the glacial overburden.

The excavation will need to extend to at least El 564 in the southeast corner of the site. Several pressure relief wells can be advanced into the sand at the perimeter of this excavation or other excavations extending deeper than El 568 prior to digging. These wells can be pumped if the excavation has to extend into or through the sand. Individual wells will have flows of about 0.25 to 0.3 gpm.

E.4.2.2 Lime Sludge Ponds

The highest recorded perched water levels at the Lime Sludge Ponds range from El 574 (east) to El 572 (west) across the site. Excavation levels over all but a limited area near the southwest portion of the South Pond will be to about El 570. Excavation to El 568 can be made without the risk of "blow out" of the bottom due to the proximity of the intermediate sand layer (at El 562) in the glacial overburden. Excavation below the perched water level can proceed with the bottom of the excavation sloped to a sump to collect any water seeping through the side walls or bottom. The sump can also be used to collect rainwater falling into the excavation. Due to the low hydraulic conductivity of the soils in this area, seepage volumes are expected to be small.

In the southwest portion of the South Pond the excavation needs to extend to at least El 568; however, the intermediate sand is at El 566. Several pressure relief wells can be advanced into the sand prior to advancing the excavation. These wells can be pumped if the excavation has to extend into or through the sand. Individual wells will have flows of about 0.25 to 0.3 gpm.

E.4.2.3 Inactive Flyash Pile

Perched water in the Inactive Flyash Pile is expected to accumulate at the interface of the fill material and the underlying glacial overburden. Therefore, no pre-excavation dewatering is planned. Pockets of waterbearing materials are expected to be encountered as excavation proceeds. The limited amounts of water in these zones can be handled by sloping the bottom of the excavation to a sump and pumping from that location. The sump can also be used to collect rainwater falling into the excavation.

E.4.2.4 South Field

The highest recorded perched water levels in the South Field range from El 555 to El 570. Ground-surface elevation over most of the area is El 575. Therefore, depending on location, excavation "in the dry" to depths of 5 to 15 feet can be expected. Excavation below the perched water level can

proceed with the bottom of the excavation sloped to a sump to collect any water seeping through the side walls or from the bottom. The sump can also be used to collect rainwater falling into the excavation. Due to the low hydraulic conductivity of the soils in this area, seepage volumes are expected to be small.

E.4.2.5 Active Flyash Pile

Perched water in the Active Flyash Pile is expected to accumulate at the interface of the fill material and the underlying glacial overburden. Therefore, no pre-excavation dewatering is planned. Pockets of waterbearing materials are expected to be encountered as excavation proceeds. The limited amounts of water in these zones can be handled by sloping the bottom of the excavation to a sump and pumping from that location. The sump can also be used to collect rainwater falling into the excavation.

E.4.3 CALCULATIONS (calculations begin on following page)

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT	JOB NUMBER		
DOE	—		
SUBJECT: INTERCEPTOR TRENCHES			
BASED ON: —	DRAWING NUMBER		
BY: T Allen	CHECKED BY: WJO	APPROVED BY	DATE: 15 MARCH 1994

TYPICAL INTERCEPTOR TRENCH FLOW CALCULATION

FLOW FROM INTERCEPTOR TRENCH – LONG TERM NORMAL FLOW

$$\frac{Q}{x} = \frac{k(H^2 - h^2)}{2(1440\ \text{min})(L)}$$

WHERE:
- L = RADIUS OF INFLUENCE, FT
- k = HYDRAULIC CONDUCTIVITY (1×10^{-4} cm/sec OR 2.13 gpd/ft²)
- H = WATER HEIGHT IN FREE FIELD, FT
- h = WATER HEIGHT AT TRENCH, FT

$$\frac{Q}{x} = \frac{2.13(10^2 - 0^2)}{2(1440)(20)}$$

$$= 3.7 \times 10^{-3}\ \text{gpm/ft}$$ (unconfined one sided flow)

FLOW FROM INTERCEPTOR TRENCH – INITIAL DRAWDOWN NORMAL

$$\frac{Q}{x}(0) = 2 \times \frac{Q}{x}\ (\text{single side})$$

$$= 7.4 \times 10^{-3}\ \text{gpm/ft}$$

NOTE: HIGH WATER LEVEL INCREASES H TO 15' FOR PERIODS AFTER LONG PERIODS OF RAIN

$$\frac{Q}{x} = \frac{2.13(15^2 - 0^2)}{2(1440)(20)} = 8 \times 10^{-3}\ \text{gpm/ft}$$

FOR DRAWDOWN, USE $2\left(\frac{Q}{x}\ \text{single side}\right)$

$$\frac{Q}{x}(0) = 2 \times (8 \times 10^{-3}\ \text{gpm/ft})$$

$$= 1.6 \times 10^{-2}\ \text{gpm/ft}$$

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT DOE		JOB NUMBER	
SUBJECT INTERCEPTOR TRENCH			
BASED ON		DRAWING NUMBER	
BY T Allen	CHECKED BY WJO	APPROVED BY	DATE 15 MARCH 1994

FOR 600 FT TRENCH SEGMENTS:

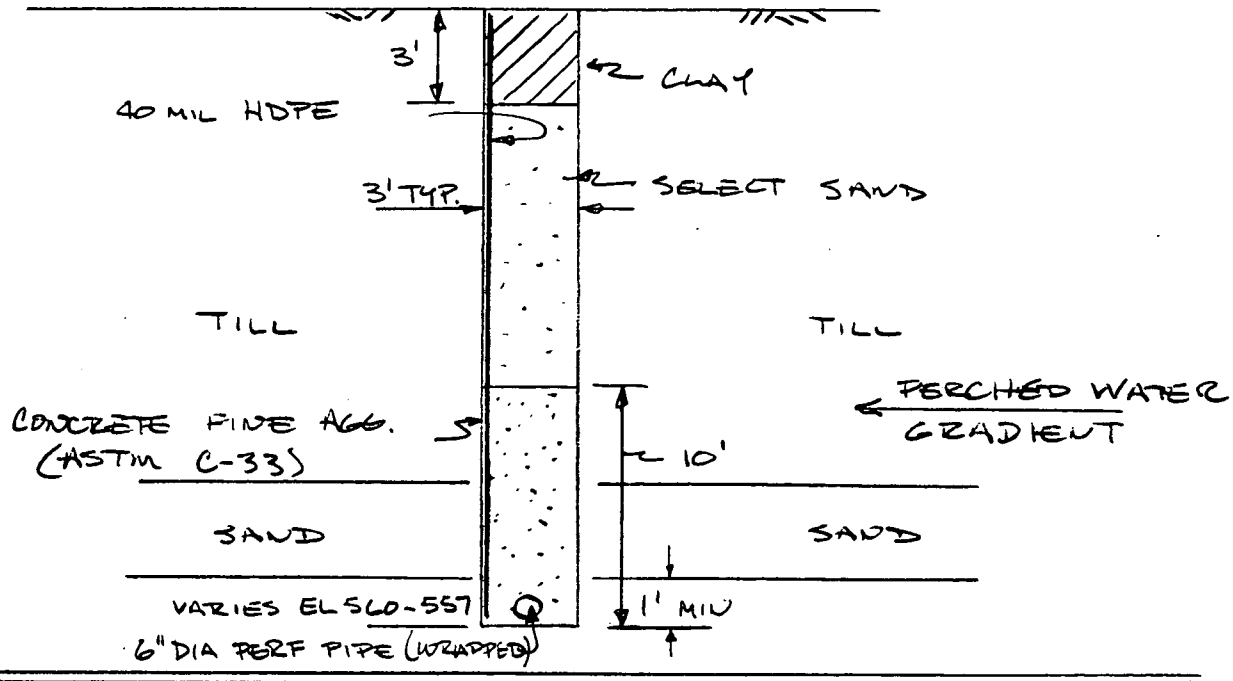
	NORMAL LEVEL	HIGH LEVEL
LONGTERM	2.2 gpm	5.0 gpm
DRAWDOWN	4.4 gpm	9.6 gpm

001011

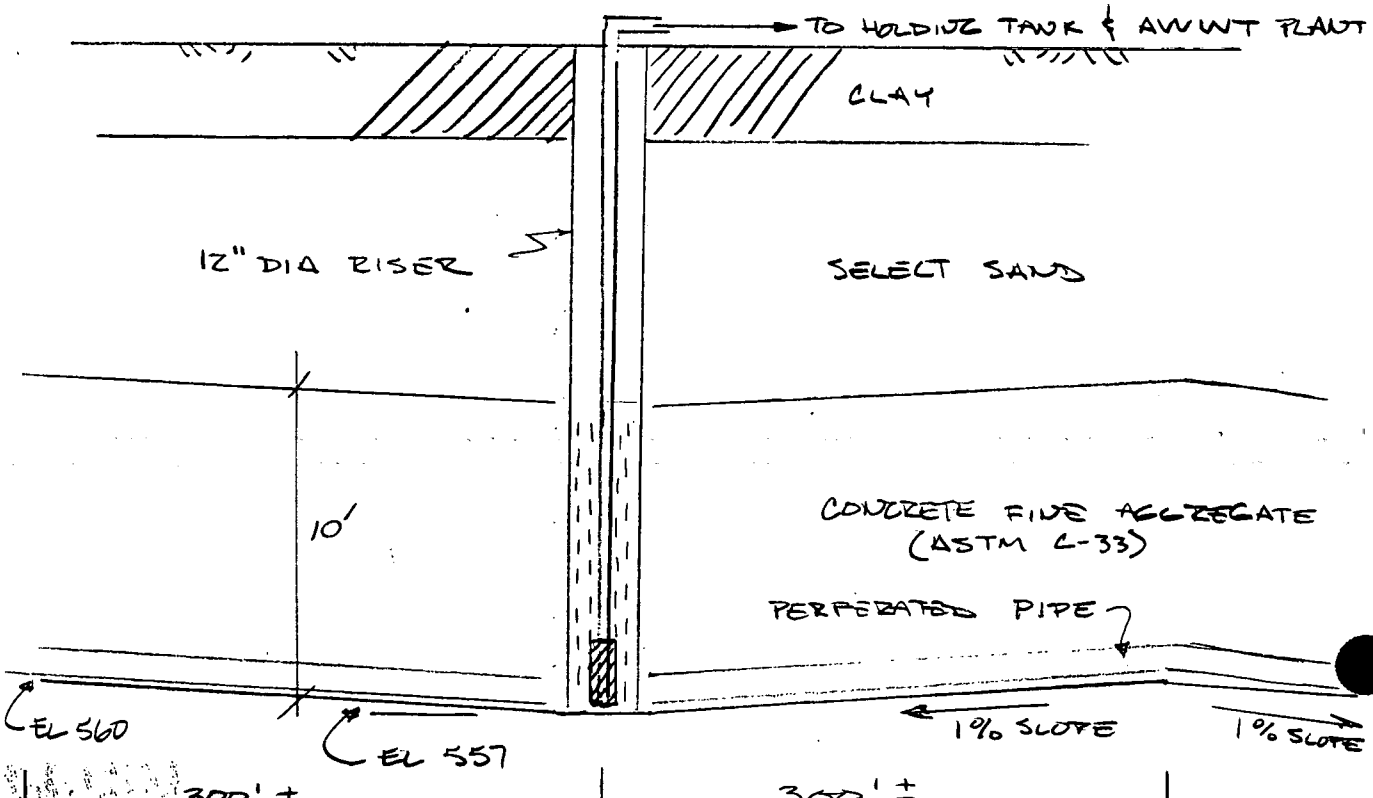
CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT DOE	JOB NUMBER —
SUBJECT INTERCEPTOR TRENCH	
BASED ON	DRAWING NUMBER
BY T Allen / CHECKED BY WO	APPROVED BY / DATE 15 MARCH 1994

TYPICAL TRENCH SECTION



TYPICAL SECTION AT SUMP



CALCULATION WORKSHEET Order No. 19116 (01-91) - 6647 PAGE 4 OF

CLIENT DOE		JOB NUMBER —	
SUBJECT INTERCEPTOR TRENCH			
BASED ON —		DRAWING NUMBER	
BY T Allen	CHECKED BY WJO	APPROVED BY	DATE 15 MARCH 1994

SOLID WASTE LANDFILL

Recorded top of perched water varies from El 580 to El 575 east to west accross site. Except for a portion of southern edge of site, excavation will not extend below these levels to remove waste.

Intermediate sand layer is located at about EL 562

Using general rule of 1' of cover for each 2' of water head, excavation can be taken to El 568 without "blowout" of bottom.

2-3 pressure relief wells located near the areas of limited excavation should provide bottom stability. These wells can be pumped to control water infiltration if excavation has to extend into the sand.

Inflow into wells:

$$Q_w = \frac{k\,(H^2 - h^2)}{458\,\ln(R_o/d)} \text{ gpm}$$

where K = hydraulic conductivity 1×10^{-4} cm sec or 2.13 gpd/ft^2
H = water height in free field, ft
h = water height at well, ft
R_o = radius of influence, ft
d = well diameter, ft

$$Q_w = \frac{2.13\,(15^2 - 0^2)}{458\,\ln(20/.5)}$$

$$= 0.28 \Rightarrow \text{SAY } 0.3 \text{ gpm}$$

001013

CALCULATION WORKSHEET Order No. 19116 (01-91)

CLIENT DOE		JOB NUMBER —	
SUBJECT INTERCEPTOR TRENCH			
BASED ON		DRAWING NUMBER	
BY T Allen	CHECKED BY WJO	APPROVED BY	DATE 15 MARCH 1994

Lime Sludge Pond

Maximum perched water levels vary from EL 574 to 572

Bottom of sludge ≈ El 570

Sump and pump as required

Sand layer typically at El 560 ∴ no bottom blowout

Exception:

SW quadrant of southern pond

Bottom of sludge at 568±

Top of sand at 566±

∴ at high water, bottom instability a problem

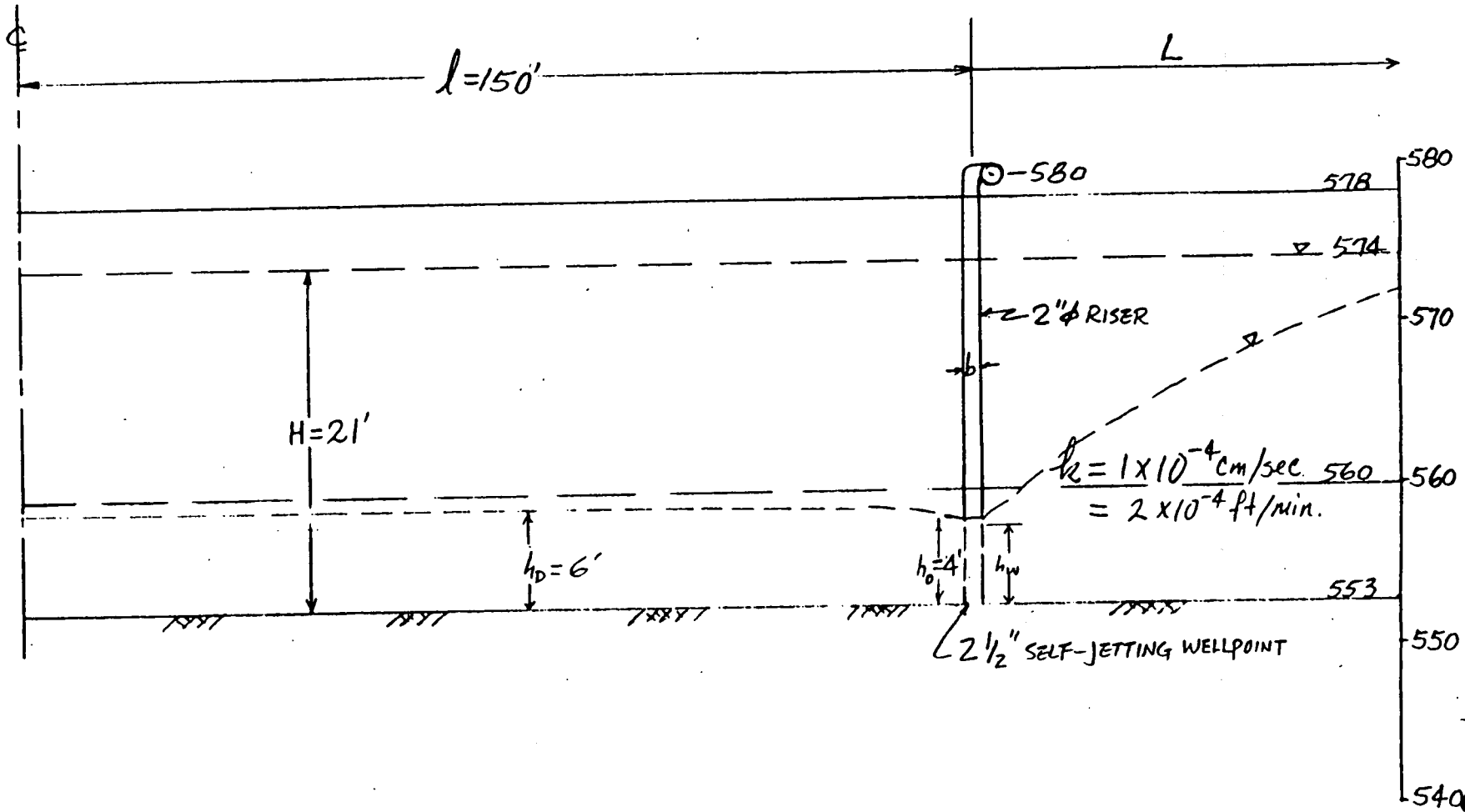
Alternates:

1) Line of well points 150' north and east from southwest corner.

See page 6-11 for calcs

2) Pressure relief wells adjacent to smaller excavation

See page 4 calcs



LIME SLUDGE PONDS

GROUNDWATER EXTRACTION CALCULATIONS

$L = C'(H - h_w)\sqrt{k}$

$C' = 3$

$H = 21'$

$h_w = 5'$

$k = 1$ (in 10^{-4} cm/sec)

$L = 3(21-5)\sqrt{1} = 48'$

$h_D = 6'$

Assume $h_o = 5'$, $H - h_D = 21' - 6' = 15'$

$l/h_o = 150/5 = 30$ $C_1 = 1.02$

Since b so small, can be assume 0 for well points

$b/H = 0$ $C_2 = 1.45$

$$h_D = h_o\left[\frac{C_1 C_2}{L}(H - h_o) + 1\right]$$

$$h_D = 5'\left[\frac{1.02 \times 1.45 \times 16'}{48} + 1\right] = 7.5' > 6' \text{ N.G.}$$

Assume $h_o = 4'$

$$h_D = 4\left[\frac{1.02 \times 1.45 \times 17}{48} + 1\right]$$

$= 6'$ O.K.

Thus $h_D = 6'$, $h_o = 4'$ $H - h_o = 17'$

Assume $h_o - h_w = 0.001H = 0.02'$ $\therefore h_w = h_o - 0.02' = 3.98$

From
$$\frac{h_o^2 - h_w^2}{H^2 - h_o^2} = \frac{a}{2\pi L}\ln\frac{a}{2\pi r_w}$$

001016

$$\frac{4^2 - 3.98^2}{21^2 - 4^2} = \frac{a}{2\pi 48} \ln \frac{a}{2\pi(0.1)}$$

$$a \ln \frac{a}{0.628} = 0.1133$$

Try $a = 0.74$

$$a \ln \frac{a}{0.628} = 0.74 \ln \frac{0.74}{0.628} = 0.121 \quad \text{OK.}$$

Use $a = 0.74'$

Then flow per wellpoint for a line of wellpoints (infinite)

$$Q_W = a Q_p = 0.74\left(0.73 + 0.27 \frac{H - h_o}{H}\right) \frac{k\pi}{2L}(H^2 - h_o^2)$$

$$= 0.74\left(0.73 + 0.27 \frac{21-4}{21}\right) \frac{0.0002 \times 10'}{2 \times 48}(21^2 - 4^2)$$

$$= 0.0062 \text{ cfm}$$

$$= 0.047 \text{ gpm.} \qquad (1 \text{ cfm} = 7.54 \text{ gpm})$$

For a finite line of wellpoints

$$Q_W = 1.35 \times 0.047 \text{ gpm} = 0.063 \text{ gpm.}$$

Hydraulic head losses:

$H_e = 0.02'$ from Fig 3-41a curve 4 wire mesh on perforated pipe

$H_s = 0.1'$ from Fig 3-41b

$H_r + H_v = 0.1'$ from Fig 3-41c

Total Head loss $H_W = 0.02 + 0.1 + 0.1 = 0.22'$

Thus $h_w - H_w = 3.98' - 0.22' = 3.76'$

Required vacuum at pump intake:

$V = M + H_c + H_w - h_w$

where $M = 580 - 553 = 27'$ = distance from base of parvious substratum to pump intake, ft.

H_c = Average head loss in header pipe up to pump intake, ft.

H_w = total head loss in wellpoint to header pipe $= 0.22'$.

$h_w = 3.98'$

Required effective vacuum is:

$V - H_c = M + H_w - h_w$

$= 27' + 0.22' - 3.98' = 23.24'$

Estimated well point spacing from Fig 3-46

$s = 6.5'$ for water level lowering of 15'.

Total line length of wellpoints

$= 150' + 150'$

$= 300'$

Total number of wellpoints:

$= 300'/6.5' = 46.15 = 46$ wellpoints.

Total discharge from all wellpoints:

$Q_T = 0.063$ gpm $\times 46 = 2.9$ gpm.

$= 4176$ gpd.

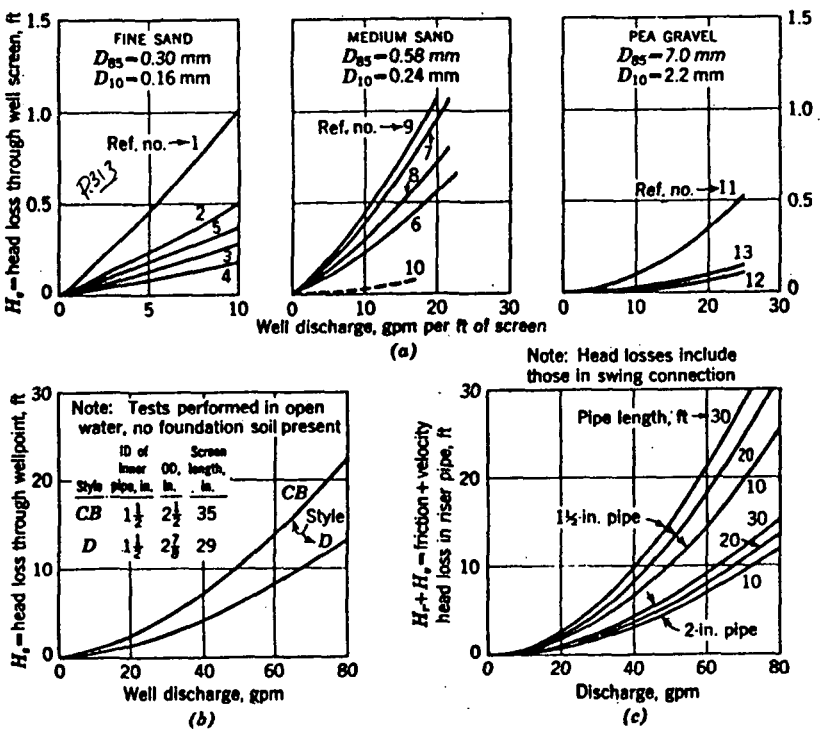
loss H_s. The total head loss in the well, H_w, is the sum of these individual head losses, and therefore

$$H_w = H_e + H_s + H_r + H_v \tag{3-101}$$

Procedures for estimating these head losses are given below.

Entrance head loss H_e is that required to force the flow through the gravel filter of the well, if the well has a filter, and the well screen. This loss depends on the flow per unit length of well screen, the type of sand adjacent to the screen, permeability of gravel filter, the number, size, and type openings in the well screen, and the diameter of the screen. Entrance head losses for various types of wellpoints installed in fine and medium sand and pea gravel determined from laboratory tests are plotted for various well flows in Fig. 3-41. Entrance head losses for two types of self-jetting wellpoints obtained from tests by the Moretrench Corporation also are shown in Fig. 3-41. Similar data for large-diameter wood-stave well screens with graded gravel filters obtained from labora-

FIG. 3-41. Entrance head loss for typical wellpoints, and velocity and friction head loss in wellpoint riser pipes. (a) 2½-in.-ID plain-tip wellpoints; (b) self-jetting wellpoints; (c) head losses in wellpoint riser pipes, $C = 110$. [(a) *U.S. Army Engineer Waterways Experiment Station, Vicksburg, Miss.* (b) *Moretrench Corp.*]



Ref.	Wellpoint	Slot or mesh	
		No.	Opening in mm
1	A and B, grooved slot	12	0.30
2	C, wire wrap on perforated pipe	20	0.51
3	D, wire mesh on perforated pipe	28	0.59
4	E, wire mesh on perforated pipe	28	0.59
5	B, grooved slot	25	0.63
6	A, grooved slot	25	0.63
7	D, wire mesh on perforated pipe	28	0.59
8	A, grooved slot	50	1.27
9	B, grooved slot	30	0.76
10	F, perforated pipe with 6-in. pea-gravel filter	5/32 in.	3.97
11	A, grooved slot	12	0.30
12	A, grooved slot	100	2.54
13	E, perforated pipe	5/32 in.	3.97
CB	Moretrench, commercial bronze, self-jetting, mesh SF	40 × 45	0.31 × 0.38
D	Moretrench, stainless steel style D, self-jetting, mesh E	12 × 68	0.30 × 1.73

tory tests and pumping tests on wells installed in pervious sand strata in the alluvial valley of the lower Mississippi River are shown in Fig. 3-42. Data for several other types of well screens are presented by Petersen, Rohwer, and Albertson (29). When estimating the entrance head loss, a weighted average flow per foot of screen should be used.

Friction loss in well screens can be estimated from the screen length and distribution of flow in the screen from hydraulic formulas for flow of water through pipes. For example, if a well fully penetrates a uniform pervious artesian stratum, the flow in the screen will increase approximately linearly from zero at the bottom to the full well flow Q_w at the top of the screen. In this case the friction loss can be computed assuming the entire well flow Q_w to be flowing through one-third the length of the well screen. If the pervious stratum grades coarser in grain size with depth or if the well only partially penetrates a uniform stratum, the flow in the lower portion of the screen will be greater than that assumed above, in which case the head loss can be estimated assuming a flow of $0.9Q_w$ through one-half of the length of well screen (30).

The friction head loss H_r in the riser pipe can be computed from the well flow Q_w and the length of riser pipe through which flow takes place using ordinary hydraulic formulas. Head losses in the connecting pipe between the well or wellpoint and collector pipe also should be included. For estimating loss in standard steel swing connections for wellpoints (including that in the cock valve in the swing), the swing can be replaced by the following equivalent lengths of riser pipe:

E-4-15
FEMP-OU02-6 FINAL
March 1, 1995
6647
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$$h_D = 16\left[1 + \frac{1.02(1.45)(40 - 16)}{700}\right] = 16.8 \text{ ft}$$

Since $h_D - h_w = 0.8$ ft, assume $h_w = 15.2$ ft and recompute h_D. $l/h_w = 63/15.2 = 4.1$, and $C_1 = 1.02$ from Fig. 3-22.

$$h_D = 15.2\left[1 + \frac{1.02(1.45)(40 - 15.2)}{700}\right] = 16.0 \text{ ft}$$

Thus $h_D = 16.0$ ft, $h_w = 15.2$ ft. Assume $h_w - h_w = 0.001H = 0.04$ ft; $h_w = 15.2 - 0.04 = 15.16$ ft. Substitute h_w for h_D and h_w, H, L, and r_w in Eq. (3-45a):

$$\frac{15.2^2 - 15.16^2}{40^2 - 15.2^2} = \frac{a}{2\pi(700)} \ln \frac{a}{2\pi(0.12)}$$

Solving this equation gives $a = 3$ ft. From Eq. (3-24) the flow per wellpoint is

$$Q_w = aQ_p = 3\left(0.73 + 0.27 \times \frac{24.8}{40}\right)\frac{0.20}{2 \times 700}(40^2 - 15.2^2) = 0.53 \text{ cfm}$$

$= 4.0$ gpm for an infinite line of wellpoints

or $1.35 \times 4.0 = 5.4$ gpm for the finite line

For this discharge $H_w = 0.26$ ft; thus $h_w - H_w = 15.16 - 0.26 = 14.90$ ft. From Eq. (3-102) the required vacuum at the wellpoint is 13.1 ft. Therefore, if the vacuum in the header is maintained at 13 ft, wellpoints on 3-ft centers would lower the ground water to el 16. However, since the available vacuum in the header is 20 ft and since generally it is not practicable to operate the pump to reduce the vacuum, the wellpoints would be installed with 20-ft-long riser pipes on about 3-ft centers. This would prevent excess air from entering the system which might otherwise occur had 13-ft-long riser pipes been used. With such a system $Q_w = 6.2$ gpm, $H_w = 0.35$ ft, and $h_w - H_w \approx 8.1$ ft, and the ground water would be lowered to about el 9.

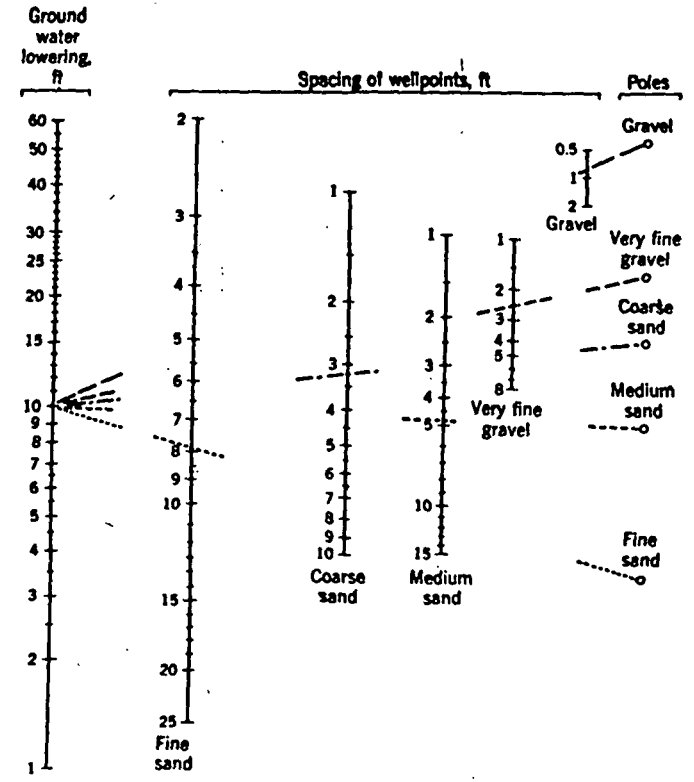
In the above case it would be advisable to observe ground-water levels before and during pumping of the upper stage and to measure the discharge. From these data the design of the lower stage could be adjusted if it is found that the observed flow per foot drawdown differs appreciably from the computed values. Such differences can occur because of limitations in accuracy of k, L, and H_w used in design.

would be installed with 20-ft risers to prevent possible reduction in efficiency of the stage due to excess air entering the system.

In lieu of the detailed computations shown in Fig. 3-45, the approximate spacing of wellpoints required to produce a given ground-water lowering in various soils can be estimated from the nomographs shown in Figs. 3-46 and 3-47. However, these nomographs should be used with caution since they are based on empirical data and are for average conditions. Nevertheless, they may be used as a guide in selecting the spacing of wellpoints.

In some cases, wellpoints alone cannot entirely eliminate seepage into an excavation and supplemental measures are necessary. For example, where a pervious stratum is underlain by rock and it is necessary to lower the ground-water level to the top of rock, some seepage will pass between

FIG. 3-46. Wellpoint spacing for uniform clean sands and gravels. (*Moretrench Corp.*)



the wellpoints even though they extend to the rock. In such cases it may be necessary to intercept this seepage with ditches or French drains and install automatic "mops" in the bottom of the ditches. In cases where the pervious stratum is immediately underlain by clay, the wellpoints can be installed in holes penetrating 3 or 4 ft into the clay and backfilled with sand so that the water level in the wellpoints during pumping can be maintained at or below the bottom of the pervious stratum. This procedure will reduce or eliminate seepage that would otherwise bypass the wellpoints had they only been installed with their tips at the top of the clay stratum.

Deep Wells. Deep wells can be used effectively for dewatering slopes and excavations where the required lowering is fairly large. Such wells can be located near or at the top of the excavation and pumped by deep-well turbine pumps, or they can be located on the excavation slope and pumped by a centrifugal pump connected to a common header pipe.

E.5

APPENDIX E.5
INFILTRATION CALCULATIONS

E.5 INFILTRATION CALCULATIONS

Infiltration rates through the waste to the Great Miami Aquifer for the Operable Unit 2 disposal cell conceptual cap and liner model were calculated using the Hydraulic Evaluation of Landfill Performance (HELP) model. The HELP model is a quasi-two-dimensional hydrologic modeling tool used to estimate infiltration and lateral drainage. The model accepts climatologic, soil, and design data and simulates a number of hydraulic processes including surface storage, runoff, infiltration, percolation, evapotranspiration, soil moisture storage, and lateral drainage.

The HELP model was run in 5-year steps using the climatologic data (precipitation and mean monthly temperatures) from 1975 to 1978 for Cincinnati, Ohio. These data were obtained from the HELP model database. The HELP model was run to "steady state," that is, until successive simulations showed less than 0.005 percent change between initial- and final-year soil moisture content in any of the layers. A successive substitution procedure was used to reach steady-state conditions.

Physical properties of waste, glacial till, and the Great Miami Aquifer soils were the same as properties used in the Operable Unit 2 Remedial Investigation fate and transport modeling (Appendix A.2 of RI Report). These values were defined based upon RI sampling activities.

Topsoil, vegetative soil support, sand filter, cobbles, gravel, recompacted clay, and compacted structural fill were simulated as HELP soil texture nos. 6, 5, 2, 1, 1, 18, and 17, respectively. HELP default hydraulic conductivities were modified to match the design. Hydraulic conductivities for these layers were $1x10^{-3}$, $5x10^{-4}$, $1x10^{-3}$, 10.0, $1x10^{-3}$, $1x10^{-7}$, and $2x10^{-4}$ cm/sec, respectively. Grass cover was assumed to be fair, and the evaporative zone depth was conservatively estimated to be 12 inches.

Bentonite geocomposite was assumed to be 0.25 inch thick with properties of recompacted clay. Geomembrane overlying a bentonite geocomposite is considered as a single layer in the HELP model. This layer is simulated with the properties of the bentonite geocomposite and a leakage factor. Leakage factor for the 60 mil HDPE geomembrane was calculated from the charts provided in the HELP model documentation for pinhole spacing of a 100 feet. The estimated leakage factor for the geomembrane was 0.003.

The HELP model output consists of input data echo, optional simulation details, and a summary of results. The summary includes average monthly totals, average annual totals, peak daily values, and final moisture contents in all layers modeled. The average totals include precipitation, runoff, evapotranspiration, percolation, and lateral drainage for appropriate layers.

The HELP model outputs (Attachment E.5-I) are attached to this appendix. The outputs provide infiltrations through the cap and liner and through the berm of the disposal cell.

ATTACHMENT E.5-I
HELP MODEL OUTPUTS

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LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY FOR OPERABLE UNIT 2
GEOCOMPOSITE CAP AND LINER - NO HDPE LINER AND FAILED LEACHATE COLLECTION SY
MINIMUM WASTE THICKNESS February 28, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1901 VOL/VOL
WILTING POINT	=	0.0848 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3243 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	21.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2440 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000500000024 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1581 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0454 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 5

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4170 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.009999999776 CM/SEC
SLOPE	=	4.00 PERCENT
DRAINAGE LENGTH	=	800.0 FEET

LAYER 6

BARRIER SOIL LINER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000010000 CM/SEC

LAYER 7

VERTICAL PERCOLATION LAYER

THICKNESS	=	2.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0564 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 8

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LAYER 9

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3808 VOL/VOL
FIELD CAPACITY	=	0.1924 VOL/VOL
WILTING POINT	=	0.1043 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2523 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000026000000 CM/SEC

LAYER 10

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2794 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 11

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0454 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.009999999776 CM/SEC

LAYER 12

BARRIER SOIL LINER

THICKNESS	=	60.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

001028

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	1102500. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	5.4600 INCHES
INITIAL VEG. STORAGE	=	3.4098 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	58.2148 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.004	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.001	0.000	0.005
STD. DEVIATIONS	0.000	0.009	0.000	0.000	0.000	0.000
	0.000	0.000	0.000	0.002	0.000	0.011
EVAPOTRANSPIRATION						
TOTALS	0.853	1.535	2.424	2.871	2.814	4.791
	3.826	4.116	2.198	1.959	1.683	0.905
STD. DEVIATIONS	0.188	0.312	0.120	0.265	1.712	1.202
	1.451	0.997	1.704	0.567	0.120	0.179
LATERAL DRAINAGE FROM LAYER 5						
TOTALS	1.3155	1.4678	1.1784	0.9902	0.6175	0.5255
	0.5178	0.4965	0.6843	0.4741	0.4245	0.7490
STD. DEVIATIONS	0.6603	1.2556	1.1494	0.6790	0.1245	0.0628
	0.0694	0.0626	0.4737	0.1049	0.1121	0.7123
PERCOLATION FROM LAYER 6						
TOTALS	0.1141	0.1071	0.1175	0.1157	0.1173	0.1063
	0.1024	0.0937	0.0851	0.0842	0.0811	0.0921
STD. DEVIATIONS	0.0405	0.0405	0.0441	0.0333	0.0261	0.0272
	0.0269	0.0232	0.0273	0.0336	0.0341	0.0355

001030

PERCOLATION FROM LAYER 8

TOTALS	0.1077	0.0983	0.1082	0.1048	0.1084	0.0978
	0.1012	0.1018	0.0970	0.0983	0.0918	0.1010
STD. DEVIATIONS	0.0025	0.0034	0.0023	0.0024	0.0026	0.0179
	0.0184	0.0169	0.0194	0.0236	0.0257	0.0161

PERCOLATION FROM LAYER 12

TOTALS	0.1050	0.0919	0.0998	0.0975	0.1018	0.0994
	0.1035	0.1042	0.1013	0.1050	0.1017	0.1051
STD. DEVIATIONS	0.0016	0.0088	0.0120	0.0100	0.0084	0.0064
	0.0050	0.0036	0.0024	0.0017	0.0013	0.0014

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	3733984.	100.00
RUNOFF	0.010	(0.014)	920.	0.02
EVAPOTRANSPIRATION	29.974	(2.728)	2753890.	73.75
LATERAL DRAINAGE FROM LAYER 5	9.4411	(3.7889)	867399.	23.23
PERCOLATION FROM LAYER 6	1.2163	(0.3337)	111743.	2.99
PERCOLATION FROM LAYER 8	1.2162	(0.1433)	111743.	2.99
PERCOLATION FROM LAYER 12	1.2162	(0.0607)	111741.	2.99
CHANGE IN WATER STORAGE	0.000	(3.907)	34.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	220500.0
RUNOFF	0.025	2269.9
LATERAL DRAINAGE FROM LAYER 5	0.5774	53045.4
PERCOLATION FROM LAYER 6	0.0045	415.1
HEAD ON LAYER 6	12.2	
PERCOLATION FROM LAYER 8	0.0036	331.4
HEAD ON LAYER 8	1.4	
PERCOLATION FROM LAYER 12	0.0034	314.4
HEAD ON LAYER 12	0.4	
SNOW WATER	1.18	108843.8

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3497

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0711

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001032

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	1.95	0.3243
2	5.12	0.2440
3	0.95	0.1581
4	1.64	0.0454
5	5.00	0.4170
6	0.40	0.4000
7	0.11	0.0564
8	10.32	0.4300
9	3.03	0.2523
10	3.35	0.2794
11	0.55	0.0454
12	25.80	0.4300
SNOW WATER	0.00	

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GRAY TILL ONLY
SOLID WASTE LANDFILL

July 12, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3970 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	99.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3140 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 3

BARRIER SOIL LINER

THICKNESS	=	155.00 INCHES
POROSITY	=	0.4100 VOL/VOL
FIELD CAPACITY	=	0.3710 VOL/VOL
WILTING POINT	=	0.2510 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4100 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000001900000 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	384.00 INCHES
POROSITY	=	0.3900 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0762 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.015900000930 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	46000. SQ FT
EVAPORATIVE ZONE DEPTH	=	12.00 INCHES
UPPER LIMIT VEG. STORAGE	=	6.2400 INCHES
INITIAL VEG. STORAGE	=	4.7640 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	128.6608 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.020	0.000	0.019	0.000	0.027
	0.022	0.043	0.008	0.027	0.000	0.016
STD. DEVIATIONS	0.000	0.044	0.000	0.042	0.000	0.061
	0.048	0.096	0.014	0.046	0.000	0.036
EVAPOTRANSPIRATION						
TOTALS	0.848	1.534	2.470	2.879	3.165	4.809
	4.073	4.272	2.250	1.983	1.672	0.892
STD. DEVIATIONS	0.189	0.311	0.128	0.331	1.635	1.381
	1.402	1.207	1.767	0.526	0.138	0.170
PERCOLATION FROM LAYER 3						
TOTALS	1.6208	1.6289	1.5251	1.1168	0.5161	0.2535
	0.1939	0.0844	0.3983	0.5914	0.3213	1.3635
STD. DEVIATIONS	0.8551	0.6425	0.5794	1.0308	0.9119	0.4921
	0.4335	0.1746	0.8906	0.6639	0.4839	0.8907
PERCOLATION FROM LAYER 4						
TOTALS	0.7604	0.8614	1.1076	1.1059	1.0855	0.9203
	0.7868	0.6540	0.5747	0.5912	0.5591	0.6059
STD. DEVIATIONS	0.3140	0.3531	0.4679	0.4935	0.5676	0.5443
	0.3844	0.2586	0.2095	0.2819	0.2379	0.2442

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	155794.	100.00
RUNOFF	0.181	(0.096)	694.	0.45
EVAPOTRANSPIRATION	30.847	(2.971)	118246.	75.90
PERCOLATION FROM LAYER 3	9.6141	(3.8484)	36854.	23.66
PERCOLATION FROM LAYER 4	9.6128	(3.9916)	36849.	23.65
CHANGE IN WATER STORAGE	0.001	(4.532)	5.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	9200.0
RUNOFF	0.214	819.0
PERCOLATION FROM LAYER 3	0.0719	275.7
HEAD ON LAYER 3	17.5	
PERCOLATION FROM LAYER 4	0.0613	234.8
SNOW WATER	1.18	4541.3

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.4811

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.1391

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	4.76	0.3970
2	31.09	0.3140
3	63.55	0.4100
4	29.27	0.0762
SNOW WATER	0.00	

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LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY FOR OU-2
COMPOSITE CAP OVER THE BERM - NO HDPE LINER
COBBLE AND P-GRAVEL LAYERS MODELED SEPERATLY October 26, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1901 VOL/VOL
WILTING POINT	=	0.0848 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3208 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	21.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2428 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000500000024 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1577 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 4

VERTICAL PERCOLATION LAYER

THICKNESS	=	36.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0381 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 5

LATERAL DRAINAGE LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0827 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.009999999776 CM/SEC
SLOPE	=	20.00 PERCENT
DRAINAGE LENGTH	=	200.0 FEET

LAYER 6

BARRIER SOIL LINER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000010000 CM/SEC

LAYER 7

VERTICAL PERCOLATION LAYER

THICKNESS	=	2.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0531 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 8

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	1102500. SQ FT
EVAPORATIVE ZONE DEPTH	=	18.00 INCHES
UPPER LIMIT VEG. STORAGE	=	8.2020 INCHES
INITIAL VEG. STORAGE	=	4.8384 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	20.8600 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND
SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99
RUNOFF						
TOTALS	0.000	0.006	0.000	0.000	0.000	0.000
	0.000	0.000	0.001	0.000	0.000	0.005
STD. DEVIATIONS	0.000	0.013	0.000	0.000	0.000	0.000
	0.000	0.000	0.001	0.000	0.000	0.011
EVAPOTRANSPIRATION						
TOTALS	0.844	1.518	2.382	2.794	2.983	4.954
	4.537	4.351	2.312	1.977	1.645	0.890
STD. DEVIATIONS	0.189	0.323	0.148	0.391	1.563	1.091
	1.396	1.298	1.628	0.510	0.152	0.188
LATERAL DRAINAGE FROM LAYER 5						
TOTALS	1.7790	1.5642	1.1466	1.3283	0.5503	0.2754
	0.3083	0.1928	0.3616	0.2700	0.2059	1.1108
STD. DEVIATIONS	1.2458	0.9454	1.2831	1.1944	0.3389	0.1618
	0.2066	0.1356	0.5858	0.4403	0.2240	1.4274
PERCOLATION FROM LAYER 6						
TOTALS	0.0549	0.0486	0.0392	0.0434	0.0243	0.0171
	0.0182	0.0154	0.0192	0.0173	0.0153	0.0383
STD. DEVIATIONS	0.0311	0.0236	0.0320	0.0298	0.0085	0.0040
	0.0052	0.0034	0.0146	0.0110	0.0056	0.0356
PERCOLATION FROM LAYER 8						
TOTALS	0.0579	0.0479	0.0397	0.0436	0.0243	0.0171
	0.0182	0.0154	0.0192	0.0173	0.0153	0.0351
STD. DEVIATIONS	0.0316	0.0226	0.0331	0.0303	0.0085	0.0040
	0.0051	0.0034	0.0145	0.0111	0.0056	0.0294

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	3733984.	100.00
RUNOFF	0.011	(0.014)	1035.	0.03
EVAPOTRANSPIRATION	31.186	(2.865)	2865230.	76.73
LATERAL DRAINAGE FROM LAYER 5	9.0932	(3.2958)	835439.	22.37
PERCOLATION FROM LAYER 6	0.3512	(0.0822)	32264.	0.86
PERCOLATION FROM LAYER 8	0.3512	(0.0851)	32263.	0.86
CHANGE IN WATER STORAGE	0.000	(3.475)	17.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	220500.0
RUNOFF	0.028	2581.9
LATERAL DRAINAGE FROM LAYER 5	0.2289	21032.3
PERCOLATION FROM LAYER 6	0.0061	556.2
HEAD ON LAYER 6	4.2	
PERCOLATION FROM LAYER 8	0.0034	313.3
HEAD ON LAYER 8	0.1	
SNOW WATER	1.18	108843.8

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3405

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0667

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FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	1.92	0.3208
2	5.10	0.2428
3	0.95	0.1577
4	1.37	0.0381
5	0.99	0.0827
6	0.10	0.4000
7	0.11	0.0531
8	10.32	0.4300
SNOW WATER	0.00	

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LOW LEVEL RADIOACTIVE WASTE DISPOSAL FACILITY FOR OU-2
TYPE A CAP AND LINER - NO HDPE LINER AND FAILED LEACHATE COLLECTION SY
Combined Cobble + Gravel Layer October 26, 1994

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FAIR GRASS

LAYER 1

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4530 VOL/VOL
FIELD CAPACITY	=	0.1901 VOL/VOL
WILTING POINT	=	0.0848 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.3208 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 2

VERTICAL PERCOLATION LAYER

THICKNESS	=	21.00 INCHES
POROSITY	=	0.4570 VOL/VOL
FIELD CAPACITY	=	0.1309 VOL/VOL
WILTING POINT	=	0.0580 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2428 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000500000024 CM/SEC

LAYER 3

VERTICAL PERCOLATION LAYER

THICKNESS	=	6.00 INCHES
POROSITY	=	0.4370 VOL/VOL
FIELD CAPACITY	=	0.0624 VOL/VOL
WILTING POINT	=	0.0245 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.1577 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.001000000047 CM/SEC

LAYER 4

LATERAL DRAINAGE LAYER

THICKNESS	=	48.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0669 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.100000001490 CM/SEC
SLOPE	=	4.00 PERCENT
DRAINAGE LENGTH	=	800.0 FEET

LAYER 5

BARRIER SOIL LINER

THICKNESS	=	0.25 INCHES
POROSITY	=	0.4000 VOL/VOL
FIELD CAPACITY	=	0.3560 VOL/VOL
WILTING POINT	=	0.2899 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4000 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000010000 CM/SEC

LAYER 6

VERTICAL PERCOLATION LAYER

THICKNESS	=	2.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0791 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	10.000000000000 CM/SEC

LAYER 7

BARRIER SOIL LINER

THICKNESS	=	24.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

LAYER 8

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.3808 VOL/VOL
FIELD CAPACITY	=	0.1924 VOL/VOL
WILTING POINT	=	0.1043 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2352 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000026000000 CM/SEC

LAYER 9

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.5200 VOL/VOL
FIELD CAPACITY	=	0.2942 VOL/VOL
WILTING POINT	=	0.1400 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.2570 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000199999995 CM/SEC

LAYER 10

VERTICAL PERCOLATION LAYER

THICKNESS	=	12.00 INCHES
POROSITY	=	0.4170 VOL/VOL
FIELD CAPACITY	=	0.0454 VOL/VOL
WILTING POINT	=	0.0200 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.0454 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.009999999776 CM/SEC

LAYER 11

BARRIER SOIL LINER

THICKNESS	=	60.00 INCHES
POROSITY	=	0.4300 VOL/VOL
FIELD CAPACITY	=	0.3663 VOL/VOL
WILTING POINT	=	0.2802 VOL/VOL
INITIAL SOIL WATER CONTENT	=	0.4300 VOL/VOL
SATURATED HYDRAULIC CONDUCTIVITY	=	0.000000100000 CM/SEC

GENERAL SIMULATION DATA

SCS RUNOFF CURVE NUMBER	=	68.00
TOTAL AREA OF COVER	=	1102500. SQ FT
EVAPORATIVE ZONE DEPTH	=	18.00 INCHES
UPPER LIMIT VEG. STORAGE	=	8.2020 INCHES
INITIAL VEG. STORAGE	=	4.8384 INCHES
INITIAL SNOW WATER CONTENT	=	0.0000 INCHES
INITIAL TOTAL WATER STORAGE IN SOIL AND WASTE LAYERS	=	54.0104 INCHES

SOIL WATER CONTENT INITIALIZED BY USER.

CLIMATOLOGICAL DATA

DEFAULT RAINFALL WITH SYNTHETIC DAILY TEMPERATURES AND SOLAR RADIATION FOR CINCINNATI OHIO

MAXIMUM LEAF AREA INDEX	=	2.00
START OF GROWING SEASON (JULIAN DATE)	=	133
END OF GROWING SEASON (JULIAN DATE)	=	300

NORMAL MEAN MONTHLY TEMPERATURES, DEGREES FAHRENHEIT

JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
28.90	32.10	41.80	53.50	63.00	71.40
75.40	74.10	67.50	55.30	43.40	33.80

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AVERAGE MONTHLY VALUES IN INCHES FOR YEARS 74 THROUGH 78

	JAN/JUL	FEB/AUG	MAR/SEP	APR/OCT	MAY/NOV	JUN/DEC
PRECIPITATION						
TOTALS	3.33	1.59	3.86	3.11	3.36	4.79
	3.54	4.80	2.89	3.33	2.69	3.36
STD. DEVIATIONS	0.56	1.34	1.71	0.63	1.78	1.24
	2.04	1.04	2.17	1.37	1.35	1.99

RUNOFF

TOTALS	0.000	0.006	0.000	0.000	0.000	0.000
	0.000	0.000	0.001	0.000	0.000	0.005
STD. DEVIATIONS	0.000	0.013	0.000	0.000	0.000	0.000
	0.000	0.000	0.001	0.000	0.000	0.011

EVAPOTRANSPIRATION

TOTALS	0.844	1.518	2.382	2.794	2.983	4.954
	4.536	4.351	2.312	1.978	1.645	0.890
STD. DEVIATIONS	0.189	0.323	0.148	0.391	1.563	1.091
	1.396	1.298	1.628	0.510	0.152	0.188

LATERAL DRAINAGE FROM LAYER 4

TOTALS	1.7186	1.5337	1.1785	1.2984	0.5949	0.2766
	0.2938	0.1688	0.3173	0.2829	0.2101	1.0189
STD. DEVIATIONS	1.1420	0.8777	1.2454	1.1669	0.4056	0.1824
	0.2145	0.1286	0.5286	0.4778	0.2498	1.2274

PERCOLATION FROM LAYER 5

TOTALS	0.0931	0.0833	0.0672	0.0726	0.0391	0.0235
	0.0247	0.0187	0.0255	0.0241	0.0203	0.0595
STD. DEVIATIONS	0.0549	0.0422	0.0599	0.0561	0.0195	0.0088
	0.0103	0.0062	0.0254	0.0230	0.0120	0.0590

PERCOLATION FROM LAYER 7

TOTALS	0.0785	0.0782	0.0774	0.0644	0.0521	0.0371
	0.0311	0.0187	0.0235	0.0261	0.0203	0.0444
STD. DEVIATIONS	0.0404	0.0382	0.0391	0.0396	0.0374	0.0372
	0.0202	0.0062	0.0210	0.0274	0.0120	0.0324

PERCOLATION FROM LAYER 11

TOTALS	0.0416	0.0381	0.0435	0.0448	0.0491	0.0495
	0.0521	0.0514	0.0478	0.0472	0.0437	0.0431
STD. DEVIATIONS	0.0114	0.0100	0.0108	0.0117	0.0138	0.0156
	0.0184	0.0190	0.0172	0.0160	0.0140	0.0130

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AVERAGE ANNUAL TOTALS & (STD. DEVIATIONS) FOR YEARS 74 THROUGH 78

	(INCHES)		(CU. FT.)	PERCENT
PRECIPITATION	40.64	(6.929)	3733984.	100.00
RUNOFF	0.011	(0.014)	1035.	0.03
EVAPOTRANSPIRATION	31.186	(2.865)	2865250.	76.73
LATERAL DRAINAGE FROM LAYER 4	8.8925	(3.3084)	816995.	21.88
PERCOLATION FROM LAYER 5	0.5517	(0.1590)	50689.	1.36
PERCOLATION FROM LAYER 7	0.5517	(0.1792)	50690.	1.36
PERCOLATION FROM LAYER 11	0.5519	(0.1592)	50708.	1.36
CHANGE IN WATER STORAGE	0.000	(3.536)	-4.	0.00

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PEAK DAILY VALUES FOR YEARS 74 THROUGH 78

	(INCHES)	(CU. FT.)
PRECIPITATION	2.40	220500.0
RUNOFF	0.028	2582.0
LATERAL DRAINAGE FROM LAYER 4	0.1638	15050.7
PERCOLATION FROM LAYER 5	0.0082	754.8
HEAD ON LAYER 5	5.8	
PERCOLATION FROM LAYER 7	0.0035	317.8
HEAD ON LAYER 7	0.4	
PERCOLATION FROM LAYER 11	0.0026	236.5
HEAD ON LAYER 11	0.0	

SNOW WATER 1.18 108843.8

MAXIMUM VEG. SOIL WATER (VOL/VOL) 0.3405

MINIMUM VEG. SOIL WATER (VOL/VOL) 0.0667

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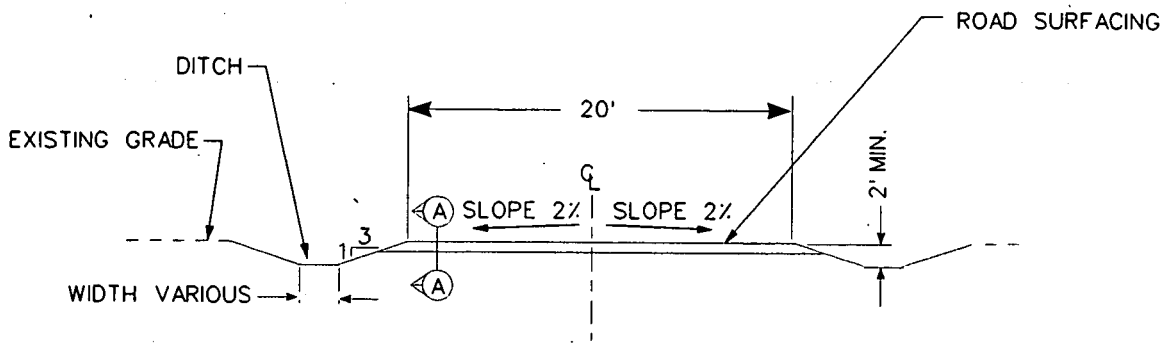
FINAL WATER STORAGE AT END OF YEAR 78

LAYER	(INCHES)	(VOL/VOL)
1	1.92	0.3208
2	5.10	0.2428
3	0.95	0.1577
4	3.21	0.0669
5	0.10	0.4000
6	0.16	0.0791
7	10.32	0.4300
8	2.82	0.2352
9	3.08	0.2570
10	0.54	0.0454
11	25.80	0.4300
SNOW WATER	0.00	

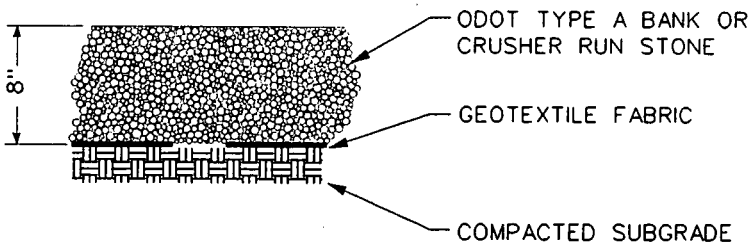
****
****

APPENDIX E.6

TYPICAL SECTIONS AND DETAILS



TYPICAL SECTION - ACCESS ROAD



SECTION A-A
ROAD SURFACING

LEGEND

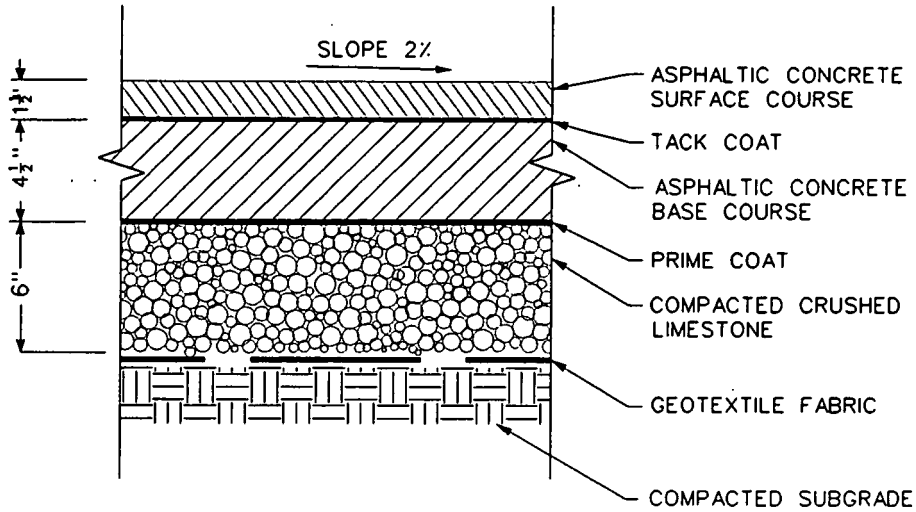
OHDOT TYPE A BANK OR CRUSHER RUN STONE

GEOTEXTILE FABRIC

COMPACTED SUBGRADE

FIGURE E.6-1
TYPICAL SECTION
ACCESS ROAD
(NOT TO SCALE)

fs1033.dgn

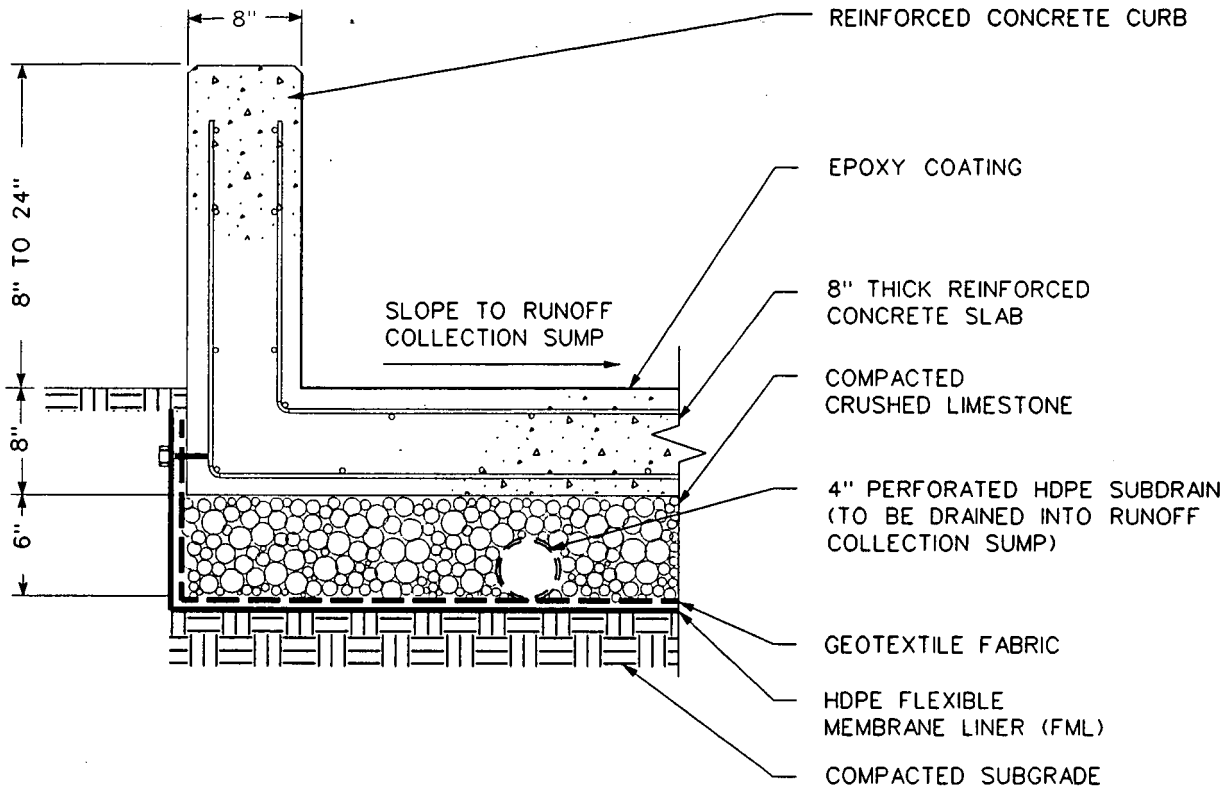


LEGEND

- ASPHALTIC CONCRETE SURFACE COURSE
- ASPHALTIC CONCRETE BASE COURSE
- COMPACTED CRUSHED LIMESTONE
- COMPACTED SUBGRADE
- PRIME COAT/ TACK COAT
- GEOTEXTILE FABRIC

FIGURE E.6-2
TYPICAL SECTION
SURFACING AT EQUIPMENT STORAGE AREA
(NOT TO SCALE)

fs1035.dgn

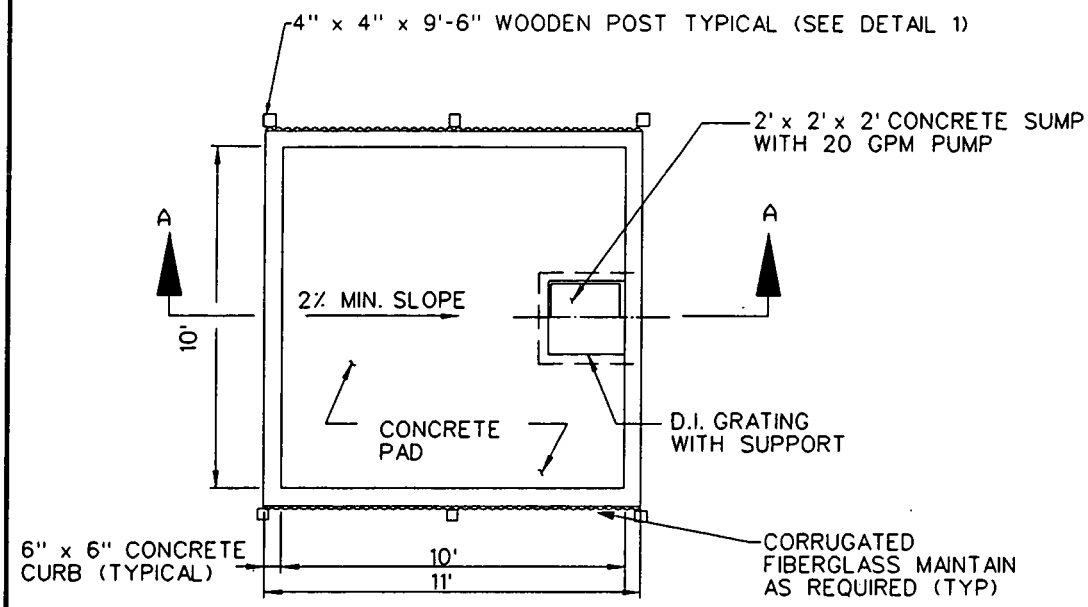


LEGEND

- COMPACTED CRUSHED LIMESTONE
- COMPACTED SUBGRADE
- GEOTEXTILE FABRIC
- HDPE FLEXIBLE MEMBRANE LINER (FML)

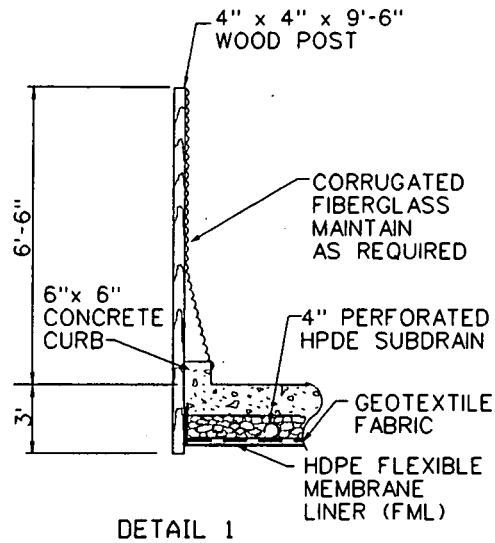
FIGURE E.6-3
TYPICAL SECTION-STAGING AREA
(NOT TO SCALE)

fs1036.dgn



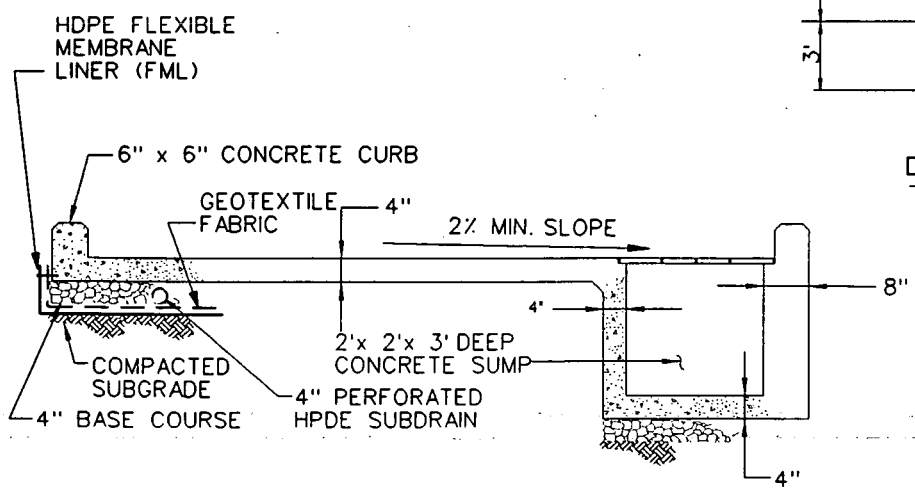
PERSONNEL DECONTAMINATION FACILITY

NTS



DETAIL 1

NTS

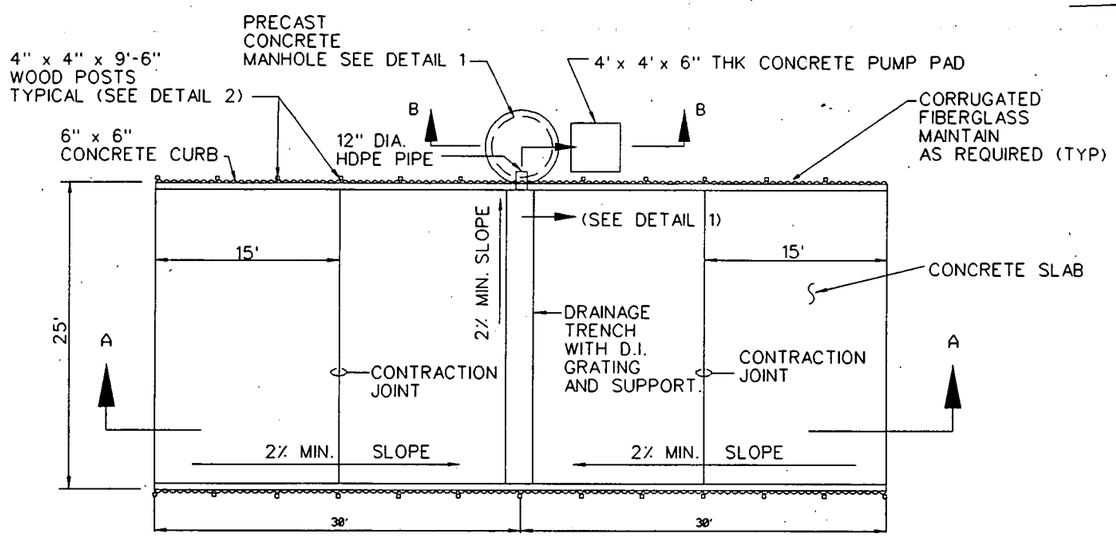


SECTION A - A

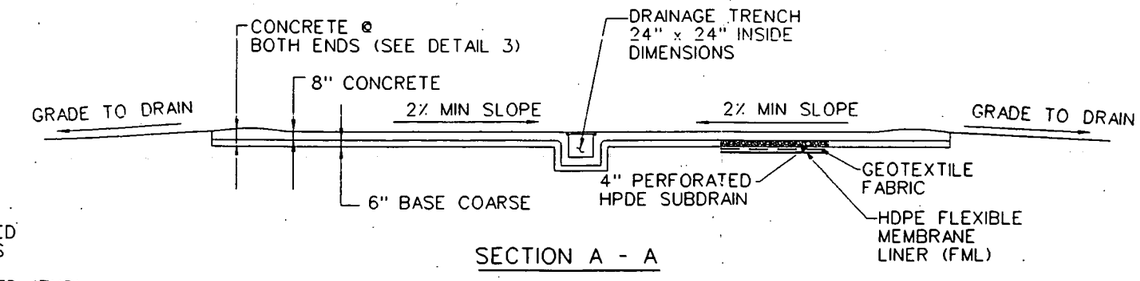
NTS

FIGURE E.6-4
TYPICAL DETAIL
PERSONNEL DECONTAMINATION FACILITY
(NOT TO SCALE)

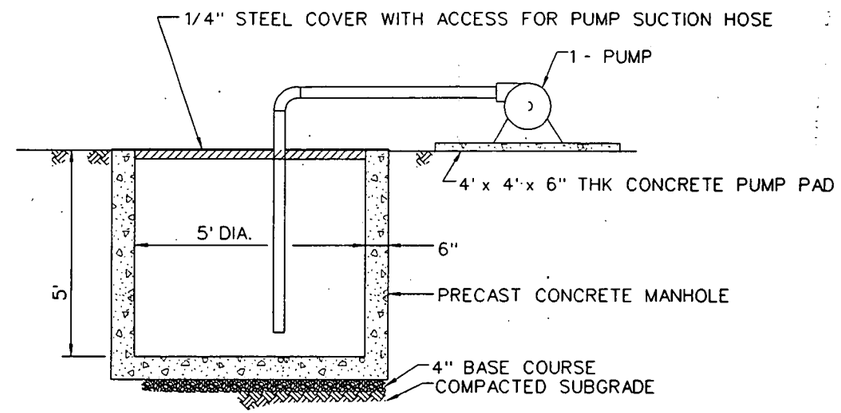
fs1081.dgn



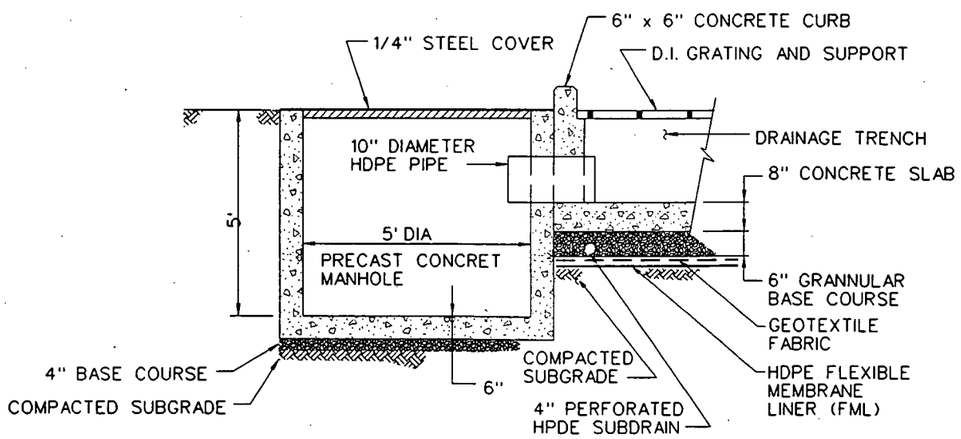
CONSTRUCTION EQUIPMENT DECONTAMINATION FACILITY



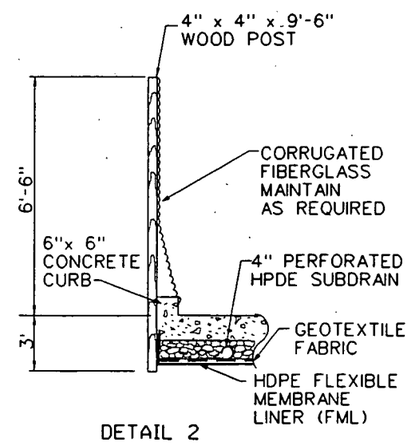
SECTION A - A



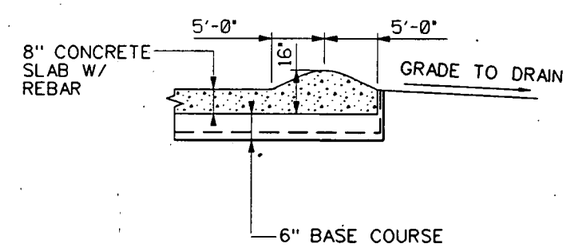
SECTION B - B
PRECAST CONCRETE MANHOLE



DETAIL 1



DETAIL 2
NTS



DETAIL 3
NTS

FIGURE E.6-5
TYPICAL DETAIL
EQUIPMENT DECONTAMINATION
FACILITY
(NOT TO SCALE)

rs1080.dgn

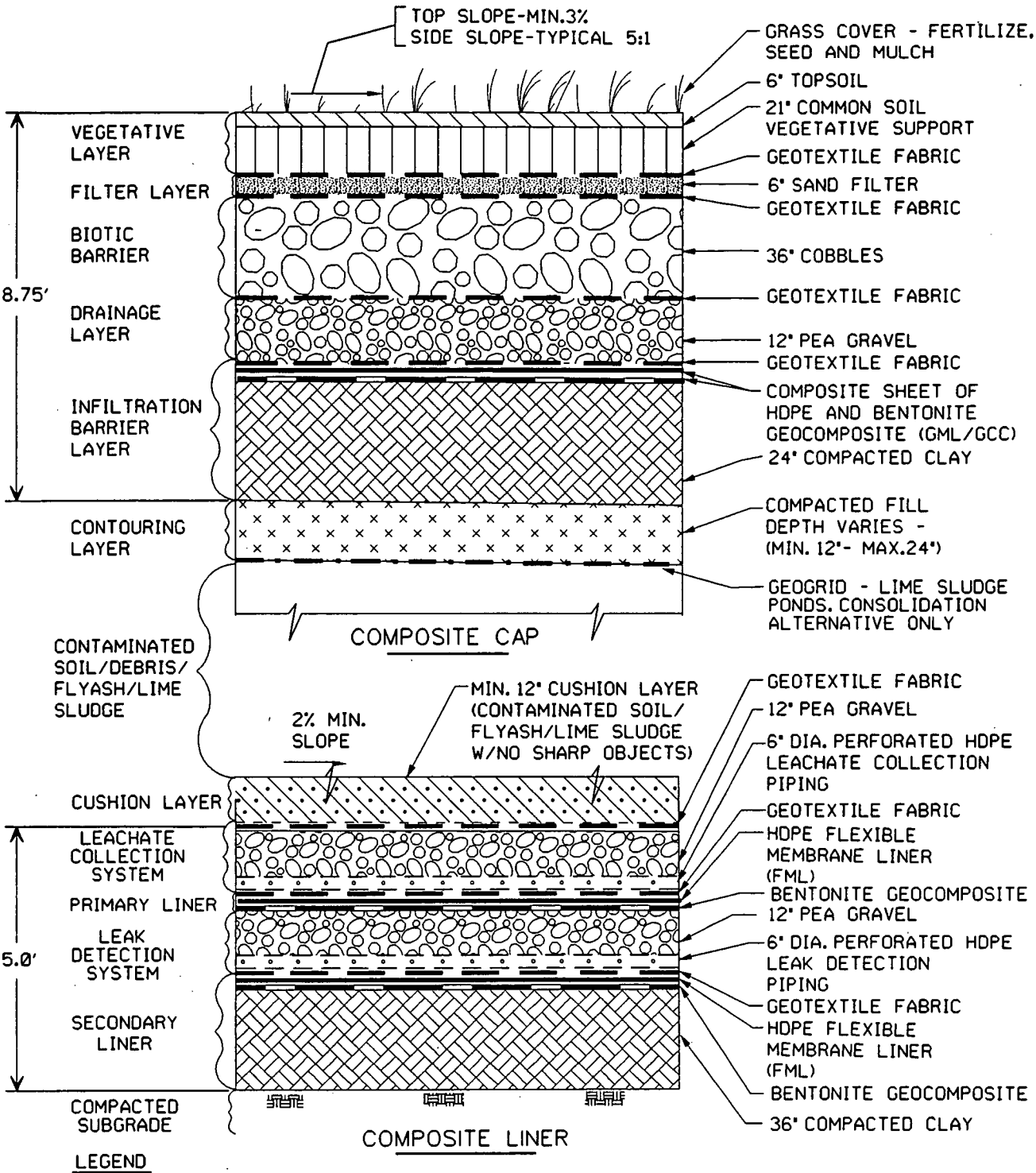
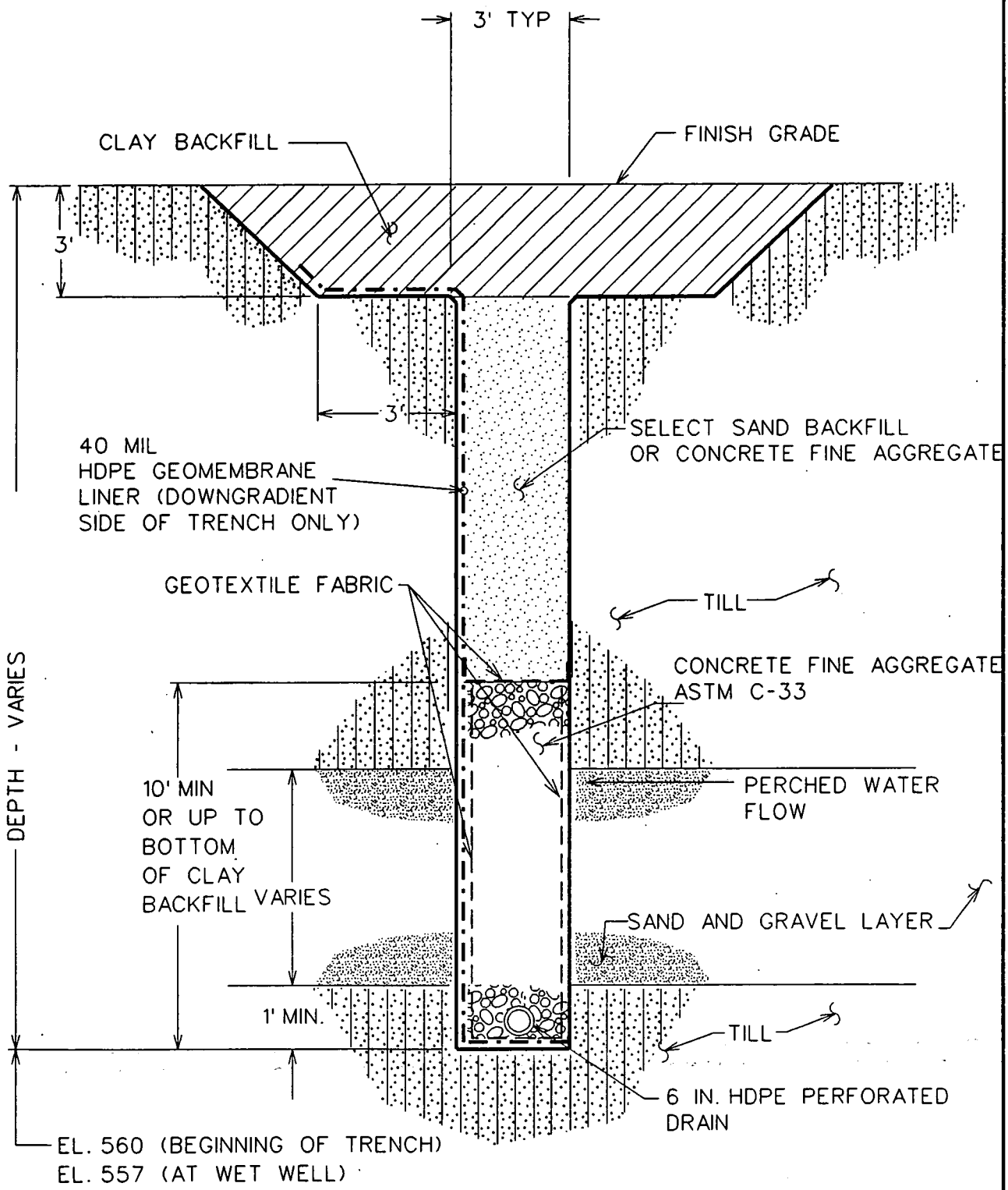


FIGURE E.6-6
TYPICAL DETAIL
COMPOSITE CAP AND LINER
(NOT TO SCALE)

fs0450.dgn



fs1085.dgn

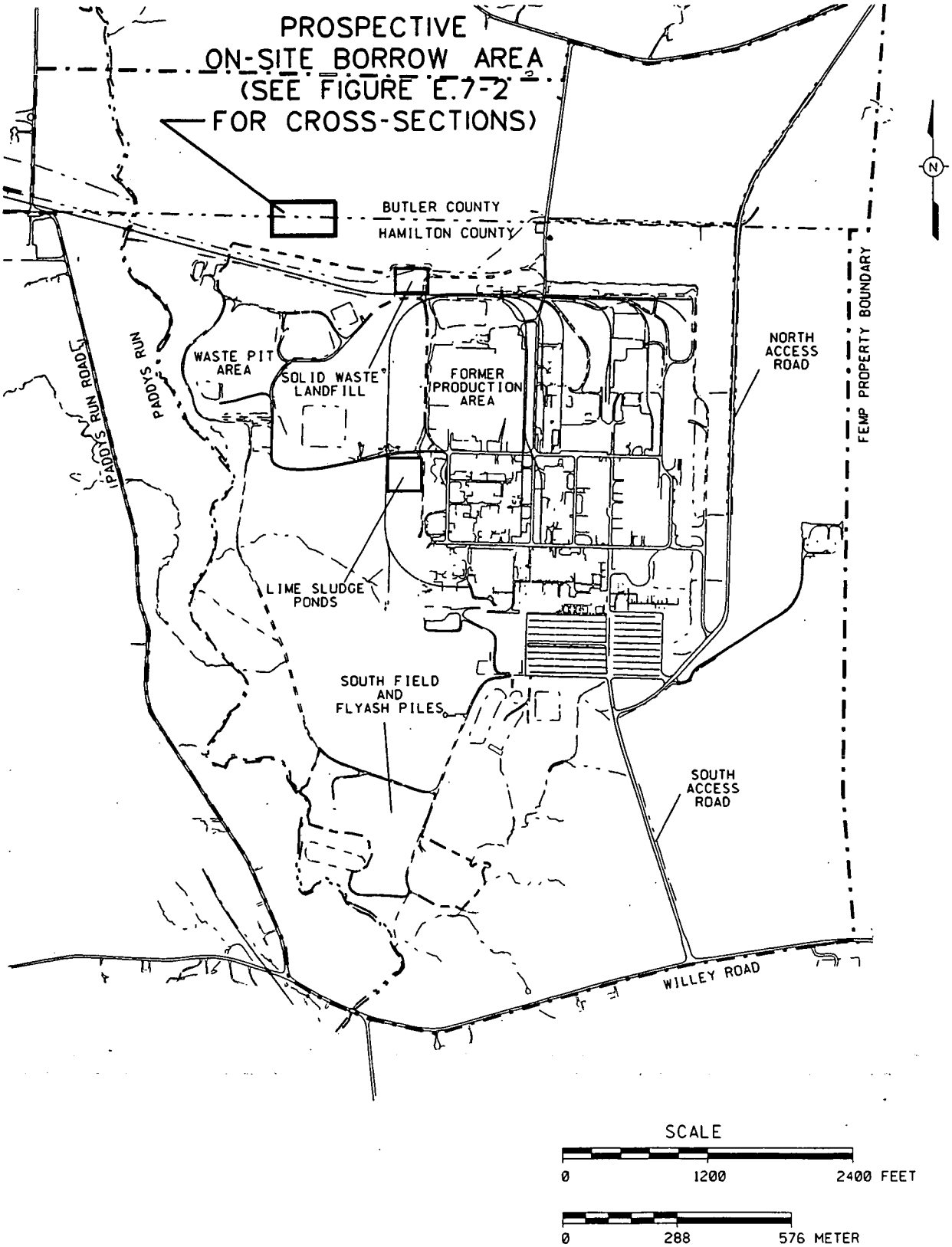
FIGURE E.6-7
TYPICAL SECTION - SUBSURFACE DRAIN

E.7

APPENDIX E.7
ON-SITE BORROW SOURCE

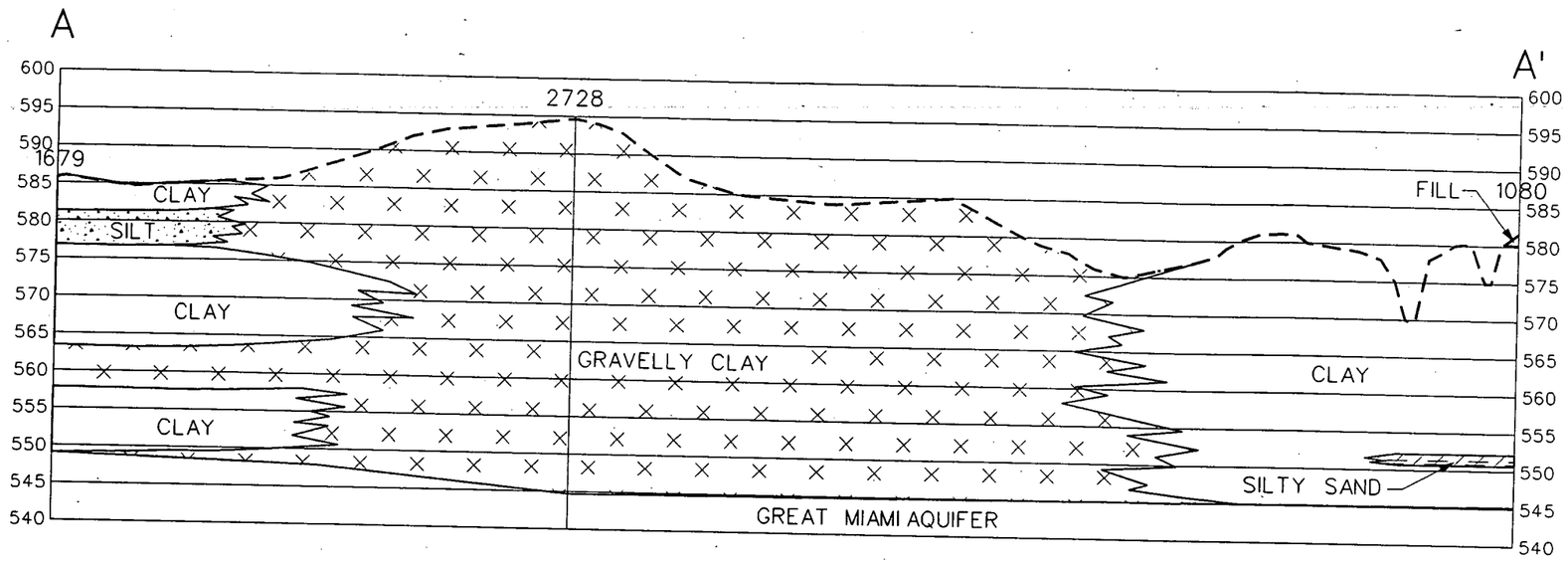
APPENDIX E.7
ON-SITE BORROW SOURCE

An on-site borrow source is being considered for soils to be used during the construction of the proposed on-site disposal facility and for restoration of the subunits. Soils from the borrow source will be investigated for use as site restoration backfill, disposal facility cap components, and disposal facility liner components. A location in the northwest portion of the FEMP (see Figure E.7-1) has been identified as a prospective source area. As indicated by the cross sections (Figure E.7-2) the soils in this area consist of clay, gravelly clay, silt, and sand. The boring logs on which the cross sections are based are included following Figure E.7.2. Additional information is needed to adequately describe the lithology and geotechnical properties in the prospective borrow source area. Therefore, additional soil borings will be considered to obtain this information. If it is determined that this area is not adequate as a borrow source, then other on-site or off-site locations may be considered.



fs0991.dgn

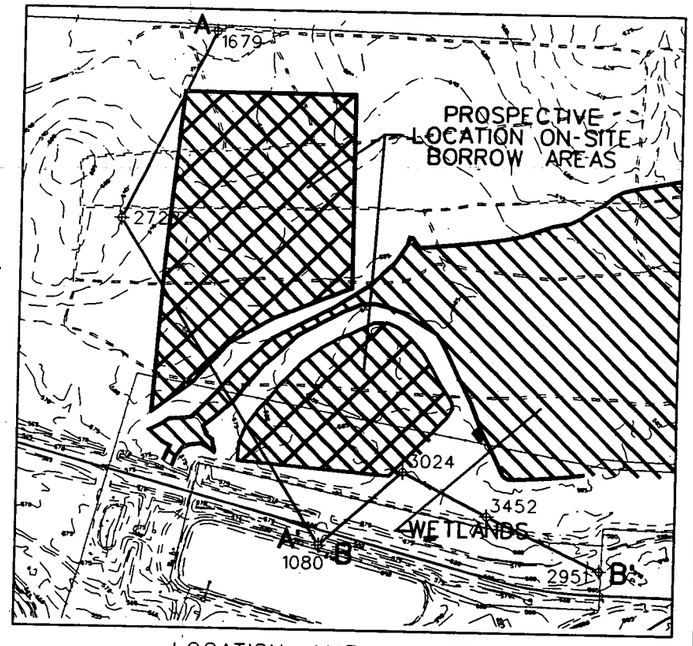
FIGURE E.7-1
LOCATION OF PROSPECTIVE ON-SITE BORROW AREA



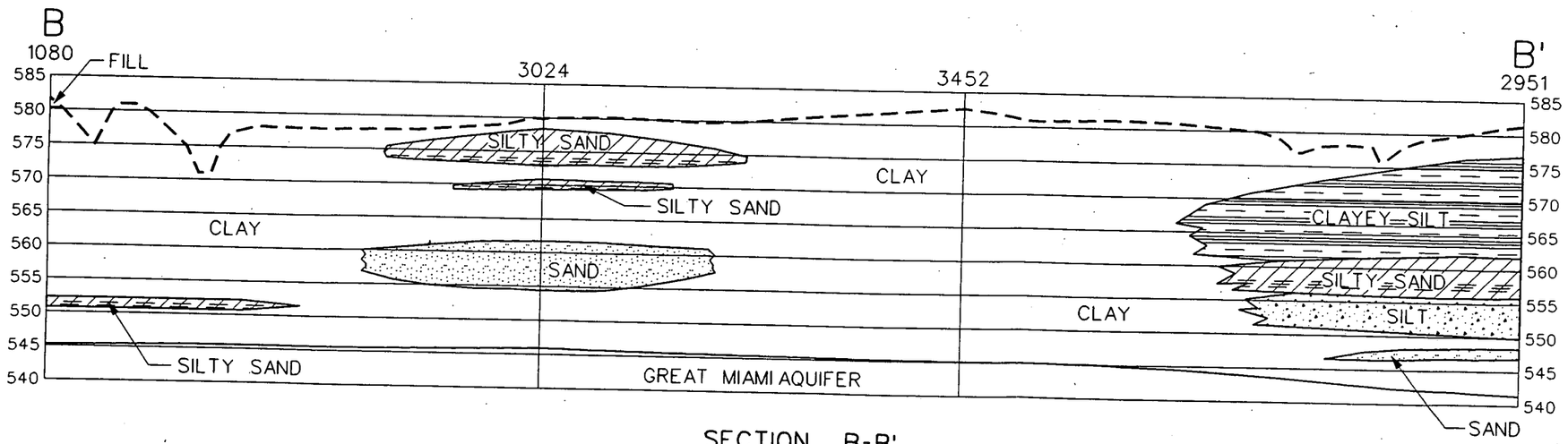
SECTION A-A'

SCALE:
HOR 1"=200'
VER 1"=20'

SCALE:
HORIZONTAL 1 cm = 24 m
VERTICAL 1 cm = 2.4 m



LOCATION MAP (1"=500')



SECTION B-B'

SCALE:
HORIZONTAL 1"=100'
VERTICAL 1"=20'

SCALE (FT)
0 50 100 200

SCALE:
HORIZONTAL 1 cm = 24 m
VERTICAL 1 cm = 2.4 m

SCALE (METER)
0 12 24 48

LEGEND

- ELEVATION CONTOURS
- ROADS
- STREAM
- FENCE
- RAILROAD
- PROSPECTIVE BORROW AREA
- WETLANDS

NOTE:
Coordinates are in State Planar NAD 1927.
Surface contours based on 1992 flyover.

FIGURE E.7-2
PROSPECTIVE LOCATION AND CROSS-SECTIONS ON-SITE BORROW AREA

fs0998.dgn

VISUAL CLASSIFICATION OF SOILS

6647

PROJECT NUMBER 20-03.05 RDC 11	PROJECT NAME CRU 2 Phase II	
BORING NUMBER 2951	COORDINATES	DATE 4-13-93
ELEVATION:	GWL: Depth 61.7 Date/Time 4/23/93 1030	DATE STARTED 4-12-93
ENGINEER/GEOLOGIST K. Payne	Depth Date/Time	DATE COMPLETED 4-23-93
DRILLING METHODS Cable Tool		PAGE 1 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	111389 0930 4-13-93	1 4 6	12	Stiff (2.5Y, 4/3) Olive Brown Silty Clay with mottling, non-plastic, slightly moist	CL	1.5	HNU = 0 ppm βγ = 100 cpm α = 0 cpm
2 3	111390 0933 4-13-93	6 10 2	12	Very Stiff (2.5Y, 5/6) light olive brown Silty Clay with trace gravel, non-plastic, slightly moist	CL	4.0	HNU = 0 ppm βγ = 100 cpm α = 0 cpm
4	111391 0940 4-13-93	6 21 25	14	Hard (2.5Y, 5/6) light olive brown, Silty Clay with trace gravel, non-plastic, slightly moist	CL	4.5	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
5 6	111392 0945 4-13-93	30 33 30	15	Very Dense (2.5Y, 6/2) light brownish gray, clayey Silt with trace gravel, non-plastic, slightly moist	ML	N/A	HNU = 0 ppm βγ = 100 cpm α = 0 cpm
7	111393 0955 4-13-93	21 27 31	16	Very Dense (2.5Y, 5/3) light olive brown, clayey Silt with trace gravel, slightly plastic, moist	ML	N/A	HNU = 0 ppm βγ = 100 cpm α = 0 cpm
8 9	111394 1005 4-13-93	34 37 30	17	Very Dense (2.5Y, 5/3) light olive brown clayey Silt with trace gravel, non-plastic, slightly moist	ML	N/A	HNU = 0 ppm βγ = 70 cpm α = 0 cpm
10	111395 1500 4-13-93	9 18 23	6	Dense (10YR, 6/6) Brownish Yellow, Clayey Silt, mottling, non-plastic, slightly moist	ML	N/A	HNU = 0 ppm βγ = 80 cpm α = 0 cpm
11 12	111396 1520 4-13-93	10 15 15	14	Medium Dense (2.5Y, 6/3) light yellowish Brown, Clayey Silt, non-plastic, slightly moist	ML	N/A	HNU = 0 ppm βγ = 80 cpm α = 0 cpm
13	111397 1535 4-13-93	4 5 8	7	Medium Dense (2.5Y, 4/2) dark grayish Brown, Clayey Silt, slight plasticity, moist	ML	N/A	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
14 15	111398 1550 4-13-93	1 4 7	6	Medium Dense (2.5Y, N4/) dark gray, Clayey Silt, low plasticity, moist	ML	N/A	HNU = 0 ppm βγ = 80 cpm α = 0 cpm

NOTES
Drilling Contractor Pennsylvania Drilling
Drilling Equipment Cyclone 42
Driller Bob Johnson
Lonnie McGloklin

SAA - Same As Above
NA - Not Applicable
Samples collected per ASTM standard penetration test
Colors identified using Munsell Color Chart

Background Readings HNU = 0 ppm
βγ = 80 cpm

VISUAL CLASSIFICATION OF SOILS

OJECT NUMBER 10.03.05 RDC 11	PROJECT NAME. CRU 2 Phase II		
NG NUMBER 2951	COORDINATES.		DATE 4-13-93
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED 4-12-93
ENGINEER/GEOLOGIST K. Payne	Depth	Date/Time	DATE COMPLETED. 4-23-93
DRILLING METHODS Cable Tool			PAGE 2 OF 10

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
16	111399 1610 4-13-93	2 4 8	5	Medium Dense (5Y, 5/2) Olive Gray, Clayey Silt, low plasticity, moist	ML	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
17, 18	111400 1630 4-13-93	1 4 8	7	SAA	ML	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
19	111401 1640 4-13-93	2 4 8	6	Medium Dense (5Y, 5/2) Olive Gray, Clayey Silt with trace gravel, low plasticity, moist	ML	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
20, 1	111402 0850 4-15-93	25 27 8	14	Dense (5Y, 5/1) Gray Silty Sand with trace gravel, non-plastic, moist	SM	N/A	HNU = 0 ppm; βγ = 120 cpm; α = 0 cpm
22	111403 0910 4-15-93	8 16 45	6	Very Dense (5Y, 4/2) Olive Gray Silty Sand, non-plastic, moist	SM	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
23, 24	111404 0925 4-15-93	31 21 35	8	Very Dense (5Y, 5/2) Olive Gray Silty Sand with trace gravel, non-plastic, moist	SM	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
25	111405 0945 4-15-93	11 25 31	5	Very Dense (5Y, 5/2) Olive Gray Silty Sand with trace gravel, non-plastic, moist	SM	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
26, 27	111406 1005 4-15-93	12 19 50/.3	9	Very Dense (5Y, 5/1) Gray Clayey Silt, non-plastic, moist	ML	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cpm
28	111407 1030 4-15-93	16 12 14	13	Medium Dense (5Y, 5/1) Gray Clayey Silt with trace organics and gravel, slightly plasticity, moist	ML	N/A	HNU = 0 ppm; βγ = 60 cpm; α = 0 cp
29, 30	111408 1040 4-15-93	11 17 17	12	Medium Dense (5Y, 5/1) Gray Clayey Silt, slight plasticity, moist	ML	N/A	HNU = 0 ppm; βγ = 80 cpm; α = 0 cpm

NOTES

Drilling Contractor Pennsylvania Drilling
Drilling Equipment Cyclone 42
Driller Bob Johnson
Lonnie McGloklin

SAA - Same as above
NA - Not Applicable

Samples collected per ASTM standard penetration
Colors identified using Munsell Color Chart

Background Readings
[illegible] HNU = 0 ppm 4-15-93 { HNU = 0 ppm, βγ = 60 cpm

001065

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 20.03.05	PROJECT NAME. CRU 2 Phase II	
BORING NUMBER 2951	COORDINATES.	DATE 4-15-93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED 4-12-93
ENGINEER/GEOLOGIST Keith Payne	Depth Date/Time	DATE COMPLETED 4-23-93
DRILLING METHODS Cable Tool		PAGE 3 of 10

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
31.0	111409 1350 4-15-93	10 11 15	14	Medium dense (5Y, 4/1) dark gray clayey silt, non plastic, moist	MC	N/A	HNU = 0 ppm βγ = 100 cpm α = 0 cpm
32.0 33.0	111410 1405 4-15-93	5 6 15	8	Medium dense (5Y, 4/1) dark gray silty sand, non plastic, moist	SM	N/A	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
34.0	111411 0910 4-16-93	12 30 25	18	Hard (5Y, 4/1) dark gray, silty gravelly, medium plasticity clay, moist	CL	4.5	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
35.0 36.0	111412 0930 4-16-93	17 21 30	13	Very Dense (2.5Y, 4/4) olive brown, well graded, pebbly sand, dry	SW	N/A	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
37.0	111413 0940 4-16-93	22 28 25	11	Very Dense (2.5Y, 6/3) light yellowish brown, well graded sand, dry	SW	N/A	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
38.0 39.0	111414 0955 4-16-93	16 15 21	9	Dense (10YR, 6/3) pale brown well graded sand, dry	SW	N/A	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
40.0							
41.0	111415 1045 4-16-93	9 9 9	10	Very soft (2.5Y, 5/2) grayish brown silty, sandy, medium plasticity clay, moist	CL	<0.25	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
42.0 43.0	111416 1330 4-16-93	27 50/.4	10	Very dense (2.5Y, 6/3) light yellowish brown, well graded pebbly sand, dry	SW	N/A	HNU = 0 ppm βγ = 60 cpm α = 0 cpm
44.0 45.0				Resumed sampling at 5 ft intervals			

Drilling Subcontractor: Pennsylvania Drilling
Drilling Equipment: Cyclone 42
Driller: Bob Johnson
Lonnie McGlocklin

4-16-93
βγ background = 40-60 cpm
α background = 0 cpm
HNU background = 0 ppm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 20.03.05	PROJECT NAME. CLU 2 Phase II	
BORING NUMBER. 2951	COORDINATES.	DATE 4-16-93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED 4-12-93
ENGINEER/GEOLOGIST Keith Payne	Depth Date/Time	DATE COMPLETED 4-17-93
DRILLING METHODS Cable tool		PAGE 4 OF 10

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (cm)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45.0							
46.0	111417 1350 4-16-93	7 21 45	7	Very Dense (10YR, 6/2) light brownish gray, well graded, gravelly sand, dry	SW	N/A	HNU = 0 ppm β γ = 60 cpm α = 0 cpm
47.0							
48.0							
49.0							
50.0							
51.0	111418 1440 4-16-93	11 10 21	10	Dense (10YR, 4/2) dark grayish brown, well graded, silty, clayey sand, wet	SC	N/A	HNU = 0 ppm β γ = 60 cpm α = 0 cpm
52.0							
53.0							
54.0							
55.0							
56.0	111419 1500 4-16-93	21 19 50/4	10	Very Dense (2.5Y, 6/2) light grayish brown, poorly graded, gravelly sand, dry	SP	N/A	HNU = 0 ppm β γ = 60 cpm α = 0 cpm
57.0				Begin continuous sampling for sieve analysis and total U			
58.0							
59.0	111420 0910 4-17-93	18 29 30	8	Very Dense (2.5Y, 6/2) light brownish gray, poorly graded, gravelly sand, dry	SP	N/A	Microtip (MT) = 5.2 ppm β γ = 60 cpm α = 0 cpm
60.0	111421			See Page 5			

NOTES

Drilling Contractor: Pennsylvania Drilling
Drilling Equipment: Cyclone 42
Driller: Bob Johnson
Lonnie McGlocklin

4-17-93
MT background = 2-3 ppm
β γ background = 60 cpm
α background = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 20.03.05	PROJECT NAME. CRU 2 Phase II	
BORING NUMBER 2951	COORDINATES.	DATE 4-17-93
ELEVATION:	GWL: Depth Date/Time	DATE STARTED 4-12-93
ENGINEER/GEOLOGIST Keith Payne	Depth Date/Time	DATE COMPLETED 4-17-93
DRILLING METHODS Cable Tool		PAGE 5 OF 10

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
61.0	111421 0930 4-17-93	4 9 10	9	Medium dense (2.5Y, 5/4) light olive brown, well graded, gravelly sand, wet	SW	N/A	MT = 6.6 ppm βγ = 60 cpm α = 0 cpm
62.0	111422 0945 4-17-93	9 10 12	16	Medium dense (2.5Y, 4/2) dark grayish brown, well graded, gravelly sand, wet	SW	N/A	MT = 8 ppm βγ = 60 cpm α = 0 cpm
63.0 64.0	111423 1000 4-17-93	14 13 14	12	Medium Dense (5Y, 5/1) gray, well graded sand with some gravel, wet	SW	N/A	MT = 7 ppm βγ = 60 cpm α = 0 cpm
66.0	111424 1030 4-17-93	18 23 16	11	Dense (5Y, 5/1) gray, well graded sand with some gravel, wet	SW	N/A	MT = 4.9 ppm βγ = 60 cpm α = 0 cpm
66.0 67.0	111425 1315 4-17-93	32 50/3	10	Very Dense (10YR, 4/1) dark gray well graded sand with some gravel wet	SW	N/A	MT = 0 ppm βγ = 60 cpm α = 0 cpm
68.0	111426 1335 4-17-93	13 15 35	15	Dense (10YR, 4/1) dark gray well graded sand with some gravel, wet	SW	N/A	MT = 0 ppm βγ = 60 cpm α = 0 cpm
69.0 70.0	111427 1400 4-17-93	12 18 18	16	Dense (5Y, 4/2) olive gray, well graded, sand with some gravel, wet	SW	N/A	MT = 0 ppm βγ = 60 cpm α = 0 cpm
71.0	111428 1415 4-17-93	10 11 12	15	Medium Dense (5Y, 4/2) olive gray, well graded sand with some gravel, wet	SW	N/A	MT = 0 ppm βγ = 60 cpm α = 0 cpm
72.0 73.0	111429 1500 4-17-93	50 50/3	10	Very Dense (5Y, 4/2) olive gray well graded sand with some gravel wet	SW	N/A	MT = 0 ppm βγ = 60 cpm α = 0 cpm
74.0 75.0				Bottom of Casing at 75.0' Bottom of boring at 75.0'			

NOTES
Drilling Contractor: Pennsylvania Drilling
Drilling Equipment: Cyclone 42
Driller: Bob Johnson
Lonnie McGlocklin

See Page 4 for background readings

PIEZOMETER INSTALLATION SHEET

PROJECT NAME CRU 2 Phase II
FIELD ENG./GEO. K. Payne
DATE 4-26
PROJECT NO. 20.03.05 RDCII
CHECKED BY
DATE
BORING NO. 2951
PIEZOMETER NO. ~~NA~~ 2951 BR 4-21-93
DATE OF INSTALLATION 4-23-93

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0.0 FT TO 65.0 FT
FLUID N/A FROM N/A TO N/A

TYPE OF BIT Hammer Percussion Bit
CASING SIZE (S) USED:
SIZE 10.0 in ID FROM 0.0 FT TO 75.0 F
SIZE N/A FROM N/A TO N/A

PIEZOMETER DESCRIPTION

TYPE Monitoring Well
DIAMETER OF PERFORATED SECTION 4.0 ID
PERFORATION TYPE:
SLOTS [X] HOLES [ ] SCREEN [ ]
AVERAGE SIZE OF PERFORATIONS .010 IN
TOTAL PERFORATED AREA 15.0 FT

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8 IN I.D. 4.0 IN
LENGTH OF PIPE SECTIONS 5-10FT; 1-5FT; 2-
JOINING METHOD Screw type - flush joint threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 FT
PROTECTIVE PIPE O.D. 10 3/4 IN

OTHER PROTECTION Hinged locking cover with padlock

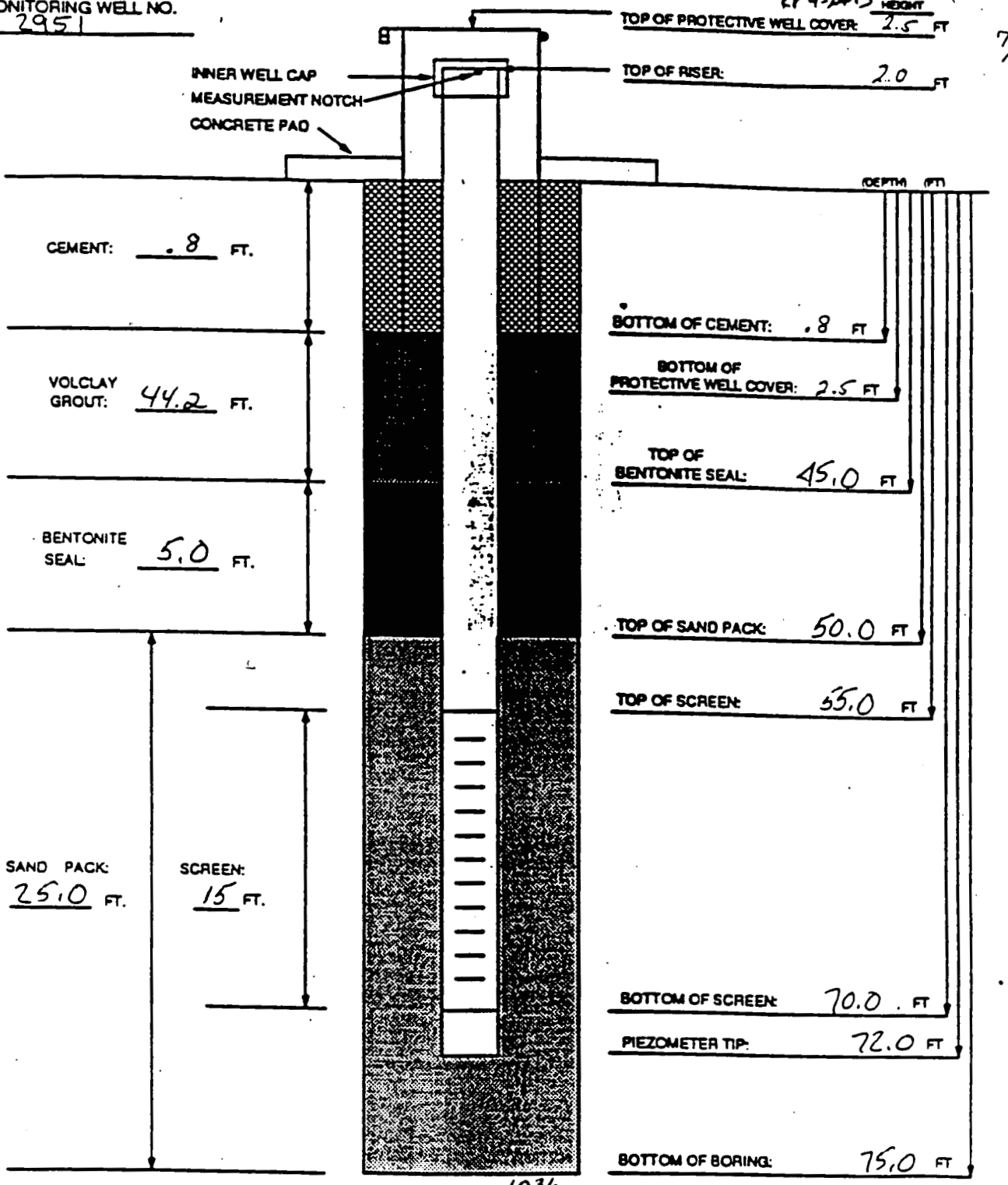
ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (FT)		ELEVATION ( )	
TOP OF RISER PIPE	2.0 FT			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 FT			
BOREHOLE FILL MATERIALS:	TOP 0.0 FT	BOTTOM .8 FT		
Cement GROUT/SLURRY	TOP .8 FT	BOTTOM 45.0 FT	TOP	BOTTOM
BENTONITE	TOP 45.0 FT	BOTTOM 50.0 FT	TOP	BOTTOM
SAND	TOP 50.0 FT	BOTTOM 75.0 FT	TOP	BOTTOM
GRAVEL	TOP N/A	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 55.0 FT	BOTTOM 70.0 FT	TOP	BOTTOM
PIEZOMETER TIP	72.0 FT			
BOTTOM OF BOREHOLE	75.0 FT			
GWL AFTER INSTALLATION	61.7 FT (Top of Riser)			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES [ ] NO [X]
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES [ ] NO [X]
REMARKS Cement was placed from 0.0 to .8 ft to hold the protective cover in place.

FERNALD RI/FS
INSTALLATION DIAGRAM
MONITORING WELL NO. 2951

INSTALLATION DATE: ~~[illegible]~~ 7-23-93
KP 4-2-93

7/10



BOREHOLE DIAMETER: 10 3/8 IN.

TERIALS USED

D TYPE AND QUANTITY: 10/20, 25 bags @ 50lb
TONITE PELLETS (5-GALLON BUCKETS): 4
S OF VOLCLAY GROUT: 10.5
UNT OF CEMENT: 1 bag @ 94lb
NT OF WATER USED: 900gal
: 13 Drums Soil ; 1 Drum Alconox/Water
20.03.05 ROC 11

NOTES:

1) RISER PIPE IS 4.0 IN. ID. 316 STAINLESS STEEL PIPE, FLUSH-THREADED JOINTS.
2) SCREEN IS 4.0 IN. ID. 316 STAINLESS STEEL PIPE WITH 0.010 IN. SLOTS.
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP.
4) WATER DEPTH AND DATE: 4/23/93 FT: 61.7
5) TOP OF CASING IS SECURED WITH A STAINLESS STEEL CAP.
6) PARENTHESIS INDICATE DEPTH BELOW GROUND LEVEL.
7) WELL CASING HAS A PROTECTIVE COVER WITH PADLOCK.

GEOLOGIST/ENGINEER: Keith Payne

FORM 0157 REV (0)

001070

8/10

MW2951

930419-048

4-20-93 Tom McCullough

C

***** CHAIN OF CUSTODY *****

Analysis ID: 930419-048 Project No.: 0020-0001 Change: RDC11
Customer No.: 111430 Customer Name: FERMCO
Matl. Descr.: OU-2 PHASE 2 Headline: 26-APR-19
Sample Matrix: SOIL Date Sampled: 17-APR-19
Comments: SEND RESULTS TO: MIKE FRAIN FAX: (513)738-0145

Sample Logged By: KS FRENCH Modified By: KS FRENCH
Sampled From: B2951 Date Modified: 19-APR-1993 13:25

ENVIRONMENTAL & PROCESS MATERIALS LABORATORY

Analysis	Units	Activ.	Prep Proc No	Analys Proc
SIEVE ANALYSIS, 40% RETAINED	.001 INCH	9158	42	9158
SIEVE ANALYSIS, 50% RETAINED	.001 INCH	9158		9158
SIEVE ANALYSIS, 90% RETAINED	.001 INCH	9158	32	9158
			8	

Crosschecked by: FAXED
~~Phoned~~ in at_____ hrs on ___
Entered on Computer by: _____
~~Mailed~~ by_____
Approved and Printed by: _____

001071

6647

Customer Number: 111730

MATERIAL: 930419-048 SAMPLE NUMBER:

DETERMINATION: Particle Size METHOD: Sieve Analysis

Sample weight: 191.9

Sieve Number	Weight Retained, g	% Retained	Cumulative % Retained	Grain Size, 1/1000 inch
10	45.4	~~23.6~~ 23.7	~~23.6~~ 23.7	78.7
20	47.3	24.6	48.3	33.5
40	53.0	27.6	75.9	16.7
60	25.8	13.4	89.3	9.8
100	8.3	4.3	93.6	5.9
200	4.8	2.5	96.0	3.0
Pan	6.9	3.6	99.6	

$\frac{W_2 \times 100\%}{W_1} = R$ 191.5

$\frac{\text{Original - Duplicate}}{\text{Average}} \times 100\% = \text{RPD}$

Analyzed by: Tom McCullough

Checked by: [signature]

Date analyzed: 4-20-93

GRAIN SIZE RETAINED

40 % 42

50 % 32

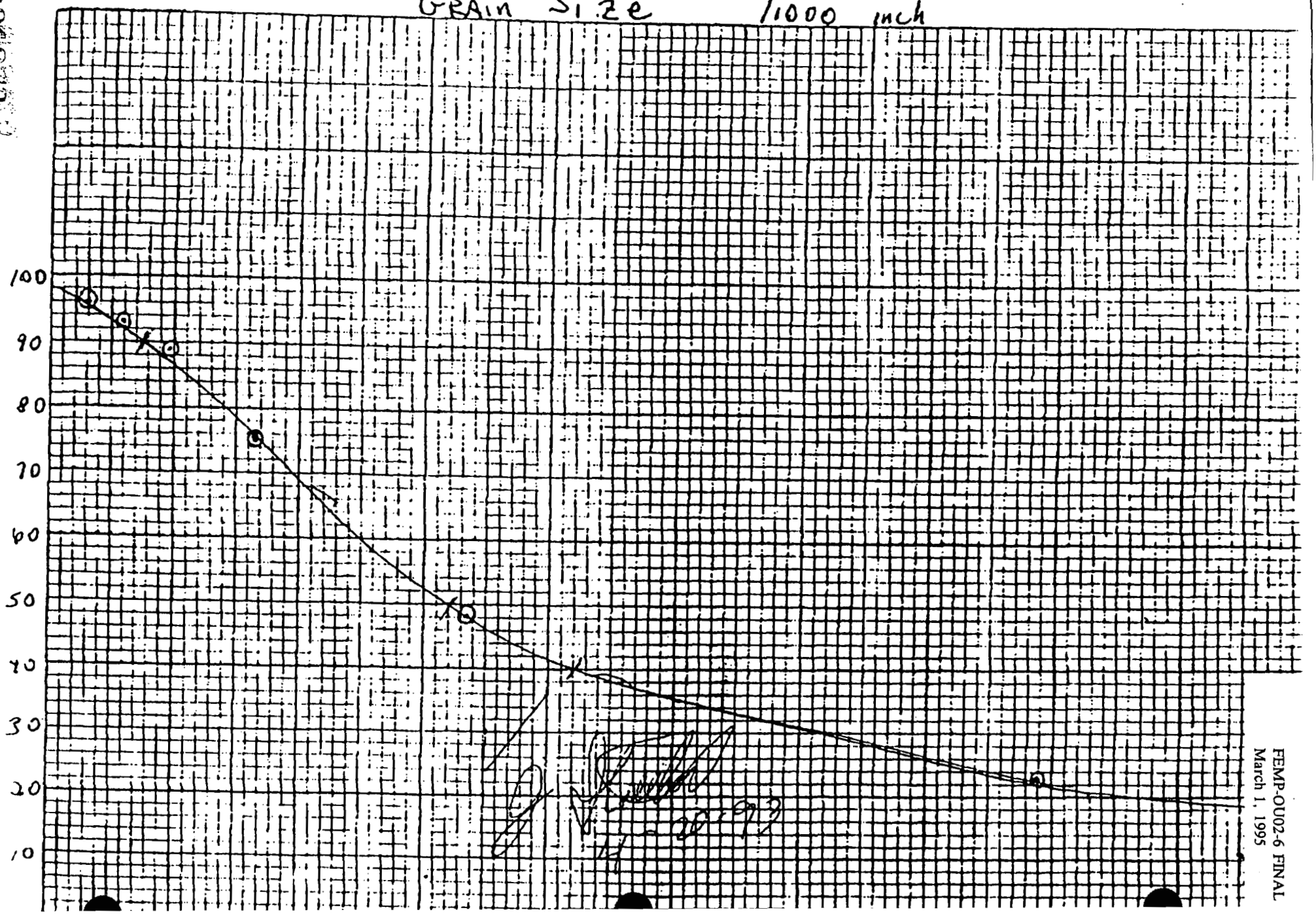
90 % 8

NO 340/ -10 DIETZGEN GRAPH PAPER
10 X 10 PER INCH

930719-048 EUGENE DIETZGEN CO MADE IN U. S. A.

Tom McDough

GRAIN SIZE 1/1000 inch



VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602 04 28 WBA-40	PROJECT NAME RCRA Phase II	
BORING NUMBER 3452	COORDINATES:	DATE 1/27/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/750	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 ft Date/Time 2/17/93/1550	DATE COMPLETED: 2/16/93
DRILLING METHODS Cable Tool		PAGE 1 OF ~~13~~ 16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0	107000 1330 1/27/93	1 2 3	18	Soft, Dark Yellowish Brown (10YR 4/4) Silty Clay with a Trace of ~~silt~~ sand, med Plasticity, Moist KG 1/27/93	KG 1/27/93 ~~.5~~ CL	.5	HNU = 0 ppm Bγ = 40 cpm α = 0 cpm Some Grass + Roots in Sample
1.5	107001 1340 1/27/93	1 1 1	13	Stiff Yellowish Brown (10YR 5/6) Silty Sandy Clay with Some Gravel ~~Low~~ Plasticity, moist	CL	1.5	HNU = 0 ppm Bγ = 40 cpm α = 0 cpm
3.0	107002 1350 1/27/93	2 3 5	18	Stiff, Yellowish Brown (10YR 5/6) Silty Clay with Some Sand and Gravel Low Plasticity, moist	CL	1.5	HNU = 0 ppm Bγ = 40 cpm α = 0 cpm
4.5	107003 1400 1/27/93	19 23 28	18	Same As Above	CL	1.5	HNU = 0 ppm Bγ = 40 cpm α = 0 cpm
				Stiff, Gray (2.5Y 5/1) Silty Sandy Clay with Some Gravel Low Plasticity, moist	CL	1.5	
6.0	107004 1410 1/27/93	19 28 32	12	Very Soft Gray (2.5Y 5/1) Silty Sandy Clay with Some Gravel Low Plasticity, moist	CL	.25	HNU = 0 ppm Bγ = 40 cpm α = 0 cpm
7.5							

NOTES:

Drilling Company: Pennsylvania Drilling
Driller: Dave Newman
Assistant Driller:

Samples collected per ASTM standard penetration test. Colors identified using Munsell Color Chart.

Background Levels
HNU = 0 ppm
Bγ = 20-40 cpm
α = 0 cpm

PRELIMINARY

402-11-8

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602 04 25 WBA-40	PROJECT NAME: RCRA Phase II	
BORING NUMBER: 3452	COORDINATES:	DATE 1/27/93
ELEVATION:	GWL: Depth 63.5 Ft Date/Time 2/5/93/950	DATE STARTED: 1/27/93
ENGINEER/GEOLOGIST: Ken Geiger	Depth 61.7 Ft Date/Time 2/17/93/1550	DATE COMPLETED: 2/16/93
DRILLING METHODS: Cable Tool		PAGE 2 OF 3/6

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
9.5	107005 1420 1/27/93	14 23 45	12	Very Soft Gray (2.5Y, 5/1) Silty Sandy Clay with Some Gravel Low Plasticity, moist	CL	.25	Hnu = 0 ppm Bg = 40 cpm α = 0 cpm
9.0	107006 1430 1/27/93	33 45 49	18	Very Soft Gray (2.5Y, 5/1) Silty Sandy Clay with Some Gravel medium Plasticity, moist	CL	.25	Hnu = 0 ppm Bg = 40 cpm α = 0 cpm
10.5	107007 1600 1/27/93	2 4 4	13	Very Soft Gray (2.5Y, 5/1) Silty Sandy Clay with a Trace of Gravel, medium Plasticity, moist	CL	.25	Hnu = 0 ppm Bg = 40 cpm α = 0 cpm
12.0	107008 830 1/28/93	4 6 9	14	Stiff Dark Gray (2.5Y 4/1) Silty Sandy Clay with Some Gravel, medium Plasticity, moist	CL	1.0	Hnu = 0 ppm Bg = 60 cpm α = 0 cpm
13.5	107009 840 1/28/92	4 6 8	7	Same As Above	CL	1.0	Hnu = 3.0 ppm Bg = 60 cpm α = 0 cpm
15.0							

NOTES:

See Page 1

Background Levels 1/24/93
Hnu = 0 ppm
Bg = 20-40 cpm
α = 0 cpm

Background Levels 1/28/93
Hnu = 0 ppm
Bg = 40-60
α = 0 cpm

402-1

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602.04.28 WBA-40	PROJECT NAME RCRA Phase II	
BORING NUMBER 3452	COORDINATES:	DATE 1/28/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/ 750	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 ft Date/Time 2/17/93/ 1550	DATE COMPLETED: 2/16/93
DRILLING METHODS Cable Tool		PAGE 3 OF ~~13~~ 16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15.0	107010 850 1/28/93	7 8 7	6	Very Soft Dark Gray (2.5Y, 4/1) Silty clay with some Sand and Gravel, medium Plasticity, Moist	CL	.25	HNU = 1ppm β γ = 40 cpm α = 0 cpm
16.5	107011 905 1/28/93	5 5 7	14	Very Soft, Dark Gray (2.5Y, 4/1) Silty clay with some Sand and Gravel, medium Plasticity, Moist	CL	.25	HNU = 1ppm β γ = 40 cpm α = 0 cpm
18.0	107012 920 1/28/93	6 9 12	18	Same As Above	CL	.25	HNU = 1ppm β γ = 40 cpm α = 0 cpm
19.5	107013 1030 1/28/93	7 12 14	14	Very Soft Dark Gray (2.5Y, 4/1) Silty clay with a Trace of sand and Gravel, medium Plasticity, Moist	CL	.25	HNU = 1ppm β γ = 40 cpm α = 0 cpm
21.0	107014 1050 1/28/93	7 13 14	13	Same As Above	CL	.25	HNU = 0ppm β γ = 40 cpm α = 0 cpm
22.5							

PRELIMINARY

NOTES:

See Page 1

Background Levels
HNU = 0ppm
β γ = 40-60 cpm
α = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 6020428 WBA-40	PROJECT NAME RCRA Phase II	
BORING NUMBER 3452	COORDINATES:	DATE 1/28/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/750	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.4 ft Date/Time 2/17/93/1550	DATE COMPLETED 2/16/93
DRILLING METHODS Cable Tool		PAGE 4 OF 51

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
22.5	107015 1340 1/28/93	1 1 50	6	Hard Dark Gray (2.5Y, 4/1) Gravelly, Sandy, Clay Low Plasticity, slightly moist	CL	4.5	HNU = 0 ppm BY = 40 cpm α = 0 cpm
24.0	107016 1430 1/28/93	32 50/4	8	Same As Above	CL	4.5	HNU = 0 ppm BY = 40 cpm α = 0 cpm
25.5	107017 1510 1/28/93	19 25 35	12	Very Stiff Dark Gray (2.5Y, 4/1) Gravelly Clay with Some Sand, medium Plasticity, slightly moist	CL	3.5	HNU = 0 ppm BY = 40 cpm α = 0 cpm
27.0	107018 1540 1/28/93	13 17 21	17	Very Stiff Dark Gray (2.5Y, 4/1) Sandy Clay with Some Gravel, medium Plasticity, slightly moist	CL	3.5	HNU = 0 ppm BY = 40 cpm α = 0 cpm
28.5	107019 1600 1/28/93	10 12 12	18	Stiff, Dark Gray (2.5Y, 4/1) Sandy Clay with Some Gravel and a Trace of organic material (wood), medium Plasticity, slightly moist	CL	2.0	HNU = 0 ppm BY = 40 cpm α = 0 cpm
30.0							

NOTES:

See Page 1

Background Levels
HNU = 0 ppm
BY = 40-60 cpm
α = 0 cpm

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 6020428 UBA-40	PROJECT NAME. RCRA Phase II	
BORING NUMBER. 3452	COORDINATES:	DATE 1/24/93
ELEVATION:	GWL: Depth 63.5 FT Date/Time 2/5/93/750	DATE STARTED 1/24/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 FT Date/Time 2/17/93/1550	DATE COMPLETED: 2/16/93
DRILLING METHODS Cable Tool		PAGE 5 OF 13 6

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30.0	107020	8		Stiff Dark Gray (2.5Y, 4/1)			HNU = 0 ppm
		11		Sandy clay with some			Bq = 40 cpm
	1450		6	Gravel, medium plasticity	CL	2.0	α = 0 cpm
		13		moist			
31.5	1/24/93						
	107021	8		Very Stiff Dark Gray (2.5Y, 4/1)			HNU = 0 ppm
		10		Sandy clay with some Gravel			Bq = 40 cpm
	1020		18	medium plasticity, moist	CL	3.5	α = 0 cpm
		12					
33.0	1/24/93						
	107022	10		Stiff, Dark Gray (2.5Y, 4/1)			HNU = 0 ppm
				Sandy Clay with some			Bq = 40 cpm
	1050	14	18	Gravel medium plasticity,	CL	1.5	α = 0 cpm
		17		moist			
34.5	1/24/93						
	107023	9		Same as Above			HNU = 0 ppm
		13					Bq = 40 cpm
	1330		17		CL	1.5	α = 0 cpm
		17					
36.0	1/24/93						
	107024	5		Stiff, Dark Gray (2.5Y, 4/1)			HNU = 0 ppm
		7		Sandy Clay with some			Bq = 40 cpm
	1350		18	Gravel, medium plasticity,	CL	1.0	α = 0 cpm
		19		moist			
37.5	1/24/93						

NOTES:

See Page 1

Background Levels
HNU = 0 ppm
Bq = 40-60 cpm
α = 0 cpm

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602.04.28 WBA-40	PROJECT NAME RCRA Phase II	
BORING NUMBER 3452	COORDINATES:	DATE 1/29/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/750	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Gerger	Depth 61.7 ft Date/Time 2/17/93/1550	DATE COMPLETED 2/16/93
DRILLING METHODS Cable Tool		PAGE 6 OF 13/6

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
37.5	107025 1410 1/29/93	29 32 45	13	Very Dense Dark Yellowish Brown (10YR,4/4) well Graded medium Sand with a Trace of Gravel, Dry	SW	N/A	Hnu = 0 ppm Br = 40 cpm α = 0 cpm
39.0	107026 1530 1/29/93	41 50/5	8	Same As Above	SW	N/A	Hnu = 0 ppm Br = 40 cpm α = 0 cpm
40.5				No Samples Taken. Samples To Be Taken Every 5' Starting at 45'			
45.0	107027 1645 1/29/93	50/5	5	Very Dense, Dark Yellowish Brown, (10YR,4/4) well Graded medium Sand with a Trace of Gravel, Dry	SW	N/A	Hnu = 0 ppm Br = 40 cpm α = 0 cpm
46.5							
50.0	107028 930 2/1/93	41 49 50/5	14	Very Dense, Dark Yellowish Brown (10YR,4/4) well Graded medium Sand with Some Gravel, Dry	SW	N/A	Hnu = 0 ppm Br = 65 cpm α = 0 cpm
51.5							
52.5							

NOTES:

See Page 1

Background Levels 1/29/93
Hnu = 0 ppm
Br = 40-60 cpm
α = 0 cpm

Background Levels 2/1/93
Hnu = 0 ppm
Br = 40-60 cpm
α = 0 cpm

PRELIMINARY

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602428 WBA-40	PROJECT NAME. RCRA Phase II	
BORING NUMBER. 3452	COORDINATES:	DATE 2/3/93
ELEVATION:	GWL: Depth 63.5 Ft Date/Time 2/5/93/ 750	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 Ft Date/Time 2/17/93/1550	DATE COMPLETED: 2/16/93
DRILLING METHODS Cable Tool		PAGE 7 OF 13/16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
52.5							
55.0	107029 840 2/3/93	32 50 50/5	4	Very Dense Dark Yellowish Brown (10YR 4/4) well Graded medium Sand with a Trace of Gravel and clay, Dry	SW	N/A	Hnu = 0 ppm Bg = 46 cpm α = 0 cpm Some moisture, Appears To Be from Drilling fluid.
56.5							
60.0	107030 950 2/3/93	32 50/5	8	Very Dense Dark Yellowish Brown (10YR, 4/4) Poorly Graded medium sand, with Some Gravel, Dry	SP	N/A	Hnu = 0 ppm Bg = 40 cpm α = 0 cpm Some moisture Appears To Be from Drilling fluid.
61.5				▽ WATER TABLE 61.7'			
65.0	107031 1335 2/3/93	35 50/3	8	Very Dense, Dark Gray (10YR, 4/1) well Graded medium Sand, with Some Gravel, wet	SW	N/A	Hnu = 0 ppm Bg = 40 cpm α = 0 cpm
66.5							
67.5							

NOTES:

See Page 1

Background Levels
Hnu = 0 ppm
Bg = 46-60 cpm
α = 0 cpm

PRELIMINARY

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 6020428 WBA-40	PROJECT NAME. RCRA Phase II	
BORING NUMBER. 3452	COORDINATES:	DATE 2/3/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93 / 750	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 ft Date/Time 2/17/93 / 550	DATE COMPLETED: 2/16/93
DRILLING METHODS: Cable Tool		PAGE 8 OF 13/16

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
69.5							
70.0	107032 1355 2/3/93	12 10 12	14	Medium Dense Dark Gray (10YR, 4/1) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Br = 40cpm α = 0cpm
71.5							
75.0	107033 1500 2/3/93	32 50/3	6	Very Dense Dark Gray (10YR, 4/1) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Br = 40-60cpm α = 0cpm
76.5							
80.0	107035 1410 2/4/93	6 10 17	12	Medium Dense Dark Gray (10YR, 4/1) Poorly Graded Sand with Some Gravel, wet	SP	N/A	Hnu = 0ppm Br = 40-60cpm α = 0cpm
81.5							
82.5							

NOTES:

See Page 2

Background Levels 2/3/93
Hnu = 0ppm
Br = 40-60 cpm
α = 0cpm

Background Levels 2/4/93
Hnu = 0ppm
Br = 40-60 cpm
α = 0cpm

402-1

001081

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602.04.29 WBA-40	PROJECT NAME. RCRA Phase II	
BORING NUMBER. 3452	COORDINATES:	DATE 2/4/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/950	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 ft Date/Time 2/17/93/1550	DATE COMPLETED: 2/16/93
DRILLING METHODS Cable Tool		PAGE 9 OF 13/16

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
82.5							
85.0	107036 1505 2/4/93	9 17 21	13	Dense Dark Gray (10YR, 4/1) Poorly Graded Gravelly Sand, wet	SP	N/A	Hnu = 0 ppm $\beta\gamma$ = 40-60 cpm α = 0 cpm
86.5							
90.0	107037 1625 2/4/93	9 12 15	18	Medium Dense Dark Gray (10YR, 4/1) Poorly Graded Gravelly Sand, wet	SP	N/A	Hnu = 0 ppm $\beta\gamma$ = 40-60 cpm α = 0 cpm
91.5							
95.0	107038 940 2/5/93	25 25 25	18	Dense Dark Gray (10YR, 4/1) Poorly Graded Gravelly Sand, wet	SP	N/A	Hnu = 0 ppm $\beta\gamma$ = 40 cpm α = 0 cpm
96.5							
97.5							

NOTES:

See Page 1

Background Levels 2/4/93
Hnu = 0 ppm
$\beta\gamma$ = 40-60 cpm
α = 0 cpm

Background Levels 2/5/93
Hnu = 0 ppm
$\beta\gamma$ = 40-60 cpm
α = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602.04.28 WBA-40	PROJECT NAME RCRA Phase II	
BORING NUMBER 3452	COORDINATES:	DATE 2/5/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/450	DATE STARTED 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 ft Date/Time 2/17/93/1560	DATE COMPLETED: 2/16/93
DRILLING METHODS Cable Tool		PAGE 10 OF 13 16

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER (6 IN)	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
97.5							
100.0	107039 1020 2/5/93	5 7 10	17	Medium Dense, Dark Gray (10YR, 4/1) Poorly Graded Sand with Some Gravel, wet	SP	N/A	Hnu = 0ppm Bγ = 40-60cpm α = 0cpm
101.5							
105.0	107041 1425 2/5/93	20 25 31	18	V. Dense, Dark Gray (10YR, 4/1) Poorly Graded Gravelly Sand with Some Clay, wet	SP	N/A	Hnu = 0ppm Bγ = 40-60cpm α = 0cpm
				V. Dense, Dark Gray (5Y, 4/1) clayey silt with a Trace of Gravel, wet	ML	N/A	
106.5	107042 1520 2/5/93	17 24 32	10	Very Dense, Dark Gray (5Y, 4/1) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Bγ = 40-60cpm α = 0cpm
108.0	107043 1535 2/5/93	12 16 21	12	Dense, Dark Gray (5Y, 4/1) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Bγ = 60cpm α = 0cpm
109.5	107044 1600 2/5/93	9 12 17	14	Medium Dense, Dark Gray (5Y, 4/1) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Bγ = 40-60cpm α = 0cpm
111.0	107045 935 2/8/93	10 32 50	14	Very Dense, Dark Gray (5Y, 4/1) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Bγ = 60cpm α = 0cpm
112.5				Very Dense, Brown (10YR, 4/3) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	

NOTES:

See Page 1

Background Levels 2/5/93
Hnu = 0ppm
Bγ = 40-60cpm
α = 0cpm

Background Levels 2/8/93
Hnu = 0ppm
Bγ = 40-60 cpm
α = 0 cpm

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER 602.04.28 WBA-40	PROJECT NAME. RCRA Phase II	
BORING NUMBER. 3452	COORDINATES:	DATE 2/8/93
ELEVATION:	GWL: Depth 63.5 ft Date/Time 2/5/93/750	DATE STARTED: 1/27/93
ENGINEER/GEOLOGIST Ken Geiger	Depth 61.7 ft Date/Time 2/17/93/1530	DATE COMPLETED: 2/16/93
DRILLING METHODS: Cable Tool		PAGE 11 OF 16

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
112.5	107046 955 2/8/93	10 24 24	12	Dense Brown (10YR, 4/3) well Graded Fine Sand with a Trace of Gravel, wet	SW	N/A	Hnu = 0ppm Bγ = 60cpm α = 0cpm
114.0				Soft, Dark Gray (10YR, 4/1) Silty Clay with a Trace of Sand, Low Plasticity, moist	CL	.5	
	107047 1020 2/8/93	12 12 42	9	Very Soft, Dark Gray (10YR, 4/1) Silty Sandy Clay, Low Plasticity, moist	CL	.25	Hnu = 0ppm Bγ = 60cpm α = 0cpm
115.5	107048 1340 2/8/93	10 13 24	18	Very Stiff, Dark Gray (5Y, 4/1) Silty Clay with Some black (5Y, 2.5/1) mottling, medium Plasticity, moist	CL	2.0	Hnu = 0ppm Bγ = 60cpm α = 0cpm
117.0	107050 1515 2/8/93	Shelby N/A Tube	18	Very Stiff, Dark Gray (5Y, 4/1) Silty Clay with a Trace of Sand and Gravel, medium Plasticity, moist	CL	2.0	Hnu = 0ppm Bγ = 60cpm α = 0cpm Shelby Tube
119.0				Bottom of Boring at 117.0 ft. Pushed Shelby Tube From 117.0 ft - 119.0 ft.			Composite Sieve Sample #107049

NOTES:

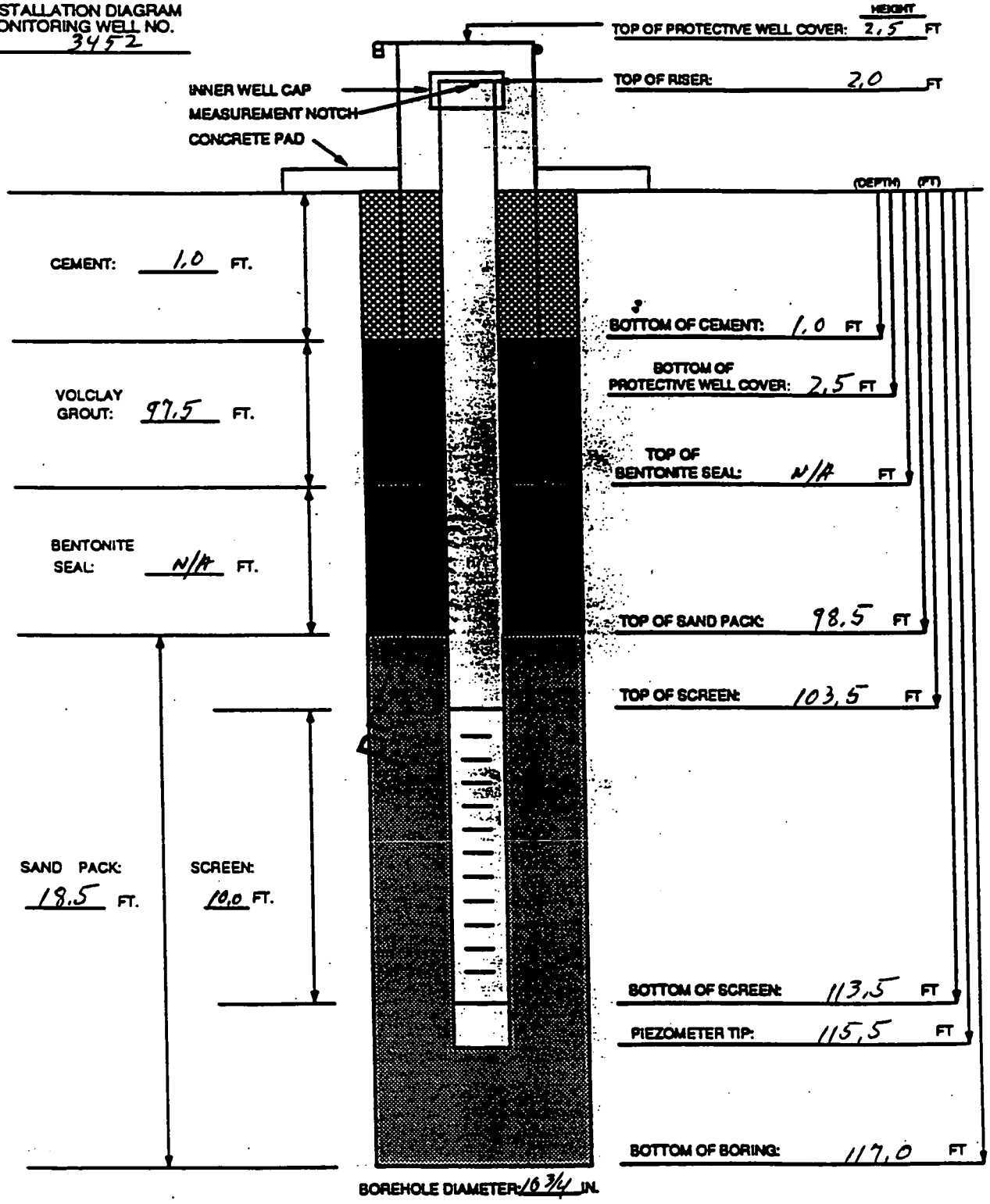
Background Levels
Hnu = 0ppm
Bγ = 40-60cpm
α = 0cpm

See Page 1

402-11-8

FERNALD RI/FS
INSTALLATION DIAGRAM
MONITORING WELL NO. 3452

INSTALLATION DATE: 2/16/93



MATERIALS USED

SAND TYPE AND QUANTITY: 10/20, 14/80 lb bags
BENTONITE PELLETS (5-GALLON BUCKETS): N/A
BAGS OF VOLCLAY GROUT: 20 - 50 lb bags
AMOUNT OF CEMENT: 1 Bag
AMOUNT OF WATER USED: 860 Gallons
OTHER: Riser Pipe Sections 1-10 Screen w/ 2 Sump, 10-10', 1-3.5'
TASK: (602.64.28) WBA-40

NOTES:

1) RISER PIPE IS 4.0 IN. ID. 316 STAINLESS STEEL PIPE, FLUSH-THREADED JOINTS.
2) SCREEN IS 4.0 IN. ID. 316 STAINLESS STEEL PIPE WITH 0.010 IN. SLOTS.
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP.

GEOLOGIST/ENGINEER: Ken Geiger

4) WATER DEPTH AND DATE 4.7 FT/ 2/17/93
5) TOP OF CASING IS SECURED WITH A STAINLESS STEEL CAP.
6) PARENTHESIS INDICATE DEPTH BELOW GROUND LEVEL.
7) WELL CASING HAS A PROTECTIVE COVER WITH PADLOCK.

ASI FORM 0157 REV. (0) 001085

PIEZOMETER INSTALLATION SHEET

PROJECT NAME RCRA Phase II
PROJECT NO. (602.04.28) WBA-40
BORING NO. 3452
~~PIEZOMETER NO.~~ All monitoring well 3452

FIELD ENG./GEO Ken Geiger DATE 2/17/93
CHECKED BY (Brier) DATE 3/01/93
DATE OF INSTALLATION 2/16/93

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID Water FROM 0.0 ft TO 65.0 ft
FLUID N/A FROM N/A TO N/A

TYPE OF BIT Hammer Percussion Bit
CASING SIZE (S) USED:
SIZE 10.0 in ID FROM 0.0 ft TO 115.0 ft
SIZE N/A FROM N/A TO N/A

PIEZOMETER DESCRIPTION

TYPE Monitoring well
DIAMETER OF PERFORATED SECTION 4.0 in I.D.
PERFORATION TYPE:
SLOTS [X] HOLES [ ] SCREEN [ ]
AVERAGE SIZE OF PERFORATIONS .010
TOTAL PERFORATED AREA 10.0 ft

RISER PIPE MATERIAL 316 Stainless Steel
RISER PIPE DIAMETERS:
O.D. 4 3/8 in I.D. 4.0 in
LENGTH OF PIPE SECTIONS 10-10 ft, 1-3.5 ft (1-10' Screen with 2' Sump)
JOINING METHOD Screw Type - Flush Joint Threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 ft
PROTECTIVE PIPE O.D. 10 3/4 in

OTHER PROTECTION Hinged well cover with lock

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft)		ELEVATION ( )	
TOP OF RISER PIPE	2.0			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5			
BOREHOLE FILL MATERIALS:				
CONCRETE	TOP 0.0	BOTTOM 1.0		
GROUT/SLURRY	TOP 1.0	BOTTOM 98.5	TOP	BOTTOM
BENTONITE	TOP N/A	BOTTOM N/A	TOP	BOTTOM
SAND	TOP 98.5	BOTTOM 117.0	TOP	BOTTOM
GRAVEL	TOP N/A	BOTTOM N/A	TOP	BOTTOM
PERFORATED SECTION	TOP 103.5	BOTTOM 113.5	TOP	BOTTOM
PIEZOMETER TIP	115.5			
BOTTOM OF BOREHOLE	117.0			
GWL AFTER INSTALLATION	61.7			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES [ ] NO [X]
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES [ ] NO [X]

REMARKS

Sieve Analysis

Well #3452
Ken Geiger

2/9/93
sample #107049

Retained Values

90% = .003
50% = .010
40% = .013

$\frac{.013}{.003} = 4.3$ 4.3 use a factor of 4

4X .010 = .040

.040 most closely fits the medium Grain Sand and The .010 Screen size.

PRELIMINARY

001087

FEB- 9-93 TUE 15:23 WMCO ANALYTICAL FAX NO. 5137386667 P.01

Ken Geiger
MW 3452

MW 34

Customer Number: 107049

MATERIAL: _____ SAMPLE NUMBER: 930208-112

DETERMINATION: Particle Size METHOD: Sieve Analysis

Sample weight: 142.8

Sieve Number	Weight Retained, g	% Retained	Cumulative % Retained	Grain Size, 1/1000 inch
10	10.25	7.2	7.2	78.7
20	10.24	7.2	14.4	33.5
40	20.36	14.3	28.7	16.7
60	41.63	29.2	57.9	9.8
100	31.63	22.1	80.0	5.9
200	9.66	6.8	86.8	3.0
Pan	16.26	11.4	98.2	

$$\frac{W_2 \times 100\%}{W_1} = R \qquad \left| \frac{\text{Original} - \text{Duplicate}}{\text{Average}} \right| \times 100\% = \text{RPD}$$

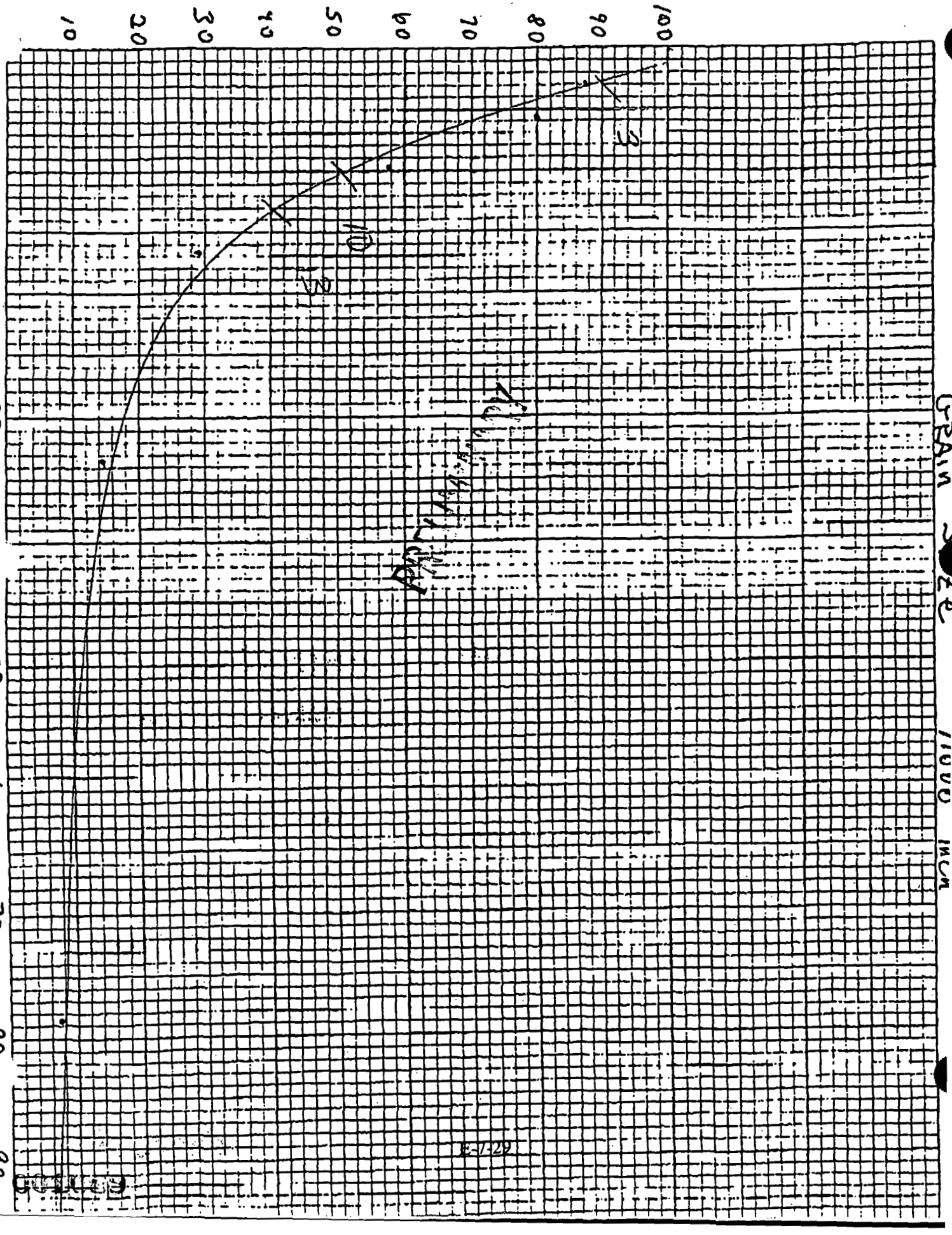
Analyzed by: John Pilhart | Checked by: J. Hooker | Date analyzed:

Grain Size Retained

40 %	13
50 %	10
90 %	3

Ken Geiger
MW 3452
Sample #107049

FEB-9-93 TUE 15:24 WMCO ANALYTICAL FAX NO. 5137386667 P. 02



6647

Black Ink corrections and White out corrections were made by Brad Dunning while the log was being completed. WPK 4/24/88

FERNALD RI/FS

	Initials	Date
1st Key In		
2nd Key In		
Hard Copy Verification		

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~324~~ 3024 BB	COORDINATES: N 482477.17 E 1378902.73	DATE: 9-14-87
ELEVATION: 579.9 ground	GWL: Depth — Date/Time —	DATE STARTED: 9-14-87 @ 1330
ENGINEER/GEOLOGIST: B. Dunning	Depth — Date/Time —	DATE COMPLETED: 10/3/87
DRILLING METHODS: Cable Tool - Split Spoon Samples		PAGE 1 OF ~~11~~ 13

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inches)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
.5 1.0'	S 07089	5 11 10	12"	Medium stiff, yellowish-brown clay with some sand, moist	CL		Background Gas $\gamma\beta$ = 40-60 α = 0 hnu = 0 Sample Caught (1345)
2' 3'	S 07090	12 17 19	24"	Stiff, dark yellowish-brown silty sand with some fine gravel moist	SM		Background Levels (1400)
4'	S 07091	12 25 32	18	Medium dense dark yellowish-brown silty sand with some gravel moist; 4.3' Coarse Gravel - grayish-brown	SP / GW		Background Levels (1440)
5' 6'	S 07092	22 12 15	14"	Medium dense dark yellowish-brown silty sandy gravel, moist. 5.5' Stiff yellowish-brown silty clay, moist	GC / CL		Background Levels (1445)
7'	S 07093	10 21 23	16"	Dense yellowish-brown silty gravel grading downward to a: 7' Hard dark gray clay with a trace of coarse sand and gravel moist 7'	GC / CL	4.5	Background Levels (1545)
8' 9'	S 07095	16 19 23	12"	Very stiff gray clay with a trace of fine gravel (slightly damp) moist.	CL	4.0	Background Levels End of Day 9-14-87 (1625)
10'	S 07096	6 11 15	6"	Medium dense, grayish-brown gravel moist.	GC		Start of Day 9-15-87 gravel is actually very loosely consolidated Background (0830)
11' 12'	S 07097	4 5 8	12"	Medium stiff olive-gray clay with a trace of fine gravel, moist.	CL	1.0	Background Lost entire first sample and had to use spring catcher (0935)
13	S 07098	6 11 17	18"	13.2' Loose gray, fine sand, moist. 13.2	CL / SM	.75	Background (0942)
14' 15'	S 07100	2 2 3	18"	Soft olive-gray clay with a trace of fine gravel, moist.	CL	.50	Background (1030)

NOTES: Background Levels 9-14-87 $\gamma\beta$ = 40 - 140 cpm α = 0 hnu = 0

Background Levels 9-15-87 $\gamma\beta$ = 40 - 80 cpm α = 0 hnu = 0

Used 40 gallons of H_2O 9-14-87

001090

402-11-86

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		Task 3.2
BORING NUMBER: ~~324~~ 3024	COORDINATES: See p1	DATE: 9-15 & 9-16-87	
ELEVATION: See p1	GWL: Depth 17.2 Date/Time 9-15 @ 1450	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 11.3 Date/Time 9-15 / 1600	DATE COMPLETED: 10-3-87	
DRILLING METHODS: CABLE TOOL		PAGE 2 OF ~~11~~ 13	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15							
16'	S 07101	6 6 9	18"	Soft, olive gray clay with a trace to some sand and gravel, MOIST	CL	.50	Background Levels (1040)
17'	S 07102	2 3 12	6"			.50	Background Levels (1350)
18'				18.2' Soft olive gray clay, MOIST. 18.2'		.50	
19'	S 07103	20 45 40	18"	Very dense gray fine gravel MOIST	GP		Background levels (1355)
20'	S 07104	46 30 27	18"	18.8 Dark yellowish-brown coarse sand 18.8	SW	–	Background
				Very dense gray coarse gravel, MOIST Wet	GP	–	End of Day 9-15-87 (1530)
21'				21.5			Start Day 9-16-87
22'	S 07105	16 33 47	18"	21.8 Very dense gray fine to medium sand MOIST 21.8	SC	–	Sand is actually Medium dense
				22 Hard olive-gray clay, trace of gravel MOIST. 22	CL	>4.0	(0905)
23'	S 07106	14 16 22	18"	Dense gray unconsolidated gravel, MOIST. grading downwards to a:	GW		Background
				23.5 Hard gray clay, some gravel MOIST 23.5			(1005)
24'							Background
25'	S 07107	20 50 (3")	12"	Medium dense grayish-brown fine to medium sand with trace of large quatz rock fragments Wet	SP		Split Spoon jammed with large rock (1420)
26'	S 07108	8 18 30	18"	Hard, dark gray olive-gray clay with some sand and fine gravel	CL	>4.5	Background (1440)
27'							
28	S 07110	35 52 30	18"	27.5 Very stiff, grayish-brown silty clay 27.5	ML	3.5	Background
				28 Very hard, gray clay 28	CL	>4.5	(1500)
29'	S 07111	46 50 –	12"	Very stiff, gray clay with twig-like fragments ?? and a trace of gravel	CL		Background
30'							End Day 9-16-87 (1520)

NOTES: Background levels 9-15-87 $\gamma\beta$ = 40-80 cpm α = 0 $h_{\gamma\alpha}$ = 0

Background Levels 9-16-87 $\gamma\beta$ = 40-80 cpm α = 0 $h_{\gamma\alpha}$ = 0

Water level 9-15-87 @ 1600 was 11.3'
" " 9-16-87 @ 0800 " 9.3'

There appears to be a substantial aquafer at 18'-21.5'

6647

	Initial	Date
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2nd Key In		
Hard Copy		

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: ~~324~~ 3024	COORDINATES: see p1	DATE: 9-17-87	
ELEVATION: see p1	GWL: Depth 41.2 Date/Time 9-17-87 @ 1730	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth — Date/Time —	DATE COMPLETED: 10-3-87	
DRILLING METHODS: CABLE TOOL		PAGE 3 OF 13	

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30'							Start Day 9-17-87
31'	S 07112	12 20 24	6"	Stiff olive gray clay with a trace of fine gravel moist	CL	2.0	Background Levels (1045)
32'	S 07113	10 11 16	18"	Very stiff gray clay with trace of gravel, moist			Background Levels - (B.G.) (1050)
33'							
34'	S 07114	10 25 37	24"	33.7 Stiff gray clay moist 33.7 34 Very stiff olive-yellow clay moist 34' Very dense yellow-brownish sand moist		1.5 4.0	B.G. (1105)
35'	S 07115	23 33 36	12"	Very dense yellowish-brown Sand moist.	SW	–	B.G. Sand is moist, but not saturated. (1400)
36'							
37'	S 07116	50 – –	9"	37' Medium stiff brownish-yellow, silt clayey moist 37'	SM	–	B.G. (1530)
38'	S 07117	9 24 42	13"	Very dense yellowish-brown, well sorted, fine grain sand Moist, but basically dry.			B.G. Very friable Sand Actually (1555)
39'							
40'					SW	–	Begin catching 5' Samples. Loose Unconsolidated Sand
41'							
42'							
43'							
44'							
45'	S 07118	25 43 45	18"				B.G. Sample 44'-45.5' End Day 9-17-87 1715

NOTES: Background Levels for 9-17-87 $\gamma\beta$ = 40-60 cpm, α = 0 hnu = 0

001092

402-11-86

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS		
BORING NUMBER: 3024	COORDINATES: see p7		DATE: 9-18-87
ELEVATION: see p1	GWL: Depth	Date/Time	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth	Date/Time	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool			PAGE 4 OF 13

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45'	07118	26 43 45	18"	SAND - As Described above	SW		End Day 9-17-87 (1715)
46'				Very dense yellowish-brown well sorted fine grain sand moist.			Start Day 9-18-87
47'							
48'							
49'					SW	-	
50'							
51'	S 07119	15 20 21	18"	Dense yellowish-brown, well sorted, damp, but not wet sand			B.G.: Loose unconsolidated Sand (1345)
52'							
53'							
54'							
55'							
56'	S 07120	13 27 (4")-50	12"	55.8 Loose grayish-brown coarse sand, moist 55.8			B.G.
				56.1 Hard gray clay moist. 56.1	CL		(1415)
57'	S 07121	13 23 43	12"	Very dense gray, salt & pepper looking, medium to coarse grain sand with trace of fine gravel. moist	SW		B.G. Sand is actually loose & unconsolidated. (1440)
58'							
59'							
60'							

NOTES:

001693

402-11-6

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2nd Key In		
Hard Copy Verification		

JAC
KKA
2/4/95

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: 89 ~~1-5-9324~~ 3024	COORDINATES: see p1	DATE: 9-19-87
ELEVATION: see p1	GWL: Depth 51.6 Date/Time 9-19/1030	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 62.6 Date/Time 9-19/1730	DATE COMPLETED: 10-3-87
DRILLING METHODS:		PAGE 5 OF X/3

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
60'							
61'	S 07122	13 25 28	18"	Very dense, dark gray coarse sand with some fine gravel wet	SW		Background End of 9-18-87 (1515)
62'							~~End~~ Start of 9-19-87
63'							
64'	S 07123	6 3 3	14"	Loose gray, lightly salt & peppered looking fine to coarse grain sand with a trace of gravel WET	SW		Borehole drilled down to 70'. Blow sand came up hole to 63' where this sample was taken. B.G. Levels (1545)
65'							
66'	S None 2	5 2 2	0"	Sand pump indicates very loose, grayish-brown unconsolidated sand, wet	SM ?		Blow Sand coming into hole. Could not obtain a sample even with catcher End Day 9-19-87
67'							Start Day 9-20-87
68'							
69'							
70'							10" Temporary Casing driven to 80' to cut off blow sand.
71'	S 07124	6 14 21	12"	Dense, gray coarse sand with some fine & coarse gravel. Wet	SP		Background Levels Only
72'							(1000)
73'							Bailer - Sand Pump bringing up large cobbles ie. 1½" x 2½" large - Diameter - ± 1½"
74'							
75'							

NOTES: Background Levels 9-19-87 $\gamma\beta$ = 40-80 α = 0 hnu = 0
" " 9-20-87 $\gamma\beta$ = 40-70 α = 0 hnu = 0

402-11-86

	Date
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Hard Copy Verification	

RKD 2/4/89

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: ~~4324~~ 3024	COORDINATES: See p1	DATE: ~~9-19-87~~ 9-20
ELEVATION: See p1	GWL: Depth 61.5' Date/Time 9-20/0900	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth Date/Time	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool		PAGE 6 OF 13

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Feet)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
75'							
76'	S 07125	16 31 46	14"	Very dense grayish-brown gravel (Color: 2.5 Y, 5/2) and Coarse Sand SEE Remarks →	GP		Background levels (B.G.) (1140)
77'							Sand pump collecting large carbonate cobbles & gravel rocks with fossil Inclusions.
78'							
79'							
80'							
81'	S 07126	2 6 16	18"	Medium dense, gray, very coarse grain sand with some fine gravel 80.8 80.8	SW		Background levels (1350)
				Medium dense grayish-brown fine gravel with some coarse gravel	GW		
82'							Drove 10" Temporary Casing to 90'
83'							Sand Pump bringing up fine to coarse gravel
84'							
85'							
86'	S 07127	20 50 (3")>50	12"	Very dense, dark gray, sandy gravel with fine to coarse sand. (Color: 2.5 Y, N4/) & large cobbles ie. 1" x 2" x 1½".	GP		Large rock jammed in Split Spoon. Actually a loose gravel. Background levels (1600)
87'							
88'							
89'							
90'							

NOTES: Background levels 9-20-87 : $\gamma\beta$ = 40-75 cpm. α = 0, hnu = 0

002095

402-11-86

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Hard Copy Verification	

JRC RKA 2/4/87

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: BB 3024	COORDINATES: see p. 1	DATE: 9-20 & 9/21/87
ELEVATION: see p. 1	GWL: Depth 52' Date/Time 9-20/1400	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 52' Date/Time 9-21/0730	DATE COMPLETED: 10-3-87
DRILLING METHODS: Cable Tool		PAGE 7 OF 13

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6")	RECOVERY (")	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
90'							
91'		2 2 5 3 8 4	0"	Sand Pump collecting fine grain Sand	SW		Lost Sample both times even with Catcher In.
92'							End 9-20-87 Start 9-21-87
93'				93 ± ? — — — ? — — — ?	?	—	Approximate depth of material change.
94'							
95'				Very Dark Gray, fine gravel with coarse sand (10YR 3/1)	GW		
96'	S 07128	18 29 36	24"	95.5 Dense gray fine to coarse gravel (2.5 Y N5) 95.5	GW		Background levels
				96.25 Very dense, grayish-brown silty sand moist. 96.25 (Color: 2.5 Y, 5/2)	GM		1350
97'							
98'							Sand pump quit sucking up sand. Sample Taken.
99'							
100'	S 07129	17 ~~13~~ 20	18"	Very Stiff, dark gray clay moist (Color: 5 Y, 4/1)	CL	3.5	Background levels (1500)
101'							
102'				— — ? — — ? — — ? — —	?		
103'							
104'							
105'							

NOTES: Background Levels 9-21-87 $\gamma\beta$ = 40-80 cpm, α = 0, hnu = 0.

001096

402-11-86

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FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC OU / FS		
BORING NUMBER: ~~324~~ 3024	COORDINATES: See p1	DATE: 9-22-87	
ELEVATION: See p1	GWL: Depth 52' Date/Time 9-21/1700	DATE STARTED: 9-14-87	
ENGINEER/GEOLOGIST: B. Dunning	Depth 64.5' Date/Time 9-22/1550	DATE COMPLETED: 10-3-87	
DRILLING METHODS: Cable Tool	92' 9-22/1715	PAGE 8 OF 13	

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
105'							
106'	S 07130	6 7 14	6"	Medium dense, grayish-brown fine grain, well graded, silty Sand (Color: 2.5 Y, 5/2)	SM		Background levels (1620)
107'							End 9-21-87
108'							
109'							
110'							
111'	S 07131	6 10 11	12"				Background levels (1035)
				111.4' Soft, dark gray silty clay (Color: 5Y, 4/2) 111.4'	CL	~~.95~~ .5	
112'							
113'							Picking Up Clay On hammer 113'-115'
114'							
115'				Medium Stiff, Olive-Gray Clay (5Y, 4/2) 115.5'			
116'	S 07132	9 14 18	18"	Very Stiff, olive gray clay (Color: 5Y, 4/2)	CL	.75 3.5	Background levels (1338)
117'							Casing Driven Down To 120'
118'							
119'							
120'							

NOTES: Background Levels 9-22-87: $\gamma\beta$ = 40-80 cpm, α = 0, hnu = 0

001097

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6647

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2nd Key In		
Hard Copy Verification		

RKA 2/4/?

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS	
BORING NUMBER: BB 1-5-9 324 3024	COORDINATES: all pj	DATE: 9/22 & 9/23/87
ELEVATION: all pj	GWL: Depth 64.5' Date/Time 9-22/1550	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 92' Date/Time 9-22/1715	DATE COMPLETED: 10-3-87
DRILLING METHODS: CABLE Tool	75' 9-23/1750	PAGE 9 OF 13

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
120'							
121'	S 07133	2 3 6	18"	Medium Stiff, gray (5Y, 5/1) to Olive gray (5Y, 5/2) clay with some fine gravel wet	CL		Moderately gravelly Sand. Background levels (1650)
122'							End Day 9-22-87 Start Day 9-23-87
123'				123.5'			Noticed Sand & Gravel On Sticking On Hammer
124'							
125'							
126'	S 07134	27 17 10	6"	Medium Dense, Olive-~~Gray~~-Brown, fine to coarse gravel wet (Color: 2.5Y, 4/4)	GP		Scanned - Background Readings Only (1025)
127'							
128'							
129'							
130'							
131'	S 07135	18 33 19	5"	Very Dense, Olive-Brown Fine Gravel (Color: 2.5Y, 4/4) wet	GW		Background levels. Spoon Plugged with light Olive-brown carbonate rock fragment (2.5Y, 5/4) (1108)
132'							132' Drilling became more difficult Lithology Change
133'							
134'							Drilled Down To 135' & Sand blew In To 124'
135'							Drive 10" Csg to 140'

NOTES: Water Level checked at 1550, 9-22-87 when temporary Casing was at 121'.
Background Levels 9-23-87: $\gamma\beta$ = 40-120 cpm hnu = 0
α = 0
Smelled Some Brackish, Semi-Petroliferous odor observed at 125'.
Hole Monitored with LLE & hnu. No Readings Detected.

002098

402-11-86

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2nd Key In		
Hard Copy Verification		

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI/FS	
BORING NUMBER: BB 1-3 ~~3024~~ 3024	COORDINATES: See P1	DATE: 9-24-87 / 9-29-87
ELEVATION: See P1	GWL: Depth 66.4' Date/Time 9-24/1245	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 58.5 Date/Time 9/29/0900	DATE COMPLETED: 10-3-87
DRILLING METHODS: CABLE TOOL		PAGE 10 OF ~~11~~ 13

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6"	RECOVERY (Inch)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
135'							End Day 9-23-87
136'		#1 #2 11 5 13 7 14 10	0"				Start Day 9-24-87 Attempted twice to obtain sample.
137'							Sand Pump indicates Fine Sand
138'							
139'							Drilled Down to 140', but sand blew in to 135'. Drive Csg to 145'
140'		#1					
141'	S 07136	50-(4") #2 45 (3") - 50	12"	Very Dense, very dark grayish-brown sand & fine gravel wet (Color: 2.5 Y, 3/2)	SW		B.G. Felt we hit a Rock (1115)
142'							
143'							Hammer Driving Hard Feels like we were pounding a large rock.
144'							
145'				Very Dense, very dark brownish-gray sand with fine gravel - generally as above (Color: 2.5 Y, 3/2) wet	SP		End Day 9/24 Start Day 9/29
146'	S 07137	38 (3") 50	12"				Background - Scanned. (1050)
147'							
148'							
149'							
150'							

NOTES: Water level with Csg at 145' 9-24 @ 1245 = 66.4'
" " " " " " 9-29 @ 58.5' after well sitting 4 days

Background Levels 9/29/87: $\beta\beta$ = 60-120
α = 0
hma = 0

001053

402-11-

6647

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Hard Copy Verification		

RKD 2/4/97

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602	PROJECT NAME: FMPC RI / FS	
BORING NUMBER: BB ~~3024~~ 3024	COORDINATES: See p 1	DATE: 9-29-87
ELEVATION: See p 1	GWL: Depth 60.7 Date/Time 9-29 / 1615	DATE STARTED: 9-14-87
ENGINEER/GEOLOGIST: B. Dunning	Depth 58.6 Date/Time 9-30 / 1340	DATE COMPLETED: 10-3-87
DRILLING METHODS: CABLE TOOL		PAGE 11 OF 13

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER (" / 6")	RECOVERY (" / mm)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
150							
151'	S 07138	20 37 (4")50	14"	Medium Dense, Gray Silty Sand grading downwards into: (Color 2.5 Y, N5) 150.6	SM		Scanned - Background levels (1415)
				Very Dense, black fine gravel wet (Color: 2.5 Y, N2/)	GW		
152'							
153'							
154'							
155'							BOB.
156'	S 07139	7 22 45	18"	Very Dense, Dark gray coarse Sand w/ some fine gravel wet (Color: 5 Y, 4/1)			Scanned - Background levels (1540)
157'				Bottom of Borehole (10") = 155' Bottom of 1st Split Spoon = 156.5'			
158'							
159'							
160'							

NOTES: Blow Sand coming into hole with Csg @ 150'. to a depth of 147'
10" Csg Driven to 155' to obtain 150 - 151.5' Split Spoon Sample.

Used a total of 500 gallons to Drill Entire Well.

001100

402-11-86

White out corrections were made by Brad Dunning at the time the form was completed.
WPK 4/23/88

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DAC
KKA 2/4/
12/1

FERNALD RI/FS

PIEZOMETER INSTALLATION SHEET

PROJECT NAME FMPC RI/FS
PROJECT NO. 602
BORING NO. BB1589 ~~324~~ 3024
PIEZOMETER NO. ~~324~~ 3024

FIELD ENG./GEO. B. Dunning DATE 10/18/87
CHECKED BY RM Goldsmith DATE 2/6/89
DATE OF INSTALLATION 10-3-87

BOREHOLE DRILLING

DRILLING METHOD Cable Tool
DRILLING FLUID (S) USED:
FLUID H_2O FROM 0 TO 155'
FLUID NA FROM NA TO NA

TYPE OF BIT Hammer
CASING SIZE (S) USED:
SIZE 10" FROM 0' TO 155'
SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Stainless Steel monitoring well
DIAMETER OF PERFORATED SECTION 4"
PERFORATION TYPE:
SLOTS ☐ HOLES ☐ SCREEN ☒
AVERAGE SIZE OF PERFORATIONS .010"
TOTAL ~~PERFORATED AREA~~ SCREEN LENGTH 10'

RISER PIPE MATERIAL Stainless Steel (316)
RISER PIPE DIAMETERS:
O.D. 4 3/8" I.D. 4"
LENGTH OF PIPE SECTIONS 10'
JOINING METHOD Flush Joint Threaded

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5'
PROTECTIVE PIPE ~~Ø~~ I.D. 10"

OTHER PROTECTION LOCKING CAP AND LOCK

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft.)		ELEVATION (FT) MSL	
TOP OF RISER PIPE	+ 2.4'		582.3	
GROUND SURFACE	0.0		579.9	
BOTTOM OF PROTECTIVE PIPE	- ~~2.4~~ 2.6' RMG 2/6/89		577.3	
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0	BOTTOM 80'	TOP 579.9	BOTTOM 497.3
BENTONITE	TOP 80'	BOTTOM 92'	TOP 497.3	BOTTOM 485.3
SAND	TOP 92	BOTTOM 110'	TOP 485.3	BOTTOM 467.3
BENTONITE PELLETS	TOP 110'	BOTTOM 125'	TOP 467.3	BOTTOM 452.3
PERFORATED SECTION	TOP 97.5'	BOTTOM 107.5'	TOP 482.4	BOTTOM 472.4
PIEZOMETER TIP	~~NA~~ ~110'		467.3	
BOTTOM OF BOREHOLE	~~155.5~~ 155.0' WPK 4/24/88		422.3	
GWL AFTER INSTALLATION	58'		521.9	

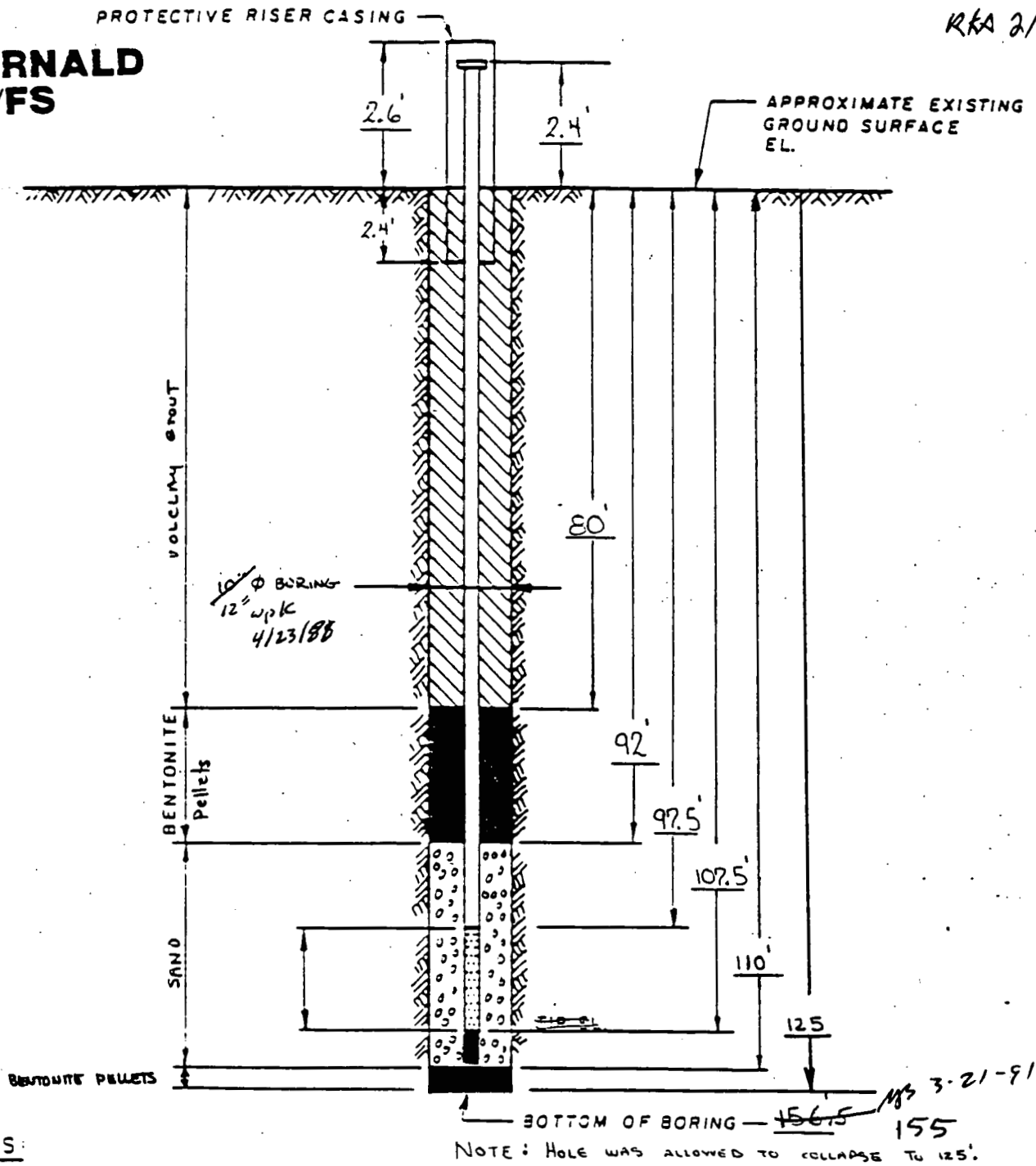
WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☑
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☑

E-7-41

REMARKS Hole was drilled to 155' to clearly define stratigraphy. Casing was pulled up to 125' and sand-hole was allowed to collapse in. The well was then plugged from 125' to 110' with bentonite to insure that no communication through "Blue Clay" was present. Well was then set from 110'.

WELL # ~~324~~ 3024
OB 1-5
RKA 2/4/89

FERNALD RI/FS



NOTE: HOLE WAS ALLOWED TO COLLAPSE TO 125'. PLUGGED WITH BENTONITE 125'-110'.

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN. SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

white out corrections were made by B. Dunning at the time the form was completed
WPK
4/23/88

INSTALLATION DETAILS
MONITORING WELL ~~324~~ 3024 RMG 2/4/89

PREPARED FOR
FMPC RI/FS

DRAWING NUMBER
CHECKED BY
APPROVED BY
DR. BY

001102

FERNALD RI/FS

REVIEWED BY QA KG. DATE

Date	
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2nd Key In	
Hard Copy	

RKA 2/4/89

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: FERNALD RI/FS	
BORING NUMBER: 180 1080 BD 1-5-89	COORDINATES: 482229.86N 1378630.45E	DATE: 4/26/88
ELEVATION: 581.7 GROUND	GWL: Depth N/A Date/Time N/A	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A Date/Time N/A	DATE COMPLETED: 4/27/88
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 6

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
0.0	08780	3 7 5	6	M. Dense, Very Pale Brown (10YR 8/4) Gravelly Sand. Fill. Dry			t = 0918 Hm = 0ppm α = 2cpm γ/β = 40cpm
2.5	08781	4 5 6	4	Very Stiff, Dark Yellowish Brown (10YR 4/4) Clay, some silt. Moist.	CL		t = 0924 Hm = 0ppm α = 2cpm γ/β = 40cpm Pebble blocked spoon.
	08782	5 9 11	12	Very Stiff, Dark Brown (10YR 3/3) Silty Clay, trace sand, trace gravel. Moist	CL	3.7	t = 0928 Hm = 0ppm α = 2cpm γ/β = 40cpm
5.0	08783	8 10 14	13	Very Stiff, Dark Yellowish Brown (10YR 4/4) with gray mottled Silty Clay, trace gravel, trace sand. Moist.	CL	2.7	t = 0933 Hm = 0ppm α = 2cpm γ/β = 40cpm
	08784	14 17 19	13	Very Stiff, Very Dark Brown (10YR 2/2) Silty Clay, trace gravel, trace sand. Moist.	CL	3.3	t = 0940 Hm = 0ppm α = 2cpm γ/β = 40cpm
7.5	08785	5 11 15	14	Very Stiff, Dark Gray (2.5Y 4/0) Clay, some silt, trace gravel, trace sand. Moist.	CL	3.5	t = 1118 Hm = 0ppm α = 2cpm γ/β = 40cpm
10.0	08786	2 10 17	12	Very Stiff, Very Dark Gray (2.5Y 3/0) Clay, some silt, trace sand. Moist	CL	2.8	t = 1142 Hm = 0ppm α = 2cpm γ/β = 55cpm
	ST 08787	NA	12				t = 1327 Pushed Shelby 1.5 Ft 1.0 Ft recovery
12.5	08788	16 24 32	18	Hard, Yellowish Brown (10YR 5/6) Silty Clay, trace sand and gravel. Moist	CL	4.1	t = 1339 Hm = 0ppm α = 2cpm γ/β = 40cpm
15.0	08789	4 14 25	9	Very Stiff, Brownish Yellow (10YR 6/8) Silty Clay, trace sand and gravel. ~~Moist~~ B.D Dry	CL	2.5	t = 1355 Hm = 0ppm α = 2cpm γ/β = 40cpm

NOTES: Drilling Contractor : Pennsylvania Drilling
Driller : Joe Barile
Helper : John Vandine
Rig : 72 Speedstar

Water Used During Drilling = 350 gallons
Soil Sampling as per ASTM
Color Descriptions as per Munsell
Field Measurements : Hm, γ/β, α

001103

402-11-86

FERNALD RI/FS

REVIEWED BY QA K.G. DATE 8/1/11

Key In	6	6	4
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RKA 2/4/87

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~180~~ 1080 BB 1-5-89	COORDINATES: See p1	DATE: 4/26/88
ELEVATION: See p1	GWL: Depth NA Date/Time N/A	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth NA Date/Time N/A	DATE COMPLETED: 4/27/88
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 6

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15.0	08790	9 34 14	16	Hard, Yellowish Brown (10YR 5/4) Silty Clay, trace sand and gravel. Moist 16.4	CL	>4.5	t: 1416 Hm: 0 ppm α: 2 cpm γ/β: 60 cpm
17.5	08791	3 8 11	12	Very Stiff, Gray (2.5Y 5/0) Silty Clay, trace sand and gravel. Moist.	CL	2.5	t: 1430 Hm: 0 ppm α: 2 cpm γ/β: 40 cpm
	08792	4 8 13	17	Stiff, Dark Gray (2.5Y 4/0) Silty Clay trace sand and gravel. Moist	CL	1.6	t: 1450 Hm: 0 ppm α: 2 cpm γ/β: 40 cpm
20.0	08793	2 5 8	14	Stiff, Gray (2.5Y 5/0) Silty Clay trace sand and gravel. Moist.	CL	1.6	t: 1501 Hm: 0 ppm α: 2 cpm γ/β: 40 cpm
							t: 1605 Pushed Shelby no recovery
22.5	08668	8 10 15	13	Stiff, Gray (2.5Y 5/0) Silty Clay trace sand and gravel. Moist.	CL	1.1	t: 1629 Hm: 0 ppm α: 2 cpm γ/β: 40 cpm
25.0	08794	NA	21				t: 1715 Pushed Shelby 2.0 Ft ~~into~~ 8.0. 1.75 Ft recovery
	08795	5 9 40	5	Stiff, Gray (2.5Y 5/0) Silty Clay, some gravel, trace sand. Moist	CL	1.5	t: 0743 4/27/88 Hm: 0 ppm α: 2 cpm γ/β: 40 cpm
27.5	08796 08797 08798	12 36 58	14	Hard, Dark Gray (2.5Y 4/0) Silty Clay, some gravel, trace sand. Moist.	CL	>4.5	t: 0805 Hm: 0 ppm α: 2 cpm γ/β: 40 cpm
30.0	08799	15 50 50/4"	16	Hard, Gray (2.5Y 5/0) Silty Clay, trace sand and gravel. Moist. 29.6	CL	>4.5	t: 0833 Hm: 0 ppm α: 2 γ/β: 40 cpm
				~~Hard~~ V. Dense, Gray 2.5Y 5/0 Fine sand some silt 29.8	SW		

NOTES:

Pushed Shelby from 21.0-23.0 Feet. No recovery.

See Following page

001104

402-11-86

FERNALD RI/FS

REVIEWED BY QA K.C. DATE 8/1/91

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RKA 2/4/99

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: ~~180~~ 1080 BB 1-5-89	COORDINATES: See P'	DATE: 4/27/88
ELEVATION: See P'	GWL: Depth N/A Date/Time N/A	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A Date/Time N/A	DATE COMPLETED: 4/27/88
DRILLING METHODS: CABLE TOOL		PAGE 3 OF ~~4~~ 6

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30.0	08800	38 50/4	10 (10.9)	Hard, Dark Gray (5Y 4/1) Sandy Silt, some clay. Moist ~31 ft.	ML	>4.5	t: 0857 Hm: 0ppm α: 2cpm γ/β: 40cpm
32.5	08801	14 24 29	18	Very Stiff, Dark Gray (5Y 4/1) Clay, some silt, trace sand and gravel. Moist	CL	3.5	t: 0958 Hm: 0ppm α: 2cpm γ/β: 40
	08802	5 11 18	4	Dark Gray (5Y 4/1) Clay, some silt and gravel. Moist.	CL		t: 1015 Hm: 0cpm α: 2cpm γ/β: 40cpm Rock in end of sampler
35.0	08803	5 9 12	17	Very Stiff Dark Gray (5Y 4/1) Silty Clay trace sand and gravel, moist			t: 1027 Hm: 0ppm α: 2cpm γ/β: 40cpm
	08804	7 21 27	15	Very Stiff, Dark Gray (5Y 4/1) Silty Clay trace sand and gravel moist. 36.6	CL	2.1	t: 1042 Hm: 0ppm α: 2cpm γ/β: 50cpm
				Hard, Brownish Yellow (10YR 6/8) Silty Clay. Moist.	CL	>4.5	
37.5				Very Dense, Very Pale Brown (10YR 7/4) Fine sand, well sorted, trace silt. Dry	SW		
40.0	08665	16 36 50	16	Very Dense, Very Pale Brown (10YR 7/4) Fine Sand, well sorted, trace silt. Slightly Moist.	SW		t: 1100 Hm: 0ppm α: 2cpm γ/β: 50cpm
42.5							
45.0							

NOTES: Bottom of hill 36.8 Feet

402-11-8

FERNALD RI/FS

REVIEWED BY QA K.G. DATE 8/1/91

Key In 6647 VPT
2nd Key In RKA 2/4/5
Hard Copy Verification

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.2	PROJECT NAME: Fernald RI/FS	
BORING NUMBER: 1080	COORDINATES: See p1	DATE: 4/27/88
ELEVATION: See p1	GWL: Depth N/A Date/Time N/A	DATE STARTED: 4/26/88
ENGINEER/GEOLOGIST: DAVIES	Depth N/A Date/Time N/A	DATE COMPLETED: 4/27/88
DRILLING METHODS:		PAGE 4 OF 6

DEPTH (Ft.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER (6 in.)	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
45.0	08666	35 49 44	18	Very Dense, Very Pale Brown (10YR 7/4) fine sand, trace med. sand to fine gravel, trace silt. Slightly moist	SW		t: 1258 Hm: 0ppm α: 2cpm γ/β: 40cpm
47.5							
50.0	08667	22 33 50	17	Very Dense Brownish Yellow (10YR 6/6) fine sand, trace med. sand to fine gravel, trace silt, Moist.			t: 1411 Hm: 0ppm α: 2cpm γ/β: 40cpm
51.5				END OF BORING 51.5 FT.			

NOTES:

FERNALD RI/FS

REVIEWED BY QA K.G. DATE 8/1/91

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2nd Key In		
Hard Copy Verification		

RKA 2/

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS FIELD ENG./GEO. DAVIES DATE 4/28/88
PROJECT NO. 602.3.2 CHECKED BY R Galbraith DATE 2/7/89
BORING NO. ~~180~~ 1080 BB 1-5-89
PIEZOMETER NO. 1080 DATE OF INSTALLATION 4/28/88

BOREHOLE DRILLING

DRILLING METHOD CABLE TOOL	TYPE OF BIT Steel
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID 350 gallon H_2O FROM 0 TO 51.5	SIZE ~~4 in~~ BD FROM ~~30.9~~ BD TO
FLUID - FROM - TO -	SIZE 10 in FROM 0.0 TO 46.0 Ft

PIEZOMETER DESCRIPTION

TYPE Monitoring Well	RISER PIPE MATERIAL Stainless Steel
DIAMETER OF PERFORATED SECTION 4 in	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 in I.D. 4.0 in
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 10 Ft.
AVERAGE SIZE OF PERFORATIONS 0.010 in	JOINING METHOD Screw wrench tight
TOTAL PERFORATED AREA 10 Ft	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5 Ft	OTHER PROTECTION Steel cover, lockable
PROTECTIVE PIPE O.D. 10 3/4 in	Stainless Steel vented cap.

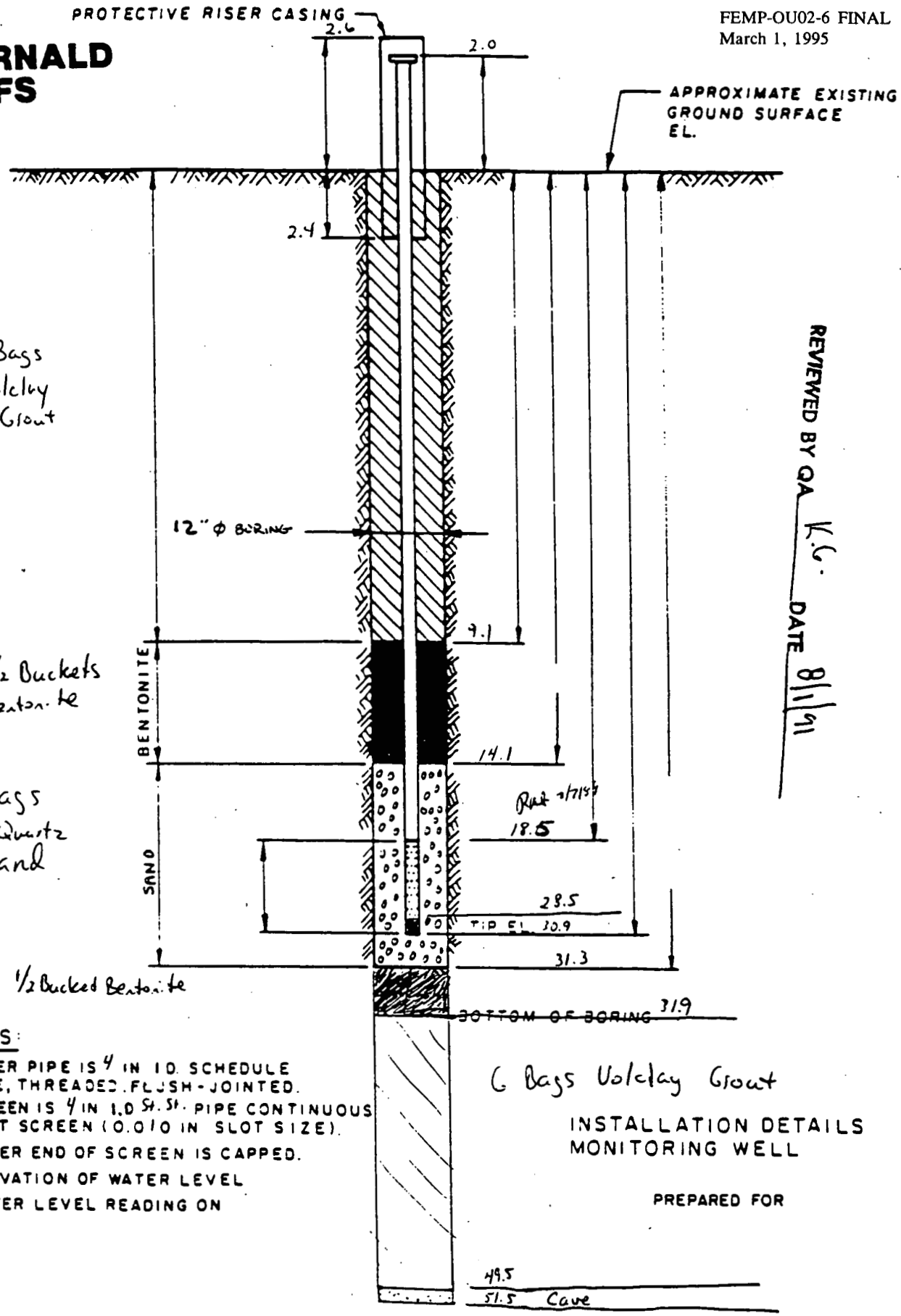
ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (Ft)		ELEVATION (ft)	
TOP OF RISER PIPE	2.0		K.G. ~~581.7~~ ~~579.7~~ 583.7	
GROUND SURFACE	0.0		581.7	
BOTTOM OF PROTECTIVE PIPE	2.6		579.4	
BOREHOLE FILL MATERIALS:				
GROUT/SLURRY	TOP 0.0	BOTTOM 9.1	TOP 581.7	BOTTOM 572.6
BENTONITE	TOP 9.1	BOTTOM 14.1	TOP ~~567.6~~ 572.6	BOTTOM 567.6
SAND	TOP 14.1	BOTTOM 31.3	TOP 567.6	BOTTOM 550.4
~~GRAVEL~~ Bentonite Grout	TOP 31.3 31.9	BOTTOM 31.9 49.3	TOP 550.4 549.8	BOTTOM 549.8 532.2
PERFORATED SECTION	TOP 18.5 Feet 2/7/89	BOTTOM 28.5 Feet 2/7/89	TOP 563.2	BOTTOM 534.7
PIEZOMETER TIP	30.9		550.8	
BOTTOM OF BOREHOLE	51.5		530.2	
GWL AFTER INSTALLATION	NA		N/A	

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒
REMARKS Screen section measured 10.5 Ft with 10.0 Ft perforated

Boring #150 1:50 66 1-5-59

6647 6/6 RKA 2/4

FERNALD RI/FS



DRAWING NUMBER

CHECKED BY | APPROVED BY

BD

DRAWN BY

REVIEWED BY QA K.G. DATE 8/1/91

NOTES:

1. RISER PIPE IS 4 IN I.D. SCHEDULE PIPE, THREADED. FLUSH-JOINTED.
2. SCREEN IS 4 IN I.D. ST. ST. PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL
5. WATER LEVEL READING ON

INSTALLATION DETAILS
MONITORING WELL

PREPARED FOR

E-7-48

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

100365	PROJECT NAME: FEMP RI/FS EWMF	DATE: 1-15-92
PROJECT NUMBER: 602.3.22	COORDINATES:	DATE STARTED: 1-15-92
DRILLING NUMBER: 2728	GWL: Depth 78.85 ft Date/Time 1/30/92/1530	DATE COMPLETED: 1-30-92
ELEVATION: ≈593.5 ft	Depth Date/Time	PAGE 1 OF 1
ENGINEER/GEOLOGIST: P. CASSEDAY		
DRILLING METHODS: CABLE TOOL		

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS Background βγ=60 cpm
0	100365 1-15-92 9:20	2	6	VERY SOFT, ~~LOOSE~~ (10 YR, 4/2) DARK GRAYISH BROWN SILTY CLAY. MINOR SAND. SOME ORGANIC MATERIAL (RNTS). SLIGHTLY MOIST. NOT VERY PLASTIC (LJ 2/2/92)	CL	0.5	βγ=0 cpm α=NA HNU=0 ppm
	100366 1-15-92 9:20	6	6	VERY STIFF, ~~[illegible]~~ (10 YR, 5/6) YELLOWISH BROWN CLAY. SLIGHTLY PLASTIC. SLIGHTLY MOIST LITTLE SILT, NO SAND. (LJ 2/2/92)	CL	2.5	βγ=0 cpm α=NA HNU=0 ppm
1	1-15-92 9:20	9	0 ~~NR~~ (LJ 2/2/92)	NR	NA	NA	βγ=0 cpm α=NA HNU=0 ppm
	1-15-92 9:20	10	0 ~~NR~~ 2/2/92	~~NA~~ PL 1-15 NR	NA	NA	βγ=0 cpm α=NA HNU=0 ppm
2	100366 1-15-92 9:35	5	6	SAA	CL	2.75	βγ=0 cpm α=NA HNU=0 ppm
	100366 1-15-92 9:35	7	3	SAA	CL	2.5	βγ=0 cpm α=NA HNU=0 ppm
3							

NOTES: DRILLER - PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERLE - HELPER

SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

Please note: Sample numbers 100311 to 100376 were not used for this well

402-11

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS EWMF		
BORING NUMBER: 2728	COORDINATES:	DATE:	
ELEVATION:	GWL: Depth / Date/Time	DATE STARTED:	
ENGINEER/GEOLOGIST: P. CASSEDAY	Depth / Date/Time	DATE COMPLETED:	
DRILLING METHODS: CABLE TOOL		PAGE 2 OF 3	

DEPTH (FT)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
3	1-15-92 9:35	11	0	NR	NA	NA	βγ = 0 cpm α = NA Hnu = 0 ppm
	1-15-92 9:35	13	0	NR	NA	NA	βγ = 0 cpm α = NA Hnu = 0 ppm
4	1-15-92 100367 9:45	17	6	MEDIUM STIFF, ~~VERY DENSE~~ (2.5Y, 6/6) OLIVE YELLOW SILTY CLAY WITH SOME GRAVEL PIECES SLIGHTLY MOIST, PLASTIC. (CM 2/3/92)	CL	1.5	βγ = 0 cpm α = NA Hnu = 0 ppm
	1-15-92 9:45 100367	19	6	SAA	CL	1.5	βγ = 0 cpm α = NA Hnu = 0 ppm
5	1-15-92 9:45 100368	31	6	HARD, ~~VERY DENSE~~ (2.5Y, 6/6) OLIVE YELLOW CLAY WITH MORE EXTENSIVELY INTERSPERSED GRAVEL THAN 4'-5'. SLIGHTLY MOIST, SLIGHTLY PLASTIC (CM 2/3/92)	CL	>4.0	βγ = 0 cpm α = NA Hnu = 0 ppm
	1-15-92 9:45 100368	41	2	SAA	CL	>4.0	βγ = 0 cpm α = NA Hnu = 0 ppm

NOTES: DRILLER - PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERLE - HELPER

SAA - SAME AS ABOVE
NA - NOT APPLICABLE
NR - NO RECOVERY

SAMPLE TECH - CHRIS JOHNSON

402-11-86

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.3.22	PROJECT NAME. FEMP RI/FS		DATE 1-15-92
BORING NUMBER: 2728	COORDINATES:		DATE STARTED 1-15-92
ELEVATION:	GWL: Depth	Date/Time	DATE COMPLETED 1-30-92
ENGINEER/GEOLOGIST. P. Casseday	Depth	Date/Time	PAGE 3 OF 15
DRILLING METHODS: CABLE TOOL			

CH 2/3/92

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
6	1-15-92 ~~100368~~ 100369 9:50	PL1-15 50/5	6	CH 2/3/92 HARD, ~~VERY DENSE~~ (2.5Y, 6/4) LIGHT YELLOWISH BROWN CLAY WITH GRAVEL. SOME DARK MOTTLING. LITTLE SILT OR SAND. SLIGHTLY MOIST. INCREASING PLASTICITY	CL	>4.0	ATTEMPTED GEOCHEM. INSUFFICIENT RECOVERY SO BOTTLED AND ARCHIVED βγ = 0 cpm α = NA HNu = 0 ppm
	1-15-92 9:50	NA	NR	NR	NA	NA	βγ = NA α = NA HNu = NA
7	1-15-92 9:50	NA	NR	NR	NA	NA	βγ = NA α = NA HNu = NA
	1-15-92 9:50	NA	NR	NR	NA	NA	βγ = NA α = NA HNu = NA
8	1-15-92 1310 100370	10	6	CH 2/3/92 MEDIUM STIFF, ~~DENSE~~ (2.5Y, 5/3) LIGHT OLIVE BROWN SILTY CLAY WITH NUMEROUS CHERT FRAGMENTS. LITTLE SAND. SLIGHTLY MOIST, LOW PLASTICITY.	CL	0.75	βγ = 0 cpm α = NA HNu = 0 ppm
	1-15-92 1310 100370	NS	6	SAA, ONLY HARD.	CL	>4.0	βγ = 0 cpm α = NA HNu = 0 ppm
9							

NOTES: DRILLER - PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

SAMPLE TECH - CHRIS JOHNSON

402-11-86

6647

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.DD	PROJECT NAME: FEMP		
BORING NUMBER: 27DB	COORDINATES:		DATE: 1-15-92
ELEVATION:	GWL: Depth: Date/Time:		DATE STARTED: 1-15-92
ENGINEER/GEOLOGIST: P. CASSEMY	Depth: Date/Time:		DATE COMPLETED: 1-15-92
DRILLING METHODS: CABLE TOOL			PAGE 1 OF 1

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
9	1-15-92 1310 100376	32	6	PC 1-15 MEDIUM HARD ~~DENSE~~ (2.5Y, 5/3) LIGHT OLIVE BROWN SILTY CLAY WITH MUCH FRAGMENTED CHERT & LIMESTONE. LITTLE SAND. SLIGHTLY MOIST, LOW PLASTICITY CB 2/3/92	CL	>4.0	BGM = 0 cpm α = NA HNU = 0 ppm
	1-15-92 1310	50	0 ~~NR~~ CB 2/3/92	NR	NA	NA	BGM = NA α = NA HNU = NA
10	PC 1-15 1-15-92 1415 100377	SHELBY TUBE ATTEMPTED	6	(2.5Y 5/4) LIGHT OLIVE BROWN SILTY CLAY WITH (5Y, 5/2) OLIVE GRAY MOTTLING. SLIGHTLY MOIST LOTS OF INTERSPERSED GRAVEL, SOME QUITE LARGE. LOW PLASTICITY	CL	NA	SHELBY TUBE 10'-12' INSUFFICIENT RECOVERY SAMPLE PULLED AND ARCHIVED. CALLED CATE GRUBE. INFORMED NOT TO ATTEMPT ANOTHER SHELBY UNTIL WE REACH SOFTER MATERIAL.
			6	SAA	CL	NA	
11			0	NR	NA	NA	BGM = 0 cpm α = NA HNU = 0 ppm
	RAD SCREEN PC 1-15 ~~100376~~ 100377		0	NR	NA	NA	
12							

NOTES

DRILLER - PENNSYLVANIA DRILLING

JOE BARILE - DRILLER

RICK PIERLE - HELPER

SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE

NR - NO RECOVERY

NA - NOT APPLICABLE

402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER:	602.3.22	PROJECT NAME: FEMP RI/FS	DATE: 1/31/92
BORING NUMBER:	2728	COORDINATES:	DATE STARTED: 1/15/92
ELEVATION:		GWL: Depth / Date/Time	DATE COMPLETED: 1/30/92
ENGINEER/GEOLOGIST:	P. McCassey	GWL: Depth / Date/Time	PAGE 15 OF 15
DRILLING METHODS:	Cable Tool		

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION (CM 2/3/92)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
12	1-15-92 1435 100377	21	6	HARD ~~VERY DENSE~~ (5Y, 5/2) OLIVE GRAY SILTY CLAY, WITH NUMEROUS ROCK FRAGMENTS. LITTLE SAND. Brown MOTTLING, SLIGHTLY MOIST, LOW PLASTICITY.	CL	>4.0	βγ = 0 cpm α = NA; HNu = 0 ppm
		31	6	SAA	CL	>4.0	βγ = 0 cpm α = NA; HNu = 0 ppm
13		33	6	SAA	CL	>4.0	βγ = 0 cpm α = NA; HNu = 0 ppm
		39	0	NR	NA	NA	βγ = PL ØNA MS α = NA; HNu = NA
14 (CM 02/05/92)	1-15-92 1500 100378	10	6	VERY STIFF, ~~VERY DENSE~~ (5Y, 5/1) GRAY CLAY WITH NUMEROUS GRAVEL PIECES. PLASTIC AND SLIGHTLY MOIST, WITH LITTLE TO NO SILT OR SAND	CL	3.0	βγ = 0 cpm α = NA; HNu = 0 ppm
	1-15-92 1500	25	0	NR	NA	NA	βγ = NA α = NA; HNu = NA
15							

TOTAL U/γ SPEC RAD SCREEN

NOTES: PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER

SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

001113

6647

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS EOMF		
BORING NUMBER: 2728	COORDINATES:	DATE: 1-15-92	
ELEVATION:	GWL: Depth: Date/Time:	DATE STARTED: 1-15-92	
ENGINEER/GEOLOGIST: R.P. Cassidy	Depth: Date/Time:	DATE COMPLETED: 1-30-92	
DRILLING METHODS: CABLE 602		PAGE 6 OF 45/17	

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
15	1-15-92 1500	30	0	NR	NA	NA	βγ = NA α = NA HNU = NA
	1-15-92 1500	35	0	NR	NA	NA	βγ = NA α = NA HNU = NA
16	1-15-92 1530 100379	13	6	VERY ~~STIFF~~, ~~VERY DENSE~~ (5Y, 5/1) GRAY CLAY WITH NUMEROUS GRAVEL PIECES, SOME LARGE, MOIST AND PLASTIC (JB 2/3/92)	CL	3.5	βγ = 0 cpm α = NA ATTEMPTED GEOTECH SAMPLE INSUFFICIENT RECOVERY BOTRED & ARCHIVED. HNU = 0 ppm
	1-15-92 1530	20	PC1-15 ~~N~~0	NR	NA	NA	βγ = NA α = NA HNU = NA
17	1-15-92 1530	25	0	NR	NA	NA	βγ = NA α = NA HNU = NA
	1-15-92 1530	50/4	0	NR	NA	NA	βγ = NA α = NA HNU = NA
18							

NOTES: PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER

SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NA - NOT APPLICABLE
NR - NO RECOVERY

-02-11-4C

001114

7/17

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS		FWMF
BORING NUMBER: 2728	COORDINATES:		DATE: 1-15-92
ELEVATION:	GWL Depth/Date/Time		DATE STARTED: 1-15-92
ENGINEER/GEOLOGIST: P. Cassidy	Depth/Date/Time		DATE COMPLETED: 1-15-92
DRILLING METHODS: Cable Tool			PAGE 1 OF 1

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 in	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
18	1-15-92 1600 100379	4	6	STIFF, MEDIUM DENSE (5Y, 5/1) GRAY CLAY WITH NUMEROUS INTERSPERSED GRAVEL MOIST AND PLASTIC. LITTLE SILT AND SAND.	CL	2.0	βr = 0 cpm α = NA HNU = 0 ppm
Archive	1-15-92 1600 100379	6	6	SAA	CL	1.5	βr = 0 cpm α = NA HNU = 0 ppm
19	1-15-92 1600 100379	11	6	SAA	CL	1.5	βr = 0 cpm α = NA HNU = 0 ppm
	1-15-92 1600 100379	13	2	SAA	CL	1.5	βr = 0 cpm α = NA HNU = 0 ppm
20	1-15-92 1656 100380	4	4	STIFF, MEDIUM DENSE (5Y, 5/1) GRAY CLAY WITH GRAVEL. LITTLE SILT, NO SAND. VERY PLASTIC AND SLIGHTLY MOIST.	CL	2.0	βr = 0 cpm α = NA HNU = 0 ppm NOTE: SHELBY TUBE DRIVEN 20-22 NO RECOVERY - SO SAMPLED 20-22 AND SHELBY AGAIN AT 22-25
Archive	1-15-92 1656	6	0	NR	NA	NA	βr = NA α = NA HNU = NA
21							

NOTES

DRILLER: PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - ASSISTANT

SAMPLE TECH - CHRIS JOHNSON

NA - NOT APPLICABLE
SAA - SAME AS ABOVE
NR - NO RECOVERY

001115

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.3.22	PROJECT NAME. FEMP RI/FS EWMF		DATE 1-15-92
BORING NUMBER: 2728	COORDINATES:		DATE STARTED: 1-15-92
ELEVATION:	GWL: Depth	Date/Time	DATE COMPLETED: 1-30-92
ENGINEER/GEOLOGIST. P. CASSEDAY	Depth	Date/Time	PAGE 8 OF 18
DRILLING METHODS: CABLE TOOL			

08 2/3/92

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
21	1-15-92 1656	18	0	NR	NA	NA	βγ = NA α = NA HNu = NA
	1-15-92 1656	15	0	NR	NA	NA	βγ = NA α = NA HNu = NA
22	1-21-92 1050 100381		27	MEDIUM STIFF (5Y, 5/1) GRAY CLAY WITH GRAVEL. SOME SILT, NO SAND. VERY PLASTIC AND MOIST	CL	X (no sample)	ATTEMPTED TO PUSH SHELBY TUBE 22.0'-25.0' βγ = 0cpm α = NA HNu = 0ppm
	RAD SCREEN TOP 100382	SHELBY TUBE PUSHED				NA	
23	RAD SCREEN BOTTOM 100383						
24							

NOTES:
PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER
SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NA - NOT APPLICABLE
NR - NO RECOVERY

402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER. 602.3.22	PROJECT NAME. FEMP RI/FS EWMF		DATE 1-21-92
BORING NUMBER: 2728	COORDINATES:		DATE STARTED 1-15-92
ELEVATION:	GWL: Depth	Date/Time	DATE COMPLETED 1-30-92
ENGINEER/GEOLOGIST. P. CASSEDAY	Depth	Date/Time	PAGE 1 OF 3
DRILLING METHODS: CABLE TOOL			

CB 2/3/92

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
24	1-21-92 1050 100381 R.S TOP 100382 RS. Bottom 100383	SHELBY TUBE PUSHED		MEDIUM STIFF (PCL-21 2.5Y, 5/1) GRAY CLAY AND GRAVEL MIX. SOME SILT, NO SAND. PLASTIC AND MOIST	CL	NA	
25	1-21-92 1315 100384	8	6	VERY STIFF. ~~[illegible]~~ (2.5Y, 4/2) DARK GRAYISH BROWN CB 2/3/92 CLAY MIXED WITH GRAVEL, SOME SILT, NO SAND. SLIGHTLY MOIST PLASTIC.	CL	3.0	βγ = 0 cpm α = NA HNu = 0 ppm
ED GEOTECH		14	6	SAA	CL	3.5	βγ = 0 cpm α = NA HNu = 0 ppm
26		16	3	SAA	CL	>4.0	βγ = 0 cpm α = NA HNu = 0 ppm
27		20	0	NR	NA	NA	βγ = NA α = NA HNu = NA

NOTES:
PENNSYLVANA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER

SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NA - NOT APPLICABLE
NR - NO RECOVERY

402-11-86

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: Temp. Rad Sewer MF		
BORING NUMBER: 2-128	COORDINATES:		DATE: 1-21-92
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 1-15-92
ENGINEER/GEOLOGIST: J. Cassedy	Depth	Date/Time	DATE COMPLETED: 1-30-92
DRILLING METHODS: Cable Tool			PAGE 2 OF 3

DEPTH (Ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION (2/3/92)	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (2/3/92)
27	1-21-92 1335 100384	7	6	~~Dense~~, VERY STIFF (2.5Y, 4/2) DARK GRAYISH BROWN CLAY WITH INTERMIXED GRAVEL. LITTLE SILT, NO SAND. MOIST AND PLASTIC.	CL	3.0	βγ = 0 cpm α = NA HNU = 0 ppm
		19	6	SAA	CL	3.5	βγ = 0 cpm α = NA HNU = 0 ppm
28		29	0	NR	NA	NA	βγ = NA α = NA HNU = NA
		40	0	NR	NA	NA	βγ = NA α = NA HNU = NA
29	1-21-92 1413 100385	14	6	DENSE, VERY STIFF (2.5Y, 4/2) DARK GRAYISH BROWN CLAY WITH VARIOUS PIECES OF GRAVEL INTERSPERSED; SOME SILT, NO SAND, MOIST AND PLASTIC	CL	3.0	ATTEMPT GEOCHEM SLEEVE SAMPLE 29'-31'. INSUFFICIENT RECOVERY SAMPLE ARCHIVED βγ = 0 cpm α = NA HNU = 0 ppm
	1-21-92 1413	25	0	NR	NA	NA	βγ = NA α = NA HNU = NA
30							

NOTES:
PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER
SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 6823	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 272	COORDINATES:	DATE: 1-21-92	
VATION:	GWL: Depth: Date/Time	DATE STARTED: 1/15/92	
ENGINEER/GEOLOGIST: P. Cassidy	Depth: Date/Time	DATE COMPLETED: 1/20/92	
DRILLING METHODS: Cable Tool		PAGE: 1 OF 3	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
30	1-21-92 1413	38	0	NR	NA	NA	BR = NA α = NA HNU = NA
	1-21-92 1413	20	0	NR	NA	NA	BR = NA α = NA HNU = NA
31	1-21-92 1535 100386	7	6	STIFF, ~~VERY DENSE~~ (2.5Y, 4/2) DARK GRAYISH BROWN CLAY WITH SILT, SAND AND GRAVEL INTERMIXED. MOIST AND VERY PLASTIC. GB 2/3/92	CL	2.5	BR = 0 cpm α = NA HNU = 0 ppm
		27	6	SAA - SAND ENCOUNTERED IN SHOE (BASE OF TILL)	CL	2.5	BR = 0 cpm α = NA HNU = 0 ppm
32		40	0	NR			SAND ENCOUNTERED - BASE OF TILL BR = NA α = NA HNU = NA
		50/2	0	NR			BR = NA α = NA HNU = NA
33							

NOTES

PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER

SAMPLE TECH. CHRIS JOHNSON

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

402-11-46

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER	602-3.22	PROJECT NAME	FEMP RI/FS	DATE	1-20-92 / 1-22-92
BORING NUMBER	2728	COORDINATES		DATE STARTED	1-15-92
ELEVATION		GWL Depth	Date/Time	DATE COMPLETED	1-30-92
ENGINEER/GEOLOGIST	P. GASSEDAY	Depth	Date/Time	PAGE	18 OF 25
DRILLING METHODS	CABLE TOOL				

DEPTH (Ft)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 in.	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
33							
34							
35	1-21-92 1700	50/.2	0	NR	NA	NA	HNu = NA α = NA βγ = NA
36							
37							
38							
39							
40	1-22-92 1015 100887	11 12 11	18	CB 2/3/92 ~~STIFF~~ MEDIUM DENSE (10YR, 3/6) DARK YELLOWISH BROWN CLAYEY SILT. NO SAND. SOME SMALL GRAVEL PIECES. FAIRLY WELL SORTED. MOIST	ML	NA ~~2.0~~ CB 2/3/92	HNu = 0 ppm α = NA βγ = 0 ppm CB 2/3/92
42							
43							
44							
45	1-22-92 1025 100888	5 7 12	18	CB 2/3/92 STIFF, ~~MEDIUM DENSE~~ (2.5Y 4/2) DARK GRAYISH BROWN CLAY WITH GRAVEL, SOME SILT, MOIST	CL	1.5	~~HNu = 0 ppm~~ α = NA
46				OVERLYING A ~~MEDIUM DENSE~~ MEDIUM DENSE (7.5YR, 4/6) STRONG BROWN CLAYEY SILT WITH INTERSPERSED SAND AND GRAVEL; MOIST	ML	0.5	βγ = 0 ppm CB 2/3/92
47							
48							

NOTES: DRILLING - PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PERLE - HELPER

SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS F-WMF		
BORING NUMBER: 2728	COORDINATES:	DATE: 1-22-92	
ELEVATION:	GWL: Depth: Date/Time	DATE STARTED: 1/15/92	
ENGINEER/GEOLOGIST: P. Cassedy	GWL: Depth: Date/Time	DATE COMPLETED: 1/30/92	
DRILLING METHODS: Cable Tool		PAGE 13 OF 15	

DEPTH (Ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
48							
49							
50				CB 2/5/92			
51	1-22-92 8 1325 100391	8 8	18	~~SOFT~~, MEDIUM DENSE (10YR, 5/6) YELLOWISH BROWN SAND, SOME SILT AND GRAVEL. POORLY SORTED ~~AND GRADED~~. MOIST CB 2/5/92	SW ~~SP~~	NA ~~0.5~~ CB 2/12/92	HNu = 0 ppm α NA βγ = 0 cpm
52							
53							
54							
55				CB 2/5/92			
56	1-22-92 12 1400 100390	32 42	18	~~VERY SOFT~~ VERY DENSE (10YR, 6/6) BROWNISH YELLOW SAND WITH MUCH GRAVEL. POORLY ~~GRADED AND~~ SORTED WITH APPRECIABLE SILT MOIST CB 2/5/92	SW ~~GM~~	NA ~~0.25~~ CB 2/13/92	HNu = 0 ppm α = NA βγ = 0 cpm
57							
58							
59							
60	1-22-92 1425 100391	15 30 50/2	14	CB 2/5/92 VERY ~~SOFT~~, DENSE (10YR, 5/4) YELLOWISH BROWN SILTY GRAVEL OVERLAIN BY A ~~SOFT~~, VERY DENSE, POORLY SORTED (10YR, 6/6) BROWNISH YELLOW GRAVELLY SAND. BOTH ARE MOIST CB 2/5/92	GM SP	NA ~~0.25~~ CB 2/12/92 NA	HNu = 0 ppm α = NA βγ = 0 cpm
61							
62							
63							

NOTES: Driller - Pennsylvania Drilling
Joe Barile - Driller
Rick Pierce - Helper
Chris Johnson - Sample Tech

SAA - Same As Above
NA - Not Applicable
NR - No Recovery

402-11-66

001121

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602[illegible]3.22	PROJECT NAME: FEMP RI/FS EWMF		
BORING NUMBER: 2228	COORDINATES:	DATE: 1-22-92/1-23-92	
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1-15-92	
ENGINEER/GEOLOGIST: [illegible]	Depth Date/Time	DATE COMPLETED: 1-28-92	
DRILLING METHODS: CABLE TOOL		PAGE 1 OF 3	

DEPTH (FT)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 IN	RECOVERY (IN)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
63							
64							
65	1-22-92 1615 100392	50/4	6	2/3/92 ~~SOFT~~, VERY DENSE (2.5Y, 5/6) LIGHT OLIVE BROWN SANDY GRAVEL. POORLY SORTED ~~AND GRADED~~. SOME SILT AND LITTLE TO NO CLAY ~~MOIST~~. SLIGHTLY MOIST PC 1-22	2/3/92 GW ~~GP~~	NA ~~0.25~~ 2/3/92	HNu = 0 ppm α = NA βγ = 0 cpm.
66							
67							
68							
69				2/3/92			
70	1-22-92 1650 100393	50/6	6	~~SOFT~~, VERY DENSE (2.5Y, 4/4) OLIVE BROWN SANDY GRAVEL. POORLY SORTED ~~AND GRADED~~ WITH LITTLE TO NO SILT OR CLAY. SLIGHTLY MOIST	GW ~~GP~~	NA ~~0.25~~ 2/3/92	HNu = 0 ppm α = NA βγ = 0 cpm
71							
72							
73							
74							
75	1-23-92 920 100394	35 45 35	8	2/3/92 ~~VERY SOFT~~, VERY DENSE (2.5Y, 5/3) LIGHT OLIVE BROWN SANDY GRAVEL. POORLY SORTED ~~AND GRADED~~ WITH LITTLE TO NO SILT OR CLAY. WET (HIT WATER TABLE)	GW ~~GP~~	NA ~~0.25~~ 2/3/92	HNu = 0 ppm α = NA βγ = 0 cpm
76							
77							
78							

NOTES

PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER

SAA - SAME AS ABOVE
NA - NOT APPLICABLE
NR - NO RECOVERY

SAMPLE TECH - CHRIS JOHNSON

10/11

HI/RS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER	60233.22	PROJECT NAME	FEMP HRI/FS
BORING NUMBER	2728	COORDINATES	DATE
ELEVATION		GWL - Depth / Date/Time	DATE STARTED 1/5/92
ENGINEER/GEOLOGIST		Depth / Date/Time	DATE COMPLETED
DRILLING METHODS	CABLE TOOL		PAGE 5 OF 5

DEPTH (FT.)	SAMPLE TYPE & NO.	BLOWS ON SAMPLER PER 6 IN.	RECOVERY (IN.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
78							
79							
80	1-23-92 1350 100395	35 18 16	12	CW 2/3/92 ~~VERY SOFT~~, DENSE (2.5Y, 5/2) GRAYISH BROWN GRAVEL WITH SAND, POORLY SORTED ~~AND GRADED~~, WITH LITTLE TO NO CLAY OR SILT. WET	GW ~~GP~~	NA ~~<0.25~~ CW 2/3/92	HNu = 0 ppm α = NA β γ = 0 cpm
81							
82							
83							
84				CW 2/3/92			
85	1-23-92 1520 100396	45 44 35	12	~~VERY SOFT~~, VERY DENSE (5Y, 5/1) GRAY CLAYEY SANDY GRAVEL. POOR SORTING ~~AND GRADING~~. SOME SILT. WET. PETROLEUM ODOR FROM CLAYS WITHIN SAMPLE.	GC	NA ~~<0.25~~ CW 2/3/92	HNu = 1.0 ppm α = NA β γ = 0 cpm
86							
87							*HNu HIT - PETROLEUM ODOR FROM SAMPLE.
88							
89							
90	1-23-92 1640 100397	17 16 14	18	CW 2/3/92 ~~VERY SOFT~~, MEDIUM DENSE (5Y, 5/1) GRAY SANDY GRAVEL WITH A LENS OF CLAY POORLY SORTED ~~AND GRADED~~. WET. PETROLEUM ODOR IN CLAY LENS.	GC	NA ~~<0.25~~ CW 2/3/92	HNu = 1.0 ppm α = NA β γ = 0 cpm
91							
92				BOTTOM OF BORE HOLE - 92.0 ft Bottom of Sampling - 91.5 ft			PETROLEUM ODOR AGAIN
93							

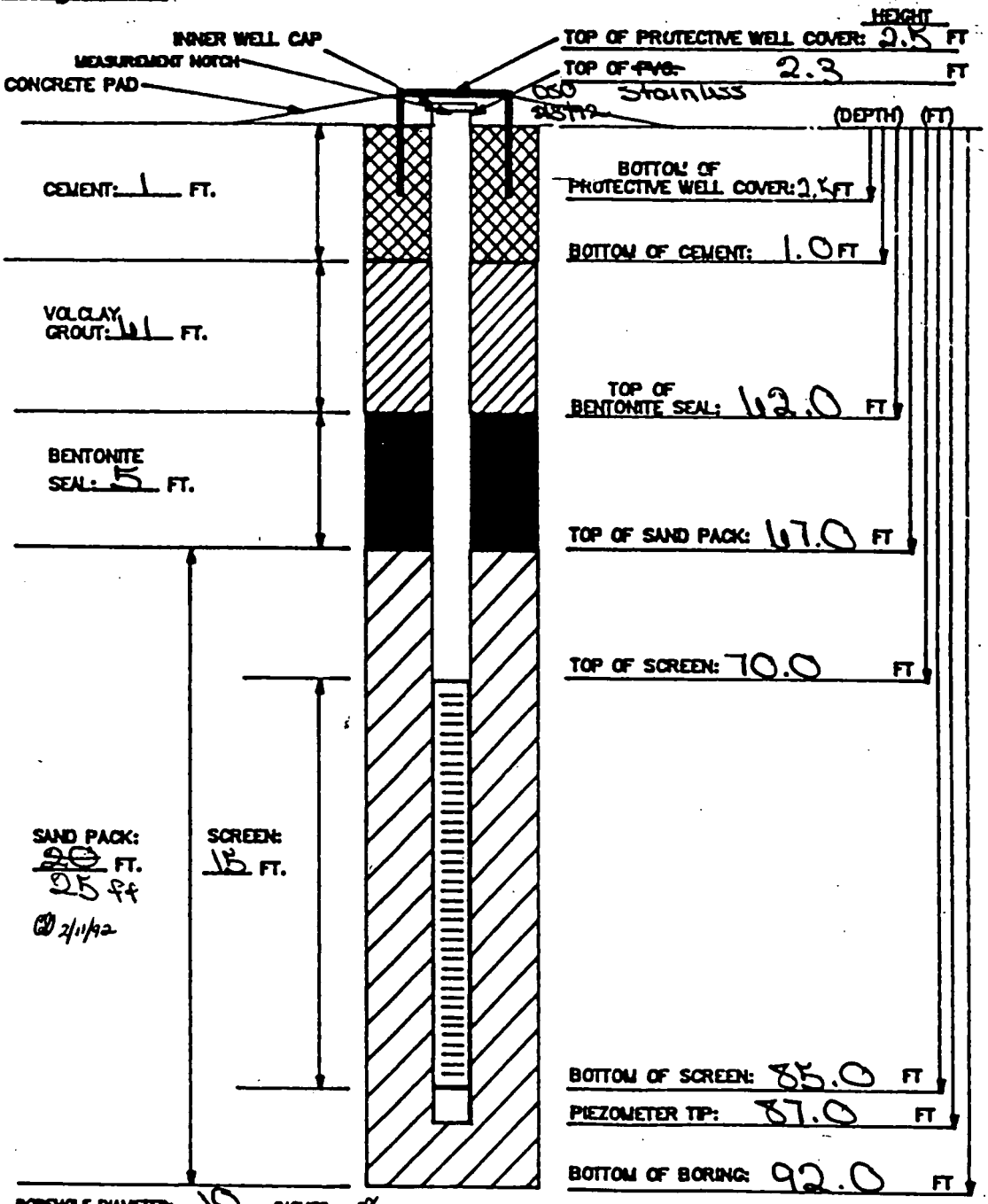
NOTES: PENNSYLVANIA DRILLING
JOE BARILE - DRILLER
RICK PIERCE - HELPER
SAMPLE TECH - CHRIS JOHNSON

SAA - SAME AS ABOVE
NR - NO RECOVERY
NA - NOT APPLICABLE

FERNALD RI/FS

INSTALLATION DATE: 11/30/92

INSTALLATION DIAGRAM
MONITORING WELL NO.
2728



BOREHOLE DIAMETER: 10 INCHES

MATERIALS USED:
SAND TYPE AND QUANTITY: 17 bag
BENTONITE PELLETS (5-GALLON BUCKETS): 11
BAGS OF VOLCLAY GROUT: 15 bag
AMOUNT OF CEMENT:
AMOUNT OF WATER USED: 600 gallons
OTHER: NA

NOTES: 4 inch 316 Stainless steel Steel
1) RISER PIPE IS ~~4-INCH-SCHEDULE-40~~ SS PVC PIPE, FLUSH-THREADED JOINTS. 4 in SS
2) SCREEN IS ~~4-INCH-ID-SCHEDULE-40~~ SS PVC PIPE WITH ~~MACHINED~~ SLOTS. 0.010 in
3) LOWER END OF SCREEN IS CAPPED WITH AN END CAP OR THREADED SUMP or welded cap
4) WATER DEPTH/DATE: 73.8 ft
5) TOP OF ~~PVC~~ SS IS SECURED WITH EXPANDABLE RUBBER PLUG AND PADLOCK.
6) PARENTHESES INDICATE DEPTH BELOW GROUND LEVEL.

TASK: 3.22 GEOLOGIST/ENGINEER: D. O'Brien

PIEZOMETER INSTALLATION SHEET

PROJECT NAME Fernald RI/FS FLUME FIELD ENG./GEO. D. O'Brien DATE 11/30/92
PROJECT NO. 602.3.22 CHECKED BY Clarke DATE 02/11/92
BORING NO. 2728
PIEZOMETER NO. 2728 DATE OF INSTALLATION 11/30/92

BOREHOLE DRILLING

DRILLING METHOD Cable Tool	TYPE OF BIT Churn Bit
DRILLING FLUID (S) USED:	CASING SIZE (S) USED:
FLUID H_2O FROM 0 TO 92.0	SIZE 10 3/4 o.d. FROM 0 TO 92.0
FLUID NA FROM NA TO NA	SIZE NA FROM NA TO NA

PIEZOMETER DESCRIPTION

TYPE Monitoring Well	RISER PIPE MATERIAL 316 stainless steel
DIAMETER OF PERFORATED SECTION 4.0 in	RISER PIPE DIAMETERS:
PERFORATION TYPE:	O.D. 4 3/8 in. I.D. 4.0 in
SLOTS ☐ HOLES ☐ SCREEN ☒	LENGTH OF PIPE SECTIONS 7 10's, 1 17ft screen, 2
AVERAGE SIZE OF PERFORATIONS 0.010 in.	JOINING METHOD flush joint threaded
TOTAL PERFORATED AREA 15 ft.	

PROTECTION SYSTEM

RISER PROTECTIVE PIPE LENGTH 5.0 ft	OTHER PROTECTION hinged locking cap
PROTECTIVE PIPE O.D. 10 3/4 in.	

ITEM	DISTANCE ABOVE/BELOW GROUND SURFACE (ft)		ELEVATION ( )	
TOP OF RISER PIPE	2.3 ft			
GROUND SURFACE	0.0			
BOTTOM OF PROTECTIVE PIPE	2.5 ft			
BOREHOLE FILL MATERIALS:				
Cement GROUT/SLURRY	Top 0 TOP 1	Bottom 1 BOTTOM 67	TOP	BOTTOM
BENTONITE	TOP 62	BOTTOM 67	TOP	BOTTOM
SAND	TOP 67	BOTTOM 92	TOP	BOTTOM
GRAVEL	TOP NA 67 11/30/92	BOTTOM NA 92 11/30/92	TOP	BOTTOM
PERFORATED SECTION	TOP 70	BOTTOM 85	TOP	BOTTOM
PIEZOMETER TIP	87			
BOTTOM OF BOREHOLE	92			
GWL AFTER INSTALLATION	73.8			

WAS THE PIEZOMETER FLUSHED AFTER INSTALLATION? YES ☐ NO ☒
WAS A SENSITIVITY TEST PERFORMED ON THE PIEZOMETER? YES ☐ NO ☒

REMARKS

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: Femp RI/FS		
BORING NUMBER: 1679	COORDINATES:		DATE 1-23-92
ELEVATION:	GWL: Depth Dry	Date/Time 1-28-92, 0945	DATE STARTED: 1-23-92
ENGINEER/GEOLOGIST: J. Lear	Depth	Date/Time	DATE COMPLETED: 1-27-92
DRILLING METHODS: Cable tool			PAGE 1 OF 7

DEPTH (ft.)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in.	RECOVERY (in.)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
1	100400 100401 1530 1-23-92	3 7 8	7	Stiff, dark brown (10yr. 3/3) silty clay, some organics, med. plasticity, low plasticity	CL	1.25	Hnu - 0 ppm Bg - 40 cpm
2	100400 1535 1-23-92	7 8 10	12	Stiff yellowish brown, (10yr. 5/8) silty clay, some gravel, med. plasticity, v. moist.	CL	1.25	Hnu - 0 - ppm Bg - 40 cpm
4	100400 1540 1-23-92	8 10 10	12	S.A.A.	CL	1.5	Hnu - 0 ppm Bg - 40 cpm
5	100402 1600 1-23-92	Shelby Attempt Recovery Not Ample to use	16 Shelby	yellowish brown, (10yr. 5/8) clay silt sand gravel, mix, ↓ 5.75 N R	GC	NA	Hnu - 0 ppm Bg - 40 cpm
6	1600	for sample Recovery is Archived	Pushed 2.7ft	↑ J.L. N.R	NA	NA	Hnu - 0 ppm Bg - 50 cpm
7							

NOTES
Drilling Contractor - Penn Drilling
Drilling Equipment - Cyclone 43
Driller - Craig Coulter
Asst. - Gary Dye

S.A.A - Same As Above
N.R. - No Recovery

Background
Hnu - 0 ppm
Bg - 50 cpm

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 1679	COORDINATES:	DATE 1-23-92
ELEVATION:	GWL: Depth see pg1 Date/Time	DATE STARTED: 1-23-92
ENGINEER/GEOLOGIST: J. Lear	Depth Date/Time	DATE COMPLETED 1-27-92
DRILLING METHODS: Cable tool		PAGE 2 OF 7

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
8	100403 100404 100405 100406 1625	9 10	12	S.A.A ~~S.A.A~~ S.A.A	GC GC	NA NA	Hnu - 0 ppm Bg - 50 cpm
9	1-23-92	10		N.R.			
10	100407 1630 1-23-92	12 13 21	8	V. stiff, brown to gray, (10yr, 5/3) to (10yr, 5/1) silty clay, trace gravel, moist. Low plasticity.	CL	3.5	Hnu - 0 ppm Bg - 50 cpm
11	100407 1635 1-23-92	10 12 18	6	Hard, gray, (10yr, 5/1) silty clay, trace gravel, sl. moist. Low plasticity	CL	4.0	Hnu - 0 ppm Bg - 50 cpm
12 13	100407 1640 1-27-92	12 16 25	8	V. stiff, gray to brown, (10yr, 5/1) to (10yr, 5/3) silty clay, some gravel, moist.	CL	3.5	Hnu - 0 ppm Bg - 50 cpm
14 15	100407 0900 1-24-92	12 15 19	0	N.R	NA	NA	Hnu Bg NA

NOTES: See Page 1

001127

FERNALD
RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS		
BORING NUMBER: 602.3.22	COORDINATES:		DATE 1-24-92
ELEVATION:	GWL: Depth	Date/Time	DATE STARTED: 1-23-92
ENGINEER/GEOLOGIST: J. Lear	Depth	Date/Time	DATE COMPLETED: 1-27-92
DRILLING METHODS: cable tool			PAGE 3 OF 7

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 (in)	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
	See Above 1-24-92	21	0	N.R.	NA	NA	See Above
16	100408 100409 100410 100411	5	6	Stiff, gray, (10yr, 5/1) silty clay, some gravel, low to med plasticity, moist to very moist.	CL	3.5	Hnu - 0 ppm
	0905	33	3	S.A.A	CL	2.5	
17		50/3	0	NR	NA	NA	Bd - 50 cpm
	1-24-92	NR	0	NR	NA	NA	
	100412	9	2	J.L. 1-27-92 Stiff Hard, gray to grayish brown, (10yr, 5/1) to (2.5y, 5/2) silty gravelly clay, low to med plast. moist. to v. moist.	CL	J.L. 1-27-92 2.0	Hnu - 0 ppm
	0910	10					Bd - 40 cpm
19	1-24-92	11					
	100413	4	9	Stiff, grayish brown, (2.5y, 5/2) silty clay, some gravel, low to med plast. moist.	CL	1.5	Hnu - 0 ppm
	0915	7					Bd - 40 cpm
20	1-24-92	10					
	100414 100415	5	8	S. A. A.	CL	1.5	Hnu - 0 ppm
21	0930	7					Bd - 50 cpm
22	1-24-92	16					
				Cont. page 4			

NOTES
See page 1

FERNALD RI/FS

VISUAL CLASSIFICATION OF SOILS

PROJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 1679	COORDINATES:	DATE 1-24-92
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1-23-92
ENGINEER/GEOLOGIST: J. Lear	Depth Date/Time	DATE COMPLETED: 1-27-92
DRILLING METHODS: Cable Tool		PAGE 4 OF 7

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 1 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS
22	100414	5		Stiff, gray, (10yr, 5/1) silty clay, some gravel, low plasticity, sl. moist. 22.4'	CL	1.5	Hnu - 0 ppm
23	0940 1-24-92	12 16	8	med dense, sandy, clayey, well graded gravel, sl. moist.	GC	NA	Bb - 40 cpm
24	1015 1-24-92	8 12 20	0	N.R.	NA	NA	Hnu - 0 ppm Bb - 40 cpm
	1020 1-24-92	10 15 19	0	N.R.	NA	NA	Hnu - NA Bb - NA
27	1040 1-29-92	8 12 12	0	N.R.	NA	NA	Hnu - NA Bb - NA
28 29	~~100416~~ 100416 1050 1-24-92	2 8 12	15	med stiff, dark grayish brown, (2.5y, 4/2) silty clay, some sand, some gravel, med plasticity, moist.	CL	.75	Hnu - 0 ppm Bb - 40 cpm

NOTES See page 1

FERNALD RI/FS

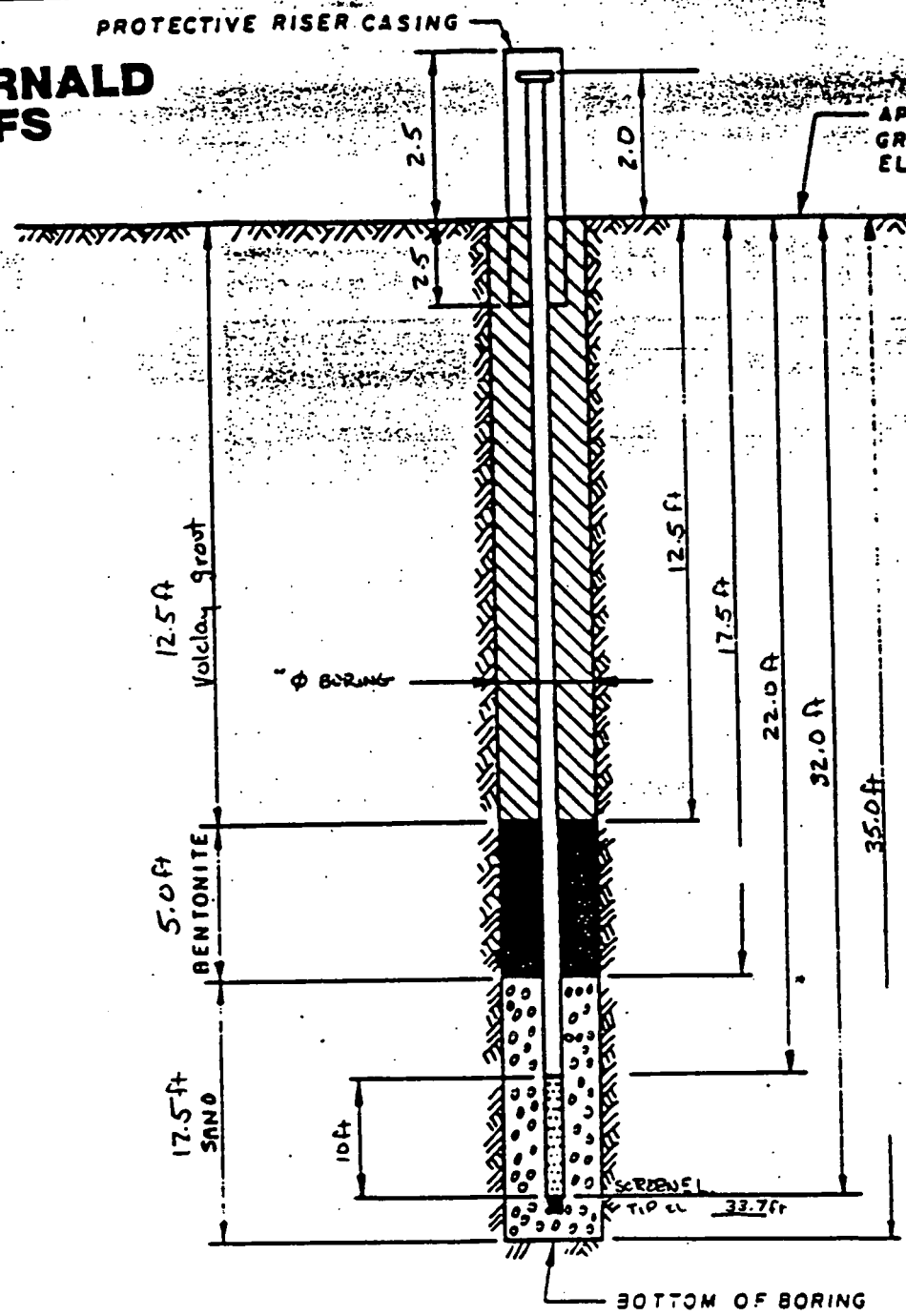
VISUAL CLASSIFICATION OF SOILS

SUBJECT NUMBER: 602.3.22	PROJECT NAME: FEMP RI/FS	
BORING NUMBER: 1679	COORDINATES:	DATE 1-24-92
ELEVATION:	GWL: Depth Date/Time	DATE STARTED: 1-23-92
ENGINEER/GEOLOGIST: J. Lear	Depth Date/Time	DATE COMPLETED: 1-24-92 1-27-92
DRILLING METHODS: Cable tool		PAGE 5 OF 7

DEPTH (ft)	SAMPLE TYPE & NO	BLOWS ON SAMPLER PER 6 in	RECOVERY (in)	DESCRIPTION	USCS SYMBOL	MEASURED CONSISTENCY (TSF)	REMARKS (QA 2/2/92)
	100417 100418 100419 (1-24-92)	No blows on shelby tube	Pushed 3.0 ft Recovery 34 in	Stiff, olive brown, (2.5Y, 4/3) silty clay, some gravel, trace sand, med plasticity, moist	CL	1.5	Hnu - 0 ppm
30							
31	1100						Bb - 40cpm
32							
	100419 100420 100421 1110 (1-24-92)	5	5	med stiff, olive brown (2.5Y, 4/3) sandy silty clay, low to med plast. moist to v. moist.	CL	.75	Hnu - 0 ppm
33		6	0	NR.			
		10	0	NR.			Bb - 40cpm
34		15	0	N.R			
				Sampling ends a ~~34.5 ft~~ 34.5 ft J.L 1-24-92			
35				Drilling Ends at 35.0 ft.			

NOTES See page 1
100422 - Full HSL
100423 - Trip Blank
100424 - Total U Wenco
100425 - Total U Th. II

FERNALD RI/FS



DRAWING NUMBER	
CHECKED BY	
APPROVED BY	
J. Lear 1-28-92	
DRAWN BY	

NOTES:

1. RISER PIPE IS 4.0 IN I.D. 316 Stainless Steel ~~SCHEDULE~~ PIPE, THREADED, FLUSH-JOINTED.
2. SCREEN IS 4.0 IN I.D SS PIPE CONTINUOUS SLOT SCREEN (0.010 IN SLOT SIZE).
3. LOWER END OF SCREEN IS CAPPED.
4. ELEVATION OF WATER LEVEL No water encountered
5. WATER LEVEL READING ON NA (Dry well)

6 bags of 10x 20 sand

4 buckets (5 gal) bentonite

2 bags Volday grout

200 gals H_2O used while Drilling

INSTALLATION DETAILS
MONITORING WELL
1679
PREPARED FOR
Fernald RI/FS

001101

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